4.0 Construction Phase Assessment Methodology

4.1 Overview

The methodology for the assessment of the project construction impacts included:

- assessing the potential construction impacts on the road network
- consideration of pedestrian routes in close proximity to construction activities
- consideration of cycle and pedestrian movements on routes proposed for construction haulage
- consideration of route diversions for scheduled bus services
- reviewing existing peak period operating conditions for key intersections in the vicinity of the proposed worksite
- assessing the impacts on pedestrians, cyclists and road users resulting from diversions required during construction activities on bridges over the project area
- assessment of the impact of the replacement buses required during the possession periods of the construction program
- forecasting of construction period traffic flows and assessment of effects, including replacement buses and route diversions through intersection modelling and estimating future Degree of Saturation (DoS) and Level of Service (LoS)
- assessment of the effects to route and additional delays to road users
- potential impacts of construction works on pedestrian, cyclist and motorist safety, major special events, emergency vehicles and power supply routes
- cumulative assessment that considers approved construction projects adjacent to the project.

As such the assessment has considered the potential impacts of construction on all modes of transport within the vicinity of the project.

The assessment of traffic and transport impacts of the project once operational is presented in Chapter 8.

4.2 Construction Haulage Traffic

The construction haulage traffic impact assessed comprises of trucks, delivery vehicles and light vehicles for station compounds and the wider project worksite. This section sets out the anticipated construction haulage vehicle traffic generation arising from the planned construction activities along the project alignment and within the station compounds. The key assumptions regarding vehicle types, volumes operating hours, and routes are set out, with the assumed traffic generation feeding into the impact assessment section below.

4.2.1 Construction Vehicle Types

The anticipated construction haulage vehicle numbers are based on the following assumed truck types:

- single unit truck, 12.5 metres long for all project worksite entrances/gates and compounds
- light construction vehicles for all station compounds.

Whilst not within the current construction assumptions, the use of truck and dog combinations would reduce the total number of vehicles. Should these vehicles be proposed, additional swept path analysis would be required for the sites being served by these vehicle combinations.

Under the Heavy Vehicle National Law (NSW) a heavy vehicle is defined has having a gross vehicle mass of more than 4.5 tonnes. Within this Technical Paper, a light vehicle is classified as any vehicle equal to or less than 4.5 tonnes.

4.2.2 Construction Hours

Proposed construction hours are shown in **Table 4.1**. The majority of the construction activities would be carried out during the following hours (except during track possessions):

- Monday to Friday – 7am to 6pm
- Saturday – 8am to 1pm.

As the project is located within an active rail corridor, works outside of standard construction hours would be required where works cannot safely be undertaken without restrictions to train operations. These activities would take place during non-peak periods, and could include full closure of the rail operations known as 'possessions'. Construction activities to be carried out during the scheduled track possessions would occur over the entire 24 hour period.

The possession periods can be summarised as follows:

- **Standard possession -** possession on the line on weekends on four occasions over the year
- **Additional possession** – additional weekend possessions as required, over and above the standard periods
- **School holiday possessions** – planned during each **December and January** school holiday period, including public holidays between 2019 and 2024. Further **2 week school holiday possessions** in July each year
- **Final possession** – between 3 to 6 months possession at the end of the construction phase.

The indicative program of possessions (longer than the standard weekend possessions) is shown in **Figure 4.1**.

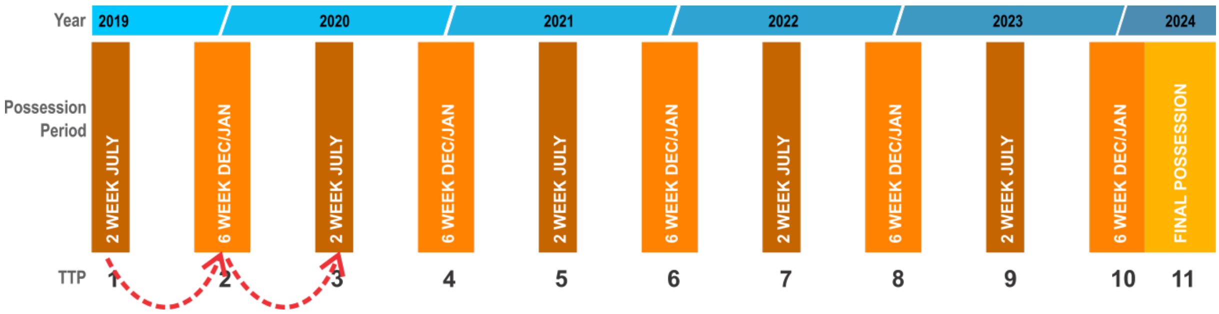

Figure 4.1 Indicative Program of Possessions

It is noted that there are other construction activities which are programmed or likely to occur in parallel with the project implementation. These schemes may result in cumulative impacts, adding additional construction haulage traffic onto existing routes or requiring additional closures. The impacts of these projects and locations are discussed in Chapter 10.

It should be noted that additional works on Sundays and Public Holidays would occur during possession periods as outlined above. These Sunday and Public Holiday works may require separate approval from various authorities, and would be communicated to relevant stakeholders well in advance of commencement.

It is therefore assumed for the purposes of the analysis that all the materials are delivered on the basis of a four year construction period, with five working days as a conservative assessment. Additional working on a weekend would reduce the daily movements below that assessed.

Table 4.1 Anticipated construction hours

<table>
<tr><th></th><th colspan="3">Non possession</th><th colspan="3">Possession period works</th><th colspan="3">Complete close-down and conversion</th></tr>
<tr><th>Site</th><th>Construction works</th><th>Spoil haulages, heavy plant and deliveries</th><th>Oversize/ wide load deliveries</th><th>Construction works</th><th>Spoil haulages, heavy plant and deliveries</th><th>Oversize/ wide load deliveries</th><th>Construction works</th><th>Spoil haulages, heavy plant and deliveries</th><th>Oversize/ wide load deliveries</th></tr>
<tr><td>Marrickville Station</td><td rowspan="10">Standard hours: Monday to Friday (7am to 6pm) Saturday (8am to 1pm)</td><td rowspan="10">Standard hours: Monday to Friday (7am to 6pm) Saturday (8am to 1pm)</td><td rowspan="10">Non-peak hours</td><td rowspan="10">24 hours/ day during possession</td><td rowspan="10">24 hours/ day during possession</td><td rowspan="10">24 hours/ day during possession</td><td rowspan="10">24 hours/ day during possession</td><td rowspan="10">Standard hours: Monday to Friday (7am to 6pm) Saturday (8am to 1pm)</td><td rowspan="10">Non-peak hours</td></tr>
<tr><td>Dulwich Hill Station</td></tr>
<tr><td>Hurlstone Park Station</td></tr>
<tr><td>Canterbury Station</td></tr>
<tr><td>Campsie Station</td></tr>
<tr><td>Belmore Station</td></tr>
<tr><td>Lakemba Station</td></tr>
<tr><td>Wiley Park Station</td></tr>
<tr><td>Punchbowl Station</td></tr>
<tr><td>Bankstown Station</td></tr>
</table>

4.2.3 Spoil Haulage Options

Spoil from the project construction would be removed using the road network. An assessment has been made of the construction access /egress gates and an initial review has shown that these are all considered feasible. All access gates facilitating access to the project construction zone are within close proximity to the motorway / main State Road network. Trucks hauling spoil would use the same routes as construction haulage vehicles. A more detailed assessment is included in Chapter 5 of this Technical Paper.

The use of freight rail to move materials has been considered and was discounted owing to the limited track capacity to cater for additional engineering trains that can carry spoil within the constrained schedule. Up to three trains would be required concurrently for spoil removal. The issues with speed of work required at the project worksite and compounds, limited availability of rolling stock, scheduling constraints and the large geographic spread of the worksite and compounds in the project area make this option unviable.

4.2.4 Construction Haulage Routes

Construction Haulage routes to and from the construction compounds and access gates to the project area have been developed with the following aims:

- use local or residential streets only for direct access to compound locations. Local streets would only be used where there is no other suitable alterative to deliver or remove materials for a particular section of the works
- minimise potential safety impacts for pedestrians, cyclists and other road users
- maximise the use of the State Road network.

Construction Haulage routes have been categorised as follows:

- primary routes forming the main access for construction haulage vehicles
- secondary routes providing links to the primary route and to State Roads
- tertiary (alternative) routes used as a back-up route to connect to the primary and secondary routes.

Routes were then mapped for each station and are presented in Chapter 5.

4.2.5 Construction Haulage Traffic Volumes

The volume of materials required to be moved to and from each construction compound has been analysed to estimate the duration of construction and the total number of haulage vehicle movements required. A flat profile of haulage vehicle movements per day has been assumed and a process of manual assignment of haulage vehicle movements to peak hours has been undertaken. Where daily haulage vehicle volumes to a compound are low (less than 10 per day), all haulage movements are assumed to take place during the peak hours. Where there are 10 or more haulage vehicles per day, 20% of the vehicle movements have been assigned to each of the peak hours. Forecast construction haulage traffic volumes are included in **Appendix C**.

As the compounds are all relatively constrained in size, there is a practical limitation on the concurrent activities that can occur within the sites, and the vehicle movements are anticipated to be correspondingly low compared with much larger sites. As such the indicative programme assumed for the purposes of this assessment has addressed this by assuming that for compounds with greater volumes of materials the duration of works would be longer. Therefore whilst the assessment has been built from the specific volumes of materials, at an hourly and daily level there is a similarity in the generated vehicles.

In some station locations construction activities would occur across multiple compounds. The peak generation of each individual compound has been assessed within the intersection analysis, although the differing nature of the works to be undertaken at each compound would mean that the peaks would not be co-incidental.

4.2.6 Construction Worker Parking

Given the nature of construction works and extended construction duration, limited on-site construction worker parking would be provided at each site compound (per station). Each construction site would typically provide 10 parking spaces for engineers, other management staff and trades.

All of the construction compounds are located in close proximity to public transport services and construction workers would be encouraged to use these services. A "Travel Demand Management" strategy would be implemented for construction worker parking demand which would seek to incentivise the use of public transport during non-possession periods.

Options considered may include:

- use of rail services
- shuttle bus transfers to worksites, particularly during possession periods
- use of existing under-utilised car parks in association with shuttle bus transfers.

Whilst the above measures may limit the number of construction workers who drive into the project area during the construction period, it is recognised that there would be a proportion of workers who drive and park in the vicinity of the compounds. Whilst the peak construction worker numbers coincide with the shutdown periods, and therefore an expected drop in commuter parking, consideration is given to the availability of nearby commuter parking within the assessment of effects in the subsequent Chapters.

4.2.7 Pedestrian, cyclist and motorist safety

The introduction of additional heavy vehicles to the network has the potential to result in safety impacts to pedestrians, cyclists and other motorists, especially where there is an increased likelihood for interaction with pedestrians and cyclists. Key locations where pedestrian, cyclist and motorist safety issues may arise include:

- construction compounds where access and egress points, or haulage routes would interface with pedestrians using surrounding footpaths and / or cyclists using marked cycle routes;
- areas where footpath widths are reduced around the construction compounds and worksites; and
- diversion routes for pedestrian and cyclists during bridge works and closures required.

Areas where there is likely to be increased interactions between cyclists, pedestrians, motorists and heavy vehicles as a result of the construction works are identified and assessed in Chapters 5 and 6.

Access and egress arrangements at construction compounds have been developed with consideration for pedestrian, cyclist and motorist safety. For example, the need for construction vehicles to turn right to or from State Roads to access construction sites has been avoided where practicable.

Appropriate controls would be established where vehicles are required to cross footpaths to access construction sites. This may include manual supervision, physical barriers or temporary traffic signals as required. Safety audits would be carried out at each of the construction compound traffic access and egress points. In addition, Sydney Metro City & Southwest is currently investigating options to further enhance pedestrian, cyclist and motorist safety in the vicinity of the construction worksite. This would include measures such as:

- use of speed awareness signs in conjunction with variable message signs near construction sites to provide alerts to drivers
- shared experience educational events that allow pedestrians, cyclists or motorists to sit in trucks and understand the visibility restrictions of truck drivers, and for truck drivers to understand the visibility from a bike
- specific construction driver training to understand route constraints, expectations, safety issues and to limit the use of compression braking
- safety devices on construction haulage vehicles that warn drivers of the presence of a vulnerable road user located in the vehicles' blind spots and warn the vulnerable road user that a vehicle is about to turn.

4.3 Bridge Works

The assumed scope of the bridge works required is based on a review of the bridge assets along the project alignment and an assumption of work made for the purposes of the traffic and transport impact assessment.

The review assessed 27 bridges, which included 17 overbridges, three footbridges and 7 underbridge structures.

The majority of the bridges were designed before the release of current collision standards (Australian Standard 5100 Bridge Design).

Some bridges were constructed at the turn of the century; with the most recent bridge structures being typically over 40 years old, and even these require upgrades to conform to the current structural standards. The bridge works do not seek to achieve full compliance with the standard, as this is considered impractical, but instead seek to provide an acceptable level of compliance.

4.3.1 Approach

The scope of bridge works for this assessment was determined in consultation with Transport for NSW and their construction advisers. A Bridge Works Assumption Memo that formed the basis of the bridge works assessment is included in **Appendix D.** This includes commentary regarding the temporary traffic management, duration of traffic management, diversion routes and necessity for modelling..

The bridge works assessment includes intersection operations during partial and full road closures and the re-directed traffic resulting.

Key underlying assumptions to the bridge works impact assessment are:

- no bridges require closures longer than eight months
- multiple bridges within close proximity to each other would not be closed simultaneously
- bridge works undertaken at or adjacent to stations during possessions, would be undertaken to avoid interaction with the refined baseline TTP bus routes..

The bridges were considered in two distinct sections; between west of Sydenham in the project area to Belmore, and between Belmore to Bankstown within the project area. A different set of assumptions are relevant for each section, as outlined below:

Between Sydenham to Belmore

- works would occur during ARTC shut down periods, where a possession is required to complete the works and therefore would not occur during school holiday periods
- bridge works requiring continuous shut down periods of longer than two days are assumed to have a significant impact on traffic and would be modelled to assess the effects
- bridge works requiring continuous shut down periods not exceeding two days would only occur during weekend and night works. Diversion routes have been identified, but it is assumed that these weekend / evening closures would have detailed Temporary Traffic Management plans prepared prior to construction and do not require modelling
- all works to bridges that do not carry motorised traffic (such as pedestrian or rail overbridges) are not expected to impact the road network
- bridges directly adjacent to each other cannot be programmed for upgrade at the same time.

Between Belmore to Bankstown

- bridge works undertaken at or adjacent to stations during possessions, would be undertaken to avoid interaction with the refined baseline TTP bus routes.
- for works on all of the bridges between Belmore and Bankstown, with the exception of Punchbowl Road Overbridge and Chapel Road Overbridge, it has been assumed that these works would continue for six to eight months, with two weeks of half or full road closures and the remaining construction occurring during weekends/nights

- Punchbowl Road Overbridge and Chapel Road Overbridge are assumed to have no effect on traffic as no lane closures would be required
- bridges directly adjacent to each other cannot be programmed for upgrade at the same time.

The diversion routes and traffic impacts are explained in Chapter 6. Potential closures and diversion routes are indicative, based on the current stage of the design. Further detailed assessment would be undertaken in the future, if required, when a more detailed construction strategy and program has been developed and to inform the specific construction traffic management plans for the sites.

4.4 Temporary Transport Strategy

The Temporary Transport Strategy (TTS) is an overarching document that describes the process for planning and delivering the integrated, multi-modal temporary transport response that would operate during possession period shutdowns on the Bankstown Line. This strategy is included in **Appendix E**.

For each possession, a Temporary Transport Plan[11] (TTP) would be developed that would detail the initiatives that would be implemented to assist customers affected by closures of the line and its stations. The TTS provides the guiding document for the development of the TTPs. The TTPs would be developed prior to construction and would be informed by stakeholder and community feedback. Each successive TTP would improve on the previous plan, based on further understanding of customer needs and ongoing development of alternatives.

Each TTP would identify:

- Impacts on other modes

  The Temporary Transport Plan would provide a forecast of how those customers using the Bankstown Line before its closure would travel during the possession periods. In addition to the range of customer demand forecasts for each temporary bus route, the outputs from TfNSW's Public Transport Project Model (PTPM) would also include impacts on other modes including the regular bus network.

- Impacts on the regular bus network

  An assessment of the change in demand for regular bus services would be undertaken. Where increases in demand are identified, the analysis would determine whether sufficient capacity exists on each route, and whether additional services may be required to prevent overcrowding.

- Impacts on road network performance

  The closure of the Bankstown Line and the provision of temporary bus services would impact the performance of the road network through a combination of the number of buses required to provide temporary bus services, and the decisions some customers might make to drive to their destination or to drive to a different station to access the rail network by park and ride or kiss and ride. Each TTP would quantify the potential increase in traffic resulting from the closure of the Bankstown Line.

  Traffic modelling would be undertaken to assess these impacts on general traffic and on the operation of the temporary bus services. This would involve the modelling of key intersections and the development of options to improve their performance, such as modifying how the intersection operates, or by changing the routes that temporary bus services take between stations to avoid congested intersections.

- Impacts on parking demand

  The temporary closure of the Bankstown Line would affect the demand for parking at stations along the Bankstown Line, and at stations on the parallel rail lines where people may choose to drive to instead. The PTPM would provide an estimate of the changes in demand for park and ride at all stations, allowing an assessment of locations where intervention may be required to mitigate the impact of increased demand.

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[11] Temporary Transport Plans, as referenced in this document, are now referred as Temporary Transport Management Plans in the EIS main report and other technical papers.

- Impact on parking provision

  Parking areas along the corridor may be affected by construction activities and the need to provide temporary bus stops. This may affect both designated dedicated commuter parking spaces and general kerbside parking.

  Each TTP would identify what changes would be required to parking arrangements during each possession, potentially including:

  - the temporary conversion of dedicated commuter car parking spaces and/or kerbside parking spaces at some Bankstown Line stations to full-time bus zones to accommodate customer and operational needs of the TTP buses. This occurs at present during weekend possessions when rail replacement bus services are provided
  - reducing the available hours of kerbside parking spaces at or near selected train stations so that the spaces can operate as a bus zone at certain times of high demand to accommodate customer and operational needs of the TTP buses
  - the provision of temporary park and ride facilities at other locations within the Bankstown Line catchment, supported by temporary bus routes to connect to rail stations on the parallel rail lines
  - extended or new clearways (with some additional temporary parking losses) to allow buses and other traffic to operate safely
  - trimming of trees where buses are proposed to operate in the kerbside lanes, where trees currently overhang in the operating area
  - traffic signal phase changes at some interactions.

  In addition, the TTP includes the provision of additional bus services to stations on parallel lines. These would inevitably require bus stop / layover space which may displace parking spaces. This would be described, assessed and mitigated where possible, when the final suite of TTPs is prepared. It is not possible to assess these impacts now as the number of buses required has not been quantified, or the routes and destinations confirmed. Final changes required would be determined during detailed design and construction planning, and would be subject to additional impact assessment if required.

- Impacts on active transport

  Each TTP would consider the potential impacts of the Bankstown Line closure on cyclists and on pedestrians, including:

  - identifying the extent to which cyclists and pedestrians may divert to stations on the parallel rail lines
  - assessing the availability and capacity of end-of-trip facilities at stations which may attract increased numbers of cyclists; and
  - assessing the suitability of existing cycle and pedestrian infrastructure to support diverted demand to/from other stations, or for customers who may choose to cycle or walk to their destination rather than use temporary bus services.

  To assist the preparation of this aspect of the Temporary Transport Plans, Sydney Metro is developing a cycling strategy to assist existing cyclists affected by closures of the Bankstown Line, and to promote cycling as an alternative mode of transport during closures.

  Each TTP would consider the following initiatives:

  - temporary train service plans that provide additional capacity on other rail lines where affected customers may be diverted to, and altered services on sections of the Bankstown Line that are not being converted to Metro operations
  - integrated temporary bus services to allow customers to travel between stations on the Bankstown Line, and to stations on the other lines. This includes understanding the opportunities that the regular bus network can provide

- planning specialised services for customers who may not be able to use the temporary bus services, such as those with mobility impairments or other special needs
- initiatives to encourage and assist customers to walk or cycle to stations on other lines, or to their destinations
- infrastructure to support temporary bus services including bus stops and shelters, improvements to walkways and lighting, and wayfinding and information signage
- improvements to the road network, such as bus priority measures to support the temporary bus services, and adjustments to traffic signals to mitigate changes in road network demand
- understanding the changes in demand for parking near rail stations, the impacts this may cause and measures to manage those impacts
- customer and stakeholder engagement strategies, including communication, information provision and supporting travel demand management initiatives.

A number of different approaches are available for providing temporary bus services. Each approach would form a component of the overall temporary bus service plan. These components, shown schematically in **Figure 4.2**, are:

- buses that stop at all stations along the corridor (component 1)
- buses that only stop at a limited number of stations before continuing an express service another station (component 2)
- buses that move passengers to another rail line such as the T2 Airport Line and the T2 South and Inner West Line (component 3)
- increasing the frequency of regular bus services at specific locations, acknowledging that customers may prefer to use those instead of the temporary bus route service (component 4).

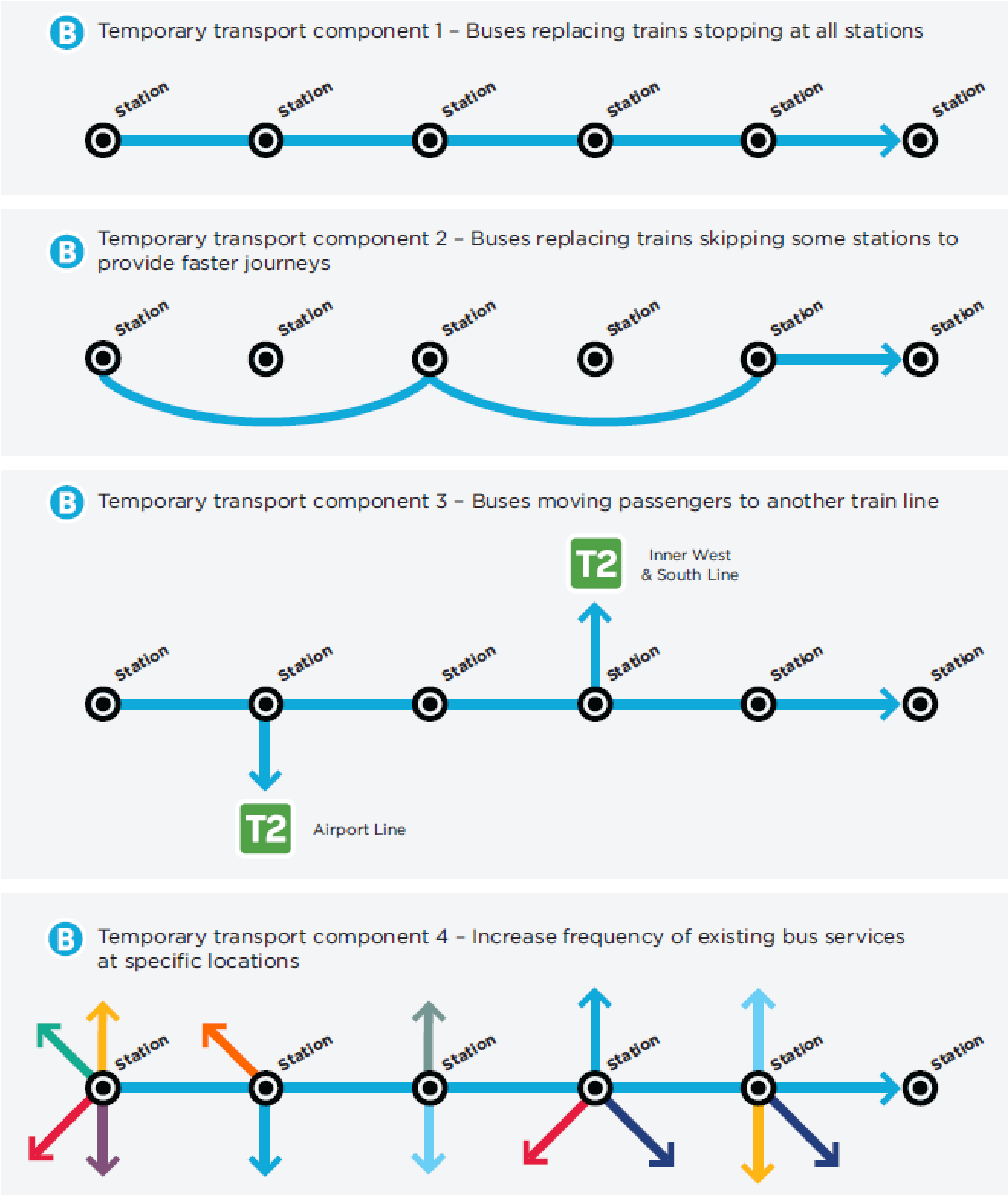


Figure 4.2 Temporary Transport Components

For the purposes of assessment, a Baseline TTP has been developed (refer also to **Appendix E**) which includes component 1 and component 2 as illustrated in **Figure 4.2**.

The Baseline TTP closely emulates the rail replacement bus services that are provided during scheduled weekend possessions that occur several times each year when maintenance activities occur.

By definition the Baseline TTP provides bus routes for customers that travel along the Bankstown Line corridor, with destinations in the CBD or beyond, to Sydenham Station to transfer to train services operating on the T2 Airport Line and T4 Illawarra Line. Minor adjustments have been made to the weekend service plan, to better serve the volume of customers travelling during weekday peak periods. It is assumed that the current regular scheduled bus routes would continue to operate as per normal unless required to divert as a result of other project construction works.

The Baseline TTP consists of four temporary bus routes as shown in **Figure 4.3**:

- Route 1: Lidcombe to Sydenham, all stations. This provides consistent, all-hours service during each possession between Sydenham and Lidcombe. During some possessions, the route may only need to travel to Sefton or Regents Park instead of Lidcombe
- Route 2: Bankstown to Sydenham, via Punchbowl, Wiley Park and Lakemba. This limited-stops route provides a reduced travel time for customers travelling from Bankstown, Punchbowl, Wiley Park and Lakemba
- Route 3: Belmore to Sydenham, via Campsie and Canterbury. This route only stops at Campsie and Canterbury when travelling from Belmore to Sydenham. It provides a reduced travel time and increased service reliability for customers travelling from Belmore, Campsie and Canterbury
- Route 4: Hurlstone Park to Sydenham, via Dulwich Hill and Marrickville. This route only stops at Dulwich Hill and Marrickville when travelling from Hurlstone Park to Sydenham. It provides increased service frequency, reliability and capacity for customers travelling from these stations.

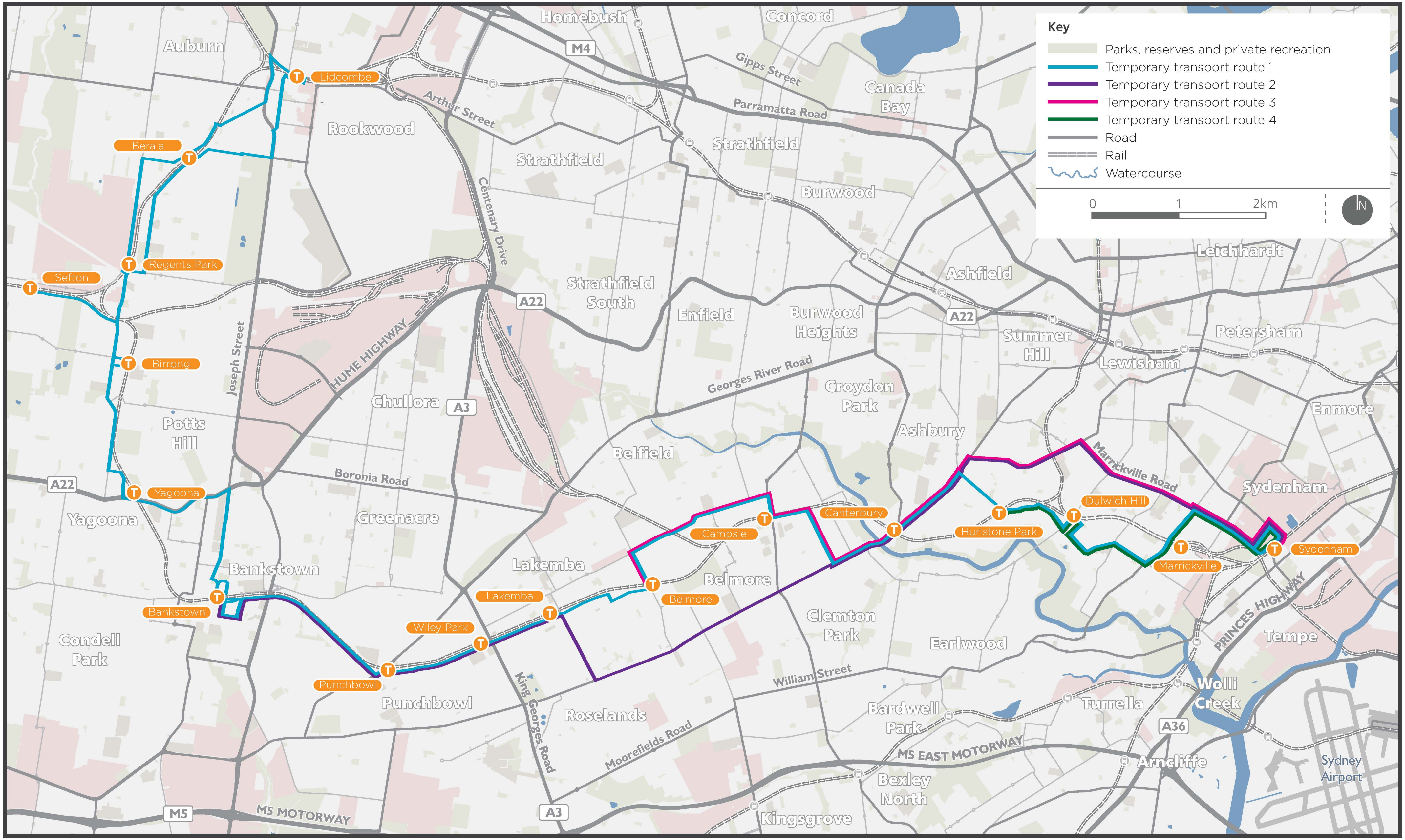
Analysis of the Baseline TTP showed that across the four routes, at least 101 bus services per hour would be required to travel in the inbound direction to Sydenham Station during the weekday AM peak period. **Table 4.2** below shows the required service frequencies for each temporary bus route.

Table 4.2 Required minimum temporary bus route frequencies for AM peak hour (TTS, Appendix E)

Route	Description	Minimum Inbound Frequency	Minimum Outbound Frequency
1	Lidcombe to Sydenham, all stations	11 buses per hour	10 buses per hour
2	Bankstown to Sydenham, via Punchbowl, Wiley Park and Lakemba	33 buses per hour	10 buses per hour
3	Belmore to Sydenham, via Campsie and Canterbury	35 buses per hour	10 buses per hour
4	Hurlstone Park to Sydenham, via Dulwich Hill and Marrickville	22 buses per hour	10 buses per hour

All planned possessions of the Bankstown Line require the closure of all stations from Marrickville to Punchbowl. Additionally, some possessions would also require the closure of Bankstown Station, Yagoona Station and Birrong Station, and changes to how stations between Liverpool and Lidcombe are serviced. During such possessions, temporary bus services would need to extend west from Bankstown Station, to Lidcombe Station and/or Sefton Station, depending on the nature of the line closure during a particular possession. The Baseline TTP responds to this more extensive closure scenario and the impact of the Baseline TTP buses travelling to Yagoona, Birrong, Regents Park and Lidcombe has been assessed (approximately 11 buses per hour per direction).

Erskineville and St Peters stations are currently serviced by the T3 Bankstown Line. During possession periods an alternative train working timetable may be implemented which could result in these stations being serviced by either the T4 Illawarra Line or the T2 Airport Line via Sydenham Station.



sydney METRO | city & southwest

Baseline TTP bus routes

FIGURE 4.3

Although there is a potential variant of Route 1 that would call at Sefton, the frequency of this service would be low and its impact has not been quantitatively assessed. At Berala, bus flows are uni-directional movements occurring on separate roads to either side of the station where local intersections are unsignalised, and consequently the low one-way flows of 11 buses per hour have not been quantitatively assessed.

Analysis of the baseline TTP is presented in Chapter 5 and Chapter 6 and shows that the large volume of buses would impact the performance of the road network.

Effectively, the Baseline TTP represents the worst case scenario. The assessment of this TTP determines the need to mitigate these impacts by adding bus services that allow some customers to travel to their destinations without travelling to Sydenham Station.

A Refined Baseline TTP has been tested to assess an alternative rail replacement strategy to convey passengers west of Campsie to parallel rail lines and reduce the impact on intersections between Dulwich Hill and Marrickville. The changes to the Baseline TTP are as follows:

- Route 1: Increased frequency to account for the reduction in service resulting from the changes to route 4
- Route 2: Removed due to the reduced eastbound demand following conveyance to parallel rail lines
- Route 3: Reduced frequency of buses and shortened route (to begin at Campsie instead of Belmore) due to the reduced eastbound demand following conveyance to parallel rail lines
- Route 4: Minor localised route alteration to bypass Marrickville Station and travel via Wardell Road. This is to reduce the impact on a number of intersections on the road network linking Dulwich Hill and Marrickville Station.

This would be achieved by adding routes that travel to other rail lines (component 3) and increasing the frequency of regular bus routes (component 4). Additionally, options would be developed for the routes that do need to travel to Sydenham Station, to travel along different roads in order to reduce the impact on any one road or intersection.

