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SYDENHAM TO BANKSTOWN

ENVIRONMENTAL IMPACT STATEMENT

> Volume 1B – Main Volume

NSW GOVERNMENT

Transport for NSW

Sydney Metro City & Southwest

Sydenham to Bankstown upgrade

Environmental Impact Statement

Volume 1B – Parts C and D

Volume 1B

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10. Construction traffic, transport and access

This chapter provides a summary of the results of the traffic, transport and access assessment as it relates to construction impacts. A full copy of the assessment report is provided as Technical paper 1 – Traffic, transport and access assessment.

The Secretary's environmental assessment requirements relevant to construction traffic, transport and access, together with a reference to where the relevant results are summarised in this chapter and in the Environmental Impact Statement, is provided in Table 10.1.

Table 10.1 Secretary's environmental assessment requirements – construction traffic, transport and access

Ref	Secretary's environmental assessment requirements – construction traffic, transport and access	Where addressed
13.1	The Proponent must assess construction transport and traffic (vehicle, pedestrian and cyclists) impacts, including, but not necessarily limited to:	A summary of the results of the construction traffic, transport and access assessment is provided in this chapter. The full results are provided in Technical paper 1.
	(a) a considered approach to route identification and scheduling of transport movements;	Sections 9.7.4 and 9.8.8
	(b) the number, frequency and size of construction related vehicles (passenger, commercial and heavy vehicles, including spoil management movements);	Sections 9.8.9
	(c) *blank*	n/a
.	(d) the need to upgrade roads proposed for construction vehicle routes including impacts of road closures, construction worker parking and impacts on availability of public parking;	Section 10.3.3
	(e) the nature of existing traffic (types and number of movements) on construction access routes (including consideration of peak traffic times and sensitive road users and parking arrangements);	Section 10.2.2
	(f) information on how construction and scheduling of works will be coordinated in regard to cumulative traffic impacts resulting from concurrent work on WestConnex and other approved key construction projects;	Section 10.4.8
	(g) access constraints and impacts on public transport, pedestrians and cyclists including:	
	• impacts on customers and the reliability of suburban and intercity rail services (including increased demand for rail services on other lines, particularly the T2 Inner West, T1 North Shore, Northern and Western Lines) during possession periods and testing and commissioning of metro trains	Section 10.4.5
	• alternative transport arrangements for customers during rail possessions and closure of the rail line (including how the Temporary Transport Plan will be developed in consultation with relevant Councils and the community); and	Sections 9.11 and 10.3.4 (details of the temporary transport strategy and development of temporary transport management plans)
	• identification of key traffic performance issues in the surrounding areas during rail shutdowns and implementation of alternate transport arrangements	Sections 10.4.2 and 10.4.5

Ref	Secretary's environmental assessment requirements – construction traffic, transport and access	Where addressed
	(h) the need to close, divert or otherwise reconfigure elements of the road and cycle network associated with construction of the project.	Sections 10.3.3 (details of the proposed changes) and Section 10.4.3 (impacts of changes).

10.1 Assessment approach

A summary of the approach to the construction traffic, transport and access impact assessment is provided in this section. Further information is provided in Technical paper 1.

10.1.1 Policy context to the assessment

The *Traffic Modelling Guidelines* (Roads and Maritime Services, 2013) were developed to provide consistency in traffic modelling practice, and promote high quality model outputs. The traffic (intersection) modelling carried out for the traffic, transport and access assessment aligns with the *Traffic Modelling Guidelines,* by including the following broad steps:

- selection of computer software models (LinSig or SIDRA) used for similar projects for similar intersection modelling purposes
- calibrate and validate models under existing (2016) conditions using current traffic data
- application of anticipated construction traffic demands to identify potential impacts
- develop mitigation measures as considered necessary.

10.1.2 Methodology

Overview

The construction traffic, transport and access assessment involved:

- general site observations, including lane and intersection configurations, queue lengths, posted speed limits, footpath conditions, lane usage, bottlenecks and pinch points, and the location of parking, bus stops, and other road and roadside infrastructure
- gathering relevant data, including:
  - traffic volume counts
  - Sydney Coordinated Adaptive Traffic System (SCATS) volume and traffic signal data
  - surveys of on-street and off-street parking undertaken between April and December 2016
- analysing future traffic conditions, including likely road changes and growth in traffic volumes
- modelling future road network performance both with and without the proposed construction works
- assessing the potential impacts of construction on road network performance, active transport, public transport, access, and parking
- assessing the potential impacts of implementing the proposed alternative transport arrangements, including the impacts of rail replacement buses
- analysing the physical constraints for construction (heavy) vehicle access to construction compounds
- assessing potential cumulative impacts
- developing mitigation measures and strategies, including for the worst affected intersections.

Further information on the key tasks undertaken is provided below. A detailed description of the methodology is provided in Technical paper 1.

Road network assessment

Modelling of intersection performance was undertaken with consideration of the *Traffic Modelling Guidelines.* Traffic modelling software (SIDRA and/or LinSig) was used to assess intersection capacity and identify potential construction impacts. The following scenarios were modelled:

- 2016 (existing) conditions, based on traffic volume data (for calibration purposes)
- 2023 (future) conditions, including the estimated natural traffic growth rate
- 2023 (future) conditions, with traffic generated by construction vehicles and rail replacement bus operations at station and corridor work sites
- 2023 (future) conditions, with traffic generated by construction vehicles during bridge works, including indicative traffic diversion routes.

The assessment was undertaken:

- for key intersections in the vicinity of compounds and work sites
- along the preliminary construction truck haulage routes, and based on the estimated construction traffic volumes described in Section 9.8
- along the potential routes for rail replacement buses identified for the refined temporary transport management plan (described in Section 10.3.4)
- along the indicative diversion routes during bridge closures, as summarised in Table 10.36 and described in Chapter 6 of Technical paper 1.

Modelling was undertaken with consideration of the impacts likely to be experienced during a typical weekday morning and afternoon peak period, consistent with the approach used for other major infrastructure projects. These peak traffic periods represent a time when the road network typically experiences its maximum demand, and the available spare capacity is at its most limited. However, it is acknowledged that in some locations, Saturday peaks are also high relative to weekday peaks. Where this is likely to occur, specific measures in the construction traffic management plan (described in Section 10.5.1) would be implemented to minimise potential impacts.

The intersection assessments that include consideration of rail replacement buses are also considered to be conservative when applied during the weekday peak period. As described in Section 9.7.3, the rail replacement bus services would typically operate during periods of lower transport infrastructure demand (weekends and school holidays).

The following indicators were used to assess intersection performance:

- Level of service (LoS) – a measure of the overall performance of the intersection. This includes the average delay likely to be experienced by a vehicle waiting at an intersection (the criteria used are listed in Table 10.2).
- Degree of saturation (DoS) – the ratio between traffic volumes and capacity of the intersection, which indicates how close to capacity an intersection is operating (with a number below 1.0 typically targeted).

Table 10.2 Level of service criteria

Level of service	Average delay (seconds)	Traffic signals and roundabouts
A	Less than 14	Good operation
B	15 to 28	Good with acceptable delays and spare capacity
C	29 to 42	Satisfactory
D	43 to 56	Operating near capacity
E	57 to 70	At capacity, incidents will cause excessive delays at signals
F	>70	Signals exceed capacity, roundabouts require other control mode

Bridge works

An assessment of intersection performance along routes that may be used for diverted traffic during partial or full bridge closures was undertaken. The proposed closure configuration, indicative closure durations, and preliminary diversion routes are outlined in Table 10.36. Consistent with the assessment for station and corridor works, the assessment of the impacts along diversion routes was undertaken for a typical weekday morning and evening peak period, based on the traffic generated by construction vehicles.

Access constraints for construction vehicles

A swept-path analysis was undertaken for the preliminary construction vehicle haulage routes, using both 8.8 and 12.5 metre long design vehicles (trucks). This type of analysis identifies possible obstructions to the vehicle performing the manoeuvre safely, and may indicate where road adjustments, such as lane widening, kerb or median adjustments, restrictions and/or removal of parking are required.

Alternative transport arrangements

The alternative transport arrangements proposed to be used during possession periods and station closures are described in Section 9.11. As described in this section, the Temporary Transport Strategy (provided in Appendix G) outlines:

- the process for planning the integrated, multi-modal transport network changes required during possessions of the T3 Bankstown Line to enable construction
- a number of components for alternative public transport arrangements by rail and bus during construction (including rail replacement buses), to minimise impacts to customers during station closures and/or possession periods
- the process for preparing and implementing a temporary transport management plan for each possession period/closure.

A ‘baseline’ temporary transport plan was developed and assessed. This consisted of replacing the peak capacity of the existing rail service with buses, similar to what currently occurs during weekend maintenance possessions by Sydney Trains. As a result of the much larger volume of passengers required to be moved during the weekday peak period, and the large number in buses required, the assessment identified there would potentially be extensive impacts on the road network, as well as to rail customers. A ‘refined baseline’ temporary transport plan was subsequently developed and assessed. This refined baseline plan included conveying passengers west of Campsie Station to other rail lines, to reduce the potential traffic and other impacts at Dulwich Hill, Marrickville and Sydenham stations as identified in the baseline plan. The refined baseline plan is assessed in this chapter.

10.2 Existing environment

A summary of the key features of the regional transport network is provided in Section 10.2.1. A description of local features within and in the vicinity of the project area is provided in Section 10.2.2.

10.2.1 Regional transport context

Active transport

Pedestrian networks

Sydney's Walking Future (Transport for NSW, 2013) identifies that the majority of south and south-western Sydney has a walking mode share of greater than 17 per cent. In general, areas surrounding rail stations that have a higher density of residential development and larger retail/commercial centres (mainly around Marrickville, Canterbury, Campsie, and Bankstown stations) have a higher volume of pedestrians.

The pedestrian network consists of footpaths and dedicated road crossings. A number of un-signalised pedestrian crossing facilities are provided throughout the footpath/road network. Dedicated road crossings also help manage and prioritise conflicting movements and improve safety and accessibility.

Pedestrians can generally move freely on local footpaths and dedicated road crossings, but may experience reduced permeability within centres such as Bankstown due to large street blocks, major roads, and the rail corridor. The areas surrounding these centres generally have a high volume of pedestrians accessing interchanges and commercial precincts.

With the exception of the medium density and commercial/industrial land uses in Canterbury, Campsie, and Bankstown, the rest of the study area generally includes lower density residential areas, generating low pedestrian volumes adjacent to and between the stations.

Cycle networks

The cycle network in the study area is developing from a series of individual on and off road facilities, towards a cohesive network, to support the varied needs of people cycling for leisure and/or commuting. In the vicinity of the project area, the cycle network provides regional and local connections to surrounding transport hubs and residential, commercial, and educational precincts. The majority of local cycling connections are on-road mixed environments or pathways through recreation areas/parks.

Typically, regional cycling routes close to the project area are off-road and shared with pedestrians and include:

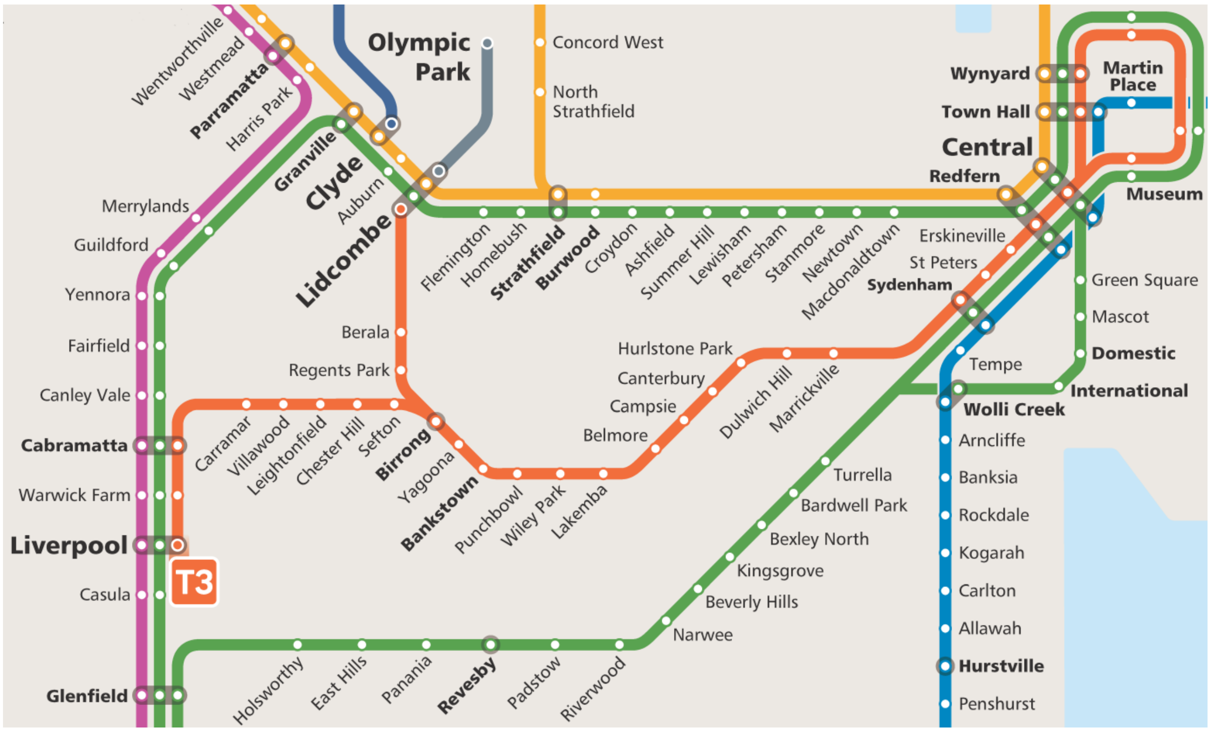
- the Greenway Cycleway, which connects Dulwich Hill to Lewisham
- the Cooks River cycle route, which connects Campsie, Canterbury and Tempe
- Salt Pan Creek cycle route, which connects Bankstown to Georges Hall.

Whilst existing facilities offer some amenity and connectivity to wider transport networks, there are several aspects contributing to a relatively low uptake in cycling. These include restricted bike parking at some locations, and limited capacity of existing cycle facilities.

Public transport

Suburban rail network

The Sydney Trains network, including the T3 Bankstown Line, is shown in Figure 10.1. The T3 Bankstown Line connects Liverpool and Lidcombe to the west, and stations within the project area, to the Sydney CBD (City Circle) via Sydenham Station. West of Bankstown, the line travels through Yagoona and Birrong stations. At Birrong, about half of the T3 Bankstown Line trains continue north to Lidcombe (via Regents Park and Berala stations). The other half travel west to Liverpool (via Sefton, Chester Hill, Leightonfield, Villawood, Carramar, Cabramatta, and Warwick Farm stations). The T2 Airport, Inner West & South Line and the T4 Eastern Suburbs & Illawarra Line also pass through Sydenham Station to the east of the project area.



Note: This figure shows the network map as at July 2017. As part of the NSW Government's More Trains, More Services program, a refreshed rail network map is in the process of being implemented. Line names used in this Environmental Impact Statement reflect the existing naming conventions.

Figure 10.1 Sydney Trains network

Bus networks

Buses in Sydney provide local connections to key transport interchanges and other services, as well as regional public transport services. The key bus routes operating south of the Sydney CBD include those operating along the Princes Highway and King Street. Cross-regional services also operate between Marrickville and Bondi Junction.

The majority of bus routes traverse the project area in a north–south direction, with services providing connections to stations, town centres, and surrounding areas. Connections between bus services and trains are focused at key transport interchanges located at Bankstown and Campsie stations. Buses using interchanges at these stations provide services to other regional centres, including Parramatta, Hurstville, Sutherland, and Macquarie Park. Services using these interchanges are frequent during peak hours.

Light rail

The L1 Dulwich Hill light rail line terminates near the project area at the Dulwich Hill light rail stop, located about 130 metres to the north-west of the Dulwich Hill Station entrance. The line provides services to the Sydney CBD, via the Inner West and Pyrmont.

Freight services

The Sydney Metropolitan Freight Network consists of dedicated freight railway lines that run through a complex metropolitan rail network and link interstate freight rail lines to Sydney's freight facilities located at Enfield and Port Botany. The network extends from Lidcombe/North Strathfield in the north, to Macarthur in the south-west (via the Southern Sydney Freight Line), and Port Botany in the south-east and is managed by ARTC.

A portion of the Metropolitan Freight Network that runs between Port Botany and Enfield is located within the project area. As shown in Figure 10.2, the freight rail line is located on the northern side of the T3 Bankstown Line from east of Marrickville Station to about 700 metres west of Campsie Station. West of Campsie, the freight line turns north towards the Enfield Intermodal Terminal. At Marrickville, the freight line turns south towards Port Botany.

Regional road network

Key roads south of the Sydney CBD include the Eastern Distributor (providing a connection to the M5 Motorway), King Street, the Princes Highway, and Regent Street.

The road network around the project area is shown in Figure 10.2. The South Western Motorway (M5) and the M5 East Motorway alignments run roughly parallel to the project area, and are located around two to three kilometres to the south. The project corridor is also intersected by Stacey Street (part of the A6), and King Georges Road (part of the A3), which are arterial roads that run north–south and provide access to both the M4 and M5.

Other key strategic road corridors situated near to the project corridor include:

- Princes Highway (the A36) and the M1 Southern Cross Drive, located to the east and south-east of Sydenham Station
- Hume Highway (the A22), located about one kilometre north of Bankstown Station
- the proposed WestConnex Motorway and St Peters interchange, located to the south and east of the project area.

10.2.2 Local transport facilities

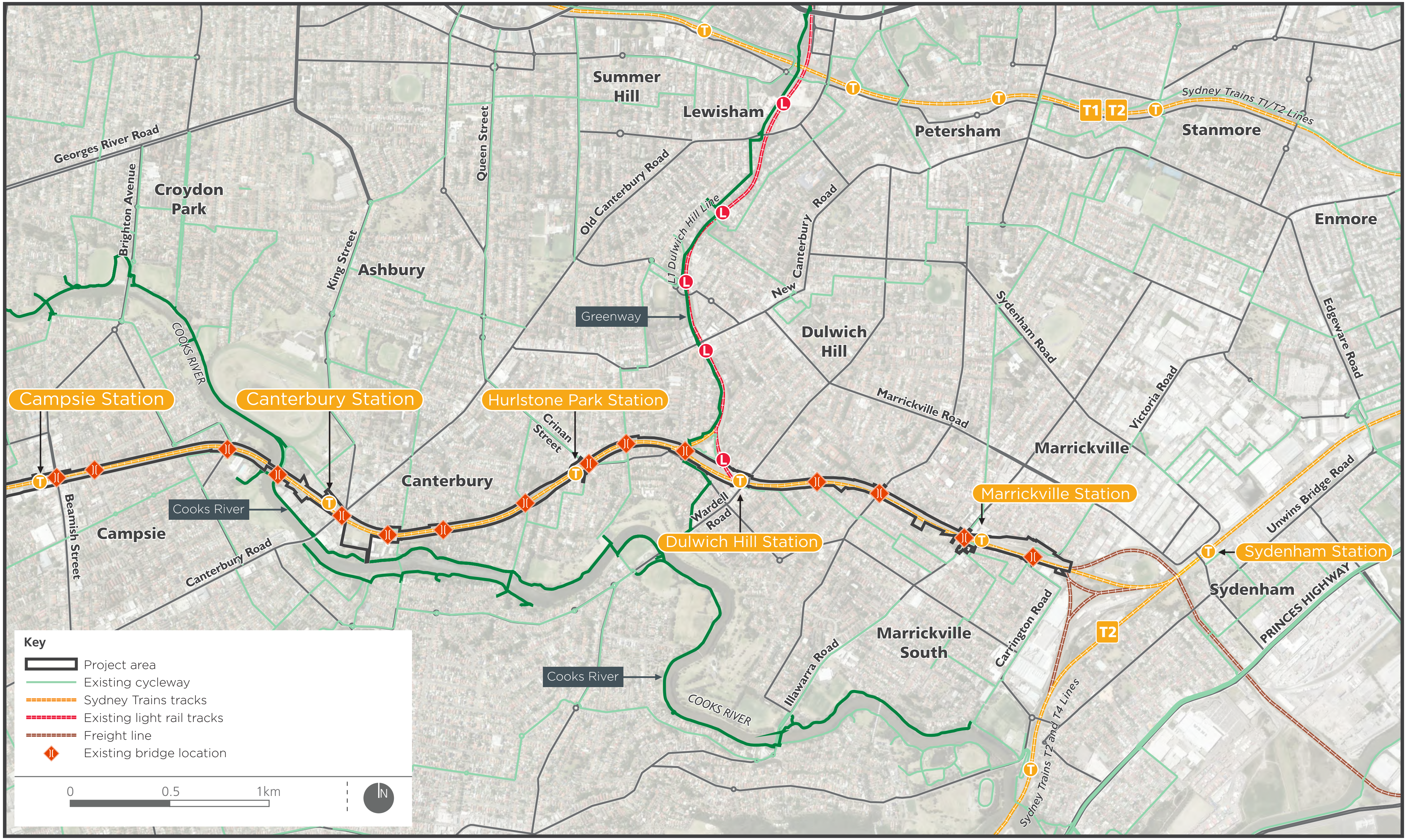
A summary of the key features of the local transport environment at each station is provided below. Further details of the local transport facilities are provided in Technical paper 1.

Marrickville Station

Existing transport facilities at Marrickville Station are shown on Figure 10.3 and summarised in Table 10.3. Further information is provided following the table.

Table 10.3 Transport facilities at Marrickville Station

Main mode of travel to station (% of total trips)	Number of bike parking spaces	Number of bus services in vicinity of station	Number of kiss and ride spaces	Number of taxi bays
Walking (86%)	8	2	3	1



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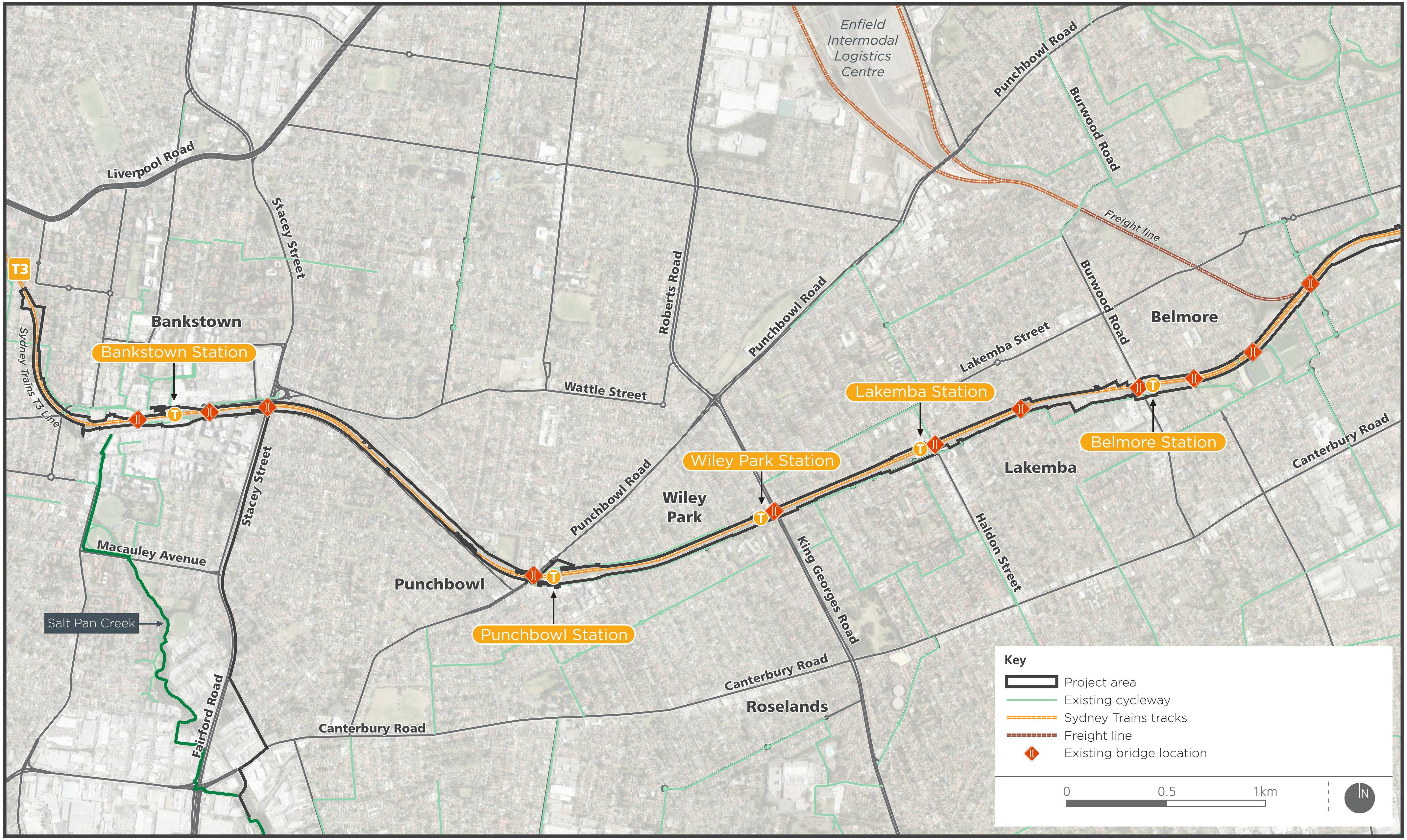
Road network and transport facilities - map 1

FIGURE 10.2



Sydney Metro city & southwest

Road network and transport facilities - map 2

FIGURE 10.2

Active transport

As shown in Table 10.3, the main mode of travel to Marrickville Station is walking (86 per cent). The walking catchment in the vicinity of the station is relatively good due to the existence of primary roads and a few perpendicular secondary streets within a predominantly residential area. Footpaths are also located on both sides of the roads.

The Cooks River Cycleway runs to the south of Marrickville Station. This cycleway is a key part of the regional cycle network. There are also a number of roads surrounding the station which have on-road cycle lanes/road shoulders/mixed traffic lanes. This includes the route on Illawarra Road, which is part of the regional cycle network and connects to Marrickville Station.

Eight bike parking spaces are provided at the station on the southern corner of Arthur Street and on the western side of Station Street.

Public transport

Existing daily rail travel volumes at Marrickville Station in 2016 were 4,594 entries and 4,356 exits. As shown on Figure 10.3, the station is also serviced by two bus routes along Illawarra Road, travelling to and from the station. These routes connect with the Sydney CBD. The services stop at two bus stops, located on Illawarra Road near the station.

Parking

As shown in Table 10.4, there are about 1,500 on-street parking spaces within 400 metres of the station, and no untimed, dedicated commuter spaces. Demand for unrestricted on-street parking is relatively high (represented by the utilisation rate of 81 per cent) as a result of the competing requirements of residents close to the station, and commuters and visitors to the area.

As shown in Table 10.3, there are three kiss and ride spaces and one taxi bay at Marrickville Station.

Table 10.4 Parking facilities at Marrickville Station

On-street spaces		Off-street spaces	
Number[1]	Overall utilisation[2]	Number[1]	Overall utilisation (%)
1,519 (1,257 unrestricted)	81%	0	n/a

Note: 1. Within 400 metres of the station.
2. Verified during parking surveys undertaken after the morning peak in October 2016 on two typical weekdays. Follow-up verification surveys undertaken in November 2016.

Road network

The main road in the vicinity of Marrickville Station is Illawarra Road, which is a regional road that travels in a roughly north–south direction immediately to the west of the station. The following State and regional roads are located in the area surrounding the station:

- State roads: Sydenham Road
- Regional roads: Illawarra Road (south of Marrickville Road), Marrickville Road (east and west of Illawarra Road).

Local roads surrounding the station are shown on Figure 10.3. Table 10.5 shows the existing weekday traffic volumes (24 hour and one-hour morning and afternoon peaks) for key roads in the vicinity of the station.

Table 10.5 Existing weekday traffic volumes – Marrickville Station

Road	24 hr (daily) volumes				1 hr (peak) volumes	
	Total count	Light	Heavy	Proportion of heavy vehicles (%)	Morning	Afternoon
Richardson Crescent	18,592	17,384	1,208	6	1,538	1,496
Illawarra Road (between Marrickville Road and Calvert Street)	11,967	11,141	826	7	990	963
Marrickville Road (between Illawarra Road and Silver Street)	16,171	14,098	2,073	13	1,338	1,301
Victoria Road (between Marrickville Road and Fernbank Street)	7,828	7,363	466	6	648	630
Warren Road (between Illawarra Road and Moyes Street)	11,039	9,625	1,414	13	913	888

Figure 10.3 Existing transport facilities at Marrickville Station

Dulwich Hill Station

Existing transport facilities at Dulwich Hill Station are shown on Figure 10.4 and summarised in Table 10.6. Further information is provided following the table.

Table 10.6 Transport facilities at Dulwich Hill Station

Main mode of travel to station (% of total trips)	Number of bike parking spaces	Number of bus services in vicinity of station	Number of kiss and ride spaces	Number of taxi bays
Walking (76%)	20	1	3	0

Active transport

As shown in Table 10.6, the main mode of travel to Dulwich Hill Station is walking (76 per cent). The walking catchment in the vicinity of the station is relatively good, and footpaths are located on both sides of the roads. However, movements are constrained by the rail corridor and the light rail line. Low vehicle speeds and relatively narrow carriageways along Wardell Road make it attractive for pedestrians.

The Cooks River Cycleway runs to the south of Dulwich Hill Station. This cycleway is a key part of the regional cycle network.

Both Albermarle Street and School Parade (parallel to the rail corridor) have on road bike lanes/road shoulders/mixed traffic lanes suitable for riders of varying experience and confidence.

There are 20 bike parking spaces at Dulwich Hill Station, located on the southern side of Bedford Crescent and the northern side of Wardell Road.

Public transport

Existing daily rail travel volumes at Dulwich Hill Station observed in 2016 were 2,706 entries and 2,464 exits. As shown on Figure 10.4, the station is serviced by one bus route that stops on either side of Dudley Street to the east of the station. This route travels to the Sydney CBD.

Parking

As shown in Table 10.7, there are about 1,300 on and off-street parking spaces within 400 metres of the station, including 55 dedicated commuter spaces in Ewart Lane. The demand for the spaces is relatively high, with an existing utilisation rate of 74 per cent for on-street parking spaces, and 100 per cent for commuter spaces.

Figure 10.4 shows the existing kiss and ride facilities (three spaces) located in Bedford Crescent to the north of the station. There are no taxi bays at the station.

Table 10.7 Parking facilities at Dulwich Hill Station

On-street spaces		Off-street spaces	
Number[1]	Overall utilisation[2]	Number[1]	Overall utilisation
1,275 (1,202 unrestricted)	74%	57 (includes 55 dedicated commuter parking spaces)	100%

Note: 1. Within 400 metres of the station
2. After the morning peak in October 2016 on two typical weekdays. Follow-up verification surveys undertaken in November 2016

Road network

The main road in the vicinity of Dulwich Hill Station is Wardell Road, which is a regional road that travels in a north–south direction immediately to the east of the station. The following State and regional roads are located in the area surrounding the station:

- State roads: New Canterbury Road
- Regional roads: Marrickville Road and Wardell Road.

Local roads surrounding the station are shown on Figure 10.4. Table 10.8 shows the existing weekday traffic volumes (24 hour and one-hour morning and afternoon peaks) for key roads in the vicinity of the station.

Table 10.8 Existing weekday traffic volumes – Dulwich Hill Station

Road	24 hr (daily) volumes				1 hr (peak) volumes	
	Total count	Light	Heavy	Proportion of heavy vehicles (%)	Morning	Afternoon
Bayley Street (between Ewart Street and Dudley Street)	781	662	119	15	59	97
Ewart Street (between Bayley Street and Wicks Avenue)	7,491	7,123	367	5	566	607
Livingstone Rd (between Warren Road and Jersey Street)	12,117	11,754	363	3	916	982
Wardell Road (between Marrickville Road and Pine Street)	14,377	14,005	372	3	1,086	1,165
Marrickville Road (between Darley Street and Wardell Road)	12,595	11,224	1,371	11	952	1,020
Terrace Road (between New Canterbury Road and Consett Street)	1,310	1,297	13	1	99	176
New Canterbury Road (between Kintore Street and Terrace Road)	28,846	27,813	1,033	4	2,180	2,337

Figure 10.4 Existing transport facilities at Dulwich Hill Station

Hurlstone Park Station

Existing transport facilities at Hurlstone Park Station are shown on Figure 10.5 and summarised in Table 10.9. Further information is provided following the table.

Table 10.9 Transport facilities at Hurlstone Park Station

Main mode of travel to station (% of total trips)	Number of bike parking spaces	Number of bus services in vicinity of station	Number of kiss and ride spaces	Number of taxi bays
Walking (81%)	12	2	0	0

Active transport

As shown in Table 10.9, the main mode of travel to Hurlstone Park Station is walking (81 per cent). The walking catchment in the vicinity of the station is relatively good, with radiating and intersecting roads, and narrow carriageways and low vehicle speeds in the town centre.

Hurlstone Park has good on-road cycle routes connecting cyclists to the station from Canterbury Road in the north-west, Floss Street in the east, and Foord Avenue in the south, A section of the Floss Street cycle route (between Garnet and Duntroon streets) connects to the Cooks River Cycleway, which runs along the southern boundary of the station area.

Twelve bike parking spaces are provided on Crinan Street outside the station entrance.

Public transport

Existing daily rail travel volumes at Hurlstone Park Station observed in 2016 were 1,532 entries and 1,312 exits.

As shown on Figure 10.5, the station is serviced by two bus routes. Stops for these routes are provided on either side of Crinan Street, near the station.

Parking

As shown in Table 10.10, there are about 1,200 on and off-street parking spaces within 400 metres of the station. There is moderate demand for on-street spaces (utilisation of 54 per cent) and high demand for commuter spaces (utilisation of 100 per cent).

There are no kiss and ride spaces or taxi bays at the station.

Table 10.10 Parking facilities at Hurlstone Park Station

On-street spaces		Off-street spaces	
Number[1]	Overall utilisation[2]	Number[1]	Overall utilisation
1,185 (1,135 unrestricted)	54%	23 (dedicated commuter parking spaces)	100%

Notes: 1. Within 400 metres of the station.
2. After the morning peak in October 2016 on two typical weekdays. Follow-up verification surveys undertaken in November 2016.

Road network

The road network at Hurlstone Park Station is focused around Crinan and Duntroon streets, which converge on the northern side of the rail corridor. Two State roads are located in the area surrounding the station – Canterbury Road and New Canterbury Road.

Local roads surrounding the station are shown on Figure 10.5. Table 10.11 shows existing weekday traffic volumes (24 hour and one-hour morning and afternoon peaks) for key roads in the vicinity of the station.

Table 10.11 Existing weekday traffic volumes – Hurlstone Park Station

Road	24 hr (daily) volumes				1 hr (peak) volumes	
	Total count	Light	Heavy	Proportion of heavy vehicles (%)	Morning	Afternoon
Duntroon Street	1,959	1,892	66	3	148	177
New Canterbury Road (between Wattle Lane and Old Canterbury Road)	25,040	23,976	1,064	4	1,892	2,028
Crinan Street (between Floss Street and Fernhil Street)	8,514	7,845	669	8	643	690
Canterbury Road (between Queen Street and Wattle Lane)	25,477	23,542	1,935	8	1,925	2,064
Canterbury Road (between Queen Street and Princess Street)	29,769	27,593	2,176	7	2,250	2,411

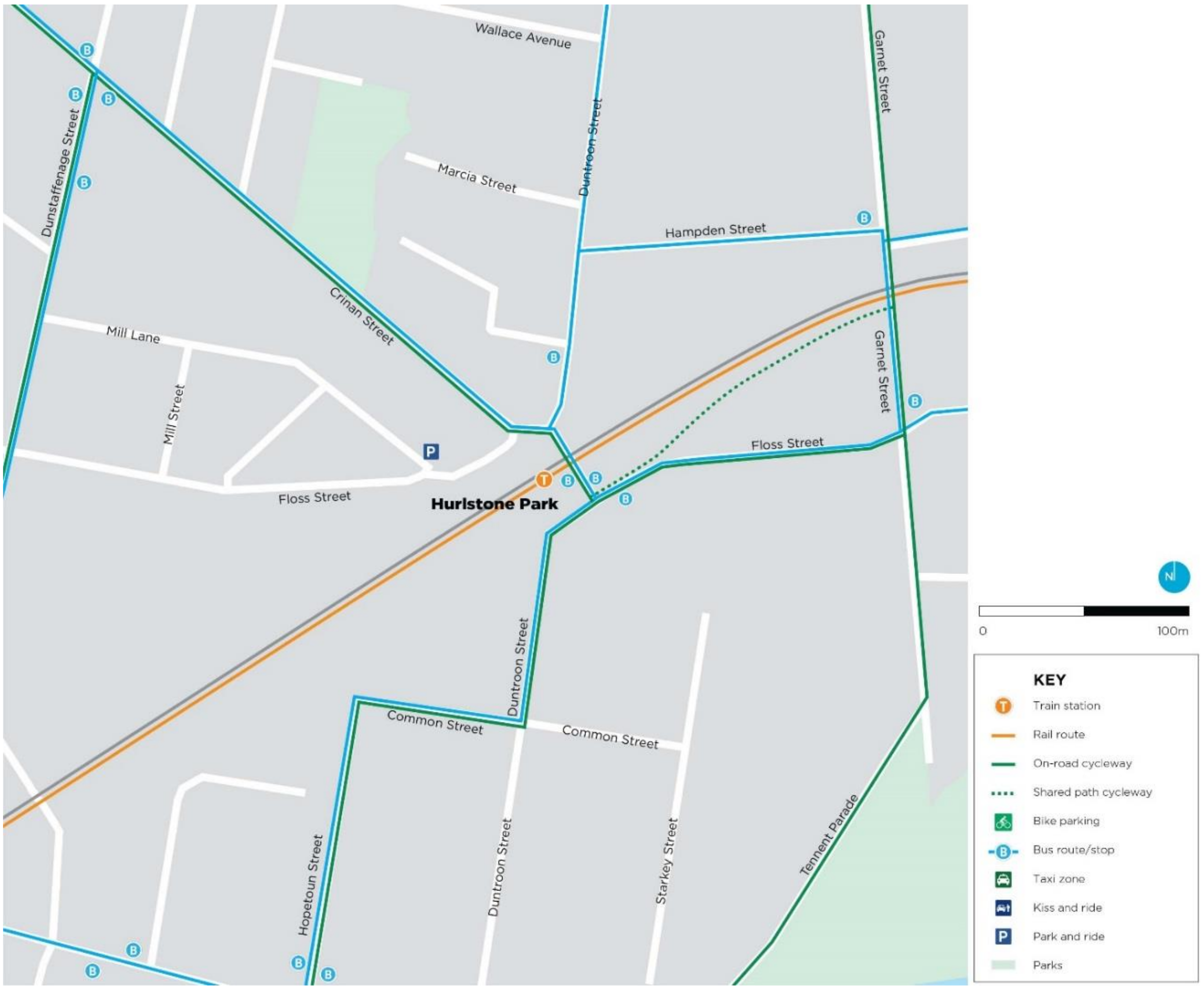


Figure 10.5 Existing transport facilities at Hurlstone Park Station

Canterbury Station

Existing transport facilities at Canterbury Station are shown on Figure 10.6 and summarised in Table 10.12. Further information is provided following the table.

Table 10.12 Transport facilities at Canterbury Station

Main mode of travel to station (% of total trips)	Number of bike parking spaces	Number of bus services in vicinity of station	Number of kiss and ride spaces	Number of taxi bays
Walking (84%)	4	6	0	0

Active transport

As shown in Table 10.12, the main mode of travel to Canterbury Station is walking (84 per cent), influenced by good pedestrian accessibility for those living to the east and the north of the station. The Cooks River, the railway corridor, and Canterbury Road present barriers to movement from the south.

The Cooks River Cycleway runs on the southern side of the station. This cycleway is a key part of the regional cycle network.

Four bike parking spaces are provided at Canterbury Station in a secured shed located on Broughton Street.

Public transport

Existing daily rail travel volumes at Canterbury Station observed in 2016 were 2,426 entries and 2,164 exits.

As shown on Figure 10.6, the station is serviced by six bus routes, including high frequency routes from the Sydney CBD, Campsie, and Hurstville. These services stop at bus stops located on Canterbury Road or in Broughton Street.

Parking

As shown in Table 10.13, there are about 850 on and off-street parking spaces within 400 metres of the station. There is moderate demand for on-street spaces (utilisation of 59 per cent) and a relatively high demand for commuter spaces (utilisation of 84 per cent).

There are no kiss and ride spaces or taxi bays at the station.

Table 10.13 Parking facilities at Canterbury Station

On-street spaces		Off-street spaces	
Number[1]	Overall utilisation[2]	Number[1]	Overall utilisation
616 (597 unrestricted)	59%	233 (includes 32 dedicated commuter parking spaces)	84%

Notes: 1. Within 400 metres of the station.
2. After the morning peak in October 2016 on two typical weekdays. Follow-up verification surveys undertaken in November 2016.

Road network

The road network at Canterbury Station is focused on Canterbury Road, which is a State road that travels in a north-east/south-west direction immediately to the south of the station. A regional road, Jeffrey Street, intersects with Canterbury road to north-east of the station.

Local roads surrounding the station are shown on Figure 10.6. Table 10.14 shows existing weekday traffic volumes (24 hour and one-hour morning and afternoon peaks) for key roads in the vicinity of the station.

Table 10.14 Existing weekday traffic volumes – Canterbury Station

Road	24 hr (daily) volumes				1 hr (peak) volumes	
	Total count	Light	Heavy	Proportion of heavy vehicles (%)	Morning	Afternoon
Canterbury Road (between Close Street and Broughton Street)	51,361	47,837	3,525	7	2,985	3,603
Broughton Street (between Canterbury Road and Robert Street)	3,613	3,166	447	12	210	253
Canterbury Road (between Jeffrey Street and Minter Street)	35,738	32,965	2,773	8	2,077	2,507
Charles Street (between Canterbury Road and Broughton Street)	929	757	172	19	54	75
Canterbury Road (between Charles Street and Close Street)	51,361	47,837	3,525	7	2,985	3,603
Wonga Street	12,925	12,771	153	1	751	907

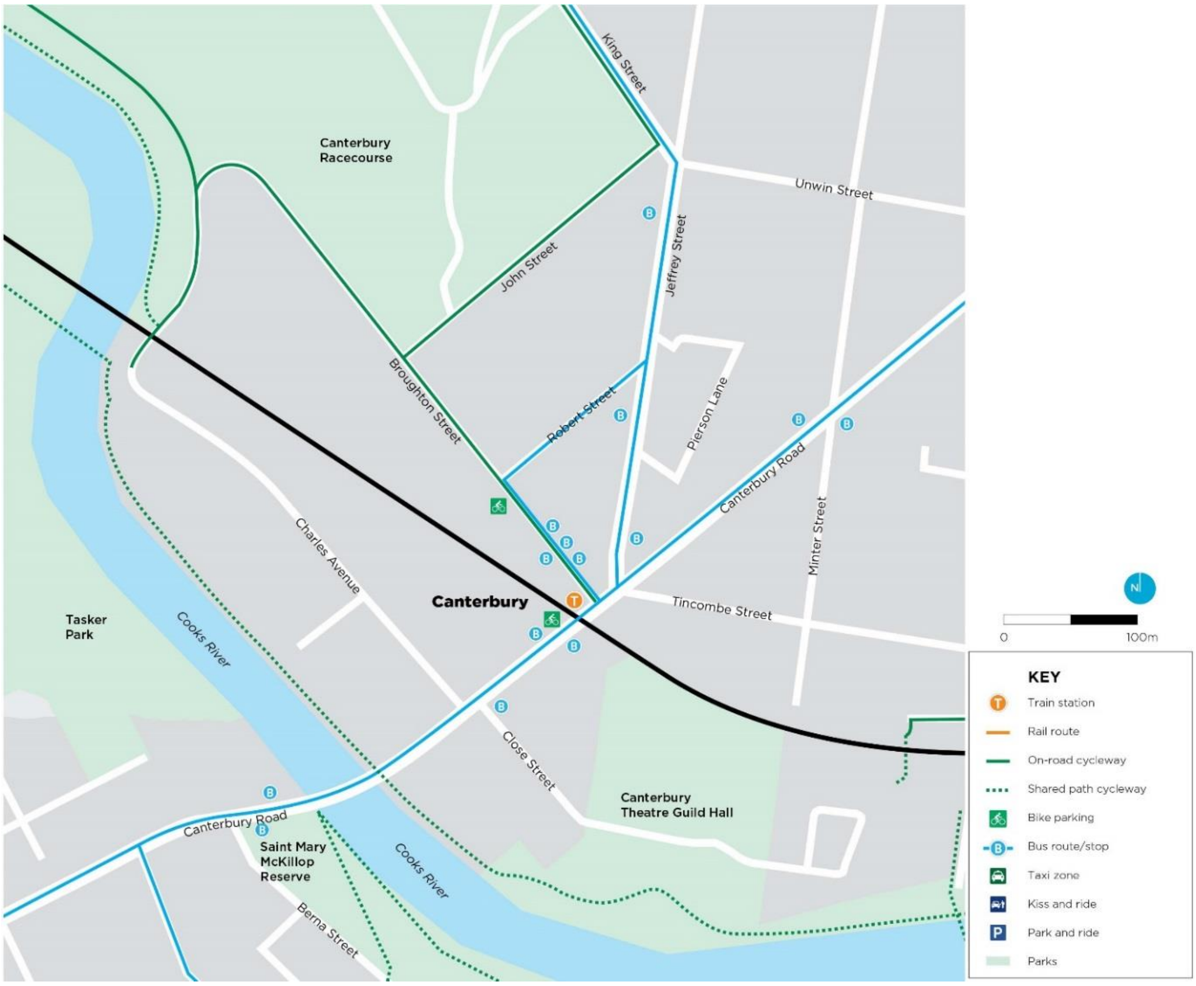


Figure 10.6 Existing transport facilities at Canterbury Station

Campsie Station

Existing transport facilities at Campsie Station are shown on Figure 10.7 and summarised in Table 10.15. Further information is provided following the table.

Table 10.15 Transport facilities at Campsie Station

Main mode of travel to station (% of total trips)	Number of bike parking spaces	Number of bus services in vicinity of station	Number of kiss and ride spaces	Number of taxi bays
Walking (73%)	10	7	4	6

Active transport

As shown in Table 10.15, the main mode of travel to Campsie Station is walking (73 per cent). The walking catchment in the vicinity of the station is relatively good, with linear intersecting regional roads (e.g. Beamish Street) and perpendicular local roads. Roads also have footpaths on both sides.

The Cooks River Cycleway runs parallel to the rail corridor to the north of the station, however there are no direct on or off road cycleways connecting this cycleway to Campsie Station. There are a number of on-road cycle lanes, road shoulders, and mixed traffic lanes that provide cycle access to the station from surrounding areas.

Ten bike parking spaces are provided on Beamish Street outside the station entrance.

Public transport

Existing daily rail travel volumes at Campsie Station observed in 2016 were 8,237 entries and 8,039 exits.

Campsie is a major hub for bus services and provides a key interchange between buses and rail services. The location of bus stops in the vicinity of the station is shown in Figure 10.7. Seven bus services use the stops on Beamish Street and South Parade. These include services providing access to Macquarie Park.

Parking

As shown in Table 10.16, there are about 1,500 on and off-street parking spaces within 400 metres of the station. About one-third of the spaces available, which includes 138 dedicated commuter spaces, are located off-street. There is a high demand for parking in the vicinity of the station, with a utilisation rate of 85 per cent for on-street spaces, and 100 per cent for off-street spaces.

Four kiss and ride spaces are provided at the station, with two in North Parade (west of Beamish Street) and two in South Parade, and six taxi bays are provided in North Parade (east of Beamish Street).

Table 10.16 Parking facilities at Campsie Station

On-street spaces		Off-street spaces	
Number[1]	Overall utilisation[2]	Number[1]	Overall utilisation
1,045 (759 unrestricted)	85%	494 (includes 138 dedicated commuter parking spaces)	100%

Notes: 1. Within 400 metres of the station.
2. After the morning peak in October 2016 on two typical weekdays. Follow-up verification surveys undertaken in November 2016.

Road network

The existing road network at Campsie Station is focused around Beamish Street, a regional road that runs in a north–south direction immediately to the east of the station. The following State and regional roads are located in the area surrounding the station:

- State roads: Canterbury Road
- Regional roads: Beamish Street, Brighton Avenue, Fifth Avenue, Ninth Avenue.

Local roads surrounding the station are shown on Figure 10.7. Table 10.17 shows the existing weekday traffic volumes (24 hour and one-hour morning and afternoon peaks) in the vicinity of Campsie.

Table 10.17 Existing weekday traffic volumes – Campsie Station

Road	24 hr (daily) volumes				1 hr (peak) volumes	
	Total count	Light	Heavy	Proportion of heavy vehicles (%)	Morning	Afternoon
Canterbury Rd (between Beamish Street and Scahill Street)	41,161	38,170	2,991	7	2,392	2,888
South Parade (between Beamish Street and Harold Street)	6,916	6,469	447	6	402	352

Road	24 hr (daily) volumes				1 hr (peak) volumes	
	Total count	Light	Heavy	Proportion of heavy vehicles (%)	Morning	Afternoon
North Parade (between Browning Street and Beamish Street)	2,366	2,351	15	1	138	166
Beamish Street (between South Parade and Amy Street)	18,858	18,457	400	2	1,290	1,430
Gould Street (between Canterbury Road and Redman Street)	2,794	2,558	236	8	162	196
Ninth Avenue (between Beamish Street and Fifth Avenue)	16,272	15,879	393	2	946	1,142
South Parade (between Beamish Street and Harold Street)	5,879	5,499	380	6	402	352
Canterbury Road (between Beamish Street and Kingsgrove Road)	43,029	39,949	3,081	7	2,501	3,019

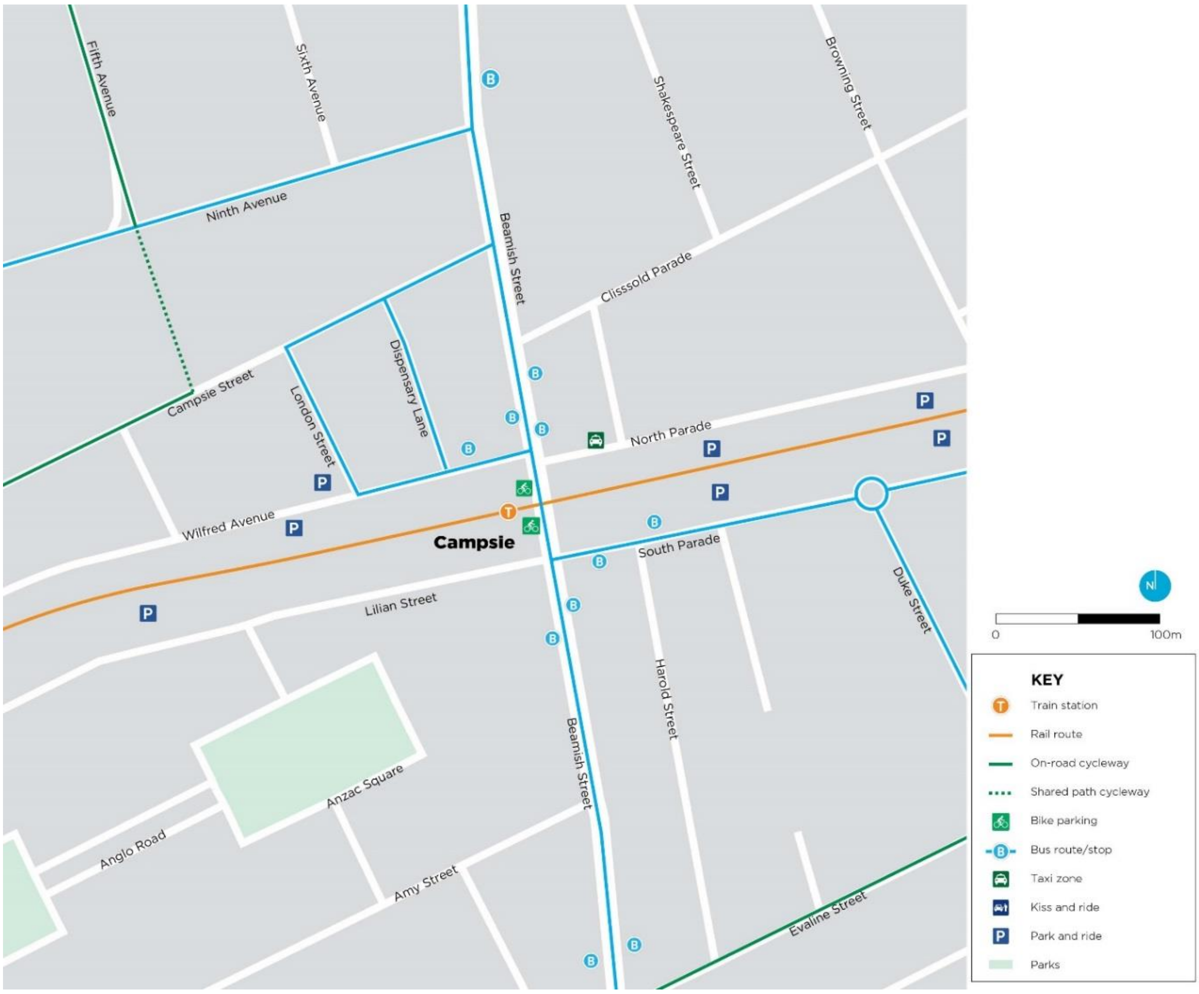


Figure 10.7 Existing transport facilities at Campsie Station

Belmore Station

Existing transport facilities at Belmore Station are shown on Figure 10.8 and summarised in Table 10.18. Further information is provided following the table.

Table 10.18 Transport facilities at Belmore Station

Main mode of travel to station (% of total trips)	Number of bike parking spaces	Number of bus services in vicinity of station	Number of kiss and ride spaces	Number of taxi bays
Walking (65%)	5	2	0	4

Active transport

As shown in Table 10.18, the main mode of travel to Belmore Station is walking (64 per cent), however the walking mode share is comparatively less than other stations. A relatively good walking catchment is provided in the vicinity of Belmore Station due to a network of intersecting roads through predominately residential areas. The majority of roads in the vicinity of the station have footpaths on both sides.

An existing off-street shared path provides pedestrian and cycle links to the east of the station towards Belmore Sports Ground (which includes Belmore Oval). This path is a key link between the station and the oval on game days. Beyond this shared path, cycle facilities are limited.

Five bike parking spaces are provided to the north of the station entrance adjacent to Burwood Road.

Public transport

Existing daily rail travel volumes at Belmore Station observed in 2016 were 3,025 entries and 2,847 exits.

The location of bus stops in the vicinity of the station is shown in Figure 10.8. The station is serviced by two bus routes, which use the stops on Burwood Road. These services provide access to Haberfield, Burwood, Strathfield, Campsie, and Roselands.

Parking

As shown in Table 10.19, there are about 1,200 on and off-street parking spaces within 400 metres of the station. This includes 56 dedicated commuter off-street parking spaces in two areas located off Redman Parade and Bridge Road. There is moderately high demand for on-street spaces (utilisation of 76 per cent) and a relatively high demand for commuter spaces (utilisation of 92 per cent).

There are no kiss and ride spaces at the station. Four taxi bays are located in Bridge Road just west of Burwood Road.

Table 10.19 Parking facilities at Belmore Station

On-street spaces		Off-street spaces	
Number[1]	Overall utilisation[2]	Number[1]	Overall utilisation
1,078 (914 unrestricted)	76%	142 (includes 56 dedicated commuter parking spaces)	92%

Notes: 1. Within 400 metres of the station.
2. After the morning peak in October 2016 on two typical weekdays. Follow-up verification surveys undertaken in November 2016.

Road network

The road network at Belmore Station is focused around Burwood Road, which is a regional road that runs in a north–south direction immediately to the east of the station. The following State and regional roads are located in the area surrounding the station:

- State roads: Canterbury Road
- Regional roads: Burwood Road and Lakemba Street.

Local roads surrounding the station are shown on Figure 10.8. Table 10.20 shows the existing weekday traffic volumes (24 hour and one-hour morning and afternoon peaks) for key roads in the vicinity of the station.

Table 10.20 Existing weekday traffic volumes – Belmore Station

Road	24 hr (daily) volumes				1 hr (peak) volumes	
	Total count	Light	Heavy	Proportion of heavy vehicles (%)	Morning	Afternoon
Redman Parade (between Burwood Road and Sudbury Street)	6,267	6,131	136	2	368	345
Burwood Road (between Redman Parade and Bridge Road)	19,742	17,629	2,115	11	1,159	1,206
Bridge Road (between Marie Lane and Burwood Avenue)	10,543	10,019	524	5	619	644
Canterbury Road (between Kingsgrove Road and Haldon Street)	42,056	38,509	3,546	8	2,444	2,950
Burwood Road (between Bridge Road and Collins Street)	21,492	19,332	2,160	10	1,262	1,313

Figure 10.8 Existing transport facilities at Belmore Station

Lakemba Station

Existing transport facilities at Lakemba Station are shown on Figure 10.9 and summarised in Table 10.21. Further information is provided following the table.

Table 10.21 Transport facilities at Lakemba Station

Main mode of travel to station (% of total trips)	Number of bike parking spaces	Number of bus services in vicinity of station	Number of kiss and ride spaces	Number of taxi bays
Walking (72%)	8	3	1	3

Active transport

As shown in Table 10.21, the main mode of travel to Lakemba Station is walking (72 per cent). A good walking catchment is provided in the vicinity of the station with a network of intersecting roads located in predominately residential areas. The majority of roads in the vicinity of the station have footpaths on both sides. The roads have low speeds and narrow carriageways, which make them attractive to pedestrians.

There are no off-street cycleways in the vicinity of the station. On-street cycleways are located along Lakemba Street, Haldon Street, and Wangee Street.

Eight bike parking spaces are provided at Lakemba Station, with four spaces on either side of the station adjacent to The Boulevarde and Railway Parade.

Public transport

Existing daily rail travel volumes at Lakemba Station observed in 2016 were 4,302 entries and 4,130 exits.

The location of bus stops in the vicinity of the station is shown in Figure 10.9. The station is serviced by three routes, which use the stops located on Railway Parade and Haldon Street. These services provide access to Roselands, Greenacre, Bankstown, Hurstville, Burwood, and Strathfield.

Parking

As shown in Table 10.22, there are about 1,500 on and off-street parking spaces within 400 metres of the station. About one-third of the spaces available, which includes 138 dedicated commuter spaces off The Boulevarde on both sides of Haldon Street, are located off-street. There is a relatively high demand for parking in the vicinity of the station, with a utilisation rate of 85 per cent for on-street spaces, and 86 per cent for off-street spaces.

A kiss and ride space is located on the southern side of The Boulevarde, east of the station. Three taxi bays are located adjacent to the station entrance on the northern side of The Boulevarde.

Table 10.22 Parking facilities at Lakemba Station

On-street spaces		Off-street spaces	
Number[1]	Overall utilisation[2]	Number[1]	Overall utilisation
961 (775 unrestricted)	85%	537 (includes 138 dedicated commuter parking spaces)	86%

Notes: 1. Within 400 metres of the station.
2. After the morning peak in October 2016 on two typical weekdays. Follow-up verification surveys undertaken in November 2016.

Road network

The existing road network around Lakemba Station is focused around Haldon Street, which runs in a roughly north–south direction immediately to the east of the station, and The Boulevarde, which runs in an east–west direction on the southern side of the rail corridor, between Punchbowl Station and to the west of Lakemba Station. The following State and regional roads are located in the area surrounding the station:

- State roads: Punchbowl Road, Canterbury Road
- Regional roads: Lakemba Street.

Local roads surrounding the station are shown on Figure 10.9. Table 10.23 shows the existing weekday traffic volumes (24 hour and one-hour morning and afternoon peaks) for key roads in the vicinity of Lakemba Station.

Table 10.23 Existing weekday traffic volumes – Lakemba Station

Road	24 hr (daily) volumes				1 hr (peak) volumes	
	Total count	Light	Heavy	Proportion of heavy vehicles (%)	Morning	Afternoon
Railway Parade (between Haldon Street and Croydon Street)	4,547	4,445	102	2	267	337
Haldon Street (between Railway Parade and The Boulevarde)	14,972	14,072	900	6	879	915

Road	24 hr (daily) volumes				1 hr (peak) volumes	
	Total count	Light	Heavy	Proportion of heavy vehicles (%)	Morning	Afternoon
The Boulevarde (between Haldon Street and Croydon Street)	8,099	7,924	174	2	475	495
Haldon Street (between The Boulevarde and Oneata Street)	9,750	8,898	852	9	572	596
Canterbury Road (between Haldon Street and Legge Street)	43,840	39,990	3,850	9	2,574	2,678

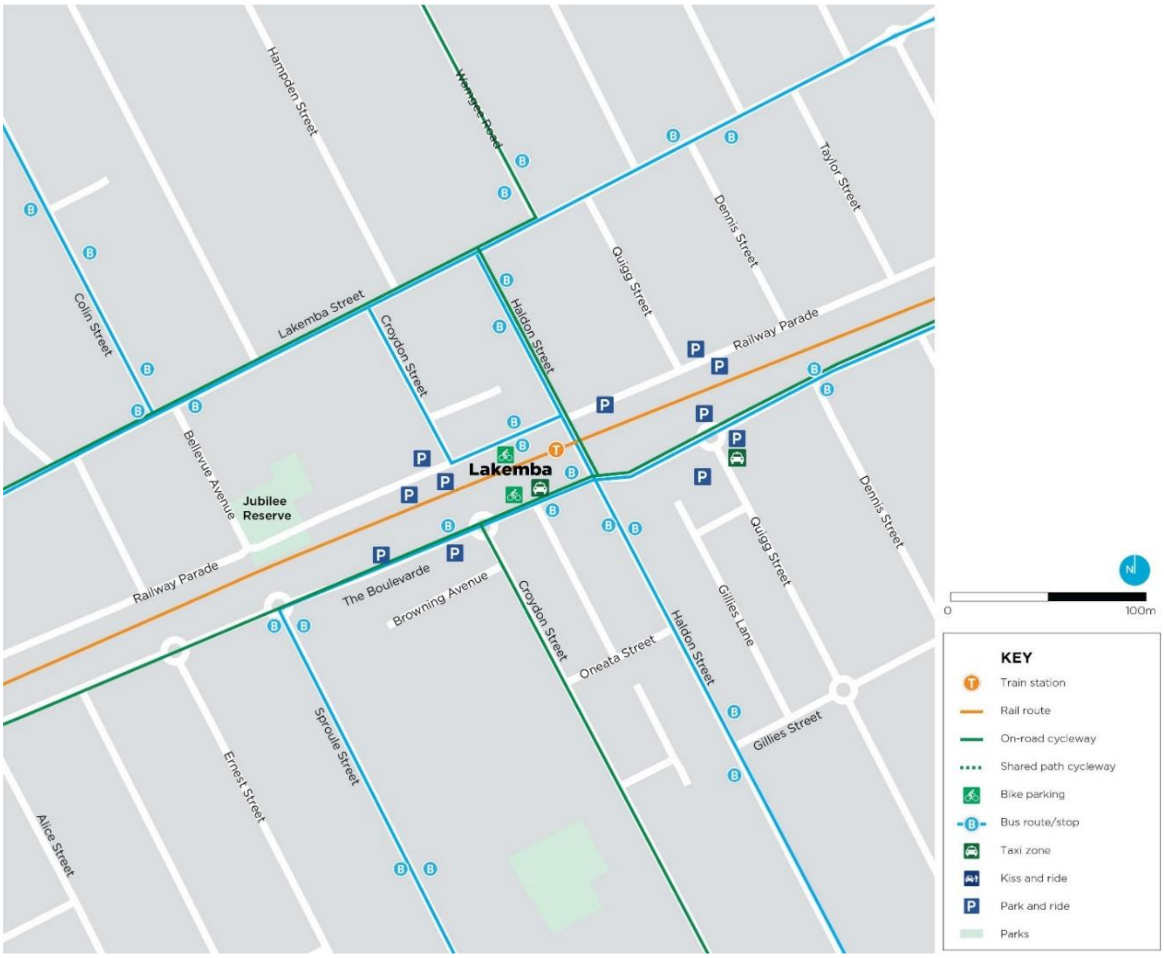


Figure 10.9 Existing transport facilities at Lakemba Station

Wiley Park Station

Existing transport facilities at Wiley Park Station are shown on Figure 10.10 and summarised in Table 10.24. Further information is provided following the table.

Table 10.24 Transport facilities at Wiley Park Station

Main mode of travel to station (% of total trips)	Number of bike parking spaces	Number of bus services in vicinity of station	Number of kiss and ride spaces	Number of taxi bays
Walking (90%)	4	2	0	0

Active transport

As shown in Table 10.24, the main mode of travel to Wiley Park Station is walking (90 per cent). A good walking catchment is provided in the vicinity of the station, with a network of intersecting roads through predominately residential areas. The majority of roads in the vicinity of the station have footpaths on both sides.

To the west of the station, access is somewhat restricted by King Georges Road, as a result of its width and high traffic volumes. There are three schools located close to the station (to the south of the project area), which would contribute to the high walking mode share.

There are limited cycle facilities in the vicinity of the station, with some cycle infrastructure on Urunga Parade and Lakemba Street.

Four bike parking spaces are provided north of the station entrance, adjacent to the walkway that connects King Georges Road to Wiley Lane and Shadforth Street.

Public transport

Existing daily rail travel volumes at Wiley Park Station observed in 2016 were 2,006 entries and 1,806 exits.

The location of bus stops in the vicinity of the station is shown in Figure 10.10. The station is serviced by two bus routes, which use the stops one King Georges Road. These services provide access to Campsie, Roselands, and Riverwood.

Parking

As shown in Table 10.25, there are about 750 parking spaces (mainly on-street) within 400 metres of the station. There is a moderate demand for parking, with a utilisation rate of 63 per cent for on-street spaces, and 60 per cent for off-street spaces.

There are no kiss and ride or taxi facilities at the station.

Table 10.25 Parking facilities at Wiley Park Station

On-street spaces		Off-street spaces	
Number[1]	Overall utilisation[2]	Number[1]	Overall utilisation
721 (693 unrestricted)	63%	25 (unrestricted)	60%

Notes: 1. Within 400 metres of the station.
2. After the morning peak in October 2016 on two typical weekdays. Follow-up verification surveys undertaken in November 2016.

Road network

The existing road network at Wiley Park Station is focused around King Georges Road, a State road that runs in a north–south direction immediately to the east of the station. King Georges Road is a major road, with up to 90,000 vehicles passing the station over a typical 24 hour period. The Boulevarde runs in an east–west direction on the southern side of the rail corridor, between Punchbowl Station and to the west of Lakemba Station. The following State and regional roads are located in the area surrounding the station:

- State roads: King Georges Road, Canterbury Road and Punchbowl Road
- Regional roads: Lakemba Street.

Local roads surrounding the station are shown on Figure 10.10. Table 10.26 shows the existing weekday traffic volumes (24 hour and one-hour morning and afternoon peaks) for key roads in the vicinity of Wiley Park Station.

Table 10.26 Existing weekday traffic volumes – Wiley Park Station

Road	24 hr (daily) volumes				1 hr (peak) volumes	
	Total count	Light	Heavy	Proportion of heavy vehicles (%)	Morning	Afternoon
The Boulevarde (between Renown Avenue and King Georges Road)	13,893	13,471	422	3	816	849
King Georges Road (between The Boulevarde and Mary Street)	88,000	78,094	9,906	11	5,167	5,375
Lakemba Street (between King Georges Road and Shadforth Street)	3,542	3,472	70	2	208	216
King Georges Road (between Lakemba St and The Boulevarde)	96,775	86,699	10,076	10	5,683	5,911
The Boulevarde (between King Georges Road and Dudley Street)	13,893	13,471	422	3	816	849

Figure 10.10 Existing transport facilities at Wiley Park Station

Punchbowl Station

Existing transport facilities at Punchbowl Station are shown on Figure 10.11 and summarised in Table 10.27. Further information is provided following the table.

Table 10.27 Transport facilities at Punchbowl Station

Main mode of travel to station (% of total trips)	Number of bike parking spaces	Number of bus services in vicinity of station	Number of kiss and ride spaces	Number of taxi bays
Walking (56%)	12	5	0	2

Active transport

As shown in Table 10.27, the main mode of travel to Punchbowl Station is walking (55 per cent). Punchbowl has one of the lowest walking mode shares of stations in the project area. The walking catchment to the west of the station is somewhat restricted by Punchbowl Road, due to its width and high traffic volumes. The residential density surrounding the station is also less dense than at other stations. The provision of dedicated commuter parking and a number of bus services provide alternate access modes.

There are no off-road cycleways in the vicinity of the station. Some cycle facilities are located along Urunga Parade that are considered suitable for less experienced riders. All other roads in the area are considered to be only suitable for more experienced riders.

Twelve bike parking spaces are provided at the station, located on either side of the rail corridor adjacent to the station entrances.

Public transport

Existing daily rail travel volumes at Punchbowl Station observed in 2016 were 2,935 entries and 2,806 exits.

The location of bus stops in the vicinity of the station is shown in Figure 10.11. The station is serviced by five bus routes, which use the stops on Punchbowl Road and The Boulevarde. These services provide access to Bankstown, Roselands, Riverwood, and Hurstville.

Parking

As shown in Table 10.28, there are about 1,100 on and off-street parking spaces within 400 metres of the station. This includes 137 dedicated commuter spaces located in the car park adjacent to the corridor east of the existing station entrance. There is a moderately high demand for on-street parking (utilisation rate of 79 per cent) and a high demand for off-street/commuter parking (utilisation rate of 100 per cent).

There are no kiss and ride spaces in the vicinity of the station. Two taxi bays are located in Arthur Street on the southern side of the rail corridor near the station entrance.

Table 10.28 Parking facilities at Punchbowl Station[1]

On-street spaces		Off-street spaces	
Number	Overall utilisation[2]	Number	Overall utilisation
838 (626 unrestricted)	79%	285 (includes 137 dedicated commuter parking spaces)	100%

Notes: 1. Within 400 metres of the station.
2. After the morning peak in October 2016 on two typical weekdays. Follow-up verification surveys undertaken in November 2016.

Road network

The existing road network at Punchbowl Station is focused around Punchbowl Road, which is a State road that runs in north-east/south-west direction immediately adjacent to the station. The Boulevarde runs in an east–west direction on the southern side of the rail corridor, between Punchbowl Station and to the west of Lakemba Station. The following State and regional roads are located in the area surrounding the station:

- State roads: Punchbowl Road and Canterbury Road
- Regional roads: Wattle Street.

Local roads surrounding the station are shown on Figure 10.11. Table 10.29 shows the existing weekday traffic volumes (24 hour and one-hour morning and afternoon peaks) for key roads in the vicinity of the station.

Table 10.29 Existing weekday daily traffic volumes – Punchbowl Station

Road	24 hr (daily) volumes				1 hr (peak) volumes	
	Total count	Light	Heavy	Proportion of heavy vehicles (%)	Morning	Afternoon
The Boulevarde (Between Punchbowl Road and Arthur Street)	24,810	23,376	1,434	6	1,457	1,515
Punchbowl Road (Between The Boulevarde and Acacia Avenue)	50,477	46,962	3,515	7	2,964	3,083
South Terrace (Between Loder Lane and Punchbowl Road)	14,041	13,630	412	3	824	858
Punchbowl Road (Between South Terrace and The Boulevarde)	60,737	56,612	4,125	7	3,566	3,710

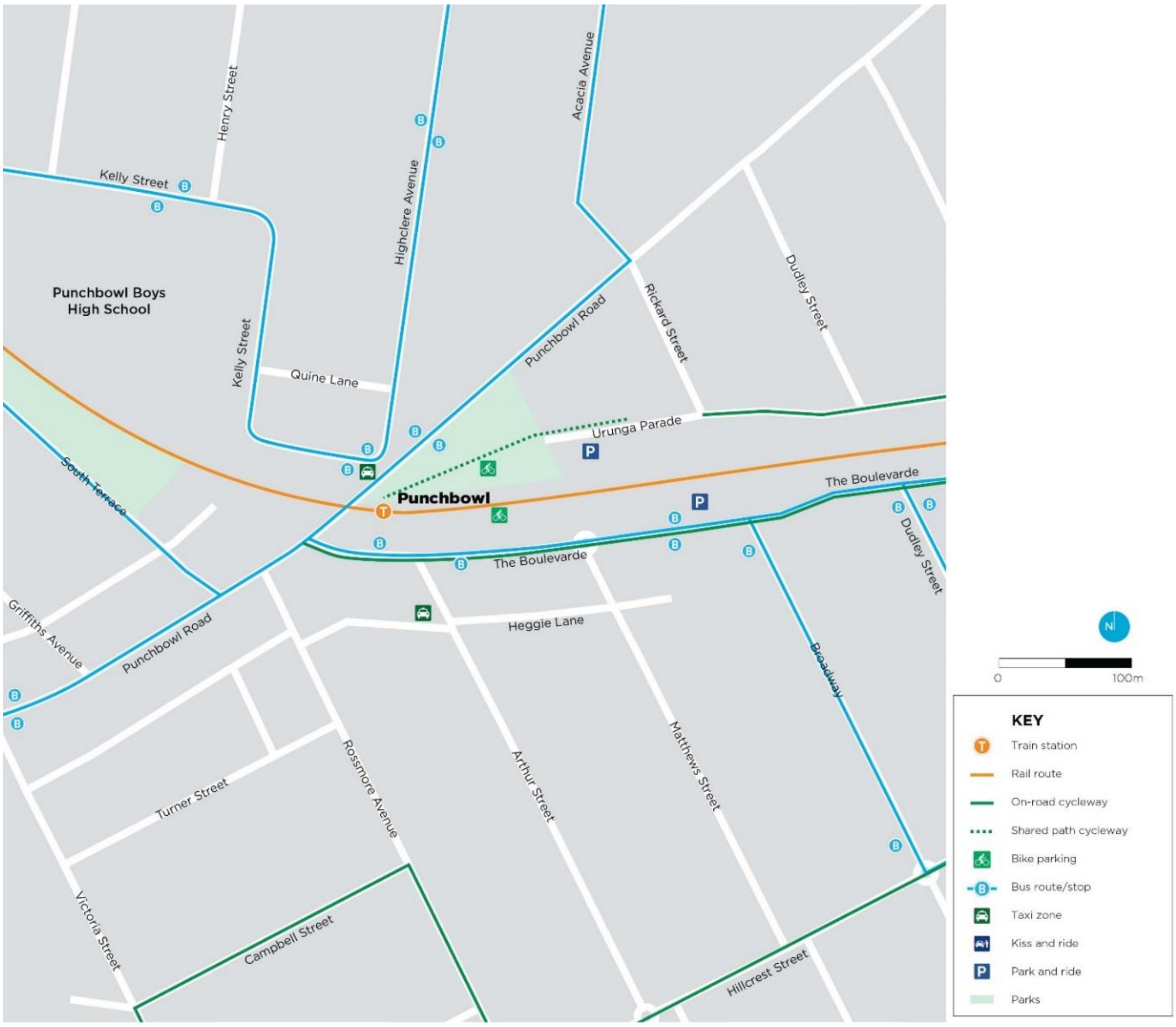


Figure 10.11 Existing transport facilities at Punchbowl Station

Bankstown Station

Existing transport facilities at Bankstown Station are shown on Figure 10.12 and summarised in Table 10.30. Further information is provided following the table.

Table 10.30 Transport facilities at Bankstown Station

Main mode of travel to station (% of total trips)	Number of bike parking spaces	Number of bus services in vicinity of station	Number of kiss and ride spaces	Number of taxi bays
Walking (49%)	32	15	4	10

Active transport

As shown in Table 10.30, the main mode of travel to Bankstown Station is walking (49 per cent). Bankstown has the lowest walking mode share of stations in the project area. The walking catchment is limited as a result of long street blocks, and the barriers presented by the rail corridor (with limited crossing locations), major roads (e.g. Stacey Street) that carry large volumes of traffic, and existing development patterns, with the nearest residential areas located some distance from the station.

The Salt Plan Creek Cycleway and a cycleway from the T2 Inner West & South Line link to the Bankstown town centre, but do not provide access to the station. From these cycleways, there are a number of on-road routes available.

Thirty-two bike parking spaces are provided at the station at the South Terrace bus interchange, Bankstown City Plaza, and on North Terrace.

Public transport

Existing daily travel volumes at Bankstown Station observed in 2016 were 8,993 entries and 9,350 exits.

Bankstown is a major bus interchange. Fifteen routes are located in the vicinity of the station, providing regional connectivity to centres such as Parramatta, Lidcombe, Burwood, Liverpool, Fairfield, Hurstville, and Sutherland. The location of bus stops is shown in Figure 10.12. The majority of the routes connect to the bus interchange located south of the station, however some services operate to a stop on North Parade.

Parking

As shown in Table 10.31, there are about 1,700 parking spaces within 400 metres of the station. The majority of these spaces are off-street spaces, which includes 147 dedicated commuter parking spaces, located adjacent to the rail corridor along North and South Terraces east of the station. There is a high demand for parking, with a utilisation rate of 93 per cent for on-street spaces, and 100 per cent for off-street/commuter parking.

There are four kiss and ride spaces and 10 taxi bays on North Parade to the north of the rail corridor.

Table 10.31 Parking facilities at Bankstown Station

On-street spaces		Off-street spaces	
Number[1]	Overall utilisation[2]	Number[1]	Overall utilisation
588 (58 unrestricted)	93%	1,108 (includes 147 dedicated commuter parking spaces)	100%

Notes: 1. Within 400 metres of the station.
2. After the morning peak in October 2016 on two typical weekdays. Follow-up verification surveys undertaken in November 2016.

Road network

The existing road network at Bankstown Station is focused around North and South terraces, which run parallel to the rail corridor. The following State and Regional roads are located in the area surrounding the station:

- State roads: Stacey Street
- Regional roads: Rickard Road, Greenwood Avenue, Wattle Street, Marion Street, Meredith Street, Chapel Road (north of Richard Road).

Local roads surrounding the station are shown on Figure 10.12. Table 10.32 shows the existing weekday traffic volumes (24 hour and one-hour morning and afternoon peaks) for key roads near the station.

Table 10.32 Existing weekday daily traffic volumes – Bankstown Station

Road	24 hr (daily) volumes				1 hr (peak) volumes	
	Total count	Light	Heavy	Proportion of heavy vehicles (%)	Morning	Afternoon
Stacey Street (between Verbena Avenue and Stanley Street)	66,028	56,288	9,740	15	3,674	4,838
Restwell Street (between Stewart Lane and Raymond Street)	8,794	8,510	284	3	489	644
Raymond Street (between Restwell Street and West Terrace)	6,298	6,014	284	5	350	461
South Terrace (between West Terrace and East Terrace)	12,018	11,777	241	2	669	880
Marion Street (between Bungalow Cres and Meredith Street)	34,733	30,672	4,061	12	1,933	2,545
Meredith Street (between Marion Street and Gordon Street)	24,572	21,064	3,508	14	1,367	1,800

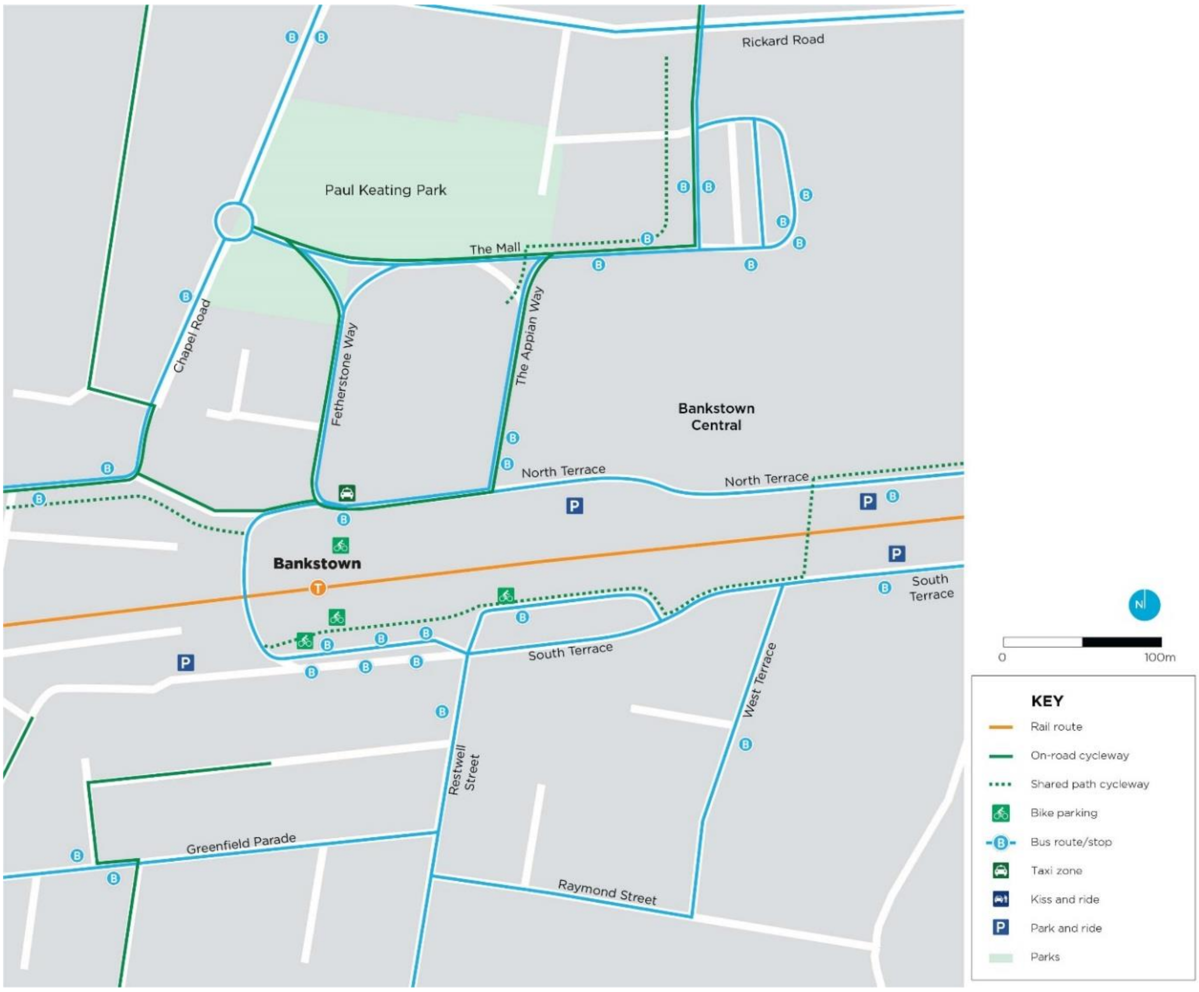


Figure 10.12 Existing transport facilities at Bankstown Station

10.3 Basis for the construction phase assessment

Temporary changes to the road network, public transport, pedestrian and cycle routes/facilities, and car parking would be required to facilitate construction. These changes are required due to the proximity of these facilities to construction compounds, work sites, or construction haulage routes (described in Section 9.8). Indicative changes to the surrounding transport network is described in the following sections.

10.3.1 Active transport

Indicative changes to pedestrian and cycle routes/facilities are outlined in Table 10.33. Cycle and pedestrian facilities would also need to be modified in some locations during the bridge works outlined in Table 10.36. Potential impacts as a result of these changes are assessed in Section 10.4 and mitigation measures are provided in Section 10.5. Diversions would be put in place where there may be impacts to pedestrian and cyclists (e.g. through the temporary closure of a footpath or cycle path) to help delineate an alternative route, maintain flow, and ensure safe access.

Table 10.33 Potential changes to pedestrian and cycle facilities

Location	Pedestrian facility changes	Cycle facility changes
Marrickville Station	Station Street – compound and work site extent would require the establishment of a modified pedestrian zone. On the corner of Warburton Road, Schwebel Street and Illawarra Road footpaths may be temporarily narrowed/require diversions due to the installation of a new signalised intersection and upgrades to the surrounding footpaths.	Illawarra Road and Carrington Road – no cycle facilities would be changed. However, cyclists and construction vehicles would be sharing the road.
Dulwich Hill Station	Ewart Lane, Bedford Crescent – Restricted access and possible diversions for access to existing station due to construction work site/compounds and proposed pavement upgrades	Existing bike parking on Bedford Crescent may be inaccessible during station upgrade works.
Hurlstone Park Station	Floss Street, Duntroon Street – footpath diversions due to the extent of the work site.	Existing bike parking facilities on Duntroon Street would be relocated. Cyclists and construction vehicles would be sharing the road.
Canterbury Station	Broughton Street – footpath diversions during relocation of the station entrance Corner of Broughton Street and Canterbury Road – footbridge relocation due to relocation of the station entrance.	The bike parking facilities on Broughton Street would be relocated into the new station pavement areas north and south of the station.
Campsie Station	South Parade, Beamish Street, North Parade, Lilian Street – potentially reduced footpath widths near construction compounds/work site extent due to site fences and hoardings Lilian Lane during possession periods and construction of the shared zone would require safe pedestrian alternatives to be provided.	The bike parking facilities on the station forecourt on Beamish Street are proposed to be relocated to the new pavement on Wilfred Ave. Cyclists and construction vehicles would be sharing the road.

Location	Pedestrian facility changes	Cycle facility changes
Belmore Station	Tobruk Avenue footpaths may be inaccessible during construction of the station and the proposed shared zone. Burwood Road footpaths may be narrowed/require diversions during the installation of a new signalised intersection and upgrades to existing footpaths.	The bike parking facilities are proposed to be upgraded and moved to the southern side of the station. Some may be temporarily unavailable during this upgrade.
Lakemba Station	The Boulevarde and Railway Parade – potentially reduced footpath widths near construction compounds/work site extent due to site fences and hoardings and during the installation of new footpaths and pavements.	The bike parking facilities are proposed to be upgraded and some may be temporarily unavailable during this upgrade. Cyclists and construction vehicles would be sharing the road.
Wiley Park Station	The Boulevarde and Stanlea Parade – potentially reduced footpath widths near construction compounds/work site extent due to site fences and hoardings and during the installation of new footpaths and pavements.	The bike parking is proposed to be relocated to the north and south side of the station. Some may be temporarily unavailable during this upgrade. Cyclists and construction vehicles would be sharing the road.
Punchbowl Station	Access to the station would be modified in a number of ways during construction at Punchbowl Station: • the corner of Punchbowl Road and Warren Reserve, would be modified due to the extent of work required. • the station access from the corner of Punchbowl Road and Warren Reserve would be removed and a new entrance constructed off Urunga Parade. • The construction of the new pavement and kerbside facilities on the Boulevarde.	The bike parking is proposed to be upgraded and moved east towards the new station entrances. Some may be temporarily unavailable during this upgrade.
Bankstown Station	Access to the station would be modified on South Terrace and North Terrace. Kerbside facilities proposed for North Terrace may also result in temporary pedestrian diversions.	No cycling facility changes.

Note: Some of the changes in the table represent transport facilities delivered as part of the project, as described in Chapter 8.

10.3.2 Public transport - buses

Table 10.34 lists the indicative changes to bus stops and routes that would be required to enable construction and the implementation of alternative transport arrangements. These arrangements may affect bus stops and layovers located between Sydenham and Yagoona stations (inclusive). Changes may include diversion of bus routes and/or relocation of bus stops, which may temporarily increase the walking distances for passengers. The proposed changes, which have been designed to minimise potential impacts on traffic flow and bus services, would be reviewed and confirmed during detailed design and construction planning in consultation with relevant stakeholders.

No changes to light rail services at the Dulwich Hill light rail stop would be required. Access to the light rail stop would be maintained during construction.

Table 10.34 Indicative modifications to public transport facilities during construction

Location[1]	Bus route changes	Bus stop changes
Sydenham Station	Not anticipated at this stage	Rail replacement buses would share existing bus stops on Railway Parade.
Marrickville Station	Route that crosses Illawarra Road Overbridge would require diversion via Charlotte Avenue underbridge (refer to Table 10.36)	Short term bus stop relocations may be required on Illawarra Road due to their close proximity to the project area. Rail replacement buses would share existing bus stops on Illawarra Road.
Dulwich Hill Station	Route that crosses Livingstone Road Overbridge would require diversion via Illawarra Road overbridge (refer to Table 10.36)	Rail replacement buses would share existing bus stops on Dudley Street.
Hurlstone Park Station	Route that crosses Garnett Street Overbridge would require diversion via Hampden Street (refer to Table 10.36) Route that crosses Crinan Street overbridge via Garnet Street overbridge	Rail replacement buses would share existing bus stops on Floss Street and Duntroon Street. Short-term relocation of bus stops may be required during works to the Crinan Street overbridge. Temporary relocation of the existing bus stop on Crinan Street (northbound) due to the presence of a construction compound/work site.
Canterbury Station	Bus routes that cross Canterbury Road Overbridge would remain open, but bus routes may be impacted by traffic management measures (refer to Table 10.36)	Rail replacement buses would share existing bus stops on Canterbury Road. A bus stop on Broughton Street would be relocated to outside the new station entrance.
Campsie Station	Routes that cross Beamish Street overbridge would require diversion via Loch St overbridge (refer to Table 10.36).	Rail replacement buses would share existing bus stops on South Parade. Temporary half lane closures are required on the Beamish Street overbridge during bridge works. The bus stops would be temporarily relocated - potentially to North Parade.
Belmore Station	Route that crosses Burwood Road overbridge would require diversion across Moreton Street Bridge (refer to Table 10.36)	Rail replacement buses would share existing bus stops on Burwood Road. Temporary closure of Burwood Road overbridge may require relocation of bus stops to minimise walking distances.
Lakemba Station	Routes that cross Haldon Street overbridge would require diversion to Moreton Street overbridge (refer to Table 10.36)	Rail replacement buses would share existing bus stops on The Boulevarde. Temporary closure of Haldon Street overbridge may require relocation of bus stops to minimise walking distances.
Wiley Park Station	Not anticipated at this stage	Not anticipated at this stage.
Punchbowl Station	Bus routes that cross Punchbowl Road overbridge would remain, but bus routes may be impacted by traffic management measures (refer to Table 10.36)	Rail replacement buses would share existing bus stops on The Boulevarde.

Location[1]	Bus route changes	Bus stop changes
Bankstown Station	Bus routes that cross Chapel Road overbridge would remain, but bus routes may be impacted by traffic management measures (refer to Table 10.36)	Existing bus stops on North Terrace, South Terrace and The Appian Way would be shared with Rail replacement buses. This includes a Special Events bus zone proposed to be used as a bus layover, and relocating and extending existing layovers.
Regents Park Station	Not anticipated at this stage	Rail replacement buses would share existing stops on Park Road and Amy Street.
Lidcombe Station	Not anticipated at this stage	Rail replacement buses would share existing bus stops on Railway Street.
Birrong Station	Not anticipated at this stage	Not anticipated at this stage.
Yagoona Station	Not anticipated at this stage	Rail replacement buses would share existing bus stops on Church Road.

Note: 1. Includes stations outside the project area that would be affected by possessions, where rail replacement buses would be required.

10.3.3 Road network – station and bridge works

Station works

Potential changes to the road network around stations as a result of construction, including the location of compounds and work sites, are outlined in Table 10.35. These changes include temporary road and lane closures. This table identifies the roads that would potentially need to be changed for the duration of works at stations (including those located within construction compounds or work sites) and roads that may need to be modified for short periods only (i.e. during possession periods). These potential changes are indicative, based on the current stage of the design. Final changes required would be determined during detailed design and construction planning, in consultation with the relevant local council and Roads and Maritime Services.

Table 10.35 Potential changes to road network for station works

Location	Road changes for the duration of construction	Road changes for short periods during construction
Marrickville Station	Station Street – construction compound and work site would occupy part of the street for new station forecourt and shared road	The corner of Station Street, Illawarra Road, Schwebel Street, Leofrene Avenue, and Warburton Street due to construction access or upgrades to intersections
Dulwich Hill Station	Nil	Ewart Lane, Bedford Crescent, Wardell Road, due to construction of new station entries and pavement/landscaping, construction of kerbside facilities, construction access
Hurlstone Park Station	Floss Street – construction compound would occupy part of the Floss Street (car park area) for station works, new pavement and bike parking	Crinan Street and Duntroon Street due to upgrades/ construction of pedestrian crossings, new station entry and construction/removal of kerbside facilities
Canterbury Station	Nil	Broughton Street, Canterbury Road and Close Street due to the construction/removal of station buildings, entries and pavement, kerbside facilities including a new bus stop, pedestrian crossing, construction access

Location	Road changes for the duration of construction	Road changes for short periods during construction
Campsie Station	Lilian Lane – access to the construction compound off Lilian Lane and upgrade of Lilian Lane	Lilian Street, Beamish Street, Wilfred Avenue, North Parade, South Parade, London Street due to construction access, construction of kerbside facilities, station entry and pavement, removal of existing kerbside facilities
Belmore Station	Nil	Tobruk Avenue (new shared area), Redman Parade, Burwood Road, Bridge Road, Acacia Lane, Myall Street due to construction of kerbside facilities, station entries, plaza and pavement, new signalised intersection, new access, removal of existing kerbside facilities, construction access
Lakemba Station	Nil	Railway Parade, Haldon Street, The Boulevarde due to the construction of the station entries and kerbside facilities
Wiley Park Station	Nil	King Georges Road, Wiley Lane, Shadforth Street, The Boulevarde due to the construction/removal of kerbside facilities, new station entry and pavement
Punchbowl Station	Nil	Punchbowl Road, Urunga Parade, The Boulevarde due to construction/removal of kerbside facilities, new station entries/ removal of existing concourse, new signalised pedestrian crossing
Bankstown Station	Nil	North Terrace, South Terrace due to construction of kerbside facilities, reconfigured bus layover, new station entry and pavement

Bridge works

In addition to the potential road network changes around stations, construction would require partial (involving closure of a single traffic lane) and/ or full closures of bridges that cross the rail corridor at times to enable a range of bridge upgrade works to occur. Table 10.36 provides a summary of the potential closures, changes to the road network, and the alternative bridge available for use during works. The types of closures and locations of works are shown in Figure 10.13.

Further information, including figures showing the proposed diversion routes, is provided in Technical paper 1. For the purposes of the traffic and transport assessment, it was assumed that adjacent bridges would not be upgraded simultaneously.

These potential closures and diversion routes are indicative, based on the current stage of the design. Final changes required would be determined during detailed design and construction planning, and would be subject to additional impact assessment if required. With respect to the Illawarra Road overbridge, potentially longer closures (up to one month) are being investigated as a result of ongoing consultation with key stakeholders. Any proposals for longer closures would be confirmed at a later date, and would be subject to additional impact assessment if required.

Table 10.36 Bridge works – indicative closures and road network changes

Bridge[1]	Type of closure (indicative duration for impact assessment purposes)	Alternate location for rail corridor crossing and distance along corridor to alternate location
Charlotte Avenue underbridge, Marrickville	Partial closures (14 weeks) Full closure (three days)	Illawarra Road overbridge – 320 m west
Illawarra Road overbridge, Marrickville	Partial closures (28 days – 14 days per side) Full closure (two days)[1]	Charlotte Avenue underbridge – 320 m east
		Livingstone Road overbridge – 475 m west

Bridge[1]	Type of closure (indicative duration for impact assessment purposes)	Alternate location for rail corridor crossing and distance along corridor to alternate location
Livingstone Road overbridge, Marrickville	Narrow lanes (8 months during weekends/nights) Full closure (two days)	Illawarra Road overbridge – 475 m east
Albermarle Street overbridge, Marrickville	Full closure (one month) Combination of partial and full closures during weekend and night-time works over a seven month period	Livingstone Road overbridge – 300 m east
Wardell Road overbridge, Dulwich Hill	Partial closures (weekends/nights over six months)	Livingstone Road overbridge – 330 m east
Ness Avenue/ Terrace Road underbridge, Dulwich Hill	Partial closures (weekends/nights over six months)	Wardell Road overbridge – 350 m east Garnet Street overbridge – 300 m west
Garnet Road overbridge, Hurlstone Park	Partial closures (weekends/nights over eight months) Full closure (two days)	Crinan Street overbridge – 200 m west Ness Avenue/Terrace Road overbridge – 300 m east
Crinan Street overbridge, Hurlstone Park	Partial closures (weekends/nights over eight months) Full closure (two days)	Garnet Street overbridge – 200 m east
Foord Avenue underbridge, Hurlstone Park	Partial closures (weekends/nights over six months)	Melford Road overbridge – 425 m west Crinan Street overbridge – 370 m east
Melford Road overbridge, Hurlstone Park	Full closures (weekends/nights over eight months)	Foord Avenue – 425 m east
Canterbury Road overbridge, Canterbury	Partial closures (weekends/nights over eight months)	No diversion required
Cooks River/ Charles Street underbridge, Canterbury	Full and partial closures (weekends/nights over six months)	Canterbury Road overbridge – 375 m east
Wairoa M24 Street underbridge Canterbury	Partial closures (weekends/nights over six months) Full closure (one night)	Beamish Street overbridge – 620 m east
Church Street/Hutton Street Footbridge (pedestrians and cyclists only), Canterbury	Full closure (periodic over six months)	No road diversions required; pedestrian and cyclist diversions to Melford Road overbridge and Canterbury Road overbridge – 275 m and 260 m respectively
Duke Street footbridge (pedestrians and cyclists only), Campsie	Full closure (periodic over six months)	No road diversions required; pedestrian and cyclist diversions to Wairoa Street underbridge and Beamish Street Overbridge – 680 m and 190 m respectively
Beamish Street overbridge, Campsie	Partial closures (weekends/nights over six months)	Loch Street overbridge – 275 m east
Loch Street overbridge, Campsie	Partial closures (weekends/nights over six months)	Beamish Street overbridge – 275 m west
Pedestrian access oval underbridge, Belmore	Full closure (weekends/nights over eight months)	No road diversions required; pedestrian and cyclist diversions to Loch Street overbridge and Burwood Road overbridge – 520 m and 500 m respectively
Burwood Road overbridge, Belmore	Partial closures (weekends/nights over six months) Partial closures (four weeks continuous)	Moreton Street overbridge – 600 m west

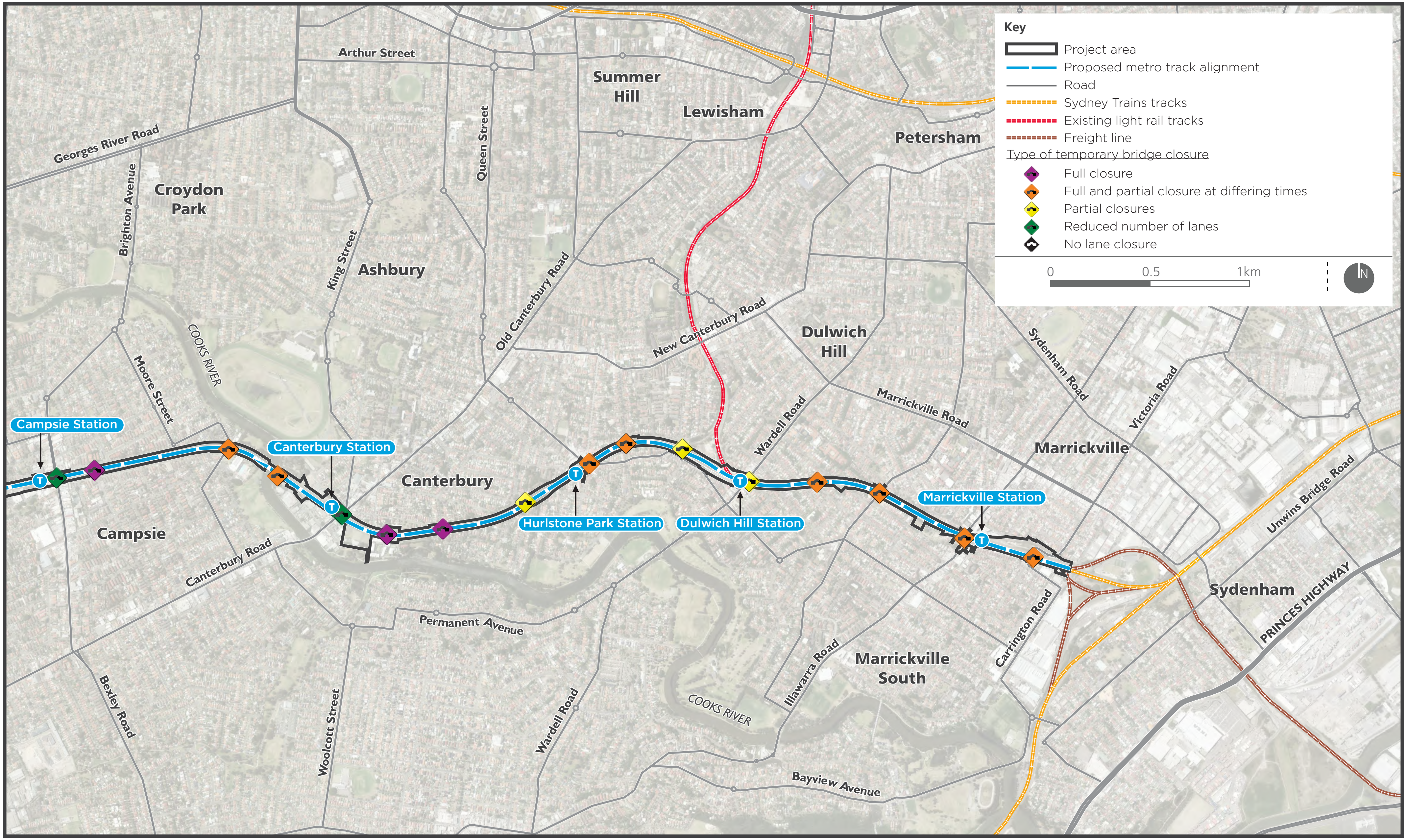
Bridge[1]	Type of closure (indicative duration for impact assessment purposes)	Alternate location for rail corridor crossing and distance along corridor to alternate location
Moreton Street overbridge, Lakemba	Partial closures (weekends/nights over six months) Partial closures (four weeks continuous)	Burwood Road overbridge – 600 m east
Haldon Street overbridge, Lakemba	Partial closures (weekends/nights over six months) Partial closures (four weeks continuous)	Moreton Street overbridge – 480 m west
King Georges Road overbridge, Wiley Park	Partial closures (three weeks)	No diversion required
Punchbowl Road overbridge, Punchbowl	No lane closures required	No diversion required
Stacey Street overbridge, Bankstown	Partial closures (weekends/nights over six months) Partial closures (four weeks continuous)	No diversion required
North Terrace/ South Terrace underbridge, Bankstown	Partial closures (weekends/nights over six months) Full closures (four weeks continuous)	Stacey Street overbridge – 280 m east
Chapel Road overbridge, Bankstown	No lane closures required	No diversion required

Notes: 1. Classified State roads are shown in **bold** font.
2: For the Illawarra Road overbridge, potentially longer closures (up to one month) are being investigated as a result of ongoing consultation with key stakeholders.

Potential modifications to accommodate construction vehicles

Construction traffic would include heavy and light vehicles associated with spoil and waste removal, material deliveries, and the arrival and departure of construction workers accessing the project area. Preliminary haulage routes were identified for each construction compound and other project area access points, as shown in Figures 9.1 and 9.5.

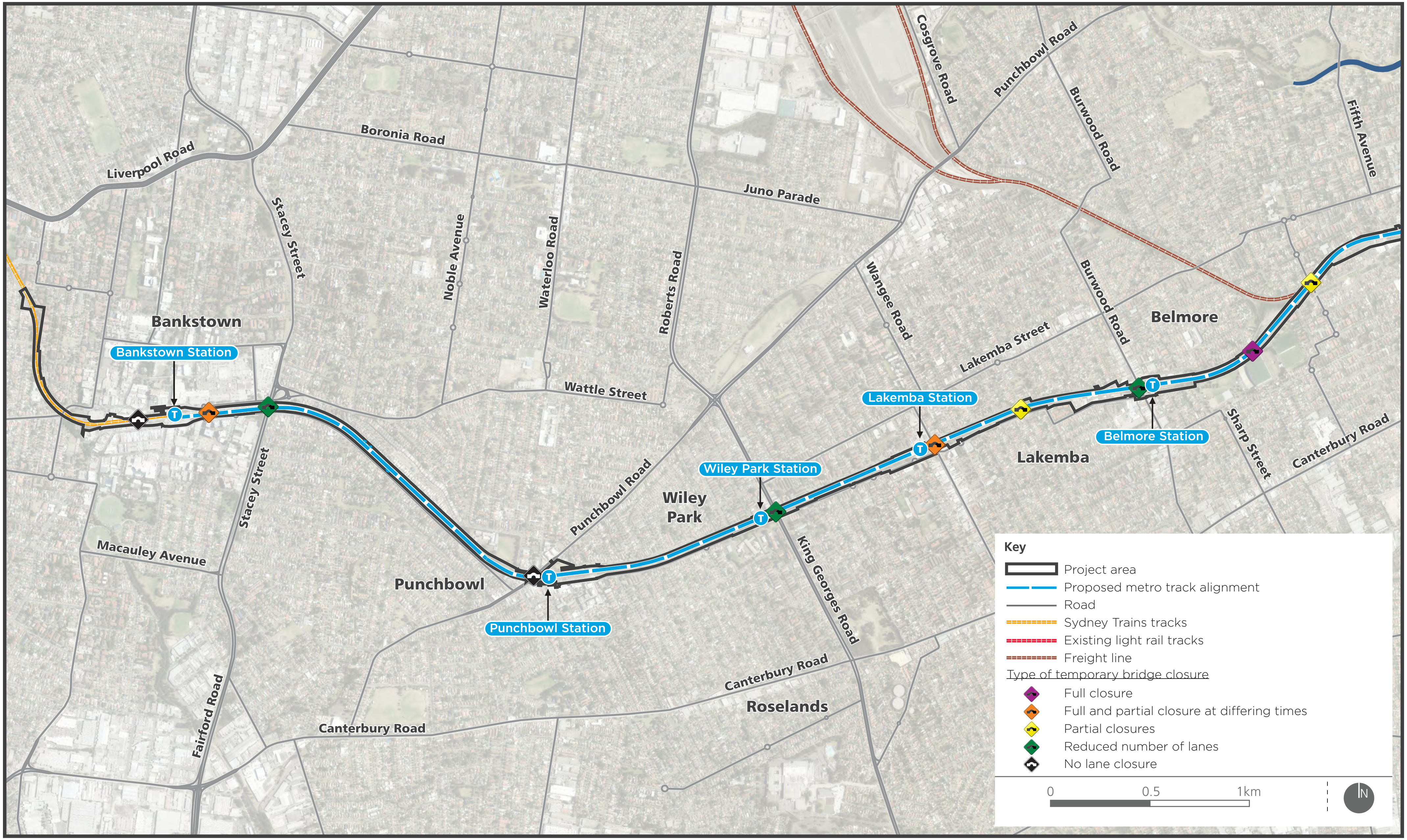
A preliminary swept-path analysis of the haulage routes was undertaken to identify potential obstacles to the movement of heavy vehicles associated with the project. Potential road modifications were identified to address these obstacles, and are outlined in Table 10.37. These works would be subject to further investigations following confirmation of the proposed haulage routes and vehicle types during detailed design and construction planning. Consideration of potential cumulative road network effects would form part of these investigations, which may result in the preliminary haulage routes being modified in consultation with relevant stakeholder.



sydney METRO | city & southwest

Location and types of bridge closures - map 1

FIGURE 10.13



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Location and types of bridge closures - map 2

FIGURE 10.13

Table 10.37 Potential road modifications required for construction vehicles

Station	Intersection/ movement requiring management or modification	Potential conflict identified	Potential scope of works to road and/or mitigation required
Marrickville	Left turn into Station Street from Illawarra Road	Conflict with existing building frontage for vehicles over 8.8 metres	Implementation of traffic controls for larger trucks
Hurlstone Park	Left turn into Crinan Street from Floss Street	Conflict with kerb and a tree	Options include: kerb adjustment works, tree removal and/or adjustment to construction hours
Canterbury	Left In and out movements at Canterbury Road/Close Street	In and out movements cannot take place simultaneously	Implementation of traffic controls for access out of Close Street onto Canterbury Road
	Movements along Close Street	Close Street is narrow and will not accommodate two way movements	Implementation of traffic controls
	Site entry to Canterbury Bowls gate	Conflict of vehicles travelling in and out of the work site	Implementation of traffic controls
	Left turn into Broughton Street from Canterbury Road	Conflicts with vehicles in the street	Temporary relocation of Broughton Street approach limit line further back to keep vehicles waiting at the traffic lights away from the conflict area
Belmore	Right turn into Tobruk Avenue from Burwood Road	Two existing kerb side car parks	Restriction or possible removal of car parking spaces during construction hours
	Right turn into Burwood Road from Dean Avenue	Kerbside parking	Restriction or possible removal of car parking spaces during construction hours
Lakemba	Left turn into Haldon Street from The Boulevarde	Existing kerb	Minor kerb cutback
Wiley Park	Left turn into The Boulevarde from King Georges Road (northbound)	Requirement to turn from lane 2 which is a through lane to avoid vehicles in The Boulevarde	Traffic management and a temporary re-alignment of the centre line on The Boulevarde
	Left turn into Lakemba Street from King Georges Road	Requirement to turn from lane 2 which is a through lane to avoid vehicles in Lakemba Street	Traffic management and closure of kerbside lane on King Georges Road during construction hours
Punchbowl	Left turn into Highclere Avenue from Wattle Street	Requirement to turn from middle lane to avoid vehicles in Highclere Avenue	Traffic management, realignment of Highclere Avenue centre line (including removal of existing centre median) and temporary parking ban on both sides of Highclere Avenue at times of delivery
	Left turn onto South Terrace from Loder Lane	Requirement for longer trucks to cross over the centre line to make the turn	Temporary removal of parking on South Terrace and use of cones or other physical barriers to separate trucks from on-coming vehicles

Station	Intersection/ movement requiring management or modification	Potential conflict identified	Potential scope of works to road and/or mitigation required
Bankstown	Right turn into Restwell Street from Raymond Street	Overlaps with adjacent right turn lane	Minor line-marking changes
	Left turn into Stacey Street from North Terrace	Overlaps with right turn lanes on Wattle Street	Minor adjustments to existing traffic island/ road marking

10.3.4 Alternative transport arrangements

As described in Section 9.11, a Temporary Transport Strategy has been developed to set a framework for managing the multi-modal transport network changes required during possession periods. The Temporary Transport Strategy is provided in Appendix G. The strategy provides options for alternative public transport arrangements, and aims to minimise transport disruption to customers currently accessing or travelling through stations between Lidcombe and Sydenham.

For each possession period, a temporary transport plan would be developed prior to works being undertaken. The temporary transport plan would define the initiatives to be implemented to assist customers affected by closures of the rail line, and the measures to minimise potential impacts associated with proposed alternative arrangements.

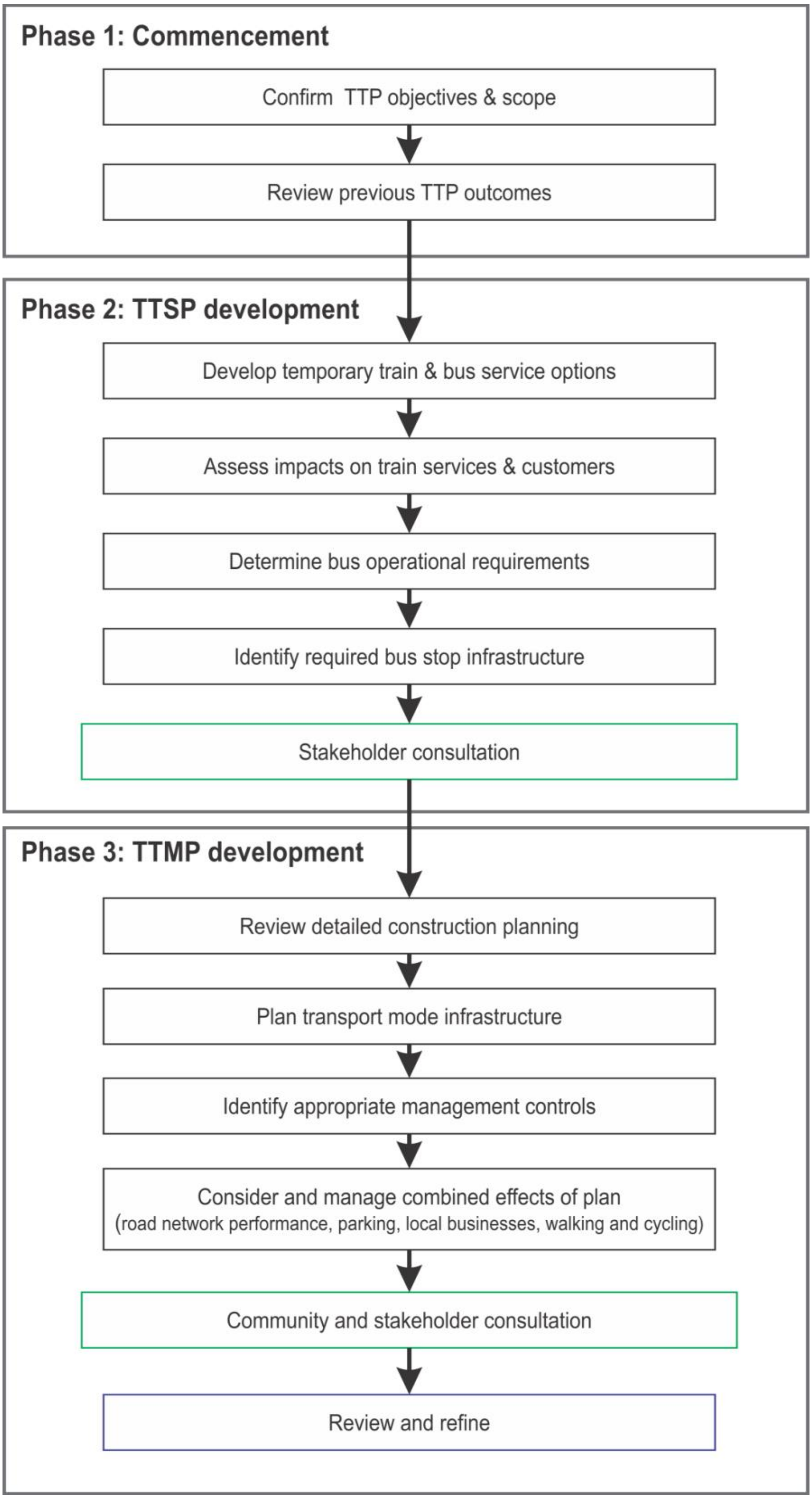
Each temporary transport plan would define the processes by which the impacts created by closures of the T3 Bankstown Line, and the operation of temporary train and bus services, would be managed. Each temporary transport plan would comprise a temporary transport service plan and a temporary transport management plan.

Developing the temporary transport plans would involve three main phases. The first phase would involve confirming the objectives and scope for the plan, and reviewing the performance of previous plans to determine the learnings that can be applied. Development of the first temporary transport plan for the project would include a review of the temporary transport plan for the Sydney Metro Northwest Epping to Chatswood project. Subsequent temporary transport plans would be developed with consideration given to the ones that preceded it, in an ongoing process of revision and refinement.

The second phase would involve preparing the temporary transport service plan. This plan would define the temporary rail and bus services that would operate during the possession period to meet the needs of affected customers.

The third phase would involve preparing the temporary transport management plan, which would consider the potential for wider impacts during possession periods, including those of the line closure, the operation of temporary transport services, and the interactions of construction activities.

The required inputs and three main phases to develop each plan is shown in Figure 10.14. Further information is provided in Section 9.11 and Appendix G.



Notes: TTP – temporary transport plan, TTSP – temporary transport services plan, TTMP – temporary transport management plan.

Figure 10.14 Process for developing a temporary transport plan

For the purposes of the assessment, the refined baseline temporary transport plan identified indicative routes proposed to be used by rail replacement buses (shown on Figure 10.15) which are:

- Route 1 - Lidcombe to Sydenham, all stations. This would provide consistent services during each possession between Sydenham and Lidcombe stations. During some possession periods, the route may only need to travel to Sefton or Regents Park instead of Lidcombe.
- Route 2 - Campsie to Sydenham, via Canterbury. This route would only stop at Canterbury Station when travelling from Campsie to Sydenham. It provides a reduced travel time and increased service reliability for customers travelling from Campsie and Canterbury.
- Route 3 - Hurlstone Park to Sydenham, via Dulwich Hill: This route would only stop at Dulwich Hill when travelling from Hurlstone Park to Sydenham. It would bypass Marrickville Station and travel via Wardell Road. It provides increased service frequency, reliability, and capacity for customers travelling from these stations.

These routes would potentially be supplemented by routes that travel to other rail lines and by increasing the frequency of regular bus routes. Additionally, options would be developed for buses to travel along different roads to reduce the concentration of buses along any one road or intersection.

Figure 10.15 Indicative routes for rail replacement bus services

10.4 Potential impacts

10.4.1 Risk assessment

Potential risks

The environmental risk assessment for the project, undertaken for the State Significant Infrastructure Application Report, identified the following as the main traffic, transport and access risks during construction:

- deterioration of traffic performance on the surrounding road network due to the movement of construction vehicles
- impacts of temporary road closures and traffic diversions
- delays or other impacts on the reliability of existing bus services
- impacts on customers during possession periods
- impacts on the reliability of rail services as a result of the closure of stations
- impacts of traffic performance in the surrounding area due to the operation of rail replacement bus services
- increased demand for rail services on other lines
- impacts on access to private properties
- impacts on availability of parking as a result of any reduction in the availability of commuter parking during construction.

How potential impacts have been avoided or minimised

Design development has included a focus on avoiding and/or minimising the potential for impacts during all key phases of the process. Potential transport and traffic impacts have been avoided/minimised where possible by:

- assessing various options and configuration of possession periods to balance the conversion of the T3 Bankstown Line stations and rail systems with the safety of rail workers, minimising impacts on Sydney Trains and ARTC operations, and options that result in the least disruption to the travelling public (as described in Chapter 6 (Alternatives and options)
- careful selection of preliminary construction haulage routes to ensure that vehicles are directed to suitably classified roads (i.e. designated heavy vehicle routes) via the shortest route and, where possible, minimising the distance travelled through residential areas, impacts to private property access, high pedestrian activity areas or other sensitive land uses
- selection of construction compounds to minimise their number and therefore the number of haulage routes required, which minimises as far as possible impacts to private properties and businesses in proximity to the stations, track and bridge works
- minimising impacts on existing parking areas, in particular used by businesses or residents as much as possible
- considering of construction methodologies to minimise the number of heavy vehicle movements required (e.g. prefabrication of components meaning that one vehicle delivers the component instead of multiple vehicles delivering small components which make the larger component)
- ensuring that viable alternative routes are available for use during bridge closures, and that cumulative impacts on network operation are considered.

- implementation of alternative transport arrangements that aim to minimise the potential impacts on the road network, and rail customers on the T3 Bankstown Line and other rail lines.

10.4.2 Station and corridor works – overview of results

This section describes the potential impacts of construction on regional and local traffic, transport, and access considerations. These potential impacts were assessed following consideration of the existing environment outlined in Section 10.2, alongside the temporary transport network changes required to construct the project outlined in Section 10.3. The results for each station are summarised in Section 10.4.3.

Active transport network

Construction would not impact on pedestrians or cyclists for extended periods of time. As described in Section 10.3, some short-term changes would occur to the active transport network. For pedestrians and cyclists, these changes may result in temporary impacts to routes due to activities such as bridge works resulting in road or pedestrian diversions, reduced road or footpaths widths, or where intersection changes/upgrades are to be undertaken.

For cyclists, construction may require shared haulage and cyclist routes, and temporary loss of cycle facilities at stations. Where practicable, existing bike parking facilities at stations would remain available for use while the new facilities are constructed. Where construction activities are likely to impact on existing bike facilities, alternate bike parking arrangements would be provided early in the construction program.

Interaction between haulage routes and cyclists surrounding stations would be minimal due to the relatively low construction traffic volumes predicted along roads where cycle facilities exist. Further, where haulage routes and cyclist would have to share a road corridor, these routes are generally located on wider streets, which would help to reduce the potential for conflict. Additional enhancements for pedestrian, cyclist, and motorist safety in the vicinity of the construction sites would be implemented where required during construction, as outlined in Section 10.5.

Public transport services

Overall impacts to bus services would be minimal. Bus routes would generally remain unchanged for the majority of the construction period with some short-term changes (described in Section 10.3.2) potentially required due to road diversions during temporary bridge closures.

Some bus stops may need to be temporarily relocated as a result of the positioning of compounds and work sites. In addition, during the implementation of the temporary transport management plans, some existing bus stops and layover areas would need to be shared with rail replacement buses, potentially resulting in temporary impacts to existing services.

Relocation of bus stops and bus rerouting would be limited, and when temporary stops are required, these would be positioned as close to the existing stops as practicable. Bus routing, stops and layover impacts would be considered in detail during preparation of the construction traffic management plan and the development of temporary transport management plans.

Transport for NSW would undertake an extensive community awareness and information campaign before each temporary transport management plan is implemented. This would include a range of communications activities, such as information at stations and bus stops regarding any short term changes, wayfinding signage, and clearly marked bus stop locations.

Road network performance

For construction haulage, the volume of materials that would need to be moved to and from the project area was analysed to estimate the total number of haulage vehicle movements required. The following maximum movements at each station were assumed:

- 20 light construction vehicle trips per hour (with the exception of Canterbury Station where 22 trips are expected)
- 20 heavy construction vehicle trips per hour (with the exception of Canterbury Station where 24 trips are expected)
- 15 to 55 bus trips per hour.

The assessment indicated that several locations exhibited deteriorating levels of service as a result of natural growth in background traffic volumes prior to construction commencing.

The assessment of the potential impacts of construction traffic movements concluded that only one intersection, the intersection of The Boulevarde and Haldon Street (near Lakemba Station on the southern side of the rail corridor), would become oversaturated in both the morning and afternoon peaks as a result of the movement of construction vehicles (not including rail replacement buses).

In addition, a number of other intersections across the project area were identified as likely to experience additional delays as a result of increases in construction traffic. In the majority of cases, the levels of service and degree of saturation would remain acceptable, and infrastructure upgrades are not considered to be required. Impacts at other intersections were remodelled using a range of mitigation options to identify whether the impacts could be reduced by minor changes to the way the intersections work.

Section 10.4.3 provides the road network performance results for each station, including the potential impacts of vehicle movements from compounds and work sites. It also summarises the results of the assessment of rail replacement buses, and the impacts of bridge works, including lane closures and diversions.

Changes to car parking

The project would require the temporary or permanent removal of some dedicated commuter parking spaces at many of the stations during construction, along with changes to the availability of some kiss and ride spaces, accessible spaces, taxis bays, and other restricted on-street parking spaces (i.e. timed spaces).

On-street parking spaces may also be affected by the provision of temporary bus stops during possession periods, however these impacts would occur during periods of lower demand (e.g. on weekends or during school holidays).

For many stations, existing unrestricted parking spaces located within a 400 metre catchment of each station could be used by commuters where dedicated commuter parking spaces (or other parking spaces) are affected during construction. Opportunities would also be investigated to provide replacement commuter parking spaces where long term impacts are anticipated (such as at Punchbowl Station, where 30 dedicated commuter parking spaces would be impacted by construction of the new station forecourt and entrance).

There is the potential that construction workers could use some of the existing parking spaces near stations and construction work areas. This potential impact would be minimised by providing some parking for workers within compounds and/or work sites where practicable. However, these spaces would generally no more than 10 per compound or work site. Opportunities for additional construction worker parking would be investigated during detailed construction planning, particularly for larger sites.

Additional strategies would be developed as part of the construction traffic management plan to minimise the potential for parking impacts, including encouraging workers to car pool or use public transport, and provision of off-site parking alternatives with associated shuttle bus arrangements.

Table 10.38 provides a summary of the indicative changes to parking during construction. These are subject to further investigation during detailed design and particularly in relation to the spaces potentially affected by rail replacement buses. The number of spaces potentially affected by rail replacement buses would be identified as part of the temporary transport management plan. It is noted that, following completion of construction in each area, the majority of these spaces would become available for use. For the purposes of this assessment, 'dedicated commuter parking' is described as existing unrestricted off-street parking spaces, located on RailCorp owned land, which is used for commuter parking.

Further information is provided for each station in Section 10.4.3.

Table 10.38 Indicative on and off-street car parking changes during construction

Station	Spaces affected for the duration of construction at stations		Spaces affected during possessions only		Additional spaces affected by rail replacement buses only	
	On-street	Off-street	On-street	Off-street	On-street	Off-street
Marrickville	3	0	7	0	3	0
Dulwich Hill	9	0	0	27	4	0
Hurlstone Park	0	23 (time-restricted)	0	0	8	0
Canterbury	0	0	0	32 (dedicated commuter)	0	0
Campsie	0	14 (dedicated commuter)	0	45 (dedicated commuter)	3 (time-restricted)	40
Belmore	0	29 (dedicated commuter) 46 (time-restricted spaces)	0	21 (time-restricted spaces)	7	0
Lakemba	0	47 (dedicated commuter)	0	25 (dedicated commuter)	12	0
Wiley Park	0	25[1]	0	0	16	0
Punchbowl	0	30 (dedicated commuter)	50	0	6 (time-restricted)	0
Bankstown	0	90 (dedicated commuter)	0	0	18	0

Note: 1. The 25 spaces temporarily removed at Wiley Park Station refers to the spaces that Roads and Maritime Services proposes to provide as part of the Sydney Clearways project.

In addition to the changes to parking outlined in Table 10.38, some changes to parking at other stations would be required to provide bus stops and layover areas during the operation of rail replacement bus services. Table 10.39 shows the potential changes at these stations, which would temporarily affect some on-street parking availability. The number of spaces affected would be reviewed during detailed design and construction planning.

Table 10.39 Indicative car parking changes at other stations

Station	Spaces affected by rail replacement buses
Sydenham	19
Yagoona	0
Birrong	6
Regents Park	0
Sefton	8
Berala	0
Lidcombe	20

10.4.3 Summary of assessment results

Marrickville Station

Active transport network

During construction of the station and associated facilities, some pedestrian or cyclist diversions would be required, due to the extent of the work site and compound area on Station Street, and during installation of the proposed new signalised intersection on the corner of Warburton Road, Schwebel Street, and Illawarra Road. Potential impacts would be managed by the installation of temporary traffic management measures, including crossings and pedestrian zones, defined by the construction traffic management plan (refer to Section 10.5).

Some changes to pedestrian and cycle networks would also be required during works to the Illawarra Road overbridge, the Charlotte Avenue underbridge, the Livingstone Road overbridge, and the Albermarle Street overbridge (refer to Table 10.36). During partial bridge closures, pedestrians would be diverted to the other side of the bridge, or within dedicated pedestrian areas. Some full closures would also be required for limited periods (up to three days). During these periods, walking distances would increase for those pedestrians diverted to the closest alternate rail corridor crossing, as outlined in Table 10.36.

Works at these bridges would result in cyclists using bridges to either:

- follow traffic management practices controlling traffic flow on the bridge
- follow the proposed traffic diversion to the next closest rail crossing, or
- dismount and walk through the closure before re-joining the route.

Use of the proposed construction haulage routes around Marrickville Station would result in Carrington Road and Illawarra Road being shared by haulage vehicles and cyclists. A review of the road geometry of Carrington Road indicated that there is sufficient width and a painted on-street bicycle shoulder lane, which would assist in minimising the potential for conflicts. As a result, there is considered to be minimal potential for impacts.

Illawarra Road is an on-road bicycle friendly road, which forms part of a regional bicycle route. Cyclists and construction haulage vehicles would share Illawarra Road. Relatively low volumes of construction vehicles would be generated, and as a result, the potential impact on user experience or safety is considered to be minor.

Public transport services

As outlined in Table 10.34, construction is not expected to affect any bus stops in the vicinity of the station, with the exception of:

- a short-term bus stop relocation may be required on Illawarra Road due to the close proximity of the project area, including the compound on Station Street
- temporary transport management plan bus stops would share existing bus stops on Illawarra Road, which may impact on the space available for existing services.

Existing bus services would not generally be impacted by construction, apart from some short-term bridge closures and partial lane closures on the Illawarra Road and Livingstone Road overbridges. This may result in inconveniences for some users of bus routes that cross these bridges. These changes would be limited and managed in consultation with the relevant bus operators and through communication to the general public.

Road network performance

Table 10.40 provides an indication of the performance of the road network surrounding Marrickville Station during construction.

Table 10.40 Marrickville Station intersection performance

Peak period	Future (without construction)		Future (with construction)		Future with construction and TTMP[1]	
	DoS[2]	LoS[3]	DoS[2]	LoS[3]	DoS[2]	LoS[3]
Illawarra Road/Warren Road (signals)						
Morning	0.81	B	0.81	B	0.89	B
Afternoon	0.89	B	0.89	B	0.88	B
Marrickville Road/Illawarra Road (signals)						
Morning	0.83	B	0.87	B	0.98	C
Afternoon	0.73	B	0.81	B	0.90	B
Marrickville Road/Victoria Road (signals)						
Morning	1.03	D	1.03	D	1.38	F
Afternoon	1.07	E	1.07	E	1.05	F
Petersham Road/Illawarra Road (signals)						
Morning	0.50	B	0.52	B	0.54	B
Afternoon	0.53	A	0.55	A	0.58	A
Marrickville Station overbridge (signals)						
Morning	0.49	A	0.50	A	0.53	A
Afternoon	0.54	A	0.56	A	0.58	A

Notes: 1. TTMP - temporary transport management plan.
2. DoS - degree of saturation.
3. LoS - level of service.
4. The assessment was based on the assumption that bridges remain open and no route diversions are in place. The potential impacts of bridge works and route diversions are considered in Section 10.4.4.

The modelling results indicate that the addition of construction vehicles would not change the level of service. However, the results predict that operation of the Marrickville Road/Victoria Road and the Marrickville Road/Illawarra Road intersections would deteriorate during weekday peak periods, as a result of the implementation of rail replacement buses as part of the refined temporary transport management plan. The performance of the Marrickville Road/Illawarra Road intersection would reduce from a level of service B to a level of service C during the morning peak period, and the Marrickville Road/Victoria Road intersection would reduce from a level of service D (morning) and E (afternoon) to a level of service F. However, rail replacement buses would operate during school holiday periods and/or times when traffic volumes are lower than the peak traffic periods used in the analysis. As a result, the potential impacts of rail replacement buses are likely to be less than predicted.

Further modelling was undertaken for the Marrickville Road/Illawarra Road intersection to include potential phasing changes at this intersection (details of these changes are provided in Section 5.3.4 of Technical paper 1) to mitigate the potential impacts of the operation of rail replacement buses. The inclusion of these phasing changes reduced congestion at this intersection. Traffic signal phasing changes would require the approval of Roads and Maritime Services.

The potential impacts of bridge closures is considered in Section 10.4.4.

Changes to parking

As there are no dedicated commuter spaces at or near Marrickville Station, there would be no impacts to commuter parking. However, three kiss and ride spaces, one accessible space, one taxi bay, and three short term spaces in Station Street, and two short-term spaces on Schwebel Street, would be intermittently unavailable during construction activities at Marrickville Station.

During operation of a temporary transport management plan, about three on-street parking spaces on Illawarra Road south of the rail line may be needed for temporary bus stops. These spaces would only be affected while rail replacement buses are operating. Rail replacement buses would operate during school holiday periods and/or times when parking demand is lower. As a result, the loss of these spaces is considered to be manageable.

These potential impacts (about 13 spaces) would be a small proportion of the existing on-street parking located in the vicinity of the station. As shown in Table 10.4, there are about 1,200 unrestricted on-street parking spaces located within 400 metres of Marrickville Station. Although the existing demand for on-street parking is relatively high (represented by the utilisation rate of 81 per cent), there would be some capacity to absorb the temporary loss of spaces during construction. It is recognised that alternative parking may be located further from the customer's preferred destination.

Dulwich Hill Station

Active transport network

During construction of the station and associated facilities, some pedestrian or cyclist diversions would be required. Construction activities would generally be located outside of the road reserve and would not affect footpaths, general pedestrian connectivity, or safety. However, restricted access and possible minor pedestrian diversions may be required as a result of the relocation of the existing station entrance on Wardell Road and the proposed pavement upgrades. Such changes would be minor and would not result in any substantial changes in travel distances for both pedestrians and cyclists.

There would be minimal potential for impacts to cyclists. Where possible, existing bike parking facilities at the station would remain available for use while the new facilities are constructed. In situations where construction activities are likely to impact the existing facilities, alternate bike parking arrangements would be provided early in the construction program.

Some changes to pedestrian and cycle networks would be required during works to the Wardell Road overbridge and the Ness Avenue/Terrace Road underbridge (refer to Table 10.36). During these works, pedestrians would be diverted to the other side of the bridge, or within dedicated pedestrian areas.

Potential impacts would be managed by the installation of temporary traffic management measures, defined by the construction traffic management plan (refer to Section 10.5).

Public transport services

As outlined in Table 10.34, construction is not expected to affect bus stops or services in the vicinity of the station. Rail replacement buses would share the existing bus stops on Dudley Street, which may impact the space available for existing services at certain times during possession periods, however such impacts are considered minimal as any queuing of buses would be temporary.

Construction would not affect access to the Dulwich Hill light rail stop. Access to the stop would be maintained at all times when the light rail is operational.

Road network performance

Table 10.41 provides an indication of the performance of the road network surrounding Dulwich Hill Station during construction.

Table 10.41 Dulwich Hill Station intersection performance

Peak period	Future (without construction)		Future (with construction)		Future with construction and TTMP[1]	
	DoS[2]	LoS[3]	DoS[2]	LoS[3]	DoS[2]	LoS[3]
Wardell Road/Ewart Street (signals)						
Morning	1.10	F	1.13	F	1.28	F
Afternoon	1.01	D	1.03	E	1.11	F
Wardell Road/Dudley Street (priority controlled)						
Morning	0.91	E	0.91	E	0.99	F
Afternoon	0.82	E	0.82	E	0.85	F
New Canterbury Road/Marrickville Road (signals)						
Morning	0.95	B	0.95	B	0.95	B
Afternoon	0.61	B	0.61	B	0.65	B
Ewart Street/Bayley Street (priority controlled)						
Morning	0.30	B	0.30	B	0.30	B
Afternoon	0.40	B	0.40	B	0.43	B
New Canterbury Road/Terrace Road (priority controlled)						
Morning	0.64	A	0.64	A	0.65	A
Afternoon	0.61	B	0.61	C	0.64	C
Wardell Road/Marrickville Road (signals)						
Morning	1.10	D	1.14	E	1.20	F
Afternoon	0.92	C	0.90	C	1.25	E

Notes: 1. TTMP - temporary transport management plan.
2. DoS - degree of saturation.
3. LoS - level of service.
4. The assessment was based on the assumption that bridges remain open and no route diversions are in place. The potential impacts of bridge works and route diversions are considered in Section 10.4.4.

The modelling results indicate that the performance of the Wardell Road/Ewart Street, the New Canterbury Road/Terrace Road, and the Wardell Road/Marrickville Road intersections would deteriorate as a result of the addition of construction traffic during morning and/or afternoon weekday peak hours. The implementation of rail replacement buses as part of the refined temporary transport management plan would result in further deterioration in performance at:

- Wardell Road/Ewart Street intersection, during the weekday afternoon peak period
- Wardell Road/Dudley Street intersection, during the weekday morning and afternoon peak periods
- Wardell Road/Marrickville Road intersection, during the weekday morning and afternoon peak periods.

The Wardell Road/Ewart Street and Marrickville Road/Wardell Road intersections are predicted to experience high congestion and delays. Further modelling was undertaken at these intersections to include changes in lane usage and traffic signal phasing (refer to Section 5.4.4 of Technical paper 1 for further details of these measures) to mitigate the potential impacts of construction traffic and rail replacement buses. The inclusion of these changes reduced congestions at both intersections. Traffic signal phasing changes would require the approval of Roads and Maritime Services.

Changes to parking

Due to the location and extent of the work site, it is estimated that about nine of the 17 time restricted on-street spaces along Bedford Crescent would be unavailable during the entire construction period. In addition, about 27 spaces (of the existing 55 dedicated commuter spaces) would be unavailable during possession periods.

The implementation of rail replacement buses is unlikely to impact any dedicated commuter spaces. However, about four on-street spaces on Dudley Street, south of the rail line, would be affected by the bus stops required to service rail replacement buses. These parking spaces would only be affected during possession periods.

Impacts to on-street parking spaces (about 13 spaces) would a small proportion of the existing on-street parking located in the vicinity of the station. About 50 per cent of the dedicated commuter parking spaces available at the station would be temporarily impacted during possession periods. As shown in Table 10.7, there are about 1,200 unrestricted on-street parking spaces within 400 metres of Dulwich Hill Station. As the utilisation rate of on-street parking is 74 per cent, there would be some capacity to absorb the temporary loss of spaces during construction. It is recognised that alternative parking may be located further from the customer’s preferred destination. In addition, the commuter spaces would only be affected during possession periods, where there may be lower demand for commuter parking.

Hurlstone Park Station

Active transport network

During construction of the station and associated facilities, footpaths, general pedestrian connectivity, and safety are not expected to be affected, as works would generally be contained in the rail corridor. However, station works would potentially require closure of the Floss Street car park and the footpath on Duntroon Street (adjacent to Hurlstone Park Station) during possession periods. During these periods, pedestrian movements would be maintained.

Bicycle friendly roads, such as Crinan Street, Garnet Street, and Dunstaffenage Street, have been identified as potential construction haulage routes. A review of the road geometry indicates that these roads are wide enough to accommodate construction vehicles. Cyclists and construction haulage vehicles would share sections of these roads. Estimates indicate relatively low volumes of construction vehicles. As a result, there would be minimal potential for impacts on user experience and safety.

Where possible, existing bike parking facilities at stations would remain available for use while the new facilities are constructed. In situations where construction activities are likely to impact the existing facilities, alternate bike parking arrangements would be provided early in the construction program.

Some changes to pedestrian and cycle networks would be required during works to the Garnet Road overbridge, the Crinan Street overbridge, the Foord Avenue underbridge, and the Melford Road overbridge (refer to Table 10.36). For all bridges other than the Melford Road overbridge, pedestrians would be diverted to the other side of the bridge, or within dedicated pedestrian areas during partial closures. For the Melford Road overbridge, the narrow width means that full closures would be required during bridge works. The Garnet Road and Crinan Street overbridges would also require some short-term (up to two days) full bridge closures. These closures would require short-term diversions, resulting in the potential for increases in travel distance (alternate rail corridor crossings are described in Table 10.36).

Public transport services

As outlined in Table 10.34, temporary relocation of the existing bus stop on Crinan Street (northbound) would potentially be required. The temporary replacement bus stop would be positioned close to the existing stop, and no impacts to bus services are expected.

Rail replacement buses would share the existing bus stops on Floss Street and Duntroon Street, which may impact the space available for existing services at certain times during possession periods.

The 406 bus service may need to be re-routed during works on the Crinan Street overbridge. This would require the temporary relocation of two bus stops (one in each direction). The replacement stops would be located as close as practicable to the existing stops, in consultation with bus operators.

The 418 bus service may also need to be re-routed during works on Garnet Street overbridge.

Road network performance

Table 10.42 provides an indication of the performance of the road network surrounding Hurlstone Park Station during construction.

Table 10.42 Hurlstone Park Station intersection performance

Peak period	Future (without construction)		Future (with construction)		Future with construction and TTMP[1]	
	DoS[2]	LoS[3]	DoS[2]	LoS[3]	DoS[2]	LoS[3]
Canterbury Road/Crinan Street (signals)						
Morning	0.67	B	0.68	B	0.73	B
Afternoon	0.78	B	0.80	B	0.83	C
Canterbury Road/New Canterbury Road (signals)						
Morning	0.96	C	0.96	C	0.99	C
Afternoon	0.91	C	0.91	C	0.90	C
Crinan Street/Floss Street - south of railway (priority controlled)						
Morning	0.28	A	0.29	A	0.37	A
Afternoon	0.24	A	0.25	A	0.29	A
Floss Street/Crinan Street/Duntroon Street (priority controlled)						
Morning	0.25	A	0.27	B	0.30	B
Afternoon	0.19	B	0.21	B	0.24	B

Notes: 1. TTMP - temporary transport management plan.
2. DoS - degree of saturation.
3. LoS - level of service.
4. The assessment was based on the assumption that bridges remain open and no route diversions are in place. The potential impacts of bridge works and route diversions are considered in Section 10.4.4.

The modelling results show that each intersection would perform satisfactorily during weekday peak hours.

Changes to parking

It is estimated that 23 time-restricted spaces on Floss Street (north) adjacent to the station would be unavailable during possession periods. About eight on-street spaces on Floss Street, south of the rail line, would also be affected by bus stops required for rail replacement buses during possession periods.

These potential impacts (about 31 spaces) would be a small proportion of the existing on-street parking located in the vicinity of the station. As shown in Table 10.10, there are about 1,100 unrestricted on-street parking spaces located within 400 metres of Hurlstone Park Station. There is moderate demand for on-street parking spaces (represented by the utilisation rate of 54 per cent). As a result, it is likely that there would be capacity to absorb the temporary loss of spaces during construction. It is recognised that alternative parking may be located further from the customer's preferred destination.

Canterbury Station

Active transport network

During construction of the station and associated facilities, some pedestrian or cycle diversions would be required, however these would be limited as the majority of works would be contained within the rail corridor. Some temporary footpath diversions may be required on Broughton Street during the construction of new kerbside facilities. Temporary pedestrian diversions would also need to be implemented during relocation of the station entrance.

There would be minimal potential for impacts to cyclists. Where possible, existing bike parking facilities at the station would remain available for use while the new facilities are constructed. In situations where construction activities are likely to impact the existing facilities, alternate bike parking arrangements would be provided early in the construction program.

Some changes to pedestrian and cycle networks would be required during works to the Canterbury Road overbridge, the Cooks River/Charles Street underbridge, and the Wairoa Street underbridge (refer to Table 10.36). During these works, pedestrians would be diverted to the other side of the bridge, or within dedicated pedestrian areas. During short-term full closures of the Cooks River/Charles Street and the Wairoa Street underbridges, the diversion of pedestrians to the closest alternate rail corridor crossing (as outlined in Table 10.36) would result in increased walking distances.

The Duke Street footbridge, a pedestrian and cyclist only bridge, would require periodic full closures during construction. During these times, pedestrians and cyclists would be diverted to the Wairoa Street and Beamish Street overbridges, resulting in some increased walking and cycling distances. Access by cycles along the Cooks River Cycleway would not be impacted. However, the movement of cycles along short sections of Broughton Street would need to be managed during construction.

Potential impacts would be managed by the installation of temporary traffic management measures, defined by the construction traffic management plan (refer to Section 10.5).

Public transport services

Construction is not expected to impact on bus stops in the vicinity of the station. However, the existing bus stop on the south side of Broughton Street would be relocated closer to the station entrance.

Rail replacement buses would share the existing bus service stops on Canterbury Road, which may affect the space available for existing services at certain times during possession periods, however such impacts are considered minimal as any queuing of buses would be temporary.

Partial road closures during works on the Canterbury Road overbridge would not affect bus routes, however service operation may be impacted by traffic management measures such as stop/go operations, or by any traffic congestion.

Road network performance

Table 10.43 provides an indication of the performance of the road network surrounding Canterbury Station during construction.

Table 10.43 Canterbury Station intersection performance

Peak period	Future (without construction)		Future (with construction)		Future with construction and TTMP[1]	
	DoS[2]	LoS[3]	DoS[2]	LoS[3]	DoS[2]	LoS[3]
Canterbury Road/Wonga Street (signals)						
Morning	0.82	B	0.83	B	0.84	B
Afternoon	0.83	B	0.84	B	0.86	B
Canterbury Road/Charles Street (priority controlled)						
Morning	0.57	F	0.58	F	0.60	F
Afternoon	0.60	F	0.66	F	0.64	F
Canterbury Road/Jeffrey Road (signals)						
Morning	0.88	B	0.88	B	0.88	B
Afternoon	0.93	B	0.93	B	0.93	B
Canterbury Road/Close Street (priority controlled)						
Morning	0.56	B	0.57	B	0.59	B
Afternoon	0.57	D	0.59	D	0.61	D

Notes:
1. TTMP - temporary transport management plan.
2. DoS - degree of saturation.
3. LoS - level of service.
4. The assessment was based on the assumption that bridges remain open and no route diversions are in place. The potential impacts of bridge works and route diversions are considered in Section 10.4.4.

The modelling results show that each intersection would perform satisfactorily during weekday peak hours.

Changes to parking

It is estimated that the 32 off-street dedicated commuter parking spaces on Charles Street would be unavailable during possession periods. No other impacts to on or off-street parking around the station are predicted.

Impacts to these off-street parking spaces would a small proportion of the unrestricted parking located in the vicinity of the station. As shown in Table 10.13, there are about 600 unrestricted on-street parking spaces located within 400 metres of Canterbury Station. There is moderate demand for on-street parking spaces (represented by the utilisation rate of 59 per cent). As a result, it is likely that there would be capacity to absorb the temporary loss of off-street parking spaces during construction. It is recognised that alternative parking may be located further from the customer's preferred destination. In addition, the commuter spaces would only be affected during possession periods, where there may be lower demand for commuter parking.

Campsie Station

Active transport network

During construction of the station and associated facilities, works would generally be contained to the rail corridor and impacts on pedestrian and cycle networks would be limited. However, the width of footpaths on South Parade, Lilian Street, and North Parade may need to be reduced in some situations.

The use of the rail corridor access gate adjacent to Lilian Street would require intermittent road closures for a limited period. These closures would occur during night works, and would have limited impacts on pedestrian movements. Traffic management (including but not limited to traffic control personnel and signage) would be put in place during closures to direct pedestrians along a safe alternative route.

Construction has the potential to impact on cyclists using Lilian Street. Traffic management measures, including detours, would be provided to ensure safe passage for cyclists.

There would be minimal potential for impacts to cyclists. Where possible, existing bike parking facilities at the station would remain available for use while the new facilities are constructed. In situations where construction activities are likely to impact the existing facilities, alternate bike parking arrangements would be provided early in the construction program.

A short section of Campsie Street, close to Beamish Street, has an on-street cycle path and is proposed as a construction haulage route. Cyclists and construction haulage vehicles would share this section of the road. Estimates indicate relatively low volumes of construction vehicles would be generated, and as a result, the potential impact on user experience and safety is considered to be minor.

Some changes to pedestrian and cycle networks would be required during works to the Beamish Street and Loch Street overbridges (refer to Table 10.36). During partial closures, pedestrians and cyclists would be diverted to the other side of the road.

Potential impacts would be managed by the installation of temporary traffic management measures, defined by the construction traffic management plan (refer to Section 10.5).

Public transport services

Works adjacent to the western end of South Parade would potentially affect a bus stop that serves a number of routes, including 487, 412, 415, 444, 445, and 473. It is proposed to relocate this stop to the opposite side of the rail corridor on North Parade. The stop would retain direct access to the station. The potential impact of this relocation on the reliability of timetabled bus services would be further evaluated during detailed design and construction planning.

During works to the Beamish Street overbridge, partial closures may require one direction of traffic to be periodically redirected to the Loch Street overbridge during weekends and nights, which would require the temporary relocation of bus routes and bus stops. This would be confirmed during detailed design and construction planning.

Rail replacement buses would share existing bus stops on South Parade, which may affect the space available for existing services at certain times during possession periods, however such impacts are considered minimal as any queuing of buses would be temporary.

Road network performance

Table 10.44 provides an indication of the performance of the road network surrounding Campsie Station during construction.

Table 10.44 Campsie Station intersection performance

Peak period	Future (without construction)		Future (with construction)		Future with construction and TTMP[1]	
	DoS[2]	LoS[3]	DoS[2]	LoS[3]	DoS[2]	LoS[3]
Beamish Street/Ninth Avenue (signals)						
Morning	0.69	B	0.69	B	0.71	B
Afternoon	0.71	B	0.73	B	0.79	B
Beamish Street/Clissold Parade (signals)						
Morning	0.81	B	0.78	B	0.92	C
Afternoon	1.05	E	1.07	E	1.35	F

Peak period	Future (without construction)		Future (with construction)		Future with construction and TTMP[1]	
	DoS[2]	LoS[3]	DoS[2]	LoS[3]	DoS[2]	LoS[3]
Beamish Street/South Parade (signals)						
Morning	0.90	B	0.92	B	0.91	C
Afternoon	0.96	B	0.94	B	1.79	F
Beamish Street/North Parade (priority controlled)						
Morning	0.71	C	0.72	C	0.72	C
Afternoon	0.72	C	0.72	C	1.78	F
Beamish Street/Amy Street (signals)						
Morning	0.51	A	0.52	A	0.52	A
Afternoon	0.94	B	0.95	B	0.96	B
Canterbury Road/Beamish Street (signals)						
Morning	0.95	C	0.95	C	0.95	C
Afternoon	0.94	C	0.94	C	0.92	C
Ninth Avenue/Loch Street (roundabout)						
Morning	0.97	D	0.97	D	1.01	E
Afternoon	0.97	B	0.97	B	0.99	C

Notes: 1. TTMP - temporary transport management plan.
2. DoS - degree of saturation.
3. LoS - level of service.
4. The assessment was based on the assumption that bridges remain open and no route diversions are in place. The potential impacts of bridge works and route diversions are considered in Section 10.4.4.

The modelling results indicate no changes to level of service as a result of the addition of construction traffic only. A number of the intersections are close to capacity based on the estimated degree of saturation. With the addition of rail replacement buses, a deterioration in the level of service was predicted at the following intersections:

- Beamish Street/Clissold Parade, during the morning and afternoon peak periods
- Beamish Street/South Parade, during the morning and afternoon peak periods
- Beamish Street/North Parade, during the afternoon peak period
- Ninth Avenue/Loch Street, during the morning and afternoon peak periods.

Changes to parking

It is estimated that about 14 of the 138 dedicated commuter parking spaces at Campsie Station would be unavailable for the duration of construction. About 45 commuter spaces would be temporarily affected during possession periods. In addition, during operation of rail replacement buses, about 40 commuter spaces would be potentially affected by the proposed bus layover areas on South Parade. About three on-street parking spaces would be required to accommodate the additional bus stop area required to manage rail replacement buses.

Impacts to on-street parking (about three spaces) would be a small proportion of the existing on-street parking located in the vicinity of the station. About 10 per cent of the dedicated commuter parking spaces at the station would be unavailable for the duration of construction. The majority of parking impacts at Campsie Station would occur temporarily during possession periods, when about 72 per cent of commuter spaces (or 20 per cent of the total number of off-street spaces) would be affected.

As shown in Table 10.16, there are about 760 unrestricted on-street parking spaces located within 400 metres of Campsie Station. Although the existing demand for on-street parking is high (represented by the utilisation rate of 85 per cent), there would be some capacity to absorb the temporary loss of spaces during construction. Alternatively, customers would need to use buses or other modes of transport, or walk further than 400 metres to access parking. It is recognised that alternative parking may be located further from the customer's preferred destination. It is noted that the main impacts to commuter parking spaces would be during possession periods, where there may be lower levels of demand.

Belmore Station

Active transport network

During construction of the station and associated facilities, impacts on pedestrian and cycle networks would be limited, as the works would generally be contained within the rail corridor. However, there may be the need for the following pedestrian diversions:

- Footpaths on Tobruk Avenue may need to be closed for limited periods during construction of the station and the proposed shared zone.
- Footpaths on Burwood Road may need to be closured during installation of the new signalised intersection and upgrades to existing footpaths.

Diversions would be provided to minimise the potential impacts of these closures.

Impacts to cyclists would be minimal, and where possible, existing bike parking facilities at the station would remain available for use while the new facilities are constructed. In situations where construction activities are likely to impact on existing bike facilities, alternate bike parking arrangements would be provided early in the construction program.

There is an off-road shared pedestrian and cycle path adjacent to the rail corridor between Bridge Road/Tobruk Avenue and Edison Lane. Works to the pedestrian underbridge to the Belmore Sports Ground would potentially require intermittent full closure of the shared pathway and underbridge. Local diversions would be put in place when works are undertaken. Where practicable, works would be programmed so as not to coincide with game days at Belmore Oval or other busy periods where practicable. Further information on traffic and access management during special events is provided in Section 10.4.7.

Some changes to pedestrian and cycle networks would be required during works to the Burwood Road overbridge (refer to Table 10.36). During partial closures, pedestrians and cyclists would be diverted to the other side of the road. Travel distances would not be impacted.

Potential impacts would be managed by the installation of temporary traffic management measures, defined by the construction traffic management plan (refer to Section 10.5).

Public transport services

Partial closure of the Burwood Road overbridge would be required for a number of weeks. During this time, bus routes 415 and 942 would need to be diverted and bus stops relocated, resulting in extra walking distances for some customers. Potential impacts would be managed, in consultation with bus operators, by the implementation of temporary traffic management measures defined by the construction traffic management plan.

Rail replacement buses would share the existing bus stops on Burwood Road, which may affect the space available for existing services at certain times during possession periods, however such impacts are considered minimal as any queuing of buses would be temporary.

Road network performance

Table 10.45 provides an indication of the performance of the road network surrounding Belmore Station during construction.

Table 10.45 Belmore Station intersection performance

Peak period	Future (without construction)		Future (with construction)		Future with construction and TTMP[1]	
	DoS	LoS	DoS	LoS	DoS	LoS
Burwood Road/Bridge Road (priority controlled)						
Morning	1.03	F	1.39	F	1.46	F
Afternoon	1.05	F	1.39	F	1.46	F
Burwood Road/Redman Parade (priority controlled)						
Morning	0.69	F	0.72	F	0.74	F
Afternoon	0.72	F	0.74	F	0.76	F
Burwood Road/Lakemba Street (signals)						
Morning	0.96	C	0.92	C	1.51	F
Afternoon	0.90	B	0.90	B	1.56	F
Canterbury Road/Burwood Road (signals)						
Morning	0.91	A	0.91	A	0.91	A
Afternoon	0.97	B	0.97	B	0.97	B

Notes: 1. TTMP - temporary transport management plan.
2. DoS - degree of saturation.
3. LoS - level of service.
4. The assessment was based on the assumption that bridges remain open and no route diversions are in place. The potential impacts of bridge works and route diversions are considered in Section 10.4.4.

The modelling results show that the level of service at each intersection would not change with the addition of construction traffic. The intersections at Burwood Road/Bridge Road and Burwood Road/Redman Parade would continue to operate at capacity. With the addition of rail replacement buses, the performance of the Burwood Road/Lakemba Street intersection is predicted to deteriorate to a level of service F.

Additional modelling was undertaken for the Burwood Road/Bridge Road and Burwood Road/Lakemba Street intersections to assess the effect of providing mitigation measures such as changes to movements and phasing. The results indicate that implementing these measures would reduce congestion during the morning and afternoon peaks, however the level of service at the Burwood Road/Lakemba Street intersection would remain at F. Further refinement of mitigation measures and routes for rail replacement buses would minimise the potential impacts.

The Burwood Road/Bridge Road intersection is proposed to be signalised as part of the project. Whilst this is not proposed to mitigate the potential construction impacts outlined above, signalising the intersection prior to the operation of rail replacement buses would reduce the potential impacts. An initial assessment showed that a signalised intersection would operate with a level of service B or C.

Change to parking

Due to the location of the work site, it is estimated that about 29 dedicated commuter spaces would be unavailable for the duration of construction. An additional 21 off-street time restricted spaces would be temporarily impacted during possession periods. Following each possession, reconfiguration of these spaces may be required depending on the proposed impacts.

It is estimated that 48 time restricted off-street parking spaces on Tobruk Avenue would be unavailable during and following construction, as this area is required for the new station forecourt and entrance. The potential impact of this long-term loss of parking is considered in Section 11.4.9.

During operation of rail replacement buses, about seven on-street parking spaces would be temporarily affected to enable provision of bus stops in the vicinity of the station.

Impacts to on-street parking spaces (about seven spaces) would a small proportion of the existing on-street parking in the vicinity of the station. About 50 per cent of the dedicated commuter parking spaces at the station would be unavailable for the duration of construction. The majority of commuter parking spaces would be unavailable during possession periods, however these additional impacts would be temporary. As shown in Table 10.19, there are about 900 unrestricted on-street parking spaces within 400 metres of Belmore Station. As the utilisation rate of on-street parking is 76 per cent, there would be some capacity to absorb the loss of spaces during construction. Alternatively, customers would need to use buses or other modes of transport, or walk further than 400 metres to access parking. It is recognised that alternative parking may be located further from the customer’s preferred destination.

Lakemba Station

Active transport network

During construction of the station and associated facilities, impacts on pedestrian and cycle networks would be limited, as the works would generally be contained within the rail corridor. However, the width of footpaths on The Boulevarde and Railway Parade may need to be reducted in some situations.

Impacts to cyclists would be minimal, and where possible, existing bike parking facilities at the station would remain available for use while the new facilities are constructed. In situations where construction activities are likely to impact on existing bike facilities, alternate bike parking arrangements would be provided early in the construction program.

A section of Haldon Street and Lakemba Street is common to both the on-street cycle friendly network and the proposed construction haulage routes. Estimates indicate that relatively low volumes of construction vehicles would be generated on the short section of road to be shared (i.e. 50 metres). As a result, the potential impact on user experience and safety is considered to be minor.

Some changes to pedestrian and cycle networks would be required during works to the Moreton Street and Haldon Street overbridges (refer to Table 10.36). During partial closures, pedestrians and cyclists would be diverted to the other side of the road.

Potential impacts would be managed by the installation of temporary traffic management measures, defined by the construction traffic management plan (refer to Section 10.5).

Public transport services

During works on the Haldon Street overbridge, the bus route using the bridge would be redirected to the Moreton Street overbridge. The diversion of this route would result in a number of stops (up to six) being skipped. This would also increase walking distances to the nearest bus stop (up to 1.2 kilometres). Further consideration of bus routes would be undertaken during detailed design and construction planning to minimise the potential impacts where practicable. Diversions are also only likely to be required during weekends and school holiday periods when the demand for buses is lower.

Rail replacement buses would share existing bus stops on The Boulevarde, which may affect the space available for existing services at certain times during possession periods, however such impacts are considered minimal as any queuing of buses would be temporary.

Road network performance

Table 10.46 provides an indication of the performance of the road network surrounding Lakemba Station during construction.

Table 10.46 Lakemba Station intersection performance

Peak period	Future (without construction)		Future (with construction)		Future with construction and TTMP[1]	
	DoS	LoS	DoS	LoS	DoS	LoS
The Boulevarde/Haldon Street (signals)						
Morning	1.05	E	1.12	F	1.21	F
Afternoon	1.10	E	1.16	F	1.18	F
Lakemba Street/Wangee Road (signals)						
Morning	0.92	B	0.92	B	0.92	B
Afternoon	0.90	B	0.90	B	0.90	B
Haldon Street/Railway Parade (priority controlled)						
Morning	1.03	F	1.22	F	1.22	F
Afternoon	1.06	F	1.18	F	1.18	F
Lakemba Street/Haldon Street (signals)						
Morning	0.59	B	0.59	B	0.59	B
Afternoon	0.57	A	0.57	A	0.57	A
Pedestrian crossing on The Boulevarde (signals)						
Morning	0.46	A	0.46	A	0.49	A
Afternoon	0.38	A	0.38	A	0.42	A
Canterbury Road/Haldon Street (signals)						
Morning	0.86	A	0.86	A	0.86	A
Afternoon	0.90	B	0.90	B	0.90	B

Notes: 1. TTMP - temporary transport management plan.
2. DoS - degree of saturation.
3. LoS - level of service.
4. The assessment was based on the assumption that bridges remain open and no route diversions are in place. The potential impacts of bridge works and route diversions are considered in Section 10.4.4.

The modelling results indicate that the level of service would not change at the majority of intersections. However, a deterioration in intersection performance is predicted at The Boulevarde/Haldon Street intersection during both the morning and afternoon peaks as a result of the addition of construction vehicles.

The Haldon Street/Railway Parade intersection is predicted to operate at a level of service F even without the addition of construction vehicles and rail replacement buses. Modelling was undertaken to assess the intersection’s performance with the inclusion of mitigation measures such as signalisation. The results indicated that these measures would improve the level of service from F to B and A during the morning and afternoon peaks respectively.

Change to parking

It is estimated that about 47 dedicated commuter parking spaces would be unavailable for the duration of construction. An additional 25 commuter parking spaces on Railway Parade would be temporarily impacted during possession periods. About 12 on-street spaces would be affected by the bus stops required for rail replacement buses during possession periods.

The predicted impacts to on-street parking would be a small proportion of the existing on-street parking located in the vicinity of the station. About 34 per cent of the dedicated commuter parking spaces at the station would be unavailable for the duration of construction. This impact would increase to 52 per cent of the spaces during possession periods. However, these additional impacts would be temporary. As shown in Table 10.22, there are about 770 unrestricted on-street and 540 off-street parking spaces within 400 metres of the station. Although the utilisation rate of on-street parking is relatively high (around 85 per cent), there would be some capacity to absorb the loss of spaces during construction. Alternatively, customers would need to use buses or other modes of transport, or walk further than 400 metres to access parking. It is recognised that alternative parking may be located further from the customer's preferred destination.

Wiley Park Station

Active transport network

During construction of the station and associated facilities, works would generally be contained within the rail corridor, however some works adjacent to footpaths on The Boulevarde and Stanlea Parade would be required. As far as practicable, works would be physically separated from footpaths to maintain footpath widths and pedestrian access. In some instances, footpaths may be affected during construction of new kerbside facilities and pavements. Diversions would be provided during these periods.

Lakemba Street and Urunga Parade are common to both the on-street cycle friendly network and the proposed construction haulage routes. Cyclists and construction haulage vehicles would share this section of the road. Estimates indicate that relatively low volumes of construction vehicles would be generated, and as a result, there would be minimal potential for impacts on user experience and safety.

Impacts to cyclists would be minimal, and where possible, existing bike parking facilities at the station would remain available for use while the new facilities are constructed. In situations where construction activities are likely to impact on existing bike facilities, alternate bike parking arrangements would be provided early in the construction program.

Some changes to pedestrian and cycle networks would be required during works to the King Georges Road overbridge (refer to Table 10.36). During partial closures, pedestrians and cyclists would be diverted to the other side of the road.

Potential impacts would be managed by the installation of temporary traffic management measures, defined by the construction traffic management plan (refer to Section 10.5).

Public transport services

Construction activities are not expected to impact on bus services or stops near the station.

Road network performance

Table 10.47 provides an indication of the performance of the road network surrounding Wiley Park Station during construction.

Table 10.47 Wiley Park Station intersection performance

Peak period	Future (without construction)		Future (with construction)		Future with construction and TTMP[1]	
	DoS	LoS	DoS	LoS	DoS	LoS
King George Road/Lakemba Street (signals)						
Morning	0.95	C	0.97	C	0.95	C
Afternoon	0.96	D	0.98	D	0.98	D
King Georges Road/The Boulevarde (signals)						
Morning	0.98	D	1.01	D	0.96	E
Afternoon	0.96	D	0.97	D	0.95	D

Notes: 1. TTMP - temporary transport management plan.
2. DoS - degree of saturation.
3. LoS - level of service.
4. The assessment was based on the assumption that bridges remain open and no route diversions are in place. The potential impacts of bridge works and route diversions are considered in Section 10.4.4.

The modelling results indicate that the addition of rail replacement buses would result in a deterioration in the level of service at the King Georges Road/The Boulevarde intersection during the morning peak period, from a level of service D to E. This intersection is already near capacity in the future scenario. The addition of construction traffic and rail replacement buses would result in a further deterioration in performance.

Scheduling works to occur during school holidays would significantly reduce congestion at this intersection due to the lower background traffic flows during these periods.

Change to parking

It is estimated that about 16 on-street parking spaces would be temporarily affected by the bus stops required for rail replacement buses during possession periods. These potential impacts would be a small proportion of the existing on-street parking located in the vicinity of the station. As shown in Table 10.25, there are about 700 unrestricted on-street parking spaces located within 400 metres of the station. As the utilisation rate of on-street parking is 63 per cent, there would be some capacity to absorb the temporary loss of spaces during construction. It is recognised that alternative parking may be located further from the customer's preferred destination.

Punchbowl Station

Active transport network

During construction of the station and associated facilities, works would generally be contained within the rail corridor, limiting potential impacts on pedestrian and cycle networks. However, there may be some situations where the width of footpaths would need to be reduced due to the extent of the work sites and the positioning of hoarding.

The implementation of management measures would ensure that the following pedestrian movements are not impacted:

- access to and from the station entrance on the northern side of the station prior to its removal
- access to and from the proposed new station entrance on the northern side of the station once it is completed and the old entrance is removed
- access along The Boulevarde during construction of new kerbside areas.

Impacts to cyclists would be minimal, and where possible, existing bike parking facilities at the station would remain available for use while the new facilities are constructed. In situations where construction activities are likely to impact on existing bike facilities, alternate bike parking arrangements would be provided early in the construction program. As outlined in Section 10.5, further information on alternative arrangements will be available following the detailed design and construction planning stages.

Potential impacts would be managed by the installation of temporary traffic management measures, defined by the construction traffic management plan (refer to Section 10.5).

Public transport services

Construction activities are not expected to impact on bus services or stops near the station. Rail replacement buses would share the existing bus stops on The Boulevarde, which may affect the space available for existing services at certain times during possession periods, however such impacts are considered minimal as any queuing of buses would be temporary.

Road network performance

Table 10.48 provides an indication of the performance of the road network surrounding Punchbowl Station during construction.

Table 10.48 Punchbowl Station intersection performance

Peak period	Future (without construction)		Future (with construction)		Future with construction and TTMP[1]	
	DoS[2]	LoS[3]	DoS[2]	LoS[3]	DoS[2]	LoS[3]
Punchbowl Road/South Terrace (signals)						
Morning	1.02	F	1.03	F	1.03	F
Afternoon	0.87	C	0.87	C	0.91	C
Punchbowl Road/The Boulevarde (signals)						
Morning	0.99	C	1.00	C	1.05	D
Afternoon	0.87	C	0.88	C	0.93	D
Punchbowl Road/Rossmore Avenue (priority controlled)						
Morning	0.42	A	0.42	A	0.42	A
Afternoon	0.48	A	0.48	A	0.48	A
The Boulevarde/Arthur Street (signals)						
Morning	0.63	B	0.65	B	0.72	B
Afternoon	0.71	B	0.70	B	0.77	B

Notes: 1. TTMP - temporary transport management plan.
2. DoS - degree of saturation.
3. LoS - level of service.
4. The assessment was based on the assumption that bridges remain open and no route diversions are in place. The potential impacts of bridge works and route diversions are considered in Section 10.4.4.

The modelling results indicate that the addition of rail replacement buses would result in a deterioration in the level of service at the Punchbowl Road/The Boulevarde intersection during the morning and afternoon peak periods, from a level of service C to D.

The Punchbowl Road/South Terrace intersection is at capacity in the future scenario during the morning peak, and its performance is predicted to worsen during construction, with delays increasing to almost 1.5 minutes. However, the level of service (F) would remain the same. The addition of rail replacement buses is not expected to change the level of service of this intersection during the morning peak. During the afternoon peak, low congestion levels mean that the addition of rail replacement buses would result in minimal change to the level of service.

Changes to parking

It is estimated that about 30 dedicated commuter spaces would be unavailable during construction, as this area is required for the new station forecourt and entry on The Boulevarde. An additional 50 unrestricted on-street spaces on The Boulevarde would be unavailable during construction. During the operation of rail replacement buses, about six on-street parking spaces would also be affected by the required bus stops.

The predicted impacts to on-street parking would affect about seven per cent of the existing on-street parking within 400 metres of the station. About 22 per cent of the dedicated commuter parking spaces would be unavailable for the duration of construction. As shown in Table 10.28, there are about 600 unrestricted on-street parking spaces within 400 metres of the station. As the utilisation rate of on-street parking is 79 per cent, there would be some capacity to absorb the loss of spaces during construction. Alternatively, customers would need to use buses or other modes of transport, or walk further than 400 metres to access parking. Opportunities would also be investigated to provide replacement commuter parking spaces for the spaces that would be permanently lost. It is recognised that alternative parking may be located further from the customer's preferred destination.

Bankstown Station

Active transport network

During construction of the station and associated facilities, works would generally be contained within the rail corridor, and would not impact on adjacent footpaths. Works in the vicinity of the station would be staged to ensure that pedestrian and cycle access is provided at all times.

Some changes to pedestrian and cycle networks would be required during works to the Stacey Street overbridge and the North Terrace to South Terrace underbridge (refer to Table 10.36). During the southbound partial closure of the Stacey Street overbridge, re-routing of pedestrians would be required.

A full closure of the North Terrace to South Terrace underbridge would also be required, and pedestrian movements would need to be diverted about 300 metres to the Stacey Street overbridge or the Chapel Street bridge (at the existing Bankstown Station entrance) for about four weeks.

Impacts to cyclists would be minimal, and where possible, existing bike parking facilities at the station would remain available for use while the new facilities are constructed. In situations where construction activities are likely to impact on existing bike facilities, alternate bike parking arrangements would be provided early in the construction program.

Potential impacts would be managed by the installation of temporary traffic management measures, defined by the construction traffic management plan (refer to Section 10.5).

Public transport services

The existing bus layover located adjacent to South Terrace, between Restwell Street and Lopez Lane, would be reconfigured. Initially, construction vehicles would use the layover area to access the adjacent compound. The use of this area is not expected to affect the functionality of the layover.

Rail replacement buses would share the existing bus stops on North Terrace, South Terrace, and Appian Way, which may impact the space available for the existing services at certain times during possession periods.

Road network performance

Table 10.49 provides an indication of the performance of the road network surrounding Bankstown Station during construction.

Table 10.49 Bankstown Station intersection performance

Peak period	Future (without construction)		Future (with construction)		Future with construction and TTMP[1]	
	DoS[2]	LoS[3]	DoS[2]	LoS[3]	DoS[2]	LoS[3]
South Terrace/Restwell Street (signals)						
Morning	0.64	B	0.65	B	0.79	C
Afternoon	0.61	B	0.62	B	0.79	C
Restwell Street/Raymond Street (signals)						
Morning	0.83	B	0.83	B	0.86	B
Afternoon	0.82	B	0.85	B	0.86	C
South Terrace/West Terrace (signals)						
Morning	0.63	C	0.64	C	0.67	B
Afternoon	0.69	C	0.70	C	0.74	C
Meredith Street/Marion Street (signals)						
Morning	0.90	C	0.90	C	0.91	C
Afternoon	0.92	C	0.92	C	0.92	C
Stacey Street/Wattle Street (roundabout)						
Morning	0.89	B	0.89	B	0.89	B
Afternoon	1.10	C	1.10	C	1.10	C
North Terrace/Wattle Street (roundabout)						
Morning	0.77	B	0.77	B	0.95	B
Afternoon	0.99	F	0.99	F	0.99	F
Stanley Street/Stacey Street (signals)						
Morning	0.95	B	0.95	B	0.95	B
Afternoon	1.10	B	1.24	B	1.24	B
The Appian Way/North Terrace (priority controlled)						
Morning	0.68	B	0.68	B	0.76	C
Afternoon	1.07	F	1.07	F	1.25	F
Marion Street/Oxford Avenue (signals)						
Morning	0.75	B	0.75	B	0.75	B
Afternoon	0.90	B	0.90	B	0.90	B
Marion Street/Greenwood Avenue (signals)						
Morning	0.89	C	0.89	C	0.89	C
Afternoon	0.90	C	0.90	C	0.91	C

Notes: 1. TTMP - temporary transport management plan.
2. DoS - degree of saturation.
3. LoS - level of service.
4. The assessment was based on the assumption that bridges remain open and no route diversions are in place. The potential impacts of bridge works and route diversions are considered in Section 10.4.4.

The modelling results predict a deterioration in intersection performance at the following intersections:

- South Terrace/Restwell Street, during the morning and afternoon peak periods
- Restwell Street/Raymond Street, during the afternoon peak period
- Appian Way/North Terrace, during the morning peak period.

The North Terrace/Wattle Street and the Appian Way/North Terrace intersections would have a level of service F in the future scenario during the afternoon peak period.

During the morning and afternoon peak periods, the South Terrace/Restwell Street intersection would experience a deterioration in performance as a result of the addition of rail replacement buses, from a level of service B to C.

The Restwell/Raymond Street intersection would also experience a reduction in the level of service from B to C during the afternoon peak period. The addition of rail replacement buses would result in a deterioration in the level of service of the Appian Way/North Terrace intersection during the morning peak period, from B to C.

Parking

About 90 dedicated commuter spaces would be unavailable during construction as a result of the proposed location of a construction compound adjacent to North Terrace. During the operation of rail replacement buses, about 18 on-street parking spaces would be temporarily affected by the required bus stops.

The predicted impacts to parking would affect about 61 per cent of the dedicated commuter parking spaces (or about eight per cent of off-street parking spaces), and three per cent of the on-street parking (during possessions only) in the vicinity of the station. As shown in Table 10.31, there is a high demand for parking in the vicinity of the station, with a utilisation rate of 93 per cent for on-street spaces, and 100 per cent for off-street/commuter parking. About 1,500 passengers enter Bankstown Station in the hour from 7:15 to 8:15. This shows that the 147 commuter parking spaces within 400 metres of the station are only providing for a small proportion of the total commuter demand.

There is limited ability for existing on and off-street parking within a 400 metre catchment of the station to absorb construction parking changes, as a result of the high levels of use. During construction, customers would need to use buses or other modes of transport, or walk further than 400 metres to park and ride.

Other stations

The following stations would not be directly impacted by construction, other than as a result of any enabling activities required to implement alternative transport arrangements in accordance with the Temporary Transport Strategy. During possession periods, rail services along the T3 Bankstown Line would be suspended, which would impact rail services at these stations.

The performance of key intersections in the vicinity of these stations was modelled taking into account the operation of rail replacement buses. Potential impacts are summarised below.

Sydenham Station

The results of modelling show that the impact of rail replacement buses would be minimal, with all intersections continuing to operate at a level of service C or better.

During possession periods, about 19 on-street parking spaces on Burrows Avenue and Railway Parade would be affected by the provision of a set down area for rail replacement buses.

Yagoona Station

The results of modelling show that with rail replacement buses operating, the Chapel Road/Hume Highway intersection would retain a level of service C during both the morning and afternoon peaks. The Church Road/Hume Highway has an existing level of service F during the morning and afternoon peaks. The modelled average delay was predicted to increase from the existing 10 minutes to nearly 13 minutes with the addition of rail replacement buses, and 16 minutes under the future scenario. It was also predicted that delays during the afternoon peak would increase from the existing five minutes to nearly 16 minutes.

The impacts of the introduction of rail replacement buses would be monitored, and mitigation strategies would developed if required. In addition, alternative routes for some or all rail replacement buses would be investigated, taking into account the results of modelling.

No impacts to parking spaces are predicted.

Birrong Station

The results of modelling show that with rail replacement buses operating, the level of service would decline to D during the morning peak. However, a level of service D would not cause delays above those that would be reasonably expected in the peak hour. In the afternoon peak, the level of service would decline to C with the addition of rail replacement buses.

During possession periods, about six on-street short-term parking spaces would be affected by the provision of bus stops for rail replacement buses.

Regents Park Station

The results of modelling show that with rail replacement buses operating, key intersections around Regents Park Station would have a level of service of B or better after accounting for a minor predicted increase in delays resulting from future traffic growth. A level of service B would not cause noticeable delays for commuters in the peak hour. In the afternoon peak, the intersections around Regents Park Station are predicted to remain at a level of service A.

No impacts to parking spaces are predicted.

Sefton Station

About eight on-street parking spaces would be impacted as a result of the operation of ail replacement buses.

Berala Station

No impacts are predicted at Berala Station.

Lidcombe Station

The results of modelling show that with rail replacement buses operating, all four intersections near Lidcombe Station would have a level of service D or better after allowing for future traffic growth. The Olympic Drive/Church Street intersection is the only intersection that is forecast to experience a noticeable decline in service, however this is mostly attributable to future traffic growth. The operation of rail replacement buses would increase the delay by about eight seconds. This is considered to be within the range of reasonable daily fluctuations and is unlikely to be noticed by commuters.

In the afternoon peak, it is predicted that three of the four intersections would have a level of service B or better. The Olympic Drive/Church Street intersection is forecast to experience some deterioration as a result of the addition of rail replacement buses in the afternoon peak, with the predicted level of service D in the future traffic scenario worsening to a level of service E. However, as the majority of the possession periods are scheduled to occur in school holidays, congestion would be expected to be less than that modelled.

During possession periods, about 20 on-street time restricted parking spaces would be affected by the provision of bus stops for rail replacement buses.

Impacts of traction power supply route

Construction of the proposed traction power supply cable between Campsie Station and the Canterbury Substation would affect a number of streets along the route. Construction would involve trenching activities within the road reserves, which has the potential to result in temporary impacts on the operation of those roads. Potential impacts would be related to impacts on the trafficable lanes, parking lanes, or footpaths along roads.

Where practicable, construction of the cable would be managed to ensure that two-way traffic along impacted roads would be maintained. However, temporary lane or road closures could be required. The community would be made aware of any changes to access along these roads, and appropriate traffic management measures would be put in place where changes in traffic movements are required.

The proposed cable would need to cross Canterbury Road, which is a main road with high traffic volumes. Impacts on the road would be minimised by undertaking the works out of hours. The use of horizontal directional drilling techniques would also be considered to minimise potential impacts.

Construction of the cable would have the potential to affect property access. Any impacts would be short-term as the works would move along the alignment. The time during which access could be affected would be minimised to the shortest period possible. Alternative arrangements would be made in consultation with property owners/occupants. This could include, for example, the use of road plates to cross the construction trench. Consultation with adjacent property owners would be undertaken to discuss access arrangements and the measures required to minimise impacts.

Potential impacts would be managed by the installation of temporary traffic management measures, defined by the construction traffic management plan (refer to Section 10.5).

10.4.4 Bridge works

Bridge works would have the potential to impact the local road network where partial or full closures are required. In most cases, this would be managed by staging works to bridges close to one another so that works to adjacent bridges are not undertaken together (and therefore managing any cumulative impacts). Additionally, bridge works requiring full closure would be undertaken during off peak periods wherever practicable. The timing of works would be confirmed during detailed design and construction planning. The construction contractor would also review the proposed staging of bridge closures, and the need for full or partial closures, with the objective of minimising disruptions to the road network.

It is predicted that works to the following bridges would have the potential to impact the performance of surrounding roads:

- Charlotte Avenue underbridge, Marrickville, with traffic diverted to the Illawarra Road overbridge
- Illawarra Road overbridge, Marrickville, with traffic diverted to the Charlotte Avenue underbridge or the Livingstone Road overbridge
- Burwood Road overbridge, Belmore, with traffic diverted to the Moreton Street overbridge
- Haldon Road overbridge, Lakemba, with traffic diverted to the Moreton Street overbridge
- King Georges Road overbridge (lane closures only), Wiley Park, no diversion
- Stacey Street overbridge (lane closures only), Bankstown, no diversion.

Table 10.50 shows the results of modelling for intersections predicted to experience a level of service F with the addition of construction traffic. Key potential impacts are discussed following the table. In reality, it is expected that drivers would use a range of routes, which would spread the area of influence to a greater number of intersections, resulting in a reduced impact to the modelled intersections compared to the predicted impacts.

As noted in Section 10.3.3, the timing of works, duration of closures, and the diversions required are indicative, based on the current stage of the design. Final changes required would be determined during detailed design and construction planning. With respect to the Illawarra Road overbridge, potentially longer closures (up to one month) are being investigated as a result of ongoing consultation with key stakeholders. Any proposals for longer closures would be confirmed at a later date, and would be subject to additional impact assessment if required.

Table 10.50 Level of service F intersection performance as a result of bridge works

Peak period	Future (without construction)		Future (with construction traffic on diversion routes)	
	DoS[1]	LoS[2]	DoS[1]	LoS[2]
Charlotte Avenue underbridge – Illawarra Road/Warren Road				
Morning - northbound closure	0.81	B	1.30	F
Afternoon – southbound closure	0.89	B	3.24	F
Charlotte Avenue underbridge – Marrickville Road/Illawarra Road				
Morning – northbound closure	0.83	B	1.29	F
Afternoon – southbound closure	0.73	B	1.43	F
Charlotte Avenue underbridge – Warren Road/Carrington Road				
Afternoon – southbound closure	0.75	C	0.93	F
Charlotte Avenue underbridge – Carrington Road/Warren Road				
Morning – southbound closure	0.75	C	1.10	F
Afternoon – southbound closure	0.75	C	1.33	F
Charlotte Avenue underbridge – Marrickville Road/Victoria Road				
Afternoon - southbound closure	1.07	E	1.74	F
Charlotte Avenue underbridge – Marrickville Station Overbridge				
Afternoon – southbound closure	0.54	A	1.05	F
Illawarra Road Overbridge - Marrickville Road/Victoria Road				
Morning – northbound closure	1.03	D	1.30	F
Afternoon – northbound closure	1.07	E	1.14	F
Morning – southbound closure	1.03	D	3.50	F
Afternoon – southbound closure	1.07	E	1.88	F
Illawarra Road Overbridge - Carrington Road/Warren Road				
Afternoon – southbound closure	0.65	C	1.44	F
Burwood Road Overbridge - Lakemba Street/Moreton Street				
Morning	0.83	B	1.81	F
Afternoon	0.88	B	2.23	F
Burwood Road Overbridge - The Boulevarde/Moreton Street				
Morning	0.75	B	1.40	F
Afternoon	0.87	C	1.86	F
Haldon Street Overbridge - Lakemba Street/Moreton Street				
Morning	0.83	B	1.19	F
Afternoon	0.88	B	1.38	F
Haldon Street Overbridge - The Boulevarde/Moreton Street				
Morning	0.75	B	1.20	F

Peak period	Future (without construction)		Future (with construction traffic on diversion routes)	
	DoS[1]	LoS[2]	DoS[1]	LoS[2]
Afternoon	0.87	C	1.84	F
King Georges Road Overbridge - King Georges Road/Lakemba Street				
Afternoon	0.98	D	1.11	F
Stacey Street Overbridge - Stacey Street/Wattle Street				
Morning	0.89	B	1.14	F
Afternoon	1.10	C	1.34	F

Notes: 1. DoS - degree of saturation.
2. LoS - level of service.
3. The assessment considered an indicated closure configuration for each bridge as outlined in Table 10.36. As the assessment was conducted during a typical weekday peak period, it did not include consideration of rail replacement buses.

Charlotte Avenue underbridge

For the northbound closure during the morning peak, it is predicted that the level of service of the Illawarra Road/Warren Road intersection would deteriorate from B to an F while the diversion is in place. The right turning movement from the Warren Road south approach is the worst performing movement, with congestion and delays increasing to over five minutes. However, drivers are unlikely to wait five minutes to turn right and would either re-route using parallel routes, or turn right during less than satisfactory gaps in traffic.

The Marrickville Road/Illawarra Road intersection would also experience a reduction in the level of service from B to an F while the diversion is in place. The movements from the Marrickville Road west approach are the worst performing movements, with delays of over five minutes. It is likely that drivers queuing to turn left at the intersection would use alternative local roads such as Despointes Street to avoid waiting at the intersection.

For the northbound closure during the afternoon peak, it is predicted that the level of service of the intersection of Warren Road/Carrington Road would reduce from C to F, with a delay of 1.5 minutes. Additional traffic added to Warren Road would increase traffic volumes on the minor road. In reality, much of this traffic would divert to a number of parallel roads, relieving some of the demand on the Warren Road/Carrington Road intersection.

During the southbound closures, the Carrington Road/Warren Road intersection would experience a deterioration of performance during the morning peak, with a reduction in the level of service from C to F. Movements from the Warren Road west approach are the worst performing movements, with delays increasing to over two minutes. However, it is expected that much of the traffic would divert to parallel roads, relieving some of the demand on the Warren Road/Carrington Road intersection.

During the afternoon peak, five intersections would have a level of service F after allowing for the diverted traffic, demonstrating that southbound lane closures would have a much greater impact on the surrounding road network during the afternoon peak than the northbound closures. To minimise this potential impact, construction planning would need to (where practicable) maintain southbound traffic on the Charlotte Avenue underbridge during the afternoon peak, and divert the northbound traffic irrespective of which lane requires closure. The required diversions would be assessed in more detail during detailed design and construction planning, to minimise the predicted peak period delays where practicable.

Illawarra Road overbridge

During the morning peak period, the Marrickville Road/Victoria Road intersection is the only intersection predicted to have a level of service F, which would be a result of traffic diversions during southbound closures of the Illawarra Road overbridge. The through and right turning movements from the Victoria Road south approach are the worst performing movements, with modelled delays showing that demand would significantly exceed capacity resulting in significant delays. Given that the degree of saturation shows that the demand is significantly over capacity, undertaking works during holidays would not significantly reduce the predicted delays.

In the afternoon peak period, the Marrickville Road/Victoria Road intersection is predicted to experience a deterioration of the level of service to F, as a result of the southbound closures. The right turning movement from the Marrickville Road west approach onto Victoria Road is the worst performing movement, with a degree of saturation of 1.88. This indicates that the intersection would experience almost twice the level of demand compared to capacity.

The Carrington Road/Warren Road intersection would experience increased delays during the afternoon peak period. The level of service is determined by the worst movement, which has a modelled theoretical delay of over seven minutes. The overall intersection delay is nearly one minute, which implies that the main (through) movement is experiencing minimal delay.

For northbound closures, only the Marrickville Road/Victoria Road intersection would experience a decline in the level of service, from D to F during the morning peak period, and from E to F during the afternoon peak period. Movements from the Victoria Road south approach are the worst performing movements in the morning, with delays of over five minutes. The left turn movement from the Marrickville Road east approach is the worst performing movement in the afternoon peak period, with average delays of over three minutes. However, similar to the southbound diversion, it is expected that actual delays would be much lower than predicted, as a result of changes in driver behaviour or routes travelled.

The required diversions would be assessed in more detail during detailed design and construction planning, to minimise predicted peak period delays where practicable.

Burwood Road overbridge

During the morning peak period, the Lakemba Street/Moreton Street and The Boulevarde/Moreton Street intersections are predicted to experience a deterioration in performance as a result of the addition of diverted traffic, with both intersections experiencing a decline in the level of service from B to F.

At the Lakemba Street/Moreton Street intersection, the movements from the Lakemba Street east approach are the worst performing movements, with delays of over 12 minutes. At The Boulevarde/Moreton Street intersection, the movements from the Moreton Street north approach are the worst performing movements, with delays of over six minutes. However, it is likely that drivers would choose a range of diversion routes, particularly the Loch Street Bridge, reducing demand and delays at these intersections.

During the afternoon peak, both intersections are predicted to experience a decline in performance as a result of the addition of diverted traffic, with the level of service deteriorating from B and C to F.

The movements from the Lakemba Street east approach at the Lakemba Street/Moreton Street intersection would have a delay of over 18 minutes, while the movements from The Boulevarde east approach at The Boulevarde/Moreton Street intersection would also deteriorate to an average delay of nearly 14 minutes. However, it is likely that drivers would choose a range of diversion routes, particularly the Loch Street Bridge.

The required diversions would be assessed in more detail during detailed design and construction planning, to minimise the predicted peak period delays where practicable.

Haldon Street overbridge

During the morning peak period, the Lakemba Street/Moreton Street and The Boulevarde/Moreton Street intersections are predicted to experience a decline in the level of service from B to F as a result of traffic diversions. The movements from the Lakemba Street west approach at the Lakemba Street/Moreton Street intersection are predicted to experience an average delay of over three minutes. The movements from The Boulevarde west approach at The Boulevarde/Moreton Street intersection are also predicted to experience an average delay of over three minutes. However, it is likely that some vehicles would divert to King Georges Road overbridge, which would reduce the delays at these intersections.

