NSW GOVERNMENT

Transport for NSW

Beaches Link and Gore Hill Freeway Connection

Appendix F

Traffic and transport

DECEMBER 2020

Transport for NSW

Beaches Link and Gore Hill Freeway Connection

Technical working paper: Traffic and transport

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Prepared for

Transport for NSW

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Contents

Glossary of terms and acronyms

Term/acronym	Definition
AADT	Annual Average Daily Traffic. The total volume of traffic (24 hours) passing a roadside observation point over a one-year period, divided by the number of days per year. It is typically calculated from mechanically obtained axle counts
AM peak hour	Unless otherwise stated, this refers to vehicle trips arriving at their destination during the average peak hour in the morning peak period between 7am and 9am on a normal working weekday
At-grade	An intersection where all permitted movements occur at the same level and no movements are grade separated
B-Line	A high frequency limited stops bus service between Mona Vale and Wynyard
Bus lane	A traffic lane for priority use by buses, but which can also be used by taxis, bicycles and motorcycles
Capacity	The nominal maximum number of vehicles which has a reasonable expectation of passing over a given section of a lane or roadway in one direction during a given time period under prevailing roadway conditions
Carriageway	The portion of a roadway used by vehicles including shoulders and ancillary lanes
CBD	Central Business District
CD	Chart Datum is the zero reference point from which tidal heights and chart soundings are calculated
Construction	Includes all physical works required to construct the project
Corridor	A substantial segment of the transport network, in which parallel, possibly competing, transport routes (and modes, where appropriate) operate between two locations
Cul-de-sac	A street or road that is open for vehicular traffic at one end only
Cumulative impacts	Impacts that, when considered together, have different and/or more substantial impacts than a single impact assessed on its own
Degree of saturation	The ratio of traffic volumes at an intersection or road, compared to its overall capacity
Detour	An alternative route, using existing roads, made available to traffic
Divided road	A road with a separate carriageway for each direction of travel created by placing a physical separation (eg median) between the opposing traffic directions
'Do minimum'	An operational model scenario that does not incorporate the proposed project infrastructure
'Do something'	An operational model scenario that incorporates the proposed project infrastructure
DPIE	NSW Department of Planning, Industry and Environment
EEC	Eastern Economic Corridor. Greater Sydney Commission's new name for the Global Economic Corridor. The EEC extends from Macquarie Park to Sydney Airport
EIS	Environmental impact statement

Term/acronym	Definition
EPA	NSW Environment Protection Authority
Footpath	A paved area dedicated for pedestrian use
Footprint	The extent of the impact that a development (in plan-view) makes on an area
Gore Hill Freeway Connection	Component of the project which includes the connection and integration works along the existing Gore Hill Freeway at Artarmon
Grade separation	The separation of a road, rail or other transport modes, so that crossing movements at intersections are at different levels
Heavy vehicles	A heavy vehicle is classified as a Class 3 vehicle (a two axle truck) or larger, in accordance with the Austroads Vehicle Classification System
hr	Hour
IDM	Intersection diagnostic monitor
Impact	Influence or effect exerted by a project or other activity on the natural, built and community environment
IMT	Immersed tube tunnel
Interchange	An intersection of two or more roads that typically uses grade separation, and one or more ramps, to permit traffic on at least one carriageway to pass through the junction without directly interfacing with any other traffic stream
Local road	A road or street used primarily for access to abutting properties
LoS	Level of Service
LU	Land use
M4-M5 Link	A component of the WestConnex program of works
Median	The central reservation which divides a carriageway for traffic travelling in opposite directions
Midblock	A general location on a road between two intersections
Mode	A type or method of transport movement
Motorway	Fast, high capacity, access controlled roads that primarily link regional hubs and cities usually with grade separated interchanges and without traffic signals. May be tolled or untolled
NSW	New South Wales
Off ramp	A ramp by which one exits a limited access highway/tunnel
On ramp	A ramp by which one enters a limited access highway/tunnel
OOHW	Out-of-hours work
PCU	Passenger car unit (equivalent)
PM peak hour	Unless otherwise stated, this refers to vehicle trips arriving at their destination during the average peak hour in the evening peak period between 4pm and 6pm on a normal working weekday
Portal	The entry and/or exit to a tunnel
Project	Beaches Link and Gore Hill Freeway Connection project (subject to this environmental impact statement)

Term/acronym	Definition
Public transport	Includes metro, train, bus, ferry and light rail
Roads and Maritime	NSW Roads and Maritime Services (formerly NSW Roads and Traffic Authority (RTA), now part of Transport for NSW)
Roundabout	An intersection where all traffic travels in one direction clockwise around a central island
RTA	NSW Roads and Traffic Authority (now part of Transport for New South Wales)
sec	Seconds
SCATS	Sydney Coordinated Adaptive Traffic System
Screenline	Theoretical boundaries specifically designed to collectively analyse directional and two-way traffic volumes
Shoulder	The portion of the carriageway beyond the traffic lanes adjacent to and flush with the surface of the pavement
SMPM	Sydney Motorway Project Model
SSI	State significant infrastructure
STM	The Sydney Strategic Travel Model
Strategic road network	The higher-order roads in the network that primarily serve a movement function connecting cities, ports, airports and other places of importance. The strategic road network is usually comprised of motorways and arterial roads generally used for long-distance travel
TPA	Transport for New South Wales' Transport Performance and Analytics division
Transport for NSW	Transport for New South Wales
Unreleased traffic	Traffic demand that goes unserved during the peak period
veh	vehicles
VHT	Vehicle hours travelled
VKT	Vehicle kilometres travelled
V/C	Volume to capacity ratio
Warringah Freeway Upgrade	Part of the Western Harbour Tunnel and Warringah Freeway Upgrade project - upgrade of the Warringah Freeway beginning immediately north of the Sydney Harbour Bridge through to Willoughby Road, Crows Nest
WestConnex	A program of works that includes the M4 Widening, King Georges Road Interchange Upgrade, M4 East, M8 and M4-M5 Link projects
Western Harbour Tunnel	Part of the Western Harbour Tunnel and Warringah Freeway Upgrade project, tunnel between the Rozelle interchange, Rozelle and the Warringah Freeway, North Sydney

Executive summary

The Western Harbour Tunnel and Beaches Link program of works is a NSW Government initiative to provide additional road network capacity across Sydney Harbour and to improve connectivity with Sydney's Northern Beaches. The Beaches Link and Gore Hill Freeway Connection project (the project) includes a new tolled motorway tunnel connection from the Warringah Freeway to Balgowlah and Frenchs Forest, and upgrade and integration works to connect to the Gore Hill Freeway.

Transport for NSW is seeking approval under Part 5, Division 5.2 of the *Environmental Planning and Assessment Act 1979* to construct and operate the project, which would comprise two main components:

- Twin motorway tunnels connecting the Warringah Freeway at Cammeray and the Gore Hill Freeway at Artarmon to the Burnt Bridge Creek Deviation at Balgowlah and Wakehurst Parkway at Killarney Heights, and an upgrade of Wakehurst Parkway (the Beaches Link)
- Connection and integration works along the existing Gore Hill Freeway at Artarmon (the Gore Hill Freeway Connection).

Key features of the project are discussed in Section 1.4. A detailed description of the project is provided in Chapter 5 (Project description) of the environmental impact statement.

This technical working paper is one of a number of technical documents that forms part of the environmental impact statement for the project. The purpose of this technical paper is to identify and assess the potential impacts of the project during both construction and operation in relation to traffic and transport. In doing so, this paper responds directly to the Secretary's environmental assessment requirements (SEARs), which are outlined in Section 1.7.

Overall assessment approach

The following methodology has been carried out to assess the impact of the project on the traffic and transport network by:

- Identifying the strategic planning context of the project
- Documenting the traffic modelling approach adopted to forecast future travel demand and traffic volumes for the project and surrounding road network, and to assess construction and operational impacts
- Detailing the existing traffic and transport environment and describing the operational performance of the road network in terms of network performance, intersection performance, travel times and crash history
- Assessing the traffic and transport impacts of construction of the project on road network performance, maritime traffic, public transport, and on pedestrian and cyclists
- Assessing the future operational performance of the transport network with and without the project
- Assessing the cumulative impacts on the transport network including the operation of the Western Harbour Tunnel
- Identifying key management measures to mitigate the identified traffic and transport impacts of the project.

Construction

Traffic and transport impacts

Warringah Freeway and surrounds

The assessment of construction activity impacts on the road network around the Warringah Freeway indicates that the performance of the transport network would not materially change, and that the temporary impacts would be manageable. Most intersections would operate at the same Level of Service with construction compared to the base scenario. The Warringah Freeway/Falcon Street interchange and the Brook Street/Merrenburn Avenue intersection that currently operate at capacity during peak periods would continue to operate at a satisfactory Level of Service during construction activities. Midblock volumes on Ernest Street, Falcon Street, Miller Street and Brook Street would increase. However, this would be a minor change when compared to pre-construction conditions.

Gore Hill Freeway and Artarmon

The assessment of construction activity impacts on the road network around the Gore Hill Freeway and Artarmon area indicates that the road network may experience some localised impacts during construction, however in most locations it would still operate at a satisfactory Level of Service during peak periods. The Gore Hill Freeway/Reserve Road interchange currently operates close to capacity during peak periods and would continue to operate poorly during construction activities. In addition, midblock volumes on Reserve Road north of Frederick Street would increase during construction. However, this would be a relatively small increase when compared to pre-construction conditions. Temporary short-term road closures would be required on sections of the road network, while Lambs Road between Punch Street and Cleg Street would be closed to traffic throughout construction. A number of parking spaces would also be removed within Artarmon, resulting in a small net decrease in on-street parking spaces.

Balgowlah and surrounds

The assessment of construction activity impacts on the road network around Balgowlah indicates that the road network may experience localised impacts during construction, however in most locations it would still operate at a satisfactory Level of Service during peak periods. The Manly Road/Sydney Road/Burnt Bridge Creek Deviation intersection would approach capacity during construction as a result of increased construction traffic to and from the Balgowlah Golf Course construction support site (BL10). Direct access to the Balgowlah golf Course construction support site (BL10) from Burnt Bridge Creek Deviation would be provided, which would reduce the traffic impact anticipated at the intersection. In addition, Spit Road and Manly Road would carry higher traffic volumes during construction.

Frenchs Forest and surrounds

The assessment of construction activity impacts on the road network around Frenchs Forest indicates that the road network would perform marginally worse during construction, however in most locations it would operate at a satisfactory Level of Service during peak periods. The Wakehurst Parkway/Warringah Road intersection would approach capacity during construction activities due to the increased demands generated by construction vehicles. Midblock volumes on Wakehurst Parkway north of Judith Street would increase during construction; this increase would be small when compared to pre-construction conditions. Kirkwood Street would be temporarily closed to general traffic during construction, removing direct access to Wakehurst Parkway and affecting access to properties in the surrounding area. Given the multiple alternative roads available nearby, impacts would be minor and manageable.

Public transport impacts

Minor adjustments would be required to some bus stops along Pacific Highway in Artarmon and Sydney Road in Balgowlah, and along Wakehurst Parkway in Seaforth, Killarney Heights and Frenchs Forest. Some potential short-term adjustments to bus priority infrastructure on Burnt Bridge Creek Deviation in Balgowlah may also be required, resulting in a minor increase in bus travel times. Overall public transport impacts would be manageable.

Active transport impacts

The assessment of construction activity impacts on the active transport network indicates that residual impacts would be moderate and manageable. Identified impacts include:

- Temporary adjustment of the Flat Rock Reserve shared user paths

- Reinstatement of the eastern footpath on Hampden Road
- Temporary adjustment of the marked on-road cycle route on Hampden Road
- Temporary adjustment of the southern footpath on Punch Street
- Temporary adjustment of the shared user path along Gore Hill Freeway between Reserve Road and Station Street
- Temporary adjustment of paths around Spit West Reserve
- Permanent adjustment of the shared user path adjacent to Burnt Bridge Creek Deviation
- Temporary adjustment of some of the mountain bike tracks on either side of Wakehurst Parkway
- Temporary adjustment of the shared user path on Wakehurst Parkway near Warringah Road.

Maritime impacts

The assessment of impacts of construction activities on the maritime network in the Outer Sydney Harbour indicates that impacts would be minimal due to infrequent marine construction vessel movements and wide navigation waterway widths.

The impact on navigation in Middle Harbour would be more substantial due to the existing constrained environment. Some exclusion zones and several temporary and short-term closures of Middle Harbour would be required which would impact on recreational marine traffic. Several 24 – 48 hour partial and full closures of Middle Harbour would be required for the immersion of the six immersed tube tunnel units and would occur on weekdays. Extensive community consultation would be carried out to notify users of the scheduled closures and exclusion zones.

Marine works are likely to interfere and require alteration of training routes for Mosman Rowing Club and sailing courses for Northbridge Sailing Club. These clubs would be consulted prior to construction and notified of the proposed works.

A large number of swing moorings would also need to be temporarily located elsewhere in Middle Harbour. This would be carried out in consultation with the lease holder(s). The location of the cofferdam at Seaforth would prevent access to three private marina berths. Temporary berths would be provided in nearby marinas in Middle Harbour.

Cumulative construction impacts

The cumulative construction impacts resulting from the project and other construction projects, including Western Harbour Tunnel, WestConnex M4-M5 Link, and Sydney Metro City and Southwest, have been assessed. The results of the assessment indicate that road network performance in North Sydney would marginally deteriorate under the cumulative construction scenarios during peak periods due to increased construction traffic movements in these areas, with impacts considered manageable.

Management of construction impacts

The implementation of appropriate environmental management measures in addition to ongoing consultation with potentially affected stakeholders would assist in avoiding or mitigating potential impacts on the traffic and transport network during the construction of the project. Safeguards and management measures relevant to the traffic and transport impacts of the project are identified in Section 9 of this report. Key environmental management measures that will be required to mitigate the construction impacts include:

- Ongoing consultation with (as relevant to the location) Greater Sydney Operations, the Port Authority of NSW, local councils, emergency services and bus operators to minimise traffic and transport impacts during construction
- Notifying the community in advance of proposed transport network changes

- Advising the public of maritime restrictions through appropriate media and other appropriate forms of community liaison such as the project website, letterbox drops, etc.
- Requiring construction vessels to operate in a manner that minimises wash to sensitive areas of shoreline
- Scheduling construction marine traffic activities to avoid times and locations of high recreational marine traffic where feasible and reasonable and maintain designated travel paths for recreational marine traffic through the works areas
- Minimising movements of construction road traffic during peak periods, where feasible and reasonable
- Managing vehicle access to and from construction sites to ensure pedestrian, cyclist and motorist safety. Depending on the location, this may require manual supervision, physical barriers, temporary traffic signals and modifications to existing signals and, on occasions, police presence
- Using directional signage and line marking to direct and guide drivers, cyclists and pedestrians past construction sites and on the surrounding network. This would be supplemented by variable message signs to advise drivers of potential delays, traffic diversions, speed restrictions, or alternative routes
- Scheduling existing network modifications and closures during non-peak periods, where feasible and reasonable.

Operation

Key benefits

The project would substantially increase accessibility for the Northern Beaches to nearby strategic centres such as Chatswood, St Leonards, North Sydney, Macquarie Park and the Sydney Central Business District (CBD).

Public transport customers would benefit substantially from the project. Existing services would benefit from reduced traffic demand on key arterial bus corridors including Warringah Road, Eastern Valley Way, Spit Road and Military Road. The project itself would enable the operation of express buses that would provide direct access between major centres on the Northern Beaches and Frenchs Forest and those in the lower North Shore, Sydney CBD, the north west and beyond.

The key traffic and transport benefits of the project include:

- Travel time savings and reliability benefits for users of the project, as well as for users of existing key corridors which would benefit from reduced traffic demand including Military Road, Spit Road, Warringah Road, and Eastern Valley Way
- Improved connections to North Sydney and Sydney CBD and new connections to St Leonards and Macquarie Park via the Gore Hill Freeway Connection
- Better access to jobs and businesses, with direct access to the new Northern Beaches Hospital at Frenchs Forest, and better access to businesses on the Northern Beaches from Greater Sydney
- Substantial improvements in road safety, with reduced traffic demand along key road transport corridors, resulting in a 77 per cent forecast reduction in crashes for vehicles redirected to Beaches Link (equating to a reduction of around 560 crashes per year)
- Major reduction of heavy vehicle traffic on the Spit Road and Military Road corridor by up to 74 per cent
- Additional capacity for outbound traffic crossing Sydney Harbour and leaving the lower North Shore, relieving existing corridors including Military Road and Eastern Valley Way. This is illustrated by substantial improvements in terms of average network speeds and the number of vehicle stops during evening peak periods
- Average travel speeds through the Balgowlah and surrounds study area would increase by up to 72 per cent in the morning peak and 40 per cent in the evening peak. The number of vehicle stops would reduce substantially by up to 57 per cent in the morning peak and 27 per cent in the evening peak

- Greater network resilience due to the provision of new road capacity and connectivity, and reduced rat-run traffic and congestion on existing surface roads including Miller Street (Cammeray), Brook Street (Naremburn), Eastern Valley Way (Northbridge), Frenchs Forest Road (Seaforth) and the Ourimbah Road corridor.

Key public and active transport benefits would include:

- New opportunities for public transport by providing the opportunity to operate express buses along the project to Sydney CBD and North Sydney (and beyond), with the potential for direct interchange to other modes at North Sydney and St Leonards with Sydney Metro and Sydney Trains
- Improved travel times and reliability for buses travelling along existing key corridors including Warringah Road, Eastern Valley Way and Military Road
- Pedestrian and cycling facilities would improve the overall active transport network with upgraded infrastructure providing increased connectivity and enhanced safety.

Traffic and transport impacts

The substantial additional travel that would be facilitated by the project would also increase localised traffic demands at either ends of the project where it would be integrated with the existing transport network. At some locations there would be some residual delay at these interface precincts. In such cases localised delays at these precincts would be offset by the strategic travel time benefits provided by the project at the broader network level.

Integration works have been developed to minimise the impact of changes to travel patterns created by the project and ensure that the competing needs of transport customers (including public transport passengers, cyclists and pedestrians) have been incorporated into a balanced, equitable outcome.

Key traffic and transport impacts that may arise as a result of the operation of the project include:

- Changes to access in and around North Sydney would streamline movements around North Sydney CBD but would adjust access for some residents and businesses in the area. Impacts would be minimised by ensuring all properties have reasonable alternative routes to maintain their access
- Southbound travel times along the Warringah Freeway to the Cahill Expressway would increase during the busiest morning peak periods. This is due to increased inbound demand on the Sydney Harbour Bridge, in the absence of the capacity and connectivity upgrades to be provided by the Western Harbour Tunnel.

Key adverse impacts on public and active transport would include some instances of localised increases to bus travel times through the North Sydney CBD area

Management of operational impacts

The implementation of appropriate environmental management measures, in addition to ongoing consultation with potentially affected stakeholders, would assist in avoiding or mitigating potential impacts on the traffic and transport network within the study area during the operation of the project, while maximising project benefits.

Safeguards and management measures relevant to the traffic and transport impacts of the project are identified in Section 9 of this report and include a review of operational network performance 12 months and then five years from the opening of the project to confirm the operational impacts of the project on the surrounding transport network. The assessment would be based on updated traffic data at the time and the methodology used would be comparable with that used in this assessment.

1. Introduction

This section provides an overview of the Beaches Link and Gore Hill Freeway Connection project (the project) including its key features and location. It also outlines the Secretary's environmental assessment requirements addressed in this technical working paper.

1.1 Overview

The Greater Sydney Commission's *Greater Sydney Region Plan – A Metropolis of Three Cities* (Greater Sydney Commission, 2018) proposes a vision of three cities where most residents have convenient and easy access to jobs, education and health facilities and services. In addition to this plan, and to accommodate for Sydney's future growth the NSW Government is implementing the *Future Transport Strategy 2056* (Transport for NSW, 2018), that sets the 40 year vision, directions and outcomes framework for customer mobility in NSW. The Western Harbour Tunnel and Beaches Link program of works is proposed to provide additional road network capacity across Sydney Harbour and Middle Harbour and to improve transport connectivity with Sydney's Northern Beaches. The Western Harbour Tunnel and Beaches Link program of works include:

- The Western Harbour Tunnel and Warringah Freeway Upgrade project which comprises a new tolled motorway tunnel connection across Sydney Harbour, and an upgrade of the Warringah Freeway to integrate the new motorway infrastructure with the existing road network and to connect to the Beaches Link and Gore Hill Freeway Connection project
- The Beaches Link and Gore Hill Freeway Connection project which comprises a new tolled motorway tunnel connection across Middle Harbour from the Warringah Freeway and the Gore Hill Freeway to Balgowlah and Killarney Heights and including the surface upgrade of the Wakehurst Parkway from Seaforth to Frenchs Forest and upgrade and integration works to connect to the Gore Hill Freeway at Artarmon.

A combined delivery of the Western Harbour Tunnel and Beaches Link program of works would unlock a range of benefits for freight, public transport and private vehicle users. It would support faster travel times for journeys between the Northern Beaches and areas south, west and north-west of Sydney Harbour. Delivering the program of works would also improve the resilience of the motorway network, given that each project provides an alternative to heavily congested existing harbour crossings.

1.2 The project

Transport for NSW is seeking approval under Part 5, Division 5.2 of the *Environmental Planning and Assessment Act 1979* to construct and operate the Beaches Link and Gore Hill Freeway Connection project, which would comprise two components:

- Twin tolled motorway tunnels connecting the Warringah Freeway at Cammeray and the Gore Hill Freeway at Artarmon to the Burnt Bridge Creek Deviation at Balgowlah and the Wakehurst Parkway at Killarney Heights, and an upgrade of the Wakehurst Parkway (the Beaches Link)
- Connection and integration works along the existing Gore Hill Freeway and surrounding roads at Artarmon (the Gore Hill Freeway Connection).

A detailed description of these two components is provided in Section 1.4.

1.3 Project location

The project would be located within the North Sydney, Willoughby, Mosman and Northern Beaches local government areas, connecting Cammeray in the south with Killarney Heights, Frenchs Forest and Balgowlah in the north. The project would also connect to both the Gore Hill Freeway and Reserve Road in Artarmon in the west.

Commencing at the Warringah Freeway at Cammeray, the mainline tunnels would pass under Naremburn and Northbridge, then cross Middle Harbour between Northbridge and Seaforth. The mainline tunnels would then split under Seaforth into two ramp tunnels and continue north to the Wakehurst Parkway at Killarney Heights and north-east to Balgowlah, linking directly to the Burnt Bridge Creek Deviation to the south of the existing Kitchener Street bridge.

The mainline tunnels would also have on and off ramps from under Northbridge connecting to the Gore Hill Freeway and Reserve Road east of the existing Lane Cove Tunnel. Surface works would also be carried out at the Gore Hill Freeway in Artarmon, Burnt Bridge Creek Deviation at Balgowlah and along the Wakehurst Parkway between Seaforth and Frenchs Forest to connect the project to the existing arterial and local road networks.

1.4 Key features of the project

Key features of the Beaches Link component of the project are shown in Figure 1-1 and would include:

- Twin mainline tunnels about 5.6 kilometres long and each accommodating three lanes of traffic in each direction, together with entry and exit ramp tunnels to connections at the surface. The crossing of Middle Harbour between Northbridge and Seaforth would involve three lane, twin immersed tube tunnels
- Connection to the stub tunnels constructed at Cammeray as part of the Western Harbour Tunnel and Warringah Freeway Upgrade project
- Twin two lane ramp tunnels:
  - Eastbound and westbound connections between the mainline tunnel under Seaforth and the surface at the Burnt Bridge Creek Deviation, Balgowlah (about 1.2 kilometres in length)
  - Northbound and southbound connections between the mainline tunnel under Seaforth and the surface at the Wakehurst Parkway, Killarney Heights (about 2.8 kilometres in length)
  - Eastbound and westbound connections between the mainline tunnel under Northbridge and the surface at the Gore Hill Freeway and Reserve Road, Artarmon (about 2.1 kilometres in length)
- An access road connection at Balgowlah between the Burnt Bridge Creek Deviation and Sydney Road including the modification of the intersection at Maretimo Street and Sydney Road, Balgowlah
- Upgrade and integration works along the Wakehurst Parkway, at Seaforth, Killarney Heights and Frenchs Forest, through to Frenchs Forest Road East
- New open space and recreation facilities at Balgowlah
- New and upgraded pedestrian and cyclist infrastructure
- Ventilation outlets and motorway facilities at the Warringah Freeway in Cammeray, the Gore Hill Freeway in Artarmon, the Burnt Bridge Creek Deviation in Balgowlah and the Wakehurst Parkway in Killarney Heights
- Operational facilities, including a motorway control centre at the Gore Hill Freeway in Artarmon, and tunnel support facilities at the Gore Hill Freeway in Artarmon and the Wakehurst Parkway in Frenchs Forest
- Other operational infrastructure including groundwater and tunnel drainage management and treatment systems, surface drainage, signage, tolling infrastructure, fire and life safety systems, roadside furniture, lighting, emergency evacuation and emergency smoke extraction infrastructure, Closed Circuit Television (CCTV) and other traffic management systems.

Key features of the Gore Hill Freeway Connection component of the project are shown in Figure 1-2 and would include:

- Upgrade and reconfiguration of the Gore Hill Freeway between the T1 North Shore & Western Line and T9 Northern Line and the Pacific Highway
- Modifications to the Reserve Road and Hampden Road bridges
- Widening of Reserve Road between the Gore Hill Freeway and Dickson Avenue
- Modification of the Dickson Avenue and Reserve Road intersection to allow for the Beaches Link off ramp
- Upgrades to existing roads around the Gore Hill Freeway to integrate the project with the surrounding road network
- Upgrade of the Dickson Avenue and Pacific Highway intersection

- New and upgraded pedestrian and cyclist infrastructure
- Other operational infrastructure, including surface drainage and utility infrastructure, signage and lighting, CCTV and other traffic management systems.

A detailed description of the project is provided in Chapter 5 (Project description) of the environmental impact statement.

Subject to obtaining planning approval, construction of the project is anticipated to commence in 2023 and is expected to take around five to six years to complete.

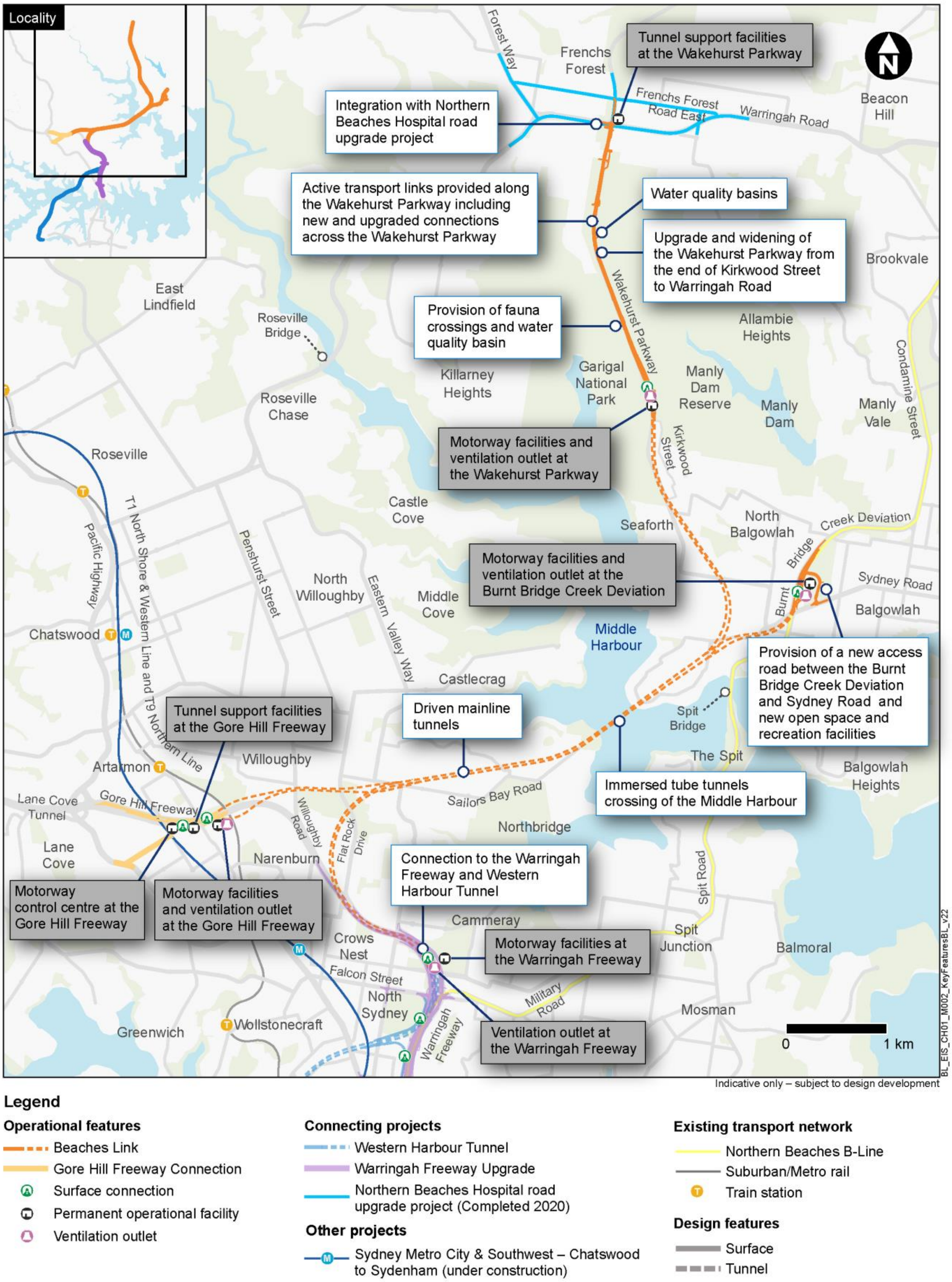


Figure 1-1 Key features of the Beaches Link component of the project

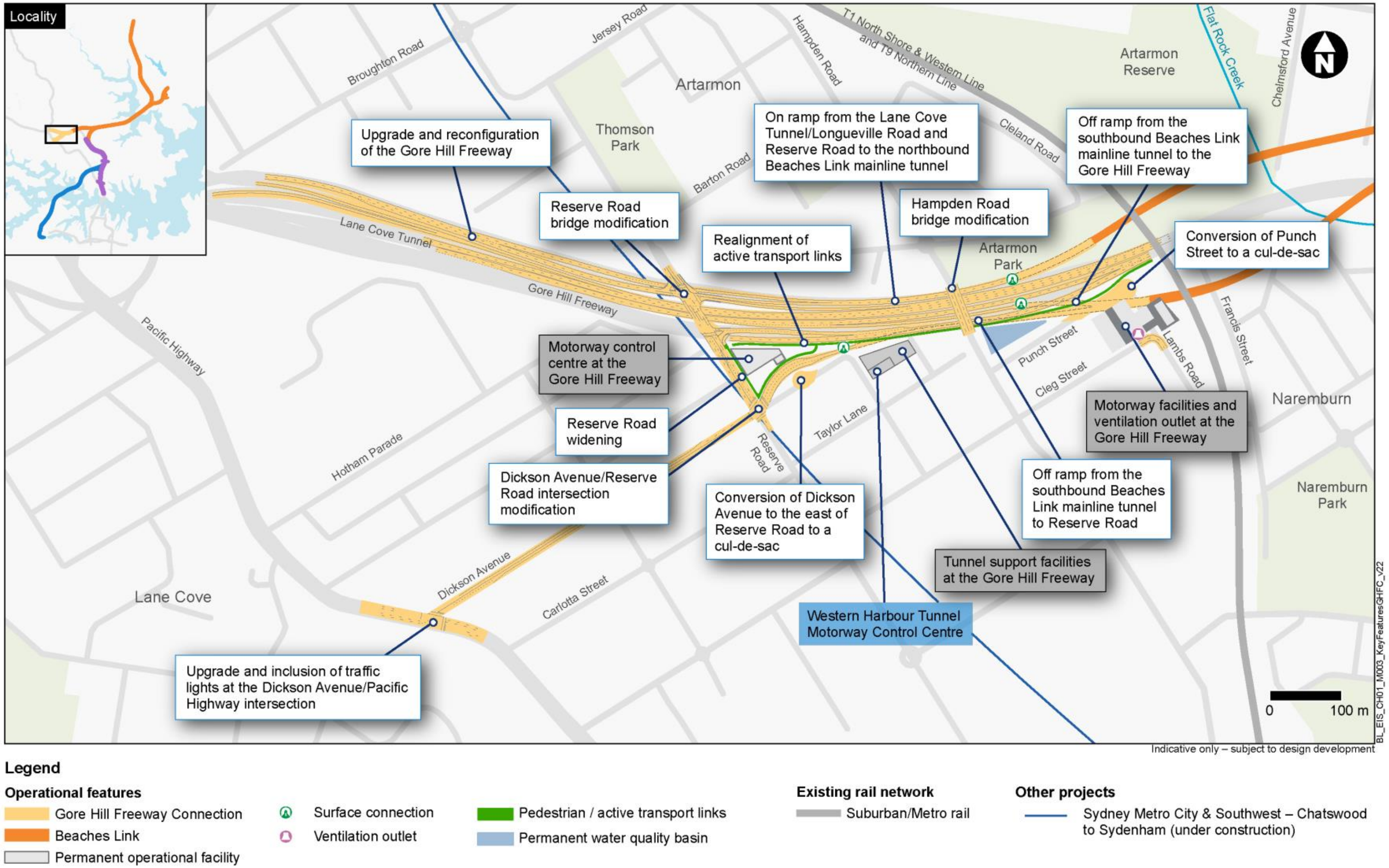


Figure 1-2 Key features of the Gore Hill Freeway component of the project

1.5 Key construction activities

The area required to construct the project is referred to as the construction footprint. The majority of the construction footprint would be located underground within the mainline and ramp tunnels. However, surface areas would also be required to support tunnelling activities and to construct the tunnel connections, tunnel portals, surface road upgrades and operational facilities.

Key construction activities would include:

- Early works and site establishment, with typical activities being property acquisition and condition surveys, utilities installation, protection, adjustments and relocations, installation of site fencing, environmental controls (including noise attenuation and erosion and sediment control), traffic management controls, vegetation clearing, earthworks, demolition of structures, building construction support sites including acoustic sheds and associated access decline acoustic enclosures (where required), construction of minor access roads and the provision of property access, temporary relocation of pedestrian and cycle paths and bus stops, temporary relocation of swing moorings and/or provision of alternative facilities (mooring or marina berth) within Middle Harbour
- Construction of the Beaches Link, with typical activities being excavation of tunnel construction access declines, construction of driven tunnels, cut and cover and trough structures, construction of surface upgrade works, construction of cofferdams, dredging and immersed tube tunnel piled support activities in preparation for the installation of immersed tube tunnels, casting and installation of immersed tube tunnels and civil finishing and tunnel fitout
- Construction of operational facilities comprising:
  - A motorway control centre at the Gore Hill Freeway in Artarmon
  - Tunnel support facilities at the Gore Hill Freeway in Artarmon and at the Wakehurst Parkway in Frenchs Forest
  - Motorway facilities and ventilation outlets at the Warringah Freeway in Cammeray (fitout only of the Beaches Link ventilation outlet at the Warringah Freeway (being constructed by the Western Harbour Tunnel and Warringah Freeway Upgrade project), the Gore Hill Freeway in Artarmon, the Burnt Bridge Creek Deviation in Balgowlah and the Wakehurst Parkway in Killarney Heights
  - A wastewater treatment plant at the Gore Hill Freeway in Artarmon
  - Installation of motorway tolling infrastructure
- Staged construction of the Gore Hill Freeway Connection at Artarmon and upgrade and integration works at Balgowlah and along the Wakehurst Parkway with typical activities being earthworks, bridgeworks, construction of retaining walls, stormwater drainage, pavement works and linemarking and the installation of roadside furniture, lighting, signage and noise barriers
- Testing of plant and equipment and commissioning of the project, backfill of access declines, removal of construction support sites, landscaping and rehabilitation of disturbed areas and removal of environmental and traffic controls.

Temporary construction support sites would be required as part of the project (refer to Figure 1-3), and would include tunnelling and tunnel support sites, civil surface sites, cofferdams, mooring sites, wharf and berthing facilities, laydown areas, parking and workforce amenities. Construction support sites would include:

- Cammeray Golf Course (BL1)
- Flat Rock Drive (BL2)
- Punch Street (BL3)
- Dickson Avenue (BL4)
- Barton Road (BL5)
- Gore Hill Freeway median (BL6)
- Middle Harbour south cofferdam (BL7)
- Middle Harbour north cofferdam (BL8)
- Spit West Reserve (BL9)
- Balgowlah Golf Course (BL10)

- Kitchener Street (BL11)
- Wakehurst Parkway south (BL12)
- Wakehurst Parkway east (BL13)
- Wakehurst Parkway north (BL14).

A detailed description of construction works for the project is provided in Chapter 6 (Construction work) of the environmental impact statement.

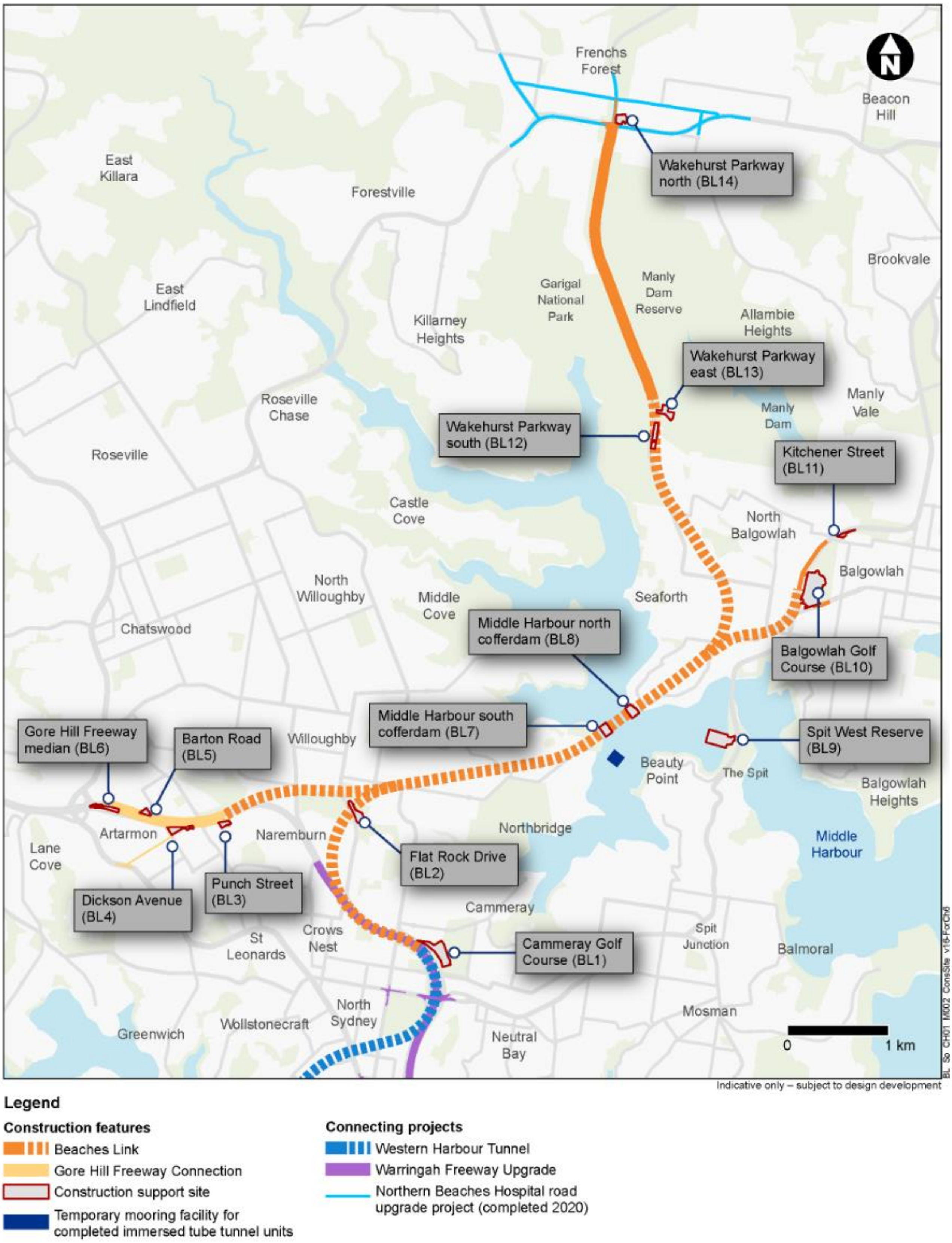


Figure 1-3 Overview of the construction support sites

1.6 Purpose of this report

This report has been prepared to support the environmental impact statement for the project and to address the environmental assessment requirements of the Secretary of the Department of Planning, Industry and Environment (DPIE) (formerly Department of Planning and Environment) ('the Secretary's environmental assessment requirements').

This report includes:

- A review of the existing transport network, including a description of transport infrastructure in the study area, traffic volumes and patterns, public transport service provision, mode share, and a review of the pedestrian and cycle networks
- Assessment of the operational performance of the existing road network in terms of network performance, intersection performance, travel times and crash history
- Assessment of construction traffic impacts, including the impact of construction-related vehicles travelling on roads providing access to construction facilities and sites
- Assessment of the future operational performance of the road network without the project
- Assessment of the future operational performance of the transport network with the project in operation
- Assessment of cumulative impacts on the transport network
- A suite of measures proposed to mitigate and manage the identified traffic and transport impacts of the project during construction and operation.

1.7 Secretary's environmental assessment requirements

The Secretary's environmental assessment requirements relating to traffic and transport, and where these requirements are addressed in this report are outlined in Table 1-1.

Table 1-1 Secretary's environmental assessment requirements - Traffic and transport

Secretary's environmental assessment requirements	Where addressed
The Proponent must assess construction transport and traffic (vehicle, marine, pedestrian and cyclists) impacts, including, but not necessarily limited to:	
a. a considered approach to route identification and scheduling of marine and land transport movements, particularly outside standard construction hours;	Sections 5.1, 5.2, 5.3, 5.4, 5.5 and 5.6 Chapter 6 (Construction work) of the EIS
b. the number, frequency and size of construction related vehicles (passenger, marine commercial and heavy vehicles, including spoil management movements);	Sections 5.1, 5.2, 5.3, 5.4, 5.5 and 5.6 Appendix A Chapter 6 (Construction work) of the EIS
c. construction worker parking;	Sections 5.2.4, 5.3.4, 5.4.4 and 5.5.4 Chapter 6 (Construction work) of the EIS
d. the nature of existing traffic (types and number of movements) on construction access routes (including consideration of peak traffic times and sensitive road users and parking arrangements;	Section 4

Secretary's environmental assessment requirements	Where addressed
e. access constraints and impacts on public transport, pedestrians and cyclists;	Sections 5.2.4, 5.3.4, 5.4.4, 5.5.4, 5.6.1 and 5.6.2
f. how construction of the project affects the capacity of, and the need to close, divert or otherwise reconfigure elements of, the road, cycle and pedestrian network;	Sections 5.2.4, 5.3.4, 5.4.4, 5.5.4 and 5.6.2
g. details of how construction and scheduling of works are to be coordinated in regard to public events and cumulative traffic impacts resulting from concurrent work on the project and other major projects, under or preparing for or commencing construction in the vicinity of the proposal;	Sections 5.6.4 and 5.7
h. alternatives to road transport of construction spoil including marine and rail options as well as potential re-use in existing land reclamation areas or in association with Resource Recovery Exceptions (if obtained from the EPA) to minimise traffic impacts on the road network;	Chapter 4 (Project development and alternatives) of the EIS Chapter 24 (Resource use and waste management) of the EIS
i. the likely risks of the project to public safety, paying particular attention to pedestrian safety and users of Middle Harbour; and	Sections 5.6.2 and 5.6.3
j. impacts on water based traffic on Middle Harbour.	Sections 5.6.3
The Proponent must assess and model the operational transport impacts of the project including, but not necessarily limited to:	
a. forecast travel demand and traffic volumes (expressed in terms of total numbers and heavy and light vehicle numbers) for the project and the surrounding road, cycle and public transport network, including potential shifts of traffic movements on alternate routes outside the proposal area (such as toll avoidance) and impact of permanent street closures directly attributable to the SSI;	Sections 7 and 8 Section 7.2.4 and 8.2.4 outline tolling scenarios and implications for the 'Do something' and 'Do something cumulative' scenarios respectively.
b. accessibility impacts in commercial centres within the vicinity of the project;	Sections 7.4.4, 7.5.4, 7.6.4, 7.7.4, 8.4.4, 8.5.4, 8.6.4 and 8.7.4
c. travel time analysis;	Sections 7.2.1, 7.4.2, 7.4.5, 7.5.2, 7.5.5, 7.6.2, 7.6.5, 7.7.2, 7.7.5, 8.2.1, 8.4.2, 8.4.5, 8.5.2, 8.5.5, 8.6.2, 8.6.5, 8.7.2 and 8.7.5
d. performance of key interchanges and intersections by undertaking a level of service analysis at key locations;	Section 7.4.3, 7.5.3, 7.6.3, 7.7.3, 8.4.3, 8.5.3, 8.6.3 and 8.7.3
e. wider transport interactions (local and regional roads, cycling, public and freight transport);	Sections 7.2 and 8.2
f. induced traffic and operational implications for existing and proposed public transport (particularly with respect to strategic bus corridors and bus routes and permanent closure/relocation of bus stops) and consideration of opportunities to improve public transport;	Sections 7.4.5, 7.5.5, 7.6.5, 7.7.5, 8.4.5, 8.5.5, 8.6.5 and 8.7.5

Secretary's environmental assessment requirements	Where addressed
g. impacts on cyclists and pedestrian access and safety;	Sections 7.4.6, 7.5.6, 7.6.6, 7.7.6, 8.4.6, 8.5.6, 8.6.6 and 8.7.6
h. property and business access and on street parking; and	Sections 7.4.4, 7.5.4, 7.6.4, 7.7.4, 8.4.4, 8.5.4, 8.6.4 and 8.7.4
i. an explanation for the scope of the modelled area, including justification of the nominated boundaries.	Section 3

1.8 Structure of this report

The remainder of this report is structured as follows:

- Section 2 summarises the strategic planning context of the project
- Section 3 documents the traffic modelling approach adopted to forecast future travel demand and traffic volumes for the project and surrounding road network, and to assess construction and operational impacts
- Section 4 details the existing traffic and transport environment and describes the operational performance of the existing road network in terms of network performance, intersection performance, travel times and crash history
- Section 5 addresses the traffic and transport impacts of construction of the project
- Section 6 describes the future operational performance of the road network without the project
- Section 7 describes the future operational performance of the transport network with only the project in operation (excluding Western Harbour Tunnel)
- Section 8 describes the future cumulative operational performance of the transport network with both the project and the full Western Harbour Tunnel and Warringah Freeway Upgrade project in operation
- Section 9 documents environmental management measures that are proposed to mitigate the identified traffic and transport impacts of the project.

2. Strategic transport and planning context

This section summarises the strategic transport and planning context of the project.

2.1 Alignment with transport policies and plans

The project addresses broader NSW Government objectives set in the *Premier's Priorities* (NSW Department of Premier and Cabinet, 2017) and supports, or is recognised in, strategic plans including:

- *State Infrastructure Strategy 2018-2038* (Infrastructure NSW, 2018)
- *A Metropolis of Three Cities – the Greater Sydney Region Plan* (Greater Sydney Commission, 2018)
- *Future Transport Strategy 2056* (NSW Government, 2018)
- NSW Freight and Ports Plan 2018-2023 (Transport for NSW, 2018a).

These strategies, together with other transport mode specific strategies, are detailed below.

2.1.1 State Infrastructure Strategy 2018-2038

The State Infrastructure Strategy is a 20-year strategy that identifies and prioritises the delivery of critical public infrastructure to drive productivity and economic growth. Infrastructure NSW's assessment of the state's existing infrastructure highlighted critical deficiencies in Sydney's road capacity. The State Infrastructure Strategy identifies strategic infrastructure options to meet the challenges of growth in travel demand and substantial increases in freight volumes.

Specifically, the State Infrastructure Strategy identifies Beaches Link as a near-term priority for the Sydney Motorway Network as it would improve the resilience of the road network and extend the network to major growth areas and connect key freight precincts. The project would primarily benefit the eastern parts of the lower North Shore and Northern Beaches, providing an alternative to bypass the Military Road/Spit Road corridor and Spit Bridge and Warringah Road/Roseville Bridge. In conjunction with the M6 Motorway (Stage 1) (previously referred to as F6 Extension (Stage 1)), these projects would provide connection to areas that were expanded over the last four decades, where substantial congestion has built up over time. The project has also been identified in Infrastructure NSW's *Infrastructure Pipeline* as an investment opportunity that would alleviate congestion on the Spit Bridge and Roseville Bridge, increase growth in strategic centres and improve connectivity for road and public transport to the wider metropolitan area.

The State Infrastructure Strategy also recognises the importance of smart motorway technology and digital infrastructure, which, subject to the completion of business cases, is proposed to be deployed across the network in time for the expected opening of the Beaches Link.

2.1.2 A Metropolis of Three Cities – the Greater Sydney Region Plan

A Metropolis of Three Cities – the Greater Sydney Region Plan (Greater Sydney Region Plan) establishes a 40-year strategic land use plan for Sydney, based on a metropolis of three cities (Eastern Harbour City, Central River City and Western Parkland City).

The project supports the following objectives identified in the plan:

- Infrastructure supports the three cities – the project would improve mobility across the Eastern Harbour City and, in conjunction with WestConnex, improve accessibility to the Central River City and the Western Parkland City
- Infrastructure aligns with forecast growth – the project would serve natural growth in demand from Sydney's growing population and economy
- Integrated land use and transport creates walkable and '30-minute cities' (see Section 2.1.3) – the project, in conjunction with Western Harbour Tunnel and Warringah Freeway Upgrade and WestConnex, and as part

of a multi-modal transport solution, would increase the number of people and places that are able to be reached within 30 minutes

- The Eastern Economic Corridor (EEC)[1] is better connected and more competitive – the project would provide critical land transport network capacity through the core of the EEC, connecting with international gateways and their surrounds
- Freight and logistics network is competitive and efficient – the project would improve network efficiency and deliver travel time savings, improving the efficiency of freight movement and reducing freight operational costs.

2.1.3 Future Transport Strategy 2056

The *Future Transport Strategy 2056* is a 40-year strategy for mobility for Sydney and regional NSW. It sets out a vision, strategic directions and customer outcomes with a focus on technology and innovation across the transport system to transform the customer experience, improve communities and boost economic performance.

A key element of the *Future Transport Strategy 2056* is the vision of a '30-minute city'. The 30-minute city is a guiding principle that provides people with access to education, jobs and services within 30 minutes of travel by public and active transport, regardless of where they live. This means people can reach their nearest metropolitan and strategic centres within 30 minutes, seven days a week. The project, as part of a multi-modal transport solution, would increase the number of people and places that are able to be reached within 30 minutes.

The *Future Transport Strategy 2056* identifies the project as a committed initiative in the zero to 10-year horizon. The project fulfils the strategic vision presented for the future strategic road network for Greater Sydney by supporting key movements by road for public transport, private vehicles and freight. The project would also create opportunities for the operation of express buses between Balgowlah and Frenchs Forest, and Sydney CBD (via the Warringah Freeway), increasing the size of 30-minute catchments to strategic centres for public transport as well as for private vehicles.

2.1.4 NSW Freight and Ports Plan 2018-2023

The *NSW Freight and Ports Plan 2018-2023* supports the *Future Transport Strategy 2056* and provides direction to business and industry for managing and investing in freight into the future. It reinforces the importance of freight and ports in NSW to the national economy and ensures the state's freight and port system needs are well positioned to respond to emerging national and international markets and opportunities. It is estimated that freight contributes about $66 billion to the NSW economy, with freight volume expected to increase by almost 50 per cent over the next 20 years in Greater Sydney.

The project supports the following objectives identified in the plan:

- Efficiency, access and connectivity – the project would improve network efficiency and reduce travel times for long distance trips. This would improve the efficiency of freight movement, resulting in reduced freight operational costs
- Capacity – in conjunction with the proposed Western Harbour Tunnel and WestConnex, the project would provide increased north-south road capacity between the Northern Beaches, and central and southern Sydney
- Sustainability – the provision of an alternative Harbour crossing would reduce travel time and vehicle hours travelled and would lead to reductions in greenhouse gas emissions.

[1] The Eastern Economic Corridor is the Greater Sydney Commission's new name for the Global Economic Corridor. The EEC extends from Macquarie Park to Sydney Airport.

2.1.5 Transport mode specific strategies

North Sydney Integrated Transport Program

The *North Sydney Integrated Transport Program* is a multi-agency coloboration between Transport for NSW, North Sydney Council, Greater Sydney Commission and Government Architect of NSW to guide future integrated transport planning and investment in the North Sydney CBD and interconnected areas over the next 20 years and beyond. Led by Transport for NSW since 2018, it aims to deliver a shared place-based vision for the North Sydney CBD.

The *North Sydney Integrated Transport Program* is being developed to support and facilitate the outcomes envisaged by the *Greater Sydney Region Plan* and the *Future Transport Strategy 2056*. The timing for deliverables in the *North Sydney Integrated Transport Program* would be cognisant of the Western Harbour Tunnel and Beaches Link program of works delivery timeframes.

Realising opportunities presented by land use development and transport infrastructure requires balanced and integrated solutions to service customer needs and manage the potential impacts of increasing travel demand to, from and within North Sydney. The *North Sydney Integrated Transport Program* would address the strategic multi-modal changes required to enable the precinct to grow and support its role as part of the Eastern Harbour City. It is framed by the desired growth and physical constraints of the North Sydney CBD, which underlines that future success of the precinct is dependent on improved transport infrastructure and efficient operations for all transport modes.

The *North Sydney Integrated Transport Program* considers strategic public transport connections to the North Sydney CBD, land use and public domain objectives, improved pedestrian amenity and safety, road network changes, improved access for cyclists to and through the CBD, convenient interchanges between bus and rail services, management of kerbside access to support business activity across the day, and place outcomes within the CBD. As such, a key focus of the *North Sydney Integrated Transport Program* is to ensure major projects, such as the Western Harbour Tunnel and Beaches Link program, integrate with the North Sydney CBD in a manner that supports the globally connected 'Harbour CBD' and enables delivery of befitting place-based outcomes.

The Beaches Link presents an opportunity to improve travel times and consequent patronage on peak express bus services by re-directing bus services from the Northern Beaches through the new motorway to North Sydney and the Sydney CBD. It also provides an opportunity to consider new express services that could use the Beaches Link to provide more direct public transport access between strategic centres across the region connecting directly with Sydney Trains and Sydney Metro services at North Sydney, reducing reliance on private vehicle travel.

The development of the *North Sydney Integrated Transport Program* is ongoing, with validation of the vision for North Sydney currently underway with a number of scenarios being considered to support the place-based outcomes. As part of the collaboration, the multi-agency group will ensure the future integrated transport network and place-based vision for North Sydney is supported through projects such as the Beaches Link and Gore Hill Freeway Connection project. Further refinements to movement and place outcomes within the North Sydney CBD may occur as part of the *North Sydney Integrated Transport Program*.

To minimise the impact of the Western Harbour Tunnel and Beaches Link program of works on the North Sydney CBD, program planning and design to date has been developed to:

- Continue to provide motorway access only via existing major road corridors
- Focus on the utilisation of existing road space to maintain network efficiency and balance the needs of all road users while minimising road widenings
- Ensure operational impacts are minimised (and critical performance issues avoided), by spreading the demand generated by new infrastructure across multiple locations

- Provide network efficiencies and safer outcomes by simplifying network operations, prioritising strategic movements and minimising conflicts
- Adopt ‘movement and place’ principles to help reprioritise access and support efficient connections for traffic, pedestrians and other transport customers.

The proposed program of works would result in a resilient network which can accommodate key road transport customers, while at the same time promoting walking, cycling and public transport access to and within the North Sydney CBD. If road transport demand is lower or demands otherwise differ as land use and transport developments mature, this approach also provides flexibility to adjust the future transport network in response to customer needs.

Transport for NSW will continue to work with North Sydney Council and key stakeholders through agreed governance structures to investigate options to improve movement and place outcomes though the *North Sydney Integrated Transport Program*, further leveraging the strategic benefits of the Western Harbour Tunnel and Beaches Link program of works.

Northern Beaches Hospital Precinct Structure Plan

The Northern Beaches Hospital Precinct Structure Plan (Northern Beaches Council, 2017) defines the desired future land uses and consequent multi-modal transport operation and infrastructure requirements to, from and through Frenchs Forest. The plan also acknowledges that a suite of regional transport network upgrades including both public transport and road upgrades would be required to maintain effective transport connections to, from and through Frenchs Forest in the medium to long term.

The project would support the implementation of the plan through supporting medium to long term growth in the area (including a proposed 5360 new dwellings in the next 20 years) by providing a new, safe high-speed road link between the precinct and broader metropolitan Sydney and removing North Sydney and Sydney CBD bound traffic from Warringah Road, therebyfore improving connectivity and accessibility surrounding the Northern Beaches Hospita.

Sydney’s Bus Future

Sydney’s Bus Future (Transport for NSW, 2013a) presents a three-stage approach to improve service outcomes, focusing on improving customer experience, integrating bus services across Sydney and serving future growth.

By reducing network congestion, improving network resilience and increasing reliability in peak periods, the project would make bus routes to and from the Northern Beaches a more attractive transport option, supporting and encouraging a mode shift to public transport. The project would also create the opportunity for new public transport routes to be developed in response to diverse travel demands and future social and economic development. The project provides the opportunity to supplement existing services with express buses using the Beaches Link Tunnel to North Sydney, St Leonards and Sydney CBD, as well as to the north-west to employment areas like Macquarie Park via Gore Hill Freeway and Lane Cove Tunnel. There would also be the opportunity for express bus services using the project to interchange with Sydney Trains and Sydney Metro at North Sydney and Crows Nest.

The Northern Beaches B-Line began operating in November 2017, providing more frequent and reliable services between the Northern Beaches and Sydney CBD. The project would support the continued operation of the B-Line service along with other existing and proposed bus servces by improving travel times and reliability on key routes connecting the Northern Beaches to key centres including Spit Road/Military Road and Warringah Road/Eastern Valley Way. The reduced vehicle congestion on Warringah Road between Frenchs Forest and Roseville would support the possible implementation of a proposed rapid bus service, similar in nature to that of the existing B-Line between Dee Why and Chatswood.

Sydney's Cycling Future

Sydney's Cycling Future (Transport for NSW, 2013b) identifies priority cycleways to improve connections to major centres and assist in reducing congestion for trips of up to five kilometres. The strategy also includes walking and cycling projects linking to public transport interchanges and stops.

The project would include a new dedicated shared user path (including a cycleway) along Wakehurst Parkway between Seaforth/North Balgowlah and Frenchs Forest, including three new underpasses to connect the existing trails of Garigal National Park and Manly Dam Reserve. The new shared user path between Seaforth/North Balgowlah and the developing Northern Beaches Hospital Precinct, would improve connectivity to the new strategic centre. There is a strong community desire to fill a perceived missing link in shared user accessibility in this location. The project would also result in a reduction in congestion on surface roads, which would contribute to improved conditions for cyclists.

Sydney's Walking Future

Sydney's Walking Future (Transport for NSW, 2013c) is the NSW Government's long-term plan to promote walking as an active transport mode throughout Sydney and an integral component in the planning of urban growth precincts and new transport infrastructure. The project would support the objectives of *Sydney's Walking Future* by providing pedestrian facilities to encourage this mode for local trips.

Transport for NSW Walking and Cycling Program

The Walking and Cycling Program 2020-2021 (Transport for NSW, 2019c) supports the walking and cycling outcomes set out in the Future Transport Strategy 2056 (NSW Government, 2018). The key objectives of the 2020/21 Walking and Cycling Program are to:

- Ensure walking and cycling are the most convenient option for short trips to key destinations and within centres
- Reduce congestion on our roads and public transport networks by delivering projects that encourage walking and cycling mode shift
- Enable efficient, safe and reliable journey times by prioritising infrastructure that supports pedestrian or cycling movement on certain corridors, consistent with the Movement and Place Framework
- Deliver projects that make walking and cycling safe, comfortable and convenient transport modes that are accessible to a wide range of users
- Enable positive health, wellbeing, social and environmental outcomes.

Under the Walking and Cycling Program, key stakeholders can apply for funding for active transport projects. The proposed scope of the project would complement other active transport planning being carried out as part of this program

2.2 WestConnex and other major road infrastructure projects

WestConnex is a program of works designed to provide 33 kilometres of motorways, linking Sydney's west, south-west, CBD, Sydney Airport and the Port Botany precinct. The overall scheme comprises a number of components staged over a period of 10 years. The scheme brings together previous proposals for the M4 Motorway and M8 Motorway corridors that have been in development over many years. WestConnex is a major investment in Sydney's road infrastructure that would transform urban travel and reshape the localities through which it passes.

The program of works would complement the multiple components of the WestConnex program of works and related projects including the proposed Sydney Gateway and M6 Motorway (Stage 1). These are described in Table 2-1 and shown in Figure 2-1.

Table 2-1 WestConnex and related projects

Project	Description	Current status (as at early 2020)
WestConnex program of works		
M4 Widening	Widening of the existing M4 Motorway between Pitt Street, Parramatta and Homebush Bay Drive, Homebush.	Opened to traffic in July 2017
M4 East	Extension of the M4 Motorway in tunnels between Homebush and Haberfield via Concord - includes provision for future connection to the M4-M5 Link.	Opened to traffic in July 2019
King Georges Road Interchange upgrade	Upgrade of the King Georges Road Interchange between the M5 South West Motorway and the M5 East Motorway at Beverly Hills, in preparation for the M8 Motorway project.	Opened to traffic in December 2016
M8 Motorway	Duplication of the M5 East from the King Georges Road Interchange at Beverly Hills to a new interchange at St Peters. The St Peters Interchange allows for connections to the proposed future Sydney Gateway project and an underground connection to the M4–M5 Link. The M8 Motorway tunnels also include provision for a future connection to the M6 Stage 1.	Opened to traffic in July 2020
M4-M5 Link	Tunnels connecting to the M4 East at Haberfield and M8 Motorway at St Peters (Stage 1), a new interchange at Rozelle and a link to Victoria Road near Iron Cove Bridge (Stage 2). The Rozelle Interchange includes provision for future connection to Western Harbour Tunnel and Beaches Link.	Under construction. Planned completion early 2023
Related projects		
Sydney Gateway	Provision of a high capacity road link between the St Peters Interchange, Sydney Airport and Port Botany.	Planning approval granted in August 2020
M6 (Stage 1)	Tunnels connecting the M8 Motorway at Arncliffe to President Avenue at Kogarah with provision for future extension south to Loftus and Waterfall.	Planning approval granted in December 2019
Northern Beaches Hospital road upgrade	Grade separation of Warringah Road with Forest Way and Wakehurst Parkway, substantially increasing the capacity of this corridor through Frenchs Forest.	Opened to traffic in August 2020
Mona Vale Road West Upgrade	Upgrade of Mona Vale Road through Ingleside to two lanes in each direction between McCarrs Creek Road and Powder Works Road.	Planning approval granted in November 2017, with construction having commenced in early 2019.

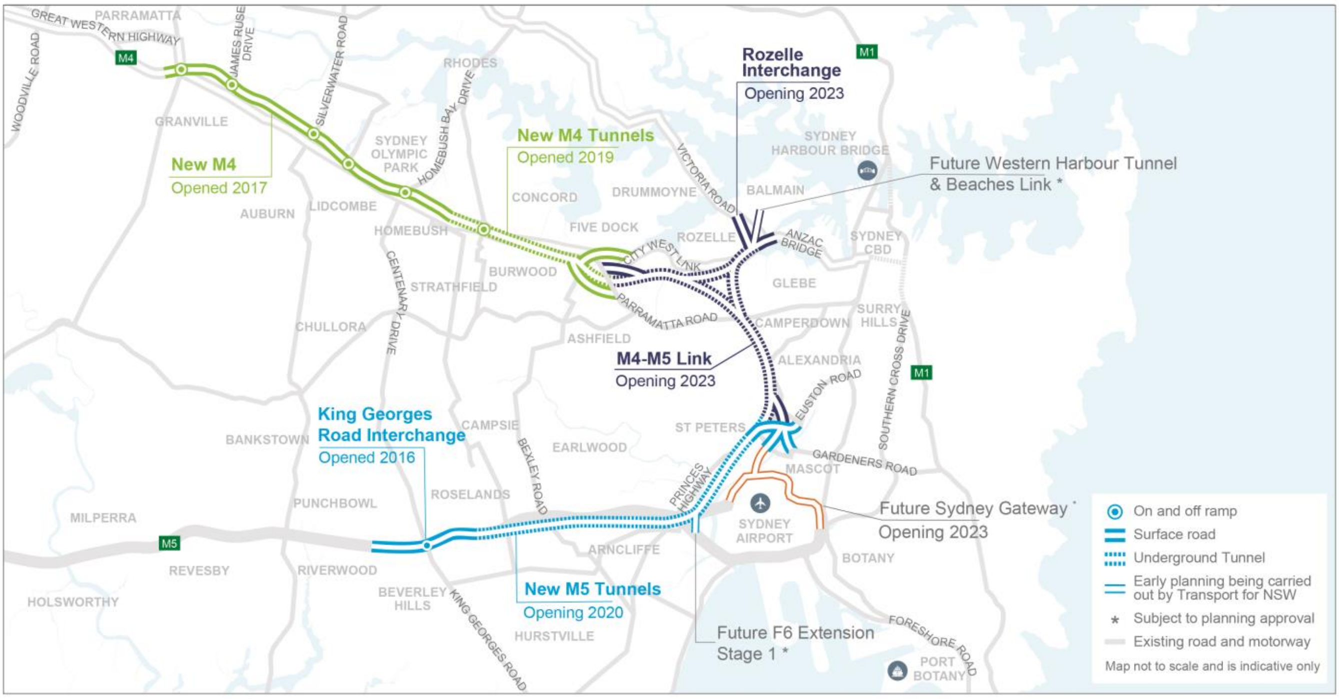


Figure 2-1 WestConnex and related projects

Source: Transurban, 2019

2.3 Northern Beaches B-Line

The Northern Beaches B-Line bus service is a new fleet of modern double-deck buses which provide frequent and reliable services between Mona Vale and Wynyard, stopping at Narrabeen, Warriewood, Collaroy, Dee Why, Brookvale, Manly Vale, Spit Junction and Neutral Bay. It began operating in November 2017.

The following road network changes were also included as part of the B-Line project:

- Conversion of existing T3 transit lanes to bus lanes along Burnt Bridge Creek Deviation (from Condamine Street to Sydney Road) and along Spit and Military Roads (from Spit Junction, Mosman to Watson Street, Neutral Bay)
- Six new commuter car parks at Mona Vale, Warriewood, Narrabeen, Dee Why, Brookvale and Manly Vale
- Supporting road works designed to reduce congestion and improve bus reliability along the corridor.

The reduced vehicle congestion on Warringah Road between Frenchs Forest and Roseville would support the possible implementation of a proposed rapid bus service, similar in nature to that of the existing B-Line, between Dee Why and Chatswood.

The project creates opportunities to increase the coverage of potential future rapid bus services, similar in nature to the existing Northern Beaches B-Line service, to other parts of the Northern Beaches by taking advantage of new connections to North Sydney, St Leonards and Sydney CBD and capitalising on traffic demand reductions along key corridors such as Military Road and Warringah Road to provide more reliable and higher speed and frequency services. Additional express bus services services to take advantage of these opportunities could greatly increase public transport connectivity between the Northern Beaches and other strategic centres such as North Sydney, Artarmon, St Leonards and Macquarie Park.

2.4 Sydney Metro

Sydney Metro is a new standalone rail network identified in *Sydney's Rail Future* (Transport for NSW, 2012). The Sydney Metro network, comprising Sydney Metro Northwest, Sydney Metro City & Southwest, Sydney Metro West and Sydney Metro - Western Sydney Airport would deliver seamless metro services for more than 65 kilometres between Rouse Hill and Bankstown. Sydney Metro would improve reliability across the rail network by addressing current and emerging constraints such as train crowding, platform and station crowding, and network complexity. The metro rail network would be capable of carrying more people, more quickly, delivering a new tier for Sydney's rail network and supporting high demand with a high capacity turn-up-and-go service. The Sydney Metro network is shown in Figure 2-2.

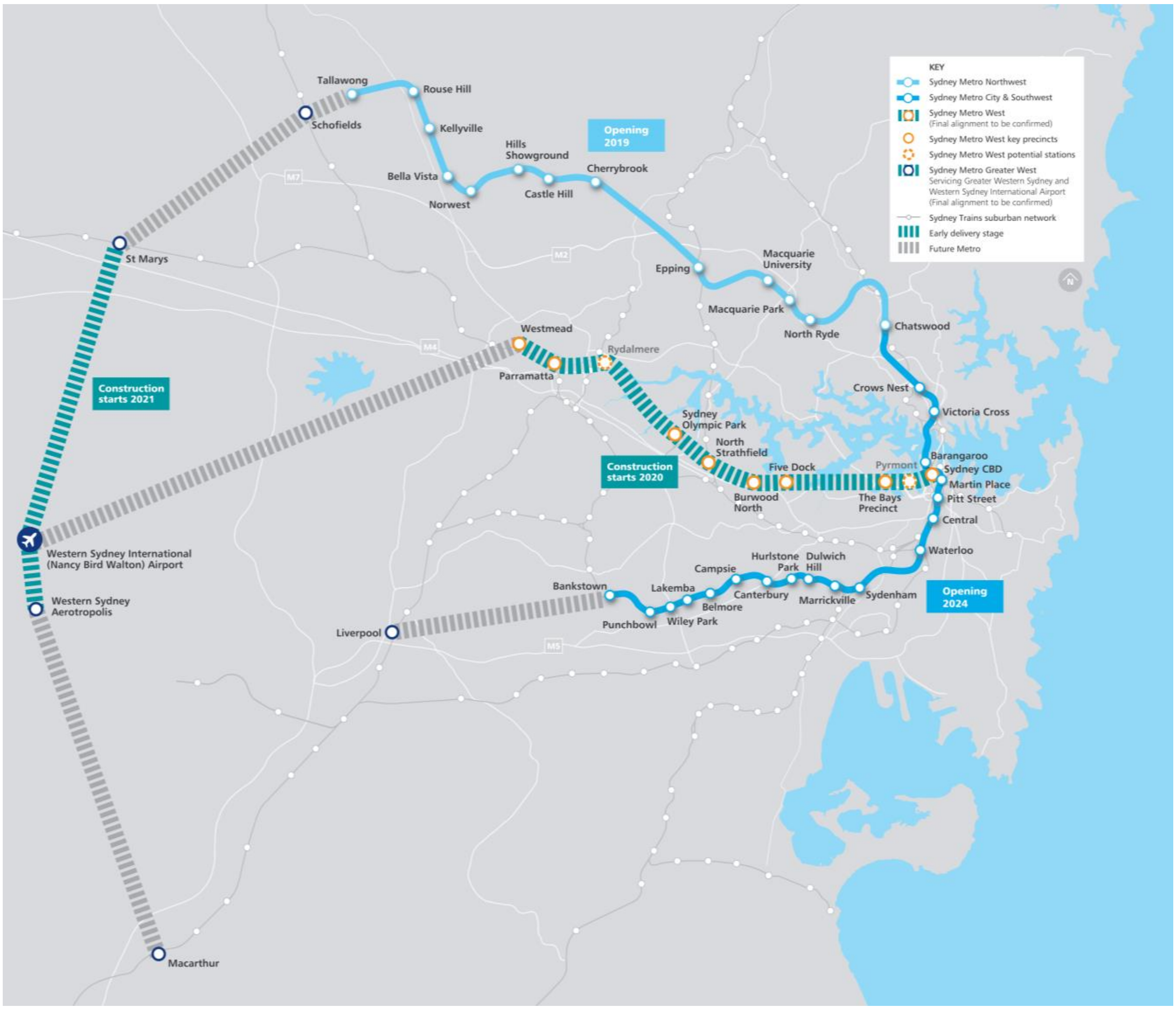


Figure 2-2 The Sydney Metro network

Source: Sydney Metro Corporate Plan 2019-21 (Sydney Metro, 2019)

The Chatswood to Sydenham component of Sydney Metro City & Southwest involves construction and operation of a 15.5 kilometre metro line from Chatswood, under Sydney Harbour and through the Sydney CBD to Sydenham. This component of Sydney Metro would influence travel patterns within the footprint of the full program of works, particularly around the lower North Shore, with metro stations at Victoria Cross in North Sydney, Crows Nest and Chatswood, as well as multiple locations within the Sydney CBD.

The Sydney Metro network would provide substantial public transport capacity to key corridors from Sydney's northwest, through to the Sydney CBD and Bankstown. By relieving rail capacity constraints crossing Sydney Harbour and opening up Sydney's northwest to rail, its opening in 2024 would substantially increase the capacity of the public transport network to serve trips crossing Sydney Harbour, facilitating a mode shift from private cars to public transport. The design of the project has been carried out with this mode shift in mind to provide opportunities for interchange with Sydney Metro and Sydney Trainsservices at both North Sydney and St Leonards, and facilitate the movement of trips that do not have the option to travel by rail.

2.5 Role and function of key road corridors

There are three key road corridors in the project's area of influence, shown in Figure 2-3. They perform a critical function for travel into and out of the Northern Beaches peninsula.

- Military Road/Spit Road corridor – this is the main route for traffic between the Northern Beaches and the wider Sydney metropolitan area. Military Road and Spit Road form a major bus corridor for services linking the Northern Beaches and the wider Sydney metropolitan area
- Warringah Road corridor – this is the main route for access between the major centres of Brookvale, Dee Why and Frenchs Forest (the location of the new Northern Beaches Hospital and hospital development precinct) and Chatswood. It is also used as a secondary route between the Northern Beaches and Sydney CBD via Eastern Valley Way. This corridor has been upgraded as part of the Northern Beaches Hospital road upgrade, which provides a grade separation of Warringah Road with Forest Way and Warringah Road with Wakehurst Parkway. It has substantially increased the capacity of this corridor through Frenchs Forest
- Mona Vale Road corridor – this is the secondary route for vehicles travelling between the Northern Beaches and the upper North Shore, connecting Mona Vale with St Ives and Gordon. Mona Vale Road is used as a key route for heavy vehicles travelling between the M1 Pacific Motorway and the Northern Beaches. Transport for NSW is currently developing an upgrade of Mona Vale Road through Ingleside to two lanes in each direction between McCarrs Creek Road and Powder Works Road (refer to Section 4.1.1).

These three key corridors carry all traffic travelling into and out of the Northern Beaches, presenting operational challenges for managing traffic flow. This presents medium and long-term challenges for managing ongoing growth in travel demand, both for general traffic and bus services.

Although not a primary route into and out of the Northern Beaches peninsula, Wakehurst Parkway plays an important role in connecting the areas of Seaforth, Frenchs Forest and Narrabeen. North of Frenchs Forest, Wakehurst Parkway is a key connection to Warringah Road and ultimately to the centres of Chatswood and Macquarie Park, while south of Frenchs Forest it provides an alternative route to Pittwater Road.

The Gore Hill Freeway also plays an important role in connecting suburbs within the lower North Shore to areas in north western Sydney via the Lane Cove Tunnel and M2 motorway.

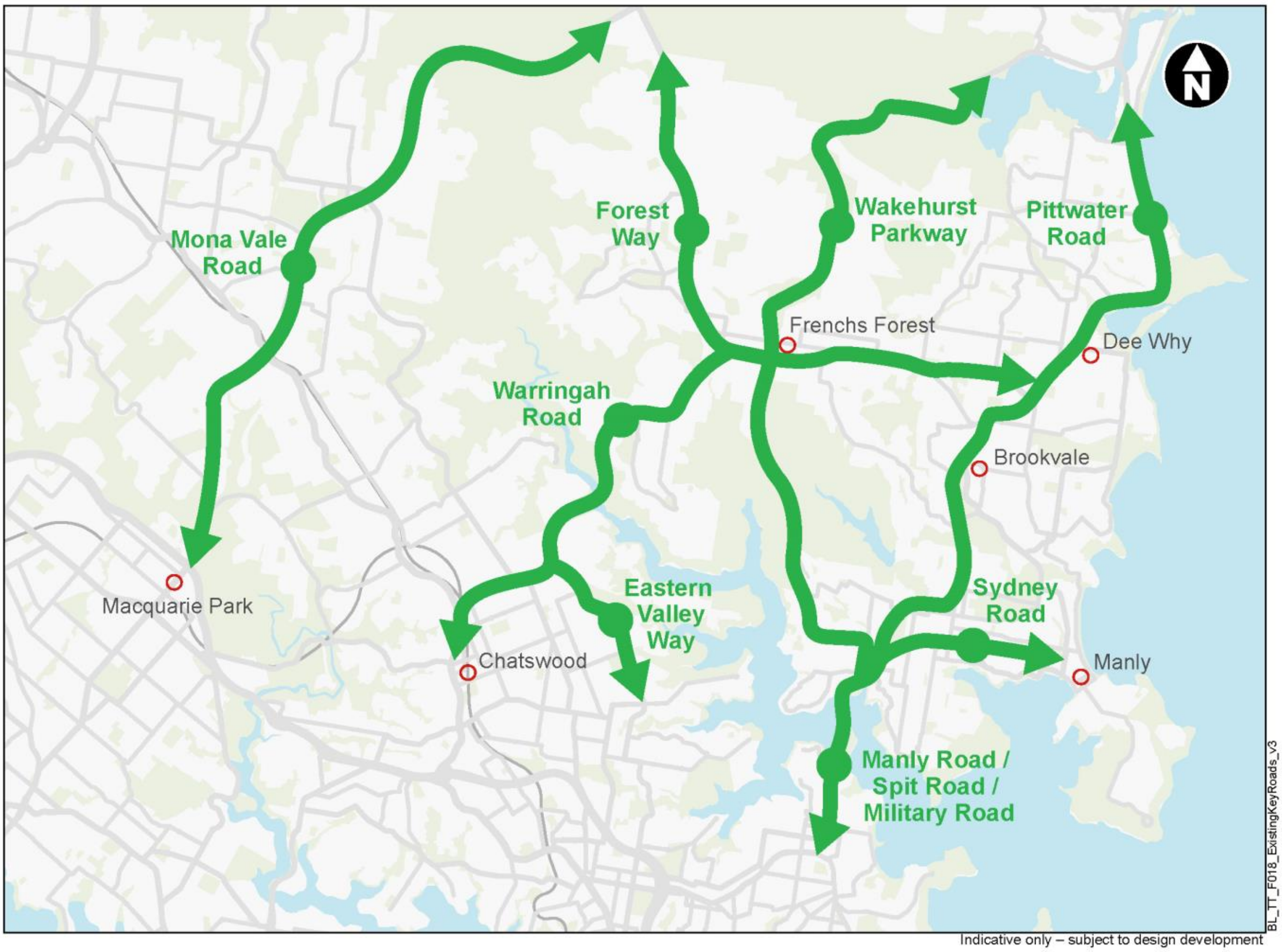


Figure 2-3 Existing key road corridors in the project's area of influence

Source: Jacobs (2018)

2.6 Strategic planning considerations – serving the right customers

By supporting the appropriate customer markets, the project can improve the productivity of the freight and business travel task, improve travel times and increase amenity for centres.

2.6.1 Target customer markets of the project

The emphasis on identifying the project's customers and meeting their needs is consistent with the *Future Transport Strategy 2056*. The outcome of this is that the project would also support customers who are best served by other transport modes rather than compete with them. The identification of customers of the project is supported by best practice nationally and internationally on motorway function and design, which treats motorways as best serving long distance and inter-regional trips connecting to or bypassing major urban centres.

Likewise, the *Future Transport Strategy 2056* states that city-shaping corridors, including motorways:

- Are important for city-to-city and centre-to-centre movement corridors
- Move people and goods over long distances and, along with trunk public transport corridors, provide higher speed and volume connections between cities and centres that shape location decisions of residents and businesses in Greater Sydney
- Will continue to support journeys on trunk routes in Greater Sydney

- Have a particularly important function in supporting road freight travelling in and around Sydney, thereby minimising impacts on amenity and safety on local roads
- Will evolve, moving towards a mass movement function for people and freight, with increased automation to support 'turn up and go' services in high demand areas.

The project, in conjunction with WestConnex and the Western Harbour Tunnel and Warringah Freeway Upgrade project, would serve customer needs that are well suited to road-based travel.

There are seven target customer markets for the project that are defined by trip purpose:

i. Movement of people and goods to and from the EEC, involving dispersed levels of demand across Sydney. This includes longer metropolitan freight trips between freight hubs located on the M2, M4 and M5 corridors and employment lands in the EEC
ii. Heavy freight movements, involving moderately dispersed trips across Sydney to areas of production, consumption, construction, transport and logistics
iii. Light freight movements to highly dispersed locations, including employment lands, major centres, localised centres and specialised precincts, such as the Northern Beaches Hospital Precinct
iv. Commercial service vehicles to highly dispersed locations including major centres, localised centres, specialised centres and households
v. Commercial business vehicles, which tend to be moderately dispersed across major centres, specialised precincts and employment lands
vi. Long distance personal trips to non-centre locations, involving diffuse origins and destinations, where locations are set away from trunk public transport corridors and interchanges
vii. Inter-regional and interstate personal trips, including trips between Sydney and the South Coast (via WestConnex and the M6 Motorway (Stage 1)); North Coast (via the Warringah and Gore Hill Freeways, Lane Cove Tunnel, M2 Motorway and NorthConnex); the Blue Mountains (via WestConnex and the M4 Motorway); and the Southern Highlands, Goulburn and Canberra (via WestConnex and the M5 Motorway).

2.6.2 Non-target customers of the project

The project would complement the function of the wider transport network. There are two non-target customer markets for the project:

- Short distance personal travel to centres that are already highly accessible from the existing motorway network. The alignment has been selected to maximise improvement of travel times between a limited selection of strategic centres with minimal intermediate connections between the start and end of the project
- Long distance freight movements to regional and interstate areas that can be efficiently served by freight rail. These trips have a relatively higher value than personal travel and occur at all times of the day.

While shorter trips and long distance freight are not the direct focus of the project, there would be a substantial reduction in traffic on the current arterial road alternatives as a result of the project, which would reduce delays on these roads and provide a secondary benefit to these customers.

Areas that would benefit from the secondary effects of the project include Naremburn, Northbridge, Willoughby, Castlecrag and Castle Cove. These areas would benefit from reduced through traffic demand using Warringah Road, Eastern Valley Way, Flat Rock Drive and Brook Street to travel to Sydney CBD, as trips currently using these corridors would use the project instead. This would assist in improving the efficiency of local movements between these localities and for those travelling from these areas into and out of the Northern Beaches.

2.7 Strategic need

Sydney's transport network faces complex challenges now and over the next 40 years. Sydney's population is anticipated to grow from five million today to eight million by 2056, which equates to an average of 75,000 additional residents per year. This growth would mean the transport network would need to handle about 28 million trips a day and double the current metropolitan freight volume[2]. As part of a multi-modal network-wide effort to tackle Sydney's transport challenges, major investments in road capacity across Sydney are required to address network underperformance and support Sydney's long-term economic growth.

The solution to Sydney's complex challenges requires the identification of the right strategic investments to provide long-term network capacity consistent with the *Future Transport Strategy 2056*, including modern road infrastructure, freight and passenger rail, and public and active transport. This means that while the project is a critical component in improving road network efficiency across Sydney in the long-term, it is also part of a wider integrated transportation plan that includes public transport and demand management initiatives.

The project would help address Sydney's future transport challenges as follows:

- The project would address major capacity constraints of the road network. It would relieve traffic demand on Warringah Road, Spit and Military Roads, Eastern Valley Way and Mona Vale Road. This would provide opportunities to improve public transport flows across Middle Harbour, which are currently constrained by the existing allocation of road space. In addition, along critical demand corridors leading to the existing Middle Harbour crossings, ageing, narrow or lower-order roads currently perform a traffic function that is better suited to motorway infrastructure. This reduces amenity and results in congestion, increased travel times, decreased travel time reliability and more traffic incidents
- The project (in conjunction with the Western Harbour Tunnel and Warringah Freeway Upgrade project) would facilitate the *Greater Sydney Region Plan*'s goal of delivering a 30-minute city by facilitating greater access to jobs, schools and health care within 30 minutes of people's homes by public transport on the Northern Beaches. While the project would deliver these benefits for existing road transport customers, the project also offers the opportunity for express buses, which would also substantially reduce travel times and increase the 30-minute public transport catchments for key strategic centres and interchange locations such as Sydney CBD, North Sydney, St Leonards , Chatswood and Macquarie Park
- The project would provide critical transport network capacity through the core of the EEC, connecting with international gateways and their surrounds. The EEC is home to many high-value service industries such as finance, insurance, technology, health, education and tourism, and contributed two-thirds of NSW's economic growth in the 2015/16 financial year[3]. The EEC is a major trip generator and economically critical to Sydney and the NSW economy. Even with the NSW Government's investment in major public transport initiatives in the EEC (for example Sydney Metro and the CBD and South East Light Rail), major new road capacity is needed to connect the EEC to markets and customers across Sydney
- The project would serve Sydney's wider, highly diverse freight and business travel task, which involves the distribution of goods and services across Sydney, and which relies on more diverse and dispersed point-to-point transport connections. The project supports this task by improving the reliability of the motorway network to connect employment areas and population centres
- The project would serve natural growth in demand from Sydney's growing population and economy. Population and employment growth are major drivers of transport demand; much of this growth would occur on the motorway network
- The project would better serve the fragmented land use patterns across Sydney by supporting efficient transport connections for trips that are not well served by other transport modes due to uneven or fragmented economic or residential development (for example between the northern and southern extremities of the EEC, away from CBD locations, such as the lower North Shore and Northern Beaches).

[2] Source: *Future Transport Strategy 2056* (NSW Government, 2018)
[3] Source: *North District Plan* (Greater Sydney Commission, 2018)

2.8 Strategic transport benefits

The project is a key component of the NSW Government's road network strategy, providing critical new strategic links within Sydney's existing motorway network. The key strategic transport benefits of the project include:

- Fulfilling the strategic vision for the future strategic road network for Greater Sydney by supporting key movements by road for public transport, private vehicles and freight
- Improving mobility across the Greater Sydney Commission's Eastern Harbour City and, in conjunction with the Western Harbour Tunnel and Warringah Freeway Upgrade project and WestConnex, improving accessibility to the Central River City and the Western Parkland City
- Serving natural growth in demand from Sydney's growing population and economy
- In conjunction with the Western Harbour Tunnel and Warringah Freeway Upgrade project and WestConnex, and as part of a multi-modal transport solution, increasing the number of people and places that are able to be reached within 30 minutes
- Providing critical land transport network capacity through the core of the EEC, connecting with international gateways and their surrounds, improving the efficiency of freight movement, resulting in reduced freight operational costs
- Improving network efficiency and reduce travel times for long-distance trips. This would improve the efficiency of freight movement, resulting in reduced freight operational costs
- Reducing greenhouse emissions through the provision of an alternative Harbour crossing with the resultant travel time savings and reduced vehicle hours travelled
- Reducing congestion within and between the lower North Shore and Northern Beaches, and the impact of traffic on other modes
- Reducing traffic demand on existing arterial routes into and out of the Northern Beaches including Military Road and Spit Road, Warringah Road and Eastern Valley Way
- Increasing reliability for buses along Spit Road and Military Road, Warringah Road and Eastern Valley Way
- Providing the opportunity for express bus services in the Beaches Link Tunnel between the Northern Beaches and Sydney CBD, North Sydney, as well as other strategic centres via the Gore Hill Freeway and Artarmon such as St Leonards and Macquarie Park
- Reducing the likelihood of conflict and competition between different customers on arterial corridors on the lower North Shore and Northern Beaches
- Improving east-west connectivity via a new Middle Harbour crossing and connection to Gore Hill Freeway / Lane Cove Tunnel which would reduce demands on existing east-west corridors including Warringah Road and Gore Hill Freeway to key strategic centres such as St Leonards and Macquarie Park
- Improving connectivity of existing cycle facilities along Wakehurst Parkway by connecting currently fragmented on-road and off-road corridors.

3. Assessment methodology

This section documents the assessment methodology carried out to determine the traffic and transport impacts of the project, including impacts of construction, impacts on operation and the cumulative impacts of the project with other projects being planned and delivered in the vicinity of the project.

3.1 Relevant guidelines and policies

The following guidelines were followed in carrying out this assessment:

- *Guide to Traffic Management – Part 3 Traffic Studies and Analysis* (Austroads, 2013)
- *Traffic Modelling Guidelines* (Roads and Maritime, 2013)
- *Guide to Traffic Generating Developments Version 2.2* (NSW Roads and Traffic Authority (RTA), 2002)
- *Cycling Aspects of Austroads Guides* (Austroads, 2014)
- *NSW Bicycle Guidelines Version 1.2* (RTA, 2005)
- *Planning Guidelines for Walking and Cycling* (Department of Infrastructure, Planning and Natural Resources, 2004)
- NSW Sustainable Design Guidelines Version 4.0 (Transport for NSW, 2017).

3.2 Overall assessment approach

To assess the impact of the project on the traffic and transport network, the following methodology has been carried out to identify and, where appropriate quantify:

- **Impacts on road network performance –** assessed through the use of traffic modelling at both the strategic and operational levels to determine the standard of performance of the road network with and without the project as described in Section 3.3 and Section 3.4
- **Impacts on public transport –** assessed through the use of traffic modelling to determine the quantitative impacts on public transport performance (increase or decrease in travel times) and through analysis of proposed changes to route and stop coverage to determine the qualitative impacts on service accessibility (increase or decrease in number of stops or change in stop coverage) as described in Section 3.4
- **Impacts on parking –** assessed through an analysis of lost parking spaces and availability of comparable alternative parking in nearby locations to determine the qualitative impacts of parking overflow to parking in nearby locations
- **Impacts on pedestrians and cyclists –** assessed through quantitative analysis of pedestrian and cycle demands (number of users at affected locations) and through analysis of proposed changes to shared user paths, cycleways, footpaths and pedestrian crossings to determine the qualitative impacts on pedestrian and bicycle accessibility (access to and availability of pedestrian and cycle infrastructure)
- **Impacts of construction –** assessed through the analysis of construction traffic generation and management plans. This includes quantitative assessment of the performance of the road network through the use of traffic modelling (intersection Level of Service and arterial road capacity) as described in Section 3.5. It also includes analysis of proposed changes to parking, public transport routes, public transport stops, shared user paths, cycleways, footpaths, pedestrian crossings, navigational waters and maritime facilities to determine the qualitative impacts on the road, public transport, pedestrian and bicycle networks, and maritime network (access to and availability of parking, public transport, pedestrian and cycle infrastructure, and maritime infrastructure).

3.3 Transport modelling approach

Transport modelling is a fundamental component of the methodology used to assess the quantitative impacts of the project on the road network. A multi-tiered transport modelling approach was adopted to carry out a comprehensive assessment of the current and future performance of the road network, as described in the following sections.

An overview of the transport modelling methodology used in the assessment of the project is provided in Figure 3-1.

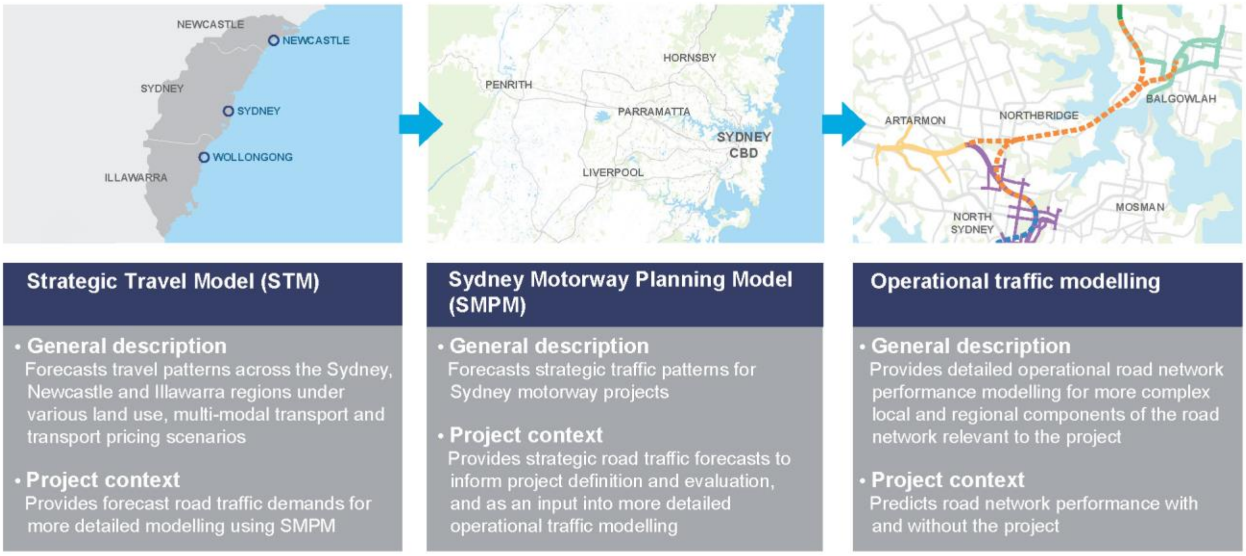


Figure 3-1 Overview of transport modelling approach

3.3.1 Sydney Strategic Travel Model

The Sydney Strategic Travel Model (STM), developed and operated by Transport for NSW, is the primary source for the extraction of region-wide trip patterns and travel demand on the transport network across Sydney, Newcastle and the Illawarra. The STM was used to extract trip matrices for road traffic demand modelling within the Sydney area (using the Sydney Motorway Planning Model (SMPM), described in Section 3.3.2). Future year trip matrices that take into account NSW Government plans and policies, population and employment projections, and transport infrastructure and service operation assumptions were also extracted from the STM.

3.3.2 Sydney Motorway Planning Model

The SMPM, developed and operated by Transport for NSW, provides a platform to understand changes in future traffic patterns under different land use, transport infrastructure and pricing scenarios. Although the SMPM is a network-wide model that encompasses all existing and future road networks in the Sydney metropolitan area, it was principally developed to assess infrastructure improvements associated with the new motorway projects under planning and assessment individually and in combination. The SMPM was used for this environmental impact statement. As traffic models undergo constant development and refinement, it is anticipated that future projects would use further iterations of SMPM as they become available.

Modelling approach

The SMPM was developed as an evolution of previous models and calibrated to current observed travel behaviour, validated against 2014 Sydney-wide conditions from a series of traffic counts and travel time surveys. The model also reflects driver behaviour on Sydney's toll roads as indicated by Value of Travel Time Savings surveys. The model calibration and validation processes maintained a specific focus and refinement on the roads within the project footprints of the Western Harbour Tunnel and Beaches Link program of works, and retained enhancements developed during the course of assessing components of the WestConnex program of works.

Key inputs and assumptions of SMPM used for this assessment include:

- Existing road infrastructure was reviewed for the 2014 base year. A set of future road infrastructure project assumptions for the modelled Sydney metropolitan area was developed and is consistent with current funding and planning policies. These projects formed the basis for the future 'Do minimum' networks modelled in SMPM. The WestConnex and Western Harbour Tunnel and Beaches Link program of works were coded into the SMPM future year scenarios (see Section 3.4.2 for definitions of modelled scenarios)
- The SMPM comprises separate weekday (school day) time period sub-models, with average one-hour peak multi-class traffic assignments run for:
  - AM period: 7am – 9am
  - Daytime inter-peak: 9am – 3pm
  - PM period: 3pm – 6pm
  - Evening off-peak: 6pm – 7am
- Base and future population and employment data for the Sydney metropolitan area was sourced from Transport for NSW Transport Performance and Analytics (TPA), which are available at five-year intervals from the most recent Census year; corresponding traffic demands were sourced from the STM
- Future demands were estimated by applying future year traffic growth forecast by the STM to the SMPM to produce the most likely future base case scenario. Traffic estimates were produced by the SMPM for the years 2021, 2026, 2031 and 2036. The demands for 2027 (assumed year of opening) were then determined by interpolating between the demands from the standard census forecast years of 2026 and 2031. The demands for 2037 (assumed year of opening plus 10 years) were determined by extrapolating the demands from the standard census forecast years of 2031 and 2036 demand matrices. This produced vehicle demands by time period for an average school day at each year and vehicle class for toll assessment
- Traffic demand data contained within this traffic and transport assessment was taken from the SMPM following assessment of the model calibration and validation by independent peer reviewers and agreement that the model is suitable for this purpose.

Data inputs into the SMPM

Available data was initially used as primary inputs for the development of the SMPM including:

- Traffic volume counts for screenlines and project specific counts
- Road travel time data sourced from Google over 2016
- Base 2011 and future year vehicle demand matrices by travel purpose from the STM, sourced from TPA in June 2016
- Population and employment by small zone area provided by TPA consistent with demographics released by NSW Department of Planning and Environment (DP&E) in 2017 (version Land Use (LU)16v1.3)
- Household travel survey data collected by TPA
- Private car driver stated and revealed preference value of travel time survey data collected in early 2013
- Commercial vehicle stated preference value of travel time survey data collected in late 2012
- Aerial photography collected for detailed auditing of road networks
- Recently completed and future infrastructure project lists, including information from other divisions of Transport for NSW. Transport for NSW is delivering and planning the following Sydney Metro projects:

- Sydney Metro Northwest (Rouse Hill to Chatswood) – opened in May 2019, the first stage of Sydney Metro delivered eight new railway stations and 4000 commuter car parking spaces and has been included in the future strategic modelling
- Sydney Metro City & Southwest (Chatswood to Bankstown) – the second stage of Sydney Metro would extend the metro across Sydney Harbour, through the Sydney CBD and to Bankstown. It would deliver seven new railway stations and is currently under construction. It has been included in the future strategic modelling
- Sydney Metro West – the EIS for Sydney Metro West was released for public exhibition between April and June 2020 and is planned to link Parramatta and Sydney CBDs and serve Sydney Olympic Park and The Bays Precinct along the route. At the time this traffic and transport assessment was carried out, Sydney Metro West was at the early stages of development and therefore not included in the future strategic modelling
- Sydney Metro – Western Sydney Airport is currently in the planning phase and will include six new metro stations from St Marys through to the new airport and the Western Sydney Aerotropolis. At the time this traffic and transport assessmemt was carried out, Sydney Metro – Western Sydney Airport was at the early stages of development and therefore not included in the future strategic modelling.

• Existing strategic models and data within the Sydney region.

Structure of the SMPM

The regional SMPM traffic forecasting model process comprises two separate elements: base demand model (based on STM, with updates to incorporate more recent data) and SMPM toll choice assignment model. The role of each element of SMPM and interaction between each element, is outlined in the following subsections.

Base demand model

The base demand model was developed using the STM, with updated information used to produce improved travel demand matrices for detailed toll choice route assignment and project appraisal testing. The base demand model provides the forecast capability to address changes in land use, trip distribution and mode choice and produces vehicle traffic demands for peak and off-peak periods for subsequent allocation to routes in the detailed SMPM toll choice assignment model.

Toll choice assignment model

The SMPM toll choice assignment model was developed to test impacts of toll and infrastructure strategies and provide infrastructure project traffic forecasts. The model is designed to forecast the traffic choosing to use tolled and non-tolled routes for the representative peak and inter-peak periods of the day. The development of the toll choice assignment model included:

- Value of Travel Time Savings survey analysis to investigate people’s willingness to pay tolls to use toll roads based on project specific market research surveys
- Development of improved road traffic demand matrices for the following vehicle classifications:
  - Private vehicles: cars not registered for business use
  - Light commercial vehicles: vehicles up to 4.5 tonnes gross vehicle mass (or under 2.8 metres height/12.5 metres length), including cars registered for business use
  - Heavy commercial vehicles: all vehicles with a gross vehicle mass of more than 4.5 tonnes that have been registered for business use.

To support the development of the SMPM, an investigation was carried out into the various toll choice assignment methods in the Sydney and Australian context. Based on the assessment, it was determined that the SMPM toll choice assignment model should adopt a distributed Value of Time multi-class equilibrium assignment methodology.

The Value of Time multi-class equilibrium assignment methodology approach addresses the functional requirements of the project model with capabilities to consider a range of tolling strategies and scenario tests. This methodology appears to be emerging as an industry standard and has recently been used as the preferred modelling approach for a number of Australian toll roads. The SMPM toll choice assignment model was constructed to model the range of driver behaviour and was adjusted to match the observed patronage on the existing toll facilities. A series of validation checks were carried out to verify the performance of the SMPM.

Land use projections

The SMPM is linked to the STM, which carries out the trip generation, trip distribution and mode choice modules of the traffic forecasting process and incorporates demographic data related to land uses including population, employment and education enrolment projections. For SMPM, this data has been supplied by TPA as data extracts from the STM and is based on the latest population and employment projections based on the latest land use data (version LU16v1.3) provided by TPA. This data has been projected from 2011 Census data and incorporates known major urban renewal projects and developments, including those around Frenchs Forest, North Sydney. As such, the model considers future traffic demand based on inputs from land use projections and demographics to enable existing and future traffic and transport conditions and road network performance to be characterised, both with and without the project. The base vehicle demands from STM are consistent with these demographic assumptions and therefore provide a consistent base for the future demand assumptions used in the SMPM.

Projects and developments included in the SMPM modelling also include the strategic directives contained in the Greater Sydney Region Plan. The SMPM also included planned future port activities and uses, for instance at Port Botany, Sydney Airport freight terminal and intermodal terminals.

Induced demand

Traffic growth on new or upgraded roads is generally a result of the following influences:

- Regional increase in number of trips due to population growth and increased economic activity
- Trips attracted from competing routes or modes as a result of improved travel times on the new or upgraded road
- Induced demand (new trips) as a result of improved travel times between homes and destinations, such as workplaces, shopping centres and education facilities, which cause changes to region-wide trip patterns.

Even with no growth in regional population and economic activity, a new or substantially upgraded road can induce changes in trip patterns, which then appear as induced traffic demand. The SMPM includes the changes in traffic associated with all three of the above sources of traffic, with induced demand equating to about 0.3 per cent additional daily trips in the Sydney metropolitan area in 2037.

SMPM also assumes instantaneous ramp-up of traffic. This assumption means that traffic patterns and volumes following network modifications – for example on project opening – immediately change to a balanced and settled end state, rather than gradually shifting over a period of time.

3.4 Operational modelling approach

3.4.1 Overview

While strategic modelling tools such as the STM and the SMPM can estimate the performance of the road network using assumptions about the relationship between forecast demand and estimated link-based capacity, it is preferable to carry out more detailed operational modelling to provide a more accurate understanding of the forecast performance of the road network. Microsimulation traffic models have the ability to reflect key network features such as traffic signal operations, freeway merging and weaving, and other detailed vehicle interactions based on individual vehicles and movements at specific times on the road network.

Due to the scale and geographical scope of the project, and the complexity and significance of the road network being assessed, operational modelling was carried out in geographical sub-areas using the software package Vissim, as shown in Figure 3-2.

The operational model areas are as follows:

- One tunnel model
  - Beaches Link
- Four surface interface models
  - Warringah Freeway Upgrade
  - Gore Hill Freeway Connection
  - Balgowlah and surrounds
  - Frenchs Forest and surrounds.

The tunnel model was used to assess the future year performance of the proposed road layout within the tunnelled carriageways, including merge and diverge locations and the impact of grades.

The four surface interface models were used to assess the current and future year road network performance, both with and without the project. Also shown in Figure 3-2 are the operational road traffic model areas associated with the Western Harbour Tunnel and Warringah Freeway Upgrade project (Western Harbour Tunnel, and Rozelle and surrounds). For the purposes of assessing the project in isolation, it has been assumed that the Warringah Freeway Upgrade works (planned to be carried out concurrently with the Western Harbour Tunnel project) would need to be completed to allow for the connection of the project to the Warringah Freeway.

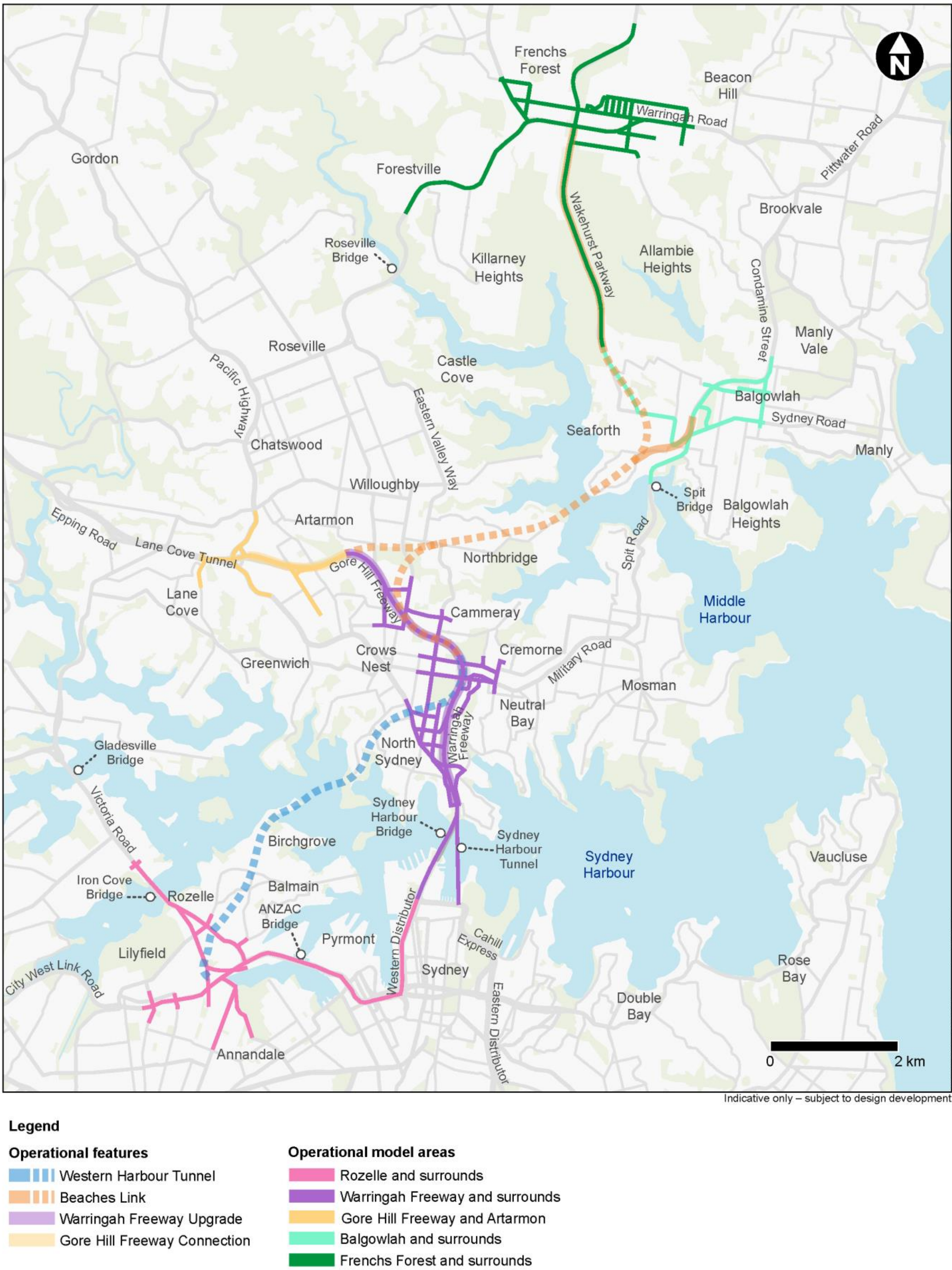


Figure 3-2 Operational road traffic model areas

3.4.2 Modelled scenarios

A summary of the scenarios modelled and assessed is provided in Table 3-1.

The calibrated base scenario reflects existing observed traffic conditions. The 'Do minimum' scenario reflects the business-as-usual road network conditions that would occur if the project was not built. The two project scenarios ('Do something' and 'Do something cumulative') reflect the road network conditions once the project is built, both on its own and in conjunction with other projects that directly and indirectly connect to it. The purpose of modelling each of these scenarios is to determine the changes in traffic flows and performance in each of the precincts surrounding the project network over time, as population and employment increases for each of the proposed network arrangements associated with the project.

Table 3-1 Summary of modelled scenarios

Scenario	Description	2016	2027	2037
Base year	Traffic model scenario used for calibration purposes and quantification of existing network performance	X		
'Do minimum'[1]	Traffic model scenario with approved, under construction and/or recently opened motorway projects (NorthConnex and WestConnex) but without Western Harbour Tunnel and Warringah Freeway Upgrade, Beaches Link and Gore Hill Freeway Connection, Sydney Gateway and M6 Motorway (Stage 1) projects. Also reflects operational effects of approved and under construction major public transport projects (e.g. Sydney Metro City & Southwest and Northern Beaches Hospital road upgrade project).		X	X
'Do something'[1]	Traffic model scenario with NorthConnex, WestConnex, Beaches Link and Gore Hill Freeway Connection and Warringah Freeway Upgrade projects but without Western Harbour Tunnel, Sydney Gateway and M6 Motorway (Stage 1) projects. Also includes Sydney Metro City & Southwest and Northern Beaches Hospital road upgrade project.		X	X
'Do something cumulative'	Traffic model scenario with NorthConnex, WestConnex, Western Harbour Tunnel and Warringah Freeway Upgrade, Beaches Link and Gore Hill Freeway Connection, Sydney Gateway and M6 Motorway projects [2, 3]. Also includes Sydney Metro City & Southwest and Northern Beaches Hospital road upgrade project.		X	X

Note 1: The M6 Motorway (Stage 1) and Sydney Gateway projects were not included in the 'Do minimum' or 'Do something' scenarios as they 6were not approved projects at the time the modelling and analysis assumptions were confirmed. Since the confirmation of these assumptions for this assessment, the M6 Motorway (Stage 1) and Sydney Gateway projects have been approved. Sensitivity testing has shown that these projects would not have a material impact on the Beaches Link and Gore Hill Freeway Connection project 'Do minimum' or 'Do something' traffic assessments; they are included in the 'Do something cumulative' traffic assessment.

Note 2: M6 Motorway (Stage 1) is considered as part of the 2027 'Do something – cumulative' scenario

Note 3 M6 Motorway (full project) is considered as part of the 2037 'Do something – cumulative' scenario

3.4.3 Base year model development

The development of each of the surface interface models involved building calibrated and validated base year models, before producing future year models with and without the project. The approach to the development of the base models is described in Table 3-2.

Table 3-2 Base model development details

Element	Comments
Model specification	• Model periods – extended peak periods modelled, including three to four-hour morning and evening peak periods • Traffic compositions – multi-modal including cars, heavy vehicles, buses (routes and stops) and impacts of pedestrians (at select key crossing locations) • Route choice – dynamic assignment.
Supply assumptions	• Road network definition – lane configurations, lane use management, intersection control, speeds and grades • Traffic signal operations – based on SCATS IDM and LX data.
Demand assumptions	• Traffic demand – developed using collected traffic count data at intersections and mainlines, with strategic model cordon matrices used to establish trip patterns as required.
Road network performance	• Estimated from recorded travel time data for key routes, in conjunction with site observations of traffic conditions.

Each base model was calibrated to ensure a match between modelled and observed traffic demands. This was followed by validation of each model by comparing a secondary set of modelled and observed results – in this case travel times for key traffic routes. Calibration and validation of the base models was carried out to demonstrate accurate representation of the existing road network and to enable a satisfactory level of confidence in the modelling of the future year scenarios with and without the project. Calibration and validation of the base models was carried out in accordance with the *Traffic Modelling Guidelines* (Roads and Maritime, 2013). This approach included assessment of the model calibration and validation by independent peer reviewers and agreement that the model was fit for purpose.

3.4.4 Future year modelling and demand adjustment approach

The growth in SMPM forecasts has been used to grow the demands from the base year to the relevant future year models. While the simulation models are over multiple hour peak periods, the SMPM forecasts typical one-hour peak (morning and evening) volumes. The forecast one-hour volumes were extrapolated across the full simulation periods to reflect typical demand profiles on either side of the peak hours. This profile was based on observed count data across the relevant networks.

SMPM is a demand-based model with limited detail to fully consider the effect of capacity constraints on traffic demand during the peak period. This means that demand forecasts from SMPM can exceed the road network capacity at specific locations.