As each TTP is developed, its impact on the road network would be assessed in the same manner as the Baseline and Refined Baseline TTP. Learnings from previous assessment would be applied to develop continuous improvements in TTPs, reducing network impacts by:

- better estimating the service levels required and patronage expectations
- applying a greater understanding of mode shift and alternate routes and travel times
- improving the accuracy of TTS services to be more closely matched to demand avoiding over provision of TTS vehicles
- monitoring intersection performance and any route pinch points to allow alternate routes to avoid specific locations
- finessing of signalled intersection timings to match the additional TTS vehicles
- improving the communication and notification of the TTPs to pedestrians, cyclists, Sydney Train, other public transport customers and road users.

The feasibility of providing the required bus stop and passenger waiting areas would be addressed during the development of each TTP, when further detail of the service frequencies and routes of the replacement buses is available. This would include the assessment of the effects of parking at stations to facilitate the TTP, and also the effects on parking at impacted stations on the T3 line and other parallel routes. Operational requirements to cater for the specific TTP such as layover areas would also be assessed as the TTP is developed.

Blending the observations from earlier implementations of the TTS with updated modelling from the PTPM would provide greater certainty in the anticipated impacts, and thereby the development of more resilient and comprehensive mitigation strategies.

4.5 Intersection Assessment Methodology

4.5.1 Overview

The project includes the upgrade of 10 stations from Marrickville to Bankstown to improve accessibility before conversion to Metro Standards. Six additional railway stations have also been considered in the assessment of potential construction impacts, including Sydenham Station and those on the T3 Bankstown line west of Bankstown. Whilst these stations would not be upgraded as part of this project, the rail services would be suspended at times during construction and so there would be transport related effects in these locations.

Intersections likely to be impacted by the project were selected following consideration of:

- those that would be impacted by the replacement buses during possessions (Baseline TTP and refined baseline TTP) bus routes, refer to **Section 4.5**), construction haulage routes and construction compounds and other worksite access points in the project area
- precinct information (road hierarchy, bus volumes, proximity to the station and key intersections)
- intersection form (e.g. signalled, roundabout, priority)
- road classifications, i.e. avoiding use of local streets to the extent practicable
- bus routes and volumes
- bridge diversion routes.

A total of 75 intersections were selected for detailed assessment with modelling using SIDRA 6.1 or LinSig (two widely used software tools) to assist in the quantitative assessment of capacity and the potential delay at these intersections that may result from the construction of the project.

The assessment of traffic conditions during construction considered the impact of the TTS, construction haulage vehicles and bridge diversion routes.

The assessment considered the following scenarios:

- 2016 Existing conditions, based on collected traffic volume data (refer to **Section 4.5.2**)
- 2023 Future conditions, based on an applied traffic growth rate (refer to **Section 4.5.3**), as well as the following analysis of the 2023 future conditions:
  A. 2023 Future Conditions Base Model as the reference case
  B. 2023 Future Conditions + Construction haulage traffic
  C. 2023 Future Conditions + Construction haulage traffic + Temporary Transport Strategy (TTS) Baseline TTP buses (Baseline TTP)
  D. 2023 Future Conditions + Construction haulage traffic + Refined Baseline Temporary Transport Plan buses (Refined Baseline TTP)
  E. 2023 Future Conditions + Construction haulage traffic + bridge works impact and traffic rerouting.

The Refined Baseline TTP is based on the premise that customers located west of Campsie would be conveyed to stations on parallel lines, reducing the volume of buses east of Campsie. The alternative scenario also reduces the number of buses on the road network connecting Dulwich Hill and Marrickville Station to reduce the effect on the intersections in that area.

Scenarios C and E above were considered to represent the worst case scenarios. It should be noted that bridge works which have a duration beyond a weekend / evening are assumed to occur outside of the possession periods (ie no TTP).

The project is being delivered in a constantly changing landscape, with multiple concurrent projects being planned, constructed and coming into use. This includes changes to land use, transport networks for both car and other modes, and commercial developments. The timescales of many of these are unknown at this time, and the overall duration of the project construction of around six years is such that there are many interdependencies and opportunities that would require management as the project evolves.

As with all construction activities, co-ordination with other temporary works, events and planned maintenance would be required as part of the mitigation of effects, and this would include known projects such as WestConnex and Chatswood to Sydenham component of the Sydney Metro. A cumulative assessment, considering the potential overlap of these projects, is provided in Chapter 10.

4.5.2 Precinct Information

The existing land use and transport patterns were reviewed, to provide additional context to the areas surrounding the stations. This assisted with the selection of the routes and intersections that required specific assessment for each station precinct. Existing land use and travel patterns contained in the "Precinct Land Use and Infrastructure Analysis" (NSW Govt. 2015) were used to identify the key intersections in the precinct and these were then modelled. Reference should be made to chapter 2 and 3 of this technical paper and Chapter 15 Land use and property of the EIS for further context on land use.

4.5.3 Traffic Volume Data

Existing traffic volumes and approach queues were surveyed for the project during April to November 2016 for key intersections. The traffic surveys contained lane by lane 15-minute counts with separate classification of light vehicles, heavy vehicles, buses, pedestrians and cyclists. Sydney Coordinated Adaptive Traffic System (SCATS) traffic signal data was also provided by Roads and Maritime Services (RMS) for all of the signalised intersections.

Sources for traffic volumes included:

- traffic surveys commissioned by AECOM
- traffic surveys provided by the Transport for NSW Technical Advisor (TA)
- base models of select intersections from the TA
- SCATS data from RMS.

This information was used to develop 2016 base models for all intersections (refer to **Section 4.5.1**) with the observed data summarised in **Appendix A**.

4.5.4 AM and PM Peak modelling

Table 4.3 displays RMS traffic count information at sites near stations to demonstrate the difference between peak hour and non-peak hour traffic flows. It should be noted that some of the count data is of varying age, collected over several years since 2009 and up 2014. While the traffic flows may have changed), this data provides an indication of the relative reduction in traffic flows experienced in the off peak periods.

Table 4.3 Peak and Off Peak Traffic Flows[12]

RMS Count Site	Average Hourly Flows (2-Way)		Difference between maximum of AM PM Peak flows and off-peak flows:		
	AM Peak	PM Peak	Day time Interpeak traffic flows	Night-time traffic flows	Weekend Traffic Flows
43236 - Fairford Road	3,990	4,898	-16%	-49%	-20%
24008 - King Georges Road	3,333	4,033	4%	-27%	10%
18032 - Railway Road	1,319	1,529	-5%	-54%	-9%
24212 - Wardell Road	1,620	1,557	-36%	-73%	-27%
24213 - Canterbury Road	2,777	3,088	-16%	-61%	-14%
24214 - Brighton Avenue	1,362	1,259	-25%	-69%	-20%
19041 - Illawarra Road	1,392	1,270	-40%	-77%	-32%

From **Figure 4.3** it can be seen that traffic flows in the interpeak period can be as much as 16% to 40% lower than traffic flows in the highest peak period. An exception to this rule is the count site at King Georges Road, which experiences marginally greater flows in the interpeak period. Consideration of traffic impacts in this report has focused on peak times when demands are generally greatest to provide worst-case modelling for the intersections. Off peak periods are generally characterised by lower traffic flows and reduced network demand. Possession periods are mostly timed to be during periods of reduced network demand. This would greatly assist in managing impacts on the network from construction work undertaken during these periods.

Weekend traffic flows are generally between 10% and 30% lower than weekday peak flows, with the count site at King Georges Road again being the exception with a 10% increase in traffic flows at the weekend. For the vast majority of locations, undertaking works at the weekend would reduce traffic impacts. The more specific impacts of out of hours and weekend works would be considered further during the development of traffic management plans, when scheduling and construction haulage traffic volumes would be known and details of traffic flows in the surrounding areas at any particular time would be more fully understood.

4.5.5 Traffic Growth

A growth factor was applied to the 2016 base models to reflect forecast land use and traffic behavioural changes that would occur over the course of the construction of the project.

A comparison between the Public Transport Project Model (PTPM), which is an incremental multi-modal model (including a strategic highway component), and RMS's Strategic Traffic Model (STM) was made by WSP | Parsons Brinckerhoff in September 2016. Both models use EMME software. The growth factors are similar for the PTPM and STM (1.4% p.a. AM Peak for PTPM and 1.2% p.a. AM Peak for STM, and both have 1.5% p.a. in the PM Peak). As the PTPM has the most up to date land use assumptions for this corridor, it was considered the most appropriate model to estimate the changes in transport behaviour for this assessment.

The growth factor used for the 2023 future model was the PTPM growth rate, which adopts the overall growth rate for car-driver trips from the PTPM strategic model. This was applied as a global increase (1.4% p.a. in the AM peak and 1.5% p.a. in the PM peak).

[12] AM and PM Peak flows are the highest recorded flows for any 60 minute period pre or post noon. The daytime Interpeak is the highest flows in 60 minutes between 10am and 3pm, and weekend flows are peak 60 minute flows on Saturday or Sunday..

Adopting a blanket traffic growth rate would not account for specific issues on the local road network which may arise as traffic growth occurs across the local network. For example, as the road becomes more congested drivers may choose to divert to other routes or transport modes or re-time their trip. To account for this:

1. The intersections were modelled using surveyed traffic volumes from 2016
2. The intersections were assessed by movement
3. Future traffic volumes were calculated based on the growth rates identified above
4. Any intersection with a current LOS of E or F had a capped growth rate so that the maximum future degree of saturation was 1.1, or the future volume was capped at the existing volume, if the existing degree of saturation was above 1.1.

4.5.6 Intersection Traffic Modelling

The approach to traffic modelling undertaken for this assessment aligns with the RMS Traffic Modelling Guidelines (version 1.0, February 2013) and includes the following broad steps:

- Development of calibrated and validated existing base models to align with existing operational conditions at each intersection. The following data sources were used in the calibration and validation process:
  - surveyed and SCATS traffic counts (including pedestrian and cyclist volumes)
  - SCATS traffic signal data
  - site observations of pedestrian delays, posted speed limits, intersection configurations, lane usage, location of parking, bus stop locations, bottlenecks and pinch points
  - pedestrian crossing volumes from traffic surveys.
- Application of anticipated construction haulage traffic demands to the calibrated and validated base models to develop construction phase models to allow the identification of potential impacts.

The traffic modelling results obtained should not be interpreted in absolute terms, rather the purposes of traffic modelling is to enable a comparison to be made between the ‘with’ and ‘without’ construction haulage traffic scenarios. Traffic signal operations have been modelled as fixed time operation whereas in reality the traffic signal control system used throughout Sydney is SCATS. Under adaptive SCATS control, the actual operational performance achieved is likely to be better than the modelled results. Furthermore, the adaptive nature of the traffic signal control available in Sydney means that intersections are able to modify phase times in response to variability in traffic demand. Therefore, it is important when reviewing the traffic modelling results that the scenarios be viewed relative to each other in order to determine any potential change in operational performance due to the project.

The traffic modelling undertaken was of the AM and PM peak periods only, consistent with the standard approach for this of type assessment. The peak traffic periods represent a ‘worst case scenario’ as during these periods the road network experiences the maximum background traffic demand and the available spare capacity of the road network is at its most limited. Construction haulage vehicle volumes are anticipated to be higher outside the AM and PM weekday peak periods; however, the number of movements would remain relatively low and be within the range of daily variations in traffic volumes on the road network when compared to background traffic.

It is acknowledged that in some locations the Saturday peaks remain high relative to weekday peaks, and for these sites the Construction Traffic Management Plan (CTMP) process would be utilised to manage the activities at specific locations or to a finer degree of detail, to minimise impacts to the road network.

4.5.7 Performance Indicators

In order to assess the impact of the 2023 scenarios as outlined in **Section 4.5.1** on the performance of the intersections, the main indicators were:

- Degree of Saturation (DoS): the ratio between traffic volumes and capacity (v/c) of the intersection, used to measure how close to capacity an intersection is operating. The DoS is a direct measure of the congestion level of the intersection and as DoS approaches 1.0, both queue length and delays increase rapidly. Satisfactory operations usually occur with a DoS range between 0.8 to 0.9 or lower

- average delay: duration, in seconds, of the average vehicle waiting time at an intersection
- Level of Service (LoS): a measure of the overall performance of the intersection. The levels of service (LoS) presented in **Table 4.4** are in accordance to the RMS Traffic Modelling Guidelines and LoS gives an indication of how well the intersection is performing in regards to delay in seconds faced by vehicles.

Table 4.4 Level of Service delay bands

Level of Service (LoS)	Average Delay (sec/vehicle)	Guide to Interpretation
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; at signals incidents would cause excessive delays
F	> 70	Exceeds capacity; roundabouts require other control mode

4.5.8 Construction phase – Assessment of traffic volumes

The construction traffic assessment is based on forecast construction haulage traffic generation along specified haulage routes, and their associated affects upon intersection operation. Construction specific activities requiring closures, work zones and other traffic management activities would be detailed in the CTMPs. Construction haulage traffic volumes generated from station construction compounds and/or construction activity within the project area were included in the future intersection models to assess construction impacts within the project area in the vicinity of the station.

Peak hour construction haulage traffic volumes determined for station compounds were used in the future models to assess construction impacts.

For other construction activities within the project area, the following assumptions were made to obtain peak hour truck movements:

- construction activity period assumed based on type of activity, size of site, etc. The peak hourly vehicle flows have been derived by averaging the overall expected volumes over the estimated construction duration
- peak hour flows worked out based on assumed construction activity duration
- movements for earthworks / fill and concrete pouring typically taking place outside of peak hours to assess a realistic scenario of construction haulage traffic impact
- site activities occur over five working days and exclude any allowance for the distribution of the deliveries during weekend works, including possessions.

The assumptions above were used to model the worst case impact to the road network. The peak hour volumes estimation and overall construction impact can be further refined with more detailed programming for individual activities and their respective access gates as the Construction Traffic Management Plans (CTMPs) are developed at a later stage.

The assumed movements for construction haulage routes are provided in **Appendix C**.

It should also be noted that traffic generation from construction workers has not been included in this assessment. Intensive station compound works are planned to occur during 24 hour possession periods and therefore worker arrivals can be expected to be dispersed throughout the day, as opposed to arriving during the morning peak hours.

4.5.9 Night-time construction haulage traffic

During the night, construction haulage traffic demands at each station are indicatively estimated to be around nine heavy vehicles and five light vehicles trips[13] per hour. **Table 4.3** demonstrates the reductions in background traffic that can be expected during the night (between 27% and 77%). As a result of the lower background traffic flows, the relatively small number of night-time construction haulage traffic trips would not result in any significant impacts in traffic terms. However it is recognised that night-time construction haulage traffic could have amenity impacts and this is considered in Technical Paper 2 – Noise and vibration assessment.

4.5.10 Construction phase – Assessment of impacted routes

The construction and TTS traffic affected intersections identified for further analysis were selected by consideration of:

- construction haulage routes - the predicted route that construction haulage vehicles would use to travel to/from compounds and access gates into the project area worksite. The predicted routes were determined by choosing the shortest travel time from a State Road to the compounds/worksite from the list of potential construction haulage routes that have been assumed for the purposes of assessment
- TTS bus routes – the plan to manage temporary transport needs during the construction period is being developed in parallel with the design and outlines the proposed strategy for managing impacts of closures of the Bankstown Line during construction. Intersections along TTS routes were identified and are included in the traffic impact assessment.

A construction haulage traffic swept path analysis was also undertaken for key construction inbound and outbound routes approaching station compounds. A 12.5m Heavy Rigid Truck was been used for the analysis. Vehicles greater than 12.5m that would access compounds and the access gates along the project area are expected to do so under active traffic management and outside of peak hours as these would be discreet movements. Discussion of the suitability of the turns is included in Chapter 5 on a station by station basis with the intersections assessed and individual turn diagrams provided in **Appendix B**.

4.5.11 Intersection Controls

A review of satellite imagery supplemented by site inspections was used to identify the type of existing intersection controls for each of the intersections along the construction haulage routes and/or TTS bus routes. The controls were categorised into signalised, roundabout or priority controlled.

The project team completed site visits to key intersections at Campsie, Bankstown and Sydenham Stations to observe existing traffic operations. The visits were undertaken during the morning peak to reflect the peak with the higher people movements based on survey data.

Additional site visits were also conducted where preliminary modelling results (LoS) differed from the existing situation. A number of intersections were visited in January and February 2017 for this reason. These visits allowed observations of recent changes to road layouts, actual lane usage to reflects parking or other factors that produced biased lane choice, and the interaction of pedestrians with traffic flows. Sites visited include:

- Gleeson Avenue / Unwins Bridge Road
- Marrickville Road / Victoria Street
- Marrickville Road Illawarra Road
- Marrickville Road / Warren Road
- Ewart Street / Wardell Street
- Ewart Street / Bayley Street
- Crinan Street / Floss Street / Duntroon Street

[13] A trip is a one-way vehicular movement from one point to another excluding the return journey. Therefore a vehicle entering and leaving a worksite is counted as two trips.

- Canterbury Road / Crinan Street / Queen Street
- Canterbury Road / Jeffrey Street / Broughton Street
- Canterbury Road / Charles Street / Close Street
- Beamish Street/Lilian Lane / South Parade.

All modelled intersections have been compared and calibrated against vehicle queue length surveys to ensure the base models reflect the existing observed intersection operation.

Signalised intersections were selected for inclusion in the assessment. Non-signalised intersections were included in the assessment if they:

- have turning TTS or construction haulage vehicle movements; or
- are shown to be key access routes within the adjacent road network.

5.0 Construction Haulage Traffic and Transport Assessment - Station and Track Alignment works

5.1 Summary

Potential construction traffic impacts would arise primarily from the addition of construction haulage vehicles (light and heavy trucks), rail replacement bus services and light vehicles (cars and utility vehicles) onto surrounding road network. These construction haulage vehicle movements may increase traffic congestion and impact on intersection performance, as well as impact on the existing bus services, pedestrians and cyclists.

Construction haulage vehicle routes to and from the construction compounds, worksites and access gates to the project area have been developed as described in Chapter 4:

There are periods during construction when the current rail services would be suspended and alternate public transport would be provided by a replacement bus service. As described in Chapter 4, an approach to the bus replacement service has been developed through the TTS, of which the ‘Baseline TTP’ and ‘Refined baseline TTP’ has been considered in this assessment.

As discussed throughout this chapter, pedestrians may be redirected to cross the road at upstream intersections. However the delay, distance and duration of these diversions have not been quantitatively assessed as they are subject to construction staging details that are yet to be developed. When staging details are available, the access routes for pedestrians and cyclists would also be assessed as part of the preparation of the Construction Traffic Management Plans (CTMPs).

Reference should be made to the summary of the existing bike parking space supply and demand at each station found in **Table 3.1** in Chapter 3. Any alternate parking provision temporarily required during the work would need to comply with the NSW Government Bike and Ride Program and the ASA Bicycle Facilities Standard (TfNSW 2016).

In total 75 intersections were assessed to determine the capacity to absorb the additional construction haulage and other traffic generated from construction work. In the intersection summary tables in the body of the report (chapter 5 and 6, the naming conventions (for example B.11 and H.11) are a standard file reference for the project and provide a cross reference point during the modelling and to the intersections diagrams provided in **Appendix A**.

The assessment included consideration of the parking, construction haulage vehicle movements and the impacts of providing temporary transport solutions such as bus replacement during temporary closures of the existing rail system on the surrounding roadways.

Section 5.17 provides a summary table which identifies the constraining intersections on the network in relation to the programmed construction activities. **Appendix A** shows station maps with modelled light and heavy vehicles, construction and Baseline TTP volumes.

Existing and anticipated vehicle flows by hour and daily, with night time flows separately identified, for all construction routes and the Baseline and Refined Baseline TTP routes can be seen in **Appendix C** and summarised as vehicles expected per day in **Section 5.17.1**. This data is also split into ‘light’ and ‘heavy’ vehicles.

Existing on and off street car parking may also be affected from construction works and / or construction worker vehicle parking. **Table 5.1** presents parking spaces and utilisation. Within the station specific discussions later in this chapter there is a discussion on indicative effects on parking from provision of stops and layovers for the TTP scenario buses, although as stated in **Section 4.4** above, the full assessment and mitigation for any parking effects would be undertaken as part of the development of each of the detailed TTPs.

Table 5.1 Existing Parking Summary

	Marrickville	Dulwich Hill	Hurlstone Park	Canterbury	Campsie	Belmore	Lakemba	Wiley Park	Punchbowl	Bankstown
On-street Parking Spaces	1519	1275	1185	616	1045	1078	961	721	838	588
Off-street Parking Spaces	0	57	23	233	494	142	537	25	285	1108
Total parking spaces	1519	1332	1208	849	1539	1220	1498	746	1123	1696
Total Parking Utilisation (%)	81%	74%	55%	68%	90%	78%	85%	63%	84%	98%

Table 5.2 below provides a summary of the total number of dedicated commuter parking spaces that would be removed due to the location of the worksite extent/ access gates.

Table 5.2 Dedicated Commuter Parking Summary Table for Spaces Affected by Worksite Extent / Access Gates

	Marrickville	Dulwich Hill	Hurlstone Park	Canterbury	Campsie	Belmore	Lakemba	Wiley Park	Punchbowl	Bankstown
Total parking spaces	1519	1332	1208	849	1539	1220	1498	746	1123	1696
Existing Dedicated Commuter Parking	0	55	0	32	138	56	138	-	137	147
Spaces removed – entire construction period (*dedicated commuter*)	3	9	23	-	*(14)*	75 *(29)*	*(47)*	25	*(30)*	*(90)*
Additional Spaces removed – short-term i.e. during possessions (*dedicated commuter*)	7	*(27)*	-	(32)	*(45)*	21	*(25)*	-	50[14]	-

Note: The 25 spaces temporarily removed at Wiley Park Station refer to the spaces which Roads and Maritime propose to install as part of the clearways project.

It should also be noted that three Kiss and Ride spaces, one taxi bay and five short term spaces are being removed from use at Marrickville Station during construction. In addition, 23 two-hour time restricted spaces on Floss Street at Hurlstone Park Station and 32 un-restricted parking spaces on

[14] Land is available for 40 replacement spaces.

Charles Street at Canterbury Station are being removed from use for the entirety of the construction period.

The following sections:

- consider the impact of heavy vehicle routes and accessibility
- the impact of the temporary transport route
- assess intersection performance with future growth traffic volumes, construction haulage traffic, Baseline TTP and Refined Baseline TTP volumes
- assess the effects on public transport
- assess the effects on the active transport network
- the impact of construction worker parking
- the impact of dedicated commuter and short-term parking.

Possessions of the Bankstown Line entail closure of all stations from Marrickville to Punchbowl. Additionally, some possessions would also require the closure of the line between Sydenham Station and Bankstown Station, Yagoona Station or Birrong Station, and changes to how stations between Liverpool and Lidcombe are serviced. During such possessions, temporary bus services would need to extend west from Bankstown Station, to Lidcombe Station and/or Sefton Station, depending on the nature of the line closure during a particular possession.

Whilst the stations below are not affected by construction activities, these stations and their surrounding network have been considered in this section as TTS bus services call at these stations:

- Sydenham Station
- Regents Park Station
- Lidcombe Station
- Birrong Station
- Yagoona Station.

Although it is recognised that works at Sydenham Station are not within the scope of works that are part of this project, the assessment has been structured in geographical sequence from east to west. As a result, in the subsequent sections of this chapter the assessment of the effects of the TTS at Sydenham are presented ahead of the stations with actual works occurring, and we conclude with the stations west of the physical works.

Using the methodology detailed in **Chapter 4**, the following section presents summary outputs of the intersections assessment for each station. Average delay per vehicle, overall level of service and the degree of saturation for the worst movement are presented for the following scenarios (refer to table headings in **Section 5.2.2 - 5.16.2** throughout Chapter 5):

- Existing: Existing traffic flows
- Future: Forecast traffic flows for the year 2023
- Construction: Future traffic flows + projected construction haulage vehicles
- Baseline TTP: Future traffic flows + projected construction haulage vehicles +Baseline TTP plan
- Refined Baseline TTP: Future traffic flows + projected construction haulage vehicles +Refined Baseline TTP plan.

5.2 Sydenham Station

Construction haulage traffic has not been modelled for Sydenham Station within this assessment because the construction of Sydenham Station would occur as part of the Sydney Metro Chatswood to Sydenham project. Therefore the Baseline TTP and Refined Baseline TTP results presented within this section do not include construction haulage traffic. However Chapter 10 of this report does consider the cumulative impact of construction haulage traffic for Sydenham Station.

Figure 5.2 overleaf, shows the intersections that were modelled around Sydenham Station for assessment of the baseline TTP.

5.2.1 Sydenham Temporary Transport Route

As noted in Section 4.5, the Baseline TTP outlines a temporary transport scenario that has all bus routes converging in Sydenham, resulting in 101 buses per hour arriving at Sydenham Station in peak periods. The temporary transport bus stops utilise existing bus set down zones in addition to some areas currently used for on-street parking.

The indicative rail replacement bus service operation at Sydenham Station is shown in **Figure 5.1**.

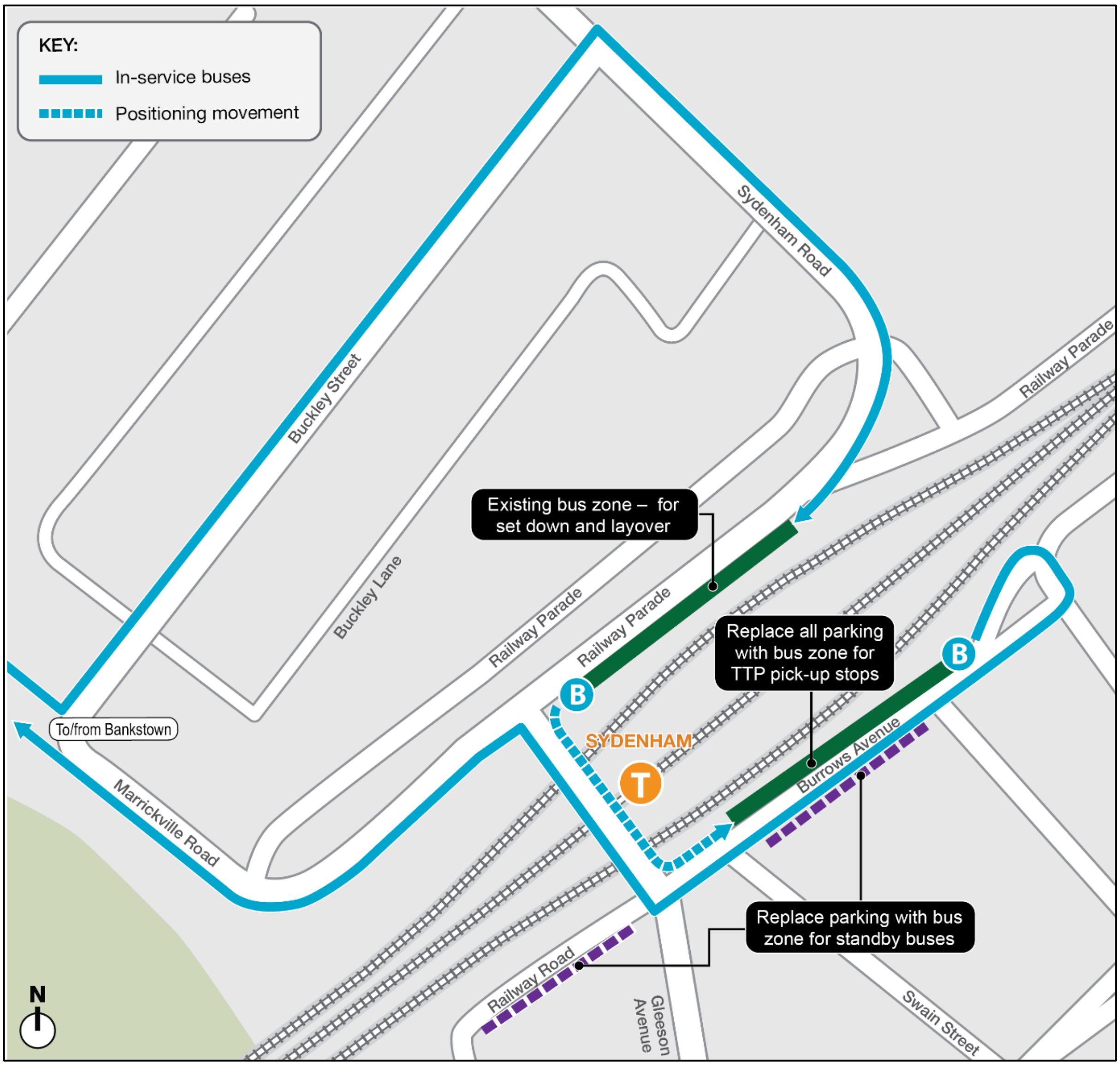


Figure 5.1 Temporary Transport Strategy - Sydenham (Sydney Metro 2017)

Sydenham station intersections

FIGURE 5.2

5.2.2 Road Network Operation and Intersection Performance

Three intersections have been modelled in the area surrounding Sydenham Station. These intersections are shown on **Figure 5.2**.

Road Network Performance - AM Peak

Table 5.3 below shows a summary of the intersection assessment undertaken for this station. Refer to **Appendix A** for the turning counts modelled and **Appendix F** for detailed intersection movement summary tables for this station and all further locations assessed in this Chapter.

Table 5.3 Sydenham Station Intersection Assessment – AM Peak

Sydenham Station – AM Peak					
Scenario	Existing	Future	Construction[15]	Baseline TTP	Refined Baseline TTP
B.19 Gleeson Avenue / Burrows Road (Signals)					**Year Capped: 2023**
Demand Flow (veh)	1962	2155	No Vehicles	2363	2268
Average Delay per Vehicle (Average over all arms in seconds)	16	15		20	17
LoS (Overall)	B	B		B	B
DoS (Worst Movement)	0.67	0.67		0.89	0.76
H.23 Gleeson Avenue / Railway Parade (Signals)					**Year Capped: 2023**
Demand Flow (veh)	2413	2650	No Vehicles	2856	2762
Average Delay per Vehicle (Average over all arms in seconds)	5	5		7	5
LoS (Overall)	A	A		A	A
DoS (Worst Movement)	0.49	0.54		0.80	0.58
H.24 Gleeson Avenue / Unwins Bridge Road (Signals)					**Year Capped: 2023**
Demand Flow (veh)	2082	2286	No Vehicles	2286	2286
Average Delay per Vehicle (Average over all arms in seconds)	29	37		37	37
LoS (Overall)	B	C		C	C
DoS (Worst Movement)	0.78	0.92		0.92	0.92

The modelled analysis showed that all of the intersections around Sydenham Station have a residual LoS ‘C’ or better after allowing for future traffic growth and the addition of TTS bus traffic. A LoS ‘C’ would not cause delays above that which could be typically expected in the peak hour in Sydney.

The Refined Baseline TTP would reduce the number of buses per hour in the Sydenham precinct from 101 to 55. Due to the relatively low levels of congestion the modelled intersections, the impact of the Refined Baseline TTP is minimal, and all intersections still perform at LoS ‘C’ or better.

15 1. The intersections surrounding Sydenham Station are not affected by construction haulage traffic associated with this project. Consequently there are no construction scenarios that have been modelled for Sydenham Station. Construction haulage vehicles for station upgrade assessed within Sydenham Station and Sydney Metro Trains Facility South Modification Report, June 2017

Road Network Performance - PM Peak

Table 5.4 below shows a summary of the intersection assessment undertaken for this station.

Table 5.4 Sydenham Station Intersection Assessment – PM Peak

Sydenham Station – PM Peak					
Scenario	**Existing**	**Future**	**Construction**	**Baseline TTP**	**Refined Baseline TTP**
B.19 Gleeson Avenue / Burrows Road (Signals)					**Year Capped: 2023**
Demand Flow (veh)	2357	2605	No Vehicles	2811	2717
Average Delay per Vehicle (Average over all arms in seconds)	28	29		35	32
LoS (Overall)	B	C		C	C
DoS (Worst Movement)	0.80	0.66		0.84	0.77
H.23 Gleeson Avenue / Railway Parade (Signals)					**Year Capped: 2023**
Demand Flow (veh)	2661	2940	No Vehicles	3148	3054
Average Delay per Vehicle (Average over all arms in seconds)	4	4		4	5
LoS (Overall)	A	A		A	A
DoS (Worst Movement)	0.45	0.50		0.57	0.54
H.24 Gleeson Avenue / Unwins Bridge Road (Signals)					**Year Capped: 2023**
Demand Flow (veh)	2433	2688	No Vehicles	2688	2688
Average Delay per Vehicle (Average over all arms in seconds)	28	33		33	33
LoS (Overall)	B	C		C	C
DoS (Worst Movement)	0.60	0.79		0.79	0.79

All of the intersections around Sydenham Station have a residual LoS ‘C’ or better after allowing for future and TTP traffic. This delay would not be atypical of peak hour conditions within Sydney.

The Refined Baseline TTP reduces the number of buses per hour in the Sydenham precinct from 101 to 55. Due to the relatively low levels of congestion at the modelled intersections, the impact of the Refined Baseline TTP is minimal.

5.2.3 Public Transport Services

The main bus routes in the Sydenham precinct are on Princes Highway, Railway Road and Marrickville Road (NSW Govt. 2016b). As there are no construction works occurring at Sydenham Station as part of the project, the bus routes would not be affected. However it is noted that as some TTP services are sharing the existing stops, there may be additional crowding of facilities which would need to be assessed and managed as part of the TTP. The cumulative impacts related to construction activities are considered in Chapter 10..

5.2.4 Active Transport Network

The project area has a number of footpaths and roads that are used by pedestrians and cyclists. These would not be affected by the construction work for the project.

5.2.5 Dedicated Commuter and Short-Term Parking

As there are currently no dedicated commuter parking spaces at or near Sydenham Station, no dedicated commuter spaces are affected by the TTP bus set down zone. Overall, there are approximately 760 on and off-street unrestricted parking spaces currently operating at 78% utilisation within a 400m catchment that can be used as informal park and ride spaces.

Approximately 19 on street spaces on Burrows Avenue / Railway Road south of the rail line would be affected by the TTP bus set down zone. These parking spaces would only be affected while the TTP is in operation, which is during possession periods when as a result of school holidays or at weekends, there would be a drop in demand.