Movements from the Lakemba Street east approach at the Lakemba Street/Moreton Street intersection would have a level of service F and an average delay of six minutes. The movements from The Boulevarde west approach at The Boulevarde/Moreton Street intersection would also have a level of service F with an average delay of 13 minutes. However, it is likely that some vehicles would divert to the King Georges Road overbridge, which would reduce the delays on both of the impacted intersections.

The required diversions would be assessed in more detail during detailed design and construction planning, to minimise the predicted peak period delays where practicable.

King Georges Road overbridge

No intersections would experience a level of service F during the morning peak period. During the afternoon peak period, the King Georges Road/Lakemba Street intersection would experience a decline in the level of service from D to F as a result of the traffic diversions. However, it is likely that some vehicles would re-route to the Haldon Street or Punchbowl Road overbridges, reducing traffic through the intersection.

Stacey Street overbridge

During the morning peak period, the Stacey Street/Wattle Street intersection would experience a reduction in the level of service from B to F as a result of traffic diversions.

It is predicted that the Stacey Street/Wattle Street intersection would have a level of service F during the afternoon peak period. The right turn movement from the Stacey Street south approach is the worst performing movement, with delays increasing from about 1.5 minutes to nearly eight minutes. However, during both the morning and afternoon periods, it is expected that a number of vehicles would divert to adjacent bridges, reducing demand at the Stacey Street/Wattle Street intersection.

The required diversions would be assessed in more detail during detailed design and construction planning, to minimise the predicted peak period delays where practicable.

10.4.5 Implications of the alternative transport arrangements

Changes to rail network operations

During possession periods and any temporary station closures, an alternate train working timetable would be required, involving adjustments to the timing and stopping patterns of trains beyond the T3 Bankstown Line. Changes may be required at stations on the T2 Airport, Inner West & South Line, between Revesby and Sydenham stations, and between Homebush and Redfern stations.

In some cases, these changes may be beneficial, as the addition of temporary additional train services would increase the frequency of services at some stations. These changes may then change the demand for train services at these stations. Initial planning suggests that extra trains may be required on the T2 Inner West & South Line, to serve passengers north and south of the T3 Bankstown Line.

Some of the changes to train services may result in changes to operations in the Sydney CBD, such as trains travelling in a different direction around the City Circle.

In addition, Erskineville and St Peters stations, which are currently serviced by the T3 Bankstown Line, could be serviced by either the T4 Illawarra Line or the T2 Airport Line via Sydenham Station.

As a result of existing infrastructure configurations, Sydney Trains services at Birrong and Yagoona stations would also need to be replaced by rail replacement bus services during certain possession periods. Buses would provide access to a nearby operating train station(s) such as Sefton or Regents Park. Train passengers could then continue their journey by train to Liverpool or Lidcombe. It is envisaged that during some of the later possession periods (for example from 2021 onwards), Sydney Trains services may be able to operate from Bankstown Station following completion of certain enabling works, which would allow rail services to be reinstated for Birrong and Yagoona stations during possession periods and closedowns.

Transport for NSW is working to determine the most effective ways to take advantage of the capacity released by the T3 Bankstown Line during construction to manage demand, journey times, and service expectations. Further work is being undertaken with respect to the following:

- changes in travel times to Central Station from all rail stations at which timetable changes occur
- changes in demand for train demand from all stations
- impact of demand changes on train loading and crowding
- changes to the locations and number of passengers who need to transfer to other rail services.

Road network performance

Local roads

Potential impacts on road network performance at each station is considered in Section 10.4.3.

Regional roads

Preliminary modelling of the potential regional road network implications of alternative transport arrangements was undertaken. Based on the preliminary modelling results, it appears that bus services could be used to influence a reduction in traffic by operating services:

- For stations east of Canterbury Station:
  - In a north-east direction towards Ultimo and along Canterbury Road/New Canterbury Road (the A34) to Petersham Station, and along Marrickville Road to Marrickville and Sydenham stations
  - At moderate levels along New Canterbury Road, Illawarra Road, and Princes Highway (the A36) to Ultimo.
- For stations west of Canterbury Station:
  - Northbound to Lidcombe Station (via the A6 Stacey Street/Rookwood Road/Joseph Street/Olympic Drive) and towards Strathfield Station (via The Boulevarde)
  - At lower levels by diverting some southbound rail services to Beverly Hills, Riverwood, Padstow, and Revesby stations on the T2 Airport, Inner West & South Line, and bus services to the Great Western Highway/Parramatta Road (the A22).

The model results indicate that traffic would divert mainly to other nearby rail stations. This demand would need to be managed as existing kiss and ride and parking facility provision along with network capacity is limited.

The temporary transport management plans would be refined to establish a balanced spread of bus service destinations and facilities, to minimise the potential impacts on the road network and customer journeys.

Parking impacts

As described in Section 10.4.3, the implementation of alternative transport arrangements would result in temporary impacts to parking at the majority of stations along the T3 Bankstown Line, due to the need to locate bus stops and layover areas. However such impacts would be temporary and would occur during periods of lower parking demand. A reduction in demand could also result from a potential modal shift to cars as people drive to alternate stations or to their ultimate destination.

Other impacts

Subject to further investigation, the operation of rail replacement buses, and bus diversions during bridge works, may require minor road improvements (to be confirmed during detailed design), including:

- extended or new clearways (with some additional temporary parking losses) to ensure buses and other traffic are able to operate safely (such as in Warren Road, Marrickville)
- trimming of trees where buses are proposed to operate in the kerbside lanes and trees currently overhang the operating area
- traffic signal phase changes at some intersections
- right hand movements at some intersections that currently do not allow this movement.

Final changes required would be determined during detailed design and construction planning.

10.4.6 Road user safety

The introduction of additional heavy vehicles to the road network has the potential to result in changes to the road and active transport networks. This may result in safety impacts to pedestrians, cyclists, and other motorists. Key locations where pedestrian and cyclist safety issues may arise include:

- construction compounds and work site access and egress points, where construction vehicles would interface with pedestrians using surrounding footpaths – this would need to be managed, particularly near Campsie, Belmore, and Bankstown stations, where high volumes of pedestrian movements occur
- construction compounds, where access and egress points, and/or haulage routes would interface with marked cycle routes
- where pedestrian and cyclist diversions are required during bridge works.

Access and egress arrangements at construction compounds would be confirmed with consideration of pedestrian, cyclist, and motorist safety. For example, the need for construction vehicles to turn right to or from arterial roads to access construction sites would be avoided, wherever practicable.

Overall, assuming the implementation of traffic control measures and other mitigation and management protocols (e.g. changes to parking or lanes along routes), no particular areas of safety concern are predicted in terms of potential conflicts with heavy vehicles.

Activities at construction compounds and work sites would be arranged to ensure that emergency vehicle access is maintained. Construction compounds would also be made available for emergency vehicle passage if required. Ongoing consultation would be carried out with emergency service providers in relation to changed traffic conditions and the need to maintain station access at all times.

Appropriate controls would be established where vehicles are required to cross footpaths to access construction sites. This could include manual supervision, physical barriers, or temporary traffic signals. Safety audits would be carried out at each construction compound access and egress point.

10.4.7 Special event management

Roads and Maritime Services' special events management guidelines identify the following classes of special events:

- Class 1 – an event that impacts major traffic and transport systems and there is significant disruption to the non-event community.
- Class 2 – an event that impacts local traffic and transport systems and there is low scale disruption to the non-event community. For example, an event that blocks off the main town street or shopping centre but does not impact a principal transport route.
- Class 3 – an event with minimal impact on local roads and negligible impact on the non-event community.
- Class 4 – an event conducted entirely under Police control (but is not a protest or demonstration).

Examples of class 1 events that would occur during construction include New Year's Eve, Mardi Gras Parade and the City 2 Surf. An example of a class 2 event that would occur during construction include game days for the Canterbury Bulldogs at Belmore Oval.

To minimise potential impacts to event visitors, the general public, and the project, appropriate management measures would be developed and implemented in consultation with event organisers of Class 1 and 2 events, and (where relevant) the Sydney Coordination Office and Roads and Maritime Services. Management measures would include measures such as temporary adjustment to haul routes, working hours, or potentially stopping works for the duration of the event.

The construction contractor/s would be required to incorporate known special events into the construction program, and including detailed responses and contingencies in the construction traffic management plan.

10.4.8 Cumulative impacts

The potential for cumulative traffic impacts with the project were considered taking into account the predicted impacts of the Chatswood to Sydenham project and the two closest WestConnex projects (the New M5 and the M4-M5 Link). No cumulative impacts associated with the WestConnex projects were identified, as a result of the distance between the project and the WestConnex projects, and because no common haulage routes are proposed. As a result, the focus for the assessment was on the potential for cumulative impacts in the vicinity of Marrickville and Sydenham stations, as a result of the construction of the project at the same time as the Chatswood to Sydenham project.

A review of the haulage routes for both projects indicated that the haulage routes would not overlap, and no cumulative construction traffic impacts are predicted. Works at Sydenham Station would result in the routes of construction vehicles being shared with the operation of rail replacement buses during possession periods. Modelling of key intersections in the vicinity of Sydenham Station was undertaken to assess the potential cumulative impacts. The results are summarised in Table 10.51.

Table 10.51 Cumulative intersection performance at Sydenham Station

Peak period	Future (without construction)		Refined TTMP[1]		Refined TTMP[1] with construction	
	DoS[2]	LoS[3]	DoS[2]	LoS[3]	DoS[2]	LoS[3]
Gleeson Avenue/Burrows Road (signals)						
Morning	0.67	B	0.76	B	0.90	B
Afternoon	0.66	C	0.77	C	0.77	C
Gleeson Avenue/Railway Parade (signals)						
Morning	0.54	A	0.58	A	0.75	A
Afternoon	0.50	A	0.54	A	0.55	A
Gleeson Avenue/Unwins Bridge Road (signals)						
Morning	0.92	C	0.92	C	0.97	C
Afternoon	0.79	C	0.79	C	0.79	C

Notes: 1. TTMP - temporary transport management plan.
2. DoS - degree of saturation.
3. LoS - level of service.

The results of modelling indicate that there would not be a reduction in the level of service at key intersections near the station. The Gleeson Avenue/Unwins Bridge Road intersection would experience increased delays, however these delays would be minor (about four seconds). As a result, there is considered to be negligible potential for cumulative impacts.

To minimise the potential for cumulative impacts between Sydney Metro projects, coordination would be undertaken through the Sydney Metro Traffic and Transport Liaison Group. Transport for NSW and the Sydney Metro Traffic and Transport Liaison Group would also coordinate with any other stakeholders to manage cumulative impacts resulting from the project and other non-metro projects.

10.5 Mitigation measures

10.5.1 Approach to mitigation and management

Potential traffic, transport and access impacts during construction would be managed in accordance with the Construction Environmental Management Framework (as described in Chapter 27 (Synthesis of the Environmental Impact Statement)), which provides for development and implementation of a traffic management plan, to include (as a minimum):

- traffic and transport mitigation measures, including those provided in the Construction Environmental Management Framework
- consultation with the relevant road authority, and/or transport operator
- overall traffic management resources, processes and procedures
- construction traffic control plans setting out the specific traffic and transport management arrangements to be implemented at specific locations during construction
- a traffic route management plan
- a parking management plan
- site specific traffic access and management plans
- event management requirements.

The management measures included in the traffic management plan would include those recommended for inclusion by Technical paper 1.

All construction activities would be undertaken in accordance with relevant Transport for NSW guidelines, and the additional guidelines and requirements of stakeholders including Roads and Maritime and local councils. The latter would include the need for road opening permits for classified roads, and for approval of specific traffic management and control plans.

As described in Section 9.11, temporary transport management plans would developed in accordance with the Temporary Transport Strategy.

10.5.2 List of mitigation measures

The mitigation measures that would be implemented to minimise potential construction traffic and transport impacts are listed in Table 10.52.

Table 10.52 Mitigation measures – construction traffic and transport

ID	Impact/issue	Mitigation measures	Relevant location(s)
Design/pre-construction			
TC1	Temporary transport arrangements	Guided by the Temporary Transport Strategy, detailed temporary transport management plan/s would be developed prior to construction to manage the movement of people along the T3 Bankstown Line during possession periods. The plans would be developed in consultation with key stakeholders (including the Sydney Coordination Office, Roads and Maritime Services, Sydney Trains, local councils, emergency services, and bus operators), and would address the requirements specified by the Temporary Transport Strategy. The development of each plan would consider, as a minimum: • a review of the road network constraints along any proposed rail replacement bus route • further traffic analysis of key intersections used by rail replacement buses • potential impacts to local road networks affected by rail passengers diverting to cars to reach their destinations • the design of temporary facilities at bus stop locations in consultation with the relevant road authority • expected changes to parking demand at other stations, displacement of existing parking, and any upgrades that may be required.	All
TC2		Transport for NSW would consult with Roads and Maritime Services, the State Transit Authority, and bus operators, to identify opportunities to minimise impacts to bus layovers and existing bus stops during operation of rail replacement buses.	All

ID	Impact/issue	Mitigation measures	Relevant location(s)
TC3	Impacts of bridge works	Detailed analysis of the network impacts of proposed bridge work would be undertaken, and management measures would be developed, in consultation with Roads and Maritime Services and the Sydney Coordination Office. Measures would include restricting work to some bridges during off peak and/or holiday periods, where practicable, including the following bridges as a minimum: • Charlotte Avenue underbridge • Illawarra Road overbridge • Burwood Road overbridge • Haldon Street overbridge • King Georges Road overbridge • Stacey Street overbridge.	Bridge works
TC4		The impacts on the surrounding road network of road diversions and lane closures resulting from bridge works across the rail corridor would be assessed in detail, to identify the suite of management measures to be implemented for each diversion/closure required. This would be undertaken in consultation with Roads and Maritime Services, the Sydney Coordination Office, the Inner West and Canterbury-Bankstown councils, emergency services, and relevant bus operators. Planning for partial or full bridge closures would consider bus rerouting and timetabling, with the intention of minimising impacts to bus customers and bus operators.	Bridge works
TC5	Pedestrian access	Work affecting the pedestrian underpass providing access to and from the Belmore Sports Ground would be timed, in consultation with the facility manager and owners, to ensure that suitable access is provided. This would include (if necessary) avoiding disruptions to access during events, such as game days at Belmore Oval. Local diversions would be put in place during periods of closure.	Belmore Station
TC6	Parking impacts during construction	Opportunities to reduce the loss of existing on and off street car parking (including the amount of spaces reduced and the time associated with this reduction) would be reviewed during detailed design and construction planning.	All
TC7		Where parking spaces are lost or access is impeded, particularly for extended periods, alternative parking would be provided wherever feasible and reasonable. This would include consideration of other privately owned (or vacant) land within close proximity to affected stations.	All
TC8	Impacts of intersection performance	Further consideration of the need for intersection modifications would be undertaken, to improve intersection performance at locations most affected by the addition of construction heavy vehicles, rail replacement buses, and diverted traffic. This would be undertaken in consultation with Roads and Maritime Services, the Sydney Coordination Office, and the relevant road authority. The improvements considered would include: • modification to the existing traffic signal phasing • lane priority changes • changing lane designations (line markings and signage)	All

ID	Impact/issue	Mitigation measures	Relevant location(s)
		• kerbside changes (such as removing on street parking or implementing no standing zones at peak times to increase lane capacity) • physical geometric changes (such as minor kerb cut-backs to enable large vehicles to safely move through intersections) • restricting turning movements where traffic demand is low.	
TC9	Changes to cyclist facilities during construction	Where existing cycle facilities (e.g. bike parking) would be temporarily unavailable at a station, suitable replacement facilities would be provided while the facility is unavailable.	All
Construction			
TC10	Management of traffic, transport and access	A construction traffic management plan would be prepared and implemented prior to construction. The plan would be prepared in accordance with the Construction Environmental Management Framework, and would detail, as a minimum: • how traffic would be managed when construction works are being carried out • the activities proposed and their impact on the road network and on road users • how these impacts would be addressed. The plan would be prepared in consultation with the Traffic and Transport Liaison Group, and would be approved by the relevant authority before construction commences.	All
TC11	Changes to public transport services and alternative transport arrangements	Modification of existing bus stops, or implementation of new stops and alterations to service patterns, would be carried out by Transport for NSW in consultation with the Sydney Coordination Office, Roads and Maritime Services, the Inner West and Canterbury-Bankstown councils, and bus operators.	All
TC12		Transport for NSW would undertake an extensive community awareness and information campaign before changes to public transport services are implemented. This would include a range of communication activities such as: • information at stations • wayfinding signage • clearly marked bus stop locations • letter box drops • web based information and transport 'app' where changes to travel are found in a single place • information via 131 500 • advertising in local papers • email information bulletins.	All
TC13	Impacts on intersection performance	Intersection operation would be optimised, where reasonable and feasible, to improve intersection performance at the worst affected intersections along construction haulage routes and/or rail replacement bus routes. This may include modifying signal phase times or sequences at traffic signal controlled intersections.	Affected intersections
TC14	Impacts on special events	Consideration of special events would be undertaken as part of construction work programming. For special events that require specific traffic and pedestrian management, measures would be developed and implemented in consultation with Roads and Maritime Services, the Inner West and Canterbury-Bankstown councils, and the organisers of the event.	All

ID	Impact/issue	Mitigation measures	Relevant location(s)
TC15	Impacts of construction compounds and work sites	Vehicle access to and from construction sites would be managed to ensure pedestrian, cyclist, and motorist safety. Depending on the location, this may require manual supervision, barrier placement, temporary traffic signals, modifications to existing traffic signals, or police assistance.	All
TC16	Construction vehicles	Construction vehicles (including contractor staff vehicles) would be managed to: • minimise parking or queuing on public roads • minimise use of residential streets to gain access to work sites or compounds • minimise vehicle movements near schools, particularly during school start and finish times.	All
TC17	Signage	Directional signage and line marking would be used to direct and guide drivers, pedestrians, and other road users past construction compounds and work sites, and on the surrounding road network. This may be supplemented by variable message signs to advise drivers of potential delays, traffic diversions, speed restrictions, or alternate routes.	All
TC18	Construction parking impacts	Construction sites would be managed to minimise construction worker parking on surrounding streets. A worker car parking strategy would be developed in consultation with the relevant local council to identify measures to reduce the impact on the availability of on street and off street parking. The strategy would identify potential mitigation measures including alternative parking locations. The strategy would encourage contractor staff to: • use public transport • car share • park in a designated off site area and access construction sites via shuttle bus.	All
TC19	Traffic incidents	In the event of a traffic related incident, co-ordination would be carried out with the Sydney Coordination Office and Transport Management Centre's Operations Manager.	All
TC20	Changes to road, pedestrian and cyclist networks	The community would be notified in advance of proposed road and pedestrian network changes through appropriate forms of community notification.	All
TC21	Impacts on pedestrian or cyclist paths	A condition survey would be undertaken to confirm changes to routes proposed to be used by pedestrians and/or cyclists are suitable (e.g. suitably paved and lit), with identified modification requirements discussed with the Inner West and/or Canterbury-Bankstown councils and implemented prior to use of the routes.	All
TC22	Pedestrian, cyclist and motorist safety	Pedestrian, cyclist, and motorist safety in the vicinity of the construction sites would be addressed during construction planning and development of the construction traffic management plan. Measures that may be implemented to assist in multi modal traffic management include: • speed awareness signs in conjunction with variable message signs near construction sites to provide alerts to drivers • a community engagement program to provide road safety education and awareness to road users about sharing the road safely with heavy vehicles	All

ID	Impact/issue	Mitigation measures	Relevant location(s)
		• heavy vehicle training for drivers to understand route constraints, safety issues, and limiting the use of compression braking • safety technology and equipment installed on heavy vehicles to enhance vehicle visibility, eliminate vehicles' blind spots, and monitor vehicle location, speeding compliance, and driver behaviour.	
TC23	Impacts to access	Access for residents, businesses, and community infrastructure would be maintained. Where disruption to access cannot be avoided, consultation would be undertaken with the owners and occupants of affected properties, to confirm their access requirements and to discuss alternatives.	All
TC24		Access to stations and surrounding properties for emergency vehicles would be provided at all times. Emergency service providers (i.e. police and ambulance) would be consulted throughout construction to ensure they are aware of changes to access, including lane, bridge or road closures, and changes to station or rail corridor access.	All
TC25	Co-ordination of cumulative traffic effects	The potential cumulative effects of construction traffic from multiple construction sites within the project (including bridge works) would be further considered during development of the construction traffic management plan. Where there is potential for cumulative impacts across the project, these issues would be addressed with the assistance of the Traffic and Transport Liaison Group.	All

10.5.3 Consideration of the interactions between mitigation measures

The implementation of alternative transport arrangements (including rail replacement buses) has the potential to result in noise and air quality impacts. These potential impacts would be experienced away from the project area, as some bus services would operate to other stations, potentially impacting sensitive receivers in the vicinity of these stations. These impacts would be minimised where practicable by the use of arterial roads.

The implementation of alternative transport arrangements also has the potential for an increase in public safety risks due to the increase in vehicles on the road network. Potential hazards and safety impacts are considered in Chapter 25 (Hazards, risks and safety).

10.5.4 Managing residual impacts

While the proposed mitigation measures would minimise the potential impacts identified, there is still the potential for additional delays and queuing that may inconvenience customers and other road users in some locations. These issues would be monitored, reported, and if required, actively addressed by the construction contractor by means of location and issue-specific measures.

Specifically, the temporary transport management plans would be time and event specific, and would be refined in consultation with the community and other stakeholders.

11. Operational traffic, transport and access

This chapter provides a summary of the results of the traffic, transport and access assessment as it relates to operational impacts. A full copy of the assessment report is provided as Technical paper 1 – Traffic, transport and access assessment. The Secretary's environmental assessment requirements relevant to operational traffic, transport and access, together with a reference to where the relevant results are summarised in this chapter and in the Environmental Impact Statement, is provided in Table 11.1.

Table 11.1 Secretary's environmental assessment requirements – operational traffic, transport and access

Ref	Secretary's environmental assessment requirements – operational traffic, transport and access	Where addressed
13. Transport and traffic		
13.2	The Proponent must assess the operational transport impacts of the project, including the wider transport interactions:	A summary of the results of the operation traffic, transport and access assessment is provided in this chapter. The full results are provided as Technical paper 1.
	• local and regional roads	Section 11.4.2
	• changes to commuter parking and loading zones	Section 11.4.2 (overview) Sections 11.4.4 to 11.4.13 (individual station discussion)
	• provision of kiss and ride facilities, cycling, public and freight transport	Section 11.4.2 (overview) Sections 11.4.4 to 11.4.13 (individual station discussion)
	The EIS must define a transport hierarchy and a framework for an active transport strategy	Sections 11.3.2 (definition of hierarchy) and 11.3.4 (framework for active transport corridor)
14. Place making and urban design - accessibility		
14.2	The Proponent must assess the accessibility elements of the project including:	This chapter provides an assessment of the potential impacts of the project in terms of accessibility. A description of how accessibility was incorporated into the design is provided in Chapter 7 (Design development and alternatives).
	(a) impacts on pedestrian access in and around stations and connecting streets, peak capacity of street at peak pedestrian times (including consideration of land use change)	Sections 11.4.4 to 11.4.13
	(b) enhancing the accessibility of each station and the general vicinity of walking and cycling catchments	Sections 7.3.8, 11.4.2 (overview) and 11.4.4 to 11.4.13 (individual station discussion)
	(c) the provision of infrastructure to support accessible paths of travel and interchange	Sections 7.3.8 and 11.4.4 to 11.4.13 (individual station discussion)
	(d) impacts on cyclists (including provision of and integration with active transport routes) and pedestrian access and safety	Sections 7.3.8 and 11.4.4 to 11.4.13

Ref	Secretary's environmental assessment requirements – operational traffic, transport and access	Where addressed
	(e) minimising barriers across the rail corridor and opportunities to integrate cycling and pedestrian elements with surrounding networks and in the project.	Sections 7.2.4 and 11.4.3

11.1 Assessment approach

11.1.1 Legislative and policy context to the assessment

The following principles have been used in the design and operation of the stations and interchanges for the project:

- The project would comply with the objectives of the Commonwealth *Disability Discrimination Act 1992* (DDA) *and Disability Standards for Accessible Public Transport 2002* (DSAPT) standards for travel paths between bus stops and stations. The DDA provides protection against discrimination in terms of disability, prohibiting discrimination in a number of areas, including access to premises used by the public.
- Using CPTED principles when designing any relocated bus stop.

11.1.2 Methodology

A summary of the approach to the operation traffic, transport and access impact assessment is provided in this section. Further information is provided in Technical paper 1.

The assessment of potential operational traffic, transport and access impacts involved:

- determining the role and function, associated demand, and transfer movements at and around existing stations (including associated transport interchanges)
- reviewing relevant design reports and plans, and discussions with the project team
- reviewing the proposed Sydney Metro station design principles that are applied to better facilitate transport integration
- reviewing patronage forecasts, including active travel, public transport, and private vehicle access to and from each station, and the proposed service operating conditions for Sydney Metro
- reviewing the concept design for each station, including how it facilitates the integration of Sydney Metro services with the surrounding transport network
- undertaking a qualitative and quantitative assessment of the potential impacts on traffic, transport, and access during operation, including impacts on active travel, public transport, and private vehicle access to and from stations
- identifying how implementation of the proposed stations would directly impact the surrounding environment and customer transfers between different transport access modes.

The Sydney Public Transport Planning Model for 2026 was specifically prepared and used to develop the patronage forecast following the introduction of Sydney Metro. This strategic transport model is able to forecast patronage, including (particularly relevant to this assessment) the multi-modal journey chains by customers who would use Sydney Metro.

11.2 Existing environment

The existing traffic, transport and access environment within the project area and its surrounds is described in Section 10.2.

11.3 Design approach

11.3.1 Baseline conditions

The baseline for the operational assessment includes other transport and urban renewal projects planned or under construction within and in the vicinity of the study area, including:

- Sydney Metro Northwest and the Sydney City & Southwest Chatswood to Sydenham project
- the Cooks River Cycleway/shared path and the proposed 'The Cooks River to Iron Cove GreenWay'
- cycle routes being developed by the Canterbury-Bankstown and Inner West councils, and routes identified in the *Sydney City Centre Access Strategy* (Transport for NSW, 2013a)
- 'More Trains and More Services' program initiatives on the Sydney Trains network
- initiatives under *Sydney's Bus Future* (Transport for NSW, 2013e)
- the WestConnex program of works, including M4 East, New M5, M4-M5 Link (not yet approved) and Sydney Gateway (not yet approved).

For the purposes of the assessment, the above projects have been considered where possible when considering future traffic and transport issues.

11.3.2 Transport hierarchy

As described in Chapter 7 (Design development and place making) the station access hierarchy (shown in Figure 11.1) was used as the basis for the design of station upgrades and associated facilities. As shown by the figure, while considering and catering for all modes, active transport and public transport modes have been given the highest priority in the design.

Source: Transport for NSW

Figure 11.1 Station access hierarchy

For each transport mode, the designs for the upgraded stations are based on this hierarchy, and the broad design principles are summarised below.

Active transport – walking and cycling

Active transport refers to the use of non-motorised travel, primarily walking and cycling. As the stations are all located within established urban areas, walking and cycling access would be provided mainly via existing and potential future route opportunities. Connections between the station entry/exits and footpaths would be provided, and cycle facilities (i.e. bike parking) would be improved where required.

Walking

The walking catchment for a rail station is generally up to 800 metres. Pedestrian facilities (connections) are designed to provide safe, direct, continuous, high quality, and clearly signposted paths to and between stations and other transport modes. Appropriate footpath widths and gradients would also be provided, wherever possible, outside station exits and around stations to improve links to other transport modes in the vicinity of the station, and provide safe and equitable pedestrian access. Vision and mobility impaired customers would be considered in the pavement designs.

Cycling

The cycling catchment for a rail station is generally up to 2.5 kilometres, or about 10 minutes travel time. Cycling facilities would be provided at stations, including secure and sheltered bike parking. Secure parking would enable customers to safely leave their bikes when catching a train.

The quantity and type of bike parking provided at stations would be based on the NSW Government's Bike and Ride Program initiative, identified in *Sydney's Cycling Future*.

Section 11.3.4 describes a framework for an active transport strategy for the project.

Public transport

A key focus of the design is providing safe and accessible connections to other public transport services. This would facilitate expansion of the customer base for Sydney Metro. To facilitate connections, clear and intuitive wayfinding would be provided. Connections to bus services at all stations and light rail at Dulwich Hill would be enhanced through improved footpaths, including provision of more accessible paths to bus stops and a number of the stations.

Taxi and kiss and ride facilities

Taxi bays with customer waiting areas and kiss and ride facilities would be provided at all stations.

Park and ride

This is the lowest priority access mode as a result of the prioritisation of other modes. Provision of new metro facilities may result in the loss of some existing dedicated (untimed) commuter parking spaces. However, the project aims to achieve no net loss of dedicated commuter parking between Marrickville and Bankstown. Where spaces at a station may be lost as a result of the proposed works, and are not able to be replaced, replacement spaces would be provided at another station.

11.3.3 Transport integration facilities at station

A description of the proposed station upgrade works is provided in Chapter 8 (Project description – operation). In most cases, they are driven by the requirement to make local connections to and from the stations seamless and efficient.

Upgraded stations and platforms would comply with the DDA and DSAPT. This includes:

- Stations, plazas, interchanges, walkways, fixtures and fittings, and retail areas would be designed to meet DDA requirements. Stations would be fully accessible, including the platform, concourse, platform-train interface and facilities.
- Interchanges would incorporate accessible facilities and accessible paths of travel between the station and other transport modes, wherever possible, and resting seats would be provided along pathways.

The proposed works generally include connections between transport modes and station entries, including weather protection. Planned improvements, including station entries, plazas and interchange facilities, would have regard to the station access hierarchy shown in Figure 11.1.

The spatial reach of the works and the extent of upgrades varies from station to station. The main changes proposed at each station are summarised in Table 11.2. The proposed layout of each station is shown in the figures provided in Chapter 8. Figure 11.4 to Figure 11.13 provide an overview of the positioning of transport facilities, such as bus stops, bike parking and kerbside facilities (including accessible parking, taxis and kiss and ride) at each of the stations and within the surrounding area.

The proposed park and ride facilities (i.e. where existing commuter parking requires reconfiguration) have also been subject to similar considerations, although at certain stations, local topography and positioning of existing infrastructure means that achieving DDA compliant access is not always possible.

Table 11.2 Existing and proposed station facilities

	Facility to be provided (number of existing facilities shown in brackets)				
Station	Accessible parking	Bicycle	Taxi	Kiss and ride	Buses
Marrickville	2 (1)	>40 (8)	2 (1)	5 (3)	Stops retained (one relocated). All but one stop would be within 100 m of entries, and all stops DDA accessible to station.
Dulwich Hill	2 (2)	>40 (10)	1 (0)	5 (3)	Stops retained. Stops are DDA accessible.
Hurlstone Park	3 (3)	>40 (12)	1 (0)	2 (0)	Stops retained. Stops are DDA accessible.
Canterbury	2 (2)	>40 (4)	2 (0)	4 (0)	Stops retained. Stops are partially DDA accessible.
Campsie	6 (6)	>50 (10)	6 (6)	6 (4)	Stops retained. Stops are partially DDA accessible.
Belmore	5 (4)	>40 (5)	1 (4)	4 (0)	Stops retained and relocated to suit new station area. Stops are DDA accessible.
Lakemba	7 (6)	>40 (8)	3 (3)	3 (1)[1]	Stops retained and relocated to suit new station area. Stops are DDA accessible.
Wiley Park	1 (1)	>40 (4)	1 (0)	5 (0)	Stops retained. Stops are DDA accessible.
Punchbowl	3 (3)	>40 (12)	3 (2)	8 (0)	Stops retained and relocated to suit new station area. Stops are DDA accessible.
Bankstown	3 (2)	>50 (32)	10 (10)	13 (4)	Stops retained. Stops are DDA accessible.

Note: 1. Not currently accessible.

11.3.4 Framework for an active transport strategy

By assigning the highest priority to active transport modes (i.e. walking and cycling), the project aims to promote active transport in the study area.

An active transport strategy would be developed by Transport for NSW. The purpose of the strategy would be to investigate measures that support the increase of the overall walking and cycling mode share of access to Sydney Metro.

The strategy would recommend initiatives to improve the mode share for walking and cycling connecting to/from each station. Recommendations would support existing cyclists as well as potential customers who may switch to cycling from other transport modes.

The outcomes of the strategy would be used to inform various aspects of the project, such as the temporary transport management plans, interchange access plans, the detailed design process, and the active transport corridor. Transport for NSW will work with the Department of Planning and Environment to support the development of an active transport corridor, including walking and cycling infrastructure. Transport for NSW will deliver sections of the active transport corridor around stations. This would facilitate walking and cycling connections to important destinations in the local area and region. The indicative location of the active transport corridor is shown in Figure 11.2. Further information on the active transport corridor is provided in Section 8.1.4.

Walking and cycling infrastructure at stations would be delivered as part of the proposed station upgrade works, and these links would form part of the active transport corridor.

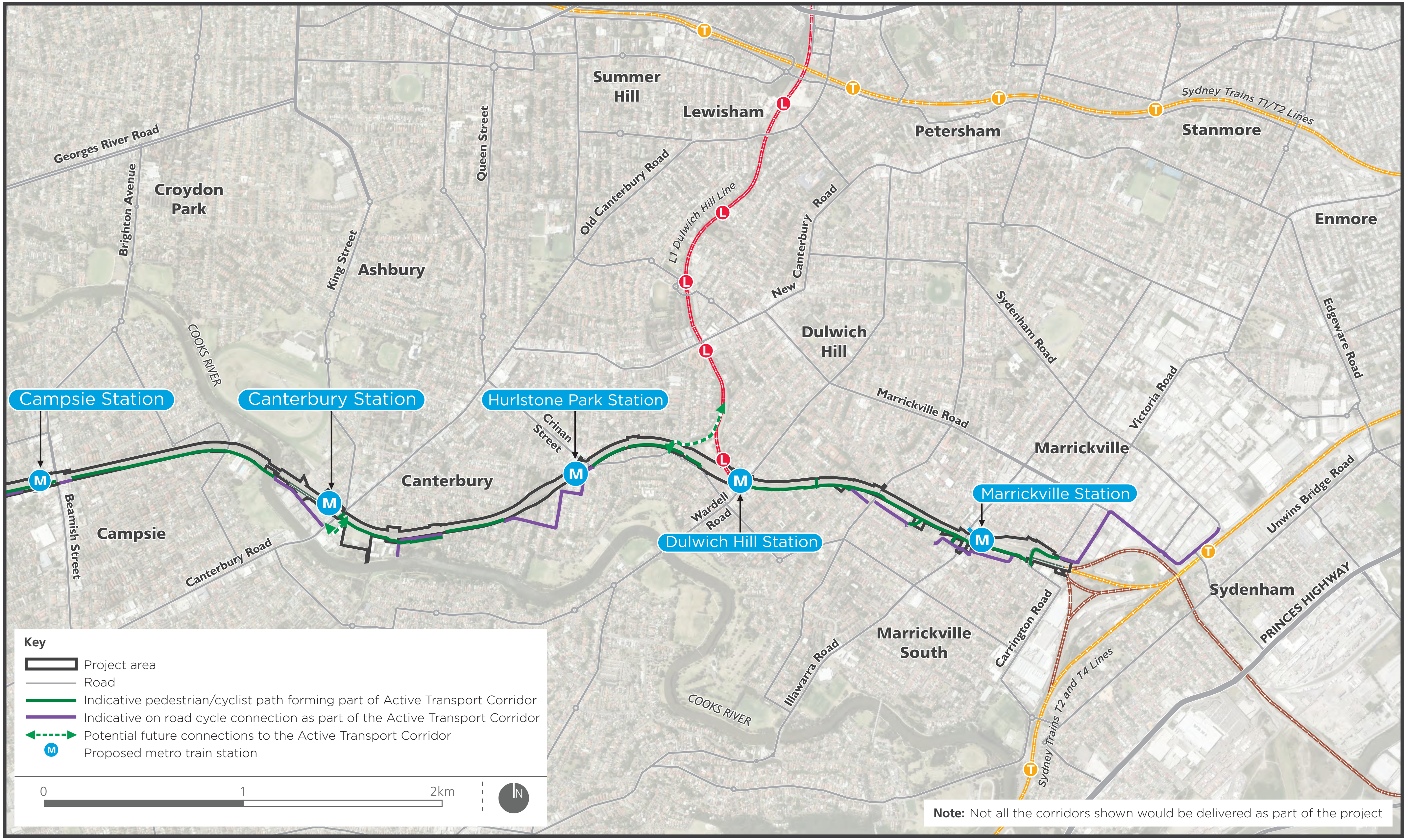
11.4 Impact assessment

11.4.1 Risk assessment

Potential risks

The environmental risk assessment for the project, undertaken for the State Significant Infrastructure Application Report, identified the following as the main traffic, transport and access risks during operation:

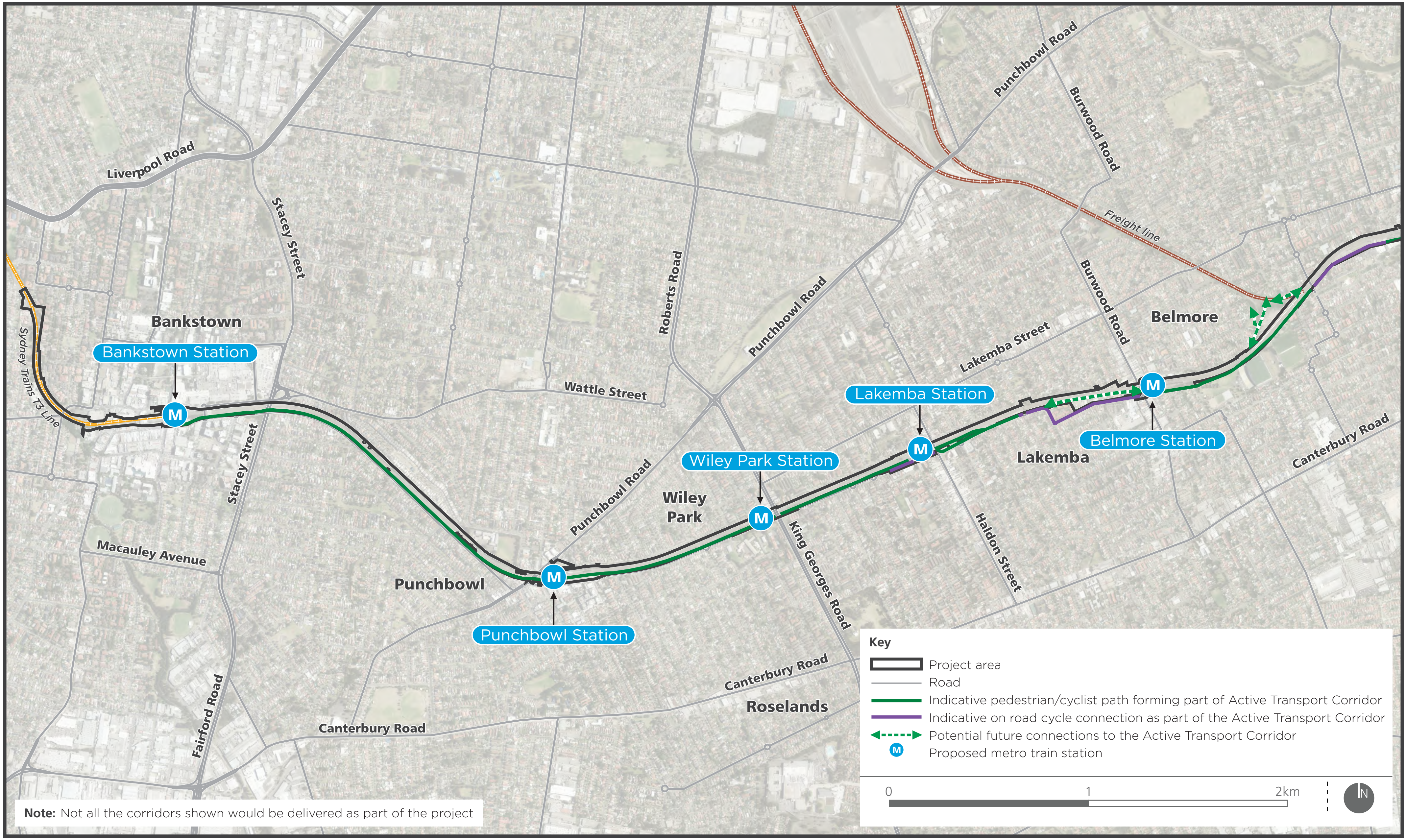
- altered (poorer) pedestrian and cyclist pathways of travel
- impacts to bus, taxi, and kiss and ride facilities at or around stations
- new interchange arrangements at Bankstown for customers moving between Sydney Trains and metro services
- changes to, and potential loss of, dedicated and informal commuter parking areas
- changes to, and potential changes to other off-street or kerbside parking areas or loading zones.



sydney METRO | city & southwest

Indicative location for an active transport corridor - map 1

FIGURE 11.2



sydney METRO | city & southwest

Indicative location for an active transport corridor - map 2

FIGURE 11.2

The report also noted that the project (as part of Sydney Metro) would have the following operational benefits:

- increased rail capacity through the CBD, which would help to relieve existing and potential future congestion issues
- support network reliability benefits across the wider rail network
- supports increased train frequency, particularly in the AM and PM peak periods
- provides customer amenity in the form of upgraded station buildings, station facilities, and connected precinct areas
- improves customer access improvements through enhanced active transport and transport interchange facilities
- supports travel options and health benefits through the provision for an active transport corridor.

How potential impacts have been avoided or minimised

The detailed design would aim to avoid or reduce impacts associated with operational traffic, transport and access. Potential traffic and transport impacts have been minimised, and benefits have been maximised, though the planning and design process, by ensuring that the number of facilities at each station is consistent with the future demand expected.

The results of the operational impact assessment with respect to the main transport modes and transport infrastructure is summarised in the following sections. This includes an assessment on a station by station basis.

11.4.2 Traffic and transport

Active transport

The project has been designed to promote active transport by incorporating the features described in Section 11.3 into the design of stations, and the areas directly surrounding the stations, where feasible. It has sought to improve walking and cycling networks in the vicinity of stations (i.e. pathways particularly connecting to existing walking and cycling networks) and to upgrade those facilities (e.g. bike parking) that would increase the attractiveness of active transport modes to access stations.

The attraction of living near metro stations is expected to promote opportunities for urban renewal, guided by existing strategic planning frameworks including the draft *Sydenham to Bankstown Urban Renewal Corridor Strategy* (Department of Planning and Environment, 2017) and the draft *South District Plan* and *Central District Plan* (Greater Sydney Commission, 2016). Increased housing densities close to many of the stations is expected to lead to an increase in walking and cycling demand, resulting in a shift to use of these modes. The proposed improvements to the pedestrian and cyclist networks would assist in achieving the shift to active transport modes as discussed below. Further information on the implications at each station is provided in Sections 11.4.4 to 11.4.13.

In addition, as described in Section 8.1.4, Transport for NSW will work with the Department of Planning and Environment to support the development of an active transport corridor, including walking and cycling infrastructure. Transport for NSW will deliver sections of the active transport corridor around stations. This would facilitate walking and cycling connections to important destinations in the local area and region.

Pedestrians

Improvements to pedestrian facilities and amenity in the vicinity of stations include the following:

- provision of new pedestrian paths to and around stations, including connections to an active transport corridor (refer to Section 8.1.4)
- creation of public spaces in the vicinity of station entrances (including forecourt areas or entrance plazas) to facilitate pedestrian flows and gathering
- improvements to make movement around stations easier for those who are less mobile, such as the provision of lifts and DDA compliant paths to and from the station entrances and to surrounding areas, including bus stops (discussed further below).

At some stations, some passengers may have to walk further as a result of the relocation of station entrances; while for other passengers, their walking distance may reduce depending on their origin or destination.

The proposed new station concourse at Dulwich Hill Station would reduce walking distances to the Dulwich Hill light rail stop for many residents, particularly those located on the southern side of the corridor. A more direct walking route would be provided to the light rail stop stairs and lift via the new concourse.

Changes to footpaths in the vicinity of stations would also improve the capacity of the pedestrian network, as described in Sections 11.4.4 to 11.4.13.

Cyclists

Designated cycle facilities, including secure access bike parking sheds and undercover bike racks, are proposed as part of the station upgrades. Bike parking has been designed to cater for existing demand and, where possible, to cater for potential future demand (even if only future proofing space for further facilities). Where possible, bike parking is proposed on both sides of the rail corridor. However, in some locations (such as Campsie Station) space constraints have resulted in the facilities being located on one side of the corridor only.

The provision of cycle facilities would improve cyclist access to and from stations, making cycling a more attractive travel mode. Providing bike parking facilities at stations would further increase the attractiveness of bikes as a transport mode to and from stations.

Pedestrian and cyclist safety

The project aims to provide pedestrians and cyclists accessing stations, or those moving around stations, a safe means to do so by:

- creating or enhancing areas to provide more space for pedestrian and cyclist circulation, including the removal of obstructions from high pedestrian areas
- improving platform capacity
- installing platform screen doors making platforms safer for pedestrians
- providing passive surveillance via station entrances and forecourts as views are opened to entrances from surrounding areas
- improving lighting at and in the vicinity of stations
- improving cycle facilities at stations.

The detailed design would continue to consider the safety of pedestrians and cyclists as a key focus.

Disabled access

The proposed station upgrades include a number of elements to ensure that stations comply with DDA and DSAPT, including:

- provision of lifts to those stations without them (such as Dulwich Hill, Hurlstone Park, Canterbury, Wiley Park and Punchbowl stations), to provide access to platforms
- provision of DDA compliant paths to and around the stations, particularly between stations and nearby bus stops.

Providing a design that fully complies with accessibility standards is challenging as the grade of the rail corridor means stations are located mostly in cuttings whereas typically entrances are from nearby road overbridges.

Where the existing terrain does not allow for DDA compliant grading of paths, the following features have been incorporated in the design:

- adjustment to surface levels to achieve full or partial compliance
- reviewing station and precinct arrangements to locate accessible facilities in areas with acceptable gradients.

Detailed design would continue to ensure that DDA compliance is met where possible and where this cannot be fully achieved, accessibility is improved from the existing situation.

Public transport

Operational benefits

As part of Sydney Metro City & Southwest, the project would offer a number of significant, strategic transport and access benefits, summarised below. Further information is provided in Chapter 5 (Project need).

- Supporting growth on the rail network – with the delivery of Sydney Metro City & Southwest (including the project), it is projected that the rail network would cater for an additional 100,000 customers per hour.
- Increased accessibility and trip diversity – improving the frequency of services, interchange with other transport modes, and connections to key destinations would increase accessibility (for example, to major employment, commercial, industrial, and residential areas) and trip diversity (for example, journey to work, education, local service, and work related trips).
- Reducing network complexity and improving reliability – the project would remove the T3 Bankstown Line from its existing requirement to merge/diverge with the T2 Airport, Inner West & South Line, converging into the constrained City Circle. This in turn would allow the City Circle to be dedicated to the T2 Airport, Inner West & South Line, reducing operational complexity and the risk of service unreliability.
- Increasing rail network capacity - removing T3 Bankstown Line services from the City Circle would enable the T2 Airport, Inner West & South Line to use the released capacity. This would improve service frequencies on the Sydney Trains network, reducing overcrowding of trains and stations and station dwell times.
- Improved service legibility – Sydney Metro would provide passengers with the ability to ‘turn up and go’ as opposed to pre-planning and co-ordinating with a specific train. This service model has led to greater rail patronage in other cities around the world. Removing T3 Bankstown Line services from the City Circle would also reduce the number of different service types/patterns operating through City Circle stations, improving service legibility and

reducing the risk of platform congestion due to passengers having to wait at these stations for a particular service in the afternoon peak.

- Travel time savings – T3 Bankstown Line customers would have access to more direct Sydney Metro services to key activity areas in the Global Economic Corridor. Travel time savings would be experienced by existing rail service passengers (who would directly benefit from shorter travel times), new metro passengers (who could transfer from road-based transport such as buses and cars to rail), and road users, who would potentially experience less congestion.

Table 11.3 provides an overview of the forecast daily travel volumes at each station between Marrickville and Bankstown, including existing volumes and those forecast for 2026 (two years after opening). As shown in the table, patronage at each station is expected to increase by at least 2,000 entries or exits per day (or a daily increase of at least 4,000 people for each station). This increase can be attributed to both improved public transport services and forecast growth.

Table 11.3 Existing and forecast station travel volumes[1]

	2016		2026[2]	
Station	**Entry**	**Exit**	**Entry**	**Exit**
Marrickville	4,594	4,356	6,900	6,900
Dulwich Hill	2,706	2,464	6,800	6,800
Hurlstone Park	1,532	1,312	4,700	4,700
Canterbury	2,426	2,164	7,100	7,100
Campsie	8,237	8,039	10,700	10,700
Belmore	3,025	2,847	6,500	6,500
Lakemba	4,302	4,130	7,400	7,400
Wiley Park	2,006	1,806	5,700	5,700
Punchbowl	2,935	2,806	6,500	6,500
Bankstown	8,993	9,350	11,900	11,900

Notes: 1. Data provided by Transport for NSW.
2. The entry/exit figures for 2026 are derived from modelled data using a method of mirroring the AM period in the PM. This results in symmetrical entry and exit forecasts but does not account for the altered journey chains undertaken by a minority of users. Numbers in table are volumes for metro services only.

Changes to station servicing arrangements

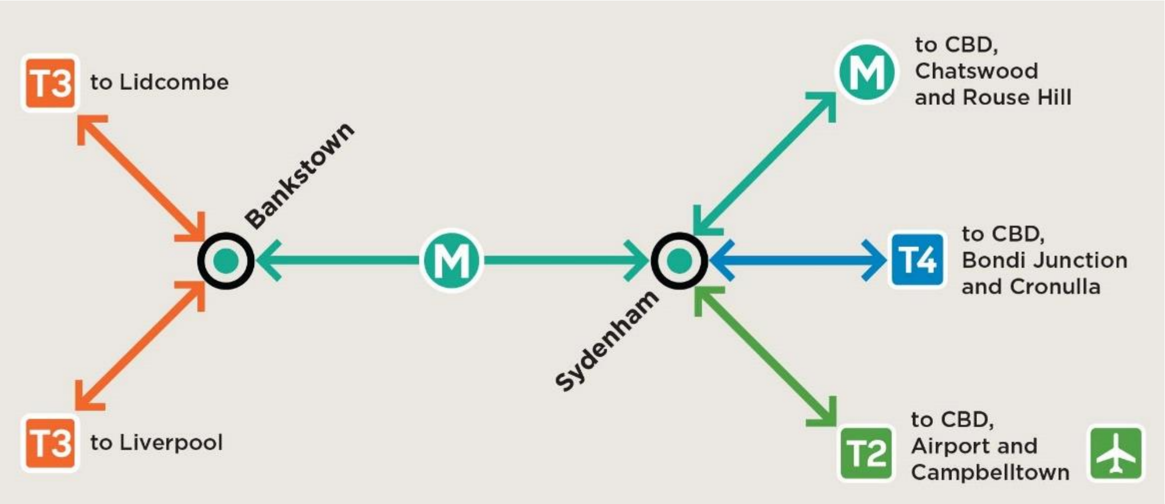
As described in Chapter 8 (Project description – operation), Sydney Metro trains would operate between Bankstown and Cudgegong Road stations, via the Sydney CBD and Chatswood. Between Sydenham and Chatswood, Sydney Metro trains would service the new Waterloo Station, Central Station (via new platforms), and the following five new stations to be constructed as part of the Chatswood to Sydenham project:

- Pitt Street Station
- Martin Place Station
- Barangaroo Station
- Victoria Cross Station (in North Sydney)
- Crows Nest Station.

The project would result in changes to service patterns for some stations along the T3 Bankstown Line and the City Circle. Proposed changes to servicing arrangements are shown in Figure 11.3 and summarised in Table 11.4 and Table 11.5.

As shown in the tables and figure, Sydney Metro customers would be able to change between Sydney Metro and Sydney Trains services at Sydenham, Bankstown, and Central stations.

West of Bankstown, the T3 Bankstown Line would continue to be operated by Sydney Trains between Liverpool, Lidcombe, and Bankstown. Sydney Trains would no longer operate on the T3 Bankstown Line between Sydenham and Bankstown stations.



Source: Transport for NSW

Figure 11.3 Metro integration with Sydney Trains services

Table 11.4 Station servicing arrangements

Existing station - origin	Service availability
Stations east of Sydenham: • St Peters, Erskineville and Redfern • Stations on the City Circle	St Peters, Erskineville and Redfern would continue to be serviced by Sydney Trains, operating on the T2 Airport Line or the T4 Illawarra Line. City Circle stations would continue to be served by T2 line services. Customers needing to access Sydney Metro services could change at Sydenham or Central stations.
Stations between Sydenham and Bankstown	Stations would be serviced by Sydney Metro. Customers needing to access Sydney Trains services could change at Bankstown, Sydenham, or Central stations.
Stations west of Bankstown: • Yagoona, Birrong, Regents Park, Berala • Sefton, Chester Hill, Leightonfield, Villawood, Carramar	Stations would continue to be serviced by Sydney Trains, via trains operating between Liverpool, Bankstown, and Lidcombe stations on the redesigned T3 Bankstown Line. Customers wishing to access Sydney Metro services would be able to change at Bankstown Station. Customers wishing to travel via Sydney Trains to other destinations could change at: • Lidcombe Station, for travel via the T1 Western Line or the T2 Inner West and South Line • Cabramatta Station, for travel via the T2 Inner West and South Line or the T5 Cumberland Line.
• Lidcombe	Lidcombe would continue to be serviced by Sydney Trains, operating on the existing T1 and T2 lines, and the redesigned T3 Bankstown Line. Customers wishing to access Sydney Metro services would be able to change at Bankstown Station.
• Cabramatta	Cabramatta would continue to be serviced by Sydney Trains, operating on the T2 Inner West and South Line, the T5 Cumberland Line, and the redesigned T3 Bankstown Line.

Existing station - origin	Service availability
	Customers wishing to access Sydney Metro services would be able to change at Bankstown Station.
• Warwick Farm and Liverpool	Stations would continue to be serviced by Sydney Trains, operating on the T2 Inner West and South Line and the T5 Cumberland Line. Customers wishing to access Sydney Metro services would need to change at Cabramatta to Sydney Trains services to Bankstown Station.

Table 11.5 Potential changes to travel patterns to key centres

	Servicing patterns on rail to key centres				
Origin	**Sydney CBD**	**Liverpool**	**Parramatta**	**Chatswood**	**Macquarie Park**
Stations east of Sydenham (St Peters, Erskineville and Redfern)	Travel directly via Sydney Trains services	Travel via Sydney Trains and Sydney Metro services by changing trains at Sydenham and Bankstown	Travel via Sydney Trains, changing trains at Redfern Station	Travel via Sydney Trains and then Sydney Metro, by changing at Central or Sydenham, or by Sydney Trains only, changing at Redfern	Travel via Sydney Trains and then Sydney Metro, by changing at Central, Sydenham or Chatswood
Stations between Sydenham and Bankstown	Travel directly via Sydney Metro	Travel via Sydney Metro and Sydney Trains services, by changing trains at Bankstown	Travel via Sydney Metro and Sydney Trains, by changing trains at Bankstown and Lidcombe, or at Sydenham and Redfern	Travel directly via Sydney Metro	Travel directly via Sydney Metro
Yagoona, Birrong, Regents Park, Berala, Sefton, Chester Hill, Leightonfield, Villawood, Carramar	Travel via Sydney Trains and Sydney Metro, changing trains at Bankstown, or by Sydney Trains only, changing at Lidcombe / Cabramatta	Travel via Sydney Trains	Travel via Sydney Trains, by changing trains at Lidcombe or Cabramatta	Travel via Sydney Trains and then Sydney Metro, by changing at Bankstown	Travel via Sydney Trains and then Sydney Metro, by changing at Bankstown
Cabramatta, Warwick Farm	Travel via by Sydney Trains only on the T2 line, or by Sydney Trains and Sydney Metro, changing trains at Bankstown	Travel directly via Sydney Trains on the T2 line	Travel directly via Sydney Trains on the T5 line	Travel via Sydney Trains and then Sydney Metro, by changing at Bankstown, or by Sydney Trains only, changing at Central	Travel via Sydney Trains and then Sydney Metro, by changing at Bankstown, or by Sydney Trains only, changing at Central

Bus network

The project would not involve major changes to existing bus service routes or stops. There are a number of stations where minor changes to service routes and/or stops are proposed, to provide improved accessible paths of travel between existing stops and station entries.

The project is being planned in conjunction with other transport initiatives (as discussed in Section 11.3) as a key component of an integrated public transport network, which includes the bus network. By providing passengers with improved ability to make mode changes (such as from bus to rail), the project would facilitate a significant increase to the passenger catchment of the rail line, with benefits to all transport modes. The project would provide benefits to bus customers by:

- optimising connections between bus and rail services where possible, by locating bus stops as close as practicable to station entries and providing DDA compliant connections, including provision of upgraded or relocated bus stops at some stations
- improving the interchange with bus services.

The proposed changes to bus routes and services at each station are considered in Sections 11.4.4 to 11.4.13.

Taxi and kiss and ride

Taxi and kiss and ride facilities would be provided at each station (refer to Table 11.2). The substantial increase in provision and repositioning of these facilities would improve existing conditions at most stations. The proposed new facilities would be generally closer to stations, more visible, and where feasible, accessible paths would be provided between the facilities and the stations, as discussed in Sections 11.4.4 to 11.4.13.

Road network

The demand for road travel is expected to increase into the future, including as a result of population growth and urban renewal initiatives outlined in the draft *Sydenham to Bankstown Urban Renewal Strategy*. The enhanced customer experience provided by metro, including travel time savings, is expected to result in growth in the use of rail services. This increased growth would potentially result in a reduction in the dependence on motor vehicles as the primary travel mode in the study area. Without an increase in modal share of rail services (and other public transport), the increases in population proposed along the corridor would give rise to greater congestion and delays on the road network. The introduction of metro would benefit local communities by providing a viable alternative to the car with benefits for the local road network

The proposed changes to the road network at each station are considered in Sections 11.4.4 to 11.4.13.

Parking and loading zones

The project has been designed to result in a 'no net loss' of dedicated commuter car parking spaces located adjacent to stations on NSW Government owned land. This commitment applies to parking that is not currently time restricted and is formally line marked and/or signposted as a dedicated commuter car parking zone or area. Additionally, the project design aims to deliver no reduction in the availability of loading zones. The project would provide about 80 additional dedicated commuter parking spaces at Campsie.The creation of new station forecourts and active transport facilities aimed at improving station access by walking and cycling would impact some of the on and off-street parking areas adjacent to stations. These impacts would be mainly as a result of the provision of accessible parking, kiss and ride, and taxi facilities. In total, these proposed changes would result in the loss of about 26 on-street parking spaces along the project area. The majority of these spaces would only be removed from areas directly adjacent to the existing stations/rail corridor, and would generally not involve removal of spaces directly outside businesses.

A loss of about 58 off-street parking areas that are not dedicated commuter parking spaces would occur at Belmore and Bankstown stations. These areas are currently timed and used for short periods. Off-street parking located within 400 metres of the stations has limited capacity to compensate for the loss of these 58 spaces, however available on-street capacity in the vicinity of the stations would assist in minimising the impacts of the loss of these spaces.

Table 11.6 summarises the expected changes to parking impacts at stations. Overall, the loss of these spaces is considered to be minor in a traffic and transport context due to the availability of alternate parking. It is also noted that the project will achieve no net loss of dedicated commuter spaces on NSW Government owned land which is aimed at facilitating access for existing users with a focus on customers with accessibility needs.

Table 11.6 Indicative parking changes at stations

	Changes to parking		
Station	**Dedicated commuter parking**	**On-street parking spaces[1, 2]**	**Other off-street parking spaces[1]**
Marrickville	0	-1	0
Dulwich Hill	0	-5	0
Hurlstone Park	0	0	0
Canterbury	0	0	0
Campsie	80	-20	0
Belmore	0	0	-48
Lakemba	0	0	0
Wiley Park	0	0	0
Punchbowl	0	0	0
Bankstown	0	0	-10
Totals	**80**	**-26**	**-58**

Notes: 1. Spaces within 400 metres of the station.
2. Does not include potentially impacts spaces due to reconfiguration of kerbside facilities.

In addition to the loss of parking outlined in Table 11.6, further parking loss would potentially occur due to the reconfiguration of kerbside areas to include kiss and ride, taxi or accessible parking facilities in the vicinity of stations. The loss of parking at each station has been estimated based on the existing design and in most instances would be small, however the exact number would be confirmed during detailed design. The sections below provide an overview of the number of spaces which would potentially be lost.

Transport for NSW would work with local councils to minimise adverse impacts from adjustments to parking and other kerbside uses in local streets. This would include for example, relocation of spaces to other kerbside areas or the consideration of kiss and ride facilities that are only available during specified periods of the day such as the peak periods. In this situation, spaces would potentially be available at other times for short-term parking (e.g. outside of the peak periods). Such an arrangement would minimise the loss of spaces for the majority of the day, but would ensure that kiss and ride facilities are provided during periods when they are most likely to be needed.

Further discussion on parking and impacts on loading zones at each station is provided in Sections 11.4.4 and 11.4.13.

Freight transport

The rail corridor between Marrickville and west of Campsie is shared with freight services operated by ARTC travelling between Port Botany and the Enfield Intermodal Terminal north of Campsie. The operation of these services would not be impacted. Some existing track connections between the existing T3 Bankstown Line and the freight line would be removed where no longer required.

Maintenance access during operation by ARTC is not anticipated to change from the existing arrangement. Should any potential changes be proposed during detailed design, this would be discussed with relevant stakeholders.

11.4.3 Transport integration strategy

To enhance access within station area, the project design has been guided by the transport access hierarchy described in Section 11.3.2. The project would:

- support projected growth in travel through appropriate planned infrastructure and service provision, which is designed to integrate with urban renewal, corridor revitalisation, and sustainable travel initiatives
- enhance the accessibility of each station and areas in their general vicinity, with regard to walking and cycling, by incorporating the features summarised in Section 11.3.3
- include infrastructure to support accessible paths of travel and interchange between transport modes, as described in Section 11.3
- maintain all existing road bridges (including underbridges) that cross the rail corridor to maintain access
- provide additional access points across the rail corridor at Dulwich Hill, Canterbury, Belmore, Punchbowl, and Bankstown stations through the provision of new cross corridor connections.

The following sections outline the changes in facilities and infrastructure proposed by the project. Reference should be made to the existing environment described in Section 10.2 for comparison with the changes proposed.

11.4.4 Marrickville Station

Figure 11.4 shows the proposed interchange arrangement in the vicinity of the upgraded station.

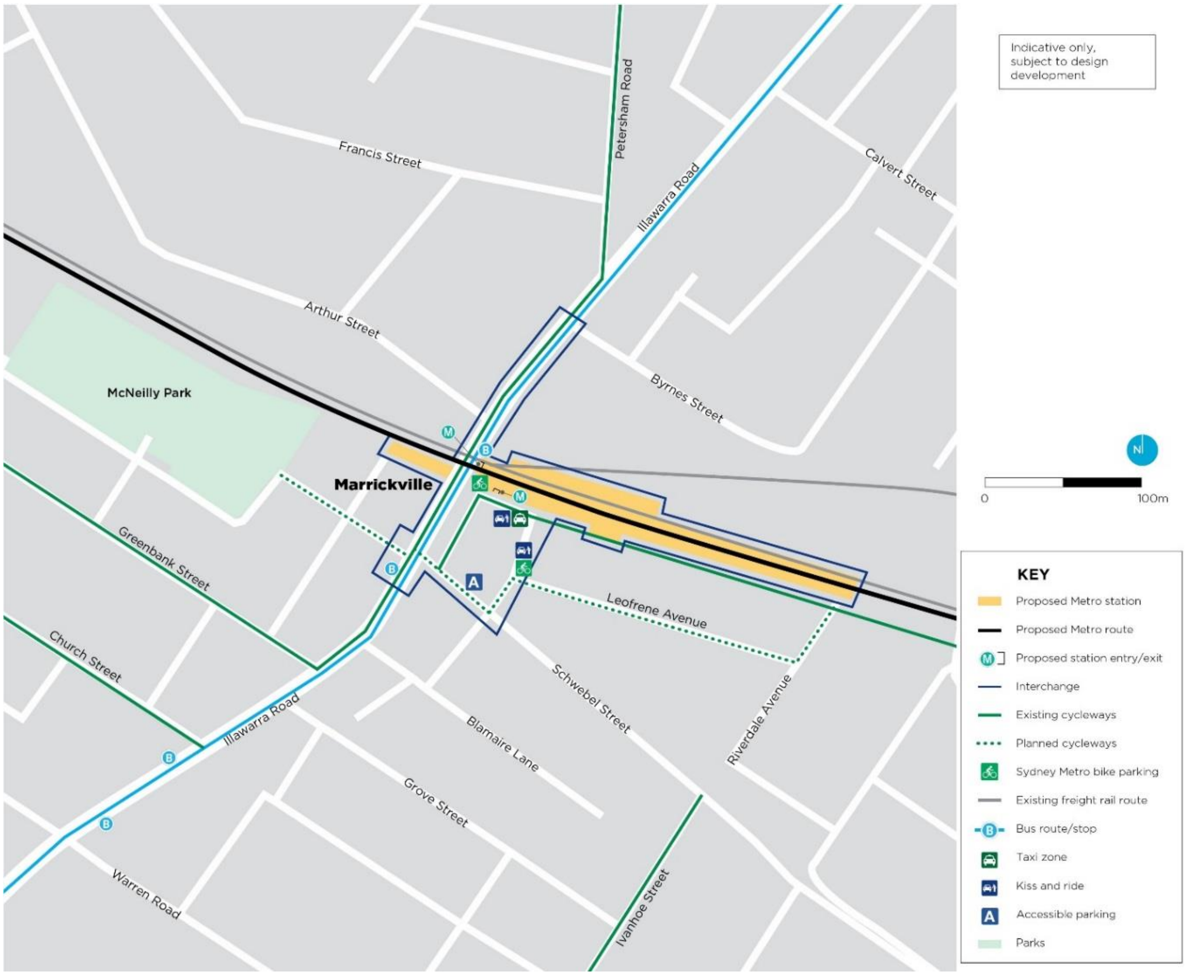


Figure 11.4 Marrickville Station transport interchange arrangement

Passenger demand

By 2026, it is forecast that there would be about 13,800 daily customer movements (i.e. an entry or exit) at Marrickville Station, with the modal split generally as follows:

- walking – 83 per cent
- cycling – 0.3 per cent
- bus – 3.5 per cent
- kiss and ride – 9.5 per cent
- park and ride – 3.7 per cent.

Pedestrian integration

It is predicted that the number of pedestrian entries and exits at the station would increase by about 3,800 per day by 2026.

Footpaths in the vicinity of the station are considered to have adequate capacity to accommodate this predicted growth. The southbound bus stop on Illawarra Road may constrain flows as people wait for a bus. However, the footpath on Illawarra Road has low pedestrian flows and adequate capacity for pedestrian movements and waiting at the bus stop.

The project includes provision of a new shared zone at Station Street, which would provide safer access to the adjacent station entrance. A new accessible ramp from the station entrance to Schwebel Street would provide a DDA compliant access route, as Station Street would remain partly non-compliant due to the gradient along this street.

The project would involve removal of the existing crossing located outside the station entrance on Illawarra Road. New crossing locations are proposed at the following locations:

- new signalised intersection at the Illawarra Road/Schwebel Street/Warburton Street intersection, including crossings of all roads
- new pedestrian crossing on Illawarra Road at Arthur Street.

The new signalised intersection would improve access to the existing northbound bus stop located south of Warburton Street, and businesses along this section of Illawarra Road.

Cyclist integration

The project would result in a substantial increase in the number of bike parking spaces at Marrickville Station, with new facilities proposed along the eastern section of the Station Street shared zone. This new bike parking would complement the existing parking facility located below the existing stairs adjacent to Station Street. The provision of additional bike parking would meet the predicted demand for spaces at Marrickville Station. Space for the future provision of additional facilities has been provided in the design should demand increase over time.

Bike parking would be provided as close to the station as possible, to allow for short connections into surrounding cycle paths and routes, including the active transport corridor.

Public transport integration

The project would not result in changes to the existing bus routes along Illawarra Road. The existing bus stops would be retained.

Road network integration

The road network in the vicinity of Marrickville Station would generally operate as it currently does. Improvements to the Station Street entrance, including provision of kerbside facilities (taxi and kiss and ride) is expected to increase vehicle movements along Schwebel Street. The project includes the upgrade of the Illawarra Road/Schwebel Street/Warburton Street intersection to a signalised intersection, which would assist with the management of traffic movements.

Kerbside facility integration

The kiss and ride facilities on Station Street would be relocated within the new Station Street shared zone. The project would result in an increase in the number of kiss and ride spaces provided. These spaces would all be fully accessible in line with DDA requirements. Taxi facilities would also be provided within the Station Street shared zone and would also be fully accessible.

Accessible parking would continue to be located on Schwebel Street, and would include an additional accessible parking space. A new path from the station entrance along Station Street would improve access to these spaces.

Parking and loading zones

There is no dedicated commuter parking at Marrickville Station.

The reconfiguration of kerbside areas would result in the potential loss of about two on-street parking spaces on Schwebel Street. Consultation would be undertaken with Inner West Council to discuss possible alternative arrangements, such as the relocation of spaces or timing of kerbside facilities, to minimise the loss of spaces to particular periods of the day (i.e. the peak periods). Based on parking surveys undertaken, the surrounding streets are considered to have adequate capacity to cater for this small loss of on-street spaces near the station.

The project would not affect any loading zones at Marrickville Station.

11.4.5 Dulwich Hill Station

Figure 11.5 shows the proposed interchange arrangement in the vicinity of the upgraded station.

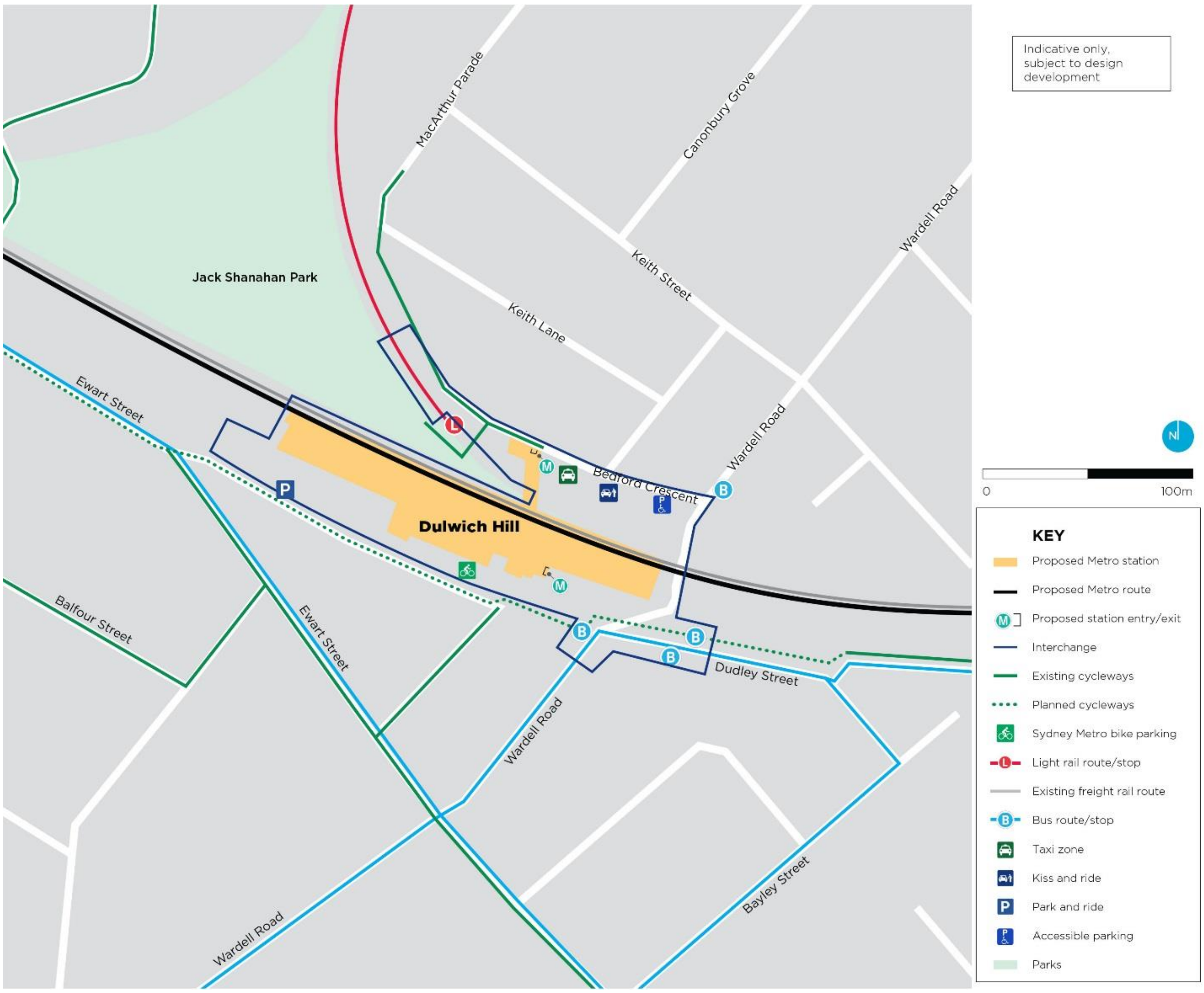


Figure 11.5 Dulwich Hill Station transport interchange arrangement

Passenger demand

By 2026, it is forecast that there would be about 13,600 daily customer movements (i.e. an entry or exit) at Dulwich Hill Station, with the modal split generally as follows:

- walking – 72 per cent
- cycling – 0.4 per cent
- bus – 4.1 per cent
- kiss and ride – 8 per cent
- park and ride – 5.5 per cent
- light rail – 10 per cent.

Pedestrian integration

It is predicted that the number of pedestrian entries and exits at the station would increase by about 5,800 per day by 2026.

Wider footpaths are proposed on Wardell Road near the new southern station entrance. As a result, retention of the existing northbound bus stop on Wardell Road adjacent to the southern entrance would not constrain pedestrian movements.

No additional pedestrian crossings are proposed in the vicinity of the station. Access to the existing crossing on Wardell Road would be improved, as the new wider footpaths would provide safe access to and from the new entrance. New footpaths would also provide access to the reconfigured car park in Ewart Lane, which is an improvement on the existing situation, as no footpaths are currently provided on the northern side of the lane.

Pedestrian access to kerbside facilities on Bedford Crescent would be provided, with accessible paths to and from the station. Access to the Dulwich Hill light rail stop would be maintained via the existing lift and stairs, which would be integrated into the new station concourse. The new concourse would also provide a more direct route to the light rail stop from areas south of the rail corridor. This would remove the need for some light rail users to travel to the stop via the Wardell Road overbridge, and decreasing the travel distance for some customers.

Cyclist integration

The project would result in a substantial increase in the number of bike parking spaces at Dulwich Hill Station, with new facilities proposed at the southern station entrance. Existing facilities on Bedford Crescent (north of stairs and lift to light rail) would also be retained. The total bike parking provision would meet the estimated demand for spaces at the station. Bike parking has been provided as close to the station as possible, to allow for short connections into surrounding cycle paths and routes, including the active transport corridor.

Public transport integration

Access to existing bus stops would be maintained. Access to the eastbound bus stop in Dudley Street would be improved, with accessible paths linking to the new southern station entrance.

The new station concourse would provide a more direct route to the light rail stop from areas south of the rail corridor.

Road network integration

The project does not involve adjustments to the road network in the vicinity of Dulwich Hill Station.

Kerbside facility integration

A new kerbside area would be provided on Bedford Crescent to the north of the station. This area would accommodate additional kiss and ride, and taxi bays.

Parking and loading zones

The project is not expected to result in a loss of dedicated commuter parking near Dulwich Hill Station. This would be confirmed during detailed design.

The project would result in the loss of up to 10 on-street spaces in Bedford Crescent as a result of the provision of new kerbside facilities in this location. Consultation would be undertaken with Inner West Council to discuss possible alternative arrangements, such as relocation of spaces or timing of kerbside facilities, to minimise the loss of spaces to particular periods of the day (i.e. the peak periods). Based on parking surveys undertaken, the surrounding streets are considered to have adequate capacity to cater for the small loss of on-street spaces near the station.

The project would not affect loading zones at Dulwich Hill Station.

11.4.6 Hurlstone Park Station

Figure 11.6 shows the proposed interchange arrangement in the vicinity of the upgraded station.

Figure 11.6 Hurlstone Park Station transport interchange arrangement

Passenger demand

By 2026, it is forecast that there would be about 9,400 daily customer movements (i.e. an entry or exit) at Hurlstone Park Station, with the modal split generally as follows:

- walking – 67.9 per cent
- cycling – 0.1 per cent
- bus – 17.1 per cent
- kiss and ride – 5.2 per cent
- park and ride – 9.7 per cent.

Pedestrian integration

Pedestrian entries and exits at the station are forecast to increase by over 4,000 per day by 2026. This volume of pedestrians can be readily accommodated on surrounding footpaths.

The proposed pedestrian crossing on Crinan Street would provide direct access to the commercial area on Duntroon Street (south of corridor) and surrounding residential areas. The existing crossing on the Duntroon Street overbridge would be modified to ensure it remains accessible and has ample space on either side to cater for future pedestrian flows.

The new station concourse would have a larger area fronting the Crinan/Duntroon Street overbridge and Duntroon Street. This would provide sufficient space to facilitate pedestrian flows to and from the station.

Cyclist integration

The project would result in a substantial increase in the number of bike parking spaces at Hurlstone Park Station, with new facilities proposed on Floss Street west of the station. The total bike parking provision would meet the estimated demand for spaces at the station. Bike parking has been provided as close to the station as possible, to allow for short connections into surrounding cycle paths and routes, including the active transport corridor.

Public transport integration

No changes to bus services at the station are proposed. Access to bus stops from the station would be similar to the existing situation. All footpaths providing access to and from stops would be accessible.

Road network integration

The project does not involve adjustments to the road network in the vicinity of Hurlstone Park Station.

Kerbside facility integration

A new kerbside area would be provided on Floss Street to the east of the station on the eastern side of the overbridge. This area would include kiss and ride and taxi bays, which would be an improvement compared to the existing situation, with no facilities currently being available.

Parking and loading zones

The project would not result in the loss of dedicated commuter parking at Hurlstone Park Station.

The reconfiguration of kerbside areas would result in the potential loss of up to five spaces in Duntroon Street (south) and Floss Street (east) due to the provision of kerbside facilities. Consultation would be undertaken with Canterbury-Bankstown Council to discuss possible alternative arrangements, such as the relocation of spaces or timing of kerbside facilities, to minimise the loss of spaces to particular periods of the day (i.e. the peak periods). Based on parking surveys undertaken, the surrounding streets are considered to have adequate capacity to cater for the small loss of on-street spaces near the station.

All existing accessible parking spaces in Floss Street to the north of the station would be retained. The existing accessible space on the southern side of the station in Duntroon Street would be relocated to a new location in the same section of Duntroon Street.

The project would not affect loading zones at Hurlstone Park Station.

11.4.7 Canterbury Station

Figure 11.7 shows the proposed interchange arrangement in the vicinity of the upgraded station.

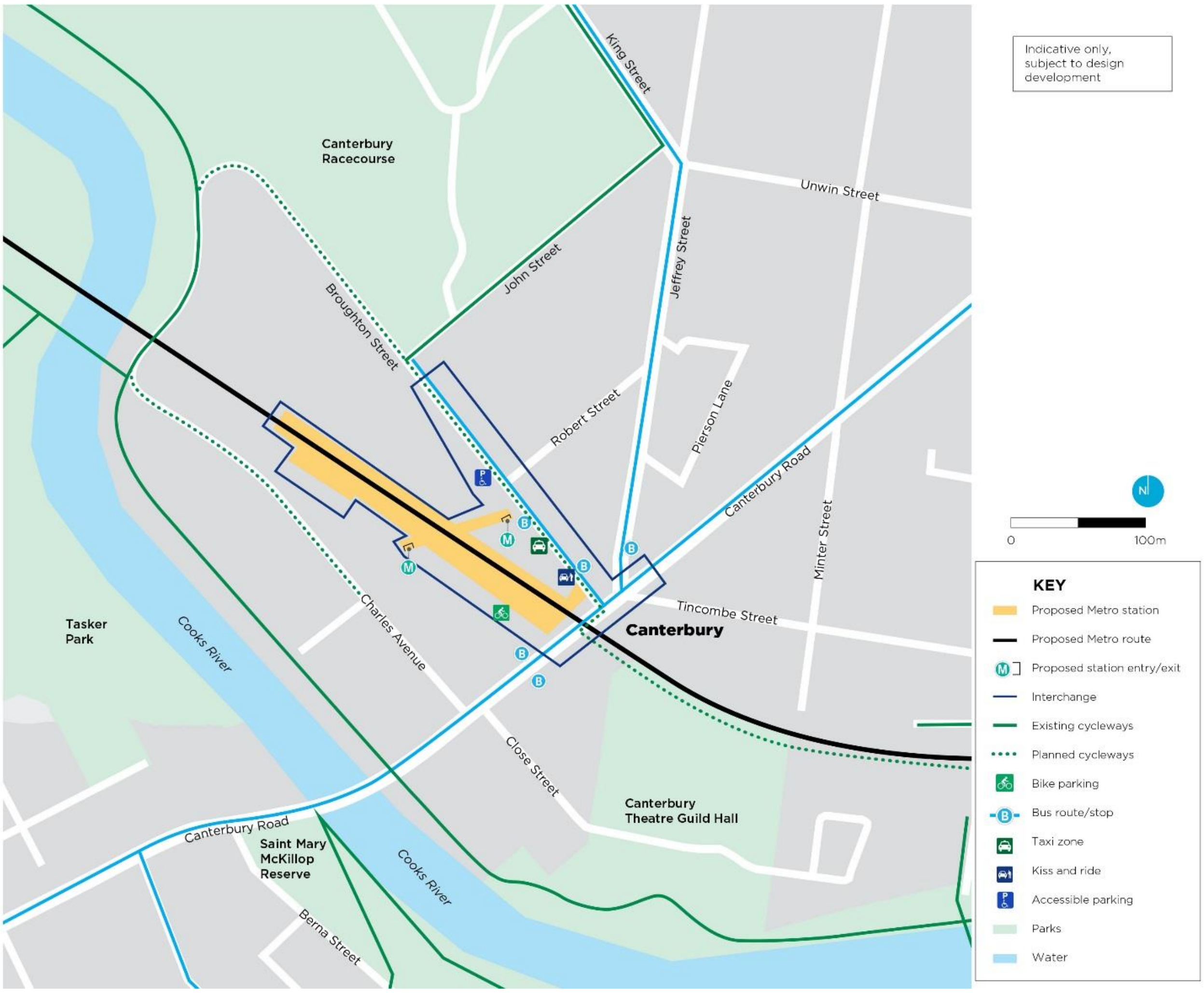


Figure 11.7 Canterbury Station transport interchange arrangement

Passenger demand

By 2026, it is forecast that there would be about 14,200 daily customer movements (i.e. an entry or exit) at Canterbury Station, with the modal split generally as follows:

- walking – 66.3 per cent
- cycling – 0.2 per cent
- bus – 12.9 per cent
- kiss and ride – 10.5 per cent
- park and ride – 10.1 per cent.

Pedestrian integration

An increase of over 5,500 pedestrians per day by 2026 would not affect the capacity of surrounding footpaths. The existing crossing at Broughton Street has the potential to be a constraint for pedestrian flows. However, the existing footpaths are generally considered to have adequate capacity, which would be enhanced as a result of the proposed upgrades and the new station entrances.

The proposed entrances at Broughton Street and Canterbury Road would improve pedestrian connections with the surrounding areas, particularly the new development areas to the south (the Canterbury Road entrance) and future development areas to the north (the Broughton Street entrance). An additional entrance has been safeguard at Charles Street which would provide improved pedestrian connections to the south of the station in the future if necessary.

The proposed pedestrian crossing on Broughton Street adjacent to the new station entrance would provide safe passage for pedestrians accessing bus stops on the northern side of Broughton Street, as well as to future development areas located north of the station.

Cyclist integration

The project would result in a substantial increase in the number of bike parking spaces at Canterbury Station. New facilities proposed at each of the new station entrances would meet the demand for spaces at the station. Bike parking has been provided as close to the station as possible, to allow for short connections into surrounding cycle paths and routes, including the active transport corridor.

Public transport integration

No changes to bus services at the station are proposed. One minor adjustment to a bus stop in Broughton Street would be required to allow room for the proposed kerbside facilities. This bus stop would be relocated closer to the new station entrance, which is considered a better outcome.

Existing bus stops would be readily accessed via accessible paths from at least one of the proposed station entrances. The provision of the new crossing on Broughton Street would improve access to bus stops on the northern side of Broughton Street.

Road network integration

The project does not involve adjustments to the road network in the vicinity of Canterbury Station.

Kerbside facility integration

New kerbside facilities (including taxi and kiss and ride facilities) would be provided at the Broughton Street entrances to the station. These would be readily accessed from DDA compliant pathways from the Broughton Street station entrance.

Parking and loading zones

The project would not result in the loss of dedicated commuter parking at Canterbury Station.

The reconfiguration of kerbside areas would result in the potential loss of up to about two spaces in Broughton Street to provide new accessible parking spaces. Consultation would be undertaken with Canterbury-Bankstown Council to discuss possible alternative arrangements, such as relocation of spaces or timing of kerbside facilities, to minimise the loss of spaces to particular periods of the day (i.e. the peak periods). Based on parking surveys undertaken, the surrounding streets are considered to have adequate capacity to cater for the small loss of on-street spaces near the station.

There would be no loss of accessible parking at the station. Existing spaces would be relocated to Broughton Street to enable them to be accessed from the new station entrance.

The project would not affect loading zones at Canterbury Station.

11.4.8 Campsie Station

Figure 11.8 shows the proposed interchange arrangement in the vicinity of the upgraded station.

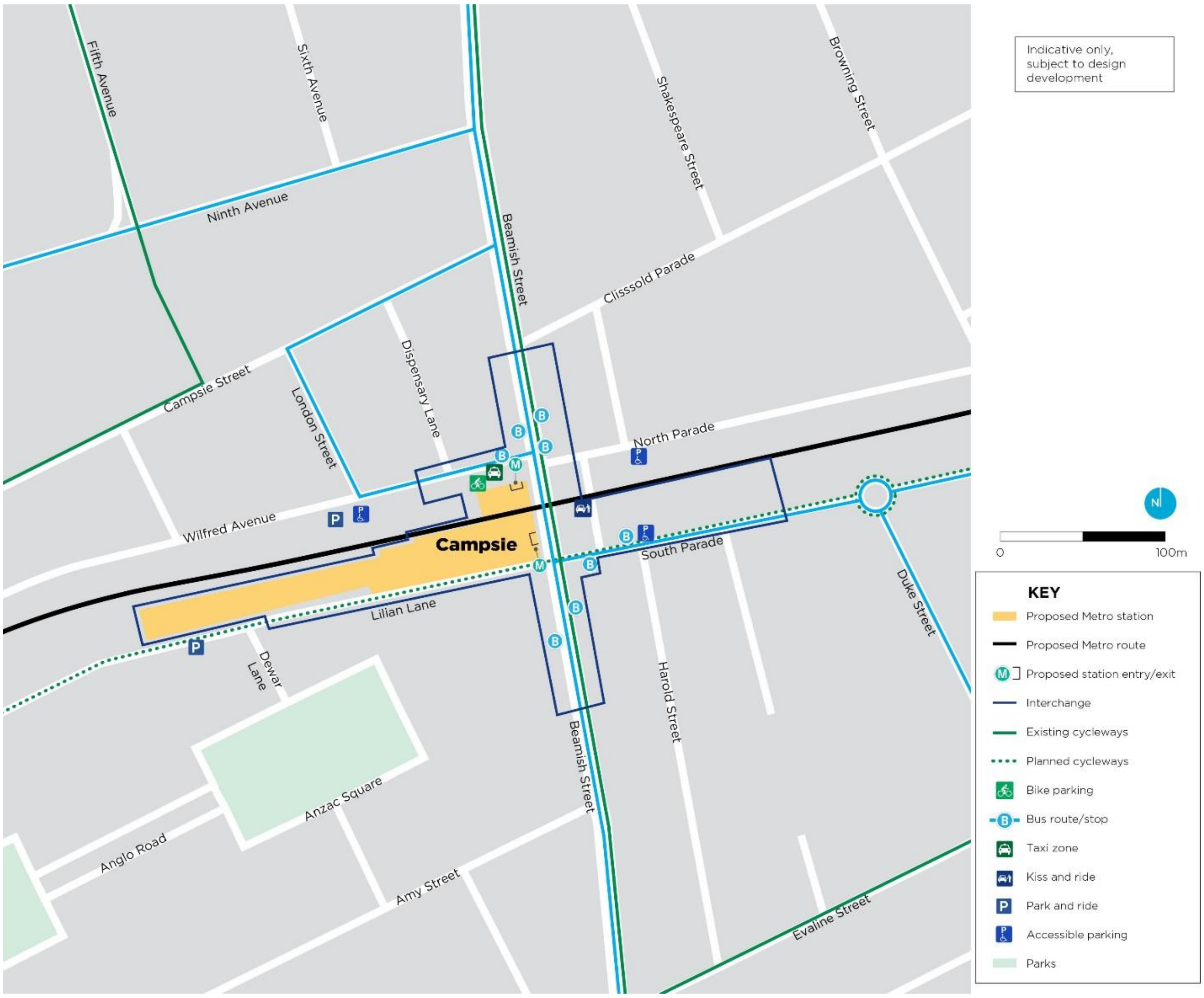


Figure 11.8 Campsie Station transport interchange arrangement

Passenger demand

By 2026, it is forecast that there would be about 21,400 daily customer movements (i.e. an entry or exit) at Campsie Station, with the modal split generally as follows:

- walking – 64.9 per cent
- cycling – 0.3 per cent
- bus – 17.5 per cent
- kiss and ride – 7.2 per cent
- park and ride – 10.2 per cent.

Pedestrian integration

The number of pedestrian entries and exits at the station is forecast to increase by over 2,000 per day by 2026. Surrounding footpaths have adequate capacity to cater for this growth.

The existing signalised crossing on Beamish Street at South Parade has the potential to be a constraint for pedestrian flows, with pedestrians waiting to cross constraining flows along Beamish Street south of the station. The capacity of existing footpaths in this area as well as the proposed widening of the station forecourt and footpaths adjacent to Beamish Street would minimise the potential for crowding. The new shared zone along Lilian Lane to the south of the station would further improve pedestrian safety.

The above changes to pedestrian facilities would contribute to improved pedestrian amenity in the area surrounding the station.

Cyclist integration

The project would result in a substantial increase in the number of bike parking spaces at the station, predominantly adjacent to the northern station entrance on North Parade. This increase in bike parking spaces would meet the demand for spaces at the station. Bike parking has been provided as close to the station as possible, to allow for short connections into surrounding cycle paths and routes, including the active transport corridor.

Public transport integration

No changes to bus services or stops at the station are proposed. Accessible paths would be provided to the bus stops.

Road network integration

To the south of the station, Lilian Lane would be upgraded to become a shared zone. Movements along the lane would remain one way, with an exit to Beamish Street.

The project would also include construction of a new access way to be used for kiss and ride facilities on the eastern side of Beamish Street. This road would be one way in a northbound direction and would provide separation from Beamish Street.

Kerbside facility integration

New kiss and ride facilities would be located above the rail corridor to the east of Beamish Street. This would be accessible by pedestrians via existing crossings on Beamish Street.

The project would involve relocation of taxi bays from North Parade (east of Beamish Street) to North Parade (west of Beamish Street). This change would improve access from the station and make this facility more visually prominent from the station entrance.

Parking and loading zones

The project includes construction of a new dedicated commuter parking area along Lilian Street to the west of the station. This area would be located on NSW government (RailCorp) owned land, and would accommodate about 80 new commuter parking spaces.

The reconfiguration of kerbside areas at the station would result in the potential loss of up to 20 on-street spaces in North and South Parade. Consultation would be undertaken with Canterbury-Bankstown Council to discuss possible alternative arrangements, such as relocation of spaces or timing of kerbside facilities, to minimise the loss of spaces to particular periods of the day (i.e. the peak periods). The impacts to on-street parking would be a small proportion of the existing on-street parking in the vicinity of the station. As shown in Table 10.16, there are about 1,000 on-street parking spaces located within 400 metres of Campsie Station. Although the existing demand for on-street parking is high (represented by the utilisation rate of 85 per cent), there would be some capacity to absorb the loss of spaces. It is recognised that alternative parking may be located further from the customer's preferred destination.

The project would not affect existing accessible parking spaces. The project would potentially affect the loading zone on North Parade (west of Beamish Street) by the proposed kerbside facilities (taxi bay). Options to minimise impacts include allowing short-term parking in this area during peak periods, with loading allowed at other times, or relocating the loading zone west of the proposed kerbside facilities. The preferred option would be identified during detailed design.

11.4.9 Belmore Station

Figure 11.9 shows the proposed interchange arrangement in the vicinity of the upgraded station.

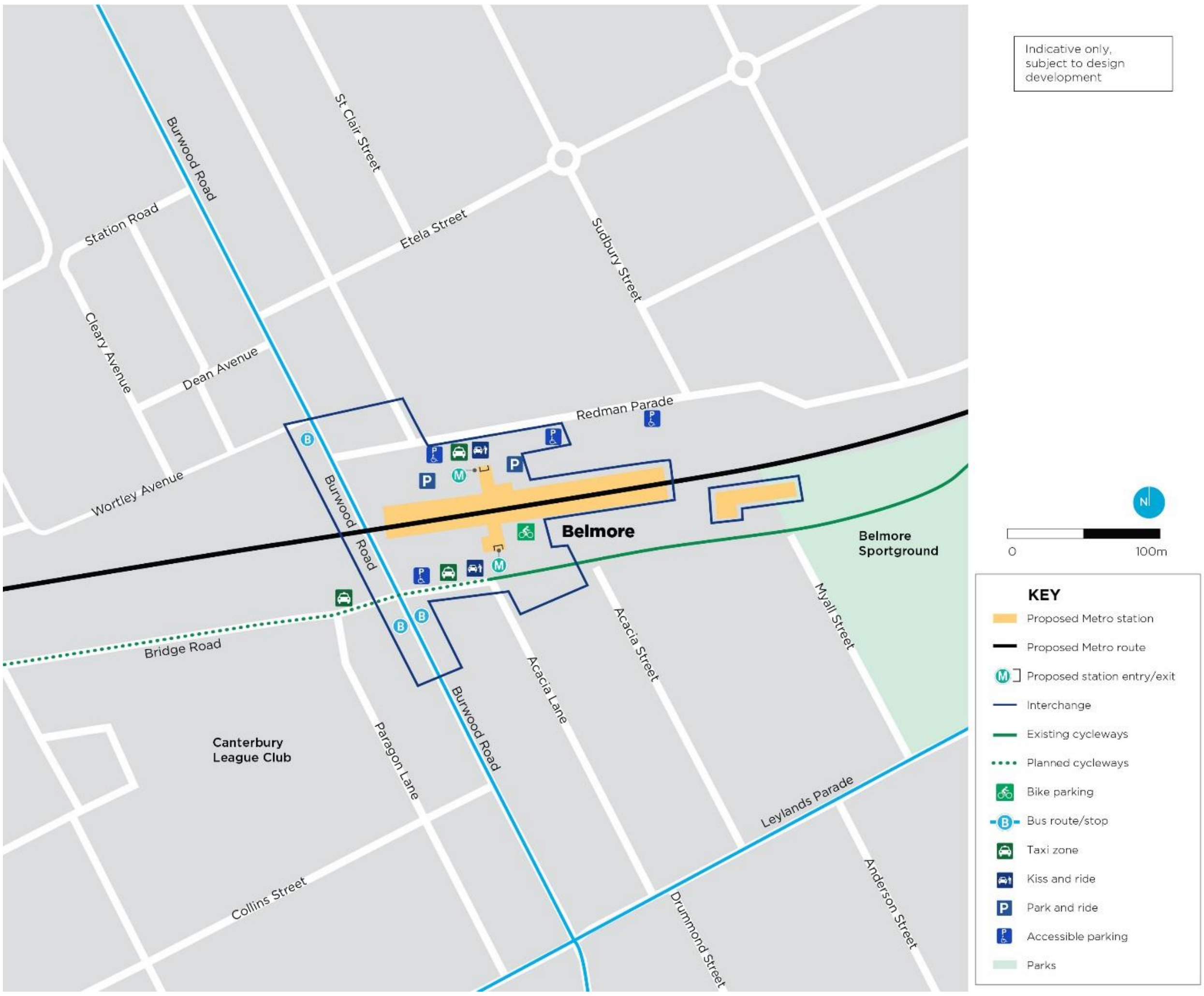


Figure 11.9 Belmore Station transport interchange arrangement

Passenger demand

By 2026, it is forecast that there would be about 13,000 daily customer movements (i.e. an entry or exit) at Belmore Station, with the modal split generally as follows:

- walking – 63.8 per cent
- cycling – 0.1 per cent
- bus – 9.9 per cent
- kiss and ride – 9 per cent
- park and ride – 17.2 per cent.

Pedestrian integration

It is forecast that the number of pedestrian entries and exits at the station would increase by about 4,500 per day by 2026. Surrounding footpaths have adequate capacity to accommodate this growth.

The proposed shared zone on Tobruk Avenue would provide a clear and legible entry to the station and be easily visible for pedestrians along Burwood Road.

The proposed signalised intersection of Tobruk Avenue/Bridge Road/Burwood Road would provide a more direct and safe path for pedestrians to access the station from the western side of Burwood Road. This intersection would also reduce the potential impacts of the removal of the existing crossing on Burwood Road at the existing station entrance. Accessible paths would also be provided from the new northern entrance to Burwood Road and the shopping areas located along this road.

Cyclist integration

The project would result in a substantial increase in the number of bike parking spaces at the station, with new facilities proposed adjacent to the stairs to the new concourse on the southern side of the corridor. This allocation of bike parking is considered to meet the demand for spaces at Belmore Station. Bike parking has been provided as close to the station as possible, and allows for connections to surrounding cycle paths and routes, including the active transport corridor, which consists of the existing network of paths east of the station towards the Belmore Sports Ground.

Public transport integration

No changes to bus services at the station are proposed. However, it is proposed to relocate the existing southbound stop from north of Tobruk Avenue to south of Tobruk Avenue. The new intersection at Tobruk Avenue/Bridge Road/Burwood Road would ensure that accessible paths are provided to both the northbound and southbound bus stops to and from the station.

Road network integration

The project includes signalisation of the Tobruk Avenue/Bridge Road/Burwood Road intersection. The signalisation of this intersection would minimise impacts to the road network as a result of increased traffic accessing the station, particularly the kerbside facilities in Tobruk Avenue.

Tobruk Avenue would become a shared zone to ensure that the area surrounding the station entrance is more pedestrian friendly while still providing vehicle access.

Kerbside facility integration

The existing station does not have kiss and ride facilities. The project would provide kiss and ride facilities in Tobruk Avenue and Redman Parade adjacent to the southern and northern entrances to the station. The existing taxi facilities in Bridge Road west of the Burwood Road intersection would be retained, and an additional space would be provided adjacent to the new station entrances.

The new kerbside facilities would be more accessible from the station entrance compared to the existing spaces. The new intersection and pedestrian crossing would improve access to the existing taxi facilities.

Parking and loading zones

There is the potential for the loss of some dedicated commuter parking spaces located off Redman Parade. The exact number of spaces would be confirmed during detailed design. It is likely that this car park would be reconfigured to ensure that there is no net loss in spaces at this station. No other loss of parking spaces is proposed in the vicinity of the station.

The project would affect the existing council car park located off Tobruk Avenue, with a total of 48 off-street parking spaces lost permanently lost as a result of the project. This car park is timed and primarily services the retail area located along Burwood Road. This impact would affect just over 50 per cent of the non-commuter off-street parking near the station.

As shown in Table 10.19, there are about 900 unrestricted on-street parking spaces within 400 metres of Belmore Station. As the utilisation rate of on-street parking is 76 per cent, there would be some capacity to absorb the loss of spaces. It is recognised that alternative parking may be located further from the customer's preferred destination.

The reconfiguration of kerbside areas would result in the potential loss of up to five on-street spaces in Tobruk Avenue due to the provision of kerbside facilities. Consultation would be undertaken with Canterbury-Bankstown Council to discuss possible alternative arrangements available such as relocation of spaces or timing of kerbside facilities to minimise the loss of spaces to particular periods of the day (i.e. the peak periods). The surrounding streets are considered to have adequate capacity to cater for the small loss of on-street spaces near the station.

The project would not affect loading zones at Belmore Station.

11.4.10 Lakemba Station

Figure 11.10 shows the proposed interchange arrangement in the vicinity of the upgraded station.

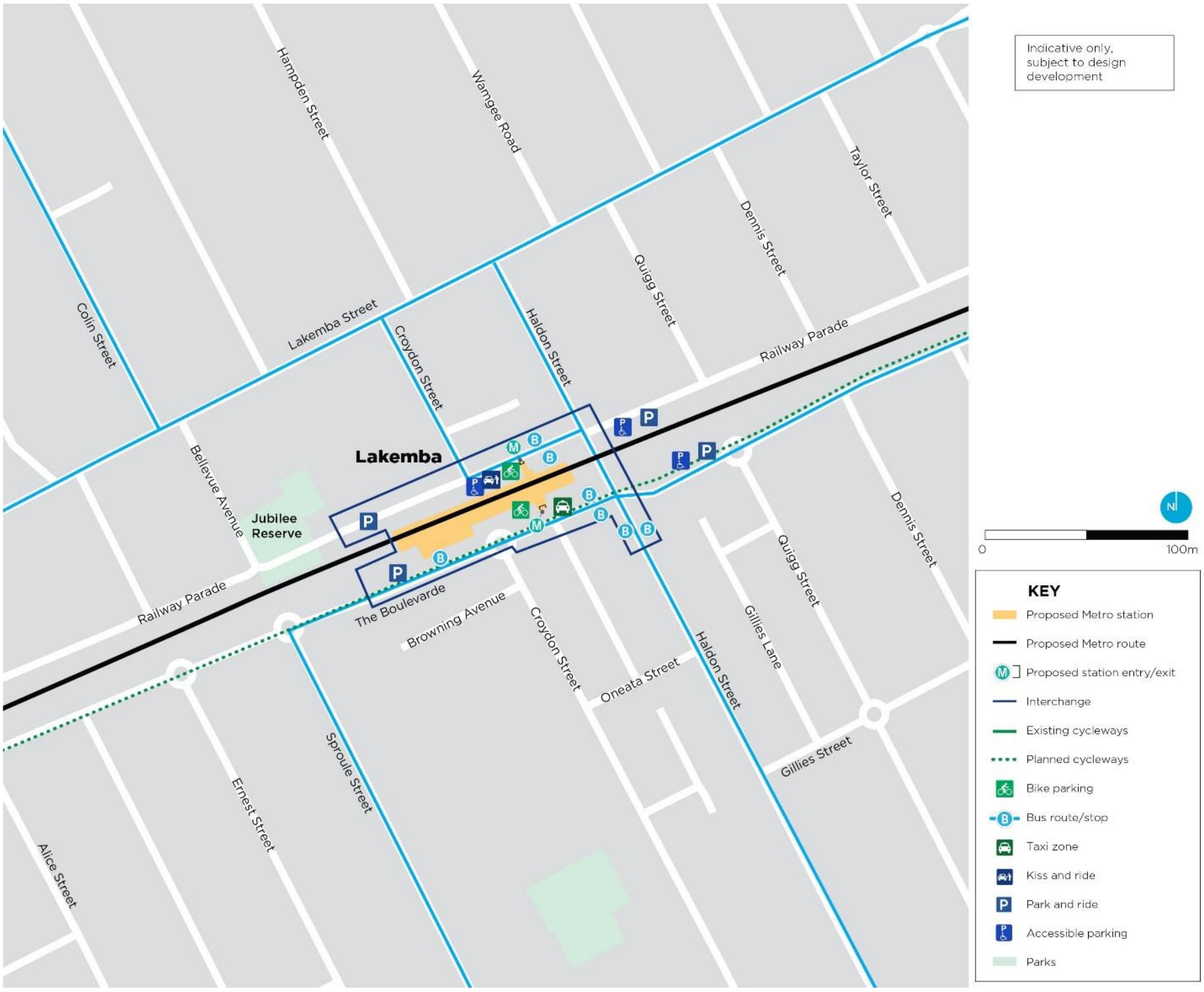


Figure 11.10 Lakemba Station transport interchange arrangement

Passenger demand

By 2026, it is forecast that there would be about 14,800 daily customer movements (i.e. an entry or exit) at Lakemba Station, with the modal split generally as follows:

- walking – 67.3 per cent
- cycling – 0.2 per cent
- bus – 6.9 per cent

- kiss and ride – 7.3 per cent
- park and ride – 18.3 per cent.

Pedestrian integration

It is forecast that the number of pedestrian entries and exits at the station would increase by about 3,800 pedestrians per day by 2026. Surrounding footpaths have adequate capacity to accommodate this increase. Although the signalised crossing at the Haldon Street/The Boulevarde intersection could potentially impact flows where pedestrians wait to cross the road, the capacity of footpaths in this area is considered to be adequate.

The area in the vicinity of the station would remain similar to the existing situation, with the existing concourse to be retained and upgraded. Some forecourt works on either side of the corridor would improve accessibility, and in some cases, result in more direct access to the station.

The existing station concourse is currently used as a cross-corridor link. The project would maintain this cross-corridor link therefore impacts to pedestrian movements are not considered likely.

Cyclist integration

The project would result in a substantial increase in the number of bike parking spaces at the station, with new facilities proposed adjacent to the access stairs on both sides of the rail corridor. This allocation of bike parking is considered to meet the demand for spaces at Lakemba Station. Bike parking has been provided as close to the station entrances as possible, and allow for connections to surrounding cycle paths and routes, including the active transport corridor along The Boulevarde.

Public transport integration

No changes to bus services or stops at the station are proposed. All stops would retain the existing level of accessibility, including the non-accessible stop on the northern side of Railway Parade. Other stops on Railway Parade and The Boulevarde would continue to be served by accessible paths.

Road network integration

No adjustments to the road network are proposed in the vicinity of Lakemba Station.

Kerbside facility integration

The project would include provision of new kiss and ride spaces along Railway Parade, accessed from the northern station entrance. Existing kiss and ride facilities on the southern side of The Boulevarde would be retained.

The project would include provision of taxi facilities on The Boulevarde, which would be positioned in a similar location to the existing taxi facilities.

Parking and loading zones

The project would not result in the loss of any dedicated commuter parking at Lakemba Station.

The reconfiguration of kerbside areas would result in the potential loss of up to about seven spaces on Railway Parade. Consultation would be undertaken with Canterbury-Bankstown Council to discuss possible alternative arrangements, such as relocation of spaces or timing of kerbside facilities, to minimise the loss of spaces to particular periods of the day (i.e. the peak periods). Based on parking surveys undertaken, the surrounding streets are considered to have adequate capacity to cater for the small loss of on-street spaces near the station.

All existing accessible parking spaces would be retained. The project includes provision of a new accessible parking bay within the kerbside area on Railway Parade near the northern station entrance.

The project would not affect loading zones at Lakemba Station.

11.4.11 Wiley Park Station

Figure 11.11 shows the proposed interchange arrangement in the vicinity of the upgraded station.

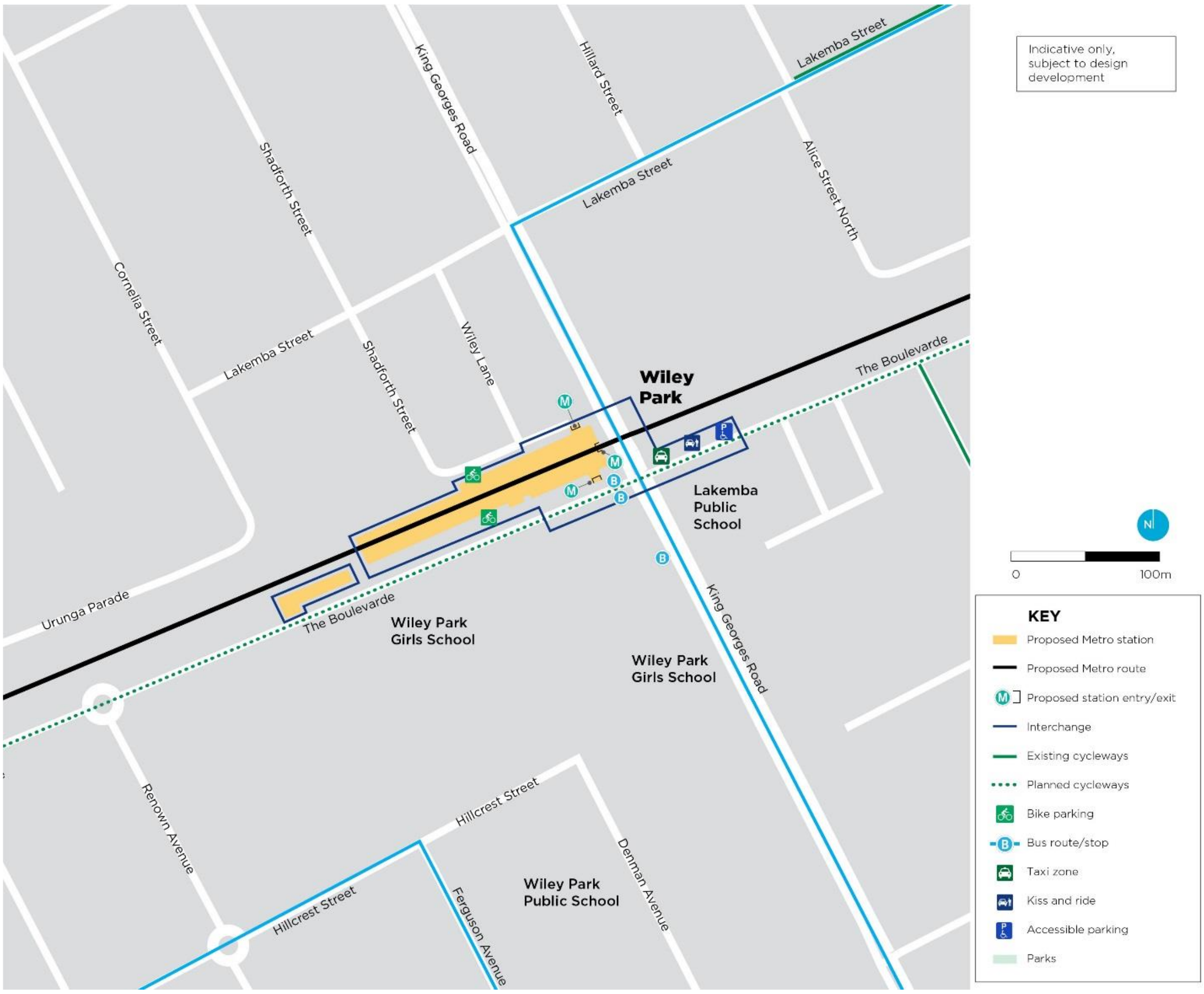


Figure 11.11 Wiley Park Station transport interchange arrangement

Passenger demand

By 2026, it is forecast that there would be about 11,400 daily customer movements (i.e. an entry or exit) at Wiley Park Station, with the modal split generally as follows:

- walking – 77.9 per cent
- cycling – 0.3 per cent
- bus – 0.9 per cent
- kiss and ride – 11.5 per cent
- park and ride – 9.4 per cent.

Pedestrian integration

Pedestrian entries and exits at the station are forecast to increase by over 5,400 people per day by 2026. Footpaths surrounding the station are generally considered to have adequate capacity to accommodate this increase pedestrian movements. Pedestrian queuing at the crossing at King Georges Road and The Boulevarde has the potential to impact pedestrian flows along King Georges Road, however paths in this location have adequate capacity to ensure that pedestrians flows are not constrained.

New station entrances to the north and south of the corridor would improve connections and accessibility to areas on either side of the rail corridor including surrounding streets.

Cyclist integration

The project would result in a substantial increase in the number of bike parking spaces at the station, with new facilities proposed both platforms to the east of the new station buildings. These two new facilities would be accessible from the adjacent footpaths located on either side of the rail corridor. This allocation of bike parking is considered to meet the demand for spaces at Wiley Park Station. Bike parking has been provided as close to the station entrances as possible, and allows for connections to surrounding cycle paths and routes, including the active transport corridor along The Boulevarde. The proposed locations of these facilities are located adjacent to futureproofed station entrances located on either side of the rail corridor.

Public transport integration

The project would not impact bus operations along King Georges Road. All bus stops would remain in their existing location. This would result in some visibility issues from the new station entrances and wayfinding signage would be installed to improve this.

Access to the bus stops on Kings Georges Road would remain accessible. Existing bus stops on The Boulevarde, which are generally only used for rail replacement buses, would be retained.

Road network integration

No adjustments to the road network are proposed in the vicinity of Wiley Park Station.

Kerbside facility integration

New kerbside facilities would be provided on The Boulevarde to the east of King Georges Road. This would contain taxi and kiss and ride spaces, neither of which are currently provided. This facility would not be highly visible from the station entrances, however accessible paths would connect directly to the station.

Parking and loading zones

The project would not result in a loss of dedicated commuter parking at Wiley Park Station.

The reconfiguration of kerbside areas would result in the potential loss of up to about 10 spaces in The Boulevarde, to the east of King Georges Road. Consultation would be undertaken with Canterbury-Bankstown Council to discuss possible alternative arrangements, such as relocation of spaces or timing of kerbside facilities, to minimise the loss of spaces to particular periods of the day (i.e. the peak periods). Based on parking surveys undertaken, the surrounding streets are considered to have adequate capacity to cater for the small loss of on-street spaces near the station.

An accessible parking space would be provided within the kerbside facilities on The Boulevarde east of King Georges Road.

The project would not affect loading zones at Wiley Park Station.

11.4.12 Punchbowl Station

Figure 11.12 shows the proposed interchange arrangement in the vicinity of the upgraded Punchbowl Station.

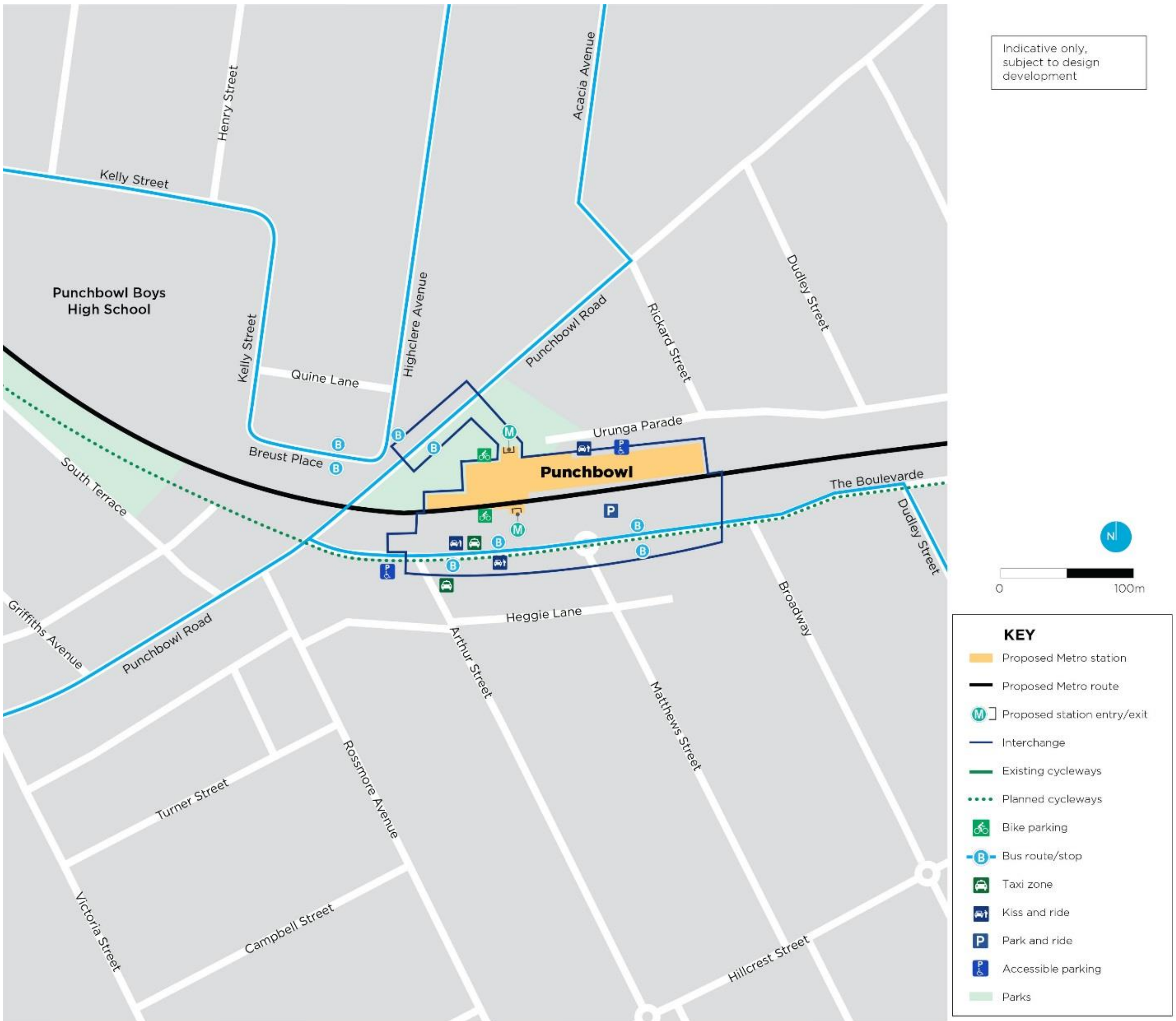


Figure 11.12 Punchbowl Station transport interchange arrangement

Passenger demand

By 2026, it is forecast that there would be about 13,000 daily customer movements (i.e. an entry or exit) at Punchbowl Station, with the modal split generally as follows:

- walking – 55.6 per cent
- cycling – 0.1 per cent
- bus – 12.3 per cent
- kiss and ride – 15.2 per cent
- park and ride – 16.8 per cent.

Pedestrian integration

The number of pedestrian entries or exits at the station is forecast to increase by over 4,000 people per day by 2026. This rate of increase in the number of pedestrians in the vicinity of the station is not considered to result in capacity issues on surrounding footpaths.

The following changes to the pedestrian network are proposed:

- new crossing across Punchbowl Road to replace the existing pedestrian underpass adjacent to the rail corridor
- accessible ramp and path to Urunga Parade
- improved station forecourt areas on both sides of the corridor providing increased space for pedestrian movements.

The above changes are considered to represent a substantial improvement to pedestrian networks in the vicinity of the station and would provide more direct routes to the station from the nearby town centre and surrounding residential areas. These changes would also assist the provision of accessible paths as part of the station design.

Cyclist integration

The project would result in a substantial increase in the number of bike parking spaces at the station with new facilities to be provided on both sides of the rail corridor adjacent to the station entrances. The provision of bike parking is considered to meet the demand for spaces at Punchbowl Station. Bike parking has been provided as close to the station entrances as possible and also allows for connections into surrounding cycle paths and routes including the active transport corridor.

Public transport integration

Existing bus routes would not be altered by the project. The majority of bus stops would remain unaffected with the exception of the eastbound stop on The Boulevarde which would be relocated east to be outside the new station entrance. This would ensure that the distance between the stop and the station is minimised and the stop is highly visible. Existing bus stops on Punchbowl Road (to be retained) would not be fully visible from the northern station entrance and therefore would require some wayfinding signage.

An accessible path would link the station entrances to the bus stops.

Road network integration

The project would not require adjustments to the road network in the vicinity of Punchbowl Station.

Kerbside facility integration

The existing taxi facilities in Arthur Street on the southern side of The Boulevarde would be retained and would be close to the new station entrance. The visibility of these spaces would however be reduced as the station is to be relocated east away from Arthur Street. An additional space would be provided adjacent to the new southern station entrance and would be highly visible and accessible to and from the station.

The project would include the provision of three new kiss and ride areas (each containing a number of kiss and ride spaces), with two new facilities on either side of The Boulevarde (near the southern entrance) and one on the southern side of Urunga Parade (east of the northern entrance). Accessible paths would link the kiss and ride facilities to the station, however only the areas on the southern side would be visible from the station entrance with wayfinding likely to be required for the facility in Urunga Parade.

Parking and loading zones

The project would result in some impacts on the existing dedicated commuter car park located off The Boulevarde, although this is unlikely to result in a loss of parking spaces, as the car park would be reconfigured to maintain the existing availability of commuter parking.

The reconfiguration of kerbside areas would result in the potential loss of up to about 20 on-street spaces in Urunga Parade and The Boulevarde. Consultation would be undertaken with Canterbury-Bankstown Council to discuss possible alternative arrangements, such as relocation of spaces or timing of kerbside facilities, to minimise the loss of spaces to particular periods of the day (i.e. the peak periods). The surrounding streets are considered to have adequate capacity to cater for the small loss of on-street spaces near the station. It is recognised that alternative parking may be located further from the customer's preferred destination.

Accessible parking spaces are to be provided on both sides of the rail corridor in Urunga Parade and The Boulevarde, connected by accessible paths to the station entrances on either side of the rail corridor.

The project would not affect loading zones at Punchbowl Station.

11.4.13 Bankstown Station

Figure 11.13 shows the proposed interchange arrangement in the vicinity of the upgraded Bankstown Station.

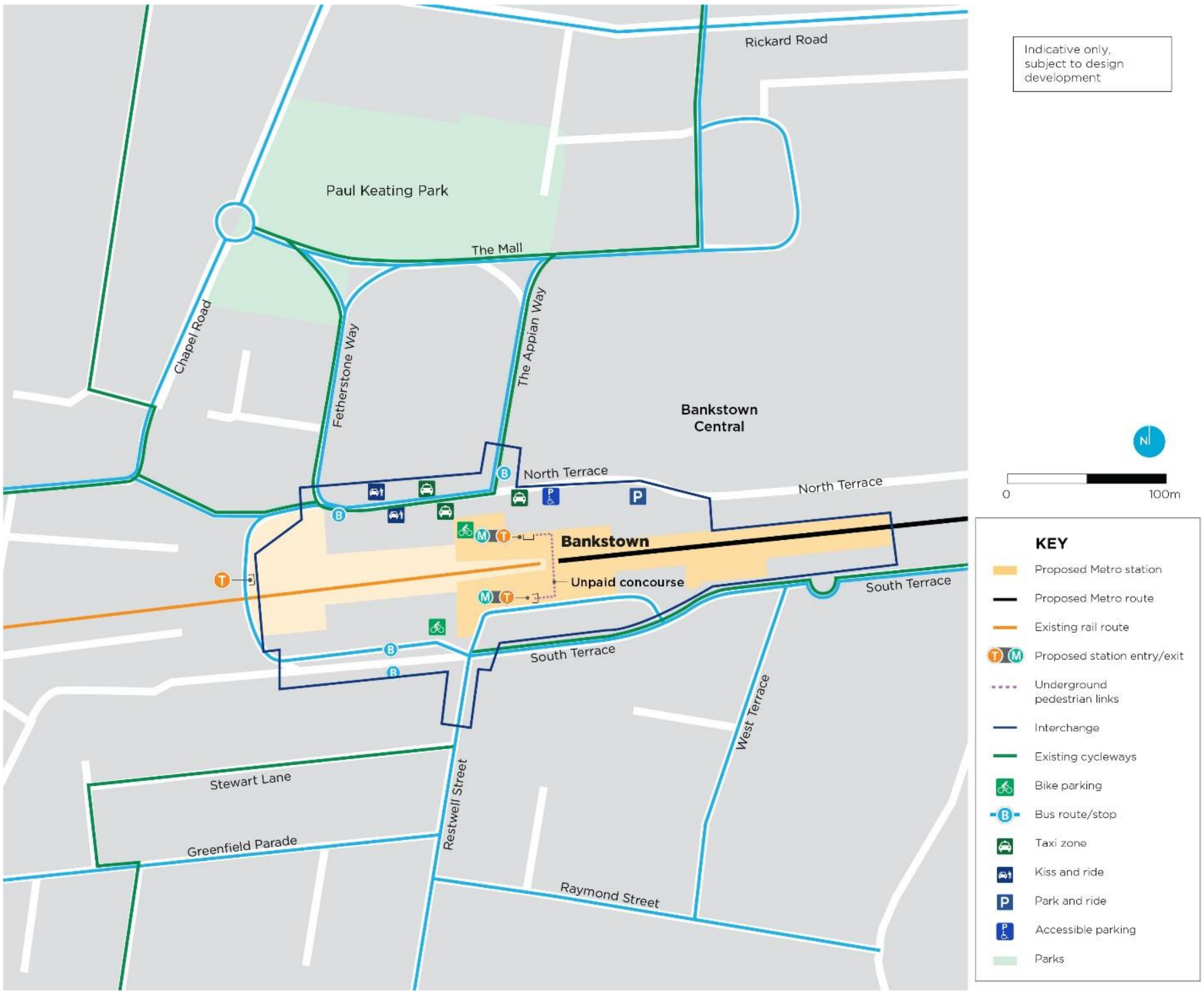


Figure 11.13 Bankstown Station transport interchange arrangement

Passenger demand

By 2026, it is forecast that there would be about 23,800 daily customer movements (i.e. an entry or exit) at Bankstown Station, with the modal split generally as follows:

- walking – 50.8 per cent
- cycling – 0.2 per cent
- bus – 28 per cent
- kiss and ride – 14.7 per cent
- park and ride – 6.3 per cent.

Pedestrian integration

The number of pedestrian entries or exits at the station is forecast to increase by over 3,000 people per day by 2026. This increase in pedestrian activity in the vicinity of the station is not considered to result in capacity issues on surrounding footpaths.

The project would include the construction of a new at grade cross-corridor link. This link would be positioned between the existing Sydney Trains station and the new metro station to be constructed east of the Sydney Trains station. The construction of this new link would provide a new direct access into the Bankstown CBD located midway between the existing crossing points at Bankstown City Plaza or the road link between North and South terraces. This new link will improve access for pedestrians particularly when accessing the Bankstown Central Shopping Centre which is located on the northern side of the corridor. This centre is a major destination within the Bankstown CBD and the new link provides a more direct link to this key land use from areas located south of the rail corridor.

Modelling was undertaken to investigate the potential for passenger movement conflicts at Bankstown Station where there would be interaction of passengers from Sydney Trains and Sydney Metro services. The assessment identified that there would be sufficient space to allow passenger queuing and circulation without undue conflict, should movements be predominately in the same direction.

Cyclist integration

The project would result in a substantial increase in the number of bike parking spaces at Bankstown Station with new facilities to be provided on both sides of the station adjacent to the new pedestrian underpass. The provision of bike parking is considered to meet the demand for spaces at Bankstown Station. Bike parking has been provided as close to the station entrances as possible, and allows for connection to surrounding cycle paths and routes, including the active transport corridor along South Terrace on the southern side of the station.

Public transport integration

The project would not result in changes to bus routes or stops. The construction of the pedestrian link across the corridor would however improve access to the existing bus interchange from the northern side of the rail corridor and particularly Bankstown Central Shopping Centre.

Road network integration

The project would not require adjustments to the road network in the vicinity of Bankstown Station.

Kerbside facility integration

Existing taxi facilities along North Terrace would be retained and would be visible from the new entrance to the station located on the northern side of the corridor.

The project would result in an increase in the number of kiss and ride spaces, all of which would be located along North Terrace adjacent to the new entrance to the station located on the northern side of the corridor.

Parking and loading zones

The project would not result in the loss of dedicated commuter parking. The existing car park located adjacent to the new station entrance on North Terrace would be removed, resulting in the loss of about 10 off-street parking spaces.

The provision of kerbside facilities would not result in the loss of any on-street parking areas.

One additional accessible parking space would be provided on North Terrace.

The project would not affect loading zones at Bankstown Station.

11.5 Mitigation measures

11.5.1 Approach to mitigation and management

The project has been designed to provide efficient interchange between Sydney Metro and other forms of transport. Mitigation measures are proposed to further ensure that the project efficiently interchanges with other forms of transport. This would include further consultation with relevant stakeholders to ensure that impacts to on-road facilities is minimised.

11.5.2 List of mitigation measures

The operational traffic and transport mitigation measures that would be implemented are listed in Table 11.7.

Table 11.7 Mitigation measures – operational traffic and transport

ID	Impact/issue	Mitigation measure	Relevant location(s)
Design/pre-construction			
TO1	Parking impacts	Further consideration of car parking management at stations would be undertaken in consultation with Roads and Maritime Services, the Sydney Coordination Office, and the Inner West and Canterbury-Bankstown councils, to minimise adverse impacts of operation on parking and other kerbside use in local streets.	All stations
Operation			
TO2	Walking	Transport for NSW would work with the Inner West and Canterbury-Bankstown councils to identify and provide improvements and minimise adverse impacts to the surrounding pedestrian network.	All stations
TO3	Cycling	Transport for NSW would work with the Inner West and Canterbury-Bankstown councils and other relevant stakeholders to enhance areas around stations for cyclists.	All stations
TO4	Bus	Transport for NSW would work with the Sydney Co-ordination Office, Roads and Maritime Services, the Inner West and Canterbury-Bankstown councils, and	All stations

ID	Impact/issue	Mitigation measure	Relevant location(s)
		bus operators to identify improvements to bus stops and services.	
TO5	Active transport corridor	Transport for NSW would work with the Department of Planning and Environment to support the development of an active transport corridor along the alignment, including walking and cycling infrastructure. Transport for NSW would deliver sections of the active transport corridor around stations.	All
TO6	Commuter parking	Transport for NSW would monitor the demand for additional commuter car parking spaces and consider opportunities for, and implications of, meeting this demand between Bankstown and Marrickville stations. Transport for NSW would consider provision for additional commuter car parking, subject to consideration of local station and town centre implications, including local traffic conditions.	All stations

11.5.3 Consideration of the interactions between mitigation measures

Mitigation measures proposed to mitigate any traffic and transport impacts during operation are not considered to result in adverse interactions with other mitigation measures.

11.5.4 Managing residual impacts

With the implementation of identified mitigations measures and ongoing development of the design (during detailed design) residual impacts on traffic and transport in the vicinity of the project area are considered to be minimal. This includes consideration of the future redevelopment of the Sydenham to Bankstown Line corridor in accordance with the draft *Sydenham to Bankstown Urban Renewal Corridor Strategy*. There is however potential for residual impacts to occur due to unforeseen changes in land use that may affect patronage at stations.

12. Construction noise and vibration

This chapter provides a summary of the construction noise and vibration assessment. A full copy of the assessment report is provided as Technical paper 2 – Noise and vibration. The Secretary's environmental assessment requirements relevant to noise and vibration, together with a reference to where the results of the assessment are summarised in this chapter and in the Environmental Impact Statement, are provided in Table 12.1.

Table 12.1 Secretary's environmental assessment requirements – noise and vibration

Ref	Secretary's environmental assessment requirements – noise and vibration	Where addressed
8. Noise and vibration - amenity		
8.1	The Proponent must assess construction and operational noise and vibration impacts in accordance with relevant NSW noise and vibration guidelines. The assessment must include consideration of impacts to sensitive receivers including small businesses, and include consideration of sleep disturbance and, as relevant, the characteristics of noise and vibration (for example, low frequency noise).	A summary of the results of the construction noise assessment is provided in this chapter. The full results are provided as Technical paper 2. Operational noise impacts are considered in Chapter 13. Construction amenity and sleep disturbance impacts to sensitive receivers are considered in Section 12.5. The characteristics of noise and vibration are explained in Technical paper 2, and no modifying factors need to be used in this assessment.
8.2	The EIS must include a framework for both an Out of Hours Works Strategy and the development of an Out of Hours Works Plan which incorporates community consultation.	Section 12.6.1
9. Noise and vibration - structural		
9.1	The Proponent must assess construction and operation noise and vibration impacts in accordance with relevant NSW noise and vibration guidelines. The assessment must include consideration of impacts to the structural integrity and heritage significance of items (including Aboriginal places and items of environmental heritage).	A summary of the results of the construction vibration assessment is provided in this chapter. The full results are provided as Technical paper 2. Operational vibration impacts are considered in Chapter 13. Consideration of potential construction impacts to structural integrity (including heritage items) is provided in Section 12.5
9.2	The Proponent must demonstrate that blast impacts are capable of complying with the current guidelines, if blasting is required.	Blasting would not be required.

12.1 Assessment approach

A summary of the approach to the construction noise and vibration assessment is provided in this section. Further information is provided in Technical paper 2.

12.1.1 Legislative and policy context to the assessment

The guidelines and standards relevant to the construction noise and vibration assessment include:

- *Interim Construction Noise Guideline* (DECC, 2009)
- *Road Noise Policy (DECCW, 2011)*
- *NSW Industrial Noise Policy* (EPA, 2000)
- *Assessing Vibration: A Technical Guideline* (DEC, 2006)
- British Standard (BS) *5228-2:2009 Code of practice for noise and vibration on construction and open sites – Part 2: Vibration* and *BS 6472:1992 Evaluation of human exposure to vibration in buildings*
- *DIN 4150:Part 3-1999 Structural vibration – Effects of vibration on structures* (Deutsches Institute fur Normung, 1999).

12.1.2 Methodology

The assessment methodology involved:

- identifying and classifying sensitive receivers
- characterising the existing noise environment based on attended and unattended noise measurements at representative locations in the study area
- determining noise and vibration management levels in accordance with relevant guidelines
- modelling to quantify predicted noise and vibration levels
- assessing the significance of predicted noise and vibration levels
- examining the proposed construction methodologies and identifying mitigation measures to minimise construction noise and vibration impacts.

The construction noise assessment has been prepared with reference to the *Interim Construction Noise Guideline* ('the ICNG') (DECC, 2009) and the Sydney Metro Construction Noise and Vibration Strategy (Appendix E). SoundPLAN computer modelling software was used to predict airborne noise levels.

Construction (airborne) noise

Airborne noise is considered to be an amenity issue. Airborne noise would be generated at all construction sites, and would mainly be associated with surface activities where there is a path between the source and receiver. Airborne noise generated by construction machinery and works has the potential to result in amenity impacts for sensitive receivers.

An assessment of the potential for construction noise (amenity) impacts was undertaken in accordance with the ICNG.

The guideline sets out ways to address the impacts of construction noise on residential receivers and other sensitive land uses, by presenting assessment approaches that are tailored to the scale of construction projects.

The ICNG quantitative assessment method involves:

- specifying project-specific noise management levels (NMLs) for potentially affected noise sensitive receivers
- predicting noise levels at sensitive receivers
- comparing them with the specified NMLs.

Where noise levels are predicted to exceed the NMLs, reasonable and feasible mitigation and work practices need to be investigated and implemented to minimise noise impacts.

Construction noise levels have been predicted based on indicative construction activities and durations (refer Table 12.8).

Some plant and equipment emit high noise levels; referred to as highly noise intensive plant. Examples include: hydraulic rock breakers, concrete saws and ballast tampers. Use of these highly noise intensive items of plant can result in noise levels exceeding the relevant assessment criteria, even though they may be used for only short periods. Adopting the methodology in the ICNG, all construction plant and equipment is assumed to be operating at full power and at the same time resulting in 'worst-case' noise level predictions, as documented later in this chapter. In practice, these levels are unlikely to be representative of noise levels experienced by the majority of the community or over the majority of the construction period.

In response to these issues, an alternative construction scenario has been assessed which does not include the use of this highly noise intensive equipment – particularly during the night-time period. Comparison of these respective scenarios – with and without the use of the highly noise intensive equipment, provides an indication of the reduction in noise levels that could be achieved when the highly noise intensive equipment is not in use. This approach allows informed decisions to be made about restricting certain activities in the night-time period. Further discussion about the basis of the construction noise assessment and use of highly noise intensive equipment is included in Section 12.4.1.

Construction traffic noise

Modelling of potential noise impacts from construction traffic movements included consideration of heavy vehicles and personnel movements to/from the identified construction compounds as well as rail replacement bus services required during track and station closures (refer to the Temporary Transport Strategy in Appendix G). A cumulative noise assessment was also undertaken to identify the potential impacts where different types of vehicle movements occur concurrently in the same location.

The assessment assumed that the majority of construction traffic vehicle movements would occur during the daytime and evening periods, although some movements would also be required at night-time, generally due to rail replacement buses operating.

Construction vibration

The construction vibration assessment considered the potential for vibration levels to occur which exceed the criteria. Vibration from construction plant and equipment was predicted and assessed with consideration given to the vibration guidelines listed in Section 12.2. Mitigation measures have been identified where vibration levels are predicted to exceed the vibration criteria.

Groundborne noise

Groundborne noise (also referred to as low-frequency noise) is noise where vibration causes objects (e.g. the floor or walls of a building) to vibrate, which generates a low frequency rumble. Groundborne noise can result in noise levels which exceed both amenity and structural criteria.

The ICNG defines internal groundborne noise goals for residential receivers during the evening (6pm to 10pm) and night-time (10pm to 7am) construction periods. It also notes that groundborne noise is only considered when the potential groundborne noise levels are likely to be higher than airborne noise levels.

Construction airborne noise levels for the project are predicted to be higher than groundborne noise levels. As a result, groundborne noise is not considered further in this assessment.

Identification of noise sensitive receivers and noise catchment areas

Potentially sensitive receivers are those that may be affected by changes in noise and vibration levels. Noise and vibration sensitive receivers were identified based on the type of use, the activities undertaken, and the nature of the building. Sensitive receivers for the project are described in Section 12.3 and are shown in Figure 12.1.

Noise catchment areas (NCAs) are areas where receivers have a similar land use and ambient noise environment. The study area for the assessment was divided into 13 NCAs, as shown in Figure 12.1.

Ambient noise surveys and monitoring locations

Ambient noise monitoring was undertaken to establish the 'background' noise environment across each noise catchment area. Noise monitoring was undertaken at sensitive receiver locations selected to be representative of a wider area. Background noise, described by the 'rating background level' (RBL) for each catchment area, is the underlying level of noise present in an area once transient and short-term noise events are filtered out.

Noise monitoring was carried out at 23 representative locations in June and July 2016 at the locations shown in Figure 12.1.

12.2 Construction noise and vibration criteria

12.2.1 Amenity

Noise management levels

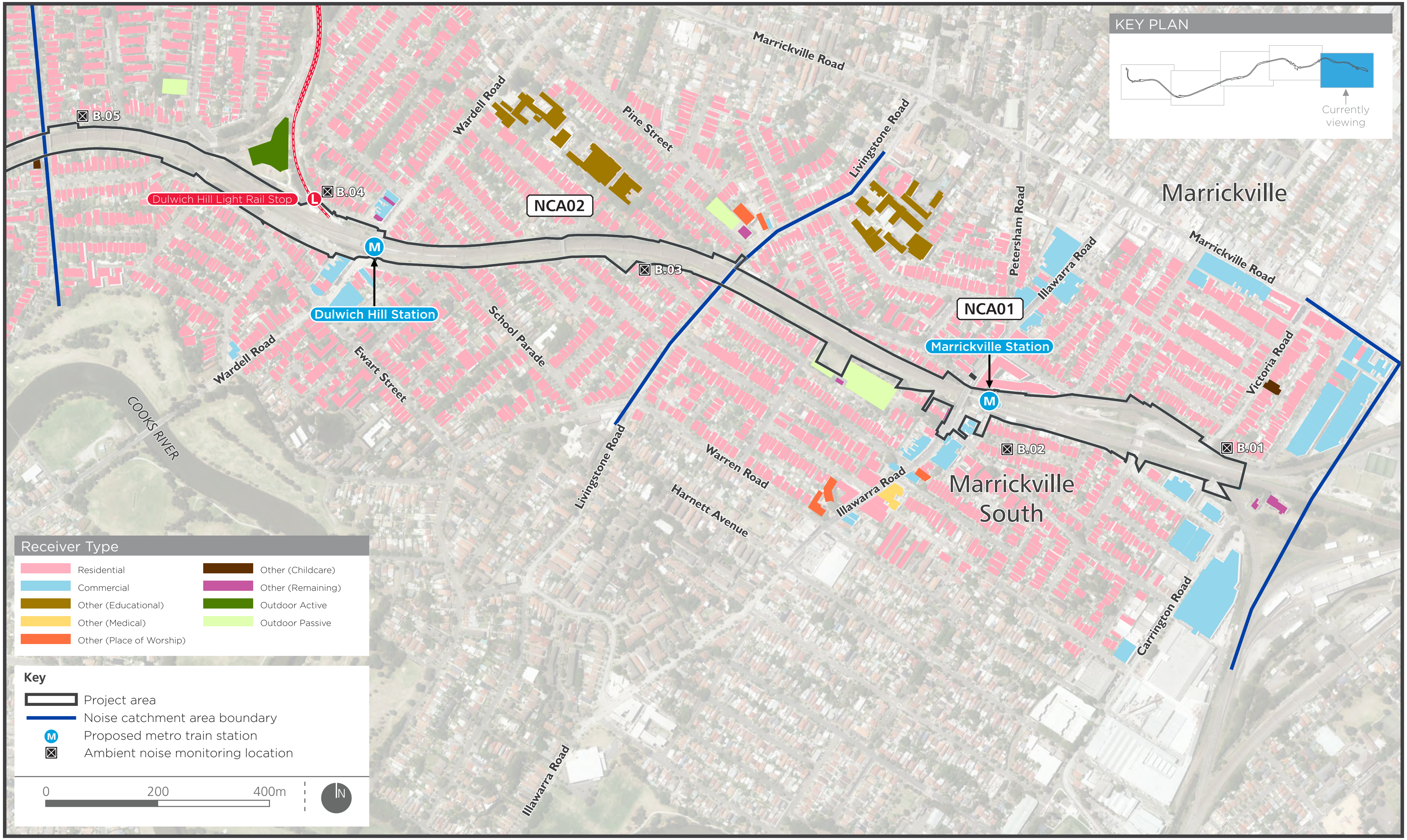
Residential receivers

People's reaction to noise from construction will depend on the time of day that works are undertaken. Residents are usually most annoyed by work at night-time as it has the potential to disturb sleep. Noise from work during the evenings, Saturday afternoons, Sundays and public holidays can also be annoying to most residents as it may interrupt leisure activities.

Based on the ICNG, the:

- 'noise affected' management level represents the level above which there may be some community reaction to noise (calculated by adding 10 dB to the RBL during recommended standard work hours and by adding five dB to the RBL for works outside of recommended standard work hours)
- 'highly noise affected' management level represents the level above which there may be strong community reaction to noise.

The project-specific NMLs for residential receivers in each of the noise catchment areas are provided in Table 12.3. These represent the 'noise affected' NMLs. A NML of 75 dB or above is considered 'highly noise affected'.



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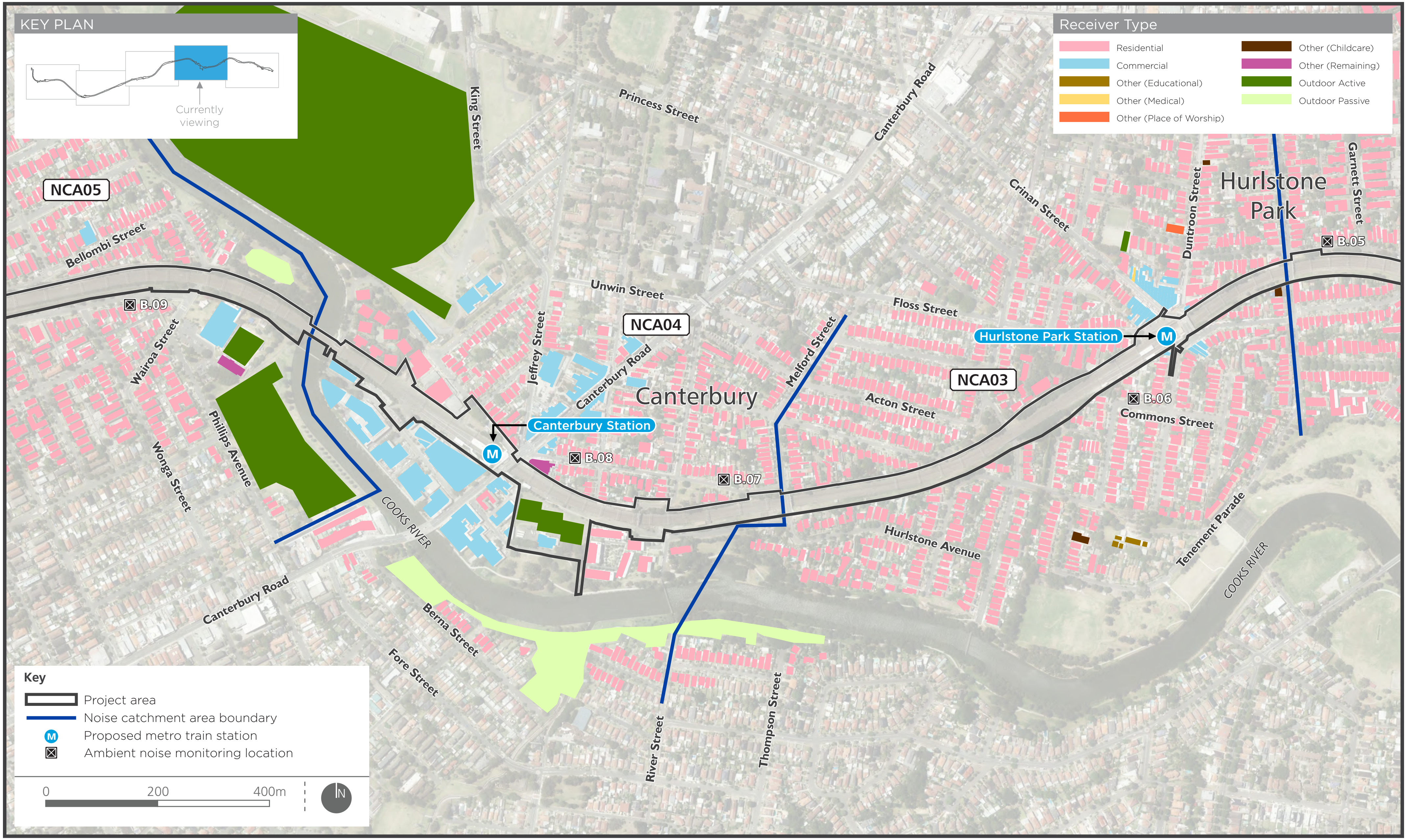
Noise catchment areas, sensitive receivers and ambient noise monitoring locations - map 1

FIGURE 12.1



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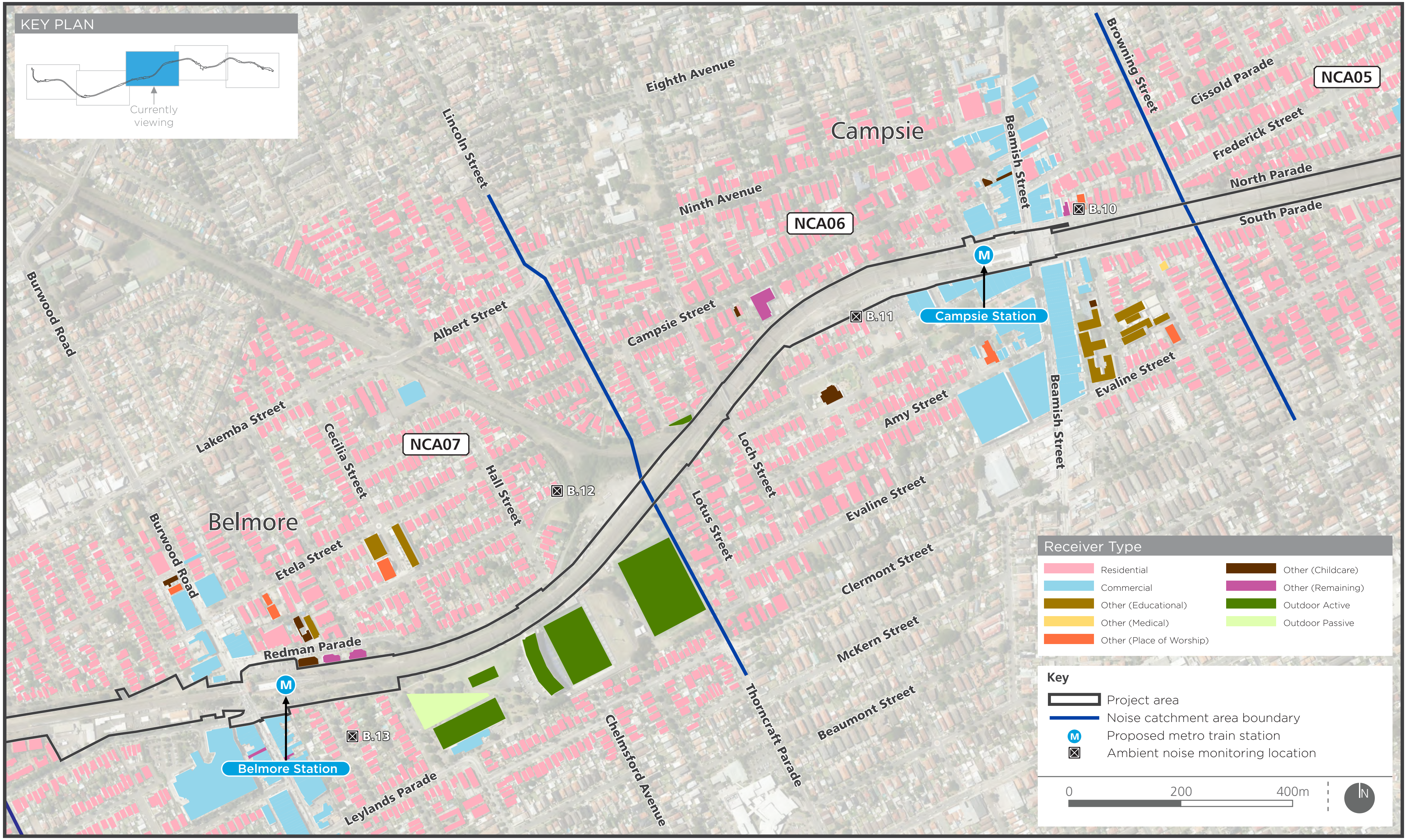
Noise catchment areas, sensitive receivers and ambient noise monitoring locations - map 2

FIGURE 12.1



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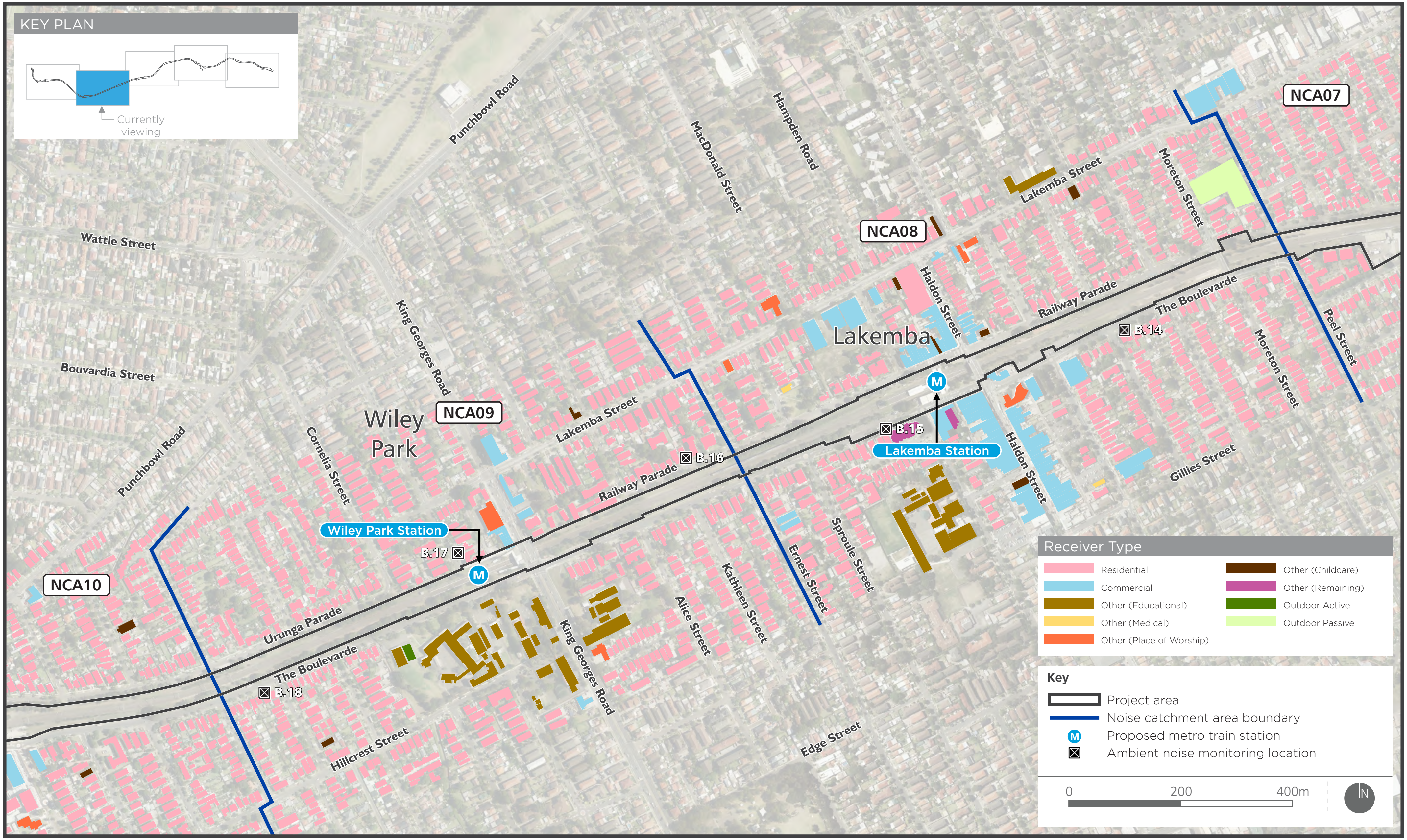
Noise catchment areas, sensitive receivers and ambient noise monitoring locations - map 3

FIGURE 12.1



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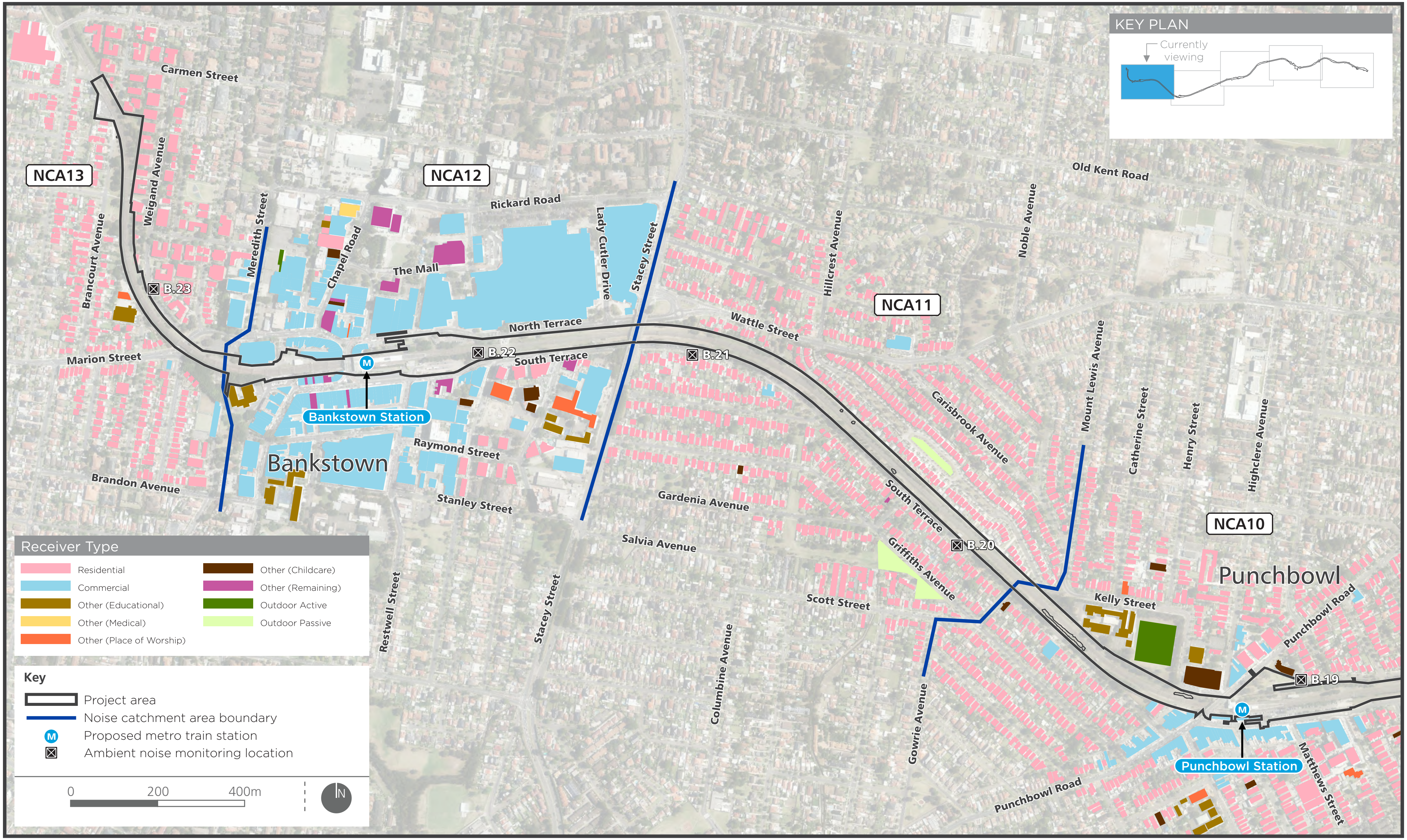
Noise catchment areas, sensitive receivers and ambient noise monitoring locations - map 4

FIGURE 12.1



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Noise catchment areas, sensitive receivers and ambient noise monitoring locations - map 5

FIGURE 12.1

Other sensitive receivers

The project-specific $L_{Aeq(15minute)}$ NMLs for non-residential noise sensitive receivers are provided in Table 12.2.

Table 12.2 Construction NMLs for other sensitive receivers

Land use	NMLs $L_{Aeq(15minute)}$ (applied when the land is in use)
Classrooms at schools and other education institutions	Internal noise level 45 dB
Hospital wards and operating theatres	Internal noise level 45 dB
Places of worship	Internal noise level 45 dB
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level 65 dB
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, e.g. reading, meditation)	External noise level 60 dB
Community centres	Depends on the intended use of the centre (refer to the recommended ‘maximum’ internal levels in Australian Standard 2107- Acoustics-Recommended design sound levels and reverberation times for building interiors for specific uses).
Commercial buildings, including offices, retail and small commercial properties	External noise level 70 dB

Other noise-sensitive businesses require separate noise goals. The ICNG recommends that the internal construction noise levels at these types of premises are determined based on the ‘maximum’ internal levels presented in *AS:2107 – Recommended Design Sound Levels and Reverberation Times for Building Interiors.* For this project, exceedances of NMLs would also be managed by the procedures contained in the Sydney Metro Construction Noise and Vibration Strategy.

The ICNG and AS2107 do not provide specific guideline noise levels for childcare centres. Childcare centres generally have internal play areas and sleeping areas. For these areas, an internal noise management level of 55 dBA $L_{Aeq(15minute)}$ has been adopted, together with an internal noise management level of 40 dBA $L_{Aeq(15minute)}$ (when in use) for sleeping areas.

On the assumption that windows and doors of childcare centres may be opened, an external noise management level of 65 dBA $L_{Aeq(15minute)}$ for play areas has been applied at the facade and would also apply to external play areas. For sleeping areas, assuming that windows are open, the external noise management level would be 50 dBA $L_{Aeq(15minute)}$).

Industrial premises

NMLs for commercial and industrial premises have been set based on the ICNG. An external noise management level of $L_{Aeq(15minute)}$ 75 dBA has been adopted for industrial premises. The external noise levels should be assessed at the most affected occupied point on the premises.

Sleep disturbance

The appropriate screening criterion for sleep disturbance is a maximum level of 15 dB above the RBL, during the night-time period (10pm to 7am). Where this criterion is met, sleep disturbance is unlikely for the majority of people, but where it is not met, a more detailed analysis is required. Sleep disturbance screening levels for each NCA are provided in Table 12.3.

Table 12.3 Construction NMLs for residential receivers

NCA	Logger ID	Recommended standard hours[1] (RBL + 10dB)	Outside recommended standard hours (RBL + 5dBA)			Sleep disturbance screening (RBL + 15dBA)
		Daytime	Daytime (7am - 6pm)	Evening (6pm - 10pm)	Night-time (10pm - 7am)	
1	B.04	48	43	43	38	48
2	B.05	48	43	43	38	48
3	B.06	48	43	43	39	49
4	B.07	50	45	45	40	50
5	B.09	46	41	41	37	47
6	B.10	55	50	47	40	50
7	B.13	51	46	46	40	50
8	B.14	57	52	52	46	56
9	B.16	54	49	49	41	51
10	B.19	57	52	52	46	56
11	B.20	57	52	52	44	54
12	B.22	64	59	56	47	57
13	B.23	52	47	47	44	54

Note: 1. Recommended standard hours (defined in the ICNG) are Monday to Friday 7am to 6pm, Saturday 8am to 1pm and no time on Sundays or public holidays.

Construction traffic noise

As required by the *NSW Road Noise Policy* (DECCW, 2011), a screening test should be undertaken to evaluate whether noise levels would increase by more than two dB as a result of construction traffic. This includes for example, a temporary diversion due to a road closure. (As a general rule of thumb, a 60 per cent increase in the number vehicles would result in an about two dB increase in road traffic noise). Where increases are two dB or less, no further assessment is required. Where noise levels increase by more than two dB, further assessment is required using the criteria presented in the *Road Noise Policy* (refer to Table 12.4).

Table 12.4 Noise criteria for construction vehicles on public roads

Road category	Type of project/land use	Assessment criteria (dB)	
		Daytime (7am - 10pm)	Night-time (10pm - 7am)
Freeway/ arterial/sub-arterial roads	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads Generated by land use developments	$L_{Aeq(15hour)}$ 60 (external)	$L_{Aeq(9hour)}$ 55 (external)
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq(1hour)}$ 55 (external)	$L_{Aeq(1hour)}$ 50 (external)

Vibration – human comfort

The vibration dose values recommended in *Assessing Vibration: a technical guideline* (DEC, 2006) (derived from British Standard 6472), for which various levels of adverse comment from occupants may be expected, are provided in Table 12.5.

Table 12.5 Vibration dose value ranges which may result in adverse comments from occupants within residential buildings

Place and time	Low probability of adverse comment ($m/s^{1.75}$)	Adverse comment possible ($m/s^{1.75}$)	Adverse comment probable ($m/s^{1.75}$)
Residential buildings 16 hr day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8 hr night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8
Offices 16 hr day	0.4 to 0.8	0.8 to 1.6	1.6 to 3.2
Workshops 16 hr day	0.8 to 1.6	1.6 to 3.2	3.2 to 6.4

Minimum safe working distances for vibration intensive plant

Table 12.6 provides the minimum safe working distance for a range of vibration intensive plant. These distances are indicative and can vary depending on the plant used and the local geotechnical conditions.

Table 12.6 Minimum safe working distances for vibration intensive plant

Plant item	Rating/description	Safe working distance	
		Cosmetic damage (m)	Human response (m)
Vibratory roller	< 50 kN (Typically 1-2t)	5	15 to 20
	< 100 kN (Typically 2-4t)	6	20
	< 200 kN (Typically 4-6t)	12	40
	< 300 kN (Typically 7-13t)	15	100
	> 300 kN (Typically 13-18t)	20	100
	> 300 kN (Typically > 18t)	25	100
Small hydraulic breaker	300 kg - 5 to 12t excavator	2	7
Medium hydraulic breaker	900 kg - 12 to 18t excavator	7	23
Large hydraulic breaker	1600 kg - 18 to 34t excavator	22	73
Jackhammer	Hand held	1 (nominal)	Avoid contact with structure

12.2.2 Structural

General

For construction activities involving intermittent vibration sources, such as hydraulic breakers, piling rigs, vibratory rollers and excavators, the predominant vibration energy occurs at frequencies greater than four hertz (Hz) (and usually in the 10 Hz to 100 Hz range). On this basis, the conservative vibration damage screening levels are as follows:

- reinforced or framed structures: 25 mm/s
- unreinforced or light framed structures: 7.5 mm/s.

Heritage structures

Heritage buildings were assessed on a case by case basis, with the 7.5 mm/s screening criterion to be applied to heritage structures. Where a building survey has found that the heritage structure is sensitive to vibration, a more conservative superficial cosmetic damage criterion of 2.5 mm/s peak component particle velocity (from DIN 4150) should be considered.

Contents damage - sensitive scientific and medical equipment

Some scientific equipment (e.g. electron microscopes and microelectronics manufacturing equipment) can require more stringent criteria than those applicable to human comfort. Where vibration sensitive scientific and/or medical instruments are likely to be used inside the premises of an identified vibration-sensitive receiver, criteria for the satisfactory operation of the instrument should be sourced from manufacturer’s data. Where manufacturer’s data is not available, generic vibration criterion curves may be used.

No usage of sensitive medical or scientific equipment was identified in close proximity to the works.

Utilities and other vibration sensitive structures

For structures and utilities that are particularly sensitive to vibration, a vibration goal which is more stringent than the above structural damage criteria may apply. Examples of such structures and utilities include tunnels, gas pipelines, and fibre optic cables.

Specific vibration goals would be determined on a case-by-case basis by an acoustic consultant prior to construction commencing.

12.3 Existing environment

The project area is described in Chapter 2 (Location and setting). The project area is located in an established urban environment, which is already subject to noise from the operation of trains along the rail corridor. The existing noise environment varies considerably along the length of the project area. In addition to rail noise, other noise sources include:

- road traffic noise
- operation of the freight line and diesel trains between east of Marrickville Station and west of Campsie Station
- industrial activities within industrial areas (particularly near Marrickville)
- other construction activities (such as building redevelopments, road, and housing construction)
- aircraft noise.

12.3.1 Sensitive receivers

The sensitivity of occupants to noise and vibration varies according to the nature of the occupancy and the activities performed within the affected premises. For example, recording studios are more sensitive to vibration and groundborne noise than residential premises, which in turn are more sensitive than typical commercial premises.

Properties within about 100 metres of the rail corridor and about 200 metres from construction compounds and other work areas were classified into the following preliminary categories:

- residential
- commercial
- educational
- industrial

- mixed commercial/residential
- places of worship
- child care
- special sensitive (e.g. hospital, precision laboratories, recording studios).

Figure 12.1 shows the location and classification of sensitive receivers in the study area.

The preliminary categorisation of receivers was undertaken using a combination of site inspections and review of aerial imagery. The preliminary categorisation of receivers would be reviewed during detailed design to confirm the receiver categories and other pertinent details. This review would focus primarily on receivers where noise and vibration impacts are predicted.

12.3.2 Existing noise levels

As outlined in Section 12.1, ambient noise monitoring at representative sensitive receivers was undertaken to establish the 'background' noise environment across each noise catchment area. The results of the unattended noise survey are summarised in Table 12.7.

Table 12.7 Summary of unattended noise monitoring (June/July 2016)

Logger location ID	Noise level (dBA)[1]					
	Daytime 7am - 6pm		Evening[2] 6pm - 10pm		Night-time 10pm - 7am	
	RBL	LAeq	RBL	LAeq	RBL	LAeq
B.01	47	61	45	61	40	58
B.02	38	59	38	58	33	51
B.03	38	57	38[2]	57	33	53
B.04	41	54	41	55	34	50
B.05	40	57	40	56	33	52
B.06	38	56	38[2]	53	34	49
B.07	40	53	40	50	35	47
B.08	43	56	43	53	36	49
B.09	36	57	36[2]	57	32	54
B.10	45	55	42	55	35	54
B.11	44	59	44[2]	57	40	57
B.12	37	50	37[2]	48	33	46
B.13	41	49	41	47	35	46
B.14	47	65	47	63	41	60
B.15	50	63	50	64	43	63
B.16	44	56	44	55	36	51
B.17	44	52	44[2]	51	41	49
B.18	46	65	46[2]	65	39	61
B.19	47	57	47	54	41	53
B.20	47	65	47[2]	64	39	60
B.21	53	66	52	66	43	61
B.22	54	64	51	63	42	60
B 23	42	56	42[2]	55	39	52

Notes: 1. The RBL and LAeq noise levels have been obtained using the calculation procedures documented in the INP.
2. Where the evening RBL was found to exceed the daytime RBL, it has been reduced to equal the daytime RBL in accordance with INP application notes.

As shown in Table 12.7, daytime noise levels ranged from 36-54 dB with noise levels generally increasing to the west. Measured daytime noise levels were lowest at Campsie Station and loudest at Bankstown Station. At nine of the logger locations, measured evening noise levels were either the same or slightly louder than daytime levels.

Night-time noise levels ranged from 32 to 43 dB across the project area, with the lowest level at Campsie Station and highest between Lakemba and Wiley Park stations. Compared to daytime levels, the greatest change in noise levels was observed at Bankstown and Campsie stations.

12.4 Basis of the construction noise assessment

12.4.1 Construction activities and use of noise intensive plant

Table 12.8 provides the various construction scenarios and activities considered as part of the construction noise assessment. The list of plant and equipment expected to be used during each of these scenarios is outlined in Section 9.9.3 along with a more detailed outline of construction processes. The table also shows the expected duration of each activity at a typical project work area. This duration represents the overall time taken for the activity to be completed which may be longer than the duration for which individual plant items would be used. As an example, the earthworks phase at each work area might typically last for six weeks, however the use of a hydraulic breaker as part of that activity would be for a much shorter period estimated to be about three days.

To demonstrate the level of conservatism built into the construction noise assessment methodology (refer to Section 12.1.1), a separate noise assessment scenario has been defined to account for the use of particularly noise intensive equipment which is believed to dominate the noise level predictions. By comparing the scenarios, with and without the use of the noise intensive equipment, the reduction in noise levels that could be achieved when the highly noise intensive equipment is not in use and a noise level which is more likely to be heard for a majority of the time can be quantified.

Comments are also provided to indicate the timing of activities occurring, particularly in relation to works conducted in possession periods and outside of recommended standard hours. A number of construction work areas would be used 24 hours per day at times, in particular during possession periods. Where 24 hour works are required, the use of highly noise intensive equipment (e.g. hydraulic breakers and ballast tampers) would be limited to day time and evening periods (between 7am and 10pm), unless constraints exist such as:

- works requiring a rail shut down
- requirements of road authorities, emergency services or Sydney Coordination Office.

The use of hydraulic breakers and ballast tampers is not proposed during the night-time period (10pm to 7am), however some other highly noise intensive equipment would potentially need to be used during this period if unforeseen circumstances arise (such as unforeseen ground or weather conditions). Such works would only occur in accordance with the out of hours work framework outlined in Section 12.6.1.

Regardless of the above, the use of highly noise intensive equipment during the night-time period has been considered in the assessment in the event such works are required.

Table 12.8 Typical duration of construction activities and noise intensive plant

Work area[1]	Activity	Typical activity duration[2]	Indicative duration of noise-intensive works where relevant	Hours of work[3]					Additional comments
				Std. day	Possession/closedown works				
					Day	Day OOHW[4]	Eve	Night	
General work areas	Earthworks	6 weeks	n/a	●					-
	Earthworks w/breaker	6 weeks	3 days	●					Breaking works would only occur intermittently during a six week period between 7am and 10pm. Total duration of works would be about 3 days.
	Piling	6 weeks	2 weeks	●					Piling works would only occur intermittently during a six week period between 7am and 6pm. Total duration of works would be about 2 weeks.
	Site establishment	4 weeks	n/a	●					-
	Operations	52 weeks	n/a	●	●				-
Corridor works - ground & track	Earthworks	30 weeks	n/a	●	●	●	●	●	-
	Earthworks w/breaker	10 weeks	3 days	●	●	●	●		Breaking works would only occur intermittently during ten weeks of possession. Total duration of works would be about 3 days. Works are proposed to be undertaken between 7am and 10pm.
	Trackform	12 days	n/a	●	●	●	●	●	
	Trackform w/ballast tamper	4 days	n/a	●	●	●	●	●	
Corridor works - track support systems	OHW[5] modifications	3 weeks	n/a	●	●	●	●	●	Works would only occur intermittently during three weeks of possession over the 3 year total construction program.

Work area[1]	Activity	Typical activity duration[2]	Indicative duration of noise-intensive works where relevant	Hours of work[3]					Additional comments
				Std. day	Possession/closedown works				
					Day	Day OOHW[4]	Eve	Night	
	Communications & signalling works	12 weeks	n/a	●	●	●	●	●	Works would only occur intermittently during 12 weeks of possession over the total construction program.
	Segregation fencing	6 weeks	n/a	●	●	●	●	●	Works would only occur intermittently during six weeks of possession over the total construction program.
Station work areas	Site establishment	3 weeks	n/a	●	●				-
	Demolition	6 weeks	2 weeks	●	●	●	●	●	Demolition works would only occur for a total duration of about 2 weeks during a 6 week possession. Works are proposed to be undertaken between 7am and 10pm unless unforeseen site conditions are encountered which may require night work.
	Demolition w/breaker & saw	6 weeks	2 weeks	●	●	●	●		Demolition works would only occur for a total duration of about 2 weeks during a 6 week possession. Works are proposed to be undertaken between 7am and 10pm.
	Concrete & structural works	8 weeks	n/a	●	●	●	●	●	This includes construction of platform canopy structures and platform re-surfacing.
	Station installation & fitout	20 weeks	n/a	●	●	●	●	●	This includes construction of station canopies, lift shafts and concourse works.
Bridge work areas	Site establishment & impact protection	2 weeks	n/a	●	●	●	●	●	Works would be carried out intermittently over a two year period during possessions.
	Demolition	2 weeks/ possession	2 weeks/ possession	●	●	●	●	●	Works would be carried out intermittently over a two year period during possessions. Demolition

Work area[1]	Activity	Typical activity duration[2]	Indicative duration of noise-intensive works where relevant	Hours of work[3]					Additional comments
				Std. day	Possession/closedown works				
					Day	Day OOHW[4]	Eve	Night	
									works would only occur for a total duration of about 2 weeks during these possessions.
	Demolition w/breaker & saw	2 weeks/ possession	2 weeks/ possession	●	●	●	●		Works would be carried out intermittently over a two year period during possessions. Demolition works would only occur for a total duration of about 2 weeks during these possessions.
	Construction & installation	20 weeks	n/a	●	●	●	●	●	Works would be carried out intermittently over a two year period during possessions.
Substation work areas	Site establishment	2 weeks	n/a	●	●	●			-
	Construction & installation	6 weeks	n/a	●	●	●	●		-

Notes:
1. Certain work areas are also major construction compounds.
2. Durations should be regarded as indicative and represent a typical work area. There would be sites within each category that require works to be shorter or longer than indicated.
3. Noise intensive works outside of recommended standard hours would typically only be undertaken during possessions/closedowns.
4. OOHW - Out of hours works refers to work conducted outside the recommended standard hours as defined in the ICNG During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 10pm.
5. OHW – Overhead wiring.

12.5 Potential impacts

12.5.1 Risk assessment

Potential risks

The environmental risk assessment for the project, undertaken for the State Significant Infrastructure Application Report, identified the following as the main construction noise and vibration risks:

- noise impacts at sensitive receivers adjacent to construction works along the rail corridor
- noise impacts from works to stations and the stabling facility in the areas surrounding stations
- increases in vehicle movements along local streets from construction traffic
- amenity and structural vibration impacts due to construction works.

How potential impacts would be avoided/minimised

Potential noise and vibration (amenity) impacts would either be avoided or minimised by:

- designing and constructing the project to minimise the potential for noise and vibration impacts
- developing specific noise mitigation approaches in accordance with the strategy described in Section 12.6.1
- implementation of the mitigation measures listed in Section 12.6.1, where reasonable and feasible.

12.5.2 Overview of construction noise and vibration results

Predicted noise levels

Table 12.9, Table 12.10 and Table 12.11 show the results of noise level predictions for residential receivers within each NCA, during the daytime, evening and night-time periods respectively. Table 12.12 shows similar information for commercial receivers during the daytime. Noise level predictions for other categories of sensitive receivers are discussed in subsequent sections for each noise catchment area.

The tables indicate the highest predicted noise level at the most exposed receiver for each activity. Typically, these are receivers which are immediately adjacent to the railway corridor and/or station and are therefore already subject to elevated levels of railway noise whether from existing operations or maintenance activities.

Consistent with other major transport infrastructure projects constructed in an urban environment, exceedances of the NMLs are predicted across the daytime, evening and/or night-time periods at residential receivers under the worst-case scenarios assessed. Exceedances of the NMLs during the evening and night-time periods were found to be higher than during the daytime which is partly as a result of lower noise criteria at these times. Exceedances of the NMLs are also predicted at commercial receivers but are generally less substantial.

While construction activities are predicted to result in noise levels at some residential receivers above the NMLs, the highest noise levels are predicted in NCA01 (Marrickville), NCA02 (Dulwich Hill), NCA07 (Belmore) and NCA11, NCA12 and NCA13 (Bankstown and surrounds), mainly as a result of the close proximity of receivers to the project area in these locations.

The highest noise levels were generally found to result from activities which require the use of noise intensive plant items such as a hydraulic breaker, rock saw and ballast tamper. This includes the following activities:

- general work areas – earthworks with hydraulic breaker
- corridor works – ground and track – earthworks with hydraulic breaker
- corridor works – ground and track – trackform with ballast tamper
- station work areas – demolition with hydraulic breaker and rock saw
- bridge work areas – demolition with hydraulic breaker and rock saw.

The predicted noise levels reduce considerably (between seven and 12 dBA) when the highly noise intensive equipment is not in use.

The use of highly noise intensive equipment is therefore proposed to be limited to the recommended standard work hours wherever possible. To reduce impacts, activities involving the use of hydraulic breakers and ballast tampers would not be scheduled during the night-time period (10pm to 7am), unless constraints exist such as: works requiring a rail shut down or due to the requirements of road authorities, emergency services or Sydney Coordination Office.

For most construction activities, it is expected that noise levels experienced during the construction period would frequently be lower than predicted at the most exposed receiver due to the conservative nature of the noise prediction methodology. Noise levels at receivers other than at these most exposed receivers for which results have been predicted would decrease with distance from the works.

Due to the requirement for construction within an operational rail corridor, there is a need to undertake works during possession periods when the trains are not operating. Due to the infrequent availability of these periods, some construction activities, including those using noise intensive plant outlined above would need to be undertaken during these periods. This would result in the highest impacts being mostly aligned with these possession periods, which would occur intermittently over the construction period. Between possession periods, the level of construction activity would be reduced and therefore the predicted maximum noise levels would also reduce.

Table 12.9 Predicted maximum noise level at the most exposed residential receiver during the daytime

NCA No.	Criteria	General work areas					Corridor work – ground and track				Corridor work – track support systems			Station work areas					Bridge work areas				Substation work areas	
		Earthworks	Earthworks - breaker	Piling	Site establishment	Operations	Earthworks	Earthworks - breaker	Trackform	Trackform - ballast tamper	OHW[1] modifications	Comms[2] & signalling works	Segregation fencing	Site establishment	Demolition	Demolition - breaker & saw	Concrete & structural	Station installation & fitout	Site establishment	Demolition	Demolition - breaker & saw	Construction & installation	Site establishment	Construction & installation
NCA 01	48	**76**	**84**	**75**	**72**	**69**	**77**	**85**	**75**	**82**	**76**	**76**	**73**	**68**	**72**	**81**	**70**	**68**	**74**	**72**	**84**	**69**	**53**	48
NCA 02	48	**80**	**88**	**79**	**76**	**73**	**78**	**86**	**76**	**83**	**76**	**76**	**73**	**70**	**74**	**83**	**72**	**70**	**79**	**77**	**89**	**74**	**78**	**73**
NCA 03	48	**80**	**88**	**79**	**76**	**73**	**80**	**88**	**78**	**85**	**76**	**76**	**73**	**63**	**67**	**76**	**65**	**63**	**78**	**76**	**88**	**73**	**65**	**60**
NCA 04	50	**58**	**66**	**57**	**54**	**51**	**78**	**86**	**76**	**83**	**74**	**74**	**71**	**67**	**71**	**80**	**69**	**67**	**75**	**73**	**85**	**70**	**69**	**64**
NCA 05	46	**70**	**78**	**69**	**66**	**63**	**70**	**78**	**68**	**75**	**71**	**71**	**68**	46	**50**	**59**	**48**	46	**74**	**72**	**84**	**69**	38	33
NCA 06	55	**76**	**84**	**75**	**72**	**69**	**79**	**87**	**77**	**84**	**75**	**75**	**72**	**65**	**69**	**78**	**67**	**65**	**78**	**76**	**88**	**73**	**67**	**62**
NCA 07	51	**76**	**84**	**75**	**72**	**69**	**73**	**81**	**71**	**78**	**72**	**72**	**69**	**73**	**77**	**86**	**75**	**73**	**72**	**70**	**82**	**67**	48	43
NCA 08	57	**61**	**69**	**60**	57	54	**70**	**78**	**68**	**75**	**69**	**69**	**66**	**68**	**72**	**81**	**70**	**68**	**70**	**68**	**80**	**65**	**71**	**66**
NCA 09	54	45	53	44	41	38	**77**	**85**	**75**	**82**	**73**	**73**	**70**	**73**	**77**	**86**	**75**	**73**	43	41	53	38	41	36
NCA 10	57	**60**	**68**	**59**	56	53	**71**	**79**	**69**	**76**	**68**	**68**	**65**	**62**	**66**	**75**	**64**	**62**	41	39	51	36	56	51
NCA 11	57	**68**	**76**	**67**	**64**	**61**	**76**	**84**	**74**	**81**	**73**	**73**	**70**	49	53	**62**	51	49	**75**	**73**	**85**	**70**	**71**	**66**
NCA 12	64	**72**	**80**	**71**	**68**	**65**	**72**	**80**	**70**	**77**	**68**	**68**	**65**	**66**	**70**	**79**	**68**	**66**	59	57	**69**	54	38	33
NCA 13	52	**62**	**70**	**61**	**58**	**55**	**70**	**78**	**68**	**75**	**74**	**74**	**71**	43	47	**56**	45	43	39	37	49	34	<30	<30

Notes: 1. OHW - overhead wiring.
2. Comms – communications systems.
3. Bold indicates exceedance of criteria predicted.

Table 12.10 Predicted maximum noise level at the most exposed residential receiver during the evening

NCA No.	Criteria	General work areas					Corridor work – ground and track				Corridor work – track support systems			Station work areas					Bridge work areas				Substation work areas	
		Earthworks	Earthworks - breaker	Piling	Site establishment	Operations	Earthworks	Earthworks - breaker	Trackform	Trackform - ballast tamper	OHW[1] modifications	Comms[2] & signalling works	Segregation fencing	Site establishment	Demolition	Demolition - breaker & saw	Concrete & structural	Station installation & fitout	Site establishment	Demolition	Demolition - breaker & saw	Construction & installation	Site establishment	Construction & installation
NCA 01	43	-	-	-	-	-	**77**	**85**	**75**	**82**	**76**	**76**	**73**	-	**72**	**81**	**70**	**68**	**74**	**72**	**84**	**69**	-	48
NCA 02	43	-	-	-	-	-	**78**	**86**	**76**	**83**	**76**	**76**	**73**	-	**74**	**83**	**72**	**70**	**79**	**77**	**89**	**74**	-	73
NCA 03	43	-	-	-	-	-	**80**	**88**	**78**	**85**	**76**	**76**	**73**	-	**67**	**76**	**65**	**63**	**78**	**76**	**88**	**73**	-	60
NCA 04	45	-	-	-	-	-	**78**	**86**	**76**	**83**	**74**	**74**	**71**	-	**71**	**80**	**69**	**67**	**75**	**73**	**85**	**70**	-	64
NCA 05	41	-	-	-	-	-	**70**	**78**	**68**	**75**	**71**	**71**	**68**	-	**50**	**59**	**48**	**46**	**74**	**72**	**84**	**69**	-	33
NCA 06	47	-	-	-	-	-	**79**	**87**	**77**	**84**	**75**	**75**	**72**	-	**69**	**78**	**67**	**65**	**78**	**76**	**88**	**73**	-	62
NCA 07	46	-	-	-	-	-	**73**	**81**	**71**	**78**	**72**	**72**	**69**	-	**77**	**86**	**75**	**73**	**72**	**70**	**82**	**67**	-	43
NCA 08	52	-	-	-	-	-	**70**	**78**	**68**	**75**	**69**	**69**	**66**	-	**72**	**81**	**70**	**68**	**70**	**68**	**80**	**65**	-	66
NCA 09	49	-	-	-	-	-	**77**	**85**	**75**	**82**	**73**	**73**	**70**	-	**77**	**86**	**75**	**73**	43	41	**53**	38	-	36
NCA 10	52	-	-	-	-	-	**71**	**79**	**69**	**76**	**68**	**68**	**65**	-	**66**	**75**	**64**	**62**	41	39	51	36	-	51
NCA 11	52	-	-	-	-	-	**76**	**84**	**74**	**81**	**73**	**73**	**70**	-	**53**	**62**	51	49	**75**	**73**	**85**	**70**	-	**66**
NCA 12	56	-	-	-	-	-	**72**	**80**	**70**	**77**	**68**	**68**	**65**	-	**70**	**79**	**68**	**66**	**59**	**57**	**69**	54	-	33
NCA 13	47	-	-	-	-	-	**70**	**78**	**68**	**75**	**74**	**74**	**71**	-	47	**56**	45	43	39	37	**49**	34	-	<30

Notes: 1. OHW - overhead wiring.
2. Comms – communications systems.
3. Bold indicates exceedance of criteria predicted.

Table 12.11 Predicted maximum noise level at the most exposed residential receiver during the night-time

NCA No.	Criteria	General work areas					Corridor work – ground and track				Corridor work – track support systems			Station work areas					Bridge work areas				Substation work areas	
		Earthworks	Earthworks - breaker	Piling	Site establishment	Operations	Earthworks	Earthworks - breaker	Trackform	Trackform - ballast tamper	OHW[1] modifications	Comms[2] & signalling works	Segregation fencing	Site establishment	Demolition	Demolition - breaker & saw	Concrete & structural	Station installation & fitout	Site establishment	Demolition	Demolition - breaker & saw	Construction & installation	Site establishment	Construction & installation
NCA 01	38	-	-	-	-	-	**77**	-	**75**	**82**	**76**	**76**	**73**	-	**72**	-	**70**	**68**	**74**	**72**	-	**69**	-	-
NCA 02	38	-	-	-	-	-	**78**	-	**76**	**83**	**76**	**76**	**73**	-	**74**	-	**72**	**70**	**79**	**77**	-	**74**	-	-
NCA 03	39	-	-	-	-	-	**80**	-	**78**	**85**	**76**	**76**	**73**	-	**67**	-	**65**	**63**	**78**	**76**	-	**73**	-	-
NCA 04	40	-	-	-	-	-	**78**	-	**76**	**83**	**74**	**74**	**71**	-	**71**	-	**69**	**67**	**75**	**73**	-	**70**	-	-
NCA 05	37	-	-	-	-	-	**70**	-	**68**	**75**	**71**	**71**	**68**	-	**50**	-	**48**	**46**	**74**	**72**	-	**69**	-	-
NCA 06	40	-	-	-	-	-	**79**	-	**77**	**84**	**75**	**75**	**72**	-	**69**	-	**67**	**65**	**78**	**76**	-	**73**	-	-
NCA 07	40	-	-	-	-	-	**73**	-	**71**	**78**	**72**	**72**	**69**	-	**77**	-	**75**	**73**	**72**	**70**	-	**67**	-	-
NCA 08	46	-	-	-	-	-	**70**	-	**68**	**75**	**69**	**69**	**66**	-	**72**	-	**70**	**68**	**70**	**68**	-	**65**	-	-
NCA 09	41	-	-	-	-	-	**77**	-	**75**	**82**	**73**	**73**	**70**	-	**77**	-	**75**	**73**	**43**	41	-	38	-	-
NCA 10	46	-	-	-	-	-	**71**	-	**69**	**76**	**68**	**68**	**65**	-	**66**	-	**64**	**62**	41	39	-	36	-	-
NCA 11	44	-	-	-	-	-	**76**	-	**74**	**81**	**73**	**73**	**70**	-	**53**	-	**51**	**49**	**75**	**73**	-	**70**	-	-
NCA 12	47	-	-	-	-	-	**72**	-	**70**	**77**	**68**	**68**	**65**	-	**70**	-	**68**	**66**	**59**	**57**	-	**54**	-	-
NCA 13	44	-	-	-	-	-	**70**	-	**68**	**75**	**74**	**74**	**71**	-	**47**	-	**45**	43	39	37	-	34	-	-

Notes: 1. OHW - overhead wiring.
2. Comms – communications systems.
3. Bold indicates exceedance of criteria predicted.