Operational traffic models include more detail around critical capacity constraints than SMPM, so that when forecast demand growth from SMPM is applied in operational traffic models, they can show that the forecast growth in demand would not all be accommodated on the road network during the peak period. In reality, when the demand for travel exceeds the capacity of the road network, drivers would change their behaviour, often travelling at a different time, by a different route or mode, or not making their trip at all.

The Beaches Link and Gore Hill Freeway Connection project assessment has taken into consideration the observed and theoretical capacities of key network constraints in locations where the SMPM forecasts exceeds capacity to provide a more realistic assessment of the performance of the road network under high forecast demands. At relevant locations, input demand has been adjusted so that it does not substantially exceed nominal capacity.

Traffic demand that is not able to be assigned in the operational models during the peak period is still assumed to exist; however, these trips would be delayed and not completed until after the peak period, effectively increasing the duration of the peak period. This effect is partly quantified by the 'latent' or 'unreleased' demand statistics generated by the operational models.

Modelling using SIDRA software (specialised software package used for intersection analysis), carried out for the construction assessment (see Section 3.5), is not subject to the same limitations in assessing each intersection in isolation. Traffic demands used in the SIDRA assessment of individual intersections have not been adjusted and would not account for downstream constraints, or for the direct interactions of adjacent intersections. As a result, the SIDRA intersection analysis generally reports large delays than the operational models, when in reality these delays would be distributed across all adjacent intersections along the corridor. In both cases, assessment of the impact of construction and operation of the project is based on the relative differences in intersection and network performance, irrespective of differences in the baseline operation reported by the different models.

3.5 Construction modelling approach

The construction modelling methodology involved deriving base year traffic patterns and developing base and future year traffic models, similar to the operational modelling approach. To ensure an accurate representation of existing conditions, further network traffic counts were gathered across the study area in the locations of the proposed construction support sites.

Base year construction models were developed using a combination of Vissim microsimulation and SIDRA intersection modelling. The construction models developed were calibrated in a similar manner to that described above for the operational models.

Future year construction models were developed for two scenarios using SIDRA intersection modelling and Vissim microsimulation modelling:

- 2024 construction – peak tunnelling for the project (SIDRA only)
- 2024 construction – peak construction year for the Western Harbour Tunnel and Beaches Link program of works (Vissim for Warringah Freeway and surrounds only).

In a similar way to the future operational demand volumes, the growth forecast by the SMPM was used to derive background traffic demand for the construction assessment year. This differs from the operational assessment, where the use of microsimulation network models (rather than SIDRA isolated intersection models) accounts for capacity constraints between intersections, as discussed in Section 3.4.4.

Construction traffic was then added to the background traffic. This was based on the proposed construction methodology covering vehicle types, volumes and construction traffic routes to and from the various construction support sites. The performance of intersections in the vicinity of the construction support sites was then assessed.

3.5.1 SIDRA modelling

To forecast the performance of key intersections where construction traffic accesses the arterial road network, intersections along the construction haulage routes between the construction support site and the arterial road network that would experience an increase in construction traffic of more than 50 vehicles per hour were selected to be modelled using SIDRA, as well as intersections that would be modified to accommodate construction activities. Intersections modelled for the construction assessment are outlined in Table 3-3. A qualitative assessment was completed for all other road segments.

Traffic growth of less than 50 vehicles per hour (less than one vehicle per minute) would generally not result in a meaningful change in the Level of Service, and hence assessment has not been carried out for any intersection where construction traffic volumes would increase by less than this threshold.

Table 3-3 Modelled SIDRA intersections during construction

Assessment area	Intersections
Warringah Freeway and surrounds	Warringah Freeway/Falcon Street interchange Warringah Freeway/Ernest Street interchange Ernest Street/Merlin Street Ernest Street/Miller Street Warringah Freeway/Miller Street interchange Warringah Freeway/Brook Street interchange Brook Street/Merrenburn Avenue Flat Rock Drive/Beaches Link construction support site access
Gore Hill Freeway and Artarmon	Gore Hill Freeway/Reserve Road interchange Reserve Road/Dickson Avenue Reserve Road/Frederick Street Herbert Street/Frederick Street Herbert Street/Cleg Street
Balgowlah and surrounds	Spit Road/Parriwi Road Manly Road/Sydney Road/Burnt Bridge Creek Deviation Sydney Road/Maretimo Street
Frenchs Forest and surrounds	Wakehurst Parkway/Burnt Street Wakehurst Parkway/Judith Street Wakehurst Parkway/Beaches Link construction support site access Wakehurst Parkway/Warringah Road

3.5.2 Vissim modelling

Vissim modelling of the Warringah Freeway and surrounds study area was carried out using the models identified and detailed in Section 3.4. Vissim modelling was carried out to understand the combined impact of construction traffic on overall network and corridor performance in North Sydney. This area is highly constrained and subject to increased construction traffic volumes from the construction of a number of concurrent transport projects already approved or in planning in addition to the project, and hence has warranted further, more holistic construction traffic modelling.

3.6 Desired standards of service

Generally, traffic operational performance can be assessed in several ways, including:

- At a network level, in terms of average speed, total distance travelled, and total time travelled
- At a corridor level, in terms of average travel times on a particular route for general traffic and buses
- At an intersection level, showing changed performance of these typically constraining elements of urban road networks
- For single-point assessment at a midblock level, showing changed travel routes and impacts.

Typically, shorter distance and less time travelled through a network implies increased network efficiency. However, because demands and networks may be different, higher values may well be indicative of a better performing network because more vehicles are able to travel through the network to reach their destinations, while shorter distances may be caused by congestion and slower vehicle speeds.

Given the existing congestion in the study area, single-point assessment criteria do not present a complete picture of road network traffic operations. Traditional midblock and intersection Levels of Service do not recognise that traffic is often constrained upstream, meaning that vehicles cannot get to the evaluation point and therefore give an unrealistically low level of demand and delay. Similarly, they do not recognise that traffic is constrained downstream, meaning vehicles are queued through the evaluation point. The measurements therefore only show throughput at that point rather than realistic overall network performance. The operation of the modelled road network as a whole is regarded as being of prime importance, recognising that there may be single locations where there may be improvement, while at others there may be some deterioration. These changes should not be considered in isolation. Overall, the critical evaluation measure is that the project does not overburden the network and provides more efficient network operations as a whole.

3.6.1 Network-wide statistics

Key network-wide statistics during the morning and evening peak periods for each modelled network are as follows:

- Primary
  - Total throughput (vehicles)
  - Average network travel speed (kilometres per hour)
  - Latent demand (vehicles)
- Secondary
  - Total vehicle hours travelled (VHT)
  - Total vehicle kilometres travelled (VKT).

Results for each of the above statistics have been used to compare the performance of each network with and without the project. VHT and VKT have been treated as secondary measures as thney are demand-dependant, and demands through the modelled areas are very different when comparing the 'Do minimum' and 'Do something' scenarios. Presenting VHT and VKT in isolation can be misleading when considering them in the context of network performance. Therefore, average network speed (which is the ratio of VKT to VHT) has been used as a primary performance metric.

3.6.2 Travel times

Travel times along key routes in each modelled area have been used to determine the relative impacts or benefits of the project. Travel times are expressed in minutes and refer to both general traffic and buses. Bus travel times are for key routes through each modelled area and have been used as a key indicator of the benefits and impacts of the project on bus performance.

3.6.3 Intersection Level of Service

The assessment of intersection performance is based on criteria outlined in Table 3-4 and defined in the *Guide to Traffic Generating Developments Version 2.2* (RTA, 2002). The average delay assessed for signalised intersections is for all movements. The average delay assessed for priority (sign-controlled) intersections is for the worst movement and is expressed in seconds per vehicle.

When assessing intersection performance for parts of the road network that already experience substantial congestion over the course of the day, achieving Level of Service (LoS) D or better may not represent good value for money, or may not be physically possible within the constraints of the project. In these locations, consideration has been given to whether achieving LoS D is practical within the constraints of the project. If not, a minimum of LoS E has been deemed acceptable.

Many intersections surrounding the project currently operate capacity during the peak period. It is expected that as traffic volumes across Sydney increase, delays would also increase with or without the project. Intersections that are outside of the scope of works but still affected by the project are expected to operate no worse than they would under the 'Do minimum' scenario. Any works required to improve the operation of these intersections would be considered under Transport for NSW's wider programs to ease congestion in the Sydney metropolitan area.

Table 3-4 Level of Service (LoS) criteria for intersections

LoS	Average delay per vehicle (seconds/vehicle)	Traffic signals and roundabouts
A	Less than 15	Good operation
B	15 to 28	Good with acceptable delays and spare capacity
C	29 to 42	Satisfactory
D	43 to 56	Operating near capacity
E	57 to 70	At capacity; at traffic signals, incidents would cause delays Roundabouts require other control mode
F	Over 70	Extra capacity required

Source: Guide to Traffic Generating Developments Version 2.2 (RTA, 2002)

Interchanges modelled in SIDRA consisted of two or more isolated intersections which were then connected as a network. Network Level of Service in SIDRA is defined by speed efficiency, which is the ratio of average travel speed for the network to the desired speed. The network Level of Service criteria adopted for this assessment is shown in Table 3-5.

Table 3-5 SIDRA LoS criteria for networks

LoS	Speed efficiency
A	0.91 to 1.00
B	0.81 to 0.90
C	0.71 to 0.80
D	0.51 to 0.70
E	0.31 to 0.50
F	0.00 to 0.30

Source: Sidra INTERSECTION 7 User Guide (Ackelik and Associates, 2016)

3.6.4 Midblock Level of Service

The assessment of network performance is based on criteria defined in the *Guide to Traffic Management – Part 3 Traffic Studies and Analysis* (Austroads, 2013) and the *Highway Capacity Manual 2010* (Transportation Research Board, 2010). The performance of surface roads is defined by the midblock Level of Service which is based on the volume to capacity (V/C) ratio. The Level of Service for freeways and motorways is calculated from vehicle density, which is the traffic volume divided by the average passenger car speed. Density is measured in passenger car units (PCU[4]) per kilometre per lane. The Level of Service criteria for midblock sections is shown in Table 3-6.

[4] Passenger car units account for the amount of road space various vehicle types use. Heavy vehicles and buses use more road space than cars or light commercial vehicles.

Table 3-6 LoS criteria for midblock sections

LoS	Definition	Multi-lane roads [1] V/C ratio	Freeways/ motorways[2] Density (PCU/km/lane)
A	A condition of free flow in which individual drivers are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to manoeuvre within the traffic stream in extremely high and the general level of comfort and convenience provided is excellent.	≤ 0.26	≤ 7.0
B	In the zone of stable flow where drivers still have reasonable freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is a little less than with LoS A.	0.27 to 0.41	7.1 to 11.0
C	Also in the zone of stable flow, but most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience declines noticeably at this level.	0.42 to 0.59	11.1 to 16.0
D	Close to the limit of stable flow and approaching unstable flow. All drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is poor, and small increases in traffic flow would generally cause operational problems.	0.60 to 0.81	16.1 to 22.0
E	Traffic volumes are at or close to capacity, and there is virtually no freedom to select desired speeds or to manoeuvre within the traffic stream. Flow is unstable and minor disturbances within the traffic stream would cause breakdown.	0.82 to 1.00	22.1 to 28.0
F	In the zone of forced flow, where the amount of traffic approaching the point under consideration exceeds that which can pass it. Flow breakdown occurs, and queuing and delays result.	> 1.00	> 28.0

Notes:

1 Where free flow speed is taken as 70 km/h

2 Where free flow speed is taken as 90 km/h

Source: Guide to Traffic Management – Part 3 Traffic Studies and Analysis (Austroads, 2013)

4. Existing traffic and transport environment

The project would provide broad road network benefits by increasing travel speeds and improving travel time reliability for travel within and surrounding the project footprint. At some locations changes to the existing road network would be required to facilitate and manage the impacts of increased connectivity provided by the project. The project includes mitigations to address potential localised impacts created by changes to the existing network, with residual local impacts offset by the broader network benefits provided by the project. For example, increased delays at an intersection would be outweighed by the travel time benefits to and from that location.

This section details the existing traffic and transport environment around the project area that would be potentially affected, which would be largely confined to the area around the Warringah Freeway and surrounds, Gore Hill Freeway and Artarmon, Balgowlah and surrounds, and Frenchs Forest and surrounds.

Assessment of the existing road network conditions within the study area is based on the following performance measures:

- Network performance based on overall traffic flows and congestion
- Travel times based on average speeds along key routes
- Intersection performance based on intersection Level of Service
- Road safety and crash history based on crash data collected over the last five years.

4.1 Metropolitan road network performance

4.1.1 Strategic corridors

The Northern Beaches peninsula is constrained by limited road access to the rest of Sydney. There are currently three routes into and out of the Northern Beaches peninsula:

- Spit Road
- Warringah Road
- Mona Vale Road.

Taken as a group, these locations define a ‘screenline’ that can be used to compare the changes in directional and two-way traffic demands across the Northern Beaches at a strategic level. A plot showing the Northern Beaches peninsula screenline and each of the crossing points along this screenline is provided in Figure 4-1.

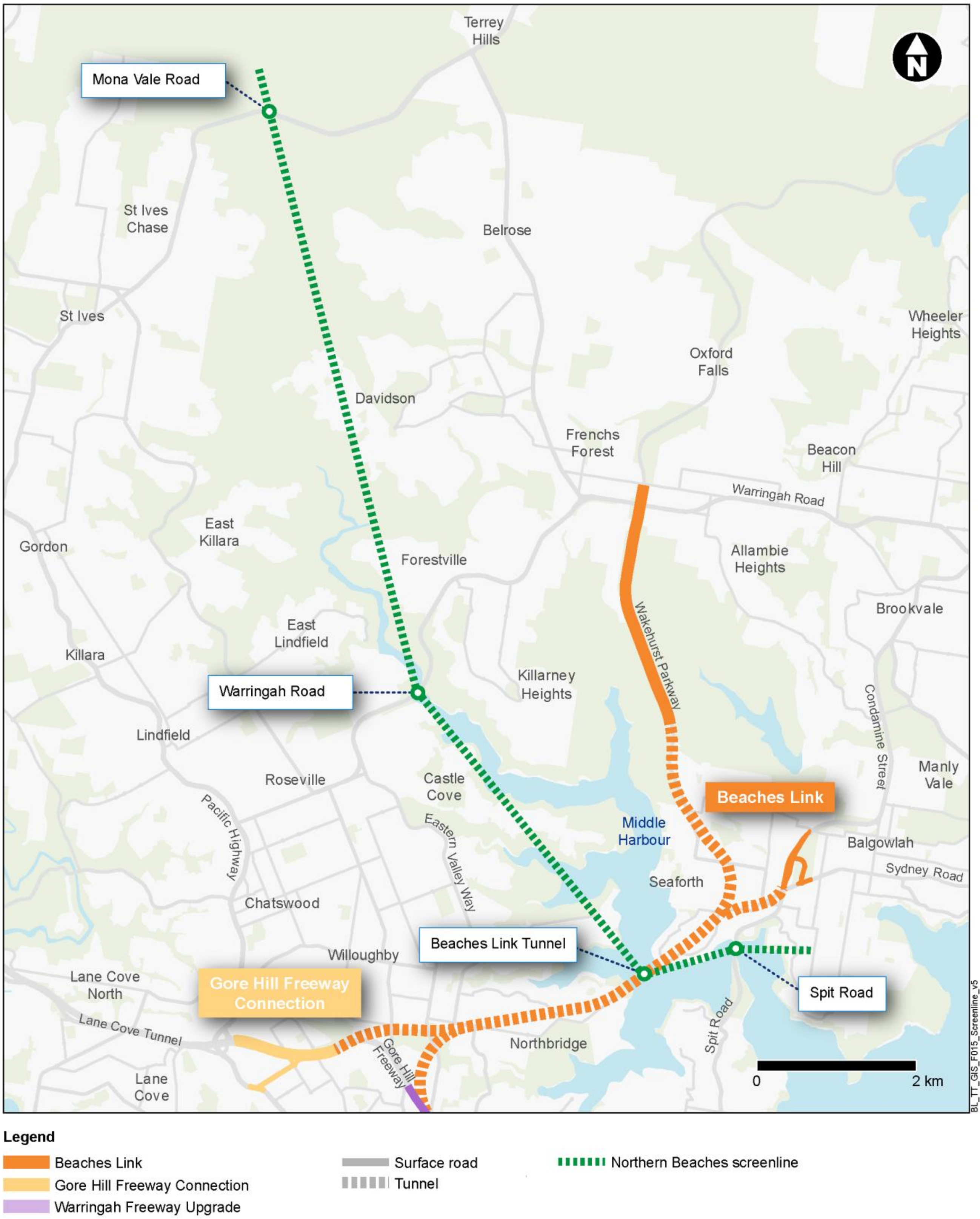


Figure 4-1 Northern Beaches peninsula screenline location

Table 4-1 presents a summary of traffic demands at key locations on each of these roads as well as on Eastern Valley Way, which provides a regional link between Warringah Road and the Warringah Freeway and surrounds.

Table 4-1 Modelled 2016 traffic demands at key locations (SMPM)

Road	Location	Direction	Morning peak hour (veh)	Evening peak hour (veh)	Daily (veh)
Spit Road	Spit Bridge	Northbound	1700	2800	36,000
		Southbound	2550	1950	33,500
		Combined	*4250*	*4750*	*69,500*
Warringah Road	Roseville Bridge	Northbound	1950	3450	39,000
		Southbound	3900	2350	40,000
		Combined	*5850*	*5800*	*79,000*
Mona Vale Road	St Ives Showground	Northbound	2250	2450	28,000
		Southbound	2600	2250	28,000
		Combined	*4850*	*4700*	*56,000*
Northern Beaches screenline		Northbound	5900	8700	103,000
		Southbound	9050	6550	101,500
		Combined	*14,950*	*15,250*	*204,500*
Eastern Valley Way	Castle Cove	Northbound	750	1350	14,500
		Southbound	1750	950	13,500
		Combined	*2500*	*2300*	*28,000*

At a network level, the project would provide an alternative route to the following corridors:

- **Warringah Road and Eastern Valley Way:** Warringah Road is the primary arterial corridor connecting Dee Why and Chatswood. Warringah Road operates at or near capacity, particularly through Frenchs Forest, Forestville and Chatswood. Eastern Valley Way is a secondary sub-arterial corridor that connects Warringah Road to Warringah Freeway via Miller Street/Strathallen Avenue or Brook Street/Flat Rock Drive. Congestion is frequently observed on Eastern Valley Way through north of Chatswood and Sailors Bay Road through Northbridge
- **Pittwater Road:** Pittwater Road is the primary north–south corridor through the Northern Beaches. Pittwater Road carries most citybound traffic from the major centres of Dee Why and Brookvale, as well as the B-Line bus service, and has substantial capacity constraints at Warringah Road and through Brookvale
- **Spit Road and Military Road:** The Spit Bridge is the primary north–south connection into and out of the Northern Beaches peninsula and is also the primary constraint for traffic travelling into and out of the Northern Beaches. The Spit Bridge operates with one bus lane and two general traffic lanes in the peak direction. Further south of the Spit Bridge, Spit Road and Military Road also experience substantial congestion during peak periods, with tidal flow in operation at Ourimbah Road and between Rangers Road and Wycombe Road. The Spit Bridge also opens for ships that cannot pass under the bridge; opening times are generally outside of peak hours
- **Pacific Highway:** Pacific Highway between Boundary Street and Gore Hill Freeway is the primary arterial route for traffic from the upper North Shore to the Sydney CBD. Tidal flow is in operation through Chatswood between Fullers Road and Eddy Road, with the intersection of Pacific Highway and Mowbray Road being a substantial constraint for north–south traffic through Lane Cove North

- **Mona Vale Road:** Mona Vale Road is an arterial road that connects Mona Vale with St Ives and Gordon. North of St Ives, Mona Vale Road is a predominantly four-lane divided carriageway, with localised widening around intersections. It widens to a six-lane road at St Ives, joining Pacific Highway at a grade-separated interchange. A number of heavy vehicle crashes, including fatal crashes, have occurred on Mona Vale Road through Ingleside. To address these road safety issues, Transport for NSW is upgrading the Mona Vale Road through Ingleside to two lanes in each direction between McCarrs Creek Road and Powder Works Road.

The following corridors have been selected to provide an overview of travel times and speeds across the network for key routes that provide the current alternatives to the project:

- North Sydney to Balgowlah – via Miller Street, Falcon Street, Military Road, Spit Road, Manly Road and Burnt Bridge Creek Deviation
- Balgowlah to North Sydney – via Burnt Bridge Creek Deviation, Manly Road, Spit Road, Military Road, Falcon Street and Miller Street
- North Sydney to Frenchs Forest – via Miller Street, Strathallen Avenue, Sailors Bay Road, Eastern Valley Way, Clive Street and Warringah Road
- Frenchs Forest to North Sydney – via Warringah Road, Clive Street, Eastern Valley Way, Sailors Bay Road, Strathallen Avenue and Miller Street
- Artarmon to Manly – via Gore Hill Freeway, Warringah Freeway, Military Road, Spit Road, Manly Road and Sydney Road
- Manly to Artarmon – via Sydney Road, Manly Road, Spit Road, Military Road, Warringah Freeway and Gore Hill Freeway.

The existing travel times and average travel speeds on key routes that provide the current alternatives to the project are presented in Figure 4-2 and Figure 4-3.

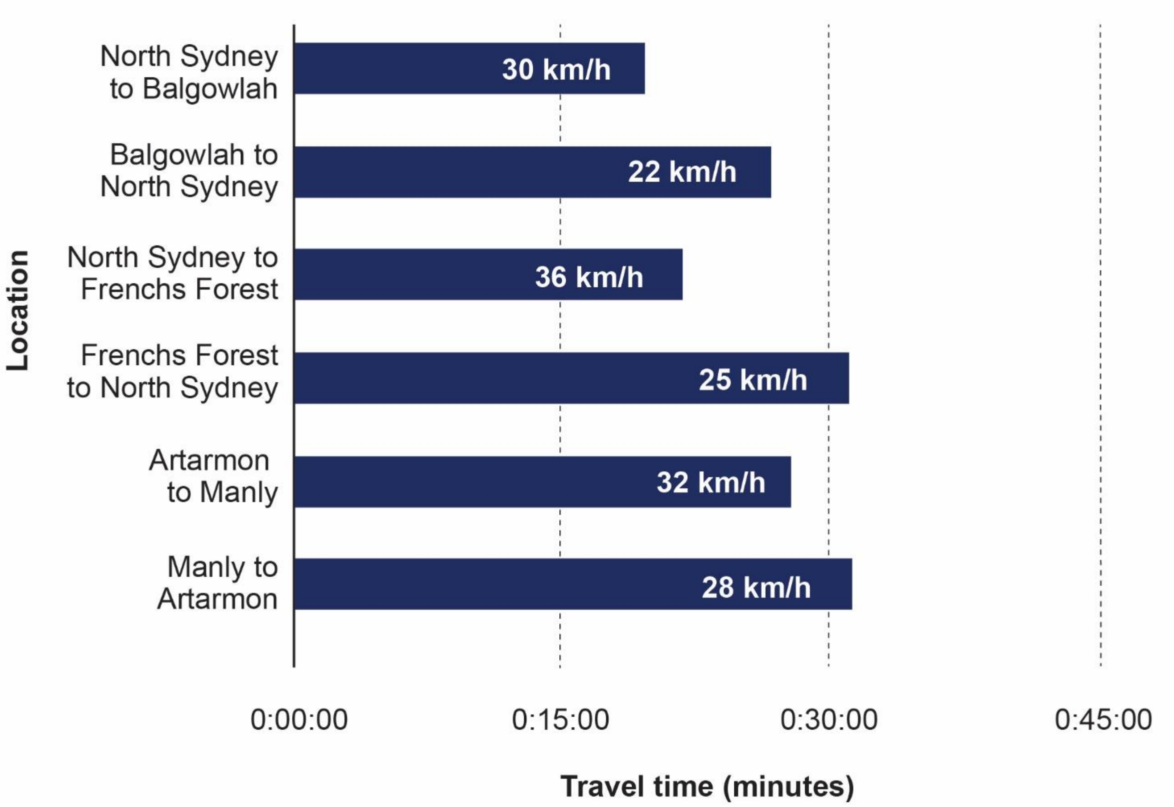


Figure 4-2 Modelled 2016 morning peak hour travel times and average speeds along key corridors (SMPM)

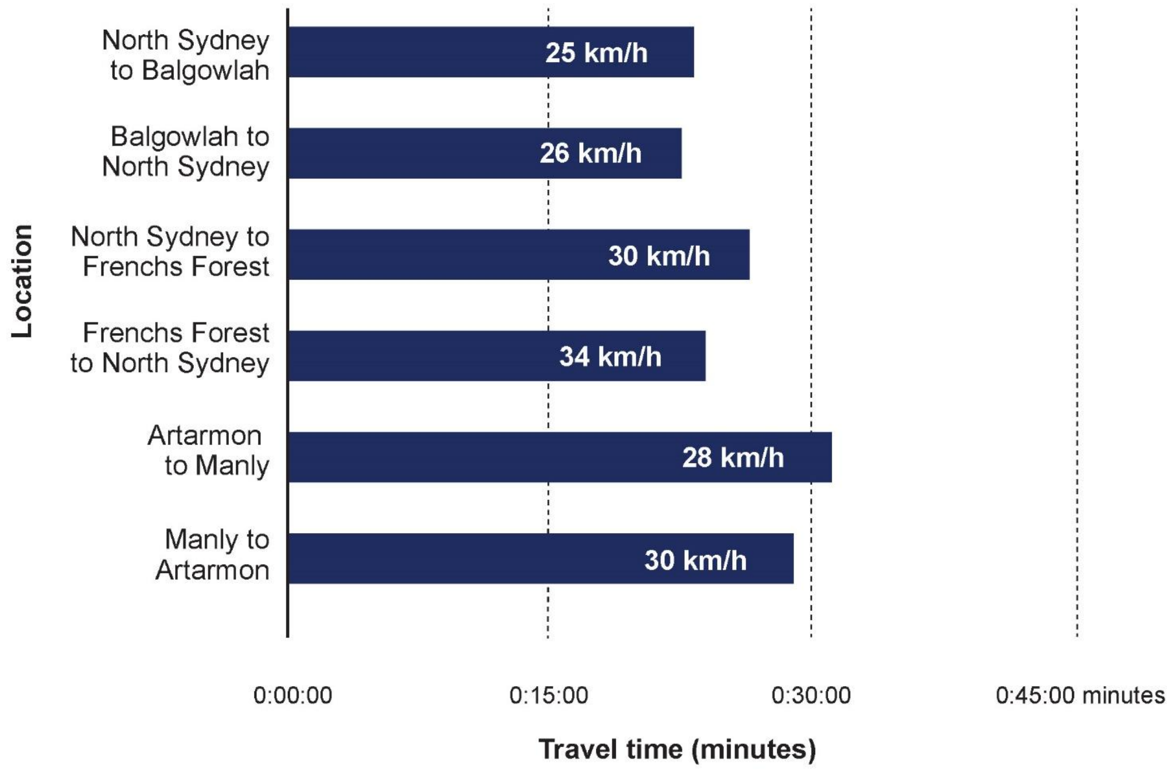


Figure 4-3 Modelled 2016 evening peak hour travel times and average speeds along key corridors (SMPM)

4.1.2 30-minute city catchments

The *Future Transport Strategy 2056* identifies a vision for Greater Sydney where people can conveniently access jobs and services. The goal for this accessibility is to provide transport infrastructure that allows people to reach their nearest metropolitan and strategic centres by public transport within 30 minutes, seven days a week. While the inclusion of new public transport services is not proposed as part of the project, the project would create opportunities for new, or extension of existing, public transport services. These new service opportunities would benefit from the same increases in catchment size as private vehicles.

Metropolitan and strategic centres that would benefit from the project include:

- Sydney CBD
- North Sydney
- Chatswood
- St Leonards
- Macquarie Park
- Brookvale-Dee Why
- Manly.

The project would also provide fast and convenient access to the Northern Beaches Hospital within the Frenchs Forest strategic centre.

Plots of the existing 30-minute catchments by road during morning peak periods for each of these centres are presented in Figure 4-4 to Figure 4-6.

Analysis of the 30-minute catchments from 2016 shows:

- Trips from Chatswood can reach Brookvale-Dee Why, Manly, St Leonards, Macquarie Park and parts of Sydney CBD within 30 minutes
- Trips from Brookvale-Dee Why can reach Manly within 30 minutes, but cannot reach Chatswood, North Sydney, St Leonards, Macquarie Park or Sydney CBD within this timeframe
- Trips from Manly can reach Dee Why-Brookvale within 30 minutes, but cannot reach Chatswood, St Leonards, Macquarie Park or Sydney CBD within this timeframe.

Overall, the analysis indicates that the two major centres within the Northern Beaches peninsula (Brookvale-Dee Why and Manly) cannot reach their surrounding centres or the Sydney CBD within 30 minutes under existing conditions.

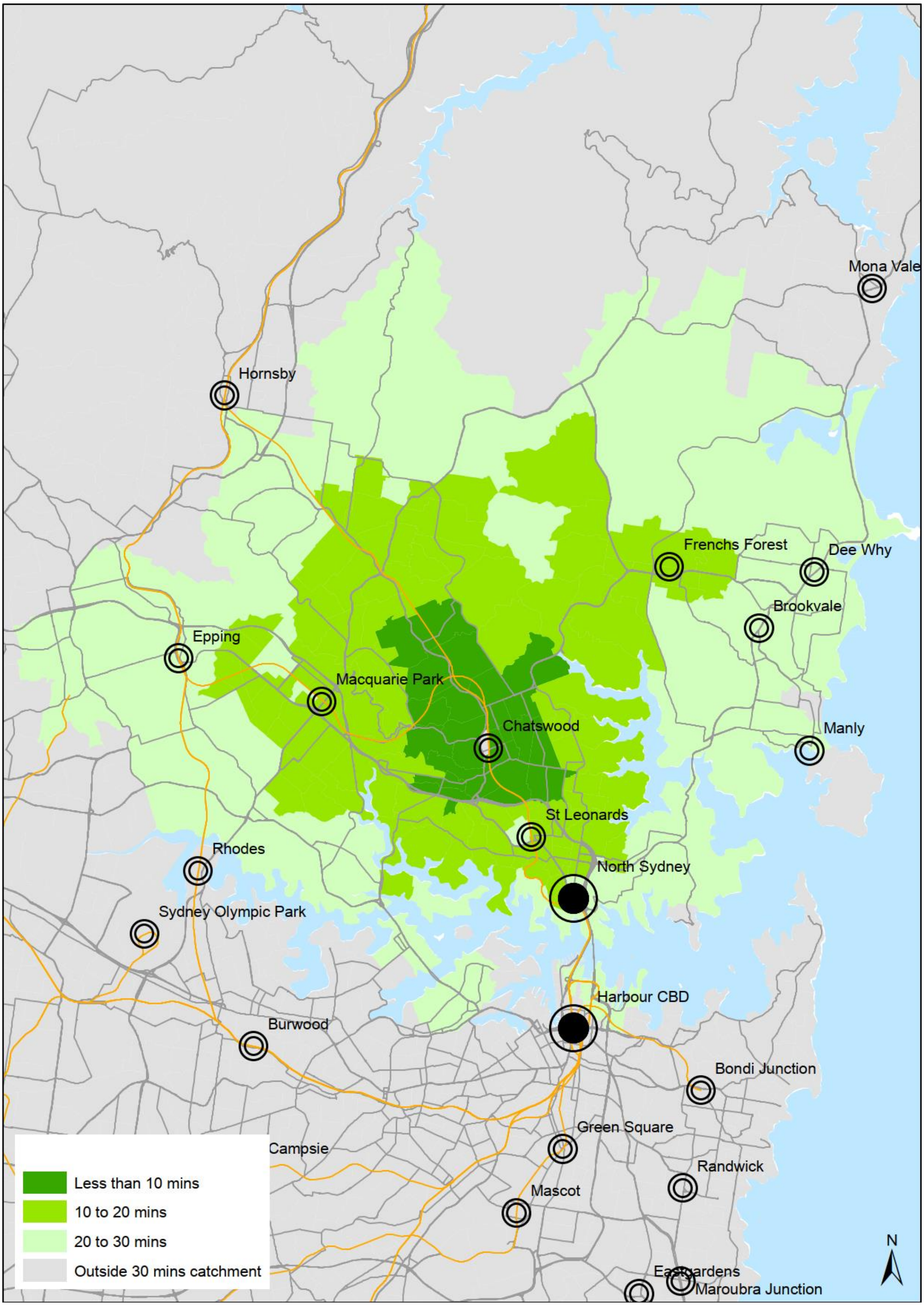


Figure 4-4 Modelled 2016 morning peak 30-minute catchment by road from Chatswood (SMPM)

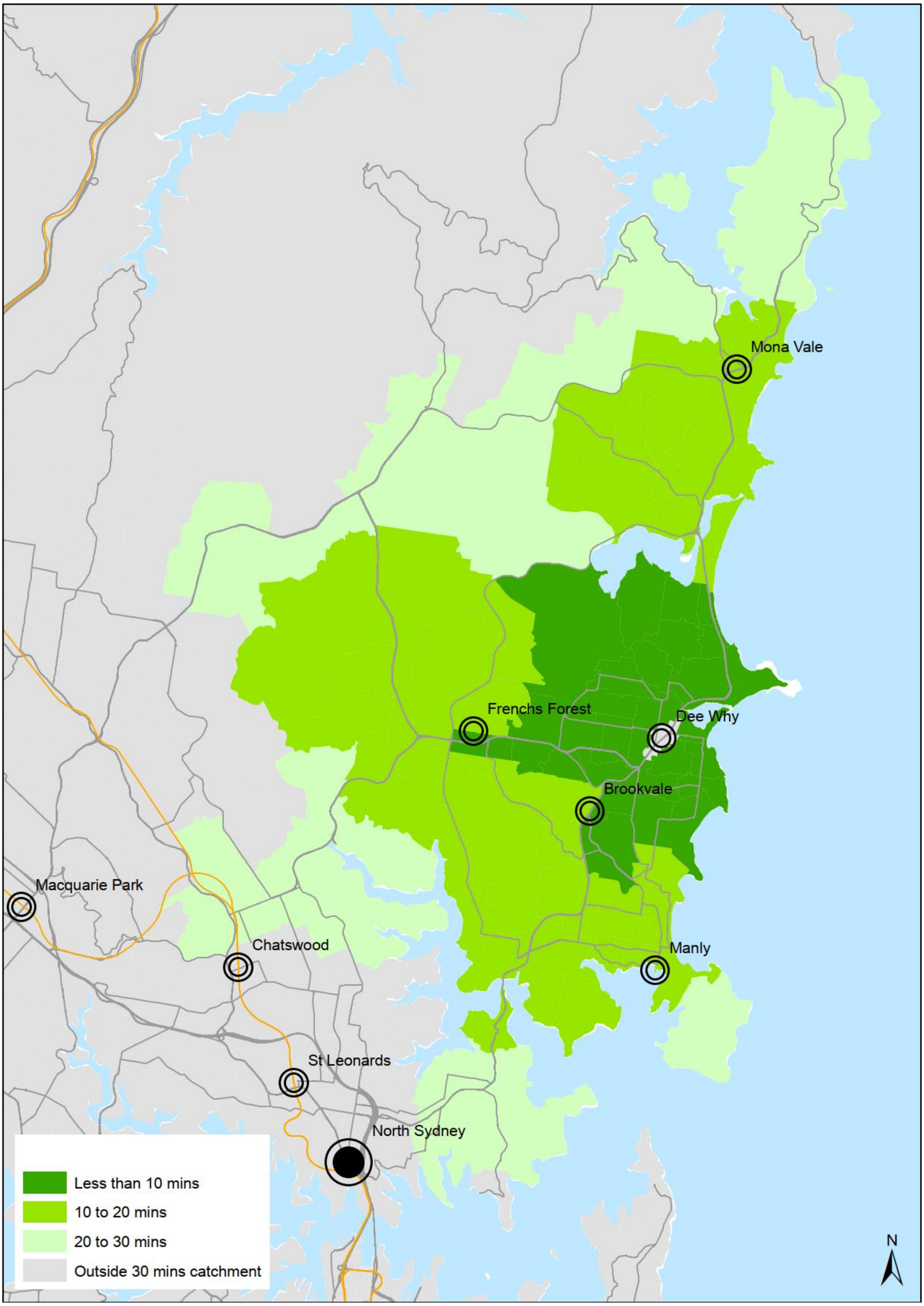


Figure 4-5 Modelled 2016 morning peak 30-minute catchment by road from Brookvale-Dee Why (SMPM)

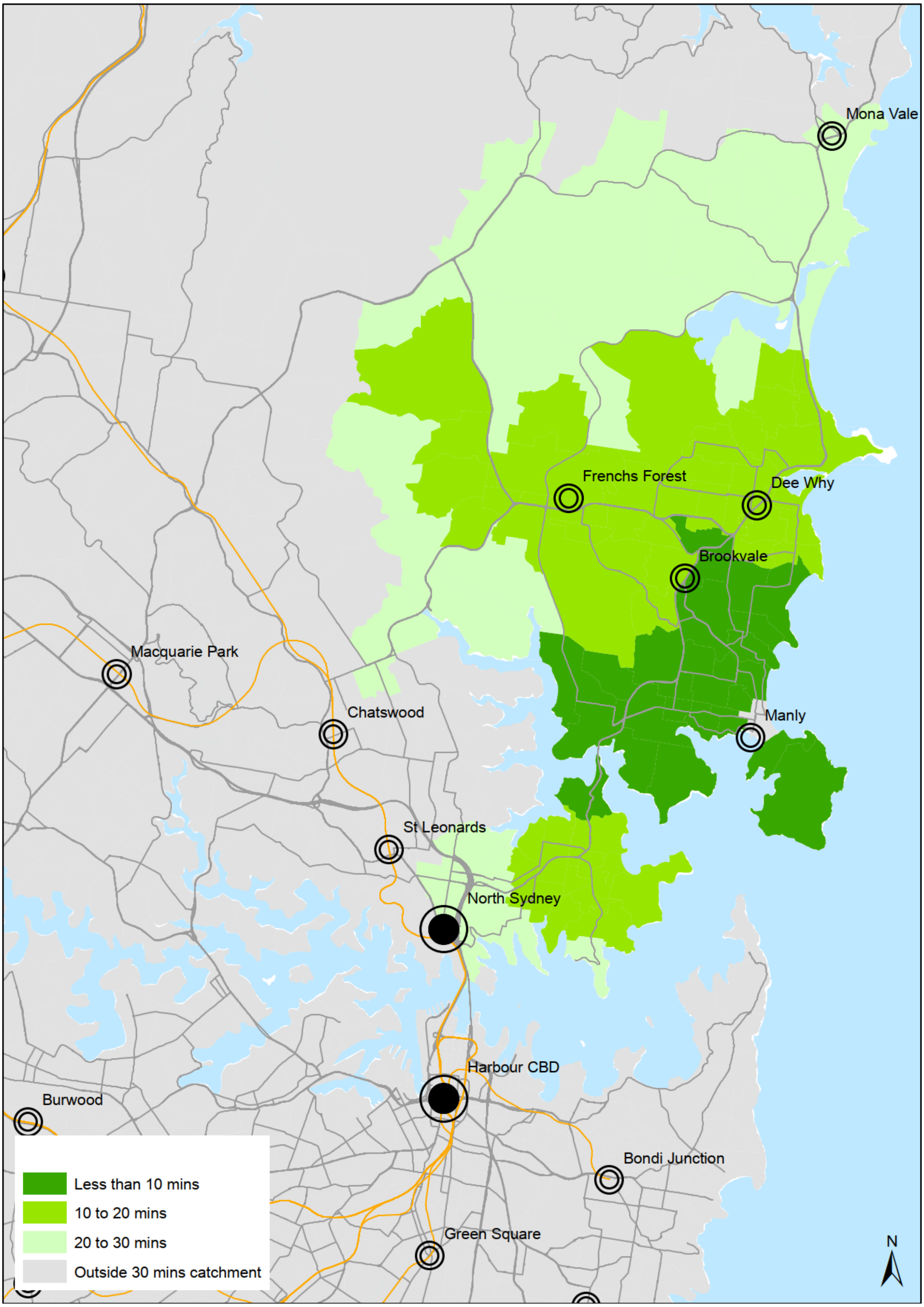


Figure 4-6 Modelled 2016 morning peak 30-minute catchment by road from Manly (SMPM)

4.1.3 Heavy vehicles and freight

The *NSW Freight and Ports Plan 2018-2023* states that freight in greater Sydney is expected to increase by almost 50 per cent over the next 20 years. Manufacturing, construction materials and wholesale/retail haulage are the top three freight activities that occur in greater Sydney, together accounting for more than half of freight activity, with the largest growth expected to occur in manufacturing and wholesale/retail. Road is by far the dominant mode for all of these freight activities. Figure 4-7 shows the mode share split of freight activities in 2016.

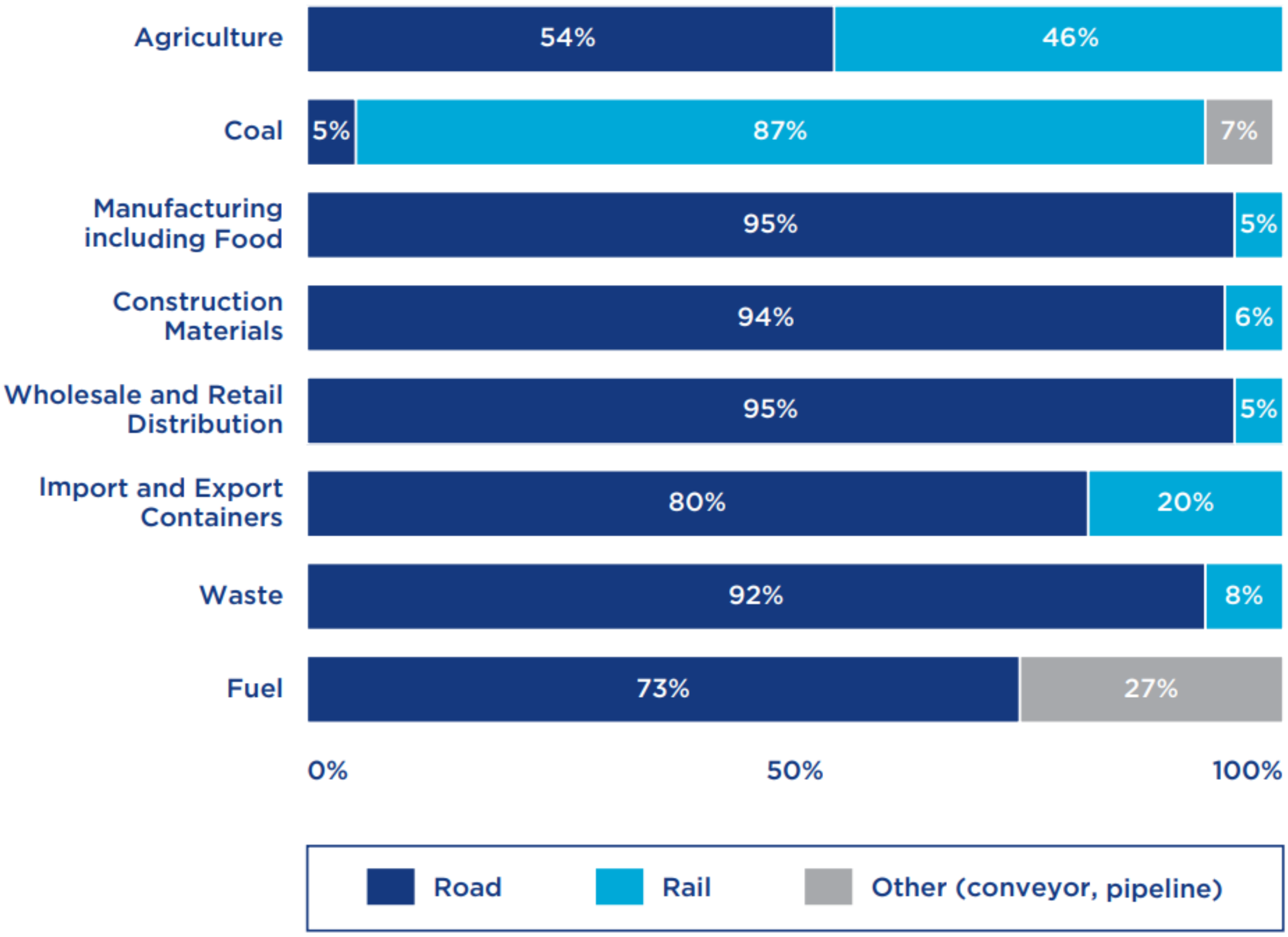


Figure 4-7 Freight mode share

Source: NSW Freight and Ports Plan 2018-2023 (Transport for NSW, 2018a)

The forecast growth in freight traffic has immediate implications for the capacity of the road network, with the greatest impact generally on arterial roads where no motorway standard alternative exists. Heavy vehicle movements are expected to increase on Spit Road, Military Road, Pittwater Road and Warringah Road by 2036. More detailed forecasts of freight growth on these corridors is provided in Section 7.2.3.

The safe and efficient transport of freight throughout greater Sydney is highly dependent on the motorway network, with more than 37 per cent of all heavy vehicle kilometres of travel taking place on motorways and highways, despite these roads accounting for less than 17 per cent of the arterial road network. While rail freight would play an increasing role in serving the freight task, particularly in and around ports and intermodal terminals, access to freight rail is limited, particularly in the urban centre of Sydney, which means that roads will continue to play the dominant role in serving freight needs for the foreseeable future.

The Western Harbour Tunnel and Beaches Link program of works is a critical part of the committed initiatives for improving the freight network in greater Sydney. Current freight access into and out of the Northern Beaches peninsula is limited to the following arterial roads:

- Spit Road–Military Road
- Warringah Road and Wakehurst Parkway
- Mona Vale Road.

Spit Road–Military Road and Warringah Road are both arterial commuter corridors and the movement of freight along these roads is limited by capacity constraints and congestion, particularly during peak periods. Mona Vale Road carries much higher volumes, but the poor standard of the road, particularly through Terrey Hills and Mona Vale, likely contributed to two fatal crashes over the past 10 years.

Access to the Northern Beaches for B-Doubles is currently limited to Mona Vale Road and Warringah Road. Military Road, Spit Road and Pittwater Road (south of Brookvale) are not approved for B-Doubles and other Higher Mass Limit vehicles, making access to the key industrial area of Brookvale from Port Botany highly circuitous for B-doubles. In order to travel east of French Forest from Warringah Road, B-Doubles must use Wakehurst Parkway to travel to and from the Northern Beaches, making Wakehurst Parkway a critical B-Double route for freight traffic travelling to and from Brookvale.

A summary of existing heavy vehicle demand along the key strategic corridors into and out of the Northern Beaches peninsula is provided in Table 4-2. Analysis of these heavy vehicles indicates that the largest proportion travel into and out of the Northern Beaches via Mona Vale Road, likely due to lower congestion and its proximity to the M1 Pacific Motorway and industrial areas in Mona Vale, Warriewood, Belrose and Terrey Hills. Conversely, Spit Road carries relatively low volumes of heavy vehicles due to access restrictions for large articulated trucks and persistent congestion on this route.

Table 4-2 Modelled 2016 heavy vehicle demands at key locations (SMPM)

Road	Location	Direction	Morning peak hour (veh)	Evening peak hour (veh)	Daily (veh)
Spit Road	Spit Bridge	Northbound	50	80	1500
		Southbound	110	50	1800
		Combined	*160*	*130*	*3300*
Warringah Road	Roseville Bridge	Northbound	150	260	3100
		Southbound	220	180	2900
		Combined	*370*	*440*	*6000*
Mona Vale Road	St Ives Showground	Northbound	160	130	2300
		Southbound	280	300	3900
		Combined	*440*	*430*	*6200*
Northern Beaches screenline		Northbound	360	470	6900
		Southbound	610	530	8600
		Combined	*970*	*1000*	*15,500*

4.1.4 Strategic model road network performance

A summary of the existing daily VKT and VHT of the Sydney region and the Western Harbour Tunnel and Beaches Link operational road traffic model area is provided in Table 4-3. Compared to the Sydney region, the Western Harbour Tunnel and Beaches Link operational road traffic model area accounts for a slightly higher proportion of motorway trips.

Table 4-3 Modelled 2016 daily VKT and VHT (SMPM)

Network measure	Road	Daily
Sydney region		
VKT	Motorway	22,594,000
	Other	71,656,000
	Total	*94,250,000*
VHT	Motorway	388,000
	Other	2,363,000
	Total	*2,751,000*
Western Harbour Tunnel and Beaches Link study area		
VKT	Motorway	4,821,000
	Other	14,300,000
	Total	*19,121,000*
VHT	Motorway	106,000
	Other	579,000
	Total	*685,000*

4.2 Warringah Freeway and surrounds

The broad study area adopted for the traffic and transport assessment of the Warringah Freeway and surrounds is shown in Figure 4-8 and includes the suburbs of Cammeray, Crows Nest, Naremburn, Neutral Bay, North Sydney and Waverton.

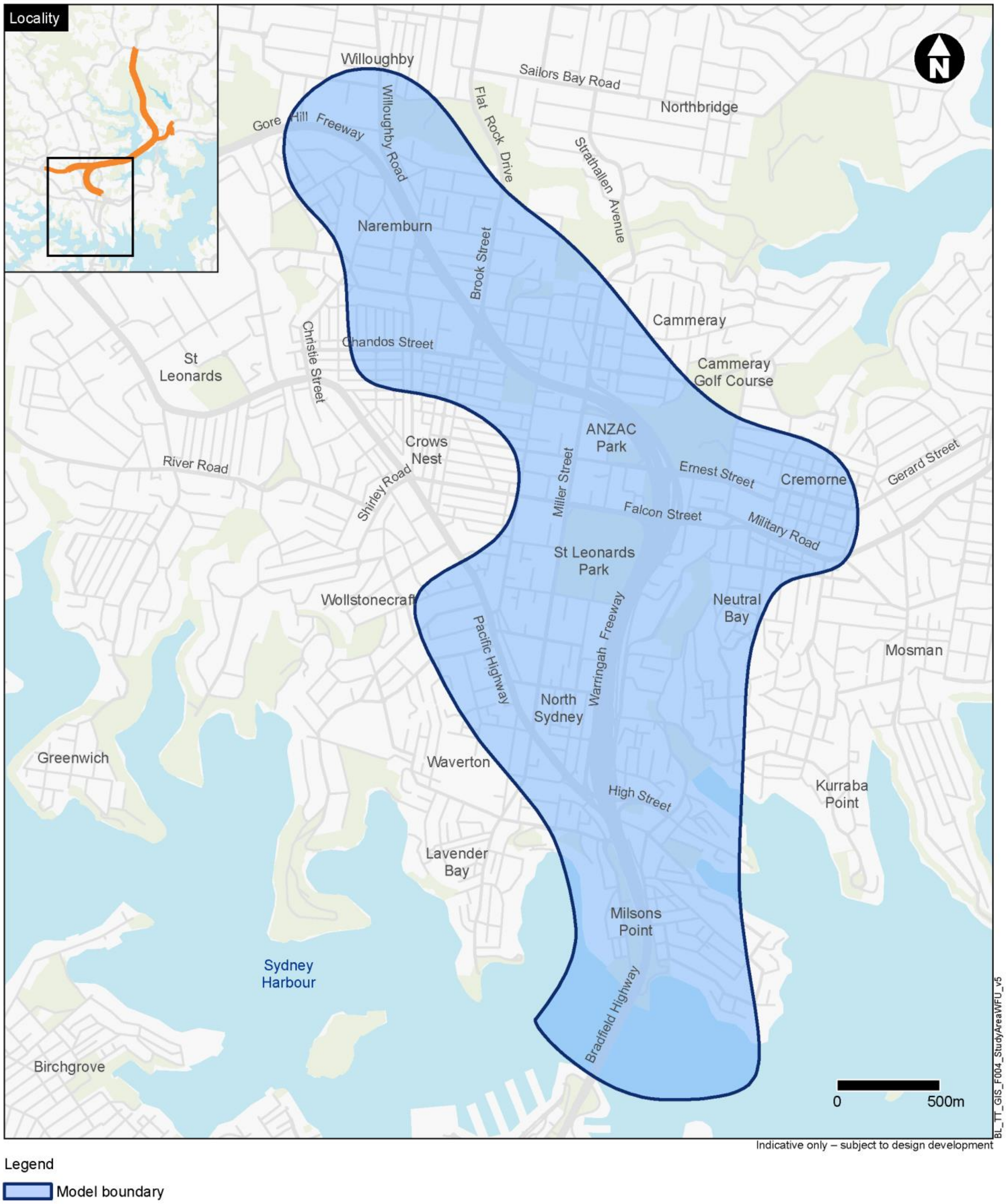


Figure 4-8 Warringah Freeway and surrounds study area and operational model boundary

4.2.1 Modes of travel

Journey to work data for the Warringah Freeway and surrounds study area (based on statistical areas defined by the Australian Bureau of Statistics that fall within the operational traffic model boundary) was analysed to determine travel patterns for residents and workers.

In 2016 the population in the Warringah Freeway and surrounds study area was 130,300[5].. The mode share for residents travelling to their employment destinations is shown in Figure 4-9. Public transport accounted for 44 per cent of trips, with 26 per cent by train, 17 per cent by bus and one per cent by ferry or tram. Private vehicles accounted for 41 per cent of trips, with 38 per cent as vehicle drivers and three per cent as passengers. Walking accounted for 11 per cent of trips. When compared to the Sydney average, the public transport mode share is relatively high and the private vehicle mode share is relatively low. This can be attributed to the locations where most residents work which are highly accessible by public transport, and include Sydney Inner City, North Sydney–Mosman and Chatswood–Lane Cove.

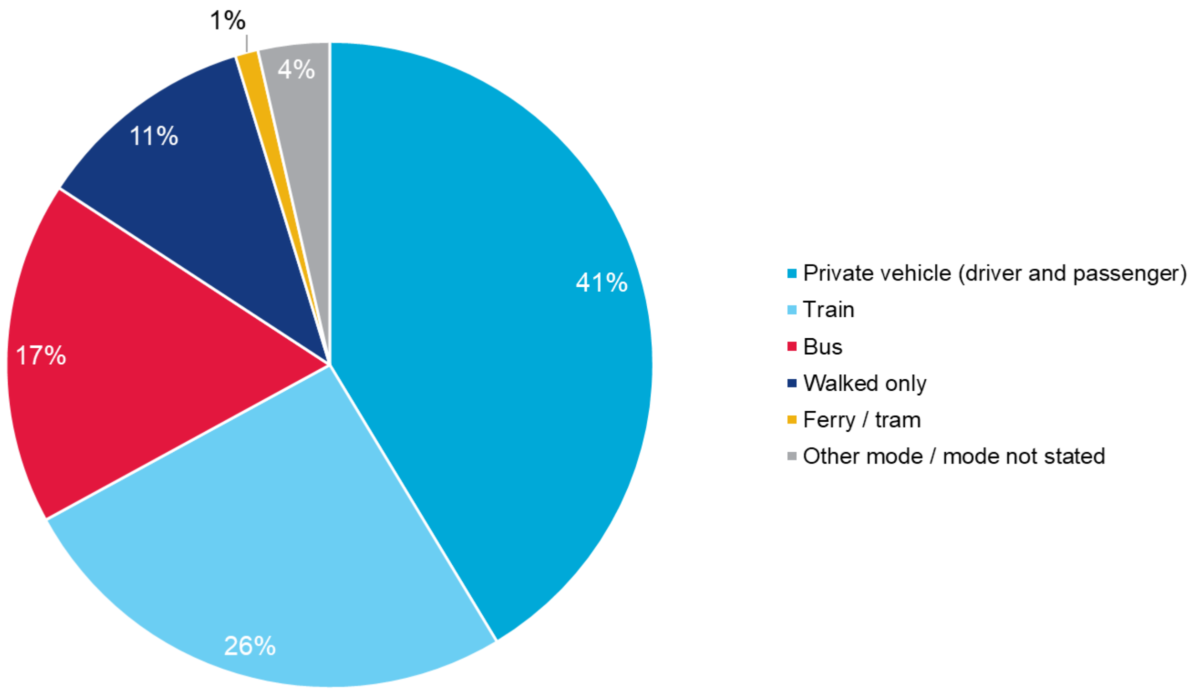


Figure 4-9 Mode share for residents in the Warringah Freeway and surrounds study area travelling to employment

Source: Journey to Work 2016 (Transport for NSW, 2018c)

In 2016 there were 132,200 workers in the Warringah Freeway and surrounds study area. The mode share for workers travelling to employment is shown in Figure 4-10. Public transport accounted for 46 per cent of trips with 36 per cent by train and nine per cent by bus. Private vehicles accounted for 45 per cent of trips with 41 per cent as vehicle drivers and four per cent as passengers. Walking accounted for six per cent of trips. When compared to the Sydney average, the public transport mode share is relatively high and the private vehicle mode share is relatively low. This can be attributed to the locations where most workers live, which are Chatswood–Lane Cove, North Sydney–Mosman, Ku-ring-gai, Warringah and Sydney Inner City. The Warringah Freeway and surrounds study area is highly accessible by public transport from these locations and parking is discouraged within North Sydney CBD through pricing mechanisms.

[5] Journey to work data is based on statistical areas defined by the Australian Bureau of Statistics that fall within the operational traffic model boundary for each study area. For Warringah Freeway and surrounds area this includes the statistical areas of North Sydney - Lavender Bay, Neutral Bay – Kirribilli, Cremorne – Cammeray, Crows Nest – Waverton, St Leonards – Naremburn, Willoughby - Castle Cove – Northbridge and Chatswood (East) – Artarmon

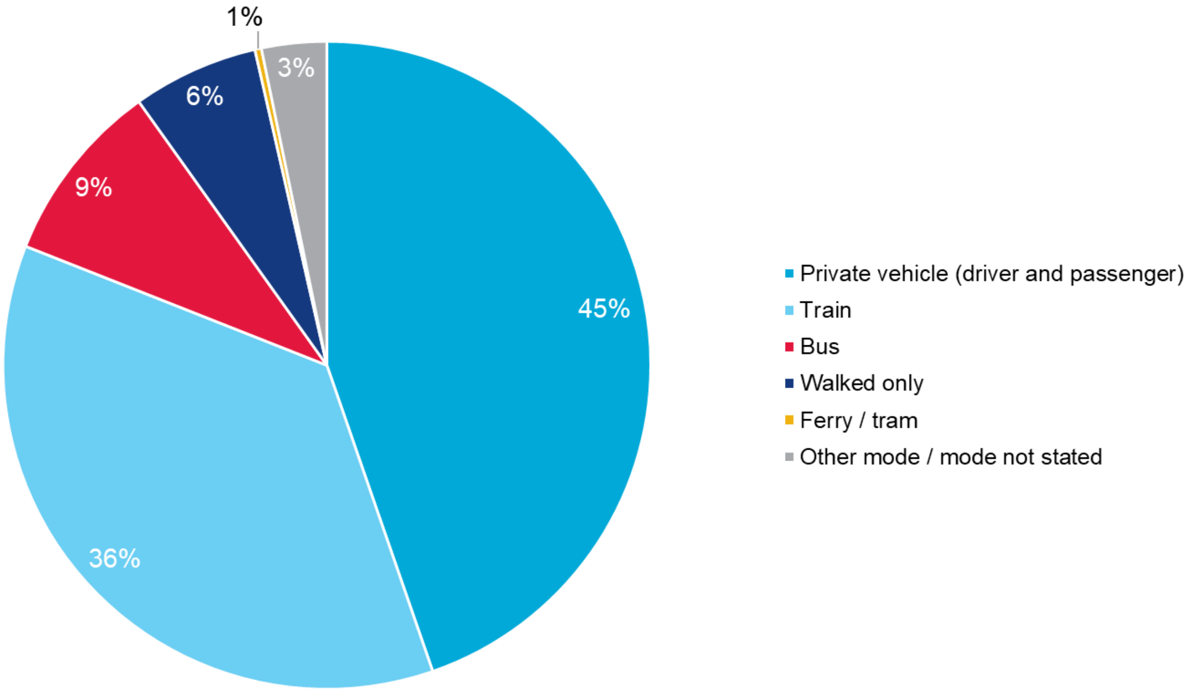


Figure 4-10 Mode share for workers travelling to employment in the Warringah Freeway and surrounds study area

Source: Journey to Work 2016 (Transport for NSW, 2018c)

4.2.2 Road network key features

Key roads in the Warringah Freeway and surrounds study area and their characteristics are summarised in Table 4-4.

Table 4-4 Summary of key roads – Warringah Freeway and surrounds study area

Road	Location	Road type and speed limit	Total number of lanes	Key destinations	On-road public transport	Operational arrangements
M1 Warringah Freeway	North Sydney, Cammeray	Motorway 80 km/h	Up to 16 (variable, depending on location)	Connectivity to the Sydney metropolitan area as part of the Sydney Orbital Network	Major bus corridor. Services to Sydney CBD, Northern Beaches, North Shore and the Hills District. Southbound 24-hour bus lane	Tidal flow in operation during weekday peak periods
Sydney Harbour Bridge (Bradfield Highway/	Sydney CBD, Milsons Point	Motorway 70 km/h	Eight (six lanes on Bradfield Highway, two lanes on	Connectivity to the Sydney metropolitan area as part of the	Major bus corridor. Services to Sydney CBD, Northern	Tidal flow in operation during weekday peak periods

Road	Location	Road type and speed limit	Total number of lanes	Key destinations	On-road public transport	Operational arrangements
Cahill Expressway)			Cahill Expressway)	Sydney Orbital Network	Beaches, North Shore, Hills District. Cahill Expressway southbound 24-hour bus lane	
Sydney Harbour Tunnel	Sydney CBD, Milsons Point	Motorway 80 km/h	Four	Connectivity to the Sydney metropolitan area as part of the Sydney Orbital Network	N/A	N/A
Pacific Highway	North Sydney, Waverton	Major arterial road 60 km/h	Six	St Leonards, Chatswood, Pymble, Hornsby, Central Coast and Newcastle (via M1 Pacific Motorway	Major bus corridor. Services to Sydney CBD, Chatswood, Epping, Gladesville and the Hills District	Clearways in operation during weekday peak periods
Falcon Street/ Military Road	North Sydney, Neutral Bay	Major arterial road 60 km/h	Up to ten (variable, depending on location)	Crows Nest, Mosman, Northern Beaches	Major bus corridor. Services to Sydney CBD, Chatswood, Mosman and Northern Beaches. Westbound bus lane during weekday morning peak	Clearways in operation during weekday peak periods
Ernest Street	Cammeray, Neutral Bay	Sub-arterial road 50 km/h	Four	Crows Nest, Cremorne, Mosman	Local services to Sydney CBD, Crows Nest and Chatswood	Clearways in operation during weekday peak periods
Miller Street	North Sydney, Cammeray	Sub-arterial road 40 km/h (in North Sydney CBD),	Up to six (variable, depending on location)	Northbridge, Chatswood. Northern Beaches (via Eastern Valley Way/Warringah Road)	Services to Sydney CBD, Northbridge, Willoughby and East Lindfield	Clearways in operation during weekday peak periods

Road	Location	Road type and speed limit	Total number of lanes	Key destinations	On-road public transport	Operational arrangements
		50 km/h elsewhere				
Brook Street/Flat Rock Drive	Crows Nest, Naremburn	Sub-arterial road 60 km/h	Four	St Leonards, Willoughby, Northern Beaches (via Eastern Valley Way/Warringah Road)	Services to Sydney CBD and the Forest District.	Clearways in operation during weekday peak periods
Willoughby Road	Naremburn, Willoughby	Sub-arterial road 60 km/h	Up to four (variable, depending on location)	St Leonards, Crows Nest, Chatswood (via Mowbray Road)	Local services to Sydney CBD, Chatswood and Willoughby.	Clearways in operation during weekday peak periods
Berry Street	North Sydney	Sub-arterial road 40 km/h	Up to four (variable depending on location)	Provides access from North Sydney to Warringah Freeway northbound and Bradfield Highway/Cahill Expressway southbound	Services to Sydney CBD via Miller Street.	Clearways in operation during weekday peak periods
Arthur Street	North Sydney	Sub-arterial road 40 km/h	Three	Provides access from North Sydney to Warringah Freeway southbound	Services to Sydney CBD. Bus only lane south of Mount Street during weekday morning peak	Clearways in operation during weekday peak periods Tidal flow in operation south of Mount Street during weekday morning peak.
High Street	North Sydney	Sub-arterial road 60 km/h	Three	Provides access between North Sydney. Kirribilli and Neutral Bay	Local services to Sydney CBD, Cremorne and Crows Nest.	Clearways in operation during weekday peak periods
Mount Street	North Sydney	Local road 40 km/h	Two	North Sydney, Neutral Bay and access to Warringah Freeway	Services to Sydney CBD from Arthur Street.	N/A
Walker Street	North Sydney	Local road	Up to three (variable	North Sydney, Sydney CBD (via	N/A	Clearways in operation

Road	Location	Road type and speed limit	Total number of lanes	Key destinations	On-road public transport	Operational arrangements
		40 km/h	depending on location)	Berry Street/Warringah Freeway)		during weekday peak periods
Alfred Street North	Neutral Bay	Local road 60 km/h	Up to three (variable depending on location)	North Sydney, Neutral Bay	N/A	N/A
Balls Head Drive/Balls Head Road	Waverton	Local road 10 km/h (Balls Head Drive), 50 km/h (Balls Head Road)	Two	Balls Head Reserve	N/A	N/A
Bay Road	Waverton	Local road 50 km/h	Two	Waverton railway station	Local services to Lane Cove and Crows Nest	N/A
Ridge Street	North Sydney	Local road 50 km/h	Two	St Leonards Park. Pedestrian and cycle route linking North Sydney and Neutral Bay via Warringah Freeway overpass	N/A	N/A
Amherst Street	Cammeray	Local road 50 km/h	Two	Cammeray Golf Club	N/A	N/A
Belgrave Street	Cremorne	Sub-arterial road 50 km/h	Four	Cremorne, Mosman	N/A	Clearways in operation during weekday peak periods
Gerard Street	Cremorne	Sub-arterial road 50 km/h	Four	Cremorne, Mosman	Local services between Sydney CBD and Spit Junction	Clearways in operation during weekday peak periods
Macpherson Street	Cremorne, Mosman	Sub-arterial road 50 km/h	Four	Cremorne, Mosman	Local services between Sydney CBD and Spit Junction	Clearways in operation during weekday peak periods

Road	Location	Road type and speed limit	Total number of lanes	Key destinations	On-road public transport	Operational arrangements
Cowles Road	Mosman	Collector road 50 km/h	Two	Mosman, Spit Junction	N/A	N/A
Chandos Street	St Leonards	Local road 50 km/h	Two	St Leonards railway station	N/A	N/A

4.2.3 Traffic volumes and patterns

The Pacific Highway and Falcon Street are major arterial roads that carry high traffic volumes. The Pacific Highway south of Walker Street is characterised by a northbound morning and evening peak direction as this section of the Pacific Highway accommodates trips from the Sydney Harbour Bridge to North Sydney. Falcon Street east of Miller Street carries average traffic volumes greater than 1000 vehicles per hour in each direction. Falcon Street west of Merlin Street accommodates trips between the Warringah Freeway and the North Shore, resulting in higher traffic volumes of at least 2000 vehicles per hour in each direction.

Sub-arterial roads such as Berry Street, Miller Street, Ernest Street and Brook Street also carry high traffic volumes ranging between 1050 and 2390 vehicles per hour in the peak direction. Alfred Street north of Mount Street accommodates a high volume of traffic in the southbound direction during both peak hours, with the majority comprising vehicles that exit the Warringah Freeway to access North Sydney, Kirribilli and Milsons Point. Local roads including Bay Road, Ridge Street and Blue Street carry lower volumes of traffic, generally less than 500 vehicles per hour in each direction.

The midblock volumes on key access roads in the Warringah Freeway and surrounds study area are summarised in Table 4-5.

Table 4-5 2016 peak hour traffic volumes – Warringah Freeway and surrounds study area

Road	Direction	Morning peak hour		Evening peak hour	
		Volume (veh)	Heavy vehicle percentage	Volume (veh)	Heavy vehicle percentage
Pacific Highway south of Walker Street	Northbound	2100	4%	1410	11%
	Southbound	380	13%	580	6%
Pacific Highway south of Bay Road	Northbound	690	8%	800	7%
	Southbound	1100	7%	950	3%
Bay Road west of Pacific Highway	Eastbound	230	2%	260	1%
	Westbound	380	4%	280	2%
Berry Street east of Walker Street	Eastbound	1650	7%	2390	4%
	Westbound	-	-	-	-
Falcon Street east of Miller Street	Eastbound	1250	2%	1350	6%
	Westbound	1170	6%	1110	5%
Ridge Street east of Miller Street	Eastbound	330	5%	130	2%

Road	Direction	Morning peak hour		Evening peak hour	
		Volume (veh)	Heavy vehicle percentage	Volume (veh)	Heavy vehicle percentage
	Westbound	160	9%	260	4%
Miller Street north of Ernest Street	Northbound	470	6%	730	8%
	Southbound	1050	4%	1060	3%
Ernest Street east of Miller Street	Eastbound	1070	4%	1380	4%
	Westbound	1050	1%	870	2%
Ernest Street west of Merlin Street	Eastbound	650	3%	2000	1%
	Westbound	2070	1%	990	1%
Blue Street south of Pacific Highway	Northbound	330	3%	500	1%
	Southbound	290	3%	220	1%
Arthur Street north of Pacific Highway	Northbound	800	2%	610	1%
	Southbound	-	-	-	-
Alfred Street north of Mount Street	Northbound	40	9%	30	0%
	Southbound	1420	1%	730	3%
Falcon Street west of Merlin Street	Eastbound	2330	7%	2910	5%
	Westbound	3140	6%	2110	8%
Walker Street north of Pacific Highway	Northbound	830	3%	650	2%
	Southbound	290	2%	360	3%
Brook Street south of Merrenburn Avenue	Northbound	720	9%	1660	2%
	Southbound	2070	2%	1020	6%

4.2.4 Road network performance

The Warringah Freeway is the busiest section of motorway in NSW and provides access to and from the Sydney CBD, southern Sydney, Inner West, the Northern Beaches and North Shore of Sydney. Although the Warringah Freeway carries high traffic volumes at all times of the day, due to the highly directional nature of traffic flow during peak periods, the central carriageway of the Warringah Freeway, between Ernest Street and High Street, is reversible and operates in the southbound direction in the morning peak period and northbound at other times.

Congestion and delays on the Warringah Freeway are highest during the morning peak period, when southbound traffic travelling to both the Sydney Harbour Tunnel and Sydney Harbour Bridge is accommodated by the southbound permanent and reversible carriageways with queues frequently extending as far north as Miller Street. During the evening peak, queuing and congestion is frequently observed on the northbound off ramp to Falcon Street eastbound.

The North Sydney CBD is located to the west of the Warringah Freeway on either side of the Pacific Highway and has direct access to the Warringah Freeway at Berry Street, Mount Street, High Street and Pacific Highway. Queuing and congestion are frequently observed on these roads during both morning and evening peak periods, with queues on Berry Street frequently extending to the intersection of Pacific Highway and Bay Street.

Falcon Street provides access from the lower North Shore to the Northern Beaches and from the Northern Beaches to the Warringah Freeway and the Sydney CBD. Falcon Street carries high traffic volumes at all times of the day, and queuing is frequently observed in the westbound direction in the morning peak, with queues extending east of the intersection of Military Road and Ben Boyd Road, and in the eastbound direction in the evening peak due to downstream constraints along Military Road through Neutral Bay and Cremorne.

A summary of modelled network performance statistics for the Warringah Freeway and surrounds study area is provided in Table 4-6.

Table 4-6 Modelled 2016 morning and evening peak network performance - Warringah Freeway and surrounds study area

Network measure	Morning peak period	Evening peak period
Network statistics for all vehicles		
Total traffic demand (veh)	96,700	101,200
Total VKT through network	339,900	331,800
Total VHT through network	9070	8550
Total number of stops	580,000	357,700
Average vehicle statistics		
Average vehicle trip length through the network (km)	3.6	3.3
Average vehicle trip time through the network (hours)	0:05:34	0:05:05
Average number of stops per trip	6.1	3.6
Average trip speed (km/h)	37.5	38.8
Unreleased traffic		
Total unreleased trips	2090	370
% of demand unreleased	2%	<1%

4.2.5 Intersection performance

Modelled performance for key intersections in the Warringah Freeway and surrounds study area under 2016 travel demands is presented in Table 4-7. Modelled intersection performance indicates that the following intersections are currently performing at a poor Level of Service during the morning peak period:

- Mount Street and Arthur Street
- High Street and Clark Road
- High Street and Alfred Street North.

The assessment also indicates that the Miller Street and Falcon Street intersection performs at an unsatisfactory level of service during the PM peak.

The intersection of Mount Street and Arthur Street is the primary western access to the Warringah Freeway where traffic heading to both the Sydney Harbour Bridge (Bradfield Highway) and Cahill Expressway lanes converges from Berry Street and Pacific Highway during the morning peak.

The intersection of Clark Road and High Street is the primary eastern access to the Sydney Harbour Bridge Cahill Expressway lane where traffic from Kirribilli and Neutral Bay converge. Queues from the intersection of High Street and Alfred Street North occasionally extend back through this intersection.

Table 4-7 Modelled 2016 morning and evening peak hour intersection performance - Warringah Freeway and surrounds study area

Intersection	Morning peak hour		Evening peak hour	
	Average delay (sec)	LoS	Average delay (sec)	LoS
Willoughby Road/Gore Hill Freeway interchange	11	A	20	B
Brook Street/Warringah Freeway on ramp	31	C	16	B
Brook Street/Warringah Freeway off ramp	30	C	22	B
Brook Street/Merrenburn Avenue	31	C	12	A
Amherst Street/West Street	6	A	10	A
Amherst Street/Miller Street	19	B	15	B
Miller Street/Warringah Freeway on ramp	<5	A	6	A
Miller Street/Warringah Freeway off ramp	13	A	13	A
Miller Street/Ernest Street	34	C	31	C
Miller Street/Falcon Street	35	C	69	E
Ernest Street/Warringah Freeway on ramp	<5	A	15	B
Ernest Street/Warringah Freeway off ramp (off ramp in PM, on ramp in AM)	<5	A	18	B
Falcon Street/Warringah Freeway ramps	38	C	46	D
Watson Street/Military Road	16	B	29	C
Military Road/Ben Boyd Road	13	A	20	B
Falcon Street/Merlin Street	17	B	38	C
Berry Street/Walker Street	32	C	50	D
Berry Street/Miller Street	30	C	27	B
Mount Street/Arthur Street	84	F	32	C
Mount Street/Walker Street	43	D	31	C
Pacific Highway/High Street/Arthur Street	53	D	19	B
Pacific Highway/Walker Street/Blue Street	53	D	48	D
Pacific Highway/Miller Street/Mount Street	52	D	41	C
Pacific Highway/Berry Street	9	A	11	A
Pacific Highway/Bay Road	21	B	14	B
Miller Street/McLaren Street	24	B	17	B
Miller Street/Ridge Street	39	C	26	B
Miller Street/Carlow Street	14	B	29	C
High Street/Clark Road	>100	F	36	C

Intersection	Morning peak hour		Evening peak hour	
	Average delay (sec)	LoS	Average delay (sec)	LoS
High Street/Alfred Street	60	E	18	B
Mount Street/Alfred Street	24	B	11	A
Ernest Street/Ben Boyd Road	11	A	16	B
Pedestrian crossing at Military Road	<5	A	20	B

4.2.6 Road safety and crash history

A summary of crash data for the five-year period between October 2014 and September 2019 on roads that would be substantially affected by the project (based on forecast traffic demand with and without the project) is presented in Table 4-8.

Key statistics include:

- Seventy-two per cent of crashes (581 crashes) resulted in at least one injury
- Two crashes resulted in a fatality: one on Pacific Highway and one on Warringah Freeway
- Twenty-seven per cent of crashes (215 crashes) involved a heavy vehicle, with the majority occurring on Warringah Freeway, Bradfield Highway and Military Road
- Ten per cent of crashes (82 crashes) involved a cyclist or pedestrian
- The three most common crash types involved vehicles travelling in the same direction (59 per cent), vehicles veering off path and onto a straight section of road (10 per cent), and vehicles vehicles travelling in the opposite direction (nine per cent)
- Fifty-eight per cent of crashes occurred at a midblock, while 42 per cent of crashes occurred at an intersection.

Table 4-8 Crash history summary – Warringah Freeway and surrounds study area

Road segment	Number of crashes by severity				Top three crash types	Number of pedestrian and cyclist crashes	Number of heavy vehicle crashes	% of midblock and intersection crashes
	Fatality	Injury	Non-injury	Total				
Belgrave Street	0	19	6	25	Opposing vehicles (44%) Pedestrian (24%) Vehicles from same direction (24%)	6 pedestrian crashes	5	96% intersection, 4% midblock
Bradfield Highway	0	89	31	120	Vehicles from same direction (76%) Veering off path on a straight (14%) Opposing vehicles (4%)	1 pedestrian crash and 1 cyclist crash	27	100% midblock
Cahill Expressway	0	28	19	47	Vehicles from same direction (68%) Veering off path on a curve (28%) Veering off path on a straight (4%)	0	15	2% intersection, 98% midblock
Cowles Road	0	1	1	2	Intersection, adjacent approaches (50%) Vehicles from same direction (50%)	0	0	50% intersection, 50% midblock
Ernest Street	0	20	4	24	Vehicles from same direction (42%) Opposing vehicles (21%) Intersection, adjacent approaches (17%)	4 cyclist crashes	3	79% intersection, 21% midblock
Falcon Street	0	53	16	69	Vehicles from same direction (45%) Intersection, adjacent approaches (20%) Opposing vehicles (16%)	3 pedestrian crashes and 5 cyclist crashes	18	91% intersection, 9% midblock
Gerard Street	0	11	3	14	Vehicles from same direction (50%) Pedestrian (29%) Opposing vehicles (7%)	4 pedestrian crashes	3	71% intersection, 29% midblock
Macpherson Street	0	2	0	2	Veering off path on a straight (50%) Veering off path on a curve (50%)	0	0	100% intersection

Road segment	Number of crashes by severity				Top three crash types	Number of pedestrian and cyclist crashes	Number of heavy vehicle crashes	% of midblock and intersection crashes
	Fatality	Injury	Non-injury	Total				
Military Road	0	115	36	151	Vehicles from same direction (63%) Pedestrian (11%) Veering off path on a straight (7%)	18 pedestrian crashes and 5 cyclist crashes	43	70% intersection, 30% midblock
Miller Street	0	27	20	47	Opposing vehicles (23%) Vehicles from same direction (23%) Veering off path on a straight (23%)	5 pedestrian crashes and 3 cyclist crashes	13	68% intersection, 32% midblock
Pacific Highway	1	44	21	66	Vehicles from same direction (42%) Pedestrian (24%) Intersection, adjacent approaches (12%)	16 pedestrian crashes and 5 cyclist crashes	16	77% intersection, 23% midblock
Strathallen Avenue	0	4	3	7	Vehicles from same direction (29%) Intersection, adjacent approaches (14%) Opposing vehicles (14%)	1 cyclist crash	1	57% intersection, 43% midblock
Sydney Harbour Tunnel	0	26	8	34	Vehicles from same direction (85%) Veering off path on a straight (12%) Pedestrian (3%)	1 pedestrian crash	7	100% midblock
Warringah Freeway	1	110	44	155	Vehicles from same direction (77%) Veering off path on a straight (12%) Veering off path on a curve (7%)	1 pedestrian crash and 1 cyclist crash	59	1% intersection, 99% midblock
Willoughby Road	0	30	14	44	Vehicles from same direction (34%) Opposing vehicles (23%) Vehicles manoeuvring (14%)	2 pedestrian crashes	5	64% intersection, 36% midblock
Total	2	579	226	807	Vehicles from same direction (59%) Veering off path on a straight (10%) Opposing vehicles (9%)	57 pedestrian crashes and 25 cyclist crashes	215	42% intersection, 58% midblock

A summary of casualty crashes for the five-year period between October 2014 and September 2019 on roads that would be substantially impacted by the project (based on forecast traffic demand with and without the project) is presented in Table 4-9.

The key road safety issues in the Warringah Freeway and surrounds study area include:

- High crash rates are observed on Pacific Highway (164.7 crashes per 100 million VKT), Belgrave Street (106.3 crashes per 100 million VKT), Falcon Street (88.3 crashes per 100 million VKT), Miller Street (75.7 crashes per 100 million VKT) and Military Road (47.8 crashes per 100 million VKT)
- Casualty crash rates on the Bradfield Highway and Warringah Freeway exceed the Sydney region average, likely due to their high demands and complex road geometry which may require drivers to perform consecutive merge or weave manoeuvres across multiple lanes
- High traffic volumes in both directions on Pacific Highway, Falcon Street and Military Road which are major bus corridors, and the presence of parking lanes and lack of turning bays on Ernest Street and Belgrave Street, which provide an alternative route for drivers avoiding the Military Road/Spit Road corridor, would also contribute to the higher than average crash rates observed.

Table 4-9 Casualty crash analysis – Warringah Freeway and surrounds study area

Road segment	Length (km)	AADT	Crash rate per 100 million VKT	Casualty crashes per km per year	Casualty crashes (Sydney average)[6]
Belgrave Street	0.4	29,700	106.3	9.3	3.9
Bradfield Highway	2.5	135,800	20.6	7.1	4.7
Cahill Expressway	1.7	36,900	38.7	3.2	5.8
Cowles Road	0.7	5700	33.3	0.3	0.8
Ernest Street	1.7	10,100	51.6	2.4	0.8
Falcon Street	0.8	24,700	88.3	7.6	5.8
Gerard Street	0.7	33,300	35.7	3.1	3.9
Macpherson Street	0.8	26,500	8.5	0.5	3.9
Military Road	3.6	57,200	47.8	8.2	4.7
Miller Street	2.6	11,400	75.7	2.1	3.9
Pacific Highway	1.3	24,000	164.7	7.2	5.8
Strathallen Avenue	0.9	26,100	16.9	0.9	3.9
Sydney Harbour Tunnel	2.6	98,500	7.3	2.0	4.7
Warringah Freeway	2.5	242,800	16.6	8.9	4.7
Willoughby Road	2.8	11,300	38.4	2.2	3.9

[6] Transport for NSW, 2019

4.2.7 Public transport network

The Warringah Freeway and surrounds study area is highly accessible by public transport. Heavy rail services are provided at Milsons Point, North Sydney, Waverton and Wollstonecraft railway stations, which are located on the T1 North Shore and T9 Northern Lines, providing direct connections to Sydney CBD, Chatswood, Macquarie Park, Epping, Hornsby, Parramatta, Blacktown, Penrith and Richmond. Direct services are also provided to and from the Central Coast from North Sydney station during the weekday peak periods.

The Warringah Freeway and surrounds study area is also a major thoroughfare for buses, with 109 routes and about 4900 timetabled services on weekdays, 2300 services on Saturdays, and 1900 services on Sundays and public holidays. Bus services are operated by Sydney Buses, Transit Systems NSW, Forest Coach Lines, Hillsbus and Transdev NSW. Major bus corridors in the Warringah Freeway and surrounds study area include:

- Warringah Freeway – for services to Sydney CBD, Northern Beaches, North Shore and the Hills District
- Military Road – for services to Mosman and the Northern Beaches
- Miller Street – for services to and from North Sydney CBD
- Pacific Highway – for services to Chatswood, Epping, Gladesville and the Hills District.

Bus route maps are shown in Figure 4-11 (Sydney Buses), Figure 4-12 (Transit Systems NSW), Figure 4-13 (Forest Coach Lines), Figure 4-14 (Hillsbus) and Figure 4-15 (Transdev NSW).

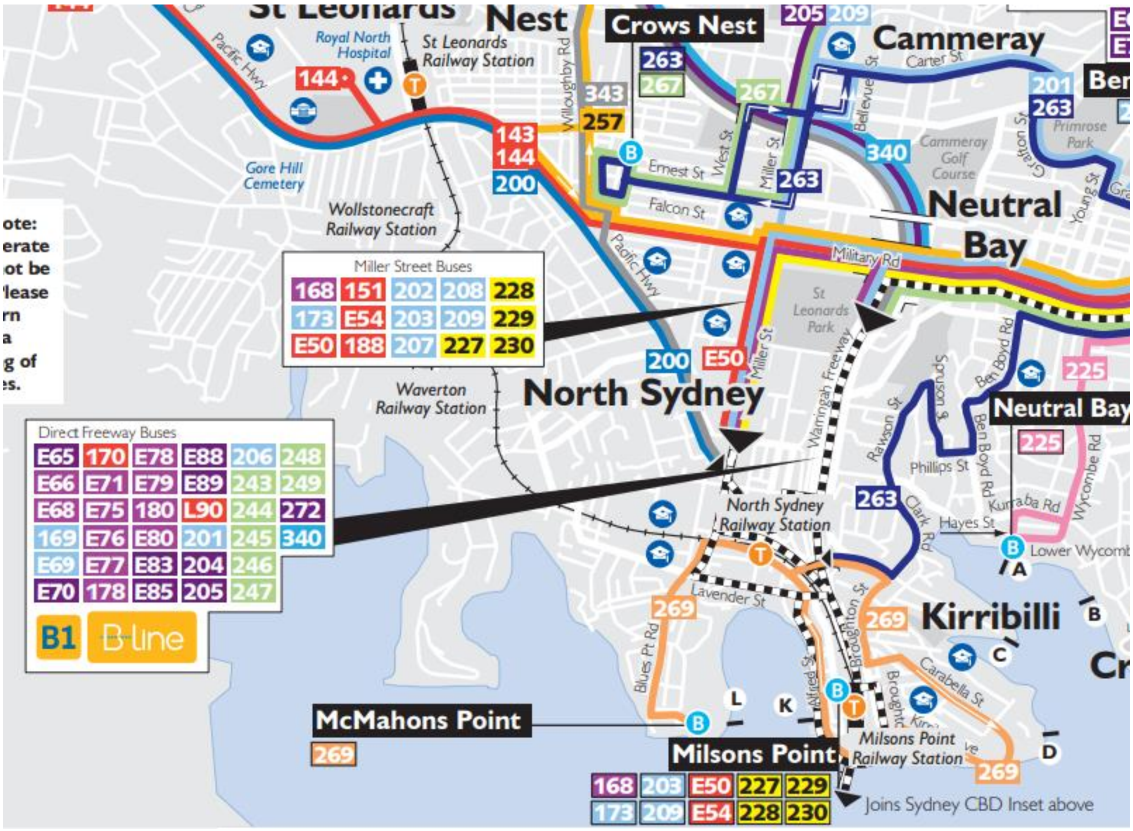


Figure 4-11 Bus routes - Warringah Freeway and surrounds study area – Sydney Buses

Source: Northern Beaches & Lower North Shore region guide (Transport for NSW, 2019a)

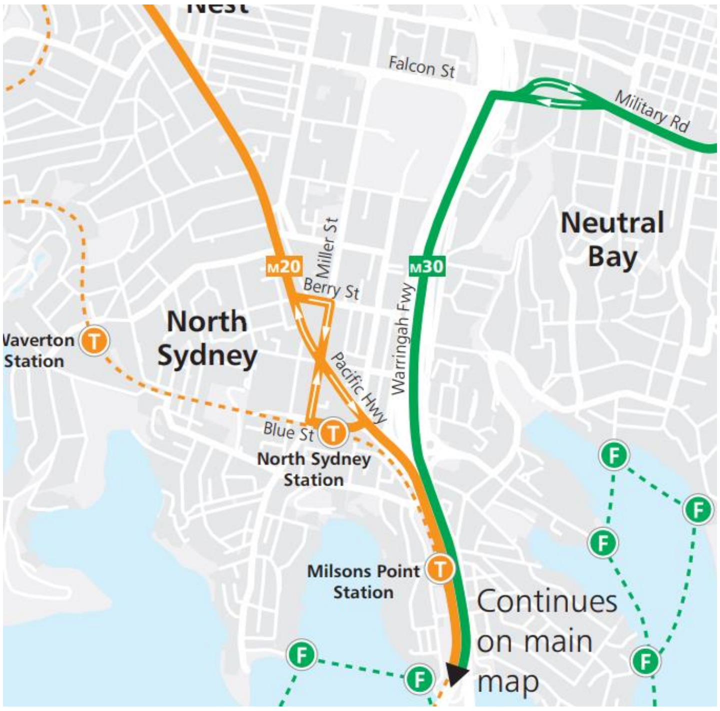


Figure 4-12 Bus routes - Warringah Freeway and surrounds study area – Transit Systems NSW

Source: Inner West and Southern region network (Transit Systems NSW, 2019)

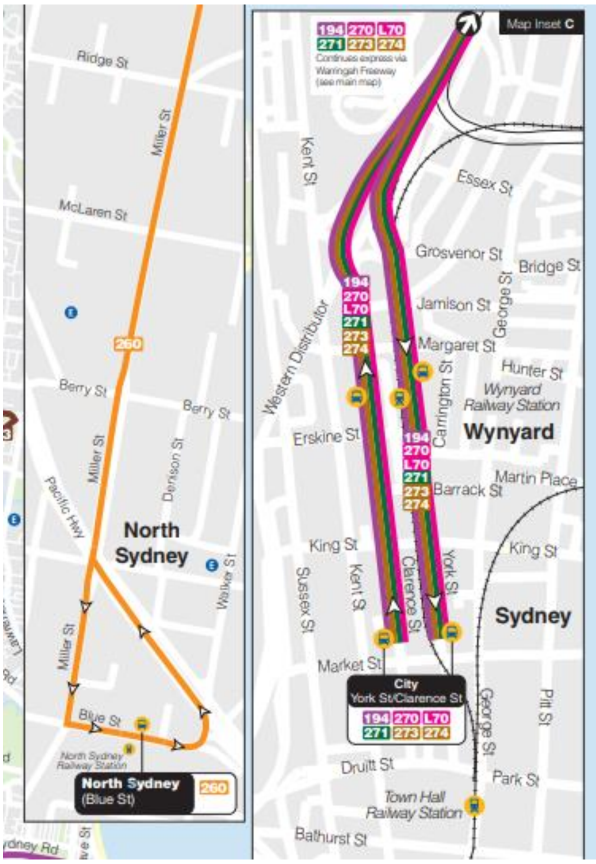


Figure 4-13 Bus routes – Warringah Freeway and surrounds study area – Forest Coach Lines

Source: Forest Coach Lines Sydney Region Network Map (Forest Coach Lines, 2019)

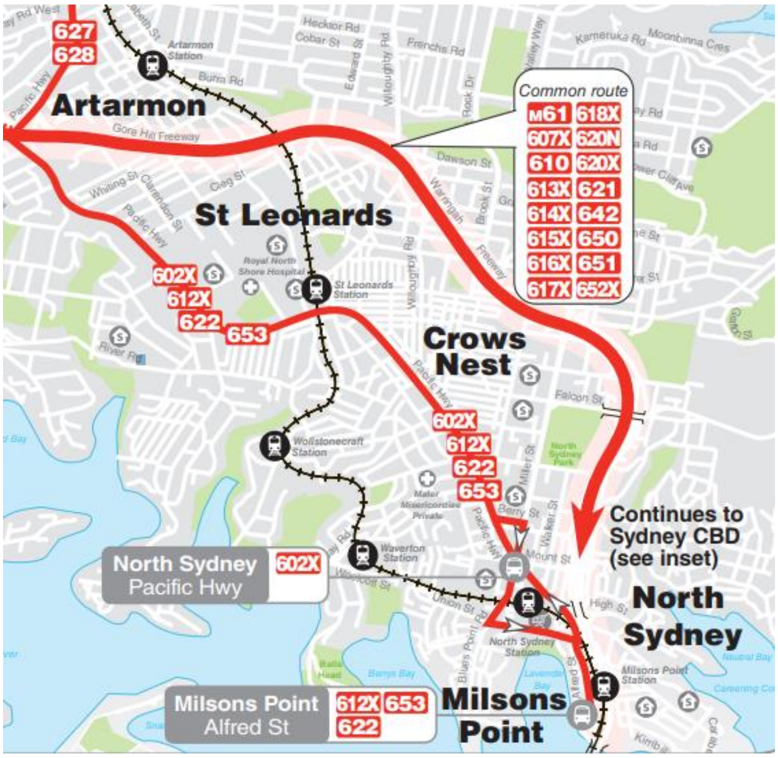


Figure 4-14 Bus routes - Warringah Freeway and surrounds study area – Hillsbus

Source: Hills District Bus Guide (Hillsbus, 2019)

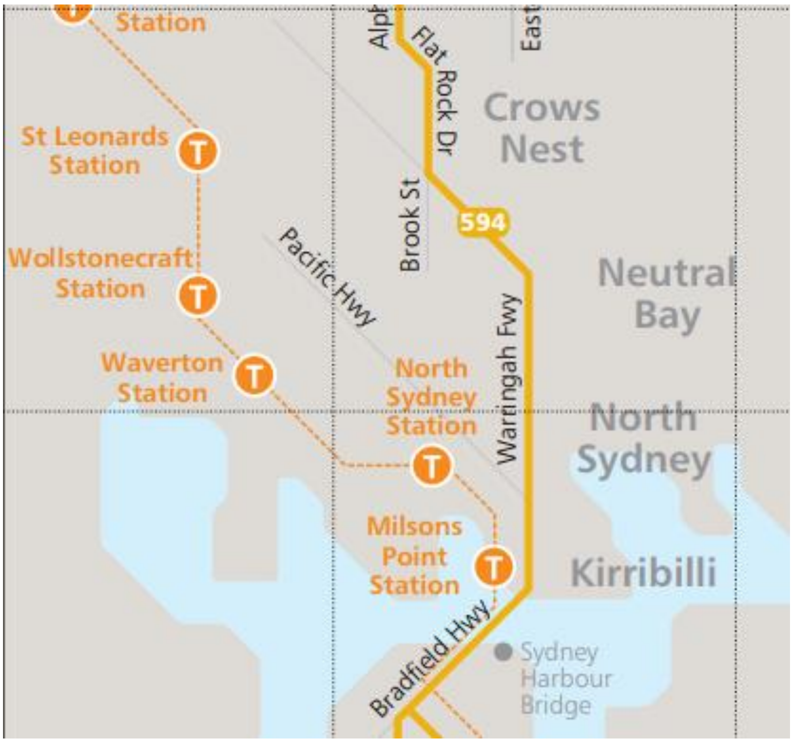


Figure 4-15 Bus routes – Warringah Freeway and surrounds study area – Transdev NSW

Source: Upper North Shore network map (Transdev NSW, 2019)

4.2.8 Active transport network

The pedestrian network in the Warringah Freeway and surrounds study area is well developed with footpaths alongside the vast majority of roads and controlled crossings at most signalised intersections. Pedestrians are prohibited from walking along the Warringah Freeway. High levels of pedestrian activity associated with retail and commercial land uses occur within North Sydney CBD, including in the vicinity of the numerous schools located west of the Pacific Highway and along Miller Street. Balls Head Reserve is also a major generator of pedestrian activity, associated with people exercising.

The cycle network in the Warringah Freeway and surrounds study area is shown in Figure 4-16 and consists mostly of on-road cycle routes on local, collector and sub-arterial roads. The regional strategic cycle network provides connections between the study area and Sydney CBD, Cremorne, Mosman, Crows Nest, St Leonards, Lane Cove and Macquarie Park. Secure bicycle lockers are located on Mount Street in North Sydney, and O-ring cycle stands and bicycle rails for cycle parking are located throughout North Sydney CBD.

The Warringah Freeway presents a barrier to east–west and north-south movements for pedestrians and cyclists, with crossings only available at select locations including:

- West Street
- Miller Street
- Ernest Street
- Shared user bridge connecting Falcon Street in North Sydney and Merlin Street in Neutral Bay
- Falcon Street
- Shared user bridge connecting Ridge Street in North Sydney and Alfred Street North in Neutral Bay
- Mount Street
- High Street.

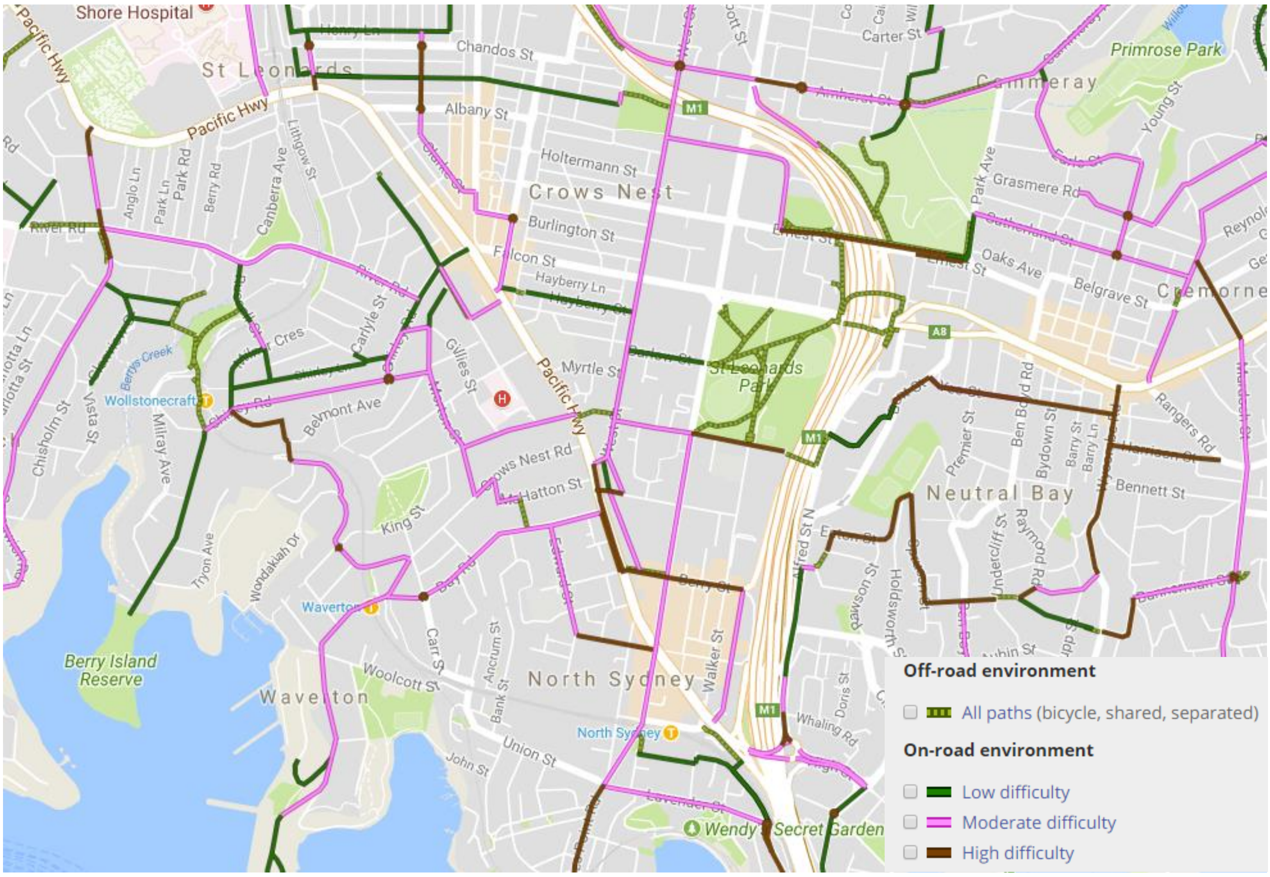


Figure 4-16 Cycle network - Warringah Freeway and surrounds study area

Source: Cycleway Finder (Roads and Maritime, 2018)

Pedestrian and cyclist surveys were carried out on Thursday 20 July 2017 between 6.30am and 6.30pm at the eight crossings of the Warringah Freeway. The survey results are summarised in Table 4-10. Over all eight crossings of the Warringah Freeway, there were a total of about 8760 pedestrians and 830 cyclists. Mount Street was the most used crossing for pedestrians, which can be attributed to its proximity to North Sydney CBD. West Street was the most used crossing for cyclists, as it is a marked on-road cycle route providing connectivity between North Sydney, Crows Nest and Willoughby.

Table 4-10 Pedestrian and cyclist survey results – Warringah Freeway crossings

Location	Time period	Number of pedestrians	Number of cyclists	Total number of pedestrians and cyclists
West Street	Morning peak (6.30am to 9.30am)	330	140	470
	Interpeak (9.30am to 3.30pm)	490	30	520
	Evening peak (3.30pm to 6.30pm)	280	150	430
	Total (6.30am to 6.30pm)	1100	320	1420
Miller Street	Morning peak (6.30am to 9.30am)	480	20	500
	Interpeak (9.30am to 3.30pm)	380	20	400
	Evening peak (3.30pm to 6.30pm)	360	30	390
	Total (6.30am to 6.30pm)	1220	70	1290

Location	Time period	Number of pedestrians	Number of cyclists	Total number of pedestrians and cyclists
Ernest Street	Morning peak (6.30am to 9.30am)	60	30	90
	Interpeak (9.30am to 3.30pm)	70	20	90
	Evening peak (3.30pm to 6.30pm)	70	20	90
	Total (6.30am to 6.30pm)	200	70	270
Shared user bridge connecting Falcon Street and Merlin Street	Morning peak (6.30am to 9.30am)	240	40	280
	Interpeak (9.30am to 3.30pm)	350	20	370
	Evening peak (3.30pm to 6.30pm)	210	30	240
	Total (6.30am to 6.30pm)	800	90	890
Falcon Street	Morning peak (6.30am to 9.30am)	110	20	130
	Interpeak (9.30am to 3.30pm)	120	10	130
	Evening peak (3.30pm to 6.30pm)	80	20	100
	Total (6.30am to 6.30pm)	310	50	360
Shared user bridge connecting Ridge Street and Alfred Street North	Morning peak (6.30am to 9.30am)	310	10	320
	Interpeak (9.30am to 3.30pm)	240	<10	250
	Evening peak (3.30pm to 6.30pm)	200	<10	210
	Total (6.30am to 6.30pm)	750	30	780
Mount Street	Morning peak (6.30am to 9.30am)	990	<10	1000
	Interpeak (9.30am to 3.30pm)	1510	20	1530
	Evening peak (3.30pm to 6.30pm)	930	10	940
	Total (6.30am to 6.30pm)	3430	40	3470
High Street	Morning peak (6.30am to 9.30am)	280	140	420
	Interpeak (9.30am to 3.30pm)	400	<10	410
	Evening peak (3.30pm to 6.30pm)	270	<10	280
	Total (6.30am to 6.30pm)	950	160	1110
Total at all sites	Morning peak (6.30am to 9.30am)	2800	410	3210
	Interpeak (9.30am to 3.30pm)	3560	140	3700
	Evening peak (3.30pm to 6.30pm)	2400	280	2680
	Total (6.30am to 6.30pm)	8760	830	9590

A pedestrian and cyclist survey was also completed on Tuesday 28 November 2017, Saturday 2 December 2017 and Sunday 3 December 2017 between 6am and 8pm at the Falcon Street underpass adjacent to the eastern side of the Warringah Freeway. The survey results are provided in Figure 4-17 to Figure 4-19. The surveys indicate that the underpass is underutilised, with fewer than 12 pedestrians and cyclists per hour using the underpass on the weekday, and fewer than six pedestrians and cyclists per hour using the underpass on the weekend.

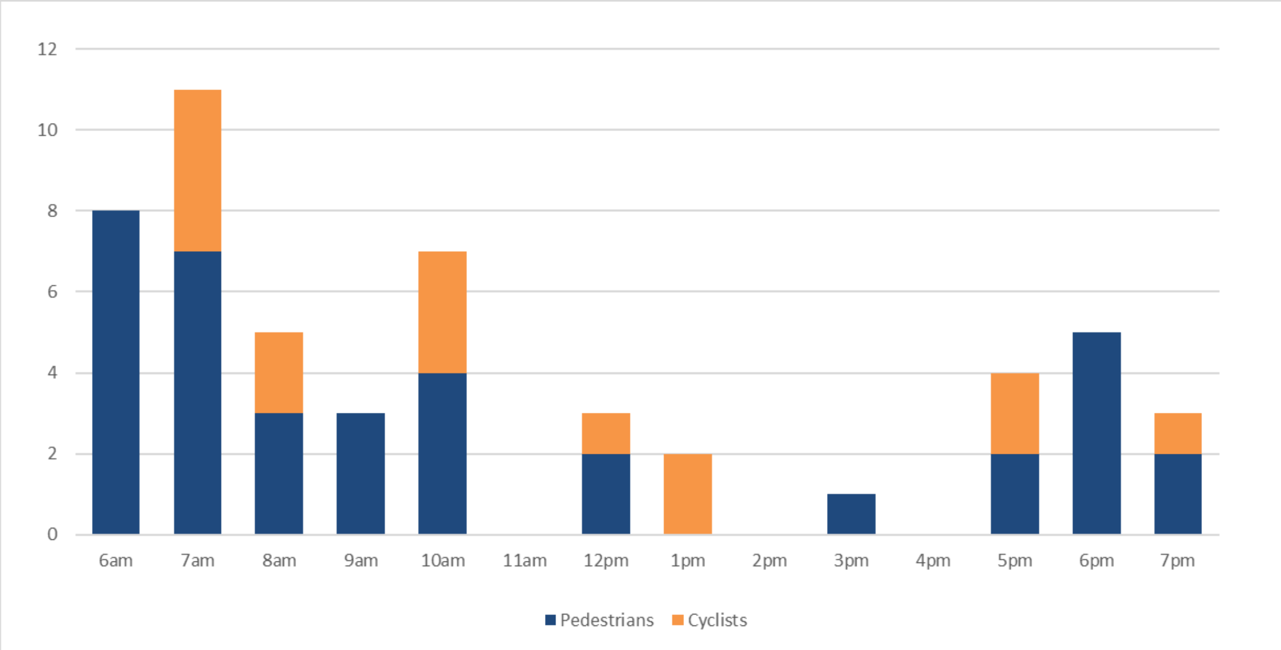


Figure 4-17 Weekday pedestrian and cyclist survey results (number per hour) – Falcon Street underpass

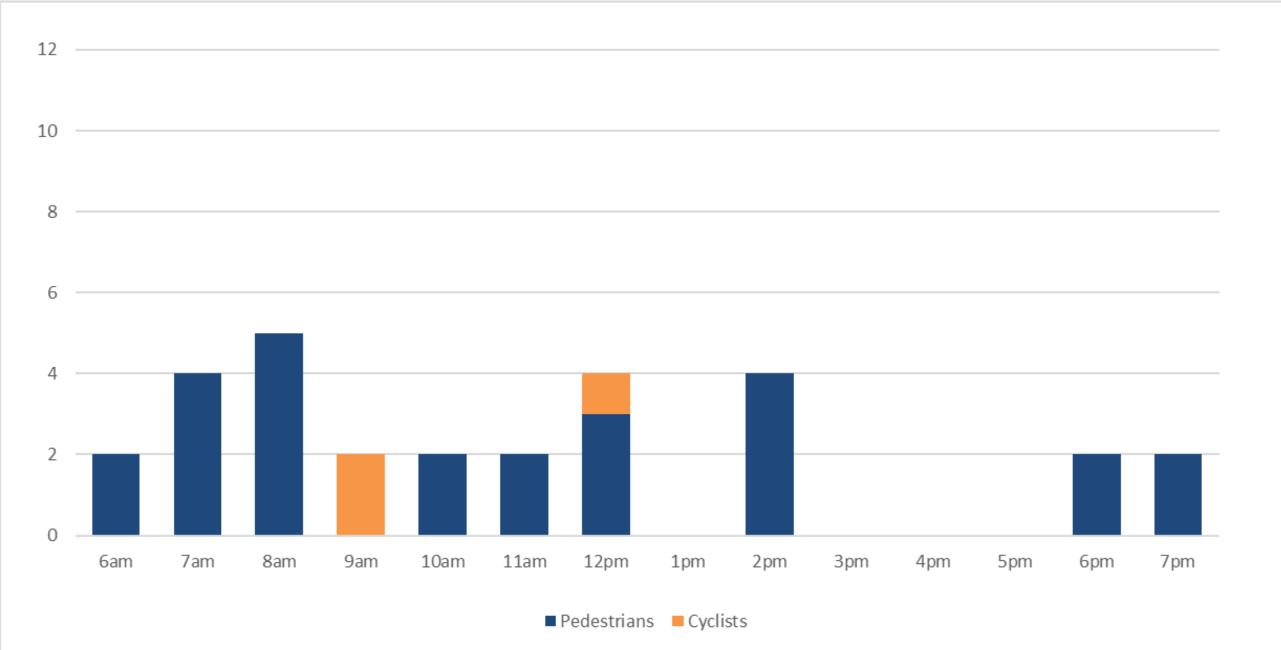


Figure 4-18 Saturday pedestrian and cyclist survey results (number per hour) - Falcon Street underpass

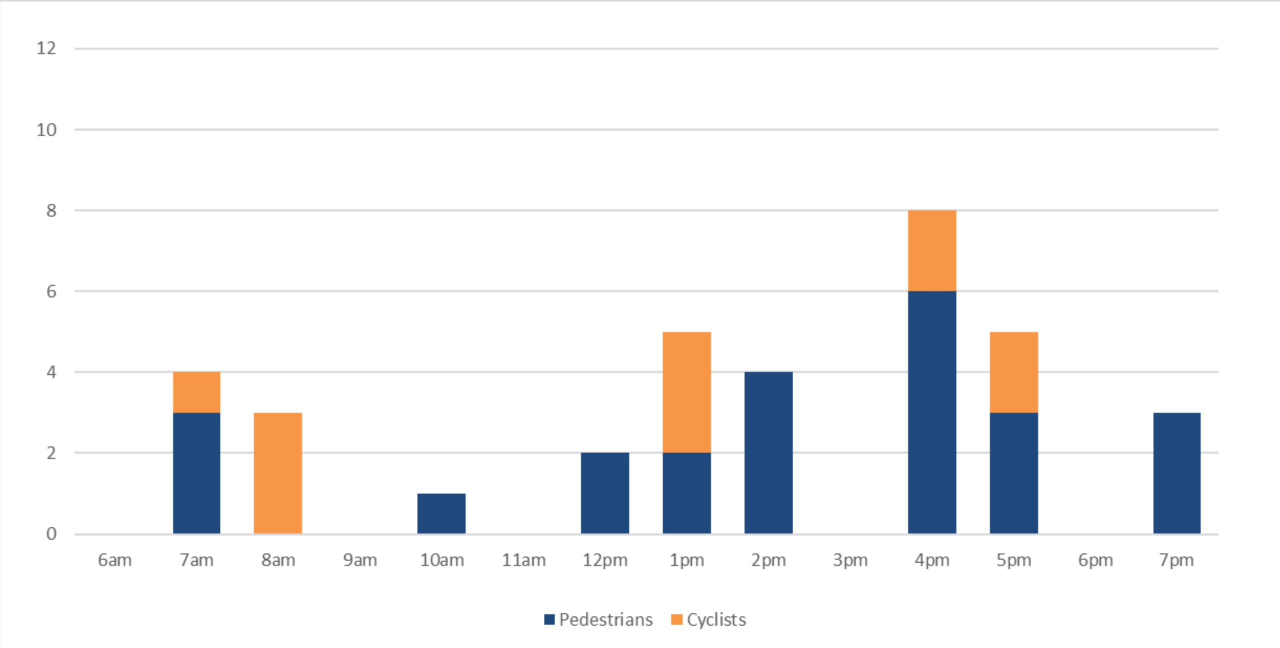


Figure 4-19 Sunday pedestrian and cyclist survey results (number per hour) - Falcon Street underpass

Pedestrian and cyclist surveys were also carried out on Wednesday 10 April 2019, Saturday 13 April 2019 and Sunday 14 April 2019 between 6am and 8pm at the shared user path in Jeaffreson Jackson Reserve. The survey results are provided in Figure 4-20 to Figure 4-22. The surveys indicate that the shared user path is used by a moderate number of pedestrians, particularly on weekdays where a maximum hourly volume of 45 pedestrians was observed. Minimal cyclists used the shared user path, with fewer than seven cyclists per hour recorded on the weekday and weekend.