5.3 Marrickville Station

5.3.1 Construction Haulage Routes

Figure 5.4 overleaf, shows the proposed construction haulage routes into the worksites within the project area surrounding Marrickville Station. At Marrickville Station it is anticipated that 10 heavy and 10 light vehicles would be generated in the AM and PM peak hours. Construction haulage trips at night would be no more than nine heavy and five light vehicle movements per hour.

The swept path analysis determined that construction haulage vehicles are able to access all of the proposed sites / gates safely with the exception of:

- 12.5m Trucks turning left from Illawarra Road into Station Street. This movement conflicts with the existing building frontage on Station Street due to lack of carriageway width. Trucks up to 8.8m can perform this movement safely. Larger trucks can access the site via active traffic management.

Drawings of the turns are included in **Appendix B**.

5.3.2 Marrickville Temporary Transport Route

The TTP shows two bus routes converging before Marrickville, resulting in 33 buses per hour in each direction calling at Marrickville Station in peak periods. The temporary transport bus stops for these routes utilise existing bus stops.

The indicative rail replacement bus operation at Marrickville Station is shown in **Figure 5.3**.

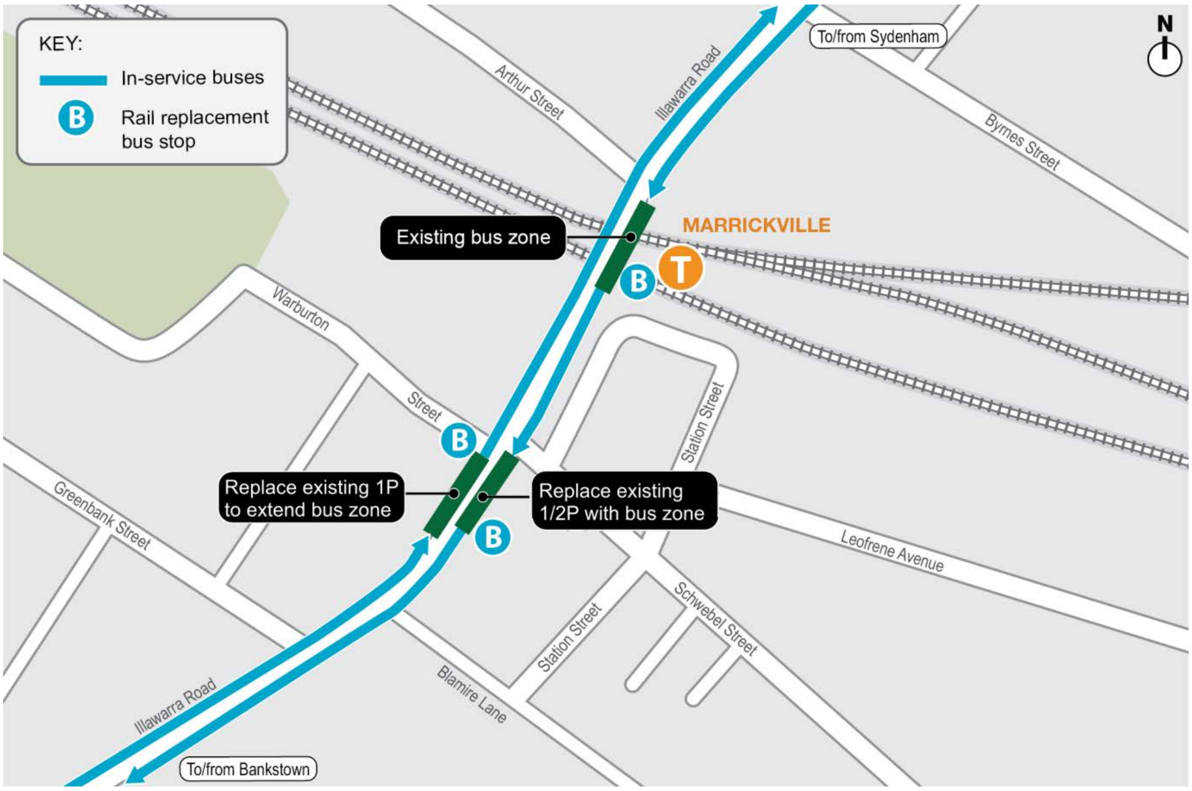


Figure 5.3 Temporary Transport Plan - Marrickville (Sydney Metro 2017)

sydney METRO | city & southwest

Marrickville heavy vehicle routes and station intersections

FIGURE 5.4

5.3.3 Road Network Operation and Intersection Performance

Five intersections were modelled in the area surrounding Marrickville Station as shown in **Figure 5.3**.

Road Network Performance - AM Peak

Table 5.5 provides a summary of the intersection assessment undertaken for this station.

Table 5.5 Marrickville Station Intersection Assessment – AM Peak

Marrickville Station – AM Peak					
Scenario	**Existing**	**Future**	**Construction**	**Baseline TTP**	**Refined Baseline TTP**
B.16 Illawarra Road / Warren Road (Signals)					**Year Capped: 2023**
Demand Flow (veh)	1407	1545	1545	1611	1575
Average Delay per Vehicle (Average over all arms in seconds)	23	25	25	32	28
LoS (Overall)	B	B	B	C	B
DoS (Worst Movement)	0.76	0.81	0.81	0.89	0.89
B.17 Marrickville Road / Illawarra Road (Signals)					**Year Capped: 2023**
Demand Flow (veh)	1762	1935	1960	2167	2073
Average Delay per Vehicle (Average over all arms in seconds)	19	22	24	76	37
LoS (Overall)	B	B	B	F	C
DoS (Worst Movement)	0.79	0.83	0.87	1.09	0.98
B.18 Marrickville Road / Victoria Road (Signals)					**Year Capped: 2023**
Demand Flow (veh)	2034	2234	2234	2438	2345
Average Delay per Vehicle (Average over all arms in seconds)	30	49	49	205	192
LoS (Overall)	C	D	D	F	F
DoS (Worst Movement)	0.79	1.03	1.03	1.38	1.38
H.19 Petersham Road / Illawarra Road (Signals)					**Year Capped: 2023**
Demand Flow (veh)	1158	1271	1297	1365	1328
Average Delay per Vehicle (Average over all arms in seconds)	16	17	16	16	16
LoS (Overall)	B	B	B	B	B
DoS (Worst Movement)	0.47	0.50	0.52	0.55	0.54
H.38 Marrickville Station Overbridge (Signals)					**Year Capped: 2023**
Demand Flow (veh)	1039	1141	1166	1233	1197
Average Delay per Vehicle (Average over all arms in seconds)	4	4	4	5	4
LoS (Overall)	A	A	A	A	A
DoS (Worst Movement)	0.45	0.49	0.50	0.55	0.53

For three of the five intersections modelled, the increase in delay resulting from future traffic growth, construction haulage traffic and TTP scenarios result in a LoS ‘C’ or better. A LoS ‘C’ would generally be considered reasonable during peak periods.

The Marrickville Road / Illawarra Road intersection is forecast to experience a drop in the level of service to ‘F’ which denotes the TTP traffic would exceed the capacity of the intersection. The intersection has a LoS of ‘B’ for the Existing, Future and Construction scenarios which would be acceptable to commuters in the peak hour. The LoS worsens to a LoS ‘F’ for the Baseline TTP scenario, however the reduced number of bus movements in the Refined Baseline TTP scenario result in a LoS of C.

The four TTP bus routes converge at this intersection, with two bus routes approaching from the west and two bus routes approaching from the south. The convergence of the bus routes from different directions results in the worst movement (through movement from Marrickville Road west) experiencing a delay of approximately two minutes.

The Refined Baseline TTP reduces the number of buses approaching from the west by approximately 30 per hour and the number approaching from the south by approximately 20 per hour. This results in the level of service improving to LoS ‘C’.

The Marrickville Road / Victoria Road intersection has an existing LoS ‘C’ which is based on an average delay across all arms. The intersection is forecast to experience a decline in amenity to a LoS ‘D’ resulting from future traffic growth and construction haulage traffic. A LoS ‘D’ would be considered a reasonably acceptable delay during peak hours in Sydney.

The level of service further declines to ‘F’ with the addition of the Baseline TTP buses, and the average delay across all arms exceeds three minutes. The through and right turning movements from the Victoria Road north approach are the worst performing movements, with delays of up to four minutes. The additional 101 Baseline TTP buses from the Marrickville Road east and west approach dictates the green time for this intersection, resulting in the large increase in DoS and delay for the movements from Victoria Road north.

The Refined Baseline TTP reduces the average delay to approximately three minutes, but still has a LoS ‘F’. Even if works were undertaken during school holidays the demand would exceed capacity, albeit delays would be reduced. Potential mitigation measures for this intersection are discussed in **Section 5.3.4**.

Road Network Performance - PM Peak

Table 5.6 provides a summary of the intersection assessment undertaken for this station.

Table 5.6 Marrickville Station Intersection Assessment – PM

Marrickville Station – PM Peak					
Scenario	**Existing**	**Future**	**Construction**	**Baseline TTP**	**Refined Baseline TTP**
B.16 Illawarra Road / Warren Road (Signals)					**Year Capped: 2023**
Demand Flow (veh)	1671	1847	1847	1914	1878
Average Delay per Vehicle (Average over all arms in seconds)	19	22	22	27	23
LoS (Overall)	B	B	B	B	B
DoS (Worst Movement)	0.69	0.89	0.89	0.90	0.88
B.17 Marrickville Road / Illawarra Road (Signals)					**Year Capped: 2023**
Demand Flow (veh)	1824	2016	2041	2245	2152
Average Delay per Vehicle (Average over all arms in seconds)	19	20	23	62	27
LoS (Overall)	B	B	B	E	B
DoS (Worst Movement)	0.60	0.73	0.81	1.08	0.90
B.18 Marrickville Road / Victoria Road (Signals)					**Year Capped: 2023**
Demand Flow (veh)	2353	2600	2600	2808	2713
Average Delay per Vehicle (Average over all arms in seconds)	38	66	66	118	71
LoS (Overall)	C	E	E	F	F
DoS (Worst Movement)	0.95	1.07	1.07	1.18	1.05
H.19 Petersham Road / Illawarra Road (Signals)					**Year Capped: 2023**
Demand Flow (veh)	1250	1381	1407	1474	1437
Average Delay per Vehicle (Average over all arms in seconds)	13	12	12	12	12
LoS (Overall)	A	A	A	A	A
DoS (Worst Movement)	0.50	0.53	0.55	0.60	0.58
H.38 Marrickville Station Overbridge (Signals)					**Year Capped: 2023**
Demand Flow (veh)	1138	1257	1283	1350	1313
Average Delay per Vehicle (Average over all arms in seconds)	4	5	5	5	5
LoS (Overall)	A	A	A	A	A
DoS (Worst Movement)	0.49	0.54	0.56	0.60	0.58

For three of the five intersections modelled, the increase in delay resulting from future traffic growth, construction haulage traffic and TTP results in a LoS 'B' or better. A level of service 'B' would not cause delays above that which could be reasonably expected in the peak hour.

The Marrickville Road / Illawarra Road intersection is forecast to experience a decline in amenity as a result of the addition of the TTP traffic. The intersection has a LoS of 'B' for the existing, future and construction scenarios, worsening to a LoS 'E' for the Baseline TTP scenario. The left and through movements from the Marrickville Road west approach are the worst performing movements with delays of nearly three minutes. The Refined Baseline TTP reduces the number of buses through the intersection, which improves the intersection to an acceptable LoS 'B'.

The Marrickville Road / Victoria Road intersection has a current LoS 'C' which declines to a LoS 'E' with future traffic growth and the addition of construction haulage traffic. The intersection further declines to a LoS 'F' with the addition of TTP traffic.

The Refined Baseline TTP reduces the average delay from two minutes to approximately one minute, but the LoS is still 'F'. This may surpass what is considered to be acceptable by local residents. The worst movements are the through and left turning movements from the Marrickville Road east approach because the right turn is being opposed by the additional TTP buses from the west approach.

Performance of the through and the right turn movements from the Victoria Road South approach are also worsened in the Baseline TTP scenario as the green time is dictated by the additional 101 Baseline TTP buses from the Marrickville Road east and west approaches. Potential mitigation measures for this intersection are discussed in the following section.

5.3.4 Mitigation

As described in **Section 5.3.3**, the LoS at the intersection of Marrickville Road / Victoria Road is expected to deteriorate in the future due to traffic volume growth and the addition of TTP bus volumes during the construction period resulting in further increased congestion and delays.

The following phasing changes have been tested as mitigation measures to improve intersection performance during the Refined Baseline TTP scenario:

- **AM Peak**: Additional traffic signal phase for Marrickville Road west approach during the AM peak. As this approach has the highest traffic volume during the AM peak, allowing an additional signal phase results in reduced delays and congestion on Marrickville Road.

  In addition to the signal phasing change, the phase times have also been 'optimised' in SIDRA to ensure each approach gets the appropriate green time, whilst maintaining the cycle time.

  Whilst the proposed mitigation measures do not reduce the LoS from 'F', the level of congestion on Marrickville Road is reduced. Overall congestion at this intersection can be further improved by increasing the overall cycle time; this however requires consideration of adjacent intersections operation and co-ordination.

- **PM Peak**: Additional traffic signal phase for Marrickville Road east approach during the PM. This approach has the highest traffic volumes during the PM peak, and allowing an additional signal phase results in reduced delays and congestion on Marrickville Road. The overall intersection LoS reduces to 'D', indicating improved intersection performance in the Mitigated TTP scenario.

  In addition to the signal phasing change, the phase times have also been 'optimised' in SIDRA to ensure each approach gets the appropriate green time, whilst maintaining the cycle time.

Table 5.7 shows the mitigation modelling results with the mitigation described above.

Table 5.7 Marrickville Road / Victoria Road AM & PM Peak Mitigation Results

B.18 Marrickville Road / Victoria Road (Signals)					
Scenario	Existing	Future	Baseline TTP	Refined Baseline TTP	Mitigated TTP
AM Peak					**Year Capped: 2023**
Demand Flow (veh)	2034	2234	2438	2345	2345
Average Delay per Vehicle (Average over all arms in seconds)	30	49	205	192	84
LoS (Overall)	C	D	F	F	F
DoS (Worst Movement)	0.79	1.03	1.38	1.38	1.14
AM Peak (125 second cycle time)					**Year Capped: 2023**
Demand Flow (veh)	2034	2234	2438	2345	2345
Average Delay per Vehicle (Average over all arms in seconds)	30	49	205	192	58
LoS (Overall)	C	D	F	F	E
DoS (Worst Movement)	0.79	1.03	1.38	1.38	0.99
PM Peak					**Year Capped: 2023**
Demand Flow (veh)	2353	2600	2808	2713	2713
Average Delay per Vehicle (Average over all arms in seconds)	38	66	118	71	47
LoS (Overall)	C	E	F	F	D
DoS (Worst Movement)	0.95	1.07	1.18	1.05	0.95

To summarise, as shown by **Table 5.7**, the proposed mitigation measures are expected to reduce overall congestion and delays. Whilst the overall intersection LoS is still 'E' during the AM peak, the level of congestion is reduced from the unmitigated scenario. It should also be noted that the models use peak hour traffic flows during non-school holiday periods. However the TTP would be in place during possession periods which is mostly during school holiday periods. Consequently the modelling results reflect the worst case scenario and the delays incurred at the intersection are likely to be lower due to lower school holiday traffic volumes.

5.3.5 Public Transport Services

The main bus routes in the Marrickville precinct are on Marrickville Road, Victoria Road, Illawarra Road and Livingstone Road (NSW Govt. 2016b). An assessment of the worksite extent shows that there should not be a requirement to move bus stops to facilitate construction haulage vehicle movements and access to the worksite.

Bus stop 2204101 is located on Illawarra Road Bridge. This bus stop should not be affected either by the worksite extent, however the stop is in close proximity to the worksite adjacent to Station Street and therefore may require relocation if cranes are to be used from the worksite extent to access the bridge.

5.3.6 Active Transport Network

The project area and associated compound area on Station Street would require the establishment of pedestrian zones for rail passengers to ensure that they can safely manoeuvre from the train to the pedestrian footpaths in the surrounding road network. The project area on the northern side of the railway line is not within the road reserve and would therefore not affect pedestrians. The bike friendly routes would not be affected by either of the project areas.

Construction works to install a new signalised intersection and upgrade existing footpaths on the corner of Warburton Road, Schwebel Street and Illawarra Road may result in short-term pedestrian movement impacts, and may require the temporary and localised diversion of some pedestrian routes at intersections for short periods, generally less than a week.

Carrington Road as there is sufficient width and a painted on-street bike path. Illawarra Road identified as an on-road bike friendly road. Cyclists and construction haulage vehicles would be sharing the road but the relatively low volume of construction haulage vehicles should not have a major effect on the user experience or safety of the cyclists.

5.3.7 Commuter and Short-Term Parking

As there are currently no dedicated commuter parking spaces at or near Marrickville Station, no long term parking spaces are affected by the worksite. However, there are three kiss and ride spaces, one accessible bay, one taxi space and three on-street time restricted parking spaces in Station Street. These parking spaces would be required for the duration of the construction activities at Marrickville Station and area.

Overall, there are approximately 1260 on-street unrestricted parking spaces currently operating at 82% utilisation within a 400m catchment that can be used as informal park and ride spaces. There are no off-street parking spaces near Marrickville Station.

Three on street spaces on Illawarra Road south of the rail line would be required to provide the TTP bus stops, only during possession periods. During these periods there is likely to be a reduction in demand for parking at the stations. This decrease results from the influence of school holiday periods and the change of mode share as parking at the station to commute by train would not be possible and alternative means to reach destinations would be required (i.e. bus service, active transport or drive).

5.3.8 Construction Worker Parking

It is anticipated that four to ten parking spaces would be provided at any one time for project workers in the Marrickville Station compound area. **Table 5.8** provides the anticipated daily construction workforce volumes for Marrickville Station. It is assumed that public transport would be promoted as the primary mode of transport for construction workers. This would reduce the impacts on the local road network and parking requirements. As noted above, parking in the area is not fully utilised therefore there is capacity to accommodate any remaining worker parking. Off-site parking alternatives and associated shuttle arrangements would also be investigated to transport workers to and from the site.

Table 5.8 Anticipated Daily Workforce- Marrickville

	Non Possession		Possession Short Period Close-down	
	Peak	Typical / Average	Peak	Typical/Average
Marrickville Station	60	40	130	65

5.4 Dulwich Hill Station

5.4.1 Dulwich Hill Construction Haulage Routes

Figure 5.6 overleaf, shows the proposed construction haulage routes into the sites to be used during construction. At Dulwich Hill Station it is anticipated that 10 heavy and 10 light vehicles would be generated in the AM and PM peak hours. Construction haulage trips at night would be no more than nine heavy and five light vehicle movements per hour.

The swept path analysis determined that construction haulage vehicles are able to access all of the proposed sites / gates safely. Drawings of the turns are included in **Appendix B**.

5.4.2 Dulwich Hill Temporary Transport Route

The TTP has two of the four bus routes converging before Dulwich Hill, resulting in 33 buses per hour in each direction calling at Dulwich Hill Station in peak periods. The temporary transport bus stops for these routes utilise existing bus stops. The other two routes do not stop at, or pass through the vicinity of the Dulwich Hill Station.

The indicative rail replacement operation at Dulwich Hill Station is shown in **Figure 5.5**.

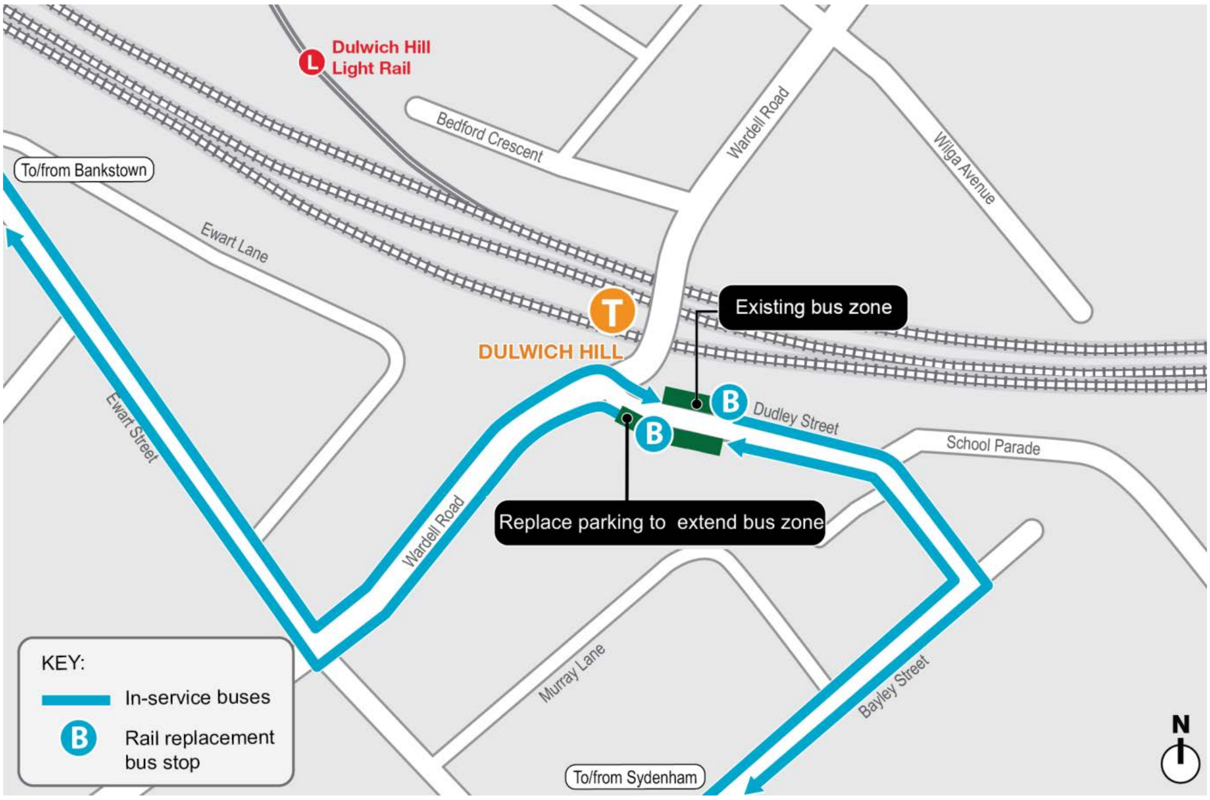


Figure 5.5 **Temporary Transport Plan – Dulwich Hill (Sydney Metro 2017)**

5.4.3 Road Network Operation and Intersection Performance

Six intersections were modelled in the area surrounding the Dulwich Hill Station as shown in **Figure 5.6**.

Road Network Performance – AM Peak

Table 5.9 provides a summary of the intersection assessment undertaken for this station.

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Dulwich Hill heavy vehicle routes and station intersections

FIGURE 5.6

Table 5.9 Dulwich Hill Station Intersection Assessment – AM Peak

Dulwich Hill Station – AM Peak					
Scenario	**Existing**	**Future**	**Construction**	**Baseline TTP**	**Refined Baseline TTP**
B.15 Wardell Road / Ewart Street (Signals)					**Year Capped: 2023**
Demand Flow (veh)	1664	1827	1843	1910	1904
Average Delay per Vehicle (Average over all arms in seconds)	30	102	120	196	179
LoS (Overall)	C	F	F	F	F
DoS (Worst Movement)	0.94	1.10	1.13	1.32	1.28
H.16 Wardell Road / Dudley Street (Priority Controlled)					**Year Capped: 2023**
Demand Flow (veh)	1204	1322	1322	1391	1385
Average Delay per Vehicle (Average over all arms in seconds)	9	18	18	34	31
Average Delay per Vehicle (Worst Movement in seconds)	38	65	65	85	85
LoS (Worst Movement)	C	E	E	F	F
DoS (Worst Movement)	0.78	0.91	0.91	1.00	0.99
B.28 New Canterbury Road / Marrickville Road (Signals)					**Year Capped: 2023**
Demand Flow (veh)	2408	2644	2644	2783	2685
Average Delay per Vehicle (Average over all arms in seconds)	16	22	22	22	22
LoS (Overall)	B	B	B	B	B
DoS (Worst Movement)	0.72	0.95	0.95	0.95	0.95
H.25 Ewart Street / Bayley Street (Priority Controlled)					**Year Capped: 2023**
Demand Flow (veh)	642	705	709	779	741
Average Delay per Vehicle (Average over all arms in seconds)	1	1	2	3	2
Average Delay per Vehicle (Worst Movement in seconds)	13	15	15	17	16
LoS (Worst Movement)	A	B	B	B	B
DoS (Worst Movement)	0.27	0.30	0.30	0.31	0.30
H.36 New Canterbury Road / Terrace Road (Priority Controlled)					**Year Capped: 2023**
Demand Flow (veh)	2271	2494	2527	2665	2578
Average Delay per Vehicle (Average over all arms in seconds)	1	1	1	1	1
Average Delay per Vehicle (Worst Movement in seconds)	10	10	12	14	13
LoS (Worst Movement)	A	A	A	A	A
DoS (Worst Movement)	0.58	0.64	0.64	0.68	0.65

Dulwich Hill Station – AM Peak					
Scenario	**Existing**	**Future**	**Construction**	**Baseline TTP**	**Refined Baseline TTP**
H.37 Wardell Road / Marrickville Road (Signals)					**Year Capped: 223**
Demand Flow (veh)	1933	2123	2140	2277	2221
Average Delay per Vehicle (Average over all arms in seconds)	28	51	61	94	88
LoS (Overall)	B	D	E	F	F
DoS (Worst Movement)	0.90	1.10	1.14	1.17	1.20

For three of the six intersections modelled, the increase in delay resulting from future traffic growth, construction haulage traffic and TTP result in a LoS 'B' or better. This delay would not be atypical of peak hour conditions within Sydney.

The Wardell Road / Ewart Street intersection is forecast to perform poorly due to future traffic volumes, regardless of this project. The addition of TTP traffic would worsen this performance. The overall intersection has a LoS of 'F' in the future, construction and TTS scenarios. Noting that the assessment has assumed the full background non holiday flows, this is a slight over estimation of the delays for the construction period, where the TTP only occurs in holidays. However, scheduling construction works during school term break periods would help to alleviate congestion at this intersection, albeit this would still require further mitigation as the intersection is some 30% over capacity.

The right turning movements from the Ewart Street north approach is the worst performing movement with an average delay of approximately six minutes in the Baseline TTP scenario. The 33 buses on the Wardell Road east approach resulted in less green time (32 seconds in the construction scenario to 27 seconds in the Baseline TTP scenario) for the opposed right turning movement from the Ewart Street north approach. The LoS remained at 'F' during the Refined Baseline TTP scenario and indicates that it would lead to a moderate increase in delays for drivers on Ewart Street.

The Wardell Road / Marrickville Road intersection is also forecast to experience a decline in performance as a result of the addition of the TTP traffic. The overall intersection has a LoS of 'E' in the construction scenario which worsens to 'F' in the TTP scenarios. Potential mitigation measures for these two intersections are discussed in **Section 5.4.4**.

The through and right turning movements from the Marrickville Road north approach are the worst performing movements. The deterioration in amenity for the through movement can be attributed to the additional TTP buses. For the opposed right turning movement, the additional TTP buses from the Marrickville Road south approach going through the intersection reduces the gaps available to make an opposed turn. The Refined Baseline TTP has a minimal reduction to the overall delay at the intersection because the number of buses along Marrickville Road is reduced, but additional buses are added to Wardell Road.

The right turning movements may choose to use a parallel road, such as Canonbury Grove, which potent would reduce delays to a level that may be considered acceptable to local residents.

The Wardell Road / Dudley Street intersection has an existing LoS 'C'. This worsens to an 'E' in the future and construction scenarios and to an 'F' in the TTP scenarios. As the intersection is a priority controlled intersection, the LoS 'F' can be attributed to the right turning movement from the Wardell Road west approach giving way to an un-opposed through movement from Wardell Road. The Refined Baseline TTP has minimal effect on the intersection performance because there are less replacement buses turning right from Wardell Road west. If works are scheduled to take place during the school term 4 break, the reduction in traffic flows during this period would help to alleviate congestion at this intersection, and therefore result in delays that are somewhat consistent with the usual non holiday period conditions.

It is noted that there are alternate routes available and whilst the TTS would retain this route, other drivers may divert onto parallel routes, further reducing the impact of the construction at this intersection.

Road Network Performance – PM Peak

Table 5.10 provides a summary of the intersection assessment undertaken for this station. Refer to **Appendix A** for the turning counts modelled and **Appendix F** for detailed intersection movement summary tables.

Table 5.10 Dulwich Hill Station Intersection Assessment – PM Peak

Dulwich Hill Station – PM Peak					
Scenario	Existing	Future	Construction	Baseline TTP	Refined Baseline TTP
B.15 Wardell Road / Ewart Street (Signals)					**Year Capped: 2023**
Demand Flow (veh)	2028	2241	2256	2323	2317
Average Delay per Vehicle (Average over all arms in seconds)	32	55	60	94	88
LoS (Overall)	C	D	E	F	F
DoS (Worst Movement)	0.91	1.01	1.03	1.11	1.11
H.16 Wardell Road / Dudley Street (Priority Controlled)					**Year Capped: 2023**
Demand Flow (veh)	1382	1527	1527	1594	1588
Average Delay per Vehicle (Average over all arms in seconds)	6	10	10	14	13
Average Delay per Vehicle (Worst Movement in seconds)	35	58	58	73	73
LoS (Worst Movement)	C	E	E	F	F
DoS (Worst Movement)	0.72	0.82	0.82	0.82	0.85
B.28 New Canterbury Road / Marrickville Road (Signals)					**Year Capped: 2023**
Demand Flow (veh)	2353	2600	2600	2737	2650
Average Delay per Vehicle (Average over all arms in seconds)	23	23	23	27	25
LoS (Overall)	B	B	B	B	B
DoS (Worst Movement)	0.55	0.61	0.61	0.71	0.65
H.25 Ewart Street / Bayley Street (Priority Controlled)					**Year Capped: 2023**
Demand Flow (veh)	796	879	884	951	914
Average Delay per Vehicle (Average over all arms in seconds)	2	2	2	3	2
Average Delay per Vehicle (Worst Movement in seconds)	16	19	19	23	20
LoS (Worst Movement)	B	B	B	B	B
DoS (Worst Movement)	0.36	0.40	0.40	0.46	0.43

Dulwich Hill Station – PM Peak					
Scenario	Existing	Future	Construction	Baseline TTP	Refined Baseline TTP
H.36 New Canterbury Road / Terrace Road (Priority Controlled)					**Year Capped: 2023**
Demand Flow (veh)	2255	2492	2525	2667	2577
Average Delay per Vehicle (Average over all arms in seconds)	1	1	2	2	2
Average Delay per Vehicle (Worst Movement in seconds)	17	22	33	44	36
LoS (Worst Movement)	B	B	C	D	C
DoS (Worst Movement)	0.55	0.61	0.61	0.69	0.64
H.37 Wardell Road / Marrickville Road (Signals)					**Year Capped: 2023**
Demand Flow (veh)	2166	2393	2411	2552	2494
Average Delay per Vehicle (Average over all arms in seconds)	29	36	36	105	70
LoS (Overall)	C	C	C	F	E
DoS (Worst Movement)	0.86	0.92	0.90	1.31	1.25

For three of the six intersections modelled, the increase in delay resulting from future traffic growth, construction haulage traffic and TTP results in a LoS 'D' or better. A LoS 'D' would generally be considered reasonable during peak periods.

The Wardell Road / Ewart Street intersection is forecast to experience a decline in amenity as a result of the addition of the future, construction and TTP traffic. The overall intersection LoS worsens with each addition of traffic, resulting in a LoS 'F' in the Baseline and Refined Baseline TTP scenarios.

The through and right turning movements from the Wardell Street east approach are the worst performing movements with an average delay of approximately two minutes in the Baseline TTP scenario. This delay results from the right turning movement occurring at the same time as the opposing Wardell west approach through traffic. The additional 33 buses at the opposing west approach in the Baseline TTP scenario results in the decreased level of service. Whilst less than desirable, a delay of 90 seconds in the peak periods is unlikely to result in congestion beyond the immediate location.

The average delay reduces by a minor amount and the level of service remains as 'F' in the Refined Baseline TTP. The minor change occurs because the number of replacement buses has reduced from 33/hour to 30/hour in the AM peak.

The Wardell Road / Marrickville Road intersection is also forecast to experience a decline in amenity as a result of the addition of the TTP traffic. The intersection has a LoS of 'C' in the future and construction scenarios, which worsens to 'F' in the Baseline TTP scenario.

The through and right turning movements from the Marrickville Road north approach are the worst performing movements with an average delay of nearly six minutes in the Baseline TTP scenario. The deterioration in amenity of the through movement can be attributed to the additional 68 buses. For the opposed right turning movement, the additional 68 buses from the Marrickville Road south approach reduces the gaps available to make an opposed turn.

The LoS improves slightly to 'E' in the Refined Baseline TTP scenario. The improvement results from a reduction of 43 TTP buses at the Marrickville Road south approach which provides more frequent gaps for the right turning traffic. Potential mitigation measures for these two intersections are discussed in **Section 5.4.4**.

The Wardell Road / Dudley Street intersection has an existing LoS 'C' which worsens to 'E' in the future and construction Scenarios. This declines further to 'F' in the Baseline TTP scenario. The worst movement is the right turning movement from the Wardell Road west approach, which must give way to an un-opposed through movement from Wardell Road, resulting in average delays in excess of one minute.

The DoS increases for the worst movement with the Refined Baseline TTP and the LoS remains as 'F' because TTP Route 4 is modified to continue straight through the Wardell Road / Dudley Street intersection. This reduces the frequency of gaps for right turning vehicles, increasing the delay.

At the Wardell / Dudley Street intersection, drivers performing opposed turning movements may choose to divert to the Wardell Road / Ewart Street signalised intersection to avoid waiting for a gap in the traffic flow at the priority intersection. If works are scheduled to take place during the school term 4 break for this intersection, the reduction in traffic flows during this period would help to alleviate congestion at this intersection.