Table 12.12 Predicted maximum noise level at the most exposed commercial receiver during the daytime

NCA No.	Criteria	General work areas					Corridor work – ground and track				Corridor work – track support systems			Station work areas					Bridge work areas				Substation work areas	
		Earthworks	Earthworks - breaker	Piling	Site establishment	Operations	Earthworks	Earthworks - breaker	Trackform	Trackform - ballast tamper	OHW[1] modifications	Comms[2] & signalling works	Segregation fencing	Site establishment	Demolition	Demolition - breaker & saw	Concrete & structural	Station installation & fitout	Site establishment	Demolition	Demolition - breaker & saw	Construction & installation	Site establishment	Construction & installation
NCA 01	70	**74**	**82**	**73**	70	67	**72**	**80**	70	**77**	68	68	65	69	**73**	**82**	**71**	69	**75**	**73**	**85**	70	41	36
NCA 02	70	52	60	51	48	45	67	**75**	65	**72**	63	63	60	61	65	**74**	63	61	62	60	**72**	57	46	41
NCA 03	70	63	**71**	62	59	56	**78**	**86**	**76**	**83**	**74**	**74**	**71**	**76**	**80**	**89**	**78**	**76**	**71**	69	**81**	66	36	31
NCA 04	70	59	67	58	55	52	**76**	**84**	**74**	**81**	**72**	**72**	69	65	69	**78**	67	65	70	68	**80**	65	46	41
NCA 05	70	**77**	**85**	**76**	**73**	70	56	64	54	61	69	69	66	46	50	59	48	46	60	58	70	55	31	<30
NCA 06	70	**80**	**88**	**79**	**76**	**73**	**74**	**82**	**72**	**79**	70	70	67	**75**	**79**	**88**	**77**	**75**	56	54	66	51	48	43
NCA 07	70	**85**	**93**	**84**	**81**	**78**	**79**	**87**	**77**	**84**	**76**	**76**	**73**	66	70	**79**	68	66	53	51	63	48	44	39
NCA 08	70	**84**	**92**	**83**	**80**	**77**	**79**	**87**	**77**	**84**	**75**	**75**	**72**	69	**73**	**82**	**71**	69	**84**	**82**	**94**	**79**	59	54
NCA 09	70	38	46	37	34	31	54	62	52	59	65	65	62	64	68	**77**	66	64	37	35	47	32	<30	<30
NCA 10	70	**77**	**85**	**76**	**73**	70	**79**	**87**	**77**	**84**	**75**	**75**	**72**	**72**	**76**	**85**	**74**	**72**	38	36	48	33	49	44
NCA 11	70	48	56	47	44	41	**73**	**81**	**71**	**78**	69	69	66	37	41	50	39	37	67	65	**77**	62	45	40
NCA 12	70	**79**	**87**	**78**	**75**	**72**	**81**	**89**	**79**	**86**	**80**	**80**	**77**	**71**	**75**	**84**	**73**	**71**	67	65	**77**	62	41	36
NCA 13	70	66	**74**	65	62	59	68	**76**	66	**73**	65	65	62	42	46	55	44	42	38	36	48	33	<30	<30

Notes: 1. OHW - overhead wiring.
2. Comms – communications systems.
3. Bold indicates exceedance of criteria predicted.

Highly noise affected receivers

The ICNG considers residential receivers that are subject to predicted noise levels of 75 dBA or above (an absolute noise level not based on measured ambient noise) to be ‘highly noise affected’. This is generally consistent with the ‘highly intrusive’ noise impact category outlined in the Sydney Metro City and Southwest Construction Noise and Vibration Strategy (described in Section 12.6.1 and provided in Appendix E).

Table 12.13 provides a summary of the duration of key noise intensive works which directly contribute to the number of highly noise affected receivers in each catchment. A more detailed breakdown of all exceedances of the highly noise affected criteria is provided in Sections 12.5.3 to 12.5.12 specific to each station area.

The table shows that the potentially greatest number of residential receivers affected is NCA02 (Dulwich Hill). This is due to the large number of dwellings in this area and their close proximity to the works. Other noise catchment areas such as NCA03 (Hurlstone Park) and NCA06 (Campsie) are also predicted to result in relatively high numbers of residential receivers affected.

For other sensitive receivers, NCAs 09, 10, 11, 12 and 13 are predicted to have the most number of receivers affected. NCA04 and NCA05 would experience fewer impacts and mostly during the daytime. No commercial receivers are predicted to be highly noise affected.

The use of highly noise intensive equipment (such as hydraulic breakers and ballast tampers) would generally be limited to day time and evening periods (between 7am and 10pm), unless constraints exist such as:

- works requiring a rail shut down
- specific requirements of relevant road authorities, emergency services, or the Sydney Coordination Office.

Ballast tamping would be restricted where reasonable and feasible however there may be times when this is required during night-time periods. Not using this item of plant during the night-time would reduce predicted noise levels by up to seven dB and substantially reduce the number of receivers highly noise affected in all catchments.

The use of noise intensive equipment would only occur infrequently during the construction period as outlined in Table 12.8. The predicted noise levels reduce considerably (between seven and 12 dBA) when the highly noise intensive equipment is not in use.

Table 12.13 Duration of noise intensive works resulting in greatest number of 'highly noise affected' residential receivers

Station	Construction activity	Indicative total duration of noise intensive activities	Maximum number of exceedances
Marrickville (NCA01)	Corridor works - ground & track, earthworks with breaker	3 days	21
	Corridor works - ground & track, trackform with ballast tamper	4 days	16
	Bridge work areas, demolition with breaker & saw	2 weeks	20
Dulwich Hill (NCA02)	General work areas, earthworks with breaker	3 days	24
	Corridor works - ground & track, earthworks with breaker	7 days	36
	Corridor works - ground & track, trackform with ballast tamper	4 days	20
	Bridge work areas, demolition with breaker & saw	2 weeks	106
Hurlstone Park (NCA03)	General work areas, earthworks with breaker	3 days	23
	Corridor works - ground & track, earthworks with breaker	7 days	48
	Corridor works - ground & track, trackform with ballast tamper	4 days	34
	Bridge work areas, demolition with breaker & saw	2 weeks	39
Canterbury (NCA04 & 05)	General work areas, earthworks with breaker	3 days	30
	Corridor works - ground & track, earthworks with breaker	3 days	7
	Station work areas, demolition with breaker & saw	2 weeks	8
	Bridge work areas, demolition with breaker & saw	2 weeks	14
Campsie (NCA06)	General work areas, earthworks with breaker	3 days	26
	Corridor works - ground & track, earthworks with breaker	3 days	37
	Corridor works - ground & track, trackform with ballast tamper	4 days	23
	Station work areas, demolition with breaker & saw	2 weeks	13
	Bridge work areas, demolition with breaker & saw	2 weeks	22
Belmore (NCA07)	General work areas, earthworks with breaker	3 days	22
	Corridor works - ground & track, earthworks with breaker	3 days	23
	Corridor works - ground & track, trackform with ballast tamper	4 days	12

Station	Construction activity	Indicative total duration of noise intensive activities	Maximum number of exceedances
	Station work areas, demolition with breaker & saw	2 weeks	8
	Bridge work areas, demolition with breaker & saw	2 weeks	10
Lakemba (NCA08)	Corridor works - ground & track, earthworks with breaker	3 days	19
	Corridor works - ground & track, trackform with ballast tamper	4 days	4
	Station work areas, demolition with breaker & saw	2 weeks	8
	Bridge work areas, demolition with breaker & saw	2 weeks	7
Wiley Park (NCA09)	Corridor works - ground & track, earthworks with breaker	3 days	27
	Corridor works - ground & track, trackform with ballast tamper	4 days	12
	Station work areas, demolition with breaker & saw	2 weeks	7
Punchbowl (NCA10)	Corridor works - ground & track, earthworks with breaker	3 days	15
	Corridor works - ground & track, trackform with ballast tamper	4 days	7
Bankstown (NCA11,12 & 13)	Corridor works - ground & track, earthworks with breaker	3 days	32
	Corridor works - ground & track, trackform with ballast tamper	4 days	24
	Bridge work areas, demolition with breaker & saw	2 weeks	30

Note: Highly noise affected is based on the ICNG definition ie predicted $LAeq_{(15minute)}$ noise at residential receiver is 75 dBA or greater.

Consideration of multiple work area activities occurring simultaneously

As outlined in Section 12.1.1, there is potential for a number of construction activities to occur simultaneously and a receiver may potentially experience noise from more than one work area and/or activity at the same time.

However, since the works are anticipated to be of a similar nature at each work area, the effect of concurrent construction works and activities would likely have only a limited effect on the noise level experienced at receivers. In practice, the noise levels experienced at receivers would vary over time due to plant and equipment moving about each work area and not all of it operating concurrently or at full power for the majority of the time as assumed by the noise prediction methodology.

The use of all work areas or construction compounds would also not necessarily occur simultaneously as, for example, works at numerous bridge sites would not occur at the same time due to the potential impacts on traffic.

Construction traffic noise

Existing traffic volumes on roads proposed to be used for construction vehicles or temporary transport services were identified either from desktop searches, information provided by road owners or by traffic counts. This enabled the determination of a background volume of road traffic and associated road noise levels. The introduction of construction traffic to these roads, including workers vehicles, haulage vehicles and rail replacement buses, is likely to influence existing traffic noise levels on these roads, and in some circumstances, may result in road traffic noise levels that exceed the applicable road traffic noise criteria.

With regard to the movement of construction vehicles to and from work areas, the assessment concluded that there would be an increase in road traffic noise of less than two dB on the majority of identified construction routes. However, construction traffic noise levels would exceed the criteria on some roads in Marrickville, Dulwich Hill, Hurlstone Park, Canterbury, and Bankstown, with the majority of exceedances occurring during the night-time, due to temporary bus services during possession periods. Table 12.14 outlines the roads where road traffic noise is predicted to exceed the road traffic noise criteria due to construction vehicles, rail replacement buses and operation of both construction vehicles and buses simultaneously. All other roads are not considered to exceed criteria.

Table 12.14 Road traffic noise exceedances for construction traffic and buses - summary

Road	Construction traffic	Rail replacement buses	Construction traffic and rail replacement buses
Marrickville			
Myrtle Street	●		●
Dulwich Hill			
Bayley Street - between Ewart Street and Dudley Street	●	●	●
Terrace Road - between New Canterbury Road and Consett Street	●		●
Ewart Street - between Wardell Road & Ness Avenue		●	●

Road	Construction traffic	Rail replacement buses	Construction traffic and rail replacement buses
Hurlstone Park			
Garnet Street - between Canterbury Road and Hampden Street)	●		●
Duntroon Street	●		●
Crinan Street - between Melford Street & Dunstaffenage Street)	●		●
Canterbury			
Close Street	●		●
Broughton Street - between Canterbury Road & Robert Street)	●		●
Campsie			
Gould Street -between Canterbury Road and Redman Street)		●	●

Further modelling of all routes would be carried out during the detailed design stage when construction traffic volumes and haulage routes are confirmed by the construction contractor. Where compliance with the criteria is unable to be achieved, reasonable and feasible noise mitigation would be applied.

Construction vibration

In the majority of cases, the separation distance between the construction works and the nearest sensitive receiver would be sufficient such that cosmetic damage to structures would be unlikely. However, there is the potential for some items of construction equipment to be operated closer than the minimum safe working distances, due to the way in which the work areas are arranged and the activities are likely to be undertaken. This is relevant for equipment such as large hydraulic breakers which have the potential to generate some of the highest vibration levels.

The assessment indicated that some receivers would be potentially affected by vibration sufficient to cause cosmetic damage and human comfort impacts. These receivers would be located within the minimum safe working distance of a large hydraulic breaker if it were to be used at the outer extent of the works area closest to the receiver. This is considered a conservative estimate however as a large rock breaker would be unlikely to be required in this manner at all work areas.

The potential for heritage buildings to be damaged due to vibration would be considered on a case by case basis, with detailed inspections and condition assessments being undertaken prior to works commencing. Up to 39 heritage buildings have been preliminarily identified to be within the recommended safe working distances for cosmetic damage. During detailed design, the location and use of vibration-intensive equipment would be reviewed to ensure the potential for cosmetic damage and human comfort impacts are minimised.

Mitigation measures

A Construction Noise and Vibration Strategy (provided in Appendix E) has been developed to manage construction noise and vibration for the Sydney Metro City & Southwest project as a whole. The strategy provides a framework for managing construction noise and vibration impacts in accordance with the ICNG and to provide a consistent approach to management and mitigation across all Sydney Metro projects.

The ICNG defines the terms ‘feasible’ and ‘reasonable’ with respect to mitigation measures for construction noise. A measure is feasible if it can be engineered and is practical to build, given project constraints such as safety and maintenance requirements. Selecting reasonable measures from those that are feasible involves judging whether the overall benefits of the measure outweighs the potentially adverse social, economic, and environmental effects (including costs).

Section 12.6 outlines the approach to management and mitigation of identified noise and vibration impacts, including measures which have been effective in reducing impacts on similar projects in the Sydney region. The measures also include a process for further investigations and consultation to be undertaken should an adaptive response be required during construction.

Of particular importance to the assessment are potential exceedances of the noise criteria during the evening and night-time periods, referred to as being outside of recommended standard work hours. As described in Chapter 9 (Project description – construction), the approach to out of hours work involves the preparation of an Out of Hours Work Strategy.

The Out Of Hours Work Strategy would be developed to guide the assessment, management, and approval of works outside the recommended standard working hours. The strategy would be developed to ensure that out of hours works are managed effectively during construction, to minimise impacts to the community. The strategy would provide guidance for the preparation of out of hours work plans for each construction work area and for key works (including for each station), would be prepared in consultation with key stakeholders (including the EPA).

The proposed mitigation measures, including the above, are provided in Section 12.6.

12.5.3 Marrickville (NCA01)

The Marrickville noise catchment area (NCA01) is dominated by residential receivers (as shown in Figure 12.1). There is a large passive recreation area west of the station (McNeilly Park) and a small commercial corridor along Illawarra Road south of the rail corridor. The freight rail line runs on the northern edge of the rail corridor.

There are a number of residential receivers on Arthur Street, Jersey Street, Leofrene Avenue, Warburton Street, Myrtle Street, and Brynes Street that are located close to the rail corridor. Bridge works and general site works would be undertaken close to these receivers. Additionally, station works are required near Charlotte Avenue, O’Hara Street, and Illawarra Road.

Predicted construction noise levels for the construction activities resulting in the highest number of ‘highly noise affected’ residential receivers during out of hours construction work are discussed below. Noise levels at residential receivers during out of hours construction activities have been selected as they represent a higher sensitivity relative to noise generated during recommended standard hours. Noise level predictions during other time periods and other receiver classifications are provided in Table 12.9, Table 12.10, and Table 12.11.

Noise level exceedances during out of hours works

It is likely that construction activities will need to be undertaken outside of recommended standard hours (out of hours works) during possessions/closedowns of the rail corridor. However out of hours works are expected to be largely undertaken during possessions/closedowns of the rail corridor.

During out of hours construction works, the highest number of night-time noise level exceedances are predicted during the following activities, with the activity generating the highest number of exceedances during the night-time shown in bold:

- corridor works - ground and track, earthworks
- **corridor works - ground and track, trackform with ballast tamper**

- corridor works - track support systems, OHW modifications
- corridor works - track support systems, communications and signalling works
- station work areas, demolition.

Ballast tamping would be scheduled where reasonable and feasible during standard day time and evening hours however despite efforts to avoid this, there may be circumstances when these works must occur, for technical reasons, during night-time periods. This item of plant can produce relatively high noise levels, however the works typically progress at a reasonably fast rate, with individual receivers only likely to be affected for a short duration (i.e. up to four days).

Relatively large numbers of receivers are predicted to be affected during the Track Support Systems activities - OHW modifications and communications and signalling works. While these works are not particularly noise intensive, they would be required along the length of the corridor in this precinct with many receivers potentially being affected.

The activity likely to result in the highest number of noise level exceedances during the night-time is corridor works - ground and track, trackform with ballast tamper. Figure 12.2 indicates the distribution of exceedances for this activity during the night-time.

The graph shows that while the activity may result in exceedance of the night-time NMLs greater than 20 dB for 20 per cent of affected receivers, a much greater percentage of receivers in this precinct are subject to lower levels of noise.

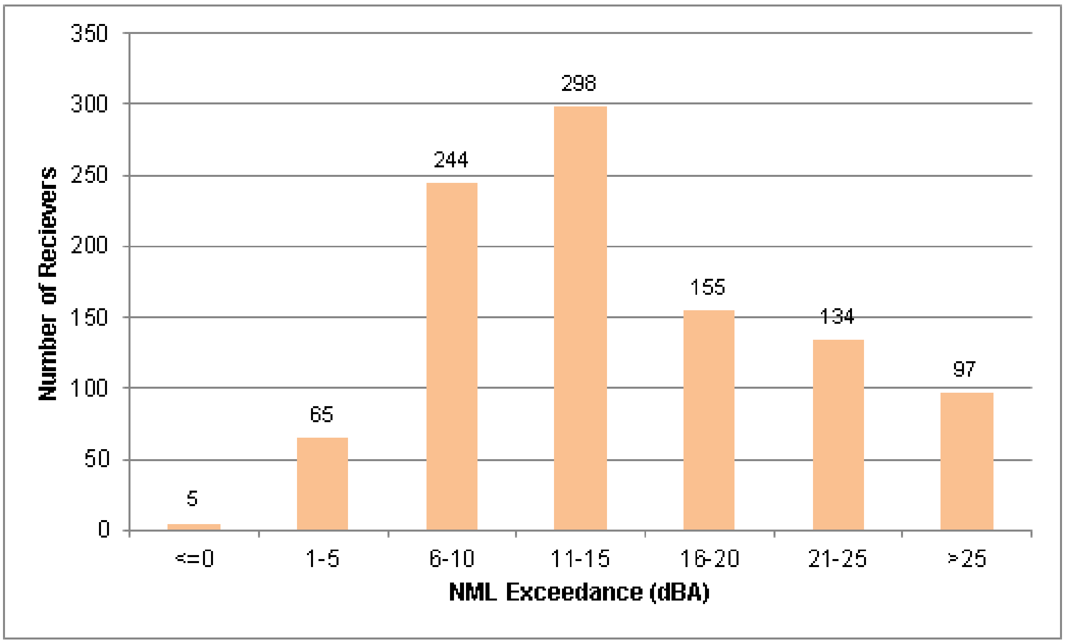


Figure 12.2 Number of night-time noise exceedances from corridor works, ground and track, trackform with ballast tamper

Figure 12.3 shows that when this noise intensive plant item (ballast tamper) is not in use, number of exceedances greater than 20 dB above the noise management level reduces to about six per cent of noise affected receivers in the precinct.

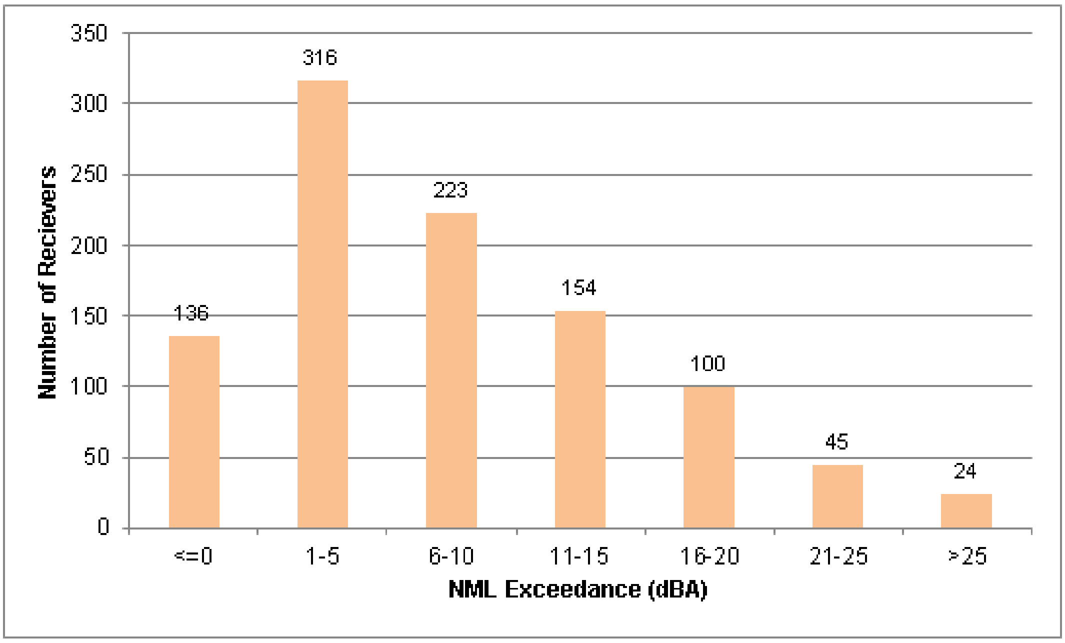


Figure 12.3 Number of night-time noise exceedances from corridor works, ground and track, trackform without ballast tamper

Highly noise affected receivers

The ICNG considers residential receivers that are subject to predicted noise levels of 75 dBA or greater to be highly noise affected.

Table 12.15 shows the number of receivers within NCA01 predicted to be highly noise affected in this catchment during certain works activities. The highest numbers are apparent during the following activities:

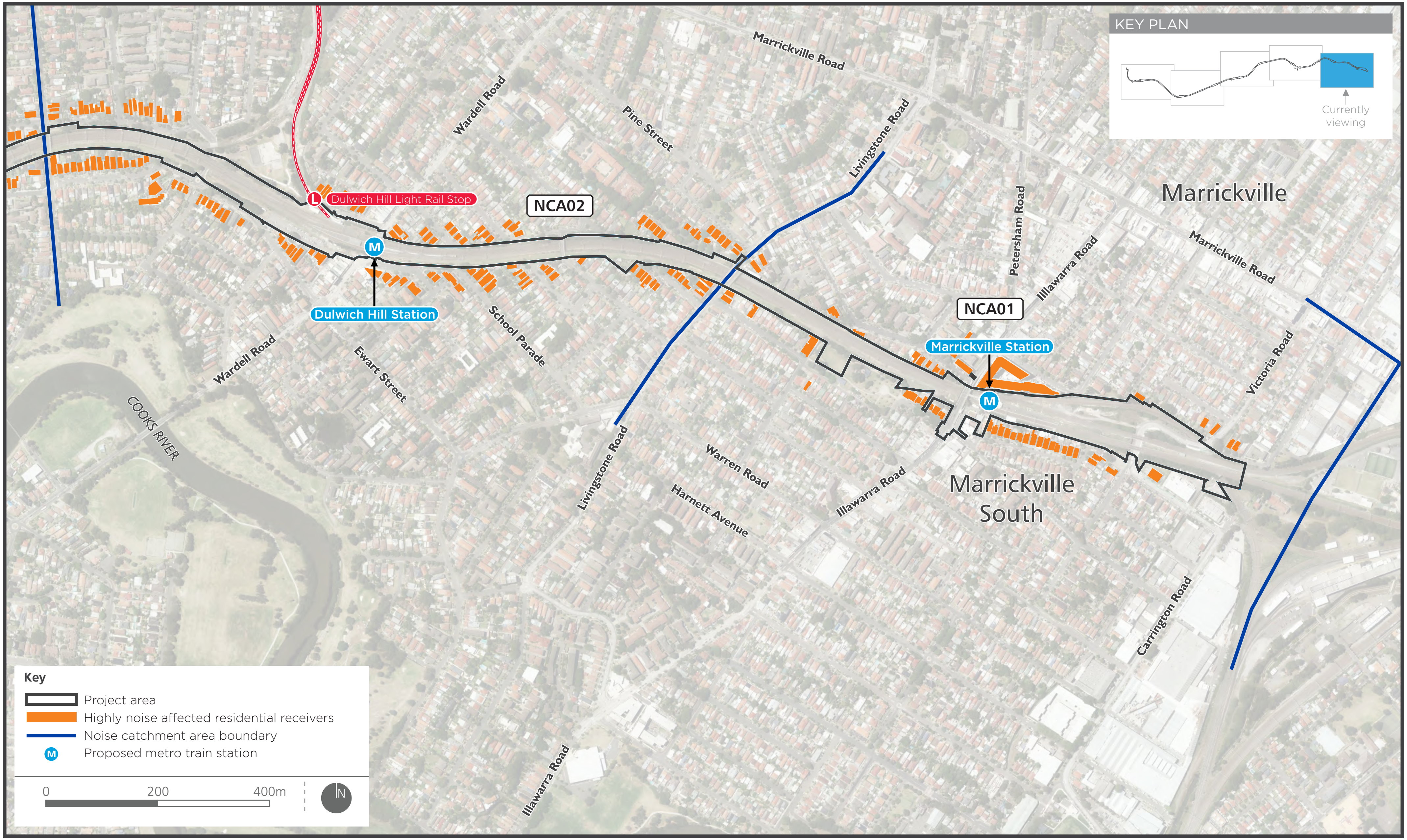
- Corridor works - ground and track, earthworks with breaker, where 21 receivers are predicted to be highly noise affected during the daytime and evening. The use of hydraulic breakers would generally be limited to day time and evening periods (between 7am and 10pm), unless constraints exist and would only be undertaken for about three days at any site.
- Corridor works - ground and track, trackform with ballast tamper, where 16 receivers are predicted to be highly noise affected during the daytime, evening and night-time periods. If the ballast tamper were to not be used during the night-time, this would reduce to five receivers being highly noise affected during this period.
- Bridge work areas, demolition with breaker and saw, where 20 receivers are predicted to be highly noise affected during the daytime and evening, which results from the large number of bridge work areas in this precinct. The use of hydraulic breakers would generally be limited to day time and evening periods (between 7am and 10pm), unless constraints exist. Demolition works will only occur for a total duration of about two weeks during these possessions.

Figure 12.4 shows the location of residential receivers which are predicted to experience exceedances of the highly noise affected criteria.

Table 12.15 Activities and durations which result in 'highly noise affected' residential receivers in Marrickville

Station (NCA no.)	Construction activities resulting in exceedances above highly noise affected criteria	Indicative total duration of construction activity	Indicative total duration of noise intensive plant use where relevant	Number of residential receivers highly noise affected		
				Day	Eve	Night
Marrickville (NCA01)	General work areas, earthworks	6 weeks	n/a	1		
	General work areas, earthworks with breaker	6 weeks	3 days	4		
	General work areas, piling	6 weeks	2 weeks	1		
	Corridor works - ground and track, earthworks	30 weeks	n/a	4	4	4
	Corridor works - ground and track, earthworks with breaker	**10 weeks**	**3 days**	**21**	**21**	
	Corridor works - ground & track, trackform	12 days	n/a	1	1	1
	Corridor works - ground & track, trackform with ballast tamper	**4 days**	**Less than 4 days**	**16**	**16**	**16**
	Corridor works – track support systems – OHW modifications	3 weeks	n/a	4	4	4
	Corridor works – track support systems – communications and signalling works	12 weeks	n/a	4	4	4
	Station work areas, demolition with breaker & saw	6 weeks	2 weeks /6 week possession	7	7	
	Bridge work areas, demolition with breaker & saw	**2 weeks/ possession**	**2 weeks/ possession**	**20**	**20**	

Note: Bold indicates the activities predicted to generate the largest number of highly noise affected receivers.



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Location of highly noise affected residential receivers – Marrickville and Dulwich Hill

FIGURE 12.4

Other sensitive receivers

Other sensitive receivers, such as educational facilities, hospitals and childcare centres, which are potentially affected by construction works have also been assessed against the relevant criteria.

The other sensitive receivers in this precinct are predicted to generally be subject to relatively minor impacts with many receiver types and works activities not resulting in any exceedances of the NMLs.

Sensitive receivers which are predicted to be subject to exceedances of 11 to 20 dB above the NMLs during the higher noise generating activities are:

- public building – 129-130 Meeks Road, Marrickville
- public building – 3-5 Carrington Road, Marrickville
- public building – McNeilly Park buildings.

One sensitive receiver, a café/bar at 1 Warburton Street, Marrickville is predicted to experience noise levels greater than 20 dB above the NMLs.

Sleep disturbance

Based on the preliminary list of plant and construction activities used in this assessment, exceedance of the sleep disturbance criteria is predicted to occur in each NCA during night works. A detailed breakdown for each time period is provided in Technical paper 2 and a summary shown in Table 12.16. Given the assessment approach, the identified impacts are considered to represent a conservative estimate of the likely impact.

The Sydney Metro Construction Noise and Vibration Strategy contains further details relating to potential sleep disturbance impacts. The strategy contains mitigation measures and procedures to address levels of adverse impact greater than 30 dB above the relevant criteria including periods of respite and alternative accommodation in specific circumstances and on a case by case basis. Construction of the project would be subject to this strategy.

Construction traffic noise

The project would result in two sources of potential traffic noise:

- construction vehicles such as heavy and light vehicles moving to and from construction compounds and work areas along identified haulage routes
- buses due to the alternative transport arrangements outlined in the Temporary Transport Strategy to service the T3 Bankstown Line during possession periods.

A construction traffic noise assessment was undertaken including the cumulative impact of both of these potential noise sources where they would share the same routes. The key finding was that collectively, both the construction vehicles and buses required as part of the alternative transport arrangements would result in an increase of less than two dB on a majority of roads used for construction traffic.

The movement of construction traffic along Myrtle Street in Marrickville is predicted to result in an increase of more than two dB and result in road traffic noise levels that exceed the criteria during the night-time period. No additional (cumulative) impacts would result from the operation of buses as part of the alternative transport arrangements outlined in the Temporary Transport Strategy.

Table 12.16 Activities which result in sleep disturbance exceedance in Marrickville - all receivers

Station (NCA no.)	Construction activities resulting in exceedances of sleep disturbance criteria	Indicative total duration of construction activity	Indicative total duration of noise intensive plant use	Number of exceedances greater than 20 dB
Marrickville (NCA01)	Corridor works - ground and track, earthworks with breaker	10 weeks	3 days	36
	Corridor works - ground & track, trackform	12 days	n/a	17
	Corridor works - ground & track, trackform with ballast tamper	4 days	Less than 4 days	257
	Corridor works – track support systems – OHW modifications	3 weeks	n/a	73
	Corridor works – track support systems – communications and signalling works	12 weeks	n/a	78
	Corridor works – track support systems – segregation fencing	6 weeks	n/a	68
	Station work areas, demolition	6 week	n/a	19
	Station work areas, concrete and structural work	8 weeks	n/a	6
	Station work areas, station installation and fitout	20 weeks	n/a	1
	Bridge work areas, site establishment and impact protection	2 weeks	n/a	16
	Bridge work areas, demolition	2 weeks	n/a	13
	Bridge work areas, construction and installation	20 weeks	n/a	12

Construction traffic volumes and routes (including rail replacement buses) would be reviewed and confirmed during subsequent stages of the project to determine if additional mitigation is required. Where compliance with the criteria is unable to be achieved, reasonable and feasible noise mitigation would be considered. Mitigation could include alternate traffic routes or reducing the maximum number of movements.

Vibration

Amenity

Large hydraulic breakers would have the highest potential to result in vibration levels above the amenity criteria. For most construction activities, vibration emissions are intermittent and for this reason, higher vibration levels, occurring over shorter periods are likely to be tolerable. Project specific information regarding the duration of construction activities and equipment would become available following the detailed design and construction planning. Recommended safe working distances have therefore been used to conservatively estimate the number of dwellings which may experience vibration affecting human comfort.

There are predicted to be a substantial number of buildings within the minimum working distance of a large hydraulic breaker used at the edge of the work area. Receivers adjacent to the construction areas have therefore been identified as likely to notice vibration impacts at times during construction works. This is expected to be primarily due to works associated with large hydraulic breakers but also other high vibration plant items. In practice, vibration impacts from most construction activities would be intermittent over the duration of construction, and more refined construction planning would seek to further reduce this impact.

Where vibration-intensive works need to be undertaken within the recommended minimum working distances, measures including monitoring would be undertaken in line with the Construction Noise and Vibration Strategy (refer to Appendix E).

Cosmetic damage

The minimum recommended offset between the construction works and the nearest sensitive receivers are expected to be generally sufficient such that buildings are unlikely to experience cosmetic damage from the use of most construction equipment. However, there may be some instances where large hydraulic breakers would be required to be within the recommended minimum distances.

Up to 40 buildings (including the heritage-listed station) would be located within the minimum recommended offset based on the cosmetic criteria of 7.5 mm/s. This is considered to be a conservative estimate as a hydraulic breaker would not be required in all locations, and would not necessarily be used at the edge of the construction area. Should the use of hydraulic breakers (or other vibration intensive plant) in these locations be unavoidable, alternative construction methods or other mitigation measures would be considered to minimise potential vibration effects.

During detailed design and construction planning, the use of vibration intensive plant would be reviewed to limit the potential for damage. Where vibration intensive works are required to be undertaken within the recommended safe working distances, vibration monitoring would be undertaken to ensure acceptable levels of vibration are not exceeded.

Where vibration-intensive works need to be undertaken within the recommended minimum offsets (refer to Table 12.6), measures including monitoring would be undertaken in line with the Construction Noise and Vibration Strategy (refer to Appendix E).

Heritage buildings and structures

Heritage buildings would be considered on a case by case basis, with detailed inspections and condition assessments of potentially affected heritage structures undertaken to determine sensitivity prior to the commencement of works. Heritage listed buildings identified in this assessment within the minimum offset distances for cosmetic damage are provided in Table 12.17.

Table 12.17 Heritage buildings and structures within the minimum recommended offset to avoid cosmetic damage

NCA	Item/ address	Building occupancy	Construction type
NCA01	Marrickville Station	Commercial	Masonry
NCA01	Carrington Road, Marrickville	Public Building	Masonry (Brick)
NCA01	1 Myrtle Street, Marrickville	Residential	Masonry (Brick)

Notes: Estimated from photographic information only. The inclusion of items is not a reflection of the heritage significance of the item. Refer to the Technical paper 3 – Non-Aboriginal heritage assessment for further information on heritage items. Some items listed above may contain more than one building or structure.

The construction fabric of the building (i.e. timber, masonry) and the structural integrity of these buildings would be confirmed during detailed design. If the building is considered structurally unsound or more susceptible to damage, a more stringent 2.5 mm/s vibration criteria would be applied for works in the vicinity of these buildings.

Measures to minimise the potential for vibration impacts are provided in Section 12.6.

12.5.4 Dulwich Hill (NCA02)

The Dulwich Hill noise catchment area (NCA02) is dominated by residential receivers (as shown in Figure 12.1). There is also a small commercial corridor along Wardell Road south of the station. The terminus stop for the L1 Dulwich Hill light rail line is located to the west of Dulwich Hill Station and the light rail line heads north away from the station. The freight rail line runs on the northern edge of the rail corridor.

Residential receivers on Livingstone Road, Randall Street, Kays Avenue, School Parade, Ewart Street, and The Parade would be located near bridge works, while substation works would also potentially affect residential receivers on Randall Street. Around Dulwich Hill Station, track realignment and station works would be undertaken near residential receivers on Ewart Lane and commercial receivers facing Wardell Road.

Predicted construction noise levels for the construction activities resulting in the highest number of ‘highly noise affected’ residential receivers during out of hours construction work are discussed below. Noise levels at residential receivers during out of hours construction activities have been selected as they represent a higher sensitivity relative to noise generated during recommended standard hours. Noise level predictions during other time periods and other receiver classifications are provided in Table 12.9, Table 12.10, and Table 12.11.

Noise level exceedances during out of hours works

It is likely that construction activities will need to be undertaken outside of recommended standard hours (out of hours works) during possessions/closedowns of the rail corridor. However out of hours works are expected to be largely undertaken during possessions/closedowns of the rail corridor.

During out of hours construction works, the highest number of night-time noise level exceedances are predicted during the following activities, with the activity generating the highest number of exceedances during the night-time shown in bold:

- **corridor works - ground and track, trackform with ballast tamper**
- corridor works - track support systems, OHW modifications
- corridor works - track support systems, communications and signalling works
- bridge work areas, site establishment and impact protection
- bridge work areas, demolition.

Ballast tamping would be scheduled where reasonable and feasible during standard day time and evening hours however despite efforts to avoid this, there may be circumstances when these works must occur, for technical reasons, during night-time periods. This item of plant can produce relatively high noise levels, however the works typically progress at a reasonably fast rate, with individual receivers only likely to be affected for a short duration (i.e. up to four days).

Relatively large numbers of receivers are predicted to be affected during the track support systems activities - OHW modifications and communications and signalling works. While these works are not particularly noise intensive, they would be required along the length of the corridor in this precinct with many receivers potentially being affected.

The activity likely to result in the highest number of noise level exceedances during the night-time is corridor works - ground and track, trackform - ballast tamper. Figure 12.5 indicates the distribution of exceedances for this activity for receivers within this precinct during the night-time. The graph shows that, while the activity may result in exceedance of the night-time NMLs greater than 20 dB for 17 per cent of affected receivers, a much greater percentage of receivers in this precinct are subject to lower levels of noise.

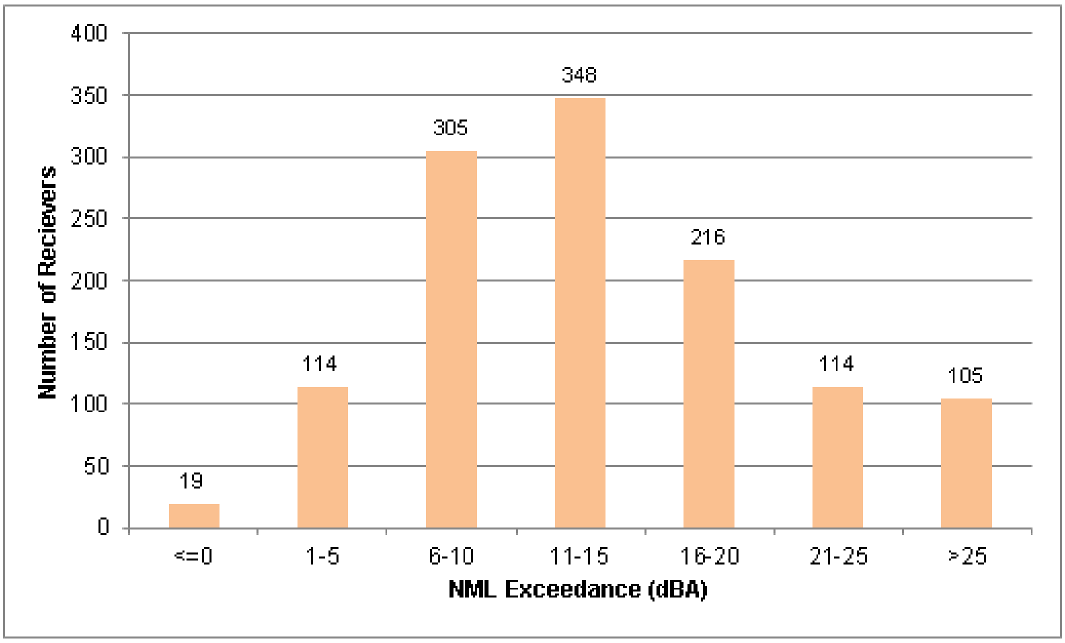


Figure 12.5 Number of night-time noise exceedances from corridor works, ground and track, trackform with ballast tamper

Figure 12.6 shows that when this noise intensive plant item (ballast tamper) is not in use, the number of exceedances greater than 20 dB above the noise management level reduces to seven per cent of affected receivers.

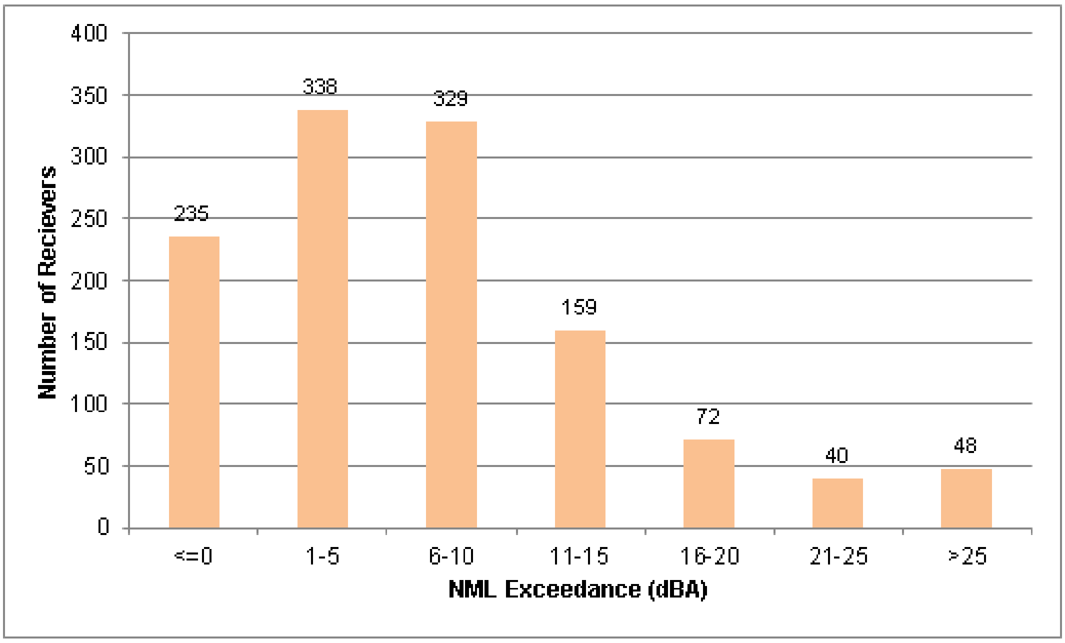


Figure 12.6 Number of night-time noise exceedances from corridor works, ground and track, trackform without ballast tamper

Highly noise affected receivers

The ICNG considers residential receivers that are subject to predicted noise levels of 75 dBA or greater to be highly noise affected.

Table 12.18 shows the number of receivers within NCA02 predicted to be highly noise affected in this catchment during certain works activities. The highest numbers are apparent during the following activities:

- General work areas, earthworks with breaker, where 24 receivers are predicted to be highly noise affected during the daytime only and would only be undertaken for about three days at any site.
- Corridor works - ground and track, earthworks with breaker, where 36 receivers are predicted to be highly noise affected during the daytime and evening. The use of hydraulic breakers would generally be limited to day time and evening periods (between 7am and 10pm), unless technical constraints exist and would only be undertaken for about three days at any site.
- Corridor works - ground and track, trackform with ballast tamper, where 20 receivers are predicted to be highly noise affected during the daytime, evening and night-time periods. If the ballast tamper were to not be used during the night-time, this would reduce to five receivers being highly noise affected during this period.
- Bridge construction areas, demolition with breaker and saw, where 106 receivers are predicted to be highly noise affected during the daytime and evening, which results from the large number of bridge work areas in this precinct. The use of hydraulic breakers would generally be limited to day time and evening periods (between 7am and 10pm), unless technical constraints exist. Demolition works would only occur for a total duration of about two weeks during these possessions.

Figure 12.4 shows the location of residential receivers which are predicted to experience exceedances of the highly noise affected criteria.

Table 12.18 Activities and durations which result in 'highly noise affected' residential receivers in Dulwich Hill

Station (NCA no.)	Construction activities resulting in exceedances above highly noise affected criteria	Indicative total duration of construction activity	Indicative total duration of noise intensive plant use, where relevant	Number of residential receivers highly noise affected		
				Day	Eve	Night
Dulwich Hill (NCA02)	General work areas, earthworks	6 weeks	n/a	9		
	General work areas, earthworks with breaker	**6 weeks**	**3 days**	**24**		
	General work areas, piling	6 weeks	2 weeks	6		
	General work areas, site establishment	4 weeks	n/a	1		
	Corridor works - ground and track, earthworks	30 weeks	n/a	11	11	11
	Corridor works - ground and track, earthworks with breaker	**10 weeks**	**3 days**	**36**	**36**	
	Corridor works - ground & track, trackform	12 days	n/a	5	5	5
	Corridor works - ground & track, trackform with ballast tamper	**4 days**	**Less than 4 days**	**20**	**20**	**20**
	Corridor works – track support systems, OHW modifications	3 weeks	n/a	5	5	5
	Corridor works - track support systems, communications and signalling	12 weeks	n/a	5	5	5
	Station work areas, demolition with breaker & saw	6 weeks	2 weeks /6 week possession	9	9	
	Bridge work areas, site establishment and impact protection	2 weeks	n/a	13	13	13
	Bridge work areas, demolition	2 weeks/ possession	2 weeks/ possession	5	5	5
	Bridge work areas, demolition with breaker & saw	**2 weeks/ possession**	**2 weeks/ possession**	**106**	**106**	
	Substation work areas, site establishment	2 weeks	n/a	1		

Note: Bold indicates the activities predicted to generate the largest number of highly noise affected receivers.

Other sensitive receivers

Other sensitive receivers, such as educational facilities, hospitals and childcare centres, which are potentially affected by construction works have also been assessed against the relevant criteria.

The other sensitive receivers in this precinct are predicted to generally be subject to relatively minor impacts with many receiver types and works activities not resulting in exceedances of the NMLs.

Sensitive receivers which are predicted to be subject to exceedances of 11 to 20 dB above the NMLs during the higher noise generating activities are:

- Place of worship – St Nicholas Greek Orthodox Church, 205 Livingstone Road, Marrickville
- Public buildings – 209 Livingstone Road, Marrickville
- Café/bar – 245 Wardell Road, Dulwich Hill.

No sensitive receivers in this area are likely to experience noise levels more than 20 dB above NMLs.

Sleep disturbance

Based on the preliminary list of plant and construction activities used in this assessment, exceedance of the sleep disturbance criteria is predicted to occur in each NCA during night works. A detailed breakdown for each time period is provided in Technical paper 2 and a summary shown in Table 12.19. Given the assessment approach used, the identified impacts are considered to represent a conservative estimate of the likely impact.

The Sydney Metro Construction Noise and Vibration Strategy contains further details relating to potential sleep disturbance impacts. The strategy contains mitigation measures and procedures to address levels of adverse impact greater than 30 dB above the relevant criteria including periods of respite and alternative accommodation in specific circumstances and on a case by case basis. Construction would be subject to this strategy.

Construction traffic noise

The project would result in two sources of potential traffic noise:

- construction vehicles such as heavy and light vehicles moving to and from construction compounds and work areas along identified haulage routes
- buses due to the alternative transport arrangements outlined in the Temporary Transport Strategy to service the T3 Bankstown Line during possession periods.

A construction traffic noise assessment was undertaken including the cumulative impact of both of these potential noise sources where they would share the same routes. The key finding was that collectively, the construction vehicles and buses required as part of the alternative transport arrangements would result in an increase of less than two dB on a majority of roads used for construction traffic.

Table 12.19 Activities which result in sleep disturbance exceedance in Dulwich Hill - all receivers

Station (NCA no.)	Construction activities resulting in exceedances of sleep disturbance criteria	Indicative total duration of construction activity	Indicative total duration of noise intensive plant use, where relevant	Number of exceedances greater than 20 dB
Dulwich Hill (NCA02)	Corridor works - ground and track, earthworks	30 weeks	n/a	69
	Corridor works - ground & track, trackform	12 days	n/a	23
	Corridor works - ground & track, trackform with ballast tamper	4 days	Less than 4 days	254
	Corridor works - track support systems, OHW modifications	3 weeks	n/a	82
	Corridor works - track support systems, communications and signalling	12 weeks	n/a	101
	Corridor works – track support systems – segregation fencing	6 weeks	n/a	51
	Station work areas, demolition	6 weeks	n/a	16
	Station work areas, concrete and structural work	8 weeks	n/a	6
	Station work areas, station installation and fitout	20 weeks	n/a	1
	Bridge work areas, site establishment and impact protection	2 weeks	n/a	96
	Bridge work areas, demolition	2 weeks/ possession	2 weeks/ possession	70
	Bridge work areas, construction and installation	20 weeks	n/a	43

The roads shown in Table 12.20 are predicted to experience an increase of more than two dB and result in road traffic noise levels that exceed the criteria during the night-time.

As outlined in Table 12.20, consideration of both construction traffic and rail replacement buses operating simultaneously would result in additional exceedances during the day time at Ewart Street (between Wardell Road & Ness Avenue).

Construction traffic volumes and routes (including rail replacement buses) would be reviewed and confirmed during subsequent stages of the project to determine if addition mitigation is required. Where compliance with the criteria is unable to be achieved, reasonable and feasible noise mitigation would be considered. Mitigation could include alternate traffic routes or reducing the maximum number of movements.

Table 12.20 Road traffic noise exceedances from construction traffic and buses – Dulwich Hill

Road	Construction traffic	Rail replacement buses	Construction traffic and rail replacement buses
Bayley Street - between Ewart Street and Dudley Street	●	●	●
Terrace Road - between New Canterbury Road and Consett Street	●		●
Ewart Street - between Wardell Road & Ness Avenue		●	●

Vibration

Amenity

Large hydraulic breakers would have the highest potential to result in vibration levels above the amenity criteria. For most construction activities, vibration emissions are intermittent and for this reason, higher vibration levels, occurring over shorter periods are likely to be tolerable. Project-specific information regarding the duration of construction equipment would become available following detailed design and construction planning. Recommended safe working distances have therefore been used to conservatively estimate the number of dwellings which may experience vibration affecting human comfort.

There are predicted to be a substantial number of buildings located within the minimum working distance of a large hydraulic breaker used at the edge of the work area. Receivers adjacent to the construction areas have therefore been identified as likely to notice vibration impacts at times during construction works. This is expected to be primarily due to works associated with large hydraulic breakers but also other high vibration plant items. In practice, vibration impacts from most construction activities would be intermittent over the duration of construction, and more refined construction planning would seek to further reduce this impact.

Where vibration-intensive works need to be undertaken within the recommended minimum working distances, measures including monitoring would be undertaken in line with the Construction Noise and Vibration Strategy (refer to Appendix E).

Cosmetic damage

The minimum recommended offset between the construction works and the nearest sensitive receivers are expected to be generally sufficient such that buildings are unlikely to experience cosmetic damage from the use of most construction equipment. However, there may be some instances where large hydraulic breakers would be required to be within the recommended minimum distances.

Up to 74 buildings (including the heritage-listed station) would be located within the minimum recommended offset based on the cosmetic criteria of 7.5 mm/s. This is considered to be a conservative estimate, as a hydraulic breaker would not be required in all locations, and would not necessarily be used at the edge of the construction area. Should the use of hydraulic breakers (or other vibration intensive plant) in these locations be unavoidable, alternative construction methods or other mitigation measures would be considered to minimise potential vibration effects.

During detailed design and construction planning, the use of vibration intensive plant would be reviewed to limit the potential for damage. Where vibration intensive works are required to be undertaken within the recommended safe working distances, vibration monitoring would be undertaken to ensure acceptable levels of vibration are not exceeded.

Where vibration-intensive works need to be undertaken within the recommended minimum offsets (refer to Table 12.6), measures including monitoring would be undertaken in line with the Construction Noise and Vibration Strategy (refer to Appendix E).

Heritage buildings and structures

Heritage buildings would be considered on a case by case basis, with detailed inspections and condition assessments of potentially affected heritage structures undertaken to determine sensitivity prior to the commencement of works. Heritage listed buildings identified in this assessment within the minimum offset distances for cosmetic damage are listed in Table 12.21.

Table 12.21 Heritage buildings and structures within the minimum recommended offset to avoid cosmetic damage

NCA	Item/address	Building occupancy	Construction type
NCA02	Dulwich Hill Station	Commercial	Weatherboard
NCA02	217 Livingstone Road, Marrickville	Residential	Masonry (Brick)
NCA02	219 Livingstone Road, Marrickville	Residential	Masonry (Brick)
NCA02	2 Hollands Avenue, Marrickville	Residential	Masonry (Brick)
NCA02	4 Hollands Avenue, Marrickville	Residential	Masonry (Brick)
NCA02	6 Hollands Avenue, Marrickville	Residential	Masonry (Brick)
NCA02	242 Wardell Road, Dulwich Hill	Residential	Masonry (Brick)
NCA02	240 Wardell Road, Dulwich Hill	Residential	Masonry (Brick/Rendered)
NCA02	5 Wilga Avenue, Dulwich Hill	Residential	Masonry (Brick)
NCA02	7 Wilga Avenue, Dulwich Hill	Residential	Masonry (Brick)
NCA02	14 Wilga Avenue, Dulwich Hill	Residential	Masonry (Brick)
NCA02	47 School Parade, Marrickville	Residential	Masonry (Brick)
NCA02	43 School Parade, Marrickville	Residential	Masonry (Brick)
NCA02	41 School Parade, Marrickville	Residential	Masonry (Brick)
NCA02	22 Kays Avenue, Marrickville	Residential	Masonry (Brick)
NCA02	26 Kays Avenue, Marrickville	Residential	Masonry (Brick)
NCA02	28 Kays Avenue, Marrickville	Residential	Masonry (Brick)
NCA02	37 Kays Avenue, Marrickville	Residential	Masonry (Brick)
NCA02	39 Kays Avenue, Marrickville	Residential	Masonry (Brick)
NCA02	34 Challis Avenue, Dulwich Hill	Residential	Masonry (Brick)
NCA02	36 Challis Avenue, Dulwich Hill	Residential	Masonry (Brick)
NCA02	35 Challis Avenue, Dulwich Hill	Residential	Masonry (Brick)

NCA	Item/address	Building occupancy	Construction type
NCA02	39 Challis Avenue, Dulwich Hill	Residential	Masonry (Brick/Rendered)
NCA02	116 Ewart Street, Dulwich Hill	Residential	Masonry

Notes: Estimated from photographic information only. The inclusion of items is not a reflection of the heritage significance of the item. Refer to the Technical paper 3 for further discussion of heritage items. Some items listed above may contain more than one building or structure.

The construction fabric of the building (i.e. timber, masonry) and the structural integrity of these buildings would be confirmed during detailed design. If the building is considered structurally unsound or more susceptible to damage, a more stringent 2.5 mm/s vibration criteria would be applied for works in the vicinity of these buildings.

Measures to minimise the potential for vibration impacts are provided in Section 12.6.

12.5.5 Hurlstone Park (NCA03)

The Hurlstone Park noise catchment area (NCA03) is dominated by residential receivers (as shown in Figure 12.1) with a small commercial corridor leading away from the station to the north along Crinan Street. The freight rail line runs on the northern edge of the rail corridor.

Bridge works would be undertaken near residential receivers on Floss Street, Foord Avenue and Hurlstone Avenue while around Hurlstone Park Station, track realignment and station works would be undertaken in proximity to a mix of commercial and residential receivers.

Predicted construction noise levels for the construction activities resulting in the highest number of ‘highly noise affected’ residential receivers during out of hours construction work are discussed below. Noise levels at residential receivers during out of hours construction activities have been selected as they represent a higher sensitivity relative to noise generated during recommended standard hours. Noise level predictions during other time periods and other receiver classifications are provided in Table 12.9, Table 12.10 and Table 12.11.

Noise level exceedances during out of hours works

It is likely that construction activities will need to be undertaken outside of the recommended standard hours (out of hours works) during possessions/closedowns of the rail corridor. However out of hours works are expected to be largely undertaken during possessions/closedowns of the rail corridor.

During out of hours construction works, the highest number of night-time noise level exceedances are predicted during the following activities, with the activity generating the highest number of exceedances during the night-time shown in bold:

- corridor works - ground and track, earthworks
- **corridor works - ground and track, trackform with ballast tamper**
- corridor works - track support systems, OHW modifications
- corridor works - track support systems, communications and signalling works.

Ballast tamping would be scheduled where reasonable and feasible during standard day time and evening hours however despite efforts to avoid this, there may be circumstances when these works must occur, for technical reasons, during night-time periods. This item of plant can produce relatively high noise levels, however the works typically progress at a reasonably fast rate, with individual receivers only likely to be affected for a short duration (i.e. up to four days).

Relatively large numbers of receivers are predicted to be affected during the track support systems activities - OHW modifications and communications and signalling works. While these works are not particularly noise intensive, they would be required along the length of the corridor in this precinct with many receivers potentially being affected.

The activity likely to result in the highest number of noise level exceedances during the night-time is corridor works - ground and track, trackform with ballast tamper. Figure 12.7 indicates the distribution of exceedances for this activity during the night-time.

The graph shows that while the activity may result in exceedance of the night-time NMLs greater than 20 dB for 25 per cent of receivers in this precinct, a much greater percentage of receivers are subject to lower levels of noise.

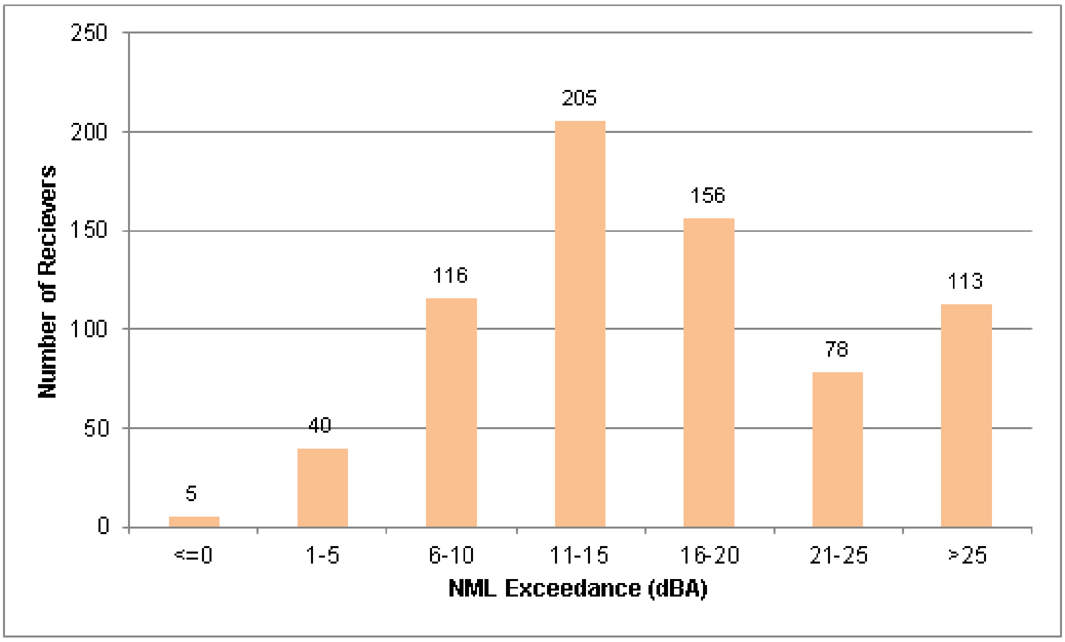


Figure 12.7 Number of night-time noise exceedances from corridor works, ground and track, trackform with ballast tamper

Figure 12.8 shows that when this noise intensive plant item (ballast tamper) is not in use, the number of exceedances greater than 20 dB above the noise management level reduces to about 11 per cent of noise affected receivers in this precinct.

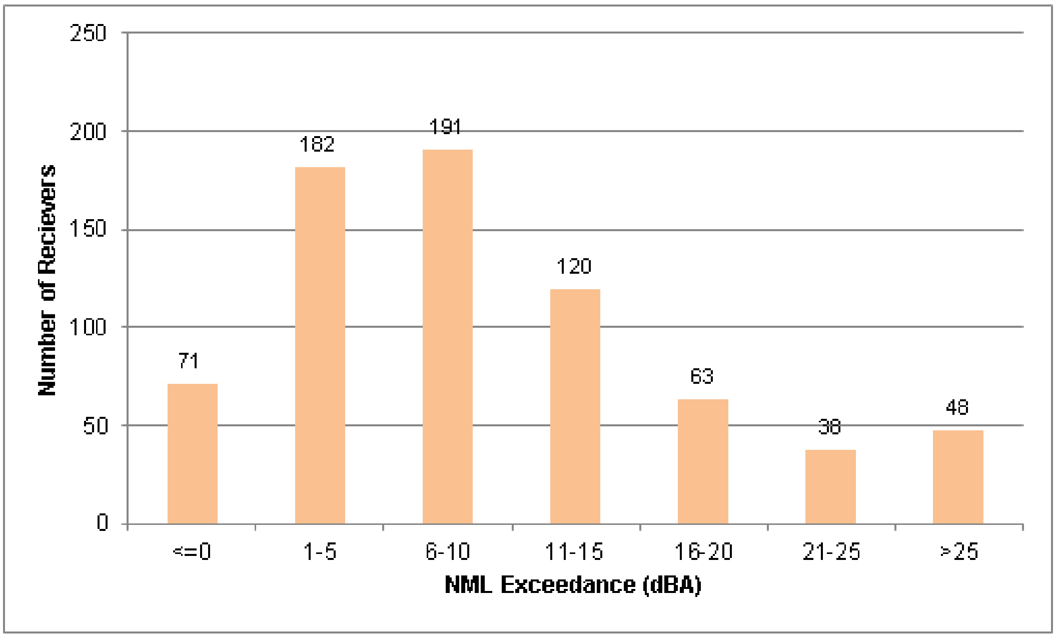


Figure 12.8 Number of night-time noise exceedances from corridor works, ground and track, trackform without ballast tamper

Highly noise affected receivers

The ICNG considers residential receivers that are subject to predicted noise levels of 75 dBA or greater to be highly noise affected.

Table 12.22 shows the number of receivers within NCA03 predicted to be highly noise affected in this catchment during certain works activities. The highest numbers are apparent during the following activities:

- General work areas, earthworks with breaker, where 23 receivers are predicted to be highly noise affected during the daytime only and would only be undertaken for about three days at any site.
- Corridor works - ground and track, earthworks with breaker, where 48 receivers are predicted to be highly noise affected during the daytime and evening. The use of hydraulic breakers would generally be limited to day time and evening periods (between 7am and 10pm), unless technical constraints exist and would only be undertaken for about three days at any site.
- Corridor works - ground and track, trackform with ballast tamper, where 34 receivers are predicted to be highly noise affected during the daytime, evening and night-time periods. If the ballast tamper were to not be used during the night-time, this would reduce to three receivers being highly noise affected during this period.
- Bridge work areas, demolition with breaker and saw, where 39 receivers are predicted to be highly noise affected during the daytime and evening. The use of hydraulic breakers would generally be limited to day time and evening periods (between 7am and 10pm), unless technical constraints exist. Demolition works will only occur for a total duration of about two weeks during these possessions.

Figure 12.9 shows the predicted location of residential receivers who are likely to experience exceedances of the highly noise affected criteria.

Other sensitive receivers

Other sensitive receivers, such as educational facilities, hospitals and childcare centres, which are potentially affected by construction works have also been assessed against the relevant criteria.

The other sensitive receivers in this precinct are predicted to generally be subject to relatively minor impacts with many receiver types and works activities not resulting in exceedances of the NMLs.

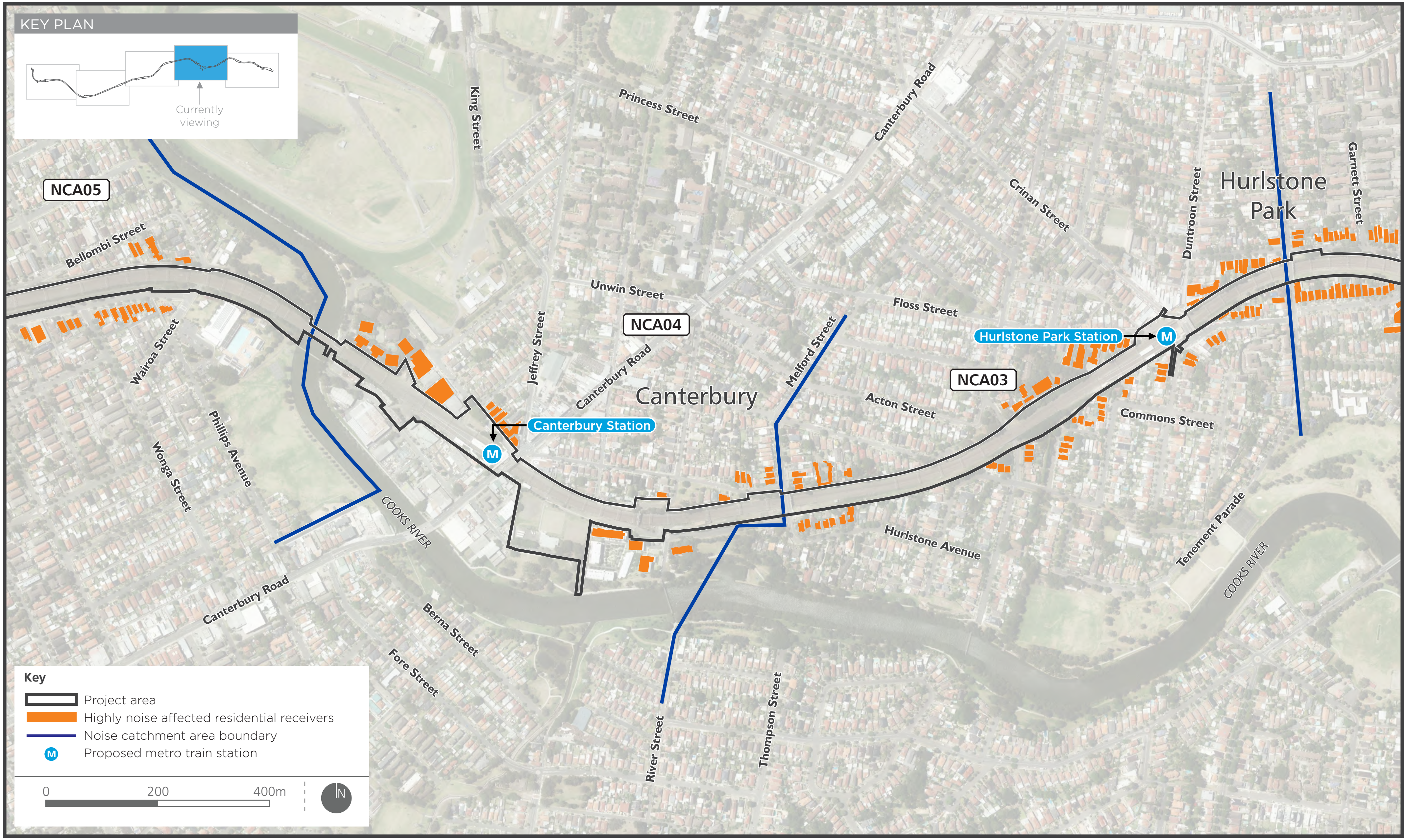
One sensitive receiver is likely to experience exceedances of 11 to 20 dB above NMLs during the higher noise generating activities, namely Hurlstone Park Children’s Centre, at 12 Smith Avenue, Hurlstone Park (child care facility).

Only one sensitive receiver, Dulwich Hill Child Care Centre, 66 Garnet Street, Hurlstone Park is predicted to experience noise levels greater than 20 dB above NMLs.

Table 12.22 Activities and durations which result in ‘highly noise affected’ residential receivers in Hurlstone Park

Station (NCA no.)	Construction activities resulting in exceedances above highly noise affected criteria	Indicative total duration of construction activity	Indicative total duration of noise intensive plant use	Number of residential receivers highly noise affected		
				Day	Eve	Night
Hurlstone Park (NCA03)	General work areas, earthworks	6 weeks	n/a	3		
	General work areas, earthworks with breaker	**6 weeks**	**3 days**	**23**		
	General work areas, piling	6 weeks	2 weeks	3		
	General work areas, site establishment	4 weeks	n/a	1		
	Corridor works - ground and track, earthworks	30 weeks	n/a	8	8	8
	Corridor works - ground and track, earthworks with breaker	**10 weeks**	**3 days**	**48**	**48**	
	Corridor works - ground & track, trackform	12 days	n/a	3	3	3
	Corridor works - ground & track, trackform with ballast tamper	**4 days**	**Less than 4 days**	**34**	**34**	**34**
	Corridor works - track support systems, OHW modifications	3 weeks	n/a	2	2	2
	Corridor works - track support systems, communications and signalling	12 weeks	n/a	2	2	2
	Station work areas, demolition with breaker & saw	6 weeks	2 weeks /6 week possession	1	1	
	Bridge work areas, site establishment and impact protection	2 weeks	n/a	2	2	2
	Bridge work areas, demolition	2 weeks/ possession	2 weeks/ possession	2	2	2
	Bridge work areas, demolition with breaker & saw	**2 weeks/ possession**	**2 weeks/ possession**	**39**	**39**	

Note: Bold indicates the activities predicted to generate the largest number of highly noise affected receivers.



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Location of highly noise affected residential receivers – Hurlstone Park and Canterbury

FIGURE 12.9

Sleep disturbance

Based on the preliminary list of plant and construction activities used in this assessment, exceedance of the sleep disturbance criteria is predicted to occur in each NCA during night works. A detailed breakdown for each time period is provided in Technical paper 2 and a summary shown in Table 12.23. Given the assessment approach used, these impacts are considered to represent a conservative estimate of the likely impact.

The Sydney Metro Construction Noise and Vibration Strategy contains further details relating to potential sleep disturbance impacts. The strategy contains mitigation measures and procedures to address levels of adverse impact greater than 30 dB above the relevant criteria including periods of respite and alternative accommodation in specific circumstances and on a case by case basis. Construction would be subject to this strategy.

Construction traffic noise

The project would result in two sources of potential traffic noise:

- construction vehicles such as heavy and light vehicles moving to and from construction compounds and work areas along identified haulage routes
- buses due to the alternative transport arrangements outlined in the Temporary Transport Strategy to service the T3 Bankstown Line during possession periods.

A construction traffic noise assessment was undertaken including the cumulative impact of both of these potential noise sources where they would share the same routes. The key finding was that collectively the construction vehicles and buses required as part of the alternative transport arrangements would result in an increase of less than two dB on a majority of roads used for construction traffic.

The movement of construction traffic along the following streets would result an increase of more than two dB and result in road traffic noise levels that exceed the criteria at night:

- Garnet Street (between Canterbury Road and Hampden Street)
- Duntroon Street
- Crinan Street (between Melford Street & Dunstaffenage Street).

The introduction of buses as part of the alternate transport arrangements would not result in exceedances additional to those above.

Construction traffic volumes and routes (including rail replacement buses as part of the alternative transport arrangements outlined in the Temporary Transport Strategy) would be reviewed and confirmed during subsequent stages of the project to determine if additional mitigation is required. Where compliance with the criteria is unable to be achieved, reasonable and feasible noise mitigation would be considered. Mitigation could include alternate traffic routes or reducing the maximum number of movements.

Table 12.23 Activities which result in sleep disturbance exceedance in Hurlstone Park - all receivers

Station (NCA no.)	Construction activities resulting in exceedances of sleep disturbance criteria	Indicative total duration of construction activity	Indicative total duration of noise intensive plant use	Number of exceedances greater than 20 dB
Hurlstone Park (NCA03)	Corridor works - ground and track, earthworks	10 weeks	3 days	60
	Corridor works - ground and track, trackform	12 days	n/a	34
	Corridor works - ground and track, trackform with ballast tamper	4 days	Less than 4 days	216
	Corridor works - track support systems, OHW modifications	3 weeks	n/a	64
	Corridor works - track support systems, communications and signalling works	12 weeks	n/a	72
	Corridor works - track support systems, segregation fencing	6 weeks	n/a	46
	Station work areas, demolition	6 week	n/a	2
	Bridge work areas, site establishment and impact protection	2 weeks	n/a	30
	Bridge work areas, demolition	2 weeks	n/a	23
	Bridge work areas, construction and installation	20 weeks	n/a	17

Vibration

Amenity

Large hydraulic breakers would have the highest potential to result in vibration levels above the amenity criteria. For most construction activities, vibration emissions are intermittent and for this reason, higher vibration levels, occurring over shorter periods are likely to be tolerable. Project-specific information regarding the duration of construction activities and equipment would become available following detailed design and construction planning. Recommended safe working distances have therefore been used to conservatively estimate the number of dwellings that may experience vibration affecting human comfort.

There are predicted to be a substantial number of buildings within the minimum working distance of a large hydraulic breaker used at the edge of the work area. Receivers adjacent to the construction areas have therefore been identified as likely to notice vibration impacts at times during construction works. This is expected to be primarily due to works associated with large hydraulic breakers but also other high vibration plant items. In practice, vibration impacts from most construction activities would be intermittent over the duration of construction, and more refined construction planning would seek to further reduce this impact.

Where vibration-intensive works need to be undertaken within the recommended minimum working distances, measures including monitoring would be undertaken in line with the Construction Noise and Vibration Strategy (refer to Appendix E).

Cosmetic damage

The minimum recommended offset between the construction works and the nearest sensitive receivers are expected to be generally sufficient such that buildings are unlikely to experience cosmetic damage from the use of most construction equipment. However, there may be some instances where large hydraulic breakers would be required to be within the recommended minimum distances.

Up to 45 buildings (including the heritage-listed station) would be located within the minimum recommended offset based on the cosmetic criteria of 7.5 mm/s. This is considered to be a conservative estimate, as a hydraulic breaker would not be required in all locations, and would not necessarily be used at the edge of the construction area. Should the use of hydraulic breakers (or other vibration intensive plant) in these locations be unavoidable, alternative construction methods or other mitigation measures would be considered to minimise potential vibration effects.

During detailed design and construction planning, the use of vibration intensive plant would be reviewed to limit the potential for damage. Where vibration intensive works are required to be undertaken within the recommended safe working distances, vibration monitoring would be undertaken to ensure acceptable levels of vibration are not exceeded.

Where vibration-intensive works need to be undertaken within the recommended minimum offsets (refer to Table 12.6), measures including monitoring would be undertaken in line with the Construction Noise and Vibration Strategy (refer to Appendix E).

Heritage buildings and structures

Heritage buildings would be considered on a case by case basis, with detailed inspections and condition assessments of potentially affected heritage structures undertaken to determine sensitivity prior to the commencement of works. Only one heritage listed building was identified in this assessment within the minimum offset distances for cosmetic damage as shown in Table 12.24.

Table 12.24 Heritage buildings and structures within the minimum recommended offset to avoid cosmetic damage

NCA	Item/ address	Building occupancy	Construction type
NCA03	Hurlstone Park Railway Station	Commercial	Masonry (Brick)

Note: Estimated from photographic information only. The inclusion of items is not a reflection of the heritage significance of the item. Refer to the Technical paper 3 for further discussion of heritage items. Some items listed above may contain more than one building or structure.

The construction fabric of the building (i.e. timber, masonry) and the structural integrity of these buildings would be confirmed during detailed design. If the building is considered structurally unsound or more susceptible to damage, a more stringent 2.5 mm/s vibration criteria would be applied for works in the vicinity of these buildings.

Measures to minimise the potential for vibration impacts are provided in Section 12.6.

12.5.6 Canterbury (NCA04 and NCA05)

The Canterbury noise catchment areas (NCA04 and NCA05) are dominated by commercial premises north of the rail corridor and a mix of commercial and residential premises south of the rail corridor (as shown in Figure 12.1). The freight rail line runs on the northern edge of the rail corridor.

In NCA04, receivers on Canberra Street, Church Street and Hutton Street would be located near bridge works, while residential receivers on Hutton Street would also potentially be affected by substation works. Around Canterbury Station, track realignment and station works would be undertaken near commercial receivers and some residential receivers to the north.

In NCA05, receivers on South Parade and Wairoa Street would be located near bridge works on the southern side of the rail corridor, while receivers on South Parade would also potentially be affected by general work areas.

Predicted construction noise levels for the construction activities resulting in the highest number of ‘highly noise affected’ residential receivers during out of hours construction work are discussed below. Noise levels at residential receivers during out of hours construction activities have been selected as they represent a higher sensitivity relative to noise generated during recommended standard hours. Noise level predictions during other time periods and other receiver classifications are provided in Table 12.9, Table 12.10, and Table 12.11.

Noise level exceedances during out of hours works

It is likely that construction activities will need to be undertaken outside of recommended standard hours (out of hours works) during possessions/closedowns of the rail corridor. However out of hours works are expected to be largely undertaken during possessions/closedowns of the rail corridor.

During out of hours construction works, the highest number of night-time noise level exceedances are predicted during the following activities, with the activity generating the highest number of exceedances during the night-time shown in bold:

- corridor works - ground and track, trackform with ballast tamper
- **corridor works - track support systems, OHW modifications**
- corridor works - track support systems, communications and signalling works
- corridor works - track support systems, segregation fencing.

Ballast tamping would be scheduled where reasonable and feasible during standard day time and evening hours however despite efforts to avoid this, there may be circumstances when these works must occur, for technical reasons, during night-time periods. This item of plant can produce relatively high noise levels, however the works typically progress at a reasonably fast rate, with individual receivers only likely to be affected for a short duration (i.e. up to four days).

Relatively large numbers of receivers are predicted to be affected during the Track Support Systems activities. While these works are not particularly noise intensive, they would be required along the length of corridor in this precinct with many receivers potentially being affected.

The activity likely to result in the highest number of noise level exceedances during the night-time is corridor works - track support systems, OHW modifications. Figure 12.10 indicates the distribution of exceedances for this activity during the night-time.

The graph shows that while the activity may result in exceedance of the night-time NMLs greater than 20 dB for the 21 per cent of affected receivers in this precinct, a much greater percentage of receivers are subject to lower levels of noise.

It is noted that the duration of these impacts at a particular receiver are likely to be relatively short as the works typically progress at a reasonably fast rate.

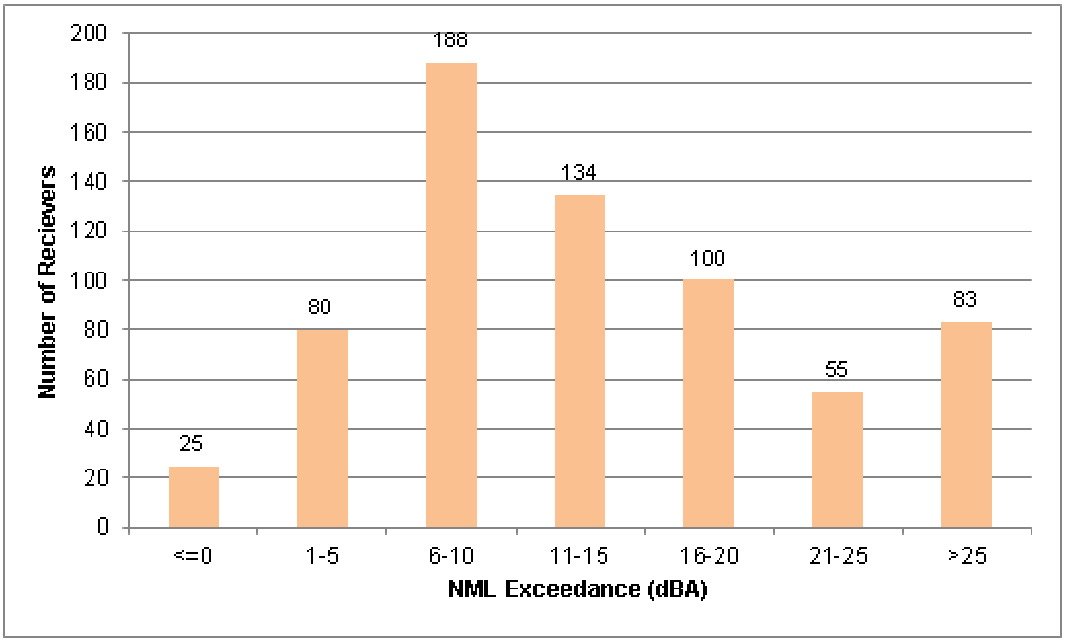


Figure 12.10 Number of night-time noise exceedances from corridor works - track support systems, overhead wiring modifications

Highly noise affected residential receivers

The ICNG considers residential receivers that are subject to predicted noise levels of 75 dBA or greater to be highly noise affected.

Table 12.25 shows the number of receivers within NCA04 and NCA05 predicted to be highly noise affected in this catchment during certain works activities. The highest numbers are apparent during the following activities:

- General work areas, earthworks with breaker, where 30 receivers are predicted to be highly noise affected in NCA05 during the daytime only and would only be undertaken for about three days at any site. The use of hydraulic breakers would generally be limited to day time and evening periods (between 7am and 10pm), unless technical constraints exist.

- Corridor works - ground and track, earthworks with breaker, where six receivers in NCA04 and one receiver in NCA05 are predicted to be highly noise affected during the daytime and evening. The use of hydraulic breakers would generally be limited to day time and evening periods (between 7am and 10pm), unless technical constraints exist and would only be undertaken for about three days at any site.
- Station work areas, demolition with breaker and saw, where eight receivers in NCA04 are predicted to be highly noise affected during the daytime and evening. The use of hydraulic breakers would generally be limited to day time and evening periods (between 7am and 10pm), unless technical constraints exist. Demolition works will only occur for a total duration of about two weeks during these possessions.
- Bridge work areas, demolition with breaker and saw, where 14 receivers in NCA04 and eight receivers in NCA05 are predicted to be highly noise affected during the daytime and evening. The use of hydraulic breakers would generally be limited to day time and evening periods (between 7am and 10pm), unless technical constraints exist. Demolition works will only occur for a total duration of about two weeks during these possessions.

Figure 12.9 shows the location of residential receivers which are predicted to experience exceedances of the highly noise affected criteria.

Other sensitive receivers

Other sensitive receivers, such as educational facilities, hospitals and childcare centres, which are potentially affected by construction works have also been assessed against the relevant criteria.

The other sensitive receivers in this precinct are predicted to generally be subject to relatively minor impacts with many receiver types and works activities not resulting in exceedances of the NMLs.

One commercial sensitive receiver is predicted to be subject to noise levels of 11 to 20 dB above NMLs during the higher noise generating activities, namely a café/bar at 208 Canterbury Road, Canterbury.

Sleep disturbance

Based on the preliminary list of plant and construction activities used in this assessment, exceedance of the sleep disturbance criteria is predicted to occur in each NCA during night works. A detailed breakdown for each time period is provided in Technical paper 2 and a summary shown in Table 12.26. Given the assessment approach, these impacts are considered to represent a conservative estimate of the likely impact.

The Sydney Metro Construction Noise and Vibration Strategy contains further details relating to potential sleep disturbance impacts. The strategy contains mitigation measures and procedures to address levels of adverse impact greater than 30 dB above the relevant criteria including periods of respite and alternative accommodation in specific circumstances and on a case by case basis. Construction would be subject to this strategy.

Table 12.25 Activities and durations which result in 'highly noise affected' residential receivers in Canterbury

Station (NCA no.)	Construction activities resulting in exceedances above highly noise affected criteria	Indicative total duration of construction activity	Indicative total duration of noise intensive plant use, where relevant	Number of residential receivers highly noise affected		
				Day	Eve	Night
Canterbury (NCA04)	Corridor works - ground and track, earthworks	30 weeks	n/a	4	4	4
	Corridor works - ground and track, earthworks with breaker	**10 weeks**	**3 days**	**6**	**6**	
	Corridor works - ground & track, trackform	12 days	n/a	1	1	1
	Corridor works - ground & track, trackform with ballast tamper	4 days	Less than 4 days	5	5	5
	Station work areas, demolition with breaker & saw	**6 weeks**	**2 weeks /6 week possession**	**8**	**8**	
	Bridge work areas, site establishment and impact protection	2 weeks	n/a	1	1	1
	Bridge work areas, demolition with breaker & saw	**2 weeks/ possession**	**2 weeks/ possession**	**14**	**14**	
Canterbury (NCA05)	**General work areas, earthworks with breaker**	**6 weeks**	**3 days**	**30**		
	Corridor works - ground and track, earthworks with breaker	**10 weeks**	**3 days**	**1**	**1**	
	Corridor works - ground and track, trackform with ballast tamper	4 days	Less than 4 days	1	1	1
	Bridge work areas, demolition with breaker and saw	**2 weeks/ possession**	**2 weeks/ possession**	**8**	**8**	

Note: Bold indicates the activities predicted to generate the largest number of highly noise affected receivers.

Table 12.26 Activities which result in sleep disturbance exceedance in Canterbury - all receivers

Station (NCA no.)	Construction activities resulting in exceedances of sleep disturbance criteria	Indicative total duration of construction activity	Indicative total duration of noise intensive plant use	Number of exceedances greater than 20 dB
Canterbury (NCA04 and NCA05)	Corridor works - ground and track, earthworks	10 weeks	3 days	11
	Corridor works - ground and track, trackform	12 days	n/a	6
	Corridor works - ground and track, trackform with ballast tamper	4 days	Less than 4 days	92
	Corridor works - track support systems, OHW modifications	3 weeks	n/a	75
	Corridor works - track support systems, communications and signalling works	12 weeks	n/a	83
	Corridor works - track support systems, segregation fencing	6 weeks	n/a	38
	Station works, demolition	6 week	n/a	8
	Station works, concrete and structural works	8 weeks	n/a	2
	Bridge work areas, site establishment and impact protection	2 weeks	n/a	17
	Bridge work areas, demolition	2 weeks	n/a	12
	Bridge work areas, construction and installation	20 weeks	n/a	6

Construction traffic noise

The project would result in two sources of potential traffic noise:

- construction vehicles such as heavy and light vehicles moving to and from construction compounds and work areas along identified haulage routes
- buses due to the alternative transport arrangements outlined in the Temporary Transport Strategy to service the T3 Bankstown Line during possession periods.

A construction traffic noise assessment was undertaken including the cumulative impact of both of these potential noise sources where they would share the same routes. The key finding was that collectively, both the construction vehicles and buses required as part of the alternative transport arrangements would result in an increase of less than two dB on a majority of roads used for construction traffic.

The roads shown in Table 12.27 are predicted to experience an increase of more than two dB and result in road traffic noise levels that exceed the criteria during the night-time (and day time at Close Street).

Construction traffic volumes and routes (including rail replacement buses) would be reviewed and confirmed during subsequent stages to determine if additional mitigation is required. Where compliance with the criteria is unable to be achieved, reasonable and feasible noise mitigation would be considered. Mitigation could include alternate traffic routes or reducing the maximum number of movements.

Table 12.27 Road traffic noise from construction traffic and buses – Canterbury

Road	Construction traffic	Rail replacement buses	Construction traffic and rail replacement buses
Close Street	●		●
Broughton Street (between Canterbury Road & Robert Street)	●		●

Vibration

Amenity

Large hydraulic breakers would have the highest potential to result in vibration levels above the amenity criteria. For most construction activities, vibration emissions are intermittent and for this reason, higher vibration levels, occurring over shorter periods are likely to be tolerable. Project-specific information regarding the duration of construction activities and equipment would become available following detailed design and construction planning. Recommended safe working distances have therefore been used to conservatively estimate the number of dwellings which may experience vibration affecting human comfort.

There are predicted to be a number substantial number of buildings within the minimum working distance of a large hydraulic breaker used at the edge of the work area. Receivers adjacent to the construction areas have been identified as likely to notice vibration impacts at times during construction works. This is expected to be primarily due to works associated with large hydraulic breakers but also other high vibration plant items. In practice, vibration impacts from most construction activities would be intermittent over the duration of construction, and more refined construction planning would seek to further reduce this impact.

Where vibration-intensive works need to be undertaken within the recommended minimum working distances, measures including monitoring would be undertaken in line with the Construction Noise and Vibration Strategy (refer to Appendix E).

Cosmetic damage

The minimum recommended offset between the construction works and the nearest sensitive receivers are expected to be generally sufficient such that buildings are unlikely to experience cosmetic damage from the use of most construction equipment. However, there may be some instances where large hydraulic breakers would be required to be within the recommended minimum distances.

Up to 23 buildings (including heritage-listed train stations) would be located within the minimum recommended offset based on the cosmetic criteria of 7.5 mm/s. This is considered to be a conservative estimate, as a hydraulic breaker would not be required in all locations, and would not necessarily be used at the edge of the construction area. Should the use of hydraulic breakers (or other vibration intensive plant) in these locations be unavoidable, alternative construction methods or other mitigation measures would be considered to minimise potential vibration effects.

During detailed design and construction planning, the use of vibration intensive plant would be reviewed to limit the potential for damage. Where vibration intensive works are required to be undertaken within the recommended safe working distances, vibration monitoring would be undertaken to ensure acceptable levels of vibration are not exceeded.

Where vibration-intensive works need to be undertaken within the recommended minimum offsets (refer to Table 12.6), measures including monitoring would be undertaken in line with the Construction Noise and Vibration Strategy (refer to Appendix E).

Heritage buildings and structures

Heritage buildings would be considered on a case by case basis, with detailed inspections and condition assessments of potentially affected heritage structures undertaken to determine sensitivity prior to the commencement of works. Heritage listed buildings identified in this assessment within the minimum offset distances for cosmetic damage are listed in Table 12.28.

Table 12.28 Heritage buildings and structures within the minimum recommended offset to avoid cosmetic damage

NCA	Item/ address	Building occupancy	Construction type
NCA04	Canterbury Station	Commercial	Masonry (Brick)
NCA04	2 Sugar House Road, Canterbury	Residential	Masonry
NCA04	193 Canterbury Road, Canterbury	Residential	Masonry (Brick)
NCA04	3 Broughton Street, Canterbury	Residential	Masonry (Brick)

Notes: Estimated from photographic information only. The inclusion of items is not a reflection of the heritage significance of the item. Refer to the Technical paper 3 for further discussion of heritage items. Some items listed above may contain more than one building or structure.

The construction fabric of the building (i.e. timber, masonry) and the structural integrity of these buildings would be confirmed during detailed design. If the building is considered structurally unsound or more susceptible to damage, a more stringent 2.5 mm/s vibration criteria would be applied for works in the vicinity of these buildings.

Measures to minimise the potential for vibration impacts are provided in Section 12.6.

12.5.7 Campsie (NCA06)

The Campsie noise catchment area (NCA06) is dominated by residential receivers (as shown in Figure 12.1) aside from areas surrounding the station along Beamish Street which comprise a mix of commercial and residential receivers. The freight rail line runs on the northern edge of the rail corridor through the station and diverts northward about mid-way between Campsie and Belmore stations.

Bridge works would be undertaken in the eastern and western ends of the noise catchment area near receivers on South Parade and Lilian Lane, while receivers on Lilian Lane would also be located near substation works. Around Campsie Station, track realignment and station works would be undertaken near a mix of commercial receivers and residential receivers.

Predicted construction noise levels for the construction activities resulting in the highest number of 'highly noise affected' residential receivers during out of hours construction work are discussed below. Noise levels at residential receivers during out of hours construction activities have been selected as they represent a higher sensitivity relative to noise generated during recommended standard hours. Noise level predictions during other time periods and other receiver classifications are provided in Table 12.9, Table 12.10 and Table 12.11.

Noise level exceedances during out of hours works

It is likely that construction activities will need to be undertaken outside of recommended standard hours (out of hours works) during possessions/closedowns of the rail corridor. However, out of hours works are expected to be largely undertaken during possessions/closedowns of the rail corridor.

During out of hours construction works, the highest number of night-time noise level exceedances are predicted during the following activities, with the activity generating the highest number of exceedances during the night-time shown in bold:

- corridor works - ground and track, earthworks
- **corridor works - ground and track, trackform with ballast tamper**
- corridor works - track support systems, OHW modifications
- corridor works - track support systems, communications and signalling works.

Ballast tamping would be scheduled where reasonable and feasible during standard day time and evening hours however despite efforts to avoid this, there may be circumstances when these works must occur, for technical reasons, during night-time periods. This item of plant can produce relatively high noise levels, however the works typically progress at a reasonably fast rate, with individual receivers only likely to be affected for a short duration (i.e. up to four days).

Relatively large numbers of receivers are predicted to be affected during the track support systems activities - OHW modifications and communications and signalling works. While these works are not particularly noise intensive, they would be required along the length of the corridor in this precinct with many receivers potentially being affected.

The activity likely to result in the highest number of noise level exceedances during the night-time is corridor works - ground and track, trackform with ballast tamper. Figure 12.11 indicates the distribution of exceedances for this activity during the night-time.

The graph shows that while the activity may result in exceedance of the night-time NMLs greater than 20 dB for the 26 per cent of receivers in this precinct, a much greater percentage of receivers in this precinct are subject to lower levels of noise.

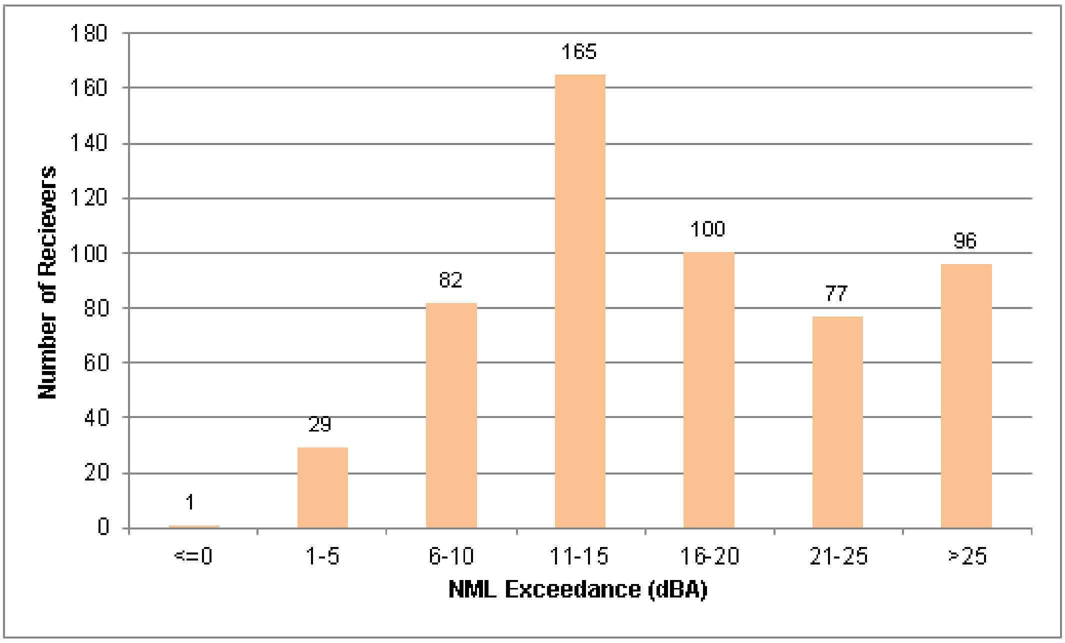


Figure 12.11 Number of night-time noise exceedances from corridor works, ground and track, trackform with ballast tamper

Figure 12.12 shows that when this noise intensive plant item (ballast tamper) is not in use, the number of exceedances greater than 20 dB above the noise management level reduces to 11 per cent of affected receivers.

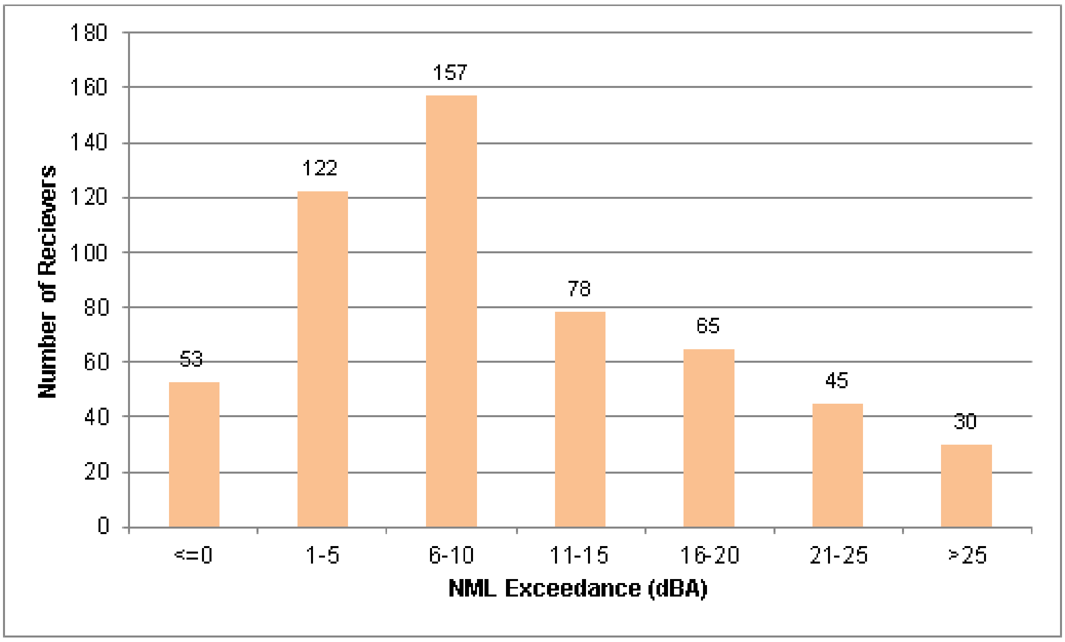


Figure 12.12 Number of night-time noise exceedances from corridor works, ground and track, trackform without ballast tamper

Highly noise affected receivers

The ICNG considers residential receivers within NCA06 that are subject to predicted noise levels of 75 dBA or greater to be highly noise affected.

Table 12.29 shows the number of receivers predicted to be highly noise affected in this catchment during certain works activities. The highest numbers are apparent during the following activities:

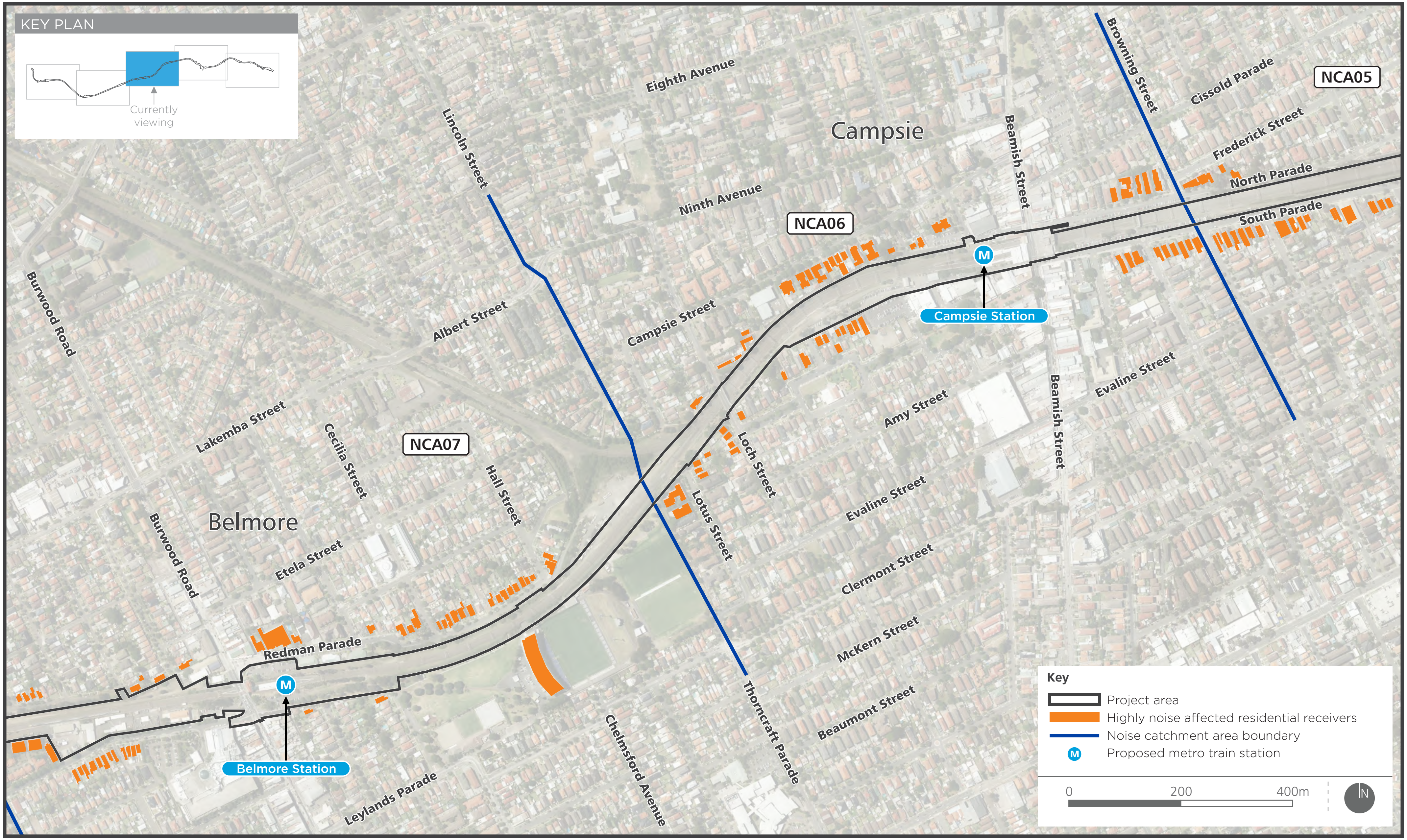
- General work areas, earthworks with breaker, where 26 receivers are predicted to be highly noise affected during the daytime only and would only be undertaken for about three days at any site. The use of hydraulic breakers would generally be limited to day time and evening periods (between 7am and 10pm), unless technical constraints exist.
- Corridor works - ground and track, earthworks with breaker, where 37 receivers are predicted to be highly noise affected during the daytime and evening. The use of hydraulic breakers would generally be limited to day time and evening periods (between 7am and 10pm), unless technical constraints exist and would only be undertaken for about three days at any site.
- Corridor works - ground and track, trackform with ballast tamper, where 23 receivers are predicted to be highly noise affected during the daytime, evening and night-time periods. If the ballast tamper were to not be used during the night-time, this would reduce to two receivers being highly noise affected during this period.
- Station work areas, demolition with breaker and saw, where 13 receivers are predicted to be highly noise affected during the daytime and evening. The use of hydraulic breakers would generally be limited to day time and evening periods (between 7am and 10pm), unless technical constraints exist. Demolition works will only occur for a total duration of about two weeks during these possessions.
- Bridge work areas, demolition with breaker and saw, where 22 receivers are predicted to be highly noise affected during the daytime and evening. The use of hydraulic breakers would generally be limited to day time and evening periods (between 7am and 10pm), unless technical constraints exist. Demolition works will only occur for a total duration of about two weeks during these possessions.

Figure 12.13 shows the location of residential receivers which are predicted to experience exceedances of the highly noise affected criteria.

Table 12.29 Activities and durations which result in 'highly noise affected' residential receivers in Campsie

Station (NCA no.)	Construction activities resulting in exceedances above highly noise affected criteria	Indicative total duration of construction activity	Indicative total duration of noise intensive plant use, where relevant	Number of residential receivers highly noise affected		
				Day	Eve	Night
Campsie (NCA06)	General work areas, earthworks	6 weeks	n/a	1		
	General work areas, earthworks with breaker	**6 weeks**	**3 days**	**26**		
	General work areas, piling	6 weeks	2 weeks	1		
	Corridor works, ground and track, earthworks	30 weeks	n/a	6	6	6
	Corridor works, ground and track, earthworks with breaker	**10 weeks**	**3 days**	**37**	**37**	
	Corridor works, ground & track, trackform	12 days	n/a	2	2	2
	Corridor works, ground & track, trackform with ballast tamper	**4 days**	**Less than 4 days**	**23**	**23**	**23**
	Corridor works, track support systems – OHW modifications	3 weeks	n/a	1	1	1
	Corridor works, track support systems – communications and signalling works	12 weeks	n/a	1	1	1
	Station work areas, demolition with breaker & saw	**6 weeks**	**2 weeks /6 week possession**	**13**	**13**	
	Bridge work areas , site establishment and impact protection	2 years	Intermittently during possessions	3	3	3
	Bridge work areas , demolition	2 years	2 weeks	1	1	1
	Bridge work areas , demolition with breaker & saw	**2 weeks/ possession**	**2 weeks/ possession**	**22**	**22**	

Note: Bold indicates the activities predicted to generate the largest number of highly noise affected receivers.



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Location of highly noise affected residential receivers – Campsie and Belmore

FIGURE 12.13

Other sensitive receivers

Other sensitive receivers, such as educational facilities, hospitals and childcare centres, which are potentially affected by construction works have also been assessed against the relevant criteria.

The other sensitive receivers in this precinct are predicted to generally be subject to relatively minor impacts with many receiver types and works activities not resulting in exceedances of the NMLs.

Sensitive receivers which are predicted to be subject to exceedances of 11 to 20 dB above the NMLs during the higher noise generating activities are:

- Medical – 7 Duke Street, Campsie
- Place or worship – St John's Anglican Church, Campsie
- Childcare – 3 Harold Street, Campsie
- Childcare – Carrington Occasional Child Care Centre, 2 Carrington Street, Campsie.

Other sensitive receivers in this area which are predicted to be subject to noise levels of more than 20 dB above NMLs are:

- Childcare – 70 Campsie Street, Campsie
- Public building – Campsie Police Station.

Sleep disturbance

Based on the preliminary list of plant and construction activities used in this assessment, exceedance of the sleep disturbance criteria is predicted to occur in each NCA during night works. A detailed breakdown for each time period is provided in Technical paper 2 and a summary shown in Table 12.30. Given the assessment approach, these impacts are considered to represent a conservative estimate of the likely impact.

The Sydney Metro Construction Noise and Vibration Strategy contains further details relating to potential sleep disturbance impacts. The strategy contains mitigation measures and procedures to address levels of adverse impact greater than 30 dB above the relevant criteria including periods of respite and alternative accommodation in specific circumstances and on a case by case basis. Construction would be subject to this strategy.

Table 12.30 Activities which result in sleep disturbance exceedance in Campsie - all receivers

Station (NCA no.)	Construction activities resulting in exceedances of sleep disturbance criteria	Indicative total duration of construction activity	Indicative total duration of noise intensive plant use	Number of exceedances greater than 20 dB
Campsie (NCA06)	Corridor works - ground and track, earthworks	10 weeks	3 days	46
	Corridor works - ground & track, trackform	12 days	n/a	13
	Corridor works - ground & track, trackform with ballast tamper	4 days	Less than 4 days	184
	Corridor works – track support systems – OHW modifications	3 weeks	n/a	20
	Corridor works – track support systems – communications and signalling works	12 weeks	n/a	40
	Corridor works – track support systems – segregation fencing	6 weeks	n/a	14
	Station work areas, demolition	6 week	n/a	13
	Station work areas, concrete and structural work	8 weeks	n/a	4
	Bridge work areas, site establishment and impact protection	2 weeks	n/a	13
	Bridge work areas, demolition	2 weeks	n/a	6
	Bridge work areas, construction and installation	20 weeks	n/a	5

Construction traffic noise

The project would result in two sources of potential traffic noise:

- construction vehicles such as heavy and light vehicles moving to and from construction compounds and work areas along identified haulage routes
- buses due to the alternative transport arrangements outlined in the Temporary Transport Strategy to service the T3 Bankstown Line during possession periods.

A construction traffic noise assessment was undertaken including the cumulative impact of both of these potential noise sources where they would share the same routes. The key finding was that collectively, both the construction vehicles and buses required as part of the alternative transport arrangements would result in an increase of less than two dB on a majority of roads used for construction traffic.

The operation of buses as part of the alternate transport arrangements is predicted to result in an increase of more than two dB and result in road traffic noise levels that exceed the criteria on Gould Street (between Canterbury Road and Redman Street) during the day time.

Construction traffic volumes and routes (including rail replacement buses) would be reviewed and confirmed during subsequent stages to determine if additional mitigation is required. Where compliance with the criteria is unable to be achieved, reasonable and feasible noise mitigation would be considered. Mitigation could include alternate traffic routes or reducing the maximum number of movements.

Vibration

Amenity

Large hydraulic breakers would have the highest potential to result in vibration levels above the amenity criteria. For most construction activities, vibration emissions are intermittent and for this reason, higher vibration levels, occurring over shorter periods are likely to be tolerable. Project-specific information regarding the duration of construction activities and equipment would become available following detailed design and construction planning. Recommended safe working distances have therefore been used to conservatively estimate the number of dwellings which may experience vibration affecting human comfort.

There are predicted to be a substantial number of buildings within the minimum working distance of a large hydraulic breaker used at the edge of the work area. Receivers adjacent to the construction areas have therefore been identified as likely to notice vibration impacts at times during construction works. This is expected to be primarily due to works associated with large hydraulic breakers but also other high vibration plant items. In practice, vibration impacts from most construction activities would be intermittent over the duration of construction, and more refined construction planning would seek to further reduce this impact.

Where vibration-intensive works need to be undertaken within the recommended minimum working distances, measures including monitoring would be undertaken in line with the Construction Noise and Vibration Strategy (refer to Appendix E).

Cosmetic damage

The minimum recommended offset between the construction works and the nearest sensitive receivers are expected to be generally sufficient such that buildings are unlikely to experience cosmetic damage from the use of most construction equipment. However, there may be some instances where large hydraulic breakers would be required to be within the recommended minimum distances.

Up to 29 buildings (including the heritage-listed station) would be located within the minimum recommended offset based on the cosmetic criteria of 7.5 mm/s. This is considered to be a conservative estimate, as a hydraulic breaker would not be required in all locations, and would not necessarily be used at the edge of the construction area. Should the use of hydraulic breakers (or other vibration intensive plant) in these locations be unavoidable, alternative construction methods or other mitigation measures would be considered to minimise potential vibration effects.

During detailed design and construction planning, the use of vibration intensive plant would be reviewed to limit the potential for damage. Where vibration intensive works are required to be undertaken within the recommended safe working distances, vibration monitoring would be undertaken to ensure acceptable levels of vibration are not exceeded.

Where vibration-intensive works need to be undertaken within the recommended minimum offsets (refer to Table 12.6), measures including monitoring would be undertaken in line with the Construction Noise and Vibration Strategy (refer to Appendix E).

Heritage buildings and structures

Heritage buildings would be considered on a case by case basis, with detailed inspections and condition assessments of potentially affected heritage structures undertaken to determine sensitivity prior to the commencement of works. Heritage listed buildings identified in this assessment within the minimum offset distances for cosmetic damage are listed in Table 12.31.

Table 12.31 Heritage buildings and structures within the minimum recommended offset to avoid cosmetic damage

NCA	Item/ address	Building occupancy	Construction type
NCA06	Campsie Station	Commercial	Masonry
NCA06	203 Beamish Street, Campsie	Commercial	Masonry (Brick/Rendered)

Note: Estimated from photographic information only. The inclusion of items is not a reflection of the heritage significance of the item. Refer to the Technical paper 3 for further discussion of heritage items. Some items listed above may contain more than one building or structure.

The construction fabric of the building (i.e. timber, masonry) and the structural integrity of these buildings would be confirmed during detailed design. If the building is considered structurally unsound or more susceptible to damage, a more stringent 2.5 mm/s vibration criteria would be applied for works in the vicinity of these buildings.

Measures to minimise the potential for vibration impacts are provided in Section 12.6.

12.5.8 Belmore (NCA07)

The Belmore noise catchment area (NCA07) is dominated by residential receivers north of the rail corridor. Between the rail corridor and Redman Parade, there are a number of other sensitive receivers, including commercial, north and south of the station along Burwood Road. A sports stadium is located south of the rail corridor and east of the station (as shown in Figure 12.1).

Track realignment works would be undertaken between the eastern and western ends of Belmore Station, near commercial and residential receivers. Station works at Belmore Station would also be undertaken near commercial and residential receivers. Receivers on Redman Parade, consisting of a mix of residential and other sensitive (sports stadium) uses, would be located near bridge works while residential receivers on Bridge Road and Lark Street would be in proximity to general works.

Predicted construction noise levels for the construction activities resulting in the highest number of highly noise affected residential receivers during out of hours construction work are discussed below. Noise levels at residential receivers during out of hours construction activities have been selected as they represent a higher sensitivity relative to noise generated during recommended standard hours. Noise level predictions during other time periods and other receiver classifications are provided in Table 12.9, Table 12.10 and Table 12.11.

Noise level exceedances during out of hours works

It is likely that construction activities will need to be undertaken outside of recommended standard hours (out of hours works) during possessions/closedowns of the rail corridor. However out of hours works are expected to be largely undertaken during possessions/closedowns of the rail corridor.

During out of hours construction works, the highest number of night-time noise level exceedances are predicted during the following activities, with the activity generating the highest number of exceedances during the night-time shown in bold:

- corridor works - ground and track, earthworks
- **corridor works - ground and track, trackform - ballast tamper**
- corridor works - track support systems, OHW modifications
- corridor works - track support systems, communications and signalling works.

Ballast tamping would be scheduled where reasonable and feasible during standard day time and evening hours however despite efforts to avoid this, there may be circumstances when these works must occur, for technical reasons, during night-time periods. This item of plant can produce relatively high noise levels, however the works typically progress at a reasonably fast rate, with individual receivers only likely to be affected for a short duration (i.e. up to four days).

Relatively large numbers of receivers are predicted to be affected during the Track Support Systems activities. While these works are not particularly noise intensive, they would be required along the length of corridor in this precinct with many receivers potentially being affected.

The activity likely to result in the highest number of noise level exceedances during the night-time is corridor works - ground and track, trackform with ballast tamper. Figure 12.14 indicates the distribution of exceedances during the night-time.

The graph shows that while the activity may result in exceedance of the night-time NMLs greater than 20 dB for 13 per cent of receivers in this precinct, a much greater percentage of receivers, in this precinct are subject to lower levels of noise.

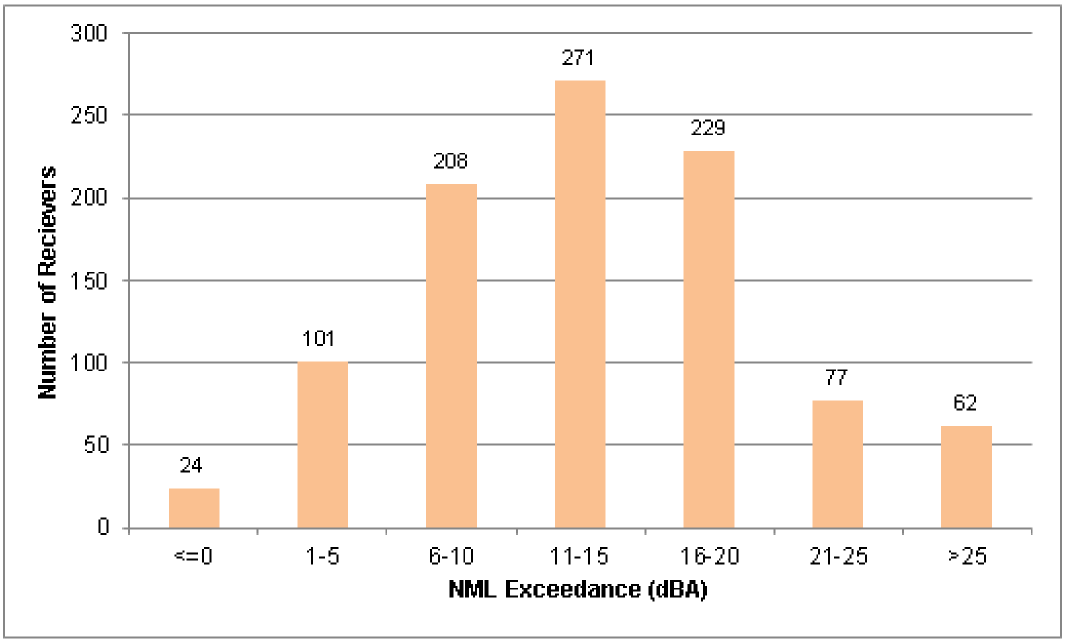


Figure 12.14 Number of night-time noise exceedances from corridor works, ground and track, trackform with ballast tamper

Figure 12.15 shows that when this noise intensive plant item (ballast tamper) is not in use, the number of exceedances greater than 20 dB above the noise management level reduces to four per cent of affected receivers.

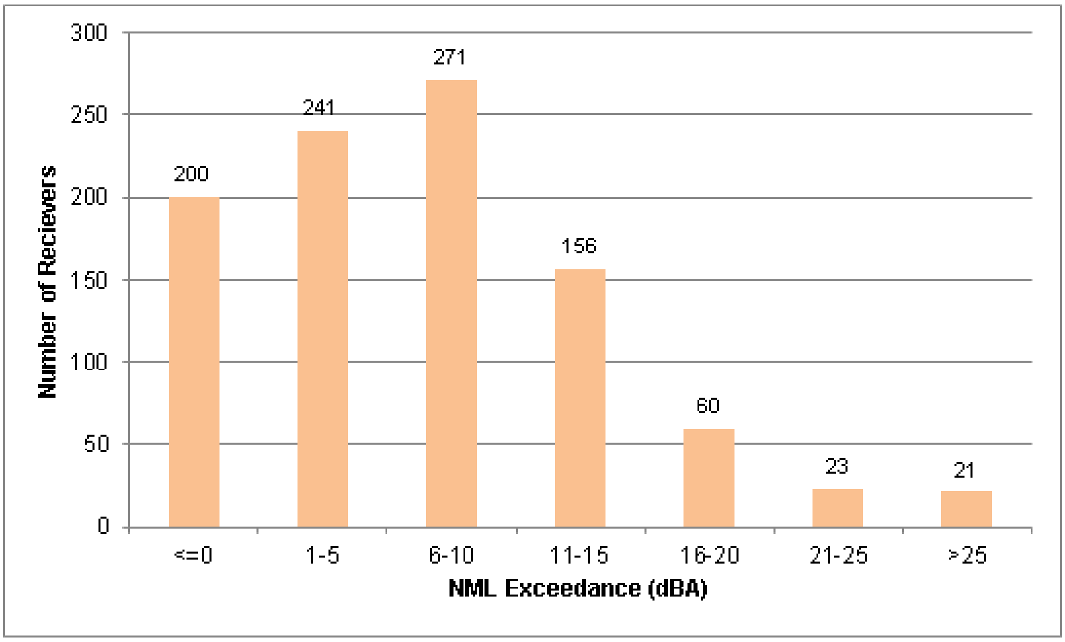


Figure 12.15 Number of night-time noise exceedances from corridor works, ground and track, trackform without ballast tamper

Highly noise affected residential receivers

The ICNG considers residential receivers that are subject to predicted noise levels of 75 dBA or greater to be highly noise affected.

Table 12.32 shows the number of receivers within NCA07 predicted to be highly noise affected in this catchment during certain works activities. The highest numbers are apparent during the following activities:

- General work areas, earthworks with breaker, where 22 receivers are predicted to be highly noise affected during the daytime only and would only be undertaken for about three days at any site.
- Corridor works - ground and track, earthworks with breaker, where 23 receivers are predicted to be highly noise affected during the daytime and evening. The use of hydraulic breakers would generally be limited to day time and evening periods (between 7am and 10pm), unless technical constraints exist and would only be undertaken for about three days at any site.
- Corridor works - ground and track, trackform with ballast tamper, where 12 receivers are predicted to be highly noise affected during the daytime, evening and night-time periods. If the ballast tamper were to not be used during the night-time, no receivers would be highly noise affected during this period.
- Station work areas, demolition with breaker and saw, where eight receivers are predicted to be highly noise affected during the daytime and evening. The use of hydraulic breakers would generally be limited to day time and evening periods (between 7am and 10pm), unless technical constraints exist. Demolition works will only occur for a total duration of about two weeks during these possessions.
- Bridge work areas, demolition with breaker and saw, where 10 receivers are predicted to be highly noise affected during the daytime and evening. The use of hydraulic breakers would generally be limited to day time and evening periods (between 7am and 10pm), unless technical constraints exist. Demolition works will only occur for a total duration of about two weeks during these possessions.

Figure 12.13 shows the location of residential receivers which are predicted to experience exceedances of the highly noise affected criteria.

Other sensitive receivers

Other sensitive receivers, such as educational facilities, hospitals and childcare centres, which are potentially affected by construction works have also been assessed against the relevant criteria.

The other sensitive receivers in this precinct are predicted to generally be subject to relatively minor impacts with many receiver types and works activities not resulting in exceedances of the NMLs.

Sensitive receivers which are predicted to be subject to exceedances of 11 to 20 dB above the NMLs during the higher noise generating activities are:

- educational – Montessori Preschool, 24 Redman Parade, Belmore
- childcare – Montessori Child Care, 24 Redman Parade, Belmore.

Table 12.32 Activities and durations which result in 'highly noise affected' residential receivers in Belmore

Station (NCA no.)	Construction activities resulting in exceedances above highly noise affected criteria	Indicative total duration of construction activity	Indicative total duration of noise intensive plant use, where relevant	Number of residential receivers highly noise affected		
				Day	Eve	Night
Belmore (NCA07)	General work areas, earthworks	6 weeks	n/a	1		
	General work areas, earthworks with breaker	**6 weeks**	**3 days**	**22**		
	General work areas, piling	6 weeks	2 weeks	1		
	Corridor works - ground and track, earthworks with breaker	**10 weeks**	**3 days**	**23**	**23**	
	Corridor works - ground and track, trackform with ballast tamper	**4 days**	**Less than four days**	**12**	**12**	**12**
	Station work areas, demolition	6 weeks	2 weeks/6 week possession	1	1	1
	Station work areas, demolition - breaker and saw	**6 weeks**	**2 weeks /6 week possession**	**8**	**8**	
	Station work areas, concrete and structural works	8 weeks	n/a	1	1	1
	Bridge work areas, demolition with breaker and saw	**2 weeks/ possession**	**2 weeks/ possession**	**10**	**10**	

Note: Bold indicates the activities predicted to generate the largest number of highly noise affected receivers.

Other sensitive receivers which are predicted to experience noise levels of more than 20 dB above NMLs are:

- educational – 10 Redman Parade Belmore
- medical – 38-40 Redman Parade, Belmore
- childcare – 38 Redman Parade, Belmore
- public building – Belmore Community Centre.

Sleep disturbance

Based on the preliminary list of plant and construction activities used in this assessment, exceedance of the sleep disturbance criteria is predicted to occur in each NCA during night works. A detailed breakdown for each time period is provided in Technical paper 2 and a summary shown in Table 12.33. Given the assessment approach, these impacts are considered to represent a conservative estimate of the likely impact.

The Sydney Metro Construction Noise and Vibration Strategy contains further details relating to potential sleep disturbance impacts. The strategy contains mitigation measures and procedures to address levels of adverse impact greater than 30 dB above the relevant criteria including periods of respite and alternative accommodation in specific circumstances and on a case by case basis. Construction of the project would be subject to this strategy.

Construction traffic noise

The project would result in two sources of potential traffic noise:

- construction vehicles such as heavy and light vehicles moving to and from construction compounds and work areas along identified haulage routes
- buses due to the alternative transport arrangements outlined in the Temporary Transport Strategy to service the T3 Bankstown Line during possession periods.

A construction traffic noise assessment was undertaken including the cumulative impact of both of these potential noise sources where they would share the same routes.

The assessment concluded that no roads in the precinct would experience an increase of more than two dB and result in road traffic noise levels that exceed the criteria.

Construction traffic volumes and routes (including rail replacement buses) would be reviewed and confirmed during subsequent stages of the project to determine if additional mitigation is required. Where compliance with the criteria is unable to be achieved, reasonable and feasible noise mitigation would be considered. Mitigation could include alternate traffic routes or reducing the maximum number of movements.

Table 12.33 Activities which result in sleep disturbance exceedance in Belmore - all receivers

Station (NCA no.)	Construction activities resulting in exceedances of sleep disturbance criteria	Indicative total duration of construction activity	Indicative total duration of noise intensive plant use	Number of exceedances greater than 20 dB
Belmore (NCA07)	Corridor works - ground and track, earthworks	10 weeks	3 days	28
	Corridor works - ground and track, trackform	12 days	n/a	8
	Corridor works - ground and track, trackform with ballast tamper	4 days	Less than 4 days	170
	Corridor works - track support systems, OHW modifications	3 weeks	n/a	23
	Corridor works - track support systems, communications and signalling works	12 weeks	n/a	29
	Corridor works - track support systems, segregation fencing	6 weeks	n/a	9
	Station work areas, demolition	6 week	n/a	8
	Station work areas, concrete and structural works	8 weeks	n/a	2
	Station work areas, station installation and fitout	20 weeks	n/a	1
	Bridge work areas, site establishment and impact protection	2 weeks	n/a	9
	Bridge work areas, demolition	2 weeks	n/a	7
	Bridge work areas, construction and installation	20 weeks	n/a	3

Vibration

Amenity

Large hydraulic breakers would have the highest potential to result in vibration levels above the amenity criteria. For most construction activities, vibration emissions are intermittent and for this reason, higher vibration levels, occurring over shorter periods are likely to be tolerable. Project-specific information regarding the duration of construction activities and equipment would not become available following detailed design and construction planning. Recommended safe working distances have been used to conservatively estimate the number of dwellings that may experience vibration affecting human comfort.

There are predicted to be a substantial number of buildings within the minimum working distance of a large hydraulic breaker used at the edge of the work area. Receivers adjacent to the construction areas have therefore been identified as likely to notice vibration impacts at times during construction works. This is expected to be primarily due to works associated with large hydraulic breakers but also other high vibration plant items. In practice, vibration impacts from most construction activities would be intermittent over the duration of construction, and more refined construction planning would seek to further reduce this impact.

Where vibration-intensive works need to be undertaken within the recommended minimum working distances, measures including monitoring would be undertaken in line with the Construction Noise and Vibration Strategy (refer to Appendix E).

Cosmetic damage

The minimum recommended offset between the construction works and the nearest sensitive receivers are expected to be generally sufficient such that buildings are unlikely to experience cosmetic damage from the use of most construction equipment. However, there may be some instances where large hydraulic breakers would be required to be within the recommended minimum distances.

Up to 41 buildings (including the heritage-listed station) would be located within the minimum recommended offset based on the cosmetic criteria of 7.5 mm/s. This is considered to be a conservative estimate, as a hydraulic breaker would not be required in all locations, and would not necessarily be used at the edge of the construction area. Should the use of hydraulic breakers (or other vibration intensive plant) in these locations be unavoidable, alternative construction methods or other mitigation measures would be considered to minimise potential vibration effects.

During detailed design and construction planning, the use of vibration intensive plant would be reviewed to limit the potential for damage. Where vibration intensive works are required to be undertaken within the recommended safe working distances, vibration monitoring would be undertaken to ensure acceptable levels of vibration are not exceeded.

Where vibration-intensive works need to be undertaken within the recommended minimum offsets (refer to Table 12.6), measures including monitoring would be undertaken in line with the Construction Noise and Vibration Strategy (refer to Appendix E).

Heritage buildings and structures

Heritage buildings would be considered on a case by case basis, with detailed inspections and condition assessments of potentially affected heritage structures undertaken to determine sensitivity prior to the commencement of works. Only one heritage listed building was identified in this assessment within the minimum offset distances for cosmetic damage as shown in Table 12.34.

Table 12.34 Heritage buildings and structures within the minimum recommended offset to avoid cosmetic damage

NCA	Item/ address	Building occupancy	Construction type
NCA07	Belmore Station	Commercial	Weatherboard

Note: Estimated from photographic information only. The inclusion of items is not a reflection of the heritage significance of the item. Refer to the Technical paper 3 for further discussion of heritage items. Some items listed above may contain more than one building or structure.

The construction fabric of the building (i.e. timber, masonry) and the structural integrity of these buildings would be confirmed during detailed design. If the building is considered structurally unsound or more susceptible to damage, a more stringent 2.5 mm/s vibration criteria would be applied for works in the vicinity of these buildings.

Measures to minimise the potential for vibration impacts are provided in Section 12.6.

12.5.9 Lakemba (NCA08)

The Lakemba noise catchment area (NCA08) is dominated by residential receivers with commercial areas both north and south of the station along Haldon Street (as shown in Figure 12.1).

Station and track realignment works about Lakemba Station would be undertaken near residential and commercial receivers on The Boulevarde and Railway Parade, while residential receivers on The Boulevarde would also be located near substation works to the east of the station.

Predicted construction noise levels for the construction activities resulting in the highest number of highly noise affected residential receivers during out of hours construction work are discussed below. Noise levels at residential receivers during out of hours construction activities have been selected as they represent a higher sensitivity relative to noise generated during recommended standard hours. Noise level predictions during other time periods and other receiver classifications are provided in Table 12.9, Table 12.10 and Table 12.11.

Noise level exceedances during out of hours works

It is likely that construction activities will need to be undertaken outside of recommended standard hours (out of hours works) during possessions/closedowns of the rail corridor. However out of hours works are expected to be largely undertaken during possessions/closedowns of the rail corridor.

During out of hours construction works, the highest number of night-time noise level exceedances are predicted during the following activities, with the activity generating the highest number of exceedances during the night-time shown in bold:

- corridor works - ground and track, earthworks
- corridor works - ground and track - trackform
- **corridor works - ground and track, trackform with ballast tamper.**

Ballast tamping would be scheduled where reasonable and feasible during standard day time and evening hours however despite efforts to avoid this, there may be circumstances when these works must occur, for technical reasons, during night-time periods. This item of plant can produce relatively high noise levels, however the works typically progress at a reasonably fast rate, with individual receivers only likely to be affected for a short duration (i.e. up to four days).

The activity likely to result in the highest number of noise level exceedances during the night-time is corridor works - ground and track, trackform with ballast tamper. Figure 12.16 indicates the distribution of exceedances for this activity for receivers within this precinct during the night-time.

The graph shows that while the activity may result in exceedance of the night-time NMLs greater than 20 dB at seven per cent of receivers in this precent, a much greater percentage of receivers in this precinct are subject to lower levels of noise.

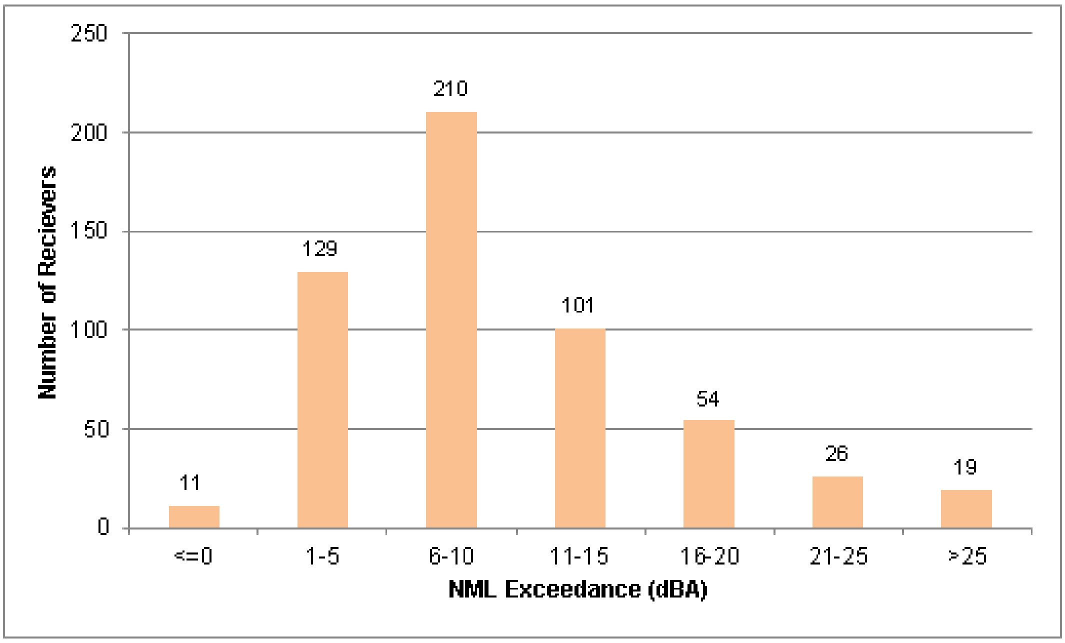


Figure 12.16 Number of night-time noise exceedances from corridor works, ground and track, trackform with ballast tamper

Figure 12.17 shows that when this noise intensive plant item (ballast tamper) is not in use, the number of exceedances greater than 20 dB above the noise management level reduces to one per cent of affected receivers.

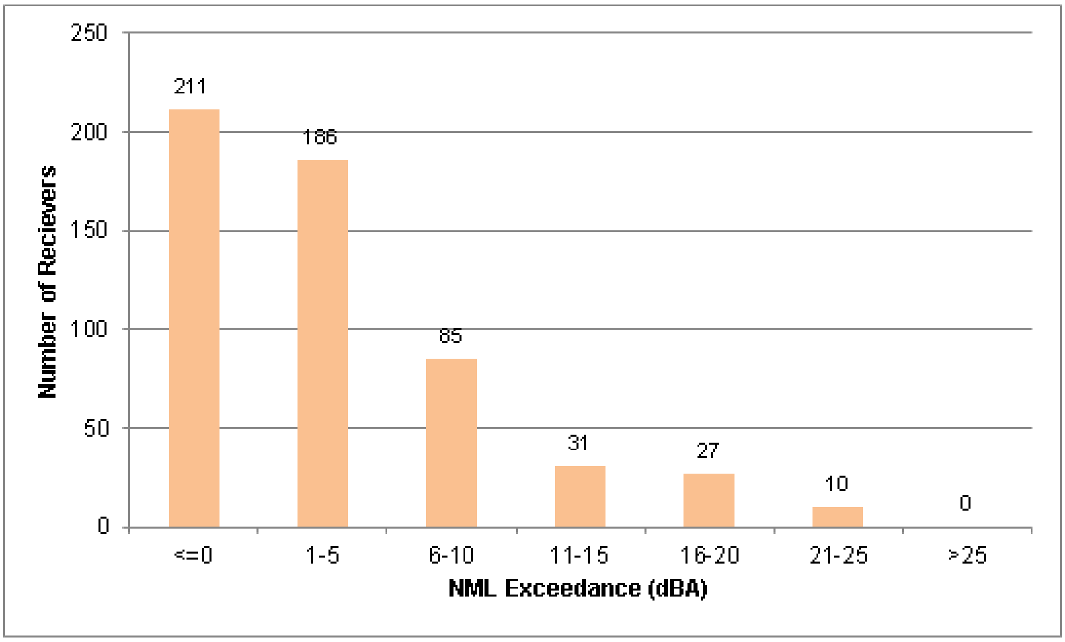


Figure 12.17 Number of night-time noise exceedances from corridor works, ground and track, trackform without ballast tamper

Highly noise affected residential receivers

The ICNG considers residential receivers that are subject to predicted noise levels of 75 dBA or greater to be highly noise affected.

Table 12.35 shows the number of receivers within NCA08 predicted to be highly noise affected in this catchment during certain works activities. The highest numbers are apparent during the following activities:

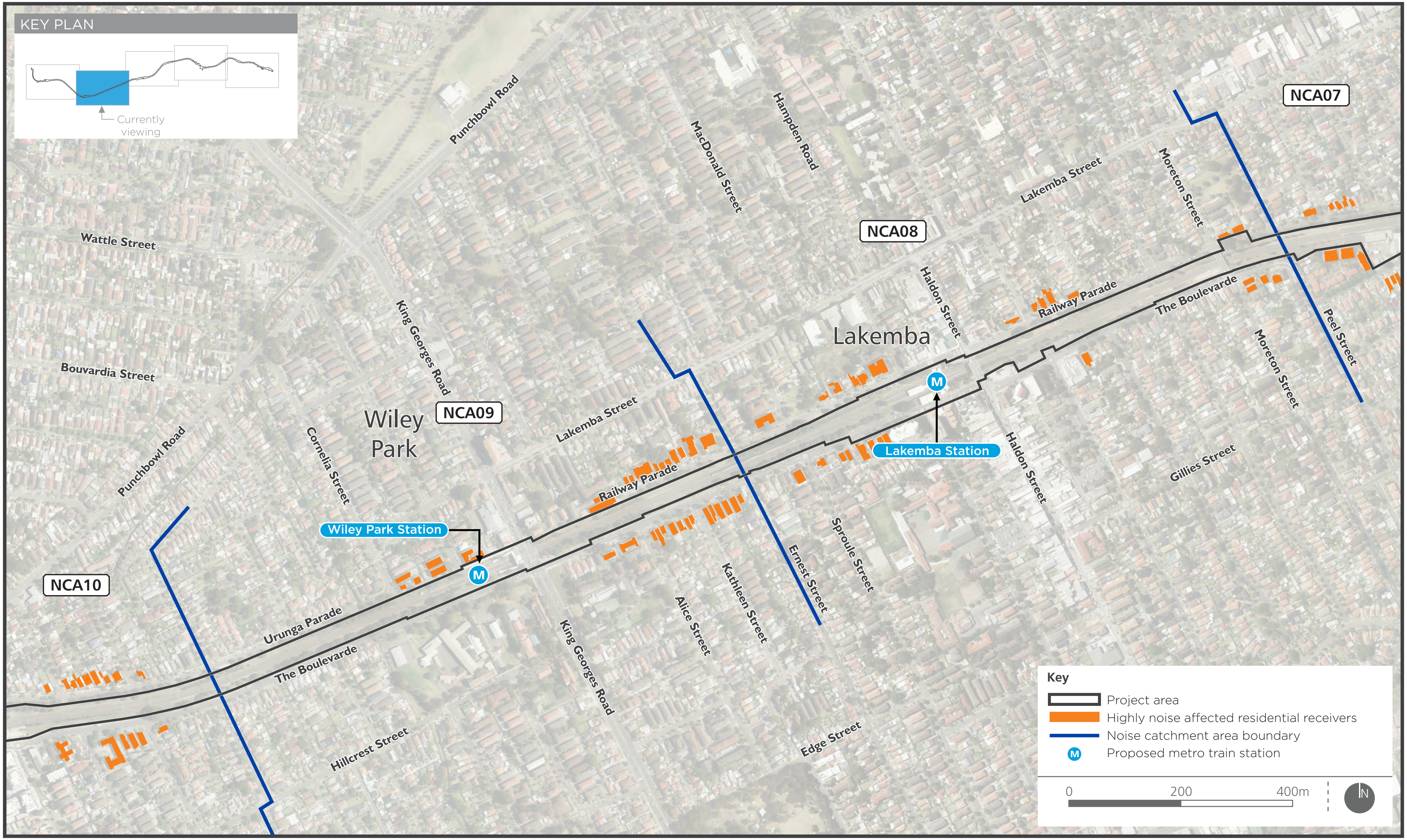
- Corridor works - ground and track, earthworks with breaker, where 19 receivers are predicted to be highly noise affected during the daytime and evening. The use of hydraulic breakers would generally be limited to day time and evening periods (between 7am and 10pm), unless technical constraints exist and would only be undertaken for about three days at any site.
- Corridor works - ground and track, trackform with ballast tamper, where four receivers are predicted to be highly noise affected during the daytime, evening and night-time periods. If the ballast tamper were to not be used during the night-time, no receivers would be highly noise affected during this period.
- Station work areas, demolition with breaker and saw, where eight receivers are predicted to be highly noise affected during the daytime and evening. The use of hydraulic breakers would generally be limited to day time and evening periods (between 7am and 10pm), unless technical constraints exist. Demolition works will only occur for a total duration of about two weeks during these possessions.
- Bridge work areas, demolition with breaker and saw, where seven receivers are predicted to be highly noise affected during the daytime and evening. The use of hydraulic breakers would generally be limited to day time and evening periods (between 7am and 10pm), unless technical constraints exist. Demolition works will only occur for a total duration of about two weeks during these possessions.

Figure 12.18 shows the location of residential receivers which are predicted to experience exceedances of the highly noise affected criteria.

Table 12.35 Activities and durations which result in 'highly noise affected' residential receivers in Lakemba

Station (NCA no.)	Construction activities resulting in exceedances above highly noise affected criteria	Indicative total duration of construction activity	Indicative total duration of noise intensive plant use, where relevant	Number of residential receivers highly noise affected		
				Day	Eve	Night
Lakemba (NCA08)	**Corridor works – ground and track, earthworks with breaker**	**10 weeks**	**3 days**	**19**	**19**	
	Corridor works – ground and track, trackform with ballast tamper	**4 days**	**Less than 4 days**	**4**	**4**	**4**
	Station work areas, demolition with breaker and saw	**6 weeks**	**2 weeks /6 week possession**	**8**	**8**	
	Bridge Work areas, demolition with breaker and saw	**2 weeks/ possession**	**2 weeks/ possession**	**7**	**7**	

Note: Bold indicates the activities predicted to generate the largest number of highly noise affected receivers.



Location of highly noise affected residential receivers – Lakemba and Wiley Park

FIGURE 12.18

Other sensitive receivers

Other sensitive receivers, such as educational facilities, hospitals and childcare centres, which are potentially affected by construction works have also been assessed against the relevant criteria.

The other sensitive receivers in this precinct are predicted to generally be subject to relatively minor impacts with many receiver types and works activities not resulting in exceedances of the NMLs.

One sensitive receiver is likely to experience exceedances of 11 to 20 dB above NMLs during the higher noise generating activities, namely a medical facility at 10 Bellevue Avenue, Lakemba.

Other sensitive receivers in this area which are predicted to be subject to noise levels of more than 20 dB above NMLs are:

- place of worship – Lakemba Uniting Church, 69 Haldon Street, Lakemba
- childcare – 27 Railway Parade, Lakemba
- childcare – 44 Railway Parade, Lakemba
- public building – Canterbury City Community Centre, 130 Railway Parade, Lakemba.

Sleep disturbance

Based on the preliminary list of plant and construction activities used in this assessment, exceedance of the sleep disturbance criteria is predicted to occur in each NCA during night works. A detailed breakdown for each time period is provided in Technical paper 2 and a summary shown in Table 12.36. Given the assessment approach, these impacts are considered to represent a conservative estimate of the likely impact.

The Sydney Metro Construction Noise and Vibration Strategy contains further details relating to potential sleep disturbance impacts. The strategy contains mitigation measures and procedures to address levels of adverse impact greater than 30 dB above the relevant criteria including periods of respite and alternative accommodation in specific circumstances and on a case by case basis. Construction of the project would be subject to this strategy.

Table 12.36 Activities which result in sleep disturbance exceedance in Lakemba - all receivers

Station (NCA no.)	Construction activities resulting in exceedances of sleep disturbance criteria	Indicative total duration of construction activity	Indicative total duration of noise intensive plant use	Number of exceedances greater than 20 dB
Lakemba (NCA08)	Corridor works - ground and track, trackform with ballast tamper	4 days	Less than 4 days	52
	Station work areas, demolition	6 week	n/a	1

Construction traffic noise

The project would result in two sources of potential traffic noise:

- construction vehicles such as heavy and light vehicles moving to and from construction compounds and work areas along identified haulage routes

- buses due to the alternative transport arrangements outlined in the Temporary Transport Strategy to service the T3 Bankstown Line during possession periods.

A construction traffic noise assessment was undertaken including the cumulative impact of both of these potential noise sources where they would share the same routes.

The assessment concluded that no roads in the precinct would experience an increase of more than two dB and result in road traffic noise levels that exceed the criteria.

Construction traffic volumes and routes (including rail replacement buses) would be reviewed and confirmed during subsequent stages of the project to determine if additional mitigation is required. Where compliance with the criteria is unable to be achieved, reasonable and feasible noise mitigation would be considered. Mitigation could include alternate traffic routes or reducing the maximum number of movements.

Vibration

Amenity

Large hydraulic breakers would have the highest potential to result in vibration levels above the amenity criteria. For most construction activities, vibration emissions are intermittent and for this reason, higher vibration levels, occurring over shorter periods are likely to be tolerable. Project-specific information regarding the duration of construction activities and equipment would become available following detailed design and construction planning. Recommended safe working distances have therefore been used to conservatively estimate the number of dwellings which may experience vibration affecting human comfort.

There are predicted to be a substantial number of buildings within the minimum working distance of a large hydraulic breaker used at the edge of the work area. Receivers adjacent to the construction areas have therefore been identified as likely to notice vibration impacts at times during construction works. This is expected to be primarily due to works associated with large hydraulic breakers but also other high vibration plant items. In practice, vibration impacts from most construction activities would be intermittent over the duration of construction, and more refined construction planning would seek to further reduce this impact.

Where vibration-intensive works need to be undertaken within the recommended minimum working distances, measures including monitoring would be undertaken in line with the Construction Noise and Vibration Strategy (refer to Appendix E).

Cosmetic damage

The minimum recommended offset between the construction works and the nearest sensitive receivers are expected to be generally sufficient such that buildings are unlikely to experience cosmetic damage from the use of most construction equipment. However, there may be some instances where large hydraulic breakers would be required to be within the recommended minimum distances.

Up to 36 buildings (including the heritage-listed station) would be located within the minimum recommended offset based on the cosmetic criteria of 7.5 mm/s. This is considered to be a conservative estimate, as a hydraulic breaker would not be required in all locations, and would not necessarily be used at the edge of the construction area. Should the use of hydraulic breakers (or other vibration intensive plant) in these locations be unavoidable, alternative construction methods or other mitigation measures would be considered to minimise potential vibration effects.

During detailed design and construction planning, the use of vibration intensive plant would be reviewed to limit the potential for damage. Where vibration intensive works are required to be undertaken within the recommended safe working distances, vibration monitoring would be undertaken to ensure acceptable levels of vibration are not exceeded.

Where vibration-intensive works need to be undertaken within the recommended minimum offsets (refer to Table 12.6), measures including monitoring would be undertaken in line with the Construction Noise and Vibration Strategy (refer to Appendix E).

Heritage buildings and structures

Heritage buildings would be considered on a case by case basis, with detailed inspections and condition assessments of potentially affected heritage structures undertaken to determine sensitivity prior to the commencement of works. Heritage listed buildings identified in this assessment within the minimum offset distances for cosmetic damage are listed in Table 12.37.

Table 12.37 Heritage buildings and structures within the minimum recommended offset to avoid cosmetic damage

NCA	Item/ address	Building occupancy	Construction type
NCA08	Lakemba Station	Commercial	Masonry (Brick)
NCA08	60 The Boulevarde, Lakemba	Commercial	Masonry (Brick)

Note: Estimated from photographic information only. The inclusion of items is not a reflection of the heritage significance of the item. Refer to the Technical paper 3 for further discussion of heritage items. Some items listed above may contain more than one building or structure.

The construction fabric of the building (i.e. timber, masonry) and the structural integrity of these buildings would be confirmed during detailed design. If the building is considered structurally unsound or more susceptible to damage, a more stringent 2.5 mm/s vibration criteria would be applied for works in the vicinity of these buildings.

Measures to minimise the potential for vibration impacts are provided in Section 12.6.

12.5.10 Wiley Park (NCA09)

The Wiley Park noise catchment area (NCA09) is dominated by residential receivers but with educational facilities south of the corridor along King Georges Road (as shown in Figure 12.1).

Station works about Wiley Park Station would be undertaken near residential, education and commercial receivers, while corridor works undertaken to the east of the station would be near residential receivers on The Boulevarde and Railway Parade.

Predicted construction noise levels for the construction activities resulting in the highest number of ‘highly noise affected’ residential receivers during out of hours construction work are discussed below. Noise levels at residential receivers during out of hours construction activities have been selected as they represent a higher sensitivity relative to noise generated during recommended standard hours. Noise level predictions during other time periods and other receiver classifications are provided in Table 12.9, Table 12.10 and Table 12.11.

Noise level exceedances during out of hours works

It is likely that construction activities will need to be undertaken outside of recommended standard hours (out of hours works) during possessions/closedowns of the rail corridor. However, out of hours works are expected to be largely undertaken during possessions/closedowns of the rail corridor.

During out of hours construction works, the highest number of night-time noise level exceedances are predicted during the following activities, with the activity generating the highest number of exceedances during the night-time shown in bold:

- corridor works - ground and track, earthworks
- corridor works - ground and track, trackform with ballast tamper

- **corridor works - track support systems, OHW modifications**
- corridor works - track support systems, communications and signalling works
- corridor works - track support systems, segregation fencing.

Ballast tamping would be scheduled where reasonable and feasible during standard day time and evening hours however despite efforts to avoid this, there may be circumstances when these works must occur, for technical reasons, during night-time periods. This item of plant can produce relatively high noise levels, however the works typically progress at a reasonably fast rate, with individual receivers only likely to be affected for a short duration (i.e. up to four days).

Relatively large numbers of receivers are predicted to be affected during the track support systems activities - OHW modifications and communications and signalling works. While these works are not particularly noise intensive, they would be required along the length of the corridor in this precinct with many receivers potentially being affected.

The activity likely to result in the highest number of noise level exceedances during the night-time is corridor works - track support systems, overhead wiring modifications. Figure 12.19 indicates the distribution of exceedances for this activity during the night-time.

The graph shows that while the activity may result in exceedance of the night-time NMLs greater than 20 dB at 15 per cent of affected receivers in this precinct, a much greater percentage of receivers in this precinct are subject to lower levels of noise.

It is noted that the duration of these impacts at a particular receiver are likely to be relatively short as the works typically progress at a reasonably fast rate.

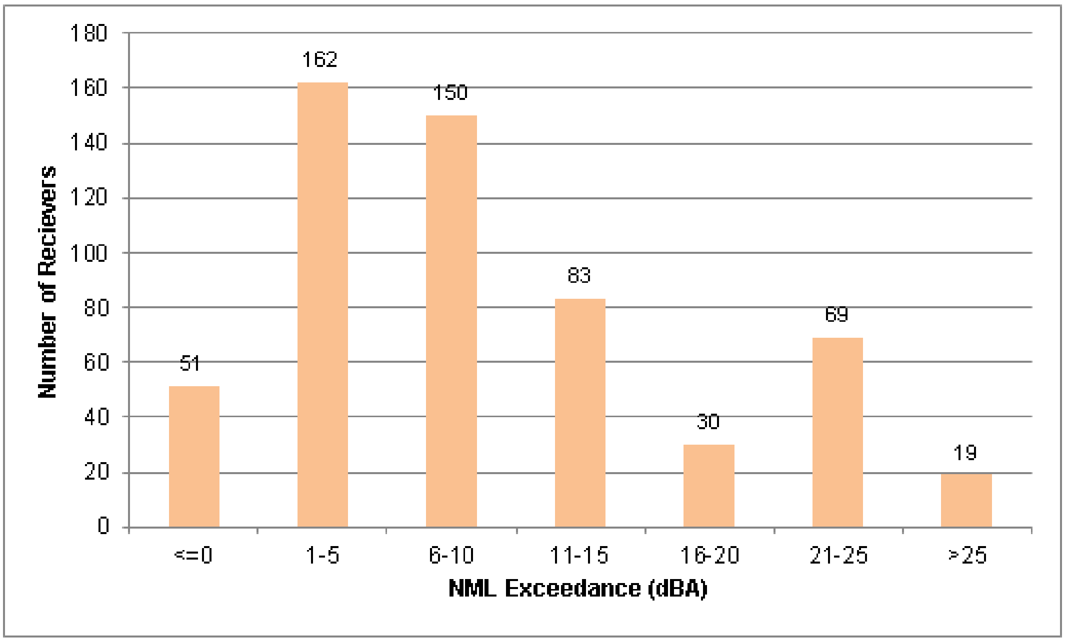


Figure 12.19 Number of night-time noise exceedances from corridor works - track support systems, overhead wiring modifications

Highly noise affected residential receivers

The ICNG considers residential receivers that are subject to predicted noise levels of 75 dBA or greater to be highly noise affected.

Table 12.38 shows the number of receivers within NCA09 predicted to be highly noise affected in this catchment during certain works activities. The highest numbers are apparent during the following activities:

- Corridor works - ground and track, earthworks with breaker, where 27 receivers are predicted to be highly noise affected during the daytime and evening. The use of hydraulic breakers would generally be limited to day time and evening periods (between 7am and 10pm), unless technical constraints exist and would only be undertaken for about three days at any site.
- Corridor works - ground and track, trackform with ballast tamper, where 12 receivers are predicted to be highly noise affected during the daytime, evening and night-time periods. If the ballast tamper were to not be used during the night-time, this would reduce to one receiver being highly noise affected during this period.
- Station work areas, demolition with breaker and saw, where seven receivers are predicted to be highly noise affected during the daytime and evening. The use of hydraulic breakers would generally be limited to day time and evening periods (between 7am and 10pm), unless technical constraints exist. Demolition works will only occur for a total duration of about two weeks during these possessions.

Figure 12.18 shows the location of residential receivers which are predicted to experience exceedances of the highly noise affected criteria.

Other sensitive receivers

Other sensitive receivers, such as educational facilities, hospitals and childcare centres, which are potentially affected by construction works have also been assessed against the relevant criteria.

The other sensitive receivers in this precinct are predicted to generally be subject to relatively minor impacts with many receiver types and works activities not resulting in exceedances of the NMLs.

Sensitive receivers which are predicted to be subject to exceedances of 11-20 dB above the NMLs during the higher noise generating activities are:

- educational – Wiley Park Girls High School (buildings shielded from the rail corridor)
- educational – Lakemba Public School.

One sensitive receiver, namely an educational facility – Wiley Park Girls High School (buildings fronting the rail corridor) is predicted to experience noise levels greater than 20 dB above the NMLs.

Sleep disturbance

Based on the preliminary list of plant and construction activities used in this assessment, exceedance of the sleep disturbance criteria is predicted to occur in each NCA during night works. A detailed breakdown for each time period is provided in Technical paper 2 and a summary shown in Table 12.39. Given the assessment approach, these impacts are considered to represent a conservative estimate of the likely impact.

The Sydney Metro Construction Noise and Vibration Strategy contains further details relating to potential sleep disturbance impacts. The strategy contains mitigation measures and procedures to address levels of adverse impact greater than 30 dB above the relevant criteria including periods of respite and alternative accommodation in specific circumstances and on a case by case basis. Construction of the project would be subject to this strategy.

Table 12.38 Activities and durations which result in 'highly noise affected' residential receivers in Wiley Park

Station (NCA no.)	Construction activities resulting in exceedances above highly noise affected criteria	Indicative total duration of construction activity	Indicative total duration of noise intensive plant use, where relevant	Number of residential receivers highly noise affected		
				Day	Eve	Night
Wiley Park (NCA09)	Corridor works - ground and track, earthworks	30 weeks	n/a	1	1	1
	Corridor works - ground and track, earthworks with breaker	**10 weeks**	**3 days**	**27**	**27**	
	Corridor works - ground and track, trackform	12 days	n/a	1	1	1
	Corridor works - ground and track, trackform with ballast tamper	**4 days**	**Less than 4 days**	**12**	**12**	**12**
	Station work areas, demolition	6 weeks	2 weeks/6 week possession	4	4	4
	Station work areas, demolition with breaker and saw	**6 weeks**	**2 weeks /6 week possession**	**7**	**7**	
	Station work areas, concrete and structural works	8 weeks	n/a	1	1	1

Note: Bold indicates the activities predicted to generate the largest number of highly noise affected receivers.

Table 12.39 Activities which result in sleep disturbance exceedance in Wiley Park - all receivers

Station (NCA no.)	Construction activities resulting in exceedances of sleep disturbance criteria	Indicative total duration of construction activity	Indicative total duration of noise intensive plant use	Number of exceedances greater than 20 dB
Wiley Park (NCA09)	Corridor works – ground and track, earthworks	30 weeks	n/a	27
	Corridor works – ground and track, trackform	12 days	n/a	2
	Corridor works – ground and track, trackform with ballast tamper	4 days	Less than 4 days	82
	Corridor works - track support systems, OHW modifications	3 weeks	n/a	11
	Corridor works - track support systems, communications and signalling works	12 weeks	n/a	19
	Corridor works - track support systems, segregation fencing	6 weeks	n/a	4
	Station work areas, demolition	6 week	n/a	7
	Station work areas, concrete and structural works	8 weeks	n/a	4
	Station work areas, station installation and fitout	20 weeks	n/a	4

Construction traffic noise

The project would result in two sources of potential traffic noise:

- construction vehicles such as heavy and light vehicles moving to and from construction compounds and work areas along identified haulage routes
- buses due to the alternative transport arrangements outlined in the Temporary Transport Strategy to service the T3 Bankstown Line during possession periods.

A construction traffic noise assessment was undertaken including the cumulative impact of both of these potential noise sources where they would share the same routes.

The assessment concluded that no roads in the precinct would experience an increase of more than two dB and result in road traffic noise levels that exceed the criteria.

Construction traffic volumes and routes (including rail replacement buses) would be reviewed and confirmed during subsequent stages of the project to determine if additional mitigation is required. Where compliance with the criteria is unable to be achieved, reasonable and feasible noise mitigation would be considered. Mitigation could include alternate traffic routes or reducing the maximum number of movements.

Vibration

Amenity

Large hydraulic breakers would have the highest potential to result in vibration levels above the amenity criteria. For most construction activities, vibration emissions are intermittent and for this reason, higher vibration levels, occurring over shorter periods are likely to be tolerable. Project-specific information regarding the duration of construction activities and equipment would become available following detailed design and construction planning. Recommended safe working distances have therefore been used to conservatively estimate the number of dwellings which may experience vibration affecting human comfort.

There are predicted to be a number of buildings within the minimum working distance of a large hydraulic breaker used at the edge of the work area. Receivers adjacent to the construction areas have therefore been identified as likely to notice vibration impacts at times during construction works. This is expected to be primarily due to works associated with large hydraulic breakers but also other high vibration plant items. In practice, vibration impacts from most construction activities would be intermittent over the duration of construction, and more refined construction planning would seek to further reduce this impact.

Where vibration-intensive works need to be undertaken within the recommended minimum working distances, measures including monitoring would be undertaken in line with the Construction Noise and Vibration Strategy (refer to Appendix E).

Cosmetic damage

The minimum recommended offset between the construction works and the nearest sensitive receivers are expected to be generally sufficient such that buildings are unlikely to experience cosmetic damage from the use of most construction equipment. However, there may be some instances where large hydraulic breakers would be required to be within the recommended minimum distances.

Up to 12 buildings (including the heritage-listed station) would be located within the minimum recommended offset based on the cosmetic criteria of 7.5 mm/s. This is considered to be a conservative estimate as a hydraulic breaker would not be required in all locations, and would not necessarily be used at the edge of the construction area. Should the use of hydraulic breakers (or other vibration intensive plant) in these locations be unavoidable, alternative construction methods or other mitigation measures would be considered to minimise potential vibration effects.

During detailed design and construction planning, the use of vibration intensive plant would be reviewed to limit the potential for damage. Where vibration intensive works are required to be undertaken within the recommended safe working distances, vibration monitoring would be undertaken to ensure acceptable levels of vibration are not exceeded.

Where vibration-intensive works need to be undertaken within the recommended minimum offsets (refer to Table 12.6), measures including monitoring would be undertaken in line with the Construction Noise and Vibration Strategy (refer to Appendix E).

Heritage buildings and structures

Heritage buildings would be considered on a case by case basis, with detailed inspections and condition assessments of potentially affected heritage structures undertaken to determine sensitivity prior to the commencement of works. Only one heritage listed building was identified in this assessment within the minimum offset distances for cosmetic damage as shown in Table 12.40.

Table 12.40 Heritage buildings and structures within the minimum recommended offset to avoid cosmetic damage

NCA	Item/ address	Building occupancy	Construction type
NCA09	Wiley Park Station	Commercial	Weatherboard

Notes: Estimated from photographic information only. The inclusion of items is not a reflection of the heritage significance of the item. Refer to the Technical paper 3 for further discussion of heritage items. Some items listed above may contain more than one building or structure.

The construction fabric of the building (i.e. timber, masonry) and the structural integrity of these buildings would be confirmed during detailed design. If the building is considered structurally unsound or more susceptible to damage, a more stringent 2.5 mm/s vibration criteria would be applied for works in the vicinity of these buildings.

Measures to minimise the potential for vibration impacts are provided in Section 12.6.

12.5.11 Punchbowl (NCA10)

The Punchbowl noise catchment area (NCA10) is dominated by residential receivers with commercial premises in the vicinity and south of the station. As shown in Figure 12.1, west of the station (north of the rail corridor), there are a number of other sensitive receivers including education and child care.

Station and track realignment works about Punchbowl Station would be undertaken near residential receivers on Urunga Parade, The Boulevarde and South Terrace and near commercial receivers surrounding the station. General work areas would also be located near commercial and residential receivers on South Terrace and Punchbowl Road.

Predicted construction noise levels for the construction activities resulting in the highest number of ‘highly noise affected’ residential receivers during out of hours construction work are discussed below. Noise levels at residential receivers during out of hours construction activities have been selected as they represent a higher sensitivity relative to noise generated during recommended standard hours. Noise level predictions during other time periods and other receiver classifications are provided in Table 12.9, Table 12.10 and Table 12.11.

Noise level exceedances during out of hours works

It is likely that construction activities will need to be undertaken outside of recommended standard hours (out of hours works) during possessions/closedowns of the rail corridor. However out of hours works are expected to be largely undertaken during possessions/closedowns of the rail corridor.

During out of hours construction works, the highest number of night-time noise level exceedances are predicted during the following activities, with the activity generating the highest number of exceedances during the night-time shown in bold:

- **corridor works - ground and track, trackform with ballast tamper**
- corridor works - track support systems, OHW modifications
- corridor works - track support systems, communications and signalling works.

Ballast tamping would be scheduled where reasonable and feasible during standard day time and evening hours however despite efforts to avoid this, there may be circumstances when these works must occur, for technical reasons, during night-time periods. This item of plant can produce relatively high noise levels, however the works typically progress at a reasonably fast rate, with individual receivers only likely to be affected for a short duration (i.e. up to four days).

Relatively large numbers of receivers are predicted to be affected during the track support systems activities. While these works are not particularly noise intensive, they would be required along the length of corridor in this precinct with many receivers potentially being affected.

The activity likely to result in the highest number of noise level exceedances during the night-time is corridor works - ground and track, trackform with ballast tamper. Figure 12.20 indicates the distribution of exceedances for this activity for receivers within this precinct during the night-time.

The graph shows that while the activity may result in exceedance of the night-time NMLs greater than 20 dB at six per cent of receivers in this precinct, a much greater percentage of receivers, in this precinct are subject to lower levels of noise.

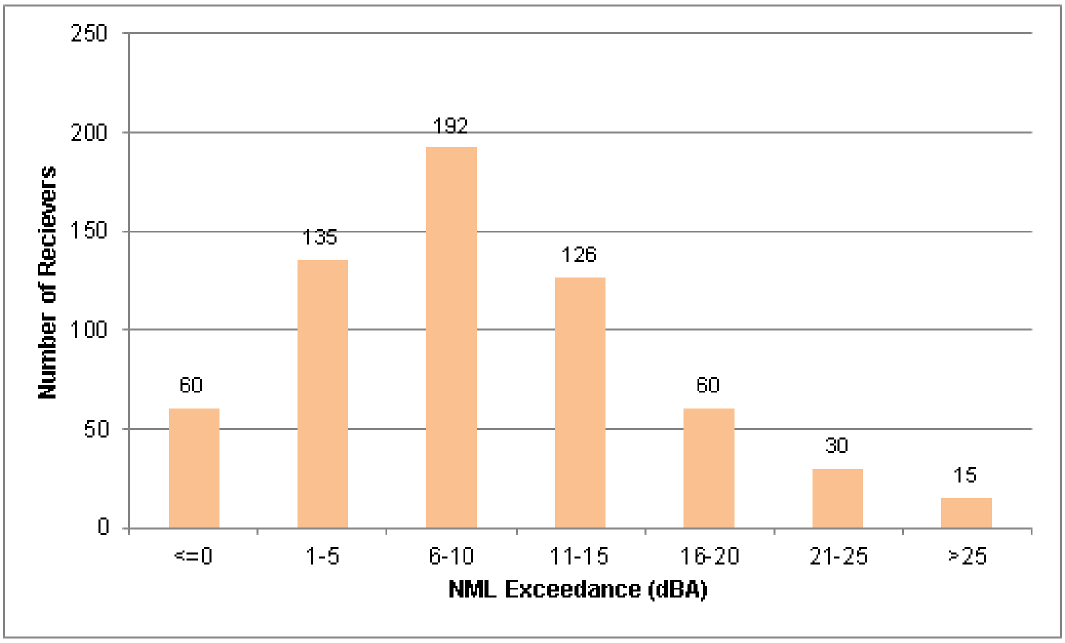


Figure 12.20 Number of night-time noise exceedances from corridor works, ground and track, trackform with ballast tamper

Figure 12.21 shows that when this noise intensive plant item (ballast tamper) is not in use, the number of exceedances greater than 20 dB above the noise management level reduces to about two per cent of noise affected receivers in the precinct.

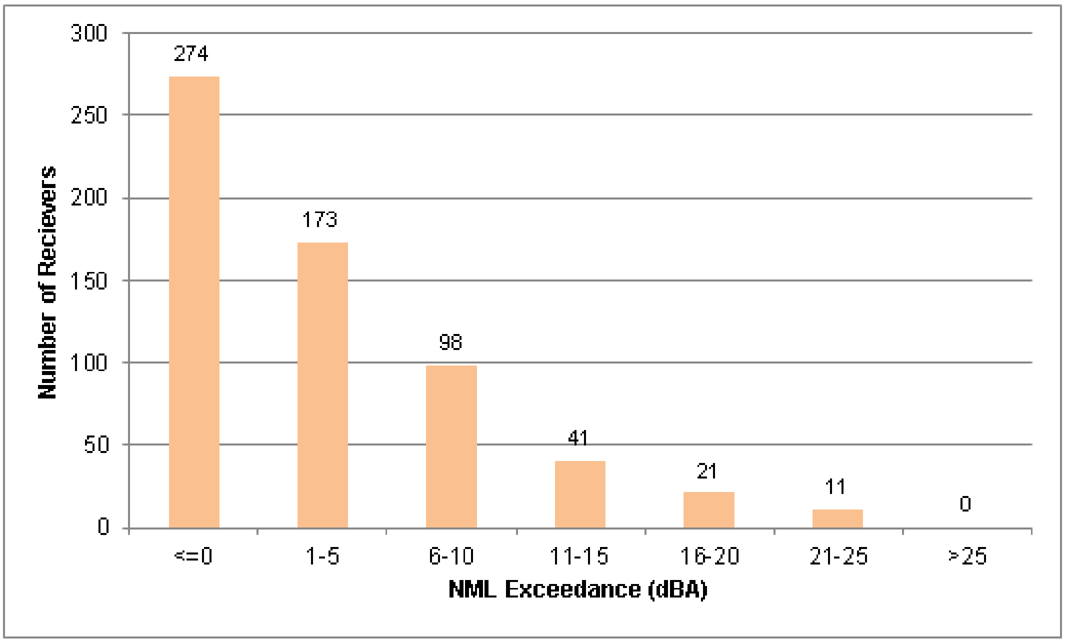


Figure 12.21 Number of night-time noise exceedances from corridor works, ground and track, trackform without ballast tamper

Highly noise affected residential receivers

The ICNG considers residential receivers that are subject to predicted noise levels of 75 dBA or greater to be highly noise affected.

Table 12.41 shows the number of receivers within NCA10 predicted to be highly noise affected in this catchment during certain works activities. The highest numbers are apparent during the following activities:

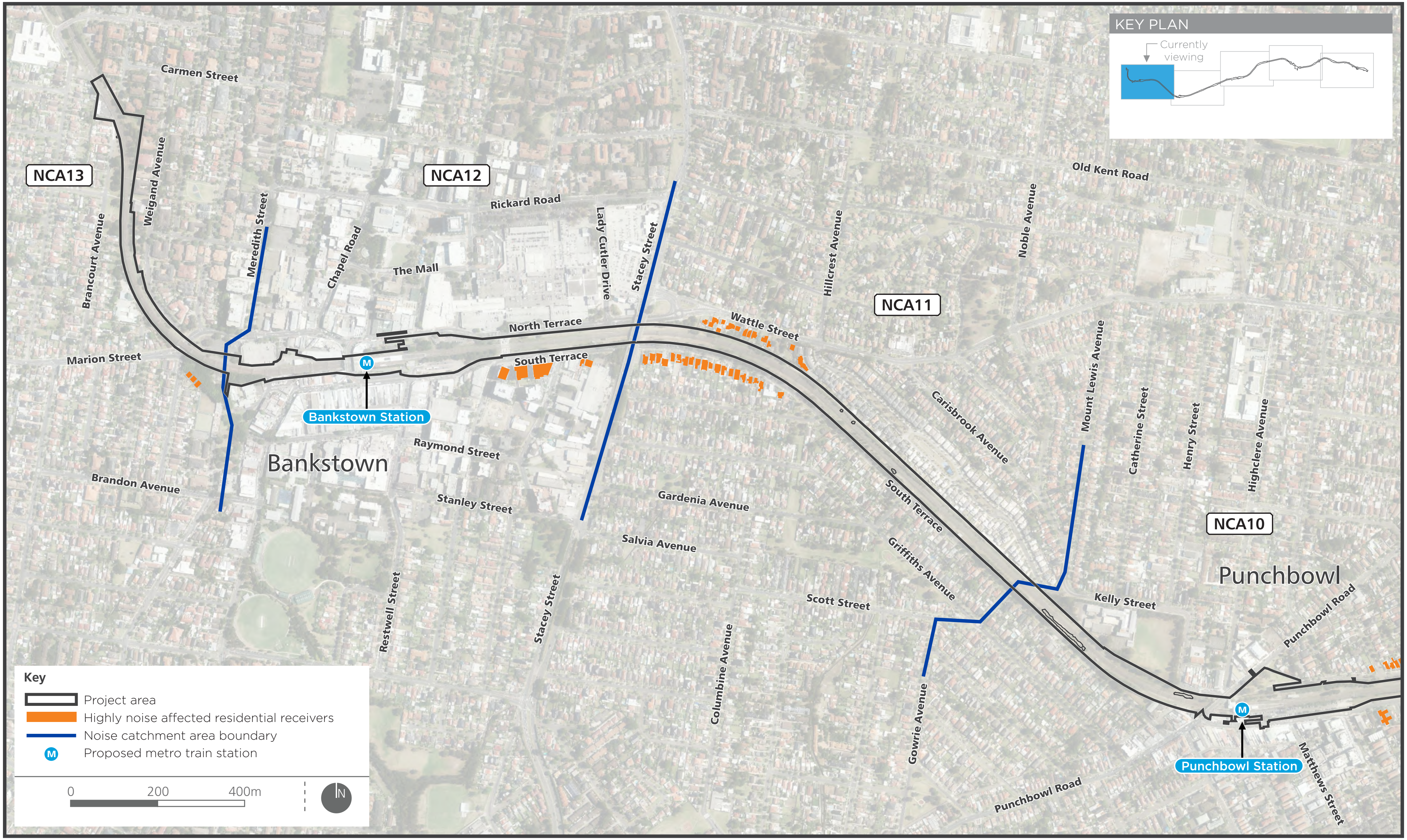
- Corridor works - ground and track, earthworks with breaker, where 15 receivers are predicted to be highly noise affected during the daytime and evening. The use of hydraulic breakers would generally be limited to day time and evening periods (between 7am and 10pm), unless technical constraints exist and would only be undertaken for about three days at any site.
- Corridor works - ground and track, trackform with ballast tamper, where seven receivers are predicted to be highly noise affected during the daytime, evening and night-time periods. If the ballast tamper were to not be used during the night-time, no receivers would be highly noise affected during this period.

Figure 12.22 shows the location of residential receivers which are predicted to experience exceedances of the highly noise affected criteria.

Table 12.41 Activities and durations which result in 'highly noise affected' residential receivers in Punchbowl

Station (NCA no.)	Construction activities resulting in exceedances above highly noise affected criteria	Indicative total duration of construction activity	Indicative total duration of noise intensive plant use	Number of residential receivers highly noise affected		
				Day	Eve	Night
Punchbowl (NCA10)	**Corridor works - ground and track, earthworks with breaker**	**6 weeks**	**3 days**	**15**	**15**	
	Corridor works - ground and track, trackform with ballast tamper	**4 days**	**Less than 4 days**	**7**	**7**	**7**
	Station work areas, demolition - breaker and saw	6 weeks	2 weeks /6 week possession	1	1	

Note: Bold indicates the activities predicted to generate the largest number of highly noise affected receivers.



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Location of highly noise affected residential receivers – Punchbowl and Bankstown

FIGURE 12.22

Other sensitive receivers

Other sensitive receivers, such as educational facilities, hospitals and childcare centres, which are potentially affected by construction works have also been assessed against the relevant criteria.

The other sensitive receivers in this precinct are predicted to generally be subject to relatively minor impacts with many receiver types and works activities not resulting in exceedances of the NMLs.

Sensitive receivers which are predicted to be subject to exceedances of 11 to 20 dB above the NMLs during the higher noise generating activities are:

- educational – Punchbowl Boys High School (buildings shielded from the rail corridor)
- educational – Church of Jesus Christ of Latter Day Saints
- childcare – Long Day Pre-School, 21 Dudley Street, Punchbowl.

Other sensitive receivers in this area which are predicted to be subject to noise levels of more than 20 dB above NMLs are:

- educational – Punchbowl Boys High School (buildings fronting the rail corridor)
- medical – 15 South Terrace, Punchbowl
- childcare – Baby Health Centre, 748 Punchbowl Road, Punchbowl
- childcare – Breust Place, Punchbowl.

Sleep disturbance

Based on the preliminary list of plant and construction activities used in this assessment, exceedance of the sleep disturbance criteria is predicted to occur in each NCA during night works. A detailed breakdown for each time period is provided in Technical paper 2 and a summary shown in Table 12.42. Given the assessment approach, these impacts are considered to represent a conservative estimate of the likely impact.

The Sydney Metro Construction Noise and Vibration Strategy contains further details relating to potential sleep disturbance impacts. The strategy contains mitigation measures and procedures to address levels of adverse impact greater than 30dB above the relevant criteria including periods of respite and alternative accommodation in specific circumstances and on a case by case basis. Construction of the project would be subject to this strategy.

Table 12.42 Activities which result in sleep disturbance exceedance in Punchbowl - all receivers

Station (NCA no.)	Construction activities resulting in exceedances of sleep disturbance criteria	Indicative total duration of construction activity	Indicative total duration of noise intensive plant use	Number of exceedances greater than 20 dB
Punchbowl (NCA10)	Corridor works - ground and track, trackform with ballast tamper	4 days	Less than 4 days	50

Construction traffic noise

The project would result in two sources of potential traffic noise:

- construction vehicles such as heavy and light vehicles moving to and from construction compounds and work areas along identified haulage routes
- buses due to the alternative transport arrangements outlined in the Temporary Transport Strategy to service the T3 Bankstown Line during possession periods.

A construction traffic noise assessment was undertaken including the cumulative impact of both of these potential noise sources where they would share the same routes.

The assessment concluded that no roads in the precinct would experience an increase of more than two dB and result in road traffic noise levels that exceed the criteria.

Construction traffic volumes and routes (including rail replacement buses) would be reviewed and confirmed during subsequent stages of the project to determine if additional mitigation is required. Where compliance with the criteria is unable to be achieved, reasonable and feasible noise mitigation would be considered. Mitigation could include alternate traffic routes or reducing the maximum number of movements.

Vibration

Amenity

Large hydraulic breakers would have the highest potential to result in vibration levels above the amenity criteria. For most construction activities, vibration emissions are intermittent and for this reason, higher vibration levels, occurring over shorter periods are likely to be tolerable. Project-specific information regarding the duration of construction activities and equipment would become available following detailed design and construction planning. Recommended safe working distances have therefore been used to conservatively estimate the number of dwellings which may experience vibration affecting human comfort.

There are predicted to be a number of buildings within the minimum working distance of a large hydraulic breaker used at the edge of the work area. Receivers adjacent to the construction areas have therefore been identified as likely to notice vibration impacts at times during construction works. This is expected to be primarily due to works associated with large hydraulic breakers but also other high vibration plant items. In practice, vibration impacts from most construction activities would be intermittent over the duration of construction, and more refined construction planning would seek to further reduce this impact.

Where vibration-intensive works need to be undertaken within the recommended minimum working distances, measures including monitoring would be undertaken in line with the Construction Noise and Vibration Strategy (refer to Appendix E).

Cosmetic damage

The minimum recommended offset between the construction works and the nearest sensitive receivers are expected to be generally sufficient such that buildings are unlikely to experience cosmetic damage from the use of most construction equipment. However, there may be some instances where large hydraulic breakers would be required to be within the recommended minimum distances.

Up to 25 buildings (including the heritage-listed station) would be located within the minimum recommended offset based on the cosmetic criteria of 7.5 mm/s. This is considered to be a conservative estimate as a hydraulic breaker would not be required in all locations, and would not necessarily be used at the edge of the construction area. Should the use of hydraulic breakers (or other vibration intensive plant) in these locations be unavoidable, alternative construction methods or other mitigation measures would be considered to minimise potential vibration effects.

During detailed design and construction planning, the use of vibration intensive plant would be reviewed to limit the potential for damage. Where vibration intensive works are required to be undertaken within the recommended safe working distances, vibration monitoring would be undertaken to ensure acceptable levels of vibration are not exceeded.

Where vibration-intensive works need to be undertaken within the recommended minimum offsets (refer to Table 12.6), measures including monitoring would be undertaken in line with the Construction Noise and Vibration Strategy (refer to Appendix E).

Heritage buildings and structures

Heritage buildings would be considered on a case by case basis, with detailed inspections and condition assessments of potentially affected heritage structures undertaken to determine sensitivity prior to the commencement of works. Only one heritage listed building was identified in this assessment within the minimum offset distances for cosmetic damage as shown in Table 12.43.

Table 12.43 Heritage buildings and structures within the minimum recommended offset to avoid cosmetic damage

NCA	Item/ address	Building occupancy	Construction type
NCA10	Punchbowl Station	Commercial	Weatherboard

Note: Estimated from photographic information only. The inclusion of items is not a reflection of the heritage significance of the item. Refer to the Technical paper 3 for further discussion of heritage items. Some items listed above may contain more than one building or structure.

The construction fabric of the building (i.e. timber, masonry) and the structural integrity of these buildings would be confirmed during detailed design. If the building is considered structurally unsound or more susceptible to damage, a more stringent 2.5 mm/s vibration criteria would be applied for works in the vicinity of these buildings.

Measures to minimise the potential for vibration impacts are provided in Section 12.6.

12.5.12 Bankstown (NCA11, NCA12 and NCA13)

The Bankstown noise catchment areas (NCA11 and NCA13) are dominated by residential receivers (as shown in Figure 12.1). NCA12 which relates to the precinct immediately surrounding Bankstown Station is dominated by commercial premises and other sensitive receivers south of the rail corridor and east of the station.

Bridge and corridor works would be undertaken in the north of NCA11 near residential receivers on South Terrace and Wattle Street, while substation works in the south would be undertaken directly adjacent to residential receivers on South Terrace.

Station and corridor works would be undertaken throughout NCA12 and would predominantly be undertaken near commercial receivers located adjacent to the corridor, with some residential receivers on South Terrace also potentially affected.

With the exception of corridor works being undertaken in the eastern end of the catchment adjacent to commercial and residential receivers on Olympic Parade, minimal construction works are proposed in NCA13.

Predicted construction noise levels for the construction activities resulting in the highest number of ‘highly noise affected’ residential receivers during out of hours construction work are discussed below. Noise levels at residential receivers during out of hours construction activities have been selected as they represent a higher sensitivity relative to noise generated during recommended standard hours. Noise level predictions during other time periods and other receiver classifications are provided in Table 12.9, Table 12.10 and Table 12.11.

Noise level exceedances during out of hours works

It is likely that construction activities will need to be undertaken outside of recommended standard hours (out of hours works) during possessions/closedowns of the rail corridor. However out of hours works are expected to be largely undertaken during possessions/closedowns of the rail corridor.

During out of hours construction works, the highest number of night-time noise level exceedances are predicted during the following activities, with the activity generating the highest number of exceedances during the night-time shown in bold:

- corridor works - ground and track, earthworks
- corridor works - ground and track, trackform with ballast tamper
- **corridor works - track support systems, OHW modifications**
- corridor works - track support systems, communications and signalling works
- corridor works - track support systems, segregation fencing.

Ballast tamping would be scheduled where reasonable and feasible during standard day time and evening hours however despite efforts to avoid this, there may be circumstances when these works must occur, for technical reasons, during night-time periods. This item of plant can produce relatively high noise levels, however the works typically progress at a reasonably fast rate, with individual receivers only likely to be affected for a short duration (i.e. up to four days).

Relatively large numbers of receivers are predicted to be affected during the track support systems activities. While these works are not particularly noise intensive, they would be required along the length of corridor in this precinct with many receivers potentially being affected.

The activity with potential for the highest number of noise level exceedances during the night-time is corridor works - track support systems, OHW modifications. Figure 12.23 indicates the distribution of exceedances for this activity during the night-time.

The graph shows that while the activity may result in exceedance of the night-time NMLs greater than 20 dB at 11 per cent of receivers in this precinct, a much greater percentage of receivers in this precinct are subject to lower levels of noise.

It is noted that the duration of these impacts at a particular receiver are likely to be relatively short as the works typically progress at a reasonably fast rate.

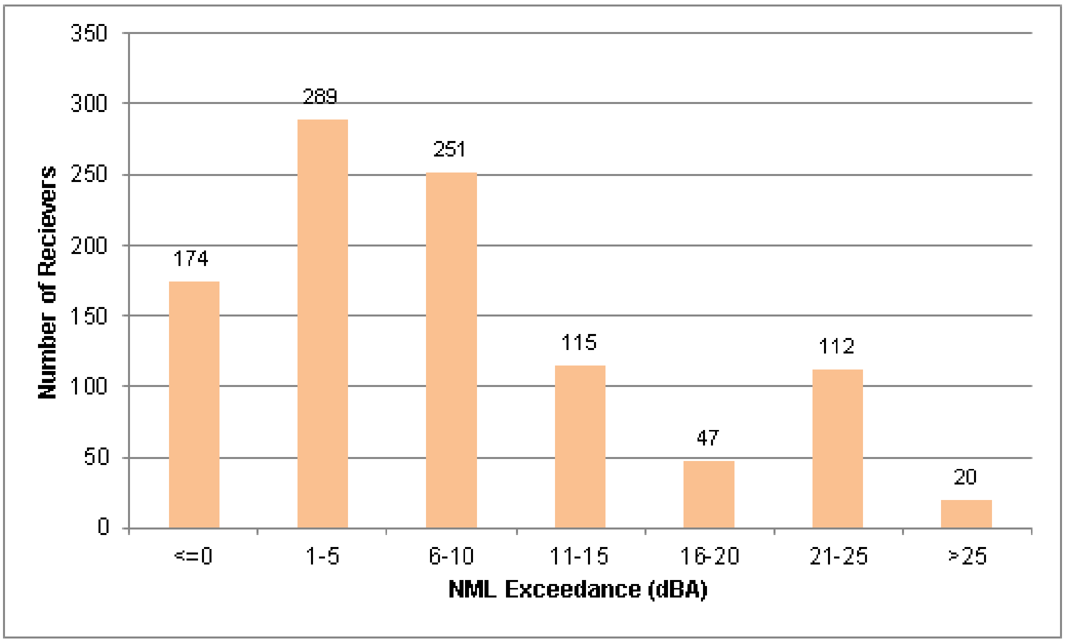


Figure 12.23 Number of night-time noise exceedances from corridor works - track support systems, overhead wiring modifications

Highly noise affected residential receivers

The ICNG considers residential receivers that are subject to predicted noise levels of 75 dBA or greater to be highly noise affected.

Table 12.44 shows the number of receivers within NCA11, NCA12 and NCA13 predicted to be highly noise affected in this catchment during certain works activities. The highest numbers are apparent during the following activities:

- Corridor works - ground and track, earthworks with breaker, where 32 receivers in NCA11 are predicted to be highly noise affected during the daytime and evening. The use of hydraulic breakers would generally be limited to day time and evening periods (between 7am and 10pm), unless technical constraints exist and would only be undertaken for about three days at any site.
- Corridor works - ground and track, trackform with ballast tamper, where 19 receivers in NCA11, three receivers in NCA12 and two receivers in NCA13 are predicted to be highly noise affected during the daytime, evening and night-time periods. If the ballast tamper were to not be used during the night-time, no receivers would be highly noise affected during this period.
- Bridge work areas, demolition - breaker and saw, where 30 receivers in NCA11 are predicted to be highly noise affected during the daytime and evening. The use of hydraulic breakers would generally be limited to day time and evening periods (between 7am and 10pm), unless technical constraints exist. Demolition works will only occur for a total duration of about two weeks during these possessions.

Figure 12.22 shows the location of residential receivers which are predicted to experience exceedances of the highly noise affected criteria.

Table 12.44 Activities and durations which result in 'highly noise affected' residential receivers in Bankstown

Station (NCA no.)	Construction activities resulting in exceedances above highly noise affected criteria	Indicative total duration of construction activity	Indicative total duration of noise intensive plant use	Number of residential receivers highly noise affected		
				Day	Eve	Night
Bankstown (NCA11)	General work areas, earthworks with breaker	6 weeks	3 days	1		
	Corridor works - ground and track, earthworks	30 weeks	n/a	1	1	1
	Corridor works - ground and track, earthworks with breaker	**10 weeks**	**3 days**	**32**	**32**	
	Corridor works - ground and track, trackform with ballast tamper	**4 days**	**Less than 4 days**	**19**	**19**	**19**
	Bridge work areas, site establishment and impact protection	2 weeks	n/a	1	1	1
	Bridge work areas, demolition with breaker and saw	**2 weeks/ possession**	**2 weeks/ possession**	**30**	**30**	
Bankstown (NCA12)	General work areas, earthworks with breaker	6 weeks	3 days	5		
	Corridor works - ground and track, earthworks with breaker	10 weeks	3 days	5	5	
	Corridor works - ground and track, trackform with ballast tamper	**4 days**	**Less than 4 days**	**3**	**3**	**3**
	Station work areas, demolition with breaker and saw	6 weeks	2 weeks /6 week possession	2	2	
Bankstown (NCA13)	Corridor works - ground and track, earthworks with breaker	10 weeks	3 days	3	3	
	Corridor works - ground and track, trackform with ballast tamper	**4 days**	**Less than 4 days**	**2**	**2**	**2**

Note: Bold indicates the activities predicted to generate the largest number of highly noise affected receivers.

Other sensitive receivers

Other sensitive receivers, such as educational facilities, hospitals and childcare centres, which are potentially affected by construction works have also been assessed against the relevant criteria.

The other sensitive receivers in this precinct are predicted to generally be subject to relatively minor impacts with many receiver types and works activities not resulting in exceedances of the NMLs.

Sensitive receivers which are predicted to be subject to exceedances of 11 to 20 dB above the NMLs during the higher noise generating activities are:

- educational – Al Amanah College, 4 Winspear Avenue, Bankstown
- place of worship – St Euphemia Greek Orthodox Church, 6 East Terrace, Bankstown
- childcare – Roly Poly Education Child Care, 9 East Terrace, Bankstown
- café/bar – three receivers on Bankstown City Plaza, Bankstown.

Other sensitive receivers in this area which are predicted to be subject to noise levels of more than 20 dB above NMLs are:

- educational – Bankstown Arts Centre, 5 Olympic Parade, Bankstown
- café/bar – three receivers on Chapel Road, Bankstown.

Sleep disturbance

Based on the preliminary list of plant and construction activities used in this assessment, exceedance of the sleep disturbance criteria is predicted to occur in each NCA during night works. A detailed breakdown for each time period is provided in Technical paper 2 and a summary shown in Table 12.45. Given the assessment approach, these impacts are considered to represent a conservative estimate of the likely impact.

The Sydney Metro Construction Noise and Vibration Strategy contains further details relating to potential sleep disturbance impacts. The strategy contains mitigation measures and procedures to address levels of adverse impact greater than 30 dB above the relevant criteria including periods of respite and alternative accommodation in specific circumstances and on a case by case basis. Construction of the project would be subject to this strategy.

Construction traffic noise

The project would result in two sources of potential traffic noise:

- construction vehicles such as heavy and light vehicles moving to and from construction compounds and work areas along identified haulage routes
- buses due to the alternative transport arrangements outlined in the Temporary Transport Strategy to service the T3 Bankstown Line during possession periods.