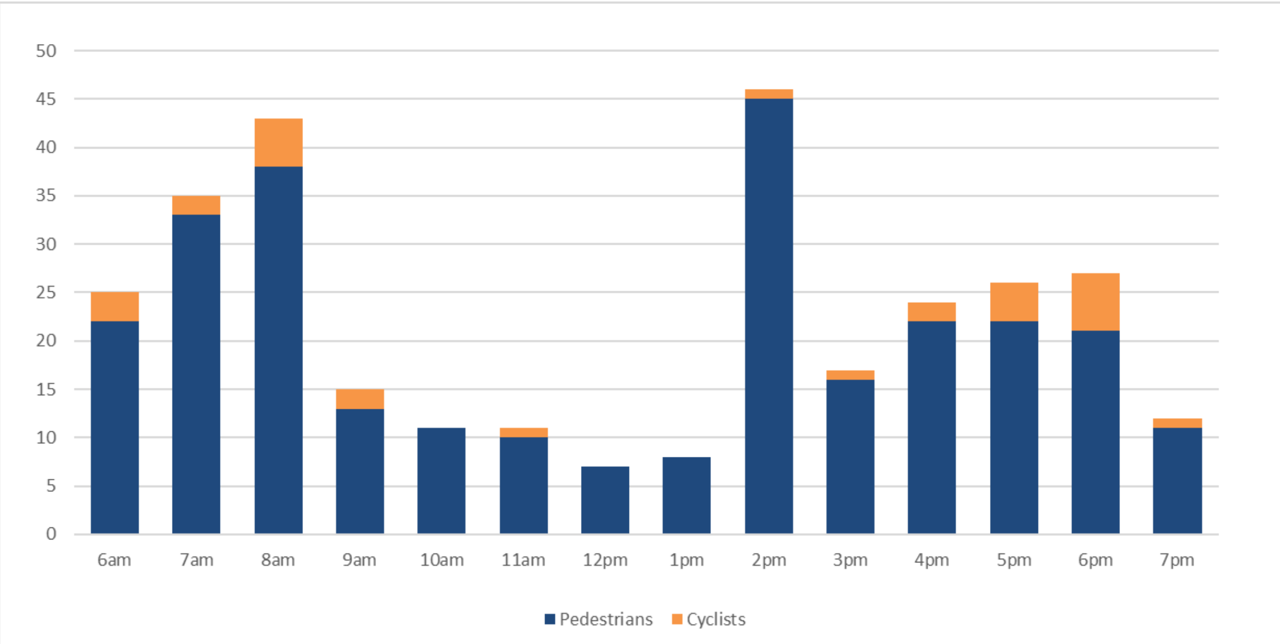


Figure 4-20 Weekday pedestrian and cyclist survey results (number per hour) - Jeaffreson Jackson Reserve shared user path

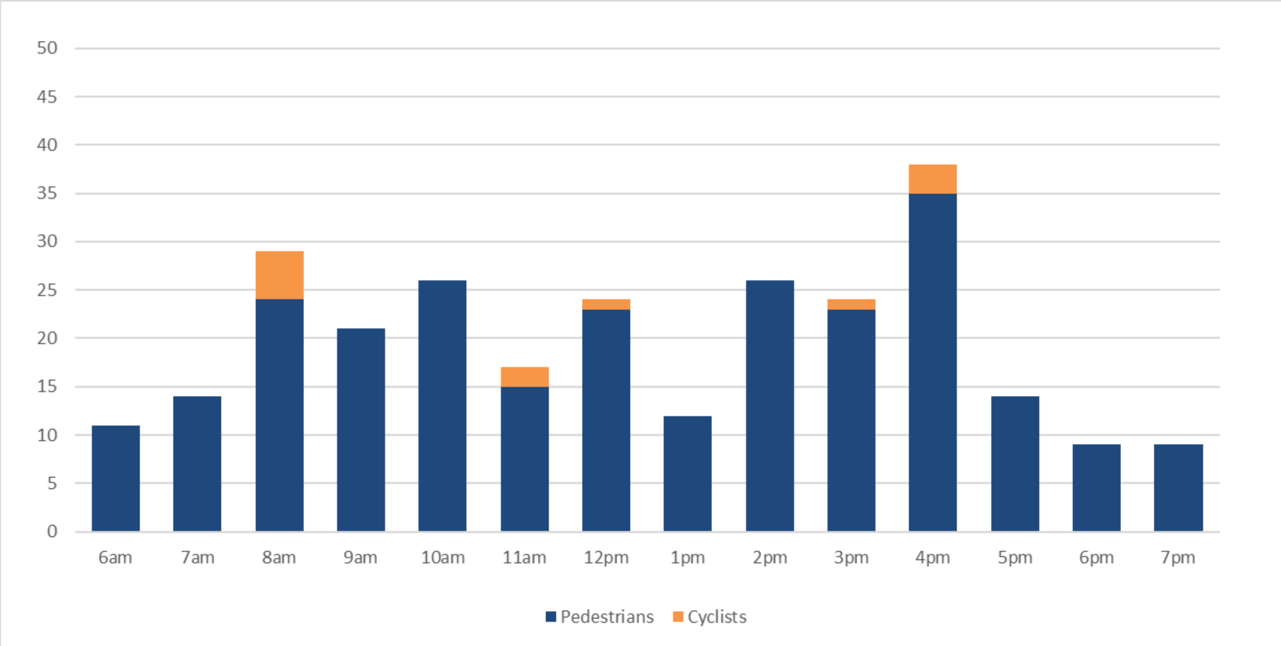


Figure 4-21 Saturday pedestrian and cyclist survey results (number per hour) - Jeaffreson Jackson Reserve shared user path

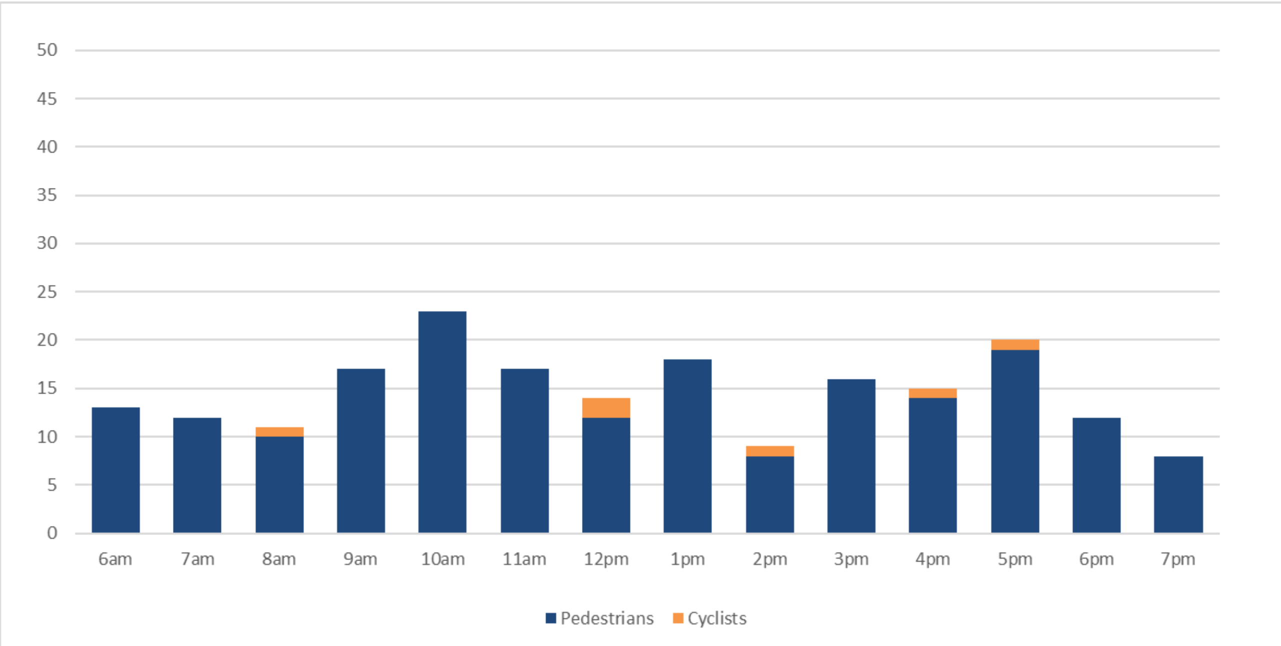


Figure 4-22 Sunday pedestrian and cyclist survey results (number per hour) - Jeaffreson Jackson Reserve shared user path

4.3 Gore Hill Freeway and Artarmon

The broad study area for the traffic and transport assessment of Gore Hill Freeway and Artarmon is shown in Figure 4-23 and includes the suburbs of Artarmon, Crows Nest, St Leonards, Cammeray, Lane Cove, Naremburn and Willoughby.

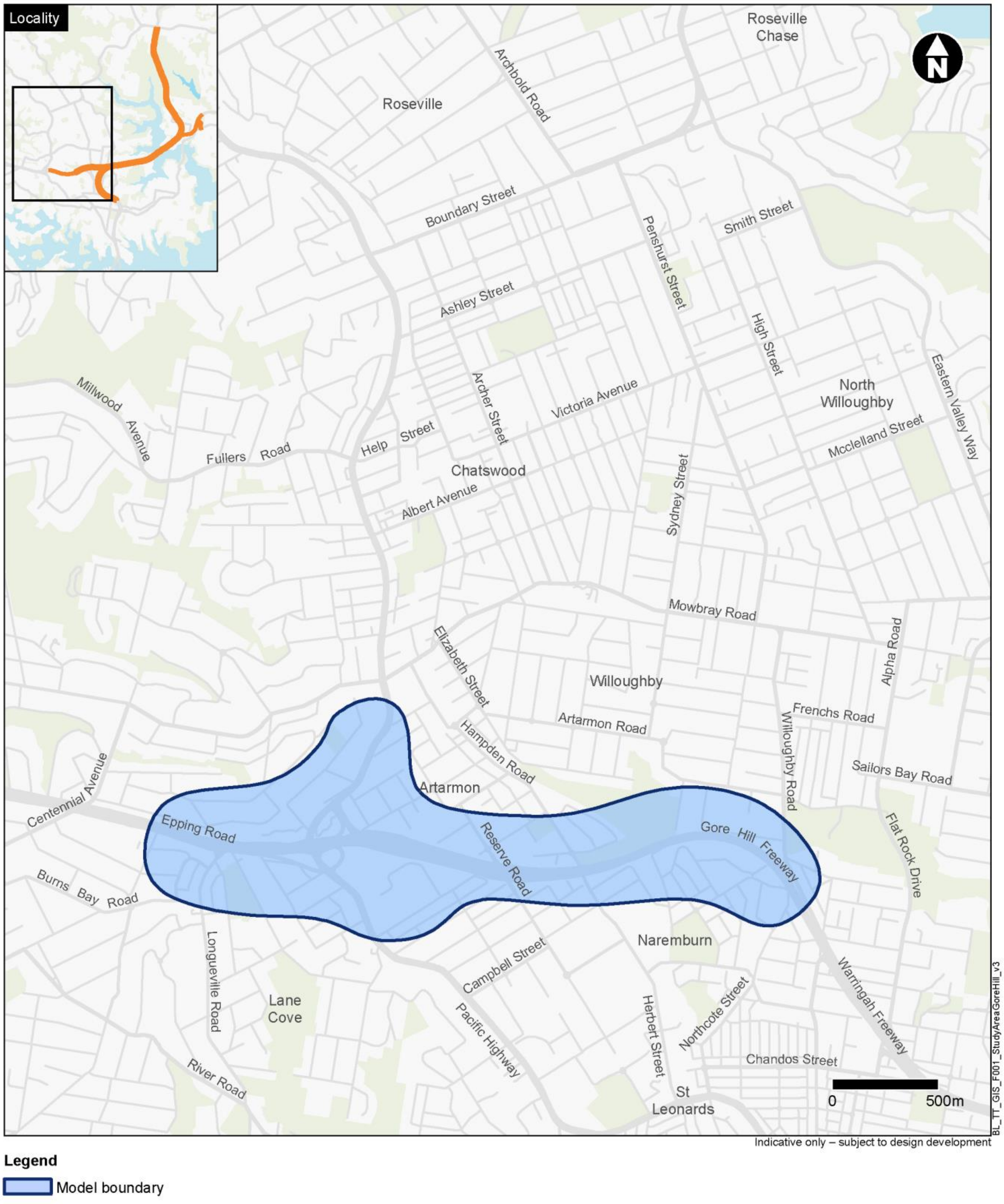


Figure 4-23 Gore Hill Freeway and Artarmon study area and operational model boundary

4.3.1 Modes of travel

Journey to work data for the Gore Hill Freeway and Artarmon study area (based on statistical areas defined by the Australian Bureau of Statistics that fall within the operational traffic model boundary) was analysed to determine travel patterns for residents and workers.

In 2016 the population in the Gore Hill Freeway and Artarmon study area was 112,200[7].. The mode share for residents travelling to their employment destinations is shown in Figure 4-24. Private vehicles accounted for 49 per cent of trips, with 45 per cent as vehicle drivers and four per cent as passengers. Public transport accounted for 40 per cent of trips, with 23 per cent by train and 17 per cent by bus. Walking accounted for eight per cent of trips. When compared to the Sydney average, the public transport mode share is relatively high and the private vehicle mode share is relatively low. This can be attributed to the locations where most residents work, which are Sydney Inner City, Chatswood–Lane Cove, and North Sydney–Mosman. These locations are highly accessible by public transport from the study area, and in the Sydney CBD parking is discouraged through pricing mechanisms.

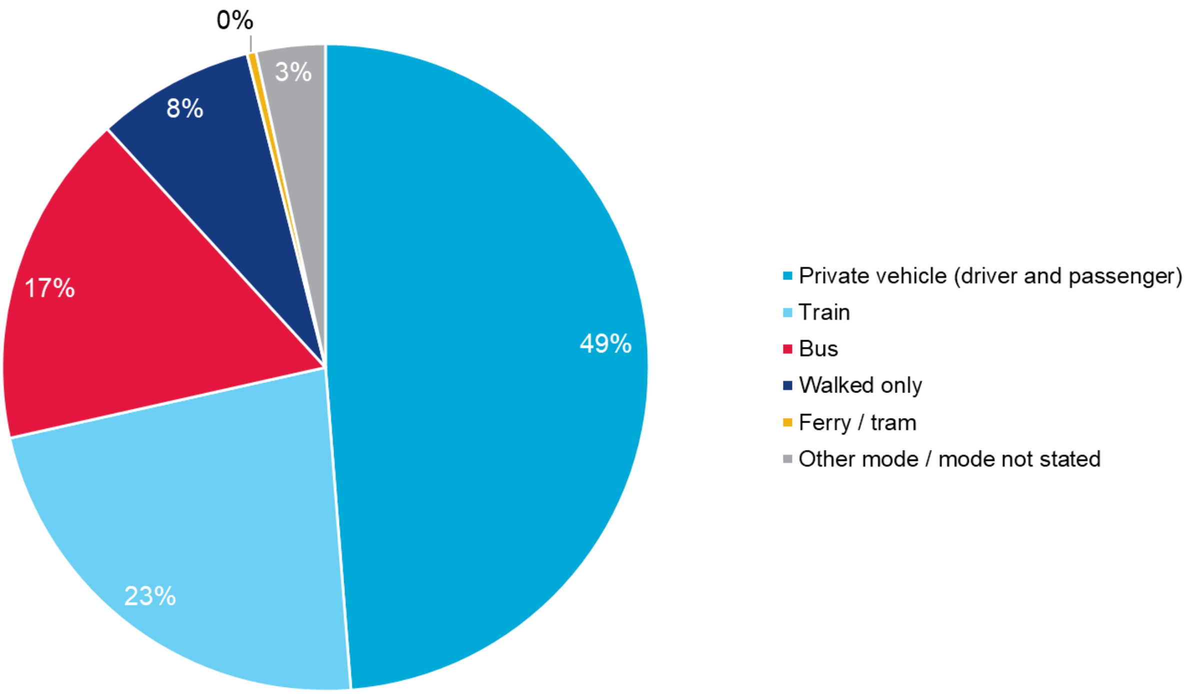


Figure 4-24 Mode share for residents in the Gore Hill Freeway and Artarmon study area travelling to their employment

Source: Journey to Work 2016 (Transport for NSW, 2018c)

In 2016 there were 79,600 workers in the Gore Hill Freeway and Artarmon study area. The mode share for workers travelling to employment is shown in Figure 4-25. Private vehicles accounted for 58 per cent of trips, with 55 per cent as vehicle drivers and three per cent as passengers. Public transport accounted for 33 per cent of trips, with 27 per cent by train and six per cent by bus. Walking accounted for six per cent of trips. When compared to the Sydney average, the public transport mode share is relatively high and the private vehicle mode share is similar. This can be attributed to the disparate locations across northern Sydney where workers live and the abundance of public transport services accessible to and from the Gore Hill Freeway and Artarmon study area.

[7] Journey to work data is based on statistical areas defined by the Australian Bureau of Statistics that fall within the operational traffic model boundary for each study area. For Gore Hill Freeway and Artarmon area this includes the statistical areas of Chatswood (East) – Artarmon, Chatswood (West) – Lane Cove North, Lane Cove – Greenwich, St Leonards – Naremburn, and Willoughby – Castle Cove – North Bridge

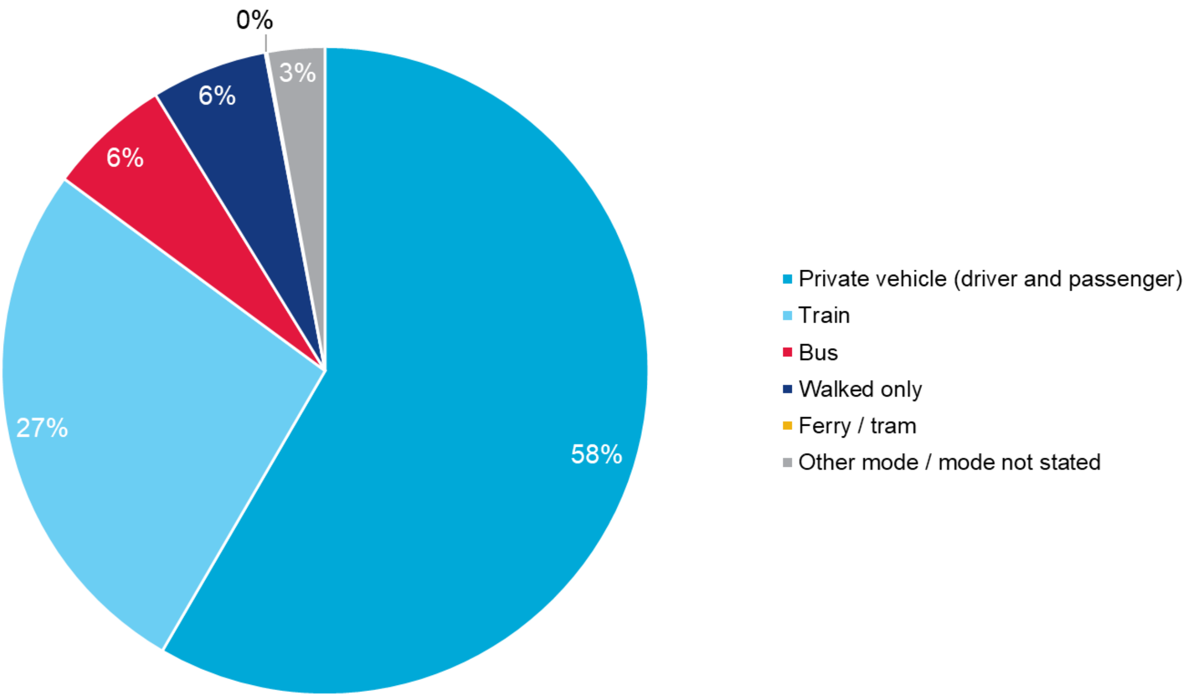


Figure 4-25 Mode share for workers travelling to employment in the Gore Hill Freeway and Artarmon study area

Source: Journey to Work 2016 (Transport for NSW, 2018c)

4.3.2 Road network key features

Key roads in the Gore Hill Freeway and Artarmon study area and their characteristics are summarised in Table 4-11.

Table 4-11 Summary of key roads – Gore Hill Freeway and Artarmon study area

Road	Location	Road type and speed limit	Total number of lanes	Key destinations	On-road public transport	Operational arrangements
M1 Gore Hill Freeway	Artarmon, Naremburn, Willoughby	Motorway 80 km/h	Six	Connectivity to the Sydney metropolitan area as part of the Sydney Orbital Network	Major bus corridor. Services to Sydney CBD, Lane Cove, Marsfield and the Hills District	24-hour T2 transit lanes in operation
M2 Lane Cove Tunnel	Artarmon	Motorway 80 km/h	Up to six (variable, depending on location)	Connectivity to the Sydney metropolitan area as part of the Sydney Orbital Network	Major bus corridor. Services to Sydney CBD, Lane Cove, Marsfield and the Hills District	24-hour T2 transit lanes in operation

Road	Location	Road type and speed limit	Total number of lanes	Key destinations	On-road public transport	Operational arrangements
Pacific Highway	Artarmon	Major arterial road 60 km/h	Up to six (variable, depending on location)	St Leonards, Chatswood, Pymble, Hornsby, Central Coast and Newcastle (via M1 Pacific Motorway)	Major bus corridor. Services to Sydney CBD, Chatswood, Epping, Gladesville and the Hills District	Clearways in operation during weekday peak periods
Longueville Road/Epping Road	Lane Cove	Major arterial road 60 km/h	Up to six (variable, depending on location)	Artarmon, North Ryde, Macquarie Park, Sydney CBD (via Sydney Orbital Network)	Major bus corridor. Services to Sydney CBD, Lane Cove, Marsfield and Epping. 24-hour bus lanes in both directions	N/A
Sailors Bay Road	Northbridge	Sub-arterial 50 km/h	Up to four (variable, depending on location)	Northbridge, Willoughby, Northern Beaches (via Eastern Valley Way/Warringah Road)	Services to Sydney CBD, North Sydney, Northbridge and East Lindfield	Clearways in operation during weekday peak periods
Eastern Valley Way/Clive Street	Northbridge, Willoughby	Sub-arterial road 60 km/h	Four	Northbridge, Castlecrag, Castle Cove, Willoughby, Northern Beaches	Major bus corridor, Services to Sydney CBD, North Sydney, Northbridge and East Lindfield	Clearways in operation during weekday peak periods
Reserve Road	Artarmon	Collector road 50 km/h	Up to four (variable, depending on location)	Artarmon commercial areas, Royal North Shore Hospital	N/A	N/A
Hampden Road	Artarmon	Collector road 50 km/h	Two	St Leonards, Artarmon railway station, Royal North Shore Hospital	NightRide bus services between Sydney CBD and Hornsby	N/A
Herbert Street	Artarmon	Collector road 50 km/h	Two	St Leonards railway station, Royal North Shore Hospital	N/A	N/A

Road	Location	Road type and speed limit	Total number of lanes	Key destinations	On-road public transport	Operational arrangements
Dickson Avenue	Artarmon	Local road 50 km/h	Two	Provides access to commercial properties in Artarmon	N/A	N/A
Punch Street	Artarmon	Local road 50 km/h	Two	Provides access to commercial properties in Artarmon	N/A	N/A
Cleg Street	Artarmon	Local road 50 km/h	Two	Provides access to commercial properties in Artarmon	N/A	N/A

4.3.3 Traffic volumes and patterns

Reserve Road is a collector road that exhibits a southbound morning peak direction and a northbound evening peak direction. Traffic volumes are higher on Reserve Road near the Gore Hill Freeway, with peak direction traffic volumes north of Dickson Avenue generally greater than 1000 vehicles per hour. Herbert Street and Frederick Street are also collector roads that carry slightly lower traffic volumes ranging between 250 and 560 vehicles per hour in each direction during peak periods.

Low traffic volumes are experienced on Cleg Street and Dickson Avenue, which are both considered local roads.

The midblock volumes on key access roads in the Gore Hill Freeway and Artarmon study area are summarised in Table 4-12.

Table 4-12 2016 peak hour traffic volumes - Gore Hill Freeway and Artarmon study area

Road	Direction	Morning peak hour		Evening peak hour	
		Volume (veh)	Heavy vehicle percentage	Volume (veh)	Heavy vehicle percentage
Reserve Road north of Dickson Avenue	Northbound	520	8%	1140	1%
	Southbound	1210	3%	610	2%
Reserve Road north of Frederick Street	Northbound	320	10%	670	3%
	Southbound	690	3%	490	1%
Frederick Street east of Reserve Road	Eastbound	440	5%	560	1%
	Westbound	360	8%	420	5%
Herbert Street north of Frederick Street	Northbound	250	3%	440	1%
	Southbound	530	3%	500	2%
Cleg Street east of Herbert Street	Eastbound	110	1%	190	1%
	Westbound	120	2%	180	2%

Road	Direction	Morning peak hour		Evening peak hour	
		Volume (veh)	Heavy vehicle percentage	Volume (veh)	Heavy vehicle percentage
Dickson Avenue east of Reserve Road	Eastbound	250	3%	150	0%
	Westbound	130	5%	30	2%
Reserve Road south of Barton Road	Northbound	350	3%	640	1%
	Southbound	470	2%	410	1%

4.3.4 Road network performance

The Gore Hill Freeway connects the M2 Motorway corridor with the M1 Motorway corridor through Artarmon and Willoughby. Although the Gore Hill Freeway carries high traffic volumes at all times of the day, traffic volumes are highest heading southbound in the morning peak and northbound in the evening peak, as a result of trips heading into and out of central Sydney from north-west Sydney via the M2 Motorway and from the North Shore via Pacific Highway, as well as more local traffic from Lane Cove and Ryde.

The Artarmon industrial area is located directly to the south of the Gore Hill Freeway, bounded by the Pacific Highway and northern railway line, with Royal North Shore Hospital further south. Traffic to and from this employment area travels predominantly via Reserve Road from the south, while directly north of Gore Hill Freeway, traffic generated by Artarmon and its surrounding high-density residential development also travels predominantly via Reserve Road. Most traffic on Reserve Road travels to and from Gore Hill Freeway; consequently, the operation of this interchange is limited by the double-point arrangement, which limits capacity for the off ramps that often operate at or close to capacity during the morning peak.

Lane Cove town centre is located immediately to the west of the Gore Hill Freeway, at the confluence of Pacific Highway, Longueville Road and Epping Road. The intersection of Longueville Road and Epping Road is the primary surface road constraint in the corridor due to the high volumes of traffic travelling to and from Lane Cove and Riverview. In the morning peak, high traffic volumes along Epping Road conflict with high right turning traffic volumes from south to east on Longueville Road as well as pedestrians crossing Epping Road. In the evening peak, high traffic volumes from Pacific Highway and Gore Hill Freeway merge into a single left turn lane into Lane Cove that is frequently blocked by buses travelling westbound at Lane Cove interchange. Traffic turning right into Parkland Avenue from Pacific Highway must weave across two lanes of heavy traffic over a short 200-metre section, often resulting in westbound delays on Gore Hill Freeway.

Longueville Road and Epping Road are key bus corridors with routes travelling to Lane Cove, Ryde and the Hills stopping at Lane Cove Interchange. Bus priority is provided on Epping Road west of Longueville Road in the form of signal priority for westbound traffic at Longueville Road and continuous bus lanes on Epping Road. Signal priority for buses is also provided for eastbound buses on Longueville Road at Pacific Highway while eastbound buses on the Gore Hill Freeway use the 24-hour T2 transit lane that extends to Willoughby Road.

A summary of modelled network performance statistics for the Gore Hill Freeway and Artarmon study area is provided in Table 4-13.

Table 4-13 Modelled 2016 morning and evening peak network performance - Gore Hill Freeway and Artarmon study area

Network measure	Morning peak period	Evening peak period
Network statistics for all vehicles		
Total traffic demand (veh)	29,700	29,700
Total VKT through network	79,500	77,600
Total VHT through network	1620	1510
Total number of stops	35,800	33,400
Average vehicle statistics		
Average vehicle trip length through the network (km)	2.5	2.5
Average vehicle trip time through the network (hours)	0:03:05	0:02:53
Average number of stops per trip	1.1	1.1
Average trip speed (km/h)	49.0	51.4
Unreleased traffic		
Total unreleased trips	<10	<10
% of demand unreleased	<1%	<1%

4.3.5 Intersection performance

Modelled performance for key intersections in the Gore Hill Freeway and Artarmon study area under 2016 travel demands is presented in Table 4-14. Modelled intersection performance indicates that the Epping Road/Longueville Road/Parklands Avenue intersection is currently performing at a relatively poor Level of Service during peak periods. This intersection has limited capacity due to the high volume of westbound traffic that conflicts with right turn traffic from Longueville Road south. Delays on the eastern approach of this intersection are also exacerbated by buses stopping at Lane Cove interchange that block traffic turning left into Longueville Road.

Table 4-14 Modelled 2016 morning and evening peak hour intersection performance - Gore Hill Freeway and Artarmon study area

Intersection	Morning peak hour		Evening peak hour	
	Average delay (sec)	LoS	Average delay (sec)	LoS
Epping Road/Longueville Road/Parkland Avenue	48	D	63	E
Longueville Road/Pacific Highway	42	C	36	C
Pacific Highway/Howarth Road/Norton Lane	7	A	7	A
Pacific Highway/Gore Hill Freeway interchange	23	B	23	B
Reserve Road/Gore Hill Freeway interchange	47	D	29	C
Reserve Road/Dickson Road	14	A	19	B
Reserve Road/Barton Road	11	A	6	A

4.3.6 Road safety and crash history

A summary of crash data for the five-year period between October 2014 and September 2019 on roads that would be substantially affected by the project (based on forecast traffic demands with and without the project) is presented in Table 4-15.

Key statistics include:

- Sixty-nine per cent of crashes (96 crashes) resulted in at least one injury
- Twenty-eight per cent of crashes (39 crashes) involved a heavy vehicle, with the majority occurring on Gore Hill Freeway and Eastern Valley Way
- Four per cent of crashes (six crashes) involved a cyclist or pedestrian
- The three most common crash types involved vehicles travelling in the same direction (58 per cent), vehicles veering off path and onto a straight section of road (11 per cent) and vehicles vehicles travelling in the opposite direction (nine per cent)
- Seventy per cent of crashes occurred at a midblock, while 30 per cent of crashes occurred at an intersection.

Table 4-15 Crash history summary – Gore Hill Freeway and Artarmon study area

Road segment	Number of crashes by severity				Top three crash types	Number of pedestrian and cyclist crashes	Number of heavy vehicle crashes	% of midblock and intersection crashes
	Fatality	Injury	Non-injury	Total				
Clive Street	0	0	0	0	0	0	0	N/A
Eastern Valley Way	0	44	18	62	Vehicles from same direction (44%) Opposing vehicles (19%) Veering off path on a curve (11%)	4 pedestrian crashes	12	61% intersection, 39% midblock
Gore Hill Freeway	0	29	20	49	Vehicles from same direction (80%) Veering off path on a straight (8%) Objects on path (6%)	0	21	6% intersection, 94% midblock
Lane Cove Tunnel	0	16	3	19	Vehicles from same direction (58%) Veering off path on a straight (32%) Objects on path (5%)	0	5	100% midblock
Sailors Bay Road	0	7	2	9	Vehicles from same direction (33%) Pedestrian (22%) Vehicle manoeuvring (22%)	2 pedestrian crashes	1	11% intersection, 89% midblock
Total	0	96	43	139	Vehicles from same direction (58%) Veering off path on a straight (11%) Opposing vehicles (9%)	6 pedestrian crashes	39	30% intersection, 70% midblock

A summary of casualty crashes for the five-year period between October 2014 and September 2019 on roads that would be substantially impacted by the project (based on forecast traffic volumes with and without the project) is presented in Table 4-16.

The key road safety issues in the Gore Hill Freeway and Artarmon study area include high crash rates on Eastern Valley Way (41.8 crashes per 100 million VKT) and Sailors Bay Road (36.8 crashes per 100 million VKT).

Table 4-16 Casualty crashes analysis – Gore Hill Freeway and Artarmon study area

Road segment	Length (km)	AADT	Crash rate per 100 million VKT	Casualty crashes per km per year	Casualty crashes (Sydney average)[8]
Clive Street	0.2	25,000	0	0	3.9
Eastern Valley Way	3.4	22,100	41.8	2.6	3.9
Gore Hill Freeway	2.0	127,400	0.0	2.9	4.7
Lane Cove Tunnel	4.0	75,900	4.2	0.8	4.7
Sailors Bay Road	2.3	22,900	36.8	0.5	3.9

4.3.7 Public transport network

The Gore Hill Freeway and Artarmon study area is highly accessible by public transport. Heavy rail services are provided at Artarmon and St Leonards railway stations, which are located on the T1 North Shore and T9 Northern Lines, providing direct connections to Sydney CBD, Chatswood, Macquarie Park, Epping, Hornsby, Parramatta, Blacktown, Penrith and Richmond. Direct services are also provided to and from the Central Coast from Artarmon and St Leonards during the weekday peak periods.

The Gore Hill Freeway and Artarmon study area is a major thoroughfare for buses, with 67 bus routes and about 3100 timetabled services on weekdays, 1500 services on Saturdays, and 1200 services on Sundays and public holidays. Bus services are operated by Sydney Buses, Transit Systems NSW, Forest Coach Lines, Hillsbus and Transdev NSW. Major bus corridors in the Gore Hill Freeway and Artarmon study area include:

- Gore Hill Freeway/Lane Cove Tunnel – for services to Sydney CBD, Lane Cove, Marsfield and the Hills District
- Pacific Highway – for services to Sydney CBD, Chatswood, Epping, Gladesville and the Hills District.

Bus route maps are shown in Figure 4-26 (Sydney Buses), Figure 4-27 (Transit Systems NSW), Figure 4-28 (Forest Coach Lines), Figure 4-29 (Hillsbus) and Figure 4-30 (Transdev NSW).

[8] Transport for NSW, 2019

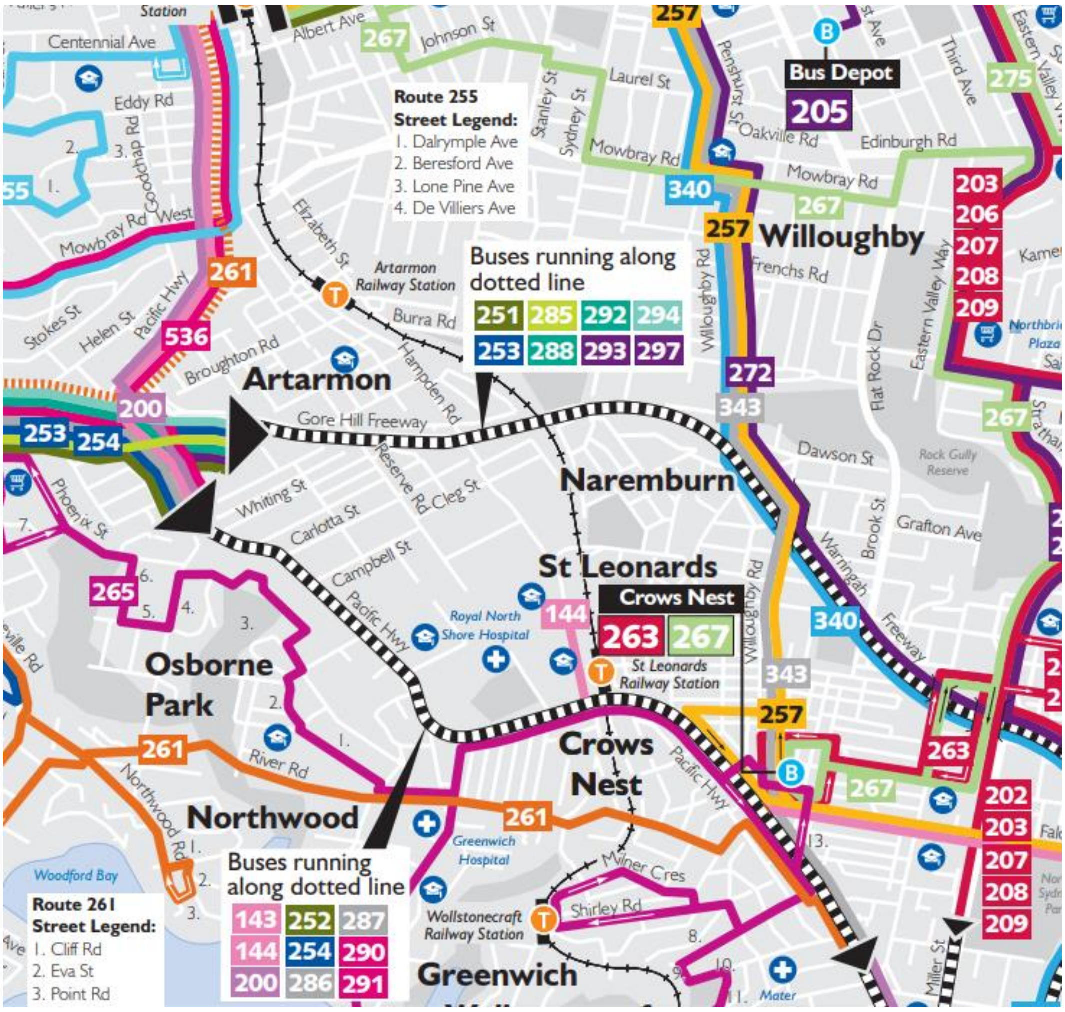


Figure 4-26 Bus routes - Gore Hill Freeway and Artarmon study area – Sydney Buses)

Source: North Shore & West region guide (Transport for NSW, 2019b)

Figure 4-27 Bus routes - Gore Hill Freeway and Artarmon study area – Transit Systems NSW

Source: Inner West and Southern region network (Transit Systems NSW, 2019)

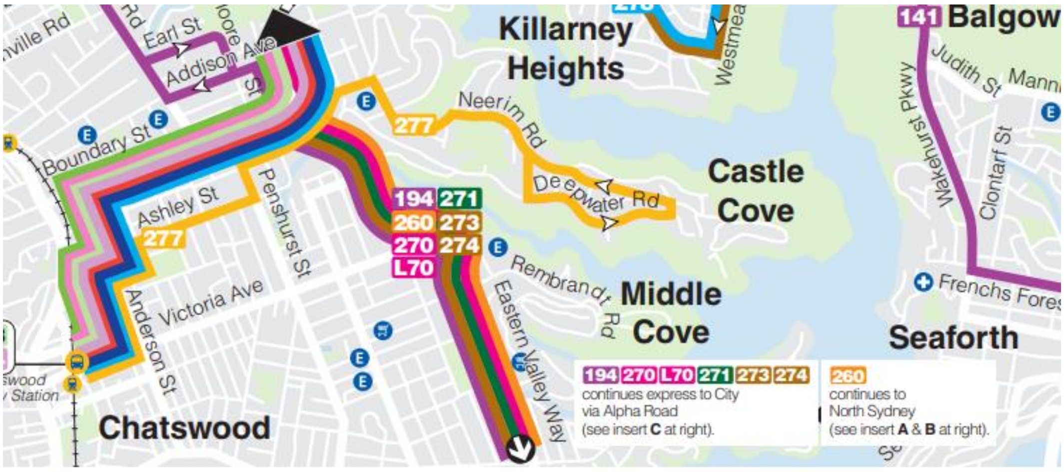


Figure 4-28 Bus routes – Gore Hill Freeway and Artarmon study area - Forest Coach Lines

Source: Forest Coach Lines Sydney Region Network Map (Forest Coach Lines, 2019)

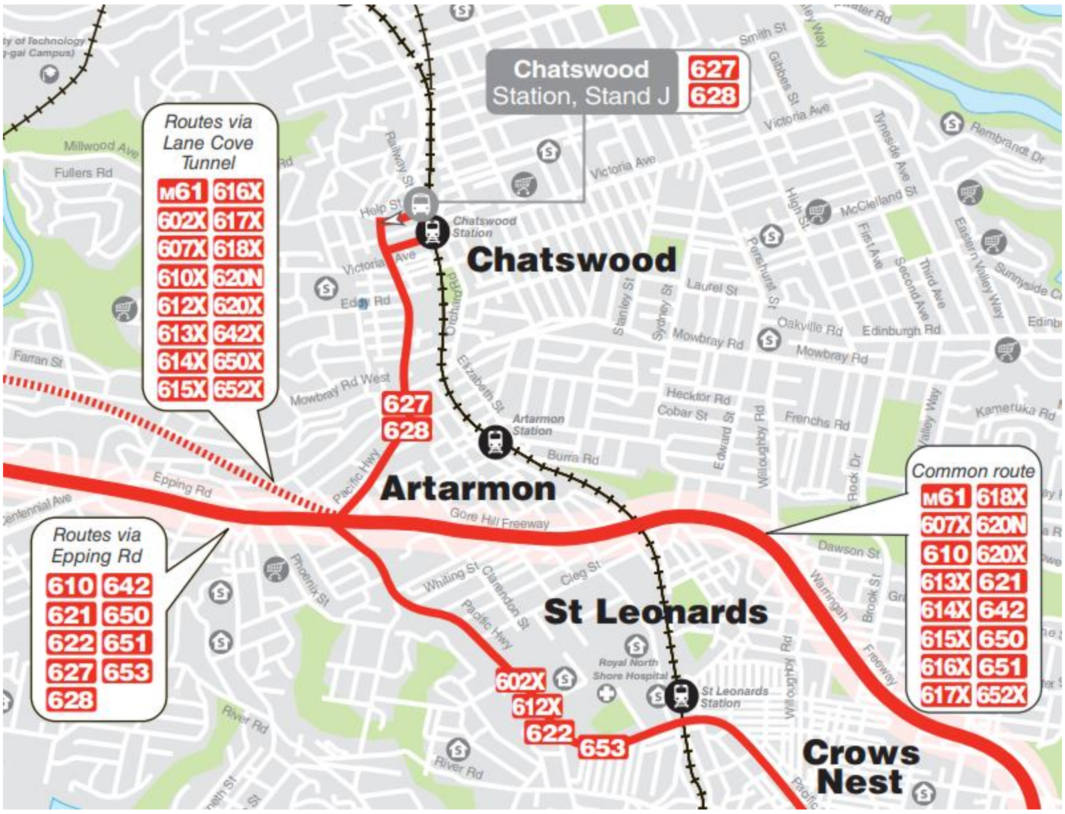


Figure 4-29 Bus routes - Gore Hill Freeway and Artarmon study area – Hillsbus

Source: Hills District Bus Guide (Hillsbus, 2019)

Figure 4-30 Bus routes - Gore Hill Freeway and Artarmon study area – Transdev NSW

Source: Upper North Shore network map (Transdev NSW, 2019)

4.3.8 Active transport network

The pedestrian network in the Gore Hill Freeway and Artarmon study area is well developed, with footpaths alongside the vast majority of roads and controlled crossings at most signalised intersections. Pedestrians are prohibited from walking along the Gore Hill Freeway and Lane Cove Tunnel. However, a shared user path is provided adjacent to the southern side of the Gore Hill Freeway. A high level of pedestrian activity occurs along Hampden Road within the vicinity of Artarmon railway station, around the commercial area of Artarmon, and around the health, educational and commercial land uses in St Leonards.

The cycle network in the Gore Hill Freeway and Artarmon study area is shown in Figure 4-31 and consists of a mixture of off-road shared pedestrian and cyclist paths and on-road cycle routes on local and collector roads. The regional strategic cycle network provides connections between the study area and the Sydney CBD, St Ives, Castle Cove, Willoughby, Chatswood, St Leonards, Lane Cove and Macquarie Park. Bicycle parking facilities are available at Artarmon and St Leonards railway stations. Off-road shared user paths are provided at the following locations:

- Along the southern side of the Gore Hill Freeway
- Adjacent to Flat Rock Creek between Weedon Road and Flat Rock Drive
- Around Artarmon Reserve, Naremburn Park, Bicentennial Reserve, and the Willoughby Leisure Centre.

The Gore Hill Freeway presents a barrier to north–south movements for pedestrians and cyclists, with crossings only available at select locations:

- Shared user bridge connecting Willoughby Road and Slade Street in Naremburn
- Underpass connecting Park Road and Northcote Street in Naremburn to Willoughby Road in Willoughby
- Underpass connecting Chelmsford Avenue in Naremburn and Willoughby
- Hampden Road
- Reserve Road
- Pacific Highway.

Figure 4-31 Cycle network - Gore Hill Freeway and Artarmon study area

Source: Cycleway Finder (Roads and Maritime, 2018)

Pedestrian and cyclist surveys were carried out on Tuesday 28 November 2017, Saturday 2 December 2017 and Sunday 3 December 2017 between 6am and 8pm at the shared user path adjacent to the southern side of the Gore Hill Freeway, near Hampden Road in Artarmon. The survey results are provided in Figure 4-32 to Figure 4-34.

The survey results indicate that the shared user path is used by a high number of cyclists during the weekday morning and evening peak periods, with up to 125 cyclists recorded each hour between 7am and 9am. This can be attributed to the shared user path forming part of a regional cycle route connecting Naremburn, Lane Cove and Macquarie Park, with most cyclists likely to be commuting to and from work. Weekday pedestrian volumes were substantially lower, with fewer than 25 pedestrians recorded during each hour surveyed. Pedestrian volumes remained low during the weekend, while weekend cyclist volumes were substantially lower compared to the weekday, with fewer than 25 cyclists recorded during each hour surveyed on Saturday and Sunday.

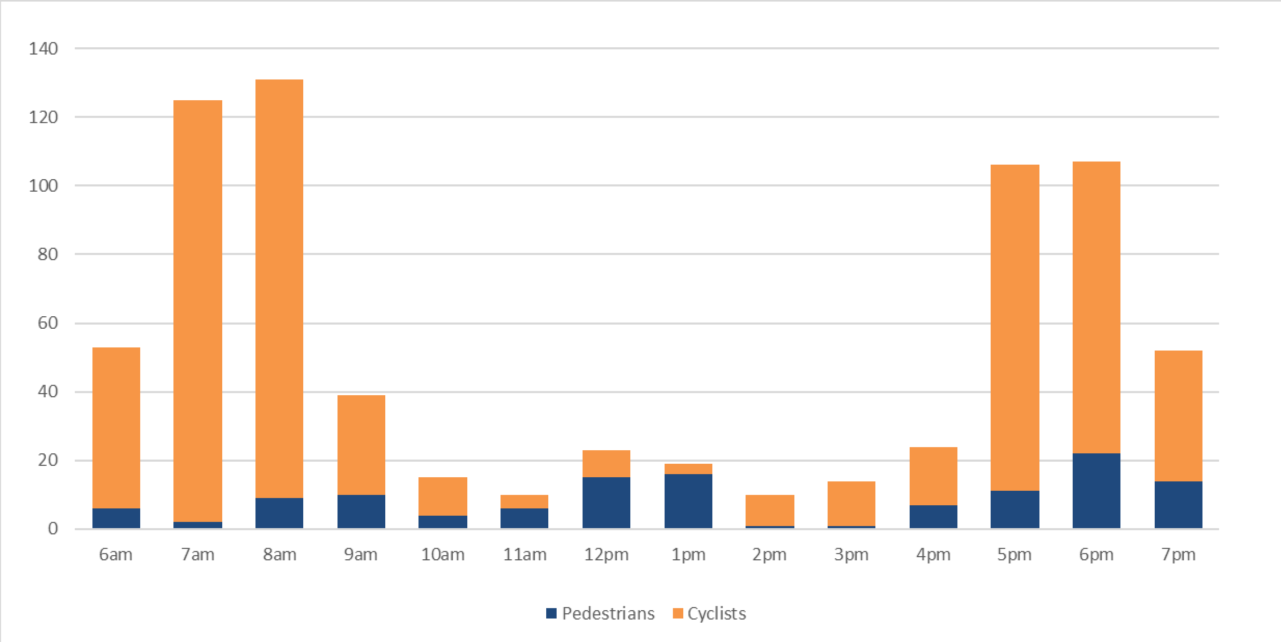


Figure 4-32 Weekday pedestrian and cyclist survey results (number per hour) - Gore Hill Freeway shared user path

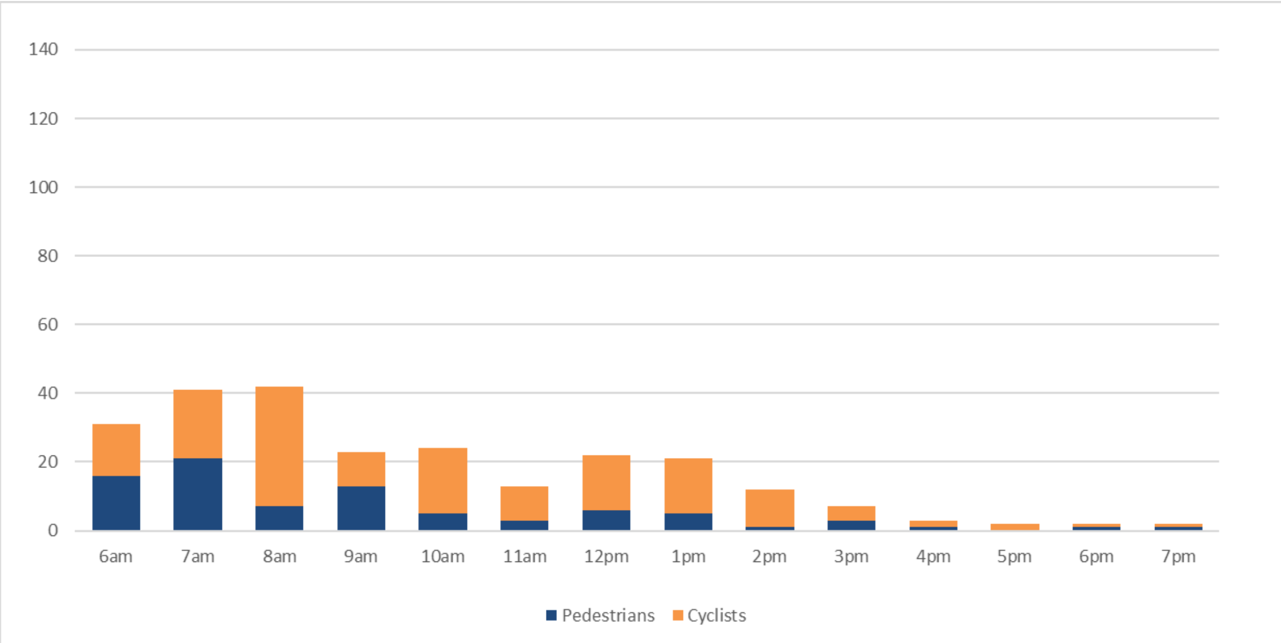


Figure 4-33 Saturday pedestrian and cyclist survey results (number per hour) - Gore Hill Freeway shared user path

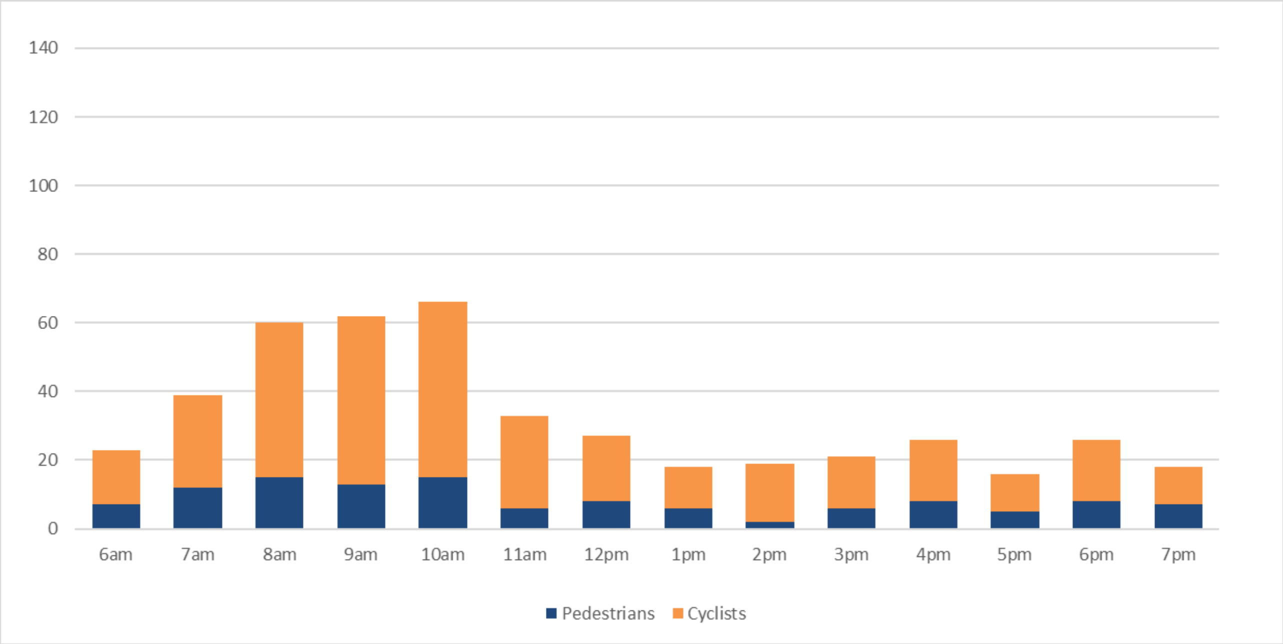


Figure 4-34 Sunday pedestrian and cyclist survey results (number per hour) - Gore Hill Freeway shared user path

4.4 Balgowlah and surrounds

The broad study area for the traffic and transport assessment of Balgowlah and surrounds is shown in Figure 4-35 and includes the suburbs of Balgowlah, Mosman, North Balgowlah, Manly Vale and Seaforth.

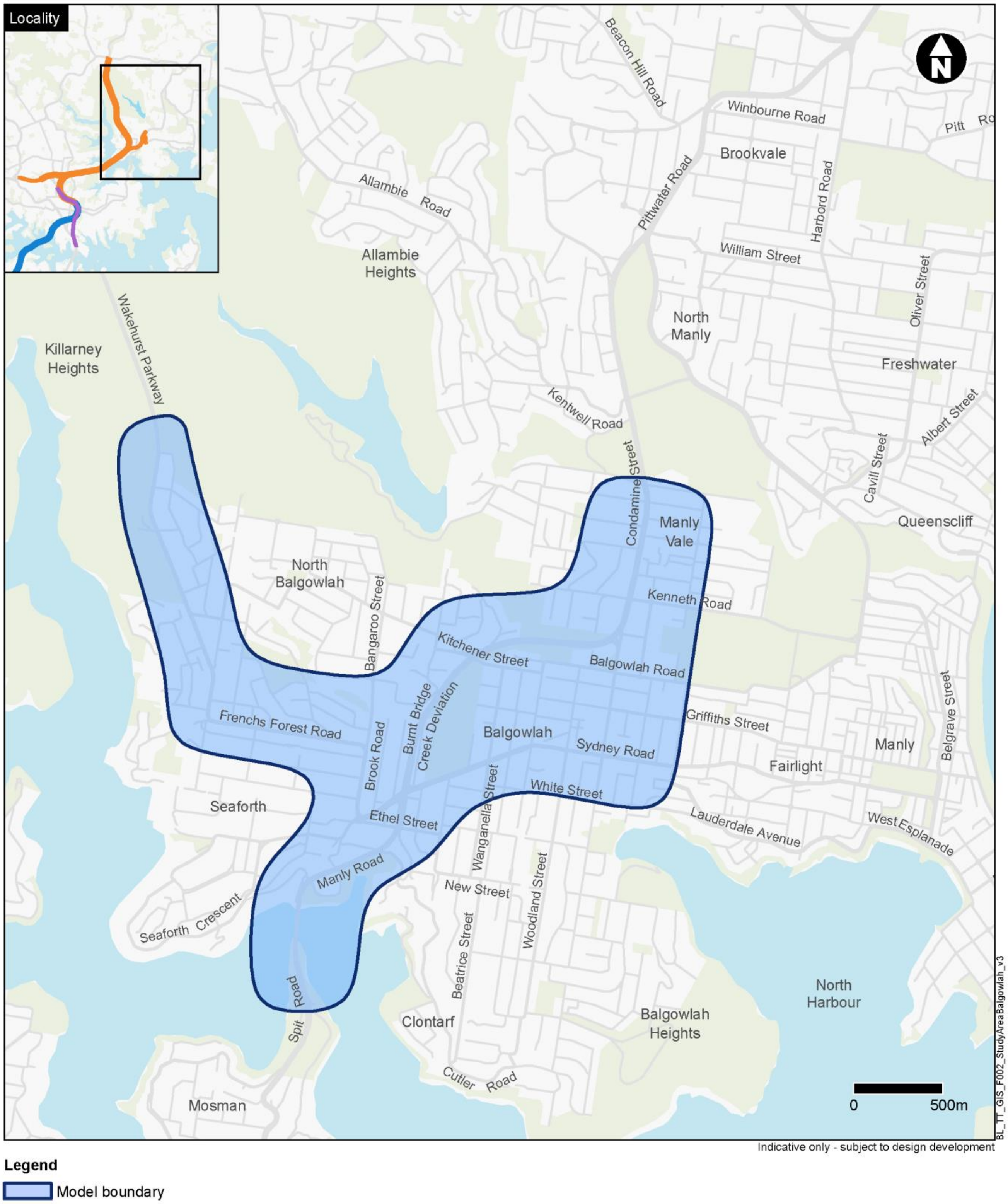


Figure 4-35 Balgowlah and surrounds study area and operational model boundary

4.4.1 Modes of travel

Journey to work data for the Balgowlah and surrounds study area (based on statistical areas defined by the Australian Bureau of Statistics that fall within the operational traffic model boundary) was analysed to determine travel patterns for residents and workers.

In 2016 the population in the Balgowlah and surrounds study area was 71,600[9]. The mode share for residents travelling to their employment destinations is shown in Figure 4-36. Private vehicles accounted for 58 per cent of trips, with 53 per cent as vehicle drivers and five per cent as passengers. Public transport accounted for 32 per cent of trips, with 18 per cent by bus, nine per cent by ferry or tram and five per cent by train. Walking accounted for five per cent of trips. When compared to the Sydney average, the public transport mode share is relatively high and the private vehicle mode share is similar. This can be attributed to the locations where most residents work, which are Sydney Inner City, Warringah, Manly, North Sydney–Mosman and Chatswood–Lane Cove. These locations are highly accessible by public transport from the study area, and in Sydney CBD and North Sydney parking is discouraged through pricing mechanisms.

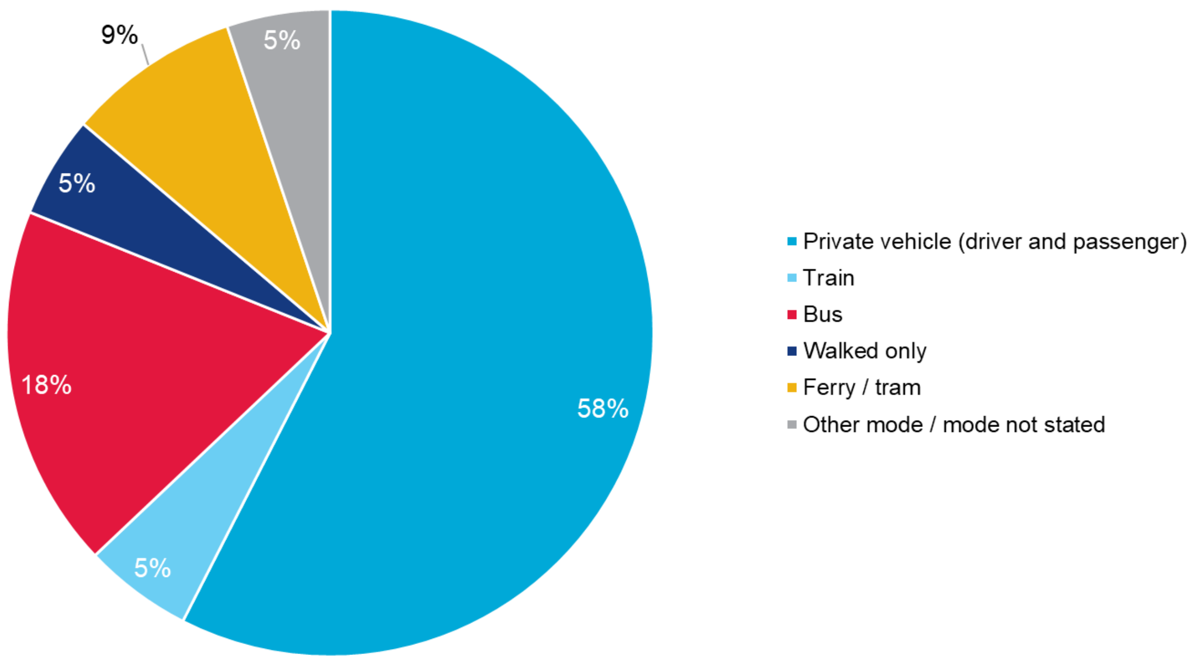


Figure 4-36 Mode share for residents in the Balgowlah and surrounds study area travelling to their employment

Source: Journey to Work 2016 (Transport for NSW, 2018c)

In 2016, there were 19,600 workers in the Balgowlah and surrounds study area. The mode share for workers travelling to employment is shown in Figure 4-37. Private vehicles accounted for 71 per cent of trips, with 65 per cent as vehicle drivers and six per cent as passengers. Public transport accounted for 14 per cent of trips, with nine per cent by bus, four per cent by train and one per cent by ferry or tram. Walking accounted for ten per cent of trips. When compared to the Sydney average, the private vehicle mode share is relatively high and the public transport mode share is similar. This can be attributed to the disparate locations across northern Sydney where workers live.

[9] Journey to work data is based on statistical areas defined by the Australian Bureau of Statistics that fall within the operational traffic model boundary for each study area. For the Balgowlah and surrounds area this includes the statistical areas of Balgowlah – Clontarf – Seaforth, Manly – Fairlight, Manly Vale – Allambie Heights, and Forestville – Killarney Heights

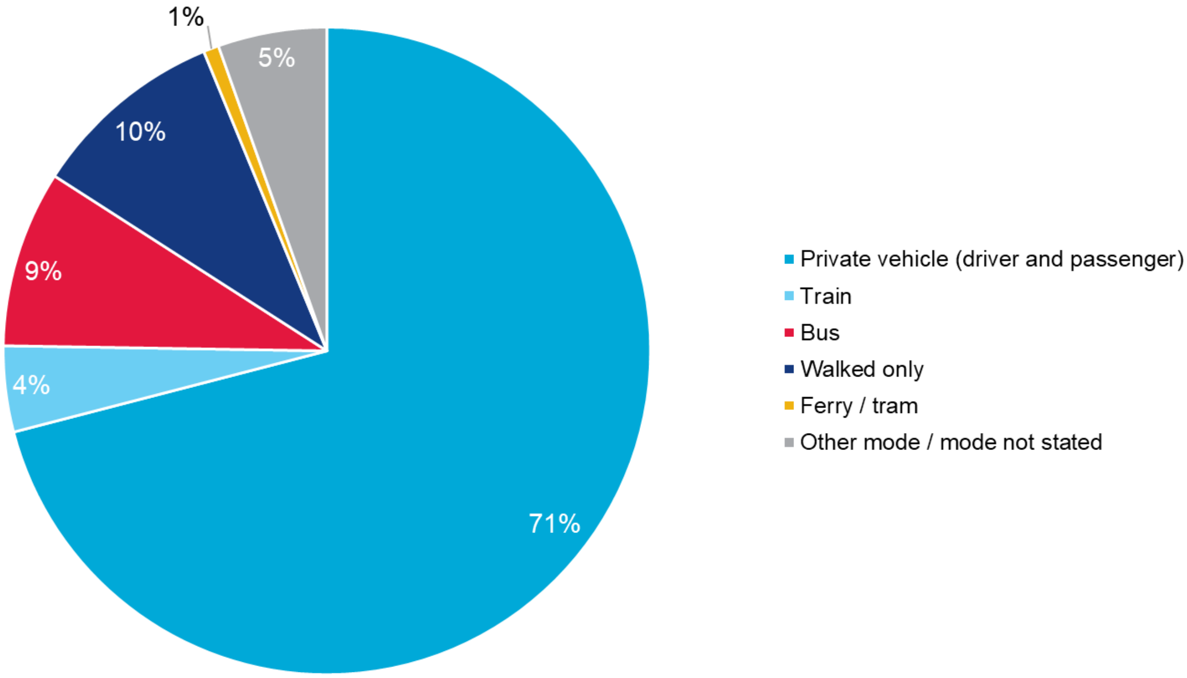


Figure 4-37 Mode share for workers travelling to employment in the Balgowlah and surrounds study area

Source: Journey to Work 2016 (Transport for NSW, 2018c)

4.4.2 Road network key features

Key roads in the Balgowlah and surrounds study area and their characteristics are summarised in Table 4-17.

Table 4-17 Summary of key roads – Balgowlah and surrounds study area

Road	Location	Road type and speed limit	Total number of lanes	Key destinations	On-road public transport	Operational arrangements
Spit Road	Mosman	Major arterial road 60 km/h	Up to six (variable, depending on location)	Mosman, North Shore, Northern Beaches (via Condamine Street/Pittwater Road)	Major bus corridor. Services to Sydney CBD, Neutral Bay, Mosman, Manly, Dee Why, Seaforth and Frenchs Forest	T3 transit lanes and clearways in operation during weekday peak periods. Tidal flow in operation between Awaba Street and Ourimbah Road, and at both ends of Spit Bridge
Manly Road	Seaforth	Major arterial road 60 km/h	Six	Mosman, Manly, Northern Beaches (via Condamine Street/Pittwater Road), Forest	Major bus corridor. Services to Sydney CBD, Neutral Bay, Mosman, Manly,	T3 transit lanes and clearways in operation during weekday peak periods. Tidal flow in

Road	Location	Road type and speed limit	Total number of lanes	Key destinations	On-road public transport	Operational arrangements
				District (via Frenchs Forest Road/Wakehurst Parkway)	Dee Why, Seaforth and Frenchs Forest. Southbound bus lane during weekday evening peak	operation at both ends of Spit Bridge
Burnt Bridge Creek Deviation	Balgowlah, North Balgowlah	Major arterial road 80 km/h	Six	Mosman, Manly, Northern Beaches (via Condamine Street/Pittwater Road), Forest District (via Condamine Street/Allambie Road)	Major bus corridor. Services to Sydney CBD, Mona Vale, Dee Why and Avalon. Northbound 24-hour bus lane and southbound bus lane during weekday peak periods	Clearways in operation during weekday evening peak
Condamine Street/ Pittwater Road	Manly Vale, Brookvale	Major arterial road 60 km/h	Six	Manly, Northern Beaches, Mona Vale	Major bus corridor. Services to Sydney CBD, Mona Vale, Dee Why and Avalon. Southbound 24-hour bus lane and northbound bus lane during weekday evening peak	Clearways in operation during weekday peak periods near Warringah Mall
Sydney Road	Balgowlah, Seaforth	Sub-arterial road 50 km/h (in Seaforth), 60 km/h elsewhere	Up to six (variable, depending on location)	Seaforth, Manly	Major bus corridor. Services to Sydney CBD, Manly, Warringah and Mona Vale. Westbound bus lane during weekday evening peak	T3 transit lanes in operation during weekday morning peak

Road	Location	Road type and speed limit	Total number of lanes	Key destinations	On-road public transport	Operational arrangements
Ourimbah Road	Mosman	Sub-arterial road 50 km/h	Four	Mosman, Manly (via Spit Road)	Local services between Sydney CBD and Spit Junction	Clearways in operation during weekday peak periods
Awaba Street	Mosman	Collector road 50 km/h	Two	Mosman, Balmoral Beach	N/A	N/A
Kitchener Street	Balgowlah	Collector road 50 km/h	Two	Provides access between North Balgowlah and Balgowlah	Local services to Sydney CBD, Warringah, Manly and North Balgowlah	N/A
Kenneth Road	Manly Vale	Collector road 50 km/h	Two	Manly Vale, Manly	Local services to Sydney CBD, North Sydney South Curl and Mona Vale	N/A
Wakehurst Parkway/ Clontarf Street/ Frenchs Forest Road	Seaforth	Major arterial road 60 km/h	Up to four (variable, depending on location)	Seaforth, Northern Beaches, Forest District	Local services to Sydney CBD, Manly and Narraweena	Clearways in operation on Frenchs Forest Road during weekday peak periods

4.4.3 Traffic volumes and patterns

Spit Road, Manly Road and Burnt Bridge Creek Deviation are major arterial roads that carry between 970 and 3050 vehicles per hour in each direction during the morning and evening peak. These roads exhibit a southbound morning peak direction towards, and northbound evening peak direction away from the Sydney CBD. Traffic volumes on Sydney Road are between 460 and 1010 vehicles per hour in each direction during peak periods and exhibit a westbound morning peak direction and eastbound evening peak direction.

The midblock volumes on key roads in the Balgowlah and surrounds study area are summarised in Table 4-18.

Table 4-18 2016 peak hour traffic volumes – Balgowlah and surrounds study area

Road	Direction	Morning peak hour		Evening peak hour	
		Volume (veh)	Heavy vehicle percentage	Volume (veh)	Heavy vehicle percentage
Spit Road south of Parriwi Road	Northbound	1280	11%	2670	6%
	Southbound	2780	7%	1610	7%
Manly Road south of Sydney Road	Northbound	1540	8%	3050	5%
	Southbound	2760	11%	1650	6%
Sydney Road east of Manly Road	Eastbound	460	8%	1010	4%
	Westbound	940	7%	750	6%
Burnt Bridge Creek Deviation west of Condamine Street	Northbound	970	7%	1790	7%
	Southbound	1350	13%	1050	6%

4.4.4 Road network performance

Military Road, Spit Road, Manly Road, Burnt Bridge Creek Deviation, Condamine Street and Pittwater Road form the primary arterial road corridor between the Northern Beaches and central Sydney. Although these roads carry high traffic volumes at all times of the day, traffic volumes are highest heading southbound in the morning peak and northbound in the evening peak as a result of commuters travelling to and from the Northern Beaches to central Sydney via Pittwater Road and Spit Road. In addition to north–south traffic along the Pittwater Road and Spit Road corridor, Sydney Road also carries high traffic volumes as the primary arterial road providing access to Balgowlah and Manly.

During the morning peak, the primary constraint for southbound traffic is Spit Bridge. Although tidal flow arrangements prioritise peak period traffic patterns through the Spit Road corridor, queues from Spit Bridge frequently extend to the intersection of Manly Road and Sydney Road, resulting in southbound queues on Burnt Bridge Creek Deviation and eastbound and westbound queues on Sydney Road.

In the evening peak, southbound queues are also observed on Manly Road when Spit Bridge operates with a single southbound lane. This results in similar, but less pronounced, queues on Burnt Bridge Creek Deviation and Sydney Road as in the morning peak period.

Seaforth shopping village is immediately west of the intersection of Sydney Road and Manly Road, with limited kerbside parking allowed on the westbound carriageway of Sydney Road between Manly Road and Frenchs Forest Road.

Bus priority is provided at the intersection of Manly Road/Burnt Bridge Creek Deviation/Sydney Road, with bus lanes provided in both directions on Burnt Bridge Creek Deviation, southbound bus lanes provided on Manly Road and westbound bus lanes on Sydney Road. In January 2018, the southbound T3 transit lane on Burnt Bridge Creek Deviation was converted from a T3 transit lane to a bus lane during the morning peak period.

A summary of modelled network performance statistics for the Balgowlah and surrounds study area is provided in Table 4-19.

Table 4-19 Modelled 2016 morning and evening peak network performance - Balgowlah and surrounds study area

Network measure	Morning peak period	Evening peak period
Network statistics for all vehicles		
Total traffic demand (veh)	16,800	18,900
Total VKT through network	42,100	50,500
Total VHT through network	1440	1440
Total number of stops	50,900	44,300
Average vehicle statistics		
Average vehicle trip length through the network (km)	2.4	2.5
Average vehicle trip time through the network (hours)	0:04:55	0:04:21
Average number of stops per trip	2.9	2.2
Average trip speed (km/h)	29.2	35.1
Unreleased traffic		
Total unreleased trips	120	50
% of demand unreleased	1%	<1%

4.4.5 Intersection performance

Modelled performance for key intersections in the Balgowlah and surrounds study area under 2016 travel demands are presented in Table 4-20. Modelled intersection performance indicates that the Frenchs Forest Road/Sydney Road intersection performs poorly during the evening peak, particularly on the western approach. This is due to the high right turn volume from the Sydney Road eastern approach to Frenchs Forest Road, resulting in queueing of vehicles on the western approach that must give way to this movement. The imbalance in traffic volumes results in poor performance at this intersection during the evening peak.

Table 4-20 Modelled 2016 morning and evening peak hour intersection performance - Balgowlah and surrounds study area

Intersection	Morning peak hour		Evening peak hour	
	Average delay (sec)	LoS	Average delay (sec)	LoS
Sydney Road/Manly Road/Burnt Bridge Creek Deviation	52	D	44	D
Frenchs Forest Road/Sydney Road	19	B	>100	F
Sydney Road/Condamine Street	20	B	24	B
Condamine Street/Burnt Bridge Creek Deviation	28	B	19	B

Intersection	Morning peak hour		Evening peak hour	
	Average delay (sec)	LoS	Average delay (sec)	LoS
Sydney Road/Maretimo Street	9	A	9	A

4.4.6 Road safety and crash history

A summary of crash data for the five-year period between October 2014 and September 2019 on roads that would be substantially impacted by the project (based on forecast traffic demand with and without the project) is presented in Table 4-21.

Key statistics include:

- Seventy-two per cent of crashes (171 crashes) resulted in at least one injury
- Twenty-four per cent of crashes (57 crashes) involved a heavy vehicle, with the majority occurring on Spit Road and Sydney Road
- Ten per cent of crashes (24 crashes) involved a cyclist or pedestrian
- The three most common crash types involved vehicles travelling in the same direction (52 per cent), vehicles travelling in the opposite direction (12 per cent) and vehicles manoeuvring (seven per cent)
- Fifty-nine per cent of crashes occurred at an intersection, and 41 per cent occurred at a midblock.

Table 4-21 Crash history summary – Balgowlah and surrounds study area

Road segment	Number of crashes by severity				Top three crash types	Number of pedestrian and cyclist crashes	Number of heavy vehicle crashes	% of midblock and intersection crashes
	Fatality	Injury	Non-injury	Total				
Awaba Street	0	6	2	8	Vehicle manoeuvring (38%) Opposing vehicles (25%) Pedestrian (13%)	1 pedestrian crash and 2 cyclist crashes	1	50% intersection, 50% midblock
Burnt Bridge Creek Deviation	0	8	3	11	Vehicles from same direction (36%) Opposing vehicles (27%) Opposing vehicles (27%)	1 cyclist crash	5	36% intersection, 64% midblock
Clontarf Street	0	1	1	2	Opposing vehicles (50%) Veering off path on a straight (50%)	0	1	100% intersection
Frenchs Forest Road	0	11	4	15	Vehicles from same direction (33%) Intersection, adjacent approaches (27%) Opposing vehicles (13%)	1 pedestrian crash and 1 cyclist crash	4	73% intersection, 27% midblock
Manly Road	0	20	7	27	Vehicles from same direction (78%) Veering off path on a straight (7%) Intersection, adjacent approaches (4%)	1 cyclist crash	4	48% intersection, 52% midblock
Ourimbah Road	0	20	6	26	Vehicles from same direction (58%) Opposing vehicles (19%) Pedestrian (8%)	2 pedestrian crashes	5	88% intersection, 12% midblock
Spit Road	0	61	30	91	Vehicles from same direction (68%) Veering off path on a curve (10%) Veering off path on a straight (5%)	3 pedestrian crashes and 3 cyclist crashes	24	43% intersection, 57% midblock

Road segment	Number of crashes by severity				Top three crash types	Number of pedestrian and cyclist crashes	Number of heavy vehicle crashes	% of midblock and intersection crashes
	Fatality	Injury	Non-injury	Total				
Sydney Road	0	44	15	59	Vehicles from same direction (31%) Opposing vehicles (22%) Vehicle manoeuvring (15%)	6 pedestrian crashes and 3 cyclist crashes	13	75% intersection, 25% midblock
Total	0	171	68	239	Vehicles from same direction (52%) Opposing vehicles (12%) Vehicle manoeuvring (7%)	13 pedestrian crashes and 11 cyclist crashes	57	59% intersection, 41% midblock

A summary of casualty crashes for the five-year period between October 2014 and September 2019 on roads that would be substantially impacted by the project (based on forecast traffic demand with and without the project) is presented in Table 4-22.

The key road safety issues in the Balgowlah and surrounds study area include:

- High crash rates on Clontarf Street (94.3 crashes per 100 million VKT), Frenchs Forest Road (81.4 crashes per 100 million VKT), Ourimbah Road (77.2 crashes per 100 million VKT), Awaba Street (77.1 crashes per 100 million VKT) and Sydney Road (48.7 crashes per 100 million VKT)
- Casualty crash rates on Awaba Street, Clontarf Street, Frenchs Forest Road and Manly Road exceed the Sydney region average for their respective similar type of road. Clontarf Street and Frenchs Forest Road function as arterial roads however the residential driveways fronting these roads, as well as the presence of parking lanes, multiple speed limits, buses and lack of turning bays would contribute to the higher crash rates observed.

Table 4-22 Casualty crashes analysis – Balgowlah and surrounds study area

Road segment	Length (km)	AADT	Crash rate per 100 million VKT	Casualty crashes per km per year	Casualty crashes (Sydney average)[10]
Awaba Street	1.1	5700	77.1	1.1	0.8
Burnt Bridge Creek Deviation	1.7	41,100	8.5	0.9	6.7
Clontarf Street	0.1	10,600	94.3	1.8	0.8
Frenchs Forest Road	1.3	10,700	81.4	1.7	0.8
Manly Road	0.8	62,700	29.6	5.1	4.7
Ourimbah Road	1.0	21,300	77.2	3.9	3.9
Spit Road	3.0	54,200	25.5	4.1	4.7
Sydney Road	3.3	22,400	48.7	2.7	5.8

4.4.7 Public transport network

The Balgowlah and surrounds study area is a major thoroughfare for buses, with 38 routes and about 1400 timetabled services on weekdays, 700 services on Saturdays and 700 services on Sundays and public holidays. Bus services are operated by Sydney Buses and Forest Coach Lines. Major bus corridors in the study area include:

- Spit Road/Manly Road – for services to Sydney CBD, Neutral Bay, Mosman, Manly, Dee Why, Seaforth and Frenchs Forest
- Sydney Road – for services to Sydney CBD, Manly, Warringah and Mona Vale
- Burnt Bridge Creek Deviation – for services to Sydney CBD, Mona Vale, Dee Why and Avalon.

In addition to these local and regional bus services, the Balgowlah and surrounds study area is served by the B-Line bus service.

Bus route maps are shown in Figure 4-38 (Sydney Buses) and Figure 4-39 (Forest Coach Lines).

[10] Transport for NSW, 2019

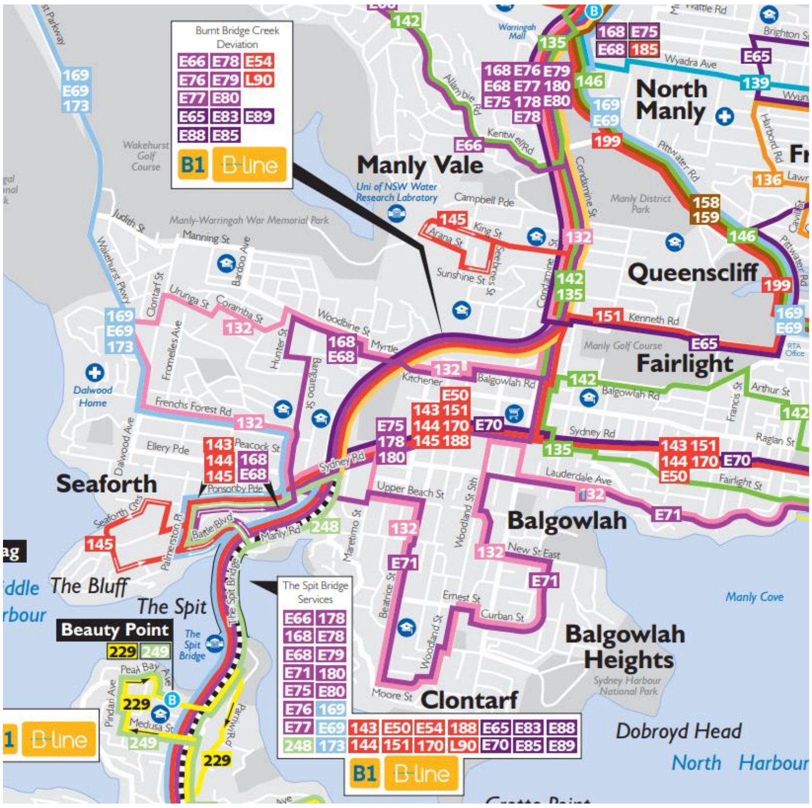


Figure 4-38 Bus routes - Balgowlah and surrounds study area - Sydney Buses

Source: Northern Beaches & Lower North Shore region guide (Transport for NSW, 2019a)

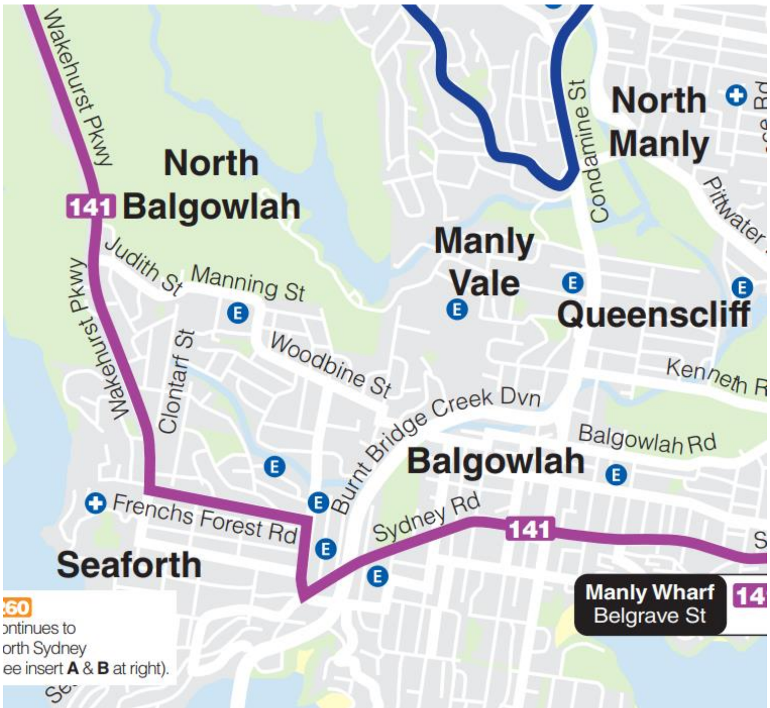


Figure 4-39 Bus routes - Balgowlah and surrounds study area - Forest Coach Lines

Source: Forest Coach Lines Sydney Region Network Map (Forest Coach Lines, 2019)

4.4.8 Active transport network

The pedestrian network in the Balgowlah and surrounds study area is well developed, with footpaths alongside the vast majority of roads and controlled crossings at most signalised intersections. A high level of pedestrian activity occurs along Spit West Reserve, around the marinas at the southern end of Spit Bridge, and near the Balgowlah and Manly Vale local town centres on Sydney Road and Condamine Street.

The cycle network in the Balgowlah and surrounds study area is shown in Figure 4-40. It consists of a mixture of off-road shared user paths and on-road cycle routes on local and collector roads. The regional strategic cycle network provides connections between the study area and the Sydney CBD, Neutral Bay, Mosman, Manly and Narrabeen. Off-road shared user paths are provided at the following locations:

- Spit Bridge
- Spit West Reserve
- Adjacent to Burnt Bridge Creek between Baringa Avenue and Condamine Street
- White Street, Lauderdale Avenue, The Crescent, Commonwealth Parade and Fairlight Walk between Balgowlah and Manly.

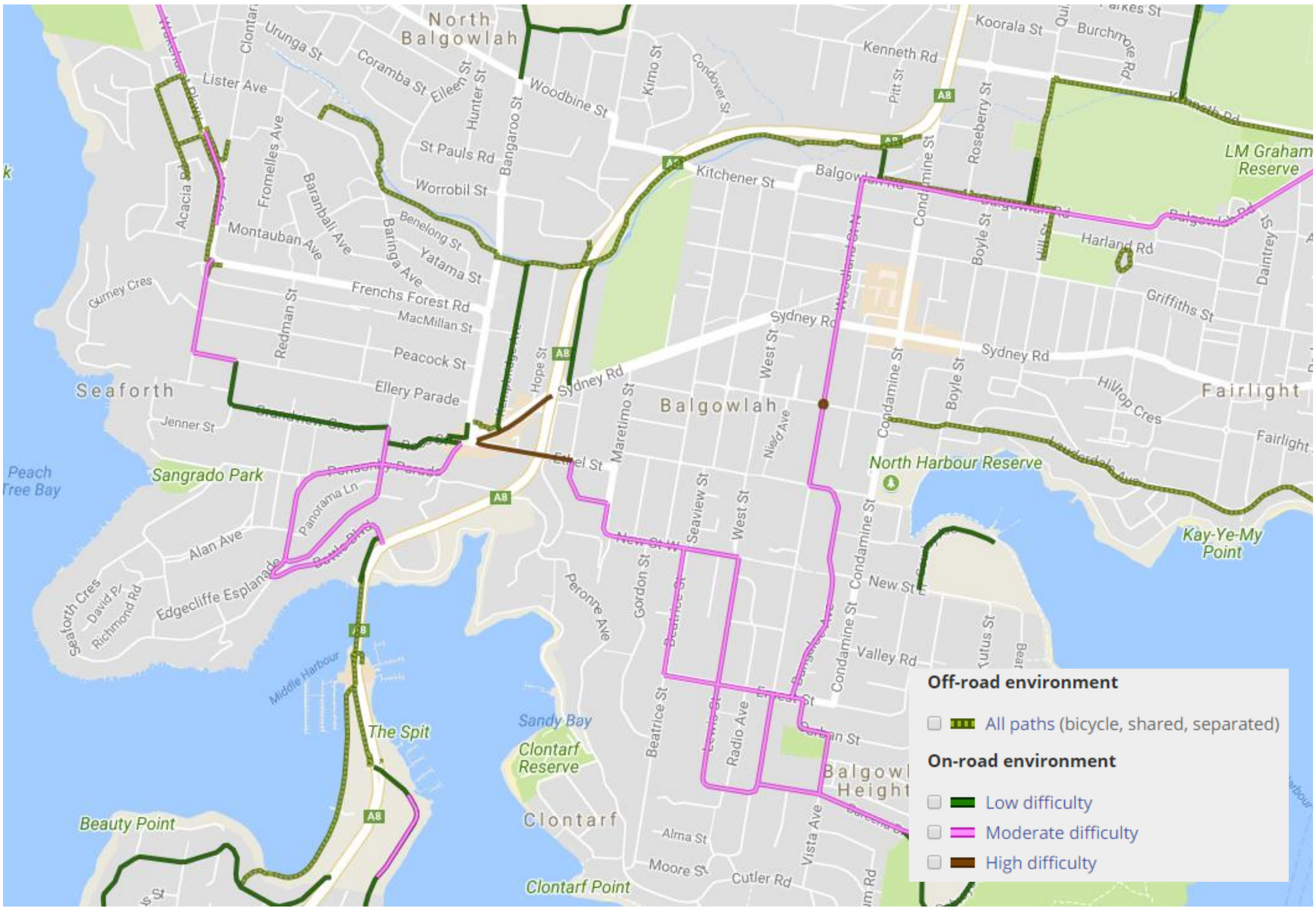


Figure 4-40 Cycle network - Balgowlah and surrounds study area

Source: Cycleway Finder (Roads and Maritime, 2018)

A pedestrian and cyclist survey was carried out on Tuesday 28 November 2017, Saturday 2 December 2017 and Sunday 3 December 2017 between 6am and 8pm at the shared user path adjacent to the eastern side of Burnt Bridge Creek Deviation near Kitchener Street in Balgowlah. The survey results are provided in Figure 4-41 to Figure 4-43.

The weekday survey results indicate that the shared user path is used by a moderate number of pedestrians and cyclists, particularly during the morning and evening peak periods, with a maximum hourly count of 22 pedestrians and 64 cyclists. The shared user path is also used by a moderate number of people on weekends, generally between 7am to 2pm with a maximum of 46 pedestrians and cyclists per hour recorded on Saturday and 54 pedestrians and cyclists per hour recorded on Sunday. These volumes are attributed to the shared user path providing links to the North Sydney to Spit Bridge cycle route and to the Northern Beaches, accommodating commuter cyclists on weekdays and recreational users on weekends.

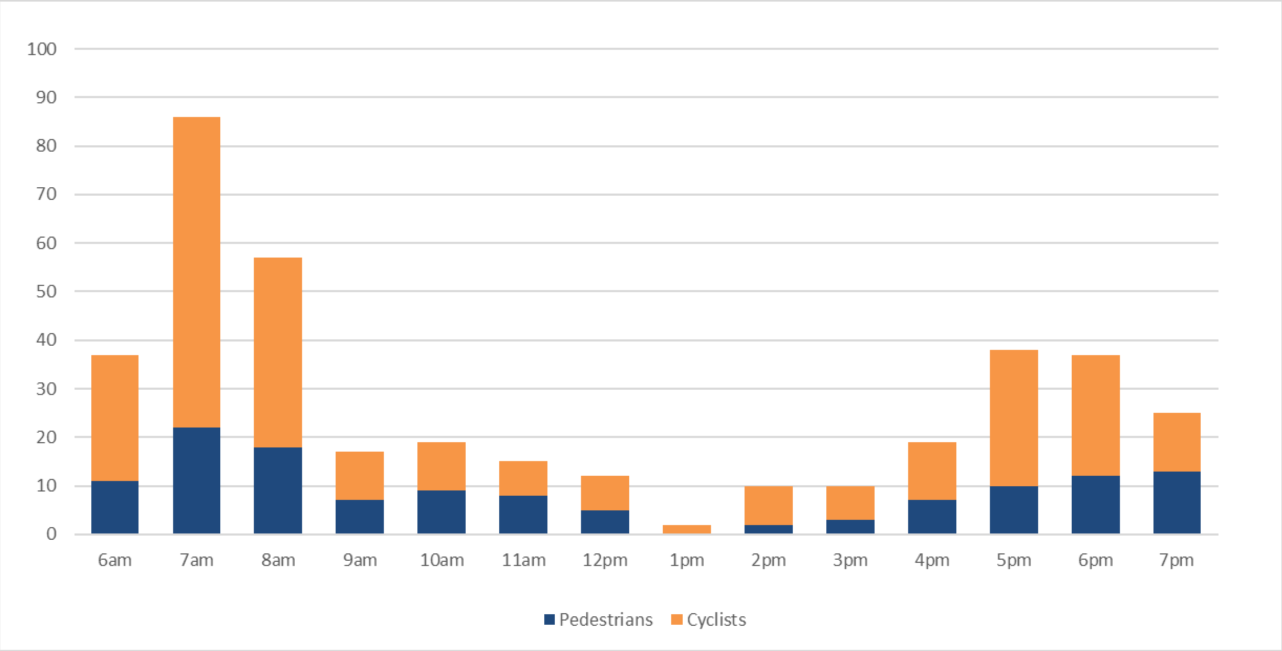


Figure 4-41 Weekday pedestrian and cyclist survey results (number per hour) - Burnt Bridge Creek Deviation shared user path

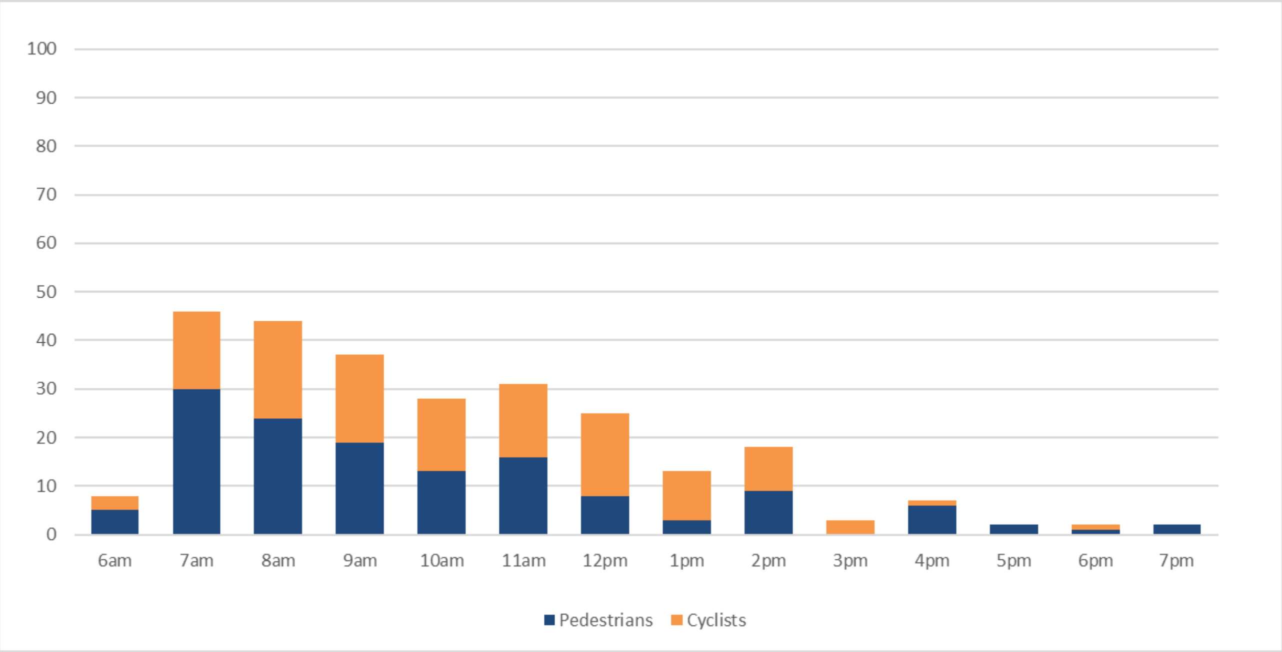


Figure 4-42 Saturday pedestrian and cyclist survey results (number per hour) - Burnt Bridge Creek Deviation shared user path

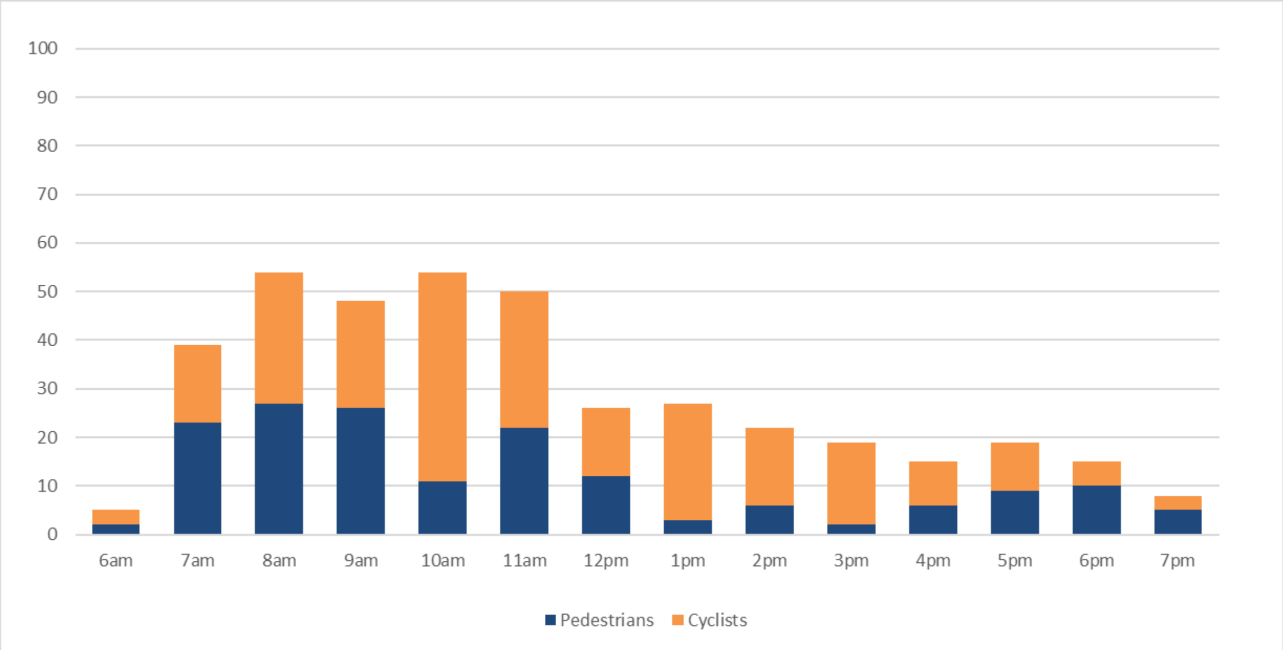


Figure 4-43 Sunday pedestrian and cyclist survey results (number per hour) - Burnt Bridge Creek Deviation shared user path

4.5 Frenchs Forest and surrounds

The broad study area for the traffic and transport assessment of Frenchs Forest and surrounds is shown in Figure 4-44 and includes the suburbs of Frenchs Forest, Killarney Heights and Seaforth.

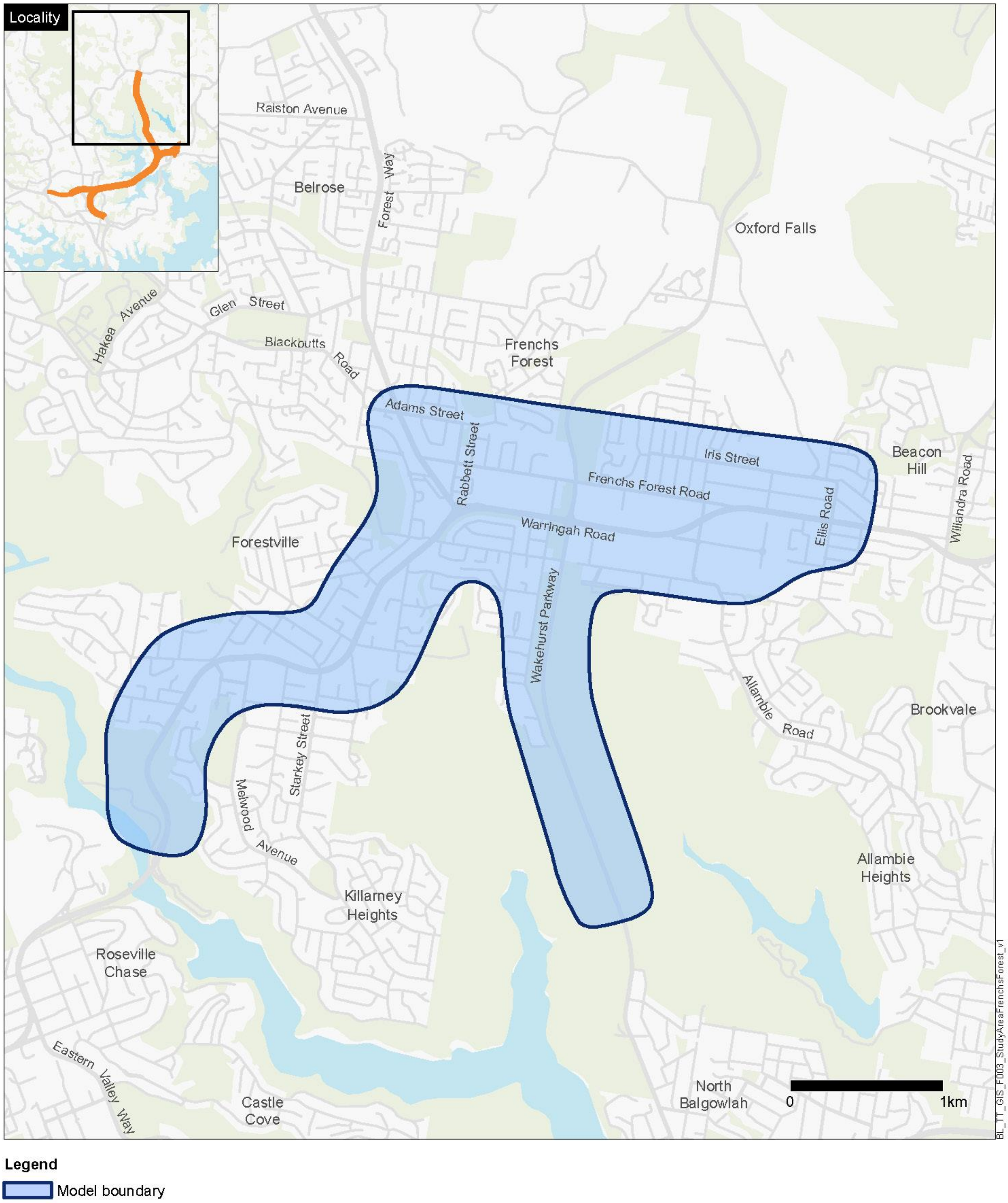


Figure 4-44 Frenchs Forest and surrounds study area and operational model boundary

4.5.1 Modes of travel

Journey to work data for the Frenchs Forest and surrounds study area (based on statistical areas defined by the Australian Bureau of Statistics that fall within the operational traffic model boundary) was analysed to determine travel patterns for residents and workers.

In 2016 the population in the Frenchs Forest and surrounds study area was 68,700[11]. The mode share for residents travelling to their employment destinations is shown in Figure 4-45. Private vehicles accounted for 74 per cent of trips, with 68 per cent as vehicle drivers and six per cent as passengers. Public transport accounted for 20 per cent of trips, with 17 per cent by bus and three per cent by train. Walking accounted for three per cent of trips. When compared to the Sydney average, the private vehicle mode share is relatively high. This can be attributed to the locations where most residents work, which are Warringah, Sydney Inner City, and Chatswood–Lane Cove. Although these locations are served by buses, they can be difficult to reach from Frenchs Forest, resulting in commuter trips by private vehicle remaining an attractive mode of transport.

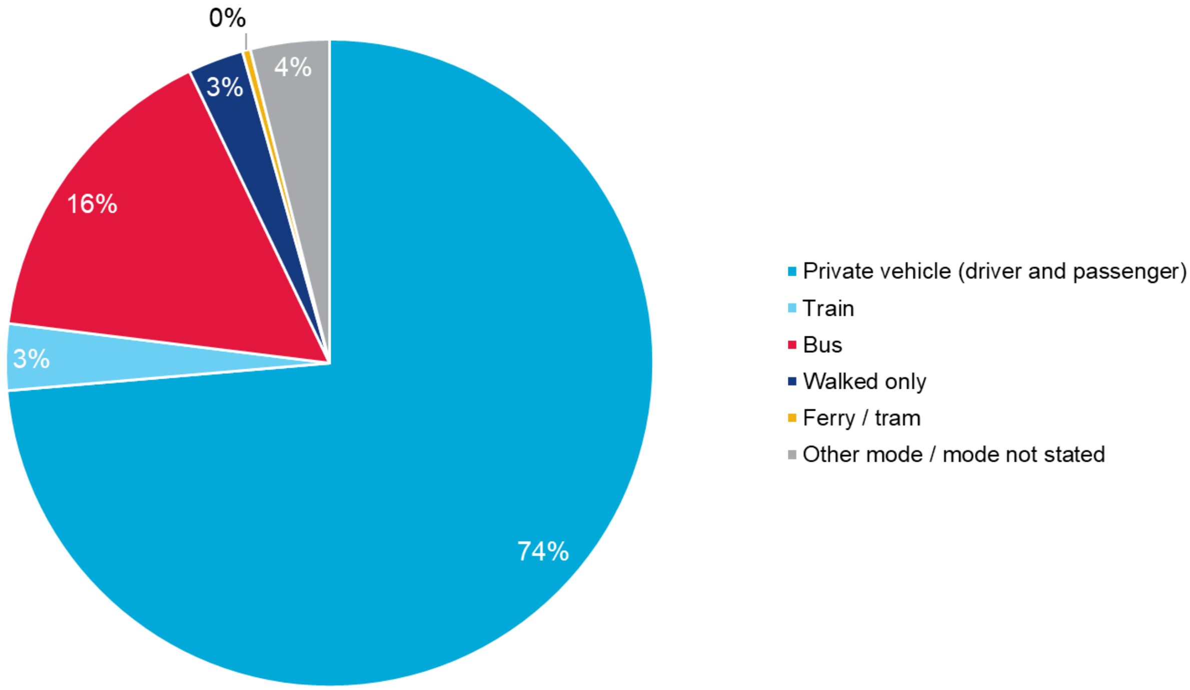


Figure 4-45 Mode share for residents in the Frenchs Forest and surrounds study area travelling to their employment

Source: Journey to Work 2016 (Transport for NSW, 2018c)

In 2016, there were 21,500 workers in the Frenchs Forest area. The mode share for workers travelling to employment is shown in Figure 4-46. Private vehicles accounted for 85 per cent of trips, with 80 per cent as vehicle drivers and five per cent as passengers. Public transport accounted for eight per cent of trips, with five per cent by bus and three per cent by train. Walking accounted for three per cent of trips. When compared to the Sydney average, the public transport mode share is relatively low and the private vehicle mode share is relatively high. This can be attributed to the disparate locations across northern Sydney where workers live.

[11] Journey to work data is based on statistical areas defined by the Australian Bureau of Statistics that fall within the operational traffic model boundary for each study area. For the Frenchs Forest and surrounds area this includes the statistical areas of Manly Vale – Allambie Heights, Forest ville – Killarney Heights, Frechs Forest – Belrose, and Beacon Hill - Narraweena

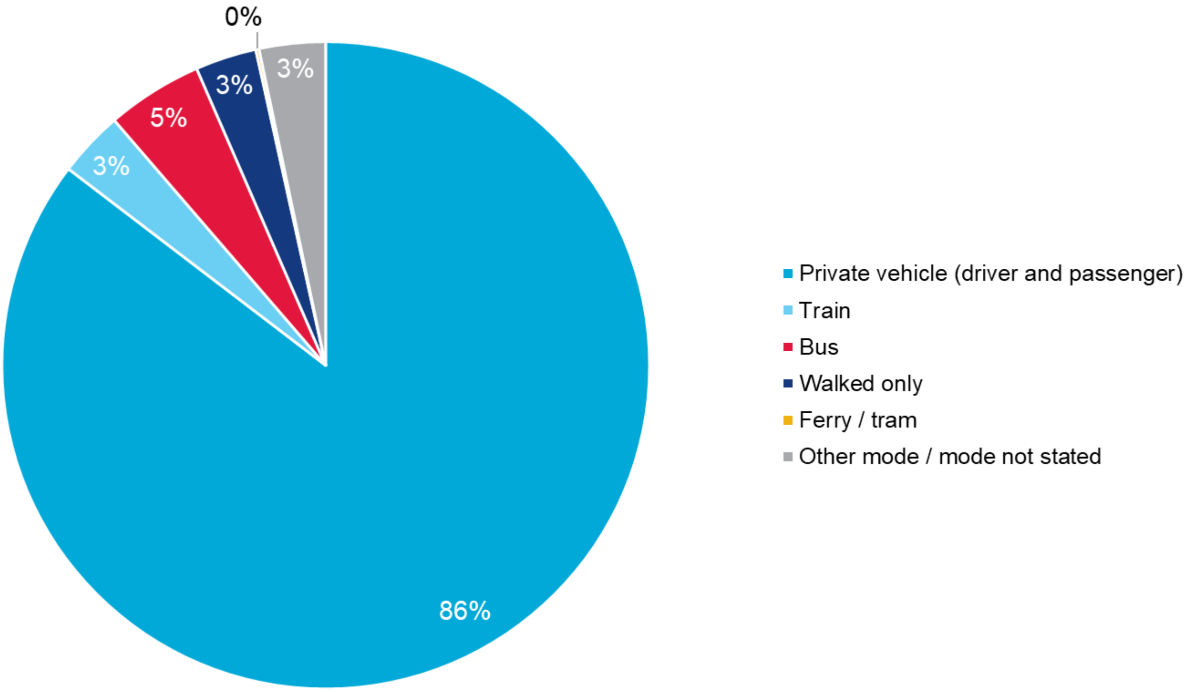


Figure 4-46 Mode share for workers travelling to employment in the Frenchs Forest and surrounds study area

Source: Journey to Work 2016 (Transport for NSW, 2018c)

4.5.2 Road network key features

Key roads in the Frenchs Forest and surrounds study area and their characteristics are summarised in Table 4-23.

Table 4-23 Summary of key roads – Frenchs Forest and surrounds study area

Road	Location	Road type and speed limit	Total number of lanes	Key destinations	On-road public transport	Operational arrangements
Wakehurst Parkway	Frenchs Forest, Killarney Heights	Major arterial road 80 km/h	Two	Seaforth, Northern Beaches, Forest District	Local services to Sydney CBD, Manly and Narraweena	N/A
Warringah Road	Frenchs Forest	Major arterial road 70 km/h	Six	Chatswood, Northern Beaches, Forest District	Major bus corridor. Services to Sydney CBD, Chatswood, Terrey Hills and Belrose	Clearways in operation during weekday peak periods
Forest Way	Frenchs Forest	Major arterial road 70 km/h	Six	Forest District	Major bus corridor. Services to Sydney CBD, Chatswood, Terrey Hills and Belrose	N/A

Road	Location	Road type and speed limit	Total number of lanes	Key destinations	On-road public transport	Operational arrangements
Frenchs Forest Road East/Frenchs Forest Road West	Frenchs Forest	Sub-arterial road 50 km/h	Two	Northern Beaches, Forest District (via Warringah Road and Forest Way)	Services to Sydney CBD, Chatswood, Manly and Brookvale	N/A
Judith Street	Seaforth	Local road 40 km/h	Two	Bantry Bay Reserve, Wakehurst Golf Course	Local services to Warringah Mall	N/A
Burnt Street	Seaforth	Local road 40 km/h	Two	Provides access Seaforth Oval, Balgowlah	N/A	N/A

4.5.3 Traffic volumes and patterns

Wakehurst Parkway and Warringah Road are major arterial roads that carry high traffic volumes. Wakehurst Parkway exhibits a northbound morning peak direction and a southbound evening peak direction. West of Wakehurst Parkway, Warringah Road exhibits a westbound morning peak direction and an eastbound evening peak direction. East of Wakehurst Parkway, Warringah Road exhibits an eastbound morning peak direction.

The midblock volumes on key roads in the Frenchs Forest and surrounds study area are summarised in Table 4-24.

Table 4-24 2016 peak hour traffic volumes – Frenchs Forest and surrounds study area

Road	Direction	Morning peak hour		Evening peak hour	
		Volume (veh)	Heavy vehicle percentage	Volume (veh)	Heavy vehicle percentage
Wakehurst Parkway north of Burnt Street	Northbound	620	4%	680	4%
	Southbound	440	8%	670	2%
Wakehurst Parkway north of Judith Street	Northbound	830	3%	830	3%
	Southbound	580	6%	860	2%
Wakehurst Parkway north of Kirkwood Street	Northbound	860	2%	800	3%
	Southbound	540	7%	820	1%
Warringah Road west of Wakehurst Parkway	Eastbound	2320	6%	3,430	2%
	Westbound	3080	4%	2,820	2%
Warringah Road east of Wakehurst Parkway	Eastbound	1690	7%	2,140	2%
	Westbound	1460	5%	2,160	2%

4.5.4 Road network performance

Warringah Road forms the primary east–west arterial corridor between Dee Why and Chatswood, while Forest Way is the arterial route providing access to Belrose, Davidson and Terrey Hills. Warringah Road and Forest Way carry high traffic volumes throughout the day; traffic volumes are highest travelling south-west in the morning peak period and north-east in the evening peak. Wakehurst Parkway also forms an alternative north–south route to Pittwater Road, providing a sub-arterial connection between Narrabeen and Seaforth.

During the morning peak, traffic heading west along Warringah Road conflicts with southbound traffic on Forest Way and to a lesser extent, Wakehurst Parkway. This results in substantial queues in the peak direction on Warringah Road on approach to Wakehurst Parkway, southbound on Wakehurst Parkway at Warringah Road and in the counter-peak direction eastbound on Warringah Road east of Forest Way.

In the evening peak, the primary constraint is the intersection of Warringah Road and Forest Way, with queues frequently observed on the western and northern approaches due to high traffic volumes into and out of Forest Way Shopping Centre and Forest High School.

Warringah Road and Forest Way are both bus corridors, primarily providing bus access to Chatswood. A southbound kerbside bus lane is provided on Wakehurst Parkway between Warringah Road and Frenchs Forest Road East and localised signal bus priority is provided westbound on Warringah Road east of Wakehurst Parkway and southbound on Forest Way north of Warringah Road.