5.4.4 Mitigation

The intersections of Wardell Road / Ewart Street and Marrickville Road / Wardell Road are expected to have high congestion and delays. Mitigation measures have been tested to potentially improve high congestion and delays resulting from additional Refined Baseline TTP volumes.

Wardell Road / Ewart Street mitigation

As described in **Section 5.4.3,** under furture scenarios, this intersection is forecast to experience LoS F. The right turning movement from Ewart Street north would experience the highest congestion and delays during the AM peak, whereas Wardell Street east approach would have the worst performance during the PM peak.

The following mitigation measures have been tested to reduce expected congestion and delays:

- change Wardell Road east approach from shared through and right to right only
- change Ewart Street north approach from shared through and right to right only
- change traffic signal phasing to run Ewart Street north approach twice during the morning peak
- change traffic signal phasing to run Wardell Road east approach twice during the evening peak
- run optimised phase times (whilst maintaining cycle time).

As both through and right turning volumes are quite high on Wardell Road and Ewart Road, changing the lane arrangement would allow traffic to flow better through the intersection. The additional phasing changes during the AM and PM peak provides the dominant approach (i.e. with high traffic volumes) more green time, and therefore reduces overall intersection delays and congestion.

These mitigation measures result in improved intersection performance, as shown with LoS 'D' during both AM and PM peaks in the Mitigated TTP scenario in **Table 5.11**.

Table 5.11 Wardell Road / Ewart Street AM & PM Peak Mitigation Results

B.15 Wardell Road / Ewart Street (Signals)					
Scenario	Existing	Future	Baseline TTP	Refined Baseline TTP	Mitigated TTP
AM Peak					**Year Capped: 2023**
Demand Flow (veh)	1664	1827	1910	1904	1904
Average Delay per Vehicle (Average over all arms in seconds)	30	102	196	179	45
LoS (Overall)	C	F	F	F	D
DoS (Worst Movement)	0.94	1.10	1.32	1.28	0.94
PM Peak					**Year Capped: 2023**
Demand Flow (veh)	2028	2241	2323	2317	2317
Average Delay per Vehicle (Average over all arms in seconds)	32	55	94	88	53
LoS (Overall)	C	D	F	F	D
DoS (Worst Movement)	0.91	1.01	1.11	1.11	0.99

To summarise, as shown by **Table 5.11**, the proposed mitigation measures are expected to reduce congestion and delays to an acceptable LoS during AM and PM peaks, and improve intersection performance during the Refined Baseline TTP scenario.

Wardell Road / Marrickville Road mitigation

As with the Wardell Road/Ewart Street intersection above, the intersection performance at Wardell Road / Marrickville Road would be expected to deteriorate due to traffic volume growth, and the addition of TTP bus volumes further increases congestion and delays at this intersection. The through and right turning movements from Marrickville Road north approach are the worst performing movements during both AM and PM peaks.

The following mitigation measures have been tested to reduce expected increase in congestion and delays:

- change lane arrangement for Wardell Road west from shared through and right, to right only
- change traffic signal phasing to run Marrickville Street north approach twice during the morning peak
- change traffic signal phasing to run Marrickville Street south approach twice during the evening peak
- run optimised phase times (whilst maintaining cycle time).

The phasing changes during the AM and PM peak provides the dominant approach more green time, and therefore reduces overall intersection delays and congestion. The lane configuration change on Wardell Road west is recommended due to the high proportion of vehicles making a right turn from this approach.

These mitigation measures result in improved intersection performance, as shown with LoS ‘D’ during the AM peak, and LoS ‘C’ during the PM peak for the Mitigated TTP scenario in **Table 5.12**.

Table 5.12 Wardell Road / Marrickville Road AM & PM Peak Mitigation Results

H.37 Wardell Road / Marrickville Road (Signals)					
Scenario	Existing	Future	Baseline TTP	Refined Baseline TTP	Mitigated TTP
AM Peak		**Year Capped: 2023**			
Demand Flow (veh)	1933	2123	2277	2221	2221
Average Delay per Vehicle (Average over all arms in seconds)	28	51	94	88	45
LoS (Overall)	B	D	F	F	D
DoS (Worst Movement)	0.90	1.10	1.17	1.20	0.97
PM Peak		**Year Capped: 2023**			
Demand Flow (veh)	2166	2393	2552	2494	2494
Average Delay per Vehicle (Average over all arms in seconds)	29	36	105	70	33
LoS (Overall)	C	C	F	E	C
DoS (Worst Movement)	0.86	0.92	1.31	1.25	0.90

To summarise, as shown by **Table 5.12**, the proposed mitigation measures are expected to reduce congestion and delays to an acceptable LoS during AM and PM peaks, and improve intersection performance during the Refined Baseline TTP scenario.

5.4.5 Public Transport Services

The main bus routes in the Dulwich Hill precinct are on Wardell Road, Ewart Street and Beauchamp Street (NSW Govt. 2016b). An assessment of the worksite extent shows that there would be no need for relocation of bus stops as a consequence of construction access and movements in the area.

While the worksite boundary is in close proximity to bus stops, it does not encroach into public land and would not therefore impact the bus network.

5.4.6 Active Transport Network

There are existing footpaths for pedestrians adjacent to the project area and associated worksite and compound areas. Construction activities are generally outside of the road reserve and therefore are not expected to affect pedestrian connectivity and safety along footpaths. Works adjacent to Ewart Lane and Bedford Crescent may require half road closures during construction activities and would potentially require closure of the footpath along one side of each road adjacent to the worksite during construction. Pedestrian accessibility would still be maintained during works via active transport management and pedestrians would be directed to footpaths unaffected by works on the opposite side of the road.

The following roads are considered cycling friendly, and within close proximity to the worksite [16]:

- Challis Avenue (dedicated cycling lanes)
- School Parade to Kays Avenue East containing separate dedicated cycling lanes along the south side of the railway
- Dudley Street (dedicated cycling lanes).

These roads are not expected to be impacted by construction activities as the works are not within the road reserve.

[16] Source - http://www.sydneycycleways.net/map/

There are five existing cycle racks, providing 10 bike parking spaces, in the open space on Bedford Crescent[17]. This area is proposed to be upgraded during station works[18]. Alternate bike parking locations would be assessed and provided during works, that would also be accessible for LRT customers, which would meet the requirements of the NSW Government Bike and Ride Program and TfNSW 'Bicycle Facilities' standard.

5.4.7 Commuter and Short-Term Parking

There are currently 55 dedicated commuter spaces in Ewart Lane near Dulwich Hill Station and due to the location of the worksite extent; approximately 27 spaces would be removed from use by short term construction possessions. During this time commuters can use on-street parking in local residential streets, transfer to buses or move to alternative modes of transport such as cycling.

Approximately nine out of the 17 time restricted spaces along Bedford Crescent would be removed from use for the entirety of the construction possession. During construction, there are short periods where construction activities may require additional footprint and the remaining spaces along Bedford Crescent would be suspended during these short term construction possessions.

Other on-street and off-street parking around the station would be unaffected by construction. Overall, there are approximately 1260 unrestricted parking spaces operating at 73% utilisation within a 400 m catchment that can be used by commuters.

Dedicated commuter spaces are not expected to be affected while the TTP is in operation, however approximately four on street spaces on Dudley Street south of the rail line would be affected by the TTP bus stops. These parking spaces would only be affected while the TTP is in operation, which is during possession periods. During these periods there is likely to be a reduction in demand for parking at the stations. This decrease results from the influence of school holiday periods and the change of mode share as some drivers choose to drive to another station or their destination.

5.4.8 Construction Worker Parking

It is anticipated that four to ten parking spaces would be provided at any one time for project workers in the Dulwich Hill area. The location of these parking spaces would be determined based on the specific location within the worksite which has active construction at the time.

Table 5.13 provides the anticipated daily construction workforce volume in the Dulwich Hill Area. It is assumed that public transport would be promoted as the primary mode of transport for construction workers. This would reduce the impacts on the local road network and parking requirements. As noted above, parking in the area is not fully utilised therefore there is capacity to accommodate any remaining demand for worker parking. Off-site parking alternatives and associated shuttle arrangements would also be investigated to transport workers to and from the site.

Table 5.13 Anticipated Daily Workforce- Dulwich Hill

	Non Possession		Possession Short Period Close-down	
	Peak	Typical / Average	Peak	Typical
Dulwich Hill Station	60	40	130	65

[17] Source - Southwest Metro – Extent of Precinct Works & Interchange Requirements, Sydney Metro
[18] Source – Sydney Metro Southwest Precinct Plan – Dulwich Hill Station, Sydney Metro

5.5 Hurlstone Park Station

5.5.1 Hurlstone Park Construction Haulage Routes

Figure 5.8 overleaf, shows the proposed construction haulage routes into the sites to be used during construction**.** At Hurlstone Park Station it is anticipated that 10 heavy and 10 light vehicles would be generated in the AM and PM peak hours. Construction haulage trips at night would be no more than nine heavy and five light vehicles per hour.

The swept path analysis determined that construction haulage vehicles are generally able to access all of the proposed sites / gates safely. However the left turn from Floss Street into Crinan Street is restricted by the existing kerb and a tree.

5.5.2 Hurlstone Park Temporary Transport Route

Two bus routes converge at Hurlstone Park, resulting in 33 buses per hour in each direction calling at Hurlstone Park Station in peak periods. The temporary transport bus stops for these routes would use existing bus stops. The remaining two TTS routes follow New Canterbury Road carrying a peak hour volume of 68 buses per hour in each direction and bypass Hurlstone Station. Please refer to **Appendix E** for the TTP.

The indicative rail replacement operation at Hurlstone Park Station is shown in **Figure 5.7**.

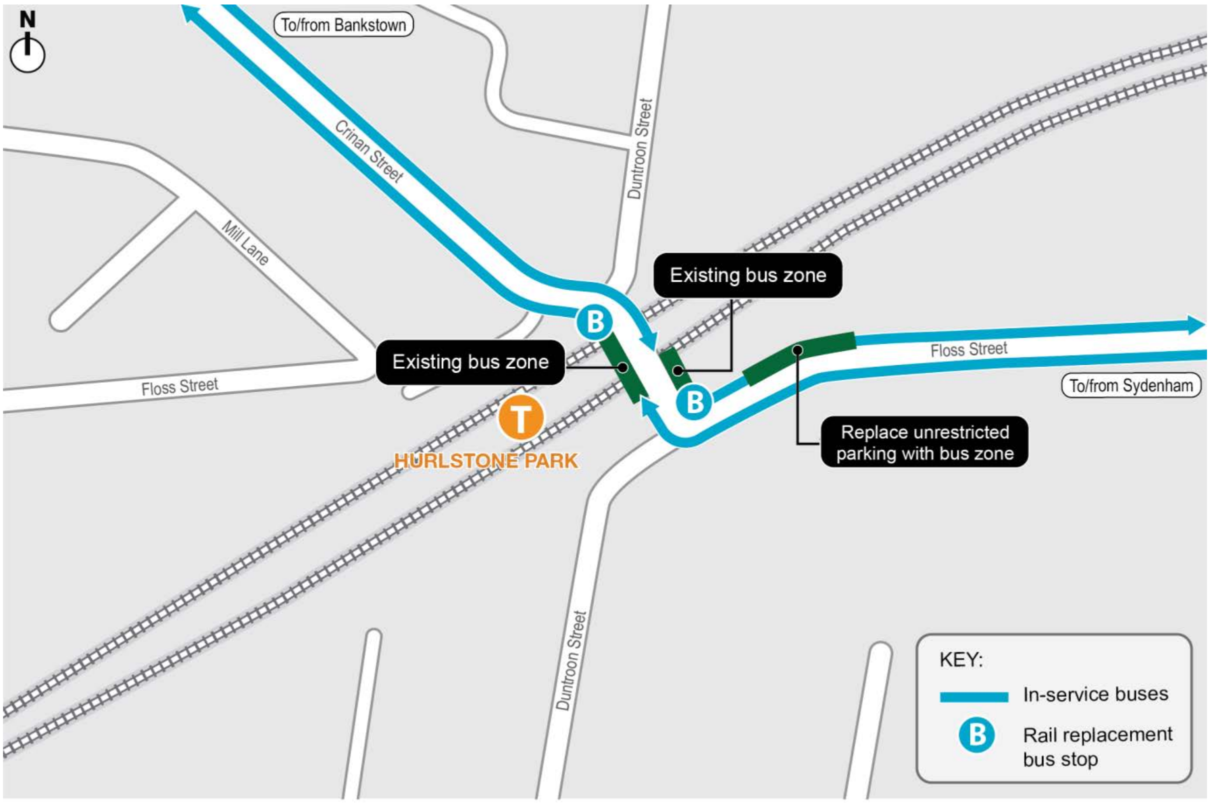

Figure 5.7 Temporary Transport Plan – Hurlstone Park (Sydney Metro 2017)

5.5.3 Road Network Operation and Intersection Performance

Four intersections were modelled in the area surrounding Hurlstone Park Station as shown in **Figure 5.8**.

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Hurlstone Park heavy vehicle routes and station intersections

FIGURE 5.8

Road Network Performance – AM Peak

Table 5.14 below shows a summary of the intersection assessment undertaken for this station.

Table 5.14 Hurlstone Park Station Intersection Assessment – AM Peak

Hurlstone Park Station – AM Peak					
Scenario	Existing	Future	Construction	Baseline TTP	Refined Baseline TTP
B.14 Canterbury Road / Crinan Street (Signals)					**Year Capped: 2023**
Demand Flow (veh)	3025	3322	3356	3503	3436
Average Delay per Vehicle (Average over all arms in seconds)	20	24	25	26	26
LoS (Overall)	B	B	B	B	B
DoS (Worst Movement)	0.61	0.67	0.68	0.74	0.73
B.27 Old Canterbury Road / New Canterbury Road (Signals)					**Year Capped: 2021**
Demand Flow (veh)	3052	3266	3266	3403	3316
Average Delay per Vehicle (Average over all arms in seconds)	26	34	34	56	41
LoS (Overall)	B	C	C	D	C
DoS (Worst Movement)	0.91	0.96	0.96	1.05	0.99
H.17 Crinan Street / Floss Street - South of Railway (Priority Controlled)					**Year Capped: 2023**
Demand Flow (veh)	703	772	788	811	852
Average Delay per Vehicle (Average over all arms in seconds)	8	8	8	8	8
Average Delay per Vehicle (Worst Movement in seconds)	12	12	12	12	13
LoS (Worst Movement)	A	A	A	A	A
DoS (Worst Movement)	0.25	0.28	0.29	0.32	0.37
H.18 Floss Street / Crinan Street / Duntroon Street (Priority Controlled)					**Year Capped: 2023**
Demand Flow (veh)	762	837	868	892	932
Average Delay per Vehicle (Average over all arms in seconds)	2	2	2	2	3
Average Delay per Vehicle (Worst Movement in seconds)	12	13	14	15	17
LoS (Worst Movement)	A	A	B	B	B
DoS (Worst Movement)	0.23	0.25	0.27	0.28	0.30

All of the intersections modelled at Hurlstone Park Station have a LoS ‘D’ or better for the worst case scenario which could be reasonably expected in the peak hour in Sydney.

Road Network Performance – PM Peak

Table 5.15 below shows a summary of the intersection assessment undertaken for this station.

Table 5.15 Hurlstone Park Station Intersection Assessment – PM Peak

Hurlstone Park Station – PM Peak					
Scenario	Existing	Future	Construction	Baseline TTP	Refined Baseline TTP
B.14 Canterbury Road / Crinan Street (Signals)				**Year Capped: 2023**	
Demand Flow (veh)	3253	3595	3629	3777	3710
Average Delay per Vehicle (Average over all arms in seconds)	20	20	22	25	27
LoS (Overall)	B	B	B	B	C
DoS (Worst Movement)	0.74	0.78	0.80	0.86	0.83
B.27 Old Canterbury Road / New Canterbury Road (Signals)				**Year Capped: 2023**	
Demand Flow (veh)	3413	3772	3772	3912	3823
Average Delay per Vehicle (Average over all arms in seconds)	31	36	36	46	37
LoS (Overall)	C	C	C	D	C
DoS (Worst Movement)	0.85	0.91	0.91	1.01	0.9
H.17 Crinan Street / Floss Street - South of Railway (Priority Controlled)				**Year Capped: 2023**	
Demand Flow (veh)	643	711	726	748	787
Average Delay per Vehicle (Average over all arms in seconds)	8	7	8	8	8
Average Delay per Vehicle (Worst Movement in seconds)	14	13	13	13	14
LoS (Worst Movement)	A	A	A	A	A
DoS (Worst Movement)	0.21	0.24	0.25	0.26	0.29
H.18 Floss Street / Crinan Street / Duntroon Street (Priority Controlled)				**Year Capped: 2023**	
Demand Flow (veh)	717	792	823	845	883
Average Delay per Vehicle (Average over all arms in seconds)	2	3	3	3	3
Average Delay per Vehicle (Worst Movement in seconds)	12	14	15	16	17
LoS (Worst Movement)	A	B	B	B	B
DoS (Worst Movement)	0.18	0.19	0.21	0.22	0.24

As with the AM Peak, all of the intersections modelled at Hurlstone Park Station have a LoS 'D' or better for the worst case scenario.

5.5.4 Public Transport Services

The main bus routes in the Hurlstone Park precinct are on Crinan Street, Hampden Street, The Parade and Garnet Street (NSW Govt. 2016b). An assessment of the worksite boundary shows that one bus stop would need to be relocated as a result of construction activities.

Bus route 406 travels along Duntroon Street which requires a full closure during possession periods. It is proposed that the bus reroutes using Tennant Parade, Garnet Street and Floss Street before crossing the Duntroon Street Overbridge. Bus stops 219319 in the southbound direction and 219350 in the northbound direction would be missed during the reroute. Passengers wishing to use these stops would be required to walk an extra 150m to the bus stops on Burnett Street.

5.5.5 Active Transport Network

There are existing footpaths for pedestrians adjacent to the worksite adjacent to Hurlstone Park Station. Construction activities at this location are generally outside of the road reserve (except for Floss Street) and therefore are not expected to affect pedestrian connectivity and safety along footpaths.

Station works would potentially require the closure of Floss Street commuter car park and footpath closure on Duntroon Street (adjacent Hurlstone Park Station) during possession periods only. During such periods, the footpath would be maintained via active traffic management and re-directing pedestrians to footpaths unaffected by works. Pedestrians may be redirected to cross the road at upstream intersections, however further analysis of these intersections feasibility are subject to construction staging details. The staging details would also provide details for pedestrian diversions and the total distance and delay experienced by them during works.

There are no dedicated or cycle friendly roads in close proximity to the worksite and 12 dedicated bike parking spaces facilities at this station [19]. The roads identified as bike friendly on Crinan Street, Garnet Street and Dunstaffenage Street have also been identified for potential construction vehicle haulage routes. The roads are reasonably wide but allow parking on either side. The relatively low volume of construction haulage vehicles should not have a major effect on the user experience or safety of the cyclists.

5.5.6 Commuter and Short-Term Parking

The 23 time-restricted spaces on Floss Street adjacent to the station are expected to be removed from use for the entirety of the possession. Other on-street and off-street parking around the station would be unaffected by construction. Overall, there are approximately 1,150 on and off-street unrestricted parking spaces operating at 55% utilisation within a 400 m catchment available for use as informal park and ride spaces.

Approximately eight on street spaces on Floss Street south of the rail line would be affected by the TTP bus stops. These parking spaces would only be affected while the TTP is in operation, which is during possession periods. During these periods demand for parking is likely to reduce at the stations. This decrease arises during school holiday periods and the change of mode share as some drivers choose to drive to another station or their destination.

5.5.7 Construction Worker Parking

It is anticipated that four to ten parking spaces would be provided at any one time for project workers in the Hurlstone Park area. The location of these parking spaces would be based on the specific location within the worksite which has active construction at the time.

Table 5.16 provides the anticipated daily construction workforce volume in the Hurlstone Park Area. It is assumed that public transport would be promoted as the primary mode of transport for construction workers. This would reduce the impacts on the local road network and parking requirements. As noted above, parking in the area is not fully utilised therefore there is capacity to accommodate any remaining demand for worker parking. Off-site parking alternatives and associated shuttle arrangements would be also investigated to transport workers to and from the site.

Table 5.16 Anticipated Daily Workforce- Hurlstone Park

	Non Possession		Possession Short Period Close-down	
	Peak	Typical / Average	Peak	Typical
Hurlstone Park Station	60	40	140	65

[19] Source - http://www.sydneycycleways.net/map/

5.6 Canterbury Station

5.6.1 Canterbury Construction Haulage Routes

Figure 5.10 overleaf, shows the proposed construction haulage routes into the sites to be used during construction. Cumulatively the peak effects on the road network from the construction activities in the locale of Canterbury Station are forecast to be an addition of 24 heavy and 22 light vehicles in the AM and PM peak hours. Construction haulage trips at night would be no more than nine heavy and five light vehicle movements per hour.

The swept path analysis determined that construction haulage vehicles are able to access all of the proposed sites / gates safely with the exception of:

- Canterbury Road / Close Street – the 12.5m truck left in and out movements cannot take place simultaneously. Access out of Close Street onto Canterbury Road could be managed through active traffic management to ensure exiting trucks would not conflict with trucks entering Close Street
- truck movement along Close Street – Close Street is quite narrow and would not accommodate two way truck movements at the same time. Inbound and outbound truck movements could be carried out under active traffic management to remove conflicts
- site entry to Canterbury Bowls gate – access to Canterbury Bowls could be carried out under active traffic management so that truck movements in and out of the worksite would not conflict with each other
- Canterbury Road / Broughton Street – the left turn truck movement into Broughton Street conflicts with vehicles exiting this street. This conflict could be mitigated by temporarily relocating the Broughton Street approach limit line further back, such that vehicles are waiting at the traffic lights away from the conflict area.

5.6.2 Canterbury Temporary Transport Route

Three bus routes converge before Canterbury, resulting in 79 buses per hour in each direction calling at Canterbury Station in peak periods. Existing bus stops would be used as temporary transport bus stops for these routes.

The indicative rail replacement operation at Canterbury Station is shown in **Figure 5.9**.

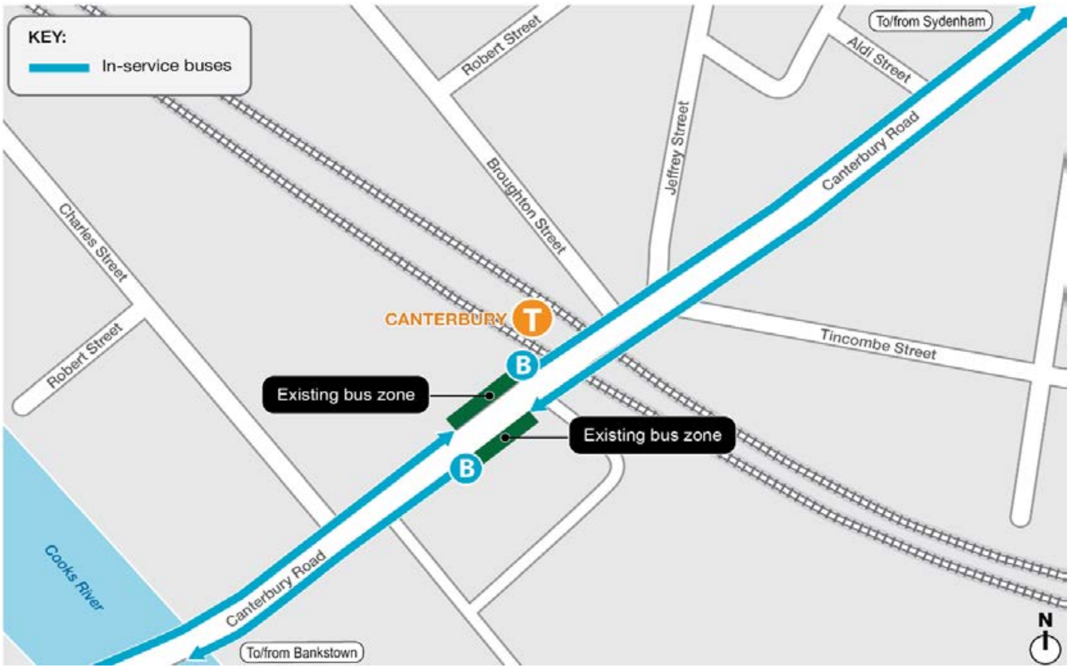
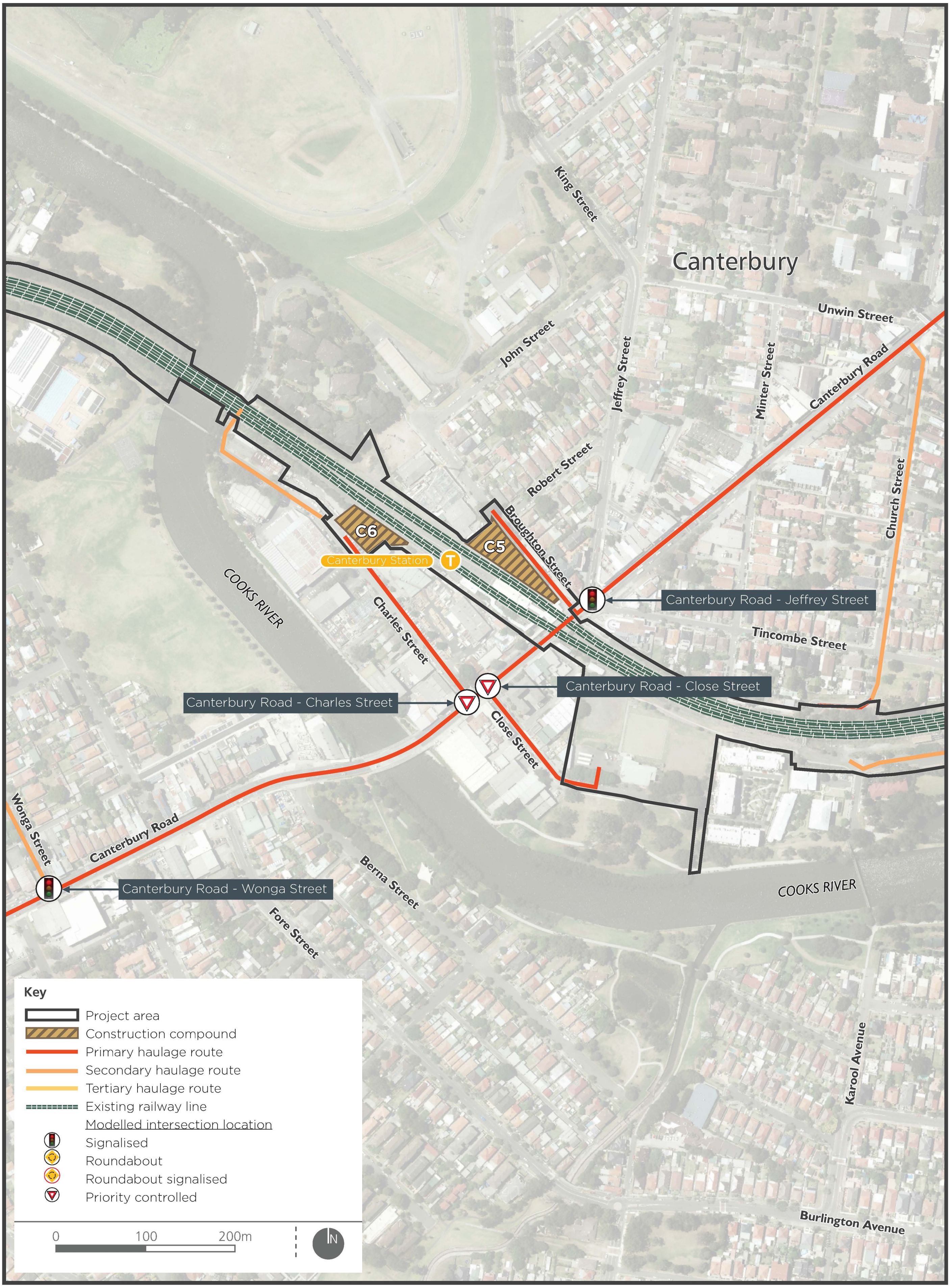


Figure 5.9 Temporary Transport Plan – Canterbury (Sydney Metro 2017)



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Canterbury Station heavy vehicle routes and station intersections

FIGURE 5.10

5.6.3 Road Network Operation and Intersection Performance

Four intersections were modelled in the area surrounding Canterbury Station as shown in **Figure 5.10**.

Road Network Performance - AM Peak

Table 5.17 below shows a summary of the intersection assessment undertaken for this station.

Table 5.17 Canterbury Station Intersection Assessment – AM Peak

Canterbury Station – AM Peak					
Scenario	Existing	Future	Construction	Baseline TTP	Refined Baseline TTP
B.13 Canterbury Road / Wonga Street (Signals)				**Year Capped: 2023**	
Demand Flow (veh)	3393	3726	3754	3913	3834
Average Delay per Vehicle (Average over all arms in seconds)	18	21	21	26	21
LoS (Overall)	B	B	B	B	B
DoS (Worst Movement)	0.79	0.82	0.83	0.90	0.84
H.14 Canterbury Road / Charles Street (Priority Controlled)				**Year Capped: 2023**	
Demand Flow (veh)	3135	3442	3471	3629	3551
Average Delay per Vehicle (Average over all arms in seconds)	3	5	5	7	6
Average Delay per Vehicle (Worst Movement in seconds)	252	460	494	737	608
LoS (Worst Movement)	F	F	F	F	F
DoS (Worst Movement)	0.52	0.57	0.58	0.62	0.60
H.15 Canterbury Road / Jeffrey Street (Signals)				**Year Capped: 2023**	
Demand Flow (veh)	3249	3568	3606	3766	3687
Average Delay per Vehicle (Average over all arms in seconds)	17	17	18	18	18
LoS (Overall)	B	B	B	B	B
DoS (Worst Movement)	0.80	0.88	0.88	0.88	0.88
H.14 Canterbury Road / Close Street (Priority Controlled)				**Year Capped: 2023**	
Demand Flow (veh)	3101	3405	3447	3605	3527
Average Delay per Vehicle (Average over all arms in seconds)	0	0	0	0	0
Average Delay per Vehicle (Worst Movement in seconds)	17	21	22	28	25
LoS (Worst Movement)	B	B	B	C	B
DoS (Worst Movement)	0.51	0.56	0.57	0.61	0.59

For three of the four intersections modelled, the increase in delay resulting from future traffic growth, construction haulage traffic and TTP results in a LoS ‘C’ or better. This delay would not be atypical of peak hour conditions within Sydney and would generally be considered reasonable during peak periods

Canterbury Road / Charles Street has an existing and future LoS ‘F’ which is based on the worst movement (right turn movement out from Charles Street).

The model shows that the average intersection delay across all arms would be a maximum of five seconds for the worst scenario and the delay for the worst movement would be approximately 14 minutes. This implies that the main (through) movement is operating with negligible delay and the level of service is being heavily influenced by the small volumes of traffic turning left and right out of Charles Street.

In practice, drivers would not wait 10 minutes to turn right from Charles Street as modelled for the existing scenario. A short detour under the Cooks River / Charles Street Underbridge to the signalised crossing at Broughton Street / Canterbury Road could be used to turn left and right onto Canterbury Road.

There is a proposal to convert the Canterbury Road / Charles Street intersection to signal control, although full details of this proposal were not available at the time this assessment was undertaken. Temporary or permanent signals at the intersection would reduce the delay for right turning vehicles. Signals would also improve safety in the area as it would reduce the number of drivers pulling out into small gaps.

Road Network Performance – PM Peak

Table 5.18 overleaf shows a summary of the intersection assessment undertaken for this station.

Table 5.18 Canterbury Station Intersection Assessment – PM Peak

Canterbury Station – PM Peak					
Scenario	Existing	Future	Construction	Baseline TTP	Refined Baseline TTP
B.13 Canterbury Road / Wonga Street (Signals)					**Year Capped: 2023**
Demand Flow (veh)	3705	4094	4121	4279	4201
Average Delay per Vehicle (Average over all arms in seconds)	21	23	23	24	23
LoS (Overall)	B	B	B	B	B
DoS (Worst Movement)	0.76	0.83	0.84	0.88	0.86
H.14 Canterbury Road / Charles Street (Priority Controlled)					**Year Capped: 2023**
Demand Flow (veh)	3502	3870	3898	4056	3978
Average Delay per Vehicle (Average over all arms in seconds)	1	2	2	2	2
Average Delay per Vehicle (Worst Movement in seconds)	321	574	573	570	570
LoS (Worst Movement)	F	F	F	F	F
DoS (Worst Movement)	0.54	0.60	0.61	0.66	0.64
H.15 Canterbury Road / Jeffrey Street (Signals)					**Year Capped: 2023**
Demand Flow (veh)	3636	4017	4056	4217	4138
Average Delay per Vehicle (Average over all arms in seconds)	20	27	27	28	27
LoS (Overall)	B	B	B	B	B
DoS (Worst Movement)	0.91	0.93	0.93	0.93	0.93

Canterbury Station – PM Peak					
Scenario	Existing	Future	Construction	Baseline TTP	Refined Baseline TTP
H.14 Canterbury Road / Close Street (Priority Controlled)					**Year Capped: 2023**
Demand Flow (veh)	3468	3832	3875	4033	3955
Average Delay per Vehicle (Average over all arms in seconds)	1	1	1	2	2
Average Delay per Vehicle (Worst Movement in seconds)	32	45	47	60	53
LoS (Worst Movement)	C	D	D	E	D
DoS (Worst Movement)	0.52	0.57	0.59	0.63	0.61

For two of the four intersections modelled, the increase in delay resulting from future traffic growth, construction haulage traffic and TTP results in a LoS 'C' or better

The Canterbury Road / Charles Street intersection has an existing and future LoS 'F' which is based off the worst movement (right turn movement out from Charles Street). The modelling shows the construction and TTP have minimal effect.