A construction traffic noise assessment was undertaken including the cumulative impact of both of these potential noise sources where they would share the same routes.

The assessment concluded that no roads in the precinct would experience an increase of more than two dB and result in road traffic noise levels that exceed the criteria.

Construction traffic volumes and routes (including rail replacement buses) would be reviewed and confirmed during subsequent stages of the project to determine if additional mitigation is required. Where compliance with the criteria is unable to be achieved, reasonable and feasible noise mitigation would be considered. Mitigation of could include alternate traffic routes or reducing the maximum number of movements.

Table 12.45 Activities which result in sleep disturbance exceedance in Bankstown - all receivers

Station (NCA no.)	Construction activities resulting in exceedances of sleep disturbance criteria	Indicative total duration of construction activity	Indicative total duration of noise intensive plant use	Number of exceedances greater than 20 dB
Bankstown (NCA11, NCA12, and NCA13)	Corridor works - ground and track, earthworks	30 weeks	n/a	21
	Corridor works - ground and track, trackform	12 days	n/a	1
	Corridor works - ground and track, trackform with ballast tamper	4 days	Less than 4 days	102
	Corridor works - track support systems, OHW modifications	3 weeks	n/a	16
	Corridor works - track support systems, communications and signalling works	12 weeks	n/a	20
	Corridor works - track support systems, segregation fencing	6 weeks	n/a	5
	Bridge work areas, site establishment and impact protection	2 weeks	n/a	2
	Bridge work areas, demolition	2 weeks	n/a	1

Vibration

Amenity

Large hydraulic breakers would have the highest potential to result in vibration levels above the amenity criteria. For most construction activities, vibration emissions are intermittent and for this reason, higher vibration levels, occurring over shorter periods are likely to be tolerable. Project-specific information regarding the duration of construction activities and equipment would become available following detailed design and construction planning. Recommended safe working distances have therefore been used to conservatively estimate the number of dwellings which may experience vibration affecting human comfort.

There would be a number of buildings located within the minimum working distance of a large hydraulic breaker used at the edge of the work area. Receivers adjacent to the construction areas have been identified as likely to notice vibration impacts at times during construction works. This is expected to be primarily due to works associated with large hydraulic breakers but also other high vibration plant items. In practice, vibration impacts from most construction activities would be intermittent over the duration of construction, and more refined construction planning would seek to further reduce this impact.

Where vibration-intensive works need to be undertaken within the recommended minimum working distances, measures including monitoring would be undertaken in line with the Construction Noise and Vibration Strategy (refer to Appendix E).

Cosmetic damage

The minimum recommended offset between the construction works and the nearest sensitive receivers are expected to be generally sufficient such that buildings are unlikely to experience cosmetic damage from the use of most construction equipment. However, there may be some instances where large hydraulic breakers would be required to be within the recommended minimum distances.

Up to 35 buildings (including the heritage-listed station) would be located within the minimum recommended offset based on the cosmetic criteria of 7.5 mm/s. This is considered to be a conservative estimate, as a hydraulic breaker would not be required in all locations, and would not necessarily be used at the edge of the construction area. Should the use of hydraulic breakers (or other vibration intensive plant) in these locations be unavoidable, alternative construction methods or other mitigation measures would be considered to minimise potential vibration effects.

During detailed design and construction planning, the use of vibration intensive plant would be reviewed to limit the potential for damage. Where vibration intensive works are required to be undertaken within the recommended safe working distances, vibration monitoring would be undertaken to ensure acceptable levels of vibration are not exceeded.

Where vibration-intensive works need to be undertaken within the recommended minimum offsets (refer to Table 12.6), measures including monitoring would be undertaken in line with the Construction Noise and Vibration Strategy (refer to Appendix E).

Table 12.46 Number of buildings within the minimum recommended offset from a hydraulic breaker to avoid cosmetic damage

Noise catchment area	Number of buildings within minimum working distance
NCA11	3
NCA12	32
NCA13	0
Total	**35**

Heritage buildings and structures

There are no heritage listed buildings identified in this assessment within the minimum offset distances for cosmetic damage within NCA11, NCA12, or NCA13.

12.5.13 Traction power supply cable

The project includes the construction of a new underground, traction power ('feeder') cable. The preliminary cable route would traverse South Parade at Campsie, along Phillips Avenue and Fore Street (crossing Canterbury Road), Burlington Street, Karool Avenue/River Street and Mooney Avenue to Ausgrid's Canterbury substation. The exact location of the cable within the roadways is subject to detailed design, however the works would likely be undertaken using typical construction equipment including 12 tonne excavator, truck and trailer, concrete saws and hydraulic breakers where necessary. The crossing of Canterbury Road would likely be undertaken at night to reduce impacts on traffic. The section along Karool Avenue/ River Street may require underboring or horizontal directional drilling due to the substantial changes in the ground level.

Table 12.47 shows the predicted noise levels at various distances from the works. The table shows that the highest noise levels at receivers within 15 metres of the project area (which is considered representative for most receivers along the cable route) would be in the vicinity of 85 dBA. If these works were undertaken during the night, noise levels may be greater than 30 dB above the noise management level if noise intensive plant items are used. It is proposed however that use of hydraulic breakers would not occur during the night-time period and where possible, their use during the evening period would also be avoided unless technical constraints exist.

Table 12.47 Predicted noise levels from traction power cable works

	Predicted noise level at distance LAeq(15minute) (dBA)			
Scenario/ activity	10 m	15 m	30 m	50 m
Excavation	88	85	82	77
Drilling	70	67	63	59
Cable laying	72	70	66	62
Cleaning	73	70	67	62

The results indicate that relatively high noise levels are likely where noise intensive plant items are used near to adjacent receivers, particularly during excavation activities. On typical streets surrounding the work areas, the closest residential receivers are likely to be situated about 15 metres from the road. In this situation, noise levels around 85 dBA are possible when noise intensive plant items are in use.

The work activities would be sequential at any one point and would progress relatively quickly from one end of the alignment to the other. The only exception would be the Canterbury Road crossing and the Karool Avenue/ River Street locations where the work activities or other constraints would likely require a longer presence in the order of a one month. Otherwise, the noise levels at other locations are unlikely to be sustained for more than a few days before the work advances.

12.5.14 Cumulative impacts

The study area is undergoing a large amount of development, including construction of the adjacent Chatswood to Sydenham project, the WestConnex project and individual urban renewal projects.

There is potential for cumulative construction noise impacts to occur in Marrickville, at the interface between the Chatswood to Sydenham project and the project (the Sydenham to Bankstown upgrade). These two projects are proposed to be undertaken over similar timeframes and potential impacts would be similar in nature to those already ongoing in the Marrickville area in relation to the Chatswood to Sydenham project.

WestConnex is more remote from the project area, and construction noise levels are unlikely to increase the noise levels experienced in the project area.

Depending on the timing and location of future urban renewal, there is potential for airborne noise to be cumulative at specific locations. Such impacts are unable to be predicted due to the unknown nature and timing of these future urban renewal projects, and therefore the nature, location and timing of potential cumulative effects is unknown.

Cumulative impacts may also include potential increases in road traffic noise levels, due to an increase of construction vehicles on the road network. The haulage routes to be used by the project are also potentially required to be used for a number of other projects (including WestConnex and Chatswood to Sydenham) which require a much larger number of vehicle movements.

Measures to avoid, reduce or mitigate construction noise and vibration impacts to heritage items are provided in Section 12.6. These would reduce the likelihood and severity of cumulative impacts.

Co-ordination between the Sydney Metro projects would be facilitated by Traffic and Transport Liaison Group and more broadly, by the Roads and Maritime Transport Management Centre.

12.6 Mitigation measures

12.6.1 Approach to mitigation and management

Construction Noise and Vibration Strategy

The Construction Noise and Vibration Strategy (Appendix E) has been developed to manage construction noise and vibration for the Sydney Metro City & Southwest project as a whole. The strategy provides a framework for managing construction noise and vibration impacts in accordance with the ICNG, to provide a consistent approach to management and mitigation across all Sydney Metro projects.

Specifically, the Construction Noise and Vibration Strategy identifies the requirements and methodology to develop construction noise impact statements. These would be prepared prior to specific construction activities and based on a more detailed understanding of the construction methods, including the size and type of construction equipment and the expected duration and timing of works. Construction noise impact statements would include confirmation of the classification of sensitive receivers, including particularly sensitive receivers such as education and child care, and vibration sensitive medical, imaging, and scientific equipment, as well as heritage buildings. Also, the façade performance of some residential premises which may have been fitted with acoustic insulation to control aircraft noise.

The statements would also include:

- application of appropriate noise and vibration criteria for each receiver type
- an assessment of the potential noise and vibration impacts as a result of different construction activities proposed as well as potentially overlapping activities
- details of the standard and project-specific noise and vibration mitigation measures identified
- noise and vibration auditing and monitoring requirements
- additional mitigation measures to be implemented when exceedances to the NMLs are likely to occur following detailed construction planning and confirmation of noise impacts.

Mitigation measures to be included in the noise impact stations would be aimed at pro-active engagement with potentially affected receivers and may include provision of respite periods, and alternative accommodation for defined exceedance categories.

Where vibration levels are predicted to exceed the screening criteria, the Construction Noise and Vibration Strategy provides for a more detailed assessment of the structure and vibration monitoring, to ensure vibration levels remain below appropriate limits for that structure. For heritage structures, condition assessments would be undertaken and more stringent levels may be applied, taking in account the heritage values of the structure as part of the more detailed assessment completed.

Out of hours work framework

As described in Chapter 9, an Out Of Hours Work Strategy would be developed to guide the assessment, management, and approval of works outside the recommended standard hours. The strategy would be developed to ensure that out of hours works are managed effectively during construction, and to avoid incidents and impacts to the community as a result of out of hours works.

The strategy would be prepared in consultation with key stakeholders (including the EPA).

Further information on the Out of Hours Work Strategy and the criteria for out of hours work is provided in Section 9.7.4.

12.6.2 List of mitigation measures

The mitigation measures that would be implemented to address potential construction noise and vibration impacts are listed in Table 12.48.

Table 12.48 Mitigation measures – construction noise and vibration

ID	Impact/issue	Mitigation measures	Relevant location(s)
Design/pre-construction			
NVC1	Noise impacts	A construction noise and vibration review would be undertaken during detailed design. This would include noise modelling to confirm the results of modelling previously undertaken. Where changes in noise levels and exceedances are modelled, reasonable and feasible mitigation measures would be reviewed.	All
NVC2		In accordance with the *Construction Noise and Vibration Strategy*, all employees, contractors and subcontractors would receive an environmental induction. The induction must at least include: • relevant project specific and standard noise and vibration mitigation measures • relevant licence and approval conditions • permissible hours of work • any limitations on high noise generating activities • location of nearest sensitive receivers • designated loading/unloading areas and procedures • site opening/closing times (including deliveries)	All
NVC3	Predicted vibration impacts	Where vibration levels are predicted to exceed the screening criteria, a more detailed assessment of the structure would be carried out to determine the appropriate vibration limits for that structure.	All

ID	Impact/issue	Mitigation measures	Relevant location(s)
NVC4		For heritage items where screening vibration levels are predicted to be exceeded, the more detailed assessment would include condition assessment and specifically consider the heritage values of the structure in consultation with a heritage specialist to ensure sensitive heritage fabric is adequately monitored and managed.	Heritage items along the project area
Construction			
NVC5	Construction noise and vibration management	The *Construction Noise and Vibration Strategy* would be implemented with the aim of achieving the noise management levels where feasible and reasonable. This may include the following example mitigation measures alone or in combination, where feasible and reasonable: • The provision of noise barriers around each construction site. • The coincidence of noisy plant working simultaneously close together would be avoided. • Offset distances between noisy plant and sensitive receivers would be increased. • Residential grade mufflers would be fitted to all mobile plant. • Dampened rock hammers would be used. • Non-tonal reversing alarms would be fitted to all permanent mobile plant. • High noise generating activities would be scheduled for less sensitive periods considering the nearby receivers, where reasonable and feasible. • The layout of construction sites would consider opportunities to shield receivers from noise. • Stationary noise sources would be enclosed or shielded whilst ensuring that the occupational health and safety of workers is maintained. • Loading and unloading of materials/deliveries is to occur as far as possible from noise sensitive receivers. • Select site access points and roads as far as possible away from noise sensitive receivers. • Dedicated loading/unloading areas to be shielded if close to NSRs wherever feasible and reasonable. • Use quieter and less vibration emitting construction methods where feasible and reasonable. • The noise levels of plant and equipment must have operating Sound Power Levels compliant with the criteria in the *Construction Noise and Vibration Strategy.* • Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site. • Where feasible and reasonable, the offset distance between noisy plant items and nearby noise sensitive receivers would be as great as possible. • Where reasonable and feasible heavy vehicle movements would be limited to daytime and evening hours, with night-time movements avoided where possible. • Active community consultation and the maintenance of positive, cooperative relationships with schools, local residents and building owners and occupiers, through: – periodic notification or work activities and progress (eg regular letterbox drops, e-consult) – specific notification (letter-box drop) prior to especially noisy activities – comprehensive website information – Project information and construction response telephone line	All

ID	Impact/issue	Mitigation measures	Relevant location(s)
		– email distribution lists.	
NVC6		Ballast tamping and hydraulic breaking would not be undertaken during the night-time period (10pm to 7am). Other noise intensive construction activities such as platform demolition, earthworks and track works would generally be limited to day time and evening periods (between 7am and 10pm), unless constraints exist such as: • works requiring a rail shutdown • requirements of road authorities, emergency services or Sydney Coordination Office.	All
NVC7		When working adjacent to schools, medical facilities and childcare centres, particularly noisy activities would be scheduled outside normal working hours, where reasonable and feasible.	All
NVC8		When working adjacent to churches and places of worship, particularly noisy activities would be scheduled outside services, where reasonable and feasible.	All
NVC9		Alternative accommodation may be offered to residents living in close proximity to construction works, where detailed design investigations confirm unreasonably high noise impacts over a prolonged period. Alternative accommodation arrangements will be offered and discussed with residents on a case-by-case basis.	All
NVC10		High noise and vibration generating activities including rock breaking, ballast tamping, demolition and ground and track earthworks may only be carried out in continuous blocks, not exceeding 3 hours each, with a minimum respite period of one hour between each block and these works.	All
NVC11		Ongoing noise monitoring during construction at sensitive receivers during critical periods (ie times when noise emissions are expected to be at their highest - eg piling and hammering) to identify and assist in managing high risk noise events.	All
NVC12	Vibration monitoring	Where vibration levels are predicted to exceed the screening criteria, attended vibration monitoring would be carried out to ensure vibration levels remain below appropriate limits for that structure.	All
NVC13	Groundborne noise	Reasonable and feasible measures would be implemented to minimise groundborne noise where exceedances are predicted.	All
NVC14	Utility adjustments/ relocation works	Reasonable and feasible mitigation measures would be implemented where power supply works would result in elevated noise levels at receivers. This would include: • carrying out works during the daytime period when in the vicinity of residential receivers • where out of hours works are required, scheduling the noisiest activities to occur in the evening period (up to 10pm) • use of portable noise barriers around particularly noisy equipment.	All

ID	Impact/issue	Mitigation measures	Relevant location(s)
NVC15	Road traffic noise	The routes for construction haulage vehicles and bus services associated with the Temporary Transport Strategy would be selected on the basis of compliance with the relevant night-time road traffic noise criteria, where reasonable and feasible.	All

12.6.3 Consideration of the interactions between mitigation measures

Mitigation measures to control construction noise and vibration impacts generally do not overlap with other measures proposed for other environmental issues.

Measures to manage construction traffic would potentially assist in minimising road traffic noise by ensuring that haulage routes and vehicle numbers are minimised where possible, particularly along local streets.

12.6.4 Managing residual impacts

Even with the implementation of mitigation measures outlined in Section 12.6.1, there is potential that exceedances of the NMLs would occur in some locations along the corridor. Further mitigation measures would be considered in these locations, in accordance with the *Construction Noise and Vibration Strategy*, including, but not limited to, provision of respite periods and alternative accommodation for receivers where significant residual impacts are experienced.

13. Operational noise and vibration

This chapter provides a summary of the operational noise and vibration assessment. A full copy of the assessment report is provided as Technical paper 2 – Noise and vibration. The Secretary's environmental assessment requirements relevant to noise and vibration, together with a reference to where the results of the assessment are summarised in this chapter and in the Environmental Impact Statement, are provided in Table 13.1.

Table 13.1 Secretary's environmental assessment requirements – noise and vibration

Ref	Secretary's environmental assessment requirements – noise and vibration	Where addressed
8. Noise and vibration - amenity		
8.1	The Proponent must assess construction and operational noise and vibration impacts in accordance with relevant NSW noise and vibration guidelines. The assessment must include consideration of impacts to sensitive receivers including small businesses, and include consideration of sleep disturbance and, as relevant, the characteristics of noise and vibration (for example, low frequency noise).	A summary of the results of the operational noise and vibration assessment is provided in this chapter. The full results are provided as Technical paper 2. Construction noise and vibration impacts are considered in Chapter 12. Operational amenity and sleep disturbance impacts to sensitive receivers are considered in Section 13.4.2. The characteristics of noise and vibration are explained in Technical paper 2, and no modifying factors need to be used in this assessment.
8.2	The EIS must include a framework for both an Out of Hours Works Strategy and the development of an Out of Hours Works Plan which incorporates community consultation.	Section 9.7.4
9. Noise and vibration - structural		
9.1	The Proponent must assess construction and operation noise and vibration impacts in accordance with relevant NSW noise and vibration guidelines. The assessment must include consideration of impacts to the structural integrity and heritage significance of items (including Aboriginal places and items of environmental heritage).	Consideration of potential operational impacts to structural integrity (including heritage items) is provided in Section 13.4.3 Potential impacts to the heritage significance of items in considered in Chapter 14.
9.2	The Proponent must demonstrate that blast impacts are capable of complying with the current guidelines, if blasting is required.	Blasting would not be required.

13.1 Assessment approach

A summary of the approach to the operational noise and vibration assessment is provided in this section. Further information is provided in Technical paper 2.

13.1.1 Legislative and policy context to the assessment

The guidelines and standards relevant to the operational noise and vibration assessment include:

- *Rail Infrastructure Noise Guideline* (EPA, 2013)
- *Assessing Vibration: A Technical Guideline* (DEC, 2006)

- International Standard ISO 14837-1 2005 *Mechanical vibration - Ground-borne noise and vibration arising from rail systems - Part 1: General Guidance*
- *NSW Industrial Noise Policy* (EPA, 2000).

13.1.2 Methodology

The assessment methodology involved:

- identifying and classifying sensitive receivers
- determining noise and vibration criteria in accordance with relevant guidelines, and where appropriate, based on the results of ambient noise monitoring (described in Chapter 12 (Construction noise and vibration))
- modelling to quantify the noise and vibration emissions likely to be experienced
- assessing the significance of noise levels which exceed the relevant guideline values
- identifying and assessing reasonable and feasible measures to mitigate predicted exceedances of the criteria.

The following operational noise and vibration sources were assessed:

- airborne noise from metro trains operating between east of Marrickville and west of Bankstown stations
- airborne noise from mechanical plant and other systems at stations and from ancillary facilities
- groundborne noise from metro trains operating between east of Marrickville and west of Bankstown stations
- vibration from metro trains operating between east of Marrickville and west of Bankstown stations.

Airborne noise

Rail noise

The NSW EPA provides guidance for the assessment and management of potential airborne noise from railways in the *Rail Infrastructure Noise Guideline* (EPA, 2013) (the RING). To assess and manage potential noise from rail projects, the RING provides non-mandatory airborne noise triggers for residential and other sensitive receivers. Where predicted rail noise levels are above the noise triggers, reasonable and feasible noise mitigation measures should be provided to achieve the trigger levels.

A computer software model SoundPLAN version 7.0 was used to predict airborne rail noise emissions. The input data used was chosen to reflect a metro fleet of single-deck trains. This included modelling using an assumed speed profile, including a maximum design speed of 100 kilometres per hour. Modelling was undertaken for the proposed metro track alignment and appropriate noise level corrections were used. Existing and future Sydney Trains operations and ARTC freight operations (including volumes and speeds) were also included in locations where they would operate close to the project.

The train volume estimates are outlined in Table 13.2. These train volume estimates are indicative and based on estimated passenger demand, minimum service levels, and the likely maximum metro service frequency.

Table 13.2 Train volume estimates

Rail line	Scenario	Train type	Trains per weekday period			
			Day 7am to 10pm		Night 10pm to 7am	
			Up	Down	Up	Down
T2 Airport Line	Existing 2017	Double-deck Sydney Trains	6	8	0	1
	Prior to opening 2024	Double-deck Sydney Trains	26	23	6	6
	After opening 2024	Double-deck Sydney Trains	26	23	6	6
	Future 2034	Double-deck Sydney Trains	26	23	6	6
	Future 2034 without project ('no build option')	Double-deck Sydney Trains	26	23	6	6
T3 Bankstown Line (including future metro services)	Existing 2017	Double-deck Sydney Trains	78	84	17	20
	Prior to opening 2024	Double-deck Sydney Trains	96	94	21	23
	After opening 2024	Single-deck Metro Trains	184	184	27	27
	Future 2034	Single-deck Metro Trains	202	202	30	30
	Future 2034 without project ('no build option')	Double-deck Sydney Trains	96	94	21	23
T4 Eastern Suburbs and Illawarra Line	Existing 2017	Double-deck Sydney Trains	96	85	26	23
	Prior to opening 2024	Double-deck Sydney Trains	111	101	28	26
	After opening 2024	Double-deck Sydney Trains	111	101	28	26
	Future 2034	Double-deck Sydney Trains	111	101	28	26
	Future 2034 without project ('no build option')	Double-deck Sydney Trains	111	101	28	26
Freight line	Existing 2017	Freight trains	27	27	9	9
	Prior to opening 2024	Freight trains	44	44	15	15
	After opening 2024	Freight trains	44	44	15	15
	Future 2034	Freight trains	63	63	21	21
	Future 2034 without project ('no build option')	Freight trains	63	63	21	21

Note: 1: Up direction refers to the direction toward Central Station. Down direction refers to the direction toward Bankstown Station.

For the purposes of the airborne noise assessment, the study area was divided into 13 noise catchment areas (NCA) as described in Chapter 12. Typically, each NCA is representative of a station area.

The RING requires noise to be assessed both at the time of opening of a project and at a future design year (typically ten years after opening). For this project, the two timeframes assessed are:

- at opening, anticipated to be in 2024
- a future scenario, based on forecasts for operations in 2034.

Stations and ancillary facilities

The *NSW Industrial Noise Policy* (EPA, 2000) provides two separate criteria to meet environmental noise objectives: one to account for intrusive noise, and the other to protect the amenity of particular land uses. These criteria are to be met at the boundary of the 'most affected' receiver. The more stringent of the criteria usually defines the project-specific noise limits. For both amenity and intrusiveness, night-time criteria are more stringent than daytime or evening criteria and these are therefore the focus for this assessment.

In addition to intrusiveness and amenity, the risk of sleep disturbance must be assessed. Sleep disturbance is assessed in accordance with the screening criterion described in the Application Notes to the *Industrial Noise Policy* and the more detailed review of sleep disturbance contained in the *Road Noise Policy* (DECCW, 2011).

According to the *Industrial Noise Policy*, where existing L_{Aeq} noise levels exceed the 'acceptable' noise level by 10 dB or more, and the existing noise level is unlikely to decrease in future, the noise criteria should be taken to be the existing noise level minus 10 dB. This approach also applies to areas with high traffic noise.

Groundborne noise and vibration

International Standard ISO 14837-1 2005 *Mechanical vibration - Ground-borne noise and vibration arising from rail systems - Part 1: General Guidance* provides relevant guidance in relation to the extent of assessment that is normally required for new rail systems. Further information about the types of models used is provided in Section 4.2.4 of Technical paper 2. It is noted that these methods are also used for the human comfort assessment.

The prediction of groundborne noise and vibration from rail systems is a complex and developing technical field. There are currently no modelling software packages available. Modelling for the project was undertaking using a modelling process developed by the noise consultant. This model has been successfully incorporated and validated for similar previous rail projects over the past ten years.

13.1.3 Definitions used in this chapter

Table 13.3 outlines a number of commonly used noise terms used within this chapter and the respective definitions of these terms.

Table 13.3 Definition of noise related terms

Term	Definition
L_{A90}(period)	The sound pressure level exceeded for 90 per cent of the measurement period
L_{Aeq}(1 hour)	The busiest 1-hour 'equivalent continuous noise level' – it represents the typical L_{Aeq} noise level from all the proposal noise events during the busiest 1-hour of the assessment period
L_{Aeq}(15 hour)	The daytime 'equivalent continuous noise level' - it represents the cumulative effects of all the proposal noise events occurring in the daytime period from 7am to 10pm
L_{Aeq}(24 hour)	The 'equivalent continuous noise level', sometimes also described as the 'energy-averaged noise level' – it represents the cumulative effects of all the proposal noise events occurring in one day

Term	Definition
L_{Aeq}(9 hour)	The night-time 'equivalent continuous noise level' - it represents the cumulative effects of all the proposal noise events occurring in the night-time period from 10pm to 7am
L_{Aeq}(time)	Typically used to described ambient (background) noise levels
L_{Amax}	The maximum sound level recorded during the measurement period

13.2 Operational noise and vibration criteria

13.2.1 Amenity

Airborne noise – rail noise

The relevant airborne noise trigger levels for residential land uses surrounding the project area are provided in Table 13.4. For residential receivers, the criteria have two components – L_{Aeq} (assessed over the day or night) and L_{Amax} (train pass by events).

Table 13.4 Airborne rail noise trigger levels for residential land use

Type of development	Noise trigger level (dBA)	
	Daytime 7am to 10pm	Night-time 10pm to 7am
Redevelopment of existing rail line	Development increases existing $L_{Aeq(period)}$[1] rail noise levels by 2 dB or more, or existing L_{Amax}[2] rail noise levels by 3 dB or more, and predicted noise levels exceed:	
	65 $L_{Aeq(15hour)}$ and 85 L_{Amax}	60 $L_{Aeq(9hour)}$ and 85 L_{Amax}

Notes: 1. $L_{Aeq(period)}$ means $L_{Aeq(15h)}$ for the day time period and $L_{Aeq(9h)}$ for the night-time period.
2. L_{Amax} refers to the maximum noise level not exceeded for 95 per cent of rail pass-by events and is measured using the 'fast' response setting on a sound level meter.

The RING noise trigger levels for non-residential sensitive receivers are provided in Table 13.5. These apply when the building or premise is in use. All noise trigger levels are external levels, except where stated. Commercial receivers are not considered sensitive to operational airborne noise impacts.

The RING acknowledges the need to protect the community from rail-noise related sleep disturbance at night and therefore encourages a greater volume of rail movements to take place during the daytime as reflected by the airborne rail noise trigger levels presented in Table 13.4 and Table 13.5.

Table 13.5 Airborne rail noise trigger levels for sensitive land uses other than residential

Sensitive land use	Noise trigger level (dBA)
Schools, educational institutions and child care centres	45 $L_{Aeq(1hour)}$ internal
Places of worship	45 $L_{Aeq(1hour)}$ internal
Hospital wards	40 $L_{Aeq(1hour)}$ internal
Hospital other uses	65 $L_{Aeq(1hour)}$
Open space – passive use (eg parkland, bush reserves)	65 $L_{Aeq(15hour)}$
Open space – active use (eg sports field, golf course)	65 $L_{Aeq(15hour)}$

Airborne noise – stations and ancillary facilities

The external amenity noise criteria based on the *Industrial Noise Policy 2000* are provided in Table 13.6.

No modifying factors have been applied (for low-frequency noise) for the stations and ancillary facilities as it assumed that these noise sources would not exhibit these characteristics if designed and constructed in accordance with industry best practice.

Table 13.6 Amenity criteria for industrial noise sources

Type of receiver	Indicative noise amenity area	Time of day	Recommended L_{Aeq} noise level (dBA)	
			Acceptable	Recommended maximum
Residence	Suburban[1]	Day	55	60
		Evening	45	50
		Night	40	45
Residence	Urban[2]	Day	60	65
		Evening	50	55
		Night	45	50
Commercial	All	When in use	65	70
Active recreation area	All	When in use	55	60
Educational	All	When in use	45[3]	50[3]
Place of worship	All	When in use	50[3]	55[3]

Notes: 1. Suburban area is characterised by local traffic with intermittent traffic flows, decreasing noise levels in the evening period, and/or evening ambient levels defined by the natural environment and infrequent human activity.
2. Urban areas are characterised by an acoustic environment dominated by 'urban hum' or industrial noise sources, through traffic with heavy and continuous traffic flows during peak hours, and/or located near commercial or industrial districts.
3. External levels, based on the internal levels specified in the Industrial Noise Policy plus 10 dB (assuming open windows).

Substations

Table 13.7 provides the operational noise criteria for the proposed substations.

Table 13.7 Industrial Noise Policy criteria for substation operation

Substation location	Logger ID	Period	Measured level, dBA		Noise criteria, dBA		
			RBL[1]	$L_{Aeq,period}$	Intrusive	Amenity	Overall
Dulwich Hill	B.03	Day	38	57	43	56	43
		Evening	39	57	43[2]	47	43
		Night	33	53	38	43	38
Canterbury	B.07	Day	40	53	45	60	45
		Evening	40	50	45	42	42
		Night	35	47	40	37	37
Campsie	B.11	Day	44	59	49	54	49
		Evening	45	57	49	47	47
		Night	40	57	45	46	45
Lakemba	B.14	Day	47	65	52	55	52
		Evening	47	63	52	53	52

Substation location	Logger ID	Period	Measured level, dBA		Noise criteria, dBA		
			RBL[1]	$L_{Aeq,period}$	Intrusive	Amenity	Overall
		Night	41	60	46	50	46
Punchbowl	B.20	Day	47	65	52	55	52
		Evening	49	64	52	54	52
		Night	39	60	44	50	44

Notes: 1. Rating background level.
2. For assessment purposes, the evening RBL has been reduced to equal the lower daytime RBL in accordance with INP application notes.

Stations

In addition to rail noise, stations would emit noise from mechanical services and public address (PA) systems which would need to comply with applicable criteria. Table 13.8 provides the noise criteria applicable to the operation of stations. The design of mechanical plant and PA systems would be confirmed during detailed design. Therefore, further modelling would be undertaken during detailed design to confirm that the operation of stations at opening would meet the specified criteria.

Table 13.8 Industrial Noise Policy criteria for station noise

Station	Representative noise logger	Period	Measured level dBA	Noise criteria dBA		
			RBL	Intrusive	Amenity	Overall
Marrickville	B.02	Day	38	42	54	42
		Evening	38	42	48	42
		Night	33	38	41	38
Dulwich Hill	B.04	Day	41	46	58	46
		Evening	41	46	45	45
		Night	34	39	40	39
Hurlstone Park	B.06	Day	38	43	58	43
		Evening	39	43	43	43
		Night	34	39	39	39
Canterbury	B.08	Day	43	48	58	48
		Evening	43	48	43	43
		Night	36	41	39	39
Campsie	B.10	Day	45	50	58	50
		Evening	42	47	45	45
		Night	35	40	44	40
Belmore	B.13	Day	41	46	60	46
		Evening	41	46	44	44
		Night	36	41	37	37
Lakemba	B.15	Day	50	55	53	53
		Evening	50	55	53	53
		Night	43	48	53	48
Wiley Park	B.17	Day	44	49	60	49
		Evening	46	49	42	42
		Night	41	46	39	39
Punchbowl	B.19	Day	47	52	56	52
		Evening	47	52	44	44

Station	Representative noise logger	Period	Measured level dBA	Noise criteria dBA		
			RBL	Intrusive	Amenity	Overall
		Night	41	46	43	43
Bankstown	B.22	Day	54	59	55	55
		Evening	51	56	53	53
		Night	60	47	50	47

Vibration – human comfort

Table 13.9 provides the human vibration criteria for the project as outlined in *Assessing Vibration: A Technical Guideline* (DEC, 2006).

Table 13.9 Acceptable maximum vibration dose values for intermittent vibration

Location	Daytime ($m/s^{1.75}$)	Night-time ($m/s^{1.75}$)
Critical areas	0.2	0.2
Residences	0.4	0.26
Offices, schools, educational institutions and places of worship	0.8	0.8
Workshops	1.6	1.6

Note: 1. No sensitive vibration equipment are identified in use in the vicinity of the project area. As a result, the more stringent vibration criteria relating to such equipment has not been applied.

13.2.2 Structural

Groundborne noise and vibration

Rail vibration is generated by dynamic forces at the wheel-rail interface and occurs due to surface irregularities at the point of contact. The vibration generated propagates through the rail mounts into the trackform, which then propagates into the surrounding ground. The vibration continues to propagate into adjacent areas including structures.

The RING outlines the groundborne noise vibration criteria for the operation of trains along the corridor. Table 13.10 provides a summary of the groundborne noise trigger levels which are relevant to the project.

The RING acknowledges that the World Health Organisation recommends avoiding individual noise events exceeding 45 dB L_{Amax} indoors in regards to sleep disturbance. This is reflected in the triggers for groundborne noise shown in Table 13.10.

Table 13.10 Groundborne noise trigger levels

Sensitive land use	Time of day	Internal noise trigger level dBA
	Development increases existing rail noise levels by 3 dBA or more, and resulting rail noise levels exceed:	
Residential	Day (7am to 10pm)	40 L_{ASmax}
	Night (10pm to 7am)	35 L_{ASmax}
Schools, educational institutions, places of worship	When in use	40 - 45 L_{ASmax}

Vibration impacts on structures

Design objectives for vibration impacts on building contents

The human comfort criteria provided in Table 13.9 are the vibration dose values for intermittent vibration considered for the project.

Some scientific equipment (e.g. electron microscopes and microelectronics manufacturing equipment) can require more stringent design goals than those that apply to human comfort. In such cases, vibration design objectives would be obtained from the specific equipment manufacturers or if unavailable, from generic vibration criteria within commonly referenced sources in the literature.

Design objectives for vibration impacts on structures

The levels of vibration required to cause damage to buildings tend to be at least an order of magnitude higher (10 times higher) than those at which people may consider the vibration to be intrusive or disturbing. It is therefore not necessary to set separate design objectives in relation to potential building damage from rail vibration, as compliance with the human comfort design objectives would ensure compliance with criteria related to potential structural damage.

13.3 Existing environment

The existing noise environment is described in Section 12.3, including figures which show the classification of different receivers and ambient noise monitoring locations along the corridor.

The existing noise environment varies considerably along the length of the project area. In addition to rail noise, other existing noise sources include:

- road traffic noise
- operation of the freight rail line and diesel trains between east of Marrickville Station and west of Campsie Station
- industrial activities within industrial areas (particularly near Marrickville)
- other construction activities (such as building redevelopments, road, and housing construction)
- aircraft noise.

Ambient noise monitoring was undertaken in June and July 2016 at 23 representative noise locations along the project area (refer Table 12.7). Daytime noise levels ranged from 36 to 54 dB with noise levels generally increasing to the west. Measured daytime noise levels were lowest at Campsie Station and loudest at Bankstown Station.

Evening noise levels were either the same or slightly quieter than daytime levels.

Night-time noise levels ranged from 32 to 43 dB across the project area, with the lowest level at Campsie Station and highest between Lakemba and Wiley Park stations. Compared with daytime levels, the greatest change in noise levels was observed at Bankstown and Campsie stations.

13.4 Potential impacts

13.4.1 Risk assessment

Potential risks

The environmental risk assessment for the project undertaken for the State Significant Infrastructure Application Report identified the following as the main operational noise and vibration risks:

- airborne noise impacts on surrounding sensitive receivers as a result of higher train speeds and higher service frequency
- airborne noise impacts from upgraded stations including new substations and upgraded systems such as public address systems
- airborne noise impact from fixed facilities such as traction substations.

Groundborne noise and vibration impacts during operation were also considered. These impacts were not considered to be a key risk, however they have been considered.

How potential impacts have been avoided or minimised

Potential noise and vibration impacts have been avoided/minimised by:

- designing the project to minimise the potential for noise and vibration impacts on surrounding receivers
- incorporating new noise barriers and adjustments (including lengthening or increasing the height), in addition to existing noise barriers located in areas where operational airborne noise is required to be mitigated in line with the RING.

13.4.2 Amenity

Airborne rail noise – normal operations

Table 13.11 provides the noise level predictions for 2024 (at opening) and 2034 (10 years after opening) at the most exposed residential receiver with and without the project. It is noted that the most exposed receiver may not necessarily be the closest to the corridor, because the most exposed location is commonly an upper storey for buildings with two or more levels. Lower floors receive more shielding from the intervening terrain and therefore noise levels are typically lower. A residential receiver with more than one storey may therefore be more affected by airborne noise then a single storey receiver located closer to the source. Rail noise levels at receivers other than the most exposed receiver would be lower and would reduce with distance from the source.

Table 13.11 indicates that predicted operational noise levels in 2024 and 2034 'without the project' generally exceed the RING L_{Aeq} and L_{Amax} noise trigger levels in NCA01 to NCA06. In NCA07, the only exceedance is the L_{Aeq} at night (in both 2024 and 2034), while there is an exceedance of L_{Amax} at both NCA10 and NCA11 in both 2024 and 2034.

The table also shows that there is only a slight increase in predicted noise levels between the 2024 and 2034 scenarios and this is limited to the section of the rail corridor where freight trains operate (NCA01 to NCA06). This reflects the modelling assumptions which indicate that freight services are likely to increase over the 10 year forecast period while passenger services are likely to remain closer to current levels.

In relation to the noise level prediction following the addition of the project ('with project'), and excluding predicted exceedances in NCA01 to NCA06 as explained above, exceedances are also predicted at NCA07, NCA09, NCA10 and NCA11. In most of these locations, the increases in noise levels may be explained by the need to move track or implement new infrastructure such as a crossover which result in the existing tracks being moved closer to the edges of the corridor.

In total, noise levels at 85 and 105 receivers are predicted to exceed the RING trigger levels in 2024 and 2034 respectively as shown in Figure 13.1. The majority of exceedances are located in NCA11 (Bankstown), where there are more multi-level residential buildings near the rail line.

Table 13.12 provides noise level predictions for non-residential sensitive receivers in 2024 and 2034. The introduction of the project is considered to result in a relatively low number of exceedances for non-residential sensitive receivers. Exceedances of the RING trigger levels would be experienced at 14 receivers in both 2024 and 2034. These exceedances would only be located in NCA07, NCA08, NCA09 and NCA10.

Receivers with predicted exceedances of the RING trigger levels would be eligible for further consideration of noise mitigation during detailed design.

Figure 13.1 shows the locations of those receivers where exceedances of the airborne noise levels are predicted to occur and where, subject to detailed design and confirmation, reasonable and feasible noise mitigation would be considered. A description of the proposed approach to mitigation is provided in Section 13.5.

Table 13.11 Predicted 2024 and 2034 airborne noise levels at most exposed receiver – residential receivers

		Without project						With project						Noise level change with and without the project						No. of exceedances of RING trigger levels	
		L_{Aeq} Day		L_{Aeq} Night		L_{Amax}		L_{Aeq} Day		L_{Aeq} Night		L_{Amax}		L_{Aeq} Day		L_{Aeq} Night		L_{Amax}			
NCA	Side	2024	2034	2024	2034	2024	2034	2024	2034	2024	2034	2024	2034	2024	2034	2024	2034	2024	2034	2024	2034
NCA01	Up	**76**	**77**	**73**	**75**	**105**	**105**	**76**	**77**	**73**	**75**	**105**	**105**	0.0	0.0	0.0	0.0	0.0	0.0	0	0
	Down	63	64	**67**	**69**	**96**	**96**	**66**	**67**	**68**	**69**	**96**	**96**	3.0	2.6	0.5	0.5	0.0	0.0	1	1
NCA02	Up	**73**	**74**	**70**	**71**	**101**	**101**	**73**	**74**	**70**	**71**	**101**	**101**	0.2	0.2	0.0	0.0	0.0	0.0	0	0
	Down	**70**	**71**	**67**	**68**	**96**	**96**	**71**	**72**	**68**	**69**	**96**	**96**	1.2	1.0	0.5	0.4	0.0	0.0	0	0
NCA03	Up	**73**	**75**	**71**	**72**	**102**	**102**	**74**	**76**	**71**	**72**	**102**	**102**	1.2	1.0	0.5	0.4	0.0	0.0	0	0
	Down	**69**	**71**	**67**	**68**	**96**	**96**	**71**	**72**	**67**	**69**	**96**	**96**	1.8	1.6	0.8	0.7	0.0	0.0	0	0
NCA04	Up	**74**	**75**	**71**	**73**	**102**	**102**	**75**	**76**	**72**	**73**	**102**	**102**	1.2	1.0	0.5	0.4	0.0	0.0	0	0
	Down	**70**	**71**	**67**	**69**	**95**	**95**	**72**	**73**	**68**	**69**	**95**	**95**	2.0	1.7	0.9	0.8	0.0	0.0	1	0
NCA05	Up	**66**	**72**	**68**	**69**	**97**	**97**	**68**	**73**	**68**	**69**	**97**	**97**	2.1	0.7	0.3	0.2	0.0	0.0	1	0
	Down	**67**	**69**	65	**66**	**91**	**91**	**69**	**70**	**65**	**66**	**91**	**91**	2.1	1.6	0.7	0.6	0.0	0.0	6	0
NCA06	Up	**67**	**68**	**71**	**72**	**99**	**99**	**69**	**70**	**71**	**72**	**99**	**99**	2.2	2.1	0.1	0.1	0.0	0.0	2	1
	Down	**67**	65	61	**69**	**95**	**95**	**69**	**69**	**63**	**69**	**95**	**95**	2.3	3.5	2.0	0.2	0.1	0.1	4	3
NCA07	Up	61	61	**69**	**71**	83	83	**66**	**66**	**69**	**71**	**86**	**86**	4.7	5.1	0.0	0.0	3.0	3.0	4	7
	Down	63	63	59	59	82	82	**68**	**68**	**62**	**62**	**86**	**86**	4.6	5.0	2.7	3.1	3.3	3.3	2	2
NCA08	Up	61	61	57	57	82	82	65	65	59	59	83	83	3.7	4.1	1.8	2.3	1.3	1.3	0	0
	Down	60	60	56	56	82	82	64	64	58	58	83	83	3.5	3.9	1.5	2.0	1.2	1.2	0	0
NCA09	Up	61	61	58	57	84	84	**66**	**67**	**61**	**61**	**86**	**86**	4.9	5.3	2.8	3.5	1.4	1.4	1	2
	Down	60	60	56	56	81	81	65	**66**	59	60	84	84	5.3	5.7	3.4	3.9	2.4	2.4	0	1

		Without project						With project						Noise level change with and without the project						No. of exceedances of RING trigger levels	
		L_{Aeq} Day		L_{Aeq} Night		L_{Amax}		L_{Aeq} Day		L_{Aeq} Night		L_{Amax}		L_{Aeq} Day		L_{Aeq} Night		L_{Amax}			
NCA	**Side**	2024	2034	2024	2034	2024	2034	2024	2034	2024	2034	2024	2034	2024	2034	2024	2034	2024	2034	2024	2034
NCA10	Up	60	60	56	56	82	82	**66**	**66**	60	60	85	85	5.5	5.9	3.6	4.0	2.7	2.7	2	6
	Down	64	64	61	61	**86**	**86**	**66**	**67**	**61**	**62**	85	85	2.8	3.2	-0.2	0.3	0.0	0.0	4	9
NCA11	Up	63	63	61	60	**86**	**86**	**68**	**69**	**64**	**64**	**89**	**89**	5.1	5.5	2.6	3.7	3.0	3.0	34	37
	Down	62	62	57	57	82	82	**67**	**67**	60	**61**	**85**	**85**	5.1	5.5	3.0	3.5	2.9	2.9	23	38
NCA12	Up	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
	Down	60	60	56	56	81	81	63	63	57	57	81	81	2.8	3.2	0.8	1.3	0.0	0.0	0	0

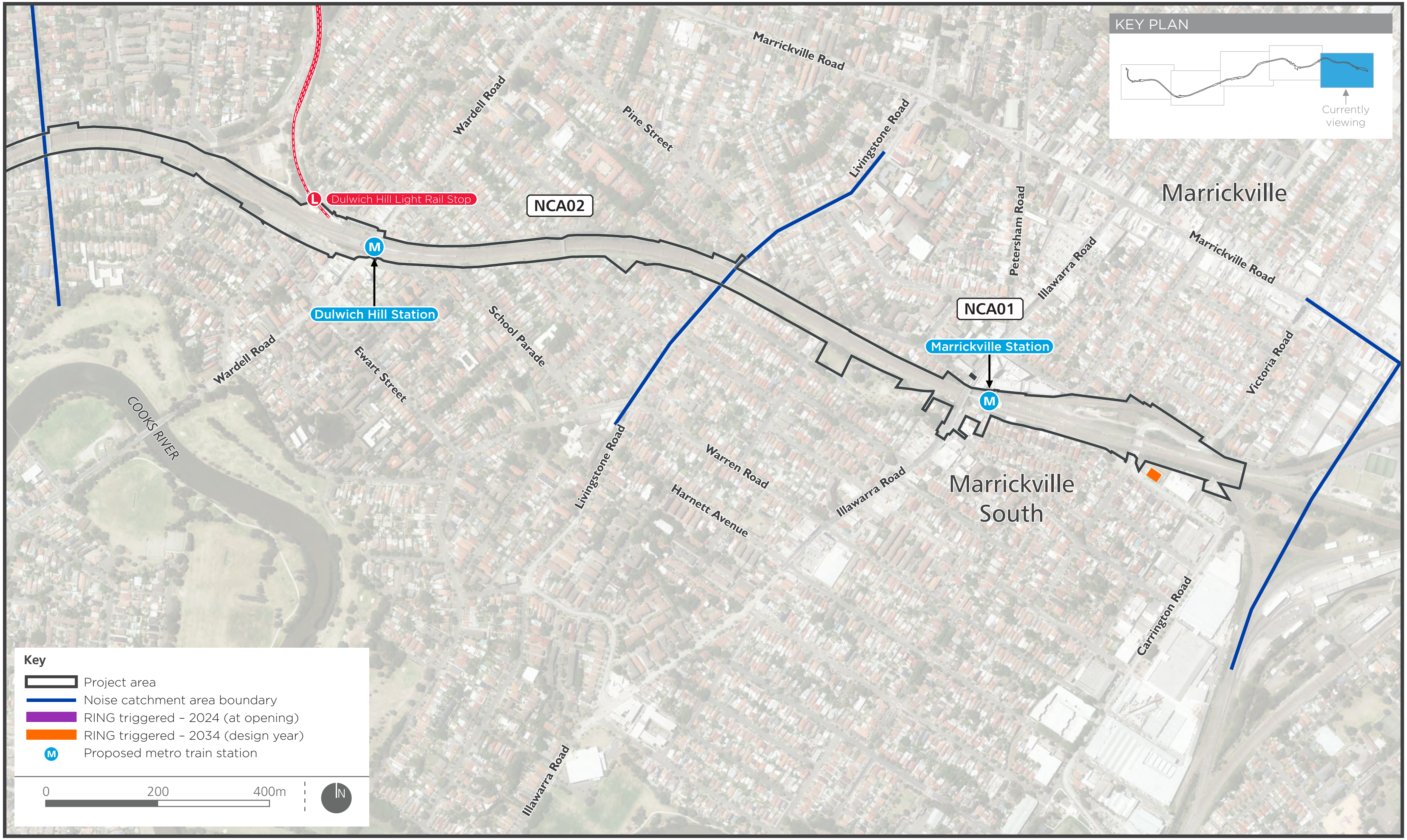
Notes: Shading and bold text indicates exceedances of the RING residential absolute noise trigger levels.
Noise level values have been rounded and noise level increases are based on additional significant figures.
A dash (-) indicates that sensitive receivers are not located close to the rail corridor in this NCA.
Up side refers to trains travelling towards Central Station. Down side refers to trains travelling away from Central (i.e. towards Bankstown in the case of the project).

Table 13.12 Predicted 2024 and 2034 airborne noise levels at most exposed receiver – non-residential receivers

		Without project				With project				Noise level change with and without the project				No. of exceedances due to the project	
		L_{Aeq} Day		L_{Aeq} Night		L_{Aeq} Day		L_{Aeq} Night		L_{Aeq} Day		L_{Aeq} Night			
NCA	**Side**	**2024**	**2034**	**2024**	**2034**	**2024**	**2034**	**2024**	**2034**	**2024**	**2034**	**2024**	**2034**	**2024**	**2034**
NCA01	Up	-	-	-	-	-	-	-	-	-	-	-	-	0	0
	Down	68	69	66	67	70	71	66	67	1.5	1.3	0.4	0.4	0	0
NCA02	Up	68	70	66	67	69	70	66	67	0.6	0.5	0.2	0.2	0	0
	Down	-	-	-	-	-	-	-	-	-	-	-	-	0	0
NCA03	Up	50	51	47	49	50	52	48	49	0.3	0.3	0.1	0.1	0	0
	Down	-	-	-	-	-	-	-	-	-	-	-	-	0	0
NCA04	Up	-	-	-	-	-	-	-	-	-	-	-	-	0	0
	Down	68	70	66	67	70	71	66	68	1.6	1.3	0.7	0.6	0	0
NCA05	Up	67	68	65	66	68	69	65	66	1.0	0.8	0.4	0.3	0	0
	Down	65	66	62	63	67	68	63	64	1.9	1.7	0.7	0.7	0	0
NCA06	Up	78	79	75	77	78	80	75	77	0.3	0.3	0.1	0.1	0	0
	Down	58	60	56	57	59	60	56	57	0.3	0.2	0.1	0.1	0	0
NCA07	Up	47	47	44	44	49	50	44	45	2.8	3.2	0.3	0.7	0	0
	Down	65	65	62	62	69	70	64	65	4.5	4.6	2.1	2.4	2	2
NCA08	Up	55	55	52	52	58	59	53	53	3.0	3.4	0.4	0.9	1	1
	Down	54	54	51	51	57	57	52	52	2.9	3.3	0.4	0.8	1	1
NCA09	Up	47	47	44	44	52	52	47	47	5.0	5.4	2.6	2.9	0	0
	Down	59	59	56	56	62	63	57	58	3.7	4.1	1.2	1.7	5	5
NCA10	Up	65	65	62	62	69	69	63	64	3.6	4.0	1.1	1.5	5	5

		Without project				With project				Noise level change with and without the project				No. of exceedances due to the project	
		L_{Aeq} Day		L_{Aeq} Night		L_{Aeq} Day		L_{Aeq} Night		L_{Aeq} Day		L_{Aeq} Night			
NCA	**Side**	**2024**	**2034**	**2024**	**2034**	**2024**	**2034**	**2024**	**2034**	**2024**	**2034**	**2024**	**2034**	**2024**	**2034**
	Down	47	47	44	44	50	50	45	45	3.6	4.0	1.0	1.5	0	0
NCA11	Up	42	42	40	40	47	48	42	43	5.0	5.5	2.6	2.9	0	0
	Down	45	45	43	43	50	51	45	45	4.9	5.3	2.4	2.8	0	0
NCA12	Up	51	52	49	49	50	51	45	46	0.0	0.0	0.0	0.0	0	0
	Down	57	57	54	54	54	54	49	49	3.7	4.1	1.2	1.6	0	0

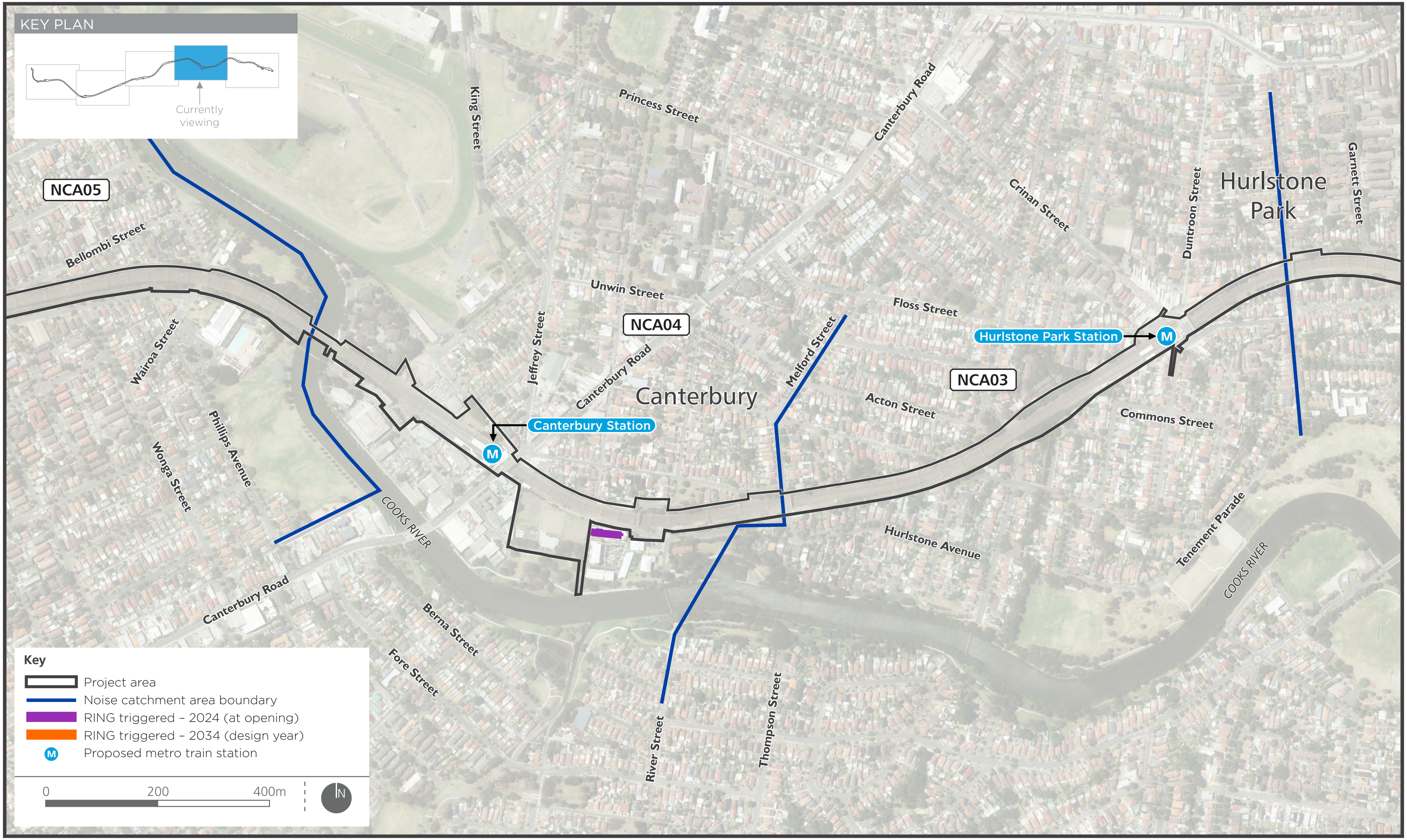
Notes: Noise predictions are external. A conservative outside-to-inside attenuation of 10 dB has been applied.
Noise level values have been rounded and noise level increases are based on additional significant figures.
A dash (-) indicates that sensitive receivers are not located close to the rail corridor in this NCA.
Up side refers to trains travelling towards Central Station. Down side refers to trains travelling away from Central (i.e. towards Bankstown in the case of the project).



sydney METRO | city & southwest

Location of receivers potentially affected by operational noise and exceeding RING criteria - map 1

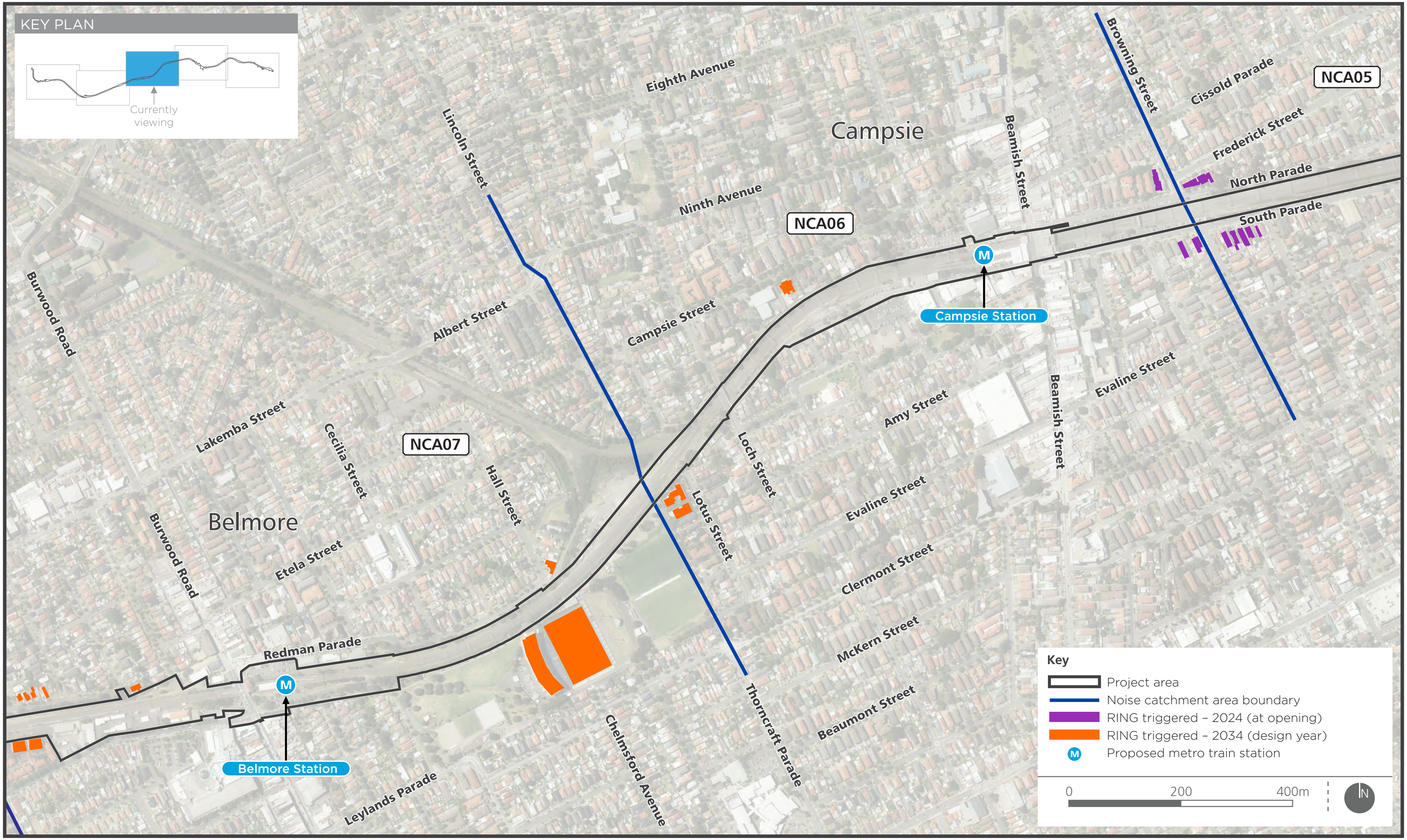
FIGURE 13.1



sydney METRO | city & southwest

Location of receivers potentially affected by operational noise and exceeding RING criteria - map 2

FIGURE 13.1



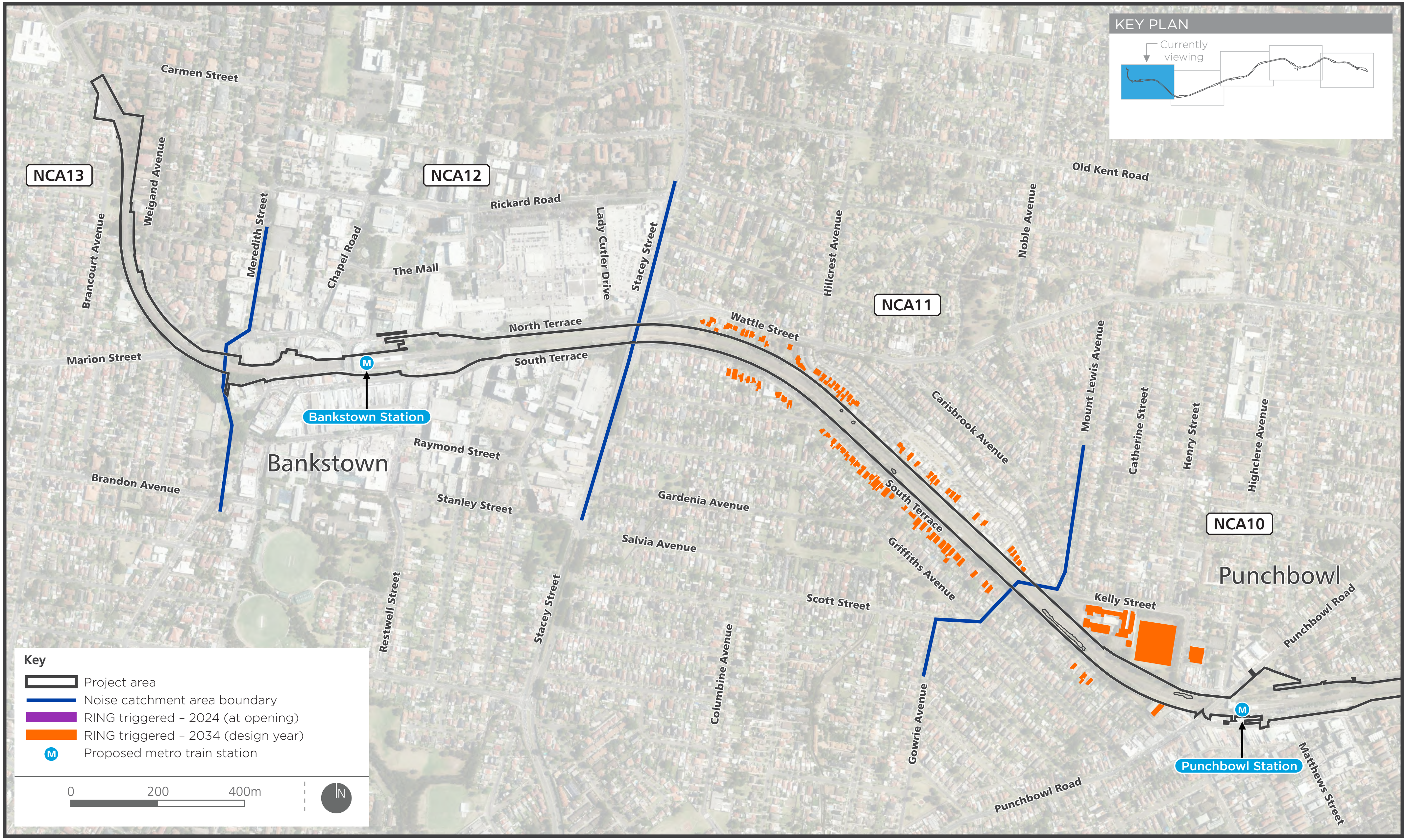
sydney METRO | city & southwest

Location of receivers potentially affected by operational noise and exceeding RING criteria - map 3

FIGURE 13.1

Location of receivers potentially affected by operational noise and exceeding RING criteria - map 4

FIGURE 13.1



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Location of receivers potentially affected by operational noise and exceeding RING criteria - map 5

FIGURE 13.1

Table 13.13 provides a summary of the number of receivers, both residential and non-residential, which would be eligible for consideration of reasonable and feasible noise mitigation measures based on the preliminary modelling conducted. As described in Section 13.5.1, further more detailed review and confirmation of these modelling results would be undertaken during detailed design and subsequent project delivery stages prior to proceeding with mitigation application.

Table 13.13 Summary of locations eligible for consideration of mitigation

Precinct	NCA	Side of corridor	Number of exceedances of RING noise trigger levels[1]				Comments
			Residential receivers		Other sensitive receivers		
			2024	2034	2024	2034	
Marrickville	01	Up	0	0	0	0	n/a
		Down	1	1	0	0	Residential receiver building
Canterbury	04	Up	0	0	0	0	n/a
		Down	1	0	0	0	Residential receiver building
Campsie	05	Up	1	0	0	0	Residential receiver building
		Down	6	0	0	0	Residential receiver buildings
	06	Up	2	1	0	0	Residential receiver buildings
		Down	4	3	0	0	Residential receiver buildings
Belmore	07	Up	4	7	0	0	Residential receiver buildings
		Down	2	2	2	2	Residential receiver buildings and other sensitive receivers (active recreation)
Lakemba	08	Up	0	0	1	1	Other sensitive receiver (medical)
		Down	0	0	1	1	Other sensitive receiver (place of worship)
Wiley Park	09	Up	1	2	0	0	Residential receiver buildings
		Down	0	1	5	5	Residential receiver building and other sensitive buildings (educational)
Punchbowl	10	Up	2	6	5	5	Residential receiver buildings and other sensitive buildings (educational and place of worship)
		Down	4	9	0	0	Residential receiver buildings
Bankstown	11	Up	34	37	0	0	Residential receiver buildings
		Down	23	38	0	0	Residential receiver buildings
TOTAL			**85**	**105**	**15**	**15**	

Note: 1. The number of locations identified counts buildings once only, in the event that more than one facade or floor of the building is triggered. This number may be less than the number of individual dwellings triggered, for example where buildings contain multiple apartments.

Airborne rail noise – testing and commissioning

During the commissioning stage, prior to the line being open to the public, testing operations would be performed within the rail corridor. Train movements during the commissioning phase are unlikely to be more frequent than during normal operations. Additionally, the train speeds during the commissioning phase are not anticipated to be significantly higher than assumed in the earlier assessment. It is therefore considered that noise impacts resulting from the testing of train operations would be equal to or lower than the predicted operational airborne noise results shown in Table 13.11 and Table 13.12.

Should vehicle testing be undertaken in a manner that differs from the assumptions in this assessment, further assessment may be required to be undertaken. If exceedances of the operational noise criteria are identified, then reasonable and feasible mitigation measures should be considered. These may include:

- scheduling unusually high noise events (such as traction, acceleration and brake testing) to less sensitive periods in consultation with the potentially affected community
- scheduling fewer commissioning operations in the same region during the same daytime or night-time period by dispersing tests throughout project area
- rescheduling commissioning operations from the night-time period to less sensitive periods eg daytime.

Substations

Table 13.14 provides the maximum predicted noise levels from substations operating, without mitigation, during the night-time period (the most stringent period) at the most affected receiver. The results show that, without mitigation, four of the five substations would result in exceedances of the night-time noise criteria.

Table 13.14 Predicted noise levels from substations at the most potentially affected receiver

Substation location	Approx. offset to nearest receiver (m)	L_{Aeq} noise level, dBA	
		Night-time criteria	Predicted
Dulwich Hill	12	38	**51**
Canterbury	35	37	**42**
Campsie	22	45	**46**
Lakemba	25	46	45
Punchbowl	24	44	**45**

Note: Shading and bold indicates predicted exceedance of criteria (without mitigation).

Predicted exceedances of the criteria range between one dB at Lakemba and Punchbowl and 13 dB at Dulwich Hill. Despite these exceedances, it is expected that noise levels can be readily reduced to acceptable levels by provision of shielding, enclosure of the noise source or locating the noise source further from the receiver as necessary. The use of acoustic louvres could be considered where ventilation is required. Such measures have been successfully used on other traction substations along the rail network in order to achieve the operational noise criteria.

Noise emitted from train stations

Train stations emit noise from mechanical services and public address systems which need to comply with the applicable noise criteria. At this stage of the design, mechanical plant and PA systems have not been identified, which means it is not possible to assess compliance with the applicable noise criteria. However given the nature of these sources and measures successfully applied to other projects, it is expected that potential impacts can be readily mitigated during the detailed phase through the selection of equipment that will not generate noise in excess of the design noise levels. The applicable criteria for operational noise from train stations is provided in Table 13.8.

Vibration – human comfort

Vibration modelling indicates that no locations would experience exceedances of the vibration (human comfort) criteria.

13.4.3 Structural

Vibration impacts on structures

As described in Section 13.2.2, compliance with human comfort criteria would ensure that the potential for structural impacts is minimal. This is because the levels of vibration required to cause damage to buildings tend to be at least an order of magnitude higher (10 times higher) than those at which people may consider the vibration to be intrusive or disturbing. As the predicted levels of vibration during operation would meet the relevant human comfort criteria, no structural impacts (including impacts to heritage structures) are expected.

Groundborne noise and vibration

The prediction modelling for groundborne noise has excluded the influence of freight traffic, which results in a more conservative assessment of groundbourne noise from Sydney Metro operations. The prediction results indicate that noise levels would be below the criteria for the majority of the project area. Minor exceedances of about one dB are predicted at four receivers near Marrickville Station. The assessment results at these four receivers are provided in Table 13.15. As the night-time criteria are the most stringent, only the night-time criteria is shown. No exceedances are predicted at non-residential receivers.

Table 13.15 Receivers in Marrickville where the groundborne noise criteria is exceeded

Address	Residential noise criteria dBA	Groundborne noise level dBA		
	Night-time	Existing situation	Future situation	Increase
30 Arthur Street	35	31	36	4.8
221 Livingstone Road	35	30	36	5.4
29 Albermarle Street	35	32	36	3.9
24 Arthur Street	35	31	36	4.7

For a receiver to be considered for mitigation, groundborne noise must dominate the internal noise environment. As indicated by the results of the airborne noise assessment in Section 13.4.2, the predicted external noise levels are much greater than those predicted for groundborne noise. Even including a moderate outdoor-to-indoor noise correction of -10 dB (assuming windows closed), airborne noise levels would be greater than groundborne noise inside the affected buildings. As such, these four receivers comply with the groundborne noise criteria, and do not require mitigation.

13.4.4 Cumulative impacts

Cumulative operational noise impacts as a result of the operation of the project combined with the operation of Sydney Trains (west of Bankstown) and ARTC freight trains between Marrickville and west of Campsie, were assessed. The results are provided in Section 13.4.

Future developments occurring in close proximity to the rail corridor that may be affected by noise emissions, must take into consideration the *Development Near Rail Corridors and Busy Roads – Interim Guideline* (Department of Planning, 2008).

13.5 Mitigation measures

13.5.1 Approach to mitigation and management

A review and iteration of predicted operational noise and vibration levels would be undertaken during detailed design, when more information is available and when specific mechanical plant and other project details have been confirmed. This would also include consideration of the mitigation options described in Section 13.5.2, and confirming reasonable and feasible mitigation approaches. The final form of mitigation would be determined during detailed design.

The operational noise and vibration review would:

- confirm predicted project noise and vibration levels at sensitive receivers, which may include a review of façade acoustic performance for non-residential receivers
- potentially include a review of the building envelopes for residential receivers, as many are located within areas subject to development requirements to mitigate aircraft noise
- assess reasonable and feasible noise and vibration measures in a hierarchical manner, consistent with the RING
- identify options for controlling noise and vibration at the source and/or receiver, including location, type, and timing of implementation (as described in Section 13.5.2)
- specify noise and vibration abatement measures for all relevant sensitive receivers
- include a consultation strategy to seek feedback from directly affected stakeholders on the proposed noise and vibration abatement measures
- include a timetable for delivery of abatement prior to operations commencing
- outline post-operational monitoring to verify noise and vibration predictions.

To validate the predicted noise levels, monitoring would be undertaken after the commencement of operation for Sydney Metro as a whole. Monitoring would confirm compliance with the predicted noise levels, as modified by the review of reasonable and feasible mitigation measures undertaken at the completion of detailed design.

If the results of monitoring indicate that the operational noise and vibration criteria are being exceeded, then additional reasonable and feasible mitigation measures would be implemented in consultation with affected property owners.

13.5.2 Reasonable and feasible mitigation options

Three main strategies are used to mitigate noise and vibration impacts:

- controlling noise and vibration at the source
- controlling noise and vibration on the source to receiver transmission path
- controlling noise and vibration at the receiver.

Section 4.1.8 of Technical paper 2 describes airborne noise mitigation options for locations where RING trigger levels are exceeded. The following reasonable and feasible mitigation options have been identified based on preliminary analysis, as summarised in Table 13.16:

- low profile noise barriers
- conventional noise barriers
- property treatment.

These mitigation options would be further considered as part of the detailed design, including further noise modelling to confirm eligibility for noise mitigation. Consideration would also be given to cost effectiveness, constructability, visual impact, overshadowing, ecological impact, impact on maintenance and safety requirements.

Table 13.16 Preliminary reasonable and feasible noise mitigation options

NCA	Side of corridor	Potential mitigation option[1]
NCA01	Down	At property treatments, where required
NCA04	Down	At property treatments, where required
NCA05 and NCA06	Down	Noise barrier, as required
	Up	Noise barrier, as required
NCA06	Down	At property treatments, where required
	Up	At property treatments, where required
NCA07	Down	At property treatments, where required
	Up	Noise barrier, as required
	Down	At property treatments, where required
NCA08	Down	At property treatments, where required
	Up	At property treatments, where required
NCA09	Down	Noise barrier, as required
	Up	At property treatments, where required
NCA09 and NCA10	Down	Noise barrier, as required
	Up	Noise barrier, as required
NCA10	Up	Noise barrier, as required
	Down	At property treatments, where required
	Down	At property treatments, where required
NCA11	Down	Noise barrier, as required
	Up	Noise barrier, as required
	Up	Property treatments, where required

Note: 1. The form and details of all noise mitigation would be confirmed during detailed design with the aim of not exceeding trigger levels from the RING. At property treatments would also be offered where there are residual exceedances of the trigger levels.

13.5.3 List of mitigation measures

Mitigation measures that would be implemented to address potential operational noise and vibration impacts are listed in Table 13.17.

Table 13.17 Mitigation measures – operational noise and vibration

ID	Impact/issue	Mitigation measures	Relevant location(s)
Design/pre-construction			
NVO1	Predicted noise impacts	An operational noise and vibration review would be undertaken to guide the approach to identifying reasonable and feasible mitigation measures to incorporate in the detailed design. This would include noise modelling to confirm the results of modelling previously undertaken. Where changes in noise levels and exceedances are modelled, reasonable and feasible mitigation measures would be reviewed.	All

ID	Impact/issue	Mitigation measures	Relevant location(s)
NVO2		The height and extent of noise barriers adjacent to the project would be confirmed during detailed design with the aim of not exceeding trigger levels from the *Rail Infrastructure Noise Guidelines* (EPA, 2013). At-property treatments would be offered either on their own or in combination with a noise barrier where there are exceedances residual exceedances of the noise trigger levels.	All
NVO3		Operational noise from substations would be controlled by inclusion of appropriate mitigation, such as shielding or enclosures, and specification of equipment selection, to comply with the *Industrial Noise Policy* (EPA, 2000).	All
Operation			
NVO4	Predicted vibration impacts	Where vibration levels are predicted to exceed the screening criteria, a more detailed assessment of the structure and vibration monitoring would be carried out to ensure vibration levels remain below appropriate limits for that structure. For heritage items where screening vibration levels are predicted to be exceeded, the more detailed assessment would specifically consider the heritage values of the structure in consultation with a heritage specialist to ensure sensitive heritage fabric is adequately monitored and managed.	All

13.5.4 Consideration of the interactions between mitigation measures

The construction of noise barriers as a mitigation measure (see NVO2 in Table 13.17) would potentially result in visual impacts for some visually sensitive receivers located in the areas surrounding any potential noise barriers. The landscape and visual assessment (Chapter 19 and Technical paper 7) has assessed the impact of the noise barriers identified in the noise and vibration assessment. Further consideration of these noise barrier locations would be undertaken as part of the operational noise and vibration review during detailed design. At this time, the visual impacts of any noise barriers may also be reconsidered.

13.5.5 Managing residual impacts

Monitoring would be undertaken to confirm the performance of the barriers and any other noise mitigation approaches. If the results of monitoring indicate that the operational noise and vibration criteria are being exceeded, then additional reasonable and feasible mitigation measures would be implemented in consultation with affected property owners.

14. Non-Aboriginal heritage

This chapter provides a summary of the results of the non-Aboriginal heritage impact assessment. A full copy of the assessment report is provided as Technical paper 3 – Non-Aboriginal heritage impact assessment. The Secretary's environmental assessment requirements relevant to non-Aboriginal heritage, together with a reference to where the results of the assessment are summarised in this chapter, are provided in Table 14.1.

Table 14.1 Secretary's environmental assessment requirements – non-Aboriginal heritage

Ref	Secretary's environmental assessment requirements – non-Aboriginal heritage	Where addressed
7. Heritage		
7.1	The Proponent must identify and assess any direct and/or indirect impacts (including cumulative impacts) to the heritage significance of: (a) Aboriginal places and objects, as defined under the *National Parks and Wildlife Act 1974* and in accordance with the principles and methods of assessment identified in the current guidelines;	A summary of the results of the non-Aboriginal heritage impact assessment is provided in this chapter. The full results are provided as Technical paper 3. This chapter considers potential impacts to non-Aboriginal heritage. Aboriginal heritage is considered in Chapter 15.
	(b) Aboriginal places of heritage significance, as defined in the Standard Instrument – Principal Local Environmental Plan;	
	(c) environmental heritage, as defined under the *Heritage Act 1977;* and	Section 14.3
	(d) items listed on the National and World Heritage lists.	No such items would be impacted by the project.
7.2	Where impacts to State or locally significant heritage items are identified, the assessment must: (a) include a statement of heritage impact for all heritage items (including significance assessment);	Section 14.3
	(b) consider impacts to the item of significance caused by, but not limited to, vibration, demolition, archaeological disturbance, altered historical arrangements and access, visual amenity, landscape and vistas, curtilage, subsidence and architectural noise treatment (as relevant);	Section 14.3
	(c) outline measures to avoid and minimise those impacts in accordance with the current guidelines;	Section 14.4
	(d) be undertaken by a suitably qualified heritage consultant(s) (note: where archaeological excavations are proposed the relevant consultant must meet the NSW Heritage Council's Excavation Director criteria);	Section 14.1.2 and Section 1.5 of Technical paper 3
	(e) have regard to the specific and broader values of historic structures (such as footbridges, overhead booking offices, platforms and platform buildings) and conservation approaches provided in the relevant conservation strategies and design guides and conservation management plans, as applicable; and	Section 14.3
	(f) identify potential uses for heritage items to be retained within the corridor.	Section 14.3

Ref	Secretary's environmental assessment requirements – non-Aboriginal heritage	Where addressed
14. Visual and landscape impacts		
14.3	The Proponent must assess the visual and landscape impacts of the project and ancillary infrastructure on … (d) heritage items including Aboriginal places and environmental heritage.	This chapter (Section 14.3) considers potential visual impacts on non-Aboriginal heritage. Further information on the visual and landscape impacts of the project are provided in Chapter 18.

14.1 Assessment approach

14.1.1 Legislative and policy context to the assessment

The main legislation relevant to non-Aboriginal heritage in NSW is the *Heritage Act 1977* ('the Heritage Act'). The Heritage Act includes provisions to conserve the State's environmental heritage; it provides for the identification, registration, and protection of items of State heritage significance; and it constitutes the Heritage Council of NSW, conferring on it functions relating to the State's heritage.

In accordance with Sections 115ZG and 115ZH of the EP&A Act, some environment and planning legislation does not apply to critical State significant infrastructure, and therefore this project. This includes approvals under Part 4, and excavation permits under Section 139 and Division 8 of Part 6 of the Heritage Act. Notification of the Heritage Council is required in writing if any relics are uncovered during construction, in accordance with the requirements of Section 146.

The Heritage Act defines 'environmental heritage' as 'places, buildings, works, relics, movable objects or precincts considered significant based on historical, scientific, cultural, social, archaeological, architectural, natural or aesthetic values'. Items considered to be significant to the State are listed on the State Heritage Register.

The EP&A Act establishes the framework for heritage values to be formally assessed in land use planning and environmental impact assessment processes. The EP&A Act requires that environmental impacts are considered prior to land development, and the level of significance of the impact assessed; this includes impacts on cultural heritage items and places, and archaeological sites and deposits.

Items and places of national heritage significance, as well as heritage places owned by the Australian Government, are managed under the EPBC Act. The EPBC Act provides for the identification, registration, and protection of items of national heritage significance. National heritage is one of the nine matters of national environmental significance protected by the EPBC Act.

Statutory registers provide legal protection for heritage items. The Heritage Act and the EP&A Act provide for heritage listings. The State Heritage Register, government agency Heritage and Conservation Registers established under Section 170 of the Heritage Act, and the environmental heritage schedules of LEPs are statutory listings. Places on the National Heritage List and Commonwealth Heritage List are protected under the EPBC Act 1999.

14.1.2 Methodology

A summary of the approach to the non-Aboriginal heritage impact assessment is provided in this section. Further information is provided in Technical paper 3. The non-Aboriginal heritage assessment was undertaken by suitably qualified heritage consultants at Artefact Heritage. A full list of personnel and their qualifications is provided in Section 1.5 of Technical paper 3.

Study area

The study area boundary for the non-Aboriginal heritage assessment was defined as a 25 metre buffer around, and including, the project area. The project area and the buffer are collectively referred to as the study area in this chapter unless otherwise stated.

The application of a buffer helps to identify heritage items potentially located within the visual catchment of the project, where potential visual impacts on that item may occur. It also supports assessment of other potential impacts on heritage items (for example, as a result of vibration during construction and operation).

Approach

The assessment involved:

- identifying listed heritage items in the study area by searching the following heritage databases:
  - World Heritage List
  - Commonwealth Heritage List
  - National Heritage List
  - NSW State Heritage Register
  - relevant local environmental plans (the Marrickville, Canterbury and Bankstown local environmental plans)
  - Section 170 Heritage and Conservation Registers (including for Sydney Water, Roads and Maritime, RailCorp, Ausgrid, and the Department of Housing).
- consideration of relevant conservation management plans
- consideration of existing and proposed heritage conservation areas
- a site survey and photographic inventory
- reviewing the project description and plans
- reviewing previous heritage investigations within or close to the project area
- preparing a statement of heritage impact in accordance with relevant guidelines (described below).

The assessment was undertaken in accordance with the *NSW Heritage Manual 1996* (Heritage Office and Department of Urban Affairs and Planning, 1996) ('the NSW Heritage Manual') and relevant guidelines, including:

- *Assessing Heritage Significance* (Heritage Office, 2001)
- *Statements of Heritage Impact* (Heritage Office, 2002)
- *Assessing Significance for Historical Archaeological Sites and Relics* (NSW Heritage Division, 2009).

Heritage structures were assessed with reference to relevant Sydney Trains guidelines, including:

- *Railway Footbridges Heritage Conservation Strategy* (NSW Government Architect's Office, 2016)
- *Railway Overhead Booking Offices Heritage Conservation Strategy* (Australian Museum Consulting, 2014)
- *Heritage Platforms Conservation Management Strategy* (Sydney Trains, 2015).

Where recent changes (such as station upgrades) have affected heritage listed items, the assessment was undertaken with reference to statutory listings, conservation management plans, and previous studies/assessments. Where recent changes may have altered the documented levels of heritage significance, a revised level of significance was identified and considered.

The heritage assessment included an assessment of the relative contributions of individual elements of heritage items to the heritage value of items. These assessments were based on the standard grades of significance, defined by *Assessing Heritage Significance* (Heritage Office, 2001), as listed in Table 4 of Technical paper 3. Where the significance of elements is discussed in listings or conservation management plans, these grades were used, unless additional information (such as a change in condition or removal) was provided that would justify a change.

The assessment also considered the principles contained in *The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance* (Australia ICOMOS, 2013) ('the Burra Charter') and the *Historical Archaeology Code of Practice* (Heritage Office, 2006a).

Potential impacts to non-Aboriginal heritage were assessed in accordance with the above guidelines, taking into consideration both negative (adverse) and positive (beneficial) impacts. The assessment addressed the significance of individual elements of heritage items (where appropriate), and assessed the impact to each element, and the overall impact to the heritage item as a whole. The assessment also provided an overall statement of non-Aboriginal heritage impacts, it considers the potential for residual impacts on heritage items, and the cumulative heritage impact of the project as a whole.

The assessment considered impacts holistically – it considered how negative impacts were offset by positive heritage outcomes, such as heritage interpretation, opening of view lines to heritage items, and the retention and adaptive reuse of heritage elements. It also provided mitigation measures to minimise heritage impacts where practicable.

The guidelines, *Canopies and Shelters, Design Guide for Heritage Stations* (Sydney Trains, December 2016) and *Design in Context Guidelines for Infill Development in the Historic Environment* (Heritage Office, 2006b), informed the development of design principles for the project. As these are design guidelines rather than assessment frameworks or conservation strategies, they were taken into account, but did not guide the assessment.

Types of impacts considered

In accordance with the *Statements of Heritage Impact,* the assessment of potential impacts on non-Aboriginal heritage was based on impacts to the significance of a heritage item and its elements, as follows:

- direct impacts – as a result of the removal/demolition or alteration of fabric of heritage significance
- visual impacts – as a result of changes to the setting or curtilage of heritage items or places, historic streetscapes, or views
- potential direct impact – as a result of impacts from vibration and removal/demolition of adjoining structures.

It is assumed that all direct and potential direct impacts are a result of construction. Visual impacts are assumed to be operational, unless specified as temporary, in which case they are related to construction.

Once the levels of all three types of impacts were assessed, adverse and positive impacts to heritage significance were balanced to determine the overall level of impact to the heritage significance of the listed item as a result of the project. Where the overall impacts to the heritage significance of an item was assessed as major (as per the definitions provided in Table 14.2), an assessment was undertaken to determine whether the item would continue to meet the threshold of significance necessary for heritage listing.

From a heritage perspective, impacts are only acceptable if sufficient justification is provided, and options to avoid harm have been explored and discounted. Where impacts are identified, the justification for these impacts (including information on the options considered) is provided in accordance with *Statements of Heritage Impact*. Additional information on how the design was developed taking into account impacts to heritage is provided in Chapter 7 (Design development and place making).

Specific terminology and corresponding definitions were used to consistently identify the magnitude of the project's direct, visual, or potential direct impacts on heritage items or archaeological remains. The terminology and definitions used are based on those in the guideline *Guidance on Heritage Impact Assessments for Cultural World Heritage Properties* (ICOMOS, 2011) and are provided in Table 14.2.

Table 14.2 Terminology for assessing the magnitude of heritage impact

Magnitude	Definition
Major	Actions that would have a long term and substantial impact on the significance of a heritage item. Includes actions that would remove key historic building elements, key historic landscape features, or significant archaeological materials, thereby resulting in a change of historic character, or altering of a historical resource. These actions cannot be fully mitigated.
Moderate	Actions involving the modification of a heritage item, including altering the setting of a heritage item or landscape, partially removing archaeological remains, or the alteration of significant elements of fabric from historic structures. The impacts of these actions may be partially mitigated.
Minor	Actions that would result in a slight alteration of heritage buildings, archaeological remains, or the setting of an historical item. The impacts of these actions can usually be mitigated.
Negligible	Actions that would result in very minor changes to heritage items.
Neutral	Actions that would have no heritage impact.

Historical archaeological assessment

The potential for a site to contain historical archaeology was assessed by identifying former land uses and associated features through historical research, and evaluating whether subsequent actions (either natural or human) may have impacted evidence for these former land uses. The significance of potential archaeological remains was then assessed using a framework based on the NSW heritage criteria.

The historical archaeological assessment involved:

- reviewing heritage and archaeological site listings
- analysis of historical background and maps
- understanding previous impacts
- assessment of archaeological significance.

Construction compounds and work site impacts

As described in Section 9.8, construction compounds would be required at each station to support construction activities and other associated works at stations. There are also a number of work sites proposed, where construction activities would be undertaken outside the rail corridor. The location of compounds and work sites are shown in Figure 9.1.

The non-Aboriginal heritage assessment included consideration of the potential direct and visual impacts of construction compounds and work sites located within the curtilage, or in the vicinity, of heritage items. This chapter summarises the results of the impacts of construction compounds and work sites as they relate to individual heritage items, with potential archaeological impacts considered as part of the archaeological assessment. As a result of the temporary nature of the impacts, the impacts of construction compounds and work sites on built heritage items is considered separately (in Section 14.3.13).

Assessment of potential vibration impacts on heritage structures

Vibration arising from construction or excavation work has the potential to impact on the fabric of heritage items, potentially causing subsidence, or affecting structural integrity. In locations where heritage items are adjacent to demolition, construction, or excavation works, an assessment of the potential impact of vibration was undertaken as part of the noise and vibration assessment for the project (refer to Technical paper 2 – Noise and vibration assessment and Chapter 12 (Construction noise and vibration)).

The assessment adopted a conservative vibration damage screening level of 7.5 millimetres per second peak particle velocity. This screening level was established with reference to the minor cosmetic damage criteria in *British Standard BS 7385-2:1993 Evaluation and measurement for vibration in buildings - Part 2: Guide to damage levels from groundborne vibration*. The vibration levels specified in this standard are designed to minimise the risk of threshold or cosmetic surface cracks, and are set well below the levels that have potential to cause damage to the main structure.

The recommended screening level of 7.5 millimetres per second peak particle velocity also applies to heritage items unless it is known that the item is already structurally unsound – in which case, a lower screening level may apply. The noise and vibration assessment provides an initial assessment of the potential for vibration impacts. Potential construction vibration impacts would continue to be assessed by applying the following methodology:

- Where vibration levels are predicted to be below the relevant vibration screening level, potential vibration impacts are considered negligible and no further assessment of vibration-related impacts on that structure would be required.
- Where vibration levels are predicted to be at or above the vibration screening level, further investigation would be undertaken prior to construction to ensure that vibration levels remain below appropriate limits for that structure, including:
  - a more detailed assessment of the structure
  - attended vibration monitoring from the structure’s closest point to the vibration source.
- Where the building is a heritage building, and the predicted vibration level is above the vibration screening level, a more detailed assessment of the structure would be undertaken, to specifically consider the heritage values of the structure and sensitive heritage fabric. The assessment would be undertaken in consultation with a heritage specialist to ensure it is adequately monitored and managed.

The potential for vibration impacts during operation was also assessed by Technical paper 2, and the results are summarised in Chapter 13 (Operation noise and vibration). No impacts were identified.

14.2 Existing environment

The following sections describe the historical context of the study area, including the development of the existing rail line and stations (Section 14.2.1), listed heritage items (Section 14.2.2), and archaeological sites and potential (Section 14.2.3).

14.2.1 Historical context

An overview of the historical context for the assessment is provided in this section, including early exploration and urban development, and the development of the rail line and stations. Although Sydenham Station is not included in the project area, Sydenham and its station are considered as they form part of the historical context of the development of the Bankstown Line.

A detailed description of the early exploration and settlement of the region, and the development of the Bankstown Line and its stations, is provided in Section 3 of Technical paper 3.

Exploration and urban/industrial development

The first European exploration of the Cooks River region (between what is now Sydenham and Bankstown) was led by Captain John Hunter in 1789. Development of the area around the Cooks River was relatively slow until construction of the Bankstown Line occurred between 1892 and 1939. Sydenham Station was previously built as part of the Illawarra Line, and was extended to accommodate the new Bankstown Line, which commenced at Sydenham Station.

Construction of the Bankstown Line changed the nature of development in the Cooks River area. New residential lots were developed, radiating from the rail line. Subdivisions were advertised in terms of their proximity to the railway and its stations.

Industrialisation in the areas adjoining the rail line increased in the early 1900s, with the introduction of the Metropolitan Goods Line (parallel to the Bankstown Line). A number of factories (such as the Great Western Milling Company, the Western Timber Mill, and Sidney Williams & Co Pty Ltd) took advantage of the ability to move their goods efficiently by rail. Employment opportunities provided by these large factories attracted numerous workers to the area, and land adjacent to the rail line was subdivided to provide housing for workers.

Key historical developments along the Bankstown Line include:

- Sydney Steel Company (Sydenham), established to the north of the rail line in 1910
- the Australasian Sugar Company Mill (Canterbury), constructed between 1840 and 1842 to the south of the rail line near the banks of the Cooks River
- Benjamin Taylor’s house ‘Lakemba’, constructed prior to the 1890s near what is now Lakemba Station.

Bankstown Line development

The Bankstown Line was constructed in three phases between 1892 and 1939. The first phase was the Sydenham to Belmore section, constructed between 1880 and 1895. Sydenham Station was originally known as Marrickville when it opened in October 1884. The station name was changed to Sydenham in 1895 when the new line was completed. Marrickville, Dulwich Hill, Hurlstone Park, Campsie, Canterbury, and Belmore stations were constructed during this period.

The second phase was constructed between 1896 and 1909 when the rail corridor was cut through undeveloped country estates and farmland to Bankstown and Lakemba. Punchbowl and Bankstown stations were opened during this period. The early twentieth century saw the addition of platform buildings, overhead booking offices, footbridges and overbridges to the existing stations. The line was electrified in 1926, marking a significant change in the railway network.

The third phase of development occurred between 1928 and 1939 when the line reached Regents Park via Yagoona and Birrong. Wiley Park opened in 1938 as an infill station on the Sydenham to Bankstown section. Dulwich Hill Station was redeveloped in 1935. Both of these stations provide examples of inter-war railway architecture.

Station development

The development of the stations on the Bankstown Line was an important driver of urban and industrial development in the surrounding areas. The history of development at each station within the project area is summarised in Table 14.3.

Table 14.3 Historical development of stations within the project area

Station	Timeline	Key development
Marrickville	1894-95	Marrickville Station constructed
	1917	New platform and building with overhead booking office built on the city bound platform, and platforms extended
	1926	Changes to the layout of the station following electrification
	1944	Booking office on Platform 2 altered
	1985	Stairs from Illawarra Road constructed
	2016	Station upgrade
Dulwich Hill	1895	Opened on 1 February as ‘Wardell Road Station’
	1920	Renamed as ‘Dulwich Hill Station’
	1935	Original 1895 timber station buildings replaced Construction of a new brick platform building, and a new overhead weatherboard booking and parcels office and bookstall
Hurlstone Park	1894	Opened on 27 November as ‘Fern Hill Station’
	1911	Renamed as ‘Hurlstone Park Station’ and a new platform constructed Metropolitan Goods Line construction commenced
	1915	Original timber station building replaced by brick buildings on both platforms, and an overhead booking office constructed
	1980s	Overhead booking office replaced
Canterbury	1895	Station opened
	1915	Platform building 2 and footbridge constructed Signal box commissioned in preparation for operation of the Metropolitan Goods Line
	1937	Signal box extensions – western annex
	1947	Footbridge extended
	1968	Signal box extensions – eastern annex
	Late 1980s	Overhead booking office and concourse constructed
	1996	Signal box decommissioned and building sealed to preserve the structure and its internal signalling equipment
Campsie	1895	Station opened
	1905	New booking office constructed
	1906	Platform extended
	1915	Present station layout and buildings constructed

Station	Timeline	Key development
	1916	Metropolitan Goods Line opened and a northern side platform constructed
	1950s	Existing concrete platform, stairs and overhead parcels office constructed
	2000	Overhead parcels office demolished and replaced
	2016	Station upgrades
Belmore	1895	Opened as the initial terminus station and included the station master's residence still present at 346 Burwood Road
	1909	Prior to 1909 there were sidings for the storage of locomotives due to the railway terminating at Belmore Station
	1925-26	Substation constructed and the platform extended
	1937	Overhead timber booking office constructed
Lakemba	1909	Station opened
	1919	New brick platform building with cantilever awnings constructed
	1926	Station modified for electrification and a haunched beam footbridge with overhead booking office constructed
	1953	War memorial monument dedicated
	2002	Booking office demolished after fire damage and replaced by a modern metal and glass structure
Wiley Park	1938	Station opened
	2016	The building on the Up platform appears to have been rebuilt in recent years, and the interior of the booking office has been refurbished
Punchbowl	1909	Station opened
	1919	Goods siding constructed
	1924	Station building awning added
	1926	Electric train depot opened in proximity to the station
	1929	Overhead booking office constructed, platforms lengthened, and the stairway to the Punchbowl Road overbridge removed
	1940s	Construction of a new lamp room and parcels office
	1981	Good siding removed
	1995	Electric train depot closed
	2014	Northern and southern footbridge stairs replaced
Bankstown	1909	Station opened
	1910	Single tier water tank on a steel stand constructed
	1915	Parcels office opened
	1920s	A pillar water tank and ash pit constructed
	1925-26	Platform extensions constructed when the line was electrified in 1926 New parcels office and booking office opened
	1948	Overhead booking office, footbridge, and parcels office constructed
	1970s	Water tank removed
	2015	New stairs, ramps, canopies, and ticket barriers installed

14.2.2 Heritage listed items and conservation areas

Heritage listed items and conservation areas located within the study area for the assessment (defined in Section 14.1.2) were identified based on a search of relevant registers (listed in Section 14.1.2) on 22 June 2016. Listed items and conservation areas are shown on Figure 14.1. A full list and detailed description of all heritage listed items and conservation areas in the study area for the assessment, and their significance, is provided in Section 4 of Technical paper 3. A summary of those items and areas located within or immediately adjoining the project area is provided in this section.

Heritage listed items and conservation areas in the study area consist of those listed on the State heritage register, local environmental plans, and/or State agency Section 170 registers. No items listed on National or World heritage lists were identified.

Heritage listed items

Heritage listed items within and adjoining the project area include:

- five items listed on the State heritage register (summarised in Table 14.4)
- 32 locally listed items - of these items, 15 are listed by local environmental plans, four are listed by various State agency Section 170 registers, and 11 are listed by both
- two locally listed heritage conservation areas.

Heritage listed items and conservation areas are shown in Figure 14.1, and further information on is provided in Sections 14.3.2 to 14.3.11.

Table 14.4 State heritage listed items and station listings

Item[1]	Listing name	Listing[1]	Location with respect to the project area
Items listed on the State Heritage Register			
Sewage Pumping Station 271	Sewage Pumping Station 271	SHR (01342) Sydney Water s.170 (4571727) Marrickville LEP (I67)	Directly adjacent to project area
Marrickville Railway Station Group	Marrickville Railway Station Group	SHR (01186) RailCorp s.170 (4801091) Marrickville LEP (I89)	In project area
Old Sugar Mill	Old Sugar mill	SHR (00290)	Directly adjacent to project area
	Canterbury Sugar Mill (former)	Canterbury LEP (I82)	Directly adjacent to project area
Canterbury Railway Station Group	Canterbury Railway Station Group	SHR (01109) RailCorp s.170 (4801100)	In project area
	Federation railway station buildings	Canterbury LEP (I67)	In project area
Belmore Railway Station Group	Belmore Railway Station Group	SHR (01081) RailCorp s.170 (4801084)	In project area
	Federation railway station buildings	Canterbury LEP (I11)	In project area
Other station listings			
Dulwich Hill Railway Station Group	Dulwich Hill Railway Station Group	RailCorp s.170 (4801909)	In project area

Item[1]	Listing name	Listing[1]	Location with respect to the project area
Hurlstone Park Railway Station Group	Hurlstone Park Railway Station Group	RailCorp s.170 (4805737) Canterbury LEP (I126)	In project area
Campsie Railway Station Group	Campsie Railway Station Group	RailCorp s.170 (4801101) Canterbury LEP (I40)	In project area
Lakemba Railway Station Group	Lakemba Railway Station Group	RailCorp s.170 (4801916) Canterbury LEP (I143)	In project area
Wiley Park Railway Station Group	Wiley Park Railway Station Group	RailCorp s.170 (4801946) Canterbury LEP (I159)	In project area
Punchbowl Railway Station Group	Punchbowl Railway Station Group	RailCorp s.170 (4802009) Canterbury LEP (I155)	In project area
Bankstown Railway Station Group	Bankstown Railway Station Group	RailCorp s.170 (4802067) Bankstown LEP (I3)	In project area

Notes: 1. SHR – State Heritage Register, s.170 – Section 170 register, LEP – local environmental plan

Heritage conservation areas

The project passes through or is adjacent to two heritage conservation areas listed under the Marrickville LEP, as summarised in Table 14.5 and shown in Figure 14.1.

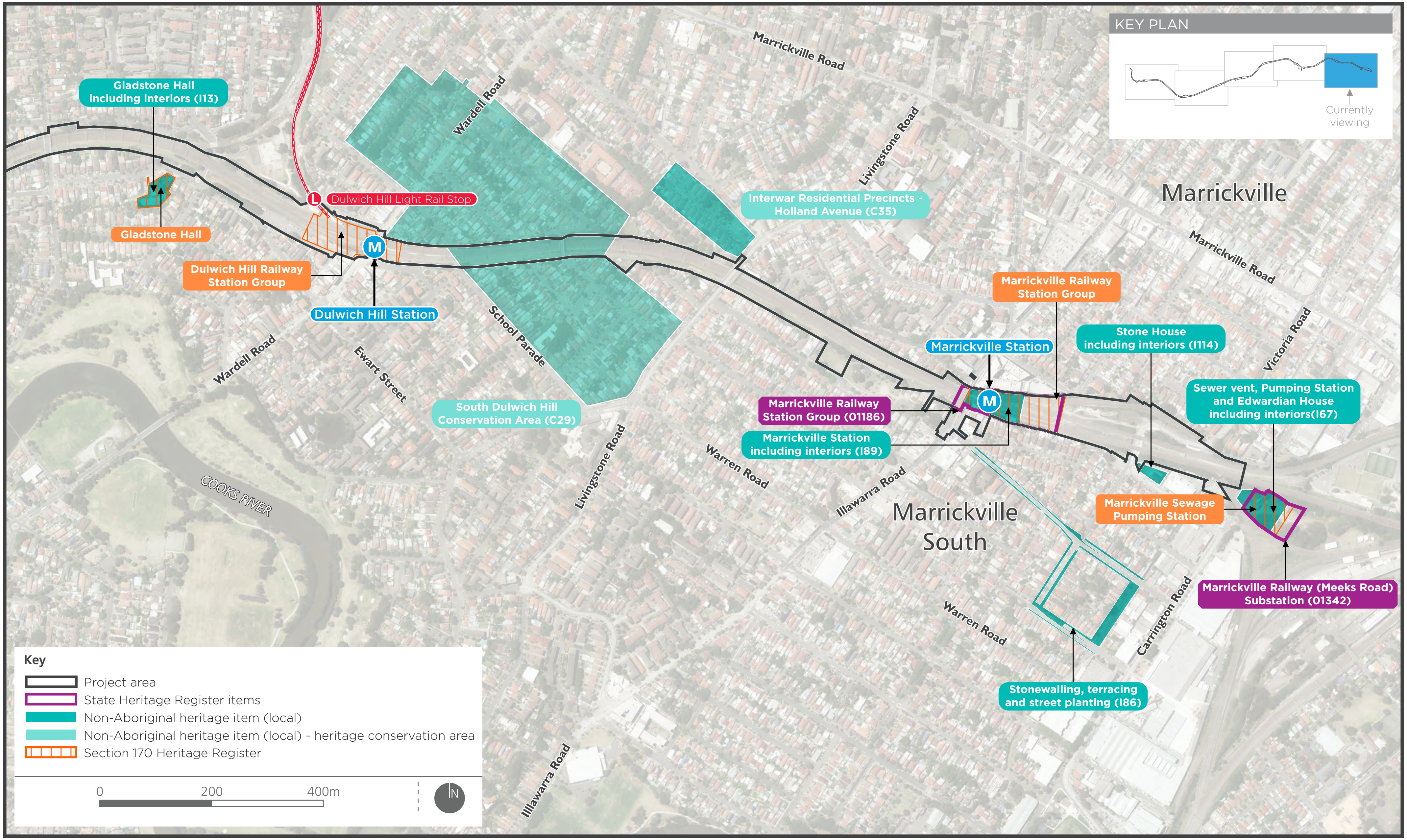
Table 14.5 Listed and proposed heritage conservation areas

Heritage conservation area	Register listings	Heritage significance	Location with respect to the project area
South Dulwich Hill Heritage Conservation Area	Marrickville LEP (C29)	Local	Project passes through part of the area at Dulwich Hill
Inter-War Heritage Conservation Area Group - Hollands Avenue; Jocelyn Avenue and Woodbury Street	Marrickville LEP (C35)	Local	Directly adjacent to project area east of Dulwich Hill Station

Two proposed heritage conservation areas are located adjacent to the project area near Hurlstone Park Station (Paul Davies Pty Ltd, 2016):

- the proposed Floss Street heritage conservation area is located adjacent to Hurlstone Park Station
- the proposed Hampden Street heritage conservation area is located adjacent to the rail corridor, to the north-east of Hurlstone Park Station.

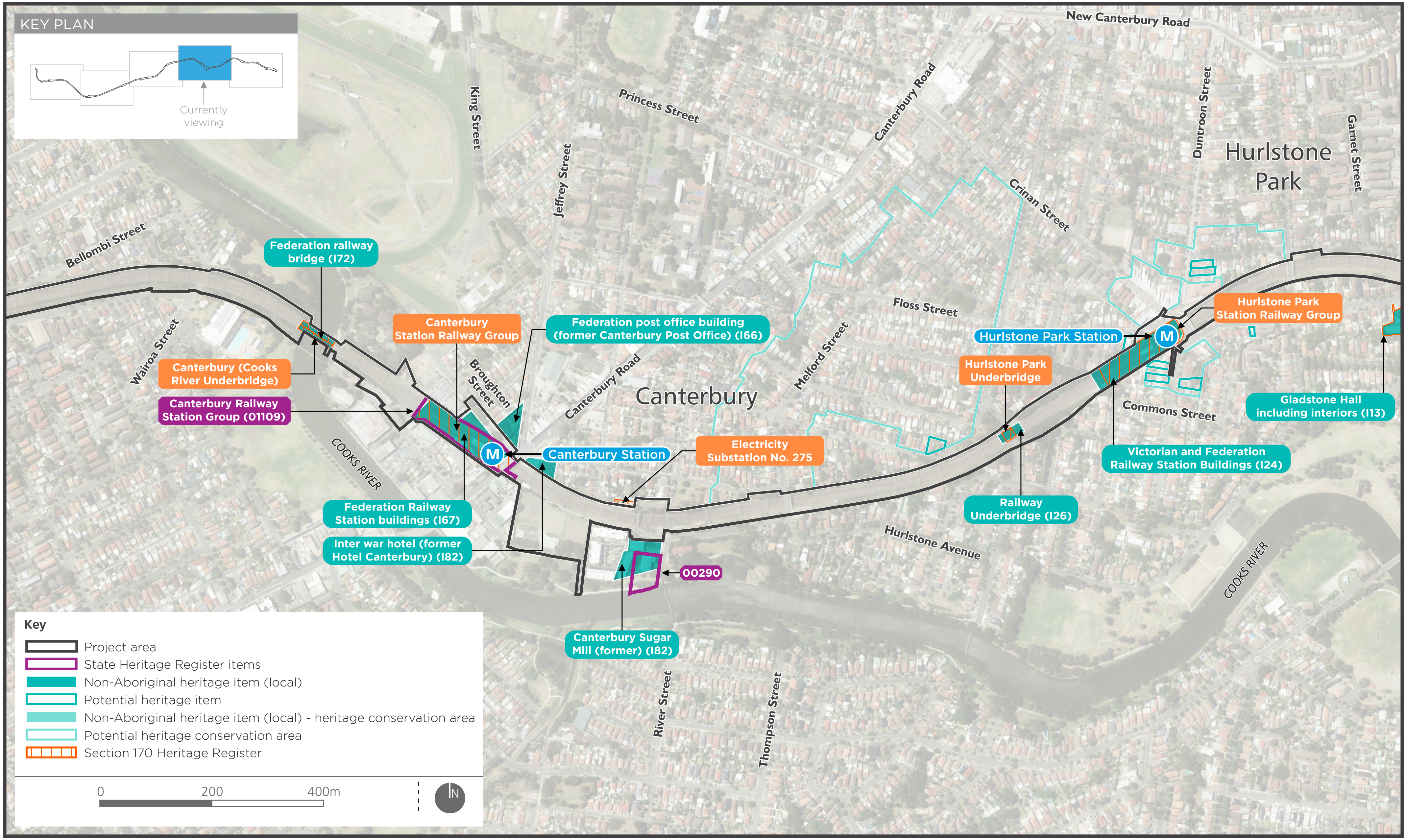
These proposed heritage conservation areas are shown in Figure 14.1. On 18 April 2017, Canterbury-Bankstown Council resolved that a planning proposal to list these areas (as part of a broader proposal to list a number of new heritage items and areas in Hurlstone Park) be submitted to the Department of Planning and Environment for a revised Gateway Determination and be placed on public exhibition.



sydney METRO | city & southwest

Heritage listed items and areas - map 1

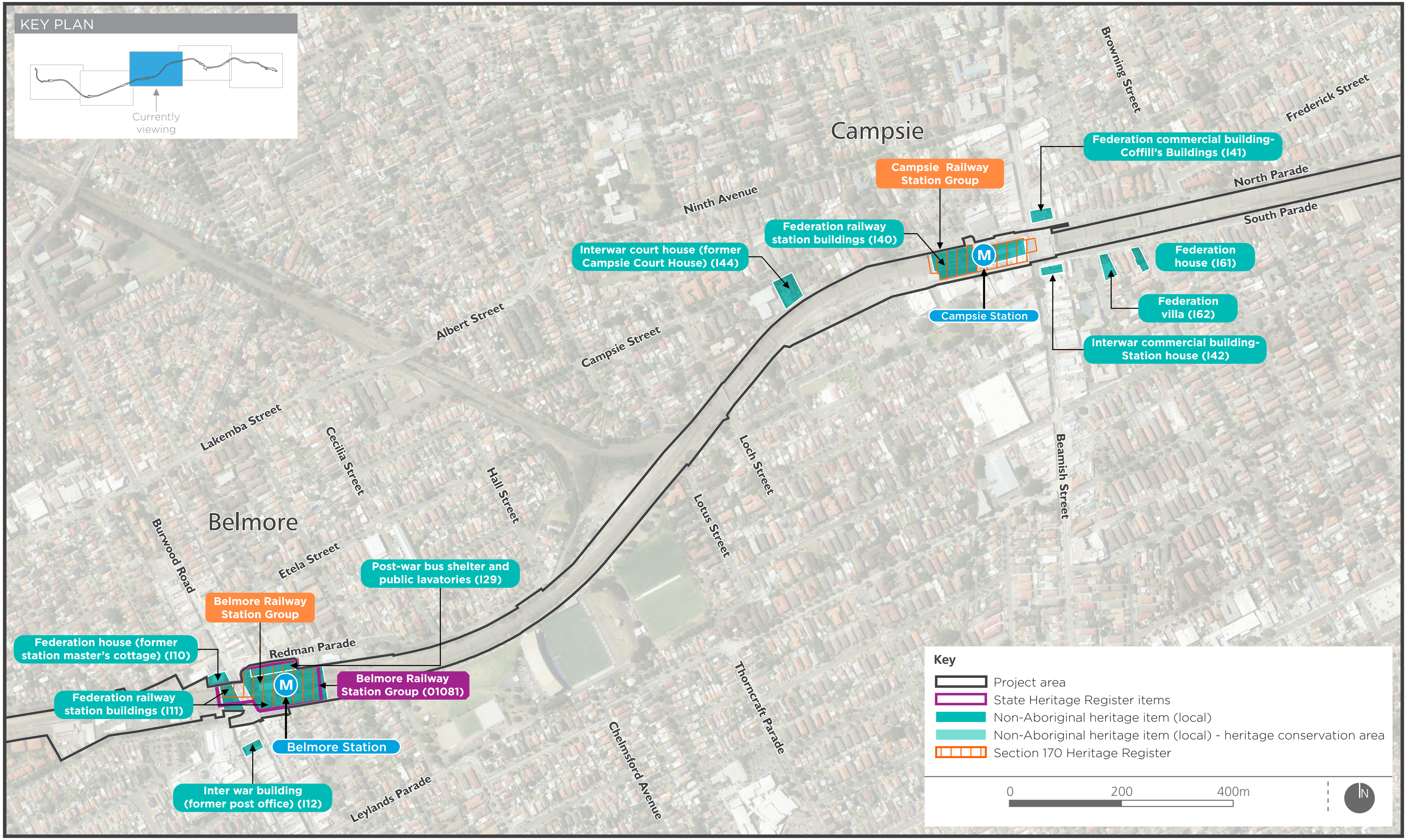
FIGURE 14.1



sydney METRO | city & southwest

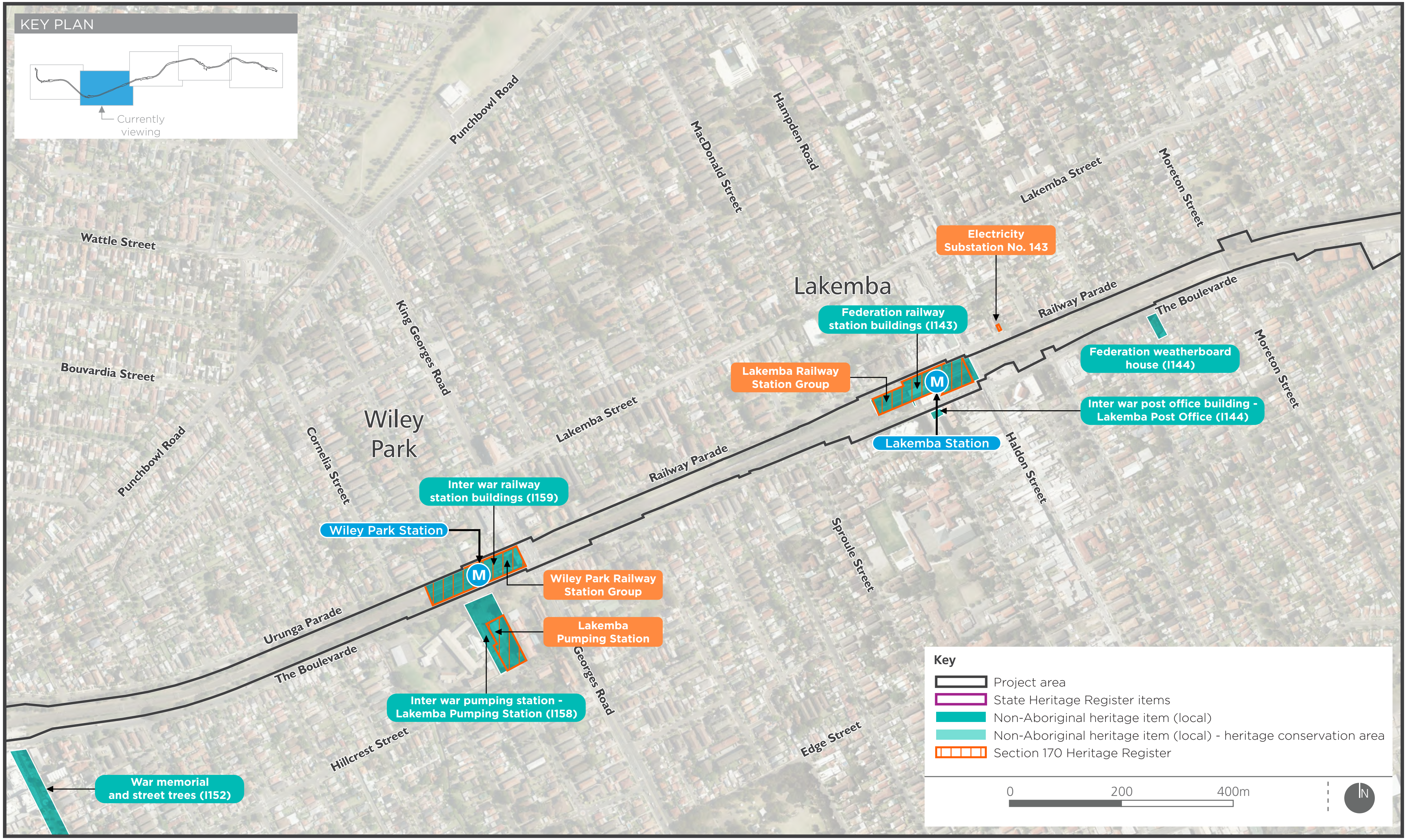
Heritage listed items and areas - map 2

FIGURE 14.1



Heritage listed items and areas - map 3

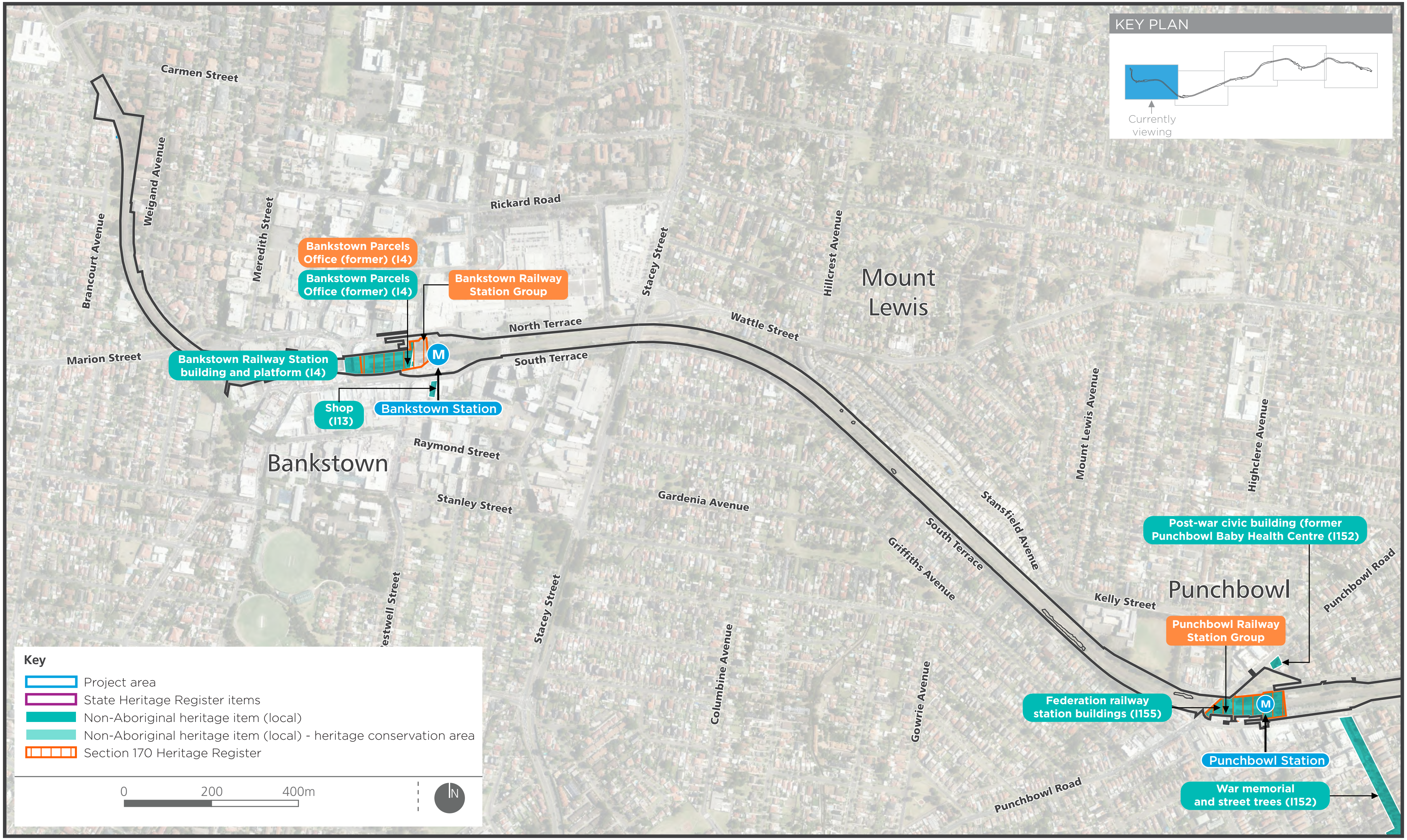
FIGURE 14.1



sydney METRO | city & southwest

Heritage listed items and areas - map 4

FIGURE 14.1



sydney METRO | city & southwest

Heritage listed items and areas - map 5

FIGURE 14.1

14.2.3 Archaeological sites and potential

Listed archaeological sites

There are no listed archaeological sites within or adjacent to the project area.

Archaeological potential

Construction of the rail line and stations would have involved a considerable amount of ground disturbance and excavation. Rail and station upgrades throughout the twentieth century would have resulted in high levels of ground impacts throughout the station catchments.

The majority of locations are considered to have nil to low archaeological potential and/or significance. The highest levels of potential and/or significance were identified at the following locations:

- Marrickville Station – There is a moderate to high potential for locally significant remains of original stone copings, earlier alignment of platforms, footscrapers, buried services, original lever set, footings of former platform stairs, platform brick dwarf walls, building footings, and the footings of former platform canopies.
- Canterbury Station – Although the location of the Canterbury Sugar Company works mill and former associated structures is outside the project area, remains of outbuildings and mill activities may exist within the rail corridor and adjoining work site (work site 8). These have the potential to reach the threshold for State significance, if intact or substantial remains are found to exist within the project area.
- Lakemba Station – There is low potential for locally significant remains associated with 'Lakemba' (a residence constructed in the late nineteenth century) to exist and be impacted by the project. There is also low to moderate potential for the potentially locally significant remains of the 1919 Lakemba Station island platform to be impacted by the project.
- Belmore Station – There is low to moderate potential for locally significant remains associated with the station goods shed and platform to be impacted by the project.

Other locations in the project area may contain archaeological 'works' such as remains of culverts, former platforms (within existing remodelled platforms), and infrastructure such as drains.

14.3 Impact assessment

14.3.1 Risk assessment

Potential risks

Construction and operation of the project would have the potential to impact on heritage items, conservation areas, and sites with archaeological potential. The environmental risk assessment for the project, undertaken for the State Significant Infrastructure Application Report, identified the following as the main non-Aboriginal heritage risks:

- direct impact to State listed heritage items during construction
- direct impacts to local and Section 170 listed heritage items during construction
- impacts to the heritage values of conservation areas during construction
- damage to heritage items from construction vibration
- impacts on unknown heritage items (e.g. archaeological items) during construction
- impacts on heritage items from construction such as change in visual outlook
- adverse impacts on heritage item values during operation (e.g. change in visual outlook)

- groundborne vibration impacts on heritage listed items during operation.

How potential impacts have been avoided/minimised

The potential for heritage impacts was considered throughout the design development process, to minimise the overall impacts to heritage, and ensure that the design would architecturally complement rather than obstruct or overshadow heritage items, where practicable.

The NSW Heritage Office guidelines for the design of new structures in historic environments provides that (Heritage Office, 2006b):

> 'New design should respond to its historic context through an understanding and informed analysis of its character and quality. This will include elements such as its grain, existing patterns of development, important views, scale, materials and building methods. As a consequence, the resulting design should create new relationships between the building, its neighbours and its setting.'

The design for the project sought to reuse and revitalise a selection of station buildings. Adaptive reuse can contribute to building social and cultural capital, environmental sustainability, and urban regeneration (Heritage Council Victoria, 2013). This can increase and retain the social significance of a heritage item by allowing it to be appreciated in a new and informative way, especially in conjunction with heritage interpretation. The project sought to retain and build upon the layers of history of the Bankstown Line. This follows the philosophy that (Heritage Office, 2006b):

> 'Adaptive reuse gives new life to a site, rather than seeking to freeze it at a particular moment in time. It explores the options that lie between the extremes of demolition or turning a site into a museum. Adding a new layer without erasing earlier layers, an adaptive reuse project becomes part of the long history of the site.'

The introduction of Sydney Metro on the T3 Bankstown Line constitutes the fourth major intervention to this existing railway landscape. As described in Chapter 7, the design process for the project involved significant work to minimise direct impacts to heritage items as far as practicable.

The design of the proposed station upgrades was undertaken with regard to the heritage values of the stations and the line overall, and has sought to:

- recognise and demonstrate the heritage significance of all phases of rail transport development along the line
- retain and conserve, wherever possible, elements of heritage significance, so that functional relationships can be understood and interpreted
- remove intrusive station elements that detract from the core heritage values
- adaptively reuse the retained and conserved heritage buildings for station and related functions
- carefully and clearly express the presence of Sydney Metro with new high quality design elements
- deliver a functionally viable line, stations, and surrounding areas, while enhancing the legibility of key heritage values.

Further information on the design approach used to achieve the required accessibility upgrades and meet the operational requirements of Sydney Metro, whilst minimising impacts on heritage, is provided in Chapter 7. The approach to the design has been to retain as many existing significant heritage items and/or elements as possible, with particular focus given to those items listed on the State Heritage Register. As part of this process, Transport for NSW has ensured that retained heritage elements would have a suitable operational purpose, and that their retention would not compromise the integrity of the station design and layout, or safety and customer requirements. Further information on the options considered to minimise heritage impacts, and the justification for removal of heritage elements where this is required, is provided in Section 5.3 of Technical paper 3.

In general, potential impacts on heritage outside the rail corridor have been avoided by designing the project to minimise impacts on land outside the corridor. In addition, construction compounds would only be located within already cleared areas (such as car parks) to avoid impacting on heritage sites and items.

A summary of the results of the assessment for the main project features is provided in the following sections.

14.3.2 Marrickville Station

Existing items

Heritage listed items in the vicinity of Marrickville Station with the potential to be impacted by the project are summarised in Table 14.6 and shown in Figure 14.1. Table 14.7 lists the main structures and elements within the Marrickville Railway Station Group, including relevant information such as date, condition, and significance.

Table 14.6 Marrickville Station – heritage items

Item	Listing	Location
Marrickville Railway Station Group	SHR (01186) RailCorp s.170 (4801091) Marrickville LEP (I89)	In project area
Sewage Pumping Station 271	SHR (01342) Sydney Water s.170 (4571727) Marrickville LEP (I67)	In project area
Stone house, including interiors	Marrickville LEP (I114)	Adjacent to project area
Stonewalling, terracing and street planting	Marrickville LEP (I86)	Adjacent to project area

Direct impacts

An assessment of the direct impacts of the project on the fabric of each element constituting the Marrickville Railway Station Group, and an assessment of the subsequent impacts on the heritage values of the station group as a whole, is provided in Table 14.7. Potential impacts are illustrated in Figure 14.2.

The project would not directly impact on Sewage Pumping Station 271, or the Stone house.

Table 14.7 Summary of direct impacts to significant elements within the Marrickville Railway Station Group

Significant elements	Condition	Significance	Proposed works	Assessment of direct impact
Platform 1 (1895)	Generally good	Exceptional	Retention of western section of platform Removal of eastern section with new platform to be rebuilt in straight alignment and extended towards the east Platform canopies and platform screen doors to be anchored on the portion of retained platform New building and canopies to be anchored on the portion of reconstructed platform	The overall impact to this element has been assessed as major due to the following: • major impact on the original platform, including the loss of about half of its fabric and brick face from the demolition eastward of the central platform building • the western section of the platform would be retained including the structure underneath the platform building • major impact on the original platform layout - reconstruction of the eastern section of the platform to accommodate the straight rail alignment would result in loss of the original curvilinear form of the platform and of the symmetry created with Platform 2 when the latter was constructed in 1911 • the new platform building, canopies, and platform screen doors would be anchored on the reconstructed platform and would not further impact significant fabric • moderate impact resulting from installing platform canopies and platform screen doors to the portion of Platform 1 to be retained.
Platform 1 building (Type 11) (1895)	Generally good	Exceptional	Retention for re-use with potential retrofitting	The overall impact to this element has been assessed as minor due to the following: • the retention of the platform building is a positive heritage outcome in the context of the project • retrofitting for new accommodation would be designed to minimise impacts to original fabric • additions to the building and platform would be designed to be sympathetic to the heritage context and minimise fabric and visual impacts.
Platform 2 (1911)	Generally good	Exceptional	Partial retention on the western side as well as the structure underneath the heritage building Removal of eastern section with retention of structure underneath platform building Platform to be rebuilt in straight alignment and extended towards the east Station buildings, platform canopies and platform screen doors to be anchored on	The overall impact to this element has been assessed as major due to the following: • the majority of the platform would be removed on the eastern side resulting in a major impact on the original platform, including the loss of most of its fabric and brick face. • reconstruction of the eastern section of the platform to accommodate the straight rail line alignment would result in the loss of the original curvilinear form of the platform and of the symmetry with Platform 1, and would have a major impact on the original platform layout. • moderate impact on the portion of retained platform where pylons and

Significant elements	Condition	Significance	Proposed works	Assessment of direct impact
			both the retained and new platforms	struts are anchored for the new platform buildings, platform canopies and platform screen doors, elements to be anchored on the reconstructed platform would not further impact significant fabric.
Platform 2 building (Type 11) (1911)	Generally good	High	Retention for re-use with potential retrofitting	The overall impact to this element has been assessed as minor due to the following: • positive heritage outcome through retention of the platform building • retrofitting for new accommodation would be designed to minimise impacts to original fabric, including preservation of the original layout where possible, and removal of any intrusive modifications • additions to the building and platform would be designed to be sympathetic to the heritage context and minimise fabric and visual impacts.
Overbridge - Illawarra Road (1911. c.2013)	Generally good	Brick parapets including curbs, piers and panels - Exceptional Structure below the deck level - Moderate	Removal and replacement - demolition of the bridge deck, adding new parapets, throw screens, waterproofing, and asphalt, new abutments, bridge beams, and concrete slab, utility modifications/relocations, bridge drainage, line markings, road level adjustments, and makeup panels.	The overall impact to this element has been assessed as major as the proposed works would remove the heritage value of this item.
Platform 2 booking office (1917, relocated)	Generally good	Exceptional	Retention in current location	The overall impact to this element has been assessed as neutral as the booking office has already been relocated from its original location during the station upgrade in 2016.
Pedestrian steps: northern set (1917, c.2013)	Generally good	Little	Retention	The overall impact to this element has been assessed as neutral as the existing stairs were installed as part of the recent upgrade and the original stairs are no longer present.
Pedestrian steps: southern set (1985, c.2013)	Generally good	Little	Retention	The overall impact to this element has been assessed as neutral as the existing stairs were installed as part of the recent upgrade and the original stairs are no longer present.

Visual impacts

Marrickville Railway Station Group

There would be some difference visually between the proposed upgrade for the project and the recent upgrade work undertaken under Transport for NSW's Transport Access Program. The recently upgraded concourse and lifts would remain with some cosmetic modifications. Pedestrian steps would also be retained. The proposed upgrades would be distinguishable and recognisable across the station as a new phase in development of the station and the Bankstown Line.

The contemporary nature of the new development would differ from the existing heritage character of the station group, creating a distinct relationship between the historic components of the site and the new elements. The new platform building on Platform 1 would be low in scale and bulk, and would be located at a distance from the heritage building. The design of the canopy has aimed to reduce bulk and height. To maximise potential view lines, canopies would be glazed adjacent to heritage buildings.

Some views from the concourse to the Platform 1 building would be discernible, while views towards the Platform 2 building would generally be obscured by the canopies between the stairs and the Platform 2 building. Canopies would extend along both platforms, with a separation of at least two metres from the significant Platform 1 and Platform 2 buildings. Views of the Platform 1 building would be available from Station Street.

The recent station upgrades resulted in some impacts to the historic context and setting of the station. The additional structures and canopies proposed for the project would further modernise the station setting. While the proposed works would have some positive impacts, including a general refresh and removal of intrusive elements, the open historic setting and character of the station would be diminished.

The proposed platform screen doors would result in a minor impact on external views from the platform buildings and from the concourse towards the heritage buildings, and a moderate impact on internal views as a result of visual clutter. The new platform screen doors would partially obscure the Platform 1 and Platform 2 building, where they would result in a moderate visual impact.

The visual impacts of the upgraded station on the Marrickville Railway Station Group would be major overall.

Existing views from the new Illawarra Road overbridge would not be significantly impacted compared to existing views and vistas. The proposed replacement of the Illawarra Road overbridge with a sympathetically designed structure would have a moderate visual impact on the station group, although views from the overbridge to the significant station buildings would be retained.

Additional impacts such as the services building to be constructed to the north-east of the station in the rail corridor, landscaping, new pavement, kerbside facilities, and signage would have a minor impact on the setting and context of the station, as they would be consistent with the use of the station.

Overall, the proposed platform canopies and platform building would have a major visual impact on the character and setting of the Marrickville Railway Station Group. The new platform screen doors would result in a moderate impact. Some views to the Platform 1 building of exceptional significance, and to the Platform 2 building of high significance, would be retained for continued appreciation, although the canopies on the stairs and platforms would obscure views from most areas apart from the section of the concourse and Station Street. This assessment considered the balance of impacts as a result of new high quality design structures being added; the positive impacts of the removal of intrusive elements; and the refresh of the station. The assessment also considered the high quality, sensitive design of the new metro layer, which would remain distinguishable from the original elements.

When considering cumulative impacts overall, the assessment concluded that the project would result in a major visual impact on Marrickville Railway Station Group.

Other items

There would be negligible visual impacts on the other listed heritage items, as the nearest item (Stonewalling terracing and street planting) is at least 70 metres from the boundary of

Marrickville Station, and views of the tracks and overhead wiring would be consistent the current views and vistas of the heritage items.

Potential direct (vibration) impacts

Table 14.8 summarises the potential vibration impacts on listed heritage items.

Table 14.8 Potential vibration impacts

Item	Potential impact
Marrickville Railway Station Group Sewage Pumping Station 271 Stone house, including interiors	Minor: The closest façades of these items would experience vibration levels above the screening level for cosmetic damage. Further assessment and management would be undertaken in accordance with the approach described in Section 14.4.
Stonewalling, terracing and street planting	Negligible: Vibration levels would be below the cosmetic damage screening level.

Statement of heritage impact

Marrickville Railway Station Group

The direct impacts of the project on the Marrickville Railway Station Group would be major overall. The platform building of exceptional significance and the Platform 2 building of high significance would be retained and retrofitted with the potential for positive impact. The Illawarra Road overbridge would be removed and replaced. The Platform 2 booking office of exceptional significance would be relocated along the platform. Potential direct impacts as a result of vibration would be minor, provided the mitigation measures outlined in Section 14.4 are implemented.

Platform buildings 1 and 2, dated 1895 and 1911 of exceptional and high significance, would still contribute to the overall significance of Marrickville Station as a major station on the Bankstown Line, as they are to be retained. The two platform buildings are good examples of their respective types and would still contribute to the aesthetic and historical significance and representativeness and rarity values of the station. The partial retention of Platforms 1 and 2 would retain representative samples of the original 1895 and 1911 platforms. The booking office, an element of exceptional significance, would be retained in its current location.

The retained elements of the station would continue to represent this historical value. The project would enable the station to continue to play a role in the growth and development of Sydney and the local area.

The overall visual impact would be major, as new elements would diminish views to significant platform buildings, impact the context and setting, and introduce visual clutter.

Although there would be significant changes as a result of the new metro design layer being added to the station, this evolution would enable the station to continue its use as a transport hub. The new layer which would remain distinguishable from the original elements, and the historic values of the station would be appreciated in the context of the evolution of the station.

When assessed cumulatively, the level of heritage impact of the project on the Marrickville Railway Station Group would be major. The heritage item would continue to meet the threshold for State significance for the historical and aesthetic significance of the station in the context of its evolution and retained elements, as well as under rarity and representativeness, as demonstrated by the retained elements of high and exceptional significance. The station would still reach the threshold of State significance under research potential, as the booking office, to which this criteria primarily refers in the State Heritage Register statement of significance, would be retained.

Direct impacts on the other three listed heritage items would be neutral. The proposed works in the vicinity of the station would result in a negligible visual impact overall. Potential direct impacts as a result of vibration would be minor, provided the mitigation measures are implemented. When assessed cumulatively, the level of heritage impact of the project on the Sewage Pumping Station 27, Stone house, and Stonewalling, terracing and street planting would be negligible. The heritage items would continue to meet the threshold for local significance.

14.3.3 Dulwich Hill Station

Existing items

Heritage listed items in the vicinity of Dulwich Hill Station with the potential to be impacted by the project are summarised in Table 14.9 and shown in Figure 14.1. Table 14.10 lists the main structures and elements within the Dulwich Hill Railway Station Group, including relevant information such as date, condition, and significance.

Table 14.9 Dulwich Hill Station – heritage items

Item	Listing	Location
Dulwich Hill Railway Station Group	RailCorp s.170 (No. 4801909)	In project area
South Dulwich Hill Heritage Conservation Area	Marrickville LEP (C29)	In project area
Gladstone Hall, including interiors	Department of Health s.170 (3540048) Marrickville LEP (I13)	Adjacent to project area
Inter-War Heritage Conservation Area Group - Hollands Avenue; Jocelyn Avenue and Woodbury Street	Marrickville LEP (C35)	Adjacent to project area

Direct impacts

An assessment of the direct impacts of the project on the fabric of each element constituting the Dulwich Hill Railway Station Group, and an assessment of the subsequent impacts on the heritage values of the station group as a whole, is provided in Table 14.10. Potential impacts are illustrated in Figure 14.2.

There would be negligible direct impacts on the South Dulwich Hill Heritage Conservation Area. Direct impacts within the curtilage of the conservation area would include an upgrade of tracks and related overhead wiring, and the removal and replacement of the Albermarle Street overbridge. No areas of heritage significance within the conservation area would be directly impacted by the works. Alterations to the rail line and the Albermarle Street overbridge would be in line with the existing setting and nature of this portion of the conservation area.

Table 14.10 Summary of direct impacts to significant elements within the Dulwich Hill Railway Station Group

Significant elements	Condition	Significance	Proposed works	Assessment of direct impact
Platforms 1/2 (1935)	Good	High	Removal apart from structure underneath heritage building Platform to be rebuilt in a similar curve to the existing and extend further towards the western end Covered concourse, access stairs, lift shaft, platform canopies and platform screen doors anchored on the west side of the new platform New services building on western end of reconstructed platform	The overall impact to this element has been assessed as major due to the following: • major impact on the station group resulting from the demolition of Platform 1/2, to be reconstructed to accommodate the station upgrade and operation of metro trains • major impact on the fabric of the platform, including the loss of the original brick face from the removal of the 1935 island platform (apart from the structure underneath the heritage building) • moderate impact on the original platform layout from the reconstruction of the platform to accommodate the rail lines and recreation of a curve similar to the original curve of the platform • the new covered concourse, access stairs, lift shaft, platform canopies, platform screen doors, and services building would be anchored and constructed on the new platform, and would not further impact significant fabric.
Platforms 1/2 building (Type 13) (1935)	Moderate	High	Retention for re-use with potential retrofitting	The overall impact to this element has been assessed as minor due to the following: • positive heritage outcome • retrofitting for new accommodation would be designed to minimise impacts to original fabric, including preservation of the original layout where possible, and removal of any intrusive modifications • additions to the building and platform would be designed to be sympathetic to the heritage context and minimise fabric and visual impacts.
Overhead booking office (1935)	Good	High	Removal of the building and the original brick pier and steel beam structure	The overall impact to this element has been assessed as major due to the following: • major impact on the setting of the station as a whole and removal of a building type that is significant in the context of Sydney Trains heritage assets as a group • the building was ranked in second position in the *Railway Overhead Booking Offices Heritage Conservation Strategy* and recommended for retention (Australian Museum Consulting, 2014).
Stairs (1935)	Good	Moderate	Removal of the stairs and footbridge	The overall impact to this element has been assessed as major due to the removal of the stairs would have a major

Significant elements	Condition	Significance	Proposed works	Assessment of direct impact
				impact on the fabric and historical values of the stairs and the station as a whole.
Overbridge (c.1930, c.1975)	Good	Moderate	Retention and upgrade	The overall impact to this element has been assessed as minor due to the removal and replacement of non-significant parapets would result in a minor impact on the heritage values of the overbridge and station overall.

Visual impacts

Dulwich Hill Railway Station Group

The proposed new concourse would be modern in style and would be considerably larger in scale compared to the 1935 platform building. Medium-scale ribbon canopies would extend from the concourse covering the central access stairs and along the length of the platform to the west. There would not be canopies above, or adjacent to, the heritage building, which would remain clearly visible from the concourse, separated from the new layers of development. The materials likely to be used and the contemporary nature of the proposed new concourse, canopies, and station buildings, would provide a distinctive design easily differentiated from the heritage components of the item. The proposed concourse, station and services buildings would be sited away from the heritage buildings.

Removal of the overhead booking office would result in a major visual impact on the station, as a significant portion of its heritage fabric would be removed. The overhead booking office is a rare example of an inter-war transitional booking office, with good condition and integrity. Its removal would result in a major impact on the setting of the station as a whole.

The platform screen doors along Platform 1/2 would result in a minor impact on external views from the platform buildings and from the new concourse towards the heritage buildings, and a moderate impact on internal views as a result of visual clutter.

Overall, the proposed ribbon canopies, covered concourse, and station infrastructure would have a major impact on the character and setting of the Dulwich Hill Railway Station Group. The removal of the overhead booking office would remove an element of high significance in the station. The new concourse would add considerable bulk to the station. The additional platform screen doors would result in a moderate visual impact.

When considering cumulative impacts overall, the assessment concluded that the project would result in a major visual impact on the Dulwich Hill Railway Station Group.

Other heritage items

There would be negligible visual impacts on the South Dulwich Hill Heritage Conservation Area and the Inter-War Heritage Conservation Area Group. This is largely due to screening of the views by existing vegetation, houses along Marrickville Avenue (in the Inter-War Heritage Conservation Area), and the position of the station below street level. In addition, the bulk of the proposed additions would be concentrated on the western side of the station, further from views from the South Dulwich Hill Heritage Conservation Area.

Neutral visual impacts are predicted on Gladstone Hall, which is located about 40 metres south of the rail corridor and 270 metres from the western edge of the platform. Views from this item towards the rail line are limited, as they are screened by vegetation. Any views of new tracks and overhead wiring would be consistent with the existing views and vistas and would have a neutral visual impact.

Potential direct (vibration) impacts

Table 14.11 summarises the potential vibration impacts on listed heritage items.

Table 14.11 Potential vibration impacts

Item	Potential impact
Dulwich Hill Railway Station Group South Dulwich Hill Heritage Conservation Area Inter-War Heritage Conservation Area Group Gladstone Hall, including interiors	Minor: The closest façades of these items would experience vibration levels above the screening level for cosmetic damage. Further assessment and management would be undertaken in accordance with the approach described in Section 14.4.

Statements of heritage impact

Dulwich Hill Railway Station Group

The direct impacts of the project on the Dulwich Hill Railway Station Group would be major overall, however the Platform 1/2 building would be retained and retrofitted with potential for positive impacts. The removal of the overhead booking office, and one of two significant buildings within the station group would have major direct and visual impacts. The new development would have a major visual impact on the setting of the item and significant views, with considerable bulk added to the station group as a result of construction of the new concourse. Potential direct impacts as a result of vibration would be minor provided that the mitigation measures in Section 14.4 are implemented.

The demolition of Platform 1/2 and the overhead booking office and stairs would remove a substantial portion of the 1935 layer of re-development of the station, and impact the integrity of the station as a whole. The representativeness significance of the station as a railway station in the Inter-War Railway Eclectic style would be severely diminished. The platform building would remain a good example of the type and the significant brick abutments and piers of the Wardell Road overbridge would be retained.

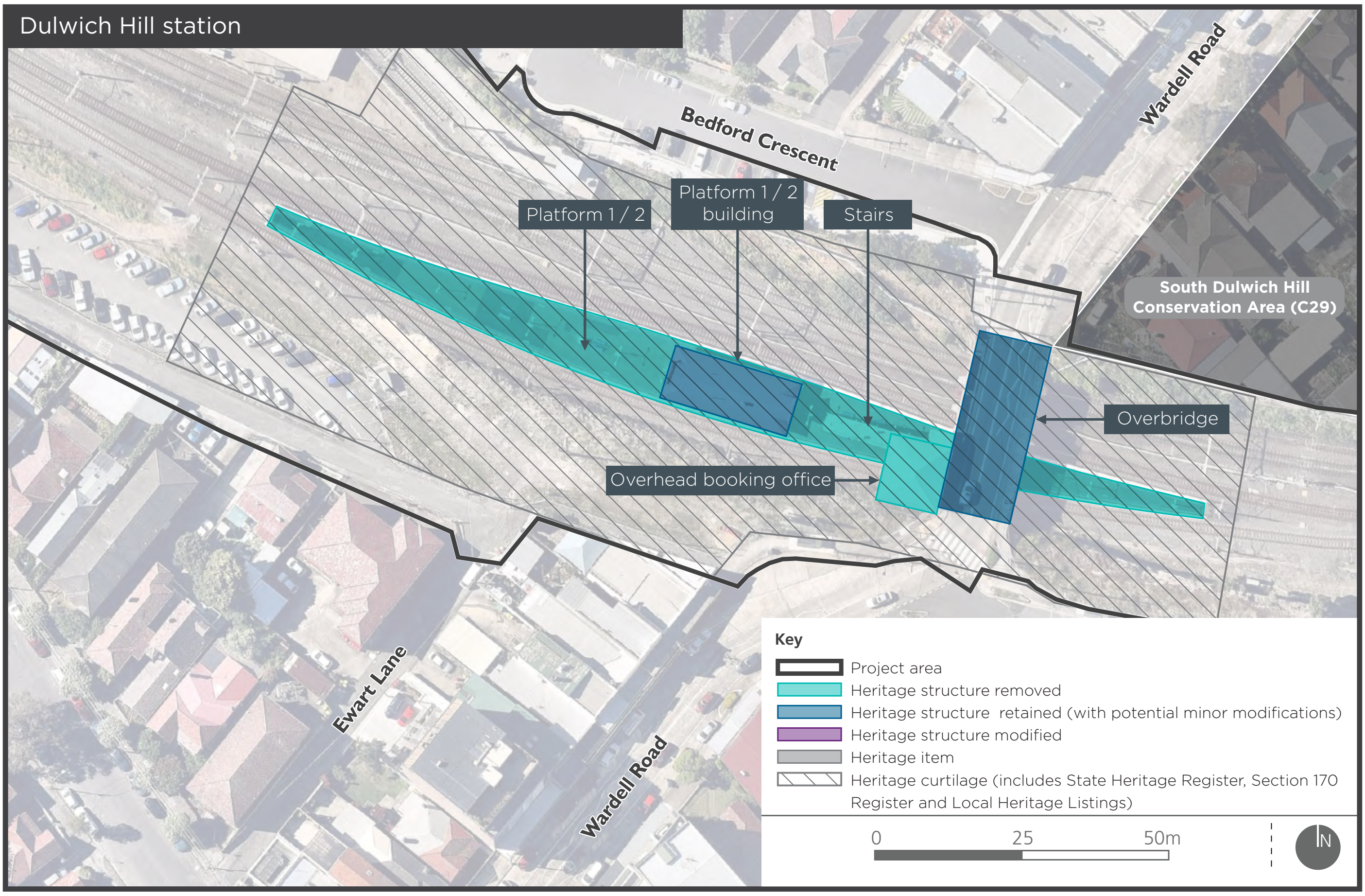
When assessed cumulatively, the level of heritage impact of the project on the Dulwich Hill Railway Station Group would be major. However, based on the historical significance of the station and the aesthetic values of the retained platform building, the heritage item would continue to meet the threshold for local significance.

Other items

Direct impacts on the other three heritage items/conservation areas would be neutral, except for the South Dulwich Hill Heritage Conservation Area, which would experience a negligible direct impact. Works in the vicinity of the South Dulwich Hill heritage conservation area and the Inter-War Heritage Conservation Area Group would result in a negligible visual impact overall, while a neutral visual impact is anticipated for Gladstone Hall.

Potential impacts as a result of vibration would be minor for all three heritage items/heritage conservation areas, provided that the measures in Section 14.4 are implemented.

When assessed cumulatively, the level of heritage impact of the project on the three heritage items/heritage conservation areas would be negligible, and they would continue to meet the threshold for local significance.



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Impacts on heritage at Marrickville and Dulwich Hill stations

FIGURE 14.2

14.3.4 Hurlstone Park Station

Existing items

Heritage listed items in the vicinity of Hurlstone Park Station with the potential to be impacted by the project are summarised in Table 14.12 and shown in Figure 14.1. Table 14.13 lists the main structures and elements within the Hurlstone Park Railway Station Group, including relevant information such as date, condition, and significance.

Table 14.12 Hurlstone Park Station – heritage items

Item	Listing	Location
Hurlstone Park Railway Station Group	RailCorp s.170 (4805737) Canterbury LEP (I124)	In project area
Hurlstone Park Railway Underbridge	Canterbury LEP (I126)	In project area

Direct impacts

An assessment of the direct impacts of the project on the fabric of each element constituting the Hurlstone Park Railway Station Group, and an assessment of the subsequent impacts on the heritage values of the station group as a whole, is provided in Table 14.13. Potential impacts are illustrated in Figure 14.3.

The direct impacts of the works on the Hurlstone Park Railway Underbridge would be negligible. General maintenance works would be required, as well as waterproofing to the whole bridge deck to mitigate future water attributed issues. Works to minimise future maintenance would involve the removal of non-significant parapets and replacement with new precast parapets with the screens pre-installed.

Table 14.13 Summary of direct impacts to significant elements within the Hurlstone Park Railway Station Group

Significant elements	Condition	Significance	Proposed works	Assessment of direct impact
Platform 1 (1894)	Generally good	High	Removal Platform to be rebuilt in straight alignment Covered concourse, access stairs, lift shaft, platform canopies, platform screen doors, and station buildings anchored on new platform	The overall impact to this element has been assessed as major due to the following: • major impact on the platform, as the removal of the platform would result in complete loss of the fabric of the platform including the original brick face and curved layout • new covered concourse, access stairs, lift shaft, platform canopies, and platform screen doors anchored and constructed on the new platform would not further impact significant fabric • major impact on the station group from the reconstruction of Platform 1 in a straight alignment.

Significant elements	Condition	Significance	Proposed works	Assessment of direct impact
Platform 2 (1894)	Generally good	High	Removal apart from structure underneath heritage building Platform to be rebuilt in straight alignment Covered concourse, access stairs, lift shaft, platform canopies, platform screen doors and station buildings anchored on new platform	The overall impact to this element has been assessed as major due to the following: • major impact on the platform, as removal would result in the complete loss of the fabric of the platform, including the original brick face and curved layout • new covered concourse, access stairs, lift shaft, platform canopies, and platform screen doors anchored and constructed on the new platform would not further impact significant fabric • major impact on the station group from the reconstruction of Platform 2 in a straight alignment.
Platform building, Platform 1 (Type 11) (1915)	Generally good	High	Removal to allow construction of a new paid concourse, canopies, and station buildings	The overall impact to this element has been assessed as major as removal of the building would have a major impact on the fabric of the building and on Hurlstone Park Station as a whole.
Platform building, Platform 2 (Type 11) (1915)	Generally good externally. The disused waiting rooms and toilets rooms in the building on Platform 2 are in a poor condition	High	Retention for re-use with potential retrofitting	The overall impact to this element has been assessed as minor due to the following: • positive heritage outcome in the context of the project from the retention of the platform building • retrofitting for new accommodation would be designed to minimise impacts to original fabric, including preservation of the original layout where possible, and removal of any intrusive modifications • additions to the building and platform would be designed to be sympathetic to the heritage context and minimise fabric and visual impacts.
Footbridge (1915)	Good	High (stairs) Moderate (footbridge) Little (deck)	Removal to allow construction of a new concourse, canopies, and station buildings	The overall impact to this element has been assessed as major as removing the footbridge and stairs would have a major impact on the fabric of the footbridge and on the station as a whole.
Brick abutments (c.1915)	Good	High	Retention and upgrade	The overall impact to this element has been assessed as minor as retaining and regrading the brick abutments would result in a minor impact on the heritage values of the brick abutments and station overall.
Overhead booking office (c.1980)	Good	Little	Removal	The overall impact to this element has been assessed as neutral as the overhead booking office is not identified as significant in the *Railway Overhead Booking Office Conservation Strategy*.

Significant elements	Condition	Significance	Proposed works	Assessment of direct impact
Landscape/ natural features	Good	High	Retention	The overall impact to this element has been assessed as neutral positive as the sandstone wall on Platform 2 would be retained.

Visual impacts

Hurlstone Park Railway Station Group

The contemporary nature of the proposed new concourse, canopies, and station buildings would present a distinctive design, easily differentiated from the heritage components. A new platform building on Platform 1 would be located opposite the Platform 2 building of a similar scale and contemporary style. The footprint of the overall concourse, new platform building, platform canopies, and platform screen doors would add considerable bulk to the original low-scale station and impact the open context and setting. The concourse would be located to the east of the retained platform building. Although the height and open layout of the new concourse would allow some views to the retained building on Platform 2, views from Crinian/Duntroon Street to the platform building would be impeded. Views would also be obscured by the proposed ribbon canopies over the two sets of access stairs from the concourse to the platforms. These canopies would extend along the platforms, with a gap of at least two metres at either side of the Platform 2 building. The canopy fabric adjacent to the Platform building would be glazed to maximise visibility. The visual impact of the new concourse on the setting of the station would be major overall.

The removal of the curved platforms, the Platform 1 building, and the footbridge stairs would result in loss of the majority of the heritage components, resulting in a major visual impact on the station. The new structures would replace the heritage components of the station group, and the overall character of the station would be significantly altered. Although the removal of the c.1980 overhead booking office would present an opportunity to enhance views to the Platform 2 building, these views would eventually be mostly screened by the new concourse and large-scale canopy.

The platform screen doors along the reconstructed platforms would have a minor impact on external views from the platform buildings and from the new concourse towards the heritage building, and a moderate impact on internal views as a result of visual clutter.

Overall, the proposed concourse and platform building would result in a major visual impact. Views to the Platform 2 building would be partially retained from the concourse, although views from Crinian/Duntroon Street would be impeded. Views of the curved platforms, the Platform 1 building, and footbridge stairs would be lost with the removal of these elements, which is considered a major impact. The platform screen doors would result in a moderate visual impact.

When considering cumulative impacts overall, the assessment concluded that the project would result in a major visual impact on the Hurlstone Park Railway Station Group.

Hurlstone Park Railway Underbridge

The visual impact on the Hurlstone Park Railway Underbridge would be negligible. The proposed works are unlikely to significantly alter the existing aesthetics of the bridge.

This item is located about 180 metres west of Hurlstone Park Railway Station, and views to the station are very limited. The proposed works to the station would have a negligible visual impact on the underbridge. New tracks and overhead wiring would consistent with the current setting of the item and would have a neutral visual impact.

Potential direct (vibration) impacts

Table 14.14 summarises the potential vibration impacts on heritage items.

Table 14.14 Potential vibration impacts

Item	Potential impact
Hurlstone Park Railway Station Group	Minor: The closest façade of this item would experience vibration levels above the screening level for cosmetic damage. Further assessment and management would be undertaken in accordance with the approach described in Section 14.4.
Hurlstone Park Railway Underbridge	Negligible: Vibration levels would be below the cosmetic damage screening level.

Statements of heritage impact

Hurlstone Park Railway Station Group

The direct impacts of the project on the Hurlstone Park Railway Station Group would be major. Most elements of high significance within the station would be removed, with the exception of the less prominent of two 1915 platform buildings (the Platform 2 building), resulting in major direct and visual impacts on the station as a whole. The visual impact on the setting of the station and significant views to and from the station would also be major.

Potential direct impacts as a result of vibration would be minor, provided that the mitigation measures in Section 14.4 are implemented.

The project would remove all the original elements of the Hurlstone Park Railway Station Group except for the Platform 2 building, the brick abutments of the Crinian Street overbridge and the sandstone wall on Platform 2. This would significantly impact the integrity, aesthetics, and representativeness significance of the station. The removal of most original elements would severely impact the legibility of the historical values of the place as one of the original railway stations on the Bankstown Line. The Platform 2 building would remain the sole tangible element to represent the heritage significance of the railway station. The Platform 2 building would retain some of the heritage values of the place, and Hurlstone Park Station would retain its historical use.

There are unlikely to be direct impacts to the currently unlisted items and heritage conservation areas considered in the *Hurlstone Park Heritage Study* (Paul Davies, 2016). The detailed design for the station catchment would consider the context and setting of the items and proposed heritage conservation areas.

When considering cumulative impacts overall, the assessment concluded that the project would result in a major impact on the Hurlstone Park Railway Station Group overall. However, based on the historical significance of the station and the heritage values of the retained platform building, the heritage item would continue to meet the threshold for local significance.

Hurlstone Park Railway Underbridge

The direct impacts of the project on the Hurlstone Park Railway Underbridge would be negligible, and works to the bridge and in its vicinity would result in negligible visual impacts. Potential direct impacts as a result of vibration would be negligible.

When considering cumulative impacts overall, the assessment concluded that the project would result in a negligible impact on the Hurlstone Park Railway Underbridge. The heritage item would continue to meet the threshold for local significance.

14.3.5 Canterbury Station

Existing items

Heritage listed items in the vicinity of Canterbury Station with the potential to be impacted by the project are summarised in Table 14.15 and shown in Figure 14.1. Table 14.16 lists the main structures and elements within the Canterbury Railway Station Group, including relevant information such as date, condition, and significance.

Table 14.15 Canterbury Station – heritage items

Item	Listing	Location
Canterbury Railway Station Group	SHR (No. 01109) RailCorp s.170 (4801100) Canterbury LEP (I67)	In project area
Canterbury (Cooks River) Underbridge	RailCorp s.170 (4801568) Canterbury LEP (I126)	In project area
Canterbury (Cooks River/ Charles St) Underbridge - Main Line	RailCorp s.170 (5062566)	In project area
Old Sugarmill/Canterbury Sugar Mill (former)	SHR (00290) Canterbury LEP (I82)	Adjacent to project area
Inter-War hotel - former Hotel Canterbury	Canterbury LEP (I68)	Adjacent to project area
Federation Post Office Building (former Canterbury Post Office)	Canterbury LEP (I66)	Adjacent to project area
Electricity Substation no. 275	Ausgrid s.170 (3430425)	Adjacent to project area

Direct impacts

An assessment of the direct impacts of the project on the fabric of each element constituting the Canterbury Railway Station Group, and an assessment of the subsequent impacts on the heritage values of the station group as a whole, is provided in Table 14.16. Potential impacts are illustrated in Figure 14.3.

The project would likely result in a moderate direct impact on the Canterbury (Cooks River) Underbridge, and minor direct impact on the Canterbury (Cooks River/Charles Street) Underbridge, as a result of the proposed removal and replacement of the parapets.

Table 14.16 Summary of direct impacts to significant elements within the Canterbury Railway Station Group

Significant elements	Condition	Significance	Proposed works	Assessment of direct impact
Platform 1 (1895)	Generally good	High	Removal Platform to be rebuilt in straight alignment Covered concourse, access stairs, lift shaft, platform canopies and platform screen doors anchored on new platform	The overall impact to this element has been assessed as major due to the following: • major impact on the platform from the complete loss of the fabric of the platform, including the original brick face and curved layout • new covered concourse, access stairs, lift shaft, platform canopies, and platform screen doors anchored and constructed on the new platform would not further impact significant fabric • major impact on the station group from complete demolition of Platform 1 to be reconstructed in a straight alignment.

Significant elements	Condition	Significance	Proposed works	Assessment of direct impact
Platform building, Platform 1 (Type 11) (1895)	Generally good	Exceptional	Retention for re-use with potential retrofitting	The overall impact to this element has been assessed as minor due to the following: • positive heritage outcome in the context of the project from retention of the platform building • retrofitting for new accommodation would be designed to minimise impacts to original fabric, including preservation of the original layout where possible, and removal of any intrusive modifications • additions to the building and platform would be designed to be sympathetic to the heritage context and minimise fabric and visual impacts. • with appropriate design for re-use, the project would have a minor impact on the heritage values of the building and station overall.
Platform 2 (1895)	Generally good	High	Removal apart from structure underneath heritage building platform to be rebuilt in straight lines Covered concourse, access stairs, lift shafts, platform canopies and platform screen doors to be anchored on new platform	The overall impact to this element has been assessed as major due to the following: • major impact on the original platform resulting from the complete loss of the fabric of the platform, including the original brick face and curved layout • new covered concourse, access stairs, lift shafts, platform canopies, and platform screen doors anchored and constructed on the new platform would not further impact significant fabric • major impact on the station group from the demolition of Platform 2 to be reconstructed in a straight alignment.
Platform building, Platform 2 (Type 11) (1915)	Generally good	High	Retention for re-use with potential retrofitting	The overall impact to this element has been assessed as minor due to the following: • positive heritage outcome in the context of the project from retention of the platform building • retrofitting for new accommodation would be designed to minimise impacts to original fabric, including preservation of the original layout where possible, and removal of any intrusive modifications • additions to the building and platform would be designed to be sympathetic to the heritage context and minimise fabric and visual impacts.
Signal box (1915)	Exterior in reasonably good condition	High	Retention	The overall impact to this element has been assessed as neutral as retaining the signal box is a positive heritage outcome in the context of the project.

Significant elements	Condition	Significance	Proposed works	Assessment of direct impact
Footbridge (1915, 1947)	Good	Moderate	Removal for replacement with new covered concourse including access stairs and lift shafts	Removal of the footbridge would have a major impact on the footbridge and a moderate impact on the station overall.
Overbridge (c.1917)	Good	High	Retention and upgrade	Maintenance and protection works would involve removal and replacement of the brick parapets, resulting in a moderate impact on the heritage values of the overbridge and the station overall.
Overhead booking office and concourse (Late 1980s)	Good	Little	Removal for replacement with new covered concourse including access stairs and lift shafts	The overall impact to this element has been assessed as neutral as the overhead booking office is not identified as significant in the *Railway Overhead Booking Office Conservation Strategy*.
Canopies (Late 1980s)	Good	Little	Removal for replacement with new platform canopies	Removal of the canopies would result in a neutral impact on the station.

Visual impacts

Canterbury Railway Station Group

Medium-scale ribbon canopies and platform screen doors would be located along the reconstructed platforms. The contemporary nature of the new concourse, canopies, and station buildings would present a distinctive design easily differentiated from the heritage components, and would not have a significant impact on internal views. The ribbon canopies from the concourse to the west would be elevated enough to allow views from the concourse onto the two retained significant platform buildings. The canopies would not continue above these structures, further facilitating the views from the concourse and lifts. Although the station currently has an open layout and setting, the existing canopies over the access stairs from the concourse obscure views, these would be removed. Views are not currently available from the walled concourse. New canopies on the western side of the station would be installed away from the heritage buildings. New station buildings would be located at a notable distance, at the western side of Platform 2. The new concourse would have a moderate visual impact on the station.

Removal of the footbridge, the integrity of which has been impacted over time, would result in a moderate visual impact on the station. The removal of the overhead booking office is of little significance, and would not result in a visual impact. The removal of the existing footbridge and overhead booking office would enlarge views to the heritage buildings from Canterbury Road, resulting in a positive heritage outcome. Such views would also be available from the new concourse. Enhanced views to the heritage buildings of exceptional and high significance would result in a positive visual impact.

The covered area from Canterbury Road would be located at street level and would be visible from the platform buildings. Views towards this area are not of high significance, and views towards the heritage buildings would be opened. This would have a negligible visual impact on the station.

The removal of the brick parapets of the overbridge would have a moderate impact on the existing view of the bridge. The platform screen doors along the platforms would result in a minor impact on external views from the platform buildings and from the new concourse towards the heritage buildings, and a moderate impact on internal views as a result of visual clutter.

When considering cumulative impacts overall, balancing the positive impacts in relation to removal of intrusive elements and the high quality design of the new elements, the assessment concluded that the project would result in a moderate visual impact on the Canterbury Railway Station Group.

Other items

There would be minor visual impacts on the Canterbury (Cooks River) Underbridge and Canterbury (Cooks River/Charles St) Underbridge – Main Line. While the removal and replacement of the parapets would have a moderate visual impact on both of the underbridges, these items are located about 200 metres away from Canterbury Station and existing views are very limited, resulting in negligible visual impacts from works to the station. New tracks and overhead wiring would be consistent with the existing setting of the heritage item and would have a neutral visual impact.

The project would result in negligible impacts on the Old Sugarmill and Electricity Substation no. 275, as existing views towards the rail corridor are partially screened. The replacement of the Church Street/Hutton Street footbridge is unlikely to significantly alter the aesthetics of the existing environment, and the visual impacts of the new bridge on the heritage items are anticipated to be negligible.

Neutral visual impacts are anticipated for both the Inter-War Hotel (former Hotel Canterbury) and Federation Post Office Building (former Canterbury Post Office). There are currently direct views to the station entrance from both items, however views towards the rail corridor are screened, as the rail line is located in a cutting at a lower level. As the booking office is of little significance, its removal would not significantly impact either item. Any views to new tracks and overhead wiring would be consistent with the existing views and vistas of the heritage item and would have a neutral visual impact.

Potential direct (vibration) impacts

Table 14.17 summarises the potential vibration impacts on listed heritage items.

Table 14.17 Potential vibration impacts

Item	Potential impact
Canterbury Railway Station Group Old Sugarmill Federation Post Office Building (former Canterbury Post Office)	Minor: The closest façade of these items would experience vibration levels above the screening level for cosmetic damage. Further assessment and management would be undertaken in accordance with the approach described in Section 14.4.
Canterbury (Cooks River) underbridge Canterbury (Cooks River/Charles St) Underbridge - Main Line Inter-War Hotel (former Hotel Canterbury) Electricity substation no. 275	Negligible: Vibration levels would be below the cosmetic damage screening level.

Statements of heritage impact

Canterbury Railway Station Group

The project would result in moderate direct impacts on the Canterbury Railway Station Group. All elements of exceptional and high significance within the station would be retained, except for the original brick platforms and their curved layout. The Platform 1 building of exceptional significance, the Platform 2 building, the Signal Box, and the overbridge of high significance would be retained for future use, resulting in a minor impact and presenting an opportunity for a positive outcome. Views to the platform buildings would be enhanced from the Canterbury Road overbridge and would also be appreciated from the new concourse, resulting in a positive visual impact.

The removal of the original curved platforms would result in a major direct and visual impact. The removal of the footbridge would result in moderate direct and visual impacts.

The new concourse would contrast with the remaining heritage elements. The concourse would be located on the western side of the station at a notable distance from the Platform 1 building and setback from the Platform 2 building. The new concourse would have a moderate visual impact overall. The construction of the covered activation area would have a negligible visual impact. The removal of the brick parapets of the overbridge would have a moderate direct impact. Potential direct impacts as a result of vibration would be minor provided that the mitigation measures in Section 14.4 are implemented.

The impacts of the removal of the original 1895 brick platforms and the 1915 footbridge within would be balanced by the retention of all other significant elements, including the 1895 platform building, the 1915 platform building, and overbridge. This would enable the station to conserve its historic, aesthetic and representativeness significance. The 1895 platform building is an excellent example of its type, and would continue to demonstrate the heritage values of the station as one of the original railway stations on the Bankstown Line. The retention of the 1915 platform building and overbridge would retain two elements of the subsequent layer of development of the station.

When considering cumulative impacts overall, the assessment concluded that the project would result in a moderate impact on the Canterbury Railway Station Group. Based on the historical significance of the station and the heritage values of the retained buildings, the item would continue to meet the threshold for State significance.

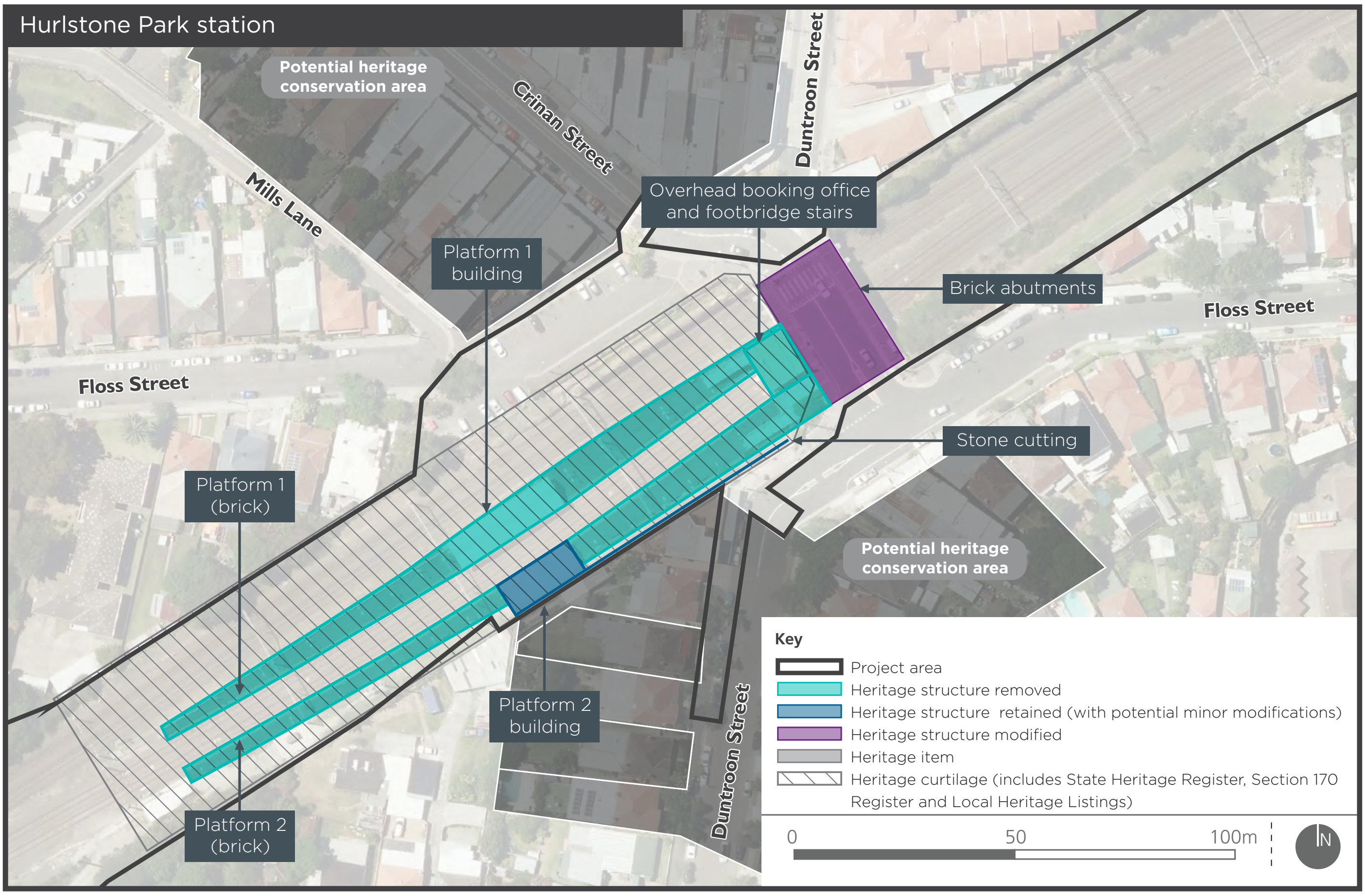
Other items

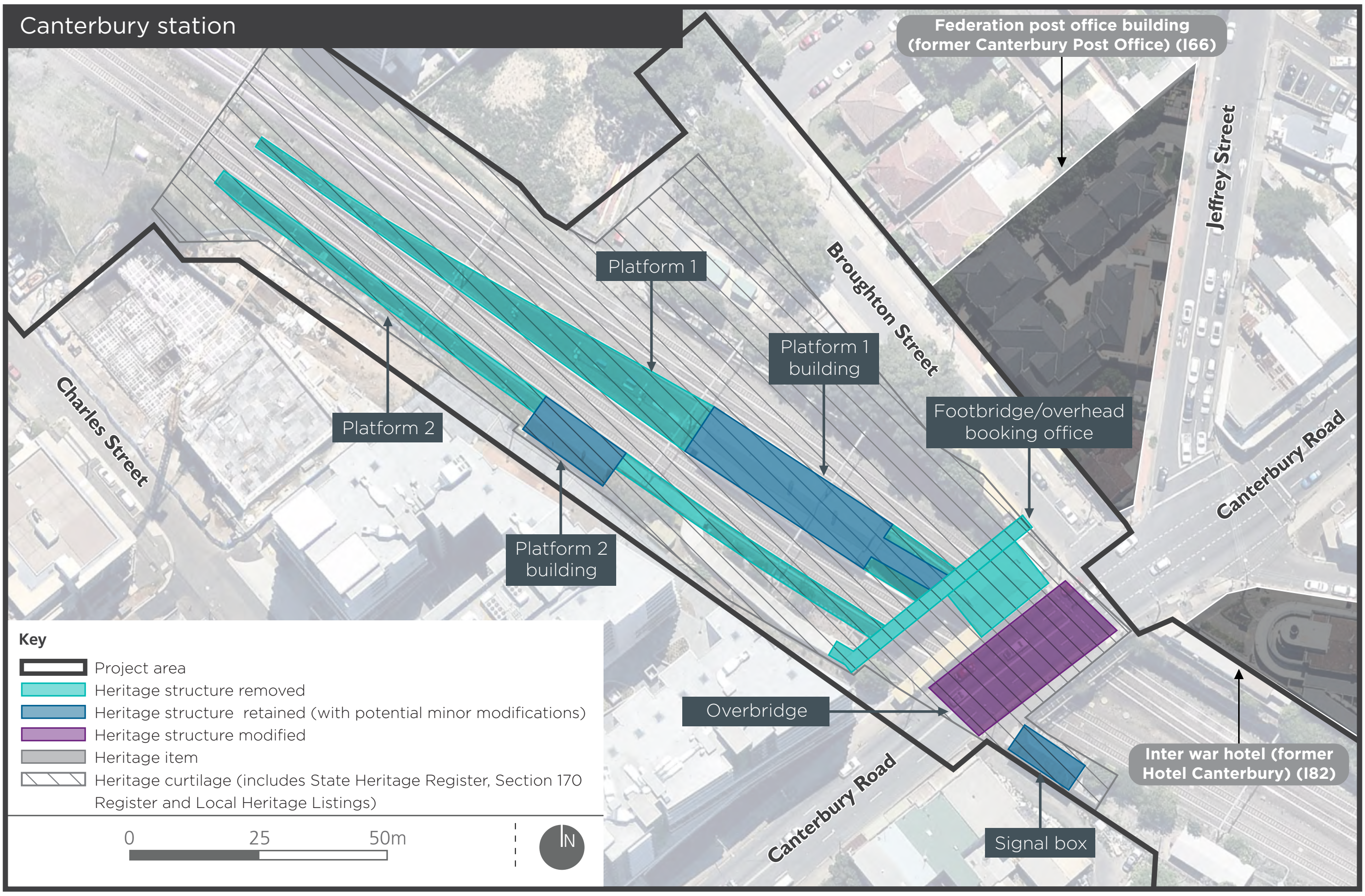
The project would result in moderate direct impacts on the Canterbury (Cooks River) Underbridge and minor direct impacts on the Canterbury (Cooks River/Charles St) Underbridge – Main Line. Works on the bridges would result in minor visual impacts at both items and vibration impacts would be negligible.

Negligible impacts are anticipated for both the Old Sugarmill and Electricity Substation no. 275. Direct impacts would be neutral, while visual impacts are anticipated to be negligible at both items. Potential direct impacts as a result of vibration would be negligible at Electricity Substation no. 275, while the Old Sugarmill would experience minor vibration impacts, provided that the mitigation measures in Section 14.4 are implemented.

The project would result in neutral direct impacts on the Inter-War Hotel and Federation Post Office Building. Vibration impacts on the Inter-War Hotel are likely to be negligible, while the Federation Post Office Building would experience minor impacts, provided that the mitigation measures in Section 14.4 are implemented.

All items would continue to meet the threshold for local significance.





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Impacts on heritage at Hurlstone Park and Canterbury stations

FIGURE 14.3

14.3.6 Campsie Station

Existing items

Heritage listed items in the vicinity of Campsie Station with the potential to be impacted by the project are summarised in Table 14.18 and shown in Figure 14.1. Table 14.19 lists the main structures and elements within the Campsie Railway Station Group, including relevant information such as date, condition, and significance.

Table 14.18 Campsie Station – heritage items

Item	Listing	Location
Campsie Railway Station Group	RailCorp s.170 (4801101) Canterbury LEP (I40)	In project area
Federation commercial building–Coffill's Buildings	Canterbury LEP (I41)	Adjacent to project area
Inter-War Commercial Building–Station House	Canterbury LEP (I42)	Adjacent to project area
Inter-War Court House (former) Campsie Court House	Canterbury LEP (144)	Adjacent to project area
War Memorial Clock Tower	Canterbury LEP I34)	Adjacent to project area
Federation house	Canterbury LEP (I61)	Adjacent to project area
Federation villa	Canterbury LEP (I62)	Adjacent to project area

Direct impacts

An assessment of the direct impacts of the project on the fabric of each element constituting the Campsie Railway Station Group, and an assessment of the subsequent impacts on the heritage values of the station group as a whole, is provided in Table 14.19. Potential impacts are illustrated in Figure 14.4.

Table 14.19 Summary of direct impacts to significant elements within the Campsie Railway Station Group

Significant elements	Condition	Significance	Proposed works	Assessment of direct impact
Platform 1 (1894)	Generally good	High	Removal apart from structure underneath heritage building Platform to be rebuilt in straight alignment Covered concourse, access stairs, lift shafts, platform canopies and platform screen doors anchored on new platform	The overall impact to this element has been assessed as major due to the following: • major impact from the almost complete loss of the fabric of the platform and of the original curved layout • new covered concourse, access stairs, platform canopies, and platform screen doors anchored and constructed on the new platform would not further impact significant fabric • major impact on the station from the reconstruction of Platform 1 in a straight alignment.
Platform 2 (1894)	Generally good	High	Removal apart from structure underneath heritage building Platform to be rebuilt in straight alignment Covered concourse, access stairs, lift shaft, platform canopies and	The overall impact to this element has been assessed as major due to the following: • major impact from the almost complete loss of the fabric of the platform and of the original curved layout

Significant elements	Condition	Significance	Proposed works	Assessment of direct impact
			platform screen doors to be anchored on new platform	• new covered concourse, access stairs, platform canopies, and platform screen doors anchored and constructed on the new platform would not further impact significant fabric • major impact on the station from the reconstruction of Platform 2 in a straight alignment.
Platform building, Platform 1 (Type 11) (1915)	Good	High	Retention for re-use with potential retrofitting	The overall impact to this element has been assessed as minor due to the following: • positive heritage outcome in the context of the project from retention of the platform building • retrofitting for new accommodation would be designed to minimise impacts to original fabric, including preservation of the original layout where possible, and removal of any intrusive modifications • additions to the building and platform would be designed to be sympathetic to the heritage context and minimise fabric and visual impacts • minor impact on the heritage values of the building and station overall.
Platform building, Platform 2 (Type 11) (1915)	Generally good	High	Retention for re-use with potential retrofitting	The overall impact to this element has been assessed as minor due to the following: • positive heritage outcome in the context of the project from retention of the platform building • retrofitting for new accommodation would be designed to minimise impacts to original fabric, including preservation of the original layout where possible, and removal of any intrusive modifications • additions to the building and platform would be designed to be sympathetic to the heritage context and minimise fabric and visual impacts • minor impact on the heritage values of the building and station overall.
Concourse including overhead booking office and Parcels Office	Good	Little (Concourse) Moderate (Overhead booking office and Parcels Office)	Retention and partial removal for upgrading	The overall impact to this element has been assessed as moderate due to the following: • remnant elements of the overhead booking office building are wholly incorporated into the modern overhead concourse • moderate impacts on the station overall as the integrity of the early elements to be removed have been greatly compromised over time.
Overbridge (1915)	Good	High	Retention and upgrade	Retention and upgrade of the overbridge would result in a minor impact on the heritage values of the overbridge and station overall.

Significant elements	Condition	Significance	Proposed works	Assessment of direct impact
Footbridge (1947, 2002)	Good	Little	Retention	Retention of the footbridge would result in a neutral impact on the station.
Platform 3[1] (1916, 1950)	Generally good	Moderate	Removal	Moderate impact from removal of the platform.
Platform canopies, Platforms 1-3 (2002)	Good	Little	Removal	Neutral impact from removal of the platform canopies.
Landscape/ natural features (n/a,1915)	Generally good	High	Removal to accommodate new covered concourse, access stairs and lift shaft	The overall impact to this element has been assessed as moderate due to the following: • major impact on the wall from the removal of the cambered stone and brick retaining wall • moderate impact on the station as the wall's significance is mainly in relation to its aesthetic qualities rather than its purpose or historical significance.

Notes: 1. Platform 3 is a disused wayside platform originally constructed in 1916 as a brick face platform. It was replaced by the existing concrete platform in about 1950.

Visual impacts

Campsie Railway Station Group

The proposed canopy above the concourse would rise to a similar height to the existing shopfronts on Beamish Street. Three ribbon canopies would extend from the concourse to cover access to the platforms. The canopies would end at least two metres from the significant heritage buildings on Platforms 1 and 2. Two ribbon canopies would extend east of the heritage buildings on Platforms 1 and 2 along the platforms. The height of the canopies would allow views of the heritage structures to be retained from the concourse.

The contemporary nature of the canopies and station buildings would be suitable as a distinctive design easily differentiated from the heritage components. The scale and height of the proposed canopy structure, the footprint of the new platform building, the platform canopies, and platform screen doors would add considerable bulk compared with the existing low-scale station catchment.

The concourse would be located to the east of the retained platform building. The height and open layout of the upgraded concourse would allow views to the retained platform buildings from the concourse. The upgraded structure would be visually dominant within the station group. Overall, the visual impact of the upgraded concourse on the setting of the station would be moderate.

The upgraded concourse would replace elements of little or moderate significance within the station, giving rise to a minor visual impact. Moderate visual impacts would arise from the removal of the cambered stone retaining wall located along the platform.

The platform screen doors would result in a minor impact on external views from the platform buildings and from the new concourse towards the heritage buildings, and a moderate impact on internal views as a result of visual clutter.

Overall, the upgraded concourse and large and medium-scale canopies would result in a moderate visual impact. Views to the platform buildings would be available from the upgraded concourse. Views to the curved platforms, cambered stone and brick retaining wall would be lost, resulting in a major visual impact. Loss of views to impacted elements such as the overhead booking office and the Parcels office would have a moderate impact. The platform screen doors would result in a moderate visual impact overall.

When considering cumulative impacts overall, the assessment concluded that the project would result in a moderate visual impact on the Campsie Railway Station Group.

Other items

Negligible visual impacts are anticipated at Federation commercial building–Coffill's Buildings, Inter-War Commercial Building–Station House, Federation house, and Federation villa. There is a direct visual connection between the station entrance and Coffill's Buildings and Station House. However, views from Federation house and Federation villa are partially screened by vegetation. Any views of the new tracks and overhead wiring from these items would be consistent with the existing views and vistas of the items, resulting in a neutral visual impact.

The new station building along South Parade would not impact on significant views to and from Federation house or Federation villa. The removal of shops along Beamish Street would open up views towards Coffill's Buildings and Station House, however the new canopy and station buildings would not impact on significant views to and from Coffills' Buildings or Station House. Works on the existing Duck Street footbridge are unlikely to significantly alter the aesthetics of the bridge, and visual impacts are anticipated to be negligible for Coffills' Buildings, Federation House, and Federation Villa.

The project would result in neutral visual impacts on the Inter-War Court House (former) Campsie Court House and War Memorial Clock Tower. Existing views from the Court House towards the rail line are partially screened by vegetation, and views from the War Memorial Clock Tower towards the station are screened by commercial buildings. Changes to the station buildings would not impact views and vistas from the War Memorial Clock Tower. Any views to the new tracks and overhead wiring from the Court House would be consistent with the existing views and vistas. In addition, works on the Lock Street overbridge are unlikely to significantly alter the aesthetics of the bridge, and visual impacts on the War Memorial Clock Tower, located at a notable distance, are anticipated to be negligible.

Potential direct (vibration) impacts

Table 14.20 summarises the potential vibration impacts on heritage items.

Table 14.20 Potential vibration impacts

Item	Potential impact
Campsie Railway Station Group Inter-War Commercial Building–Station House	Minor: The closest façade of these items would experience vibration levels above the screening level for cosmetic damage. Further assessment and management would be undertaken in accordance with the approach described in Section 14.4.
Federation commercial building–Coffill's Buildings Inter-War Court House (former) Campsie Court House War Memorial Clock Tower Federation house Federation villa	Negligible: Vibration levels would be below the cosmetic damage screening level.

Statements of heritage impact

Campsie Railway Station Group

Overall, it is anticipated that the project would result in a moderate heritage impact on the Campsie Railway Station Group. Based on the historical significance of the station and the heritage values of the retained platform buildings, the heritage item would continue to meet the threshold for local significance.

The direct impacts of the project on the item would be moderate. Elements of high significance would be retained. The original 1894 platforms and the 1915 cambered stone retaining wall would be removed. This would result in moderate to major direct and visual impacts. Other elements to be removed are of little or moderate significance, resulting in minor to moderate direct and visual impacts. The visual impact on the setting of the station would be moderate overall. Potential direct impacts as a result of vibration would be minor, provided the mitigation measures in Section 14.4 are implemented.

The removal of some elements of high and moderate significance would be generally balanced by retention of the 1915 platform buildings and overbridge, enabling the station to continue to demonstrate its historic and aesthetic significance, and representativeness. The retention of the 1915 elements would allow the station to retain the historical values of the place as one of the original stations on the Bankstown Line. The two platform buildings are good examples of their type and would continue to contribute to the aesthetic significance of the station.

Other items

Overall, the project would result in negligible impacts on Federation Commercial Building–Coffill's Buildings, Inter-War Commercial Building–Station House, Federation House, and Federation villa. Direct impacts would be neutral, and negligible visual impacts are anticipated.

Potential vibration impacts would be negligible at the Federation Commercial Building, Federation House, and Federation villa, while minor impacts are predicted on the Inter-War Commercial Building–Station. Implementation of the measures in Section 14.4 would minimise the potential for vibration impacts.

Neutral impacts are anticipated for both the Inter-War Court House and the War Memorial Clock Tower. Direct and visual impacts are likely to be neutral for both items, while vibration impacts are likely to be negligible.

All items would continue to meet the threshold for local significance.

14.3.7 Belmore Station

Existing items

Heritage listed items in the vicinity of Belmore Station with the potential to be impacted by the project are summarised in Table 14.21 and shown in Figure 14.1. Table 14.22 lists the main structures and elements within the Belmore Railway Station Group, including relevant information such as date, condition, and significance.

Table 14.21 Belmore Station – heritage items

Item	Listing	Location
Belmore Railway Station Group	SHR (01081) RailCorp s.170 (4801084)	In project area
Post-war bus shelter and public lavatories	Canterbury LEP (I29)	In project area
Federation House (former station master's cottage)	Canterbury LEP (I10)	Adjacent to project area

Direct impacts

An assessment of the direct impacts of the project on the fabric of each element constituting the Belmore Railway Station Group, and an assessment of the subsequent impacts on the heritage values of the station group as a whole, is provided in Table 14.22. Potential impacts are illustrated in Figure 14.4. The project would not directly impact on the Post-war bus shelter and public lavatories.

Table 14.22 Summary of direct impacts to significant elements within the Belmore Railway Station Group

Significant elements	Condition	Significance	Proposed works	Assessment of direct impact
Platform 1/2 (1895, 1907)	Generally good	High	Removal apart from structure underneath heritage building, platform to be rebuilt in a straight alignment Covered concourse, access stairs, lift shafts, platform station building, platform canopies, and platform screen doors anchored on new platform	The overall impact to this element has been assessed as major due to the following: • major impact on the fabric of the platform including the loss of the original platform brick face • major impact on the original platform layout resulting from the loss of the historic curved platform • new covered concourse, access stairs, lift shaft, platform station building, platform canopies, and platform screen doors anchored and constructed on the new platform would not further impact significant fabric • demolition of Platform 1/2 to be reconstructed in a straight alignment would result in a major impact on the station overall.
Platform building (Type 11) (1895)	Good	Exceptional	Retention for re-use with potential retrofitting	The overall impact to this element has been assessed as minor due to the following: • positive heritage outcome in the context of the project from the retention of the platform building • retrofitting for new accommodation would be designed to minimise impacts to original fabric, including preservation of the original layout where possible, and removal of any intrusive modifications • additions to the building and platform would be designed to be sympathetic to the heritage context and minimise fabric and visual impacts

Significant elements	Condition	Significance	Proposed works	Assessment of direct impact
				• the project would have a minor impact on the heritage values of the building and station overall.
Overhead booking office and concourse (1937, 2008)	Good	High	Retention for re-use with potential retrofitting	The overall impact to this element has been assessed as minor due to the following: • positive heritage outcome in the context of the project from retention of the overhead booking office • retrofitting for new accommodation would be designed to minimise impacts to original fabric, including preservation of the original layout where possible, and removal of any intrusive modifications • additions to the building and platform would be designed to be sympathetic to the heritage context and minimise fabric and visual impacts.
Overbridge (Modified 1961)	Good	Little	Retention and upgrade	Negligible impacts on the heritage values of the overbridge and station overall from protection works, bridge widening, maintenance works, and retaining wall works.
Platform canopies (2008)	Good condition	Little	Removal for replacement with new covered concourse including access stairs and lift shafts	Neutral impact on the station from removal of the canopies

Visual impacts

Belmore Railway Station Group

Visual impacts would result from the removal of the original brick face and curved layout of the original island platform. The contemporary nature of the new development would contrast with the historic components of the site. The new concourse and access stairs would add considerable footprint and bulk within the station. As they would be situated close to the platform building, they would dominate the building, resulting in a moderate visual impact. The new station buildings would be of a similar scale as the heritage buildings, and located at a notable distance, resulting in a minor visual impact. The design of the concourse canopy would allow new views to the building of exceptional significance from the concourse. The existing intrusive canopy structure would be removed, enhancing views from the booking office. The canopy would extend from the concourse to the eastern edge of the significant platform building with at least two metres separation. Canopies would not extend between the platform building and the overhead booking office, retaining the relationship between these structures.

