Chapter 5

Project description

January 2020

5 Project description

This chapter describes the project, including the route alignment, project footprint, main project elements, operational facilities and environmental controls.

The project design presented in this environmental impact assessment would continue to be refined during further design development, and where relevant, respond to feedback from the community and other stakeholders during public display.

The Secretary's environmental assessment requirements as they relate to the project description, and where in the environmental impact statement these have been addressed, are detailed in Table 5-1. Environmental controls to manage potential impacts are discussed in Section 5.2.11 and Section 5.3.9.

Table 5-1 Secretary's environmental assessment requirements – Project Description

Secretary's requirement	Where addressed in EIS
Environmental impact statement	
1. The EIS must include, but not necessarily be limited to, the following: b. description of the project and all components and activities (including ancillary components and activities) required to construct and operate it, including: – the proposed route;	**Section 5.1, Section 5.2** and **Section 5.3** describe the proposed route.
– design of the tunnels, interchanges (inclusive of tunnel portals and entry and exit ramps), road user, pedestrian and cyclist facilities, and lighting;	**Sections 5.2** and **Section 5.3** describe the design of the tunnels, including tunnel-to-tunnel connections and entry and exit ramps as well as active transport infrastructure, lighting and other operational ancillary infrastructure.
– surface road upgrade works, including road widening, intersection treatment and grade separation works, property access, parking, pedestrian and cyclist facilities (including appropriate locations for overbridges) and public transport facilities;	**Sections 5.2** and **Section 5.3** describe the surface road works and surface connections as well as pedestrian, cyclist and public transport facilities. **Chapter 6** (Construction work), **Section 6.4** describes the construction method for surface road works and associated infrastructure, including bridgeworks and pedestrian facilities. **Chapter 8** (Construction traffic and transport), **Chapter 9** (Operational traffic and transport) and **Chapter 20** (Land use and property) discuss property access.
– ancillary infrastructure and operational facilities, such as operational and maintenance facilities, ventilation structures and systems, and fire and emergency services and infrastructure for the proposal, including (if required) additional infrastructure (such as	**Sections 5.2.7** and **Section 5.3.5** describe operational facilities and ancillary infrastructure. **Chapter 6** (Construction work), **Section 6.7** describes the construction support sites required to construct the project, while **Section 6.4** outlines detail on the construction of operational facilities and ancillary infrastructure.

Secretary's requirement	Where addressed in EIS
tolling infrastructure);	
– location and operational requirements of construction ancillary facilities and access;	**Sections 5.2** and **Section 5.3** describe operational facilities and ancillary infrastructure. **Chapter 6** (Construction works), **Section 6.7** describes the location and hours of construction at each of the construction support sites and their respective access arrangements.
– land use changes as a result of the proposal and the acquisition of privately owned, Council and Crown lands, and impacts to Council and Crown lands; and	**Chapter 20** (Land use and property), **Section 20.4** discusses land use changes (including acquisition and impacts to Council and Crown Lands).
– the relationship and/or integration of the project with existing and proposed public and freight transport services.	**Chapter 3** (Strategic context and project need) and **Chapter 8** (Construction traffic and transport) discuss the relationship and/or integration of the project with existing public and freight transport services. **Chapter 6** (Construction work), **Sections 6.7** and **Section 6.8** detail information on site access to the construction support sites and expected vehicle numbers. Additional information about the relationship and/or integration of the project with existing and proposed public and freight transport services is provided in **Chapter 9** (Operational traffic and transport) and **Chapter 27** (Cumulative impacts).

5.1 Project overview

The Western Harbour Tunnel and Warringah Freeway Upgrade project (the project) forms a core component of the broader Western Harbour Tunnel and Beaches Link program of works. The program of works would deliver new strategic road links for Greater Sydney, improving journey times for freight, public transport and private vehicle customers and alleviating pressure on some of the city's most critical transport corridors. The program of works is designed to boost transport capacity around the Harbour CBD and improve connectivity to and from the Northern Beaches – two areas of importance to Greater Sydney's future as a liveable, productive and sustainable global city. The Beaches Link and Gore Hill Freeway Connection project is subject to separate environmental assessment and approval.

The project is shown in Figure 5-1 to Figure 5-6 and would comprise:

- A new crossing of Sydney Harbour involving twin tolled motorway tunnels connecting the M4-M5 Link at Rozelle and the Warringah Freeway at North Sydney (the Western Harbour Tunnel). The motorway tunnels would form a new, motorway-standard western bypass of the Harbour CBD and improve the performance and reliability of the heavily congested ANZAC Bridge, Western Distributor and the Sydney Harbour Bridge corridor. Ramps would also be provided to service the Rozelle and North Sydney/Crows Nest areas
- Upgrade and integration works along the existing Warringah Freeway and surrounding roads (the Warringah Freeway Upgrade). The Warringah Freeway Upgrade would include allowance

for connections to the Western Harbour Tunnel and the Beaches Link and Gore Hill Freeway Connection project. Reconfiguration works as part of the Warringah Freeway Upgrade would optimise the road corridor and improve the performance of the Sydney Harbour Tunnel, the Sydney Harbour Bridge and the Western Harbour Tunnel.

The delivery method for the Warringah Freeway Upgrade component would depend on future project decisions and would be carried out with the aim to improve the efficiency in the delivery of the Warringah Freeway Upgrade. Warringah Freeway Upgrade may also be delivered by a separate contractor to the Western Harbour Tunnel component. For this reason, the Warringah Freeway Upgrade has been assessed and designed as a potentially separable component of the project.

For the purpose of the assessment of environmental impacts of the project, impacts from the project as a whole (ie the Western Harbour Tunnel and Warringah Freeway Upgrade) have been identified and assessed. However, where possible, these impacts have been separated to identify impacts that would result from each component of the project. To account for possible staging, identification is made of those impacts that would result from each component of the project and the applicable environmental management measures.

Project elements that would be delivered to safeguard delivery of either the Western Harbour Tunnel component or Beaches Link and Gore Hill Freeway project connections to the Warringah Freeway, or tunnel-to-tunnel connections (irrespective of delivery program) are described in Section 5.2.4 and Section 5.3.3.

5.1.1 Western Harbour Tunnel

Key features of the Western Harbour Tunnel component of the project are summarised in Table 5-2 and detailed in the following sections. These key features are shown in Figure 5-1 to Figure 5-4.

Table 5-2 Key features of the Western Harbour Tunnel component

Key project component	Summary
Mainline tunnels	The mainline tunnels would comprise: • Twin mainline tunnels about 6.5 kilometres long, connecting the stub tunnels from the approved M4-M5 Link at Rozelle to the Warringah Freeway and to the Beaches Link and Gore Hill Freeway Connection project mainline tunnels at Cammeray (subject to separate environmental assessment and approval) • Each mainline tunnel would accommodate three traffic lanes • Mostly driven tunnels, except for the crossing of Sydney Harbour between Birchgrove and Waverton which would be a dual, three lane, immersed tube tunnel.
Tunnel-to-tunnel connections	The following tunnel-to-tunnel connections would be provided: • Connections to the stub tunnels approved as part of the M4-M5 Link project. The stub tunnels would be located between the Rozelle Interchange to around the boundary of Rozelle and Balmain (refer to Figure 5-1) • Stub tunnels from the mainline tunnels at Cammeray for a future connection to the mainline tunnels of the Beaches Link and Gore Hill Freeway Connection project.

Key project component	Summary
Surface connections	The following surface connections would be provided: • At Rozelle, on and off ramps connecting the mainline tunnels with the surface at City West Link • At North Sydney and Cammeray: – Connection from the northbound mainline tunnel to the Warringah Freeway – Connection from the Warringah Freeway to the southbound mainline tunnel – An off ramp from the northbound mainline tunnel would connect to Falcon Street, North Sydney – An on ramp from Berry Street, North Sydney, would connect to the southbound mainline tunnel.
Operational facilities and ancillary infrastructure	Operational facilities and ancillary infrastructure provided by the project would include: • Motorway facilities at the Rozelle Interchange and at the Warringah Freeway, comprising: – A ventilation outlet and motorway facilities for the Western Harbour Tunnel at the Rozelle Interchange, the civil construction of which was approved as part of the M4-M5 Link. The project would include the fitout and commissioning only of this infrastructure for operation of the Western Harbour Tunnel – A ventilation outlet located within the Warringah Freeway corridor to the north of Ernest Street, immediately south of the Beaches Link and Gore Hill Freeway Connection project ventilation outlet. The ventilation outlet would be connected to motorway facilities at the Warringah Freeway via a ventilation tunnel, which would transfer tunnel air to the ventilation outlet. Separately, fresh air would be provided to the southbound mainline tunnel via a different ventilation tunnel. The Western Harbour Tunnel component of the project would be responsible for the civil works of the Beaches Link and Gore Hill Freeway Connection project ventilation outlet at the Warringah Freeway (the fitout of the ventilation outlet would be carried out under the Beaches Link and Gore Hill Freeway Connection project) • A motorway control centre at Waltham Street, within the Artarmon industrial area • Tunnel support facilities at the Warringah Freeway in Cammeray • Groundwater and tunnel drainage management and treatment systems, including a wastewater treatment plant at the Rozelle Interchange • Signage, tolling, fire and life safety systems, lighting, emergency evacuation and emergency smoke extraction infrastructure • Closed Circuit Television (CCTV) and other traffic management systems.

Key project component	Summary
Public and active transport infrastructure	The mainline tunnels have been designed to allow use by buses including the taller double-decker bus services (within general traffic lanes). Pedestrian and cyclist traffic would be excluded from the mainline tunnels and ramps.
Other project features	The project would also include: • Environmental controls, surface drainage, utilities connections and modifications • Landscape treatments.

5.1.2 Warringah Freeway Upgrade

Key features of the Warringah Freeway Upgrade component of the project are summarised in Table 5-3 and detailed in the following sections. These key features are shown in Figure 5-3 to Figure 5-6.

Table 5-3 Key features of the Warringah Freeway Upgrade component

Key project component	Summary
Upgrade and reconfiguration of the Warringah Freeway	The main works along the Warringah Freeway would comprise: • Upgrade and reconfiguration of the Warringah Freeway for about four kilometres, from immediately north of the Sydney Harbour Bridge at Milsons Point through to the intersection of the Warringah Freeway with Willoughby Road at Naremburn • Simplification of traffic flows and wayfinding by separating: – Through traffic to and from the Western Harbour Tunnel – Through traffic to and from the Sydney Harbour Bridge and the Sydney Harbour Tunnel – Local distributor traffic to and from the Lower North Shore • The provision of elements of cut and cover and trough structures required for the Western Harbour Tunnel and the Beaches Link and Gore Hill Freeway Connection project (subject to separate environmental assessment and approval) within the road corridor.
Upgrades to interchanges	• The High Street interchange would be upgraded, including widening of the High Street bridge, a new northbound on ramp to the Warringah Freeway and conversion of the intersection of High Street/Alfred Street North to traffic signals (refer to Figure 5-26) • The Falcon Street interchange would be upgraded to a diverging diamond interchange configuration. This would require bridge widening and reconfigured signalisation of the interchange (refer to Figure 5-27).
New, modified and relocated bridges	Works to modify, replace and provide new road bridges would include: • Widening of the High Street bridge (as part of the High Street interchange upgrade) • Modification and minor widening of the Mount Street bridge

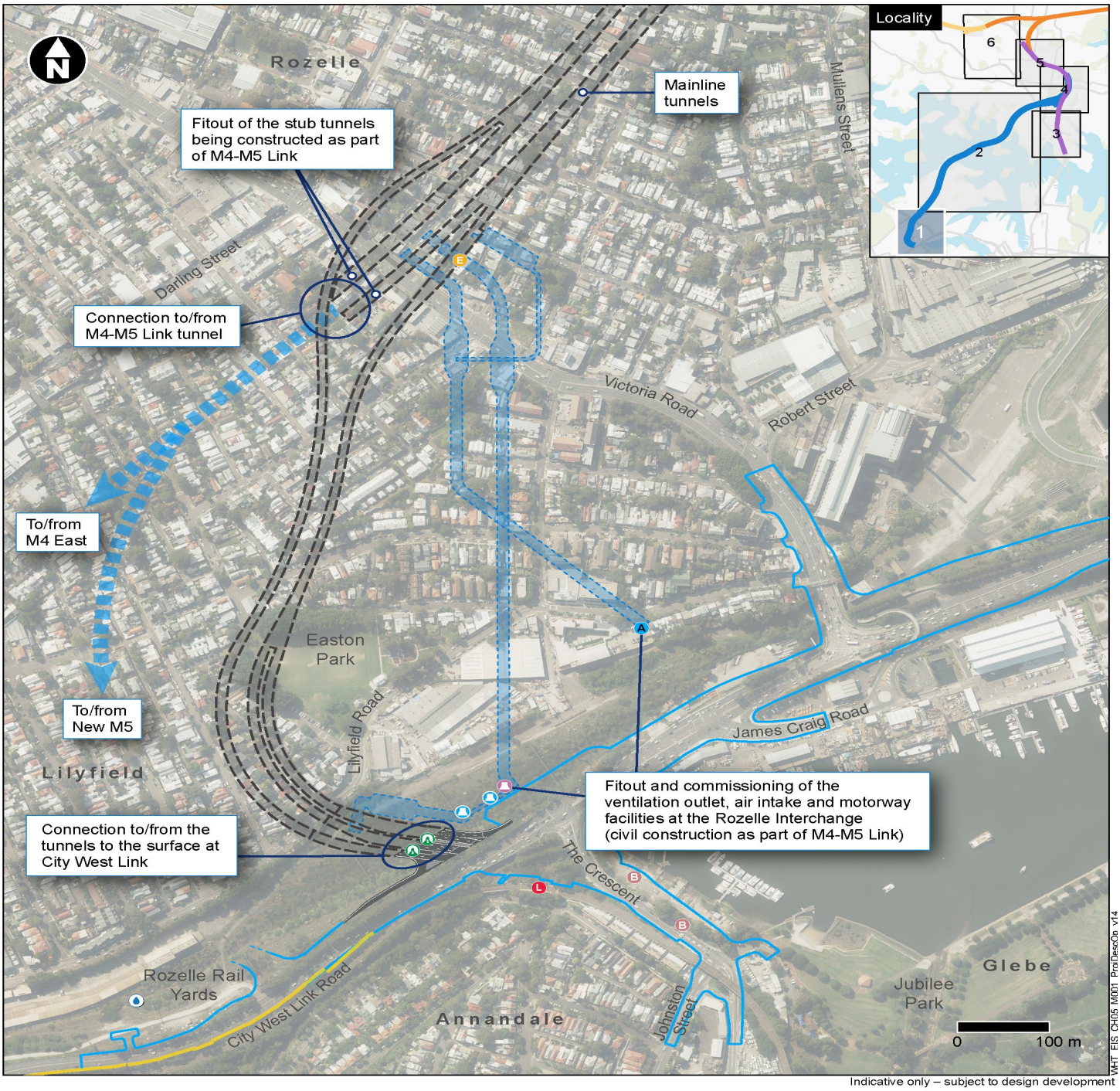
Key project component	Summary
	• A new underpass beneath Mount Street as part of the new dedicated southbound bus lane • A new bridge structure as part of the Alfred Street North off ramp from the Warringah Freeway, spanning the new dedicated southbound bus lane and connecting the southbound carriageways of the Warringah Freeway to the Cahill Expressway and High Street • Modification and minor widening of the Falcon Street bridge (as part of the Falcon Street interchange upgrade) • Modification of the Ernest Street bridge • A new underpass beneath Ernest Street as part of a dedicated southbound bus lane and the new Warringah Freeway connection from the Beaches Link and Gore Hill Freeway Connection project • A new bridge to connect Brook Street/Miller Street with the Warringah Freeway, spanning the new dedicated southbound bus lane • Replacement of the Ridge Street shared user bridge, spanning the Warringah Freeway • Replacement of the Falcon Street shared user bridge, spanning the Warringah Freeway.
Upgrades and changes to the surrounding road network	Upgrades to existing roads around the Warringah Freeway would be required to integrate the project with the surrounding road network, including: • Conversion of the intersection at the High Street and Alfred Street North intersection to traffic signals • Along the Pacific Highway, median works between Arthur Street and Denison Street, to accommodate changes to lane arrangements, as well as changes to turning movements at the intersection of the Pacific Highway with Walker Street and Blue Street • Capacity and configuration works along Alfred Street North, including the realignment of Alfred Street North between Wyagdon Street and the Ridge Street shared user bridge, as well as reconfiguration of Alfred Street North to provide new off ramp lanes from the Warringah Freeway to the High Street interchange • Kerb works, an additional eastbound lane and a new section of clearway on Berry Street, as well as changes to the intersection with Miller Street • Changes to the Pacific Highway/Berry Street intersection • Changes to the lane configuration along Arthur Street • Changes to turning movements, lane configurations and traffic signals along Falcon Street to integrate with the Falcon Street interchange upgrade and Western Harbour Tunnel off ramp to Falcon Street • Changes to the Falcon Street/Miller Street intersection • Provision of a new signalised intersection and changes to turning movements at the intersection of Miller Street and Amherst Street in Cammeray • Changes to parking arrangements and restrictions along some sections of High Street, Miller Street and Berry Street in North Sydney, Clark Road and West Street in Crows Nest, Ben Boyd Road in Neutral Bay, Miller Street and Amherst Street in Cammeray.

Key project component	Summary
Public and active transport infrastructure	The project would include the following public and active transport infrastructure: • New and upgraded pedestrian and cyclist infrastructure, including replacement of the Ridge Street shared user bridge, a replacement of the Falcon Street shared user bridge, a new shared user bridge to the north of Ernest Street and a new dedicated cycleway between Ernest Street and Miller Street • Relocation of the existing bus layover on the Warringah Freeway from north of Ernest Street to within the widened section of the Warringah Freeway near the Cammeray Golf Course and on the Cahill Expressway at Milsons Point • Provision of a dedicated southbound bus lane along the Warringah Freeway from near Miller Street to the southernmost extent of the project near the Sydney Harbour Bridge, removing the need for buses and general traffic to weave.
Operational ancillary infrastructure	Operational ancillary infrastructure would include: • Signage, tolling and lighting infrastructure • CCTV and other traffic management systems • Emergency vehicle stopping bays.
Other project features	The project would also include: • Environmental controls, surface drainage, utilities connections and modifications • Landscape treatments.

5.1.3 Excluded activities

The project would not include:

- Ongoing maintenance activities during operation
- Future use of residual land occupied or affected by project construction activities but not required for operational infrastructure
- Surveys, test drilling, test excavations, geotechnical investigations or other tests, surveys, sampling or investigations for the purposes of the design or assessment of the project.



Legend

Tunnels
- Driven tunnel
- Ventilation tunnel
- Maintenance and emergency breakdown bay
- Surface connection

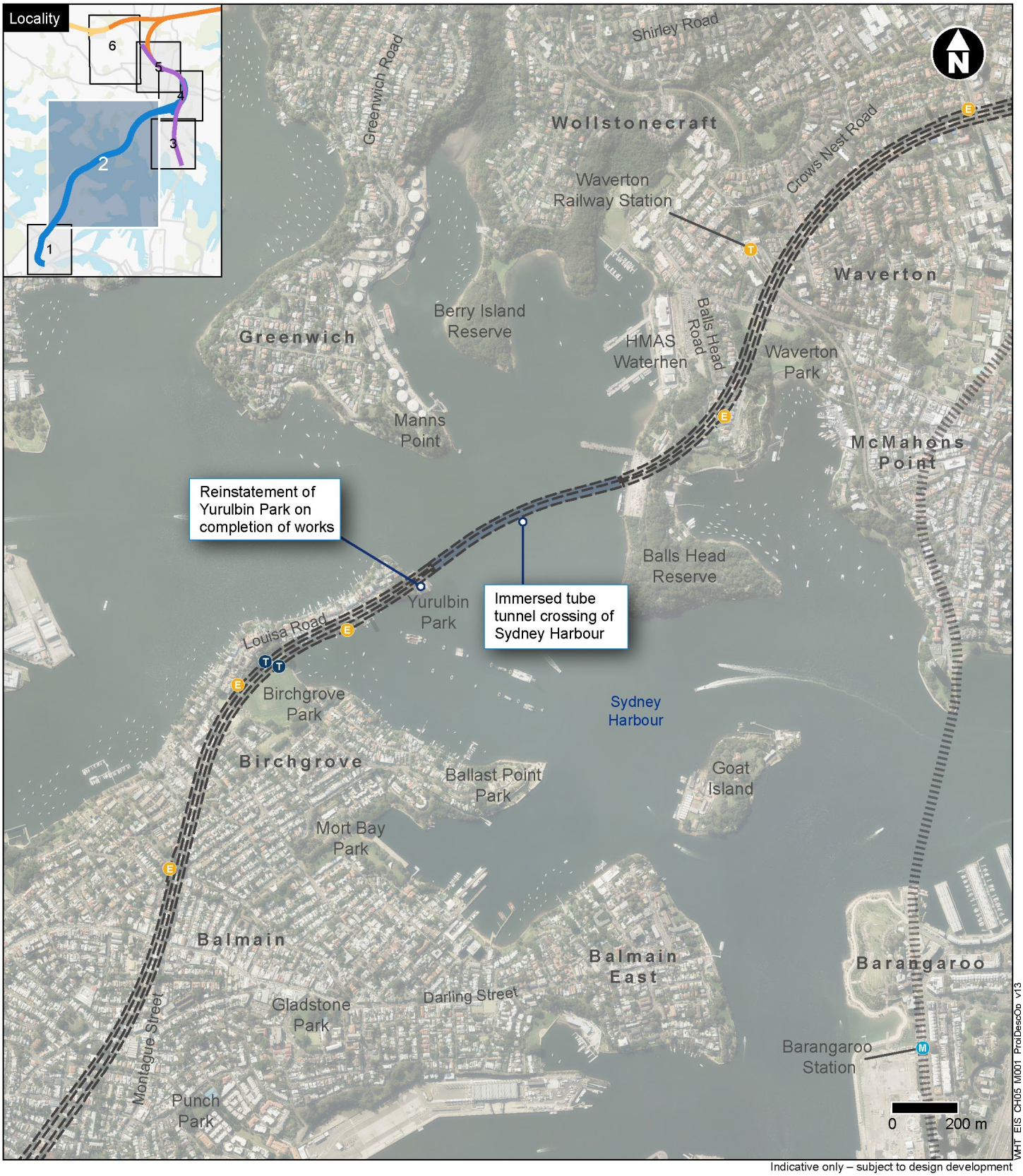
Surface features
- Surface road

Operational infrastructure
- Ventilation outlet
- Wastewater treament plant

Existing infrastructure
- Proposed bus stops
- Light rail stations
- Existing noise barrier

M4-M5 Link project
- Surface road (as modified)
- Connections (indicative)
- Ventilation outlet
- Air intake facility

Figure 5-1 Overview of the Western Harbour Tunnel and Warringah Freeway Upgrade project (map 1)