In 2015, Transport for NSW commenced work on the Northern Beaches Hospital road upgrade project to facilitate the construction of the new Northern Beaches Hospital. This project was completed in August 2020 and involved the construction of a grade-separated underpass on Warringah Road, allowing for traffic heading eastbound and westbound on Warringah Road to bypass the intersections of Wakehurst Parkway, Forest Way and Hilmer Street. The project started construction in December 2015 along with local road network upgrades and localised widening. During this period, traffic conditions have been affected by construction activities occurring near the Northern Beaches Hospital. Permanent traffic counts on Warringah Road at Beacon Hill indicate that there was a substantial reduction in traffic volumes in 2016 by up to 17 per cent over the average weekday, indicating that construction activities in Frenchs Forest substantially reduced traffic volumes during the peak construction period. Permanent traffic count data shows that by 2017, daily traffic volumes returned to 2012 levels, indicating that traffic conditions have generally returned to preconstruction levels and that there has been negligible growth in peak period traffic volumes through the area. Since completion of the Northern Beaches Hospital road upgrade project, updated data unaffected by COVID-19 is not readily available to assess if the grade separation works have influenced traffic. Traffic data for 2012 was therefore considered appropriate and suitable to model existing traffic volumes.

A summary of modelled network performance statistics for the Frenchs Forest and surrounds study area is provided in Table 4-25.

Table 4-25 Modelled 2012 morning and evening peak network performance - Frenchs Forest and surrounds study area

Network measure	Morning peak period	Evening peak period
Network statistics for all vehicles		
Total traffic demand (veh)	29,400	31,400
Total VKT through network	84,100	93,200
Total VHT through network	3410	3050
Total number of stops	121,600	97,900

Network measure	Morning peak period	Evening peak period
Average vehicle statistics		
Average vehicle trip length through the network (km)	2.8	3.0
Average vehicle trip time through the network (hours)	0:06:48	0:05:51
Average number of stops per trip	4.0	3.1
Average trip speed (km/h)	24.7	30.6
Unreleased traffic		
Total unreleased trips	40	420
% of demand unreleased	<1%	1%

4.5.5 Intersection performance

Modelled performance for key intersections in the Frenchs Forest and surrounds study area under 2012 travel conditions are presented in Table 4-26. As noted in Section 4.5.4, analysis of historical traffic volumes through the area shows that there was a substantial reduction in traffic volumes in 2016, but that 2017 traffic volumes were generally equivalent to 2012 volumes. Traffic data for 2012 was therefore considered appropriate and sufficient to model existing traffic volumes. Modelled intersection performance indicates that the following intersections within the Frenchs Forest and surrounds study area currently perform at or above capacity, as highlighted in Table 4-26:

- Wakehurst Parkway/Frenchs Forest Road East
- Warringah Road/Allambie Road
- Wakehurst Parkway/Warringah Road
- Warringah Road/Hilmer Street
- Warringah Road/Forest Way
- Warringah Road/Brown Street/Currie Road.

The *Northern Beaches Hospital Stage 2 Network Enhancement Works environmental impact statement* (Roads and Maritime, 2015) identified that road network performance following the grade separation of Warringah Road would be slightly improved in the morning peak period when compared to 2012 road network performance. However, the assessment identified that road network performance would be slightly worse in the evening peak period when compared to 2012 road network performance due to additional traffic generated by the Northern Beaches Hospital. Overall, network performance at Frenchs Forest and surrounds would not be materially changed due to the Northern Beaches Hospital Stage 2 Network Enhancement Works.

Table 4-26 Modelled 2012 morning and evening peak hour intersection performance - Frenchs Forest and surrounds study area

Intersection	Morning peak hour		Evening peak hour	
	Average delay (sec)	LoS	Average delay (sec)	LoS
Wakehurst Parkway/Frenchs Forest Road East	>100	F	67	E
Warringah Road/Allambie Road	65	E	56	D
Wakehurst Parkway/Warringah Road	>100	F	48	D

Intersection	Morning peak hour		Evening peak hour	
	Average delay (sec)	LoS	Average delay (sec)	LoS
Warringah Road/Hilmer Street	58	E	49	D
Warringah Road/Forest Way	>100	F	34	C
Forest Way/Naree Road	<5	A	7	A
Warringah Road/Brown Street/Currie Road	70	F	11	A
Warringah Road/Starkey Street	37	C	10	A
Warringah Road/Darley Street	20	B	22	B
Warringah Road/Forestville Avenue	16	B	28	B

4.5.6 Road safety and crash history

A summary of crash data for the five-year period between October 2014 and September 2019 on roads that would be substantially impacted by the project (based on forecast traffic demand with and without the project) is presented in Table 4-27.

Key statistics include:

- Sixty-seven per cent of crashes (230 crashes) resulted in at least one injury
- Two crashes resulted in a fatality: one on Wakehurst Parkway and one on Warringah Road
- Thirty per cent of crashes (104 crashes) involved a heavy vehicle, with the majority occurring on Warringah Road
- Seven per cent of crashes (23 crashes) involved a cyclist or pedestrian
- The three most common crash types involved vehicles travelling in the same direction (55 per cent), vehicles travelling in the opposite direction (13 per cent), and vehicles travelling from adjacent approaches (eight per cent)
- Fifty-three per cent of crashes occurred at an intersection, while 47 per cent occurred at a midblock.

Table 4-27 Crash history summary – Frenchs Forest and surrounds study area

Road segment	Number of crashes by severity				Top three crash types	Number of pedestrian and cyclist crashes	Number of heavy vehicle crashes	% of midblock and intersection crashes
	Fatality	Injury	Non-injury	Total				
Forest Way	0	37	16	53	Vehicles from same direction (62%) Opposing vehicles (11%) Intersection, adjacent approaches (9%)	2 pedestrian crashes and 3 cyclist crashes	20	49% intersection, 51% midblock
Wakehurst Parkway	1	31	13	45	Vehicles from same direction (29%) Opposing vehicles (20%) Veering off path on a straight (18%)	2 pedestrian crashes and 7 cyclist crashes	7	38% intersection, 62% midblock
Warringah Road	1	160	85	246	Vehicles from same direction (59%) Opposing vehicles (12%) Intersection, adjacent approaches (9%)	7 pedestrian crashes and 2 cyclist crashes	77	57% intersection, 43% midblock
Total	2	228	114	344	Vehicles from same direction (55%) Opposing vehicles (13%) Intersection, adjacent approaches (8%)	11 pedestrian crashes and 12 cyclist crashes	104	53% intersection, 47% midblock

A summary of casualty crashes for the five-year period between October 2014 and September 2019 on roads which would be substantially impacted by the project (based on forecast traffic demand with and without the project) is presented in Table 4-28. The data shows that crash rates in the Frenchs Forest and surrounds study area are highest on Forest Way. In contrast, crash rates on Warringah Road and Wakehurst Parkway are low compared to crash rates on other roads within the strategic context of the project. It is likely that the reduced speed conditions associated with ongoing construction for the Northern Beaches Hospital road upgrade project has skewed the incidence of crashes in the area over the last five years.

Table 4-28 Casualty crashes analysis – Frenchs Forest and surrounds study area

Road segment	Length (km)	AADT	Crash rate per 100 million VKT	Casualty crashes per km per year	Casualty crashes (Sydney average)[12]
Forest Way	1.4	38,900	64.0	5.4	6.7
Wakehurst Parkway	6.3	18,700	20.5	1.0	3.9
Warringah Road	9.5	78,700	25.7	3.4	4.7

4.5.7 Public transport network

The Frenchs Forest and surrounds study area is well served by buses, with 21 unique routes and about 600 individual timetabled services on weekdays, 300 services on Saturdays and 200 services on Sundays and public holidays. Bus services are operated by Sydney Buses and Forest Coach Lines. Warringah Road and Forest Way are major bus corridors for services to Sydney CBD, Chatswood, Terrey Hills and Belrose. Bus route maps are shown in Figure 4-47 (Sydney Buses) and Figure 4-48 (Forest Coach Lines).

As part of the Growth Services Program 2018-2019, the following services are now in operation and support the Northern Beaches Hospital:

- Two new routes to service the Northern Beaches Hospital directly: route 141 from Manly to Austlink via Balgowlah and route 193 from Austlink to Warringah Mall via Frenchs Forest
- Extension of the existing route 169 to access the Northern Beaches Hospital
- Enhancement of existing route 136 between Chatswood and Manly via Frenchs Forest and Dee Why to provide customers with a daytime service frequency of at least every 15 minutes, seven days a week
- Additional weekend services on routes 270 and 271 to provide passengers travelling from Frenchs Forest to the Sydney CBD more service frequency.

Further, a rapid bus service, similar in nature to that of the existing B-Line, is proposed between Dee Why and Chatswood and is anticipated to be operational before the project commences construction.

[12] Transport for NSW, 2019

Figure 4-47 Bus routes - Frenchs Forest and surrounds study area (Sydney Buses)

Source: Northern Beaches & Lower North Shore region guide (Transport for NSW, 2019a)

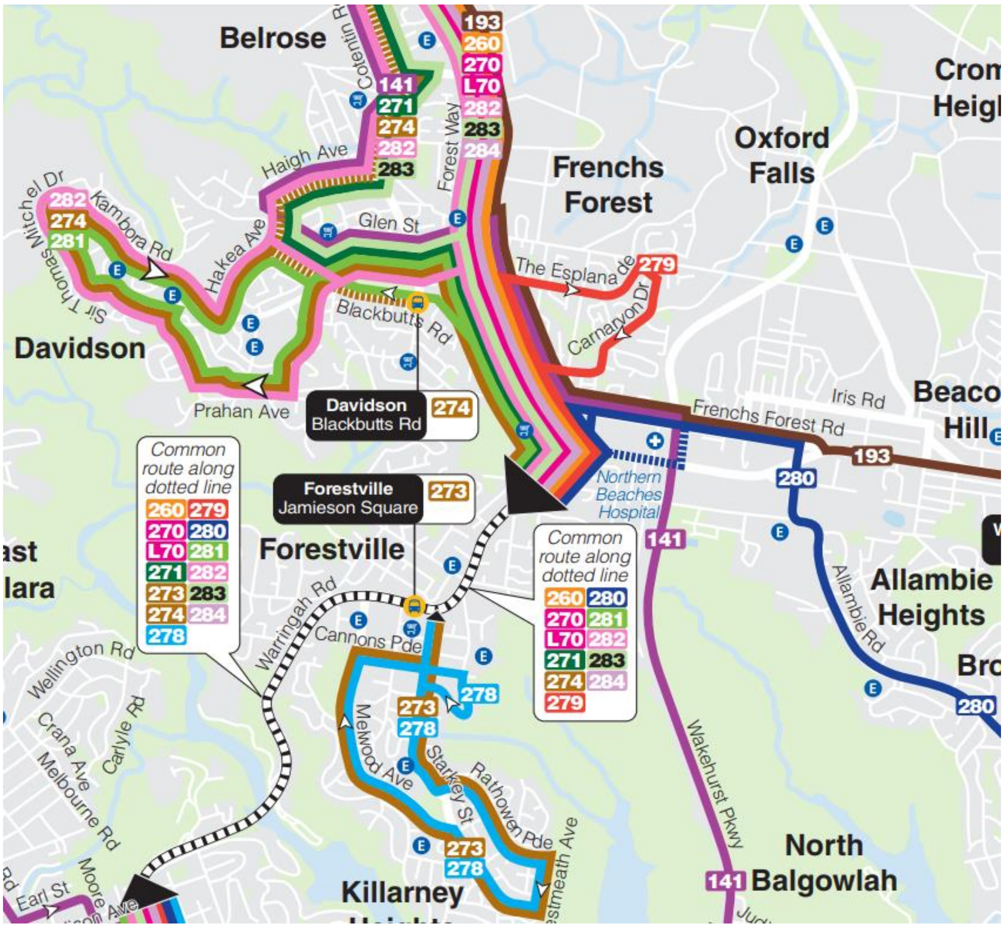


Figure 4-48 Bus routes - Frenchs Forest and surrounds study area (Forest Coach Lines)

Source: Forest Coach Lines Sydney Region Network Map (Forest Coach Lines, 2019)

4.5.8 Active transport network

The pedestrian network in the Frenchs Forest and surrounds study area is limited with no footpaths alongside Wakehurst Parkway and most local roads. However, footpaths are provided alongside other arterial roads, and controlled crossings are provided at most intersections. High levels of pedestrian activity occur around the Warringah Aquatic Centre and near the Frenchs Forest local town centre on Warringah Road and Forest Way.

The cycle network in the Frenchs Forest and surrounds study area is shown in Figure 4-49 and consists of a mix of off-road shared user paths and on-road cycle routes on local and collector roads. The regional strategic cycle network provides connections between the study area and Balgowlah, Manly and Narrabeen. Off-road shared user paths are provided at the following locations:

- Karingal Crescent Reserve
- Shared pedestrian and cyclist bridge connecting Karingal Crescent Reserve and Forest Way
- Between Wakehurst Parkway north of Warringah Road and Frenchs Forest Road East west of Inverness Avenue
- Shared pedestrian and cyclist bridge connecting Warringah Aquatic Centre and Bantry Bay Road
- Allambie Road between Aquatic Drive and Eaton Square
- Shared pedestrian and cyclist bridge across Warringah Road west of the intersection of Forest Way
- Shared pedestrian and cyclist bridge across Warringah Road on the western side of the intersection with Hilmer Street.
- Manly Dam Bike Track within Manly Dam Reserve, east of Wakehurst Parkway.

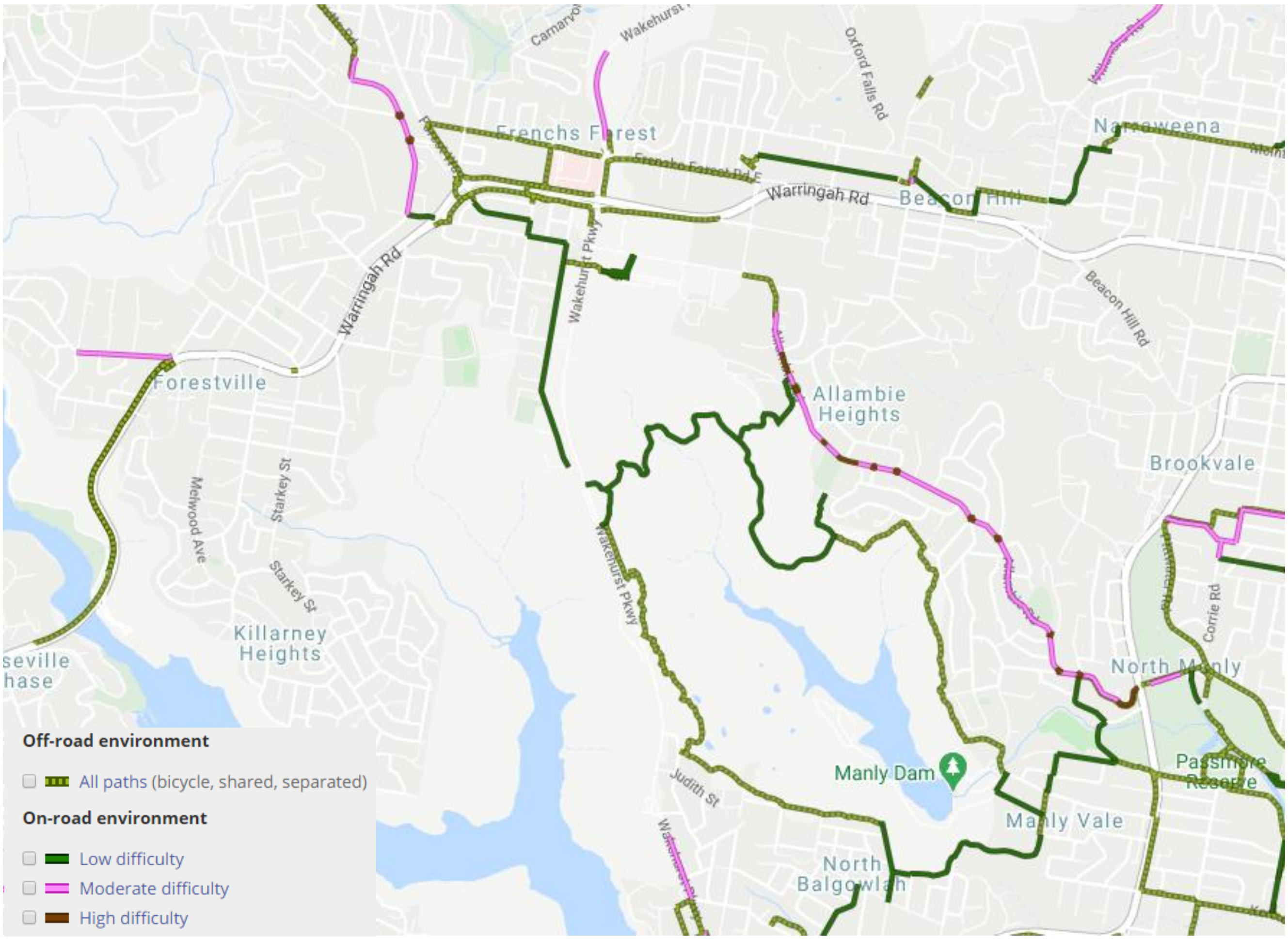


Figure 4-49 Cycle network - Frenchs Forest and surrounds study area

Source: Source: Cycleway Finder (Transport for NSW, 2020)

4.6 Existing maritime activities

This section presents a summary of the existing maritime environment, described in more detail in the navigation impact assessment completed by Royal Haskoning DHV (provided in Annexure A. Navigational impact assessment).

The broad maritime footprint adopted for the traffic and transport assessment includes two areas of Port Jackson, which is a natural harbour of Sydney. These areas are:

- Outer Sydney Harbour – a wide waterway between Sydney Heads, the Opera House at Bennelong Point and Admiralty House at Kirribilli Point
- Middle Harbour – a waterway bordering the western side of Outer Sydney Harbour and extending west of Middle Head and Grotto Head.

4.6.1 Bathymetry and navigation widths

Outer Sydney Harbour is relatively deep and wide, with water depths generally exceeding 20 metres below Chart Datum (CD) (expressed as -20 metres CD) between South Head and North Head, decreasing to eight metres below CD between Grotto Point and Middle Head.

The entrance to Middle Harbour about 750 metres wide, decreasing to a width of 165 metres at the Spit Bridge. However, the navigable width between the piers of the opening span of the Spit Bridge is 24.3 metres. Highly variable water depths limit the type of vessels that can navigate through Middle Harbour. A flood tide delta (The Bar) is located near the entrance to Middle Harbour between Wyargine Point and Grotto Point, with the deepest part of the channel about three metres below CD. Immediately upstream of The Bar, the water depth increases with two deep basins located on the eastern side of The Spit. These basins have a water depth of about -24 to -26 metres CD. Upstream of the Spit Bridge, the width of the waterway increases to about 400 metres and the water depth generally exceeds -20 metres CD. The waterway width and depth generally decrease towards the head of the several bays within Middle Harbour. However, the foreshore of Middle Harbour is relatively steep and water depth in excess of - 10 metres CD is typically available close to the shoreline.

Between Northbridge and Seaforth, the channel is relatively deep, up to -32 metres CD at its deepest point, and has a navigable width of about 350 metres.

A detailed bathymetric map is provided in the navigation impact assessment (Annexure A. Navigational impact assessment).

Spit Bridge

The Spit Bridge, spanning Middle Harbour and connecting Mosman and Seaforth, presents a barrier to boats with masts greater than five or six metres above the water level (depending on tides). Clearance height under the bridge when it is closed is as follows:

- 4.7 metres at highest astronomical tide under the opening span
- 5.7 metres at highest astronomical tide under the first fixed span at the northern end.

The Spit Bridge has scheduled daily openings to allow boats that are above the clearance height to pass through. When the bridge is open, the navigational channel between the piers of the lifting span is 24.3 metres.

Table 4-29 identifies the bridge opening times for each day of the week.

Table 4-29 Spit Bridge opening times

Weekdays	Weekends and public holidays
10.15am	8.30am
11.15am	10am
1.15pm	11.30am
2.15pm	2.30pm
8.15pm	4.30pm
9.15pm (during daylight saving only)	6.30pm
	8.30pm
	9.30pm

4.6.2 Commercial operators and organisations

Commercial shipping operations occur within Sydney Harbour and are focused around the Overseas Passenger Terminal and Glebe Island and White Bay areas. Middle Harbour does not accommodate any major commercial shipping operations, with most of the maritime traffic associated with recreational and sporting activities.

Due to the existing shallow sand bar and draft restrictions at the entrance to Middle Harbour, only a limited number of government organisations and commercial operators are located or navigate through Middle Harbour including:

- The Royal Australian Navy, specifically HMAS Penguin located at Balmoral
- NSW Police Marine Area Command
- NSW Department of Primary Industries Water taxis
- Yacht charter and boat hire companies such as Champagne Sailing, Clontarf and Eco Boats Hire, Northbridge
- Jungle Float mobile water park, anchored about 20 metres off Clontarf Beach when in operation.

4.6.3 Recreational activity

Middle Harbour and the Outer Sydney Harbour cater to a wide range of recreational activities, including:

- Swimming and diving
- Rowing
- Water skiing and wakeboarding
- Sailing
- General cruising
- Kayaking and canoeing
- Recreational fishing.

Numerous foreshore recreation activities occur downstream of the Spit Bridge, with many reserves and sandy beaches suitable for swimming and bathing. In contrast, foreshore recreation upstream of the Spit Bridge is limited due to most foreshore areas being either steep and rocky, or privately owned.

Community groups and clubs that use Middle Harbour include:

- Paddle craft clubs
- Fishing clubs
- Sailing clubs
- Scout and guide clubs
- Marine Rescue NSW.

Additional details of these user groups including course maps for these clubs is provided in Annexure A. Navigational impact assessment.

The *Regional Boating Plan – Sydney Harbour Region* (Transport for NSW, 2015) states that about 20,000 recreational vessels are registered within Sydney Harbour and more than one million people participate in boating as a form of recreation annually.

4.6.4 Maritime facilities

Facilities such as moorings, marinas and boat ramps are provided throughout Middle Harbour. The majority cater to recreational user groups. Three houseboats with permanent land access are located near the head of Pearl Bay, while jetties, pontoons and mooring pens adjoining private residence are located on the foreshore of Seaforth Bluff, Long Bay and Sailors Bay. Locations of moorings and the locations of marinas and boats ramps are listed in Table 4-30, however not all mooring locations would be impacted by the project. Additional information on maritime facilities is provided in Annexure A. Navigational impact assessment.

A number of moorings are commercially leased by local marinas from Transport for NSW with a lease arrangement for occupants. Some of the marinas offer a tender service to commercial and/or privately leased moorings within a defined area for vessels registered with the club or marina.

Table 4-30 Moorings, marinas and boat ramps within Middle Harbour

Facility	Location
Mooring fields	Fisher Bay The Spit Pearl Bay Beauty Point Quakers Hat Bay Long Bay Willoughby Bay Long Bay Salt Plan Creek Long Bay Northbridge Sailors Bay Castlecrag Pickering Point Powder Hulk Bay Seaforth
Marinas	Middle Harbour Yacht Club at Spit Bridge Smiths Boatshed Marina at Spit Bridge Fergusons Boat Shed at Spit Bridge D'Albora Marina at Spit Bridge Cammeray Marina in Cammeray Northbridge Marina in Northbridge Castlecrag Marina in Castlecrag Roseville Bridge Marina in Roseville Clontarf Marina in Clontarf
Boat ramps	Tunks Park boat ramp in Cammeray Roseville Bridge boat ramp in Killarney Heights An informal sand ramp at Clontarf Reserve in Clontarf

4.6.5 Navigation restrictions

Relevant navigation restrictions within Middle Harbour include:

- HMAS Penguin, an Australian Defence Force facility – Vessels are required to keep clear of the facility by staying outside of the yellow buoys
- Waters between Clontarf Point and Parriwi Point, extending upstream to D'Albora Marina and the eastern end of Peach Tree Bay (including Spit Bridge) – A speed limit of four knots is imposed for all vessels
- All land and structures including moorings in Middle Harbour – Vessels travelling more than six knots are required to maintain a distance of 30 metres from vessels, land or structures
- Waters at Spit Bridge from Beauty Point to Clontarf point – A 'No Wash' zone is imposed for all vessels
- Waters between a line from Inner South Head to Inner North Head and a line from the stone pillar at Bradleys Head to Hermit Point – A speed limit of 12 knots is imposed for vessels exceeding 30 metres

- Aquatic events – Additional restrictions may be imposed by an Aquatic Event such as a race, competition or exhibition, and an aquatic licence issued by Transport for NSW may be required for organised activities on navigable waters that restrict the availability of those waters for normal use by the public. Transport for NSW may elect to establish an exclusion zone around the activity.

5. Construction impact assessment

This section provides an assessment of the potential traffic and transport impacts associated with construction of the project and addresses the following issues:

- Summary of construction activities
- Location of construction activities including construction support sites
- Impacts of changed conditions as a result of construction activities on traffic (road and maritime), public transport, pedestrians and cyclists
- Impacts of additional traffic associated with construction activities.

The assessment conservatively focusses on the impacts during peak construction activities to demonstrate the maximum potential impact of the project. For example, the traffic performance effects of the highest potential construction site traffic generation per hour. These peak construction activities assessed are likely to be relatively short in duration; they would only occur for a small proportion of the overall construction program. Therefore, generally, typical site traffic generated per hour would be lower than the peak site traffic numbers which were assessed to demonstrate the maximum potential expected impacts.

5.1 Construction overview

5.1.1 Construction stages and program

Subject to planning approval, construction of the project is planned to commence in 2023, with completion of construction in 2028. The total period of construction works would be about five to six years. Key stages and an indicative program for the project are shown in Table 5-1 (refer to Chapter 6 (Construction work) of the environmental impact statement for specific indicative programs for each construction support site). Typical activities for each stage of construction are described in Table 5-2.

The construction delivery method for the project would depend on future project decisions.

Where feasible and reasonable, some aspects of the Beaches Link component (i.e. the civil works for the on ramp and off ramp cut and cover and trough structures to the west of the T1 North Shore and Western Line and T9 Northern Line) of the project may be delivered by the Gore Hill Freeway Connection construction contractor to minimise disruption to the Gore Hill Freeway.

It is assumed that the Western Harbour Tunnel and Warringah Freeway Upgrade project (subject to separate assessment and approval) would commence construction before the Beaches Link and Gore Hill Freeway Connection project. Should timeframes for the Beaches Link component of the project be advanced, some surface works would be carried out to safeguard delivery of either surface connections or tunnel-to-tunnel connections between the two projects. Should the Beaches Link and Gore Hill Freeway Connection project be constructed before the Western Harbour Tunnel and Warringah Freeway Upgrade project, the project would construct stub tunnels at Cammeray to connect to the Western Harbour Tunnel component in the future.

Table 5-1 Construction stages and indicative timing

Construction activity	Indicative construction program					
	2023	2024	2025	2026	2027	2028
Early works and site establishment works						
Construction of driven tunnels						
Immersed tube tunnel construction and installation						
Tunnel fitout and finishing						
Construction of operational facilities						
Surface road works						
Testing and commissioning						
Site rehabilitation and demobilisation						
New and improved open space and recreation facilities at Balgowlah (subject to further consultation)						

Table 5-2 Overview of construction activities

Component	Typical activities
Early works and site establishment	• Survey work and investigations • Property acquisitions and condition surveys • Utilities installation, protection, adjustment and relocation • Land remediation and heritage conservation and/or salvage works (where required) • Temporary relocation of swing moorings, where required • Provision of alternative facilities (swing mooring or marina berth) for users, where required • Installation of site fencing, environmental controls and traffic management controls • Vegetation clearing, earthworks and demolition of structures • Construction of minor access roads and the provision of property access where required • Relocation of bus stops • Establishment of construction support sites and acoustic sheds, where required.
Construction of the Beaches Link Tunnel component	• Excavation of tunnel construction accesses • Construction of driven tunnels and surface connections • Construction of cut and cover and trough structures • Cofferdam construction and dredging activities in preparation for the installation of immersed tube tunnels (crossing of Middle Harbour) • Removal of temporary cofferdams

Component	Typical activities
	• Casting and installation of immersed tube tunnels • Civil finishing works and tunnel fitout • Construction of operational facilities including: - A motorway control centre within the Artarmon industrial area, next to the Gore Hill Freeway - Motorway facilities and substations at Warringah Freeway, Gore Hill Freeway, Burnt Bridge Creek Deviation and Wakehurst Parkway - Fitout of the Beaches Link ventilation outlet at Warringah Freeway. Civil construction of the ventilation outlet would form part of the Western Harbour Tunnel and Warringah Freeway Upgrade project (subject to separate environmental assessment and approval) - A wastewater treatment plant within the industrial area at Artarmon - Tunnel support facilities at Artarmon and Frenchs Forest - Installation of motorway tolling infrastructure (in tunnel).
Surface road works (Beaches Link and Gore Hill Freeway Connection components)	• Traffic staging works to enable access for the road works • Earthworks • Bridgeworks • Construction of retaining walls • Construction of cut and cover and trough for connections to and from the Gore Hill Freeway, the Burnt Bridge Creek Deviation and the Wakehurst Parkway • Construction and installation of stormwater and cross drainage • Pavement works and linemarking • Utilities installation and relocation • Localised adjustment of a small section of Burnt Bridge Creek for road widening and existing culvert extension works • Tolling gantries and associated infrastructure • Installation of road furniture, fauna crossings and underpasses, lighting, signage and noise barriers • Construction of new active transport infrastructure.
New open space and recreation facilities at Balgowlah	• Staged construction of the new open space and recreation facilities • Facilities may include shared user paths, open space areas, amenities, carpark, playground, netball courts, soccer field, hockey field and new enlarged AFL/cricket oval
Testing, commissioning and site rehabilitation	• Testing of plant and equipment • Commissioning of the project • Removal of temporary infrastructure at construction support sites • Backfill of access declines • Landscaping and rehabilitation of disturbed areas • Removal of temporary environmental and traffic controls.

5.1.2 Construction footprint

The total area required for construction of the project is referred to as the construction footprint. The construction footprint consists of the anticipated area needed for the project and includes construction support sites and additional areas where work would be required to construct the project.

Most of the construction would be underground (the mainline and ramp tunnels). However, surface areas would be required to support tunnelling activities and to construct the surface connections, tunnel portals, surface road works, shared user paths and operational facilities.

Details of the construction footprint can be found in Chapter 6 (Construction Work) with an overview shown in Figure 5-1 to Figure 5-7. To facilitate construction of the project, 14 construction support sites are required. These sites are summarised in Table 5-3.

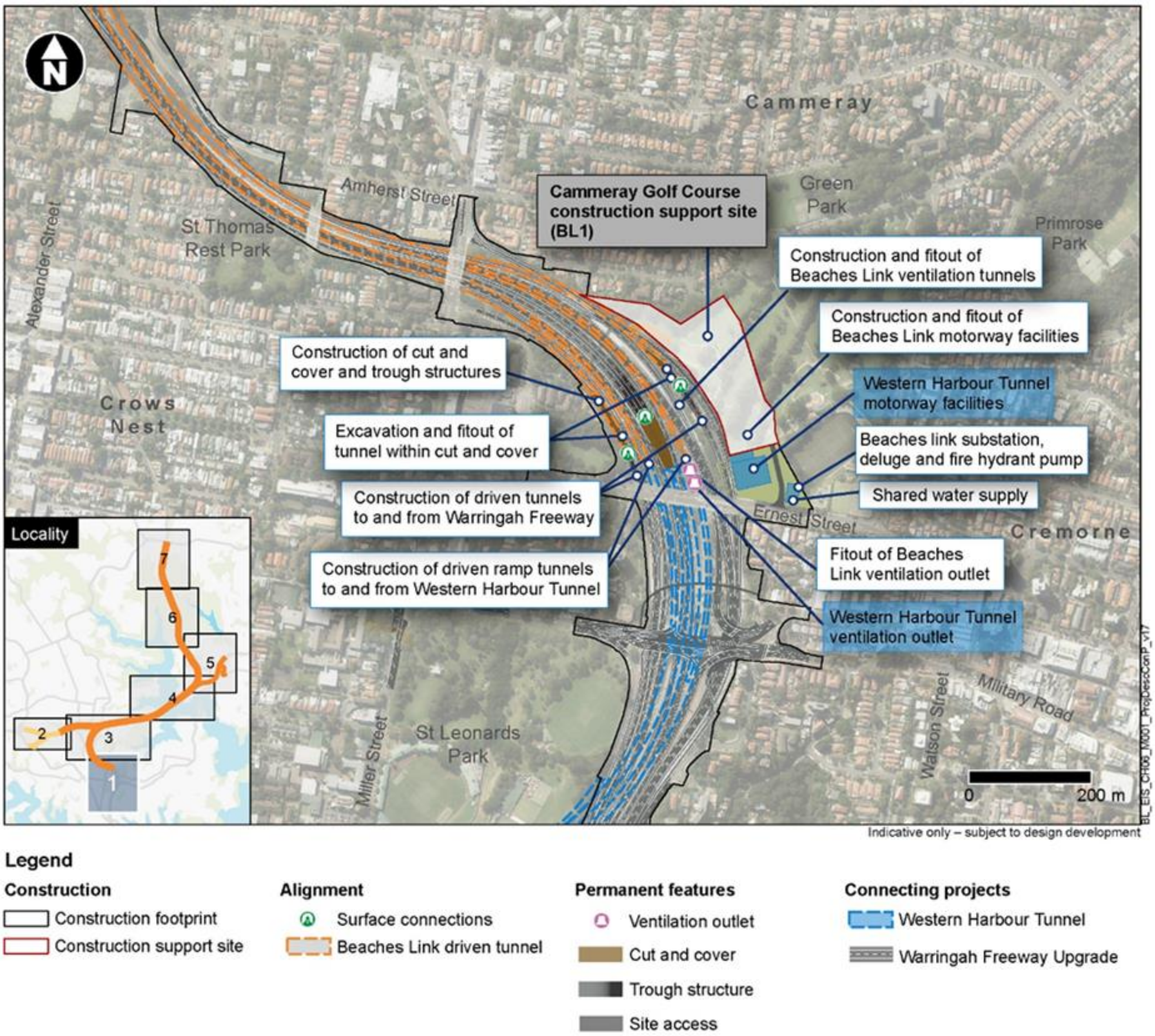


Figure 5-1 Construction footprint around Cammeray (map 1)[13]

[13] Note: The construction footprint shown on Warringah Freeway within this area extends to include construction activities that would be associated with traffic control and management, line marking, tie-in works and utility and cable works.

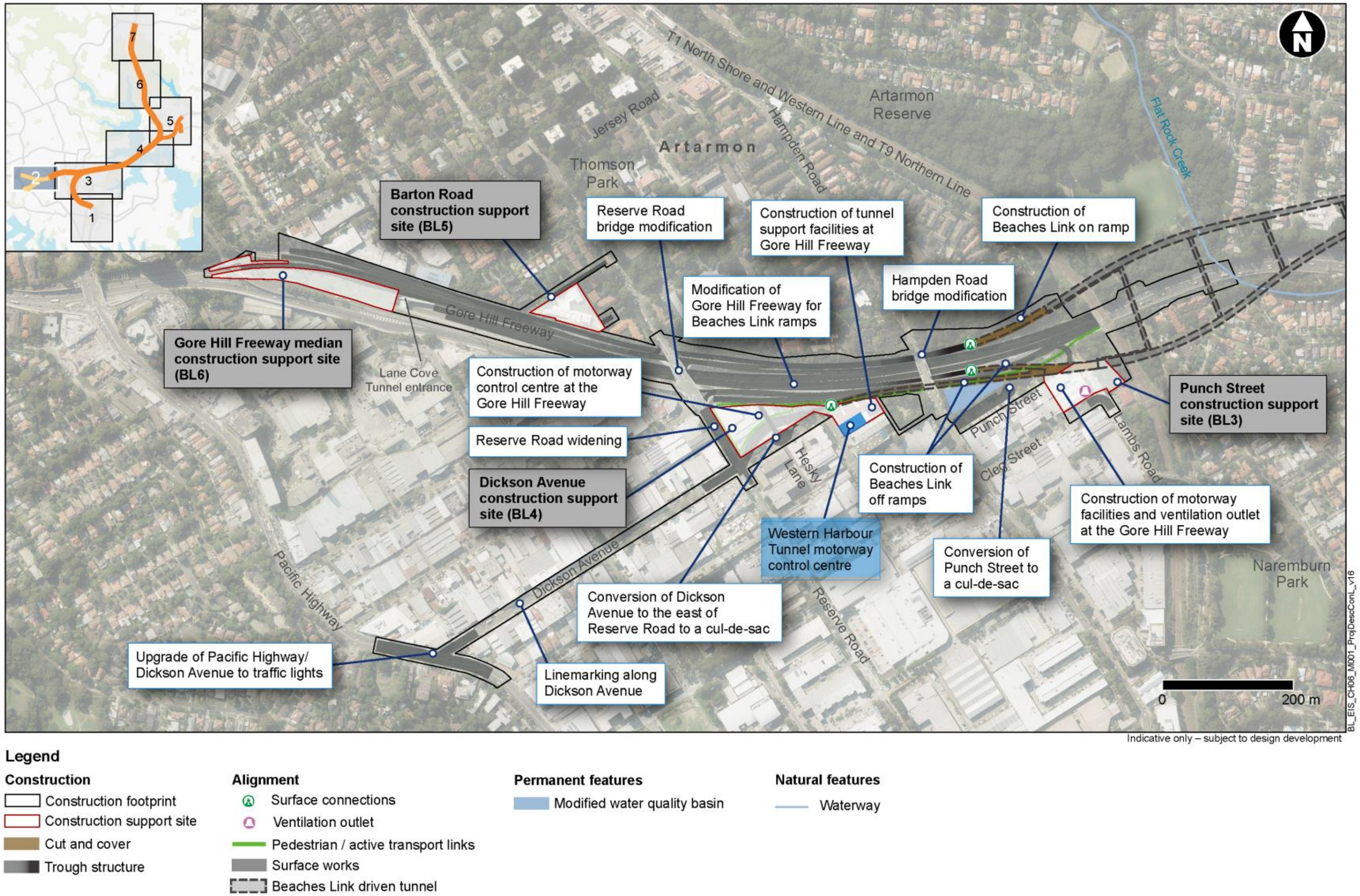


Figure 5-2 Construction footprint around Artarmon (map 2)

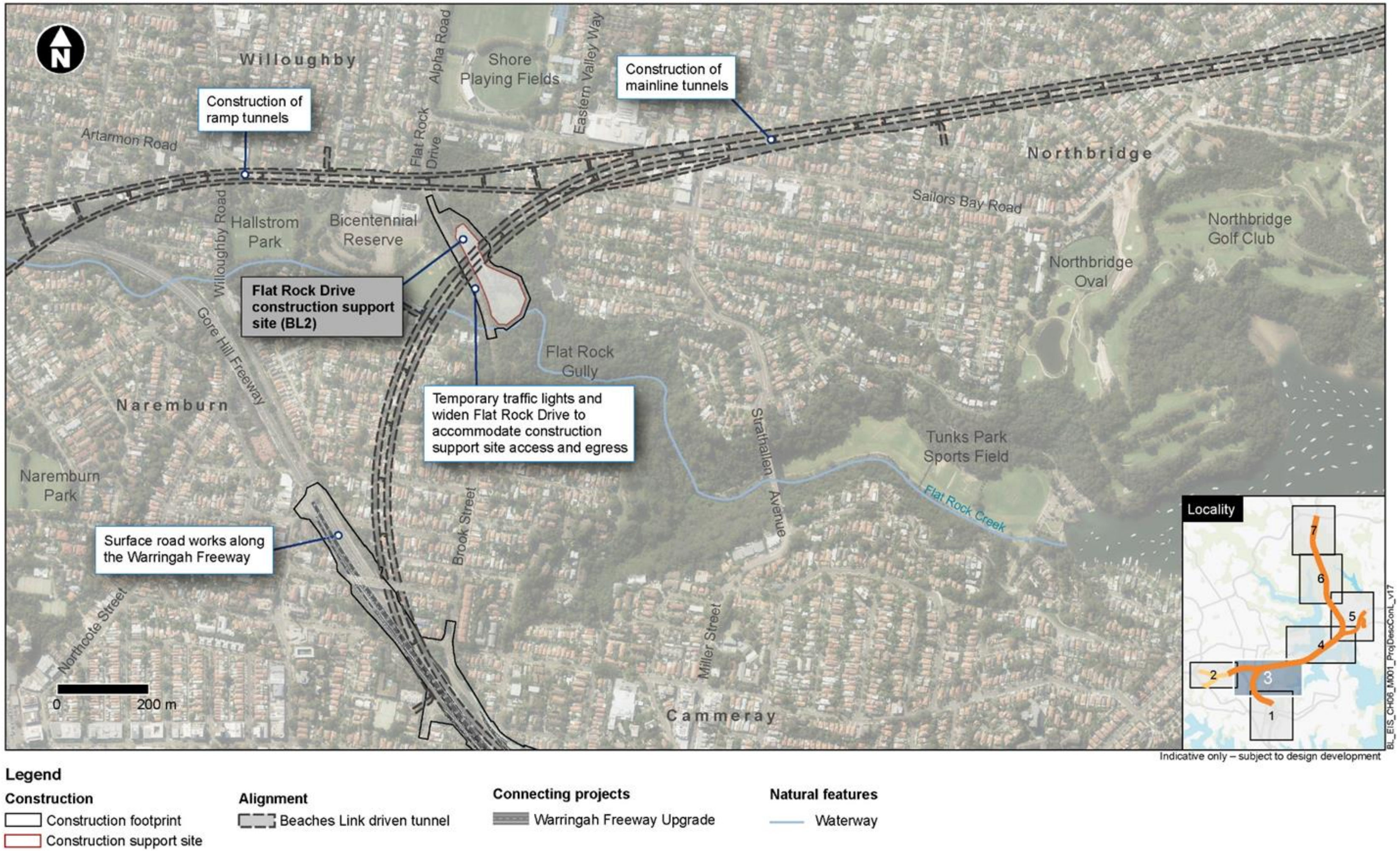


Figure 5-3 Construction footprint around Naremburn (map 3)[14]

[14] Note: The Beaches Link construction footprint shown on Warringah Freeway within this area extends to include construction activities that would be associated with traffic control and management, line marking, tie-in works and utility and cable works.

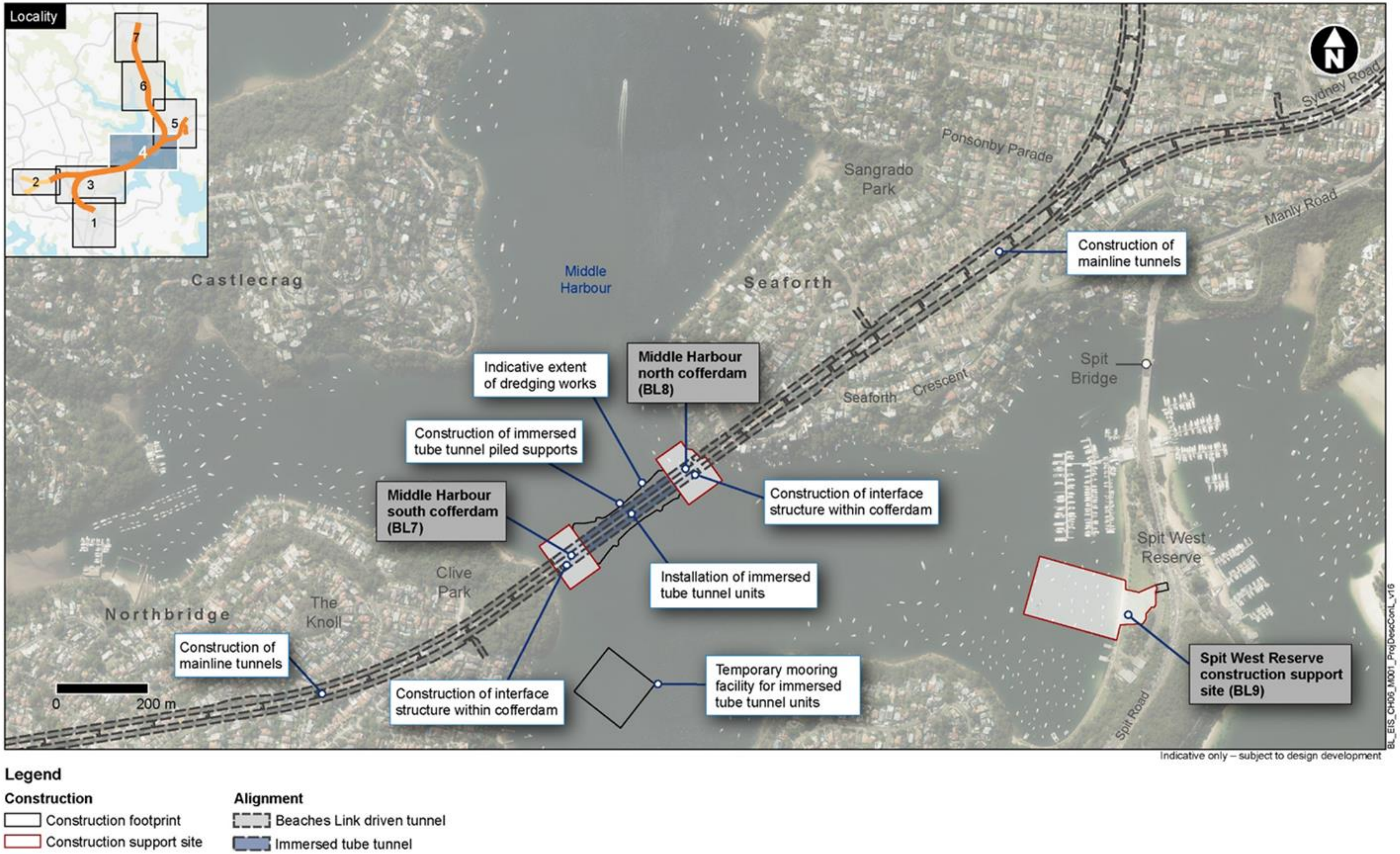


Figure 5-4 Construction footprint around Middle Harbour (map 4)

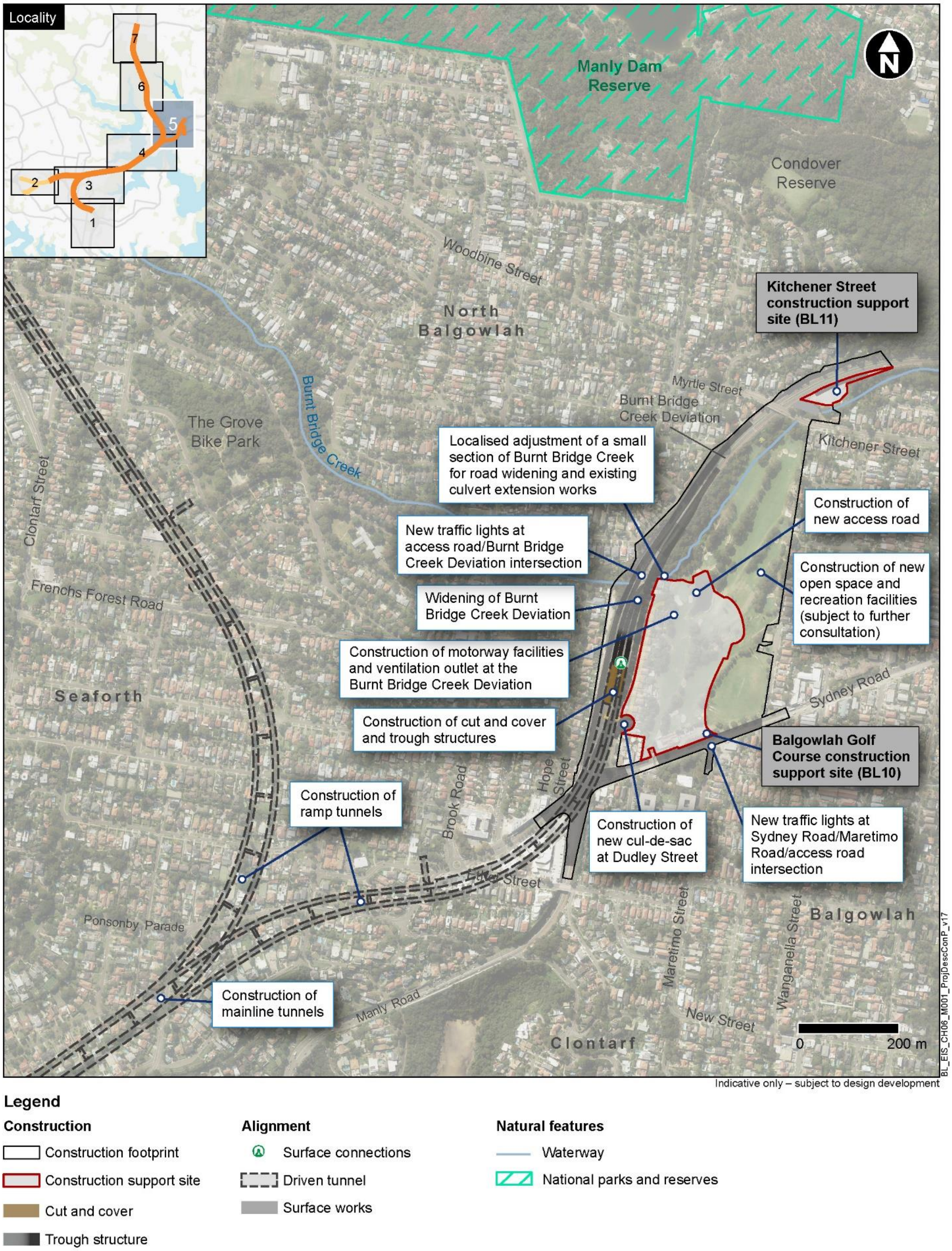


Figure 5-5 Construction footprint around Balgowlah (map 5)

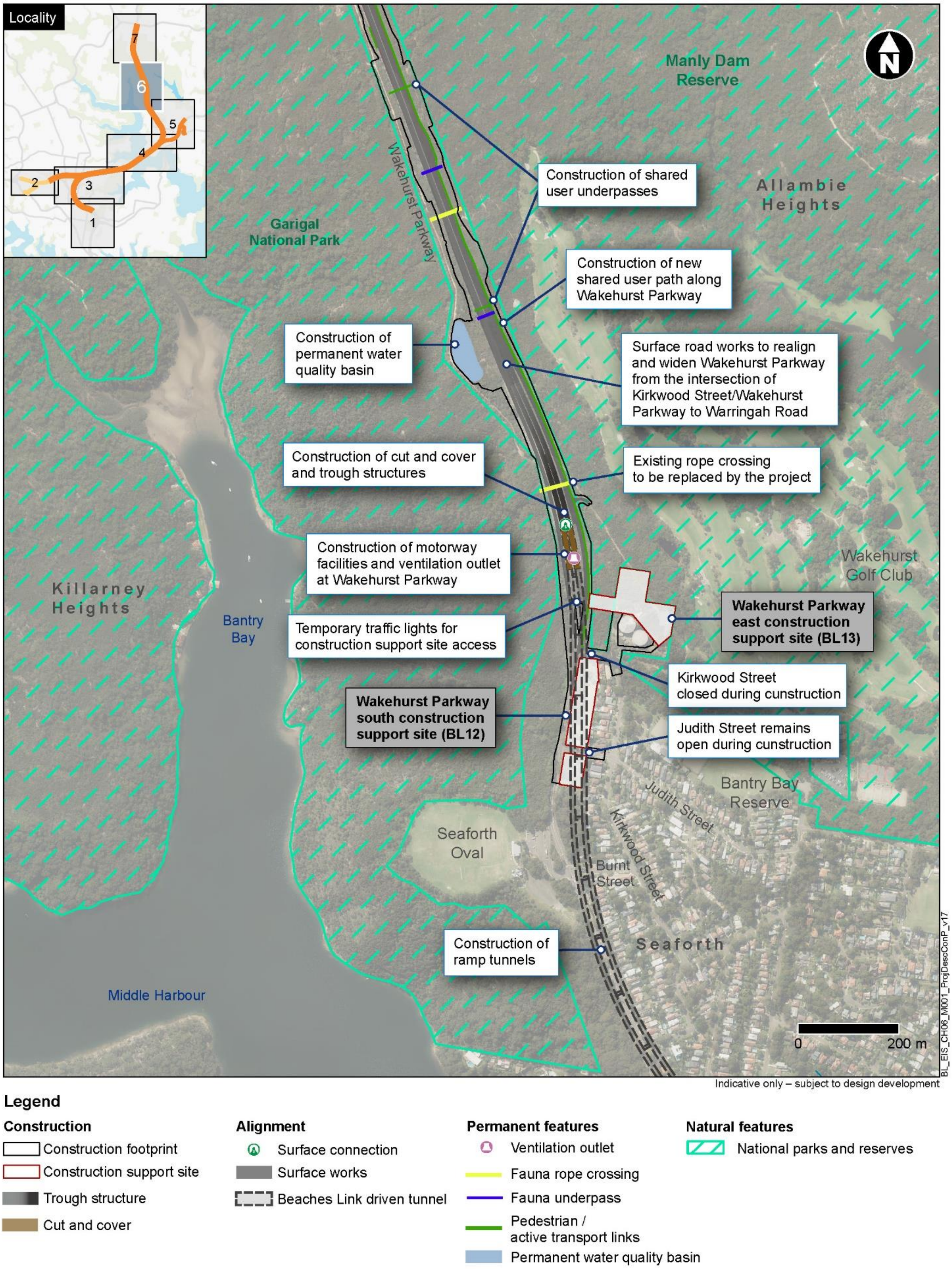


Figure 5-6 Construction footprint around Seaforth (map 6)

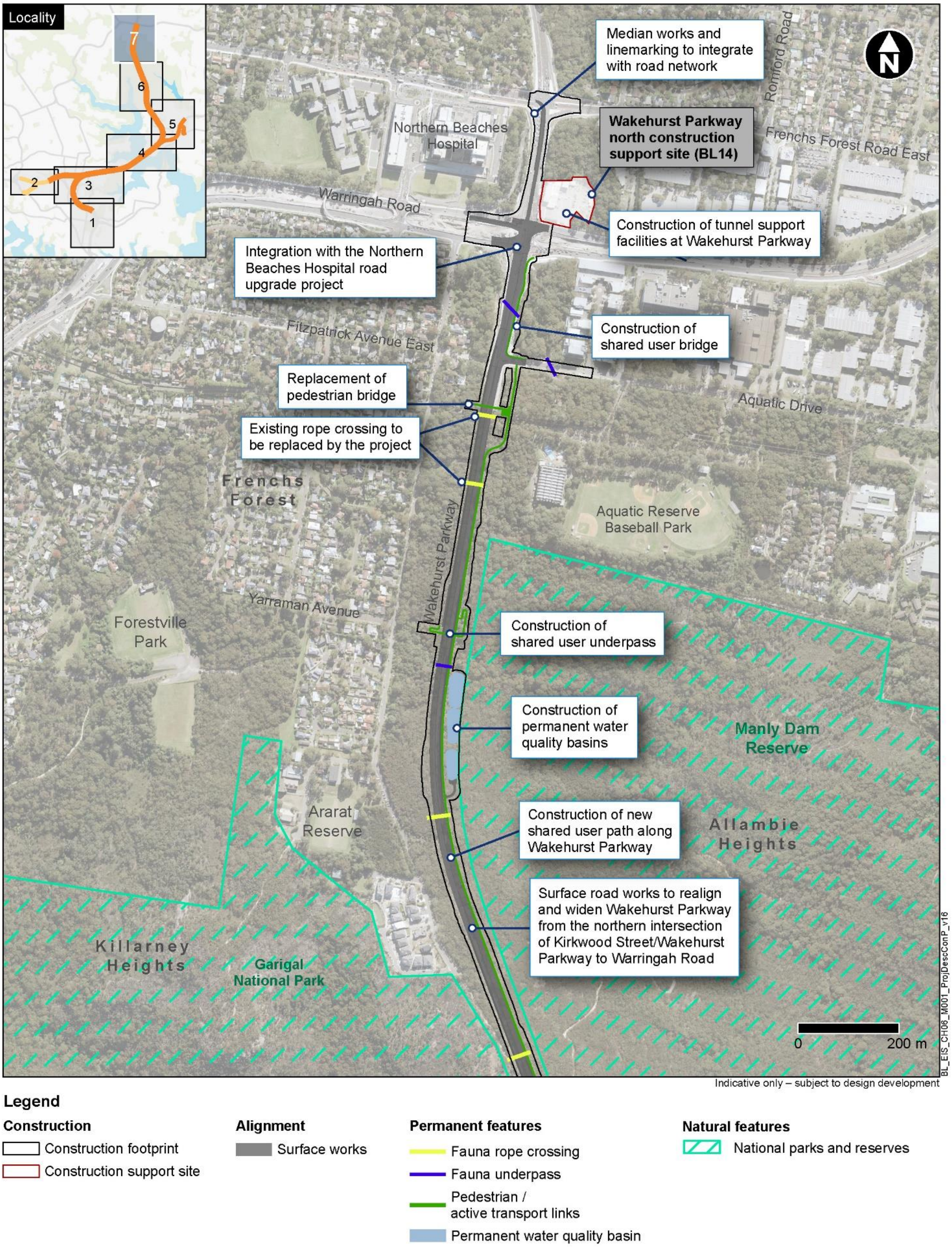


Figure 5-7 Construction footprint around Frenchs Forest (map 7)

Table 5-3 Summary of activities proposed at Beaches Link and Gore Hill Freeway Connection construction support sites

No.	Site	Study area	Key temporary site facilities/uses															Peak vehicle movements per day		Peak vessel movements per day	
			Site offices	Project management compound	Staff amenities	Tunnelling launch and support	Workshop	Car park	Laydown facilities	Sediment pond	Spoil shed	Water treatment plant	Substation	Ventilation plant	Batch plant	Crane pad	Mooring or pontoon facilities	Light	Heavy	Light	Heavy
BL1	Cammeray Golf Course	Warringah Freeway and surrounds	X	X	X	X	X	X	X	X	X	X	X					305	275	-	-
BL2	Flat Rock Drive	Warringah Freeway and surrounds	X		X	X	X	X	X	X	X	X	X	X				355	545	-	-
BL3	Punch Street	Gore Hill Freeway and Artarmon	X	X	X	X	X	X	X	X	X	X	X	X				580	370	-	-
BL4	Dickson Avenue	Gore Hill Freeway and Artarmon	X	X	X			X	X									500	90	-	-
BL5	Barton Road	Gore Hill Freeway and Artarmon	X		X				X									120	35	-	-

No.	Site	Study area	Key temporary site facilities/uses															Peak vehicle movements per day		Peak vessel movements per day	
			Site offices	Project management compound	Staff amenities	Tunnelling launch and support	Workshop	Car park	Laydown facilities	Sediment pond	Spoil shed	Water treatment plant	Substation	Ventilation plant	Batch plant	Crane pad	Mooring or pontoon facilities	Light	Heavy	Light	Heavy
BL6	Gore Hill Freeway median	Gore Hill Freeway and Artarmon						X	X									100	10	-	-
BL7	Middle Harbour south cofferdam	-			X	X			X								X	-	-	60	4
BL8	Middle Harbour north cofferdam	-			X	X			X								X	-	-		
BL9	Spit West Reserve	Balgowlah and surrounds	X		X	X		X	X								X	200	220	8	16
BL10	Balgowlah Golf Course	Balgowlah and surrounds	X	X	X	X	X	X	X	X	X	X	X	X	X			1195	495	-	-

No.	Site	Study area	Key temporary site facilities/uses															Peak vehicle movements per day		Peak vessel movements per day	
			Site offices	Project management compound	Staff amenities	Tunnelling launch and support	Workshop	Car park	Laydown facilities	Sediment pond	Spoil shed	Water treatment plant	Substation	Ventilation plant	Batch plant	Crane pad	Mooring or pontoon facilities	Light	Heavy	Light	Heavy
BL11	Kitchener Street	Balgowlah and surrounds	X		X			X	X	X						X		65	10	-	-
BL12	Wakehurst Parkway south	Frenchs Forest and surrounds	X		X		X	X	X									285	15	-	-
BL13	Wakehurst Parkway east	Frenchs Forest and surrounds	X	X	X	X	X	X	X	X	X	X	X	X				305	275	-	-
BL14	Wakehurst Parkway north	Frenchs Forest and surrounds	X	X	X		X	X	X						X			180	95	-	-

Artarmon Park in Artarmon would be used as a work zone to facilitate construction of the project. It would generate 80 light vehicle and 60 heavy vehicle movements per day. An additional three barge movements would be generated per day, transporting spoil from the Middle Harbour dredge area to offshore disposal.

5.1.3 Construction traffic management

For each construction support site, temporary partial or complete road closures of local streets may be required. These closures would generally be short-term and be subject to local traffic management. In the instances of localised road closures, access for general traffic and emergency vehicles would be provided either by an alternative detour route, or under traffic control. Management of these day-to-day road closures and associated traffic management measures would be outlined in a construction traffic management plan for each work site. Changes to parking arrangements would be outlined in the construction traffic management plan, which would require approval prior to the start of works. The construction workforce would be encouraged to use public transport and shuttle bus transfers would be provided where reasonable and where feasible, but where this is impractical, the construction traffic management plan would outline the changes to local parking required to accommodate the workforce, plant and equipment. The construction traffic management plan would also include measures to manage public safety, including for pedestrians, such as the provision of safety barriers or fencing, along with signage that would be implemented throughout construction to provide separation of active construction areas from pedestrian or shared user paths.

5.2 Warringah Freeway and surrounds

5.2.1 Construction support site locations

The assessment of construction impacts in the Warringah Freeway and surrounds study area includes the following construction support sites:

- BL1 – Cammeray Golf Course
- BL2 – Flat Rock Drive.

Indicative construction support site layouts for each of these sites are shown in Figure 5-8 to Figure 5-9.

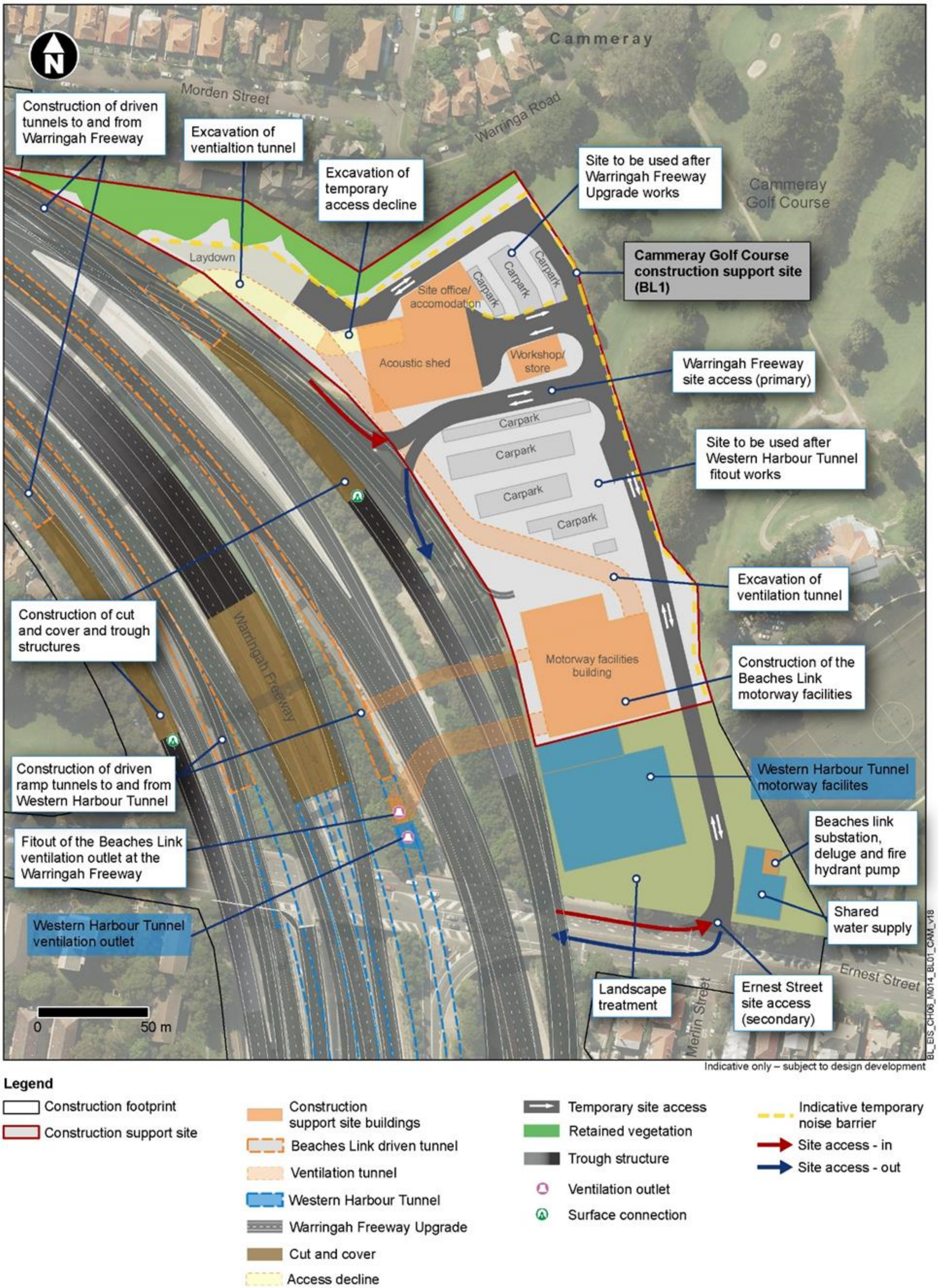


Figure 5-8 Indicative construction support site layout – BL1 – Cammeray Golf Course

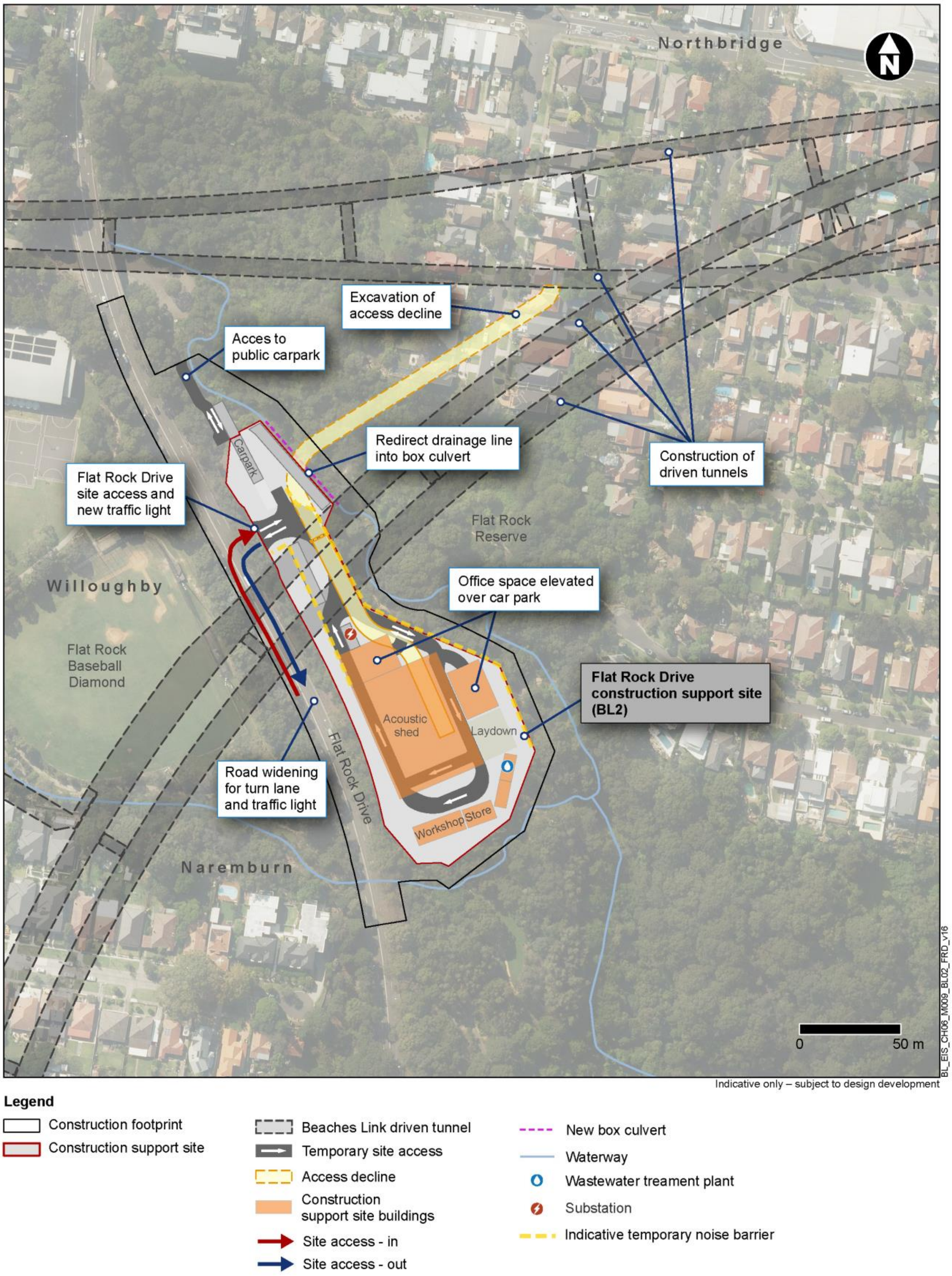


Figure 5-9 Indicative construction support site layout – BL2 – Flat Rock Drive[15]

[15] Note: Further detail on Flat Rock Creek characteristics is provided in Chapter 17 (Hydrodynamics and water quality) of the environmental impact statement.

5.2.2 Construction support site access and traffic generation

The proposed routes to and from each construction support site are summarised in Table 5-4, Figure 5-10 and Figure 5-11. Access routes are proposed to be from major arterial roads rather than local roads where feasible. Daily peak light vehicle and heavy vehicle volumes associated with spoil and waste removal, material deliveries and arrival and departure of construction personnel are also summarised in Table 5-4.

Table 5-4 Proposed access routes and peak traffic generation for each construction support site – Warringah Freeway and surrounds study area

No.	Site	Proposed access routes	Peak vehicle movements per day		Morning peak vehicle movements (6am to 10am)		Evening peak vehicle movements (3pm to 7pm)	
			Light	Heavy	Light	Heavy	Light	Heavy
BL1	Cammeray Golf Course	Ernest Street, Warringah Freeway	305	275	99	72	142	73
BL2	Flat Rock Drive	Flat Rock Drive	355	545	165	145	136	146

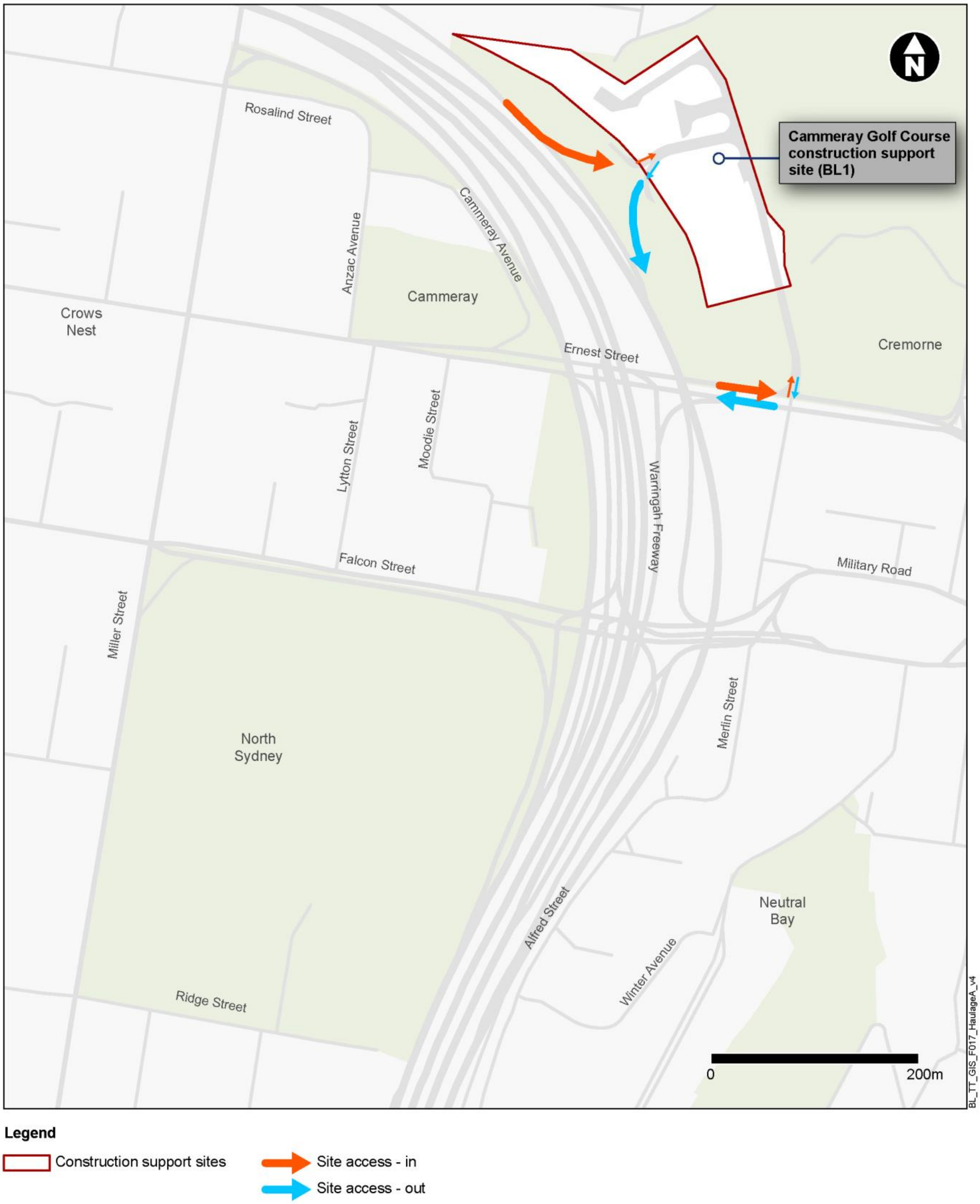


Figure 5-10 Indicative construction vehicle routes – BL1 – Cammeray Golf Course

Figure 5-11 Indicative construction vehicle routes – BL2 – Flat Rock Drive

5.2.3 Timing of construction support site use

The indicative timing of the use of each construction support site is summarised in Table 5-5 and includes site establishment and site rehabilitation.

Table 5-5 Timing of construction support site use – Warringah Freeway and surrounds study area

No.	Site	Indicative timing of construction support site use				
		2023	2024	2025	2026	2027
BL1	Cammeray Golf Course					
BL2	Flat Rock Drive					

5.2.4 Impact on traffic flows

Intersection performance

SIDRA intersection modelling has been carried out to determine the relative impacts of construction traffic at key access points to and from construction support sites when compared to conditions without construction of the project.

The intersection performance results for the road network under the ‘base’ (without construction vehicles) and ‘construction’ (with construction vehicles and proposed intersection modifications during construction) scenarios are summarised in Table 5-6 for the morning and evening peak hours.

Table 5-6 Modelled base and construction morning and evening peak hour intersection performance - Warringah Freeway and surrounds study area

Intersection/peak period	2024 base						2024 construction					
	Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	LoS	Degree of saturation	Maximum queue length by directional approach (metres)		Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	LoS	Degree of saturation	Maximum queue length by directional approach (metres)	
Warringah Freeway/Falcon Street interchange												
Morning peak	13,670	N/A*	F*	>1	Northbound	>500	14,140	N/A*	F*	>1	Northbound	>500
					Eastbound	55					Eastbound	60
					Southbound	65					Southbound	60
					Westbound	>500					Westbound	>500
Evening peak	14,000	N/A*	F*	>1	Northbound	>500	14,650	N/A*	F*	>1	Northbound	>500
					Eastbound	140					Eastbound	140
					Southbound	45					Southbound	145
					Westbound	280					Westbound	>500
Warringah Freeway/Ernest Street interchange												
Morning peak	6410	N/A*	C*	0.60	Northbound	-	6520	N/A*	C*	0.61	Northbound	-
					Eastbound	15					Eastbound	15
					Southbound	-					Southbound	-
					Westbound	140					Westbound	145
Evening peak	5910	N/A*	D*	0.58	Northbound	-	6060	N/A*	D*	0.60	Northbound	-
					Eastbound	135					Eastbound	140

Intersection/peak period	2024 base						2024 construction					
	Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	LoS	Degree of saturation	Maximum queue length by directional approach (metres)		Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	LoS	Degree of saturation	Maximum queue length by directional approach (metres)	
					Southbound	-					Southbound	-
					Westbound	80					Westbound	85
Ernest Street/Merlin Street/BL1 construction support site access												
Morning peak	2910	7	A	0.49	Northbound	20	2980	8	A	0.49	Northbound	20
					Eastbound	80					Eastbound	90
					Southbound	-					Southbound	-
					Westbound	110					Westbound	110
Evening peak	3220	9	A	0.78	Northbound	30	3320	10	A	0.81	Northbound	25
					Eastbound	260					Eastbound	285
					Southbound	-					Southbound	-
					Westbound	60					Westbound	60
Ernest Street/Miller Street												
Morning peak	3290	20	B	0.65	Northbound	115	3330	20	B	0.65	Northbound	115
					Eastbound	65					Eastbound	65
					Southbound	75					Southbound	85
					Westbound	105					Westbound	105
Evening peak	3700	32	C	0.79	Northbound	140	3700	32	C	0.79	Northbound	140
					Eastbound	150					Eastbound	150

Intersection/peak period	2024 base						2024 construction					
	Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	LoS	Degree of saturation	Maximum queue length by directional approach (metres)		Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	LoS	Degree of saturation	Maximum queue length by directional approach (metres)	
					Southbound	185					Southbound	185
					Westbound	100					Westbound	100
Warringah Freeway/Miller Street interchange												
Morning peak	5160	N/A*	C*	0.79	Northbound	35	5200	N/A*	C*	0.81	Northbound	35
					Eastbound	-					Eastbound	-
					Southbound	130					Southbound	90
					Westbound	115					Westbound	130
Evening peak	5270	N/A*	D*	0.89	Northbound	60	5270	N/A*	D*	0.89	Northbound	60
					Eastbound	-					Eastbound	-
					Southbound	30					Southbound	30
					Westbound	180					Westbound	180
Warringah Freeway/Brook Street interchange												
Morning peak	5240	N/A*	B*	0.82	Northbound	55	5430	N/A*	C*	0.85	Northbound	60
					Eastbound	-					Eastbound	-
					Southbound	225					Southbound	250
					Westbound	75					Westbound	80
Evening peak	6530	N/A*	C*	0.89	Northbound	215	6730	N/A*	C*	0.89	Northbound	215
					Eastbound	-					Eastbound	-

Intersection/peak period	2024 base						2024 construction					
	Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	LoS	Degree of saturation	Maximum queue length by directional approach (metres)		Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	LoS	Degree of saturation	Maximum queue length by directional approach (metres)	
					Southbound	200					Southbound	215
					Westbound	175					Westbound	190
Brook Street/Merrenburn Avenue												
Morning peak	3340	92	F	>1	Northbound	80	3460	>100	F	>1	Northbound	95
					Eastbound	20					Eastbound	20
					Southbound	>500					Southbound	>500
					Westbound	-					Westbound	-
Evening peak	3240	40	C	>1	Northbound	155	3380	47	D	>1	Northbound	170
					Eastbound	45					Eastbound	45
					Southbound	300					Southbound	345
					Westbound	-					Westbound	-
Flat Rock Drive/BL2 construction support site access												
Morning peak	-	-	-	-	Northbound	-	2590	5	A	0.56	Northbound	95
					Eastbound	-					Eastbound	-
					Southbound	-					Southbound	100
					Westbound	-					Westbound	25

Intersection/peak period	2024 base						2024 construction					
	Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	LoS	Degree of saturation	Maximum queue length by directional approach (metres)		Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	LoS	Degree of saturation	Maximum queue length by directional approach (metres)	
Evening peak	-	-	-	-	Northbound	-	2770	5	A	0.67	Northbound	140
					Eastbound	-					Eastbound	-
					Southbound	-					Southbound	50
					Westbound	-					Westbound	30

*Interchanges were modelled as a network, where Level of Service is based on speed efficiency (SIDRA Level of Service criteria for networks) and not average vehicle delay.

Pre-construction performance

Intersections that would operate at LoS D or worse without construction vehicles include:

- Warringah Freeway/Falcon Street interchange (morning and evening peak)
- Warringah Freeway/Ernest Street (evening peak)
- Warringah Freeway/Miller Street interchange (evening peak)
- Brook Street/Merrenburn Avenue (morning peak).

The Warringah Freeway/Falcon Street interchange and Brook Street/Merrenburn Avenue during both peaks would also operate with a degree of saturation greater than one, meaning they would be operating at capacity during these times.

Construction performance

With construction traffic included on the road network, the Warringah Freeway/Brook Street interchange would deteriorate from LoS B to LoS C during the morning peak. The intersection would continue to operate with spare capacity during construction and at least at a satisfactory performance level. The performance of Brook Street/Merrenburn Avenue would deteriorate from LoS C to LoS D during the evening peak, with a minor increase in average delay of four seconds. Without construction vehicles, the intersection would operate near the LoS C/D threshold and, given the minor increase in average delay during construction, the intersection would still operate satisfactorily. All other intersections would operate at the same Level of Service with construction compared to the base scenario.

A new intersection with traffic signals would be constructed to provide access to the Flat Rock Drive construction support site (BL2). During construction, this intersection would operate at LoS A.

Midblock performance

In the Warringah Freeway and surrounds study area, the capacity and operation of intersections is generally the constraining factor for network performance. Notwithstanding this, midblock performance has been assessed to determine the potential relative impacts of construction traffic on key routes.

The midblock performance results for the road network under the 'base' (without construction vehicles) and 'construction' (with construction vehicles and proposed intersection modifications during construction) scenarios are summarised in Table 5-7 for the morning and evening peak hours.

Table 5-7 Base and construction morning and evening peak hour midblock performance - Warringah Freeway and surrounds study area

Location/ direction	Capacity (pcu)	Morning peak						Evening peak					
		2024 base			2024 construction			2024 base			2024 construction		
		Vol (pcu)	V/C	LoS	Vol (pcu)	V/C	LoS	Vol (pcu)	V/C	LoS	Vol (pcu)	V/C	LoS
Miller Street north of Ernest Street													
Northbound A	900 (AM) 1900 (PM)	660	0.74	D	660	0.74	D	880	0.47	C	880	0.47	C
Southbound B	2900 (AM) 1900 (PM)	1180	0.41	B	1220	0.42	C	1380	0.73	D	1380	0.73	D

Location/ direction	Capacity (pcu)	Morning peak						Evening peak					
		2024 base			2024 construction			2024 base			2024 construction		
		Vol (pcu)	V/C	LoS	Vol (pcu)	V/C	LoS	Vol (pcu)	V/C	LoS	Vol (pcu)	V/C	LoS
Ernest Street east of Miller Street													
Eastbound	1900	1250	0.66	D	1300	0.68	D	1580	0.83	E	1580	0.83	E
Westbound	1900	1030	0.54	C	1030	0.54	C	890	0.47	C	890	0.47	C
Ernest Street west of Merlin Street													
Eastbound	1900	780	0.41	B	820	0.43	C	2120	>1	F	2190	>1	F
Westbound	2900	2120	0.73	D	2170	0.75	D	1060	0.36	B	1120	0.39	B
Falcon Street west of Merlin Street													
Eastbound	3900	2590	0.67	D	2740	0.70	D	3140	0.80	D	3330	0.85	E
Westbound	5900	3520	0.60	D	3670	0.62	D	2370	0.40	B	2560	0.43	C
Brook Street south of Merrenburn Avenue													
Northbound	1900	900	0.48	C	990	0.52	C	1940	>1	F	2030	>1	F
Southbound	1900	2150	>1	F	2240	>1	F	1120	0.59	C	1210	0.64	D

[A] Miller Street north of Ernest Street in the northbound direction has a clearway in operation during the evening peak period only.

[B] Miller Street north of Ernest Street in the southbound direction has a clearway in operation during the morning peak period only.

Pre-construction performance

Without construction traffic, traffic demand is forecast to exceed capacity at the following locations:

- Ernest Street west of Merlin Street in the eastbound direction (evening peak)
- Brook Street south of Merrenburn Avenue in the northbound direction (evening peak)
- Brook Street south of Merrenburn Avenue in the southbound direction (morning peak).

Construction performance

The addition of construction traffic is forecast to change the midblock Level of Service at the following locations:

- Miller Street north of Ernest Street in the southbound direction from LoS B to LoS C (morning peak)
- Ernest Street west of Merlin Street in the eastbound direction from LoS B to LoS C (morning peak)
- Falcon Street west of Merlin Street in the eastbound direction from LoS D to LoS E (evening peak)
- Falcon Street west of Merlin Street in the westbound direction from LoS B to LoS C (evening peak)
- Brook Street south of Merrenburn Avenue in the southbound direction from LoS C to LoS D (evening peak).

Miller Street and Brook Street in the southbound direction, Ernest Street in the eastbound direction and Falcon Street in the westbound direction would operate with spare capacity and at least to an acceptable performance level during construction. Falcon Street west of Merlin Street in the eastbound direction would deteriorate from LoS D to LoS E in the evening peak during construction. This section of road is already operating close to the LoS D/E threshold and therefore the additional vehicles would not be expected to lead to any major additional capacity issues during construction, given the marginal increase in the volume to capacity ratio.

Local road impacts

Most roads forming part of construction vehicle routes for the project in the Warringah Freeway and surrounds study area are state or regional roads. They include Brook Street, Flat Rock Drive, Ernest Street and Miller Street.

As part of the Western Harbour Tunnel and Warringah Freeway Upgrade project, the Ernest Street/Merlin Street intersection would be modified with the addition of a north approach allowing access to the Cammeray Golf Course construction support site (BL1). This provides a secondary access point to the Cammeray Golf Course construction support site (BL1), with primary access for heavy vehicles to be provided directly to and from the Warringah Freeway. Up to 10 parking spaces on Ernest Street would be removed as part of the Western Harbour Tunnel and Warringah Freeway Upgrade project to provide suitable access to the Cammeray Golf Course construction support site (BL1), with access maintained while the construction support site is operational. Clearways operate on Ernest Street during peak periods, and therefore any closure of the kerbside lane associated with the construction support site would only result in loss of parking outside of peak periods. Combined with the availability of parking on nearby local roads such as Ernest Street (east of Merlin Street), Oaks Avenue and Park Avenue, the impact of losing these parking spaces outside of peak periods would be negligible.

Construction workforce parking

A car parking area would be provided at the Cammeray Golf Course (BL1) and Flat Rock Drive (BL2) construction support sites. Worker parking would be maximised within the constraints of the respective construction support sites. The number of car parking spaces would be determined during construction planning.

Where on-site parking is not provided or where provision of on-site parking cannot accommodate the full construction workforce, the workforce may be required to park on the surrounding road network. To minimise the potential parking impacts on the surrounding road network, the workforce would be actively encouraged to avoid parking on the surrounding road network, and parking would be actively managed using the following mitigation measures:

- Construction workforce would be encouraged to use public transport where feasible, with key bus corridors including Pacific Highway, Warringah Freeway, Miller Street, Falcon Street and Military Road. In addition, the T1 North Shore and T9 Northern Lines are accessible from North Sydney, St Leonards and Waverton railway stations
- Where public transport availability to construction support sites is limited, shuttle bus transfers may also be provided from public transport centres where required.

Any potential impacts to affected roads would be detailed in the construction traffic management plan.

Warringah Freeway and surrounds construction impact summary

Assessment of the performance of key locations in the road network affected by construction activities indicates that the road network in the Warringah Freeway and surrounds study area would not materially change under construction conditions, and that the temporary impacts of construction on traffic operation would be manageable. The Warringah Freeway/Falcon Street interchange and the Brook Street/Merrenburn Avenue intersection currently operate at capacity during peak periods, and would continue to operate at a comparable Level of Service during construction activities. Midblock volumes on Ernest Street, Falcon Street and Brook Street would also increase. However, this would be a minor change when compared to pre-construction conditions.

5.3 Gore Hill Freeway and Artarmon

5.3.1 Construction support site locations

The assessment of construction impacts in the Gore Hill Freeway and Artarmon study area includes the following construction support sites:

- BL3 – Punch Street
- BL4 – Dickson Avenue
- BL5 – Barton Road
- BL6 – Gore Hill Freeway median.

Indicative construction support site layouts for each of these sites are shown in Figure 5-12 to Figure 5-15.

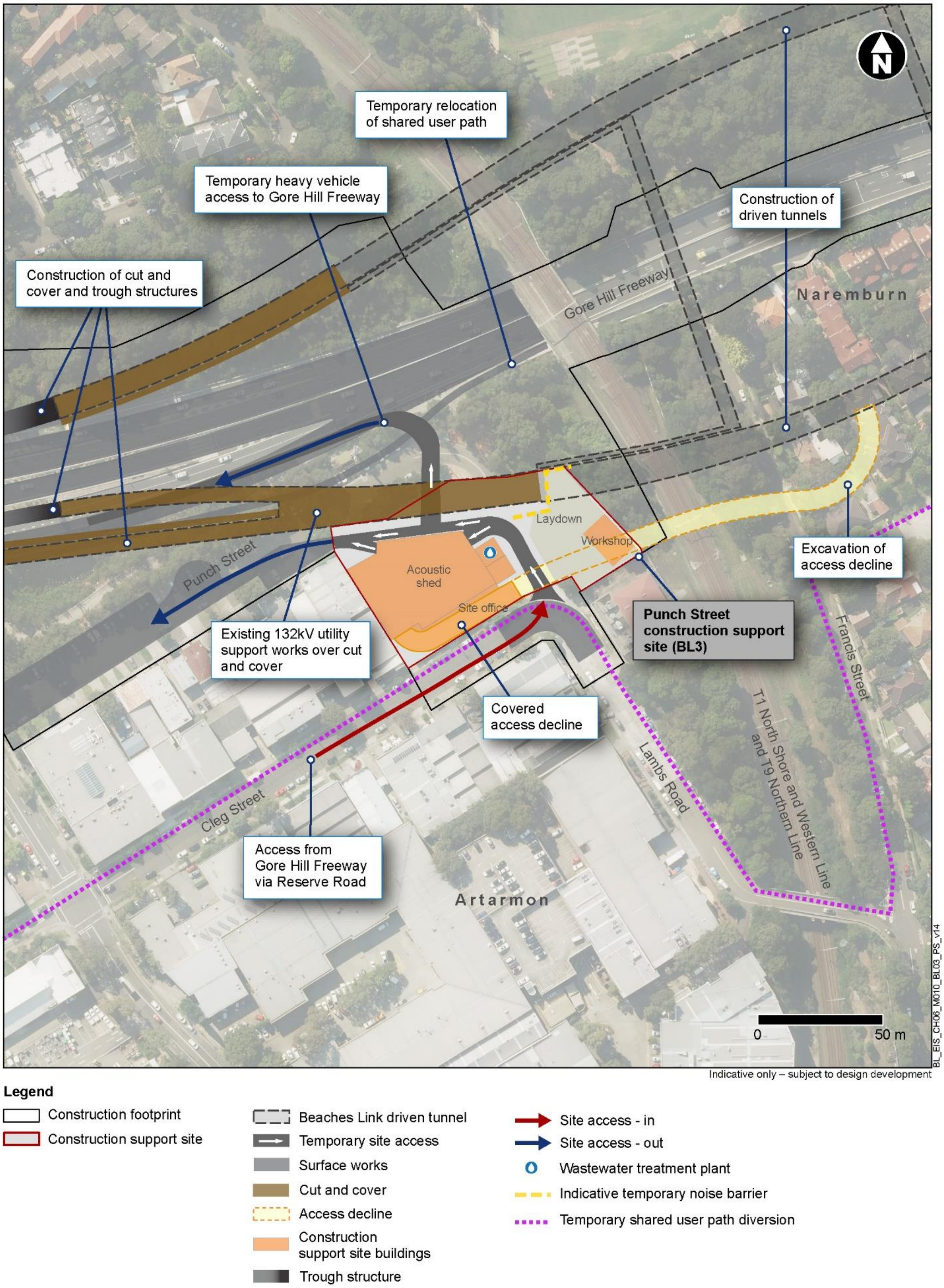


Figure 5-12 Indicative construction support site layout – BL3 – Punch Street

Figure 5-13 Indicative construction support site layout – BL4 –Dickson Avenue

Figure 5-14 Indicative construction support site layout – BL5 –Barton Road

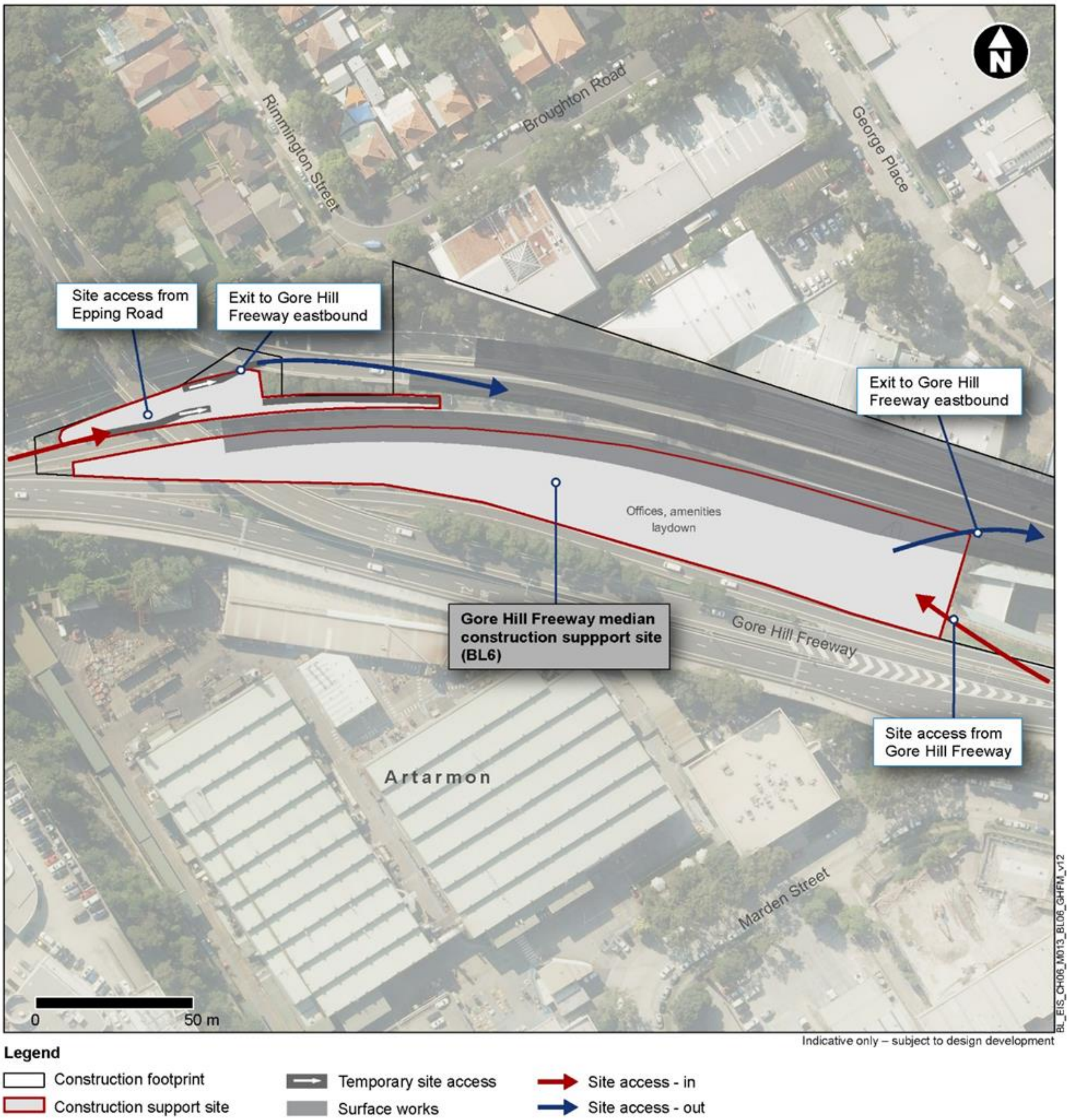


Figure 5-15 Indicative construction support site layout – BL6 – Gore Hill Freeway median

5.3.2 Construction support site access and traffic generation

The proposed access routes to and from each construction support site are summarised in Table 5-8 and Figure 5-16. Access routes are proposed to be from major arterial roads rather than local roads where feasible. Daily peak light vehicle and heavy vehicle volumes associated with spoil and waste removal, material deliveries and arrival and departure of construction personnel are also summarised in Table 5-8.

Table 5-8 Proposed access and egress routes and peak traffic generation for each construction support site – Gore Hill Freeway and Artarmon study area

No.	Site	Proposed access routes	Peak vehicle movements per day		Morning peak vehicle movements (6am to 10am)		Evening peak vehicle movements (3pm to 7pm)	
			Light	Heavy	Light	Heavy	Light	Heavy
BL3	Punch Street	Punch Street, Cleg Street, Reserve Road, Gore Hill Freeway (heavy goods vehicles only)	580	370	222	110	203	87
BL4	Dickson Avenue	Dickson Avenue, Reserve Road	500	90	160	40	132	8
BL5	Barton Road	Reserve Road, Barton Road, Butchers Lane	120	35	45	5	45	10
BL6	Gore Hill Freeway median	Epping Road, Gore Hill Freeway	100	10	20	2	21	0
-	Artarmon Park	Hampden Road	80	60	29	24	28	10

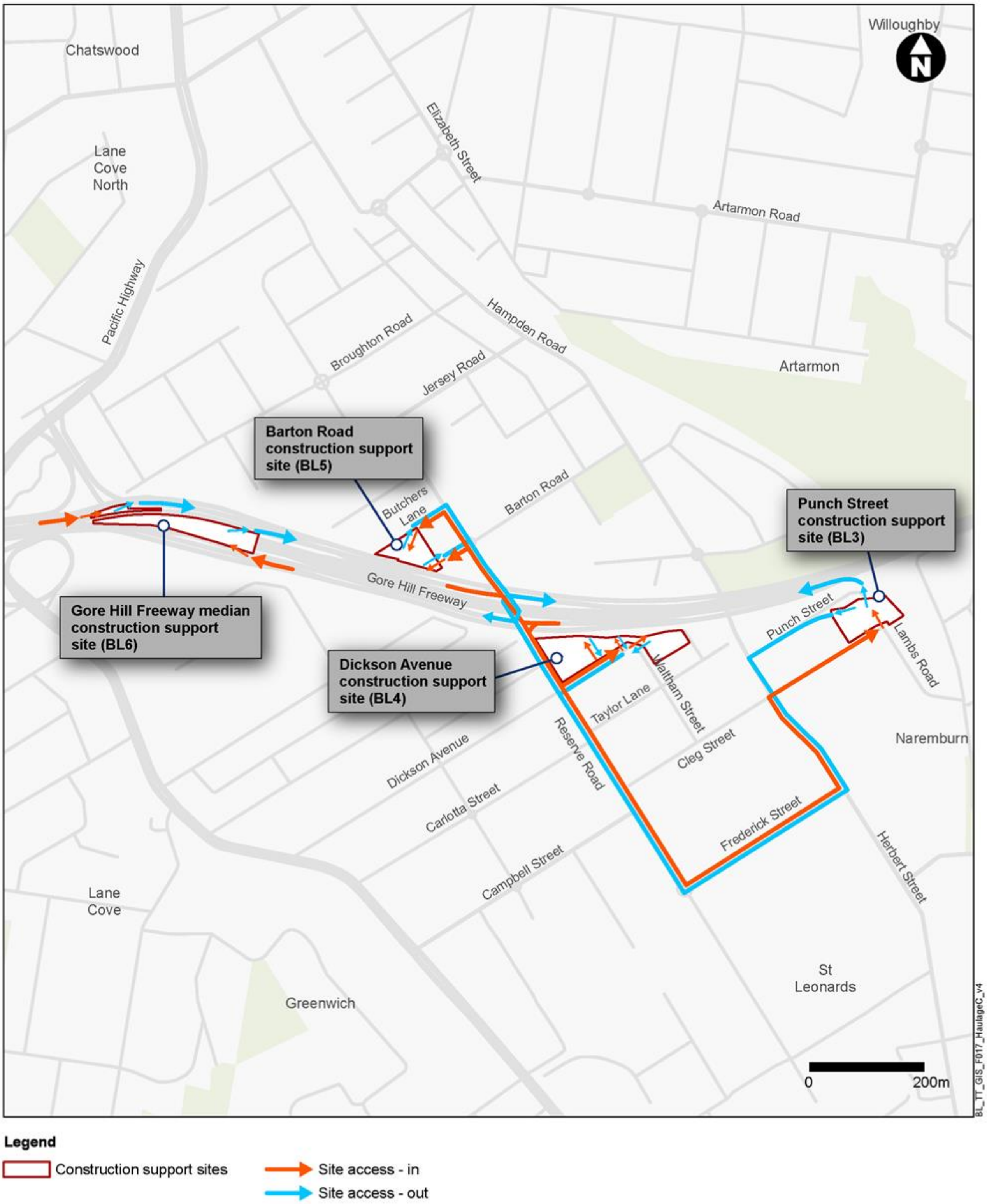


Figure 5-16 Indicative construction vehicle routes – BL3 to BL6

5.3.3 Timing of construction support site use

The indicative timing of the use of each major construction support site is summarised in Table 5-9 and includes site establishment and site rehabilitation. Dickson Avenue (BL4), Barton Road (BL5) and Gore Hill Freeway median (BL6) construction support sites would primarily be used for additional equipment laydown facilities, car parking for construction workers and temporary site office buildings.

Table 5-9 Timing of construction support site use – Gore Hill Freeway and Artarmon study area

No.	Site	Indicative timing of construction support site use				
		2023	2024	2025	2026	2027
BL3	Punch Street					
BL4	Dickson Avenue					
BL5	Barton Road					
BL6	Gore Hill Freeway median					

5.3.4 Impact on traffic flows

Intersection performance

SIDRA intersection modelling has been carried out to determine the relative impacts of construction traffic at key access points to and from construction support sites when compared to conditions without construction of the project.

The intersection performance results for the road network under the 'base' (without construction vehicles) and 'construction' (with construction vehicles and proposed intersection modifications during construction) scenarios are summarised in Table 5-10 for the morning and evening peak hours.

Table 5-10 Modelled base and construction morning and evening peak intersection performance - Gore Hill Freeway and Artarmon study area

Intersection/ peak period	2024 base						2024 construction					
	Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	LoS	Degree of saturation	Maximum queue length by directional approach (metres)		Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	LoS	Degree of saturation	Maximum queue length by directional approach (metres)	
Gore Hill Freeway/Reserve Road interchange												
Morning peak	3890	N/A*	E*	>1	Northbound	100	4200	N/A*	F*	>1	Northbound	100
					Eastbound	235					Eastbound	>500
					Southbound	75					Southbound	65
					Westbound	270					Westbound	>500
Evening peak	3990	N/A*	F*	>1	Northbound	>500	4200	N/A*	F*	>1	Northbound	>500
					Eastbound	120					Eastbound	150
					Southbound	70					Southbound	65
					Westbound	280					Westbound	375
Reserve Road/Dickson Avenue												
Morning peak	1980	17	B	0.57	Northbound	25	2160	20	B	0.68	Northbound	30
					Eastbound	55					Eastbound	50
					Southbound	140					Southbound	195
					Westbound	40					Westbound	55
Evening peak	2000	27	B	0.74	Northbound	85	2130	29	C	0.82	Northbound	90
					Eastbound	100					Eastbound	100
					Southbound	175					Southbound	230

Intersection/ peak period	2024 base						2024 construction					
	Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	LoS	Degree of saturation	Maximum queue length by directional approach (metres)		Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	LoS	Degree of saturation	Maximum queue length by directional approach (metres)	
					Westbound	70					Westbound	80
Reserve Road/Frederick Street												
Morning peak	1140	9	A	0.43	Northbound	5	1230	9	A	0.48	Northbound	5
					Eastbound	<5					Eastbound	<5
					Southbound	5					Southbound	30
					Westbound	5					Westbound	25
Evening peak	1300	10	A	0.42	Northbound	20	1400	10	A	0.46	Northbound	20
					Eastbound	<5					Eastbound	<5
					Southbound	20					Southbound	25
					Westbound	15					Westbound	15
Herbert Street/Frederick Street												
Morning peak	1390	22	B	0.76	Northbound	35	1490	24	B	0.81	Northbound	35
					Eastbound	75					Eastbound	80
					Southbound	100					Southbound	110
					Westbound	5					Westbound	5
Evening peak	1750	28	B	0.79	Northbound	70	1850	31	C	0.87	Northbound	65
					Eastbound	135					Eastbound	150
					Southbound	115					Southbound	145
					Westbound	25					Westbound	25

Intersection/ peak period	2024 base						2024 construction					
	Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	LoS	Degree of saturation	Maximum queue length by directional approach (metres)		Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	LoS	Degree of saturation	Maximum queue length by directional approach (metres)	
Herbert Street/Cleg Street												
Morning peak	1110	12	A	0.43	Northbound	20	1210	12	A	0.45	Northbound	20
					Eastbound	20					Eastbound	20
					Southbound	55					Southbound	60
					Westbound	20					Westbound	20
Evening peak	1480	17	B	0.48	Northbound	95	1580	18	B	0.51	Northbound	100
					Eastbound	40					Eastbound	40
					Southbound	65					Southbound	75
					Westbound	35					Westbound	35

*Interchanges were modelled as a network, where Level of Service is based on speed efficiency (SIDRA Level of Service criteria for networks) and not average vehicle delay.

Pre-construction performance

The Gore Hill Freeway/Reserve Road interchange would operate at LoS D or worse without construction vehicles during both the morning and evening peak.

This interchange would also operate with a degree of saturation greater than one during both peaks, meaning it would be operating at capacity.

Construction performance

With construction traffic included on the road network, the intersection of Reserve Road/Dickson Avenue and Herbert Street/Frederick Street would change from LoS B to LoS C during the evening peak. These intersections would still operate with spare capacity and at least to a satisfactory Level of Service.

The performance of the Gore Hill Freeway/Reserve Road interchange would worsen from LoS E to LoS F during the morning peak, with demand remaining above capacity. This interchange already performs poorly without construction vehicles, and therefore there would be a need to manage construction vehicle movements to and from the construction support sites around Artarmon to limit the potential traffic impacts. This may include scheduling heavy vehicle movements related to spoil and deliveries during out of peak hours. These refinements would be detailed in the construction management plans prepared for the construction works associated with the project.

All other intersections continue to operate at the same Level of Service with and without construction vehicles.

Midblock performance

In the Gore Hill Freeway and Artarmon study area, the capacity and operation of intersections is generally the constraining factor for network performance. Notwithstanding this, midblock performance has been assessed to determine the potential relative impacts of construction traffic on key routes.

The midblock performance results for the road network under the 'base' (without construction vehicles) and 'construction' (with construction vehicles and proposed intersection modifications during construction) scenarios are summarised in Table 5-11 for the morning and evening peak hours.

Table 5-11 Base and construction morning and evening peak midblock performance - Gore Hill Freeway and Artarmon study area

Location/ direction	Capacity (pcu)	Morning peak						Evening peak					
		2024 base			2024 construction			2024 base			2024 construction		
		Vol (pcu)	V/C	LoS	Vol (pcu)	V/C	LoS	Vol (pcu)	V/C	LoS	Vol (pcu)	V/C	LoS
Reserve Road north of Dickson Avenue													
Northbound	1900	610	0.32	B	680	0.36	B	1180	0.62	D	1230	0.65	D
Southbound	1900	1290	0.68	D	1430	0.75	D	680	0.36	B	780	0.41	B
Reserve Road north of Frederick Street													
Northbound	900	370	0.42	C	420	0.46	C	680	0.76	D	730	0.81	D
Southbound	900	670	0.74	D	750	0.83	E	500	0.55	C	580	0.64	D
Frederick Street east of Reserve Road													
Eastbound	900	430	0.47	C	510	0.57	C	570	0.63	D	650	0.72	D

Location/ direction	Capacity (pcu)	Morning peak						Evening peak					
		2024 base			2024 construction			2024 base			2024 construction		
		Vol (pcu)	V/C	LoS	Vol (pcu)	V/C	LoS	Vol (pcu)	V/C	LoS	Vol (pcu)	V/C	LoS
Westbound	900	410	0.46	C	460	0.51	C	430	0.48	C	470	0.53	C
Herbert Street north of Frederick Street													
Northbound	900	260	0.29	B	350	0.38	B	470	0.52	C	550	0.61	D
Southbound	900	550	0.62	D	600	0.66	D	510	0.57	C	550	0.62	D
Cleg Street east of Herbert Street													
Eastbound	900	110	0.13	A	180	0.20	A	200	0.22	A	270	0.30	B
Westbound	900	130	0.15	A	130	0.15	A	180	0.20	A	180	0.20	A
Dickson Avenue east of Reserve Road													
Eastbound	900	260	0.29	B	320	0.35	B	180	0.20	A	200	0.22	A
Westbound	900	150	0.16	A	200	0.22	A	240	0.27	B	250	0.28	B
Reserve Road south of Barton Road													
Northbound	900	390	0.43	C	400	0.45	C	660	0.73	D	680	0.75	D
Southbound	900	510	0.56	C	520	0.58	C	420	0.47	C	430	0.48	C

Pre-construction performance

Without construction traffic, all midblock locations assessed on Reserve Road, Frederick Street, Herbert Street, Cleg Street and Dickson Avenue would operate at LoS D or better with spare capacity during both peaks and in both directions.

Construction performance

The addition of construction traffic is forecast to change the midblock Level of Service at the following locations:

- Reserve Road north of Frederick Street in the southbound direction from LoS D to LoS E (morning peak) and LoS C to LoS D (evening peak)
- Herbert Street north of Frederick Street in the northbound and southbound direction from LoS C to LoS D (evening peak)
- Cleg Street east of Herbert Street in the eastbound direction from LoS A to LoS B (evening peak).

Reserve Road north of Frederick Street would change from LoS D to LoS E during the morning peak hour and LoS C to LoS D during the evening peak hour in the southbound direction. Parking lanes are available on each side of the road, with signposted 'no parking' during specific times of the day, which increase the road's capacity. Given the potential to temporarily increase capacity and the relatively minor increase in construction vehicles travelling on Reserve Road, residual impacts on the overall road network would likely be minor and manageable.

At all other midblock locations in the table above, these sections of road would continue to operate with spare capacity and at least to a satisfactory performance level during construction.

Local road impacts

The installation of new traffic signals and line marking at the intersection of Pacific Highway with Dickson Avenue would have impacts on traffic that include:

- Temporary lane closures on Pacific Highway while removing existing median and line marking, minor pavement works and relocation of the existing bus stop on Pacific Highway west of Dickson Avenue
- Temporary closure of Dickson Avenue during line marking, minor kerb adjustment and minor pavement works
- Removal of about six motorbike parking spaces and three, four-hour car parking spaces
- Permanent relocation of the existing mail zone on Dickson Avenue within close proximity to the existing zone, to be carried out in consultation with Australia Post.

Temporary lane and road closures would be carried out outside of peak periods and the impacts of these closures would be low.

Several roads form part of construction vehicle routes associated with the works to be carried out around Artarmon. These roads include:

- Reserve Road
- Dickson Avenue
- Frederick Street
- Herbert Street
- Punch Street
- Hampden Road
- Barton Road
- Butchers Lane.

Most heavy vehicles accessing the construction area would be travelling to and from the Punch Street construction support site, with all other sites operating as smaller support sites, generating a substantially lower number of heavy vehicle movements. Relatively low impacts are anticipated on Hampden Road, Barton Road, Butchers Lane and Reserve Road north of Gore Hill Freeway given the low number of construction vehicles on these roads (fewer than 120 light vehicle and 60 heavy vehicle movements per day).

At peak production, the Punch Street construction support site (BL3) would generate about 580 light vehicle and 370 (total, 185 in and 185 out) heavy vehicle movements per day while the Dickson Avenue construction support site (BL4) would generate about 500 light vehicle and 90 heavy vehicle movements per day. This would occur for a relatively short duration with typical truck movements generally becoming lower throughout the course of construction. These vehicles would travel on Reserve Road south of Gore Hill Freeway, Dickson Avenue, Frederick Street, Herbert Street, Punch Street or Cleg Street. Across the broader network, construction traffic would access the construction support site via the motorway network where practical to minimise impacts to local roads. Although these construction traffic volumes are relatively high in the context of existing traffic volumes, impacts on the local road network are anticipated to be relatively low as these roads would operate with spare capacity during construction, as shown in Table 5-11, and form a direct route for construction vehicles to access the arterial road network.