The Canterbury Road / Close Street intersection is forecast to experience a slight increase in delays for in the PM Peak for the future scenarios. The worst movement delay is the right turn movement from the Canterbury Road west approach onto Close Street, which is approximately one minute. The delay for this movement results from the increase in future traffic and TTP buses through Canterbury Road which provides fewer opportunities for gaps to allow drivers to perform safe right turn movements. This pushes the level of service to the LoS 'E' in the TTP scenario from LoS 'D' in the Construction scenario.

5.6.4 Public Transport Services

The main bus routes in the Canterbury precinct are on Canterbury Road, Fore Street, Wonga Street and Jeffrey Street (NSW Govt. 2016b). An assessment of the worksite extent shows that there should not be a requirement for bus stops to be relocated in the area as a result of construction activities.

While there are a number of construction access gates in close proximity to bus stops, the worksite extent is assumed to be in land owned by the RailCorp and should therefore not impact the bus network.

5.6.5 Active Transport Network

There are existing footpaths for pedestrians adjacent to the project area in this region. The majority of the construction activities at these sites are outside of the road reserve and therefore are not expected to affect pedestrian connectivity and safety. However, it is proposed to relocate the existing footbridge off Broughton Street/Canterbury Road. During this relocation, temporary pedestrian diversions would be in place. The operational impacts of these changes are discussed separately in Chapter 8.

Further, footpath diversions may be required temporarily along Broughton Street during the relocation of the station entrance. Additional compounds and accesses to facilitate bridge related construction are considered separately in Chapter 6.

There are no cycle friendly roads in close proximity to the worksites in this area, other than a dedicated separate cycleway along Cooks River south of Canterbury Station, which would not be impacted by construction activities[20].

There are no dedicated bike parking facilities at this station[21].

[20] Source - http://www.sydneycycleways.net/map/

5.6.6 Commuter and Short-Term Parking

There are currently 32 dedicated commuter spaces at or near Canterbury Station. All of the 32 unrestricted spaces in the recently constructed off-street parking area along Charles Street to the southwest of the station are expected to be removed from use by short term construction possessions, returning to parking during possessions.

Other on-street and off-street parking around the station would be unaffected by construction. Overall, there are approximately 700 on and off-street unrestricted parking spaces operating at 64% utilisation within a 400 m catchment which can be used as informal park and ride spaces.

While the TTP is in operation, the replacement buses would stop on Canterbury Road Overbridge and would not interfere with on and off street carpark spaces.

5.6.7 Construction Worker Parking

It is anticipated that four to ten parking spaces would be provided at any one time for project workers in the Canterbury area. The location of these parking spaces would move dependent on the specific location within the worksite which has active construction at the time.

Table 5.19 provides the anticipated daily construction workforce volume in the Canterbury Area. It is assumed that public transport would be promoted as the primary mode of transport for construction workers. This would reduce the impacts on the local road network and parking requirements. As noted above, parking in the area is not fully utilised therefore there is capacity to accommodate any remaining demand for worker parking. Off-site parking alternatives and associated shuttle arrangements would also be investigated to transport workers to and from the site.

Table 5.19 Anticipated Daily Workforce- Canterbury

	Non Possession		Possession Short Period Close-down	
	Peak	Typical / Average	Peak	Typical
Canterbury Station	75	50	160	75

[21] Source - Southwest Metro – Extent of Precinct Works & Interchange Requirements, Sydney Metro

5.7 Campsie Station

5.7.1 Campsie Construction Haulage Routes

Figure 5.12 overleaf, shows the proposed construction haulage routes into the sites to be used during construction. At Campsie Station it is anticipated that 10 heavy and 10 light vehicles would be generated in the AM and PM peak hours. Construction haulage trips at night would be no more than nine heavy and five light vehicle movements per hour.

The swept path analysis determined that construction haulage vehicles are able to access all of the proposed sites / gates safely. Campsie Temporary Transport Route

Two bus routes converge before Campsie, resulting in 46 buses per hour in each direction calling at Campsie Station in peak periods. The temporary transport bus stops for these routes would be existing bus stops.

The indicative rail replacement operation at Campsie Station is shown in **Figure 5.11**.

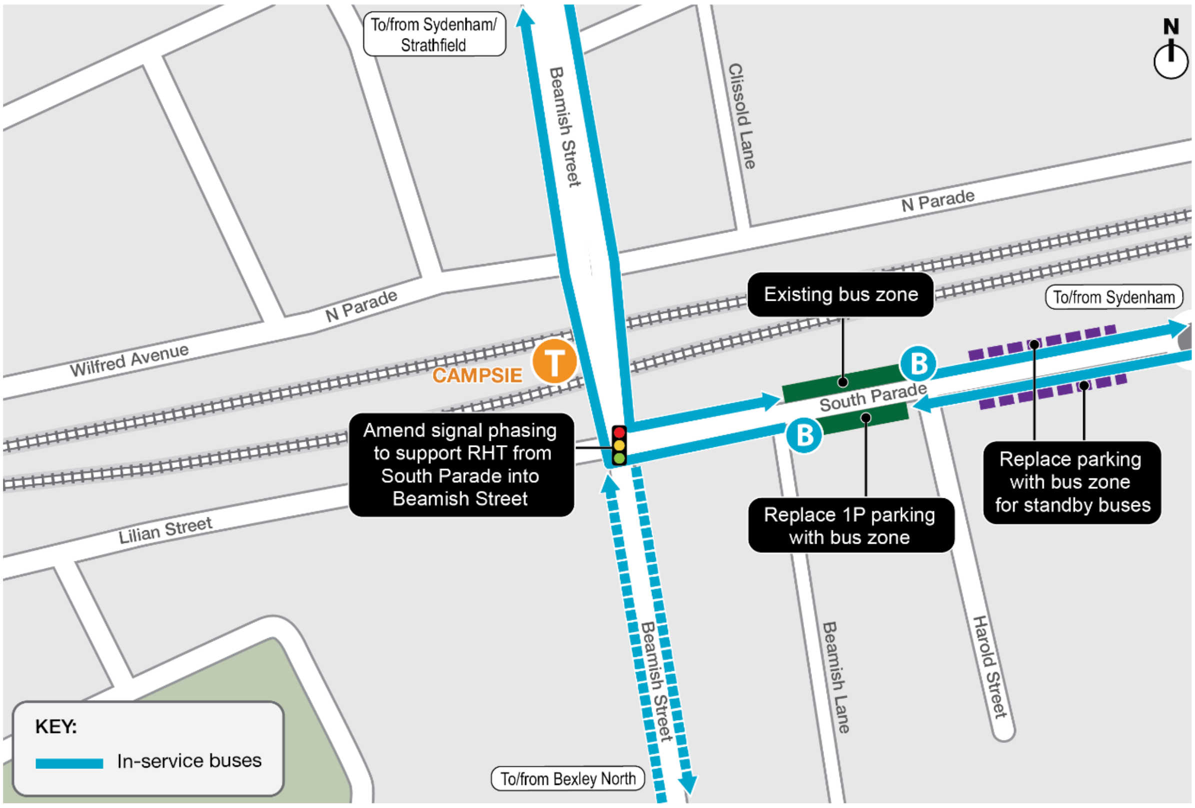
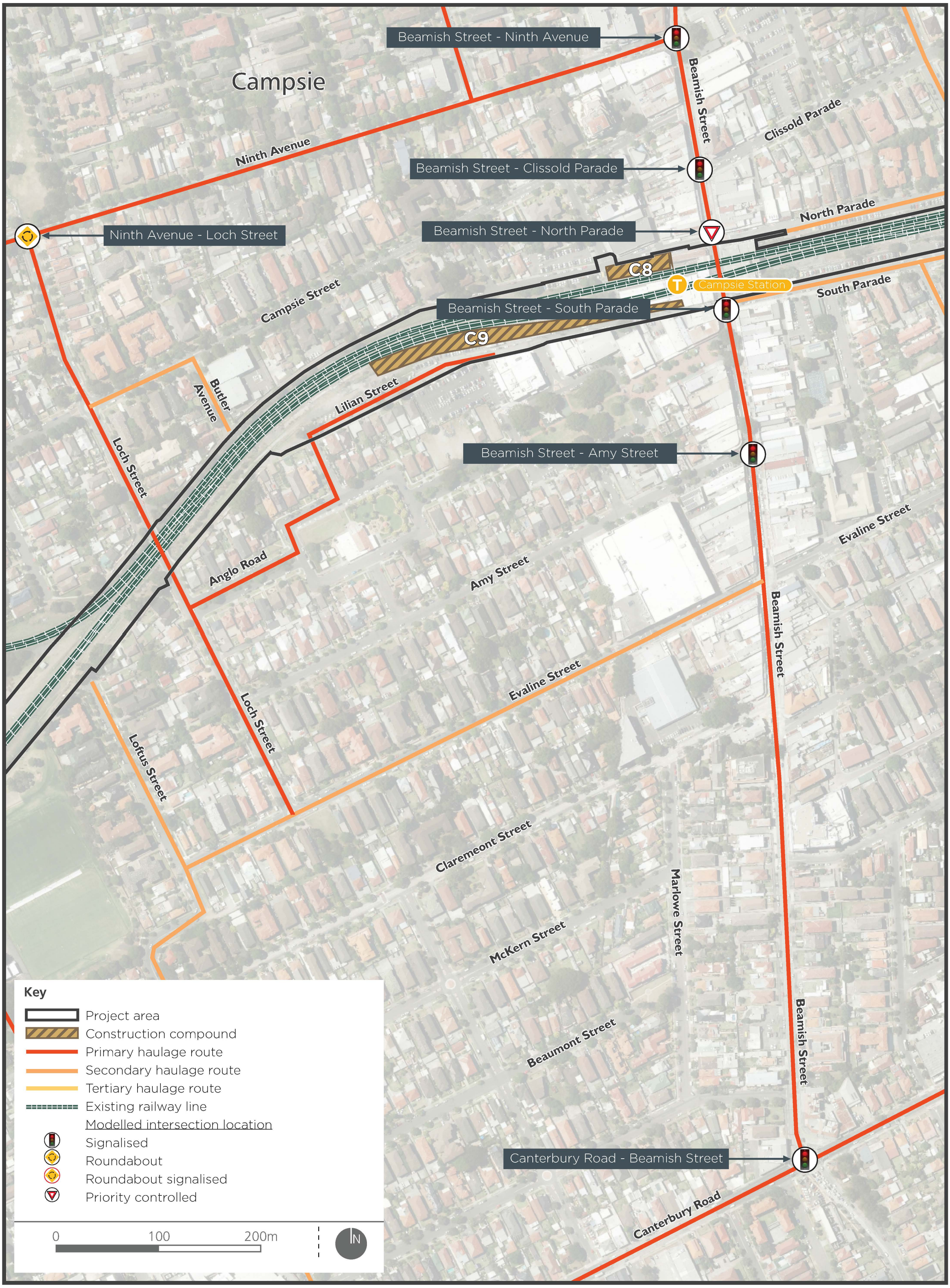


Figure 5.11 Temporary Transport Plan – Campsie (Sydney Metro 2017)

Bus route 2 travels down Canterbury Road, avoiding Campsie Station. The remaining bus route originates east of Campsie.

5.7.2 Road Network Operation and Intersection Performance

Seven intersections were modelled in the area surrounding Campsie Station as shown on **Figure 5.12**.



Sydney Metro city & southwest

Campsie Station heavy vehicle routes and station intersections

FIGURE 5.12

Road Network Performance – AM Peak

Table 5.20 below shows a summary of the intersection assessment undertaken for this station.

Table 5.20 Campsie Station Intersection Assessment – AM Peak

Campsie Station – AM Peak					
Scenario	**Existing**	**Future**	**Construction**	**Baseline TTP**	**Refined Baseline TTP**
B.10 Beamish Street / Ninth Avenue (Signals)					**Year Capped: 2023**
Demand Flow (veh)	1771	1944	1960	2053	1990
Average Delay per Vehicle (Average over all arms in seconds)	15	15	16	16	16
LoS (Overall)	B	B	B	B	B
DoS (Worst Movement)	0.60	0.69	0.69	0.71	0.71
B.11 Beamish Street / Clissold Parade (Signals)					**Year Capped: 2023**
Demand Flow (veh)	1494	1641	1657	1751	1739
Average Delay per Vehicle (Average over all arms in seconds)	14	28	24	39	38
LoS (Overall)	A	B	B	C	C
DoS (Worst Movement)	0.70	0.81	0.78	0.94	0.92
B.12 Beamish Street / South Parade (Signals)					**Year Capped: 2023**
Demand Flow (veh)	1486	1632	1649	1742	1730
Average Delay per Vehicle (Average over all arms in seconds)	20	21	22	31	29
LoS (Overall)	B	B	B	C	C
DoS (Worst Movement)	0.73	0.90	0.92	0.91	0.91
H.11 Beamish Street / North Parade (Priority Controlled)[22]					**Year Capped: 2023**
Demand Flow (veh)	1446	1593	1616	1711	1699
Average Delay per Vehicle (Average over all arms in seconds)	2	2	3	3	3
Average Delay per Vehicle (Worst Movement in seconds)	27	31	36	43	35
LoS (Worst Movement)	B	C	C	D	C
DoS (Worst Movement)	0.64	0.71	0.72	0.72	0.72

[22] This intersection has been modelled within a local network of Beamish Street/Clissold Street and Beamish Street/South Parade Street intersections in order to take the northbound and southbound gaps in the traffic flows into account.

Campsie Station – AM Peak					
Scenario	**Existing**	**Future**	**Construction**	**Baseline TTP**	**Refined Baseline TTP**
H.12 Beamish Street / Amy Street (Signals)					**Year Capped: 2023**
Demand Flow (veh)	1145	1257	1267	1267	1267
Average Delay per Vehicle (Average over all arms in seconds)	8	8	8	8	8
LoS (Overall)	A	A	A	A	A
DoS (Worst Movement)	0.45	0.51	0.52	0.52	0.52
H.13 Canterbury Road / Beamish Street (Signals)					**Year Capped: 2023**
Demand Flow (veh)	4227	4642	4642	4713	4642
Average Delay per Vehicle (Average over all arms in seconds)	38	38	38	38	38
LoS (Overall)	C	C	C	C	C
DoS (Worst Movement)	0.94	0.95	0.95	0.91	0.95
H.34 Ninth Avenue / Loch Street (Roundabout)					**Year Capped: 2023**
Demand Flow (veh)	2067	2270	2270	2364	2301
Average Delay per Vehicle (Average over all arms in seconds)	10	20	20	47	26
Average Delay per Vehicle (Worst Movement in seconds)	18	44	44	123	63
LoS (Worst Movement)	B	D	D	F	E
DoS (Worst Movement)	0.81	0.97	0.97	1.10	1.01

For six of the seven intersections modelled, the increase in delay resulting from future traffic growth, construction haulage traffic and TTP results in a LoS 'D' or better.

'The Ninth Avenue / Loch Street roundabout is the only intersection forecast to experience a significant decline in amenity as a result of the addition of the TTP traffic. The overall intersection has a LoS of 'D' in the construction scenario, worsening to a LoS 'F' in the TTS scenario.

The through and right turning movements from the Ninth Avenue west approach are the worst performing movements with a delay of two minutes in the TTP scenario. The intersection is already near capacity in the construction scenario, and with the additional 46 TTP buses to the Ninth Avenue west approach, the intersection is pushed over capacity leading to the sharp increase in delay.

The Refined Baseline TTP scenario reduces the delay for the worst movement to just over one minute and reduces the LoS to 'E' which is a level of service most drivers would consider acceptable during peak periods.

There are a number of parallel roads, such as Eighth Avenue, which do not have TTS buses travelling along them. Some of the vehicles that currently use Ninth Avenue would divert to those parallel roads while the TTP is in operation. This would reduce the demand at the Ninth Avenue / Loch Street intersection. Scheduling construction works during any of the school term break periods would alleviate congestion to the point that the roundabout would be operating within capacity.

Due to the proximity and interaction between Beamish Street/ Clissold Street and Beamish Street/ South Parade Street, these have been modelled within a local network in order to take the northbound and southbound gaps in the traffic flows into account.

Road Network Performance – PM Peak

Table 5.21 below shows a summary of the intersection assessment undertaken for this station.

Table 5.21 Campsie Station Intersection Assessment – PM Peak

Campsie Station – PM Peak					
Scenario	**Existing**	**Future**	**Construction**	**Baseline TTP**	**Refined Baseline TTP**
B.10 Beamish Street / Ninth Avenue (Signals)					**Year Capped: 2023**
Demand Flow (veh)	1869	2065	2081	2175	2111
Average Delay per Vehicle (Average over all arms in seconds)	17	17	17	19	18
LoS (Overall)	B	B	B	B	B
DoS (Worst Movement)	0.61	0.71	0.73	0.85	0.79
B.11 Beamish Street / Clissold Parade (Signals)					**Year Capped: 2023**
Demand Flow (veh)	1595	1762	1778	1872	1860
Average Delay per Vehicle (Average over all arms in seconds)	19	60	68	203	180
LoS (Overall)	B	E	E	F	F
DoS (Worst Movement)	0.82	1.05	1.07	1.41	1.35
B.12 Beamish Street / South Parade (Signals)					**Year Capped: 2023**
Demand Flow (veh)	1531	1692	1710	1802	1790
Average Delay per Vehicle (Average over all arms in seconds)	20	25	26	103	93
LoS (Overall)	B	B	B	F	F
DoS (Worst Movement)	0.83	0.96	0.94	1.88	1.79
H.11 Beamish Street / North Parade (Priority Controlled)[23]					**Year Capped: 2023**
Demand Flow (veh)	1447	1609	1566[24]	1558[20]	1720
Average Delay per Vehicle (Average over all arms in seconds)	2	2	2	3	36
Average Delay per Vehicle (Worst Movement in seconds)	26	29	35	60	877
LoS (Worst Movement)	B	C	C	E	F
DoS (Worst Movement)	0.65	0.72	0.72	0.78	1.78
H.12 Beamish Street / Amy Street (Signals)					**Year Capped: 2023**
Demand Flow (veh)	1266	1399	1408	1408	1408
Average Delay per Vehicle (Average over all arms in seconds)	9	17	19	19	19
LoS (Overall)	A	B	B	B	B
DoS (Worst Movement)	0.84	0.94	0.95	0.95	0.96

[23] * This intersection has been modelled within a local network of Beamish Street/Clissold Street and Beamish Street/South Parade Street intersections in order to take the northbound and southbound gaps in the traffic flows into account.

[24] Arrival flow is reduced by the model due to capacity constraint at oversaturated upstream lanes.

Campsie Station – PM Peak					
Scenario	**Existing**	**Future**	**Construction**	**Baseline TTP**	**Refined Baseline TTP**
H.13 Canterbury Road / Beamish Street (Signals)					**Year Capped: 2023**
Demand Flow (veh)	3848	4252	4252	4319	4252
Average Delay per Vehicle (Average over all arms in seconds)	34	35	35	35	34
LoS (Overall)	C	C	C	C	C
DoS (Worst Movement)	0.94	0.94	0.94	0.94	0.92
H.34 Ninth Avenue / Loch Street (Roundabout)					**Year Capped: 2023**
Demand Flow (veh)	2279	2518	2518	2612	2548
Average Delay per Vehicle (Average over all arms in seconds)	11	21	21	40	26
Average Delay per Vehicle (Worst Movement in seconds)	13	29	29	63	37
LoS (Worst Movement)	A	B	B	E	C
DoS (Worst Movement)	0.84	0.97	0.97	1.04	0.99

For four of the seven intersections modelled, the increase in delay resulting from future traffic growth, construction haulage traffic and TTP results in a LoS ‘C’ or better. This delay would not be atypical of peak hour conditions within Sydney.

The Beamish Street / Clissold Parade intersection is forecast to experience a decline in amenity as a result of the addition of the TTP traffic. The intersection has a LoS of ‘E’ in the construction scenario, worsening to a LoS ‘F’ in the Baseline TTP.

The right turning movement from the Beamish Street south approach is the worst performing movement with a modelled delay increasing to over seven minutes in the Baseline TTP . This is a modelled delay, and reflects the demands are exceeding capacity. Drivers would be unlikely to choose to queue for seven minutes to turn right from Beamish Street south, instead diverting or retiming their journey to avoid the peak periods. Drivers could potentially reroute using North Parade while the through traffic at the Beamish Street / Clissold Parade intersection is in the intergreen phase.

The Refined Baseline TTP scenario results in a minor reduction in delay and no change in the level of service as there are still 15 replacement buses running along Beamish Street.

The Beamish Street / South Parade intersection is also forecast to experience a decline in amenity as a result of the addition of the TTP buses. The intersection has a LoS of ‘B’ in the construction scenario, worsening to a LoS of ‘F’ in the TTP scenario.

The right turning movement from the South Parade east approach is the worst performing movement with the delay for the movement increasing to over 14 minutes. This results from the high volume of pedestrian movements across Beamish Street and the 46 TTP buses waiting to turn right from South Parade east. The Refined Baseline TTP has 40 buses and therefore the level of service remains as ‘F’.

Site observations in March 2017 observed additional delays at the beginning of the movements from the eastern and western approaches. The average delays recorded were approximately seven, 12 and 10 seconds for the left and right turn movements from the east approach (South Parade) and left turn out from the west approach (Lilian Street), respectively. The pedestrian count records at the Beamish Street / North Parade intersection shows a lower magnitude of pedestrian activity in the AM peak by nearly 35 percent. However, the same levels of lost times as the observed values in the PM peak are assumed for the AM peak, given the observed delays are close to the minimum crossing times for pedestrians over the approaches of the intersection.

It is likely that drivers would continue to use Beamish Street / South Parade while the TTP is in operation despite the increased levels of delay as it connects people from the northern and southern sides of the railway line with few local diversion routes available. As a result, whilst the modelled delay is a theoretical value that exceeds any likely delay that would occur, there are potential safety impacts that this highlights. With modelled delays at this level it suggest that driver frustration would potentially lead to drivers attempting manoeuvres during the late amber period of signal phase changes.

The Ninth Avenue / Loch Street intersection is also forecast to experience a decline in amenity as a result of the addition of the TTP buses. The intersection has a LoS of 'B' in the future and construction scenarios, worsening to a LoS of 'E' in the Baseline TTP. This roundabout provides local access to residential areas at Campsie.

The through and left turning movements from the Ninth Avenue east approach are the worst performing movements with the delay increasing to over one minute in the TTP scenario. The intersection is already near capacity in the construction scenario, and with the additional 46 TTP buses to the Ninth Avenue east approach, the intersection is pushed over capacity leading to the sharp increase in delay. Whilst the PM LoS would not justify it, the timing of the works for the term 4 break to mitigate the morning conditions would result in further reductions to the delay predicted in the PM.

5.7.3 Public Transport Services

The main bus routes at Campsie Station are on Beamish Street, Ninth Avenue, Fifth Avenue, Brighton Avenue, South Parade and Duke Street (NSW Govt. 2016b). An assessment of the worksite extent shows that a bus stop would need to be relocated to accommodate construction activities.

Works adjacent to South Parade, west of the bus stop, are next to bus stop 419216. This bus stop is along bus route 487 and the origin/destination of routes 412, 415, 444, 445 and 473. Half lane closures are required for this activity for day and night works. During this time, the bus stop for the origin/destination routes could be moved to the opposite side of the railway track on North Parade, still providing direct access to the station. As North Parade / Beamish Street is a priority intersection, it is recognised that this proposal may create additional delays for buses turning out of North Parade. Further consultation and assessment of alternatives would be undertaken prior to construction.

Route 487 could travel through Evaline Street, avoiding South Parade. If this diversion was to be put in place, temporary bus stops would need to be established on Evaline Street, requiring pedestrians to walk approximately 300m further to access the station.

A potential alternative diversion would involve redirecting the buses on a full loop of Campsie; using Evaline Street, Beamish Street, South Parade, Duke Street and back along Evaline Street, before continuing on its usual route. This enables all buses to travel in a one way direction along South Parade.

5.7.4 Active Transport Network

There are existing footpaths for pedestrians next to the works adjacent to South Parade (east of Campsie Station), Lilian Lane, Wilfred Ave and North Parade (west of Campsie Station). Construction activities for this worksite extent are generally outside of the road reserve and therefore are not expected to affect pedestrian connectivity and safety along footpaths. The extent of impacts to pedestrians in these locations would be expected to hoardings resulting in reduced footpath widths.

The exception is one of the construction haulage routes into Lilian Street and the construction compound adjacent to Lilian Street/Lilian Lane. Access to this compound and wider worksite area is expected to require some discreet road closure periods, but this is planned to occur during night works and therefore expected to have minor effects on pedestrians. Active traffic management would be in place during closure periods to direct pedestrians to a safe alternative route away from the access gate. Pedestrians may be redirected to cross the road at upstream locations, however further analysis of the feasibility of using theses intersections are subject to construction staging details. The staging details would also provide details for pedestrian diversions and the total distance and delay experienced by them during works.

Works to install a new kerbside facility on the east side of Beamish Street may also require pedestrian management on South Parade and North Parade during construction. Dedicated separate cycleways at Anzac Square connect to Beamish Street and on Harold Street between South Parade and Evaline Street[25]. There are no adjacent works or station compound sites nearby which could potentially impact these cycleways. However, as noted above, Lilian Lane is narrow and combined with the expected night time road closures and presence of some construction traffic that would be larger and wider than other vehicles, some minor effects on cyclists can be expected. Traffic management practices including detours would enable safe passage for cyclists.

There is existing bike parking on the station forecourt at Beamish Street[26]. This area is proposed to be upgraded to a mixed use / plaza type area and the bike parking relocated to North Parade[27]. It is recommended to stage construction such that the new bike parking is completed prior to affecting the existing bike parking.

A short section of Campsie Street, closest to Beamish Street, is common to both the on-street cycle friendly network and the construction haulage routes. Due to the relatively low volume of construction haulage vehicles and the short section of road, there should not be a major effect on the user experience or safety of the cyclists.

5.7.5 Commuter and Short-Term Parking

There are currently 138 dedicated commuter parking spaces at or near Campsie Station and 14 of these spaces would be removed from use for the entirety of the construction possession due to the location of the worksite extent. A further 45 spaces would be removed from use by short term construction possessions. During this time commuters can use on-street parking in local residential streets, transfer to buses or move to alternative modes of transport such as cycling.

Other on-street and off-street parking around the station would be unaffected by construction. Overall, there are approximately 925 unrestricted parking spaces operating at 89% utilisation within a 400 m catchment that can be used as informal park and ride spaces.

Extra bus stops required for TTP operation would impact 40 dedicated commuter spaces on the northern side of South Parade. Approximately three further on street short-term spaces on the southern side of South Parade would be affected by the TTP bus stops. These parking spaces would only be affected while the TTP is in operation, which is during possession periods. During these periods there is likely to be a reduction in demand for parking at the stations owing to school holiday periods and the change of mode share as some drivers choose to drive to another station or their destination.

5.7.6 Construction Worker Parking

It is anticipated that four to ten parking spaces would be provided at any one time for project workers in the Campsie area. The exact location of these parking spaces would vary based on the specific location within the worksite which has active construction at the time.

Table 5.22 provides the anticipated daily construction workforce volume in the Campsie Area. Public transport would be promoted as the primary mode of transport for construction workers, in order to reduce the traffic impacts on the local road network and parking requirements. As noted above, parking in the area is not fully utilised therefore there is some capacity to accommodate demand for worker parking. Taking into account the removal of dedicated commuter spaces during construction, there may be insufficient capacity to accommodate peak (non-possession[28]) worker parking. Off-site parking alternatives and associated shuttle arrangements would be investigated to transport workers to and from the site.

[25] Source - http://www.sydneycycleways.net/map/
[26] Source - Southwest Metro – Extent of Precinct Works & Interchange Requirements, Sydney Metro
[27] Source – Sydney Metro Southwest Precinct Plan – Campsie, Sydney Metro
[28] Peak worker demand during possession periods is greater, however background park and ride demand is expected to be much less.

Table 5.22 Anticipated Daily Workforce- Campsie

	Non Possession		Possession Short Period Close-down	
	Peak	Typical / Average	Peak	Typical
Campsie Station	75	50	160	75

As noted above, parking in the area is not fully utilised therefore there is capacity to accommodate any remaining demand for worker parking.

5.8 Belmore Station

5.8.1 Belmore Construction Haulage Routes

Figure 5.14 overleaf, above shows the proposed construction haulage routes into the sites to be used during construction. At Belmore Station it is anticipated that 10 heavy and 10 light vehicles would be generated in the AM and PM peak hours. Construction haulage trips at night would be no more than nine heavy and five light vehicle movements per hour.

The swept path analysis determined that construction haulage vehicles are generally able to access all of the proposed sites / gates safely. Drawings of the turns are included in **Appendix B**. However, the following specific movements are noted:

- right turn from Burwood Road into Tobruk Avenue overlaps two existing kerb side car parks. This can be resolved by removing / restricting car parking during construction hours
- right turn from Dean Avenue onto Burwood Rood has trucks conflicting against existing kerbside parking. This can be resolved by removing / restricting car parking during construction hours.

All of the above would be considered in the detailed design of the project.

5.8.2 Belmore Temporary Transport Route

Two bus routes converge before Belmore, resulting in 46 buses per hour in each direction calling at Belmore Station in peak periods. The temporary transport bus stops for these routes utilise existing bus stops.

The indicative rail replacement operation at Belmore Station is shown in **Figure 5.13**.

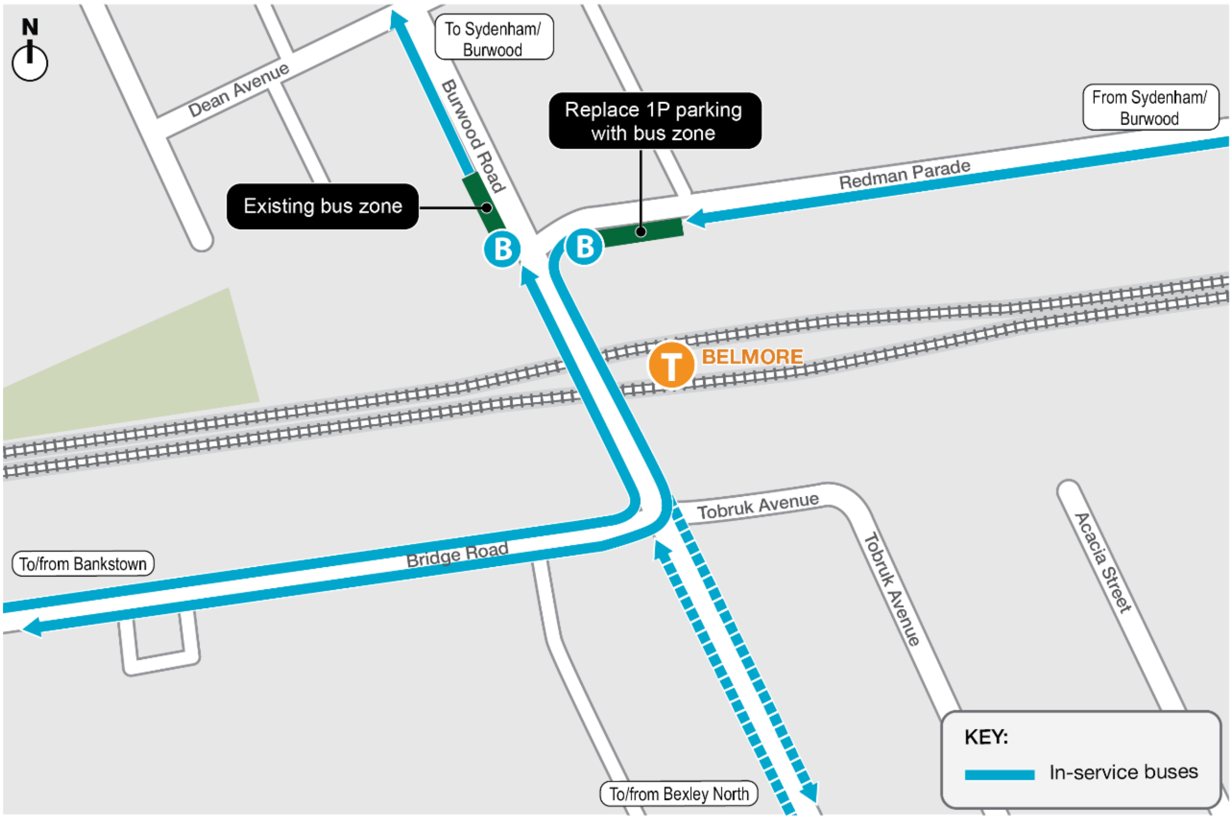


Figure 5.13 Temporary Transport Plan – Belmore (Sydney Metro 2017)

Bus route 2 travels down Canterbury Road, avoiding Belmore Station. The remaining bus route originates east of Belmore.

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Belmore Station modelled intersections and heavy vehicle routes

FIGURE 5.14

5.8.3 Road Network Operation and Intersection Performance

Four intersections were modelled in the area surrounding Belmore Station as shown in **Figure 5.14**.

Road Network performance - AM Peak

Table 5.23 below shows a summary of the intersection assessment undertaken for this station.

