NSW GOVERNMENT

Roads and Maritime Services

F6 Extension Stage 1

New M5 Motorway at Arncliffe to President Avenue at Kogarah

Environmental Impact Statement

Executive Summary
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Volume 1

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Certification

Submission of environmental impact statement

Prepared under Part 5, Division 5.2 of the *Environmental Planning and Assessment 1979 Act* (NSW).

Environmental impact statement prepared by:

Name:	Elizabeth Thornton
Qualifications:	Bachelor of Environmental Science (Hons I) Master of Environmental Law
Address:	AECOM, Level 21 420 George Street Sydney NSW 2000
Responsible person:	Camilla Drover Executive Director, Motorways Roads and Maritime Services Level 22, 101 Miller Street North Sydney NSW 2060

Address of the land to which the statement relates:

Land within the Bayside and Canterbury-Bankstown local government areas as described within the environmental impact statement.

Description of the infrastructure to which this statement relates:

Construction and operation of the F6 Extension Stage 1, which would comprise a new four kilometre, multi-lane underground road link between the New M5 Motorway at Arncliffe to President Avenue at Kogarah. The project would include an intersection at President Avenue and the widening and raising of President Avenue at this location.

Environmental impact statement:

An environmental impact statement is attached addressing all matters in accordance with Part 5, Division 5.2 of the *Environmental Planning and Assessment Act 1979* (NSW) and Schedule 2 of the *Environmental Planning and Assessment Regulation 2000* (NSW).

Declaration:

I certify that this environmental impact statement has been prepared in accordance with the Secretary's Environmental Assessment Requirements as issued on 23 January 2018. The environmental impact statement contains all available information that is relevant to the environmental assessment of the infrastructure to which the statement relates. To the best of my knowledge, the information contained in the environmental impact statement is neither false nor misleading.

Signature:

Name: Elizabeth Thornton

Date: 26 October 2018

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Executive Summary

The NSW Government is investing $51.2 billion on transport projects across NSW over the next four years. The F6 Extension is one of the NSW Government's transport priority projects to improve efficiency of traffic flows between the Sutherland and Illawarra region, Sydney Airport and Port Botany precinct, with onward connectivity to the north and west of Sydney.

NSW Roads and Maritime Services (Roads and Maritime) is seeking approval to construct and operate the F6 Extension Stage 1 from the New M5 Motorway at Arncliffe to President Avenue at Kogarah (the project).

Bypassing up to 23 sets of traffic lights on the Princes Highway, the project would reduce congestion on surface roads by removing more than 2,000 heavy vehicles as well as about 10,000 vehicles from major thoroughfares each weekday. By reducing congestion along parallel routes, the project would lead to opportunities for improvements in urban amenity and place making within the project vicinity.

The project would make vital trips across Sydney faster and more reliable by reducing travel times and by connecting Sydney's south to the wider motorway network, providing direct access to WestConnex and through to the proposed Sydney Gateway and Western Harbour Tunnel. Further, the project would introduce new shared cycle and pedestrian pathways, that would expand the existing active transport network, improving pedestrian and cyclist safety.

The project would contribute to a more accessible, more liveable and more productive Greater Sydney as well as growth in Southern Sydney.

What is proposed?

The project would comprise a new four kilometre, multi-lane underground road link between the New M5 Motorway and a surface intersection at President Avenue, Kogarah (refer to Figure 1).

The project would be located within the Bayside Local Government Area, and partially within the Canterbury-Bankstown Local Government Area. It would be mainly located underground, with the majority of the motorway operational surface infrastructure located within the existing F6 reserved corridor. This would minimise the environmental and social impacts by reducing the total surface construction footprint.

Key features of the project

- Mainline tunnels around 2.5 kilometres in length, sized for three lanes of traffic and line marked for two on opening
- Connection to the New M5 Motorway and line marking of additional travel lanes between St Peters interchange to the F6 Extension Stage 1 tunnels
- Entry and exit ramp tunnels around 1.5 kilometres in length and a tunnel portal connecting the tunnels to a surface intersection with President Avenue
- Provision of a new intersection with President Avenue including the widening and raising of President Avenue at this location
- Upgrade of the President Avenue / Princes Highway intersection to improve capacity
- Provision of new shared cycle and pedestrian pathways connecting Bestic Street, Brighton-Le-Sands to Civic Avenue, Kogarah, including a bridge over President Avenue
- Three complexes to operate the motorway (one co-located with the New M5 Motorway operations complex at Arncliffe and two at Rockdale)
- Ventilation facilities would be located at Marsh Street, Arncliffe and West Botany Street, Rockdale and linked to the in-tunnel ventilation systems
- New service utilities, including a permanent power supply line.

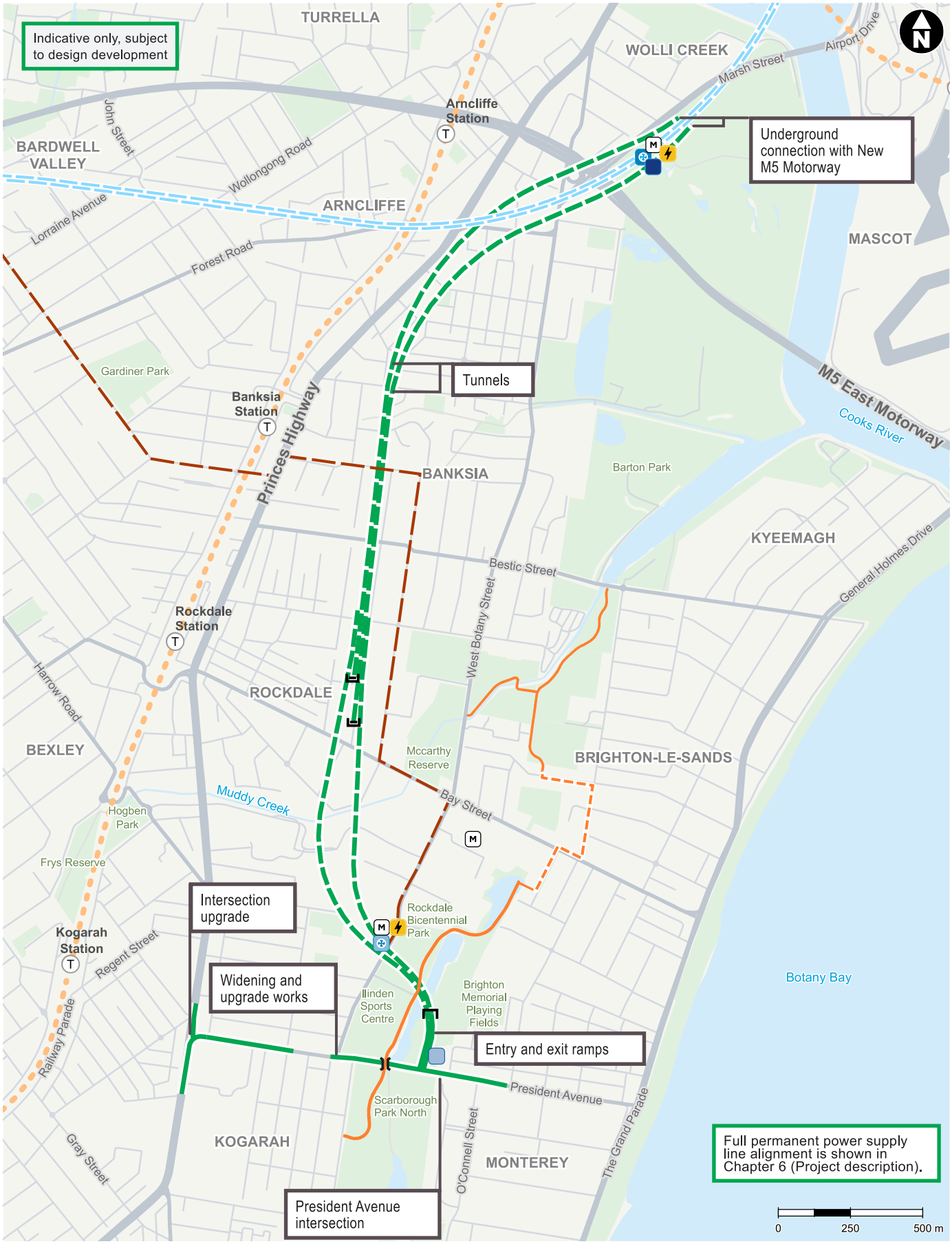

Figure 1 The project

The project would utilise the following six sites to support construction activities:

- Arncliffe construction ancillary facility (C1) at Kogarah Golf Course, which is currently being used for the New M5 Motorway construction
- Rockdale construction ancillary facility (C2), within an existing Roads and Maritime depot at West Botany Street
- President Avenue construction ancillary facility (C3) at Rockdale, north and south of President Avenue within Rockdale Bicentennial Park and part of Scarborough Park North, plus a smaller site west of West Botany Street
- Construction ancillary facilities (C4 and C5) at the recreation area between West Botany Street and Francis Avenue near Muddy Creek, to support construction of the shared cycle and pedestrian pathways
- Princes Highway construction ancillary facility (C6) on the corner of Princes Highway and President Avenue, Kogarah to support the intersection surface works.

What are the project objectives?

The objectives of the project are detailed in the figure below.

Why is it needed?

Road congestion across metropolitan Sydney is estimated to cost up to $6.1 billion per annum, rising to $12.6 billion by 2030 if there is no improvement. Travel by road is Sydney's dominant transport mode. Even with high growth in rail freight and public transport, road transport is predicted to remain the most dominant mode over at least the next 20 years. Traffic congestion hinders Sydney's road freight, services and business operations and reduces the reliability of, and accessibility to, public transport. It adversely affects pedestrians and cyclists, as well as noise and air quality.

Both the Princes Highway and The Grand Parade experience high levels of daily traffic including freight, commuter and leisure travel. Travel times are unacceptably long during peak hours, with The Grand Parade currently supporting over 67,000 vehicles each weekday. Through traffic affects pedestrian safety and local amenity, causing significant traffic delays.

There is no motorway between the M1 Princes Motorway south of Waterfall and the Sydney motorway network. This leaves the local roads to handle heavy traffic and at times major congestion.

The Sydney transport network currently services a population of some five million people with about 15.5 million trips on a normal weekday. The population of Greater Sydney is estimated to grow from around five to eight million over the next 40 years, with an additional 817,000 jobs. With this increase in population, there will be continued growth in traffic on Sydney's roads, with the number of trips made around Sydney each day forecast to increase by 31 per cent, from 16 million to 21 million by 2036. This growth will place increasing pressure on the transport network and the key travel demand corridors across the greater Sydney metropolitan area.

Population growth and increasing road freight in the Sydney metropolitan area will result in continued and increasing demand for roads that provide north-south and east-west connections. Without infrastructure investment, the continued demand and use of these corridors will result in additional, prolonged congestion.

How would the project satisfy this need?

The project would ease congestion on surface roads by providing an underground motorway alternative, allowing users to bypass up to 23 sets of traffic lights on the Princes Highway between St Peters and Kogarah. There would also be a reduction of about 10,000 vehicles per day on General Holmes Drive. This would enhance the use of surface roads by public transport and cyclists, and an overall improvement of local air quality and amenity. The project would not preclude any planned bus service or rail infrastructure improvements. The reduction in through traffic would also create opportunities for place-making at key locations along The Grand Parade and the Princes Highway.

The project would form the first stage of the F6 Extension, which would provide economic benefits by reducing travel times through southern Sydney and between Sydney and the Illawarra region.

What is the approval process for the project?

The project is State significant infrastructure and requires assessment and approval under Division 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). This Environmental Impact Statement has been prepared in accordance with the provisions of the EP&A Act and the Secretary's Environmental Assessment Requirements (SEARs). A full checklist of the SEARs is provided in **Appendix A** (Statutory requirements).

A request has been made to the Minister for Planning to specifically declare the project to be critical State significant infrastructure.

The Environmental Impact Statement is publicly exhibited to provide the community, government agencies and stakeholders with an understanding of what is proposed and an opportunity to make comment. Roads and Maritime will consider the feedback in the further development of the project. Roads and Maritime will then submit a report that documents the submissions and responds to issues raised to the Department of Planning and Environment. The Department will prepare an assessment report for the Minister for Planning who will then determine whether or not to grant project approval and specify any project conditions.

What alternatives were considered?

A multi-criteria analysis was undertaken to confirm the most appropriate section to commence construction of the F6 Extension (Arncliffe to Loftus). The multi-criteria assessment identified that Stage 1 (the project) would be the section between the New M5 Arncliffe to President Avenue at Kogarah. This section was selected as it would provide the greatest benefits to the community, including providing a direct connection to the Sydney motorway network.

The merits of the project were considered in the context of a range of alternatives based on transport, environmental, engineering, social and economic factors, taking the following project components into account:

- Use of the existing F6 reserved corridor
- Northern connection to the motorway network
- Alignment of the mainline tunnel
- Connection at the southern end to the arterial road network
- Any surface road works required
- Shared cycle and pedestrian pathway options.

The preferred design provides a combination of benefits compared with other options assessed, including better constructability, improved access, as well as minimised impacts on properties and on future development potential.

What are the main community participation outcomes?

Consultation on the project began in October 2017 following the NSW Government's decision to progress with the development of the project. This involved community engagement activities such as doorknocking and distributing fact sheets, in addition to engaging with local stakeholders and government agencies. A range of communication channels were established for the project, to seek input from stakeholders and communities and to support engagement. Key periods of consultation and feedback were:

- Preliminary consultation - October to December 2017
- Ongoing design development - December 2017 to June 2018
- Project information and design - June 2018 to August 2018

The feedback has informed environmental assessment activities and ongoing communications. Key concerns communicated during this period related to:

- Local traffic and increased congestion as a result of the project
- Ecological values and water quality of the Rockdale Wetlands and Rockdale Bicentennial Park
- Property and land use impacts, particularly the potential loss of homes and/or green space
- Noise and pollution resulting from heavy vehicles and increased traffic
- Health and safety of the emissions from the ventilation outlets
- Local business changes in access and loss of parking.

What are the main beneficial outcomes expected?

These include:

- More direct access from southern Sydney to the wider Sydney motorway network
- Less stop-start travel, with more reliable and shorter travel times between southern Sydney and the CBD
- Reduction in general traffic on sections of General Holmes Drive of about 10,000 vehicles each weekday
- Reduction in heavy vehicles on sections of Princes Highway and West Botany Street of about 40 per cent each weekday and on sections of General Holmes Drive of more than 30 per cent each weekday
- Reduced traffic on surface roads, returning streets to local communities
- Tunnels designed for free-flow traffic at 80 kilometres per hour, leading to reduced vehicle emissions than with stop-start traffic due to congestion or traffic lights
- New shared cycle and pedestrian pathways, connecting Bestic Street, Brighton-le-Sands to Civic Avenue, Kogarah through the reinstated Rockdale Bicentennial Park
- A safe cycle and pedestrian connection across President Avenue
- An enhancement of public recreation facilities at Rockdale Bicentennial Park.

What are the main adverse outcomes?

The aim is to minimise or avoid any environmental or social impacts by locating the majority of the project underground and by having the majority of surface infrastructure within the existing F6 reserved corridor. However, there will still be some temporary and permanent impacts on the environment associated with the construction and operation of the project, within the total construction footprint of around 34 hectares (including a site currently used for construction of the New M5 Motorway and an existing Roads and Maritime depot site).

Construction impacts

- Exceedances of acceptable noise criteria during both day and night for the most affected sensitive receptors in the vicinity of some construction ancillary facilities during certain construction activities

- Potential adverse health impacts (e.g. stress, annoyance, sleep disturbance) as a result of traffic and access changes, noise, and visual impacts
- Potential increased congestion during the upgrade of the Princes Highway and President Avenue intersection, while noting that the additional construction traffic is expected to be relatively low compared to existing traffic
- Potential for occasional, temporary and minor dust impacts during construction
- Potential for offensive odours during excavation of the cut-and-cover tunnels due to the natural presence of acid sulfates in the soils
- Temporary loss of access to the facilities within Rockdale Bicentennial Park, including playing fields, skate park and playground
- Biodiversity affected by the project includes:
  - Removal of around 1.24 hectares of native vegetation including two threatened ecological communities listed under the *Biodiversity Conservation Act 2016*
  - Loss of around 4.45 hectares of potential foraging habitat for the Grey-headed Flying Fox, however, no roosting sites or camps occur within the study area
  - Indirect impacts on the Green and Golden Bell Frog related to light, noise, dust and vibration arising from the continued use of the construction site at Arncliffe for an additional four years.

Property impacts

- Permanent acquisition of five residential properties, six industrial properties, one service station, the partial acquisition of land from three residential properties and from the TAFE NSW St George Main Campus
- Permanent acquisition of around 1.9 hectares of open space within Kogarah Golf Course, Rockdale Bicentennial Park and Scarborough Park North (all owned by Bayside Council)

Traffic impacts

- Increased traffic along President Avenue, Kogarah, due to the forecast increase in demand to and from the project
- Increased traffic along O'Connell Street, due to the forecast increase in demand to and from the project
- Increased traffic on the New M5 Motorway entry and exit ramps to the St Peters interchange, due to the forecast demand to and from the project, however average speeds on the ramps are forecast to be at least 90 per cent of the posted speed limit during peak hours
- Changes to access arrangements for residents for residents of Moorefield Estate

Air quality impacts

- Under normal traffic conditions, the contribution of tunnel ventilation outlets to overall pollutant concentrations is expected to be minimal
- For ambient air quality, there are predicted to be mostly small exceedances of some air quality criteria, including one-hour NO_2 and 24-hour PM_{10}, both with and without the project. However, the total numbers of receptors with exceedances decreased slightly with the project and in the cumulative scenarios
- Assuming no further construction above 30 metres in the vicinity of the project ventilation outlets, the changes in annual mean $PM_{2.5}$ concentration at heights of up to 45 metres above ground level are acceptable (i.e. lower than at ground level, and below the human health risk based criterion for an increase in $PM_{2.5}$ of 1.8 $\mu g/m^3$).

Health impacts

- Potential adverse health impacts (annoyance, sleep disturbance) are predicted where there are noise exceedances of the operational road traffic noise criteria
- A small increase in air pollutant concentrations may occur in some areas located near existing surface roads in the vicinity of the project. Potential health impacts associated with changes in air quality, specifically nitrogen dioxide and particulates, are expected to be tolerable/acceptable within the local community as a result of surface traffic changes.

Noise impacts

- Exceedances of the operational road traffic noise criteria are expected for a total of 109 receptors (including residential and educational facilities). Affected receptors may therefore be eligible for consideration of at-property noise attenuation.

Impacts to open space

- Temporary loss of access to Rockdale Bicentennial Park during construction (for around four years), including playing fields, skate park and playground. Compensatory facilities would be installed prior to construction of the project, to be determined in consultation with Bayside Council
- Rockdale Bicentennial Park would be reinstated following construction with enhanced facilities in consultation with Bayside Council and other key stakeholders.

How will the likely impacts be managed?

The Environmental Impact Statement identifies comprehensive environmental management measures to avoid, manage, mitigate, offset and/or monitor impacts during construction and operation of the project.

These include best practice environmental planning and management techniques, urban design and landscaping treatments and noise mitigation measures. Key environmental planning and management mitigations outlined in this Environmental Impact Statement include:

- Preparation of a Construction Traffic and Access Management Plan to manage construction traffic
- A Construction Noise and Vibration Management Plan to manage construction noise and vibration, including out-of-hours work procedures
- Operational road noise mitigation measures that include at-property noise treatments identified through an Operational Noise and Vibration Review
- Preparation of a Construction Air Quality Management Plan to manage construction air quality impacts
- The in-tunnel ventilation system would be designed to maintain in-tunnel air quality well within operational limits, and a monitoring system will be included to monitor and assess both ambient and in-tunnel air quality against relevant criteria
- A Biodiversity Offset Strategy will be prepared and implemented to compensate for losses to biodiversity values in the form of 26 offset credits to achieve a net gain in biodiversity values
- Property acquisition consistent with the requirements of the *Land Acquisition (Just Terms Compensation) Act 1991*
- Ongoing consultation with affected community members in accordance with the Draft Community Consultation Framework
- Urban design and landscaping treatments in accordance with the Place Making and Urban Design Strategy
- A review of operational network performance will be undertaken at both 12 months and five years from commencement of operation to confirm operational traffic impacts. The review would identify relevant mitigation measures, if required, to address impacts on road network performance.

Further mitigation requirements are likely to be identified during detailed design and construction planning and in consultation with communities and relevant stakeholders.

The design, construction and operation of the project would be carried out in accordance with the management measures identified in this Environmental Impact Statement, as well as any additional measures identified in the project's conditions of approval.

How can I comment on the environmental impact statement?

The NSW Department of Planning and Environment (DPE) will place the Environmental Impact Statement on public exhibition. During the exhibition period, the Environmental Impact Statement will be available for inspection electronically:

- on the DPE website (http://majorprojects.planning.nsw.gov.au/)
- at a NSW Service Centre located near you (www.service.nsw.gov.au/servicecentre/service-nsw)
- on the Roads and Maritime Services project website (http://www.rms.nsw.gov.au/f6).

It will also be available at selected Roads and Maritime offices, at various staffed displays in the region, and at selected local council offices and libraries in the Bayside and Canterbury-Bankstown local government areas.

Roads and Maritime will conduct a number of community information sessions. A project information line will be available throughout the exhibition period to answer questions from the community relating to the project at 1800 789 297 (toll free).

Advertisements will be placed in newspapers to advise of the public exhibition, to advise where the Environmental Impact Statement can be viewed, and to provide details of community consultation activities and information sessions.

During the exhibition period, government agencies, project stakeholders and the community will be able to make written submissions to DPE for consideration in its assessment of the project. Submissions can be made electronically through the DPE website (http://www.majorprojects.planning.nsw.gov.au). Written submissions may also be directed to:

Director Transport Assessments

Planning Services Division

Department of Planning and Environment

Application number - SSI 8931

GPO Box 39

Sydney NSW 2001

Submissions must be received before the close of the exhibition period. All submissions received will be placed on the DPE website.

Glossary of terms and abbreviations

Terms	Meaning
ADT	Average Daily Traffic. The total volume of traffic (24 hours) passing a roadside observation point over a seven-day period during a set number of weeks; divided by the total number of days. It is calculated from mechanically obtained axle counts.
AAQ	Ambient air quality
AAQ NEPM	*National Environment Protection (Ambient Air Quality) Measure*
ABL	Assessment background noise level
Aboriginal archaeological site	The present spatial extent of visible Aboriginal archaeological material(s) at a given location
Aboriginal cultural heritage	The tangible (objects) and intangible (dreaming stories, song lines and places) cultural practices and traditions associated with past and present day Aboriginal communities
Aboriginal object	Any deposit, object or material evidence (not being a handicraft made for sale), including Aboriginal remains, relating to the Aboriginal habitation of NSW
Aboriginal place	Any place declared to be an Aboriginal place under section 94 of the *National Parks and Wildlife Act 1974* (NSW)
ABS	Australian Bureau of Statistics
Absorption	The process of taking in. For a person or an animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs
Acid sulfate soils	Naturally occurring soils, sediments or organic substrates (eg peat) that are formed under waterlogged conditions. These soils contain iron sulfide minerals (predominantly as the mineral pyrite) or their oxidation products. In an undisturbed state below the water table, acid sulfate soils are benign. However if the soils are drained, excavated or exposed to air by a lowering of the water table, the sulfides react with oxygen to form sulfuric acid
ACM	Asbestos containing material
ACTAQ	NSW Government Advisory Committee on Tunnel Air Quality
AHD	Australian height datum
ADT	Average Daily Traffic. The total volume of traffic (24 hours) passing a roadside observation point over a seven-day period during a set number of weeks; divided by the total number of days. It is calculated from mechanically obtained axle counts
Adverse health effect	A change in body function or cell structure that might lead to disease or health problems
Aeolian	Clays, silts and sands that have been deposited by wind.
AEP	Annual Exceedance Probability
AHD	Australian Height Datum. The standard reference level used to express the relative elevation of various features. A height in metres AHD is essentially the height above sea level.
AHIMS	Aboriginal Heritage Information Management System - A register of NSW Aboriginal heritage information maintained by the NSW Office of Environment and Heritage A register of NSW Aboriginal heritage information maintained by the NSW Office of Environment and Heritage
Airshed	A part of the atmosphere that shares a common flow of air and is exposed to similar meteorological influences.

Terms	Meaning
Alignment	The geometric layout (eg of a road) in plan (horizontal) and elevation (vertical)
Alluvium	Sediments (clays, sands, gravels and other materials) deposited by flowing water. Deposits can be made by streams on river beds, floodplains and alluvial fans.
ALS	Airborne Laser Scanning.
AM peak hour	Unless otherwise stated, this refers to vehicle trips arriving at their destination during the average peak one hour in the AM peak period between 7.00 am–9.00 am on a normal working weekday
Amenity	'The pleasantness of a place as conveyed by desirable attributes including visual, noise, odour etc.' (AILA 2018)
ANZECC	Australian and New Zealand Environment and Conservation Council
AQIA	Air quality impact assessment
Aquifer	Geologic formation, group of formations, or part of a formation capable of transmitting and yielding quantities of water.
Archaeological potential	The likelihood of undetected surface and/or subsurface archaeological materials existing at a location
ARI	Average Recurrence Interval - Average recurrence interval An indicator used to describe the frequency of floods. The average period in years between the occurrence of a flood of a particular magnitude or greater. In a long period of say 1,000 years, a flood equivalent to or greater than a 100 year ARI event would occur 10 times. The 100 year ARI flood has a one per cent chance (ie a onein-100 chance) of occurrence in any one year. Floods generated by runoff from the study catchments is referred to in terms of their ARI, for example the 100 year ARI flood
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
Artefact	Any object which has been physically modified by humans
AS	Australian Standard
ASC NEPM	*National Environment Protection (Assessment of site Contamination) Measure 2013*
ASS	Acid sulfate soil
Assessment background level [ABL]	The overall background level for each day, evening and night period for each day of the noise monitoring.
ASSMAC	Acid Sulfate Soils Management Advisory Committee
At-grade	A road at ground level, not on an embankment or in a cutting
ATSDR	Agency for Toxic Substances and Disease Register
AWT	Average Weekday Traffic. The total volume of traffic (24 hours) passing a roadside observation point over a five-day weekday period during a set number of weeks (outside of school/public holidays); divided by the total number of days. It is generally calculated from axle counts of passing vehicles
Background noise level	The ambient sound-pressure noise level in the absence of the sound under investigation exceeded for 90 per cent of the measurement period. Normally equated to the average minimum A-weighted sound pressure level
BAM	Biodiversity Assessment Method
BAMC	Biodiversity Assessment Method Credit Calculator
Bank cubic metres	A measure of volume representing a cubic metre of unexcavated material. Once material is excavated, it expands to varying degrees depending on its constituents
BaP	Benzo(a)pyrene

Terms	Meaning
BBWQIP	*Botany Bay and Catchment Water Quality Improvement Plan*
BC Act	*Biodiversity Conservation Act 2016*
BDAR	Biodiversity Development Assessment Report
Biodiversity credit report	The report produced by the Biodiversity Credit Calculator that sets out the number and class of biodiversity credits required to offset the remaining adverse impacts on biodiversity values at a development site, or on land to be biodiversity certified, or that sets out the number and class of biodiversity credits that are created at a biodiversity stewardship site (OEH 2017).
Biodiversity credits	Ecosystem credits or species credits
Biodiversity offsets	Management actions that are undertaken to achieve a gain in biodiversity values on areas of land in order to compensate for losses to biodiversity values from the impacts of development (OEH 2017).
BL	Beaches Link
Blasting	Rock blasting is the controlled use of explosives and other methods such as gas pressure blasting pyrotechnics or plasma processes, to excavate, break down or remove rock
BoM	Australian Bureau of Meteorology
Bore	A cylindrical drill hole sunk into the ground from which water is pumped for use or monitoring.
Borehole	A hole produced in the ground by drilling for the investigation and assessment of soil and rock profiles.
Box culvert	A culvert of rectangular cross section.
BTEX	Benzene, toluene, ethylbenzene, xylenes
BTEXN	Benzene, toluene, ethylbenzene, xylenes, naphthalene
BTX	Benzene, toluene and total xylenes
Bund	A small embankment designed to retain water
Bus lane	A traffic lane dedicated to buses, but which can also be used by taxis, bicycles and motorcycles
Capacity	The nominal maximum number of vehicles which has a reasonable expectation of passing over a given section of a lane or roadway in one direction during a given time period under prevailing roadway conditions
Carcinogen	A substance that causes cancer
Carriageway	The portion of a roadway used by vehicles including shoulders and ancillary lanes
CASA	Civil Aviation Safety Authority
Catchment	The land area draining through the main stream, as well as tributary streams, to a particular site. It always relates to an area above a specific location
CBD	Central Business District
CCME	Canadian Council of Ministers of the Environment
CCTV	Closed-circuit television
CEMP	Construction Environmental Management Plan
CGS	Characteristic gas situation
Chronic exposure	Contact with a substance or stressor that occurs over a long time (more than one year) [compare with acute exposure and intermediate duration exposure].
Clearing	The removal of vegetation or other obstacles at or above ground level.

Terms	Meaning
Climate change	A change in the state of the climate that can be identified (for example by statistical tests) by changes in the mean and/or variability of its properties, and that persists for an extended period of time, typically decades or longer (IPCC 2007)
Climate projection	A climate projection is the simulated response of the climate system to a scenario of future emission or concentration of greenhouse gases and aerosols, generally derived using climate models. Climate projections are distinguished from climate predictions by their dependence on the emission/concentration/radiative forcing scenario used, which in turn is based on assumptions concerning, for example, future socio-economic and technological developments that may or may not be realised (IPCC 2007)
CLM Act	*Contaminated Land Management Act 1997* (NSW)
CNVG	*Construction Noise and Vibration Guideline*
CNVMP	Construction Noise and Vibration Management Plan
CO	Carbon monoxide
CO_2	carbon dioxide
Concept design	Initial functional layout of a road/road system or other infrastructure. Used to facilitate understanding of a project, establish feasibility and provide basis for estimating and to determine further investigations needed for detailed design
Construction	Includes all physical work required to construct the project
Construction ancillary facilities	Temporary facilities during construction that include, but are not limited to construction sites (civil and tunnel), sediment basins, temporary water treatment plants, precast yards and material stockpiles, laydown areas, workforce parking, maintenance workshops and offices
Construction boundary	The area required for project construction is referred to as the 'construction boundary'.
Construction fatigue	Impact on receivers in the vicinity of concurrent and/or consecutive construction activities
Construction footprint	The land above and below the ground that is required to construct the project.
COPD	Chronic Obstructive Pulmonary Disease
Corridor	A substantial segment of the transport network, in which parallel, possibly competing, transport routes (and modes, where appropriate) operate between two locations
CoRTN	Calculation of Road Traffic Noise
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSM	Conceptual site model
CSWMP	Construction Soil and Water Management Plan
CTAMP	Construction Traffic and Access Management Plan
Cul-de-sac	A street or road that is open for vehicular traffic at one end only
Culvert	A structure that allows water to flow under a road
Cumulative impact	The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Refer to the project SEARs for cumulative impact assessment requirements.
Cut-and-cover	A method of tunnel construction whereby the structure is built in an open excavation and subsequently covered
dB	Decibel - sound level measurement

Terms	Meaning
dB(A)	Decibels (A-weighted)
DCP	Development control plan
DEC	Department of Environment and Conservation
DECC	NSW Department of Environment and Climate Change
DECCW	NSW Department of Environment, Climarte Change and Water
Design speed	A nominal speed which determines the geometric design features of a road
DET	Department of Education and Training
Detailed design	The phase of the project following concept design where the design is refined, and plans, specifications and estimates are produced, suitable for construction
Detection limit	The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.
Detour	An alternative route, using existing roads, made available to traffic
DG	Dangerous Goods
DIRDC	Department of Infrastructure, Regional Development and Cities
Discharge	A release of water from a particular source. The volume of water flowing in a stream or through an aquifer past a specific point over a given period of time.
DIWA	Directory of Important Wetlands of Australia
DLWC	Department of Land and Water Conservation
DM 2026	Operation 'do minimum' (DM 2026)
DM 2036	Operation 'do minimum' (DM 2036)
DoEE	Commonwealth Department of Environment and Energy
DP&E	NSW Department of Planning and Environment
DPI	NSW Department of Primary Industries
DPI-Fisheries	NSW Department of Primary Industries – Fisheries. State agency responsible for managing fisheries.
DPI-Water	NSW Department of Primary Industries – Water.
Drainage	Natural of artificial means for the interception and removal of surface or subsurface water.
Drawdown	A lowering of the water table in an unconfined aquifer or the potentiometric surface of a confined aquifer caused by the groundwater inflow to tunnels or pumping of groundwater from wells.
Driven tunnel	Mechanical excavation of a tunnel through rock by a road header or tunnel boring machine, driven along the tunnel alignment from the tunnel entrance.
DS 2026	Operation 'do something' (DS 2026)
DSC 2036	Operation 'cumulative' (DSC 2036)
DUAP	Department of Urban Affairs and Planning
DWE	NSW Department of Water and Energy
Dyke	A vertical or sub-vertical geological structure composed of igneous rock that typically cross cuts the host rock. The dyke is formed as magma from a larger igneous body intrudes the host rock typically along structural weaknesses.
Earthworks	All operations involving the loosening, excavating, placing, shaping and compacting of soil or rock.
EB	Eastbound
Ecology	The study of the relationship between living things and the environment.

Terms	Meaning
Ecosystem credit species	A measurement of the value of threatened species habitat for species that can be reliably predicted to occur with a plant community type (PCT)
ED	Emergency department
EHC Act	*Environmentally Hazardous Chemicals Act 1985* (NSW)
EIA	Effective impervious area
EIS	Environmental impact assessment
ELA	Eco Logical Australia Pty Ltd
Embankment	An earthen structure where the road (or other infrastructure) is located above the natural surface.
Emergency management	A range of measures to manage risks to communities and the environment. In the flood context it may include measures to prevent, prepare for, respond to and recover from flooding.
Emission	The discharge of a substance into the environment.
Emission factor (EF)	A quantity which expresses the mass of a pollutant emitted per unit of activity. For road transport, the unit of activity is usually either distance (i.e. g/km) or fuel consumed (i.e. g/litre).
Emission rate	A quantity which expresses the mass of a pollutant emitted per unit of time (e.g. g/second)
EMS	Environmental management system. A quality system that enables an organisation to identify, monitor and control its environmental aspects. An EMS is part of an overall management system, which includes organisational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the environmental policy.
Enabling works	Works which are required to enable the commencement of the main construction works
ENMM	Environmental Noise Management Manual
Entry ramp	A ramp by which one enters a limited-access highway/tunnel
Environment	Includes all aspects of the surroundings of humans, whether affecting any human as an individual or in his or her social groupings (from EP&A Act)
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999*
EPHC	Environment Protection Heritage Council
EPL	Environment protection licence
ERP	Environmental Risk and Planning
ESA	Environmental site assessment
ESCP	Erosion and Sediment Control Plan
Evening	Construction noise:
Exit blocking	Queuing traffic from a downstream link or intersection that blocks traffic from being able to travel through and exit an intersection
Exit ramp	A ramp by which one exits a limited-access highway/tunnel
Exposure	Contact with a substance by swallowing, breathing, or touching the skin or eyes. Also includes contact with a stressor such as noise or vibration. Exposure may be short term [acute exposure], of intermediate duration, or long term [chronic exposure].

Terms	Meaning
Exposure assessment	The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.
Exposure pathway	The route a substance takes from its source (where it began) to its endpoint (where it ends), and how people can come into contact with (or get exposed) to it. An exposure pathway has five parts: a source of contamination (such as chemical leakage into the subsurface); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.
F6 Extension (previously referred to as SouthLink)	A proposed motorway link between the New M5 at Arncliffe and the existing M1 Princes Highway at Loftus, generally along the alignment known as the F6 corridor. The project is being delivered by NSW Roads and Maritime Services and would be subject to separate assessment and planning approval
FD	Finite difference
Feasible and reasonable	Consideration of standard or good practice taking into account the benefit of proposed measures and their technological and associated operational application in the NSW and Australian context. 'Feasible' relates to engineering considerations and what is practical to build. 'Reasonable' relates to the application of judgement in arriving at a decision, taking into account mitigation benefits and cost of mitigation versus benefits provided, community expectations and nature and extent of potential improvements
Fill	The material place in an embankment.
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.
Flood immunity	Relates to the level at which a particular structure would be clear of a certain flood event.
Flood prone land	Land susceptible to flooding by the Probable Maximum Flood. Note that the flood prone land is synonymous with flood liable land.
Flood storage area	Those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. The extent and behaviour of flood storage areas may change with flood severity, and loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation. Hence, it is necessary to investigate a range of flood sizes before defining flood storage areas.
Floodplain	Area of land which is subject to inundation by floods up to and including the probable maximum flood event (i.e. flood prone land).
Floodplain Risk Management Plan	A management plan developed in accordance with the principles and guidelines in the NSW Floodplain Development Manual (FDM), (DIPNR 2005). Usually includes both written and diagrammatic information describing how particular areas of flood prone land are to be used and managed to achieve defined objectives.
Floodway area	Those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels.
FM Act	*Fisheries Management Act 1994* (NSW)
FMS	Flood Management Strategy
Footpath	The paved area in a footway

Terms	Meaning
Footway	An area open to the public designated for the movement of pedestrians or has one of its main uses for pedestrians
Fractured Rock Aquifer	Occur in sedimentary, igneous and metamorphosed rocks that have been subjected to disturbance, deformation or weathering, which allow water to move through joints, bedding planes and faults. Although fractured rock aquifers are found over a wide area, they generally contain much less groundwater than alluvial and porous sedimentary aquifers.
Freeboard	A factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc. It is usually expressed as the difference in height between the adopted Flood Planning Level and the peak height of the flood used to determine the flood planning level. Freeboard provides a factor of safety to compensate for uncertainties in the estimation of flood levels across the floodplain, such as wave action, localised hydraulic behaviour and impacts that are specific event related, such as levee and embankment settlement, and other effects such as future climate change. Freeboard is included in the FPL.
Freeways	Fast, high volume, access controlled roads that primarily link regional hubs and cities usually with grade separated intersections and without traffic lights
Gateway to the South	An accelerated pinch points program, the Gateway to the South Pinch Points Program aims to ease congestion and improve journey reliability on Sydney's key southern corridors. The NSW Government has committed $300 million to address critical pinch points along the A1, A3 and A6 routes south of the M5 Motorway
GDEs	Groundwater dependent ecosystems. Refers to communities of plants, animals and other organisms whose extent and life process are dependent on groundwater, such as wetlands and vegetation on coastal sand dunes.
Genotoxic carcinogen	These are carcinogens that have the potential to result in genetic (DNA) damage (gene mutation, gene amplification, chromosomal rearrangement). Where this occurs, the damage may be sufficient to result in the initiation of cancer at some time during a lifetime.
GHG	greenhouse gas
GIL	Groundwater investigation level
Glare	'The uncomfortable brightness of a light source when viewed against a darker background.' (ILE 2011)
GMP	Groundwater monitoring plan
GPS	Global Positioning System
GPT	Gross pollutant trap
Grade separation	The separation of road, rail or other transport modes, so that crossing movements at intersections are at different levels
GRAL	Dispersion modelling system
GRAMM	Meteorological modelling system
Groundwater	Water located within an aquifer or aquitard that is held in the rocks and soil in interconnected pores or fractures located beneath the water table.
GSP	NSW State Gross Product
GWh	Gigawatt hours
Ha	Hectares
HCV	Heavy commercial vehicle
HDD	Horizontal Directional Drilling
Heavy vehicles	A heavy vehicle is classified as a Class 3 vehicle (a two axle truck) or larger, in accordance with the Austroads Vehicle Classification System

Terms	Meaning
HI	Hazard Index
HSL	Health screening level
Hydraulics	The term given to the study of water flow in waterways, in particular the evaluation of flow parameters such as water level and velocity.
Hydrogeology	The study of subsurface water in its geological context.
Hydrograph	A graph which shows how the discharge or stage/flood level at any particular location varies with time during a flood.
Hydrology	The study of rainfall and surface water runoff processes.
IAQM	Institute of Air Quality Management
IARC	International Agency for Research on Cancer
IBRA	Interim Biogeographic Regionalisation for Australia
ICNG	*Interim Construction Noise Guideline*
Impact	Influence or effect exerted by a project or other activity on the natural, built and community environment
Indirect impact	An impact on biodiversity values that occurs when development related activities affect threatened species, threatened species habitat, or ecological communities in a manner other than direct impact. Compared to direct impacts, indirect impacts often:
Inhalation	The act of breathing. A hazardous substance can enter the body this way [see route of exposure].
Interchange	An intersection of two or more roads that typically uses grade separation, and one or more ramps, to permit traffic on at least one carriageway to pass through the junction without directly crossing any other traffic stream
IPCC	Intergovernmental Panel on Climate Change
IS	Infrastructure Sustainability
ISCA	Infrastructure Sustainability Council of Australia
Junction	A place where two or more roads meet
km/h	Kilometres per hour
K_v	Vertical hydraulic conductivity
L_{A1}	A-weighted sound level exceeded for 1% of the measurement period
L_{A90}	A-weighted sound level exceeded for 90% of the measurement period
L_{Aeq}	A-weighted equivalent sound level
LALC	Local Aboriginal Land Council
L_{Amax}	A-Weighted, maximum sound level
Landscape character zone	‘An area of landscape with similar properties or strongly defined spatial qualities, distinct from areas immediately nearby.’ (RMS 2018)
LATM	Local Area Traffic Management
LCV	Light Commercial Vehicle. Vehicles up to 4.5 tonnes Gross Vehicle Mass (GVM), including cars which have been registered for business use
LCZs	landscape character zones
LEP	Local Environmental Plan
LGA	Local Government Area
LiDAR	Light detection and ranging
LOAEL	lowest observed adverse effect level

Terms	Meaning
Local Drainage	Smaller scale drainage systems in urban areas. Commonly defined as areas where the depth of inundation along overland flow paths is less than 150 millimetres during a 1% AEP storm.
Local population	The population that occurs in the study area. In cases where multiple populations occur in the study area or a population occupies part of the study area, impacts on each subpopulation must be assessed separately (OEH 2017).
Local road	A road or street used primarily for access to abutting properties
LoS	Level of service
LTAAEL	Long Term Average Annual Extraction Limit as outlined in the water sharing plan
Lugeon	The lugeon (L) is a unit of measure to quantify hydraulic conductivity, generally used by geotechnical engineers in describing packer tests. 1L represents 1 x 10^{-7} m/sec (8.6 x 10^{-3} m/day in a homogeneous isotropic medium).
LUIP	Land Use and Infrastructure Plan
m	Metres.
m^2	Square metres.
m^3	Cubic metres.
M5 East Motorway	Part of the M5 Motorway corridor. Located between Beverly Hills and Sydney Airport (General Holmes Drive)
M5 motorway corridor	The M5 East Motorway and the M5 South West Motorway
Magnitude	Magnitude is the … *'measurement of the scale, form and character of a development proposal when compared to the existing condition. In the case of visual assessment this also relates to how far the proposal is from the viewe*r.' (RMS 2018)
MAH	Monocyclic aromatic hydrocarbons
Managed motorway	A managed motorway uses active traffic management to reduce congestion, improve reliability of travel times and inform travellers of real-time incidents and expected travel times to set destination along the motorway
Median	The central reservation which divides a carriageway for traffic travelling in opposite directions
Merit approach	The merit approach weighs social, economic, ecological and cultural impacts of land use options for different flood prone areas together with flood damage, hazard and behaviour implications, and environmental protection and well-being of the State's rivers and floodplains.
mg/m^3	micrograms per cubic metre
Mitigation measure	Any measure that facilitates the safe movement of wildlife and/or prevents wildlife mortality.
MLALC	Metropolitan Local Aboriginal Land Council
MNES	Matters of National Environmental Significance
MOC1	Arncliffe Motorway Operations Complex
MOC2	Rockdale Motorway Operations Complex (north)
MOC3	Rockdale Motorway Operations Complex (south)
Mode	A type or method of transport movement – including for the road corridor: cars, buses, bikes and pedestrians
Model area	Area covered by the groundwater model as shown on Figure 3-4.
Motorway	Fast, high volume controlled access roads. May be tolled or untolled
MUSIC	Model for Urban Stormwater Improvement Conceptualisation

Terms	Meaning
MVHT	million vehicle hours travelled
MVKT	million vehicle kilometres travelled
NB	Northbound
NCA	Noise catchment areas
NCG	Noise Criteria Guideline
NCG	Noise Criteria Guideline (various, as referenced in the report)
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
Network productivity	Indication of efficiency of a road network, which can be expressed in terms of vehicle kilometres travelled and vehicle hours travelled per day
NH_3	Ammonia
NHMRC	National Health and Medical Research Council
NMG	Noise Mitigation Guideline
NML	Noise management level
NO	nitric oxide
NO_2	Nitrogen dioxide
NOAEL	No observed adverse effect level
NoW	NSW Office of Water
NO_x	Nitogen oxides
NPfI	Noise Policy for Industry
NPW Act	*National Parks and Wildlife Act 1974* (NSW)
NSW	New South Wales
NSW DEC	NSW Department of Environment and Conservation
NSW DPI	NSW Department of Primary Industries
NSW EPA	NSW Environmental Protection Agency
NSW Health	NSW Department of Health
NSW OEH	NSW Office of Environment and Heritage
NTU	Nephelometric Turbidity Unit
O_3	Ozone
OCP	Organochlorine pesticide
OCPs	Organochlorine pesticides
OEH	NSW Office of Environment and Heritage
OEHHA	Office of Environmental Health Hazard Assessment, California Environment Protection Agency (Cal EPA)
OEMP	Operational Environmental Management Plan
OFFMP	Operation Flora and Fauna Management Plan
OLS	Obstacle limitation surface
OU	Odour units
Overbridge	Bridge that conveys another road, rail or pedestrians over the described road
Overland flooding	Inundation by local runoff rather than overbank discharge from a stream, river, estuary, lake or dam.

Terms	Meaning
PACHCI	Procedure for Aboriginal Cultural Heritage Consultation and Investigation (Roads and Maritime 2011)
PAD	Potential Archaeological Deposit
PAH	Polycyclic aromatic hydrocarbon
Palaeochannel	Ancient river systems eroded deeply into the landscape and infilled with alluvial sediments. These systems often underlie modern creek or river systems but not always.
PANS-OPS	Procedures for air navigation systems operations
PASS	Potential acid sulfate soils
PCB	Polychlorinated Biphenyls
PCT	Plant community type
PCU	passenger car units
Peak flood level	The maximum water level occurring during a flood event.
Peak spreading	Increases in traffic demand in time periods immediately before or after the critical AM peak and PM peak periods, with commensurate decreases in the forecast peak period traffic demand
Perched Water	Unconfined groundwater held above the water table by a layer of impermeable rock or sediment.
PEST	Parameter Estimation
PFAS	Perfluoralkylated Substances
PFOA	Perfluorooctanoic acid
PIARC	Permanent International Association of Road Congresses
PM	Particulate matter
PM peak hour	Unless otherwise stated, this refers to trips travelling on the network during the average peak one hour in the PM peak period between 3.00 pm–6.00 pm on a weekday hour
PM_1	Particulate matter below one micron in diameter, often termed very fine particles
PM_{10}	Particulate matter less than or equal to 10 micrometre diameter
$PM_{2.5}$	Particulate matter less than or equal to 2.5 micrometre diameter
PMA	Personal Manager - Acquisition
PMF	Probable Maximum Flood
POEO Act	Protection of the Environment Operations Act 1997 (NSW)
POEO Regulation	Protection of the Environment Operations (Waste) Regulation 2014 (NSW)
Point of exposure	The place where someone can come into contact with a substance present in the environment [see exposure pathway].
Pollutant	Any matter that is not naturally present in the environment.
Population	A group of organisms, all of the same species, occupying a particular area.
Portal	The entry and/or exit to a tunnel
ppbv	Parts per billion by volume
ppm	Parts per million
Pre-construction	All work prior to, and in respect of the State significant infrastructure, that is excluded from the definition of construction
Private vehicle	Includes all motorised vehicles such as cars, 4WDs, vans, motorbikes, motor scooters, utes and trucks, not registered for business use

Terms	Meaning
Probability	A statistical measure of the expected chance of flooding (see annual exceedance probability).
RBL	Rating background levels
RCP	Reinforced concrete pipe
Revegetation	Direct seeding or planting (generally with native species) within an area in order to re-establish vegetation that was previously removed from that area.
Riparian	Relating to the banks of a natural waterway.
Risk	The probability that something would cause injury or harm.
RL	Reduced Level. The reduced level is the vertical distance between an elevation and an adopted datum plane such as the Australian Height Datum (AHD).
RMS	Roads and Maritime Services
RNP	*NSW Road Noise Policy*
Road reserve	An area of land within which facilities such as roads, footpaths and associated features may be constructed for public travel
Roads and Maritime	NSW Roads and Maritime Services
Roadside	The area from the edge of the carriageway to the boundary of the road reserve
Roadside furniture	A general term covering all signs, street lights, protective devices for the control, guidance and safety of traffic and convenience of road users
ROL	Road Occupancy Licence
Roundabout	An intersection where all traffic travels in one direction clockwise around a central island
Route of exposure	The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].
RSLs	Regional Screening Levels
RTA	NSW Roads and Traffic Authority
Runoff	The portion of water that drains away as surface flow.
RWQ	Recreational water quality
s	Seconds
SA	Statistical area
SA1	Statistical area level 1 district
SA2	Statistical area level 2 district
SA3s	Statistical Areas Level 3
SACL	Sydney Airport Corporation Limited
Salinity	The concentration of dissolved salts in water, usually expressed in EC units or milligrams of total dissolved solids per litre (mg/L TDS). The conversion factor between EC and mg/L is dependent on the chemical composition of the water, but a conversion factor of 0.6 mg/L TDS = 1EC unit is commonly used as an approximation.
SAQP	Sampling, analysis and quality plan
Saturation flow	The number of vehicles per hour that could pass through a signalised intersection on a specific approach lane if the signal remained green for the entire 60 minutes
SB	Southbound
Scour	The erosion of material by the action of flowing water.

Terms	Meaning
Screenline	Theoretical boundaries specifically designed to collectively analyse directional and two-way traffic volumes
SEARs	Secretary Environmental Assessment Requirements
Secant pile wall	A continuous barrier wall formed by constructing intersecting reinforced concrete piles socketed into bedrock.
SEIFA	Socioeconomic indices for areas
Sensitive receiver	A location where a person works or resides, including residential, hospitals, hotels, shopping centres, play grounds, recreational centres or similar.
Sensitivity	'Capacity of a landscape or view to accommodate change without losing valued attributes.' (AILA 2018)
SEPP	State Environmental Planning Policy
SEPP 33	*State Environmental Planning Policy No. 33 – Hazardous and Offensive Development*
SEPP 55	*State Environmental Planning Policy No. 55 – Remediation of Land*
SES	State Emergency Services
SHR	State Heritage Register
Sky glow	'The brightening of the night sky' (ILE 2011)
SLG	stakeholder liaison group
Slug test	A hydraulic test conducted in a monitoring well to measure the hydraulic conductivity of the screened lithology. The test is conducted by adding or removing a slug of water and monitoring the response.
SMCMA	Sydney Metropolitan Catchment Management Authority Area
SMP	Sustainability Management Plan
SMPM	Sydney Strategic Motorway Project Model
SO_2	Sulfur dioxide
SoHI	Statement of Heritage Impact
Species credits	The class of biodiversity credits created or required for the impact on threatened species that cannot be reliably predicted to use an area of land based on habitat surrogates. Species that require species credits are listed in the Threatened Biodiversity Data Collection.
Species credit species	Threatened species that are assessed and require credits and offsets according to Section 6.4.of the Biodiversity Assessment Method
SPI	St Peters interchange
Spoil	Surplus excavated material
SSI	State significant infrastructure
Steady state	Steady state flow conditions occur when the magnitude and direction of flow is constant across the whole model domain. Compare to transient flow conditions.
STM	Strategic Travel Model
Stockpile	Temporarily stored materials such as soil, sand, gravel and spoil/waste.
Stub tunnel	Driven tunnels constructed to connect to potential future motorway links
Surface water	Water flowing or held in streams, rivers and other water bodies in the landscape.
SVOC	Semi-volatile organic compounds
Swale	A shallow, grass-lined drainage channel.
SWOOS	Southern and Western Suburbs Ocean Outfall Sewer

Terms	Meaning
SWSOOS	Southern and Western Sydney Ocean Outfall System
Sydney Gateway	A high-capacity connection between the St Peters interchange (under construction as part of the New M5 project) and the Sydney Airport and Port Botany precinct
T90	Distillation temperature where 90% of the fuel is evaporated
TAGG	Transport Authorities Greenhouse Group
Tanked structure	A tanked structure is constructed with a fully impermeable casing or membrane that reduces inflows to such an extent that for all intents and purposes are considered negligible.
TAPM	The Air Pollution Model
TCEQ	Texas Commission on Environmental Quality
TCP	Traffic Control Plan
TCS	Traffic Control Signal
TEQ	Toxicity equivalent
TfNSW	Transport
THC	total hydrocarbons
Threatened Biodiversity Data Collection	Part of the BioNet database, published by OEH and accessible from the BioNet website at www.bionet.nsw.gov.au.
TKN	Total Kjedahl Nitrogen
TMC	Transport Management Centre
Toxicity	The degree of danger posed by a substance to human, animal or plant life.
Toxicological profile	An assessment that examines, summarises, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.
TP	Total Phosphorus
Transport for NSW	NSW Government Department Transport for NSW
Transport infrastructure	Permanent installations including roads, rail, buildings and storage associated with transport
TRH	Total recoverable hydrocarbons
Tributary	A river or stream flowing into a larger river or lake.
TSP	Total suspended particulates
Tunnel portal	The entrance/exit to the tunnel.
TWA	Trade waste agreement
UBD	Universal Business to Business Directories Pty LTD
UK	United Kingdom
UN	United Nations
Uncertainty factor	Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure would cause harm to people [also sometimes called a safety factor].

Terms	Meaning
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
US EPA	United States Environmental Protection Agency
V/C	Volume to Capacity ratio
Vadose zone	Within an aquifer the vadose zone is the unsaturated zone between the water table and ground surface.
Values	'Any aspect of landscape or views people consider to be important. Landscape and visual values may be reflected in local, state or federal planning regulations, other published documents or be established through community consultation and engagement, or as professionally assessed.' (AILA 2018)
Veh	Vehicle
Veh/h	Vehicle per hour
VEM	Visual Envelope Map
VENM	Virgin excavated natural material
Ventilation facility	Facility for the mechanical removal of air from the mainline tunnels, or mechanical introduction of air into the tunnels. May comprise one or more ventilation outlets
VHT	vehicle hours travelled
Viewpoint	'The specific location of a view, typically used for assessment purposes.' (AILA 2018)
VKT	Vehicle kilometres travelled
VOC	Volatile organic compounds
Vulnerable	As defined under the *Threatened Species Conservation Act 1995* (NSW), a species that is facing a high risk of extinction in NSW in the medium-term future.
WARR Act	*Waste Avoidance and Resource Recovery Act 2001* (NSW)
Water table	The surface of saturation in an unconfined aquifer at which the pressure of the water is equal to that of the atmosphere.
Waterway	Any flowing stream of water, whether natural or artificially regulated (not necessarily permanent).
WB	Westbound
WestConnex program of works	A program of works that includes the M4 Widening, King Georges Road Interchange Upgrade, M4 East, New M5 and M4-M5 Link projects
Western Harbour Tunnel and Beaches Link	The Western Harbour Tunnel component would connect to the M4-M5 Link at the Rozelle interchange, cross underneath Sydney Harbour between the Birchgrove and Waverton areas, and connect with the Warringah Freeway at North Sydney. The Beaches Link component would comprise a tunnel that would connect to the Warringah Freeway, cross underneath Middle Harbour and connect with the Burnt Bridge Creek Deviation at Balgowlah and Wakehurst Parkway at Seaforth. It would also involve the duplication of the Wakehurst Parkway between Seaforth and Frenchs Forest
WHO	World Health Organisation
WHT	Western Harbour Tunnel
WHTBL	Western Harbour Tunnel and Beaches Link
WM Act	*Water Management Act 2000* (NSW)
WQO	Water Quality Objectives
β coefficient	Beta coefficient

1 Introduction

This chapter provides a brief overview of the F6 Extension Stage 1 from New M5 Motorway at Arncliffe to President Avenue at Kogarah (the project), including its location and key features.

1.1 Project overview

Roads and Maritime Services (Roads and Maritime) is seeking approval to construct and operate the project. This project would comprise a new, twin motorway tunnel between the New M5 at Arncliffe and President Avenue at Kogarah.

The project would be located mainly within the Bayside local government area (LGA), with a small area in the Canterbury Bankstown LGA around nine kilometres to the southwest of the Sydney Central Business District (CBD). The project would be predominately located underground, with the majority of the motorway operational surface infrastructure located within land that has been previously reserved for the F6 Extension (the existing F6 reserved corridor).

Figure 1-1 depicts the project and its surrounding location. Project features are outlined in **section 1.2**, and are provided in greater detail in **Chapter 6** (Project description).

Once complete, it would improve connections and travel times between the A1 Princes Highway and other arterial roads, south of President Avenue, and the Sydney CBD. It would also improve connections for residents and businesses within the broader regional area, promoting and supporting economic development in areas to the south such as Sutherland and the Illawarra.

The project would form the first stage of the F6 Extension. The existing F6 reserved corridor between Arncliffe and Loftus was reserved in the 1950s to ensure land was available to accommodate the required road infrastructure for a future connection to link the existing A1 Princes Highway at Loftus with the Sydney motorway network at Arncliffe. Much of that same reservation remains in place today and forms part of the study area being considered in investigations for the F6 Extension.

Approval for the project is being sought under Part 5, Division 5.2 (State significant infrastructure) of the *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act), requiring an environmental impact statement (EIS). If approved, it would be carried out generally in accordance with its description in this EIS and any conditions issued upon approval of the project, taking into account subsequent response to submissions and any preferred infrastructure report.