Indicative only – subject to design development

Legend

Tunnels

- Driven tunnel
- Immersed tube tunnel
- Maintenance and emergency breakdown bay

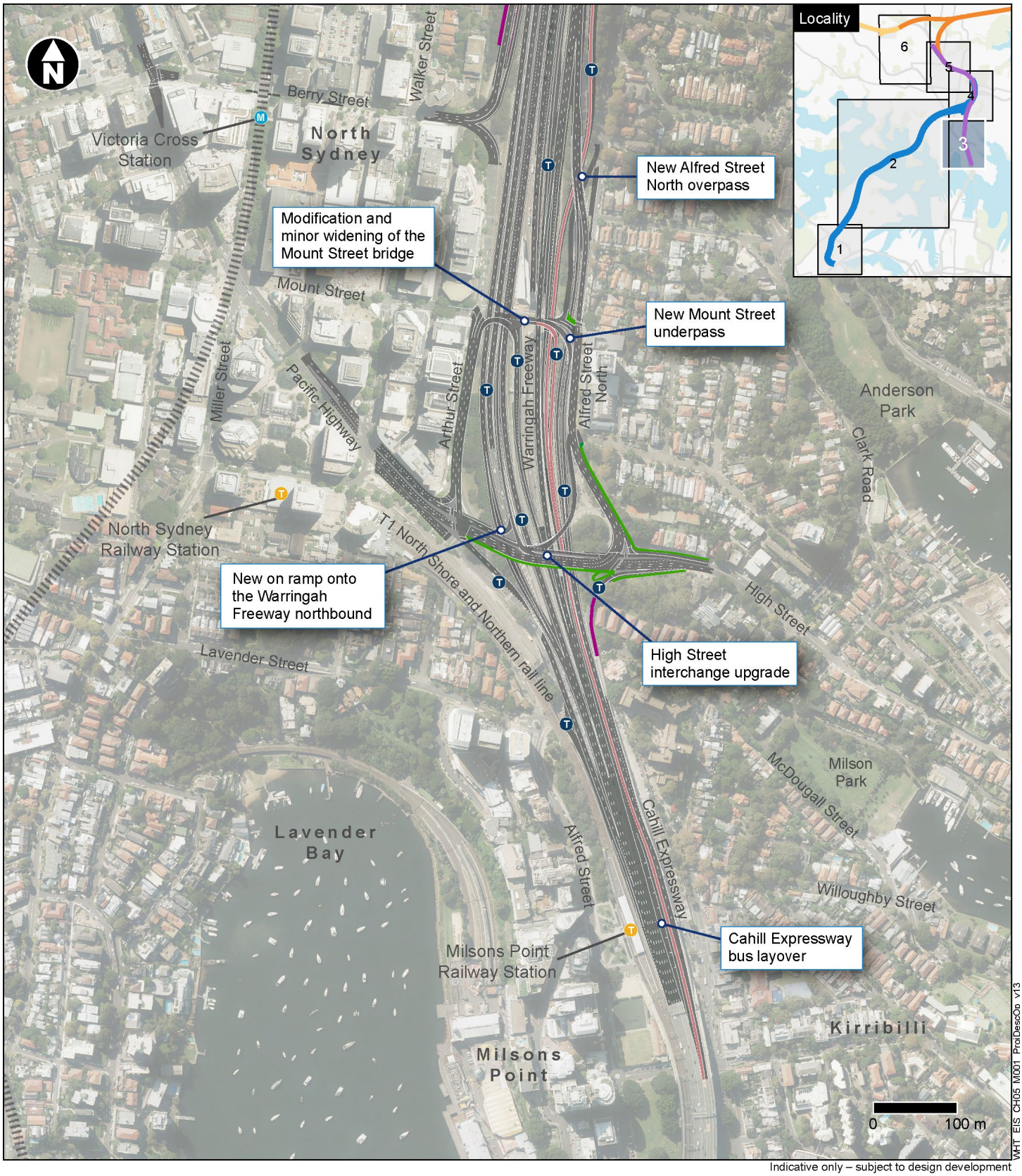
Operational infrastructure

- Provision for tolling gantries

Existing infrastructure

- Train stations
- Sydney Metro City & Southwest – Chatswood to Sydenham (under construction)

Figure 5-2 Overview of the Western Harbour Tunnel and Warringah Freeway Upgrade project (map 2)



Legend

Surface features

- Surface road
- Bus lane
- Pedestrian / shared user path

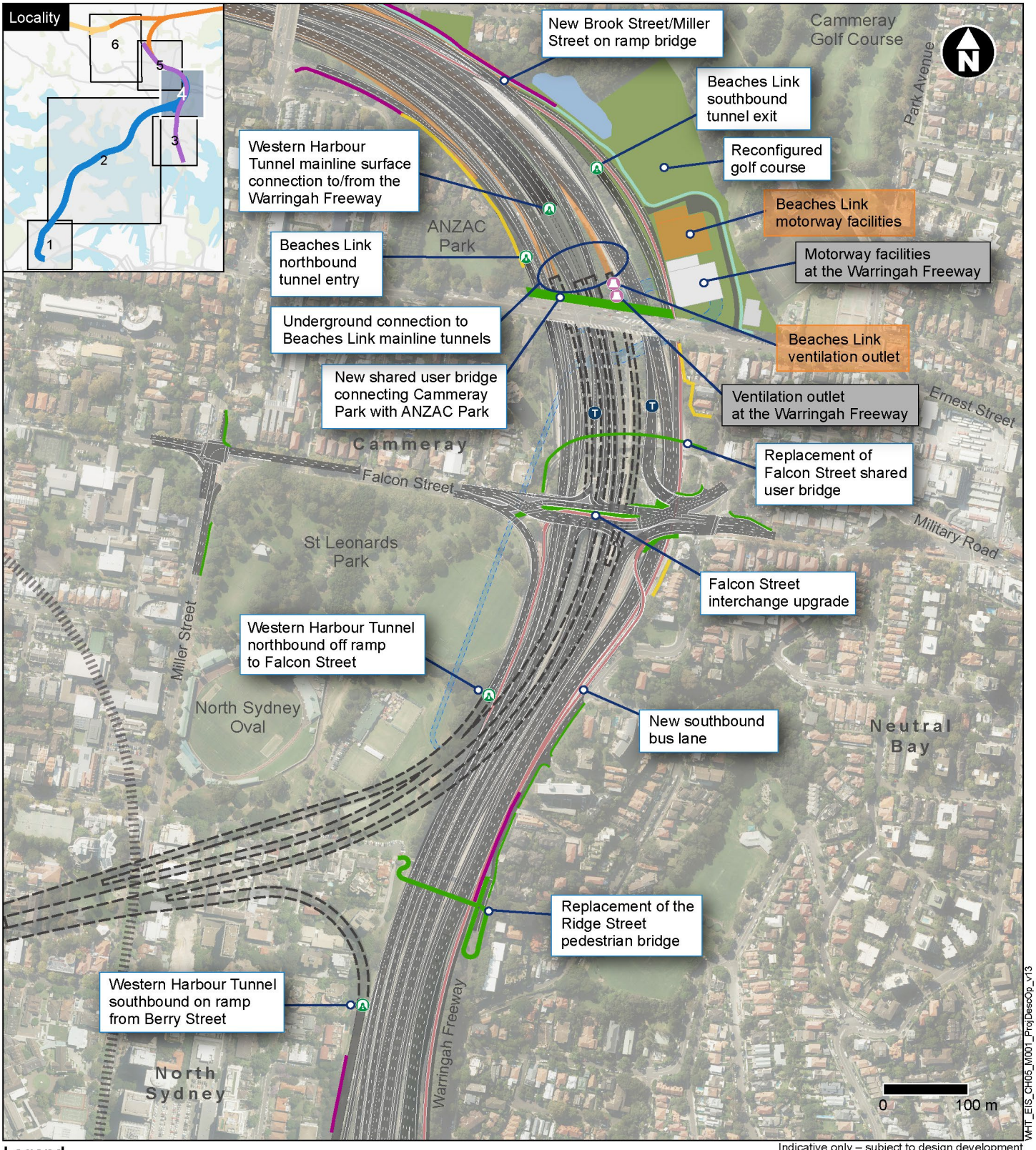
Operational infrastructure

- Provision for tolling gantries
- Indicative new noise barrier

Existing infrastructure

- Train stations
- Sydney Metro City & Southwest – Chatswood to Sydenham (under construction)

Figure 5-3 Overview of the Western Harbour Tunnel and Warringah Freeway Upgrade project (map 3)



Indicative only – subject to design development

Legend

Tunnels
- Western Harbour Tunnel driven tunnel
- Ventilation tunnel
- Surface connection

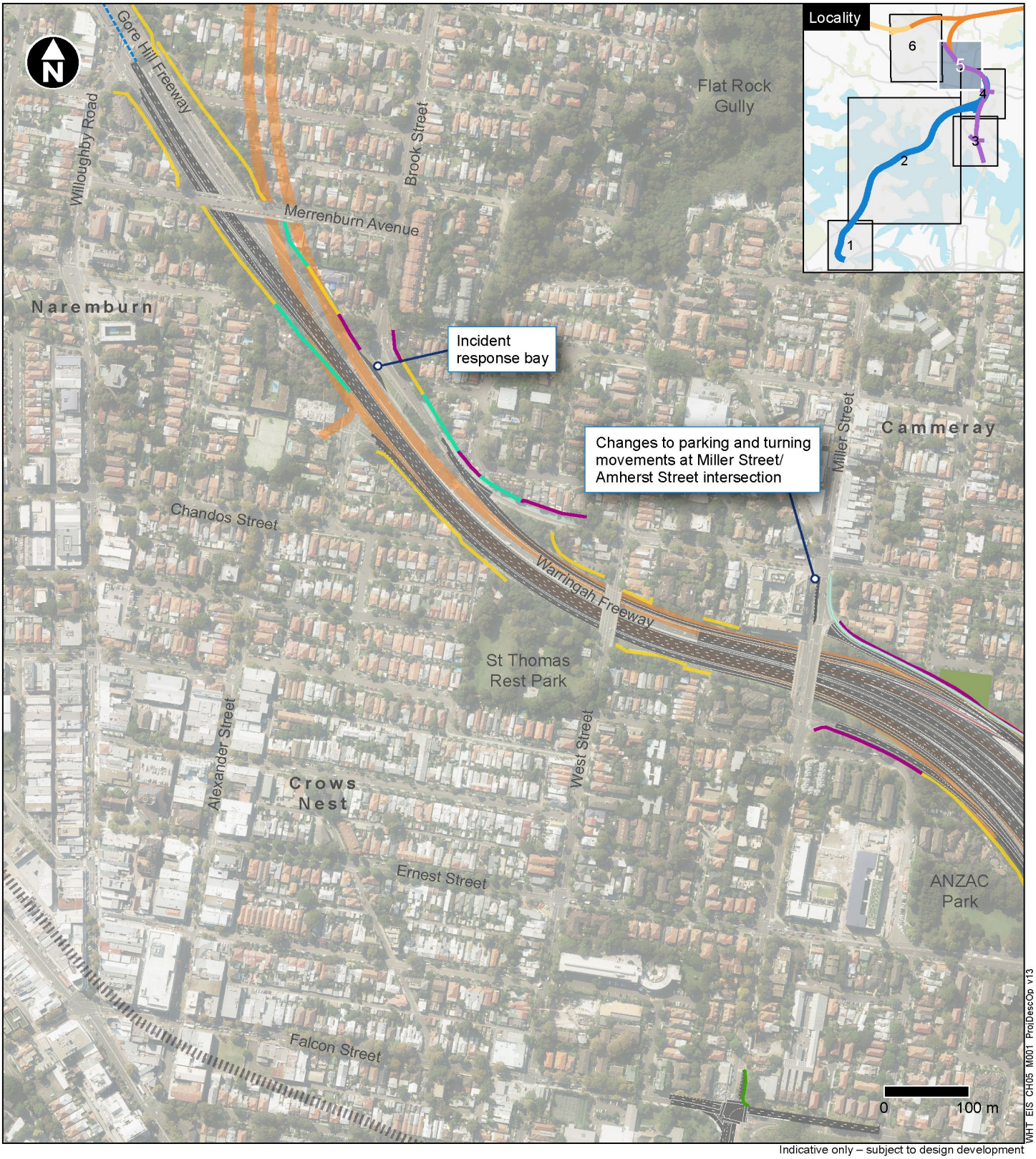
Surface features
- Surface road
- Bus lane
- Cycleway
- Pedestrian / shared user path

Operational infrastructure
- Provision for tolling gantries
- Ventilation outlet
- Indicative new noise barrier
- Operational facilities and ancillary infrastructure
- Indicative location for stormwater harvesting dam

Connecting projects
- Beaches Link and Gore Hill Freeway Connection project

Existing infrastructure
- Existing noise barrier
- Sydney Metro City & Southwest – Chatswood to Sydenham (under construction)

Figure 5-4 Overview of the Western Harbour Tunnel and Warringah Freeway Upgrade project (map 4)



Legend

Surface features

- Surface road
- Bus lane
- Cycleway
- Pedestrian / shared user path

Operational infrastructure

- Indicative new noise barrier
- Indicative upgraded noise barrier
- Communications cable for motorway control centre

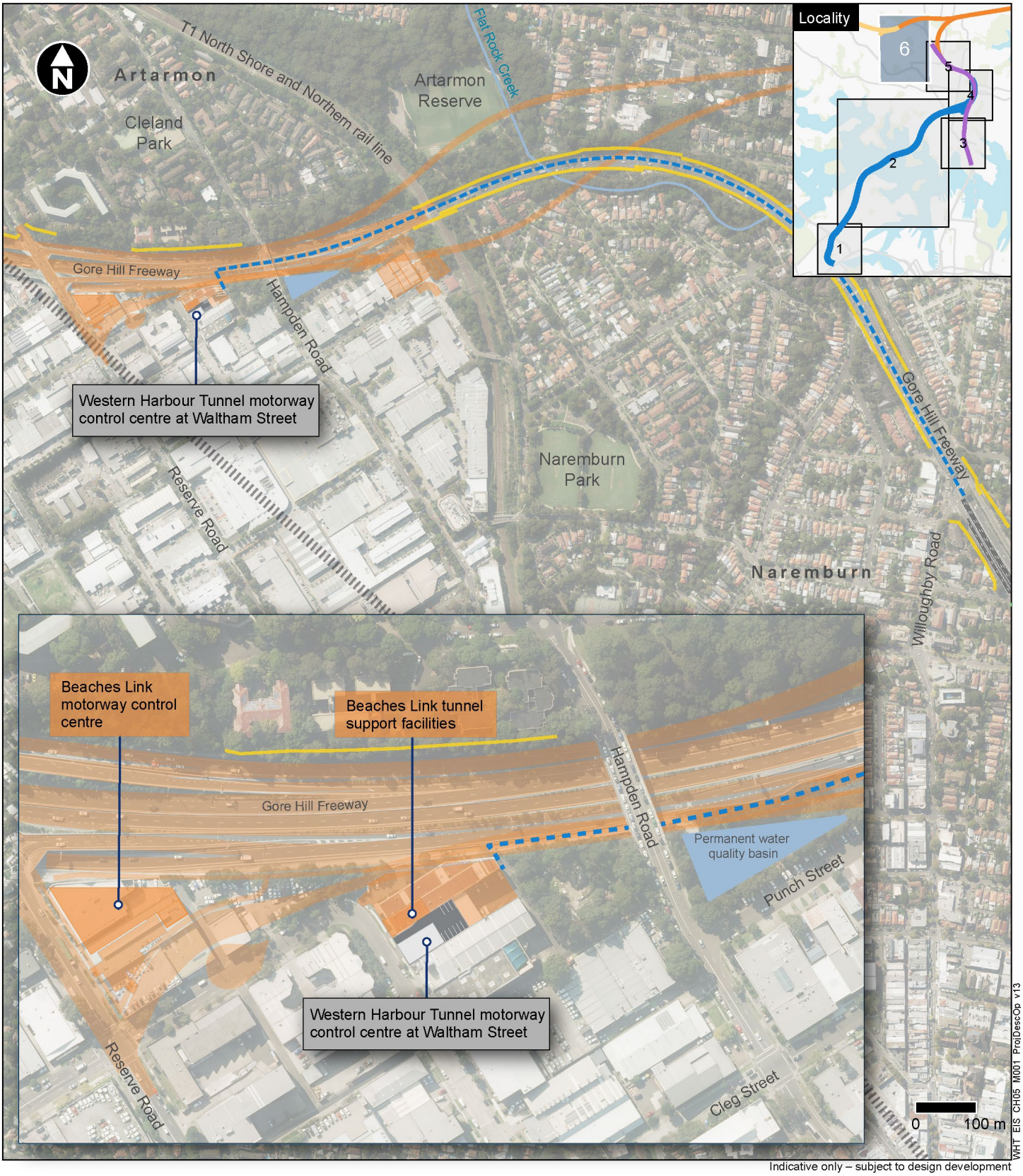
Connecting projects

- Beaches Link and Gore Hill Freeway Connection project

Existing infrastructure

- Existing noise barrier
- Sydney Metro City & Southwest – Chatswood to Sydenham (under construction)

Figure 5-5 Overview of the Western Harbour Tunnel and Warringah Freeway Upgrade project (map 5)



Legend

Surface features

- Surface road

Operational infrastructure

- Operational facilities and ancillary infrastructure
- Communications cable for motorway control centre

Connecting projects

- Beaches Link and Gore Hill Freeway Connection project

Existing infrastructure

- Existing noise barrier
- Sydney Metro City & Southwest – Chatswood to Sydenham (under construction)

Figure 5-6 Overview of the Western Harbour Tunnel and Warringah Freeway Upgrade project (map 6)

5.2 Western Harbour Tunnel

5.2.1 Overview

The Western Harbour Tunnel component of the project would connect the approved M4-M5 Link in Rozelle to the Warringah Freeway at North Sydney/Cammeray and with the Beaches Link and Gore Hill Freeway Connection project at Cammeray. The mainline tunnels would be mostly driven tunnels, with an immersed tube tunnel crossing of Sydney Harbour between Birchgrove and Waverton.

At Rozelle, the mainline tunnels would connect with the approved M4-M5 Link underground. Tunnel-to-tunnel connections would be provided with the Beaches Link and Gore Hill Freeway Connection project mainline tunnels at Cammeray.

On and off ramps would provide connectivity with Rozelle at City West Link and North Sydney at the Warringah Freeway. The on and off ramps at Rozelle would be constructed as part of the approved M4-M5 Link project, and the project would carry out the fitout and commissioning of these ramps only (refer to Chapter 6 (Construction work) for more information). At North Sydney, an off ramp from the northbound mainline tunnel would connect to Falcon Street, and an on ramp from Berry Street would connect to the southbound mainline tunnel.

Key operational infrastructure would include a motorway control centre at Waltham Street in Artarmon, tunnel support facilities at the Warringah Freeway in Cammeray, and a ventilation outlet with motorway facilities at the Rozelle Interchange in Rozelle and at the Warringah Freeway in Cammeray. The construction of the ventilation outlet and motorway facilities for the project at the Rozelle Interchange has been approved as part of the M4-M5 Link Rozelle East Motorway Operations Complex, and the project would include fitout and commissioning of this operational ancillary infrastructure. The motorway facilities at the Warringah Freeway would be located in Cammeray Golf Course, and a ventilation outlet provided within the Warringah Freeway road corridor.

5.2.2 Alignment

Horizontal alignment

The horizontal alignment of the project is shown in Figure 5-1 to Figure 5-6. The mainline tunnels would be about 6.5 kilometres long and would be located between the Rozelle Interchange (which is to be constructed as part of the approved M4-M5 Link), the Warringah Freeway at North Sydney, and the Beaches Link and Gore Hill Freeway Connection project at Cammeray. The project alignment at the Rozelle Interchange shown in Figure 5-1 and elsewhere in the environmental impact statement reflects the arrangement presented in the environmental impact statement for the M4-M5 Link, and as amended by the proposed modifications. The project would be constructed in accordance with the finalised M4-M5 Link detailed design (refer to Section 2.1.1 of Chapter 2 (Assessment process) for further details).

The mainline tunnels would pass beneath the suburbs of Rozelle, Balmain, Birchgrove, Waverton, North Sydney and Cammeray.

Vertical alignment

The vertical alignment of the mainline tunnels are shown in Figure 5-7. As discussed in Chapter 4 (Project development and alternatives), several key factors have influenced the vertical alignment of the project tunnels including:

- Required transport connectivity
- Geology and geotechnical conditions
- The elevation of land on each side of Sydney Harbour
- Operational performance and safety
- Limited opportunity for the project tunnels to come to the surface in a highly developed urban environment
- The need to avoid other major infrastructure, including the Sydney Metro City & Southwest project tunnels at North Sydney.

These factors result in the mainline tunnels being about 70 metres below the surface of the ground at the deepest point near Balmain. The top of the mainline tunnels would be:

- About 25 metres below the water surface of Sydney Harbour
- About 30 metres below ground beneath North Sydney.

The mainline tunnels and on and off ramps would rise to the ground surface at the tunnel portals.

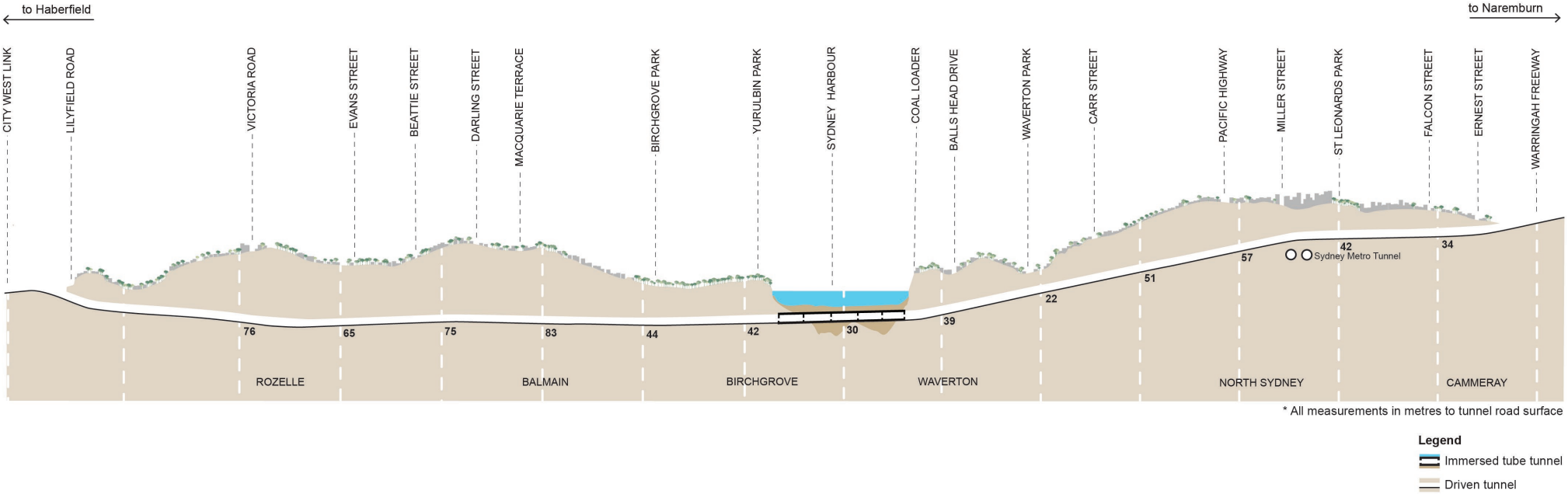


Figure 5-7 Indicative vertical alignment of the mainline tunnels (Rozelle to Cammeray)

5.2.3 Tunnels

The project would comprise twin tunnels about 6.5 kilometres long, connecting the M4-M5 Link at Rozelle to the Warringah Freeway and to the Beaches Link and Gore Hill Freeway Connection project mainline tunnels at Cammeray. The project would comprise mostly driven tunnels, apart from the crossing of Sydney Harbour between Birchgrove and Waverton which would be an immersed tube tunnel.

Each tunnel would provide three traffic lanes. The posted speed limit would be 80 km/h.

On and off ramps would carry one or two lanes of traffic, depending on location (refer to Section 5.2.5). The posted speed limit for on and off ramps would be 60 km/h.

Driven tunnels

Most of the project would be driven tunnels, which would be constructed using roadheaders. The driven tunnels would be located below the surface and would connect with the immersed tube tunnel crossing of Sydney Harbour.

An indicative cross-section of the driven mainline tunnels is shown in Figure 5-8.

Driven tunnels would be mainly drained structures, designed and managed so that groundwater ingress is no greater than one litre per kilometre per second on average. The exception would be areas of driven tunnels approaching the crossing of Sydney Harbour, which may require lining or similar treatment to prevent excessive ingress of water. The requirement for, and extent of, lining or similar treatment would be confirmed during further design development.

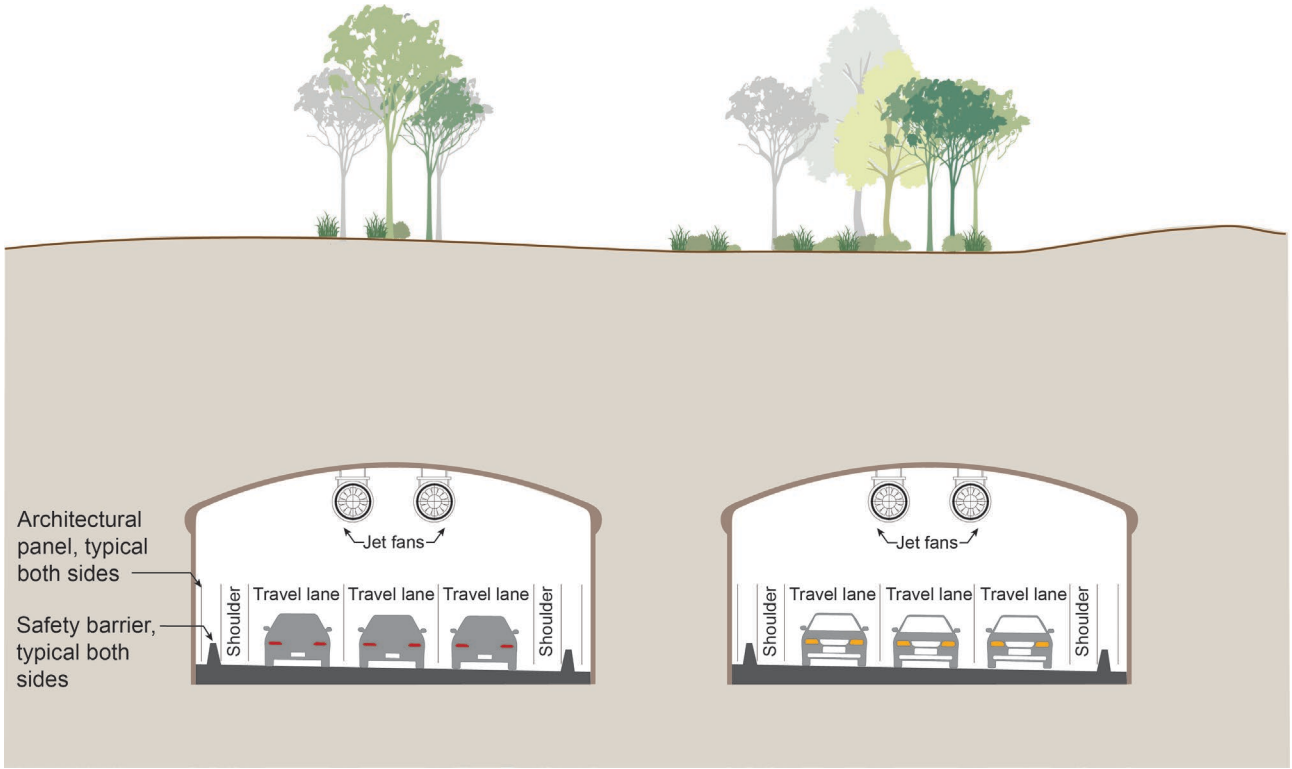


Figure 5-8 Indicative cross-section of the driven mainline tunnels

Immersed tube tunnels

The vertical alignment would require the mainline tunnels to pass through the rock and sediments forming the bed of Sydney Harbour. Given the physical nature of these materials, immersed tube tunnels would be used to provide a safe, stable and effective method of crossing Sydney Harbour.