Table 5.23 Belmore Station Intersection Assessment –AM

Belmore Station – AM Peak					
Scenario	Existing	Future	Construction	Baseline TTP	Refined Baseline TTP
B.08 Burwood Road / Bridge Road (Priority Controlled)					**Year Capped: 2017**
Demand Flow (veh)	1736	1760	1795	1818	1826
Average Delay per Vehicle (Average over all arms in seconds)	11	12	20	21	21
Average Delay per Vehicle (Worst Movement in seconds)	266	322	611	660	679
LoS (Worst Movement)	F	F	F	F	F
DoS (Worst Movement)	0.95	1.03	1.39	1.44	1.46
B.09 Burwood Road / Redman Parade (Priority Controlled)					**Year Capped: 2023**
Demand Flow (veh)	1652	1813	1845	1938	1875
Average Delay per Vehicle (Average over all arms in seconds)	3	4	4	6	5
Average Delay per Vehicle (Worst Movement in seconds)	55	93	110	195	130
LoS (Worst Movement)	D	F	F	F	F
DoS (Worst Movement)	0.63	0.69	0.72	0.78	0.74
H.20 Burwood Road / Lakemba Street (Signals)					**Year Capped: 2021**
Demand Flow (veh)	2149	2300	2309	2404	2340
Average Delay per Vehicle (Average over all arms in seconds)	24	36	34	84	111
LoS (Overall)	B	C	C	F	F
DoS (Worst Movement)	0.84	0.96	0.92	1.30	1.51
H.33 Canterbury Road / Burwood Road (Signals)					**Year Capped: 2023**
Demand Flow (veh)	2526	2774	2774	2774	2774
Average Delay per Vehicle (Average over all arms in seconds)	10	13	13	13	13
LoS (Overall)	A	A	A	A	A
DoS (Worst Movement)	0.72	0.91	0.91	0.91	0.91

The Burwood Road / Bridge Road intersection has an existing LoS 'F'. The level of service continues to be 'F' during the future, construction, TTP and Refined Baseline TTP scenarios. The average delay for the worst movement in the TTP scenario (through and right turn movements from the Bridge Road west approach) is 11 minutes. This results from the right turn movement from Bridge Road west being opposed by the through movements from the Burwood Road north and south approaches. There is 30 times more volume going through these approaches than the Bridge Road west approach, which results in few gaps to facilitate the through and right movements. The Refined Baseline TTP has a minor increase in delay for the worst movement because the number of replacement buses increases from 11 to 15 per hour at the Bridge Road west approach.

The overall intersection delay is approximately 21 seconds for the worst case scenario which indicates that the main (through) movement is operating with negligible delay.

A potential diversion route could turn left at the intersection and turn around using Redman Parade, or use a parallel road such as Leylands Parade which has a signalised intersection onto Burwood Road to aid right turning vehicles in order to avoid the significant delay forecast for the intersection. The DoS indicated that undertaking the works in holidays would not reduce flows significantly to avoid delays.

The Burwood Road / Redman Parade intersection has an existing LoS ‘D’. The level of service declines to be ‘F’ during the future, construction, baseline TTP and Refined Baseline TTP scenarios. The right turning movement from Redman Parade experiences a modelled delay of over three minutes. Potential mitigation measures for these two intersections are discussed in a later section following the discussion of the PM performance.

While the modelled delay indicates that the right turning movement would experience delays of over three minutes, short detours to parallel roads, such as Lakemba Street, would be used by some vehicles mitigating the effects of the construction over the expected future conditions.

The Burwood Road / Lakemba Street intersection is forecast to experience a decline in amenity as a result of the addition of the TTP traffic. The existing intersection has a LoS of ‘B’ which reduces in each scenario to a LoS ‘F’ in the TTP scenario.

The right turning movements from the Lakemba Street west approach are the worst performing movements with delays of five minutes. With the additional 46 TTP buses from the Lakemba Street east approach, the opposed right turn from the Lakemba Street west approach has less opportunity for gaps and to make a turn, resulting in increased movement delay in the TTP scenario. This reduces the number of replacement buses from 46 buses/hour to 15 buses/hour which reduces the delay for the worst movement to two minutes.

Unless the timing of the signals is amended to provide additional capacity for the right turn, there is the potential for an increased likelihood for drivers to turn on the amber which increases the crash risk.

For the mid-block pedestrian crossing at Burwood Road, considering the directional traffic volumes at this crossing, which are expected to be less than 950 in each direction in 2023 (taking into account the construction and TTP traffic), and considering the fact that mid-block crossings normally allow for 75% green split for the vehicular traffic, no capacity issue is foreseeable as a result of operation of this pedestrian crossing.

Road Network Performance – PM Peak

Table 5.24 below shows a summary of the intersection assessment undertaken for this station. .

Table 5.24 Belmore Station Intersection Assessment – PM Peak

Belmore Station – PM Peak					
Scenario	Existing	Future	Construction	Baseline TTP	Refined Baseline TTP
B.08 Burwood Road / Bridge Road (Priority Controlled)					**Year Capped: 2018**
Demand Flow (veh)	1735	1787	1822	1845	1853
Average Delay per Vehicle (Average over all arms in seconds)	10	14	22	24	24
Average Delay per Vehicle (Worst Movement in seconds)	198	297	581	627	644
LoS (Worst Movement)	F	F	F	F	F
DoS (Worst Movement)	0.89	1.05	1.39	1.44	1.46
B.09 Burwood Road / Redman Parade (Priority Controlled)					**Year Capped: 2023**
Demand Flow (veh)	1625	1795	1826	1919	1857
Average Delay per Vehicle (Average over all arms in seconds)	3	4	4	6	5
Average Delay per Vehicle (Worst Movement in seconds)	56	103	124	248	152
LoS (Worst Movement)	D	F	F	F	F
DoS (Worst Movement)	0.65	0.72	0.74	0.80	0.76
H.20 Burwood Road / Lakemba Street (Signals)					**Year Capped: 2023**
Demand Flow (veh)	2315	2558	2567	2660	2598
Average Delay per Vehicle (Average over all arms in seconds)	21	27	28	101	98
LoS (Overall)	B	B	B	F	F
DoS (Worst Movement)	0.62	0.90	0.90	1.44	1.56
H.33 Canterbury Road / Burwood Road (Signals)					**Year Capped: 2023**
Demand Flow (veh)	2810	3106	3106	3106	3106
Average Delay per Vehicle (Average over all arms in seconds)	12	24	24	24	24
LoS (Overall)	A	B	B	B	B
DoS (Worst Movement)	0.85	0.97	0.97	0.97	0.97

One of the four intersections modelled has a negligible increase in delay and a resultant LoS ‘B’.

The Burwood Road / Bridge Road priority controlled intersection has a LoS of ‘F’ in all scenarios, including existing. This is due to the imbalance between the flows. A small number of vehicles on the minor arms experience a high delay, but when combined with the large number of vehicles with no delay on the Burwood Road west and east approaches, it averages to a relatively low average delay. There is 30 times greater traffic volume going through these approaches than the Bridge Road west approach, which results in few gaps to facilitate the through and right movements leading to high modelled theoretical delays of over 10 minutes for both the Construction and TTP scenarios. The overall intersection delay is approximately 20 seconds.

As with the AM Peak, vehicles would be likely to reroute rather than queue on Bridge Road.

The Burwood Road / Redman Parade intersection has an existing LoS 'D'. The level of service declines to 'F' during the future, construction, TTP and Refined Baseline TTP scenarios. The right turning movement from Redman Parade experiences a modelled delay of over four minutes. In practice, short detours to parallel roads, such as Lakemba Street, would be used for vehicles not wishing to pull out into less than satisfactory gaps.

The average delay for the intersection is approximately six seconds which indicates that the major (through) movement operates with negligible delay. Even with the addition of TTP, delays only occurs on the minor approach.

The Burwood Road / Lakemba Street intersection is forecast to experience a decline in amenity as a result of the addition of the TTP traffic. The intersection has a LoS 'B' in the existing, future and construction scenario, worsening to LoS 'F' in the TTS scenario.

The right turning movement from the Lakemba Street west approach is the worst performing movement with delay increasing to nearly seven minutes. The additional 46 TTP buses from the Lakemba Street east approach provides less gaps for the opposed right turn from the Lakemba Street west. Potential mitigation measures for these two intersections are discussed in the next section of this Chapter.

Due to limited alternative routes, it is likely that right turning vehicles would continue to use this intersection. This has the potential unless mitigated to lead to driver frustration.

For the mid-block pedestrian crossing at Burwood Road, considering the directional traffic volumes at this crossing, which are expected to be less than 950 in each direction in 2023 (taking into account the construction and TTP traffic), and considering the fact that mid-block crossings normally allow for 75% green split for the vehicular traffic, no capacity issue is foreseeable as a result of operation of this pedestrian crossing.

5.8.4 Mitigation

The intersections of Burwood Road / Bridge Road and Burwood Road / Lakemba Street have high DoS and LoS F during the Refined Baseline TTP scenario, suggesting high congestion and delays. These intersections have been further tested in SIDRA with mitigation measures to improve intersection performance.

Burwood Road / Bridge Road mitigation testing

As stated in **Section 5.8.3**, Burwood Road / Bridge Road intersection operates at LoS 'F' in all scenarios due to it being a priority controlled intersection, and with very low traffic volumes from the minor arms.

A through and right turn movement ban from Bridge Road west has been tested, with the following results from SIDRA in **Table 5.25**. The Mitigation TTP scenario shows reduction in congestion during both AM and PM peaks, with the reduction of DoS to less than 1, showing that the intersection is within capacity, albeit with delays. The LoS is still F during the AM peak and PM for the worst movement. This is due to very low volumes of right turners off Tobruk Ave (three vehicles) against high traffic volumes on Burwood Road.

As a result of banning the through and right turn movements from Bridge Road west, there is a traffic diversion which impacts other movements. It is therefore assumed that all through and right turning traffic would divert through Marie Lane and Collins Street to reach Burwood Road. For the right turning traffic this would not be expected to add distance to the route. However, noting that Tobruk Avenue is one way, the natural diversion route where the 'ahead' movements divert via Burwood Avenue northbound and then turn right into Tobruk Avenue has been assessed. This is included within the modelling described below.

Table 5.25 Burwood Road / Bridge Road Mitigation Assessment – AM & PM Peak

B.08 Burwood Road / Bridge Road (Priority Controlled)					
Scenario	Existing	Future	Baseline TTP	Refined Baseline TTP	Mitigated TTP
AM Peak					**Year Capped: 2017**
Demand Flow (veh)	1736	1760	1818	1826	1826
Average Delay per Vehicle (Average over all arms in seconds)	11	12	21	21	7
Average Delay per Vehicle (Worst Movement in seconds)	266	322	660	679	293
LoS (Worst Movement)	F	F	F	F	F
DoS (Worst Movement)	0.95	1.03	1.44	1.46	0.756
PM Peak					**Year Capped: 2018**
Demand Flow (veh)	1735	1787	1845	1853	1853
Average Delay per Vehicle (Average over all arms in seconds)	10	14	24	24	9
Average Delay per Vehicle (Worst Movement in seconds)	198	297	627	644	248
LoS (Worst Movement)	F	F	F	F	F
DoS (Worst Movement)	0.89	1.05	1.44	1.46	0.77

To summarise, as shown by **Table 5.25**, the proposed mitigation measures are expected to reduce congestion and delays to an acceptable LoS during AM and PM peaks, and improve intersection performance during the TTP Scenario.

Notwithstanding the proposed mitigation outlined above, as shown in Chapter 8 this intersection is proposed to be signalled as part of the project. Whilst not a requirement to mitigate the construction effects, implementation of the signals ahead of construction would provide the opportunity to give priority to the minor arms, and an initial assessment has shown that the signalled intersection would operate with LoS B or C during the construction phase.

Burwood Road / Lakemba Street

As stated in **Section 5.8.3**, Burwood Road / Lakemba Street intersection performance deteriorates to LoS 'F' with the addition of TTP traffic. Congestion is particularly worse on Lakemba Street west approach. This is due to high right turning volumes from this approach.

The following mitigation measures have been tested to improve intersection performance:

- change lane arrangement from through and right, to right only on the Lakemba Street west approach
- change phase times to 'optimum' using SIDRA, for better allocation of green time against increased traffic volumes
- increase Lakemba Street west lane from 25m to 70m to allow more vehicles to queue without impacting right turning vehicles. This requires only two parking spaces to be removed.

As the right turning volumes from Lakemba Street west forms a sizable portion of the traffic at this approach, the lane re-arrangement improves overall intersection performance. The results of this are shown in **Table 5.26**.

Table 5.26 Burwood Road / Lakemba Street Mitigation Assessment – AM & PM Peak

H.20 Burwood Road / Lakemba Street (Signals)					
Scenario	Existing	Future	Baseline TTP	Refined Baseline TTP	Mitigated TTP
AM Peak		**Year Capped: 2021**			
Demand Flow (veh)	2149	2300	2404	2340	2340
Average Delay per Vehicle (Average over all arms in seconds)	24	36	84	111	22
LoS (Overall)	B	C	F	F	B
DoS (Worst Movement)	0.84	0.96	1.30	1.51	0.67
PM Peak		**Year Capped: 2023**			
Demand Flow (veh)	2315	2558	2660	2598	2598
Average Delay per Vehicle (Average over all arms in seconds)	21	27	101	98	22
LoS (Overall)	B	B	F	F	B
DoS (Worst Movement)	0.62	0.90	1.44	1.56	0.71

To summarise, as shown by **Table 5.26**, the proposed mitigation measures are expected to reduce congestion and delays to an acceptable LoS during AM and PM peaks, and improve intersection performance during the TTP Scenario.

5.8.5 Public Transport Services

The main bus routes in the Belmore precinct are on Burwood Road, Lakemba Street and Leylands Parade. An assessment of the worksite extent shows that there would be no need to relocate bus stops in the area as a result of construction activities.

While there are a number of construction access gates in close proximity to bus stops, the construction activities are assumed to be in land owned by the RailCorp and should therefore cause no major effects to the bus network.

5.8.6 Active Transport Network

There are existing footpaths for pedestrians adjacent to the worksite extent in this region. Construction activities at these sites are outside of the road reserve and therefore are not expected to affect pedestrian connectivity and safety along footpaths.

Tobruk Ave would form an access way into the worksite and a compound area, as well as be converted into a shared zone for the operation of the project. Active pedestrian management would be required on the footpaths on the north side of Tobruk Ave during the construction works at this location.

Construction works to install a new signalised intersection and upgrade existing footpaths on Burwood Road may result in short-term pedestrian movement impacts, requiring the localised diversion of pedestrians to adjacent footpaths for periods of a week or less.

Works by the Belmore Sports Ground are considered separately in Chapter 6.

There is an off road separate dedicated cycleway along the railway line, between Bridge Road and Edison lane[29]. Further separation can be maintained via the use of hoardings, which can be confirmed closer to works. Works adjacent to the carpark (south of Belmore Station) runs along the edge of the cycleway and is therefore not expected to affect cyclists. Bridge works by the Belmore Sports Ground could potentially require closure of this cycleway. Cyclists can be diverted through the existing carpark onto Edison Lane under active traffic management during closure periods.

There are six cycle racks at Burwood Road station entry[30]. Belmore Station frontage along Burwood Road would be upgraded as part of the project. New cycle parking facilities are proposed as part of the station upgrade in the new station plaza south of the station. The new facilities should be constructed prior to removal of the facilities on Burwood Road.

5.8.7 Commuter and Short Term Parking

There are currently 56 dedicated commuter spaces near Belmore Station. There are further two hour parking spaces on Tobruk Avenue and Redman Parade which also falls on RailCorp land. Due to the location of the worksite extent, an estimated 29 of the dedicated commuter spaces would be removed from use for the entirety of the construction possession. The 46 two hour spaces on Tobruk Avenue would also be removed from use for the entirety of the construction possessions as it would be subsumed into the new station forecourt and entry for Belmore Station.

Some 21 spaces would be removed from use by short term construction possessions. Outside of possessions these 21 two hour spaces could be converted to dedicated commuter car parking.

Other on and off-street parking around the station would be unaffected by construction. Overall, there are approximately 980 unrestricted parking spaces operating at 75% utilisation within a 400 m catchment that can be used as informal park and ride spaces.

Approximately seven on street spaces would be affected by the TTP bus stops. These parking spaces would only be affected while the TTP is in operation, which is during possession periods. During these periods there is likely to be a reduction in demand for parking at the stations. This decline results from the influence of school holiday periods and the change of mode share as some drivers choose to drive to another station or their destination.

5.8.8 Construction Worker Parking

It is anticipated that four to ten parking spaces would be provided at any one time for project workers in the Belmore area. The location of these parking spaces would be dependent on the specific location within the worksite which has active construction at the time.

Table 5.27 provides the anticipated daily construction workforce volume in the Belmore Area. It is assumed that public transport would be promoted as the primary mode of transport for construction workers. This would reduce the impacts on the local road network and parking requirements. As noted above, parking in the area is not fully utilised therefore there is capacity to accommodate any remaining demand for worker parking. Off-site parking alternatives and associated shuttle arrangements would also be investigated to transport workers to and from the site.

Table 5.27 Anticipated Daily Workforce- Belmore

	Non Possession		Possession Short Period Close-down	
	Peak	Typical / Average	Peak	Typical
Belmore Station	60	40	130	60

[29] Source - http://www.sydneycycleways.net/map/
[30] Source - Southwest Metro – Extent of Precinct Works & Interchange Requirements, Sydney Metro

5.9 Lakemba Station

5.9.1 Lakemba Construction Haulage Routes

Figure 5.16 overleaf, shows the proposed construction haulage routes into the sites to be used during construction. At Lakemba Station it is anticipated that 10 heavy and 10 light vehicles would be generated in the AM and PM peak hours. Construction haulage trips at night would be no more than nine heavy and five light vehicle movements per hour.

The swept path analysis determined that construction haulage vehicles are generally able to access all of the proposed sites / gates safely. However, the left turn from The Boulevarde into Haldon Street impacts an existing kerb. Minor kerb cutback at this corner would resolve this conflict. This would be considered in detailed design.

5.9.2 Lakemba Temporary Transport Route

Two bus routes converge before Lakemba, resulting in 44 buses per hour in each direction calling at Lakemba Station in peak periods. The temporary transport bus stops for these routes would use existing bus stops. Please refer to **Appendix E** for the TTS.

The indicative rail replacement operation at Lakemba Station is shown in **Figure 5.15**.

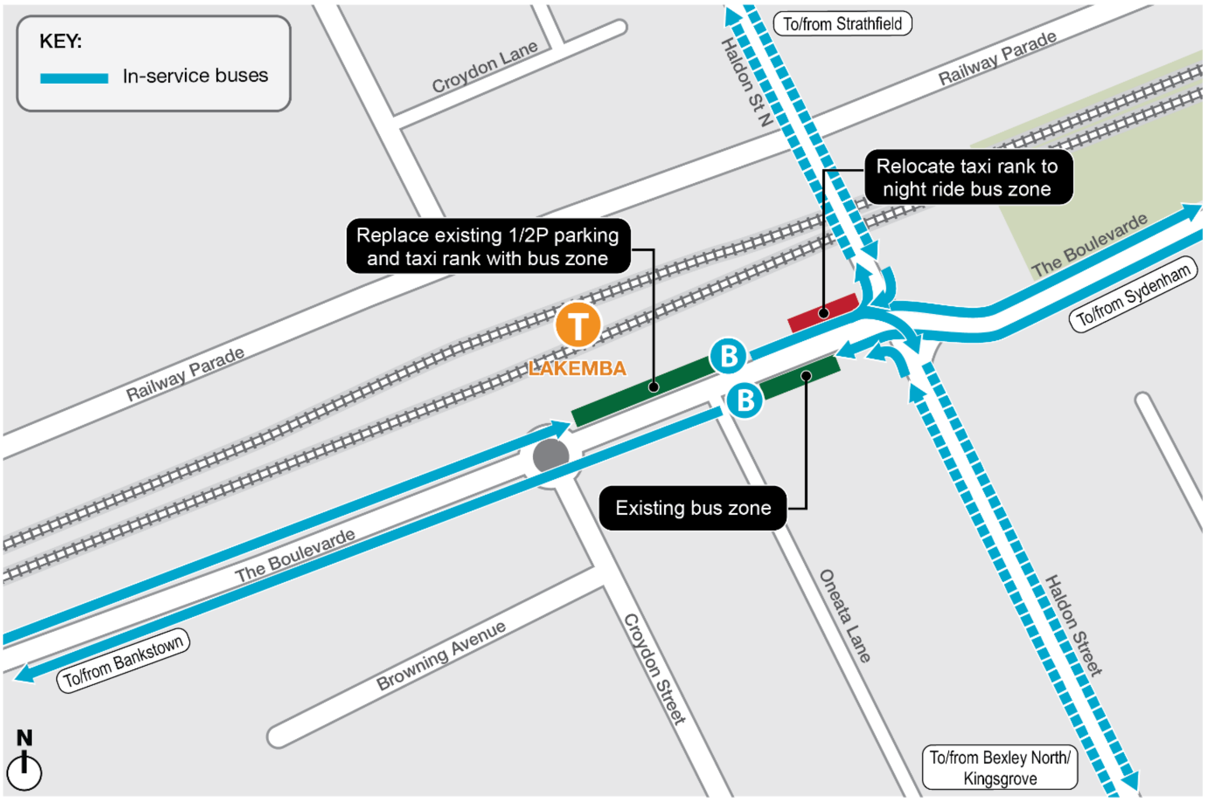

Figure 5.15 Temporary Transport Plan – Lakemba (Sydney Metro 2017)

The remaining bus routes originate east of Lakemba.

5.9.3 Road Network Operation and Intersection Performance

Six intersections were modelled in the area surrounding Lakemba Station as shown in **Figure 5.16**.

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Lakemba Station heavy vehicle routes and station intersections

FIGURE 5.16

Road Network Performance – AM Peak

Table 5.28 below shows a summary of the intersection assessment undertaken for this station.

Table 5.28 Lakemba Station Intersection Assessment – AM Peak

Lakemba Station – AM Peak					
Scenario	Existing	Future	Construction	Baseline TTP	Refined Baseline TTP
B.07 The Boulevarde / Haldon Street (Signals)					**Year Capped: 2021**
Demand Flow (veh)	1964	2102	2139	2232	2171
Average Delay per Vehicle (Average over all arms in seconds)	29	65	91	208	108
LoS (Overall)	C	E	F	F	F
DoS (Worst Movement)	0.93	1.05	1.12	1.47	1.21
H.07 Lakemba Street / Wangee Road (Signals)					**Year Capped: 2023**
Demand Flow (veh)	1565	1729	1729	1729	1729
Average Delay per Vehicle (Average over all arms in seconds)	13	18	18	18	18
LoS (Overall)	A	B	B	B	B
DoS (Worst Movement)	0.62	0.92	0.92	0.92	0.92
H.08 Haldon Street / Railway Parade (Priority Controlled)					**Year Capped: 2023**
Demand Flow (veh)	1376	1511	1527	1527	1527
Average Delay per Vehicle (Average over all arms in seconds)	8	20	32	32	32
Average Delay per Vehicle (Worst Movement in seconds)	65	186	326	326	326
LoS (Worst Movement)	E	F	F	F	F
DoS (Worst Movement)	0.72	1.03	1.22	1.22	1.22
H.09 Lakemba Street / Haldon Street (Signals)					**Year Capped: 2023**
Demand Flow (veh)	1757	1929	1929	1929	1929
Average Delay per Vehicle (Average over all arms in seconds)	15	15	15	15	15
LoS (Overall)	B	B	B	B	B
DoS (Worst Movement)	0.54	0.59	0.59	0.59	0.59
H.10 Ped Crossing on The Boulevarde (Signals)					**Year Capped: 2020**
Demand Flow (veh)	1012	1111	1111	1215	1154
Average Delay per Vehicle (Average over all arms in seconds)	3	4	4	4	4
LoS (Overall)	A	A	A	A	A
DoS (Worst Movement)	0.41	0.46	0.46	0.53	0.49

Lakemba Station – AM Peak					
Scenario	Existing	Future	Construction	Baseline TTP	Refined Baseline TTP
H.21 Canterbury Road / Haldon Street (Signals)					**Year Capped: 2023**
Demand Flow (veh)	2779	3051	3051	3118	3051
Average Delay per Vehicle (Average over all arms in seconds)	12	12	12	15	12
LoS (Overall)	A	A	A	B	A
DoS (Worst Movement)	0.58	0.86	0.86	0.92	0.86

For four of the six intersections modelled, the increase in delay resulting from future traffic growth, construction haulage traffic and baseline TTP results in a LoS ‘B’ or better. A LoS ‘B’ would result in negligible delays.

The Boulevarde / Haldon Street has an existing LoS ‘C’. The intersection is forecast to experience a decline in amenity as a result of the addition of the future traffic, construction and baseline TTP. The intersection has a LoS of ‘F’ for both the construction and TTP scenarios.

The worst movements (through and right turning movements from The Boulevarde west approach) experience modelled delays of nearly seven minutes. The average delay for the whole intersection is over three minutes which indicates that, while a lot of the delay is being experienced at the west approach, the other approaches also experience some delay.

The through movement from the Haldon Street south approach is also worsened with an average modelled delay of five minutes. The delay results from the increased volume through the intersection with the additional 33 TTP buses, along with a reduction in green time to accommodate the additional 44 TTS buses at The Boulevarde west approach. The intersection remains as LoS ‘F’ in the Refined Baseline TTP scenario but the average delay is halved because route 2 of the TTS does not run.

Local traffic may divert to the main arterials via local roads, such as Croydon Street to avoid waiting at the Boulevarde / Haldon Street intersection.

The Haldon Street / Railway Parade intersection has an existing LoS ‘E’. The intersection is forecast to experience a decline in amenity with the introduction of the construction haulage traffic which stays constant in the TTP scenario. Despite overall intersection delays in the range of less than 35 seconds (LoS ‘C’), the intersection has a LoS of ‘F’ for the future, construction and TTP scenarios due to the movement delays from the Railway Parade west approach.

Being a left, through and right shared lane, all movements from the Railway Parade west approach are the worst performing movements with delays of over five minutes. Although a shared lane, the through and right turning movements are the critical movements as they both must cross northbound and southbound traffic to complete their movement. As it is a priority intersection, these two movements are opposed by over 12 times the traffic from the Haldon Street north and south approaches, leading to few gaps for the movement to be achieved.

Although only three construction haulage vehicles are added to the Railway Parade west approach, given that the intersection is already over capacity this small number of heavy vehicles increases the average movement delay. Mitigation measures for this intersection are discussed in **Section 5.9.4**.

In practice, drivers would not wait for five minutes at the Railway Parade west approach. Left turning vehicles would likely form a short queue to the left of the right turning vehicles. Through and right turning vehicles would become frustrated, reroute along parallel streets, such as Lakemba Street, or turn left at the intersection and reroute.

Road Network Performance – PM Peak

Table 5.29 below shows a summary of the intersection assessment undertaken for this station.

Table 5.29 Lakemba Station Intersection Assessment – PM Peak

Lakemba Station – PM Peak					
Scenario	**Existing**	**Future**	**Construction**	**Baseline TTP**	**Refined Baseline TTP**
B.07 The Boulevarde / Haldon Street (Signals)					**Year Capped: 2021**
Demand Flow (veh)	1988	2138	2175	2267	2206
Average Delay per Vehicle (Average over all arms in seconds)	31	61	79	164	99
LoS (Overall)	C	E	F	F	F
DoS (Worst Movement)	0.95	1.10	1.16	1.32	1.18
H.07 Lakemba Street / Wangee Road (Signals)					**Year Capped: 2023**
Demand Flow (veh)	1720	1900	1900	1900	1900
Average Delay per Vehicle (Average over all arms in seconds)	16	20	20	20	20
LoS (Overall)	B	B	B	B	B
DoS (Worst Movement)	0.75	0.90	0.90	0.90	0.90
H.08 Haldon Street / Railway Parade (Priority Controlled)					**Year Capped: 2023**
Demand Flow (veh)	1381	1526	1541	1541	1541
Average Delay per Vehicle (Average over all arms in seconds)	10	22	31	31	31
Average Delay per Vehicle (Worst Movement in seconds)	57	177	271	271	271
LoS (Worst Movement)	E	F	F	F	F
DoS (Worst Movement)	0.74	1.06	1.18	1.18	1.18
H.09 Lakemba Street / Haldon Street (Signals)					**Year Capped: 2023**
Demand Flow (veh)	1905	2105	2105	2105	2105
Average Delay per Vehicle (Average over all arms in seconds)	14	13	13	13	13
LoS (Overall)	A	A	A	A	A
DoS (Worst Movement)	0.51	0.57	0.57	0.57	0.57
H.10 Ped Crossing on The Boulevarde (Signals)					**Year Capped: 2020**
Demand Flow (veh)	1056	1167	1167	1271	1210
Average Delay per Vehicle (Average over all arms in seconds)	3	3	3	4	4
LoS (Overall)	A	A	A	A	A
DoS (Worst Movement)	0.34	0.38	0.38	0.46	0.42

Lakemba Station – PM Peak					
Scenario	Existing	Future	Construction	Baseline TTP	Refined Baseline TTP
H.21 Canterbury Road / Haldon Street (Signals)					**Year Capped: 2023**
Demand Flow (veh)	3050	3370	3370	3440	3370
Average Delay per Vehicle (Average over all arms in seconds)	12	15	15	16	15
LoS (Overall)	A	B	B	B	B
DoS (Worst Movement)	0.60	0.90	0.90	0.90	0.90

For four of the six intersections modelled, the increase in delay resulting from future traffic growth, construction haulage traffic and TTP results in a LoS 'B' or better. A LoS 'B' would result in negligible delays for the peak hour in Sydney.

The Boulevarde / Haldon Street has an existing LoS 'C'. The intersection is forecast to experience increased delays as a result of the addition of the future traffic, construction and TTP. The intersection has a LoS of 'F' for both the construction and TTP scenarios.

The worst movement (right turning movements from The Boulevarde east approach) experience modelled delays of five minutes. With the additional TTP buses from The Boulevarde west approach, the opposed right turn from The Boulevarde east approach has less opportunity for gaps and to make a turn, resulting in increased movement delay. The Railway Parade west approach has a modelled delay which is nearly as poor as the eastern approach (4.5 minutes).

The average delay for the whole intersection is nearly three minutes which indicates that, while a lot of the delay is being experienced at the west approach, the other approaches also experience some delay.

Local traffic may divert to the main arterials via local roads, such as Croydon Street to avoid waiting at the Boulevarde / Haldon Street intersection.

Haldon Street / Railway Parade has an existing LoS 'E'. The intersection is forecast to increase to LoS 'F' based on the worst movement. The average delay for the worst movement is modelled to be nearly five minutes. TTP does not travel through this intersection and so the delay for the construction scenario and TTP scenarios are the same. Mitigation measures for this intersection are discussed in **Section 5.9.4** .

Most of the increase in delay results from the future traffic. Future traffic is not a result of this project and should therefore not be considered as a negative impact of the Sydney Metro Sydenham to Bankstown upgrade project.

5.9.4 Mitigation

As described in **Section 5.9.3**, Haldon Street / Railway Parade intersection is expected to have high LoS 'F' during the Future and TTP scenarios. Expected traffic growth increases delays at this intersection, and with the addition of TTP buses, the delays are expected to further increase. LoS 'F' and long delays are predominantly at the Railway Parade approach, due to high opposing traffic volumes on Haldon Street.

To mitigate the deteriorating LoS at this intersection, and specifically for Railway Parade approach, signalisation has been tested using SIDRA. Mitigation results are shown in **Table 5.30**.

Signalisation of this intersection is potentially merited due to high traffic volumes approaching on the Railway Parade approach. Mitigation results suggest that the overall intersection LoS improves to 'B' during AM peak and 'A' during PM peak, mainly due to signals reducing delays and allowing traffic from Railway Parade to access Haldon Street.

Table 5.30 Haldon Street / Railway Parade AM & PM Peak Mitigation results

H.08 Haldon Street / Railway Parade (Priority Controlled)					
Scenario	Existing	Future	Baseline TTP	Refined Baseline TTP	Mitigated TTP
AM Peak					**Year Capped: 2023**
Demand Flow (veh)	1376	1511	1527	1527	1527
Average Delay per Vehicle (Average over all arms in seconds)	8	20	32	32	15
Average Delay per Vehicle (Worst Movement in seconds)	65	186	326	326	21
LoS (Worst Movement) (overall for signals)	E	F	F	F	B
DoS (Worst Movement)	0.72	1.03	1.22	1.22	0.78
PM Peak					**Year Capped: 2023**
Demand Flow (veh)	1381	1526	1541	1541	1541
Average Delay per Vehicle (Average over all arms in seconds)	10	22	31	31	13
Average Delay per Vehicle (Worst Movement in seconds)	57	177	271	271	26
LoS (Worst Movement) (overall for signals)	E	F	F	F	A
DoS (Worst Movement)	0.74	1.06	1.18	1.18	0.64

To summarise, as shown by **Table 5.30**, the proposed mitigation measures are expected to reduce congestion and delays to an acceptable LoS during AM and PM peaks, and improve intersection performance during the TTP Scenario.

5.9.5 Public Transport Services

The main bus routes in the Lakemba precinct are on Haldon Street, Railway Parade, Croydon Street, Lakemba Street, Colin Street and The Boulevarde (NSW Govt. 2016b). An assessment of the worksite extent shows that there should not be a requirement for the relocation of bus stops in the area as a result of construction worksites/compound activities.

While there are a number of construction access gates in the area and in close proximity to bus stops, the construction activities are assumed to be on land owned by the RailCorp and should not impact the bus network.

5.9.6 Active Transport Network

Footpaths are adjacent the worksite extent, as well as construction compounds at Lakemba Station. Construction activities at these sites are outside of the road reserve and therefore are not expected to affect pedestrian connectivity and safety along footpaths. Installation of hoarding and site fences in this area may reduce footpath widths. New footpaths and pavements along Railway Parade and the Boulevard may require active pedestrian management.

The construction compound and worksite area west of Haldon Street, adjacent to The Boulevarde is a bridge construction site and is assessed separately in Chapter 6.

The Boulevarde is considered as a cycling friendly road. There are no dedicated on road cycling facilities close to the worksite extent[31]. Although works on Haldon Street Bridge would require full closure of Haldon Street adjacent the station, it is not expected to affect westbound cyclists on The Boulevarde (along the cycle friendly route).

Four cycle racks are located on either side of the station[32] (Railway Parade and The Boulevarde). These areas are proposed to be upgraded as part of the station works[33], and would be phased to provide continuous availability of the parking throughout construction.

A section of Haldon Street and Lakemba Street is common to both the on-street cycle friendly network and the construction haulage routes. Due to the relatively low volume of construction haulage vehicles and the short section of road, there should not be an impact on the user experience or safety of the cyclists.