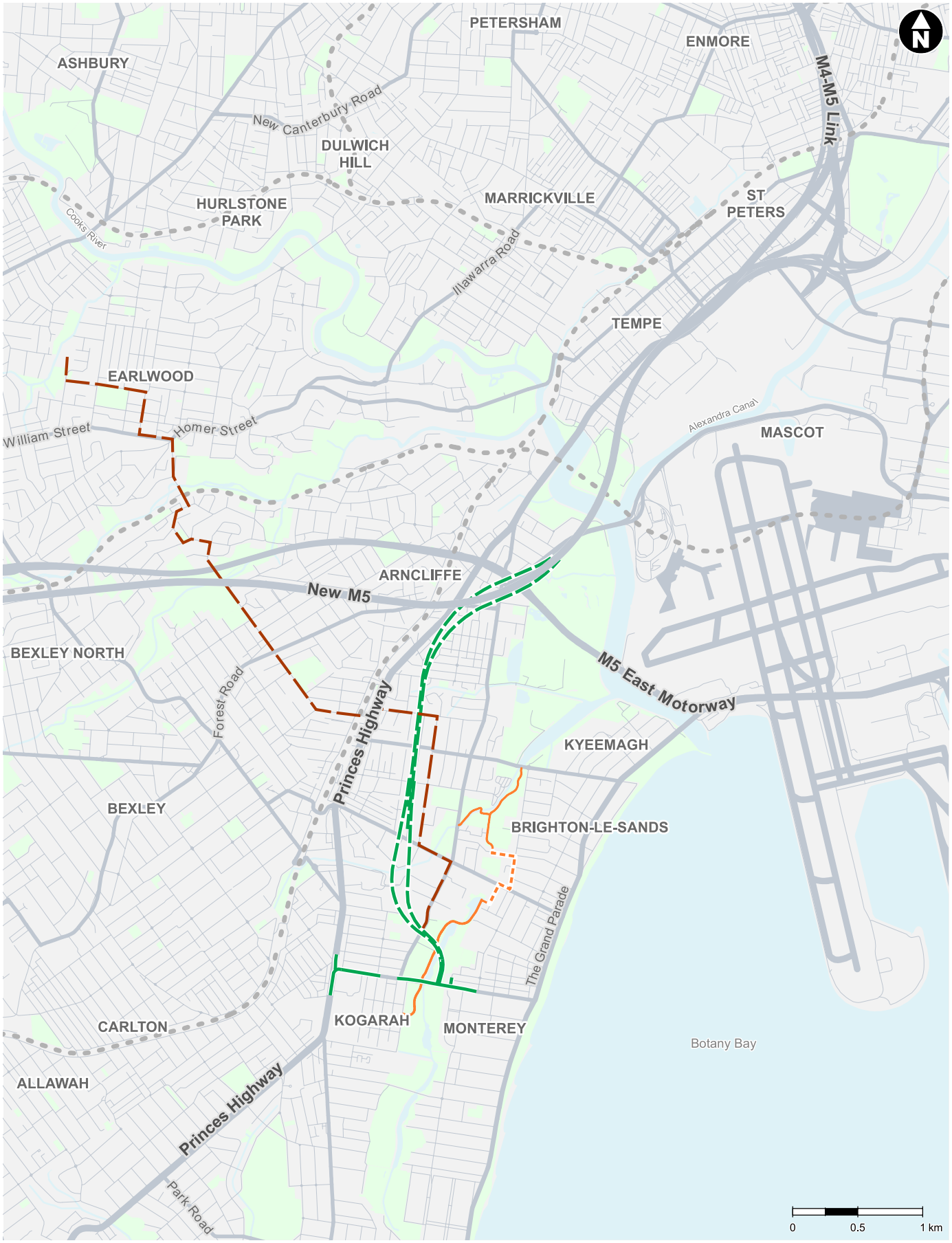

Figure 1-1 Project overview and location

1.2 Project features

Key components of the project would include:

- An underground connection to the existing stub tunnels at the New M5 at Arncliffe
- Twin motorway tunnels (around four kilometres in length) between the New M5 at Arncliffe and President Avenue, Kogarah
- A tunnel portal and entry and exit ramps connecting the tunnels to the surface
- An intersection with President Avenue, including widening and raising of President Avenue
- Intersection improvements at the President Avenue / Princes Highway intersection
- Mainline tunnel stubs to allow for connections to future stages of the F6 Extension
- Shared cycle and pedestrian pathways connecting Bestic Avenue, Rockdale to Civic Avenue, Kogarah via Rockdale Bicentennial Park (including an on-road cycleway)
- An Operational Motorway Control Centre to be located off West Botany Street, Rockdale
- Ancillary infrastructure and operational facilities for signage (including electronic signage), ventilation structures and systems at Rockdale, fire and safety systems, and emergency evacuation and smoke extraction infrastructure
- A permanent power supply connection from the Ausgrid Canterbury subtransmission substation to the operational facility at West Botany Street
- Temporary construction ancillary facilities and temporary works to facilitate the construction of the project.

Project features are shown on **Figure 1-2**.

1.3 Project benefits

The project would deliver the following key benefits and opportunities:

- Improved network productivity on the metropolitan network, with more trips forecast or longer distances travelled on the network in shorter timeframes
- Reduced congestion on surface roads, including Princes Highway and The Grand Parade, by providing an underground motorway alternative. This would also enhance the use of surface roads for public transport and cyclists
- Improved accessibility and connectivity for active transport modes
- Improved travel times for some bus services by decreasing traffic along the Princes Highway, and other arterial roads, particularly towards the Sydney CBD, and improved accessibility to the nearby local train stations, thereby supporting greater use of public transport
- Improved intersection operation and traffic flow, leading to a reduction in traffic incidents. Changes to surface road layouts and provision of additional pedestrian and cyclist links would make it safer for pedestrians and cyclists
- Enabler of place making along sections of the Princes Highway and The Grand Parade due to the reduction of the number of vehicles on these roads, resulting in improvements to urban amenity.

Further transport outcomes and social and economic benefits associated with the project are discussed in this EIS.

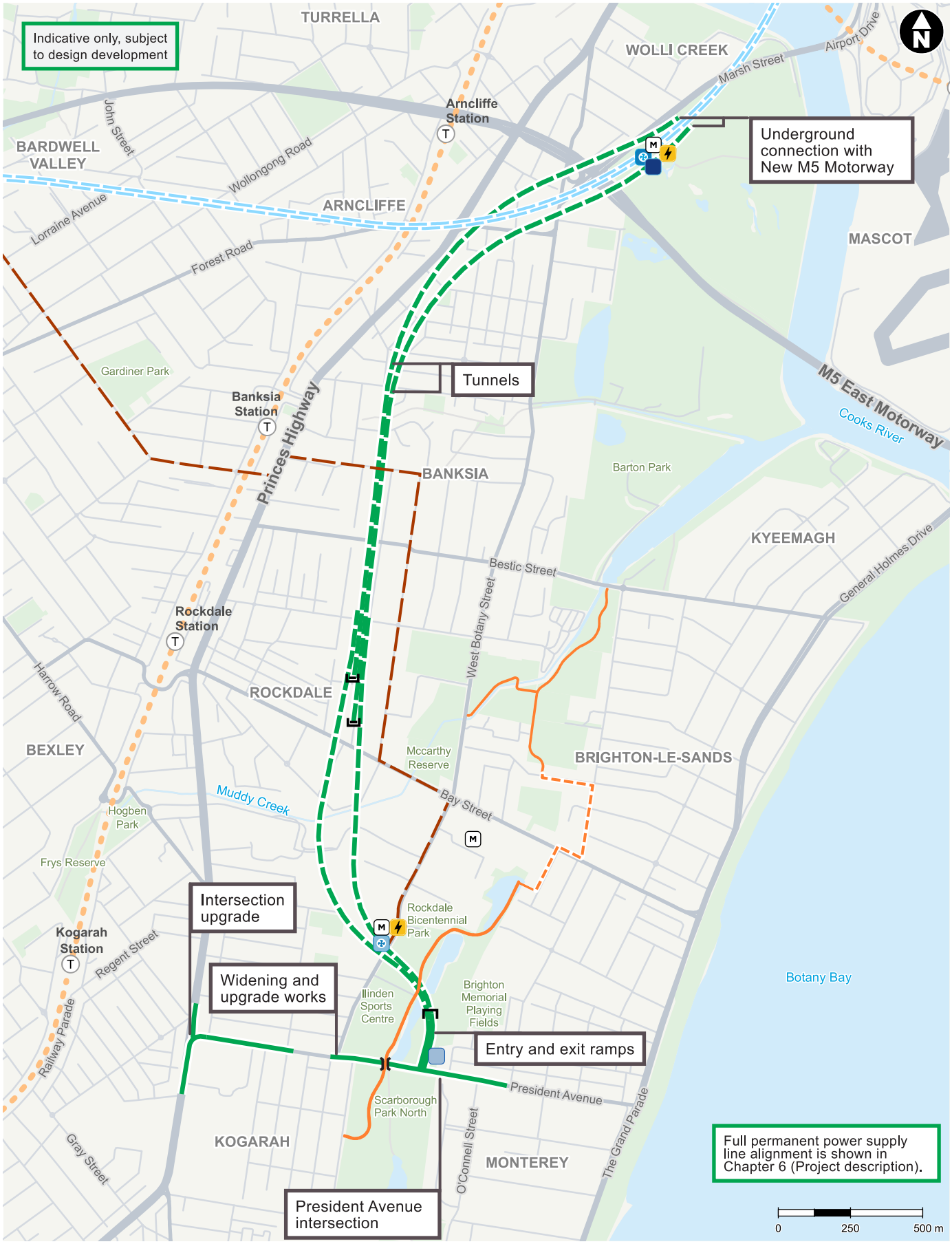

Figure 1-2 Project features

1.4 Purpose of this environmental impact statement

This EIS has been prepared in accordance with the relevant provisions of the EP&A Act. This EIS has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) issued by the Planning Secretary on 23 January 2018 and the relevant provisions of Part 3 of Schedule 2 of the *Environmental Planning and Assessment Regulation 2000* (NSW).

In accordance with Division 5.2 of the EP&A Act, this EIS presents an assessment of potential environmental issues identified during the planning and assessment of the project. The assessment considers the area directly or indirectly affected by construction and operation of the project, as relevant to each technical assessment. This EIS also provides the proposed management and mitigation measures to mitigate impacts both during construction and operation.

This EIS will be placed on public exhibition and will provide an opportunity for the community, government agencies and other interested parties to comment on the project. Roads and Maritime will consider this feedback and respond to issues raised in a submissions report. Further details on the assessment process for the project are provided in **Chapter 2** (Assessment process).

The SEARs are provided in **Appendix A** (Statutory requirements), along with a reference to where these have been addressed in this EIS.

This EIS is divided into seven volumes

Volumes 1 to 2 comprises:

1 | Introduction

Provides an overview of the project.

2 | Assessment process

Outlines the statutory requirements and explains the steps in the assessment and approval process.

3 | Consultation

Outlines the consultation activities undertaken, issues raised and how these issues have been addressed, as well as outlining the consultation activities planned.

4 | Strategic context and project need

Provides the strategic context and the need for the project, including the consequences of not proceeding.

5 | Project alternatives and options

Outlines the alternatives and options considered in developing the project.

6 | Project description

Provides a detailed description of the project including the route alignment, design standards and key design features.

7 | Construction

Describes how the project is likely to be constructed.

8-23 | Environmental assessment

Provides an assessment of environmental impacts and presents management and mitigation measures.

24 | Project Synthesis

Presents a synthesis of the EIS including the justification for the project.

Volumes 3 to 7 comprises:

Appendices

- A Statutory requirements
- B Draft community consultation framework
- C Place making and urban design
- D Traffic and transport technical report
- E Air quality technical report
- F Human health technical report
- G Noise and vibration technical report
- H Biodiversity development assessment report
- I Social and economic supporting information
- J Contamination technical report
- K Groundwater technical report
- L Surface water technical report
- M Flooding technical report
- N Statements of heritage impact
- O Methodologies

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2 Assessment process

2.1 Environmental Planning and Assessment Act 1979

Roads and Maritime is seeking approval for the project as State significant infrastructure under Part 5, Division 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

Clause 94 of the *State Environmental Planning Policy (Infrastructure) 2007* (the Infrastructure SEPP) applies to development for the purpose of a road or road infrastructure facilities and provides that these types of works are permissible without consent if being undertaken by a public authority. The project is for the purpose of a 'road' and 'road infrastructure facilities' under the Infrastructure SEPP.

Roads and Maritime has formed the opinion that the project is likely to significantly affect the environment and would require the preparation of an EIS.

On this basis, pursuant to Section 5.12(2) of the EP&A Act, the project is declared to be State significant infrastructure under Clause 14 of the *State Environment Planning Policy (State and Regional Development) 2011* (State and Regional Development SEPP).

The project requires approval from the NSW Minister for Planning under Section 5.14 of the EP&A Act.

In November 2017, Roads and Maritime prepared a State significant infrastructure scoping report to support an infrastructure application for the project under section 5.15 of the EP&A Act.

DP&E issued the Planning Secretary's Environmental Assessment Requirements (SEARs) for the project on 23 January 2018. The SEARs identify the assessment requirements for the project. A copy of the SEARs and where they have been addressed in this EIS is provided in **Appendix A** (Statutory requirements).

The assessment and approval process under Division 5.2 of the EP&A Act is shown in **Figure 2-1**. Further information on the assessment process is available on the Department of Planning and Environment website (www.planning.nsw.gov.au).

2.2 Critical State significant infrastructure

F6 Extension Stage 1 was declared by Ministerial Order on 26 October 2018 to be State significant infrastructure and critical State significant infrastructure under Sections under Section 5.12(4) and Section 5.13 of the EP&A Act, respectively. The Ministerial Order also amended Schedule 5 of the State and Regional Development SEPP to include the project as critical State significant infrastructure.

2.3 Other NSW legislation

Approvals under other NSW legislation that may apply to the project include:

- An Environment Protection Licence under Part 3 of the *Protection of the Environment Operations Act 1997* (NSW) (POEO Act). In accordance with section 5.24 of the EP&A Act, such a licence cannot be refused for an approved project and is to be substantially consistent with any approval under Division 5.2 of the EP&A Act
- Consent from the relevant roads authority under section 138 of the *Roads Act 1993* (NSW) including to carry out work in, on or over a public road, dig up or disturb the public surface of a public road or connect a road to a classified road.

Other NSW legislation that would apply to the project includes:

- The *Land Acquisition (Just Terms Compensation) Act 1991* (NSW), which applies to the acquisition of any land by an Authority of the State which is authorised to acquire the land by compulsory process. Acquisition is further discussed in **Chapter 6** (Project description) and **Chapter 14** (Property and Land use)
- The *Contaminated Land Management Act 1997* (NSW) outlines the circumstances in which notification of the NSW Environment Protection Authority is required in relation to contamination of land. This is discussed further in **Chapter 16** (Soils, Geology and Contamination).

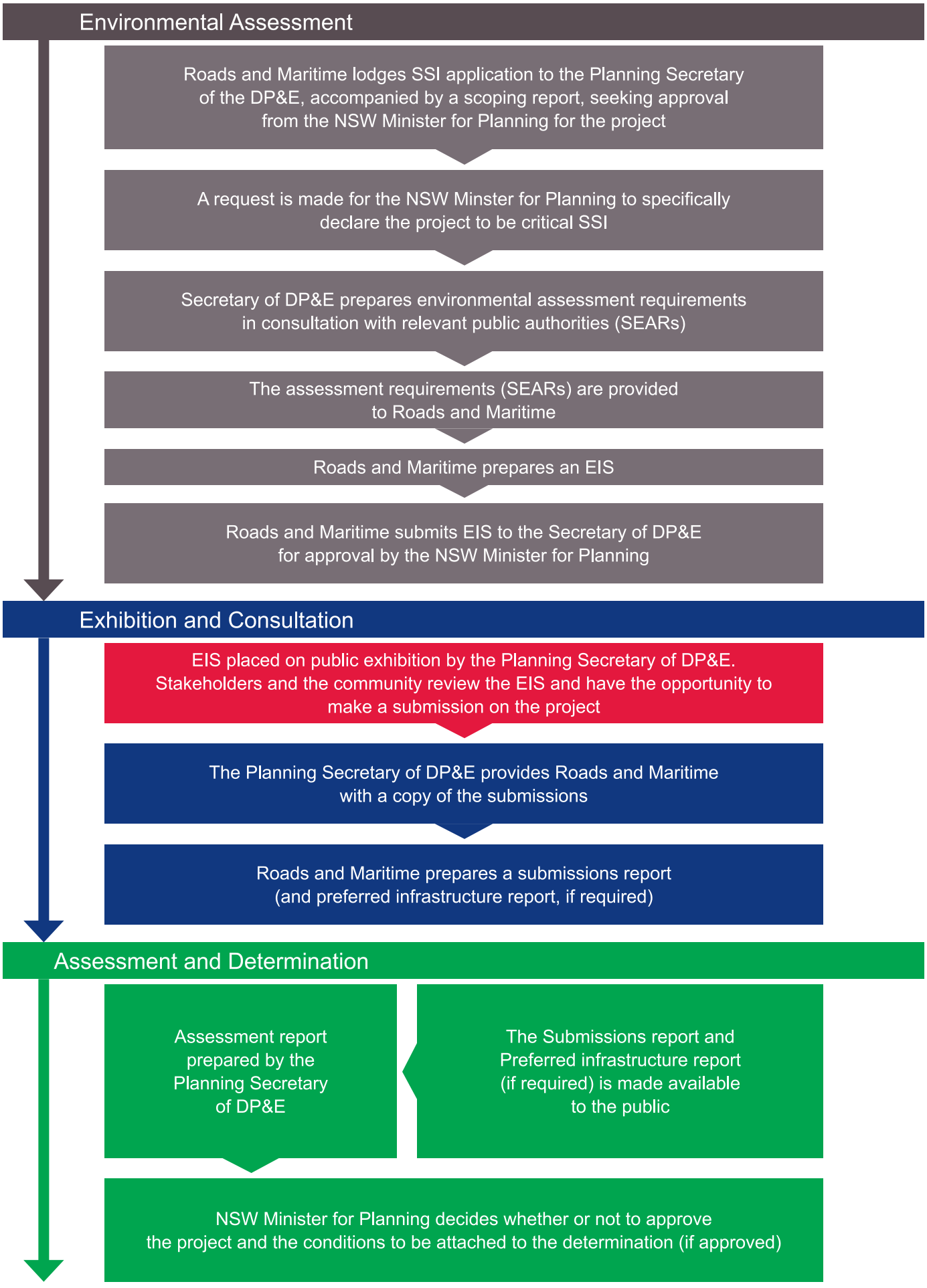

Figure 2-1 Assessment and approval process

A number of approvals are not required for a project approved under Section 5.23 of Division 5.2 of the EP&A Act. Those approvals not required for the project are:

- Permits under sections 201, 205 or 219 of the *Fisheries Management Act 1994*
- Approvals under Part 4 or excavation permits under Section 139 of the *Heritage Act 1977*
- Aboriginal heritage permits under Section 90 of the *National Parks and Wildlife Act 1974*
- A bush fire safety authority under Section 100B of the *Rural Fires Act 1997.*

Water use approvals under Section 89, water management work approvals under Section 90, and activity approvals (other than an aquifer interference approval) under Section 91 of the *Water Management Act 2000*.

2.4 Commonwealth legislation

2.4.1 Environment Protection and Biodiversity Conservation Act 1999

Under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) (EPBC Act), proposed 'actions' that have the potential to significantly impact on matters of national environmental significance or the environment of Commonwealth land, or 'actions' that are being carried out by a Commonwealth agency, must be referred to the Australian Government. If the Australian Government Minister for the Environment and Energy determines that a referred project is a 'controlled action', the approval of that Minister will be required for the project in accordance with the EPBC Act, in addition to the approval required from the NSW Minister for Planning under Division 5.2 of the EP&A Act.

Based on the results of the environmental investigations carried out for this EIS, it is considered that matters of national environmental significance and the environment of Commonwealth land are not likely to be significantly impacted by the project. Accordingly Roads and Maritime has determined that no referral is required at this stage.

2.4.2 Airports Act 1996

Under section 183 of the *Airports Act 1996* (Commonwealth), a controlled activity must not be undertaken in relation to 'prescribed airspace' without the approval of the Secretary of the Commonwealth Department of Infrastructure, Regional Development and Cities (the Department of Infrastructure).

'Prescribed airspace' is the airspace above any part of either an Obstacle Limitation Surface or a 'procedures for air navigation systems – aircraft operations' (PANS-OPS) surface for Sydney Airport.

The project would include the construction and operation of a ventilation facility and outlet at Rockdale, and the operation of a ventilation outlet at the Arncliffe ventilation facility constructed as part of the New M5 project. Rising air plumes from both the Rockdale and Arncliffe (F6 Extension Stage 1) ventilation facility have the potential to penetrate the OLS and PANS-OPS for Sydney Airport. The New M5 Arncliffe ventilation facility was assessed in the *Westconnex New M5 Plume Rise Assessment* (Pacific Environment, 2015) which was completed as part of the New M5 project and approval was sought for only the New M5 Project. Approval was not sought at that time for the F6 Extension Stage 1 ventilation outlet from that facility. The plumes from the Rockdale ventilation facility may impact the prescribed airspace and approval to operate it may be required from the Secretary of the Department of Infrastructure, Regional Development and Cities. Approval may also be required for the Arncliffe outlet at the Arncliffe ventilation facility to operate for the F6 Extension Stage 1 project as prior approvals for the operation of this facility were only sought for the New M5 project. The Civil Aviation Safety Authority and Airservices Australia would be consulted on the application for approval.

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3 Consultation

3.1 Community and stakeholder engagement overview

For the purposes of this chapter, consultation and engagement activities for the project have been described within three main phases:

- **Consultation prior to the public exhibition of the Environmental Impact Statement (EIS)** (mid-2016 to late 2018), including consultation carried out during:
  - **Project development** comprising consultation activities carried out from the preliminary planning phase in June 2016 to the NSW Government's announcement in October 2017 to progress the project to the EIS planning phase.
  - **EIS preparation**, comprising consultation activities carried out during the preparation of the EIS including the submission of the State Significant Infrastructure (SSI) application in November 2017 and scoping report to the NSW Department of Planning and Environment (DP&E) and the public display of project information and design in August 2018.
- **Consultation during the public exhibition of the EIS** (late 2018), including the display of the EIS and the preparation of a submissions report and a preferred infrastructure report (if required)
- **Consultation after the public exhibition of the EIS** (early 2019 onwards), including proposed consultation activities during project delivery.

The consultation phases within the overall project development and delivery phases is shown in **Figure 3-1**.

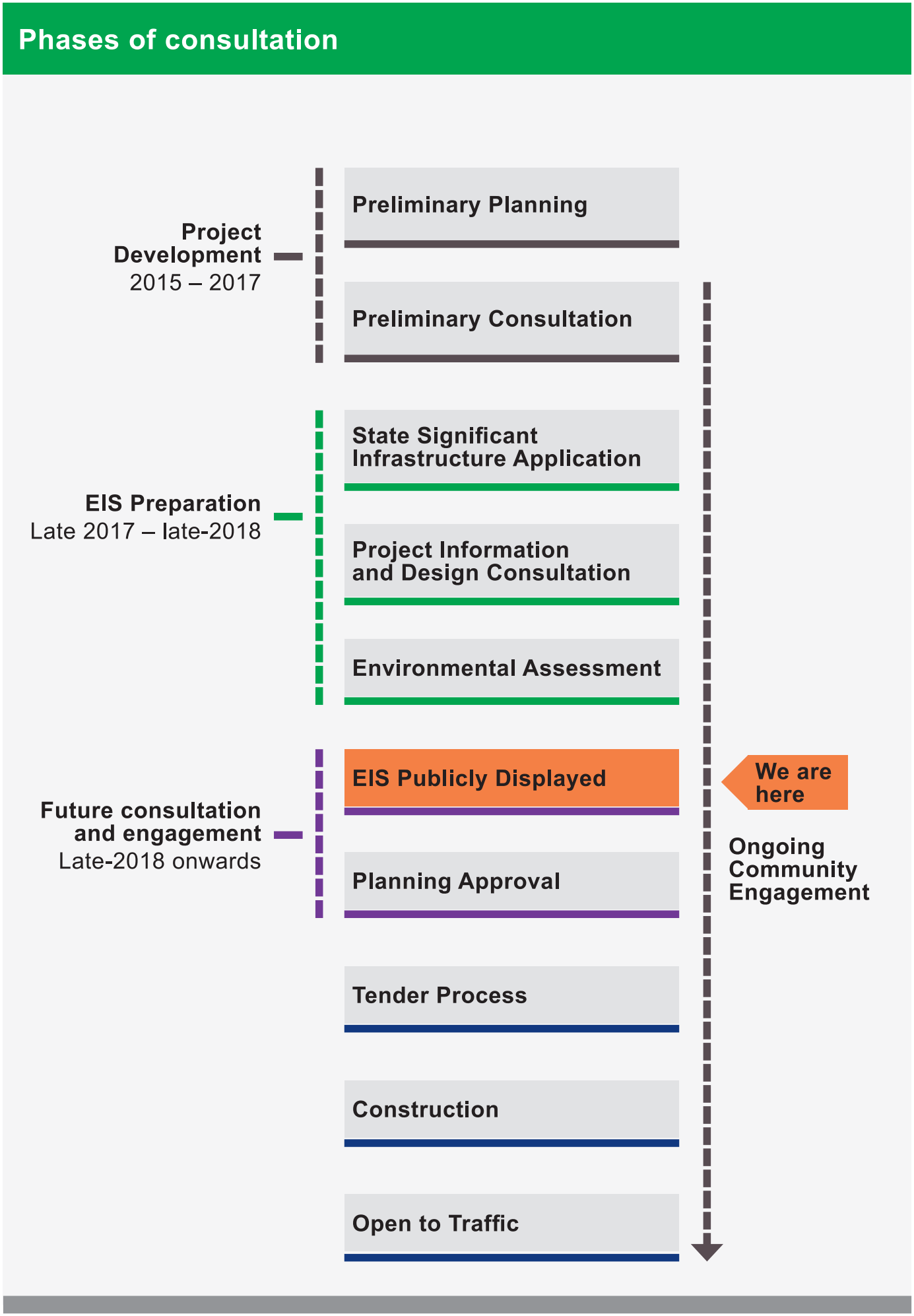

Figure 3-1 Consultation process within the project delivery

A detailed stakeholder analysis has informed the communication and engagement strategy for the project. Stakeholders include:

- Landowners, residents, schools and businesses near the project
- Members of the community
- Interest groups including industry, business, community groups, sporting groups, pedestrian and cyclist user groups
- Local Aboriginal stakeholders
- Government including local, State and Commonwealth agencies
- Utility and service providers.

The objectives of the consultation activities are to provide stakeholders and community members with opportunities to understand the project and provide feedback, and to communicate the benefits and potential impacts of the project.

A range of community engagement channels have been established for the project, to seek input from stakeholders and communities and support ongoing community and stakeholder engagement. These include:

- A postal address to receive written feedback (Customer Feedback Roads and Maritime Services Locked Bag 928, North Sydney NSW 2059)
- A toll-free project number for feedback, enquiries and complaints (1800 789 297)
- A project email address to provide updates to subscribers and to receive feedback from the community (F6Extension@rms.nsw.gov.au)
- A website (www.rms.nsw.gov.au/F6) which provides background information, maps, updates, announcements and details on how to provide feedback on the project.

A range of additional tools have been used to support communication and engagement activities for the project including:

- Letter box drops
- An interactive online mapping tool where community members were invited to submit comments onto a project footprint map
- Project information stands at local shopping centres
- Community information sessions at local venues within the project area
- Local newspaper advertisements
- Media releases
- Doorknocking
- A survey of local business owners and operators
- Project briefings with key stakeholders
- An online portal with information on air quality
- Air quality information fact sheets (translated into Greek, Mandarin, Cantonese, Macedonian, Arabic and Nepali)
- Project specific information fact sheets.

Written communication materials produced for the project included information on translation services available.

3.2 Consultation prior to public exhibition of the EIS

Community engagement and consultation prior to public exhibition of the EIS was carried out between June 2016 and August 2018.

Initial community engagement and consultation was carried out during the preliminary planning stage of the project between June 2016 and October 2017. During this period, consultation activities were primarily focused on informing community members and stakeholders of the geotechnical work being carried out in the vicinity of the project.

Consultation activities following the October 2017 project announcement included:

- Consultation with potentially impacted landowners and residents, with the method and frequency of contact tailored to suit the preferences of each stakeholder
- Doorknocks and letterbox drops to advise residents and local businesses of investigation work being carried out near their premises to inform the environmental assessment and design
- Project briefings offered to key stakeholders within the vicinity of the project including:
  - Bayside Council
  - Local schools
  - Interested property owners (if requested)
  - Local sporting clubs
  - Industry, business and community groups
  - Resident action groups
  - Environmental groups
- Responding to phone calls received via the project 1800 number, and emails received via the project email address.

Extensive community consultation activities have been carried out between June and August 2018 to provide opportunities for the community and stakeholders to learn more about the proposal, and have their say.

The community consultation activities carried out during the project development and EIS preparation phases are summarised below.

Table 3-1 Community consultation activities

Key consultation purpose or outcome	Consultation activity and communication summary
Preliminary planning	June 2016 to October 2017
Inform stakeholders and community members of geotechnical work related to the project.	• Briefings with Bayside Council to explain the project and discuss geotechnical investigations and studies within the local government area (LGA) • Doorknocks and letterbox drops to residents and local businesses near geotechnical work locations • Distribution of two fact sheets on the geotechnical work in June 2016 and May 2017. The fact sheets were posted to residences within about 100 metres of the geotechnical work. The facts sheets were provided to council for display at community locations, such as libraries. The fact sheets were also made available on the project web page.
Preliminary consultation	October to December 2017
Proactively engage with the community and seek feedback prior to the commencement of the formal environmental impact assessment process.	• Media release issued at the beginning of the consultation period • Meetings with potentially impacted property owners and residents • Project update delivered to about 70,000 residents. Suburbs captured in the distribution area included: – Bayside Council LGA (Wolli Creek, Arncliffe, Banksia, Kyeemagh, Monterey, Kogarah, Sans Souci, Sandringham, Brighton-Le-Sands, Rockdale, Ramsgate, Ramsgate Beach, Dolls Point) – Georges River Council LGA (Beverley Park, Sans Souci, Ramsgate, Kogarah) – Sutherland Shire LGA (Miranda, Engadine, Heathcote, Waterfall, Loftus, Yarrawarrah, Sutherland, Kirrawee, Gymea, Miranda, Taren Point, Sylvania Waters) • Details of the proposal uploaded on the project web page on the Roads and Maritime website • Email sent to stakeholders who registered an interest in the project • Nine informal community information stands held at shopping centres close to the project in October and November 2017. The stands were attended by about 2000 community members, and were held at the following locations and times: Kogarah Town Centre – 23 October 2017 from 10am to 4pm – 24 October 2017 from 10am to 4pm – 25 October 2017 from 10am to 4pm – 26 October 2017 from 1pm to 6pm – 27 October 2017 from 10am to 4pm – 28 October 2017 from 10am to 1pm Rockdale Plaza – 31 October 2017 from 10am to 4pm – 2 November 2017 from 1pm to 6pm – 4 November 2017 from 10am to 1pm • A collaborative and interactive online map of the preliminary project alignment was launched in October 2017 via the project webpage, inviting community members to provide comments on the project. Roads and Maritime received 295 comments from 205 individuals during the consultation period between 17 October and 22 December 2017 • Doorknocking up to 1000 residences and businesses located near the proposed intersection on President Avenue. The doorknock area included residences within Moorefield Estate and residences and businesses along West Botany Street and President Avenue.

Key consultation purpose or outcome	Consultation activity and communication summary
SSI application submission	November to December 2017
Proactively engage with the community and seek feedback at commencement of the formal environmental impact assessment process	• Emails sent to stakeholders and community members with a registered interest in the project, to advise of the submission of the SSI application • Distribution of two fact sheets on the SSI planning and application process, and the preliminary design. The fact sheets were made available on the project web page and links to the fact sheets were also included in an email sent to registered stakeholders. Printed copies of the fact sheets were provided to all southern Sydney electorate offices for distribution • Collation and consideration of community feedback received to date and preparation of a Community Feedback Summary Report.
Ongoing design development	December 2017 to June 2018
Continued engagement with stakeholders in regards to investigations within the project area.	• Details of upcoming investigations provided on the project webpage on the Roads and Maritime website • Doorknocks and letterbox drops to residents and local businesses close to investigation locations
Project information and design consultation	June 2018 to August 2018
Continued engagement with stakeholders, special interest groups, businesses and community members to inform and seek feedback	• Media release issued at the beginning of the consultation period • Meetings with potentially impacted and newly impacted property owners, business owners and residents • Consultation with pedestrian and cyclist user groups, industry, business, and community groups in June and July 2018 • Project update delivered to about 46,000 residents. Suburbs captured in the distribution area included: – Bayside Council LGA (Wolli Creek, Arncliffe, Banksia, Kyeemagh, Monterey, Kogarah, Sans Souci, Sandringham, Brighton-Le-Sands, Rockdale, Ramsgate, Ramsgate Beach, Dolls Point) – Georges River Council LGA (Beverley Park, Sans Souci, Ramsgate, Kogarah) • Details of the proposal uploaded on the project web page on the Roads and Maritime website • Email sent to stakeholders who registered an interest in the project • Doorknocking over 1500 residences and businesses from 12 June to 27 July 2018 • Five Community information sessions held at local venues close to the project in June and July 2018. The sessions were attended by about 185 community members, and were held at the following locations and times: Brighton-Le-Sands Public School – 23 June 2018 from 9am to 1pm – 30 June 2018 from 9am to 1pm Salvation Army Store Rockdale – 3 July 2018 from 3pm to 7pm Rowers on Cooks River – 5 July 2018 from 3pm to 7pm – 7 July 2018 from 9am to 1pm. • Five informal community 'Pop-up' information sessions held at shopping centres close to the project in July 2018. The sessions were attended by about 700 community members, and were held at the following locations and times: Kogarah Town Centre – 9 July 2018 from 10am to 4pm

Key consultation purpose or outcome	Consultation activity and communication summary
	Rockdale Plaza – 16 July 2018 from 10am to 4pm – 17 July 2018 from 10am to 4pm – 18 July 2018 from 10am to 4pm – 19 July 2018 from 10am to 4pm. • A collaborative and interactive online map of the proposed project alignment was launched in June 2018 via the project webpage, inviting community members to provide comments on the project. Roads and Maritime received 165 comments from 74 individuals during the consultation period between 12 June and 27 July 2018. • Survey of local businesses on President Avenue and West Botany Street carried out over a three-week period in July and August 2018. Around 40 businesses participated in the survey including local retailers and commercial operators.

Government agencies

Consultation with State and Commonwealth Government agencies has been ongoing during the development of the EIS. **Table 3-2** provides a summary of the consultation activities undertaken.

Table 3-2 Consultation with government agencies

Stakeholder	Purpose of consultation	Date
DP&E, Office of Environment and Heritage, Office of Chief Scientist and Engineer, Sydney Water Corporation, NSW Health, Department of Primary Industries – Fisheries, Bayside Council	Planning focus meeting with relevant government agencies to provide a briefing on the project and to discuss issued to be considered during the preparation of the EIS.	8 December 2017
Office of Chief Scientist and Engineer, DP&E, NSW Health	Meetings to discuss the implementation of the NSW Government Tunnel Ventilation Initiative.	16 and 22 February 2018 22 August 2018
NSW Health	A briefing on the project during the preparation of the EIS.	17 July 2018
Department of Primary Industries – Fisheries	A briefing on the project during the preparation of the EIS.	7 March 2018
Environmental Protection Authority NSW	A briefing on the project during the preparation of the EIS.	12 March 2018
Department of Education	Briefings on the project during the preparation of the EIS.	18 April 2018 27 July 2018
Department of Environment and Energy	A briefing on the project during the preparation of the EIS.	3 May 2018
Office of Environment and Heritage	An invitation to meet has been offered.	November 2017
Sydney Water Corp	Briefings on the project during the preparation of the EIS.	9 July 2018 6 August 2018
Department of Infrastructure and Regional Development (DIRD), Civil Aviation Safety Authority (CASA) and Sydney Airport Corporation Limited (SACL)	Briefings on the project during the preparation of the EIS.	22 May 2018 22 August 2018

Bayside Council

Consultation with Bayside Council has occurred on October 24, November 2 and December 14 in 2017 and has been ongoing since June 2018 during the development of the EIS. The purpose of this consultation was to:

- Brief Council on the project
- Discuss impacts on Rockdale Bicentennial Park
- Plan for the air quality monitoring program and station locations
- Discuss other impacts via a series of technical working groups:
  - Impacts to open space
  - Local traffic management
  - The shared cyclist and pedestrian pathway
  - General environmental issues.

Utility and service providers

Consultation with utility and service providers has been carried out to discuss potential impacts on existing and future utility supply, adjustments and project timing. Consultation has been ongoing since November 2017 before the development of the EIS and would continue should the project be approved.

Directly impacted landowners and residents

Residents and land owners who may be potentially impacted by land acquisition have been notified.

All acquisition required for the project would be carried out in a manner consistent with the *Land Acquisition (Just Terms Compensation) Act 1991* (NSW) (Just Terms Act), the Land Acquisition Information Guide[1] and the land acquisition reforms announced by the NSW Government in 2016.

Roads and Maritime have appointed a Personal Manager - Acquisition (PMA) to assist each of the landowners, residents and business owners who may potentially be affected by acquisition for the project. The PMA has met with potentially impacted landholders and residents and is in regular contact with these individuals to provide updates on the project and respond to questions and queries. When acquisition for the project is confirmed, the PMA would work with affected land owners and residents to offer assistance and support throughout the acquisition and relocation process (Refer to **Chapter 14** (Property and land use)).

Other industry and key stakeholders

Consultation with other industry and stakeholders started before the development of the EIS. Consultation would continue during design and construction. **Table 3-3** provides a summary of the consultation during the development of this EIS.

Table 3-3 Other industry and key stakeholder consultation

Stakeholder	Purpose of consultation	Date
TAFE NSW	• Briefings to explain the project • Discussion on TAFE access and operation	21 November 2017 22 August 2018

[1] NSW Government (2014) Land Acquisition Information Guide

Stakeholder	Purpose of consultation	Date
Brighton-Le-Sands Public School St. Georges School Cairnsfoot School Moorefield Girls High School Sir Thomas More School Arncliffe Public School Kyeemagh Infants School Kogarah High School Kogarah Public School Little Sails Pre-School St. Francis Xavier Catholic Primary School James Cook Boys Technology High School Rockdale Public School St Dominic Savio School Al Zahra College primary & secondary school	• Briefings to explain the project • Discussions on potential impacts of the project on access to and operation of the school	October 2017 - August 2018
Sunnyhaven Disability Services	• Briefing offered to explain the project. • Provide ongoing project updates by email.	Ongoing
SES Sydney Southern Headquarters	• A briefing on the project during the preparation of the EIS. No concerns regarding emergency management arrangements for flooding were raised.	20 March 2018
Fire & Rescue NSW	• A briefing on the project during the preparation of the EIS.	20 March 2018
Rockdale City Suns Football Club	• Briefings to explain the project • Discussion on potential impacts to sporting fields and club operation during construction and operation of the project • Discussion on options for sporting field relocation prior to the commencement of construction.	14 November 2017 10 July 2018
St George Football Association	• Briefing to explain the project • Discussion on potential impacts to sporting fields and club operation during construction and operation of the project • Discussion on options for sporting field relocation prior to the commencement of construction.	7 December 2017 2 July 2018
Illawarra Tennis Club	• Provide ongoing project updates by email.	Ongoing
Loftus Yarrawarrah Rovers Football Club	• Provide ongoing project updates by email.	Ongoing
National Parks Association	• Briefing to explain the project • Discussions on the project impact on the Royal National Park	30 November 2017
Botany Bay and Catchment Alliance (BBACA); Rockdale Wetlands Preservation Society	• Briefing to explain the project • Discussion on potential impacts to biodiversity and waterways in Rockdale Bicentennial Park and Scarborough Park North. • Discussion on shared cycle and pedestrian pathways design.	13 July 2018

Stakeholder	Purpose of consultation	Date
St George Bicycle User Group (St George BUG)	• Briefing offered. Provide ongoing project updates by email.	Ongoing
Bicycle NSW	• Briefing to explain the project • Discussions on the proposed bicycle route for the shared pedestrian and cycle pathways	26 July 2018
NSW Taxi Council Ltd	• Provide a project overview and design and seek feedback.	24 July 2018
St George Private Hospital	• Provide ongoing project updates by email.	Ongoing
St George Public Hospital	• Provide ongoing project updates by email.	Ongoing

Aboriginal cultural heritage

The following Aboriginal community consultation process has occurred:

- Identification of key Aboriginal stakeholders and the relevant local Aboriginal land council (LALC) through searches of the National Native Title Register and Registrar of Aboriginal Owners
- Engagement of Metropolitan Local Aboriginal Land Council (LALC) Culture and Heritage Officer to participate in the archaeological survey
- Preparation of a cultural heritage assessment report.

Consultation and field inspection was carried out on 25 January 2018. The Culture and Heritage Officer from the Metropolitan LALC attended the field inspection and was consulted for any relevant cultural information (refer to **Chapter 20** (Aboriginal cultural heritage)).

Stakeholder Liaison Group

The purpose of the F6 Extension Stage 1 Stakeholder Liaison Group (SLG) is to provide a forum for discussion between Roads and Maritime, Bayside Council and representatives from community groups and organisations that have a direct interest in matters relating to Rockdale Bicentennial Park, East Bicentennial Playing Fields and Brighton Memorial Playing Fields.

The project team has worked with Bayside Council to identify stakeholders' to participate in the Stakeholder Liaison Group. Stakeholders invited to participate include:

- Rockdale City Suns Football Club
- Dolls Point Football Club
- St George Football Association
- Department of Education and Training (DET)
- Brighton-Le-Sands Public School
- Botany Bay and Catchment Alliance
- Rockdale Wetlands Preservation Society
- St George Bike User Group
- St George Youth Services
- St George Children with Disabilities
- St George Nepalese Club
- The Supreme Islamic Shiite Council
- Guthi Australia Inc
- Madif Al Ameer Youth.

3.3 Feedback received prior to public exhibition of the EIS

Feedback provided by Government agencies, Bayside Council, key stakeholders and the wider community was recorded and considered during the preparation of this EIS.

Government agencies

A summary of the feedback received from State and Commonwealth Government agencies up to August 2018 and where the issues have been assessed in this EIS is provided in **Table 3-4** below.

Table 3-4 Feedback from government agencies

Stakeholder	Feedback	Where addressed in EIS
NSW Health	Concerns raised around the following issues: • Location of tunnel ventilation facilities • Cumulative impacts – Arncliffe ventilation and other project ventilation sites • Cumulative impacts – Arncliffe construction site • Filtration of ventilation facilities • Settlement • Vibration • Sub-stratum acquisition • Chief Scientist on review and statement • Night time construction noise • Odour assessment / issues • Construction fatigue • Contamination specifically at Bicentennial Park and Arncliffe • Stockpile sites • Spoil management / location	The project design including location of tunnel ventilation facilities is outlined in Chapter 6 (Project description). Options considered for the location of the ventilation facilities are outlined in Chapter 5 (Project alternatives and options). Experience from previous motorway tunnel projects in Sydney has demonstrated that emissions from tunnel ventilation outlets do not measurably affect local or regional air quality. Air quality impacts (including cumulative impacts) for the project are assessed in Chapter 9 (Air quality and greenhouse gas). Construction and operational noise and vibration impacts are assessed in Chapter 11 (Noise and vibration). Settlement impacts are discussed in Chapter 17 (Groundwater and geology) and sub-stratum acquisition is discussed in Chapter 14 (Property and land use). The spoil management strategy for the project is discussed in Chapter 21 (Waste management). The potential to encounter contamination and the management of soil and contamination impacts is discussed in Chapter 16 (Soils and contamination). The potential for construction fatigue has been considered in section 3.5 and an assessment provided in Chapter 15 (Social and economic) and Chapter 11 (Noise and vibration).
NSW Office of Chief Scientist and Engineer, NSW Health and Department of Planning and Environment.	As part of the NSW Governments initiative to ensure that all motorway tunnels undergo a scientific review of air quality and ventilation components prior to the public exhibition of an EIS, a number of meetings were held to discuss the requirements of the assessments and documentation.	Appendix E (Air Quality technical report) includes a tunnel ventilation facility subsection (Annexure J), focused on the resultant air quality emissions from the tunnel ventilation facilities and the air dispersion modelling results. This documentation will facilitate the scientific review and enable preparation of the Chief Health Officer's statement on the health impacts of the ventilation outlets. The Department of Planning and Environment will upload these and made publicly available at the same time as the EIS is exhibited.

Stakeholder	Feedback	Where addressed in EIS
Department of Primary Industry - Fisheries	Matters discussed included: • Any potential for impacts on Scarborough Ponds as this is a key fish habitat that feeds into Botany Bay • Any potential for changes to the hydrology and groundwater connectivity to the wetland • Opportunities to improve the Rockdale Bicentennial Park wetland water quality during re-instatement of the park areas impacted during construction.	An assessment on the potential impact on the aquatic ecology for the project is provided in Chapter 12 (Biodiversity) and Appendix H (Biodiversity development assessment report). Changes in hydrology and groundwater expected for the project are detailed in Chapter 17 (Groundwater and geology) and Chapter 18 (Surface water and flooding). The design of the project has considered how the project could be constructed to minimise disturbance to waterways. Environmental impacts on waterways within the vicinity of the project are assessed in Chapter 18 (Surface water and flooding). Environmental impacts to groundwater as a result of the project are assessed in Chapter 17 (Geology and groundwater). Appendix C (Place making and urban design) outlines what opportunities exist for re-instatement of the park and wetland areas. The potential to improve water quality is discussed in Chapter 18 (Surface water and flooding).
NSW Environmental Protection Authority	The meeting with NSW Environmental Protection Authority identified the following key areas of focus for the project assessment: • Construction fatigue for surrounding residents where works may be continuous between other projects • Out of hours works, in particular the need for utility works at night and the expect durations. • Community consultation prior to works, ensuring that concerns held by the community were properly considered.	The potential for construction fatigue has been considered in section 3.5 and an assessment provided in Chapter 15 (Social and economic) and Chapter 11 (Noise and vibration). The need for out of hours works has been considered in the development of the concept design assessed in the EIS. This has included the likelihood that in particular utility works would require out of hours work in order to maintain the safety of the road network. The Noise and vibration impact assessment (refer to Chapter 11 (Noise and vibration)) has undertaken a specific assessment of these works where they have the potential to occur. The scope of the work and any resultant mitigation would be further refined as part of the Construction Noise and Vibration Management Plan. Consultation proposed during construction of the project is outlined in section 3.5 of this chapter and Appendix B (Draft community consultation framework) provides the expected processes for consultation.
Commonwealth Department of Environment and Energy (DEE)	A meeting with DEE was held to discuss the impacts of the project on any Matters of National Environmental Significance and the relevant provisions of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999.* An outline of the assessment of significance was provided in particular for listed species including the Green and Golden Bell Frog. Additionally, the discussion included any potential for impacts on Commonwealth Land.	The assessment on listed species has determined that a referral to the DEE is necessary given that impacts on species are expected to be below the required threshold. The assessment is provided in Chapter 12 (Biodiversity) and Appendix H (Biodiversity development assessment report). The project may have a requirement for sub-stratum property impact on a parcel of Commonwealth Land as discussed further in Chapter 14 (Property and land use).

Stakeholder	Feedback	Where addressed in EIS
Sydney Water Corporation	Questions and concerns raised around: • The project's shared cycleway and pedestrian pathways interface with the Muddy Creek Revitalisation project and • Identifying and assessing potential impacts on existing Sydney water utilities.	The alignment and design of the shared cycle and pedestrian pathways are outlined in Chapter 6 (Project description) and Appendix C (Place making and urban design). Impacts of the project on existing utilities are discussed in Chapter 7 (Construction).
Department of Education	The Department expressed general interest around impacts of the project on local schools, particularly Brighton Le Sands Public School which is located adjacent to Bicentennial Park. Key areas of interest included: • Location of tunnel ventilation facilities • Air quality • Local traffic impacts • Provision of pedestrian access in and around Bicentennial Park.	The project design including location of tunnel ventilation facilities is outlined in Chapter 6 (Project description). Experience from previous motorway tunnel projects in Sydney has demonstrated that emissions from tunnel ventilation outlets do not measurably affect local or regional air quality. Air quality impacts for the project are assessed in Chapter 9 (Air quality and greenhouse gas). Comprehensive traffic modelling has been carried out to assess the impact of the project on the main and local road network. A traffic impact assessment for the project is provided in Chapter 8 (Traffic and transport). Pedestrian movements in and around Bicentennial Park have been investigated with details provided in Chapter 8 (Traffic and Transport) as well as Appendix C (Place making and urban design).
Department of Infrastructure and Regional Development (DIRD), Civil Aviation Safety Authority (CASA) and Sydney Airport Corporation Limited (SACL)	As part of the Plume Rise Assessment preparation, meetings were held with DIRD, CASA and SACL to discuss: • Location of tunnel ventilation facilities • Cumulative impacts – Arncliffe ventilation and other project ventilation sites.	The project design including location of tunnel ventilation facilities is outlined in Chapter 6 (Project description). Options considered for the location of the ventilation facilities are outlined in Chapter 5 (Project alternatives and options). Experience from previous motorway tunnel projects in Sydney has demonstrated that emissions from tunnel ventilation outlets do not measurably affect local or regional air quality. Air quality impacts for the project (including cumulative impacts with other projects) are assessed in Chapter 9 (Air quality and greenhouse gas).

Bayside Council

Table 3-5 summarises the feedback provided by Bayside Council up to August 2018 and indicates where in the EIS this has been addressed. **Table 3-6** summarises the discussions which occurred during the technical working group meetings with Bayside Council.

Table 3-5 Consultation with Bayside Council

Summary of feedback	Response or where addressed in EIS
Biodiversity impacts	
Questions and concerns around environmental impacts on wetlands, vegetation removal and impacts to flora and fauna within the vicinity of the project, including at Rockdale Bicentennial Park and Patmore Swamp.	The project design has minimised disturbance to biodiversity where possible. An assessment of the potential impacts on wetlands, flora and fauna within the vicinity of the project are assessed in Chapter 12 (Biodiversity) and Appendix H (Biodiversity development assessment report).
Questions regarding the management of pest species.	An assessment of potential impacts due to pest species and proposed management of these species is provided in Chapter 12 (Biodiversity) and Appendix H (Biodiversity development assessment report).

Summary of feedback	Response or where addressed in EIS
Water impacts	
Questions and concerns about environmental impacts on waterways and water quality within the vicinity of the project including: • Impacts on local waterways • Impacts to ground water from drawdown effects • Interruption and pollution of ground water and local water courses • Impacts due to change in water flow • How water quality would be measured	The design of the project has considered how the project could be constructed to minimise disturbance to waterways. Environmental impacts on waterways within the vicinity of the project are assessed in Chapter 18 (Surface water and flooding). Environmental impacts to groundwater as a result of the project are assessed in Chapter 17 (Geology and groundwater). Contamination related impacts are assessed in Chapter 16 (Soils and contamination).
Water monitoring to be undertaken pre, during and post construction. Control measures should be as per the State government guidelines, entitled *Managing urban stormwater: soils and construction.*	Management measures for the waterways within the vicinity of the project are assessed in Chapter 18 (Surface water and flooding). Management measures for groundwater as a result of the project are assessed in Chapter 17 (Geology and groundwater). Construction of the project would be carried out in line with the *Managing urban stormwater: soils and construction guidelines.*
Flooding	
Concerns around flood modelling and infrastructure choices such as piping to managing flooding impacts. No concerns regarding emergency management arrangements for flooding were raised.	The design of the project has considered how the project could be constructed to minimise flood impacts. Appendix L (Surface water technical report) details the flood modelling and infrastructure choices.
Contamination	
Concerns around site contamination, particularly at Bicentennial Park and the impacts it could have to human health and the environment.	Chapter 16 (Soils and contamination) and Appendix C (Place making and urban design) address the potential contamination impacts. Appendix H (Biodiversity development assessment report) identifies the measures to manage impacts to human health.
Non-Aboriginal heritage impacts	
A Heritage Impact Statement of the route must be prepared.	A Statement of Heritage Impact has been prepared and is provided in Appendix N (Statement of heritage impact).
Aboriginal cultural heritage impacts	
An Aboriginal Heritage Impact Statement of the route must be prepared in consultation with Local Aboriginal Land Councils.	In consultation with a Culture and Heritage Officer from the Metropolitan Local Aboriginal Land Council (MLALC), an assessment of Aboriginal cultural heritage has been prepared which is provided in Chapter 20 (Aboriginal cultural heritage).
Air quality impacts	
Concerns about impacts on air quality and associated health impacts.	Experience from previous motorway tunnel projects in Sydney has demonstrated that emissions from tunnel ventilation outlets do not measurably affect local or regional air quality. Assessment of air quality impacts is provided in Chapter 9 (Air quality and greenhouse gas) and assessment of potential human health impacts as a result of the project is provided in Chapter 10 (Health safety and hazards).

Summary of feedback	Response or where addressed in EIS
Questions about the air quality monitoring that has been carried out for the project.	In October and November 2017, Roads and Maritime installed air quality monitoring stations at: • the end of Kings Road, Brighton-Le-Sands • the corner of General Holmes Drive and Tancred Avenue, Kyeemagh. Air quality monitoring stations measured concentrations of air pollutants such as carbon monoxide and nitrogen dioxide, as well as ozone and particulate matter within the air. They also monitored weather conditions, including temperature, wind direction and wind speed. Further details are provided in Chapter 9 (Air quality and greenhouse gas) and Appendix F (Human health technical report).
Queries about air quality management measures and what best practice standards would be used as part of the project.	Air quality management measures are provided in Chapter 9 (Air quality and greenhouse gas) and Appendix E (Air quality technical report).
Noise and vibration impacts	
Questions and concerns about noise and vibration impacts as a result of the construction and operation of the project, including vibration impacts on the structural integrity of buildings.	Noise and vibration impacts are addressed in Chapter 11 (Noise and vibration). A construction Noise and Vibration Management Plan would be prepared prior to construction and would include: • Acceptable noise levels • Noise and vibration monitoring methods during construction • Measures to reduce noise and vibration during construction.
Comments regarding property damage during tunnelling works (as a result of vibration impacts).	Property impacts are discussed in Chapter 17 (Groundwater and geology) and Chapter 14 (Property and land use). Further assessment of potential settlement impacts will be undertaken prior to excavation and tunnelling. Pre-construction Building Condition Surveys will be offered in writing, to the owners of properties where there is a potential for construction activities to cause cosmetic or structural damage. If accepted, a comprehensive written and photographic condition report would be produced by an appropriate professional.
Suggests Roads and Maritime undertake condition surveys prior to the start of construction and detailed asset monitoring during construction and post construction of public and private assets directly and adjacent to tunnelling sites.	As described in Chapter 24 (Project Synthesis) pre-construction building condition surveys of properties in the vicinity of the project will be offered.
Design	
Queries and concerns relating to the design including: • Ventilation outlet locations • Interchange locations • Road connections • Project/tunnel route • Active transport routes including the footbridge • Street scaping • Changes to Bicentennial Park.	The project design including location of tunnel ventilation facilities is outlined in Chapter 6 (Project description). The alternatives considered to the project are discussed in Chapter 5 (Project alternatives and options). Appendix C (Place making and urban design) outlines that streetscaping will be undertaken in consultation with Council. Indicative designs including the cyclist and pedestrian footbridge are also included.

Summary of feedback	Response or where addressed in EIS
Suggests investigating a direct motorway connection from Port Botany and Sydney Airport to the F6 Extension via an access point at the Arncliffe Interchange with the new M5 as part of Stage 1 F6 extension.	The alternatives considered to the project are discussed in Chapter 5 (Project alternatives and options).
Suggests that the bicycle bridge south of President Avenue should be realigned to accommodate the existing natural environment which has biodiversity value.	Appendix C (Place making and urban design) explains that the shared cycle and pedestrian pathways and shared bridge over President Avenue have been designed to fit with the redevelopment / reinstatements plans of the park which includes the wetland.
Community consultation	
Roads and Maritime to expedite the commencement of the Stakeholder Liaison Group to identify ways to reduce impacts Loss of Public Amenity of the proposed motorway.	Chapter 3 (Consultation) outlines that there is ongoing community and stakeholder engagement with Bayside Council and local schools / stakeholders.
Traffic and transport – heavy vehicles	
Suggests that the EIS should detail how a detour via Joyce Drive and the proposed Gateway/Northern Lands will provide a preferential heavy vehicle route	Chapter 8 (Traffic and transport) assesses the operational performance with the project, and provides justification for the access changes along President Avenue. The alternatives considered to the project are discussed in Chapter 5 (Project alternatives and options).
Traffic and transport – local traffic and road impacts	
Questions and concerns about impacts on local traffic and local streets including parking at various locations as a result of the project.	Comprehensive traffic modelling has been carried out to assess the impact of the project during construction and operation on the main and local road network. A traffic impact assessment for the project is provided in Chapter 8 (Traffic and transport).
Specific requests for traffic changes at the intersection of President Avenue and Civic Avenue to increase safety for residents entering and exiting Moorefield Estate.	Potential traffic changes at the intersection of President Avenue and Civic Avenue have been considered in Chapter 5 (Project alternatives and options).The installation of traffic lights at Civic Avenue has been considered, however the proximity of the intersection of President Avenue and West Botany Street, and President Avenue and Civic Avenue is considered to be too close to justify the provision of traffic lights.
Suggestions and concerns raised regarding local traffic movements to and from Moorefield Estate.	Chapter 8 (Traffic and transport) assesses the operational performance with the project, and provides justification for the access changes along President Avenue. Alternative arrangements for local traffic movements to and from Moorefield Estate, these considerations are detailed in Chapter 5 (Project development and alternatives). Chapter 8 (Traffic and transport) includes details on the proposed local traffic movements to and from Moorefield Estate.
Suggests Roads and Maritime undertakes post completion surveys to monitor how the predicted traffic impacts transpire, and whether the proposed mitigation measures are effective.	Chapter 8 (Traffic and transport) includes how a review of operational network performance will be undertaken 12 months and five years from commencement of operation to confirm the operational traffic impacts of the project on surrounding arterial roads and major intersections.
Council requests that a Construction Traffic Management Plan, Parking Management Plan and Pedestrian and Active Transport Management Plan be prepared.	Chapter 8 (Traffic and transport) includes the measures to prepare a Traffic Management Plan.
Community amenity	

Summary of feedback	Response or where addressed in EIS
Queries relating to the impact of the project on Bicentennial Park East, and relocation arrangements and timelines for local sporting groups and school sports associations occupying the fields impacted by the project footprint.	Appendix C (Place making and urban design) provides design strategies for the reinstatement of Rockdale Bicentennial Park. Areas of recreational land within Rockdale Bicentennial Park and Bicentennial East soccer field would be temporarily acquired for the project. Impacts on community amenity and access to local facilities and green space are assessed in Chapter 15 (Social and economic).
Suggests consultation be undertaken with the NSW Government and Council to identify strategic Government owned land holdings that can be dedicated to Council to provide a continuous green link of open space incorporating active transport from Bestic Street, Kyeemagh to President Avenue, Kogarah.	Chapter 3 (Consultation) outlines that there is ongoing community and stakeholder engagement with Bayside Council, local schools and stakeholders.
Pedestrian and cyclists	
Queries about impacts on active transport.	Roads and Maritime have incorporated cyclist and pedestrian infrastructure into the design of the project, to maintain and improve connections between key centres, and provide better access to active transport facilities for all residents in the area. Impacts of the project on the active transport network are assessed in Chapter 8 (Traffic and transport).
Shared cycle and pedestrian pathways	
Suggestions/Queries about alignment changes for the proposed shared cycle and pedestrian pathways.	Roads and Maritime have incorporated cyclist and pedestrian infrastructure into the design of the project, to maintain and improve connections between key centres, and provide better access to active transport facilities for all residents in the area. Impacts of the project on the active transport network are assessed in Chapter 8 (Traffic and transport).
Property and access	
Comments and queries about property access, property values and property acquisitions as a result of the project.	The project has been designed to minimise impact on property. Roads and Maritime will be responsible for acquisition of properties required for the project in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* and the property acquisition reforms introduced by the NSW Government in late 2016. Property access and property acquisitions as a result of the project is outlined in Chapter 14 (Property and land use).
Suggests that Council is included into the decision making process for the road reservation located from Arncliffe to Kogarah.	Property access and property acquisitions as a result of the project is outlined in Chapter 14 (Property and land use).
Project staging/ timeframe	
Questions about timing of the project.	Timing of the project is described in Chapter 6 (Project description).
Comments and queries relating to future F6 Extension project stages (Sections B & C), including: • Property impacts • Project route (including whether or not future sections would be above or below ground) • Road connections • Interchange locations • Ventilation outlet locations • Project timeframes.	Future project stages are not assessed as part of this EIS. Roads and Maritime is continuing investigations between Kogarah and Loftus to help determine any possible corridor adjustments for the future motorway, including any impacts that the project may have in subsequent project stages.