The immersed tube tunnels would connect to the driven mainline tunnels in Sydney Harbour offshore from Yurulbin Point at Birchgrove and from Balls Head at Waverton.

An indicative long section of the immersed tube tunnel crossing of Sydney Harbour is shown in Figure 5-9. Indicative cross-sections of the immersed tube tunnels are shown in Figure 5-10 (end sections) and Figure 5-11 (middle sections).

The immersed tube tunnels would be installed as a series of pre-cast units in a trench excavated in the bed of Sydney Harbour. Fill and armour materials would be placed around the immersed tube tunnels for stability and protection. The top of the immersed tube tunnels, including rock armour, would not reduce the navigation depth of existing shipping channels.

Each immersed tube tunnel would accommodate three traffic lanes in each direction.

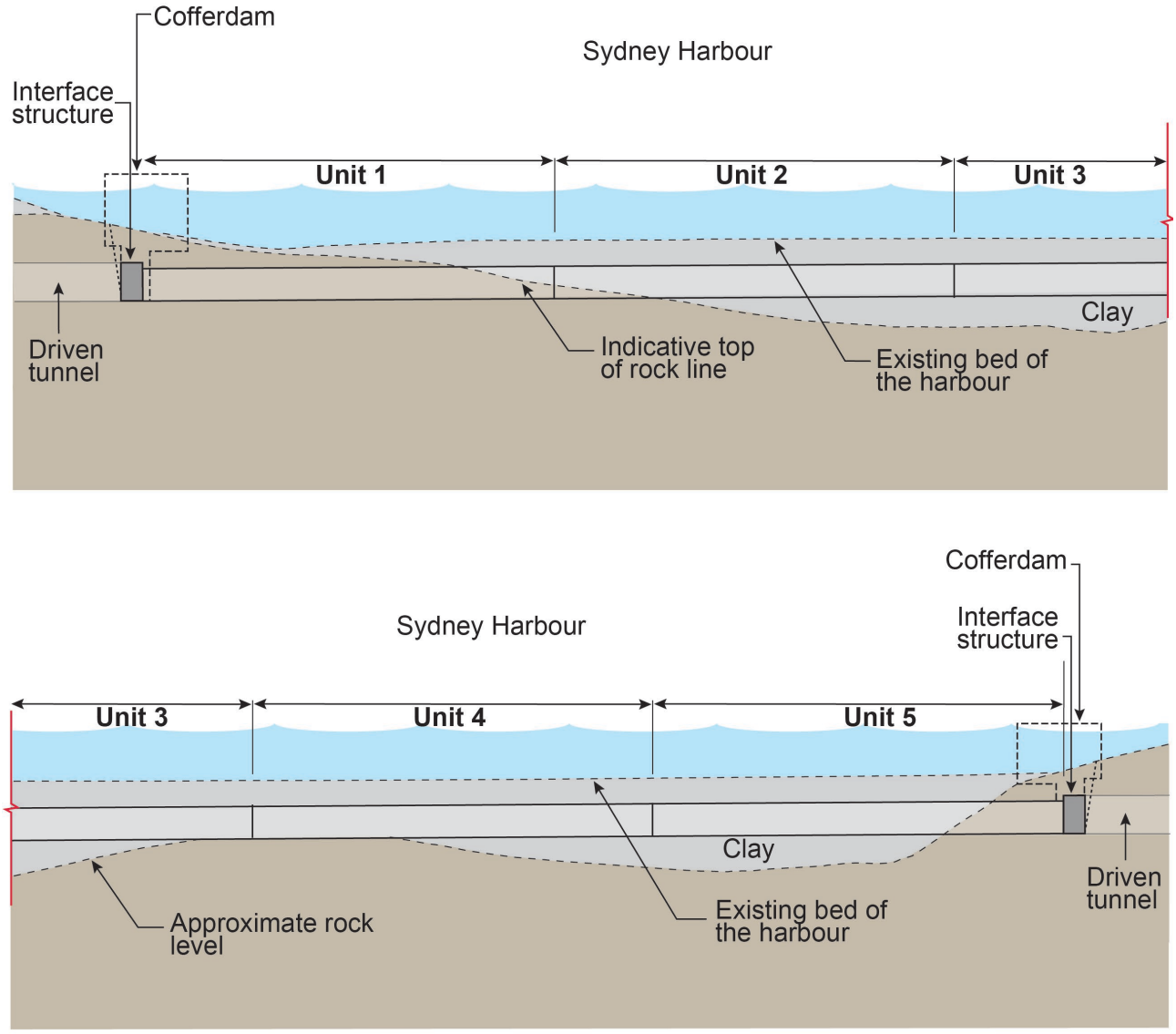


Figure 5-9 Indicative long section of the immersed tube tunnel crossing of Sydney Harbour

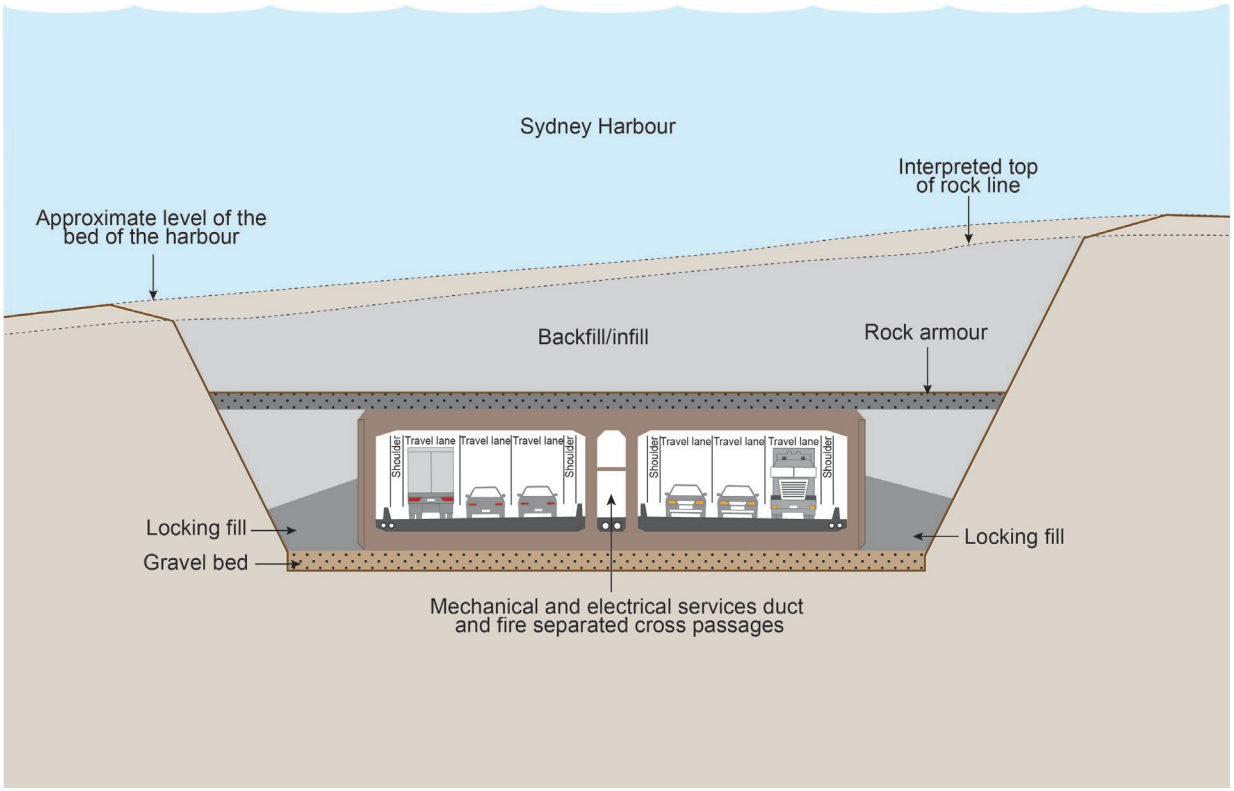


Figure 5-10 Indicative cross-section of the end sections of immersed tube tunnels (Sydney Harbour)

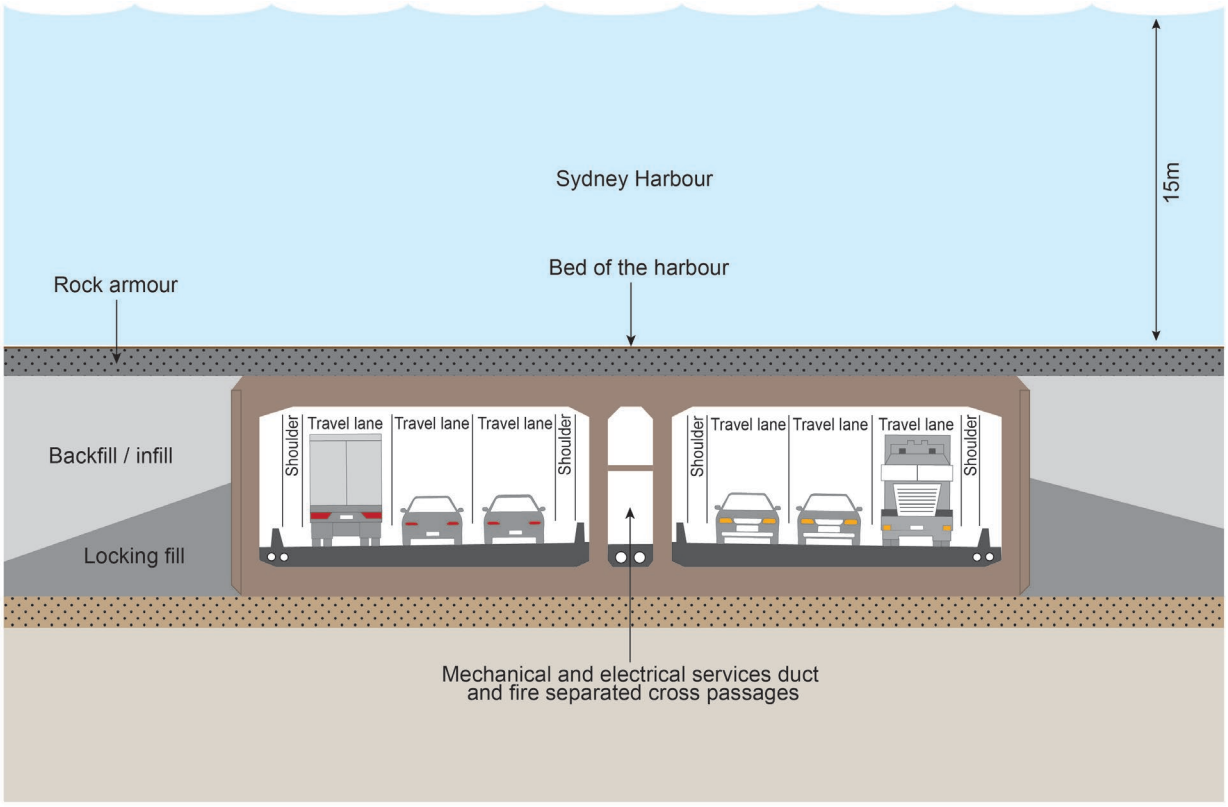


Figure 5-11 Indicative cross-section of the middle sections of immersed tube tunnels (Sydney Harbour)

5.2.4 Tunnel-to-tunnel connections

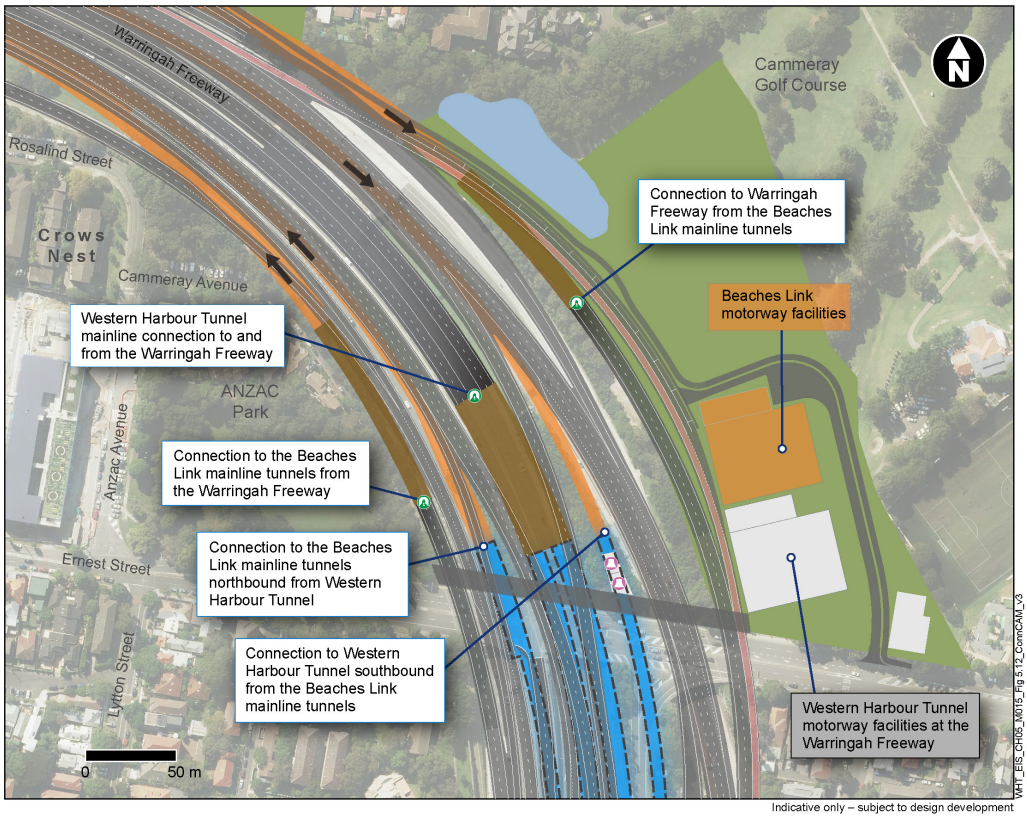
Connections to and from the M4-M5 Link

The mainline tunnels would connect to stub tunnels around the boundary between Rozelle and Balmain. The construction of these stub tunnels have been approved as part of the M4-M5 Link and would be fitted out and commissioned as part of the project.

Connections to the Beaches Link and Gore Hill Freeway Connection project

The project would include a tunnel connection between the Western Harbour Tunnel component of the project and the Beaches Link and Gore Hill Freeway Connection project at Cammeray (refer to Figure 5-12). Depending on the relative timing of construction of the mainline tunnels of the Western Harbour Tunnel component and the Beaches Link and Gore Hill Freeway Connection project, the tunnel-to-tunnel connection between the projects may be:

- Constructed at or around the same time
- Constructed either consecutively, or at different times. Should this occur and the project be constructed first, stub tunnels would be constructed at Cammeray as part of the project to connect to the Beaches Link and Gore Hill Freeway Connection project in the future. Should the Beaches Link and Gore Hill Freeway Connection project be constructed before the project, the Beaches Link and Gore Hill Freeway Connection project would construct stub tunnels at Cammeray for Western Harbour Tunnel to connect to in the future.



Legend

Tunnels
- Western Harbour Tunnel driven tunnel
- Cut and cover
- Surface connection

Surface features
- Surface road
- Bus lane

Operational infrastructure
- Ventilation outlet
- Operational facilities and ancillary infrastructure
- Direction of traffic
- Indicative location for stormwater harvesting dam

Connecting projects
- Beaches Link and Gore Hill Freeway Connection project

Figure 5-12 Indicative tunnel-to-tunnel connections to the Beaches Link and Gore Hill Freeway Connection project

5.2.5 Surface connections

The mainline tunnels would be connected to the surface road network through on and off ramps. The project would include the following surface connections:

- Connections to and from the City West Link at Rozelle
- Connections to and from the Warringah Freeway at Cammeray
- Connections to and from North Sydney.

Connections to and from the City West Link

The project would include on and off ramps from the Western Harbour Tunnel to the City West Link. The on and off ramps at Rozelle would be constructed as part of the approved M4-M5 Link project, and the Western Harbour Tunnel component of the project would include the fitout and commissioning of these ramps. Connections to and from the City West Link are summarised in Table 5-4 and shown in Figure 5-13.

Table 5-4 Connections to and from the City West Link

Connection	Summary
On ramp from City West Link to the northbound mainline tunnel	Provision for the following movements into the Western Harbour Tunnel: • Left turn for vehicles heading east on the City West Link • Straight through connection for vehicles heading north on The Crescent.
Off ramp from the southbound mainline tunnel to City West Link	Provision for the following movements from the Western Harbour Tunnel: • Right turn onto the City West Link to travel west • Straight through movement to The Crescent • Left turn movement onto the City West Link to travel east.

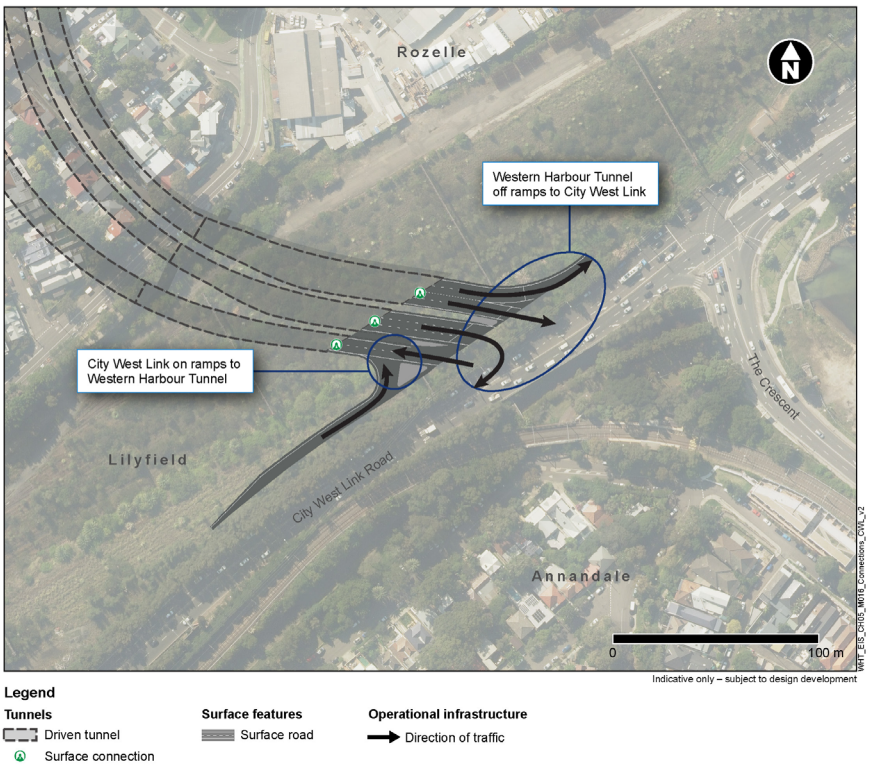


Figure 5-13 Connections to and from the City West Link

Connections to and from the Warringah Freeway

The project would include on and off ramps from the Western Harbour Tunnel mainline tunnels to the Warringah Freeway. The on and off ramps between the Warringah Freeway and Western Harbour Tunnel would be provided as part of the Western Harbour Tunnel component of the project. The ramps would be located around Ernest Street, Cammeray (refer to Figure 5-12).

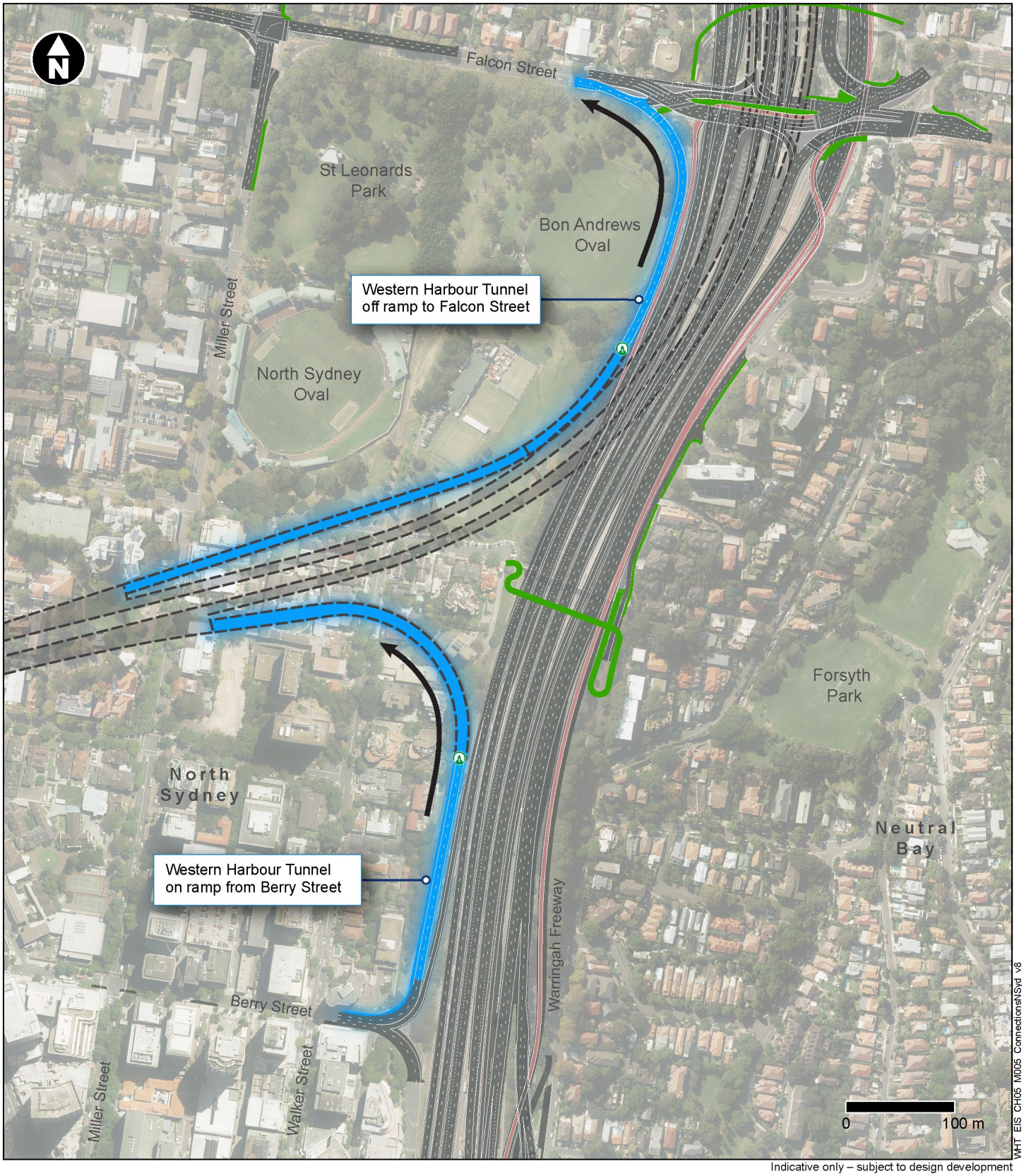
Additional information about the construction of the on and off ramp connections from the mainline tunnels to and from the Warringah Freeway is described in more detail in Chapter 6 (Construction work).

Connections to and from North Sydney

On and off ramps would be provided to connect the mainline tunnels with Berry Street and Falcon Street in North Sydney, as summarised in Figure 5-14 and summarised in Table 5-5.

Table 5-5 Connections to and from North Sydney

Connection	Summary
On ramp from Berry Street to the southbound mainline tunnel	Two traffic lanes in a combination of surface road, trough structure and mined tunnel.
Off ramp from the northbound mainline tunnel to Falcon Street	Two traffic lanes, in a combination of surface road cut and cover, trough and mined tunnel.