5.9.7 Commuter and Short Term Parking

There are currently 138 dedicated commuter spaces near Lakemba Station on Railway Parade and The Boulevarde which fall on RailCorp land. Due to the location of the worksite extent, an estimated 47 of these dedicated commuter spaces would be removed from use for the entirety of the construction possessions. An additional 25 of the dedicated commuter spaces would be removed from use by short term construction possessions.

Other on and off-street parking around the station would be unaffected by construction. Overall, there are approximately 960 unrestricted parking spaces operating at 89% utilisation within a 400 m catchment that can be used as informal park and ride spaces.

Approximately 12 on street spaces would be affected by the TTP bus stops in addition to the 25 spaces described above. These parking spaces would only be affected while the TTP is in operation, which is during possession periods. During these periods there is likely to be a reduction in demand for parking at the stations. This reduction results from the influence of school holiday periods and the change of mode share as some drivers choose to drive to another station or their destination.

5.9.8 Construction Worker Parking

It is anticipated that four to ten parking spaces would be provided at any one time for project workers in the Lakemba area. The location of these parking spaces would be dependent on the specific location within the worksite which has active construction at the time.

Table 5.31 provides the anticipated daily construction workforce volume in the Lakemba area. It is assumed that public transport would be promoted as the primary mode of transport for construction workers. This would reduce the impacts on the local road network and parking requirements. As noted above, parking in the area is not fully utilised therefore there is capacity to accommodate any remaining demand for worker parking. Off-site parking alternatives and associated shuttle arrangements would be investigated to transport workers to and from the project area.

Table 5.31 Anticipated Daily Workforce- Lakemba

	Non Possession		Possession Short Period Close-down	
	Peak	Typical / Average	Peak	Typical
Lakemba Station	60	40	130	60

[31] Source - http://www.sydneycycleways.net/map/
[32] Source - Southwest Metro – Extent of Precinct Works & Interchange Requirements, Sydney Metro
[33] Source – Sydney Metro Southwest Precinct Plan – Sydenham, Sydney Metro

5.10 Wiley Park Station

5.10.1 Wiley Park Construction Haulage Routes

Figure 5.18 overleaf, shows the proposed construction haulage routes into the sites to be used during construction. At Wiley Park Station it is anticipated that 10 heavy and 10 light vehicles would be generated in the AM and PM peak hours. Construction haulage trips at night would be no more than nine heavy and five light vehicle movements per hour.

The swept path analysis determined that construction haulage vehicles are generally able to access all of the proposed sites / gates safely.

However, the following movements are noted:

- trucks turning left from King Georges Road into The Boulevarde need to turn from lane 2 (currently a through lane) to avoid conflict with opposing traffic on The Boulevarde. This can be resolved via traffic management and temporary re-alignment of The Boulevarde centre line
- trucks turning left from King Georges Road into Lakemba Street need to turn from Lane 2 (currently a through movement only lane) to avoid conflict with opposing traffic on Lakemba Street. Traffic management and closure of the kerbside lane is recommended during construction delivery hours to remove this conflict.

These movements would be given further consideration in detailed design.

5.10.2 Wiley Park Temporary Transport Route

Two bus routes converge before Wiley Park, resulting in 44 buses per hour in each direction calling at Wiley Park Station in peak periods. Existing unrestricted parking on both the north and south sides of The Boulevarde would be replaced by temporary transport bus stops for these routes. Please refer to **Appendix E** for the TTS.

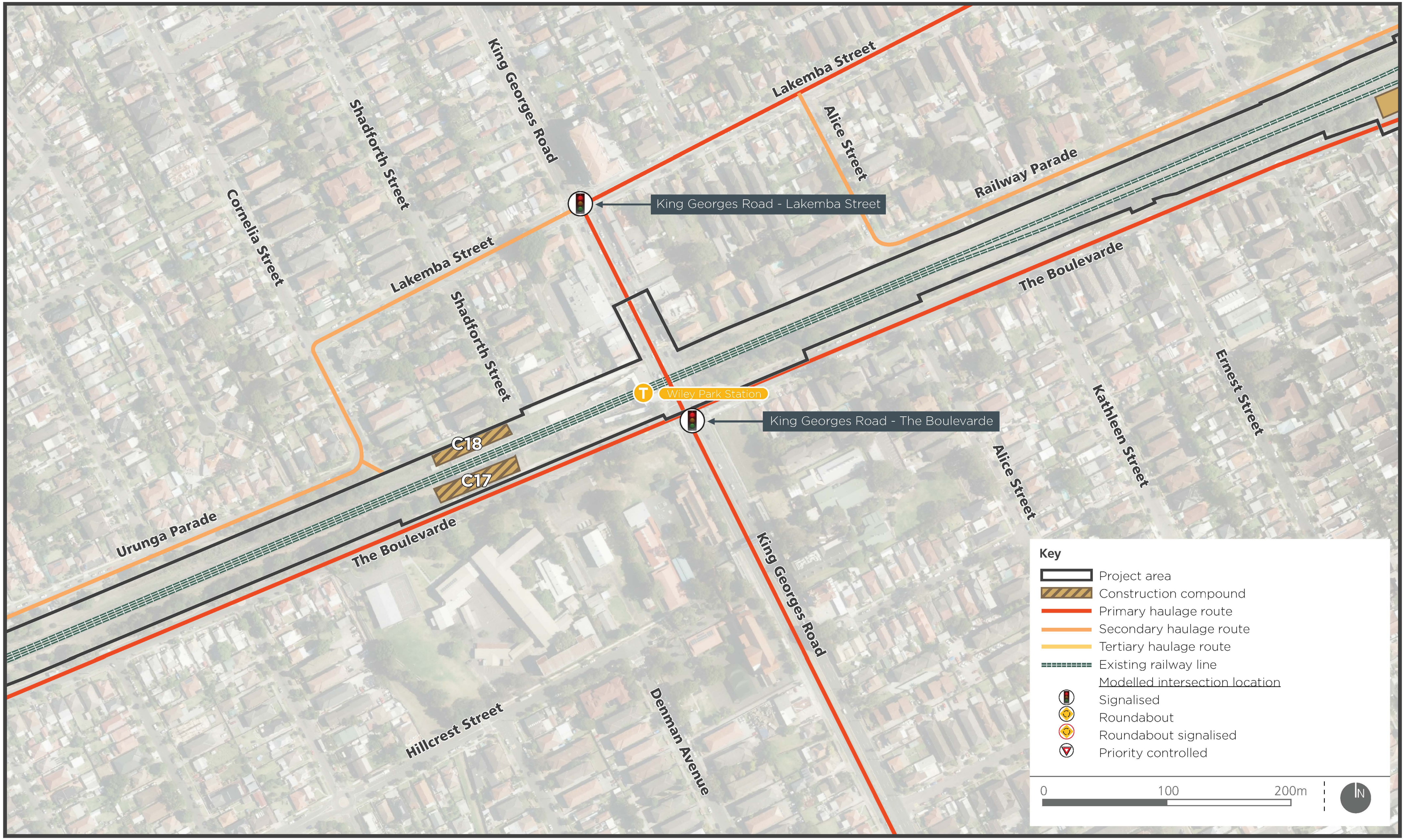
The indicative rail replacement operation at Wiley Park Station is shown in **Figure 5.17**.

Figure 5.17 Temporary Transport Plan – Wiley Park (Sydney Metro 2017)

The remaining bus routes originate east of Wiley Park.

5.10.3 Road Network Operation and Network Performance

Two intersections were modelled in the area surrounding Wiley park Station as shown in **Figure 5.18**.



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Wiley Park Station heavy vehicle routes and station intersections

FIGURE 5.18

Road Network Performance – AM Peak

Table 5.32 below shows a summary of the intersection assessment undertaken for this station.

Table 5.32 Wiley Park Station Intersection Assessment – AM Peak

Wiley Park Station – AM Peak					
Scenario	Existing	Future	Construction	Baseline TTP	Refined Baseline TTP
H.06 King Georges Road / Lakemba Street (Signals)					**Year Capped: 2023**
Demand Flow (PCU)	5881	6483	6528	6528	6528
Average Delay per PCU (Overall)	23	30	31	31	30
LoS (Overall)	B	C	C	C	C
DoS (Worst Movement)	0.86	0.95	0.97	0.98	0.95
B.06 King Georges Road / The Boulevarde (Signals)					**Year Capped: 2023**
Demand Flow (PCU)	5868	6468	6517	6693	6577
Average Delay per PCU (Overall)	35	45	47	87	57
LoS (Overall)	C	D	D	F	E
DoS (Worst Movement)	0.95	0.98	1.01	1.01	0.96

For the King Georges Road / Lakemba Street intersection, the increase in delay resulting from future traffic growth, construction haulage traffic and TTP would not cause delays above that which could be reasonably expected in the peak hour in Sydney.

The King Georges Road / The Boulevarde intersection is forecast to experience a decline in amenity as a result of the addition of the TTP traffic. The intersection currently has a LoS of ‘C’ which worsens to a LoS ‘F’ in the TTP scenario.

The worst performing movement at this intersection is The Boulevarde west approach with a DoS of 1.01 for both the Construction and TTP scenarios. The additional TTP buses (44 per hour in the peak arriving at the intersection from the east and west approaches of The Boulevarde) also increases the delay for the through movement from the King George Road south approach which increases to nearly two minutes.

The Refined Baseline TTP continues along the same route as the baseline TTP, but the number of replacement buses reduces to 15 per hour. The reduction in replacement buses improves the level of service to ‘E’ which is negligibly above the future conditions.

Road Network Performance – PM Peak

Table 5.33 below shows a summary of the intersection assessment undertaken for this station.

Table 5.33 Wiley Park Station Intersection Assessment – PM Peak

Wiley Park Station – PM Peak					
Scenario	Existing	Future	Construction	Baseline TTP	Refined Baseline TTP
H.06 King Georges Road / Lakemba Street (Signals)					**Year Capped: 2023**
Demand Flow (PCU)	5656	6277	6322	6322	6322
Average Delay per PCU (Overall)	25	43	45	47	38
LoS (Overall)	B	D	D	D	D
DoS (Worst Movement)	0.83	0.96	0.98	0.99	0.98
B.06 King Georges Road / The Boulevarde (Signals)					**Year Capped: 2023**
Demand Flow (PCU)	5796	6432	6481	6657	6511
Average Delay per PCU (Overall)	35	50	51	89	53
LoS (Overall)	C	D	D	F	D
DoS (Worst Movement)	0.84	0.96	0.97	1.02	0.95

For the King Georges Road / Lakemba Street intersection, the increase in delay resulting from future traffic growth, construction haulage traffic and TTP results in a LoS 'D'.

The King Georges Road / The Boulevarde intersection has an existing LoS 'C'. The TTP scenario is forecast to experience a decline in amenity to LoS 'F' as a result of the additional TTP traffic.

The Boulevarde east approach is the worst performing movement with a delay of over two minutes in the TTP scenario. An additional 44 buses/hour travel through the intersection from the east and west approaches in the TTP scenario. This causes queues for other traffic at the same approaches.

The additional TTP buses reduce the green time for the northbound/southbound phase. This reduces the northbound capacity at the King George Road north approach which leads to a delay of over one minute for the through movement from the King Georges Road north.

The Refined Baseline TTP continues along the same route as the baseline TTP, but the number of replacement buses reduces to 15 per hour. The reduction in replacement buses improves the level of service to 'D' which would not be of any note within the context of the typical journey at peak time.

It should be noted that due to the close proximity of the King Georges Road / Lakemba Street and King Georges Road / The Boulevarde there is a high level of interdependence between the intersections. A shift in green time at one intersection causes a misalignment of signal phases between the intersections. This could lead to additional queues for southbound traffic on the King Georges Road overbridge. This interdependence has been included in the models.

5.10.4 Public Transport Services

The main bus routes in the Wiley Park precinct are on King Georges Road and Lakemba Street. The night bus (N40) travels along The Boulevarde. An assessment of the worksite extent shows that there should not be a requirement for bus stops to be relocated as a consequence of construction activities.

While there are a number of construction access gates in the area and in close proximity to bus stops, the construction activities are assumed to be on land owned by the RailCorp and should therefore not impact the bus network.

5.10.5 Active Transport Network

Pedestrian footpaths are next to the works adjacent to the works west of Wiley Park Station. Construction activities at the worksite extent are outside of the road reserve and therefore are not expected to affect pedestrian connectivity and safety along footpaths. Installation of hoarding and site fences in this area may reduce footpath widths.

There may be some construction activities adjacent the footpath on The Boulevarde, including removal of the existing access. Works on the Boulevarde to the west of King Georges Road would be physically separated from footpaths to maintain pedestrian and construction activity separation and way-finding provided. Works on the Boulevarde to the east of King Georges Road may temporarily require pedestrian management while the kerbside facilities are constructed.

The Boulevarde is considered to be a cycling friendly road, without any dedicated on road cycling facilities close to worksite extents[34]. Works on King Georges Road Bridge in the vicinity of the station would require lane closures on King Georges Road adjacent the station, but is not expected to affect westbound / eastbound cyclists on The Boulevarde (along the cycle friendly route).

There are currently five cycle parks on the northern side of the station entry on King Georges Road[35]. This area is proposed to be upgraded as part of the station works[36], and the phasing of the works would be such to maintain at least five cycle parks throughout the construction period. The temporary cycle parks would meet the requirements of the NSW Government Bike and Ride Program and TfNSW 'Bicycle Facilities' standard.

Lakemba Street and Urunga Parade are common to both the on-street cycle friendly network and the construction haulage routes. Due to the relatively low volume of construction haulage vehicles there should not be a major effect on the user experience or safety of the cyclists.

5.10.6 Commuter and Short Term Parking

As there are currently no dedicated commuter spaces at or near Wiley Park Station, and so there are no dedicated spaces expected affected by the worksite extent. Overall, there are approximately 720 unrestricted parking spaces currently operating at 63% utilisation within a 400 m catchment that can be used as informal park and ride spaces.

Approximately 16 on street spaces would be affected by the TTP bus stops. These parking spaces would only be affected while the TTP is in operation, which is during possession periods. During these periods there is likely to be reduced demand for parking at the stations. This decline results from the influence of school holiday periods and the change of mode share as some drivers choose to drive to another station or their destination.

5.10.7 Construction Worker Parking

It is anticipated that four to ten parking spaces would be provided at any one time for project workers in the Wiley Park area. These parking spaces would be located dependent on the specific location within the worksite which has active construction at the time.

Table 5.34 provides the anticipated daily construction workforce volume in the Wiley Park area. It is assumed that public transport would be promoted as the primary mode of transport for construction workers. This would reduce the impacts on the local road network and parking requirements. As noted above, parking in the area is not fully utilised therefore there is capacity to accommodate any remaining demand for worker parking. Off-site parking alternatives and associated shuttle arrangements would also be investigated to transport workers to and from the site.

[34] Source - http://www.sydneycycleways.net/map/
[35] Source - Southwest Metro – Extent of Precinct Works & Interchange Requirements, Sydney Metro
[36] Source – Sydney Metro Southwest Precinct Plan – Wiley Park, Sydney Metro

Table 5.34 Anticipated Daily Workforce- Wiley Park

	Non Possession		Possession Short Period Close-down	
	Peak	Typical / Average	Peak	Typical
Wiley Park Station	60	40	130	60

5.11 Punchbowl Station

5.11.1 Punchbowl Construction Haulage Routes

Figure 5.20 overleaf, shows the proposed construction haulage routes into the sites to be used during construction. At Punchbowl Station it is anticipated that 10 heavy and 10 light vehicles would be generated in the AM and PM peak hours. Construction haulage trips at night would be no more than nine heavy and five light vehicle movements per hour.

The swept path analysis determined that construction haulage vehicles are generally able to access all of the proposed sites / gates safely. However, the following specific movements are noted:

- trucks turning left from Wattle Street into Highclere Avenue need to turn from the through (middle) lane in order to avoid opposing traffic on Highclere Avenue. This conflict can be resolved via traffic management and re-aligning the centreline along Highclere Avenue (would require removal of median traffic island which would be reinstated post construction) and temporary parking ban on both sides of Highclere Avenue at times of delivery
- Loder Lane / South Terrace –the left turn for a 12.5m truck from Loder Lane onto South Terrace tracks over the centre line. This can be managed via temporary parking removal on South Terrace to allow eastbound vehicles to drive along closer to the kerb. The turning truck can be further separated from on-coming vehicles by using cones or other physical barriers.

These options would be further considered in detailed design.

5.11.2 Punchbowl Temporary Transport Route

Two bus routes converge before Punchbowl, resulting in 44 buses per hour in each direction calling at Punchbowl Station in peak periods. The temporary transport bus stops for these routes would use existing bus stops.

The indicative rail replacement operation at Punchbowl Station is shown in **Figure 5.19**.

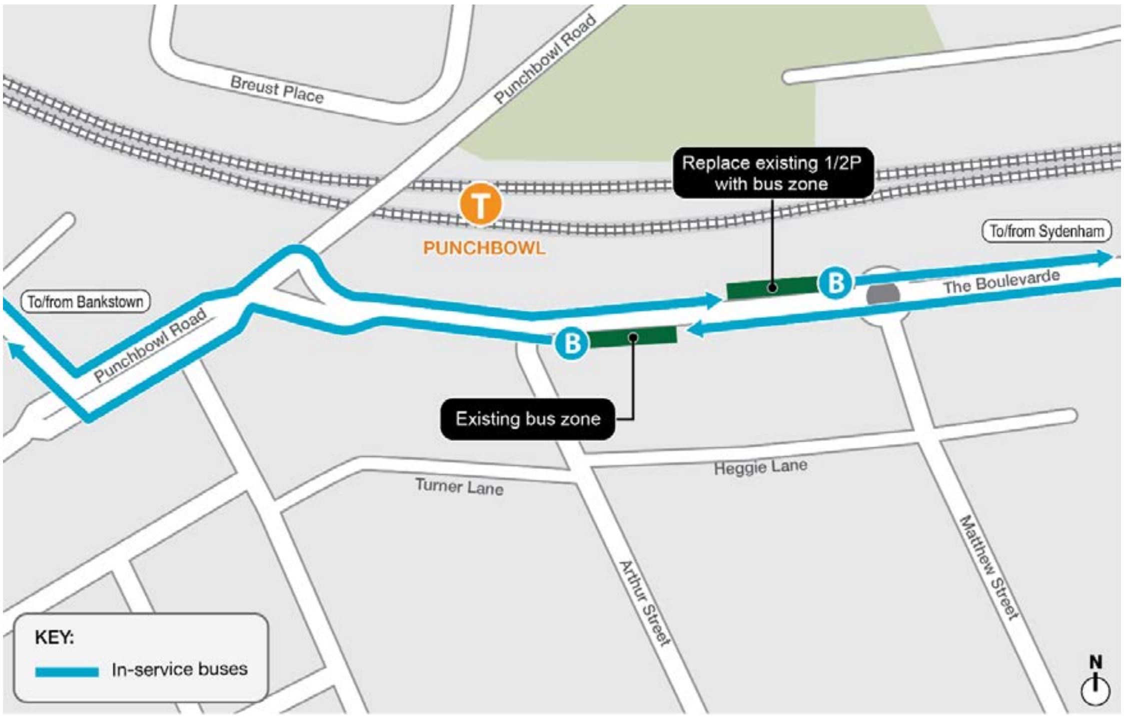


Figure 5.19 Temporary Transport Plan – Punchbowl (Sydney Metro 2017)

The remaining bus routes originate east of Punchbowl.

5.11.3 Road Network Operations and Intersection Performance

Four intersections were modelled in the area of Punchbowl Station as shown in **Figure 5.20**.

Punchbowl Station heavy vehicle routes and station intersections

FIGURE 5.20

Road Network Performance – AM Peak

Table 5.35 below shows a summary of the intersection assessment undertaken for this station.

Table 5.35 Punchbowl Station Intersection Assessment – AM Peak

Punchbowl Station – AM Peak					
Scenario	Existing	Future	Construction	Baseline TTP	Refined Baseline TTP
B.04 Punchbowl Road / South Terrace (Signals)					**Year Capped: 2023**
Demand Flow (PCU)	2425	2637	2649	2825	2709
Average Delay per PCU (Overall)	41	75	78	118	85
LoS (Overall)	C	F	F	F	F
DoS (Worst Movement)	0.95	1.02	1.03	1.09	1.03
B.05 Punchbowl Road / The Boulevarde (Signals)					**Year Capped: 2023**
Demand Flow (PCU)	2901	3153	3177	3353	3237
Average Delay per PCU (Overall)	33	40	42	48	46
LoS (Overall)	C	C	C	D	D
DoS (Worst Movement)	0.95	0.99	1.00	1.05	1.05
H.05 Punchbowl Road / Rossmore Avenue (Priority Controlled)					**Year Capped: 2023**
Demand Flow (PCU)	1061	1153	1159	1247	1189
Average Delay per PCU (Overall)	1	2	2	2	2
Average Delay per PCU (Worst Movement)	1	2	2	2	2
LoS (Worst Movement)	A	A	A	A	A
DoS (Worst Movement)	0.39	0.42	0.42	0.42	0.42
H.22 The Boulevarde / Arthur Street (Signals)					**Year Capped: 2023**
Demand Flow (PCU)	1278	1388	1400	1576	1460
Average Delay per PCU (Overall)	15	17	17	17	17
LoS (Overall)	B	B	B	B	B
DoS (Worst Movement)	0.60	0.63	0.65	0.72	0.72

For three of the four intersections modelled, the increase in delay resulting from future traffic growth, construction haulage traffic and TTP results in a LoS ‘D’ or better. A LoS ‘D’ would not cause delays above that which could be reasonably expected in the peak hour in Sydney.

The Punchbowl Road / South Terrace intersection has a current LoS ‘C’. The intersection is forecast to experience a decline in amenity to LoS ‘F’ for the future, construction and TTP scenarios. The through and left turning movements from the Punchbowl Road west approach are the worst performing movements in the TTP scenario with a modelled delay of over three minutes.

The intersection delay is nearly two minutes for the TTP and nearly 1.5 minutes for the Refined Baseline TTP scenario. This implies that the South Terrace and Punchbowl Road east approaches both experience some delay.

The reduction in delay for the Refined Baseline TTP results from a reduction of 29 replacement buses in the Refined Baseline TTP scenario.

It is expected that most commuters would continue to use the intersection with these levels of delay. Those wishing to reduce their travel time may use the local roads, such as Rossmore Avenue. Due to a reduction in background traffic, scheduling works during the school term 4 break period would help to alleviate congestion at this intersection although further mitigation measures may be required.

Road Network Performance – PM Peak

Table 5.36 below shows a summary of the intersection assessment undertaken for this station.

Table 5.36 Punchbowl Station Intersection Assessment – PM Peak

Punchbowl Station – PM Peak					
Scenario	Existing	Future	Construction	Baseline TTP	Refined Baseline TTP
B.04 Punchbowl Road / South Terrace (Signals)					**Year Capped: 2023**
Demand Flow (PCU)	2397	2620	2632	2808	2662
Average Delay per PCU (Overall)	28	33	34	41	35
LoS (Overall)	B	C	C	C	C
DoS (Worst Movement)	0.79	0.87	0.87	0.94	0.91
B.05 Punchbowl Road / The Boulevarde (Signals)					**Year Capped: 2023**
Demand Flow (PCU)	2716	2969	2993	3169	3053
Average Delay per PCU (Overall)	30	35	36	41	38
LoS (Overall)	C	C	C	C	D
DoS (Worst Movement)	0.79	0.87	0.88	0.93	0.93
H.05 Punchbowl Road / Rossmore Avenue (Priority Controlled)					**Year Capped: 2023**
Demand Flow (PCU)	1302	1423	1429	1517	1459
Average Delay per PCU (Overall)	2	2	2	2	2
Average Delay per PCU (Worst Movement)	2	2	2	2	2
LoS (Worst Movement)	A	A	A	A	A
DoS (Worst Movement)	0.44	0.48	0.48	0.48	0.48
H.22 The Boulevarde / Arthur Street (Signals)					**Year Capped: 2023**
Demand Flow (PCU)	1440	1574	1586	1762	1646
Average Delay per PCU (Overall)	21	17	16	20	17
LoS (Overall)	B	B	B	B	B
DoS (Worst Movement)	0.80	0.71	0.70	0.77	0.77

All of the intersections modelled in the PM around Punchbowl Station have a level of service of 'C' or better after accounting for the increase in delay resulting from future traffic growth, construction haulage traffic and TTP scenarios.

The Refined Baseline TTP reduces the number of buses per hour through the intersection from 44 to 15 per hour. Due to the relatively low levels of congestion, the impact of the reduced TTP is minimal.

5.11.4 Public Transport Services

The main bus routes in the Punchbowl precinct are on Punchbowl Road, Dudley Street and Acacia Avenue. The night bus (N40) travels along The Boulevarde. An assessment of the construction worksite extent shows that bus stops would not need to be relocated as a consequence of construction activities.

While there are a number of construction access gates in the area and in close proximity to bus stops, the construction activities are assumed to be in land owned by the RailCorp and should therefore have no impact on the bus network.

5.11.5 Active Transport Network

There are existing footpaths for pedestrians adjacent the worksite extent around Punchbowl Station. Construction activities at these sites are outside of the road reserve and therefore are not expected to affect pedestrian connectivity and safety along footpaths. Installation of hoarding and site fences in this area may reduce footpath widths.

Pedestrian management may be required during the following construction activities:

- for access to the station from the corner of Punchbowl Road and Warren Reserve, due to the extent of the worksite and construction compound in this location for the duration of the project
- during the removal of the station access from the corner of Punchbowl Road and Warren Reserve and construction of the new station entrance off Urunga Parade
- during the construction of the new pavement and kerbside facilities on the Boulevarde.

There are no dedicated cycleways or designated cycle friendly roads within the Punchbowl Station catchment[37].

There are six existing bike parking facilities on each side of the station (off The Boulevarde and Punchbowl Road)[38]. These areas are proposed to be upgraded with secure bike parking[39], and installation of the new facilities would be phased to occur prior to the removal of the existing facilities. These new facilities would meet the requirements of the NSW Government Bike and Ride Program and TfNSW 'Bicycle Facilities' standard.

5.11.6 Commuter and Short-Term Parking

There are currently 137 dedicated commuter spaces at or near Punchbowl Station which fall on RailCorp land. Approximately 30 of these spaces would be removed from use for the entirety of the construction possessions from long term construction possessions. They would be subsumed by the new station forecourt and entry on The Boulevarde. In addition, approximately 50 unrestricted spaces on The Boulevarde would be removed from use by short term construction possessions to accommodate construction activities on land managed by RailCorp. Land is available during this time for 40 replacement spaces to be built along The Boulevarde.

Other on-street and off-street parking around the station would be unaffected by construction. Overall, there are approximately 825 unrestricted parking spaces operating at 84% utilisation within a 400 m catchment that can be used as informal park and ride spaces.

Dedicated commuter spaces are not expected to be affected while the TTP is in operation, however six on street short-term spaces would be affected by the TTP bus stops. These parking spaces would only be affected while the TTP is in operation, which is during possession periods. During these periods there is likely to be a reduction in demand for parking at the stations. This decline results from the influence of school holiday periods and the change of mode share as some drivers choose to drive to another station or their destination.

[37] Source - http://www.sydneycycleways.net/map/
[38] Source - Southwest Metro – Extent of Precinct Works & Interchange Requirements, Sydney Metro
[39] Source – Sydney Metro Southwest Precinct Plan – Punchbowl, Sydney Metro

5.11.7 Construction Worker Parking

It is anticipated that four to ten parking spaces would be provided at any one time for project workers in the Punchbowl area. The location of these parking spaces would move dependent on the specific location within the worksite which has active construction at the time.

Table 5.37 provides the anticipated daily construction workforce in the Punchbowl Area. It is assumed that public transport would be promoted as the primary mode of transport for construction workers. This would reduce the impacts on the local road network and parking requirements. As noted above, parking in the area is not fully utilised therefore there is capacity to accommodate any remaining demand for worker parking. Off-site parking alternatives and associated shuttle arrangements would be investigated to transport workers to and from the site.

Table 5.37 Anticipated Daily Workforce- Punchbowl

	Non Possession		Possession Short Period Close-down	
	Peak	Typical / Average	Peak	Typical
Punchbowl Station	60	40	130	60

5.12 Bankstown Station

5.12.1 Bankstown Construction Haulage Routes

Figure 5.22 overleaf, shows the proposed construction haulage routes into the sites to be used during construction. At Bankstown Station it is anticipated that 10 heavy and 10 light vehicles would be generated in the AM and PM peak hours. Construction haulage trips at night would be no more than nine heavy and five light vehicle movements per hour.

The swept path analysis determined that construction vehicles are generally able to access all of the proposed sites / gates safely. However the following specific movements are noted:

- right turn from Raymond Street into Restwell Street overlaps on adjacent right turn lane. This is expected to be a minor issue and can be resolved by minor road marking changes to remove the conflict zone
- left turn from North Terrace onto Stacey Street overlaps slightly over the right turning lanes on Wattle Street. This issue can be resolved by minor adjustments to the existing traffic island / road marking to remove the conflict.

These matters would be considered further in detailed design.

5.12.2 Bankstown Temporary Transport Route

Two bus routes converge at Bankstown, resulting in 44 buses per hour in each direction calling at Bankstown Station in peak periods. The temporary transport bus stops would use areas that are currently allocated car parking, bus layovers, loading zones and special events bus zones.

The indicative rail replacement operation at Bankstown Station is shown in **Figure 5.21**.

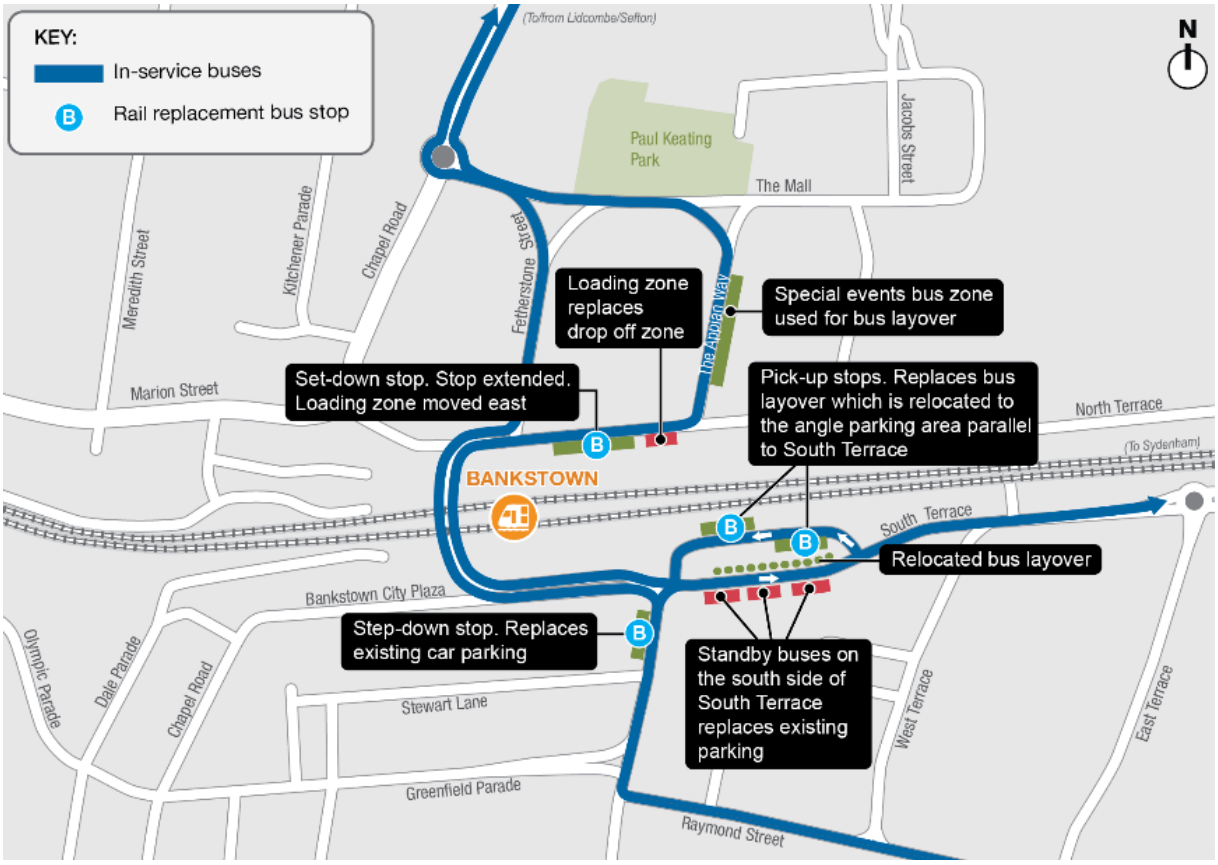
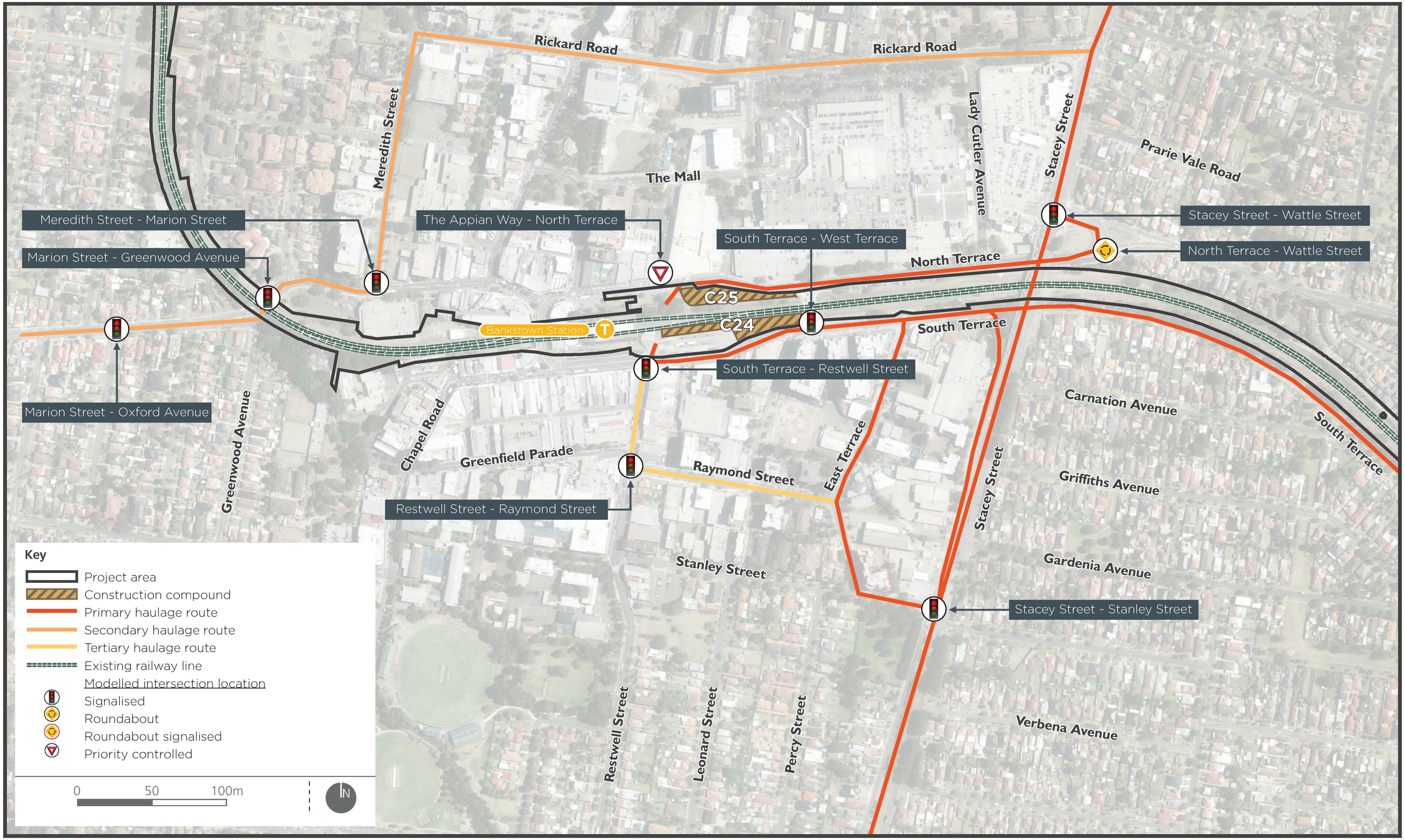


Figure 5.21 Temporary Transport Plan – Bankstown (Sydney Metro 2017)

The remaining bus routes originate east of Bankstown.