Summary of feedback	Response or where addressed in EIS
Project justification and need	
Comments regarding the justification of the project and that improvements to public transport infrastructure would better reduce traffic congestion, cost and have a lower environmental impact.	The strategic context and need for the project is discussed in Chapter 4 (Strategic context and project need). The alternatives considered to the project are discussed in Chapter 5 (Project alternatives and options).
Project alternatives: Safer active transport routes	
Comments regarding the detailed design of the shared cycle and pedestrian pathways would be developed in consultation with Bayside Council and other key stakeholders such as Sydney Water. Additional options that would be considered include: • Extension of the pathways west towards Rockdale Plaza and Kogarah Station • Extension of the pathways north, such as along Cooks Cove • Extension of the pathways east along Bay Street towards the beach	Chapter 3 (Consultation) outlines that there is ongoing community and stakeholder engagement with Bayside Council and local schools / stakeholders. Chapter 5 (Project alternatives and options) identifies the desired active transport route for the project.
Socio-economic: Impact on local businesses	
Questions how compensatory measures will be implemented to address the impacts on local businesses and the process for local businesses to access compensatory funding.	Chapter 15 (Social and economic) describes the compensatory measures for impacted businesses.
Socio-economic: Construction fatigue	
Questions how construction fatigue would be addressed including the community engagement process.	Chapter 15 (Social and economic) describes the processes involved to assist the community through construction fatigue related impacts.

Table 3-6 Consultation with Bayside Council - Technical working group meetings

Summary of feedback	Actions
Open space	
Concern and questions around temporary and permanent impacts to open space, which is valued by the community, and questions regarding the reinstatement of Rockdale Bicentennial Park.	Appendix C (Place making and urban design) provides design strategies for the reinstatement of Rockdale Bicentennial Park. Areas of recreational land within Rockdale Bicentennial Park and Bicentennial East soccer field would be temporarily acquired for the project. Impacts on community amenity and access to local facilities and green space are assessed in Chapter 15 (Social and economic). Impacts on community amenity and access to local facilities and green space are assessed in the same chapter, and includes the mitigation measures proposed to minimise or avoid impacts to social infrastructure. The final landscape plan for the reinstatement of parklands would be developed in consultation with key stakeholders.
Shared cycle and pedestrian pathways	
Questions regarding the final form and alignment of the shared cycle and pedestrian pathways.	Appendix C (Place making and urban design) shows diagrams of the shared cycle and pedestrian pathways. The path would be split for cyclists and pedestrians. Final alignment would be developed in consultation with Council. Potential options to be considered are in Chapter 5 (Project alternatives and options).

Summary of feedback	Actions
Questions regarding collaboration with Sydney Water's Muddy Creek revitalisation program.	Sydney Water has plans to naturalise the concrete-lined channel at Muddy Creek interfacing with Whiteoak Reserve as shown in Appendix C (Place making and urban design). There is an opportunity to work with Sydney Water to ensure a coordinated design approach.
Questions regarding the provision of lighting along the shared cycle and pedestrian pathways	Lighting along the shared cycle and pedestrian pathways, including the dedicated shared bridge, has been designed to meet the requirements of Australian Standard AS/NZS 1158: Lighting for roads and public spaces. Light poles would be offset one metre from the path to minimise risk of collisions for road users as described in Chapter 6 (Project Description).
Planning	
Concerned about the potential difference between Council's and Roads and Maritime's flood models.	Chapter 18 (Surface water and flooding) lists the different methods and models used for the flood assessment. Flooding patterns in the vicinity of the project were defined using the TUFLOW two-dimensional (in plan) hydraulic modelling software.
Council expressed a preference for filtered ventilation outlets	The tunnel ventilation system and tunnel operational parameters have been designed to ensure the in-tunnel concentration limits are not exceeded. Chapter 5 (Project alternatives and options) justifies why no in-tunnel filtration system is proposed for the project and more information is provided in Chapter 9 (Air quality).
Council questioned how odour and landfill gases would be managed during construction. Discussion was had on both points regarding current findings of the assessments	Chapter 16 (Soils and contamination) details that a further detailed investigation and assessment would be undertaken in order to development plans for landfill gases. Chapter 18 (Surface water and flooding) notes that redirecting discharges to Muddy Creek would avoid potential odour impacts.
What options are being considered for enhancement of the park and water quality of Bicentennial Park? What can Roads and Maritime do to prevent groundwater from flowing into the ponds? (Would a cut off wall be feasible?).	The design of the project has considered how the project could be constructed to minimise disturbance to waterways. Environmental impacts on waterways within the vicinity of the project are assessed in Chapter 18 (Surface water and flooding). Environmental impacts to groundwater as a result of the project are assessed in Chapter 17 (Geology and groundwater).
Council has assets in the ponds: • Stormwater treatment (GPT on western side of pond near Illinden Sports Field) • Two floating wetlands moored to the island in the southern part of the ponds. • Turtle steps on weir at President Avenue How will these assets be protected and maintained during construction?	Appendix K (Groundwater technical report) describes that the existing floating wetlands within the Rockdale Bicentennial Park Pond would be retained and protected. Inflow from construction discharges are unlikely to significantly affect the water level within the pond with the additional flow discharging over the weir and being conveyed to the Northern Scarborough Pond The stormwater outlet (and its trash rack) adjacent to the Rockdale Bicentennial Park Pond footbridge is located within the cut and cover zone. The stormwater pipe would be diverted around the cut and cover structure and the trash rack relocated or replaced.

Summary of feedback	Actions
Council question on vegetation within the large construction area at Bicentennial Park. It was asked whether Roads and Maritime will maintain (weed) vegetation within the construction site that is protected within 'no-go' zones during the lease period.	As describes in Chapter 12 (Biodiversity) that a Construction Flora and Fauna Management Plan (CFFMP) would be prepared containing the process for identifying and managing priority and environmental weeds and other pests – including within vegetation exclusion zones.
Council would like to be part of the Urban Design Panel	Council would be consulted as part of the further development of the urban design for the project.
Traffic and transport	
Moorefield's Estate – Roads and Maritime confirmed surveys being undertaken. Council acknowledged there is not an easy answer to access to the estate - Suggestions and concerns raised regarding local traffic movements to and from Moorefield Estate.	Chapter 8 (Traffic and transport) assesses the operational performance with the project, and provides justification for the access changes along President Avenue.
Council would like off road and move route closer to West Botany Street	Chapter 5 (Project alternatives and options) identifies the desired route for the project.

Community

Feedback provided by community members, special interest groups (including pedestrian and cyclist user groups, sporting associations and environmental groups), businesses and adjoining, affected landowners and stakeholders during the preparation of this EIS. **Table 3-7** consolidates feedback from the community for the purpose of this EIS and provides a response or indicates where in the EIS this topic has been addressed.

Table 3-7 Feedback from the community

Summary of feedback	Response or where addressed in EIS
Biodiversity impacts	
Questions and concerns about environmental impacts on wetlands, flora and fauna within the vicinity of the project, including at Rockdale Bicentennial Park. Comments about the removal of trees and vegetation.	The project design has minimised disturbance to biodiversity where possible. An assessment of the potential impacts on wetlands, flora and fauna within the vicinity of the project are assessed in Chapter 12 (Biodiversity).
Comments regarding impacts to the wetland ecosystem in Bicentennial Park and downstream as a result of tunnelling through the park.	Chapter 12 (Biodiversity) provides a summary of the biodiversity impacts associated with the project and outlines how the desired performance outcomes have been met.
Comments about the removal of trees and vegetation, and questions about the mitigation measures proposed.	Chapter 12 (Biodiversity) provides information on the proposed tree management strategy. The replacement of trees is also described in Chapter 13 (Landscape and visual)
Questions and concerns about environmental impacts on flora and fauna including: • How much existing vegetation would be removed and would it be compensated • How vegetation would be protected • How would local populations of native animals be identified and protected	A detailed biodiversity development assessment report (BDAR) has been prepared for the project and is included in Appendix H (Biodiversity development assessment report). Chapter 12 (Biodiversity) also provides information on impacts on flora and fauna.
Questions and concerns regarding the baseline data used to assess the local wildlife and the monitoring process during and post construction.	Chapter 12 (Biodiversity) lists information on baseline monitoring and describes actions required during and after construction.

Summary of feedback	Response or where addressed in EIS
Water impacts	
Questions and concerns about environmental impacts on waterways within the vicinity of the project including: • Impacts on local waterways • Impacts to ground water from drawdown effects • Interruption and pollution of ground water and local water courses • Impacts due to change in water flow.	The design of the project has considered how the project could be constructed to minimise disturbance to waterways. Environmental impacts on waterways within the vicinity of the project are assessed in Chapter 18 (Surface water and flooding). Environmental impacts to groundwater as a result of the project are assessed in Chapter 17 (Geology and groundwater).
Concerns and questions surrounding the data and assumptions on which the flood modelling is based. Claims have been made that President Avenue has never experienced flooding.	Chapter 18 (Surface water and flooding) lists the different methods and models used for the flood assessment. Flooding patterns in the vicinity of the project were defined using the TUFLOW two-dimensional (in plan) hydraulic modelling software.
Non-Aboriginal heritage impacts	
Concerns about impacts on areas and properties of heritage significance.	Assessment of non-Aboriginal heritage impacts is provided in Chapter 19 (Non-Aboriginal heritage). All properties located above the tunnel alignment, within 50 metres of the outer edge of the tunnel alignment, or within 50 metres of surface construction work would be offered a property condition survey before and after construction. This would ensure a clear record of the condition of each property before construction starts.`
Requires as part of the EIS that a Statement of Heritage Impact assessments be prepared using the *2014 Conservation Management Plan for Scarborough Park is to be referenced as a policy document*.	A Statement of Heritage Impact has been prepared and is provided in Appendix N (Statement of heritage impact).
Aboriginal cultural heritage impacts	
Concerns that insufficient consultation has been undertaken with the local Aboriginal community.	During preparation of this EIS Roads and have worked with a Culture and Heritage Officer from the Metropolitan Local Aboriginal Land Council (MLALC) to understand any potential impacts to items or areas of Aboriginal cultural heritage significance. Assessment of Aboriginal cultural heritage impacts and details of consultation undertaken with the local aboriginal community is provided in Chapter 20 (Aboriginal cultural heritage).
Air quality impacts	
Concerns about impacts on air quality and associated health impacts.	Experience from previous motorway tunnel projects in Sydney has demonstrated that emissions from tunnel ventilation outlets do not measurably affect local or regional air quality. Assessment of air quality impacts is provided in Chapter 9 (Air quality and greenhouse gas) and Assessment of potential human health impacts as a result of the project is provided in Chapter 10 (Health safety and hazards).

Summary of feedback	Response or where addressed in EIS
Questions about the air quality monitoring that has been carried out for the project.	In October and November 2017, Roads and Maritime installed air quality monitoring stations at: • the end of Kings Road, Brighton-Le-Sands • the corner of General Holmes Drive and Tancred Avenue, Kyeemagh. Air quality monitoring stations measured concentrations of air pollutants such as carbon monoxide and nitrogen dioxide, as well as ozone and particulate matter within the air. They also monitored weather conditions, including temperature, wind direction and wind speed. Further details are provided in Chapter 9 (Air quality and greenhouse gas) and Appendix F (Human health technical report).
Queries about air quality ventilation outlet health impacts including: • Method of assessment of air pollution impacts associated with ventilation outlets • The effects of inhalation of particles from the ventilation outlets, particularly if they are proposed within close proximity to schools and recreational facilities.	Experience from previous motorway tunnel projects in Sydney has demonstrated that emissions from tunnel ventilation outlets do not measurably affect local or regional air quality. Assessment of air quality impacts is provided in Chapter 9 (Air quality and greenhouse gas) and Appendix E (Air quality technical report). Assessment of human health impacts is provided in Chapter 10 and Appendix F (Human health technical report).
Comments or questions about the locations of the ventilation outlets. Comments that research and assessments be carried out to understand the implications of unfiltered ventilation outlets on the health and safety of residents in the area.	Evidence to date suggests that the effectiveness of filtration, when applied to road tunnels, is limited to specific situations. Repeated assessments have concluded that there is little to no health benefit for surrounding communities in installing tunnel air treatment systems. Further details are provided in Chapter 9 (Air quality and greenhouse gas) and Chapter 10 (Health safety and hazards).
Noise and vibration impacts	
Questions and concerns about noise and vibration impacts as a result of the construction and operation of the project, including vibration impacts on the structural integrity of buildings.	Noise and vibration impacts are addressed in Chapter 11 (Noise and vibration). A construction Noise and Vibration Management Plan would be prepared prior to construction and would include: • Acceptable noise levels • Noise and vibration monitoring methods during construction • Measures to reduce noise and vibration during construction.
Questions about the measures that will be taken to minimise the significant levels of noise and vibrations that will be emitted by heavy trucks braking and accelerating on President Avenue. Concerns about sleep disruption for residents in the vicinity of President Avenue.	Mitigation measures to minimise noise and vibrations associated with heavy trucks are outlined in Chapter 11 (Noise and vibration) and Appendix G (Noise and vibration technical report). A construction Noise and Vibration Management Plan would be prepared prior to construction and would include: • Acceptable noise levels • Noise and vibration monitoring methods during construction • Measures to reduce noise and vibration during construction.
Questions about the measures (such as noise walls and at-property noise treatments) that will be taken to minimise noise and vibration impacts during project operation.	An operational road traffic noise assessment has been completed. Appendix G (Noise and vibration technical report) provides details and potential mitigation measurements.

Summary of feedback	Response or where addressed in EIS
Construction impacts: Traffic	
Questions and concerns about the frequency and management of construction vehicles entering and exiting the project and surrounding depots.	Construction traffic management and access is discussed in Chapter 8 (Traffic and transport). This chapter identifies the route and scheduling of construction movements, and the number, frequency and size of construction-related vehicles, including for spoil removal.
Construction impacts	
Questions and concerns raised about construction impacts such as noise, dust and vibration on local infrastructure, including local schools, hospitals, disability centres and aged care facilities.	Chapter 9 (Air quality) and Chapter 11 (Noise and vibration) discuss the impacts and management measures surrounding air quality and noise and vibration. Chapter 15 (Social and economic) outlines the potential social and economic impacts.
Questions and concerns raised about construction working hours.	Chapter 11 (Noise and vibration) identifies the construction working hours and relevant guidelines.
Design	
Queries and concerns relating to the design including: • Ventilation outlet locations • Interchange locations • Road connections • Project route • Changes to Bicentennial Park.	The preferred project design is outlined in Chapter 6 (Project description) while Chapter 5 (Project alternatives and options) describes design options that were considered as part of the design development process.
Community consultation	
Dissatisfaction with the community consultation process, including the consultation period and materials.	Chapter 2 (Assessment process) describes the formal process to be applied under the *Environmental Planning and Assessment Act 1979* (EP&A Act). Chapter 3 (Consultation) provides details on the process applied by the project.
Local traffic	
Questions and concerns about impacts on local traffic at various locations as a result of the project.	Chapter 5 (Project alternatives and options) provides an summary of the options considered to address changes to local traffic at various locations, including O'Connell Street and Civic Avenue. Comprehensive traffic modelling has been carried out to assess the impact of the project during construction and operation on the main and local road network. A traffic impact assessment for the project is provided in Chapter 8 (Traffic and transport).
Specific requests for traffic changes at the intersection of President Avenue and Civic Avenue to increase safety for residents entering and exiting Moorefield Estate.	Potential traffic changes at the intersection of President Avenue and Civic Avenue have been considered in Chapter 5 (Project alternatives and options). The installation of traffic lights at Civic Avenue has been considered, however the proximity of the intersection of President Avenue and West Botany Street, and President Avenue and Civic Avenue is considered to be too close to justify the provision of traffic lights.

Summary of feedback	Response or where addressed in EIS
Suggestions or feedback provided regarding the local traffic changes necessary to integrate the proposed new President Avenue intersection with the existing road network.	Comprehensive traffic modelling has been carried out to assess the impact of the project on the main and local road network. A traffic impact assessment for the project is provided in Chapter 8 (Traffic and transport). Design options have been investigated to improve the performance of main roads surrounding the proposed new intersection on President Avenue at Kogarah. Potential traffic changes at the President Avenue intersection have been considered in Chapter 5 (Project alternatives and options).
Suggestions and concerns raised regarding local traffic movements to and from Moorefield Estate.	Chapter 8 (Traffic and transport) assesses the operational performance with the project, and provides justification for the access changes along President Avenue. Chapter 5 (Project alternatives and options) provides an analysis of local traffic movements to and from Moorefield Estate. The proposed arrangement is discussed in further detail in Chapter 8 (Traffic and transport).
Health and safety	
Comments relating to potential health and safety impacts of the project including those due to: • Air quality impacts associated with ventilation outlets • Health impacts associated with reduced available green space • Health impacts associated with reduced access to local community facilities • Impacts on pedestrian and cyclist safety • Potential increases in vehicle accidents • Vehicles speeding on President Avenue	Health, safety and hazards for the project including health impacts associated with reduced available green space are assessed in Chapter 10 (Health safety and hazards) and Appendix F (Human health technical report). Experience from previous motorway tunnel projects in Sydney has demonstrated that emissions from tunnel ventilation outlets do not measurably affect local or regional air quality. Air quality impacts for the project are assessed in Chapter 9 (Air quality and greenhouse gas). Impacts on pedestrian and cyclist safety, and road safety are assessed in Chapter 10 (Health safety and hazards) and Chapter 8 (Traffic and transport).
Questions and concerns about impacts on health resultant from air from ventilation outlets contaminating local produce.	Experience from previous motorway tunnel projects in Sydney has demonstrated that emissions from tunnel ventilation outlets do not measurably affect local or regional air quality. Health impacts due to air ventilation outlets are assessed in Chapter 10 (Health safety and hazards).
Public transport	
Questions and concerns about impacts on public transport as a result of the project.	Impacts on public transport as a result of the project are provided in Chapter 8 (Traffic and transport). Any decisions regarding changes to existing transport infrastructure would be made in consultation with Transport for NSW and the local community.
Queries about justification of the development of the project as opposed to developing additional public transport infrastructure.	Alternatives to the project including development of additional public transport infrastructure as an alternative to the project have been considered in Chapter 5 (Project alternatives and options).
Community amenity	
Questions about impacts on community amenity, including access to local facilities and green space (including Rockdale Bicentennial Park) resulting from the project.	Roads and Maritime have incorporated cyclist and pedestrian infrastructure into the design of the project, to maintain and improve connections between key centres, and provide better access to active transport facilities for all residents in the area. There are no direct impacts proposed to the Ilinden Sports Centre facility or Brighton Memorial Fields by the project. Impacts on community amenity and access to local facilities and green space are assessed in Chapter 15 (Social and economic), and includes the mitigation measures proposed to minimise or avoid impacts to social infrastructure.

Summary of feedback	Response or where addressed in EIS
Feedback received about the physical appearance of ventilation outlets, noise walls, and the proposed new intersection on President Avenue.	Visual amenity impacts as a result of the project are assessed in Chapter 13 (Landscape and visual) including detailed urban design assessments and considerations.
Questions about impacts to Beehag Reserve, Spring Street.	The project would have no direct impact on Beehag Reserve. The project would be a tunnel for the majority of its length and would be underground in the vicinity of Beehag Reserve and Spring Street as described in Chapter 6 (Project description).
Questions about the impact the project will have on Memorial Playing Fields, used by local schools and sporting groups.	The project design as described in Chapter 6 (Project description) does not impact on Memorial Playing Fields during construction or operation.
Questions about the impact the project will have on the dog park at Patmore Swamp.	The project design as described in Chapter 6 (Project description) does not impact the dog park at Patmore Swamp (Scarborough Park) located next to Civic Avenue, south of President Avenue.
Questions and concerns raised about impacts on community amenity, including access to local facilities and services including public transport, local schools, and green space resulting from the project.	Impacts on community amenity and access to local facilities and green space are assessed in Chapter 15 (Social and economic), and includes the mitigation measures proposed to minimise or avoid impacts to social infrastructure.
Request for the project to include improvements to the visual amenity of the local area to boost the attractiveness of the area for locals and tourists.	Appendix C (Place making and urban design) details the improvements to the visual amenity of the local area.
Queries relating to the impact of the project on Bicentennial Park East, and relocation arrangements and timelines for local sporting groups and school sports associations occupying the fields impacted by the project footprint.	Appendix C (Place making and urban design) provides design strategies for the reinstatement of Rockdale Bicentennial Park. Areas of recreational land within Rockdale Bicentennial Park and Bicentennial East soccer field would be temporarily acquired for the project. Impacts on community amenity and access to local facilities and green space are assessed in Chapter 15 (Social and economic).
Comments regarding community access across Rockdale Bicentennial Park during project construction and operation.	Appendix C (Place making and urban design) provides design strategies for the reinstatement of Rockdale Bicentennial Park. Areas of recreational land within Rockdale Bicentennial Park would be temporarily acquired for the project. Impacts on community amenity and access to local facilities and green space are assessed in Chapter 15 (Social and economic). Chapter 7 (Construction) also provides information on impacts to Rockdale Bicentennial Park during construction.
Questions about impacts to Scarborough Park, south of President Avenue.	Chapter 6 (Project description) provides a detailed description of the works proposed within the northern section of Scarborough Park.
Questions about impacts to Barton Park and comments regarding the proposed relocation of Kogarah Golf Course.	Chapter 15 (Social and economic) details the potential impacts to Barton Park and the Kogarah Golf Course.
Queries relating to the impact on recreational facilities within Rockdale Bicentennial Park, including Rockdale Skate Park and the proposed relocation arrangements and timelines.	Appendix C (Place making and urban design) provides design strategies for the reinstatement of Rockdale Bicentennial Park. Chapter 15 (Social and economic) details the impact on recreational facilities within Rockdale Bicentennial Park including the skate park, including the approach for temporary and permanent relocation of these facilities.

Summary of feedback	Response or where addressed in EIS
Questions and concerns raised about impacts to Rockdale Public School due to the proximity of the construction site, ventilation facility and proposed new intersection on President Avenue.	Impacts to public schools and their proximity to the surrounding project facilities are assessed in Chapter 15 (Social and economic). Chapter 9 (Air quality) determines the impacts of ventilation outlets to remain below the relevant air quality criteria.
Questions and concerns that changed local traffic conditions and increased traffic on President Avenue would reduce the amenity of the local area.	Changed local traffic conditions and their potential impact to the local amenity of the are addressed in Chapter 15 (Social and economic) and Chapter 14 (Property and land use).
Pedestrian and cyclists	
Queries about impacts on active transport.	Roads and Maritime have incorporated cyclist and pedestrian infrastructure into the design of the project, to maintain and improve connections between key centres, and provide better access to active transport facilities for all residents in the area. Impacts of the project on the active transport network are assessed in Chapter 8 (Traffic and transport).
Shared cycle and pedestrian pathways	
Suggestions/Queries about alignment changes for the proposed shared cycle and pedestrian pathways.	Roads and Maritime have incorporated cyclist and pedestrian infrastructure into the design of the project, to maintain and improve connections between key centres, and provide better access to active transport facilities for all residents in the area. Impacts of the project on the active transport network are assessed in Chapter 8 (Traffic and transport).
Public transport	
Questions and concerns about impacts on public transport as a result of the project.	Impacts on public transport as a result of the project are provided in Chapter 8 (Traffic and transport). Any decisions regarding changes to existing transport infrastructure would be made in consultation with Transport for NSW and the local community.
Queries about justification of the development of the project as opposed to developing additional public transport infrastructure.	Alternatives to the project including development of additional public transport infrastructure as an alternative to the project have been considered in Chapter 5 (Project alternatives and options).
Property and access	
Comments and queries about property access, property values and property acquisitions as a result of the project.	The project has been designed to minimise impact on property. Roads and Maritime will be responsible for acquisition of properties required for the project in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* and the property acquisition reforms introduced by the NSW Government in late 2016. Property access and property acquisitions as a result of the project is outlined in Chapter 14 (Property and land use).
Comments relating to the impacts on parking on various roads and local roads, including possible business implications from loss of parking.	Parking impacts of the project and mitigation measures to address these impacts are discussed in Chapter 8 (Traffic and transport). Impacts to businesses as a result of changes to parking is discussed in Chapter 15 (Social and economic).
Comments regarding property damage during tunnelling works (as a result of vibration and settlement impacts).	Ground settlement and property impacts are discussed in Chapter 17 (Geology and groundwater) and Chapter 14 (Property and land use). Further assessment of potential settlement impacts will be undertaken prior to excavation and tunnelling. Pre-construction Building Condition Surveys will be offered in writing, to the owners of properties where there is a potential for construction activities to cause cosmetic or structural damage. If accepted, a comprehensive written and photographic condition report would be produced by an appropriate professional.

Summary of feedback	Response or where addressed in EIS
Project staging/ timeframe	
Questions about timing of the project.	Timing of the project is described in Chapter 6 (Project description).
Comments and queries relating to future F6 Extension project stages (Sections B & C), including: • Property impacts • Project route (including whether or not future sections would be above or below ground) • Road connections • Interchange locations • Ventilation outlet locations • Project timeframes.	Future project stages are not assessed as part of this EIS. Roads and Maritime is continuing investigations between Kogarah and Loftus to help determine any possible corridor adjustments for the future motorway, including any impacts that the project may have in subsequent project stages.
Project justification and need	
Comments regarding the justification of the project and that improvements to public transport infrastructure would better reduce traffic congestion, cost and have a lower environmental impact.	The strategic context and need for the project is discussed in Chapter 4 (Strategic context and project need). The alternatives considered to the project are discussed in Chapter 5 (Project alternatives and options).
Queries relating funding being provided to the project prior to the completion of a thorough environmental assessment and traffic management assessment.	In June 2018 the NSW Government announced that Stage 1 of the project is fully funded. Chapter 2 (Assessment process) describes the formal process to be applied under the *Environmental Planning and Assessment Act 1979* (EP&A Act). Comprehensive traffic modelling has been carried out to assess the impact of the project during construction and operation on the main and local road network. A traffic impact assessment for the project is provided in Chapter 8 (Traffic and transport).

3.4 Consultation during public exhibition of the EIS

3.4.1 Display of the EIS

The Department of Planning and Environment (DP&E) will place this Environmental Impact Statement (EIS) on public exhibition for a minimum of 30 days. During the exhibition period, government agencies, project stakeholders and community members will be able to review the EIS and make a written submission to the DP&E for consideration in its assessment of the project. Advertisements will be placed in newspapers to advise of the public exhibition, where the EIS can be viewed and details of community consultation activities and information sessions.

Copies of the EIS would be available for viewing at the following locations:

- Roads and Maritime (Head office): 20-44 Ennis Road, Milsons Point NSW 2061
- Department of Planning and Environment: 320 Pitt Street, Sydney NSW 2000
- Council offices:
  - Bayside Council: Rockdale Customer Service Centre, 444-446 Princes Highway, Rockdale NSW 2216
  - Georges River Council: Kogarah Library and Service Centre: Kogarah Town Square, Belgrave Street, Kogarah NSW 2223
  - Inner West Council: Petersham Customer Service Centre, 2-14 Fisher Street, Petersham NSW 2049
  - Canterbury-Bankstown Council: Bankstown Customer Service Centre: Upper Ground Floor, Bankstown Civic Tower, 66 – 72 Rickard Road (Corner of Jacob Street), Bankstown NSW 2200
- Libraries:
  - Bayside Council:
    - Brighton-Le-Sands Library Brighton-Le-Sands Library: 1 Moate Avenue, Brighton-Le-Sands, NSW 2216
    - Rockdale Library: 444-446 Princes Hwy, Rockdale NSW 2216
    - Arncliffe Library: 11 Firth St, Arncliffe NSW 2205
    - Sans Souci Library: 104 Russell Ave, Sans Souci NSW 2219
  - Canterbury-Bankstown:
    - Earlwood Library and Knowledge Centre, Corner of Homer and William Street, Earlwood NSW 2206
  - Inner West Council:
    - St Peters/Sydenham Library: 39 Unwins Bridge Road, Sydenham NSW 2044
  - Georges River Council:
    - Kogarah Library and Service Centre: Kogarah Town Square, Belgrave Street, Kogarah NSW 2223

Electronic copies of the EIS would be made available for viewing and download from the DP&E website.

Community information sessions and ‘Pop-up’ information stands

A series of community information sessions and ‘Pop-up’ information stands are being held to provide community members an opportunity to discuss the EIS with technical specialists and to learn about the submission process.

The information sessions are being held in an informal drop-in style, and are scheduled at different dates and times during and after business hours to provide various opportunities for community members and interested parties to attend at a time that is convenient for them. The time and location of these sessions has been advertised in local and metropolitan newspapers, published on the project website, detailed in a community update, and sent via an email to registered stakeholders.

Activities planned to support the display of the EIS include:

- The provision of a project overview document
- Project website updates
- Displays at local councils
- A community update newsletter delivered to residences and businesses within the project area
- An email to registered stakeholders to notify them that the EIS is on display
- Targeted stakeholder briefings and meetings
- Newspaper advertising to promote the exhibition of the EIS and community information sessions
- The provision of project fact sheets
- An online EIS navigator tool
- A project email (F6Extension@rms.nsw.gov.au) and phone number (1800 789 297) to manage enquiries and provide information on the EIS.

During the EIS exhibition, community members, government agencies and other interested parties may send written submissions on the project to the DP&E. At the completion of the public exhibition period and after reviewing the submissions, Roads and Maritime would prepare a submissions report and/or a preferred infrastructure report, to respond to the issues raised. This report would be made available to the public. Further information on the approvals process is provided in **Chapter 2** (Assessment process).

3.4.2 Preparation of submissions report

The Planning Secretary would provide copies of submissions made during the exhibition of the EIS to Roads and Maritime as the project proponent. The Planning Secretary would then require the proponent to prepare a submissions report to respond to the issues raised in submissions and a preferred infrastructure report to outline any proposed changes to the project. If the Planning Secretary considers that significant changes to the project are proposed, the Planning Secretary may make the preferred infrastructure report publicly available in accordance with section 115Z(7) of the EP&A Act.

DP&E would prepare the Planning Secretary's environmental assessment report and provide it to the Minister for Planning. The Minister for Planning would then decide whether to approve the project and, if approved, identify a set of conditions of approval for Roads and Maritime to adhere to during construction and operation of the project.

Roads and Maritime would continue to engage with the community and stakeholders during the assessment process. Further details, including a flow chart outlining the assessment and approval process following EIS submission, can be found in **Chapter 2** (Assessment process).

3.5 Consultation during construction of the project

If the project is approved a construction contractor would be engaged to carry out detailed design, and construct the project. Both Roads and Maritime and the construction contractor would be responsible for communication and consultation with stakeholders and the community during project construction.

The objective of consultation activities supporting construction of the project is to:

- Keep the community informed about the project including construction activities, work programs and associated impacts
- Ensure there is an opportunity to provide feedback on the project or to register complaints about impacts
- Provide a process to resolve complaints and issues raised.

The community and stakeholder consultation carried out during construction would include updates on the planned construction activities and program, and would respond to enquiries and concerns in a timely manner, and seek to minimise potential impacts where possible.

During construction, a dedicated community relations team would deliver:

- A detailed Community Communication Strategy to detail the processes to facilitate communication and feedback between the project team and the community
- Notification letters and phone calls to residents and businesses directly affected by construction works notifying them of matters such as changes to traffic arrangements and out of hours works
- Face-to-face meetings with landowners as needed
- Regular community updates on the progress of the construction program
- Regular updates to the project website
- Media releases and project advertising in local and metropolitan English language and non-English language newspapers to provide contact information for the project team
- Site signage around construction and ancillary facilities
- A 24 hour, toll-free project information and complaints line, a dedicated email address and postal address.

Managing complaint fatigue

The extent and impacts of complaint fatigue would be considered by:

- Identifying regular complainants from previous and current projects (including the New M5 Motorway) within close proximity to the construction
- Analysing the cause and solution to each complaint
- Determining whether the project would result in similar or overlapping impacts with other projects, which are likely to result in a complaint.

A Complaints Management System would be in place for the duration of construction. This system would include the recording of complaints and how the complaint has been addressed (within a Complaints Register). Complainants would be contacted within 24 hours to follow up and respond to their complaint. A Community Complaints Commissioner, who is an independent specialist, would oversee the system and would follow-up on any complaint where the public is not satisfied with the response.

The community relations team would build a working relationship with the project teams for other major projects which would be under construction at the same time as the project to identify stakeholders and community members who may be susceptible to complaint fatigue.

The project team would ensure a number of different complaint mechanisms are provided to cater to different needs and preferences. Complaint management tools for the project are outlined in **Appendix B** (Draft community consultation framework).

Managing consultation fatigue

The extent and impacts of consultation fatigue would be assessed by:

- Identifying potentially impacted stakeholders and community members by both previous/current projects (including the New M5 Motorway) and the project
- Analysing the type, extent and timing of consultation – for other projects and the project – that has been/would be received by these community members
- Determining whether consultation for the project is likely to result in overload or disinterest for community members.

The community relations team would build a working relationship with the project teams for other major projects in the area to identify those persons or organisations who may be susceptible to consultation fatigue.

The project team would work to develop an integrated approach to contacting persons or organisations that may experience consultation fatigue. The project team would also determine which communication mechanisms stakeholders prefer.

Managing construction fatigue

The extent and impacts of construction fatigue would be assessed by:

- Identifying where the project would have sustained impacts to stakeholders or community members
- Identifying whether the project would result in similar or overlapping impacts with other projects, to the same stakeholders or community members
- Analysing whether the project would increase the magnitude and intensity of overlapping impacts on any stakeholders or community members
- Analysing the extension of duration of impacts for stakeholders or community members.

A preliminary assessment was completed to identify areas where the project would have sustained impacts to stakeholders or community members and where stakeholders or community members would be impacted by construction fatigue. Project activities which could lead to construction fatigue, the potentially impacted persons or organisations and a summary of the mitigations proposed to address these issues is provided in **Chapter 15** (Social and economic).

During construction of the project, the community relations team would build a working relationship with the project teams for other major projects to identify stakeholders or community members who may be susceptible to construction fatigue. The project team would ensure the expectations of these stakeholders or community members are managed for the project.

The management measures for the project would be aligned with the New M5 Motorway project management measures. The potential for construction fatigue would be taken into account when finalising the management measures for the project, and the project team would ensure the implementation of these measures is timely.

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4 Strategic context and project need

4.1 Current issues with the road network

4.1.1 Traffic congestion across Greater Sydney

Traffic growth is forecast across NSW and will include around one million extra road users in Sydney within the next decade and nearly twice the freight movements by 2031.

Congestion across metropolitan Sydney is estimated to cost up to $6.1 billion per annum, rising to $12.6 billion by 2030 if nothing is done[1]. Travel by road is the dominant transport mode in Sydney. Even with high growth in rail freight and public transport, road travel is predicted to continue to be the most dominant travel choice for at least the next 20 years[2]. Traffic congestion impacts communities and businesses by:

- Affecting Sydney's large and significant freight, service and business operations
- Reducing the reliability of, and accessibility to, public transport
- Constraining the movement of pedestrians and cyclists
- Reducing amenity for nearby residents, pedestrians, cyclists and sensitive land uses (educational and health facilities).

4.1.2 Missing regional motorway link

In Sydney's South District (which includes the Canterbury-Bankstown, Georges River and Sutherland LGAs), over 50 per cent of journeys are undertaken by car.

There is currently no motorway between the existing M1 Princes Motorway south of Waterfall and the Sydney motorway network. All local and through traffic, including heavy vehicle traffic, is currently required to use the arterial road network to travel between Waterfall and Sydney, principally the A1 Princes Highway, the A3 King Georges Road and / or the A6 Heathcote Road / New Illawarra Road. This results in traffic congestion, leading to delayed travel times.

Traffic congestion can reduce the capacity for freight vehicles to move from and to the nationally significant gateways of Sydney Airport, Port Botany and Port Kembla. Addressing the gaps in Sydney's motorway network is one of the most important steps in expanding capacity for freight across Greater Sydney.

The project would form the first stage of the F6 Extension. The existing F6 reserved corridor between Arncliffe and Loftus was reserved in the 1950s to ensure land was available to accommodate the required road infrastructure for a future connection to link the existing A1 Princes Highway at Loftus with the Sydney motorway network at Arncliffe. Much of that same reservation remains in place today and forms part of the study area being considered in investigations for the F6 Extension.

[1] Infrastructure NSW (2018) NSW State Infrastructure Strategy
[2] Infrastructure NSW (2012) First things first - The State Infrastructure Strategy 2012 – 2032

4.1.3 Local context

The President Avenue intersection to St Peters interchange corridor accommodates high volumes of daily traffic, including freight, commuter and leisure trips. The average speeds experienced by motorists on routes along these corridors particularly The Grand Parade and the Princes Highway, during peak periods are significantly less than the sign posted speed limits indicating congested conditions on these roads. This congestion results in long journey times for motorists.

The Grand Parade

The Grand Parade accommodates high levels of daily traffic which predominantly travel to and from the Sydney CBD via General Holmes Drive. More than 2700 vehicles travel northbound along The Grand Parade (north of President Avenue) during the weekday AM peak hour, and around 3600 vehicles travel southbound along The Grand Parade during the weekday PM peak hour (2015 – 2017).

About 67,500 vehicles travel on the Grand Parade, between Bay Street and the M5 East, each weekday (2017). Around 13 per cent of total vehicles on The Grand Parade in the vicinity of President Avenue are heavy vehicles.

In the period from 2012 to 2016, there were 219 injury crashes along The Grand Parade / General Holmes Drive, between Southern Cross Drive and Barton Street.

The Grand Parade is a popular destination for local residents and visitors due to its retail and dining precinct at Brighton-Le-Sands, as well as its proximity to Lady Robinsons Beach and views to Botany Bay. Through traffic along The Grand Parade impacts on pedestrian and cyclist safety and amenity of the area.

Princes Highway

The Princes Highway accommodates high levels of daily traffic including freight, commuter and leisure travel. The Princes Highway (north of Rocky Point Road) accommodates more than 37,000 vehicles travelling northbound during the weekday AM peak hour (2015-2017).

The Princes Highway (north of Bestic Street) accommodates more than 35,000 vehicles per weekday (2017 two-way). Users of the Princes Highway frequently experience congestion and delays and travel times are unacceptably long during peak hours. In the period from 2012 to 2016, there were 309 injury crashes along the Princes Highway, between Gannon Street and Jubilee Street.

The Princes Highway is also used for several bus routes which provide services to and from Rockdale Plaza, Rockdale Station and the Sydney CBD. There are currently no dedicated bus lanes on the Princes Highway, resulting in frequent delays to bus services due to congestion.

4.2 Future changes affecting transport in Greater Sydney

4.2.1 Population growth

The Greater Sydney transport network currently services a population of some five million people with about 15.5 million trips on a normal weekday. The population of Greater Sydney will grow to around eight million over the next 40 years, with an additional 817,000 jobs.

With a continuing increase in population, it is anticipated there will be continued growth in traffic on Sydney's roads, with the number of trips made around Sydney each day forecast to increase by 31 per cent, from 15.5 million to 21 million by 2036[3]. This growth will place growing pressure on the NSW transport network and the key travel demand corridors connecting regional cities and major centres across the greater Sydney metropolitan area.

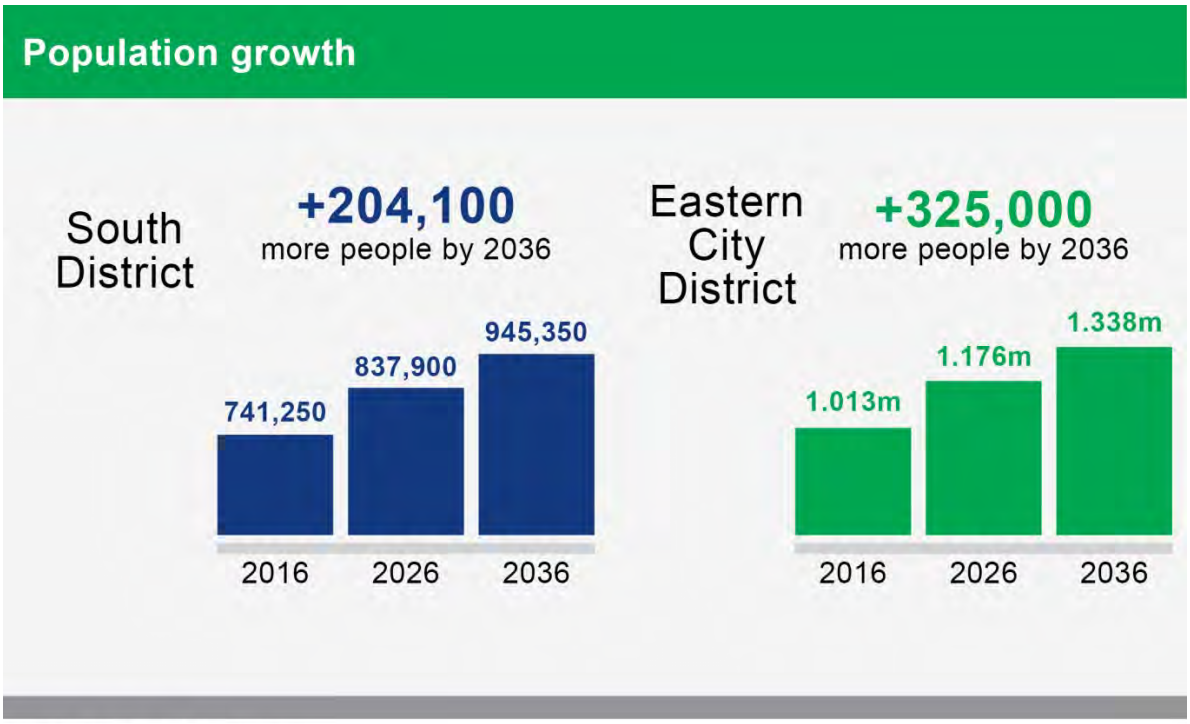
In the *Greater Sydney Region Plan*[4], Greater Sydney has been divided into five districts. The Greater Sydney Commission identifies that, by 2036, the population in the South District is expected to grow by around 204,100 people[5] while the population in the Eastern City District (which includes the Rockdale area) is expected to grow by around 325,000 people[6]. The population in the former Rockdale LGA alone is forecast to grow by 41,000 people from 2016 to 2036[7]. **Figure 4-1** shows the population projections for the Eastern City and South Districts of Greater Sydney.

Many South District residents travel to work destinations outside of the District as there is an imbalance between the number and types of local jobs available and the available labour force. Work destinations for those living in the South District include employment clusters in Sydney City, Green Square-Mascot, Port Botany, Bankstown and Greater Parramatta. Nearly 20 per cent of the journeys to work from the South District are to the City of Sydney[8].

This imbalance between workforce and employment means that there will remain strong demand for workers to travel by car or public transport to employment clusters as well as non-peak hour business travel between the economic centres of south and central or northern Sydney.

Over 50 per cent of journeys in the South District are undertaken by car (refer to **Figure 4-2**), this forms a large part of demand on the road network. Other modes of transport used by residents in the South District include walk/bike (about two per cent), bus (about three per cent) and rail (about eight percent).

[3] Infrastructure Australia (2015). *Australian Infrastructure Audit*
[4] Greater Sydney Commission (2018) *Greater Sydney Region Plan*
[5] Greater Sydney Commission (2018) *South District Plan.*
[6] Greater Sydney Commission (2018) *Eastern City District Plan*
[7] NSW Department of Planning and Environment (2016). *2016 New South Wales State and Local Government Area Population Projections, 2011 – 2036.* New South Wales Government
[8] Greater Sydney Commission (2018) *South District Plan*



Source Greater Sydney Commission

Figure 4-1 Population growth projections

4.2.2 Future trends in transport

Future trends in transport have been taken into consideration in the development of the project in line with the NSW Government's *Future Transport Strategy 2056*. In the last decade, the number of train and bus trips has grown faster than population growth, meaning that a greater percentage of the population is travelling on public transport. During that same timeframe, there were fewer vehicle drivers under 30 years of age on roads than drivers over 60 years of age[9]. This indicates that fewer young people are driving and owning cars as they are increasingly using public transport or other mobility service providers, such as ride sharing services and taxis.

We are moving away from a view of transport as only being the infrastructure and vehicles we use to travel, to a future that evolves with the customer and integrates technology into the network. Concurrent with this trend is the development of autonomous vehicles for both buses and cars. It is expected that fully autonomous vehicles would be active on our roads within the next 15 to 20 years, reducing the need for licensed drivers. Connected and automated vehicles are expected to reduce rates of road trauma caused by human error, improve traffic flow and efficiently manage higher traffic volumes. Motorways will drive and facilitate this shift and will respond to these emerging technologies.

In addition to these trends, there is still a need to make provision for the growth in commercial and freight travel demand (e.g. trade vehicles, grocery and goods delivery) and to reduce congestion across the Sydney road network.

Future Transport outlines that the NSW Government will continue to embrace automation to achieve safety and efficiency benefits as well as service improvements for customers by:

- Enabling new and upgraded physical and digital assets to support new technologies and to adapt to future developments
- Identifying road infrastructure and furniture required to support automated vehicles
- Implementing intelligent traffic management methods to improve road network efficiency
- Delivering 'Smart Motorways' on all NSW motorways

[9] Bureau of Transport Statistics (2015). Household Travel Survey Highlights 2014/2015

- Supporting the NSW Innovation Strategy to manage the workforce transition associated with the increase in automation.

With these emerging trends, the need for rapid transport infrastructure, including motorways, will remain. The project will play an important role in meeting the needs of these emerging trends and be part of an integrated transport solution for Greater Sydney.

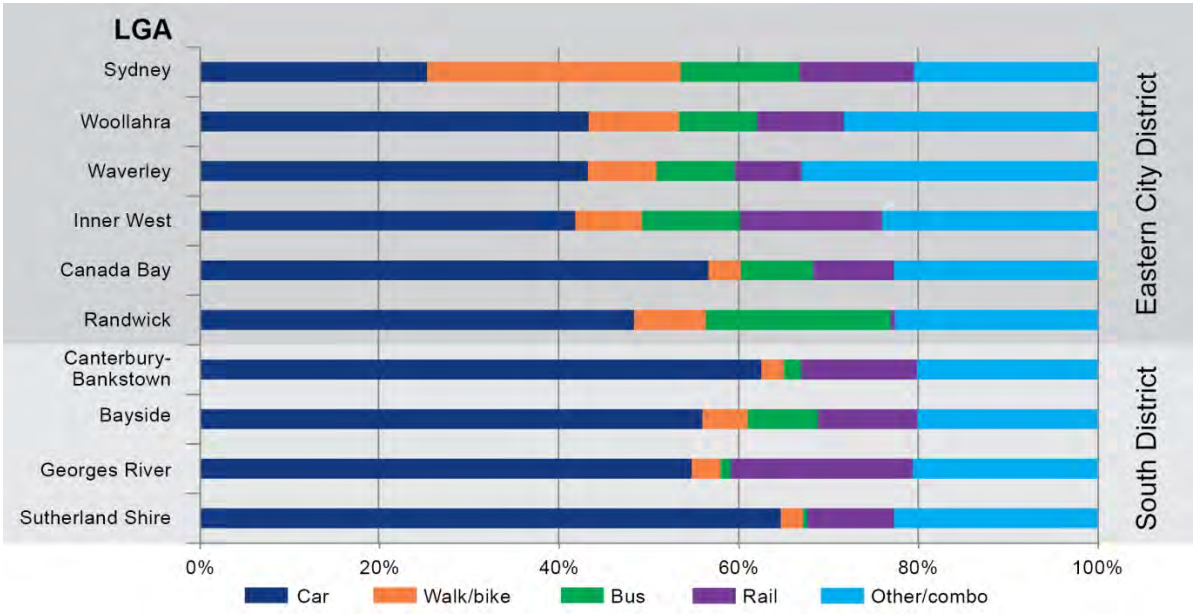


Figure 4-2 Sydney Travel to work data (2016)

4.2.3 Future motorway network

The project would form a key component of the existing and committed motorway network of Greater Sydney (refer to **Figure 4-3**), linking southern Sydney with the Sydney motorway network. The project would provide a direct link with the WestConnex motorways, through to the proposed Sydney Gateway and Western Harbour Tunnel projects. It would also provide stub tunnels to connect to future stages of the F6 Extension.

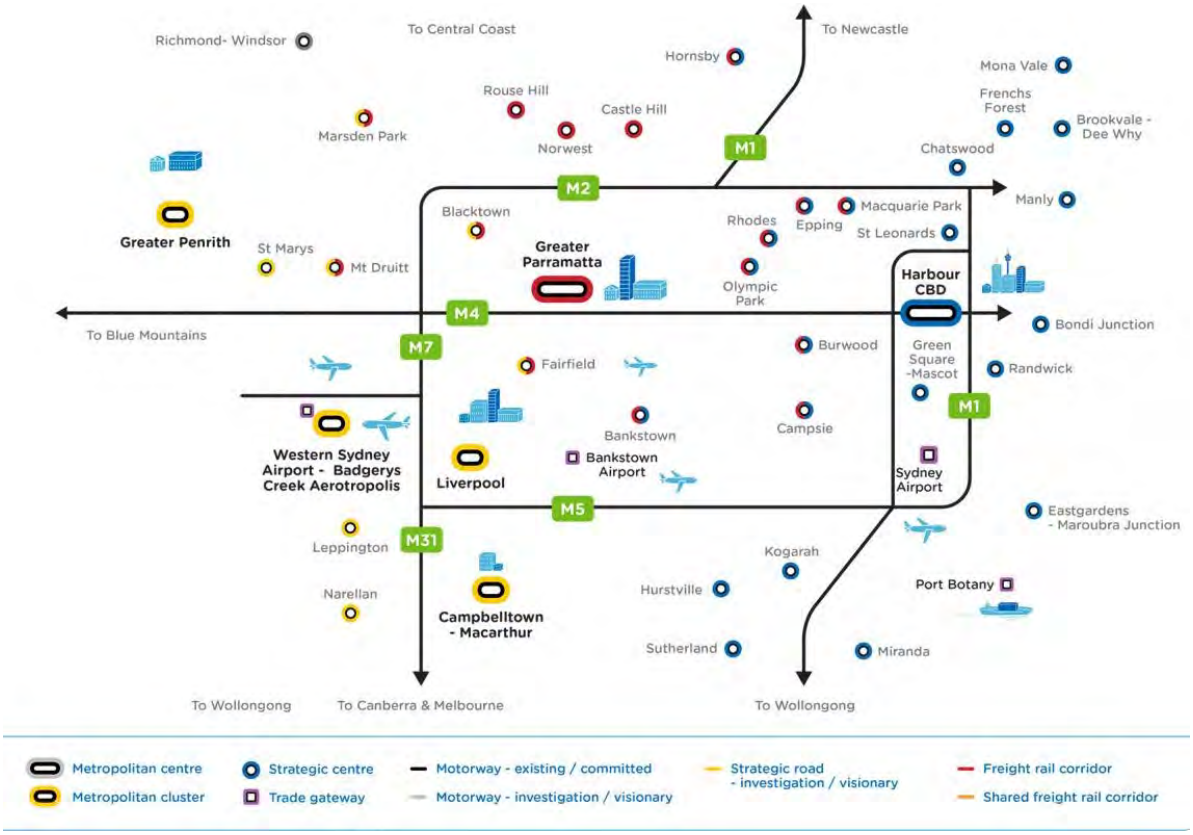


Figure 4-3 Existing and committed motorway network of Greater Sydney[10]

4.3 Project objectives

Project objectives have been established to meet the strategic and project need. The objectives have been developed from the objectives of the overall F6 Extension, and aim to achieve similar outcomes on the portion of the overall F6 Extension that the project would deliver. These objectives incorporate environmental, social and economic considerations.

Project objectives have been identified to address the key road network issues and project need outlined in **section 4.1**. The objectives for the project have been grouped according to the key focus areas of transport, productivity, city shaping, community and environment.

Transport - Improve travel times and reliability for road users travelling between Southern Sydney and strategic centres in Greater Sydney while supporting faster and more reliable times for local bus customers and road users in Southern Sydney.

Productivity - Support the future growth and productivity of Southern Sydney by improving connectivity between these regions and strategic centres in Greater Sydney

City Shaping - Provide opportunity for improvements to urban amenity and place making by reducing through traffic along corridors that perform a key place function.

Community and Environment - Minimises adverse impacts on the environment and the community during construction and operation.

[10] NSW Government (2018) *Future Transport Strategy 2056*

4.4 Project benefits

The project benefits are centred on the importance of the road network to businesses and communities within the project area and the effects that improvements to its functioning may provide to its surrounds (refer to **Figure 4-4**). Benefits also include enabling future stages of the missing motorway link between the M1 Princes Motorway and the Sydney motorway network.

A Final Business Case[11] was completed for the F6 Extension Stage 1 and it outlines the following expected benefits of the project:

- Transport benefits would result from reduced travel time and better reliability for road users; better connectivity for active transport; and improved road safety. These benefits are estimated at $2,005 million
- Productivity benefits would result from it being easier for people to get to jobs, for businesses to access their markets and for heavy vehicles to move more efficiently through southern Sydney. These benefits are estimated to be $236 million
- City-shaping benefits would result from easier access for residents when through traffic is reduced from local centres and more certainty is provided around planning and investment. These benefits are estimated at $137 million.

Figure 4-4 Project benefits

[12]Infrastructure NSW, 2018. *Final Business Case Summary: F6 Extension – Stage 1.*

4.4.1 Easing congestion and improved connectivity

As part of an integrated transport solution for Sydney, the project, is expected to reduce traffic on parts of the Sydney road network. This investment in Sydney's road network would contribute to improvements across the network and would generate benefits to the local and the wider Australian economy.

Congestion within the vicinity of the project is influenced by a number of factors, including residents driving to work (refer to **Figure 4-5**). The project would provide increased capacity to reduce congestion and free up surface roads for public transport.

This reduction in congestion would also facilitate improved greater east-west connectivity for inter-regional traffic and facilitate more efficient journeys to and from southern Sydney by providing a motorway connection between Arncliffe and Kogarah.

The project, through a connection with the New M5 Motorway, would assist in providing more efficient and economic transport connections for freight vehicles, workers and other commercial operators travelling from A1 Princes Highway to Sydney Airport and other industrial and commercial areas in Sydney. The economic impacts of the project are discussed in more detail in **Chapter 15** (Social and economic). The project would improve the journey experience for pedestrians and cyclists by providing an alternative for through traffic, in some places reducing the traffic along the local surface road network and by improving cycling infrastructure near the new motorway corridor.

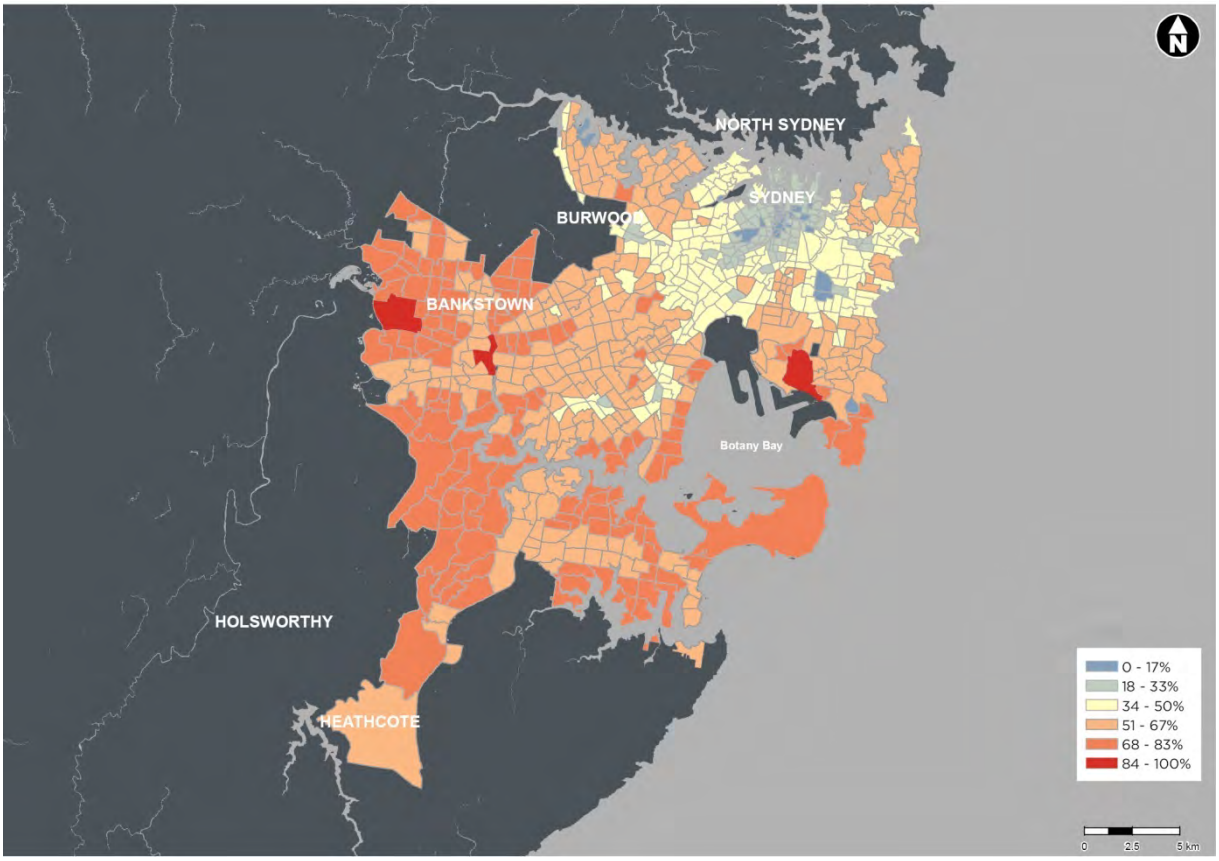


Figure 4-5 Percentage of residents who drive to work (2016)[12]

[12] Australian Bureau of Statistics (2016) Travel to work data

4.4.2 Integrated land use and transport planning

The NSW Government aims to integrate land use with transport planning. This is evident through the release of the *Greater Sydney Region Plan* and *Future Transport 2056*. The project is one component of a larger land use and transport plan for Greater Sydney.

The project plays a key role as a movement corridor, within the Sydney orbital network. Orbital motorway networks provide efficient, high speed motorway travel, which is central to the needs of a growing global city such as Greater Sydney. The benefits of motorways within the context of an international city such as Sydney are shown in **Figure 4-6**.