Legend

Tunnels
- Ramp tunnel
- Driven tunnel
- Surface connection

Surface features
- Ramp surface
- Surface road
- Bus lane
- Pedestrian / shared user path

Operational infrastructure
- Direction of traffic

Figure 5-14 Connections to and from North Sydney

5.2.6 Surface road works

Surface road works to be carried out as part of the Western Harbour Tunnel component of the project are associated with the surface connection to City West Link. Integration works would be required to connect the on and off ramps at the Western Harbour Tunnel to City West Link. These integration works would involve pavement works, linemarking and road furniture adjustments.

Surface road works to be carried out as part of the Warringah Freeway Upgrade component are detailed in Section 5.3.4.

5.2.7 Operational facilities and ancillary infrastructure

Operational facilities for the Western Harbour Tunnel component of the project would include:

- Tunnel ventilation systems
- A motorway control centre
- Tunnel support facilities.

Operational ancillary infrastructure for the Western Harbour Tunnel component of the project would include:

- Fire and life safety systems
- Tunnel drainage and wastewater treatment plant
- Lighting
- Signage, CCTV and other traffic management systems
- Tolling infrastructure
- Electrical substations (discussed in Section 5.2.9).

Tunnel ventilation systems

Tunnel ventilation systems would be installed to ensure in-tunnel air quality is protective of human health and amenity, and to manage fire and smoke in the event of an incident in the tunnels. The tunnel ventilation systems would include:

- Jet fans installed in the ceiling of the tunnels
- Axial fans within the motorway facilities to extract air from the tunnel via ventilation tunnels
- Axial fans within the motorway facilities to supply air to the tunnel via ventilation tunnels
- Ventilation outlets to effectively disperse tunnel air into the atmosphere
- Air quality monitoring systems in the tunnels and ventilation outlets to monitor and control the ventilation system.

The design and operation of the tunnel ventilation systems are detailed in Appendix H (Technical working paper: Air quality).

During normal operating conditions, most air would be forced through the tunnels by the movement of vehicles (the piston effect). Jet fans would be used to assist with the movement of tunnel air, if required, to maintain acceptable in-tunnel air quality. The air pressure inside the exit portals would be maintained below atmospheric pressure to avoid the release of tunnel air from the portals. This would be achieved by having the jet fans located close to the exit portals to move air from the portal into the tunnel and onwards to the outlet. Tunnel air flow during normal operating conditions is shown in Figure 5-15.

If the tunnels become congested, or in instances of reduced traffic speeds, jet fans would be used to maintain air flow and acceptable in-tunnel air quality.

Air would be removed from the tunnels before it reaches the exit portals and directed to motorway facilities at the Rozelle Interchange and at the Warringah Freeway.

In the case of a fire, the carriageway on which the incident has occurred would be closed to incoming traffic and traffic downstream of the fire would exit the tunnel. Jet fans would be used to control smoke and fire in the event of an incident in the tunnels, and would propel the smoke downstream and away from the stopped vehicles to the nearest ventilation outlet, or the tunnel portal(s), depending on the location of the fire. The ventilation system would be designed to prevent smoke spreading to adjoining tunnels.

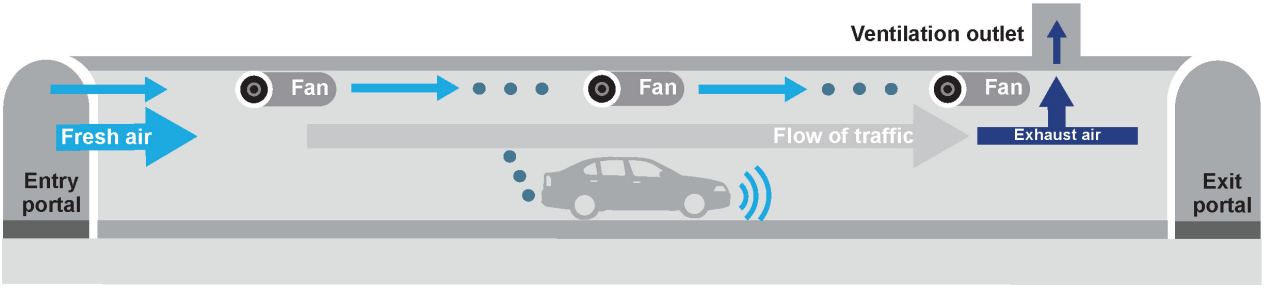


Figure 5-15 Tunnel air flow during normal operating conditions

Motorway control centre

The Western Harbour Tunnel motorway control centre would be located at Waltham Street, within the Artarmon industrial area, as shown in Figure 5-16.

The motorway control centre would comprise a building with an area of about 2500 square metres and a height of about five metres. It would be continuously staffed and used to monitor, and if necessary respond to, conditions in the tunnels and on surface road connections.

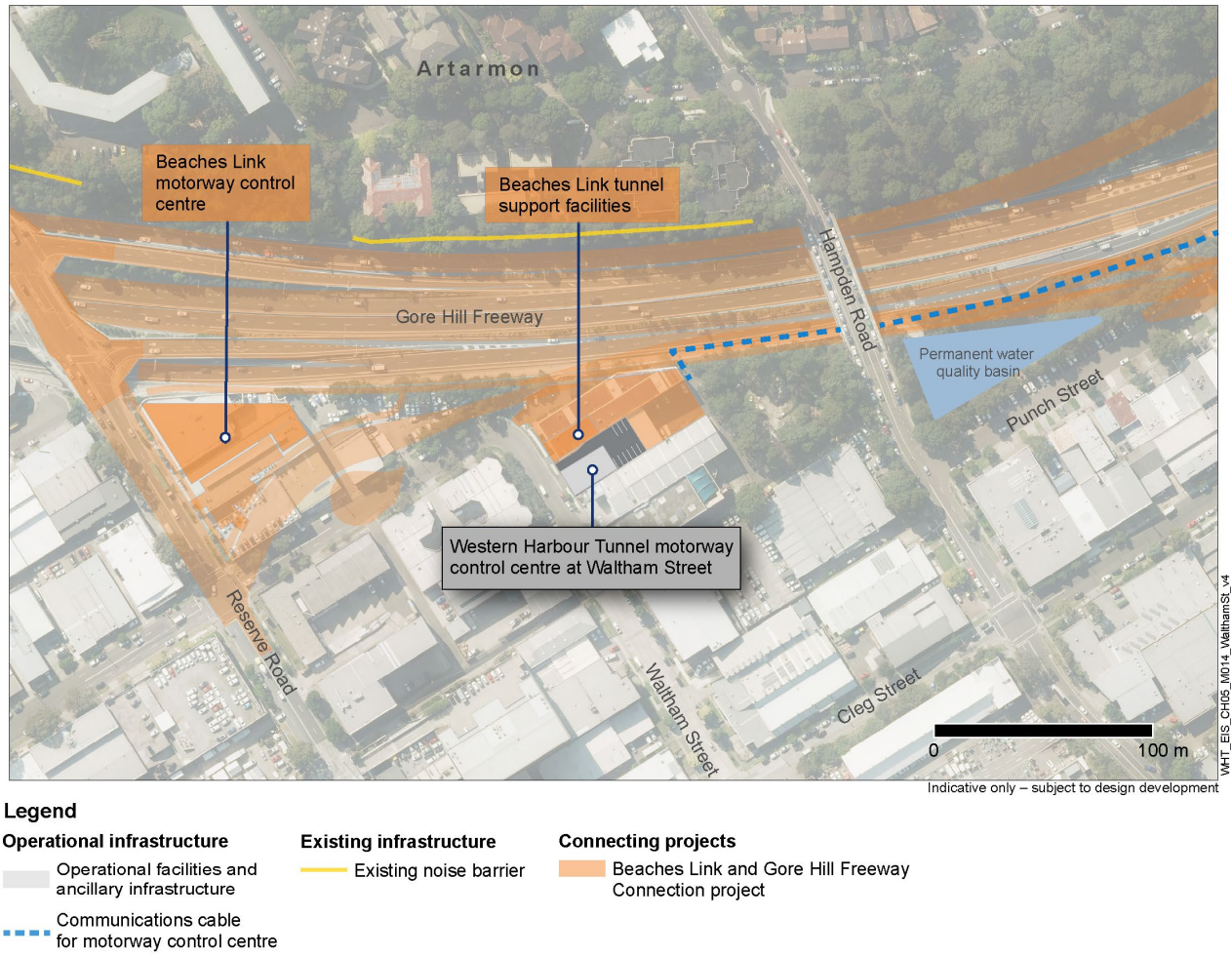


Figure 5-16 Motorway control centre at Waltham Street in Artarmon

Tunnel support facilities

Tunnel support facilities would be located at the Warringah Freeway, in the south-west corner of the Cammeray Golf Course.

Tunnel support facilities would include a deluge and hydrant pump system, supplied by water storage tanks. Firefighting water would also be located within the site.

The site would be enclosed by high security fencing and accessed via a dedicated connection with Ernest Street and heavy vehicle maintenance access directly from Warringah Freeway.

Fire and life safety systems

The tunnels would be fitted with fire and life safety systems compliant with Australian Standard *AS 4825:2011 Tunnel Fire Safety*, applicable Austroads and Roads and Maritime guidelines, and the outcomes of consultation with emergency services. Fire and life safety systems would include:

- Fire and incident detection equipment, a CCTV monitoring system, automatic video incident detection system and linear heat detection systems
- Communication systems, public and emergency broadcast services, and motorist emergency telephones
- Fire suppression systems, including a deluge water suppression system, a fire hydrant system, and emergency equipment points containing hydrants, fire hose reels and fire extinguishers
- Emergency lighting, smoke management and power systems
- Pedestrian cross passages between the mainline tunnels, or longitudinal egress passages, to provide safe access or exit in the event of a fire or other emergency
- Tunnel closure systems.

Tunnel drainage and wastewater treatment plant

A drainage and sump system would be installed within the mainline tunnels to collect:

- Groundwater ingress into the tunnels
- Deluge water in the event of an incident or during routine testing of emergency systems
- Washdown water
- Spills and leaks.

Wastewater intercepted by the tunnel drainage systems would be collected at a sump and pumped to the project wastewater treatment plant at the Rozelle Interchange (refer to Chapter 17 (Hydrodynamics and water quality) for the location of operational wastewater treatment plant for the project). A sump or crest would also be provided at the interface with the M4-M5 Link to stop water flowing between the M4-M5 Link and the project tunnels. The treated water would be discharged into a channel in the former Rozelle Rail Yards, under City West Link and into Rozelle Bay via the local stormwater system.

The wastewater treatment plant would consist of:

- A balance tank to regulate flows into the plant
- A treatment plant, including clarifier and control room, to treat water prior to discharge into the stormwater drainage system.

To minimise the impact on downstream water quality, the wastewater treatment plant would be designed to treat the wastewater to comply with the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG, 2018) (ie to maintain or improve the receiving marine water quality) prior to discharge to the receiving environment. Additionally, where required, appropriate tunnel lining design would reduce water inflow into the tunnel thereby minimising the amount of wastewater treatment and disposal required during tunnel operation.

Lighting

Lighting would be provided within the mainline tunnels and along surface roads, consistent with the guidelines published by Austroads and Roads and Maritime, as well as the relevant and applicable Australian Standards.

Emergency lighting would also be installed in the project tunnels. This would include fixed direction exit signage and illuminated signage. Aviation hazard lighting may be installed on motorway facilities if required as a result of consultation with the Civil Aviation Safety Authority.

Lighting of aboveground operational facilities would be provided, consistent with Australian Standard *AS 4282-1977 Control of Obtrusive Effects of Outdoor Lighting*. Lighting would be designed and installed to ensure safety and security, and to minimise the potential for light spill and nuisance impacts.

Signage, CCTV and other traffic management systems

Traffic, locational, directional, warning and variable message signs would be installed along the length of the project. Signage would satisfy the requirements of applicable Australian Standards, and guidelines published by Austroads and Roads and Maritime.

The project would include intelligent transport system technology and traffic control infrastructure including:

- Variable message signs
- Lane use management systems
- Variable speed limit signs
- A CCTV system and automatic incident detection systems
- Ramp metering infrastructure
- Motorists emergency telephones
- Vehicle enforcement systems.

Tolling infrastructure

While no decision on tolls has yet been made, works for the Western Harbour Tunnel component of the project includes provision for tolling gantries for northbound traffic should the government elect to introduce a northbound toll. Toll gantries would span one or more traffic lanes, depending on location. The tolling gantries would be installed with lighting (where required) and electronic tolling units. Toll gantries would indicatively be located inside the tunnels at locations to be determined during further design development along both the northbound and southbound carriageways.

Additional information about tolling infrastructure for the Sydney Harbour Bridge and Sydney Harbour Tunnel is included in Section 5.3.5.

5.2.8 Public and active transport infrastructure

Most of the public and active transport infrastructure included within the project would be delivered as part of the Warringah Freeway Upgrade component (refer to Section 5.3.6).

Pedestrians and cyclists would be excluded from the tunnels. The tunnels have been designed to allow use by buses including the taller double-decker bus services.

Any new or modified infrastructure associated with the project would satisfy relevant accessibility requirements as per the *Disability Discrimination Act 1992* and the ‘crime prevention through environmental design’ principles.

5.2.9 Utilities

The project would require the installation, relocation, adjustment and/or protection of utilities, particularly within and around surface connections and surface road works (refer to Section 5.2.5 and Section 5.2.6). The Utilities management strategy for the project (refer to Appendix D) provides a framework for utility installations, relocations, adjustments and protection. The Utilities management strategy provides information in relation to:

- Utility installations, relocations and adjustments which are currently known and proposed within the project footprint
- Utility installations, relocations and adjustments which are currently unknown and/or located outside of the project footprint. The Utilities management strategy provides the framework for how these utility relocations and adjustments would be assessed and managed.

The Utilities management strategy should be read in conjunction with Chapter 6 (Construction work) and Chapter 20 (Land use and property).

The location of existing utilities and any changes required would be confirmed during further design development of the project in consultation with the relevant utility provider.

The project would also require connection with electricity and water supply networks, as outlined below.

Electricity supply

Electricity would be supplied to, and distributed through, the project via:

- Underground substations along the length of the mainline tunnels
- Aboveground substations that would be co-located with motorway facilities at the Rozelle Interchange and at the Warringah Freeway. The substation at Rozelle forms part of the Rozelle East Motorway Operations Complex approved as part of the M4-M5 Link.

The aboveground substations would be connected to the existing electricity supply network. Subject to further consultation with Ausgrid, it is expected that electricity supply connections would be made with the Rozelle sub-transmission substation.

Water supply

The project would be connected to the mains water supply network to provide water for essential services. Mains water would be used in cases where treated groundwater and rainwater harvesting are of insufficient quality or quantity to fully meet project needs.

During operation, water would be required for:

- Testing and operation of the tunnel deluge water suppression system (which forms part of the fire and life safety system)
- Motorway facilities ablutions
- Landscape irrigation.

The mains water supply network connection requirements, including connection location and design, would be determined in consultation with Sydney Water prior to the start of construction. Connection to water supply infrastructure would be subject to separate assessment and approval.

Water storage tanks to supply the tunnel hydrant and deluge water suppression systems would be located with other operational ancillary infrastructure at Rozelle and Cammeray (refer to Section 5.2.7).

5.2.10 Property acquisition

The project has been designed to minimise land acquisition and limit the severance of private properties. The Western Harbour Tunnel component of the project would require acquisition of four properties (three private commercial properties and one private residential property). A further three Government properties would be temporarily used during construction. Property impacts are discussed further in Chapter 20 (Land use and property).

The total area and number of properties that would be acquired for the project may change as the project continues to be refined, or in response to changes resulting from the exhibition of the environmental impact statement and conditions of approval that may be applied by the Minister for Planning and Public Spaces.

The project would also involve the subdivision of private and public land. In some cases, whole lots would be acquired to avoid creating small unusable lots. Where a part of any lot is identified as being usable post construction and surplus to operational requirements, or requiring boundary adjustment following the completion of construction, Deposited Plans of subdivision, would be lodged at NSW Land Registry Services.

5.2.11 Environmental controls

The project has been designed to avoid or minimise environmental impacts, as detailed in Chapter 4 (Project development and alternatives). Further, key physical environmental controls that would be provided as part of the Western Harbour Tunnel component of the project are summarised in Table 5-6. Environmental controls forming part of the Warringah Freeway Upgrade component of the project are detailed in Section 5.3.9.

Table 5-6 Key environmental controls of the Western Harbour Tunnel component

Infrastructure	Summary
General environmental controls	
Air quality monitoring and management systems	A description of the proposed tunnel ventilation is provided in Section 5.2.7. Continuous emission monitoring and ambient air quality monitoring would be carried out during operation of the project to monitor: • In-tunnel air quality • Air quality within ventilation outlets • Ambient air quality at representative locations for a defined period of project operation. Air quality monitoring and ventilation for the project would be coordinated across the broader road network (including the Beaches Link and Gore Hill Freeway Connection and M4-M5 Link projects) to ensure: • Air quality remains within specified limits for motorists and road workers • Required airflows can be achieved for safety outcomes in the event of an incident or emergency • Ventilation systems are used efficiently to minimise day-to-day energy usage and cost and to maximise asset life • Airflows required for safety outcomes in the event of an incident can be achieved. Continuous emissions monitoring equipment for key contaminants (NO_2 and CO), visibility and potentially other pollutants would be installed at appropriate locations within tunnels and ventilation outlets to ensure the project is operating within the prescribed emission limits for the project set by the conditions of approval, and as set by the NSW Environment Protection Authority (NSW EPA). Periodic manual monitoring of ventilation outlet emissions would also be carried out as required, to validate the accuracy of the continuous emission monitoring equipment. Continuous ambient air quality monitoring of key contaminants (particulate matter ($PM_{2.5}$ and PM_{10}), oxides of nitrogen (NO and NO_2) and CO would also be provided at representative locations in the vicinity of the ventilation outlets to allow for the review of the predicted air quality outcomes. Monitoring would be in accordance with Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales (EPA, 2007) or as otherwise agreed with NSW Environment Protection Authority. Ambient air quality monitoring would occur at least 12 continuous months prior to operation and continue for two years following the commencement of operation. At the conclusion of the two year operational monitoring period, the need for continued use of ambient air quality monitoring stations would be reviewed in consultation with the NSW Environment Protection Authority and the Department of Planning, Industry and Environment.
Environmental controls at Rozelle	
Tunnel water drainage and management infrastructure	• The wastewater treatment plant at the Rozelle Interchange would be designed to treat stormwater, groundwater, deluge water, or spills collected within the Western Harbour Tunnel to comply with ANZG (2018) guidelines before reuse or discharge • The design of the tunnel lining would reduce water inflow into the mainline tunnels, minimising the amount of wastewater treatment and disposal required during operation • The Rozelle Interchange would continue to connect to the drainage design assessed as part of M4-M5 Link.

Infrastructure	Summary
Noise attenuation measures	Noise attenuation measures as part of the project at Rozelle would include noise attenuators fitted on jet fans within the motorway facilities. The final road pavement surface used for the project would be subject to various requirements aside from acoustic benefits, including structural integrity, skid resistance, water dispersion, maintenance and design life.
Environmental controls at North Sydney and Cammeray	
Surface water drainage and management infrastructure	Most of the surface water drainage and management infrastructure at North Sydney and Cammeray would be provided as part of the Warringah Freeway Upgrade component of the project (refer to Section 5.3.9). Key surface water drainage and management to be provided at North Sydney and Cammeray as part of the Western Harbour Tunnel component of the project would include: • A new drainage network at the tunnel portals at Berry Street and Falcon Street to minimise the potential for ingress of water • Replacement of existing drainage infrastructure directly affected by surface works where required.
Noise attenuation measures	Most of the noise attenuation measures at North Sydney and Cammeray would be provided as part of the Warringah Freeway Upgrade component of the project (refer to Section 5.3.9). Noise attenuation measures as part of the project at North Sydney and Cammeray would include noise attenuators fitted on jet fans within the motorway facilities. The final road pavement surface used for the project would be subject to various requirements aside from acoustic benefits, including structural integrity, skid resistance, water dispersion, maintenance and design life.

5.2.12 Landscape treatments

Landscape treatments for the project would be consistent with the Western Harbour Tunnel and Warringah Freeway Upgrade Urban Design Framework in Appendix V (Technical working paper: Urban design, landscape character and visual impact assessment). Landscape treatments would be designed and implemented with the aims of:

- Minimising the visual and landscape impacts of the project
- Integrating the project into the surrounding visual catchment
- Improving local and regional amenity
- Maximising the use of endemic species, including consideration of current and future climate conditions
- Providing opportunity for improvements in urban ecology.

Landscape treatments would be provided along and around surface road works, including around tunnel portals and bridges, and around operational ancillary infrastructure. Key features of landscape treatments for the Western Harbour Tunnel component of the project are summarised in Table 5-7. Landscape treatments for the Warringah Freeway Upgrade component of the project are outlined in Section 5.3.10.

Land used for construction but not required for operational infrastructure would be reinstated as outlined in Chapter 6 (Construction work).

The landscape design for the project would continue to be refined through further design development in line with the principles established in Appendix V (Technical working paper: Urban design, landscape character and visual impact assessment).

Table 5-7 Landscape treatments of the Western Harbour Tunnel component

Area	Key features of landscape treatments
Rozelle Interchange	Landscape treatments in and around the Rozelle Interchange, including operational ancillary infrastructure, would be delivered as part of the approved M4-M5 Link project.
North Sydney and Cammeray surface works	Landscape treatments around the North Sydney and Cammeray surface works and operational ancillary infrastructure would include: • Planting around the motorway facilities at the Warringah Freeway, within the existing Cammeray Golf Course site to provide visual screening • Planting to assist with integrating the tunnel portals with the surrounds • Replacement of vegetation removed as part of the construction of the Western Harbour Tunnel with similar species where possible.
Motorway control centre at Waltham Street in Artarmon	Landscape treatments would include planting around the motorway control centre site.

5.3 Warringah Freeway Upgrade

5.3.1 Overview

The Warringah Freeway Upgrade component of the project would involve works along the Warringah Freeway from immediately north of the Sydney Harbour Bridge at Milsons Point to the intersection with Willoughby Road at Naremburn.

The Warringah Freeway Upgrade would:

- Connect and integrate with the Western Harbour Tunnel and Beaches Link and Gore Hill Freeway Connection project and with the existing motorway and arterial road network
- Improve wayfinding and separate traffic on the freeway depending on different trip functions (through traffic, traffic for arterial distribution and traffic for local destinations).

The conceptual trip distribution strategy for the Warringah Freeway Upgrade is broadly based on differentiating and optimising the use of the harbour crossings as follows (refer to Figure 5-17):

- The central carriageway would act as the mainline motorway corridor connecting the Gore Hill Freeway/M1 North, the Warringah Freeway and the 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 the Sydney Harbour Tunnel)
- The northbound outer carriageway would act as the access distributor for North Sydney, the Sydney CBD and journeys from the Eastern Suburbs (including the Sydney Harbour Bridge and the Sydney Harbour Tunnel).