Platform screen doors would result in a minor impact on external views from the platform buildings and from the new concourse towards the heritage buildings, and a moderate impact on internal views as a result of visual clutter.

The new station building on Platforms 1 and 2 and the new services building would not visually dominate the retained heritage buildings, as they would be located at a distance to the east.

Overall, the project would add a contemporary layer of development on the east side of the station in contrast with the heritage components on the west side. Views towards the heritage buildings within the station catchment would not be obstructed, although the new structures would be large in scale and may be dominant. The project offers opportunity for positive impacts by enhancing views to the 1895 platform building from both the east and west. The project would alter the existing setting of the station, however visual impacts would be moderate.

When considering cumulative impacts overall, the assessment concluded that the project would result in a moderate visual impact on the Belmore Railway Station Group.

Other items

The project would result in minor visual impacts on the Post-war bus shelter. Views to the platform building of exceptional significance would continue to be appreciated from the item. However the new concourse, which would add considerable bulk to the station, would be visible in the background of the item.

Negligible visual impacts are anticipated for Federation House. While there is a direct visual connection between Federation House and the station entrance, the existing heritage station buildings next to the item would be retained, which would partially screen the new buildings and canopies. Views from Federation House are therefore unlikely to be significantly altered. No views towards Federation house would be impacted.

Potential direct (vibration) impacts

Table 14.23 summarises the potential vibration impacts on listed heritage items.

Table 14.23 Potential vibration impacts

Item	Potential impact
Belmore Railway Station Group Federation House (former station master's cottage)	Minor: The closest façade of this item would experience vibration levels above the screening level for cosmetic damage. Further assessment and management would be undertaken in accordance with the approach described in Section 14.4.
Post-war bus shelter and public lavatories	Negligible: Vibration levels would be below the cosmetic damage screening level.

Statements of heritage impact

Belmore Railway Station Group

Overall, the project would result in a moderate impact on the Belmore Railway Station Group.

There would be moderate direct impacts on the station. All elements of exceptional and high significance would be retained, except for the original 1895 brick island platform and its curved layout. The retention and retrofitting of the retained elements are anticipated to have a minor impact, and present an opportunity for a positive outcome. Views to the Platform 1/2 building would be enhanced from the overhead booking office and would also be appreciated from the new concourse. The scale and bulk of the new development is likely to dominate the platform building, resulting in a moderate visual impact. Potential vibration impacts would also be minor, provided that the measures in Section 14.4 are implemented.

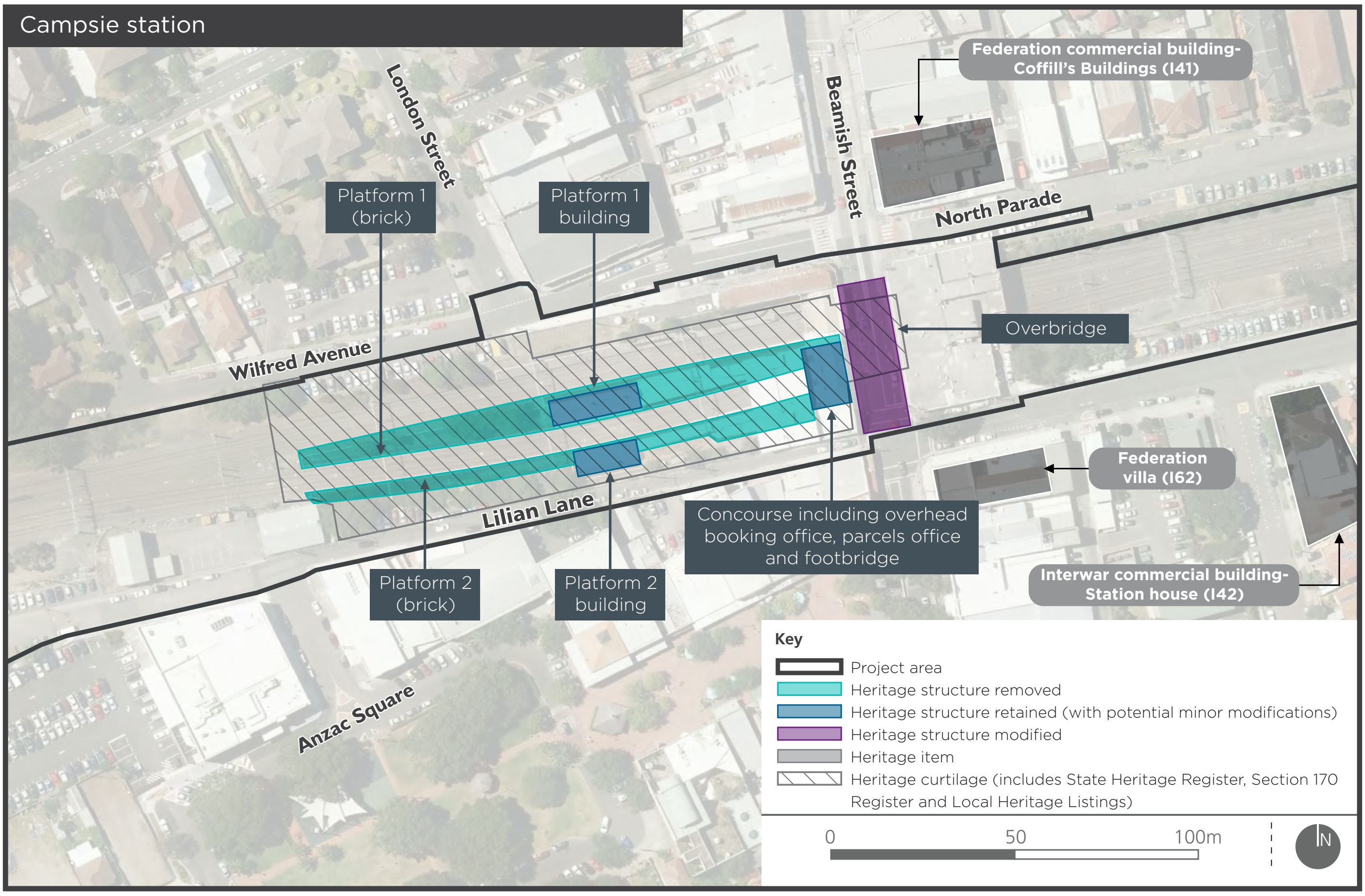
The impacts of the removal of the original island platform would be balanced by the retention of all other significant elements, including the platform building, overhead booking office, and the remaining elements of the overbridge. This would enable the station to conserve its historic, aesthetic, and representativeness significance. The platform building would continue to demonstrate the heritage values of the station as one of the original stations on the Bankstown Line. The retention of the overhead booking office, although modified, would conserve a good example of an inter-war weatherboard booking office, and would continue contribute to the setting of the station.

All buildings listed as contributing to the State significance of the item would be retained. Based on the historical significance of the station and the heritage values of the retained buildings, the heritage item would continue to meet the threshold for State significance.

Other items

The project would result in a minor impact on the Post-war bus shelter and public lavatories, and a negligible impact on Federation House. Neutral direct impacts are predicted for both heritage items, however there would be minor visual impacts on the Post-war bus shelter and public lavatories, and negligible visual impacts on Federation House. The Post-war bus shelter would experience only negligible vibration impacts, while the Federation House would experience minor impacts, provided that the measures outlined in Section 14.4 are implemented.

Both heritage items would continue to meet the threshold for local significance.



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Impacts on heritage at Campsie and Belmore stations

FIGURE 14.4

14.3.8 Lakemba Station

Existing items

Heritage listed items in the vicinity of Lakemba Station with the potential to be impacted by the project are summarised in Table 14.24 and shown in Figure 14.1. Table 14.25 lists the main structures and elements within the Lakemba Railway Station Group, including relevant information such as date, condition, and significance.

Table 14.24 Lakemba Station – heritage items

Item	Listing	Location
Lakemba Railway Station Group	RailCorp s.170 (4801916) Canterbury LEP (I143)	In project area
Federation weatherboard house	Canterbury LEP (I144)	Adjacent to project area
Inter-War post office building - Lakemba Post Office	Canterbury LEP (I45)	Adjacent to project area
Electricity Substation no. 143	Ausgrid s.170 (3430296)	Adjacent to project area

Direct impacts

An assessment of the direct impacts of the project on the fabric of each element constituting the Lakemba Railway Station Group, and an assessment of the subsequent impacts on the heritage values of the station group as a whole, is provided in Table 14.25. Potential impacts are illustrated in Figure 14.5.

Table 14.25 Summary of direct impacts to significant elements within the Lakemba Railway Station Group

Significant elements	Condition	Significance	Proposed works	Assessment of direct impact
Platform 1/2 (1919)	Good	High	Removal apart from structure underneath heritage building and the existing concourse and stairs Platform to be rebuilt in straight alignment Platform canopies and platform screen doors anchored on new platform	The overall impact to this element has been assessed as major due to the following: • major impact on the fabric of the platform including the loss of the original brick face • major impact on the original platform layout from loss of the historic curved platform • platform canopies and platform screen doors anchored and constructed on the new platform would not further impact significant fabric • major impact on the station group overall from demolition of Platform 1/2 to be reconstructed in a straight alignment and extended.

Significant elements	Condition	Significance	Proposed works	Assessment of direct impact
Platform building, Platform 1/2 (Type 11) (1919)	Generally good	High	Retention for re-use with potential retrofitting	The overall impact to this element has been assessed as minor due to the following: • positive heritage outcome in the context of the project from the retention of the platform building • retrofitting for new accommodation would be designed to minimise impacts to original fabric, including preservation of the original layout where possible, and removal of any intrusive modifications • additions to the building and platform would be designed to be sympathetic to the heritage context and minimise fabric and visual impacts. • minor impact on the heritage values of the building and station overall if these considerations are implemented.
Footbridge and stairs (1926)	Good	Moderate	Retention with new lifts constructed to platform	The overall impact to this element and station overall has been assessed as minor due to the retention of the footbridge and construction of the new lifts to the platform.
War Memorial (1953)	Good	High	Retention Construction of new platforms	Platform works would have a neutral impact provided that works minimise any direct impacts and that the memorial is adequately protected during the works.
Overhead booking office/ concourse (2001)	Good	Little/ Intrusive	Existing concourse structure retained and expanded with new lifts to platforms	Retention of the existing concourse structure including stairs to platforms, stairs and lifts to north and south entries would result in a neutral impact and provide opportunity for a positive visual impact. The overhead booking office is not identified as significant in the *Railway Overhead Booking Offices Heritage Conservation Strategy* (Australian Museum Consulting, 2014).
Canopies (2001)	Good	Intrusive	Removal of the canopy over the stairs to the platform for replacement with new canopy Retention of concourse canopy	Minor positive impact on the station catchment from the removal of the modern canopies over the stairs to the platform.

Visual impacts

Lakemba Railway Station Group

New structures would be located on the western side of the station, with the retained Platform 1/2 building located roughly in the centre of the platform. The contemporary nature of the new development would contrast with the historic building. Platform canopies would be located between the new concourse and the platform building, resulting in a minor impact on views when looking towards the west façade of the platform building. The building would be clearly visible from the concourse and stairs. Platform screen doors would generally have a moderate impact on internal views. The removal and replacement of the lifts to the platform would have a minor visual impact.

The expanded concourse would result in moderate visual impacts on the station overall. The expanded concourse would add considerable footprint and bulk, and as it would be situated close to the platform building, it would dominate the platform building, resulting in a moderate visual impact. There would be major visual impacts from the removal of the original brick face and curved layout of the platform, and moderate visual impacts from the expansion of the existing concourse that incorporates elements of the original footbridge and stairs. The intrusive canopy structure currently obstructing views to the platform building would be removed.

The visual impacts of the works to the Haldon Street overbridge would be minor. The works to the bridge would be located a notable distance from the platform building, and would be mostly screened by the concourse. The works are unlikely to significantly alter the existing aesthetics of the bridge. The new retaining walls would be located along the embankments and would not be visually intrusive.

The new services building would be over 200 metres west of the station, and would not visually dominate the remaining heritage structures.

Overall, the project would add a contemporary layer of development on the eastern side of the station, contrasting with the heritage components on the western side. Views to the heritage buildings within the station catchment would not be obstructed, although the new structures would be large in scale and may be dominant. The expanded concourse would offer views to the platform building. The project would alter the existing setting of the station, however visual impacts would be moderate.

When considering cumulative impacts overall, the assessment concluded that the project would result in a moderate visual impact on the Lakemba Railway Station Group.

Other items

The project would result in neutral visual impacts on the Federation weatherboard house and Electricity Substation no.143. Existing views from the items towards the station/rail corridor are screened by vegetation. Any views to the new tracks and overhead wiring would be consistent with the existing views and vistas and would have a neutral visual impact. In addition, the new canopy and northern entrance concourse would remain outside views from the Electricity Substation no. 143. Views and vistas from the Federation weatherboard house would not be impacted.

Negligible visual impacts are anticipated for the Inter-War post office. The existing station entrance can be viewed from the post office, however the new canopy and station buildings would be mostly screened by existing buildings located on the northern side of The Boulevarde. The works would be larger in scale than the existing development, however, the scale and character of the new structures would not significantly detract from the existing.

Potential direct (vibration) impacts

Table 14.26 summarises the potential vibration impacts on heritage items.

Table 14.26 Potential vibration impacts

Item	Potential impact
Lakemba Railway Station Group	Minor: The closest façade of this item would experience vibration levels above the screening level for cosmetic damage. Further assessment and management would be undertaken in accordance with the approach described in Section 14.4.
Federation weatherboard house Inter-War post office building - Lakemba Post Office Electricity Substation no. 143	Negligible: Vibration levels would be below the cosmetic damage screening level.

Statements of heritage impact

Lakemba Railway Station Group

There would be moderate direct impacts on the Lakemba Railway Station Group as a result of the removal of the original island platform. The visual impact of the works on the setting of the station would be moderate overall. The expanded concourse would offer views to the platform building. Potential direct impacts as a result of vibration would be minor, provided the measures in Section 14.4 are implemented.

The removal of the original 1919 island platform would remove an element of high significance within the station group. The removal of this structure would alter the aesthetics and representativeness significance of the station, and impact its integrity overall. The Platform 1/2 building would remain to represent the heritage significance of the station. This would retain some of the historical values of the place as one of the original stations of the second stage of development of the Bankstown Line. The platform building is a good example of its type, and would contribute to the aesthetic significance of the station.

The project would result in a moderate impact on the Lakemba Railway Station Group overall. Based on the historical significance of the station and the heritage values of the retained platform building, the heritage item would continue to meet the threshold for local significance.

Other items

The project would result in neutral impacts on the Federation weatherboard house and Electricity Substation no. 143, with neutral direct, visual, and vibration impacts predicted.

Negligible impacts are anticipated for the Inter-War post office building overall. It is anticipated that there would be neutral direct impacts, and negligible visual and vibration impacts resulting from the project.

The items would continue to meet the threshold for local significance.

14.3.9 Wiley Park Station

Existing items

Heritage listed items in the vicinity of Wiley Park Station with the potential to be impacted by the project are summarised in Table 14.27 and shown in Figure 14.1. Table 14.28 lists the main structures and elements within the Wiley Park Railway Station Group, including relevant information such as date, condition, and significance.

Table 14.27 Wiley Park Station – heritage items

Item	Listing	Location
Wiley Park Railway Station Group	RailCorp s.170 (4801946) Canterbury LEP (I159)	In project area
Inter-War water pumping station – Lakemba Pumping Station	Sydney Water s.170 (4570136) Canterbury LEP (I158)	Adjacent to project area

Direct impacts

An assessment of the direct impacts of the project on the fabric of each element constituting the Wiley Park Railway Station Group, and an assessment of the subsequent impacts on the heritage values of the station group as a whole, is provided in Table 14.28. Potential impacts are illustrated in Figure 14.5.

Table 14.28 Summary of direct impacts to significant elements within the Wiley Park Railway Station Group

Significant elements	Condition	Significance	Proposed works	Assessment of direct impact
Platform 1 and 2 (1938)	Generally good	High	Removal Platform to be rebuilt in a straight alignment Covered concourse, access stairs, lift shafts, platform canopies, and protective barriers anchored on new platform	The overall impact to this element has been assessed as major due to the following: • major impact on the platform including the loss of a typical example of its type • new covered concourse, access stairs, lift shaft, platform canopies, and platform screen doors anchored and constructed on the new platform would not further impact significant fabric • major impact on the station group overall from the removal of Platform 1 and 2.
Platform building, Platform 1 (Type 13) (1938) an Platform building, Platform 2 (Type 13) (1938)	Good	High	Removal Replacement with platform canopies and protective barriers anchored on new platform	Major impact on the buildings and on the station as a whole from the removal of the buildings.
Overhead booking office (1938)	Good	High	Removal and replacement with new covered concourse including access stairs and lift shafts	Major impact on the building and on the station as a whole from removal of the overhead booking office, which was recommended for adaptive reuse by the *Railway Overhead Booking Offices Heritage Conservation Strategy* (Australian Museum Consulting, 2014).
Footbridge (1938)	Good	Moderate	Removal and replacement with new covered concourse	Major impact on the footbridge and a moderate impact on the station overall from the removal of the footbridge and stairs.
Access ramp canopies (Modern)	Good	Little	Removal for replacement with new covered concourse including access stairs and lift shafts	Neutral impact on the station catchment from the removal of the access ramp canopies.

Significant elements	Condition	Significance	Proposed works	Assessment of direct impact
Landscape/ natural features	Good	Moderate	Retain in majority New station building to be constructed along the southern boundary to the west of the platforms	Moderate impact on the landscape features and a minor impact on the station overall, as the existing landscape would be mostly retained, apart from an area located west of the platforms along the southern boundary, where a new station services building would be constructed.

Visual impacts

Wiley Park Railway Station Group

The proposed canopy above the new concourse would be larger in scale compared to the existing structures on the site. However, all station buildings which include the Platform 1 building, Platform 2 building, and the overhead booking office are proposed to be removed. Therefore, the scale of the proposed new development would not visually impact the heritage components of the site as these would no longer be present. Visual impacts would result from the removal of all heritage structures. As all original 1938 station elements would be removed, all views and appreciation of these elements would be lost, resulting in a major visual impact on the station as a whole. Any visual impacts resulting from the proposed works to the King Georges Road overbridge would not further detract significant views, as the setting of the station would have been fully impacted.

Medium-scale canopies and platform screen doors would be located along the reconstructed platforms on the western side of the station. The new concourse, canopies, and station buildings would introduce a contemporary design to the station. A new service building would be located at the western end of the platforms along the southern boundary. The scale and height of the proposed canopy structure, the footprint of the overall concourse, stairs, new platform, station buildings, platform canopies, and platform screen doors would add considerable bulk to the originally low-scale station catchment. The 1930s station would be redeveloped into a contemporary transport interchange.

The proposed removal of all significant buildings and structures within the station would result in a major visual impact, as no original elements would be retained to demonstrate the significance of the station.

When considering cumulative impacts overall, the assessment concluded that the project would result in a major visual impact on Wiley Park Railway Station Group.

Inter-War water pumping station – Lakemba Pumping Station

The project would result in negligible visual impacts on the Inter-War water pumping station–Lakemba Pumping Station. Views from the item towards the railway corridor are mostly screened by existing vegetation, and views towards the station are mostly screened as the rail line and station buildings are located below street level. The proposed works would be consistent with the existing visual landscape to and from the pumping station, while trees to be planted on the southern side of the station would further screen views.

Potential direct (vibration) impacts

Table 14.29 summarises the potential vibration impacts on listed heritage items.

Table 14.29 Potential vibration impacts

Item	Potential impact
Wiley Park Railway Station Group	Minor: The closest façade of this item would experience vibration levels above the screening level for cosmetic damage. Further assessment and management would be undertaken in accordance with the approach described in Section 14.4.
Inter-War water pumping station–Lakemba Pumping Station	Negligible: Vibration levels would be below the cosmetic damage screening level.

Statements of heritage impact

Wiley Park Railway Station Group

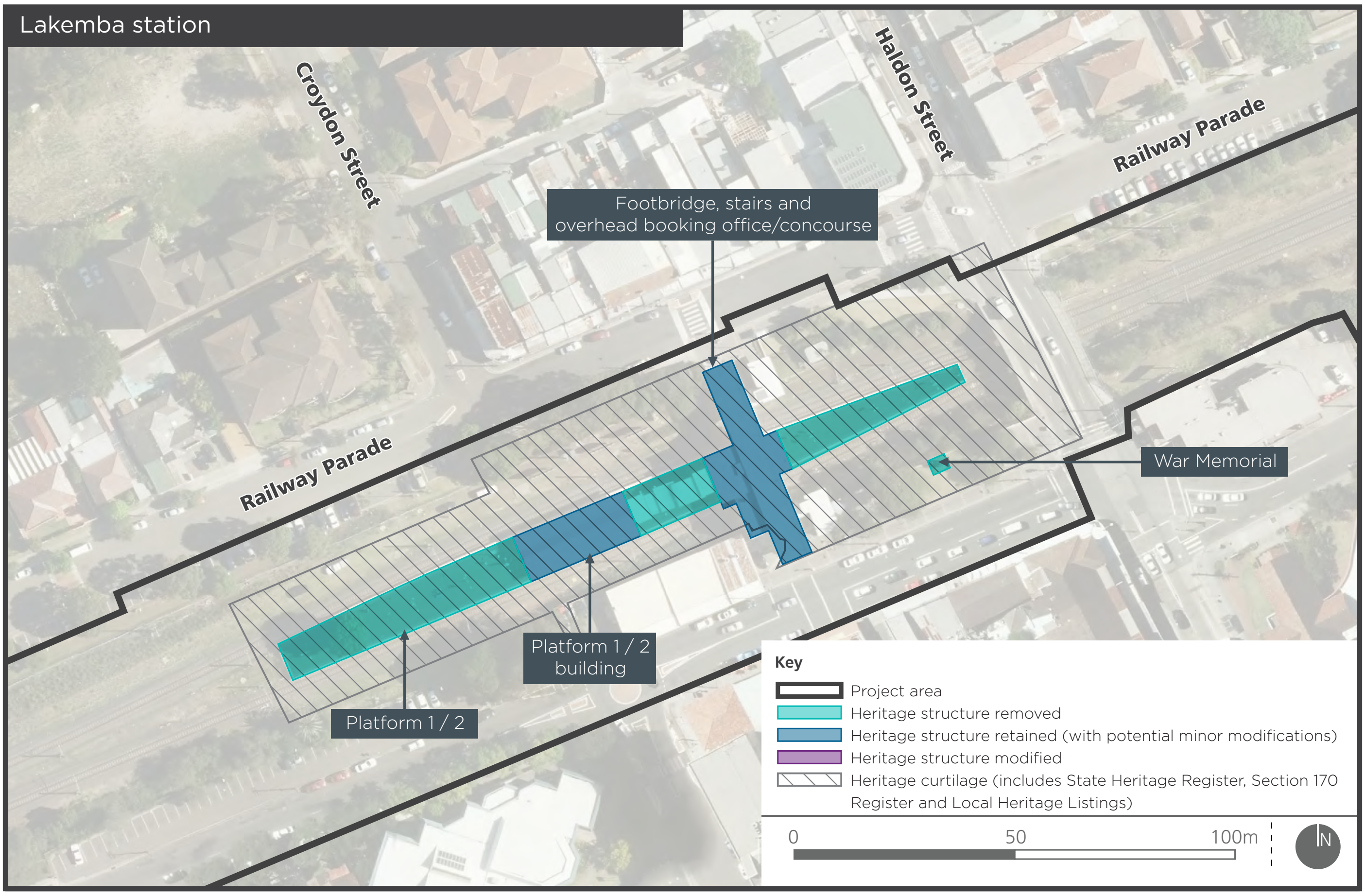
Overall, the project would result in a major impact on the Wiley Park Railway Station Group. All elements of high significance within the station would be removed. There would be no tangible elements of significance remaining. This would have major direct and visual impacts on the station as a whole. The new development would introduce contemporary structures and alter the character of the station from a late 1930s precinct into a contemporary transport interchange. The setting of the station would be fully impacted.

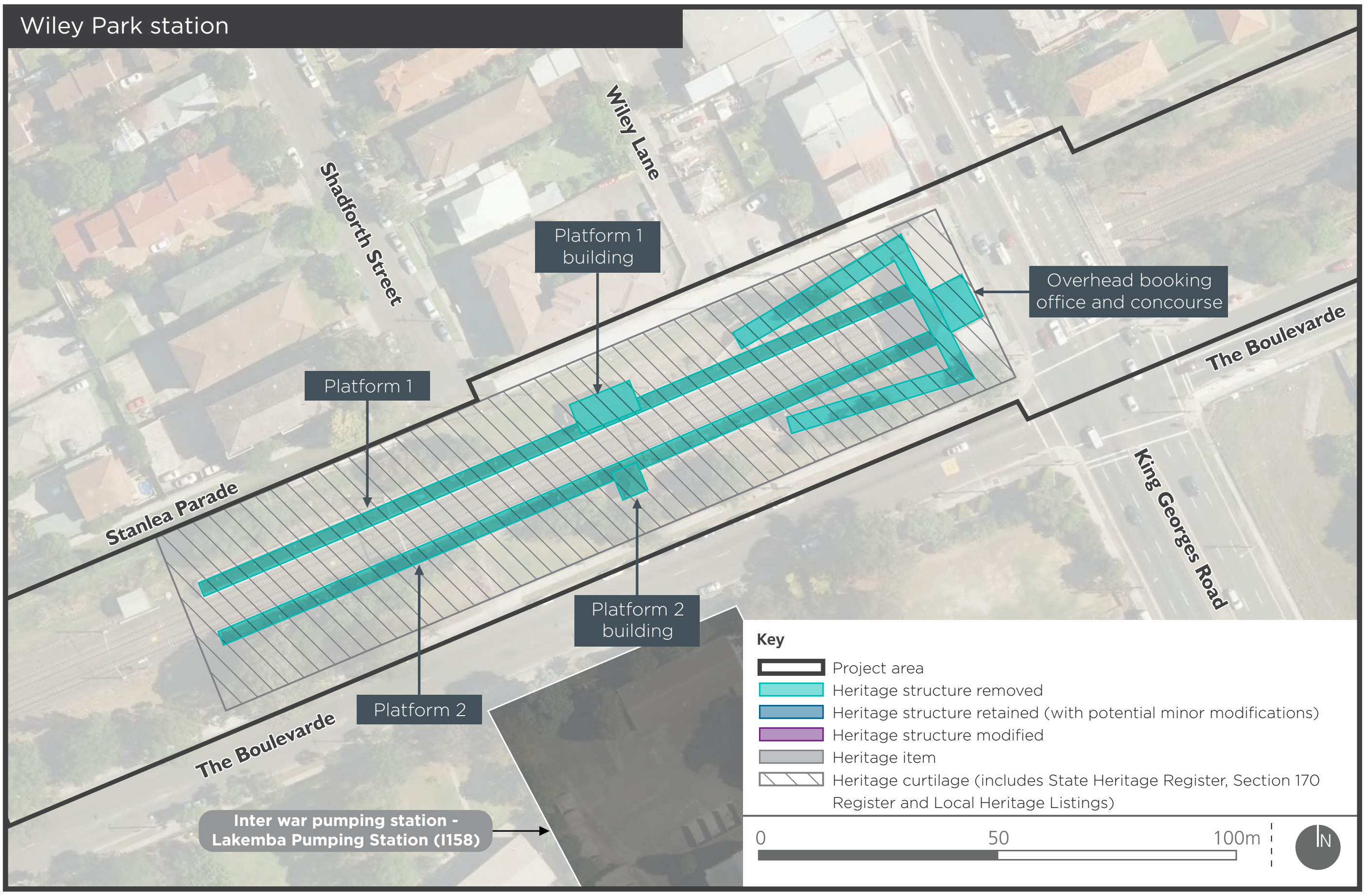
The demolition of all original structures of high and moderate significance would remove the original station dated 1938. Wiley Park Railway Station Group is historically significant on the Bankstown Line, as an infill station and the last of the stations to be constructed. The station is also significant as it was financed and constructed by the local Council rather than the State government. Therefore, the station has social and rarity values. The demolition of these structures would deprive the station of any tangible elements of significance. A good example of the Inter-War Railway Domestic style in the NSW railway network would be lost, and the aesthetic significance of the station would be fully impacted. Although all original buildings have been subject to detracting modifications overtime, their significance is retained in their historical and representative values as well as in substantial original fabric. By removing all heritage components, the project would result in Wiley Park Railway Station no longer meeting the threshold for local significance.

Interpretation would be able to convey the previous significance of the item, but would not fully mitigate impacts and would not enable the heritage item to retain its local significance. As a result, the heritage item would no longer meet the threshold for local significance and would likely be delisted.

Inter-War water pumping station – Lakemba Pumping Station

The direct impacts of the project on the Inter-War water pumping station would be neutral. The proposed works would result in a negligible visual impact. Potential direct impacts as a result of vibration would be negligible. The overall level of heritage impact on the Inter-War water pumping station would be negligible. The item would continue to meet the threshold for local significance.





Impacts on heritage at Lakemba and Wiley Park stations

FIGURE 14.5

14.3.10 Punchbowl Station

Existing items

Heritage listed items in the vicinity of Punchbowl Station with the potential to be impacted by the project are summarised in Table 14.30 and shown in Figure 14.1. Table 14.31 lists the main structures and elements within the Punchbowl Railway Station Group, including relevant information such as date, condition, and significance.

Table 14.30 Punchbowl Station – heritage items

Item	Listing	Location
Punchbowl Railway Station Group	RailCorp s.170 (4802009) Canterbury LEP (I155)	In project area
War Memorial and street trees	Canterbury LEP (I152)	Adjacent to project area
Post-war Civic Building (former Punchbowl Baby Health Centre)	Canterbury LEP (I154)	Adjacent to project area

Direct impacts

An assessment of the direct impacts of the project on the fabric of each element constituting the Punchbowl Railway Station Group, and an assessment of the subsequent impacts on the heritage values of the station group as a whole, is provided in Table 14.31. Potential impacts are illustrated in Figure 14.6.

Table 14.31 Summary of direct impacts to significant elements within the Punchbowl Railway Station Group

Significant elements	Condition	Significance	Proposed works	Assessment of direct impact
Platform 1/2 (1909)	Generally good	High	Removal Platform to be rebuilt in straight alignment Covered concourse, access stairs, lift shafts, platform canopies, and platform screen doors anchored on new platform	The overall impact to this element has been assessed as major due to the following: • major impact on the platform including the loss of the original brick face • loss of the historic curved platform and a major impact on the original platform layout from the reconstruction of the extended platform in a straight alignment • new covered concourse, access stairs, lift shaft, platform canopies, and platform screen doors anchored and constructed on the new platform would not further impact on significant fabric • major impact on the station group overall from the demolition of Platform 1/2.
Overhead booking office (1929)	Good	High	Removal for replacement with new covered concourse including access stairs and lift shafts	Major impact on the original footbridge and station overall from the removal of the overhead booking office, which was recommended for adaptive reuse in the *Railway Overhead Booking Offices Heritage Conservation Strategy* (Australian Museum Consulting, 2014).

Significant elements	Condition	Significance	Proposed works	Assessment of direct impact
Footbridge (1930, 2014)	Fair	Moderate	Removal and replacement with new covered concourse including access stairs	Major impact on the remaining original elements of the footbridge and a moderate impact on the station overall, from the removal of the footbridge and replacement with a new covered concourse.
Toilet block, Platform 1/2 (1970s)	Good	Moderate	Removal and replacement with new covered concourse	Major impact on the toilet block and a moderate impact on the station overall from the removal of the toilet block on Platform 1/2.
Platform building, Platform 1/2 (early 1980s)	Good	Moderate	Removal for replacement with new covered concourse including access stairs and station buildings	Major impact on the building and a moderate impact on the station overall from the removal of the main building on Platform 1/2.
Canopies and extensions to overhead booking office (c.2000s)	Good	Little	Removal and replacement with new covered concourse	Neutral impact on the station from the removal of the canopies and extensions.

Visual impacts

Punchbowl Railway Station Group

The proposed canopies above the new concourse would be larger in scale compared with the existing structures on the site. However, all station buildings, including the Platform 1/2 building, toilet block, overhead booking office, and footbridge are to be removed. The scale of the proposed new development would not visually impact the heritage components of the site, as they would no longer be present. Visual impacts would result from the removal of all structures at Punchbowl station. All views and appreciation of the original platform and original overhead booking office and stairs would be lost. There would be visual impacts resulting from the removal of the original brick face and curved layout of the platform, and of the replacement of the original island platform with two platforms, resulting in a major visual impact.

The removal of later structures (e.g. the 1970s toilet block) would have moderate visual impacts on the station. Any visual impacts resulting from the proposed works to the Punchbowl Road overbridge would not further detract significant views, as the setting of the station would be fully impacted.

The nature of the new concourse, canopies and station buildings would introduce a contemporary design to the station in replacement of the existing buildings. The scale and height of the new canopy structure, the footprint of the overall concourse, stairs, new platform and station buildings as well as the platform canopies and platform screen doors would add considerable bulk to the originally low-scale station catchment. The original railway station with layers of 1970s and 1980s development would be replaced with a contemporary transport interchange, resulting in a major visual impact.

When considering cumulative impacts overall, the assessment concluded that the project would result in a major visual impact on Punchbowl Railway Station Group.

Other items

The project would result in negligible visual impacts on the War Memorial and street trees, and the Post-war Civic Building (former Punchbowl Baby Health Centre).

A small section of the curtilage of the War Memorial and street trees is located within the project area, where roads close to the station would provide access during construction. However, the area of impact does not comprise any of the significant trees that form part of the heritage significance of the item. The War Memorial is outside the project area to the south-east, resulting in neutral visual impacts on the item and negligible visual impacts from construction.

Views from the northern boundary of the War Memorial and street trees to the station would be mostly screened by existing mature trees along The Boulevarde, resulting in a neutral visual impact.

Similarly, views from the Post-war Civic Building towards the railway corridor, platforms, and station are mostly screened by vegetation. The proposed works would be consistent with the existing views to and from the heritage item.

Potential direct (vibration) impacts

Table 14.32 summarises the potential vibration impacts on listed heritage items.

Table 14.32 Potential vibration impacts

Item	Potential impact
Punchbowl Railway Station Group	Minor: The closest façade of this item would experience vibration levels above the screening level for cosmetic damage. Further assessment and management would be undertaken in accordance with the approach described in Section 14.4.
War Memorial and street trees Post-war Civic Building (former Punchbowl Baby Health Centre)	Negligible: Vibration levels would be below the cosmetic damage screening level.

Statements of heritage impact

Punchbowl Railway Station Group

The impacts on the Punchbowl Railway Station Group would be major. All elements of high and moderate significance within the station would be removed. There would be no tangible elements of significance remaining, resulting in major direct and visual impacts on the station as a whole. The new development would introduce contemporary structures and alter the character of the station from an early nineteenth-century station with layers of 1970s and early 1980s development, into a contemporary transport interchange. The setting of the station would be fully impacted.

The removal of all original structures of high and moderate significance would remove the original station developed between 1909 and 1929, as well as later layers of development from the 1970s and early 1980s. The station is historically significant as one of the original railway stations from the second phase of development of the Bankstown Line. A good example of an Inter-War Transitional style overhead booking office in the NSW railway networks would be lost, as would the original island platform. As a result, the aesthetic significance of the station would be fully impacted. Although the existing structures have been subject to modifications over time, their significance is retained in their historical and representative values, as well as in substantial original fabric.

When assessed cumulatively, the level of heritage impact of the project on the station would be major. The significance of the station is encompassed in its historical use, which is represented by tangible elements, including platforms and individual buildings. By removing these elements, there would be no tangible elements to represent the historic role of the station. The aesthetic significance of the station demonstrated in its nineteenth-century architecture with layers of 1970s and early 1980s development would also be lost. Interpretation would be able to convey the previous significance of the site; however, it would not fully mitigate impacts and would not enable the heritage item to retain its local significance. Therefore, the heritage item would no longer meet the threshold for local significance and it is likely to be delisted.

Other items

The project would result in negligible impacts on the War Memorial and street trees and Post-war Civic Building (former Punchbowl Baby Health Centre). Both items would therefore continue to meet the threshold for local significance.

14.3.11 Bankstown Station

Existing items

Heritage listed items in the vicinity of Bankstown Station with the potential to be impacted by the project are summarised in Table 14.33 and shown in Figure 14.1. Table 14.34 lists the main structures and elements within the Bankstown Railway Station Group, including relevant information such as date, condition, and significance.

Table 14.33 Bankstown Station – heritage items

Item	Listing	Location
Bankstown Railway Station Group	RailCorp s.170 (4802067) Bankstown LEP (I3)	In project area
Bankstown Parcels Office (former)	RailCorp s.170 (4802067) Bankstown LEP (I4)	In project area
Shop	Bankstown LEP (I13)	Adjacent to project area

Direct impacts

An assessment of the direct impacts of the project on the fabric of each element constituting the Bankstown Railway Station Group, and an assessment of the subsequent impacts on the heritage values of the station group as a whole, is provided in Table 14.34. Potential impacts are illustrated in Figure 14.6.

The project would result in neutral direct impacts on the Bankstown Parcels Office (former). The parcels office has good integrity and is currently used as a storage facility. The structure is proposed to be retained for ongoing use, resulting in a neutral direct impact on the parcels office and the Bankstown Railway Station Group. Any retrofitting for re-use of the parcels office would be designed to minimise impacts to original fabric. The original layout would be preserved, and intrusive modifications removed, where possible. If these considerations are implemented, it is predicted that the project would have a minor direct impact on this item.

Table 14.34 Summary of direct impacts to significant elements within the Bankstown Railway Station Group

Significant elements	Condition	Significance	Proposed works	Assessment of direct impact
Platform 1/2 (1909)	Good	High	Existing station platforms would be retained and a new island platform would be provided to the east of the new station entrance The platform would be retained except for the eastern end of the platform Covered concourse, access stairs, lift shafts, platform canopies and platform screen doors anchored on a section of extended platform	The overall impact to this element has been assessed as major due to the following: • loss of the historic curved platform and a major impact on the original platform layout from the reconstruction of the platform in a straight alignment and extension to the east • new covered concourse, access stairs, lift shaft, platform canopies and platform screen doors anchored and constructed on the new platform would not further impact significant fabric • moderate direct impact to the platform from the construction of a platform canopy to the east of the current station building • major impact on the station group overall from the partial removal of the eastern end of Platform 1/2 to be reconstructed in a straight alignment and extended.
Platform building, Platform 1/2 (Type 11) (1909, 1923)	Good	Exceptional	Retention for re-use with potential retrofitting	The overall impact to this element has been assessed as minor due to the following: • positive heritage outcome in the context of the project from the retention of the platform building • retrofitting for new accommodation would be designed to minimise impacts to original fabric, including preservation of the original layout where possible, and removal of any intrusive modifications • additions to the building and platform would be designed to be sympathetic to the heritage context and minimise fabric and visual impacts.
Overbridge (1909, 1997)	Fair	Moderate	Retention and upgrade	Minor impact on the overbridge and Bankstown Railway Station from removal and replacement of the non-significant parapets.
Overhead booking office (Type 19) (1948)	Good	Moderate	Retention for ongoing use	The overall impact to this element has been assessed as neutral as the overhead booking office is not identified in the *Railway Overhead Booking Office Conservation Strategy* (Australian Museum Consulting, 2014).
Footbridge (1948, 2012-13)	Good	Little	Retention for ongoing use	Neutral impact on the footbridge and Bankstown Railway Station from the retention of the structure.
Canopies (Modern)	Good	Intrusive	Retention for ongoing use	Neutral impact on the footbridge and Bankstown Railway Station from the retention of the structure.

Significant elements	Condition	Significance	Proposed works	Assessment of direct impact
Landscape/ natural features	Good	Moderate	Retention	Landscape elements are limited to a palm tree next to the eastern end entrance portico, which may have been planted at the time of construction of the parcels office. Retention of the tree would result in a neutral impact on the existing landscape features and the station.

Visual impacts

Bankstown Railway Station Group

The proposed new structures would be located on the eastern side of the station on a platform extension, and at a distance from the existing station buildings. The overhead booking office, footbridge, platform building, and part of the brick platform would remain on the western side. There would be a visual impact resulting from straightening the curved layout of the platform, resulting in a moderate visual impact overall.

The contemporary nature of the new development would differ from the existing heritage character of the station group, however, this would juxtapose with the historic components of the site. The new station buildings would be of a similar scale as the heritage buildings, and located at a notable distance, resulting in a minor visual impact. The new concourse and access stairs would add considerable footprint and bulk to the station; however, they would be located at a distance of about 80 metres from the Platform building 1/2. The bulk of the new covered concourse would be reduced by this distance, and potential visual impacts would be minor. A new platform canopy would be located on the existing platform to the east of the station building and would extend within two metres of the significant platform building resulting in a moderate visual impact.

Medium-scale canopies and platform screen doors located to the east of the new concourse would be mostly screened from significant views. They would not be located along the original platform, and would not obstruct views to the Platform building 1/2.

Overall, the project would add a contemporary layer of development on the eastern side of the station in contrast with the heritage components to the west. Views to the heritage buildings within the station catchment would be partially obscured by the large ribbon canopy extending from the concourse to the west. The concourse and eastern canopies would be large in scale, but would be located a notable distance from the heritage structures and would not be overly dominant. The project would alter the existing setting of the station. However, due to siting of the new concourse, visual impacts would be moderate overall.

The new services building would not visually dominate significant elements of the station catchment as it would be located over 150 metres to the east.

When considering cumulative impacts overall, the assessment concluded that the project would result in a moderate visual impact on the Bankstown Railway Station Group.

Other items

The project would result in neutral visual impacts on Bankstown Parcels Office (former) and negligible visual impacts on the Shop.

As Bankstown Parcel's Office is proposed to be retained for ongoing use, there would be a neutral visual impact. Any retrofitting would be designed to minimise impacts to original fabric and retain original detailing and features. The original layout would be preserved where possible.

Existing views from the Shop towards the rail corridor and station are mostly screened by vegetation and the existing bus interchange along South Terrace. The proposed new canopy and concourse would be located in the eastern section of the station to the north of the heritage item, and would be mostly screened by existing development and vegetation.

Potential direct (vibration) impacts

Table 14.35 summarises the potential vibration impacts on listed heritage items.

Table 14.35 Potential vibration impacts

Item	Potential impact
Bankstown Railway Station Group Shop	Negligible: Vibration levels would be below the cosmetic damage screening level.
Bankstown Parcels Office (former)	Minor: Modelling indicates that the closest façade of this item would experience vibration levels above the screening level for cosmetic damage. Further assessment and management would be undertaken in accordance with the approach described in Section 14.4.

Statements of heritage impact

Bankstown Railway Station Group

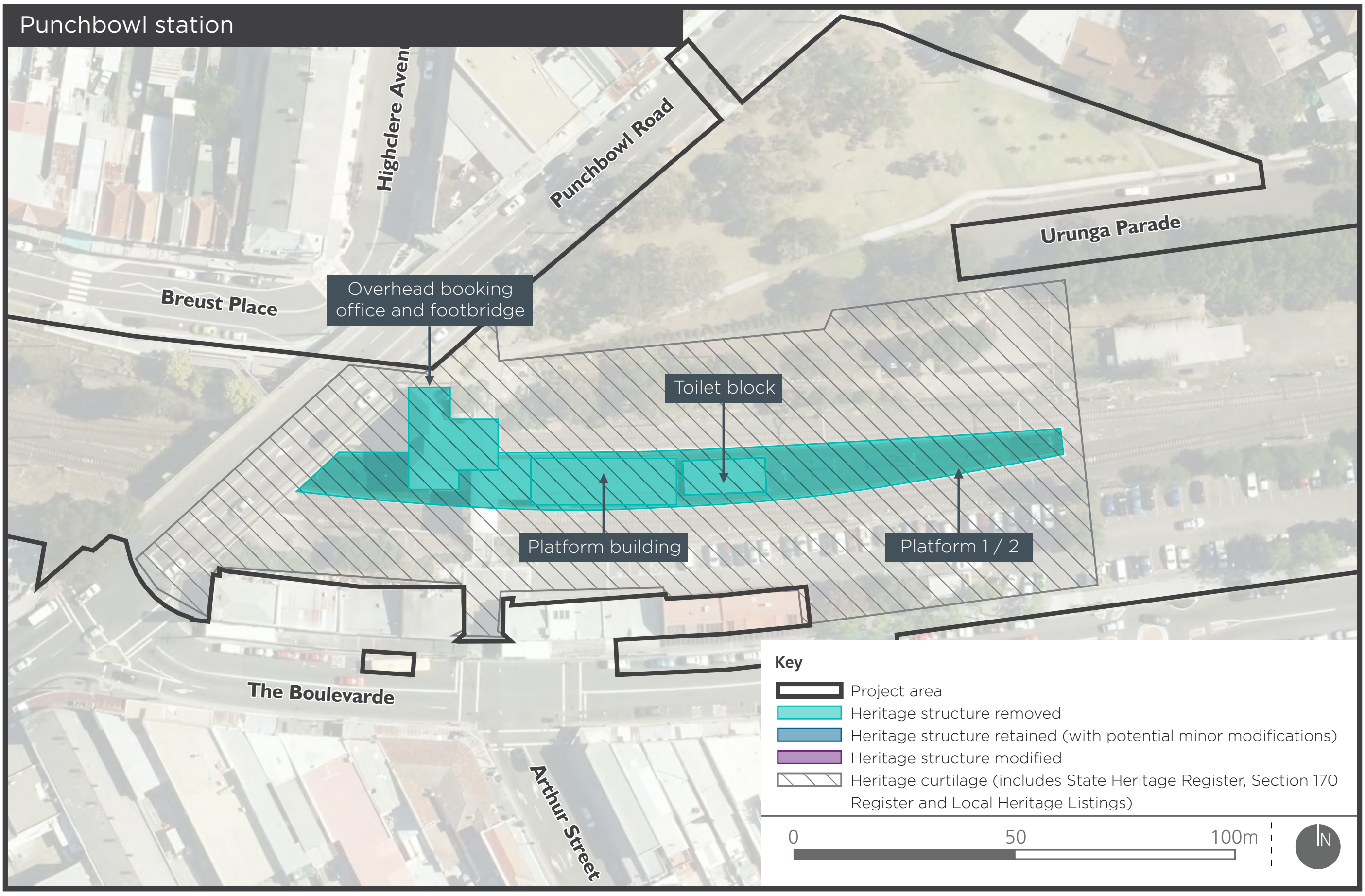
Overall, the direct impacts of the project on the station would be moderate. There would be moderate direct impacts. The platform building of exceptional significance would be retained with potential for positive impact. However, the eastern curve of the original platform of high significance would be removed, which would result in a major direct impact. Retention of all other heritage elements of significance except for the curved eastern section of the original platform would enable the station to continue to demonstrate its historic, aesthetic and representativeness significance. The retention of the platform building of exceptional significance would retain the historical values of the place as one of the original railway stations dating from the early 20th century expansion of the railway between Belmore and Bankstown. The platform building is an excellent example of its type, and would continue to contribute to the presentation of the station.

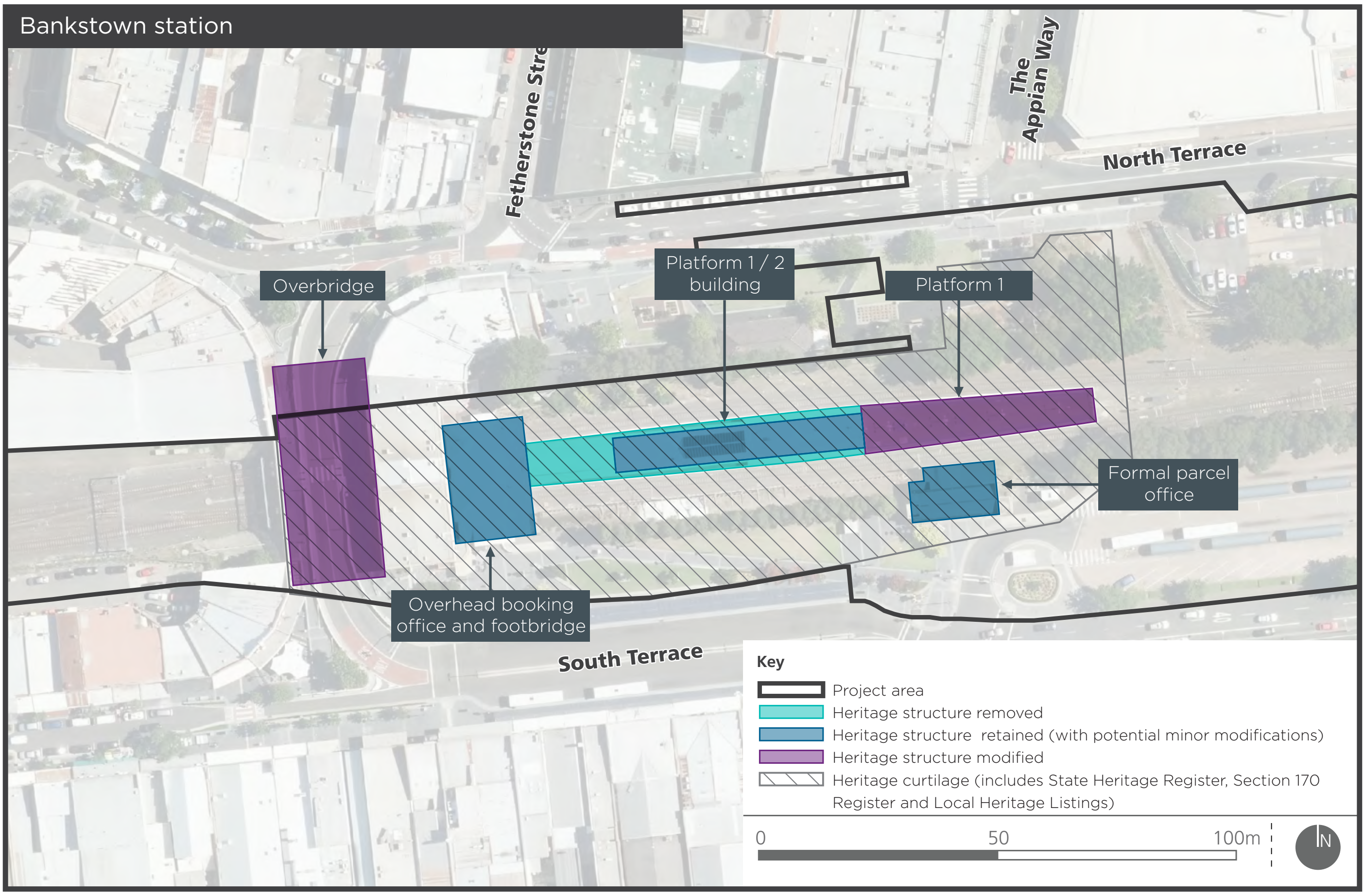
Views to the heritage buildings would not be obstructed by the new concourse, which would be located at a notable distance from the existing station. Visual impacts on the station would be moderate overall. Potential direct impacts as a result of vibration would be negligible.

Other items

The project would result in neutral impacts on the Bankstown Parcels Office (former) and negligible impacts on the Shop overall. The direct impacts of the project on both heritage items would be neutral. Visual impacts would be neutral for the Bankstown Parcels Office (former) and negligible for the Shop. Potential vibration impacts on the Shop would also be negligible, while vibration impacts on the Bankstown Parcels Office (former) would be minor, provided that the measures in Section 14.4 are implemented.

Both heritage items would continue to meet the threshold for local significance.





Impacts on heritage at Punchbowl and Bankstown stations

FIGURE 14.6

14.3.12 Impacts on archaeology

The project would involve excavation in a number of locations, including to construct drainage facilities, substations, retaining walls, and utilities. Depending on the depth of excavation, there may be an impact on significant archaeological remains as discussed below.

Marrickville Station

Works within the Marrickville Station area would involve trenching and subsurface ground disturbance within the existing rail and road corridor.

There is a moderate to high potential for locally significant archaeological remains associated with the station to be impacted by the proposed works. The remains are generally works and former railway infrastructure, identified in the draft conservation management plan for Marrickville Station (Scobie, 2016).

Canterbury Station

Works within the Canterbury Station area would involve trenching and subsurface ground disturbance.

Although the location of the Old Sugarmill and former associated structures is to the east of the station, there is a moderate to high potential that remains associated with this item could extend into the project area. These remains would have local or State significance depending on their nature and intactness.

The former Canterbury Township is located to the east of Canterbury Station. Any subsurface works have a moderate to high potential to impact any associated intact archaeological remains. These remains would have local significance.

Lakemba Station

Works within the Lakemba Station area would involve earthworks, trenching, and subsurface ground disturbance.

There is a low potential for locally significant remains associated with the early settlement of Lakemba, including structures associated with 'Lakemba' heritage item, such as outbuildings and stables, and archaeological features associated with farming activities, domestic and agricultural structures, refuse pits and drains or culverts. Works within the station area have the potential to impact any associated intact archaeological remains. There is a low to moderate potential for the locally significant remains of the 1919 Lakemba island platform to be impacted by works.

Belmore Station

Works within the Belmore Station area would involve trenching and subsurface ground disturbance.

There is low to moderate potential for locally significant archaeological remains associated with the railway station goods shed and goods platform to be impacted.

To minimise the potential for the above impacts, the mitigation measures in Section 14.4 provide for the development of an archaeological research design document.

Other

Other locations may contain archaeological 'works' such as remains of culverts, former platforms (within existing remodelled platforms), and infrastructure such as drains. However, the archaeological assessment in Technical paper 3 concluded that overall, the study area has a nil to low potential to contain significant archaeological remains.

14.3.13 Construction compounds and work sites

This section provides a summary of the results of the assessment of the potential impacts of construction compounds and work sites on heritage items. A description and full list of the proposed location of compounds and work sites is provided in in Section 9.8.

Compound C4 would be located along the northern boundary of the Hurlstone Park Railway Station Group heritage item outside its heritage curtilage. There would be some views to the compound from the heritage item. This would result in a temporary minor visual impact on the item.

A work site (to be used mainly for laydown) would be located in the vicinity of the Old Sugarmill in Canterbury, to the west of the item. There would be some views to the work site from the item. This would result in a temporary minor visual impact on the item. Views to the site would be obstructed by existing development to the north and west of the item.

Compound C11 would be located within the curtilage of the locally listed Post-war bus shelter and public lavatories in the vicinity of Belmore Station. Compound C10 would be located on the opposite side of the rail corridor to the south of the site. This would result in a temporary moderate visual impact on the item.

Compounds C12 and C13, near Belmore Station, would be located in the vicinity of the locally listed Federation House (former station master's cottage) opposite Burwood Road. There would be some views to these compounds from this item. This would result in a temporary minor visual impact on the item. Impacts of construction compounds on the item are considered to be minor.

Compound C17 would be located opposite the locally listed Inter-War water pumping station - Lakemba Pumping Station, across The Boulevarde at Wiley Park, on the southern side of the rail corridor. There would be views to this compound from this item. This would result in a temporary minor visual impact on the item.

Compounds C19 and C20 would be located opposite the locally listed War Memorial and street trees, across The Boulevarde at Punchbowl, on the northern side of the rail corridor. There would be some views to the compounds from within the heritage curtilage of the item. However, the War Memorial and street trees would be located outside the visual catchment of the compound. This would result in a temporary negligible visual impact on the item. The impacts of the compounds on the item would be negligible.

Two compounds, C23 and C24, would be located in close proximity to the Bankstown Railway Station Group along both sides of the rail corridor. Compound C23 would also be located opposite the locally listed Bankstown Parcels Office (former), across the rail corridor to the north. There would be some views to the compound from the item. This would result in a temporary minor visual impact on the item. Compound C24 would be located in close proximity to the Bankstown Parcels Office (former), to the east along the rail corridor. There would be views to the compound from the item, resulting in a temporary moderate visual impact on the item. The impacts of the compounds on the item would be minor.

Compounds C23 and C24 would also be located opposite the locally listed shop heritage item. There would be some views to the compounds from this item. This would result in a temporary minor visual impact on the item. The impacts of the compounds on this item would be minor.

No other potential impacts on heritage items were identified as a result of the presence of construction compounds and work sites.

The mitigation measures provided in Section 14.4 would be implemented to minimise the potential impacts identified.

14.3.14 Operation impacts

Operation of the project would not directly impact any listed heritage items. The main potential for indirect impacts relates to vibration generated by the movement of trains, and a change in the visual setting and/or character associated with the presence of new infrastructure.

The potential for structural vibration impacts was considered by the noise and vibration assessment for the project, and the results are summarised in Chapter 12. No operational impacts on heritage items were predicted.

The potential for visual impacts was considered by the landscape and visual impact assessment for the project, and the results are summarised in Chapter 19 (Landscape and visual amenity). The assessment concluded that the overall visual impact of the project would be negligible to minor adverse. Measures are provided in Chapter 19 to mitigate the potential for visual impacts.

Retrofitting and reuse of significant structures to be retained in accordance with their heritage values has been a key consideration during the design process, and would continue to be refined during detailed design. This would be a positive heritage outcome, as it would enable public engagement with heritage values within the upgraded stations, conservation of significant elements, and would facilitate maintenance and care of structures in use. Retrofitting would aim to highlight the heritage values of the structures to customers, both through sensitive design and fit out, and use of heritage interpretation.

Reuse of salvaged significant fabric, such as platform bricks or fittings, could be used as part of design or as public art/interpretation. A salvage strategy would be prepared which would detail the proposed strategies for selecting salvaged material.

Reuse and retrofitting would be guided by the Burra Charter, the Heritage Council Guidelines for Altering Heritage Assets, relevant Sydney Trains guidelines, and all relevant conservation management plans and statements of significance.

14.3.15 Summary of impacts

The Bankstown Line

Section 14.3 describes and assesses the direct, visual, potential direct and archaeological impacts on each item within the project area and concludes the level of impact and significance of changes proposed as part of the project. A summary of the information is provided below.

Of the ten heritage railway stations located on the Marrickville to Bankstown section of the Bankstown Line, the project would result in a major direct impact to five stations, one of which is listed on the State Heritage Register (Marrickville). The project would also result in a direct and major visual impact to four stations of local significance. There would be a moderate direct impact to five stations, two of which are listed on the State Heritage Register: Canterbury and Belmore. Five stations would be subject to a moderate visual impact, two of which are listed on the State Heritage Register, Canterbury and Belmore.

Two locally-listed items, Wiley Park and Punchbowl railway station groups, would no longer meet the threshold for local significance and would likely be delisted.

All State Heritage Register listed stations would continue to meet the threshold for State significance under more than one significance assessment criteria. Overall, all ten stations would be subject to moderate to major direct and visual impacts, apart from Bankstown which would have a minor visual impact.

Direct and visual impacts to three railway underbridges would be negligible to moderate. There would be major direct impacts to the Illawarra Road overbridge at Marrickville, which is within the station's State Heritage Register listed curtilage.

As there would be impacts to significant elements at all listed stations along the line, conservation management plans for State Heritage Register listed stations and conservation management strategies for items of local significance would be prepared. These documents would address any changes to the item including updated assessment of significance of elements and recommendations on curtilage changes, for example a possible reduction in curtilage at Marrickville Station as a result of impacts to the Illawarra overbridge. The conservation management plan would also provide suggested site specific exemptions or management policies.

Station types

Stations constituting the first layer of development of the line would generally be retained. All platform buildings and general station configurations would be conserved at Marrickville, Hurlstone Park, Campsie, Canterbury, and Belmore, except for the Platform 1 building at Hurlstone Park, which would be removed.

Stations constituting the second layer of development of the line would mostly be conserved in their existing states. Lakemba and Bankstown station’s island platform configurations and platform buildings would be retained. Punchbowl Station would be subject to greater impacts as it would be fully redeveloped.

The inter-war layer of the Bankstown Line would be impacted, with Wiley Park Station fully redeveloped, constituting the loss of the only example of an Inter-War Railway Domestic station on the line. The inter-war phase of redevelopment of Dulwich Hill station would also be altered, with the loss of the overhead booking office and major visual impacts on the station building, although the station building and the island platform configuration would be retained.

The most significant stations on the line (Marrickville, Canterbury and Belmore), dating from the first phase of development, would retain their significant near-identical brick buildings of exceptional significance. The intermediate stations of the first phase of development have more modest brick buildings dated 1915, including at Campsie and Hurlstone Park stations.

Campsie would retain its original configuration and platform buildings, whilst Hurlstone Park would be subject to greater impacts, with the more prominent of two platform buildings removed. The configuration of Punchbowl and Wiley Park stations would be fully modified from island platforms to side platforms. The configuration of Bankstown Station would be retained, and the station extended to the east.

Station elements

Examples of each significant platform building type on the Marrickville to Bankstown section of the line would be conserved. Examples of 1895 buildings of exceptional significance would be conserved at Marrickville, Canterbury, and Belmore stations. Several examples of 1911-1919 buildings would be conserved at Marrickville, Hurlstone Park, Canterbury, Campsie, Lakemba, and Bankstown stations. Evidence of the transitional style of inter-war railway architecture would be retained at Dulwich Hill Station, although the inter-war domestic style buildings at Wiley Park Station would be lost.

A good example of an overhead booking office would be conserved at Belmore Station, whilst good to fair examples noted in the *Railway Overhead Booking Offices Heritage Conservation Strategy* would be removed at Dulwich Hill, Wiley Park, and Punchbowl stations. The platform booking office at Marrickville Station, which is of exceptional significance, would be retained. A significant portion of original footbridges already impacted would be removed. A footbridge assessed to be of high significance by the Sydney Trains’ *Railway Footbridges Heritage Conservation Strategy* would be removed at Dulwich Hill Station, as would three footbridges of moderate significance at Hurlstone Park, Canterbury, and Wiley Park stations.

Original platforms along the line would be removed to meet accessibility and operational requirements for straight platforms except for the platforms at Bankstown Station, which would be mostly retained. This would result in a loss of curved platforms, and of brick vertical and battered platform walls. The general platform configuration would be retained at all stations, except at Punchbowl and Wiley Park stations.

The overbridges along the line have been generally impacted over time. The majority of the overbridges would be conserved for continued use, with the exception of the Illawarra Road overbridge, which would be removed and replaced.

Archaeology

The archaeological assessment concluded that the study area has nil to low potential to contain significant archaeological remains. However, the assessment found that there are four locations (Marrickville Station Catchment, Canterbury Station Catchment and work site, the Lakemba Station Catchment and Belmore Station Catchment) with the potential to contain significant archaeological remains. Other locations may contain archaeological 'works' such as remains of culverts, former platforms (within existing remodelled platforms), and infrastructure such as drains.

Construction compounds

The assessment concluded that the impacts of construction sites would be minor and temporary. Provided that mitigation measures are implemented to remediate the sites following the completion of the project, overall impacts from the construction of the project on the current Bankstown Line would be negligible.

Residual impacts

Residual impacts would include items proposed for removal where the function and condition of the item would not easily enable re-use or interpretation in any meaningful way. More generally, the historic character of the rail line, a late nineteenth-century to early twentieth century rail line with layers of inter-war development, would be altered by the contemporary infrastructure.

The study area

Section 14.3 describes and assesses the direct, visual, potential direct and archaeological impacts on each item within the project area and concludes the level of impact and significance of changes proposed as part of the project. A summary of the information is provided below.

Of the five items listed on the State Heritage Register in the study area, the assessment concluded that the project would result in:

- a major direct impact to one item (Marrickville Railway Station Group)
- moderate direct impacts to two items (Canterbury Railway Station Group and Belmore Railway Station Group)
- neutral direct impacts to two items (Sewage Pumping Station 271 and Old Sugarmill).

The project would result in major visual impacts to one State Heritage Register listed item (Marrickville Railway Station Group), moderate visual impacts to two State Heritage Register listed items (Canterbury Railway Station Group, and Belmore Railway Station Group), and negligible visual impacts to two items (Sewage Pumping Station 271 and Old Sugarmill).

All items listed on the State Heritage Register would continue to meet the threshold for State significance.

Among the 35 local items in the study area, five would have major direct impacts (Marrickville, Dulwich Hill, Hurlstone Park, Wiley Park and Punchbowl railway station groups) and five

(Marrickville, Dulwich Hill, Hurlstone Park, Wiley Park and Punchbowl railway station groups) major visual impacts.

Among the four items of local significance to have major impacts, Wiley Park and Punchbowl railway station groups would no longer meet the threshold for local significance and would likely be delisted.

For heritage items located in the vicinity of the project area, impacts would range from neutral to minor, with the majority of impacts being neutral or negligible and temporary, as a result of activities at construction sites.

The project passes through or is adjacent to the South Dulwich Hill heritage conservation area and the Inter-War Heritage Conservation Area Group listed under the Marrickville LEP. The proposed Floss Street heritage conservation area and Hampden Street heritage conservation area are located adjacent to Hurlstone Park Station. Direct impacts on the South Dulwich Hill heritage conservation area would be negligible, and impacts on the Inter-War Heritage Conservation Area Group would be neutral.

Works within the boundaries of the South Dulwich Hill heritage conservation area and in its vicinity would result in negligible visual impacts. Works in the vicinity of the Inter-War Heritage Conservation Area Group would also have a negligible visual impact. Potential direct impacts as a result of vibration would be minor, provided that the mitigation measures are implemented.

When assessed cumulatively, the level of heritage impact of the project on the South Dulwich Hill heritage conservation area and the Inter-War Heritage Conservation Area Group would be negligible. The heritage conservation area would continue to meet the threshold for local significance.

14.3.16 Cumulative impacts

A summary of the cumulative impacts of the project, when the various types of impacts to individual items and locations of the project is assessed as a whole, is provided in Section 14.3.15.

The contrasting contemporary design of the upgraded stations would be generally distinguishable from the heritage character of the historic stations, and would provide enhanced views of significant platform buildings. The upgraded line would be read as the latest phase of development of the Bankstown Line, and would enable the line to function in its original use within a modern railway infrastructure context. The continued use of the stations, the retention of the majority of platform buildings for re-use, and enhanced views of significant buildings, would constitute positive heritage impacts in the context of the project and its requirements.

Cumulative impacts could occur when the impacts identified in Sections 14.3.2 to 14.3.15 are considered in addition to other projects undertaken in the study area. Other major rail and road infrastructure projects in the vicinity of the study area include the Chatswood to Sydenham project and WestConnex, which would also result in impacts to non-Aboriginal heritage.

The Chatswood to Sydenham project, including the proposed modification to include upgrade works at Sydenham Station, may result in cumulative impacts with the other impacts to the T3 Bankstown Line. The WestConnex project would also result in a cumulative impact on heritage resources in the Sydney region.

Measures to avoid, reduce or mitigate visual, noise and vibration, and direct construction impacts to heritage items are provided in Section 14.4.2. These would reduce the likelihood and severity of cumulative impacts.

14.4 Mitigation measures

14.4.1 Approach to mitigation and management

Managing potential impacts on heritage during construction

The Construction Environmental Management Framework for the project (Appendix D) includes a requirement to prepare a heritage management plan as part of the construction environmental management plan, to provide a consistent approach to management and mitigation of heritage impacts during construction. The construction heritage management plan would guide the management of all proposed heritage mitigation approaches and plans, detailing timing, responsibilities, review, and monitoring requirements.

With respect to the potential for vibration impacts, as described in Chapter 12 (Construction noise and vibration), the Construction Noise and Vibration Strategy (Appendix E) provides a framework for managing construction noise and vibration impacts for the project. Where vibration levels are predicted to exceed the screening criteria, the Construction Noise and Vibration Strategy provides for a more detailed assessment of the structure and vibration monitoring, to ensure vibration levels remain below appropriate limits for that structure. For heritage structures, more stringent levels are applied, and the heritage values of the structure need to be taken into account as part of the more detailed assessment. Further information on the management of potential vibration impacts during construction, including relevant mitigation measures, is provided in Chapter 12.

As described in Chapter 13 no vibration impacts to heritage structures were predicted during operation. As a result, no operation vibration mitigation measures are required.

Project specific mitigation measures for heritage

Measures to minimise the impacts identified by the non-Aboriginal heritage assessment are provided in Section 14.4.2.

14.4.2 List of mitigation measures

The mitigation measures that would be implemented to address potential impacts on non-Aboriginal heritage items and areas of archaeological potential are listed in Table 14.36.

Table 14.36 Mitigation measures – non-Aboriginal heritage

ID	Impact/issue	Mitigation measures	Relevant location(s)
Design/pre-construction			
NAH1	Minimising impacts during design	The project design would be sympathetic to impacted items (including retained significant elements) and surrounding heritage items by minimising impacts to sight lines, views and setting. Detailed design would be carried out in accordance with the relevant specific element principles, including the significant fabric strategy, provided in the Design Guidelines.	All heritage items
NAH2		Except for the heritage significant elements affected by the project, direct impacts to other heritage significant items and elements would be avoided.	All heritage items
NAH3		The appropriately qualified and experienced heritage architect who is part of the Sydney Metro City & Southwest Design Review Panel would provide independent review periodically throughout detailed design.	All heritage items

ID	Impact/issue	Mitigation measures	Relevant location(s)
NAH4		Where heritage significant items or elements are to be retained within the operational area, detailed design would consider appropriate retrofitting and reuse in consultation with a heritage architect and the Design Review Panel. Where retrofitting and reuse is not practicable for significant elements, justification would be provided to the Design Review Panel, and for State Heritage Register listed items, to the NSW Heritage Council.	All heritage items
NAH5		Design and construction planning within the Marrickville Station State Heritage register curtilage would consider the recommendations of the 2016 Conservation Management Plan and the significant fabric strategy.	Marrickville Railway Station Group
NAH6	Interpretation	Appropriate heritage interpretation would be incorporated into the design in accordance with the *NSW Heritage Manual*, the NSW Heritage Office's *Interpreting Heritage Places and Items: Guidelines* (August 2005), and the NSW Heritage Council's *Heritage Interpretation Policy*.	All stations Hurlstone Park Railway Underbridge Overbridge - Illawarra Road Canterbury (Cooks River) Underbridge Canterbury (Cooks River/Charles St) Underbridge - Main Line Post-war bus shelter and public lavatories Bankstown Parcels Office (former)
NAH7	Management of moveable heritage and heritage fabric	A moveable heritage item strategy would be prepared by a suitably qualified heritage consultant in consultation with Sydney Trains, and would include a comprehensive record of significant railway elements to be impacted. This would include items contained within station and platform buildings as well as of any other significant equipment within the curtilage of the heritage railway stations. The moveable heritage item strategy would form part of the broader interpretation strategy.	Bankstown Line: each railway station in the project area apart from Bankstown, and Bankstown Parcels Office (former)

ID	Impact/issue	Mitigation measures	Relevant location(s)
NAH8		Fabric of high and exceptional significance of items proposed for removal would be identified and catalogued according to the significant fabric strategy prior to design development, and would be re-used where possible. Where not able to be re-used, the significant fabric strategy would indicate appropriate storage locations, as well as appropriate types of buildings and structures where salvaged elements may be reused in the future. Where large elements are impacted, a sample of fabric may be appropriate.	Marrickville Railway Station Group: Overbridge- Illawarra Road Dulwich Hill Railway Station Group: overhead booking office and access stairs Hurlstone Park Railway Station Group: Platform 1 building Campsie Railway Station Group: overhead booking office and Parcels office Wiley Park Railway Station Group: Platform 1 building, Platform 2 building and overhead booking office Punchbowl Railway Station Group: overhead booking office and footbridge
NAH9	Impacts to the Old Sugarmill	A landscape scheme would be prepared for the Old Sugarmill to re-instate planting within and close to the curtilage of the item. The scheme would consider appropriate period plants and trees. Any boundary wall treatment would be designed in consultation with a heritage architect.	Old Sugarmill
NAH10	Impacts to archaeology	An archaeological research design would be prepared and implemented to identify the need for archaeological testing or monitoring. Archaeological mitigation measures recommended in the archaeological research design would be implemented in accordance with relevant guidelines, and where identified in the archaeological research design, would be supervised by a suitably qualified Excavation Director with experience in managing State significant archaeology.	Marrickville Station Catchment (specific requirements) Canterbury Station Catchment and work site (specific requirements) Belmore Station Catchment (specific requirements) Lakemba Station Catchment (specific requirements)
NAH11	Archival recording	Photographic archival recording and reporting would be carried out in accordance with the NSW Heritage *Office's How to Prepare Archival Records of Heritage Items* (1998), and *Photographic Recording of Heritage Items Using Film or Digital Capture* (2006).	Overbridge- Illawarra Road Hurlstone Park Railway Underbridge Canterbury (Cooks River) Underbridge Canterbury (Cooks River/Charles St) Underbridge - Main Line Post-war bus shelter and public lavatories Bankstown Parcels Office (former)
NAH12	Conservation management	A conservation management plan would be prepared for all State Heritage Register listed stations, in accordance with NSW Heritage Council guidelines. The plan would address any changes to the item, including updated assessment of significance of elements and recommendations on curtilage changes. It would also provide suggested site specific exemptions and management policies.	Marrickville Railway Station Group Canterbury Railway Station Group Belmore Railway Station Group

ID	Impact/issue	Mitigation measures	Relevant location(s)
NAH13		A conservation management strategy would be prepared for nominated Section 170 register listed stations not listed on the State Heritage Register, in accordance with NSW Heritage Council guidelines.	Hurlstone Park Railway Station Group Campsie Railway Station Group Lakemba Railway Station Group Bankstown Railway Station Group
NAH14	Unexpected finds	An unexpected finds procedure would be developed and included in the construction heritage management plan.	All
Construction			
NAH15	Minimising impacts during construction	Methodologies for the removal of existing structures and construction of new structures would be developed and implemented during construction to minimise direct and visual impacts to other elements within the curtilages of the heritage items, or to heritage items located in the vicinity of works.	All heritage items
NAH16	Unexpected finds	In the event that unexpected archaeological remains, relics, or potential heritage items are discovered during construction, all works in the immediate area would cease, and the unexpected finds procedure would be implemented.	All
NAH17	Human skeleton material	In the event that a potential burial site or potential human skeletal material is exposed during construction, the procedure recommended by the historic heritage impact assessment would be followed in accordance with the Policy Directive – *Exhumation of Human Remains* (NSW Department of Health, 2008), *Skeletal Remains – Guidelines for the Management of Human Skeletal Remains under the Heritage Act 1977* (NSW Heritage Office, 1998) and the *Aboriginal Cultural Heritage Standards and Guidelines Kit* (NPWS, 1997).	All

14.4.3 Consideration of the interactions between mitigation measures

Mitigation measures in other chapters that are relevant to the management of potential heritage impacts include:

- Chapter 12 (Construction noise and vibration) with respect to management of potential vibration impacts during construction
- Chapter 19 (Landscape character and visual amenity) with respect to management of potential visual impacts during construction and operation.

Together, all these measures would minimise the potential heritage impacts of the project.

14.4.4 Managing residual impacts

Heritage impacts caused by the project have been minimised by the approach described in Section 14.3.1, and the measures provided in Section 14.4.2. However, impacts assessed as major would not be fully mitigated, and there would be some residual impacts, as follows:

- a major impact to Marrickville Railway Station Group as a result of upgrading the Illawarra Road overbridge
- major impacts to Marrickville, Dulwich Hill, Hurlstone Park, Wiley Park and Punchbowl railway station groups as a result of the removal of one or more heritage elements associated with these items (summarised in Section 14.3)
- major visual impacts on the Marrickville, Dulwich Hill, Hurlstone Park, Wiley Park, and Punchbowl railway station groups
- Wiley Park and Punchbowl railway station groups would no longer meet the threshold for local significance, and would likely be delisted.

Despite the residual impacts described above, the T3 Bankstown Line would continue to retain some of its heritage values and demonstrate the phases of development of the line as a historical line in the NSW railway network.

15. Aboriginal heritage

This chapter provides a summary of the results of the Aboriginal heritage impact assessment. A full copy of the assessment report is provided as Technical paper 4 – Aboriginal heritage impact assessment. The Secretary's environmental assessment requirements relevant to Aboriginal heritage, together with a reference to where the results of the assessment are summarised in this chapter, are provided in Table 15.1.

Table 15.1 Secretary's environmental assessment requirements – Aboriginal heritage

Ref	Secretary's environmental assessment requirements – Aboriginal heritage	Where addressed
7. Heritage		
7.2	The Proponent must identify and assess any direct and/or indirect impacts (including cumulative impacts) to the heritage significance of:	A summary of the results of the Aboriginal heritage impact assessment is provided in this chapter. The full results are provided as Technical paper 4. This chapter considers impacts to Aboriginal heritage. Non-Aboriginal heritage is considered in Chapter 14.
	(a) Aboriginal places and objects, as defined under the *National Parks and Wildlife Act 1974* and in accordance with the principles and methods of assessment identified in the current guidelines	Section 15.3
	(b) Aboriginal places of heritage significance, as defined in the Standard Instrument – Principal Local Environmental Plan	Section 15.2.6
7.3	Where archaeological investigations of Aboriginal objects are proposed these must be conducted by a suitably qualified archaeologist, in accordance with Section 1.6 of the *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW* (Department of Environment and Climate Change, 2010a).	Section 15.4.2
7.4	Where impacts to Aboriginal objects and/or places are proposed, consultation must be undertaken with Aboriginal people in accordance with the current guidelines. The significance of cultural heritage values for Aboriginal people who have a cultural association with the land must be assessed.	Sections 15.1.3 and 15.3.3

15.1 Assessment approach

15.1.1 Legislative and policy context relevant to the assessment

The primary legislation relevant to Aboriginal heritage in NSW is the *National Parks and Wildlife Act 1974* (NP&W Act) and its supporting regulation. The NP&W Act defines an Aboriginal object as 'any deposit, object or material evidence (not being a handicraft made for sale) relating to the Aboriginal habitation of the area that comprises New South Wales'.

Under section 84 of the NP&W Act, an Aboriginal place is declared by the Minister as a place that, in the opinion of the Minister, is or was of special significance with respect to Aboriginal culture.

Under the NP&W Act, it is an offence to harm or desecrate an Aboriginal object or Aboriginal place. Under section 87(1) of the Act, it is a defence to a prosecution offence if the harm or desecration of an Aboriginal object was authorised by an Aboriginal Heritage Impact Permit (AHIP) and the activities were carried out in accordance with that AHIP. As described in Chapter 3 (Planning and assessment process), the provisions of the EP&A Act provide an exemption from the requirement for an AHIP for activities approved as critical State significant infrastructure, however, the other provisions of the NP&W Act still apply.

The *Standard Instrument – Principal Local Environmental Plan* defines an 'Aboriginal place of heritage significance' as an area of land, the general location of which is identified in an Aboriginal heritage study adopted by the Council after public exhibition, and that may be shown on the Heritage Map.

No sites or places listed under the EPBC Act were identified in the project area, and therefore there are no requirements under that Act relevant to the assessment.

The assessment was undertaken in accordance with:

- *Code of practice for archaeological investigation of Aboriginal objects in New South Wales* (DECC, 2010a)
- *Aboriginal cultural heritage consultation requirements for proponents* (DECC, 2010b)
- *Guide to investigating assessing and reporting on Aboriginal cultural heritage in NSW* (OEH, 2011).

15.1.2 Methodology

The methodology for the assessment involved:

- a desktop review of archaeological literature and databases to identify listed Aboriginal sites and places within the project area, including:
  - a search of the Aboriginal Heritage Information Management System (AHIMS) for listed Aboriginal sites
  - a search of relevant LEPs for listed Aboriginal places
- consulting with registered Aboriginal parties (described below)
- field surveys on 17 June 2016, and 7 and 8 March 2017, to identify visible surface evidence of Aboriginal heritage sites and landforms in the presence of representatives of the Metropolitan and Gandangara Local Aboriginal Land Councils
- developing a predictive model to assist in determining archaeological potential
- assessing the potential impacts of the project
- identifying mitigation measures to minimise the risk of impacting Aboriginal items or areas of Aboriginal cultural sensitivity.

15.1.3 Aboriginal consultation

Aboriginal consultation was undertaken in accordance with the requirements of *Aboriginal cultural heritage consultation requirements for proponents* (DECC, 2010b). Letters were sent to the relevant organisations requesting details of Aboriginal people who may hold cultural knowledge relevant to determining the Aboriginal significance of Aboriginal objects and/or places within and adjacent to the project area, including:

- Regional Operations Group, Metropolitan Region, OEH
- Metropolitan Local Aboriginal Land Council
- Gandangara Local Aboriginal Land Council
- The Registrar, *Aboriginal Land Rights Act 1983*
- National Native Title Tribunal

- NTSCORP Limited
- Canterbury-Bankstown Council
- Inner West Council
- Greater Sydney Catchment Management Authority.

Additionally, an advertisement inviting all Aboriginal persons and organisations who hold relevant cultural knowledge was placed in the Sydney Morning Herald and Koori Mail on 4 May 2016.

Fifteen Aboriginal stakeholders registered as persons or organisations that may hold cultural knowledge relevant to determining the Aboriginal cultural values of the study area.

Transport for NSW are commenced preparation of an Aboriginal Cultural Heritage Assessment Report which would include additional consultation with registered Aboriginal parties. Consultation would continue during the EIS process and as necessary during detailed design and construction, in accordance with *Aboriginal cultural heritage consultation requirements for proponents*.

15.1.4 Field surveys

For the purposes of the field surveys, the project area was divided into survey units. Each station area and associated construction compound was designated as a survey unit. The remainder of the project area was considered as a single survey unit. All survey units were covered on foot where it was safe to do so.

Potential archaeological deposits (PADs) identified during the field survey are described in Section 15.2.5.

15.2 Existing environment

15.2.1 Aboriginal historical context

Evidence of Aboriginal occupation in NSW dates back to around 50,000 to 60,000 years at Lake Mungo (in NSW's south-western region, about 110 kilometres north-east of Mildura) and up to 30,000 years at Parramatta. Aboriginal people lived in small family or clan groups that were associated with particular territories or places. The language group spoken across Sydney was known as Darug. The Darug language group is thought to have covered the area south from Port Jackson, north from Botany Bay and west from Parramatta.

The project area is located within the area thought to have been inhabited by the Wangal clan. The Wangal clan's territory extended between the Parramatta River and the Cooks River, from Darling Harbour to Rosehill. The wetlands associated with the Cooks River and Gumbramorra Swamp would have been reliable fresh water and food sources. The Hawkesbury Sandstone around the Cooks River would have provided Aboriginal people with shelter, and the surrounding environment would have provided ample materials for tools and other material culture.

15.2.2 Aboriginal material

The most common type of Aboriginal objects remaining in the archaeological record are stone artefacts, followed by bones and shells. There is potential for Aboriginal objects to occur across the landscape. The nature of the underlying geology and proximity of water sources to portions of the study area indicates the potential for the occurrence of artefact sites and/ or midden sites.

15.2.3 Previously registered Aboriginal heritage sites

The AHIMS database search identified six sites within an extended search area. No listed Aboriginal sites are located within the project area.

The closest previously recorded Aboriginal heritage site is the Fraser Park potential archaeological deposit (PAD), located about 650 metres north-east of the project area boundary at Marrickville. The Fraser Park PAD was subject to archaeological excavations for a proposed underground electricity supply project in 2003. The report indicated that the area of PAD is not in the location registered on AHIMS, but is instead located in the Fraser Park sporting complex, about 130 metres east of the project area.

15.2.4 Archaeological implications

The presence of intact Aboriginal archaeological deposits within the study area is largely dependent on the nature and extent of disturbance associated with historical construction and development activities. Subsurface disturbance such as the removal of top soil and other bulk earthworks would substantially lower the potential for intact archaeological deposits in those areas. This is especially relevant in areas of relatively shallow residual soils, which includes the majority of the study area.

Whilst the study area is likely to have been a site of Aboriginal occupation in the past, the likelihood of evidence of this occupation surviving to the present is influenced by a range of factors. These factors include the durability of the material evidence and subsequent disturbance. The large-scale removal and modification of the underlying geology and associated shallow residual soils during construction of the existing rail line and surrounding urban infrastructure is likely to have significantly impacted or removed many former natural landform contexts and associated archaeological potential in the study area.

15.2.5 Potential archaeological deposits identified during field surveys

Two areas of PADs were identified during field surveys near Belmore and Punchbowl stations (S2B PAD01 and S2B PAD02 respectively).

S2B PAD01 is located in a small park (Guide Park) outside the project area near Belmore Station and is covered by dense grass and several trees. Analysis of aerial photography indicates that the area has been used as open space since at least 1943 and no major ground disturbance has occurred.

S2B PAD02 is an area of archaeological potential within Warren Reserve adjacent to Punchbowl Station. Analysis of aerial photography from 1943 and over the past 10 years indicates that there appears to have been little subsurface disturbance. Intact soils were observed in a cutting to the north of the station.

15.2.6 Aboriginal places of heritage significance

No Aboriginal places declared under section 84 of the National Parks and Wildlife Act, or Aboriginal places of heritage significance defined by the *Standard Instrument – Principal Local Environmental Plan,* are located within or near the project area.

15.2.7 Archaeological potential and significance

An assessment of archaeological potential and significance was undertaken. The likelihood of Aboriginal heritage sites occurring in the project area is influenced by a range of factors, including the durability of the material evidence, and the subsequent level of disturbance.

The Burra Charter defines cultural significance in terms of aesthetic, scientific, historic, and social values. Aboriginal cultural heritage is typically assessed according to its social and scientific significance; however other values may also be of importance. The assessment of significance provides a guideline for determining appropriate mitigation and management strategies.

The relationship between levels of significance and management strategies can be summarised as follows:

- high significance – the site should be conserved and protected from the impacts of development, where possible
- moderate significance – the site should be protected if possible, however, if impacts to the site are unavoidable, appropriate mitigation strategies should be implemented prior to impact
- low significance – the site should be protected if possible, however, if impacts to the site are unavoidable, the presence of the site should not impede the proposed development.

Due to the extent of previous disturbance within the project area, archaeological potential is only likely to occur in areas that have not been subject to extensive sub-surface disturbance. The archaeological significance of the project area within the existing rail corridor is considered to be low as a result of the high levels of ground disturbance.

With respect to the two areas of potential archaeological deposits identified during field surveys, the assessment concluded that:

- S2B PAD01 is considered to have low to moderate significance. The area has potential to contribute to research for this portion of the Cumberland Plain.
- S2B PAD02 is considered to have moderate significance and low to moderate potential for intact archaeological deposits to be identified. The identification of Aboriginal objects within this area would contribute to a knowledge gap in the region and contribute to research for the Sydney Basin more generally.

No other sites of archaeological potential were identified.

15.3 Impact assessment

15.3.1 Risk assessment

The main risks relating to Aboriginal heritage would occur during construction. Works within the project area have the potential to directly or indirectly disturb identified Aboriginal sites and areas of archaeological potential.

The environmental risk assessment for the project, undertaken for the State Significant Infrastructure Application Report, identified the potential to inadvertently impact unrecorded Aboriginal sites and/or areas of archaeological sensitivity during project construction as the main Aboriginal heritage risk.

15.3.2 Impact assessment

An assessment of archaeological significance was prepared for each survey unit (refer to Section 15.1.4) using the significance ratings outlined in Section 15.2.7 and the following criteria:

- Research potential – does the evidence suggest potential to contribute to an understanding of the area and/or region and/or the State’s natural and cultural history?
- Representativeness – how much variability (outside and/or inside the subject area) exists, what is already conserved, how much connectivity is there?
- Rarity – is the subject area important in demonstrating a distinctive way of life, custom, process, land-use, function or design no longer practised? Is it in danger of being lost or of exceptional interest?
- Education potential – does the subject area contain teaching sites or sites that might have teaching potential?

15.3.3 Assessment findings

A summary of the results of the assessment is provided in Table 15.2.

Table 15.2 Aboriginal heritage assessment findings

Study area survey unit	Archaeological potential	Archaeological significance	Assessment of potential impact
Marrickville Station	Nil to low	Nil to low	Unlikely to impact Aboriginal objects
Dulwich Hill Station	Nil to low	Nil to low	Unlikely to impact Aboriginal objects
Hurlstone Park Station	Nil to low	Low	Unlikely to impact Aboriginal objects
Canterbury Station	Nil to low	Low	Unlikely to impact Aboriginal objects
Campsie Station	Nil to low	Low	Unlikely to impact Aboriginal objects
Belmore Station	Nil to low S2B PAD01 has low to moderate archaeological potential but is located outside project area	Low S2B PAD01 has low to moderate significance, but is located outside project area	Unlikely to impact Aboriginal objects S2B PAD01 would not be impacted as it is located outside project area
Lakemba Station	Nil to low	Low	Unlikely to impact Aboriginal objects
Wiley Park Station	Nil to low	Low	Unlikely to impact Aboriginal objects
Punchbowl Station	S2B PAD02 has moderate archaeological potential Rest of unit is nil to low	S2B PAD02 not rare but has potential to contribute to knowledge gap Rest of unit is nil to low	S2B PAD02 has the potential to be impacted by construction Work in rest of unit unlikely to impact Aboriginal objects
Bankstown Station	Nil to low	Low	Unlikely to impact Aboriginal objects
Rest of corridor	Nil to low	Low	Unlikely to impact Aboriginal objects

Construction of the project would not impact previously recorded Aboriginal heritage sites. No previously recorded items or places are located within the project area. The closest previously recorded Aboriginal heritage site is located about 650 metres outside the project area.

A portion of S2B PAD02 would be impacted by the proposed new access way from Punchbowl Road to Punchbowl Station and proposed landscaping works. S2B PAD01 would not be impacted.

Operation of the project is not expected to result in impacts on Aboriginal heritage.

There are no cumulative impacts on Aboriginal heritage predicted during construction or operation of the project.

15.4 Mitigation measures

15.4.1 Approach to mitigation and management

The overall approach to cultural heritage management that has framed development of the project is that, where possible, impacts to Aboriginal sites, places, and objects would be avoided. If conservation is not practicable, measures would be taken to mitigate potential impacts.

Potential impacts to Aboriginal heritage would be managed in accordance with the Construction Environmental Management Framework (as described in Chapter 28 Synthesis of the Environmental Impact Statement), which provides for the development of a heritage management plan in consultation with registered Aboriginal parties. Transport for NSW has also commenced preparation of an Aboriginal Cultural Heritage Assessment Report including consultation with registered stakeholders.

15.4.2 List of mitigation measures

The mitigation measures that would be implemented to address potential impacts on Aboriginal heritage sites and areas of archaeological potential are listed in Table 15.3.

Table 15.3 Mitigation measures – Aboriginal heritage

ID	Impact/issue	Mitigation measures	Relevant location(s)
Design/pre-construction			
AH1	Consultation	Aboriginal stakeholder consultation would continue to be undertaken in accordance with *Aboriginal Cultural Heritage Consultation Requirements for Proponents* (DECC, 2010b).	All
AH2	Avoiding impacts to Aboriginal heritage	An Aboriginal cultural heritage assessment report would be prepared in accordance with the *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW* (OEH, 2011). The report would include: • details of Aboriginal stakeholder consultation conducted • an assessment of cultural significance for the project area and identification of any specific areas of cultural significance based on consultation with Aboriginal stakeholders • a methodology for archaeological test excavation and salvage, to be undertaken by suitably qualified personnel • procedures for any unexpected finds.	All (this item has already commenced)
AH3	Managing impacts to identified PADs	Direct impacts to S2B PAD02 at Punchbowl Station would be avoided where practicable. If impacts to S2B PAD02 cannot be avoided, archaeological test excavation (and salvage when required) would be undertaken prior to construction in accordance with the methodology defined by the Aboriginal cultural heritage assessment report.	S2B PAD02
AH4	Interpretation	Appropriate Aboriginal heritage interpretation would be incorporated into the design in consultation with Aboriginal stakeholders.	All

ID	Impact/issue	Mitigation measures	Relevant location(s)
Construction			
AH5	Unexpected finds	If potential Aboriginal items are uncovered, works within 10 metres of the item would cease. The item would then be assessed and managed by a suitability qualified person in accordance with the unexpected finds procedure in the Aboriginal cultural heritage report. During pre-work briefings, employees would be made aware of the unexpected finds procedures and obligations under the NPW Act.	All

15.4.3 Consideration of the interactions between mitigation measures

There are no interactions between Aboriginal heritage and other project mitigation measures.

15.4.4 Managing residual impacts

There are no residual impacts on Aboriginal heritage predicted during construction or operation of the project. Implementation of the management measures included in the Construction Environmental Management Framework would reduce the likelihood of potential impacts on Aboriginal heritage as a result of the project.

16. Land use and property

This chapter assesses the potential impacts of the project on land use and property. The Secretary's environmental assessment requirements relevant to land use and property, and reference to where they are addressed in this chapter and in the Environmental Impact Statement, are provided in Table 16.1.

Table 16.1 Secretary's environmental assessment requirements – land use and property

Ref	Secretary's environmental assessment requirements – land use and property	Where addressed
10.2	The Proponent must assess impacts from construction and operation on:	
	• potentially affected properties,	Section 16.4
	• businesses,	Chapter 18 (Business impacts)
	• recreational users,	Section 16.4
	• land and water users,	Section 16.4 (existing land users). No water users would be impacted by the project
	• including property acquisitions/adjustments,	Section 16.4.2
	• access,	Chapters 10 (Construction traffic, transport and access) and 11 (Operation traffic, transport and access)
	• amenity, and	Chapter 17 (Socio-economic impacts)
	• relevant statutory rights.	The impacts of property acquisition are considered in Section 16.4.2 Potential amenity impacts are considered in Chapter 17

16.1 Assessment approach

16.1.1 Legislative and policy context to the assessment

Relevant legislation and planning instruments (including the EP&A Act, State environmental planning policies, and local environmental plans) are described in Chapter 3 (Planning and assessment process). Land use planning strategies relevant to the study area and the project are described in Chapter 5 (Project need) and Section 16.3.

16.1.2 Methodology

The assessment involved:

- describing the existing environment with reference to existing land uses and planning controls, based on a review of aerial photography, land use zones specified by applicable local environmental plans, and a site visit
- reviewing key strategic planning policies and documents relevant to the study area, to identify planned future priorities, including land uses and developments
- assessing the potential impacts of construction and operation on existing and likely future land uses, and properties in and around the project area
- identifying mitigation measures to avoid or manage potential impacts.

16.2 Existing environment

A description of the project area for the purpose of the Environmental Impact Statement is provided in Chapter 2 (Location and setting). This section describes existing land uses and properties within and immediately surrounding the project area. Future land use planning is described in Section 16.3.

The vast majority of the project area is located within the existing rail corridor, which is used for infrastructure (transport – rail and supporting infrastructure) purposes. The majority of the rail corridor is zoned SP2 Infrastructure (Rail) under the Marrickville, Canterbury, and Bankstown local environmental plans. Some sections of the rail corridor are also zoned as follows:

- B4 Mixed Use - at Bankstown Station
- B2 Local Centre - at Canterbury, Campsie, Belmore, and Lakemba stations
- SP2 Infrastructure (Classified Road) – at Canterbury.

Although the main land use of the stations is transport (rail infrastructure), there are a number of businesses operating within the stations (described in Chapter 18 (Business impacts)). The main land uses in the areas immediately surrounding the stations are commercial and residential. Most of the stations are located within/next to a local/neighbourhood centre, which provide a range of services and facilities. Further information is provided below, and in Chapter 18.

Between the stations, the rail corridor is surrounded by a mix of land uses, including residential, commercial, industrial, and recreation/open space, with pockets of education and community uses. Further information on the location of key community facilities is provided in Chapter 17 (Socio-economic impacts).

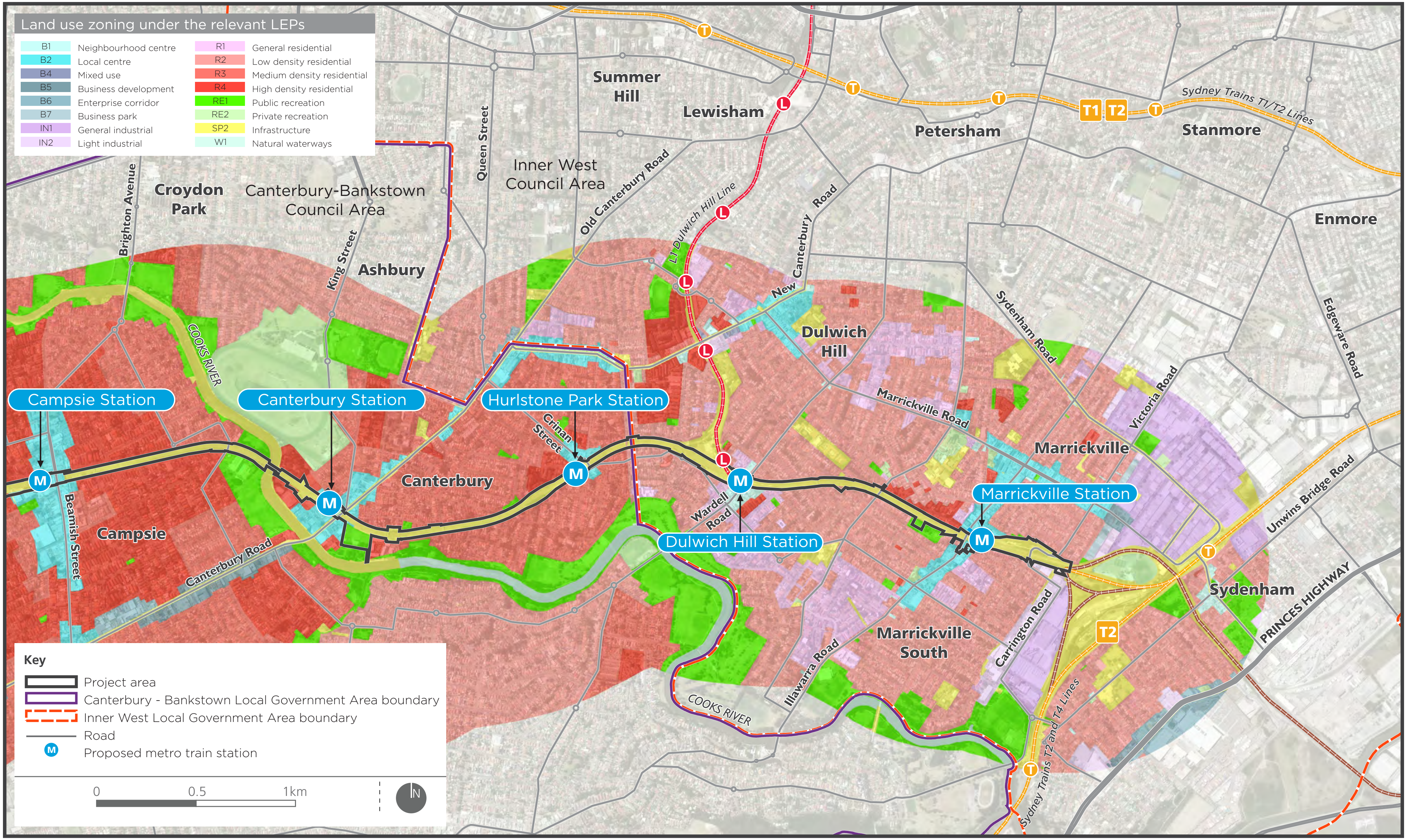
Key land uses around each station are described in the following sections. Land use zones in and around the project area are shown in Figure 16.1. Key features in and around the project area are shown in Figure 2.1.

16.2.1 Marrickville Station

Marrickville Station is located about seven kilometres south-west of the Sydney CBD. The station is located on the edge of the Marrickville town centre, which is centred on the corner of Illawarra and Marrickville roads. The town centre has a thriving and multicultural business community, and includes a wide variety of commercial and retail premises. The town centre is surrounded by a variety of housing, including detached and attached dwellings, and apartment buildings.

The station is surrounded by roads to the west (the Illawarra Road overbridge) and south (Station Street). Immediately north of the rail corridor and east of Illawarra Road is a large, relatively recent multi-storey residential apartment building, with street level commercial uses.

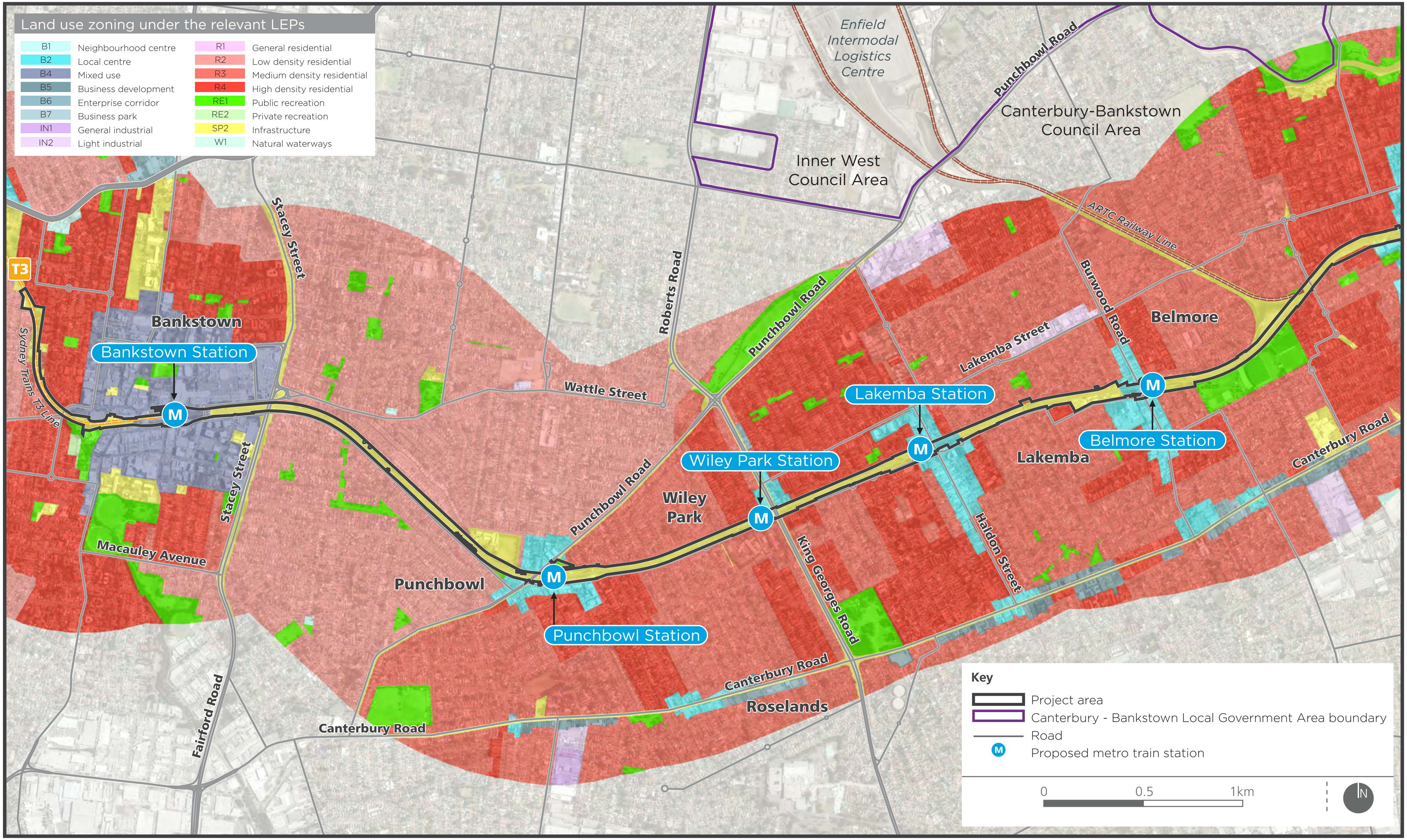
Characteristic of its near city location, land uses surrounding the station include a mix of residential, commercial, and light industrial. A recreational land use (McNeilly Park) is located about 120 metres to the west of the station.



sydney METRO | city & southwest

Land uses - map 1

FIGURE 16.1



sydney METRO | city & southwest

Land uses - map 2

FIGURE 16.1

16.2.2 Dulwich Hill Station

Dulwich Hill Station is located about 7.8 kilometres south-west of the Sydney CBD. The station is surrounded by roads to the east (the Wardell Road overbridge), north (Bedford Crescent), and south (Wardell Road and Ewart Lane). Commercial land uses associated with the Dulwich Hill town centre are located further to north and south, along Wardell Road, on either side of the rail corridor. The town centre also includes some residential uses. Areas dominated by residential land uses are located further to the north-east, north-west, and south of the station.

Recreational land uses are located about 160 metres to the north-west of the station (Jack Shanahan Park, including the Dulwich Hill Skate Park), and 400 metres to the south-west, on the Cooks River (the Marrickville Golf Club).

The Dulwich Hill light rail stop, the terminus for the L1 Dulwich Hill Line, is located about 130 metres to the north-west of the station.

16.2.3 Hurlstone Park Station

Hurlstone Park Station is located about 8.4 kilometres south-west of the Sydney CBD. The station is surrounded by roads to the north (Floss Street – with associated commuter car parking), east (the Crinian Street road overbridge), and south (Duntroon Street). Further to the north are a range of commercial land uses associated with the Hurlstone Park local centre (along Crinan Street). The local centre is located mainly to the north of the station. Residential land uses, which include a mix of apartment buildings and detached houses, are located to the north-west, north-east, and south of the station.

16.2.4 Canterbury Station

Canterbury Station is located about 9.5 kilometres south-west of the Sydney CBD. The station is surrounded by Broughton Street to the north/north-east, Canterbury Road (road overbridge) to the east, and a large mixed use development site which fronts Charles Street to the south.

Traditional commercial land uses are located to the north-east of the station, along Canterbury Road and Jeffrey Street. Residential land uses are located to the north, east, and south of the station. Substantial redevelopment activity (both residential and commercial) is occurring to the south and south-west of the station, between the station and the Cooks River foreshore (about 170 metres to the south-west). A number of multi-storey residential and mixed use apartment buildings are being constructed in this area. The new Canterbury Plaza and shops adjoin the rail corridor to the south-west.

The Close Street reserve is located about 160 metres to the south of the station, and Canterbury Racecourse is located about 400 to the north-west.

Areas of open space are located along the Cooks River foreshore further to the west of the station (on the western side of the Cooks River, about 500 metres to the west of the station), including Tasker Park, the Canterbury Aquatic and Fitness Centre, and Olympic Ice Rink.

16.2.5 Campsie Station

Campsie Station is located about 10.7 kilometres south-west of the Sydney CBD. The station is directly adjoined by a number of buildings (located on land owned by Railcorp) that are used for a variety of retail/commercial purposes. The station area is surrounded by North Parade to the north, Beamish Street to the east, and Lillian Lane to the south. The station is located in the middle of the Campsie town centre, which is a busy, vibrant, and culturally diverse retail and commercial centre. The Campsie town centre hosts a mix of commercial, retail, administrative, and civic functions, which are concentrated along Beamish Street and surrounding streets, including Anzac Mall.

Residential areas surrounding the centre consist of a mix of two to three storey walk up residential flat buildings, and detached houses.

Anzac Mall and Square and Carrington Square provide the main areas of public open space for the Campsie town centre. Other areas of open space are further away from the town centre, about one kilometre to the east and north along the Cooks River foreshore.

Campsie Public School is located about 240 metres to the south of the station.

16.2.6 Belmore Station

Belmore Station is located about 12 kilometres south-west of the Sydney CBD. The station is surrounded by car parks to the north (on Redman Parade) and south (on Tobruk Avenue), and Burwood Road (overbridge) to the west.

A range of commercial land uses extend along Burwood Road to the north and south of the station. Canterbury League Club is located about 100 metres to the south-west of the station on Bridge Road.

Residential land uses, consisting mainly of detached housing, are located further to the north-west, north-east, and south-east of the station.

Belmore Sports Ground and parkland is located about 400 metres east of the station.

16.2.7 Lakemba Station

Lakemba Station is located about 13.5 kilometres south-west of the Sydney CBD. The station is surrounded by Railway Parade to the north, Haldon Street (overbridge) further to the east, and The Boulevarde to the south.

Commercial land uses associated with the Lakemba town centre are located to the north and south of the station, mainly along Railway Parade and Haldon Street. Residential uses, including a mix of medium density apartment buildings and detached housing, surround the town centre.

The Lakemba Library and Senior Citizen’s Centre is located about 80 metres to the south-west of the station. The Lakemba Uniting Church is located about 100 metres to the south-east. Jubliee Reserve is located about 100 metres to the west.

16.2.8 Wiley Park Station

Wiley Park Station is located about 14.3 kilometres south-west of the Sydney CBD. The station is surrounded by commercial land uses to the north, King Georges Road (overbridge) to the east, and The Boulevarde to the south.

A small commercial strip is located along King Georges Road to the north of the station. A number of education land uses are located to the south of the station – Wiley Park Girls High School and Wiley Park Public School are located opposite Wiley Park Station and the rail corridor on the southern side of The Boulevarde. Residential land uses (a mix of detached housing and medium density apartment buildings) are located further to the north and east of the station.

16.2.9 Punchbowl Station

Punchbowl Station is located about 15.4 kilometres south-west of the Sydney CBD. The station is surrounded by Punchbowl Road to the north-west and west, Warren Reserve to the north, and The Boulevarde and commercial land uses to the south.

A range of commercial land uses associated with the Punchbowl town centre are located along Punchbowl Road to the north and south of the station, and along The Boulevarde to the south.

Warren Reserve adjoins the station area to the north-east. The Punchbowl Community Centre is located about 150 metres south of the station on Rossmore Avenue.

Punchbowl Boys High School, which adjoins the rail corridor, is located about 300 metres north-west of the station. The Saint Jerome Catholic Church and School is located about 200 metres south of the station.

Residential land uses, consisting mainly of detached housing, are located further to the north, south, and west of the station.

16.2.10 Bankstown Station

Bankstown Station is located about 17 kilometres south-west of the Sydney CBD. The station is surrounded by the Bankstown City Plaza to the east and south, North Terrace to the north, and South Terrace further to the south-east.

The station is located within the Bankstown town centre, which is a regional centre providing administrative, retail, business, and service functions for the Canterbury-Bankstown local government area.

The Bankstown town centre includes a varied mix of land uses, and a number of community facilities, including Canterbury-Bankstown Council, Bankstown Library, and the Bankstown Arts Centre.

Bankstown Central, a large shopping mall with about 300 stores and a floor area of about 85,800 square metres, is located about 160 metres to the north-east of the station.

Bankstown Girls High School and Bankstown Public School are located to the south of the town centre, about 200 metres to the south of the station. Saint Euphemia College is located about 500 metres to the south-east of the station.

16.2.11 Traction power supply cable

The route for the proposed high voltage traction power electricity cable, between the proposed Campsie traction substation and the existing Ausgrid Canterbury electrical substation, would be mainly located within existing road reserves. The main land use surrounding the majority of the route is residential. Recreation land uses also adjoin the route, including:

- Canterbury Olympic Ice Rink
- Canterbury Aquatic and Fitness Centre
- Tasker Park
- Earlwood Park.

The route also passes through Hughes Park in Earlwood.

16.3 Future land use

16.3.1 Strategic planning

Development around the stations along the T3 Bankstown Line has predominately occurred since the line was constructed, and will continue to occur into the future. Strategic planning for the study area has and is being undertaken by a number of agencies, including the Department of Planning and Environment, the Greater Sydney Commission, and the Inner West and Canterbury-Bankstown Councils. This strategic planning is separate to the planning and approval process for the project, however the project has been informed by the broader strategic planning context.

The main strategies relevant to future land use planning for the study area are summarised below.

Sydney regional planning - A Plan for Growing Sydney

A Plan for Growing Sydney, which was released in December 2014, is the NSW Government's 20 year plan for Greater Sydney (the Sydney metropolitan area). *A Plan for Growing Sydney* is also known as the Sydney Metropolitan Strategy. The plan provides a direction for Sydney's productivity, environmental management, and liveability; and for the location of housing, employment, infrastructure, and open space.

Greater Sydney is defined as the area extending from Wyong and Gosford in the north, to the Royal National Park in the south, and west to include the Blue Mountains, Wollondilly, and Hawkesbury.

Relevant to the project, one of the key directions noted by the plan is to 'accelerate housing supply across Sydney'. An action under this direction is to 'accelerate new housing in designated infill areas (established urban areas) through the Priority Precincts and Urban Growth NSW programs' and in these precincts '… the Government is working to match population growth with investment in infrastructure, providing new schools and recreation facilities alongside improvements to roads and public services.' The Sydenham to Bankstown corridor is identified as an urban renewal corridor under the plan.

The plan also proposes a number of 'enterprise corridors', which are defined as 'an area designed to attract investment and stimulate employment-generating development that is aligned with specific sections of rail or road transport infrastructure'. Bankstown to Liverpool is nominated as an enterprise corridor by the plan.

A key direction noted by the plan is to 'invest in strategic centres across Sydney to grow jobs and housing and create vibrant hubs of activity'. The plan nominates Bankstown as a strategic centre. Another key direction is to 'expand the Global Economic Corridor', which extends from Macquarie Park through the Sydney CBD to Port Botany and Sydney Airport. Marrickville is located at the south-western edge of the Global Economic Corridor. An action under this direction is to 'invest to improve infrastructure and remove bottlenecks to grow economic activity'.

A draft amendment to the plan, *Towards our Greater Sydney 2056*, was placed on public exhibition by the Greater Sydney Commission in November 2016. *Towards our Greater Sydney 2056* sets the direction for a review of *A Plan for Growing Sydney*, and provides a linkage with the current district planning process (described below). *Towards our Greater Sydney 2056* promotes the concept of Greater Sydney as a metropolis of three cities (the established Eastern City, the developing Central City, and the emerging Western City). Relevant to the project, *Towards our Greater Sydney 2056* provides for the following priorities:

- A productive city – increasing the range of jobs and services that people can get to within 30 minutes, and improving accessibility to jobs across all districts.
- Accelerating housing opportunities and urban renewal – investigating urban renewal corridors, and providing opportunities for new housing in existing and new centres with frequent public transport, including aligning development with infrastructure investment (such as Sydney Metro).

District planning

The Greater Sydney Commission was established in 2016 to lead metropolitan planning in Greater Sydney. Greater Sydney has been divided into six districts, with a district plan being developed for each. The district plans provide the link between *A Plan for Growing Sydney* (described above) and councils' local environmental plans. The goal of the district plans is to have well-coordinated, integrated, and effective planning for land use, transport, and infrastructure.

The plans set out the opportunities, priorities, and actions required to put *A Plan for Growing Sydney* into action at a local level. Draft plans for each district were placed on public exhibition in November 2016. The project area is located within two districts:

- central district – between east of Marrickville Station and west of Dulwich Hill Station
- south district – between west of Dulwich Hill Station to Bankstown Station.

Relevant to the future planning of the study area, the two draft district plans seek to increase the number of jobs and dwellings within each of plan areas. The plans note that urban renewal activities, such as the draft *Sydenham to Bankstown Urban Renewal Corridor Strategy*, would assist with driving this growth, particularly along the T3 Bankstown Line. The project, both individually and as part of the wider metro network, is identified as being a key driver for urban renewal.

The existing town centres in the vicinity of Campsie and Bankstown stations are identified as district centres by the South District Plan. The plan notes the need to strengthen these centres to attract people for work and recreation, through the activation of the centres, particularly at night. The plan notes that the project would provide an opportunity to grow local employment, enhance public amenity, and increase densities.

Sydenham to Bankstown Urban Renewal Corridor Strategy

The draft *Sydenham to Bankstown Urban Renewal Corridor Strategy*, was released by the Department of Planning and Environment in 2017. The strategy was prepared to identify opportunities for urban renewal around the stations between Sydenham and Bankstown over the next 20 years.

The strategy was based on a review of existing conditions in the areas around each station, considering demographics and forecast housing and employment growth. The strategy also identifies key constraints to urban renewal and new development.

With respect to housing, the strategy notes that improvements to public transport provided by Sydney Metro should increase the attractiveness of the area as a place to live. The strategy aims to improve the overall supply of new housing within the corridor, and ensure that there is a choice of housing to meet the needs of diverse communities.

With respect to employment, the strategy aims to:

- promote the Bankstown CBD as a place for business and investment, and increase the number of people living within the CBD to drive economic growth
- support the growth of the Marrickville and Campsie town centres as destinations for retail, local business, and community functions
- encourage local services, retail, and convenience shops close to stations.

The strategy identifies opportunities for additional housing and jobs within walking distance of the stations. The strategy forecasts that over 35,000 additional dwellings could be built within the corridor by 2036, and about 8,000 jobs could be generated. This is based on a number of factors, including existing and historic growth rates, with the introduction of the project a contributing factor.

The draft vision for the area surrounding each station, and indicative development and employment increases, are summarised in Table 16.2.

The Canterbury, Campsie, Lakemba, and Belmore precincts have been identified as priority precincts along the corridor. Work would be undertaken by the Department of Planning and

Environment in conjunction with Canterbury-Bankstown Council to identify areas within these precincts that are to be the focus of more detailed planning.

Table 16.2 Draft Urban Renewal Corridor Strategy – key proposals

Station	Vision	Proposed residential development increase by 2036 (approximate)	Predicted increase in employment (number of jobs)
Marrickville	A diverse and vibrant community focused around a reinvigorated Illawarra Road	6,000 new dwellings. Accommodate an area of high rise residential and mixed use around the station	555
Dulwich Hill	A local centre that provides a high quality living environment with good transport connections	2,000 new dwellings. Small amount of medium to high rise housing on the southern side of station	275
Hurlstone Park	Retain the heritage and character of Hurlstone Park and increase the vibrancy of the local main street shops on Crinan Street	100 new dwellings. Medium rise housing west of the station on the northern side of the rail corridor.	216
Canterbury	A reinvigorated town centre that supports the role of Canterbury as a local centre in the South District of Metropolitan Sydney	4,000 new dwellings. Medium to high density surrounding the station particularly, to the north.	398
Campsie	Promote the growth of Campsie Station Precinct to reinvigorate the centre and support the role of Campsie as a district centre within the Sydney South District	6,000 new dwellings. Higher density housing in the vicinity of the station	1,765
Belmore	Burwood Road will continue to be a vibrant, popular eat street	3,000 new dwellings. Higher densities in the vicinity of the station, with high/mixed use development to the south	569
Lakemba	A centre that capitalises on its vibrant shopping strip, with great places to shop, eat, and socialise	3,000 new dwellings. Increase in densities along the rail corridor, with higher densities near the station	735
Wiley Park	A great place for families with a range of new and existing housing, good access to schools, and improved public open space	2,400 new dwellings. Increased densities along the rail corridor, with higher densities near the station and along the southern side of the corridor	364
Punchbowl	A centre that is better connected to its well-loved cosmopolitan shopping strip, with great places to shop, eat and socialise – day and night	2,400 new dwellings. Increased densities surrounding the station, with medium to high rise development close to the station	599
Bankstown	Bankstown will continue to provide shops, jobs, and community services for the wider corridor, consistent with its role as a district centre	6,000 new dwellings. Increased densities surrounding the station, with predominately high rise and mixed use development	2,493

16.3.2 Future developments within and surrounding the project area

Development surrounding the project area

As noted in Section 16.3.1, the draft *Sydenham to Bankstown Urban Renewal Corridor Strategy* predicts strong housing and employment growth within the project area. Other future development opportunities and strategies relevant to land within and in vicinity of the project area include, but are not limited to:

- *North East Local Area Plan* (Bankstown City Council, 2016) – sets the vision for the North East Local Area (which includes Punchbowl) to be a place for people, maintaining the qualities and places that encourage jobs and sustainable urban renewal, with an emphasis on urban design and connectivity. The plan identifies the 'Punchbowl Small Village Centre' as a transit-oriented centre, along the Sydenham to Bankstown urban renewal corridor, which would be well used by commuters using Sydney Metro. It provides a vision for Punchbowl Station as a focal point for local retail activity along the main streets (The Boulevarde and Punchbowl Road), and as a civic space that connects development on both sides of the rail corridor. A planning proposal (re-zoning application) giving effect to the Local Area Plan has received a gateway determination from the Department of Planning and Environment.
- *Bankstown CBD Local Area Plan* (Bankstown City Council, 2011b) – sets out the vision for the Bankstown CBD to strengthen its role as a major activity and transport hub, servicing Bankstown and the wider West Central Subregion (now part of the South District), and for it to continue to be a place of strong population and economic growth.
- *Anzac Mall Place Management Strategy* (Macroplan, 2011) – assesses commercial vitality and vibrancy in the area of the existing Anzac Mall near Campsie Station, and makes a number of recommendations for improvements.
- *Towards 2032 - City of Canterbury Economic Development and Employment Strategy* (SGS, 2009a) identifies the long-term potential for the Canterbury Racecourse site to include commercial development.
- *Bankstown Employment Lands Development Study* (SGS, 2009b) – identifies the potential for alternative development opportunities for the Bankstown town centre.
- In September 2016, the Campsie RSL Club lodged an updated Planning Proposal and Master Plan with Canterbury-Bankstown Council to guide the redevelopment of its Anglo Road landholdings in the Campsie town centre. The proposed redevelopment involves an expanded club facility, high rise residential apartments and seniors living, and a range of other facilities, including retail and childcare.
- In 2006, Canterbury Council prepared a master plan to revitalise the Canterbury town centre and riverfront precinct, and transform it into a modern, vibrant mix of commercial and residential developments. Subsequent to the release of the master plan, a package of documents to implement Council's vision for the town centre was released in 2009, including a local environmental plan to rezone land, a development control plan, and urban design plan.
- The Australian Turf Club, owners of the Canterbury Racecourse, has considered selling/redeveloping a 6.5 hectare parcel of land that they own, located across the road from the racecourse. This land is indicated as a site for future residential development by the draft *Sydenham to Bankstown Urban Renewal Corridor Strategy.*

Development within the project area

The project has been designed to safeguard future rail corridor development opportunities. Future rail corridor development could involve commercial or mixed use development integrated with the stations, adjacent to stations, over or adjacent to the rail line, where existing in-corridor development is to be removed, or where suitable residual land is identified. Any future development proposals would be subject to a separate approvals process.

At Campsie Station, enabling works for a future rail corridor development are included as part of the project scope. These works would involve construction of an over track platform and foundations for a future development, to replace the existing retail/commercial building adjoining the Beamish Street overbridge. This over track platform would also support a lane (roadway) which would be used for a kiss and ride facility.

Provision of retail opportunities has been included as part of the project scope at most stations. The locations of these retail opportunities are shown on the station layout drawings in Chapter 8 (Project description – operation). The use of these spaces would be subject to a separate approvals process.

16.4 Impact assessment

16.4.1 Risk assessment

Potential risks

The environmental risk assessment for the project, undertaken for the State Significant Infrastructure Application Report, identified the following as the main land use and property risks:

- temporary acquisition or leasing of property to enable construction compounds to be established and/or construction work to occur
- temporary loss of public open space and car parking for construction sites
- permanent property acquisition to enable establishment and operation of project infrastructure
- indirect positive impacts and land use changes as a result of opportunities for urban renewal near stations
- rail corridor development.

How potential impacts have been avoided or minimised

Design development has included a focus on avoiding or minimising the potential for impacts during all key phases of the process. In general, potential impacts on land use and property have been avoided or minimised by:

- designing the project to minimise the potential for impacts outside the rail corridor
- designing the project to minimise the need for acquisition of private property
- designing station upgrades to minimise the impacts on, and complement, surrounding land uses
- taking a place making approach to the design process (as described in Chapter 7 (Design development and place making))
- consultation with other agencies undertaking strategic planning in the study area, to identify and maximise the benefits of the project for future land uses and development.

16.4.2 Construction

Property

Property and land requirements

As described in Chapter 8, permanent land acquisition would involve:

- full acquisition of three privately owned lots near Marrickville Station
- partial acquisition of land from three publicly owned lots near Marrickville and Punchbowl stations.

Property and land acquisition requirements are summarised in Table 16.3 and Table 16.4. The location of these properties are shown in Figure 8.23.

Table 16.3 Property acquisition requirements

Acquisition details						Number of interests affected	
Location	Project feature	Lot to be acquired and address	Partial/full acquisition	Owner	Existing land use/occupancy	Free-hold	Lease-hold
Marrickville Station	Station area works	Lot 10 DP 10198 1 Leofrene Avenue	Full	Private	Residential (land occupied by a residential dwelling subject to a lease)	1	1
		Lot 11 DP 746611 2 to 4 Station Street	Full	Private	Mixed use	1	1
		Lot 10 DP 710424 6 to 12 Station Street	Full	Private		1	3

Table 16.4 Public land requirements

Location	Project feature	Lot to be acquired and address	Partial/full acquisition	Owner	Existing land use/occupancy
Marrickville Station	Station area works	Untitled Carriageway Land in Station Street	Partial	Public	Infrastructure (access road)
Punchbowl Station	Station area works	Lot 7 DP 18474 Lot 76 DP 5701 752 to 764 Punchbowl Road	Partial	Public	Warren Reserve

A direct impact on property and land use is expected where land would be acquired at Marrickville and Punchbowl stations for the provision of station entrances, plazas, and shared zones. To enable development of the proposed western entrance, concourse, and shared zone at Marrickville Station, three privately owned lots (one residential and two commercial lots) would need to be acquired, and a portion of publicly owned land (in Station Street) would also need to be acquired. Similarly, to enable development of the new station entrance and concourse at Punchbowl Station, partial acquisition of two parcels of public land at Warren Reserve would be required.

The acquisition of privately owned land would be managed in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*. Further information is provided in Section 8.2.5.

Lease cessation

A number of existing station buildings and concourses would be altered or removed as part of the project. As a result, the project would require the cessation of commercial leases at the following six stations: Dulwich Hill, Belmore, Lakemba, Wiley Park, Canterbury, and Punchbowl. The project would also require cessation of 31 commercial leases at Campsie Station, as the buildings in which these leases are located would be removed.

These leases are with the NSW Government (RailCorp) as the owner of the relevant buildings/spaces. All the impacted leases would be ceased in accordance with lease agreements held with the NSW Government. The cessation of these leases would impact those businesses currently holding these leases. These impacts are considered in Chapter 18.

Temporary acquisition or lease of property

As described in Section 9.8, a number of compound areas and work sites would be required for temporary use during construction. The majority of these sites would be located within the rail corridor, which would minimise the potential for direct impacts on land use and property. Some areas of land would need to be temporarily leased or occupied to locate some of these compounds and work sites.

Land use

Direct impacts on land use during construction would include temporary land take and the short term presence of construction equipment, plant, vehicles, compounds, and work sites within the project area. During construction, the use of the land would change from a transport corridor (the use of the majority of land) to a partial and temporary construction site.

At Canterbury Station, the project would temporarily impact land owned by NSW Government and leased to Canterbury-Bankstown Council for use as a car park on Charles Street. While this land would not be acquired, the existing land use (parking) would temporarily change to a construction site.

At some stations, the use of some existing on-street areas (used typically for parking and loading) and some off-street parking areas, would be temporarily restricted during construction. Impacts on parking during construction is considered in Chapter 10 (Construction traffic and transport).

Table 16.5 provides a summary of the potential impacts of temporary construction sites and facilities on land uses. These impacts would be predominantly minor and short term. Table 16.5 does not consider impacts on road reserves/public land adjacent to roadways (e.g. verges), as impacts to these areas would be minor.

An underground detention basin would be constructed within McNeilly Park, on the southern side of the rail corridor, west of Marrickville Station (facility W2 in Table 16.5). The use of this area within the park would be temporarily restricted during construction of the basin. At the former Canterbury Bowling and Community Club, the majority of the site is proposed for use as a work site during construction. The use of areas occupied by the work site would be temporarily restricted during the presence of the work site. Both sites would then be returned to their existing use following completion.

During construction, land subject to acquisition would also change from its existing use (commercial, residential, public road, and reserve) to a temporary construction site. Public access would be restricted.

Typically, the temporary use of land would be secured through a lease or a memorandum of understanding with the relevant land owner or manager. In most cases, the government (e.g. Council) owns the land.

Table 16.5 Impacts of temporary construction sites and ancillary facilities on land use

Site	Location	Temporary proposed use	Owner	Potential temporary impact on land use
C2	Station Street, Marrickville	Construction compound (land is subject to permanent acquisition)	Public and Private	• temporary alterations to pedestrian access to the station • change from existing use (road) to construction compound
W2	McNeilly Park, Marrickville	Construction of flood retention basin	Public	• change from existing use (recreation) to construction area during construction of underground detention basin
C3	Ewart Lane, Dulwich Hill	Construction compound	Public	• change from existing use (parking) to construction compound
C4	Floss Street, Hurlstone Park	Construction compound	Public	• change from existing use (street/parking) to construction compound
W8	Former Canterbury bowling club (now leased for community purposes)	Support for Canterbury Station works including car parking	Public	• change from existing community use to construction use for the majority of the site, however the buildings would remain, with opportunities for some continued community use during construction
C5	Vacant land adjacent to rail corridor Broughton Street, Canterbury	Construction compound	Public	• change from existing use (vacant land) to construction compound
C14, C15, C16	Car parking around Lakemba Station	Construction compound	Public	• change from existing use (parking) to construction compound
C21	The Boulevarde, Punchbowl	Construction compound	Public	• change from existing use (parking) to construction compound

Construction of the proposed electricity supply cable would result in a temporary change of the existing land use along the route (mainly road and recreation (Hughes Park)) to a construction site. The implementation of standard construction traffic management measures, defined by the construction transport management plan (described in Section 10.5), would minimise the potential for impacts on the operation of the road and access to surrounding properties.

Within Hughes Park, use of the area required for construction of the cable would be restricted while the cable is constructed. Such impacts are considered to be relatively minor, as the works in any one location would be limited to a short period of time (likely to be less than about a week) as the works move along the alignment. Land would be restored to its pre-existing use and condition following construction.

16.4.3 Operation

Property

Property acquisition would occur during the project planning and pre-construction phases. Direct impacts to properties are not expected during operation.

Land use

Operation of the project would result in minimal direct impacts to land use. The proposal would involve the continued use of a rail corridor for transport purposes. Direct operational impacts on land use relate to the acquisition described in Section 16.4.2. By maximising the use of existing rail corridor land, the need for property acquisition has been minimised.

The three privately owned lots to be acquired at Marrickville Station would result in a negligible impact, as the change in land use would be consistent with the adjacent B2 Local Centre zoning.

The impact on land use near Punchbowl Station, which would result from the partial acquisition of public land at the adjacent Warren Reserve, has the potential to benefit the reserve. It would provide an opportunity for enhanced landscape treatment, increased public use, and activation of the surrounding area. The impacts to Warren Reserve would be limited to about 15 per cent of the overall reserve, located adjacent the existing rail corridor.

The project would also affect NSW Government (RailCorp) owned land at Charles Street, Canterbury, which is leased to Canterbury-Bankstown Council for use as a car park. The existing land use (parking) would change to rail infrastructure. The potential impacts on the availability of parking are considered in Chapter 11.

Stations

A summary of the key potential operational land use impacts, benefits, and opportunities at each station is provided in Table 16.6. Some of these changes would have the potential for beneficial impacts to local businesses. This is considered in Chapter 18.

Table 16.6 Key potential land use changes at stations

Location	Benefits and impacts
Marrickville	• improvements to the station entrance and creation of a public space in Station Street would result in a change in land use and new retail opportunities along the Station Street shared zone
Dulwich Hill	• creation of a public space providing access to the station from the commuter car park, Ewart Lane, and Wardell Road • improved connection from Bedford Crescent and the light rail stop, resulting in a more refined transition between the station and surrounding land uses • new retail opportunities at the southern station entrance forecourt
Hurlstone Park	• enlarged station entrance area at the Crinan Street overbridge with increased set back from the roadway to improve pedestrian flow, and provide new retail opportunities at the station entrance
Canterbury	• potential for small scale retail in the station plazas at the station entrances on Broughton Street and Canterbury Road • improved connections with the expanded town centre (to be located to the north) and new developments located south of the station near Canterbury Road • safeguarding of potential additional station entrance to Charles Street which would improve connections to future developments to be located south of the station
Campsie	• transformation of a portion of Lillian Lane to a shared zone, with the change in land use promoting pedestrian connectivity to the upgraded station entrance to the south of the station, and increasing space for pedestrian flows • an enlarged station entrance and forecourt and widened footpath on Beamish Street and provision of new retail opportunities would be a positive land use change • new retail opportunities and kiss and ride facilities on the eastern side of Beamish Street on a new deck over the rail corridor, which would allow for future rail corridor development

Location	Benefits and impacts
Belmore	• better integration with the nearby commercial and residential areas, including provision of new station concourse and cross corridor connection • the southern station entry and forecourt would provide an opportunity for retail development
Lakemba	• forecourt works would provide extended areas for community gathering and interaction • surrounding land uses/businesses would benefit from improved amenity and increased pedestrian traffic
Wiley Park	• positive change in land use to the north and south of the station, with two new entrances • opportunity for retail development within the new station concourse adjacent to Kings Georges Road
Punchbowl	• positive impact for the adjacent Warren Reserve, providing opportunity for enhanced landscape treatment and increased public use • surrounding land uses/businesses to the north of the station would benefit from improved amenity and increased pedestrian traffic • realigned rail line to the north would allow for a larger station entrance to the south of the station, improving the integration of the station with The Boulevarde and associated land uses • opportunity for retail development within the southern station entrance plaza
Bankstown	• provision of a new cross-corridor connection to provide more direct connection across the corridor, particularly between new development areas on the southern side of the corridor and the Bankstown Central Shopping Centre to the north

Ancillary facilities

Additional ancillary facilities such as substations or services buildings would be located within the rail corridor or on NSW Government owned land (RailCorp), which is located outside the existing operational corridor. The impact on land use and property of these facilities would be negligible.

The project includes works outside the rail corridor to adjust the road network, bus stops and kerbside facilities in the vicinity of stations. These changes would not result in any impacts on land use during operation, as the changes would be consistent with the existing use (transport for example). Overall, the project would not result in any changes to land use outside the rail corridor (including any NSW Government owned land adjacent to the rail corridor) which would result in impacts to land use.

Future land use and development opportunities

Use of residual land

The rail corridor currently contains areas of unused land. The project design has prioritised the use, wherever possible, of corridor land for project facilities. Once all project infrastructure is constructed, some space may be available for other uses.

In the event that there are competing demands for the use of this land, the following hierarchy would be adopted:

- Safeguard land for provision of an active transport corridor as described in Section 8.1.4.
- Future development opportunities (subject to separate approvals process) - promote mixed use, residential, and community use, and urban renewal that reinforces existing centres.
- Commuter parking facilities:
  - provide sufficient facilities to offset the displaced parking spaces
  - promote share parking facilities with other developments or institutions

– promote parking integrated with development where possible
– design surface parking areas that can be used for other community activities outside commuter parking hours.

Other potential uses for residual land in accordance with the hierarchy would maximise beneficial outcomes for the community, contributing to the sustainability and vitality of local centres, and the corridor generally.

Surrounding land uses

The project presents opportunities for positive change within the vicinity of the stations, supporting urban renewal, and creating attractive, vibrant, and highly accessible places (refer to Table 16.6). The relationship between the project and surrounding land uses is mainly being addressed through the planning and land use integration process that commenced with the draft *Sydenham to Bankstown Urban Renewal Corridor Strategy* (described in Section 16.3.1). This was also considered as part of the place-making work undertaken during design development (described in Chapter 7). Transport for NSW will contribute to a study being undertaken by the Department of Planning and Environment and Canterbury-Bankstown Council to determine a master plan and business case for the Bankstown town centre, including how the station fits with the centre. The study will be funded by Transport for NSW and Canterbury-Bankstown Council.

The project would have minor impacts on land that is not already used for rail infrastructure. In most cases, the project would lead to improvements in accessibility to stations and better integration of the rail network with existing and improved pedestrian, cycle, and bus networks. The project would play a part in facilitating the future development envisaged by the broader urban renewal program.

Overall, the project is anticipated to integrate positively with the initiatives proposed by the draft *Sydenham to Bankstown Urban Renewal Corridor Strategy*, by providing a public transport facility that can meet future needs.

By converting the T3 Bankstown Line to metro and delivering greater efficiency and reliability along the line, and an increase in the number of services, the project would encourage urban renewal and transit oriented urban development around stations between Sydenham and Bankstown.

16.4.4 Cumulative impacts

The assessment of potential cumulative impacts, summarised in Chapter 27 (Cumulative impacts), considered the potential for impacts taking into account other projects being undertaken.

The project results in limited changes in land use in the long term and therefore does not contribute to any cumulative land use changes in the region. Any short-term impacts on land use would also be limited, with the majority of the project located within the rail corridor, not resulting in a significant changes in land use.

16.5 Mitigation measures

16.5.1 Approach to mitigation and management

Overall, the majority of potential construction related impacts would be short term and temporary in nature. The potential for these impacts would be significantly reduced by:

- effective construction design and planning
- implementation of the mitigation measures provided in Table 16.7
- consultation with individual property owners to identify individual concerns, and develop and document strategies to address these concerns
- ongoing communication with the broader community.

To maximise the benefits resulting from any residual land and future rail development opportunities, ongoing coordination with relevant local and State government agencies would be undertaken. Any future development would be subject to a separate approvals process.

16.5.2 List of mitigation measures

The mitigation measures that would be implemented to minimise potential impacts on land use and property are listed in Table 16.7.

Table 16.7 Mitigation measures – land use and property

ID	Impact/issue	Mitigation measures	Relevant location(s)
Design/pre-construction			
LU1	Acquisition	All acquisitions/adjustments would be undertaken in consultation with landowners and in accordance with the requirements of the *Land Acquisition (Just Terms Compensation) Act 1991*.	All
LU2	Future planning	Transport for NSW will continue to work the Department of Planning and Environment and the Greater Sydney Commission in relation to future planning for the Sydenham to Bankstown corridor.	All
LU3		Transport for NSW will contribute funding towards, and work with, the Department of Planning and Environment and Canterbury-Bankstown Council, on a master plan and business case for the Bankstown town centre, including how the station fits with the centre.	Bankstown
Construction			
LU4	Temporary use	Temporary use areas, including public open space, would be restored to their pre-existing condition (as a minimum) as soon as practicable following completion of construction. This would be undertaken in consultation with the relevant council and/or the landowner.	All

16.5.3 Consideration of the interactions between mitigation measures

Mitigation measures in other chapters that are relevant to the management of potential land use and property impacts include:

- Chapter 10 (Construction traffic, transport and access), particularly with respect to the management of traffic and property access during construction

- Chapter 12 (Construction noise and vibration) with respect to management of potential noise impacts during construction, to minimise amenity impacts
- Chapter 13 (Operation noise and vibration) with respect to management of potential noise impacts during operation, to minimise amenity impacts
- Chapter 18 (Business impacts) with respect to management of impacts to businesses during construction.

Together, all these measures would minimise the potential land use and property impacts of the project.

16.5.4 Managing residual impacts

Residual land use and property impacts following implementation of the mitigation measures described in Section 16.5.2 are predicted to include full or partial acquisition of six lots, including one residential lot, and subsequent change in land use to transport from residential, commercial, road, and open space/recreation uses.

On balance, the residual impacts described above would result in minimal direct impacts to land use.

17. Socio-economic impacts

This chapter provides a summary of the results of the social impact assessment, and the potential socio-economic impacts of the project. A full copy of the assessment report is provided as Technical paper 5 – Social impact assessment. The Secretary's environmental assessment requirements relevant to social impacts, together with a reference to where the results of the assessment are addressed, are provided in Table 16.1.

Table 17.1 Secretary's environmental assessment requirements – social impacts

Ref	Secretary's environmental assessment requirements – social impacts	Where addressed
10.1	The Proponent must assess social and economic impacts of the project. This must be done having regard to issues raised by relevant communities and businesses.	A summary of the results of the social impact assessment is provided in this chapter. The full results are provided as Technical paper 5. This chapter considers social and socio-economic impacts. Business impacts are considered in Chapter 18.

17.1 Assessment approach

17.1.1 Legislative and policy context to the assessment

The EP&A Act establishes the framework for social impacts to be formally assessed in land use planning and development assessment processes. Environment is defined in Section 4 of the EP&A Act as 'all aspects of the surroundings of humans, whether affecting any human as an individual or in his or her social groupings'.

The assessment of social impacts was undertaken with reference to:

- *International Principles for Social Impact Assessment* (Vanclay, 2003)
- *Environmental Impact Assessment Practice Note - Socio-economic assessment* (Roads and Maritime, 2013)
- *Social Impact Assessment: Guidance for Assessing and Managing the Social Impacts of Projects* (Vanclay F., et al, 2015)
- *Social impact assessment: Draft guidelines for State significant mining, petroleum production and extractive industry development* (Department of Planning and Environment, 2016).

17.1.2 Methodology

This section provides a summary of the approach to the social impact assessment. Further information is provided in Technical paper 5. The assessment involved:

- confirming the study area for the purposes of the assessment
- describing the existing social environment of the study area, including developing a demographic profile for communities in the study area with the potential to be affected by the project
- identifying and mapping community infrastructure and facilities with the potential to be affected by the project

- reviewing information on the project, including the indicative construction methodology, and the proposed operational features and details
- reviewing other technical papers prepared for the Environmental Impact Statement to understand the nature, scale and significance of potential impacts, and identify resultant social impacts
- assessing the potential social impacts and benefits of the project, in accordance with the principles and guidelines listed in Section 17.1.1
- taking into account issues raised by the community and relevant stakeholders (described in Chapter 4 (Stakeholder and community consultation).
- identifying measures to mitigate the potential impacts.

17.2 Existing environment

Key social characteristics of the study area are summarised in this section. The study area for the assessment stretches covers 16 suburbs in the Inner West and Canterbury-Bankstown local government areas (LGAs), including those in which the project area is located, comprising:

- St Peters
- Tempe
- Sydenham
- Marrickville
- Dulwich Hill
- Hurlstone Park
- Canterbury
- Campsie
- Belmore
- Lakemba
- Wiley Park
- Punchbowl
- Bankstown
- Yagoona
- Birrong
- Earlwood.

The study area is highly urbanised and densely populated. According to the 2011 census[1], the combined population of both LGAs was 542,514 people (ABS, 2011). About 35 per cent of the population live in the Inner West LGA, and 65 per cent in the Canterbury-Bankstown LGA. The study area is characterised by socially and culturally diverse communities.

17.2.1 Demographic characteristics

The LGAs have a combined worker population of 131,302. Almost half of the population of the Canterbury-Bankstown LGA (45.9 per cent) speak a language other than English at home, compared to 30.7 per cent of the population in the Inner West LGA, and 32 per cent in Greater Sydney.

There are also higher levels of disadvantage in the Canterbury-Bankstown LGA compared to the Inner West LGA. These measures include lower income, educational attainment, English language skills, unemployment, dwellings without motor vehicles, and higher need for assistance with self-care, communication or mobility services, due to illness, age or disability.

The key demographic characteristics of the two LGAs compared to Greater Sydney include:

- a more densely populated area (with the Inner West LGA more densely populated than the Canterbury-Bankstown LGA)
- higher proportions of people born overseas and people who speak a language other than English (in the Canterbury-Bankstown LGA)

[1] At the time of the assessment, the 2016 Census data had not yet been released

- higher levels of public transport use, with lower usage of cars, and higher levels of active transport (in the Inner West LGA)
- higher levels of disadvantage (in the Canterbury-Bankstown LGA, except in Hurlstone Park)
- lower levels of disadvantage with a higher household income and educational attainment (in the Inner West LGA, except in Sydenham, which has a higher level of disadvantage and similar household income and educational attainment)
- fewer children, people over 70 years of age, and smaller households in the Inner West LGA, while the Canterbury-Bankstown LGA has higher proportions of children and larger households.

17.2.2 Community infrastructure

The study area is well serviced by major public transport facilities, with connections to key employment centres including the Sydney CBD, Sydney Olympic Park, Parramatta, and Liverpool.

The cycle network in the study area consists mainly of short, unmarked, on-road cycle routes. Dedicated cycle routes include the Cooks River Cycleway, which connects Campsie, Canterbury, and Tempe, and the Salt Pan Creek cycle route, which connects Bankstown to Georges Hall. Beyond the study area, the Greenway Cycleway connects Dulwich Hill to Lewisham.

Both LGAs contain a large range of community facilities and services, including educational facilities, places of worship, sport and recreational areas, health and community services. Community infrastructure is located throughout the study area. Concentrations of facilities are located in the vicinity of Campsie, Lakemba, Punchbowl, and Bankstown stations. Facilities located within or directly adjoining the project area include:

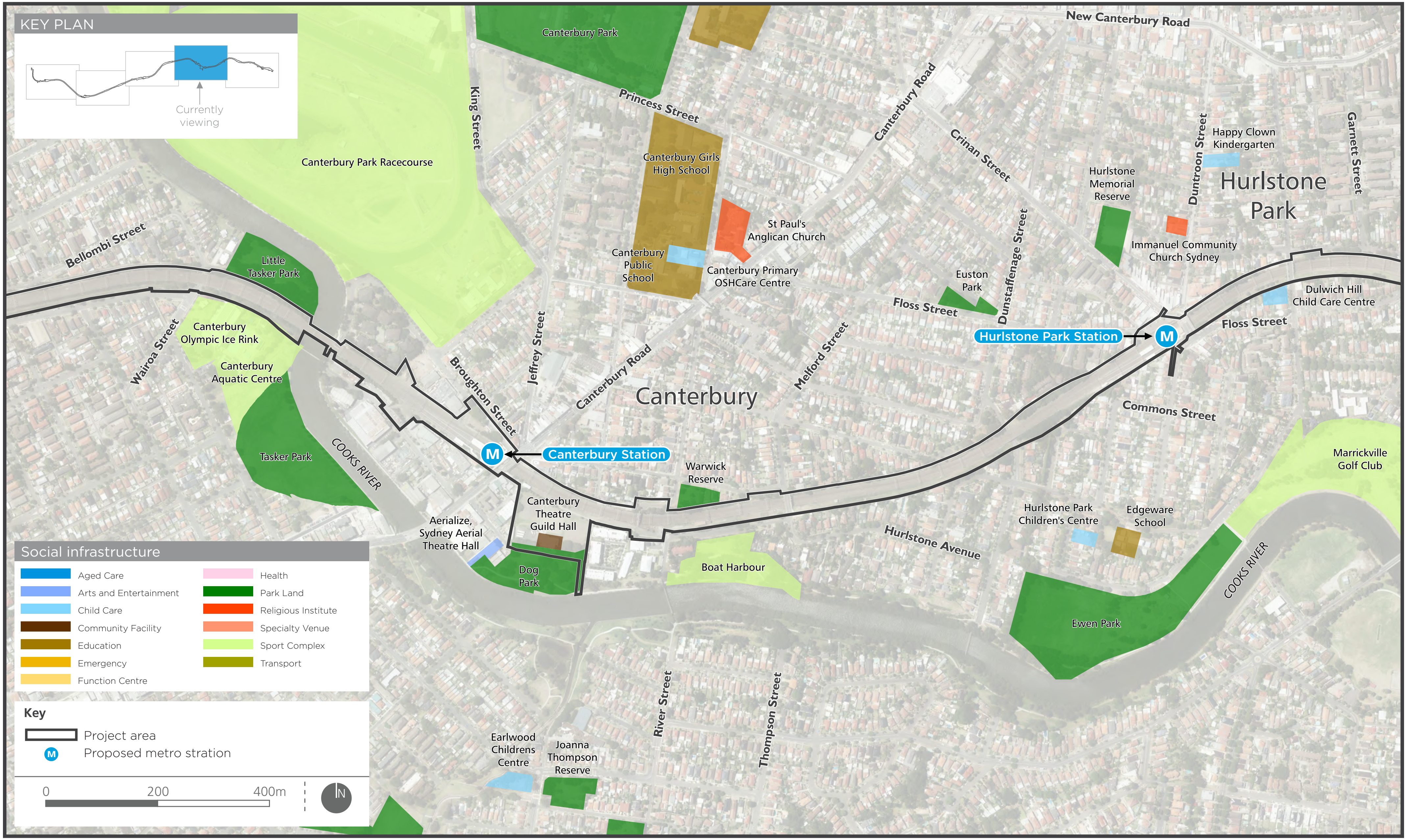
- McNeilly Park
- Jack Shanahan Park (including Dulwich Hill Skate Park)
- Dulwich Hill child care centre
- Warwick Reserve
- former Canterbury Bowling and Community Club
- Close Street Reserve
- Little Tasker Park
- Canterbury Olympic Ice Rink
- Canterbury Aquatic Centre
- Campsie Medical and Dental Centre
- Campsie RSL Club
- Campsie Day Surgery
- Campsie Police Station
- Belmore Sports Ground (including Belmore Oval)
- Belmore Youth and Resource Centre
- PCYC Belmore
- Canterbury City Community Centre
- Lakemba Senior Citizens Centre and Lakemba Branch Library
- Punchbowl Children’s Centre
- Warren Reserve
- Mary Barry Park
- Punchbowl Boys High School
- Bankstown Art Centre
- Masjid Abu Bakr Bankstown Mosque
- Al Amanah College
- St Nicholas Antiochian Orthodox Church
- Park on Brancourt Avenue.

Community infrastructure and facilities in the vicinity of the study area are shown in Figure 17.1. Further information on community infrastructure in the study area is provided in Section 17.3.2 and Technical paper 5.

sydney METRO | city & southwest

Community infrastructure - map 1

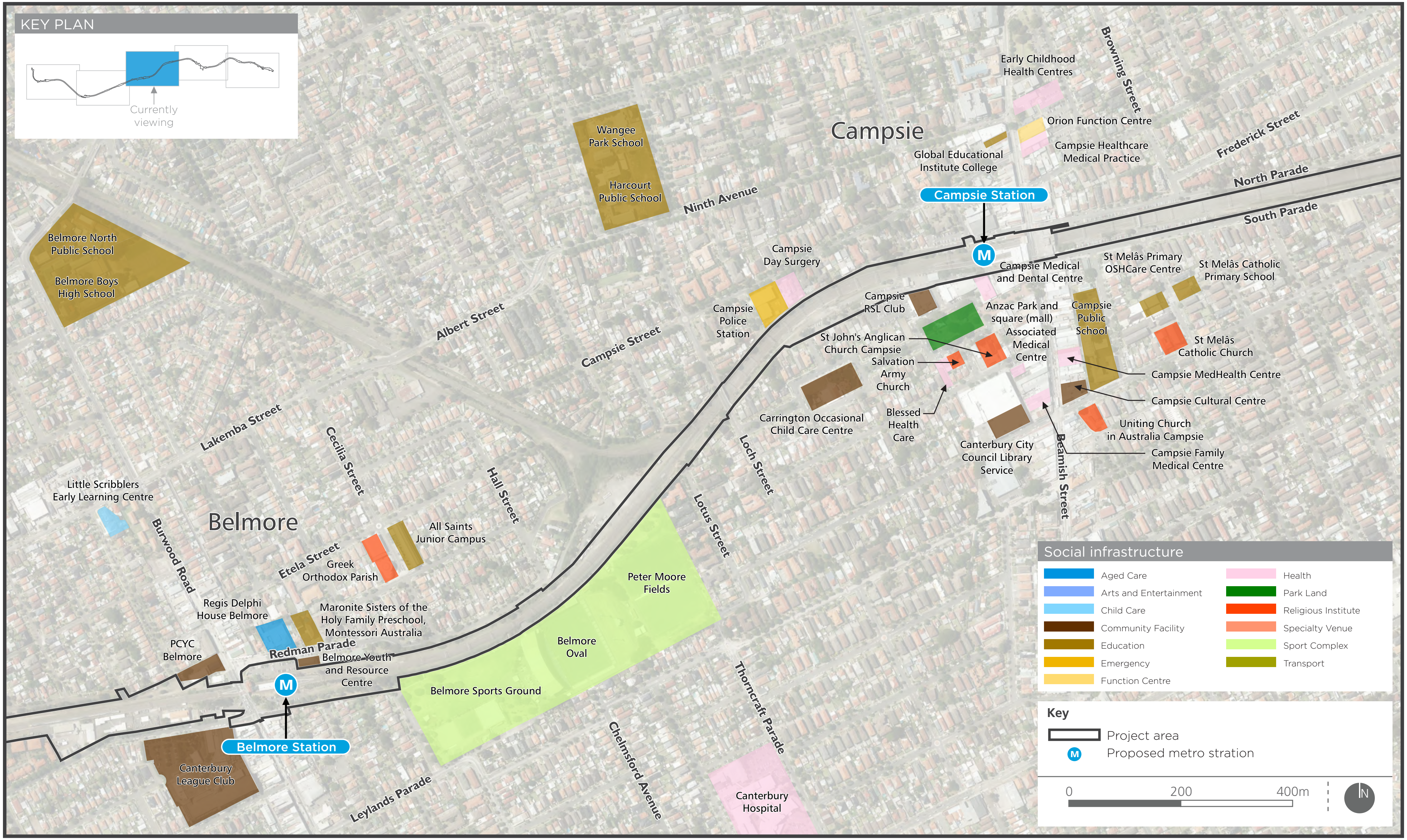
FIGURE 17.1



sydney METRO | city & southwest

Community infrastructure - map 2

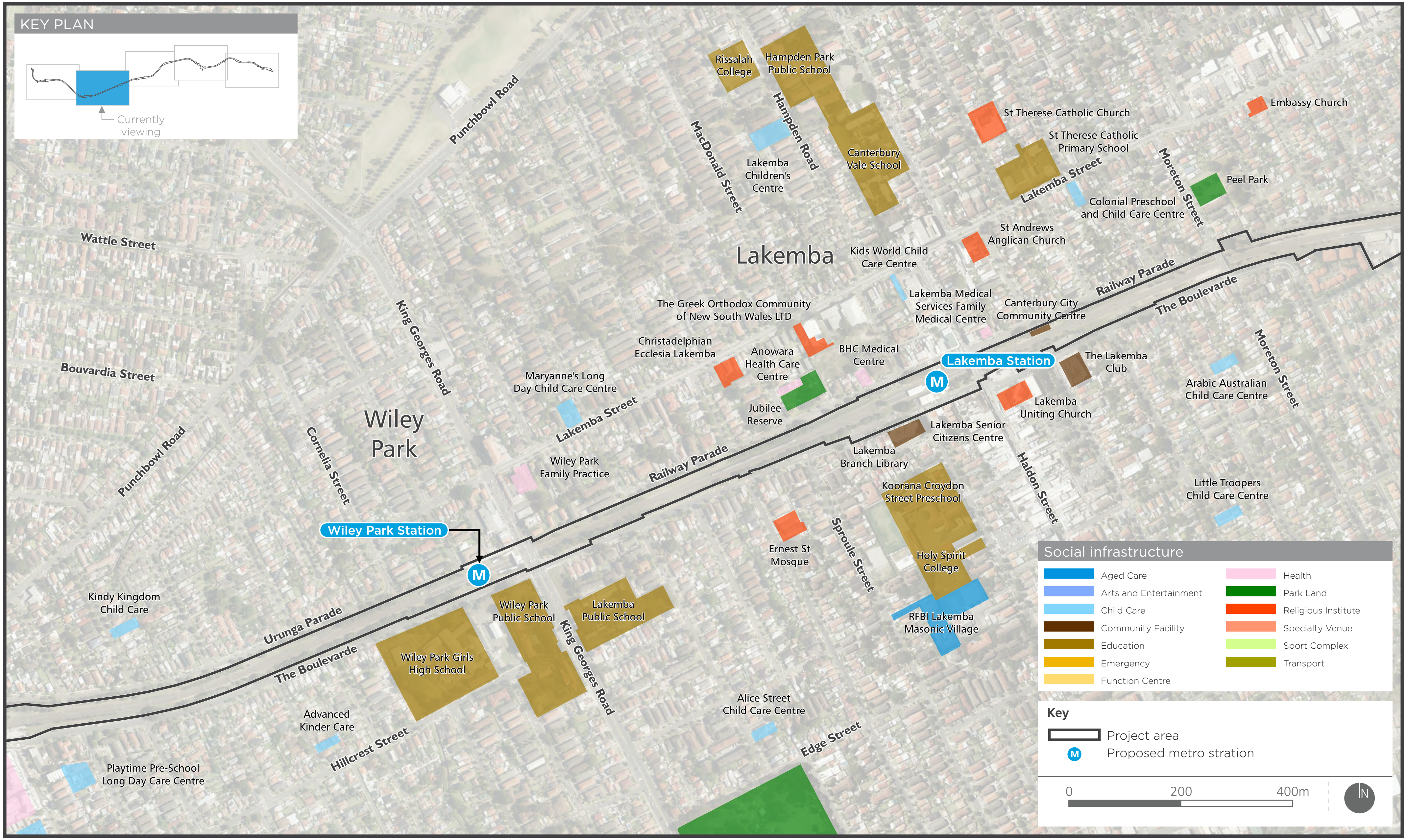
FIGURE 17.1



sydney METRO | city & southwest

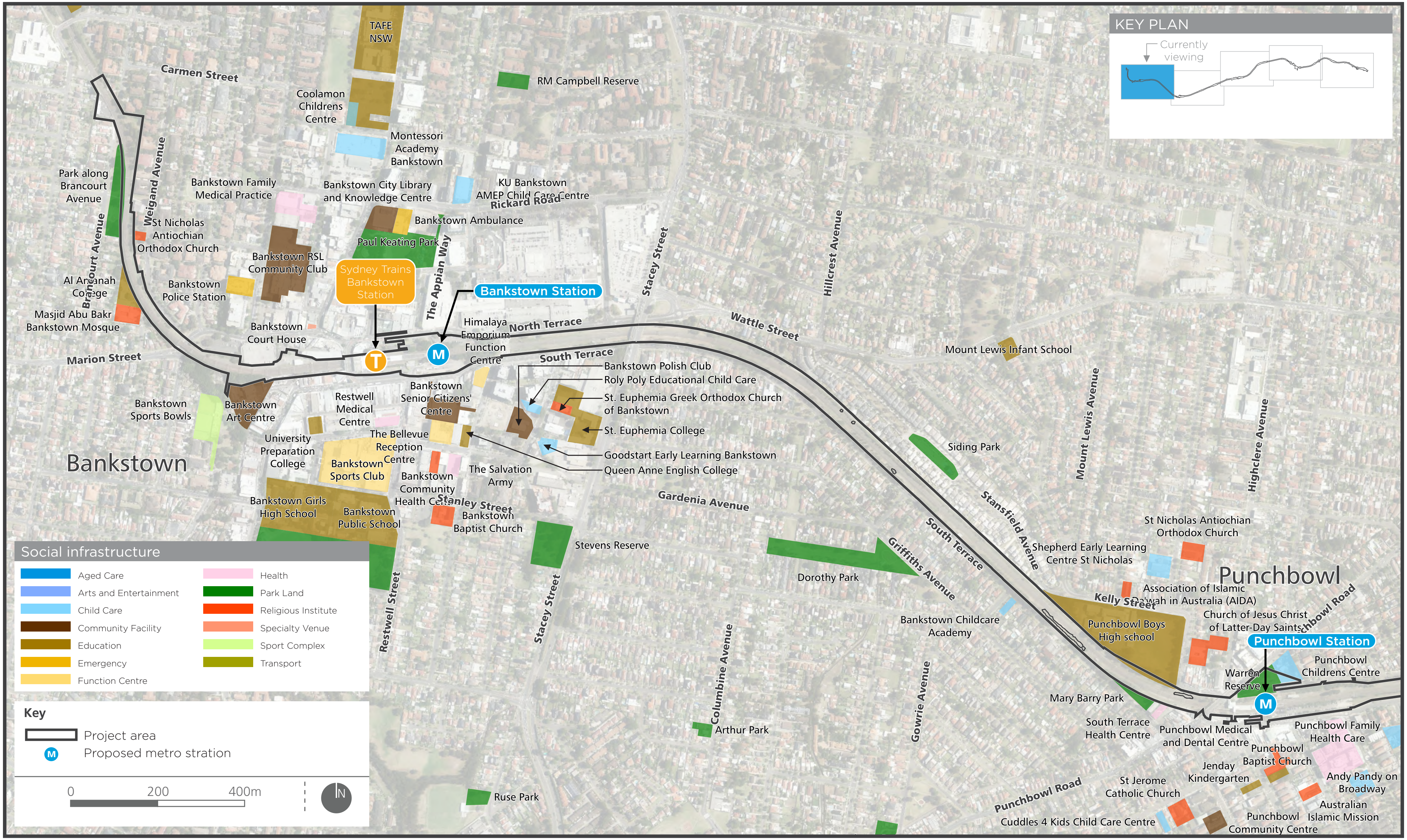
Community infrastructure - map 3

FIGURE 17.1



Community infrastructure - map 4

FIGURE 17.1



sydney METRO | city & southwest

Community infrastructure - map 5

FIGURE 17.1

17.2.3 Community values

Community values refer to tangible and intangible characteristics and aspects of a community, such as amenity, character, lifestyle, access, connectivity, community cohesion, and community health and safety. A project may affect these aspects by changing noise levels, visual amenity, traffic conditions and access, movement across the community, the use and enjoyment of community spaces, and by requiring relocation as a result of property acquisition.

The values held by communities in the study area were identified by analysing community feedback received to date (refer to Chapter 4), and reviewing relevant State and local government strategic and community planning documents such as the following documents:

- former Marrickville Council's community strategic plan, *Our Place Our Vision*
- former Canterbury Council's *Community Strategic Plan 2014-2023*
- former Bankstown City Council's *Bankstown Community Plan 2023*.

Inner West LGA

Local amenity and character

The Inner West LGA is characterised by densely populated, older, inner-city suburbs, with numerous significant heritage and cultural items, including sites of Aboriginal significance. The LGA also contains substantial industrial and commercial areas, many of these being historic areas that are gradually converting to other uses. Since the 1970s, the area has experienced significant urban renewal and gentrification.

The Cooks River provides natural amenity for the LGA. It borders a number of open spaces and sport and recreation facilities, including Marrickville Golf Club and the Mahoney Reserve Sports Field.

Community consultation has indicated that illegal graffiti on station buildings and community assets is an amenity issue. The community desires accessible and clean streets, lanes and public spaces. They would also like to minimise aircraft and other significant noise impacts on homes, businesses, and public spaces. The community feels that there is an undersupply of open space.

Access and public transport

Members of the community value connected and accessible infrastructure, which supports walking, cycling, and public transport usage. The community would like to reduce car dependency through improved accessibility, including accessible railway stations, bus stops, and well connected footpaths, cycleways, and associated facilities.

The community feels that access to public transport needs to be improved. Connected and accessible infrastructure can support increased opportunities for participation in the community, and contribute to community cohesion.

The community is concerned that the majority of train stations within the LGA are still inaccessible to many community members, affecting their ability to participate fully. The community is concerned about the reliability and frequency of train and bus services, as well as the availability of routes linking destinations within the inner west.

The condition of roads, footpaths, and parks is also a key community concern. Foot and cycle path maintenance is identified as a high priority, followed by road maintenance; reinforcing the view that the community values walking and cycling. Consultation undertaken as part of the project to date indicated that there is a lack of available bike parking at stations.

Health and safety

Members of the community have indicated that there are safety issues in the LGA. Concerns were raised about antisocial behaviour, including illegal graffiti on station buildings and community assets, which reduces the perceived safety of the area. The community desires better street lighting, and reduced occurrences of illegal graffiti.

The community aspires to be active and healthy through improved walking, cycling, and other transport infrastructure. Diversity is valued, as are opportunities for community participation through safe and accessible infrastructure. There should be safe places for people to meet and interact. The community would like to reduce accidental injuries and opportunistic crime in public places.

Canterbury-Bankstown LGA

Local amenity and character

The former Canterbury LGA is densely populated and culturally diverse. Parks, historical sites, open space, and sport and recreational facilities contribute to the amenity of the LGA. These include Belmore Sports Ground (previously known as Belmore Oval), Canterbury Racecourse, Canterbury Ice Rink, Canterbury Aquatic and Fitness Centre, and open space corridors surrounding the Cooks River, Wolli Creek, and Salt Pan Creek. A designated cycle path and walking track is located along the Cooks River.

Members of the community value attractive streetscapes and balanced development, and would like streets to be clean and tidy, with minimal graffiti and rubbish, and well maintained gardens and trees. The community notes that development within the LGA should maintain a balance of historic and modern streetscapes. People consider the natural environment could be enhanced by reducing road congestion, while improving both air quality and noise amenity. The community also values vibrant town centres with a variety of uses.

The character of the former Bankstown LGA is largely residential. It has a commercial core (the Bankstown town centre) adjacent to Bankstown Station, which is surrounded by suburbs that provide character and amenity. The community seeks to retain the character, built heritage, and village atmosphere of the area.

The community values the local centres and community assets. Clean and safe parks, public centres, and facilities are considered important to the amenity and liveability of the area.

Access and public transport

The community within the former Canterbury LGA values access to services. Public transport and road networks provide access and connectivity throughout the area. The community desires a pedestrian and cycle friendly area, with reliable public transport, adequate parking for all vehicle types, better integration with the existing road network, and less congestion.

Similarly, the community within the former Bankstown LGA desires a well-connected transport network, which serve the community’s needs, whilst being sustainable, efficient, and affordable. Walking and cycling paths are valued. Residents seek a well-connected community, supported by transport, access, and connectivity.

Health and safety

Health and safety are priorities within the LGA. The community values transport options that provide access to a range of community facilities and services. Fostering access to facilities and services, such as healthcare, education, and open space, can support healthy lifestyles. People consider that traffic congestion would also improve road safety.

Providing different transport options could reduce car dependency and support a healthy natural environment. Low crime, a strong police presence, and adequate street lighting, would improve community perceptions of safety.

Within the former Bankstown LGA, consultation has indicated that members of the community perceive some areas as unsafe at night, especially around train stations. Providing clean and safe community areas, including open space and parks, would improve perceptions of safety.

17.2.4 Role of the existing stations

As described in Section 7.1, the stations within the project area have played an important role in developing the local and regional economies, while enabling people to live, trade and travel within and through the corridor to access business, family, work, recreation, culture, leisure, health, education, shopping and entertainment services. Tens of thousands of people pass through these stations each day. In most cases, the stations are located at the centre of their surrounding communities and are the focal point for intensive activity, as well as integrated transport services.

17.3 Impact assessment

17.3.1 Risk assessment

Potential risks

The project would contribute to benefits for, and potential impacts to, the community. The environmental risk assessment for the project, undertaken for the *State Significant Infrastructure Application Report*, identified the following potential social risks:

- Temporary impacts on community values and lifestyle for local residents, workers, and visitors, due to changes to travel patterns and interruptions to transport services during construction. Groups who may be particularly vulnerable to these impacts include people with limited English language skills, older people, children (including school children), and people with a disability.
- Amenity impacts (including noise, vibration, air quality and visual changes) on residents, businesses, and community infrastructure. Some residents may be more vulnerable to these impacts, and some community facilities may be more sensitive (such as childcare centres).
- Temporary access restrictions or changes resulting from construction sites and activities, which may affect how people access community infrastructure, and how they use the existing rail and road infrastructure.
- Cumulative social issues resulting from the potential for overlap with construction associated with urban renewal around train stations.

How potential impacts have been avoided or minimised

Design development has included a focus on avoiding and/or minimising the potential for impacts during key phases of the project. Potential socio-economic impacts have been avoided or minimised by:

- designing the project to minimise the potential for noise, air, and visual amenity impacts during construction and operation, including the implementation of design responses summarised in Chapters 8 and 9 (Project description – construction and operation)
- designing the project to maximise safety and accessibility, as described in Chapters 7 (Design development and place making), 8 (Project description – operation), 11 (Operational traffic, transport and access), and 25 (Hazards, risks and safety)

- minimising impacts on the community through the positioning of construction compounds and careful consideration of working periods
- implementation of the Temporary Transport Strategy (provided in Appendix G and described in Chapter 9 (Project description - construction)
- ongoing consultation with the local community and key stakeholders, as described in Chapter 4 (Stakeholder and community consultation).

17.3.2 Construction

The main potential for socio-economic impacts during construction would occur as a result of:

- changes to access arrangements and connectivity
- employment generation and other economic benefits, including increased trade
- amenity impacts as a result of construction works
- impacts to community infrastructure and facilities.

A summary of the results of the assessment in relation to these potential impacts is provided below.

Access and connectivity

As described in Chapter 10 (Construction traffic, transport and access), construction of the project would result in temporary impacts to traffic and access within the study area, and an increase in both heavy and light vehicle movements on the local and regional road network. This would result in inconvenience and disruption to existing access for residents, visitors, customers, businesses, and service providers along and around the project area. These impacts would include:

- changes to access for pedestrians, cyclists, and bus users around stations and construction work areas
- altered movement patterns and traffic routes in some areas
- changed access or increased travel time to community places and facilities
- loss of some areas of parking in the vicinity of stations, including accessible parking, kiss and ride, and taxi spaces
- changes to access across some rail overbridges during bridge upgrade works.

Changes to traffic, pedestrian, and cyclist access could result in a temporary increase in the distance travelled, increased travel times, inconvenience and delays for some community members.

These potential impacts would be temporary and would be minimised as far as possible by the implementation of the construction traffic, transport, and access management measures provided in Section 10.5. These measures would include the development and implementation of a construction traffic management plan, which would aim to:

- minimise disruption to traffic operation, road users, pedestrians, cyclists and access to adjoining properties (private and public)
- limit access restrictions, and where required, provide alternatives to maintain access for the local community.

Communication with potentially affected users and information provision would assist in reducing uncertainty and the impacts of changes to access and movement patterns. A comprehensive community and stakeholder awareness program would be implemented during construction (as described in Chapter 4), which would assist in managing these impacts and communicating changes to relevant stakeholders.

The other key potential impact relates to the temporary closure of stations and the rail line that would occur at certain times during the construction period. As described in Chapter 9, the Sydney Trains network would remain operational during the majority of the construction period. However, some construction activities need to be undertaken during rail possession periods, when trains are not operating.

As described in Chapter 9, a Temporary Transport Strategy has been prepared to guide the implementation of temporary transport arrangements during station and rail line closures. The Temporary Transport Strategy includes provision of a fleet of rail replacement buses to cater for rail customers.

Closure of the stations at certain times during construction has the potential to impact the community, which has higher levels of public transport use compared to the Sydney average (about 85,000 movements per day were recorded during 2014). Station and rail line closures and the associated alternative public transport arrangements have the potential to lead to increased traffic generation, traffic congestion and delays and diversions with the following resultant social impacts:

- Travel time delays (compared to rail trips) for commuters, customers, and other road users, leading to the potential for anxiousness and concern, especially during peak hours or when trying to access important events. More significant delays could also reduce people's leisure or family time.
- People may be less likely to use public transport or access retail and commercial establishments near the project area, thereby reducing participation in the community. The reduced likelihood to use public transport could particularly affect vulnerable groups, such as the elderly, economically disadvantaged, and people with disabilities.
- Commuters would need to keep informed about changes in traffic and transport conditions. This may be more difficult for vulnerable groups within the community, including the elderly, disabled, and those from linguistically and culturally diverse backgrounds (this is a key characteristic of the Canterbury-Bankstown LGA, as described in Section 17.2).
- A reduction in connectivity between stations and adjoining retail, employment and community areas could limit the community's access to these areas for people journeying from locations outside the study area.

The implementation of temporary transport management plans would assist in mitigating the impacts associated with station and rail line closures. The potential significance of impacts would depend on how closely the rail replacement buses are able to replicate similar levels of service provided by the rail network, as well as other important factors such as customer disposition to bus travel, convenience of facilities, availability of seats, etc. Each subsequent temporary transport management plan would incorporate learnings from the previous plan, and the feedback of any affected stakeholders, so that any issues experienced would be addressed in future plans. It is recognised that these impacts would be temporary, and would be limited to regular, defined intervals each year.

Employment and other economic benefits

Construction of the project would generate employment. It is estimated that the peak workforce required would range from 705 up to 1,540 people.

This could benefit the local community, as the workforce is likely to include local. These jobs are only limited to the workforce that would be directly employed to construct the project, and do not include additional jobs or increased demand stimulated by the project to downstream providers of goods and services. Industries that support construction of the project would also experience economic benefits.

New employment opportunities would also provide the opportunity for training and the development of new skills, which has the potential to benefit the local area and region.

A Workforce Development and Industry Participation Strategy has been developed for Sydney Metro. The strategy includes objectives to support local employment and business opportunities, provide skills development, and increase workplace diversity. Initiatives of the strategy would include:

- assessing current and future workforce skill needs and workforce profiles including a skills and workforce gap plan
- increasing local employment, local business opportunities, and involvement of local small and medium enterprises
- provision of relevant Nationally Recognised Accredited Training
- increasing workforce diversity and inclusion, targeting indigenous workers and businesses, female representation in non-traditional trades and the long-term unemployed
- participation in work placement and education programs for young people
- increasing participation of apprentices and trainees.

Construction activities also have the potential to result in increased trade for local businesses. Potential impacts on local businesses are considered in Chapter 18 (Business impacts).

Amenity

'Amenity' refers to the pleasant or normally satisfactory aspects of a location which contribute to its overall character and the enjoyment of residents or visitors. Construction of the project may result in the following amenity impacts being experienced by members of the community surrounding the project area:

- increase in noise levels as a result of construction plant and equipment
- increase in traffic movements and congestion (and associated road traffic noise), around work areas, compounds and work sites, corridor access points, and construction haulage routes
- increase in dust generated during construction
- changes in the visual outlook in the vicinity of compounds and construction work areas – particularly potential impacts on existing character, introduction of additional visual clutter, and interruption of existing sight lines.

These potential impacts and relevant mitigation measures are considered in Chapters 10 (Construction traffic, transport and access), 12 (Construction noise and vibration), 19 (Landscape and visual impacts), and 23 (Air quality). Amenity impacts would be temporary, and managed by the mitigation measures outlined in these chapters.

Community infrastructure and facilities

Construction has the potential to affect community infrastructure and facilities located near the project area, as a result of changes in amenity, local access, or requirements for acquisition or temporary use. Key impacts are summarised in Table 17.2.

The amenity impacts noted above may affect the enjoyment of community facilities located close to the project area, particularly outdoor areas.

In addition to the impacts noted in Table 17.2, changes to traffic and transport conditions in the vicinity of the project area could also affect the time and route taken to travel to community facilities. Further information on potential social impacts as a result of access changes is provided above (under access and connectivity). These potential impacts would be temporary, and would be minimised as far as possible by the implementation of the construction traffic, transport, and access management measures provided in Section 10.5.

Impacts to specific community facilities in the project area are summarised in Table 17.2.

Table 17.2 Community facilities potentially affected by the project

Community facility	Impact overview
Marrickville	
Fraser Park (includes the Fraser Park Football Club and the KIKOFF Soccer Centre - Fraser Park)	Fraser Park is an active recreation area located close to the eastern boundary of the project area. Amenity impacts (noise and visual) may affect the outdoor enjoyment of Fraser Park and its associated sporting facilities, however are not expected to restrict use or function of these facilities.
McNeilly Park	McNeilly Park is a well-used park with a playground, paths, small basketball court, open grassed areas, an off-leash dog exercise area, and a Girl Guides hall, located adjacent to the project area. The north-west section of park (where the off-leash area is located) would be directly affected during construction. An underground detention basin is proposed to be constructed in this area. The work site to construct the basin would affect about 35 per cent of the park. An indicative layout of the proposed work site is shown in Figure 9.4. Construction of the basin would mean that the grassed area in this location (and potentially sections of the existing path) would not be available for use for the duration of construction of the basin. The presence of the work site (work site 2) also has the potential to affect the amenity of adjoining areas. The playground area of the park (which was recently updated) would not be directly impacted, and would be accessible by the public at all times. The area subject to works would be restored and returned to public use when works are complete.
Ness Park	Ness Park is a passive recreation area with a small playground, located to the north of the project area. There may be potential for noise impacts to affect the outdoor enjoyment of Ness Park, however these are not expected to restrict use or function of the park.
Maronite Sisters of the Holy Family Village (aged care).	The facility is located to the north of the project area. Construction activities have the potential to result in temporary noise impacts on the facility. However, potential impacts would mainly occur from corridor works given the distance to Dulwich Hill Station (about 400 metres) and Marrickville Station (about 700 metres).
St Nicholas Greek Orthodox Church	The church is located to the north of the project area (around 90 metres) and adjacent to Ness Park. Construction activities have the potential to result in amenity (noise) impacts on the church.
Braddock Playground	Braddock Playground is passive recreation area with a playground, located to the north of the project area (rail corridor). There may be potential for noise impacts to affect the outdoor enjoyment of the playground, however it is not expected to restrict its use or function.
Dulwich Hill	
Jack Shanahan Park (includes various sporting facilities, including Dulwich Hill Skate Park)	Jack Shanahan Park, which includes a range of active and passive recreation facilities, adjoins the project area (rail corridor). Construction activities in the project area are likely to be audible by users, and amenity impacts (mainly noise and visual) have the potential to affect the outdoor enjoyment of this facility. However, these impacts would be restricted to the duration of any track works in the vicinity of the park. Given the distance to Dulwich Hill Station (about 40 metres) works at the station are less likely to impact users of the park.

Community facility	Impact overview
Hurlstone Park	
Dulwich Hill Child Care Centre	Dulwich Hill Child Care Centre adjoins the project area (rail corridor). In this location, the rail corridor is in a cutting, which would limit the potential for visual impacts. While there would be the potential for noise impacts, particularly to outdoor play areas, given the distance to Hurlstone Park Station (about 200 metres), these impacts are expected to be limited to any track works required in the vicinity of the centre. The centre would be subject to consideration of additional noise mitigation measures during construction.
Warwick Reserve	Warwick Reserve is a passive recreation area with a playground that adjoins the project area. The topography and existing vegetation in the reserve would limit the potential for visual impacts, however noise impacts have the potential to affect the outdoor enjoyment of this facility. It is expected that such impacts would be restricted to the duration of any track works required in the vicinity of the reserve.
Canterbury	
Former Canterbury Bowling and Community Club (Canterbury Theatre Guild Hall)	The former Canterbury Bowling and Community Club facility would be impacted during construction. This facility is used for a number of community purposes (including the Canterbury Theatre Guild and a play group) under lease from Canterbury-Bankstown Council. Areas within the club building and the surrounding open space are proposed for use as a construction compound and site office (work site 8). An area within the building would remain available for community use. An indicative layout of the proposed work site is shown in Figure 9.4. There is the potential for amenity impacts (mainly noise and visual) to be experienced by users of the facility. Transport for NSW would work closely with Canterbury-Bankstown Council and users of the facility to manage how it would be used during construction.
Little Tasker Park	Little Tasker Park is a passive recreation area that adjoins the project area. Existing vegetation would limit the potential for visual impacts during construction. However, noise impacts have the potential to affect the outdoor enjoyment of the facility. It is expected that such impacts would be restricted to the duration of any track works required in the vicinity of the park.
Tasker Park	Tasker Park is an active recreation area that adjoins the project area. The park includes sports fields, basketball courts and a playground area. Noise and visual impacts may affect the outdoor enjoyment of the facility, however impacts are not expected to restrict the use or function of the park.
Canterbury Olympic Ice Rink	Canterbury Olympic Ice Rink is located in Tasker Park. Track works are likely to be audible from the facility due to its proximity to the project area. Visual impacts would be limited as the facility is enclosed and is visually separated from the rail corridor by vegetation.
Canterbury Aquatic and Fitness Centre	Canterbury Aquatic and Fitness Centre is located adjacent to the Canterbury Olympic Ice Rink in Tasker Park. Amenity impacts (e.g. noise and dust) have the potential to affect users of the facility, particularly during works to the Wairoa Street underbridge and any track works (including activities at work site 10 and construction compound 7). Amenity impacts are not expected to restrict the use or function of the centre.
Close Street Reserve	Close Street reserve is a passive recreation area and off leash dog exercise park located off Close Street to the south of the project area. There may be potential for noise and visual impacts to affect the outdoor enjoyment of the park, particularly while work site 8 (located directly to the north of the park) is in use.
Aerialize - Sydney Aerial Theatre	Aerialize is located to the south of the project area. Construction activities in the project area are likely to be audible at the facility. However, impacts are not expected to restrict the use or function of the facility given the distance from the project area (about 100 metres).

Community facility	Impact overview
Boat Harbour	Boat Harbour is a passive recreation reserve on the Cooks River, which contains a constructed inlet of water. The reserve is connected to the Close Street Reserve and Sutton Park by a walkway. There is potential for noise and visual impacts on the outdoor enjoyment of the reserve. It is expected that such impacts would be restricted to the duration of any track works required in the vicinity. Amenity impacts are not expected to restrict the use or function of the reserve.
Campsie	
Campsie RSL Club	Campsie RSL Club adjoins the project area. Noise impacts have the potential to affect users of the facility. There is the potential for impacts during most of the construction period, as the club is located close to the station. Amenity impacts are not expected to restrict the use or function of the club.
Anzac Park	Anzac Park is a passive recreation area with playground facilitates located to the south of the project area. Noise impacts have the potential to affect the outdoor enjoyment of this facility. Amenity impacts are not expected to restrict the use or function of the park.
Campsie Day Surgery	The Campsie Day Surgery adjoins the project area. Users and staff may experience reduced amenity during construction as a result of increases in noise. However, these are not expected to restrict the use or function of the facility.
Campsie Police Station	Campsie Police Station adjoins the project area. The station is predicted to be affected by noise during certain construction activities. The centre would be subject to consideration of additional noise mitigation measures during construction.
Campsie Medical and Dental Centre	The medical centre is located to the south of the project area. Users and staff may experience temporary reduced amenity during construction as a result of increased noise. These impacts are not expected to restrict the use or function of these facilities.
Carrington Occasional Child Care Centre	Carrington Occasional Care Centre is located to the south of the project area. There would be potential noise impacts during construction. Potential noise impacts would be most relevant for children playing outdoors. Such impacts are not expected to restrict the use or function of the facility.
Belmore	
Belmore Youth and Resource Centre, Belmore Early Childhood Health Centre and Belmore Community Centre	These community facilities adjoin the project area (station). In this location, the rail corridor is located in a cutting, which would limit the potential for visual impacts during construction. However, there would be the potential for noise impacts. The centre would be subject to consideration of additional noise mitigation measures during construction.
Regis Delphi House Belmore (aged care)	This facility is located to the north of the project area. Construction activities have the potential to result in temporary noise impacts on residents of the facility. Visual impacts are unlikely due to the distance and visual buffers between the facility and the project area. Potential noise impacts are not expected to restrict the use or function of the facility.
Maronite Sisters of the Holy Family Montessori Preschool	The preschool is located to the north of the project area. Construction activities would have the potential to result in temporary noise impacts. Potential noise impacts would be most relevant when children are outdoors. Visual impacts are unlikely due to the distance and visual buffers between the preschool and the project area. Amenity impacts are not expected to restrict the use or function of the preschool.
PCYC Belmore	PCYC Belmore is a youth club adjoining the project area. Construction activities would have the potential to result in temporary noise impacts on the facility. Visual impacts are unlikely due to the visual buffers between the facility and the project area. Amenity impacts are not expected to restrict the use or function of the facility.

Community facility	Impact overview
Belmore Sports Ground (including Belmore Oval)	Belmore Sports Ground is an active recreation area adjoining the project area. The sports ground contains a sporting stadium (Belmore Oval – the home ground of the Canterbury Bulldogs), Peter Moore Fields, and Belmore Bowling Club. Amenity impacts (noise and visual) during construction may affect the outdoor enjoyment of the facility, however are not expected to restrict its use or function. A key potential impact would be access to the facility, particularly during games at Belmore Oval. Potential access impacts (including during special events) are considered in Chapter 10, and relevant mitigation measures are provided in Section 10.5. Further information on potential social impacts as a result of access changes is provided above (under access and connectivity).
Peter Moore Fields	Peter Moore Fields are an active recreation area adjoining the project area. Amenity impacts (noise and visual) during construction may affect the outdoor enjoyment of the fields and its associated sporting facilities, however the impacts are not expected to restrict use or function of the fields.
Canterbury League Club	Canterbury League Club is located to the south of the project area. Construction activities in the project area are likely to be audible at the club. However, impacts are not expected to restrict use or function of the facility given the distance from the project area (about 100 metres).
Lakemba	
The Lakemba Club	The Lakemba Club is located on the southern side of The Boulevarde opposite the project area. Construction activities in the project area are predicted to be audible at the club particularly from the nearby construction compound (C14) or any track works. However, impacts are not expected to restrict the use of the club.
Canterbury City Community Centre	Canterbury City Community Centre is located adjacent to the project area east of Lakemba Station. Noise impacts are predicted due to its close proximity to corridor works and construction compound (C14) on the southern side of the corridor. The centre would be subject to consideration of additional noise mitigation measures during construction.
Lakemba Uniting Church	The Lakemba Uniting Church is located on the opposite side of The Boulevarde to the project area (east of Lakemba Station). Due to the proximity of the church to the project area, and the presence of construction compound (C14), construction noise impacts are predicted. The centre would be subject to consideration of additional noise mitigation measures during construction.
BHC Medical Centre	The BHC Medical Centre is located north of the project area on the northern side of Railway Parade. The centre would be potentially subject to amenity impacts (noise, air quality and visual) as a result of its proximity to the station and rail corridor. Amenity impacts are not expected to restrict the use of the centre.
Jubilee Reserve	Jubilee Reserve is a passive recreation area including a playground. The reserve is located north of the project area west of Lakemba Station. Amenity impacts (such as noise, visual and dust) may affect the outdoor enjoyment of the reserve, however are not expected to restrict its use or function.
Anowara Health Care Centre	Anowara Health Care Centre is located in Bellevue Street to the north of Jubilee Reserve, this facility includes a surgery. With the implementation of reasonable and feasible noise mitigation, these impacts are not expected to restrict the use or function of the facility. Visual impacts would be limited due to the orientation of the facility parallel to the project area.
Lakemba Senior Citizen's Centre and Lakemba Library	These facilities occupy a single building located south of the corridor near Lakemba Station. There is the potential for amenity impacts (particularly noise) to be experienced at the facilities, however such impacts are not expected to restrict the use or function of the facilities.
Lakemba Medical Services Family Medical Centre	The Lakemba Medical Services Family Medical Centre is located north of the project area on Railway Parade. The centre would be subject to consideration of additional noise mitigation measures during construction.