Lambs Road between Punch Street and Cleg Street would be closed to make way for the Punch Street construction support site (BL3). Existing access to this section of Lambs Road is via Cleg Street and Punch Street, and therefore access impacts due to this closure would be minor. Periodic short-term closures of Reserve Road, Hampden Road, Dickson Avenue and Punch Street would also be required during construction. Given the extensive local road network in Artarmon, vehicles would have multiple alternative routes available during these interim closures. Potential detour roads include Herbert Street, Carlotta Street, Campbell Street, Frederick Street and Cleg Street.

Construction works in Artarmon would require the temporary and permanent removal of on-street parking spaces including the following:

- The closure of Lambs Road in conjunction with the requirement to detour pedestrians and cyclists due to adjustments to the Gore Hill Freeway shared user path (detailed in Section 5.6.2) resulting in the permanent loss of up to 25 parking spaces on Lambs Road and Punch Street
- Construction works at Artarmon Park requiring about six on-street parking spaces on Hampden Road to be temporarily removed for the duration of construction
- Temporary removal of an additional 20 on-street parking spaces on Hampden Road during northern abutment works
- The potential temporary removal of up to 10 parking spaces on other local roads such as Cleg Street, Dickson Avenue and Barton Road to provide suitable access to the construction support sites in the Artarmon study area.

The cumulative loss of parking spaces associated with the establishment of construction support sites would have some impact on on-street parking in surrounding streets in Artarmon that currently have high parking demand. The availability of on-street parking in Artarmon is likely to substantially reduce for the duration of construction. Measures to manage the parking impacts in adjacent streets would be addressed in the construction traffic management plan.

Construction workforce parking

Car parking areas would be provided at the following construction support sites:

- Punch Street (BL3)
- Dickson Avenue (BL4)
- Barton Road (BL5)
- Gore Hill Freeway median (BL6).

Worker parking would be maximised within the constraints of the respective construction support sites. The number of car parking spaces would be determined during construction planning.

Where on-site parking is not provided or where provision of on-site parking cannot accommodate the full construction workforce, the workforce may be required to park on the surrounding road network. To minimise the potential parking impacts on the surrounding road network, the workforce would be actively encouraged to avoid parking on the surrounding road network, and parking would be actively managed using the following mitigation measures:

- Construction workforce would be encouraged to use public transport where feasible, with key bus corridors including Pacific Highway, Gore Hill Freeway and Epping Road. In addition, the T1 North Shore and T9 Northern Lines are accessible from Artarmon and St Leonards railway stations
- Where public transport availability to construction support sites is limited, shuttle bus transfers may also be provided from public transport centres where required.

Any potential impacts to affected roads would be detailed in the construction traffic management plan.

The acquisition of property for Punch Street (BL3) and Dickson Avenue (BL4) construction support sites would reduce parking demand that would otherwise be generated by the businesses currently located at these sites. As parking for the construction support sites would be provided on-site, it is expected that the project would have minimal impact on parking demand and supply in the area.

Gore Hill Freeway and Artarmon construction impact summary

Assessment of the performance of key locations in the road network affected by construction activities indicates that the road network in the Gore Hill Freeway and Artarmon study area may experience localised impacts under construction, however in most locations, this would still fall within satisfactory performance levels. The Gore Hill Freeway/Reserve Road interchange currently operates close to capacity during peak periods and would continue to operate at a comparable Level of Service during construction activities. In addition, midblock volumes on Reserve Road north of Frederick Street would increase during construction. However, this would be a relatively small increase when compared to pre-construction conditions. Detailed construction management plans would be developed to ensure that the impacts would be appropriately managed.

Temporary road closures would be required on sections of the road network, while Lambs Road between Punch Street and Cleg Street would be closed to traffic throughout construction. A number of parking spaces would also be removed throughout Artarmon, resulting in a net-decrease in on-street parking on surrounding streets.

5.4 Balgowlah and surrounds

5.4.1 Construction support site locations

The assessment of construction impacts in the Balgowlah and surrounds study area includes the following construction support sites:

- BL9 – Spit West Reserve
- BL10 – Balgowlah Golf Course
- BL11 – Kitchener Street.

Indicative construction support site layouts for each of these sites are shown in Figure 5-17 to Figure 5-19.

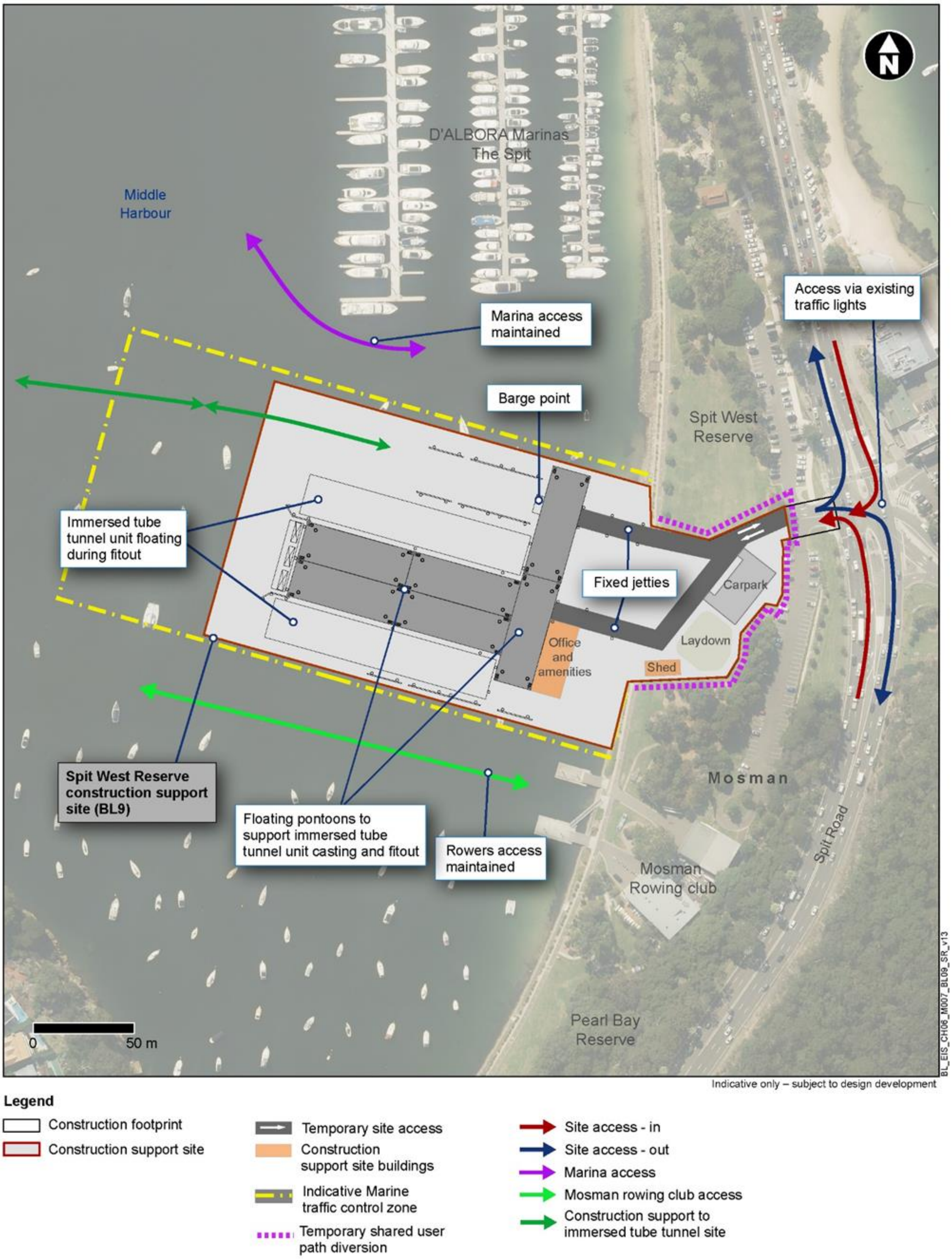


Figure 5-17 Indicative construction support site layout – BL9 – Spit West Reserve

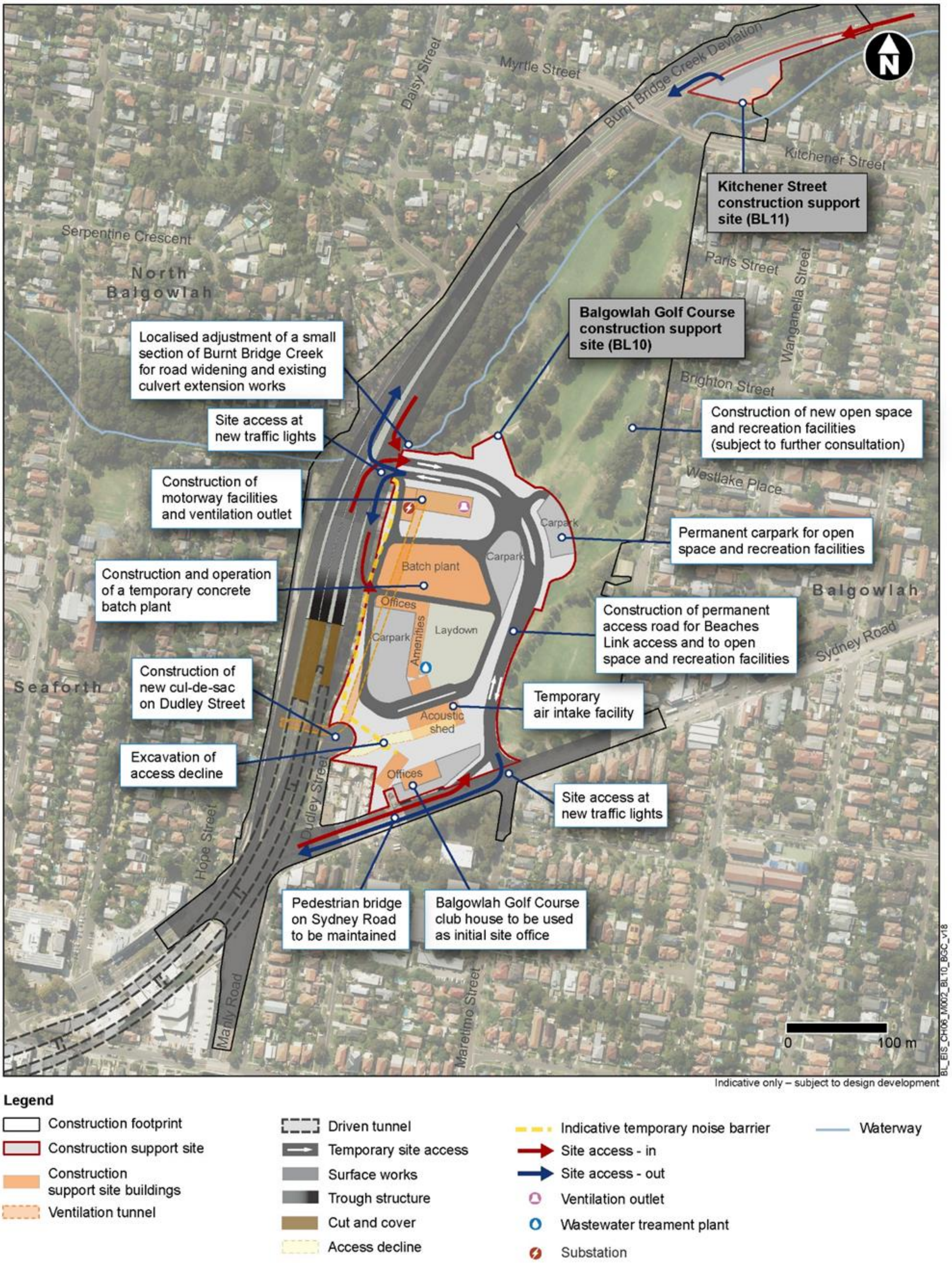


Figure 5-18 Indicative construction support site layout – BL10 – Balgowlah Golf Course

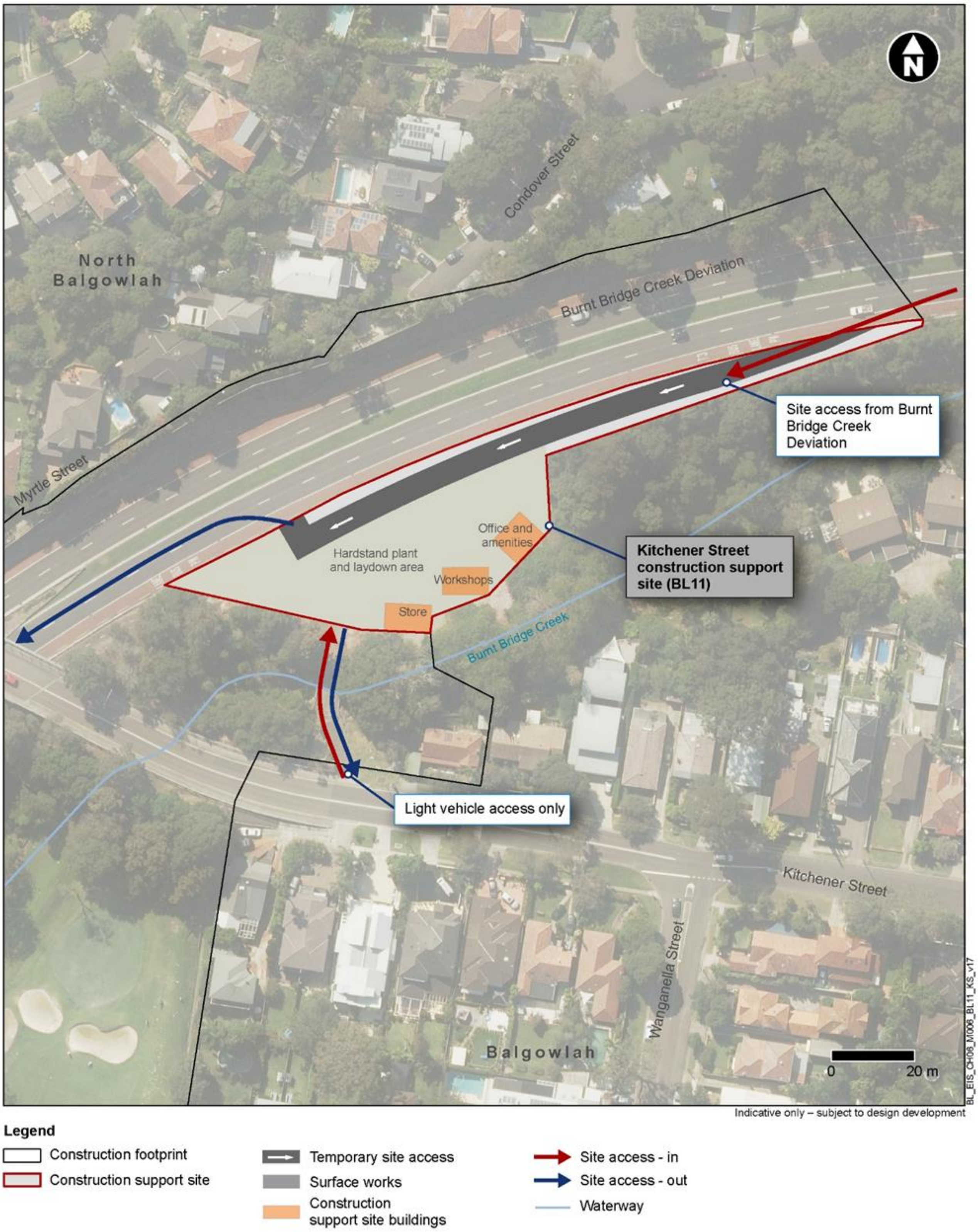


Figure 5-19 Indicative construction support site layout – BL11 – Kitchener Street

5.4.2 Construction support site access and traffic generation

The proposed access routes to and from each construction support site are summarised in Table 5-12, Figure 5-20 and Figure 5-21. Access routes are proposed to be from major arterial roads rather than local roads where feasible. Daily peak light vehicle and heavy vehicle numbers associated with spoil and waste removal, material deliveries and arrival and departure of construction personnel are also summarised in Table 5-12.

Table 5-12 Proposed access routes and peak traffic generation for each construction support site – Balgowlah and surrounds

No.	Site	Proposed access routes	Peak vehicle movements per day		Morning peak vehicle movements (6am to 10am)		Evening peak vehicle movements (3pm to 7pm)	
			Light	Heavy	Light	Heavy	Light	Heavy
BL9	Spit West Reserve	Spit Road	200	220	71	60	86	60
BL10	Balgowlah Golf Course	Sydney Road, Burnt Bridge Creek Deviation	1195	495	429	149	460	119
BL11	Kitchener Street	Burnt Bridge Creek Deviation	65	10	27	2	25	2

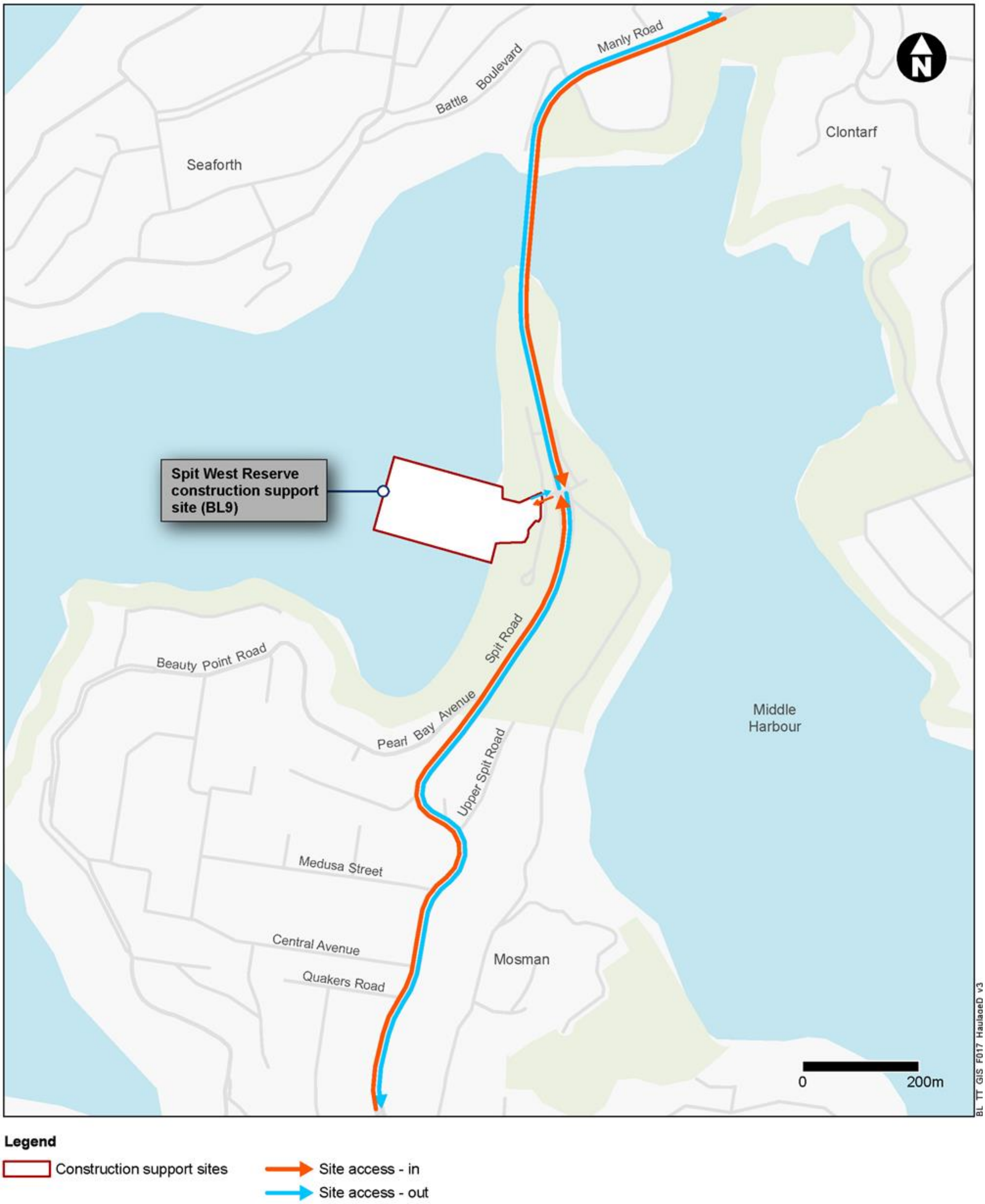


Figure 5-20 Indicative construction vehicle routes – BL9

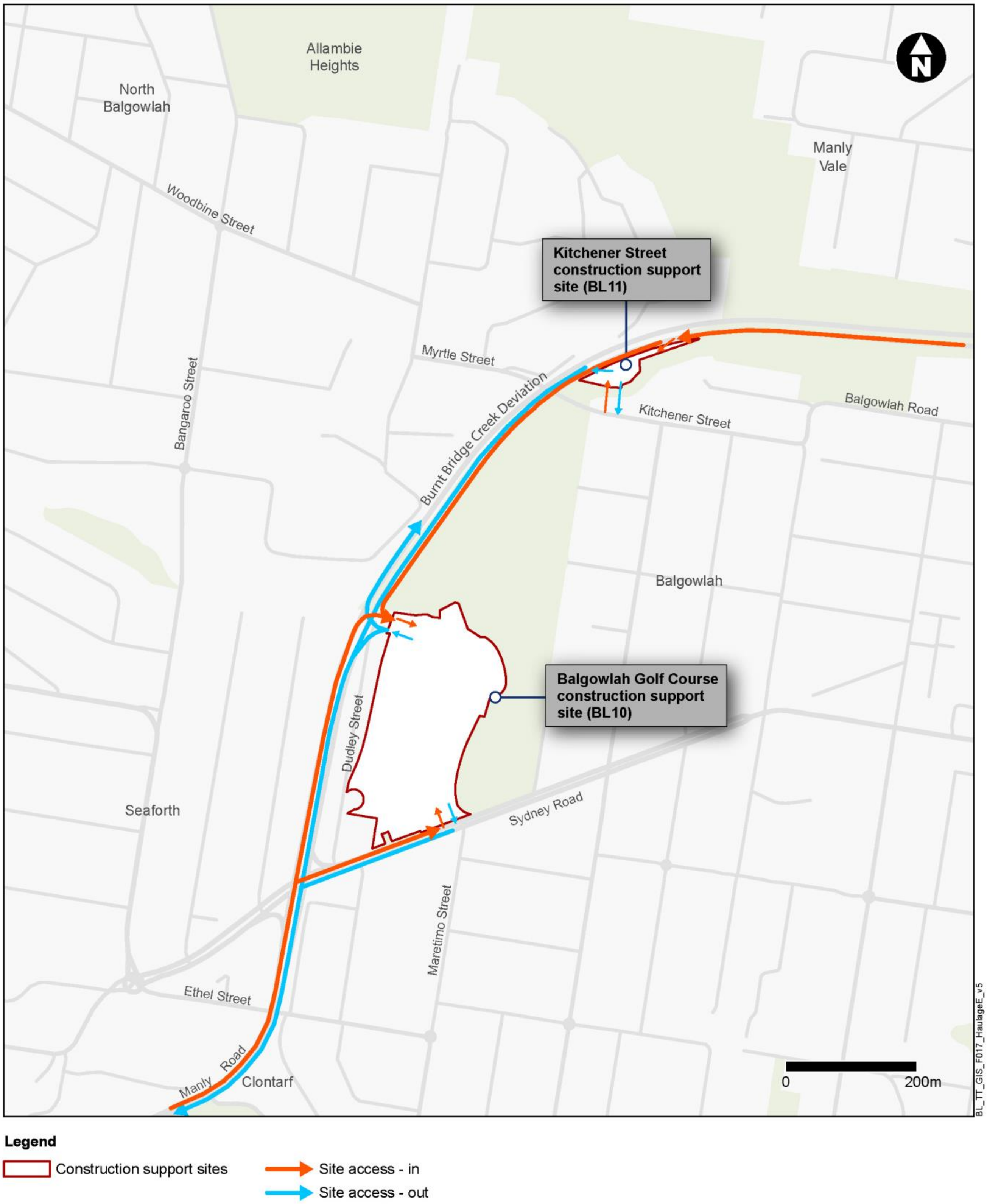


Figure 5-21 Indicative construction vehicle routes – BL10 and BL11

5.4.3 Timing of construction support site use

The indicative timing of the use of each major construction support site is summarised in Table 5-13 includes site establishment and site rehabilitation.

Table 5-13 Timing of construction support site use – Balgowlah and surrounds study area

No.	Site	Indicative timing of construction support site use					
		2023	2024	2025	2026	2027	2028
BL9	Spit West Reserve						
BL10	Balgowlah Golf Course						
BL11	Kitchener Street						

5.4.4 Impact on traffic flows

Intersection performance

SIDRA intersection modelling has been carried out to determine the relative impacts of construction traffic at key access points to and from construction support sites when compared to conditions without construction of the project.

The intersection performance results for the road network under the 'base' (without construction vehicles) and 'construction' (with construction vehicles and proposed intersection modifications during construction) scenarios are summarised in Table 5-14 for the morning and evening peak hours.

Table 5-14 Modelled base and construction morning and evening peak hour intersection performance - Balgowlah and surrounds study area

Intersection/peak period	2024 base						2024 construction					
	Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	LoS	Degree of saturation	Maximum queue length by directional approach (metres)		Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	LoS	Degree of saturation	Maximum queue length by directional approach (metres)	
Spit Road/Parriwi Road/Spit West Reserve car park/BL9 construction support site access												
Morning peak	4850	8	A	0.73	Northbound	145	5070	8	A	0.76	Northbound	165
					Eastbound	10					Eastbound	15
					Southbound	265					Southbound	290
					Westbound	5					Westbound	5
Evening peak	5370	21	B	0.89	Northbound	490	5700	31	C	0.94	Northbound	>500
					Eastbound	5					Eastbound	15
					Southbound	195					Southbound	215
					Westbound	10					Westbound	10
Manly Road/Sydney Road/Burnt Bridge Creek Deviation												
Morning peak	4740	49	D	0.91	Northbound	80	4860	54	D	0.95	Northbound	90
					Eastbound	145					Eastbound	160
					Southbound	345					Southbound	375
					Westbound	240					Westbound	255
Evening peak	5680	34	C	0.92	Northbound	175	5840	45	D	0.99	Northbound	205
					Eastbound	70					Eastbound	65
					Southbound	200					Southbound	265

Intersection/peak period	2024 base						2024 construction					
	Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	LoS	Degree of saturation	Maximum queue length by directional approach (metres)		Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	LoS	Degree of saturation	Maximum queue length by directional approach (metres)	
					Westbound	65					Westbound	70
Sydney Road/Maretimo Street/BL10 construction support site access												
Morning peak	1460	70	E	0.24	Northbound	<5	1560	10	A	0.35	Northbound	<5
					Eastbound	<5					Eastbound	45
					Southbound	-					Southbound	25
					Westbound	<5					Westbound	80
Evening peak	1830	>100	F	0.27	Northbound	<5	1970	12	A	0.50	Northbound	<5
					Eastbound	-					Eastbound	95
					Southbound	<5					Southbound	25
					Westbound	<5					Westbound	60

Pre-construction performance

The following intersections would operate at LoS D or worse without construction vehicles:

- Manly Road/Sydney Road/Burnt Bridge Creek Deviation (morning peak)
- Sydney Road/Maretimo Street (morning and evening peak).

The Manly Road/Sydney Road/Burnt Bridge Creek Deviation intersection would operate close to capacity with a degree of saturation approaching one.

The poor performance of Sydney Road/Maretimo Street is due to this intersection being priority controlled in the base scenario, with substantial delays experienced by vehicles turning into and out of Maretimo Street. While Maretimo Street is a local road, it provides access to Northern Beaches Secondary College.

Construction performance

With construction traffic on the road network, the intersection of Manly Road/Sydney Road/Burnt Bridge Creek Deviation deteriorates from LoS C to LoS D during the evening peak. Average vehicle delays would increase by 11 seconds during the evening peak. Direct access to the Balgowlah Golf Course construction support site (BL10) from Burnt Bridge Creek Deviation would be provided, which would reduce the traffic impact anticipated at the intersection. Environmental management measures outlined in Section 9 would be implemented during construction to ensure that the impacts of the Balgowlah Golf Course construction support site (BL10) and Kitchener Street construction support site (BL11) would be appropriately managed.

The Sydney Road/Maretimo Street intersection performance is forecast to improve from LoS E to LoS A during the morning peak and LoS F to LoS A during the evening peak. This is because traffic signals would be installed at the intersection during construction with the addition of a north approach that would provide access to the Balgowlah Golf Course construction support site (BL10). The assessment of priority-controlled intersections is based on the worst performing movement, corresponding to the right turns into and out of Maretimo Street; while for intersections with traffic signals, performance assessment is based on the average delay of all movements. Signalisation of the Sydney Road/Maretimo Street intersection would add a small amount of delay to vehicles travelling east–west on Sydney Road that under the existing configuration would not experience any delay, but would still achieve an average LoS A for the intersection. Spit Road/Parriwi Road would continue to operate at a satisfactory Level of Service with and without construction vehicles.

Midblock performance

In the Balgowlah and surrounds study area, the capacity and operation of intersections is generally the constraining factor for network performance. Notwithstanding this, midblock performance has been assessed to determine the potential relative impacts of construction traffic on key routes.

The midblock performance results for the road network under the 'base' (without construction vehicles) and 'construction' (with construction vehicles and proposed intersection modifications during construction) scenarios are summarised in Table 5-15 for the morning and evening peak hours.

Table 5-15 Base and construction morning and evening peak hour midblock performance - Balgowlah and surrounds study area

Location/ direction	Capacity (pcu)	Morning peak						Evening peak					
		2024 base			2024 construction			2024 base			2024 construction		
		Vol (pcu)	V/C	LoS	Vol (pcu)	V/C	LoS	Vol (pcu)	V/C	LoS	Vol (pcu)	V/C	LoS
Spit Road south of Parriwi Road													
Northbound	2900	3110	>1	F	3250	>1	F	1820	0.63	D	2010	0.69	D
Southbound	2900	1520	0.52	C	1670	0.58	C	2960	>1	F	3160	>1	F
Manly Road south of Sydney Road													
Northbound	2900	1720	0.59	D	1830	0.63	D	3400	>1	F	3550	>1	F
Southbound	2900	3270	>1	F	3390	>1	F	1840	0.63	D	1990	0.69	D
Sydney Road east of Manly Road													
Eastbound	1900	520	0.28	B	590	0.31	B	1080	0.57	C	1160	0.61	D
Westbound	2900	1060	0.37	B	1130	0.39	B	830	0.28	B	910	0.31	B
Burnt Bridge Creek Deviation west of Condamine Street													
Northbound	2900	1070	0.37	B	1070	0.37	B	2040	0.70	D	2040	0.70	D
Southbound	2900	1620	0.56	C	1620	0.56	C	1150	0.40	B	1160	0.40	B

Pre-construction performance

Without construction traffic, traffic demand is forecast to exceed capacity at the following locations:

- Spit Road south of Parriwi Road in the northbound direction (morning peak)
- Spit Road south of Parriwi Road in the southbound direction (evening peak)
- Manly Road south of Sydney Road in the northbound direction (evening peak)
- Manly Road south of Sydney Road in the southbound direction (morning peak).

Construction performance

The addition of construction traffic is forecast to change the midblock Level of Service at the following location:

- Sydney Road east of Manly Road in the eastbound direction from LoS C to LoS D (evening peak).

Sydney Road in the eastbound direction would operate with spare capacity and at least to a satisfactory performance level.

Local road impacts

All roads in the Balgowlah and surrounds study area that form part of construction vehicle routes are state or regional roads. However, there are some local roads that would experience a direct impact due to construction works.

The Sydney Road/Maretimo Street intersection would be modified during construction, with an additional approach allowing site access to the Balgowlah Golf Course construction support site (BL10) from Sydney Road. Signalising the intersection would be beneficial to vehicles performing a right turn into or out of Maretimo

Street, including to and from the Northern Beaches Secondary College Balgowlah Boys Campus, given that they have to give way to multiple conflicting movements under the current priority controlled intersection arrangement. In addition, construction vehicles exiting the Balgowlah Golf Course construction support site (BL10) would be required to give way to vehicles turning left from Maretimo Street and would not conflict with vehicles turning right. Traffic movements north-south (and vice versa) through the intersection between Maretimo Street and the Balgowlah Golf Course construction support site (BL10) (and future access road) would not be permitted.

Access to the Kitchener Street construction support site (BL11) to and from the Burnt Bridge Creek Deviation is considered unlikely to result in significant impacts to traffic.

Public parking spaces would be removed at the Balgowlah Golf Course car park to accommodate the Balgowlah Golf Course construction support site (BL10). These spaces are used for both the golf course and for the nearby Balgowlah Oval, but as the golf course would no longer be in operation during construction and alternative parking is available on Pickworth Avenue, impacts would be negligible.

Site entry for construction vehicles at the Spit West Reserve construction support site (BL9) would be separated from users of the car parks, and therefore minimal impacts at the access points are anticipated given the reduction in conflict between construction vehicles and the general public.

Construction workforce parking

Car parking areas for construction workers would be provided at the Balgowlah Golf Course construction support site (BL10). Therefore, no loss of parking on adjacent local streets is anticipated during construction.

The Spit West Reserve construction support site (BL9) and Kitchener Street construction support site (BL11) would have limited parking for supervision staff. The construction workforce at the Middle Harbour south cofferdam (BL7), Middle Harbour north cofferdam (BL8), Spit West Reserve construction support site (BL9) and Kitchener Street construction support site (BL11) would park at the Balgowlah Golf Course construction support site (BL10) and be transported to the sites by shuttle bus (where required). The Spit West Reserve construction support site (BL9) would be accessed from the existing Spit West Reserve entry from Spit Road. Impacts to affected roads would be detailed in the construction traffic management plan.

The construction workforce would also be encouraged to use public transport where possible, with key bus corridors (including the Northern Beaches B-Line) including Military Road, Spit Road, Manly Road, Sydney Road, Burnt Bridge Creek Deviation and Condamine Street.

Balgowlah and surrounds construction impact summary

Assessment of the performance of key locations in the road network affected by construction activities indicates that the road network in the Balgowlah and surrounds study area may experience localised impacts under construction, however in most locations, this would perform at a satisfactory level. The Manly Road/Sydney Road/Burnt Bridge Creek Deviation intersection would approach capacity during construction as a result of increased construction traffic to and from the Balgowlah Golf Course construction support site (BL10). In addition, Spit Road and Manly Road would carry higher traffic volumes during construction. Detailed construction traffic management plans would be developed to ensure that these impacts would be appropriately mitigated.

5.5 Frenchs Forest and surrounds

5.5.1 Construction support site locations

The assessment of construction impacts in the Frenchs Forest and surrounds study area includes the following construction support sites:

- BL12 – Wakehurst Parkway south

- BL13 – Wakehurst Parkway east
- BL14 – Wakehurst Parkway north.

Indicative construction support site layouts for each of these sites are shown in Figure 5-22 to Figure 5-24.

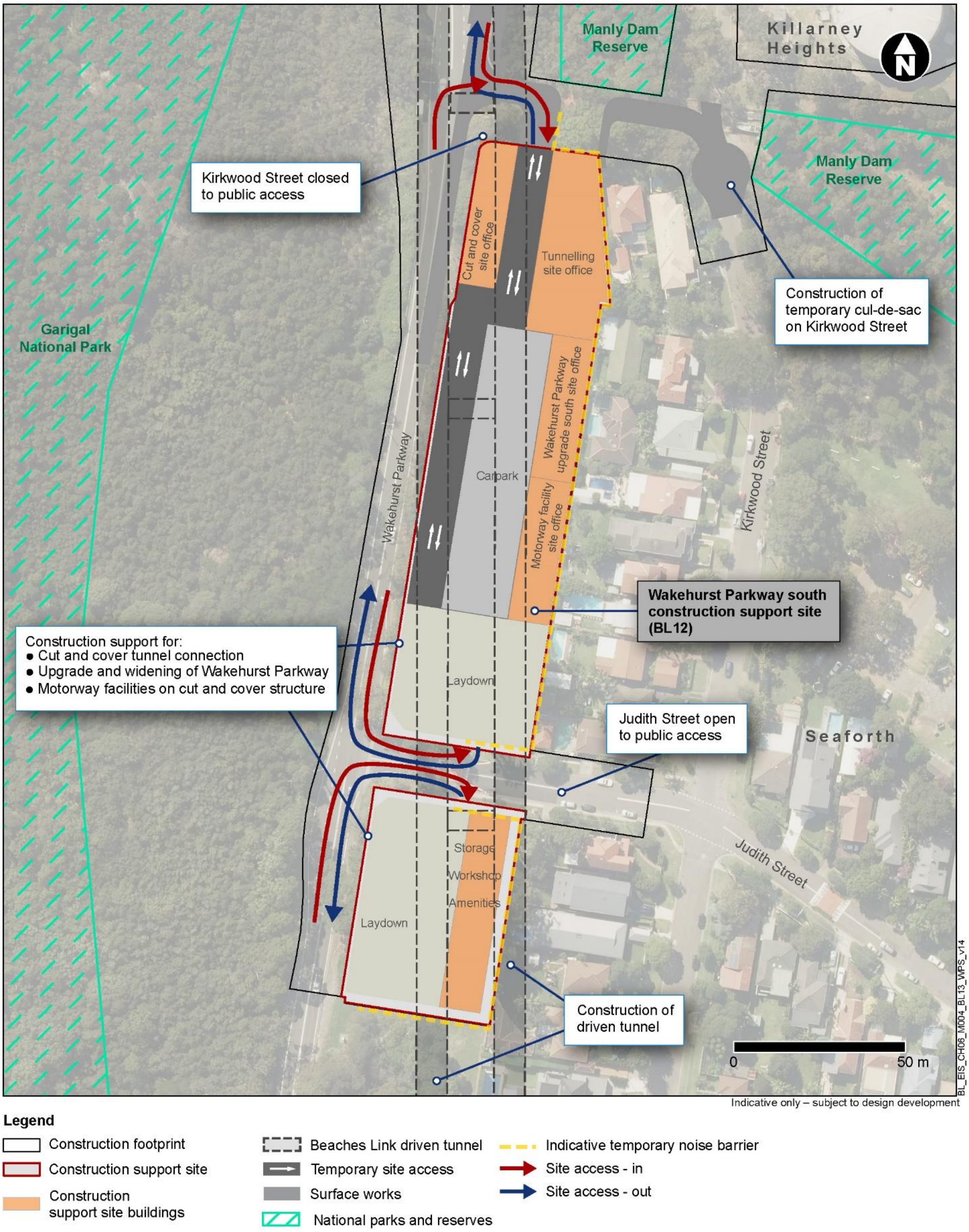


Figure 5-22 Indicative construction support site layout – BL12 – Wakehurst Parkway south

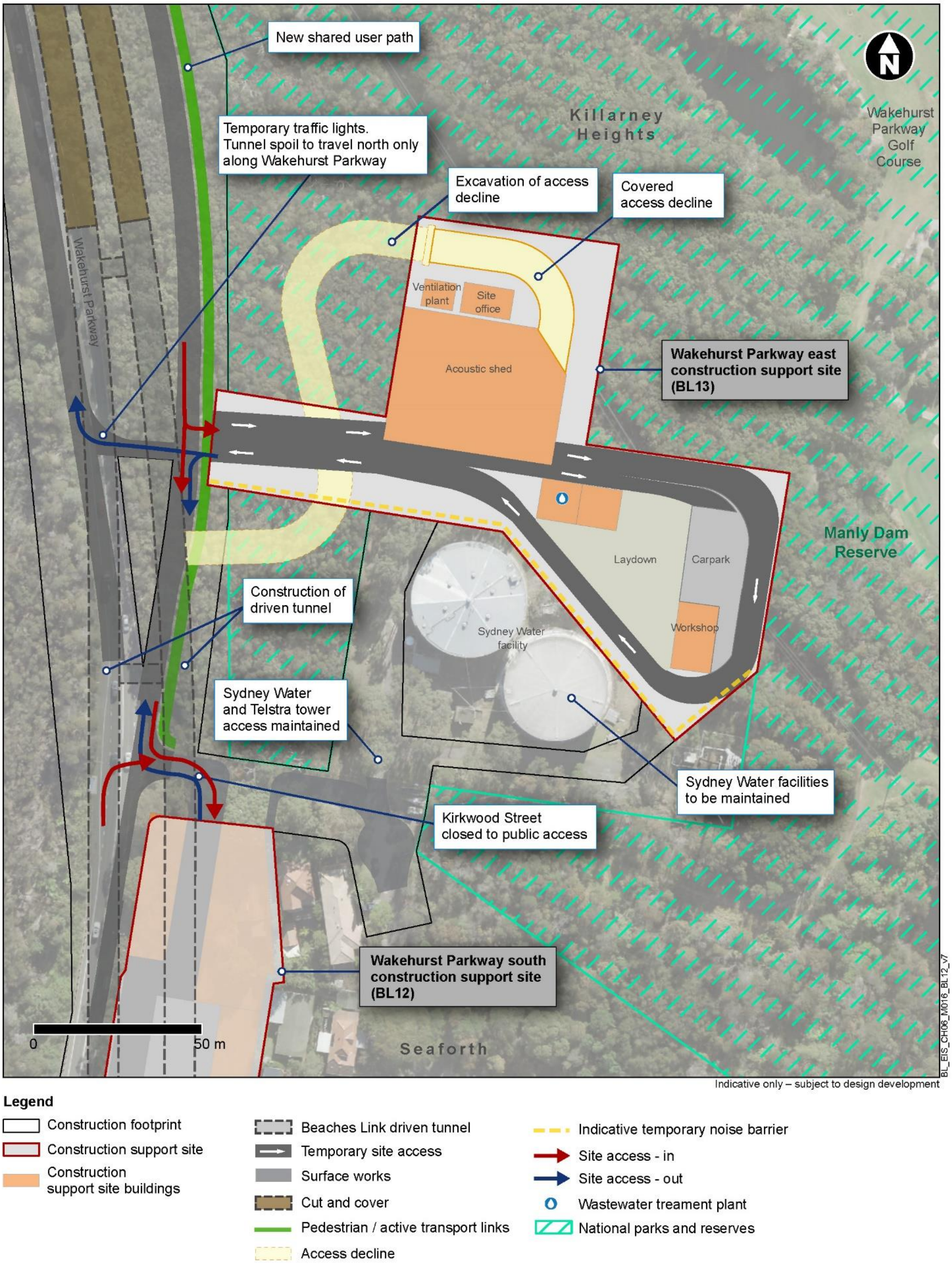


Figure 5-23 Indicative construction support site layout – BL13 – Wakehurst Parkway east

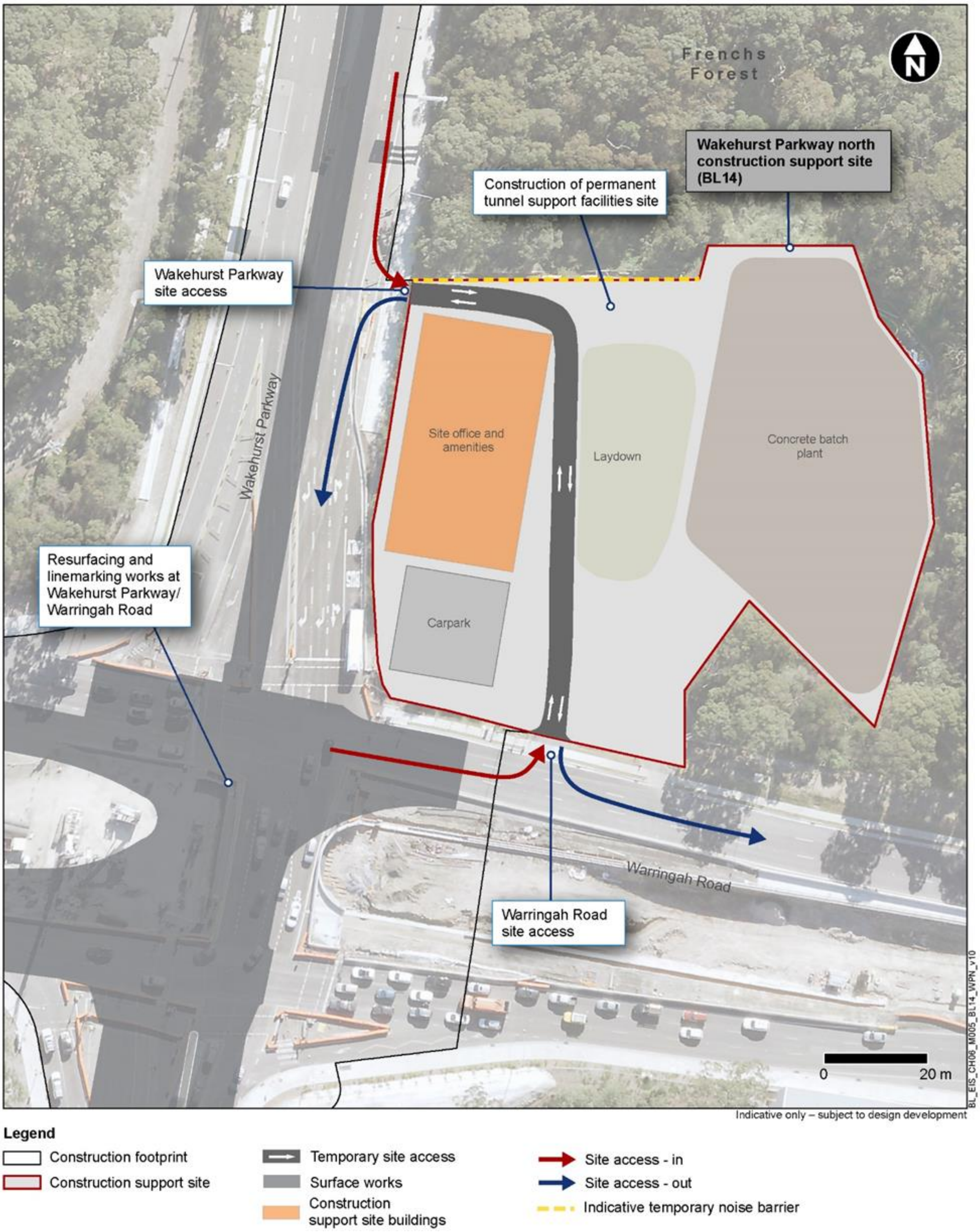


Figure 5-24 Indicative construction support site layout – BL14 – Wakehurst Parkway north[16]

[16] Note: The indicative layout does not show the revegetation area associated with the recent demobilisation of the Northern Beaches Hospital road upgrade project. During further design development and construction planning, the support site layout would be refined to ensure the revegetated area is avoided and protected.

5.5.2 Construction support site access and traffic generation

The proposed access routes to and from each construction support site are summarised in Table 5-16 and Figure 5-25. Access routes are proposed to be from major arterial roads rather than local roads where feasible. Daily peak light vehicle and heavy vehicle numbers associated with spoil and waste removal, material deliveries and arrival and departure of construction personnel are summarised in Table 5-16.

Table 5-16 Proposed access routes and peak traffic generation – Frenchs Forest and surrounds study area

No.	Site	Proposed access routes	Peak number of construction vehicle movements per day		Morning peak vehicle movements (6am to 10am)		Evening peak vehicle movements (3pm to 7pm)	
			Light	Heavy	Light	Heavy	Light	Heavy
BL12	Wakehurst Parkway south	Wakehurst Parkway	285	15	119	6	102	1
BL13	Wakehurst Parkway east	Wakehurst Parkway	305	275	99	72	142	73
BL14	Wakehurst Parkway north	Warringah Road	180	95	58	29	52	26

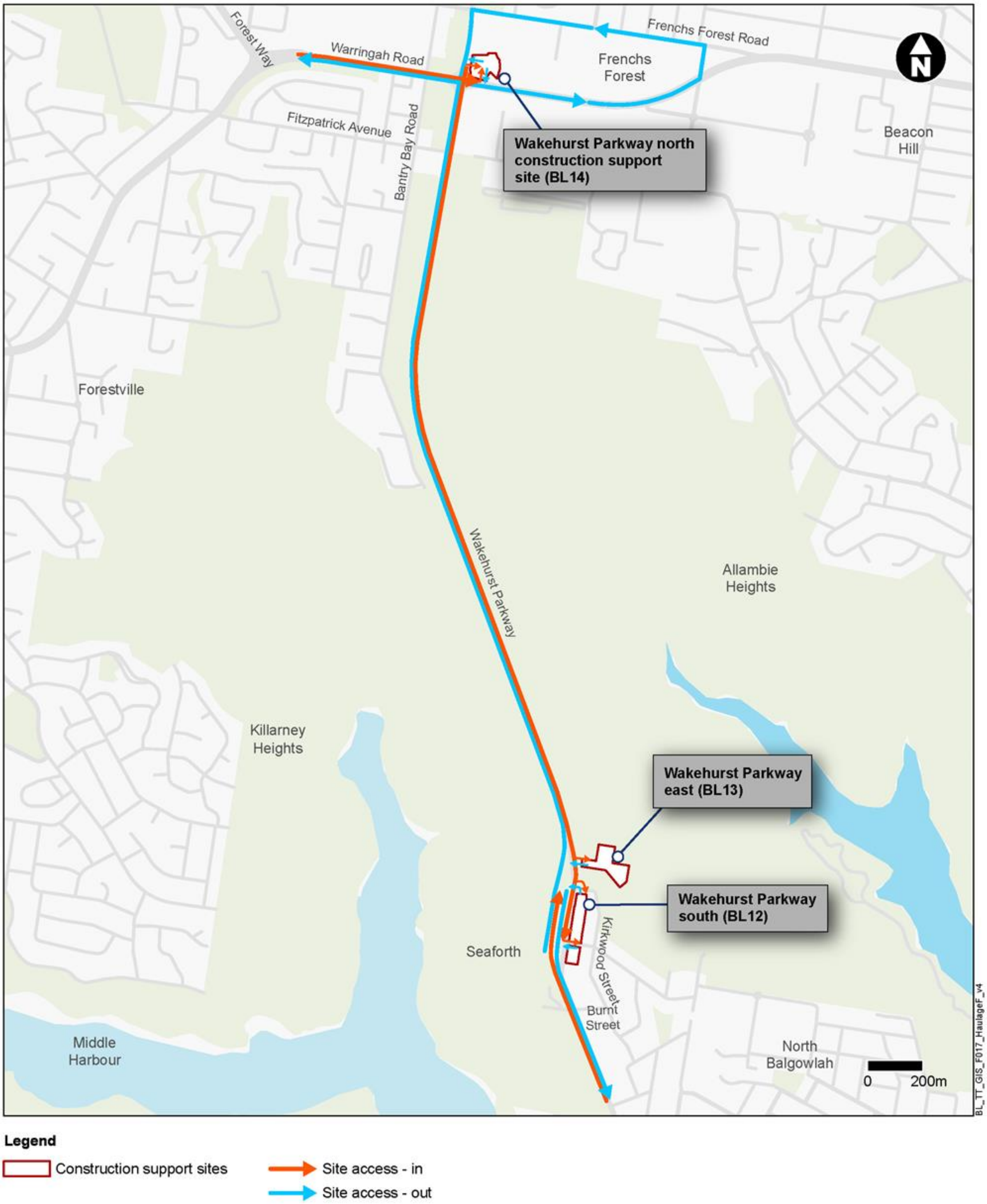


Figure 5-25 Indicative construction vehicle routes – BL12 to BL14

5.5.3 Timing of construction support site use

The indicative timing of the use of each construction support site is summarised in Table 5-17 and includes site establishment and site rehabilitation.

Table 5-17 Indicative timing of construction support site use – Frenchs Forest and surrounds study area

No.	Site	Indicative timing of construction support site use				
		2023	2024	2025	2026	2027
BL12	Wakehurst Parkway south					
BL13	Wakehurst Parkway east					
BL14	Wakehurst Parkway north					

5.5.4 Impact on traffic flows

Intersection performance

SIDRA intersection modelling has been carried out to determine the relative impacts of construction traffic at key access points to and from construction support sites when compared to conditions without construction of the project.

The intersection performance results for the road network under the 'base' (without construction vehicles) and 'construction' (with construction vehicles and proposed intersection modifications during construction) scenarios are summarised in Table 5-18 for the morning and evening peak hours.

Table 5-18 Modelled base and construction morning and evening peak hour intersection performance - Frenchs Forest and surrounds study area

Intersection/peak period	2024 base						2024 construction					
	Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	LoS	Degree of saturation	Maximum queue length by directional approach (metres)		Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	LoS	Degree of saturation	Maximum queue length by directional approach (metres)	
Wakehurst Parkway/Burnt Street/Seaforth Oval car park												
Morning peak	1160	7	A	0.42	Northbound	65	1470	21	B	0.67	Northbound	140
					Eastbound	5					Eastbound	<5
					Southbound	55					Southbound	120
					Westbound	15					Westbound	95
Evening peak	1430	6	A	0.47	Northbound	85	1610	17	B	0.60	Northbound	140
					Eastbound	<5					Eastbound	<5
					Southbound	85					Southbound	150
					Westbound	15					Westbound	70
Wakehurst Parkway/Judith Street/BL12 construction support site access												
Morning peak	1520	27	B	0.76	Northbound	<5	1640	30	C	0.51	Northbound	5
					Eastbound	-					Eastbound	-
					Southbound	<5					Southbound	<5
					Westbound	30					Westbound	<5
Evening peak	1800	49	D	0.82	Northbound	10	1870	33	C	0.53	Northbound	15
					Eastbound	-					Eastbound	-
					Southbound	<5					Southbound	<5

Intersection/peak period	2024 base						2024 construction					
	Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	LoS	Degree of saturation	Maximum queue length by directional approach (metres)		Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	LoS	Degree of saturation	Maximum queue length by directional approach (metres)	
					Westbound	30					Westbound	<5
Wakehurst Parkway/Kirkwood Street/BL12 construction support site access												
Morning peak	1470	52	D	0.65	Northbound	<5	1510	45	D	0.46	Northbound	<5
					Eastbound	-					Eastbound	-
					Southbound	<5					Southbound	<5
					Westbound	20					Westbound	5
Evening peak	1670	71	F	0.54	Northbound	<5	1710	59	E	0.44	Northbound	<5
					Eastbound	-					Eastbound	-
					Southbound	<5					Southbound	<5
					Westbound	15					Westbound	5
Wakehurst Parkway/ BL13 construction support site access												
Morning peak	-	-	-	-	Northbound	-	1580	30	C	0.91	Northbound	340
					Eastbound	-					Eastbound	-
					Southbound	-					Southbound	155
					Westbound	-					Westbound	10
Evening peak	-	-	-	-	Northbound	-	1810	11	A	0.70	Northbound	155
					Eastbound	-					Eastbound	-
					Southbound	-					Southbound	190
					Westbound	-					Westbound	20

Intersection/peak period	2024 base						2024 construction					
	Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	LoS	Degree of saturation	Maximum queue length by directional approach (metres)		Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	LoS	Degree of saturation	Maximum queue length by directional approach (metres)	
Wakehurst Parkway/Warringah Road												
Morning peak	4080	43	D	0.79	Northbound	105	4220	44	D	0.86	Northbound	110
					Eastbound	145					Eastbound	180
					Southbound	220					Southbound	240
					Westbound	105					Westbound	105
Evening peak	4770	57	E	0.95	Northbound	225	4940	69	E	1.00	Northbound	270
					Eastbound	215					Eastbound	295
					Southbound	225					Southbound	235
					Westbound	290					Westbound	350

Pre-construction performance

Intersections that would operate at LoS D or worse without construction vehicles include:

- Wakehurst Parkway/Judith Street (evening peak)
- Wakehurst Parkway/Kirkwood Street (morning and evening peak)
- Wakehurst Parkway/Warringah Road (morning and evening peak).

Wakehurst Parkway/Judith Street and Wakehurst Parkway/Kirkwood Street are priority-controlled intersections. Their poor performance is due to vehicles turning right out of Judith Street or Kirkwood Street, both minor roads, having to give way to vehicles travelling along Wakehurst Parkway.

The Wakehurst Parkway/Warringah Road intersection would operate close to capacity with a degree of saturation approaching one.

Construction performance

Spoil trucks exiting the Wakehurst Parkway east construction support site (BL13) would be required to travel north on Wakehurst Parkway, minimising the impact of spoil truck movements on surrounding local roads. Spoil trucks would not be permitted to travel south through Frenchs Forest Road and Sydney Road and would not impact businesses in the Seaforth commercial centre along Sydney Road.

During construction, Kirkwood Street would be closed to general traffic at its intersection with Wakehurst Parkway. Vehicles that currently use Kirkwood Street would be required to detour either via Judith Street or Burnt Street to reach Wakehurst Parkway. Kirkwood Street would provide construction light vehicle access to the Wakehurst Parkway south construction support site (BL12). The reduction in general traffic accessing Kirkwood Street in conjunction with only light vehicles accessing the Wakehurst Parkway south construction support site (BL12) at Kirkwood Street would result in an overall marginal improvement in the performance of the Wakehurst Parkway/Kirkwood Street intersection.

The closure of Kirkwood Street to general traffic and resulting detoured vehicles would lead to a redistribution of traffic to Judith Street. Given the relative difficulty in performing a right turn manoeuvre out of Judith Street across Wakehurst Parkway, construction modelling has assumed that existing local traffic that currently turns right out of Judith Street and Kirkwood Street would use the traffic signals at Burnt Street instead. The performance of Wakehurst Parkway/Judith Street due to the redistributed traffic would deteriorate from LoS B to LoS C during the morning peak and improve from LoS D to LoS C during the evening peak; an acceptable level during both peaks.

As discussed above, during construction, vehicles that currently turn right out of Kirkwood Street and Judith Street across Wakehurst Parkway have been assumed to perform the right turn at Burnt Street instead. With these additional detoured vehicles, the performance of the Wakehurst Parkway/Burnt Street intersection during construction would continue to operate at an acceptable LoS B.

A new intersection with traffic signals would be constructed to provide access to the Wakehurst Parkway east construction support site (BL13). During construction, this intersection would operate at LoS C during the morning peak and LoS A during the evening peak.

With construction traffic included on the road network, the Wakehurst Parkway/Warringah Road intersection would continue to operate at LoS D and LoS E during the morning and evening peak, respectively, taking into account the opening of the underpass arrangement along Warringah Road as part of the Northern Beaches Hospital road upgrade project. During the evening peak the intersection is forecast to continue to operate close to capacity.

Midblock performance

In the Frenchs Forest and surrounds study area, the capacity and operation of intersections is generally the constraining factor for network performance. Notwithstanding this, midblock performance has been assessed to determine the potential relative impacts of construction traffic on key routes.

The midblock performance results for the road network under the 'base' (without construction vehicles) and 'construction' (with construction vehicles and proposed intersection modifications during construction) scenarios are summarised in Table 5-19 for the morning and evening peak hours.

Table 5-19 Base and construction morning and evening peak hour midblock performance - Frenchs Forest and surrounds study area

Location/ direction	Capacity (pcu)	Morning peak						Evening peak					
		2024 base			2024 construction			2024 base			2024 construction		
		Vol (pcu)	V/C	LoS	Vol (pcu)	V/C	LoS	Vol (pcu)	V/C	LoS	Vol (pcu)	V/C	LoS
Wakehurst Parkway north of Judith Street													
Northbound	900	880	0.97	E	970	>1	F	860	0.96	E	910	>1	F
Southbound	900	670	0.74	D	690	0.77	D	910	>1	F	930	>1	F
Wakehurst Parkway north of Kirkwood Street													
Northbound	900	900	1.00	E	960	>1	F	830	0.92	E	920	>1	F
Southbound	900	630	0.70	D	700	0.77	D	860	0.96	E	950	>1	F
Warringah Road west of Wakehurst Parkway[1]													
Eastbound	3900	1670	0.43	C	1750	0.45	C	1940	0.50	C	2030	0.52	C
Westbound	2900	620	0.21	A	710	0.24	A	1410	0.49	C	1510	0.52	C
Warringah Road east of Wakehurst Parkway[1]													
Eastbound	2900	710	0.24	A	720	0.25	A	580	0.20	A	590	0.20	A
Westbound	2900	620	0.21	A	620	0.21	A	1030	0.36	B	1030	0.36	B

Note 1: Assumed capacity on Warringah Road refers to capacity on the surface lanes adjacent to the Wakehurst Parkway intersection. Eastbound capacity on Warringah Road west of Wakehurst Parkway is greater than eastbound capacity east of Wakehurst Parkway due to the presence of the additional short right-turn lanes.

Pre-construction performance

Without construction traffic, traffic demand is forecast to exceed capacity at the following location:

- Wakehurst Parkway north of Judith Street in the southbound direction (evening peak).

Construction performance

The addition of construction traffic is forecast to change the midblock Level of Service at the following locations:

- Wakehurst Parkway north of Judith Street in the northbound direction from LoS E to LoS F (morning and evening peak)
- Wakehurst Parkway north of Kirkwood Street in the northbound direction from LoS E to LoS F (morning and evening peak)

- Wakehurst Parkway north of Kirkwood Street in the southbound direction from LoS E to LoS F (evening peak).

Wakehurst Parkway north of Judith Street and north of Kirkwood Street are already operating close to the LoS E/F threshold. Therefore, the relatively small change in traffic volume and volume to capacity ratio due to construction vehicles and general traffic diverted due to the temporary long-term closure of Kirkwood Street would not lead to any major additional traffic performance impacts.

Local road impacts

The closure of the northern section of Kirkwood Street would be required during construction. The impact to diverted vehicles would be minor given that a number of nearby alternative local roads are available for vehicles to complete their trip, including Judith Street and Burnt Street. Similarly, access to properties owned by Sydney Water and Telstra would also be impacted, with vehicles required to access the properties via Judith Street and Kirkwood Street south.

Allambie Road north of Warringah Road and Frenchs Forest Road East are local roads which form part of the egress route from the proposed Wakehurst Parkway north construction support site (BL14). Relatively low impacts are anticipated on these roads given the low number of construction vehicle movements of about 90 light vehicle and 50 heavy vehicle movements (egress only) per day.

Blasting may be required along Wakehurst Parkway and would require the short-term closure (up to 10 minutes at a time) of sections of Wakehurst Parkway to general traffic. Any road closures would be carried out under traffic control and outside of peak periods to ensure safety and minimise disruption to the road network.

Construction workforce parking

Car parking areas would be provided at the following construction support sites:

- Wakehurst Parkway south (BL12)
- Wakehurst Parkway east (BL13)
- Wakehurst Parkway north (BL14).

Worker parking would be maximised within the constraints of the respective construction support sites. Parking for site vehicles associated with the realignment and upgrade of the Wakehurst Parkway would be managed as the works sites move and would be contained within the relevant work sites. The number of car parking spaces would be determined during construction planning.

Notwithstanding, the construction workforce would be encouraged to use public transport where feasible, with key bus corridors including Warringah Road and Forest Way. Where public transport availability to construction support sites is limited, shuttle bus transfers may also be provided from public transport centres where required.

Any potential impacts to affected roads would be detailed in the construction traffic management plan.

Frenchs Forest and surrounds construction impact summary

Assessment of the performance of key locations in the road network affected by construction activities indicates that the road network in the Frenchs Forest and surrounds study area would perform marginally worse under construction, however in most locations this would still perform at a satisfactory performance level. The Wakehurst Parkway/Warringah Road intersection would approach capacity during construction activities due to the increased demands generated by construction vehicles. Midblock volumes on Wakehurst Parkway north of Judith Street would increase during construction; this increase would be small when compared to pre-construction conditions. Detailed construction management plans would be developed to ensure that these impacts would be appropriately managed.

Kirkwood Street would be temporarily closed to general traffic during construction, removing direct access to Wakehurst Parkway and affecting access to properties in the surrounding area including those owned by Sydney Water and Telstra. Given the multiple alternative roads available nearby, impacts would be minor and manageable.

Spoil trucks exiting the Wakehurst Parkway east construction support site (BL13) would be required to travel north on Wakehurst Parkway, minimising the impact of spoil truck movements on surrounding local roads to the south including Seaforth commercial area on Sydney Road. Spoil trucks would not be permitted to travel south through Frenchs Forest Road and Sydney Road and would not impact businesses in the Seaforth commercial centre along Sydney Road.

5.6 Impact on other groups

5.6.1 Public transport

An overview of the impacts on the public transport network during construction of the project is shown in Figure 5-26 to Figure 5-29.

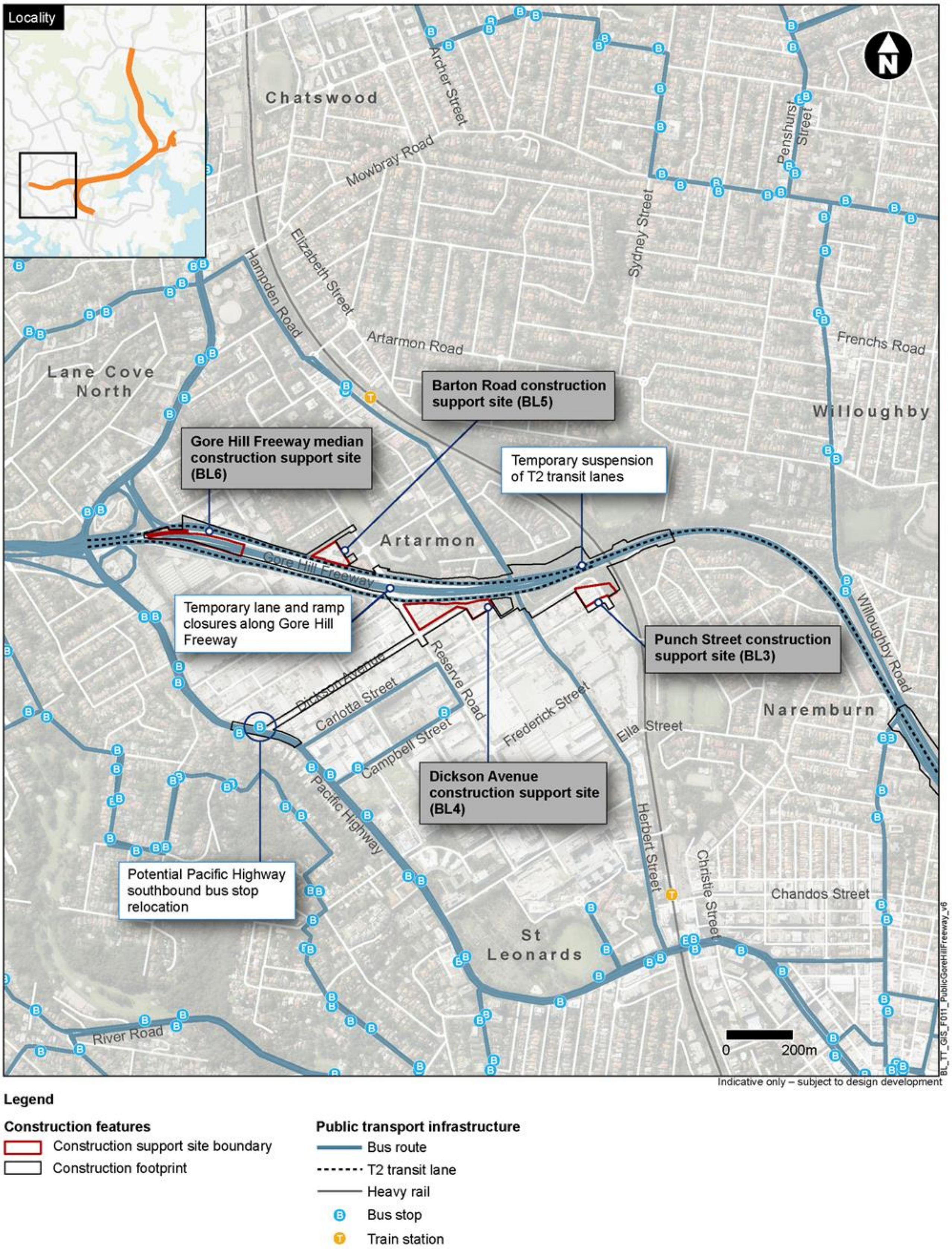


Figure 5-26 Public transport impacts during construction around Artarmon

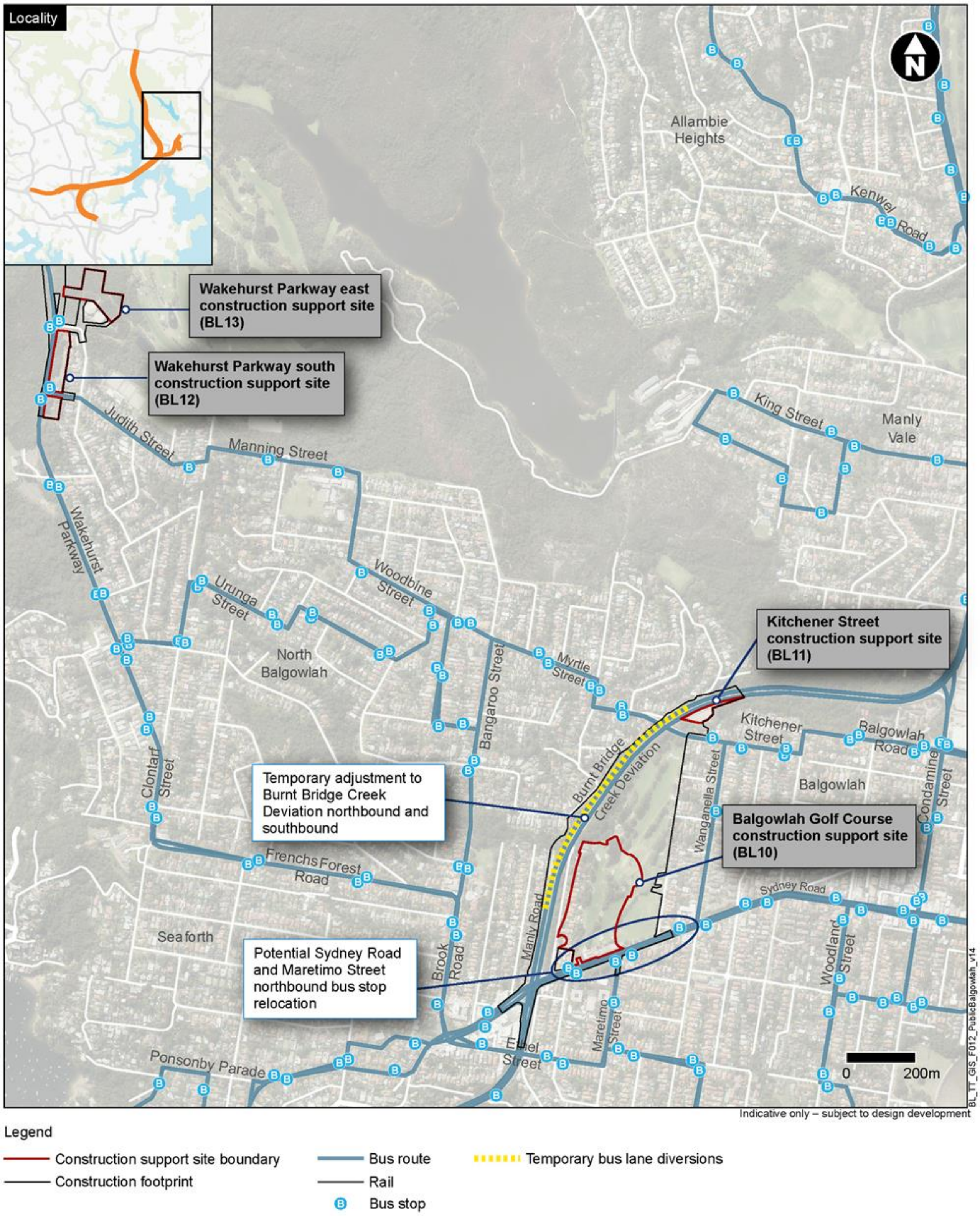


Figure 5-27 Public transport impacts during construction around Balgowlah

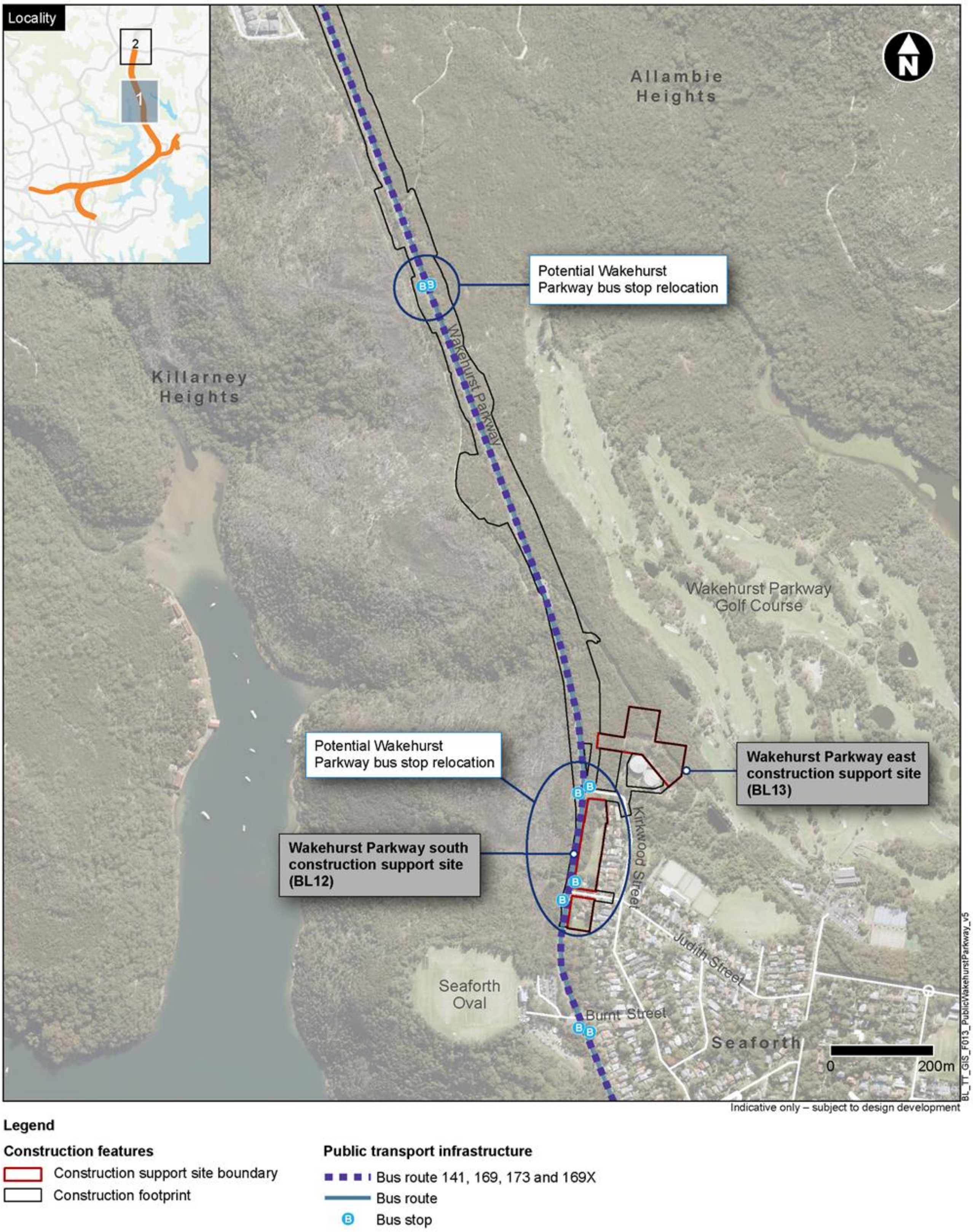


Figure 5-28 Public transport impacts during construction around Seaforth

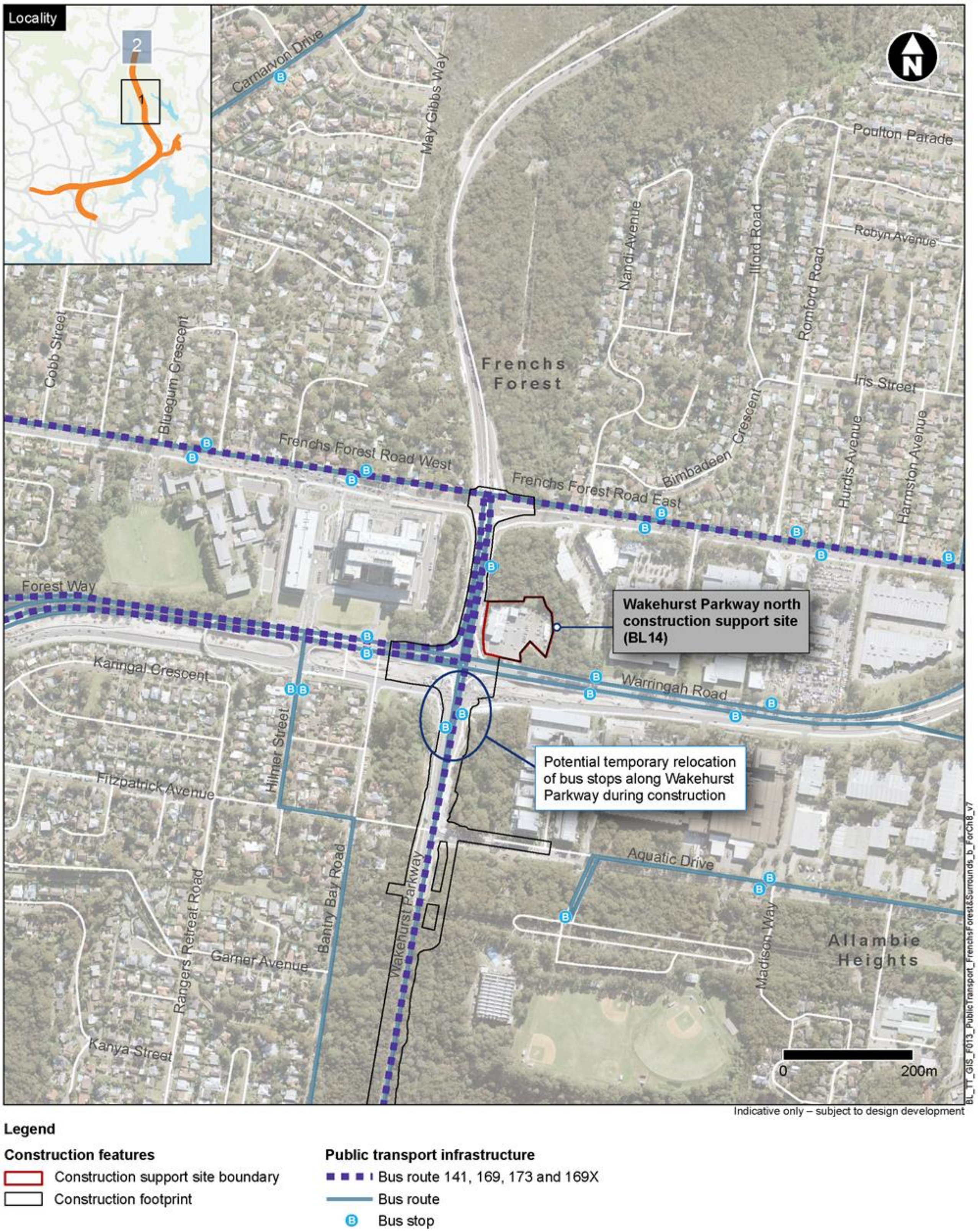


Figure 5-29 Public transport impacts during construction around Frenchs Forest

Impacts on bus stops

The southbound bus stop located on Pacific Highway near Dickson Avenue would be permanently relocated (to a location to be determined in consultation with Sydney Buses and Transport for NSW) during the construction works required to upgrade the Pacific Highway/Dickson Avenue intersection. Disruption to bus customers would be minimised by relocating the bus stop to the closest practical alternative, within 50 metres of its existing location. Given the potential small increase in travel distance to the relocated bus stop, impacts are anticipated to be acceptable and manageable.

Bus stops within the construction footprint along Wakehurst Parkway in Seaforth, Killarney Heights and Frenchs Forest would require minor adjustments during construction. These stops serve bus routes 141, 169, 173 and 169X which provide connections to the Austlink Corporate Centre, Narraweena, Manly and Sydney CBD. Adjustments to these bus stops may require bus customers to walk small additional distances, increasing their travel times slightly. Therefore, impacts on bus customers would be minor. Any changes to bus stop location would be communicated to the local community and relevant stakeholders.

Minor adjustments to bus stops within the construction footprint on Sydney Road in Balgowlah may also be required. Sydney Road is a major bus corridor and bus stops on Sydney Road serve buses that provide connections to Sydney CBD, Manly, Brookvale/Dee Why area and Mona Vale. Any adjustments to these bus stops would be determined as the project progresses, with advanced notification provided to affected bus customers of the changes to stopping sequences and location of bus stops. Disruption to bus customers would be minimised by relocating the bus stops to the closest practical alternative in consultation with Transport for NSW. In some instances, bus stop relocations may require some existing parking spaces to be removed. Given the potential small increase in travel distance to a relocated bus stop, impacts would be manageable.

Impacts on bus routes

The signalisation of the Flat Rock Drive construction support site (BL2) access would impact buses that use Flat Rock Drive and Brook Street. This would increase bus travel times slightly as buses could be required to stop at the new traffic signals while construction vehicles egress from the site. Overall impacts would be negligible given that the intersection would generate an additional five seconds of delay on average, as shown in Table 5-6.

Construction works in the Gore Hill Freeway and Artarmon study area would require interim lane and ramp closures along Gore Hill Freeway, which may impact bus travel times and reliability. Where practical, most works would be scheduled outside of peak hours to minimise disruption to bus services. The T2 transit lanes currently in operation in both directions along the Gore Hill Freeway would be converted to general traffic lanes to allow for construction of the Gore Hill Freeway Connection and improve lane utilisation. This is not expected to materially impact bus travel times, as illustrated in Section 6.4.

Overall, construction of the project would result in additional construction vehicles travelling on the road network in and nearby the construction footprint which would potentially increase bus travel times. Given the large amount of road surface works, particularly in the Artarmon and Balgowlah study areas, extensive community and stakeholder consultation would be carried out in conjunction with other divisions of Transport for NSW and Greater Sydney Operations. This would form the basis of a community and road user campaign to inform all road users, including bus operators, of the upcoming network changes and proposed detours that would be implemented prior to the start of works.

Impacts on bus priority infrastructure

Works in Balgowlah are scheduled along Burnt Bridge Creek Deviation between Sydney Road and Condamine Street, which is a major bus corridor with bus lanes in operation in both directions. The current bus lanes on Burnt Bridge Creek Deviation would operate on temporary alignments near the general traffic lanes. Given that the temporary alignments would be of a similar distance to the current configuration of Burnt Bridge Creek Deviation, impacts on bus travel times would be negligible.

Other impacts on public transport

No direct impacts to heavy rail services are anticipated during construction. Light rail and ferry services do not operate within the construction footprint of the project.

Public transport construction impact summary

Assessment of the impact of construction activities on the land-based public transport network indicates that residual impacts would be manageable with minor adjustments to some bus stops along Pacific Highway in Artarmon, Sydney Road in Balgowlah, and Wakehurst Parkway in Seaforth, Killarney Heights and Frenchs Forest. Some potential short-term adjustments would be required for bus priority infrastructure on Burnt Bridge Creek Deviation in Balgowlah, resulting in a negligible increase in bus travel times.

5.6.2 Active transport

An overview of impacts on the active transport network during construction of the project is shown in Figure 5-30 to Figure 5-35.

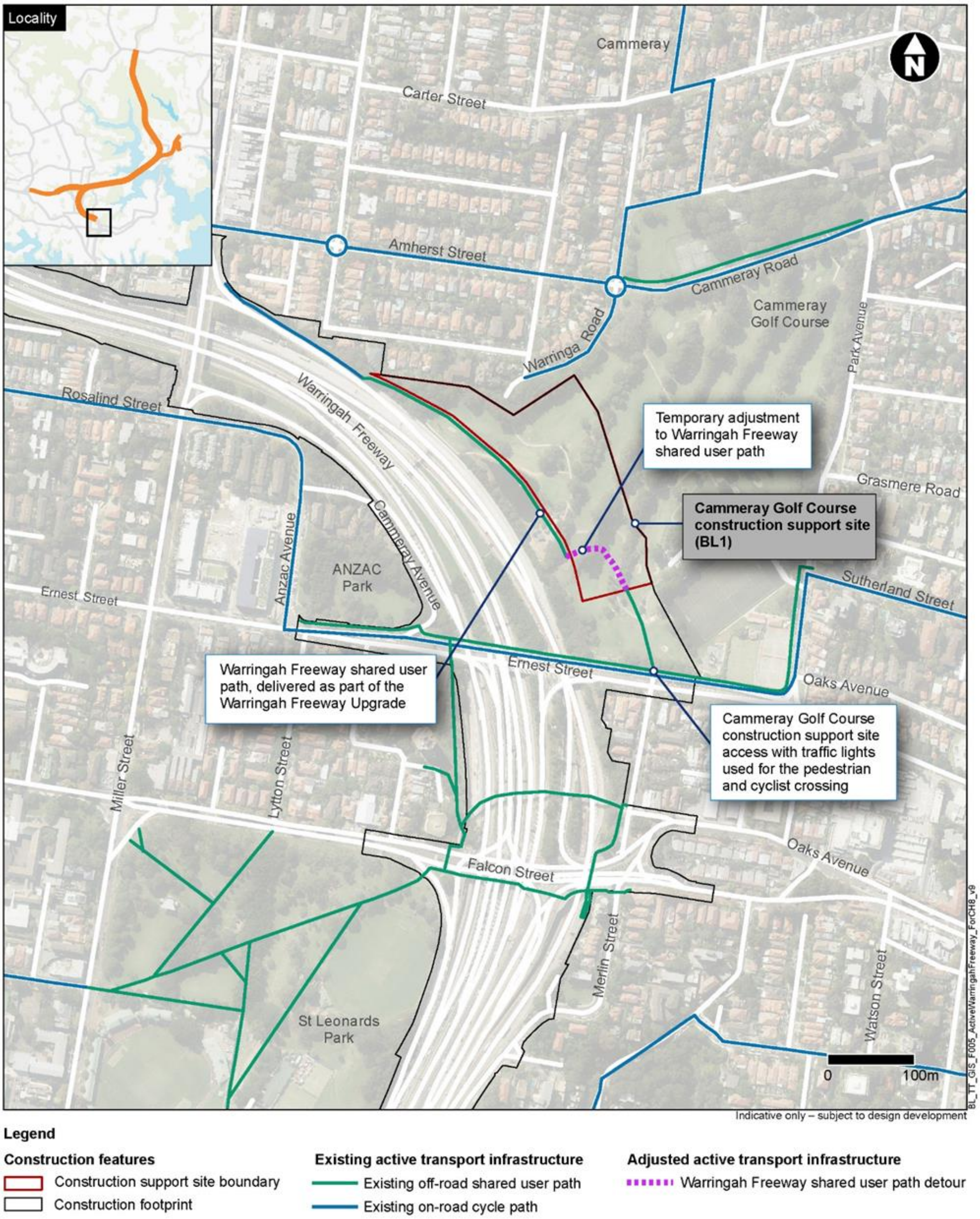


Figure 5-30 Active transport impacts during construction around Warringah Freeway and surrounds study area

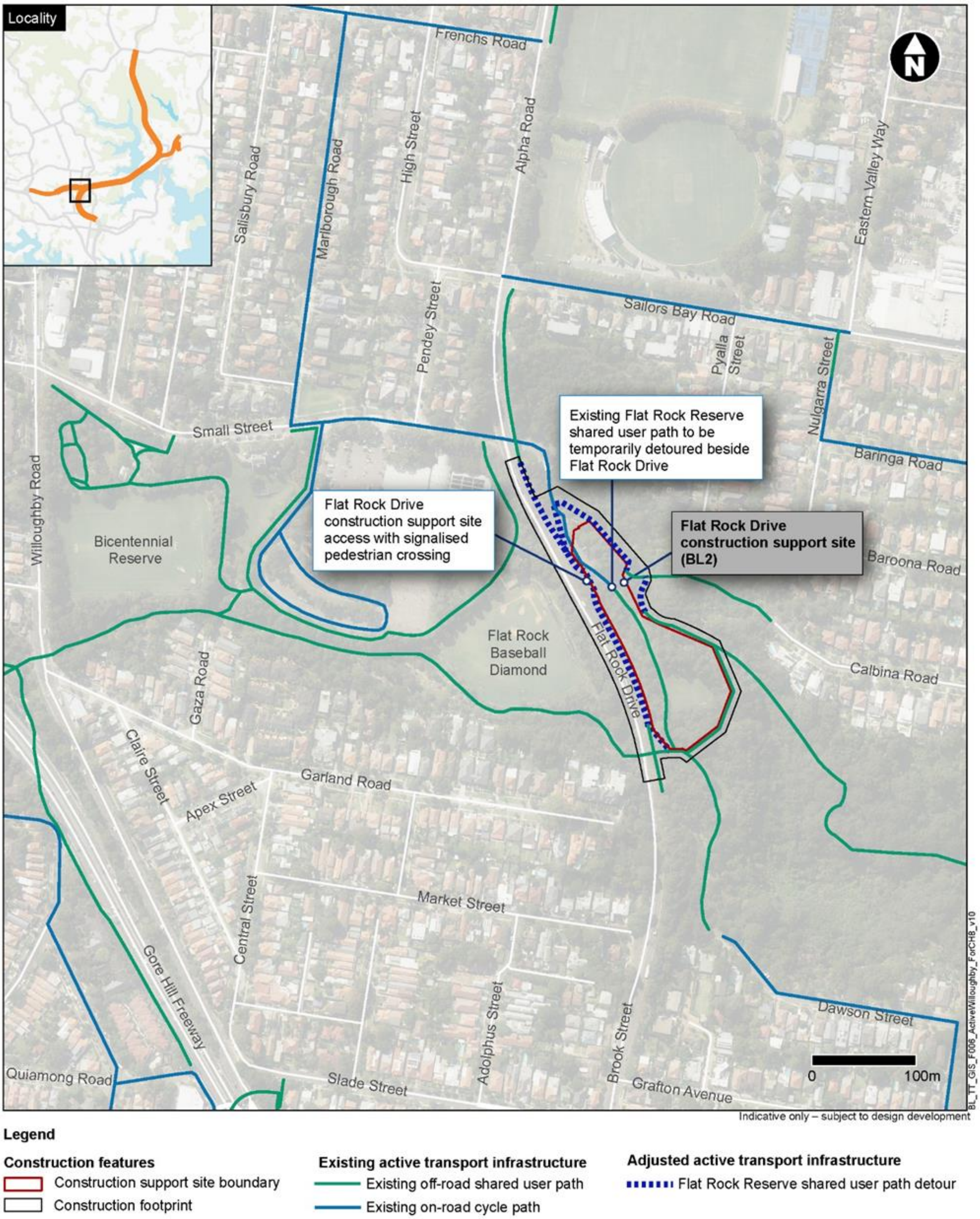


Figure 5-31 Active transport impacts during construction around Naremburn

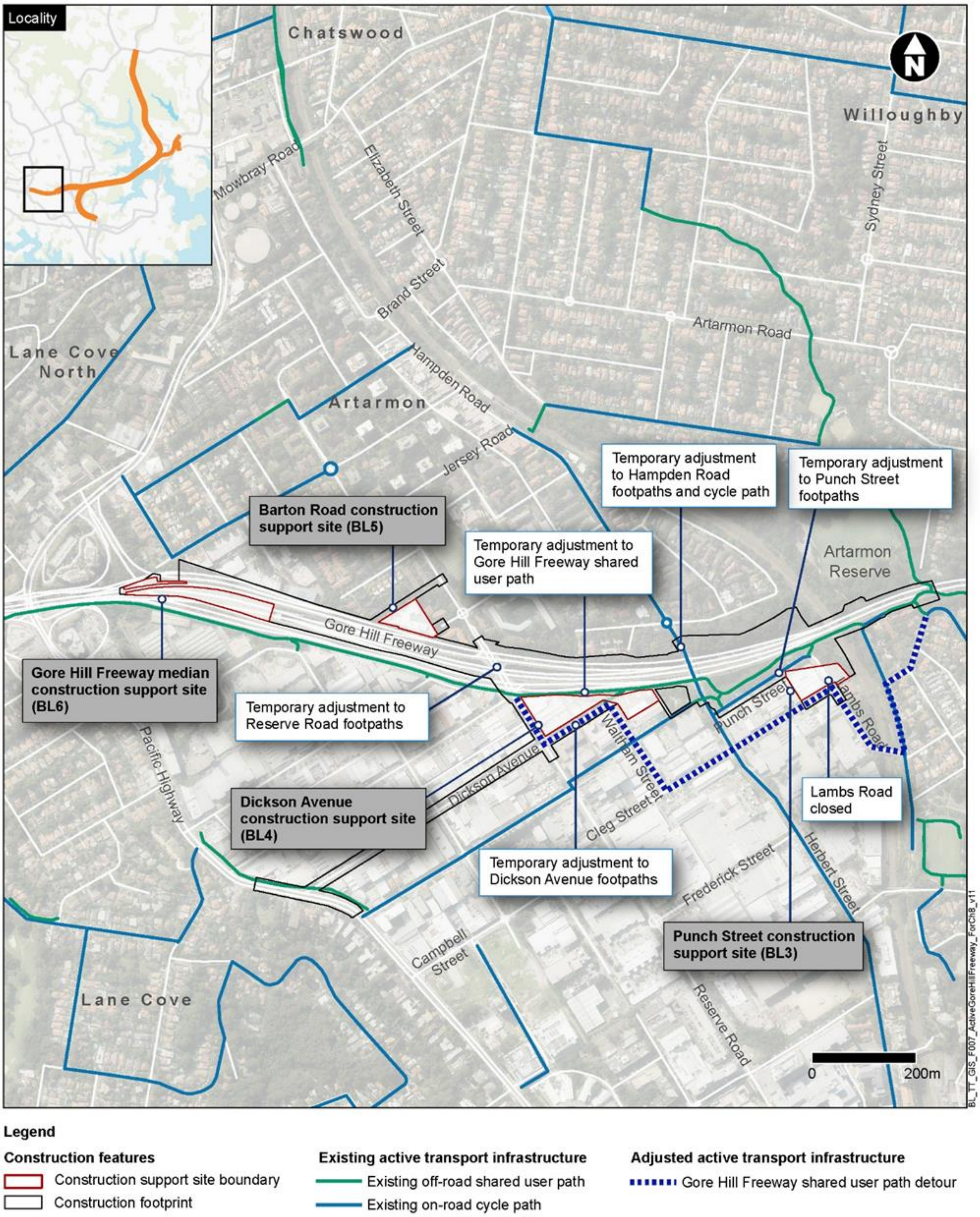


Figure 5-32 Active transport impacts during construction around Artarmon

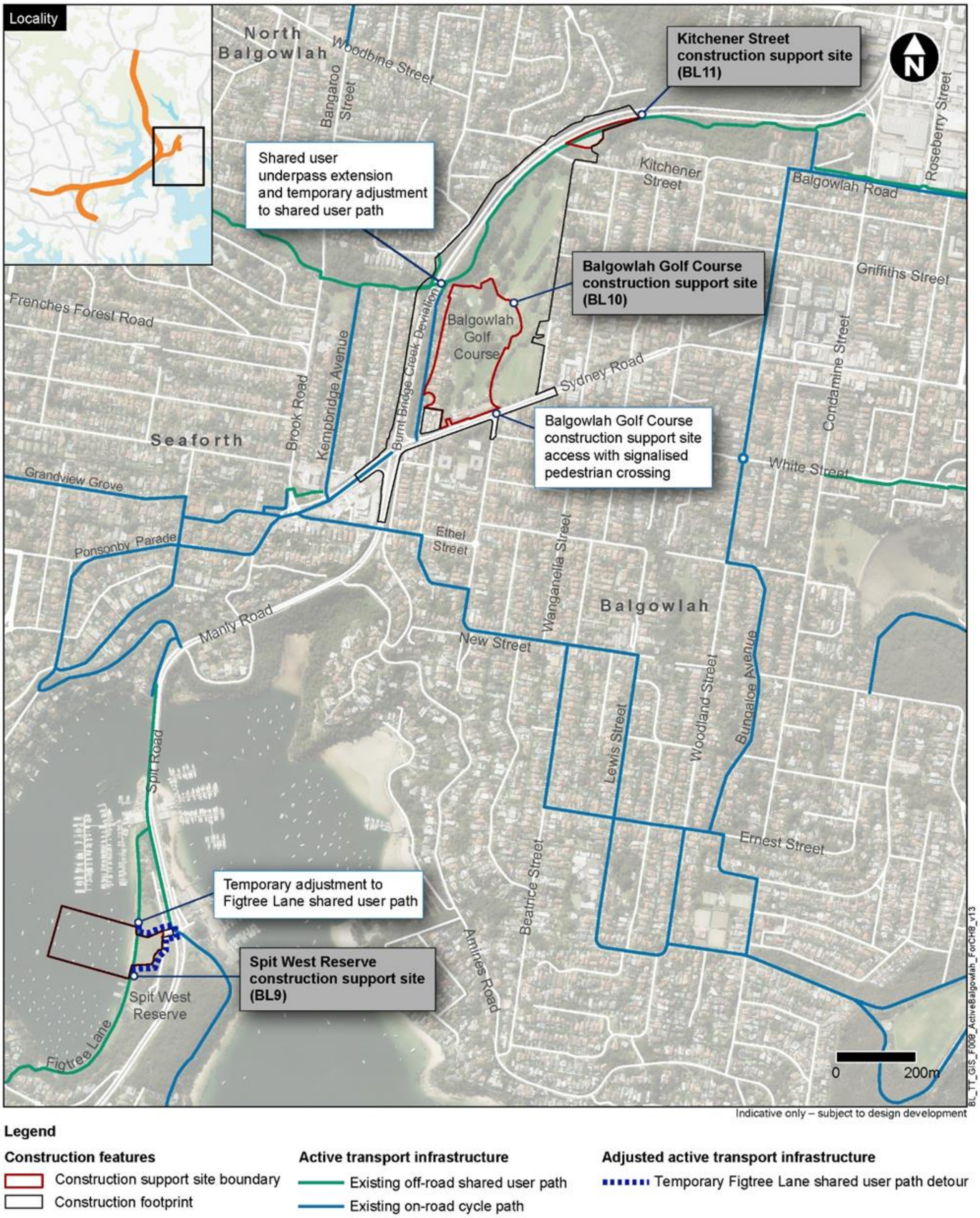


Figure 5-33 Active transport impacts during construction around Balgowlah

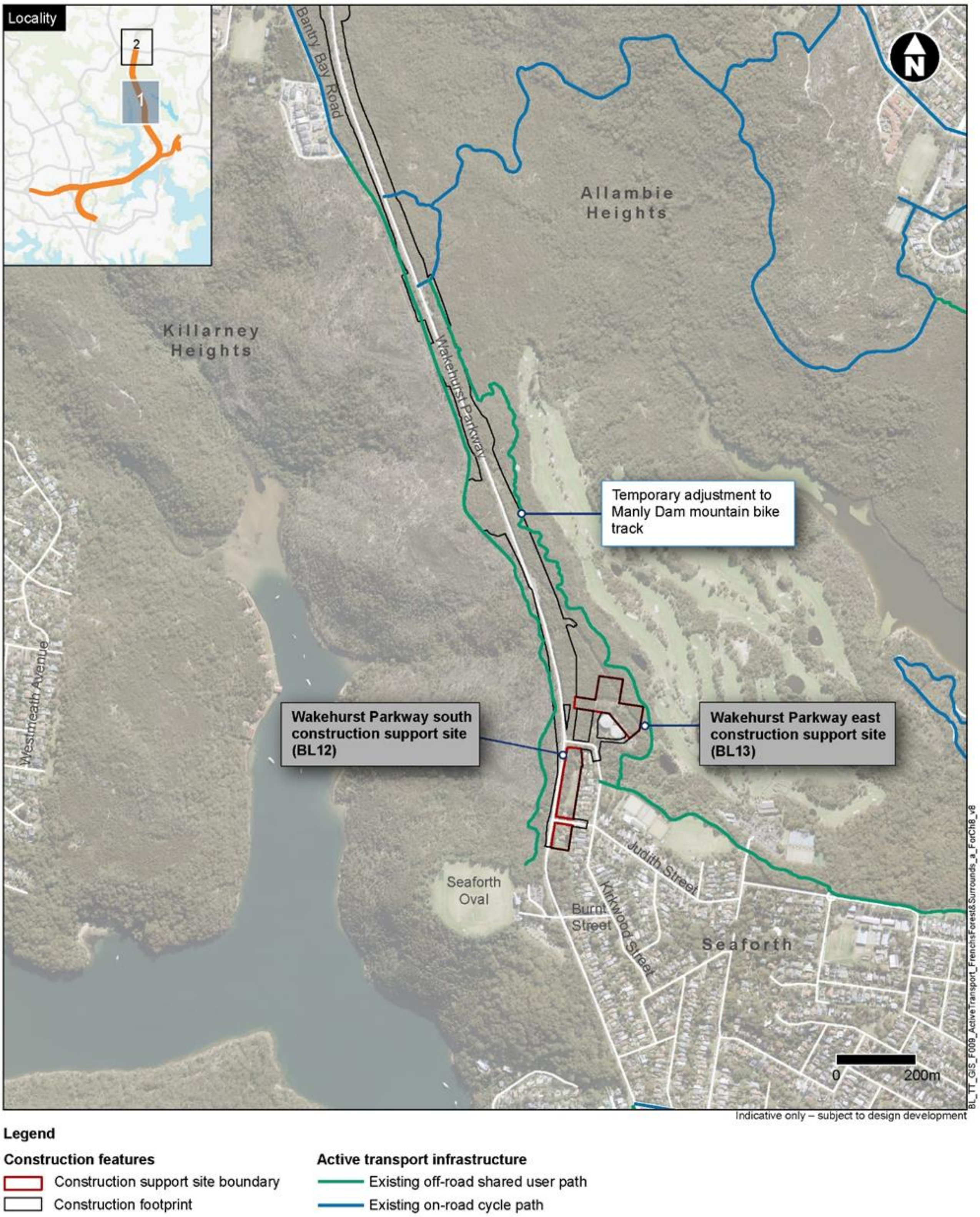


Figure 5-34 Active transport impacts during construction around Seaforth

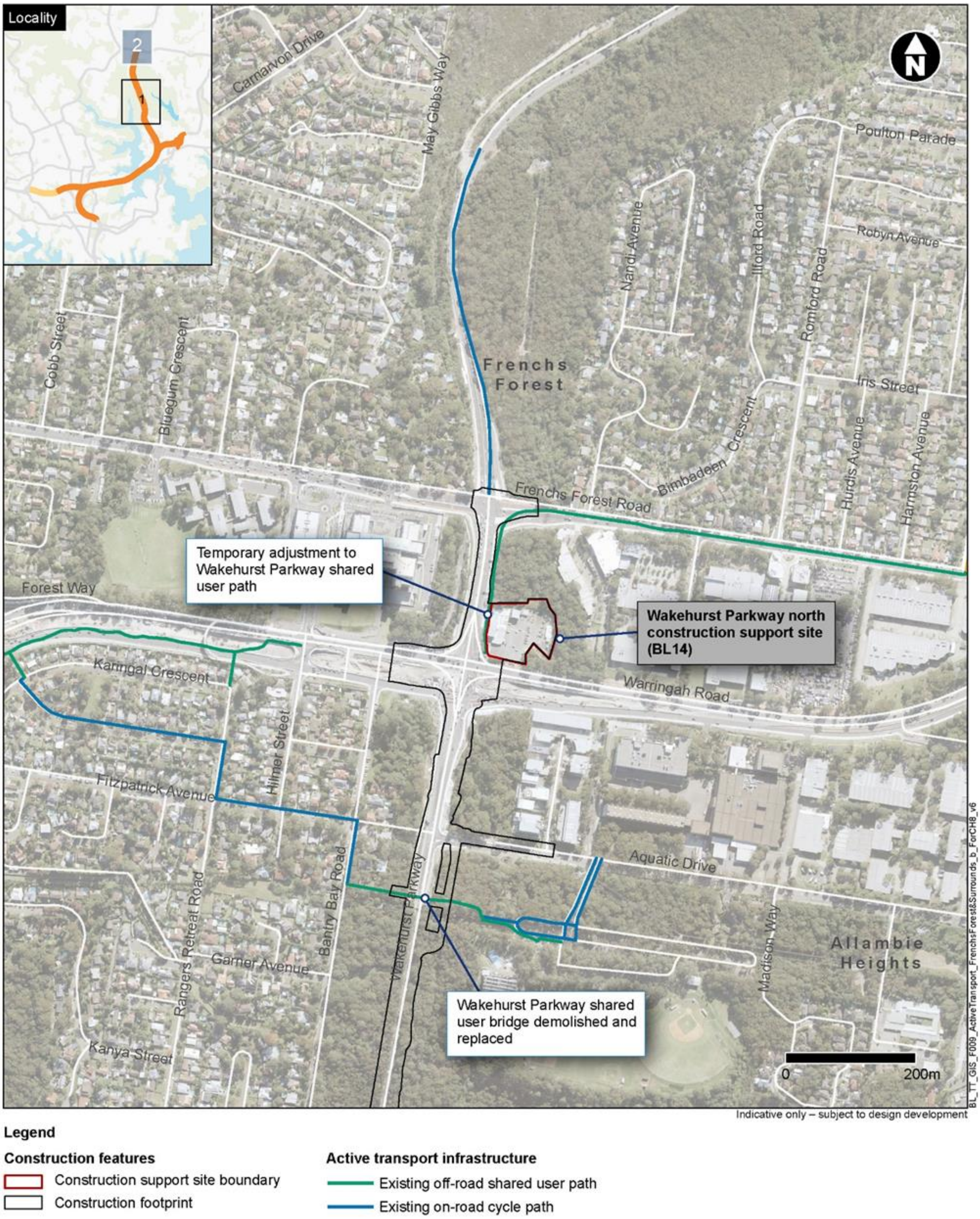


Figure 5-35 Active transport impacts during construction around Frenchs Forest

On-road cycle routes

Northern abutment works on Hampden Road would impact the ability for cyclists to travel on the road shoulder on either side of Hampden Road. During construction, one lane in each direction would be provided and cyclists would be required to travel on-road. Impacts would be minor given that these works are short in duration and parking would be removed on both sides of the road.

Footpath and shared user path adjustments

Warringah Freeway and surrounds

As part of the Western Harbour Tunnel and Warringah Freeway Upgrade, the shared user path along Warringah Freeway near Cammeray Golf Course would be realigned to travel along the rear of the Cammeray Golf Course construction support site (BL1) until the Ernest Street/Merlin Street intersection. Minor impacts to pedestrians and cyclists are anticipated given that existing connectivity would be maintained and a short additional travel distance of up to 100 metres.

The temporary adjustment of the Flat Rock Reserve shared user path (parallel to Flat Rock Drive, on the western side of the construction support site) would be required to accommodate the Flat Rock Drive construction support site (BL2). This path would be temporarily realigned along the western perimeter of the construction support site, resulting in an additional travel distance of up to 100 metres. The existing walking tracks along the eastern perimeter of the site will be largely maintained with two minor diversions required. Given that existing connectivity would be maintained and the small potential increase in travel distance, impacts on pedestrians and cyclists using the shared user path are anticipated to be minor.

Gore Hill Freeway and Artarmon

A number of modifications to the active transport network around Artarmon would be likely during construction of the Gore Hill Freeway Connection. Modifications that would require temporary diversions to pedestrians and/or cyclists include:

- Reinstatement of the eastern footpath on Hampden Road, including diversion of pedestrians to the western footpath, minimally impacting their travel
- Temporary adjustment of the southern footpath on Punch Street adjacent to the construction support site boundary. Users would be diverted to Clegg Street resulting in an increase in travel distance of up to around 70 metres, which would result in relatively low impacts on pedestrians and cyclists
- Temporary adjustment of the shared user path along Gore Hill Freeway between Reserve Road and Station Street. Impacts on pedestrians and cyclists due to the closure of the shared footpath adjacent to Gore Hill Freeway between Reserve Road and Station Street would be moderate given that up to 150 pedestrians and cyclists currently use the shared user path during the weekday peak hour (see Figure 4-32) and the additional distance they would be required to travel. An alternative route would involve diverting these users via Station Street, Francis Road, Lambs Road, Cleg Street and Reserve Road, resulting in an additional travel distance of around 550 metres. This would be a moderate impact on pedestrians but a minor impact to cyclists which would be managed by providing advanced notification to the community and appropriate linemarking and signage to clearly articulate the suggested detour route to pedestrians and cyclists.

Northern abutment works on Hampden Road would impact cyclists who currently travel on the road shoulder on either side of Hampden Road. During construction, one lane in each direction would be provided and cyclists would be required to travel on-road in traffic. Impacts would be minor given that these works are short in duration and parking would be removed on both sides of the road.

Periodic diversions of pedestrians to footpaths opposite construction activities or use of traffic control may also be required to ensure the safety of pedestrians, particularly on Punch Street, Dickson Avenue and Reserve Road. Residents may also be escorted through work sites when accessing properties to ensure safe passage. Targeted engagement with affected residents would be carried out before and during construction.

Balgowlah and surrounds

Changes to the active transport network would also be relatively minor around Balgowlah during construction of surface connections at Balgowlah. This would include:

- Temporary adjustment to paths at Spit West Reserve around the Spit West Reserve construction support site (BL9), specifically Fig Tree Lane, resulting in an increase in travel distance of up to 100 metres, which would be considered a minor impact due to the short detour distance
- A 50 metres temporary shared user path would be constructed within the Balgowlah Golf Course when the shared user path along the existing Burnt Bridge Creek Deviation is adjusted for the box culvert extension and the existing shared user underpass of Burnt Bridge Creek Deviation is extended. The extension of the existing shared user underpass beneath the Burnt Bridge Creek Deviation at Burnt Bridge Creek would be staged to maintain access at all times. Subject to final planning for staging of these works, additional short term detours may be required due to construction access restrictions
- A signalised pedestrian crossing would be provided at the entrance to the Balgowlah Golf Course construction support site (BL10) off Sydney Road via the traffic signals provided for the Sydney Road/Maretimo Street/Access Road intersection. This would ensure safe passage from users of the Sydney Road pedestrian bridge, including students from Northern Beaches Secondary College – Balgowlah Boys Campus, to the Balgowlah Oval.

Impacts on pedestrians and cyclists are expected to be minor given that existing connectivity would be maintained and additional travel distances via the temporary shared user path would be minimal. Appropriate linemarking and signage would be used to identify diversions and, where required, traffic controllers would ensure safe passage for users.

Frenchs Forest and surrounds

Temporary adjustment of some of the mountain bike tracks on either side of Wakehurst Parkway may also be required. If this is necessary, minor detour routes would be implemented and advanced notification of track closures provided at key locations. Construction of the three permanent shared user path underpasses along Wakehurst Parkway would be prioritised.

The existing shared user path adjacent to the Wakehurst Parkway north construction support site (BL14) would also be temporarily impacted during the use of the site. Affected areas would include the off-road pedestrian and cyclist paths along Wakehurst Parkway, north of Warringah Road. Pedestrian and cyclist access would be maintained at all times during construction.

Additionally, the shared user path bridge over Wakehurst Parkway connecting the Warringah Aquatic Centre and Bantry Bay Road would be demolished and a new and lengthened replacement overpass constructed as part of the project. Construction would be staged to ensure pedestrian and cyclist access over Wakehurst Parkway would be maintained at all times.

Construction support site access

Pedestrians and cyclists may be impacted by potential conflicts with construction vehicles at site accesses to construction support sites. To mitigate these potential conflicts, existing traffic signals would be modified or new traffic signals would be installed to provide safe access at the following construction support sites:

- Cammeray Golf Course (BL1) – Addition of a north approach at the Ernest Street/Merlin Street intersection as part of the Warringah Freeway Upgrade
- Flat Rock Drive (BL2) – New intersection with traffic signals on Flat Rock Drive
- Balgowlah Golf Course (BL10) – Signalisation of the Sydney Road/Maretimo Street intersection
- Wakehurst Parkway east (BL13) – New intersection with traffic signals on Wakehurst Parkway.

Conflicts between pedestrians and/or cyclists using the footpath or shared user path near these sites and construction vehicles would be minimised through the signalised control of movements at the site entry/exit. In addition, heavy vehicles at the Cammeray Golf Course construction support site (BL1) would be directed to access the site directly from the Warringah Freeway where feasible and reasonable, while direct access off Burnt Bridge Creek Deviation would be provided for the Balgowlah Golf Course construction support site (BL10).