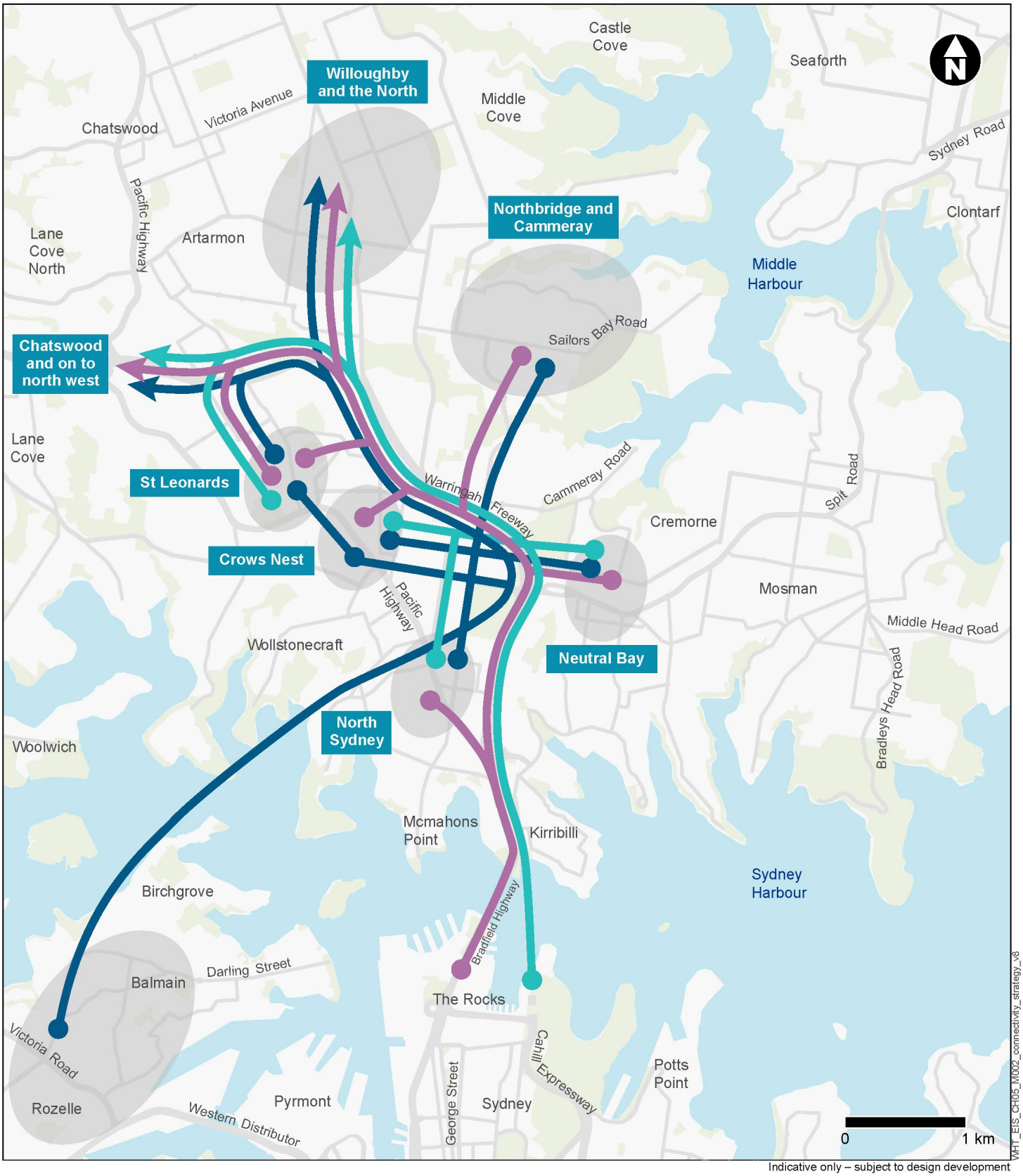
Traffic from the west or the east of the CBD would access local destinations along the Warringah Freeway not otherwise directly connected by the Western Harbour Tunnel or the Sydney Harbour Tunnel by:

- Accessing the Sydney Harbour Bridge via the Western Distributor in the case of traffic from the west
- Accessing the Sydney Harbour Bridge via the Cahill Expressway and Eastern Distributor in the case of traffic from the east.

To achieve the outcomes of the conceptual trip distribution strategy, the Warringah Freeway Upgrade would include the following:

- Upgrade and reconfiguration of the Warringah Freeway traffic lanes
- Surface road works, including upgrades to existing interchanges with High Street and Falcon Street, the provision of new, upgraded and relocated road bridges, upgrades to the surrounding road network and installation of cut and cover structures.

Key features of the Warringah Freeway Upgrade component of the project are shown in Figure 5-3 to Figure 5-5. Additional information about the upgrade and reconfiguration of the Warringah Freeway and surface road works that would be required to facilitate the Warringah Freeway Upgrade is provided in Section 5.3.2 and Section 5.3.4, respectively. New, upgraded and modified bridge structures along the Warringah Freeway Upgrade are shown in Figure 5-28 and Figure 5-29. Upgrades and changes to the surrounding road network are shown in Figure 5-30 to Figure 5-32.



Indicative only – subject to design development

Legend

- Sydney Harbour Tunnel
- Sydney Harbour Bridge
- Proposed Western Harbour Tunnel and Beaches Link
- Precincts

Figure 5-17 Conceptual trip distribution strategy

5.3.2 Upgrade and reconfiguration of the Warringah Freeway

To achieve the functionality requirements of the conceptual trip distribution strategy, as described in Section 5.3.1, the Warringah Freeway Upgrade component of the project would include:

- The provision of new and reconfigured traffic lanes along the Warringah Freeway
- Removal of the existing tidal flow arrangements on the Warringah Freeway.

Reconfiguration of traffic lanes along the Warringah Freeway

As described in Section 5.3.1, the conceptual trip distribution strategy is based on differentiating and optimising the use of the harbour crossings.

The reconfigured Warringah Freeway would provide further separation between traffic lanes within the three broad categories:

- A northbound outer carriageway which would comprise:
  - An outer western carriageway, carrying northbound traffic from the Sydney Harbour Bridge to the Beaches Link and Gore Hill Freeway Connection project northbound on ramp and for local distribution to local destinations such as North Sydney and Crows Nest
  - Inner western carriageways carrying northbound through traffic from the Sydney Harbour Bridge and the Sydney Harbour Tunnel
- A central carriageway which would carry northbound and southbound motorway traffic between the Western Harbour Tunnel, Gore Hill Freeway and Willoughby Road
- A southbound outer carriageway which would comprise:
  - An inner eastern carriageway, carrying southbound through traffic to the Sydney Harbour Tunnel
  - The outer eastern carriageway, carrying southbound traffic for the Sydney Harbour Bridge (both the Bradfield Highway and Cahill Expressway) and distribution to local destinations such as Neutral Bay, 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.

The reconfiguration of the Warringah Freeway traffic lanes is shown in Figure 5-18.

Removal of tidal flow arrangements

The improved functionality of the Warringah Freeway corridor with a new western bypass of Sydney CBD provided by the Western Harbour Tunnel, in conjunction with the reconfiguration of the traffic lanes as detailed above, would allow for the removal of the current tidal flow arrangements along the Warringah Freeway, along with those at the Mount Street and Ernest Street interchanges.

The existing tidal flow arrangements on the Sydney Harbour Bridge would not be directly affected by the project. Automatic moveable carriageway delineation markers would be installed at the transition between non-tidal traffic on the Warringah Freeway and tidal traffic on the Sydney Harbour Bridge as part of the project to manage this interface.

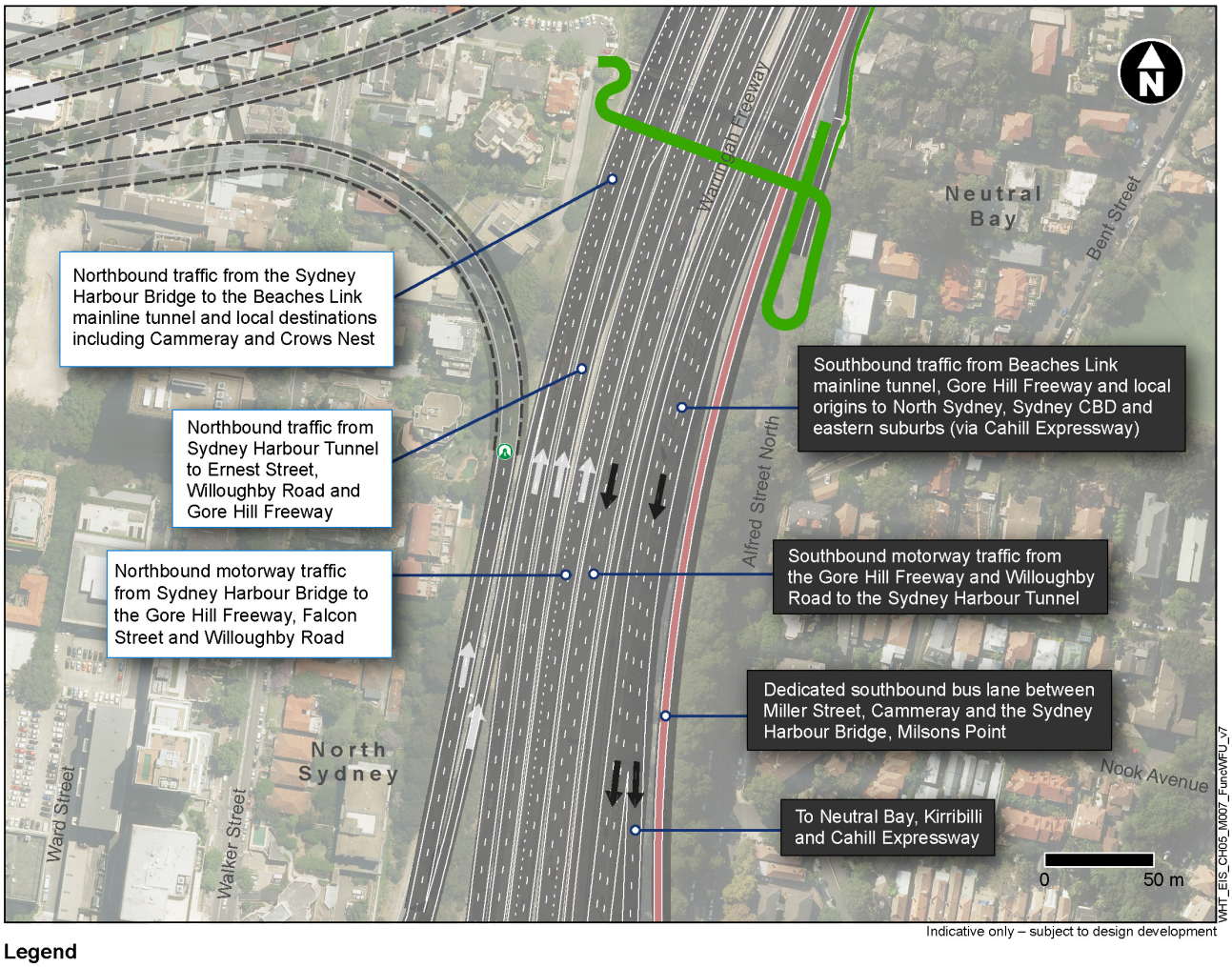


Figure 5-18 Reconfiguration of the Warringah Freeway traffic lanes

5.3.3 Connectivity

For the Warringah Freeway Upgrade component of the project to achieve optimised connectivity for the harbour crossings, an improvement of the bypass and access/distributor functions of the road corridor is required. This would require the current access arrangements to the Warringah Freeway corridor to be modified, for streamlined connectivity and to support the growth in traffic demand. These modifications would also result in improvements to performance, safety and wayfinding. Residents and businesses in the suburbs around the Warringah Freeway would remain connected to at least one harbour crossing.

Connections between the Warringah Freeway and motorway tunnels

The connections between the Warringah Freeway and motorway tunnels are summarised in Table 5-8. The Warringah Freeway Upgrade would include some elements that would be delivered to safeguard delivery of either the Western Harbour Tunnel or Beaches Link and Gore Hill Freeway Connection project connections to the Warringah Freeway (irrespective of delivery program).

Table 5-8 Connections between the Warringah Freeway Upgrade component and motorway tunnels

Location/Connection	Summary
Connections between the Warringah Freeway and motorway tunnels	
Between the Warringah Freeway and the Sydney Harbour Tunnel	The existing connections between the Warringah Freeway and the Sydney Harbour Tunnel (north of the High Street interchange, North Sydney) would be reconfigured as part of the project. The reconfigured and reduced connectivity from the Lower North Shore to the Sydney Harbour Tunnel would be possible as access to these locations and the Eastern Distributor would still be available via the Cahill Expressway. Local connections to Neutral Bay and Cammeray would be maintained. The existing tunnel dive structures would not be directly affected by the Warringah Freeway Upgrade.
Between the mainline tunnels of the Western Harbour Tunnel and the Warringah Freeway	To the north of Ernest Street and located in the centre of the Warringah Freeway, Cammeray, there would be: • An off ramp from the northbound mainline tunnel of the Western Harbour Tunnel to the Warringah Freeway northbound, constructed by the Western Harbour Tunnel component of the project • An on ramp from Warringah Freeway southbound to the southbound mainline tunnel of Western Harbour Tunnel, constructed by the Western Harbour Tunnel component of the project.
Between the Beaches Link and Gore Hill Freeway Connection project mainline tunnels and the Warringah Freeway	To the north of Ernest Street, there would be: • An on ramp from the Warringah Freeway northbound to the northbound mainline tunnel of Beaches Link and Gore Hill Freeway Connection project, located on the western side of the Warringah Freeway, Cammeray (refer to Figure 5-18) and constructed by the Beaches Link and Gore Hill Freeway Connection project • An off ramp from the southbound mainline tunnel of the Beaches Link and Gore Hill Freeway Connection project to the Warringah Freeway southbound, located on the eastern side of the Warringah Freeway (refer to Figure 5-12) and constructed by the Beaches Link and Gore Hill Freeway Connection project.

Connections between the Warringah Freeway and surface roads

A summary of the connections between the Warringah Freeway Upgrade component and surface roads is provided in Table 5-9. The connections detailed in Table 5-9 take into account the changes to access that would be completed as part of the project.

Surface connections between the Western Harbour Tunnel component of the project, the Beaches Link and Gore Hill Freeway Connection project, and North Sydney are shown in Figure 5-12 and Figure 5-14, respectively. Cross-sections, showing the connection of the Warringah Freeway and the Western Harbour Tunnel near St Leonards Park, and the Warringah Freeway and the Beaches Link and Gore Hill Freeway Connection project mainline tunnels to the north of Ernest Street are shown in Figure 5-19 to Figure 5-21 and in Figure 5-22 to Figure 5-25, respectively.

Table 5-9 Connections between the Warringah Freeway Upgrade component and surface roads

Location/ Connection	Summary
Motorways	
Sydney Harbour Bridge, Milsons Point	The Sydney Harbour Bridge comprises two key motorway elements, the Bradfield Highway and Cahill Expressway, and connects directly with the Warringah Freeway. This services journeys to and from: • The Eastern Suburbs and Sydney Airport (Cahill Expressway) • The Sydney CBD (Bradfield Highway) • The Inner West and Western Suburbs via the Western Distributor (Bradfield Highway). The existing connectivity to the Sydney Harbour Bridge (Cahill Expressway and Bradfield Highway) would be maintained for all interchanges except for: • Ernest Street (which would be changed to allow access to and from the Sydney Harbour Tunnel) • Falcon Street to the Cahill Expressway southbound only.
Gore Hill Freeway, Naremburn	The Gore Hill Freeway connects directly with the Warringah Freeway at around Naremburn and continues on to connect through to locations like: • Reserve Road • Pacific Highway • Lane Cove Tunnel • Longueville Road/Epping Road. The existing connectivity between the Gore Hill Freeway and Warringah Freeway will remain unchanged.
Interchanges	
High Street interchange, North Sydney	The High Street interchange connects the Pacific Highway to and from the north-west (via High Street) to Kirribilli to the east. The existing connectivity provided by this interchange would be maintained by the Warringah Freeway Upgrade, and a new northbound connection to the Warringah Freeway would also be provided. The High Street interchange would provide the following connectivity: • Two south-facing ramps providing: – An off ramp connection from the Bradfield Highway northbound to the Pacific Highway and Arthur Street northbound – An on ramp connection from High Street to the Cahill Expressway southbound • Two north-facing ramps providing: – An off ramp connection from the Warringah Freeway southbound via Alfred Street North to High Street (eastbound and westbound) – An on ramp connection from High Street (eastbound and westbound) to the Warringah Freeway northbound. Further detail of the High Street interchange upgrade is provided in Section 5.3.4 and shown on Figure 5-26.

Location/ Connection	Summary
Mount Street interchange, North Sydney	Mount Street connects Arthur Street in the west to Alfred Street North in the east. The current tidal flow arrangements on the Mount Street interchange would be removed as part of the project to reflect the removal of tidal flow in the Warringah Freeway corridor. The Mount Street interchange would include three south-facing on ramps, which would connect traffic from the Mount Street bridge to the Warringah Freeway southbound with subsequent direct connections with the Bradfield Highway southbound, bus lane southbound and the Cahill Expressway southbound.
Falcon Street interchange, North Sydney	Falcon Street provides a connection with Military Road/Falcon Street to and from the east, and to the Pacific Highway and Miller Street in the west via Falcon Street. As part of the Warringah Freeway Upgrade, the following changes to access at the Falcon Street interchange would occur: • Access from the Warringah Freeway northbound to Falcon Street westbound would be removed to accommodate the Falcon Street off ramp from the Western Harbour Tunnel. The adjacent interchanges to the north and south of Falcon Street would provide similar, alternative connectivity to that currently provided by Falcon Street • Access from Falcon Street southbound to the Cahill Expressway southbound would be removed • Access between the tolled north facing ramps at Falcon Street and Brook Street would be removed and traffic would instead be required to travel via the local road network. With the Warringah Freeway Upgrade, the Falcon Street interchange would provide the following connectivity: • Two south-facing ramps providing: - An off ramp connection from Warringah Freeway northbound (both Sydney Harbour Tunnel and Sydney Harbour Bridge) to Falcon Street/Military Road eastbound - An on ramp connection from Falcon Street to the Sydney Harbour Tunnel and the Sydney Harbour Bridge (Bradfield Highway only) • Two north-facing ramps providing: - A tolled off ramp connection from the Warringah Freeway southbound to Military Road eastbound - A tolled on ramp connection from Falcon Street (eastbound and westbound) to Warringah Freeway northbound. Further detail of the Falcon Street interchange upgrade is provided in Section 5.3.4 and shown in Figure 5-27.
Ernest Street interchange, Cammeray	Ernest Street provides a crossing of Warringah Freeway, connecting Neutral Bay in the east and Cammeray in the west. As part of the Warringah Freeway Upgrade component the following changes to access at the Ernest Street interchange would occur: • Access from Ernest Street to the Sydney Harbour Bridge (Bradfield Highway only) southbound would be removed. Adjacent interchanges to the north and south of Ernest Street would provide similar, alternate connectivity to that currently provided by Ernest Street • Access to Ernest Street from the Sydney Harbour Bridge (Cahill

Location/ Connection	Summary
	Expressway and Bradfield Highway) northbound would be removed. Adjacent interchanges to the north and south of Ernest Street would provide similar, alternate connectivity to that currently provided by Ernest Street. With the Warringah Freeway Upgrade, the following connectivity would be provided: • An off ramp from the Sydney Harbour Tunnel northbound to Ernest Street eastbound and westbound • An on ramp to the Sydney Harbour Tunnel southbound from Ernest Street eastbound and westbound.
Miller Street, Cammeray	Miller Street provides a connection over the Warringah Freeway linking Cammeray and Crows Nest. Access between the Sydney Harbour Tunnel northbound and the Miller Street off ramp would be removed. The Ernest Street interchange would provide the similar, alternate connectivity between the Sydney Harbour Tunnel northbound and Cammeray. Two ramps would connect Miller Street, Cammeray, with the Warringah Freeway northbound and southbound: • An off ramp connecting the Warringah Freeway northbound to Miller Street at Cammeray. This ramp would diverge from the Beaches Link and Gore Hill Freeway Connection project northbound on ramp, and continue as a long off ramp to Brook Street • The on ramp from Miller Street would connect to the Warringah Freeway northbound via the long on ramp from Brook Street and continue to connect to the Warringah Freeway southbound to the north of the Ernest Street bridge.
Brook Street, Crows Nest/Cammeray	Brook Street provides a connection under the Warringah Freeway linking Naremburn and Crows Nest. Access between the Sydney Harbour Tunnel and Brook Street would be removed. Two ramps would connect Brook Street, Crows Nest/Cammeray, with the Warringah Freeway northbound and southbound: • A long separated off ramp from the Warringah Freeway northbound that diverges from the outer Warringah Freeway northbound carriageway and connects to Miller Street, Cammeray and on to Brook Street at Crows Nest • A long separated on ramp which connects from Brook Street at Cammeray, merges with the Miller Street on ramp and on to the Warringah Freeway southbound to the north of the Ernest Street bridge.
Willoughby Road, Naremburn	Willoughby Road provides a connection over the Warringah Freeway linking Naremburn. Two ramps would connect Willoughby Road, Naremburn, with Warringah Freeway northbound and southbound: • An off ramp from Warringah Freeway northbound to Willoughby Road, Naremburn • The on ramp from Willoughby Road to the Warringah Freeway southbound would not be directly affected by the project, and would remain as per the existing arrangement.

Location/ Connection	Summary
Surface roads	
From the Alfred Street North southbound off ramp to Alfred Street North (northbound)	The access from the southbound off ramp to travel northbound on Alfred Street North would be removed and traffic would be required to exit the Warringah Freeway at Falcon Street or continue onto High Street and travel via the local road network around Neutral Bay to access Alfred Street North.
Berry Street, North Sydney	Connections would be provided from Berry Street to the Western Harbour Tunnel, the outer northbound carriageway to Warringah Freeway and have provision for a future connection to the Beaches Link and Gore Hill Freeway Connection project mainline tunnels, and the Miller Street and Brook Street off ramps. Access to Falcon Street eastbound or the Warringah Freeway northbound would be removed as part of the project. Traffic wanting to access Falcon Street eastbound or the Warringah Freeway northbound would instead be able to use the new High Street northbound ramp or the Falcon Street interchange.

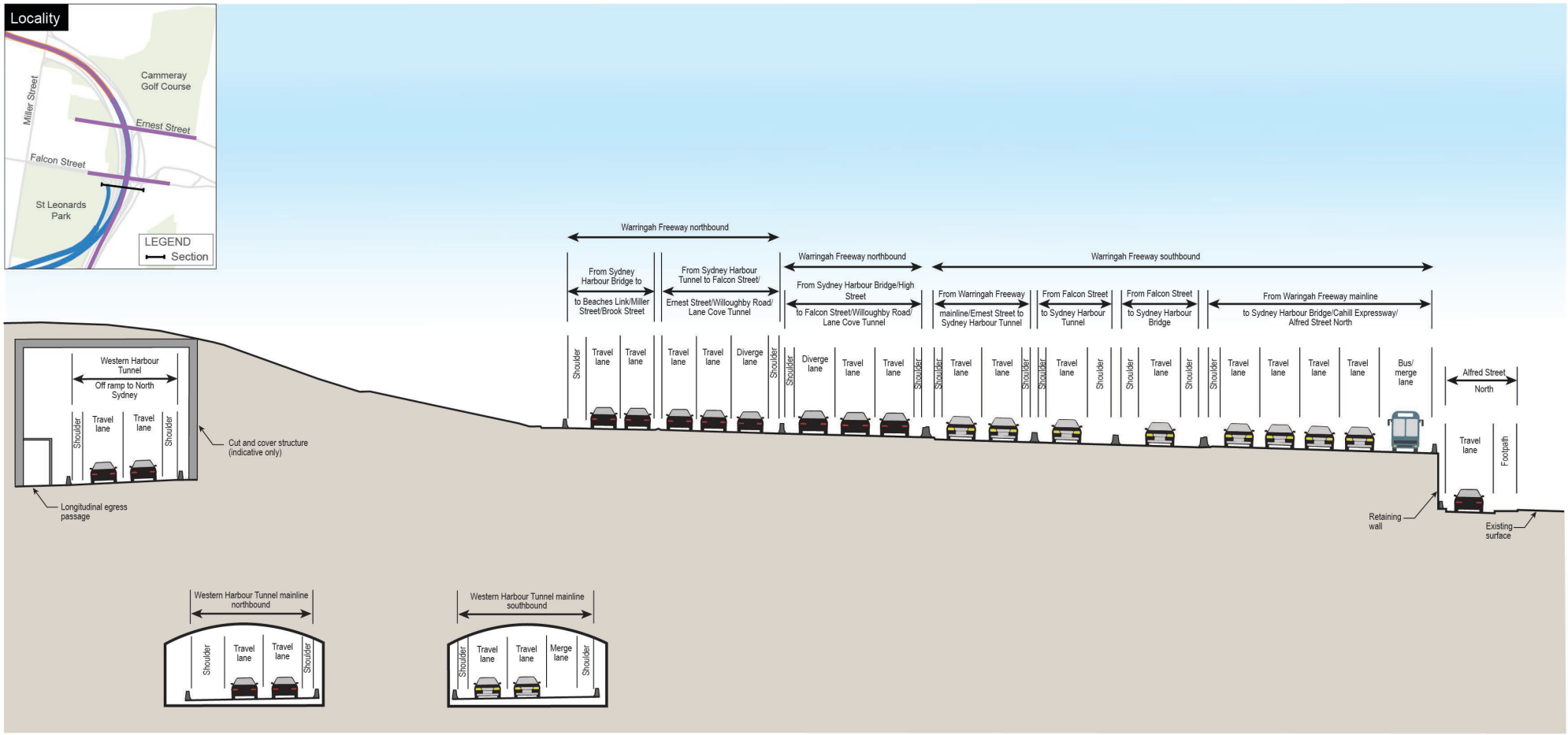


Figure 5-19 Indicative cross-section through the connection between the Western Harbour Tunnel and the Warringah Freeway Upgrade – overview