Community facility	Impact overview
Wiley Park	
Wiley Park Girls High School	Wiley Park Girls High School is located adjacent to the project area, on the southern side of The Boulevarde. It is predicted that some buildings within the school would be subject to noise impacts during construction. The centre would be subject to consideration of additional noise mitigation measures during construction.
Wiley Park Public School	Wiley Park Public School is located adjacent to the project area, on the southern side of The Boulevarde. There is the potential for amenity impacts (noise and visual) to be experienced at the school, which may be subject to consideration of additional noise mitigation measures during construction.
Lakemba Public School	Lakemba Public School is located on King Georges Road and is set back from the project area. There is the potential for amenity impacts (noise) to be experienced at the school, which may be subject to consideration of additional noise mitigation measures during construction.
Punchbowl	
Punchbowl Children's Centre	Punchbowl Children's Centre is located on the northern side of Warren Reserve. Due to the positioning of the centre north of the works at Punchbowl Station, there is the potential for noise impacts. The centre would be subject to consideration of additional noise mitigation measures during construction.
Warren Reserve	Warren Reserve is a passive recreation area located to the north of Punchbowl Station. About 15% of the reserve along its southern edge would be acquired for a new station entrance. As this area is located adjacent to the rail corridor, acquisition would not impact highly used areas. There would be potential for amenity impacts (noise and visual) to other areas of the reserve during construction. Amenity impacts may affect the outdoor enjoyment of this reserve, but are not expected to restrict its use or function.
Punchbowl Boys High School	Punchbowl Boys High School is located directly adjacent to the northern side of the project area, to the west of Punchbowl Road. There is the potential for amenity impacts (particularly noise) at this school due to its proximity to the project area. The school would be subject to consideration of additional noise mitigation measures during construction.
Mary Barry Park	Mary Barry Park is located on the northern side of South Terrace (west of Punchbowl Road) and is located adjacent to the rail corridor. Amenity impacts may affect the outdoor enjoyment of this reserve, but are not expected to restrict its use or function
Church of Jesus Christ of Latter-Day Saints	The Church of Jesus Christ and Latter-Day Saints is located about 60 metres north of the project area. There is the potential for amenity (noise) impacts at this location, however these are not expected to impact on the use or function of the church.
Punchbowl Family Health Care	The Punchbowl Family Health Care is located within the Broadway Plaza shopping centre on the southern side of The Boulevarde at Punchbowl Station. Amenity impacts at this facility are expected due to its proximity to the rail corridor and proposed construction compound (C21). Amenity impacts are not expected to impact on the use or function of this facility.
Bankstown Childcare Academy	The Bankstown Childcare Academy is located on the southern side of South Terrace opposite the project area. There would be the potential for noise impacts, particularly to outdoor play areas, during construction. The academy would be subject to consideration of additional noise mitigation measures during construction.
Playtime Pre-School Long Day Care Centre	The Playtime Pre-School Long Day Care Centre is located about 90 metres south of the rail corridor. Visual amenity impacts are not expected with no direct views of the project area. There would be the potential for noise impacts, particularly to outdoor play areas, during construction. The centre would be subject to consideration of additional noise mitigation measures during construction.
South Terrace Health Centre	South Terrace Health Centre is located adjacent to the southern side of the project area to the west of Punchbowl Road. There would be the potential for noise impacts during construction. The centre would be subject to consideration of additional noise mitigation measures during construction.

Community facility	Impact overview
Bankstown	
Bankstown Arts Centre	The Bankstown Arts Centre is located directly adjacent to the rail corridor to the west of Bankstown City Plaza. The project would involve track work in this area, which would have the potential for amenity impacts. Though works are likely to be minimal in this location, the works would result in potential noise impacts. The centre would be subject to consideration of additional noise mitigation measures during construction.
Himalaya Emporium Function Centre	The Himalaya Emporium Function Centre is located on the southern side of South Terrace adjacent to the project area. Due to the positioning of this facility opposite the upgraded station, some potential amenity impacts (both visual and noise) are expected. These impacts are not expected to impact on the use or function of the function centre.
The Bellevue Reception Centre	The Bellevue Reception Centre is located on Restwell Street to the south of the project area and is setback from the project area. As a result, visual impacts are unlikely, however potential noise impacts may result. Noise impacts are not considered likely to result in any impacts on the use or function of this centre.
Bankstown Sports Bowls	Bankstown Sports Bowls is located west of Bankstown City Plaza south of the corridor, however it is setback from the rail corridor with the car park between it and project area. Due to the limited works in this area, there is unlikely to be any impact on the use or function of these facilities.
Al Amanah College	Al Amanah College is located adjacent to the project area just north and towards the western end of the Marion Street overbridge. Works in this area would be limited to track adjustments and therefore potential amenity impacts, in particular noise may occur but only during limited periods. The college would be subject to consideration of additional noise mitigation measures during construction.
Masjid Abu Bakr Bankstown Mosque	The Masjid Abu Bakr Bankstown Mosque is located adjacent to the project area just north of the Marion Street overbridge towards the western end of the project area. Works in this area would be limited to track adjustments and therefore potential amenity impacts may result. Such impacts are not considered to impact the use or function of the mosque.
St Nicholas Antiochian Orthodox Church	The St Nicholas Antiochian Orthodox Church is located adjacent to the project area just north and towards the western end of the Marion Street overbridge. Works in this area would be limited to track adjustments and therefore potential amenity impacts may result. Such impacts are not expected to impact the use of function of the church.
Park along Brancourt Avenue	A small park located between Brancourt Avenue and the project area is using for passive recreation including a playground. Amenity impacts would potentially affect the outdoor enjoyment of this park; however these impacts are not expected to restrict the use or function of the park, particularly due to the small scale and nature of works in the vicinity of the park.
St. Euphemia Greek Orthodox Church of Bankstown	The St. Euphemia Greek Orthodox Church of Bankstown while over 100 metres from the project area would potentially experience some noise impacts. The church would be subject to consideration of additional noise mitigation measures during construction.
Roly Poly Educational Childcare	The Roly Poly Educational Childcare, while over 100 metres from the project area, would potentially experience some noise impacts. The child care would be subject to consideration of additional noise mitigation measures during construction.
Traction supply cable	
Earlwood Children's Centre	Earlwood Children's Centre is located on Fore Street adjacent to Cup and Saucer Creek. There would be potential amenity and access impacts at this facility due to the trenching works along Fore Street. Works would however progressively move along the alignment meaning impacts would be limited to a short period only. These impacts are not considered to impact the use or function of the facility.

Community facility	Impact overview
Joanna Thompson Reserve	Joanna Thompson Reserve is located on the corner of Burlington Avenue and Woolcott Street and is a passive recreation space with no playgrounds or sports fields. Potential amenity impacts may affect the outdoor enjoyment of this reserve; however these impacts are not expected to restrict the use or function of the reserve. Any impacts would be short term as the works move along the alignment.
Montgomery Reserve	Montgomery Reserve is located west of Karool Avenue, and is a passive recreation area with a small playground. Potential amenity impacts may affect the outdoor enjoyment of this reserve; however these impacts are not expected to restrict the use or function of the reserve. Any impacts would be short term as the works move along the alignment.
Earlwood Oval and Earlwood-Bardwell Park RSL and Sports Club	These facilities are located between Spark Street and Doris Avenue. The site contains a sports club and also an oval, bowling greens and tennis courts. There would be potential amenity impacts at these facilities. Such amenity impacts may affect the outdoor enjoyment of this reserve; however these impacts are not expected to restrict the use or function of the reserve. Any impacts would be short term as the works move along the alignment.
Hughes Park	Hughes Park is an active recreation area containing sports fields. The alignment of the feeder cable would result in direct impacts on the oval. Further review of the route alignment would seek to minimise impacts by potentially realigning around the oval. Any necessary impacts on this space would be discussed with Canterbury-Bankstown Council to confirm the management approach required during construction. Potential noise impacts would also arise when adjacent works are located near to the park including within the adjacent substation. These amenity impacts may affect the outdoor enjoyment of this reserve.

17.3.3 Operation

The main potential for socio-economic impacts and benefits during operation would occur as a result of:

- improved public transport facilities and services, promoting access and connectivity
- community amenity benefits and impacts
- economic impacts and benefits
- health and safety benefits
- impacts to community infrastructure
- the place-making role of the stations, and future socio-economic opportunities the project would provide.

A summary of the results of the assessment in relation to these potential impacts is provided below.

Access and connectivity

Accessibility and connectivity have formed one of the foundation elements for design of the project. The relevant design principle has been to ensure the stations and associated spaces are safe, efficient, universally accessible, legible, and easy to use for customers and pedestrians.

Design development has included an emphasis on ensuring that:

- connections to and from the stations and between all transport modes are easy, and intuitive for all metro customers
- there is equality of access for all people within the stations.

The project would improve access for people of all ages and mobility levels. During operation, community access and connectivity are expected to improve through the provision of efficient public transport and accessible station designs.

Increased frequency of services, improved reliability, and shorter journey times would reduce overall commuting times for customers. This would enable customers to potentially participate in community activities that further afield or on a more frequent basis, providing better access to local and city-wide employment opportunities, housing choices and other services.

New trains would provide wheelchair spaces and separate priority seating to improve accessibility for customers, as well as multi-purpose areas for people with prams, luggage, and bicycles. There would be level access between the platform and train for easier and safer accessibility. These features would improve the accessibility and connectivity for customers of the T3 Bankstown Line, as well as other parts of the transport network. Improved public transport access would particularly benefit those groups that currently experience transport or mobility difficulties, such as elderly people, youth, people with a disability, non-drivers, people travelling with small children or prams, and people without access to a private vehicle.

Pedestrian and cyclist infrastructure enhancements are expected to improve community access and connectivity between the stations and surrounding areas. These improvements may encourage more pedestrian activity and the potential for social interactions. Provision of new or upgraded station concourses and cross-corridor access would also offer more opportunities for communities on both sides of the rail corridor to connect and interact, contributing to community and social cohesion.

Consultation with the Inner West Council identified that there is currently a shortage of bike parking at stations reducing access for cyclists. The project includes the provision of additional bike parking facilities at each station.

In addition, as described in Section 8.1.4, Transport for NSW will work with the Department of Planning and Environment to support the development of an active transport corridor, including walking and cycling infrastructure. Transport for NSW will deliver sections of the active transport corridor around stations.

These facilities would promote active transport along the corridor, integrating with bike parking facilities at stations to enhance integration between public and active transport modes. This would support community aspirations for the provision of cycling infrastructure, promoting healthy and active lifestyles.

Adjacent to the stations, new, upgraded, or relocated parking and kerb side facilities, including accessible parking, kiss and ride, and taxi facilities, would be provided. This would improve access and connectivity within the area surrounding the stations.

Amenity

In line with community aspirations for well-planned and attractive urban environments, the operation of the project has the potential to enhance local amenity and character in the areas immediately surrounding the stations. New stations, which are integrated with their surroundings, would provide a positive experience for customers, while maintaining and improving the character of areas surrounding the stations. Improvements to the station areas, including improved lighting, landscaped areas at entrances, and new and enlarged concourses with retail opportunities are expected to encourage greater customer activity, improve the customer experience, and provide spaces for people to meet.

Through an improved, safer customer experience combined with more frequent services, the project also has the potential to stimulate growth, new development, and urban renewal around stations, including new housing, employment opportunities, public places, community facilities, and integration with other transport infrastructure. This would enhance the overall local amenity around each station, benefitting the local community.

The communities in the study area value heritage conservation and maintaining the built form of the area. Chapter 7 documents the effort undertaken during design development to integrate consideration of heritage impacts into the station upgrade options considered. The project provides opportunities to enhance the amenity and character of stations and surrounding areas with new structures, spaces, and materials, which are sympathetic to the existing heritage items. However, it is recognised that some members of the community may object to these new items. Some members of the community may also attach less value to future urban renewal and associated growth and development.

There is the potential for operational noise impacts in selected locations along the corridor. While the character of the noise experience would be similar to the existing situation, noise levels are predicted to increase compared to the existing situation. Noise impacts from the project would be further assessed during detailed design, and where necessary, reasonable and feasible mitigation measures would be incorporated into the final design and project delivery. Further information is provided in Chapter 13 (Operational noise and vibration).

The project would also result in the need to remove trees both in the vicinity of station areas and more broadly, along the corridor between Marrickville and Bankstown stations, to facilitate the range of works proposed. Chapter 9 provides indicative information on the number of trees predicted to be removed as a result of the project, however further work is being undertaken to quantify these impacts more accurately. Similar to the commitments made as part of the Chatswood to Sydenham project, Transport for NSW will be implementing a tree management strategy (described in Section 9.3.2) to preserve the maximum number of trees possible, including a commitment to replace removed trees in consultation with relevant stakeholders.

Economic benefits

Sydney Metro City & Southwest as whole, including the project, would contribute to economic growth by providing improved reach and faster access to education, employment opportunities, and access to a wider potential workforce.

Planning being carried out by the Department of Planning and Environment as part of the Sydenham to Bankstown urban renewal corridor indicates that the project would help to support about 650,000 jobs within 800 metres of stations by 2036.

Despite these substantial benefits, the business impact assessment (described in Chapter 18) indicates that the project has the potential to result in a small loss of local employment, due to the cessation of commercial leases at Dulwich Hill, Canterbury, Campsie, Belmore, Lakemba, Wiley Park, and Punchbowl stations. However it is likely that some of these employment losses would be able to be replaced locally. Further information is provided in Chapter 18.

The NSW Government’s planned expansion of rail services would result in ongoing opportunities for train drivers across the Sydney Trains network.

Health and safety benefits

The project has been designed to promote walking and cycling and provide improved interchange facilities for customers, pedestrians and cyclists. The adopted transport access hierarchy specifically promotes station access by active transport modes (particularly pedestrians and cyclists). The opportunity for an active transport corridor has been identified, and the project has been designed to incorporate parts of this within the station areas. Further information is provided in Section 8.1.4.

Secure bike parking facilities would be provided at stations. These facilities have been designed to enable future expansion as demand increases.

Improved pedestrian and cycling facilities are expected to improve community access and connectivity between stations and surrounding areas and across the rail line. Improvements may encourage more pedestrian and cyclist activity, and potential for social interactions. More people, combined with better station design, lighting in and outside stations, and the application of CPTED principles during design development, would improve the perception of safety in the station environments. Improved active and passive surveillance would also discourage antisocial behaviour, such as graffiti and vandalism.

Overall, the project is expected to contribute to healthier and safer environments by increasing public and active transport opportunities, and potentially reducing private vehicle use. This would respond to community expectations to reduce environmental footprints, improve local air quality, reduce anti-social behaviour, and protect the environment.

Community infrastructure and facilities

Operation of the project would improve public transport access and connectivity to community infrastructure and social services, such as health, education, sport, recreation and leisure facilities, and community support services across the wider Sydney region. This could support:

- improved long term economic opportunities through better access to education and employment opportunities
- increased opportunities for social interaction, by encouraging people to take trips that they may have avoided due to unacceptable travel times, and improved access to meeting places at stations and within the wider Sydney region
- increased physical activity through improved access to sport, recreation, and leisure facilities
- enhanced community health outcomes, through improved access to health, medical, and community support facilities.

These outcomes would be augmented by the provision of those parts of the active transport corridor that would be delivered by the project (as described in Section 8.1.4). This corridor (once complete) would function as a key piece of community infrastructure in itself, enabling strategic walking and cycling connections to a number of important destinations.

Indirectly, the project would also provide opportunities for transformation and renewal around the stations. This could include new or improved community facilities to support future growth, such as arts and cultural facilities, community centres, meeting halls and libraries.

Further work by State government agencies, local government, and other stakeholders would inform more detailed social infrastructure planning as urban renewal activities progress along the Sydenham to Bankstown corridor.

Social benefits

As described in section 7.2, the design development process has been based on the recognition and reinforcement of the important role of the stations for communities in the project area, with two key elements adopted:

- The stations would have important functions as community places, in their own right and as a focal point within, or in close proximity to a town centre, thereby attracting a range of benefits and land uses, including:
  - reducing dependence on private vehicles

- providing a public place for gathering, commercial/retail uses, and human interaction, and a focal point for surrounding communities
- encouraging exercise, by promoting walking and cycling as an attractive form of transport to and from stations.

- The stations would contribute to the surrounding urban environment or 'place' in which they are located, and would:
  - act a catalyst for the nature and form of development within each of their catchments
  - attract people wanting to live close to, or who are dependent on, public transport facilities
  - operate as a transfer point between other transport modes, increasing mode share for more sustainable transport and meeting the increasing demand for public transport
  - act as a focal point in the local community which can draw people to an area, and enliven adjoining areas and support local businesses.

Social benefits anticipated to be delivered at each station are summarised in Table 17.3.

Table 17.3 Social benefits at each station

Location	Social benefits delivered by the project
All stations	• All stations are designed to be fully accessible, with station entrances and concourses that comply fully with DDA requirements. • The provision of bike facilities at each station would help make bikes an attractive mode of transport to and from stations.
Marrickville	• Improved safety (CPTED) outcomes and passive surveillance of the station plaza and Station Street. • Improved access to Schwebel Street and Illawarra Road via an accessible ramp on Station Street (west).
Dulwich Hill	• Improved access across the corridor through a new concourse and accessible cross corridor link, facilitating community cohesion. • Opportunity for greater community interaction and identity through the provision of a new paved forecourt area and station entrance. • The new station entrance would be closer to the light rail stop to improve interchange between the two transport modes. • Improved access to the station via a new pavement on Ewart Lane.
Hurlstone Park	• Provision of an enlarged station forecourt for community gathering and interaction, and improved safety and pedestrian movements in this area. • New pedestrian crossings would improve access to surrounding areas, including the Crinan Street commercial area, facilitating community cohesion.
Canterbury	• Improved access to potential new town centre and future development areas in the vicinity of the station through a new station entrance on Broughton Street, promoting accessibility, community interaction, and cohesion. • Provision of fully accessible access to existing bus stops on Canterbury Road to improve accessibility to public transport. • Opportunities for community interaction away from the busy Canterbury Road thoroughfare. • Potential improved access across the corridor through the provision of a new concourse and accessible corridor link should the safeguarded station entrance at Charles Street be constructed. This connection would improve permeability and the accessibility of the station precinct, and facilitate community cohesion.

Location	Social benefits delivered by the project
Campsie	• The new station entrance would be more open to Beamish Street, which would further consolidate the station as a focal point for the community. • The upgrade of Lilian Lane to a shared zone with improved lighting and wayfinding would contribute to the public realm and the safety of pedestrians, and improve integration. • The wider entry forecourt would significantly improve pedestrian amenity and enable greater community interaction.
Belmore	• New concourse would provide a new accessible cross corridor link, improving access, and facilitating community cohesion. • New station plaza would promote community gathering and interaction. • Accessible paths from Redman Parade would provide safe passage to Burwood Road and the existing pedestrian crossing, improving community connectivity.
Lakemba	• The new station entrance forecourts, and upgrades to the existing courtyard and memorial space on The Boulevarde, would maintain the existing sense of local pride and community identity. • Forecourt works, including new paving, would provide accessible access and extended areas for community gathering and interaction. • Improved access and integration would present opportunities for community interaction and a greater village identity.
Wiley Park	• New station entrance and associated public domain improvements would be set back further from busy King Georges Road, presenting a more comfortable, safe entrance, facilitating access, and community gathering and interaction. • The upgrade of pedestrian paths and bike parking would activate surrounding streets, providing increased opportunities for passive surveillance, and addressing perceived community safety issues.
Punchbowl	• The new station entrance, to be located further east along The Boulevarde away from busy Punchbowl Road, would create a safer, more spacious entrance, to better address emerging changes in Punchbowl's town centre, provide comfort and amenity for the community, and facilitate community integration. • The new station concourse would provide a new accessible cross corridor link, improving access to the town centre, and facilitating community cohesion. • The new northern entrance and interchange plaza would activate the southern edge of Warren Reserve, and improve pedestrian amenity, safety, and access across the park. • Accessible pedestrian links to and along The Boulevarde would enable easy access for pedestrians to other areas, enhancing community cohesion.
Bankstown	• New concourse would provide a new accessible cross corridor link, improving access, and facilitating community cohesion and integration. • New metro station entrances on North and South Terrace, with legible station entry points and spacious plazas, would reinforce the station's identity within the community. • Public domain improvements would provide comfort and amenity to meeting and waiting areas, facilitating community contact and interactions. • Presents opportunity for greater community interaction and an enhanced village identity.

17.3.4 Cumulative impacts

A number of major projects are either currently occurring in Sydney, or are scheduled to occur at the same time as the project. These include the Sydney Metro Chatswood to Sydenham project, various WestConnex projects and the Sydenham to Bankstown Urban Renewal Corridor. Potential cumulative social impacts during construction could include safety risks as a result of increased traffic, and increased amenity impacts as a result of noise, visual change, and dust emissions.

Cumulative traffic and access impacts leading to delays in travel time or difficulties accessing public transport during construction could also lead to indirect social impacts such anxiousness and concern during the construction period. Genuine consultation with the affected communities and provision of adequate, advance information in different languages, will be critical to maintain trust. The Sydney Metro Place Managers would play a key role in this engagement and ongoing communication process.

The cumulative benefit of the project with other transport projects during operation is expected to result in a substantial net benefit for the community. Considered together with these other projects, the project would provide:

- increased capacity of the rail and arterial road networks
- faster, more frequent, and reliable public transport services
- improved accessibility at stations and connectivity with the public transport network overall
- improved access to employment areas and housing across Sydney
- an increase in economic activity, businesses and employment opportunities, particularly around stations.

This project and others currently occurring in Sydney are anticipated to complement urban renewal opportunities, being investigated by the NSW Department of Planning and Environment. The urban renewal initiatives would encourage development including new housing, employment areas, town centres and community infrastructure close to existing public transport networks. This would support population growth and increases to the supply of housing along the corridor, promoting transit-oriented development.

As a result, the following cumulative impacts could occur during operation of this and other projects and could be perceived as either negative, or positive impacts:

- increased housing density, population increases, and demographic changes as the projects provide improved connections and greater reach within Sydney
- changes to community values, including changes to the existing amenity and character
- changes to access, connectivity, and community cohesion
- changes to community infrastructure and services provision due to population increases and increased opportunities for communities to access infrastructure.

Urban renewal opportunities would need to balance perceived conflicts between demand and these potential impacts and the community reaction to them by careful planning and consultation.

17.4 Mitigation measures

17.4.1 Approach to mitigation and management

Implementation of a comprehensive approach to consultation, communication, and environmental management during construction, together with a rigorous monitoring program, would assist in minimising the potential for socio-economic impacts.

Temporary transport management plans would be prepared and implemented, guided by the Temporary Transport Strategy, to manage the movement of people during closures of stations and/or possessions, in order to minimise the potential impacts on the community. Further information on alternative transport arrangements during possessions and station closures, the Temporary Transport Strategy, is provided in Section 9.11.

Environmental management during construction would be guided by the Construction Environmental Management Framework (provided in Appendix D). The framework requires preparation and implementation of a workforce development plan as one of the components of a construction sustainability management plan. The aim of the plan would be to support local employment and business opportunities, provide skills development, and increase workplace diversity.

As noted in Section 17.3.2, the framework would also require preparation of construction traffic management plans, which would be implemented to minimise disruption to the community, and manage access arrangements during construction.

17.4.2 List of mitigation measures

The mitigation measures that would be implemented to address potential socio-economic impacts are listed in Table 17.4.

Table 17.4 Mitigation measures – socio-economic impacts

ID	Impact/issue	Mitigation measures	Relevant location(s)
Design/pre-construction			
SO1	Socio-economic impacts	Transport for NSW would continue to work with stakeholders and the community to ensure they are informed about the project and have opportunities to provide feedback to the project team. The existing community contact and information tools would remain in place throughout the duration of the project. Consultation prior to and during construction would involve the use of appropriate tools, including, but not limited to, tools such as community information sessions, forums, briefings, and displays; distribution of project materials in a variety of languages; door knocks; Place Managers; and site signage.	All
SO2	Community facilities	Prior to construction, consultation would be undertaken with sensitive community facilities (including aged care, childcare centres, educational institutions, and places of worship). Consultation would aim to identify and develop measures to manage the specific construction impacts for individual sensitive community facilities. These measures would be incorporated into the relevant management plans.	All
Construction			
SO3	Community facilities and infrastructure	Access to community facilities and infrastructure would be maintained during construction. Where alternative access arrangements need to be made, these would be developed in consultation with relevant service providers, and communicated to users.	All
SO4	Employment	A workforce development plan would be prepared and implemented during construction, to support local employment and business opportunities, provide skills development, and increase workplace diversity.	All

17.4.3 Consideration of the interactions between mitigation measures

Mitigation measures in other chapters that are relevant to the management of potential socio-economic impacts include:

- Chapter 4 (Stakeholder and community consultation) with respect to ongoing consultation during the EIS process, construction and operation phases
- Chapter 10 (Construction traffic, transport and access), particularly with respect to the management of traffic, public transport arrangements, and access during construction, including the implementation of temporary transport arrangements

- Chapter 11 (Operation traffic, transport and access) particularly with respect to the management of public transport, pedestrian and cyclist integration during operation
- Chapter 12 (Construction noise and vibration) with respect to management of potential noise impacts during construction, to minimise amenity impacts
- Chapter 13 (Operation noise and vibration) with respect to management of potential noise impacts during operation, to minimise amenity impacts
- Chapter 19 (Landscape character and visual amenity) with respect to management of potential visual amenity impacts during construction and operation
- Chapter 23 (Air quality) with respect to management of potential air quality impacts during construction
- Chapter 25 (Hazards, risk and safety) with respect to managing potential risks to the community during construction and operation.

Together, all these measures would minimise the potential socio-economic impacts of the project.

17.4.4 Managing residual impacts

Residual impacts and benefits following implementation of the mitigation measures described in Section 17.4.2, and those provided in other chapters, are predicted to include:

- increased employment, business, and development opportunities in the study area in both the short and long term
- small loss of local employment and provision of goods and services due to the cessation of commercial leases, some of which would be expected to be replaced
- improved amenity and access to transport facilities and community infrastructure
- visual and character changes within and around the stations, which may be considered to be either detrimental or beneficial by different members of the community
- improved customer and community safety, and opportunities for community interaction
- health benefits due to better access to public transport and options for active transport
- broader economic benefits.

On balance, it is considered that the residual impacts described above would result in a positive improvement for the local community.

18. Business impacts

This chapter provides a summary of the results of the business impact assessment. A full copy of the assessment report is provided as Technical paper 6 – Business impact assessment. The Secretary's environmental assessment requirements relevant to business impacts, together with a reference to where they are addressed, are provided in Table 18.1.

Table 18.1 Secretary's environmental assessment requirements – business impacts

Ref	Secretary's environmental assessment requirements – business impacts	Where addressed
10.1	The Proponent must assess social and economic impacts of the project. This must be done having regard to issues raised by relevant communities and businesses.	A summary of the results of the business impact assessment is provided in this chapter. The full results are provided as Technical paper 6. This chapter considers potential impacts to businesses. Land use and property impacts are considered in Chapter 16. Socio-economic impacts are considered in Chapter 17.
10.2	The Proponent must assess impacts from construction and operation on potentially affected properties, businesses, recreational users and land and water users including property acquisitions/adjustments, access, amenity and relevant statutory rights.	

18.1 Assessment approach

18.1.1 Legislative and policy context to the assessment

The EP&A Act establishes the framework for social and economic impacts to be formally assessed in land use planning and development assessment processes. 'Environment' is defined in the EP&A Act as, 'all aspects of the surroundings of humans, whether affecting any human as an individual or in his or her social groupings'.

The assessment of business impacts was undertaken with regard to the aims, objectives, and actions, as they relate to local business planning, of the relevant local environmental plans and strategic plans for the study area, as described in Chapter 16 (Land use and property).

18.1.2 Methodology

This section provides a summary of the methodology for the business impact assessment. Further information is provided in Technical paper 6. The assessment involved:

- defining the study area and local business precincts for the purpose of the assessment
- reviewing data and reports from the Australian Bureau of Statistics, Transport for NSW's Transport Performance and Analytics unit, and the Inner West and Canterbury-Bankstown councils
- preparing a profile of existing business precincts that may be affected by the project
- consultation with businesses as described below, to identify relevant characteristics and issues
- analysing the outcomes of broader consultation undertaken (described in Chapter 4 (Stakeholder and community consultation)) with regard to potential issues and concerns for businesses
- assessing the potential impacts of construction and operation on businesses

- identifying measures to mitigate and manage potential impacts.

Study area and local business precincts

The study area for the assessment includes the project area and areas defined as 'local business precincts' for the purpose of the assessment. The local business precincts were identified using Transport Performance and Analytics travel zone data, which generally conforms to an area within a 400 metre radius of the stations. Within the study area, 10 local business precincts were identified, as described in Section 18.2.2 and shown in Figure 18.1.

Consultation for the business impact assessment

A representative survey of 100 businesses in the study area was undertaken in June 2016 for this assessment. The aim of the survey was to identify key business characteristics, and issues and concerns regarding the potential impacts of the project. The survey included a range of questions relating to awareness of the project, existing access and delivery requirements, and issues associated with the construction and operational phases of the project. The results of the survey identified information and issues used to focus the study, and to inform the impact assessment.

Assessment framework

The assessment involved identifying and evaluating potential changes to existing business conditions as a result of the construction and operation of the project. This included assessing both direct and indirect benefits and impacts. The assessment considered potential impacts such as the effect on passing trade, employment and recruitment prospects, access and connectivity to business premises, disruption to utilities, and business revenue.

18.2 Existing environment

18.2.1 Local business precincts

The local business precincts identified for the assessment are shown in Figure 18.1. The key business and employment characteristics of each precinct are summarised in Table 18.2 and in the following sections. A more detailed description of each precinct is provided in Appendix B of Technical Paper 6.

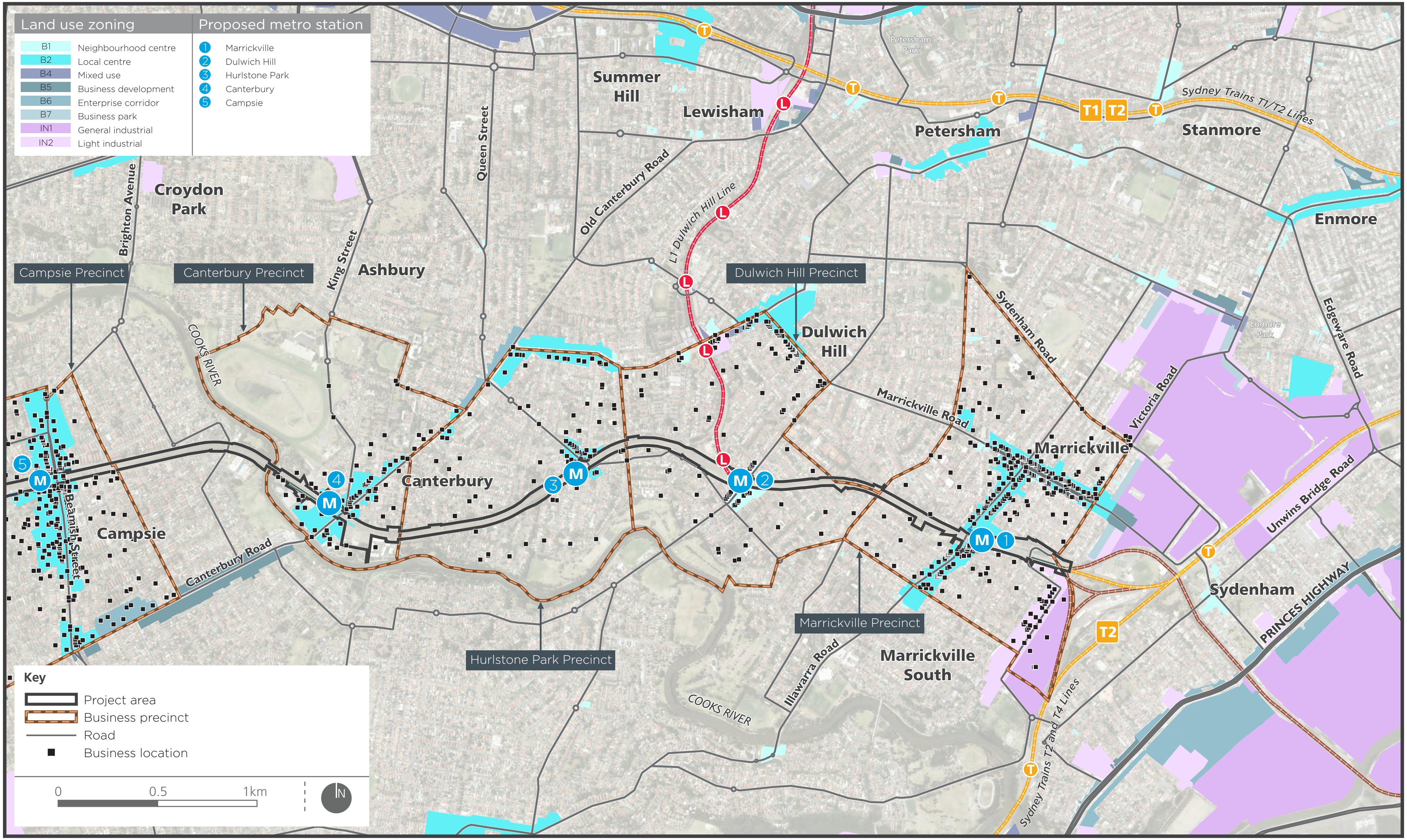
18.2.2 Business and employment profile

The local business precincts vary in size, as does the proportion of land used for business purposes, with distinct differences in business and industry profiles. In 2011, the Sydenham to Bankstown corridor hosted about 19,700 jobs. About 45 per cent of the employment was attributed to three major industries: health care and social assistance (18 per cent); retail trade (16 per cent); and accommodation and food services (11 per cent).

Bankstown's status as a regional centre is reflected in its role as the largest retail employer in the study area, employing about 1,670 people.

Campsie, which has the largest percentage of employment by industries, is the second largest centre along the rail corridor (behind Bankstown).

As shown in Table 18.2, the majority of local industries service household and local business consumption.



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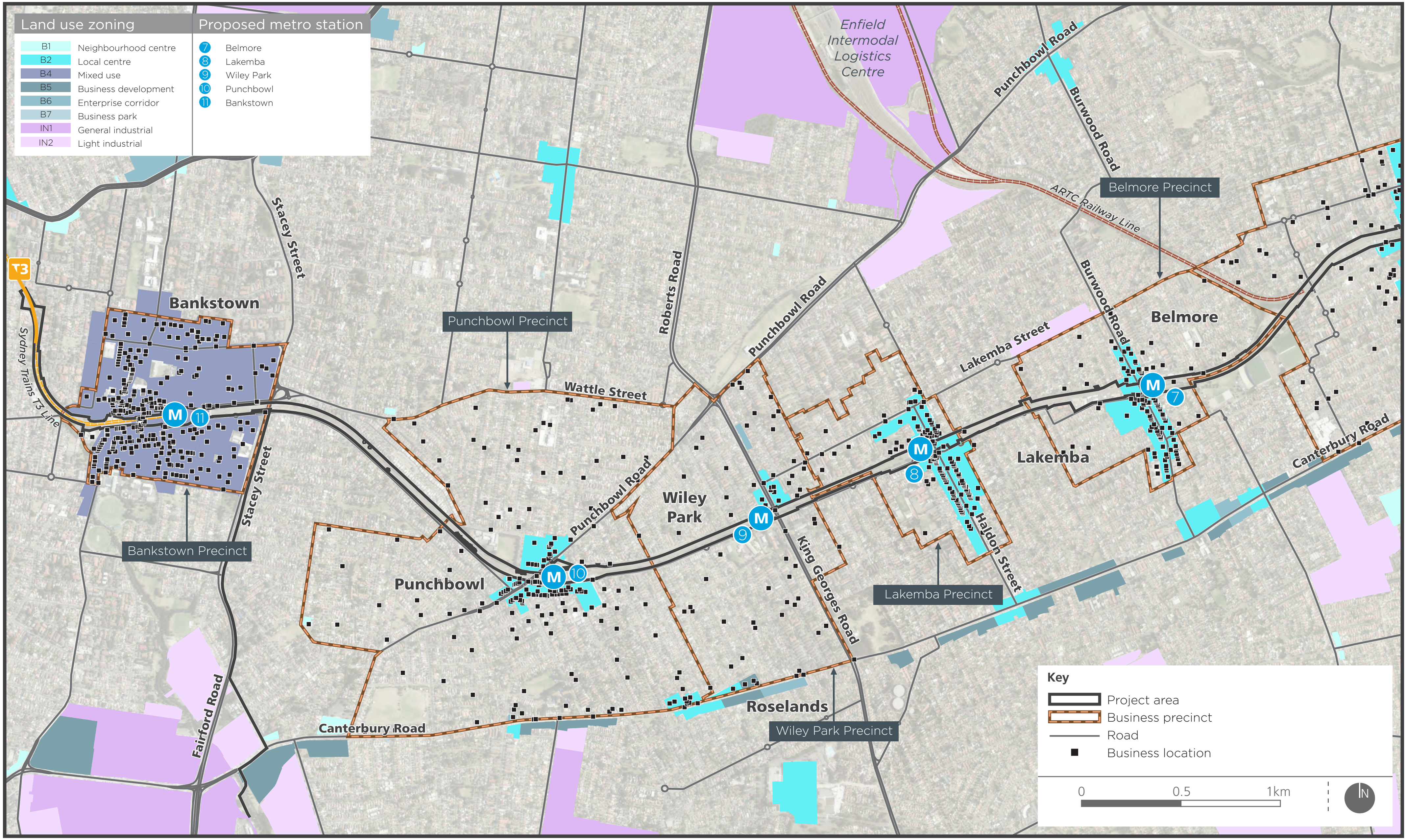
Local business precincts- map 1

FIGURE 18.1



Local business precincts - map 2

FIGURE 18.1

Table 18.2 Business and employment profile of local business precincts

Local business precinct	Size (ha)	% zoned for business or industry[1]	Number of businesses	Local business precinct employment	Main employment industries in the precinct by industry code[2]
Marrickville	131	21	590	1,645	Retail trade Health care and social assistance Manufacturing
Dulwich Hill	111	4	130	575	Health care and social assistance Accommodation and food services Professional, scientific and technical services
Hurlstone Park	109	5	85	580	Accommodation and food services Health care and social assistance Professional, scientific and technical services
Canterbury	97	7	160	796	Education and training Manufacturing Retail trade
Campsie	155	13	510	4,079	Health care and social assistance Retail trade Public administration and safety
Belmore	80	13	205	1,164	Accommodation and food services Health care and social assistance Retail trade
Lakemba	55	24	255	1,040	Health care and social assistance Education and training Retail trade
Wiley Park	117	3	70	488	Education and training Accommodation and food services Transport, postal and warehousing
Punchbowl	246	4	195	1,179	Education and training Health care and social assistance Retail trade
Bankstown	71	89	1,090	8,159	Retail trade Health care and social assistance Public administration and safety

Notes: 1. Includes B1, B2, B4, B5, B6, B7, IN1 and IN2 land use zones.
2. Based on the number of employees, with industry classifications as per ABS publication 1292.0 - Australian and New Zealand Standard Industrial Classification (ANZSIC).
3. Precincts are shown on Figure 18.1.

18.2.3 Employee travel method and place of origin

Journey to work data provides information about employment travel characteristics. The data indicates that a significant proportion of people employed in the study area live relatively close to the business precincts. Despite this however, the majority of people choose to travel to work by private vehicle.

Table 18.3 provides a breakdown of the preferred travel method for the 10 identified local business precincts for residents and employees. As shown in the table, the majority (about 60 per cent) of people use private vehicles to travel to work. Punchbowl, Lakemba, Wiley Park, Bankstown and Belmore have the highest private vehicle usage, while Marrickville and Dulwich Hill have the lowest. In all cases, more employees use private vehicles than residents do.

The second most popular travel mode to work is by train (about 17 per cent). A larger proportion of residents use the train to travel to work compared with employees across each of the business precincts. Punchbowl, Wiley Park, and Hurlstone Park precincts have the lowest train usage, while Marrickville has the highest. The next most popular journey to work mode is walking (about five per cent) and bus (about three per cent), with the remainder either working from home/not working (12 per cent) or using another mode (two per cent).

Journey to work data is important in determining the potential for passing trade, as people walking or catching public transport within or surrounding a local business precinct are generally more likely to contribute to passing trade. Precincts with potentially higher proportions of passing trade (that is, those with a higher proportion of residents or employees who travel to work by walking or catching public transport) are Marrickville, Dulwich Hill, and Campsie.

Table 18.3 Business precinct resident and employee preferred travel modes

Precinct		Travel method (as % of total number surveyed)					
		Train	Bus	Private vehicle	Other mode	Walked only	Worked at home/ did not work
Marrickville	Residents	35	6	40	3	5	11
	Employees	13	2	63	3	8	11
Dulwich Hill	Residents	29	6	47	3	3	12
	Employees	8	2	57	1	8	24
Hurlstone Park	Residents	26	4	53	2	3	12
	Employees	5	2	62	4	8	19
Canterbury	Residents	29	6	49	2	2	12
	Employees	8	3	71	1	4	13
Campsie	Residents	30	5	50	1	6	8
	Employees	8	3	67	1	8	13
Belmore	Residents	26	2	57	2	4	9
	Employees	9	1	71	3	6	10
Lakemba	Residents	31	2	54	1	4	8
	Employees	6	2	74	1	8	9
Wiley Park	Residents	26	1	62	2	2	7
	Employees	5	1	64	4	7	19
Punchbowl	Residents	20	1	68	1	2	8
	Employees	7	0	74	4	4	11
Bankstown	Residents	25	4	56	1	6	8
	Employees	7	3	73	1	4	12

18.2.4 Survey findings

Key findings of the business survey undertaken as part of the assessment include:

- Over 59 per cent of the businesses that responded to the survey were supportive or very supportive of the project.
- The majority of respondents (58 per cent) considered that key project benefits, including reduced traffic, more frequent and reliable public transport, improved pedestrian access to stations, and an improved direct rail system, would be beneficial for business.
- 79 per cent of the respondents thought that construction of the project would affect their business, with the main issues relating to customer access by vehicle, parking availability, revenue, traffic congestion, and general disturbance.
- 78 per cent of the respondents thought that operation of the project would affect their business, with the majority stating that increased revenues were likely.
- 49 per cent stated that property and land values would improve once the project was operational, 27 per cent thought that it would have no impact, and 23 per cent were unsure.

Further information on the survey results is provided in Appendix A of Technical paper 6.

18.3 Impact assessment

18.3.1 Risk assessment

Potential risks

The environmental risk assessment for the project, undertaken for the State Significant Infrastructure Application Report, identified the following as the main risks to businesses surrounding the project area:

- acquisition or lease cessation
- impacts on property values and rent return
- maintaining access and connectivity (including alterations to rail services, traffic network, servicing and delivery, pedestrian and cyclist movement, public transport, and parking)
- other impacts, including disruptions to utilities, noise and vibration, air quality, and visual amenity.

How potential impacts have been avoided or minimised

In general, potential impacts on businesses have been avoided or minimised by:

- designing the project to maximise opportunities to activate existing local centres, with regard to urban design and place-making considerations, as described in Chapter 7 (Design development and place making)
- minimising the need for private land acquisition outside the rail corridor
- retaining existing station locations and access to local centres
- maintaining connectivity on key routes in and around the local centres
- ongoing consultation with business owners as part of the community consultation strategy, as described in Chapter 4 (Stakeholder and community consultation)
- providing compensation to businesses subject to acquisition in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*.

18.3.2 Construction

Chapter 8 (Project description – operation) describes the works required to construct the project. This broadly includes works at stations, including works to upgrade road overbridges, works along the corridor between stations, and ancillary infrastructure. As described, the nature and scale of works to be completed would require temporary closure of stations as well as closures of the T3 Bankstown Line as a whole.

During periods when trains are not operating, alternative transport arrangements (in the form of rail replacement buses) would be implemented. Associated with these arrangements, and to facilitate construction more generally, a range of adjustments to the transport network and infrastructure would be required, including:

- temporary adjustments to vehicle, pedestrian and bike routes, including detours and some lane closures
- relocation of bus stops and taxi/loading zones
- changes to parking
- temporary lane/road closures and kerb adjustments
- changes to the scheduling of train services on other lines.

These changes would result in the potential for impacts and opportunities for existing businesses, particularly those close to the work. Consistent with the results of the business survey, the key potential impacts to businesses are:

- land requirements (acquisition and lease cessation)
- change in property values and rental return
- changes to access arrangements and connectivity, including parking
- amenity impacts
- loss or disruption to utilities
- increased demand for goods and services.

These potential impacts are considered below.

Land requirements (acquisition and lease cessation)

Land requirements for the project would affect business interests as follows:

- acquisition of two privately owned commercial lots near Marrickville Station
- cessation of six commercial leases at each of the following stations: Dulwich Hill, Belmore, Lakemba, Wiley Park, Canterbury, and Punchbowl
- cessation of 31 commercial leases at Campsie Station, as the buildings in which these leases are located would be removed.

Potential impacts on businesses affected by acquisition and lease cessation include:

- difficultly finding alternative properties, particularly for those businesses with very specific requirements
- limitations for some businesses to relocate, particularly those offering services at stations
- inconvenience and loss of productivity during relocation
- expense of relocating or purchasing another property
- potential shift in trade catchment and need to re-establish a customer base.

The majority of the commercial lease cessations would occur at Campsie Station, where the project would result in a loss of 31 businesses in one location immediately adjacent to the station. Businesses who have their leases ceased may choose to relocate to another location within the same catchment and continue trading. There may be the opportunity for businesses to re-establish in the same area following construction. Alternatively, they could move out of the catchment altogether, resulting in a permanent loss to the local economy, including revenue, employment opportunities, and specific services provided to the community.

It is considered unlikely that all the businesses would be able to relocate into the local area of the station. Other businesses may benefit as a result. While the impact on individual businesses would be significant, the notification and proposed compensation process (for acquired properties) would aim to ameliorate this impact as far as practicable.

Compensation paid to landowners where land or property is to be acquired would be in accordance with relevant legislation. Transport for NSW recognises that each business has specific and individual needs. Therefore, the property acquisition process includes the establishment of individual tenancy agreements between the business owner and Transport for NSW. Where compensation is payable, consideration is given to the following, where reasonable, for inclusion in the compensation payment:

- legal costs
- valuation fees
- lease transfer fees
- outsourcing costs for relocation services and other costs directly associated with the move
- other financial costs incurred as a direct result of the acquisition of the leasehold interest including re-establishment costs on a like for like basis.

The significance of property acquisition or lease cessation on business interests would vary in scale across the local business precincts, depending on

- the number of businesses acquired
- their contribution to the local economy
- their ability to re-establish in the local area
- the ability of the remaining businesses and local business precinct to absorb the changes.

Land acquisition and lease cessation associated with the project is considered to result in a moderate adverse impact, which would be reduced to only a slight adverse impact following implementation of the proposed business management plan (described in Section 18.4.1) and following consideration of compensation in accordance with legislation.

Property values and rental return

Property and rent values have a tendency to change in response to various positive and negative influences in a given area. Extended periods of construction, whether individual or cumulative due to other development, can place downward pressure on prices and returns in the short term. However, general market forces remain the key influence in the medium to long term.

The impact of construction on property value or rent returns would be based on the perceived project benefits or impacts. Perceived impact is based on uncertainty, and is difficult to quantify. The more information people have about the risks to business, property, and their immediate environment, the less of a risk it is perceived to be.

The choice of a business to close or relocate during a project is due to a long term view that the property value or rental return may be detrimentally affected as a result of the project. A multi-year construction project can affect a person's ability to sell a property within the construction period – the property may take longer to sell, or construction may limit the market to longer term investors.

Of business survey respondents, 41 per cent thought that an increase in land values would be likely as a reflection of future development opportunities and improved future access to the area. However, this perception did not correlate with the rental return on properties, with respondents suggesting that rent should or would decrease during construction to compensate businesses for reduced amenity and disruptions to operations.

As potential buyers are usually aware of the temporary nature of construction and the longer term strategic benefits of infrastructure projects, the impact on property values is likely to be minimal, with the market more likely to reflect broader trends.

In summary, there is considered to be only a slight temporary potential for impacts to property values and rental return, and long term impacts as a result of construction are considered unlikely.

Access and connectivity

Temporary changes to public transport provision, road transport infrastructure, and active transport networks have the potential to affect customer travel patterns, and access to, and servicing of, businesses. These potential impacts are considered below.

Station closures and possessions

As outlined above and described in Section 9.7, construction would involve periodic temporary closures of the T3 Bankstown Line as well as stations during the construction period. The temporary transport management plans to be implemented would detail the frequency and routing of replacement buses, the effect on transport infrastructure (such as bus stops, road closures, and diversions) and the modifications required.

Closures of stations and changes to rail services would temporarily alter commuter travel patterns, which could affect the amount of passing trade for businesses. It is expected that a small proportion of commuters would choose not to use rail replacement buses and instead drive to work. Additionally, changes to bus stops may reduce trade at particular locations, while at other locations (such as temporary bus stops) there may be an increase in trade during the possession period.

Changes to rail service arrangements and the use of rail replacement buses would increase the amount of traffic on key roads, which has the potential to affect employee travel times and access patterns. It is noted that only a third of the business survey respondents believed that staff travel times would be affected.

It is predicted that station and track closures would have the potential to affect mainly those businesses located close to the stations that have a higher reliance on passing trade, including food services and some retail stores, particularly during the longer duration possessions. Overall, the potential impacts would range from slightly negative to moderately negative. A summary of the key potential issues and impacts associated with station and track closures is provided in Table 18.4.

Table 18.4 Potential impacts of station and track closures

Key issue	Potential impacts
Provision of rail replacement buses	• temporary change in customer travel patterns • may affect passing trade • increase in road congestion and delays, with the potential to impact the efficient provisioning of businesses (i.e. deliveries) • increased customer or employee travel times (compared to current rail services), which may lead to reduced productivity as employees may be late to work or need to leave earlier
Changes to key infrastructure locations, such as temporary bus stops	• increase in trade near temporary bus stops • decrease in trade at some businesses, due to temporary closure of station and changed pedestrian routes
Increases in number of buses and layover facilities	• reduced business visibility if buses are parked outside of businesses • may reduce access to business for deliveries and customer convenience as a result of changes to loading zones, parking etc • reduced amenity around bus stops, including as a result of potential noise and visual impacts

Road and pedestrian network changes

The project would require a number of temporary changes to the road network to facilitate construction. In particular, these would be required to undertake works to road overbridges crossing the rail corridor, which are important means of access for business customers, employees, and deliveries. Depending on the business, temporary changes to the road network could result in inefficiencies, potentially reducing revenue and providing a disincentive for visiting the area.

Table 18.5 outlines how different industry types may be affected by road network changes.

Table 18.5 Sensitivity to road network changes

Type of industry[1]	Sensitivity/ impact
Manufacturing Transport, postal and warehouse Wholesale trade	These industries are generally more dependent on deliveries and the distribution of goods. Alterations to local road networks may result in: • extended travel times and vehicle operation costs • delays in receiving or distributing goods • reduced transport efficiency and reliability of deliveries to customers • increased overheads for businesses.
Retail trade Accommodation and food service	These industries are generally more reliant on passing trade. Alterations to local road networks may result in: • reduction in passing trade and subsequent sales • loss of trade to more accessible centres, with the potential for long term changes in consumer behaviour • reduction in amenity due to traffic congestion, and subsequent reduction in business revenue and potential repeat customers • delays in receiving goods.
Education and training Health care and social assistance Public administration and safety	These industries generally have large workforces or a large client/student/visitor base. Alterations to local road networks may result in increased travel time for employees, students, clients, and visitors.

Note: 1. Industry classifications as per ABS publication 1292.0 - Australian and New Zealand Standard Industrial Classification (ANZSIC)

The main potential impacts as a result of bridge works are summarised in Table 18.6.

Table 18.6 Potential impacts as a result of bridge works

Precinct	Bridge	Potential impacts
Marrickville	Illawarra Road Charlotte Avenue Livingstone Road	Diversions may affect peak weekday traffic volumes along Illawarra Road and Marrickville Road, increasing traffic congestion, reducing delivery and servicing efficiency, and in some instances, diverting vehicles away from the town centre. Businesses close to Marrickville Station, such those as along Illawarra Road and Station Street, would be particularly affected by the works to the Illawarra Road overbridge.
Dulwich Hill	Wardell Road Ness Avenue/ Terrace Road	Diversions may affect business visibility and passing trade, with traffic directed away from the local centre.
Hurlstone Park	Crinian/Duntroon Street	Diversions may affect business visibility and passing trade, with traffic directed away from the local centre.
Campsie	Beamish Street Loch Street	Diversions may increase congestion through the local centre, affecting business servicing and delivery efficiency. Diversions may also affect the visibility of businesses and passing trade along Beamish Street, south of Campsie Street and north of Evaline Street.
Belmore	Burwood Road Moreton Street	Diversions may affect business servicing and delivery efficiency, business visibility, and passing trade, with traffic directed towards or away from the local centre.
Lakemba and Punchbowl	Haldon Street	Diversions may affect business visibility and passing trade for businesses along Haldon Street, between Lakemba Street and Gillies Street. Increased traffic congestion may affect business servicing and delivery efficiency for businesses along Haldon Street.

Changes to the road network as a result of construction activities has the potential to impact the business precincts and the transport efficiency of the broader region. Local traffic congestion was raised as a concern by about 64 per cent of businesses surveyed. Businesses that are more heavily reliant on deliveries and distribution as well as those dependent on amenity (such as cafes/restaurants with outdoor dining) would generally be the most affected.

Parking

About 68 per cent of business survey respondents identified parking as a major perceived issue during construction. A number of respondents noted that they have no access to a designated or off-street loading area, relying on on-street loading zones or parking for deliveries and services.

During construction, some on and off-street parking spaces would be unavailable, either intermittently, or for the duration of the construction period. These spaces are typically located immediately adjacent to the rail corridor, and the impacts of the temporary loss of these spaces for businesses in most precincts would be minor. However, at some stations this loss is likely to be more pronounced. For example, about 48 short-term parking spaces around Belmore Station would be unavailable during construction and would also not be reinstated when the project commences operation (potential operational impacts are considered in Section 18.3.3). This has the potential to affect any businesses on Burwood Road and Bridge Road that depend on easy access to nearby parking. It is noted that surrounding streets contained timed parking areas that are currently not fully utilised, which would provide opportunities for customers to find alternative parking.

Implementation of the alternative transport arrangements during possession periods would also affect a small number of additional on-street parking spaces (to accommodate temporary bus zones) near Campsie, Belmore, Lakemba, Wiley Park, Punchbowl, and Bankstown stations. In addition, some loading zones could be temporarily affected during these periods.

While construction workers would be encouraged to take public transport to work, it is likely that some would drive and require parking. This may result in increased competition for parking near stations. A review of the parking capacity near each station was undertaken as part of the traffic, transport and access assessment (Technical paper 1). The results of the review indicated that there is the potential for parking near Marrickville, Campsie, Lakemba, and Bankstown stations to be more constrained by any increase in parking demand during construction. There is considered to be sufficient capacity to absorb additional worker parking requirements near other stations.

Changes to parking arrangements, include the temporary removal of some existing parking spaces, has the potential to affect deliveries and convenience for business employees and customers. Convenient and accessible parking is particularly important for retail and service-based businesses, which require quick and efficient access for customers. Survey respondents suggested that changes in parking arrangements could potentially lead to decisions by customers/clients to visit other businesses/locations or to use alternative services. This could impact business revenue and the productivity of the local economy.

Temporary changes to parking in the local business precincts near the stations has the potential to result in a slight to moderately adverse impact on some businesses. The more impacted businesses would be those in areas where parking is already in short supply, those located close to stations, and/or retail or service-oriented businesses that require quick and efficient access for customers.

Amenity impacts

Construction has the potential to result in the following amenity impacts for businesses and their customers:

- increase in noise as a result of the operation of construction plant and equipment
- increase in road traffic, and associated noise for businesses around the project area and along construction access routes
- increase in dust generated during construction
- visual impacts due to interruption of existing sight lines, reduced natural light, loss of business visibility, removal of trees, and other changes to streetscapes.

Concerns regarding the potential for noise, vibration, and dust during construction were raised by 65 per cent of the business survey respondents, with noise identified as the main concern. Amenity impacts could affect customer behaviour, reduce trade, and impact on business operation and productivity. Businesses in the following industry sectors are more likely to affected by amenity impacts:

- accommodation and food services
- retail trade
- health care and social assistance.

Based on the proximity of works, businesses in the following areas may be exposed to adverse amenity (noise and vibration) impacts during construction:

- Marrickville – works, including station and bridge works are proposed close to local businesses on Station Street and Illawarra Road, including businesses providing health care, accommodation, and food services

- Campsie – station, bridge, track, and substation works have the potential to result in amenity impacts to businesses on North Parade, South Parade, and Lilian Lane. This may affect businesses providing accommodation and food service, retail trade, and health care and beauty services.
- Lakemba – station and track works have the potential to result in amenity impacts, particularly to businesses involved in accommodation and food services, retail trade, and health care and social assistance located on Railway Parade and The Boulevarde.
- Punchbowl – station and track works have the potential to result in amenity impacts to businesses on The Boulevarde and Urunga Parade, including businesses providing accommodation and food services, retail trade, and health care and social assistance.
- Bankstown – the regional centre surrounds the station, works have the potential to result in amenity impacts to businesses along North Terrace, South Terrace, and Bankstown City Plaza, including businesses providing accommodation and food services, retail trade, and health care and social assistance.

Visual amenity issues have the potential to be neutral or slightly adverse across all business precincts and areas.

Potential amenity impacts are considered in more detail in Chapters 12 (Construction noise and vibration), 19 (Landscape and visual impacts), and 23 (Air quality). Amenity impacts would be temporary during construction, and would be managed by the implementation of industry standard mitigation measures, as outlined in those chapters.

Utility disruptions

Businesses depend on the availability of services, particularly the supply of electricity and water. Disruption to utility services, arising from accidental or planned shutdowns, was a concern raised during the business survey. The disruption of services, even for short periods, can cause inconvenience, and impact on productivity and revenue. Disruptions due to utility outages could potentially impact on:

- businesses that rely on electronic transactions (e.g. using an EFTPOS machine)
- businesses such as manufacturing or industrial that are more reliant on electricity and communication networks to run computers, machinery, equipment, and/or communication systems
- businesses such as restaurants and cafes that rely on clean potable water, refrigeration, electricity, and gas for the preparation and operation of food and beverage services.

To some extent, all businesses may be affected by the accidental disruption of services. However, some businesses may be particularly sensitive to disruptions at any time, including health care providers, accommodation and food services, retail and wholesale trade, and manufacturing. The longer the outage, the greater the impact would on productivity and revenue.

To minimise the potential for impacts and inconvenience to businesses, interruptions to utilities would be planned and communicated in advance to affected premises. The Utilities Management Framework (provided in Appendix I) would be implemented to minimise the potential for impacts to businesses. The framework requires consideration of all potentially affected businesses prior to changes to utilities, and for those changes to be discussed with any business owners likely to be affected.

Increased demand for goods and services

Some businesses may benefit from an increase in workers in the local area, and potential diversions in pedestrian and vehicle travel routes during construction. These benefits include:

- benefits for businesses located close to construction sites or along access routes, particularly those that sell goods or services to construction workers or related industries (for example, cafes, coffee shops, takeaway food, service stations and convenience stores)
- in certain local business precincts, diversions may lead people into local business precincts, potentially increasing passing trade opportunities and exposure of businesses
- generation of regional demand for services, such as construction recruitment agencies, construction companies, and resource suppliers.

Most of the local business precincts have convenience retail and food service businesses located close to the project area. These businesses may benefit from the presence of the construction workforce.

Potential increases in demand for goods and services are likely to result in a slight to moderate positive impact, potentially resulting in an increase in trade and revenue.

18.3.3 Operation

Operation of the project would largely result in major benefits to businesses at the local and regional level, as a result of the enhanced capacity and frequency of rail services, which would improve access to the global economic corridor of the Sydney CBD, North Sydney, Chatswood, and Macquarie Park. Adverse impacts to local businesses would be more limited, and would include the potential for increased commercial rents and increased levels of competition.

The key potential impacts during operation relate to the following, and are considered below:

- access and connectivity
- amenity impacts
- land use impacts
- increased urban renewal and development capacity.

Access and connectivity

Changes to public transport, road networks, and active transport networks during operation have the potential to result in both benefits and negative impacts on access and connectivity for business owners, employees, and customers.

Improved rail capacity and increased service frequency

The project would provide high frequency, high capacity, direct rail services between the study area and the global economic corridor. It has the potential to result in the following benefits for local businesses:

- Increased capacity for businesses to attract a larger customer market. The frequency, reliability, and efficiency of metro services may encourage short trips between local business precincts, improve customer access, and improve passing trade.
- Potentially longer peak times may provide opportunities for businesses. About 39 per cent of survey respondents acknowledged the potential positive impact of the project on enhanced customer access.

- Enhanced connectivity may support the clustering of businesses (such as start-ups and entrepreneurs) that are looking for more affordable locations, which are highly connected and well supported and serviced.
- Larger business precincts, such as Campsie and Bankstown, may become more attractive for national and multi-national brands as a place for new business investment and growth. The vast majority (94 per cent) of survey respondents believed that a direct, high frequency, and more reliable rail service between the Sydney CBD and Bankstown would enhance business opportunity, and would be better for business operations.
- Enhanced workforce accessibility may create a larger employment pool, increase staff choice, and broaden the available skill set to businesses.

An increase in rail service capacity and frequency is expected to benefit businesses across all 10 business precincts.

Active transport networks

The project has been designed to promote active transport modes to and from stations. Changes to pedestrian and cyclist movements through the local business precincts have the potential to impact passing trade, customer numbers, and business visibility. The changed location of station entries, transport interchange improvements, and new pedestrian paths and crossings have the potential to impact passing trade, drawing people towards some businesses and away from others. Improved safety and accessibility of businesses via new accessible paths and cross-corridor connections could also facilitate improved access to local centres, encouraging people to visit centres more often, and increasing the likelihood of additional expenditure.

Improvements in active transport connections to the stations could result in improvements across all local business precincts in terms of passing trade, business exposure, connectivity, and business revenue. The increase in patronage would potentially benefit the majority of businesses, however, those types of business that benefit from passing trade (such as convenience stores, cafes, pharmacies) are likely to experience the greatest potential revenue growth. This may also result in improved property prices and rental return.

The improved cycling facilities and accessible pedestrian paths and spaces would result in a slight to large positive impact in each business precinct.

Connectivity

The project design integrates transport options at each station, by providing for taxi, buses, light rail (at Dulwich Hill Station), and private vehicle facilities in close proximity. This would improve the ease by which people are able to access the public transport network, and connect with rail and other transport modes. Improved connections for active transport to and from stations would also be provided at each station.

Improved connectivity, and higher capacity and frequency rail services, would be attractive to more customers, increasing the exposure of businesses, and the overall vibrancy of local business precincts. Improved public transport integration can also act as a catalyst for development investment, attracting more residents and businesses to a location, increasing potential trade opportunities.

Improved transport integration and connectivity with local businesses is considered to provide a moderately positive impact to all businesses in the study area.

Parking

Convenient and accessible parking plays a critical function for most businesses. A reduction in parking availability potentially deters customers from visiting a shopping area, affecting business revenues.

The business survey identified that parking availability was one of the biggest issues of concern across the local business precincts. Consequently, there were mixed opinions regarding the availability of parking and customer access once the project becomes operational. Of the business survey respondents, one quarter believed that parking would worsen, and 45 per cent stated that it would not improve from current levels. These concerns were largely related to the permanent loss of on-street parking and the likely addition of more commuters wanting to park close to stations.

Transport for NSW has committed to maintaining the same number of dedicated commuter car parking spaces across the whole corridor. However, the project would result in an increase in the number of dedicated commuter parking spaces across the corridor, with an additional 80 spaces proposed to be provided at Campsie Station. As a result of proposed station area improvements, reconfiguration of kerbside areas at stations, and better integration of transport modes, there would be some losses to on-street and off-street parking immediately surrounding stations. The resulting impact on off-street parking would be the loss of about 58 spaces in total at Belmore and Bankstown stations, plus about 20 spaces at Campsie. These spaces are located adjacent to the stations and/or the rail corridor, and are not designated commuter parking.

The parking review undertaken for the traffic, transport and access assessment concluded that there is considered to be sufficient parking in surrounding areas to accommodate the predicted loss of parking at Belmore and Bankstown stations. However, at Campsie Station, there is already limited availability of parking, and the potential loss of parking may increase competition for employee and customer parking.

Overall, the impact of these changes to the availability of parking is considered to be neutral at most stations, although could be slightly adverse for some businesses at Campsie Station.

Amenity impacts

Noise and vibration

Operational noise and vibration is considered in Chapter 13 (Operational noise and vibration). Businesses can be sensitive to noise if it exceeds comfortable levels or continues for extended periods of time. An exceedance of comfortable noise levels can affect employee health and wellbeing, employee productivity, the ability to communicate and interact, and workplace ambiance.

The operational noise assessment predicts that noise levels may increase in some areas. However, there would be limited impacts to amenity in the majority of areas. In summary, there is expected to be a slightly adverse impact on business amenity in areas closest to the rail corridor.

Visual amenity

The impact of the project on visual amenity is considered in Chapter 19. The project would result in changes to local visual amenity due to the presence of new and upgraded infrastructure, public gathering spaces, landscaping, and urban design features. The majority of these features would be located in and around stations.

All local business precincts are expected to experience changes in visual amenity due to the upgraded stations, plaza areas, and ancillary facilities. In the majority of cases, the changes would be considered to be positive compared to the existing environment. Enhancements to the visual amenity of stations (including improved night-time lighting) are expected to lead to an improved experience, generally resulting in people choosing to stay for longer periods and returning in the future.

Overall, the changes to the station areas are expected to result in a neutral to moderately positive impact to local business in the immediate vicinity of stations.

Retail opportunities

As a result of the station upgrades and ancillary works, the project would result in the provision of potential retail opportunities at each station. These are shown in the station layout drawings provided in Chapter 8. These also have the potential to benefit local businesses and owners. Some of these retail opportunities may be considered or possibly taken up by businesses that would be acquired. Potential opportunities identified include:

- Marrickville – new retail/hospitality opportunities along the Station Street shared zone.
- Canterbury – potential for small scale retail in the northern plaza and retail at the new Canterbury Road entrance. The new northern plaza would complement plans for a new town centre along Robert Street North adjacent to the station.
- Campsie – transformation of a portion of Lillian Lane to a shared zone, promoting pedestrian connectivity. The larger public plaza off Beamish Street would provide new retail opportunities.
- Belmore – better integration with nearby commercial and residential areas. The southern public plaza would provide an opportunity for a new retail development.
- Lakemba – the proposed new plaza to the north of the station would provide an opportunity for a small scale retail development.
- Wiley Park – the proposed new plaza at the entrance to King Georges Road would provide an opportunity for a small scale retail development.
- Punchbowl – surrounding land uses to the north of the station would benefit from improved amenity and increased pedestrian traffic. Existing retail to the south of the station would benefit from the improved plaza off The Boulevarde. There would also be an opportunity for a small retail development within the southern station entrance forecourt adjacent to The Boulevarde and existing retail spaces.
- Bankstown – provision of a new cross-corridor connection to the east of the existing station entrance would enhance the integration of the station with surrounding land uses (including businesses). Upgrades of the southern and northern plazas would promote revitalisation of surrounding land uses, including opportunities for business.

Retail development can increase the revitalisation of an area, attract new ‘anchor tenants’ (which in turn can raise the profile of a location), and increase the visibility and opportunity for existing retailers to capture passing trade. It is considered that these retail opportunities would result in a moderate positive impact for local businesses.

Urban renewal and land development

The draft *Sydenham to Bankstown Urban Renewal Corridor Strategy* identifies opportunities for urban renewal along the Sydenham to Bankstown corridor over the next 20 years. The strategy identifies opportunities for additional housing and employment within walking distance of each of the stations.

This renewal and development may act as a catalyst for increased retail investment, as a result of the enlarged customer market. The predicted increase in population around the stations identified in the strategy would provide opportunities for redevelopment within the local business precincts, and subsequent opportunities for businesses to leverage a growing resident and employer population.

While these opportunities could be considered to be a moderately positive impact for new and existing businesses, renewal and population growth might also result in increased business competition, greater demand for parking, and a potential stimulant for rental increases. A long term positive impact on property values may also result.

18.3.4 Cumulative impacts

Potential cumulative impacts to businesses as a result of other projects being undertaken simultaneously in the surrounding area could include:

- temporary changes and general disruption to transport services
- interruption of utilities
- temporary changes to property access
- reduction in parking availability for customers and/or staff
- increased travel times for workers
- reduction in amenity (as a result of construction noise, traffic congestion, changes to visibility, and construction dust).

Measures to avoid, reduce, or mitigate the potential impacts of the project are collated in Chapter 28 (Synthesis of the Environmental Impact Statement). These measures would reduce the likelihood and severity of cumulative impacts should they occur. Construction planning and co-ordination would aim to ensure that the project is scheduled and managed to minimise the potential for cumulative impacts to occur.

The cumulative impact of the project during operation is expected to be a substantial net positive impact for the community. Considered together with other major transport initiatives in Sydney, such as WestConnex and the broader Sydney Metro project, the project would provide:

- increased business opportunities and enlarged customer markets
- improved local amenity
- improved access and connectivity within the project area and to other areas in the Sydney region
- improved transport options and integration
- improved safety, health benefits, and access to active transport options
- stimulus for the provision of new services and facilities.

18.4 Mitigation measures

18.4.1 Approach to mitigation and management

A business management plan would be developed, documenting key issues relating to business impacts by locality, with a particular focus on proactive consultation with affected businesses by Place Managers. It would include:

- identification of specific businesses which are sensitive to construction activity disturbances
- a summary of the commercial character of the locality, its general trading profile (daily and annually) and information gained from the business profiling such as:
  - operating hours
  - main delivery times
  - reliance on passing trade
  - signage or advertising that may be affected
  - customer origin

  - other specific information that will need to be considered in construction scheduling and planning
- locality-specific business mitigation measures, including:
  - business management strategies for each construction site (and/or activity), identifying affected businesses and associated management strategies, including the employment of Place Managers, and specific measures to be put in place to assist small business owners adversely impacted by construction
  - other matters raised in consultation with affected business
- a business consultation forum linked to the consultation strategy for the project (described in Chapter 4)
- definition of the roles and responsibilities in relation to the control and monitoring of business disturbances
- written notifications confirming in advance the dates and timing of construction works being planned, including maps and diagrams to illustrate the information for easy identification of the measures that would be implemented
- when required, noise, dust, and vibration monitoring, auditing, and reporting procedures
- procedure for reviewing performance and implementing corrective actions
- description of the complaints handling process.

In conjunction with the business management plan, a small business owners' support program would provide assistance to small business owners adversely impacted by construction. The assistance provided would involve working with small business owners to identify ways of minimising the impacts of construction by providing wayfinding signage, maintaining visibility where practicable, and facilitating access and deliveries at critical times. The program would be administered by a retail advisory/support panel established by Transport for NSW.

18.4.2 List of mitigation measures

The mitigation measures that would be implemented to address potential business impacts are provided in Table 18.7.

Table 18.7 Mitigation measures – business impacts

ID	Impact/issue	Mitigation measures	Relevant location(s)
Pre-construction and construction			
BI1	Managing construction impacts	A business management plan would be prepared and implemented during construction, to define the location specific measures and strategies to minimise impacts on individual businesses during construction. The plan would also include: • a business consultation forum • roles and responsibilities • monitoring, auditing, reporting, and complaints management procedures.	All
BI2	Supporting businesses during construction	A small business owners support program would be developed and implemented to provide assistance to small business owners adversely impacted by construction. The program would be administered by a retail advisory/support panel established by Transport for NSW.	All

18.4.3 Consideration of the interactions between mitigation measures

As described in Section 28.4, the Construction Environmental Management Framework requires preparation of a workforce development plan as one of the components of a construction sustainability management plan. The workforce development plan would be prepared to support local employment and business opportunities, provide skills development, and increase workplace diversity. Together, the workforce development plan and the business management plan would assist in minimising the potential impacts of construction on businesses.

Mitigation measures identified in other chapters that are relevant to the management of potential business impacts include:

- Chapter 4 (Stakeholder and community consultation), with respect to ongoing consultation with affected communities prior to and during construction
- Chapter 10 (Construction traffic, transport and access), particularly with respect to the management of traffic, public transport arrangements, and access during construction, including the implementation of temporary transport arrangements
- Chapter 12 (Construction noise and vibration), with respect to management of potential noise and vibration impacts during construction, to minimise amenity impacts
- Chapter 13 (Operational noise and vibration), with respect to management of potential noise and vibration impacts during operation, to minimise amenity impacts
- Chapter 16 (Land use and property), with respect to land acquisition process and temporary use of areas for construction
- Chapter 19 (Landscape character and visual amenity), with respect to management of potential visual amenity impacts during construction and operation
- Chapter 23 (Air quality), with respect to management of potential air quality impacts during construction.

Collectively, these measures would minimise the potential business related impacts of the project.

18.4.4 Managing residual impacts

The main potential for residual impacts to businesses would result from impacts to access and connectivity during construction, and impacts to the availability of on-street parking during operation.

19. Landscape character and visual amenity

This chapter provides a summary of the results of the landscape and visual impact assessment. A full copy of the assessment report is provided as Technical paper 7 – Landscape and visual impact assessment. The Secretary's environmental assessment requirements relevant to landscape and visual impacts, together with a reference to where the results of the assessment are summarised in this chapter, are provided in Table 19.1.

The chapter also considers the potential impacts of the project on the existing urban fabric (requirement 14.1(d). The potential for visual impacts on heritage items (in terms of heritage significance) was assessed by the non-Aboriginal heritage impact assessment (Technical paper 3), and the results of this assessment are summarised in Chapter 14 (Non-Aboriginal heritage).

Table 19.1 Secretary's environmental assessment requirements – visual and landscape

Ref	Secretary's environmental assessment requirements – visual and landscape	Where addressed
14.3	The Proponent must assess the visual and landscape impacts of the project and ancillary infrastructure on:	A summary of the results of the landscape and visual impact assessment is provided in this chapter. The full results are provided as Technical paper 7.
	(a) views and vistas;	Section 19.3
	(b) streetscapes, key sites and buildings;	Section 19.3
	(c) landscaping, green spaces and existing trees;	Section 19.3
	(d) heritage items, including Aboriginal places and environmental heritage; and	The project would not impact any Aboriginal places. Visual impacts on environmental heritage are considered in Chapter 14 (Non-Aboriginal heritage).
	(e) the local community	Section 19.3

19.1 Assessment approach

19.1.1 Policy context to the assessment

The landscape and visual impact assessment was undertaken with reference to the following guidelines, policies, and standards:

- *Environmental Impact Assessment Guidance Note – Guidelines for landscape character and visual impact assessment* (Roads and Maritime, 2013b)
- *Beyond the Pavement: urban design policy, procedures and design principles* (Roads and Maritime, 2014)
- *Guidelines for Landscape and Visual Impact Assessment,* (Landscape Institute and Institute of Environmental Management and Assessment, 2013)
- *AS 4282-1997 Control of the obtrusive effects of outdoor lighting*
- *Better Placed: A design led approach: developing an Architecture and Design Policy for New South Wales* (Government Architect NSW, 2016)

- *Bridge Aesthetics: Design guidelines to improve the appearance of bridges in NSW* (Roads and Maritime, 2012)
- *Creating Places for People: An Urban Design Protocol for Australian Cities* (Infrastructure Australia, 2011)
- *NSW Sustainable Design Guidelines* (Transport for NSW, 2013b)
- *Urban Green Cover in NSW Technical Guidelines* (OEH, 2015).

Reference was also made to relevant local environmental plans, development control plans, and planning strategies.

19.1.2 Methodology

A summary of the approach to the assessment is provided in this section. Further information is provided in Technical paper 7.

As described below, the assessment considered the potential for impacts to overall landscape character, and visual amenity near the main project features. Potential impacts on visual amenity were considered during both the day and night. Potential landscape character and visual amenity impacts were assessed prior to the implementation of any form of mitigation.

Landscape character impact assessment

In the urban context, landscape refers to the overall character and function of a place. It includes all elements within the public realm and the interrelationship between these elements and the people who use it. The landscape character assessment identified key landscapes in the existing environment, and determined landscape sensitivity using the definitions provided in Table 19.2.

The potential levels of landscape modification as a result of the project (defined in Table 19.3) were identified. Landscape modification refers to the change in public realm or landscape element that would occur as a result of the project. This includes direct impacts, such as the removal of trees or other existing landscape features, and indirect impacts, such as a change in the function of an area as a result of changes to land use and access. Potential impacts could be adverse or beneficial. The overall levels of potential landscape impacts were determined by assessing the extent of modification in combination with sensitivity, using the ratings shown in Figure 19.1.

Visual amenity impact assessment

The visual impact assessment considered the range of views that may be impacted, including views from residential areas, offices, parks, and streets. Viewpoints were selected to illustrate the visual influence of the project. These represent publically accessible views and vistas from a range of locations and viewing situations. Particular attention was paid to views from places where viewers are expected to congregate, such as plazas, parks, public transport nodes, and commercial areas, as well as views to and from heritage items.

The daytime assessment identified existing visual conditions, representative views, and the sensitivity of each view using the definitions provided in Table 19.2. The potential levels of visual modification as a result of the project (defined in Table 19.3) were identified, and the overall levels of potential impacts to visual amenity were determined by assessing the extent of modification in combination with sensitivity, using the ratings shown in Figure 19.1.

The assessment of potential impacts to visual amenity during the night-time involved a similar methodology to the daytime assessment. The assessment had regard to *AS4282-1997 Control of the obtrusive effects of outdoor lighting*. The sensitivity ratings for the night-time assessment are defined in Table 19.4. The ratings were assigned by identifying existing night-time visual environmental zones, based on characteristics such as sky glow, glare, and the amount of existing light. The overall levels of potential impacts to night-time visual amenity were determined by assessing the extent of modification (defined in Table 19.3) in combination with sensitivity, using the night-time assessment ratings shown in Figure 19.2.

Table 19.2 Sensitivity level definitions

	Description	
Sensitivity	**Landscape character**	**Visual amenity**
National	Landscape feature protected with national or international legislation, e.g. the Sydney Opera House.	Heavily experienced view to a national icon, e.g. the view to Sydney Opera House from Circular Quay or Lady Macquarie's Chair.
State	Landscape feature or urban place that is heavily used and is iconic to the State, for example Martin Place and Hyde Park.	Heavily experienced view to a feature or landscape that is iconic to the State, for example the view along the main avenue in Hyde Park.
Regional	Landscape feature that is heavily used and valued by residents of a region, for example, Belmore Sports Ground.	Heavily experienced view to a feature or landscape that is iconic to a region, or an important view from an area of regional open space, for example, views to the Cooks River.
Local	Landscape feature valued and experienced by concentrations of residents and/or local recreational users, for example, Jubilee Reserve in Lakemba.	High quality view experienced by concentrations of residents and/or local recreational users, users of local commercial areas, and/or large numbers of road or rail users, for example, the view from McNeilly Park in Marrickville.
Neighbour-hood	Landscape feature valued and appreciated mainly by local residents, such as street trees in a local street.	Views important to the local community and not particularly valued by the wider community.

Table 19.3 Modification level definitions

	Description	
Modification	**Landscape character**	**Visual amenity**
Considerable reduction or improvement	A substantial portion of the landscape is changed. This may include substantial changes to parkland function, footpath continuity, building access, permeability of local streets, and/or street tree cover. Involves substantial changes to level of comfort, vibrancy, safety and walkability, connectivity, and diversity.	Alternations to a substantial portion of the view. The project contrasts substantially with surrounding landscape.
Noticeable reduction or improvement	A portion of the landscape is changed. This may include the alteration of parkland function, footpath continuity, building access, permeability of local streets, and/or street tree cover. Involves some alteration to level of comfort, vibrancy, safety and walkability, connectivity, and diversity.	Alterations to the view are clearly visible. The project contrasts with surrounding landscape.
No perceived reduction or improvement	Either the landscape quality is unchanged, or if it is, changes are mitigated by proposed public realm improvements. Does not alter or noticeably alter level of comfort, vibrancy, safety and walkability, connectivity, and diversity.	Either the view is unchanged, or if it is, changes are generally unlikely to be perceived by viewers. The project does not contrast with the surrounding landscape.

Table 19.4 Environmental zone sensitivity – night-time

Sensitivity	Description
E1: Intrinsically dark landscapes	Very high sensitivity visual settings at night, including national parks, state forests etc.
E2: Low district brightness areas	Highly sensitive visual settings at night, including rural, small village, or relatively dark urban locations.
E3: Medium district brightness areas	Moderately sensitive visual settings at night, including small town centres or urban locations.
E4: High district brightness areas	Low sensitivity visual settings at night, including town/city centres with high levels of night-time activity.

Level of modification \ Sensitivity	National	State	Regional	Local	Neighbour-hood
Consideration reduction	Very high adverse	Very high adverse	High adverse	Moderate adverse	Minor adverse
Noticeable reduction	Very high adverse	High adverse	Moderate adverse	Minor adverse	Negligible
No perceived change	Negligible	Negligible	Negligible	Negligible	Negligible
Noticeable improvement	Very high beneficial	High beneficial	Moderate beneficial	Minor beneficial	Negligible
Considerable improvement	Very high beneficial	Very high beneficial	High beneficial	Moderate beneficial	Minor beneficial

Figure 19.1 Impact ratings for the daytime visual amenity assessment

Level of modification \ Sensitivity	E1 Intrinsically dark landscapes	E2 Low district brightness	E3 Medium district brightness	E4 High district brightness
Consideration reduction	Very high adverse	High adverse	Moderate adverse	Minor adverse
Noticeable reduction	High adverse	Moderate adverse	Minor adverse	Negligible
No perceived change	Negligible	Negligible	Negligible	Negligible
Noticeable improvement	High beneficial	Moderate beneficial	Minor beneficial	Negligible
Considerable improvement	Very high beneficial	High beneficial	Moderate beneficial	Minor beneficial

Figure 19.2 Impact ratings for the night-time visual amenity assessment

19.2 Existing environment

19.2.1 Landscape and visual sensitivity

The landscape character areas at each station and at other locations in the project area were determined. A landscape sensitivity rating for each character area was then determined, based on the sensitivity ratings provided in Table 19.2. The landscape character areas and ratings are listed in Table 19.5. All stations are heritage listed, with three stations (Marrickville, Canterbury, and Belmore) listed on the State Heritage Register. The heritage features of the project area (including the stations) are described in Chapter 14 (Non-Aboriginal heritage). Land uses within and surrounding the project area are described in Chapter 16 (Land use and property).

Table 19.5 Landscape character areas and sensitivity

Location	Landscape character area	Landscape and visual sensitivity rating
Marrickville Station	Marrickville Station	Local
	Illawarra Road commercial precinct	Local
	Rail corridor to Schwebel Street residential area	Neighbourhood
	O'Hara Street playground	Neighbourhood
Dulwich Hill Station	Dulwich Hill Station	Local
	Dulwich Hill light rail stop	Local
	Jack Shanahan Park	Local
	Wardell Road commercial precinct	Local
	South Dulwich Hill heritage residential area	Local
	Dulwich Hill residential areas	Neighbourhood
Hurlstone Park Station	Hurlstone Park Station	Local
	Crinan Street commercial precinct	Local
	Hurlstone Park residential precinct	Neighbourhood
Canterbury Station	Canterbury Station	Local
	Canterbury Road commercial precinct	Local
	Canterbury residential area	Neighbourhood
Campsie Station	Campsie Station	Local
	Beamish Street commercial precinct	Local
	Campsie residential area	Neighbourhood
Belmore Station	Belmore Station	Local
	Belmore Station linear park	Neighbourhood
	Burwood Road commercial precinct	Local
	Belmore residential area	Neighbourhood
Lakemba Station	Lakemba Station	Local
	Haldon Street commercial precinct	Local
	Lakemba residential	Neighbourhood
Wiley Park Station	Wiley Park Station	Local
	King Georges Road commercial precinct	Local
	Wiley Park residential area and schools	Neighbourhood
Punchbowl Station	Punchbowl Station	Local
	Warren Reserve	Local
	Punchbowl Road commercial precinct	Local

Location	Landscape character area	Landscape and visual sensitivity rating
	Punchbowl residential area	Neighbourhood
Bankstown Station	Bankstown Station	Local
	Bankstown commercial precinct	Local
Project area	Local Parks - Fraser Park, Tillman Park, McNeilly Park, Tasker Park, Belmore Sports Ground, and Terry Lamb Reserve	Local
	Neighbourhood Parks - Sawyer Reserve, Acton Street, Warwick Reserve	Neighbourhood
	Other State heritage items - Sydney Water sewage pumping station 271, Electrical substation no. 275	Local
	Church Street pedestrian bridge	Neighbourhood
	Rail corridor	Local
	Esplanade roads and adjacent residential areas	Neighbourhood

19.2.2 Daytime viewpoint locations and sensitivity

Table 19.6 lists the viewpoints assessed by the visual amenity impact assessment and their visual sensitivity rating. The locations of these viewpoints are shown on Figure 19.3.

Table 19.6 Daytime viewpoint locations and sensitivity

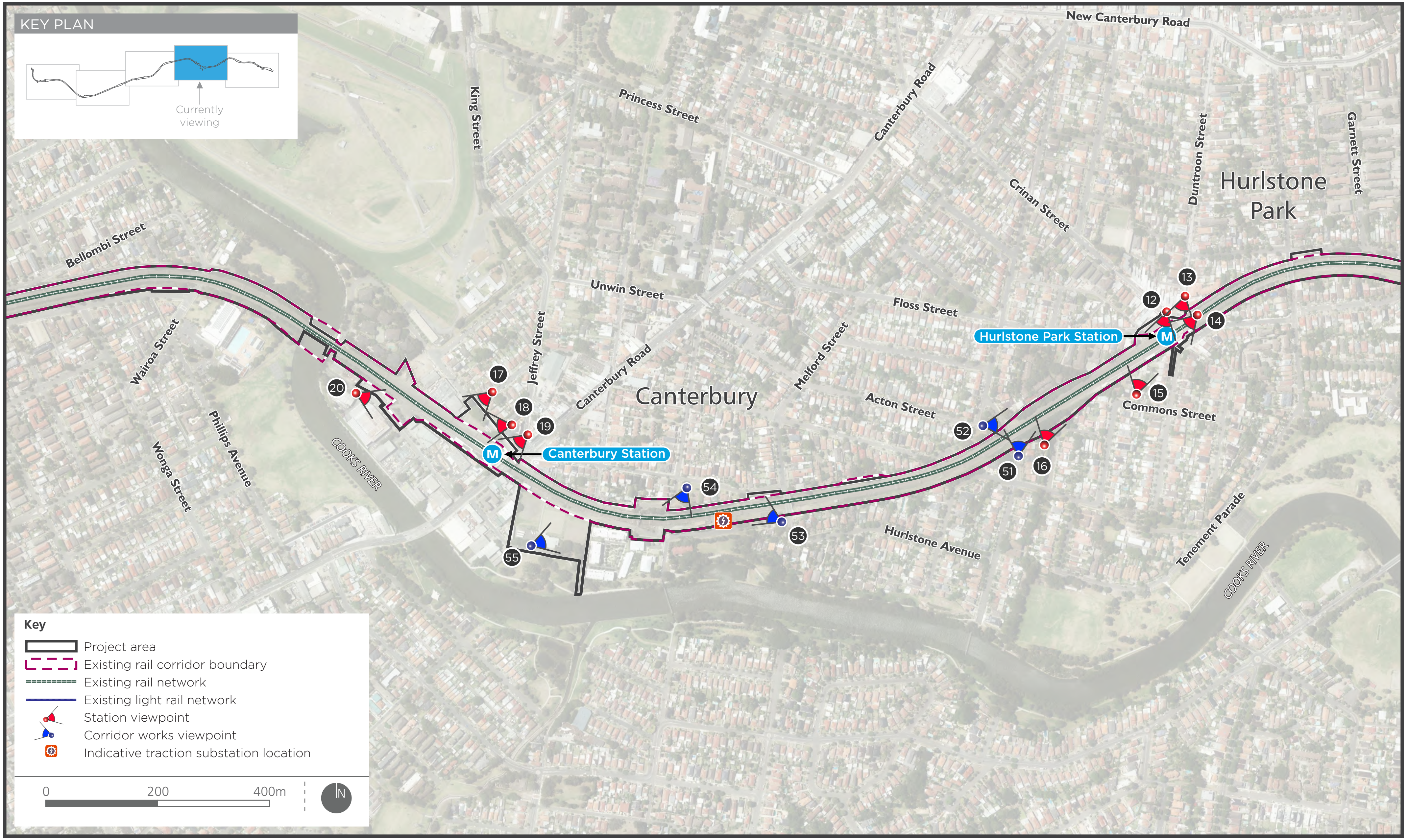
Location	No.	Viewpoint	Sensitivity
Marrickville Station	1	View south-east from Illawarra Road	Local
	2	View south-west from O'Hara Street playground	Neighbourhood
	3	View north from Riverdale Road	Neighbourhood
	4	View north from Leofrene Avenue	Neighbourhood
	5	View north from Station Street	Local
Dulwich Hill Station	6	View south from Jack Shanahan Reserve	Local
	7	View south-east from Dulwich Hill light rail stop	Local
	8	View south from Bedford Crescent to Dulwich Hill light rail stop entrance	Neighbourhood
	9	View west to Dulwich Hill Station from Wardell Road overbridge	Local
	10	View west from corner of Wardell Road and Dudley Street	Local
	11	View south-east from Ewart Lane	Neighbourhood
Hurlstone Park Station	12	View south-west from the Floss Street commuter car park	Local
	13	View south-west across Floss Street	Local
	14	View south-west from the Crinian Street overbridge	Local
	15	View north from Commons Street	Neighbourhood
	16	View from Railway Street	Neighbourhood
Canterbury Station	17	View south-west from Robert Street	Neighbourhood
	18	View north-west from Broughton Street	Local
	19	View south-west from corner of Broughton Street and Canterbury Road	Local
	20	View north-east from Charles Street	Neighbourhood

Location	No.	Viewpoint	Sensitivity
Campsie Station	21	View south-east from corner of Wilfred Avenue and London Street	Neighbourhood
	22	View west along North Parade	Neighbourhood
	23	View south-west from Beamish Street	Local
	24	View north-east from Lilian Lane	Neighbourhood
	25	View west from Lilian Street	Neighbourhood
	26	View east Lilian Street	Neighbourhood
Belmore Station	27	View east from Burwood Road overbridge	Local
	28	View north-east from Tobruk Avenue	Local
	29	View north-west from shared path to the Terry Lamb Reserve	Neighbourhood
	30	View west from the Terry Lamb Reserve	Neighbourhood
	31	View south-west from Redman Parade	Local
Lakemba	32	View north-east from Railway Parade	Local
	33	View south-west along The Boulevarde	Local
	34	View south-west from The Boulevarde commuter car park	Neighbourhood
	35	View south-east from Jubilee Reserve	Neighbourhood
Wiley Park	36	View south-west from laneway at King Georges Road	Local
	37	View north-west across King Georges Road	Local
	38	View north-west along The Boulevarde	Neighbourhood
	39	View north-east from The Boulevarde	Neighbourhood
Punchbowl	40	View south from Warren Reserve	Local
	41	View west along Urunga Parade	Neighbourhood
	42	View west along The Boulevarde at Matthew Street	Local
	43	View north from The Boulevarde	Local
Bankstown	44	View east along North Terrace	Local
	45	View south-west from North Terrace	Local
	46	View north-east from South Terrace	Local
Rail corridor	47	View north-west in McNeilly Park, Marrickville	Local
	48	View west from the Livingstone Road overbridge, Marrickville	Neighbourhood
	49	View east from Challis Avenue, Dulwich Hill	Neighbourhood
	50	View east from Wardell Road overbridge, Dulwich Hill	Local
	51	View north from Foord Avenue, Hurlstone Park	Neighbourhood
	52	View north-east from Sawyer Reserve, Hurlstone Park	Neighbourhood
	53	View west along Hutton Street, Hurlstone Park	Neighbourhood
	54	View south from Church Street Park, Hurlstone Park	Neighbourhood
	55	View north-east from Close Street, Canterbury	Local
	56	View east from the Terry Lamb Reserve, Belmore	Local
	57	View north-east from The Boulevarde, Lakemba	Neighbourhood
	58	View east from Scott Street, Punchbowl	Neighbourhood
	59	View north from the Bankstown Arts Centre courtyard	Local

sydney METRO | city & southwest

Representative viewpoints - map 1

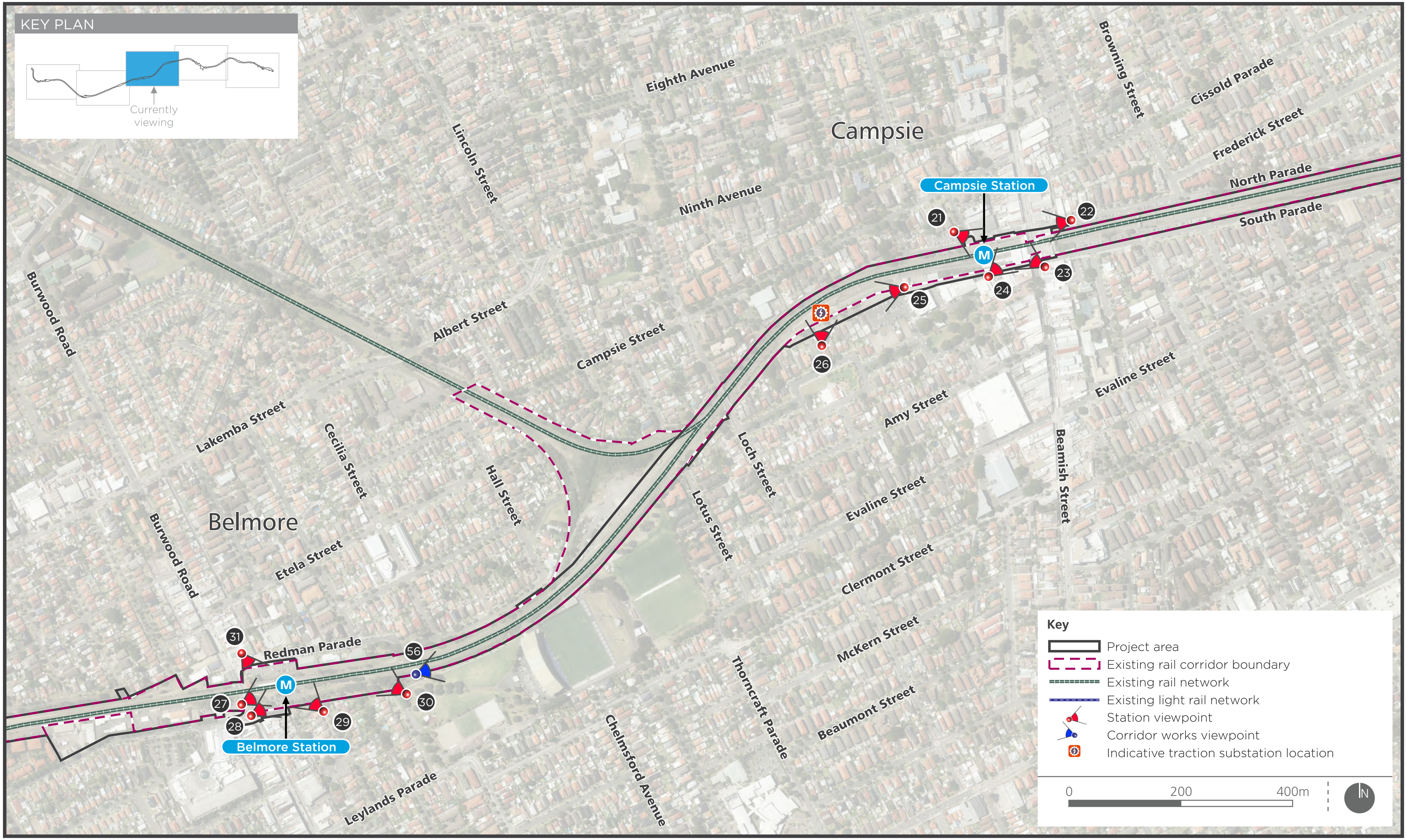
FIGURE 19.3



Sydney METRO | city & southwest

Representative viewpoints - map 2

FIGURE 19.3



sydney METRO | city & southwest

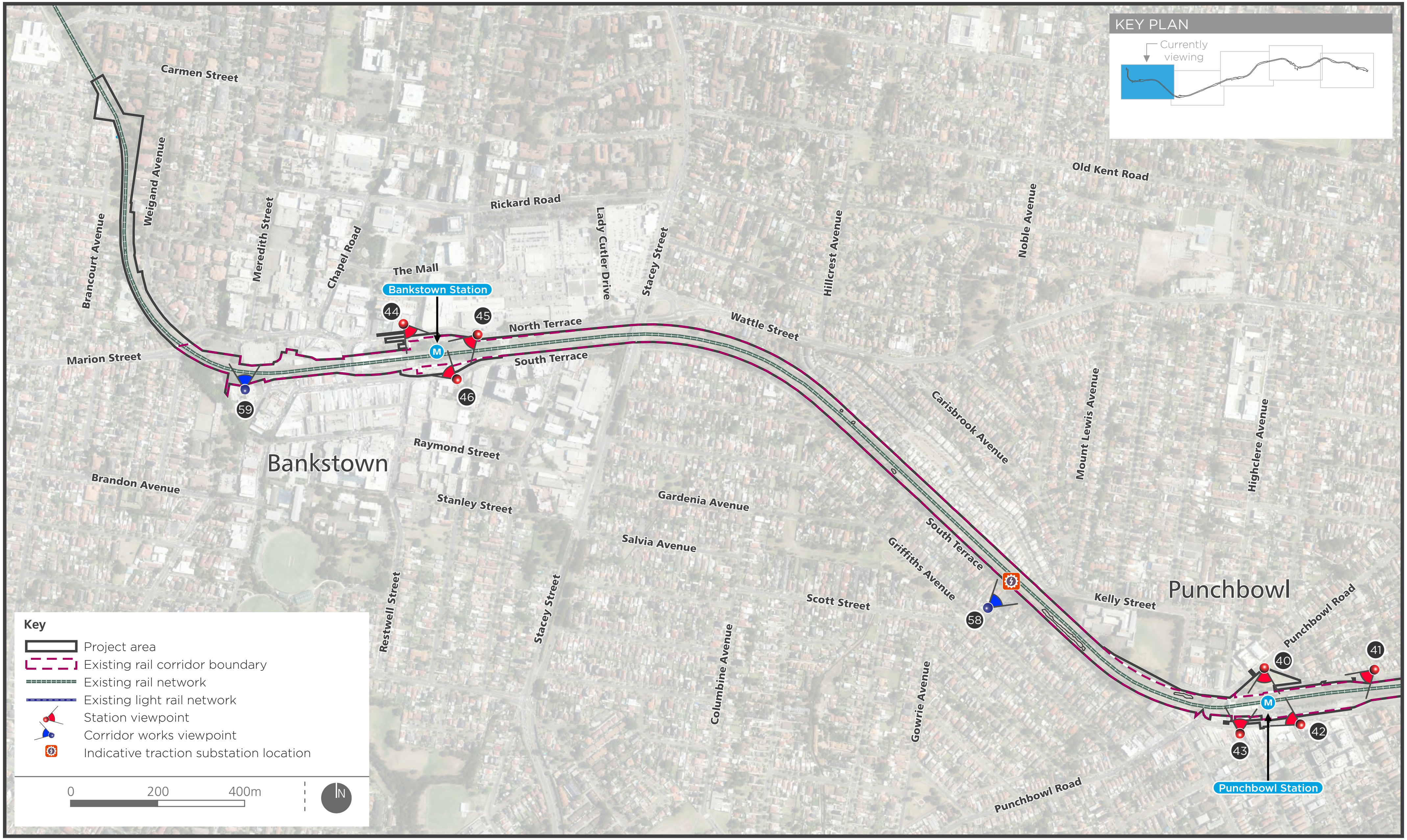
Representative viewpoints - map 3

FIGURE 19.3

sydney METRO | city & southwest

Representative viewpoints - map 4

FIGURE 19.3



sydney METRO | city & southwest

Representative viewpoints - map 5

FIGURE 19.3

19.2.3 Night-time settings

The night-time environmental zone sensitivity (as described in Table 19.4) of all locations was rated as E3: Medium district brightness. The exception to this was Bankstown Station and the rail corridor in the vicinity of the station, where the sensitivity was rated as E4: High district brightness.

19.2.4 Trees and vegetation

Within the project area, there are street trees located in the vicinity of each station, and vegetation within the rail corridor between stations. In some locations, the existing trees and vegetation contribute to landscape character and amenity, and provide visual screening of the rail corridor, in particular of the tracks and trains. The biodiversity characteristics of existing vegetation is described in Chapter 22 (Biodiversity).

19.3 Impact assessment

19.3.1 Risk assessment

Potential risks

The environmental risk assessment for the project, undertaken for the State Significant Infrastructure Application Report, identified the following as the main landscape and visual risks:

- visual impacts from the presence of construction activities
- impacts on landscape character during construction
- light-spill on sensitive receivers during night-time construction works
- visual impacts associated with the introduction of new station buildings and concourses, and associated infrastructure including noise barriers
- light spill from upgraded stations during operation
- impacts on landscape character from operation of the project, which could include improvements to the public domain around station facilities.

How potential impacts have been and would be avoided/minimised

Place making, urban design, and the appearance and visual form of the visible features of the project have been important considerations in the design process. The design has been prepared in accordance with the Sydney Metro City & Southwest Sydenham to Bankstown Design Guidelines (provided in Appendix C). Developing the design involved a comprehensive urban design analysis. For each station, the design has taken local conditions and place making opportunities into account to develop unique solutions, unified by an architectural style that supports the future prospects for each centre.

Further information on how the design developed, including a description of the key place making and urban design considerations, is provided in Chapter 7 (Design development and place making).

The design would continue to be refined during the detailed design phase, which would integrate all relevant design considerations, including:

- the design guidelines
- place making and urban design
- security and safety (including consideration of CPTED principles)
- functional and operational requirements, such as the accessibility of the stations

- community and stakeholder input
- relevant land use plans and strategies (described in Chapter 16)
- environmental constraints and sustainability
- access and maintenance requirements
- minimising impacts to heritage
- mitigation measures provided in Section 19.4.

19.3.2 General construction impacts

The general impacts that would potentially be experienced during construction are summarised in this section. A summary of the assessment results for each station and other key locations in the project area is provided in Sections 19.3.4 to 19.3.14.

Visual amenity

The project would have the potential to affect visual amenity during construction. Potential impacts would be experienced by sensitive visual receivers (including residents, pedestrians, cyclists, motorists, and local workers) in the vicinity of works and from the identified representative viewpoints. During construction, visible elements would include compounds and work sites, machinery and equipment, fencing, soil stockpiles, waste materials, and partially constructed structures.

The potential visual impact of the project would depend on the nature and intensity of the construction works. The change in the visual environment would generally be experienced from a relatively short distance. Visual impacts would also be more significant at locations where residential or other sensitive receivers have an unscreened view of the project area. However, the impacts would be temporary and limited to the construction period. In addition, the majority of the construction works would be viewed within the context of a highly developed and dynamic urban environment, where construction and associated works are frequent occurrences.

The areas with the most potential for visual impacts during construction include areas surrounding stations. However, these impacts would be temporary and limited to the construction phase of the project.

Trees

The project would require removal of some vegetation within the project area. This would include removal of street trees (described in Section 9.3.2), and clearing of rail corridor vegetation (described in Chapter 22). Some of these trees and vegetation contribute to the amenity and character of the local area and/or screen views from properties surrounding the project area. The removal of this vegetation would have the potential to reduce some screening between residential dwellings and the rail corridor, and impact on existing amenity.

The final number of trees impacted would be confirmed during detailed design and final construction planning. Impacts to trees would be minimised where practicable. Where removal of trees is unavoidable, the tree management strategy (described in Section 9.3.2) would be implemented to mitigate the loss of trees. In addition, as described in Section 22.5, biodiversity offsets are proposed to mitigate the loss of ecological values as a result of clearing in the rail corridor.

Lighting

The use of lighting for works outside standard working hours may result in light spill impacting neighbouring properties and residents.

Potential construction impacts would be minimised by implementing the mitigation measures provided in Section 19.4.

19.3.3 General operational impacts

With the introduction of upgraded stations and new infrastructure in the project area, the project has the potential to result in changes to landscape character, visual amenity, and the urban fabric. The project would result in changes to the appearance (to differing degrees) of stations, and the introduction of new infrastructure along the rail corridor. However, as the corridor is currently used for rail purposes, in most instances the changes would not be substantial, as rail infrastructure is visible from a number of receivers and would be considered in the context of the existing rail environment. The project would result in changes to views for a number of visual receivers, with the level of impact varying depending on the works within the viewshed of receivers.

As described in Section 19.3.1, the design of the project has been, and would continue to be, developed with consideration given to its place making role and consideration of agreed design objectives and principles. The design guidelines emphasise the need to respond to place and context, acknowledge the existing conditions, and promote the need to improve the urban interfaces at each station. A key project design principle is to ‘create welcoming, secure and well maintained public domain spaces and station buildings with an attractive sense of place that responds to the distinct cultures of each station precinct.’

The design of the stations and associated facilities has been undertaken to reinforce their role. As new vibrant spaces and destinations, the stations would fit with the NSW Government’s transformation and renewal vision for the Sydenham to Bankstown corridor. The station upgrades could serve as a catalyst for regeneration in the surrounding neighbourhoods and along connecting road corridors, reflecting a high level of land use and transport integration. The detailed design of the project would include measures to integrate the changes to the stations into the surrounding urban fabric.

The results of the assessment of potential operational impacts for each assessment area is provided in sections 19.3.4 to 19.3.14. Potential visual impacts during operation would be minimised by implementing the mitigation measures provided in Section 19.4.

19.3.4 Marrickville Station

Landscape character impacts

Impacts during construction have the potential to be moderately adverse as shown in Table 19.7. This is largely due to the introduction of works and the closure of the Station Street access to the station, which makes the station less visible from areas to the south-east of the station.

The presence of works would improve surveillance in the station area during construction due to increased lighting and passive surveillance from workers.

The project has the potential to result in minor beneficial impacts, as the works would involve improving the existing access from Station Street. Although the new station and station services building would be visible from areas to the north of the station, there would be no direct landscape impacts, and no change to the O’Hara Street playground.

Table 19.7 Marrickville Station – landscape character impacts

Location	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
Marrickville Station precinct	Local	Noticeable reduction	Minor adverse	Noticeable improvement	Minor beneficial

Daytime visual amenity impacts

The following viewpoints were selected as representative of views to the Marrickville Station site:

1. view south-east from Illawarra Road
2. view south-west from O'Hara Street playground
3. view north from Riverdale Avenue
4. view north from Leofrene Avenue
5. view north from Station Street.

Potential daytime visual impacts on representative viewpoints are summarised in Table 19.8. Construction has the potential to result in moderate adverse impacts. The construction compound and other construction activities are predicted to impact on existing views, and would appear in contrast with the surrounding landscape for each of the viewpoints.

Views from Illawarra Road would be consistent with the existing entrance. There is the potential for some impacts to views from the O'Hara Street playground and Riverdale Avenue due to the change in the size of the new station compared to the existing station. Views from Station Street would improve, as the station entrance would be upgraded, views to the entrance opened up, and the proposed new forecourt area and shared zone would include street trees and new pavement. The space would also be activated with retail uses. These changes would result in a noticeable improvement in the amenity of this view.

Table 19.8 Marrickville Station – daytime visual amenity impacts

Viewpoint	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
View south-east from Illawarra Road	Local	Considerable reduction	Moderate adverse	No perceived change	Negligible
View south-west from O'Hara Street playground	Neighbourhood	Considerable reduction	Minor adverse	Noticeable reduction	Negligible
View north from Riverdale Avenue	Neighbourhood	Considerable reduction	Minor adverse	Noticeable reduction	Negligible
View north from Leofrene Avenue	Neighbourhood	Considerable reduction	Minor adverse	Noticeable improvement	Minor beneficial
View north from Station Street	Local	Considerable reduction	Moderate adverse	No perceived change	Negligible

Night-time visual amenity impacts

Changes in lighting during both construction and operation in the vicinity of Marrickville Station would have a minor adverse impact on amenity as a result of light spill onto adjacent properties, as shown in Table 19.9.

Table 19.9 Marrickville Station – night-time visual amenity impacts

Location	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
Marrickville Station precinct	E3: Medium district brightness	Considerable reduction	Minor adverse	Noticeable reduction	Minor adverse

19.3.5 Dulwich Hill Station

Landscape character impacts

As summarised in Table 19.10, construction is predicted to have a moderate adverse impact. This is due to the removal of street trees, closure of car parks, temporary diversion of pedestrians, and the presence of construction activities, which would reduce the connectivity, legibility, and amenity of the station precinct.

Impacts during operation are considered to be minor beneficial, even with the removal of the heritage listed overhead booking office. There is the potential for an improvement in landscape quality, from improvements to the legibility of the station, sense of place, and character in the surrounding streetscapes. Some heritage buildings and structures would be retained to maintain the heritage component of the station.

Table 19.10 Dulwich Hill Station – landscape character impacts

Location	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
Dulwich Hill Station precinct	Local	Considerable reduction	Moderate adverse	Noticeable improvement	Minor beneficial

The following viewpoints were selected as representative of views to Dulwich Hill Station:

6. view south from Jack Shanahan Reserve
7. view south-east from the Dulwich Hill light rail stop
8. view south from Bedford Crescent to the entrance of the Dulwich Hill light rail stop
9. view west to Dulwich Hill Station from the Wardell Road bridge
10. view west from the corner of Wardell Road and Dudley Street
11. view south-east from Ewart Lane.

Daytime visual amenity impacts

Potential daytime visual impacts on representative viewpoints are summarised in Table 19.11. During construction, there would be a potential reduction in visual amenity from all views due to the visibility of construction activities, which would obstruct some existing views.

The footbridge and canopy structure over the rail corridor would be a prominent skyline feature. However, the new structures would be generally consistent with the character of the existing station and rail corridor, and there would not be a perceived change in the amenity of this view, resulting in a negligible operational impact. Minor adverse impacts are predicted for the view from the Wardell Road bridge, as the scale of the structure would increase.

Table 19.11 Dulwich Hill Station – daytime visual amenity impacts

Viewpoint	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
View south from Jack Shanahan Reserve	Local	Noticeable reduction	Minor adverse	No perceived change	Negligible
View south-east from Dulwich light rail stop	Local	Noticeable reduction	Minor adverse	No perceived change	Negligible
View south from Bedford Crescent to Dulwich Hill light rail stop entrance	Local	Considerable reduction	Moderate adverse	Noticeable reduction	Minor adverse
View west to Dulwich Hill stop from Wardell Road bridge	Local	Considerable reduction	Moderate adverse	Noticeable reduction	Minor adverse
View west from corner of Wardell Road and Dudley Street	Local	Noticeable reduction	Minor adverse	Noticeable improvement	Minor beneficial
View south-east from Ewart Lane	Neighbour-hood	Considerable reduction	Minor adverse	Noticeable improvement	Negligible

Night-time visual amenity impacts

As summarised in Table 19.12, construction has the potential to impact on receivers with direct views of light sources or glow from the station.

During operation, lighting impacts would be similar to the existing situation. However, there would be an increase in lighting intensity near residences on Ewart Lane, Wardell Road, and Bedford Crescent, due to the relocated station entrances, and a corresponding noticeable reduction in visual amenity.

Table 19.12 Dulwich Hill Station – night-time visual amenity impacts

Location	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
Dulwich Hill Station precinct	E3: Medium district brightness	Noticeable reduction	Minor adverse	Noticeable reduction	Minor adverse impact

19.3.6 Hurlstone Park Station

Landscape character impacts

The removal of commuter parking and the closure and diversion of footpaths in some areas would reduce the legibility and accessibility of this precinct by vehicles and for pedestrians. Due to the scale of works, construction would result in a considerable reduction in the landscape quality and functionality of this precinct, and result in a moderate adverse impact during construction (refer to Table 19.13).

Operation has the potential to result in moderate beneficial impacts, even though the removal of the heritage listed overhead booking office, footbridge, and stairs would reduce legibility. Other improvements would result in an overall beneficial impact. These include improvements to access, safety, and amenity, due to the new station entrances, the overall station design with a greater visual presence in the village, and conservation of the heritage listed rock face to the rear of the Platform 2 building.

Table 19.13 Hurlstone Park Station – landscape character impacts

Location	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
Hurlstone Park Station	Local	Considerable reduction	Moderate adverse	Considerable improvement	Moderate beneficial

The following viewpoints were selected as representative of views to Hurlstone Park Station:

12. view south-west from the Floss Street commuter car park
13. view south-west across Floss Street
14. view south-west from the Crinian Street overbridge
15. view north from Commons Street
16. view from Railway Street.

Daytime visual amenity impacts

Potential impacts on representative viewpoints are summarised in Table 19.14.

During construction, views of construction activities would obstruct some existing views and would be in contrast with the surrounding landscape. Potential impacts are rated from minor to moderate adverse, depending on the location of the view. Some views would have construction activities in the foreground, resulting in greater impacts.

Operation would have a negligible impact on all viewpoints. In this location, the rail corridor is considered to have the capacity to absorb the new structures, which would be consistent with the existing views of railway infrastructure. The proximity of the new structures to residents has the potential to reduce the amenity of the view north from Commons Street. The visual containment of the station due to the cutting, intervening vegetation, and buildings, would allow for the absorption of the new station into the view. The proximity of new structures to residences would create a considerable reduction in the amenity of this view, and have an minor adverse visual impact during operation.

Table 19.14 Hurlstone Park Station – daytime visual amenity impacts

Viewpoint	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
View south-west to rail corridor and Floss Street commuter car park	Local	Considerable reduction	Moderate adverse	No perceived change	Negligible
View south-west across Floss Street	Local	Considerable reduction	Moderate adverse	No perceived change	Negligible

Viewpoint	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
View south-west from Crinian Street overbridge	Local	Considerable reduction	Moderate adverse	No perceived change	Negligible
View north from Commons Street	Neighbour-hood	Considerable reduction	Minor adverse	Considerable reduction	Minor Adverse
View from Railway Street	Neighbour-hood	Considerable reduction	Minor adverse	Considerable reduction	Minor adverse

Night-time visual amenity impacts

There is the potential for construction impacts to receivers adjacent to the rail corridor who have direct views of light sources or the glow from the station.

During operation, lighting from the new station structures and the headlights of metro trains would be generally consistent with the intensity of lighting at the existing station, and would be absorbed by the surrounding commercial precinct. However, the new entrance plaza on Crinian/Duntroon Street would increase lighting intensity for nearby residents with minor adverse impacts (refer to Table 19.15).

Table 19.15 Hurlstone Park Station – night-time visual amenity impacts

Location	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
Hurlstone Park Station precinct	E3: Medium district brightness	Noticeable reduction	Minor adverse	Noticeable reduction	Minor adverse

19.3.7 Canterbury Station

Landscape character impacts

As summarised in Table 19.16, construction impacts are rated as moderate adverse, due to the changes to station access, removal of vegetation, diversion of pedestrians, and the presence of construction compounds and work sites.

There is the potential for moderate beneficial impacts during operation as Canterbury Station would be transformed by the project, with the station set back from Canterbury Road and comprising an entirely new concourse structure. The introduction of prominent new station architecture and plazas connecting to the existing and emerging urban renewal precincts would create a new place with a distinct identity within Canterbury.

Although the relocated station entrance on Broughton Street would change the legibility and character of this station precinct, the new entrance and associated access would provide for greater street activation and level of comfort. The community would also be able to view heritage buildings in close proximity. Overall, there would be a considerable improvement in the functioning and quality of this landscape resulting in a moderate beneficial landscape impact.

Table 19.16 Canterbury Station – landscape character impacts

Location	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
Canterbury Station precinct	Local	Considerable reduction	Moderate adverse	Considerable improvement	Moderate beneficial

The following viewing locations were selected as representative of views to Canterbury Station:

17. view south-west from Robert Street
18. view north-west from Broughton Street
19. view south-west from corner of Broughton Street and Canterbury Road
20. view north-east from Charles Street.

Daytime visual amenity impacts

Potential daytime visual impacts on representative viewpoints are summarised in Table 19.17. Construction has the potential to impact views due to the visibility of construction, including compounds and work sites, and the associated removal of vegetation.

The new station entrance and associated features would be generally consistent with the surrounding environment, and would result in improvements to visual amenity for some views. Overall, the new station would integrate with the surrounding urban environment, with a number of multi-storey apartment developments under construction with negligible visual impacts.

Table 19.17 Canterbury Station – daytime visual amenity impacts

Viewpoint	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
View south-west from Robert Street	Neighbour-hood	Considerable reduction	Minor adverse	No perceived change	Negligible
View north-west from Broughton Street	Local	Considerable reduction	Moderate adverse	No perceived change	Negligible
View south-west from corner of Broughton Street and Canterbury Road	Local	Considerable reduction	Moderate adverse	Noticeable improvement	Negligible
View north-east from Charles Street	Neighbour-hood	Noticeable reduction	Negligible	No perceived change	Negligible

Night-time visual amenity impacts

There is the potential for construction impacts for receivers adjacent to the rail corridor, including the units overlooking the rail corridor on Charles and Broughton streets and several detached houses and townhouse buildings on Broughton Street who have views of direct light sources or the sky glow above the station (refer Table 19.18).

During operation as summarised in Table 19.18, the project would result in an intensification of light sources for nearby receivers, resulting in a minor adverse impact.

Table 19.18 Canterbury Station – night-time visual amenity impacts

Location	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
Canterbury Station precinct	E3: Medium district brightness	Noticeable reduction	Minor adverse	Noticeable reduction	Minor adverse

19.3.8 Campsie Station

Landscape character impacts

As summarised in Table 19.19, there is the potential for moderate adverse construction impacts as a result of the extent of construction works on Beamish Street, reduction in the accessible platform area, closure of footpaths, temporary closure of Lilian Lane and the temporary diversion of pedestrian and vehicular traffic. Legibility of the station precinct would be reduced during this time while new routes and connections are established.

Much of the station architecture would be replaced with a contemporary structure with would have a greater visual presence on the street. The station entry would be more open to Beamish Street surrounded by high quality plazas, including Lilian Lane. On balance, the improved plaza and station entry would result in a noticeable improvement in landscape quality and functionality of the precinct and have a minor beneficial landscape impact during operation.

Table 19.19 Campsie Station – landscape character impacts

Location	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
Campsie Station precinct	Local	Considerable reduction	Moderate adverse	Noticeable improvement	Minor beneficial

The following viewing locations were selected as representative of views to the Campsie Station site:

21. view south-east from corner of Wilfred Avenue and London Street
22. view west along North Parade
23. view south-west from Beamish Street
24. view north-east from Lilian Lane
25. view west from Lilian Street
26. view east from Lilian Street.

Daytime visual amenity impacts

Potential daytime visual impacts on representative viewpoints are summarised in Table 19.20. During construction, the construction compound and temporary station access structure, and reconstruction of the new station entrance on Beamish Street, would impact on views. Construction activities would also be visible above the temporary hoarding

The concourse and overhead booking office would be visible extending across the corridor and rising above the surrounding development. The scale of these structures would reflect the importance of the station entry and be a prominent feature in the view. Overall the increased scale and more open form of the new station structures, would provide a level of prominence which marks it as an entry to the station, whilst being visually consistent with the character of the surrounding commercial precinct. This change would result in a noticeable improvement in the amenity of this view and a minor beneficial visual impact.

Table 19.20 Campsie Station – daytime visual amenity impacts

Viewpoint	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
View south-east from corner of Wilfred Avenue and London Street	Neighbourhood	Considerable reduction	Minor adverse	Noticeable improvement	Negligible
View west along North Parade	Neighbourhood	Considerable reduction	Minor adverse	No perceived change	Negligible
View south-west from Beamish Street	Local	Considerable reduction	Moderate adverse	Noticeable improvement	Minor beneficial
View north-east from Lilian Lane	Neighbourhood	Considerable reduction	Minor adverse	Noticeable improvement	Negligible
View west from Lilian Street	Neighbourhood	Considerable reduction	Minor adverse	Noticeable reduction	Negligible
View east Lilian Street	Neighbourhood	Considerable reduction	Minor adverse	No perceived change	Negligible

Night-time visual amenity impacts

As summarised in Table 19.21, there is the potential for a reduction in night-time amenity during construction due to an increase in lighting. These impacts would be experienced on Lilian Street, Wilfred Avenue, North Parade, and South Parade, as well as at retail buildings on Beamish Street and North Parade.

During operation, there is the potential for a reduction in amenity due to an intensification of lighting at the upgraded station. These impacts would be most noticeable for receivers adjacent to the station.

Table 19.21 Campsie Station – night-time visual amenity impacts

Location	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
Campsie Station precinct	E3: Medium district brightness	Noticeable reduction	Minor adverse	Noticeable reduction	Minor adverse

19.3.9 Belmore Station

Landscape character impacts

Construction would result in a considerable reduction in landscape quality and functionality, and have a moderate adverse impact, as summarised in Table 19.22.

The redevelopment along Tobruk Avenue and new station entrances would alter the character of the area. However, historic landmark buildings would remain, including the main station building on Burwood Road, Art Deco post war bus shelter, and public lavatories building in Redman Parade.

These heritage buildings maintain the legacy and contribute to the vibrancy and built form of the precinct. Overall, the new station entrances would lead to a noticeable improvement in the landscape quality and functionality and a minor beneficial landscape impact during operation.

Table 19.22 Belmore Station – landscape character impacts

Location	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
Belmore Station precinct	Local	Considerable reduction	Moderate adverse	Noticeable improvement	Minor beneficial

The following viewpoints were selected as representative of views to Belmore Station:

27. view east from Burwood Road overbridge
28. view north-east from Tobruk Avenue
29. view north-west from shared path linking to the Terry Lamb Reserve
30. view west from the Terry Lamb Reserve
31. view south-west from Redman Parade.

Daytime visual amenity impacts

Potential daytime visual impacts are summarised in Table 19.23. Construction impacts are rated as minor to moderate adverse. The view north-west from the pathway linking to the Belmore Sports Ground would be impacted by removal of vegetation and the presence of construction activities. All other views would be impacted as a result of the presence of the construction compound and construction of the station platform.

During operation, the impacts to most viewpoints are rated as minor adverse or negligible. Impacts on views would be a result of the new station buildings and entrance, widening of the rail corridor, and vegetation removal. The views from Tobruk Avenue would improve due to the new shared zone, the retention of existing vegetation, and the new station entry forecourt.

Table 19.23 Belmore Station – daytime visual amenity impacts

Viewpoint	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
View east from Burwood Road overbridge	Local	Considerable reduction	Moderate adverse	Noticeable reduction	Minor adverse
View north-east from Tobruk Avenue	Local	Considerable reduction	Moderate adverse	Noticeable improvement	Minor beneficial
View north-west from shared path linking to the Terry Lamb Reserve	Neighbour-hood	Considerable reduction	Minor adverse	Considerable reduction	Minor adverse
View west from the Terry Lamb Reserve	Neighbour-hood	Considerable reduction	Minor adverse	Considerable reduction	Minor adverse
View south-west from Redman Parade	Local	Considerable reduction	Moderate adverse	No perceived change	Negligible

Night-time visual amenity impacts

Night works would occur within the station as well as the adjacent construction compounds, extending the works into the commuter car parks in Redman Parade and Tobruk Avenue, and the work site on Myall Street. At these sites there would be views to direct light sources and sky glow above the sites. As summarised in Table 19.24, there is the potential for a noticeable reduction in amenity of views from residences in Redman Parade, upper Acacia Lane, Acacia Street, and Myall Street during construction, resulting in minor adverse visual impact at night.

During operation, the station would be brightly lit at night around the station entries, new elevated concourse, and platforms. Much of the light within the station would be contained by the adjacent cutting and consistent with the lighting seen at the existing station. However, lighting from the elevated footbridge would be visible above the cuttings and from surrounding areas. Lighting from the platforms would also be visible in areas to the east, as the new platforms would be generally level with the surrounding landform.

Table 19.24 Belmore Station – night-time visual amenity impacts

Location	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
Belmore Station precinct	E3: Medium district brightness	Noticeable reduction	Minor adverse	Noticeable reduction	Minor adverse

19.3.10 Lakemba Station

Landscape character impacts

As summarised in Table 19.25, there is the potential for moderately adverse impacts during construction due to the presence of construction works close to the station. Construction would result in temporary station access structures, and potential temporary diversion of pedestrian routes, which would reduce pedestrian connectivity and legibility of the station precinct.

The location of the station buildings would be unchanged, however, minor additions to widen the concourse area, and the new roof and platform canopies, would alter the character of the station and surrounding streetscapes. The strong architectural statement and consistency of form of the station architecture would improve the prominence and legibility of the station entries. The provision of new plazas, and upgrades to the existing square and memorial space on The Boulevarde, would maintain the sense of local identity. Overall, as the facilities have been recently upgraded, although some minor improvements have been made, the project would result in a noticeable improvement in the landscape functioning of the precinct and a minor beneficial landscape impact.

Table 19.25 Lakemba Station – landscape character impacts

Location	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
Lakemba Station precinct	Local	Considerable reduction	Moderate adverse	Noticeable improvement	Minor beneficial

The following viewpoints were selected as representative of views to Lakemba Station:

32. view north-east from Railway Parade

33. view south-west along The Boulevarde

34. view south-west from The Boulevarde commuter car park

35. view south-east from Jubilee Reserve.

Daytime visual amenity impacts

Potential daytime visual impacts on representative viewpoints are summarised in Table 19.26. During construction, there is the potential for moderately adverse visual impacts due to the construction work areas being highly visible to all viewpoints. The removal of vegetation would reduce visual amenity and increase views of the construction work areas.

During operation, there would be improvements to the view south-west along The Boulevarde, as the new station building would create a focal point. The war memorial and park setting would continue to filter views to the platforms and rail corridor. There is the potential for a reduction in the amenity of other views, due to the loss of mature vegetation (some of which currently filter views of the rail corridor) and the introduction of more prominent structures.

Table 19.26 Lakemba Station – daytime visual amenity impacts

Viewpoint	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
View north-east from Railway Parade	Local	Noticeable reduction	Minor adverse	Noticeable reduction	Minor adverse
View south-west along The Boulevarde	Local	Noticeable reduction	Minor adverse	Noticeable improvement	Minor beneficial
View south-west from The Boulevarde commuter car park	Neighbour-hood	Considerable reduction	Minor adverse	Noticeable reduction	Negligible
View south-east from Jubilee Reserve	Neighbour-hood	Considerable reduction	Minor adverse	Noticeable reduction	Negligible

Night-time visual amenity impacts

Much of the night works would occur within the station and adjacent areas including construction compounds south-east of the station on The Boulevarde and north-west on Railway Parade. This activity may result in some additional light visible from residences adjacent to the rail corridor, and the potential for a reduction in amenity for receivers on Railway Parade and The Boulevarde, as summarised in Table 19.27.

The new station entrances in railway parade and The Boulevarde would increase and extend the lighting beyond the existing station area during operation. However, it is expected that this lighting is generally consistent with the intensity of lighting seen at the existing station, and it would be absorbed into the surrounding commercial precinct. The platform lighting and train headlights would extend the brightly lit station environment west, in a location that is elevated above the surrounding residential area to the south of The Boulevarde and north of Railway Parade. It is expected there would be a noticeable reduction in the amenity of views at night from these locations, and a minor adverse visual impact.

Table 19.27 Lakemba Station – night-time visual amenity impacts

Location	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
Lakemba Station precinct	E3: Medium district brightness	Noticeable reduction	Minor adverse	Noticeable reduction	Minor adverse

19.3.11 Wiley Park Station

Landscape character impacts

As summarised in Table 19.28, there is the potential for minor adverse impacts during construction due to the relocation of station entrances, removal of heritage listed platform buildings, temporary diversion of pedestrian and vehicular traffic, and the presence of construction activities.

During operation, the permeability and accessibility of the station would be improved by the station entrance on King Georges Road, with two additional station entrances on Stanlea Parade and The Boulevarde. The loss of heritage listed items on the platforms and King Georges Road would alter the sense of place and character of the station and surrounding streetscape. However, the new station entrances and overall design would have a recognisable style, with simple forms, large plaza spaces, and canopies.

Table 19.28 Wiley Park Station – landscape character impacts

Location	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
Wiley Park Station precinct	Local	Noticeable reduction	Minor adverse	Considerable improvement	Minor beneficial

The following viewpoints were selected as representative of views to Wiley Park Station:

36. view south-west from laneway at King Georges Road
37. view north-west across King Georges Road
38. view north-west along The Boulevarde
39. view north-east from The Boulevarde.

Daytime visual amenity impacts

Potential daytime visual impacts on representative viewpoints are summarised in Table 19.29. During construction, minor adverse impacts to most views are predicted. Views of the rail corridor would be obstructed in some locations due to the visibility of construction works, particularly the construction compound and hoarding. Temporary station access structures would be established followed by the demolition of platform buildings and ramped canopy, resulting in a considerable reduction in the amenity of the view on The Boulevarde.

During operation, minor adverse impacts are predicted for the view south-west from the laneway at King Georges Road, due to the addition of new infrastructure, which would be different from the existing station character, with an increased scale and height. The new station entry building would create a strong architectural statement, highlighting the new entrance. The station would be consistent with the height of the adjacent commercial development to the north, maintaining the predominant scale of the built form along King Georges Road. There would be a noticeable improvement in the amenity of this view, and a minor beneficial visual impact.

Table 19.29 Wiley Park Station – daytime visual amenity impacts

Viewpoint	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
View south-west from laneway at King Georges Road	Local	Noticeable reduction	Minor adverse	Noticeable reduction	Minor adverse
View north-west across King Georges Road	Local	Noticeable reduction	Minor adverse	Noticeable improvement	Minor beneficial
View north-west along The Boulevarde	Neighbour-hood	Noticeable reduction	Negligible	Noticeable improvement	Negligible
View north-east from The Boulevarde	Neighbour-hood	Considerable reduction	Minor adverse	Noticeable reduction	Negligible

Night-time visual amenity impacts

As summarised in Table 19.30, there would be the potential for a reduction in amenity due to an increase in lighting during construction for residences located in The Boulevarde, Stanlea Parade, Wiley Lane, Shadforth Street, and Urunga Parade.

During operation, lighting would be visible beyond the existing station area. A general sky glow would be seen from residences to the north and south of the corridor. From King Georges Road, additional lighting would be generally consistent with the intensity of lighting at the existing station, and would be absorbed into the nearby commercial precinct.

Table 19.30 Wiley Park Station – night-time visual amenity impacts

Location	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
Wiley Park Station	E3: Medium district brightness	Noticeable reduction	Minor adverse	Noticeable reduction	Minor adverse

19.3.12 Punchbowl Station

Landscape character impacts

There is the potential for moderately adverse impacts during construction due to the changes to the station buildings and removal of adjacent vegetation, altering the character of the precinct and sense of place. The location of construction works, including compounds and work sites, would impact the visual landscape in the vicinity of the station, with a moderate adverse landscape impact, as shown in Table 19.31.

While the existing station would be upgraded, changing the sense of place, character, and legibility, the upgraded station has the potential to result in an overall improvement to the visual appearance of the surroundings. At night, the additional lighting provided at the station entries and plaza areas would improve the safety and security of the station precinct. In particular, in areas between the station and the adjacent interchange on The Boulevarde, where the station entry would be located on the street, rather than behind commercial properties, safety and legibility would improve.

Although the removal of existing station platforms, platform buildings, and associated entrances would alter the character and legibility of the location, the new station entrances and overall design would result in a considerable improvement in landscape quality and functionality, and would have a moderate beneficial landscape impact.

Table 19.31 Punchbowl Station – landscape character impacts

Location	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
Punchbowl Station precinct	Local	Considerable reduction	Moderate adverse	Considerable improvement	Moderate beneficial

The following viewpoints were selected as representative of views to Punchbowl Station:

40. view south from Warren Reserve
41. view east along Urunga Parade
42. view west along The Boulevarde at Matthew Street
43. view north from The Boulevarde.

Daytime visual amenity impacts

Potential daytime visual impacts on representative viewpoints are summarised in Table 19.32. During construction, views would be impacted due to the visibility of the construction activities, and the removal of vegetation, opening up views to the commercial areas.

During operation, minor adverse impacts are predicted for the view west along Urunga Parade, as the addition of new station infrastructure (such as the services building and retaining wall) would result in a more developed, open character to this view. Beneficial impacts are predicted for views from Warren Reserve and The Boulevarde (at Matthew Street).

Table 19.32 Punchbowl Station – daytime visual amenity impacts

Viewpoint	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
View south from Warren Reserve	Local	Noticeable reduction	Minor adverse	Noticeable improvement	Minor beneficial
View west along Urunga Parade	Neighbour-hood	Considerable reduction	Minor adverse	Considerable reduction	Minor adverse
View west along The Boulevarde at Matthew Street	Local	Noticeable reduction	Minor adverse	Considerable improvement	Moderate beneficial
View north from The Boulevarde	Local	Noticeable reduction	Minor adverse	No perceived change	Negligible

Night-time visual amenity impacts

As summarised in Table 19.33, there is the potential for a noticeable reduction in amenity during construction due to an increase in lighting in the vicinity of the station.

During operation, lighting at the main station building would be generally consistent with the intensity of lighting at the existing station. However, the project would introduce additional lighting towards residential areas on Urunga Parade.

Table 19.33 Punchbowl Station – night-time visual amenity impacts

Location	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
Punchbowl Station precinct	E3: Medium district brightness	Noticeable reduction	Minor adverse	Noticeable reduction	Minor adverse

19.3.13 Bankstown Station

Landscape character impacts

To the east of the station, construction compounds and a work site would be established between North and South terraces, and would extend east across the North/South terrace underbridge. The establishment of these sites would require removal of trees and vegetation along the corridor. There would also temporary closure of grassed areas at the station, and commuter car parks and footpaths along both North and South terraces. During this time, there would be impacts to pedestrian and vehicular movement, as well as visual impacts, reducing accessibility and legibility. This would lead to a noticeable reduction in landscape quality and functionality, and minor adverse landscape impacts as summarised in Table 19.34.

During operation, the new station design, streetscape upgrades, and improved lighting at night would result in a noticeable improvement in overall landscape quality and functionality, and a minor beneficial impact during operation, as shown in Table 19.34. The retention of heritage buildings in the vicinity of the station would maintain the existing character of the station area.

Table 19.34 Bankstown Station – landscape character impacts

Location	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
Bankstown Station precinct	Regional	Noticeable reduction	Minor adverse	Noticeable improvement	Minor beneficial

The following viewpoints were selected as representative of views to Bankstown Station:

44. view east along North Terrace
45. view south-west from North Terrace
46. view north-east from South Terrace.

Daytime visual amenity impacts

Potential daytime visual impacts on representative viewpoints are summarised in Table 19.35. During construction, views would be affected by the removal of vegetation and the presence of construction activities. Construction works would be seen above the hoardings.

Minor beneficial impacts are predicted during operation. The new station building would be a contemporary architectural structure, which would be visually appropriate within the existing commercial setting. The removal of vegetation would open up views to this structure and the large Fig tree would be retained within a new pedestrian plaza.

Table 19.35 Bankstown Station – daytime visual amenity impacts

Viewpoint	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
View east along North Terrace	Local	Considerable reduction	Moderate adverse	Noticeable improvement	Minor beneficial
View south-west from North Terrace	Local	Noticeable reduction	Minor adverse	Noticeable improvement	Minor beneficial
View north-east from South Terrace	Local	Noticeable reduction	Minor adverse	Noticeable improvement	Minor beneficial

Night-time visual amenity impacts

Negligible impacts are predicted, as the existing area around the station is well lit. During operation, additional lighting would be generally consistent with the surrounding high district brightness environment with negligible visual impact (refer to Table 19.36).

Table 19.36 Bankstown Station – night-time visual amenity impacts

Location	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
Bankstown Station precinct	E4: High district brightness	Noticeable reduction	Negligible	No perceived change	Negligible

19.3.14 Ancillary facilities along the rail corridor

Landscape character impacts

Table 19.37 summarises the landscape character impacts for nominated sections of the rail corridor. Construction would result in minor adverse impacts due to the presence of construction works, compounds and work sites, and the removal of vegetation. The exception to this would be between Marrickville and Dulwich Hill stations, where a moderate adverse impact is expected. This is a result of the works within McNeilly Park for the new detention basin, and other works in visually prominent areas at this location.

During construction, there would be an overall change in character due to the removal of vegetation and the presence of construction works along the corridor, which would contrast with adjacent receivers.

During operation, there would be additional rail infrastructure along the rail corridor altering the character of the corridor and reducing the visual amenity for adjacent residential areas.

Table 19.37 Rail corridor – landscape character impacts

Viewpoint (along rail corridor unless indicated)	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
Marrickville Station to Dulwich Hill Station	Local	Considerable reduction	Moderate adverse	Noticeable reduction	Minor adverse
Dulwich Hill Station to Hurlstone Park Station	Local	Noticeable reduction	Minor adverse	Noticeable reduction	Minor adverse
Hurlstone Park Station to Canterbury Station	Local	Noticeable reduction	Minor adverse	Noticeable reduction	Minor adverse
Canterbury Station to Campsie Station	Local	Noticeable reduction	Minor adverse	Noticeable reduction	Minor adverse
Power supply feeder south of Canterbury	Local	Noticeable reduction	Minor adverse	No perceived reduction	Negligible
Campsie Station to Belmore Station	Local	Noticeable reduction	Minor adverse	Noticeable reduction	Minor adverse
Belmore Station to Lakemba Station	Local	Noticeable reduction	Minor adverse	Noticeable reduction	Minor adverse
Lakemba Station to Wiley Park Station	Local	Noticeable reduction	Minor adverse	Noticeable reduction	Minor adverse
Wiley Park Station to Punchbowl Station	Local	Noticeable reduction	Minor adverse	Noticeable reduction	Minor adverse
Punchbowl Station to Bankstown Station	Local	Noticeable reduction	Minor adverse	Noticeable reduction	Minor adverse
Areas west of Bankstown Station	Local	Noticeable reduction	Minor adverse	Noticeable reduction	Minor adverse

Daytime visual amenity impacts

Potential daytime visual impacts on representative viewpoints are summarised in Table 19.38. Construction has the potential to result in a minor adverse impact to all viewpoints, due to the visibility of construction works, compounds, work sites and the removal of vegetation.

Operation has the potential to impact some viewpoints, as the project would result in the introduction of new structures. In general, changes would be minimal, as existing views already feature rail infrastructure.

The introduction of the five proposed traction substations, at Dulwich Hill, Canterbury, Campsie, Lakemba, and Punchbowl, would have a minor impact on visual amenity. Potential visual impacts relate to the presence of a new structure in the landscape. However, substations are common features/land uses in urban areas. The appearance of the substations would be consistent with the surrounding rail corridor/infrastructure uses, which include existing buildings and other rail infrastructure (including overhead power lines). In some locations, such as Punchbowl, the new substations would screen the surrounding area from the railway operations. The detailed design of the substations would ensure that the facilities incorporate appropriate architectural treatments and landscaping, guided by the design guidelines, to minimise the potential for visual impacts.

Table 19.38 Corridor and ancillary development – daytime visual amenity impacts

Viewpoint	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
View north-west in McNeilly Park, Marrickville	Local	Considerable reduction	Moderate adverse	Noticeable reduction	Minor adverse
View west from the Livingstone Road rail bridge, Marrickville	Neighbourhood	Considerable reduction	Minor adverse	Noticeable reduction	Negligible
View east from Challis Avenue, Dulwich Hill	Neighbourhood	Considerable reduction	Minor adverse	No perceived change	Negligible
View east from Wardell Road overbridge, Dulwich Hill	Local	Noticeable reduction	Minor adverse	Noticeable reduction	Minor adverse
View north from Foord Avenue, Hurlstone Park	Neighbourhood	Considerable reduction	Minor adverse	Noticeable reduction	Negligible
View north-east from Sawyer Reserve, Hurlstone Park	Neighbourhood	Noticeable reduction	Negligible	Noticeable reduction	Negligible
View west along Hutton Street, Hurlstone Park	Neighbourhood	Considerable reduction	Minor adverse	Considerable reduction	Minor adverse
View south from Church Street Park, Hurlstone Park	Neighbourhood	Noticeable reduction	Negligible	Noticeable reduction	Negligible
View north-east from Close Street, Canterbury	Local	Considerable reduction	Moderate adverse	Noticeable reduction	Minor adverse
View east from the Terry Lamb Reserve, Belmore	Local	Noticeable reduction	Minor adverse	No perceived change	Negligible
View north-east from The Boulevarde, Lakemba	Neighbourhood	Considerable reduction	Minor adverse	Considerable reduction	Minor adverse
View east from Scott Street, Punchbowl	Neighbourhood	Considerable reduction	Minor adverse	Noticeable reduction	Negligible
View north from the Bankstown Arts Centre courtyard	Local	Noticeable reduction	Minor adverse	No perceived change	Negligible

Night-time visual amenity impacts

As summarised in Table 19.39, construction has the potential to result in minor adverse impacts as some lighting would be required. Light spill would potentially impact on receivers along the edge of the rail corridor.

During operation, impacts would be limited to lighting from the movement of metro trains, which would be similar to the existing situation.

Table 19.39 Rail corridor – night-time visual amenity impacts

Viewpoint	Sensitivity rating	Construction impact		Operation impact	
		Modification rating	Impact rating	Modification rating	Impact rating
Rail corridor (excluding Bankstown)	E3: Medium district brightness	Noticeable reduction	Minor adverse	Noticeable reduction	Minor adverse
Rail corridor through Bankstown	E4: High district brightness	Noticeable reduction	Negligible	Noticeable reduction	Negligible

19.3.15 Cumulative impacts

The urban corridor between Sydenham and Bankstown has been identified as an urban renewal corridor with development proposed to occur at key locations along the corridor. Many of the adverse impacts outlined in this chapter would potentially decrease with development of the surrounding area, which would involve increasing densities and introduction of new buildings and structures in urban renewal areas. The increase in densities and the modernisation of development would mean that the upgraded stations would better integrate with the surrounding development compared to the existing situation.

19.4 Mitigation measures

19.4.1 Approach to mitigation and management

Construction

In addition to consideration of visual impacts through design development, construction planning would continue to be undertaken in a way that visual impacts are minimised. The Construction Environmental Management Framework (provided in Appendix D) provides for development and implementation of a visual amenity management plan, to include (as a minimum):

- visual mitigation measures, including those provided in the framework
- input from an experienced landscape or urban designer
- maintenance of outward facing elements of site hoarding or noise barriers
- measures to minimise lighting impacts on sensitive receivers
- applying relevant CPTED principles
- monitoring
- compliance record generation and management.

Where removal of trees is unavoidable, trees would be replaced in accordance with a tree management strategy, which would be prepared in consultation with relevant stakeholders (including local councils). The strategy would to guide the management of trees that need to be removed, including options for their replacement. Further information on the proposed tree management strategy is provided in Section 9.3.2.

Operation

Design development has included a focus on avoiding and/or minimising the potential for visual impacts during all key phases of the process. Implementation of the Sydney Metro Sydenham to Bankstown Design Guidelines (Appendix C) would continue to ensure that the project meets the design criteria (established by the guidelines) and that the project is designed to minimise the potential for visual impacts. Further information on key design considerations, including urban design and place making, and how these have been integrated in the design process to date, is provided in Chapter 7.

To manage and mitigate the potential for visual impacts during operation, the detailed design would be developed in accordance with the design guidelines, and would take into account relevant requirements, including:

- use of a high quality landscape buffers (with street trees and planting) where practicable along the corridor, in consultation with relevant stakeholders, to integrate with the new infrastructure and improve the visual experience
- strategic use of materials that blend, enhance and/or complement existing surfaces, and improve the visual coherence of the project and its context
- materials, finishes, colour schemes and maintenance procedures, including graffiti control for new walls, barriers, and fences
- strategic location of signage to maintain sensitive sight lines, avoid unnecessary intrusion into receivers' views, and enhance legibility
- design of barriers (railings, fences or walls) required for safety to complement the existing visual environment
- the heritage significance of stations, heritage conservation areas, and other listed heritage items
- safety and security requirements, including CPTED requirements.

19.4.2 List of mitigation measures

The mitigation measures that would be implemented to address potential landscape and visual amenity impacts are listed in Table 19.40.

Table 19.40 Mitigation measures – landscape and visual amenity

ID	Impact/issue	Mitigation measures	Relevant location(s)
Design/pre-construction			
LV1	General visual impacts	The design would continue to be guided by the *Sydney Metro City & Southwest Sydenham to Bankstown Design Guidelines*.	All
LV2		Urban design and landscaping would be incorporated as part of the detailed station designs and precinct plans to provide a consistent approach to the management and mitigation of landscape and visual impacts across the project, and implementation of the proposed mitigation strategies.	All
LV3		Fencing would be designed to be of a high quality urban finish near stations.	All stations

ID	Impact/issue	Mitigation measures	Relevant location(s)
LV4	Impacts to trees and screening vegetation	The management of trees during detailed design and construction planning would be guided by the project's tree management strategy. Where removal cannot be avoided, trees would be replaced in accordance with the tree management strategy. Opportunities to retain and protect existing trees would be defined during detailed design and construction planning, in accordance with the project's tree management strategy. The design would aim to reduce tree removal to the extent practicable, particularly where they contribute to screening vegetation or landscape character.	All
LV5	Light spill	Lighting for the project would be designed in accordance with *AS 4282 Control of the Obtrusive Effects of Outdoor Lighting*. Lighting would be designed to minimise glare and light spill into adjoining areas.	Entire corridor, stations and other ancillary infrastructure
LV6	Impacts of noise barriers	The selection of materials and colours for noise barriers and hoardings would aim to minimise their visual prominence.	Noise barrier locations
LV7		The use of transparent panels in noise barriers would be considered where views to local landscape features and district views would be obstructed.	Noise barrier locations
LV8	Substations	The detailed design of the substations would ensure that they incorporate appropriate architectural treatments and landscaping, guided by the design guidelines, to minimise the potential for visual impacts.	Substations
Construction			
LV9	Visual impacts	A visual amenity management plan would be prepared and implemented during construction, to define the measures to minimise visual impacts during construction. The plan would include requirements in relation to construction site remediation.	All
LV10		Mitigation measures for landscape and visual impacts would be implemented as soon as feasible and reasonable after the commencement of construction, and remain for the duration of the construction period.	All
LV11	Impacts to trees	Trees to be retained would be protected prior to the commencement of construction in accordance with *AS4970-2009 Protection of trees on development sites* and the project's tree management and replacement strategy. Any tree pruning would be undertaken in accordance with the project's tree management strategy, guided by a tree report prepared by a qualified arborist.	All
LV12	Impacts from construction, including compounds and work sites	The design and maintenance of construction compound hoardings would aim to minimise visual amenity and landscape character impacts. Graffiti would be removed promptly, and public art opportunities would be considered.	All
LV13		The selection of materials and colours would aim to minimise their visual prominence.	All
LV14		Lighting of work areas, compounds, and work sites would be oriented to minimise glare and light spill impact on adjacent receivers.	All

ID	Impact/issue	Mitigation measures	Relevant location(s)
LV15		Following completion of construction, site restoration would be undertaken in accordance with the visual amenity management plan. Temporary impacts to public open space would be rehabilitated in consultation with the relevant local council and/or landowner.	All

19.4.3 Consideration of the interactions between mitigation measures

Noise barriers proposed to mitigate noise impacts have the potential to result in visual impacts. Mitigation measures are provided in Table 19.40 to minimise the potential impacts of noise barriers.

Potential visual impacts on heritage items, and relevant mitigation measures, are provided in Chapter 14.

19.4.4 Managing residual impacts

The proposed new structures would be visible from surrounding areas. The potential for residual impacts would be minimised as far as possible during detailed design, with further consideration of screening opportunities.

20. Soils and contamination

This chapter provides an assessment of the potential soil and contamination impacts of the project. The Secretary's environmental assessment requirements addressed in this chapter are listed in Table 20.1.

Table 20.1 Secretary's environmental assessment requirements – soils

Ref	Secretary's environmental assessment requirements - soils	Where addressed
11.1	The Proponent must assess whether the land is likely to be contaminated and identify if remediation of the land is required, having regard to the ecological and human health risks posed by the contamination in the context of past, existing and future land uses. Where assessment and/or remediation is required, the Proponent must document how the assessment and/or remediation would be undertaken in accordance with current guidelines.	The potential for contamination is considered in Section 20.2.4. The need for remediation would be confirmed as an outcome of the more detailed contamination assessment to be undertaken for the detailed design, as described in Sections 20.3.2 and 20.4.1.

20.1 Assessment approach

20.1.1 Legislation and policy context for the assessment

Legislation and policies relevant to the assessment and management of contaminated land include:

- *Managing Land Contamination: Planning Guidelines SEPP 55 – Remediation of Land* (Department of Urban Affairs and Planning and the Environment Protection Authority, 1998)
- *Acid Sulfate Soil Manual* (ASSMAC, 1998)
- *AS4482:2005 Guide to the investigation and sampling of sites with potentially contaminated soil*
- *Guidelines for Consultants Reporting on Contaminated Sites* (Office of Environment and Heritage, 2011)
- *National Environment Protection (Assessment of Site Contamination) Amendment Measure (No.1)* (National Environment Protection Council (NEPC), 2013)
- *Waste Classification Guidelines* (EPA, 2014a)
- *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997* (EPA, 2015a).

20.1.2 Methodology

The assessment generally involved:

- a review of available contamination assessments relevant to the study area, including a preliminary contamination ('environmental site') assessment undertaken as an input to the design
- a review of available geotechnical information relevant to the study area, including information on soil characteristics

- a review of publicly available data and web-based information searches, including:
  - the Contaminated Sites Register and Record of Notices under Section 58 of the *Contaminated Land Management Act 1997*, maintained by the NSW Environment Protection Authority
  - environment protection licences, applications, notices, audits or pollution studies and reduction programs
  - Australian Soil Resource Information System (maintained by the Commonwealth Scientific and Industrial Research Organisation (CSIRO))
  - *Sydney 1:100,000 Geological Map 9130* (NSW Department of Mineral Resources, 1983)
  - *Soil Landscapes of the Sydney 1:100,000 Sheet map (9130)* (Chapman, G.A. et al, 2009)
  - NSW Soil and Land Information System (maintained by the Office of Environment and Heritage)
- identification of the potential to disturb acid sulfate soils and areas of salinity
- recommendations for additional investigations, where necessary
- identification of mitigation measures to address potential soil and contamination impacts.

It is noted that the contamination assessment undertaken as an input to the design was a preliminary assessment only. The purpose of the assessment was to identify areas of potential contamination, and provide recommendations for future more detailed investigations if required. It did not involve any soil sampling, or identify the need for any remediation. This would be undertaken as part of a more detailed contamination assessment, to be undertaken at the detailed design stage.

20.2 Existing environment

20.2.1 Topography

The project area ranges in elevation from the lowest point, which is about 3.5 metres above Australian height datum near Marrickville Station, to the highest point, which is about 36 metres above Australian height datum near Wiley Park Station. Bankstown Station is located about 23 metres above Australian height datum.

Between Punchbowl and Bankstown stations, the project area is located on or near a localised ridgeline. East of Punchbowl Station, the natural topography varies through a series of ridges and gullies. Between Marrickville and Sydenham stations, the project area is located in low-lying terrain.

20.2.2 Geology

The project area traverses six regional geological units, summarised in Table 20.2.

Table 20.2 Geology along the project alignment

Geological unit	Description
Fill	Located in former industrial sites and embankments along the T3 Bankstown Line (e.g. at Marrickville, Dulwich Hill, Wiley Park, and Lakemba stations), below track level within the existing rail corridor, and a thin layer at the top of most cuttings.
Quaternary sediments	Alluvium and estuarine deposits – ranging from sands to sandy clays, to clays, located in vicinity of Marrickville station, and the Cooks River.

Geological unit	Description
Wianamatta Group	Comprising: • Bringelly Shale - siltstone and claystone interbedded with fine sandstone • Minchinbury Sandstone - fine to medium sandstone, bedrock outcropping identified in vicinity of Wiley Park Station • Ashfield Shale – with bedrock outcropping identified between Canterbury and Punchbowl stations.
Mittagong Formation	Interbedded fine to medium sandstone and shale, often disturbed. Bedrock outcropping identified between Dulwich Hill and Canterbury stations.
Hawkesbury Sandstone	Medium to coarse quartzic sandstone, either massive, cross bedded or with occasional shale interbeds. Bedrock outcropping identified between Marrickville and Canterbury stations.
Dykes	Volcanic intrusions - dykes are located at Marrickville, Canterbury and Belmore. Faults and joint swarms (which act as preferential drainage paths) are located near Canterbury, Marrickville, and Bankstown stations.

20.2.3 Soils

The following soil types underlie the project area:

- Blacktown, mapped across most of the project area
- Gymea, mapped as a larger patch between Canterbury and Dulwich Hill stations, and a smaller area between Dulwich Hill and Marrickville stations
- Glenorie, mapped north of Bankstown Station
- Birrong, mapped west of Cooks River, and local occurrences in Belmore and Wiley Park
- disturbed terrain, mapped west of Punchbowl Station.

There is a substantial amount of fill material along and within 100 metres of the project area, including railway ballast, gravel, building debris, and excavated soil material. The majority of the project area consists of fill associated with railway embankments, or exposed bedrock associated with cuttings and overlain with rail ballast or fill.

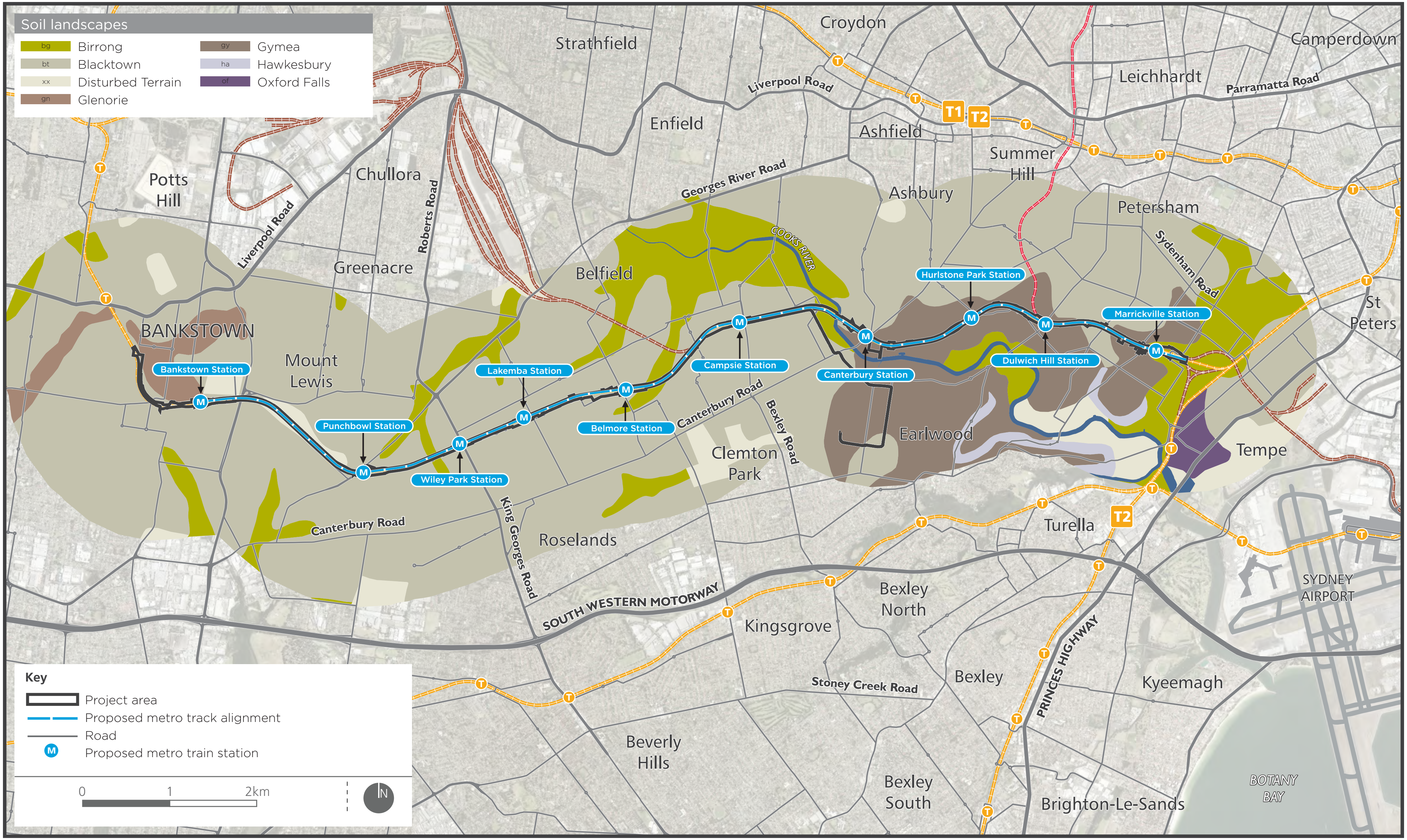
Soil types are shown on Figure 20.1.

Soil salinity

Areas prone to salinity are usually located at low points in the landscape, such as floodplains, valley floors, or at the foot of a ridge. As shown in Figure 20.2, potential saline soils are located west of Punchbowl Station, including:

- high salinity potential soils on either side of Stacey Street and north of Gordon Street
- moderate salinity potential soils between Punchbowl and Bankstown stations.

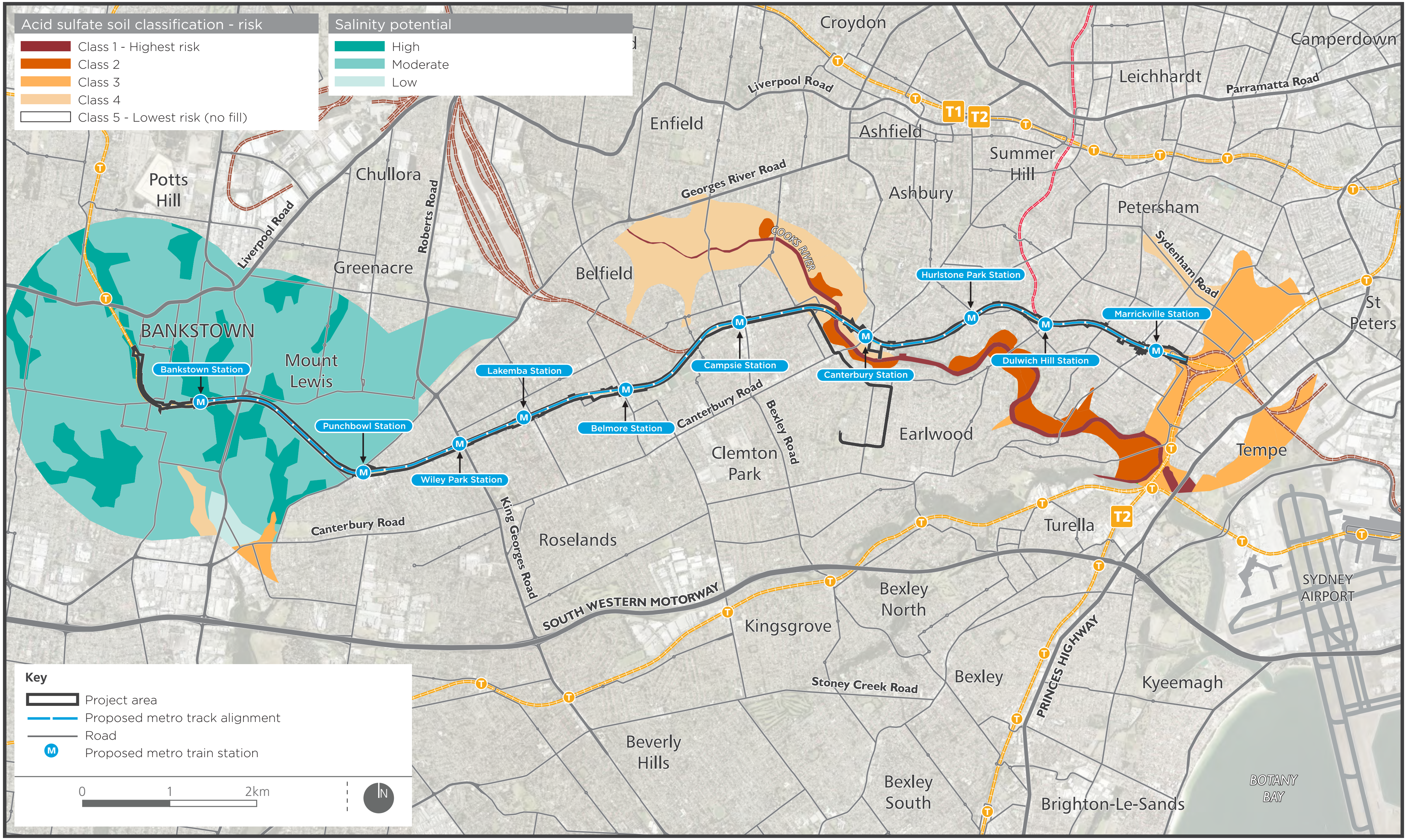
The remainder of the project area is not mapped as having salinity potential. However, there may be areas of salinity potential in these areas.



sydney METRO | city & southwest

Soils types along the project alignment

FIGURE 20.1



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Salinity potential and acid sulfate soils risk

FIGURE 20.2

Acid sulfate soils

Acid sulfate soils are naturally occurring soils containing iron sulfides, which, on exposure to air, oxidise and create sulfuric acid. This increase in acidity can result in the mobilisation of aluminium, iron, and manganese from the soils. As shown in Figure 20.2, potential acid sulfate soils are located near the Cooks River at Canterbury, which is mapped as having a high likelihood of acid sulfate soils. Areas mapped with a low likelihood of acid sulfate soils are located between Canterbury and Campsie stations. Acid sulfate soils may also be encountered in areas mapped as ‘disturbed terrain’, including around Canterbury Station, and between Canterbury and Campsie stations.

20.2.4 Potential for contamination

Contaminated sites

No site listed on the EPA’s contaminated land register are located within 100 metres of the project area. However, three sites which have been notified to the EPA are located within 100 metres of the project area, as listed in Table 20.3.

Table 20.3 Registered contamination sites

Suburb	Site name and address	Site activity	Contamination status	Location in relation to the project area
Marrickville	Way Street	XPT Maintenance Facility, other industry	Regulation under CLM Act not required	East of the project area between Sydenham and Marrickville stations
Marrickville	2 Carrington Road	Unclassified	Regulation under CLM Act not required	Within the project area between Sydenham and Marrickville stations
Belmore	348 Burwood Road	Rail land, unclassified	Regulation under CLM Act not required	Within the project area between Belmore and Lakemba stations

Note: 1: CLM Act - *Contaminated Land Management Act 1997*

Potentially contaminated areas

The preliminary environmental site assessment identified the potential risk of contamination along the project area. The assessment concluded that there is a risk of contamination along the length of the project area, albeit a low to medium risk for the majority of the project area, with potential contamination sources being historical rail activities, and commercial and residential land use in surrounding areas. Potential contaminants identified in low to medium risk areas included:

- asbestos
- hydrocarbons
- heavy metals
- herbicides.

Sections of the project area are suspected have a medium to high risk of contamination are listed in Table 20.4.

Table 20.4 Areas with a medium to high contamination risk in the project area

Location	Potential contamination sources	Potential contaminants present
Between Sydenham and Marrickville stations	• previous site investigations identified asbestos in soil and petroleum aromatic hydrocarbons in groundwater north of the project area, at 361 Victoria Road	Within the vicinity of 361 Victoria Road: • asbestos in soil • petroleum aromatic hydrocarbons in groundwater
Between Campsie and Belmore stations (triangular area within the rail corridor)	• historical rail activities • historical commercial and residential land use	• arsenic in ballast • asbestos • hydrocarbons (including chlorinated hydrocarbons in fill) • heavy metals (including in groundwater) • herbicides
Between Punchbowl and Bankstown stations (car park at North Terrace)	• historical rail activities • historical commercial and residential land use	• asbestos • hydrocarbons (in soil and groundwater) • heavy metals • herbicides

20.3 Impact assessment

20.3.1 Risk assessment

Potential risks

The environmental risk assessment for the project, undertaken for the State Significant Infrastructure Application Report, identified the following as the main soil and contamination risks:

- exposure of acid sulfate soils during construction
- disturbance of contaminated land during construction
- encountering contaminated building structures during demolition works
- contamination of land, groundwater or waterways due to leaks and spills.

Other potential risks include ground disturbance as a result of vegetation removal and the creation of embankments, increasing the potential for erosion and sedimentation.

How potential impacts would be avoided

In general, potential soils and contamination impacts would be avoided by:

- managing risks associated with contamination in accordance with relevant legislative and policy requirements, as described in Section 20.4
- designing, constructing, and operating the project in a way to minimise impacts associated with soils and contamination
- implementing standard soil and contamination mitigation measures described in Section 20.4.

20.3.2 Construction

Excavation and ground disturbance activities would expose and disturb soils, which, if not adequately managed, could result in:

- erosion of exposed soil and stockpiled materials
- dust generation
- an increase in sediment loads entering the stormwater system and/or local runoff, and therefore nearby receiving waterways
- increase in salinity levels in soil
- acid sulfate soil conditions
- mobilisation of contaminated sediments, with resultant potential for environmental and human health impacts.

Potential impacts as they relate to soils and contamination are considered below. Potential water quality impacts, including impacts caused by increased sediment loads, are considered in Chapter 21 (Hydrology, flooding and water quality), air quality (dust) impacts are considered in Chapter 23 (Air quality), and health and safety risks, including as a result of contamination and hazardous materials, are considered in Chapter 25 (Hazards, risks and safety).

Soils

Soil erosion

Construction of the project would temporarily expose the natural ground surface and sub-surface through the removal of vegetation, overlying structures (such as buildings and footpaths), and excavation. The exposure of soil to runoff and wind can increase soil erosion potential, particularly where construction activities are undertaken in soil landscapes characterised by a high and extreme erosion hazard. These include the:

- Birrong landscape, which underlies the project area west of Cooks River, and local occurrences in Belmore and Wiley Park
- Glenorie landscape, which underlies the area north of Bankstown Station.

Soil erosion impacts are expected to be minimal for the majority of project as a result of the relatively limited areas of excavation and earthworks, the overall topography of the project area, and the temporary nature of exposure.

Regardless of the amount of excavation required, the potential for erosion impacts would be minimised by implementing standard soil erosion management measures during construction, as described in Section 20.4.

Acid sulfate soils

The exposure of acid sulfate soils can impact water quality and structures. Soils excavated from potential acid sulphate areas would be subject to the provisions of an acid sulphate soil management plan. Once acid sulphate soils have been treated, depending on the results of testing, they could either be reused on site, or disposed of at an appropriate facility.

Salinity

Excavation would be undertaken in areas with high to moderate potential for salinity surrounding Bankstown and Punchbowl stations. In addition, construction may also disturb soils in areas with unidentified salinity potential in the rest of the project area.

Impacts may occur as a result of the erosion and off-site transport of saline sediments, resulting in impacts on the receiving environment.

The potential for impacts would be minimised by implementing the mitigation measures provided in Section 20.4.

Contamination

Excavation may disturb any contamination and hazardous materials present in soil. If inadequately managed, the disturbance of areas of contamination has the potential for:

- direct contact and/or inhalation by site workers, users, and visitors
- impacts to surrounding environmental receivers (including surrounding ecosystems and flora and fauna, where present)
- mobilisation and migration of surface and subsurface contaminants via leaching, runoff and/or subsurface flow, impacting nearby soils, surface water, and groundwater.

Prior to the disturbance of areas identified to have the potential for contamination (described in Section 20.2.4), further investigation and testing would be undertaken in accordance with the recommendations of the preliminary contamination assessment and any subsequent assessments, to determine the likely risk and appropriate management protocols. This may include the requirement for remediation in certain areas. Relevant mitigation measures are provided in Section 20.4. The need for any remediation would be determined as an outcome of a future, more detailed site assessments.

If inadequately managed, construction activities have the potential to result in the contamination of soil due to spills and leaks of fuel, oils, and other hazardous materials. These potential impacts would be minimal with the implementation of standard mitigation measures, provided in Section 20.4.

Hazardous materials

The demolition of buildings and structures may result in disturbance of hazardous materials. Mishandling of hazardous material waste has the potential to contaminate soils. Mitigation measures are provided in Section 20.4.2 and Chapter 25 (Hazards, risks and safety) to minimise the potential impacts of hazardous materials.

20.3.3 Operation

Contamination

Operation has the potential to result in contamination of soils due to any spills and leaks of fuel, oils, and other hazardous materials from the routine operation of trains, maintenance vehicles, and other project infrastructure, including operation and maintenance activities at substations.

The potential for contamination as a result of general maintenance activities is considered to be low, based on the amount of vehicles and equipment which would likely be used during maintenance. This impact would be minimised by implementing procedures to manage spills during operation of the rail network similar to those used on existing Sydney Trains/Transport for NSW operations.

Bunding designed in accordance with the applicable standards and guidelines would be incorporated into the design of relevant facilities, including substations, to contain any chemical spills or leaks.

20.4 Mitigation measures

20.4.1 Approach to mitigation and management

Site-specific investigations and analysis would be undertaken during detailed design as an input to the design of the project and identification of appropriate treatment measures (as required) prior to construction.

Soils

Construction erosion and sediment control measures would be developed and implemented in accordance with *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom, 2004) and *Managing Urban Stormwater: Soils and Construction Volume 2A* (Department of Environment and Climate Change, 2008). Measures would be designed as a minimum for the 80th percentile; five-day rainfall event.

As described in Section 9.1.2, environmental management during construction would be guided by the Construction Environmental Management Framework (provided in Appendix D). The framework requires preparation of a soil and water management plan as one of the components of the Construction Environmental Management Plan. The soil and water management plan is required to define the management and monitoring measures that would be implemented to manage, in accordance with relevant guidelines:

- surface and groundwater impacts
- contaminated material
- erosion and sediment control.

Further information on the approach to environmental management during construction is provided in Section 28.4.

Contamination and the need for remediation

Further contamination assessments would be undertaken based on the results of the preliminary assessment, to confirm the risk of contamination and management requirements. This would include intrusive soil investigations in areas known or suspected to be contaminated, to confirm the extent of contamination, and identify appropriate management and remediation requirements. Hazardous material surveys would also be undertaken for structures to be removed.

Requirements for remediation would be driven by the site specific exposure scenarios and environmental risk. Where contamination cannot be managed appropriately in accordance with standard construction processes, a remediation action plan (RAP) would be developed, and an Environment Protection Authority Accredited Site Auditor would be engaged to audit the works. Triggers for a RAP and the involvement of an auditor include the management of hazardous waste or contaminated groundwater remediation for the purposes of managing human health or environmental risk. The excavation and disposal of waste to a licenced facility for construction and operational purposes does not trigger the need for a RAP, and this be managed as described in Chapter 26 (Waste Management). Where practicable, any remediation required would be integrated with construction activities to achieve efficiencies in the use of plant, equipment, and materials.

20.4.2 List of mitigation measures

The mitigation measures that would be implemented to address potential soil and contamination impacts are listed in Table 20.5.

Table 20.5 Mitigation measures – soils and contamination

ID	Impact/issue	Mitigation measures	Relevant locations(s)
Design/pre-construction			
SC1	General soil and erosion management	Erosion and sediment control measures would be implemented in accordance with *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom, 2004) and *Managing Urban Stormwater: Soils and Construction Volume 2A* (DECC, 2008). Measures would be designed as a minimum for the 80th percentile, five day rainfall event.	All
SC2	Acid sulfate soils	Prior to ground disturbance in high probability acid sulfate areas, testing would be carried out to determine the presence of acid sulfate soils. If acid sulfate soils are encountered, they would be managed in accordance with the *Acid Sulfate Soil Manual* (Acid Sulfate Soil Management Advisory Committee, 1998), and the *Waste Classification Guidelines* - Part 4: Acid Sulfate Soils (EPA, 2014).	Canterbury station, and sections between Sydenham and Marrickville stations, and Canterbury and Campsie stations
SC3	Saline soils	Prior to ground disturbance in areas of potential soil salinity, testing would be carried out to confirm the presence of saline soils. If saline soils are encountered, they would be managed in accordance with *Site Investigations for Urban Salinity* (DLWC, 2002).	Area surrounding Bankstown and Punchbowl stations
SC4	Contamination	WorkCover dangerous goods searches would be carried out for properties that have potential contamination near Belmore Station, to provide additional site characterisation and identify the risk of contamination in these areas.	Belmore Station
SC5		A detailed contamination assessment would be undertaken in areas with a medium to high risk of contamination, to confirm the nature and extent of contamination, specific requirements for further investigation and any remediation, and/or management requirements of any contamination.	Between Sydenham and Marrickville stations, Campsie and Belmore stations; and Punchbowl and Bankstown stations
SC6		Hazardous materials surveys would be undertaken during detailed design for all proposed demolition activities, and for utility adjustments as required.	All
SC7		In the event a remediation action plan is required, it would be developed in accordance with *Managing Land Contamination: Planning Guidelines SEPP 55 – Remediation of Land* (Department of Urban Affairs and Planning and Environment Protection Authority, 1998), and a NSW Environment Protection Authority Accredited site auditor would be engaged to audit the works.	Between Sydenham and Marrickville stations, Campsie and Belmore stations; and Punchbowl and Bankstown stations

ID	Impact/issue	Mitigation measures	Relevant locations(s)
Construction			
SC8	Unexpected contamination	In the event that indicators of contamination are encountered during construction (such as odours or visually contaminated materials), work in the area would cease, and the finds would be managed in accordance with the unexpected contamination finds procedure.	All
Operation			
SC9	Soil erosion and sedimentation	During any maintenance work where soils are exposed, sediment and erosion control devices would be installed in accordance with *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom, 2004).	All

20.4.3 Consideration of the interactions between mitigation measures

There are interactions between the mitigation measures for soils and contamination (summarised in Section 20.4) and those for water quality (Chapter 21), waste (Chapter 26), and hazardous materials (Chapter 25). Together, all these measures would ensure appropriate management of soil, including contaminated soils and materials, to minimise the potential for impacts to the community and environment.

The implementation of erosion control measures and devices during construction has the potential to result in some potential impacts on overland flow paths. Impacts on overland flow paths are considered to be manageable, as all measures would be installed in accordance with *Managing Urban Stormwater: Soils and Construction Volume 1* and *Managing Urban Stormwater: Soils and Construction Volume 2A*.

20.4.4 Managing residual impacts

The mitigation measures provided in Section 20.4.2 are expected to reduce the potential for soil and contamination impacts during construction and operation. With the implementation of these measures, residual impacts are expected to be minimal.

21. Hydrology, flooding and water quality

This chapter provides a summary of the results of the hydrology, flooding and water quality assessment. A full copy of the assessment report is provided as Technical paper 8 – Hydrology, flooding and water quality assessment. This chapter also includes consideration of the potential impacts on groundwater. The Secretary's environmental assessment requirements relevant to hydrology, flooding and water quality (including groundwater), together with a reference to where the results of the assessment are summarised in this chapter, is provided in Table 21.1.

Table 21.1 Secretary's environmental assessment requirements – hydrology, flooding and water quality

Ref	Secretary's environmental assessment requirements – hydrology, flooding and water quality	Where addressed
6. Flooding and hydrology		
6.1	The Proponent must assess and model (where appropriate), taking into account any relevant Council-adopted flood model or latest flood data available from Councils, the impacts on flood behaviour during construction and operation for flood events ranging from the 1% AEP up to the probable maximum flood (taking into account sea level rise and storm intensity due to climate change) including:	A summary of the results of the hydrology, flooding and water quality assessment is provided in this chapter. The full results are provided as Technical paper 8.
	(a) detrimental increases in the potential flood affectation of other properties, assets and infrastructure; (b) consistency (or inconsistency) with applicable Council floodplain risk management plans; (c) compatibility with the flood hazard of the land; (d) compatibility with the hydraulic functions of flow conveyance in flood ways and storage areas of the land (e) downstream velocity and scour potential; (f) impacts the development may have upon existing community emergency management arrangements for flooding. These matters must be discussed with the State Emergency Services and Council; (g) impacts the development may have on the social and economic costs to the community as consequence of flooding.	Requirements (a) – (g) are addressed in Sections 21.3.2 and 21.3.4.
6.2	The Proponent must describe (and map) the existing hydrological regime for any surface and groundwater resource (including reliance by users and for ecological purposes) likely to be impacted by the project, including stream orders, as per the Framework for Biodiversity Assessment (FBA).	Section 21.2
6.3	The Proponent must assess (and model if appropriate) the impact of the construction and operation of the project and any ancillary facilities (both built elements and discharges) on surface and groundwater hydrology in accordance with the current guidelines, including:	
	(a) minimising the effects of proposed stormwater and wastewater management during construction and operation on natural hydrological attributes (such as volumes, flow rates, management methods and re-use options) and on the conveyance capacity of existing stormwater systems where discharges are proposed through such systems; and	Sections 21.3.2 and 21.3.4
	(b) water take (direct or passive) from all surface and groundwater sources with estimates of annual volumes during construction and operation.	Section 21.3.2

Ref	Secretary's environmental assessment requirements – hydrology, flooding and water quality	Where addressed
6.4	The Proponent must identify any requirements for baseline monitoring of hydrological attributes.	Section 21.4.1
15. Water quality		
15.1	The Proponent must:	
	(a) state the ambient NSW Water Quality Objectives (NSW WQO) and environmental values for the receiving waters relevant to the project, including the indicators and associated trigger values or criteria for the identified environmental values;	Section 21.2.5
	(b) identify pollutants that may be introduced into the water cycle and describe the nature and degree of impact that any discharge(s) may have on the receiving environment, including consideration of all pollutants that pose a risk of non-trivial harm to human health and the environment;	Sections 21.3.3 and 21.3.5
	(c) identify the rainfall event that the water quality protection measures will be designed to cope with; (d) assess the significance of identified impacts including consideration of the relevant ambient water quality outcomes; (e) demonstrate how construction and operation of the project will, to the extent that the project can influence, ensure that: - where the NSW WQOs for receiving waters are currently being met they will continue to be protected; and - where the NSW WQOs are not currently being met, activities will work toward their achievement over time; (f) justify, if required, why the WQOs cannot be maintained or achieved over time;	Requirements (c) to (f) - limited water quality modelling was undertaken as described in Section 21.1.2. Further information is provided in Technical paper 8.
	(g) demonstrate that all practical measures to avoid or minimise water pollution and protect human health and the environment from harm are investigated and implemented;	Section 21.4
	(h) identify sensitive receiving environments (which may include estuarine and marine waters downstream) and develop a strategy to avoid or minimise impacts on these environments; and	Sections 21.2 and 21.4
	(i) identify indicative monitoring locations, monitoring frequency and indicators of surface and groundwater quality.	Section 21.4.1

21.1 Assessment approach

21.1.1 Legislative and policy context to the assessment

Relevant legislation, policies, and guidelines are summarised below.

Hydrology and water quality

The main legislation relevant to water management in NSW are the *Water Management Act 2000* (the Water Management Act), the *Water Act 1912* (the Water Act), and the POEO Act.

Water Management Act* and *Water Act

The Water Management Act and the Water Act control the extraction of water, the use of water, the construction of works such as dams and weirs, and the carrying out of activities in or near water sources in NSW. The Water Management Act recognises the need to allocate and provide water for the environmental health of NSW's rivers and groundwater systems. The provisions of the Water Management Act are being progressively implemented to replace the Water Act. Since July 2004, the licensing and approvals system under the Water Management Act has been in effect in areas of NSW covered by water sharing plans.

The area in which the project is located is subject to the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*. This is a statutory instrument made under section 50 of the Water Management Act, which includes rules for protecting the environment, water extractions, managing licence holders' water accounts, and water trading.

A controlled activity approval under the Water Management Act is required for certain types of developments and activities carried out in or near waterfront land that have the potential to affect water quality. It is noted that, as per section 115ZG of the EP&A Act, an activity approval (including a controlled activity approval) under section 91 of the Water Management Act is not required for critical State significant infrastructure. However, to minimise the potential for impacts to water quality, design and construction of the project would take into account the NSW Office of Water's guidelines for controlled activities on waterfront land.

Protection of the Environment Operations Act

Section 120 of the POEO Act prohibits the pollution of waters by any person. Under section 122, holding an environment protection licence is a defence against accidental pollution of watercourses. The Act permits (but does not require) an environment protection licence to be obtained for a non-scheduled activity for the purpose of regulating water pollution resulting from that activity.

Policies and strategies

The *National Water Quality Management Strategy* is a nationally agreed set of policies, processes, and 21 guideline documents, developed jointly by the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) and the Australian and New Zealand Environment and Conservation Council (ANZECC). The strategy establishes objectives to achieve sustainable use of the nation's water resources by protecting and enhancing their quality.

The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (known as the ANZECC 2000 guidelines) (ANZECC/ARMCANZ, 2000a) forms part of the strategy. This document sets water quality guidelines (numerical concentration limits or descriptive statements) for a range of ecosystem types, water uses (environmental values), and water quality indicators for Australian waters.

In 2006, water quality and river flow objectives were developed for 31 river catchments in NSW based on the ANZECC 2000 guidelines. These include the Cooks River catchment, in which the majority of the project is located, and the Georges River catchment, which the Salt Pan Creek catchment is contained within. These objectives (known as the *NSW Water Quality and River Flow Objectives*) are the agreed environmental values and long-term goals for NSW's surface water receptors. Guidance on the use of the ANZECC 2000 guidelines and the NSW water quality objectives is provided by *Using the ANZECC Guidelines and Water Quality Objectives in NSW* (DEC, 2006b).

Other relevant policies and strategies for the Cooks River and Georges River catchments are the *Greater Metropolitan Regional Environmental Plan No 2 – Georges River Catchment* (a deemed State environmental planning policy) and the *Cooks River Catchment Management Strategy* (Cooks River Catchment Management Committee, 1999).

Groundwater

The *NSW Aquifer Interference Policy* (NSW Office of Water, 2012) explains the water licensing and impact assessment processes for aquifer interference activities under the Water Management Act and other relevant legislation.

Flooding

The *New South Wales Floodplain Development Manual: the management of flood liable land* (DIPNR, 2005) ('the floodplain development manual') defines the main requirements for floodplain development in NSW. The manual highlights requirements to manage flooding risks and reduce the impact of flooding on owners.

The floodplain development manual incorporates the NSW Government's Flood Prone Land Policy, which provides for the development of sustainable strategies for the occupation and use of the floodplain. Implementation of the policy is primarily the responsibility of local government. By applying the floodplain development manual, local councils can balance the conflicting objectives of the floodplain by developing and implementing floodplain risk management plans.

Consideration of the potential impacts on flooding is a requirement for developments proposed in the floodplain.

Other guidelines that support the implementation of the Flood Prone Land Policy include:

- *Floodplain Risk Management Guide Incorporating Sea Level Rise Benchmarks in Flood Risk Assessments* (DECCW, 2010)
- *Floodplain Risk Management Guideline: Practical Considerations of Climate Change* (DECC, 2007)
- *Planning circular: New guideline and changes to section 117 direction and EP&A Regulation on flood prone land* (Department of Planning, 2007).

21.1.2 Methodology

A summary of the methodology for the hydrology, flooding and watery quality assessment is provided in this section. Further information is provided in Technical paper 8.

Hydrology and water quality

The hydrology and water quality assessment involved:

- reviewing background information relevant to the study area to define the existing environment, including previous studies, mapping, survey data, and topography
- identifying water quality objectives for the catchments in which the project area is located, based on the *NSW Water Quality and River Flow Objectives* website
- a site visit to ground truth the results of the desktop review
- identifying and assessing construction and operational activities that may impact on the surface water hydrology and water quality of watercourses within the study area
- identifying potential impacts on groundwater
- identifying mitigation measures to minimise potential impacts on surface water and groundwater hydrology and water quality.

Flooding

The project involves upgrading rail infrastructure in areas subject to regular existing flooding – particularly in Marrickville. As a result, a flooding assessment was undertaken as an input to the design of the project. The aim of the assessment was to determine the existing flooding and drainage characteristics and any impacts of the project. The flooding assessment involved:

- hydraulic modelling to quantify flood behaviour, using catchment study reports and GIS drainage data obtained from the local councils

- an assessment of flooding impacts and risks associated with the project at key locations, including around Marrickville and the remainder of the railway corridor to Bankstown
- developing measures to minimise potential changes to the flood regime as a result of the project.

A full range of flooding events, from the 63 per cent to the one per cent annual exceedance probability (AEP) event, were modelled in the vicinity of Marrickville Station. The AEP represents the likelihood of occurrence of a flood of given size or larger occurring in any one year. A one per cent AEP event is a rainfall event with a one per cent chance of being exceeded in magnitude in any year. In all cases, the one per cent AEP event included a 10 per cent allowance for climate change.

The probable maximum flood (PMF) event was also modelled for the Marrickville area. The PMF is considered to be the worst case flood event for an area. The PMF represents extreme flooding conditions and defines the extent of flood prone/liable land.

West of Marrickville, more limited flood modelling was undertaken at selected locations and for selected design events. This was on the basis that existing flood conditions are less severe, and that the influence of the project would be unlikely to result in noticeable changes.

Water quality

Water quality modelling undertaken was limited to a test site at Punchbowl Station, and involved using the MUSIC (Model for Urban Stormwater Conceptualisation) computer software model. This site was modelled to assess the potential effect of increases in impervious areas on pollutant generation and retention rates. Punchbowl Station was modelled as it would have one of the largest increases in impervious areas of all the stations to be upgraded.

The results indicated that provision of a gross pollutant trap coupled with either a bioretention swale or rain garden would generally meet the pollutant reduction targets for the project. The assessment also concluded that, because the project area represents a very small proportion of the overall catchment, proposed water quality treatment measures would have a minimal effect on pollutant concentrations at discharge locations.

21.2 Existing environment

21.2.1 Catchments

As shown in Figure 21.1, the project area is located in two water catchments. The majority of the project area, between Marrickville and Punchbowl stations, is located in the Cooks River catchment. Between Punchbowl and Bankstown stations, the project area drains to Salt Pan Creek, which is located in the Georges River catchment.

Both catchments are highly urbanised, meaning that the rainfall-runoff response of the catchments has been altered from a natural state. This has resulted in changes to the quantity and speed of runoff within the catchment.

Cooks River catchment

The Cooks River catchment, located in the inner to middle south-western suburbs of Sydney, has an area of about 102 square kilometres. The majority of the catchment is highly developed. The Cooks River itself is about 23 kilometres long, and flows from Chullora in the west to Botany Bay in the east. The river discharges into the north of Botany Bay, near Sydney Airport. The river is tidally influenced as far as South Enfield. Major tributaries of the river include:

- Coxs Creek
- Cup and Saucer Creek
- Wolli Creek
- Alexandra Canal
- Muddy Creek
- Eastern Channel
- Western Channel.

Parts of the Cooks River remain in a natural state, while other sections were lined with concrete from the 1940s onwards. Sydney Water has undertaken progressive channel naturalisation works at three locations to restore the river closer to its natural state. Between 2008 and 2012, the former Sydney Metropolitan Catchment Management Authority undertook, in consultation with local councils, a number of wetland remediation projects along the Cooks River.

Georges River catchment

The Georges River catchment, located in the southern and western suburbs of Sydney, covers an area of about 960 square kilometres. With a population of over one million people, it one of the most highly urbanised catchments in Australia. Georges River itself is about 96 kilometres long, and flows from Appin in the south in a northerly direction to Chipping Norton, then in an easterly direction to Botany Bay. The river discharges into the south of Botany Bay, between Sans Souci and Kurnell.

The western most portion of the project area drains to Salt Pan Creek, which is one of the major tributaries of the Georges River. Salt Pan Creek has a catchment area of about 26 square kilometres. The creek itself is about seven kilometres long, and flows in a generally southerly direction to the Georges River, at Riverwood. The creek is tidally influenced as far west as Fairford Road at Bankstown.