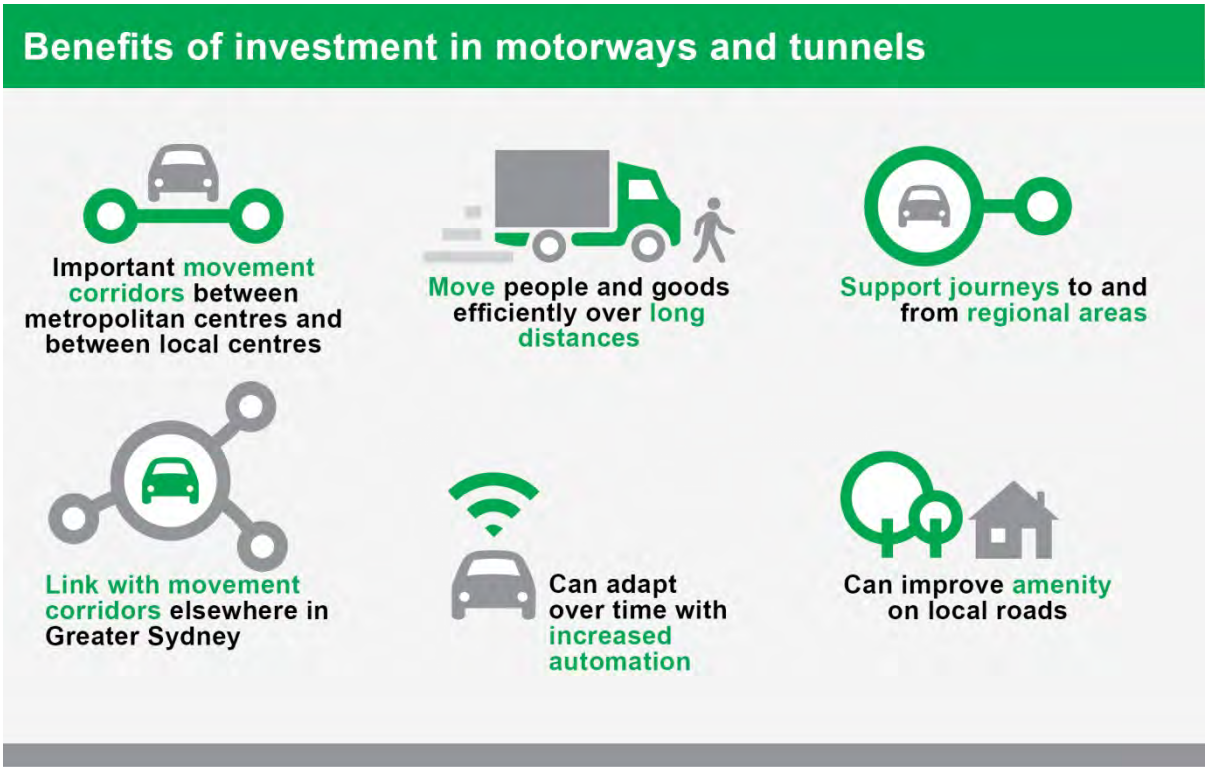


Figure 4-6 Benefits of investment in motorways and tunnels

The project would directly contribute to the following land use and transport outcomes:

- Connected communities – improved city to city and centre to centre connections, as well as better north-south and east-west pedestrian connectivity through the provision of the shared pedestrian and cycle pathways
- A safer environment – improved intersections and traffic flow would reduce the number of traffic incidents, while changes to surface road layouts and provision of additional pedestrian and cyclist links would make it safer for pedestrians and cyclists
- Securing open space - improved amenity within Rockdale Bicentennial Park, contributing to the Green Grid (discussed further below)
- Improvements to other transport modes – by increasing traffic capacity for commercial and through traffic the project supports greater use of public transport (such as buses and Rockdale and Kogarah train stations) and active transport networks (new and proposed walking and cycling routes in the vicinity of the project)
- Place making and urban amenity – supports the ability to realise strategic plans along The Grand Parade and the Princes Highway to improve urban amenity.

The project would also contribute towards the Greater Sydney Commission's 30 minute city concept (refer to **Figure 4-7**).

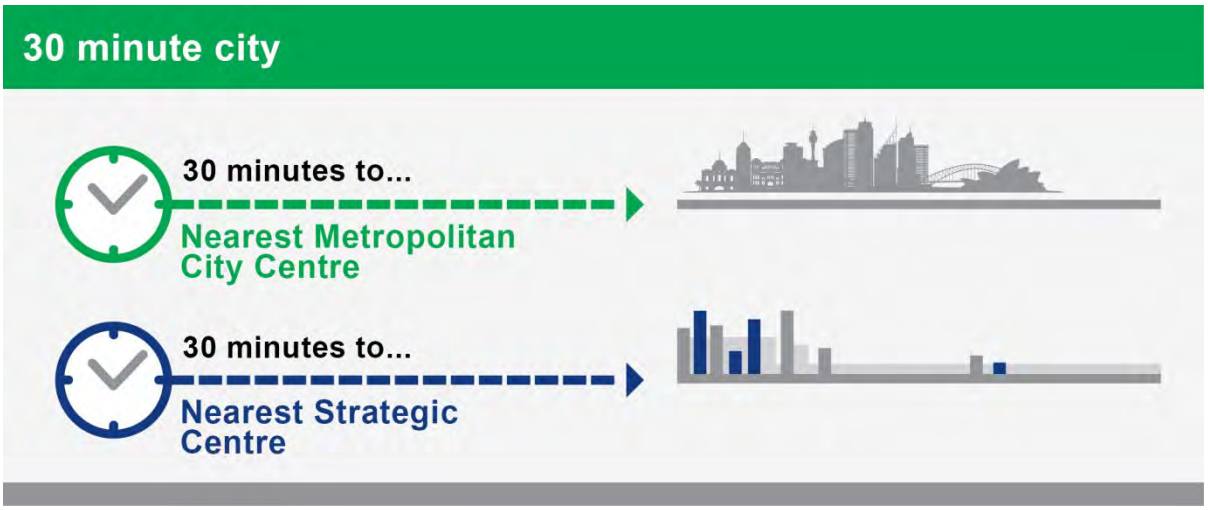


Figure 4-7 Greater Sydney Commission's concept of a 30 minute city

4.4.3 Opportunities for place making

Future Transport 2056 is underpinned by the movement and place framework (refer to **Figure 4-8**). This framework aims to balance the needs of:

- Vibrant commercial centres, where customers want easy access and pedestrian friendly environments
- Public transport customers who depend on movement corridors for efficient movement to their destinations
- Private car users who use the movement corridors and on-street or nearby parking areas
- Freight operators who need efficient movement corridors and kerbside access to meet delivery timeframes
- Local communities who are interested in 'liveability' and places that easily accessible and within walking distance.

Along with future stages of the F6 Extension, the project would support the movement and place framework by changing the role of arterial roads such as The Grand Parade and the Princes Highway. Currently these routes function primarily as movement corridors. The F6 Extension would allow these arterial roads to retain their purpose as movement corridors.

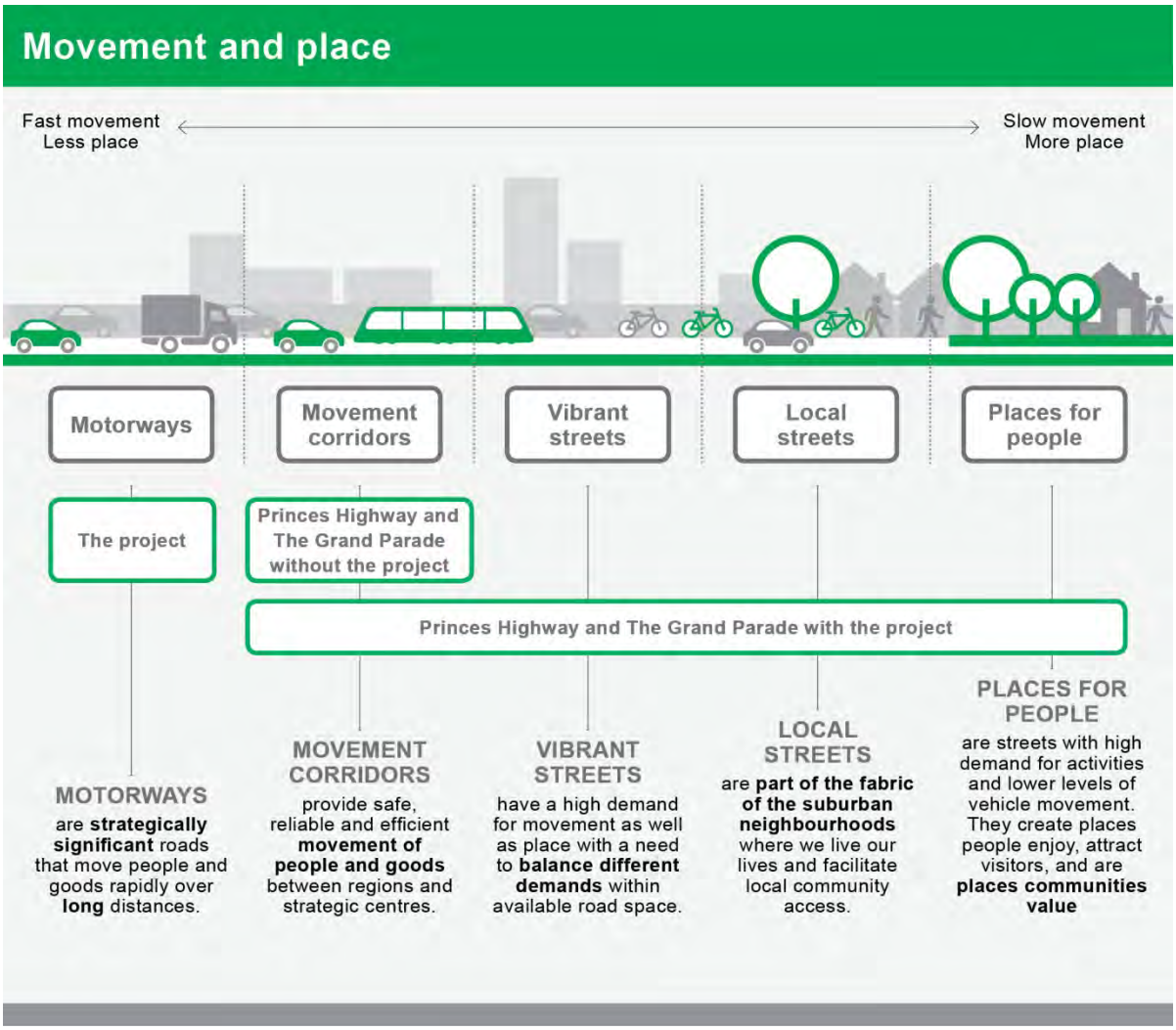


Figure 4-8 Movement and place framework

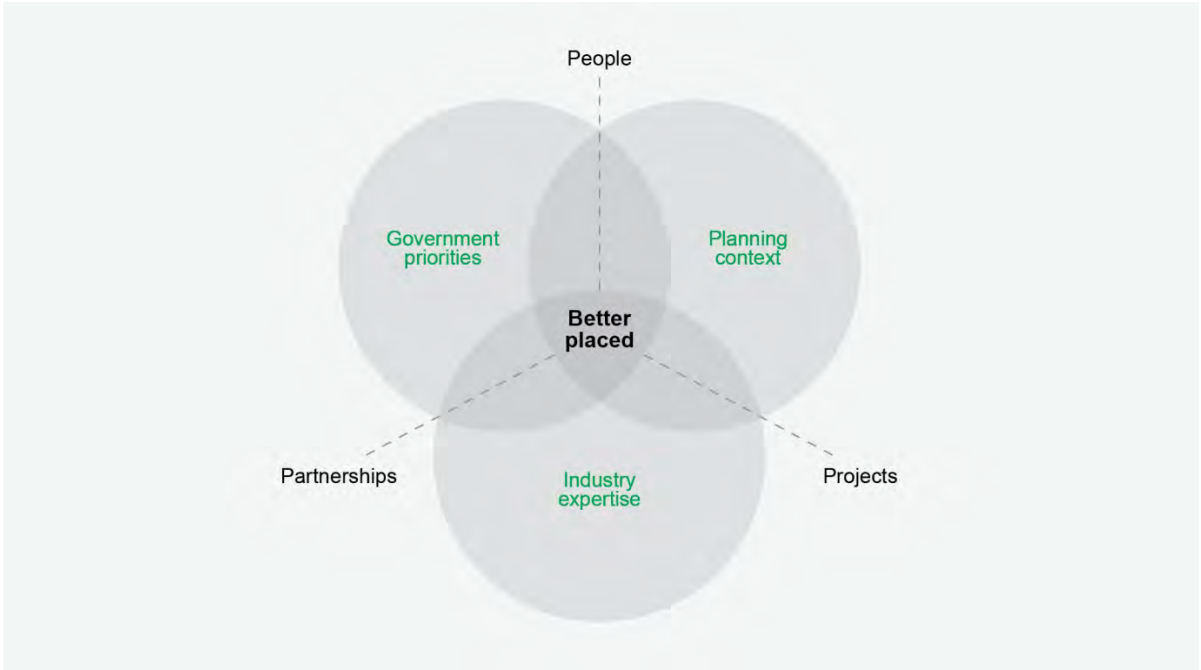


Figure 4-9 The role of the 'Better Placed' policy

In 2017 the NSW Government Architect introduced the *Better Placed* policy[13]. This policy is about enhancing all aspects of urban environments, to create better places, spaces and buildings, and thereby better cities, towns and suburbs. *Better Placed* is positioned among a range of national, state, city, and local government policies that reference design. **Figure 4-9** shows where *Better Placed* fits within the government, planning and industry context.

The project would provide opportunities for the implementation of the *Better Placed* policy by reducing through traffic, including freight vehicles, at key locations along The Grand Parade and Princes Highway. The project would also enable the rejuvenation of Rockdale Bicentennial Park, contributing to Sydney's Green Grid. The following sections discuss these opportunities. Further information is provided in **Appendix C** (Place making and urban design).

The Grand Parade

The Grand Parade currently provides a connection for traffic traveling between southern Sydney and the Sydney CBD. As a result, this key corridor along the shores of Botany Bay is often congested, resulting in reduced amenity of the foreshore precinct. By reducing through traffic at this location, the project would reduce amenity impacts for the users of the Botany Bay foreshore.

Brighton-le-Sands is identified as a local centre in the *Eastern City District Plan*. The vision for local centres is as focal point of neighbourhoods, where there is a focus on walking and cycling, with a mix of uses and urban spaces creating a vibrant character and places to meet and socialise. The Greater Sydney Commission sees the success of local centres and high streets, such as the Grand Parade, as being supported through specific and flexible measures to improve activation and viability[14].

Princes Highway

The *Bayside West Precincts 2036*[15] plan includes the Arncliffe Precinct, Banksia Precinct and the Cooks Cove Precinct. The plan aims to create connected town centres for Arncliffe, Banksia and Cooks Cove, better transport connections, more housing choices, a vibrant Princes Highway corridor and new areas of open space.

Reduced daily traffic is forecast on sections of the Princes Highway through Arncliffe and Banksia with the project, assisting the facilitation of this strategy. By reducing the number of vehicles on surface roads, the project supports future growth and urban changes along the Princes Highway corridor and improves the safety of connections for active transport users.

[13] http://www.governmentarchitect.nsw.gov.au/thinking/integrated-design-policy/introducing-better-placed
[14] Greater Sydney Commission (2018) *Greater Sydney Region Plan*
[15] NSW Department of Planning and Environment (2018) *Bayside West Precincts 2036 – Arncliffe, Banksia and Cooks Cove*

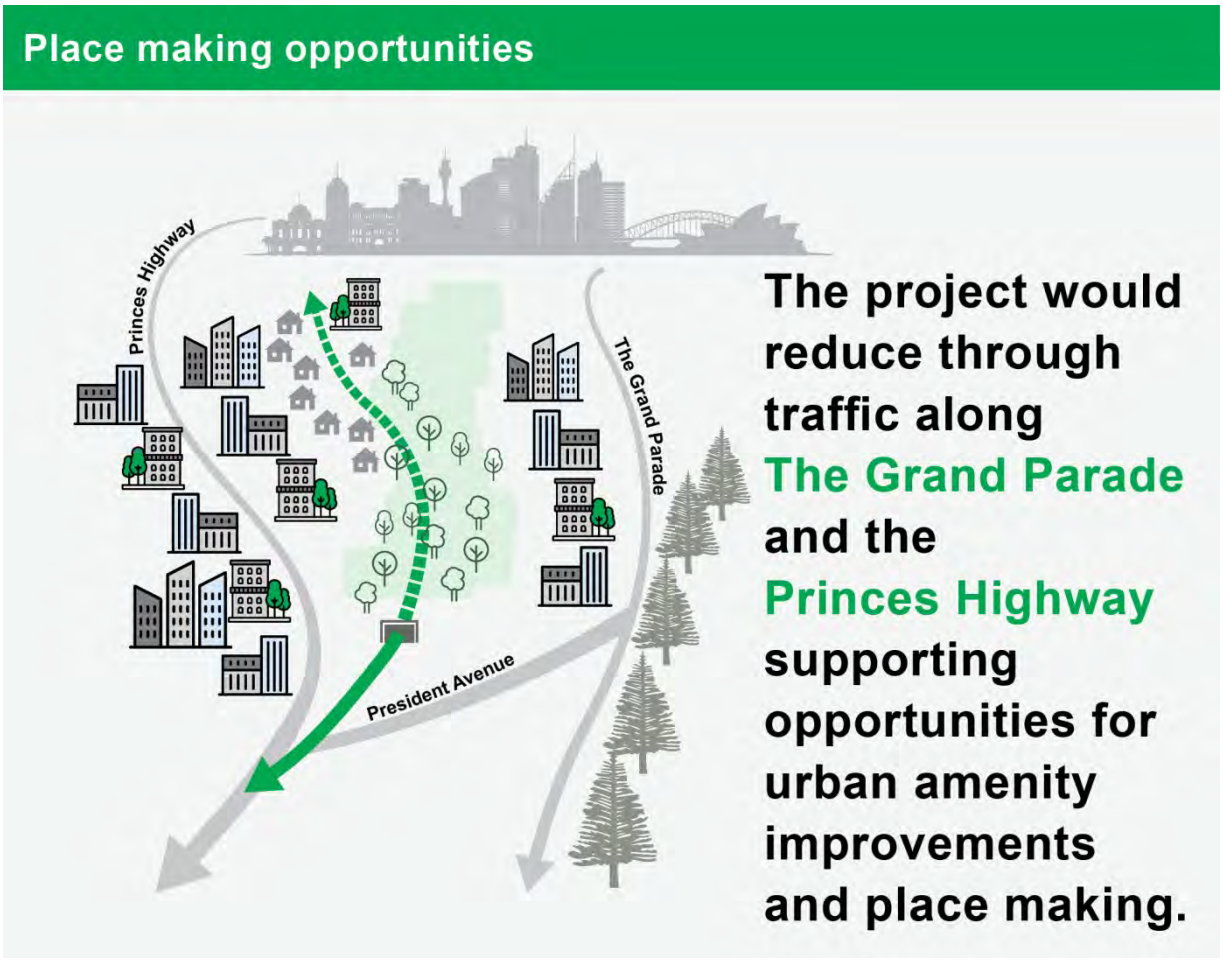


Figure 4-10 Place making opportunities along parallel routes

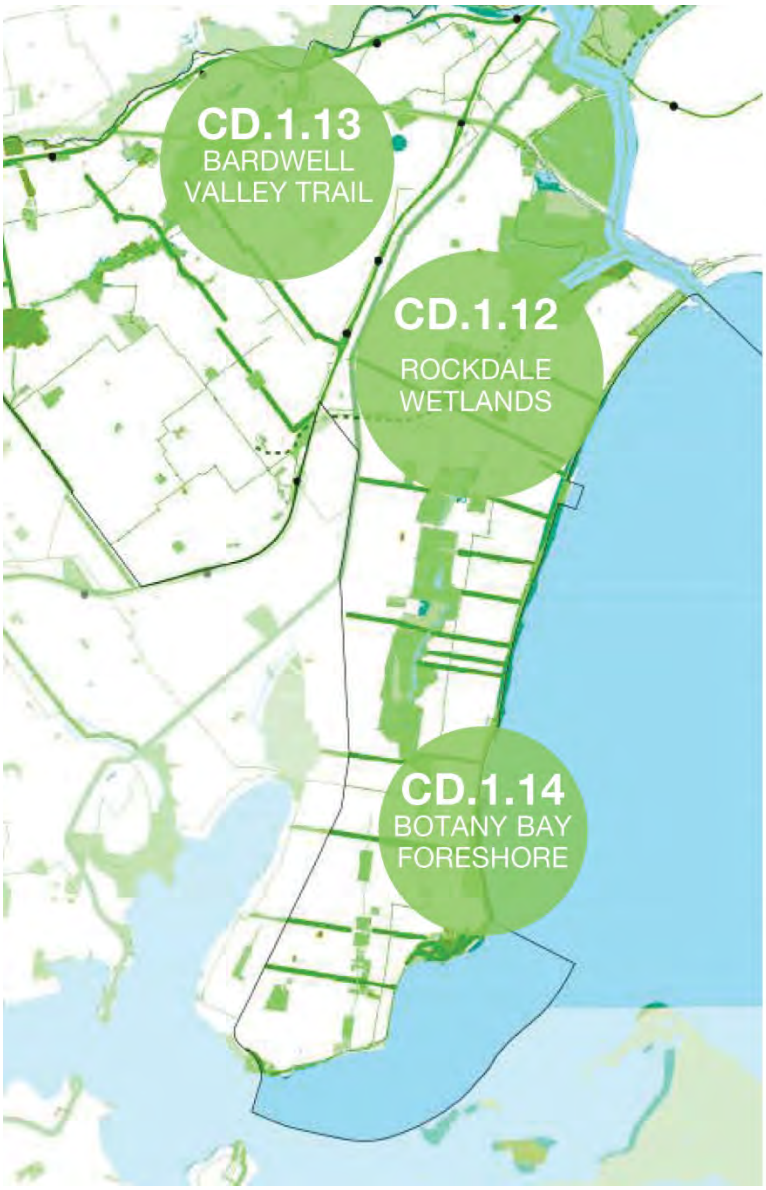
Sydney Green Grid

The NSW Office of the Government Architect has released a plan to seek out opportunities for a network of high-quality green space that connects town centres, public transport hubs, and major residential areas. This network is known as the Sydney Green Grid[16].

The vision for the Sydney Green Grid is identified in the *Eastern City District Plan,* and includes the Rockdale Wetlands Open Space Corridor. The plan states that parts of this corridor which are currently zoned for a future motorway, should be designed to retain and protect recreational open spaces and the ecological values of the corridor. The project has been designed to align with this vision, minimising impacts on recreational open space and ecological values within the project corridor by placing the motorway predominantly underground.

The reinstatement of Rockdale Bicentennial Park would be undertaken in consultation with Bayside Council, key stakeholders and the NSW Office of the Government Architect to ensure the vision and objectives of the Sydney Green Grid are taken into consideration. **Figure 4-11** shows the Green Grid within the vicinity of the project.

[16] www.governmentarchitect.nsw.gov.au/articles/2017/06/sydney-green-grid



SD.1.12 ROCKDALE WETLANDS – GEORGES RIVER TO COOKS RIVER

This group of projects have a very high conservation value extending from the Cooks to the Georges River along Muddy Creek, through Eve Street Wetlands, Spring Creek Wetlands, Landing Light Wetland, Patmore Swamp, Scarborough Park Ponds and through to Sans Souci. Opportunities include wetland restoration, establishment of bird hides education, interpretation and an improved pedestrian and cyclist environment.

CD.1.13 BARDWELL VALLEY TRAIL

This project cluster contains projects from Hurstville to Turella connecting pockets of natural bushland and remnant Turpentine forest and Eucalypt woodland which create a swathe of green in the middle of the densely populated area of the district. Projects include conservation management, green skills and interpretation, connectivity and biodiversity.

- Consider open space acquisition of Bardwell Valley Golf Course to provide additional open space in the rapidly growing area.
- Enhance the Two Valley Trail.

CD.1.14 BOTANY BAY FORESHORE AND COOKS PARK TRAIL

The Botany Bay Foreshore project is important in its context of linking the Great Coastal Walk to Botany Bay and the coastal projects of the South District. This cluster of projects provides an opportunity to improve connectivity to the foreshore and provide enhancements to the length of Cook Park from Brighton le Sands to Sans Souci.

Figure 4-11 Rockdale Wetlands' place in Sydney's Green Grid[17]
Extract from the NSW Government Architect's 'Sydney Green Grid'(2017)

4.4.4 Consistency with strategic planning

The project is consistent with a number of strategic plans for transport, development and freight that have been prepared at a national and State level. Key national and State strategies, policies, and plans have also informed and influenced the vision, objectives, and development of the project. **Table 4-1** provides an overview of relevant strategic plans and their relationship to the project.

[17] www.governmentarchitect.nsw.gov.au/articles/2017/06/sydney-green-grid

Table 4-1 Strategic planning and policy framework

Policy	Description
Australian Infrastructure Plan	Infrastructure Australia's *Australian Infrastructure Plan: The Infrastructure Priority List* (the Priority List) dated February 2017 sets out a number of projects and initiatives identified as priority infrastructure investments that Australia needs over the next 15 years. The 2017 Priority List identifies the F6 Extension as a 'Priority Initiative'. A 'Priority Initiative' is a potential infrastructure solution for which a business case has not yet been completed but seeks to address a problem or opportunity of national significance. The Priority List describes the problem as connectivity between Wollongong and the Sydney CBD. The project would form the first stage of the F6 Extension.
NSW State Priorities	There are 18 State Priorities currently being actioned by the NSW Government. The project would contribute to achieving a number of these priorities including: • Encouraging business investment –by linking southern Sydney with key employment centres such as the Sydney CBD, and providing improved conditions for freight transport • Boosting apprenticeships –by delivering apprenticeships and becoming a major employer in NSW. Refer to Chapter 15 (Social and economic) for more information • Protecting NSW's credit rating –by delivering financial solutions to fund delivery of the motorway to ensure a positive net result for the NSW economy while minimising impacts on the State's budget • Improving road travel reliability –by delivering travel time savings for motorists travelling from southern Sydney to the Greater Sydney region, also enabling better use of existing roads • Reducing road fatalities – by providing a free-flowing motorway alternative for through traffic, reducing traffic on surface roads and improving traffic flows which is correlated with a lower number of road crashes. Refer to Chapter 8 (Traffic and transport) for more information.
State Infrastructure Strategy	The *State Infrastructure Strategy 2018-2038*[18] is a 20-year strategy, which identifies and prioritises the delivery of critical public infrastructure to drive productivity and economic growth. The *2018* strategy switches the focus from preceding years of developing an infrastructure project pipeline to achieving sustainable growth in the NSW. The Strategy acknowledges that the F6 Extension has been identified as a priority and that it (as well as other projects) is envisaged to extend the strategic road and motorway network, providing crucial functions such as improving its resilience, extending the network to major growth areas and connecting key freight precincts.
Future Transport 2056	*Future Transport 2056* is an update to NSW's *Long Term Transport Master Plan*[19]. This Master Plan specifically identified the gap in the motorway network between the M1 Princes Motorway at Waterfall and the Sydney motorway network. It identifies the connection of the F6 Freeway (M1 Princes Motorway) to Sydney's motorway network as a major long term priority. The Master Plan also identifies as a key priority the completion of the 'missing links' in the motorway network to reduce congestion and consequent trip delays that adversely impact across the Sydney road network. The project is identified in the *Future Transport Strategy* as a committed initiative for the next 0 – 10 years, with future stages of the F6 Extension also identified as a visionary motorway for investigation. Committed initiatives are for immediate detailed planning or are part of key maintenance, renewal or safety programs.
Greater Sydney Region Plan	The *Greater Sydney Region Plan* presents opportunities to leverage unprecedented infrastructure investment and provide the right transport connections across the city and within neighbourhoods. The project would provide a connection from southern Sydney to the Sydney motorway network, linking the region with the Eastern Harbour City and Central River City. The project is identified in the *Greater Sydney Region Plan* as a committed initiative for immediate detailed planning (subject to Final Business Case).

[18] Infrastructure NSW (2018) First things first - The State Infrastructure Strategy 2012 – 2032
[19] Transport for NSW (2012) *NSW Long Term Transport Master Plan*, TfNSW, Sydney, Australia

Policy	Description
District Plans	The *Eastern City District Plan*[20] states the F6 Extension will improve motorway access and freight movements from the Eastern Harbour City across Greater Sydney and to Port Kembla/Illawarra, supporting the functions of critical economic gateways and freeing up road capacity. The plan identifies Kogarah as a health and education precinct/collaboration area, and Brighton-Le-Sands and Rockdale as local centres. The project would improve connections between Kogarah and other strategic centres across greater Sydney, as well as the Sydney CBD. The project would also improve the amenity and liveability of the local centres of Brighton-Le-Sands and Rockdale, reducing through traffic and the number of freight vehicles. The *South District Plan*[21] notes that planning is underway for the F6 Extension linking the New M5 Motorway near Sydney Airport with the Princes Highway at Waterfall. The plan also acknowledges the northern parts of the F6 Extension are in the Eastern City District. Delivery of this connection will improve connections between Wollongong and the Eastern Harbour City, particularly with Sydney Airport and Port Botany.
NSW Freight and Ports Strategy	The aim of the *NSW Freight and Ports Strategy*[22] (*the Strategy*) is to provide a transport network in NSW that allows for the efficient flow of goods to market. The *Strategy* states that the NSW freight task is expected to almost double over the next 20 years. Such growth has implications for the capacity of the road network, with increased heavy vehicle volumes forecast on Princes Highway, as well as on key connections to Port Botany. Sydney Ports forecasts container trade through Port Botany to nearly quadruple by 2031, reaching seven million containers per year by 2031[23]. Sydney's heavy vehicle freight task is highly dependent on the motorway network. The *Strategy* identifies that the NSW road network carried 63 per cent of the state's total freight volume in 2011, with 33 per cent of freight carried by rail in the same year. Heavy vehicles would continue to have a substantial role in moving freight across NSW for the foreseeable future. The *Strategy* identifies the challenge of increasing the capacity of NSW roads to support the growth in freight. The *Strategy* states that addressing the gaps in Sydney's motorway network is one of the most important steps in expanding capacity for freight on the motorway network and is particularly critical in creating a more efficient freight network to the nationally significant gateways of Sydney Airport, Port Botany and Port Kembla. The *Strategy* has two main objectives: to deliver a freight network that efficiently supports the projected growth of the NSW economy, and to balance freight needs with those of the broader community and the environment. The project is consistent with the three strategic action programs identified in the *Strategy*: • Network efficiency – the project would improve network efficiency by delivering travel time savings and improved connectivity on the Sydney motorway network • Network capacity – the project, through its connection with the New M5 Motorway, would provide increased road capacity on the north–south network for the movement of freight between Sydney Airport/Port Botany (via the St Peters interchange) and southern Sydney • Network sustainability – traffic modelling indicates that the project would remove a large number of heavy freight vehicles travelling along The Grand Parade and the Princes Highway, which would result in improved network capacity and reducing surface road traffic.

[20] Greater Sydney Commission (2018) *Eastern City District Plan*
[21] Greater Sydney Commission (2018) *South District Plan*
[22] Transport for NSW (2013b) *NSW Freight and Ports Strategy*
[23] Infrastructure NSW (2012) First things first - The State Infrastructure Strategy 2012 – 2032

5 Project alternatives and options

This chapter describes and analyses the alternatives to the project, as well as the options that were considered as part of the design development process. It explains how and why the project was selected as the preferred option for assessment in this EIS.

5.1 Strategic alternatives to the project

The project is the first stage of the F6 Extension. The merits of the F6 Extension were considered in the context of a range of other alternatives based on transport, environmental, engineering, social and economic factor performance.

The following strategic alternatives to the F6 Extension were considered:

- Alternative 1 – The base case or 'do nothing/do minimum'
- Alternative 2 – Rail infrastructure improvement options
- Alternative 3 – Bus service improvements
- Alternative 4 – Motorway option (development of the F6 Extension).

These alternatives are described in more detail in **section 5.1.1** to **section 5.1.4.**

5.1.1 Alternative 1 – The base case or 'do nothing/do minimum'

This base case would involve carrying out only currently planned and funded transport infrastructure improvements on the existing road network, such as routine road network and intersection upgrades that would be provided over time to incrementally improve capacity and traffic throughput to address specific congestion issues.

This has been developed by considering the following planned programs to improve road based transport infrastructure in southern Sydney:

- Roads and Maritime's Easing Sydney's Congestion Program, which includes:
  - the Pinch Point Programs
  - the Sydney Clearways Program
- Transport for NSW's proposed Bus Priority Infrastructure Program
- Arterial road upgrades.

Details on these programs, their relevance to southern Sydney and their assessment as an alternative or complementary program to the proposed F6 Extension are provided below.

Pinch Point Program

The Pinch Point Program aims to reduce traffic delays, manage congestion and improve travel times on Sydney's major roads, particularly during weekday peak periods. Pinch points are traffic congestion points, intersections or short lengths of road where a traffic bottleneck slows down the broader network.

In February 2015, the NSW Government committed to the Gateway to the South Pinch Point Program to address critical pinch points along the A1, A3 and A6 routes south of the M5 Motorway. More than 20 locations have been identified as part of this program for further investigations and potential improvements. Potential improvements include:

- Electronic message signs, to provide road users with real-time information on planned events and unplanned incidents
- Closed-circuit television cameras, to monitor and manage traffic
- Work to maximise capacity at key intersections, which could include lengthening or widening turn bays or implementing turn restrictions.

Pinch Point Program work is currently proposed in the vicinity of the project at the following locations:

- Princes Highway, Forest Road and Wickham Road, Arncliffe
- Princes Highway and Rockdale Plaza Drive, Rockdale
- The Grand Parade and President Avenue, Monterey (completed 2017)
- Princes Highway, Gray Street and Rocky Point Road, Kogarah (underway in 2018).

Sydney's Clearways Program

In December 2013, the NSW Government published the Sydney Clearways Strategy which identified routes on Sydney's road network that could benefit from new clearways.

Clearways are installed on key arterial roads where traffic is often heavy and congested. When vehicles are parked in the kerbside lane, fewer lanes are available to traffic and road users are forced to merge from the kerbside lane which can create significant delays and queues. Clearways help keep vehicles moving by making all lanes available to road users. The only exceptions are the stopping of buses and taxis dropping off or picking up passengers as well as emergency vehicles. Clearways:

- Reduce congestion by making an additional lane available to traffic
- Improve journey times, allowing drivers to get to their destination sooner and more reliably
- Improve safety by removing parked vehicles from the kerbside lane
- Have an immediate positive impact on traffic flow as it uses existing road space for the movement of vehicles
- Improve the efficiency of intersections along the corridor, as all lanes are used.

The Sydney Clearways Strategy identifies over 1000 kilometres of state roads on key corridors across Sydney, which may benefit from the introduction of new and extended weekday and new weekend clearways, to improve the movement of goods and people. These routes were identified as possible clearways, based on a 2013 assessment of the following criteria:

- Directional traffic flows exceed 800 vehicles per hour per lane
- Travel speeds are 30km/h or less during peak periods.

Corridors identified in the strategy are currently under further investigation. Along with detailed parking and traffic analysis, the following two areas are now being considered:

- If the roads are strategic bus or freight transport corridors for moving people and goods
- Whether alternate public parking close to local businesses can be found, taking into account the quantity and usage of customer parking removed to extend or introduce a new clearway.

Clearway hours are determined based on an analysis of traffic volumes and times along the corridor, taking into consideration a need for consistency in the clearway hours of operation both along a corridor and across the network. Since 2013, new and extended clearways have been installed on some of Sydney's busiest corridors including along the Princes Highway from President Avenue, Kirrawee to King Georges Road, Blakehurst.

Community engagement has also commenced for new weekend and extended weekday clearways on Taren Point Road between Captain Cook Bridge, Taren Point and Kingsway, Caringbah.

Other corridors for investigation in southern Sydney are identified in the 2013 Sydney Clearways Strategy, including:

- Princes Highway through Blakehurst, Kogarah , Rockdale and Wolli Creek
- Rocky Point Road from Kogarah to Sans Souci
- General Holmes Drive, The Grand Parade and Sandringham Street from Kyeemagh to Sans Souci.

The identification of possible new and extended clearways in the Sydney Clearways Strategy was based on assessment of traffic volumes and speeds in 2013 and is separate to and is not prompted by the F6 Extension Stage 1 project.

Clearways have an immediate positive impact on traffic flow as they use existing road space for the movement of vehicles and are an operational traffic management solution, intended to be

implemented in the short to medium term to address current congestion.

Irrespective of the future changes to traffic flows and patterns resulting from the F6 Extension Stage 1 (if approved), clearways for certain periods would likely still be required in the future because of the expected growth in traffic volumes.

The implementation of new and extended clearways, with alternate business parking solutions, within the project area provides a response to managing current road congestion, using our existing road assets.

Bus Priority Infrastructure Program

Sydney's Bus Future: simpler, faster, better bus services[1] is the NSW Government's long-term plan to redesign Sydney's bus network to meet customer needs now and into the future. The plan sets out step-by-step actions to improve bus services, aiming to provide integrated connections to existing train services. For southern Sydney and specifically for areas in the vicinity of the project, the plan proposes improved integration with the rail network, upgraded interchanges at Arncliffe and Kogarah, and a new high frequency route between Miranda and Sydney Airport via the St George area, and various upgrades.

Arterial road improvements

Traffic modelling predicts that key arterial roads in southern Sydney will experience increased congestion and will operate near or above their capacities by 2036 during peak periods. Ongoing improvements to the broader transport network are therefore either planned or already underway. Operational traffic modelling conducted as part of the project has taken into consideration the effect of the implementation of these road improvements.

In December 2016, construction was completed on an additional right turn lane from The Grand Parade into President Avenue to improve traffic flow and safety. This provided increased capacity of the intersection to cater for growth in traffic.

However, this and other improvements to the arterial road network would only provide incremental change in the efficiency of the road network, and would not support the additional capacity required for regional traffic growth associated with the forecast increase in Sydney's population and subsequent increases in vehicle travel.

Further, continued urban development along the arterial roads in southern Sydney, including the Princes Highway, means there is limited capacity to widen and/or upgrade these roads. Future improvements to the surface road network would be challenging, potentially requiring the acquisition of a large number of properties. This could have significant negative community impact, with increased traffic flows in residential areas as well as limited land use regeneration, urban renewal opportunities or upgrades to public transport services.

Even if broader arterial road upgrades could be achieved at reasonable cost and impacts, the improvements are unlikely to match the capacity that would be provided by the project and future stages of the F6 Extension. In particular, arterial road upgrades would not provide the required separation of inter-regional and intra-regional traffic movements.

Improvements to the arterial road network alone, other than those already planned through the Easing Sydney's Congestion Program, are not a feasible or long-term alternative to the project and would not meet the project objectives. If combined with the project and future stages of the F6 Extension, arterial road upgrades including the potential enabling works for a future motorway, would provide more effective solutions to congested parts of the road network.

Summary

The planned transport improvements described above improve traffic flow by improving the capacity of intersections to cater for growth in traffic, and improve the reliability of some bus services. However, they would not provide any separation of inter-regional and intra-regional traffic movements. As a result, the do nothing/do minimum alternative would not meet the forecast traffic needs and the existing road network would need to accommodate all future traffic growth.

The project would not preclude any of the transport improvements that are currently proposed for southern Sydney.

[1] Transport for NSW (2013). *Sydney's Bus Future: Simpler, faster, better bus services*

5.1.2 Alternative 2 – Rail infrastructure improvements

The strategic alternative to improve rail infrastructure considered options to improve the existing corridor of the T4 Eastern Suburbs and Illawarra Line and/or the provision of a new mass transit line servicing southern Sydney and the Illawarra. *Future Transport 2056* identifies current government initiatives to expand existing rail infrastructure in southern Sydney including the following initiatives for investigation:

- Train improvements on the T4 Illawarra Line (0-10 years)
- Mass transit/train link CBD to South East (10-20 years)
- Parramatta to Kogarah mass transit/train link (10-20 years)
- Extension of South East mass transit/train link (20+ years).

Improvements to the existing T4 Illawarra Rail Line would likely involve the provision of additional sections of track and expansion of stations at strategic locations. A new southern mass transit line would involve the identification of a new alignment for an additional rail line servicing southern Sydney, which could include above ground and/or underground sections.

The expansion of existing or the provision of new rail infrastructure alone would not address the needs of customers to access highly dispersed locations involving longer trips, nor would rail provide the separation of inter-regional and intra-regional traffic movements. Further, with about 60 per cent of employment dispersed across the Sydney metropolitan area, public transport alone cannot viably serve many of these locations.

Demand for mobility by road travel is forecast to continue to grow. Public transport initiatives such as rail would only partially contribute to relieving congestion on arterial roads. Options to improve rail infrastructure would not considerably enhance the productivity of commercial and freight-generating land uses in isolation – and they would not address the strategic need for the project identified in **Chapter 4** (Strategic context and project need).

The project would not preclude rail infrastructure improvements from occurring as they would address different objectives. Any rail infrastructure improvements are likely to be complementary to the project as they would further reduce the number of vehicles on surface roads and would provide opportunity for place making at key strategic centres.

In June 2018, the NSW Government announced an investment into technology improvements to modernise the Sydney Trains network, including signalling upgrades along the T4 Illawarra Line. These upgrades are part of the ‘More Trains, More Services’ program and will significantly boost capacity and reliability for all train customers.

5.1.3 Alternative 3 – Bus service improvements

There is a low use of buses in the area for commuting to work, at around two per cent. It is around four per cent for trips originating or terminating in Kogarah and Rockdale. Buses nevertheless perform a critical role in the region, as they feed trunk rail services and are the main form of public transport in southern Sydney aside from trains. Alternative 3 therefore focuses on potential improvements to bus services.

Southern Sydney currently has few bus priority measures. Bus journey times are therefore heavily influenced by general traffic conditions. Several bus routes in southern Sydney include sections of ‘slow’ road links, which are defined in Roads and Maritime’s Performance Monitoring Information Management System as roads with average travel speeds during peak periods of less than 30 km/h.

The majority of bus routes in the area have average peak period speeds of between 21 km/h and 30 km/h, with the average across all bus routes around 26 km/h. All bus services in southern Sydney, with the exception of the ‘400’ line, experience more than 50 per cent variability in travel time, resulting in unreliable service operations for customers.

Sydney's Bus Future's proposed improvements to bus services in southern Sydney described in **section 5.1.1.** It would be possible to improve bus services in southern Sydney. However, in isolation, such improvements are unlikely to fully address the region's future transport needs as:

- Development across southern Sydney is relatively dispersed and typically of low density, meaning the private vehicle is the predominant form of intra-regional travel
- The reliability of bus services in southern Sydney is affected by traffic congestion and improvements in performance are likely to be limited while the area is without a motorway-level road to divert intra-regional traffic off arterial roads
- Public transport can only partially address the transport demands in the area. There are no feasible strategic transport alternatives, such as light rail or bus corridors, that would meet the diverse range of customer needs for travel in this corridor.

However, improvements to public transport, including improved bus services, would be complementary to the project. The project is aligned with the *'simpler, faster, better'* strategy of *Sydney's Bus Future* as it would:

- Improve bus travel times and travel time reliability on existing routes due to a decrease in through traffic on arterial roads
- Create opportunities to reallocate existing general traffic lanes on arterial and other roads as dedicated bus lanes at strategic locations
- Identify the opportunity for introducing new express bus routes along the project.

5.1.4 Alternative 4 – Motorway option (development of the F6 Extension)

The *State Infrastructure Strategy Update 2014*[2] recommended that the WestConnex program of works include a connection to allow for a potential future southern extension. It stated that a southern motorway that connects the New M5 Motorway to the A1 Princes Highway would remove inter-regional traffic from the existing arterial road network, which would ease traffic congestion, improve local air quality and amenity and create opportunities for urban renewal in some areas of southern Sydney that currently experience heavy traffic congestion. A southern motorway would also deliver economic benefits by reducing travel times for journeys through southern Sydney and between Sydney and the Illawarra region.

Reduced travel times would make travel to southern Sydney employment areas more feasible and therefore more attractive to employers. This would include improved travel times for bus services, which in turn would increase the reliability of these services. A motorway could also create opportunities for new express bus routes.

The motorway option (development of the F6 Extension) was chosen as the preferred option as it would:

- Improve journey times and reliability for road users travelling between the Illawarra, Southern Sydney and strategic centres in Greater Sydney, while supporting faster and more reliable journey times for local bus customers and road users in Southern Sydney
- Support the future growth and productivity of Southern Sydney and the Illawarra by improving connectivity between these regions and strategic centres in Greater Sydney
- Support urban renewal at key centres on arterial roads by reducing through traffic along corridors that perform a key place function.

[2] Infrastructure NSW (2014) NSW Infrastructure Strategy Update 2014

5.2 Strategic corridor options analysis

After deciding on the motorway option, Roads and Maritime undertook preliminary environmental investigations into the proposal to link the A1 Princes Highway at Loftus with the existing and proposed motorway network in Sydney. This included a study into several motorway corridor options and the development of a strategic business case.

Motorway corridor options were assessed based on their ability to meet the strategic need for the project (refer to **Chapter 4** (Strategic context and project need)) and the objectives of the proposal.

The key aims of the proposal to link the A1 Princes Highway at Loftus with the existing and proposed motorway network in Sydney were to:

- Provide a high standard access controlled motorway that integrates with the regional transport network
- Minimise adverse social and environmental impacts in the local area during construction and operation
- Provide opportunities for improved public transport in the (former) Rockdale and Sutherland local government areas
- Assist in a reduction in traffic congestion, particularly along A1, A3 and A6 corridors, and provide shorter travel times for road users
- Provide a motorway that is safe and reliable for road users
- Contribute towards a reduction in the number of heavy vehicles using A1, A3 and A6 corridors and local roads in the region
- Improve amenity of the western coastline of Botany Bay by reducing the number of heavy vehicles which use The Grand Parade
- Demonstrate excellence in design and environmental sustainability
- Be economically justified and affordable to Government.

Four corridor options were assessed (refer to **Figure 5-1**), being:

- F6 corridor option – broadly aligned with land previously reserved for the F6 Freeway
- A1 corridor option – broadly aligned with the existing A1/ A36 arterial road (Princes Highway)
- A3 corridor option – broadly aligned with the existing A1/ A3 arterial road (Princes Highway, King Georges Road)
- A6 corridor option – broadly aligned with the existing A6 arterial road (Heathcote Road, New Illawarra Road, Alfords Point Road, Davies Road and Fairford Road).

These four corridors are shown on **Figure 5-2**.

Each corridor was assessed against desired criteria relating to traffic and transportation benefits, environmental and social impacts and benefits, engineering requirements, geotechnical conditions, property impacts, cost and place making opportunities.

The F6 Extension corridor was broadly defined by two key drivers:

- Infrastructure NSW's recommendation to provide a connection to a southern extension from the New M5 Motorway, and the subsequent decision by Sydney Motorway Corporation to include stub tunnels for a southern extension (refer to **section 5.4.1**)
- The land previously reserved for the F6 Freeway (the F6 corridor option).

The F6 corridor was selected as the preferred corridor as it would:

- Cater for the eastern distribution of future traffic demand travelling north
- Provide a motorway solution without removing arterial roads
- Have a greater impact on reducing congestion for north-south traffic
- Create, in conjunction with the New M5 Motorway and other projects, a new north-south motorway through Sydney, completing a missing connection in the national highway.

Criteria	F6 Corridor	A1 Corridor	A3 Corridor	A6 Corridor
Traffic and transportation	●	●	●	●
Environmental and social	●	●	●	●
Engineering requirements	●	●	●	●
Geotechnical conditions	●	●	●	●
Property	●	●	●	●
Cost	●	●	●	●
Place making	●	●	●	●

Key

- Option meets the desired criteria for the preferred strategic corridor
- Option meets some of the desired criteria for the preferred strategic corridor
- Option meets the least number of the desired criteria for the preferred strategic corridor

Figure 5-1 Strategic alternatives: corridor options analysis

Figure 5-2 Strategic alternatives: corridor options

5.3 F6 Extension staging options

A multi-criteria analysis of staging and incremental works (refer to **Figure 5-3**) was undertaken to confirm the most appropriate area to commence construction of the F6 Extension based on the defined geographic sections (A – C) (refer to **Figure 5-4**). Each section was assessed against desired criteria relating to traffic and transportation benefits, environmental and social benefits and impacts, increase in productivity and cost benefits.

The analysis identified that Section A would be the preferred first stage as it would provide the greatest benefits to the community across the criteria. Section A has high levels of traffic congestion, with peak hour speeds on the existing arterial network amongst the lowest in Sydney. As a first stage, it would alleviate this congestion and provide a direct connection to the motorway network in Sydney.

Section A, providing a connection between the motorway network at Arncliffe to an intersection at President Avenue, Kogarah, was developed in further detail.

In parallel, Roads and Maritime determined to continue with the investigation work along the preferred updated corridor for the F6 Extension between Kogarah and Loftus (Sections B to C) to identify any potential corridor adjustments for the future motorway.

Figure 5-3 F6 Extension: staging options analysis

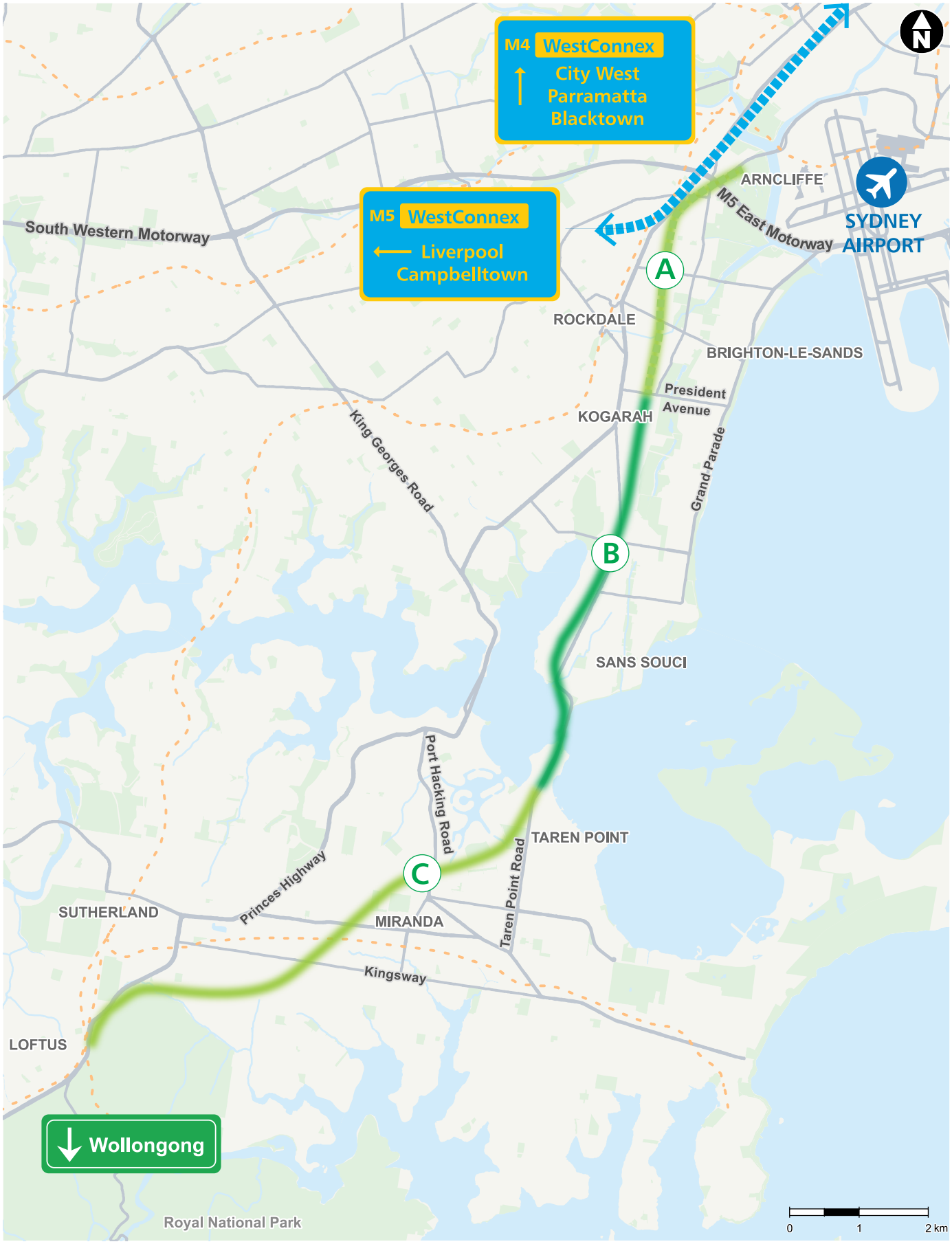


Figure 5-4 F6 Extension staging: study area

5.4 Project options and alternatives

After confirming the F6 option as the preferred corridor and deciding that Section A would be delivered as the first stage of the F6 Extension, Roads and Maritime developed the design options for the project. In doing so, the following project components were considered:

- Use of the existing F6 reserved corridor
- Northern connection
- Mainline tunnel alignment
- Southern connection
- Princes Highway / President Avenue intersection upgrade
- President Avenue surface works
- Shared cycle and pedestrian pathways.

Each of the project components was considered against option analysis criteria. Multiple alignments, infrastructure types and interchange options were generated as discussed below. Some options were readily assessed as impractical due to the inability to meet basic connectivity, constructability or other set criteria.

5.4.1 Existing F6 reserved corridor

The use of the existing F6 reserved corridor between Arncliffe and President Avenue was considered in the early stages of project development. However, it was discounted for the following reasons:

- The high value of the ecological and recreational resources within the existing F6 reserved corridor
- The social and environmental impacts of a surface motorway (either at-grade or on viaduct)
- The engineering challenge of tunnelling under the existing F6 reserved corridor given the identified poor geotechnical conditions
- The significant constraints on any northern end connection due to previous commercial and residential developments, with a lack of viability without a connection to the New M5 Motorway.

As a result of the preferred location and alignment of the project, the existing F6 reserved corridor (shown in **Figure 5-5**) would not be required for the project, aside from a small portion of land within Rockdale Bicentennial Park. Therefore, the existing F6 reserved corridor between Arncliffe and President Avenue would no longer be required for motorway purposes.

5.4.2 Northern connection

The northern connection of the project takes advantage of the significant investment made by the New M5 Motorway project, where tunnel stubs and associated infrastructure would be provided by the New M5 Motorway project at Arncliffe. The New M5 Motorway and the associated St Peters interchange have been specifically designed to facilitate this connection to the south and a future link to the international gateways of Sydney Airport and Port Botany.

The New M5 Motorway project identified that a tunnel was preferred over a surface connection for the F6 Extension at the St Peters interchange. This was on the basis that a tunnel would better integrate with the planned motorway network and have reduced impacts on community and environment aspects, than if it had been designed as a surface road alignment.

Other northern connection options for the project were considered in addition to the New M5 Motorway (northbound) connection, including a connection with the New M5 westbound tunnels, and the M5 East Motorway near General Holmes Drive. These options and the key outcomes of the options assessment are provided below.

New M5 Motorway westbound

- The New M5 project did not provide any tunnel stub connections, which would have resulted in significant modifications required to the New M5 Motorway tunnel
- Strategic traffic analysis found that there was insufficient demand for a connection to the New M5 westbound.

M5 East Motorway near General Holmes Drive

- Strategic traffic analysis identified some benefits to providing a direct connection from the project to Sydney Airport
- Strategic traffic analysis found that this option would result in:
  - a further decrease in peak hour traffic on The Grand Parade and other surface roads
  - an increase in congestion on the M5 East Motorway and M1 Southern Cross Drive
- Providing a connection from the F6 Stage 1 tunnel to the surface at this location would result in steep grades, making the connection unsuitable for heavy vehicles
- Geological conditions east of the F6 Stage 1 tunnel alignment were considered unsuitable for tunnel construction
- Construction would result in impacts to Eve Street Wetland.

Based on the preliminary options assessment, a connection to the New M5 Motorway westbound was not considered viable. A connection to the M5 East Motorway was considered, however the network traffic benefits did not outweigh the engineering and environmental constraints. Furthermore, a direct connection from the project to Sydney Airport would ultimately be provided by the proposed Sydney Gateway project.

5.4.3 New M5 Motorway lanes

The northern connection of the F6 Extension is to the New M5 Motorway with traffic continuing north to St Peters Interchange and beyond. The New M5 Motorway between the F6 Extension connection and St Peters Interchange is planned to be marked as two lanes in each direction, however the New M5 Motorway tunnel in this location has been constructed wide enough for four lanes in each direction.

Consideration has been given as to the connection of the F6 Extension to the New M5 Motorway and the number of lanes required. Two main options have been considered:

- A minimum treatment could incorporate the F6 Extension merging with the existing two lanes of the New M5 Motorway, allowing for the additional lanes to be utilised at a later date by others.
- Enable the two lanes of the F6 Extension join the two lanes of the New M5 Motorway to form a four lane motorway between the F6 Extension and St Peters Interchange.

Modelling undertaken for the F6 Extension project, within **Chapter 8** (Traffic and Transport), indicates that there is sufficient demand from both the F6 Extension and New M5 Motorway to facilitate the use of four lanes within this section. This aligns with analysis previously undertaken by the New M5 Motorway and the significant investment in constructing width in the tunnel sufficient for four lanes.

As such the F6 Extension project proposes to modify the line marking in the New M5 Motorway tunnel between the F6 Extension and St Peters Interchange to increase the lanes from two to four lanes in each direction.

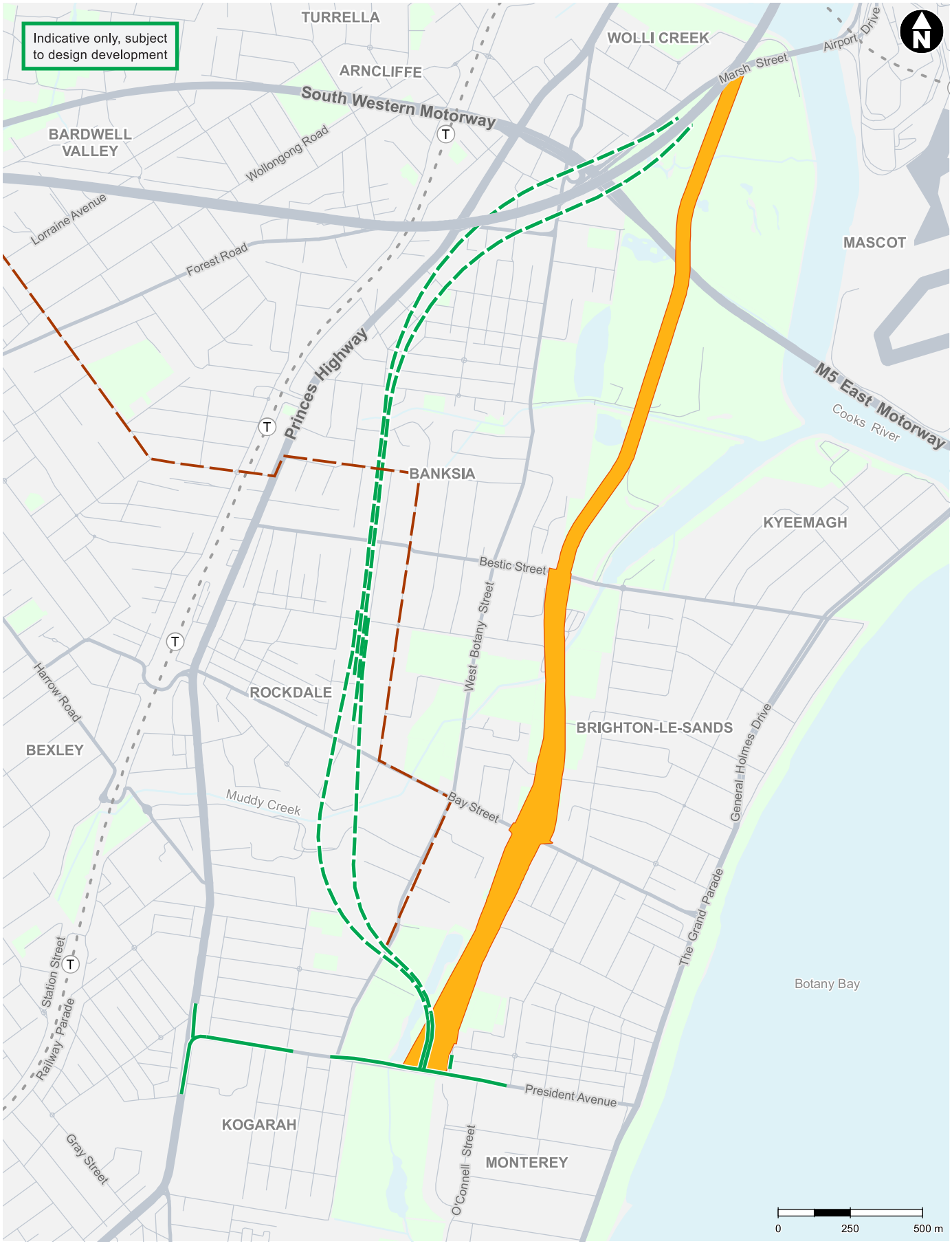


Figure 5-5 Existing F6 reserved corridor

5.4.4 Mainline tunnel

Tunnel alignment

The mainline tunnel alignment was chosen based on the following considerations:

- **New M5 Motorway stub tunnels** - The stub tunnels at Arncliffe were built specifically for a connection to a southern motorway. The stub tunnels face in a south-westerly direction at a depth of approximately 75 metres. This set the following parameters for the tunnel alignment:
  - The location of the stub tunnels precluded a surface connection at Arncliffe
  - The depth of the stub tunnels meant the project's mainline tunnel needed to cross below the New M5 Motorway tunnel.
- **Geological conditions** - Analysis of geotechnical conditions to the east of West Botany Street found that it was not optimal for tunnel construction. Geological conditions improved west of West Botany Street, indicating that a tunnel alignment closer to the Princes Highway would reduce construction risk and cost. The refinement of the horizontal and vertical alignment of the tunnel corridor has also been heavily influenced by a combination of new geological information, improvements in road alignment and preliminary ventilation requirements.