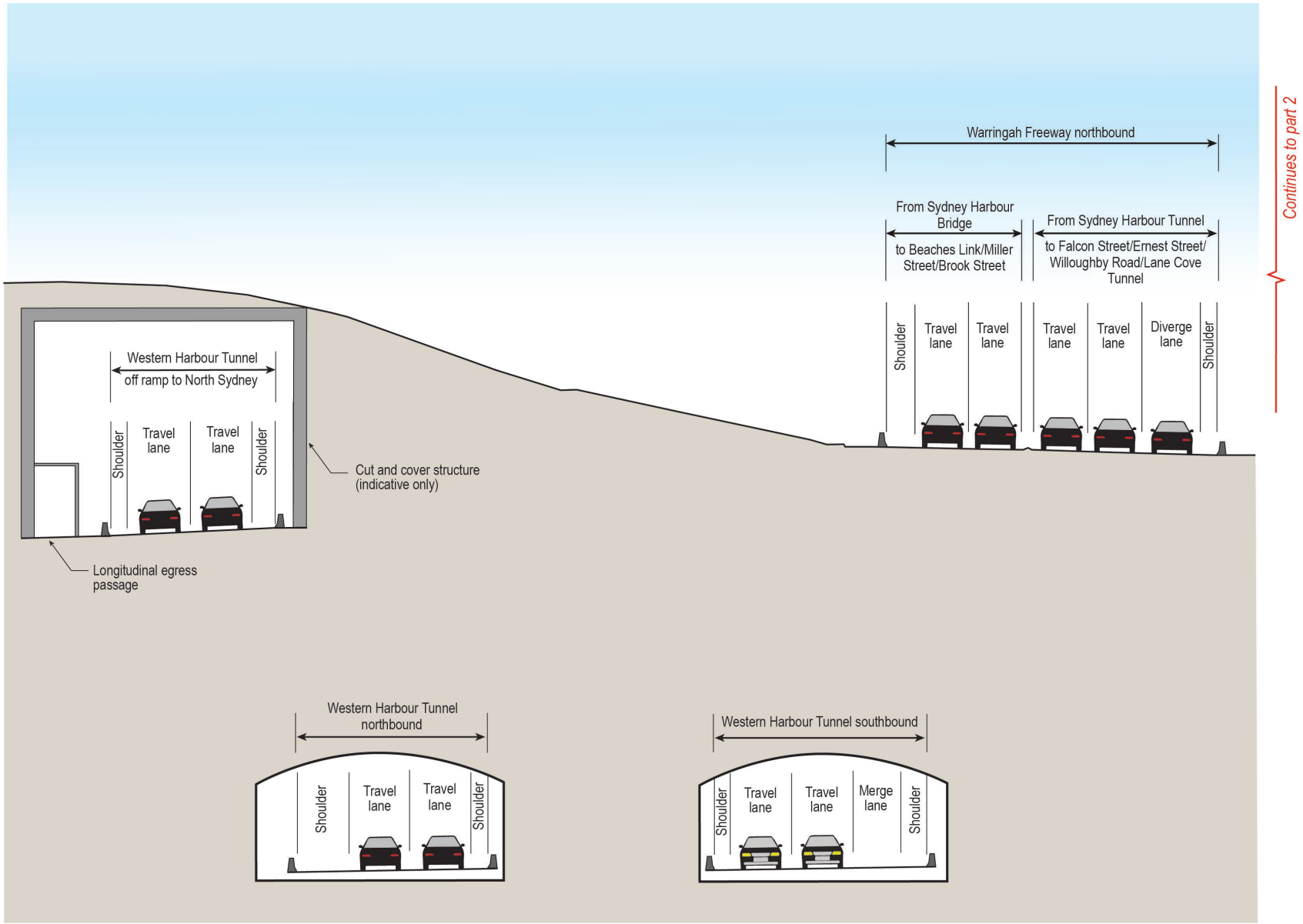


Figure 5-20 Indicative cross-section through the connection between the Western Harbour Tunnel and the Warringah Freeway Upgrade (part 1)

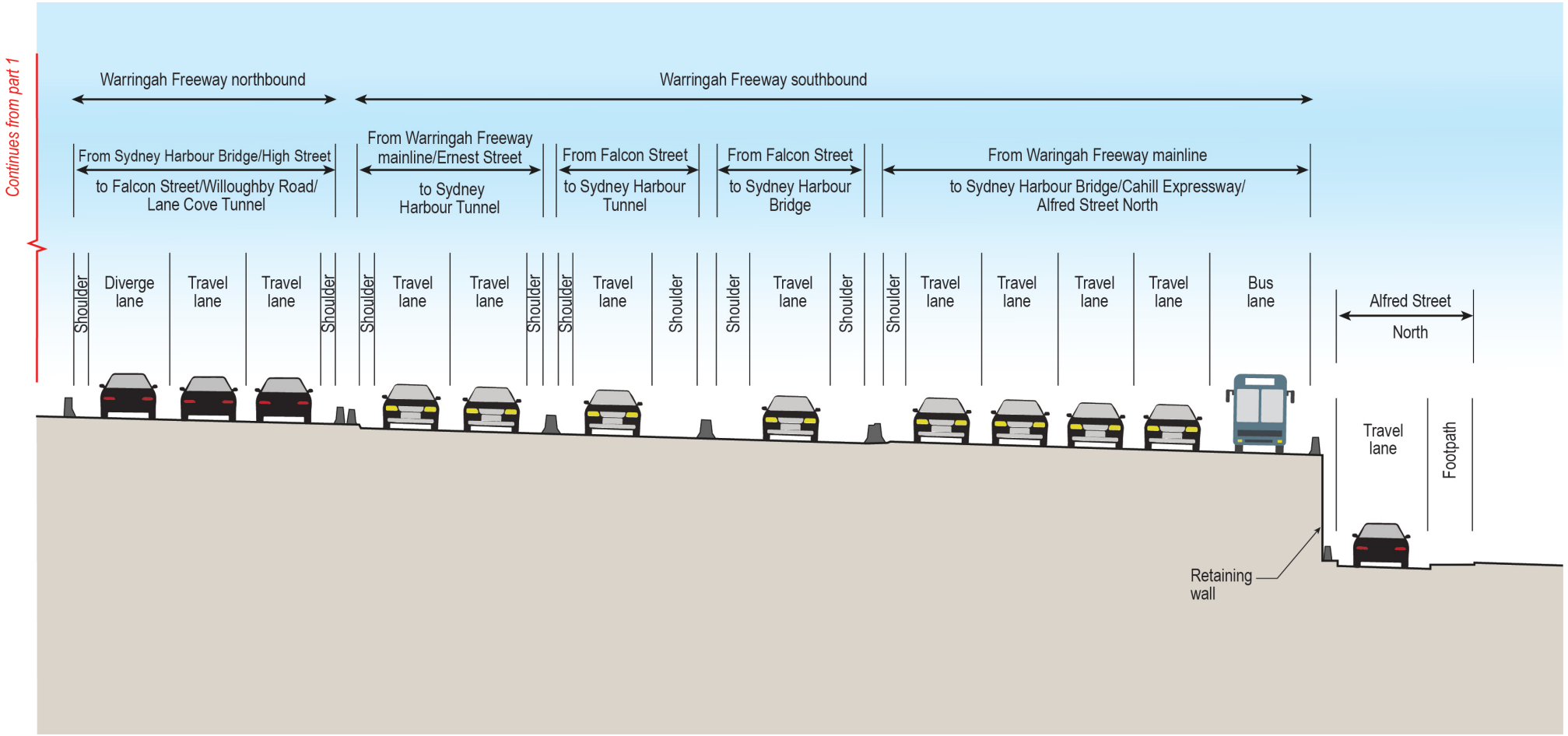


Figure 5-21 Indicative cross-section through the connection between the Western Harbour Tunnel and the Warringah Freeway Upgrade (part 2)

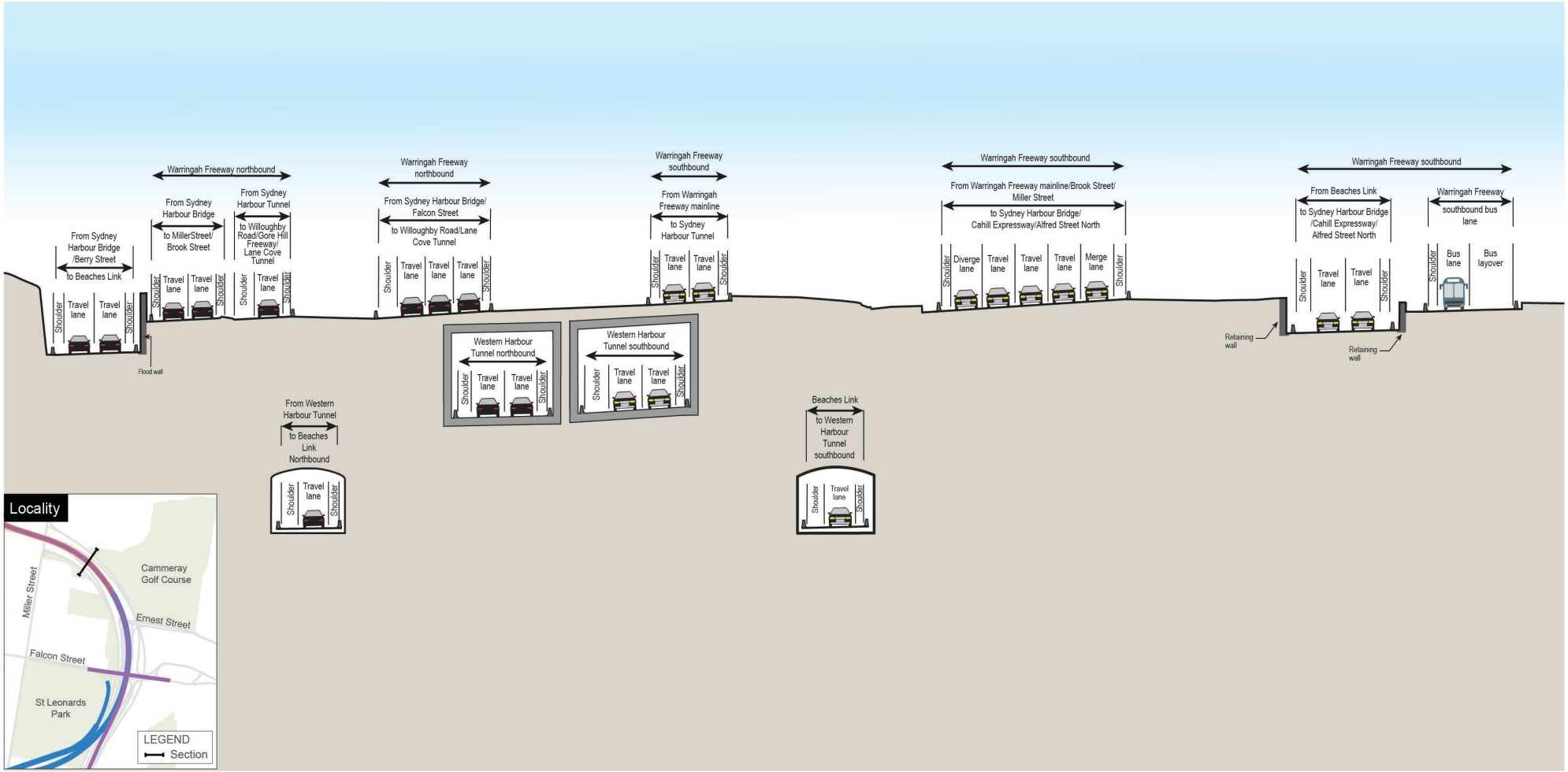


Figure 5-22 Indicative cross-section through the connection between the Beaches Link and Gore Hill Freeway Connection project and the Warringah Freeway Upgrade - overview

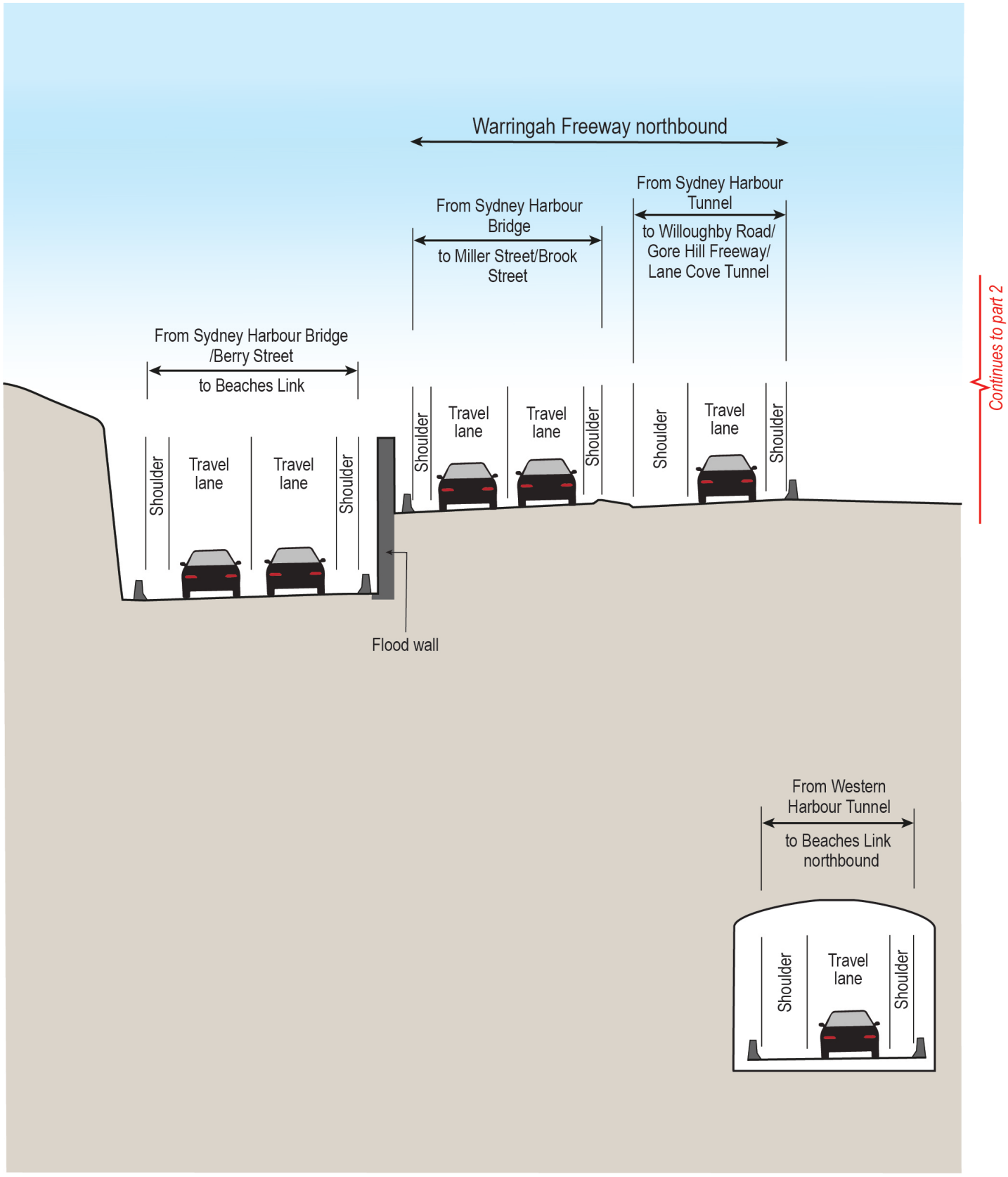


Figure 5-23 Indicative cross-section through the connection between the Beaches Link and Gore Hill Freeway Connection project and the Warringah Freeway Upgrade (part 1)

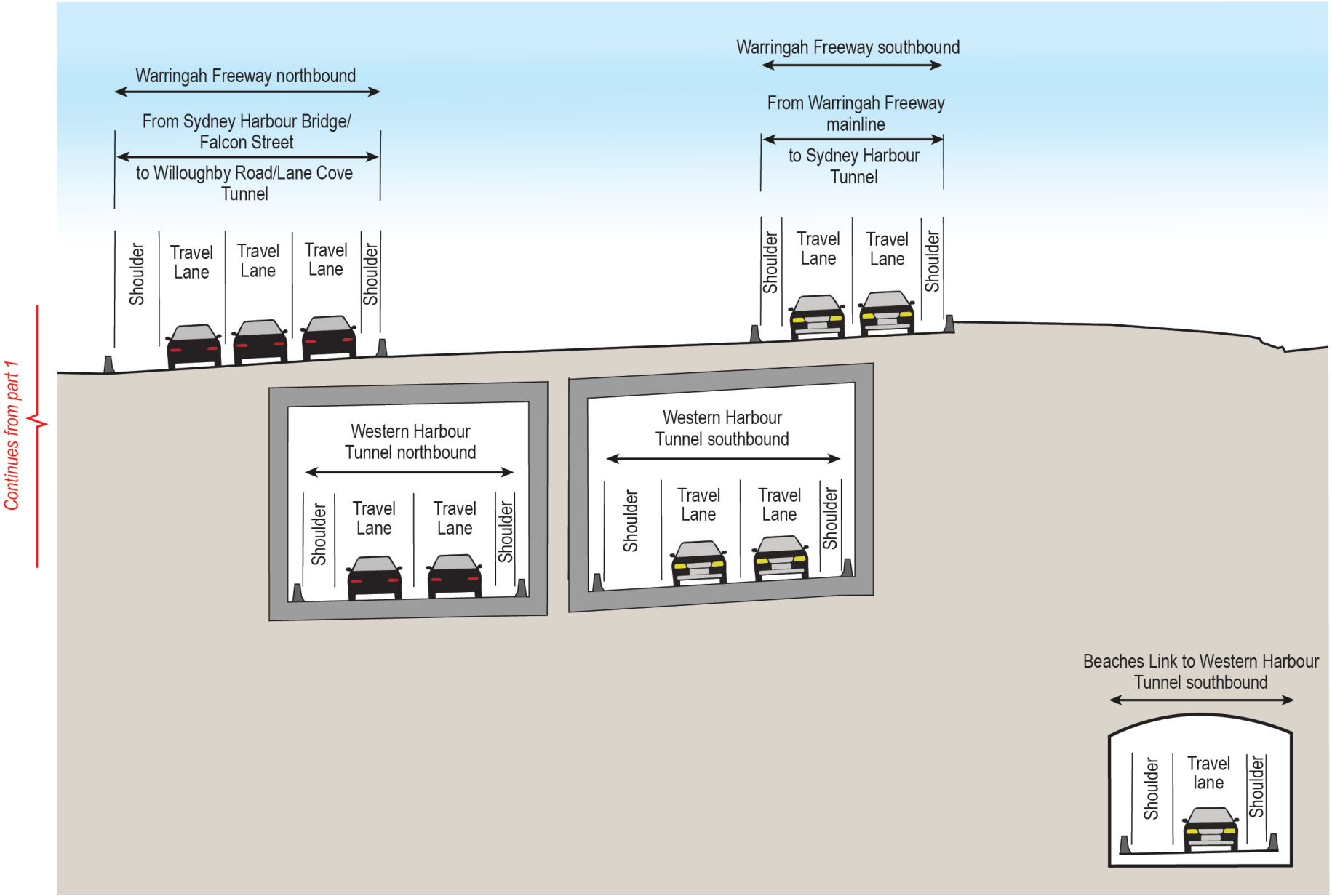


Figure 5-24 Indicative cross-section through the connection between the Beaches Link and Gore Hill Freeway Connection project and the Warringah Freeway Upgrade (part 2)

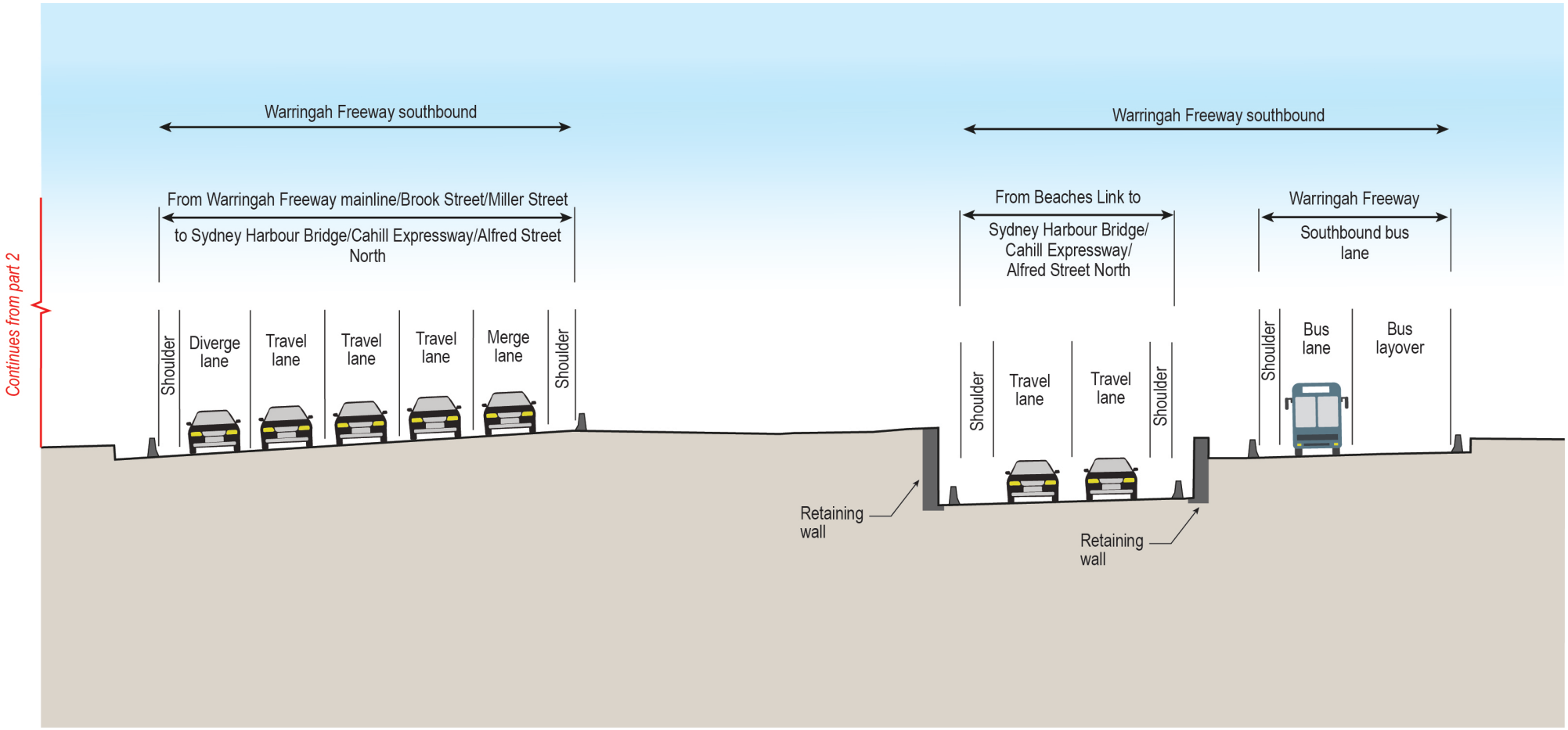


Figure 5-25 Indicative cross-section through the connection between the Beaches Link and Gore Hill Freeway Connection project and the Warringah Freeway Upgrade (part 3)

5.3.4 Surface road works

Key components of the surface road works that would be carried out as part of the Warringah Freeway Upgrade component of the project include:

- Upgrades to the interchanges with High Street and Falcon Street at North Sydney
- New, upgraded and relocated road bridges
- Minor upgrades and changes to parts of the surrounding road network
- Elements of cut and cover and trough structures for:
  - The on and off ramps at the Warringah Freeway, to provide surface connections between the Western Harbour Tunnel component of the project and the Warringah Freeway Upgrade
  - The on and off ramps at the Warringah Freeway to provide surface connections between the Beaches Link and Gore Hill Freeway Connection project mainline tunnels (subject to separate assessment and approval) and the Warringah Freeway Upgrade
  - The tunnel to tunnel connection between the Western Harbour Tunnel component of the project and the Beaches Link and Gore Hill Freeway Connection project mainline tunnels.

Upgrades to interchanges at High Street and Falcon Street at North Sydney

There are currently two interchanges in North Sydney and Cammeray that connect the Warringah Freeway with the surrounding arterial road network:

- The High Street interchange, which connects the Warringah Freeway with the Pacific Highway to the north-west and the Cahill Expressway to the south. It also provides local connectivity into North Sydney, to the north and west, and Kirribilli, to the east
- The Falcon Street interchange, which connects the Warringah Freeway to Military Road to the east. It also provides an arterial connection to Miller Street and on to the Pacific Highway to the west.