Traffic controllers would also control construction vehicle movements to and from the work zone located on the eastern side of Hampden Road south of Parkes Road in Artarmon to minimise conflict between vehicles and pedestrians.

Active transport construction impact summary

Assessment of the impact of construction activities on the active transport network indicates that residual impacts would be manageable, with some detour routes required.

The potential additional travel distances would be relatively low, except for the Gore Hill Freeway shared user path in Artarmon. This impact would be moderate and manageable and would not require any further environmental management measures.

5.6.3 Maritime movements and activities

This section presents a summary of the maritime impacts during construction. Further detail is provided in the Navigation Impact Assessment completed by Royal Haskoning DHV (refer to Appendix A).

The assessment of construction impacts on maritime activities relates to the following construction support sites:

- BL7 – Middle Harbour south cofferdam (shown in Figure 5-36)
- BL8 – Middle Harbour north cofferdam (shown in Figure 5-36)
- BL9 – Spit West Reserve (shown previously in Figure 5-17).

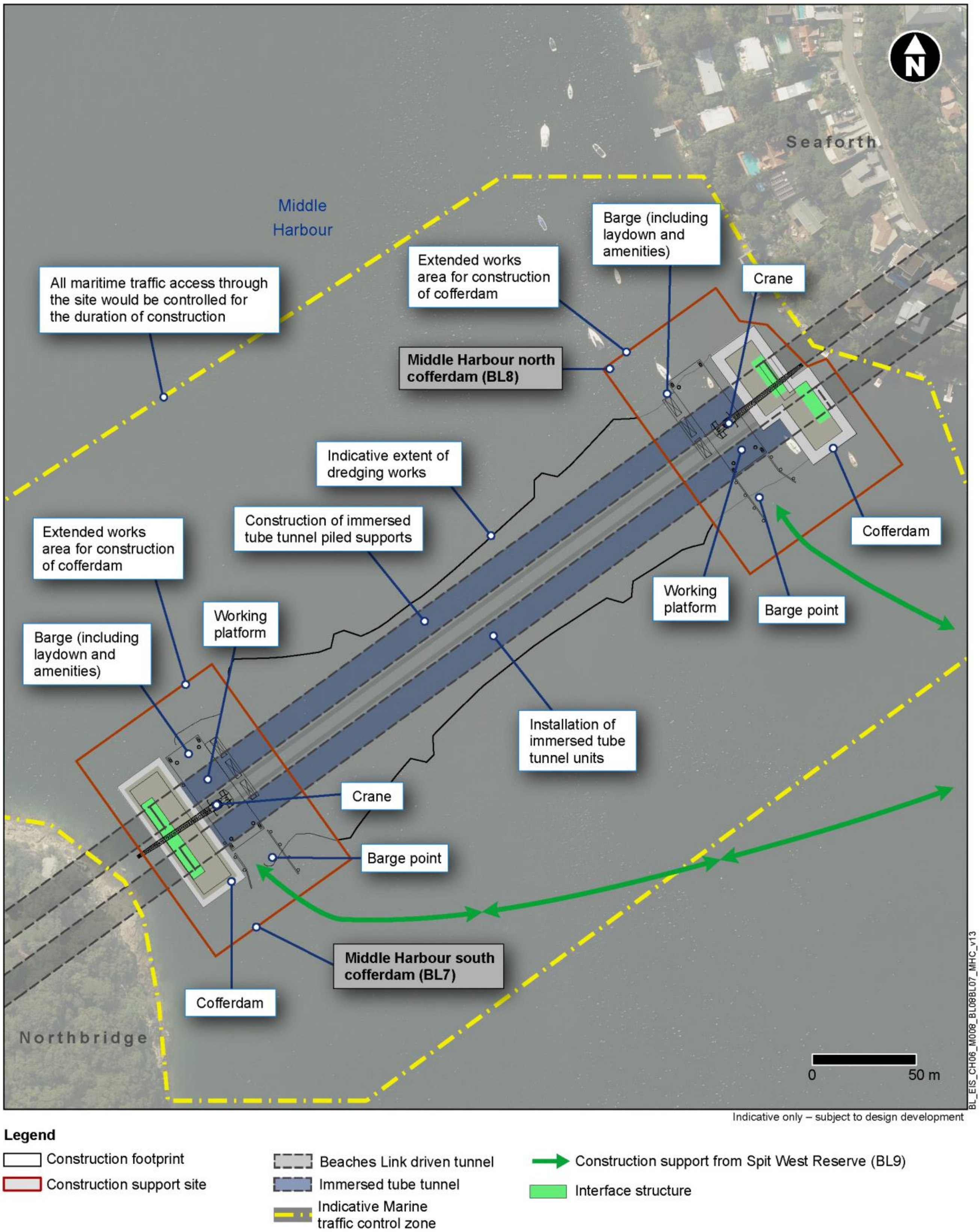


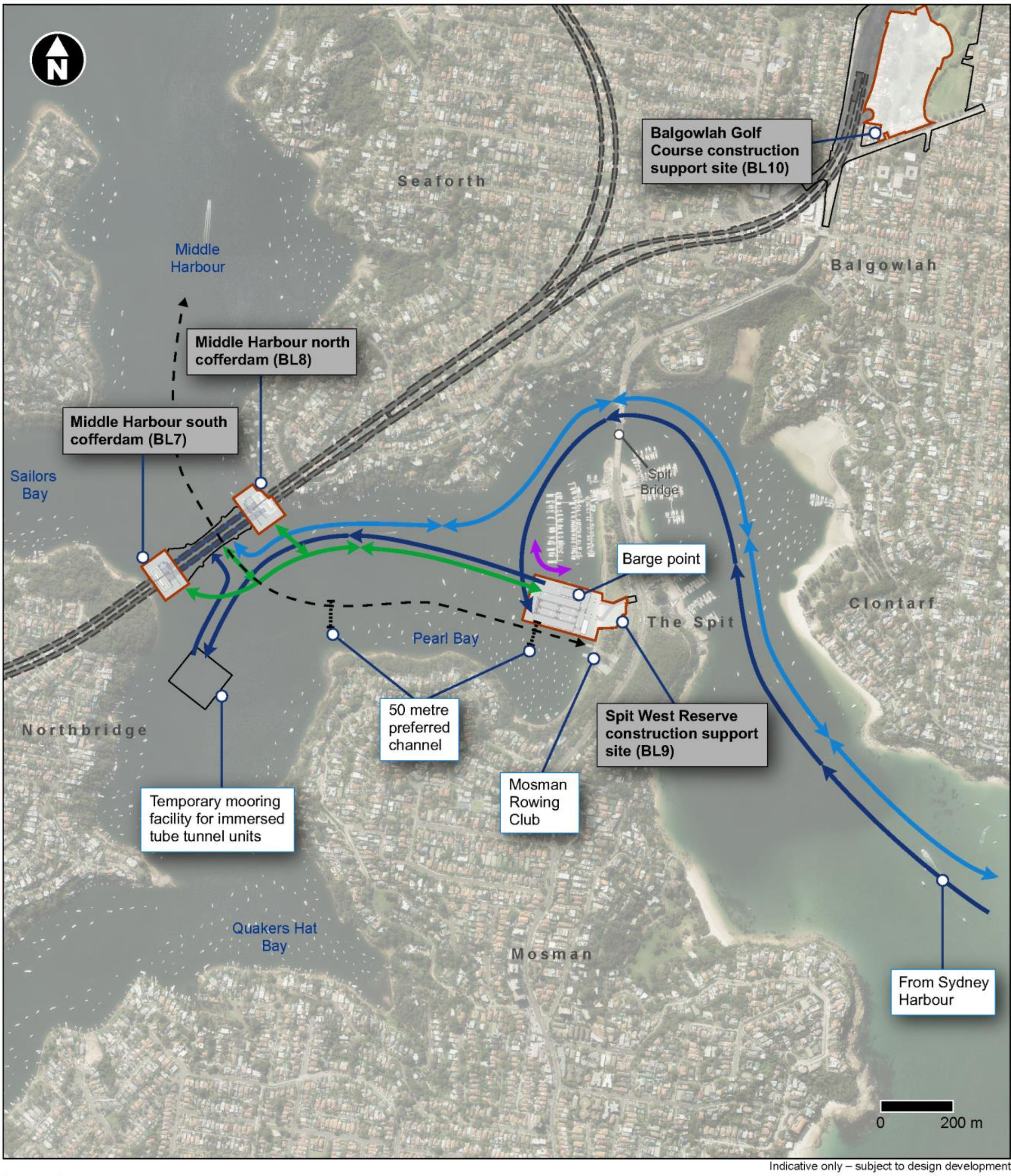
Figure 5-36 Indicative construction support site layout – BL7 – Middle Harbour south cofferdam, BL8 – Middle Harbour north cofferdam

The indicative type and number of marine transport and construction vessels likely to be used during construction is summarised in Table 5-20, and the main routes these vessels would travel across Middle Harbour during construction are shown in Figure 5-37.

Table 5-20 Marine traffic generation for each construction support site

<table>
<tr><th rowspan="2">No.</th><th rowspan="2">Site</th><th colspan="4">Vessel type, function and peak vessel movements per day</th></tr>
<tr><th>Small boat (workforce)</th><th>Barge (deliveries)</th><th>Barge (spoil)</th><th>Ferry (deliveries)</th></tr>
<tr><td>BL7</td><td>Middle Harbour south cofferdam</td><td rowspan="2">12</td><td rowspan="2">4</td><td rowspan="2">-</td><td rowspan="2">48</td></tr>
<tr><td>BL8</td><td>Middle Harbour north cofferdam</td></tr>
<tr><td>BL9</td><td>Spit West Reserve</td><td>12</td><td>4</td><td>-</td><td>48</td></tr>
<tr><td>-</td><td>Dredge/immersed tube tunnel area</td><td>-</td><td>-</td><td>3*</td><td>-</td></tr>
</table>

*Includes barge movements transporting spoil to offshore disposal



Legend

Construction features

- Driven tunnel
- Immersed tube tunnel
- Construction footprint
- Construction support site

Maritime traffic routes

- Immersed tube tunnel transportation route
- Route for offshore disposal
- Marina access
- Marine construction traffic routes for dredging, cofferdams and permanent transition structures
- Proposed Mosman Rowing Club route

Figure 5-37 Marine transport and construction vessel routes in Middle Harbour

The indicative timing of the use of the sites is summarised in Table 5-21. The timeframe includes site establishment and site rehabilitation.

Table 5-21 Timing of construction support site use with potential for impact on maritime activities

No.	Site	Indicative timing of construction support site use					
		2022	2023	2024	2025	2026	2027
BL7	Middle Harbour south cofferdam						
BL8	Middle Harbour north cofferdam						
BL9	Spit West Reserve						

Impacts on maritime services and activities are anticipated due to:

- Generally, access through the site between Northbridge and Seaforth Bluff would be restricted via a controlled navigation route for all business related water craft. These controlled restrictions would occur during the whole of the construction period
- Up to six closures (full and partial) of Middle Harbour between Clive Park and Seaforth for a period of up to 48 hours during weekdays for the installation of the immersed tube tunnel units
- Establishment and operation of the Spit West Reserve construction support site (BL9) in Pearl Bay
- Transport of partially constructed steel shell immersed tube tunnel units to Spit West Reserve construction support site (BL9)
- Installation of cofferdams at Clive Park and Seaforth
- Dredging activities and barge movements to the offshore disposal site
- Installation of piling for immersed tube tunnel units support between Northbridge and Seaforth
- Installation of immersed tube tunnel support headstocks on installed piles
- Barge movements to and from the project construction support sites
- Boat movements for transporting the construction workforce
- The temporary mooring facility east of Clive Park in Middle Harbour to be used as a storage facility for completed immersed tube tunnel units
- Ferry movements for delivering concrete.

Harbour closures

Scheduling of the Middle Harbour closures for the installation of the immersed tube tunnel units would be carried out in consultation with Port Authority NSW, other divisions of Transport for NSW and all other relevant stakeholders. These closures would occur on weekdays to limit the disturbance to recreational boating. At least 12 months' notice would be provided to Port Authority NSW of the closures required. The closure of the channel would impact recreational marine traffic, with extensive community consultation to be carried out to notify these users of the scheduled closures and exclusion zones, including local residents, Mosman Rowing Club, Northbridge Sailing Club, Middle Harbour Yacht Club, users of D'Albora Marinas The Spit, and businesses located on the eastern side of Spit Bridge. During partial closure of Middle Harbour, navigational restrictions would prohibit larger vessels from crossing the Harbour between Clive Park and Seaforth. Smaller vessels passing through may require escort vessels to ensure safe passage.

Although Middle Harbour does not contain a commercial navigational channel, a marine works management plan and marine traffic management plan would be prepared and approved by the Harbour Master before the start of works. These would outline how marine works would be carried out. Special Event Marine Notices would also be issued notifying all marine users of the navigational restrictions.

Relocation of swing moorings and marina berths

About 45 swing moorings located in Pearl Bay would be temporarily relocated (for a period of about 48 months) during construction due to the location of a casting facility off Spit West Reserve. An additional 10 swing moorings in Seaforth would also require temporary relocation due the Seaforth cofferdam. These moorings would be relocated elsewhere in Middle Harbour in consultation with the lease holder(s) and therefore the impact on recreational boat users due to the displaced moorings would be minor.

A temporary mooring to be used as a storage facility for immersed tube tunnel segments would also be located east of Clive Park. Deliveries of immersed tube tunnel units between the construction support sites may require a small number of additional swing moorings west of Bradys Point to be temporarily relocated. If required, arrangements would be determined in consultation with the lease holder(s). Impacts on any additional relocated moorings would be limited to a relatively small change to their location. Figure 5-37 shows the location of the mooring areas during construction within Middle Harbour.

The location of the cofferdam at Seaforth would also prohibit access to three private marina berths as shown in Figure 5-38. Temporary alternative marina berths would be provided at D'Albora Marinas, The Spit or other marinas nearby.

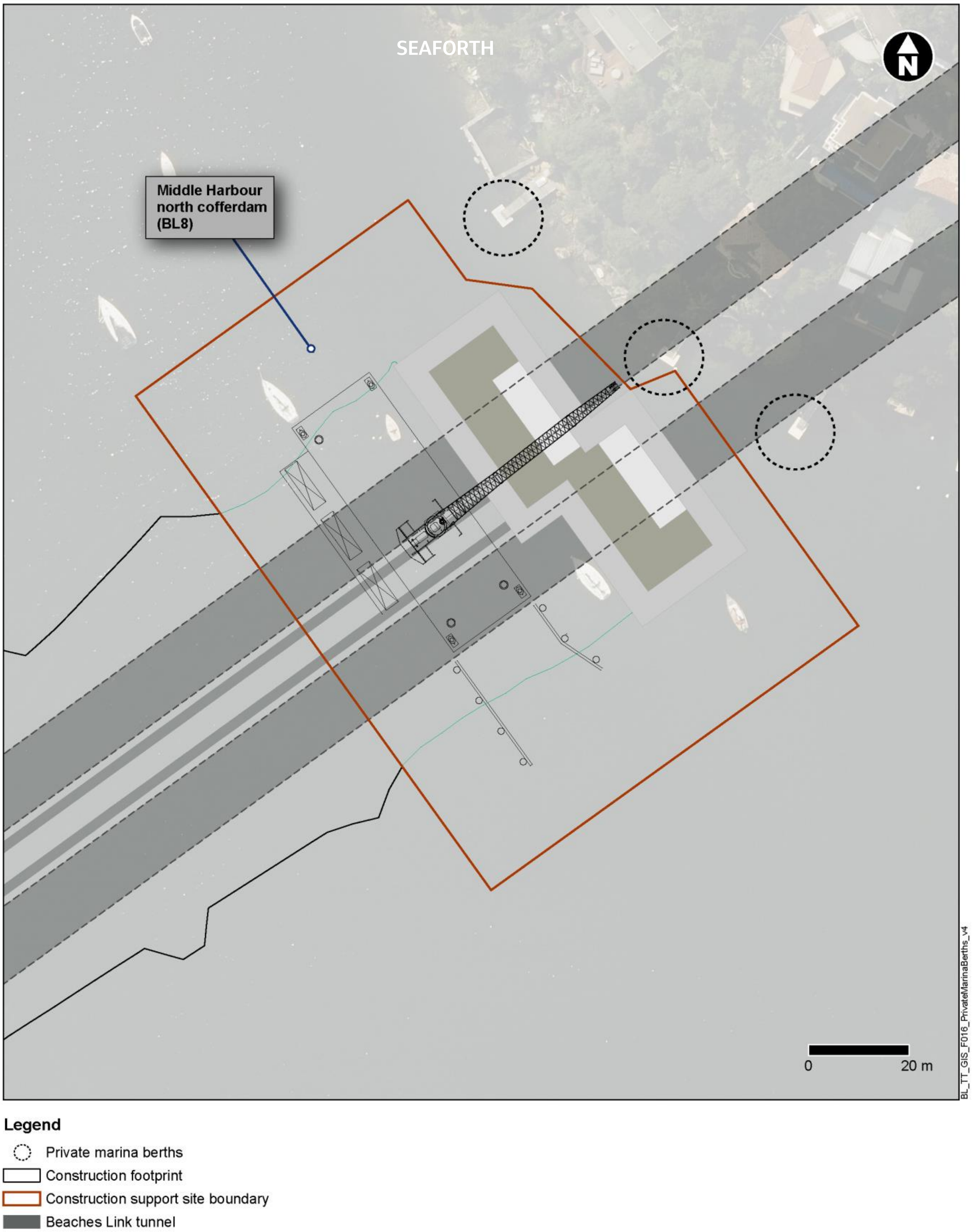


Figure 5-38 Inaccessible marina berths during construction

Exclusion zones

Exclusion zones would be set up around the cofferdams at Clive Park and Seaforth, thereby reducing navigation width. The exclusion zones would be marked by lit yellow buoys as specified by the Harbour Master to clearly demarcate these zones and facilitate the safe passage of all vessels travelling within the vicinity of the cofferdams.

Dredging activities and the installation of immersed tube tunnel support piles would also reduce navigation width. Impacts due to the reduced navigation widths however would be manageable, with specific mitigations detailed in the marine traffic management plan.

Barge and boat movements

The peak period for marine traffic would be during construction of the interface structures, where there may be up to 68 barge and workboat movements between the Spit West Reserve construction support site (BL9) and the cofferdams and the dredging works per day. However, the duration of these works would be relatively short.

Prolonged periods of relatively high marine activity would occur over a three-month period due to the following activities:

- Concreting of transition structure
- Dredging of sediment and rock
- Transport of partially completed and completed immersed tube tunnel units.

Details of the construction activities associated with these vessel movements and the marine traffic routes are provided in Annexure A. Navigational impact assessment.

Construction vessel movements would be managed to minimise residual impacts to scheduled recreational activities within Middle Harbour. This is important near Spit Bridge, which is a congested area particularly during Spit Bridge opening times. Construction vessels transporting immersed tube tunnel steel shell segments from the Outer Sydney Harbour to Middle Harbour would require access when the bridge is open. Given the length, draught, limited speed and limited manoeuvrability of the immersed tube tunnel segments, special bridge opening times outside of peak traffic periods would be required in order to transport these segments to their intended destination. This would require special arrangements and permits to be obtained. Any proposed changes to standard opening times would be outlined in the marine traffic management plan.

The waterway between Beauty Point and Clontarf Point is a designated 'no wash' zone and therefore all marine construction vessels near or within this zone would be required to minimise vessel wash by keeping travel speeds to a minimum.

The proposed construction works have the potential to impact Mosman Rowing Club. These potential impacts would be mitigated wherever practical. Mosman Rowing Club would be consulted during construction planning of the project to address any additional concerns and develop additional mitigation measures as may be deemed necessary.

Similarly, course layouts for Northbridge Sailing Club, which provides races for dinghies and other sail craft, are currently situated within the immediate vicinity of the immersed tube tunnel crossing. Construction of the immersed tube tunnel, particularly the primary silt curtains for dredging, would have a substantial impact on the layout of the Northbridge Sailing Clubs race courses. Northbridge Sailing Club would be consulted and advised of the works and proposed mitigation measures during the detailed design phase of the project. The club would be consulted on feasible and reasonable mitigation measures including the measure to relocate their race courses to upstream of the Middle Harbour Crossing.

Residual impacts on key stakeholders would be addressed during the preparation of appropriate management plans.

Impacts on other harbour users such as boat hire businesses, commercial boats, Department of Defence, Transport for NSW, and the Water Police would be limited to a minor increase in travel time resulting from imposed speed restrictions during construction.

Annexure A. Navigational impact assessment provides additional details regarding impacts on the maritime network during construction.

Maritime construction impact summary

The assessment of the impact of construction activities on the maritime network in the Outer Sydney Harbour would be minimal due to infrequent marine construction vessel movements and wide navigation waterway widths.

The impact on navigation in Middle Harbour would be more substantial. This is due to the existing constrained environment in Middle Harbour, where there are restrictions for vessel types and timing of vessel movements through Spit Bridge, highly variable water depths, and a number of recreational users and clubs (particularly Mosman Rowing Club and Northbridge Sailing Club) using the waterways and foreshore areas. Residual impacts to key stakeholders would be addressed through consultation during the preparation of appropriate management plans.

5.6.4 Special events

Most of the land-based construction for the project would have minimal impact on special events as the proposed construction zones and construction traffic routes are not located close to venues that regularly schedule events requiring traffic or public transport event plans.

Major events do not occur in Middle Harbour. However, races that are held by the recreational clubs along the foreshore may interfere with the marine construction traffic routes. Impacts would be similar to those discussed Section 5.6.3 in relation to the clubs' training routes and course layouts, with mitigation measures required to reduce the potential impacts outlined in Section 9.

Construction activities on road corridors would require a Road Occupancy Licence to close the road for any period. The granting of a Road Occupancy Licence would generally be subject to network operation restrictions, which would preclude road closures during high-activity holidays such as New Year's Eve, or during arrival and departure periods for major events such as sports grand finals or during major road closures in the Sydney CBD.

The likely impact of construction activities on special events would be minimal and not require any further environmental management measures.

5.7 Cumulative construction impacts

5.7.1 Cumulative construction impacts - Western Harbour Tunnel and Warringah Freeway Upgrade

As outlined in Section 3.5, peak construction of the project and the Western Harbour Tunnel and Warringah Freeway Upgrade project is expected to occur in 2024, should the project and the Western Harbour Tunnel and Warringah Freeway Upgrade be constructed concurrently.

The Cammeray Golf Course construction support site (BL1) would be used for both projects and therefore the cumulative impact at this compound has been assessed. However, in the event that Western Harbour Tunnel and Beaches Link are both constructed concurrently, works at the Cammeray Golf Course construction support site (BL1) would be planned and programmed to manage any overlap between the two projects.

Vissim construction modelling

As discussed in Section 3.5.2, to assess worst-case cumulative construction impacts, network simulation modelling was carried out in Vissim of the Warringah Freeway and surrounds study area, to quantify the performance of the road network with and without construction traffic during concurrent construction of the project and the Western Harbour Tunnel and Warringah Freeway Upgrade.

Network performance

Table 5-22 and Table 5-23 demonstrate forecast network performance in 2024 both without and with cumulative construction activities occurring.

Table 5-22 Modelled morning peak network performance with concurrent construction program – Warringah Freeway and surrounds study area

Network measure	2024 base	2024 cumulative construction
Network statistics for all vehicles		
Total traffic demand (veh)	105,000	106,200
Total VKT through network	346,800	344,500
Total VHT through network	10,100	10,500
Total number of stops	597,700	664,200
Average vehicle statistics		
Average vehicle trip length through the network (km)	3.5	3.6
Average vehicle trip time through the network (hours)	0:06:11	0:06:29
Average number of stops per trip	6.1	6.9
Average trip speed (km/hr)	34.3	32.9
Unreleased traffic		
Total unreleased trips	7200	9190
% of demand unreleased	7%	9%

Table 5-23 Modelled evening peak network performance with concurrent construction program -Warringah Freeway and surrounds study area

Network measure	2024 base	2024 cumulative construction
Network statistics for all vehicles		
Total traffic demand (veh)	104,800	106,000
Total VKT through network	344,800	345,500
Total VHT through network (hours)	10,200	10,600
Total number of stops	661,700	754,800
Average vehicle statistics		
Average vehicle trip length through the network (km)	3.4	3.4
Average vehicle trip time through the network (hours)	0:06:01	0:06:15
Average number of stops per trip	6.5	7.4
Average trip speed (km/hr)	34.0	32.6
Unreleased traffic		
Total unreleased trips	3470	4200
% of demand unreleased	3%	4%

The results indicate that when compared to forecast 2024 peak period base conditions, cumulative construction activities in the Warringah Freeway and surrounds study area has the potential to:

- Increase traffic demand by around one per cent
- Create less than one additional stop per trip
- Reduce average trip speeds by around four per cent.

Cumulative construction activities are therefore only expected to have minor and manageable impacts on overall network performance in the area.

General traffic travel times

Table 5-24 and Table 5-24 demonstrate forecast corridor travel times for general traffic in 2024 both without and with cumulative construction activities occurring.

Table 5-24 Modelled morning peak hour general traffic travel times with concurrent construction program – Warringah Freeway and surrounds study area

Route	Direction	2024 base (hours)	2024 cumulative construction (hours)
Sydney Harbour Bridge to Warringah Freeway/Falcon Street interchange	Northbound	0:04:42	0:04:39
	Southbound	0:04:02	0:04:01
Sydney Harbour Tunnel to Warringah Freeway/Falcon Street interchange	Northbound	0:03:51	0:03:57
	Southbound	0:04:06	0:04:03
Sydney Harbour Bridge to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:06:13	0:06:13
	Southbound	0:08:48	0:10:53

Route	Direction	2024 base (hours)	2024 cumulative construction (hours)
Sydney Harbour Tunnel to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:05:22	0:05:28
	Southbound	0:08:50	0:11:21
Berry Street to Amherst Street via Miller Street	Northbound	0:04:10	0:04:05
	Southbound	0:07:48	0:09:22

Table 5-25 Modelled evening peak hour general traffic travel times with concurrent-construction program – Warringah Freeway and surrounds study area

Route	Direction	2024 base (hours)	2024 cumulative construction (hours)
Sydney Harbour Bridge to Warringah Freeway/Falcon Street interchange	Northbound	0:03:43	0:03:45
	Southbound	0:04:16	0:05:32
Sydney Harbour Tunnel to Warringah Freeway/Falcon Street interchange	Northbound	0:03:36	0:03:42
	Southbound	0:14:27	0:15:05
Sydney Harbour Bridge to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:05:31	0:05:59
	Southbound	0:16:15	0:16:13
Sydney Harbour Tunnel to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:05:19	0:06:01
	Southbound	0:19:51	0:20:20
Berry Street to Amherst Street via Miller Street	Northbound	0:04:34	0:05:36
	Southbound	0:13:45	0:10:39

The results indicate that when compared to forecast 2024 peak period base conditions, cumulative construction activities in the Warringah Freeway and surrounds study area has the potential to:

- Impact corridor travel times by less than one minute for most routes
- Increase travel times by between one and three minutes for the following routes:
  - Warringah Freeway: Gore Hill Freeway to Sydney Harbour Bridge (morning peak)
  - Warringah Freeway: Gore Hill Freeway to Sydney Harbour Tunnel (morning peak)
  - Warringah Freeway: Falcon Street to Sydney Harbour Bridge (evening peak)
  - Miller Street: Amherst Street to Berry Street (morning peak)
  - Miller Street: Berry Street to Amherst Street (evening peak).

For Miller Street southbound the base case was observed to experience longer travel times in comparison to the 2024 cumulative construction scenario. Falcon Street/Military Road westbound between Ben Boyd Road and Miller Street is predicted experience a slight increase in congestion in the 2024 cumulative construction scenario when compared to the 2024 base case resulting in less throughput and delays at the Falcon Street left turn onto Miller Street. As the performance of the Miller Street corridor is sensitive to the traffic arrival rates from side streets, this reduction in throughput results in the observed improvement to the Miller Street southbound travel time in the 2024 cumulative construction scenario.

Bus travel times

Table 5-26 and Table 5-27 demonstrate forecast corridor travel times for buses in 2024 both without and with cumulative construction activities occurring.

Table 5-26 Modelled morning peak hour bus travel times with concurrent construction program – Warringah Freeway and surrounds study area

Route	Direction	2024 base (hours)	2024 cumulative construction (hours)
Sydney Harbour Bridge to Amherst Street (via Miller Street and North Sydney Station)	Northbound	0:13:01	0:11:25
	Southbound	0:14:56	0:16:08
Sydney Harbour Bridge to Bay Street (Via North Sydney Station and Pacific Highway)	Northbound	0:07:20	0:06:17
	Southbound	0:12:44	0:12:16
Sydney Harbour Bridge to Ben Boyd Road	Northbound	0:06:51	0:07:02
	Southbound	0:07:12	0:06:57
Sydney Harbour Bridge to Lane Cove Tunnel (via Gore Hill Freeway)	Northbound	0:06:49	0:06:38
	Southbound	0:17:54	0:26:18

Table 5-27 Modelled evening peak hour bus travel times with concurrent construction program – Warringah Freeway and surrounds study area

Route	Direction	2024 base (hours)	2024 cumulative construction (hours)
Sydney Harbour Bridge to Amherst Street (via Miller Street and North Sydney Station)	Northbound	0:12:04	0:13:03
	Southbound	0:18:07	0:16:14
Sydney Harbour Bridge to Bay Street (Via North Sydney Station and Pacific Highway)	Northbound	0:07:13	0:07:23
	Southbound	0:09:30	0:09:53
Sydney Harbour Bridge to Ben Boyd Road	Northbound	0:08:39	0:10:31
	Southbound	0:05:40	0:05:33
Sydney Harbour Bridge to Lane Cove Tunnel (via Gore Hill Freeway)	Northbound	0:06:13	0:06:22
	Southbound	0:18:44	0:17:21

The results indicate that when compared to forecast 2024 peak period base conditions, cumulative construction activities in the Warringah Freeway and surrounds study area has the potential to:

- Impact corridor travel times by less than one minute for most routes
- Increase travel times by between one and three minutes for the following routes:
  - Southbound via Miller Street to the Sydney Harbour Bridge (morning peak)
  - Northbound via the Warringah Freeway and Military Road to Ben Boyd Road (evening peak).

The most substantial potential impact is to southbound travel times via the Warringah Freeway. For Warringah Freeway routes, increased traffic demand including potential additional traffic movements across the southbound bus lane south of Falcon Street, could increase congestion, impacting bus travel times. This issue could be mitigated by considered and tailored construction traffic planning based on actual traffic conditions and confirmed cumulative activities at the time of construction.

Intersection performance

The intersection performance results for the road network with and without cumulative construction traffic are provided in Table 5-28 and Table 5-29 for the morning and evening peak hours, respectively.

Table 5-28 Modelled morning peak hour intersection performance with concurrent construction program – Warringah Freeway and surrounds study area

Intersection	2024 base		2024 cumulative construction	
	Average delay (sec)	LoS	Average delay (sec)	LoS
Willoughby Road/Gore Hill Freeway interchange	66	E	>100	F
Brook Street/Warringah Freeway on ramp	>100	F	>100	F
Brook Street/Warringah Freeway off ramp	58	E	95	F
Brook Street/Merrenburn Avenue	>100	F	>100	F
Amherst Street/West Street	6	A	<5	A
Amherst Street/Miller Street	21	B	22	B
Miller Street/Warringah Freeway on ramp	<5	A	7	A
Miller Street/Warringah Freeway off ramp	13	A	34	C
Miller Street/Ernest Street	58	E	67	E
Miller Street/Falcon Street	56	D	58	E
Ernest Street/Warringah Freeway on ramp	41	C	31	C
Ernest Street/Warringah Freeway off ramp (off ramp in PM, on ramp in AM)	41	C	31	C
Falcon Street/Warringah Freeway ramps	73	F	57	E
Watson Street/Military Road	38	C	38	C
Military Road/Ben Boyd Road	33	C	35	C
Falcon Street/Merlin Street	57	E	55	D
Berry Street/Walker Street	35	C	35	C
Berry Street/Miller Street	68	E	59	E
Mount Street/Arthur Street	73	F	76	F
Mount Street/Walker Street	42	D	37	C
Pacific Highway/High Street/Arthur Street	52	D	42	D
Pacific Highway/Walker Street/Blue Street	55	D	50	D
Pacific Highway/Miller Street/Mount Street	93	F	74	F
Pacific Highway/Berry Street	51	D	48	D
Pacific Highway/Bay Road	68	E	74	F
Miller Street/McLaren Street	24	B	23	B

Intersection	2024 base		2024 cumulative construction	
	Average delay (sec)	LoS	Average delay (sec)	LoS
Miller Street/Ridge Street	11	A	11	A
Miller Street/Carlow Street	12	A	12	A
High Street/Clark Road	60	E	31	C
High Street/Alfred Street	13	A	17	B
Mount Street/Alfred Street	17	B	17	B
Ernest Street/Ben Boyd Road	33	C	52	D
Pedestrian crossing at Military Road	5	A	<5	A

Table 5-29 Modelled evening peak hour intersection performance with concurrent construction program – Warringah Freeway and surrounds study area

Intersection	2024 base		2024 cumulative construction	
	Average delay (sec)	LoS	Average delay (sec)	LoS
Willoughby Road/Gore Hill Freeway interchange	41	C	47	D
Brook Street/Warringah Freeway on ramp	29	C	27	B
Brook Street/Warringah Freeway off ramp	31	C	29	C
Brook Street/Merrenburn Avenue	24	B	24	B
Amherst Street/West Street	6	A	28	B
Amherst Street/Miller Street	26	B	31	C
Miller Street/Warringah Freeway on ramp	5	A	7	A
Miller Street/Warringah Freeway off ramp	14	B	18	B
Miller Street/Ernest Street	62	E	58	E
Miller Street/Falcon Street	83	F	86	F
Ernest Street/Warringah Freeway on ramp	12	A	13	A
Ernest Street/Warringah Freeway off ramp (off ramp in PM, on ramp in AM)	15	B	16	B
Falcon Street/Warringah Freeway ramps	62	E	61	E
Watson Street/Military Road	30	C	37	C
Military Road/Ben Boyd Road	39	C	48	D
Falcon Street/Merlin Street	98	F	87	F
Berry Street/Walker Street	57	E	39	C
Berry Street/Miller Street	45	D	42	D

Intersection	2024 base		2024 cumulative construction	
	Average delay (sec)	LoS	Average delay (sec)	LoS
Mount Street/Arthur Street	61	E	78	F
Mount Street/Walker Street	61	E	23	B
Pacific Highway/High Street/Arthur Street	46	D	53	D
Pacific Highway/Walker Street/Blue Street	54	D	45	D
Pacific Highway/Miller Street/Mount Street	46	D	44	D
Pacific Highway/Berry Street	19	B	30	C
Pacific Highway/Bay Road	15	B	19	B
Miller Street/McLaren Street	44	D	26	B
Miller Street/Ridge Street	86	F	45	D
Miller Street/Carlow Street	42	C	24	B
High Street/Clark Road	49	D	34	C
High Street/Alfred Street	>100	F	24	B
Mount Street/Alfred Street	10	A	12	A
Ernest Street/Ben Boyd Road	14	A	15	B
Pedestrian crossing at Military Road	9	A	11	A

With construction traffic, intersections that operate with a reduced Level of Service compared to without construction traffic include:

- Willoughby Road/Gore Hill Freeway interchange (morning and evening peak)
- Brook Street/Warringah Freeway off ramp (morning peak)
- Amherst Street/West Street (evening peak)
- Amherst Street/Miller Street (evening peak)
- Miller Street/Warringah Freeway off ramp (morning peak)
- Miller Street/Falcon Street (morning peak)
- Military Road/Ben Boyd Road (evening peak)
- Mount Street/Arthur Street (evening peak)
- Pacific Highway/Berry Street (evening peak)
- Pacific Highway/Bay Road (morning peak)
- High Street/Alfred Street (morning peak)
- Ernest Street/Ben Boyd Road (morning and evening peak).

During the morning peak, intersections which would experience a material increase in average vehicle delay (ie around 30-40 seconds) during construction include Willoughby Road/Gore Hill Freeway interchange, intersection of Brook Street and Merrenburn Avenue and Brook Street/Warringah Freeway ramps. This is due to the introduction of construction traffic which would use these roads to access and egress the Cammeray Golf

Course (BL1) and Flat Rock Drive (BL2) construction support sites, incrementally increasing demand and consequent delays.

A minor increase in average vehicle delay during construction would occur at intersections within North Sydney during the evening peak.

Other impacts

Cumulative construction impacts on the local road network, public transport, active transport and maritime activities within the project's footprint would be similar to those which would be expected under the 'project only' scenario discussed in Sections 5.2 to 5.6.

Potential cumulative construction program construction impact summary

Assessment of the performance of key locations in the road network affected by construction activities indicates that the road network under the concurrent Western Harbour Tunnel and Beaches Link construction programs would impact corridor travel times by up to three minutes and reduce overall average travel speeds by about four per cent. Potential impacts to bus travel times are more substantial for southbound buses that use the Warringah Freeway due to increased traffic demand and increased traffic movements across the southbound bus lane south of Falcon Street, increasing congestion.

Impacts to the Warringah Freeway and surrounds study area could be mitigated by considered and tailored construction traffic planning based on actual traffic conditions and confirmed cumulative activities at the time of construction.

5.7.2 Cumulative construction impact – other projects

Peak construction activity for the project would not overlap with peak construction activities for other committed major infrastructure projects including Sydney Metro City & Southwest and M4-M5 Link. There is potential for some overlap with the construction of the Sydney Metro West project or other major projects within the Sydney metropolitan area, including the Channel 9 site staged residential development. Spoil trucks and other construction vehicles associated with these projects have the potential to generate cumulative impacts on the broader road network. Overall, given that spoil trucks for the project and any overlapping major projects would predominantly use only major arterial roads, potential cumulative impacts would be minor.

6. Future road network performance without the project

6.1 Overview

This section provides a summary of road network operation under 2027 and 2037 forecast traffic demand without the project (the 'Do minimum' scenario). This reflects the operation of the network under the assumptions that the Beaches Link and Gore Hill Freeway Connection is not built and represents a business-as-usual 'Do minimum' including all approved projects such as the Rozelle Interchange and associated M4-M5 Link works as part of WestConnex. Assessment of the future road network performance without the project is based on the following performance measures:

- Network performance based on vehicle hours of travel (VHT), vehicle kilometres of travel (VKT) and average network speed
- Intersection performance based on intersection Level of Service
- General traffic and bus travel times for key corridors.

6.2 Metropolitan road network performance

6.2.1 Strategic corridors

A summary of the forecast growth at key locations for the 2027 and 2037 forecast years is provided in Table 6-1 to Table 6-3.

Table 6-1 Modelled 'Do minimum' morning peak hour traffic demands at key locations (SMPM)

Road	Location	Direction	2016 (veh)	2027 (veh)	2037 (veh)
Spit Road	Spit Bridge	Northbound	1700	1750	1850
		Southbound	2550	2700	3050
		Combined	*4250*	*4450*	*4900*
Warringah Road	Roseville Bridge	Northbound	1950	2100	2250
		Southbound	3900	4100	4300
		Combined	*5850*	*6200*	*6550*
Mona Vale Road	St Ives Showground	Northbound	2250	2450	2600
		Southbound	2600	2750	2900
		Combined	*4850*	*5200*	*5500*
Northern Beaches screenline		**Northbound**	**5900**	**6300**	**6700**
		Southbound	**9050**	**9550**	**10,250**
		Combined	***14,950***	***15,850***	***16,950***
Eastern Valley Way	Castle Cove	Northbound	750	950	1000
		Southbound	1750	1900	2050
		Combined	*2500*	*2850*	*3050*

Table 6-2 Modelled 'Do minimum' evening peak hour traffic demands at key locations (SMPM)

Road	Location	Direction	2016 (veh)	2027 (veh)	2037 (veh)
Spit Road	Spit Bridge	Northbound	2800	3000	3250
		Southbound	1950	2050	2150
		Combined	*4750*	*5050*	*5400*
Warringah Road	Roseville Bridge	Northbound	3450	3650	3750
		Southbound	2350	2450	2650
		Combined	*5800*	*6100*	*6400*
Mona Vale Road	St Ives Showground	Northbound	2450	2600	2700
		Southbound	2250	2450	2550
		Combined	*4700*	*5050*	*5250*
Northern Beaches screenline		**Northbound**	**8700**	**9250**	**9700**
		Southbound	**6550**	**6950**	**7350**
		Combined	***15,250***	***16,200***	***17,050***
Eastern Valley Way	Castle Cove	Northbound	1350	1550	1700
		Southbound	950	1100	1200
		Combined	*2300*	*2650*	*2900*

Table 6-3 Modelled 'Do minimum' daily traffic demands at key locations (SMPM)

Road	Location	Direction	2016 (veh)	2027 (veh)	2037 (veh)
Spit Road	Spit Bridge	Northbound	36,000	38,500	41,500
		Southbound	33,500	36,000	38,500
		Combined	*69,500*	*74,500*	*80,000*
Warringah Road	Roseville Bridge	Northbound	39,000	41,500	43,500
		Southbound	40,000	41,500	43,500
		Combined	*79,000*	*83,000*	*87,000*
Mona Vale Road	St Ives Showground	Northbound	28,000	29,500	31,000
		Southbound	28,000	30,000	31,500
		Combined	*56,000*	*59,500*	*62,500*
Northern Beaches screenline		**Northbound**	**103,000**	**109,500**	**116,000**
		Southbound	**101,500**	**107,500**	**113,500**
		Combined	***204,500***	***217,000***	***229,500***
Eastern Valley Way	Castle Cove	Northbound	14,500	17,500	19.000
		Southbound	13,500	15,500	16.500
		Combined	*28,000*	*33,000*	*35,500*

Analysis of the forecast traffic demands across Middle Harbour shows a substantial growth in peak period trips into and out of the Northern Beaches of up to 13 per cent by 2037, with daily trips also forecast to increase by

12 per cent within the same period. Proportional growth in daily trips would be highest on Spit Road and Military Road, reflecting the importance of this corridor for residents of, and visitors to, the Northern Beaches. Demand on Eastern Valley Way is also forecast to increase by around 27 per cent as a result of continued growth in the area.

A summary of forecast travel times during peak periods for key routes in the vicinity of the project is provided in Figure 6-1 and Figure 6-2.

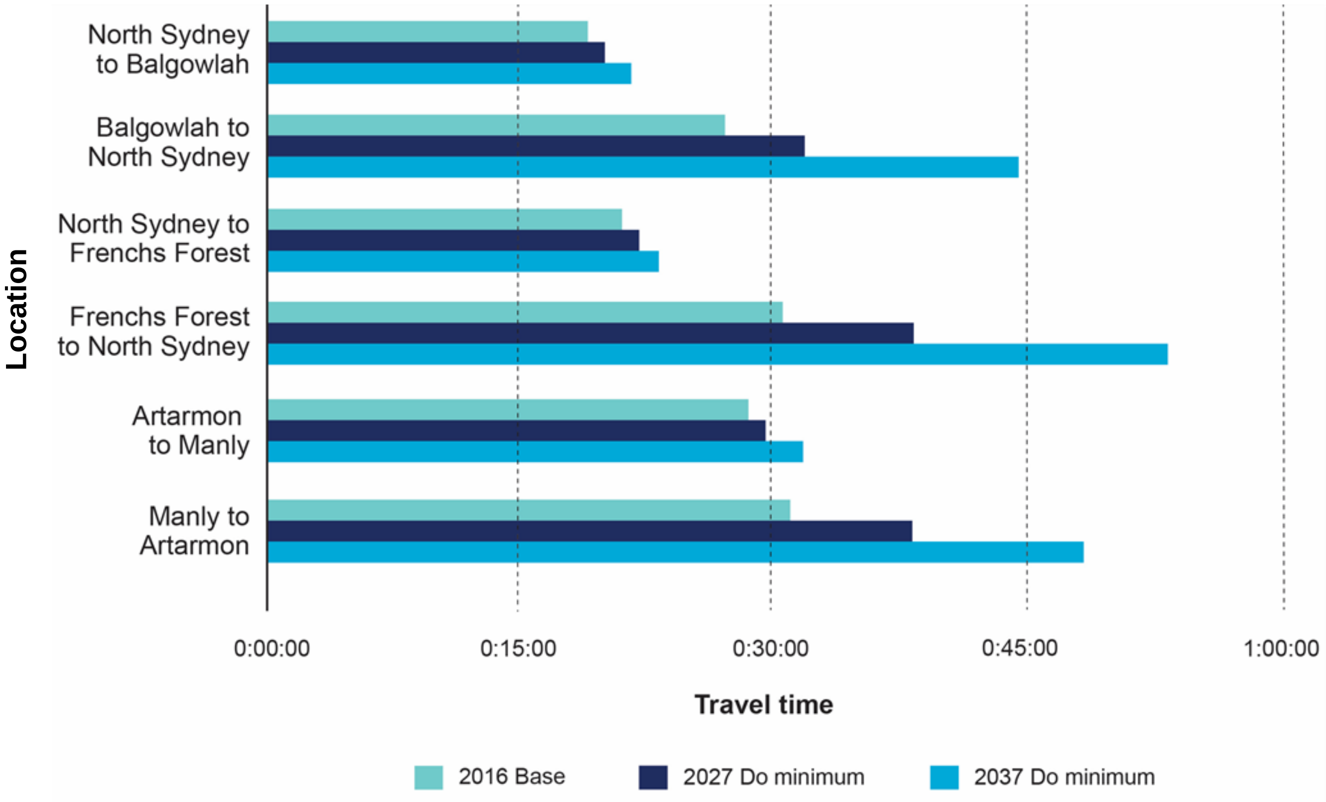


Figure 6-1 Modelled 'Do minimum' morning peak hour travel times along key corridors (SMPM)

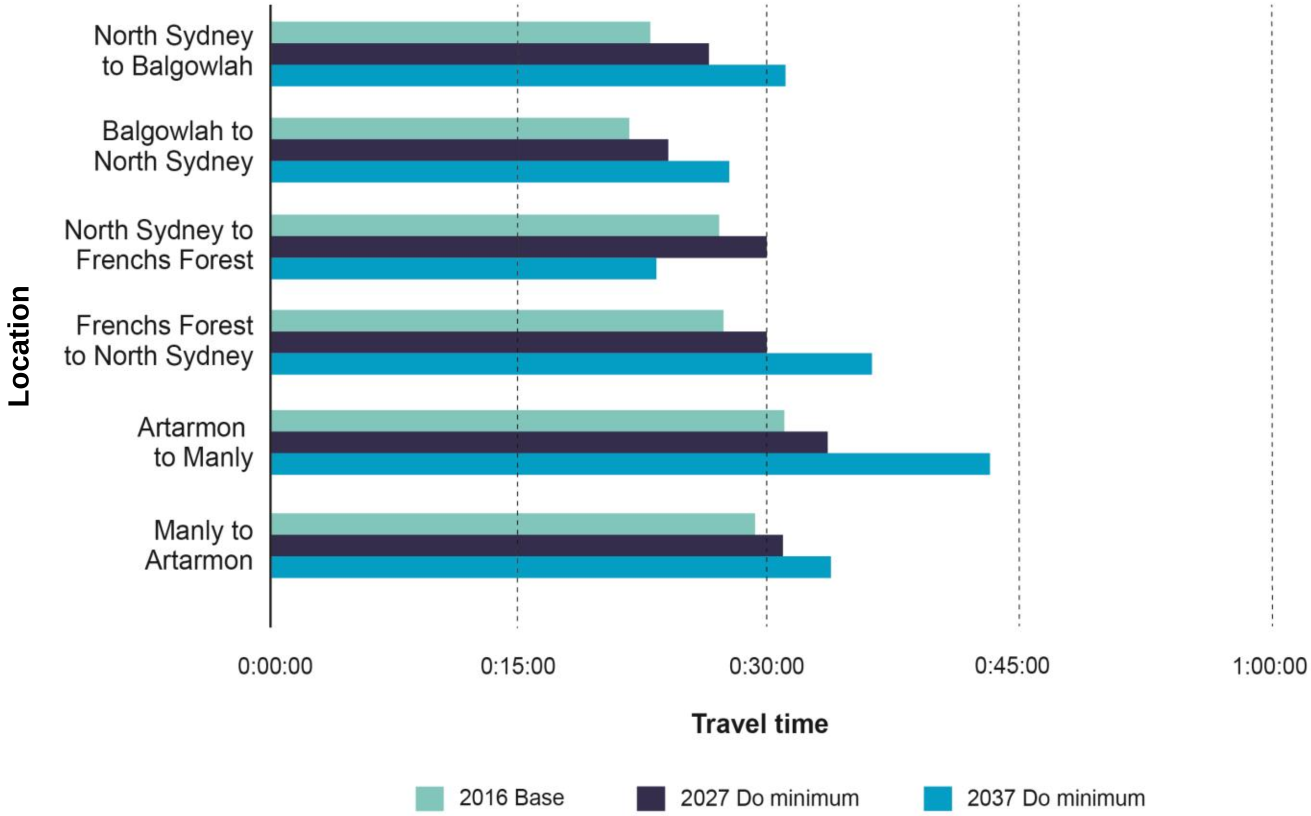


Figure 6-2 Modelled 'Do minimum' evening peak hour travel times along key corridors (SMPM)

Analysis of the modelled forecast travel times along key routes in the vicinity of the project indicate that a substantial increase in travel times would occur by 2037. The largest increases would occur on the following routes:

- Southbound routes in the morning peak period
- Northbound trips in the evening peak period
- Trips with substantial portions of their journey on the arterial road network, particularly Spit Road, Military Road and Warringah Road.

Morning peak travel times would increase more than evening peak travel times; this is a reflection of the unique conditions for morning peak travel on Spit and Military Roads. In addition to morning peak travel generally being more concentrated in time, the southbound T3 transit lane between Sydney Road and Spit Bridge and from Ourimbah Road to Watson Street (recently converted to bus lanes) limit southbound capacity. Northbound evening peak transit lanes are not as extensive as the southbound morning peak and are not proposed to be converted to bus lanes.

These trends in forecast travel times indicate that travel patterns would remain consistent with existing conditions, albeit with substantial increases in overall demand. This would result in the most pronounced increases in travel time along arterial roads, where there is less available capacity, high volumes of opposing traffic and interactions with other road users including public transport and pedestrians. Trips along Spit Road and Military Road during peak periods in particular would see a large increase in travel times relative to the current travel times on these routes. The Warringah Road and Eastern Valley Way corridor would also be subject to increased demand and congestion. This indicates that, without additional capacity for trips into and from the Northern Beaches peninsula, accessibility to and from the Northern Beaches would become substantially restricted, which further demonstrates the need for an additional corridor into and out of the Northern Beaches.

6.2.2 30-minute city catchments

Plots of the forecast 30-minute catchments by road for strategic centres in the vicinity of the project are provided in Figure 6-3 to Figure 6-5.

Analysis of the 30-minute catchments under the 2037 'Do minimum' scenarios shows:

- Access to nearby strategic centres from Chatswood would worsen, with Manly and Sydney CBD no longer accessible from Chatswood within 30 minutes
- Access to nearby strategic centres from Dee Why-Brookvale would worsen, with Chatswood no longer accessible from Dee-Why-Brookvale within 30 minutes
- Access to nearby strategic centres from Manly would worsen, with North Sydney and Mona Vale no longer accessible from Manly within 30 minutes
- A trip from north of Sydney Harbour to access the Sydney CBD would not be possible within 30 minutes.

Overall, by 2037, traffic growth on the road network within the study area would increase to the degree that the associated increases in road vehicle travel time would make many nearby strategic centres no longer accessible within a 30-minute trip. This growth in traffic volumes would also result in higher travel times for public transport and would also reduce the size of equivalent public transport catchments.

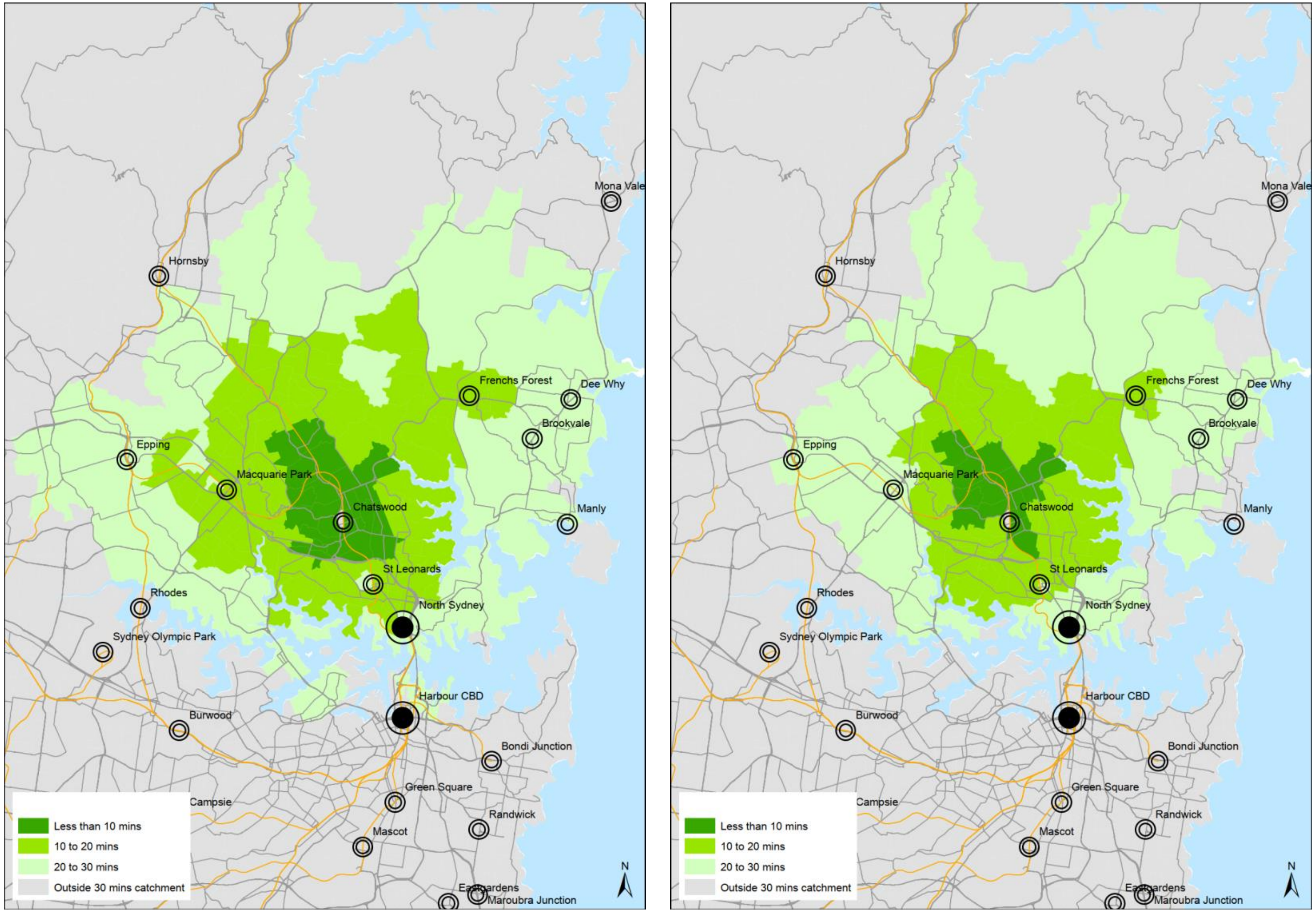
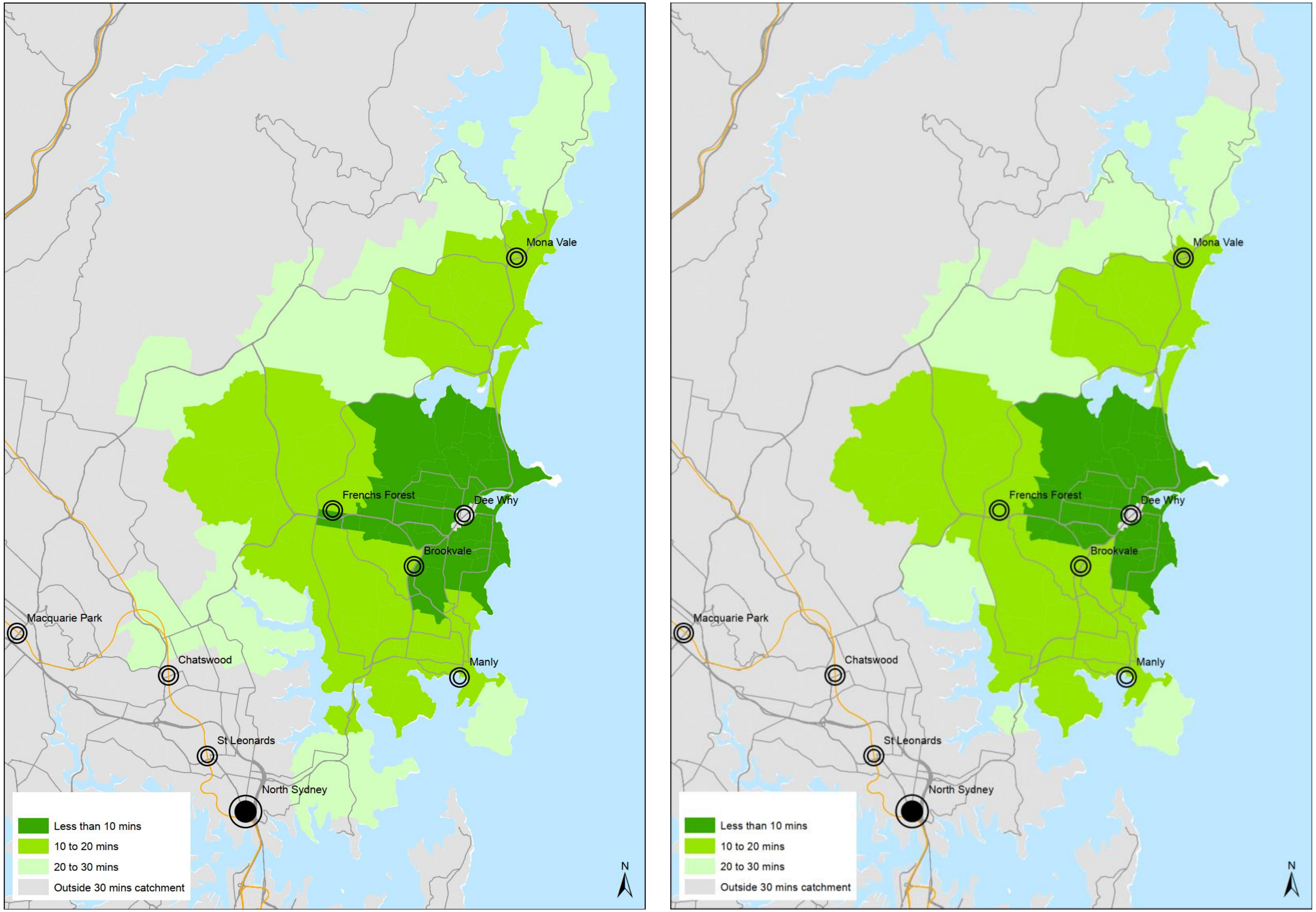
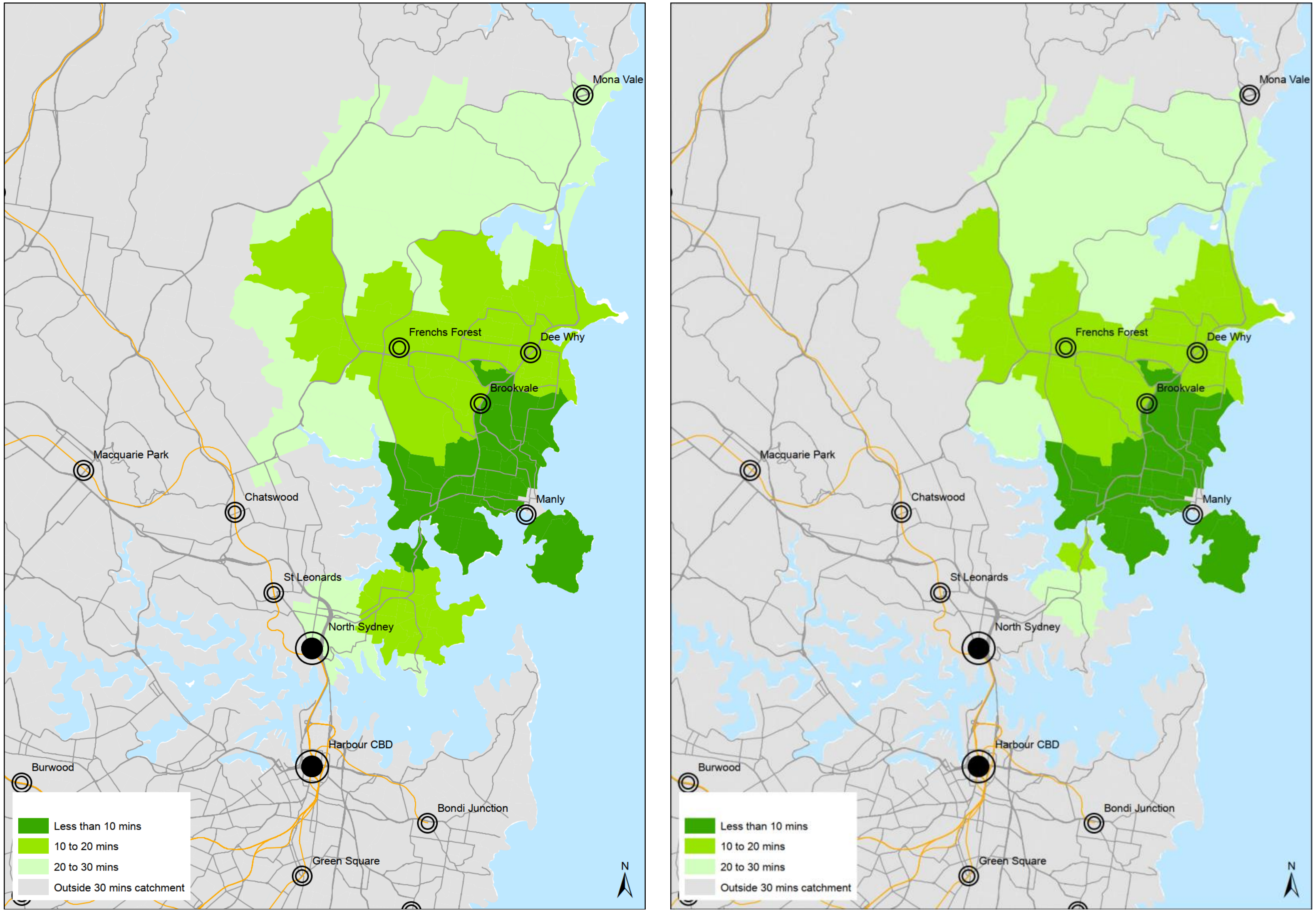


Figure 6-3 Modelled 2037 'Do minimum' morning peak 30-minute catchment by road from Chatswood



2016 **2037 Do minimum**

Figure 6-4 Modelled 2037 'Do minimum' morning peak 30-minute catchment by road from Brookvale-Dee Why



2016 **2037 Do minimum**

Figure 6-5 Modelled 2037 'Do minimum' morning peak 30-minute catchment by road from Manly

6.2.3 Heavy vehicles and freight

Forecast heavy vehicle demands into and out of the Northern Beaches peninsula are presented in Table 6-4 to Table 6-6.

Table 6-4 Modelled 'Do minimum' morning peak hour heavy vehicle demands at key locations (SMPM)

Road	Location	Direction	2016 (veh)	2027 (veh)	2037 (veh)
Spit Road	Spit Bridge	Northbound	50	60	60
		Southbound	110	150	170
		Combined	*160*	*210*	*230*
Warringah Road	Roseville Bridge	Northbound	150	160	190
		Southbound	220	240	280
		Combined	*370*	*400*	*470*
Mona Vale Road	St Ives Showground	Northbound	160	170	210
		Southbound	280	290	330
		Combined	*440*	*460*	*540*
Northern Beaches screenline		**Northbound**	**360**	**390**	**460**
		Southbound	**610**	**680**	**780**
		Combined	***970***	***1070***	***1240***

Table 6-5 Modelled 'Do minimum' evening peak hour heavy vehicle demands at key locations (SMPM)

Road	Location	Direction	2016 (veh)	2027 (veh)	2037 (veh)
Spit Road	Spit Bridge	Northbound	80	110	130
		Southbound	50	60	80
		Combined	*130*	*170*	*210*
Warringah Road	Roseville Bridge	Northbound	260	260	280
		Southbound	180	190	220
		Combined	*440*	*450*	*500*
Mona Vale Road	St Ives Showground	Northbound	130	160	180
		Southbound	300	340	380
		Combined	*430*	*500*	*560*
Northern Beaches screenline		**Northbound**	**470**	**530**	**590**
		Southbound	**530**	**590**	**680**
		Combined	***1000***	***1120***	***1270***

Table 6-6 Modelled 'Do minimum' daily heavy vehicle demands at key locations (SMPM)

Road	Location	Direction	2016 (veh)	2027 (veh)	2037 (veh)
Spit Road	Spit Bridge	Northbound	1500	1900	2300
		Southbound	1800	2300	2700
		Combined	*3300*	*4200*	*5000*
Warringah Road	Roseville Bridge	Northbound	3100	3300	3500
		Southbound	2900	3000	3400
		Combined	*6000*	*6300*	*6900*
Mona Vale Road	St Ives Showground	Northbound	2300	2500	2900
		Southbound	3900	4100	4800
		Combined	*6200*	*6600*	*7700*
Northern Beaches screenline		**Northbound**	**6900**	**7700**	**8700**
		Southbound	**8600**	**9400**	**10,900**
		Combined	***15,500***	***17,100***	***19,600***

Forecast heavy vehicle demands across Sydney Harbour and into the Northern Beaches peninsula show that heavy vehicle demands would increase by up to 28 per cent during peak periods and 26 per cent over the day by 2037.

The modelled travel times across Sydney Harbour and into the Northern Beaches peninsula indicate substantial increases in travel time during peak periods, with comparable traffic growth during peak periods and across the day.

While shorter distance freight movements generally avoid travelling during the commuter peak period, longer distance freight trips are more likely to be required to travel during the peak. Increased traffic volumes and travel times on both motorway and arterial corridors would result in lower productivity for freight vehicles and an overall reduction in the efficiency of the road-based freight network.

The forecast increase in freight movements over the next 20 years within Greater Sydney would also increase potential safety risks of freight vehicles travelling on already congested arterials and motorways as these vehicles interact with commuters, public transport and pedestrians, demonstrating the need to provide more motorway-standard connections to separate freight from other travel taking place on surface roads.

6.2.4 Strategic model road network performance

A summary of the forecast daily VKT and VHT of the Sydney region and the Western Harbour Tunnel and Beaches Link study area is provided in Table 6-7. In the Sydney region, daily VKT is forecast to increase by 44 per cent and daily VHT is forecast to more than double by 2037. In the Western Harbour Tunnel and Beaches Link study area, daily VKT is forecast to increase by 23 per cent and daily VHT is forecast to increase by 40 per cent by 2037. The forecast increases in daily VKT and VHT under the 'Do minimum' scenario indicates declining productivity on the road network.

Table 6-7 Modelled 'Do minimum' daily VKT and VHT (SMPM)

Network measure	Road	2016	2027	2037
Sydney region				
Daily VKT	Motorway	22,594,000	27,135,000	31,810,000
	Other	71,656,000	87,592,000	103,604,000
	Total	94,250,000	114,727,000	135,414,000
Daily VHT	Motorway	388,000	513,000	758,000
	Other	2,363,000	3,248,000	5,174,000
	Total	2,751,000	3,761,000	5,931,000
Western Harbour Tunnel and Beaches Link study area				
Daily VKT	Motorway	4,821,000	6,377,000	6,891,000
	Other	14,300,000	15,315,000	16,654,000
	Total	19,121,000	21,693,000	23,545,000
Daily VHT	Motorway	106,000	149,000	187,000
	Other	579,000	656,000	774,000
	Total	685,000	805,000	961,000

6.3 Warringah Freeway and surrounds

6.3.1 Network performance

A summary of future network performance statistics for the Warringah Freeway and surrounds study area under the 'Do minimum' scenario is presented in Table 6-8 and Table 6-9. Analysis of the network performance without the project indicates:

- Peak period travel demand through the Warringah Freeway and surrounds study area would increase by up to 17 per cent by 2037
- Average travel speeds through the Warringah Freeway and surrounds study area during peak periods would substantially decrease in the future by up to 27 per cent
- The number of stops during peak periods would substantially increase in the future, indicating that traffic conditions in the modelled area would become increasingly congested, with queues extending from the Sydney Harbour Bridge and Sydney Harbour Tunnel as far back as Brook Street and Willoughby Road
- Forecast demand would be increasingly unable to travel as desired during peak periods. This is reflected in higher numbers of unreleased traffic at the end of the modelled period.

Network performance measures for the Warringah Freeway and surrounds study area show that forecast traffic conditions are expected to degrade into the future as traffic demands both on the Warringah Freeway and within North Sydney CBD increase over time. As the total distance travelled through the network increases only marginally, reductions in speed and increases in travel time would generally be a consequence of increased congestion and delays, particularly on the Warringah Freeway in the peak direction towards the Sydney CBD in the morning peak and from the Sydney CBD in the evening peak.

Most delays through the North Sydney area are a result of increased travel demand through the Berry Street and Miller Street corridors. These corridors provide access to North Sydney CBD itself, but also provide access to the adjacent motorway corridor both northbound and southbound. These corridors intersect at a busy intersection with high pedestrian volumes that conflict with turning movements for general traffic as well as the right turn movement for buses from Berry Street to Miller Street. The opening of Victoria Cross Metro station as part of the Sydney Metro City & Southwest project would substantially increase pedestrian volumes at this location, which would further increase delays to road traffic.

Table 6-8 Modelled 'Do minimum' morning peak network performance - Warringah Freeway and surrounds study area

Network measure	2016	2027	2037
Network statistics for all vehicles			
Total traffic demand (veh)	96,700	104,500	112,400
Total VKT through network	339,900	340,400	350,700
Total VHT through network	9070	9000	10,160
Total number of stops	580,000	616,200	746,100
Average vehicle statistics			
Average vehicle trip length through the network (km)	3.6	3.5	3.5
Average vehicle trip time through the network (hours)	0:05:34	0:05:32	0:06:01
Average number of stops per trip	6.1	6.3	7.4
Average trip speed (km/h)	37.5	37.8	34.5
Unreleased traffic			
Total unreleased trips	2090	6890	11,270
% of demand unreleased	2%	7%	10%

Table 6-9 Modelled 'Do minimum evening peak network performance - Warringah Freeway and surrounds study area

Network measure	2016	2027	2037
Network statistics for all vehicles			
Total traffic demand (veh)	101,200	109,500	118,100
Total VKT through network	331,800	344,900	349,000
Total VHT through network	8550	9880	12,370
Total number of stops	357,700	621,100	980,300
Average vehicle statistics			
Average vehicle trip length through the network (km)	3.3	3.3	3.2
Average vehicle trip time through the network (hours)	0:05:05	0:05:37	0:06:51
Average number of stops per trip	3.6	5.9	9.1
Average trip speed (km/h)	38.8	34.9	28.2

Network measure	2016	2027	2037
Unreleased traffic			
Total unreleased trips	370	3900	9800
% of demand unreleased	<1%	4%	8%

6.3.2 General traffic travel times

Modelled future general traffic travel times for key routes through the Warringah Freeway and surrounds study area under the 'Do minimum' scenario are presented in Table 6-10 and Table 6-11. Analysis of modelled travel times for the 'Do minimum' scenario shows:

- Travel times along Warringah Freeway from both Gore Hill Freeway and Falcon Street would generally increase in the future, due to increased traffic volumes and the associated merging and weaving delays that this additional traffic would generate
- Travel times through North Sydney CBD would generally increase in the future, also due to increased development and traffic and pedestrian demand within the CBD, although the broader capacity constraints of the connecting road network would limit the amount of additional traffic that would travel into North Sydney from other areas.

Overall, the forecast growth in demand within North Sydney under the 'Do minimum' scenario would increase travel times both along Warringah Freeway and through North Sydney CBD.

Table 6-10 Modelled 'Do minimum' morning peak hour general traffic travel times - Warringah Freeway and surrounds study area

Route	Direction	2016 (hours)	2027 (hours)	2037 (hours)
Sydney Harbour Bridge to Warringah Freeway/Falcon Street interchange	Northbound	0:04:47	0:04:40	0:04:51
	Southbound	0:10:31	0:04:03	0:04:02
Sydney Harbour Tunnel to Warringah Freeway/Falcon Street interchange	Northbound	0:03:37	0:03:55	0:04:08
	Southbound	0:04:26	0:04:03	0:04:02
Sydney Harbour Bridge to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:06:35	0:06:13	0:06:16
	Southbound	0:16:45	0:13:35	0:15:22
Sydney Harbour Tunnel to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:05:23	0:05:26	0:05:30
	Southbound	0:06:28	0:11:39	0:12:37
Berry Street to Amherst Street via Miller Street	Northbound	0:04:03	0:03:42	0:03:53
	Southbound	0:04:40	0:04:25	0:05:43

Table 6-11 Modelled 'Do minimum' evening peak hour general traffic travel times - Warringah Freeway and surrounds study area

Route	Direction	2016 (hours)	2027 (hours)	2037 (hours)
Sydney Harbour Bridge to Warringah Freeway/Falcon Street interchange	Northbound	0:03:54	0:04:02	0:07:51
	Southbound	0:06:51	0:06:09	0:05:02

Route	Direction	2016 (hours)	2027 (hours)	2037 (hours)
Sydney Harbour Tunnel to Warringah Freeway/Falcon Street interchange	Northbound	0:03:52	0:03:57	0:07:36
	Southbound	0:10:26	0:14:54	0:14:59
Sydney Harbour Bridge to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:05:40	0:05:35	0:06:45
	Southbound	0:11:40	0:13:56	0:17:31
Sydney Harbour Tunnel to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:05:38	0:05:28	0:06:46
	Southbound	0:14:23	0:25:21	0:30:09
Berry Street to Amherst Street via Miller Street	Northbound	0:06:44	0:03:52	0:03:50
	Southbound	0:04:48	0:05:01	0:08:39

6.3.3 Bus travel times

Modelled future bus travel times for key routes through the Warringah Freeway and surrounds study area under the 'Do minimum' scenario are presented in Table 6-12 and Table 6-13. Analysis of modelled bus travel times under the 'Do minimum' scenario indicates that southbound bus travel times through North Sydney CBD, either via Pacific Highway or Miller Street, would increase in the future.

This increase in bus travel time through North Sydney would result from increased traffic and pedestrian demands and conflicts along Miller Street, Berry Street and Pacific Highway, which would increase delays at the following critical intersections for buses that travel through North Sydney CBD:

- Pacific Highway and Berry Street
- Miller Street and Berry Street
- Miller Street and Pacific Highway.

For buses travelling into the Sydney CBD, increased queues from the additional traffic travelling through the Cahill Expressway via Sydney Harbour Bridge would result in queuing across the bus lane south of Falcon Street and south of High Street. This would substantially increase travel times to the Sydney CBD from Gore Hill Freeway and North Sydney, as these queues are likely to block access for buses travelling along this lane.

Bus travel times along Warringah Freeway would also increase, particularly southbound from Gore Hill Freeway, which would be impacted by increased queues that would extend from the Cahill Expressway as a result of traffic growth on this corridor. Buses travelling southbound along the Warringah Freeway from Falcon Street and Military Road would also be impacted by this queue.

Table 6-12 Modelled 'Do minimum' morning peak hour bus travel times - Warringah Freeway and surrounds study area

Route	Direction	2016 (hours)	2027 (hours)	2037 (hours)
Sydney Harbour Bridge to Amherst Street (via Miller Street and North Sydney Station)	Northbound	0:13:56	0:09:55	0:09:30
	Southbound	0:11:21	0:11:31	0:13:26
Sydney Harbour Bridge to Bay Street (via North Sydney Station and Pacific Highway)	Northbound	0:09:29	0:06:05	0:06:29
	Southbound	0:07:28	0:11:35	0:13:31
Sydney Harbour Bridge to Ben Boyd Road (via Military Road)	Northbound	0:06:39	0:06:28	0:06:43
	Southbound	0:06:14	0:06:28	0:06:33

Route	Direction	2016 (hours)	2027 (hours)	2037 (hours)
Sydney Harbour Bridge to Lane Cove Tunnel (via Gore Hill Freeway)	Northbound	0:07:10	0:06:43	0:06:42
	Southbound	0:07:09	0:25:33	0:28:17

Table 6-13 Modelled 'Do minimum' evening peak hour bus travel times - Warringah Freeway and surrounds study area

Route	Direction	2016 (hours)	2027 (hours)	2037 (hours)
Sydney Harbour Bridge to Amherst Street (via Miller Street and North Sydney Station)	Northbound	0:13:08	0:11:03	0:13:34
	Southbound	0:11:51	0:13:14	0:19:09
Sydney Harbour Bridge to Bay Street (via North Sydney Station and Pacific Highway)	Northbound	0:06:41	0:07:13	0:09:52
	Southbound	0:07:29	0:09:17	0:13:59
Sydney Harbour Bridge to Ben Boyd Road (via Military Road)	Northbound	0:06:45	0:08:27	0:08:36
	Southbound	0:05:34	0:05:52	0:06:51
Sydney Harbour Bridge to Lane Cove Tunnel (via Gore Hill Freeway)	Northbound	0:06:13	0:06:12	0:06:33
	Southbound	0:06:36	0:15:53	0:20:57

6.3.4 Intersection performance

Modelled future performance for key intersections in the Warringah Freeway and surrounds study area under the 'Do minimum' scenario are presented in Table 6-14 and Table 6-15. Modelled intersection performance indicates that a large proportion of intersections would perform at capacity at LoS F during the morning and/or evening peak periods by 2037:

- Willoughby Road and Gore Hill Freeway
- Brook Street and Warringah Freeway
- Brook Street and Merrenburn Avenue
- Falcon Street and Warringah Freeway
- Falcon Street and Merlin Street
- Berry Street and Walker Street
- Berry Street and Miller Street
- Mount Street and Arthur Street
- Mount Street and Walker Street
- Pacific Highway and Walker Street/Blue Street
- Pacific Highway and Bay Road
- Miller Street and McLaren Street
- Miller Street and Ridge Street
- High Street and Clark Road
- High Street and Alfred Street
- Ernest Street and Ben Boyd Road.

Unsatisfactory performance of some intersections under the future 'Do minimum' scenario generally results from increased demand in combination with the following broader network constraints:

- Southbound traffic volumes on the Cahill Expressway: there is only a single southbound lane for general traffic on the Sydney Harbour Bridge to the Cahill Expressway that currently operates at capacity during peak periods. Any additional traffic demand for this lane would result in increased southbound queues, which extend north along the Warringah Freeway causing delays at upstream interchanges including Willoughby Road and Brook Street. This has limited impact on the Miller Street interchange due to the length of the Miller Street on ramp, which is sufficient to prevent this queue from affecting traffic on Miller Street
- Increased traffic and pedestrian volumes within North Sydney CBD: the key intersections of Miller Street and Berry Street and Pacific Highway and Berry Street currently operate close to capacity during peak periods. Combined with high pedestrian volumes, which reduces the capacity for left and right turn movements along Berry Street and Miller Street, and the high volume of buses that turn left from Pacific Highway into Berry Street then right from Berry Street into Miller Street, intersections along these important road corridors would perform substantially worse in the morning peak as demand within North Sydney CBD increases. In later years, queues would extend further, leading to poor operation of adjacent intersections along parallel routes such as Walker Street

Falcon Street Interchange: during the evening peak, the large volume of traffic travelling northbound on the Warringah Freeway and exiting at Falcon Street to turn right conflicts with traffic travelling along Falcon Street. Increased volumes for these conflicting movements would result in longer delays at this interchange, with the potential risk of increased queuing onto the Warringah Freeway northbound.

Table 6-14 Modelled 'Do minimum' morning peak hour intersection performance - Warringah Freeway and surrounds study area

Intersection	2016		2027		2037	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	Level of Service
Willoughby Road/Gore Hill Freeway interchange	11	A	>100	F	>100	F
Brook Street/Warringah Freeway on ramp	31	C	>100	F	>100	F
Brook Street/Warringah Freeway off ramp	30	C	61	E	67	E
Brook Street/Merrenburn Avenue	31	C	>100	F	>100	F
Amherst Street/West Street	6	A	5	A	5	A
Amherst Street/Miller Street	19	B	21	B	20	B
Miller Street/Warringah Freeway on ramp	<5	A	7	A	6	A
Miller Street/Warringah Freeway off ramp	13	A	12	A	13	A
Miller Street/Ernest Street	34	C	25	B	32	C
Miller Street/Falcon Street	35	C	35	C	38	C
Ernest Street/Warringah Freeway on ramp	<5	A	5	A	5	A
Ernest Street/Warringah Freeway off ramp (off ramp in PM, on ramp in AM)	<5	A	5	A	5	A

Intersection	2016		2027		2037	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	Level of Service
Falcon Street/Warringah Freeway ramps	38	C	29	C	15	B
Watson Street/Military Road	16	B	18	B	26	B
Military Road/Ben Boyd Road	13	A	15	B	23	B
Falcon Street/Merlin Street	17	B	24	B	32	C
Berry Street/Walker Street	32	C	29	C	39	C
Berry Street/Miller Street	30	C	55	D	69	E
Mount Street/Arthur Street	84	F	46	D	59	E
Mount Street/Walker Street	43	D	36	C	48	D
Pacific Highway/High Street/Arthur Street	53	D	19	B	38	C
Pacific Highway/Walker Street/Blue Street	53	D	36	C	65	E
Pacific Highway/Miller Street/Mount Street	52	D	38	C	41	C
Pacific Highway/Berry Street	9	A	56	E	52	D
Pacific Highway/Bay Road	21	B	55	D	77	F
Miller Street/McLaren Street	24	B	23	B	72	F
Miller Street/Ridge Street	39	C	38	C	53	D
Miller Street/Carlow Street	14	B	13	A	13	A
High Street/Clark Road	>100	F	18	B	55	D
High Street/Alfred Street	60	E	13	A	62	E
Mount Street/Alfred Street	24	B	<5	A	<5	A
Ernest Street/Ben Boyd Road	11	A	12	A	12	A
Pedestrian crossing at Military Road	<5	A	6	A	5	A

Table 6-15 Modelled 'Do minimum' evening peak hour intersection performance - Warringah Freeway and surrounds study area

Intersection	2016		2027		2037	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Willoughby Road/Gore Hill Freeway interchange	20	B	38	C	76	F
Brook Street/Warringah Freeway on ramp	16	B	14	B	17	B

Intersection	2016		2027		2037	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Brook Street/Warringah Freeway off ramp	22	B	22	B	20	B
Brook Street/Merrenburn Avenue	12	A	11	A	13	A
Amherst Street/West Street	10	A	9	A	14	A
Amherst Street/Miller Street	15	B	29	C	31	C
Miller Street/Warringah Freeway on ramp	6	A	6	A	6	A
Miller Street/Warringah Freeway off ramp	13	A	15	B	15	B
Miller Street/Ernest Street	31	C	41	C	43	D
Miller Street/Falcon Street	69	E	44	D	49	D
Ernest Street/Warringah Freeway on ramp	15	B	15	B	15	B
Ernest Street/Warringah Freeway off ramp (off ramp in PM, on ramp in AM)	18	B	17	B	17	B
Falcon Street/Warringah Freeway ramps	46	D	72	F	>100	F
Watson Street/Military Road	29	C	46	D	59	E
Military Road/Ben Boyd Road	20	B	54	D	70	E
Falcon Street/Merlin Street	38	C	>100	F	>100	F
Berry Street/Walker Street	50	D	44	D	73	F
Berry Street/Miller Street	27	B	46	D	70	F
Mount Street/Arthur Street	32	C	49	D	92	F
Mount Street/Walker Street	31	C	32	C	75	F
Pacific Highway/High Street/Arthur Street	19	B	46	D	61	E
Pacific Highway/Walker Street/Blue Street	48	D	40	D	80	F
Pacific Highway/Miller Street/Mount Street	41	C	41	C	58	E
Pacific Highway/Berry Street	11	A	23	B	56	E
Pacific Highway/Bay Road	14	B	15	B	41	C
Miller Street/McLaren Street	17	B	21	B	55	D
Miller Street/Ridge Street	26	B	40	C	91	F
Miller Street/Carlow Street	29	C	8	A	19	B

Intersection	2016		2027		2037	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
High Street/Clark Road	36	C	61	E	97	F
High Street/Alfred Street	18	B	>100	F	>100	F
Mount Street/Alfred Street	11	A	12	A	10	A
Ernest Street/Ben Boyd Road	16	B	44	D	94	F
Pedestrian crossing at Military Road	20	B	27	B	34	C

6.4 Gore Hill Freeway and Artarmon

6.4.1 Network performance

A summary of future network performance statistics for the Gore Hill Freeway and Artarmon study area under the ‘Do minimum’ scenario is presented in Table 6-16 and Table 6-17. Analysis of the network performance without the project indicates:

- Peak period traffic demand through the Gore Hill Freeway and Artarmon study area would increase by up to 16 per cent by 2037
- Average travel speeds through the Gore Hill Freeway and Artarmon study area would substantially decrease by up to 22 per cent
- The number of stops would substantially increase, indicating that traffic conditions through the corridor would become increasingly unstable.

Network performance measures for the Gore Hill Freeway and Artarmon study area indicate a substantial degradation in traffic performance through the area, consistent with a substantial increase in traffic demand. This indicates that additional network capacity may be required to accommodate traffic growth.

Table 6-16 Modelled ‘Do minimum’ morning peak network performance - Gore Hill Freeway and Artarmon study area

Network measure	2016	2027	2037
Network statistics for all vehicles			
Total traffic demand (veh)	29,700	31,100	34,100
Total VKT through network	79,500	79,800	87,900
Total VHT through network	1620	1710	2280
Total number of stops	35,800	43,100	113,700
Average vehicle statistics			
Average vehicle trip length through the network (km)	2.5	2.4	2.4
Average vehicle trip time through the network (hours)	0:03:05	0:03:08	0:03:48
Average number of stops per trip	1.1	1.3	3.2
Average trip speed (km/h)	49.0	46.8	38.5

Network measure	2016	2027	2037
Unreleased traffic			
Total unreleased trips	<10	<10	530
% of demand unreleased	<1%	<1%	1%

Table 6-17 Modelled 'Do minimum' evening peak network performance - Gore Hill Freeway and Artarmon study area

Network measure	2016	2027	2037
Network statistics for all vehicles			
Total traffic demand (veh)	29,700	31,100	34,400
Total VKT through network	77,600	79,400	85,800
Total VHT through network	1510	1800	2010
Total number of stops	33,400	48,000	62,400
Average vehicle statistics			
Average vehicle trip length through the network (km)	2.5	2.4	2.4
Average vehicle trip time through the network (hours)	0:02:53	0:03:17	0:03:23
Average number of stops per trip	1.1	1.5	1.8
Average trip speed (km/h)	51.4	44.0	42.6
Unreleased traffic			
Total unreleased trips	<10	260	820
% of demand unreleased	<1%	1%	2%

6.4.2 General traffic travel times

Modelled future general traffic travel times for key routes through the Gore Hill Freeway and Artarmon study area under the 'Do minimum' scenario are presented in Table 6-18 and Table 6-19 . Analysis of modelled travel times for the 'Do minimum' scenario shows that most forecast travel times would remain similar by 2037, with the exception of the Gore Hill Freeway westbound in the evening peak. This is generally reflective of this section of the Gore Hill Freeway and the surrounding roads being primarily governed by the capacity at two key intersections:

- Longueville Road and Epping Road
- Pacific Highway and Longueville Road.

Given that these intersections are already operating at capacity, and their proximity to one another, increased demand at these intersections would also increase existing delays and queuing, and potentially impact operation of the Gore Hill Freeway.

Table 6-18 Modelled 'Do minimum' morning peak hour general traffic travel times - Gore Hill Freeway and Artarmon study area

Route	Direction	2016 (hours)	2027 (hours)	2037 (hours)
Longueville Road to Gore Hill Freeway	Eastbound	0:01:30	0:01:28	0:01:24
	Westbound	0:01:24	0:01:24	0:01:28
Lane Cove Tunnel to Gore Hill Freeway via transit lanes	Eastbound	0:01:24	0:01:24	0:01:18
Lane Cove Tunnel to Gore Hill Freeway	Eastbound	0:01:18	0:01:18	0:01:24
	Westbound	0:01:17	0:01:17	0:02:16

Table 6-19 Modelled 'Do minimum' evening peak hour general traffic travel times - Gore Hill Freeway and Artarmon study area

Route	Direction	2016 (hours)	2027 (hours)	2037 (hours)
Longueville Road to Gore Hill Freeway	Eastbound	0:01:22	0:01:26	0:01:25
	Westbound	0:01:20	0:01:23	0:01:23
Lane Cove Tunnel to Gore Hill Freeway via transit lanes	Eastbound	0:01:20	0:01:20	0:01:20
Lane Cove Tunnel to Gore Hill Freeway	Eastbound	0:01:21	0:01:22	0:01:23
	Westbound	0:01:12	0:01:12	0:01:12

6.4.3 Bus travel times

The bus travel times for key routes through the Gore Hill Freeway and Artarmon study area under the 'Do minimum' scenario are presented in Table 6-20 and Table 6-21. Analysis of the modelled bus travel times under the 'Do Minimum' scenario indicates that they would not change substantially along the Gore Hill Freeway through Artarmon.

Table 6-20 Modelled 'Do minimum' morning peak hour bus travel times - Gore Hill Freeway and Artarmon study area

Route	Direction	2016 (hours)	2027 (hours)	2037 (hours)
Lane Cove Tunnel to Gore Hill Freeway	Eastbound	0:01:16	0:01:26	0:01:26
	Westbound	0:01:21	0:01:18	0:01:26

Table 6-21 Modelled 'Do minimum' evening peak hour bus travel times - Gore Hill Freeway and Artarmon study area

Route	Direction	2016 (hours)	2027 (hours)	2037 (hours)
Lane Cove Tunnel to Gore Hill Freeway	Eastbound	0:01:15	0:01:22	0:01:22
	Westbound	0:01:24	0:01:13	0:01:13

6.4.4 Intersection performance

Modelled future performance for key intersections in the Gore Hill Freeway and Artarmon study area under the 'Do minimum' scenario is presented in Table 6-22 and Table 6-23. Modelled intersection performance indicates that the following intersections would perform at or above capacity at LoS E or F during the morning and/or evening peak periods by 2037:

- Epping Road/Longueville Road/Parklands Avenue
- Reserve Road/Gore Hill Freeway interchange
- Reserve Road/Dickson Road
- Reserve Road/Barton Road.

The degradation of performance at the intersection of Epping Road and Longueville Road is consistent with existing delays at this intersection, which would be exacerbated by increased traffic demands through the intersection in future years. Similarly, the Reserve Road/Gore Hill Freeway interchange, while operating acceptably under existing traffic volumes, would not have sufficient capacity for future growth and delays that would develop at this interchange. This would also impact the intersection of Reserve Road and Dickson Road, and Reserve Road and Barton Road, resulting in unsatisfactory performance by 2027.

Table 6-22 Modelled 'Do minimum' morning peak hour intersection performance - Gore Hill Freeway and Artarmon study area

Intersection	2016		2027		2037	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Epping Road/Longueville Road/Parklands Avenue	48	D	52	D	83	F
Longueville Road/Pacific Highway	42	C	40	C	54	D
Pacific Highway/Howarth Road/Norton Lane	7	A	20	B	28	B
Pacific Highway/Gore Hill Freeway interchange	23	B	29	B	41	C
Reserve Road/Gore Hill Freeway interchange	47	D	61	E	47	D
Reserve Road/Dickson Road	14	A	14	A	19	B
Reserve Road/Barton Road	11	A	69	E	>100	F

Table 6-23 Modelled 'Do minimum' evening peak hour intersection performance - Gore Hill Freeway and Artarmon study area

Intersection	2016		2027		2037	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Epping Road/Longueville Road/Parklands Avenue	63	E	80	F	87	F
Longueville Road/Pacific Highway	36	C	42	C	49	D

Intersection	2016		2027		2037	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Pacific Highway/Howarth Road/Norton Lane	7	A	13	A	13	A
Pacific Highway/Gore Hill Freeway interchange	23	B	29	C	23	B
Reserve Road/Gore Hill Freeway interchange	29	C	55	D	57	E
Reserve Road/Dickson Road	19	B	73	F	85	F
Reserve Road/Barton Road	6	A	>100	F	>100	F

6.5 Balgowlah and surrounds

6.5.1 Network performance

A summary of future network performance statistics for the Balgowlah and surrounds study area under the ‘Do minimum’ scenario is presented in Table 6-24 and Table 6-25. Analysis of the network performance without the project indicates:

- Peak period traffic demand through the Balgowlah and surrounds study area would increase up to 14 per cent by 2037
- Average travel speeds through the Balgowlah and surrounds study area would substantially decrease by up to 38 per cent
- The number of stops would substantially increase, indicating that traffic conditions through the corridor would become increasingly unstable
- Forecast demand would be increasingly unable to travel as desired during evening peak periods. This is reflected in higher numbers of unreleased vehicles at the end of the modelled periods.

Network performance measures for the Balgowlah and surrounds study area indicate a substantial degradation in traffic performance through the area, consistent with a substantial increase in traffic demand without additional infrastructure to provide additional network capacity that would facilitate traffic growth.

Table 6-24 Modelled ‘Do minimum’ morning peak network performance - Balgowlah and surrounds study area

Network measure	2016	2027	2037
Network statistics for all vehicles			
Total traffic demand (veh)	16,800	17,400	19,200
Total VKT through network	42,100	44,800	49,500
Total VHT through network	1440	1600	2280
Total number of stops	50,900	57,000	94,600
Average vehicle statistics			
Average vehicle trip length through the network (km)	2.4	2.4	2.4

Network measure	2016	2027	2037
Average vehicle trip time through the network (hours)	0:04:55	0:05:10	0:06:40
Average number of stops per trip	2.9	3.1	4.6
Average trip speed (km/h)	29.2	28.1	21.7
Unreleased traffic			
Total unreleased trips	120	20	120
% of demand unreleased	1%	<1%	1%

Table 6-25 Modelled 'Do minimum' evening peak network performance - Balgowlah and surrounds study area

Network measure	2016	2027	2037
Network statistics for all vehicles			
Total traffic demand (veh)	18,900	19,400	20,900
Total VKT through network	50,500	50,800	52,300
Total VHT through network	1440	1910	2400
Total number of stops	44,300	65,200	92,500
Average vehicle statistics			
Average vehicle trip length through the network (km)	2.5	2.6	2.5
Average vehicle trip time through the network (hours)	0:04:21	0:05:46	0:06:54
Average number of stops per trip	2.2	3.3	4.4
Average trip speed (km/h)	35.1	26.5	21.8
Unreleased traffic			
Total unreleased trips	50	430	1320
% of demand unreleased	<1%	2%	6%

6.5.2 General traffic travel times

Modelled future general traffic travel times for key routes through the Balgowlah and surrounds study area under the 'Do minimum' scenario are presented in Table 6-26 and Table 6-27. Analysis of modelled travel times for the 'Do minimum' scenario shows:

- Travel times in the peak direction along Burnt Bridge Creek Deviation and Manly Road would increase in the future as a result of increased traffic demands through fixed capacity constraints at Spit Bridge and Sydney Road
- Travel times through Seaforth would also increase as a result of increased traffic demands through the fixed capacity constraint of the Sydney Road and Frenchs Forest Road roundabout.

Table 6-26 Modelled 'Do minimum' morning peak hour general traffic travel times - Balgowlah and surrounds study area

Route	Direction	2016 (hours)	2027 (hours)	2037 (hours)
Spit Bridge to Condamine Street (via Manly Road and Burnt Bridge Creek Deviation)	Northbound	0:03:25	0:03:09	0:04:08
	Southbound	0:08:40	0:06:15	0:11:46
Spit Bridge to Wakehurst Parkway/Judith Street (via Frenchs Forest Road)	Northbound	0:05:48	0:05:55	0:06:47
	Southbound	0:07:21	0:07:37	0:09:22

Table 6-27 Modelled 'Do minimum' evening peak hour general traffic travel times - Balgowlah and surrounds study area

Route	Direction	2016 (hours)	2027 (hours)	2037 (hours)
Spit Bridge to Condamine Street via Manly Road and Burnt Bridge Creek Deviation	Northbound	0:03:42	0:05:24	0:05:48
	Southbound	0:03:38	0:07:49	0:11:12
Spit Bridge to Wakehurst Parkway/Judith Street (via Frenchs Forest Road)	Northbound	0:07:57	0:09:57	0:10:19
	Southbound	0:06:40	0:14:19	0:16:07

6.5.3 Bus travel times

Modelled future bus travel times for key routes through the Balgowlah and surrounds study area under the 'Do minimum' scenario are presented in Table 6-28 and Table 6-29. Analysis of modelled bus travel times under the 'Do minimum' scenario indicates that:

- Additional green signal time provided to through movements along Burnt Bridge Creek Deviation and Condamine Street to accommodate southbound traffic growth in the morning peak would also result in northbound travel times marginally decreasing for buses between Sydney Road and Condamine Street via Burnt Bridge Creek Deviation, as they would not wait as long at this intersection. This would not be the case for southbound buses; as the southbound bus lane does not extend to the stop-line at Condamine Street and buses would be held up by traffic in the left lane that does not merge right until after this intersection
- Travel times for buses to Manly from Cremorne would increase due to increased delays at the intersection of Manly Road and Sydney Road
- Travel times for buses travelling through Seaforth shopping village would increase due to increased delays at intersections along Sydney Road.

Travel times for other bus routes through the Balgowlah and surrounds study area would remain similar to existing travel times as these routes generally use dedicated bus lanes and would be unaffected by increased traffic demands.

Table 6-28 Modelled 'Do minimum' morning peak hour bus travel times - Balgowlah and surrounds

Route	Direction	2016 (hours)	2027 (hours)	2037 (hours)
Spit Bridge to Manly Road/Sydney Road	Northbound	0:02:09	0:02:20	0:03:10
	Southbound	0:02:02	0:02:08	0:02:17
Manly Road/Sydney Road to Burnt Bridge Creek Deviation/Condamine Street	Northbound	0:02:01	0:01:30	0:01:29
	Southbound	0:02:10	0:02:23	0:02:25

Route	Direction	2016 (hours)	2027 (hours)	2037 (hours)
Manly Road/Sydney Road to Wakehurst Parkway/Judith Street (via Frenchs Forest Road)	Southbound	0:11:58	0:11:44	0:13:38

Table 6-29 Modelled 'Do minimum' evening peak hour bus travel times - Balgowlah and surrounds study area

Route	Direction	2016 (hours)	2027 (hours)	2037 (hours)
Spit Bridge to Manly Road/Sydney Road	Northbound	0:01:58	0:04:39	0:04:14
	Southbound	0:01:06	0:01:10	0:01:13
Manly Road/Sydney Road to Burnt Bridge Creek Deviation/Condamine Street	Northbound	0:01:46	0:01:34	0:01:36
	Southbound	0:01:55	0:02:19	0:02:10
Manly Road/Sydney Road to Wakehurst Parkway/Judith Street (via Frenchs Forest Road)	Southbound	0:13:13	0:18:03	0:21:46

6.5.4 Intersection performance

Modelled future performance for key intersections in the Balgowlah and surrounds study area under the 'Do minimum' scenario are presented in Table 6-30 and

Table 6-31. Modelled intersection performance indicates that the following intersections would perform at a relatively poor Level of Service during the morning and/or evening peak periods by 2037:

- Sydney Road/Manly Road/Burnt Bridge Creek Deviation
- Frenchs Forest Road/Sydney Road.

Forecast traffic demands would exceed capacity at the intersection of Manly Road and Sydney Road by 2027 due to the increased traffic demand through the intersection, particularly on the western approach, where queues would extend along Sydney Road and Frenchs Forest Road. These queues would extend through the existing roundabout at the intersection of Sydney Road and Frenchs Forest Road, resulting in poor performance at this location.

Table 6-30 Modelled 'Do minimum' morning peak hour intersection performance - Balgowlah and surrounds study area

Intersection	2016		2027		2037	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Sydney Road/Manly Road/Burnt Bridge Creek Deviation	52	D	48	D	68	E
Frenchs Forest Road/Sydney Road	19	B	21	B	32	C
Sydney Road/Condamine Street	20	B	33	C	26	B
Condamine Street/Burnt Bridge Creek Deviation	28	B	19	B	32	C
Sydney Road/Maretimo Street	9	A	10	A	9	A

Table 6-31 Modelled Do minimum' evening peak hour intersection performance - Balgowlah and surrounds study area

Intersection	2016		2027		2037	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Sydney Road/Manly Road/Burnt Bridge Creek Deviation	44	D	93	F	>100	F
Frenchs Forest Road/Sydney Road	>100	F	>100	F	>100	F
Sydney Road/Condamine Street	24	B	33	C	40	C
Condamine Street/Burnt Bridge Creek Deviation	19	B	17	B	16	B
Sydney Road/Maretimo Street	9	A	9	A	30	C

6.6 Frenchs Forest and surrounds

6.6.1 Network performance

A summary of future network performance statistics for the Frenchs Forest and surrounds study area under the 'Do minimum' scenario is presented in Table 6-32 and Table 6-33. The forecast analysis of the network performance without the project indicates that:

- Peak period traffic demand through the Frenchs Forest and surrounds study area would increase by up to 15 per cent by 2037
- Average travel speeds through the Frenchs Forest and surrounds study area would substantially increase by up to 40 per cent by 2027, but then reduce by 2037. This increase in travel speeds from the base year to 2027 is a consequence of the Northern Beaches Hospital road upgrade project, which substantially reduces travel times for traffic travelling east–west along Warringah Road
- The number of stops would substantially decrease between 2012 and 2027, indicating that traffic conditions through the corridor would improve with fewer trips stopping at traffic signals on Warringah Road
- Traffic growth between 2027 and 2037 would increase congestion, reduce network speeds and increase the number of stops over this period.

Table 6-32 Modelled 'Do minimum' morning peak network performance – Frenchs Forest and surrounds study area

Network measure	2012	2027	2037
Network statistics for all vehicles			
Total traffic demand (veh)	29,400	32,100	33,700
Total VKT through network	84,100	94,500	98,900
Total VHT through network	3410	2720	3180
Total number of stops	121,600	81,000	101,000
Average vehicle statistics			

Network measure	2012	2027	2037
Average vehicle trip length through the network (km)	2.8	2.9	3.0
Average vehicle trip time through the network (hours)	0:06:48	0:05:02	0:05:51
Average number of stops per trip	4.0	2.5	3.1
Average trip speed (km/h)	24.7	34.8	31.1
Unreleased traffic			
Total unreleased trips	40	220	270
% of demand unreleased	<1%	1%	1%

Table 6-33 Modelled 'Do minimum' evening peak network performance – Frenchs Forest and surrounds study area

Network measure	2012	2027	2037
Network statistics for all vehicles			
Total traffic demand (veh)	31,400	33,600	35,400
Total VKT through network	93,200	101,400	107,100
Total VHT through network	3050	2760	3100
Total number of stops	97,900	76,200	89,500
Average vehicle statistics			
Average vehicle trip length through the network (km)	3.0	3.0	3.1
Average vehicle trip time through the network (hours)	0:05:51	0:04:52	0:05:27
Average number of stops per trip	3.1	2.2	2.6
Average trip speed (km/h)	30.6	36.7	34.6
Unreleased traffic			
Total unreleased trips	420	230	370
% of demand unreleased	1%	1%	1%

6.6.2 General traffic travel times

Modelled future general traffic travel times for key routes through the Frenchs Forest and surrounds study area under the 'Do minimum' scenario are presented in Table 6-34 and Table 6-35. Analysis of modelled travel times for the 'Do minimum' scenario shows:

- Travel times for general traffic travelling along Wakehurst Parkway through Frenchs Forest would improve substantially when compared to existing conditions. This is due to the increased capacity provided as part of the Northern Beaches Hospital road upgrade project
- Travel times for general traffic travelling along Warringah Road through Frenchs Forest would also improve when compared to existing conditions. This is due to the grade-separation of this movement, bypassing two existing intersections as part of the completed Northern Beaches Hospital road upgrade project.

Table 6-34 Modelled 'Do minimum' morning peak hour general traffic travel times - Frenchs Forest and surrounds study area

Route	Direction	2012 (hours)	2027 (hours)	2037 (hours)
Wakehurst Parkway/Judith Street to Wakehurst Parkway/Dreadnought Road	Northbound	0:08:17	0:04:27	0:06:59
	Southbound	0:08:53	0:04:29	0:05:05
Warringah Road/Forestville Avenue to Ellis Road/Warringah Road	Eastbound	0:10:28	0:05:25	0:05:24
	Westbound	0:13:55	0:05:55	0:06:11

Table 6-35 Modelled 'Do minimum' evening peak hour general traffic travel times - Frenchs Forest and surrounds study area

Route	Direction	2012 (hours)	2027 (hours)	2037 (hours)
Wakehurst Parkway/Judith Street to Wakehurst Parkway/Dreadnought Road	Northbound	0:09:44	0:04:37	0:07:02
	Southbound	0:03:52	0:04:10	0:04:04
Warringah Road/Forestville Avenue to Ellis Road/Warringah Road	Eastbound	0:09:39	0:06:05	0:06:22
	Westbound	0:06:17	0:05:15	0:05:36

6.6.3 Bus travel times

Modelled future bus travel times for key routes through the Frenchs Forest and surrounds study area under the 'Do minimum' scenario are presented in Table 6-36 and Table 6-37. Analysis of modelled bus travel times under the 'Do minimum' scenario indicates that:

- Travel times for buses travelling along Warringah Road and Forest Way would improve following construction of the Northern Beaches Hospital road upgrade. These improved bus travel times reflect the travel time savings from reduced congestion and the provision of bus priority under the Northern Beaches Hospital road upgrade.

Table 6-36 Modelled 'Do minimum' morning peak hour bus travel times - Frenchs Forest and surrounds study area

Route	Direction	2012 (hours)	2027 (hours)	2037 (hours)
Forestville Avenue to Adams Street via Warringah Road and Forest Way	Northbound	0:13:09	0:10:26	0:10:44
	Southbound	0:16:13	0:07:55	0:08:16
Forestville Avenue to Ellis Road via Warringah Road and French Forest Road East	Northbound	-	0:16:04	0:15:45
	Southbound	-	0:12:26	0:15:08

Table 6-37 Modelled Do minimum evening peak hour bus travel times - Frenchs Forest and surrounds study area

Route	Direction	2012 (hours)	2027 (hours)	2037 (hours)
Forestville Avenue to Adams Street via Warringah Road and Forest Way	Northbound	0:13:22	0:11:22	0:11:09
	Southbound	0:13:10	0:07:13	0:07:16
Forestville Avenue to Ellis Road via Warringah Road and French Forest Road East	Eastbound	-	0:16:55	0:16:37
	Westbound	-	0:12:50	0:12:45

6.6.4 Intersection performance

Modelled future performance for key intersections in the Frenchs Forest and surrounds study area under the 'Do minimum' scenario is presented in Table 6-38 and

Table 6-39. Modelled intersection performance indicates that the Northern Beaches Hospital road upgrade (completed in August 2020) would substantially improve intersection performance in 2027, although performance would then begin to deteriorate again by 2037 due to ongoing demand growth. Most intersections along Warringah Road would initially benefit from substantial decreases in delays as a result of east–west through traffic being grade-separated. However, by 2037, forecast traffic growth would result in the following intersections operating at a reduced Level of Service compared to 2027:

- Wakehurst Parkway/Frenchs Forest Road East
- Wakehurst Parkway/Warringah Road.

These intersections would experience delays as a result of growth in north–south traffic movements along Wakehurst Parkway, which conflict with increasing traffic demand along the Warringah Road surface corridor.

Table 6-38 Modelled 'Do minimum' morning peak hour intersection performance – Frenchs Forest and surrounds study area

Intersection	2012		2027		2037	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Wakehurst Parkway/Frenchs Forest Road East	>100	F	44	D	66	E
Warringah Road/Allambie Road	65	E	44	D	46	D
Wakehurst Parkway/Warringah Road	120	F	58	E	78	F
Warringah Road/Hilmer Street	58	E	14	A	38	C
Warringah Road/Forest Way	>100	F	18	B	21	B
Forest Way/Naree Road	<5	A	24	B	36	C
Warringah Road/Brown Street/Currie Road	70	F	20	B	23	B
Warringah Road/Starkey Street	37	C	23	B	26	B
Warringah Road/Darley Street	20	B	28	B	30	C
Warringah Road/Forestville Avenue	16	B	10	A	14	A

Table 6-39 Modelled 'Do minimum' evening peak hour intersection performance - Frenchs Forest and surrounds study area

Intersection	2012		2027		2037	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Wakehurst Parkway/Frenchs Forest Road East	67	E	46	D	46	D
Warringah Road/Allambie Road	56	D	46	D	49	D
Wakehurst Parkway/Warringah Road	48	D	33	C	41	C
Warringah Road/Hilmer Street	49	D	12	A	13	A
Warringah Road/Forest Way	34	C	24	B	26	B
Forest Way/Naree Road	7	A	19	B	27	B
Warringah Road/Brown Street/Currie Road	11	A	10	A	11	A
Warringah Road/Starkey Street	10	A	20	B	19	B
Warringah Road/Darley Street	22	B	19	B	19	B
Warringah Road/Forestville Avenue	28	B	35	C	46	D

7. Future transport network performance with the project only

7.1 Overview

This section provides a summary of the road network performance in 2027 and 2037 with the project (the 'Do something' scenario). This assessment has been based on a comparison against the 'Do minimum' scenario (refer to Section 6) for the following performance measures:

- Strategic road network performance based on vehicle hours of travel (VHT), vehicle kilometres of travel (VKT) and average network speed
- Intersection performance based on intersection Level of Service
- General traffic and bus travel times for key corridors.

Strategic traffic modelling of the project indicates that the project would deliver substantial benefits to traffic travelling on the strategic road network, with trips between strategic centres saving up to 30 minutes when travelling between the Northern Beaches and locations in the lower North Shore during peak periods. These travel time savings would also substantially increase accessibility for these centres, increasing the catchment of residents who can travel to and from their place of work within the '30-minute city' window that is critical to maintaining the vision of a productive city promoted by the Greater Sydney Commission.

Increasing the size of this 30-minute city catchment would not be limited to private vehicles; public transport customers would also benefit substantially from the project. Existing services would benefit from reduced traffic demand on key arterial bus corridors including Warringah Road, Eastern Valley Way, Spit Road and Military Road, while the project itself would facilitate the operation of express buses that would provide direct access between major centres on the Northern Beaches and Frenchs Forest and those in the lower North Shore, north west Sydney and Sydney CBD including potential rapid bus services along Warringah Road from Dee Why to Chatswood.

The substantial additional travel that would be facilitated by the project would also increase traffic demands at either end of the project where it would integrate with the existing transportation network. There would be some residual delay surrounding these interface precincts. However, the additional delay associated with these precincts would be offset by the large travel time benefits provided by the project at the broader network level. These integration works have been developed to minimise the impact of additional travel facilitated by the project and ensure that the competing needs of customers (including private vehicles, public transport passengers, cyclists and pedestrians) have been incorporated into a balanced, equitable outcome.

7.2 Metropolitan road network performance

7.2.1 Strategic corridors

A summary of the forecast growth at key locations into and out of the Northern Beaches peninsula for the 2027 and 2037 forecast years is presented in Table 7-1 to Table 7-3.