Three options were considered for the mainline tunnel alignment. These were an east, a central and a west option.

All three options commenced at President Avenue and met the New M5 Motorway stub tunnels at Arncliffe. **Figure 5-6** shows the mainline tunnel alignment options. The central option was chosen for the following reasons:

- Favourable geological conditions when compared to the east option, minimising the need for the cut-and-cover construction to extend west of West Botany Street
- Shorter tunnel length when compared to the west option, resulting in reduced costs and resource use.

Further refinement of this alignment may occur during detailed to achieve an optimal tunnel alignment.

Number of tunnel lanes

The project consists of twin mainline tunnels extending through to stubs for connection to a future stage of the F6 Extension; north facing interchange ramps connecting with the surface road network; and associated upgrade works to President Avenue and Princes Highway to facilitate the new motorway connection.

Originally, three options were considered within each of the mainline tunnels. These options were of two, three or four lanes in each direction, plus merges and tie-ins. The preferred project option is two lanes for the following reasons:

- The New M5 Motorway stub tunnels will be constructed as two lanes (as part of the New M5 Motorway)
- The southern entry and exit ramps of the project would be constructed as two lanes (for operational and safety reasons)
- Three kilometres was considered too short a length of motorway to introduce a third lane in each direction.

It was determined that the mainline tunnels would be constructed to allow a future third lane in each direction to allow for future stages of the F6 Extension.

Refer to **Chapter 8** (Traffic and transport) for further details on lane functionality. Further details on lane configurations and the direction of traffic flow within the tunnels, is provided in **Chapter 6** (Project description).

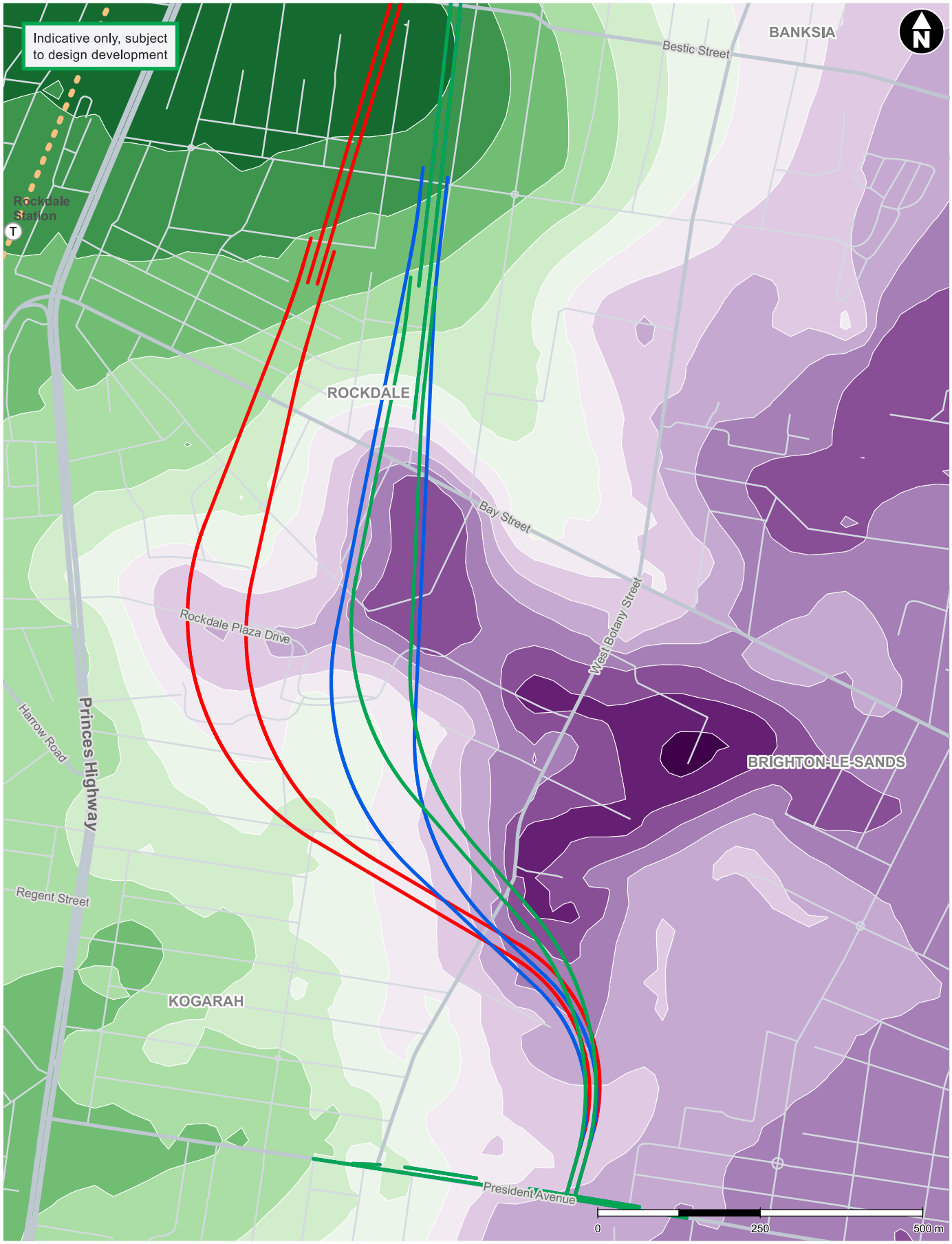


Figure 5-6 Mainline tunnel alignment options

5.4.5 Southern connection

There were a number of options considered to provide a southern connection between the project and the surrounding road network. These options included interchanges at Bay Street, President Avenue, Ramsgate Road, Sandringham Street and Rocky Point Road/Princes Highway. The viability of these connections is based on the potential surface/tunnel alignments, impacts of these intersections to land uses and traffic performance of the surrounding road network.

Sandringham Road and Ramsgate Road are local roads with a low level of traffic demand and limited connectivity. Bay Street is unsuitable due to its closeness to the tunnel structure and the New M5 Motorway connection. The entry and exit ramps would need to have tight curves and maximum grading (i.e. incline) as it approaches the surface. A southern connection at Bay Street would also require a larger amount of property acquisition than at President Avenue.

A connection within the vicinity of the Rocky Point Road/Princes Highway intersection was considered. However, the design was not developed given the proximity of St George Private Hospital, Moorefield Girls High School, James Cook Boys Technology High School and large multi-unit dwellings close to the Princes Highway. It would also reduce the accessibility for the Kogarah, Rockdale and surrounding suburbs.

President Avenue was selected as the best option against the criteria (listed below) for a number of reasons, including:

- **Motorway gradient:** given the depth of the connection at the New M5 Motorway and the need to have a uniform grade of alignment according to relevant design standards, the surface connection could not occur until south of Bestic Street, Kogarah
- **Network connectivity:** the project should connect with the arterial road network associated with the existing A1, including Princes Highway and the Grand Parade. A President Avenue connection provides a connection to the arterial State road within an appropriate road environment with capacity to absorb additional traffic, providing optimal connectivity in the St George area and improving connectivity to both Princes Highway and The Grand Parade
- **Community and Environment:** this option recognises the value of community and environmental assets and minimises impacts on land or property, including providing the opportunity for amenity improvements along The Grand Parade and the Bay Street cultural precinct. It is acknowledged that this option would result in temporary impacts to Rockdale Bicentennial Park
- **Land use:** A President Avenue connection would allow for the majority of the surface works to be located within the existing F6 reserved corridor within Rockdale Bicentennial Park East.

5.4.6 President Avenue surface works

The project would involve upgrade and widening works at President Avenue in order to ensure safe and efficient connections with the road infrastructure proposed as part of the project. President Avenue would also be raised by up to three metres to improve its level of flood immunity to the one per cent Annual Exceedance Probability (AEP) level.

The surface works in the vicinity of the President Avenue intersection would include changes to local traffic and access including:

- Changes to O'Neill Street
- Changes to the currently priority controlled movements in and out of the Moorefield Estate access roads (Lachal Avenue, Traynor Avenue, Cross Street, Oakdale Avenue, Moorefield Avenue and Civic Avenue) and the TAFE car park on President Avenue.

Options for these works were reviewed to identify the most appropriate arrangements from a road safety and traffic operations perspective. The options and rationale for the preferred option are outlined in **Table 5-1**. Proposed local access arrangements for the preferred option are shown on **Figure 5-7**.

Roads and Maritime would work with Bayside Council to refine the traffic arrangements at these locations and address potential impacts as a result of the proposed access changes.

Table 5-1 Justification for changes in local access along President Avenue

Proposed surface works	Current situation	Options considered and rationale for preferred option
O'Neill Street – cul-de-sac at President Avenue	Currently allows all movements to and from President Avenue	O'Neill Street would need to be converted to a cul-de-sac at President Avenue given the proximity of the new President Avenue intersection to ensure safe movements for vehicles as they turn in or out of the upgraded President Avenue. Due to these reasons, other options, including a 'do nothing' option, were not considered. Residents and drivers would still maintain access in and out of O'Neill Street via Crawford Road, about 200 metres to the east.
Lachal Avenue: conversion to two-way and formalise right turn movements.	Currently one-way northbound	Converting Lachal Ave to two-way operation is proposed due to: • Available space: which would allow for the addition of a right turn bay from President Avenue into Lachal Avenue • Location: being situated about halfway between Princes Highway and West Botany Street means that allowing all movements at the President Avenue / Lachal Avenue intersection would minimise impacts to those two signalised intersections • Combined arrangement with the TAFE carpark: formalising the right turn movements at Lachal Avenue would also allow formalised right turns in and out of the TAFE car park. Traynor Avenue and Cross Street were also considered for formalising right turn movements into and out of Moorefield Estate. However, due to the reasons listed above, the Lachal Avenue option was considered to perform better than providing right turn movements at Traynor Avenue or Cross Street.
Traynor Avenue	Currently one-way southbound. Allows left-in	At Traynor Avenue, a formalised right turn into Traynor Avenue would not be possible, due to the right turn arrangements at Lachal Avenue, but the left-in movement would remain. Vehicles wanting to turn right in to the Moorefield Estate would be able to use Lachal Avenue, about 75 metres to the west.
Oakdale Avenue	Currently allows left-in, left-out and right-in, right-out movements	No options were considered for changing the traffic arrangements at Oakdale Avenue as the current arrangement would remain suitable with the project.
Moorefield Avenue	Currently allows left-in, left-out access	Options of closing Moorefield Avenue at President Avenue or maintaining the left-in, left-out movements were reviewed and it was considered that, due to the close proximity to West Botany Street, a cul-de-sac option provided improved safety with the project.
Civic Avenue	Currently allows left-in, left-out and right-out movements	The existing right-out movement at this location would not be accommodated by the project due to the proposed lengthening of the right turn lane on the westbound President Avenue approach to the West Botany Street intersection. Vehicles wanting to turn right onto President Avenue would be able to use the Oakdale Avenue / President Avenue intersection, located about 150 metres to the west, at which all turning movements are allowed. Options of closing Civic Avenue at President Avenue or maintaining the left-in, left-out movements were reviewed and it was considered that maintaining the left-in, left-out movements provided better overall access and improved safety with the project.

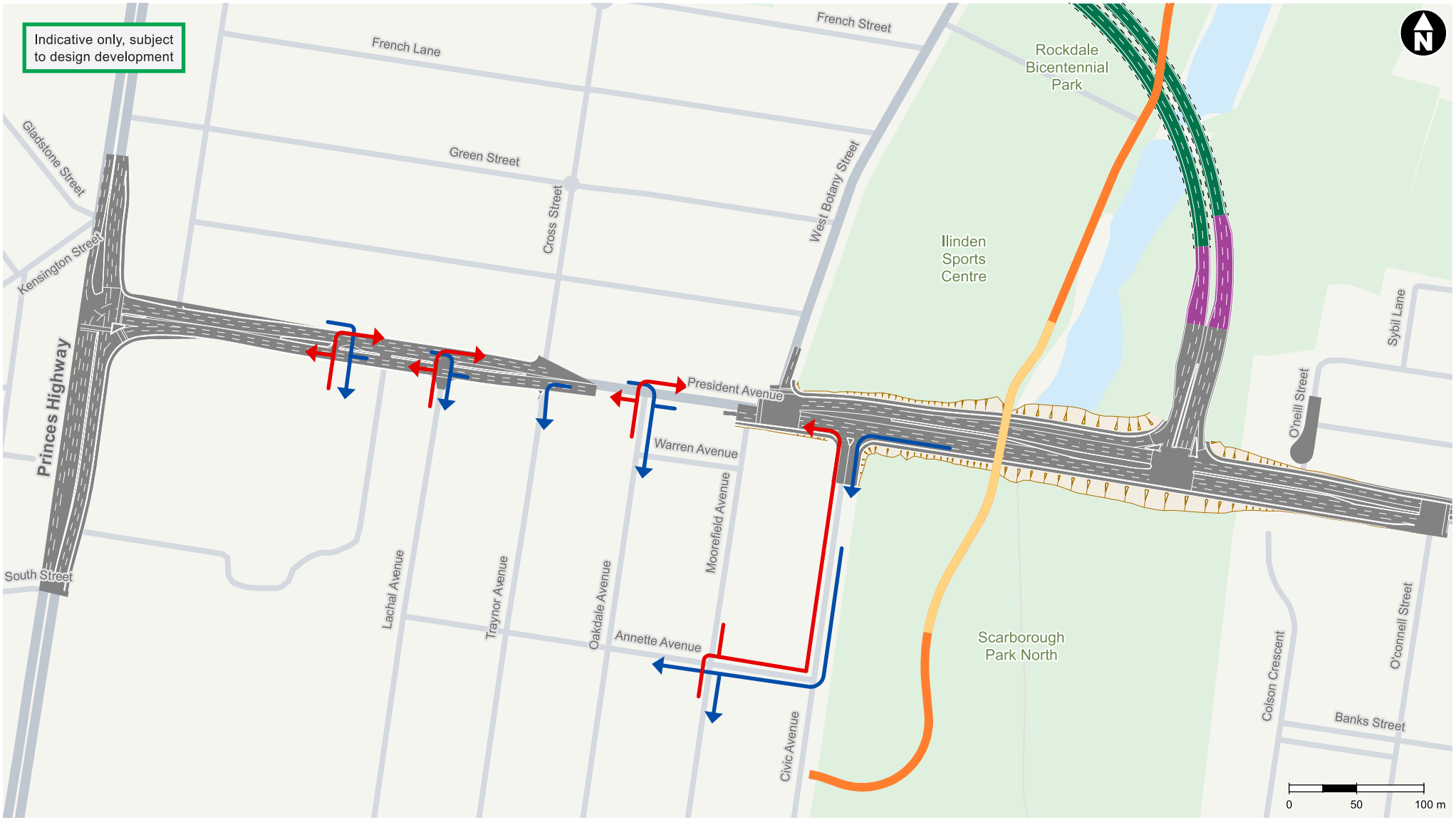


Figure 5-7 Proposed local access arrangement for residents around President Avenue

5.4.7 Princes Highway / President Avenue intersection

Preliminary traffic modelling indicated that upgrades at the Princes Highway / President Avenue intersection would be required to accommodate the additional traffic anticipated as a result of the project. Three options were considered to meet the traffic demand:

- Do nothing: this option would retain the existing arrangement at the Princes Highway / President Avenue intersection
- Right turn overpass: this option would include a northbound, single lane right turn overpass from Princes Highway into President Avenue
- Surface works: this option would include the addition of a right turn lane from Princes Highway northbound into President Avenue.

An assessment of each of these three options was undertaken and the outcomes were as follows:

- Do nothing: traffic modelling indicated that adopting this option would result in increased waiting times at the Princes Highway / President Avenue intersection due to additional traffic accessing the tunnel portals for the project
- Right turn overpass:
  - Traffic modelling indicated that this option would improve the traffic performance at the Princes Highway / President Avenue intersection by removing an at grade movement in the signal phasing. However, traffic modelling indicated that the single lane overpass would provide insufficient capacity for the projected traffic volumes and therefore would result in extended queues.
  - A review of environmental and social costs indicated that the visual impacts to the streetscape of this option would be undesirable for local residents and users of the intersection.
- Surface Works:
  - Traffic modelling indicated that providing an additional right turn to the intersection would increase capacity for the right turn movement giving opportunity for more vehicles to exit the intersection per cycle, therefore improving the overall performance of this intersection.
  - A review of environmental and social costs identified the social cost of strip acquisition along President Avenue.

A multi-criteria analysis assessed these options against desired criteria relating to traffic, environmental and social, engineering and cost. A summary of the multi-criteria analysis of the three options is shown in **Figure 5-8**. The preferred option for the project was to undertake surface works at the intersection, in order to meet the projected traffic demand.

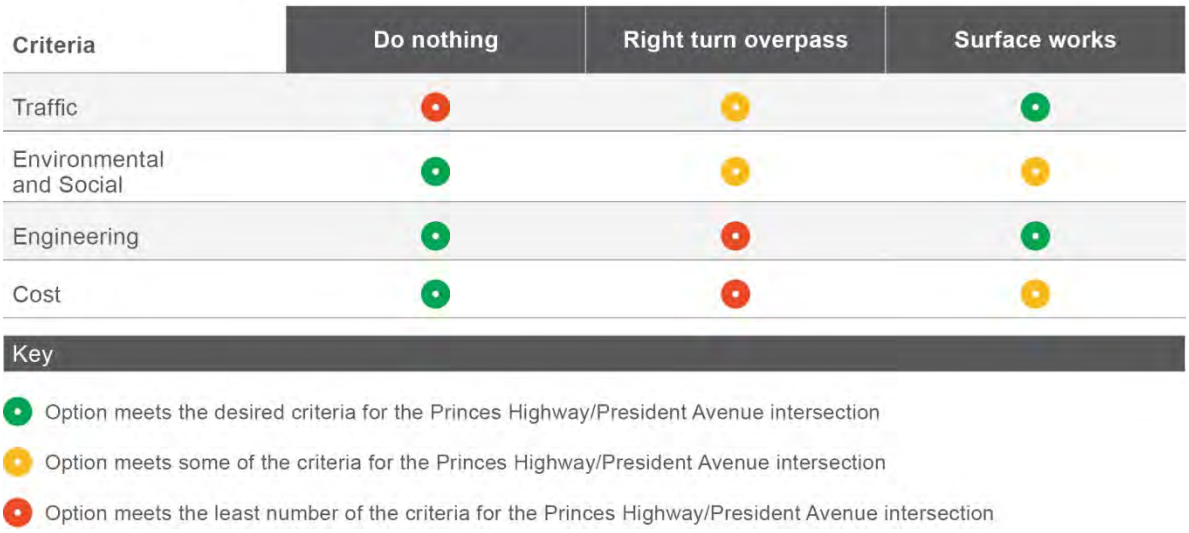


Figure 5-8 Princes Highway / President Avenue intersection improvement options

5.4.8 Shared cycle and pedestrian pathways

The following route options for the shared cycle and pedestrian pathways were considered and discounted for reasons as described below:

- A route that finished at Bay Street did not provide a connection with the cycleway north of Bestic Street
- Shared cycle and pedestrian pathways that provided a direct route (i.e. predominately off-street) between Rockdale Bicentennial Park and Bruce Street required property acquisition
- A route that traversed the eastern side of Rockdale Wetlands did not provide a connection to West Botany Street and would preclude a bridge crossing over President Avenue
- A route that followed Muddy Creek would not have utilised land within the existing F6 reserved corridor.

The preferred shared cycle and pedestrian pathway route has been designed to provide a safe and direct connection between Bestic Street and Civic Avenue, via a shared bridge over President Avenue, whilst minimising impacts on property and utilising the existing F6 reserved corridor.

Further details on the shared cycle and pedestrian pathways are provided in **Chapter 6** (Project description).

The detailed design of the shared cycle and pedestrian pathways would be developed in consultation with Bayside Council and other key stakeholders such as Sydney Water. Additional options that would be considered include:

- Extension of the pathways west towards Rockdale Plaza and Kogarah Station
- Extension of the pathways north, such as along Cooks Cove
- Extension of the pathways east along Bay Street towards the beach.

5.4.9 Dedicated shared cycle and pedestrian bridge

There were two main options for the location of the dedicated shared cycle and pedestrian bridge, each addressed the aim to provide a connection between Rockdale Bicentennial Park north of President Avenue, and the area south of President Avenue (refer to **Figure 5-9**). The two options were:

- East of the proposed President Avenue intersection (eastern option)
- West of the proposed President Avenue intersection (western option).

There were four variations of the eastern option. Due to the proposed raising of President Avenue at the location of the intersection, each of the eastern options would have been higher than the roof line of nearby residential dwellings. This would have resulted in visual impacts and reduction in privacy for residents along President Avenue and Colson Crescent. In addition, the residential catchment east of Scarborough Park North is already served by a shared pedestrian and cycle network along The Grand Parade and Brighton-Le-Sands foreshore.

The western option is considered the preferred option because it would:

- Follow the existing path alignment within Rockdale Bicentennial Park north
- Provide a direct connection between Council owned open space/recreation areas
- Minimise the visual impacts of the project
- Provide a connection to a shared pedestrian and cycle network for the residential catchment west of Scarborough Park North.

5.4.10 Permanent power supply connection

The route of the permanent power supply connection was developed based on the most direct and efficient connection between the Ausgrid Canterbury substation and the Rockdale Motorway Operations Complex south (MOC3). It has also been developed so that it follows arterial roads where possible in order to minimise impacts on the local traffic and transport network during construction. The route is located within the road reserve where possible in order to minimise impacts to open space, private property, vegetation and heritage items.

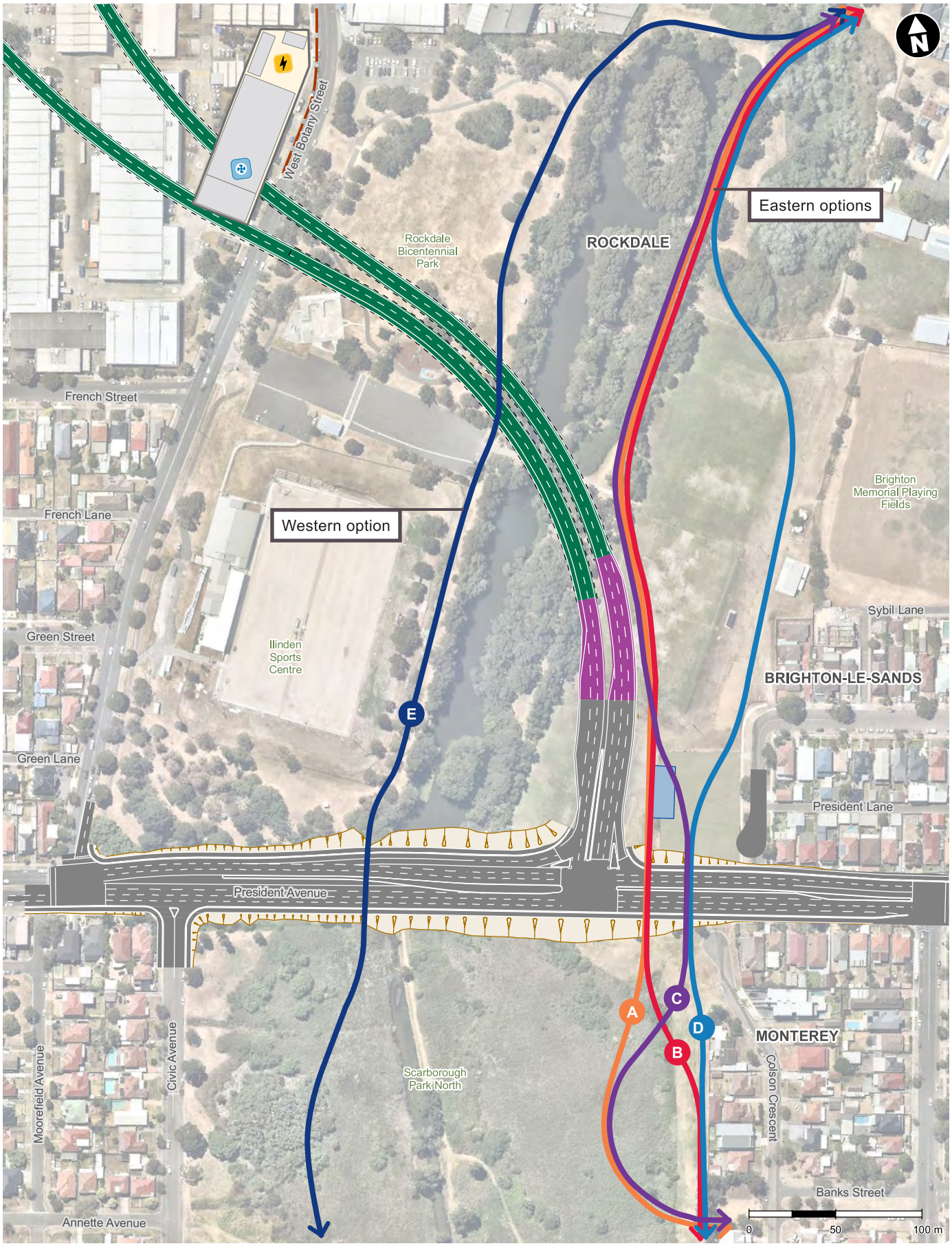


Figure 5-9 Dedicated shared cycle and pedestrian bridge options

5.5 Other project options considered

This section outlines options considered within the project including ventilation facilities, construction ancillary facility locations, tunnel construction methodologies, as well as spoil transport and disposal.

5.5.1 Ventilation

Ventilation system design

The mainline tunnel would be unidirectional, in common with all long tunnels in NSW, meaning that traffic travels in one direction only within the tunnel. In order to have travel in both directions, two tunnels could be constructed side by side such as the Lane Cove Tunnel, or one on top of the other, such as the Eastern Distributor.

On an open roadway, vehicle emissions are diluted and dispersed by natural surface air flows. However, in a tunnel, mechanical ventilation is required to ensure the maintenance of air quality standards and to control smoke in the rare case of fire. Tunnel ventilation requirements are determined by the air flows, the forecast vehicle emissions in the tunnel and the limits of pollutant levels set by regulatory authorities. Air quality is managed by ensuring that the volume of fresh air coming into the tunnel adequately dilutes emissions and balances the air removed through the elevated ventilation outlets. Elevated ventilation outlets are used for tunnels longer than about one kilometre in Australia's urban areas to disperse tunnel air at a height that ensures compliance with ambient air quality criteria. A number of options for the design of the ventilation system were considered. These systems are described below and illustrated in **Figure 5-10**.

Natural ventilation

Road tunnels with natural ventilation rely on vehicle movements, prevailing winds and differences in air pressure between the tunnel portals to move air through the tunnels without the assistance of mechanical ventilation, such as fans. In the case of unidirectional naturally ventilated tunnels, the piston effect generated by traffic using the tunnels also assists in the movement of air. Because naturally ventilated tunnels do not have mechanical ventilation outlets, all air from within the tunnels is emitted via the tunnel portals.

In NSW, natural ventilation is only acceptable for use in relatively short tunnels (i.e. less than one kilometre) as without the assistance of mechanical ventilation, vehicle emissions can build up within the tunnels leading to unacceptable in-tunnel air quality under some traffic scenarios. Emergency smoke management considerations may also dictate a mechanical solution. Natural ventilation is not practical for the longer road tunnels proposed for the project, as it would not achieve acceptable in-tunnel air quality under low vehicle speed conditions or during emergencies. It is therefore not an appropriate ventilation design for the project.

Longitudinal ventilation

The simplest form of ventilation for road tunnels is longitudinal ventilation, in which fresh air is drawn in at the entry portal and passes out through the exit portal with the flow of traffic. For longer tunnels, the air flow is supplemented by fans that are used when traffic is moving too slowly to maintain adequate air flow, or to draw air back from the exit portals against the flow of exiting traffic. This air is then exhausted through an elevated ventilation outlet to maximise dispersion. All road tunnels longer than one kilometre built in Australia in the last 20 years have been designed and operated with longitudinal ventilation systems. This includes the Eastern Distributor, Lane Cove and Cross City Tunnels in Sydney.

Transverse ventilation

Emissions can be adequately diluted with the provision of fresh air inlets along the length of the tunnel along one side, with outlets on the opposite side. This system requires two ducts to be constructed along the length of the tunnel: one for the fresh air supply and one for the exhaust air. Transverse ventilation has been used in the past when vehicle emissions produced greater levels of pollutants than they do today. A transverse ventilation system is more expensive to construct because of the additional ducts that need to be excavated for each tunnel. This type of system is less effective than a longitudinal system for controlling smoke in the tunnel in case of a fire. It is also more energy intensive as more power is consumed to manage air flows.

Semi-transverse ventilation

Semi-transverse ventilation combines both longitudinal and transverse ventilation. Fresh air can be supplied through the portals and can be continuously exhausted through a duct along the length of the tunnel. Alternatively, fresh air can be supplied through a duct and exhausted through the portals. This option would be slightly less energy intensive than transverse ventilation, however it would still require the construction of some additional fresh air ducts and would not be as effective as a longitudinal system for controlling smoke in the tunnel in the case of a fire. The Sydney Harbour Tunnel uses a semi-transverse ventilation system**.**

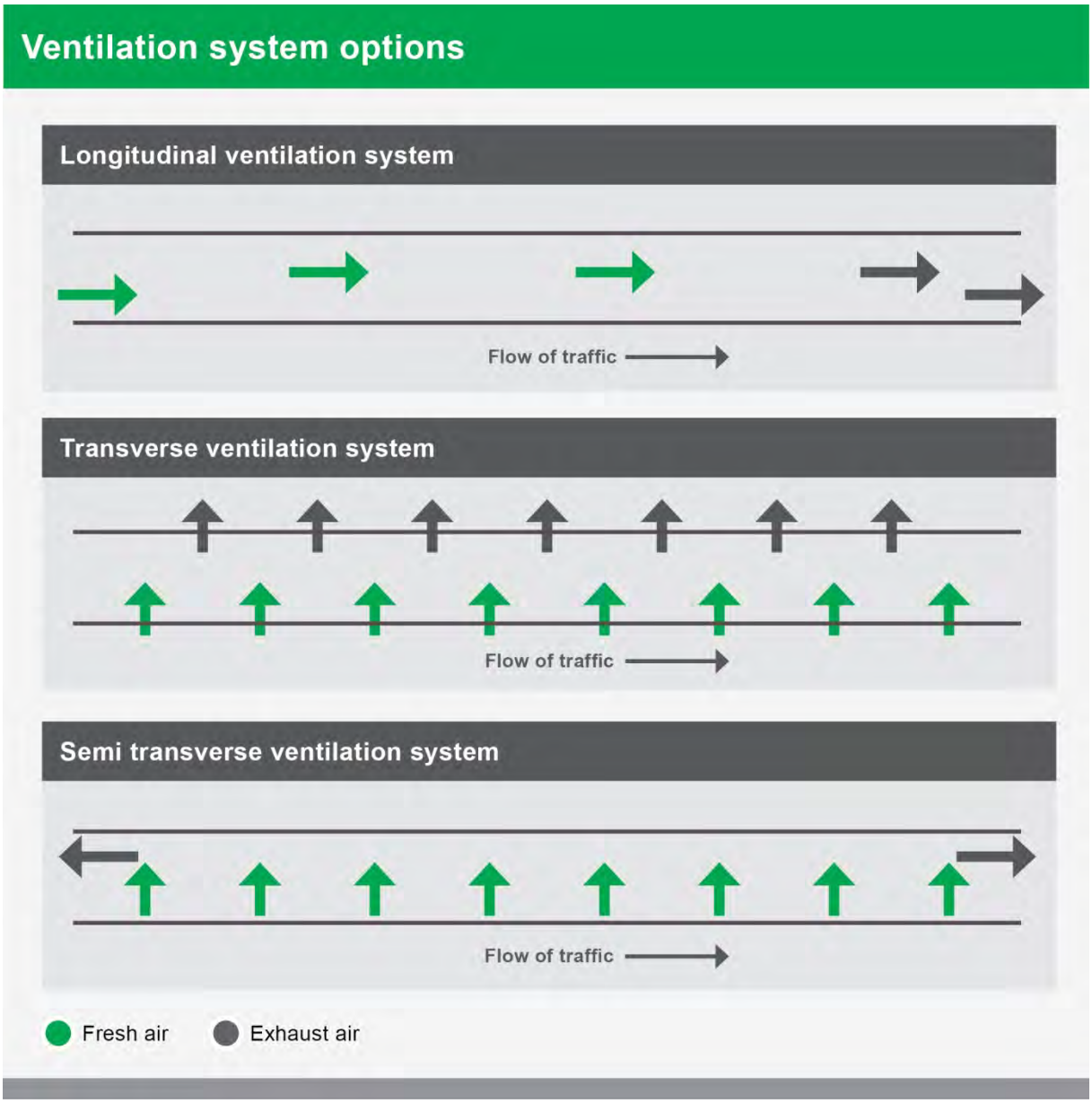


Figure 5-10 Ventilation options

Preferred ventilation system design

The development of new vehicle technologies in response to cleaner fuel and emissions standards has led to a significant reduction in vehicle emissions over the past 20 years. Consistent with other motorway tunnels in Sydney, a longitudinal ventilation system was chosen as the preferred ventilation system for the project.

Although other mechanical ventilation systems (such as natural ventilation, transverse ventilation and semi-transverse ventilation as discussed above) could be designed to meet in-tunnel air quality criteria, a well-designed longitudinal ventilation system is considered most suitable as it can maintain acceptable air quality in long tunnels and would provide the most efficient and effective tunnel ventilation[3].

The effectiveness of elevated ventilation outlets in dispersing emissions is well established. **Chapter 9** (Air quality) presents the air quality assessments for both in-tunnel and external air quality. An overview of the ventilation system design and operation is provided in **Chapter 6** (Project description).

Ventilation facility locations

Main considerations in relation to ventilation facilities included co-location with other approved projects where possible; minimising local air quality impacts on nearby receptors; and maximising the operational efficiency of the tunnel ventilation system.

Arncliffe ventilation facility

The location selected for a northern ventilation facility was based on co-location with other projects. In this instance, there was the option to fitout the New M5 Motorway Arncliffe ventilation facility for the project. Alternative locations were considered, however they were not chosen as they would have required a more complex ventilation system, increased operating costs, and unnecessary property and visual impacts.

Rockdale ventilation facility

Three options were considered for the southern ventilation facility in Rockdale. These options were:

- Rockdale Bicentennial Park, above the tunnel portal
- Roads and Maritime Depot at West Botany Street, Rockdale
- West Botany Street.

These options were assessed against desired criteria relating to the proximity to the tunnel portal, environmental impacts, social impacts, engineering requirements and cost. A summary of the multi-criteria analysis is shown in **Figure 5-11**.

A key design requirement for ventilation facilities is to locate them as close as possible to the tunnel portal, to minimise the ongoing power requirements and operational costs associated with pumping air from the tunnel portal to the ventilation outlet. This design arrangement ensures there are no unmanaged emissions at the portal location. Given this requirement, Rockdale Bicentennial Park, above the tunnel portal was considered as a location. However, this location would increase the social impacts of the project by requiring additional open space to be permanently required for the project.

The Roads and Maritime Depot at West Botany Street was also considered which would avoid the need for acquisition of private property. However, locating the facility at the depot would require the construction of a cut-and-cover tunnel through poor ground conditions, resulting in additional impacts to shallow groundwater and further impacting on the open space and ecological attributes of this area. Furthermore, this site is located about 500 metres from the tunnel portal, increasing the power requirements over the operational life of the project. For these reasons, this location was not chosen as the preferred option.

The preferred location for the ventilation facility is on West Botany Street, opposite Rockdale Bicentennial Park. This was chosen as it is located above the tunnel, close to the portal and would not require additional open space to be taken for the project.

[3] Advisory Committee on Tunnel Air Quality (2014). *Technical Paper 04: Road Tunnel Ventilation Systems NSW Government*

Criteria	Roads and Maritime Depot at West Botany Street, Rockdale	Rockdale Bicentennial Park, above the tunnel portal	West Botany Street (preferred option)
Proximity to tunnel portal	●	●	●
Environmental	●	●	●
Social	●	●	●
Engineering	●	●	●
Cost	●	●	●

Key

- Option meets the desired criteria for the location of the southern ventilation facility
- Option meets some of the desired criteria for the location of the southern ventilation facility
- Option meets the least number of the desired criteria for the location of the southern ventilation facility

Figure 5-11 Southern ventilation facility options assessment

Air filtration

Modelling demonstrates that the proposed ventilation system would be effective in ensuring compliance with in-tunnel air quality criteria and with the external air quality around the outlets (**Chapter 9** (Air Quality)).

In-tunnel air quality

There are several in-tunnel air filtration options, these include the electrostatic precipitator, filtering, denitrification and biofiltration, agglomeration and scrubbing. These are described in (**Chapter 9** (Air Quality)). Around the world, there are relatively few road tunnels with installed filtration systems. There are no Australian road tunnel projects that have installed air filtration systems, these projects rely on the primary approach of dilution of air pollution, through ventilation systems.

The inclusion of in-tunnel air filtration was evaluated and found not to provide any material benefit to air quality or community health. If the proposed ventilation system does not achieve the required in-tunnel air quality levels, the most effective solution would be the introduction of additional ventilation outlets and additional locations for fresh air supply. This discussion is provided in the air quality impact assessment in **Appendix E** (Air quality technical report). As a result, an in-tunnel filtration system is not proposed for the project.

Ambient air quality

The inclusion of filtration would result in no material change in air quality in the surrounding community as compared to the current project ventilation system and outlet design. Any predicted changes in the concentration of pollutants would be driven by changes in the surface road traffic.

5.5.2 Construction ancillary facility locations

Five construction ancillary facilities listed in **Table 5-2** and described in further detail in **Chapter 7** (Construction) have been identified to support project construction. The sites would be used for a mix of civil surface works, tunnelling support and administrative purposes. Locations were based on:

- Proximity to location of key project infrastructure
- Co-location of sites with other approved projects where possible
- Minimisation of impacts on land use, biodiversity and heritage values
- Access to key arterial routes for spoil haulage
- Minimisation of private property acquisition
- Construction efficiency.

The following alternative facilities were not chosen as they failed to meet the criteria listed above:

- Industrial sites north of Rockdale Bicentennial Park and south of Muddy Creek as property acquisition would have been required and local streets may have been impacted
- Ilinden Sports Centre as this would have resulted in a loss of a permanent sporting facility
- A construction ancillary facility mid-way along the tunnel alignment was considered for a third tunnelling site, however it would have required additional property acquisition.

Table 5-2 Reasons for the selection of construction ancillary facilities

Ancillary facility	Reason for location of construction ancillary facility
Arncliffe construction ancillary facility	• Co-located with New M5 Motorway construction ancillary facility • Provides access to the stub tunnels via the existing shaft or decline constructed as part of the New M5 Motorway project • No requirement to use additional private or public land.
Rockdale construction ancillary facility	• Within land owned by Roads and Maritime (Roads and Maritime depot) • No requirement to use private or public land • Located within an industrial area, with limited sensitive receptors • Direct access to West Botany Street.
President Avenue connection construction ancillary facility	• Location of cut-and-cover and surface works within Rockdale Bicentennial Park • Location of Rockdale ventilation facility • Direct access to West Botany Street and President Avenue for spoil haulage.
Princes Highway construction ancillary facility	• Location of Princes Highway and President Avenue intersection upgrade works • Land is also partially required for the operation of the project, reducing the need for additional property acquisition.
Two ancillary facilities for the shared cycle and pedestrian pathways construction	• Direct access to either side of Muddy Creek recreation area, the location of the proposed shared cycle and pedestrian pathways.

5.5.3 Tunnel construction methods

A number of tunnel construction methods were considered for the construction of the mainline tunnel and entry and exit ramp tunnels. These options are listed in **Table 5-3**.

It is anticipated that the project would require a combination of roadheader excavation and drill and blast methods, for the following reasons:

- Roadheaders offer advantages over tunnel boring machines such as:
  - Ease of excavation of varying cross sections, caverns, niches and cross passages
  - They can be moved to different parts of the tunnel alignment
  - It is more economic because it takes less time and generates less spoil
  - They are more suited to the road geometry and cross-sectional dimensions
- The combination of roadheader excavation and drill and blast methods speeds up excavation compared to work being undertaken solely with roadheaders
- Noise and vibration impacts are reduced for residential and commercial properties given the shorter duration impacts associated with blasting compared to other tunnel construction methods
- Geological conditions along the preferred alignment are suitable for both roadheader excavation and drill and blast methods.

Further detail on the mainline tunnelling construction approach is provided in **Chapter 7** (Construction).

Table 5-3 Mainline tunnel construction method options

Method	Description
Tunnel boring machine	A tunnel boring machine is a specialist machine that excavates a circular bore of fixed diameter by rotary action. Tunnel boring machines are normally custom made to suit the particular requirements of the project and require considerable time to deliver and mobilise for full operation. They also require a large open area on site to assemble and align in position for driving. Tunnel boring machines are typically used for underground rail projects where a set width is required for the length of the tunnel. Tunnel boring machines are less preferred for underground motorway projects due to the cross section of the tunnel necessitating a very large tunnel boring machine. Other considerations are the lack of cost effectiveness (when compared to road header excavation) due to the excess of spoil generated and that Sydney geological conditions (sandstone) generally do not require the support or waterproofing benefits of tunnel boring machine construction.
Drill and blast	The drill and blast excavation method involves a sequence of drilling holes, charging the holes with explosives, blasting, mucking out, and installing roof and wall ground support. The method is an efficient and cost effective way of excavating in rock, and provides an effective tunnel excavation method which assists in achieving an overall shorter project delivery.
Road header excavation	Roadheaders are commonly used for excavation in sandstone and have been successfully used in other tunnel projects in Sydney. A roadheader is specialised tunnelling equipment that excavates with picks mounted on a rotary cutter head attached to a hydraulically operated boom. As the excavation advances, temporary or permanent ground support would be installed behind the excavation face.

The entry and exit ramp tunnels, east of West Botany Street and extending beneath Rockdale Bicentennial Park to the President Avenue intersection, would not be constructed using the methods discussed above. These sections of the alignment would be constructed using a cut-and-cover structure and, closer to President Avenue, a slot structure (refer to **Chapter 7** (Construction)). These methods, as opposed to roadheader excavation and drill and blast methods, are required at these locations for the following reasons:

- Poor geological conditions east of West Botany Street, which preclude driven tunnel construction options
- Shallow depth of the tunnel at this location due to the need to connect the underground motorway with the surface at President Avenue.

5.5.4 Spoil storage, transport and disposal options

Construction of the project would generate around 1.4 million cubic metres of spoil, which allows for numerous spoil reuse and disposal options. Consideration has been given to the various modes available to store and transport spoil, as outlined below.

Spoil storage options

Selection of the construction ancillary facilities (refer to **section 5.5.3**) was the main driver for the location of spoil storage. Spoil would be stored within each of the three construction ancillary facilities. This provides direct access to each of the tunnelling sites and the cut-and-cover sites. Furthermore, each of the construction ancillary facilities has been located based on their proximity to arterial roads for the transport of spoil.

Spoil transport options

Rail as a spoil transport option allows large volumes of spoil to be moved while reducing the number of heavy vehicle movements on the wider road network. However, this transport option was not selected as the preferred option because there are very few spare train paths on the Sydney rail network, which presents logistical challenges. Chullora would be the closest appropriate intermodal terminal, which is over 10 kilometres from the construction ancillary facilities. The material would also need to be double or triple handled as trucks would be required to move material to the train loading facility and potentially from the rail facility to its final location.

As with rail, the main benefit of barge transport is the ability to move large volumes of spoil, while reducing the number of heavy vehicle movements on the wider road network. However, this option presents a number of issues including that the material would need to be double (or possibly triple) handled, as trucks would be required to move material to the barge loading facility, and potentially from the barge to its final location, if this does not have barge access. Infrastructure upgrades would also potentially be required to allow the barge loading facility to receive the material.

Spoil removal using heavy vehicles (i.e. trucks) is the preferred transport option for the project and would involve transporting material from the construction sites directly to the spoil's final destination. This would be primarily via the arterial road network. The use of trucks would avoid the need for double or triple handling, as would be the case with rail or barging options, but would result in a higher number of trucks on the road. This increase is considered acceptable given the transport options.

Notwithstanding the current preferred option, further investigations would be undertaken into spoil transport options, including the potential transport by barge, during detailed design.

Chapter 8 (Traffic and transport) provides a summary of heavy vehicle movements, including spoil related haulage. This transport of spoil would be investigated further by the construction contractor.

Spoil disposal options

As described in **Chapter 21** (Waste management), there would be a beneficial reuse of as much spoil as possible as part of the project before pursuing any alternative spoil disposal options, such as use in other infrastructure or development projects.

Potential opportunities for reuse of spoil within the project include for the formation of embankments, site rehabilitation and landscaping, and infill for temporary tunnel access shafts and declines.

The majority of usable (e.g. uncontaminated) construction and demolition spoil is anticipated to be reused and/or recycled. Residual spoil waste which cannot be reused or recycled would be disposed of to a suitably licensed landfill or waste management facility.

Several spoil management sites have been identified to receive project spoil (refer to **Chapter 21** (Waste management)). These range from between 40 to 70 kilometres from the project. Final destination(s) for construction spoil would be determined during the detailed design stage, and may include more than one disposal site.

Alternative and/or additional spoil reuse options may be identified by the construction contractor as the project progresses.

5.5.5 Other operational ancillary facilities

Operational Motorway Control Centre

The Operational Motorway Control Centre would manage all motorway controls for operation of the project. This would be located at West Botany Street in Rockdale, within the motorway operations complex. This land is currently used, and will continue to be used, as a Roads and Maritime depot.

Alternative locations for the Operational Motorway Control Centre were considered but were not chosen as they:

- Required additional property acquisition
- Resulted in a loss of public open space
- Had insufficient space at other operational infrastructure sites (namely the Rockdale ventilation facility).

Water treatment facilities

The operational water treatment facility would be located next to the existing Arncliffe Motorway Operations Complex. A number of options were considered for the location of the plant and for the infrastructure which would transport the tunnel water to the treatment plant.

These options included utilising the New M5 Motorway water treatment plant and constructing a new plant at a location next to the Cooks River. These options were not selected as they would have not provided sufficient capacity for the volumes of water anticipated to be treated, or would have required additional undisturbed land.

5.6 Staging the project

The project is the first stage of the F6 Extension. However, it is also considered a stand-alone project given its own objectives and project benefits. Future stages of the F6 Extension would be subject to separate planning approval.

The construction of the project would occur in one stage, with road header excavation occurring from the northern and southern extents, and the cut-and-cover construction being undertaken simultaneously.

The project is anticipated to be open by the end of 2024.

5.7 Justification of the preferred option

The project would facilitate improved connections between southern Sydney, the Sydney CBD and Port Botany, as well as better connectivity between key employment hubs and local communities. Together with future stages of the F6 Extension, it would also provide improved connections between the Sydney CBD and the Illawarra Region.

The project would ease congestion on surface roads by providing an underground motorway alternative. This would allow for increased use of surface roads by pedestrians and cyclists due to a reduction in through traffic, including freight vehicles, along The Grand Parade and Princes Highway. The project would support opportunities for place-making at key locations along these routes. In addition, the project would provide shared cycle and pedestrian pathways aimed at improving north-south active transport movements between Bestic Street and Civic Avenue.

The merits of the project were considered in the context of a range of strategic alternatives, based on the extent to which they could meet the project objectives. Design options for the project were also assessed on how well they performed with reference to transport, environmental, engineering, social and economic factors. The project concept design was determined based on these outcomes.

The project is aligned with the objectives for the overall F6 Extension, which aim to achieve similar outcomes for the entire length of the F6 Extension, linking the A1 Princes Highway at Loftus with the existing and proposed motorway network in Sydney.

The project is consistent with the project objectives and is consistent with, or does not preclude, the strategies and recommendations identified in **Chapter 4** (Strategic context and project need).

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6 Project description

6.1 The project

The project would comprise a new multi-lane road between the New M5 Motorway at Arncliffe and President Avenue at Kogarah. The project would connect underground with the New M5 Motorway tunnel and to a new surface level intersection at President Avenue, Kogarah. The project would allow commuters to connect to the motorway network and travel north on the New M5 Motorway to St Peters Interchange or the M4-M5 Link.

Detailed illustrations of project components are provided in **Figure 6-1** and **Figure 6-2**.

The project description presented in this EIS represents the concept design for the project. If approved, a further detailed design process would follow which may include refinements to the concept design. The final design may therefore vary from the concept design described in this chapter. Any changes would be reviewed for consistency with the assessment contained in this EIS including relevant mitigation measures, performance outcomes and any future conditions of approval.

Key components of the project are detailed in **section 6.3** to **section 6.12** would include:

- Twin mainline tunnels. Each mainline tunnel would be around 2.5 kilometres in length, sized for three lanes of traffic, and line marked for two lanes as part of the project
- A tunnel-to-tunnel connection of two additional lanes in each carriage way to the New M5 Motorway southern extension stub tunnels, including line marking of the New M5 Motorway tunnels from the stub tunnels from the F6 Extension connection to St Peters interchange
- Entry and exit ramp tunnels about 1.5 kilometres long (making the tunnel four kilometres in length overall) and a tunnel portal connecting to the President Avenue intersection
- An intersection with President Avenue including entry and exit ramps and the widening and raising of President Avenue
- Upgrade of the President Avenue / Princes Highway intersection to improve intersection capacity
- Shared cycle and pedestrian pathways connecting Bestic Street, Brighton-Le-Sands to Civic Avenue, Kogarah (including an on-road cycleways)
- Three motorway operation complexes:
  - Arncliffe, including a water treatment plant, substation and fitout (mechanical and electrical) of a ventilation facility currently being constructed as part of the New M5 Motorway project (MOC1)
  - Rockdale (north), including a motorway control centre, deluge tanks, a workshop and an office (MOC2)
  - Rockdale (south), including a ventilation facility, substation and power supply (MOC 3)
- Reinstatement of Bicentennial Park and recreational facilities
- In-tunnel ventilation systems including jet fans and ventilation ducts connecting to the ventilation facilities
- Drainage infrastructure to collect surface water and groundwater inflows for treatment
- Ancillary infrastructure for electronic tolling, traffic control and signage (both static and electronic signage)
- Emergency access and evacuation facilities (including pedestrian and vehicular cross and long passages); and fire and life safety systems
- A permanent power supply connection from the Ausgrid Canterbury sub-transmission substation, to Rockdale Motorway Operations Complex south
- New service utilities, and modifications and connections to existing service utilities.

The project does not include:

- Ongoing motorway maintenance activities during operation
- Future upgrades to other intersections in the vicinity of the project.

These works are permitted under separate existing approvals and / or are subject to separate assessment and approval.

LEGEND

- The project in tunnel
- Shared cycle and pedestrian pathways
- Motorway operations complex
- Permanent power supply line
- Substation
- Water treatment facility
- Operational discharge location
- New M5 Tunnel
- Arncliffe ventilation facility*
- * Under construction as part of the New M5 Motorway project
- Railway station
- Railway line

Figure 6-1 Project operational layout - Map 1

LEGEND

- The project in tunnel
- The project on surface
- The project as an open slot
- On-road cycleway
- Shared cycle and pedestrian pathways
- President Avenue shared cycle and pedestrian bridge
- Building
- Embankment
- Water quality basin
- Motorway operations complex
- Permanent power supply line
- Substation
- Rockdale ventilation facility
- Railway station
- Railway line

Figure 6-2 Project operational layout - Map 2

The project would interface with several aspects of the New M5 Motorway project; these are outlined in **Table 6-1**. The tunnel-to-tunnel connection, lane configuration, ventilation facility and water treatment facility associated with the New M5 Motorway are shown in **Figure 6-3**.

Table 6-1 The project's interface with the New M5 Motorway

Interface	New M5 Motorway	The project
Tunnel-to-tunnel connection	The stub tunnels at Arncliffe will be built in a south-westerly direction and at a depth of about 75 metres underground.	The project would connect to the New M5 stub tunnels and continue south, with the northbound tunnel passing beneath the New M5 at about 100 metres underground.
Lane configuration	The New M5 tunnels, between Arncliffe and St Peters interchange, will be constructed for four lanes (allowing for an ultimate five lanes) and marked for two lanes as part of the New M5.	The project would include line marking of two additional lanes, for a total of four lanes, in the New M5 tunnels from St Peters interchange to where the project would join the New M5 tunnels at Arncliffe.
Ventilation facility	The New M5 includes a motorway operations complex at Arncliffe, which will house the Arncliffe ventilation facility.	The project would include the mechanical and engineering fit out, and the operation of the project's ventilation facility at Arncliffe constructed by the New M5 project.
Water treatment plant	The New M5 includes a water treatment plant within the motorway operations complex at Arncliffe.	The project would construct its own water treatment plant at Arncliffe.
Substation	The New M5 includes a substation which will be designed and constructed to include sufficient capacity to supply power to the New M5 project.	The project would construct its own substation at Arncliffe to supply power to the mainline tunnels. Power supply to this substation would be determined in detailed design.
Signage	The New M5 does not include directional signage for the project.	The project would include the installation of signage within the New M5 tunnels to provide guidance for motorists wishing to access the project.
Motorway control centre	The WestConnex motorway control centre will be built at St Peters interchange.	The project would include the installation of communication infrastructure within the motorway tunnels and provide a communications and operational connection between the WestConnex motorway control centre and the project's motorway control centre at MOC2 in Rockdale.
Tolling	The New M5 tolling arrangement is part of an overall WestConnex tolling strategy.	The project would be tolled separately from WestConnex.
Construction ancillary facilities	The New M5 construction ancillary facility would be demobilised as part of the New M5.	The project would utilise the New M5 construction site. Following completion of the project, the remaining land would be rehabilitated and returned to Bayside Council.

The F6 Extension Stage 1 will be a toll road. Tolls provide a fair and equitable means to help fund the project where the people using the new infrastructure help to pay for it.

In this way, tolls will contribute to funding the construction and ongoing operation and maintenance of the F6 Extension Stage 1. A tolling framework has been developed for the project that is consistent with other recent motorway projects. The motorway tunnel is proposed to be tolled at a flat rate of $1.77 each way (2017 dollars). The shortest trip possible when using the motorway tunnel would be between President Avenue and St Peters Interchange, via the New M5 Motorway. The WestConnex flagfall and distance based toll will also apply to journeys along that part of the road network.

Heavy vehicles will pay three times the toll of light vehicles, reflecting the greater wear and tear that trucks have on our roads. This is consistent with other recent motorways including WestConnex and NorthConnex.

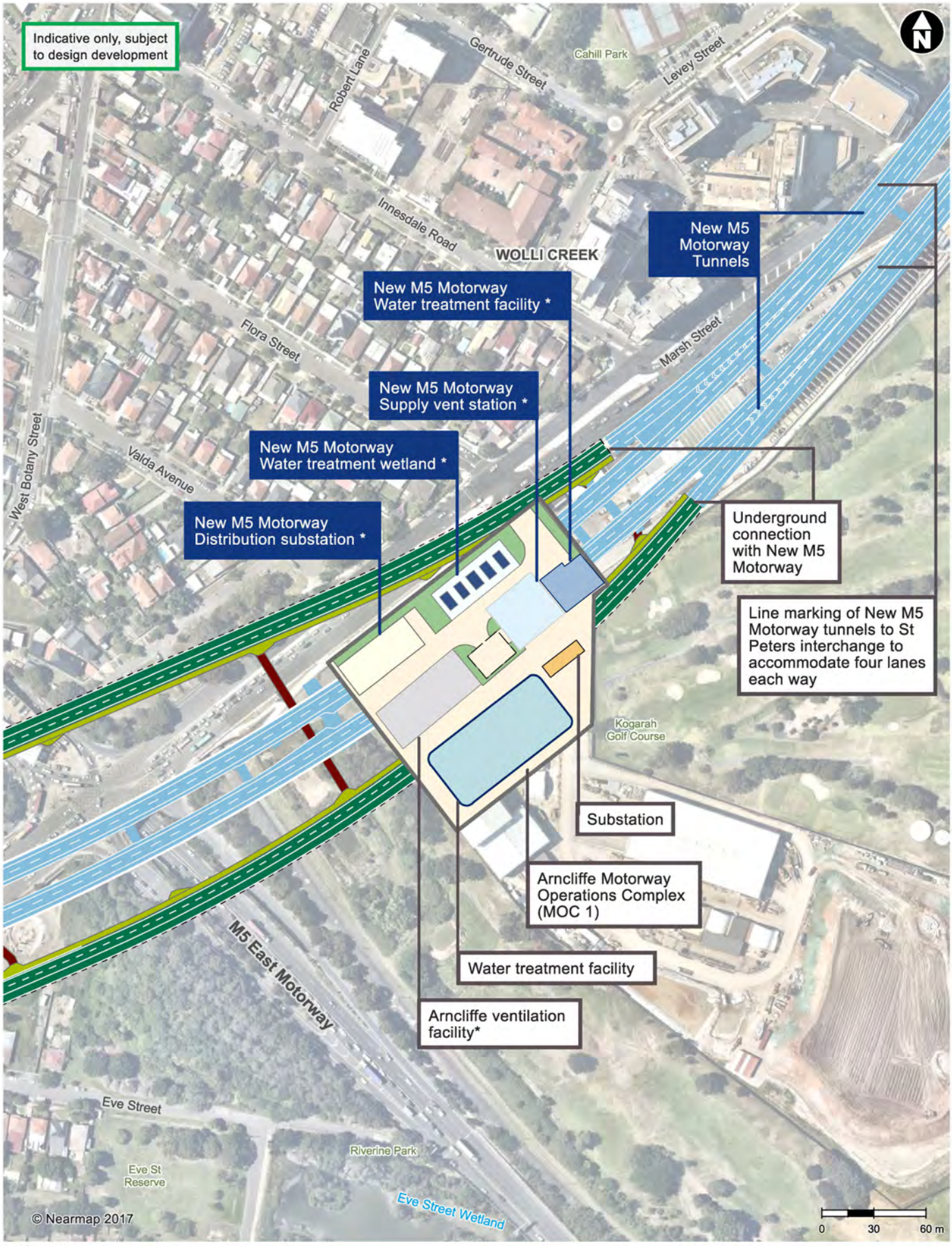


Figure 6-3 Connection with the New M5 Motorway

6.2 Urban design objectives and principles

Urban design principles have been developed for the project, consistent with the key urban design guidelines and policies including *Beyond the Pavement: Urban Design Procedures and Design Principles*[1] and *Tunnel urban design guidelines*[2]. The urban design principles applied to the design of the project and the rationale for their use is provided in **Figure 6-4**. Further detail is provided in **Appendix C** (Place making and urban design).