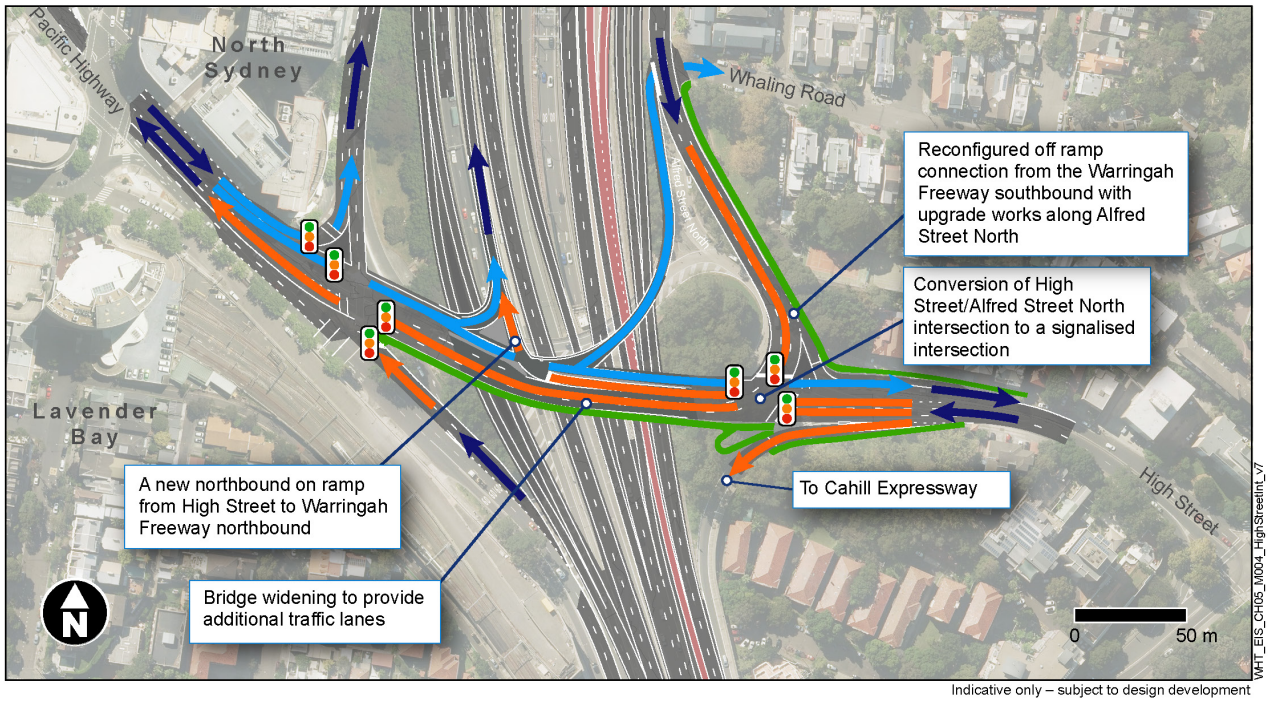
Both of these interchanges would be upgraded as part of the Warringah Freeway Upgrade component of the project to integrate with, and manage the redistribution of, traffic as a consequence of the project and Beaches Link and Gore Hill Freeway Connection project.

The connectivity that would be provided by these interchanges is described in Section 5.3.3. Upgrade works that would be carried out on the High Street interchange and the Falcon Street interchange are summarised in Table 5-10 and shown in Figure 5-26 and Figure 5-27, respectively.

Table 5-10 Upgrades to interchanges of the Warringah Freeway Upgrade component

Upgrade works	Summary
High Street interchange	
High Street bridge	• Upgrade and widening of the High Street bridge for additional traffic lanes to provide improved capacity into North Sydney via the Pacific Highway. The widened bridge would consist of girders and a deck superstructure on piers with footings matching existing locations • A new on ramp from the interchange to the Warringah Freeway northbound • An upgraded off ramp connection from the Warringah Freeway southbound, with associated upgrade works along Alfred Street North • Conversion of the existing High Street/Alfred Street intersection to a signalised intersection • A new access to/from Whaling Road via Alfred Street North. • New and upgraded active transport infrastructure around the interchange (refer to Section 5.3.6).

Upgrade works	Summary
Falcon Street interchange	
Upgrade to Falcon Street interchange	The Falcon Street interchange would be upgraded to a diverging diamond interchange configuration to address the future forecast traffic volumes. These interchanges are characterised by cross-over intersections at each end of the interchange, which temporarily swap the directional carriageways across the bridge. In doing so, this swap converts the traditional conflicting right turn movements to free-flow right turn movements. Works would include: • Modification and minor widening of the Falcon Street bridge, and the upgrade and reconfiguration of traffic lanes approaching and through the interchange • Reconfiguration of medians, signage and traffic signals of the interchange at the western and eastern ends, which would: – Temporarily switch eastbound and westbound carriageways to opposite sides of the interchange – Avoid conflicting traffic movements, with no right turns across other traffic lanes – Simplify traffic signalisation, with fewer phase changes and longer green time for each movement • Replacement and upgrade of active transport infrastructure around and through the interchange (refer to Section 5.3.6) • Widening of the north-eastern corner of the bridge to support reconfiguration of the off ramp from the Warringah Freeway southbound to Military Road eastbound. Bridge widening works would comprise steel girders with a concrete deck, similar to the existing bridge structure • A new structure in the south-eastern corner of the bridge to support the bus on ramp from Falcon Street westbound to the Warringah Freeway southbound • Trimming and support works on both the eastern and western bridge abutments.

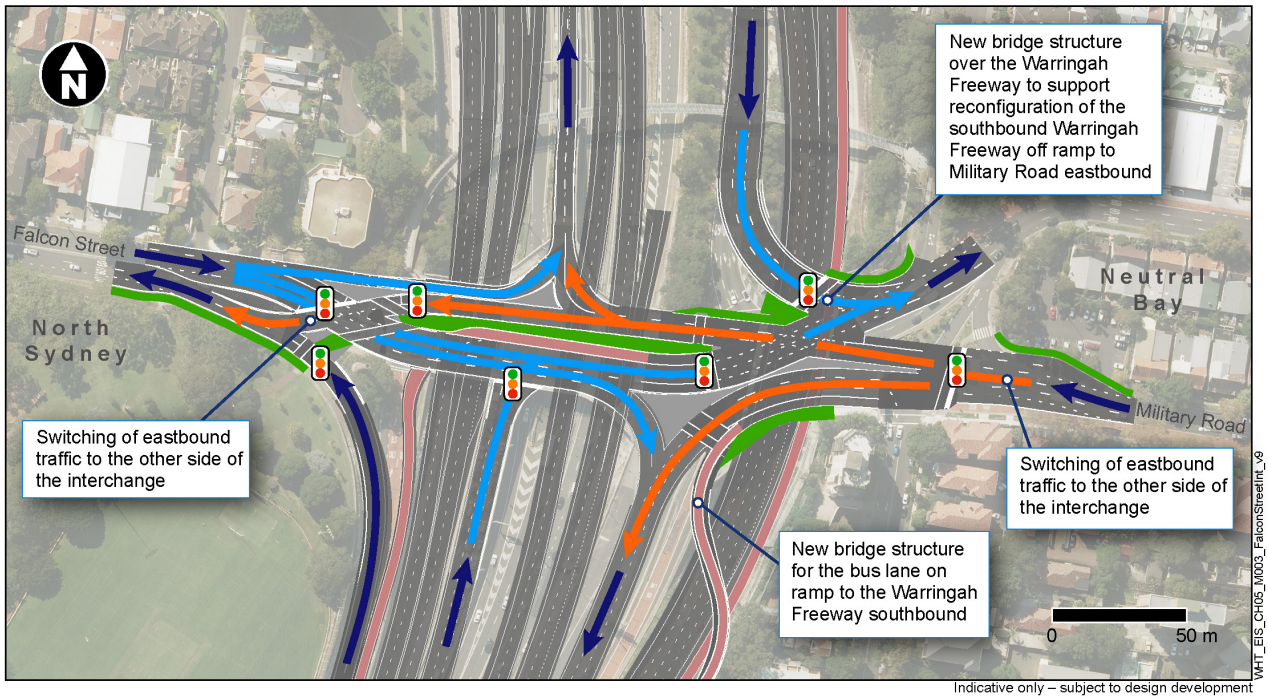


Legend

Surface features
- Surface road
- Bus lane
- Pedestrian / shared user path

Traffic movements
- Direction of travel outside the connection
- Eastbound travel
- Westbound travel
- Signalised intersection

Figure 5-26 Upgrade of the High Street interchange



Legend

Surface features
- Surface road
- Bus lane
- Pedestrian / shared user path

Traffic movements
- Direction of travel outside the connection
- Eastbound travel
- Westbound travel
- Signalised intersection

Figure 5-27 Upgrade of the Falcon Street interchange

New, modified and relocated road bridges

New, modified and relocated road bridges would be required as part of the Warringah Freeway Upgrade component of the project to:

- Accommodate the Western Harbour Tunnel and the Beaches Link and Gore Hill Freeway Connection project mainline tunnels
- Accommodate widening and lane reconfigurations along the Warringah Freeway
- Allow for upgrades to the High Street interchange and Falcon Street interchange
- Integrate the project with the surrounding surface road network.

Road bridge works that would be carried out at as part of the Warringah Freeway Upgrade component are summarised in Table 5-11 and shown in Figure 5-28 and Figure 5-29. Details of the relocation and upgrade of the Ridge Street shared user bridge are provided separately in Section 5.3.6. For details relating to the High Street and Falcon Street bridges, refer to Table 5-10.

Table 5-11 New, modified and relocated road bridges of the Warringah Freeway Upgrade component

Road bridge	Summary
Mount Street bridge	The existing Mount Street bridge would be modified around its south-west and south-east corners to support new and modified on and off ramps, including: • Widening the existing abutment • Removal of some existing girders and installation of new girders • A new deck slab and traffic barriers in some areas • A new suspended deck structure to support the new southbound bus lane on ramp to the Warringah Freeway (refer to Section 5.3.6) and associated new retaining walls.
Mount Street underpass	A new single lane underpass would be constructed beneath Mount Street to the west of the Warringah Freeway as part of the new dedicated southbound bus lane (refer to Section 5.3.6). The underpass would include planks or girders and a deck slab on piles.
Alfred Street North overpass	A new overpass bridge would be constructed over the new dedicated southbound bus lane (refer to Section 5.3.6). The overpass would form part of the connection between the Warringah Freeway, High Street interchange and Cahill Expressway, in an area to the north of Kurraba Road. The overpass would include: • Girders with a deck, based on piers • Abutments with retaining walls on the northern and southern sides of the overpass.
Ernest Street underpass	A new underpass for the new dedicated southbound bus lane and the Beaches Link and Gore Hill Freeway Connection off ramp to Warringah Freeway. The underpass would include planks or girders and a deck slab on piles.
Brook Street/Miller Street on ramp bridge	The on ramp to the Warringah Freeway southbound from Brook Street and Miller Street at Cammeray would include a bridge near the existing Miller Street on ramp, Cammeray. The new on ramp bridge would: • Pass over the new dedicated southbound bus lane and bus layover • Include girders and piers.

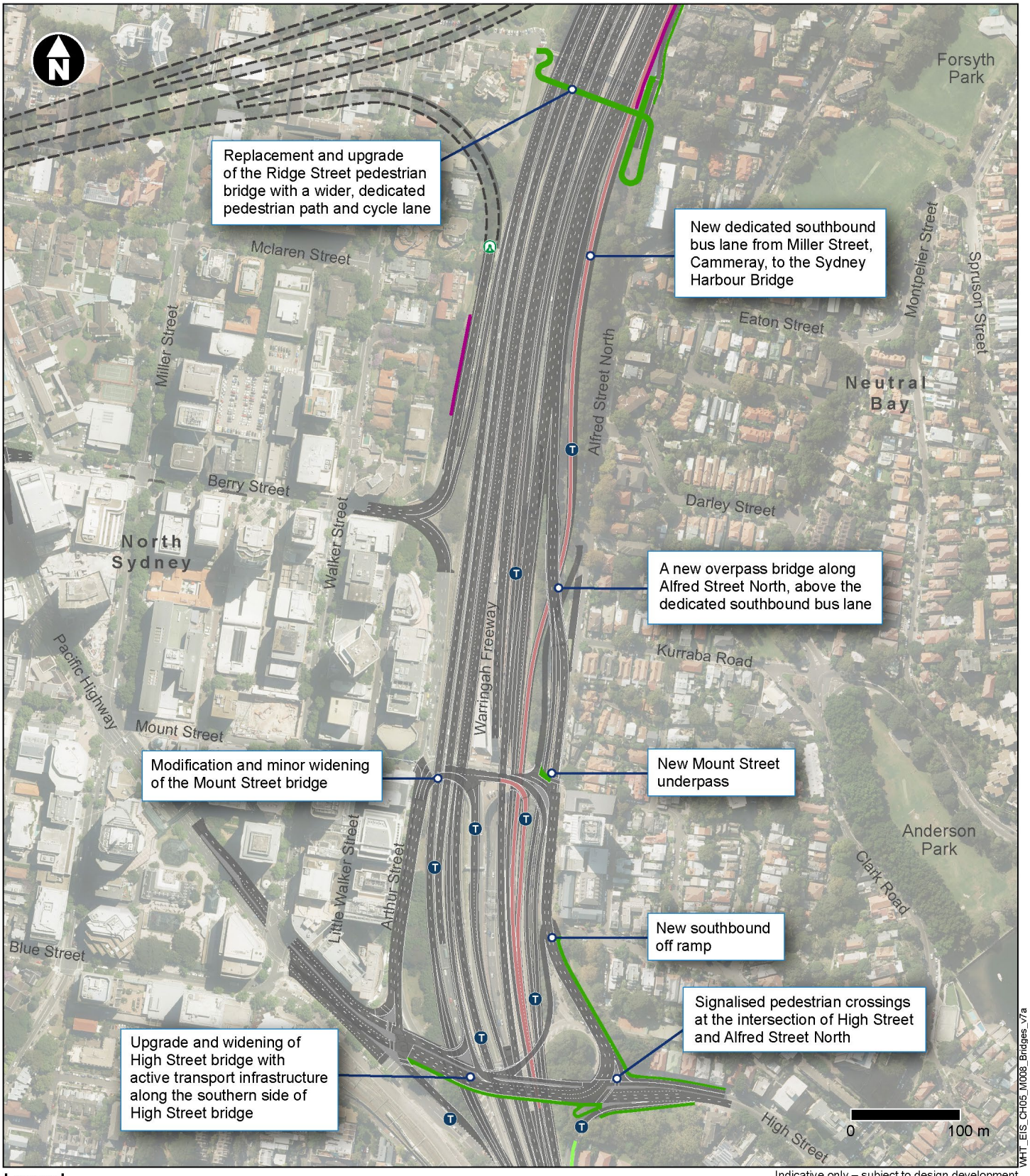
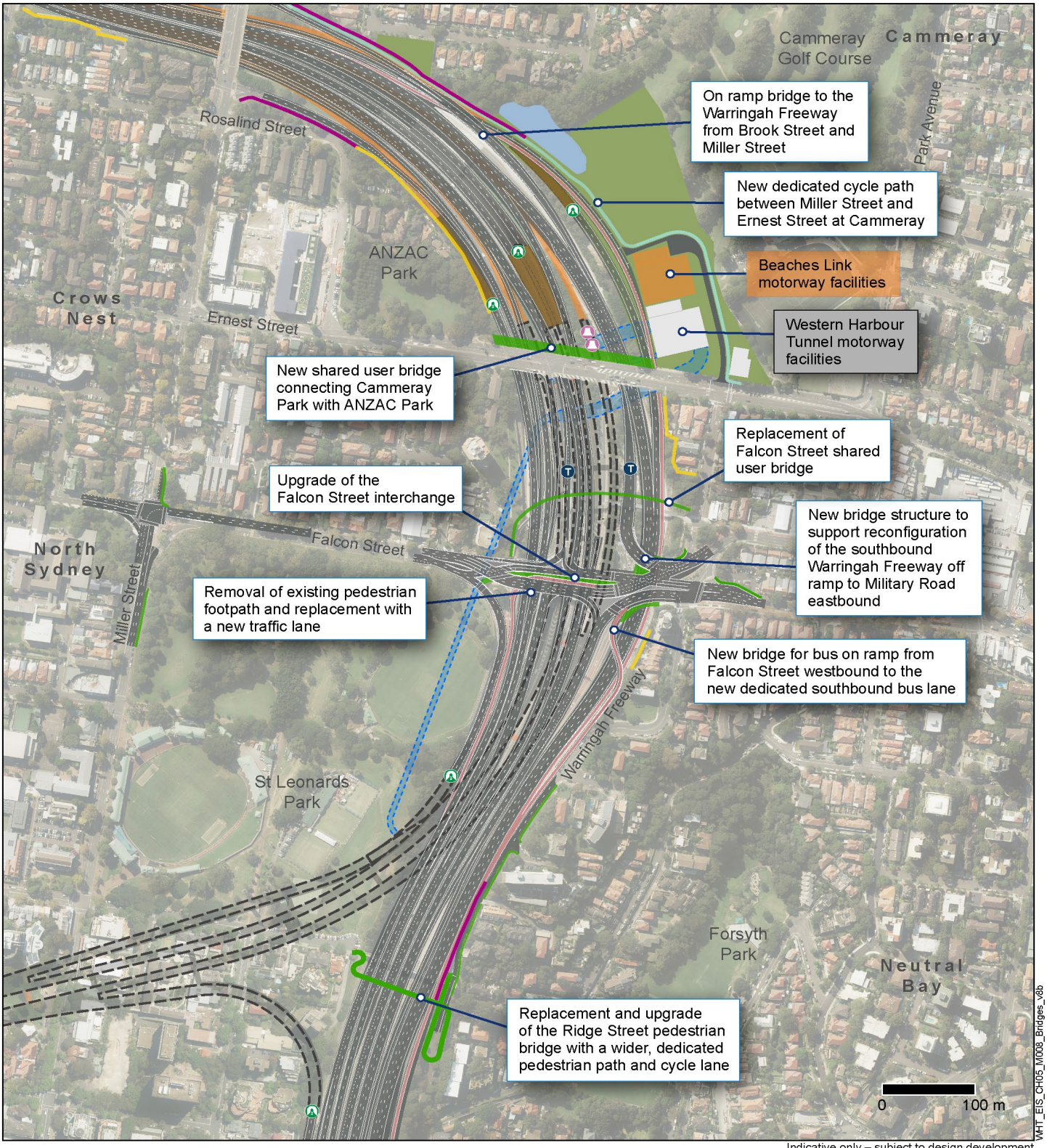


Figure 5-28 New, modified and relocated road bridges of the Warringah Freeway Upgrade component (map 1)



Legend

Tunnels
- Western Harbour Tunnel Driven tunnel
- Ventilation tunnel
- Cut and cover
- Surface connection

Surface features
- Surface road
- Bus lane
- Cycleway
- Pedestrian / shared user path

Operational infrastructure
- Provision for tolling gantries
- Ventilation outlet
- Indicative new noise barrier
- Operational facilities and ancillary infrastructure
- Indicative location for stormwater harvesting dam

Connecting projects
- Beaches Link and Gore Hill Freeway Connection project

Existing infrastructure
- Existing noise barrier

Figure 5-29 New, modified and relocated road bridges of the Warringah Freeway Upgrade component (map 2)

Upgrades to the surrounding road network

In response to changes in the distribution of traffic as a consequence of the Western Harbour Tunnel and Beaches Link program of works, minor upgrades and changes to parts of the road network around the Warringah Freeway would be carried out. The works would affect local and arterial roads in North Sydney and Cammeray as summarised in Table 5-12 and shown in Figure 5-30 to Figure 5-32.

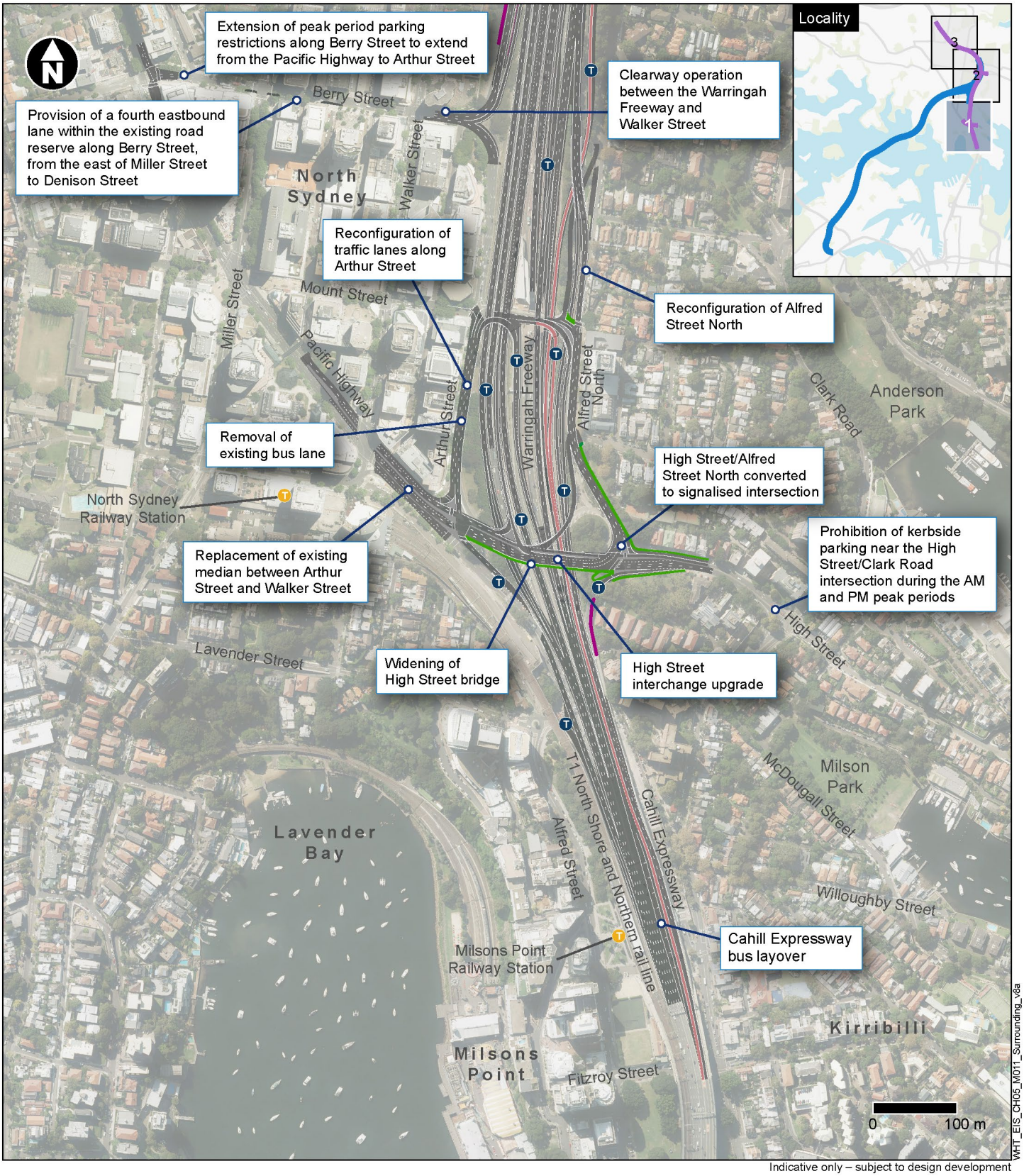
Table 5-12 Upgrades and changes to the surrounding road network of the Warringah Freeway Upgrade component

Upgrades and changes	Summary
High Street, North Sydney	
Interchange upgrade	The High Street interchange would be upgraded and reconfigured as detailed earlier in this section.
Intersection works	The intersection of High Street and Alfred Street North (west of the Warringah Freeway) would be converted to a signalised intersection.
Parking	Existing kerbside parking on High Street from near the intersection of Clark Road and High Street, North Sydney, would be prohibited during AM and PM peak periods.
Clark Road, North Sydney	
Parking	Existing kerbside parking along Clark Road on approach to the intersection with High Street, North Sydney, would be prohibited during AM and PM peak periods.
Alfred Street North, North Sydney/Neutral Bay	
Capacity and configuration	Capacity and configuration works would be carried out along Alfred Street North, including: • Realignment of the existing alignment further east from the existing Ridge Street shared user bridge to the intersection of Wyagdon Street, Neutral Bay • New Alfred Street North overpass bridge over the new dedicated southbound bus lane to remove weaving between buses and general traffic • Realignment, upgrade and widening to provide: – Two off ramp traffic lanes from the Warringah Freeway around Darley Street to around Mount Street – One lane to the Cahill Expressway from around Darley Street and two lanes continuing on Alfred Street North to around Mount Street – Three lanes from around Mount Street to the High Street interchange.
Pacific Highway, North Sydney	
Capacity and configuration	Capacity and configuration works would be carried out along the Pacific Highway between High Street and around Denison Street, including: • Replacement and adjustment of the existing raised median between Arthur Street and Walker Street • Extension of the existing physical separation of High Street and Pacific

Upgrades and changes	Summary
	Highway travelling northbound. This would prevent northbound traffic from the Bradfield Highway being able to turn right into Walker Street northbound.
Intersection works	The following works would be carried out at the intersection of the Pacific Highway, Walker Street and Blue Street: • Median adjustment works to tie in with the works described between Walker Street and High Street • Existing turning movements would be maintained. The following works would be carried out at the intersection of Pacific Highway and Berry Street: • Conversion of the Pacific Highway southbound approach to two through lanes and one left turn lane into Berry Street • Conversion of the Pacific Highway northbound approach to two northbound through lanes and two dedicated right turn lanes into Berry Street. This is to allow for the changes in traffic distribution that would result from the changes to the Berry Street and Miller Street intersection outlined in the Berry Street section of this table.
Arthur Street, North Sydney	
Capacity and configuration	The lanes along Arthur Street from the intersection with the Pacific Highway and High Street to Mount Street would be reconfigured to include an additional northbound kerbside traffic lane (currently used as on-street parking). This would allow for three right turn lanes into Mount Street eastbound and one left turn lane into Mount Street westbound. The existing bus lane would be removed.
Berry Street, North Sydney	
Capacity and configuration	Capacity and configuration works would be carried out along Berry Street, including: • Provision of a fourth eastbound lane from the east of the Berry Street and Miller Street intersection to around west of Denison Street by removing the existing kerb build outs • Extension of the existing eastbound clearway during the AM and PM peak periods, to create a continuous clearway between the Pacific Highway and Arthur Street.
Intersection works	The following works would be carried out at the intersection of Berry Street and Miller Street: • Conversion of the existing pedestrian crossings to a scramble crossing, with a pedestrian only phase. This would allow pedestrians to access any leg of the intersection during the pedestrian only phase • The right turn from Miller Street northbound to Berry Street eastbound would be banned for general traffic. Buses would still be permitted to make the right turn.
Falcon Street, North Sydney/Cammeray	
Interchange upgrade	The Falcon Street interchange would be upgraded and reconfigured as detailed earlier in this section.