Table 7-1 Modelled 'Do something' morning peak hour traffic demands at key locations (SMPM)

Road	Location	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Spit Road	Spit Bridge	Northbound	1750	1350	1850	1450
		Southbound	2700	1750	3050	1950
		Combined	*4450*	*3100*	*4900*	*3400*
Warringah Road	Roseville Bridge	Northbound	2100	1550	2250	1650
		Southbound	4100	3300	4300	3550

Road	Location	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
		Combined	*6200*	*4850*	*6550*	*5200*
Mona Vale Road	St Ives Showground	Northbound	2450	2350	2600	2450
		Southbound	2750	2500	2900	2600
		Combined	*5200*	*4850*	*5500*	*5050*
Beaches Link Tunnel	Killarney Heights	Northbound	N/A	1250	N/A	1400
		Southbound	N/A	2850	N/A	3350
		Combined	*N/A*	*4100*	*N/A*	*4750*
Northern Beaches screenline		**Northbound**	**6300**	**6500**	**6700**	**6950**
		Southbound	**9550**	**10,400**	**10,250**	**11,450**
		Combined	***15,850***	***16,900***	***16,950***	***18,400***
Eastern Valley Way	Castle Cove	Northbound	950	550	1000	600
		Southbound	1900	1550	2050	1800
		Combined	*2850*	*2100*	*3050*	*2400*

Note: Comparing the 'Do something' scenario with the 'Do minimum' scenario, a reduction in demand greater than 10 per cent is highlighted in green while an increase in demand greater than 10 per cent is highlighted in blue.

Table 7-2 Modelled 'Do something' evening peak hour traffic demands at key locations (SMPM)

Road	Location	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Spit Road	Spit Bridge	Northbound	3000	1750	3250	1900
		Southbound	2050	1600	2150	1700
		Combined	*5050*	*3350*	*5400*	*3600*
Warringah Road	Roseville Bridge	Northbound	3650	2600	3750	2850
		Southbound	2450	1950	2650	2050
		Combined	*6100*	*4550*	*6400*	*4900*
Mona Vale Road	St Ives Showground	Northbound	2600	2450	2700	2450
		Southbound	2450	2250	2550	2450
		Combined	*5050*	*4700*	*5250*	*4900*
Beaches Link Tunnel	Killarney Heights	Northbound	N/A	2950	N/A	3300
		Southbound	N/A	1450	N/A	1650
		Combined	*N/A*	*4400*	*N/A*	*4950*
Northern Beaches screenline		**Northbound**	**9250**	**9750**	**9700**	**10,500**
		Southbound	**6950**	**7250**	**7350**	**7850**
		Combined	***16,200***	***17,000***	***17,050***	***18,350***

Road	Location	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Eastern Valley Way	Castle Cove	Northbound	1550	1050	1700	1300
		Southbound	1100	750	1200	1050
		Combined	*2650*	*1800*	*2900*	*2350*

Note: Comparing the 'Do something' scenario with the 'Do minimum' scenario, a reduction in demand greater than 10 per cent is highlighted in green while an increase in demand greater than 10 per cent is highlighted in blue.

Table 7-3 Modelled 'Do something' daily traffic demands at key locations (SMPM)

Road	Location	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Spit Road	Spit Bridge	Northbound	38,500	24,000	41,500	25,500
		Southbound	36,000	24,500	38,500	26,500
		Combined	*74,500*	*48,500*	*80,000*	*52,000*
Warringah Road	Roseville Bridge	Northbound	41,500	29,500	43,500	31,500
		Southbound	41,500	32,500	43,500	34,500
		Combined	*83,000*	*62,000*	*87,000*	*66,000*
Mona Vale Road	St Ives Showground	Northbound	29,500	27,500	31,000	28,000
		Southbound	30,000	27,000	31,500	28,500
		Combined	*59,500*	*54,500*	*62,500*	*56,500*
Beaches Link Tunnel	Killarney Heights	Northbound	N/A	32,000	N/A	35,000
		Southbound	N/A	26,500	N/A	29,500
		Combined	*N/A*	*58,500*	*N/A*	*64,500*
Northern Beaches screenline		**Northbound**	**109,500**	**113,000**	**116,000**	**120,000**
		Southbound	**107,500**	**110,500**	**113,500**	**119,000**
		Combined	***217,000***	***223,500***	***229,500***	***239,000***
Eastern Valley Way	Castle Cove	Northbound	17,500	10,500	19,000	12,000
		Southbound	15,500	10,500	16,500	13,000
		Combined	*33,000*	*21,000*	*35,500*	*25,000*
Brook Street	Naremburn (north of Merrenburn Avenue)	*Combined*	*35,500*	*33,500*	*37,500*	*36,000*

Note: Comparing the 'Do something' scenario with the 'Do minimum' scenario, a reduction in demand greater than 10 per cent is highlighted in green while an increase in demand greater than 10 per cent is highlighted in blue.

Analysis of the modelled forecast traffic demands across Middle Harbour with the project in 2037 indicates that:

- Peak period traffic demand on Spit Road and Warringah Road would decrease substantially as a result of the project, by up to 33 per cent and 23 per cent, respectively

- Peak period traffic demand on Mona Vale Road would decrease by up to eight per cent as a result of the project
- Peak period traffic demand into and out of the Northern Beaches peninsula would increase by up to nine per cent as a result of the project.
- Daily traffic demand on Eastern Valley Way would decrease by up to 30 per cent as a result of the project.

Overall, the project would result in substantial reductions in traffic demand on the existing crossings into and out of the Northern Beaches peninsula, with the largest reductions in traffic demands being on the Spit Road and Military Road corridor. The project would also facilitate an increase in traffic demand into and out of the Northern Beaches peninsula, resulting from the increased accessibility that it would provide.

A summary of forecast travel times during peak periods for key routes in the vicinity of the project is presented in Figure 7-1 and Figure 7-2.

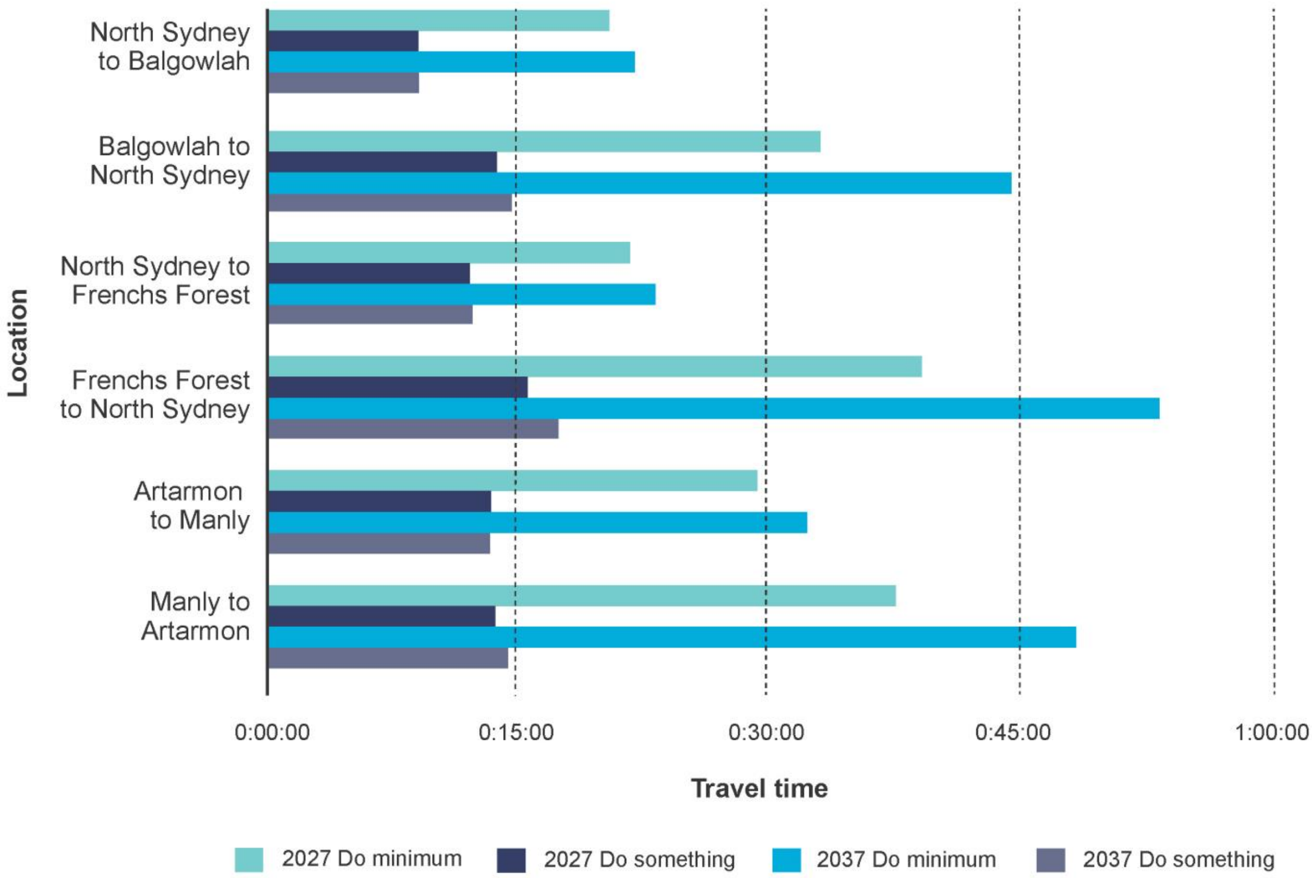


Figure 7-1 Modelled 'Do something' morning peak hour travel times along key corridors (SMPM)

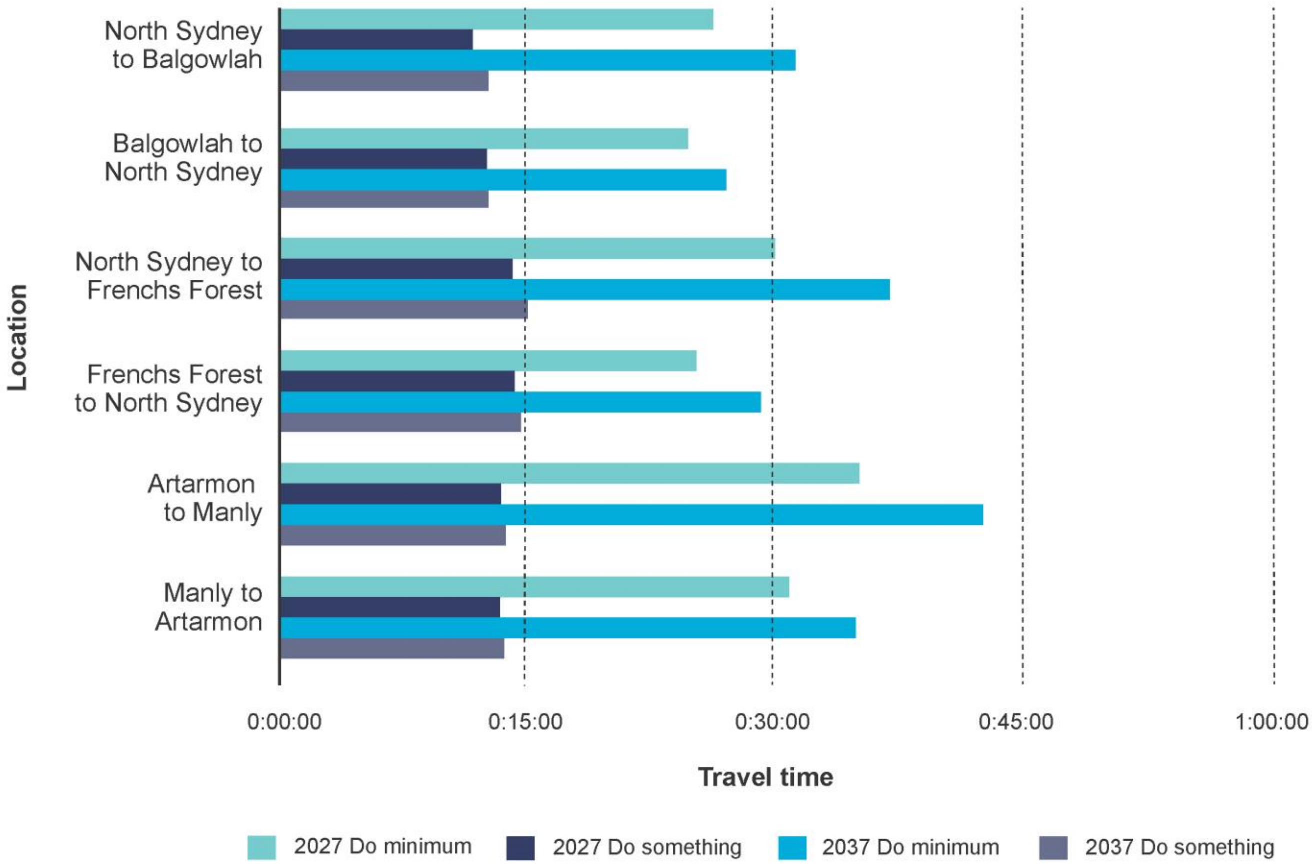


Figure 7-2 Modelled 'Do something' evening hour peak travel times along key corridors (SMPM)

Analysis of the modelled forecast travel time along key routes in the vicinity of the project shows that travel times through the study area would decrease substantially by 2037. Most of these travel time savings would be for trips that would otherwise use Spit Road and Military Road or Warringah Road to travel to and from the Northern Beaches peninsula, although users of existing routes would also benefit from reduced congestion.

7.2.2 30-minute city catchments

Plots of the forecast morning peak 30-minute catchments by road for strategic centres in the vicinity of the project in 2037 are presented in Figure 7-3 to Figure 7-5.

Analysis of the 30-minute catchments for the 'Do something' scenarios shows:

- The project would increase accessibility between Chatswood and Manly, allowing Manly to be reached within 30 minutes
- The project would substantially increase accessibility from Dee Why-Brookvale, allowing for access to Chatswood and St Leonards within 30 minutes
- The project would substantially increase accessibility from Manly, allowing Chatswood, St Leonards, Macquarie Park and North Sydney to be reached within 30 minutes.

Overall, the project would substantially increase accessibility from the Northern Beaches to nearby strategic centres. However, it would not substantially increase 30-minute catchments to and from strategic centres south of Sydney Harbour. This reduction in general traffic travel times would also result in reduced travel times for public transport and would increase the size of equivalent public transport catchments, which could be further extended by express buses operating through the Beaches Link Tunnel.

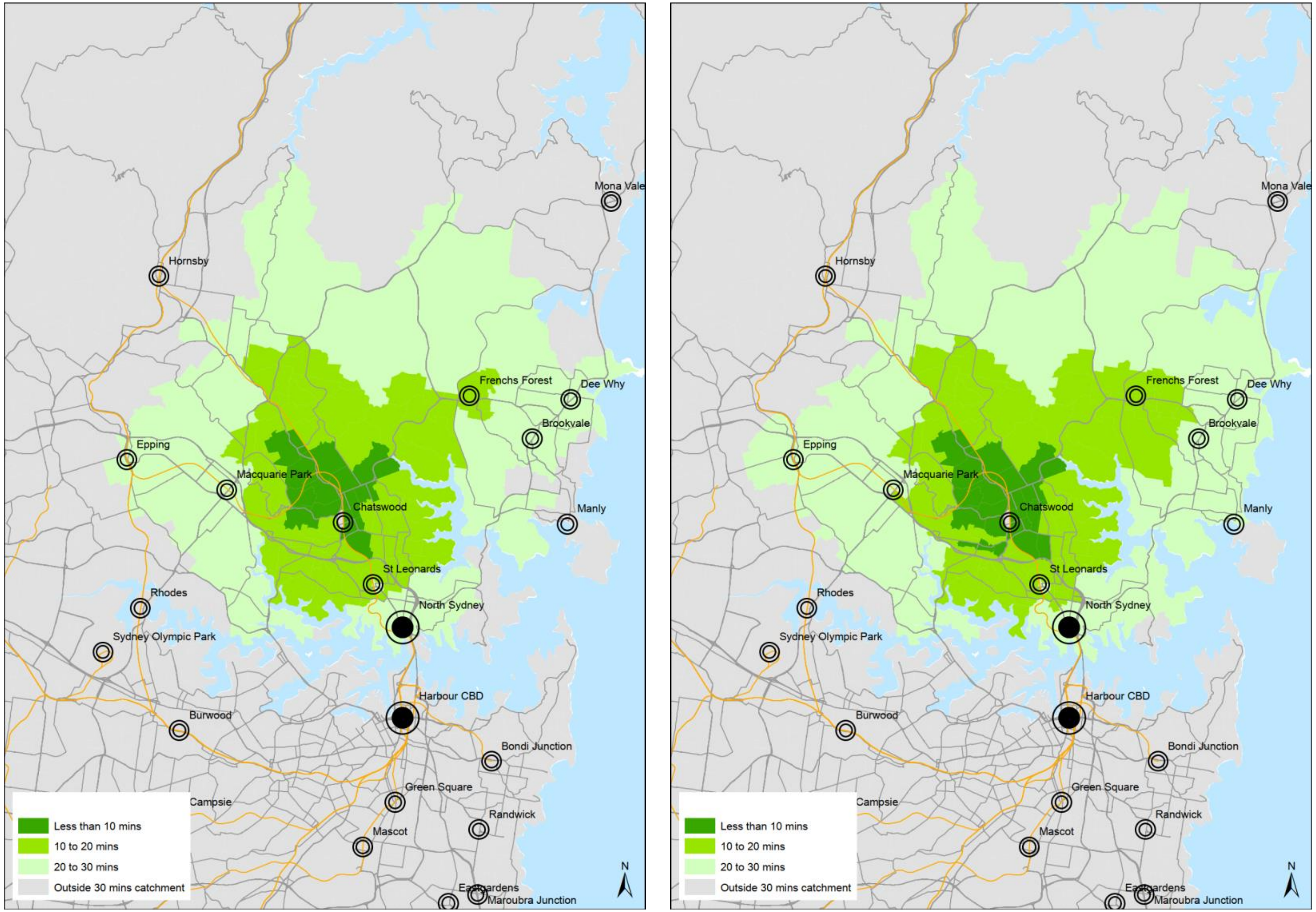


Figure 7-3 Modelled 2037 'Do something' morning peak 30-minute catchment by road from Chatswood (SMPM)

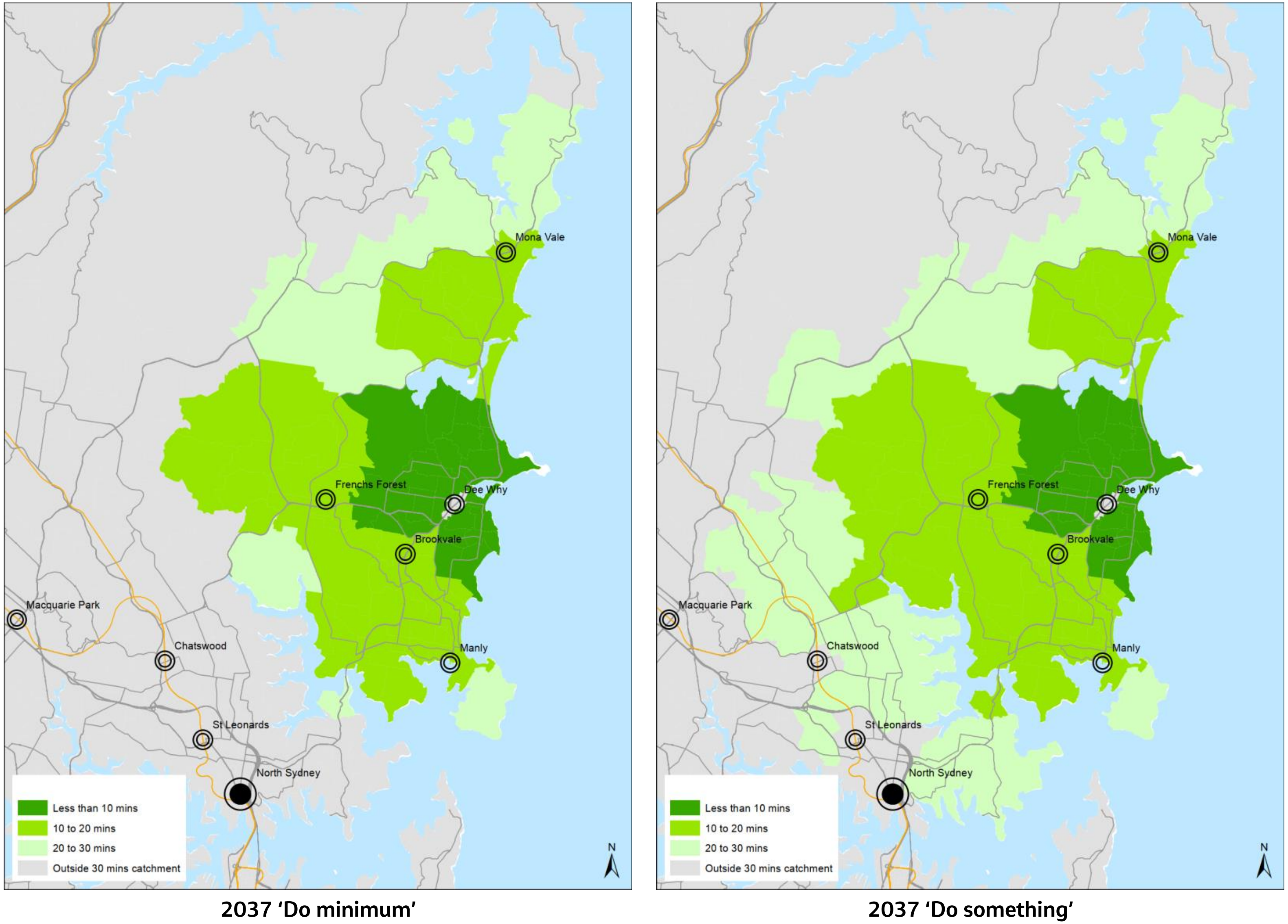


Figure 7-4 Modelled 2037 'Do something' morning peak 30-minute catchment by road from Brookvale-Dee Why (SMPM)

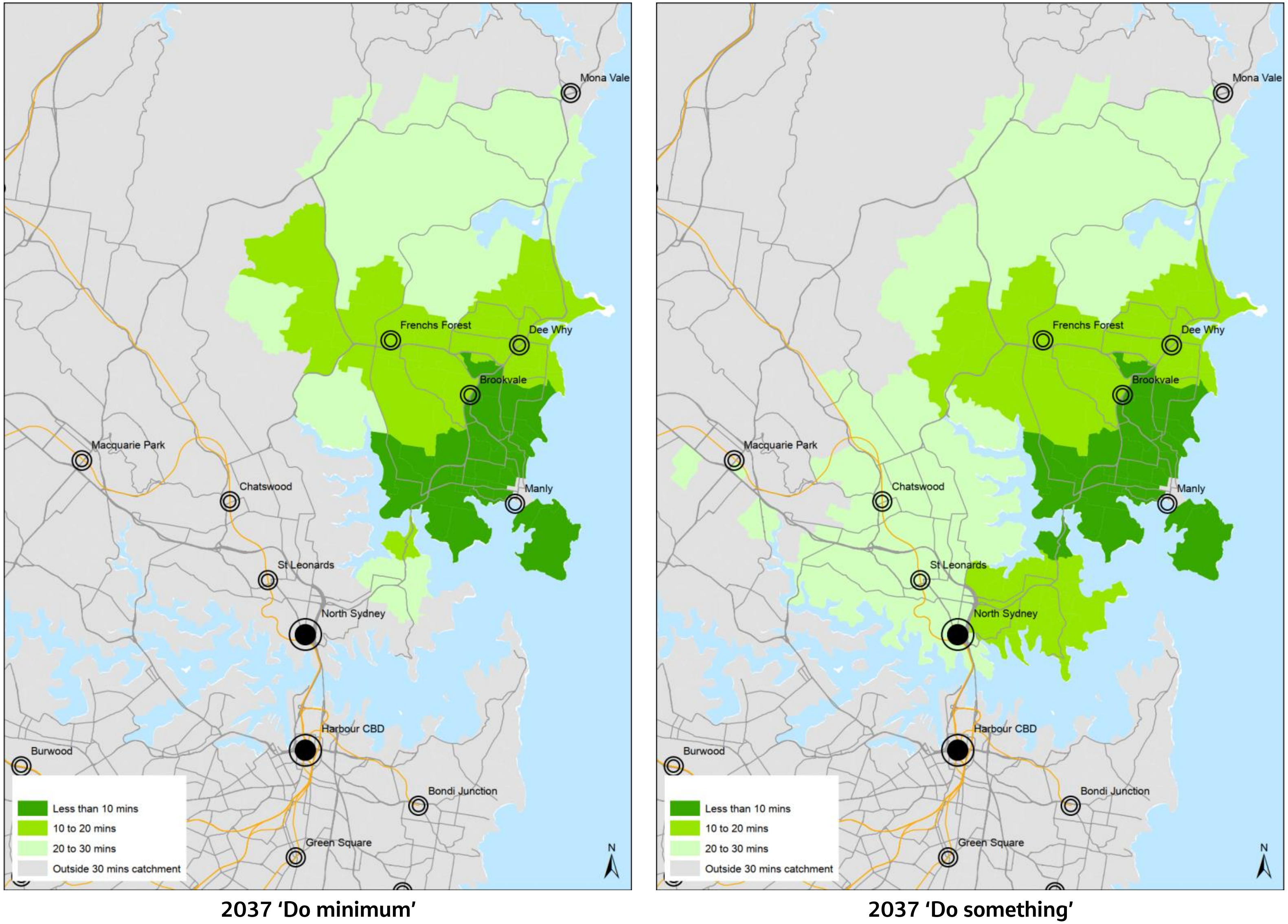


Figure 7-5 Modelled 2037 'Do something' morning peak 30-minute catchment by road from Manly (SMPM)

7.2.3 Heavy vehicles and freight

A summary of the forecast heavy vehicle demand at key locations into and out of the Northern Beaches peninsula for the 2027 and 2037 forecast years is presented in Table 7-4 to Table 7-6.

Table 7-4 Modelled 'Do something' morning peak hour heavy vehicle demands at key locations (SMPM)

Road	Location	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Spit Road	Spit Bridge	Northbound	60	20	60	20
		Southbound	150	30	170	40
		Combined	*210*	*50*	*230*	*60*
Warringah Road	Roseville Bridge	Northbound	160	40	190	50
		Southbound	240	100	280	130
		Combined	*400*	*140*	*470*	*180*
Mona Vale Road	St Ives Showground	Northbound	170	130	210	160
		Southbound	290	180	330	190
		Combined	*460*	*310*	*540*	*350*
Beaches Link Tunnel	Killarney Heights	Northbound	N/A	210	N/A	240
		Southbound	N/A	380	N/A	450
		Combined	*N/A*	*590*	*N/A*	*690*
Northern Beaches screenline		**Northbound**	**390**	**400**	**460**	**470**
		Southbound	**680**	**690**	**780**	**810**
		Combined	***1070***	***1090***	***1240***	***1280***

Note: Comparing the 'Do something' scenario with the 'Do minimum' scenario, a reduction in demand greater than 10 per cent is highlighted in green while an increase in demand greater than 10 per cent is highlighted in blue.

Table 7-5 Modelled 'Do something' evening peak hour heavy vehicle demands at key locations (SMPM)

Road	Location	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Spit Road	Spit Bridge	Northbound	110	20	130	30
		Southbound	60	20	80	30
		Combined	*170*	*40*	*210*	*60*
Warringah Road	Roseville Bridge	Northbound	260	80	280	90
		Southbound	190	90	220	100
		Combined	*450*	*170*	*500*	*190*
Mona Vale Road	St Ives Showground	Northbound	160	90	180	100
		Southbound	340	250	380	290
		Combined	*500*	*340*	*560*	*390*

Road	Location	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Beaches Link Tunnel	Killarney Heights	Northbound	N/A	340	N/A	380
		Southbound	N/A	230	N/A	270
		Combined	*N/A*	*570*	*N/A*	*650*
Northern Beaches screenline		**Northbound**	**530**	**530**	**590**	**600**
		Southbound	**590**	**590**	**680**	**690**
		Combined	***1120***	***1120***	***1270***	***1290***

Note: Comparing the 'Do something' scenario with the 'Do minimum' scenario, a reduction in demand greater than 10 per cent is highlighted in green while an increase in demand greater than 10 per cent is highlighted in blue.

Table 7-6 Modelled 'Do something' daily heavy vehicle demands at key locations (SMPM)

Road	Location	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Spit Road	Spit Bridge	Northbound	1900	500	2300	600
		Southbound	2300	700	2700	800
		Combined	*4200*	*1200*	*5000*	*1400*
Warringah Road	Roseville Bridge	Northbound	3300	1000	3500	1200
		Southbound	3000	1400	3400	1700
		Combined	*6300*	*2400*	*6900*	*2900*
Mona Vale Road	St Ives Showground	Northbound	2500	1800	2900	2000
		Southbound	4100	3100	4800	3400
		Combined	*6600*	*4900*	*7700*	*5400*
Beaches Link Tunnel	Killarney Heights	Northbound	N/A	4400	N/A	5000
		Southbound	N/A	4400	N/A	5100
		Combined	*N/A*	*8800*	*N/A*	*10,100*
Northern Beaches screenline		**Northbound**	**7700**	**7700**	**8700**	**8800**
		Southbound	**9400**	**9600**	**10,900**	**11,000**
		Combined	***17,100***	***17,300***	***19,600***	***19,800***

Note: Comparing the 'Do something' scenario with the 'Do minimum' scenario, a reduction in demand greater than 10 per cent is highlighted in green while an increase in demand greater than 10 per cent is highlighted in blue.

Analysis of the modelled forecast heavy vehicle demands across Middle Harbour under the 'Do something' scenario in 2037 shows:

- Peak period heavy vehicle demand on Spit Road and Warringah Road would decrease substantially as a result of the project, by up to 74 per cent and 62 per cent, respectively
- Peak period heavy vehicle demand on Mona Vale Road would decrease by up to 35 per cent as a result of the project
- Peak period heavy vehicle demand into and out of the Northern Beaches would not change substantially as a result of the project.

Overall, the project would result in most heavy vehicle trips on the existing crossings into and out of the Northern Beaches peninsula transferring to the Beaches Link Tunnel, with the largest proportional reductions in traffic volumes being on the Spit Road and Military Road corridor. While the project would not generally increase the heavy vehicle demand travelling into and out of the Northern Beaches peninsula, it would substantially reduce the travel times of these freight trips and increase their productivity.

The transfer of these trips from surface arterial corridors to motorways would also increase the amenity of the main arterial corridors into and out of the Northern Beaches peninsula, decreasing the interactions between general traffic, public transport, pedestrians and cyclists and increasing road safety in these arterial corridors.

7.2.4 Tolling scenarios and implications

The 'Do something' scenario was assessed based on the following assumed tolling regime:

- Beaches Link Tunnel: two-way tolling
- Sydney Harbour Tunnel: existing southbound only toll
- Sydney Harbour Bridge (including Cahill Expressway): existing southbound only toll.

The decision to apply a toll to a road is a NSW Government decision and is not made at the project level. Tolling infrastructure has been included as part of this environmental assessment to provide the NSW Government with the option to apply tolls to traffic using the Beaches Link tunnel.

7.2.5 Strategic model road network performance

A summary of the forecast daily VKT and VHT of the Sydney region and the Western Harbour Tunnel and Beaches Link study area under the 'Do something' scenario for the 2027 and 2037 forecast years is provided in Table 7-7.

Analysis of the forecast daily VKT and VHT under the 'Do something' scenario shows that:

- The project would improve network productivity due to an increase in motorway daily VKT and decrease in daily VHT
- The road network would accommodate more or longer trips in a shorter time
- Traffic would shift from arterial (non-motorway) roads to the project (motorway) as evident in the similar or reduction in daily VHT and VKT on the non-motorway road network.

Table 7-7 Modelled 'Do something' daily VKT and VHT (SMPM)

Network measure	Road	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Sydney region					
Daily VKT	Motorway	27,135,000	27,399,000	31,810,000	32,170,000
	Other	87,592,000	87,570,000	103,604,000	103,601,000
	Total	114,727,000	114,969,000	135,414,000	135,772,000
Daily VHT	Motorway	513,000	501,000	758,000	737,000
	Other	3,248,000	3,244,000	5,174,000	5,167,000
	Total	3,761,000	3,745,000	5,931,000	5,904,000
Western Harbour Tunnel and Beaches Link study area					
Daily VKT	Motorway	6,377,000	6,623,000	6,891,000	7,253,000
	Other	15,315,000	15,286,000	16,654,000	16,656,000

Network measure	Road	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
	Total	21,693,000	21,909,000	23,545,000	23,909,000
Daily VHT	Motorway	149,000	136,000	187,000	165,000
	Other	656,000	655,000	774,000	773,000
	Total	805,000	791,000	961,000	938,000

7.2.6 Impacts on road safety

The project would substantially reduce the volume of traffic travelling on arterial roads at the metropolitan level. Vehicles using the Beaches Link and Gore Hill Freeway Connection on the motorway network would be travelling on a higher standard of road than urban arterials. This would have an impact on the number of crashes on arterial roads where traffic volumes would decrease when the project is in operation. Key existing roads that would have materially reduced daily traffic demands include:

- Spit and Military Roads
- Ourimbah Road
- Wakehurst Parkway
- Warringah Road and Boundary Street
- Pittwater Road
- Pacific Highway
- Eastern Valley Way.

A summary of the change in VKT from arterial standard to motorway standard roads as a result of the project is presented in Table 7-8. This change in arterial and motorway VKT, along with the associated average crash rates for arterial roads (based on the last five years of crash data) and motorways (based on the last five years of crash data for the Sydney Harbour Tunnel), indicate that overall crashes across the network would decrease by up to 562 crashes per year (77 per cent) as a result of the project.

Table 7-8 Forecast crash reduction due to Beaches Link and Gore Hill Freeway Connection

Project forecast annual VKT	Arterial crash rate (crashes per million VKT)	Tunnel crash rate (crashes per million VKT)	Reduction in annual crashes
22,591,803	32	7	562

In addition to these likely road safety benefits associated with a reduction in the number of crashes, the project would substantially reduce the volumes of trucks travelling on arterial corridors. This would also increase road safety on these arterial corridors and potentially reduce the severity of crashes, which would be less likely to involve heavy vehicles.

7.3 Beaches Link and Gore Hill Freeway Connection

7.3.1 Midblock Level of Service

A summary of midblock performance of the Beaches Link and Gore Hill Freeway Connection mainline and on and off ramps for the 2027 and 2037 forecast years is provided in Table 7-9 and Table 7-10.

Analysis of midblock performance indicates that generally the project would provide sufficient capacity to accommodate forecast traffic demands. However, forecast demand would be at capacity during peak periods at the following locations:

- Gore Hill Freeway Connection southbound diverge (2027 and 2037 morning peak)
- Beaches Link Tunnel southbound main carriageway (2037 morning peak)
- Balgowlah Connection and Frenchs Forest Connection southbound merge (2037 morning peak).

Although the Beaches Link Tunnel southbound main carriageway and Balgowlah Connection/Frenchs Forest Connection southbound merge would perform at LoS E, these segments of the project would be marginally above the LoS E threshold and operate within 10 per cent of the posted speed limit. It is estimated that the Gore Hill Freeway Connection southbound carriageway would operate around 10 kilometres per hour lower than the 80 kilometres per hour posted speed limit if forecast peak demands are realised.

Overall, analysis of the performance of the Beaches Link and Gore Hill Freeway Connection under the 'Do something' scenario under forecast morning and evening peak flows shows that the tunnel would operate efficiently under the 2027 and 2037 peak hour demands.

Table 7-9 Modelled 'Do something' morning peak hour Beaches Link and Gore Hill Freeway Connection performance

Segment	Direction	Minimum number of lanes	2027		2037	
			Density (PCU/km/lane)	LoS	Density (PCU/km/lane)	LoS
Beaches Link Tunnel (main carriageway)	Northbound	3	9.2	B	9.5	B
	Southbound	3	20.0	D	23.9	E
Warringah Freeway Connection (main carriageway)	Northbound	3	4.4	A	4.2	A
	Southbound	3	10.6	B	11.8	C
Gore Hill Freeway Connection (main carriageway)	Northbound	2	6.3	A	7.4	B
	Southbound	2	14.6	C	18.4	D
Balgowlah Connection (main carriageway)	Northbound	3	5.5	A	5.9	A
	Southbound	2	15.5	C	18.6	D
Frenchs Forest Connection (main carriageway)	Northbound	2	5.3	A	6.2	A
	Southbound	2	13.0	C	14.6	C
Gore Hill Freeway Connection (merge)	Northbound	3	8.9	B	10.2	B
Gore Hill Freeway Connection (diverge)	Southbound	2	22.8	E	26.5	E
Balgowlah/Frenchs Forest Connection (merge)	Southbound	3	19.8	D	23.7	E
Balgowlah/Frenchs Forest Connection (diverge)	Northbound	3	9.0	B	9.3	B

Table 7-10 Modelled 'Do something' evening peak hour Beaches Link and Gore Hill Freeway Connection performance

Segment	Direction	Minimum number of lanes	2027		2037	
			Density (PCU/km/lane)	LoS	Density (PCU/km/lane)	LoS
Beaches Link Tunnel (main carriageway)	Northbound	3	16.9	D	19.3	D
	Southbound	3	9.4	B	11.2	C
Warringah Freeway Connection (main carriageway)	Northbound	3	8.4	B	10.0	B
	Southbound	3	5.2	A	6.1	A
Gore Hill Freeway Connection (main carriageway)	Northbound	2	12.0	C	14.2	C
	Southbound	2	6.1	A	8.1	B
Balgowlah Connection (main carriageway)	Northbound	3	10.0	B	11.6	C
	Southbound	2	7.9	B	9.0	B
Frenchs Forest Connection (main carriageway)	Northbound	2	11.9	C	12.8	C
	Southbound	2	5.1	A	6.0	A
Gore Hill Freeway Connection (merge)	Northbound	3	18.1	D	20.5	D
Gore Hill Freeway Connection (diverge)	Southbound	2	10.2	B	12.6	C
Balgowlah/Frenchs Forest Connection (merge)	Southbound	3	10.1	B	11.1	B
Balgowlah/Frenchs Forest Connection (diverge)	Northbound	3	16.8	C	19.3	D

7.4 Warringah Freeway and surrounds

7.4.1 Network performance

A summary of future network performance statistics for the Warringah Freeway and surrounds study area is provided in Table 7-11 and Table 7-12. Analysis of the network performance with the project indicates:

- Peak period travel demand through the Warringah Freeway and surrounds study area would increase by around two per cent by 2037
- Average travel speeds through the Warringah Freeway and surrounds study area would decrease by up to six per cent in the morning peak, but increase by up to 23 per cent in the evening peak
- The number of stops during peak periods would increase in the morning peak by u to 29 per cent, indicating that the additional demand facilitated by Beaches Link could increase localised delays.

Network statistics for the Warringah Freeway and surrounds study area show that localised delays are expected to increase as a result of the project in the morning peak. This is primarily due to the transfer of traffic demand from existing surface roads to the Beaches Link Tunnel, which would increase demand on the Sydney Harbour Bridge. In the absence of the capacity and connectivity upgrades provided by the Western Harbour Tunnel, this increase in demand would increase delays on the existing Sydney Harbour crossings, with upstream effects on adjacent network connections.

In the evening peak Beaches Link would provide additional capacity for outbound traffic crossing Sydney Harbour and leaving the lower North Shore, relieving existing corridors including Military Road and Eastern Valley Way. This is shown by substantial improvements in terms of average network speeds and the number of stops.

Table 7-11 Modelled 'Do something' morning peak network performance - Warringah Freeway and surrounds study area

Network measure	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Network statistics for all vehicles				
Total traffic demand (veh)	104,500	105,900	112,400	115,000
Total VKT through network	340,400	360,400	350,700	375,900
Total VHT through network	9000	10,800	10,160	11,550
Total number of stops	616,200	788,500	746,100	856,000
Average vehicle statistics				
Average vehicle trip length through the network (km)	3.5	3.7	3.5	3.6
Average vehicle trip time through the network (hours)	0:05:32	0:06:40	0:06:01	0:06:43
Average number of stops per trip	6.3	8.1	7.4	8.3
Average trip speed (km/hr)	37.8	33.3	34.5	32.5
Unreleased traffic				
Total unreleased trips	6890	8480	11,270	11,750
% of demand unreleased	7%	8%	10%	10%

Table 7-12 Modelled 'Do something' evening peak network performance - Warringah Freeway and surrounds study area

Network measure	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Network statistics for all vehicles				
Total traffic demand (veh)	109,500	111,800	118,100	120,700
Total VKT through network	344,900	371,900	349,000	385,500
Total VHT through network	9880	9130	12,370	11,100
Total number of stops	621,100	263,500	980,300	460,700

Network measure	2027 ‘Do minimum’	2027 ‘Do something’	2037 ‘Do minimum’	2037 ‘Do something’
Average vehicle statistics				
Average vehicle trip length through the network (km)	3.3	3.6	3.2	3.6
Average vehicle trip time through the network (hours)	0:05:37	0:05:17	0:06:51	0:06:08
Average number of stops per trip	5.9	2.5	9.1	4.2
Average trip speed (km/hr)	34.9	40.7	28.2	34.8
Unreleased traffic				
Total unreleased trips	3900	8030	9800	12,100
% of demand unreleased	4%	7%	8%	10%

7.4.2 General traffic travel times

Modelled future general traffic travel times for key routes through the Warringah Freeway and surrounds study area are provided in Table 7-13 and Table 7-14. Analysis of the modelled general traffic travel times shows:

- Evening peak travel times for most routes along the Warringah Freeway would remain similar or improve as a result of the project. This is due to the additional outbound capacity and simplification of weaving and merging arrangements provided as part of the Warringah Freeway Upgrade
- Morning peak travel times along the Warringah Freeway to the Cahill Expressway would increase as a result of the project. This is due to increased inbound demand on the Sydney Harbour Bridge. In the absence of the capacity and connectivity upgrades provided by the Western Harbour Tunnel, this increase in demand would increase delays on the existing Sydney Harbour crossings and upstream motorway corridor.

Table 7-13 Modelled ‘Do something’ morning peak hour general traffic travel times - Warringah Freeway and surrounds study area

Route	Direction	2027 ‘Do minimum’	2027 ‘Do something’	2037 ‘Do minimum’	2037 ‘Do something’
Sydney Harbour Bridge to Warringah Freeway/Falcon Street interchange	Northbound	0:04:40	0:05:47	0:04:51	0:04:56
	Southbound	0:04:03	0:04:06	0:04:02	0:04:13
Sydney Harbour Tunnel to Warringah Freeway/Falcon Street interchange	Northbound	0:03:55	0:11:50	0:04:08	0:12:07
	Southbound	0:04:03	0:04:17	0:04:02	0:04:18
Sydney Harbour Bridge to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:06:13	0:07:41	0:06:16	0:06:45
	Southbound	0:13:35	0:13:29	0:15:22	0:13:46
Sydney Harbour Tunnel to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:05:26	0:16:21	0:05:30	0:17:03
	Southbound	0:11:39	0:11:20	0:12:37	0:11:30
Berry Street to Amherst Street via Miller Street	Northbound	0:03:42	0:03:56	0:03:53	0:04:07
	Southbound	0:04:25	0:04:04	0:05:43	0:04:05

Table 7-14 Modelled 'Do something' evening peak hour general traffic travel times - Warringah Freeway and surrounds study area

Route	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Sydney Harbour Bridge to Warringah Freeway/Falcon Street interchange	Northbound	0:04:02	0:03:26	0:07:51	0:04:51
	Southbound	0:06:09	0:04:44	0:05:02	0:04:41
Sydney Harbour Tunnel to Warringah Freeway/Falcon Street interchange	Northbound	0:03:57	0:03:22	0:07:36	0:03:25
	Southbound	0:14:54	0:05:52	0:14:59	0:07:41
Sydney Harbour Bridge to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:05:35	0:05:26	0:06:45	0:06:53
	Southbound	0:13:56	0:06:18	0:17:31	0:07:28
Sydney Harbour Tunnel to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:05:28	0:05:17	0:06:46	0:05:22
	Southbound	0:25:21	0:07:23	0:30:09	0:13:50
Berry Street to Amherst Street via Miller Street	Northbound	0:03:52	0:04:39	0:03:50	0:10:22
	Southbound	0:05:01	0:05:30	0:08:39	0:05:01

7.4.3 Intersection performance

Modelled future performance for key intersections in the Warringah Freeway and surrounds study area under the 'Do something' scenario are presented in Table 7-15 and Table 7-16. Modelled intersection performance indicates the following when compared to the equivalent 'Do minimum' scenarios:

- Average delays around some local intersections along Berry Street and Pacific Highway could increase by around 30 to 40 seconds following the introduction of Beaches Link traffic along these corridors
- Intersection performance along Brook Street in the vicinity of the Warringah Freeway would improve substantially as a result of the Warringah Freeway Upgrade during the morning peak. This due to the changes in access to Brook Street from the Warringah Freeway, which under the Warringah Freeway Upgrade would be limited to trips from the Sydney Harbour Bridge and Berry Street. In the evening peak localised congestion on the Warringah Freeway may continue to impact the efficiency of this interchange.
- Intersections along Pacific Highway would experience increased localised delays at some locations in the morning peak period as a result of the project. This is due to the changes to traffic patterns and access arrangements to, from, and within North Sydney as a result of the Warringah Freeway Upgrade
- The intersection of Ben Boyd Road and Military Road has the potential to operate with higher delays as a result of the Warringah Freeway Upgrade due to the reconfiguration of Warringah Freeway, which would change the accessibility of the Ernest Street ramps to and from the Warringah Freeway. Traffic that currently uses the Ourimbah Road corridor as an alternative to Military Road would no longer be able to access the same destinations that are currently accessible from Ernest Street.

Overall, although the project would generally improve network performance for most of the day, it would not resolve localised performance issues at several intersections during the busiest peak periods. However, there would be an overall net improvement in traffic and network speeds across the broader network as a result of the project.

The proposed road network integration works and resultant traffic performance in the North Sydney area have been developed in the context of the growing North Sydney CBD environment. The works in the area proposed by the project seek to maintain an appropriate level of traffic movement while also preserving capacity and connectivity for other customers whose needs conflict with traffic – particularly pedestrians. Options to further increase traffic performance at intersections throughout the area have been investigated. However, these alternative options would result in further impacts on other customers. The proposed works are considered to provide an equitable and balanced outcome from the perspective of maintaining a balanced and integrated transport network through North Sydney. Further refinements and changes to network operations within the North Sydney CBD may occur as part of the North Sydney Integrated Transport Program works.

Table 7-15 Modelled 'Do something' morning peak hour intersection performance - Warringah Freeway and surrounds study area

Intersection	2027 'Do minimum'		2027 'Do something'		2037 'Do minimum'		2037 'Do something'	
	Ave delay (sec)	LoS	Ave delay (sec)	LoS	Ave delay (sec)	LoS	Ave delay (sec)	LoS
Willoughby Road/Gore Hill Freeway interchange	>100	F	27	B	>100	F	21	B
Brook Street/Warringah Freeway on ramp	>100	F	13	A	>100	F	70	E
Brook Street/Warringah Freeway off ramp	61	E	21	B	67	E	9	A
Brook Street/Merrenburn Avenue	>100	F	31	C	>100	F	70	E
Amherst Street/West Street	5	A	7	A	5	A	>100	F
Amherst Street/Miller Street	21	B	38	C	20	B	58	E
Miller Street/Warringah Freeway on ramp	7	A	<5	A	6	A	<5	A
Miller Street/Warringah Freeway off ramp	12	A	5	A	13	A	5	A
Miller Street/Ernest Street	25	B	44	D	32	C	40	C
Miller Street/Falcon Street	35	C	27	B	38	C	25	B
Ernest Street/Warringah Freeway on ramp	5	A	19	B	5	A	53	D
Ernest Street/Warringah Freeway off ramp (off ramp in PM, on ramp in AM)	5	A	19	B	5	A	48	D
Falcon Street/Warringah Freeway ramps	29	C	36	C	15	B	45	D
Watson Street/Military Road	18	B	38	C	26	B	37	C
Military Road/Ben Boyd Road	15	B	47	D	23	B	44	D
Falcon Street/Merlin Street	24	B	46	D	32	C	47	D
Berry Street/Walker Street	29	C	76	F	39	C	46	D
Berry Street/Miller Street	55	D	49	D	69	E	39	C
Mount Street/Arthur Street	46	D	46	D	59	E	33	C
Mount Street/Walker Street	36	C	47	D	48	D	41	C
Pacific Highway/High Street/Arthur Street	19	B	57	E	38	C	45	D

Intersection	2027 'Do minimum'		2027 'Do something'		2037 'Do minimum'		2037 'Do something'	
	Ave delay (sec)	LoS	Ave delay (sec)	LoS	Ave delay (sec)	LoS	Ave delay (sec)	LoS
Pacific Highway/Walker Street/Blue Street	36	C	55	D	65	E	49	D
Pacific Highway/Miller Street/Mount Street	38	C	79	F	41	C	72	F
Pacific Highway/Berry Street	56	E	17	B	52	D	16	B
Pacific Highway/Bay Road	55	D	23	B	77	F	23	B
Miller Street/McLaren Street	23	B	40	C	72	F	42	C
Miller Street/Ridge Street	38	C	33	C	53	D	45	D
Miller Street/Carlow Street	13	A	8	A	13	A	8	A
High Street/Clark Road	18	B	32	C	55	D	37	C
High Street/Alfred Street	13	A	49	D	62	E	32	C
Mount Street/Alfred Street	<5	A	16	B	<5	A	16	B
Ernest Street/Ben Boyd Road	12	A	11	A	12	A	14	B
Pedestrian crossing at Military Road	6	A	<5	A	5	A	<5	A

Table 7-16 Modelled 'Do something' evening peak hour intersection performance - Warringah Freeway and surrounds study area

Intersection	2027 'Do minimum'		2027 'Do something'		2037 'Do minimum'		2037 'Do something'	
	Ave delay (sec)	LoS	Ave delay (sec)	LoS	Ave delay (sec)	LoS	Ave delay (sec)	LoS
Willoughby Road/Gore Hill Freeway interchange	38	C	10	A	76	F	10	A
Brook Street/Warringah Freeway on ramp	14	B	9	A	17	B	92	F
Brook Street/Warringah Freeway off ramp	22	B	17	B	20	B	87	F
Brook Street/Merrenburn Avenue	11	A	53	D	13	A	59	E
Amherst Street/West Street	9	A	89	F	14	A	>100	F
Amherst Street/Miller Street	29	C	47	D	31	C	52	D
Miller Street/Warringah Freeway on ramp	6	A	6	A	6	A	6	A
Miller Street/Warringah Freeway off ramp	15	B	9	A	15	B	9	A
Miller Street/Ernest Street	41	C	36	C	43	D	35	C

Intersection	2027 'Do minimum'		2027 'Do something'		2037 'Do minimum'		2037 'Do something'	
	Ave delay (sec)	LoS	Ave delay (sec)	LoS	Ave delay (sec)	LoS	Ave delay (sec)	LoS
Miller Street/Falcon Street	44	D	82	F	49	D	95	F
Ernest Street/Warringah Freeway on ramp	15	B	12	A	15	B	12	A
Ernest Street/Warringah Freeway off ramp (off ramp in PM, on ramp in AM)	17	B	13	A	17	B	14	A
Falcon Street/Warringah Freeway ramps	72	F	70	E	>100	F	68	E
Watson Street/Military Road	46	D	50	D	59	E	46	D
Military Road/Ben Boyd Road	54	D	65	E	70	E	>100	F
Falcon Street/Merlin Street	>100	F	94	F	>100	F	93	F
Berry Street/Walker Street	44	D	82	F	73	F	81	F
Berry Street/Miller Street	46	D	35	C	70	F	76	F
Mount Street/Arthur Street	49	D	17	B	92	F	18	B
Mount Street/Walker Street	32	C	47	D	75	F	59	E
Pacific Highway/High Street/Arthur Street	46	D	14	A	61	E	23	B
Pacific Highway/Walker Street/Blue Street	40	D	65	E	80	F	79	F
Pacific Highway/Miller Street/Mount Street	41	C	57	E	58	E	78	F
Pacific Highway/Berry Street	23	B	15	B	56	E	34	C
Pacific Highway/Bay Road	15	B	22	B	41	C	40	C
Miller Street/McLaren Street	21	B	39	C	55	D	76	F
Miller Street/Ridge Street	40	C	15	B	91	F	57	E
Miller Street/Carlow Street	8	A	6	A	19	B	55	D
High Street/Clark Road	61	E	50	D	97	F	52	D
High Street/Alfred Street	>100	F	41	C	>100	F	42	C
Mount Street/Alfred Street	12	A	14	A	10	A	14	A
Ernest Street/Ben Boyd Road	44	D	10	A	94	F	38	C
Pedestrian crossing at Military Road	27	B	5	A	34	C	5	A

7.4.4 Road network changes and access arrangements

At its southern end, the project would connect directly via on and off ramps to the Warringah Freeway at Cammeray, north of Ernest Street Bridge. Onward connections to North Sydney, Bradfield Highway and the Cahill Expressway would be provided as part of the Warringah Freeway Upgrade project.

The project would also connect to the Western Harbour Tunnel via a direct underground connection in the Warringah Freeway and surrounds area.

Warringah Freeway Upgrade

The remaining road network changes in the Warringah Freeway and surrounds study area would be associated with the Warringah Freeway Upgrade (part of the Western Harbour Tunnel and Warringah Freeway Upgrade project, subject to separate environmental assessment and approval), which is required for the Beaches Link and Gore Hill Freeway Connection to be operational.

The Warringah Freeway Upgrade component of the Western Harbour Tunnel and Warringah Freeway Upgrade project is proposed to substantially improve the efficiency and safety of the motorway and arterial road interfaces. The upgrade would involve extensive upgrades to surface roads and existing connections that would:

- Connect and integrate with the Western Harbour Tunnel
- Improve wayfinding and separate traffic on the freeway based on trip function (through traffic, traffic for arterial distribution and traffic for local destinations).

The upgrade would include the removal of tidal flow arrangements on the Warringah Freeway, while existing tidal flow arrangements on the Sydney Harbour Bridge would not be directly affected by the project. In addition, the upgraded Warringah Freeway would simplify traffic flow and improve wayfinding by providing the following traffic lanes:

- A northbound outer carriageway that would comprise:
  - An outer western carriageway, carrying northbound traffic from the Sydney Harbour Bridge to the Beaches Link northbound on ramp and for local distribution to local destinations such as North Sydney and Crows Nest
  - Inner western carriageways, carrying northbound traffic from the Sydney Harbour Bridge and Sydney Harbour Tunnel
- A central carriageway that would carry northbound and southbound motorway traffic between the Western Harbour Tunnel, Gore Hill Freeway and Willoughby Road
- A southbound outer carriageway would comprise:
  - Inner eastern carriageways, carrying southbound traffic to the Sydney Harbour Tunnel and for distribution to local destinations such as Neutral Bay
  - The outer eastern carriageway, carrying southbound traffic for the Sydney Harbour Bridge (both the Bradfield Highway and Cahill Expressway) and for distribution to local destinations such as North Sydney and Kirribilli
  - A dedicated bus lane between Miller Street, Cammeray and the Sydney Harbour Bridge, Milsons Point, which would carry southbound buses and other permitted bus lane vehicles.

Access restrictions proposed by the project and the Warringah Freeway Upgrade are presented in Figure 7-6 and are as follows:

- The existing Falcon Street westbound off ramp from the Warringah Freeway would be converted to the northbound off ramp from the Western Harbour Tunnel, thereby removing connectivity between the Warringah Freeway northbound and Falcon Street westbound. Adjacent interchanges north and south of Falcon Street would provide similar alternative connectivity
- Existing connectivity between Sydney Harbour Tunnel in the northbound direction to Falcon Street (in the westbound direction only), Miller Street and Brook Street would be removed. Alternative connectivity would be included by providing a new northbound access between Sydney Harbour Tunnel and Ernest Street or Sydney Harbour Bridge/Cahill Expressway and Miller Street/Brook Street

- There would be no access from the Berry Street northbound on ramp to the Falcon Street eastbound off ramp (in addition to the Falcon Street westbound off ramp identified above), or to the Warringah Freeway mainline. Connections to Western Harbour Tunnel, Beaches Link, and the Miller Street and Brook Street off ramps would only be provided from the Berry Street northbound on ramp and provision made for future connection to the Western Harbour Tunnel. Traffic would be required to travel via the North Sydney road network to access the new High Street northbound on ramp, Falcon Street eastbound or the Warringah Freeway via the Falcon Street interchange
- Access from the Falcon Street southbound on ramp to the Cahill Expressway would be removed. Access would be maintained from the Falcon Street southbound on ramp to Sydney Harbour Bridge (Bradfield Highway) and Sydney Harbour Tunnel, providing connectivity to the Sydney CBD and Western Suburbs, and the Eastern Suburbs, respectively
- Access between the ramps at Falcon Street and Brook Street via the Warringah Freeway would be removed. Traffic would instead be required to travel via alternative roads to access these locations
- Access would be removed from the Alfred Street North southbound off ramp to Alfred Street North in the northbound direction. Traffic would be required to exit the Warringah Freeway at Falcon Street or continue onto High Street and travel via alternative roads to access Alfred Street North.

The Warringah Freeway Upgrade involves several modifications to existing bridges that span across the Warringah Freeway between the Sydney Harbour Bridge and Willoughby Road in Naremburn. These modifications are outlined in Table 7-17.

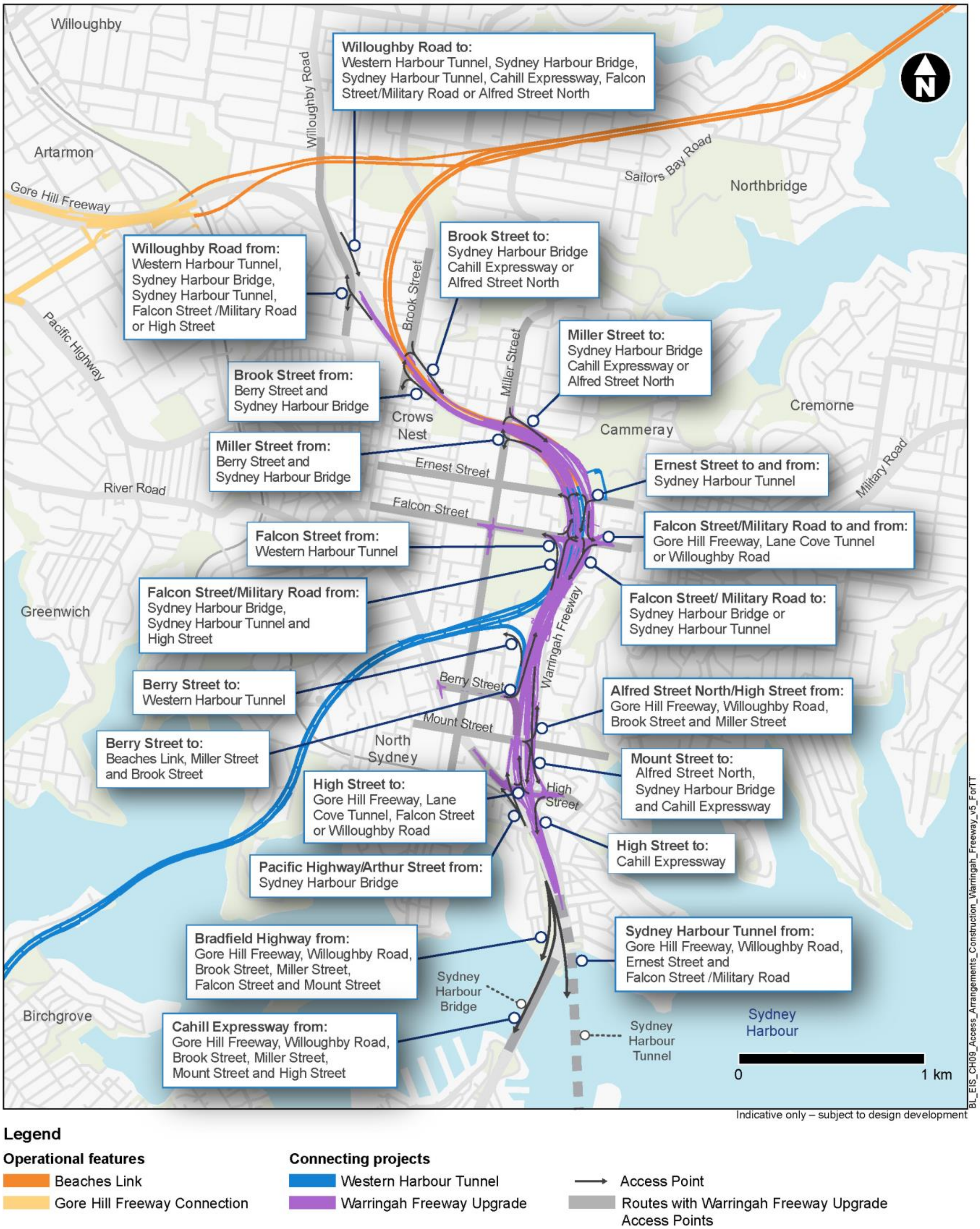


Figure 7-6 Access arrangements upon completion of construction works at the Warringah Freeway

Table 7-17 Bridge modifications as part of the Warringah Freeway Upgrade

Location	Modifications
High Street	High Street bridge would be widened to provide an additional westbound traffic lane and a new shared user path on the southern side. A new northbound on ramp and southbound off ramp connection (with associated upgrade works along Alfred Street North) to and from Warringah Freeway would also be provided.
Mount Street	Mount Street bridge would be widened at its south-eastern and south-western corners to support new or modified on and off ramps. A new single lane underpass would be constructed beneath Mount Street as part of a new dedicated southbound bus lane.
Alfred Street North	A new bridge structure would be provided over the southbound bus lane and the Alfred Street North connection to Mount Street.
Ridge Street	Ridge Street shared user bridge would be replaced and constructed further south from its existing location.
Falcon Street	Falcon Street bridge would be widened to accommodate a diverging diamond interchange configuration. This involves the signalisation of the interchange at its eastern and western ends. In addition, the footpath on the southern side would be removed and replaced by a traffic lane and the alignment of the northbound off ramp would be moved and widened. The pedestrian underpass on the eastern side of the bridge would also be removed.
Falcon Street Pedestrian Bridge	The existing Falcon Street pedestrian bridge would be demolished and replaced with a new bridge that would provide the same connectivity as the existing pedestrian bridge. The new pedestrian bridge would be constructed prior to the demolition of the existing bridge, maintaining the existing connectivity for pedestrians and cyclists through the course of the project.
Ernest Street	A new active transport bridge between Cammeray Park and ANZAC Park would be constructed on the same alignment as Ernest Street and would deliver the same connectively as is currently provided by the existing Ernest Street cycleway A new bridge would be constructed to the east of the existing bridge prior to the Merlin Street and Ernest Street intersection. Referred to as the 'mouse-hole', this would be a cut and cover underpass (underpass for road lanes) on the eastern side of Ernest Street bridge.
Miller Street/Brook Street	A new on ramp bridge would be constructed to accommodate traffic from Miller Street and Brook Street onto the Warringah Freeway.

The diverging diamond configuration at the Falcon Street interchange would comprise cross-over intersections at each end of the interchange, requiring vehicles to travel on the right side of the road to avoid conflicting right turn movements. This configuration would reduce the number of signal phases required and the number of opposing traffic movements, which would improve road safety and traffic efficiency. As a result of these changes, connections between the upgraded Warringah Freeway and arterial road network would be provided at:

- Willoughby Road
- Brook Street
- Miller Street
- Falcon Street
- Berry Street
- Mount Street

- High Street
- Pacific Highway.

In addition to the bridge modifications outlined in Table 7-17, other local road changes would be required as part of the Warringah Freeway Upgrade to integrate the project with the existing road network. These changes are outlined in Table 7-18

Table 7-18 Local road and intersection changes as part of Warringah Freeway Upgrade

Location	Upgrade or changes
High Street	The High Street interchange would be upgraded and reconfigured as discussed in Table 7-17 The roundabout at High Street/Alfred Street (east of Warringah Freeway) would be converted to a signalised intersection Kerbside parking on High Street on the approach to the intersection with Clark Road would be prohibited during the morning and evening peak periods
Clark Road	Kerbside parking on Clark Road on the approach to the intersection with High Street would be prohibited during the morning and evening peak periods
Alfred Street North	Alfred Street North would be realigned to the east of its existing alignment from around the existing Ridge Street pedestrian bridge to Wyagdon Street The road would be widened to provide a two-lane off ramp from the Warringah Freeway around Darley Street to Mount Street, one lane to the Cahill Expressway from around Darley Street, two lanes continuing on Alfred Street North to around Mount Street, and three lanes from around Mount Street to High Street
Pacific Highway	The existing raised median separating northbound traffic on lane 2 and lane 3 between Arthur Street and Walker Street would be replaced and shifted to separate northbound traffic on lane 3 and lane 4 At the Pacific Highway/Berry Street intersection, the Pacific Highway southbound approach would be reconfigured to one left turn lane and two through lanes, and the Pacific Highway northbound approach would be reconfigured to two right turn lanes and two through lanes
Arthur Street	Existing traffic lanes on Arthur Street from Pacific Highway to Mount Street would be reconfigured to include a northbound kerbside traffic lane, allowing for three right turn traffic lanes and one left turn lane into Mount Street The existing bus lane would be removed
Berry Street	Kerb build outs would be removed to provide an additional eastbound lane at the intersection with Miller Street An eastbound clearway on the southern side of Berry Street between Pacific Highway and Walker Street would be introduced At the Berry Street/Miller Street intersection, an exclusive pedestrian phase would be implemented and the right turn from Miller Street northbound into Berry Street would be closed (buses excepted) Reconfiguration of Berry Street east of Walker Street with provision of two traffic lanes connecting to the project, one traffic lane providing connection to the Warringah Freeway northbound and Arthur Street southbound, and one traffic lane connecting to Arthur Street southbound only
Falcon Street	The Falcon Street interchange would be upgraded and reconfigured as discussed in Table 7-17 At the Falcon Street/Miller Street intersection:

Location	Upgrade or changes
	▪ A new shared left turn and through movement short lane would be provided on the Falcon Street eastbound approach ▪ A new left turn short lane would be provided on the Miller Street southbound approach ▪ The shared through movement and right turn traffic lane would be converted to a right turn only lane on the Falcon Street northbound approach
West Street	Parking restrictions on both sides of West Street would be implemented on the approach to the intersection with Falcon Street
Ben Boyd Road	Parking restrictions on both sides of Ben Boyd Road would be implemented on the approach to the intersection with Military Road
Miller Street	Parking restrictions on Miller Street northbound between Pacific Highway and Berry Street would be implemented At the Miller Street/Amherst Street intersection, the Miller Street northbound right turn bay would be extended The Miller Street/Warringah Freeway southbound on ramp intersection would be upgraded to a signalised intersection
Amherst Street	Parking restrictions on Amherst Street in the westbound direction would be extended from around 50 metres to 100 metres between Miller Street and Tarella Place Parking restrictions on Amherst Street in the eastbound direction would be extended from around 60 metres to 100 metres between Miller Street and Ixion Lane

The proposed local road and intersection changes identified in Table 7-18 would improve traffic flow and increase capacity. The performance of the road network and intersections is discussed in sections 7.4.1 to 7.4.3. Some proposed changes would require motorists to change their route due to the closure of movements at intersections. These include closure of the right turn from Miller Street northbound into Berry Street, which would divert traffic onto Pacific Highway northbound to access Berry Street from its western end.

7.4.5 Public transport impacts

Modelled future bus travel times for key routes through the Warringah Freeway and surrounds area under the ‘Do something’ scenario are shown in Table 7-19 and Table 7-20. Analysis of the modelled bus travel times indicates:

- Travel times on bus routes through North Sydney may incur localised impacts during peak periods due to changed traffic patterns at the perimeter of North Sydney CBD
- Travel times for southbound buses through North Sydney via Pacific Highway and Berry Street would improve due to the changes to the arrangements at the intersection of Berry Street and Miller Street, which would simplify signal phasing and remove the existing conflict between right turning buses and pedestrians
- Travel times for buses from Gore Hill Freeway to the Sydney Harbour Bridge would improve substantially, particularly southbound during peak periods. This is due to the reconfiguration of the southbound bus lane between Miller Street and the Cahill Expressway, which would be separated from the general traffic lanes, thereby removing two existing weave movements between buses and cars. Buses would no longer be required to merge from left to right to access the bus lane from the north and cars would no longer be able to cross the bus lane between Falcon Street and the Cahill Expressway
- Travel times for buses travelling to and from Falcon Street would generally improve as a result of the upgrade of this interchange and reconfiguration of the southbound bus lane, which removes the existing conflict with general traffic, and also as a result of the reduction in traffic demand to the Willoughby Road

and Falcon Street ramps, which would otherwise cause increasing congestion, blocking access to the northbound bus off ramp to Falcon Street.

Table 7-19 Modelled 'Do something' morning peak hour bus travel times - Warringah Freeway and surrounds study area

Route	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Sydney Harbour Bridge to Amherst Street (via Miller Street and North Sydney Station)	Northbound	0:09:55	0:17:00	0:09:30	0:14:34
	Southbound	0:11:31	0:10:45	0:13:26	0:09:35
Sydney Harbour Bridge to Bay Street (via North Sydney Station and Pacific Highway)	Northbound	0:06:05	0:12:54	0:06:29	0:09:55
	Southbound	0:11:35	0:07:39	0:13:31	0:07:27
Sydney Harbour Bridge to Ben Boyd Road	Northbound	0:06:28	0:07:25	0:06:43	0:06:07
	Southbound	0:06:28	0:05:17	0:06:33	0:05:19
Sydney Harbour Bridge to Lane Cove Tunnel (via Gore Hill Freeway)	Northbound	0:06:43	0:07:57	0:06:42	0:06:39
	Southbound	0:25:33	0:11:52	0:28:17	0:09:48

Table 7-20 Modelled 'Do something' evening peak hour bus travel times - Warringah Freeway and surrounds study area

Route	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Sydney Harbour Bridge to Amherst Street (via Miller Street and North Sydney Station)	Northbound	0:11:03	0:12:56	0:13:34	0:23:14
	Southbound	0:13:14	0:16:03	0:19:09	0:15:52
Sydney Harbour Bridge to Bay Street (via North Sydney Station and Pacific Highway)	Northbound	0:07:13	0:08:21	0:09:52	0:11:10
	Southbound	0:09:17	0:12:39	0:13:59	0:13:06
Sydney Harbour Bridge to Ben Boyd Road	Northbound	0:08:27	0:04:50	0:08:36	0:06:08
	Southbound	0:05:52	0:05:27	0:06:51	0:05:41
Sydney Harbour Bridge to Lane Cove Tunnel (via Gore Hill Freeway)	Northbound	0:06:12	0:06:14	0:06:33	0:07:33
	Southbound	0:15:53	0:06:51	0:20:57	0:07:21

As part of the Warringah Freeway Upgrade, a new dedicated southbound bus lane on the Warringah Freeway would extend from Miller Street to the Sydney Harbour Bridge, with new bus lanes connecting bus services to this lane from Falcon Street and Mount Street. This would remove direct interaction between buses and general traffic on the approach to the Sydney Harbour Bridge, thereby improving southbound bus operations.

Bus lanes at the Falcon Street interchange would be maintained as part of the diverging diamond configuration.

The Warringah Freeway Upgrade would also result in the relocation of existing bus layover facilities on the Warringah Freeway north of Ernest Street to within a widened section of the motorway near Cammeray Golf Course (14 bays and an amenity block for drivers) and on the Cahill Expressway south of High Street (nine bays). Similar layover space would be provided as per the existing arrangement.

As outlined previously in Table 7-18, the northbound bus only lane that operates during the weekday morning peak on Arthur Street would also be removed as part of the Warringah Freeway Upgrade.

Overall, the impacts of the project on buses would be generally positive, with travel time savings for the high-demand bus routes from the Gore Hill Freeway and Military Road corridors, although in some specific instances there would be some localised increase in bus travel times through the North Sydney CBD area.

7.4.6 Active transport impacts

The changes to the active transport network within the Warringah Freeway and surrounds study area would be due to the Warringah Freeway Upgrade component of the Western Harbour Tunnel and Warrigah Freeway Upgrade project, with no changes proposed as part of Beaches Link. The Warringah Freeway Upgrade would deliver new or upgraded pedestrian and cycle infrastructure, enhancing pedestrian and cyclist safety, accessibility, and connectivity. This would include:

- A new dedicated cycleway on the eastern side of Warringah Freeway between Miller Street and Falcon Street
- A new shared user path on the southern side of the High Street bridge and signalised pedestrian crossings at the Alfred Street North/High Street intersection
- Replacement of the Ridge Street bridge with a wider structure with dedicated cycle lanes and a pedestrian path
- Replacement of the Falcon Street shared user bridge with a new structure to be constructed prior to the demolition of the existing bridge
- A new shared user bridge, about 10 metres wide, to the north of Ernest Street at Cammeray, to connect the Cammeray Golf Course with ANZAC Park that would provide the same pedestrian and cycle connectivity as the existing shared user path and cycleway on the Ernest Street bridge
- Consolidating pedestrian crossings into a central median shared user path at the Falcon Street interchange as part of the diverging diamond configuration
- Improved pedestrian crossings at the Falcon Street interchange ramp connections and increased pedestrian safety with fencing along the footpath
- Removal of the pedestrian underpass at the eastern side of the Falcon Street bridge. This underpass would be permanently removed during construction, with users required to travel up to an additional 380 metres, increasing their travel time. However, existing pedestrian volumes are low and therefore overall impacts would be minor.

7.5 Gore Hill Freeway and Artarmon

7.5.1 Network performance

A summary of future network performance statistics for the Gore Hill Freeway and Artarmon study area under the ‘Do something’ scenario is presented in Table 7-21 and Table 7-22

- Peak period traffic demand through the Gore Hill Freeway and Artarmon study area would increase by up to 13 per cent by 2037
- Average travel speeds through the Gore Hill Freeway and Artarmon study area would increase by up to 19 per cent in the morning peak but would not change substantially in the evening peak. This is a consequence of the conversion of the existing eastbound T2 transit lane to a general traffic lane. This change would reduce delays primarily during the morning peak, with lower evening peak flows in this section of the network
- The number of stops would remain generally similar to the ‘Do minimum’ scenario, except during the 2037 morning peak, when they would reduce substantially. This is also due to the conversion of the existing

eastbound T2 transit lane to a general traffic lane, providing additional capacity in the morning peak to meet forecast demand.

Network performance measures for the Gore Hill Freeway and Artarmon study area indicate that the localised works associated with the Beaches Link and Gore Hill Freeway Connection would facilitate additional traffic travelling through the corridor at a generally similar or reduced level of delay.

Table 7-21 Modelled 'Do something' morning peak network performance - Gore Hill Freeway and Artarmon study area

Network measure	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Network statistics for all vehicles				
Total traffic demand (veh)	31,100	35,000	34,100	38,400
Total VKT through network	79,800	94,500	87,900	102,700
Total VHT through network	1710	2070	2280	2250
Total number of stops	43,100	54,000	113,700	55,700
Average vehicle statistics				
Average vehicle trip length through the network (km)	2.4	2.5	2.4	2.5
Average vehicle trip time through the network (hours)	0:03:08	0:03:21	0:03:48	0:03:20
Average number of stops per trip	1.3	1.5	3.2	1.4
Average trip speed (km/h)	46.8	45.7	38.5	45.7
Unreleased traffic				
Total unreleased trips	<10	790	530	890
% of demand unreleased	<1%	2%	1%	2%

Table 7-22 Modelled 'Do something' evening peak network performance - Gore Hill Freeway and Artarmon study area

Network measure	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Network statistics for all vehicles				
Total traffic demand (veh)	31,100	33,600	34,400	36,300
Total VKT through network	79,400	91,000	85,800	97,500
Total VHT through network	1800	1930	2010	2250
Total number of stops	48,000	44,200	62,400	63,000
Average vehicle statistics				
Average vehicle trip length through the network (km)	2.4	2.5	2.4	2.6
Average vehicle trip time through the network (hours)	0:03:17	0:03:14	0:03:23	0:03:32
Average number of stops per trip	1.5	1.2	1.8	1.6

Network measure	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Average trip speed (km/h)	44.0	47.2	42.6	43.3
Unreleased traffic				
Total unreleased trips	260	60	820	1060
% of demand unreleased	1%	<1%	2%	3%

7.5.2 General traffic travel times

Modelled future general traffic travel times for key routes through the Gore Hill Freeway and Artarmon study area under the 'Do something' scenario are presented in Table 7-23 and Table 7-24. Analysis of the modelled general traffic travel times indicates that travel times along the Gore Hill Freeway through Artarmon would not change substantially due to the project, with the exception of westbound trips from Gore Hill Freeway to the Lane Cove Tunnel, which would marginally improve in the morning peak due to the reduction in traffic volumes from the Reserve Road interchange to the Lane Cove Tunnel.

Table 7-23 Modelled 'Do something' morning peak hour general traffic travel times - Gore Hill Freeway and Artarmon study area

Route	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Longueville Road to Gore Hill Freeway	Eastbound	0:01:28	0:01:28	0:01:24	0:01:28
	Westbound	0:01:24	0:01:22	0:01:28	0:01:22
Lane Cove Tunnel to Gore Hill Freeway	Eastbound	0:01:18	0:01:16	0:01:24	0:01:17
	Westbound	0:01:17	0:01:17	0:02:16	0:01:18

Table 7-24 Modelled 'Do something evening peak hour general traffic travel times - Gore Hill Freeway and Artarmon study area

Route	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Longueville Road to Gore Hill Freeway	Eastbound	0:01:26	0:01:26	0:01:25	0:01:26
	Westbound	0:01:23	0:01:23	0:01:23	0:01:23
Lane Cove Tunnel to Gore Hill Freeway	Eastbound	0:01:22	0:01:16	0:01:23	0:01:16
	Westbound	0:01:12	0:01:17	0:01:12	0:01:17

7.5.3 Intersection performance

Modelled future performance for key intersections in the Gore Hill Freeway and Artarmon study area for under the 'Do something' scenario is presented in Table 7-25 and Table 7-26. Analysis of intersection performance with the project indicates:

- The Epping Road/Longueville Road/Parklands Avenue intersection would continue to operate with substantial delays during peak periods due to continued high levels of traffic demand. As traffic volumes increase, queuing on Parklands Avenue and Longueville Road may increase as priority is given to the east–west movements through this intersection

- The Longueville Road/Pacific Highway intersection would operate satisfactorily, indicating that additional traffic volumes at the intersection of Epping Road and Longueville Road would not impact on performance at this adjacent intersection
- The Gore Hill Freeway/Reserve Road interchange would operate at a similar or improved level of service with the project due to the proposed capacity and signal operation upgrades.

Analysis of the modelled intersection performance for the Gore Hill Freeway and Artarmon study area indicates that the project would result in increased demand through the area and that the proposed design would facilitate this additional travel without substantially increasing delays at critical intersections on the arterial road network.

Table 7-25 Modelled 'Do something' morning peak hour intersection performance - Gore Hill Freeway and Artarmon study area

Intersection	2027 'Do minimum'		2027 'Do something'		2037 'Do minimum'		2037 'Do something'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Epping Road/Longueville Road/Parkland Avenue	52	D	73	F	83	F	74	F
Longueville Road/Pacific Highway	40	C	49	D	54	D	33	C
Pacific Highway/Howarth Road/Norton Lane	20	B	8	A	28	B	9	A
Pacific Highway/Gore Hill Freeway interchange	29	B	32	C	41	C	24	B
Reserve Road/Gore Hill Freeway interchange	61	E	46	D	47	D	55	D
Reserve Road/Dickson Road	14	A	21	B	19	B	29	B
Reserve Road/Barton Road	69	E	87	F	>100	F	84	F

Table 7-26 Modelled 'Do something' evening peak hour intersection performance - Gore Hill Freeway and Artarmon study area

Intersection	2027 'Do minimum'		2027 'Do something'		2037 'Do minimum'		2037 'Do something'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Epping Road/Longueville Road/Parkland Avenue	80	F	66	E	87	F	71	F
Longueville Road/Pacific Highway	42	C	38	C	49	D	42	C

Intersection	2027 'Do minimum'		2027 'Do something'		2037 'Do minimum'		2037 'Do something'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Pacific Highway/Howarth Road/Norton Lane	13	A	5	A	13	A	6	A
Pacific Highway/Gore Hill Freeway interchange	29	C	17	B	23	B	17	B
Reserve Road/Gore Hill Freeway interchange	55	D	48	D	57	E	47	D
Reserve Road/Dickson Road	73	F	50	D	85	F	66	E
Reserve Road/Barton Road	>100	F	69	E	>100	F	>100	F

7.5.4 Road network changes and access arrangements

As shown in Figure 7-7, at its western end, the project would connect to the Gore Hill Freeway at Artarmon west of the T1 North Shore and Western and T9 Northern lines. The connection would include:

- Eastbound on ramps to Beaches Link from the Lane Cove Tunnel, Epping Road, and Reserve Road, providing three access points from Artarmon and beyond
- Westbound off ramps from Beaches Link onto Reserve Road and the Lane Cove Tunnel, providing access points to Artarmon and beyond.

The Gore Hill Freeway Connection component of the project would also require local road changes to integrate the project with the existing road network. This would involve:

- Reducing connectivity between Dickson Avenue and Reserve Road to accommodate the Beaches Link westbound off ramp onto Reserve Road. Dickson Avenue east of Reserve Road would be converted to a cul-de-sac, and property access from Reserve Road would be removed. Access to properties would be provided via Hesky Lane and the surrounding road network, such as Taylor Lane, Cleg Street, Herbert Street and Waltham Street. Access to Dickson Avenue west of Reserve Road would be maintained
- Disconnecting Lambs Road from the road network between Punch Street and Cleg Street to facilitate the installation of tunnel support facilities. Lambs Road would connect directly onto Cleg Street at its northern end while a cul-de-sac would be installed on Punch Street at its eastern end. Vehicles would be required to use Punch Street and Herbert Street, which would not substantially increase travel time given an additional travel distance of up to 480 metres
- Modifying the Reserve Road/Dickson Avenue intersection to accommodate the Beaches Link westbound off ramp
- Signalisation of the Pacific Highway/Dickson Avenue intersection to increase safety and connectivity.

Additional capacity would be provided at the Reserve Road bridge, with the existing footpaths converted to traffic lanes, and a new footpath constructed on the eastern side of the bridge. Also, the T2 transit lanes on the Gore Hill Freeway in both directions would be removed and converted to general traffic lanes to improve lane utilisation.

25 on-street parking spaces would be removed on Lambs Road and Punch Street during construction and would not be reinstated. About 10 on-street parking spaces for cars and six on-street parking spaces for motorcycles would also be removed at the Pacific Highway/Dickson Avenue intersection during construction and would not be reinstated. Given the availability of parking on surrounding streets this impact is anticipated to be absorbed by the surrounding network. Beaches Link operational facilities including the Motorway Control Centre would provide sufficient off-street parking for staff and would not generate additional on-street parking demand. Therefore, there would be no additional impacts on parking would not worsen once Beaches Link is operational.

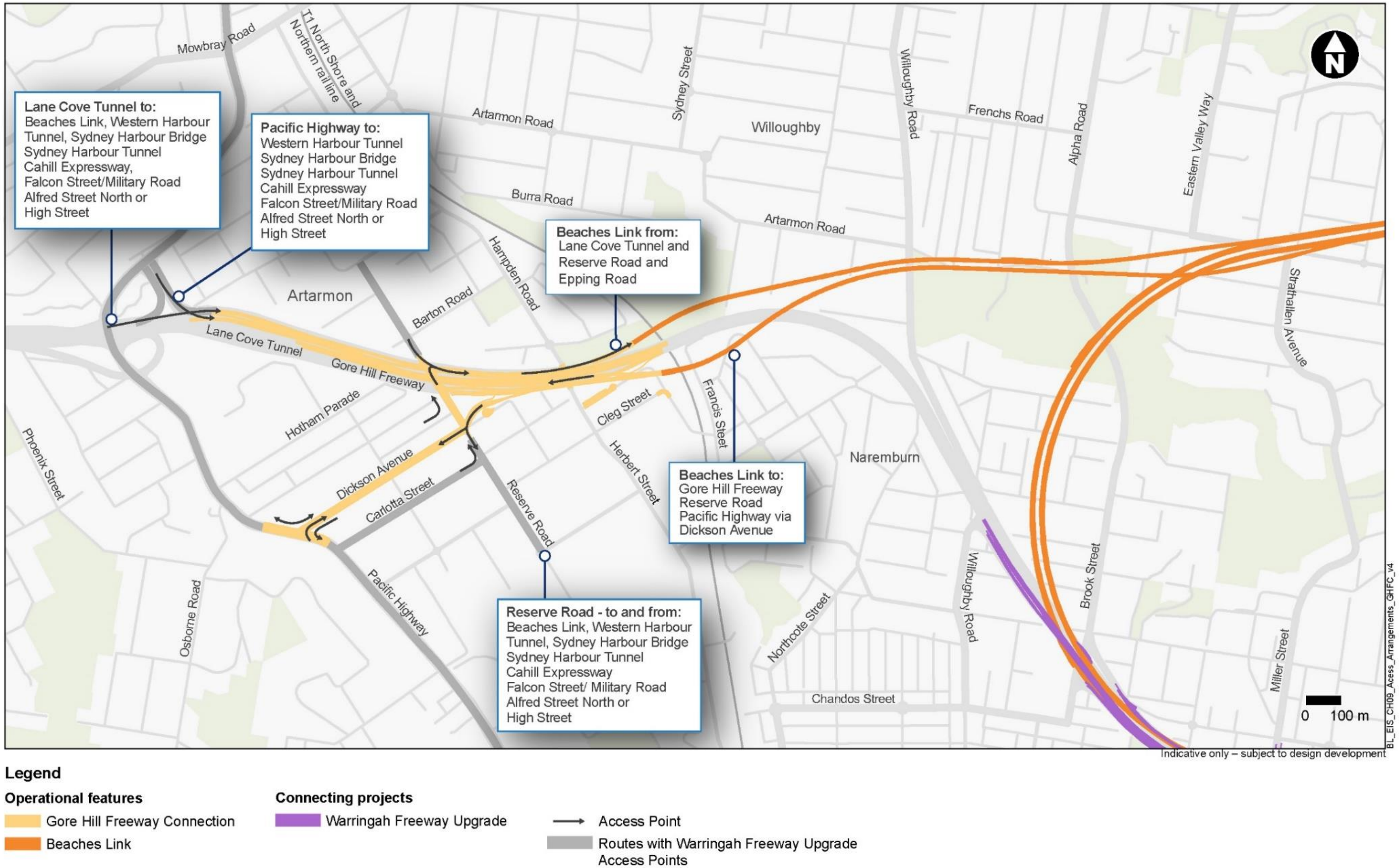


Figure 7-7 Access arrangements upon completion of construction works at Gore Hill Freeway

7.5.5 Public transport impacts

Modelled future bus travel times for key routes through the Gore Hill Freeway and Artarmon study area with the project are presented in Table 7-27 and Table 7-28. Analysis of the modelled bus travel times indicates that the conversion of the Gore Hill Freeway T2 transit lanes to general traffic lanes would not have a material impact on travel times for buses within the modelled area.

The project also offers the opportunity for express bus services in the Beaches Link tunnel between the Northern Beaches and strategic centres (such as Macquarie Park) via the Gore Hill Freeway

Table 7-27 Modelled 'Do something' morning peak hour bus travel times - Gore Hill Freeway and Artarmon study area

Route	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Lane Cove Tunnel to Gore Hill Freeway	Eastbound	0:01:26	0:01:22	0:01:26	0:01:22
	Westbound	0:01:18	0:01:16	0:01:26	0:01:18

Table 7-28 Modelled 'Do something' evening peak hour bus travel times - Gore Hill Freeway and Artarmon study area

Route	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Lane Cove Tunnel to Gore Hill Freeway	Eastbound	0:01:22	0:01:21	0:01:22	0:01:21
	Westbound	0:01:13	0:01:17	0:01:13	0:01:27

A southbound bus stop on Pacific Highway would be permanently relocated once the Pacific Highway/Dickson Avenue is signalised. The bus stop would be relocated within 50 metres of its existing location and therefore minor impacts are anticipated given the minor increase in travel distance.

7.5.6 Active transport impacts

A shared user path would be provided on the southern side of the Gore Hill Freeway between the railway line and Reserve Road, replacing and connecting to the existing path. Pedestrian fencing would be installed along the northern side of the shared user path to improve safety and quality of the active transport network. In addition, the existing pedestrian footpath along the eastern side of Reserve Road Bridge would be replaced, maintaining existing connectivity.

7.6 Balgowlah and surrounds

7.6.1 Network performance

A summary of future network performance statistics for the Balgowlah and surrounds study area under the 'Do something' scenario is presented in Table 7-29 and Table 7-30. Analysis of the network performance with the project indicates:

- Peak period traffic demand through the Balgowlah and surrounds study area would increase by up to 15 per cent by 2037 with the inclusion of the project
- Average travel speeds through the Balgowlah and surrounds study area would increase by up to 77 per cent in the morning peak and 49 per cent in the evening peak. This is due to a substantial shift of traffic demand to the Beaches Link and Gore Hill Freeway Connection. In addition to increasing travel speed for vehicles travelling to and from outside of the Balgowlah area, the transfer of this demand from surface arterial roads to the motorway would improve travel speeds for local trips within Balgowlah

- The number of stops would reduce substantially by up to 56 per cent in the morning peak and 22 per cent in the evening peak. This is due to the reduction in traffic on the surface roads, particularly through the intersection of Manly Road and Sydney Road, which is the primary source of delays in the area.

Analysis of network performance measures for the Balgowlah and surrounds study area indicates that the operation of the Beaches Link and Gore Hill Freeway Connection would facilitate additional traffic through the corridor at greatly reduced levels of delay and would benefit both regional and local trips.

Table 7-29 Modelled 'Do something' morning peak network performance - Balgowlah and surrounds study area

Network measure	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Network statistics for all vehicles				
Total traffic demand (veh)	17,400	19,900	19,200	21,800
Total VKT through network	44,800	55,500	49,500	61,600
Total VHT through network	1600	1390	2280	1600
Total number of stops	57,000	35,000	94,600	42,000
Average vehicle statistics				
Average vehicle trip length through the network (km)	2.4	2.8	2.4	2.8
Average vehicle trip time through the network (hours)	0:05:10	0:04:13	0:06:40	0:04:25
Average number of stops per trip	3.1	1.8	4.6	1.9
Average trip speed (km/h)	28.1	39.9	21.7	38.4
Unreleased traffic				
Total unreleased trips	20	<10	120	30
% of demand unreleased	<1%	<1%	1%	<1%

Table 7-30 Modelled 'Do something' evening peak network performance - Balgowlah and surrounds study area

Network measure	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Network statistics for all vehicles				
Total traffic demand (veh)	19,400	22,400	20,900	24,100
Total VKT through network	50,800	64,800	52,300	69,000
Total VHT through network	1910	1900	2400	2130
Total number of stops	65,200	64,200	92,500	71,700
Average vehicle statistics				
Average vehicle trip length through the network (km)	2.6	2.9	2.5	3.0
Average vehicle trip time through the network (hours)	0:05:46	0:05:18	0:06:54	0:05:29
Average number of stops per trip	3.3	2.9	4.4	3.1

Network measure	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Average trip speed (km/h)	26.5	33.3	21.8	32.4
Unreleased traffic				
Total unreleased trips	430	410	1320	720
% of demand unreleased	2%	2%	6%	3%

7.6.2 General traffic travel times

Modelled future general traffic travel times for key routes through the Balgowlah study area the 'Do something' scenario are presented in Table 7-31 and Table 7-32. Analysis of the modelled general traffic travel times indicates that performance on most key routes throughout the modelled area is expected to improve as a result of the project.

Table 7-31 Modelled 'Do something' morning peak hour general traffic travel times - Balgowlah and surrounds study area

Route	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Spit Bridge to Burnt Bridge Creek Deviation/Condamine Street	Northbound	0:03:09	0:03:27	0:04:08	0:03:29
	Southbound	0:06:15	0:03:44	0:11:46	0:03:38
Spit Bridge to Wakehurst Parkway/Judith Street (via Frenchs Forest Road)	Northbound	0:05:55	0:06:23	0:06:47	0:06:03
	Southbound	0:07:37	0:06:31	0:09:22	0:06:30

Table 7-32 Modelled 'Do something' evening peak hour general traffic travel times - Balgowlah and surrounds study area

Route	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Spit Bridge to Burnt Bridge Creek Deviation/Condamine Street	Northbound	0:05:24	0:03:54	0:05:48	0:04:00
	Southbound	0:07:49	0:05:41	0:11:12	0:05:13
Spit Bridge to Wakehurst Parkway/Judith Street (via Frenchs Forest Road)	Northbound	0:09:57	0:08:28	0:10:19	0:08:13
	Southbound	0:14:19	0:14:05	0:16:07	0:14:20

7.6.3 Intersection performance

Modelled future performance for key intersections in the Balgowlah and surrounds study area under the 'Do something' scenario is presented in Table 7-33 and Table 7-34. Analysis of intersection performance with the project indicates:

- Demand at the roundabout controlled Frenchs Forest Road/Sydney Road intersection would continue to exceed capacity, resulting in relatively poor performance during evening peak periods
- The Sydney Road/Manly Road/Burnt Bridge Creek Deviation intersection would improve during peak periods but continue to operate at a poor Level of Service with the project in the evening peak. Localised average delays would be comparable to the 'Do minimum' scenario. The proximity of this intersection to the

Frenchs Forest Road/Sydney Road intersection would result in queues approaching both intersections, decreasing the capacity and performance of the other
- All other intersections would operate at a similar Level of Service under both the 'Do minimum' and 'Do something' scenarios.

Analysis of the modelled general traffic travel times indicates that travel times on most key routes throughout the modelled area are expected to improve as a result of the project. While some intersections would continue to experience a poor level of service, when combined with the above travel time benefits, the project would result in an overall improvement to network performance.

Table 7-33 Modelled 'Do something' morning peak hour intersection performance - Balgowlah and surrounds study area

Intersection	2027 'Do minimum'		2027 'Do something'		2037 'Do minimum'		2037 'Do something'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Sydney Road/Manly Road/Burnt Bridge Creek Deviation	48	D	26	B	68	E	27	B
Frenchs Forest Road/Sydney Road	21	B	29	B	32	C	28	B
Sydney Road/Condamine Street	33	C	24	B	26	B	29	C
Condamine Street/Burnt Bridge Creek Deviation	19	B	31	C	32	C	38	C
Access Road/Sydney Road/Maretimo Street	10	A	23	B	9	A	28	B
Access Road/Burnt Bridge Creek Deviation	-	-	11	A	-	-	14	A

Table 7-34 Modelled 'Do something' evening peak hour intersection performance - Balgowlah and surrounds study area

Intersection	2027 'Do minimum'		2027 'Do something'		2037 'Do minimum'		2037 'Do something'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Sydney Road/Manly Road/Burnt Bridge Creek Deviation	93	F	86	F	>100	F	93	F
Frenchs Forest Road/Sydney Road	>100	F	>100	F	>100	F	>100	F
Sydney Road/Condamine Street	33	C	39	C	40	C	48	D
Condamine Street/Burnt Bridge Creek Deviation	17	B	35	C	16	B	38	C

Intersection	2027 'Do minimum'		2027 'Do something'		2037 'Do minimum'		2037 'Do something'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Access Road/Sydney Road/Maretimo Street	9	A	20	B	30	C	27	B
Access Road/Burnt Bridge Creek Deviation	-	-	11	A	-	-	12	A

7.6.4 Road network changes and access arrangements

At its eastern end, the project would connect to Burnt Bridge Creek Deviation at Balgowlah, south of the Kitchener Street bridge. This would include a two-lane southbound on ramp and a three-lane northbound off ramp.

Local road changes would be required to integrate the project with the existing road network. This would involve:

- A new access road in Balgowlah, providing local access and connectivity to the new open space and recreation facilities and connecting to the tunnel portals/Burnt Bridge Creek Deviation and Sydney Road. The new access road would accommodate travel in either direction
- A new intersection with traffic signals connecting the new access road with Burnt Bridge Creek Deviation and the tunnel portals adjacent to the northern end of Dudley Street. This would include right turn lanes into the new access road from the Beaches Link off ramp, and left turn lanes out of the new access road to the Beaches Link on ramp and Burnt Bridge Creek Deviation southbound. Non-tunnel northbound traffic on Burnt Bridge Creek Deviation would bypass these traffic signals.
- A new signalised intersection would be provided at the southern end of the new access road to accommodate its connection with Sydney Road. Traffic movements north-south (and vice versa) through the intersection between Maretimo Street and the access road would not be permitted. The new intersection would include a pedestrian crossing across the new access road on the northern side of Sydney Road. Pedestrian connectivity between the new open space and recreation facilities, the Northern Beaches Secondary College – Balgowlah Boys Campus and Maretimo Street would be provided via the existing pedestrian bridge to the west of the new access road and would continue to provide north-south connectivity for pedestrians in the area. Pedestrian connectivity across Sydney Road to and from Maretimo Street would not be provided at the intersection
- Relocating the existing cul-de-sac at Dudley Street further south to accommodate construction of the new tunnel portals and the associated realignment of Burnt Bridge Creek Deviation.

Relatively low impacts are anticipated due to the relocation of the cul-de-sac on Dudley Street, given the minimal number of properties that would be impacted by the change, which would remain accessible from Dudley Street.

Surface connections at Balgowlah would attract traffic demand from both east and west of Burnt Bridge Creek Deviation. The additional traffic from North Balgowlah could travel via Kitchener Street to access the new access road from Sydney Road east. This could increase traffic volumes on local roads between Kitchener Street and Sydney Road, unless local area traffic management is also put in place to minimise increased traffic on local roads. Local area traffic management on Wanganella Street, Rickard Street and West Street would result in traffic demand using Woodland Street and Condamine Street instead, which is more appropriate to the function of these roads. Local traffic management measures proposed would be discussed further and agreed with Northern Beaches Council during detailed design.

7.6.5 Public transport impacts

Modelled future bus travel times for key routes through the Balgowlah study area are presented in Table 7-35 and Table 7-36. Analysis of the modelled bus travel times indicates that bus travel times would be maintained or improved as a result of the project, as existing bus priority in the area would be maintained and traffic congestion reduced.

Table 7-35 Modelled 'Do something' morning peak hour bus travel times - Balgowlah and surrounds study area

Route	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Spit Bridge to Manly Road/Sydney Road	Northbound	0:02:20	0:02:44	0:03:10	0:02:38
	Southbound	0:02:08	0:01:48	0:02:17	0:01:42
Manly Road/Sydney Road to Burnt Bridge Creek Deviation/Condamine Street	Northbound	0:01:30	0:01:31	0:01:29	0:01:45
	Southbound	0:02:23	0:02:37	0:02:25	0:02:21
Manly Road/Sydney Road to Wakehurst Parkway/Judith Street (via Frenchs Forest Road)	Southbound	0:11:44	0:08:07	0:13:38	0:08:07

Table 7-36 Modelled 'Do something' evening peak hour bus travel times - Balgowlah and surrounds study area

Route	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Spit Bridge to Manly Road/Sydney Road	Northbound	0:04:39	0:03:56	0:04:14	0:03:37
	Southbound	0:01:10	0:01:19	0:01:13	0:01:19
Manly Road/Sydney Road to Burnt Bridge Creek Deviation/Condamine Street	Northbound	0:01:34	0:01:38	0:01:36	0:01:47
	Southbound	0:02:19	0:02:22	0:02:10	0:02:25
Manly Road/Sydney Road to Wakehurst Parkway/Judith Street (via Frenchs Forest Road)	Southbound	0:18:03	0:18:25	0:21:46	0:16:27

7.6.6 Active transport impacts

Pedestrian and cyclist facilities provided as part of the 'Do something' scenario would generally improve the extent of the overall active transport network in Balgowlah and surrounds. The following is proposed as part of the project:

- New shared user paths would be provided along the eastern side of the new access road
- A portion of the existing shared user path along Burnt Bridge Creek within the existing golf course would require minor adjustment due to a localised adjustment of the creek alignment
- The existing box culvert crossing of Burnt Bridge Creek Deviation and adjacent pedestrian underpass beneath Burnt Bridge Creek Deviation would both be extended under the realigned road, maintaining existing connectivity across the widened Burnt Bridge Creek Deviation. This would connect to the existing shared user path at Dudley Street. Pedestrian fencing would be provided along the outside of the shared user path and the realigned section of Burnt Bridge Creek Deviation
- New signal controlled pedestrian crossings across the new access road at its interfaces with Sydney Road and Burnt Bridge Creek deviation would maintain connectivity to the existing Balgowlah Oval from Northern Beaches Secondary College – Balgowlah Boys Campus

- An at grade signalised crossing of the access road would provide access to the intersections of the Burnt Bridge Creek Deviation and the new public car park within the open space and recreation facilities area at Balgowlah.

The final layout of the new open space and recreation facilities at Balgowlah including shared user paths are subject to a dedicated consultation process jointly led by Transport for NSW and Northern Beaches Council to give the community an opportunity to provide input. This consultation will be separate to the consultation for the environmental impact statement. This process will start after the environmental impact statement public exhibition period and well in advance of construction starting. As part of this consultation process, a community reference group will be established, with representative stakeholder groups and the community, to support Transport for NSW and Northern Beaches Council with the development of this important public space.

Pedestrian and cycle facilities to be provided as part of the project would improve the extent of the overall active transport network in the Balgowlah study area, with upgraded infrastructure providing increased connectivity and enhanced safety.

7.7 Frenchs Forest and surrounds

7.7.1 Network performance

A summary of future network performance statistics for the Frenchs Forest and surrounds study area for the 'Do something' scenario is presented in Table 7-37 and Table 7-38. Analysis of the network performance with the project indicates:

- Peak period traffic demand through the Frenchs Forest and surrounds study area would increase by up to 10 per cent by 2037
- Average travel speeds through the Frenchs Forest and surrounds study area could decrease by up to 13 per cent. This is primarily a consequence of the change in traffic patterns that result from the project. A substantial proportion of traffic that would travel east–west along Warringah Road would travel from east to south and from south to east between Wakehurst Parkway and Warringah Road and through the intersection of Warringah Road and Wakehurst Parkway, instead of through the underpass. Similarly, southbound traffic on Forest Way that currently turns right onto Warringah Road would instead turn left, then right from Warringah Road to Wakehurst Parkway, increasing localised delays at the intersection of Warringah Road and Wakehurst Parkway
- The number of stops would increase as a result of the project. This is also due to the change in the pattern of demand with fewer trips passing through the underpass and travelling through surface road intersections.

Analysis of network performance measures for the Frenchs Forest and surrounds study area indicates that the new underpasses at Forest Way and Wakehurst Parkway would not be impacted for the main east/west traffic route on Warringah Road. However, the changes to travel patterns associated with the Beaches Link and Gore Hill Freeway Connection would generally result in increased localised delays on the Warringah Road surface lanes between Forest Way and Wakehurst Parkway and reduced travel speeds through the area. This is generally due to the change in the pattern of traffic demand from principally east and west to principally east and south, reflecting a change in the primary southbound route from Warringah Road to Wakehurst Parkway and the project. This would transfer traffic demand from a largely grade-separated movement through several additional intersections, resulting in localised delays.

Although some localised delays may be experienced during peak periods, broader modelling indicates that most road users would benefit from substantial travel time savings on the broader network due to the strategic benefits provided by Beaches Link.

Table 7-37 Modelled 'Do something' morning peak network performance - Frenchs Forest and surrounds study area

Network measure	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Network statistics for all vehicles				
Total traffic demand (veh)	32,100	35,300	33,700	36,900
Total VKT through network	94,500	98,900	98,900	102,800
Total VHT through network	2720	3220	3180	3600
Total number of stops	81,000	102,300	101,000	125,300
Average vehicle statistics				
Average vehicle trip length through the network (km)	2.9	2.8	3.0	2.9
Average vehicle trip time through the network (hours)	0:05:02	0:05:28	0:05:51	0:06:00
Average number of stops per trip	2.5	2.9	3.1	3.5
Average trip speed (km/h)	34.8	30.7	31.1	28.6
Unreleased traffic				
Total unreleased trips	220	370	270	780
% of demand unreleased	1%	1%	1%	2%

Table 7-38 Modelled 'Do something' evening peak network performance - Frenchs Forest and surrounds study area

Network measure	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Network statistics for all vehicles				
Total traffic demand (veh)	33,600	37,200	35,400	39,000
Total VKT through network	101,400	106,500	107,100	111,400
TotalVHT through network	2760	3200	3100	3710
Total number of stops	76,200	95,600	89,500	114,900
Average vehicle statistics				
Average vehicle trip length through the network (km)	3.0	2.9	3.1	3.0
Average vehicle trip time through the network (hours)	0:04:52	0:05:14	0:05:27	0:06:00
Average number of stops per trip	2.2	2.6	2.6	3.1
Average trip speed (km/h)	36.7	33.2	34.6	30.0
Unreleased traffic				
Total unreleased trips	230	640	370	1400
% of demand unreleased	1%	2%	1%	4%

7.7.2 General traffic travel times

Modelled future general traffic travel times for key routes through the Frenchs Forest and surrounds study area under the ‘Do something’ scenario are presented in Table 7-39 and Table 7-40. Analysis of the modelled general traffic travel times:

- Overall travel times for general traffic on Warringah Road and Forest Way would remain generally unaffected by the project, indicating that potentially increased delays at the intersections along Wakehurst Parkway would not impact east-west trips
- In the morning peak, southbound travel times along Wakehurst Parkway would increase as a result of the project. This is due to the change in traffic pattern that would increase the volumes of traffic turning right from Warringah Road to Wakehurst Parkway, conflicting with the increase in southbound traffic on Wakehurst Parkway
- In the evening peak, travel times for general traffic along Wakehurst Parkway would remain comparable or improve as a result of the project. This is because the primary southbound movements in the evening peak do not conflict as they do in the morning peak and would have additional capacity provided on Wakehurst Parkway south of Warringah Road.

Overall traffic modelling carried out indicates that potentially increased localised delays at intersections would be offset by the broader improvement in connectivity and reduction in congestion created by the project.

Table 7-39 Modelled ‘Do something’ morning peak hour general traffic travel times - Frenchs Forest and surrounds study area

Route	Direction	2027 ‘Do minimum’	2027 ‘Do something’	2037 ‘Do minimum’	2037 ‘Do something’
Wakehurst Parkway/Judith Street to Wakehurst Parkway/Dreadnought Road	Northbound	0:04:27	0:04:17	0:06:59	0:04:27
	Southbound	0:04:29	0:09:13	0:05:05	0:07:36
Warringah Road/Forestville Avenue to Ellis Road/Warringah Road	Eastbound	0:05:25	0:05:26	0:05:24	0:05:22
	Westbound	0:05:55	0:05:24	0:06:11	0:05:53

Table 7-40 Modelled ‘Do something’ evening peak hour general traffic travel times - Frenchs Forest and surrounds study area

Route	Direction	2027 ‘Do minimum’	2027 ‘Do something’	2037 ‘Do minimum’	2037 ‘Do something’
Wakehurst Parkway/Judith Street to Wakehurst Parkway/Dreadnought Road	Northbound	0:04:37	0:05:35	0:07:02	0:05:30
	Southbound	0:04:10	0:03:20	0:04:04	0:03:24
Warringah Road/Forestville Avenue to Ellis Road/Warringah Road	Eastbound	0:06:05	0:06:09	0:06:22	0:06:42
	Westbound	0:05:15	0:05:24	0:05:36	0:05:15

7.7.3 Intersection performance

Modelled future performance for key intersections in the Frenchs Forest and surrounds study area under the ‘Do something’ scenario is presented in Table 7-41 and Table 7-42. Analysis of intersection performance with the project indicates that by 2037, changes to traffic patterns and growth would result in the following intersections continuing to operate at a relatively poor Level of Service during the morning or evening peak periods:

- Wakehurst Parkway/Frenchs Forest Road East
- Wakehurst Parkway/Warringah Road
- Warringah Road/Hilmer Street (caused by queue propagation from Wakehurst Parkway).

These intersections would experience increased localised delays as a result of the changes in traffic patterns that would arise from the project. However, the project would reduce congestion and delays at intersections along the broader Warringah Road corridor due to the substantial reductions in traffic volumes along Warringah Road to the west of Forest Way.

Table 7-41 Modelled 'Do something' morning peak hour intersection performance - Frenchs Forest and surrounds study area

Intersection	2027 'Do minimum'		2027 'Do something'		2037 'Do minimum'		2037 'Do something'	
	Ave delay (sec)	LoS	Ave delay (sec)	LoS	Ave delay (sec)	LoS	Ave delay (sec)	LoS
Wakehurst Parkway/Frenchs Forest Road East	44	D	>100	F	66	E	86	F
Warringah Road/Allambie Road	44	D	50	D	46	D	51	D
Wakehurst Parkway/Warringah Road	58	E	93	F	78	F	73	F
Warringah Road/Hilmer Street	14	A	18	B	38	C	50	D
Warringah Road/Forest Way	18	B	15	A	21	B	16	B
Forest Way/Naree Road	24	B	56	D	36	C	54	D
Warringah Road/Brown Street/Currie Road	20	B	16	B	23	B	18	B
Warringah Road/Starkey Street	23	B	20	B	26	B	21	B
Warringah Road/Darley Street	28	B	27	B	30	C	26	B
Warringah Road/Forestville Avenue	10	A	14	A	14	A	14	A

Table 7-42 Modelled 'Do something' evening peak hour intersection performance - Frenchs Forest and surrounds study area

Intersection	2027 'Do minimum'		2027 'Do something'		2037 'Do minimum'		2037 'Do something'	
	Ave delay (sec)	LoS	Ave delay (sec)	LoS	Ave delay (sec)	LoS	Ave delay (sec)	LoS
Wakehurst Parkway/Frenchs Forest Road East	46	D	45	D	46	D	43	C
Warringah Road/Allambie Road	46	D	52	D	49	D	52	D
Wakehurst Parkway/Warringah Road	33	C	75	F	41	C	59	E
Warringah Road/Hilmer Street	12	A	17	B	13	A	88	F
Warringah Road/Forest Way	24	B	24	B	26	B	31	C

Intersection	2027 'Do minimum'		2027 'Do something'		2037 'Do minimum'		2037 'Do something'	
	Ave delay (sec)	LoS	Ave delay (sec)	LoS	Ave delay (sec)	LoS	Ave delay (sec)	LoS
Forest Way/Naree Road	19	B	28	B	27	B	28	B
Warringah Road/Brown Street/Currie Road	10	A	9	A	11	A	9	A
Warringah Road/Starkey Street	20	B	20	B	19	B	20	B
Warringah Road/Darley Street	19	B	17	B	19	B	19	B
Warringah Road/Forestville Avenue	35	C	29	B	46	D	35	C

7.7.4 Road network changes and access arrangements

At its northern end, the project would connect to Wakehurst Parkway at Killarney Heights, north of Kirkwood Street. This connection would include a two-lane southbound on ramp and a two-lane northbound off ramp.

Additional capacity would be provided on Wakehurst Parkway, which would be upgraded to two lanes in each direction between the tunnel connection to the project and Warringah Road. Minor changes to the Northern Beaches Hospital road upgrade including to the intersections of Wakehurst Parkway with Kirkwood Street, Fitzpatrick/Aquatic Drive, Warringah Road and Frenchs Forest Road East and Frenchs Forest Road West would be required. These changes would be generally limited to linemarking, median adjustments and asphalt resurfacing in order to accommodate the anticipated changes to traffic patterns created by the project.

Other local road changes required to integrate the project with the existing road network would involve:

- Modifying linemarking near the Wakehurst Parkway/Burnt Street intersection
- Minor changes to the Wakehurst Parkway/Aquatic Drive intersection
- Removing the right turn from Wakehurst Parkway northbound into Frenchs Forest Road East eastbound.

Impacts due to these local road changes would be minimal given the minor works involved.

The removal of the right turn from Wakehurst Parkway northbound into Frenchs Forest Road East would result in an additional travel distance of up to 1.3 kilometres via Warringah Road and Allambie Road and an associated minor increase in travel time of up to four minutes.

Kirkwood Street would be reopened at its interface with Wakehurst Parkway after construction.

7.7.5 Public transport impacts

Modelled future bus travel times for key routes through the Frenchs Forest and surrounds study area under the 'Do something' scenario are presented in Table 7-43 and Table 7-44. Analysis of the modelled bus travel times indicates that bus travel times would not be materially impacted by the project.

Four new dedicated bus bays and two associated shared user path underpasses would also be provided along Wakehurst Parkway, improving bus and bus passenger safety, and reducing conflicts between buses and general traffic. In addition to these localised improvements, the 'Do something' scenario would also decrease traffic demand heading to the lower North Shore via the Warringah Road and Eastern Valley Way corridors. Both these corridors also carry regional and local buses, and these services would benefit from improved travel times and reliability as result of reduced traffic demands and congestion.