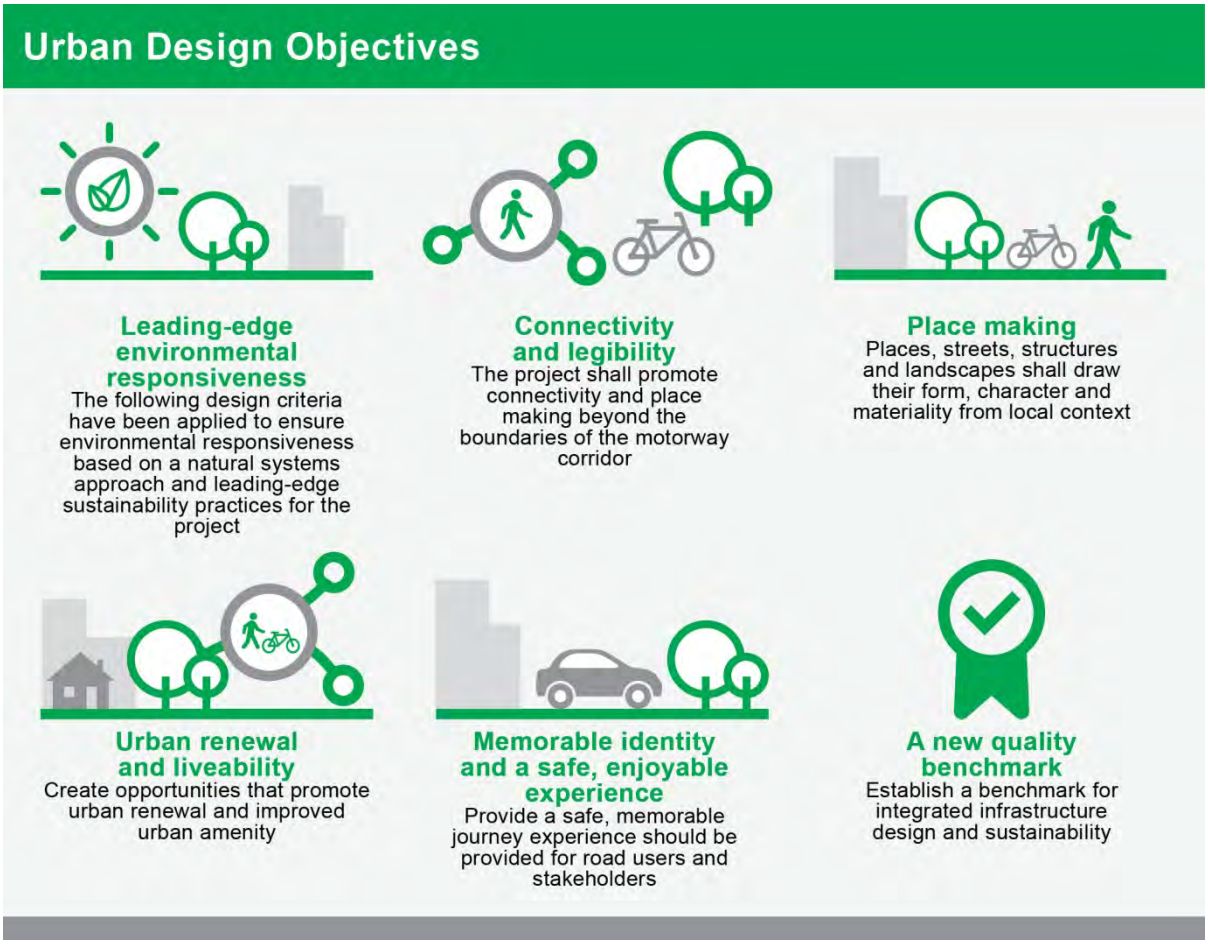


Figure 6-4 Urban design objectives

During detailed design, there would be a detailed review and finalisation of the architectural treatment of the motorway's operational ancillary facilities, ventilation facilities, the President Avenue intersection portals and all permanent infrastructure, including the President Avenue shared cycle and pedestrian bridge. The architectural treatment of these facilities would be guided by ventilation facility performance requirements, the outcomes of community consultation and urban design principles. Landscaping works would be carried out next to disturbed areas; around operational infrastructure (such as ventilation facilities); and along the shared cycle and pedestrian pathways.

Preliminary concept plans have also been prepared for Rockdale Bicentennial Park and the President Avenue surface works in consideration of the urban design objectives described in **Figure 6-4**. These would inform the Urban Design and Landscape Plan that would be prepared for the project**.**

Further details about urban design for the project are provided in **Appendix C** (Place making and urban design).

[1] Roads and Maritime (2014) Beyond the Pavement: Urban Design Procedures and Design Principles
[2] Roads and Maritime (2017) Tunnel urban design guidelines

6.3 Tunnels

6.3.1 Tunnel design

The tunnels would comprise two mainline tunnels (about 2.5 kilometres in length) in each direction, together with entry and exit ramp tunnels to the tunnel portal (about 1.5 kilometres in length). Each mainline tunnel would extend from the underground connection with the New M5 Motorway through to stub tunnels for a connection to a future stage of the F6 Extension (underground, just north of Bay Street). The mainline tunnel would be connected to the surface road network at President Avenue via the entry and exit ramp tunnels leading to and from the surface.

The tunnels would range in depth from just below the surface near the tunnel portal, to about 100 metres underground. The average depth of the mainline tunnels would be 70 metres underground. Each tunnel would be around 6.5 metres in height from floor to ceiling with a vehicle height clearance of 5.3 metres (see **Figure 6-5**). Mainline tunnel grades would not exceed four percent and the entry and exit ramp tunnels would not exceed grades of 6.25 per cent.

6.3.2 Lane configuration

Under the concept design assessed in this EIS, the mainline tunnels would be marked for two lanes in each direction, although the tunnels would be constructed to allow for a potential future third lane in each direction. The width of the caverns for the mainline tunnels has been designed to allow for this capacity increase without the need for further excavation. It should be noted that any change in operation from two lanes to three lanes would be subject to future environmental assessment and approval. To prevent driving in the wide shoulder during Stage 1, temporary barriers would be installed to limit the shoulder to 2.5 metres.

The project would include line marking of two additional lanes, for a total of four lanes, in the New M5 tunnels from St Peters interchange to where the project would join the New M5 tunnels at Arncliffe (about two kilometres).

The configuration of traffic lanes within the mainline tunnels and the entry and exit ramp tunnels is described in **Table 6-2**. Indicative cross-sections of the mainline tunnels are shown in **Figure 6-5**. An indicative cross-section of the entry and exit ramp tunnels is shown in **Figure 6-6**.

Table 6-2 Lane configuration and widths for the tunnels

Tunnel section	No. of lanes to each tunnel	Width of lanes (metres)	Width of nearside shoulder (metres)	Width of offside shoulder (metres)	Carriageway width kerb to kerb (min.) (metres)	Posted speed (km/h)
New M5 Motorway mainline tunnel connection to merge/diverge with F6 Extension mainline tunnel	2	3.5	2.5	1	10.5	80
Mainline tunnel (New M5 Motorway stub tunnels to F6 Extension stub tunnels)	2[1]	3.5	4.5[1]	1	12.5	80
Entry and exit ramp tunnels to tunnel portal	2	3.5	1	1	9	60

[1] The mainline tunnels would be built to three lanes wide and line marked for two lanes as part of this project. This allows for a future third 3.5m lane and 1.0m shoulder. To prevent driving in the wide shoulder during Stage 1, a nominal 2m shoulder will be line marked and temporary barriers installed.

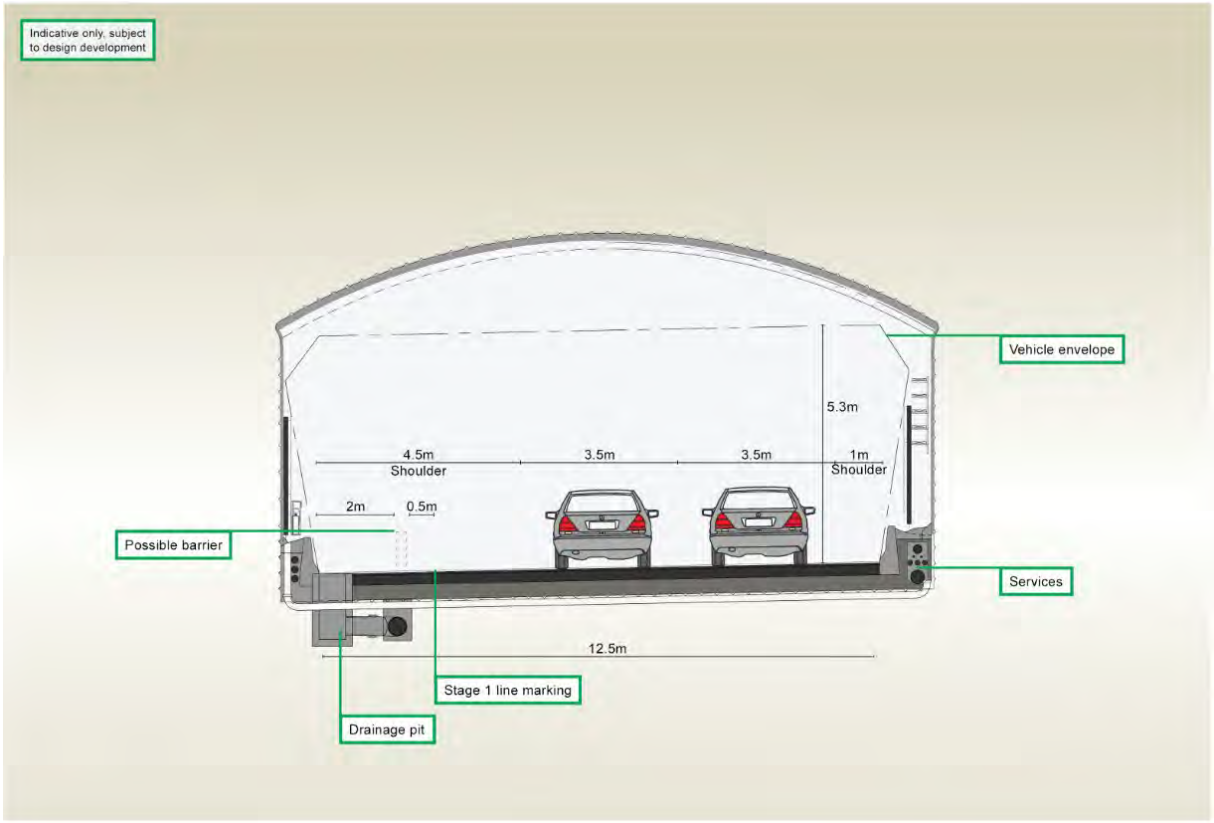


Figure 6-5 Indicative cross-section of the mainline tunnels

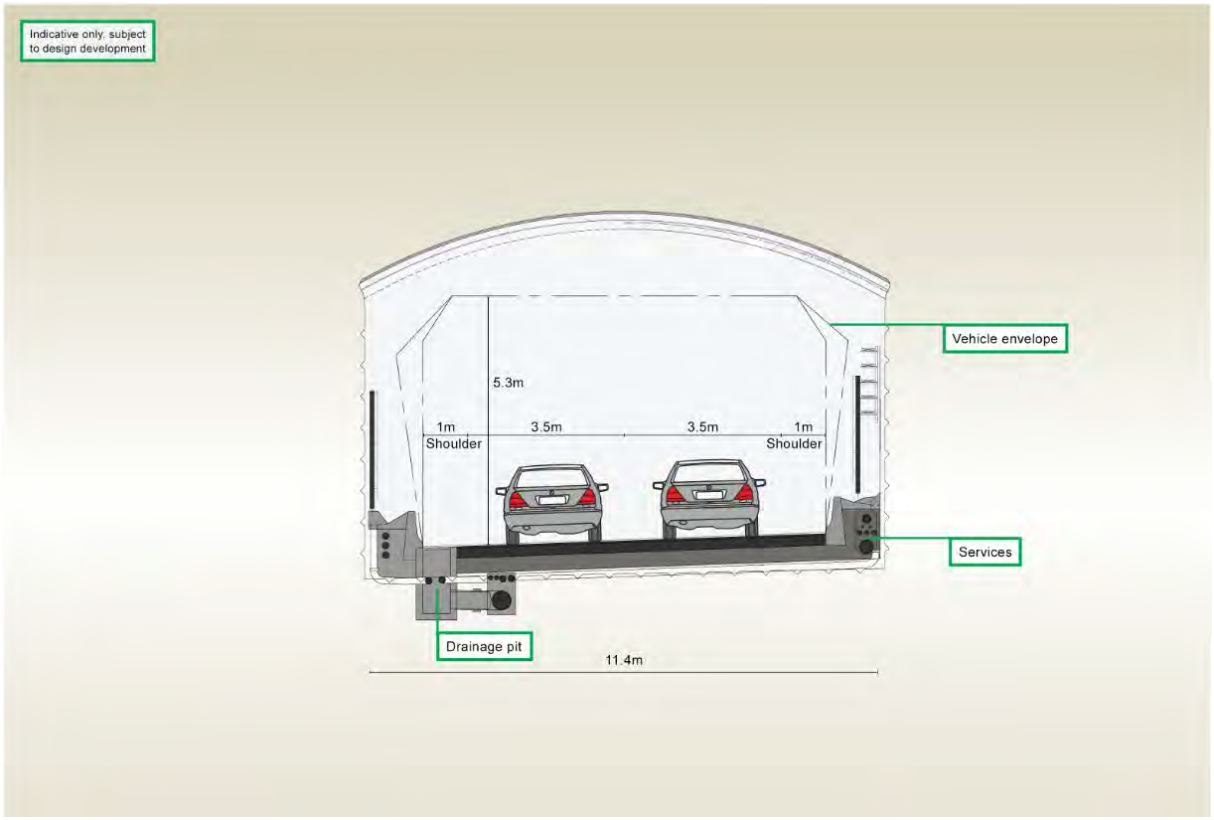


Figure 6-6 Indicative cross-section of the entry and exit ramp tunnels

6.3.3 Emergency breakdown facilities

The tunnels would include one vehicular cross-passage to allow for emergency services vehicles to switch between the northbound and southbound tunnels, as well as multiple pedestrian cross-passages at regular distances of around every 120 metres and longitudinal egress passages with doors that provide emergency pedestrian egress between tunnels. Additional access passages would be included so that there is a maximum walking distance of 250 metres for Fire and Rescue NSW personnel from a vehicle to an incident site. An indicative cross-passage layout is shown in **Figure 6-7**.

Fire and life safety provisions for the project are discussed in more detail in **section 6.9.5**.

Tunnels would include breakdown bays, large enough for vehicles to park safely without interrupting traffic flow. An indicative layout of a mainline tunnel maintenance and breakdown bay is shown in **Figure 6-8**.

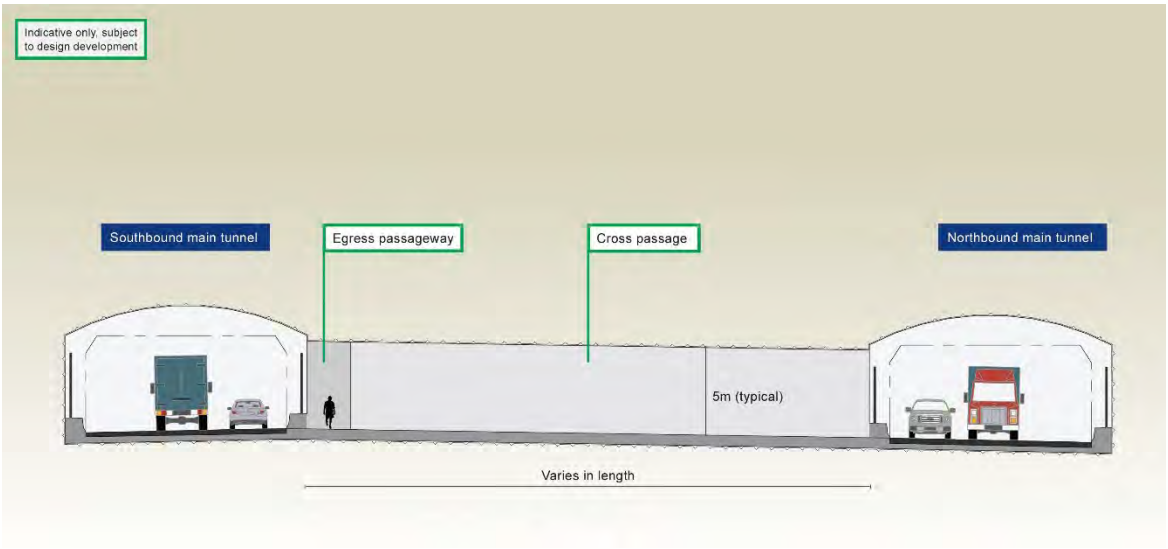


Figure 6-7 Indicative cross-passage layout

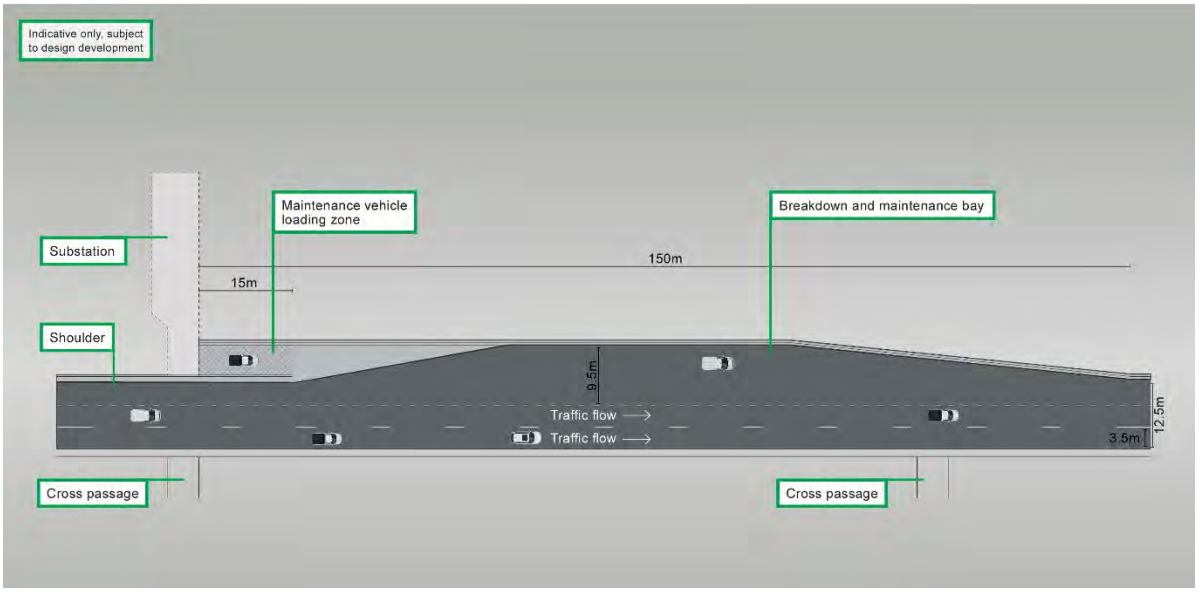


Figure 6-8 Indicative layout of a mainline maintenance and breakdown bay

6.3.4 Tunnel portal and slot structure

A tunnel portal would be located north of President Avenue, within the current Rockdale Bicentennial Park East. The portal has been designed to provide for a 5.4 metre vertical clearance consistent with Roads and Maritime guidelines, and Austroads' *Guide to Road Design*[3] and *Guide to Road Tunnels*[4]. An open slot structure would provide a connection between the tunnel portal and the surface road network. The slot structure would consist of north facing ramps with two lanes in each direction. Typical lane configuration and widths for the ramps are outlined in **Table 6-3**. This open slot structure for the entry and exit ramps is shown in **Figure 6-9**.

Table 6-3 Lane configurations and widths for entry and exit ramps

Element	No. of lanes	Width of lanes (metres)	Width of nearside shoulder (metres)	Width of offside shoulder (metres)	Carriageway width kerb to kerb (min.) (metres)	Posted speed (km/h)
President Avenue intersection entry and exit ramps	2	3.5	1	1	9	60

[3] Austroads (2016) Guide to Road Design
[4] Austroads (2015) Guide to Road Tunnels

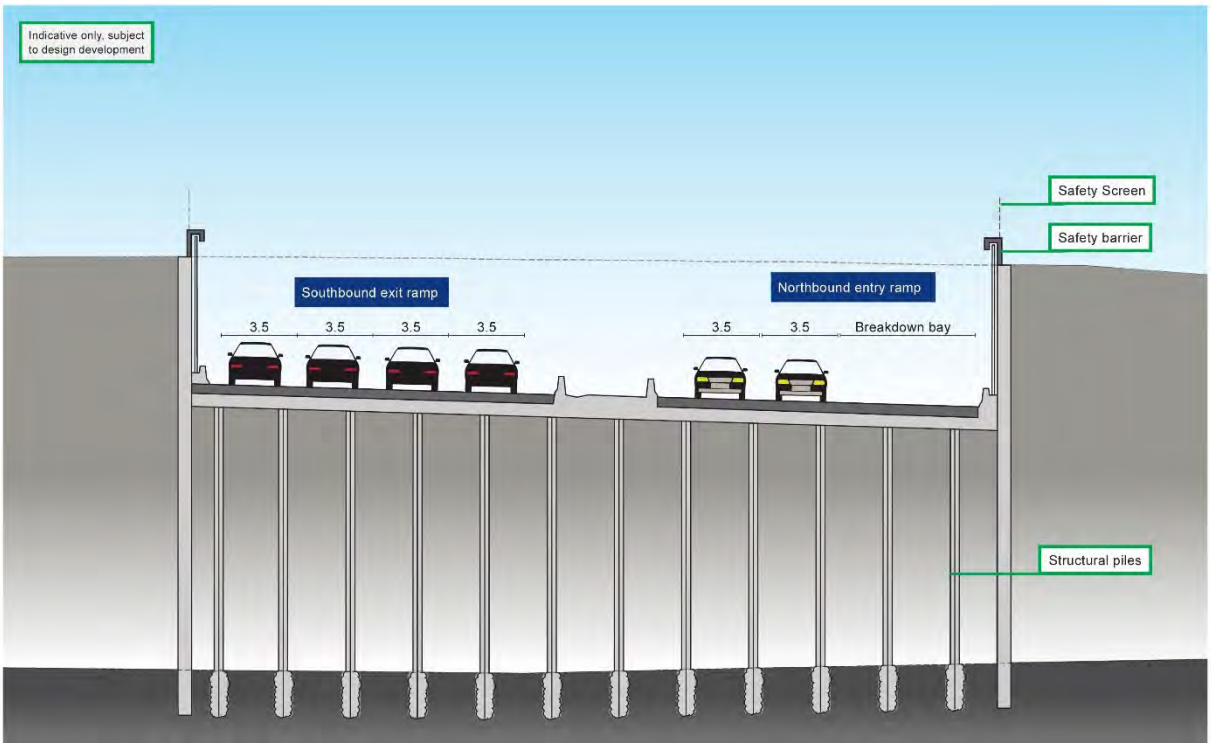


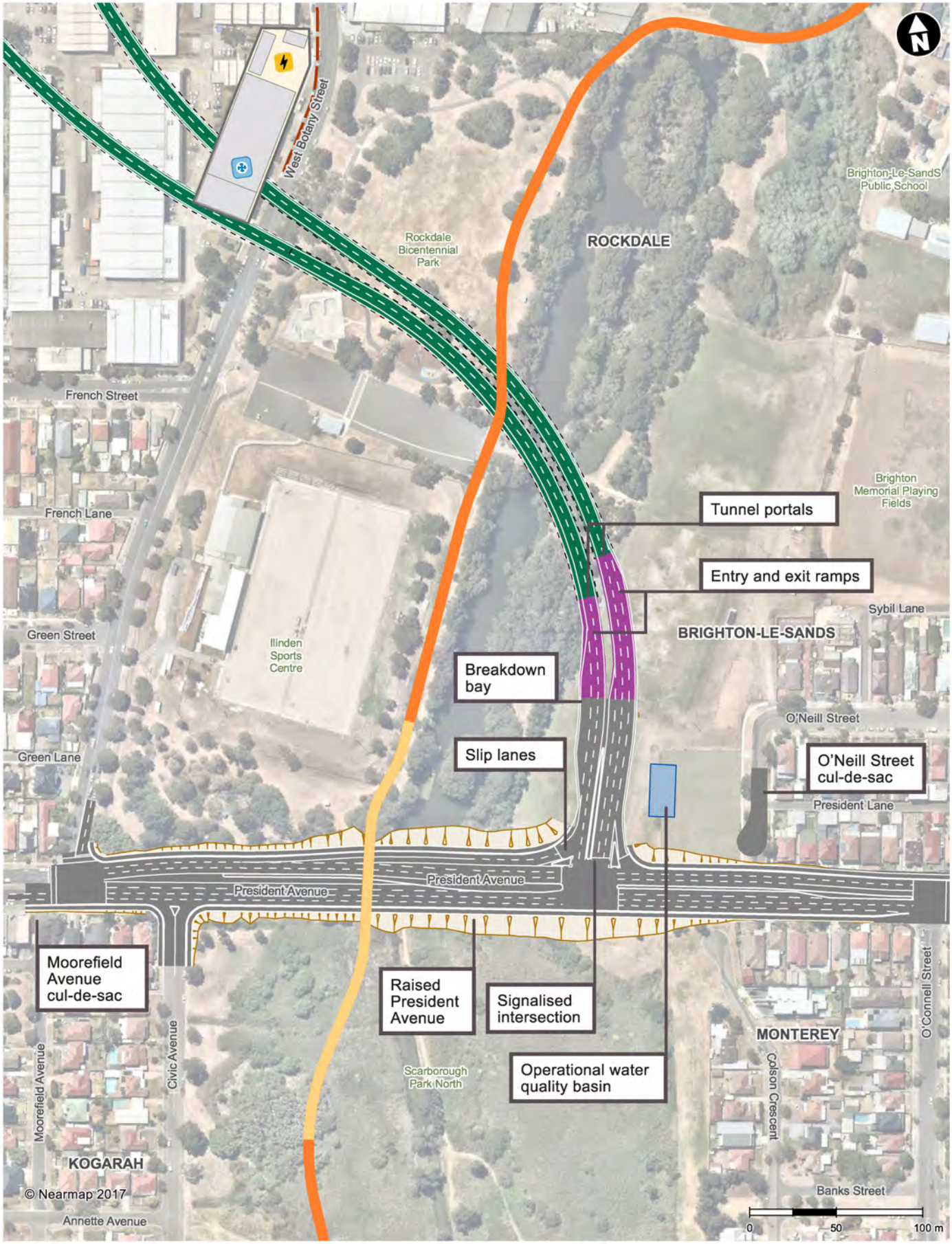
Figure 6-9 Indicative slot structure for entry and exit ramps

6.4 President Avenue intersection

The President Avenue intersection would connect the tunnels and entry and exit ramps with the existing surface road network. All traffic would enter and exit the project at the President Avenue intersection. Traffic signals would be installed at the intersection. The operational layout of the President Avenue intersection is shown in **Figure 6-10**.

The project would retain existing signalised pedestrian crossings of President Avenue at Princes Highway, West Botany Street and O'Connell Street. Footpaths would be upgraded where widening of President Avenue is proposed.

Between West Botany Street and O'Neill Street, the main east-west pedestrian movement would be on the southern side of President Avenue, adjacent to Scarborough Park North, by way of a new shared path. Pedestrian connectivity would be provided within and around Rockdale Bicentennial Park to enable movement of pedestrians and cyclists within the parkland and to/from President Avenue.



LEGEND

- The project in tunnel
- The project on surface
- The project as an open slot
- Shared cycle and pedestrian pathways
- President Avenue shared cycle and pedestrian bridge
- Building
- Embankment
- Water quality basin
- Motorway operations complex
- Substation
- Permanent power supply line
- Rockdale ventilation facility

Figure 6-10 President Avenue intersection layout

6.5 President Avenue surface works

The project would involve upgrade and widening works along President Avenue to ensure safe and efficient connections with the road infrastructure proposed as part of the project, and to cater for additional future traffic demand.

Surface works on President Avenue would allow the project to integrate with the existing arterial roads and would cater for future demand. These works would include:

- Consolidate street accesses and egresses to remove safety issues with right turning traffic in to and out of Moorefield Avenue
- Widening sections of President Avenue to three through lanes eastbound and three through lanes westbound
- Addition of slip lanes to provide a connection to the intersection with the project
- Raising President Avenue about three metres at the location of the President Avenue intersection with the tunnel portal
- Creating cul-de-sacs to close existing local road intersections with President Avenue including Moorefield Avenue and O'Neill Street
- Conversion of Civic Avenue to allow left in/left out movements only at President Avenue
- Conversion of Lachal Avenue to a two way street to enable all vehicle movements to occur
- Addition of a right turn bay and refuge bay to formalise a right turn into Lachal Avenue from President Avenue.

The lane configuration and operational layout of President Avenue is outlined in **Table 6-4** and shown in **Figure 6-10** and **Figure 6-11.**

Roads and Maritime would continue to work with Bayside Council to confirm modifications to the local road network, particularly in the vicinity of President Avenue between West Botany Street and Princes Highway.

Table 6-4 Lane configuration of President Avenue

Element	No. of lanes	Width of lanes (metres)	Width of nearside shoulder (metres)	Width of offside shoulder (metres)	Carriageway width kerb to kerb (min.) (metres)	Posted speed (km/h)
President Avenue	3	3 to 3.5	-	-	9	60

6.6 President Avenue / Princes Highway intersection

The project would include widening of President Avenue and Princes Highway at their intersection to provide additional turning lanes and to increase the intersection's capacity and performance (refer to **Figure 6-11**), as follows:

- Upgrade from a two lane signalised right turn to a three lane signalised right turn from northbound Princes Highway to eastbound President Avenue. The additional northbound right turn lane would have 110 metres of car space and would provide additional intersection capacity for northbound vehicles on Princes Highway turning right onto President Avenue
- Upgrade from three lanes southbound on Princes Highway with a shared straight/ left turn lane to four lanes including a dedicated, signalised, left turn from Princes Highway southbound onto President Avenue eastbound. The new southbound left turn lane would have 70 metres of storage.

The additional lanes would require realignment of the intersection and alterations to the traffic signal phasing at the intersection.

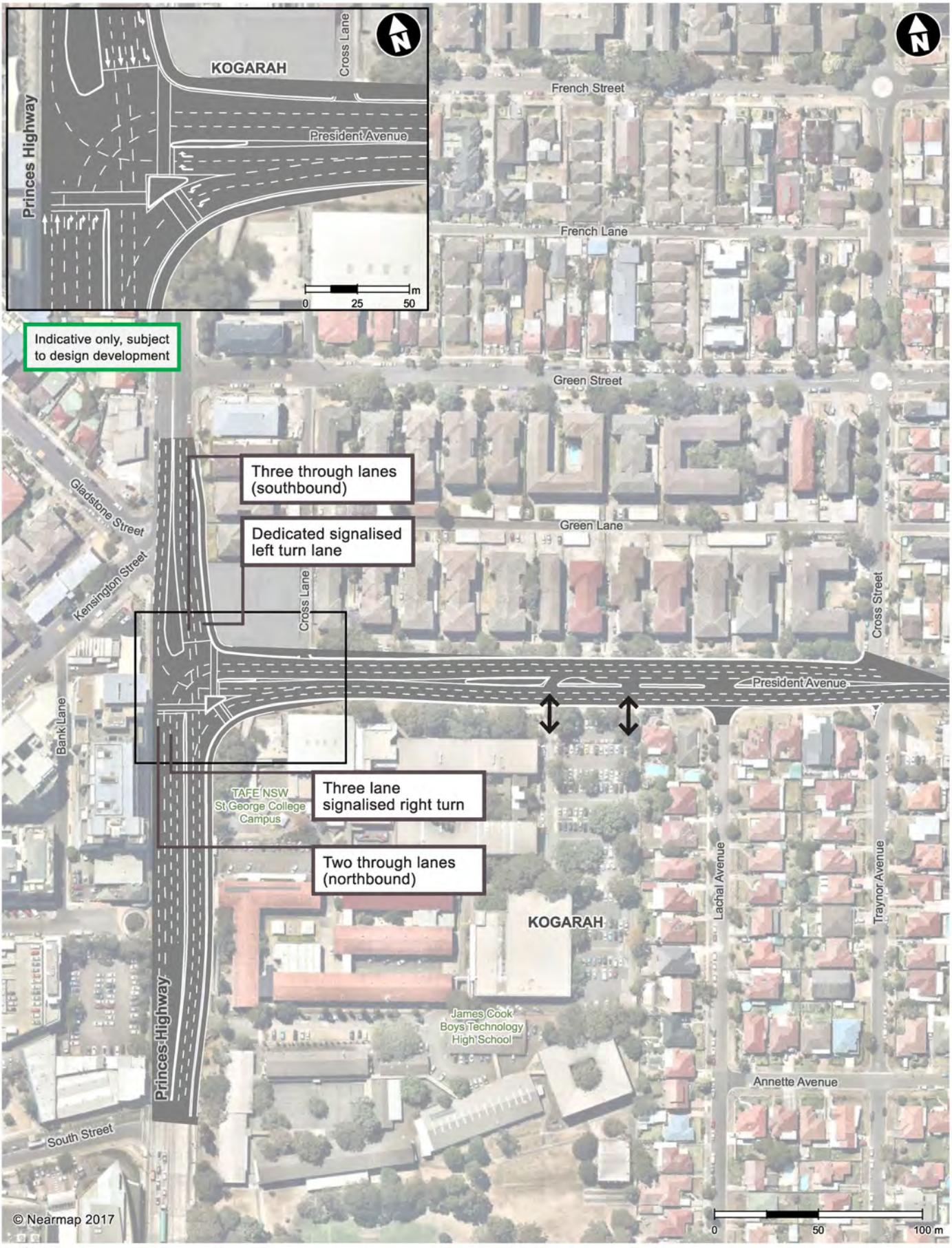


Figure 6-11 Princes Highway and President Avenue operational layout

6.7 Reinstatement of Rockdale Bicentennial Park

Sporting fields and recreational facilities within Rockdale Bicentennial Park would be directly impacted by the project, including a playground with equipment, a skate park, an open recreational oval and up to three soccer playing fields.

Prior to construction commencing, some of these facilities would be offset with new facilities at nearby locations. The construction and installation of these facilities would be subject to separate planning approvals.

Following completion of the motorway elements of the project, and to ensure the park's ongoing use, Rockdale Bicentennial Park would be reconfigured as part of the project. Roads and Maritime is in consultation with Bayside Council, as the facility owner, and the sporting groups that use the facilities to develop a master plan for the reconfiguration of the Rockdale Bicentennial Park and associated facilities. The aim of the plan would be to enhance the recreational, scenic and ecological values of Rockdale Bicentennial Park.

Reconfigured facilities would be comparable with existing facilities and where possible enhanced according to the needs of the users. The reinstatement would involve:

- Earthworks and landscaping to reshape the site around the motorway operational infrastructure
- Landscape works to improve pedestrian circulation and integration with the shared cycle and pedestrian pathways/existing path network
- Reconfiguration of sporting fields and associated amenities
- Landscape works to provide additional recreational amenity including seating, bin enclosures, shelters and drinking fountains
- Revegetation, including tree planting, at key locations including around the reinstated wetlands and water quality basin.

A concept design for the reinstatement of Rockdale Bicentennial Park has been prepared (refer to **Figure 6-12**) having regard to the urban design objectives and principles in **section 6.2**. The concept design is detailed further in **Appendix C** (Place making and urban design).

The concept design would be refined during the development of an Urban Design and Landscape Plan, which would be prepared based on the detailed design for the project and in accordance with relevant commitments in this EIS. The Urban Design and Landscape Plan would also be prepared in consultation with Bayside Council, other key stakeholders and the community.

Figure 6-12 Preliminary concept plan for reinstated Rockdale Bicentennial Park

6.8 Shared cycle and pedestrian pathways

The project would deliver new shared cycle and pedestrian pathways. These would be developed from Bestic Street, Brighton-le-Sands south to Civic Avenue, Kogarah through the reinstated Rockdale Bicentennial Park, including some parts as an on-road cycleway. As part of the project, a dedicated shared bridge would be built over President Avenue. The shared cycle and pedestrian pathways would be designed to respond to the surrounding context without obstructing visibility or creating a safety concern. The design would also fit with the redevelopment of Rockdale Bicentennial Park following construction and does not preclude a legible connection with President Avenue shared cycle and pedestrian bridge.

The shared cycle and pedestrian pathways would provide connections with several existing and proposed routes including:

- Bestic Street and cycleways north of Bestic Street, along Muddy Creek
- West Botany Street, opposite Ador Avenue Reserve
- Bruce Street, Francis Street, Bay Street and England Street, Brighton-le-Sands
- West Botany Street, next to Rockdale Bicentennial Park
- Rockdale Bicentennial Park
- Civic Avenue, Kogarah.

The shared bridge over President Avenue is intended to provide a corridor scale connection for pedestrians and cyclists, rather than a pedestrian crossing for short trips back and forth across President Avenue. For these movements, pedestrians would be able to cross President Avenue via the signalised intersections at West Botany Street and O'Connell Street. However, if so desired, pedestrians would also be able to access the shared bridge, on the northern side via footpaths or on the southern side via Civic Avenue.

Where possible the shared pathways would be a separate pedestrian path and cycle way unless surrounding constraints require a shared section. Where space permits the key components of the shared cycle and pedestrian pathways are:

- The average width would be five metres, comprising a three metre two-way cycle lane, 1.5 metre pedestrian path and 0.5 metre buffer
- The President Avenue shared cycle and pedestrian bridge would be 5.5 metres high (from underside of bridge to road surface)
- Lighting would be provided along the length of the shared cycle and pedestrian pathways where required (refer to **section 6.9.7**).

The key design guidelines of the shared cycle and pedestrian pathways are:

- Design pathways and cycle facilities to current best practice and design standards
- Provide tree planting to provide shade as well as improve visual amenity
- Provide appropriate street and pathway lighting for users to safely and comfortably navigate outside daylight hours
- Develop a prioritised program of appropriate way-finding tools (e.g. directional signage and distance markers) at critical locations on the network
- Provide continuous cycle and pedestrian path treatment past driveways to reinforce the priority of pedestrians and cyclists over crossing vehicles
- Remove barriers along the route that may create hazardous situations
- Ensure appropriate surface quality to pathways
- Include kerb build outs to reduce crossing distances and pedestrian refuges to aid the safe movement of pedestrians and cyclists across busy roads
- Paint white bicycle symbols on the road to raise driver awareness when cyclists need to share the road with vehicles.

A cross section of the shared cycle and pedestrian pathways is shown on **Figure 6-13**. The general alignment of the shared cycle and pedestrian pathways is shown on **Figure 6-14**. Detailed descriptions of the shared cycle and pedestrian pathways are also provided in **Appendix C** (Place making and urban design).

Figure 6-13 Indicative cross section of the shared cycle and pedestrian pathways through Rockdale Bicentennial Park

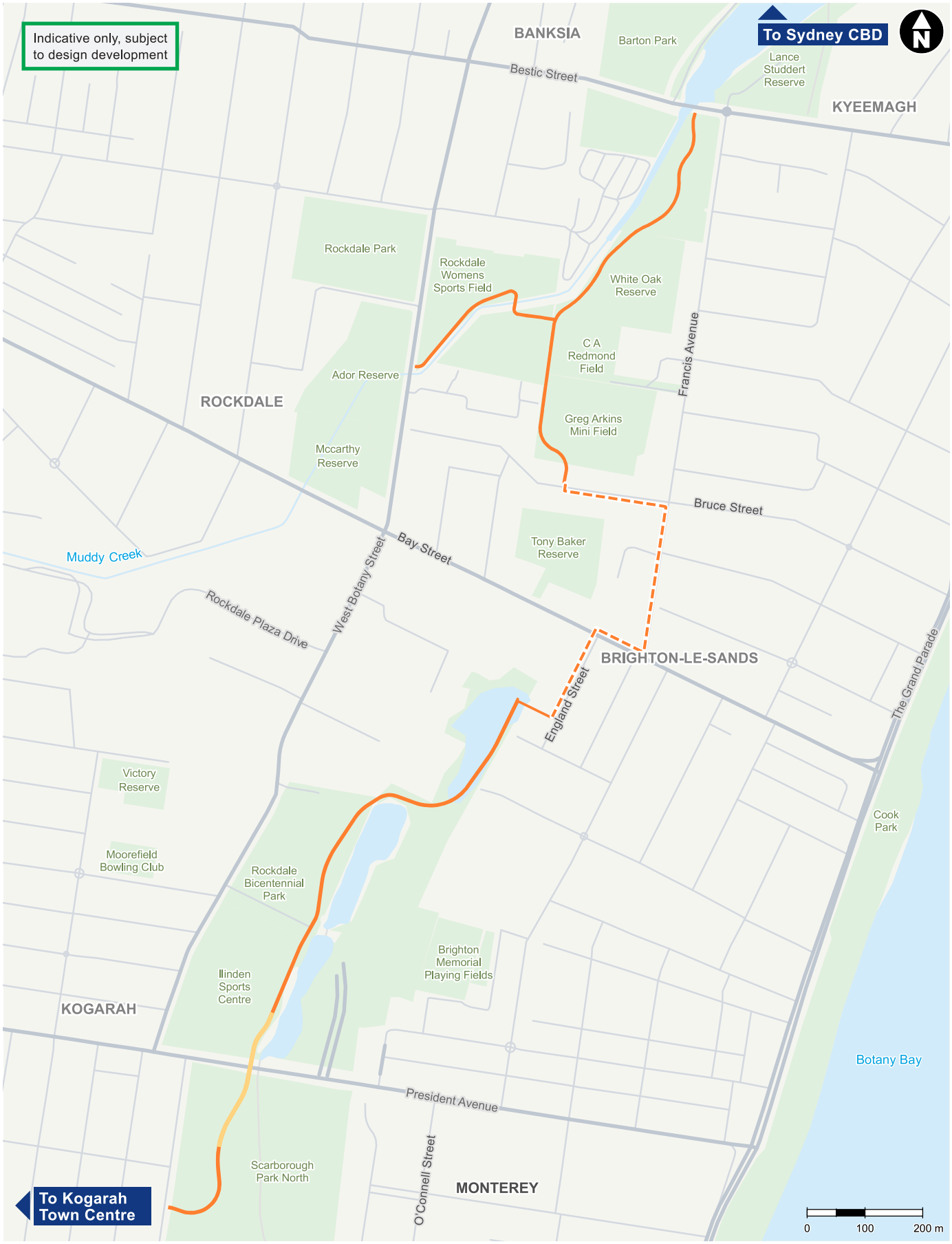


Figure 6-14 Shared cycle and pedestrian pathways

6.9 Motorway operational ancillary infrastructure

6.9.1 Motorway operations complex

The Arncliffe Motorway Operations Complex being constructed as part of the New M5 Motorway would be used for the Arncliffe ventilation facility. A substation and water treatment plant would be constructed adjacent to the New M5 Motorway Arncliffe Motorway Operations Complex, within MOC1 for the project.

The operational infrastructure in the south of the project area would be shared between two separate facilities, Rockdale Motorway Operations Complex (north) (MOC2) and Rockdale Motorway Operations Complex (south) (MOC3). The operational infrastructure that would be located within each of these complexes is listed in **Table 6-5** and shown in **Figure 6-15**.

Table 6-5 Rockdale motorway operations complexes

Motorway operations complex	Operational infrastructure
Arncliffe Motorway Operations Complex (MOC1)	• Substation • Water treatment facility • Mechanical fitout of ventilation facility
Rockdale Motorway Operations Complex (north) (MOC2)	• Operational motorway control centre • Car parking • Deluge tanks • Workshop • Office • Bulky equipment store • Pump station and pump room • Work yard
Rockdale Motorway Operations Complex (south) (MOC3)	• Ventilation facility • Car parking • Two substations and power supply • Disaster recovery site

6.9.2 Operational management

The motorway would be controlled and managed from the motorway control centre located within Rockdale Motorway Operations Complex (north) (MOC2) at West Botany Street as shown in **Figure 6-15**. The motorway control centre would operate 24 hours a day, seven days a week.

This centre would house the control systems for the project to allow monitoring and operation of the tunnel systems. A computerised operations management and control system would be provided that integrates the traffic management and control system and the plant management and control system. The operations management and control system would enable operators to monitor and control the section of the project tunnel between Arncliffe and Kogarah. The traffic management and control system would interface with and control:

- Electronic signage
- Vehicle detection
- Closed-circuit television (CCTV) and video based incident detection
- Tunnel closure devices
- Messaging via the rebroadcast break-in and public address systems
- Security systems and doors.

The Plant Management and Control System would interface with and monitor and control:

- Power supply and distribution equipment
- Air quality instruments, ventilation fans and dampers
- Fire detection and suppression (deluge)
- Carriageway main lighting (e.g. transition and threshold levels) and wayfinding lighting
- Drainage sumps and pumps
- Water treatment
- Plant room building services.

The operations management and control system would be equipped with real time external interfaces to the WestConnex operations management and control system and with Transport for NSW's Transport Management Centre.

The interface with the WestConnex system would permit integration of the project for coordinated operation of nearby tunnel infrastructure. During detailed design, the operations management and control system for the tunnels would require the development of robust and reliable communications system to implement coordinated incident responses. This is of particular importance where ventilation systems are linked and to respond to incidents that occur at or near the interface between the tunnels. The project's Rockdale ventilation facility would be operated by the WestConnex motorway control system.

The operations management and control system would include incident management functionality that facilitates implementation of pre-planned, location and incident-specific, coordinated responses to incidents by:

- Deploying electronic signage plans such as lane closures, warning signage and reduced speed limits
- Playing appropriate pre-recorded radio rebroadcast and public address messages as required periodically to different tunnel zones to alert motorists
- Changing ventilation strategies to suit traffic or fire conditions
- Implementing wayfinding lighting strategies as required
- Prompting appropriate operator steps including:
  - Notifying emergency services, Transport Management Centre and other tunnels/roads
  - Recording of details
  - Archiving recorded CCTV footage
- Restoring normal operations at the conclusion of an incident.

6.9.3 Traffic monitoring and management

The project would include the integration of 'Smart Motorway' (also known as 'managed motorway') features. This means that it would use real-time information, communication and incorporated traffic control systems into and alongside the road, in order to improve traffic flow and the safety of the road environment.

The following infrastructure would be provided as part of the traffic monitoring and management systems to support the future implementation of a smart motorway:

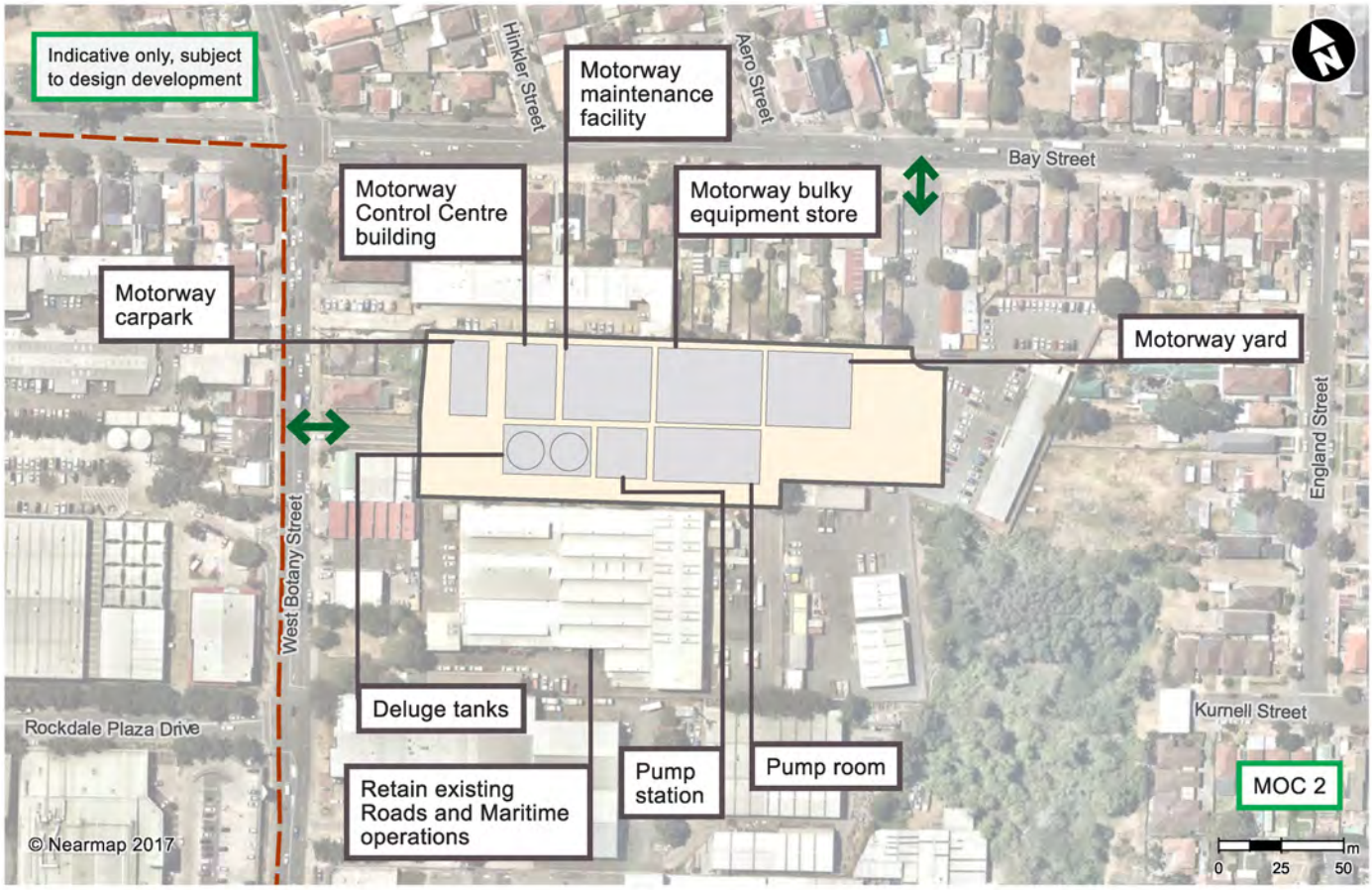
- Variable message signs on the tunnel entry portals and approaches along President Avenue
- Tunnel message signs at about 120 metre intervals in the tunnel to coincide with egress points
- Integrated speed and lane use signs within the tunnel at mid-points between tunnel message signs
- Vehicle detectors placed to detect traffic congestion
- Fixed CCTV cameras at about 60 metre intervals within the tunnel
- Pan-tilt-zoom CCTV cameras at about 240 metre intervals within the tunnel, providing full coverage of the portals, ramps and approach intersections
- Over-height vehicle detection and dynamic diversion signage integrated with the President Avenue variable message signs
- Tunnel closure and diversion measures:
  - Overhead changeable message signs and in-pavement lights on President Avenue to delineate changed lane configurations
  - Advanced warning signs to slow traffic
  - Portal physical barriers (boom gates)
  - Traffic signals at the entry portals coinciding with physical barriers
  - Interface with traffic signals on President Avenue.

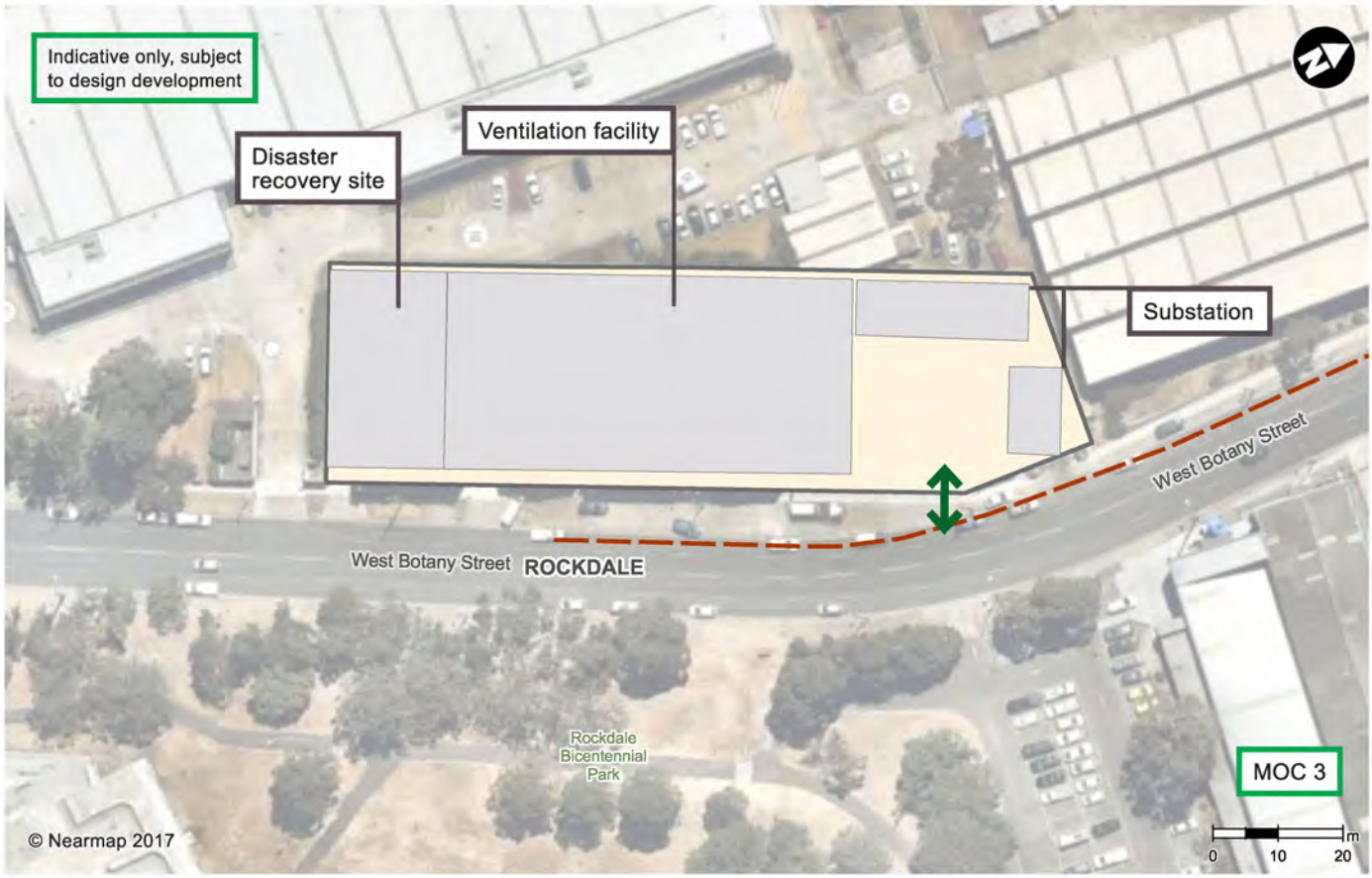
Additional tunnel infrastructure would include:

- In-tunnel radio rebroadcast providing:
  - Rebroadcast of popular AM and FM radio stations complete with zoned audio break-in facilities to communicate with motorists
  - Coverage for emergency services two-way radios
  - Mobile phone coverage
- Zoned public address system to carriageways and egress passages
- Lighting control system with the ability to dynamically control wayfinding signage for compatibility with incident response
- Video-based incident detection for fixed cameras.

The traffic monitoring and management systems would be used to monitor traffic volumes and speeds within the mainline tunnels. Should the systems identify heavy congestion and/or an incident, the following measures would be implemented to manage traffic, as required:

- Signs would be used to notify road users of the incident ahead, and to display lowered speed limits, if required
- Public address and re-broadcast systems would notify road users of the management measures in place within the tunnels
- A tunnel closure system would be used to prevent additional vehicles from entering the mainline tunnels, where appropriate
- Traffic signals on President Avenue would be controlled to prevent entry to the tunnel when a closure is implemented.





LEGEND

- Building
- Motorway operations complex
- Permanent power supply line
- Heavy and light vehicle access

Figure 6-15 Rockdale Motorway Operations Complexes (north and south)

6.9.4 Ventilation system and facilities

The project ventilation system for the northbound tunnels would be integrated with the New M5 Motorway project, while a separate system has been designed for the southbound tunnels. The project's ventilation system has been designed to:

- Ensure the safety and health of motorists using the tunnels during normal operation, maximum (heavy) traffic conditions and emergency conditions
- Ensure that air inside and outside the tunnels meets relevant air quality criteria
- Operate in a safe, effectively controlled and managed manner, including during major and minor incidents
- Meet the requirements of the Australian Government's Civil Aviation Safety Authority (CASA) noting the limitations on the velocity and height of plume rise as well as limitations on the height of buildings and structures around Sydney Airport as described in **Chapter 10** (Health, safety and hazards)
- Minimise the consumption of energy and other resources, in a manner which would not jeopardise the health and amenity of motorists using the tunnels or the achievement of applicable air quality criteria inside and outside the tunnels
- Integrate with the adjoining New M5 Motorway tunnel and future stages of the F6 Extension.

Overview of the ventilation system design and operation

The project would include longitudinally ventilated tunnels, which rely on the movement of air through the tunnels in the same direction as the flow of traffic. This air moves from the tunnel entry portals towards ventilation facilities located near the tunnel exit portals, before it is emitted through elevated outlets (refer to **Figure 6-16**).

With longitudinal ventilation, air would move through the project tunnels in the direction of traffic flow using two mechanisms. The first mechanism is the 'piston effect', caused by the movement of vehicles through the project tunnels which pushes air in front of moving vehicles and pulls fresh air behind them. Secondly, jet fans would be installed to assist the piston effect if and when required. Before the tunnel air reaches the exit portals, the air would be drawn from the tunnels into the ventilation outlets using large exhaust fans. The project has been designed to avoid the emission of tunnel air from the exit portals.

Ventilation outlets provide an effective means of dispersing air drawn from the tunnels. Further detail about ventilation outlets and potential air quality impacts associated with ventilation outlet emissions is provided in **Chapter 9** (Air quality).

In the unlikely event of a fire within the tunnels, the jet fans in the ceiling of the tunnels would be operated to prevent smoke spreading upstream of the fire where traffic is likely to be stopped behind an incident. The fire and life safety systems (see **section 6.9.5**) would operate to bring the fire under control, and to remove smoke from the tunnels.

Depending on the location of a fire, smoke would be contained and removed from the tunnels through the nearest practical and safe point, which may be:

- The ventilation facilities located at Arncliffe or Rockdale
- The tunnel portals, if the fire is close to a portal.

Further details of tunnel fire hazards and their management are provided in **Chapter 10** (Health, safety and hazards).

In-tunnel air quality criteria

The tunnel ventilation system has been designed to achieve acceptable in-tunnel air quality outcomes for carbon monoxide (CO), nitrogen dioxide (NO_2) and visibility (as a measure of in-tunnel particulate matter concentrations) for traffic volumes up to and including the maximum traffic throughput capacity of the tunnels. **Chapter 9** (Air quality) provides details on the in-tunnel air quality criteria applied for the engineering design of the ventilation system.

Ventilation facilities

Ventilation facilities include ventilation supply and exhaust facilities, axial fans, ventilation outlets and ventilation tunnels.

Two ventilation facilities would be used as part of the project, namely:

- Arncliffe ventilation facility - constructed as part of the New M5 Motorway project at 15 Marsh Street, Arncliffe
- Rockdale ventilation facility - a new ventilation facility located at 427-441 West Botany Street, Rockdale, within the Rockdale Motorway Operations Complex (south) (MOC3).

Key components of the project's ventilation systems are shown in **Figure 6-16**. The locations of ventilation facilities for the project are shown in **Figure 6-1** and **Figure 6-2**.

Operating modes

The tunnel ventilation system would operate in three modes:

- Normal (expected) traffic conditions
- Maximum traffic flow
- Emergency conditions.

Operation of the ventilation system under these three conditions is detailed in the following sections.

Normal traffic conditions

Normal traffic conditions are considered to be when traffic flow within the tunnel is steady and travelling at posted speed limits (as outlined in **Table 6-6**).

Table 6-6 Posted speed limits for road elements of the project

Road elements	Posted speed
Mainline carriageways	80 km/hr
Entry and exit ramps for President Avenue	60 km/hr
President Avenue	60 km/hr

Under normal traffic conditions, ventilation would occur due to the piston effect, where fresh air is drawn into the tunnels at entry portals by the aerodynamic drag of vehicles entering the tunnel or supplied at air supply stations. This fresh air would move along the tunnel with the traffic and be extracted at the ventilation outlets.

Under these conditions, the volume of air moving along the tunnel would be sufficient to satisfy the fresh air demand inside the tunnels.