Upgrades and changes	Summary
Intersection works	The following works would be carried out at the intersection of Falcon Street and Miller Street: • For traffic travelling westbound on Falcon Street all existing movements would be maintained • For traffic travelling eastbound on Falcon Street, a new short lane would be provided on the eastern side of Miller Street for shared use by through traffic and for traffic to turn left into the northbound carriageway of Miller Street • For traffic travelling southbound on Miller Street, a new short left turn traffic lane would be provided to connect with the eastbound carriageway of Falcon Street • For traffic travelling northbound on Miller Street: – An existing shared traffic lane (through traffic and right turn traffic) would be converted to a second dedicated right turn traffic lane to connect with the eastbound carriageway of Falcon Street – Kerb and footpath adjustment works would be required for the left turn high-angle entry into Falcon Street westbound.
West Street, Crows Nest	
Parking	Parking restrictions would be implemented along the northbound and southbound carriageways of West Street on approach to the intersection with Falcon Street.
Ben Boyd Road, Neutral Bay	
Parking	Parking restrictions would be implemented along the northbound and southbound carriageways of Ben Boyd Road on approach to the intersection with Military Road.
Miller Street, North Sydney	
Capacity and configuration	Kerb and footpath adjustment works would occur on Miller Street southbound around the intersection with Falcon Street. These works would provide a new dedicated lane for left turning traffic from Falcon Street westbound to Miller Street southbound. Further review of the impacts in this area are currently being carried out and permanent impacts to St Leonards Park would be minimised or, where possible, eliminated.
Parking	Parking restrictions would be implemented along the northbound carriageway of Miller Street, between the Pacific Highway and Berry Street.
Miller Street, Cammeray	
Intersection works	• Extension of the right turn bay at the intersection of Miller Street and Amherst Street for northbound traffic on Miller Street to connect to the eastbound carriageway of Amherst Street • Signalisation of the intersection of Miller Street and the on ramp to the southbound carriageway of the Warringah Freeway.

Upgrades and changes	Summary
Amherst Street, Cammeray	
Intersection works	Right turn movements from Amherst Street westbound into Miller Street northbound, and from Amherst Street eastbound into Miller Street southbound, would be prohibited during AM and PM peak periods.
Parking	The following changes to parking arrangements along Amherst Road would be made: • Extension of parking restrictions westbound from about 50 metres to about 100 metres westbound on Amherst Street, to around the intersection with Tarella Place • Extension of parking restrictions from about 60 metres to about 100 metres eastbound on Amherst Street to around the intersection with Ixion Lane.



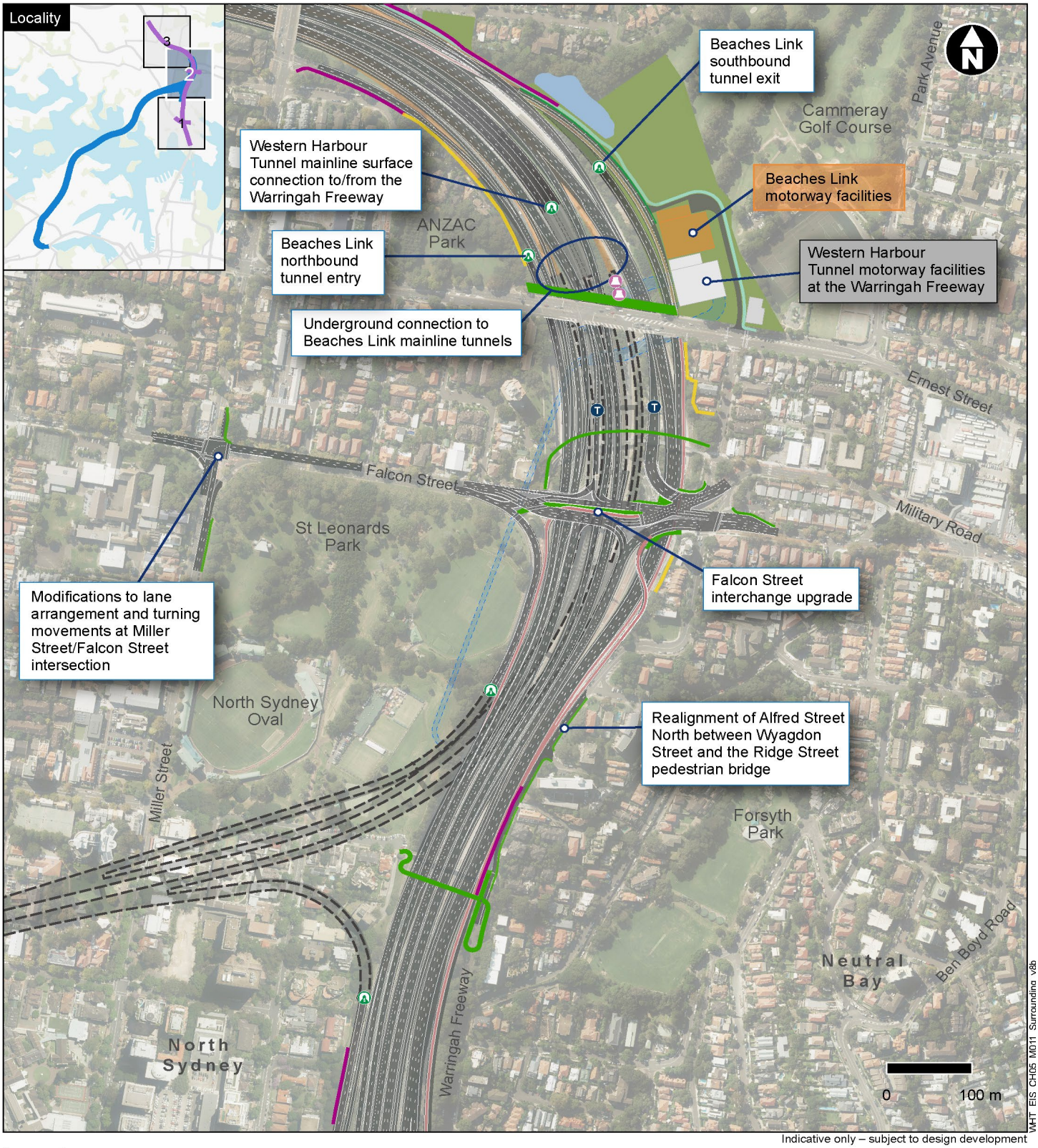
Legend

Surface features
- Surface road
- Bus lane
- Pedestrian / shared user path

Operational infrastructure
- Provision for tolling gantries
- Indicative new noise barrier

Existing infrastructure
- Train stations

Figure 5-30 Upgrades and changes to the surrounding road network of the Warringah Freeway Upgrade component (map 1)



Indicative only – subject to design development

Legend

Tunnels
- Western Harbour Tunnel Driven tunnel
- Ventilation tunnel
- Surface connection

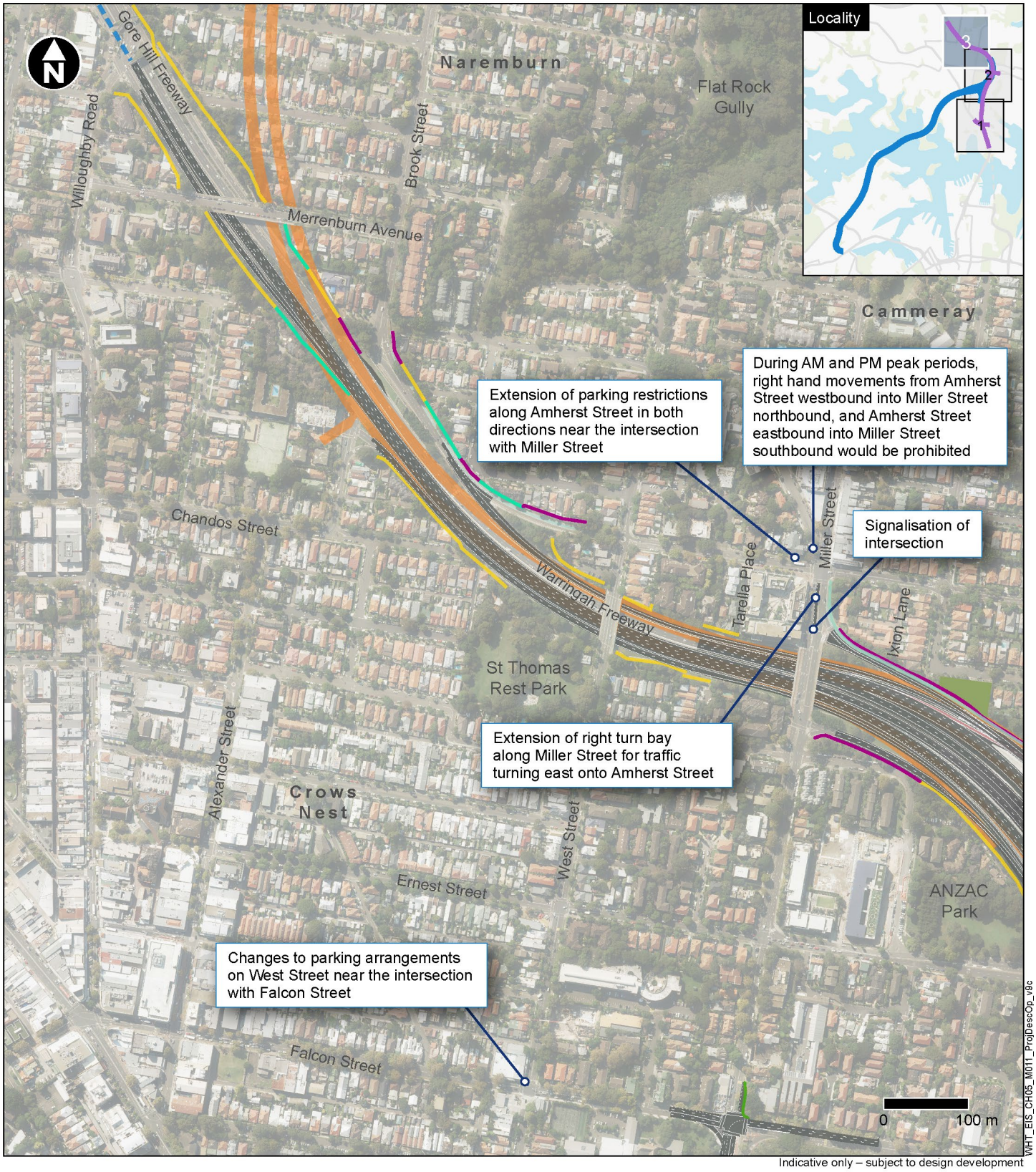
Surface features
- Surface road
- Bus lane
- Cycleway
- Pedestrian / shared user path

Operational infrastructure
- Provision for tolling gantries
- Ventilation outlet
- Indicative new noise barrier
- Operational facilities and ancillary infrastructure
- Indicative location for stormwater harvesting dam

Connecting projects
- Beaches Link and Gore Hill Freeway Connection project

Existing infrastructure
- Existing noise barrier

Figure 5-31 Upgrades and changes to the surrounding road network of the Warringah Freeway Upgrade component (map 2)



Indicative only – subject to design development

Legend

Surface features
- Surface road
- Cycleway

Operational infrastructure
- Indicative new noise barrier
- Indicative upgraded noise barrier
- Communications cable for motorway control centre

Existing infrastructure
- Existing noise barrier

Connecting projects
- Beaches Link and Gore Hill Freeway Connection project

Figure 5-32 Upgrades and changes to the surrounding road network of the Warringah Freeway Upgrade component (map 3)

Cut and cover and trough structures

The Warringah Freeway Upgrade component of the project would include the provision of trough and cut and cover structures within the road corridor at the Warringah Freeway, to provide surface connections between:

- The Western Harbour Tunnel component of the project and the Warringah Freeway Upgrade
- The Beaches Link and Gore Hill Freeway Connection project mainline tunnel (subject to separate assessment and approval) and the Warringah Freeway Upgrade.

The Warringah Freeway Upgrade component of the project would include piling and construction of the 'roof' and excavation of the abovementioned on and off ramp structures. As detailed in Section 5.2.4, the fitout of the Western Harbour Tunnel on and off ramps would form part of the Western Harbour Tunnel component of the project, and the excavation and fitout of the Beaches Link on and off ramps would form part of the Beaches Link component of the Beaches Link and Gore Hill Freeway Connection project, which is subject to separate assessment and approval.

Additional information about the construction and fitout works that would be carried out is provided in Chapter 6 (Construction work).

5.3.5 Operational ancillary infrastructure

Operational ancillary infrastructure forming part of the Warringah Freeway Upgrade component of the project would include:

- Lighting
- Vehicle bays
- Signage, CCTV and traffic management systems
- Tolling infrastructure.

Lighting

The Warringah Freeway Upgrade component of the project would be provided with lighting in line with the guidelines published by Austroads and Roads and Maritime as well as the relevant and applicable Australian Standards. Lighting would be designed and installed to ensure safety and security, and to minimise the potential for light spill and nuisance impacts.

Vehicle bays

The project would provide vehicle bays for incident response, breakdowns and/or maintenance where required and feasible. These would occur in both the mainline tunnels and at the surface, and would be consistent with the requirements in Australian Standards and guidelines published by Austroads and Roads and Maritime.

Signage, CCTV and traffic management systems

Traffic, locational, directional, warning and variable message signs would be installed along the Warringah Freeway Upgrade component. Signage would satisfy the requirements of applicable Australian Standards and guidelines published by Austroads and Roads and Maritime.

The project would include intelligent transport system technology and traffic control infrastructure including:

- Variable message signs
- Vehicle detection sites
- Lane use management systems

- Variable speed limit signs
- A CCTV system and automatic incident detection systems
- Ramp metering infrastructure
- Motorists emergency telephones
- Vehicle enforcement systems.

Tolling infrastructure

The project would include the installation of tolling gantries within Western Harbour Tunnel in both directions. The Warringah Freeway Upgrade would include the retention or upgrade of existing toll gantries for the Sydney Harbour Bridge, Sydney Harbour Tunnel, and Military Road E-ramps. Although no decision has yet been made, the provision for new toll gantries would also be included on northbound locations of the Sydney Harbour Bridge and Sydney Harbour Tunnel, should the Government elect to apply northbound tolls to these crossings. Tolling gantries would span one or more traffic lanes, depending on location. The tolling gantries would be installed with lighting and electronic tolling units. Provisions for tolling gantries along the Warringah Freeway are shown in Figure 5-30 and Figure 5-31 and would be located at:

- Lavender Street off ramp from the Sydney Harbour Bridge northbound
- Pacific Highway off ramp from the Sydney Harbour Bridge northbound
- North of the High Street Bridge for the northbound carriageway from the Sydney Harbour Bridge to Falcon Street and on to Gore Hill Freeway
- North of the High Street Bridge for the northbound carriageway from the Sydney Harbour Bridge to the Beaches Link and Lower North Shore and northbound Sydney Harbour Tunnel
- Military Road on ramp to the Warringah Freeway northbound (existing)
- High Street on ramp to Cahill Expressway
- North of High Street Bridge for southbound Cahill Expressway carriageway and Mount Street on ramp to Cahill Expressway southbound
- Mount Street bus lane on ramp to southbound mainline bus lane
- Near Berry Street for all southbound Bradfield Highway and Sydney Harbour Tunnel carriageways
- Near Berry Street for southbound bus lane carriageway
- Military Road off ramp from the Warringah Freeway southbound (existing).

5.3.6 Public and active transport infrastructure

Public and active transport infrastructure that would be provided as part of the Warringah Freeway Upgrade component of the project is shown in Figure 5-28 and Figure 5-29 and summarised in Table 5-13.

Table 5-13 Public and active transport infrastructure of the Warringah Freeway Upgrade component

Infrastructure	Summary
Public transport infrastructure	New and upgraded bus infrastructure would be provided as part of the Warringah Freeway Upgrade, including: • A new dedicated southbound bus lane from Miller Street, Cammeray, to the Sydney Harbour Bridge • Improved connectivity from the southbound bus lane to the Alfred Street North off ramp and on to High Street, providing new opportunities for buses to connect with the North Sydney CBD • A new underpass beneath Mount Street to remove the existing 400 metre weave between buses and general traffic before High Street • A new bus lane bridge connecting from Mount Street to the new dedicated southbound bus lane • A new bus lane bridge connecting from Falcon Street, Crows Nest, to the new dedicated southbound bus lane • Replacement of existing bus lanes at the Falcon Street interchange with the Warringah Freeway, as part of the interchange upgrade at this location • Relocation and replacement of the existing bus layover facilities from the current location to the north of Ernest Street, Cammeray, to: – Bus bays and an amenity block adjacent to the Cammeray Golf Course site, to the north of Ernest Street – Bus bays on the Warringah Freeway/Cahill Expressway, to the south of High Street, North Sydney.
Active transport infrastructure	The following pedestrian and cyclist infrastructure would be provided as part of the Warringah Freeway Upgrade: • A new shared user path along the southern side of the High Street bridge at North Sydney • Signalised pedestrian crossings at the intersection of High Street and Alfred Street North at North Sydney • Replacement and upgrade of the existing Ridge Street shared user bridge at North Sydney/Neutral Bay with a wider, dedicated pedestrian footpath and bicycle lanes • A new shared user bridge to the north of Ernest Street at Cammeray to connect the Cammeray Golf Course site with ANZAC Park • Upgraded pedestrian crossings at the Falcon Street on and off ramps, at North Sydney/Cammeray/Neutral Bay • Replacement of the Falcon Street shared user bridge • Removal of the existing pedestrian underpass beneath Falcon Street at Cammeray • Provision of a new pedestrian footpath along the median through the centre of the Falcon Street interchange upgrade • A new dedicated bicycle path along the eastern side of the Warringah Freeway between Miller Street at Cammeray and Ernest Street.

5.3.7 Utilities

The project would require the installation, relocation, adjustment and/or protection of utilities, particularly within and around surface connections and surface road works (refer to Section 5.3.3 and Section 5.3.4). The Utilities management strategy for the project (refer to Appendix D) provides a framework for utilities installation, relocations, adjustments and protection, including consultation with relevant utility providers.

5.3.8 Property acquisition

The project has been designed to minimise land acquisition and limit the severance of private properties. The Warringah Freeway Upgrade component of the project would require acquisition of 20 properties (16 private residential, one private commercial and three Government properties). A further one Government property would be temporarily leased during construction. Property impacts are discussed further in Chapter 20 (Land use and property).

The total area and number of properties that would be acquired for the project may change as the project continues to be refined, or in response to changes resulting from the exhibition of the environmental impact statement and conditions of approval that may be applied by the Minister for Planning and Public Spaces.

In some cases, whole lots would be acquired to avoid creating small unusable lots. Where a part of any lot is identified as being usable post construction and surplus to operational requirements, or requiring boundary adjustment following the completion of construction, Deposited Plans of subdivision would be lodged at NSW Land Registry Services.

5.3.9 Environmental controls

The project has been designed to avoid or minimise environmental impacts, as detailed in Chapter 4 (Project development and alternatives). Further, key physical environmental controls that would be provided as part of the Warringah Freeway Upgrade component of the project would include:

- Surface water drainage and management infrastructure
- Noise attenuation measures.

Environmental controls to be implemented as part of the Warringah Freeway Upgrade component of the project are summarised in Table 5-14. Environmental controls forming part of the Western Harbour Tunnel component of the project are listed in Section 5.2.11.

Table 5-14 Key environmental controls of the Warringah Freeway Upgrade component

Infrastructure	Summary
Environmental controls as part of the Warringah Freeway Upgrade	
Surface water drainage and management infrastructure	Key surface water drainage and management infrastructure that would be provided as part of the Warringah Freeway Upgrade would include: • A new drainage network around the Western Harbour Tunnel and the Beaches Link and Gore Hill Freeway Connection project on and off ramp portals within the Warringah Freeway road corridor to minimise the potential for ingress of water • New and upgraded longitudinal drainage infrastructure to convey runoff from the upgraded section of the Warringah Freeway and to maintain drainage performance generally consistent with existing arrangements • Installing a flow attenuation storage tank in the existing road reserve adjacent

Infrastructure	Summary
	to the High Street on ramp to the Warringah Freeway southbound, and connecting discharge drainage infrastructure with the stormwater drainage system near south of High Street • Replacement of the two existing box culverts which cross beneath the Warringah Freeway between ANZAC Park and the Cammeray Golf Course site, carrying the upstream flows of Willoughby Creek. The upgrade would include: – Installing new drainage pipelines, as well as lowering, realignment and regrading works to allow return flow to Willoughby Creek – Installing a drainage pipe beneath ANZAC Park, parallel to the existing drainage pipe from near the intersection of Ernest Street and Lytton Street, and connecting with the new drainage infrastructure beneath the Warringah Freeway – Upgrading the upstream drainage pit near Cammeray Avenue to provide additional capacity • Upgrade and capacity improvements to the drainage pipelines along the on and off ramps connecting the Warringah Freeway • A new, relocated storage dam within the Cammeray Golf Course would replace the existing storage dam which forms part of the North Sydney Council stormwater harvesting scheme. The new dam would have a stormwater harvesting yield comparable to the existing one. The operational stage of the project would not impact the operation and volume of water harvested for the North Sydney Council stormwater harvesting scheme. The new, storage dam is anticipated to be located directly north of the existing basin (the exact location of the dam would be determined in consultation with the Cammeray Golf club), and would not be constructed until the Beaches Link and Gore Hill Freeway Connection project construction support site at Cammeray Golf Course would no longer be in use. The indicative location of the storage dam is shown in Figure 5-4. • Reconstruction of the existing drainage infrastructure beneath Hampden Road, beneath Berry Street and beneath St Leonards Park.
Noise attenuation measures	Noise attenuation measures as part of the project at the Warringah Freeway upgrade component would include: • Eight new noise barriers with a maximum allowable height of between four and five metres • One new noise barrier, which would consist of a combination of existing and modified noise barriers. The final height, design and feasibility of the noise barriers would be confirmed during further design development. The final road pavement surface used for the project would be subject to various requirements besides acoustic benefits, including structural integrity, skid resistance, water dispersion, maintenance and design life. The final road pavement surface design and the use of low noise pavements to reduce noise at the source would be investigated during further design development of the project and would consider the specific engineering requirements and the overall social, economic and reasonable and feasible environmental outcomes. The project does not propose to remove existing noise barriers.

5.3.10 Landscape treatments

Landscape treatments for the project would be consistent with the Western Harbour Tunnel and Warringah Freeway Upgrade Urban Design Framework in Appendix V (Technical working paper: Urban design, landscape character and visual impact assessment). Landscape treatments would be designed and implemented with the aims of:

- Minimising the visual and landscape impacts of the project
- Integrating the project into the surrounding visual catchment
- Improving local and regional amenity
- Maximising the use of endemic species, including consideration of current and future climate conditions
- Providing opportunity for improvements in urban ecology.

Landscape treatments for the Warringah Freeway Upgrade component of the project would include:

- Provision of screen planting to replace vegetation removed during use of land as construction support sites
- Provision of street trees to adjoining local streets affected by the project, where space permits
- Use of native species, with consideration of longevity and ongoing maintenance requirements.

Landscape treatments for the Western Harbour Tunnel component of the project are outlined in Section 5.2.12.

Land used for construction but not required for operational infrastructure would be rehabilitated as outlined in Chapter 6 (Construction work).

The landscape design for the project would continue to be refined through further design development in line with the principles established in Appendix V (Technical working paper: Urban design, landscape character and visual impact).

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