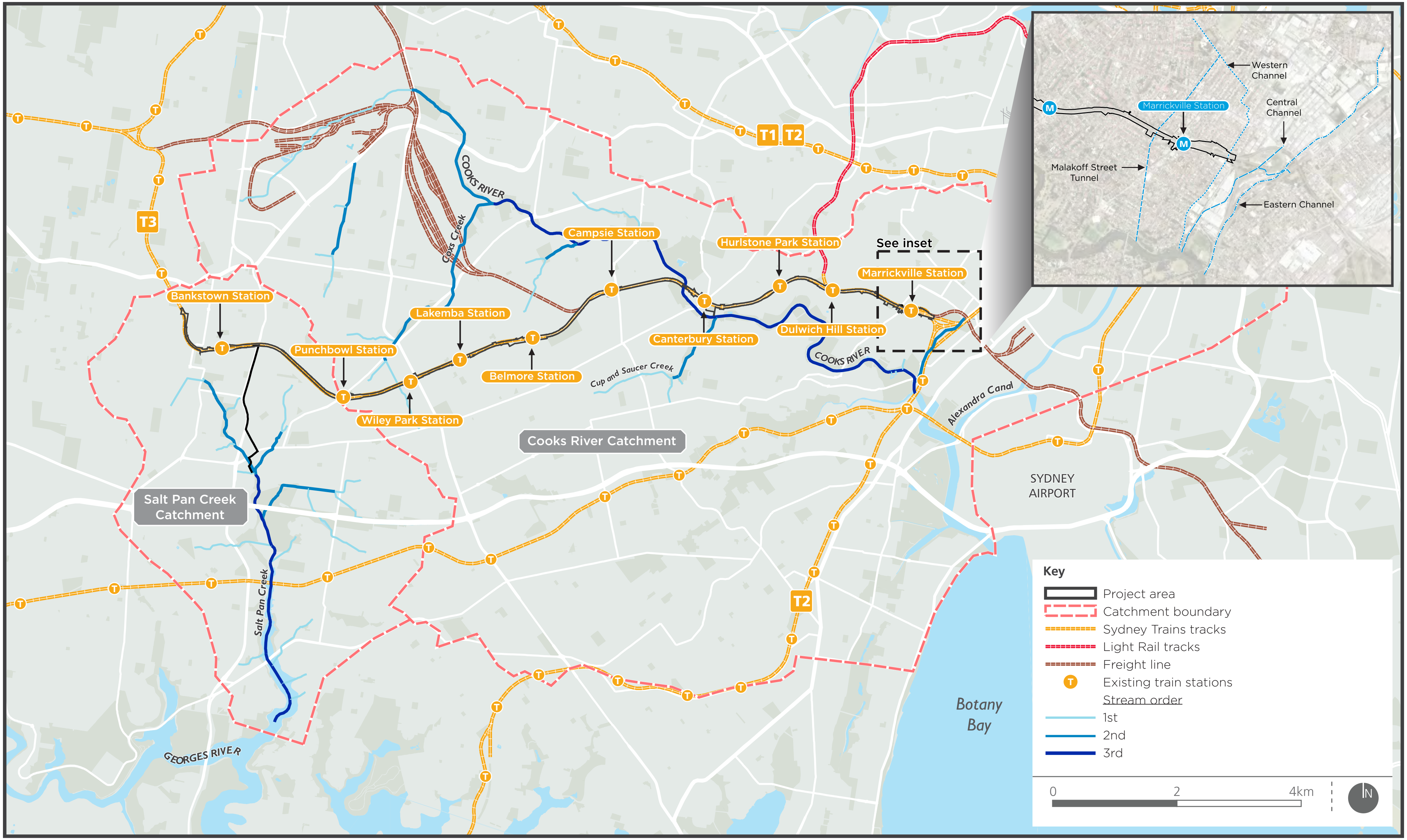
The upper reaches of the creek are highly modified and are generally concrete lined, with limited vegetation until the Canterbury Road crossing. There are no recognised tributaries for the creek on available mapping, however a number of unnamed channels drain to its upper reaches.

The project is located in the upper reaches of the Salt Pan Creek catchment. Upstream (north) of the project area, the catchment is relatively steep, and surface water runoff is managed by the existing stormwater drainage network.

21.2.2 Key watercourses

Key watercourses in the vicinity of the project area are shown in Figure 21.1. The project area crosses the following watercourses:

- Western Channel (a tributary of the Cooks River) in Marrickville, located about 450 metres east of Marrickville Station
- Cooks River at Canterbury, about 400 metres north-west of Canterbury Station
- a tributary of Coxs Creek at Wiley Park, about 250 metres west of Wiley Park Station
- the proposed route for the electricity feeder cable crosses Cup and Saucer Creek in Earlwood.



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Catchment areas and watercourse locations

FIGURE 21.1

21.2.3 Existing flooding and drainage conditions

As noted above, the Cooks River and Salt Pan Creek catchments are both highly urbanised and dominated by impervious surfaces. This means that these systems experience very low flows during dry periods and very high flows after storms, causing erosion and flooding. Key flooding information relevant to the project area is summarised below.

Cooks River catchment

The *Marrickville Valley Flood Study* (Marrickville Council and NSW Government, 2013) identifies that four major trunk drainage lines discharge to the Cooks River in the area subject to the study – the Eastern Channel, Central Channel, Western Channel, and the Malakoff Street Tunnel. The Malakoff Street Tunnel is a significant drainage asset which conveys stormwater from the Malakoff Street area, under the rail corridor, and through McNeilly Park to the Cooks River.

Marrickville Oval (located in Marrickville Park, about one kilometre to the north of the project area) is as an important flood storage location, acting as a detention basin during flood events. McNeilly Park, which adjoins the project area to the west of Marrickville Station, also acts a flood storage area during flood events.

The *Marrickville Valley Flood Study* notes that the existing rail corridor and surrounds near Marrickville Station are susceptible to flooding, with flooding predicted to occur in events as frequent as the 39 per cent AEP. Flood depths in the rail corridor are estimated to be up to one metre in a one per cent AEP event near the Illawarra Road bridge. Most of the rail corridor between Livingstone Road and Illawarra Road, and a section of corridor about 150 metres east of Marrickville Station, is identified as a high flood hazard area during the one per cent AEP event.

In other areas of the catchment, the draft *Overland Flow Study Canterbury LGA Cooks River Catchment* (Cardno, 2016) indicates that a section of the existing rail corridor located east of Canterbury Station is subject to flooding during the five per cent AEP event. The study also identifies that sections of the rail corridor 100 metres east of Canterbury Station and 100 metres west of Campsie Station are high flood hazard areas during the one per cent AEP event. The majority of the remainder of the rail corridor is either not classified as a flood hazard, or is classified as a low flood hazard in short sections.

Salt Pan Creek catchment

Mapping undertaken for the *Salt Pan Creek Stormwater Catchment Study* (Bankstown City Council, 2011a) indicates the potential for flooding of the rail corridor during the one per cent AEP event at several locations. The mapping indicates:

- Ponding on the north side of the rail corridor adjacent to Marion Street in Bankstown near the intersection with Bungalow Crescent, in events as frequent as a 63 per cent AEP event.
- Flooding and surface ponding from the local drainage network near the rail corridor on Olympic Parade and short sections of North Terrace and South Terrace in Bankstown during the one per cent AEP event.
- Downstream of the rail corridor, a number of residential properties would be impacted by flooding in events as small as the 18 per cent AEP event.

The report also identifies velocity-depth information for the rail corridor between Punchbowl Station and west of Bankstown Station. A section of the rail corridor 400 metres west of Punchbowl Station is likely to be associated with a low flood hazard. Shorter sections of the corridor, about 200 metres in length, around Stacey Street and to the east of Bankstown Station, are likely to be classified as low flood hazard areas.

The *Salt Pan Creek Catchments Floodplain Risk Management Study and Plan* (Bankstown City Council, 2013) identifies drainage issues and mitigation for the Bankstown CBD, including the need for works to improve the overland flow path near the rail corridor underpass adjacent to North Terrace.

21.2.4 Surface hydrology and identified project-specific flooding conditions

The stormwater drainage network controls stormwater flows for the smaller storm events throughout the project area, mainly from roads and urban areas. There are numerous stormwater drainage crossings beneath the rail corridor, including more than 40 drainage culverts that are larger than 450 millimetres in diameter.

Existing drainage issues within the rail corridor are generally related to one or both of the following:

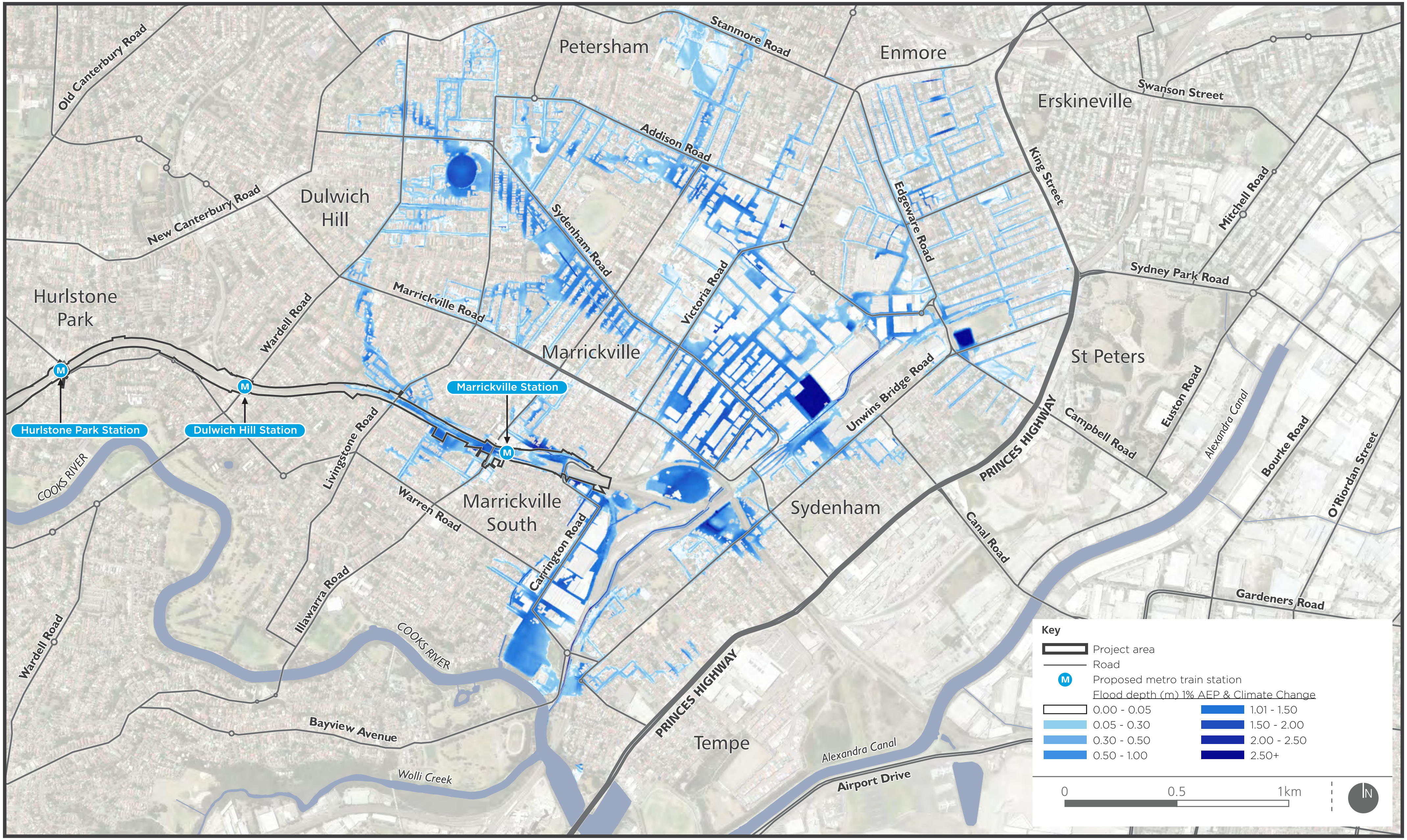
- insufficient capacity within the surrounding local stormwater drainage network, which overflows into the rail corridor during flood events
- lack of drainage infrastructure within the rail corridor to capture flows from external catchments – this is particularly the case where the ARTC freight tracks are located up-slope of the Sydney Trains tracks.

Marrickville

The most flood affected parts of both the project area and surrounding areas are located in the vicinity of Marrickville Station. Modelling of existing flood conditions was undertaken by the design team for the one per cent AEP event, with a ten per cent allowance for an increase in peak rainfall intensity (to account for climate change). This is referred to as the one per cent AEP climate change event. Modelling was also undertaken for the PMF event, which is the maximum flood which can theoretically occur. The extent and depth of existing flooding for the one per cent AEP climate change event and the PMF is shown in Figure 21.2 and Figure 21.3 respectively. The existing provisional flood hazard mapping for the one per cent AEP and PMF events are shown in Figure 21.4 and Figure 21.5 respectively.

The mapping shows:

- flooding of the rail corridor with flood depths greater than one metre between Livingstone Road and Illawarra Road near Marrickville Station in a one per cent AEP event
- most of the rail corridor between Livingstone Road and Illawarra Road, and a section of corridor east of Marrickville Station, is identified as a high flood hazard area during the one per cent AEP event
- in the one per cent AEP event, high flood hazard areas are also located along public roads (Sydenham Road and Carrington Road in particular) and open channels, consistent with their definition as floodways
- during the PMF, these same roads and areas are more severely affected, including the rail corridor between Livingstone Road and Illawarra Road, Sydenham Road (and roads leading south), Carrington Road, Meeks Road/Fitzroy Street, and areas to the east
- access routes around Marrickville Station, including some used for emergency access, would be flooded, including Railway Parade, Sydenham Road, Marrickville Road, Illawarra Road, Schwebel Street, and Arthur Street.



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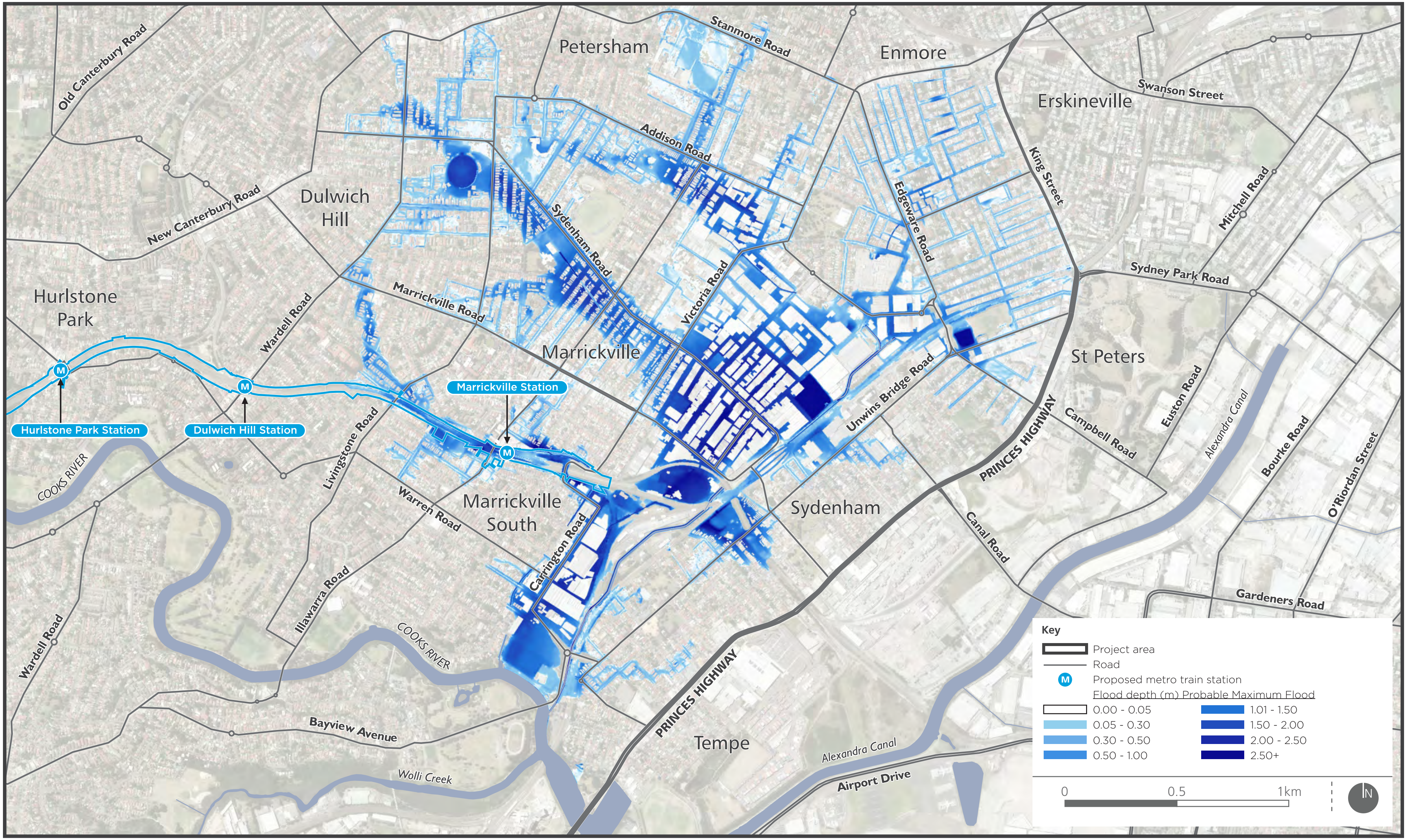
Marrickville and surrounds – existing flood depth and extent - one per cent AEP plus climate change

FIGURE 21.2



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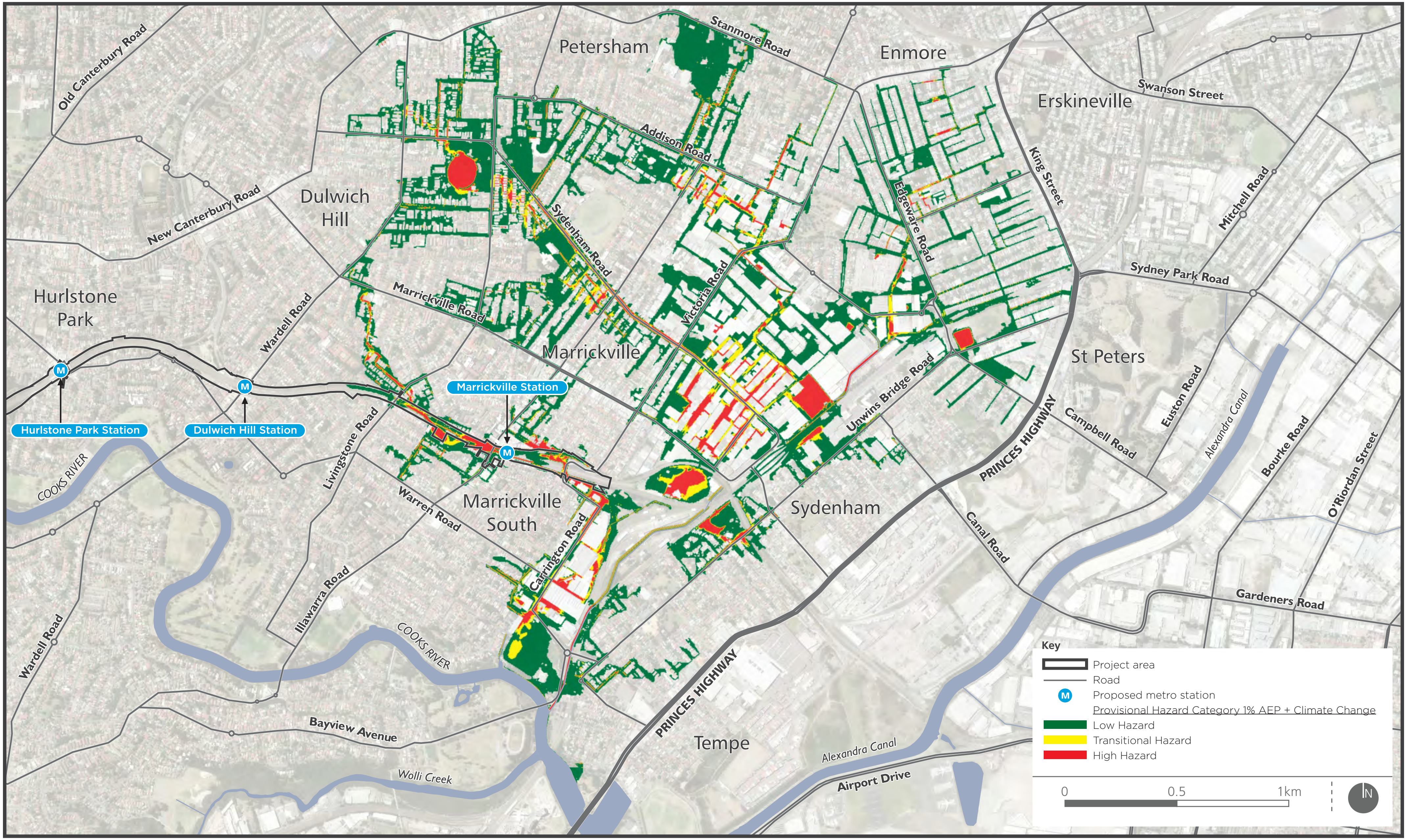
Marrickville and surrounds – existing flood depth and extent - probable maximum flood

FIGURE 21.3



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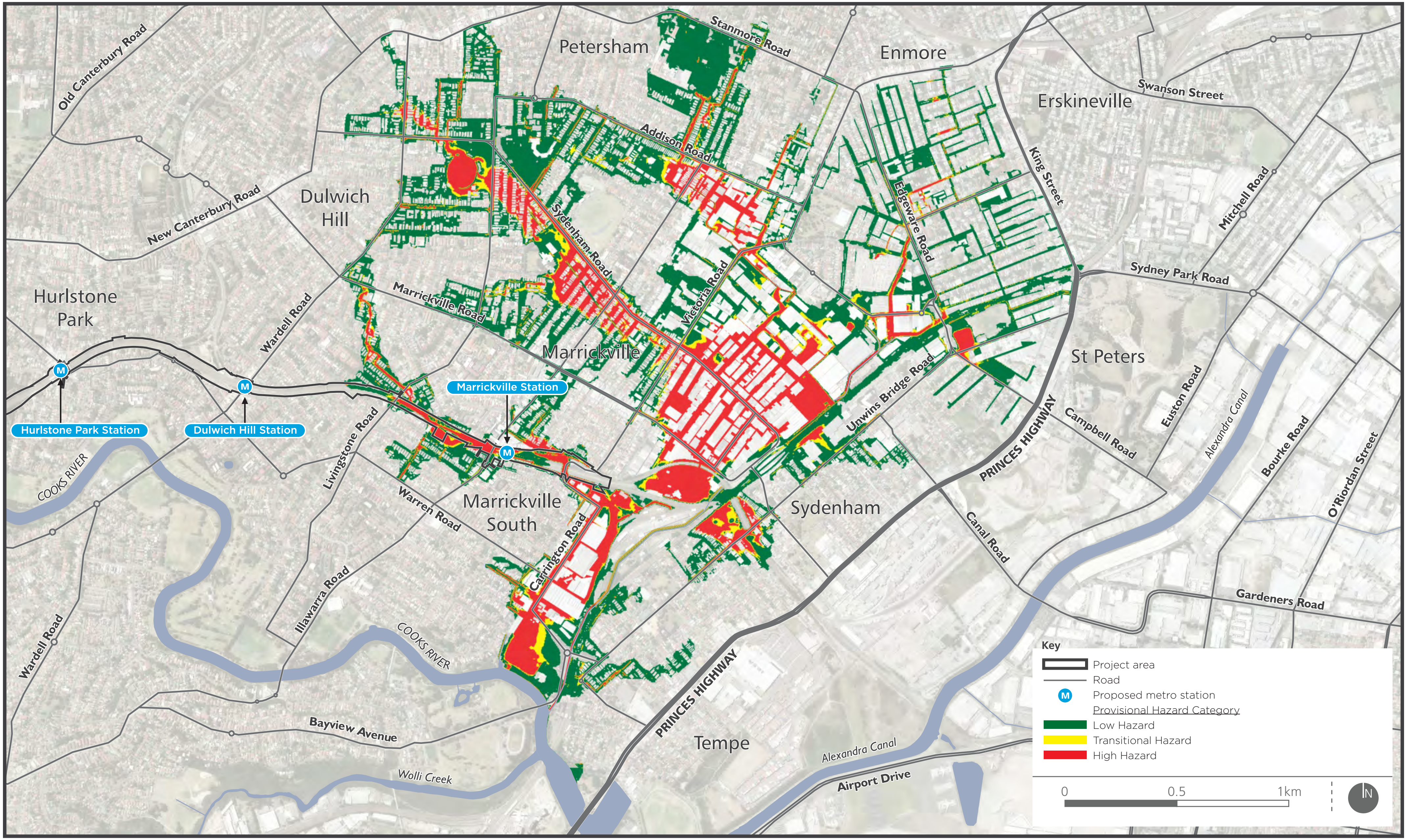
Marrickville and surrounds - existing provisional flood hazard - one per cent AEP plus climate change

FIGURE 21.4



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Marrickville and surrounds - existing provisional flood hazard - probable maximum flood

FIGURE 21.5

Rest of the project area

Table 21.2 lists the flooding and drainage issues occurring in the remainder of the project area between Dulwich Hill and Bankstown stations. These issues are generally considered to be more minor than at Marrickville Station.

Table 21.2 Summary of other drainage and flooding conditions – rest of project area

Location	Existing issues identified
Dulwich Hill Station to Canterbury Station	Overland flooding into the rail corridor occurs in some locations where existing cross drainage capacity is exceeded. These include: • substantial overland flooding east of Canterbury Station (high flood hazard area) • minor overland flooding potential west of Canterbury Station (low flood hazard area).
Campsie Station	Overland flooding into the rail corridor occurs: • from west of Campsie Station (high flood hazard area) during events greater than the 10% AEP • near the Belmore triangle area during events greater than the 39% AEP.
Belmore Station	Local drainage capacity constraints outside the rail corridor in some locations. Rail alignment in fill, therefore no predicted overland flood issues.
Lakemba Station	East of the station there is a risk of flooding in the rail corridor for events equal to and greater than the 5% AEP. West of the station there is limited cross drainage capacity however the rail corridor is on fill.
Wiley Park Station	Limited cross drainage capacity however rail line is mostly in fill.
Punchbowl Station	East of the rail corridor there are a number of culverts with varying capacities, and potential for overflows into the rail corridor. West of the rail corridor, modelling indicates overflows into the rail corridor at one location for the 1% AEP climate change event.
Bankstown Station	Rail line mostly in fill with limited potential for flooding of rail corridor.

Scour potential

The results of flood modelling for the one per cent AEP event under existing conditions indicates that 10 of the 40 culverts located within the project area with diameters greater than 450 millimetres have flow velocities greater than 2.5 metres per second. This corresponds to the velocity above which scour and erosion may occur. The culvert locations where flow velocities are considered to be relatively high are listed in Table 21.3.

Table 21.3 Culverts with high flow velocities

Culvert number[1]	Approximate location	Dimensions (m)	1% AEP discharge (m^3/s)	1% AEP velocity (m/s)	Existing capacity (AEP)
9	West of Melford Street, Canterbury	Box 0.75 x 0.8m	1.27	6	>1% AEP
13	West of Loch Street, Campsie	Box 1.1 x 0.7m	1.76	5	< 39% AEP
16	Near Marie Lane, Belmore	Box 0.9 x 0.9m	3.1	3.5	< 39% AEP
17	East of Dennis Street, Lakemba	Arch 0.9 x 0.9m	1.75	4.8	< 5% AEP
18	East of Quigg Street South, Lakemba	Arch 0.9 x 0.9m	2.2	4.6	Not available

Culvert number[1]	Approximate location	Dimensions (m)	1% AEP discharge (m^3/s)	1% AEP velocity (m/s)	Existing capacity (AEP)
24	Adjacent Rosemont Street South, Punchbowl	0.9m diameter	1.9	5.3	< 18% AEP
25	Adjacent Matthews Street, Punchbowl	0.9m diameter	1.7	4.8	< 2% AEP
26	Adjacent Matthews Street, Punchbowl	0.75m diameter	1.4	3.2	< 5% AEP
27	West of Kelly Street, Punchbowl	0.9m diameter	1.5	3.5	> 1% AEP
28	West of Scott Street, Bankstown	Arch 0.9 x 0.9m	3.45	5.4	> 1% AEP

Note: 1. Culvert numbers correspond to those shown on Figures 3-9 to 3-14 in Technical paper 8.

Emergency management

The relevant emergency management plan for the study area is the *South West Metropolitan Emergency Management District Disaster Plan* (NSW Government, July 2012). No other currently published flood plans for the area are available on the NSW State Emergency Service Floodsafe webpage.

Flood emergency management is incorporated into the design criteria for the proposed upgrade to stations. Flood emergency management procedures would also be incorporated into the project's operational emergency management plans.

The project team has held preliminary discussions with the NSW State Emergency Service who identified Unwins Bridge Road in the Marrickville area as being a key evacuation route in advance of a flood event. However, it was noted that in recent flood history, flood events at this location have been up to the 20 per cent AEP event.

21.2.5 Water quality

As a consequence of the heavily urbanised nature of the catchments, water quality is generally relatively poor, with stormwater runoff fouling the river systems with litter, petroleum derivatives, excess nutrients, and other pollutants. No existing water quality treatment measures within the project area were identified in the desktop research or site visit.

Cooks River catchment

Water quality within the Cooks River is generally considered to be poor and unfit for contact by humans (Cooks River Alliance, 2014). The main sources of poor water quality within the river are wastewater overflows, illegal dumping, and litter. The *Cooks River Alliance Management Plan 2014* targets, amongst other objectives, the improvement of water quality.

Further downstream in the Cooks River estuary, water quality is monitored as part of OEH's Beachwatch program. The most relevant monitoring location is at Kyeemagh Baths. The most recent State of the Beaches annual report noted that Kyeemagh Baths was graded as 'good', with the microbial water quality suitable for swimming most of the time, but that the water may be susceptible to pollution from a number of potential sources of faecal contamination, including the Cooks River, stormwater, and sewage overflows (OEH, 2016).

Salt Pan Creek catchment

Development in the Salt Pan Creek catchment, including construction impacts and litter, as well as other influences such as wastewater overflows and a landfill operation, have resulted in poor water quality. Since about 2009/2010, water quality has improved following the efforts of local councils and others. Salt Pan Creek is now considered to have good water quality (Georges River Combined Councils Committee, 2016).

A number of beaches in the lower Georges River are monitored as part of OEH's Beachwatch program. The most recent State of the Beaches annual report noted that these locations were graded as 'good', meaning that the quality of the water was appropriate for swimming most of the time (OEH, 2016).

Water quality objectives and criteria

The *NSW Water Quality and River Flow Objectives* provide water quality objectives for the Cooks River and Georges River catchments, for the protection of the following (within waterways affected by urban development, or estuaries):

- aquatic ecosystems
- visual amenity
- secondary contact recreation
- primary contact recreation.

Waterways affected by urban development are defined as streams within urban areas, which are frequently substantially modified and generally carry poor quality stormwater. The majority of watercourses within the study area meet this definition, with the exception of the Cooks River, which meets the definition of an estuary, as it is dominated by saline conditions.

The water quality objective for aquatic ecosystems is to 'maintain or improve the ecological condition of waterbodies and their riparian zones over the long term'. The indicators and criteria (trigger values) for this objective are listed in Table 21.4. While it is likely that watercourses within the study area would be classified as highly disturbed systems (being urban streams receiving road and stormwater runoff), the ANZECC 2000 guidelines recommend that the guideline trigger values for slightly to moderately disturbed systems should also apply to highly disturbed ecosystems wherever possible. Therefore, the water trigger values provided in Table 21.4 are based on the ANZECC 2000 guideline default trigger values for the protection of aquatic ecosystems in slightly disturbed river ecosystems in south-eastern Australia.

A detailed list of the indicators and criteria for the other water quality objectives for the Cooks River and Georges River catchments is provided in Technical Paper 8.

Table 21.4 Water quality trigger values for aquatic ecosystems

Indicator	Criteria (lowland rivers)
Total phosphorus	50 ug/L
Total nitrogen	500 ug/L
Chlorophyll-a	5 g/L
Turbidity	6–50 NTU
Salinity (electrical conductivity)	125–2,200 uS/cm
Dissolved oxygen (per cent saturation)	85–110 %
pH	6.5–8.5

21.2.6 Groundwater

The groundwater level along most of the project area was recorded at between about 2.3 metres below ground level (to the east of the project area in Marrickville) and about 10.3 metres below ground level (near Bankstown Station).

Groundwater has been observed discharging from open cuttings along the rail corridor. The surface groundwater system is likely to be recharged by rainfall and percolation from irrigation of residential gardens and open spaces, as well as incidental runoff from impervious surfaces, such as roads and footpaths.

A search of the NSW Water Register was undertaken on 22 September 2016 to identify existing users and extraction rates. The search identified 17 groundwater boreholes located within 400 metres of the project area, the majority of which were registered as monitoring bores/wells.

Quaternary alluvium underlies the Cooks River and its tributaries and forms an aquifer. Groundwater is also present within localised alluvial deposits in some gullies. Groundwater salinity within the Quaternary alluvium and localised alluvial deposits is expected to vary from lower salinity in the upper reaches of the Cooks River, to higher salinity in the lower reaches due to mixing and tidal influences.

Groundwater encountered at deeper levels within the Mittagong Formation and Hawkesbury Sandstone is expected to have lower salinity and low concentrations of dissolved metals and nutrients.

21.3 Impact assessment

21.3.1 Risk assessment

Potential risks

A sensitive receiving environment is one that has a high conservation value, or supports human uses of water that are particularly sensitive to degraded water quality (DECC, 2008). With regard to the study area, sensitive receiving environments are considered to include:

- threatened ecological communities associated with aquatic ecosystems
- known and potential habitats for threatened fish
- key fish habitats
- recreational swimming areas
- areas that contribute to drinking water catchments.

Cooks River is mapped as key fish habitat, and threatened fauna species listed under the *Fisheries Management Act 1994* have been recorded or are predicted to occur in the study area. However, based on the poor quality of the river, previous records, and habitat requirements, these species are considered unlikely to occur. The other watercourses in the project area are considered unlikely to contain any significant sensitive environments.

The environmental risk assessment for the project, undertaken for the State Significant Infrastructure Application Report, identified the following as the main hydrology, flooding and water quality risks:

- impacts on flood-prone areas during construction and operation (e.g. increase in flood risk outside the project area)
- impacts on construction activities due to flooding
- flooding impacts on project infrastructure during operation
- water quality impacts due to spills and erosion during construction and operation
- adverse impacts on groundwater flows, quality, and levels due to excavation.

Other potential risks include:

- temporary impact to the behaviour of local surface water systems during construction
- blockages of flow paths affecting low flows through construction within watercourses and through erosion and sedimentation control structures
- reduced water quality (including increased total suspended solids and turbidity) as a result of erosion and sedimentation near watercourses
- modification to existing drainage infrastructure resulting in water quality impacts
- impact to surface water quality and receiving environments due to increased runoff from impervious areas.

How potential impacts would be avoided

In general, potential flooding impacts would be avoided by implementing the proposed drainage works described in Section 8.1.3, and the mitigation measures in Section 21.4.

Potential water quality impacts would be avoided by managing water quality in accordance with the requirements of the POEO Act and the environment protection licence for the project, and implementing the mitigation measures in Section 21.4.

21.3.2 Construction impacts – hydrology and flooding

Potential for detrimental increases in the flood affectation of other properties, assets and infrastructure

During construction, there may be a need to temporarily disconnect or divert existing stormwater drainage pipes, which could result in localised modifications to existing flooding patterns, flow volumes, and velocities.

Temporary diversions would be required to transfer runoff around construction work areas. This may involve excavations and embankments, which would alter localised flow patterns. These changes would be temporary and limited to the construction phase. The landform would be restored as close as practicable to the pre-works condition following construction.

Construction would result in a small increase in impervious areas, which would have the potential to increase the volume of water flowing to watercourses. However, the change in impervious area would be negligible compared to the overall catchment area.

Temporary changes to the stormwater drainage system during construction would be subject to further design and analysis to confirm the potential impacts and to identify any required mitigation. Any flood impacts during construction are expected to be localised and relatively minor, and would be managed by implementing the measures provided in Section 21.4.2. This would include, wherever possible, implementation of replacement drainage in advance of any disconnections or diversions.

The locations of work areas and compounds within designated flood hazard areas would not result in flood affectation of other properties, assets, and infrastructure (refer explanation below).

Consistency with Council floodplain risk management plans

Relevant plans are described in Section 21.2.1. The *Salt Pan Creek Catchments Floodplain Risk Management Study and Plan* proposes drainage modifications near Wattle Street in Bankstown, which is close to the project area. Construction of the project would not prevent or compromise these proposed works. The proposed works are therefore considered to be consistent with Council's floodplain risk management plans.

Compatibility with the flood hazard of the land

Some construction activities, work sites, and compounds would be located in areas where there is an existing flood hazard. However, due to the generally small sizes of compounds and work sites relative to the size of the floodplain, minimal impacts on flood hazard would result. The layout of construction compounds and work sites would be undertaken with consideration of overland flow paths and avoid flood liable land where practicable. The location of compounds and work sites would be reviewed during construction planning to avoid, where possible, high hazard areas. Following completion of construction, no further impacts would occur.

Compatibility with the hydraulic functions of flow conveyance in floodways and storage areas of the land

Some areas of construction are located in areas with overland flow paths that may constitute floodways. Obstruction of flow paths and floodways due to the presence of construction works and equipment has the potential to redistribute flood flows and impact downstream properties, and/or mobilise construction equipment or debris, which could result in downstream safety or water quality impacts.

Careful review of the proposed layout of construction compounds, including siting of buildings and plant, would be undertaken where these are located within or partially within flood liable land. However, given their small size relative to the overall floodplain area, minimal impacts are expected. Following completion of construction, no further impacts would occur.

Some modifications to flood storage areas, including at McNeilly Park, are proposed. Construction flood management planning would incorporate measures to maintain the storage function of those areas in a flood event.

Downstream velocity and scour potential

There is the potential for temporary drainage works to impact overland flow paths during construction. This could divert or concentrate flows, potentially resulting in the scouring of downstream areas, particularly where soil has been exposed during construction.

Soil and water management measures would be implemented in accordance with *Managing Urban Stormwater: Soils and Construction, Volume 1* (Landcom, 2004) and *Managing Urban Stormwater: Soils and Construction, Volume 2A* (DECC, 2008), to minimise any potential impacts resulting from runoff and flooding during construction.

Impacts on existing emergency management arrangements

Preliminary consultation was undertaken with the NSW State Emergency Service and local councils regarding existing flood evacuation routes and the potential impacts of the project. A number of roads providing access to the project area around Marrickville are subject to flooding under existing conditions (described in Section 21.2.4).

With the implementation of mitigation measures provided in Section 21.4.2, no impacts on existing emergency management arrangements are expected during construction. Ongoing liaison would be undertaken with relevant stakeholders during detailed design and the construction period.

Social and economic costs to the community

Although there would be temporary changes during construction, including installation of drainage and culvert works, there is not expected to be any social and economic costs to the community as a result of these works.

Groundwater levels and flows

The project would involve limited excavation. Piling may intercept groundwater where encountered at depth, however potential impacts can be effectively managed by implementing the standard mitigation measures provided in Section 21.4.2. Negligible impacts on groundwater levels are expected, and no major dewatering activities are likely to be required. Construction of the project is unlikely to impact on groundwater flows.

Interaction between surface water and groundwater

Excavation of some cuttings would be undertaken during construction. These works have the potential to intersect dykes or faults which may require management to minimise risks to structural stability and interference with groundwater. Piling work could also result in the connection of surface water with deeper aquifers during pile shaft excavation, depending on the depth of the piles and the presence of perched water. These potential impacts are considered to be relatively minor as a result of the nature of the works and the limited excavation required. Mitigation measures are provided in Section 21.4.2.

Construction water usage

Water would be required for dust control, soil compaction, and vegetation establishment. The required volume of water would depend on climatic conditions during construction. It is expected that potable or recycled water (preferably) would be used for this purpose, with the construction contractor to investigate the various sources of water available and obtain any necessary approvals. No groundwater extraction or surface water harvesting is proposed for the construction of the project.

Water usage during construction could also increase infiltration rates and surface water runoff in the project area. The impact of this additional discharge is expected to be minimal, as the additional flow and infiltration would be negligible compared to regional rainfall levels. Any impacts would be short term.

21.3.3 Construction impacts – water quality

Construction presents a risk to downstream water quality if standard construction management measures are not implemented, monitored and maintained throughout the construction period. If inadequately managed, construction activities can impact water quality if they disturb soil or watercourses, result in uncontrolled discharges of substances to watercourses, or generate contamination. Potential sources of water quality impacts include:

- increased sediment loads from exposed soil transported off-site to downstream watercourses during rainfall events
- increased sediment loads from discharge of sediment laden water from dewatering of excavations
- increased levels of nutrients, metals, and other pollutants, transported in sediments to downstream watercourses or via discharge of water to watercourses
- chemicals, oils, grease, and petroleum hydrocarbon spills from construction machinery directly polluting downstream watercourses
- litter from construction activities polluting downstream watercourses
- contamination of watercourses due to runoff from contaminated land.

The downstream effects of water quality impacts include:

- smothering aquatic life and/or inhibiting photosynthesis conditions for aquatic and riparian flora

- impacts to breeding and spawning conditions of aquatic fauna
- changes to water temperature due to reduced light penetration
- impacts to the ecosystems of downstream sensitive watercourses, wetlands, and floodplains
- increased turbidity levels above the design levels of water treatment infrastructure
- reduced visibility in recreation areas.

The potential for soil and contamination impacts during construction, including the potential for contamination of surface water and groundwater due to spills and leaks, and/or the mobilisation of contaminants encountered during demolition of structures, are considered in Chapter 20 (Soils and contamination). Potential water quality impacts are considered in this section.

Changes to surface water flows

Changes to surface water flows can impact water quality – an increase in flow rate and volume can lead to increased erosion and turbidity. The potential impacts of changes to surface water flows are considered in Section 21.3.2.

Works in watercourses

The project would involve works in and around watercourses, including the Cooks River and Cup and Saucer Creek. These works could disturb the bed and banks, and potentially lead to localised erosion and sediment transport downstream. The NSW Office of Water's guidelines for controlled activities would be considered when undertaking works on waterfront land to minimise the potential for impacts to water quality. It is noted that Cup and Saucer Creek is a lined concrete channel in the vicinity of the proposed route for the electricity feeder cable, which is proposed to cross the creek via an existing road bridge.

Earthworks, demolition, stockpiling and general runoff from construction sites

Construction can impact water quality in downstream watercourses as a result of erosion. Runoff from stockpiles has the potential to impact downstream water quality during rainfall if stockpiles are not managed appropriately. Sediments from the stockpiles could wash into watercourses, increasing levels of turbidity.

Stockpiling cleared vegetation creates a risk of tannins leaching into watercourses, resulting in an increased organic load. Discharge of water high in tannins can increase the biological oxygen demand of the receiving environment, which may in turn result in a decrease in available dissolved oxygen. Once discharged to the environment, tannins may also reduce visibility, light penetration, and change the pH of receiving waters. These impacts may affect aquatic ecosystems in receiving environments.

Sediment loads in watercourses can increase in the vicinity of hard surfaces (such as roads) and compacted areas due to increased surface runoff.

Although the project has the potential to temporarily reduce water quality from pollutants and run-off, it would not be expected to cause significant impacts to the overall condition of surrounding waterways. Construction is unlikely to result in any long-term water quality impacts in the study area.

The mitigation measures provided in Section 21.4.2 would be implemented to minimise the potential for water quality impacts during construction.

Minimising the effects of proposed stormwater and wastewater management during construction on natural hydrological attributes

Surface water at construction sites would be managed by implementing standard erosion and sediment control measures in accordance with *Managing Urban Stormwater: Soils and Construction* volumes 1 and 2A.

Groundwater quality

Potential risks to groundwater quality during construction include:

- contamination by hydrocarbons from accidental fuel and chemical spills
- contaminants contained in turbid runoff from impervious surfaces.

Surface water from site runoff may infiltrate and impact groundwater sources. As the infiltration process is generally effective in filtering polluting particles and sediment, the risk of contamination of groundwater from any pollutants bound in particulate form in surface water run-off, such as heavy metals, is generally low.

Soluble pollutants, such as pH altering solutes, salts and nitrates, as well as soluble hydrocarbons, can infiltrate soils and contaminate the groundwater system. Under certain pH conditions, metals may also become soluble and could infiltrate groundwater.

The mitigation measures provided in Section 21.4.2 would be implemented to minimise the potential for groundwater quality impacts.

The presence of salinity within the project area is considered in Chapter 19. Given the limited amount of excavation proposed, and the low likelihood of intercepting groundwater during works, impacts to groundwater resources and hydrology due to soil salinity are considered unlikely. However, any potential impacts would be mitigated by implementing standard erosion and sediment control measures during construction, including measures to minimise infiltration of increased surface water, and backfilling soil units in the order they were excavated.

21.3.4 Operation impacts – hydrology and flooding

Potential for detrimental increases in the flood affectation of other properties, assets and infrastructure

As noted in Section 21.2, the most flood affected parts of both the project area and surrounding study area are located in the vicinity of Marrickville Station. The key outcomes in relation to flooding in Marrickville are summarised in Table 21.5 and shown on Figure 21.6 to Figure 21.11.

Table 21.5 Performance against flood criteria in Marrickville

<table>
<tr><th>Key design criteria[1]</th><th>Marrickville Station</th><th>Adjacent lands</th><th>Public roads</th></tr>
<tr><td>Maximum increase in time of inundation of one hour in a 1% AEP event</td><td>Achieved</td><td rowspan="4">For the 1% AEP climate change event:
• no increase in flooding in the majority of the study area
• reduction in flood levels of up to 300 mm along the rail corridor west of Marrickville Station, and between 50 to 150 mm further to the west
• reduction in flood levels between 50 to 100 mm east of Marrickville station.
For events up to the 1% AEP climate change event, where there are increases, these are only up 50 mm.
A floor level survey and a detailed analysis is required to assess the above floor impacts at +/- 10 mm accuracy.
Flood level increases are expected in the PMF.
Flood level changes elsewhere are still to be assessed, but are expected to be relatively minor.</td><td rowspan="4">A reduction in the flood level of between 150 to 200 mm is predicted in the vicinity of Byrnes Street, O'Hara Street, and Cavey Street.
A reduction in the flood level of between 50 to 100 mm is predicted at the southern end of Carrington Road and Richardsons Crescent, including Mackey Park and the Carrington Road industrial area. The only exception is the section of Junction Street between Ruby and Schwebel Street, where an increase of 100 mm is predicted for the 39% AEP event.
For the PMF event, a reduction in the flood level of between 50 to 100 mm is predicted at the northern end of Carrington Road and the industrial area.
For events up to the 1% AEP climate change event, where there are increases, these are only up 50 mm.
For the PMF event, flood level increases are predicted on access routes already flooded under existing conditions.
Flood level changes elsewhere are still to be assessed, but are expected to be relatively minor.</td></tr>
<tr><td>Maximum increase of 10 mm in flood level at properties where floor levels are already exceeded in a 1% AEP event</td><td>Floor level survey not available. Any potential flooding above-floor level would be assessed during detailed design.</td></tr>
<tr><td>Maximum increase of 50 mm in flood level at properties where floor levels are not exceeded in a 1% AEP event</td><td>Achieved</td></tr>
<tr><td>Increase in flood velocities - identification of mitigation measures</td><td>Many locations benefit from flood velocity decreases. Selected locations of velocity increase are generally less than 0.25 m/s for all flood events with further development of mitigation measures to be undertaken during the next stage of design.</td></tr>
</table>

Note:1. Refers to design criteria outlined in Table 4-2 of Technical paper 8

At other locations along the corridor between Marrickville and Bankstown stations, more limited modelling was undertaken to confirm that the introduction of the proposed infrastructure would not result in downstream impacts.

The conclusion of the assessment is that the proposed drainage measures would generally be effective at limiting downstream impacts. While detailed assessment of flooding at Canterbury Station was not undertaken, based on the draft *Overland Flow Study Canterbury LGA Cooks River Catchment* (Cardno, 2016), flooding was found to occur along the rail corridor at Canterbury Road, with flood depths of up to two metres for the five per cent AEP, one per cent AEP, and PMF events.

In general, it was identified that peak flow rates from cross drainage structures would increase where no detention basins are currently proposed. It was also identified that the overall peak flow rates in the drainage systems would not increase, due to differences in the timing of peak flows between the rail culverts and the wider drainage network.

Further analysis and design would confirm the required design mitigation measures and impacts at lower risk locations.

Consistency (or inconsistency) with applicable Council floodplain risk management plans

As noted in Section 21.3.2, drainage works associated with the project are compatible with local floodplain risk management plans, and would result in generally a reduction of existing flood extent and depth.

Compatibility with the flood hazard of the land

Results of flood modelling indicate that the project would not result in a change to existing flood hazard in or surrounding the rail corridor.

Compatibility with the hydraulic functions of flow conveyance in floodways and storage areas of the land

Drainage works have been designed to mitigate potential adverse impacts on more minor floodways (such as roads) in events up to the PMF.

Detention capacity in McNeilly Park (and at other locations) would be increased to cater for additional flows. Therefore, the project is considered to be compatible with the floodway and flood storage functions of the floodplain.

Downstream velocity and scour potential

At Marrickville, changes in velocities are estimated to be generally less than 0.25 metres per second at all locations for the full range of flood events. As in the case of flood levels, many of the areas would benefit from a net reduction in velocities as a result of the project.

Modelling of existing conditions indicates that about 10 of the existing culverts have exit velocities greater than 2.5 metres per second, which is the velocity above which scour and erosion could occur. While an increase in velocities is predicted to occur at two culverts, following implementation of the project, the level of increase would be small, and the velocity would be less that the design limit.

Appropriate methods of scour protection at identified locations would be identified during detailed design.

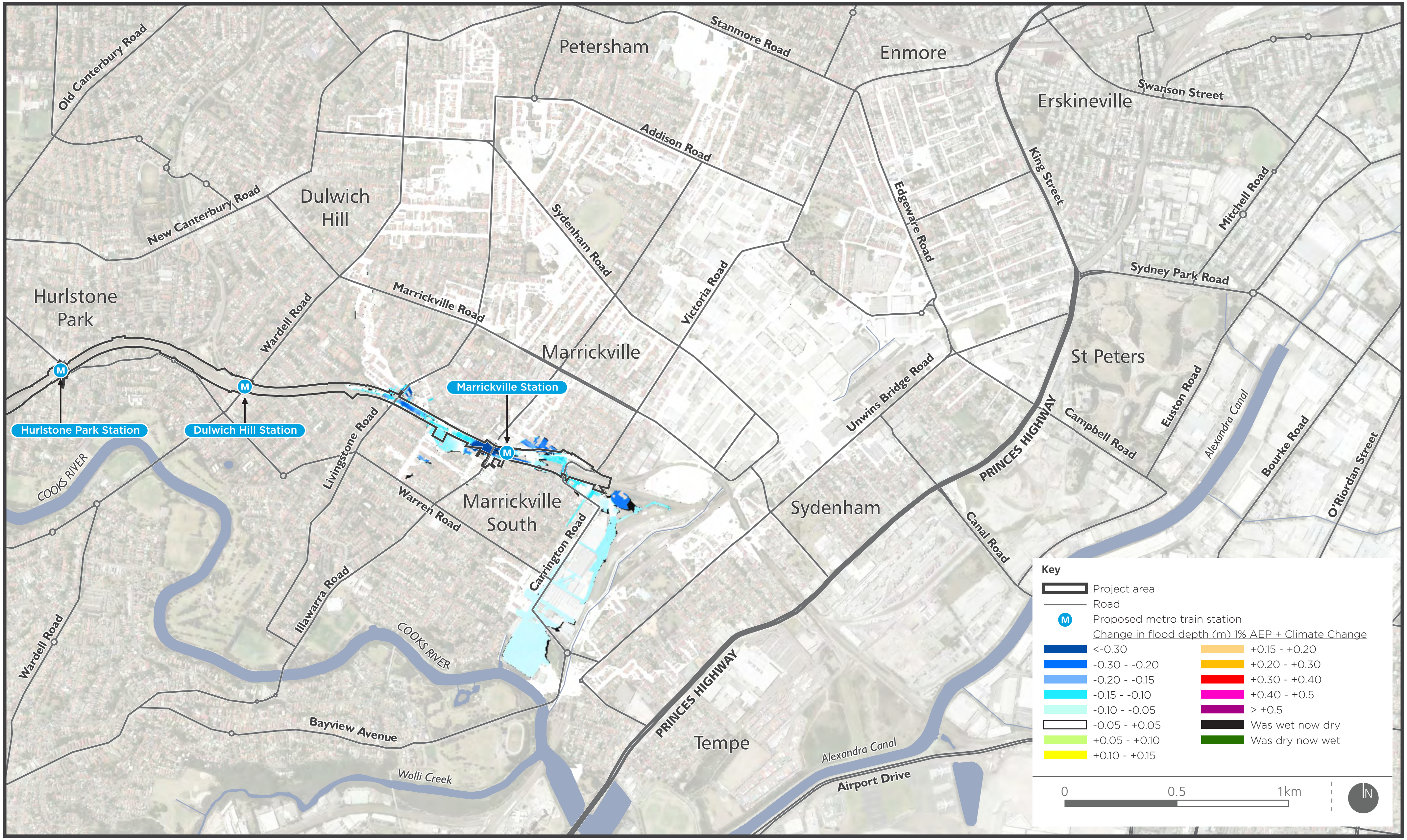
Impacts of flooding on existing emergency management arrangements

Preliminary consultation was undertaken with the NSW State Emergency Service regarding existing flood evacuation routes and the potential impacts of the project. Roads identified to be flooded under existing conditions, which provide access to the project area around Marrickville (described in Section 21.2.4) are also expected to be flooded once the project is operational. For the PMF event, no changes to existing flood levels on emergency flood access routes are expected.

Flood emergency management is incorporated in the design criteria for station infrastructure. Flood emergency management procedures would be incorporated in Sydney Metro's operational emergency management plans.

Social and economic consequences

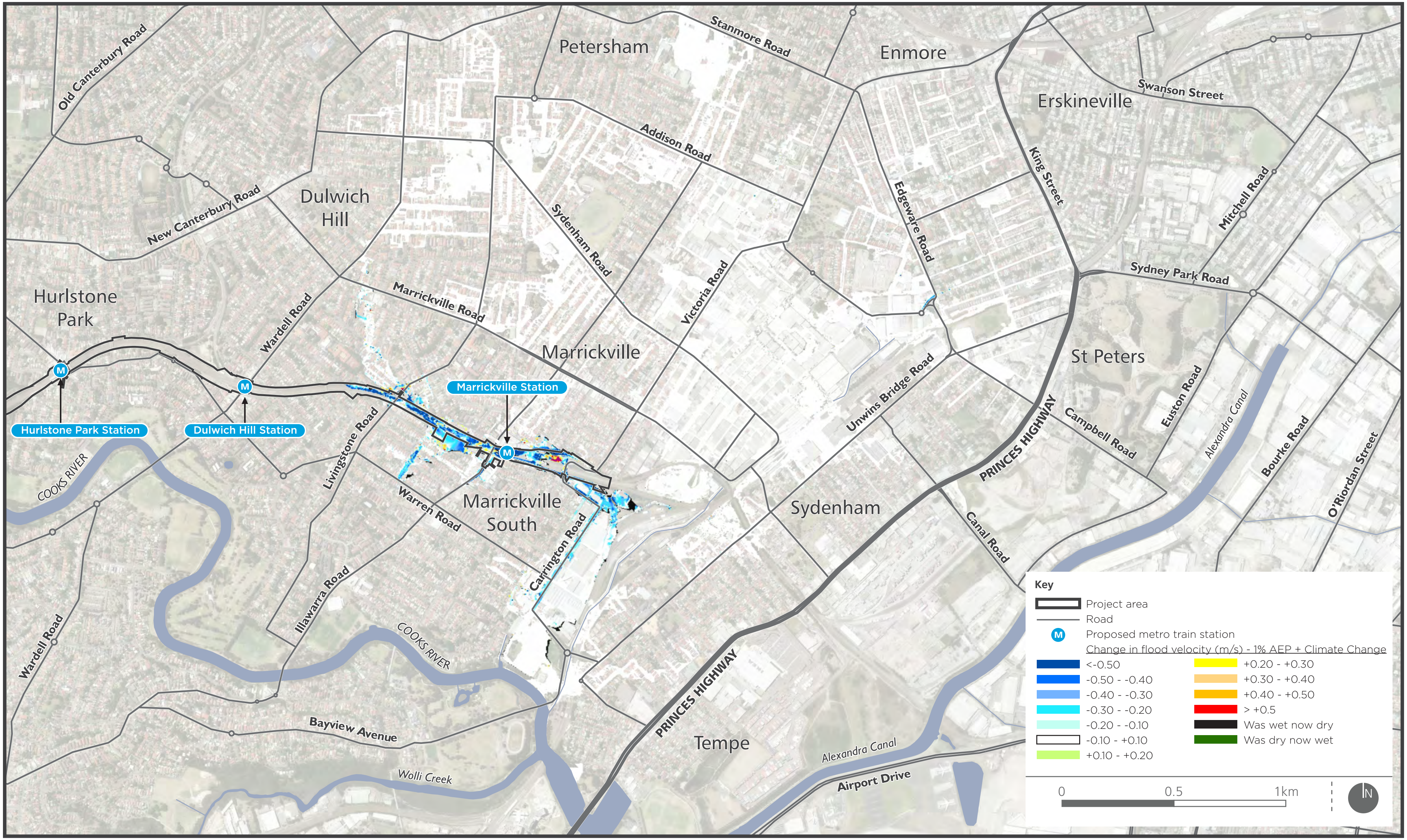
The analysis undertaken during design development indicates that there are limited adverse flooding and hydrology impacts resulting from the project, and no change or an improvement to many aspects relative to existing conditions under a range of potential flood events. The impacts identified are mainly increases in velocity at a limited number of locations. The economic and social consequences of the project (with respect to flooding) are considered to be negligible.



sydney METRO | city & southwest

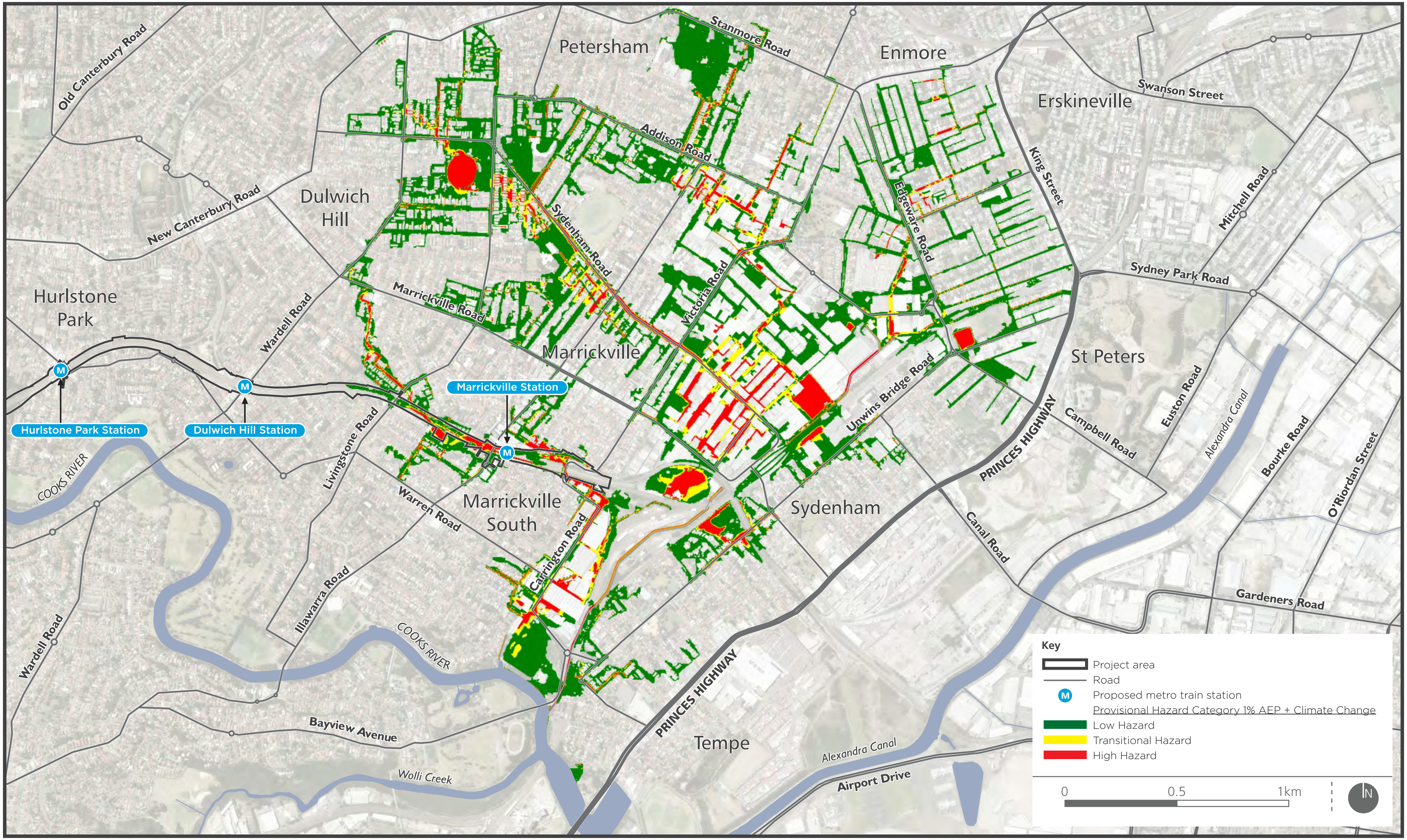
Marrickville and surrounds – change in flood depth and extent with the project - one per cent AEP plus climate change

FIGURE 21.6



Marrickville and surrounds – change in flood velocity - one per cent AEP plus climate change

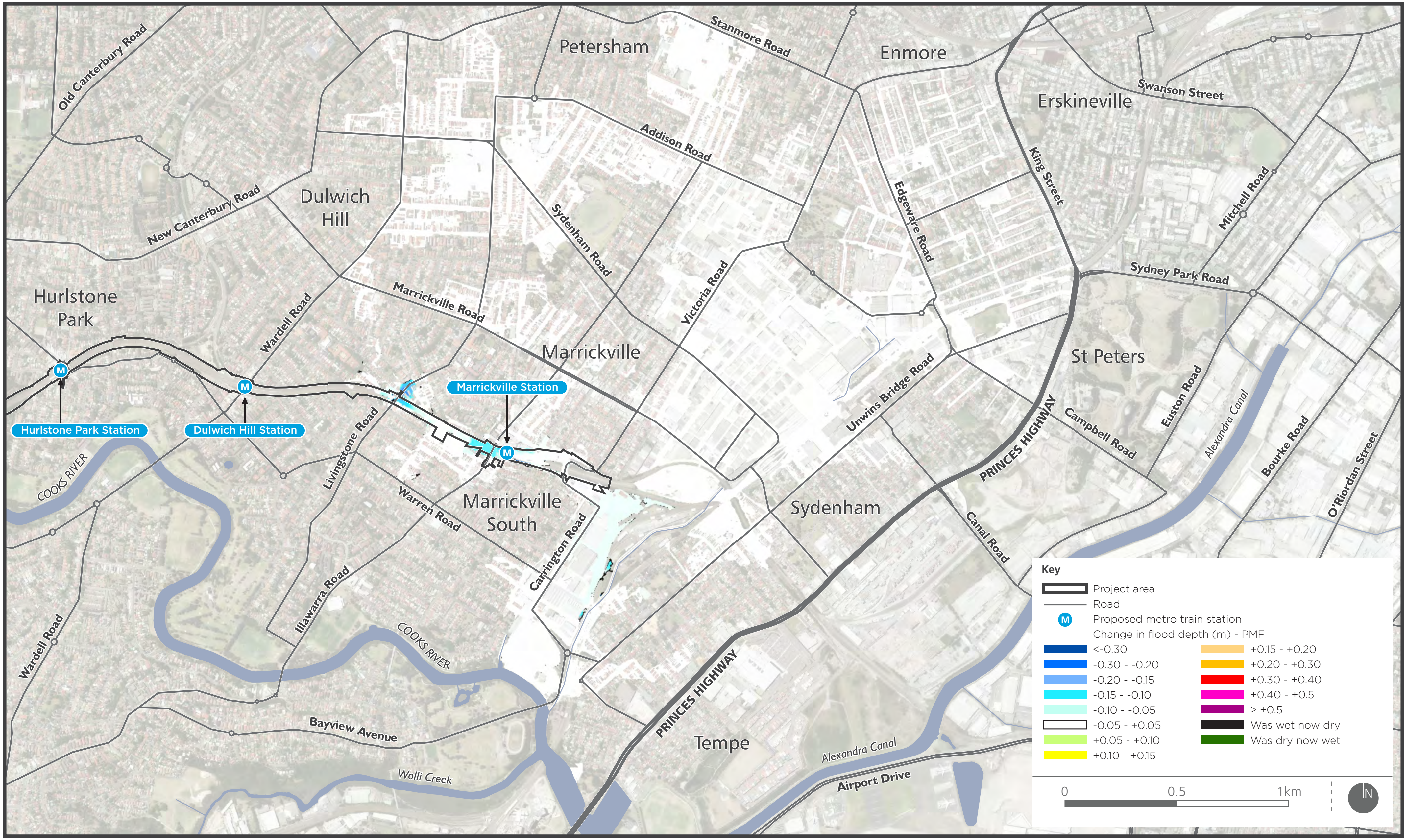
FIGURE 21.7



sydney METRO | city & southwest

Marrickville and surrounds – flood hazard - one per cent AEP plus climate change

FIGURE 21.8



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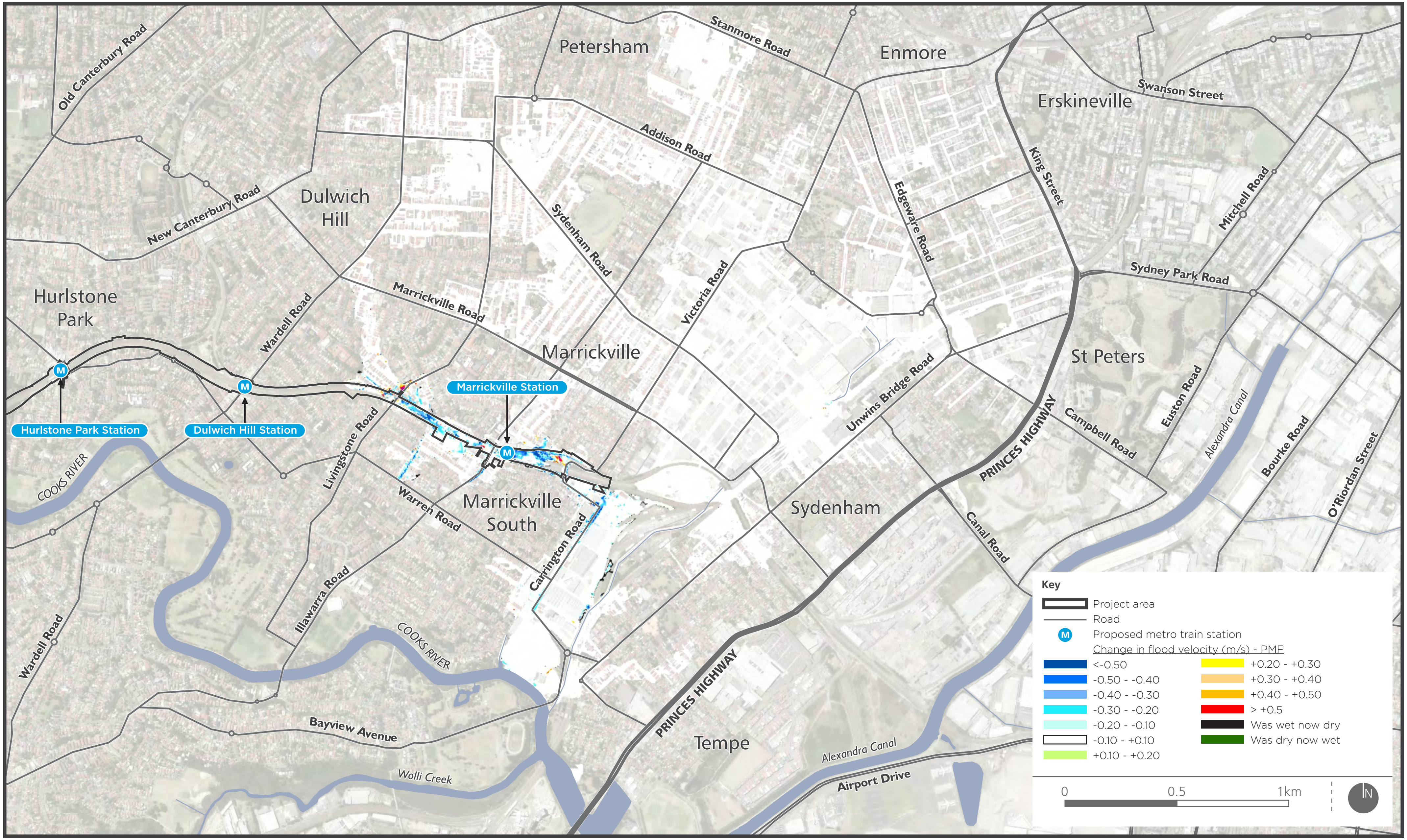
Marrickville and surrounds – change in flood depth and extent – probable maximum flood

FIGURE 21.9



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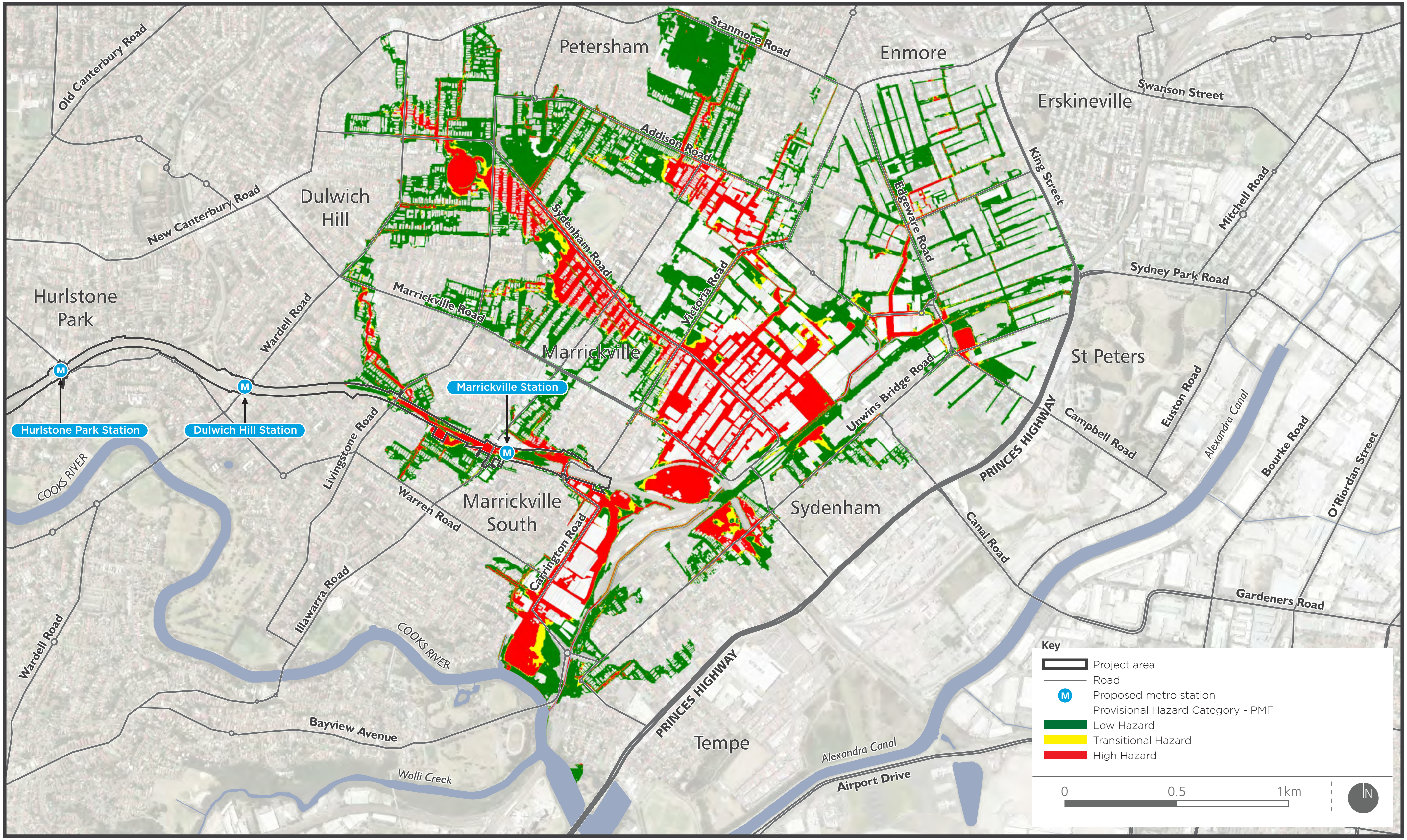
Marrickville and surrounds – change in flood velocity - probable maximum flood

FIGURE 21.10



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Marrickville and surrounds – flood hazard - probable maximum flood

FIGURE 21.11

21.3.5 Operation impacts – water quality

During operation, the project has the potential to result in water quality impacts mainly from changes in hydrology leading to an increase in erosion and sedimentation, and the mobilisation of pollutants from the rail corridor.

As outlined in Section 21.1, gross pollutant traps and rain gardens would be implemented to manage water quality outcomes from the project area in accordance with the project water quality guidelines.

Table 21.6 provides details of the proposed water quality treatment measures by location, including indicative sizing. It is noted that the impervious area of each station is very small relative to the total catchment area, ranging from only 0.02 to 1.56 per cent. Consequently, there would be very little influence on overall catchment water quality.

Table 21.6 Proposed water quality treatment measures

Location	Total station impervious area[1] (ha)	Total catchment area (ha)	% station impervious area[2]	Rain garden area (m^2)	Number of gross pollutant traps
Marrickville	0.23	68	0.34	n/a[3]	1
Dulwich Hill	0.45	42	1.07	55	1
Hurlstone Park	0.10	41	0.24	15	1
Canterbury	0.23	1150	0.02	30	1
Campsie	0.61	39	1.56	75	1
Belmore	0.39	100	0.39	50	1
Lakemba	0.34	69	0.49	45	2
Wiley Park	0.16	118	0.14	20	2
Punchbowl	0.73	118	0.62	90	1
Bankstown	0.55	127	0.43	70	1

Notes:
1. Hardstand area within station precinct under proposed development conditions.
2. Station precinct hardstand area as a percentage of catchment area.
3. Marrickville Station precinct has a net reduction in impervious area of about 700 m^2 after development, and hence no rain garden is proposed.

Change in pollutants entering watercourses

Contamination of watercourses could occur through increased stormwater runoff containing typical pollutants, such as oils and greases, petrochemicals, and heavy metals, as a result of the operation of rolling stock, track operational wear, and any uncontrolled spills within stations or other facilities. Any contamination of watercourses could result in a reduction in water quality, which could impact biodiversity in downstream areas. However, as the proposed use of the railway corridor would be similar to the existing, the potential increase in contamination from these types of pollutants is expected to be very small.

Erosion and sedimentation

Changes in stormwater flows from any areas that are not adequately stabilised could result in increased erosion and sedimentation impacts. Such impacts could occur in areas that were not previously subject to such flows, such as the embankments near Marrickville Station.

An increase in impervious areas could also result in increased flow volumes and velocities, which have the potential to result in erosion and sedimentation at discharge locations if not adequately mitigated.

The change in impervious areas resulting from the project would be very small compared with the level of urbanisation which already exists in the catchment as a whole (refer to Table 21.6). Additionally, the design would provide necessary flow retardation structures, including scour protection, to minimise the erosion potential of stormwater flows. As such, potential impacts would be limited and localised in nature.

Minimising the effects of proposed stormwater and wastewater management during construction and operation on natural hydrological attributes

Elsewhere in the corridor, peak flow rate increases would generally be mitigated by providing the proposed detention basins at drainage outlets. In some locations, a localised increase in peak flow would be accommodated where modelling indicates that the total peak flow in the stormwater network immediately downstream would not be impacted.

Achieving water quality objectives

As outlined in Table 21.6, water quality control devices are proposed to be incorporated into station areas where space allows. The measures would be variously designed to retain litter and course sediments, and oils and grease where necessary, in accordance with the design guidelines.

As outlined in Section 21.1, the results of preliminary MUSIC modelling indicate that the proposed measures would be effective at reducing pollutant loads to the design guideline targets. However, it is noted that:

- treatment is not proposed within the rail corridor itself
- the targets may not be met at each discharge location, however it is expected that the average would meet the design guideline targets.

To mitigate potential spills of hazardous materials, the project design team would also consider the need for spill containment to be included along with the currently proposed water quality treatment measures.

It is noted that the water quality outcomes have not yet been assessed against the ANZECC 2000 guideline criteria. An assessment against these criteria would be undertaken during the detailed design.

Provision of the proposed water quality treatment measures is expected to contribute to improved water quality overall, although further analysis would be required during detailed design to confirm this. Implementation of effective water quality treatment measures would mean that the project would not impact on the ability of the catchment to meet the water quality objectives over time.

21.3.6 Cumulative impacts

Various drainage works are proposed for flood mitigation purposes, including works by the relevant councils. The design has been prepared taking these into account where details are available. Modelling of the impacts of the project has indicated some reductions in flooding, which may reduce the scope of works required. Ongoing consultation with local councils would be undertaken during detailed design to confirm where the project would interact with local drainage networks.

The project adjoins the Chatswood to Sydenham project. Interface and coordination meetings are being undertaken to ensure that there are no conflicts in scheduling, and that potential cumulative impacts can be avoided. Additional measures would also be confirmed during detailed design for the Chatswood to Sydenham project, with the aim of further reducing flood levels in existing flood areas, including levels at private property.

Urban renewal activities along the corridor include the potential construction of medium and high-rise buildings, within 400 metres of railway stations. It is assumed that all buildings and associated infrastructure would be designed in accordance with relevant council standards and guidelines with respect to flooding.

Considering that the study area is already highly urbanised, it is expected that redevelopment along the corridor would not have any significant impacts in terms of increased runoff and flow velocities. On this basis, no adverse cumulative impacts are expected.

21.4 Mitigation measures

21.4.1 Approach to mitigation and management

The detailed design of the project would continue to take into account necessary measures to minimise the potential for hydrology, flooding, and water quality impacts. Further consideration of measures would, where possible, account for forecast future growth under the draft *Sydenham to Bankstown Urban Renewal Corridor Strategy*.

Mitigation measures are provided in this section to mitigate the potential impacts that have not been avoided by the project design to date.

The main water quality risks are associated with erosion and sedimentation, and works within or near watercourses. The Construction Environmental Management Framework (described in Section 9.1) requires the preparation of a soil and water management plan. This would define the management and monitoring measures that would be implemented to manage water quality impacts, erosion, and sediment control in accordance with relevant guidelines. Soil and water management measures would be developed and implemented in accordance with *Soils and Construction - Managing Urban Stormwater Volume 1* (Landcom 2004) and *Volume 2A* (DECC 2008). In accordance with these guidelines, management measures would be designed to manage a 10 per cent AEP rainfall event.

Where discharge to surface watercourses is required, a monitoring program would be implemented as part of the construction environmental management plan to assess water quality prior to discharge. Indicative requirements for the monitoring program would involve monitoring at six locations, for the duration of construction or as otherwise determined, at monthly intervals. Monitoring parameters would be as per the water quality objectives defined in Section 21.2.5. Proposed monitoring locations are as follows:

- Cooks River downstream of Canterbury Station – at Charles Street, corner of Broughton Street, Canterbury
- Cooks River upstream of Canterbury Station – at Close Street, Canterbury
- upstream channel of Salt Pan Creek – Stacey Street, near Marcella Street, Bankstown
- channel south of Salvia Street, upstream of Salt Pan Creek.

During operation, water quality would be managed to comply with the project’s operational environment protection licence.

The Construction Environmental Management Framework also requires preparation of stormwater and flooding management plans for relevant construction sites, to identify the appropriate design standard for flood mitigation based on the duration of construction, proposed activities, and flood risks. These plans would include develop procedures to ensure that threats to human safety and damage to infrastructure are not exacerbated during the construction period.

21.4.2 List of mitigation measures

The mitigation measures that would be implemented to address potential hydrology, flooding and water quality impacts are listed in Table 21.7.

Table 21.7 Mitigation measures – hydrology, flooding and water quality

ID	Impact/issue	Mitigation measures	Relevant location(s)
Design/pre-construction			
FHW1	Flooding	The design would be reviewed to, where feasible and reasonable, not worsen existing flooding characteristics up to and including the one per cent AEP event (incorporating a 10 per cent allowance for climate change) in the vicinity of the project. Detailed flood modelling would consider: • potential changes to flood prone land and flood levels, including areas of flood risk not already addressed • potential changes to overland flow paths • redistribution of surface runoff as a result of project infrastructure • behaviour of existing stormwater runoff, including the results of any recent flood events • results of detailed asset surveys (e.g. floor levels) • potential changes required to flood evacuation routes, flood warning systems and signage. Flood modelling to support detailed design would be carried out in accordance with the following guidelines: • *Floodplain Development Manual* (DIPNR, 2005) • *Floodplain Risk Management Guideline: Practical Consideration of Climate Change* (DECC, 2007) • *Floodplain Risk Management Guide: Incorporating Sea Level Rise Benchmarks in Flood Risk Assessments* (DECCW, 2010c) • *New guideline and changes to section 117 direction and EP&A Regulation on flood prone land, Planning Circular PS 07-003* (NSW Department of Planning, 2007). Flood modelling and consideration of mitigation measures would be carried out in consultation with the relevant local councils, and the NSW State Emergency Service.	All
FHW2	Stormwater runoff	Where feasible and reasonable, detailed design would result in no net increase in stormwater runoff rates in all storm events, unless it can be demonstrated that increased runoff rates as a result of the project would not increase downstream flood risk.	All
FHW3		Where space permits, on-site detention of stormwater would be introduced where stormwater runoff rates are increased. Where there is insufficient space for the provision of on-site detention, the upgrade of downstream infrastructure would be implemented where feasible and reasonable.	All
FHW4	Consultation	Where relevant, detailed design and construction planning would occur in consultation with the NSW State Emergency Service, and the Inner West and Canterbury-Bankstown councils, to ensure that flood related outcomes are consistent with floodplain risk management studies.	All
FHW5	Scour potential	Further analysis of potential scour would be undertaken during detailed design. This would include the development of appropriate mitigation measures where required, including the installation of detention basins for the duration of construction.	All

ID	Impact/issue	Mitigation measures	Relevant location(s)
FHW6	Water quality	The project would be designed to ensure there is minimal potential for water quality impacts, including incorporating water sensitive urban design elements.	All
Construction			
FHW7	Flooding	Detailed construction planning would consider flood risk for all compounds and work sites. This would include identification of measures to not worsen existing flooding characteristics. Not worsen is defined as: • a maximum increase in flood levels of 50 mm in a one per cent AEP event • a maximum increase in time of inundation of one hour in a one per cent AEP event • no increase in the potential for soil erosion and scouring from any increase in flow velocity in a one per cent AEP flood event.	All
FHW8		The site layout and staging of construction activities would: • avoid or minimise obstruction of overland flow paths and limit the extent of flow diversion required • consider how works would affect the existing stormwater network such that alternatives are in place prior to any disconnection or diversion of stormwater infrastructure.	All
FHW9	Watercourse impacts	Works within or near watercourses (including the Cooks River) would be undertaken with consideration given to the NSW Office of Water's guidelines for controlled activities.	All
FHW10	Water quality	Erosion and sediment mitigation measures would be installed and maintained for the duration of the construction period.	All
FHW11	Water quality monitoring	A water quality monitoring program would be developed and implemented, to monitor water quality at identified discharge points. The program would include relevant water quality objectives, parameters, and criteria and specific monitoring locations identified in consultation with DPI (Water) and the EPA.	All
FHW12		Discharges from construction water treatment devices would be monitored to ensure compliance with the discharge criteria in the environment protection licence.	All
Operation			
FHW13	Water quality	Operational water discharges would be managed in accordance with the water quality management requirements specified in the environment protection licence.	All

21.4.3 Consideration of the interactions between mitigation measures

In addition to the measures for water quality measures described above, there are interactions between the mitigation measures for soils and contamination (Chapter 20), waste (Chapter 26 (Waste management)), and hazardous materials (Chapter 25 (Hazards, risks and safety)). Together, all these measures would ensure appropriate management of water quality, to minimise the potential for impacts to the community and environment.

21.4.4 Managing residual impacts

It is expected that with the appropriate mitigation measures in place, residual impacts during construction are likely to be negligible.

Residual operational impacts of the project could include increases in flood level in rare to extreme flood events of greater than the one per cent AEP climate change event. This could include impacts to surrounding properties, including increased flood depth, potential flood damages during a flood event, and emergency access during times of flooding. Further consultation with relevant stakeholders and consideration of these potential impacts during the detailed design phase would reduce any residual impacts to an acceptable level.

22. Biodiversity

This chapter provides a summary of the results of the biodiversity assessment of the proposal undertaken in accordance with the *Framework for Biodiversity Assessment* (Office of Environment and Heritage, 2014a). A full copy of the assessment report is provided as Technical paper 9 – Biodiversity assessment report. The Secretary's environmental assessment requirements relevant to biodiversity, together with a reference to where the results of the assessment are summarised in this chapter, is provided in Table 22.1.

Table 22.1 Secretary's environmental assessment requirements – biodiversity

Ref	Secretary's environmental assessment requirements - biodiversity	Where addressed
5. Biodiversity		
5.1	The Proponent must assess biodiversity impacts in accordance with the current guidelines including the Framework for Biodiversity Assessment (FBA).	A summary of the results of the biodiversity assessment is provided in this chapter. The full results are provided as Technical paper 9.
5.2	The Proponent must assess any impacts on biodiversity values not covered by the FBA as specified in s2.3.	Section 22.3.7
5.3	The Proponent must assess impacts on the Long-nosed Bandicoot Inner Western Sydney Population (including an assessment of vehicle strike (from more frequent trains) and a loss of threatened species and their habitat which is not associated with vegetation (e.g. building demolition, bridge reconstruction, etc.) and provide the information specified in s9.2 of the FBA.	Sections 22.3.2, 22.3.3 and 22.3.5
5.4	The Proponent must identify whether the project as a whole, or any component of the project, would be classified as a Key Threatening Process in accordance with the listings in the *Threatened Species Conservation Act 1997*, *Fisheries Management Act 1994* and *Environmental Protection and Biodiversity Conservation Act 2000*.	Section 22.3.4

22.1 Assessment approach

22.1.1 Legislation and policy context to the assessment

In addition to the EP&A Act, the following legislation is relevant to the biodiversity assessment:

- TSC Act – provides the statutory framework for the conservation and management of biota of conservation significance in NSW. It lists terrestrial flora, fauna, populations, and communities that must be assessed to determine if an activity would have a significant impact and further assessment or approval is required.
- FM Act – aims to conserve, develop and share the fishery resources of the State for the benefit of present and future generations. It lists aquatic flora, fauna, populations, and communities that must be assessed to determine if an activity would have a significant impact and further assessment or approval is required.
- *Noxious Weeds Act 1993* – provides for the declaration of noxious weeds. It identifies certain classes of noxious weed and required controls. All private landowners, occupiers, public authorities, and councils are required to control noxious weeds on their land.
- EPBC Act – lists matters of national environmental significance, which relevantly include listed threatened species and communities, listed migratory species, Ramsar wetlands of

international significance, and the Commonwealth marine environment, and outlines the approval process where there is the potential for significant impacts to these matters.

The *NSW Biodiversity Offsets Policy for Major Projects* (Office of Environment and Heritage, 2014b) ('the Biodiversity Offsets Policy') provides guidance in relation to biodiversity offsetting for major project approvals. A key principle underpinning the policy is that offset requirements should be based on a reliable and transparent assessment of biodiversity losses and gains. The policy:

- establishes a set of offsetting principles for major projects
- defines key thresholds for when offsetting is required
- adopts an assessment methodology to quantify and describe the offset required
- defines the mechanisms required to establish offset sites
- provides a range of flexible options that can be used in lieu of providing offsets, including rehabilitation actions and supplementary measures.

The Biodiversity Offsets Policy is underpinned by the *Framework for Biodiversity Assessment*. The framework sets out:

- requirements for a reliable and transparent assessment of biodiversity values on land to:
  - identify the biodiversity values subject to a proposed major development
  - determine the impacts of the development on biodiversity
  - quantify and describe the biodiversity offsets required for the unavoidable impacts of the development on biodiversity values
- types of conservation measures that are available to offset the unavoidable impacts of major projects, and how they may be used by a proponent to prepare a biodiversity offset strategy.

Under the *Framework for Biodiversity Assessment*, should biodiversity credits be required to offset impacts, a Biodiversity Offset Strategy must be prepared to outline how the proponent intends to offset the impacts of a major project.

Where a proponent is proposing to establish an offset site as part of a biodiversity offset strategy for a major project, the *Framework for Biodiversity Assessment* requires that the Biobanking Assessment Methodology be used to:

- assess the biodiversity values of the offset site
- identify the number and type of biodiversity credits that may be created on the offset site.

22.1.2 Methodology

The main components of the methodology for the biodiversity assessment were:

- A desktop assessment was undertaken to describe relevant features of the existing environment and to identify the suite of threatened biota potentially affected by the project.
- Field surveys were undertaken to describe the biodiversity values of the project area and wider study area, to determine the likelihood of threatened biota and their habitats occurring in the project area and/or being potentially impacted by the project.
- Calculations were undertaken in accordance with the *Framework for Biodiversity Assessment,* using the credit calculator (version 4.1), to quantify the biodiversity impacts of the project, and determine the biodiversity credits required to offset these impacts.

Study area

The study area for the biodiversity assessment included the project area with buffers in some locations to include areas of adjoining vegetation or biodiversity value. The study area is shown in Figure 22.1.

Literature review and database searches

Existing information on the biodiversity of the study area was obtained from a range of sources, including databases, aerial photographs and maps, and previous studies carried out in the study area. Previous documents and reports relevant to the study area were reviewed, including previous biodiversity studies, environmental attribute mapping, and previous impact assessments. Digital aerial photography was reviewed to identify spatial patterns in vegetation, land use, and landscape features.

Searches were undertaken of species databases to identify:

- threatened flora and fauna species, populations and ecological communities, listed under the TSC Act and FM Act
- nationally threatened native species, ecological communities, and native migratory species listed under the EPBC Act.

The search area adopted was a radius of ten kilometres around the study area.

Likelihood of occurrence

The database searches identified threatened flora and fauna species either recorded or considered likely to occur in the search area. The probability of each threatened species occurring within the study area was rated as low, moderate, high, or known, based on the criteria provided in Technical paper 9.

Survey effort

Staged surveys of the study area were conducted with reference to Section 6 of the *Framework for Biodiversity Assessment* and relevant targeted survey guidelines. This included taking into consideration the threatened biota that may occur given the urban context of the study area and the modified nature of habitats present.

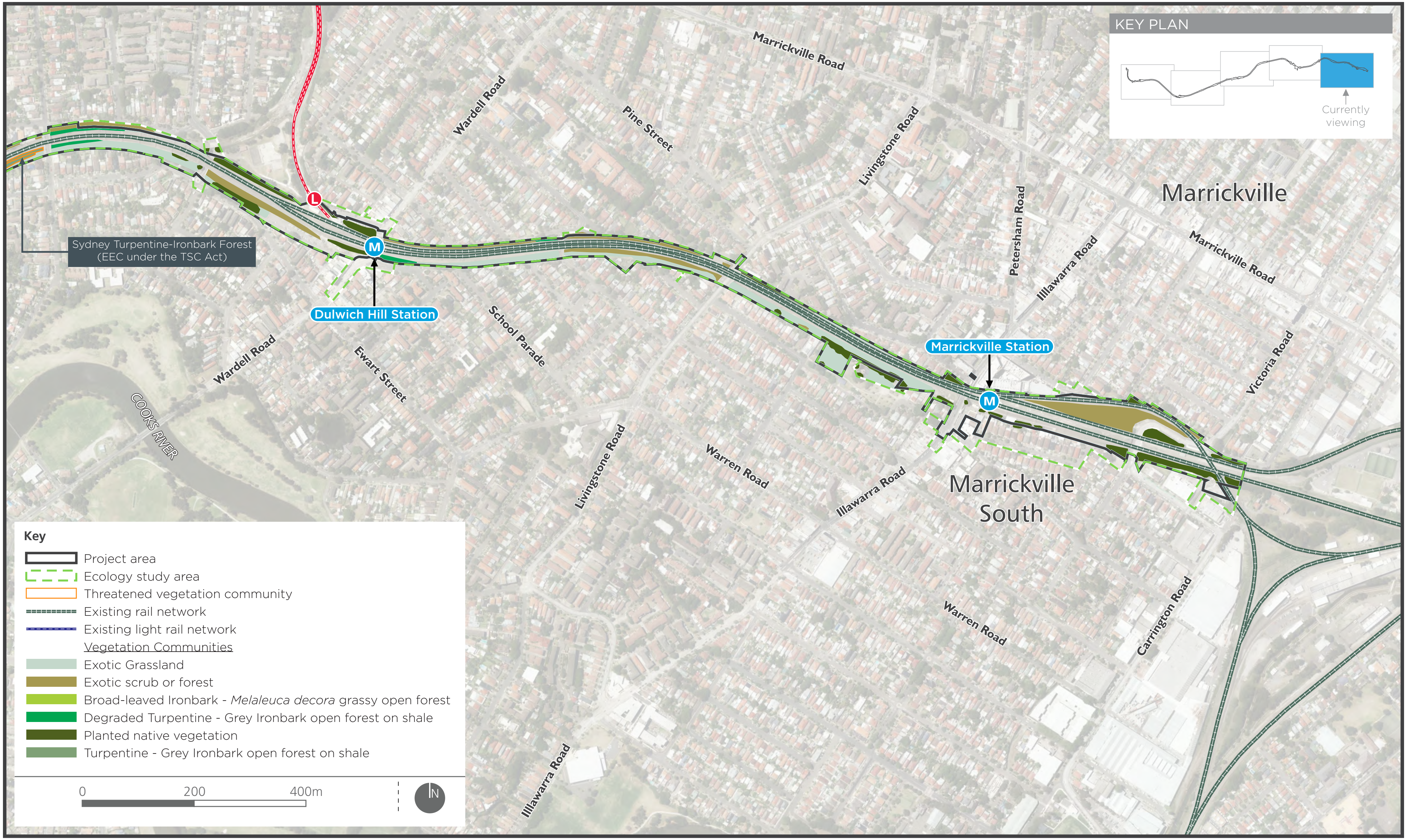
Surveys were undertaken on 16 June 2016, 22-23 June 2016 and 5 October 2016.

Biodiversity credits

The Biobanking Assessment Methodology sets out how biodiversity values are to be assessed, establishes rules for calculating the number and class of biodiversity credits, and determines the trading rules that will apply. The methodology includes a software package known as the BioBanking Credit Calculator, which processes site survey and assessment data by:

- assessing the biodiversity on a project site
- calculating the number and type of credits required to offset impacts on biodiversity and to be created on a biobank site
- estimating the approximate area of land required for an offset.

The credit calculator was used to determine the number and type of biodiversity credits required to offset the impacts of the project.



sydney METRO | city & southwest

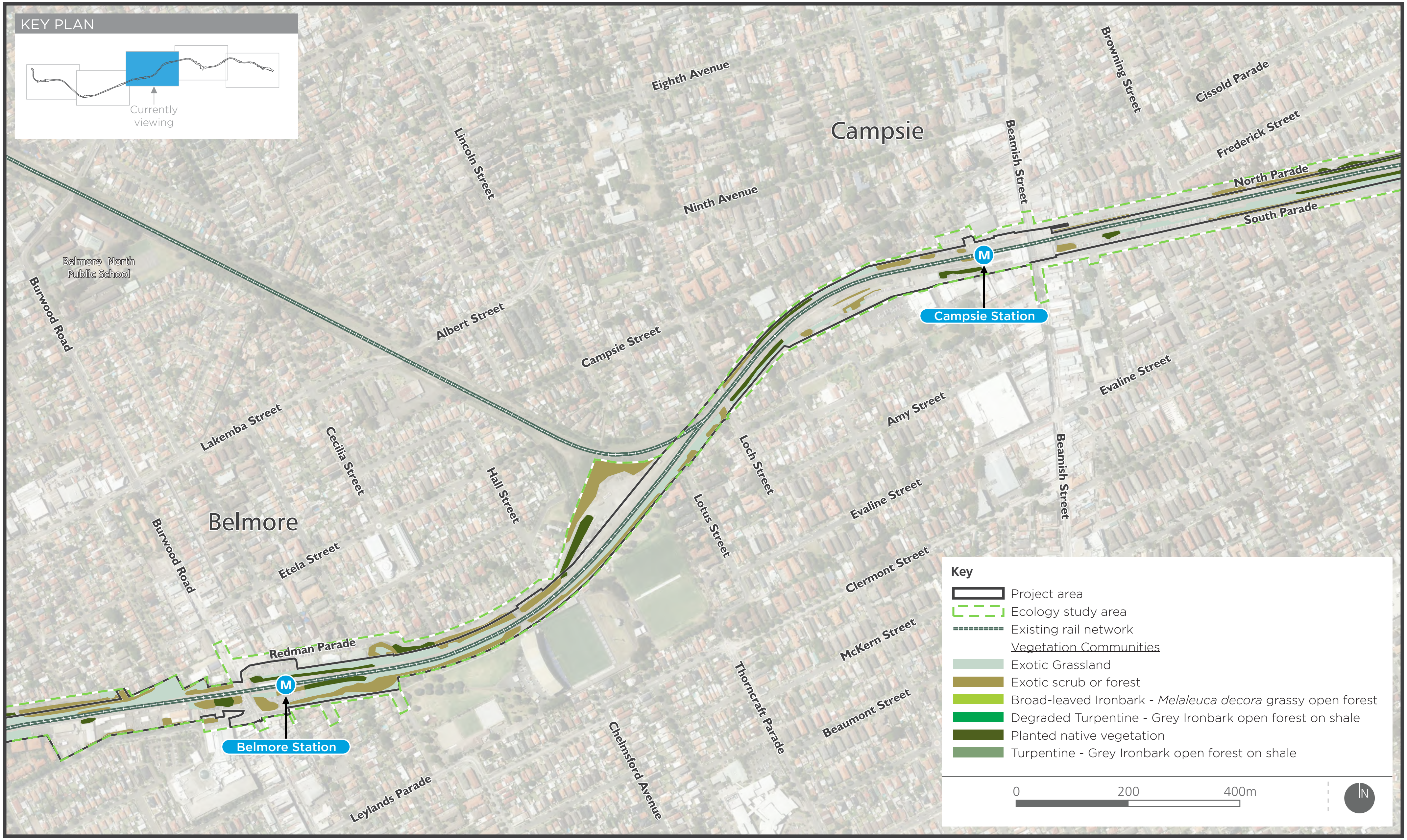
Biodiversity study area, vegetation and threatened species - map 1

FIGURE 22.1

sydney METRO | city & southwest

Biodiversity study area, vegetation and threatened species - map 2

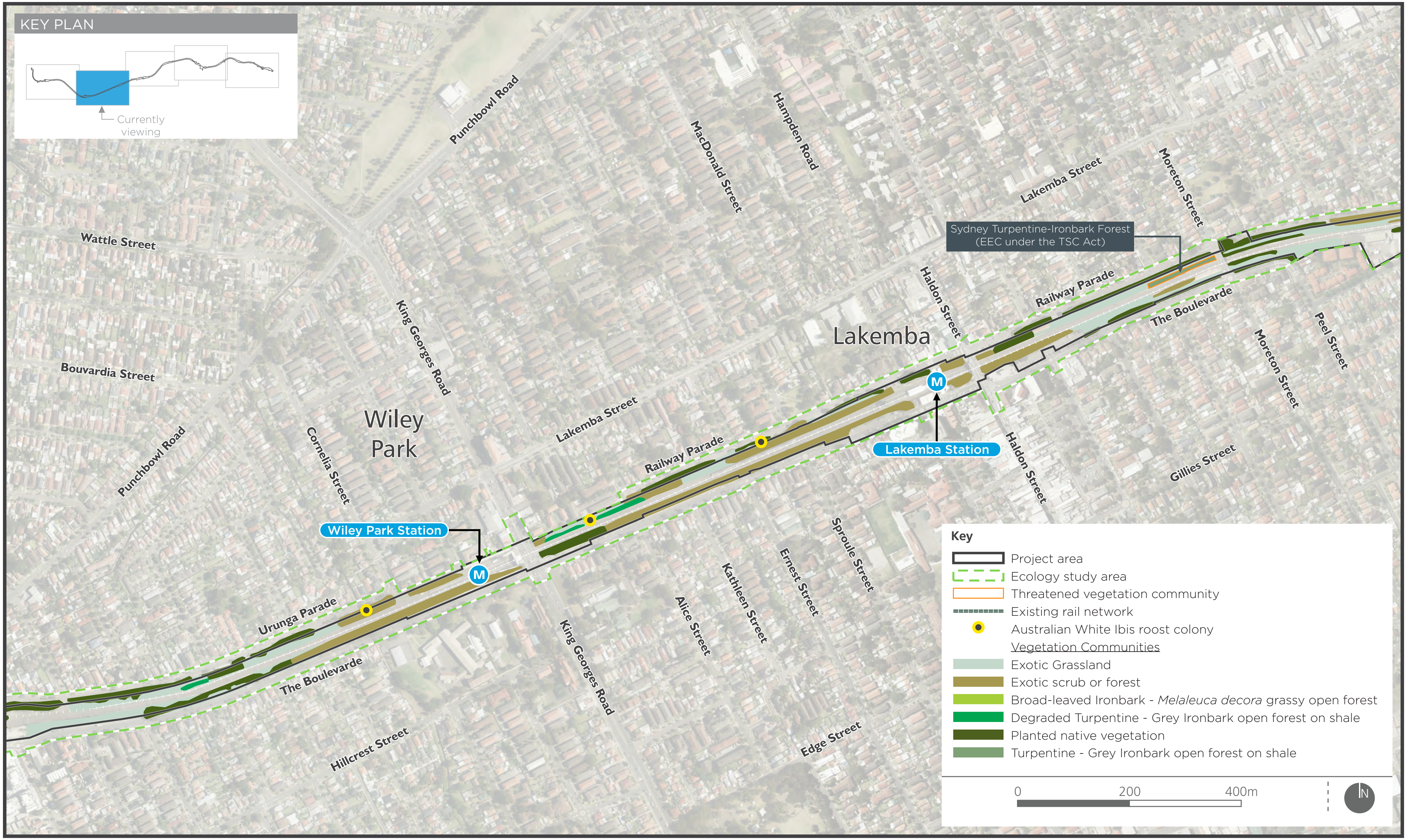
FIGURE 22.1



sydney METRO | city & southwest

Biodiversity study area, vegetation and threatened species - map 3

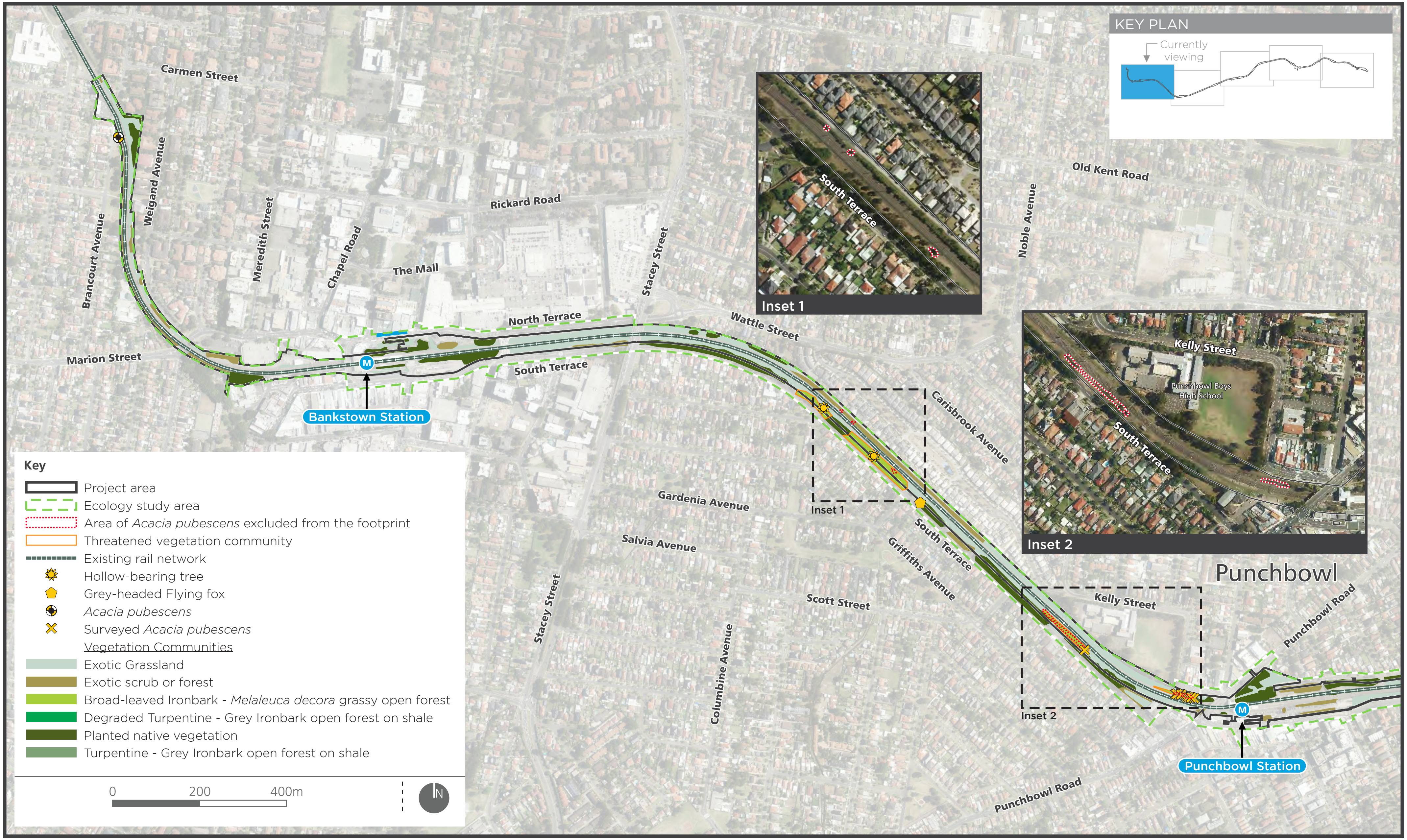
FIGURE 22.1



Sydney METRO | city & southwest

Biodiversity study area, vegetation and threatened species - map 4

FIGURE 22.1



sydney METRO | city & southwest

Biodiversity study area, vegetation and threatened species - map 5

FIGURE 22.1

Flora surveys

Vegetation was mapped in the field via systematic walked transects across the entire study area, which was divided into relatively homogenous or discrete units. The remainder of the study area (containing non-native vegetation) was divided into separate map units based on observed structure and species composition.

Threatened plant surveys were conducted throughout the study area during field surveys. Threatened plants potentially present were identified based on the desktop assessment results and the species credit-type threatened species identified by the preliminary *Framework for Biodiversity Assessment* credit calculations. Habitat for these species was identified based on threatened species profiles. A supplementary threatened flora survey was conducted over one day, including targeted threatened flora searches in areas of previously identified habitat, and precise mapping of the locations of threatened plants.

Fauna surveys

The survey methodology included relatively limited targeted fauna survey techniques. This was because of the limited extent and quality of fauna habitat in the study area, and because the *Framework for Biodiversity Assessment* assesses the majority of threatened fauna species that could occur based on habitat.

An assessment was made of the type and quality of habitats present in the study area for native fauna. Habitat quality was based on the level of breeding, nesting, feeding, and roosting resources available. The study area was searched for habitat features, such as hollow-bearing trees, feed trees for the Grey-headed Flying-fox, and shelter habitat for the Long-nosed Bandicoot. Culverts and bridges were inspected for signs of roosting bats (such as bat droppings) or bird nests.

Spotlighting for nocturnal fauna was also carried out, targeting the Long-nosed Bandicoot, Grey-headed Flying-fox, and other nocturnal fauna. Spotlighting was conducted within the rail corridor near Dulwich Hill and Marrickville stations, and between Bankstown and Punchbowl stations. Call playback for the Barking Owl and Powerful Owl was also conducted.

Three motion activated infra-red cameras were set in the rail corridor between Hurlstone Park and Marrickville stations, particularly targeting potential habitat for the Long-nosed Bandicoot. Searches for bandicoot diggings were also conducted in grassland areas between Hurlstone Park and Marrickville.

22.2 Existing environment

22.2.1 Flora

The majority of the study area has been heavily modified by past and ongoing disturbances associated with urban development and the active rail corridor. Urban development, clearance, and ongoing maintenance of the rail corridor has resulted in fragmentation, a high level of disturbance, and degradation of vegetation communities.

The majority of vegetation in the project area and surrounding study area comprises exotic or planted native species on highly modified landforms. There are small isolated patches of remnant or regrowth native vegetation in small portions of the study area associated with rail cuttings with less disturbed soil profiles.

Native vegetation and habitat within the project area is in medium to poor condition, and features impacts from existing maintenance activities, edge effects, weed infestation, and exotic pests.

Database search results

A search of relevant databases indicated that 38 threatened flora species or populations listed under the TSC Act, 25 threatened flora species listed under the EPBC Act, and six threatened ecological communities listed under the TSC Act and/or the EPBC Act have been recorded or are predicted to occur in the search area.

Threatened species with the potential to occur, given nearby records and potential presence of suitable habitat, include:

- a small shrub (*Pultenaea parviflora*), listed as an endangered species under the TSC Act and a vulnerable species under the EPBC Act
- Matted Pea Bush, listed as an endangered species under the TSC Act
- Narrow-leafed Wilsonia*,* listed as a vulnerable species under the TSC Act
- Downy Wattle*,* listed as a vulnerable species under the TSC Act and the EPBC Act
- Austral Toadflax, listed as a vulnerable species under the TSC Act and the EPBC Act.

Vegetation mapping

According to *Native vegetation of the Sydney Metropolitan Area,* the most extensive vegetation map unit in the study area is 'Urban/exotic/native'. No native vegetation is mapped within the study area. A linear strip of 'Estuarine Mangrove Forest' is mapped immediately adjacent to the study area where it crosses the Cooks River.

Flora survey results

There is relatively low native species richness within the study area, which confirms that the native vegetation has been extensively modified and is in moderate to poor condition.

A total of 129 flora species from 40 families were recorded within the study area, comprising 63 native and 66 exotic species. Poaceae (grasses, 22 species, 11 native), Myrtaceae (flowering shrubs and trees, 20 species, 13 native), Fabaceae (23 species, 17 native), and Asteraceae (flowering herbs, 11 species, 2 native) were the most diverse families recorded. One threatened flora species (Downy Wattle) was recorded in the study area, outside the project area.

Plant communities

Plant communities in the study area are summarised in Table 22.2 and shown in Figure 22.1.

The majority of vegetation in the study area (97 per cent) comprises exotic or planted native species. About 0.6 hectares of the native vegetation matches two plant community types according to the *Framework for Biodiversity Assessment*:

- Turpentine - Grey Ironbark open forest on shale (PCT ID 1281, Biometric vegetation type HN604)
- Broad-leaved Ironbark - Grey Box - *Melaleuca decora* grassy open forest (PCT ID 724, Biometric vegetation type HN512).

Table 22.2 Vegetation in the study area

Plant community type	Condition	Conservation significance	Extent in study area (hectares)
Turpentine - Grey Ironbark open forest on shale	Moderate/good - medium	Conforms to the TSC Act listed endangered ecological community *Sydney Turpentine Ironbark Forest in the Sydney Basin Bioregion*	0.2
Degraded Turpentine - Grey Ironbark open forest on shale	Moderate/good - poor	Not an endangered ecological community because it does not contain characteristic canopy species.	0.4
Broad-leaved Ironbark - Grey Box - *Melaleuca decora* grassy open forest	Moderate/good	Conforms to the TSC Act endangered ecological community *Shale Gravel Transition Forest in the Sydney Basin Bioregion*	0.4
Subtotal – native vegetation			***1.0***
Exotic grassland	Cleared/non-native vegetation	Very low (exotic vegetation)	12.5
Exotic scrub or forest	Cleared/non-native vegetation	Very low (exotic vegetation)	9
Planted native species	Cleared/non-native vegetation	Low (non-indigenous native vegetation)	7.3
Subtotal – exotic or planted native vegetation			***28.8***
Total vegetation in study area			**29.8**

Noxious weeds

Fifteen species of noxious and environmental weeds are broadly distributed throughout the study area. Many of these are also listed as 'weeds of national significance', which are recognised as Australia's worst invasive plants.

Threatened flora species

No listed threatened flora species were recorded in the project area. One threatened plant species Downy Wattle (*Acacia pubescens)* listed as vulnerable under the EPBC Act and TSC Act, was recorded in the study area. Around 650 stems are located near the project area as shown in Figure 22.1.

The patches of stems recorded are located mainly in the vicinity of Punchbowl Station, with around two stems recorded in the rail corridor, and one stem in a Council reserve around 100 metres east of the Yagoona substation. The project has been designed to avoid impacting on the recorded locations of this species.

Threatened ecological communities

As noted in Table 22.2, two of the native plant communities identified conform to the following threatened ecological communities listed under the TSC Act:

- *Sydney Turpentine Ironbark Forest in the Sydney Basin Bioregion* (Sydney Turpentine Ironbark Forest)
- *Shale Gravel Transition Forest in the Sydney Basin Bioregion* (Shale Gravel Transition Forest).

No threatened ecological communities listed under the EPBC Act are located in the study area.

Groundwater dependent ecosystems

The National Atlas of Groundwater Dependent Ecosystems, maintained by the Bureau of Meteorology, maps known groundwater dependent ecosystems and ecosystems that potentially use groundwater. No groundwater dependent ecosystems are located in the study area.

Some patches of vegetation along Wolli Creek downstream of the study area are mapped as potential groundwater dependent ecosystems. Wolli Creek is subject to pollution from urban environments, and its interaction with the Cooks River, which is heavily polluted.

22.2.2 Terrestrial fauna

Database search results

A total of 60 threatened fauna species listed under the TSC Act and 25 threatened fauna species listed under the EPBC Act have been recorded or are predicted to occur in the search area. Most of these threatened species are considered unlikely to occur, as they rely on specific habitat that is not present in the project area.

Species considered most likely to occur include:

- the Grey-headed flying-fox, listed as a vulnerable species under the TSC Act and the EPBC Act
- microchiropteran bats, such as the Eastern Bentwing Bat and Large-footed Myotis, listed as vulnerable species under the TSC Act
- a range of threatened bird species listed, under the TSC Act and/or the EPBC Act, which may forage in planted trees or along the Cooks River on occasion.

Terrestrial fauna habitats

Several general fauna habitat types were identified during field surveys. Each of these habitat types has a range of characteristics that influence habitat value, and the range of fauna species with the potential to be present. These are summarised below.

Exotic and native grassland

The majority of the rail corridor is cleared and vegetated with introduced grasses and herbs, interspersed with bare ground, ballast, and other artificial substrates. Some areas with native groundcover species are present. These areas are devoid of shrubs and trees. Exotic and native grassland contains few habitat resources of relevance to most native species.

Exotic forest and scrub and planted native species

Patches of weeds and planted native or exotic trees and shrubs within the study area provide potential foraging habitat for a range of common bird species (the Noisy Miner was the most abundant species observed) and mammal species (including the Common Brushtail Possum and Common Ringtail Possom).

Three roosting colonies of the Australian White Ibis were observed in planted trees in the rail corridor near Wiley Park Station.

Native woodland and forest

Occasional hollow-bearing trees, which could provide potential nesting habitat for arboreal mammals or birds, were recorded in the Punchbowl to Bankstown section of the study area. A range of flowering shrubs and trees are present, including Tallowood, Sydney Blue Gum, Turpentine, and Red Ironbark, which provide foraging resources for a range of birds, including cockatoos, parrots, honeyeaters, and arboreal mammals.

Two hollow-bearing trees were identified within the rail corridor at Punchbowl. These would potentially be used by common and introduced species. They could also be used by microbat species as roosting habitat.

No large hollows suitable for threatened owls were identified. Species such as the Powerful Owl may forage for arboreal mammals (including possums) within the rail corridor.

Culverts and bridges

Culverts provide potential temporary roosting habitat for microbat species, such as the threatened Eastern Bentwing Bat and Large-footed Myotis. The Eastern Bentwing Bat breeds in specific maternity roosts and would not breed in these structures. However, there is potential for the Large-footed Myotis to breed in these structures. No bats were observed in the culverts inspected during surveys, and no bat droppings were detected.

No bird nests were observed in any culverts inspected during the surveys, although it is possible that species such as Welcome Swallows and Fairy Martins could use these built features for nesting.

Many rail bridges are present in the project area. These provide breeding habitat for the introduced Rock Dove. No evidence of roosting bats or bat droppings were detected at any of the bridges inspected.

A number of structures (e.g. station buildings, warehouses, and residential buildings) within the project area may provide roosting habitat for the introduced Rock Dove and native species, such as Welcome Swallows and Fairy Martins. Microbats, including the Gould's Wattled Bat, were recorded by Arcadis (2016) in the Marrickville area during surveys for the Chatswood to Sydenham project.

Urban gardens

Urban gardens are known to provide shelter and foraging habitat for the Long-nosed Bandicoot. However, no evidence of bandicoots was recorded during targeted surveys, and no evidence of bandicoots was recorded in 2016 during four months of infra-red camera surveys along the light rail line or from the associated community survey.

Fauna survey results

A low diversity of fauna species was recorded during the field surveys, as would be expected in a highly modified urban environment. A total of 23 native species were recorded during surveys, which included 17 bird species, two mammal species, three reptile species, and one frog species. No microbat species were recorded. Five introduced bird species and three introduced mammal species were also recorded. One threatened fauna species, the Grey-headed Flying-fox, was recorded.

Literature review

The Long-nosed Bandicoot population in inner western Sydney is known or predicted to occur in the study area. The rail corridor is located along the southern boundary of the mapped core area of records of the population. The exact area occupied by the population is not clearly defined, but it includes parts of the former local government areas of Marrickville and Canada Bay, with the likelihood that it also includes parts of the former Canterbury, Ashfield, and Leichhardt local government areas. Potential habitat for the bandicoot is present in parts of the study area.

Threatened fauna species and populations

The Grey-headed Flying-fox, which is listed as vulnerable under the TSC Act and EPBC Act, was recorded in the study area. The location of this record is shown in Figure 22.1. No microbats were recorded during anabat surveys. This may suggest there is only limited habitat for these species, and that none rely on the habitats present for their foraging requirements. Nevertheless, the following species listed as vulnerable under the TSC Act are considered likely to occur:

- Eastern Bentwing Bat
- Large-footed Myotis
- Eastern Freetail Bat
- Yellow-bellied Sheath-tail Bat.

Although the Long-nosed Bandicoot population in inner western Sydney is known or predicted to occur in the study area, no evidence of the population was found, either from searches for diggings or camera surveys, and there have been no records of the population or any recent sightings since 2014. Spotlighting undertaken during the assessment did not identify any records of this species.

The biodiversity assessment concluded that the Long-nosed Bandicoot is unlikely to occur in the project area, as a result of:

- the lack of evidence of the species in the project area and surrounding area, despite recent targeted surveys
- limited presence of shelter habitat
- high abundance of introduced predators
- difficulty of access to the rail corridor.

22.2.3 Aquatic ecology

Cooks River

The project area crosses the Cooks River to the west of Canterbury Station. The Cooks River is also located downstream of the study area between Marrickville and Campsie stations. The Cooks River is mapped as key fish habitat.

Two threatened fauna species listed under the FM Act have been recorded or are predicted to occur in the study area. However, based on previous records and habitat requirements, these species are considered unlikely to occur.

Sampling carried out in 2007 in Wolli Creek, which flows into the Cooks River at Tempe, identified six native fish species in the freshwater section above the Henderson Street weir at Turella:

- Empire Gudgeon
- Flathead Gudgeon
- Striped Gudgeon
- Firetail Gudgeon
- Common Galaxia
- Long-Finned Eel.

The following species were collected immediately below the weir and are likely to occur along the Cooks River:

- Sea Mullet
- Yellow-fin Bream
- Port Jackson Perchlet
- Toadfish.

Table drains

Aquatic habitats within the project area are mostly limited to a number of shallow table drains alongside the rail line. Most ditches are shallow, with no emergent vegetation, however some display emergent rushes (*Typha*). Table drains are generally fed by seepages from embankments. Some drains run into concrete gutters before exiting from the railway corridor. The Common Eastern Froglet was heard calling from table drains.

No threatened species listed under the FM Act have potential habitat in these table drains. Table drains do not classify as key fish habitat.

Cup and Saucer Creek

The route for the proposed high voltage electricity feeder cable between the proposed Campsie traction substation and the existing Ausgrid Canterbury electrical substation would cross Cup and Saucer Creek. At the crossing location, the creek consists of a concrete canal. The canal is concrete-lined to its confluence with the Cooks River, about 250 metres to the north, and for a number of kilometres upstream. A stormwater treatment wetland (Cup and Saucer Wetland) was constructed by Sydney Water in 2010 near the confluence of the creek and the river to filter some of the stormwater in Cup and Saucer Creek.

22.2.4 Other matters of national environmental significance

The protected matters search tool identified six World Heritage Properties, six National Heritage Places, and one wetland of international importance within the search area. The project would not impact on the World Heritage Properties and National Heritage Places as they are outside the study area. The wetland of international importance, Towra Point Nature Reserve, is located on the southern side of Botany Bay, over four kilometres from the mouth of the Cooks River. This location is well beyond the maximum extent of potential impacts arising from the project.

A large number of migratory species were reported in the search area by the protected matters search tool based on species behaviour and habitat presence. However, only three of these species were considered to have the potential to occur within the study area on an occasional or transient basis – Satin Flycatcher, Rufous Fantail, and Rainbow Bee-eater. No potential habitat for these wetland species is present in the project area.

22.3 Impact assessment

22.3.1 Risk assessment

Potential risks

The environmental risk assessment for the project, undertaken for the State Significant Infrastructure Assessment Report, identified the following as the main potential biodiversity risks:

- impacts to the Long-nosed Bandicoot listed under the TSC Act, and areas of known habitat
- loss of foraging habitat for the threatened Grey-headed Flying Fox (vegetation adjoining the corridor) and foraging and roosting habitat (e.g. culverts and bridges) for threatened microchiropteran bats
- impacts to patches of remnant or regenerating vegetation, comprising potential habitat for threatened ecological communities and/or threatened plants
- impacts to riparian and aquatic habitats associated with the Cooks River crossing
- removal of street trees, particularly at stations.

Other potential risks include:

- clearing of native vegetation resulting in direct impacts on threatened species and endangered populations and communities, loss of fauna habitat, habitat fragmentation, and loss of connectivity
- potential for pest plants and animals
- indirect impacts due to increased dust, sedimentation and erosion, noise, and light
- disturbance to aquatic habitats
- alterations to surface water flow regimes and interruptions to fish passage
- fauna mortality from vehicle strikes.

How potential impacts have been avoided or minimised

In general, potential impacts on biodiversity have been avoided or minimised by:

- designing the project to minimise the potential for impacts outside the rail corridor
- placement of construction compounds within already cleared areas where practicable (e.g. carparks)
- the location of project infrastructure at Punchbowl Station was refined to avoid impacts on Downy Wattle
- areas of Downy Wattle between Punchbowl and Bankstown stations were excluded from the project area and would be protected during construction.

22.3.2 Construction impacts

Potential impacts on biodiversity during construction include:

- direct impacts as a result of clearing of vegetation in the project area
- indirect impacts on flora and fauna located outside the project area as a result of activities within the project area.

A summary of the results of the impact assessment is provided below.

Vegetation clearing

As described in Chapter 9 (Project description - construction), it is assumed that construction of the project would require removal of all vegetation located along the rail corridor in the project area. This would involve removal of 29.8 hectares of vegetation. The majority of this vegetation comprises exotic plants or planted (often non-indigenous) native species on fill material, with native vegetation making up around three per cent of the direct disturbance footprint. Removing all vegetation in the rail corridor would impact a total of one hectare of native vegetation.

The project has been designed to avoid impacts on the local population of the endangered plant species Downy Wattle. There are no Downy Wattle stems in the project area, and none would be impacted during construction.

As described in Section 9.3, a number of trees of varying sizes would also need to be removed to facilitate works at each station. This impact, which has the potential to affect the amenity and character of station areas, is considered in Section 19.3.2. Impacts to trees would be managed in accordance with the proposed tree management and replacement strategy (described in Section 9.3). This would include preparation of comprehensive tree reports by a qualified arborist for each tree requiring protection, pruning, or removal, to guide the approach to managing each tree during construction.

Terrestrial habitat removal

Only a small area of fauna habitat would be removed, as most of the project area is already cleared land. The vegetation that would be removed or modified provides limited habitat resources for native fauna species, due to its existing highly modified nature and the surrounding urban environment. Fauna habitat resources that would be removed include foraging and shelter resources for mainly common native fauna typical of urban environments. It is highly unlikely that any threatened species or any fauna populations would rely on the habitat resources within the project area for their survival.

Loss of fauna habitat would involve the following:

- removal of one hectare of native vegetation, and 7.3 hectares of planted native species, which would provide nesting and foraging habitat for common species of birds and possums
- removal of 7.9 hectares of foraging habitat for the threatened Grey-headed Flying-fox, Eastern Bentwing Bat and other threatened fauna species with known or potential habitat in the study area
- removal of 21.5 hectares of exotic vegetation with a forest, scrub, or grassland structure, which provides nesting and potential foraging habitat for species such as the Long-nosed Bandicoot and common small birds, as well as shelter and foraging habitat for reptiles and frogs
- removal of aquatic habitat associated with drainage channels
- possible removal of potential roost sites for common microbats associated with two hollow-bearing trees at Punchbowl, and impacts to bridges and culverts
- removal or disturbance of vegetation providing habitat for the Australian White Ibis near Wiley Park Station, resulting in dispersal of individuals to other locations.

Fragmentation or isolation of habitat

The vegetation within the study area is currently fragmented by the existing rail corridor, roads, and urban development. It is unlikely that the project would create an additional barrier to movement. Therefore, the project is unlikely to affect the life cycle of either common or threatened flora species.

The only remnant vegetation adjacent to the study area is a narrow, linear strip along the banks of the Cooks River. The removal of a small area of vegetation at the edge of this patch would not sever this connecting link, and is unlikely to significantly increase the degree of fragmentation of native vegetation and habitat in the local area. Connectivity of terrestrial, riparian, and aquatic habitat would be maintained.

Works to overbridges and culverts have been designed to minimise the impact on hydrology and flooding. Once construction is complete, connectivity of aquatic habitats would be relatively unaffected.

Fauna injury or mortality

Construction has the potential to result in injury or mortality of some individuals of less mobile fauna species, and other small terrestrial fauna that may be sheltering in vegetation within the project area. The potential injury or mortality of individuals is highly unlikely to affect an ecologically significant proportion of any local populations. More mobile native fauna, such as native birds, bats, terrestrial, and arboreal mammals are likely to be able to evade injury during construction activities.

Impacts on the Long-nosed Bandicoot Inner Western Sydney population

As noted in Section 22.2.2, the biodiversity assessment concluded that the Long-nosed Bandicoot is unlikely to occur in the project area. As a result, no direct impacts of the project on this species are predicted.

Construction traffic has the potential to introduce a vehicle strike risk to any individuals that may be present in the surrounding area. However, given the lack of evidence of a resident population in the project area and its position at the edge of the mapped habitat area, it is unlikely that this would occur.

The project would not increase the predation risk of the bandicoot in the region, as it would not result in an increase in foxes or cats.

Noise and vibration from construction and operation has the potential to disturb fauna adjacent to the project area. However, individuals are likely to be accustomed to existing noise from trains, road traffic, and the urban environment, as well as lights from trains, cars, streetlights, and buildings. While there would be localised increases in noise and light that could temporarily create disturbance, increases in noise and light above existing background levels are unlikely to result in a significant impact.

Aquatic habitat

The project would remove small areas of low quality aquatic habitat associated with drainage structures and small depressions. There would be no direct impacts (such as blockage of fish passage or removal of key fish habitat) on the Cooks River.

Impacts on groundwater dependent ecosystems

Any runoff (including water, sediments and contaminants) during construction would be managed to minimise the potential for indirect impacts on downstream areas, including the groundwater dependent ecosystems present along Wolli Creek.

Indirect impacts

Indirect impacts could include the following:

- Edge effects – these can occur in adjoining areas of vegetation and habitat as a result of weed growth, increased noise and light, erosion and sedimentation, and can result from vegetation clearance, where a new edge is created between vegetation and cleared areas, or from widening or extending cleared easements through existing vegetation.
- Light and noise – these could impact breeding, foraging, and roosting activities where fauna are located close to construction activities.
- Erosion, sedimentation, and dust generation – uncontrolled erosion can cause weed problems, reduce habitat values, and stifle plant growth.
- Weeds – dispersal of weed propagules (seeds, stems and pollen) into areas of native vegetation could occur as a result of erosion (wind and water) and the movement of workers and vehicles.
- Plant pathogens – potential spread of soil-borne pathogens of native plants (such as Phytophthora) spread on machinery.
- Disease – potential spread of Chytrid fungus into local native frog populations, through soil and water carried on machinery and by the movement of workers between different areas.
- Aquatic habitat disturbance – as a result of works near the Cooks River and potential water quality impacts.

These impacts can be managed through the implementation of standard construction soil and water management measures (listed in Chapters 20 (Soils and contamination) and 21 (Hydrology, flooding and water quality)), and the mitigation measures listed in Section 22.4. With the implementation of these measures, no significant indirect impacts on biodiversity are predicted.

22.3.3 Operation impacts

The project area is dominated by existing rail and road infrastructure, and is located in a highly modified environment. Vegetation adjoining the project area is already subject to weed infestation and other edge effects. Fauna that occupies habitats within the project area and adjacent areas are likely to be accustomed to noise from trains, road traffic, and the urban environment. Given the highly modified habitats present, additional train movements are unlikely to significantly increase the risk of collisions.

In this context, the project is likely to comprise only a minor increase in any of these potential impacts. The project is unlikely to increase the extent, duration, or magnitude of these impacts, to the extent that a significant negative effect on biodiversity values would result during operation.

As noted in Section 22.3.2, the Long-nosed Bandicoot is not considered likely to occur within the project area. However, for any individual present, operation of the project has the potential to increase the risk of vehicle strike due to an increased frequency of metro services along the corridor compared to existing services. Given the lack of evidence of a resident population in the project area, and the project area's position at the edge of the mapped habitat area, any increase in the number of train services is unlikely to impact the bandicoot.

Similar to the potential for construction impacts, any additional noise or light during operation is unlikely to impact any local population of the Long-nosed Bandicoot. Bandicoots (if present) are likely to be accustomed to existing noise and light from trains, road traffic, and the urban environment. Increases in noise and light above existing background levels are unlikely to result in a significant change in impacts.

22.3.4 Key threatening processes

A key threatening process is as an action, activity, project or potential threat, listed under the TSC Act, FM Act, and EPBC Act, which:

- adversely affects two or more threatened species, populations, or ecological communities
- could cause species, populations or ecological communities that are not currently threatened to become threatened.

The key threatening processes relevant to the project are considered in Table 22.3. The project itself does not constitute a key threatening process, and is unlikely to exacerbate those processes. Implementation of the mitigation measures described in Section 22.4 would minimise the potential impacts identified.

Table 22.3 Key threatening processes relevant to the project

Key threatening process	Listing	Assessment
Clearing of native vegetation	TSC Act EPBC Act	The project would involve clearing of one hectare of remnant and regrowth native vegetation, and would not affect the viability of remnant vegetation in the study area, or reduce the extent of habitat below the minimum size required for any fauna species. The majority of vegetation to be removed is in relatively poor condition, and on the edge of remnant patches adjacent to the rail corridor.
Clearing of hollow-bearing trees	TSC Act	Surveys undertaken for the biodiversity assessment indicated that the project would remove two hollow bearing trees as part of the clearing of native vegetation within the rail corridor.
Removal of dead wood and dead trees	TSC Act	The project area contains very little fallen timber. Construction may result in the removal or disturbance of the minimal amounts of timber that occur.
The degradation of native riparian vegetation along NSW water courses	FM Act	Planted riparian vegetation is located along the banks of the Cooks River (near Canterbury Station). The project would not impact this vegetation.
Human-caused climate change	TSC Act EPBC Act	Combustion of fuels associated with construction and operation would contribute to emissions of greenhouse gases. The project does not pass through any areas mapped as coastal corridors for climate change.

22.3.5 Impacts on biodiversity related matters of national environmental significance

Threatened ecological communities

There are no threatened ecological communities listed under the EPBC Act in the study area. There is native vegetation in the study area that is floristically similar to Cumberland Plain Woodland and Shale-gravel Transition Forest or Sydney Turpentine Ironbark Forest, both of which are listed as Critically Endangered Ecological Communities under the EPBC Act. The vegetation in the study area does not meet the patch size or condition criteria required to comprise occurrences of these Critically Endangered Ecological Communities as defined under the EPBC Act.

Threatened species

The study area contains around 650 stems of Downy Wattle, which is listed as a vulnerable species under the EPBC Act. The project has been purposefully designed to avoid impacts on the population of this threatened plant. There are no Downy Wattle stems in the project area. An assessment of the likely significance of impacts on Downy Wattle was prepared as part of the biodiversity assessment in accordance with the EPBC Act significant impact guidelines. The assessment concluded that the project would remove around 0.6 hectares of potential habitat for this species. This would result in indirect effects on occupied habitat through increased fragmentation of habitat, reduction in native vegetation cover, and disturbance of surface soil in the vicinity of occupied habitat. The local population has persisted in a highly modified environment adjacent to heavy rail infrastructure. The post-construction environment would be very similar to the existing environment.

The project would not directly harm any individuals of this species, and construction and environmental management measures are likely to mitigate the risk of indirect impacts. Based on these considerations, the project is not likely to have a significant impact on Downy Wattle.

The Grey-headed Flying-fox was recorded foraging within the project area during surveys. The project would remove foraging habitat for this species. An assessment of the likely significance of impacts on the Grey-headed Flying-fox was prepared in accordance with the EPBC Act significant impact guidelines. The Grey-headed Flying-fox may forage on occasion in the project area, especially when figs are fruiting or eucalypts are in flower. The project would not directly or indirectly affect roost camps. Construction would remove 7.9 hectares of foraging habitat, including remnant, regrowth and planted native tree species in the project area. The habitat to be removed comprises a minor proportion of the available habitat resources in the wider region, which includes many thousands of individual blossom or fruit bearing trees in streetscapes, parks and gardens. Based on these considerations, the project is not likely to have a significant impact on the Grey-headed Flying-fox.

No other threatened fauna species listed under the EPBC Act are likely to be impacted by the project. Given the minor magnitude of impacts on threatened fauna and their habitats further assessment or approval under the EPBC Act is highly unlikely to be required and a referral is not required.

Migratory species

No migratory bird species listed under the EPBC Act were recorded during field surveys. However, there is potential habitat for species such as the Rufous Fantail and Rainbow Bee-eater in the project area and study area. As discussed previously, vegetation in the study area is highly modified, fragmented, and would have limited value for these migratory species. Individuals that may occur would occur on a transient basis only.

The study area is not considered important habitat for migratory species according to the significant impact criteria for migratory species (Department of the Environment, 2013). No assessments of significance have been prepared for migratory species. Based on the above considerations, the project is unlikely to significantly impact any of the listed migratory fauna species that were predicted to occur.

22.3.6 Assessment against the Framework for Biodiversity Assessment

The *Framework for Biodiversity Assessment* requires assessment of the project against a number of factors. The results of the assessment are presented in the Biodiversity Assessment Report (Technical paper 9) and summarised below.

Impacts on biodiversity that require further consideration

Under the *Framework for Biodiversity Assessment,* impacts that require further consideration include:

- significant impacts on landscape features
- impacts on endangered ecological communities that are likely to significantly affect the persistence or viability of that community
- impacts on critical habitat or on threatened species that are likely to significantly affect the persistence or viability of a population of a threatened species.

The project has been designed to avoid impacts on biodiversity values as far as is practicable. The project has been designed to avoid impacts on Downy Wattle.

The project would result in minor impacts on Sydney Turpentine Ironbark Forest and Shale Gravel Transition Forest, but would not significantly affect the persistence or viability of these communities.

Although the project would result in the loss of very small areas of foraging habitat, it would not affect any critical habitat for the Grey-headed Flying-fox, threatened microbats, or other mobile threatened fauna that may potentially occur. The project would remove low quality, potential habitat for the endangered population of the Long-nosed Bandicoot in Inner Western Sydney located outside of its known area of occupancy. However, this is highly unlikely to threaten the viability of these species or population.

The project would not threaten the persistence or viability of any threatened species.

The project would not impact on matters that require further consideration.

Impacts requiring biodiversity offsets

The project would result in the removal of one hectare of native vegetation requiring biodiversity offsets. The biodiversity credits that would be required to offset impacts are summarised in Table 22.4. A biodiversity offset strategy has been prepared to offset the required credits and is discussed in Section 22.4.2.

Table 22.4 Ecosystem credits required to offset impacts of the project

Plant community type	Area (ha)	Loss in landscape value	Loss in site value score	Threatened species with highest credit requirement	Threatened species offset multiplier	Credits required
Turpentine - Grey Ironbark open forest on shale (ME041)	0.2	6.00	39.58	Greater Broad-nosed Bat	2.2	6
Turpentine - Grey Ironbark open forest on shale (ME041)	0.4	6.00	24.48	Greater Broad-nosed Bat	2.2	8
Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils (ME004)	0.4	6.00	38.54	Greater Broad-nosed Bat	2.2	13
Total credits required						**27**

Areas not requiring offset determination

The majority of native flora in the project area is contained within patches of planted native species. These areas were identified as planted, rather than regrowth or remnant native vegetation, because they contained sub-mature, even aged plants arranged in straight lines and are located on cuttings or fill material associated with unnatural landforms such as embankments. Further, many of these native plant species are not native to the Sydney region or are garden cultivars.

These planted native species would provide some habitat for threatened species, including the Grey-headed Flying-fox. However, the vegetation lacks the structural and species diversity of native vegetation communities. In addition, it does not contain species credit type threatened species or their habitats. Therefore, this vegetation does not require offset calculation, and is not included in the above calculations.

Areas not requiring assessment

The assessment did not address non-native or exotic vegetation, gravel tracks, hardstand areas, and other infrastructure with occasional plants associated with cracks or shallow soil deposits that clearly do not comprise native vegetation within the meaning of the *Framework for Biodiversity Assessment*.

22.3.7 Impacts on biodiversity values not covered by the Framework for Biodiversity Assessment

The Secretary's environmental assessment requirements specify that the biodiversity assessment must assess impacts on biodiversity values not covered by the *Framework for Biodiversity Assessment*, and that these should include values specified for consideration by the Office of Environment and Heritage. The framework nominates a number of biodiversity values that are not considered under the framework as requiring further consideration. No additional values where specified by the Office of Environment and Heritage for consideration (refer to the summary of responses provided by government agencies during consultation for the Secretary's environmental assessment requirements, provided in Appendix A).

The following values are not assessable under the framework, but are considered to be relevant to the project and were assessed by the biodiversity assessment:

- vehicle strike
- aquatic biodiversity
- downstream impacts on terrestrial and aquatic vegetation, including groundwater dependent ecosystems.

Vehicle strike was considered as a potential operational impact in general, and for the Long-nosed Bandicoot Inner Western Sydney population in particular (refer to Section 22.3.3). Potential construction impacts on aquatic biodiversity and downstream areas are considered in Section 22.3.2.

22.3.8 Cumulative impacts

The study area is located within a developed urban area, with an extensive rail and road network, and urban development.

The project would involve the removal of small patches of already highly fragmented, predominantly planted vegetation. Future infrastructure and road projects, as well as residential development along the Sydenham to Bankstown corridor, would result in the removal of mainly planted vegetation and associated fauna habitats. These losses in biodiversity are likely to be restricted in area, given their location in a highly modified environment. Together, these projects and other developments would result in the further loss of habitat from an already modified environment with limited natural biodiversity values.

22.4 Mitigation measures

22.4.1 Approach to mitigation and management

The overall approach to managing impacts to biodiversity is, in order of importance, to:

- avoid impacts on habitat, through the planning and design process
- mitigate impacts on habitat, through the use of a range of mitigation measures
- offset any residual impact that could not be avoided or mitigated.

The project is largely contained within an existing rail corridor. The project area falls within land which has been previously modified by land clearing and development. Impacts on native flora and fauna are substantially less than would be associated with an undisturbed 'greenfield' site. There is no practical alternative to the location of the project. As such, there is little opportunity to further avoid impacts, other than through the micro-siting of infrastructure.

Mapping of biodiversity values early in the design process has allowed some impacts to be avodied. Notably, the project has been purposefully designed to avoid direct impacts to Downy

Wattle. Siting construction compounds in cleared areas has also been able to avoid or minimise impacts on native flora and fauna.

The Construction Environmental Management Framework (Appendix D) provides for the development and implementation of a Flora and Fauna Management Plan during construction. Additional mitigation measures are identified in Table 22.5.

22.4.2 List of mitigation measures

The mitigation measures that would be implemented to address potential biodiversity impacts are listed in Table 22.5.

Table 22.5 Mitigation measures – biodiversity

ID	Impact/issue	Mitigation measures	Relevant location(s)
Design/pre-construction			
B1	Direct impacts to biodiversity	Detailed design and construction planning would minimise direct impacts to vegetation mapped as threatened ecological communities as far as practicable, and have regard to the habitat management measures provided in the biodiversity assessment report.	All
B2		Pre-clearing surveys and inspections for endangered and threatened flora and fauna species would be undertaken by qualified ecologists prior to any clearing occurring. The surveys and inspections, and any subsequent relocation of species, would be undertaken in accordance with the measures provided in the biodiversity assessment report.	All
B3	Biodiversity offsets	The biodiversity offset strategy prepared for the Environmental Impact Statement would be updated to confirm the approach to retiring the required biodiversity credits (including appropriate biobank sites). It would also include a timeframe to retire the required credits based on the confirmed construction schedule and biobank site owner agreements/ requirements.	All
Construction			
B4	Direct impacts to biodiversity	Areas of biodiversity value outside the project area would be marked on plans, and fenced or signposted where practicable, to prevent unnecessary disturbance.	All
B5		Impacts to Downy Wattle would be avoided. The locations of Downy Wattle stems would be marked on plans, fenced on site, and avoided.	Punchbowl and Bankstown stations
B6		Equipment storage and stockpiling would be restricted to identified compound sites and already cleared land.	All
B7		A trained ecologist would be present during the clearing of native vegetation or removal of potential fauna habitat (including underbridges) to avoid impacts on resident fauna, and to salvage habitat resources as far as is practicable.	All
B8	Management of weeds	Noxious weeds would be managed in accordance with the *Noxious Weeds Act 1993*. Weeds of national environmental significance would be managed in accordance with the *Weeds of National Significance Weed Management Guide*.	All
Operation			
B9	Management of weeds	Annual inspections would be undertaken for weed infestations and to assess the need for control measures.	All

ID	Impact/issue	Mitigation measures	Relevant location(s)
B10		Any outbreak of noxious and/or weeds of national environmental significance would be managed in accordance with the relevant guidelines.	All

22.4.3 Consideration of the interactions between mitigation measures

Measures to minimise potential impacts associated with noise, air quality, soils, hydrology, and water quality and would also assist in minimising potential impacts to biodiversity. These mitigation measures are provided in Chapters 12, 13, 20, 21, and 23.

22.4.4 Managing residual impacts

Despite measures taken to avoid and mitigate impacts, the project would result in some unavoidable residual adverse impacts, including removal of native vegetation and habitat resources, and edge effects on adjoining areas of native vegetation.

Residual impacts following implementation of the mitigation measures in Section 22.4.2 are predicted to include:

- removal or modification of one hectare of native vegetation and associated habitat resources
- removal or modification of 7.3 hectares of planted native species that provide potential habitat for threatened species
- noise, light, traffic and altered environmental conditions associated with construction and operation.

The above residual impacts are small in extent and magnitude, and would comprise a minor reduction in biodiversity values in the study area. The biodiversity offset strategy (described below) would assist in mitigating residual impacts.

Biodiversity offset strategy

A biodiversity offset strategy has been developed to compensate for the unavoidable loss of ecological values as a result of the project. Transport for NSW commits to the retirement of the required credits in accordance with the *Framework for Biodiversity Assessment* and the NSW offsets policy. The Biodiversity Offset Strategy requires the purchase and retirement of biodiversity credits calculated in accordance with the *Framework for Biodiversity Assessment*. Transport for NSW would consult with the vendor/s of the biodiversity credits detailed in Technical Paper 9, and arrange to purchase and retire a total of 27 biodiversity credits appropriate to offset the impacts of the project.

23. Air quality

This chapter provides an assessment of the potential impacts of the project on air quality. Although there are no Secretary's environmental assessment requirements directly relevant to air quality, the assessment has been undertaken as air quality was identified as a potential risk by the State Significant Infrastructure Application Report, particularly in terms of the potential for amenity impacts.

23.1 Assessment approach

23.1.1 Legislative and policy context relevant to the assessment

The main legislation and guidelines relevant to the assessment and management of air quality are summarised below.

Protection of the Environment Operations Act 1997

As described in Section 20.1, the POEO Act provides the statutory framework for managing pollution in NSW. It includes procedures to regulate the potential for pollution, including the issue of environment protection licences, in relation to aspects such as air pollution. Air quality requirements (including criteria) are specified by environment protection licences. Environment protection licences would be obtained for both the construction and operation of the project, and the project would comply with requirements related to the minimisation of air quality impacts.

Clean Air Regulation

The *Protection of the Environment Operations (Clean Air) Regulation 2010* (the Clean Air Regulation) provides regulatory requirements to control emissions from motor vehicles, fuels, and industry. The project would be constructed and operated to ensure it complies with the Clean Air Regulation.

Approved Methods

Air quality impact assessment is guided by the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (DEC, 2005) (known as 'the Approved Methods'). The Approved Methods generally apply to stationary sources of air pollution. However, the qualitative assessment described in this chapter gave consideration to the Approved Methods, including relevant criteria and the assessment methodology.

Air NEPM

The *National Environment Protection (Ambient Air Quality) Measure* ('the Air NEPM') sets non-binding standards and ten-year goals. The Air NEPM has a goal for particulate matter with an aerodynamic diameter of less than 10 microns (PM_{10}) of 50 micrograms per cubic metre ($\mu g/m^3$) as a 24-hour average (no exceedances per year), and a $PM_{2.5}$ goal of 25 $\mu g/m^3$ as a 24-hour average. Consideration was given to these goals as part of the assessment.

23.1.2 Methodology

The main risk of the project with respect to air quality is emissions (mainly dust) during construction. These potential impacts would be temporary, confined to the construction period, and readily managed through the implementation of standard construction management measures.

As such, potential air quality impacts of the project have been assessed qualitatively, involving:

- a desktop review of the background air quality environment, including:
  - air quality data sourced from the NSW Office of Environment and Heritage's air quality monitoring stations, located at Earlwood, Chullora, and Liverpool (the closest stations to the project area)
  - the National Pollutant Inventory maintained by the Australian Government Department of the Environment and Energy, to identify any facilities that may be contributing to local/regional air quality conditions
- identifying sensitive receivers with the potential to be adversely affected by air quality impacts
- reviewing the construction and operational aspects of the project with the potential to generate air emissions
- a qualitative assessment of potential air quality impacts
- identifying appropriate mitigation and management measures, as necessary.

23.2 Existing environment

23.2.1 Ambient air quality

Ambient air quality in Sydney is influenced by a number of factors, including topography, prevailing meteorological conditions (such as wind and temperature, which vary seasonally), and local and regional air pollution sources (such as motor vehicles, industrial facilities and bushfires). Consequently, regional air quality can be highly variable and impacted by events occurring a significant distance away.

Air quality surrounding the project area is typical of a highly developed urban area that consists of a mix of land uses. Local air quality is mainly affected by vehicles on the road network, in particular on major roads such as Canterbury Road, King Georges Road, and Stacey Street/Fairford Road. Air quality is also affected by the operation of diesel freight trains along the rail corridor between east of Marrickville Station and west of Campsie Station.

The NSW Office of Environment and Heritage uses a standardised measure known as the air quality index to characterise air quality at a location and compare it in relative terms with other locations throughout NSW. The average daily air quality index values for the monitoring stations at Earlwood, Chullora, and Liverpool (refer to Table 23.1) varied between 46 and 51 in the available monitoring years. These values correspond with an air quality index outcome of 'good', indicating that air quality is generally of an acceptable quality.

23.2.2 Local emission sources

The desktop review identified the following potential air pollution sources in the study area:

- industrial facilities that reported air emissions during the 2014-2015 reporting period, including:
  - petroleum and coal product manufacturing facility (in Alexandria)
  - Sydney Trains Sydenham Maintenance Centre (in Sydenham)
  - airport operations and other air transport support services (in Mascot)
  - ceramic product manufacturing facility (in Punchbowl)
  - basic chemical manufacturing facility (in Bankstown)
- vehicle exhaust emissions from road and rail networks

- commercial businesses, such as service stations and smash repairs
- domestic activities, such as wood-fired home heaters and lawn mowing.

Only one air pollution source, the XPT Maintenance Centre located on Way Street in Sydenham, is located in the immediate vicinity of the project area (about 200 metres south-east). All other sources are located more than one kilometre from the project area.

23.2.3 Background air quality data

Air quality monitoring data sourced from the monitoring stations is summarised in Table 23.1. The data shows that the concentrations of air pollutants were generally below the applicable air quality criteria, with the exception of occasional days when PM_{10} exceeded 50 µg/m^3. These occurrences are generally the result of natural events such as dust storms and bushfires.

Table 23.1 Background air quality data

Pollutant	Averaging period	Criteria	Earlwood			Chullora			Liverpool		
			2013	2014	2015	2013	2014	2015	2013	2014	2015
PM_{10} (µg/m^3)	Maximum 24-hour	50	63	45	67	69	40	65	99	41	69
	95th percentile 24-hour	50	35	30	28	32	30	29	37	33	31
	Annual	30	20	18	17	18	18	18	21	19	19
Carbon monoxide (CO) (mg/m^3)	Maximum 1-hour	30	-	-	-	3	2	2	3	3	2
Nitrogen dioxide (NO_2) (µg/m^3)	Maximum 1-hour	246	97	81	107	111	130	109	113	89	122
	Annual	62	20	16	16	26	26	26	22	20	20
Sulphur dioxide (SO_2) (µg/m^3)	Maximum 1-hour	570	-	-	-	34	54	40	-	-	-
	Annual	60	-	-	-	3	3	3	-	-	-

23.2.4 Sensitive receivers

The project area is surrounded by a wide range of sensitive receivers, including residential properties, community facilities (such as schools, childcare centres, places of worship, and medical facilities), and recreational areas. A number of these receivers are located immediately adjacent to the project area.

Land uses surrounding the project area are described in Chapter 16 (Land use and property). Figure 12.1 shows sensitive receivers located generally within about 250 metres of the project area.

23.3 Impact assessment

23.3.1 Risk assessment

Potential risks

The environmental risk assessment for the project, undertaken for the State Significant Infrastructure Application Report, identified the following as the main air quality risks:

- impacts to local air quality due to the operation of construction plant and equipment.
- impacts to local air quality due to increased vehicle movements from replacement bus services and transport of construction materials
- impacts to local air quality due to dust generation from exposed surfaces.

As the project would be powered by electricity, there is expected to be minimal risk of air quality impacts during operation.

Chapter 24 (Sustainability and climate change) provides estimates of electricity use, and the initiatives and targets proposed to be considered further during detailed design. A preliminary estimate of construction emissions from plant and equipment use was prepared as part of greenhouse gas assessment (refer to Chapter 24).

How potential risks and impacts would be avoided

In general, potential air quality impacts would be avoided by:

- managing air quality in accordance with relevant legislative and policy requirements, as described in Section 23.1.1
- managing air quality in accordance with the environment protection licences for construction and operation
- implementing the air quality management measures described in Section 23.4.

23.3.2 Construction

Construction activities, including earthworks, storage and transport of spoil and waste materials, demolition of buildings, and exhaust emissions from construction equipment and vehicles, have the potential to impact on local air quality. The main potential impacts on air quality during construction are described below.

Dust generation

The processes that have the potential to generate particulate matter during construction are:

- mechanical disturbance − dust emissions as a result of earthworks/excavation and the operation/movement of construction vehicles and equipment
- wind erosion − dust emissions from disturbed soil surfaces and stockpiles in windy conditions.

Construction activities with the greatest potential to generate dust would include:

- demolition of buildings and infrastructure
- excavations and trenching for the installation of footings and new infrastructure
- transport, handling, stockpiling, loading, and unloading of spoil and imported materials

- creation of exposed surfaces through the clearing of vegetation, stripping of topsoil and other overlying structures (such as road and footpath pavements)
- other general construction activities that would occur along the length of the corridor.

The volume of dust generated would depend on the:

- type of equipment used
- construction technique employed
- type, particle size, and moisture content of material
- size of the exposed area
- meteorological conditions (in particular wind conditions).

Without the implementation of effective mitigation measures, dust emissions from construction could reduce local air quality and impact on nearby sensitive receivers.

The project would involve surface works in the project area, including track realignment, and other civil works to adjust drainage, install noise barriers, maintain embankments, upgrade and replace bridges, and to demolish and upgrade station buildings and structures. However, no major earthworks are required.

As a result of the limited scale of earthworks and nature of the works proposed, dust emissions are expected to be manageable through the implementation of standard erosion control and dust management measures applied successfully to other similar rail infrastructure projects, as required by the Construction Environmental Management Framework (refer to Section 23.4).

Exhaust emissions

The main source of emissions would be from the combustion of diesel fuel and petrol from heavy vehicles, mobile excavation machinery, and stationary combustion equipment as well as from the handling and/or on-site storage of fuel and other chemicals.

The volume of emissions from construction vehicles and machinery would depend on the type of fuel used, the power output and condition of the engine, and duration of operation.

Exhaust emissions would involve periodically localised emissions of carbon monoxide, particulate matter (PM_{10} and $PM_{2.5}$), nitrous oxides, sulphur dioxide, volatile organic compounds, and polycyclic aromatic hydrocarbons associated with the combustion of diesel fuel and petrol.

The highest potential for air quality impacts from plant emissions would be associated with works where multiple items of equipment operate simultaneously.

Exhaust emissions generated during construction would not significantly contribute to emissions in the project area, given the existing levels of vehicle use. These emissions would be managed by the implementation of standard construction mitigation measures, described in Section 23.4. As such, no long-term adverse impacts to air quality are anticipated.

23.3.3 Operation

Local impacts

There is the potential for minor air quality impacts. Any greenhouse gas emissions associated with the consumption of electricity during operation would be fully offset. Further information is provided in Chapter 24.

As the project would be powered by electricity, local emissions during operation are expected to be minimal and highly dispersed. Minor quantities of particulate matter (PM_{10}) emissions would be generated along the corridor, mainly due to the wear of the train brake pads, vaporisation of metals due to sparking, and wear of steel due to friction between wheels and rail. These emissions would be in very low concentrations, and are not expected to be different from the current operational rail corridor.

Regional impacts

The project would not to result in any substantial regional air quality impacts as any emissions would be highly dispersed in the local area and would not impact on any areas away from the project.

23.3.4 Cumulative impacts

Cumulative air quality impacts may result from increased dust generation and emissions from other projects occurring concurrently to the project. The Chatswood to Sydenham project is the only identified project that would coincide spatially with the project area, at the eastern extent of the project near Fraser Park. The surface sections of WestConnex Stage 2 are located about two kilometres south of the project area at Lakemba, and about one kilometre south of Sydenham Station. Therefore, it is unlikely that these projects would combine with the project to generate cumulative air quality impacts.

The linear extent of the project and the scope and nature of the emission sources means that any cumulative impacts, are likely to be limited. The adoption of standard control measures, are expected to result in the successful management of dust and other emissions from the project, including any cumulative impacts.

As described in Section 23.3.3, operational air quality impacts are expected to be minor. Cumulative impacts associated with operation of the project and other local emissions sources are not expected.

23.4 Mitigation measures

23.4.1 Approach to mitigation and management

Potential impacts to air quality would be managed in accordance with the Construction Environmental Management Framework (as described in Chapter 28 (Synthesis of the Environmental Impact Statement)), which provides for development and implementation of an air quality management plan, to include (as a minimum):

- air quality mitigation measures, including those provided in the framework
- requirements of the environmental protection licence
- site plans or maps indicating locations of sensitive receivers and key air quality/dust controls
- responsibilities of key project personnel with respect to the implementation of the plan
- air quality and dust monitoring requirements
- compliance record generation and management.

During operation, air quality would be managed in accordance with the operational environment protection licence, in accordance with the operational environmental management plan.

23.4.2 List of mitigation measures

Table 23.2 provides the relevant mitigation measure for air quality impacts.

Table 23.2 Mitigation measures – air quality impacts

ID	Impact/issue	Mitigation measures	Applicable location(s)
Design/pre-construction and construction			
AQ1	Air quality impacts	An air quality management plan would be prepared and implemented during construction, to define the measures to minimise air quality impacts during construction.	All

23.4.3 Consideration of the interactions between mitigation measures

Measures to minimise the potential for air quality impacts would overlap with the measures proposed for the control of erosion and sedimentation (described in Chapter 20 (Soils and contamination)), as the major pollutant of concern is dust. As described in Section 20.4, soil and erosion control measures would be implemented during construction in accordance with *Soils and Construction - Managing Urban Stormwater Volume 1* (Landcom, 2004) and *Volume 2A* (DECC, 2008). Implementation of these measures would be guided by a soil and water management plan prepared in accordance with the Construction Environmental Management Framework.

Other interactions include measures relating to the emission of contaminated substances (also described in Chapter 20), sustainability and climate change measures to be implemented to manage impacts of electricity use during construction and operation (described in Chapter 24), and measures to manage impacts as a result of hazardous materials (described in Chapter 25). Implementation of these measures, together with the requirements of the Construction Environmental Management Framework, would minimise the potential for air quality impacts.

23.4.4 Managing residual impacts

The mitigation and management measures proposed are expected to minimise the potential for impacts to air quality. With the implementation of these measures, residual impacts are expected to be minimal.

24. Sustainability and climate change

This chapter assesses the project in terms of sustainability, and how it does, and would continue to, meet relevant sustainability requirements. It addresses the Secretary's environmental assessment requirements listed in Table 24.1. The chapter also provides a climate change risk assessment, and a greenhouse gas assessment for the project.

Table 24.1 Secretary's environmental assessment requirements – sustainability

Ref	Secretary's environmental assessment requirements - sustainability	Where addressed
12. Sustainability		
12.1	The Proponent must assess the sustainability of the project in accordance with the Infrastructure Sustainability Council of Australia (ISCA) *Infrastructure Sustainability Rating Tool* or equivalent and relevant rating tool.	Section 24.3.1
12.2	The Proponent must review the project against the current guidelines including targets and strategies to improve Government efficiency in use of water, energy and transport.	Sections 24.2 and 24.3

24.1 Assessment approach

24.1.1 Sustainability

What is sustainability?

Sustainability, or sustainable development, has many different definitions, depending on the application and context. In 1987, the Brundtland Commission defined sustainable development 'as development that meets the needs of the present, without compromising the ability of future generations to meet their own needs' (World Commission on Environment and Development, 1987).

In 1992, ecologically sustainable development (ESD) was defined by the Ecologically Sustainable Development Steering Committee as 'using, conserving and enhancing the community's resources so that ecological processes, on which life depends are maintained, and the total quality of life, now and in the future can be increased' (Ecologically Sustainable Development Steering Committee, 1992).

In NSW, the concept of ESD was introduced into planning and development legislation by the EP&A Act. One of the objectives of the EP&A Act is '(vii) to encourage ecologically sustainability development'. In accordance with part 3 of schedule 2 of the Regulation, an Environmental Impact Statement is required to include '(f) the reasons justifying the carrying out of the development, activity or infrastructure in the manner proposed, having regard to … the principles of ecologically sustainable development set out in subclause (4).'

Section 6(2) of the *Protection of the Environment Administration Act 1991* states that ESD can be achieved through the implementation of:

- the precautionary principle
- intergenerational equity
- conservation of biological diversity and ecological integrity
- improved valuation, pricing and incentive mechanisms.

For infrastructure projects, ‘infrastructure sustainability’ is defined by the Infrastructure Sustainability Council of Australia (ISCA) as ‘infrastructure that is designed, constructed and operated to optimise environmental, social and economic outcomes of the long term’.

Methodology for this assessment

The assessment summarised in this chapter considers the application of sustainability principles to the project, and the opportunities to achieve sustainability targets and outcomes aligned with best practice infrastructure projects. It considers Transport for NSW’s sustainability strategy for Sydney Metro City & Southwest (provided in Appendix F), and other relevant policies and legislation.

The sustainability targets and initiatives outlined have been developed in response to various guidance documents and will be integrated into the design, construction, and operation of the project.

24.1.2 Climate change

What is climate change?

Climate change has the potential to alter the frequency, intensity, and distribution of extreme weather related natural hazards, including more intense and frequent heat waves, droughts, floods, and storm surges. The risk of climate change impacts on infrastructure (including the project) needs to be considered as part of the design process, as structures need to be designed to last for many years, and therefore need to be resilient to climate change.

Climate change adaptation planning and risk management is an evolving field. Responses to reduce the risks of climate change broadly fall into two categories: mitigation and adaptation. Using the definitions of the Inter-governmental Panel on Climate Change, mitigation aims to reduce human effects on the climate system by strategies to reduce greenhouse gas sources and emissions, and to enhance greenhouse gas sinks. Adaptation refers to adjustments in response to actual or anticipated climate changes or their effects, to moderate harm or to exploit beneficial opportunities. Infrastructure design and planning needs to incorporate adaptation measures, based on the assessed risk of climate change to a proposal.

Methodology for this assessment

The purpose of the climate change risk assessment is to:

- identify and assess the risks that climate change poses to the project
- prioritise risks that require further action as a basis for decision-making and planning.

A climate change risk assessment was undertaken by Transport for NSW in accordance with the *TfNSW* C*limate Risk Assessment Guidelines* (Transport for NSW, 2016b) and based on *AS 5334-2013 Climate change adaptation for settlements and infrastructure – A risk based approach.*

The following steps were undertaken to complete the risk assessment:

- determine the climate change context
- identify the climate risks and assess the likelihood and consequence of each risk
- identify adaptation responses.

During design development, two risk workshops were held with multidisciplinary members of the project team. The preliminary risks identified at the workshops were formalised in a risk register, and thorough risk descriptions were provided, including cause, impact/consequence, and current treatment.

Climate projections

Climate change risks associated with the operational phase of the project are much greater than during the construction phase, as there is much more time for those effects to be realised. Due to the expected design life of assets such as bridges and drainage infrastructure (60 to 100 years), the time periods selected for the assessment were 2030, 2060, and 2090. The climate models used to project future climate conditions are not an effective tool to determine near term changes, such as within the next 10 years. Construction phase climate change risks were therefore not assessed.

The climatic variables identified as potentially generating risks for the project were annual average rainfall, extreme rainfall, extreme temperature, extreme wind, storms (cyclones, hail, dust and lightning), sea level rise, and fire danger.

Climate change has the potential for direct and indirect impacts on the project. The types of potential impacts are relatively well understood, but their severity and extent is uncertain. As such, there is a need to identify these risks and develop strategies to treat them. Risks were identified and rated as either low, medium, high, or very high.

24.1.3 Greenhouse gas and energy

What are greenhouse gases?

Greenhouse gas is a collective term for a range of gases that absorb outgoing infrared radiation reflected from the earth, which in turn generate heat. This heat warms the atmosphere. This is known as the greenhouse effect, which is linked to climate change.

Human activities, including the combustion of carbon-based fuels, increase the concentration of greenhouse gases in the atmosphere. This leads to greater absorption of infrared radiation and an increase in atmospheric temperature. This is known as the enhanced greenhouse effect. The following six greenhouse gases are covered under international climate change agreements:

- carbon dioxide (CO_2)
- methane (CH_4)
- nitrous oxide (N_2O)
- hydrofluorocarbons (HFCs)
- perfluorocarbons (PFCs)
- sulphur hexafluoride (SF_6).

Identifying the likely greenhouse gas emissions associated with a project enables the scale of potential emissions to be determined, providing a baseline from which to develop and deliver greenhouse gas reduction measures.

Each greenhouse gas behaves differently in the atmosphere with respect to its ability to trap outgoing radiation and its residence time in the atmosphere. To achieve a common unit of measurement, each greenhouse gas was compared to the warming potential of carbon dioxide over a 100 year period. This provides a global warming potential for each greenhouse gas, which can be applied to the estimated emissions of the project. The resulting aggregated emissions are referred to in terms of carbon dioxide-equivalent emissions (or CO_2-e).

Methodology for this assessment

A greenhouse gas assessment was undertaken by Transport for NSW in accordance with *The Greenhouse Gas Protocol* (WRI and WBCSD, 2004), the Intergovernmental Panel on Climate Change, and Australian Government greenhouse gas accounting/classification systems.

Emissions were categorised into three different categories (known as ‘scopes’) to help differentiate between direct emissions from sources that are owned or controlled by a project, and upstream indirect emissions that are a consequence of project activities, but which occur at sources owned or controlled by another entity. The three greenhouse gas scopes are:

- Scope 1 emissions, also referred to direct emissions
- Scope 2 emissions, also referred to as indirect emissions
- Scope 3 emissions, includes all indirect emissions (not included in scope 2) due to upstream or downstream activities.

The objectives of the greenhouse gas assessment were to:

- identify the likely sources of greenhouse gas emissions associated with construction and operation
- quantify the greenhouse gas emissions associated with each greenhouse gas source
- identify opportunities (mitigation measures) to reduce greenhouse gas emissions.

The greenhouse gas assessment is a preliminary estimate based on current design information and construction staging. The assessment would be revised and updated as the design evolves and more accurate information becomes available.

Operational greenhouse gas emissions related to maintenance equipment use, maintenance transport, waste generation, and materials used for maintenance, are considered to be low compared with electrical consumption, and were not included in the greenhouse gas assessment.

24.2 Context for the assessment

24.2.1 Sustainability

Legislative and policy context for the assessment

Sustainability considerations have been embedded in a number of legislative and policy mechanisms, particularly in relation to resource use, waste, and energy efficiency. These include:

- *Waste Avoidance and Resource Recovery Act 2001*
- *National Greenhouse and Energy Reporting Act 2007*
- *National Strategy for Ecologically Sustainable Development* (Ecologically Sustainable Development Steering Committee, 1992)
- *National Waste Policy: Less Waste, More Resources* (Environment Protection and Heritage Council, 2009)
- *Sustainable Procurement Guide* (Australian Government, 2013)
- *NSW Government Resource Efficiency Policy* (Office of Environment and Heritage, 2014d).

The *NSW Long Term Transport Master Plan* (Transport for NSW, 2012b) acknowledges that meeting community expectations in environmental sustainability is a statewide challenge. Initiatives to manage and minimise the environmental impacts of NSW’s transport system include:

- a co-ordinated approach to addressing environmental issues at all levels of transport planning
- sustainable design guidelines for transport projects
- better ways to assess the environmental benefits of projects.

The *Transport Environment and Sustainability Policy Framework* is a collective and co-ordinated approach to deliver the NSW Government's environmental and sustainability agenda across the transport 'cluster' (Transport for NSW, Sydney Trains, NSW Trains, Roads and Maritime Services, and the State Transit Authority of NSW. The framework was developed to implement the *Transport Environment and Sustainability Policy Statement* (Transport for NSW, 2013c).

Regulatory and policy drivers for the inclusion of workforce development initiatives as part of the sustainability program for the project include:

- The NSW State Priorities include creating jobs and apprenticeships for the construction sector through infrastructure investment, and increasing the proportion of people completing apprenticeships and traineeships to 65 per cent.
- The *Australian Jobs Act 2013* requires proponents of major projects, with a capital expenditure of $500 million or more, to prepare and implement an Australian Industry Participation plan, to support the development of a more diverse workforce, and future growth opportunities for Australian enterprises.
- The NSW Aboriginal Participation in Construction Policy aims to deliver more employment and business opportunities for Aboriginal people on selected NSW Government construction projects. The category of a project defines the percentage of the project spend to be directed to Aboriginal-related employment and education activities, and/or the procurement of goods or services from recognised Aboriginal businesses or other programs.

Sydney Metro City & Southwest Sustainability Strategy

Figure 24.1 shows how sustainability is governed for Sydney Metro, and Figure 24.2 shows how it is integrated into the environmental management system.

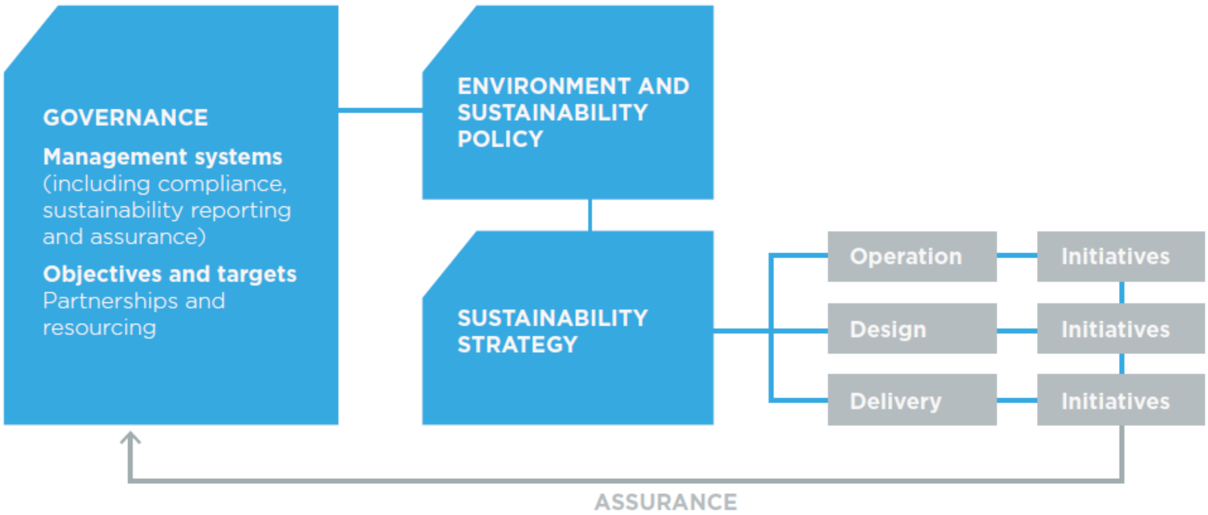


Figure 24.1 Sydney Metro sustainability governance structure

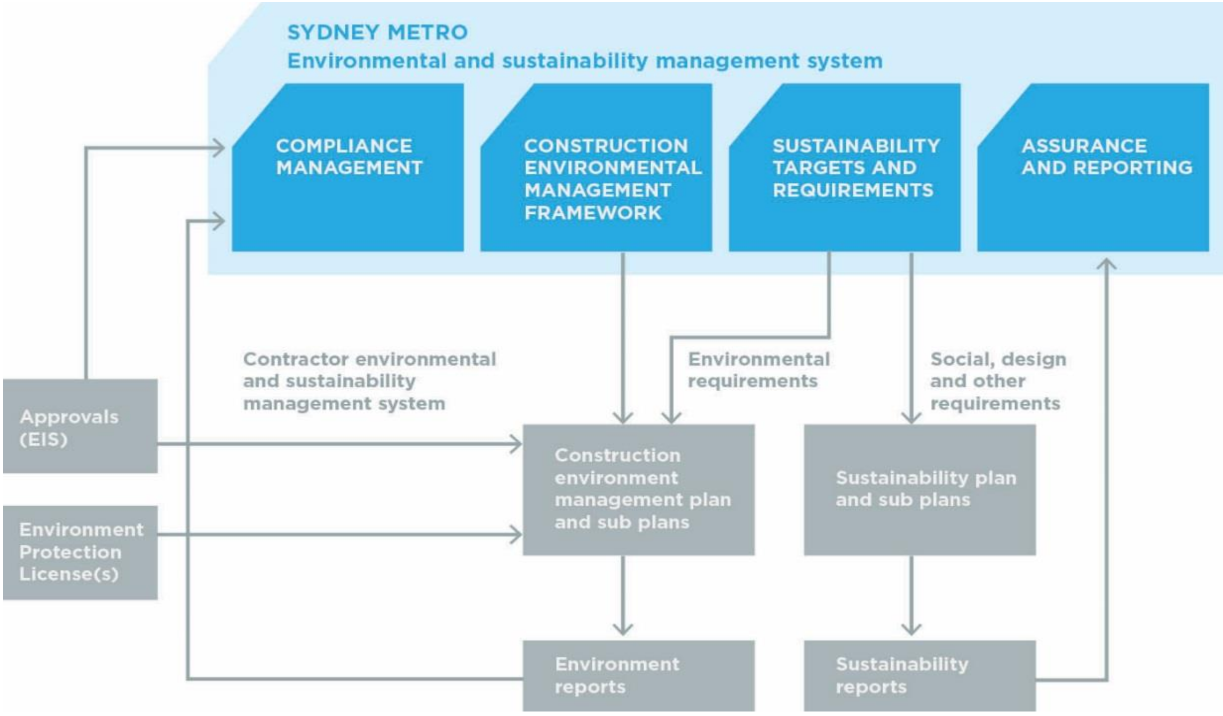


Figure 24.2 Sydney Metro environmental and sustainability management system

A sustainability strategy has been developed for Sydney Metro City & Southwest taking into account Transport for NSW sustainability commitments, and a copy is provided in Appendix F. The strategy provides an overarching framework for integrating sustainability into project planning, design, procurement, and operation. The strategy outlines objectives, targets, initiatives, and requirements for embedding sustainability across each of the following themes:

- governance
- carbon and energy management
- pollution control
- climate change resilience
- resources water efficiency
- resource waste and materials
- biodiversity conservation
- heritage conservation
- liveability
- community benefit
- supply chain
- workforce development
- economic.

24.2.2 Climate change

Legislative and policy context for the assessment

Relevant climate change policies, guidelines, and standards include:

- *Climate Change Impacts and Risk Management – A Guide for Business and Government* (Australian Greenhouse Office, 2006)
- *AS 5334:2013 Climate change adaptation for settlements and infrastructure – a risk based approach*
- *National Climate Resilience and Adaptation Strategy* (Australian Government, 2015)
- *Climate Change in Australia - East Coast Cluster Report* (CSIRO and Bureau of Meteorology, 2015)
- Office of Environment and Heritage's NSW climate change adaptation guidelines.

As noted in Section 24.2.1, the *NSW Long Term Transport Master Plan* acknowledges that meeting community expectations in environmental sustainability is a statewide challenge. Relevant actions include 'boosting our resilience to climate change and natural disasters' and 'assessing transport climate resilience'.

The Transport for NSW *Environment and Sustainability Policy Framework's* climate change resilience theme acknowledges that some level of climate change is inevitable. It focuses on Transport for NSW's efforts to adapt and build resilience into its planning, projects and operations, to minimise the impacts and costs of climate change on customers, and contribute to greater climate change resilience for NSW.

The Sydney Metro City & Southwest sustainability strategy includes an objective that infrastructure and operations are resilient to the impacts of climate change.

24.2.3 Greenhouses gases

Transport for NSW's online Carbon Estimate and Reporting Tool was used for the greenhouse gas emissions assessment. The tool was developed to provide consistency in greenhouse gas emissions assessment and reporting for the construction stage of Transport for NSW projects.

24.3 Assessment results

24.3.1 Sustainability

The ISCA's Infrastructure Sustainability framework ('the IS framework'), or equivalent, would be applied to the project. The IS framework applies a point score across 15 sustainability themes, including water and energy use, innovation, materials, management, climate change, heritage, stakeholders, and biodiversity. The IS framework's themes and aims are consistent with those in the Sydney Metro City & Southwest Sustainability Strategy. Under the IS framework, points are achieved by providing verified evidence of performance, and totalled to achieve an overall project rating. The IS rating is determined by a score out of 100 and has four rating levels – Commended (25 to 29 points); Excellent (50 to 74 points); and Leading (75 to 100 points). A rating of Commended indicates that a project is achieving better than business as usual. A rating of Excellent indicates that a project is generally achieving Australian best practice in sustainability. A Leading rating indicates that a project is close to world's best practice.

The project would comprise a number of contract packages. For those packages where the IS framework is relevant, Transport for NSW is targeting achievement of an 'Excellent' rating, with a minimum score of 65 points. Where the IS framework is not relevant, Transport for NSW would apply the principles of other equivalent guidance and rating schemes, and would target a high level of achievement under those schemes.

Sustainability initiatives and targets that would be integrated into the design, construction and operation of the project, following confirmation during the detailed design process, are summarised in Table 24.2.

Table 24.2 Sustainability initiatives and targets

Area	Project response/targets
Governance	• targeting a 65-point 'Excellent' rating under the ISCA IS framework for the design and 'as built' ratings • regular reporting of sustainability performance
Carbon and energy management	• 15 per cent station energy performance improvement over minimum Building Code of Australia requirements, including use of efficient glazing, building fabric, mechanical, electrical, and lighting systems • use of onsite solar photovoltaics renewable energy systems • offset 25 per cent of construction electricity • reducing greenhouse gases by 20 per cent compared to business as usual, using sustainable construction practices • reduction of traction electricity demand using regenerative braking • offset 100 per cent of operational electricity
Pollution control	• integration of water sensitive urban design measures • placing limits on volatile organic compounds for paints, finishes, adhesives, and sealants, and on formaldehyde for all composite wood products
Climate change resilience	• station and critical infrastructure levels and drainage design to allow for an increase in rainfall intensity
Water	• 10 per cent saving in potable water use during construction • using rainwater harvesting and reuse to reduce potable water consumption at stations • incorporating water efficient fixtures and fittings • using drought resistant species in landscaping
Waste and materials	• 90 per cent of construction and demolition waste to be recycled • 60 per cent of site office waste generated during construction to be recycled • 100 per cent beneficial reuse of usable spoil • 15 per cent reduction in the environmental impact of materials, compared to business as usual • 25 per cent reduction in Portland cement used in concrete
Biodiversity	• retention of existing trees where practicable • using drought resistant native plants for landscaping • additional street tree planting to complement existing plantings
Heritage conservation	• heritage interpretation which supports local heritage values, existing community values, and station identity
Liveability	• stations minimise distance for interchange, and prioritise pedestrians and cycle accessibility to integrate with existing or planned pedestrian and cycle networks. • stations provide secure cycle parking spaces
Community benefit	• station works include pedestrian pathway improvements and improved connections to existing cycle ways • creation of enhanced and additional public plazas • increased accessibility of existing stations
Supply chain	• use of sustainably sourced timber • responsible sourcing of steel and concrete

Area	Project response/targets
Workforce development	• increase opportunities for employment of local people, participation of local businesses, and participation of small to medium enterprises • enable targeted and transferable skills development that resolves local and national skills shortages, supports industry to compete in home and global markets, and embeds a health and safety culture within all induction and training activities, promoting continuous improvement • increased workforce diversity and inclusion, targeting Aboriginal workers and businesses, female representation in non-traditional trades, and long term unemployed • inspire future talent and develop capacity in the sector, engaging young people via education and work experience, collaborating with higher education institutions to provide programs responding to rapid transit and other infrastructure requirements, and supporting vocational career development through apprenticeships and traineeships

24.3.2 Climate change

In summary, the climate risk assessment process identified (residual risks):

- no very high ('unacceptable') risks
- no high ('undesirable') risks
- fifteen medium ('tolerable') risks
- no low ('acceptable') risks.

The fifteen medium risks comprised issues in the following categories:

- increased rainfall intensity and extreme events affecting stations and surrounds
- changed rainfall patterns affecting overland flows and drainage requirements
- effects of changes in groundwater levels and extreme rainfall events resulting in instability of cuttings and embankments
- damage of roofs and critical equipment associated with hailstorm events.

All proposed drainage works have been designed to comply with relevant guidelines as far as possible. Where necessary, drainage works have included carparks and as well as drainage in areas surrounding the stations. Flood modelling included a 10 per cent allowance for the effects of climate change. Further sensitivity analyses for additional increases in rainfall intensity would be completed during detailed design.

Retaining walls have been designed to allow for elevated ground water levels. As a result, changes in ground water levels do not represent a high risk.

To effectively manage these and other climate change risks, each stage of the design and delivery of the project would consider the most up to date climate change projections and design guidelines and would be subject to ongoing review and response by designers and constructors.

24.3.3 Greenhouse gas

Potential greenhouse gas emissions

Potential scope 1, 2 and 3 greenhouse gas sources for construction and operation are listed in Table 24.3.

Table 24.3 Potential greenhouse gas sources and categorisation

Scope	Description	Construction	Operation
Scope 1	Direct greenhouse gas emissions generated on site.	Construction equipment – use of fossil fuels, typically diesel, which would create greenhouse gas emissions. Removal of vegetation – vegetation absorbs carbon dioxide from the atmosphere by photosynthesis. Where vegetation is removed, the ability for the vegetation to act as a carbon sink would be lost.	Maintenance plant and equipment – use of fossil fuels, typically diesel, which would create greenhouse gas emissions.
Scope 2	Indirect greenhouse gas emissions associated with electricity used on-site for lighting construction sites, where actual emissions are generated elsewhere (generally at the source of the electricity generation).	Electricity and fuel use - used by site offices for lighting and security.	Traction power and rail systems electricity Electricity for station and maintenance facilities Upstream fuel and electricity usage.
Scope 3	Other indirect emissions, such as the extraction and production of purchased materials and fuels, transport-related activities, and waste disposal.	Construction materials embodied energy – different construction materials contain varying levels of embodied emissions. For example, high-strength concrete contains a greater proportion of cement (which has a high level of embodied emissions), compared to concrete for lower-strength applications that contain fly-ash (which has a lower level of embodied emissions). Transport of construction materials and wastes – transport would create greenhouse gas emissions from the burning of fossil fuels.	Materials used for operation and maintenance – different materials contain varying levels of embodied emissions. Operations and maintenance vehicles – consumption and burning of fossil fuels.

Greenhouse gas emissions – construction estimates

Greenhouse gas emissions were estimated for the range of construction emission sources. The estimated scope 1, 2 and 3 emissions are summarised in Table 24.4.

Table 24.4 Estimated construction phase greenhouse gas emissions

Scope	Source	Greenhouse gas emissions (tCO_2e)[1,2]
Scope 1	Construction plant and equipment energy use (on site)	7,533
	Land and vegetation clearing	Not assessed – minor contribution relative to others
Scope 2	Upstream electricity and fuel use	9,940
Scope 3	Embodied emissions of construction materials	47,793
	Transport of materials	3,309

Scope	Source	Greenhouse gas emissions (tCO_2e)[1,2]
	Construction related transport to and from site	2,652
TOTAL		**71,225**

Notes: 1. tCOe = tonnes of CO equivalent.
2. These are preliminary estimates which would be further refined during detailed design. Estimates include the Sydney Metro Trains Facility South stabling yard and do not include demolition works.

In 2013, NSW's annual greenhouse gas emissions were about 146.7 million tCO_2-e (EPA, 2015b), with the transport industry sector accounting for about 8.44 per cent of the total. Construction of the project would equate to about 0.5 per cent of the transport industry's 2013 annual greenhouse gas emissions.

Greenhouse gas emissions – operation

Operational greenhouse gas emissions would mainly be associated with the scope 2 emissions, such as electricity consumption to power:

- metro trains (traction power)
- station facilities
- signalling and communications.

The annual electricity consumption during operation was estimated to be 86,576 tonnes of CO_2 equivalent. Operation of the project would represent about 0.7 per cent of NSW's transport industry's 2013 annual greenhouse gas emissions.

Operation and maintenance of the project would result in increased emissions of greenhouse gas as a result of increased electricity use. However, the project has the potential to reduce greenhouse gas emissions by providing a comfortable and efficient alternative to private car travel.

24.4 Mitigation measures

24.4.1 Approach to mitigation and management

Figure 24.2 shows how sustainability is integrated with the construction environmental management process for Sydney Metro. The project would be constructed and operated in accordance with the Sydney Metro City & Southwest sustainability strategy (described in Section 24.2) and constructed in accordance with the Construction Environmental Management Framework.

The Construction Environmental Management Framework (included in Appendix D) provides for the development and implementation of a construction sustainability management plan. The framework provides minimum requirements for the plan, which includes a:

- construction workforce development plan
- construction carbon and energy management plan
- waste management and recycling plan.

The construction sustainability plan would also incorporate the project specific mitigation measures listed in Table 24.5, and address the requirements of the Sydney Metro City & Southwest sustainability strategy. Further information on the approach to environmental management during construction and operation is provided in Section 28.4.

24.4.2 List of mitigation measures

The mitigation measures that would be implemented to address potential sustainability and climate change impacts are listed in Table 24.5.

Table 24.5 Mitigation measures – sustainability and climate change

ID	Impact/issue	Mitigation measures	Relevant location(s)
Design/pre-construction			
SCC1	Sustainability	Sustainability initiatives and targets would be reviewed and incorporated into the detailed design to support the achievement of the project's sustainability objectives. A best practice level of performance would be targeted using relevant sustainability rating tools eg ISCA as built 'excellent' level rating.	All
SCC2		A sustainable procurement strategy would be developed and implemented to apply to Principal Contractors, their subcontractors and their suppliers.	All
SCC3		A workforce development plan would be developed covering both construction and operation.	All
SCC4	Climate change	Climate change risk treatments would be incorporated into the detailed design, including ensuring that adequate flood modelling is carried out and integrated into the design.	All
SCC5	Greenhouse gas emissions	An iterative process of greenhouse gas assessments and design refinements would be carried out during detailed design and construction to identify opportunities to minimise greenhouse gas emissions. Performance would be measured in terms of a percentage reduction in greenhouse gas emissions from a defined reference footprint.	All
Construction			
SCC6	Sustainability	Sustainability reporting (and corrective action where required) would be undertaken during construction.	All
SCC7		The construction workforce development plan would be implemented.	All
SCC8	Greenhouse gas emissions	25 per cent of the greenhouse gas emissions associated with consumption of electricity during construction would be offset.	All
Operation			
SCC9	Sustainability	Prior to operation commencing, sustainability initiatives would be reviewed and updated, and relevant initiatives would be implemented to support the achievement of the project's sustainability objectives.	All
SCC10		The operation workforce development plan would be implemented.	All
SCC11	Climate change risks	Periodic review of climate change risks would be carried out to ensure ongoing resilience to the impacts of climate change.	All
SCC12	Greenhouse gas emissions	100 per cent of the greenhouse gas emissions associated with consumption of electricity during operation would be offset.	All

24.4.3 Consideration of the interactions between mitigation measures

The relationship between key documents within the Sydney Metro environment and sustainability management system and the contractor's environment and sustainability management system is shown in Figure 24.2, notably:

- The construction environment management plan and its sub-plans would capture the construction environmental management requirements of this Environmental Impact Statement, approval conditions, and the Sydney Metro City & Southwest Sustainability Strategy.
- The sustainability plan and its sub-plans would define the governance and design requirements, as well as the sustainability initiatives under the Sydney Metro City & Southwest Sustainability Strategy.
- These plans would vary across different delivery packages.

Sub-contractors engaged by the contractor would be required to work under the contractor's environmental and sustainability management system.

25. Hazards, risks and safety

This chapter considers the potential hazard, risk, and safety impacts of the project. There are no Secretary's environmental assessment requirements specifically relevant to hazards, risks, or safety. The assessment has been undertaken as the State Significant Infrastructure Application Report identified hazards, risk and safety as a potential issue associated with the project.

25.1 Assessment approach

25.1.1 Legislative and policy context to the assessment

The assessment considered the following legislation, policies, and guidelines:

- *Australian Code for the Transport of Dangerous Goods by Road & Rail* (National Transport Commission, 2017) ('the Dangerous Goods Code')
- *Dangerous Goods (Road and Rail Transport) Regulation 2009*
- *Code of practice for the storage and handling of dangerous goods* (WorkCover NSW, 2005)
- *Hazardous and Offensive Development Application Guidelines: Applying SEPP 33* (Department of Planning, 2011) ('Applying SEPP 33').