Maximum traffic flow conditions

The piston effect associated with traffic movement would be reduced where traffic flow within the tunnel is travelling at low speeds (i.e. around 40 kilometres per hour or less). This is typically as a result of a traffic incident or congestion. Under these conditions, longitudinal ventilation may require mechanical support to maintain air movement through the tunnels. Jet fans would increase tunnel airflows in the same direction as the traffic flow, when traffic speeds are low. These would be directly controlled by operators in the operational motorway control centre and would ensure sufficient fresh air to dilute vehicle emissions to meet relevant air quality criteria. Under these traffic conditions, additional fresh air may also be required to maintain acceptable air quality. Additional air may be injected into the mainline tunnels via the ventilation facility at Arncliffe.

Emergency conditions

During a major incident, when traffic is stopped in the tunnel, the jet fans would be used to increase the air flow to protect vehicle occupants and emergency services personnel from a build-up of emissions. Drivers would be requested via the public address system to turn off vehicle engines if there is an extended delay, while the incident is cleared. This would help in reducing emissions inside the tunnel.

Air quality monitoring and management

Continuous emission monitoring and ambient air quality monitoring would be undertaken 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 would be coordinated across the motorway to ensure:

- Air quality remains within specified limits for motorists and road workers, irrespective of their origin and destination
- Required airflows for safety outcomes in the event of an incident or emergency can be achieved
- 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 emission monitoring equipment for key contaminants, CO and NO_2, visibility and potentially other pollutants) would be installed at appropriate locations in the tunnels and on the ventilation outlets to ensure the project is operating within the prescribed emission limits for the project set by the conditions of approval.

Further details about external and in-tunnel air quality and the assessment of the project's ventilation system are provided in **Chapter 9** (Air quality).

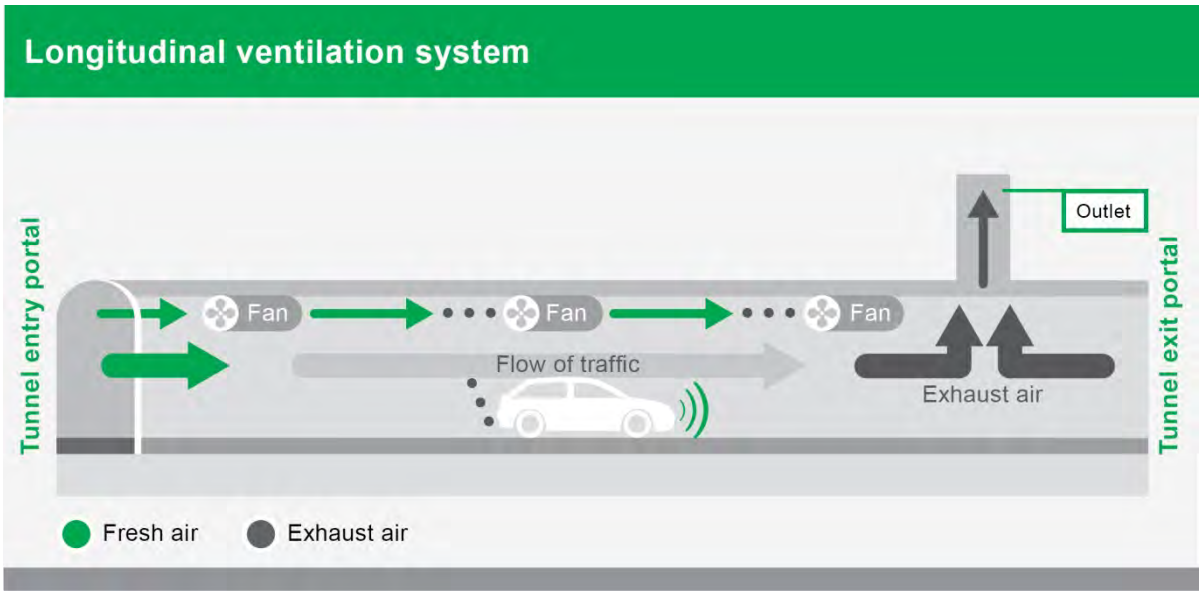


Figure 6-16 Key components of the project's ventilation system

6.9.5 Fire and life safety

Fire safety in Australian road tunnels follows a defined fire safety engineering process outlined in Australian Standard AS4825 – *Tunnel fire safety*, which also provides a 'Trial Concept Design' when developing road tunnel fire safety systems. As the mainline tunnels for the project would connect directly to the New M5 Motorway tunnels below ground, the fire safety systems would be coordinated between the projects to ensure safety during an incident. The operational motorway control centre at West Botany Street would coordinate the operation of tunnel systems under emergency conditions.

Key objectives of the fire and life safety design would be to protect life and assets, control the incident and facilitate intervention by the emergency services.

Fire and life safety measures

Twin tunnels

The tunnels would be separated by fire-rated materials to provide for one-way, fire-separated carriageways. This arrangement would allow motorists to move to a safe place underground into a fire-separated carriageway not affected by the incident.

For the entry and exit ramp tunnels, there is the same objective to provide access and egress to a safe place underground, however there would not need to be an adjoining ramp.

Emergency egress and access for emergency response teams

The tunnels would include at least one vehicular cross-passage to allow for emergency vehicles and traffic to be moved from one tunnel into another in the case of an emergency (refer to **Figure 6-7**). The vehicular cross-passage would be provided between the northbound and southbound tunnels and would be designed to accommodate a 14.5 metre long bus; so that general traffic could be evacuated during incidents that required tunnel closure. In the event that a vehicle over this size is in a closed tunnel during an incident, vehicle occupants would be evacuated and the vehicle would remain in the closed tunnel until the incident is resolved and the tunnel reopens.

Pedestrian cross-passages would be located within the tunnel, at regular distances of around every 120 metres (refer to **Figure 6-8**). Cross-passages would connect to the adjoining tunnel, providing access to a non-incident zone during an emergency. Connections between the tunnels would cater for egress for people with disabilities by minimising stairs or ramps with steep grades and by providing alternative safe holding zones.

Shoulders would be provided within the tunnels to enable safe passage to the cross-passages. These shoulders would be appropriately sized for the project and also the ultimate possible configuration of the mainline tunnel.

For the entry and exit ramp tunnels in some locations, it may be impractical to connect them to an adjoining tunnel. This would therefore require the use of longitudinal egress passages which are generally needed where adjoining entry and exit ramps are separated by long distances; are at significantly different elevations or are on either side of the mainline tunnels, all of which prevents the use of a level cross-passage.

Longitudinal egress passages would be located in:

- Mainline tunnels from the northern stub tunnels to the south where the two tunnels are at different depths
- The entry and exit ramps from the mainline tunnel to just before the driven tunnel portal, near West Botany Street.

Additional access passages would also be required so that there is a maximum walking distance of 250 metres for Fire and Rescue NSW personnel from a vehicle to an incident site.

Breakdown bays would also be included as part of the project as described in **section 6.3.3** and as shown in **Figure 6-8.**

Smoke control system

Longitudinal smoke control is proposed as the primary means of smoke management for the project, involving blowing smoke along the tunnel in the direction of vehicle travel. This has two effects; firstly, it ensures the safety of vehicles stopped upstream of (or before) an incident and secondly it allows vehicles downstream of (or after) an incident to keep driving out of the tunnel or into the next ventilation section. Smoke would be removed from the tunnel at portals or via the ventilation outlets.

The ventilation outlets and portals would be used to remove smoke and to prevent it from spreading to adjoining tunnel sections. This is particularly important at the project's interface with the New M5 Motorway where the ventilation system would be designed to prevent smoke spreading between the two projects.

Water suppression system

Water suppression (deluge) would be used to manage fire and ensure occupant safety, operational continuity and asset protection. A deluge suppression system would minimise the fire size, reduce fire spread and heat generation and help the fire brigade in managing a fire event. These factors allow for efficient incident management and minimise the time it takes for the tunnels to reopen.

Water supply for the project's suppression system would be provided from water tanks located at the Motorway Operations Complex (MOC2) at West Botany Street, Rockdale.

Transport of Dangerous Goods

Vehicles transporting dangerous goods as defined by the *Australian Dangerous Goods Code*[5] would be prohibited within the project tunnels consistent with the prohibitions applying to other tunnels within Sydney's motorway network.

6.9.6 Motorway tolling infrastructure

Tolling points would be installed at the President Avenue entry and exit ramps or the tunnel portal. The location would be determined based on accessibility, protection from weather and space availability.

An electronic tag-based free-flow type of roadside tolling equipment would be used and would include:

- Vehicle classification signage
- Electronic tag readers
- Cameras for enforcement and number plate identification
- Toll point lighting
- Overhead gantry complete with maintenance access
- Secure roadside technical shelter, housing servers and communication equipment.

Due to the close proximity of the northbound and southbound lanes, a radio frequency barrier may be required between the carriageways to prevent tags being read at both toll points in one passage. This would be developed during the design and delivery phase.

6.9.7 Lighting

In-tunnel lighting

In-tunnel lighting would be based on road geometry and would be designed to comply with the Australian/New Zealand Standard AS/NZS 1158.5:2007: *Lighting for roads and public spaces, and the International Standard CIE 88-2004: International Commission of Illumination Publication Guide for the Lighting of Road Tunnels and Underpasses.*

Lighting at the tunnel portals would be able to be changed in response to varying levels of brightness due to time of day and weather conditions. Uniform lighting would be provided along the tunnels, in rows along the ceilings.

Surface road lighting

Surface road lighting, including at ramps, intersections and along local roads upgraded as part of the project would be designed to meet the requirements of Australian Standard AS/NZS 1158: *Lighting for roads and public spaces*.

To provide lighting at the tolling points, the proposed overhead gantries would emit a blue light during the operations phase similar to that used on many of Sydney's existing toll roads. The lighting is designed to meet the requirements of international and Australian Standards concerning electrical safety and eye safety. The proposed lights would be hooded and directed down towards the toll points to minimise potential light spill.

[5] National Transport Commission, 2015. Australian Dangerous Goods Code

Shared cycle and pedestrian pathways lighting

Lighting along the shared cycle and pedestrian pathways, including the dedicated shared bridge, has been designed to meet the requirements of Australian Standard AS/NZS 1158: *Lighting for roads and public spaces*. Light poles would be offset one metre from the path to minimise risk of collisions for road users.

Emergency lighting

Emergency lighting would be installed to provide adequate illumination for evacuation of the tunnels in the event that primary lighting is inoperable. Emergency lighting would be provided as fixed direction exit signage, illuminated signage and LED light fittings within and in the vicinity of cross-passages and emergency egress paths.

Aviation hazard lighting

Aviation hazard lighting may be required at the Rockdale ventilation facility. All aviation hazard lighting would be provided in accordance with the protection of airspace regulations required by the Civil Aviation Safety Authority.

6.9.8 Signage

Message signs related to traffic, location, directions, warnings and variable conditions would be incorporated within the tunnels and on surface roads at tunnel approaches. Message signs would operate as part of the integrated signage provided within the tunnel network. Directional signage would be installed in accordance with the Austroads and Roads and Maritime standards, with a focus on providing clear and unambiguous direction to motorists and enhancing road safety.

Variable message signs would be mounted on gantries along those roads which approach the tunnels and would be used to advise motorists of traffic conditions. The signs would be located directly adjacent to existing arterial roads such as President Avenue, the Princes Highway and The Grand Parade. Other locations on the arterial road network may also benefit from variable message signs. Specific locations would be chosen to minimise impacts to existing land use, biodiversity and the visual environment and would be determined during detailed design.

Integrated speed and lane-use signs would be installed along the length of the project. These signs would generally display the regulatory speed limit along the project, and would be modified at the operational motorway control centre to display variable speed limits in response to incidents and congestion.

6.9.9 Drainage and water treatment facility

The drainage and water treatment facilities for the project would include two main components:

- Tunnel water drainage, including the construction of an operational water treatment facility to treat surplus groundwater collected within the project tunnels before discharge into the Cooks River.
- Surface water drainage and management infrastructure.

The drainage system would be designed to prevent flooding and aquaplaning within the tunnels and to avoid adverse effects on private properties and the surface road networks surrounding the project. Further details on drainage and water quality can be found in **Chapter 18** (Surface water and flooding) and **Chapter 17** (Groundwater and geology).

Tunnel drainage and treatment infrastructure

This would be designed to accommodate a combination of water ingress events including:

- Groundwater ingress
- Stormwater ingress at portals
- Tunnel wash-down water
- Fire suppressant deluge or fire main rupture
- Spillage of flammable or other hazardous materials.

Further information about the likely treatment methods and wastewater volumes is provided in **Chapter 18** (Surface water and flooding).

The southbound and northbound mainline tunnels would drain towards tunnel 'sumps' (low points), from which the water would be pumped and conveyed north-east via a rising main towards the water treatment facility. The water would then be treated and discharged to the Cooks River. The same drainage arrangements would transport tunnel wash-down water, fire suppressant deluge and liquid from flammable or other hazardous material spills.

Water treatment facilities

The operational water treatment facility has been designed to treat tunnel water before discharge to the stormwater drainage system. The facility consists of:

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

The location of the water treatment facility is shown in **Figure 6-3**. Further information about the likely treatment methods and wastewater volumes is provided in **Chapter 18** (Surface water and flooding).Surface water drainage and management infrastructure

Surface water drainage and management infrastructure would be provided for new surface roads constructed as part of the project, and any existing drainage conditions would be modified as part of the project.

Surface water drainage and management infrastructure would be designed to:

- Limit the flow in gutters to acceptable widths
- Convey runoff collected from a 10-year average recurrence interval (ARI) storm event
- Capture pavement runoff at the tunnel portals for storms up to the 100-year ARI event, to limit the volume of rainfall runoff that enters the tunnel drainage system
- Direct collected surface-water runoff through appropriate water quality treatment devices before appropriate discharge or disposal.

Pavement drainage

Changes to the existing pavement drainage system in the vicinity of the President Avenue surface works as part of the project would include:

- A new pavement drainage system to intercept runoff generated by direct rainfall at the President Avenue intersection to minimise stormwater ingress into the tunnels
- Diversion of runoff from the tunnel portal to temporary storage tanks and pump wells located beneath the carriageways before pumping to a water quality basin (refer to **Figure 6-17** for the location of this basin) and discharges into Scarborough Ponds
- A new pavement drainage system along President Avenue. Runoff from the upgraded section of President Avenue would discharge directly to Scarborough Ponds.

Stormwater treatment

- Where suitable space is available, stormwater runoff generated by the project would be treated in an effort to achieve the targets identified in **Chapter 18** (Surface water and flooding) and to deliver water-sensitive urban design outcomes
- Stormwater treatment infrastructure for the project would include the water quality basin to the east of the President Avenue intersection within the south-east corner of Rockdale Bicentennial Park
- Runoff captured before entering the tunnel portals would be pumped to the basin where it would be treated before discharge into Scarborough Ponds.

Flood mitigation

The following works would form part of the project:

- Raised openings to the ventilation facility and substation at Rockdale to protect against the ingress of floodwater for events up to the Probable Maximum Flood (PMF)
- Raising of President Avenue to improve its level of flood immunity to the 1% Annual Exceedance Probability (AEP) level
- Provision of flood protection barriers around the open slot structure to a minimum elevation in order to prevent the ingress of floodwater for events up to the PMF
- Replacement of existing concrete box culverts that cross President Avenue at Scarborough Ponds (refer to **Figure 6-17**)
- Replacement of the weir that is located upstream of the existing concrete box culvert with a similar arrangement to maintain the existing permanent water level in the section of Scarborough Ponds upstream of President Avenue
- Lowering of ground levels along the eastern side of the tunnel portal extending to the existing Scarborough Ponds within Scarborough Park North to provide an overland flowpath to control flow that approaches the tunnel portal from O'Neill Street for events up to the PMF
- Regrading of the western overbank of the existing Scarborough Ponds immediately south of President Avenue to provide an overland flow path to control flow that surcharges the transverse drainage structure (refer to **Figure 6-17**).

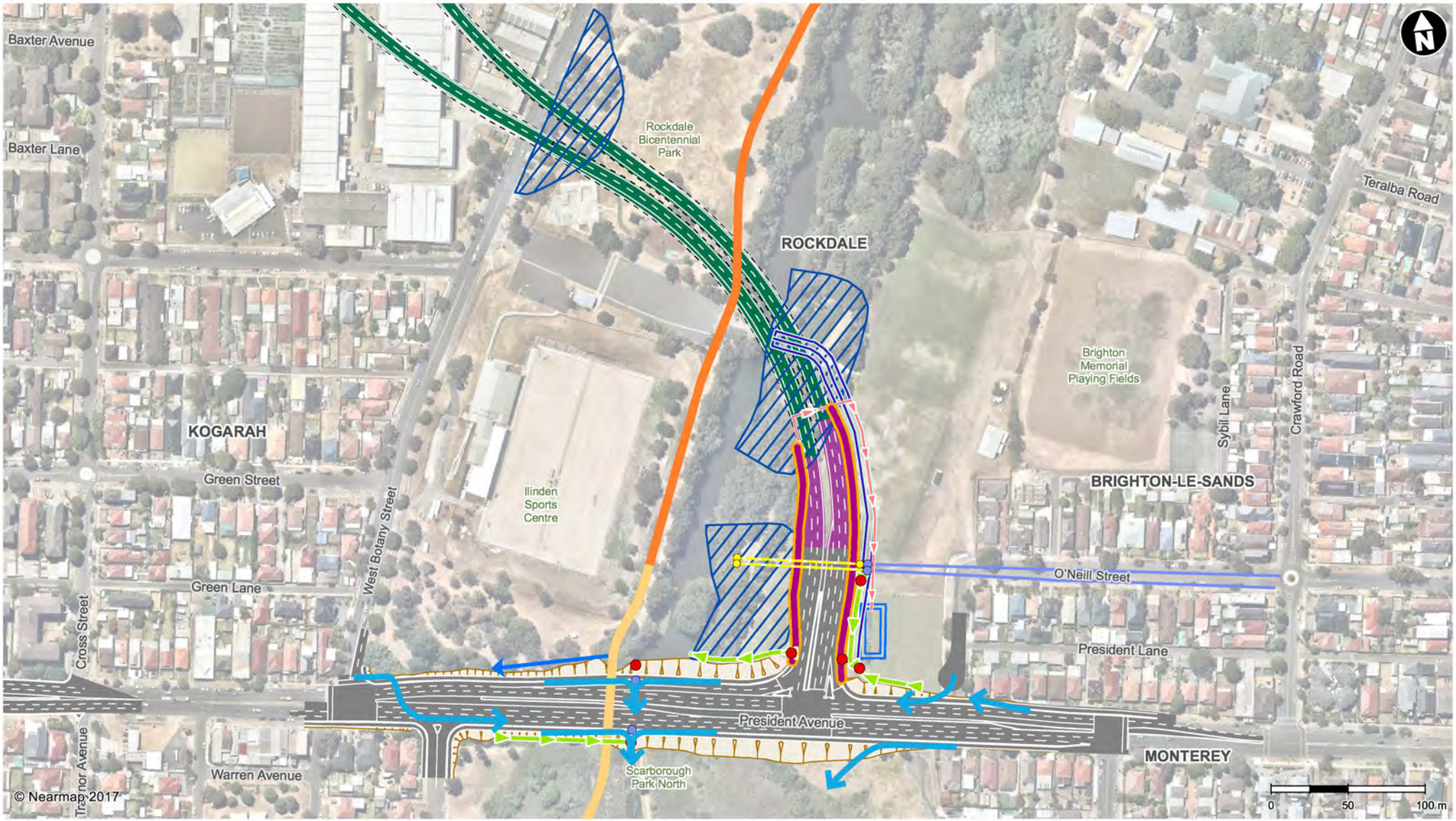


Figure 6-17 Existing and proposed surface flooding and drainage system

6.10 Property access and acquisition

6.10.1 Property access

Access to properties not acquired, leased or otherwise occupied for the project would generally be maintained at all times during construction and operation. Where temporary impacts on existing property access are unavoidable as a result of construction activities (e.g. footpath and pavement works), the landowner and/or tenant would be consulted regarding provision of an appropriate alternate access, which would be to the equivalent standard where possible. Temporary parking where access to private parking is blocked would also be provided if necessary.

Short-term changes to access during construction are described further in **Chapter 7** (Construction).

Chapter 8 (Traffic and transport) includes discussion on indirect, permanent changes to access resulting from road closures and / or modifications, and their associated impacts. **Chapter 14** (Property and land use) includes discussion on impacts on pedestrian and cyclist access and indirect impacts on property access.

6.10.2 Property acquisition

Where land required for the project is not currently owned by the NSW Government, discussions are being held with affected owners concerning the purchase, lease or licence of the land. The project would require full acquisition of 12 privately owned properties and partial acquisition of three privately owned properties. **Chapter 14** (Property and land use) provides further detail.

All compulsory acquisition required for the project would be carried out in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* (NSW), the *Land Acquisition Information Guide*[6] and the land acquisition reforms announced by the NSW Government in 2016[7], which can be viewed online at:

https://www.finance.nsw.gov.au/sites/default/files/NSW_Government_Response.pdf

Relocation and some other categories of expenses would be claimable under this Act and related policies.

The project would also use government-owned land. Roads and Maritime would enter into agreements with relevant government departments about the temporary or permanent use of this land. Where government-owned land is required temporarily, this would generally be established through a lease or a Memorandum of Understanding.

6.11 Noise attenuation

The project may require measures to minimise the levels of traffic noise experienced at residences and other sensitive receptor locations once the project is operational.

The project has been designed to include all feasible and reasonable noise mitigation and management measures, where it is predicted that noise assessment thresholds in the *Road Noise Policy*[8] would be exceeded. This has included the following (in order of application and priority):

- Minimising noise generation at the source. This would be achieved through careful selection of road pavement materials, and by design that minimises the potential for secondary traffic noise sources, such as compression (or engine) braking
- Constructing noise walls, berms and earthworks at the Rockdale construction ancillary facility
- Consideration of where residential properties may be eligible for at property treatment.

More information regarding the process for identifying noise mitigation measures is detailed in **Chapter 11** (Noise and vibration) and **Appendix G** (Noise and vibration technical report).

[6] NSW Government (2014) Land Acquisition Information Guide
[7] NSW Government (2016) Review of the NSW *Land Acquisition (Just Terms) Compensation Act 1991*
[8] Department of Environment, Climate Change and Water (2011). Road Noise Policy

6.12 Utility services

Utilities and services located in close proximity to the project would need to be protected, relocated or realigned during construction, particularly in areas of surface or shallow soil disturbance. These services include electricity, telecommunications, sewer, water and gas services.

Chapter 14 (Property and land use) includes discussion on the relocation of utilities.

The location of existing utility services and any changes required would be confirmed by the construction contractor during the detailed design of the project in consultation with the relevant utility providers.

The project would also require connection to existing electricity, water and wastewater/sewer utilities.

The project includes construction / installation of electrical supply networks to connect the project to existing supply locations (refer **section 6.12.3**).

6.12.1 Water

The project would require the use of water for operation purposes. This would include water for maintenance activities, fire testing and for domestic purposes at each of the motorway operation complexes.

Where water quality requirements are met, treated tunnel water would be used to minimise the need to use potable water. This may include use of treated tunnel water for landscape management.

Water for use inside the buildings within the motorway operation complexes would be supplied via a connection to the Sydney Water mains feed. Fire water would be stored within tanks and pumps that would be located at MOC2. Fire water storage tanks would be sized to provide 100 per cent of the maximum design water flow requirements for up to two hours, and would be fed via connection to the Sydney Water mains feed.

The tunnel deluge and fire suppression system, including number, location and capacity of water storage facilities, would be designed and sized to meet the requirements of Fire and Rescue NSW.

6.12.2 Wastewater / sewer

The tunnels, entry and exit ramps would be subject to groundwater and road runoff ingress. Wastewater captured within the tunnels would also include stormwater entering the tunnels via the portals, deluge water, wash-down water and hydrant water.

The motorway operations complexes would be connected to Sydney Water's wastewater system for domestic purposes.

6.12.3 Electricity

Electricity supply infrastructure would be installed to supply power to the tunnels and associated mechanical and electrical equipment needed during operation. Uninterrupted electrical power is essential for ventilation, lighting and other safety reasons within the tunnels.

Estimated power demand

The projected estimate of maximum power demand for the project is 30 Gigawatt hours (GWh) per year.

The maximum power demand for the tunnels is driven predominantly by the ventilation system, particularly for scenarios involving congested traffic conditions. During normal free-flowing traffic conditions, the power demand for ventilation is significantly reduced. Therefore much of the network capacity remains unused for most of the time.

Power supply connection location

A bulk power supply would be provided in a single location and then distributed to the ventilation outlets and jet fans within the tunnels.

A substation at the Rockdale Motorway Operations Complex (south) (MOC3) would provide the bulk power supply connection for the project. A connection from MOC3 to a substation at the Arncliffe Motorway Operations Complex (MOC1) would be provided through the tunnel.

Redundancy has been built into the electricity supply system for the project. If electricity supply is not available despite the inbuilt redundancy, a system of uninterrupted power supplies would provide back-up power for operation of essential equipment for at least one hour.

Essential operational equipment would include:

- Communications and monitoring equipment
- Fire and life-safety systems
- Tolling systems
- Tunnel signage
- Emergency power outlets
- Closed-circuit television
- Emergency lighting, which would be distributed evenly along the tunnels.

Permanent power supply

A permanent power supply connection would be required within and outside of the construction boundary to service the operation of the project. The permanent power supply connection is proposed to run from the Ausgrid Canterbury sub-transmission substation, located at 16A Hansen Avenue Earlwood, to the Rockdale Motorway Operations Complex south (MOC3).

The power supply would be 33 kV and could potentially run mainly underground from Westfield Street, along Mooney Avenue, through local roads until Harthill-Law Avenue in the suburb of Earlwood. It would then pass through the local roads in Bardwell Park and Bardwell Valley including part of Bardwell Valley Golf Club and the along the edge of Silver Jubilee Park. It would then run along Wolli Creek Road, Kimpton Street through the T4 Eastern Suburbs and Illawarra Line, the Princes Highway and Tarbrett Street in the suburb of Banksia and through Farr Street, Bay Street and finally ending in West Botany Street in Rockdale.

The total length of the power line would be about seven kilometres. The permanent power supply would be either installed underground using a cut and cover trench method or, where the power line crosses waterways or railways, installed in a conduit attached to existing bridges. Where it would be required to cross Bardwell Valley Golf Club, it would be installed using a horizontal under boring method.

The power line would generally be located within the existing road reserve with the exception of where it would cross Bardwell Valley Golf Club where it would be installed using a horizontal under boring method. The location of the permanent power supply route is shown in **Figure 6-18**. The route is indicative and would be further refined and confirmed in consultation with Ausgrid and other key stakeholders.

LEGEND

- The project in tunnel
- The project on surface
- The project as an open slot
- On-road cycleway
- Shared cycle and pedestrian pathways
- President Avenue shared cycle and pedestrian bridge
- Permanent power supply line
- Substation
- Rockdale ventilation facility
- Arncliffe ventilation facility*
- Motorway operations complex

Figure 6-18 Permanent power supply

7 Construction

7.1 Construction strategy

Construction of the project would utilise the following six key construction sites:

- Arncliffe construction ancillary facility (C1) within Kogarah Golf Course, currently being used for New M5 construction
- Rockdale construction ancillary facility (C2) at Rockdale, within a Roads and Maritime depot at West Botany Street
- President Avenue construction ancillary facility (C3) at Rockdale, north and south of President Avenue within Rockdale Bicentennial Park and part of Scarborough Park North, and a site west of West Botany Street
- Shared cycle and pedestrian pathways construction ancillary facilities (C4 and C5) at Brighton-le-Sands, within the recreation area between West Botany Street and Francis Avenue, near Muddy Creek
- Princes Highway construction ancillary facility (C6), on the north-east corner of the President Avenue and Princes Highway intersection.

The location of these construction ancillary facilities is shown in **Figure 7-1**.

The method of construction presented in this EIS represents the concept design for the project. If approved, a further detailed design process would follow which may include refinements to the concept design. Any changes would be reviewed for consistency with the assessment contained in this EIS including relevant mitigation measures, performance outcomes and any future conditions of approval.

7.1.1 Construction program

The project would take around four years to build, including commissioning. For the purposes of this EIS, the project is expected to be completed towards the end of 2024, however this is subject to change depending on when a construction contractor is engaged. Detailed construction timing, staging and sequencing details would be confirmed when construction contractors have been engaged.

The duration of project delivery is mostly determined by the extent of soft ground tunnelling and the complexity of the interfaces between tunnelling activities and the construction of the surface infrastructure. The indicative construction program is shown in **Figure 7-2**.

7.1.2 General principles of the construction strategy

The strategy would be developed in accordance with the following general principles:

- Construct the project generally in accordance with the description of the approved project
- Manage community and environmental issues including noise, access and amenity, in consultation with those potentially affected
- Design and plan efficient site layouts that ensure the safety of project staff and the public
- Make construction staging and sequencing as safe and efficient as possible, providing a simplified construction process, where practical
- Minimise the length of the construction period and the duration of construction activities
- Minimise disruptions to traffic on the existing road network
- Where possible, locate temporary construction facilities on sites where permanent works are proposed
- Achieve safe, efficient and convenient access for construction vehicles, plant and equipment, while minimising impacts on the local road network
- Minimise adverse changes to the safety, efficiency and accessibility of road and related transport networks and ensure ongoing community access and connectivity
- Minimise interdependencies between disciplines to allow construction activities to occur in parallel
- Manage risks to existing infrastructure including roads, railways, utilities and service
- Minimise impacts on parking by providing off-street parking where possible for the construction workforce and by encouraging the use of public transport.

C1

- Tunnelling and spoil handling
- Construction of MOC1 (Water treatment plant, substation)
- Fitout, testing and commissioning of tunnels and MOC 1

C2

- Construction of the decline tunnel
- Tunnelling and spoil handling
- Pavement works for internal access road
- Construction of MOC2
- Reconfiguration of the site to enable ongoing/future use for maintenance activities

C3

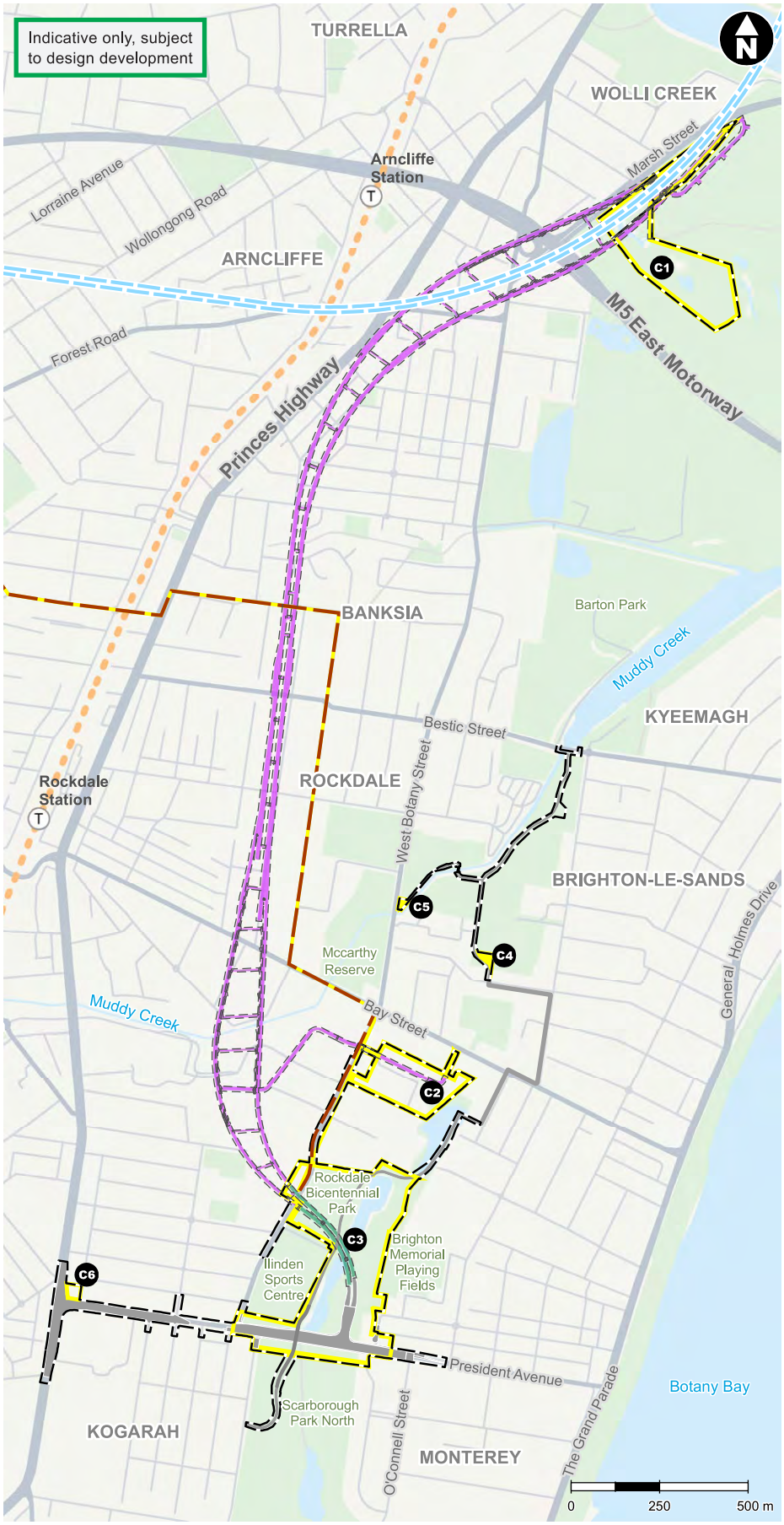
- Demolition of buildings and vegetation clearing and removal
- Relocation of utilities
- Temporary stockpiling of spoil and fill materials
- Management of any contaminated land, including acid sulphate soils
- Construction of cut-and-cover structures
- Construction of MOC3 (Rockdale ventilation facility and substation)
- President Avenue intersection upgrade works
- Construction of shared pedestrian and cyclist path and overpass

C4/C5

- Site establishment
- Vegetation clearing and removal, topsoil stripping areas and land-form shaping
- Temporary stockpiling of materials
- Construction of the shared pedestrian and cyclist path
- Finishing works including lighting, line marking and signage installation

C6

- Property adjustment and demolition
- Relocation of utilities, stormwater infrastructure, underground storage tanks and substation
- Laydown and parking of construction vehicles and equipment
- Reinstatement of site



LEGEND

- Surface works
- Construction boundary
- Cut-and-cover structures
- Underground construction
- Construction ancillary facility
- Permanent power supply line
- Permanent power supply construction route
- New M5 Tunnel
- Road
- Waterway
- Railway line
- Railway station
- Parks and recreation

Figure 7-1 Overview of construction boundary and construction ancillary facilities

Construction Program

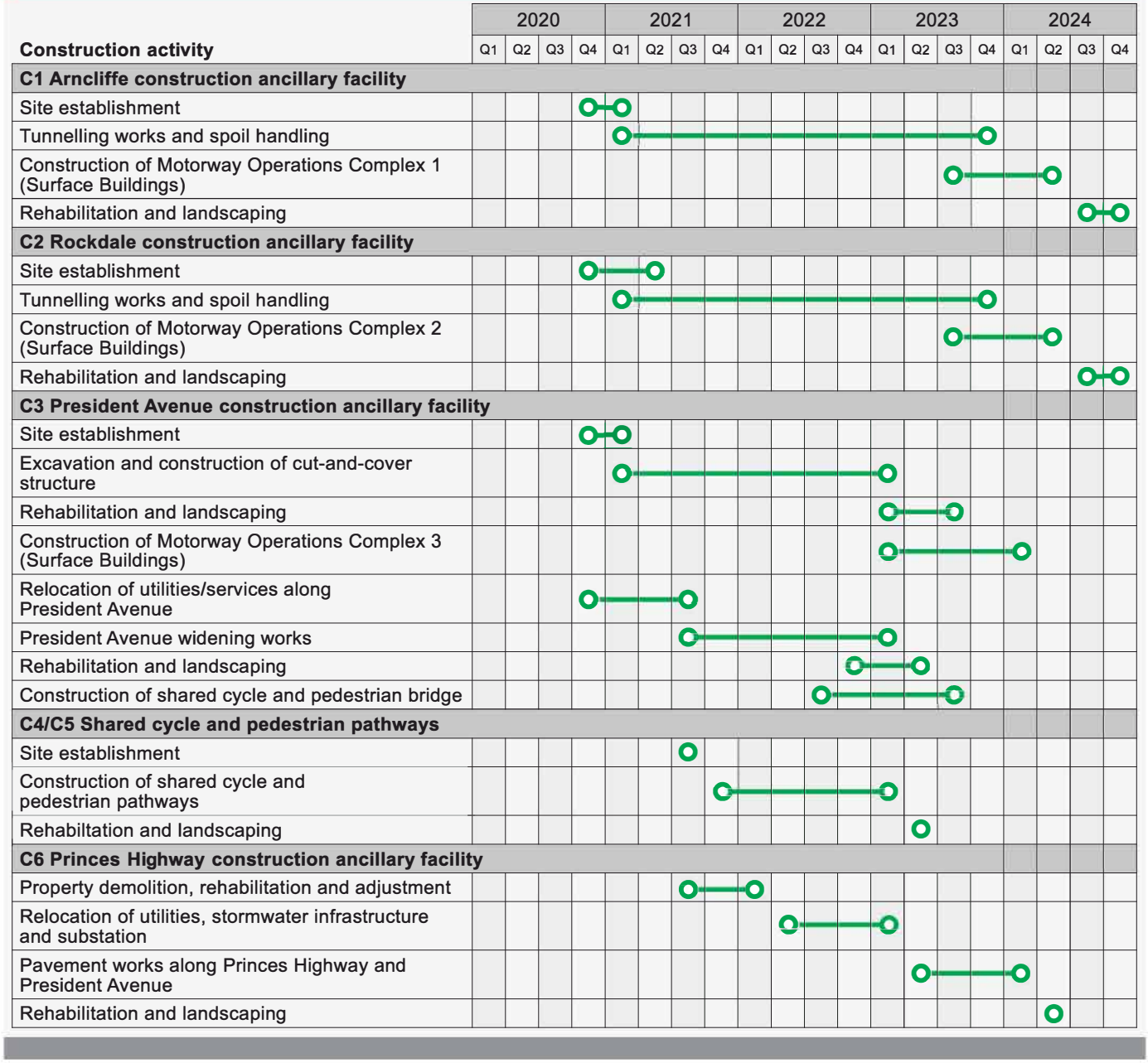


Figure 7-2 Indicative construction program

7.2 Construction boundary

The area required to construct the project is defined by the 'construction boundary'. This comprises the surface construction works area, and construction ancillary facilities (refer to **Figure 7-1**). Utility work to support the project would occur mostly within and sometimes outside the construction boundary (refer to **section 7.5**). In addition to these works, the underground construction boundary (including mainline tunnel construction and temporary access tunnels) is also shown on **Figure 7-1**.

7.3 Construction ancillary facilities

7.3.1 Overview

Construction ancillary facilities would be used to support a combination of civil surface works, tunnelling and tunnelling support, parking and administrative purposes, as summarised in **Table 7-1** and described in more detail in the following sections.

The location, layout and access arrangements for the construction ancillary facilities are based on the concept design and would be confirmed and refined during detailed design. They have also taken into account the following amenity criteria:

- Where practicable, temporary buildings and structures would be used to provide a noise barrier between the construction site and adjacent sensitive receptors
- The location of temporary buildings and structures would have regard to overlooking and overshadowing impacts on adjacent sensitive receptors
- Acoustic sheds would be provided where required to ensure that spoil handling undertaken outside standard construction hours comply with relevant noise guidelines
- Lighting would be designed to minimise light spill onto adjoining properties
- Spoil stockpiles would be located away from adjacent sensitive receptors where possible and would be managed to avoid adverse impacts on land and water quality
- Vehicle access points would be located to minimise the need for heavy vehicles to travel on local roads
- Construction sites would provide sufficient area for the storage of raw materials to minimise, to the greatest extent practical, the number of deliveries or the need to haul material outside of standard construction hours.

Temporary water treatment plants would be constructed at most construction ancillary facilities to treat construction wastewater, including:

- Tunnel groundwater ingress
- Rainfall runoff in tunnel portals and ventilation shaft construction areas
- Dust suppression water
- Wash down runoff.

It is expected that the majority of construction wastewater will be treated and disposed to stormwater. In instances where the discharge criteria cannot be met, the wastewater would be captured and tankered offsite for disposal at a licenced facility.

Table 7-1 Proposed construction ancillary facilities and indicative activities

	C1	C2	C3	C4	C5	C6
Site offices	✓	✓	✓			
Staff and workforce amenities	✓	✓	✓	✓	✓	✓
Stores and laydown	✓	✓	✓	✓	✓	✓
Workshop/maintenance	✓	✓	✓			
Tunnel launch & support	✓	✓				
Spoil management and haulage	✓	✓	✓			
Civil and surface works	✓	✓	✓	✓	✓	✓
Construction water treatment plant	✓	✓	✓			✓
Sedimentation pond	✓	✓	✓			
Temporary ventilation plant	✓	✓				
Temporary substation	✓	✓				
Parking	✓	✓	✓	✓	✓	✓

7.3.2 Arncliffe construction ancillary facility (C1)

The Arncliffe construction ancillary facility (C1) would be located at Kogarah Golf Course at Marsh Street. This facility would utilise the land currently used as a construction ancillary facility for the New M5 Motorway project, which is around 78,000 square metres. This site would be used to support the tunnel fitout; including loading of spoil, spoil removal and haulage off-site, as well as to construct a substation and water treatment plant for operation of the project.

The construction site for the New M5 Motorway would be demobilised prior to being made available for construction of this project.

An indicative site layout for the Arncliffe construction ancillary facility is shown in **Figure 7-3**.

Key construction activities to be carried out at and supported by the Arncliffe construction ancillary facility include:

- Establishment of temporary noise attenuation measures, including construction of an acoustic shed
- Tunnel excavation and other tunnelling works
- Stockpiling of excavated material and spoil haulage
- Civil tunnel fitout works (including pavement and drainage works)
- Mechanical and electrical services within the tunnel and fitout of the tunnel with additional infrastructure
- Mechanical and electrical fitout of the Arncliffe ventilation facility, being constructed as part of the New M5 Motorway project
- Construction of a substation and water treatment facility
- Finishing works including asphalting, lighting, line marking, utilities and signage installation
- Rehabilitation and/ or landscaping of areas that will not be occupied by permanent operational infrastructure.

Access to the site would be provided via traffic signals at the Marsh Street / Flora Street intersection that were installed as part of the New M5 Motorway project.

Tunnelling and spoil management within C1 would occur 24 hours a day, seven days a week. The majority of spoil removal and haulage would occur during 7am – 6pm on weekdays and between 8am – 1pm on Saturday. Where practical, spoil would be removed outside of peak periods. Some night time spoil haulage would be required. Further details about spoil haulage routes are included in **section 7.6.4** and details on construction hours are included in **section 7.7.2**.

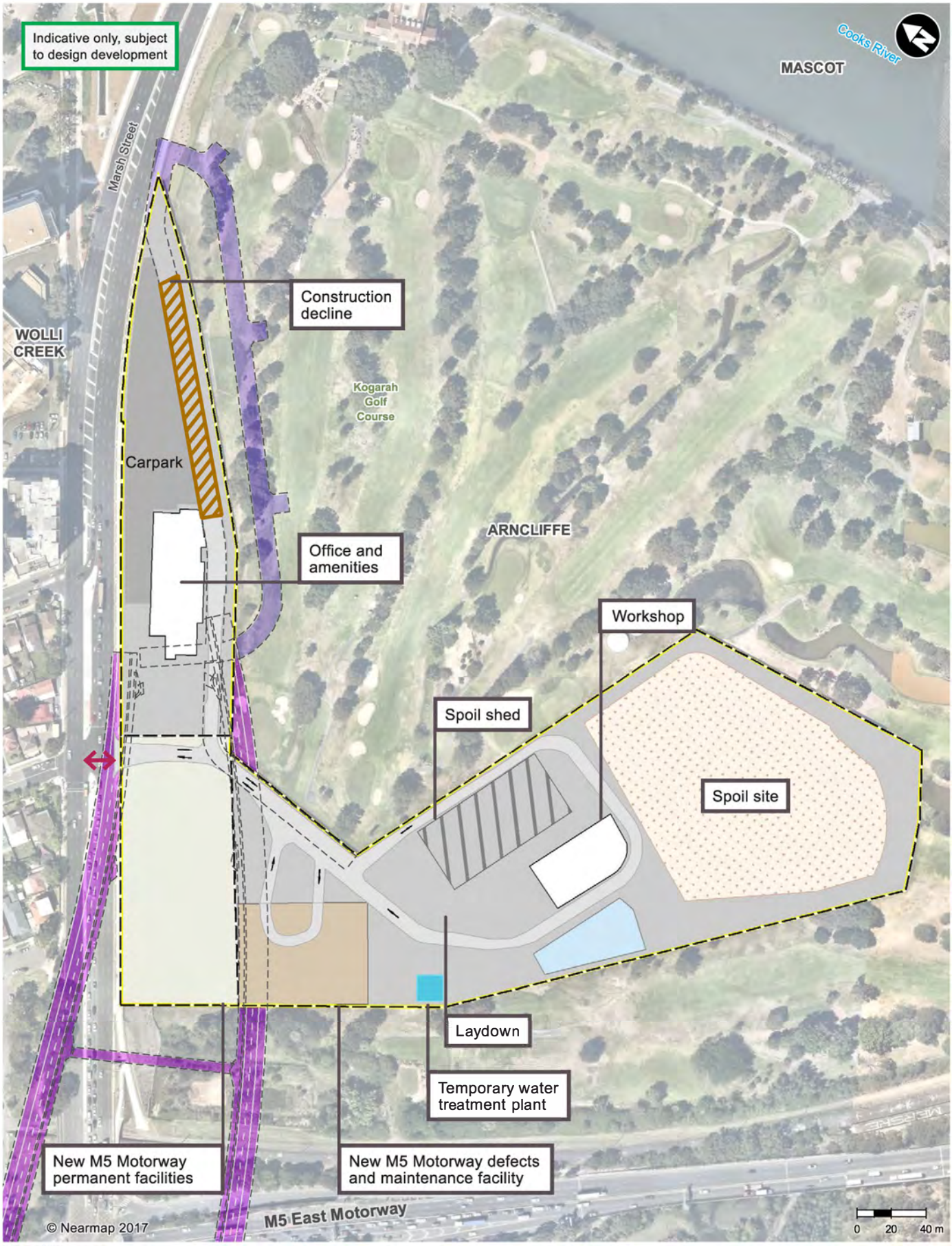


Figure 7-3 Arncliffe construction ancillary facility (C1) indicative layout

7.3.3 Rockdale construction ancillary facility (C2)

The Rockdale construction ancillary facility (C2) would be located at Rockdale, east of West Botany Street and south of Bay Street, on land currently occupied by a Roads and Maritime depot. This construction ancillary facility would require about 12,000 square metres of the existing depot. This site would be used to support the tunnel fitout, including loading of spoil and spoil removal, as well as to construct the operational infrastructure.

An indicative site layout for the Rockdale construction ancillary facility is shown in **Figure 7-4**.

Key construction activities to be carried out at and supported by the Rockdale construction ancillary facility include:

- Support of the ongoing investigation and survey to inform design and construction
- Establishment of temporary noise attenuation measures, including construction of an acoustic shed
- Construction of the decline tunnel
- Civil tunnel fitout works (including pavement and drainage works)
- Mechanical and electrical services within the tunnel and fitout of the tunnel with additional infrastructure
- Tunnel excavation and other tunnel works, as well as stockpiling of excavated material and spoil haulage
- Pavement works including asphalting, lighting, line marking and signage installation for the internal access road
- Construction of operational infrastructure including the Motorway Control Centre
- Reconfiguration of the site to enable ongoing/future use for maintenance activities
- Rehabilitation and landscaping.

To access the mainline tunnels for excavation, it is proposed to excavate a decline tunnel from within C2 and join the mainline tunnels in the vicinity of where the entry and exit ramps rise up from the mainline tunnel.

This decline will commence in a slot structure and then progress into a cut-and-cover structure through the site. As the decline meets West Botany Street, it would progress into a tunnel dive structure.

Access to C2 would be gained from West Botany Street.

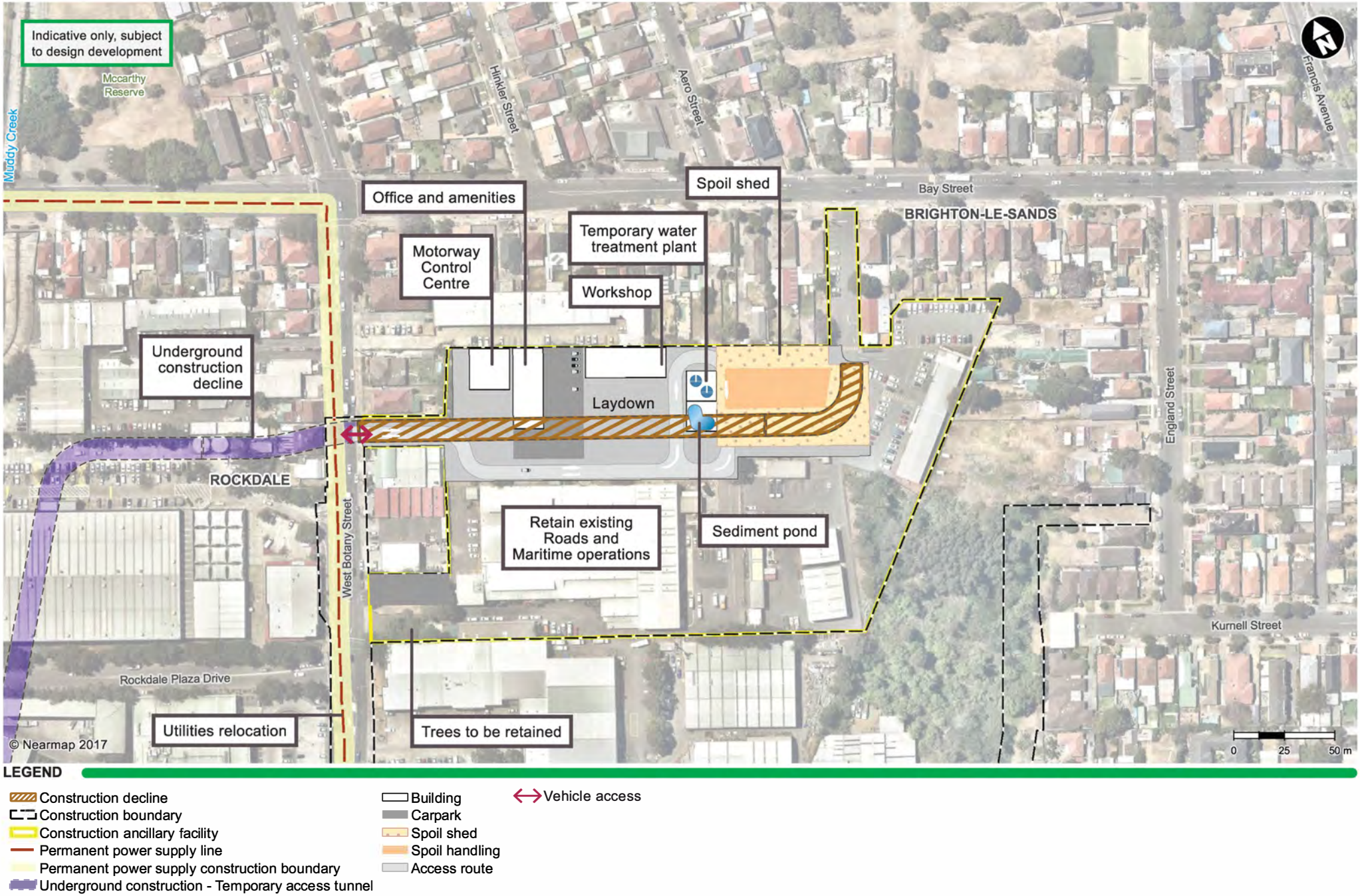


Figure 7-4 Rockdale construction ancillary facility (C2) indicative layout

7.3.4 President Avenue construction ancillary facility (C3)

The President Avenue construction ancillary facility (C3) would be located above ground at Rockdale Bicentennial Park and on the western side of West Botany Street. It would be around 151,000 square metres. Vehicle access to C3 would be gained from West Botany Street and President Avenue.

The site would be used to support construction of:

- The cut-and-cover structures for the entry and exit ramps and the tunnel portal
- The new intersection with President Avenue
- The Rockdale Motorway Operations Complex (south) (MOC3) including the Rockdale ventilation facility
- The shared cycle and pedestrian pathways in Rockdale Bicentennial Park and over President Avenue
- The upgraded intersection at President Avenue / Princes Highway
- The reinstatement of Rockdale Bicentennial Park, water body and facilities.

An indicative site layout for the President Avenue construction ancillary facility is shown in **Figure 7-5**.

Key construction activities to be carried out and supported by C3 include:

- Demolition of houses around the O'Neill Street and President Avenue intersection
- Demolition of commercial buildings on west side of West Botany Street
- Removal of sporting facilities within the construction boundary
- Establishment of vegetation exclusion zones within the construction footprint, followed by vegetation clearing and removal (including around one hectare of native vegetation)
- Establishment of temporary noise attenuation measures, such as noise barriers or hoarding
- Relocation of utilities along West Botany Street and President Avenue
- Temporary stockpiling of spoil and fill materials for later re-use, where possible, within the project or prior to off-site removal
- Management of any contaminated land, and treatment of acid sulphate soil
- Construction of the cut-and-cover structures including excavation, piling, concrete works, installation of diaphragm walls and installation of mechanical and electrical services
- Construction of the Rockdale ventilation facility
- President Avenue intersection upgrade works
- Construction of the shared cycle and pedestrian pathways, including the President Avenue shared cycle and pedestrian bridge and abutments
- Construction of new and upgraded drainage infrastructure and water treatment basin
- Finishing works including asphalting, lighting, line marking and signage installation
- Rehabilitation and landscaping of areas that will not be occupied by permanent operational infrastructure, including Rockdale Bicentennial Park.

A large area is required to support the diaphragm wall works for the cut-and-cover structures. This area would be located on the northern side of the alignment adjacent to West Botany Street, within Rockdale Bicentennial Park North (refer to **Figure 7-5**).

During construction of the cut-and-cover structures the existing waterbody within Rockdale Bicentennial Park would be temporarily diverted to maintain surface water flow to the wetlands south of President Avenue (refer to **Chapter 18** (Surface water and flooding)).

West Botany Street would also require a temporary diversion to maintain traffic flow (refer to **Chapter 8** (Traffic and transport)).

Some works along President Avenue and works associated with the cut-and-cover structure would need to be undertaken at night. These include utility relocation and protection works, traffic management works, erection of dedicated shared bridge or if construction of the diaphragm wall extends beyond normal construction hours.

Spoil at C3 would be removed during the day and outside of peak traffic periods where possible. Feasible and reasonable management strategies would be investigated to minimise the number of heavy vehicle movements at night. Further details about construction hours are included in **section 7.7.2**.

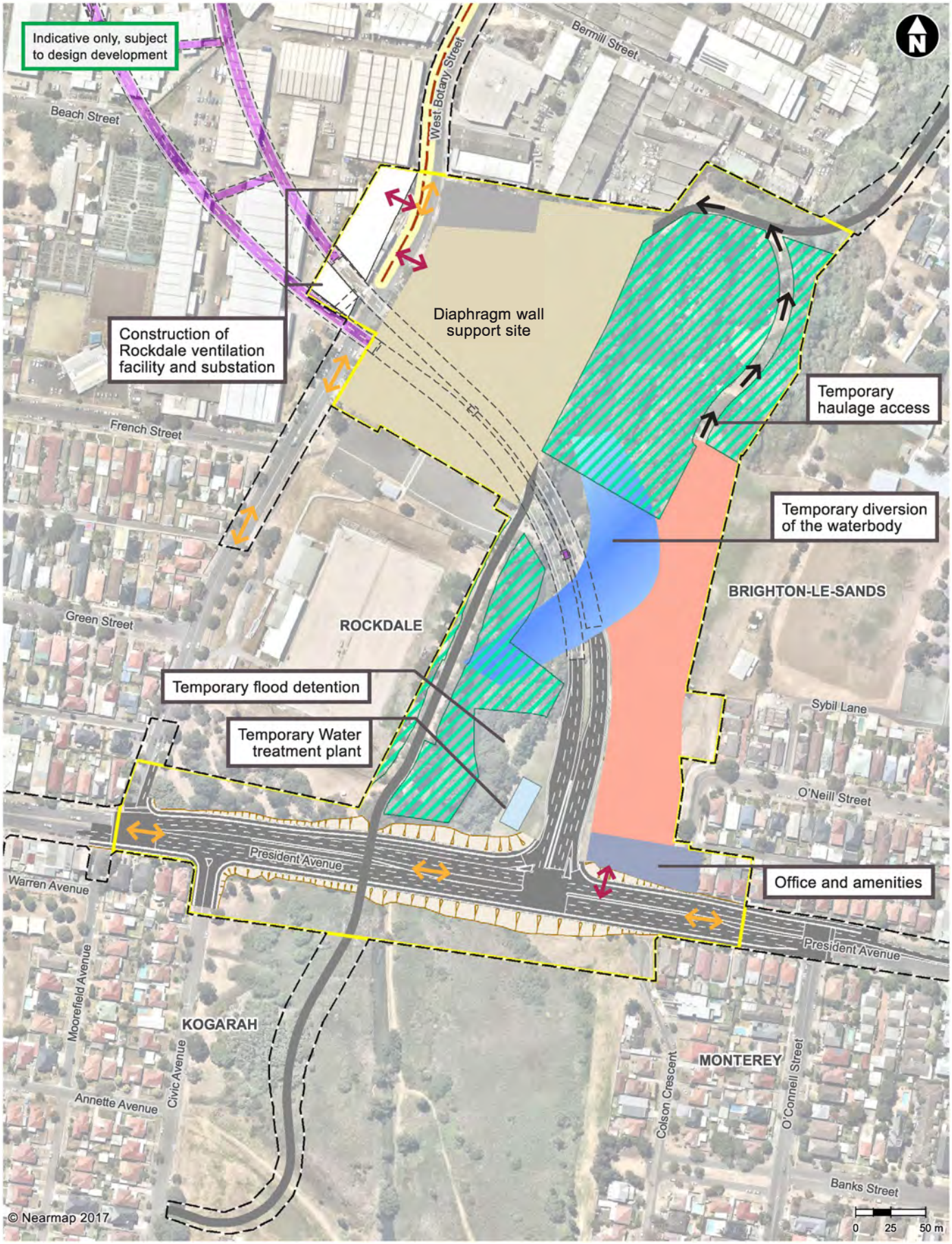


Figure 7-5 President Avenue construction ancillary facility (C3) indicative layout

7.3.5 Shared cycle and pedestrian pathways construction ancillary facilities (C4/C5)

Construction of the shared cycle and pedestrian pathways between Bestic Street and Bruce Street would be supported by C4 and C5, including the following key construction activities:

- Vegetation clearing and removal, topsoil stripping areas and landform shaping
- Excavation of spoil and removal off-site
- Provision of utilities for lighting
- Concrete formation and concrete pathway pouring
- Finishing works including lighting, line marking and signage installation.

C4 and C5 are shown on **Figure 7-6.** The shared cycle and pedestrian pathways would be constructed during standard working hours at this location.

Figure 7-6 Shared cycle and pedestrian pathways construction ancillary facilities (C4 and C5) indicative layout

7.3.6 Princes Highway construction ancillary facility (C6)

The Princes Highway ancillary facility (C6) would be located at Kogarah, on the north-east corner of Princes Highway and President Avenue. This land is currently occupied by 7-Eleven service station Kogarah.