Table 7-43 Modelled 'Do something morning peak hour bus travel times – Frenchs Forest and surrounds study area

Route	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Forestville Avenue to Adams Street via Warringah Road and Forest Way	Eastbound	0:10:26	0:10:17	0:10:44	0:10:08
	Westbound	0:07:55	0:07:41	0:08:16	0:08:36
Forestville Avenue to Ellis Road via Warringah Road and French Forest Road East	Eastbound	0:16:04	0:15:53	0:15:45	0:16:01
	Westbound	0:12:26	0:14:17	0:15:08	0:13:13

Table 7-44 Modelled 'Do something' evening peak hour bus travel times – Frenchs Forest and surrounds study area

Route	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Forestville Avenue to Adams Street via Warringah Road and Forest Way	Eastbound	0:11:22	0:11:04	0:11:09	0:11:35
	Westbound	0:07:13	0:07:15	0:07:16	0:07:33
Forestville Avenue to Ellis Road via Warringah Road and French Forest Road East	Eastbound	0:16:55	0:16:57	0:16:37	0:18:18
	Westbound	0:12:50	0:11:24	0:12:45	0:11:40

7.7.6 Active transport impacts

The project would include the following pedestrian and cycle infrastructure:

- A new shared user path on the eastern side of Wakehurst Parkway from the northern end of Kirkwood Street to Warringah Road
- A new shared user underpass beneath Wakehurst Parkway near Yarraman Avenue
- A shared user bridge over the drainage culvert and fauna underpass (being constructed as part of the Northern Beaches Hospital road upgrade project) on the eastern side of Wakehurst Parkway about 150 metres south of Warringah Road
- Three shared user underpasses beneath Wakehurst Parkway, connecting Garigal National Park and Manly Dam Reserve
- Replacement of the existing pedestrian bridge with a new longer pedestrian bridge over Wakehurst Parkway located about 350 metres south of Warringah Road.

The modified and new pedestrian and cycle crossings proposed would improve the safety and connectivity of the active transport network to, from, and within the Frenchs Forest study area.

7.7.7 Northern Beaches Hospital road upgrade project and Northern Beaches Hospital Precinct Structure Plan

The assessment of the Frenchs Forest and surrounds study area indicates that the Northern Beaches Hospital road upgrades (completed in August 2020), and included in the assessment of the project, would substantially improve road network performance. 'Do minimum' 2027 results indicate that compared to existing conditions:

- Traffic demand is forecast to increase by 10 per cent
- Overall network speeds would be improved by up to 40 per cent

- Travel speeds along Warringah Road and other key corridors would be improved by over 50 per cent in some cases.

The results of the ‘Do minimum’ 2037 scenario illustrate similar benefits, but also indicate that continued long-term background demand growth in the area would reduce road network performance over time. Between 2027 and 2037:

- Demand is forecast to increase by an additional five per cent
- Network speeds would consequently reduce by around five to 10 per cent.

Transport for NSW is continuing to investigate options to mitigate potential localised network performance issues in the area, and further leverage the overall benefits and opportunities of the project. This work is cognisant of and reliant on the *Northern Beaches Hospital Precinct Structure Plan* (Northern Beaches Council, 2017) implementation, which highlights that future precinct development is dependent on further delivery of improved transport infrastructure and a continued modal shift from private to public transport.

The *Northern Beaches Hospital Precinct Structure Plan* defines the desired future land uses and consequent multi-modal transport operation and infrastructure requirements to, from, and through the area. It also acknowledges that a suite of regional transport network upgrades including both public transport and road upgrades would be required to maintain effective transport connections to, from, and through the area in the medium to long-term.[17]

7.8 Maritime movements and activities

There would be no operational impacts to maritime movements and activities as a result of the project.

The project would result in a reduction in water depth at some locations within the proposed harbour crossing of around 10 metres. This is not expected to have an impact on navigation given the current depth is typically greater than 20 metres below chart datum at the crossing location, and vessels in this part of the harbour are already constrained by shallow water depths downstream, with the maximum water depth at the entrance to Middle Harbour being around 3.5 metres at low tide to 5.1 metres at high tide.

Moorings impacted during construction would be reinstated as close as practical to their current locations.

[17] Northern Beaches Hospital Precinct Structure Plan (Northern Beaches Council, August 2017)

8. Cumulative operational impacts assessment

8.1 Overview

The project has been designed to allow for extension to the proposed Western Harbour Tunnel and Warringah Freeway Upgrade, providing a full motorway-standard corridor from Rozelle to Frenchs Forest and Balgowlah.

This section provides an assessment of the impacts of the full Western Harbour Tunnel and Warringah Freeway Upgrade, and the Beaches Link and Gore Hill Freeway Connection scenario (the 'Do something cumulative' scenario) for the following performance measures:

- Strategic road network performance based on VHT, VKT and average network speed
- Intersection performance based on intersection Level of Service
- General traffic and bus travel times for key corridors.

Strategic traffic modelling of the project indicates that the project combined with the Western Harbour Tunnel and Warringah Freeway Upgrade would deliver substantial benefits to traffic travelling on the strategic road network, with trips between strategic centres saving up to 22 minutes when travelling across Sydney Harbour from the Northern Beaches during peak periods. These travel time savings would also substantially increase accessibility for these centres, increasing the catchment of residents that can travel to and from their place of work within the '30-minute city' window that is critical to maintaining the vision of a productive city promoted by the Greater Sydney Commission.

Increasing the size of this 30-minute city catchment would not be limited to private vehicles; public transport customers would also benefit substantially from the inclusion of the Western Harbour Tunnel and Warringah Freeway Upgrade with the project. This cumulative program of works would further facilitate the operation of express buses that would provide direct access between major centres in the Northern Beaches to the lower North Shore and Inner West.

The Western Harbour Tunnel and Warringah Freeway Upgrade would facilitate substantial additional travel that would also increase traffic demands at either ends of the project, which integrate with the existing transportation network. There would be some residual delays surrounding these interface precincts. However, the additional delay associated with these precincts would be offset by the large travel time benefits provided by the project and Western Harbour Tunnel and Warringah Freeway Upgrade at the strategic network level.

This section identifies the key trips that would benefit from the project and the locations where integration works have been identified and incorporated into the design. These integration works have been developed to minimise the impact of additional travel facilitated by the project and ensure that the competing needs of customers (including private vehicles, public transport passengers, cyclists and pedestrians) have been incorporated into a balanced, equitable outcome.

8.2 Metropolitan road network performance

8.2.1 Strategic corridors

A summary of the forecast growth at key locations into and out of the Northern Beaches peninsula for the 2027 and 2037 forecast years is presented in Table 8-1 to Table 8-3 and visually in Annexure B.

Table 8-1 Modelled 'Do something cumulative' morning peak hour traffic demands at key locations (SMPM)

Road	Location	Direction	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Spit Road	Spit Bridge	Northbound	1750	1350	1300	1850	1450	1400
		Southbound	2700	1750	1700	3050	1950	1850
		Combined	*4450*	*3100*	*3000*	*4900*	*3400*	*3250*
Warringah Road	Roseville Bridge	Northbound	2100	1550	1500	2250	1650	1550
		Southbound	4100	3300	3250	4300	3550	3550
		Combined	*6200*	*4850*	*4750*	*6550*	*5200*	*5100*
Mona Vale Road	St Ives Showground	Northbound	2450	2350	2300	2600	2450	2400
		Southbound	2750	2500	2450	2900	2600	2550
		Combined	*5200*	*4850*	*4750*	*5500*	*5050*	*4950*
Beaches Link Tunnel	Killarney Heights	Northbound	N/A	1250	1500	N/A	1400	1750
		Southbound	N/A	2850	3200	N/A	3350	3750
		Combined	*N/A*	*4100*	*4700*	*N/A*	*4750*	*5500*
Northern Beaches screenline		**Northbound**	**6300**	**6500**	**6600**	**6700**	**6950**	**7100**
		Southbound	**9550**	**10,400**	**10,600**	**10,250**	**11,450**	**11,700**
		Combined	***15,850***	***16,900***	***17,200***	***16,950***	***18,400***	***18,800***
Eastern Valley Way	Castle Cove	Northbound	950	550	500	1000	600	600
		Southbound	1900	1550	1600	2050	1800	1850
		Combined	*2850*	*2100*	*2100*	*3050*	*2400*	*2450*

Note: Comparing the 'Do something cumulative' scenario with the 'Do something' scenario, a reduction in demand greater than 10 per cent is highlighted in green while an increase in demand greater than 10 per cent is highlighted in blue.

Table 8-2 Modelled 'Do something cumulative' evening peak hour traffic demands at key locations (SMPM)

Road	Location	Direction	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Spit Road	Spit Bridge	Northbound	3000	1750	1650	3250	1900	1750
		Southbound	2050	1600	1600	2150	1700	1650
		Combined	*5050*	*3350*	*3250*	*5400*	*3600*	*3400*
Warringah Road	Roseville Bridge	Northbound	3650	2600	2600	3750	2850	2850
		Southbound	2450	1950	1900	2650	2050	2050
		Combined	*6100*	*4550*	*4500*	*6400*	*4900*	*4900*
Mona Vale Road	St Ives Showground	Northbound	2600	2450	2400	2700	2450	2400
		Southbound	2450	2250	2150	2550	2450	2350
		Combined	*5050*	*4700*	*4550*	*5250*	*4900*	*4750*
Beaches Link Tunnel	Killarney Heights	Northbound	N/A	2950	3200	N/A	3300	3650
		Southbound	N/A	1450	1650	N/A	1650	1900
		Combined	*N/A*	*4400*	*4850*	*N/A*	*4950*	*5550*
Northern Beaches screenline		**Northbound**	**9250**	**9750**	**9850**	**9700**	**10,500**	**10,650**
		Southbound	**6950**	**7250**	**7300**	**7350**	**7850**	**7950**
		Combined	***16,200***	***17,000***	***17,150***	***17,050***	***18,350***	***18,600***
Eastern Valley Way	Castle Cove	Northbound	1550	1050	1050	1700	1300	1300
		Southbound	1100	750	750	1200	1050	1050
		Combined	*2650*	*1800*	*1800*	*2900*	*2350*	*2350*

Note: Comparing the 'Do something cumulative' scenario with the 'Do something' scenario, a reduction in demand greater than 10 per cent is highlighted in green while an increase in demand greater than 10 per cent is highlighted in blue.

Table 8-3 Modelled 'Do something cumulative' daily traffic demands at key locations (SMPM)

Road	Location	Direction	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Spit Road	Spit Bridge	Northbound	38,500	24,000	22,500	41,500	25,500	24,000
		Southbound	36,000	24,500	24,000	38,500	26,500	25,500
		Combined	*74,500*	*48,500*	*46,500*	*80,000*	*52,000*	*49,500*
Warringah Road	Roseville Bridge	Northbound	41,500	29,500	29,500	43,500	31,500	31,500
		Southbound	41,500	32,500	32,000	43,500	34,500	34,000
		Combined	*83,000*	*62,000*	*61,500*	*87,000*	*66,000*	*65,500*
Mona Vale Road	St Ives Showground	Northbound	29,500	27,500	26,500	31,000	28,000	27,500
		Southbound	30,000	27,000	26,500	31,500	28,500	28,000
		Combined	*59,500*	*54,500*	*53,000*	*62,500*	*56,500*	*55,500*
Beaches Link Tunnel	Killarney Heights	Northbound	N/A	32,000	34,500	N/A	35,000	38,500
		Southbound	N/A	26,500	29,500	N/A	29,500	33,000
		Combined	*N/A*	*58,500*	*64,000*	*N/A*	*64,500*	*71,500*
Northern Beaches screenline		**Northbound**	**109,500**	**113,000**	**113,000**	**116,000**	**120,000**	**121,500**
		Southbound	**107,500**	**110,500**	**112,000**	**113,500**	**119,000**	**120,500**
		Combined	***217,000***	***223,500***	***225,000***	***229,500***	***239,000***	***242,000***
Eastern Valley Way	Castle Cove	Northbound	17,500	10,500	9,500	19,000	12,000	12,000
		Southbound	15,500	10,500	10,500	16,500	13,000	13,500
		Combined	33,000	21,000	20,000	35,500	25,000	25,500
Brook Street	Naremburn (north of Merrenburn Avenue)	*Combined*	35,500	33,500	29,000	37,500	36,000	32,500

Note: Comparing the 'Do something cumulative' scenario with the 'Do something' scenario, a reduction in demand greater than 10 per cent is highlighted in green while an increase in demand greater than 10 per cent is highlighted in blue.

Analysis of the modelled forecast traffic demands across Middle Harbour for the ‘Do something cumulative’ scenario in 2037 shows:

- Peak period traffic demand into and out of the Northern Beaches Peninsula would increase by two per cent in the morning peak and one per cent in the evening peak when compared to the ‘Do something’ scenario
- Daily traffic demand into and out of the Northern Beaches peninsula would not materially change
- Peak period demand would increase on the Beaches Link Tunnel by up to 16 per cent, with a corresponding reduction in peak period traffic volumes on Spit Road and Warringah Road
- Daily traffic demand would increase in the Beaches Link tunnel by up to 11 per cent with a corresponding reduction in daily traffic demand on Spit Road and Warringah Road
- There would be no material difference to demand on Eastern Valley Way when compared to the ‘Do something’ scenario.

Overall, the ‘Do something cumulative’ scenario would not result in substantially more traffic travelling into and out of the Northern Beaches peninsula, but it would further reduce demand on Warringah Road, Spit Road, and Military Road, Brook Street and Eastern Valley Way with more of this traffic travelling via the Beaches Link Tunnel.

A summary of forecast travel times during peak periods for key routes in the vicinity of the project is presented in Figure 8-1 and Figure 8-2.

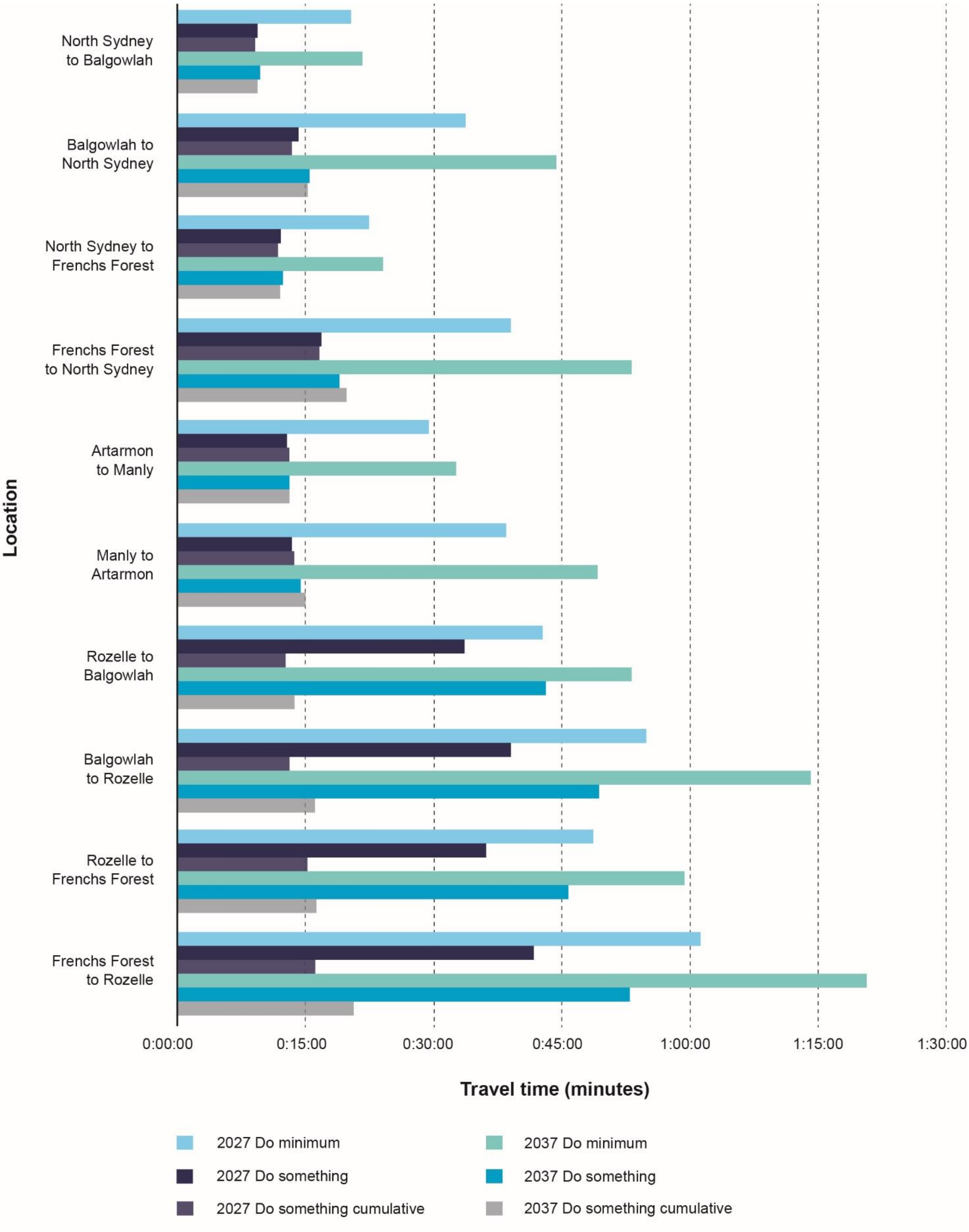


Figure 8-1 Modelled 'Do minimum', 'Do something' and 'Do something cumulative' morning peak hour travel times along key corridors (SMPM)

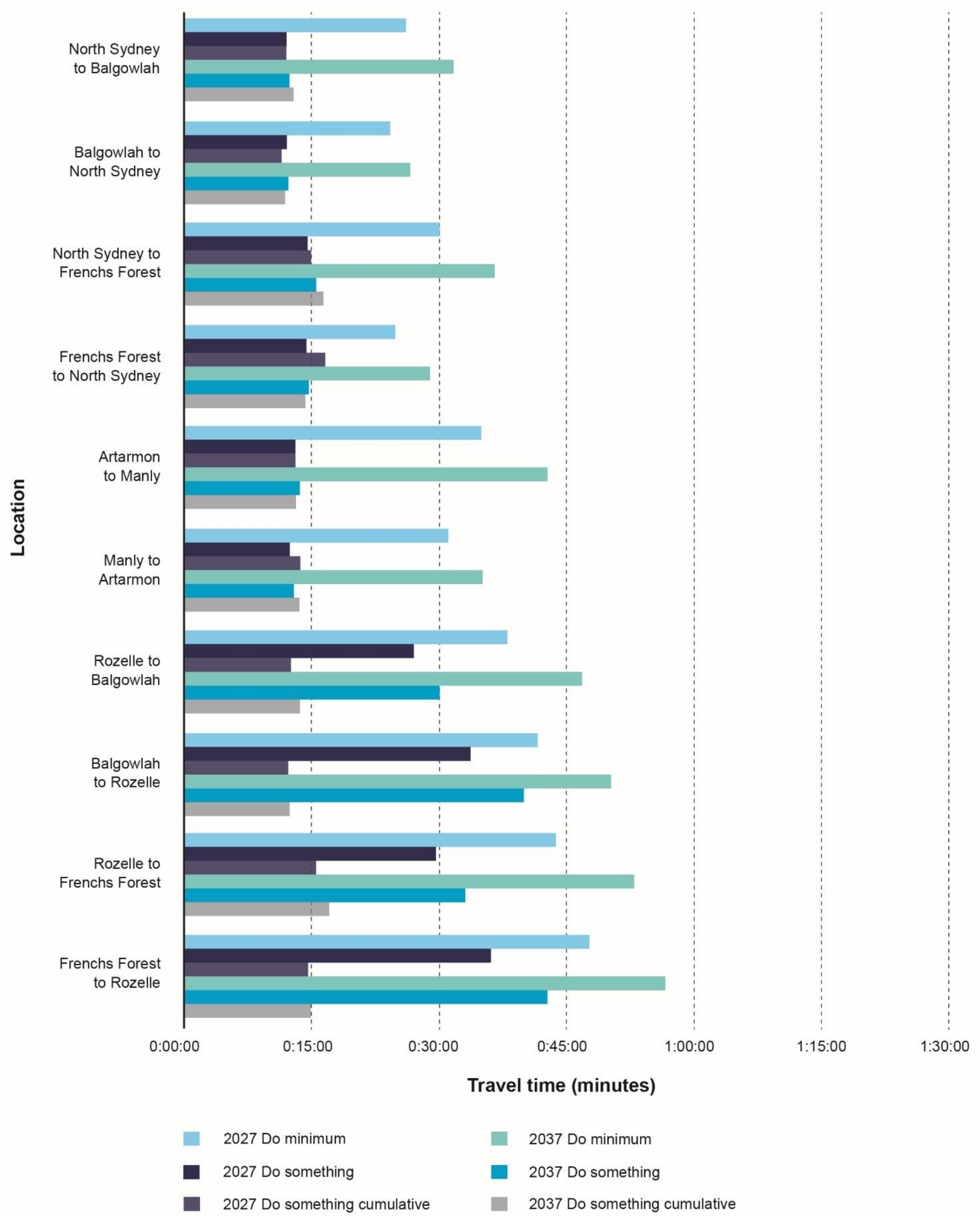


Figure 8-2 Modelled 'Do minimum', 'Do something' and 'Do something cumulative' evening peak hour travel times along key corridors (SMPM)

Analysis of the modelled forecast travel times along key routes in the vicinity of the project shows that travel time reductions resulting from the ‘Do something cumulative’ scenario are generally a consequence of reduced travel time for trips that would have the option to also use the Western Harbour Tunnel. The additional forecast demand in the project would not materially increase travel times via the project, indicating that there would be sufficient capacity to maintain efficient performance.

8.2.2 30-minute city catchments

Plots of the forecast 30-minute catchments by road for strategic centres in the vicinity of the project in 2037 are presented in Figure 8-3 to Figure 8-5.

Analysis of the 30-minute catchments for the ‘Do something cumulative’ scenario shows:

- Accessibility from Chatswood would not substantially change when compared to the ‘Do something’ scenario
- Accessibility from Dee Why and Brookvale would not substantially change under the ‘Do something cumulative’ scenario
- Accessibility from Manly would increase under the cumulative case, allowing for access to Rozelle and Five Dock within 30 minutes.

Overall, the ‘Do something cumulative’ scenario would increase the accessibility to/from Manly and the Sydney CBD due to the improved capacity and connectivity across Sydney Harbour provided by the Western Harbour Tunnel, but have limited impact on other centres. This reduction in road-based travel times would also result in reduced travel times for public transport and would increase the size of equivalent public transport catchments, particularly if express buses operate through both the Beaches Link Tunnel and Western Harbour Tunnel, substantially increasing the catchment size for centres north of Sydney Harbour.

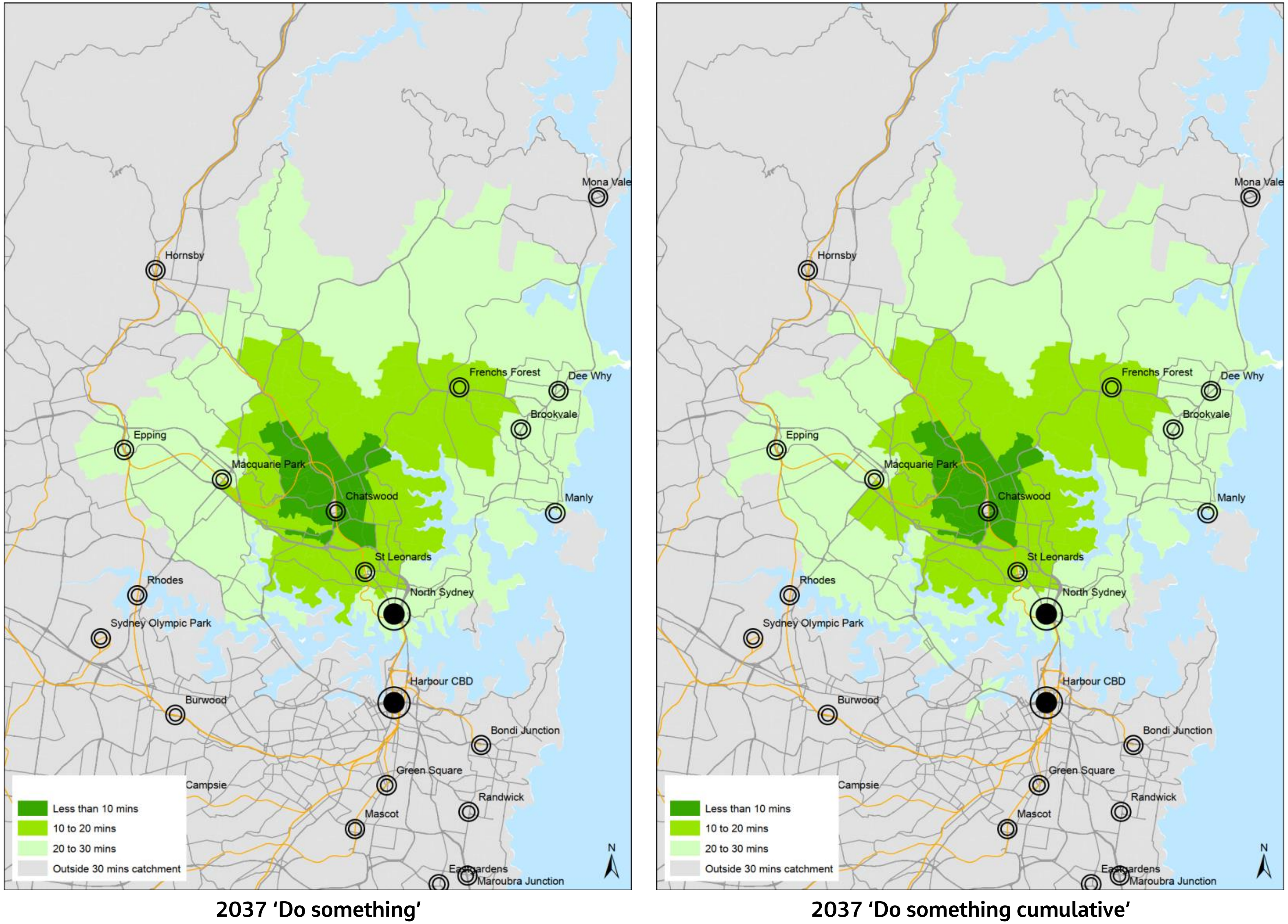


Figure 8-3 Modelled 2037 'Do something' and 'Do something cumulative' morning peak 30-minute catchments by road from Chatswood (SMPM)

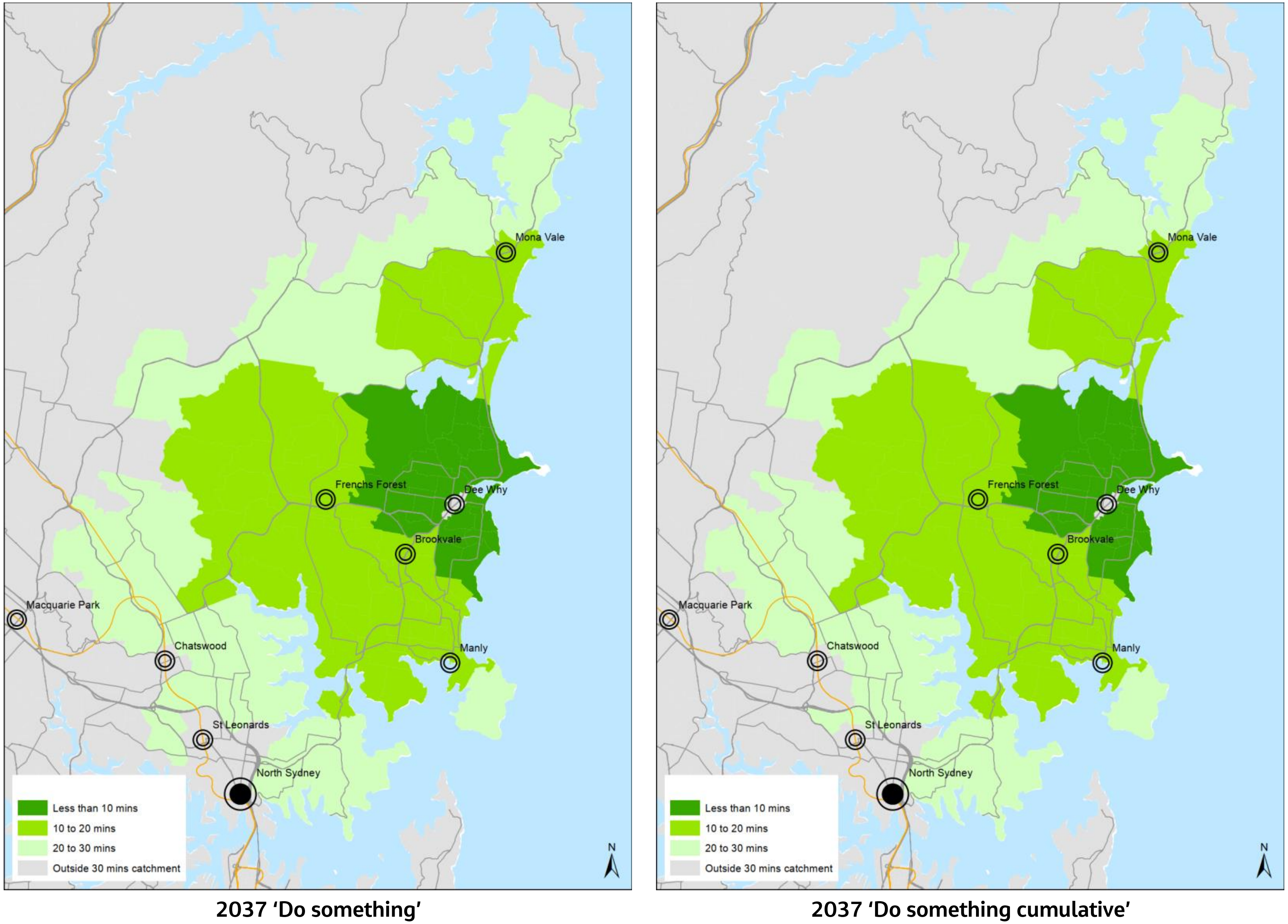


Figure 8-4 Modelled 2037 'Do something' and 'Do something cumulative' morning peak 30-minute catchments by road from Brookvale-Dee Why (SMPM)

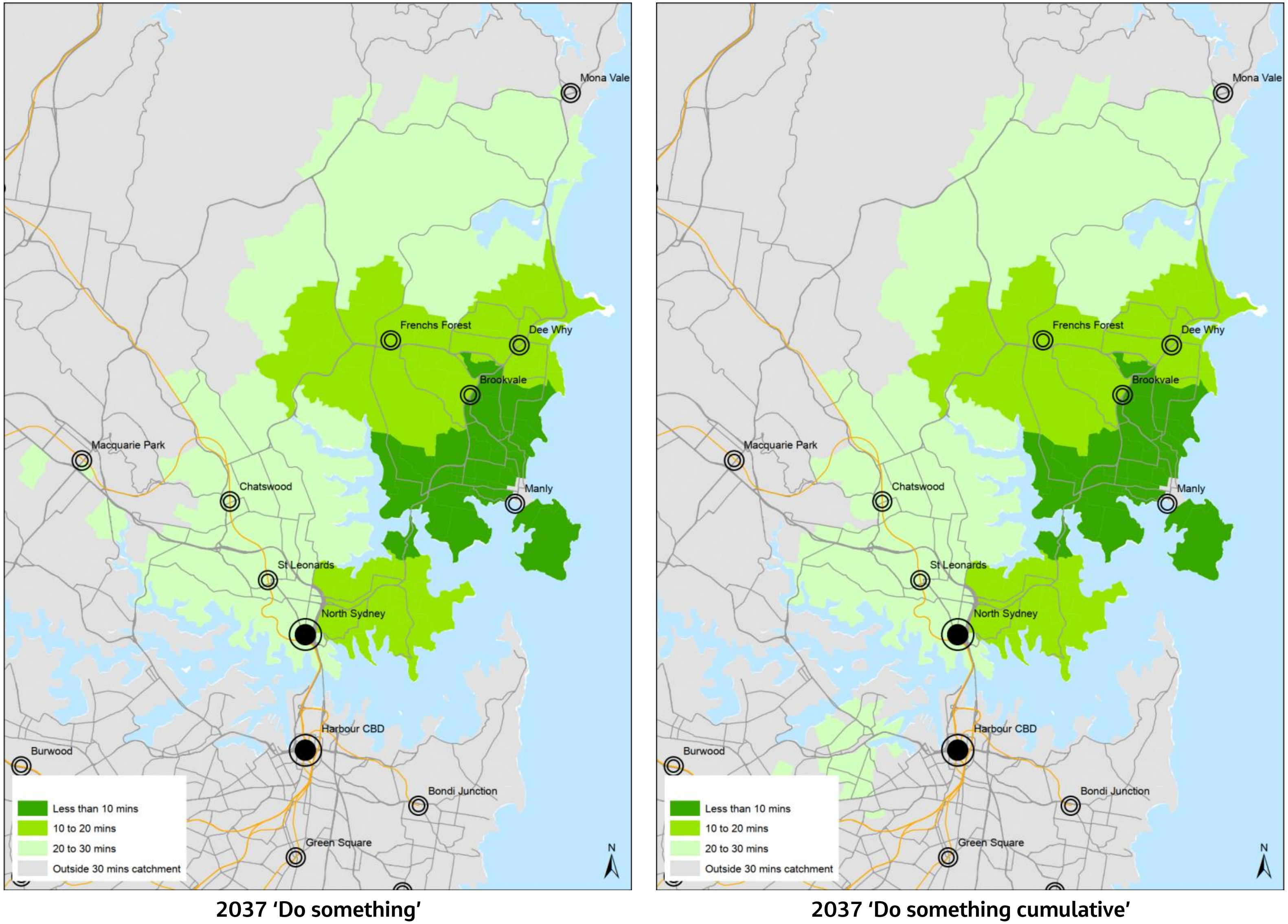


Figure 8-5 Modelled 2037 'Do something' and 'Do something cumulative' morning peak 30-minute catchments by road from Manly (SMPM)

8.2.3 Heavy vehicle movements

A summary of the forecast heavy vehicle demands at key locations under the 'Do something cumulative' scenario is presented in Table 8-4 to Table 8-6.

Analysis of the modelled forecast heavy vehicle demands under the 'Do something cumulative' scenario in 2037 shows there would be no material change in heavy vehicles travelling into and out of the Northern Beaches peninsula as result of the inclusion of the Western Harbour Tunnel and Warringah Freeway Upgrade project.

Table 8-4 Modelled 'Do something cumulative morning peak hour heavy vehicle demands at key locations (SMPM)

Road	Location	Direction	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Spit Road	Spit Bridge	Northbound	60	20	10	60	20	20
		Southbound	150	30	30	170	40	40
		Combined	*210*	*50*	*40*	*230*	*60*	*60*
Warringah Road	Roseville Bridge	Northbound	160	40	40	190	50	50
		Southbound	240	100	90	280	130	120
		Combined	*400*	*140*	*130*	*470*	*180*	*170*
Mona Vale Road	St Ives Showground	Northbound	170	130	120	210	160	150
		Southbound	290	180	180	330	190	180
		Combined	*460*	*310*	*300*	*540*	*350*	*330*
Beaches Link Tunnel	Killarney Heights	Northbound	N/A	210	230	N/A	240	260
		Southbound	N/A	380	390	N/A	450	460
		Combined	*N/A*	*590*	*620*	*N/A*	*690*	*720*
Northern Beaches screenline		**Northbound**	**390**	**400**	**400**	**460**	**470**	**480**
		Southbound	**680**	**690**	**690**	**780**	**810**	**800**
		Combined	***1070***	***1090***	***1090***	***1240***	***1280***	***1280***

Note: Comparing the 'Do something cumulative' scenario with the 'Do something' scenario, a reduction in demand greater than 10 per cent is highlighted in green while an increase in demand greater than 10 per cent is highlighted in blue.

Table 8-5 Modelled 'Do something cumulative' evening peak hour heavy vehicle demands at key locations (SMPM)

Road	Location	Direction	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Spit Road	Spit Bridge	Northbound	110	20	20	130	30	20
		Southbound	60	20	20	80	30	20
		Combined	*170*	*40*	*40*	*210*	*60*	*40*
Warringah Road	Roseville Bridge	Northbound	260	80	80	280	90	90
		Southbound	190	90	80	220	100	90
		Combined	*450*	*170*	*160*	*500*	*190*	*180*
Mona Vale Road	St Ives Showground	Northbound	160	90	90	180	100	90
		Southbound	340	250	240	380	290	270
		Combined	*500*	*340*	*330*	*560*	*390*	*360*
Beaches Link Tunnel	Killarney Heights	Northbound	N/A	340	340	N/A	380	390
		Southbound	N/A	230	240	N/A	270	290
		Combined	*N/A*	*570*	*580*	*N/A*	*650*	*680*
Northern Beaches screenline		**Northbound**	**530**	**530**	**530**	**590**	**600**	**590**
		Southbound	**590**	**590**	**580**	**680**	**690**	**670**
		Combined	***1120***	***1120***	***1110***	***1270***	***1290***	***1260***

Note: Comparing the 'Do something cumulative' scenario with the 'Do something' scenario, a reduction in demand greater than 10 per cent is highlighted in green while an increase in demand greater than 10 per cent is highlighted in blue.

Table 8-6 Modelled 'Do something cumulative' daily heavy vehicle demands at key locations (SMPM)

Road	Location	Direction	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Spit Road	Spit Bridge	Northbound	1900	500	400	2300	600	500
		Southbound	2300	700	600	2700	800	700
		Combined	*4200*	*1200*	*1000*	*5000*	*1400*	*1200*
Warringah Road	Roseville Bridge	Northbound	3300	1000	1000	3500	1200	1200
		Southbound	3000	1400	1300	3400	1700	1600
		Combined	*6300*	*2400*	*2300*	*6900*	*2900*	*2800*
Mona Vale Road	St Ives Showground	Northbound	2500	1800	1700	2900	2000	1900
		Southbound	4100	3100	3000	4800	3400	3300
		Combined	*6600*	*4900*	*4700*	*7700*	*5400*	*5200*
Beaches Link Tunnel	Killarney Heights	Northbound	N/A	4400	4500	N/A	5000	5200
		Southbound	N/A	4400	4500	N/A	5100	5300
		Combined	*N/A*	*8800*	*9000*	*N/A*	*10,100*	*10,500*
Northern Beaches screenline		**Northbound**	**7700**	**7700**	**7600**	**8700**	**8800**	**8800**
		Southbound	**9400**	**9600**	**9400**	**10,900**	**11,000**	**10,900**
		Combined	***17,100***	***17,300***	***17,000***	***19,600***	***19,800***	***19,700***

Note: Comparing the 'Do something cumulative' scenario with the 'Do something' scenario, a reduction in demand greater than 10 per cent is highlighted in green while an increase in demand greater than 10 per cent is highlighted in blue.

8.2.4 Tolling scenarios and implications

The ‘Do something cumulative’ scenario was assessed based on the basis of the following assumed tolling regimes:

- Beaches Link Tunnel: two-way tolling
- Western Harbour Tunnel: two-way tolling, with price equalised with Sydney Harbour Bridge/Sydney Harbour Tunnel
- Sydney Harbour Tunnel: two-way tolling, with price equalised with Sydney Harbour Bridge/Western Harbour Tunnel
- Sydney Harbour Bridge (including Cahill Expressway): two-way tolling, with price equalised with Sydney Harbour Tunnel/Western Harbour Tunnel.

Although no decision on tolls has yet been made for northbound traffic using the Sydney Harbour Bridge and Sydney Harbour Tunnel, the assessment assumptions include equalised tolling (toll parity) between Sydney Harbour Bridge/Sydney Harbour Tunnel and Western Harbour Tunnel.

In the context of this assessment, toll avoidance is the potential impact of traffic diverting from currently non tolled roads due to the introduction of a new toll. The potential introduction of a northbound toll on the Sydney Harbour Bridge and Sydney Harbour Tunnel has the potential to result in toll avoidance. However, it should be noted that the alternative non-tolled route for the Western Harbour Tunnel, Sydney Harbour Bridge and Sydney Harbour Tunnel corridor is Victoria Road. Traffic forecasting undertaken for the assessment (which includes toll choice assignment) indicates that traffic volumes and travel times would not materially change on Victoria Road following the introduction of Western Harbour Tunnel, including assumed changes to the existing tolling regime on Sydney Harbour Bridge and Sydney Harbour Tunnel.

8.2.5 Strategic model road network performance

A summary of the forecast daily VKT and VHT of the Sydney region and the Western Harbour Tunnel and Beaches Link study area under the ‘Do something cumulative’ scenario for the 2027 and 2037 forecast years is provided in Table 8-7.

Analysis of the forecast daily VKT and VHT under the ‘Do something cumulative’ scenario shows that:

- The addition of Western Harbour Tunnel would further improve network productivity due to an increase in motorway daily VKT
- Motorway daily VHT would also increase and is the consequence of more trips being carried out on the motorway network due to improved connectivity
- Traffic would shift from the arterial (non-motorway) roads to the project (motorway) as evident in the reduction in daily VHT and VKT on the non-motorway road network.

Table 8-7 Modelled ‘Do something cumulative’ daily VKT and VHT (SMPM)

Network measure	Road	2027 ‘Do minimum’	2027 ‘Do something’	2027 ‘Do something cumulative’	2037 ‘Do minimum’	2037 ‘Do something’	2037 ‘Do something cumulative’
Sydney region							
Daily VKT	Motorway	27,135,000	27,399,000	28,614,000	31,810,000	32,170,000	34,186,000
	Other	87,592,000	87,570,000	86,794,000	103,604,000	103,601,000	102,416,000
	Total	114,727,000	114,969,000	115,408,000	135,414,000	135,772,000	136,602,000

Network measure	Road	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Daily VHT	Motorway	513,000	501,000	509,000	758,000	737,000	753,000
	Other	3,248,000	3,244,000	3,193,000	5,174,000	5,167,000	5,065,000
	Total	3,761,000	3,745,000	3,702,000	5,931,000	5,904,000	5,819,000
Western Harbour Tunnel and Beaches Link study area							
Daily VKT	Motorway	6,377,000	6,623,000	7,711,000	6,891,000	7,253,000	8,605,000
	Other	15,315,000	15,286,000	14,673,000	16,654,000	16,656,000	16,027,000
	Total	21,693,000	21,909,000	22,384,000	23,545,000	23,909,000	24,632,000
Daily VHT	Motorway	149,000	136,000	142,000	187,000	165,000	173,000
	Other	656,000	655,000	616,000	774,000	773,000	718,000
	Total	805,000	791,000	758,000	961,000	938,000	890,000

8.2.6 Impacts on road safety

The impact of the 'Do something cumulative' scenario on road safety in the vicinity of the project would be minimal, and generally a consequence of decreased traffic volumes on key arterial roads including Warringah Road, Eastern Valley Way, Military Road and Spit Road. These decreased traffic volumes and increased capacity provided by the Beaches Link Tunnel would reduce the potential for crashes, particularly for heavy vehicles.

8.3 Beaches Link and Gore Hill Freeway Connection

8.3.1 Midblock Level of Service

A summary of midblock performance of the Beaches Link and Gore Hill Freeway Connection mainline and on and off ramps for the 2027 and 2037 forecast years is presented in Table 8-8 and Table 8-9.

Analysis of midblock performance indicates that there would be minimal change in the Level of Service for the Beaches Link mainline tunnel with the inclusion of the Western Harbour Tunnel, with the exception of the northbound Gore Hill Freeway Connection which would operate at LoS E during the busiest peak periods. This section would only operate marginally above the threshold value between LoS D and E, maintaining a travel speed of over 70 kilometres per hour.

Table 8-8 Modelled ‘Do something cumulative’ morning peak hour Beaches Link and Gore Hill Freeway Connection performance

Segment	Direction	Min no. of lanes	2027 ‘Do something’		2027 ‘Do something cumulative’		2037 ‘Do something’		2037 ‘Do something cumulative’	
			Density (PCU/km/ lane)	LoS	Density (PCU/km/ lane)	LoS	Density (PCU/km/ lane)	LoS	Density (PCU/km/ lane)	LoS
Beaches Link Tunnel (main carriageway)	Northbound	3	9.2	B	9.9	B	9.5	B	11.9	C
	Southbound	3	20.0	D	20.7	D	23.9	E	23.8	E
Warringah Freeway Connection (main carriageway)	Northbound	3	4.4	A	5.7	A	4.2	A	6.9	A
	Southbound	3	10.6	B	14.0	C	11.8	C	15.8	C
Gore Hill Freeway Connection (main carriageway)	Northbound	2	6.3	A	6.3	A	7.4	B	5.7	A
	Southbound	2	14.6	C	13.1	C	18.4	D	14.8	C
Balgowlah Connection (main carriageway)	Northbound	3	5.5	A	5.9	A	5.9	A	6.3	A
	Southbound	2	15.5	C	17.2	D	18.6	D	20.6	D
Frenchs Forest Connection (main carriageway)	Northbound	2	5.3	A	6.4	A	6.2	A	7.7	B
	Southbound	2	13.0	C	13.7	C	14.6	C	16.0	C
Gore Hill Freeway Connection (merge)	Northbound	3	8.9	B	9.2	B	10.2	B	10.9	B
Gore Hill Freeway Connection (diverge)	Southbound	2	22.8	E	22.5	E	26.5	E	25.4	E
Balgowlah/Frenchs Forest Connection (merge)	Southbound	3	19.8	D	21.3	D	23.7	E	25.2	E
Balgowlah/Frenchs Forest Connection (diverge)	Northbound	3	9.0	B	9.8	B	9.3	B	11.5	B

Table 8-9 Modelled 'Do something cumulative' evening peak hour Beaches Link and Gore Hill Freeway Connection performance

Segment	Direction	Min no. of lanes	2027 'Do something'		2027 'Do something cumulative'		2037 'Do something'		2037 'Do something cumulative'	
			Density (PCU/km/ lane)	LoS	Density (PCU/km/ lane)	LoS	Density (PCU/km/ lane)	LoS	Density (PCU/km/ lane)	LoS
Beaches Link Tunnel (main carriageway)	Northbound	3	16.9	D	18.8	D	19.3	D	20.8	D
	Southbound	3	9.4	B	10.5	B	11.2	C	11.7	C
Warringah Freeway Connection (main carriageway)	Northbound	3	8.4	B	10.7	B	10.0	B	12.3	C
	Southbound	3	5.2	A	6.8	A	6.1	A	8.0	B
Gore Hill Freeway Connection (main carriageway)	Northbound	2	12.0	C	14.0	C	14.2	C	12.7	C
	Southbound	2	6.1	A	6.4	A	8.1	B	6.7	A
Balgowlah Connection (main carriageway)	Northbound	3	10.0	B	11.3	C	11.6	C	11.5	C
	Southbound	2	7.9	B	8.7	B	9.0	B	9.7	B
Frenchs Forest Connection (main carriageway)	Northbound	2	11.9	C	12.8	C	12.8	C	13.8	C
	Southbound	2	5.1	A	6.4	A	6.0	A	7.4	B
Gore Hill Freeway Connection (merge)	Northbound	3	18.1	D	19.1	D	20.5	D	22.9	E
Gore Hill Freeway Connection (diverge)	Southbound	2	10.2	B	11.4	B	12.6	C	13.2	C
Balgowlah/Frenchs Forest Connection (merge)	Southbound	3	10.1	B	11.2	B	11.1	B	12.2	C
Balgowlah/Frenchs Forest Connection (diverge)	Northbound	3	16.8	C	19.0	D	19.3	D	20.6	D

8.4 Warringah Freeway and surrounds

8.4.1 Network performance

A summary of future network performance statistics for the Warringah Freeway and surrounds study area under the 'Do something cumulative' scenario is provided in Table 8-10 and Table 8-11. The introduction of the Western Harbour Tunnel would generally result in improved travel times when compared to the 'Do something' scenario. Analysis of the modelled network statistics shows that, compared to the 'Do something' scenario:

- Peak period travel demand through the Warringah Freeway and surrounds study area would increase by up to 15 per cent by 2037 as a result of the introduction of the Western Harbour Tunnel
- The project would result in a greater amount of forecast demand being able to travel as desired during the morning peak period. This is reflected in fewer unreleased vehicles at the end of the modelled period when compared with the morning peak 'Do minimum' and 'Do something' scenarios
- Average travel speeds through the Warringah Freeway and surrounds study area would improve by up to 30 per cent as a result of the introduction of the Western Harbour Tunnel
- The number of stops during peak periods would substantially decrease as a result of the introduction of the Western Harbour Tunnel, particularly in the morning peak.

Overall, Western Harbour Tunnel would improve network capacity and connectivity across Sydney Harbour. This would reduce demand and delays on Sydney Harbour Bridge and Sydney Harbour Tunnel, consequently improving network performance throughout the Warringah Freeway and surrounds study area during peak periods.

Table 8-10 Modelled 'Do something cumulative' morning peak network performance - Warringah Freeway and surrounds study area

Network measure	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Network statistics for all vehicles						
Total traffic demand (veh)	104,500	105,900	117,700	112,400	115,000	131,700
Total VKT through network	340,400	360,400	419,800	350,700	375,900	451,600
Total VHT through network	9000	10,800	9690	10,160	11,550	11,300
Total number of stops	616,200	788,500	296,500	746,100	856,000	486,600
Average vehicle statistics						
Average vehicle trip length through the network (km)	3.5	3.7	3.7	3.5	3.6	3.7

Network measure	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Average vehicle trip time through the network (hours)	0:05:32	0:06:40	0:05:07	0:06:01	0:06:43	0:05:31
Average number of stops per trip	6.3	8.1	2.6	7.4	8.3	4.0
Average trip speed (km/hr)	37.8	33.3	43.3	34.5	32.5	40.1
Unreleased traffic						
Total unreleased trips	6890	8480	4080	11,270	11,750	9190
% of demand unreleased	7%	8%	4%	10%	10%	7%

Table 8-11 Modelled 'Do something cumulative' evening peak network performance - Warringah Freeway and surrounds study area

Network measure	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Network statistics for all vehicles						
Total traffic demand (veh)	109,500	111,800	117,200	118,100	120,700	129,700
Total VKTthrough network	344,900	371,900	378,700	349,000	385,500	412,700
Total VHT through network	9880	9130	9070	12,370	11,100	10,500
Total number of stops	621,100	263,500	249,900	980,300	460,700	314,900
Average vehicle statistics						
Average vehicle trip length through the network (km)	3.3	3.6	3.4	3.2	3.6	3.5
Average vehicle trip time through the network (hours)	0:05:37	0:05:17	0:04:55	0:06:51	0:06:08	0:05:17

Network measure	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Average number of stops per trip	5.9	2.5	2.3	9.1	4.2	2.7
Average trip speed (km/hr)	34.9	40.7	41.8	28.2	34.8	39.3
Unreleased traffic						
Total unreleased trips	3900	8030	6670	9800	12,100	10,700
% of demand unreleased	4%	7%	6%	8%	10%	8%

8.4.2 General traffic travel times

Modelled general traffic travel times for key routes through the Warringah Freeway and surrounds study area are provided in Table 8-12 and Table 8-13. Analysis of modelled travel times under the 'Do something cumulative' scenario shows the following:

- Travel times along Warringah Freeway would generally improve. This is a result of the transfer of trips to the Western Harbour Tunnel, with some of this traffic travelling directly between Beaches Link and Western Harbour Tunnel. This would relieve capacity constraints on the Warringah Freeway, Sydney Harbour Bridge, and Sydney Harbour Tunnel both northbound and southbound
- Travel times in North Sydney could experience a general incremental increase as a result of changes to traffic patterns and access arrangements to, from and within North Sydney.

Overall, introduction of the Western Harbour Tunnel would result in generally improved travel times along the Warringah Freeway due to the transfer of traffic from alternative routes, reducing congestion on existing Sydney Harbour crossings and approaches. However, this would be accompanied by localised increases in travel times for trips within North Sydney and surrounds.

Table 8-12 Modelled 'Do something cumulative' morning peak hour general traffic travel times - Warringah Freeway and surrounds study area

Route	Direction	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Sydney Harbour Bridge to Warringah Freeway/Falcon Street interchange	Northbound	0:04:40	0:05:47	0:03:33	0:04:51	0:04:56	0:04:12
	Southbound	0:04:03	0:04:06	0:04:07	0:04:02	0:04:13	0:04:06
Sydney Harbour Tunnel to Warringah Freeway/Falcon Street interchange	Northbound	0:03:55	0:11:50	0:03:31	0:04:08	0:12:07	0:04:27
	Southbound	0:04:03	0:04:17	0:04:27	0:04:02	0:04:18	0:04:26
Sydney Harbour Bridge to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:06:13	0:07:41	0:05:26	0:06:16	0:06:45	0:05:29
	Southbound	0:13:35	0:13:29	0:08:02	0:15:22	0:13:46	0:07:54
Sydney Harbour Tunnel to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:05:26	0:16:21	0:05:18	0:05:30	0:17:03	0:05:23
	Southbound	0:11:39	0:11:20	0:07:59	0:12:37	0:11:30	0:08:08
Berry Street to Amherst Street via Miller Street	Northbound	0:03:42	0:03:56	0:04:06	0:03:53	0:04:07	0:04:03
	Southbound	0:04:25	0:04:04	0:06:01	0:05:43	0:04:05	0:07:01

Table 8-13 Modelled 'Do something cumulative' evening peak hour general traffic travel times - Warringah Freeway and surrounds study area

Route	Direction	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Sydney Harbour Bridge to Warringah Freeway/Falcon Street interchange	Northbound	0:04:02	0:03:26	0:03:25	0:07:51	0:04:51	0:03:28
	Southbound	0:06:09	0:04:44	0:04:37	0:05:02	0:04:41	0:04:33
Sydney Harbour Tunnel to Warringah Freeway/Falcon Street interchange	Northbound	0:03:57	0:03:22	0:03:24	0:07:36	0:03:25	0:03:31
	Southbound	0:14:54	0:05:52	0:05:28	0:14:59	0:07:41	0:05:35
Sydney Harbour Bridge to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:05:35	0:05:26	0:05:21	0:06:45	0:06:53	0:05:24
	Southbound	0:13:56	0:06:18	0:06:10	0:17:31	0:07:28	0:06:10
Sydney Harbour Tunnel to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:05:28	0:05:17	0:05:12	0:06:46	0:05:22	0:05:14
	Southbound	0:25:21	0:07:23	0:07:00	0:30:09	0:13:50	0:07:07
Berry Street to Amherst Street via Miller Street	Northbound	0:03:52	0:04:39	0:04:46	0:03:50	0:10:22	0:05:14
	Southbound	0:05:01	0:05:30	0:04:35	0:08:39	0:05:01	0:05:37

8.4.3 Intersection performance

Modelled future intersection performance for key intersections in the Warringah Freeway and surrounds study area under the 'Do something cumulative' scenario is presented in Table 8-14 and Table 8-15. The introduction of the Western Harbour Tunnel would generally result in improved intersection performance when compared to the 'Do something' scenario. Analysis of intersection performance under the 'Do something cumulative' scenario indicates:

- Most intersections would perform similarly to the 'Do something' scenario
- Some intersections on the Pacific Highway, Walker Street, Miller Street and Berry Street could experience increased localised delays with the introduction of the Western Harbour Tunnel due to increased demand and changes to local traffic patterns
- Intersections along the Falcon Street and Military Road corridor would perform marginally better with the introduction of the Western Harbour Tunnel, as trips from the Pittwater Road corridor bypassing the Sydney CBD would avoid Spit Road and Military Road and use the direct connection from the project to Western Harbour Tunnel
- With respect to future traffic on Willoughby Road in the vicinity of the proposed Channel 9 site staged residential development, traffic modelling shows that in the 'Do minimum' scenario (ie without the project), the Willoughby Road interchange with the Gore Hill Freeway would be expected to perform at LoS F in the 2037 morning and evening peaks, with traffic and congestion expected to increase due to population and employment growth. However, in both the 'Do something' and 'Do something cumulative' scenarios, the Willoughby Road interchange with the Gore Hill Freeway is modelled to perform at LoS A in morning and evening peaks in 2037. The traffic modelling therefore indicates that in the 'Do something' and 'Do something cumulative' scenarios, that Willoughby Road and Gore Hill Freeway interchange would have capacity to accommodate potential additional traffic generated by the proposed Channel 9 site staged residential development.

Overall, intersection performance in North Sydney under the 'Do something cumulative' scenario would be similar during peak periods. Changed traffic patterns and volumes in the North Sydney area would result in reduced localised delays at some locations and increased delays at others.

Changes to connectivity associated with the Western Harbour Tunnel would result in the following localised impacts:

- Brook Street and Miller Street: Under the 'Do something' scenario, trips travelling across Sydney Harbour from these locations would have no access to the Sydney Harbour Tunnel. The addition of the Western Harbour Tunnel as an additional harbour crossing would reduce demand on the Sydney Harbour Bridge and reduce travel times for trips from these locations
- Berry Street on ramp: The introduction of the Western Harbour Tunnel would draw additional traffic to the Berry Street on ramp to access Western Harbour Tunnel southbound. This would increase localised delays during morning peak periods when compared to the project only case; the magnitude of delays would be similar to the 'Do minimum' scenario.

Although some traffic would be impacted by an increase in localised intersection delays, road users would still generally benefit from substantial overall travel time savings on the broader network (eg via Beaches Link, Western Harbour Tunnel, ANZAC Bridge, and Sydney Harbour Bridge). Consequently, traffic impacted at individual intersections in the North Sydney area is still anticipated to receive a net benefit due to the broader connectivity and efficiency improvements.

Table 8-14 Modelled 'Do something cumulative' morning peak hour intersection performance - Warringah Freeway and surrounds study area

Intersection	2027 'Do minimum'		2027 'Do something'		2027 'Do something cumulative'		2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Willoughby Road/Gore Hill Freeway interchange	>100	F	27	B	9	A	>100	F	21	B	10	A
Brook Street/Warringah Freeway on ramp	>100	F	13	A	8	A	>100	F	70	E	64	E
Brook Street/Warringah Freeway off ramp	61	E	21	B	9	A	67	E	9	A	16	B
Brook Street/Merrenburn Avenue	>100	F	31	C	26	B	>100	F	70	E	50	D
Amherst Street/West Street	5	A	7	A	50	D	5	A	>100	F	>100	F
Amherst Street/Miller Street	21	B	38	C	42	C	20	B	58	E	44	D
Miller Street/Warringah Freeway on ramp	7	A	<5	A	<5	A	6	A	<5	A	5	A
Miller Street/Warringah Freeway off ramp	12	A	5	A	8	A	13	A	5	A	8	A

Intersection	2027 'Do minimum'		2027 'Do something'		2027 'Do something cumulative'		2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Miller Street/Ernest Street	25	B	44	D	42	C	32	C	40	C	41	C
Miller Street/Falcon Street	35	C	27	B	30	C	38	C	25	B	44	D
Ernest Street/Warringah Freeway on ramp	5	A	19	B	29	C	5	A	53	D	36	C
Ernest Street/Warringah Freeway off ramp (off ramp in PM, on ramp in AM)	5	A	19	B	28	B	5	A	48	D	34	C
Falcon Street/Warringah Freeway ramps	29	C	36	C	42	C	15	B	45	D	51	D
Watson Street/Military Road	18	B	38	C	28	C	26	B	37	C	30	C
Military Road/Ben Boyd Road	15	B	47	D	47	D	23	B	44	D	43	D
Falcon Street/Merlin Street	24	B	46	D	39	C	32	C	47	D	54	D
Berry Street/Walker Street	29	C	76	F	41	C	39	C	46	D	50	D

Intersection	2027 'Do minimum'		2027 'Do something'		2027 'Do something cumulative'		2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Berry Street/Miller Street	55	D	49	D	58	E	69	E	39	C	57	E
Mount Street/Arthur Street	46	D	46	D	18	B	59	E	33	C	33	C
Mount Street/Walker Street	36	C	47	D	35	C	48	D	41	C	43	D
Pacific Highway/High Street/Arthur Street	19	B	57	E	18	B	38	C	45	D	19	B
Pacific Highway/Walker Street/Blue Street	36	C	55	D	33	C	65	E	49	D	32	C
Pacific Highway/Miller Street/Mount Street	38	C	79	F	62	E	41	C	72	F	62	E
Pacific Highway/Berry Street	56	E	17	B	60	E	52	D	16	B	60	E
Pacific Highway/Bay Road	55	D	23	B	42	D	77	F	23	B	88	F
Miller Street/McLaren Street	23	B	40	C	56	E	72	F	42	C	62	E
Miller Street/Ridge Street	38	C	33	C	63	E	53	D	45	D	70	E
Miller Street/Carlow Street	13	A	8	A	15	B	13	A	8	A	28	C

Intersection	2027 'Do minimum'		2027 'Do something'		2027 'Do something cumulative'		2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
High Street/Clark Road	18	B	32	C	36	C	55	D	37	C	38	C
High Street/Alfred Street North	13	A	49	D	19	B	62	E	32	C	18	B
Mount Street/Alfred Street North	<5	A	16	B	14	B	<5	A	16	B	14	A
Ernest Street/Ben Boyd Road	12	A	11	A	18	B	12	A	14	B	26	B
Pedestrian crossing at Military Road	6	A	<5	A	5	A	5	A	<5	A	6	A

Table 8-15 Modelled 'Do something cumulative' evening peak hour intersection performance - Warringah Freeway and surrounds study area

Intersection	2027 'Do minimum'		2027 'Do something'		2027 'Do something cumulative'		2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Willoughby Road/Gore Hill Freeway interchange	38	C	10	A	11	A	76	F	10	A	11	A
Brook Street/Warringah Freeway on ramp	14	B	9	A	<5	A	17	B	92	F	25	B
Brook Street/Warringah Freeway off ramp	22	B	17	B	17	B	20	B	87	F	29	C
Brook Street/Merrenburn Avenue	11	A	53	D	17	B	13	A	59	E	39	C
Amherst Street/West Street	9	A	89	F	43	D	14	A	>100	F	73	F
Amherst Street/Miller Street	29	C	47	D	43	D	31	C	52	D	48	D
Miller Street/Warringah Freeway on ramp	6	A	6	A	6	A	6	A	6	A	7	A
Miller Street/Warringah Freeway off ramp	15	B	9	A	7	A	15	B	9	A	8	A
Miller Street/Ernest Street	41	C	36	C	34	C	43	D	35	C	39	C

Intersection	2027 'Do minimum'		2027 'Do something'		2027 'Do something cumulative'		2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Miller Street/Falcon Street	44	D	82	F	38	C	49	D	95	F	48	D
Ernest Street/Warringah Freeway on ramp	15	B	12	A	13	A	15	B	12	A	13	A
Ernest Street/Warringah Freeway off ramp (off ramp in PM, on ramp in AM)	17	B	13	A	14	A	17	B	14	A	15	B
Falcon Street/Warringah Freeway ramps	72	F	70	E	52	D	>100	F	68	E	60	E
Watson Street/Military Road	46	D	50	D	37	C	59	E	46	D	38	C
Military Road/Ben Boyd Road	54	D	65	E	55	D	70	E	>100	F	83	F
Falcon Street/Merlin Street	>100	F	94	F	83	F	>100	F	93	F	88	F
Berry Street/Walker Street	44	D	82	F	69	E	73	F	81	F	74	F
Berry Street/Miller Street	46	D	35	C	54	D	70	F	76	F	63	E
Mount Street/Arthur Street	49	D	17	B	21	B	92	F	18	B	>100	F

Intersection	2027 'Do minimum'		2027 'Do something'		2027 'Do something cumulative'		2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Mount Street/Walker Street	32	C	47	D	78	F	75	F	59	E	96	F
Pacific Highway/High Street/Arthur Street	46	D	14	A	16	B	61	E	23	B	21	B
Pacific Highway/Walker Street/Blue Street	40	D	65	E	54	D	80	F	79	F	60	E
Pacific Highway/Miller Street/Mount Street	41	C	57	E	50	D	58	E	78	F	66	E
Pacific Highway/Berry Street	23	B	15	B	85	F	56	E	34	C	87	F
Pacific Highway/Bay Road	15	B	22	B	27	B	41	C	40	C	33	C
Miller Street/McLaren Street	21	B	39	C	37	C	55	D	76	F	50	D
Miller Street/Ridge Street	40	C	15	B	21	B	91	F	57	E	39	C
Miller Street/Carlow Street	8	A	6	A	7	A	19	B	55	D	7	A
High Street/Clark Road	61	E	50	D	56	D	97	F	52	D	65	E
High Street/Alfred Street	>100	F	41	C	42	C	>100	F	42	C	46	D

Intersection	2027 'Do minimum'		2027 'Do something'		2027 'Do something cumulative'		2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Mount Street/Alfred Street	12	A	14	A	12	A	10	A	14	A	13	A
Ernest Street/Ben Boyd Road	44	D	10	A	10	A	94	F	38	C	46	D
Pedestrian crossing at Military Road	27	B	5	A	<5	A	34	C	5	A	5	A

8.4.4 Road network changes and access arrangements

In addition to the road network changes proposed for the project and the Warringah Freeway Upgrade, other modifications to the road network in North Sydney would be required to accommodate the Western Harbour Tunnel as well as the Beaches Link and Gore Hill Freeway Connection projects.

The Western Harbour Tunnel project would connect to North Sydney with a new on ramp from Berry Street for vehicles travelling southbound and a new off ramp to Falcon Street for vehicles travelling northbound. In addition, the Beaches Link tunnel would also directly connect to the Warringah Freeway north of Ernest Street.

A new private service road would be constructed from Ernest Street, Cammeray to provide light vehicle access to staff parking facilities for the motorway facilities and motorway control centre at Cammeray established for the project.

The Western Harbour Tunnel and Beaches Link program of works would separate traffic on the Warringah Freeway based on trip function (through traffic, traffic for arterial distribution and traffic for local distribution), as shown in the Warringah Freeway connectivity strategy as shown in Figure 8-6.

Separation of traffic based on trip function is shown conceptually in Figure 8-6. The trip distribution strategy, which is based on differentiating and optimising the use of the harbour crossing locations, would be implemented as follows:

- The central carriageway would act as the mainline motorway corridor connecting Gore Hill Freeway/M1 North, Warringah Freeway and Western Harbour Tunnel
- The southbound outer carriageway would act as the access distributor for North Sydney, Sydney CBD and journeys on to the Eastern Suburbs (including the Sydney Harbour Bridge and Sydney Harbour Tunnel)
- The northbound outer carriageway would act as the access distributor for North Sydney, Sydney CBD and journeys from the Eastern Suburbs (including the Sydney Harbour Bridge and Sydney Harbour Tunnel).

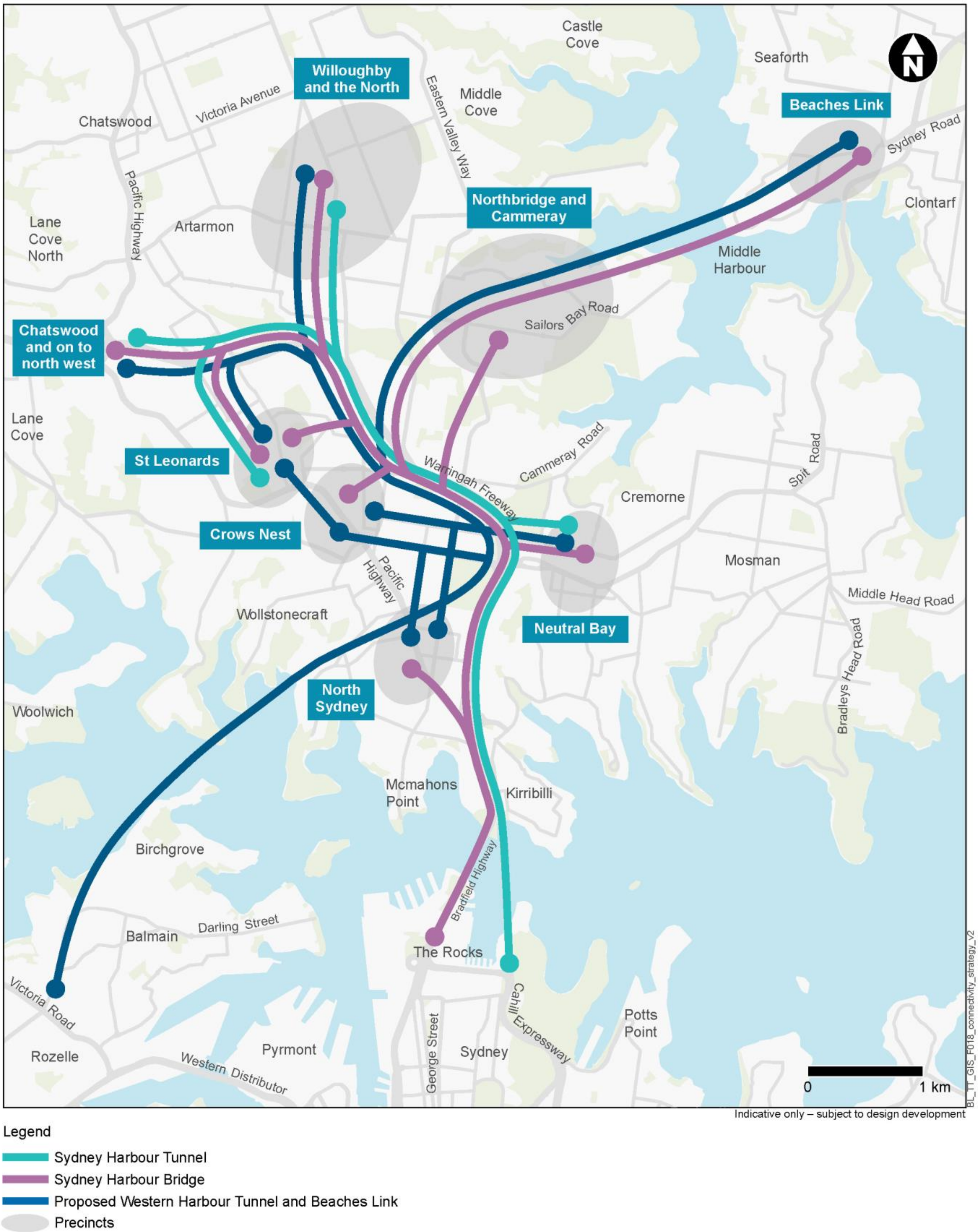


Figure 8-6 Conceptual trip distribution strategy

Additional access restrictions and local road changes due to Western Harbour Tunnel are as follows:

- The existing Falcon Street westbound off ramp from the Warringah Freeway would be converted to the northbound off ramp from Western Harbour Tunnel, thereby removing connectivity between the Warringah Freeway northbound and Falcon Street westbound. Adjacent interchanges north and south of Falcon Street would provide similar alternative connectivity
- Berry Street east of Walker Street would be reconfigured with the provision of two traffic lanes connecting to the Western Harbour Tunnel, one traffic lane providing connection to the Warringah Freeway northbound and Arthur Street southbound, and one traffic lane connecting to Arthur Street southbound only.

In general, these access restrictions would result in minor increases in travel distance and time for the affected trips. However, these changes would result in improved traffic performance and reduced congestion through the North Sydney road network as a whole and contribute to a road network arrangement that balances the needs of all users including public transport passengers, pedestrians and cyclists.

8.4.5 Public transport impacts

Modelled future bus travel times for key routes through the Warringah Freeway and surrounds study area under the 'Do something cumulative' scenario are presented in Table 8-16 and Table 8-17. Analysis of the modelled bus travel times indicates:

- Bus travel times through North Sydney could experience some localised delays that may occur during the busiest peak periods as a result of the introduction of the Western Harbour Tunnel
- Bus travel times along the Warringah Freeway would generally improve as a result of the project, due to the reduction of demand on Warringah Freeway caused by trips transferring to the project and Western Harbour Tunnel
- Bus travel times for trips travelling between Warringah Freeway and Military Road would remain largely unchanged. The introduction of the Western Harbour Tunnel would not substantially change traffic conditions for these routes, which would retain the same level of priority.

In general, the introduction of the Western Harbour Tunnel could impact localised travel times for buses travelling through North Sydney while travel times for buses on the Warringah Freeway would generally improve.

Table 8-16 Modelled 'Do something cumulative' morning peak hour bus travel times - Warringah Freeway and surrounds study area

Route	Direction	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Sydney Harbour Bridge to Amherst Street (via Miller Street and North Sydney Station)	Northbound	0:09:55	0:17:00	0:10:35	0:09:30	0:14:34	0:10:45
	Southbound	0:11:31	0:10:45	0:10:45	0:13:26	0:09:35	0:12:58
Sydney Harbour Bridge to Bay Street (via North Sydney Station and Pacific Highway)	Northbound	0:06:05	0:12:54	0:05:59	0:06:29	0:09:55	0:06:04
	Southbound	0:11:35	0:07:39	0:11:47	0:13:31	0:07:27	0:15:02
Sydney Harbour Bridge to Ben Boyd Road	Northbound	0:06:28	0:07:25	0:04:52	0:06:43	0:06:07	0:05:11
	Southbound	0:06:28	0:05:17	0:05:20	0:06:33	0:05:19	0:05:23
Sydney Harbour Bridge to Lane Cove Tunnel (via Gore Hill Freeway)	Northbound	0:06:43	0:07:57	0:05:37	0:06:42	0:06:39	0:05:44
	Southbound	0:25:33	0:11:52	0:07:16	0:28:17	0:09:48	0:07:30

Table 8-17 Modelled 'Do something cumulative' evening peak hour bus travel times - Warringah Freeway and surrounds study area

Route	Direction	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Sydney Harbour Bridge to Amherst Street (via Miller Street and North Sydney Station)	Northbound	0:11:03	0:12:56	0:12:42	0:13:34	0:23:14	0:13:21
	Southbound	0:13:14	0:16:03	0:12:54	0:19:09	0:15:52	0:21:17
Sydney Harbour Bridge to Bay Street (via North Sydney Station and Pacific Highway)	Northbound	0:07:13	0:08:21	0:08:06	0:09:52	0:11:10	0:07:53
	Southbound	0:09:17	0:12:39	0:11:35	0:13:59	0:13:06	0:16:59
Sydney Harbour Bridge to Ben Boyd Road	Northbound	0:08:27	0:04:50	0:04:50	0:08:36	0:06:08	0:04:47
	Southbound	0:05:52	0:05:27	0:06:03	0:06:51	0:05:41	0:05:45
Sydney Harbour Bridge to Lane Cove Tunnel (via Gore Hill Freeway)	Northbound	0:06:12	0:06:14	0:06:12	0:06:33	0:07:33	0:06:13
	Southbound	0:15:53	0:06:51	0:06:57	0:20:57	0:07:21	0:06:34

8.4.6 Active transport impacts

There would be no additional impacts on the active transport network under the 'Do something cumulative' scenario.

8.5 Gore Hill Freeway and Artarmon

8.5.1 Network performance

A summary of future network performance for the Gore Hill Freeway and Artarmon study area under the 'Do something cumulative' scenario is presented in Table 8-18 and Table 8-19. Analysis of the modelled network statistics shows that, compared to the 'Do something' scenario:

- Peak period traffic demand through the Gore Hill Freeway and Artarmon study area would increase by up to 2.5 per cent by 2037
- Average travel speeds through the Gore Hill Freeway and Artarmon study area would not materially change in the morning peak but could decrease by up to seven per cent in the evening peak. This is a consequence of potentially increased traffic demand on the Gore Hill Freeway as a result of the Western Harbour Tunnel
- The number of stops would not materially change in the morning peak but increase in the evening peak when compared to a 'Do minimum' scenario. This is also due to the increased traffic volumes heading west from Gore Hill Freeway, which would require increased priority at the intersection of Epping Road and Longueville Road to ensure that queues from this intersection do not interfere with the operation of the Gore Hill Freeway. This change to intersection operation would increase queues on Longueville Road and Parklands Avenue.

Network performance measures for the Gore Hill Freeway and Artarmon study area indicate that the network integration works associated with the Beaches Link and Gore Hill Freeway Connection would facilitate additional traffic travelling through the corridor while maintaining a similar level of overall network performance. The introduction of Western Harbour Tunnel would potentially increase demand in the area, which could marginally reduce network speeds during evening peaks. This demonstrates that additional regional connectivity from the Artarmon area from the project and the Western Harbour Tunnel would create only relatively minor localised residual impacts to traffic through the Artarmon area.

Table 8-18 Modelled 'Do something cumulative' morning peak network performance - Gore Hill Freeway and Artarmon study area

Network measure	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Network statistics for all vehicles						
Total traffic demand (veh)	31,100	35,000	35,900	34,100	38,400	39,400
Total VKT through network	79,800	94,500	99,100	87,900	102,700	101,000
Total VHT through network	1710	2070	2110	2280	2250	2170
Total number of stops	43,100	54,000	52,700	113,700	55,700	57,500

Network measure	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Average vehicle statistics						
Average vehicle trip length through the network (km)	2.4	2.5	2.6	2.4	2.5	2.6
Average vehicle trip time through the network (hours)	0:03:08	0:03:21	0:03:18	0:03:48	0:03:20	0:03:21
Average number of stops per trip	1.3	1.5	1.4	3.2	1.4	1.5
Average trip speed (km/h)	46.8	45.7	47.0	38.5	45.7	46.5
Unreleased traffic						
Total unreleased trips	<10	790	540	530	890	590
% of demand unreleased	<1%	2%	1%	1%	2%	1%

Table 8-19 Modelled 'Do something cumulative' evening peak network performance - Gore Hill Freeway and Artarmon study area

Network measure	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Network statistics for all vehicles						
Total traffic demand (veh)	31,100	33,600	34,200	34,400	36,300	37,100
Total VKT through network	79,400	91,000	90,800	85,800	97,500	101,200
Total VHT through network	1800	1930	1980	2010	2250	2500
Total number of stops	48,000	44,200	50,300	62,400	63,000	89,000
Average vehicle statistics						
Average vehicle trip length through the network (km)	2.4	2.5	2.5	2.4	2.6	2.6
Average vehicle trip time	0:03:17	0:03:14	0:03:19	0:03:23	0:03:32	0:03:52

Network measure	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
through the network (hours)						
Average number of stops per trip	1.5	1.2	1.4	1.8	1.6	2.3
Average trip speed (km/h)	44.0	47.2	45.9	42.6	43.3	40.5
Unreleased traffic						
Total unreleased trips	260	60	150	820	1060	1500
% of demand unreleased	1%	<1%	<1%	2%	3%	4%

8.5.2 General traffic travel times

Modelled general traffic travel times for key routes through the Gore Hill Freeway and Artarmon study area are presented in Table 8-20 and Table 8-21. Analysis of modelled travel times under the 'Do something cumulative' scenario shows that travel times for general traffic along the Gore Hill Freeway through Artarmon would not change substantially, with the exception of westbound travel to Longueville Road in the evening peak which would experience a relatively minor increase. Additional traffic demand as a result of the introduction of the Western Harbour Tunnel would mean that delays at the intersection of Epping Road and Longueville Road would need to be managed to avoid propagation to Gore Hill Freeway.

Table 8-20 Modelled 'Do something cumulative' morning peak hour general traffic travel times - Gore Hill Freeway and Artarmon study area

Route	Direction	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Longueville Road to Gore Hill Freeway	Eastbound	0:01:28	0:01:28	0:01:29	0:01:24	0:01:28	0:01:29
	Westbound	0:01:24	0:01:22	0:01:23	0:01:28	0:01:22	0:01:23
Lane Cove Tunnel to Gore Hill Freeway	Eastbound	0:01:18	0:01:16	0:01:16	0:01:24	0:01:17	0:01:17
	Westbound	0:01:17	0:01:17	0:01:18	0:02:16	0:01:18	0:01:18

Table 8-21 Modelled 'Do something cumulative' evening peak hour general traffic travel times - Gore Hill Freeway and Artarmon study area

Route	Direction	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Longueville Road to Gore Hill Freeway	Eastbound	0:01:26	0:01:26	0:01:26	0:01:25	0:01:26	0:01:27
	Westbound	0:01:23	0:01:23	0:01:23	0:01:23	0:01:23	0:02:02

Route	Direction	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Lane Cove Tunnel to Gore Hill Freeway	Eastbound	0:01:22	0:01:16	0:01:16	0:01:23	0:01:16	0:01:18
	Westbound	0:01:12	0:01:17	0:01:17	0:01:12	0:01:17	0:01:17

8.5.3 Intersection performance

Modelled future performance for key intersections in the Gore Hill Freeway and Artarmon study area under the 'Do something cumulative' scenario is presented in Table 8-22 and Table 8-23. Analysis of intersection performance under the 'Do something cumulative' scenario indicates:

- The Epping Road/Longueville Road/Parklands Avenue intersection would continue to operate at a poor Level of Service as a result of continued high traffic demands through this intersection
- Increased delays from the Epping Road/Longueville Road intersection are likely to result in increased localised delays at the Longueville Road/Pacific Highway intersection during evening peak periods
- The Reserve Road/Gore Hill Freeway interchange would continue to operate at capacity under the 'Do something cumulative' case in 2037 during the evening peak, with queuing potentially increased due to the increased traffic demands in the corridor. This has the potential to increase delays at adjacent intersections along Reserve Road, with the intersection of Dickson Road and Reserve Road continuing to operate at a relatively poor LoS F.

Increased traffic demands would result in some increased delays for intersections in the area. However, these intersections could be optimised to ensure that Gore Hill Freeway would continue to operate satisfactorily. A consequence of this optimisation would be longer delays on side streets and surface roads during peak periods.

With respect to future traffic on Willoughby Road in the vicinity of the proposed Channel 9 site staged residential development, traffic modelling shows that in the 'Do minimum' scenario (ie without the project), the Willoughby Road interchange with the Gore Hill Freeway would be expected to perform at LoS F in the 2037 morning and evening peaks, with traffic and congestion expected to increase due to population and employment growth. However, in both the 'Do something' and 'Do something cumulative' scenarios, the Willoughby Road interchange with the Gore Hill Freeway is modelled to perform at LoS A in morning and evening peaks in 2037.

Although traffic may be impacted by an increase in localised intersection delays under the 'Do something cumulative' scenario, broader modelling indicates that road users would benefit from substantial travel time savings on the broader network (eg via Western Harbour Tunnel and improved efficiency of the Warringah Freeway and beyond). Consequently, road users that travel on and around the Gore Hill Freeway would still benefit from the construction of the Western Harbour Tunnel due to the increased connectivity to the area and on the surrounding strategic road network.

Table 8-22 Modelled 'Do something cumulative' morning peak hour intersection performance - Gore Hill Freeway and Artarmon study area

Intersection	2027 'Do minimum'		2027 'Do something'		2027 'Do something cumulative'		2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Epping Road/Longueville Road/Parklands Avenue	52	D	73	F	75	F	83	F	74	F	77	F
Longueville Road/Pacific Highway	40	C	49	D	39	C	54	D	33	C	38	C
Pacific Highway/Howarth Road/Norton Lane	20	B	8	A	10	A	28	B	9	A	11	A
Pacific Highway/Gore Hill Freeway interchange	29	B	32	C	25	B	41	C	24	B	25	B
Reserve Road/Gore Hill Freeway interchange	61	E	46	D	52	D	47	D	55	D	60	E
Reserve Road/Dickson Road	14	A	21	B	24	B	19	B	29	B	27	B
Reserve Road/Barton Road	69	E	87	F	77	F	>100	F	84	F	85	F

Table 8-23 Modelled 'Do something cumulative' evening peak hour intersection performance - Gore Hill Freeway and Artarmon study area

Intersection	2027 'Do minimum'		2027 'Do something'		2027 'Do something cumulative'		2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	`LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Epping Road/Longueville Road/Parklands Avenue	80	F	66	E	81	F	87	F	71	F	>100	F
Longueville Road/Pacific Highway	42	C	38	C	45	D	49	D	42	C	86	F
Pacific Highway/Howarth Road/Norton Lane	13	A	5	A	11	A	13	A	6	A	13	A
Pacific Highway/Gore Hill Freeway interchange	29	C	17	B	29	B	23	B	17	B	29	B
Reserve Road/Gore Hill Freeway interchange	55	D	48	D	48	D	57	E	47	D	51	D
Reserve Road/Dickson Road	73	F	50	D	87	F	85	F	66	E	95	F
Reserve Road/Barton Road	>100	F	69	E	>100	F	>100	F	>100	F	>100	F

8.5.4 Road network changes and access arrangements

There would be no additional road network changes under the 'Do something cumulative' scenario.

8.5.5 Public transport impacts

Modelled future bus travel times for key routes through the Gore Hill Freeway and Artarmon study area under the 'Do something cumulative' scenario are presented in Table 8-24 and Table 8-25. Analysis of the modelled bus travel times indicates that bus travel times along the Gore Hill Freeway through Artarmon would not change substantially and that increased traffic flows through the area would not materially impact bus travel times for key routes.

Table 8-24 Modelled 'Do something cumulative' morning peak hour bus travel times - Gore Hill Freeway and Artarmon study area

Route	Direction	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Lane Cove Tunnel to Gore Hill Freeway	Eastbound	0:01:26	0:01:22	0:01:22	0:01:26	0:01:22	0:01:22
	Westbound	0:01:18	0:01:16	0:01:18	0:01:26	0:01:18	0:01:18

Table 8-25 Modelled 'Do something cumulative' evening peak hour bus travel times - Gore Hill Freeway and Artarmon study area

Route	Direction	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Lane Cove Tunnel to Gore Hill Freeway	Eastbound	0:01:22	0:01:21	0:01:21	0:01:22	0:01:21	0:01:22
	Westbound	0:01:13	0:01:17	0:01:17	0:01:13	0:01:17	0:01:18

8.5.6 Active transport impacts

There would be no additional impacts on the active transport network under the 'Do something cumulative' scenario.

8.6 Balgowlah and surrounds

8.6.1 Network performance

A summary of future network performance for the Balgowlah and surrounds study area under 'Do something cumulative' scenario is presented in Table 8-26 and Table 8-27. Analysis of the modelled network statistics shows that, compared to the 'Do something' scenario:

- Peak period traffic demand through the Balgowlah and surrounds study area would not substantially change
- Average travel speeds through the study area would not substantially change and would still be substantially improved compared to the 'Do minimum' scenario.

Network performance measures for the Balgowlah and surrounds study area indicate that the localised works associated with the Beaches Link and Gore Hill Freeway Connection would facilitate additional traffic travelling through the area. Extending connectivity further with the inclusion of the Western Harbour Tunnel would be result in similar travel times and speeds to that of the 'Do something' scenario.

Table 8-26 Modelled 'Do something cumulative' morning peak network performance - Balgowlah and surrounds study area

Network measure	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Network statistics for all vehicles						
Total traffic demand (veh)	17,400	19,900	20,300	19,200	21,800	22,200
Total VKT through network	44,800	55,500	56,500	49,500	61,600	62,800
Total VHT through network	1600	1390	1430	2280	1600	1640
Total number of stops	57,000	35,000	36,600	94,600	42,000	43,700
Average vehicle statistics						
Average vehicle trip length through the network (km)	2.4	2.8	2.8	2.4	2.78	2.8
Average vehicle trip time through the network (hours)	0:05:10	0:04:13	0:04:13	0:06:40	0:04:25	0:04:28
Average number of stops per trip	3.1	1.8	1.8	4.6	1.9	2.0
Average trip speed (km/h)	28.1	39.9	39.6	21.7	38.4	38.2
Unreleased traffic						
Total unreleased trips	20	<10	10	120	30	90
% of demand unreleased	<1%	<1%	<1%	1%	<1%	<1%

Table 8-27 Modelled 'Do something cumulative' evening peak network performance - Balgowlah and surrounds study area

Network measure	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Network statistics for all vehicles						
Total traffic demand (veh)	19,400	22,400	22,700	20,900	24,100	24,400
Total VKT through network	50,800	64,800	65,100	52,300	69,000	69,800
Total VHT through network	1910	1900	1880	2400	2130	2150
Total number of stops	65,200	64,200	59,000	92,500	71,700	72,800
Average vehicle statistics						
Average vehicle trip length through the network (km)	2.6	2.9	2.9	2.5	3.0	3.0
Average vehicle trip time through the network (hours)	0:05:46	0:05:18	0:05:06	0:06:54	0:05:29	0:05:28
Average number of stops per trip	3.3	2.9	2.7	4.4	3.1	3.1
Average trip speed (km/h)	26.5	33.3	34.6	21.8	32.4	32.5
Unreleased traffic						
Total unreleased trips	430	410	540	1320	720	770
% of demand unreleased	2%	2%	2%	6%	3%	3%

8.6.2 General traffic travel times

Modelled general traffic travel times for key routes through the Balgowlah and surrounds study area are presented in Table 8-28 and Table 8-29. Analysis of modelled travel times under the 'Do something cumulative' scenario shows that there would be minimal change in general traffic travel times as a result of the introduction of Western Harbour Tunnel, with the exception of potentially marginally higher travel times along Sydney Road and French Forest Road in both directions during the morning and evening peaks as a result of additional traffic demand.

Table 8-28 Modelled ‘Do something cumulative’ morning peak hour general traffic travel times - Balgowlah and surrounds study area

Route	Direction	2027 ‘Do minimum’	2027 ‘Do something’	2027 ‘Do something cumulative’	2037 ‘Do minimum’	2037 ‘Do something’	2037 ‘Do something cumulative’
Spit Bridge to Burnt Bridge Creek Deviation/ Condamine Street	Northbound	0:03:09	0:03:27	0:03:25	0:04:08	0:03:29	0:03:28
	Southbound	0:06:15	0:03:44	0:03:48	0:11:46	0:03:38	0:03:40
Spit Bridge to Wakehurst Parkway/ Judith Street (via Frenchs Forest Road)	Northbound	0:05:55	0:06:23	0:06:33	0:06:47	0:06:03	0:05:58
	Southbound	0:07:37	0:06:31	0:06:36	0:09:22	0:06:30	0:06:30

Table 8-29 Modelled ‘Do something cumulative’ evening peak hour general traffic travel times - Balgowlah and surrounds study area

Route	Direction	2027 ‘Do minimum’	2027 ‘Do something’	2027 ‘Do something cumulative’	2037 ‘Do minimum’	2037 ‘Do something’	2037 ‘Do something cumulative’
Spit Bridge to Burnt Bridge Creek Deviation/ Condamine Street	Northbound	0:05:24	0:03:54	0:04:00	0:05:48	0:04:00	0:03:47
	Southbound	0:07:49	0:05:41	0:04:57	0:11:12	0:05:13	0:05:10
Spit Bridge to Wakehurst Parkway/ Judith Street (via Frenchs Forest Road)	Northbound	0:09:57	0:08:28	0:07:17	0:10:19	0:08:13	0:07:39
	Southbound	0:14:19	0:14:05	0:14:16	0:16:07	0:14:20	0:14:23

8.6.3 Intersection performance

Modelled future performance for key intersections in the Balgowlah and surrounds study area under the 'Do something cumulative' scenario is presented in Table 8-30 and Table 8-31. Analysis of intersection performance under the 'Do something cumulative' scenario indicates:

- Most intersections in the Balgowlah and surrounds study area would continue to operate at a similar level of delay
- A reduction in traffic volumes from Spit Road would reduce the extent of queueing at the roundabout of Sydney Road and Frenchs Forest Road, reducing the impact on adjacent intersections.

Table 8-30 Modelled 'Do something cumulative' morning peak hour intersection performance - Balgowlah and surrounds study area

Intersection	2027 'Do minimum'		2027 'Do something'		2027 'Do something cumulative'		2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Sydney Road/Manly Road/Burnt Bridge Creek Deviation	48	D	26	B	28	B	68	E	27	B	26	B
Frenchs Forest Road/Sydney Road	21	B	29	B	25	B	32	C	28	B	40	C
Sydney Road/Condamine Street	33	C	24	B	23	B	26	B	29	C	26	B
Condamine Street/Burnt Bridge Creek Deviation	19	B	31	B	32	C	32	C	38	C	36	C
Access Road/Sydney Road/Maretimo Street	10	A	23	B	29	C	9	A	28	B	27	B
Access Road/Burnt Bridge Creek Deviation	-	-	11	A	10	A	-	-	14	A	14	A

Table 8-31 Modelled 'Do something cumulative' evening peak hour intersection performance - Balgowlah and surrounds study area

Intersection	2027 'Do minimum'		2027 'Do something'		2027 'Do something cumulative'		2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Sydney Road/Manly Road/Burnt Bridge Creek Deviation	93	F	86	F	62	E	>100	F	93	F	73	F
Frenchs Forest Road/Sydney Road	>100	F	>100	F	>100	F	>100	F	>100	F	>100	F
Sydney Road/Condamine Street	33	C	39	C	42	C	40	C	48	D	45	D
Condamine Street/Burnt Bridge Creek Deviation	17	B	35	C	40	C	16	B	38	C	41	C
Access Road/Sydney Road/Maretimo Street	9	A	20	B	20	B	30	C	27	B	30	C
Access Road/Burnt Bridge Creek Deviation	-	-	11	A	11	A	-	-	12	A	11	A

8.6.4 Road network changes and access arrangements

There would be no additional road network changes under the 'Do something cumulative' scenario.

8.6.5 Public transport impacts

Modelled future bus travel times for key routes through the Balgowlah and surrounds study area under the 'Do something cumulative' scenario are presented in Table 8-32 and Table 8-33. Analysis of the modelled bus travel times indicates:

- Bus travel times along Frenchs Forest Road would potentially increase marginally during evening peak periods as a result of the increased traffic travelling through the Sydney Road/Frenchs Forest Road roundabout, when compared to the 'Do something' scenario
- All other bus routes would be generally unaffected by the changes in traffic as a result of the 'Do something cumulative' scenario. These routes are generally served by bus priority infrastructure either in the form of bus lanes or traffic signal priority.

Overall, bus travel times would be minimally impacted by the 'Do something cumulative' scenario, with some potentially minor delays when travelling through the Sydney Road/Frenchs Forest Road intersection due to marginally increased traffic volumes.

Table 8-32 Modelled ‘Do something cumulative’ morning peak hour bus travel times - Balgowlah and surrounds study area

Route	Direction	2027 ‘Do minimum’	2027 ‘Do something’	2027 ‘Do something cumulative’	2037 ‘Do minimum’	2037 ‘Do something’	2037 ‘Do something cumulative’
Spit Bridge to Manly Road/Sydney Road	Northbound	0:02:20	0:02:44	0:01:29	0:03:10	0:02:38	0:01:32
	Southbound	0:02:08	0:01:48	0:01:17	0:02:17	0:01:42	0:01:17
Manly Road/ Sydney Road to Burnt Bridge Creek Deviation/ Condamine Street	Northbound	0:01:30	0:01:31	0:01:56	0:01:29	0:01:45	0:01:56
	Southbound	0:02:23	0:02:37	0:02:31	0:02:25	0:02:21	0:02:23
Manly Road/Sydney Road to Wakehurst Parkway/ Judith Street (via Frenchs Forest Road)	Southbound	0:11:44	0:08:07	0:05:19	0:13:38	0:08:07	0:05:13

Table 8-33 Modelled ‘Do something cumulative’ evening peak hour bus travel times - Balgowlah and surrounds study area

Route	Direction	2027 ‘Do minimum’	2027 ‘Do something’	2027 ‘Do something cumulative’	2037 ‘Do minimum’	2037 ‘Do something’	2037 ‘Do something cumulative’
Spit Bridge to Manly Road/Sydney Road	Northbound	0:04:39	0:03:56	0:01:35	0:04:14	0:03:37	0:01:39
	Southbound	0:01:10	0:01:19	0:01:31	0:01:13	0:01:19	0:01:33
Manly Road/ Sydney Road to Burnt Bridge Creek Deviation/ Condamine Street	Northbound	0:01:34	0:01:38	0:02:25	0:01:36	0:01:47	0:02:08
	Southbound	0:02:19	0:02:22	0:03:26	0:02:10	0:02:25	0:03:37
Manly Road/Sydney Road to Wakehurst Parkway/ Judith Street (via Frenchs Forest Road)	Southbound	0:18:03	0:18:25	0:12:45	0:21:46	0:16:27	0:12:50

8.6.6 Active transport impacts

There would be no additional impacts on the active transport network under the 'Do something cumulative' scenario.

8.7 Frenchs Forest and surrounds

8.7.1 Network performance

A summary of future network performance for the Frenchs Forest and surrounds study area under the 'Do something cumulative' scenario is presented in Table 8-34 and Table 8-35. Analysis of the modelled network statistics shows that, compared to the 'Do something' scenario:

- Peak period traffic demand through the area would increase by up to two per cent
- Average travel speeds through the area could decrease by up to 12 per cent, largely due to additional demand and redistribution of traffic from Warringah Road (Roseville Bridge) to Beaches Link. This would increase the volume of traffic through the intersection of Warringah Road and Wakehurst Parkway, and reduce the volume travelling through the grade separation along Warringah Road
- The number of stops would increase under the 'Do something cumulative' scenario by up to 15 per cent. This would be a consequence of the small redistribution of traffic from Warringah Road grade separation to the Warringah Road/Wakehurst Parkway intersection.

Network performance measures for the Frenchs Forest and surrounds study area indicate that there would not be a substantial increase in overall travel demand. However, the additional redistribution of demand from Warringah Road to the Beaches Link and Gore Hill Freeway Connection would result in some additional localised delay through the network. The additional localised delay is a result of these trips being transferred from the Warringah Road grade separation to the Warringah Road/Wakehurst Parkway surface intersection, which would be operating at capacity.

Table 8-34 Modelled 'Do something cumulative' morning peak network performance – Frenchs Forest and surrounds study area

Network measure	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Network statistics for all vehicles						
Total traffic demand (veh)	32,100	35,300	35,900	33,700	36,900	37,600
Total VKT through network	94,500	98,900	98,600	98,900	102,800	99,300
Total VHT through network	2720	3220	3480	3180	3600	3910
Total number of stops	81,000	102,300	117,300	101,000	125,300	144,000
Average vehicle statistics						
Average vehicle trip length	2.9	2.8	2.8	3.0	2.9	3.0

Network measure	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
through the network (km)						
Average vehicle trip time through the network (hours)	0:05:02	0:05:28	0:05:56	0:05:51	0:06:00	0:06:59
Average number of stops per trip	2.5	2.9	3.3	3.1	3.5	4.3
Average trip speed (km/h)	34.8	30.7	28.4	31.1	28.6	25.4
Unreleased traffic						
Total unreleased trips	220	370	750	270	780	2430
% of demand unreleased	1%	1%	2%	1%	2%	6%

Table 8-35 Modelled 'Do something cumulative' evening peak network performance - Frenchs Forest and surrounds study area

Network measure	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Network statistics for all vehicles						
Total traffic demand (veh)	33,600	37,200	37,700	35,400	39,000	39,700
Total VKT through network	101,400	106,500	107,600	107,100	111,400	112,400
Total VHT through network	2760	3200	3290	3100	3710	3950
Total number of stops	76,200	95,600	97,900	89,500	114,900	124,800
Average vehicle statistics						
Average vehicle trip length through the network (km)	3.0	2.9	2.9	3.1	3.0	3.1
Average vehicle trip time through the network (hours)	0:04:52	0:05:14	0:05:20	0:05:27	0:06:00	0:06:28

Network measure	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Average number of stops per trip	2.2	2.6	2.6	2.6	3.1	3.4
Average trip speed (km/h)	36.7	33.2	32.7	34.6	30.0	28.4
Unreleased traffic						
Total unreleased trips	230	640	790	370	1400	1960
% of demand unreleased	1%	2%	2%	1%	4%	5%

8.7.2 General traffic travel times

Modelled general traffic travel times for key routes through the Frenchs Forest and surrounds study area are presented in Table 8-36 and Table 8-37. Analysis of modelled travel times under the 'Do something cumulative' scenario shows that travel times would generally be maintained following the introduction of the Western Harbour Tunnel. The most substantial impacts would be:

- Increased travel times on Wakehurst Parkway southbound
- Increased demand at the intersections of Wakehurst Parkway with Frenchs Forest Road and Warringah Road would create localised delays during peak periods in 2037.

Table 8-36 Modelled 'Do something cumulative' morning peak hour general traffic travel times - Frenchs Forest and surrounds study area

Route	Direction	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Wakehurst Parkway/ Judith Street to Wakehurst Parkway/ Dreadnought Road	Northbound	0:04:27	0:04:17	0:04:11	0:06:59	0:04:27	0:04:00
	Southbound	0:04:29	0:09:13	0:10:07	0:05:05	0:07:36	0:10:14
Warringah Road/ Forestville Avenue to Ellis Road/ Warringah Road	Eastbound	0:05:25	0:05:26	0:05:21	0:05:24	0:05:22	0:06:39
	Westbound	0:05:55	0:05:24	0:05:30	0:06:11	0:05:53	0:06:13

Table 8-37 Modelled 'Do something cumulative' evening peak hour general traffic travel times - Frenchs Forest and surrounds study area

Route	Direction	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Wakehurst Parkway/ Judith Street to Wakehurst Parkway/ Dreadnought Road	Northbound	0:04:37	0:05:35	0:06:15	0:07:02	0:05:30	0:05:39
	Southbound	0:04:10	0:03:20	0:03:40	0:04:04	0:03:24	0:09:12
Warringah Road/ Forestville Avenue to Ellis Road/ Warringah Road	Eastbound	0:06:05	0:06:09	0:05:58	0:06:22	0:06:42	0:06:21
	Westbound	0:05:15	0:05:24	0:05:19	0:05:36	0:05:15	0:05:24

8.7.3 Intersection performance

Modelled future performance for key intersections in the Frenchs Forest and surrounds study area under the 'Do something cumulative' scenario is presented in Table 8-38 and Table 8-39. Analysis of intersection performance under the 'Do something cumulative' scenario indicates:

- The intersections of Wakehurst Parkway/Warringah Road and Wakehurst Parkway/Frenchs Forest Road East would operate with higher average delays due to the further redistribution of traffic from Warringah Road to Beaches Link
- Delays at the Forest Way/Naree Road intersection would increase as a result of the increase in demand through the area.

The 'Do something cumulative' scenario would result in increased localised delays at intersections, primarily as a result of the redistribution of traffic from Warringah Road to Beaches Link, but also due to an increase in forecast demand through the area.

Although there would be an increase in localised intersection delays, road users would generally benefit from substantial overall travel time savings on the broader network (eg via Beaches Link, Warringah Road, Wakehurst Parkway, and beyond). Consequently, traffic at individual intersections in the area would receive a substantial net benefit due to the broader connectivity and efficiency improvements.

Table 8-38 Modelled 'Do something cumulative' morning peak hour intersection performance - Frenchs Forest and surrounds study area

Intersection	2027 'Do minimum'		2027 'Do something'		2027 'Do something cumulative'		2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Wakehurst Parkway/ Frenchs Forest Road East	44	D	>100	F	>100	F	66	E	86	F	>100	F
Warringah Road/Allambie Road	44	D	50	D	54	D	46	D	51	D	50	D
Wakehurst Parkway/Warringah Road	58	E	93	F	94	F	78	F	73	F	81	F
Warringah Road/Hilmer Street	14	A	18	B	35	C	38	C	50	D	57	D
Warringah Road/Forest Way	18	B	15	A	18	B	21	B	16	B	26	B
Forest Way/Naree Road	24	B	56	D	57	D	36	C	54	D	69	E
Warringah Road/Brown Street/Currie Road	20	B	16	B	17	B	23	B	18	B	17	B
Warringah Road/Starkey Street	23	B	20	B	21	B	26	B	21	B	25	B
Warringah Road/Darley Street	28	B	27	B	29	B	30	C	26	B	26	B
Warringah Road/Forestville Avenue	10	A	14	A	14	A	14	A	14	A	14	A

Table 8-39 Modelled ‘Do something cumulative’ evening peak hour intersection performance - Frenchs Forest and surrounds study area

Intersection	2027 ‘Do minimum’		2027 ‘Do something’		2027 ‘Do something cumulative’		2037 ‘Do minimum’		2037 ‘Do something’		2037 ‘Do something cumulative’	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Wakehurst Parkway/Frenchs Forest Road East	46	D	45	D	45	D	46	D	43	C	98	F
Warringah Road/Allambie Road	46	D	52	D	50	D	49	D	52	D	48	D
Wakehurst Parkway/Warringah Road	33	C	75	F	86	F	41	C	59	E	60	E
Warringah Road/Hilmer Street	12	A	17	B	21	B	13	A	88	F	73	F
Warringah Road/Forest Way	24	B	24	B	33	C	26	B	31	C	24	B
Forest Way/Naree Road	19	B	28	B	24	B	27	B	28	B	53	D
Warringah Road/Brown Street/Currie Road	10	A	9	A	9	A	11	A	9	A	10	A
Warringah Road/Starkey Street	20	B	20	B	18	B	19	B	20	B	19	B
Warringah Road/Darley Street	19	B	17	B	15	B	19	B	19	B	15	B
Warringah Road/Forestville Avenue	35	C	29	B	21	B	46	D	35	C	34	C

8.7.4 Road network changes and access arrangements

There would be no additional road network changes under the 'Do something cumulative' scenario.

8.7.5 Public transport impacts

Modelled future bus travel times for key routes through the Frenchs Forest and surrounds study area under the 'Do something cumulative' scenario are presented in Table 8-40 and Table 8-41. Analysis of the modelled bus travel times indicates that bus travel times would generally be maintained during evening peaks. In the morning peak some localised impacts to travel times would be experienced due to increased demand created by the additional connectivity to the Western Harbour Tunnel, with increased intersection delays along Warringah Road and Wakehurst Parkway.

In addition to localised impacts to bus travel times through Frenchs Forest, the 'Do something cumulative' scenario would also further decrease traffic demand heading to the Sydney CBD via the Warringah Road and Eastern Valley Way corridors to the west and south of Frenchs Forest. Both corridors also carry regional and local buses, and these services would benefit from improved travel times and reliability as result of reduced congestion.

8.7.6 Active transport impacts

There would be no additional impacts on the active transport network under the 'Do something cumulative' scenario.

Table 8-40 Modelled Do something cumulative' morning peak hour bus travel times - Frenchs Forest and surrounds study area

Route	Direction	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Forestville Avenue to Adams Street via Warringah Road and Forest Way	Eastbound	0:10:26	0:10:17	0:10:15	0:10:44	0:10:08	0:10:53
	Westbound	0:07:55	0:07:41	0:08:07	0:08:16	0:08:36	0:10:21
Forestville Avenue to Ellis Road via Warringah Road and French Forest Road East	Eastbound	0:16:04	0:15:53	0:16:06	0:15:45	0:16:01	0:19:20
	Westbound	0:12:26	0:14:17	0:14:02	0:15:08	0:13:13	0:19:18

Table 8-41 Modelled 'Do something cumulative' evening peak hour bus travel times - Frenchs Forest and surrounds study area

Route	Direction	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Forestville Avenue to Adams Street via Warringah Road and Forest Way	Eastbound	0:11:22	0:11:04	0:11:18	0:11:09	0:11:35	0:12:00
	Westbound	0:07:13	0:07:15	0:07:09	0:07:16	0:07:33	0:09:00
Forestville Avenue to Ellis Road via Warringah Road and French Forest Road East	Eastbound	0:16:55	0:16:57	0:17:25	0:16:37	0:18:18	0:19:07
	Westbound	0:12:50	0:11:24	0:11:47	0:12:45	0:11:40	0:10:49

9. Environmental management measures

Most long-term impacts of the project have been addressed through the design and include the following:

- Maintenance of access to existing roads and properties to be addressed through an access strategy for affected properties
- Management of capacity constraints to be addressed through the design and operation of existing traffic signals and other road network treatments
- Provision for public transport capacity and priority to be addressed through the design and by provision for double-deck buses through the mainline tunnel
- Provision of active transport to be addressed through the design by maintaining or improving existing active transport facilities within the footprint of the project.

Residual impacts of the project that arise from engineering constraints or from construction activities, and which cannot be removed through the design, are considered manageable. The proposed environmental management measures would be reconfirmed as the project progresses to detailed design and as more detailed construction management plans are developed.

A summary of the environmental management measures identified for the project is provided in Table 9-1.

Table 9-1: Environmental management measures

Ref	Impact	Environmental management measures	Location
Pre-construction			
CTT1	Construction traffic	A road condition report should be prepared, in consultation with relevant councils and road owners, identifying existing conditions of local roads that would be used by heavy vehicles associated with the project and mechanisms to repair damage to the road network (beyond normal wear and tear) caused by these movementsproject.	BL/GHFC
CTT2	Maritime construction traffic	Transport for NSW should consult with the owners and/or leaseholders and/or licence holders of jetties and moorings that require temporary relocation to determine alternative arrangements. Moorings impacted during construction will be temporarily relocated elsewhere in Middle Harbour in consultation with the lease holder(s) and coordination with the Port Authority of NSW. All efforts will be made to relocate facilities as close to their original locations as possible. Impacted mooring licence holders may be entitled to a fee waiver or fee reimbursement where appropriate.	BL
Construction			
CTT3	Maritime construction traffic	Construction vessels should be required to operate in a manner that minimises wash to areas of shoreline.	BL
CTT4	Maritime construction traffic	Construction marine traffic activities should be scheduled to avoid times and locations of high recreational marine traffic where feasible and reasonable.	BL
CTT5	Maritime construction traffic	Harbour closures scheduling should be carried out in consultation with Port Authority of NSW, other divisions of Transport for NSW and other relevant stakeholders	BL

Ref	Impact	Environmental management measures	Location
CTT6	Construction traffic	Ongoing consultation, as relevant to the location, should be carried out with Greater Sydney Operations, the Port Authority of NSW, local councils, emergency services and bus operators in order to minimise traffic and transport impacts.	BL/GHFC
CTT7	Construction traffic	The community should be notified in advance of proposed transport network changes, and maritime restrictions through appropriate media and other appropriate forms of community liaison.	BL/GHFC
CTT8	Construction traffic	Construction road traffic should be managed to minimise impacts of movements during peak periods where feasible and reasonable.	BL/GHFC
CTT9	Construction traffic	Vehicle movements to and from construction sites and construction support sites should be managed to ensure pedestrian, cyclist and road user safety. Depending on the location, this may require manual supervision, physical barriers, temporary traffic signals and modifications to existing signals or, on occasions, police presence.	BL/GHFC
CTT10	Construction traffic	Directional signage, barriers and/or line marking should be used as required to direct and guide motorists, cyclists and pedestrians past construction sites and construction support sites and on the surrounding network. This should be supplemented by variable message signs to advise all road users of potential delays, traffic diversions, speed restrictions, or alternative routes.	BL/GHFC
CTT11	Construction traffic	Where provision of construction on-site parking cannot accommodate the full construction workforce, construction worker parking should be actively managed to minimise impacts on parking on local roads. Depending on the location, this may include encouraging the use of public transport and may may include provision of shuttle buses for workforce transport where appropriate.	BL/GHFC
CTT12	Construction traffic	Any adjustments to existing bus stops should be determined in consultation with relevant stakeholders including other divisions of Transport for NSW and advanced notification would be provided to affected bus customers. Relocations should be as close to their existing position as feasible and reasonable.	BL/GHFC
CTT13	Construction traffic	Truck marshalling areas should be identified and used where feasible and reasonable to minimise potential queueing and traffic and access disruptions in the vicinity of construction support sites.	BL/GHFC
CTT14	Construction traffic	Activities requiring temporary partial road closures should be carried out outside of peak periods and/or during night time to minimise the impact of these activities on the road network where feasible and reasonable.	BL/GHFC
CTT15	Construction traffic	Direct impacts to existing pedestrian and cycling facilities should be minimised where reasonable and feasible. Any detours and adjustments should be designed with consideration of user safety and convenience.	BL/GHFC

Ref	Impact	Environmental management measures	Location
CTT16	Maritime construction impacts	Consultation will be carried out with surrounding water based users of Middle Harbour including Mosman Rowing Club and Northbridge Sailing Club to minimise construction impacts.	BL
Operation			
OTT1	Operational traffic	A review of operational network performance should be carried out 12 months and five years from the opening of the project to confirm the operational impacts of the project on surrounding arterial roads and major intersections. The assessment should be based on updated traffic data at the time and the methodology used should be comparable with that used in this assessment. Where required, additional feasible and reasonable mitigation measures should be identified in consultation with Department of Planning, Industry and Environment and the relevant council to manage any additional traffic performance impacts identified during the review of operational network performance.	BL/GHFC
OTT2	Impacts on local roads	Where required, Transport for NSW should investigate local area traffic management measures to minimise the impact of the project on the surrounding local road network. Such measures should be determined in consultation with relevant councils and implemented where feasible and reasonable.	BL/GHFC

BL = Beaches Link, GHFC = Gore Hill Freeway Connection

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