Dangerous goods and hazardous materials

Hazardous materials (or substances) are those that, following exposure, can have an adverse effect on health. Examples include materials that cause cancer, burns, skin and eye irritations, and poisons. Hazardous materials are those that meet the classification criteria specified by the *Work Health and Safety Regulations 2011* and the Globally Harmonised System of Classification and Labelling of Chemicals (an internationally agreed system of chemical classification).

Dangerous goods are classified according to their physical or chemical effects, such as fire, explosion, corrosion and poisoning, affecting property, the environment, or people. Dangerous goods are substances that, because of their physical, chemical (physicochemical) or acute toxicity properties, present a risk to people, property, or the environment. Types of substances classified as dangerous goods include explosives, flammable liquids and gases, corrosives, and chemically reactive or acutely (highly) toxic substances. Dangerous goods are defined by the Dangerous Goods Code. Many dangerous goods are also classed as hazardous substances.

As the project is critical State significant infrastructure, the guideline, Applying SEPP 33, does not apply to the project. However, Applying SEPP 33 provides a process of identifying a potentially hazardous development by identifying storage and transport screening thresholds. The thresholds in Applying SEPP 33 represent the maximum quantities of hazardous materials or substances that can be stored or transported without causing a significant off-site risk. Applying SEPP 33 defines hazardous materials as substances falling within the classification of the Dangerous Goods Code.

25.1.2 Methodology

A qualitative desktop assessment was undertaken, which included:

- reviewing the relevant regulatory framework and applicable guidelines (described in Section 25.1.1)
- identifying construction and operational activities with the potential to cause risks to health and safety
- identifying and assessing the hazards that could be encountered during construction and operation (including hazardous materials and dangerous goods)

- identifying storage and transport screening thresholds for hazardous materials and dangerous goods that may be required during construction and operation
- qualitatively assessing potential impacts to public health and safety
- providing mitigation and management measures.

The assessment focuses on those construction and operational activities with the potential to result in health and safety impacts on surrounding communities, land uses, and the environment (also known as 'off-site receivers'). The assessment does not take into account potential health and safety risks to on-site workers associated with normal construction operations, as these are regulated by workplace health and safety legislation (including the *Work Health and Safety Act 2011*), and are not relevant to approval of the project under Part 5.1 of the EP&A Act. Site management would be the responsibility of the construction contractor/s, who would be required (under the Work Health and Safety Act and applicable regulations) to manage the site in accordance with relevant regulatory requirements.

25.2 Existing environment

The urban setting of the project means that there is the potential for the community to be impacted if construction and operation activities are not properly managed. A description of existing land use patterns and sensitive receivers surrounding the project area is provided in Chapter 16 (Land use and property). Other sensitive receivers include members of the community travelling or moving in close proximity to work areas and operational areas.

25.3 Impact assessment

25.3.1 Risk assessment

Potential risks

The environmental risk assessment for the project, undertaken for the State Significant Infrastructure Application Report, identified the following as the main risks in relation to hazards, risks and safety:

- onsite storage, use, and transport of chemicals, fuels, and materials during construction and operation
- rupture of, or interference with, underground services during construction
- construction of new traction substations which have the potential to introduce risks associated with electric and magnetic fields.

Other potential risks include:

- emissions from vehicles or plant during construction
- reduced safety for road users and pedestrians during construction
- health impacts from noise and air pollution during construction
- structural risks and exposure to hazardous materials and any contaminated soil during demolition and construction works
- potential for train strike for pedestrians and vehicles crossing the rail corridor during operation.

How potential risks and impacts would be avoided

In general, potential health and safety impacts would be avoided by:

- managing construction and operation in accordance with relevant legislative and policy requirements, including those listed in Section 25.1.1
- designing, constructing, and operating the project to minimise risks to health and safety, including the features described in Chapter 8 (Project description – operation) and summarised below
- implementing the management and mitigation measures described in Section 25.4.

Further information on the measures that would be implemented to minimise risks to the health and safety of customers and the community is provided below.

Unauthorised access to the rail corridor

Unauthorised access to the rail corridor has the potential to result in serious injury or fatality. To prevent unauthorised access, the project would incorporate the following elements (further information is provided in Chapter 8):

- security fencing installed along both sides of the rail corridor
- a trackside intruder detection system, consisting of non-mechanical protection measures to supplement the fencing, including closed circuit television.

Customer safety and security

A key metro characteristic is to provide a system that is inherently safe for customers on trains, at stations, and at the interface with the public domain. As described in Chapters 7 (Design development and place making) and 8, the safety of passengers and the general public has been, and will continue to be, a key consideration during the design process. The following metro features would contribute to the safety and security of customers:

- customer service assistants at every station and moving through the network during the day and night
- station and train design that allow for good line of sight to enable passive and active surveillance
- stations and surrounding areas that are designed to be highly visible, active spaces with good lighting and amenity
- ensuring customers can see all the way along the train and move easily between carriages, including wide, open walkways between carriages
- providing platform screen doors at stations which keep people and objects away from the edge, improving customer safety and allowing trains to get in and out of stations much faster.

Other station safety features include:

- CCTV cameras linked to the operations control centre
- emergency help points
- passenger information signage.

Further information on safety and security is provided in Chapter 8.

25.3.2 Construction impacts

Storage, handling, and transport of dangerous goods and hazardous materials

The storage and handling of dangerous goods and hazardous materials have the potential to impact the surrounding community and environment if leaks and spills occur, resulting in the potential contamination of air, soils, surface water, and/or groundwater.

Dangerous goods that may be used during construction are listed in Table 25.1. These are compared to the storage and transport thresholds in Applying SEPP 33. These thresholds represent the maximum amounts of dangerous goods that can be stored or transported to and from a construction site without causing a significant risk to off-site receptors.

In general, low volumes of dangerous goods would be stored at construction sites. The quantity of goods stored would be commensurate with the demand for those goods so that excess goods are not sitting idle.

Table 25.1 Dangerous goods volumes and thresholds

Material	Dangerous Good Code Class	Storage method	SEPP 33 thresholds		
			Storage volume	Minimum storage distance from sensitive receivers	Transport
Diesel	C11; 3 PG III2	20 litre drums/ carry cans	Greater than 5 tonnes, if stored with other Class 3 flammable liquids	5 metres	Not applicable if not transported with Class 3 dangerous goods
Petrol	C11; 3 PG III2	20 litre drums	Greater than 5 tonnes, if stored with other Class 3 flammable liquids	5 metres	Not applicable if not transported with Class 3 dangerous goods
Lubricating and hydraulic oils and greases	C2	20 litre drums	n/a	n/a	Not applicable, if not transported with Class 3 dangerous goods
Acetylene	2.1	Cylinders (up to 55 kgs) in rack	Greater than 0.1 tonnes (100 kg)	15 metres	2 tonnes; 30 times per week
Cement	n/a	Bags/pallets (in container)	n/a	n/a	Not subject to Applying SEPP 33 transport thresholds
Premix concrete	n/a	Bags/pallets (in container)	n/a	n/a	Not subject to Applying SEPP 33 transport thresholds
Concrete curing compounds	n/a	20 litre drums	n/a	n/a	Not subject to Applying SEPP 33 transport thresholds
Concrete retardant	3 PG III	205 litre drums	Greater than 5 tonnes	5 metres	10 tonnes; 60 times per week
Epoxy glue	3 PG III	Small containers	Greater than 5 tonnes	5 metres	10 tonnes; 60 times per week

Material	Dangerous Good Code Class	Storage method	SEPP 33 thresholds		
			Storage volume	Minimum storage distance from sensitive receivers	Transport
Coagulants	n/a	1,000 litre intermediate bulk containers	n/a	n/a	Not subject to Applying SEPP 33 transport thresholds
Acids	8 PG II	1,000 litre intermediate bulk containers	Greater than 25 tonnes	n/a	2 tonnes; 30 times per week
Bases	8 PG II	1,000 litre intermediate bulk containers	Greater than 25 tonnes	n/a	2 tonnes; 30 times per week
Disinfectant	8 PG III	500 litre intermediate bulk containers	Greater than 50 tonnes	n/a	2 tonnes; 30 times per week
Anti-scalent	n/a	100 litre drums	n/a	n/a	Not subject to Applying SEPP 33 transport thresholds
Membrane preser-vative	8 PG III	10 litre drums	Greater than 50 tonnes	n/a	2 tonnes; 30 times per week
De-bonding agents	n/a	Drums/ containers	n/a	n/a	Not applicable
Contamin-ated waste	Dependent on nature of material	Bunded areas or removed directly from site	Dependent on nature of material	Dependent on nature of material	Dependent on nature of material
Paint	n/a	20 litre drums	n/a	n/a	Not subject to Applying SEPP 33 transport thresholds

Underground utilities

As described in Chapter 9 (Project description – construction), a number of utilities would need to be adjusted, relocated, and/or protected to enable construction. The potential rupture of underground utilities during excavation or collision of plant and equipment with aboveground services could pose risks to public safety. Rupture or contact with services during works could also result in releases and/or short-term outages, as could relocation of utilities and services.

Health and safety impacts associated with encountering utilities would be minimised by implementing the utilities management strategy described in Section 9.10.

Working in the vicinity of utilities

If inadequately managed, works in the vicinity of utilities which are not protected or relocated (such as high voltage electricity transmission lines or gas pipelines) could result in increased risks to the workforce and/or surrounding environment/community. These potential risks would be minimised through careful construction planning and the implementation of the utilities management strategy described in Section 9.10.

Removal of buildings and structures

The project requires the removal of structures at and around stations. Hazards and risks associated with building demolition include:

- unplanned structure collapse
- falls from one level to another
- falling objects
- the location of above and underground services
- exposure to any hazardous chemicals and materials (such as asbestos fibres, lead dust, and biological material)
- noise from plant and explosives used in demolition work
- proximity of the building or structure being demolished to other buildings or structures.

To minimise exposure to these hazards and risks, a risk assessment would be carried out prior to works commencing. The risk assessment would include:

- an assessment of the structural integrity of the structure to be demolished
- an assessment of the method of demolition, including sequencing, scheduling, plant and equipment, and the layout of work areas
- a hazardous material survey for those buildings and structures suspected of containing hazardous materials (particularly asbestos).

Demolition would be carried out by licensed demolition contractors, in accordance with relevant regulatory requirements, and the project specific construction environmental management requirements described in Chapter 28 (Synthesis of the Environmental Impact Statement).

Potential contamination

Contaminants of potential concern that could be exposed during excavation include hydrocarbons, heavy metals, herbicides, and asbestos. Exposure to these contaminants could cause health and safety impacts to the community through inhalation and/or direct contact, or impacts to the environment due to contamination of land.

Health and safety impacts associated with potential exposure to contaminated and hazardous materials would be minimised through implementation of an unexpected finds protocol and waste management plan. Further information on contamination and waste, and associated mitigation measures is provided in Chapters 20 (Soils and contamination) and 26 (Waste management).

Risk of subsidence

As described in Chapter 21 (Hydrology, flooding and water quality), the potential for changes to groundwater levels as a result of construction is low, due to the generally shallow depth and limited extent of excavation. The project would also not involve the excavation of any tunnels or other sub-surface cavities. Based on the nature of the works being undertaken and the existing environment, the risk of subsidence as a result of construction is considered negligible.

Other health and safety risks

Other construction activities could result in impacts to the health and safety of site workers, users, visitors, and the local community if improperly managed. These include:

- working within an operating rail environment
- the operation of vehicles and construction equipment on site

- the transportation of equipment, excavated spoil, and material to and from site
- construction failures or incidents resulting in flooding, inundation, or excavation collapse.

In addition to the above, there is the potential for risks to pedestrians/public safety resulting from unauthorised access to construction work areas.

NSW workplace safety laws require construction sites to have adequate site security, which includes appropriate fencing. All construction work would be isolated from the general public. The construction contractor/s would need to ensure that construction sites are secure at all times, and take all possible actions to prevent entry by unauthorised persons.

Health and safety risks during construction would be managed by the implementation of standard workplace health and safety requirements. A work health and safety management plan, and safe work method statements would be developed in accordance with regulatory requirements.

The mitigation measures provided in Section 25.4 would be implemented to minimise and avoid the potential for health and safety impacts during construction.

25.3.3 Operation

Storage, handling and transport of dangerous goods and hazardous materials

The amount of hazardous materials and dangerous goods that would be used during maintenance activities would be much smaller than the volumes required during construction. Hazardous materials and dangerous goods required during maintenance would be similar to those listed in Table 25.1, and would be transported in vehicles/trucks to areas requiring maintenance. Therefore, the potential for impacts during operation associated with the storage and handling of hazardous materials and dangerous goods is considered negligible. Potential impacts would be managed through the implementation of standard mitigation measures to be developed as part of the operational environmental management plan.

Operation of traction substations and electrical wiring

The project includes the augmentation of existing power supplies, including new traction substations, feeders and overhead wiring. The possibility of adverse health effects due to the electro-magnetic fields associated with electrical equipment, including traction substations and overhead wiring, has been the subject of considerable research, and the results are still inconclusive.

The design, construction, and operation of the project's power supply would be undertaken in accordance with standard industry guidelines and codes of practice, such that conductive and semi-conductive materials effectively shield electrical fields. With regard to magnetic fields, the separation distance would be maximised between substations and public areas to minimise the potential to alter electro-magnetic field strength within the surrounding area.

The project would be designed to comply with appropriate Australian and international standards, to minimise the risk associated with electro-magnetic field exposure.

Other health and safety risks

Potential impacts to the health and safety of the community and customers during operation include:

- safety risks (e.g. unauthorised access)
- general worker health and safety issues for drivers and maintenance staff.

As described in Section 25.3.1, these risks would be mitigated through the design process which would include an appropriate emphasis on safety according to relevant design standards and requirements. The project has been designed to incorporate features which would ensure sufficient levels of safety specific to metro operations, for example security fencing, platform screen barriers, and a trackside intruder detection system. Further information is provided in Chapter 8.

Maintenance activities and other works within the rail corridor would be undertaken in accordance with Transport for NSW's standing operating procedures, reducing the potential for impacts to the health and safety of workers, visitors, and customers.

25.4 Mitigation measures

25.4.1 Approach to mitigation and management

Dangerous goods and hazardous materials

The construction environmental management plan for the project, and operational procedures for Sydney Metro as a whole, would include requirements for the storage, handling, and transport of dangerous goods and hazardous materials, in accordance with relevant regulatory requirements and standards. This would include procedures for the management of any accidental spills.

The risk of mobilising hazardous materials during construction and operation would be managed by:

- undertaking demolition and hazardous materials removal in accordance with relevant regulatory requirements and the construction environmental management plan
- transporting, storing, and using dangerous goods and hazardous materials in accordance with applicable standards
- the implementation of spill management and emergency and incident response procedures, defined by the environmental management plans for construction and operation
- managing any contaminated soils as described in Chapter 20
- incorporating bunding designed in accordance with the applicable standards into the design of relevant facilities to contain any chemical spills or leaks.

Emergency and incident response

The construction environmental management plan would include emergency and incident response procedures, as specified by the Construction Environmental Management Framework. The procedures would specify:

- roles and responsibilities
- notification and reporting protocols
- action and investigation requirements
- training programs to ensure that all staff are familiar with the plan
- design and management measures to address the potential environmental impacts of an emergency situation.

Response to emergencies during operation would be undertaken in accordance with Transport for NSW's existing procedures.

25.4.2 List of mitigation measures

The mitigation measures that would be implemented to minimise health and safety risks are listed in Table 25.2.

Table 25.2 Mitigation measures – hazards, risks and safety

ID	Impact/issue	Mitigation measures	Relevant location(s)
Design/pre-construction			
HRS1	Public safety	A hazard analysis would be undertaken during the detailed design stage to identify risks to public safety from the project, and how these can be mitigated through safety in design.	All
Construction and operation			
HRS2	Hazardous materials and substances	All hazardous substances that may be required for construction and operation would be stored and managed in accordance with the *Code of practice* for the *storage and handling of dangerous goods* (WorkCover NSW, 2005) and the *Hazardous and Offensive Development Application Guidelines: Applying SEPP* 33 (Department of Planning, 2011).	All

25.4.3 Consideration of the interactions between mitigation measures

There are interactions between the mitigation and management measures for hazards, risks and safety, and those for traffic, transport and access (Chapters 10 and 11), noise and vibration (Chapters 12 and 13), soils and contamination (Chapter 20), water quality (Chapter 21), and air quality (Chapter 23). Together, all these measures would serve to minimise the potential for impacts to the community.

25.4.4 Managing residual impacts

With the incorporation of design features described in Section 25.3.1, and implementation of the mitigation and management measures provided in this section, no residual health and safety risks are anticipated.

26. Waste management

This chapter assesses the predicted waste generation during construction and operation, and provides a description of how waste would be managed. There are no Secretary's environmental assessment requirements specifically relevant to waste. The assessment has been undertaken as the State Significant Infrastructure Application Report identified waste management as a potential issue associated with the project.

26.1 Assessment approach

26.1.1 Legislative and policy context to the assessment

The main legislation relevant to the management of waste are the POEO Act, the *Protection of the Environment Operations (Waste) Regulation 2014* (the Waste Regulation) made under the POEO Act, and the *Waste Avoidance and Resource Recovery Act 2007* (the WARR Act).

The POEO Act establishes the procedures for environmental control, and for issuing environmental protection licences covering issues such as waste. The Waste Regulation regulates matters such as the obligations of consignors (producers and agents), transporters, and receivers of waste, in relation to waste transport licensing and tracking requirements.

The movement of controlled waste is also regulated by the *National Environment Protection (Movement of Controlled Waste between States and Territories) Measure 1998*, made under the *National Environment Protection Council Act 1994*.

Definition of waste

Schedule 5 of the POEO Act defines waste as:

> *(a) any substance (whether solid, liquid or gaseous) that is discharged, emitted or deposited in the environment in such volume, constituency or manner as to cause an alteration in the environment*
>
> *(b) any discarded, rejected, unwanted, surplus or abandoned substance*
>
> *(c) any otherwise discarded, rejected, unwanted, surplus or abandoned substance intended for sale or for recycling, processing, recovery or purification by a separate operation from that which produced the substance*
>
> *(d) any processed, recycled, reused or recovered substance produced wholly or partly from waste that is applied to land, or used as fuel, but only in the circumstances prescribed by the regulations*
>
> *(e) any substance prescribed by the regulations to be waste.*

Waste classification

The classifications that apply to waste in NSW and the descriptions of each are provided by the POEO Act, and the Waste Regulation and supporting guidelines, including the *Waste Classification Guidelines* (EPA, 2014a). Many waste types are pre-classified under the POEO Act and do not require testing. However, if a waste is not pre-classified, it may need to be tested to determine its classification.

Waste policy and strategic framework

The WARR Act aims to ensure that waste management options are considered against the following waste management hierarchy:

1. avoidance of unnecessary resource consumption
2. resource recovery (including reuse, reprocessing, recycling and energy recovery)
3. disposal.

To support the waste hierarchy, the *NSW Waste Avoidance and Resource Recovery Strategy 2014–21* (EPA, 2014b) provides a framework and targets for waste management and recycling in NSW. Targets established under this strategy comprise:

- avoiding and reducing the amount of waste generated per person in NSW
- increasing recycling rates to 70 per cent for municipal solid waste, 70 per cent for commercial and industrial waste, and 80 per cent for construction and demolition waste
- increasing waste diverted from landfill to 75 per cent
- managing problem wastes better, and establishing 86 drop-off facilities and services across NSW.

Transport for NSW, as a NSW Government agency, has a general responsibility to support these targets by:

- implementing complementary policies and programs, including sustainable procurement
- incorporating resource recovery and waste reduction objectives into its operations
- complying with relevant regulations.

26.1.2 Methodology

A desktop assessment was carried out, which involved:

- reviewing the regulatory framework for waste management
- identifying potential waste generating activities during construction and operation
- reviewing the likely waste streams and volumes, including wastewater and demolition materials
- identifying the likely classification of waste streams in accordance with relevant legislation and guidelines
- estimating the quantities of bulk earthworks and spoil balance to be generated through the construction of the project
- developing proposed management and handling techniques for key wastes streams including contingencies for managing unexpected waste volumes
- identifying lawful disposal or recycling locations.

It is noted that the waste types and quantities estimated are indicative, and have been identified for the purpose of determining potential waste management options. Although the quantities of waste actually generated by the project may differ from the estimates made, the identified waste management options would be appropriate to the final waste quantities.

Potential impacts of transport during construction (which includes the transport of construction waste) are considered in Chapter 10 (Construction traffic, transport and access). The management of any contaminated soils and hazardous materials are considered in Chapters 20 (Soils and contamination) and 25 (Hazards, risks and safety) respectively.

26.2 Impact assessment

26.2.1 Risk assessment

Potential risks

The main potential risks in terms of waste management would occur during construction. The environmental risk assessment for the project, undertaken for the State Significant Infrastructure Assessment Report, identified the following as the main risks:

- incorrect disposal of general, demolition, and construction waste generated
- incorrect disposal of any excess spoil
- incorrect disposal of any contaminated or hazardous waste.

The assessed risk level for the potential risks was low. This is because the project is unlikely to result in significant amounts of waste, with the exception of construction related waste.

How potential impacts would be avoided

In general, with respect to waste, potential impacts would be avoided by:

- managing waste in accordance with relevant legislative and policy requirements, as outlined in Section 26.1.1
- designing, constructing and operating the project so that wastes are managed according to the waste minimisation hierarchy
- implementing the waste management and mitigation measures provided in Section 26.3.

26.2.2 Construction

Waste generation

The main construction activities anticipated to generate waste are listed in Table 26.1 together with the materials that may be produced, and likely waste classifications.

Table 26.1 Indicative types of waste generated during construction

Activity	Waste streams that may be produced	Likely classification of waste stream
Excavation and general earthworks	Spoil comprising virgin excavated natural material (uncontaminated soil and crushed rock)	General solid waste (non-putrescible)
	Contaminated materials	Hazardous waste and/or special waste
	Potential acid sulfate soils	Special waste
	Ballast	General solid waste (non-putrescible)
Demolition/removal of buildings (mainly at stations) and other infrastructure (such as road overbridges)	Concrete, asphalt, bricks, tiles, timber (treated and untreated), metals, plasterboard, carpets, electrical and plumbing fittings and furnishings (such as doors and windows)	General solid waste (non-putrescible)
	Hazardous waste (such as asbestos and insulation)	Hazardous waste and/or special waste
Dust suppression, wash down of plant and equipment, and staff amenities at construction sites (such as toilets)	Sediment-laden and/or potentially contaminated wastewater, sewage and grey water	Liquid waste

Activity	Waste streams that may be produced	Likely classification of waste stream
Station fit-out and general construction activities and resource use	Concrete waste, timber formwork, scrap metal, steel, plasterboard, cable and packaging material	General solid waste (non-putrescible)
Maintenance of construction plant, vehicles and equipment	Adhesives, lubricants, waste fuels and oils, engine coolant, batteries, hoses	Hazardous waste
	Tyres	Special waste
Activities at offices and crib rooms	Putrescibles	General solid waste (putrescible)
	Paper, cardboard, plastics, glass and printer cartridges	General solid waste (non-putrescible)
Clearing and grubbing of vegetation, landscaped and/or turfed areas	Green waste	General solid waste (non-putrescible)

The types and quantities of construction waste generated by the project would vary throughout construction. Of these, estimates for the main waste streams (spoil, ballast, concreate/brick, and asphalt) are provided in Table 26.2. The volumes of other wastes are expected to be comparable to similar infrastructure projects. The quantities and classifications of all waste streams would be confirmed following finalisation of the detailed design.

With respect to waste generation, based on the current design, it is estimated that:

- about 85,000 cubic metres of spoil would be required for fill
- about 45,000 cubic metres of surplus material would be generated.

Table 26.2 Indicative waste estimates for the main waste streams

Location	Spoil (tonnes)	Spent ballast (tonnes)	Concrete/brick (tonnes)	Asphalt (tonnes)
Marrickville	300	2,400	900	200
Dulwich Hill	11,000	2,400	800	700
Hurlstone Park	1,800	2,400	500	200
Canterbury	600	2,400	150	250
Campsie	4,000	2,400	500	300
Belmore	6,000	2,700	1,000	1,000
Lakemba	6,000	2,400	1,000	1,000
Wiley Park	400	2,400	50	0
Punchbowl	6,000	2,400	1,000	200
Bankstown	14,000	1,800	1,800	200
Drainage works	17,800	0	0	0
Earthworks in corridor (away from stations)	38,200	0	0	0
Bridge works	300	0	0	0
Substation works	1,250	0	0	0
Combined services route	400	0	0	0
Total	**108,050**	**23,700**	**7,700**	**4,050**

Waste management

Consistent with the waste hierarchy, the approach to spoil management for uncontaminated spoil would follow the hierarchy of options listed in Table 26.3.

Table 26.3 Spoil management hierarchy (uncontaminated spoil)

Priority	Reuse options	Potential options for reuse of spoil
1	Within the project area	• fill embankments and mounds within a short haulage distance of the source • site restoration • feed product in construction materials.
2	Environmental work	• for environmental restoration projects (such as coastal protection, flood mitigation).
3	Other development projects (including other Sydney Metro projects)	• fill embankments and mounds on projects within a financially feasible transport distance of the site • land reclamation or remediation projects • for manufacturing concrete, bricks and tiles.
4	Land restoration	• fill for disused facilities (for example mines and quarries) to enable either future development or site rehabilitation.
5	Landfill management	• capping completed landfill cells • daily covering of landfill waste.

As part of the project, the reconditioning of ballast would occur where practicable. It is estimated that about 60 per cent of ballast is likely to be suitable for reuse within the project area.

Waste handling and management measures are provided in Table 26.4 based on the waste hierarchy for the identified types of waste. Although the waste hierarchy has been considered for each waste type, not all waste management options apply to a given waste type. For example, some types of waste are non-recyclable.

Table 26.4 Management of construction waste

Waste type	Management
Spoil	Spoil comprising virgin excavated natural material (uncontaminated soil and crushed rock) would be managed in accordance with the spoil management hierarchy (Table 26.3).
Ballast	Where practicable, ballast would be reconditioned for reuse within the rail corridor. Excess ballast waste would be removed for reuse or disposal.
Contaminated spoil and acid sulfate soils	In situ testing of soils in areas of potential contamination concern would be undertaken to determine the appropriate waste classification. Contaminated spoil would be sampled and immobilised before being transported and disposed of at a suitably licensed offsite location.
Demolition waste (concrete, asphalt, bricks tiles, timber, metals, plasterboard, carpets, electrical and plumbing fittings and furnishing)	Demolition waste would be managed in accordance with the waste hierarchy. Demolition waste would be segregated and stockpiled on site, with materials such as bricks and tiles, timber, plastic, and metals separated and sent to a construction and demolition waste recycling facility. Electrical waste would be stored for collection by an authorised contractor for recycling offsite, where feasible, or disposal at an appropriately licenced facility. All demolition waste would be classified in accordance with the *Waste Classification Guidelines* (EPA, 2014a) and directed to a waste management facility that is lawfully permitted to accept that type of waste.
Hazardous waste including asbestos	The disturbance, movement, and disposal of asbestos containing materials would be undertaken in accordance with the *Work Health and Safety Regulations 2011* and applicable guidelines.
Liquid waste	Wastewater, sewage, and grey water would be disposed to sewer or transported to an appropriately licenced liquid waste treatment facility.

Waste type	Management
Adhesives, lubricants, waste fuels and oils, engine coolant, tyres	Waste from construction vehicle and plant maintenance activities would be collected and stored in designated waste storage areas for collection by an authorised contractor for offsite disposal. Where feasible, containers holding oil, grease, and lubricants would be washed prior to disposal, or stored separately for disposal as hazardous waste. Waste oil and oil filters would be stored in recycling bins and collected by an authorised contractor, and recycled offsite, where feasible. Tyres would be collected by an authorised contractor for recycling or disposal offsite at an appropriately licenced facility.
Office waste including kitchen waste, paper, cardboard, plastics, glass	Recyclable materials such as paper, cardboard, plastics, glass, ferrous, and non-ferrous containers would be stored at recycling bins for collection by an authorised contractor, and recycled offsite. Where recycling is not feasible, waste would be collected and stored in designated waste storage areas for collection by an authorised contractor for offsite disposal at a licenced waste facility.
Green waste	As far as practicable, green waste would be chipped, mulched and reused for vegetation management on site, or collected by an authorised contractor and recycled offsite. Noxious weeds would be disposed of in accordance with relevant guidelines/requirements.

26.2.3 Operation

Waste generation

The main types of activities with the potential to generate waste during operation are listed in Table 26.5, together with the likely waste materials and classifications.

Table 26.5 Indicative types of waste generated during operation

Activity	Waste streams that may be produced	Likely classification of waste stream
Disposal of general litter in station bins and cleaning activities associated with trains, stations and other infrastructure	General non-recyclable and putrescible waste (such as food waste from station rubbish bins)	General solid waste (putrescible)
	Recyclable wastes such as plastics and aluminium cans, office waste including paper and plastics	General solid waste (non-putrescible)
Infrastructure maintenance	Cable and conduit off-cuts from maintenance of electrical infrastructure	General solid waste (non-putrescible)
	Solvents, paints, adhesives, cleaning fluids, greases, acids and alkali materials, and spent spill kit absorbent materials used to clean up accidental spills during maintenance	Hazardous waste and/or special waste
Capture and treatment of stormwater	Sediment-laden and/or potentially contaminated wastewater and solids	Liquid waste
Use of station customer facilities (such as toilets)	Sewage and grey water	Liquid waste

The volumes of wastes generated during operation would be considerably lower than that generated during construction. Wastes would be typical of similar transport facilities, including the existing Sydney Trains network. Wastes would be managed by the implementation of standard waste management strategies (provided in Table 26.6 and Section 26.3).

Waste management

Waste handling and management measures are provided in Table 26.6, based on the waste hierarchy for the identified types of waste.

Table 26.6 Management of operational waste

Waste type	Management
General litter and station waste such as food waste, paper, cardboard, plastics, glass	Bins would be provided for collection by an authorised contractor for offsite recycling or disposal at a licenced waste facility.
Adhesives, lubricants, waste fuels and oils, engine coolant, tyres	Waste from maintenance activities would be collected and stored in designated waste storage areas, for collection by an authorised contractor for offsite disposal. Where feasible, containers holding oil, grease, and lubricants would be washed prior to disposal or stored separately for disposal as hazardous waste. Waste oil and oil filters would be stored in recycling bins and collected by an authorised contractor, and recycled offsite, where feasible.
Liquid waste	Wastewater, sewage and grey water would be disposed to sewer or transported to an appropriately licenced liquid waste treatment facility.

26.2.4 Recycling and disposal locations

There are a number of options for recycling and disposal of construction and operation waste generated by the project. Waste facilities in Sydney licensed to accept general solid waste (putrescible) include (but are not limited to):

- Clyde Transfer Terminal
- Eastern Creek Resource Recovery Park
- Kemps Creek Advanced Resource Recovery Park
- Lucas Heights Resource Recovery Park
- a number of waste transfer stations.

A larger number of licenced facilities in Sydney accept general solid (non-putrescible) waste and vegetation/green waste.

A number of waste facilities in Sydney are licenced to accept asbestos, including:

- Elizabeth Drive Landfill, Kemps Creek
- Eastern Creek Resource Recovery Park
- Genesis Xero Waste – Landfill and Recycling
- Horsley Park Waste Management Facility
- Jacks Gully Waste and Recycling Centre
- Kimbriki Recycling and Waste Disposal Centre
- Lucas Heights Resource Recovery Park
- Wetherill Park Resource Recovery Facility.

Recyclables such as containers (plastics, glass, cans, etc), paper and cardboard would be collected by an authorised contractor for off-site recycling. There are a number of materials recovery facilities in Sydney. The recycling facility would be determined by the contractor engaged to collect the material.

Specific facilities and collection contractors would be selected during the later stages of the project and documented in the construction environmental management plan.

26.3 Mitigation measures

26.3.1 Approach to mitigation and management

Waste during construction would be managed in accordance with the Construction Environmental Management Framework (as described in Chapter 28 (Synthesis of the Environmental Impact Statement)). The framework requires implementation of strategies to reduce waste volumes and report on waste generated, and provides for development and implementation of a waste management and recycling plan, to include (as a minimum):

- waste management measures
- responsibilities of key project personnel
- waste monitoring requirements
- a procedure for the assessment, classification, management and disposal of waste in accordance with the *Waste Classification Guidelines*
- compliance record generation and management.

Operational procedures would consider waste management in accordance with regulatory requirements and the waste hierarchy.

Project specific mitigation measures are provided in Table 26.7.

26.3.2 List of mitigation measures

The mitigation measures that would be implemented to manage waste are listed in Table 26.7.

Table 26.7 Mitigation measures – waste management

ID	Impact/issue	Mitigation measures	Relevant location(s)
Design/pre-construction			
WM1	Waste generation and recycling	Detailed design would include measures to minimise excess spoil generation. This would include a focus on optimising the design to minimise spoil volumes, and the reuse of material on-site.	All
WM2		A recycling target of at least 90 per cent would be adopted.	All
Construction			
WM3	Waste and spoil management	Spoil would be managed in accordance with the spoil management hierarchy.	All
WM4		Target 100 per cent reuse of reusable spoil.	All
WM5		Construction waste would be minimised by accurately calculating materials brought to the site and limiting materials packaging.	All
WM6		All waste would be assessed, classified, managed and disposed of in accordance with the *Waste Classification Guidelines* (EPA, 2014a).	All
WM7		Waste segregation bins would be located at various locations within the project area, if space permits, to facilitate segregation and prevent cross contamination.	All

26.3.3 Consideration of the interactions between mitigation measures

There are interactions between the mitigation measures for waste management and soils and contamination (provided in Chapter 20), and hazardous materials (provided in Chapter 25). The project-specific sustainability initiatives described in Chapter 24 (Sustainability and climate change) are also relevant to the management of waste. Together, all these measures would ensure appropriate handling of waste materials to minimise the potential for impacts to the community and environment.

26.3.4 Residual impacts

Construction waste quantities, including estimated spoil generation, spoil reuse, and spoil surplus, would be confirmed during detailed design. Classifications and reuse/recycling/disposal locations would also be confirmed at this stage. However, it is recognised that there is potential for unexpected volumes of potentially contaminated spoil to be generated. Any spoil classified as contaminated in accordance with *Waste Classification Guidelines* would be directed to a waste management facility that is lawfully permitted to accept that type of contaminated waste.

There are a number of solid waste landfills in Sydney that are licensed to accept contaminated soils. It is anticipated that the volumes of contaminated spoil generated by the project could be readily accommodated at these facilities.

Further information on the management of soils and contamination is provided in Chapter 20.

27. Cumulative impacts

This chapter considers the potential cumulative impacts of the project. It has been prepared to support the cumulative impact assessments undertaken as part of the assessments summarised in Chapters 10 to 23. The Secretary's environmental assessment requirement addressed in this chapter is provided in Table 27.1.

Table 27.1 Secretary's environmental assessment requirements – cumulative impacts

Ref	Secretary's environmental assessment requirements – cumulative impacts	Where addressed
2.1(o)	An assessment of the cumulative impacts of the project taking into account other projects that have been approved but where construction has not commenced, projects that have commenced construction, and projects that have recently been completed (for example WestConnex and approved construction in the relevant precincts).	Chapters 10 to 23 and this chapter

27.1 Assessment approach

For an environmental impact statement, cumulative impacts can be defined as the successive, incremental, and combined effect of multiple impacts, which may in themselves be minor, but could become significant when considered together.

The assessment of potential cumulative impacts has been undertaken in accordance with the Secretary's environmental assessment requirements, and considers the potential for impacts taking into account other projects in close proximity to the project (referred to as the 'Sydenham to Bankstown upgrade' for the purpose of this chapter). The assessment draws on the findings of Chapters 10 to 23, and environmental impact assessments for other projects, where these are available.

The potential for cumulative impacts for each environmental issue is considered in each of the key issue chapters (refer to Chapters 10 to 23).

27.1.1 Methodology

The following tasks were undertaken to assess the potential for cumulative impacts:

- identifying existing (approved or under construction) and proposed projects in the vicinity of the Sydenham to Bankstown upgrade, based on information available in the public domain
- screening identified projects for their potential to interact with the Sydenham to Bankstown upgrade
- identifying and assessing the significance of potential cumulative impacts by:
  - considering project-specific impacts for the key projects with the potential for cumulative impacts when combined with the construction and/or operation of the Sydenham to Bankstown upgrade (described in Section 27.2)
  - undertaking an issue-specific cumulative assessment for the key environmental issues listed in the Secretary's environmental assessment requirements, taking into account major projects being undertaken close to the project area for the Sydenham to Bankstown upgrade (described in Section 27.2).

The screening of projects took into account the following:

- The project location – projects in close proximity to the Sydenham to Bankstown upgrade where there is potential for impacts to spatially overlap. This included potential for shared use of roads for construction access, for example.
- The project timeframe and planning approval – only projects likely to be built concurrently with the Sydenham to Bankstown upgrade were assessed. This includes projects currently under construction and/or projects that have received planning approval. Projects at a conceptual or pre-approval stage were generally not able to be considered due to an absence of project and/or environmental impact details or development timeframes.
- The project size – projects considered are typically larger scale projects identified on the Department of Planning and Environment's Major Projects Register and council development application registers.

Projects considered to have the potential for cumulative impacts with the Sydenham to Bankstown upgrade are listed in Table 27.2.

Table 27.2 Projects with the potential for cumulative impacts

Project and date	Project details	Proponent	Status	Construction timeframe	Nearest project location
Sydney Metro City and Southwest: Chatswood to Sydenham	A new metro rail line, about 16 kilometres long (of which about 15 kilometres is located in underground rail tunnels) between Chatswood and Sydenham with six metro stations.	Transport for NSW	Approved	2017 – 2023	Marrickville Station
Sydney Metro City and Southwest: Chatswood to Sydenham – modification	Modification to include the upgrade of Sydenham Station and the construction of the Sydney Metro Trains Facility South	Transport for NSW	On exhibition	As above	Marrickville Station
WestConnex Stage 2: New M5 (Beverley Hills to St Peters)	Proposed new M5 to extend from the existing M5 East corridor at Beverly Hills via a tunnel to St Peters.	Roads and Maritime	Approved	2015 – 2019	Marrickville Station
WestConnex Stage 3: M4-M5 Link	Construction of an 8.5 kilometre motorway tunnel linking the M4 and M5 corridors. The alignment would provide a western bypass of the Sydney CBD Interchange.	Roads and Maritime	Pending approval	2019 – 2023	Marrickville Station

Project and date	Project details	Proponent	Status	Construction timeframe	Nearest project location
Sydney Airport	Upgrade of roads east of the airport and removal of the General Holmes Drive rail level crossing by constructing a road underpass.	Roads and Maritime	Under construction	2017 – 2018	Marrickville Station
Marrickville Metro redevelopment 34 Victoria Road Marrickville	Expansion of shopping centre by about 16,000 square metres in two stages.	Private	Under construction	Stage 1A commenced in 2016 and is due for completion in early 2017. Completion date for Stage 1B is unknown	Marrickville Station
401 Illawarra Road Marrickville	Demotion of existing building and construction of a six storey mixed use building above basement car parking containing a ground level shop and 21 dwellings	Private	Approved	Unknown	Marrickville Station
36 Floss Street & 118 Duntroon Street Hurlstone Park	Construction of a four storey mixed use development.	Private	Currently on exhibition	Unknown	Hurlstone Park Station
211-215 Canterbury Road, Canterbury	Demolition of existing structures and the construction of a new mixed-use development comprising 11 commercial tenancies and 69 residential apartments with basement car parking.	Private	Under construction	Unknown	Canterbury Station
10B Charles Street, Canterbury	Construction of a new ten storey residential flat building with two levels of basement parking.	Private	Under construction	Unknown	Canterbury Station
477 Burwood Road, Belmore	Construction of a new six storey mixed use commercial and residential development with basement parking.	Private	Under construction	Private	Belmore Station

Project and date	Project details	Proponent	Status	Construction timeframe	Nearest project location
Sydenham to Bankstown Urban Renewal Corridor	Potential redevelopment of areas along the Bankstown Line leading to increased densities	Department of Planning and Environment	Master planning	Unknown	All stations Marrickville to Bankstown

27.2 Potential cumulative impacts

Of the projects listed in Table 27.2, the Chatswood to Sydenham project (including the modification) is the only other major project considered to potential to result in cumulative impacts.

Surface works associated with WestConnex Stage 2: New M5 (Beverley Hills to St Peters) and Stage 3: M4-M5 Link are located approximately at Erskineville approximately 2.3 kilometres to the east and are unlikely to be additive to the project impacts.

The draft *Sydenham to Bankstown Urban Renewal Corridor Strategy* is relevant to the study area in which the project is located. The draft strategy proposes 35,400 new homes and 8,700 jobs over the next 20 years and associated infrastructure between Sydenham and Bankstown. However, due to the draft and strategic nature of this plan, there are no definitive works proposed, and it is not considered as part of the cumulative impact assessment.

27.2.1 Sydney Metro City & Southwest: Chatswood to Sydenham

Project details

The Chatswood to Sydenham project involves about 16 kilometres of new underground rail line and six new stations between Chatswood and Sydenham. The project includes a tunnel dive structure and a temporary construction compound to the north-east of Sydenham Station.

The Chatswood to Sydenham project was approved on 9th January 2017. A number of modifications are being prepared that would extend the project about 1.4 kilometres to the west of the tunnel dive structure, including the upgrade of Sydenham Station and development of the Sydney Metro Trains Facility South (stabling facility). Construction is due to commence in 2017 and is expected to be completed by 2023.

Location with respect to the Sydenham to Bankstown upgrade

The two projects form part of Sydney Metro City & Southwest and would interface with one another east of Marrickville Station. Although some construction activities would be undertaken concurrently, only works associated with the Sydenham Station upgrade and construction of the Sydney Metro Trains Facility South would be undertaken in the vicinity of the project.

Timing

Table 27.3 provides the indicative construction programs for the Chatswood to Sydenham and Sydenham to Bankstown projects. Potential interactions and cumulative impacts are considered in the following sections.

Table 27.3 Indicative construction programs for Chatswood to Sydenham and Sydenham to Bankstown upgrade

Project	2017	2018	2019	2020	2021	2022	2023	2024
Sydney Metro City and Southwest: Sydenham to Bankstown upgrade		■	■	■	■	■	■	■
Sydney Metro City and Southwest: Chatswood to Sydenham	■	■	■	■	■	■		

Cumulative impacts

Potential cumulative impacts that may arise as a result of both projects are summarised in Table 27.4.

Table 27.4 Cumulative impacts of the Sydenham to Bankstown upgrade with the Chatswood to Sydenham project

Environmental impact	Potential cumulative impacts without mitigation
Construction transport and access	The following potential cumulative transport and access impacts could occur during construction: • additional road closures around Sydenham Station • additional pedestrian and passenger movements around Sydenham Station as a result of station upgrade works and rail replacement buses • safety risk to pedestrians, cyclists and other motorists due to increase in vehicle movements due to construction traffic for both projects • additional loss of on street parking.
Operational traffic and transport	Once complete, the two projects would provide cumulative transport-related benefits, including a major increase in the capacity of Sydney's rail network, with the capacity to run up to 30 trains per hour through the Sydney CBD in each direction. This provides the foundation for delivering a 60 per cent increase in the number of trains operating through Sydney's CBD during peak periods, which would cater for an extra 100,000 customers per hour. Further details of the cumulative benefits of Sydney Metro as a whole are provided in Chapter 5 (Project need).
Construction noise and vibration	Construction of the project could result in additional receivers experiencing noise levels above adopted criteria. Additional construction traffic may also result in cumulative road traffic noise, depending on routes chosen.
Operational noise and vibration	Cumulative noise impacts associated with both the Chatswood to Sydenham and Sydenham to Bankstown projects are unlikely.
Non-Aboriginal heritage	The Chatswood to Sydenham project would impact on Sydenham Station, which would increase the number of stations on the T3 Bankstown Line affected by upgrades to undertake Sydney Metro City & Southwest. Overall, any changes to the heritage elements of station are considered to be as part of the latest phase of the development of the T3 Bankstown Line, which has developed over the years as new stations were added to the line. The line would continue to operate for its original use while simply adding a modern railway infrastructure context. All stations would continue to be used for the purpose they were built and therefore still hold significance.
Aboriginal heritage	Due to developed nature of both project areas, cumulative impacts on Aboriginal heritage are considered to be minimal.
Hydrology, flooding and water quality	The flooding assessment provided in Chapter 21 (Hydrology, flooding and water quality) has considered the cumulative impacts of flooding resulting from both projects. While in most locations, flooding is not expected to worsen, in some locations around Marrickville and Sydenham stations, a reduction in flooding is anticipated.

Environmental impact	Potential cumulative impacts without mitigation
Land use and property	While total acquisitions would increase as a result of both projects, the effects would be different as the Chatswood to Sydenham modification only affects industrial land uses. There would not be a cumulative loss of residential or commercial properties due to the two projects.
Business impacts	The projects would result in cumulative acquisition and lease termination. When coupled with the impacts at Marrickville near Sydenham Station, the amount of viable alternate locations for businesses to re-establish would reduce. The provision of retail opportunities at some upgraded stations might potentially offset the impacts on some businesses. During operation, the project would increase accessibility to locations along the T3 Bankstown Line due to improved train services. This would result in benefits for businesses.
Landscape character and visual amenity	Additional temporary visual impacts during construction may occur due to the presence of multiple construction sites and out-of-hours light spill around Sydenham Station and Sydney Metro Trains Facility South. Cumulative operational impacts are expected to be negligible as the combined changes would be consistent with the character of the surrounding area.
Socio-economic impacts	During construction, there is potential for additional pedestrian and customer movements in the vicinity of Sydenham Station as a result of rail replacement buses. This could lead to an increased safety risk to pedestrians, cyclists, and other motorists as a result of increased traffic in the area (including possible detours/diversions) resulting from the two projects. Increased amenity impacts (noise, traffic, visual, and dust) may also result from simultaneous construction activities, particularly where the two projects interface east of Marrickville Station. The nature of works at this location (mainly track work) means the cumulative impacts would be limited, and could be managed effectively through mitigation measures. The operation of the two projects would improve access to areas surrounding the stations and along the line, including to the Sydney CBD. The two projects would also include aspects of an active transport corridor, which would be connected with similar facilities at Sydenham Station. This would be a positive cumulative impact. The provision of this corridor and improved accessibility would encourage healthy lifestyles for communities along the T3 Bankstown Line.
Air quality	There is potential for additional dust emissions during construction. Potential cumulative impacts are not considered to be significant.

The scale of these cumulative impacts and benefits would vary but would be additional with those of the Sydenham to Bankstown upgrade. The benefits of the project would be maximised, and the adverse impacts minimised, by implementing the mitigation measures provided in Section 27.3.

27.2.2 Other projects

Potential cumulative impacts may occur as a result of construction activities occurring simultaneously with other smaller developments within the vicinity of the project area. Potential cumulative impacts could include:

- increased construction traffic travelling through the study area and on the surrounding road network
- increase in construction noise and vibration, including road traffic noise
- increased impacts on non-Aboriginal heritage
- reduced visual amenity
- increase in dust emissions.

These other cumulative impacts are unlikely to be significant and would be minimised and managed by implementing the mitigation measures provided in Table 27.5.

Part D

Conclusion

28. Synthesis of the Environmental Impact Statement

This chapter provides a synthesis of the findings of the Environmental Impact Statement. It addresses the Secretary's environmental assessment requirements listed in Table 28.1.

Table 28.1 Secretary's environmental assessment requirements – synthesis

Ref	Secretary's environmental assessment requirements - synthesis	Where addressed
2.1	(q) a chapter that synthesises the environmental impact assessment and provides: • a succinct but full description of the project for which approval is sought;	Section 28.1
	• a description of uncertainties that still exist around design, construction methodologies and/or operational methodologies and how these will be resolved in the next stages of the project;	Section 28.2 and Table 28.2
	• a compilation of the impacts of the project that have not been avoided;	Section 28.3
	• a compilation of the proposed measures associated with each impact to avoid or minimise (through design refinements or ongoing management during construction and operation) or offset these impacts;	Sections 28.4 and 28.5
	• a compilation of the outcome(s) the proponent will achieve; and	Section 28.6
	• the reasons justifying carrying out the project as proposed, having regard to the biophysical, economic and social considerations, including ecologically sustainable development and cumulative impacts.	Section 28.7

28.1 Description of the project for which approval is sought

This Environmental Impact Statement considers the potential impacts of constructing the Sydenham to Bankstown upgrade, and operating it as part of Sydney Metro City & Southwest. It has been prepared to support Transport for NSW's application for approval of the project as critical State significant infrastructure, in accordance with the requirements of Part 5.1 of the EP&A Act. The Environmental Impact Statement addresses the environmental assessment requirements of the Secretary of the Department of Planning and Environment, dated 23 March 2017.

28.1.1 Project features

The project involves upgrading 10 existing stations west of Sydenham (Marrickville to Bankstown inclusive), and a 13 kilometre long section of the Sydney Trains T3 Bankstown Line, between west of Sydenham Station and west of Bankstown Station, to improve accessibility for customers and meet the standards required for metro operations. The project would enable Sydney Metro to operate beyond Sydenham, to Bankstown.

A key element of the project is upgrading stations along the corridor from Marrickville to Bankstown, to allow better access for more people, by providing new concourses, level platforms, and lifts at all stations. These upgrades aim to provide a better, more convenient and safer experience for public transport customers by delivering:

- stations that are accessible to people with a disability or limited mobility, the elderly, people with prams, and people travelling with luggage

- upgraded station buildings and facilities for all transport modes that meet the needs of a growing population
- interchanges that support an integrated transport network and allow seamless transfers between different modes for all customers.

The key features of the project are listed below.

Works to upgrade access at stations

The project includes upgrading the 10 stations between Marrickville and Bankstown as required, to meet legislative requirements for accessible public transport, including the requirements of the *Disability Discrimination Act 1992* and the *Disability Standard for Accessible Public Transport 2002*. The proposed works include:

- works to platforms to address accessibility issues, including levelling and straightening platforms
- new station concourse and station entrance locations, including:
  - new stairs and ramps
  - new or relocated lifts
- provision of additional station facilities as required, including signage and canopies.

Works would also be undertaken in the areas around the stations to better integrate with other modes of transport, improve travel paths, and meet statutory accessibility requirements. This would include provision of pedestrian, cyclist, and other transport interchange facilities; as well as works to the public domain, including landscaping.

Works to convert stations and the rail line to metro standards

Station works

In addition to the station upgrades to improve accessibility, works to meet the standards required for metro services would be carried out, including:

- installation of platform screen doors
- provision of operational facilities, such as station services buildings.

Track and rail system facility works

Upgrading the track and rail systems to enable operation of metro services would include:

- track works where required along the rail corridor, including upgrading tracks and adjusting alignments, between west of Sydenham Station and west of Bankstown Station
- new turn back facilities and track crossovers
- installing Sydney Metro rail systems and adjusting existing Sydney Trains rail systems
- overhead wiring adjustments.

Other works

Other works proposed to support Sydney Metro operations include:

- upgrading existing bridges and underpasses across the rail corridor
- installation of security measures, including fencing
- installation of noise barriers where required
- modifications to corridor access gates and tracks

- augmenting the existing power supply, including new traction substations and provision of new feeder cables
- utility and rail system protection and relocation works
- drainage works to reduce flooding and manage stormwater.

Active transport corridor and future rail corridor development

The project would also provide for:

- sections of an active transport corridor located around the station areas, to facilitate walking and cycling connections to each station and between Marrickville and Bankstown
- enabling works to support future development at Campsie Station (future development would be subject to separate approvals).

Temporary works during construction

During construction, the project would involve:

- provision of temporary facilities to support construction, including construction compounds and work sites
- implementation of alternative transport arrangements for rail customers during possession periods and/or station closures, guided by the Temporary Transport Strategy.

Further information on the design features of the project is provided in Chapter 8.

28.1.2 Location

The project is located mainly within the existing rail corridor, from about 800 metres west of Sydenham Station in Marrickville, to about one kilometre west of Bankstown Station in Bankstown.

The location of the project is shown in Figure 1.3.

28.1.3 Construction

Construction of the project would commence once all necessary approvals are obtained (anticipated to be in 2018). Upgraded stations would be progressively delivered from 2019 until 2024, with the main station upgrade works estimated to take about two years for each station. During this period, works to upgrade other infrastructure, such as tracks, bridges, embankments and drainage, would also be undertaken.

The T3 Bankstown Line and freight tracks operated by ARTC (between Marrickville and west of Campsie) would remain operational for the majority of the construction period. However, to ensure the station and infrastructure upgrade works are completed as efficiently and safely as possible, and to accommodate works that cannot be undertaken when trains are operating, it would be necessary to undertake some work during rail possession periods, when trains are not operating. It is anticipated that these rail possession periods would comprise the routine weekend maintenance possessions scheduled by Sydney Trains (and ARTC), together with some longer possession periods during periods of reduced patronage such as school holidays.

A final, longer possession of about three to six months would also be required. This would involve full closure of the line to enable it to be converted to metro operations. This final possession period is to enable works that can only be completed once Sydney Trains services are not operating. It would include works such as the installation of new signalling, communication systems, and platform screen doors.

During each possession period, a temporary transport management plan would be implemented to provide alternative transport arrangements and ensure that customers can continue to reach their destinations.

Further information on how the project would be constructed is provided in Chapter 9.

28.1.4 Operation

The project would connect with the Chatswood to Sydenham project within the existing rail corridor, about 800 metres to the west of Sydenham Station.

The project would operate in conjunction with Sydney Metro Northwest and the Sydney Metro City & Southwest Chatswood to Sydenham project, which, subject to the modification described in Section 1.1, is proposed to extend from Chatswood Station to Sydenham Station.

Sydney Metro Northwest will be operational between Cudgegong Road and Chatswood stations by 2019. Sydney Metro City & Southwest would be fully operational by 2024, with the opportunity of operation commencing in two phases. Initially, Sydney Metro Northwest services would be extended by the City & Southwest project, and would operate from Chatswood Station to Sydenham Station. Some months later, metro operations would extend from Sydenham Station to Bankstown Station, with both phases planned to be completed before the end of 2024. The opportunity for phased opening of the project would enable metro trains to operate from Cudgegong Road Station to Sydenham Station prior to the final conversion of the T3 Bankstown Line to metro operations.

Once the project is operational, Sydney Trains services would no longer operate between Sydenham and Bankstown stations. Metro trains would run between Sydenham and Bankstown stations in each direction, at least every four minutes in peak periods, with at least 15 trains per hour. Customers would be able to interchange with Sydney Trains services at Sydenham and Bankstown stations. Sydney Trains services to Liverpool and Lidcombe stations from Bankstown Station would also not be affected.

Further information on how the project would operate is provided in Section 8.3.

28.1.5 Project objectives

The primary objectives of the project are to:

- improve the quality of the transport experience
- provide a system that is able to satisfy long-term demand
- improve the resilience of the transport network

Secondary objectives are to:

- grow public transport patronage and mode share
- support the productivity of the Global Economic Corridor
- serve and stimulate urban development
- improve the efficiency and cost effectiveness of the public transport system
- implement a feasible solution recognising impacts, constraints and delivery risks.

The project also aims to

- deliver accessible, modern, secure and integrated transport infrastructure
- contribute to the accessibility and connectivity of existing and future communities.

28.2 Project uncertainties and approach to design refinements

28.2.1 Project uncertainties

Given the complexity of delivering the project, the design presented in this Environmental Impact Statement is indicative. The design serves to:

- confirm that the proposed performance and technical requirements can be achieved
- validates the feasibility and methodology of the required construction
- identifies key risks/constraints and environmental assessment issues.

There remain some uncertainties relating to technical requirements and how the project would be constructed. These would be resolved as the design progresses. A summary of the uncertainties that have the potential to impact on the environment, and how these would be resolved, is provided in Table 28.2.

Table 28.2 Project uncertainties

Category of impact	Key uncertainty	How uncertainties will be resolved
Transport, traffic and access	Possession strategy	A number of possession options are being considered for use for construction. The preferred option will be identified taking into consideration the final design, and construction planning undertaken by the construction contractor.
	Temporary transport arrangements - rail replacement services during construction, including: • final service provision and arrangements • services west of Bankstown • infrastructure required • rail network changes for Circle Line stations and other network changes	Transport for NSW will work to ensure disruptions to customers are minimised. In accordance with the Temporary Transport Strategy, temporary transport management plans will be implemented during possessions to cater for displaced train passengers between Sydenham and Bankstown, and stations west of Bankstown where services are impacted. Development of the plans have commenced and will continue during detailed design. Further information is provided in Appendix G.
	Program for bridge closures	Transport for NSW will work to ensure disruptions to road operations and users are minimised. Detailed design and construction planning will determine a program for the road network configurations required to undertake bridge works. This will include consideration of interfaces with the Temporary Transport Strategy and other construction traffic movements.
Noise	Final noise mitigation requirements	Further noise modelling will be undertaken during detailed design to confirm the receivers that are eligible for mitigation. Feasible and reasonable mitigation measures will be considered for each of the receivers during detailed design.
Hydrology and flooding	Flood management	Additional flood modelling will be undertaken for the area west of Marrickville Station during detailed design. This will include modifications to the design where required and practicable, to confirm and where possible reduce identified issues.
Across a number of potential impact areas	Compounds and work sites – location, layout and facilities	The final location and layout of compounds and work sites will be confirmed based on the detailed design and final construction methodology, taking into account the criteria and requirements provided in Section 9.8.

Category of impact	Key uncertainty	How uncertainties will be resolved
	Utilities – impacts to utilities to be defined in detail	Utility investigations are ongoing and will be completed during detailed design, to validate current assessments, and confirm relocation/protection requirements. To minimise potential impacts to utilities and the community, utilities would be managed in accordance with the Utilities Management Framework, provided in Appendix I.

28.2.2 Approach to design refinements

The design as described in the Environmental Impact Statement would be subject to ongoing refinements during the detailed design phase. Refinements may be made to:

- avoid services that present significant construction difficulties in terms of logistics, time and/or cost
- reduce the construction timeframe
- avoid areas of environmental sensitivity identified following approval
- reduce impacts on the community
- improve operation without increasing the potential environmental impacts.

Such refinements may include, for example:

- minor changes to the location of compounds, work sites, and construction site accesses
- minor changes to the location of key infrastructure, refinement or reorientation of site boundaries
- minor changes the features of key project components
- utility relocations outside the existing project area
- additional infrastructure to support the implementation of the Temporary Transport Strategy.

For design refinements, a screening assessment would be undertaken to consider whether the refinement would:

- result in any of the conditions of approval not being met
- be consistent with the objectives and operation of the project as described in the Environmental Impact Statement
- result in a significant change to the approved project
- result in any potential environmental or social impacts of a greater scale or impact on previously unaffected receivers than that considered by the Environmental Impact Statement.

A refinement that does not meet these criteria would be considered a design modification. Approval would be sought from the Minister for Planning for any such modifications in accordance with the requirements of Part 5.1 of the EP&A Act.

28.3 Compilation of impacts

28.3.1 Impacts that have not been avoided

Part C of the Environmental Impact Statement provides an assessment of the potential impacts during construction and operation. The key potential adverse impacts requiring mitigation and management are summarised in Table 28.3 and Table 28.4. Further information on these impacts is provided in Chapters 10 to 27. The operational benefits are summarised in Section 28.7.2.

Impacts would be mitigated by implementing the environmental management procedures and plans described in Section 28.4, and the mitigation measures compiled in Table 28.5.

Table 28.3 Summary of key potential construction impacts

Issue	Key potential construction impacts
Traffic, transport and access	• Increase in vehicle movements on the local and regional road network due to construction traffic, resulting in increased congestion and delays. • Local traffic disruptions and short-term access restrictions and detours for road users during station and bridge works. • Access restrictions for pedestrians and cyclists within and surrounding the stations during station works. • A number of on and off-street (including commuter) parking spaces would be unavailable to the general public for the duration of construction at each station, with the main potential impacts at Hurlstone Park, Belmore, Lakemba, Punchbowl, and Bankstown stations. • Additional temporary impacts to on and off-street parking are also predicted during possession periods, with the main potential for impacts during these periods at Dulwich Hill, Canterbury, Campsie, Belmore, Lakemba, and Punchbowl stations. • The establishment of temporary bus layovers and bus stops near stations for the operation of rail replacement buses would impact some on-street and off-street parking spaces, with the main potential impacts at Campsie, Lakemba, Wiley Park, and Bankstown stations. As a result of the operation of rail replacement buses, some impacts to parking may also be experienced at other stations, including Sydenham, Birrong, Sefton, and Lidcombe stations. • Implementation of rail replacement buses during possessions, guided by the Temporary Transport Strategy, would add to road traffic and congestion, and change the amenity of public transport trips, with corresponding changes to travel times and mode choice. • Impacts to rail customers, as a result of changes to rail timetables on the T3 Bankstown Line and on the connecting lines during possession periods.
Noise and vibration	• Construction noise levels were predicted to exceed the relevant criteria at most sites for the majority of construction scenarios modelled, with a number of exceedances at residential receivers being greater than 20 decibels above the relevant criteria during the day and night. These predictions identify noise levels at the most exposed receiver, which may not be reached, or only infrequently reached, during the construction period. • There is also the potential for sleep disturbance impacts during the night. • Construction traffic movements, including both heavy vehicles and rail replacement buses, may result in road traffic noise levels above the relevant criteria. • In the event that large hydraulic rock breakers are used at the edge of the work site closest to the receiver, a large number of buildings adjacent to the project area would be located within the recommended offset distance for potential amenity and cosmetic damage resulting from vibration. • In practice, this may not be necessary and vibration impacts would be intermittent over the duration of construction. • Given the proximity of construction to a number of heritage items, particularly at stations, there is the potential for vibration impacts if appropriate mitigation measures are not implemented.
Non-Aboriginal heritage	• The project would result in the removal of one or more heritage elements at each station, which would directly impact on heritage listed items as follows:

Issue	Key potential construction impacts
	– a major impact to the State Heritage Register listed Marrickville Railway Station Group, mainly as a result of upgrading the Illawarra Road overbridge – moderate impacts to the State Heritage Register listed Canterbury and Belmore railway station groups – major impacts to four locally listed items (Dulwich Hill, Hurlstone Park, Wiley Park, and Punchbowl railway station groups) – moderate impacts to three locally listed heritage items (Campsie, Lakemba and Bankstown railway station groups) – a moderate impact to the locally listed Canterbury (Cooks River) Underbridge, as a result of the proposed removal and replacement of the parapets during bridge works. • Major visual impact to one item listed on the State heritage Register (Marrickville Station). • Moderate visual impacts to two items listed on the State Heritage Register (the Canterbury and Belmore railway station groups). • Major visual impacts to four items with a local heritage listing (the Dulwich Hill, Hurlstone Park, Wiley Park, and Punchbowl railway station groups). • Potential for impacts to significant archaeological remains at Marrickville, Canterbury, Lakemba, and Belmore stations. • Two locally listed items (Wiley Park and Punchbowl railway station groups) would no longer meet the threshold for local significance and would likely be de-listed.
Aboriginal heritage	• Construction may disturb a potential Aboriginal archaeological deposit of moderate significance and low to moderate potential for intact archaeological deposits (S2B PAD 02), located adjacent to Punchbowl Station.
Land use and property	• Acquisition of three privately owned lots under one ownership near Marrickville Station. • Partial acquisition of land from three publicly owned lots near Marrickville and Punchbowl stations, including a small area within Warren Reserve, adjacent to Punchbowl Station. • Some areas of land would need to be temporarily leased or occupied to locate some of the proposed compounds and work sites. • During construction, the use of land within the project area would change from its existing use (mainly transport) to use as a partial and temporary construction site. • Recreation use of the area of McNeilly Park in Marrickville where the underground detention basin is proposed would be temporarily restricted during construction of the basin.
Socio-economics	• Changes in existing access arrangements and connectivity across and within the station areas. • Possessions and/or station closures, and the associated alternative public transport arrangements, have the potential to impact the community, including as a result of travel time delays, and a reduced likelihood to use public transport. • Impacts on the amenity of the local community, including as a result of an increase in noise levels, traffic movements and congestion, dust, and changes in visual outlook. • Impacts on community infrastructure located near the project area, mainly as a result of changes to amenity and access arrangements.
Business	• Cessation of a total of 37 existing commercial leases at seven stations, including one lease at each of Dulwich Hill, Belmore, Lakemba, Wiley Park, Canterbury, and Punchbowl stations, and 31 leases at buildings surrounding Campsie Station. • Slight temporary potential for impacts to property values and rental return.

Issue	Key potential construction impacts
	• Station and track closures would have the potential to affect businesses, mainly those located close to the stations that have a higher reliance on passing trade, particularly during longer duration possessions. • Temporary changes to the road network could result in inefficiencies, potentially reducing revenue and providing a disincentive for visiting some local centres near stations. • Changes to parking arrangements and the temporary removal of some existing parking spaces has the potential to affect deliveries and convenience for business employees and customers, particularly for areas where parking is already in short supply, businesses close to stations, and/or retail or service-oriented businesses that require quick and efficient access for customers. • Impacts on amenity for businesses, including as a result of an increase in noise levels, traffic movements and congestion, dust, and changes in visual outlook.
Landscape character and visual impact	• Visual impacts during construction as a result of the presence of construction works, plant, and disturbance. • Loss of mature street trees providing screening and amenity, particularly in the vicinity of stations.
Hydrology, flooding and water quality	• Potential for inundation of construction areas during flood events particularly in areas where flooding is currently problematic (such as high flood risk areas at Marrickville Station, Canterbury, and Campsie). • Changes in surface water flows as a result of construction activities. • Impacts on downstream water quality if management measures are not implemented, monitored, and maintained.
Biodiversity	• It was assumed for the purpose of the biodiversity assessment that construction would require removal of all vegetation located along the rail corridor in the project area. This would involve removal of about 29.8 hectares of vegetation, the majority of which comprises exotic plants (about 21.5 hectares) or planted, often non-indigenous, native species on fill material (about 7.3 hectares). • Removing all vegetation in the rail corridor would impact about one hectare of native vegetation, including about 0.6 hectares of threatened ecological communities listed under the TSC Act. • Removing all vegetation in the rail corridor would also impact some nesting and foraging habitat, including about 7.9 hectares of foraging habitat for the threatened Grey-headed Flying-fox, Eastern Bentwing Bat, and other threatened fauna species with known or potential habitat in the study area.

Table 28.4 Summary of key potential operation impacts

Issue	Key potential operation impacts
Traffic, transport and access	• Kerbside parking arrangements around some station areas would be reconfigured to support access to the stations. This would include reallocation of kerbside space, mainly to provide/upgrade accessible parking, and areas for kiss and ride, and taxis. This reallocation would result in a loss of some on-street parking spaces in the immediate vicinity all stations. • Creation of new station forecourts and active transport facilities would impact off-street parking areas adjacent to some stations, including a loss of about 58 off-street spaces at Belmore and Bankstown stations, and about 20 spaces at Campsie. All these spaces are adjacent to the stations and/or rail corridor, and are not designated commuter parking.
Noise and vibration	• Noise levels at a number of residential receivers adjacent to the rail corridor have the potential exceed the *Rail Infrastructure Noise Guideline* criteria, and are therefore eligible for further consideration of noise mitigation (i.e. noise barriers).

Issue	Key potential operation impacts
Land use and property	• The use of the portion of Warren Reserve to be acquired near Punchbowl Station (about 15 per cent of the overall reserve, located adjacent the existing rail corridor) would change from recreation to rail infrastructure. • The use of NSW Government (RailCorp) owned land at Charles Street, Canterbury would change from parking to rail infrastructure.
Business	• Loss of parking described above may impact the availability of parking for some customers of local businesses in the vicinity of stations.
Landscape character and visual amenity	• Introduction of new structures in the visual landscape, including upgraded stations (with elevated station concourses and buildings).

28.4 Approach to environmental management

28.4.1 Environmental management during construction

The approach to environmental management during construction is shown on Figure 28.1 and involves:

- Project design – measures incorporated in the design and construction planning to avoid and minimise impacts. Further information is provided in Chapters 7 (Design development and place making) and 9 (Project description – construction).
- Mitigation measures – identified as an outcome of the environment impact assessment detailed in Chapters 10 to 27, and consolidated in Table 28.5.
- Environmental performance outcomes – future construction planning would be considered against the environmental performance outcomes provided in Section 28.6.
- Implementation of the following project specific construction environmental management frameworks/strategies (described below):
  - Construction Environmental Management Framework
  - Construction Noise and Vibration Strategy
  - Temporary Transport Strategy
  - Utilities Management Framework.

Construction Environmental Management Framework

The Construction Environmental Management Framework, provided in Appendix D, details the approach to environmental management and monitoring during construction. The framework is a linking document between the planning approval documentation and the construction environmental management documentation (including the Construction Environmental Management Plan), which would be developed by the construction contractors.

The framework details the environmental, stakeholder, and community management systems and processes that would be applied during construction. Specifically, it details the requirements in relation to the Construction Environmental Management Plan, sub-plans, and other supporting documentation for each specific environmental aspect.

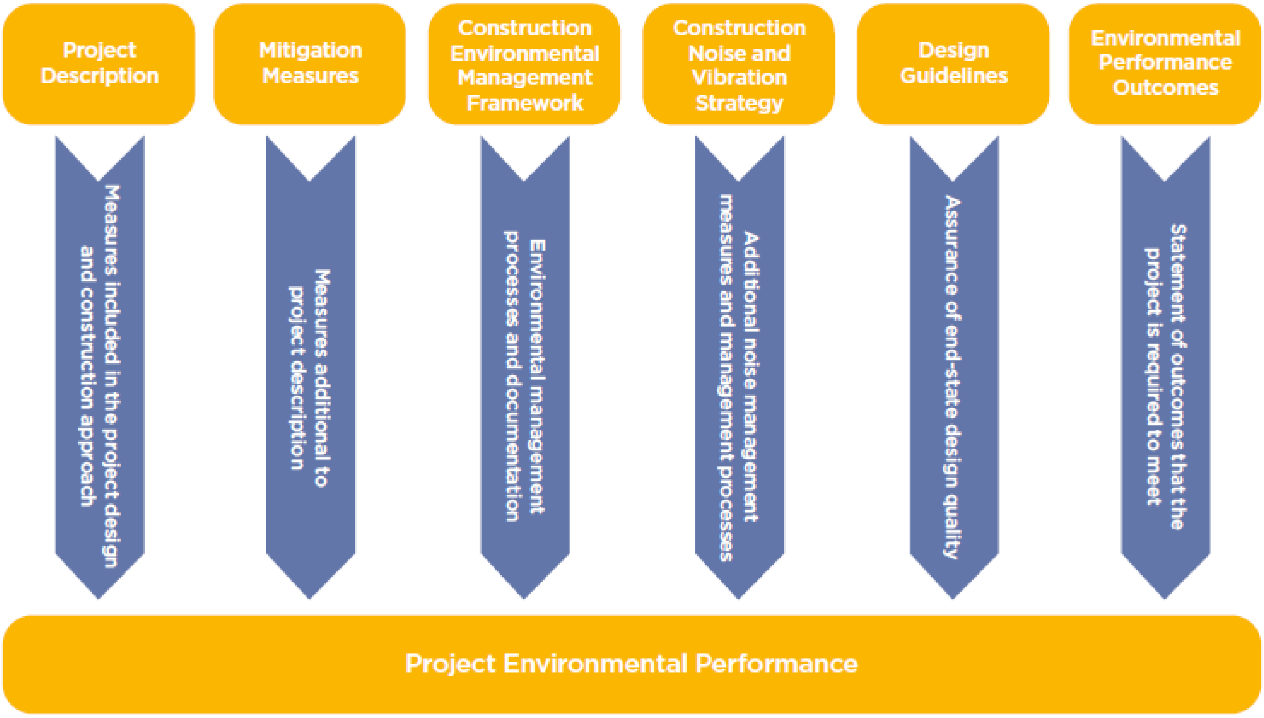


Figure 28.1 Approach to environmental mitigation and management during construction

Construction Noise and Vibration Strategy

The Construction Noise and Vibration Strategy (provided in Appendix E) defines how construction noise and vibration will be managed for the Sydney Metro City & Southwest project as a whole. The strategy provides guidance for managing construction noise and vibration impacts in accordance with the *Rail Infrastructure Noise Guideline*, to provide a consistent approach to management and mitigation across all Sydney Metro projects.

The strategy identifies the requirements and methodology to develop construction noise impact statements. These would be prepared prior to specific construction activities, based on a more detailed understanding of construction methods, including the size and type of construction equipment.

Temporary Transport Strategy

A Temporary Transport Strategy (provided in Appendix G) has been prepared to provide a guide to managing alternative public transport arrangements during construction, to minimise impacts to customers during station closures and possession periods. The strategy identifies:

- objectives for customers and bus services
- customer markets to be served by temporary transport management plans
- the process for developing temporary transport management plans to guide alternative transport arrangements, including stakeholder and community consultation
- options to maintain public transport connections to and from all affected rail stations
- impacts associated with temporary transport options and the level of assessment to be provided in temporary transport management plans
- temporary transport facilities and measures required to support the implementation of temporary transport management plans, ensuring provision of accessible services
- performance outcomes for temporary transport management plans.

Guided by the strategy, temporary transport management plans would be developed to manage, during station closures and possessions, the movement of customers who would usually use the T3 Bankstown Line. The plans would focus on what needs to happen during closures and possession periods to ensure customers have an acceptable means to travel by public transport.

Further information on the proposed approach to alternative transport arrangements, including the Temporary Transport Strategy and plans is provided in Section 9.11.

Utilities Management Framework

A Utilities Management Framework (provided in Appendix I) has been prepared, adopting a risk-based approach to avoiding and/or minimising impacts associated with the relocation and/or adjustment of public utilities affected by the project. The framework provides a consistent approach to the assessment and management of public utilities relocation/adjustment across all project activities.

28.4.2 Environmental management during operation

The approach to environmental management during operation involves:

- Project design – measures inherent in the design to avoid and minimise impacts. Further information on how the project design has been developed to minimise the potential for operational impacts is provided in Chapter 7.
- Mitigation measures – identified through the environment impact assessment in Chapters 10 to 27, and consolidated in Table 28.5.
- Environmental performance outcomes – future design development and any design changes would be considered against the environmental performance outcomes provided in Section 28.6.
- Sydenham to Bankstown Design guidelines (described below).
- Operational environmental management – the approach to environmental management during operation would be defined in the Operational Environmental Management Plan.

Sydenham to Bankstown Design Guidelines

The Sydenham to Bankstown Design Guidelines (provided in Appendix C) describes how Transport for NSW proposes to achieve a quality design for the project, which is integrated with the surrounding environment and town centres. The guidelines:

- guide the design development process
- support the development of healthy, cohesive and inclusive communities
- respond to the strategic directions and urban design strategies of the local councils
- establish the design standards, by guiding the design of the interface between stations and their surrounding locality, including:
  - stations
  - transport interchange facilities (bicycle facilities, bus stops, kiss and ride, taxi ranks and connections to existing rail and light rail infrastructure)
  - landscaping and other public domain elements
  - rail corridor works.

Operational Environmental Management Plan

Environmental performance during operation would be managed by the implementation of an Operational Environmental Management Plan. The plan would detail how the mitigation measures and performance outcomes would be implemented and achieved during operation, and specify the environmental management practices and procedures to be followed during operation. The plan would be prepared in consultation with relevant agencies and in accordance with the *Guideline for the Preparation of Environmental Management Plans* (Department of Infrastructure, Planning and Natural Resources, 2004). The plan would include, but not be limited to, the following:

- a description of activities to be undertaken during operation
- statutory and other obligations, including approvals, consultations and agreements required from authorities and other stakeholders
- overall environmental policies, guidelines and principles to be applied to operation
- a description of the roles and responsibilities, including relevant training and induction to ensure that employees are aware of their environmental and compliance obligations
- an environmental risk analysis to identify the key environmental performance issues associated with the operation phase
- details of how environmental performance would be managed and monitored.

28.5 Compilation of mitigation measures

Table 28.5 provides a compilation of the measures proposed to mitigate and manage the potential impacts of the project, as provided in the chapters in Part C of the Environmental Impact Statement. The measures described in the chapters and compiled in this table were developed based on the recommended measures in the technical papers, adapted as required to take into account the findings of all the assessments undertaken for the Environmental Impact Statement. The mitigation measures provided in the chapters and compiled in Table 28.5 also include additional measures, consistent with the commitments made by Transport for NSW for other Sydney Metro projects, including the Sydney Metro City & Southwest Chatswood to Sydenham project.

The mitigation measures compiled in Table 28.5, together with the approach to environmental management described in Section 28.4, provide Transport for NSW's commitments for the project. The mitigation measures may be revised in response to submissions raised during public exhibition and/or any design changes made following exhibition. The final list of mitigation measures would be provided in the submissions/preferred infrastructure report. If the project is approved, the conditions of approval, which would include reference to the final mitigation measures, would guide subsequent phases of the project. The project would be undertaken in accordance with the conditions of approval and the final list of mitigation measures.

The measures are broadly grouped according to the main stage of implementation. However, it is noted that the implementation of some measures may occur across a number of stages.

The location/s applicable to each mitigation measure are identified by using a unique identifier as follows:

- All – Project as a whole
- BW – Bridge works
- AS – All stations
- MA – Marrickville Station
- DU - Dulwich Hill Station
- CP – Campsie Station
- BE – Belmore Station
- LA – Lakemba Station
- WP – Wiley Park Station
- PB – Punchbowl Station.

- HP – Hurlstone Park Station
- CB – Canterbury Station
- BA – Bankstown Station
- SS – Substations.

Table 28.5 Compilation of project specific mitigation measures

ID	Impact	Mitigation measures	Relevant location(s)
Traffic, transport and access			
Design/pre-construction			
TC1	*Temporary transport arrangements*	Guided by the Temporary Transport Strategy, detailed temporary transport management plan/s would be developed prior to construction to manage the movement of people along the T3 Bankstown Line during possession periods. The plans would be developed in consultation with key stakeholders (including the Sydney Coordination Office, Roads and Maritime Services, Sydney Trains, local councils, emergency services, and bus operators), and would address the requirements specified by the Temporary Transport Strategy. The development of each plan would consider, as a minimum: • a review of the road network constraints along any proposed rail replacement bus route • further traffic analysis of key intersections used by rail replacement buses • potential impacts to local road networks affected by rail passengers diverting to cars to reach their destinations • the design of temporary facilities at bus stop locations in consultation with the relevant road authority • expected changes to parking demand at other stations, displacement of existing parking, and any upgrades that may be required.	AS
TC2		Transport for NSW would consult with Roads and Maritime Services, the State Transit Authority, and bus operators, to identify opportunities to minimise impacts to bus layovers and existing bus stops during operation of rail replacement buses.	AS
TC3	*Impacts of bridge works*	Detailed analysis of the network impacts of proposed bridge work would be undertaken, and management measures would be developed, in consultation with Roads and Maritime Services and the Sydney Coordination Office. Measures would include restricting work to some bridges during off peak and/or holiday periods, where practicable, including the following bridges as a minimum: • Charlotte Avenue underbridge • Illawarra Road overbridge • Burwood Road overbridge • Haldon Street overbridge • King Georges Road overbridge • Stacey Street overbridge.	BW

ID	Impact	Mitigation measures	Relevant location(s)
TC4		The impacts on the surrounding road network of road diversions and lane closures resulting from bridge works across the rail corridor would be assessed in detail, to identify the suite of management measures to be implemented for each diversion/closure required. This would be undertaken in consultation with Roads and Maritime Services, the Sydney Coordination Office, the Inner West and Canterbury-Bankstown councils, emergency services, and relevant bus operators. Planning for partial or full bridge closures would consider bus rerouting and timetabling, with the intention of minimising impacts to bus customers and bus operators.	BW
TC5	*Pedestrian access*	Work affecting the pedestrian underpass providing access to and from the Belmore Sports Ground would be timed, in consultation with the facility manager and owners, to ensure that suitable access is provided. This would include (if necessary) avoiding disruptions to access during events, such as game days at Belmore Oval. Local diversions would be put in place during periods of closure.	BE
TC6	*Parking impacts during construction*	Opportunities to reduce the loss of existing on and off street car parking (including the amount of spaces reduced and the time associated with this reduction) would be reviewed during detailed design and construction planning.	AS
TC7		Where parking spaces are lost or access is impeded, particularly for extended periods, alternative parking would be provided wherever feasible and reasonable. This would include consideration of other privately owned (or vacant) land within close proximity to affected stations.	AS
TO1	*Parking impacts during operation*	Further consideration of car parking management at stations would be undertaken in consultation with Roads and Maritime Services, the Sydney Coordination Office, and the Inner West and Canterbury-Bankstown councils, to minimise adverse impacts of operation on parking and other kerbside use in local streets.	AS
TC8	*Impacts of intersection performance*	Further consideration of the need for intersection modifications would be undertaken, to improve intersection performance at locations most affected by the addition of construction heavy vehicles, rail replacement buses, and diverted traffic. This would be undertaken in consultation with Roads and Maritime Services, the Sydney Coordination Office, and the relevant road authority. The improvements considered would include: • modification to the existing traffic signal phasing • lane priority changes • changing lane designations (line markings and signage) • kerbside changes (such as removing on street parking or implementing no standing zones at peak times to increase lane capacity) • physical geometric changes (such as minor kerb cut-backs to enable large vehicles to safely move through intersections) • restricting turning movements where traffic demand is low.	All
TC9	*Changes to cyclist facilities during construction*	Where existing cycle facilities (e.g. bike parking) would be temporarily unavailable at a station, suitable replacement facilities would be provided while the facility is unavailable.	AS

ID	Impact	Mitigation measures	Relevant location(s)
Construction			
TC10	*Management of traffic, transport and access*	A construction traffic management plan would be prepared and implemented prior to construction. The plan would be prepared in accordance with the Construction Environmental Management Framework, and would detail, as a minimum: • how traffic would be managed when construction works are being carried out • the activities proposed and their impact on the road network and on road users • how these impacts would be addressed. The plan would be prepared in consultation with the Traffic and Transport Liaison Group, and would be approved by the relevant authority before construction commences.	All
TC11	*Changes to public transport services and alternative transport arrangements*	Modification of existing bus stops, or implementation of new stops and alterations to service patterns, would be carried out by Transport for NSW in consultation with the Sydney Coordination Office, Roads and Maritime Services, the Inner West and Canterbury-Bankstown councils, and bus operators.	AS
TC12		Transport for NSW would undertake an extensive community awareness and information campaign before changes to public transport services are implemented. This would include a range of communication activities such as: • information at stations • wayfinding signage • clearly marked bus stop locations • letter box drops • web based information and transport 'app' where changes to travel are found in a single place • information via 131 500 • advertising in local papers • email information bulletins.	AS
TC13	*Impacts on intersection performance*	Intersection operation would be optimised, where reasonable and feasible, to improve intersection performance at the worst affected intersections along construction haulage routes and/or rail replacement bus routes. This may include modifying signal phase times or sequences at traffic signal controlled intersections.	Affected intersections
TC14	*Impacts on special events*	Consideration of special events would be undertaken as part of construction work programming. For special events that require specific traffic and pedestrian management, measures would be developed and implemented in consultation with Roads and Maritime Services, the Inner West and Canterbury-Bankstown councils, and the organisers of the event.	All
TC15	*Impacts of construction compounds and work sites*	Vehicle access to and from construction sites would be managed to ensure pedestrian, cyclist, and motorist safety. Depending on the location, this may require manual supervision, barrier placement, temporary traffic signals, modifications to existing traffic signals, or police assistance.	All

ID	Impact	Mitigation measures	Relevant location(s)
TC16	*Construction vehicles*	Construction vehicles (including contractor staff vehicles) would be managed to: • minimise parking or queuing on public roads • minimise use of residential streets to gain access to work sites or compounds • minimise vehicle movements near schools, particularly during school start and finish times.	All
TC17	*Signage*	Directional signage and line marking would be used to direct and guide drivers, pedestrians, and other road users past construction compounds and work sites, and on the surrounding road network. This may be supplemented by variable message signs to advise drivers of potential delays, traffic diversions, speed restrictions, or alternate routes.	All
TC18	*Construction parking impacts*	Construction sites would be managed to minimise construction worker parking on surrounding streets. A worker car parking strategy would be developed in consultation with the relevant local council to identify measures to reduce the impact on the availability of on street and off street parking. The strategy would identify potential mitigation measures including alternative parking locations. The strategy would encourage contractor staff to: • use public transport • car share • park in a designated off site area and access construction sites via shuttle bus.	All
TC19	*Traffic incidents*	In the event of a traffic related incident, co-ordination would be carried out with the Sydney Coordination Office and Transport Management Centre's Operations Manager.	All
TC20	*Changes to road, pedestrian and cyclist networks*	The community would be notified in advance of proposed road and pedestrian network changes through appropriate forms of community notification.	All
TC21	*Impacts on pedestrian or cyclist paths*	A condition survey would be undertaken to confirm changes to routes proposed to be used by pedestrians and/or cyclists are suitable (e.g. suitably paved and lit), with identified modification requirements discussed with the Inner West and/or Canterbury-Bankstown councils and implemented prior to use of the routes.	All
TC22	*Pedestrian, cyclist and motorist safety*	Pedestrian, cyclist, and motorist safety in the vicinity of the construction sites would be addressed during construction planning and development of the construction traffic management plan. Measures that may be implemented to assist in multi modal traffic management include: • Speed awareness signs in conjunction with variable message signs near construction sites to provide alerts to drivers. • A community engagement program to provide road safety education and awareness to road users about sharing the road safely with heavy vehicles. • Heavy vehicle training for drivers to understand route constraints, safety issues, and limiting the use of compression braking. • Safety technology and equipment installed on heavy vehicles to enhance vehicle visibility, eliminate vehicles' blind spots, and monitor vehicle location, speeding compliance, and driver behaviour.	All

ID	Impact	Mitigation measures	Relevant location(s)
TC23	*Impacts to access*	Access for residents, businesses, and community infrastructure would be maintained. Where disruption to access cannot be avoided, consultation would be undertaken with the owners and occupants of affected properties, to confirm their access requirements and to discuss alternatives.	All
TC24		Access to stations and surrounding properties for emergency vehicles would be provided at all times. Emergency service providers (i.e. police and ambulance) would be consulted throughout construction to ensure they are aware of changes to access, including lane, bridge or road closures, and changes to station or rail corridor access.	All
TC25	*Co-ordination of cumulative traffic effects*	The potential cumulative effects of construction traffic from multiple construction sites within the project (including bridge works) would be further considered during development of the construction traffic management plan. Where there is potential for cumulative impacts across the project, these issues would be addressed with the assistance of the Traffic and Transport Liaison Group.	All
Operation			
TO2	*Walking*	Transport for NSW would work with the Inner West and Canterbury-Bankstown councils to identify and provide improvements and minimise adverse impacts to the surrounding pedestrian network.	AS
TO3	*Cycling*	Transport for NSW would work with the Inner West and Canterbury-Bankstown councils and other relevant stakeholders to enhance areas around stations for cyclists.	AS
TO4	*Bus*	Transport for NSW would work with the Sydney Co-ordination Office, Roads and Maritime Services, the Inner West and Canterbury-Bankstown councils, and bus operators to identify improvements to bus stops and services.	AS
TO5	Active transport corridor	Transport for NSW would work with the Department of Planning and Environment to support the development of an active transport corridor along the alignment, including walking and cycling infrastructure. Transport for NSW would deliver sections of the active transport corridor around stations.	All
TO6	*Commuter parking*	Transport for NSW would monitor the demand for additional commuter car parking spaces and consider opportunities for, and implications of, meeting this demand between Bankstown and Marrickville stations. Transport for NSW would consider provision for additional commuter car parking, subject to consideration of local station and town centre implications, including local traffic conditions.	AS
Noise and vibration			
Design/pre-construction			
NVC1	*Predicted construction noise impacts*	A construction noise and vibration review would be undertaken during detailed design. This would include noise modelling to confirm the results of modelling previously undertaken. Where changes in noise levels and exceedances are modelled, reasonable and feasible mitigation measures would be reviewed.	All

ID	Impact	Mitigation measures	Relevant location(s)
NVC2		In accordance with the *Construction Noise and Vibration Strategy*, all employees, contractors and subcontractors would receive an environmental induction. The induction must at least include: • relevant project specific and standard noise and vibration mitigation measures • relevant licence and approval conditions • permissible hours of work • any limitations on high noise generating activities • location of nearest sensitive receivers • designated loading/unloading areas and procedures • site opening/closing times (including deliveries).	All
NVC3	*Predicted vibration impacts*	Where vibration levels are predicted to exceed the screening criteria, a more detailed assessment of the structure would be carried out to determine the appropriate vibration limits for that structure.	All
NVC4		For heritage items where screening vibration levels are predicted to be exceeded, the more detailed assessment would include condition assessment and specifically consider the heritage values of the structure in consultation with a heritage specialist to ensure sensitive heritage fabric is adequately monitored and managed.	Heritage items along the project area
NVO1	*Predicted operational noise impacts*	An operational noise and vibration review would be undertaken to guide the approach to identifying reasonable and feasible mitigation measures to incorporate in the detailed design. This would include noise modelling to confirm the results of modelling previously undertaken. Where changes in noise levels and exceedances are modelled, reasonable and feasible mitigation measures would be reviewed.	All
NVO2		The height and extent of noise barriers adjacent to the project would be confirmed during detailed design with the aim of not exceeding trigger levels from the *Rail Infrastructure Noise Guidelines* (EPA, 2013). At-property treatments would be offered either on their own or in combination with a noise barrier where there are exceedances residual exceedances of the noise trigger levels.	All
NVO3		Operational noise from substations would be controlled by inclusion of appropriate mitigation, such as shielding or enclosures, and specification of equipment selection, to comply with the *Industrial Noise Policy* (EPA, 2000).	All

ID	Impact	Mitigation measures	Relevant location(s)
Construction			

NVC5	*Construction noise and vibration management*	The *Construction Noise and Vibration Strategy* would be implemented with the aim of achieving the noise management levels where feasible and reasonable. This may include the following example mitigation measures alone or in combination, where feasible and reasonable:
		• The provision of noise barriers around each construction site.
		• The coincidence of noisy plant working simultaneously close together would be avoided.
		• Offset distances between noisy plant and sensitive receivers would be increased.
		• Residential grade mufflers would be fitted to all mobile plant.
		• Dampened rock hammers would be used.
		• Non-tonal reversing alarms would be fitted to all permanent mobile plant.
		• High noise generating activities would be scheduled for less sensitive periods considering the nearby receivers, where reasonable and feasible.
		• The layout of construction sites would consider opportunities to shield receivers from noise.
		• Stationary noise sources would be enclosed or shielded whilst ensuring that the occupational health and safety of workers is maintained.
		• Loading and unloading of materials/deliveries is to occur as far as possible from noise sensitive receivers.
		• Select site access points and roads as far as possible away from noise sensitive receivers.
		• Dedicated loading/unloading areas to be shielded if close to noise sensitive receivers wherever feasible and reasonable.
		• Use quieter and less vibration emitting construction methods where feasible and reasonable.
		• The noise levels of plant and equipment must have operating Sound Power Levels compliant with the criteria in the *Construction Noise and Vibration Strategy*.
		• Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site.
		• Where feasible and reasonable, the offset distance between noisy plant items and nearby noise sensitive receivers would be as great as possible.
		• Where reasonable and feasible heavy vehicle movements would be limited to daytime and evening hours, with night-time movements avoided where possible.
		• Active community consultation and the maintenance of positive, cooperative relationships with schools, local residents and building owners and occupiers, through:
		  – periodic notification or work activities and progress (eg regular letterbox drops, e-consult)
		  – specific notification (letter-box drop) prior to especially noisy activities
		  – comprehensive website information
		  – project information and construction response telephone line
		  – email distribution lists.
			All

ID	Impact	Mitigation measures	Relevant location(s)
NVC6		Ballast tamping and hydraulic breaking would not be undertaken during the night-time period (10pm to 7am). Other noise intensive construction activities such as platform demolition, earthworks and track works would generally be limited to day time and evening periods (between 7am and 10pm), unless technical constraints exist such as: • works requiring a rail shutdown • requirements of road authorities, emergency services or Sydney Coordination Office.	All
NVC7		When working adjacent to schools, medical facilities and childcare centres, particularly noisy activities would be scheduled outside normal working hours, where reasonable and feasible.	All
NVC8		When working adjacent to churches and places of worship, particularly noisy activities would be scheduled outside services, where reasonable and feasible.	All
NVC9		Alternative accommodation may be offered to residents living in close proximity to construction works, where detailed design investigations confirm unreasonably high noise impacts over a prolonged period. Alternative accommodation arrangements will be offered and discussed with residents on a case-by-case basis.	All
NVC10		High noise and vibration generating activities including rock breaking, ballast tamping, demolition and ground and track earthworks may only be carried out in continuous blocks, not exceeding 3 hours each, with a minimum respite period of one hour between each block and these works.	All
NVC11		Ongoing noise monitoring during construction at sensitive receivers during critical periods (ie times when noise emissions are expected to be at their highest - eg piling and hammering) to identify and assist in managing high risk noise events.	All
NVC12	*Vibration monitoring*	Where vibration levels are predicted to exceed the screening criteria, attended vibration monitoring would be carried out to ensure vibration levels remain below appropriate limits for that structure.	All
NVC13	*Groundborne noise*	Reasonable and feasible measures would be implemented to minimise groundborne noise where exceedances are predicted.	All
NVC14	*Utility adjustments/ relocation works*	Reasonable and feasible mitigation measures would be implemented where power supply works would result in elevated noise levels at receivers. This would include: • carrying out works during the daytime period when in the vicinity of residential receivers • where out of hours works are required, scheduling the noisiest activities to occur in the evening period (up to 10pm) • use of portable noise barriers around particularly noisy equipment.	All
NVC15	*Road traffic noise*	The routes for construction haulage vehicles and bus services associated with the Temporary Transport Strategy would be selected on the basis of compliance with the relevant night time road traffic noise criteria, where reasonable and feasible.	All

ID	Impact	Mitigation measures	Relevant location(s)
Operation			
NVO4	*Predicted vibration impacts*	Where vibration levels are predicted to exceed the screening criteria, a more detailed assessment of the structure and vibration monitoring would be carried out to ensure vibration levels remain below appropriate limits for that structure. For heritage items where screening vibration levels are predicted to be exceeded, the more detailed assessment would specifically consider the heritage values of the structure in consultation with a heritage specialist to ensure sensitive heritage fabric is adequately monitored and managed.	All
Non-Aboriginal heritage			
Design/pre-construction			
NAH1	*Minimising impacts during design*	The project design would be sympathetic to impacted items (including retained significant elements) and surrounding heritage items by minimising impacts to sight lines, views and setting. Detailed design would be carried out in accordance with the relevant specific element principles, including the significant fabric strategy, provided in the Design Guidelines.	All heritage items
NAH2		Except for the heritage significant elements affected by the project, direct impacts to other heritage significant items and elements would be avoided.	All heritage items
NAH3		The appropriately qualified and experienced heritage architect who is part of the Sydney Metro City & Southwest Design Review Panel would provide independent review periodically throughout detailed design.	All heritage items
NAH4		Where heritage significant items or elements are to be retained within the operational area, detailed design would consider appropriate retrofitting and reuse in consultation with a heritage architect and the Design Review Panel. Where retrofitting and reuse is not practicable for significant elements, justification would be provided to the Design Review Panel, and for State Heritage Register listed items, to the NSW Heritage Council.	All heritage items
NAH5		Design and construction planning within the Marrickville Station State Heritage register curtilage would consider the recommendations of the 2016 Conservation Management Plan and the significant fabric strategy.	MA
NAH6	*Interpretation*	Appropriate heritage interpretation would be incorporated into the design in accordance with the *NSW Heritage Manual*, the NSW Heritage Office's *Interpreting Heritage Places and Items: Guidelines* (August 2005), and the NSW Heritage Council's *Heritage Interpretation Policy*.	AS Hurlstone Park Railway Underbridge Overbridge - Illawarra Road Canterbury (Cooks River) Underbridge Canterbury (Cooks River/Charles St) Underbridge - Main Line

ID	Impact	Mitigation measures	Relevant location(s)
			Post-war bus shelter and public lavatories Bankstown Parcels Office (former)
NAH7	*Management of moveable heritage and heritage fabric*	A moveable heritage item strategy would be prepared by a suitably qualified heritage consultant in consultation with Sydney Trains, and would include a comprehensive record of significant railway elements to be impacted. This would include items contained within station and platform buildings as well as of any other significant equipment within the curtilage of the heritage railway stations. The moveable heritage item strategy would form part of the broader interpretation strategy.	Bankstown Line: AS apart from BA and Bankstown Parcels Office (former)
NAH8		Fabric of high and exceptional significance of items proposed for removal would be identified and catalogued according to the significant fabric strategy prior to design development, and would be re-used where possible. Where not able to be re-used, the significant fabric strategy would indicate appropriate storage locations, as well as appropriate types of buildings and structures where salvaged elements may be reused in the future. Where large elements are impacted, a sample of fabric may be appropriate.	MA: Overbridge-Illawarra Road DU: overhead booking office and access stairs HP: Platform 1 building CP: overhead booking office and Parcels office WP: Platform 1 building, Platform 2 building and overhead booking office PB: overhead booking office and footbridge
NAH9	*Impacts to the Old Sugarmill*	A landscape scheme would be prepared for the Old Sugarmill to re-instate planting within and close to the curtilage of the item. The scheme would consider appropriate period plants and trees. Any boundary wall treatment would be designed in consultation with a heritage architect.	Old Sugarmill
NAH10	*Impacts to archaeology*	An archaeological research design would be prepared and implemented to identify the need for archaeological testing or monitoring. Archaeological mitigation measures recommended in the archaeological research design would be implemented in accordance with relevant guidelines, and where identified in the archaeological research design, would be supervised by a suitably qualified Excavation Director with experience in managing State significant archaeology.	MA Catchment (specific requirements) CB Catchment and work site (specific requirements) BE Catchment (specific requirements) LA Catchment (specific requirements)

ID	Impact	Mitigation measures	Relevant location(s)
NAH11	*Archival recording*	Photographic archival recording and reporting would be carried out in accordance with the NSW Heritage *Office's How to Prepare Archival Records of Heritage Items* (1998), and *Photographic Recording of Heritage Items Using Film or Digital Capture* (2006).	Overbridge-Illawarra Road Hurlstone Park Railway Underbridge Canterbury (Cooks River) Underbridge Canterbury (Cooks River/Charles St) Underbridge - Main Line Post-war bus shelter and public lavatories Bankstown Parcels Office (former)
NAH12	*Conservation management*	A conservation management plan would be prepared for all State Heritage Register listed stations, in accordance with NSW Heritage Council guidelines. The plan would address any changes to the item, including updated assessment of significance of elements and recommendations on curtilage changes. It would also provide suggested site specific exemptions and management policies.	MA, CA, BE
NAH13		A conservation management strategy would be prepared for nominated Section 170 register listed stations not listed on the State Heritage Register, in accordance with NSW Heritage Council guidelines.	HP, CP, LA, BA
NAH14	*Unexpected finds*	An unexpected finds procedure would be developed and included in the construction heritage management plan.	All
Construction			
NAH15	*Minimising impacts during construction*	Methodologies for the removal of existing structures and construction of new structures would be developed and implemented during construction to minimise direct and visual impacts to other elements within the curtilages of the heritage items, or to heritage items located in the vicinity of works.	All heritage items
NAH16	*Unexpected finds*	In the event that unexpected archaeological remains, relics, or potential heritage items are discovered during construction, all works in the immediate area would cease, and the unexpected finds procedure would be implemented.	All
NAH17	*Human skeleton material*	In the event that a potential burial site or potential human skeletal material is exposed during construction, the procedure recommended by the historic heritage impact assessment would be followed in accordance with the Policy Directive – *Exhumation of Human Remains* (NSW Department of Health, 2008), *Skeletal Remains – Guidelines for the Management of Human Skeletal Remains under the Heritage Act 1977* (NSW Heritage Office, 1998) and the *Aboriginal Cultural Heritage Standards and Guidelines Kit* (NPWS, 1997).	All

ID	Impact	Mitigation measures	Relevant location(s)
Aboriginal heritage			
Design/pre-construction			
AH1	*Consultation*	Aboriginal stakeholder consultation would continue to be undertaken in accordance with *Aboriginal Cultural Heritage Consultation Requirements for Proponents* (DECC, 2010b).	All
AH2	*Avoiding impacts to Aboriginal heritage*	An Aboriginal cultural heritage assessment report would be prepared in accordance with the *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW* (Office of Environment and Heritage, 2011a). The report would include: • details of Aboriginal stakeholder consultation conducted • an assessment of cultural significance for the project area and identification of any specific areas of cultural significance based on consultation with Aboriginal stakeholders • a methodology for archaeological test excavation and salvage, to be undertaken by suitably qualified personnel • procedures for any unexpected finds.	All (this item has already commenced)
AH3	*Managing impacts to identified PADs*	Direct impacts to S2B PAD02 at Punchbowl Station would be avoided where practicable. If impacts to S2B PAD02 cannot be avoided, archaeological test excavation (and salvage when required) would be undertaken prior to construction in accordance with the methodology defined by the Aboriginal cultural heritage assessment report.	S2B PAD02
AH4	*Interpretation*	Appropriate Aboriginal heritage interpretation would be incorporated into the design in consultation with Aboriginal stakeholders.	All
Construction			
AH5	*Unexpected finds*	If potential Aboriginal items are uncovered, works within 10 metres of the item would cease. The item would then be assessed and managed by a suitability qualified person in accordance with the unexpected finds procedure in the Aboriginal cultural heritage report. During pre-work briefings, employees would be made aware of the unexpected finds procedures and obligations under the NPW Act.	All
Land use and property			
Design/pre-construction			
LU1	*Acquisitions*	All acquisitions/adjustments would be undertaken in consultation with landowners and in accordance with the requirements of the *Land Acquisition (Just Terms Compensation) Act 1991*.	All
LU2	*Future planning*	Transport for NSW will continue to work the Department of Planning and Environment and the Greater Sydney Commission in relation to future planning for the Sydenham to Bankstown corridor.	All
LU3		Transport for NSW will contribute funding towards, and work with, the Department of Planning and Environment and Canterbury-Bankstown Council, on a master plan and business case for the Bankstown town centre, including how the station fits with the centre.	BA

ID	Impact	Mitigation measures	Relevant location(s)
Construction			
LU4	*Temporary use*	Temporary use areas, including public open space, would be restored to their pre-existing condition (as a minimum) as soon as practicable following completion of construction. This would be undertaken in consultation with the relevant council and/or the landowner.	All
Socio-economic impacts			
Design/pre-construction			
SO1	*Socio-economic impacts*	Transport for NSW would continue to work with stakeholders and the community to ensure they are informed about the project and have opportunities to provide feedback to the project team. The existing community contact and information tools would remain in place throughout the duration of the project. Consultation prior to and during construction would involve the use of appropriate tools, including, but not limited to, tools such as community information sessions, forums, briefings, and displays; distribution of project materials in a variety of languages; door knocks; Place Managers; and site signage.	All
SO2	*Community facilities*	Prior to construction, consultation would be undertaken with sensitive community facilities (including aged care, childcare centres, educational institutions, and places of worship). Consultation would aim to identify and develop measures to manage the specific construction impacts for individual sensitive community facilities. These measures would be incorporated into the relevant management plans.	All
Construction			
SO3	*Community facilities and infrastructure*	Access to community facilities and infrastructure would be maintained during construction. Where alternative access arrangements need to be made, these would be developed in consultation with relevant service providers, and communicated to users.	All
SO4	*Employment*	A workforce development plan would be prepared and implemented during construction, to support local employment and business opportunities, provide skills development, and increase workplace diversity.	
Business impacts			
Design/pre-construction			
BI1	*Managing construction impacts*	A business management plan would be prepared and implemented during construction, to define the location specific measures and strategies to minimise impacts on individual businesses during construction. The plan would also include: • a business consultation forum • roles and responsibilities • monitoring, auditing, reporting, and complaints management procedures.	All

ID	Impact	Mitigation measures	Relevant location(s)
BI2	*Supporting businesses during construction*	A small business owners support program would be developed and implemented to provide assistance to small business owners adversely impacted by construction. The program would be administered by a retail advisory/support panel established by Transport for NSW.	All
Landscape and visual impacts			
Design/pre-construction			
LV1	*General visual impacts*	The design would continue to be guided by the *Sydney Metro City & Southwest Sydenham to Bankstown Design Guidelines*.	All
LV2		Urban design and landscaping would be incorporated as part of the detailed station designs and precinct plans to provide a consistent approach to the management and mitigation of landscape and visual impacts across the project, and implementation of the proposed mitigation strategies.	All
LV3		Fencing would be designed to be of a high quality urban finish near stations.	AS
LV4	*Impacts to trees and screening vegetation*	The management of trees during detailed design and construction planning would be guided by the project's tree management strategy. Where removal cannot be avoided, trees would be replaced in accordance with the tree management strategy. Opportunities to retain and protect existing trees would be defined during detailed design and construction planning, in accordance with the project's tree management strategy. The design would aim to reduce tree removal to the extent practicable, particularly where they contribute to screening vegetation or landscape character.	All
LV5	*Light spill*	Lighting would be designed in accordance with *AS 4282 Control of the Obtrusive Effects of Outdoor Lighting*. Lighting would be designed to minimise light spill and glare into adjoining areas.	All
LV6	*Impacts of noise barriers*	The selection of materials and colours for noise barriers and hoardings would aim to minimise their visual prominence.	Noise barrier locations
LV7		The use of transparent panels in noise barriers would be considered where views to local landscape features and district views would be obstructed.	Noise barrier locations
LV8	Substations	The detailed design of the substations would ensure that they incorporate appropriate architectural treatments and landscaping, guided by the design guidelines, to minimise the potential for visual impacts.	Substations
Construction			
LV9	*Visual impacts*	A visual amenity management plan would be prepared and implemented during construction, to define the measures to minimise visual impacts during construction. The plan would include requirements in relation to construction site remediation.	All
LV10		Mitigation measures for landscape and visual impacts would be implemented as soon as feasible and reasonable after the commencement of construction, and remain for the duration of the construction period.	All

ID	Impact	Mitigation measures	Relevant location(s)
LV11	*Impacts to trees*	Trees to be retained would be protected prior to the commencement of construction in accordance with *AS4970-2009 Protection of trees on development sites* and the project's tree management and replacement strategy. Any tree pruning would be undertaken in accordance with the project's tree management strategy, guided by a tree report prepared by a qualified arborist.	All
LV12	*Impacts from construction, including compounds and work sites*	The design and maintenance of construction compound hoardings would aim to minimise visual amenity and landscape character impacts. Graffiti would be removed promptly, and public art opportunities would be considered.	All
LV13		The selection of materials and colours would aim to minimise their visual prominence.	All
LV14		Lighting of work areas, compounds and work sites would be oriented to minimise glare and light spill impact on adjacent receivers.	All
LV15		Following completion of construction, site restoration would be undertaken in accordance with the visual amenity management plan. Temporary impacts to public open space would be rehabilitated in consultation with the relevant local council and/or landowner.	All
Soils and contamination			
Design/pre-construction			
SC1	*General soil and erosion management*	Erosion and sediment control measures would be implemented in accordance with *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom, 2004) and *Managing Urban Stormwater: Soils and Construction Volume 2A* (DECC, 2008a). Measures would be designed as a minimum for the 80th percentile, five day rainfall event.	All
SC2	*Acid sulfate soils*	Prior to ground disturbance in high probability acid sulfate areas, testing would be carried out to determine the presence of acid sulfate soils. If acid sulfate soils are encountered, they would be managed in accordance with the *Acid Sulfate Soil Manual* (Acid Sulfate Soil Management Advisory Committee, 1998) and the *Waste Classification Guidelines* - Part 4: Acid Sulfate Soils (EPA, 2014).	MA, CB, CP
SC3	*Saline soils*	Prior to ground disturbance in areas of potential soil salinity, testing would be carried out to confirm the presence of saline soils. If saline soils are encountered, they would be managed in accordance with *Site Investigations for Urban Salinity* (DLWC, 2002).	PB, BA
SC4	*Contamination*	WorkCover dangerous goods searches would be carried out for properties that have potential contamination near Belmore Station, to provide additional site characterisation and identify the risk of contamination in these areas.	BE
SC5		A detailed contamination assessment would be undertaken in areas with a medium to high risk of contamination, to confirm the nature and extent of contamination, specific requirements for further investigation and remediation, and/or management requirements of any contamination.	MA, CP, BE, PB, BA

ID	Impact	Mitigation measures	Relevant location(s)
SC6		Hazardous materials surveys would be undertaken during detailed design for all proposed demolition activities, and for utility adjustments as required.	All
SC7		In the event a Remediation Action Plan is required, it would be developed in accordance with *Managing Land Contamination: Planning Guidelines SEPP 55 – Remediation of Land* (Department of Urban Affairs and Planning and Environment Protection Authority, 1998) and a NSW Environment Protection Authority Accredited site auditor would be engaged to audit the works.	MA, CP, BE, PB, BA
Construction			
SC8	*Unexpected contamination*	In the event that indicators of contamination are encountered during construction (such as odours or visually contaminated materials), work in the area would cease, and the finds would be managed in accordance with the unexpected contamination finds procedure.	All
Operation			
SC9	*Soil erosion and sedimentation*	During any maintenance work where soils are exposed, sediment and erosion control devices would be installed in accordance with *Managing Urban Stormwater: Soils and Construction* (Landcom, 2004).	All
Hydrology, flooding and water quality			
Design/pre-construction			
FHW1	*Flooding*	The design would be reviewed to, where feasible and reasonable, not worsen existing flooding characteristics up to and including the one per cent AEP event (incorporating a 10 per cent allowance for climate change) in the vicinity of the project. Detailed flood modelling would consider: • potential changes to flood prone land and flood levels, including areas of flood risk not already addressed • potential changes to overland flow paths • redistribution of surface runoff as a result of project infrastructure • behaviour of existing stormwater runoff, including the results of any recent flood events • results of detailed asset surveys (e.g. floor levels) • potential changes required to flood evacuation routes, flood warning systems and signage. Flood modelling to support detailed design would be carried out in accordance with the following guidelines: • *Floodplain Development Manual* (DIPNR, 2005) • *Floodplain Risk Management Guideline: Practical Consideration of Climate Change* (DECC, 2007) • *Floodplain Risk Management Guide: Incorporating Sea Level Rise Benchmarks in Flood Risk Assessments* (DECCW, 2010c) • *New guideline and changes to section 117 direction and EP&A Regulation on flood prone land, Planning Circular PS 07-003* (NSW Department of Planning, 2007). Flood modelling and consideration of mitigation measures would be carried out in consultation with the relevant local councils, and the NSW State Emergency Service.	All

ID	Impact	Mitigation measures	Relevant location(s)
FHW2	*Stormwater runoff*	Where feasible and reasonable, detailed design would result in no net increase in stormwater runoff rates in all storm events, unless it can be demonstrated that increased runoff rates as a result of the project would not increase downstream flood risk.	All
FHW3		Where space permits, on-site detention of stormwater would be introduced where stormwater runoff rates are increased. Where there is insufficient space for the provision of on-site detention, the upgrade of downstream infrastructure would be implemented where feasible and reasonable.	All
FHW4	*Consultation*	Where relevant, detailed design would occur in consultation with the NSW State Emergency Service, and the Inner West and Canterbury-Bankstown councils, to ensure that flood related outcomes are consistent with floodplain risk management studies.	All
FHW5	*Scour potential*	Further analysis of potential scour would be undertaken during detailed design. This would include the development of appropriate mitigation measures where required, including the installation of detention basins for the duration of construction.	All
FHW6	*Water quality*	The project would be designed to ensure there is minimal potential for water quality impacts, including incorporating water sensitive urban design elements.	All
Construction			
FHW7	*Flooding*	Detailed construction planning would consider flood risk for all compounds and work sites. This would include identification of measures to not worsen existing flooding characteristics. Not worsen is defined as: • a maximum increase in flood levels of 50 mm in a one per cent AEP event • a maximum increase in time of inundation of one hour in a one per cent AEP event • no increase in the potential for soil erosion and scouring from any increase in flow velocity in a one per cent AEP flood event.	All
FHW8		The site layout and staging of construction activities would: • avoid or minimise obstruction of overland flow paths and limit the extent of flow diversion required • consider how works would affect the existing stormwater network such that alternatives are in place prior to any disconnection or diversion of stormwater infrastructure.	All
FHW9	*Watercourse impacts*	Works within or near watercourses (including the Cooks River) would be undertaken with consideration given to the NSW Office of Water's guidelines for controlled activities.	All
FHW10	*Water quality*	Erosion and sediment mitigation measures would be installed and maintained for the duration of the construction period.	
FHW11	*Water quality monitoring*	A water quality monitoring program would be developed and implemented, to monitor water quality at identified discharge points. The program would include relevant water quality objectives, parameters, and criteria and specific monitoring locations identified in consultation with DPI (Water) and the EPA.	All

ID	Impact	Mitigation measures	Relevant location(s)
FHW12		Discharges from construction water treatment devices would be monitored to ensure compliance with the discharge criteria in the environment protection licence.	All
Operation			
FHW13	*Water quality*	Operational water discharges would be managed in accordance with the water quality management requirements specified in the environment protection licence.	All
Biodiversity			
Design/pre-construction			
B1	*Direct impacts to biodiversity*	Detailed design and construction planning would minimise direct impacts to vegetation mapped as threatened ecological communities as far as practicable, and have regard to the habitat management measures provided in the biodiversity assessment report.	All
B2		Pre-clearing surveys and inspections for endangered and threatened flora and fauna species would be undertaken by qualified ecologists prior to any clearing occurring. The surveys and inspections, and any subsequent relocation of species, would be undertaken in accordance with the measures provided in the biodiversity assessment report.	All
B3	*Biodiversity offsets*	The biodiversity offset strategy prepared for the Environmental Impact Statement would be updated to confirm the approach to retiring the required biodiversity credits (including appropriate biobank sites). It would also include a timeframe to retire the required credits based on the confirmed construction schedule and biobank site owner agreements/requirements.	All
Construction			
B4	*Direct impacts to biodiversity*	Areas of biodiversity value outside the project area would be marked on plans, and fenced or signposted where practicable, to prevent unnecessary disturbance.	All
B5		Impacts to Downy Wattle would be avoided. The locations of Downy Wattle stems would be marked on plans, fenced on site, and avoided.	PB, BA
B6		Equipment storage and stockpiling would be restricted to identified compound sites and already cleared land.	All
B7		A trained ecologist would be present during the clearing of native vegetation or removal of potential fauna habitat to avoid impacts on resident fauna and to salvage habitat resources as far as is practicable.	All
B8	*Management of weeds*	Noxious weeds would be managed in accordance with the *Noxious Weeds Act 1993*. Weeds of national environmental significance would be managed in accordance with the *Weeds of National Significance Weed Management Guide*.	All
Operation			
B9	*Management of weeds*	Annual inspections would be undertaken for weed infestations and to assess the need for control measures.	All
B10		Any outbreak of noxious and/or weeds of national environmental significance would be managed in accordance with the relevant guidelines.	All

ID	Impact	Mitigation measures	Relevant location(s)
Air quality			
Design/pre-construction			
AQ1	*Air quality impacts*	An air quality management plan would be prepared and implemented during construction, to define the measures to minimise air quality impacts during construction.	All
Sustainability and climate change			
Design/pre-construction			
SCC1	*Sustainability*	Sustainability initiatives and targets would be reviewed and incorporated into the detailed design to support the achievement of the project's sustainability objectives. A best practice level of performance would be targeted using relevant sustainability rating tools eg ISCA as built 'excellent' level rating.	All
SCC2		A sustainable procurement strategy would be developed and implemented to apply to Principal Contractors, their subcontractors and their suppliers.	All
SCC3		A workforce development and industry participation strategy would be developed covering both construction and operation.	
SCC4	*Climate change*	Climate change risk treatments would be incorporated into the detailed design, including ensuring that adequate flood modelling is carried out and integrated with design.	All
SCC5	*Greenhouse gas emissions*	An iterative process of greenhouse gas assessments and design refinements would be carried out during detailed design and construction to identify opportunities to minimise greenhouse gas emissions. Performance would be measured in terms of a percentage reduction in greenhouse gas emissions from a defined reference footprint.	All
Construction			
SCC6	*Sustainability*	Sustainability reporting (and corrective action where required) would be undertaken during construction.	All
SCC7		The construction workforce development would be implemented.	All
SCC8	*Greenhouse gas emissions*	25 per cent of the greenhouse gas emissions associated with consumption of electricity during construction would be offset.	All
Operation			
SCC9	*Sustainability*	Prior to operation commencing, sustainability initiatives would be reviewed and updated, and relevant initiatives would be implemented to support the achievement of the project's sustainability objectives.	All
SCC10		The operation workforce development plan would be implemented.	All
SCC11	*Climate change risks*	Periodic review of climate change risks would be carried out to ensure ongoing resilience to the impacts of climate change.	All

ID	Impact	Mitigation measures	Relevant location(s)
SCC12	*Greenhouse gas emissions*	100 per cent of the greenhouse gas emissions associated with consumption of electricity during operation would be offset.	All
Hazards, risks and safety			
Design/pre-construction			
HRS1	*Public safety*	A hazard analysis would be undertaken during the detailed design stage to identify risks to public safety from the project, and how these can be mitigated through safety in design.	All
Construction and operation			
HRS2	*Hazardous materials and substances*	All hazardous substances that may be required for construction and operation would be stored and managed in accordance with the *Storage and Handling of Dangerous Goods Code of Practice* (WorkCover NSW, 2005) and the *Hazardous and Offensive Development Application Guidelines: Applying SEPP* 33 (Department of Planning, 2011).	All
Waste management			
Design/pre-construction			
WM1	*Waste generation and recycling*	Detailed design would include measures to minimise excess spoil generation. This would include a focus on optimising the design to minimise spoil volumes, and the reuse of material on-site.	All
WM2		A recycling target of at least 90 per cent would be adopted.	All
Construction			
WM3	*Waste and spoil management*	Spoil would be managed in accordance with the spoil management hierarchy.	All
WM4		Target 100 per cent reuse of reusable spoil.	All
WM5		Construction waste would be minimised by accurately calculating materials brought to the site and limiting materials packaging.	All
WM6		All waste would be assessed, classified, managed and disposed of in accordance with the *Waste Classification Guidelines* (EPA, 2014a).	All
WM7		Waste segregation bins would be located at various locations within the project area, if space permits, to facilitate segregation and prevent cross contamination.	All
Cumulative impacts			
Pre-construction and construction			
CI1	*Cumulative impacts*	Transport for NSW would manage and co-ordinate the interface with projects under construction at the same time. Co-ordination and consultation with the following stakeholders would occur, where required: • Department of Planning and Environment • Roads and Maritime Services • Sydney Trains • NSW Trains • Sydney Buses	All

ID	Impact	Mitigation measures	Relevant location(s)
		• Inner West Council • Canterbury-Bankstown Council • Sydney Motorways Corporation • emergency service providers • utility providers • construction contractors. Co-ordination and consultation with these stakeholders would include: • provision of regular updates to the detailed construction program, construction sites and haul routes • identification of key potential conflict points with other construction projects • developing mitigation strategies in order to manage conflicts. Depending on the nature of the conflict, this could involve: – adjustments to the construction program, work activities or haul routes; or adjustments to the program, activities or haul routes of Sydney Metro or other construction projects – co-ordination of traffic management arrangements between projects.	

28.6 Compilation of performance outcomes

The Secretary's environmental assessment requirements identify a number of desired performance outcomes for the project. These desired performance outcomes outline the broader objectives to be achieved during design, construction, and operation. Based on the outcomes of the environmental impact assessment summarised in Part C, and implementation of the mitigation measures compiled in Section 28.4.2, environmental performance outcomes have been established. These are listed in Table 28.6. The first and second columns provide the key issue and desired performance outcome from the Secretary's environmental assessment requirements, and the third column provides the project specific environmental performance objectives to achieve the desired outcome.

Future design development and any design changes would be considered against these environmental performance outcomes.

Table 28.6 Compilation of environmental performance outcomes

Key issue (as listed in the SEARs)	**SEARs desired performance outcomes**	**Project specific environmental performance outcomes**
5 . Biodiversity	The project design considers all feasible measures to avoid and minimise impacts on terrestrial and aquatic biodiversity. Offsets and/or supplementary measures are assured which are equivalent to any remaining impacts of project construction and operation.	The project is designed to minimise impacts on biodiversity. Where practicable, the design minimises the need to clear vegetation. Potential impacts on biodiversity are managed in accordance with relevant legislation, including the EP&A Act, TSC Act, EPBC Act, and the *Noxious Weeds Act 1993*. The biodiversity outcome is consistent with the *Framework for Biodiversity Assessment* (OEH, 2014a).

Key issue (as listed in the SEARs)	**SEARs desired performance outcomes**	**Project specific environmental performance outcomes**
		Offsets are provided in accordance with the *NSW Biodiversity Offsets Policy for Major Projects* (OEH, 2014).
6. Flooding and hydrology	The project minimises adverse impacts on existing flooding characteristics. Construction and operation of the project avoids or minimises the risk of, and adverse impacts from, infrastructure flooding, flooding hazards, or dam failure. Long term impacts on surface water and groundwater hydrology (including drawdown, flow rates and volumes) are minimised. The environmental values of nearby, connected and affected water sources, groundwater and dependent ecological systems including estuarine and marine water (if applicable) are maintained (where values are achieved) or improved and maintained (where values are not achieved). Sustainable use of water resources.	Construction is undertaken in a manner that minimises the potential for adverse flooding impacts, through staging of works and the implementation of mitigation measures. Construction compounds and work sites are laid out such that flows are not significantly impeded. The project maintains or reduces flood levels within and adjacent to the rail corridor. The project avoids long term impacts to surface water. Opportunities to reuse water resources are considered during the design process. The use of water during construction is minimised.
7. Heritage	The design, construction and operation of the project facilitates, to the greatest extent possible, the long term protection, conservation and management of the heritage significance of items of environmental heritage and Aboriginal objects and places. The design, construction and operation of the project avoids or minimises impacts, to the greatest extent possible, on the heritage significance of environmental heritage and Aboriginal objects and places.	The design is sympathetic to the historic significance of existing stations and the heritage significance of surrounding listed heritage items, and where practicable, avoids and minimises impacts to heritage. The design and mitigation strategies are reviewed by the Sydney Metro Design Review Panel. Impacts on heritage are managed in accordance with relevant legislation, including the EP&A Act, the *Heritage Act 1977*, and relevant guidelines. The potential impacts identified are mitigated by the mitigation measures provided.
8. Noise and vibration – amenity	Construction noise and vibration (including airborne noise, ground-borne noise and blasting) are effectively managed to minimise adverse impacts on acoustic amenity. Increases in noise emissions and vibration affecting nearby properties and other sensitive receivers during operation of the project are effectively managed to protect the amenity and well-being of the community.	The project minimises impacts to the local community by: • controlling noise and vibration at the source • controlling noise and vibration on the source to receiver transmission path • controlling noise and vibration at the receiver • implementing practicable and reasonable measures to minimise the noise and vibration impacts of construction activities on local sensitive receivers.
9. Noise and vibration – structural	Construction noise and vibration (including airborne noise, ground-borne noise and blasting) are effectively managed to minimise	The project minimises impacts to structures by: • controlling vibration at the source • controlling vibration on the source to receiver transmission path

Key issue (as listed in the SEARs)	**SEARs desired performance outcomes**	**Project specific environmental performance outcomes**
	adverse impacts on the structural integrity of buildings, items including Aboriginal places and environmental heritage, and nearby road infrastructure. Increases in noise emissions and vibration affecting environmental heritage as defined in the Heritage Act 1977 during operation of the project are effectively managed.	• implementing practicable and reasonable measures to minimise vibration impacts of construction activities on structures.
10. Socio-economic, land use and property	The project minimises adverse social and economic impacts and capitalises on opportunities potentially available to affected communities. The project minimises impacts to property and business and achieves appropriate integration with adjoining land uses, including maintenance of appropriate access to properties and community facilities, and minimisation of displacement of existing land use activities, dwellings and infrastructure.	The project minimises impacts to the local community, community infrastructure, and businesses. Impacts to existing land use and properties are minimised. The project is appropriately integrated with adjoining land uses, and access to private properties is maintained. The project is appropriately integrated with local and regional land use planning strategies, including the *Sydenham to Bankstown Corridor Urban Renewal Strategy*. During operation, the project would improve access to local facilities, services and destinations, supporting opportunities for community interaction.
11. Soils	The environmental values of land, including soils, subsoils and landforms, are protected. Risks arising from the disturbance and excavation of land and disposal of soil are minimised, including disturbance to acid sulfate soils and site contamination.	Site-specific soil characteristics are taken into consideration during detailed design and construction. Any contamination is managed in accordance with relevant regulatory requirements. Any soil waste is assessed, classified, managed and disposed of in accordance with the *Waste Classification Guidelines* (EPA, 2014).
12. Sustainability	The project reduces the NSW Government's operating costs and ensures the effective and efficient use of resources. Conservation of natural resources is maximised.	Sustainability considerations are integrated throughout design, construction, and operation. The project would be carried out in accordance with the Sydney Metro City & Southwest Sustainability Policy.
13. Traffic, transport and access	Network connectivity, safety and efficiency of the transport system in the vicinity of the project are managed to minimise impacts. The safety of transport system customers is maintained. Impacts on network capacity and the level of service are effectively managed. Works are compatible with existing infrastructure and future transport corridors.	The project would reduce station crowding, increase rail network reach and use, improve network resilience, and improve travel times within the global economic corridor. Impacts to traffic and transport are minimised. Motorist, pedestrian and cyclist safety will be maintained or improved. Safe access to properties is maintained. The project is integrated with existing and future local and regional transport infrastructure and planning strategies. Metro customers would be provided with a safe and secure service.

Key issue (as listed in the SEARs)	**SEARs desired performance outcomes**	**Project specific environmental performance outcomes**
14. Place making and urban design	The project capitalises on opportunities to improve place, character and quality of the surrounding build and natural environment (including adjoining public spaces). The project contributes to the accessibility and connectivity of communities.	The project is designed to have regard to the surrounding landscape and visual environment and to minimise the potential for visual impacts. The project is visually integrated with its surroundings. The stations provide a sense of place, and contribute positively to the surrounding urban environment. The design takes into account future planning for the *Sydenham to Bankstown Corridor Urban Renewal Strategy*. Vegetation providing screening to the rail corridor is retained where practicable.
15. Water - quality	The project is designed, constructed and operated to protect the NSW Water Quality Objectives where they are currently being achieved, and contribute towards achievement of the Water Quality Objectives over time where they are currently not being achieved, including downstream of the project to the extent of the project impact including estuarine and marine waters (if applicable).	Impacts to water quality during construction and operation are minimised. Erosion and sediment controls during construction are implemented in accordance with *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom, 2004) and Managing Urban Stormwater: Soils and Construction Volume 2 (Department of Environment and Climate Change, 2008a). The project would protect or contribute to achieving the Water Quality Objectives, during construction and operation. Construction water quality discharge would comply with the requirements of an environment protection licence issued to the project.
16. Utilities	The project is designed, constructed and operated to minimise impacts to utilities and provision of such to the public.	Impacts to utilities during construction are minimised. The design takes into account the input of utility providers and owners.

28.7 Project justification

28.7.1 Summary of project justification

The project forms a key part of Sydney Metro, which is Australia's largest public transport project. A new standalone railway, this 21st century network will deliver 31 metro stations and 66 kilometres of new metro rail for Australia's biggest city – revolutionising the way Sydney travels.

Sydney is experiencing sustained population and economic growth. The need for the project, as part of Sydney Metro as a whole, is driven by the challenges being experienced in responding to this growth, including the existing and future capacity of the Sydney's transport system.

The rail network is heavily congested, with customers on most rail lines often experiencing significant crowding on trains and station platforms during the morning and evening peaks.

Sydney's current suburban system can reliably carry 24,000 people an hour per line. As population and employment continue to grow, rail is forecast to experience the highest growth in travel demand, with about an additional 100,000 trips expected on Sydney's rail network during the morning peak by 2036. This will place additional pressure on the rail network.

It is forecast that without further investment, Sydney’s rail network will reach capacity in the Sydney CBD and on critical suburban rail lines by the mid to late 2020s. Sydney Metro (including the project) will have a long-term target capacity of about 40,000 customers per hour in each direction, similar to other metro systems worldwide. Sydney Metro, together with signalling and infrastructure upgrades across the existing Sydney rail network, will increase the capacity of train services entering the Sydney CBD – from about 120 an hour today to up to 200 services beyond 2024. This is an increase of up to 60 per cent capacity across the network to meet demand.

Over the next 15 years, NSW will require infrastructure to support 40 per cent more train trips, 30 per cent more car trips and 31 per cent more households. Sydney Metro, including the project, is identified as a key infrastructure project as part of the NSW Government’s infrastructure investment program.

Sydney Metro will transform Sydney, cutting travel times, reducing congestion and delivering economic and social benefits for generations to come. It will boost economic activity by more than $5 billion a year, supporting major jobs and business growth along its route with better connectivity and land development opportunities, and greatly improving business logistics, especially for knowledge-based businesses.

With at least1 5 trains an hour in the peak when services start in 2024, the conversion of the T3 Bankstown Line to metro operations would address one of Sydney’s biggest rail bottlenecks, delivering benefits across Sydney’s rail network. These benefits would further increase when the number of trains increases to 20 per hour as part of the ultimate operations.

The T3 Bankstown Line effectively slows down the Sydney Trains network because of the way it merges with other railway lines closer to the city, including the T2 Airport, Inner West & South Line.

Parts of the T3 Bankstown Line are over 120 years old with existing infrastructure in varying conditions. A key challenge for this line is customer accessibility, with five of the stations not having lifts. In addition, a number of these stations have larger than desirable gaps between the platforms and trains, which makes access difficult for some customers, particularly the disabled, elderly, and those travelling with young children, prams or luggage.

28.7.2 Summary of project benefits

The project would have the following benefits:

- all stations fully accessible, with lifts and level access between trains and platforms
- more job opportunities faster, more frequent and direct access to key employment centres
- better access to education, with fast, more frequent and direct connections
- no timetable required – customers can just turn up and go
- new and direct access to major CBD stations, including Martin Place, Pitt Street, Barangaroo and North Sydney
- increased train frequency in AM and PM peak services – a train at least every four minutes
- improved interchange with bus, light rail, pedestrian and cycling networks, and provision of taxi, kiss and ride and bike parking facilities at key stations
- fast, safe and reliable – a new generation of 21st century metro trains.

28.7.3 Consequence of not proceeding

The project is a section of Sydney Metro as a whole, and one of two components of Sydney Metro City & Southwest. Without the project, the benefits of Sydney Metro City & Southwest would not be fully realised. The bottleneck created by the T3 Bankstown Line would remain. There would not be sufficient rail capacity to provide for Sydney's growth, as summarised in Section 28.7.1.

28.7.4 Environmental considerations

Environmental investigations were undertaken during preparation of the Environmental Impact Statement to assess the potential impacts of the project. These included specialist assessments of traffic and transport, noise and vibration; heritage; hydrology, flooding and water quality; landscape and visual amenity; biodiversity; socio-economics; and business impacts. The Environmental Impact Statement has documented the potential environmental impacts, considering both potential positive and negative impacts, and identifies mitigation measures to protect the environment where required.

The key potential impacts on the biophysical, social and cultural environments are summarised in Section 28.3.

As described in Chapters 7 to 9 and Section 28.4, the project would incorporate environmental management and design features to ensure that potential impacts are managed and mitigated as far as practicable.

28.7.5 Ecologically sustainable development

The EP&A Act adopts the definition of ecologically sustainable development contained in the *Protection of the Environment Administration Act 1991*. An assessment of the project against the principles of ecologically sustainable development as per clause 7(4) of Schedule 2 of the *Environmental Planning and Assessment Regulation 2000* is provided below.

Precautionary principle

A range of environmental investigations, as described in Part C of the Environmental Impact Statement, have been undertaken during the development of the project and the environmental assessment process, to ensure that potential impacts are understood with a high degree of certainty. The assessment of the potential impacts of the project is considered to be consistent with the precautionary principle. The assessments undertaken are consistent with accepted scientific and assessment methodologies, and have taken into account relevant statutory and agency requirements. The assessments have applied a conservative approach with regard to construction and operational arrangements, and the modelling used.

Examples of the application of the precautionary principle include the biodiversity assessment, and the noise and vibration assessment. For the biodiversity assessment, although the Long-nosed Bandicoot population in inner western Sydney was considered unlikely to occur in the project area, the potential impacts on this species were still assessed.

The noise and vibration assessment involved a 'worst case' construction noise impact assessment, even though the likelihood of the worst-case is considered to be low and therefore potential noise impacts are considered to be lower than assessment. Due to much of the works being undertaken during possession periods many of the predicted noise impacts would be limited to these periods and therefore would not occur throughout the construction period.

The project has evolved to avoid impacts where possible, and to reflect the findings of the assessments undertaken. A number of safeguards have been proposed to minimise potential impacts. These safeguards would be implemented during construction and operation. No safeguards have been postponed as a result of lack of scientific certainty.

Principle of inter-generational equity

Construction along a long linear corridor has the potential for some degree of environmental and social disturbance. These disturbances include the clearing of vegetation; amenity impacts during construction; impacts to heritage items; and changes to traffic movements and access. However, the potential for environmental and social disturbance as a result of construction has to be balanced against the long term benefits of Sydney Metro overall.

Once operational, the project (in conjunction with other Sydney Metro projects) would benefit future generations. The project would provide long-term benefits by strengthening connections and access across Sydney, through the provision of a more efficient means of public transport. These benefits would be most felt by future generations as the population along the project area increases in line with future development proposed by the draft *Sydenham to Bankstown Urban Renewal Strategy*.

In addition to the broader Sydney transport operational benefits, the 'door-to-door' experience provided by Sydney Metro would also result in long-term health benefits with the creation of safer and more appealing conditions for pedestrians, cyclists, and other transit users. The would make modes of transport like walking and cycling more desirable, which would result in increased health of future generations.

The project would also facilitate future delivery of active transport corridor that would further improve the health of the community including future generations. In addition, the project would promote better access for all people, by upgrading stations to meet statutory accessibility requirements.

Conservation of biological diversity and ecological integrity

The majority of the project area is located within an existing transport corridor, with minimal habitat value. The few areas of Downy Wattle (*Acacia pubescens)* located between Punchbowl and Bankstown stations have been excluded from the project area.

A biodiversity assessment was undertaken in accordance with the *Framework for Biodiversity Assessment* to identify potential adverse impacts on biodiversity. The main potential impact on biodiversity would occur as a result of clearing of vegetation to enable the project to be constructed. It was assumed for the purpose of the assessment that construction would require removal of all vegetation located along the rail corridor in the project area. This would involve removal of 29.8 hectares of vegetation, the majority of which comprises exotic plants (about 21.5 hectares) or planted, often non-indigenous, native species on fill material (about 7.3 hectares). Removing all vegetation in the rail corridor would impact on one hectare of native vegetation.

The assessment concluded that the project would not significantly impact any listed ecological community or species.

To mitigate potential impacts to biodiversity as a result of clearing of native vegetation in the rail corridor, the proposed Biodiversity Offset Strategy would be implemented in accordance with *the NSW Biodiversity Offsets Policy for Major Projects*. The offset strategy requires the purchase and retirement of biodiversity credits calculated in accordance with the *Framework for Biodiversity Assessment*.

Improved valuation and pricing of environmental resources

Economic appraisal draws on a number of established methodologies that provide for the valuation of externalities, including environmental externalities, and their inclusion in the appraisal process. Environmental parameters that can be valued include air pollution, greenhouse gas emissions, noise pollution and water run-off. Valuations typically adopt broad average values.

The assessment has identified the environmental and other consequences of the project, and identified mitigation measures where appropriate to manage potential impacts. If approved, construction and operation would be undertaken in accordance with relevant legislation, the conditions of approval, and the environmental management plans described in Section 28.4. These requirements would result in an economic cost to the proponent. The implementation of mitigation measures would increase the capital and operating costs of the project. This signifies that environmental resources have been given appropriate valuation.

The design has been developed with an objective of minimising potential impacts on the surrounding environment. This indicates that the design has been developed with an environmental objective in mind.

28.8 Conclusion

The project involves upgrading 10 existing stations west of Sydenham (Marrickville to Bankstown inclusive), and a 13 kilometre long section of the Sydney Trains T3 Bankstown Line, between west of Sydenham Station and west of Bankstown Station, to improve accessibility for customers and meet the standards required for metro operations. The project is needed to support the development of Sydney Metro, in line with the objectives of *Sydney's Rail Future*.

The detailed design would be developed with the objective of minimising potential impacts on the local and regional environment and community. The design and construction methodology would continue to be developed with this overriding objective in mind, taking into account the input of stakeholders and the local community.

To manage the potential impacts identified by the Environmental Impact Statement, and in some cases remove them completely, the assessment chapters detail a range of management and mitigation measures that would be implemented during construction and operation. The project's environmental performance would be managed in accordance with the approach described in Section 28.4. This includes implementing the Construction Environmental Management Framework, Construction Environmental Management Plan, Construction Noise and Vibration Strategy, Temporary Transport Strategy, Utilities Management Framework, and the Operational Environmental Management Plan. These plans would also ensure compliance with relevant legislation and any conditions of approval.

Section 28.5 compiles the mitigation measures that would be implemented.

With the implementation of the proposed management and mitigation measures, the potential environmental impacts of the project are considered manageable.

29. Reference list, definitions and abbreviations

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Abbreviations

Abbreviation	Definition
$\mu g/m^3$	micrograms per cubic metre
AEP	annual exceedance probability
AHD	Australian Height Datum
AHIMS	Aboriginal Heritage Information Management System
AHIP	Aboriginal heritage impact permit
Air NEPM	*National Environment Protection (Ambient Air Quality) Measure*
ANZECC	Australian and New Zealand Environment and Conservation Council
ARTC	Australian Rail Track Corporation
AS	Australian Standard
ASSMAC	Acid Sulfate Soils Management Advisory Committee
BoM	Bureau of Meteorology
BS	British Standard
CBD	central business district
CEMP	construction environmental management plan
CH_4	methane
Clean Air Regulation	*Protection of the Environment Operations (Clean Air) Regulation 2010*
CO	carbon monoxide
CO_2	carbon dioxide
CPTED	crime prevention through environmental design
CSIRO	Commonwealth Scientific and Industrial Research Organisation
dB	Decibel (A-weighted)
DDA	*Disability Discrimination Act 1992*
DEC	NSW Department of Environment and Conservation
DECC	Department of Environment and Climate Change
DECCW	Department of Environment, Climate Change and Water
DIPNR	NSW Department of Infrastructure, Planning and Natural Resources
DPI	Department of Primary Industries
DSAPT	*Disability Standards for Accessible Public Transport 2002*
EIS	environmental impact statement
EP&A Act	*Environmental Planning and Assessment Act 1979*
EP&A Regulation	*Environmental Planning and Assessment Regulation 2000*
EPA	Environment Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
ESD	*ecologically sustainable development*
FM Act	*Fisheries Management Act 1994*
HFCs	hydrofluorocarbons
Hz	hertz
ICNG	*Interim Construction Noise Guideline*
Infrastructure SEPP	*State Environmental Planning Policy (Infrastructure) 2007*
km	kilometres

Abbreviation	Definition
km/hr	kilometres per hour
LEP	local environmental plan
LGA	local government area
m	metres
m/s	metres per second
m^3	cubic metre
mg	milligram
N_2O	nitrous oxide
NCA	noise catchment areas
NEPC	National Environment Protection Council
NO_2	nitrogen dioxide
NPW Act	*National Parks and Wildlife Act 1974*
NSW	New South Wales
NW Act	*Noxious Weeds Act 1993*
OEH	Office of Environment and Heritage
PAD	potential archaeological deposit
PFCs	perfluorocarbons
PMF	probable maximum flood
POEO Act	*Protection of the Environment Operations Act 1974*
RAP	remediation action plan
RBL	rating background level
RING	*Rail Infrastructure Noise Guideline* (EPA, 2013)
RNP	*Road Noise Policy 2011*
Roads and Maritime	Roads and Maritime Services
SEPP	State environmental planning policy
SEPP 33	*State Environmental Planning Policy No 33 – Hazardous and Offensive Development*
SF_6	sulphur hexafluoride
SHR	State heritage register
SO_2	sulphur dioxide
State and Regional Development SEPP	*State Environmental Planning Policy (State and Regional Development) 2011*
Waste Regulation	*Protection of the Environment Operations (Waste) Regulation 2014*
TSC Act	*Threatened Species Conservation Act 1995*
WARR Act	*Waste Avoidance and Resource Recovery Act 2007*

Definitions

Term	Definition
100-year flood	A 100-year flood is the flood that will occur or be exceeded on average once every 100 years. It has a one per cent probability of occurring in any given year. The same principle applies to other flooding events, such as the 10-year, 20-year and 50-year floods.
Aboriginal object	Defined by the *National Parks and Wildlife Act 1974* as 'any deposit, object or material evidence (not being a handicraft made for sale) relating to the Aboriginal habitation of the area that comprises New South Wales, being habitation before or concurrent with (or both) the occupation of that area by persons of non-Aboriginal extraction, and includes Aboriginal remains'.
Aboriginal site	A place where physical remains or modification of the natural environment indicate past and 'traditional' activities by Aboriginal people. Site types include artefact scatters, isolated artefacts, burials, shell middens, scarred trees, quarries, and contact sites. Includes sites listed on the AHIMS. Also known as Aboriginal objects.
Aboriginal place	Declared by the Minister for the Environment, in accordance with Section 84 of the *National Parks and Wildlife Act 1974* and by an order published in the Gazette, as a place that, in the opinion of the Minister, is or was of special significance with respect to Aboriginal culture.
Aboriginal places of heritage significance	Defined in the *Standard Instrument - Principal Local Environmental Plan* as an area of land, the general location of which is identified in an Aboriginal heritage study adopted by the Council, and that may be shown on the Heritage Map. The term may include (but is not limited to) places that are declared as Aboriginal places under section 84 of the *National Parks and Wildlife Act 1974.*
Accessibility	A public transport customer's ability to reach their destination unhindered and as independently as possible. Includes compliance with relevant disability standards such as the *Disability Discrimination Act 1992* and the *Disability Standards for Accessible Public Transport 2002*. Also refers to a measure of the ability or ease of customers to travel between various origins and destinations.
Annual exceedance probability	The annual exceedance probability (AEP) is a measure of the frequency of a rainfall event. It is the probability that a given rainfall total, accumulated over a given duration, will be exceeded in any one year. A one per cent AEP event is a rainfall event with a one per cent chance of being exceeded in magnitude in any year.
Anti-throw screen	Installed on structures such as bridges or overhead walkways to prevent injury and damage resulting from objects being thrown off the structure.
Archaeological potential	The likelihood of unregistered surface and/or subsurface archaeological materials to be present at a location.
Australian height datum	A common reference surface level used in Australia which is approximately equivalent to the height above mean sea level.
Average delay	Duration, in seconds, of the average vehicle waiting time at an intersection.
Average recurrence interval	The long-term average number of years between the occurrence of a flood larger than the selected event.
Ballast	Crushed rock, stone etc used to provide a foundation for a railway track. Ballast usually provides the bed on which railway sleepers are laid, transmits the load from train movements, and restrains the track from movement.
Biobank site	A site to which a biobanking agreement applies.
Biobanking agreement	Landowners enter into a biobanking agreement with the Minister for the Environment to establish a biobank site. A biobanking agreement is a conservation covenant that is attached to the land title. It specifies the management actions to be undertaken on biobank sites to improve biodiversity values and allow biodiversity credits to be created.
Biodiversity credits	In accordance with the *Framework for Biodiversity Assessment* (OEH, 2014b), biodiversity credits, which consist of ecosystem credits and species credits, represent the impacts on threatened species as a result of a proposal. A decision support tool produced by OEH is used to determine the number of biodiversity credits required to offset the impacts of a development.

Term	Definition
Biodiversity offsets	Biodiversity offsets are measures that benefit biodiversity by compensating for the adverse impacts elsewhere of an action, such as clearing for development. Biodiversity offsets work by protecting and managing biodiversity values in one area in exchange for impacts on biodiversity values in another.
Biodiversity offset strategy	The section of a Biodiversity Assessment Report prepared in accordance with the *Framework for Biodiversity Assessment,* which presents the approach to the delivery of biodiversity offsets for a project, including the quantum of offsets required, options to deliver these offsets, an estimate of the costs involved, and the additional steps required to finalise their delivery.
Biodiversity values	The composition, structure and function of ecosystems, including native species, populations and ecological communities, and their habitats.
Biophysical environment	The physical environment (water, soil etc) as well as the biological activity within it (plants, animals etc.).
Catchment	The area drained by a stream or body of water, or the area of land from which water is collected.
Chatswood to Sydenham project	One of the two components of the Sydney Metro City & Southwest project, the other being the Sydenham to Bankstown upgrade.
Classified road	A road that meets the definition of a classified road and is listed as such under the *Roads Act 1993* – includes main roads, highways, freeways etc.
Climate	The average weather experienced at a site or region over a period of many years, ranging from months to many thousands of years. The relevant measured quantities are most often surface variables such as temperature, rainfall, and wind.
Community	A physical or cultural grouping of stakeholders with common interests created by shared proximity or use.
Concourse	The paved open area at a station – can be located either behind or in front of ticket barriers.
Construction compound	An area used as the base for construction activities, usually for the storage of plant, equipment and materials, and/or construction site offices and worker facilities.
Crossover	Points and tracks enabling trains to switch from one line to another.
Cutting	Excavation from the surface down, so that the new surface level sits below the adjacent ground level.
Dangerous goods	Dangerous goods are substances or articles that pose a risk to people, property or the environment, due to their chemical or physical properties. They are usually classified with reference to their immediate risk.
Degree of saturation	The ratio between traffic volumes and capacity of an intersection used to measure how close to capacity an intersection is operating. Degree of saturation is a direct measure of the congestion level at the intersection. As it approaches 1.0, both queue length and delays increase rapidly. Satisfactory operations usually occur with a degree of saturation between 0.8-0.9 or below.
Discharge	The quantity of water per unit of time flowing in a stream, for example cubic meters per second or megalitres per day.
Ecologically sustainable development	Development that uses, conserves and enhances the resources of the community so that ecological processes on which life depends are maintained, and the total quality of life, now and in the future, can be increased.
Ecosystem credit	A measurement of the value of endangered ecological communities, critically endangered ecological communities, and threatened species habitat for species that can be reliably predicted to occur with a plant community type. Ecosystem credits measure the loss in biodiversity values as a result of a proposal, and the gain in biodiversity values at an offset site.
Emission	A substance discharged into the air.
Embankment	A structure to allow rail lines (or other infrastructure) to be located above the natural ground surface.
Erosion	A natural process where wind or water detaches a soil particle and provides energy to move the particle.

Term	Definition
Flood	The inundation of normally dry land by water which escapes from, is released from, is unable to enter, or overflows from the normal confines of a natural body of water or watercourse, such as rivers, creeks or lakes, or any altered or modified body of water, including dams, canals, reservoirs and stormwater channels.
Flood liable land	Land which is within the extent of the probable maximum flood and therefore prone to flooding.
Floodplain	The area of land subject to inundation by floods up to and including the probable maximum flood.
Flora and fauna	Plants and animals
Formation	Refer to track formation
Glare	The uncomfortable brightness of a light source when viewed against a dark background.
Groundwater	All waters occurring below the land surface. The upper surface of the soils saturated by groundwater in any particular area is called the water table.
Habitat tree	A tree that is recognised as being of value as a shelter, roosting, and/or nesting resource for fauna species. Includes hollow-bearing trees, stags (standing dead trees), and trees with nests or other signs of fauna occupancy.
Heritage listed	An item, building or place included on statutory heritage lists maintained by local, State and/or the Australian Government.
Impervious	Surfaces that are not permeable to water, such as paved areas.
Infiltration	The downward movement of water into soil and rock, which is largely governed by the structural condition of the soil, the nature of the soil surface (including presence of vegetation), and the moisture content of the soil.
Interchange	A location where customers transfer from one mode of transport to another or between two services of the same mode. Also includes a place where customers join or leave the public transport system on foot, by bicycle, motorcycle, or car.
Kiss and ride	An area allocated for cars to pull out of the active traffic lane and drop passengers off at a station.
$L_{A90(period)}$	The sound pressure level exceeded for 90 per cent of the measurement period.
$L_{Aeq(1\ hour)}$	The busiest one hour ‘equivalent continuous noise level’, representing the typical L_{Aeq} noise level from all the proposal noise events during the busiest one hour of the assessment period.
$L_{Aeq(15\ hour)}$	The daytime ‘equivalent continuous noise level’, representing the cumulative effects of all the proposal noise events occurring in the daytime period from 7am to 10pm.
$L_{Aeq(24\ hour)}$	The ‘equivalent continuous noise level’, sometimes also described as the ‘energy-averaged noise level’, representing the cumulative effects of all the proposal noise events occurring in one day.
$L_{Aeq(9\ hour)}$	The night-time ‘equivalent continuous noise level’, representing the cumulative effects of all the proposal noise events occurring in the night-time period from 10pm to 7am.
$L_{Aeq(time)}$	Typically used to describe ambient (background) noise levels.
L_{Amax}	The maximum sound level recorded during the measurement period.
Landform	A specific feature of the landscape or the general shape of the land.
Landscape	All aspects of a tract of land, including landform, vegetation, buildings, villages, towns, cities, and infrastructure.
Landscape character	The combined quality of built, natural and cultural aspects that make up an area and provide its unique sense of place.
Landscape character zone	An area of landscape with similar properties or strongly defined spatial qualities, distinct from areas immediately adjacent.
Landscape feature	A component, part or feature of the landscape that is prominent or eye-catching, e.g. hills, buildings, vegetation.
Landscape quality	Largely subjective judgement based on particular characteristics that influence the way in which the environment is experienced, including special interests such as cultural associations or heritage interests, the presence and/or type of elements, and condition.

Term	Definition
Level of service	Defined by Austroads as a measure for ranking operating road and intersection conditions, based on factors such as speed, travel time, freedom to manoeuvre, interruptions, comfort, and convenience.
Light spill	The spilling of light beyond the boundary of a property or lit area.
Local road	Road used mainly to access properties located along the road.
pH	A measure of the degree of acidity or alkalinity expressed on a logarithmic scale of one to four, with one being most acid, seven neutral, and 14 most basic (alkaline).
PM_{10}	Particulate matter 10 micrometres or less in diameter. Particles in this size range make up a large proportion of dust that can be drawn deep into the lungs. This is a classification of particles by size rather than chemical properties.
Platform screen doors	Screens the platform from an approaching train. The doors open after the train doors have opened to let passengers move between the train and platform, and close before the train doors have been closed, to improve safety and efficiency.
Possession	A period of time during which a rail line is shut down to trains, to permit work to be carried out on or near the line.
Potential archaeological deposit	An area where sub-surface stone artefacts and/or other cultural materials are likely to occur.
Power supply feeder	Electricity distribution line
Probable maximum flood	The largest flood that could conceivably occur (a worst-case flood event). It is typically estimated from probable maximum precipitation coupled with the worst flood-producing catchment conditions. The probable maximum flood extent defines the floodplain and incorporates all flood-prone land.
Project	The construction and operation of the Bankstown to Sydenham upgrade component of Sydney Metro City & Southwest.
Project area	The area that would be directly affected by construction works (also known as the construction footprint). It includes the location of project infrastructure, the area that would be directly disturbed by the movement of construction plant and machinery, and the location of the storage areas/compounds sites etc, that would be used to construct that infrastructure.
Rail alignment	The exact positioning of the track, accurately defined both horizontally and vertically, along which the rail vehicles operate.
Rail corridor	The corridor within which the rail tracks and associated infrastructure are located.
Rail junction	A point where two or more rail lines either meet or cross.
Rating background level	The underlying level of noise present in an area once transient and short-term noise events are filtered out.
Relic	A relic is defined by the NSW *Heritage Act 1977* as 'any artefact, object or material evidence which relates to the settlement of the area that comprises New South Wales, not being Aboriginal settlement, and which is of State or local heritage significance.'
Riparian	Pertaining to, or situated on, the bank of a river or other water body.
Runoff	The amount of rainfall which ends up as streamflow, also known as rainfall excess.
Salinity	The total soluble mineral content of water or soil (dissolved solids), with concentrations of total salts are expressed as milligrams per litre (equivalent to parts per million).
Sediment	Material of varying sizes that has been, or is being moved from its site of origin by the action of wind, water or gravity.
Sky glow	The brightening of the night sky above towns, cities, and countryside.
Surface water	Water that is derived from precipitation or pumped from underground and may be stored in dams, rivers, creeks and drainage lines.
Section 170 register	Under section 170 of the *Heritage Act 1977*, all state government agencies must keep and administer a database of heritage assets called a Section 170 Heritage and Conservation Register.
Sensitive receivers	Land uses which are sensitive to potential noise, air, and visual impacts, such as residential dwellings, schools and hospitals.

Term	Definition
Sensitivity	The sensitivity of a landscape character area or view and its capacity to absorb change. In the case of visual impact this also relates to the type of viewer and number of viewers.
Species credit	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 species profile database.
Spoil	Material generated by construction
Station area	A subset of the project area. It includes the station and the area around the station where works are proposed as part of the project – mainly to provide facilities/space for customers to transfer between other forms of transport (such as bus stops, taxi parking bays, kiss and ride bays, cycle parking/storage).
Station catchment	That part of each suburb located within a radius of about 400 metres of a station.
Study area	The study area is defined as the wider area including and surrounding the project area, with the potential to be directly or indirectly affected by the project (for example, by noise and vibration, visual or traffic impacts). The actual size and extent of the study area varies according the nature and requirements of each impact assessment technical report.
Sydenham to Bankstown upgrade	The Sydenham to Bankstown upgrade forms the project for the purposes of this EIS. It is one of the two components of the Sydney Metro City & Southwest project, the other being the Chatswood to Sydenham project.
Sydney Metro	Sydney Metro is a new standalone automated rapid transit rail network under construction in Sydney. The Sydney Metro network consists of Sydney Metro Northwest (under construction) and Sydney Metro City & Southwest, which together would provide 66 kilometres of metro rail line and 31 metro railway stations.
Sydney Metro City & Southwest	Part of the Sydney Metro network proposed between Chatswood and Bankstown, comprising two core components - the Chatswood to Sydenham project and the Sydenham to Bankstown upgrade.
Sydney Trains	The agency responsible for the provision of suburban passenger train services in/around Sydney.
Tree	A long lived woody perennial plant growing to greater than (or usually greater than) three metres in height, with one or relatively few main stems or trunks.
Threatened biota	Threatened species, populations or communities listed under the EPBC Act, FM Act and/or the TSC Act.
Topography	Representation of the features and configuration of land surfaces.
Track	The structure consisting of the rails, fasteners, sleepers, and ballast, which sits on the track formation.
Track formation	The earthworks/material on which the ballast, sleepers, and tracks are laid.
Trackside intruder detection system	A system where information is fed to the control centre whenever a large object moves from the platform to the tracks.
Traction substation	An electrical substation that converts electric power from the form provided by the electricity provider to an appropriate voltage, current type and frequency, which can be used to supply the rail network with power.
View	The visual experience from the viewer's perspective.
Visual amenity	The value of a particular area or view in terms of what is seen.
Visual catchment	Extent of potential visibility to or from a specific area, feature or proposal.
Visual impact	The impacts on the views from residences, workplaces, and public places. This can be positive (i.e. benefit or an improvement) or negative (i.e. adverse or a detraction).
Waste	Waste is defined by the EPA as any matter (whether liquid, solid, gaseous or radioactive) that is discharged, emitted, or deposited in the environment in such volume, constituency, or manner as to cause an alteration to the environment.
Waste management hierarchy	The waste management hierarchy is a set of priorities for the efficient use of resources, which underpins the objectives of the *Waste Avoidance and Resource Recovery Act 2001*. The waste management hierarchy progresses from avoidance (most preferred), to re-use/recycling, to disposal (least preferred).

Term	Definition
Watercourse	Refers to waterways, such as rivers, streams and creeks
Water quality	Chemical, physical and biological characteristics of water, including the degree (or lack) of contamination.
Water sharing plan	A legal document prepared under the *Water Management Act 2000* (NSW) that establishes rules for sharing water between the environmental needs of the river or aquifer and water users and also different types of water use.
Water table	The surface of saturation in an unconfined aquifer, or the level at which pressure of the water is equal to atmospheric pressure.

Document Status

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Appendices

Appendix A – Secretary's environmental assessment requirements

Table A.1 General standard SEARs

Item	Requirement	Where addressed?
1. Environmental Impact Assessment Process	1. The Environmental Impact Statement must be prepared in accordance with Part 3 of Schedule 2 of the Environmental Planning and Assessment Regulation 2000 (the Regulation).	Certification page, Section 3.1.3 and Appendix B
	2. It is the Proponent's responsibility to determine whether the project needs to be referred to the Commonwealth Department of the Environment for an approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Proponent must contact the Commonwealth Department of the Environment immediately if it is determined that an approval is required under the EPBC Act, as supplementary environmental assessment requirements may need to be issued to ensure a streamlined assessment under the Bilateral agreement can be achieved.	No approval is required. Refer to Section 3.2.2
	3. Where the project requires approval under the EPBC Act and is being assessed under the Bilateral Agreement the EIS should address: (a) Consideration of Protected Matters that may be impacted by the development where the Commonwealth Minister has determined that the proposal is a Controlled Action (b) Identification and assessment of those Protected Matters that are likely to be significantly impacted (c) Details of how significant impacts to Protected Matters have been avoided, mitigated and, if necessary, offset (d) Consideration of, and reference to, relevant conservation advices, recovery plans and threat abatement plans	No approval is required. Refer to Section 3.2.2
	4. The onus is on the Proponent to ensure legislative requirements relevant to the project are met.	The statutory context and approval pathway is provided in Chapter 3
2. Environmental Impact Statement	1. The EIS must include, but not necessarily be limited to, the following:	
	(a) executive summary	Executive summary
	(b) a description of the project, including all components and activities (including ancillary components and activities) required to construct and operate it	Chapter 8 and Chapter 9
	(c) a statement of the objective(s) of the project	Section 28.1.5
	(d) a summary of the strategic need for the project with regard to its critical State significance and relevant State Government policy	Chapter 5
	(e) an analysis of any feasible alternatives to the project	Sections 6.1 and 6.4
	(f) a description of feasible options within the project	Sections 6.3, 6.5 and 6.6
	(g) a description of how alternatives to and options within the project were analysed to inform the selection of the preferred alternative / option. The description must contain sufficient detail to enable an understanding of why the preferred alternative to and options(s) within the project were selected	Sections 6.1, 6.3, 6.5 and 6.6
	(h) describe opportunities for further network expansion and consideration of relationship to other Government public transport initiatives	Section 6.8
	(i) a concise description of the general biophysical and socio-economic environment that is likely to be impacted by the project (including offsite impacts). Elements of the environment that are not likely to be affected by the project do not need to be described	Chapter 2
	(j) a demonstration of how the project design has been developed to avoid or minimise likely adverse impacts	Section 7.3

Item	Requirement	Where addressed?
	(k) the identification and assessment of key issues as provided in the 'Assessment of Key Issues' performance outcome	Chapters 10 to 27
	(l) a statement of the outcome(s) the proponent will achieve for each key issue	Chapters 10 to 27
	(m) measures to avoid, minimise or offset impacts must be linked to the impact(s) they treat, so it is clear which measures will be applied to each impact	Section 28.5
	(n) consideration of the interactions between measures proposed to avoid or minimise impact(s), between impacts themselves and between measures and impacts	Chapters 10 to 27
	(o) an assessment of the cumulative impacts of the project taking into account other projects that have been approved but where construction has not commenced, projects that have commenced construction, and projects that have recently been completed (for example WestConnex and approved construction in the relevant precincts)	Chapter 27
	(p) statutory context of the project as a whole, including: • how the project meets the provisions of the EP&A Act and EP&A Regulation	Section 3.1
	• a list of approvals that must be obtained under other Acts or laws before the project may lawfully be carried out	Section 3.2
	(q) a chapter that synthesises the environmental impact assessment and provides:	Chapter 28
	• a succinct but full description of the project for which approval is sought	Section 28.1
	• a description of uncertainties that still exist around design, construction methodologies	Section 28.2 and Table 28.2
	• and/or operational methodologies and how these will be resolved in the next stages of the project	Section 28.4.2
	• a compilation of the impacts of the project that have not been avoided	Section 28.3
	• a compilation of the proposed measures associated with each impact to avoid or minimise (through design refinements or ongoing management during construction and operation) or offset these impacts	Sections 28.5 and 28.6
	• a compilation of the outcome(s) the proponent will achieve	Section 28.6
	• the reasons justifying carrying out the project as proposed, having regard to the biophysical, economic and social considerations, including ecologically sustainable development and cumulative impacts	Section 28.7
	(r) relevant project plans, drawings, diagrams in an electronic format that enables integration with mapping and other technical software.	Throughout the EIS
	2. The EIS must only include data and analysis that is reasonably needed to make a decision on the proposal. Relevant information must be succinctly summarised in the EIS and included in full in appendices. Irrelevant, conflicting or duplicated information must be avoided.	Throughout the EIS
3. Assessment of key issues	1. The level of assessment of likely impacts must be proportionate to the significance of, or degree of impact on, the issue, within the context of the proposal location and the surrounding environment. The level of assessment must be commensurate to the degree of impact and sufficient to ensure that the Department and other government agencies are able to understand and assess impacts	Chapters 10 to 27
	2. For each key issue the Proponent must:	

Item	Requirement	Where addressed?
	(a) describe the biophysical and socio-economic environment, as far as it is relevant to that issue	A general description of the biophysical and socio-economic environment is provided in Sections 2.3 and 2.4. Further detail is provided in Chapters 10 to 27.
	(b) describe the legislative and policy context, as far as it is relevant to the issue	Section 3.2 and Chapters 10 to 27
	(c) identify, describe and quantify (if possible) the impacts associated with the issue, including the likelihood and consequence (including worst case scenario) of the impact (comprehensive risk assessment), and the cumulative impacts	Chapters 10 to 27 and Technical papers 1 to 9.
	(d) demonstrate how potential impacts have been avoided (through design, or construction or operation methodologies);	An overview of how the design has been developed to minimise potential impacts is provided in Section 7.5. A description of how further impacts would be avoided during construction and operation are provided in Chapters 10 to 27.
	(e) detail how likely impacts that have not been avoided through design will be minimised, and the predicted effectiveness of these measures (against performance criteria where relevant)	A description of how impacts would be further refined during detailed design to minimise potential impacts is provided in Chapters 10 to 27.
	(f) detail how residual impacts will be managed or offset, and the approach and effectiveness of these measures.	Chapters 10 to 27
	3. Where multiple reasonable and feasible options to avoid or minimise impacts are available, they must be identified and considered and the proposed measure justified taking into account the public interest.	Refer to the approach to mitigation and management in Chapters 10 to 27.
4. Consultation	1. The project and its assessment must be informed by consultation, including with relevant government agencies (including the Department of Planning and Environment (Growth, Designs and Programs) and within the Transport for NSW cluster (such as Roads and Maritime Services and Sydney Trains), local councils, infrastructure and service providers, special interest groups, affected landowners, businesses and the community. The consultation process must be undertaken in a manner commensurate with expected levels of impact and stakeholder significance.	Chapter 4
	2. The Proponent must document the consultation process, and demonstrate how the project has responded to the inputs received (inclusive of a strategy of engagement with key stakeholders on key design elements of the project).	Sections 4.1, 4.2 and 4.3
	3. The Proponent must describe the timing and type of community consultation proposed during the design and delivery of the project, the mechanisms for community feedback, the mechanisms for keeping the community informed, and procedures for complaints handling and resolution.	Section 4.4

Table A.2 Key issue requirements

Key issue	Requirement	Where addressed?
5. Biodiversity	1. The Proponent must assess biodiversity impacts in accordance with the current guidelines including the Framework for Biodiversity Assessment (FBA).	A summary of the results of the biodiversity assessment is provided in Chapter 22. The full results are provided as Technical paper 9.
	2. The Proponent must assess impacts on biodiversity values not covered by the FBA as specified in s2.3.	Section 22.3.7
	3. The Proponent must assess impacts on the Long-nosed Bandicoot Inner Western Sydney Population (including an assessment of vehicle strike (from more frequent trains) and a loss of threatened species and their habitat which is not associated with vegetation (e.g. building demolition, bridge reconstruction, etc.). and provide the information specified in s9.2 of the FBA.	Sections 22.3.2, 22.3.3 and 22.3.5
	4. The Proponent must identify whether the project as a whole, or a component of the project, would be classified as a Key Threatening Process (KTP) in accordance with the listings in the *Threatened Species Conservation Act 1997* (TSC Act), *Fisheries Management Act 1994* (FM Act) and *Environmental Protection and Biodiversity Conservation Act 2000* (EPBC Act).	Section 22.3.4
6. Flooding and hydrology	1. The Proponent must assess and model (where appropriate), taking into account any relevant Council-adopted flood model or latest flood data available from Councils, the impacts on flood behaviour during construction and operation for a full range of flood events up to the probable maximum flood (taking into account storm intensity due to climate change) including:	A summary of the results of the hydrology, flooding and water quality assessment is provided in Chapter 21. The full results are provided as Technical paper 8.
	(a) detrimental increases in the potential flood affectation of other properties, assets and infrastructure	Sections 21.3.2 and 21.3.4
	(b) consistency (or inconsistency) with applicable Council floodplain risk management plans	Sections 21.3.2 and 21.3.4
	(c) compatibility with the flood hazard of the land	Sections 21.3.2 and 21.3.4
	(d) compatibility with the hydraulic functions of flow conveyance in flood ways and storage areas of the land	Sections 21.3.2 and 21.3.4
	(e) downstream velocity and scour potential	Sections 21.3.2 and 21.3.4
	(f) impacts the development may have upon existing community emergency management arrangements for flooding. These matters must be discussed with the State Emergency Services and Council	Sections 21.3.2 and 21.3.4
	(g) impacts the development may have on the social and economic costs to the community as consequence of flooding.	Sections 21.3.2 and 21.3.4
	2. The Proponent must describe (and map) the existing hydrological regime for any surface and groundwater resource (including reliance by users and for ecological purposes) likely to be impacted by the project, including stream orders, as per the Framework for Biodiversity Assessment (FBA).	Section 21.2

Key issue	Requirement	Where addressed?
	3. The Proponent must assess (and model if appropriate) the impact of the construction and operation of the project and any ancillary facilities (both built elements and discharges) on surface and groundwater hydrology in accordance with the current guidelines, including:	
	(a) minimising the effects of proposed stormwater and wastewater management during construction and operation on natural hydrological attributes (such as volumes, flow rates, management methods and re-use options) and on the conveyance capacity of existing stormwater systems where discharges are proposed through such systems	Sections 21.3.2 and 21.3.4
	(b) water take (direct or passive) from all surface and groundwater sources with estimates of annual volumes during construction and operation.	Section 21.3.2
	4. The Proponent must identify any requirements for baseline monitoring of hydrological attributes.	Section 21.4.1
7. Heritage	1. The Proponent must identify and assess direct and/or indirect impacts (including cumulative impacts) to the heritage significance of:	A summary of the results of the non-Aboriginal heritage impact assessment is provided in Chapter 14. The full results are provided as Technical paper 3. A summary of the results of the Aboriginal heritage impact assessment is provided in Chapter 15. The full results are provided as Technical paper 4.
	(a) Aboriginal places and objects, as defined under the *National Parks and Wildlife Act 1974* and in accordance with the principles and methods of assessment identified in the current guidelines	Section 15.3
	(b) Aboriginal places of heritage significance, as defined in the Standard Instrument – Principal Local Environmental Plan	Section 15.2.6
	(c) environmental heritage, as defined under the *Heritage Act 1977*	Section 14.3
	(d) items listed on the National and World Heritage lists.	No such items would be impacted by the project
	2. Where impacts to State or locally significant heritage items are identified, the assessment must:	
	(a) include a statement of heritage impact for all heritage items (including significance assessment)	Section 14.3
	(b) consider impacts to the item of significance caused by , but not limited to, vibration, demolition, archaeological disturbance, altered historical arrangements and access, visual amenity, landscape and vistas, curtilage, subsidence and architectural noise treatment (as relevant)	Section 14.3
	(c) outline measures to avoid and minimise those impacts in accordance with the current guidelines	Section 14.4
	(d) be undertaken by a suitably qualified heritage consultant(s) (note: where archaeological excavations are proposed the relevant consultant must meet the NSW Heritage Council's Excavation Director criteria)	Section 14.1.2 and Section 1.5 of Technical paper 3

Key issue	Requirement	Where addressed?
	(e) have regard to the specific and broader values of historic structures (such as footbridges, overhead booking offices, platforms and platform buildings) and conservation approaches provided in the relevant conservation strategies and design guides and conservation management plans, as applicable	Section 14.3
	(f) identify potential uses for heritage items to be retained within the corridor.	Section 14.3
	3. Where archaeological investigations of Aboriginal objects are proposed these must be conducted by a suitably qualified archaeologist, in accordance with section 1.6 of the *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW* (DECCW 2010).	Section 15.4.2
	4. Where impacts to Aboriginal objects and/or places are proposed, consultation must be undertaken with Aboriginal people in accordance with the current guidelines. The significance of cultural heritage values for Aboriginal people who have a cultural association with the land must be assessed.	Sections 15.1.3 and 15.3.3
8. Noise and Vibration - Amenity	1. The Proponent must assess construction and operational noise and vibration impacts in accordance with relevant NSW noise and vibration guidelines. The assessment must include consideration of impacts to sensitive receivers including small businesses, and include consideration of sleep disturbance and, as relevant, the characteristics of noise and vibration (for example, low frequency noise).	A summary of the results of the construction and operational noise and vibration assessment is provided in Chapters 12 and 13. The full results are provided as Technical paper 2. Construction amenity impacts and sleep disturbance impacts are considered in Section 12.5. Operational amenity impacts and sleep disturbance impacts are considered in Section 13.4.2. The characteristics of noise and vibration are explained in Technical paper 2.
	2. The EIS must include a framework for both an Out of Hours Works Strategy and the development of an Out of Hours Works Plan which incorporates community consultation.	Sections 9.7.4 and 12.6.1

Key issue	Requirement	Where addressed?
9. Noise and Vibration - Structural	1. The Proponent must assess construction and operation noise and vibration impacts in accordance with relevant NSW noise and vibration guidelines. The assessment must include consideration of impacts to the structural integrity and heritage significance of items (including Aboriginal places and items of environmental heritage).	A summary of the results of the construction vibration assessment is provided in Chapter 12. The full results are provided as Technical paper 2. Operational vibration impacts are considered in Chapter 13. Consideration of potential construction impacts to structural integrity and heritage items is provided in Section 12.5. Impacts to the heritage significance of items is considered in Chapter 14 (Non-Aboriginal Heritage).
	2. The Proponent must demonstrate that blast impacts are capable of complying with the current guidelines, if blasting is required.	Blasting would not be required.
10. Socio-economic, Land Use and Property	1. The Proponent must assess social and economic impacts of the project. This must be done having regard to issues raised by relevant communities and businesses.	Chapters 17 and 18. Amenity impacts are also a key potential socio-economic impact. As such Chapter 17 and Technical paper 5, also consider the potential impacts of the project on amenity.
	2. The Proponent must assess impacts from construction and operation on:	
	• potentially affected properties	Section 16.4
	• businesses	Chapter 18
	• recreational users	Section 16.4
	• land and water users	Section 16.4 No water users would be impacted by the project.
	• including property acquisitions/adjustments	Section 16.4.2
	• access	Chapters 10 and 11
	• amenity	Chapter 17
	• relevant statutory rights.	Section 16.4.2 and Chapter 17

Key issue	Requirement	Where addressed?
11. Soils	1. The Proponent must assess whether the land is likely to be contaminated and identify if remediation of the land is required, having regard to the ecological and human health risks posed by the contamination in the context of past, existing and future land uses. Where assessment and/or remediation is required, the Proponent must document how the assessment and/or remediation would be undertaken in accordance with current guidelines.	The potential for contamination is considered in Section 20.2.4. The need for remediation would be confirmed as an outcome of the more detailed contamination assessment to be undertaken for the detailed design, as described in Sections 20.3.2 and 20.4.1.
12. Sustainability	1. The Proponent must assess the sustainability of the project in accordance with the Infrastructure Sustainability Council of Australia (ISCA) *Infrastructure Sustainability Rating Tool* or equivalent and relevant rating tool.	Section 24.3.1
	2. The Proponent must review the project against the current guidelines including targets and strategies to improve Government efficiency in use of water, energy and transport.	Sections 24.2 and 24.3
13. Transport and Traffic	1. The Proponent must assess construction transport and traffic (vehicle, pedestrian and cyclists) impacts, including, but not necessarily limited to:	A summary of the results of the operation traffic, transport and access assessment is provided in Chapter 10. The full results are provided as Technical paper 1.
	(a) a considered approach to route identification and scheduling of transport movements	Section 9.7.4 and 9.8.8
	(b) the number, frequency and size of construction related vehicles (passenger, commercial and heavy vehicles, including spoil management movements)	Sections 9.8.9
	(c) blank	
	(d) need to upgrade roads proposed for construction vehicle routes including impacts of road closures, construction worker parking and impacts on availability of public parking	Section 10.3.3
	(e) the nature of existing traffic (types and number of movements) on construction access routes (including consideration of peak traffic times and sensitive road users and parking arrangements)	Section 10.2.2
	(f) information on how construction and scheduling of works will be coordinated in regard to cumulative traffic impacts resulting from concurrent work on WestConnex and other approved key construction projects	Section 10.4.8
	(g) access constraints and impacts on public transport, pedestrians and cyclists including:	
	• impacts on customers and the reliability of suburban and intercity rail services {including increased demand for rail services on other lines, particularly the T2 Inner West, T1 North Shore, Northern and Western Lines) during possession periods and testing and commissioning of metro trains	Section 10.4.5

Key issue	Requirement	Where addressed?
	• alternative transport arrangements for customers during rail possessions and closure of the rail line (including how the Temporary Transport Plan will be developed in consultation with relevant Councils and the community)	Sections 9.11 and 10.3.4
	• identification of key traffic performance issues in the surrounding areas during rail shutdowns and implementation of alternate transport arrangements.	Section 10.4.2 and 10.4.5
	(h) the need to close, divert or otherwise reconfigure elements of the road and cycle network associated with construction of the project.	Sections 10.3.3 and 10.4.3
	2. The Proponent must assess the operational transport impacts of the project, including the wider transport interactions:	A summary of the results of the operation traffic, transport and access assessment is provided in Chapter 11. The full results are provided as Technical paper 1.
	• local and regional roads	Section 11.4.2
	• changes to commuter parking and loading zones	Section 11.4.2, 11.4.4 and 11.4.13
	• provision of kiss and ride facilities, cycling, public and freight transport	Sections 11.4.2, 11.4.4 to 11.4.13
	The EIS must define a transport hierarchy and a framework for an active transport strategy.	Sections 11.3.2 and 11.3.4
14. Place Making and Urban Design	1. The Proponent must deliver functional 'place' outcomes of public benefit, inclusive of how the project integrates with proposed land use changes occurring within the corridor, and how it contributes to the accessibility and connectivity of existing and future communities {with specific consideration given to the Sydenham to Bankstown Urban Renewal Corridor Strategy {as updated)). This must be done in collaboration with the Department of Planning and Environment and Councils, and must include but is not limited to:	Chapter 7 and Appendix H
	(a) the defining of existing and proposed station precincts including implications for urban renewal	Section 7.2
	(b) identifying design principles, strategies and opportunities to enhance healthy, cohesive and inclusive communities (including consideration of government strategies and plans)	Section 7.3
	(c) identifying the urban design and landscaping aspects and user facilities of the project and its components	Section 7.3.8
	(d) assessing the impact of the project on the urban and natural fabric	Section 7.3.4
	(e) incorporating the use of Crime Prevention Through Environmental Design (CPTED) principles during the design development process.	Section 7.2.5
	2. The Proponent must describe the accessibility elements of the project including relevant accessibility legislation and guidelines and:	Chapters 7 and 11
	(a) impacts on pedestrian access in and around stations and connecting streets (including consideration of land use change)	Section 11.4.4 to 11.4.13
	(b) enhancing the accessibility of each station and the general vicinity of walking and cycling catchments	Sections 7.3.8, 11.4.2 and 11.4.4 to 11.4.13

Key issue	Requirement	Where addressed?
	(c) the provision of infrastructure to support accessible paths of travel and interchange	Sections 7.3.8 and 11.4.4 to 11.4.13
	(d) impacts on cyclists (including provision of and integration with active transport routes) and pedestrian access and safety	Sections 7.3.8, 11.4.4 to 11.4.13
	(e) minimising barriers across the rail corridor and opportunities to integrate cycling and pedestrian elements with surrounding networks and in the project.	Section 7.2.4 and 11.4.3
	3. The Proponent must assess the visual and landscape impacts of the project and ancillary infrastructure on:	
	(a) views and vistas	Section 19.3
	(b) streetscapes, key sites and buildings	Section 19.3
	(c) landscaping, green spaces and existing trees	Section 19.3
	(d) heritage items including Aboriginal places and environmental heritage	The project would not impact any Aboriginal places Visual impacts on environmental heritage are considered in Chapter 14.
	(e) the local community.	Section 19.3
	4. The Proponent must provide artist impressions and perspective drawings of the project from key receiver locations to illustrate the project.	Section 8.1
15. Water - Quality	1. The Proponent must:	
	(a) state the ambient NSW Water Quality Objectives (NSW WQO) and environmental values for the receiving waters relevant to the project, including the indicators and associated trigger values or criteria for the identified environmental values	Section 21.5
	(b) identify pollutants that may be introduced into the water cycle and describe the nature and degree of impact that discharge(s) may have on the receiving environment, including consideration of all pollutants that pose a risk of non-trivial harm to human health and the environment	Sections 21.3.3 and 21.3.5
	(c) identify the rainfall event that the water quality protection measures will be designed to cope with (d) assess the significance of identified impacts including consideration of the relevant ambient water quality outcomes (e) demonstrate how construction and operation of the project will, to the extent that the project can influence, ensure that: • where the NSW WQOs for receiving waters are currently being met they will continue to be protected • where the NSW WQOs are not currently being met, activities will work toward their achievement over time. (f) justify, if required, why the WQOs cannot be maintained or achieved over time	Requirements (c) to (f) - limited water quality modelling was undertaken as described in Section 21.1.2. Further information is provided in Appendix A and Technical Paper 8.
	(g) demonstrate that all practical measures to avoid or minimise water pollution and protect human health and the environment from harm are investigated and implemented	Section 21.4
	(h) identify sensitive receiving environments (which may include estuarine and marine waters downstream) and develop a strategy to avoid or minimise impacts on these environments	Section 21.2 and 21.4

Key issue	Requirement	Where addressed?
	(i) identify proposed monitoring locations, monitoring frequency and indicators of surface water quality.	Section 21.4.1
16. Utilities	1. The Proponent must identify and assess potential impacts on key identified active or disused public trunk utilities infrastructure (including communications, electricity, gas, and water and sewerage).	Section 9.10
	2. Where impacts on utilities are expected, the Proponent must prepare a utilities management framework, to identify a management strategy for options, including relocation or adjustment of the utilities.	Section 9.10 and Appendix I
	3. The utilities management framework must identify ways in which opportunities to integrate with and support initiatives adopted by Councils and utilities providers and how access to assets will be maintained during construction.	Section 9.10 and Appendix I

Table A.3 Agency requirements – responses to the SEARs

Agency	Issues raised	Where addressed in the EIS
Ausgrid	A number of assets are located within the corridor and would potentially be impacted. These assets need to be accounted for in designs and during construction.	Section 9.10
	Specifically concerned with ensuring that safety risks associated with operating in the vicinity of high voltage cables is addressed.	Sections 9.10 and 25.3.2
Canterbury-Bankstown Council	Would like to be involved in the design to ensure that place making is captured in the design, including the development of urban design principles.	Chapter 4
	The project is a good opportunity to transform the Bankstown CBD and connect the CBD which is currently severed by the existing train line. This could include the provision of an at grade crossing of the corridor.	Table 7.5
	The project should include the provision of an active transport corridor which connects into existing active transport routes.	Section 8.1.4
	Concerned about impacts to business and the community during construction.	Chapter 17 and 18
	Flooding mitigation considered as part of the project should be based on future growth associated with the Draft Sydenham to Bankstown Urban Renewal and not existing flood conditions.	Sections 21.3 and 21.4
	Any over station development associated with metro should be considered as part of the Draft Sydenham to Bankstown Urban Renewal Strategy and not through the State Significant Development process due to reduced opportunities for sound place making.	Chapter 8
Department of Primary Industries and Department of Industry - Lands	Standard SEARs provided adequately addressed their requirements.	Tables A.1 and A.2
Environment Protection Authority	Standard SEARs adequately address their requirements.	Tables A.1 and A.2
Heritage Council of NSW	Standard SEARs provided are adequate with the exception of the below additional requirements:	Tables A.1 and A.2
	• Requirement for an assessment of the impacts to the broader heritage assets of the Sydenham to Bankstown Railway Line. This should include a history, assessment of significance of the broader Bankstown to Sydenham Line, and an assessment of its contribution to the heritage significance of the NSW suburban network.	Section 14.3 Technical paper 3 (Section 9.1)
	• Consider conservation approaches and rarity/integrity values of historic structures.	Technical paper 3 (Section 6)
	• Consideration of the Conservation Management Plans for all impacted items listed on the State Heritage Register.	Technical paper 3 (Section 6)
	• Consider alternate uses for heritage items no longer required for operational activities.	Sections 7.2.3 and 14.3.1
	• Consideration of the guideline, Assessing Significance for Historical Archaeological Sites and Relics.	Section 14.1.2 Technical paper 3 (Section 2.3)
	• Due to impacts on heritage (particularly at stations) key stakeholders should be consulted throughout the project.	Sections 4.3.2 and 14.4
Inner West Council	Fully independent access should be provided across the project including at station. This should not be limited to the stations only but the wider station precincts.	Chapter 8 and Section 11.4

Agency	Issues raised	Where addressed in the EIS
	A detailed accessibility report should be provided to examine each aspect of the travel journey from a best practice access perspective, to ensure functional and seamless independent provision to/from and within the surrounding precinct of each station.	A description of how accessibility has been incorporated into the design is provided in Chapter 7. Chapter 11 provides an assessment of impacts in terms of accessibility.
	Project should include flood management solutions rather than just saying negative impacts would be reduced.	Section 21.4
	The project should refer to the NSW Government WSUD Guideline (2016) for NSW transport projects.	The project would be designed to incorporate water sensitive urban design elements. Refer to Section 21.4.2.
	Contribution to climate change during both construction and operation. The project should include performance outcomes to minimise contribution to climate change during the works and in the final product.	Section 24.3
Office of Environment and Heritage	Identification and description of Aboriginal cultural heritage values that exist within the project area and the assessment of impacts on these areas of value. This should be guided by the *Guide to Investigating ,assessing and reporting on Aboriginal Cultural heritage in NSW (*DECCW, 2011). The assessment must demonstrate attempts to avoid impact upon cultural heritage values and identify any conservation outcomes. Where impacts are unavoidable, measures to mitigate impacts must be outlined. Any objects recorded as part of the assessment must be documented and notified to OEH.	Sections 15.2 and 15.3 The full assessment is provided as Technical paper 4.
	Consultation with Aboriginal people should be undertaken where high values are identified in accordance with the *Aboriginal cultural heritage consultation requirements for proponents 2010* (DECCW). The significance of cultural heritage values for Aboriginal people who have cultural association with the land must also be documented.	Section 15.1.3 and 15.4.1
	Biodiversity impacts to be assessed in accordance with the *NSW Biodiversity Offsets Policy for Major Projects 2014* and the Framework for Biodiversity Assessment, by a person accredited in accordance with s142B(1) of *the Threatened Species Conservation Act 1995.*	Chapter 22. The full assessment is provided as Technical paper 9.
	Impacts on the Long-nosed Bandicoot Inner Western Sydney Population (including an assessment of vehicle strike for more frequent trains and a loss of threatened species and their habitat not associated with vegetation) are to be considered in line with the requirements of the Framework for Biodiversity Assessment.	Section 22.2.2, 22.2.3 and 22.2.5. The full assessment is provided as Technical paper 9.
Sydney Water	Demands and servicing arrangements for drinking water, wastewater and recycled water to be considered.	Section 9.10.1
	Consideration of impacts on Sydney Water assets during both construction and operation. The proponent should seek confirmation from Sydney Water to ensure that the project does not impact on Sydney Water's assets. Landscaping options should avoid tree species that cause cracking or blockages to Sydney Water pipes.	Section 9.10.2

Agency	Issues raised	Where addressed in the EIS
	Ensure satisfactory protection for stormwater assets, building bridges over stormwater assets, potential flood, water quality, heritage impacts and creation of easements.	Sections 9.10, 21.3 and 21.4
	Flood mitigation assets and water quality for drainage into the Cooks River (and its tributaries) should be factored in as part of the project.	Section 21.4
	Impacts to Sydney Water owned State Heritage items, Sydenham Pit and Drainage Pumping Station and Sewage Pumping Station 271.	Section 14.3.2. Impacts to Sydenham Pit and Drainage Pumping Station would not occur as part of the project.
	Sustainability initiatives that would reduce the demand for drinking water including any proposed alternative water supply, proposed end uses of drinking and non-drinking water, demonstration of water sensitive urban design and any proposed water conservation measures should be outlined.	Sections 24.3.1, 24.4 and 24.5

Table B.1 Requirements of Schedule 2 (Part 3) of the Regulation

Requirement	EIS reference
6. Form of the environmental impact statement	
An environmental impact statement must contain the following information:	
(a) the name, address and professional qualifications of the person by whom the statement is prepared	Refer certification at the front of the EIS with respect to a-f
(b) the name and address of the responsible person	
(c) the address of the land: (i) in respect of which the development application is to be made, or (ii) on which the activity or infrastructure to which the statement relates is to be carried out	
(d) a description of the development, activity or infrastructure to which the statement relates	
(e) an assessment by the person by whom the statement is prepared of the environmental impact of the development, activity or infrastructure to which the statement relates, dealing with the matters referred to in this Schedule	
(f) a declaration by the person by whom the statement is prepared to the effect that: (i) the statement has been prepared in accordance with this Schedule, and (ii) the statement contains all available information that is relevant to the environmental assessment of the development, activity or infrastructure to which the statement relates, and (iii) that the information contained in the statement is neither false nor misleading.	
7. Content of environmental impact statement	
(1) An environmental impact statement must also include each of the following:	
(a) a summary of the environmental impact statement	Executive summary
(b) a statement of the objectives of the development, activity or infrastructure	Chapter 28
(c) an analysis of any feasible alternatives to the carrying out of the development, activity or infrastructure, having regard to its objectives, including the consequences of not carrying out the development, activity or infrastructure	Chapter 6
(d) an analysis of the development, activity or infrastructure, including: (i) a full description of the development, activity or infrastructure, and	Chapters 8 and 9
(ii) a general description of the environment likely to be affected by the development, activity or infrastructure, together with a detailed description of those aspects of the environment that are likely to be significantly affected, and	Chapter 2 and Part C
(iii) the likely impact on the environment of the development, activity or infrastructure, and	Part C
(iv) a full description of the measures proposed to mitigate any adverse effects of the development, activity or infrastructure on the environment, and	Part C
(v) a list of any approvals that must be obtained under any other Act or law before the development, activity or infrastructure may lawfully be carried out	Chapter 3
(e) a compilation (in a single section of the environmental impact statement) of the measures referred to in item (d) (iv)	Chapter 28
(f) the reasons justifying the carrying out of the development, activity or infrastructure in the manner proposed, having regard to biophysical, economic and social considerations, including the principles of ecologically sustainable development set out in subclause (4).	Chapter 28

SYDENHAM TO BANKSTOWN

ENVIRONMENTAL IMPACT STATEMENT

> Volume 1B