This construction ancillary facility would be around 1,500 square metres and would support the construction of the Princes Highway and President Avenue intersection upgrade. The site would include offices and amenities Key construction activities to occur at this site would include:

- Property adjustment and demolition of the existing 7-Eleven service station including the removal of tanks and rehabilitation of site to treat contaminants
- Relocation of utilities, stormwater infrastructure and substation
- Laydown and parking of construction vehicles and equipment
- Pavement works along Princes Highway and President Avenue
- Rehabilitation and landscaping.

A construction water treatment plant may also be located at C6 during the rehabilitation of the site to treat contaminants.

An indicative site layout for the Rockdale construction ancillary facility is shown in **Figure 7-7**. Access to C6 would be gained from President Avenue.

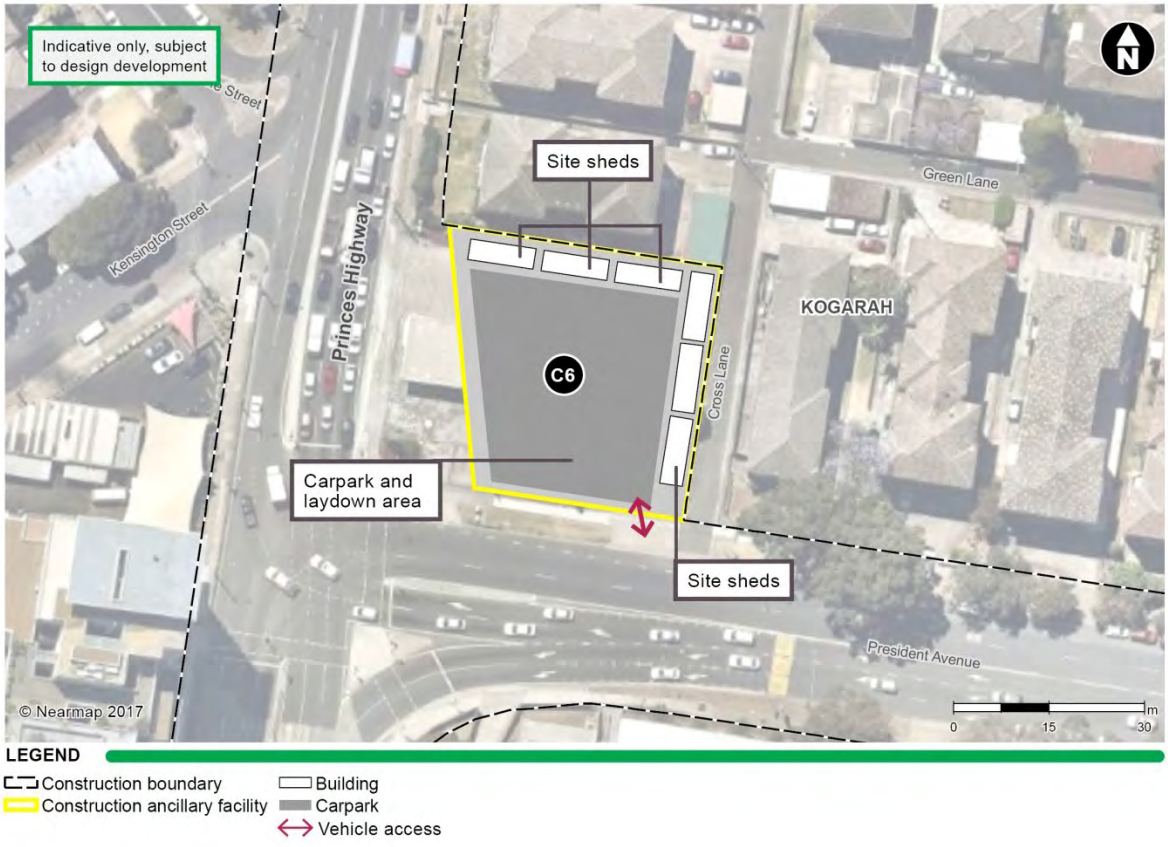


Figure 7-7 Princes Highway construction ancillary facility (C6) indicative layout

7.3.7 Other construction sites

Additional construction sites would be required. These would include sites located:

- Between Bruce Street and the President Avenue construction ancillary facility for the construction of the on-road cycleway
- Access from Bestic Street would be required for construction workers, delivery of materials and removal of spoil for the shared cycle and pedestrian pathways. Refer to **section 7.6** for indicative construction vehicle numbers accessing the sites from Bestic Street
- South of President Avenue, east of Civic Avenue for the construction of the shared cycle and pedestrian pathways and dedicated shared bridge

7.3.8 Potential additional construction sites

Although every endeavour has been made to identify the land required for the construction of the project, the construction contractor(s) may require additional construction sites and/or compounds to those detailed in **section 7.3.2** to **section 7.3.6**. For example, construction methodologies may require mid tunnel access shafts for materials delivery and for safety reasons during construction such as fresh air ventilation and emergency egress. Alternative or additional sites would be assessed against the following environmental criteria, and the impacts assessed in accordance with relevant legislation:

- Be located more than 50 metres from a waterway, unless an erosion or sediment control plan is developed and implemented
- Be located within or adjacent to the project
- Have ready access to the road network, and be located to minimise the need for heavy vehicles to travel on local streets and/or through residential areas
- Be located on relatively level land
- Be separated from the nearest residences by at least 200 metres, unless feasible and reasonable noise and light spill mitigation measures are implemented
- Not require native vegetation clearing beyond that already required for the project
- Not have any more than a minor impact on heritage items beyond those already required for the project
- Not unreasonably affect the land of adjacent properties
- Be above the 20 year average recurrence interval flood level, unless a contingency plan to manage flooding is prepared and implemented
- Provide sufficient space for the storage of soil, raw materials and other construction materials to minimise the number of deliveries required outside of standard daytime construction hours.

7.4 Project construction activities

Construction activities for the project are discussed in this section and would include:

- Preparatory investigations
- Site establishment and enabling work
- Tunnelling
- Surface earthworks and structures
- Construction of permanent operational infrastructure
- Drainage and water management infrastructure
- Road pavement works
- Finishing works.

7.4.1 Preparatory investigations

The project would require preparatory investigations and survey activities to inform the detailed design prior to the main construction activities. These activities include test drilling, test excavations, geotechnical or contamination investigations or other tests, utility location identification or surveys, sampling or investigations for the purposes of the design of the project. These activities would be required within the construction boundary, including areas within Rockdale Bicentennial Park wetland and Scarborough Park north. These areas are identified as coastal wetlands under the State Environmental Planning Policy (Coast Management) 2018 (Coastal Management SEPP).

These activities would inform design and construction and would be expected to be carried out before the start of substantial construction works within the area of the tunnel dive and cut-and-cover structures and construction access tunnels at the President Avenue intersection and for the bridge approaches and structures for the shared pedestrian and cycle pathway.

Typically, preparatory investigations to inform the design may involve:

- Installation of site environment management controls
- Boreholes and tests pits to determine soil and ground conditions
- Ground and utility surveys including excavation to confirm depths of location of utilities
- Installation of piezometers to allow for ongoing groundwater monitoring.

Boreholes would be advanced through soils and extended into rock at bridge piers and abutments. The clear site area required for each borehole would typically be eight metres by three metres. Where an external water supply is required, this would be provided from approved sources including water hydrants. Water would be the principle drilling fluid, although a biodegradable oil-based polymer may also be used depending on the subsurface conditions encountered. After drilling has been completed, the sites would be reinstated to pre-works condition. This would involve stabilising the site with the original removed turf if possible.

Test pits would be excavated using a backhoe for sampling of sub-grade materials and excavation conditions at regular intervals. At each test pit location, dynamic cone penetration tests may be conducted to assess the in-situ strength and relative density of the underlying soils. Test pits would be typically three metres deep, 0.5 metres wide and three to four metres long.

Ground disturbance would occur at the test pit location and immediately adjacent where excavated spoil is temporarily stockpiled prior to backfilling. Material extracted from test pits would be returned in the reverse order to which it was removed.

It is anticipated that piezometers would be used as part of an ongoing program of groundwater monitoring to inform the design. The piezometers would be closed with a locked cover, to be flush with the ground surface for all public footpaths, cycle ways, roads and public recreational areas. Following installation, piezometers would be periodically monitored as part of an ongoing groundwater-monitoring program.

These investigations would not result in significant adverse environmental or socio-economic impacts with any potential environmental impacts considered minor. In particular, the investigations within coastal management areas will not significantly impact on the biophysical, hydrological or ecological integrity of the adjacent coastal wetland, or the quantity and quality of surface and ground water flows to the coastal wetland.

Standard environmental management measures would be implemented to avoid, minimise and mitigate potential adverse impacts from the investigation works. These measures include:

- Avoiding or minimising impacts on biodiversity, in particular coastal management areas
- Implementing appropriate erosion and sediment controls
- Implementing appropriate waste, dust and noise controls.

A management plan would be prepared to describe safeguards and management measures identified. This plan will provide a framework for establishing how these measures will be implemented and who would be responsible for their implementation.

7.4.2 Site establishment and enabling works

These works would be initial works, managed through a site establishment and enabling works management plan. Site establishment works are expected to include:

- Installation of site fencing and hoarding
- Provision of access and parking areas
- Installation of site offices and crib rooms
- Construction of acoustic sheds
- Installation of sediment and erosion control measures
- Installation of traffic management measures and changes
- Establishment of temporary pedestrian and cyclist diversions
- Installation of other environmental controls (such as screening and noise attenuation)
- Installation of temporary utility services to support construction (including construction power)
- Installation of temporary water treatment facilities
- Utility works including protection and/or adjustment of existing utilities, removal of redundant utilities, and the installation of new utilities
- Vegetation clearing and removal. A total of 449 trees were identified within the construction boundary which may need to be removed for the project. A tree management strategy would be prepared and implemented for the project. Trees would be retained wherever possible
- Demolition and clearing of structures, including buildings.

Demolition

Construction of the project would require demolition or partial demolition of around 20 surface properties (subject to the conditions of the project approval). **Table 7-2** provides an indicative list of the number of buildings and their current primary use proposed to be demolished for the project.

Table 7-2 Indicative number and types of buildings proposed for demolition

Land use type	Buildings to be demolished
Industrial	Five industrial buildings and one service station
Roads and Maritime depot	Up to five large sheds/ small buildings
Residential	Nine single dwelling houses
Other	Substation

Typically, access and egress to and from the site of demolition would use existing driveways; however, alternative access may be required. Demolition would be carried out by licensed demolition contractors and in stages where possible.

An asbestos survey will be undertaken of buildings to be demolished as part of the project in accordance with a Hazardous Building Materials Management Plan developed for the project. The survey will be conducted by a suitably qualified person. Recyclable resources generated during demolition will be segregated for recycling and sent to an appropriate recycling facility for processing.

7.4.3 Tunnelling

Tunnel excavation

The project would involve tunnel excavation for the mainline tunnels, entry and exit ramp tunnels, and various connected ancillary tunnels and cross passages.

The depth of the tunnels below ground level would vary according to localised geological conditions, and they would be located underneath the New M5 Motorway tunnels in the vicinity of the underground connection with the New M5 Motorway. The deepest point of the tunnel crowns (top of the tunnels) would be greater than 80 metres below ground level, with shallower sections approaching the connection to the surface road network at the President Avenue intersection. The shallower sections would be along the entry and exit ramp tunnels.

It is anticipated that the tunnels would be excavated using a combination of roadheader excavation and drill and blast methods. Using roadheaders and drill and blast methods would speed up the excavation process. The drill and blast method would likely involve the excavation of the heading (top section of the tunnel) and bench (bottom section of the tunnel).

The bench (lower section of the tunnel) would then be removed using a roadheader, surface miner, drill and blast or conventionally by excavators with rock hammers. Profilers would only be used for the last 200-300 millimetres of the floor. Another technique that would be available to the construction contractor for excavating the bench is controlled blasting which would reduce the reliance on roadheaders and reduce the time taken for the tunnel excavation. The controlled blasting method involves a sequence of:

- Drilling holes and charging them with explosives
- Carrying out controlled blasts
- Removing loosened material (‘mucking out’).

Roadheaders would be launched from tunnelling sites (refer to **section 7.3**). An indicative tunnel excavation method using roadheaders is illustrated in **Figure 7-8**. The tunnel excavation methods would be confirmed by the contractors engaged to construct the project.

Blasting methods can significantly reduce exposure to noise and vibration for residents and businesses above the tunnels. Blasting would also shorten excavation timeframes. A Blast Management Strategy will be prepared in accordance with relevant guidelines before blasting begins. Blast patterns would be designed and sequenced to minimise impacts of vibration on properties above the tunnels and on existing below ground infrastructure such as utilities. Blasting would only be undertaken at depths of 30 metres or greater underground and only in locations where the geology is suitable (i.e. not soft ground). **Chapter 11** (Noise and vibration) provides an assessment of the underground blasting impacts on surface receptors during construction.

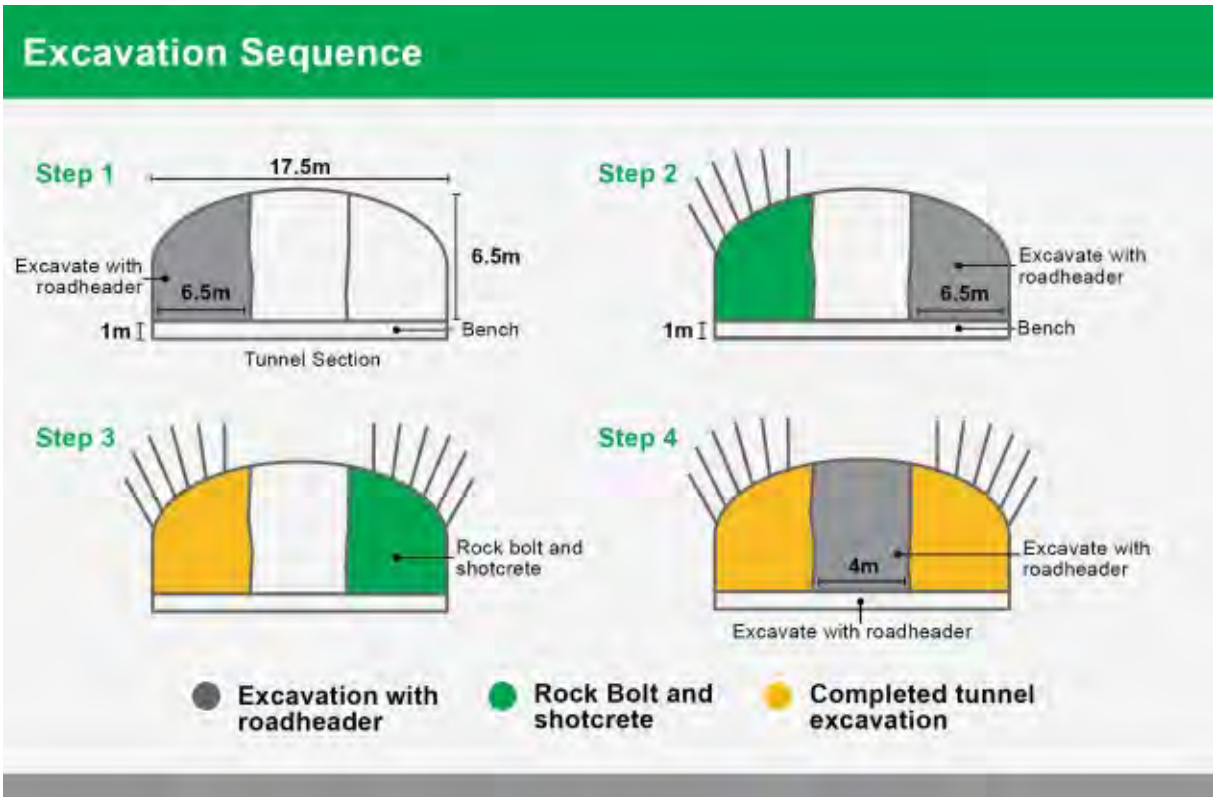


Figure 7-8 Indicative roadheader excavation method

Ground support, including rock bolting and shotcrete, would be installed as the tunnelling face is advanced. There would be progressive installation of tunnel lining following tunnel excavation. Tunnel lining would typically consist of rock bolts and shotcrete with additional water resisting treatments provided based on the local geology and groundwater inflows.

In addition to the mainline tunnels and entry and exit ramp tunnels, the following tunnel infrastructure would be constructed using either roadheaders, excavators with rock hammers, or blasting (unlikely to be used in soft ground conditions):

- Temporary access tunnels to access the road and ventilation tunnels from construction ancillary facilities
- Ventilation shafts and tunnels
- Niches for underground substations
- Breakdown and maintenance bays.

The indicative depths of the mainline tunnel below ground level are shown in **Figure 7-9**.

Spoil management

Excavated spoil from tunnelling would be stockpiled within each of the construction ancillary facilities, within spoil handling sheds. Any excess spoil that cannot be reused within the project would require off-site reuse/disposal. Estimated volumes of spoil generated at each construction ancillary facility are provided in **Table 7-3**.

Table 7-3 Estimated spoil generated at each construction ancillary facility

Site	Volume of spoil (m^3)
C1	612,650
C2	347,900
C3	195,950

Civil finishing works for the tunnels

On completion of the tunnel excavation works, there would be a variety of civil finishing works, including:

- Installation of stormwater and groundwater drainage systems, including sumps
- Installation of water resisting treatments (where required)
- Finishing of:
  - Cross-passages and longitudinal egress passages
  - Substation niches
- Pavement construction and line marking
- Installation of:
  - Electrical and communication conduits and cable trays
  - Deluge and hydrant fire mains
  - Road furniture (e.g. safety barriers, lighting and signage)
  - Architectural panels
- Painting.

Tunnel fitout and testing

Following tunnel excavation and civil finishing works, the tunnels would be fitted out with operational infrastructure including power, ventilation systems, fire safety systems, communications, traffic control device and systems, tunnel lighting, tolling infrastructure and other operation management and control systems.

This would be followed by a comprehensive commissioning process to validate the operation and integration of tunnel systems before the tunnels are opened to traffic.

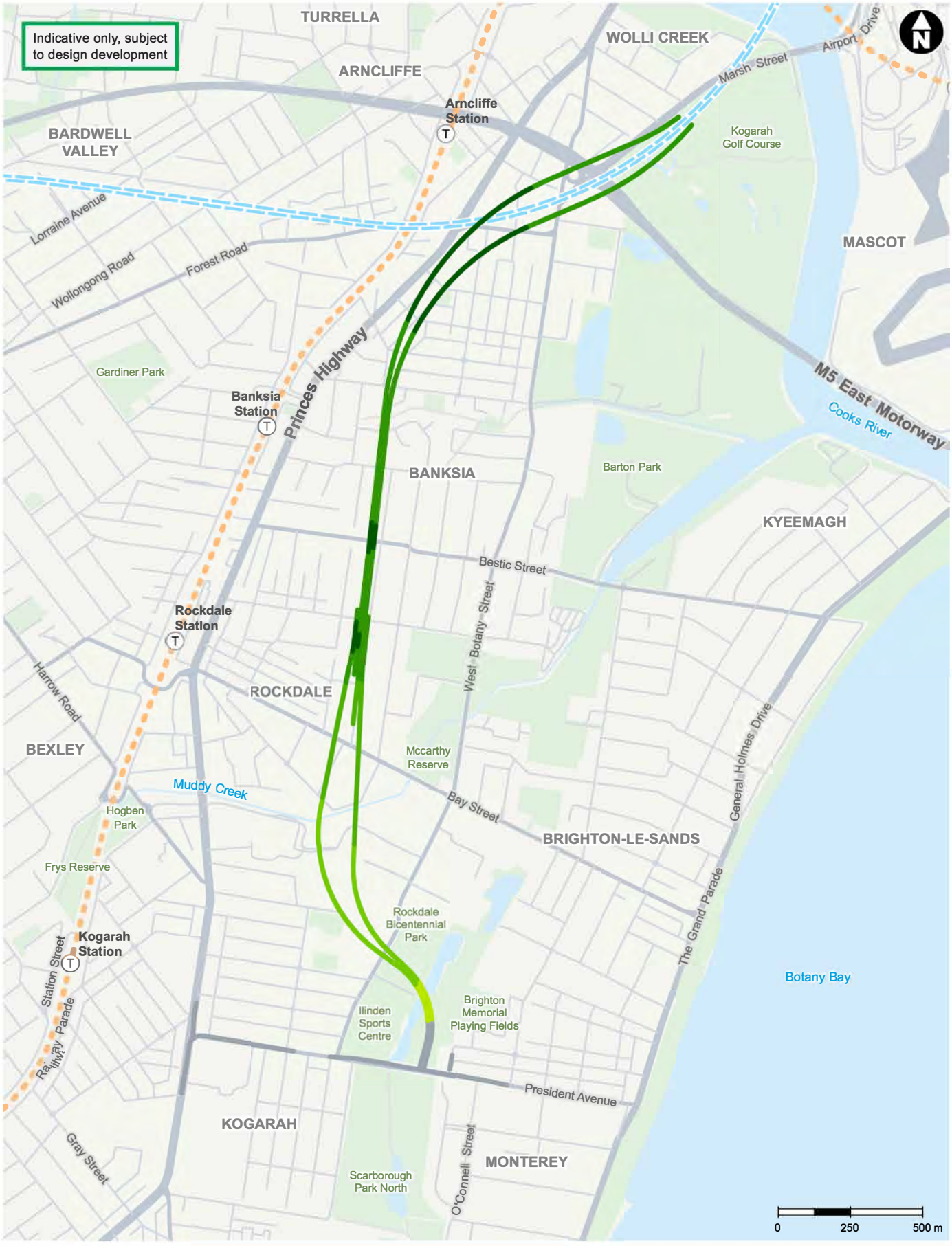


Figure 7-9 Indicative tunnel depths - mainline tunnels

7.4.4 Surface earthworks and structures

Earthworks would be required for the construction of above ground sections of the project, including work in Bicentennial Park, the President Avenue intersection upgrade and Princes Highway/President Avenue intersection upgrade, and within the shared cycle and pedestrian pathways.

The work would be completed using conventional methods of construction and may include:

- Vegetation clearing, topsoil stripping areas and landform shaping, including construction of retaining walls and reinforced soil walls to design levels.
- Treatment of contaminated excavated materials or groundwater, where required (refer to **Chapter 16** (Soils and contamination) and **Chapter 17** (Groundwater and geology))
- Installation of drainage infrastructure
- Excavation for road widening along President Avenue and Princes Highway
- Road embankment works
- Utility works including protection and/or adjustment of existing utilities, removal of redundant utilities and installation of new utilities.

Other earthworks would be required for:

- Tunnel dive and cut-and-cover structures at the President Avenue intersection and construction access tunnels
- Installation of stabilisation and excavation support (retention systems) such as sheet pile walls (where required) and diaphragm walls
- Construction of retaining structures
- Construction of the shared cycle and pedestrian pathways
- Piling excavation for President Avenue shared cycle and pedestrian bridge
- Drainage structures including the operational water treatment basin
- Excavation for temporary diversion of the waterbody within Rockdale Bicentennial Park
- Temporary diversion of West Botany Street to allow construction of cut and cover tunnel section.

Princes Highway/President Avenue intersection upgrade

The Princes Highway/ President Avenue intersection upgrade works would consist of:

- Protection and relocation of utilities
- Demolition and clearing of structures
- Excavation of the road to sub-grade level, and the installation of the new road pavement and stormwater infrastructure
- Footpath pavement work, final asphalt and line marking and traffic signal, street lighting and signage installation.

The traffic management for the construction of this intersection is detailed in **section 7.6**.

Cut-and-cover structures

A cut-and-cover structure would be required at the following locations:

- C2 - within the existing Roads and Maritime depot for the construction decline, providing construction access to the mainline tunnels
- C3 - north of President Avenue intersection through Rockdale Bicentennial Park, Rockdale Wetlands and West Botany Street for the tunnel dive structure.

Cut-and-cover is a tunnel excavation method that generally involves excavating downwards from the surface of the ground, with installation of a tunnel structure including a base, walls and a roof (refer to **Figure 7-10**). The excavation area would be waterproofed to prevent groundwater infiltration. Once the roof is in place, surface activity can generally resume as construction works continue below. Construction activities associated with cut-and-cover structures would include:

- Excavation, together with the temporary diversion of the waterbody within Rockdale Bicentennial Park and West Botany Street
- Stabilisation and excavation support (retention systems) such as sheet pile walls and diaphragm walls (where required)
- Piling works
- Construction of pile capping beams
- Installation of roof slabs
- Installation of permanent struts and form, reinforcement and pouring of horizontal beams used for bracing and support
- Waterproofing and dewatering
- Finishing works.

Shared cycle and pedestrian pathways

Construction of the shared cycle and pedestrian pathways north of Rockdale Bicentennial Park would involve site establishment, excavation of the path to subgrade level, pavement works, followed by rehabilitation and landscaping.

Construction of the President Avenue shared cycle and pedestrian bridge would involve:

- Site establishment
- Piling excavation and construction of abutments and piers
- Construction of spans, headstocks and girders
- Construction of the southern and northern approach pathways
- Erection of the final girder and span onto the bridge
- Installation of the hand rails, anti-throw screens
- Final fit-out, landscaping and rehabilitation of site.

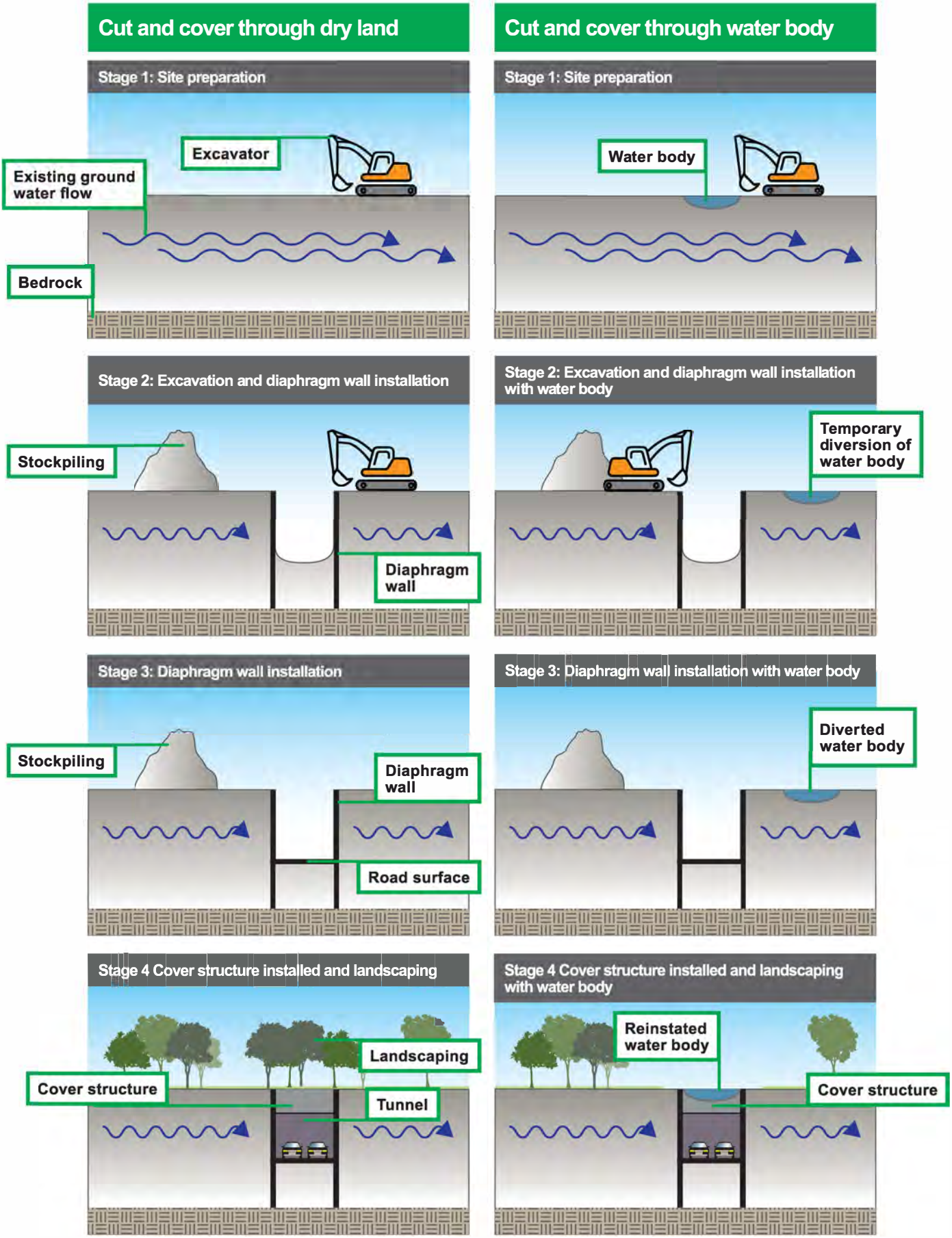


Figure 7-10 Indicative cut-and-cover excavation method

7.4.5 Construction of permanent operational infrastructure

Operation of the project requires permanent infrastructure. The majority would be constructed within C2 and C3. Construction of a substation and water treatment facility would occur within C1. Refer to **section 6.9.1** for further details on the permanent operational infrastructure.

Mechanical and electrical fitout of the Arncliffe ventilation facility would need to occur within C1. These structures are currently being constructed as part of the New M5 Motorway project.

Construction of permanent infrastructure within C2 would include pavement works for the construction of the motorway carpark and the motorway yard, as well as the construction of the Motorway Control Centre building, maintenance facility, pump room and deluge tanks and bulky equipment store. These buildings would be constructed using conventional steel frame or reinforced concrete methods, followed by internal fitout and reconfiguration of the site to enable ongoing/future use for maintenance activities, including rehabilitation and landscaping.

Ventilation facilities

The Rockdale ventilation facility would be constructed on the west side of West Botany Street and would involve:

- Footing and base slab installation
- Erection of precast or in situ poured concrete wall panels for shaft structure stability
- Installation of precast floor or in situ poured elements at the fan room and damper levels
- Installation of roof panels and stair structures for maintenance, access and monitoring of the facilities
- Fixing of façade support structures to ventilation shaft walls as per architectural requirements
- Internal fitout of plant areas, equipment installation and commissioning.

Fitout and installation works would also occur at the Arncliffe ventilation facility being built as part of the New M5 Motorway project. It is envisioned that a significant portion of the ventilation facility would be constructed within the cut and cover structure for the southbound tunnel.

Fire pumps and tanks

The project would require water storage in the form of tanks and a pump station to supply the deluge fire suppression system that would service the tunnels. The tanks and pump station would be located within MOC2, and constructed within C2. The construction would involve:

- Footing and base slab installation
- Construction of fire deluge tanks
- Construction of concrete blockwork walls and precast walls for tank enclosure
- Installation of roofing
- Installation of architectural treatments and façade systems
- Installation of in-ground services
- Internal fitout and commissioning of fire pump infrastructure.

Electrical substations

One intake substation would be constructed above ground within MOC3. This intake electrical substation would manage the intake and distribution of the project's power needs.

The substation would be constructed by installing the concrete blockwork, in-ground services, architectural treatments and façade systems, followed by internal fitout and commissioning of electrical infrastructure.

Permanent power supply connection

A permanent power supply connection would be constructed within and outside the project footprint to service the construction and operation of the project (refer to **Figure 7-11**).

The power line would be constructed underground either by trenching or, where required, under-boring. Where the power line crosses waterways or railways, it would be installed in a conduit attached to an existing bridge. The power line would be located within the existing road reserve or underbored, where allowed by the relevant authority, with the exception of where it would cross Bardwell Valley Golf Club and run along the edge of Silver Jubilee Park.

Prior to work commencing the following planning measures will be carried out by each site specific work crew:

- Obtain current Dial Before You Dig (DBYD) drawings for the work area
- Locate existing services
- Undertake dilapidation survey
- Obtain a current Excavation/Penetration Permit for excavation work
- Notify residents and businesses of any out-of-hours works or impacts on access
- Assess the area for potential contamination
- Submit Traffic Control Plan (TCP) and Road Occupancy Licence (ROL) for approval where required
- Subcontractor's crew to conduct/attend prestart induction prior to any work commencing
- TCP to be implemented on site for work in close proximity to live traffic.

Site-specific environmental controls would be implemented within each construction area along the route of the power line.

The works would generally involve the following:

- Trenching (or under-boring) and excavation of the road reserve, park area or railway corridor
- Relocation or protection of existing services
- Placement of power cables
- Horizontal Directional Drilling (HDD) or under-boring
- Backfilling trenches and reinstatement of pavement.

The works would require small amounts of localised excavation for trenching and under-boring. Where possible, excavated material would be backfilled and the pavement reinstated or re-moved from site. There would be limited surface disturbance beyond the limits of the utility trenches.

No ancillary facilities are proposed in conjunction with the proposed works. Temporary fencing would be erected around the work site during works and would be removed once works in the area were completed. For the duration of the work program, plant and equipment would be left in-situ within the road reserve each night until works are completed.

Construction of the power line would generally be carried out during standard daytime construction hours. Certain activities would need to occur out of hours, as directed by the relevant road authorities to minimise traffic impacts, or by the utilities providers to minimise disruption to services. The affected community would receive appropriate notification of the works.

The land required for the proposal is owned by Roads and Maritime or the relevant Council.

Figure 7-11 Permanent power supply line and construction route

7.4.6 Drainage and water management infrastructure

The project would require construction of new drainage infrastructure and alterations to existing drainage infrastructure (refer to **Chapter 6** (Project description) and **Chapter 18** (Surface water and flooding)). It would also require the construction of water management infrastructure, including water treatment plants for the construction and operational phases of the project (see section **7.4.5** for a description of the construction methodology for water treatment plants).

Drainage and water management infrastructure works would include construction of the following:

- A tunnel drainage system
- Operational water treatment facility at Arncliffe (MOC1)
- Temporary water treatment plants (at most construction ancillary facilities)
- Temporary flood detention basin at C3
- A new pavement drainage system at the President Avenue tunnel portals
- New surface water drains, drainage pits and pipes at the President Avenue intersection
- An operational water treatment basin adjacent to the President Avenue intersection
- New and upgraded culverts at President Avenue intersection
- Adjustment to Princes Highway stormwater infrastructure.

The operational water treatment facility at Arncliffe (MOC1) would be constructed using prefabricated components which would be assembled on site. The water treatment facility would then be connected to the incoming power supply, followed by testing and commissioning.

There would also be demolition and removal of redundant drainage infrastructure where required.

7.4.7 Road pavement works

These works would be carried out along the tunnels and surface roads following construction of the main structures. Existing road pavements would be modified to integrate with the project where required.

Where the project ties into existing roads (i.e. at the President Avenue intersection and the connection with the New M5 Motorway), pavements would be widened, reconfigured, milled and resurfaced.

7.4.8 Finishing works

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

- Line marking of new road surfaces and some existing roads
- Erection of directional and other signage and other roadside furniture such as street lighting
- Erection of toll gantries and other control systems
- Traffic signal installation and modification
- Earthworks including cutting, filling and grading to shape the finished surface level
- Landscaping and revegetation works
- Construction of pedestrian and cycle paths
- Closure and backfill of temporary access tunnels
- Site demobilisation and removal of construction ancillary facilities, and preparation of the sites for future use
- Rehabilitation of land where not required for operational use
- Reinstatement of Bicentennial Park waterway.

7.4.9 Concurrent activities

Concurrent project construction activities are likely to take place in the vicinity of President Avenue, Princes Highway and West Botany Street for a period of up to three years. These activities would include:

- Tunnelling works and spoil handling at C2
- Excavation and construction of cut-and-cover structure at C3
- President Avenue widening works at C3
- Property demolition, rehabilitation and adjustment at C6
- Relocation of utilities, stormwater infrastructure and substation at C6
- Pavement works along Princes Highway and President Avenue at C6

Concurrent construction activities are likely to result in greater noise, air quality and traffic impacts, which would be considered during the development of the detailed construction program. Such activities would be staged where possible to minimise cumulative impacts.

7.5 Utility works

Assessment of impacts to utilities identified key areas of interest within the project (see **Figure 7-12**). Existing major utilities within the areas of interest include:

- Power (Ausgrid) – high voltage transmission (33kV or greater) and substations
- Gas (Jemena) – secondary gas mains
- Potable water (Sydney Water) – mains of 300 millimetre diameter or greater
- Sewer (Sydney Water) – gravity mains of 300 millimetre or greater
- Telecommunications – multiple fibre optic cables.

It is likely that utilities affected by the project would need to be protected, relocated or realigned as part of construction of the project. This is particularly the case around areas of surface or shallow soil disturbance. The nature and extent of utility changes has been proposed, however would be confirmed during the design development of the project following consultation with the utility providers. **Table 7-4** provides an overview of the proposed treatments for major services.

Table 7-4 Indicative utility management during construction

Utility	Location	Proposed treatment
Ausgrid 132kV Feeder – Feeder 9RT and 91 ExL	President Avenue, under the current trafficable pavement.	Maintained and protected during construction.
Ausgrid 132kV Feeder – Feeder 91H/2 and 907	Intersection of President Avenue and O'Neill Street	Maintained and protected during construction.
Secondary Gas Main	President Avenue and West Botany Street intersection	Maintained and protected during construction. To be determined following consultation with Jemena.
Water Main	President Avenue	Permanent relocation to the project's services corridor.
Ausgrid 33kV Feeder	West Botany Street	The existing cables would be replaced by a standard six-way duct line after construction.
Secondary gas main	West Botany Street	Temporary relocation during construction and reinstatement during final stages of construction
Sewer Main	West Botany Street	Temporary relocation during construction and reinstatement during final stages of construction

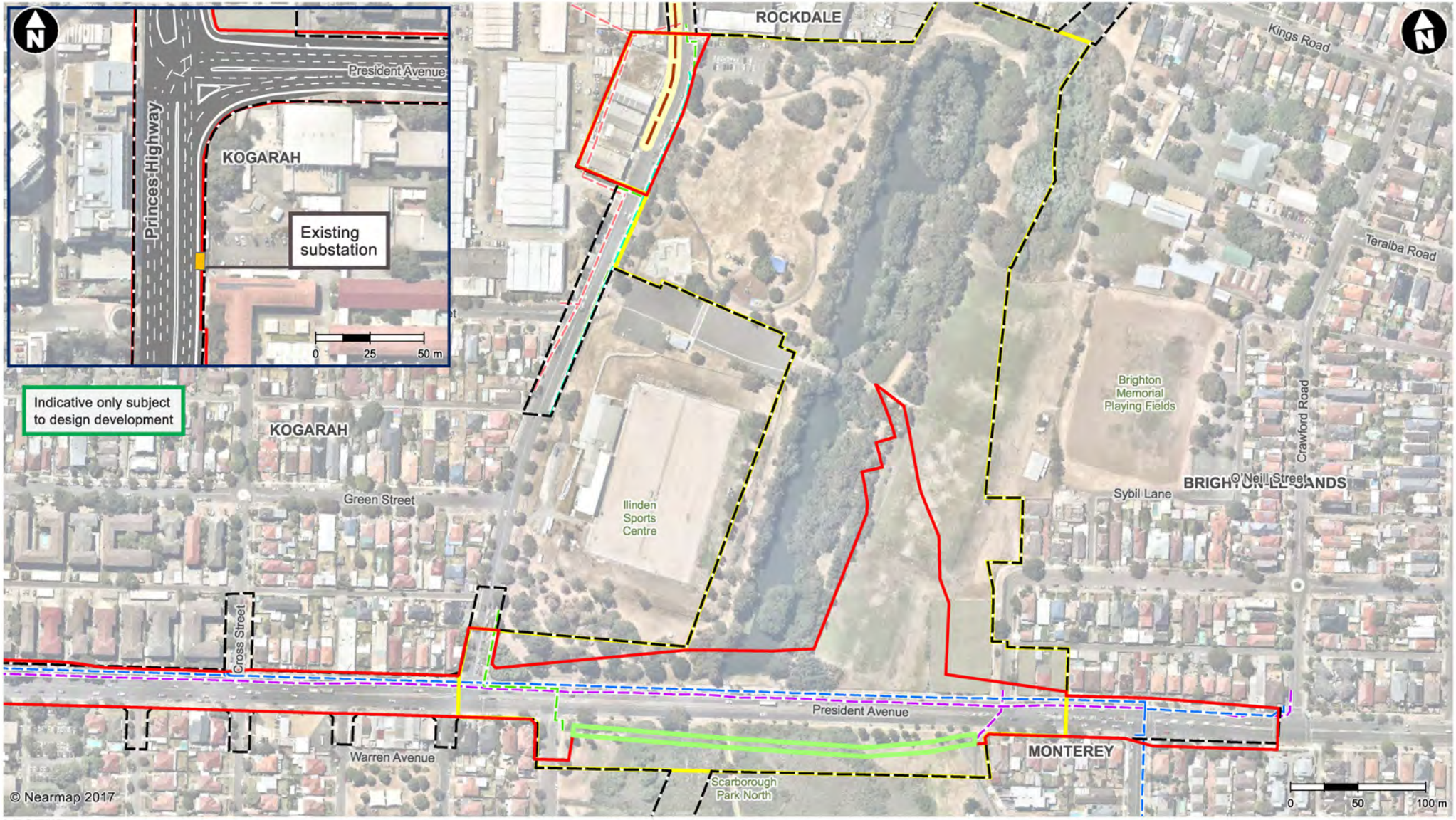


Figure 7-12 Utility area of interest

7.6 Traffic management and access

Construction of the project would be subject to careful traffic management to maintain the functionality of surrounding roads as well as the safety of members of the public, motorists and construction personnel. Generally, temporary road pavements would be constructed as early as possible within the program to separate motorists from work zones. However, phases of traffic management and traffic switches may be required at some locations to facilitate construction.

The detailed design process will determine traffic management measures to be implemented during construction. These will be documented in a Construction Traffic and Access Management Plan (CTAMP) as part of the Construction Environmental Management Plan.

7.6.1 Changes to the road network

Detailed traffic staging and the use of temporary retaining structures would allow the maintenance of existing through lanes (two eastbound and two westbound) and turn movements along President Avenue during construction. President Avenue would need to be closed to traffic for a number of nights during the erection of the President Avenue shared cycle and pedestrian bridge, to ensure safe construction.

In addition, the outer lanes of West Botany Street will need to be closed outside of peak hours during site establishment at C3, prior to construction of the cut-and-cover structures.

Other changes to the road network around President Avenue, shown on **Figure 7-13** and **Figure 7-14**, are anticipated to include:

- Temporary diversion of West Botany Street traffic lanes for the cut-and-cover structures across West Botany Street and utility relocations
- Reinstatement of original alignment of West Botany Street following construction of the cut and cover structures
- Temporary traffic signals on West Botany Street at C2 to allow safe movements of construction traffic into and out of C2
- Temporary traffic signals on West Botany Street at C3 in order to allow construction traffic to pass from the construction area for MOC3 on the eastern side to the western side of West Botany Street
- Temporary closure of access to and from President Avenue at Civic Avenue to ensure the safety of construction workers and road users during the President Avenue intersection upgrade
- Reopening of Civic Avenue to ‘left in’ and ‘left out’ turns only following the President Avenue intersection upgrade
- Permanent closure of access to and from President Avenue at Moorefield Avenue and O’Neill Street during the President Avenue intersection upgrade
- Temporary closure of the outer southbound lane of Princes Highway and outer eastbound lane of President Avenue during the Princes Highway / President Avenue intersection upgrade works. Vehicular access will be blocked during utilities relocation and pavement widening works
- Reopening of lanes at the Princes Highway / President Avenue intersection following the upgrade works
- Provision of a right turn bay and refuge bay to formalise a right turn into Lachal Avenue from President Avenue.

Parking along President Avenue would be made progressively unavailable during construction. The sign-posted speed along West Botany Street and President Avenue may be reduced for safety reasons and to facilitate traffic management during some parts of construction.

In addition, parking along West Botany Street adjacent to construction works would be unavailable during construction of the cut-and-cover structures.

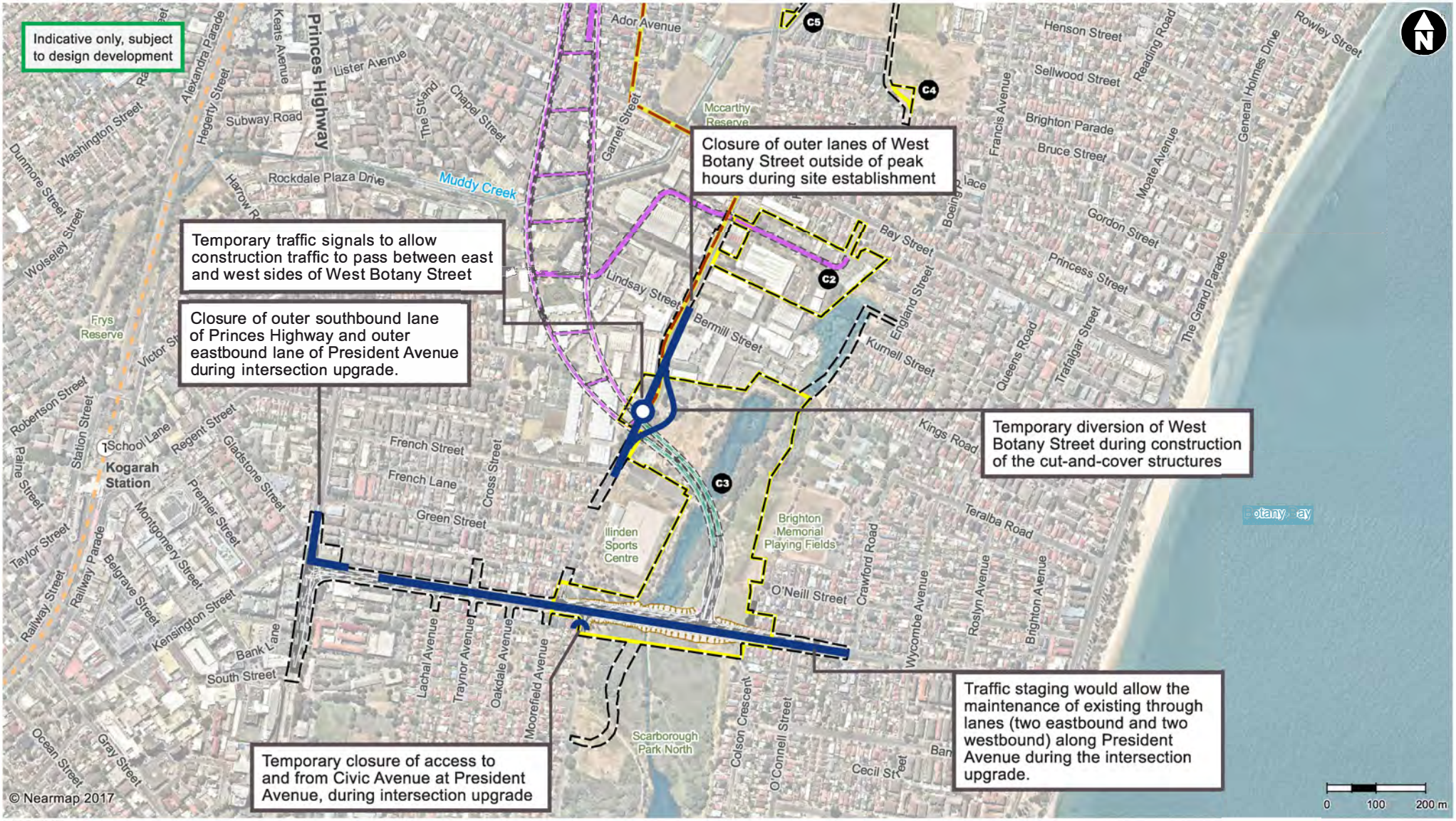


Figure 7-13 Temporary changes to the road network

LEGEND

- Surface works
- Embankment
- Construction boundary
- Underground construction
- Construction ancillary facility
- Permanent power supply line
- Permanent power supply construction boundary
- Waterbody
- Permanent road closure
- Road reopening

Figure 7-14 Permanent changes to the road network

7.6.2 Temporary changes to the active transport network

The CTAMP would also include a strategy for managing temporary changes to pedestrian and cyclist facilities including:

- Closing or detouring the pedestrian pathways along either side of President Avenue during works along President Avenue. This would occur one side at a time and diversions would be put in place.
- Temporary blocking of the walking path that circumnavigates Rockdale Bicentennial Park during construction of the cut-and-cover structure. Pedestrian movements would be diverted along the northern boundary of C3 or along West Botany Street and President Avenue to the south of C3
- Retention of the pedestrian access between West Botany Street and Kings Road with potential relocation to the northern extent of the park area
- Closure of the pedestrian bridge over Rockdale Wetlands for the duration of the construction works in the area. Pedestrians would be diverted along President Avenue

Temporary closure (one side at a time) of pedestrian pathways along either side of Princes Highway during the intersection upgrade works. Pedestrians would be diverted to the opposite side during closure of one side.

7.6.3 Temporary changes to the public transport network

Bus stops are located at the following locations within the construction boundary:

- President Avenue at O'Neill Street, Brighton-Le-Sands
- President Avenue at West Botany Street, Kogarah
- President Avenue at Traynor Avenue, Kogarah
- President Avenue at Cross Street, Kogarah
- President Avenue opposite TAFE Sydney, Kogarah
- Two stops at James Cook Boys Technology High School, Kogarah – located along the southbound side of Princes Highway.

Some lane closures would be required along President Avenue and West Botany Street outside of peak hours, and along Princes Highway for a number of weeks. These works may require the temporary relocation of some bus stops along President Avenue and Princes Highway. This would be undertaken in consultation with Transport for NSW and the bus operators and Bayside Council.

The relocation of bus stops would not impact on the operation of bus services, however it may result in some passengers having to walk a short distance further to access a temporary bus stop. For the bus stops which are required to be relocated, the distance from existing bus stops would be minimised. The same access provisions as those currently provided at these bus stops would be retained.

7.6.4 Access routes and vehicles numbers

Construction vehicles expected to access the works include:

- Light trucks and commercial vehicles (e.g. delivery vans)
- Heavy vehicles (e.g. semi-trailers, spoil trucks, concrete trucks and cranes)
- Oversize and over mass vehicles and special purpose vehicles (e.g. precast concrete beam delivery, plant on low loaders or large mobile cranes).

Oversize and over mass vehicles would predominantly access the works at night given the restrictions on movement of these vehicles during the day, and to minimise impacts on the surface road network during peak periods.

Table 7-5 summarises proposed access to the construction sites. Wherever possible, it is proposed that access be gained directly from arterial roads. The delivery of materials and/or equipment by heavy vehicles to C5 would be via local streets. **Table 7-6** sets out estimated daily construction vehicle numbers during construction. **Section 7.7.2** provides details about construction hours, including when spoil haulage would occur**.**

During detailed design, confirmation of access routes between construction sites would be confirmed and documented in the CTAMP.

The confirmation of access routes would also consider the use of a marshalling area(s) for spoil trucks to further assist in managing the arrival of vehicles to site. A marshalling area would be provided within the boundaries of C1. Additional marshalling areas may be located in a non-residential area and in close proximity to both the arterial road network and construction ancillary facilities.

The use of dedicated marshalling areas would avoid queuing and parking of heavy vehicles on local roads in the vicinity of the project. The CTAMP will confirm marshalling area(s) and provisions for their use.

Table 7-5 Indicative access routes between construction ancillary facilities

Site	Access and egress points (light and heavy vehicles)
C1	Marsh Street (existing signalised intersection) – left-in and right-in, left-out
C2	West Botany Street (temporary traffic signals) – left-in and right-in, left-out and right-out
C3	President Avenue – left-in, left-out West Botany Street (temporary traffic signals) – left-in and right-in, left-out and right-out from east and west of West Botany Street
C4	West Botany Street – left-in, left-out and right in, right out
C5	Bruce Street (temporary traffic controls) – right-in, left-out
C6	President Avenue – left-in, left-out
-	Bestic Street (temporary traffic controls) – left-in and right-in, left-out and right-out

Table 7-6 Indicative construction vehicle numbers

Location		Daily vehicles		AM peak hour				PM peak hour			
		(two-way)		(7.00–8.00 am)				(5.00–6.00 pm)			
		Heavy vehicles	Light vehicles	Heavy vehicles		Light vehicles		Heavy vehicles		Light vehicles	
				Arrive	Depart	Arrive	Depart	Arrive	Depart	Arrive	Depart
C1	Arncliffe construction ancillary facility	276	336	13	13	65	1	13	13	1	76
C2	Rockdale construction ancillary facility	274	352	12	12	47	1	11	11	1	52
C3	President Avenue construction ancillary facility.	178	642	6	6	53	1	15	15	1	114
C4	Shared cycle and pedestrian pathways construction ancillary facility	16	64	1	1	5	1	1	1	1	8
C5	Shared cycle and pedestrian pathways construction ancillary facility	26	88	1	1	7	1	2	2	1	10
C6	Princes Highway construction ancillary facility	20	176	1	1	7	1	1	1	1	25
-	Bestic Street	16	22	1	1	2	1	1	1	1	2

Notes:

Vehicle numbers include the total movements to and from the site (i.e. two way) in the time period specified. Indicative construction vehicle numbers (daily and for the AM and PM peak hour) would vary based on the final construction methodology and program.

7.6.5 Spoil haulage routes

Excess spoil that cannot be reused within the project would require off-site reuse or disposal. The project would target 95 per cent beneficial re-use of the usable portion of the spoil, in accordance with the project spoil management hierarchy.

It is anticipated that spoil would be hauled to spoil reuse and disposal sites using heavy vehicles. Spoil haulage routes to and from construction ancillary facilities have been developed (and would be confirmed during detailed design) with the following aims:

- Minimise the use of local or residential streets and maximise the use of arterial roads
- Minimise any safety implications for pedestrians, cyclists and other road users
- Avoid the need to pass through or under the Sydney CBD
- Minimise the cumulative use of roads accessing different construction sites.

It is assumed spoil haulage routes would be the same as heavy haulage routes. The majority of spoil haulage would occur during 7am – 6pm on weekdays and between 8am – 1pm on Saturday. Spoil removal would occur outside of peak periods where feasible. Some night time spoil haulage would be required.

Several potential spoil management sites have been identified which could receive spoil generated by the project. They are all located within 40 to 70 kilometres from the construction boundary. The selected sites would be determined during detailed design. Alternative haulage routes would be available for spoil trucks under 'exceptional circumstances'. These would be outlined in the CTAMP and may include:

- Queuing of heavy vehicles onsite, requiring other heavy vehicles to temporarily bypass construction ancillary facility sites to prevent queuing on public roads
- Road works or an accident/incident that prevents heavy vehicles from accessing or travelling on the designated haulage route
- A temporary hazard (e.g. an illegally parked vehicle, a lost vehicle load or floodwater) requires a heavy vehicle(s) to bypass an access gate or designated route to avoid causing damage to public and/or private property
- During temporary road closures.

Chapter 21 (Waste management) outlines the spoil strategy for the project and identifies potential spoil disposal sites.

7.6.6 Workforce parking

It is anticipated that construction workforce parking would be provided at the following sites:

- Arncliffe construction ancillary facility (C1) – around 140 car parking spaces
- Rockdale construction ancillary facility (C2) – around 50 car parking spaces
- President Avenue construction ancillary facility (C3) – around 150 car parking spaces
- Shared cycle and pedestrian pathways construction ancillary facilities (C4/C5) – around 10 parking spaces at each
- Princes Highway construction ancillary facility (C6) – around 25 car parking spaces.

These facilities would be used to provide worker parking and shuttle bus transfers to other nearby construction sites. The numbers of construction personnel requiring parking would vary over the duration of the construction program.

The CTAMP will include a car parking strategy which will detail measures to manage parking impacts in adjacent streets. It would also identify areas where there are high levels of existing parking demand around the construction ancillary facilities and works sites as well as alternative car parking sites for use by the construction workforce.

7.7 Construction workforce numbers and work hours

7.7.1 Construction workforce

The indicative peak construction workforce at each site is detailed in **Table 7-7**. The construction workforce would comprise trades and construction personnel, subcontractor construction personnel and engineering, functional and administrative staff. The size of the workforce would vary across the working day with a reduction in personnel for night shifts. The total daily peak workforce is around 270 personnel.

Table 7-7 Peak construction workforce estimates

Site	Approximate day shift peak construction workforce[1]	Approximate night shift peak construction workforce[2]
C1	65	35
C2	94	55
C3	114	11
C4	10	1
C5	12	1
C6	30	25
Total	273	101

[1] Assuming a typical day / night approximately 6 – 12 months into construction
[2]The workforce comprises construction management personnel, supervision staff, plant operators, inspection personnel (Contractors/Roads and Maritime) and support (e.g. cleaners, security).

7.7.2 Construction hours

Identification of construction hours has taken into account the key objectives of reducing the length of construction and minimising all noise- and traffic-related impacts.

Table 7-8 provides a summary of the proposed construction work hours at each construction ancillary facility and at others areas within the construction boundary.

Works outside of standard construction hours

Other activities that would be carried out outside of standard daytime construction hours include:

- Work determined to comply with the relevant noise management level at the nearest sensitive receptor
- The occasional delivery of materials on oversized vehicles outside approved hours as required by the NSW Police or other authorities (including Roads and Maritime) for safety reasons
- Construction activities that cannot be interrupted and also cannot be completed within daytime hours, including:
  - Completion of diaphragm walls or concrete pouring
  - Some utilities relocation or protection works
- Emergency responses to avoid injury, the loss of life, damage to property and/or to prevent environmental harm
- Activities requiring the temporary possession of roads or to complete traffic switches may need to be carried out outside the standard daytime construction hours during periods of low traffic volumes, to minimise safety impacts and inconvenience to road users, including work along President Avenue and Princes Highway
- Activities agreed with potentially affected receptors.

With the exception of emergencies, activities would not take place outside standard daytime construction hours without prior notification to potentially affected receptors.

Table 7-8 Typical construction work hours

Work hours	Activity	Site or construction area
24 hours a day, up to seven days a week	• Tunnelling and spoil handling within construction sites • Underground construction and tunnel mechanical and electrical fitout • Occasional delivery of oversize plant • Spoil removal and haulage	C1, C2 and C3 Underground, in-tunnel
7.00 am to 6.00 pm on weekdays, 8.00 am to 1.00 pm on Saturdays No works on Sundays or public holidays (Standard construction working hours)	• Demolition and surface works and structures • Construction of permanent operational infrastructure • Cut-and-cover construction • Mechanical and electrical fitout of operational buildings.	C1, C2, C3, C4, C5 and C6
Any time	Minor activities or non-disruptive preparatory work, repairs or maintenance may be carried out outside standard daytime construction hours, where the activities do not lead to an exceedance of the applicable noise management level at an affected receptor.	Within the construction boundary
Between 9.00 am and 5.00 pm, Mondays to Fridays and 9.00 am to 1.00 pm on Saturdays.	Controlled blasting underground and rock breaking. Blasts would be limited to one single detonation in any one day per receptor group, unless otherwise agreed by the Secretary or the NSW Environment Protection Authority (EPA). Respite periods would be scheduled to minimise the frequency and duration of extended rock breaking activities with potential for impulsive or tonal noise emissions.	Underground construction of the mainline tunnels
As specified in an Environmental Protection Licence (e.g. out of hours)	Activities authorised by an Environment Protection Licence. For example, blasting and rock breaking and other high impact noise activities could also occur outside of standard day time construction hours, if authorised by an Environmental Protection Licence.	Within the construction boundary
At any time	Emergency or directed activities, such as: • Activities as directed by a relevant authority • Activities if required to prevent an imminent loss of life or environmental damage.	Within the construction boundary

7.7.3 Construction noise attenuation

Temporary noise attenuation at construction ancillary facilities may include:

- Temporary acoustic barriers along the boundaries of construction ancillary facilities at locations that face sensitive receptors
- Acoustic sheds around temporary access tunnels and associated above ground spoil handling areas where out-of-hours works would be undertaken near sensitive receptors, including:
  - Arncliffe construction ancillary facility (C1)
  - Rockdale construction ancillary facility (C2).

In addition, spoil stockpiling and management would occur within the President Avenue construction ancillary facility (C3).

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