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Bankstown Station heavy vehicle routes and station intersections

FIGURE 5.22

5.12.3 Road Network Operation and Intersection Performance

Ten intersections were modelled in the area surrounding Bankstown Station as shown in **Figure 5.22**.

Road Network performance - AM Peak

Table 5.38 below shows a summary of the intersection assessment undertaken for this station.

Table 5.38 Bankstown Station Intersection Assessment – AM Peak

Bankstown Station – AM Peak					
Scenario	Existing	Future	Construction	Baseline TTP	Refined Baseline TTP
B.01 South Terrace / Restwell Street (Signals)					**Year Capped: 2023**
Demand Flow (Veh)	1183	1299	1314	1445	1385
Average Delay per Vehicle (Average over all arms in seconds)	24	25	26	48	35
LoS (Overall)	B	B	B	D	C
DoS (Worst Movement)	0.58	0.64	0.65	0.88	0.79
B.02 Restwell Street / Raymond Street (Signals)					**Year Capped: 2023**
Demand Flow (Veh)	1446	1588	1596	1643	1612
Average Delay per Vehicle (Average over all arms in seconds)	23	26	26	34	28
LoS (Overall)	B	B	B	C	B
DoS (Worst Movement)	0.76	0.83	0.83	0.91	0.86
B.03 South Terrace / West Terrace (Signals)					**Year Capped: 2023**
Demand Flow (Veh)	2322	2550	2558	2603	2589
Average Delay per Vehicle (Average over all arms in seconds)	29	30	30	31	31
LoS (Overall)	C	C	C	C	B
DoS (Worst Movement)	0.56	0.63	0.64	0.71	0.67
H.01 Meredith Street / Marion Street (Signals)					**Year Capped: 2023**
Demand Flow (Veh)	2645	2905	2905	2905	2905
Average Delay per Vehicle (Average over all arms in seconds)	28	32	32	32	32
LoS (Overall)	B	C	C	C	C
DoS (Worst Movement)	0.85	0.90	0.90	0.90	0.91
H.02 Stacey Street / Wattle Street (Signals)					**Year Capped: 2023**
Demand Flow (Veh)	4598	5049	5064	5064	5064
Average Delay per Vehicle (Average over all arms in seconds)	16	16	17	17	17
LoS (Overall)	B	B	B	B	B
DoS (Worst Movement)	0.81	0.89	0.89	0.89	0.89

Bankstown Station – AM Peak					
Scenario	**Existing**	**Future**	**Construction**	**Baseline TTP**	**Refined Baseline TTP**
H.03 North Terrace / Wattle Street (Roundabout)					**Year Capped: 2023**
Demand Flow (Veh)	2719	2985	3001	3001	3001
Average Delay per Vehicle (Average over all arms in seconds)	8	10	11	11	11
Average Delay per Vehicle (Worst Movement in seconds)	17	22	22	22	22
LoS (Worst Movement)	B	B	B	B	B
DoS (Worst Movement)	0.66	0.77	0.77	0.77	0.95
H.04 Stanley Street / Stacey Street (Signals)					**Year Capped: 2023**
Demand Flow (Veh)	4449	4885	4926	4926	4926
Average Delay per Vehicle (Average over all arms in seconds)	25	26	28	28	28
LoS (Overall)	B	B	B	B	B
DoS (Worst Movement)	0.86	0.95	0.95	0.95	0.95
H.30 The Appian Way / North Terrace (Priority Controlled)					**Year Capped: 2023**
Demand Flow (Veh)	1263	1387	1387	1409	1409
Average Delay per Vehicle (Average over all arms in seconds)	7	9	9	10	10
Average Delay per Vehicle (Worst Movement in seconds)	18	26	26	34	34
LoS (Worst Movement)	B	B	B	C	C
DoS (Worst Movement)	0.60	0.68	0.68	0.76	0.76
H.31 Marion Street / Oxford Avenue (Signals)					**Year Capped: 2023**
Demand Flow (Veh)	2675	2937	2937	2937	2937
Average Delay per Vehicle (Average over all arms in seconds)	14	23	23	23	23
LoS (Overall)	A	B	B	B	B
DoS (Worst Movement)	0.73	0.75	0.75	0.75	0.75
H.32 Marion Street / Greenwood Avenue (Signals)					**Year Capped: 2023**
Demand Flow (Veh)	3407	3741	3741	3741	3741
Average Delay per Vehicle (Average over all arms in seconds)	29	33	33	33	33
LoS (Overall)	C	C	C	C	C
DoS (Worst Movement)	0.77	0.89	0.89	0.89	0.89

All of the intersections modelled in the AM around Bankstown Station have a level of service of ‘D’ or better after accounting for the increase in delay resulting from future traffic growth, construction haulage traffic and TTP scenarios. A LoS ‘D’ would generally be considered reasonable during peak periods.

The Refined Baseline TTP reduces the number of buses per hour in the Bankstown precinct from 44 to 15 per hour. Due to the relatively low levels of congestion and the low interaction of TTP buses with the modelled intersections, the impact of the reduced TTP is minimal.

It should be noted that the improvement in the DoS from the Existing to Future scenarios is due to SCATS optimising the signal times from what has been observed, resulting in improved performance of the intersection.

Road Network Performance – PM Peak

Table 5.39 below shows a summary of the intersection assessment undertaken for this station.

Table 5.39 Bankstown Station Intersection Assessment – PM Peak

Bankstown Station – PM Peak					
Scenario	Existing	Future	Construction	Baseline TTP	Refined Baseline TTP
B.01 South Terrace / Restwell Street (Signals)					**Year Capped: 2023**
Demand Flow (Veh)	1032	1141	1157	1290	1229
Average Delay per Vehicle (Average over all arms in seconds)	26	27	27	49	38
LoS (Overall)	B	B	B	D	C
DoS (Worst Movement)	0.56	0.61	0.62	0.88	0.79
B.02 Restwell Street / Raymond Street (Signals)					**Year Capped: 2023**
Demand Flow (Veh)	1318	1456	1464	1509	1479
Average Delay per Vehicle (Average over all arms in seconds)	23	26	27	34	29
LoS (Overall)	B	B	B	C	C
DoS (Worst Movement)	0.74	0.82	0.85	0.91	0.86
B.03 South Terrace / West Terrace (Signals)					**Year Capped: 2023**
Demand Flow (Veh)	2290	2530	2538	2582	2568
Average Delay per Vehicle (Average over all arms in seconds)	29	30	30	32	31
LoS (Overall)	C	C	C	C	C
DoS (Worst Movement)	0.61	0.69	0.70	0.77	0.74
H.01 Meredith Street / Marion Street (Signals)					**Year Capped: 2023**
Demand Flow (Veh)	2764	3054	3054	3054	3054
Average Delay per Vehicle (Average over all arms in seconds)	43	42	42	42	42
LoS (Overall)	C	C	C	C	C
DoS (Worst Movement)	0.94	0.92	0.92	0.92	0.92
H.02 Stacey Street / Wattle Street (Signals)					**Year Capped: 2018**
Demand Flow (Veh)	5882	6058	6074	6074	6074
Average Delay per Vehicle (Average over all arms in seconds)	38	39	40	40	40
LoS (Overall)	C	C	C	C	C
DoS (Worst Movement)	0.92	1.10	1.10	1.10	1.10

Bankstown Station – PM Peak					
Scenario	**Existing**	**Future**	**Construction**	**Baseline TTP**	**Refined Baseline TTP**
H.03 North Terrace / Wattle Street (Roundabout)					**Year Capped: 2023**
Demand Flow (Veh)	2411	2664	2680	2680	2680
Average Delay per Vehicle (Average over all arms in seconds)	11	20	20	20	20
Average Delay per Vehicle (Worst Movement in seconds)	28	81	81	81	81
LoS (Worst Movement)	B	F	F	F	F
DoS (Worst Movement)	0.77	0.99	0.99	0.99	0.99
H.04 Stanley Street / Stacey Street (Signals)					**Year Capped: 2017**
Demand Flow (Veh)	5548	5631	5672	5672	5672
Average Delay per Vehicle (Average over all arms in seconds)	14	18	27	27	27
LoS (Overall)	B	B	B	B	B
DoS (Worst Movement)	0.94	1.10	1.24	1.24	1.24
H.30 The Appian Way / North Terrace (Priority Controlled)					**Year Capped: 2022**
Demand Flow (Veh)	1367	1490	1490	1511	1511
Average Delay per Vehicle (Average over all arms in seconds)	11	27	27	52	52
Average Delay per Vehicle (Worst Movement in seconds)	26	121	121	267	267
LoS (Worst Movement)	B	F	F	F	F
DoS (Worst Movement)	0.74	1.07	1.07	1.25	1.25
H.31 Marion Street / Oxford Avenue (Signals)					**Year Capped: 2023**
Demand Flow (Veh)	2616	2891	2891	2891	2891
Average Delay per Vehicle (Average over all arms in seconds)	14	17	17	17	17
LoS (Overall)	B	B	B	B	B
DoS (Worst Movement)	0.86	0.90	0.90	0.90	0.90
H.32 Marion Street / Greenwood Avenue (Signals)					**Year Capped: 2023**
Demand Flow (Veh)	3550	3923	3923	3923	3923
Average Delay per Vehicle (Average over all arms in seconds)	30	29	29	29	30
LoS (Overall)	C	C	C	C	C
DoS (Worst Movement)	0.91	0.90	0.90	0.90	0.91

For eight of the ten intersections modelled, the increase in delay resulting from future traffic growth, construction haulage traffic and TTP results in a LoS ‘D’ or better. A LoS ‘D’ would not cause delays above that which could be reasonably expected in the peak hour in Sydney.

The North Terrace / Wattle Street roundabout has an existing LoS ‘B’. The intersection worsens to a LoS ‘F’ with the addition of future traffic. There are only eight construction haulage vehicles at the eastern approach, eight construction haulage vehicles at the western approach and no additional TTP buses passing through the North Terrace / Wattle Street intersection. Therefore the average delay remains the same as the future scenario. The decline in amenity that has been modelled for this intersection is therefore not attributed to the Sydney Metro Sydenham to Bankstown Project.

The Appian Way / North Terrace intersection has an existing LoS ‘B’. The intersection delays increase and the LoS changes to ‘F’ with the introduction of future traffic volumes. Construction haulage traffic does not affect the intersection but TTP traffic travels along The Appian Way and onto North Terrace. The average delay for the whole intersection increases to nearly one minute in the TTP scenario.

The right turning movement from The Appian Way north approach is the worst performing movement with a delay of over four minutes. This approach is nearly over capacity in the future traffic scenario and so the additional 20 TTP buses leads to a sharp increase in delay.

The Refined Baseline TTP reduces the number of buses per hour in the Bankstown precinct from 44 to 15 per hour. Due to the relatively low levels of congestion and the low interaction of TTP buses with the modelled intersections, the impact of the reduced TTP is minimal.

Due to a reduction in background traffic, scheduling works during the school term 4 break period would significantly reduce congestion at the North Street / Wattle Street roundabout and would help to alleviate congestion at the Appian Way / North Terrace intersection although further mitigation measures would be required, as identified in Chapter 9.

5.12.4 Public Transport Services

There are a number of different bus routes that travel through the Bankstown precinct. An assessment of the worksite extent shows that there should not be a requirement for bus stops to be relocated in the area as a consequence of construction activities.

The works adjacent to South Terrace, between Restwell Street and Lopez Lane, are next to bus stop 2200343. Construction haulage vehicles are expected to use the bus bay to approach the access gate, however truck movements should not affect the ability of the bay to function as a bus stop.

5.12.5 Active Transport Network

Footpaths adjacent to the worksite extent in Bankstown are outside of the road reserve and would not be impacted by construction activities.

Pedestrian management may be required during the construction of the new station entrance on South Terrace and North Terrace, as well as the kerbside facilities proposed for North Terrace.

Works at Stacey Street Overbridge are a bridge construction site and are considered separately in Chapter 6.

There are existing bike parking areas on both sides of the station (North Terrace and South Terrace)[40]. These areas are proposed to be upgraded with secure bike parking[41]. Bike parking is recommended to be managed through staged construction activities.

5.12.6 Commuter and Short Term Parking

There are currently 147 dedicated commuter spaces near Bankstown Station on North Terrace and South Terrace, which fall on RailCorp land. Due to the location of the worksite extent, an estimated 90 of these dedicated commuter spaces would be removed from use for the entirety of the construction possessions.

Other on-street and off-street parking around the station would be unaffected by construction. Overall, there are only approximately 80 unrestricted parking spaces within a 400 m catchment that can be used as informal park and ride spaces and these are already operating at 98% utilisation.

The analysis in Chapter 3 shows that passengers are already used to parking more than 400m from the station at Bankstown.

[40] Source - Southwest Metro – Extent of Precinct Works & Interchange Requirements, Sydney Metro
[41] Source – Sydney Metro Southwest Precinct Plan – Bankstown, Sydney Metro

Dedicated commuter spaces are not expected to be affected while the TTP is in operation, however approximately 18 on street spaces would be affected by the TTP bus stops. These parking spaces would only be affected while the TTP is in operation, which is during possession periods. During these periods there is likely to be a reduction in demand for parking at the stations. This decline results from the influence of school holiday periods and the change of mode share as some drivers choose to drive to another station or their destination.

5.12.7 Construction Worker Parking

It is anticipated that four to ten parking spaces would be provided at any one time for project workers in the Bankstown area. The location of these parking spaces would move dependent on the specific location within the worksite which has active construction at the time.

Table 5.40 provides the anticipated daily workforce volume for construction workers in the Bankstown Area. It is assumed that public transport would be promoted as the primary mode of transport for construction workers. This would reduce the impacts on the local road network and parking requirements. As noted above, there is very little spare parking capacity in this location to accommodate worker parking. Off-site parking alternatives and associated shuttle arrangements would be investigated to transport workers to and from the site.

Table 5.40 Anticipated Daily Workforce - Bankstown

	Non Possession		Possession Short Period Close-down	
	Peak	Typical / Average	Peak	Typical
Bankstown Station	135	90	300	130

5.13 Regents Park Station

Regents Park Station, and the other stations west of Bankstown do not have any civil construction related activities occurring as part of the project. Some enabling activities related to the implementation of the TTP may be required as detailed in Chapter 9 of the main EIS report. However as a result of the track possessions which are required for the project, the current rail services would be suspended to these stations in addition to those above, with the TTP implemented. This requires consideration of the effects on the road network from these additional bus movements.

5.13.1 Active Transport Network

There are no proposed construction activities within those station catchments and therefore there are no expected effects on active transport modes.

5.13.2 Regents Park Temporary Transport Route

The Baseline TTP assumes the need for one bus service for Regents Park Station, resulting in 12 buses per hour in each direction. The temporary transport bus stops would use areas that are currently used for bus stops.

The remaining bus routes originate east of Regents Park.

The indicative rail replacement operation at Regents Park Station is shown in **Figure 5.23**.

Figure 5.23 Temporary Transport Plan – Regents Park (Sydney Metro 2017)

5.13.3 Road Network Performance – AM Peak and PM Peaks

Table 5.41 and **Table 5.42** below shows a summary of the intersection assessment undertaken for this station.

Table 5.41 Regents Park Station Intersection Assessment – AM Peak

Regents Park Station – AM Peak					
Scenario	Existing	Future	Construction	Baseline TTP	Refined Baseline TTP
H.35 Auburn Road / Amy Street (Roundabout)					**Year Capped: 2023**
Demand Flow (Veh)	2216	2433	No Vehicles	2446	2446
Average Delay per Vehicle (Average over all arms in seconds)	10	13		14	14
Average Delay per Vehicle (Worst Movement in seconds)	13	18		18	18
LoS (Worst Movement)	A	B		B	B
DoS (Worst Movement)	0.70	0.81		0.82	0.82

Table 5.42 Regents Park Station Intersection Assessment – PM Peak

Regents Park Station – PM Peak					
Scenario	Existing	Future	Construction	Baseline TTP	Refined Baseline TTP
H.35 Auburn Road / Amy Street (Roundabout)					**Year Capped: 2023**
Demand Flow (Veh)	1985	2193	No Vehicles	2205	2205
Average Delay per Vehicle (Average over all arms in seconds)	9	10		10	10
Average Delay per Vehicle (Worst Movement in seconds)	10	12		13	13
LoS (Worst Movement)	A	A		A	A
DoS (Worst Movement)	0.56	0.65		0.65	0.65

In the AM peak, the intersections around Regents Park Station have a level of service of 'B' or better after accounting for the increase in delay resulting from future traffic growth and TTP scenarios. A LoS 'B' would not cause noticeable delays for commuters in the peak hour in Sydney.

5.13.4 Commuter and Short Term Parking

Dedicated commuter and other unrestricted parking spaces are not expected to be affected while the TTP is in operation.

5.14 Lidcombe Station

5.14.1 Lidcombe Temporary Transport Route

One bus route travels past Lidcombe Station, resulting in six buses per hour in each direction. The temporary transport bus stops would utilise areas that are currently used for bus stops and car parking.

The indicative rail replacement operation at Lidcombe is shown in **Figure 5.24**.

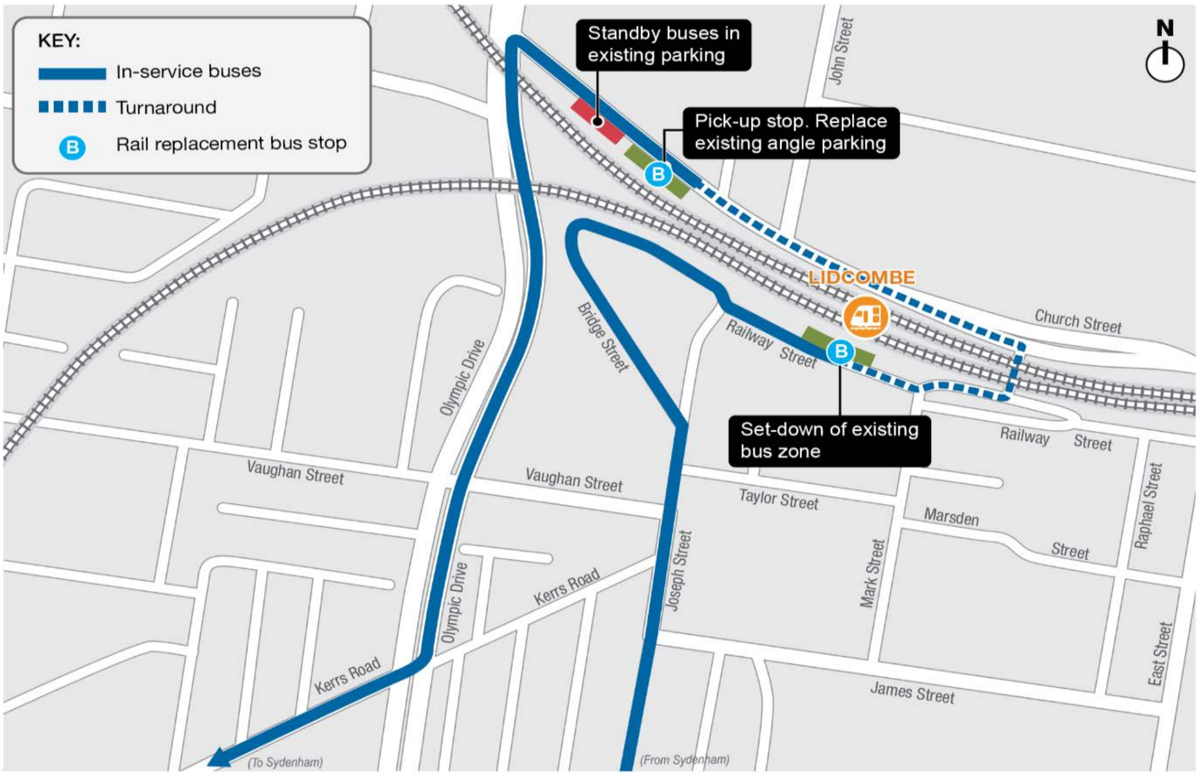

Figure 5.24 Temporary Transport Plan – Lidcombe (Sydney Metro 2017)

The remaining bus routes originate east of Lidcombe.

5.14.2 Road Network Performance – AM Peak

Table 5.43 below shows a summary of the intersection assessment undertaken for this station.

Table 5.43 Lidcombe Station Intersection Assessment – AM Peak

Lidcombe Station – AM Peak					
Scenario	**Existing**	**Future**	**Construction**	**Baseline TTP**	**Refined Baseline TTP**
H.26 Joseph Street / Georges Avenue (Signals)					**Year Capped: 2023**
Demand Flow (Veh)	5386	5914	No Vehicles	5928	5928
Average Delay per Vehicle (Average over all arms in seconds)	21	20		20	20
LoS (Overall)	B	B		B	B
DoS (Worst Movement)	0.89	0.96		0.96	0.96
H.27 Olympic Drive / Joseph Street (Signals)					**Year Capped: 2019**
Demand Flow (Veh)	4661	5117	No Vehicles	5131	5131
Average Delay per Vehicle (Average over all arms in seconds)	5	5		5	5
LoS (Overall)	A	A		A	A
DoS (Worst Movement)	0.75	0.76		0.78	0.78
H.28 Vaughan Street / Joseph Street (Signals)					**Year Capped: 2023**
Demand Flow (Veh)	1323	1453	No Vehicles	1468	1468
Average Delay per Vehicle (Average over all arms in seconds)	12	13		13	13
LoS (Overall)	A	A		A	A
DoS (Worst Movement)	0.75	0.80		0.80	0.80
H.29 Olympic Drive / Church Street (Signals)					**Year Capped: 2023**
Demand Flow (Veh)	4888	5367	No Vehicles	5381	5381
Average Delay per Vehicle (Average over all arms in seconds)	20	41		49	49
LoS (Overall)	B	C		D	D
DoS (Worst Movement)	0.80	0.96		0.98	0.98

All four intersections near Lidcombe Station have a LoS ‘D’ or better after allowing for future traffic growth and TTP scenarios.

Olympic Drive / Church Street is the only intersection which is forecast to experience a decline in amenity. This decline is mostly attributed to future traffic growth. The TTP scenario increases the delay by eight seconds as a result of 14 buses travelling through the intersection. Eight seconds could be considered to be within the range of reasonable daily fluctuations and therefore should not be noticed by commuters.

5.14.3 Road Network Performance – PM Peak

Table 5.44 below shows a summary of the intersection assessment undertaken for this station.

Table 5.44 Lidcombe Station Intersection Assessment – PM Peak

Lidcombe Station – PM Peak					
Scenario	**Existing**	**Future**	**Construction**	**Baseline TTP**	**Refined Baseline TTP**
H.26 Joseph Street / Georges Avenue (Signals)					**Year Capped: 2023**
Demand Flow (Veh)	5300	5856	No Vehicles	5871	5871
Average Delay per Vehicle (Average over all arms in seconds)	22	25		25	25
LoS (Overall)	B	B		B	B
DoS (Worst Movement)	0.71	0.91		0.94	0.94
H.27 Olympic Drive / Joseph Street (Signals)					**Year Capped: 2023**
Demand Flow (Veh)	4495	4967	No Vehicles	4981	4981
Average Delay per Vehicle (Average over all arms in seconds)	6	6		6	6
LoS (Overall)	A	A		A	A
DoS (Worst Movement)	0.69	0.72		0.73	0.73
H.28 Vaughan Street / Joseph Street (Signals)					**Year Capped: 2023**
Demand Flow (Veh)	1440	1591	No Vehicles	1606	1606
Average Delay per Vehicle (Average over all arms in seconds)	14	14		14	14
LoS (Overall)	A	B		B	B
DoS (Worst Movement)	0.52	0.56		0.58	0.58
H.29 Olympic Drive / Church Street (Signals)					**Year Capped: 2022**
Demand Flow (Veh)	4802	5306	No Vehicles	5320	5320
Average Delay per Vehicle (Average over all arms in seconds)	29	56		65	65
LoS (Overall)	B	D		E	E
DoS (Worst Movement)	0.90	0.94		0.97	0.97

The Olympic Drive / Church Street intersection is forecast to experience an increase in delay as a result of the addition of the TTP traffic in the PM Peak. The intersection has a LoS of 'D' in the Future scenario, worsening to a LoS 'E' in the TTP scenario. Scheduling works during the school term break periods would help to alleviate congestion at this intersection.

The through movement from the Olympic Drive north approach is the worst performing movement with an average delay of over 1 minute. There are 14 replacement buses travelling southeast in the TTP scenario, causing green time to be taken away from the dominant north-south movement and reallocated to the southeast movement.

5.14.4 Active Transport Network

There are no proposed construction activities within this station catchment and therefore there are no expected effects on active transport modes.

5.14.5 Commuter and Short Term Parking

Approximately 20 on street short-term spaces would be affected by the TTP bus stops. These parking spaces would only be affected while the TTP is in operation, which is during possession periods. During these periods there is likely to be a reduction in demand for parking at the stations. This reduction results from the influence of school holiday periods and the change of mode share as some drivers choose to drive to another station or their destination.

5.15 Birrong Station

5.15.1 Birrong Temporary Transport Route

One bus route travels past Birrong Station, resulting in twelve buses per hour. The temporary transport bus stops would use areas that are currently used for car parking.

The indicative rail replacement operation at Birrong is shown in **Figure 5.25**.

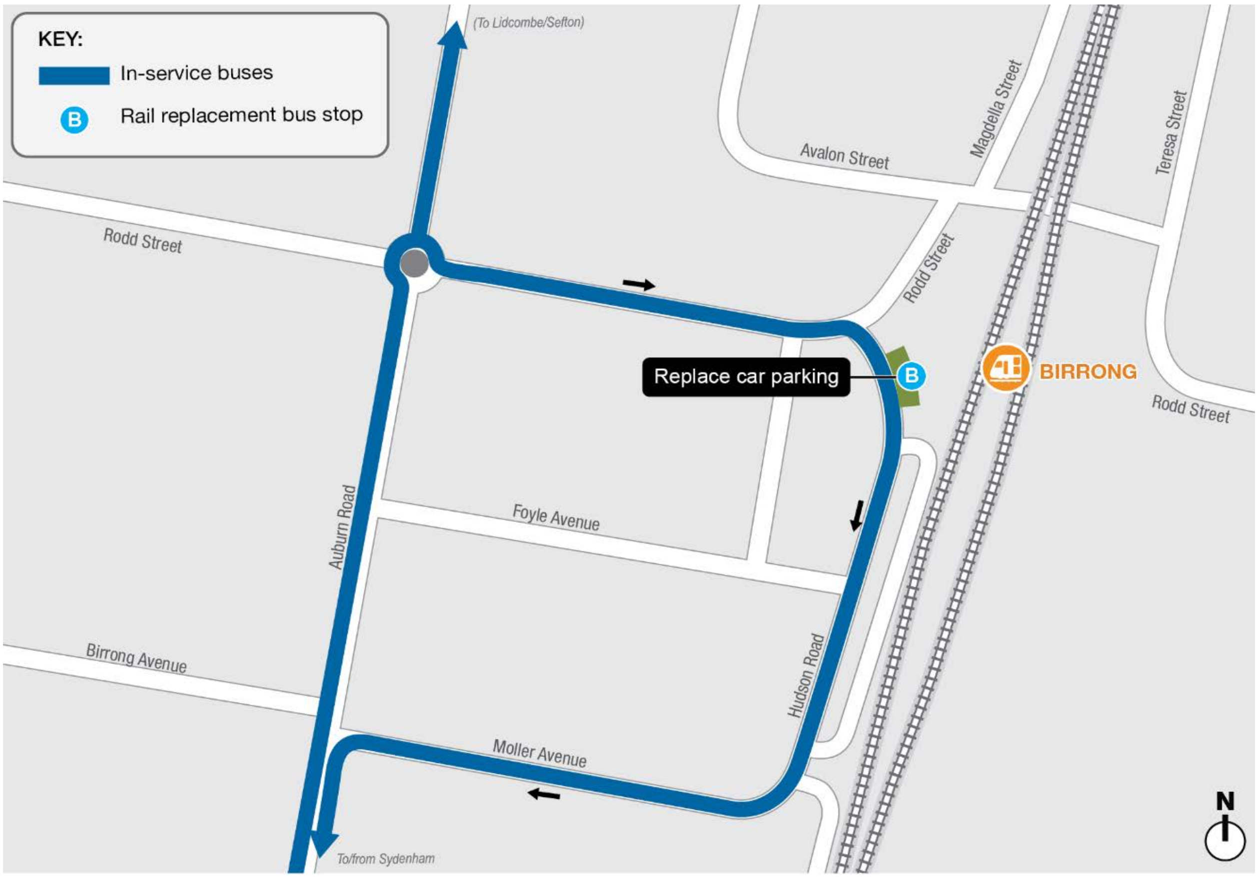

Figure 5.25 Temporary Transport Plan – Birrong (Sydney Metro 2017)

The remaining bus routes originate east of Birrong.

5.15.2 Road Network Performance – AM Peak and PM Peak

Table 5.45 and **Table 5.46** below show a summary of the intersection assessment undertaken for this station.

Table 5.45 Birrong Station Intersection Assessment – AM Peak

Birrong Station – AM Peak					
Scenario	Existing	Future	Construction	Baseline TTP	Refined Baseline TTP
H.44 Auburn Road / Moller Avenue (Priority Controlled)					**Year Capped: 2023**
Demand Flow (Veh)	1271	1396	No Vehicles	1437	1437
Average Delay per Vehicle (Average over all arms in seconds)	1	1		1	1
Average Delay per Vehicle (Worst Movement in seconds)	31	41		47	47
LoS (Worst Movement)	C	C		D	D
DoS (Worst Movement)	0.35	0.39		0.41	0.41

Table 5.46 Birrong Station Intersection Assessment – PM Peak

Birrong Station – PM Peak					
Scenario	Existing	Future	Construction	Baseline TTP	Refined Baseline TTP
H.44 Auburn Road / Moller Avenue (Priority Controlled)					**Year Capped: 2023**
Demand Flow (Veh)	1303	1440	No Vehicles	1481	1481
Average Delay per Vehicle (Average over all arms in seconds)	0	0		0	0
Average Delay per Vehicle (Worst Movement in seconds)	22	28		31	31
LoS (Worst Movement)	B	B		C	C
DoS (Worst Movement)	0.36	0.40		0.42	0.42

In the AM peak the level of service declines from 'C' in the existing and future scenario, and declines to 'D' with the addition of TTP which is based off the worst movement (right turning movement from the Birrong Road approach). A LoS 'D' would not cause delays above that which could be reasonably expected in the peak hour in Sydney.

In the PM peak the level of service declines from 'B' in the existing and future scenario, and declines to 'C' with the addition of TTP which is based off the worst movement (right turning movement from the Birrong Road approach).

5.15.3 Active Transport Network

There are no proposed construction activities within this station catchment and therefore there are no expected effects on active transport modes.

5.15.4 Commuter and Short Term Parking

Approximately six on street short-term spaces would be affected by the TTP bus stops. These parking spaces would only be affected while the TTP is in operation, which is during possession periods. During these periods there is likely to be a decline in demand for parking at the stations. This decline results from the influence of school holiday periods and the change of mode share as some drivers choose to drive to another station or their destination.

5.16 Yagoona Station

5.16.1 Yagoona Temporary Transport Route

One bus route travels past Yagoona Station, resulting in 12 buses per hour in each direction. The temporary transport bus stops would use existing bus stops.

The indicative rail replacement operation at Yagoona is shown in **Figure 5.26**.

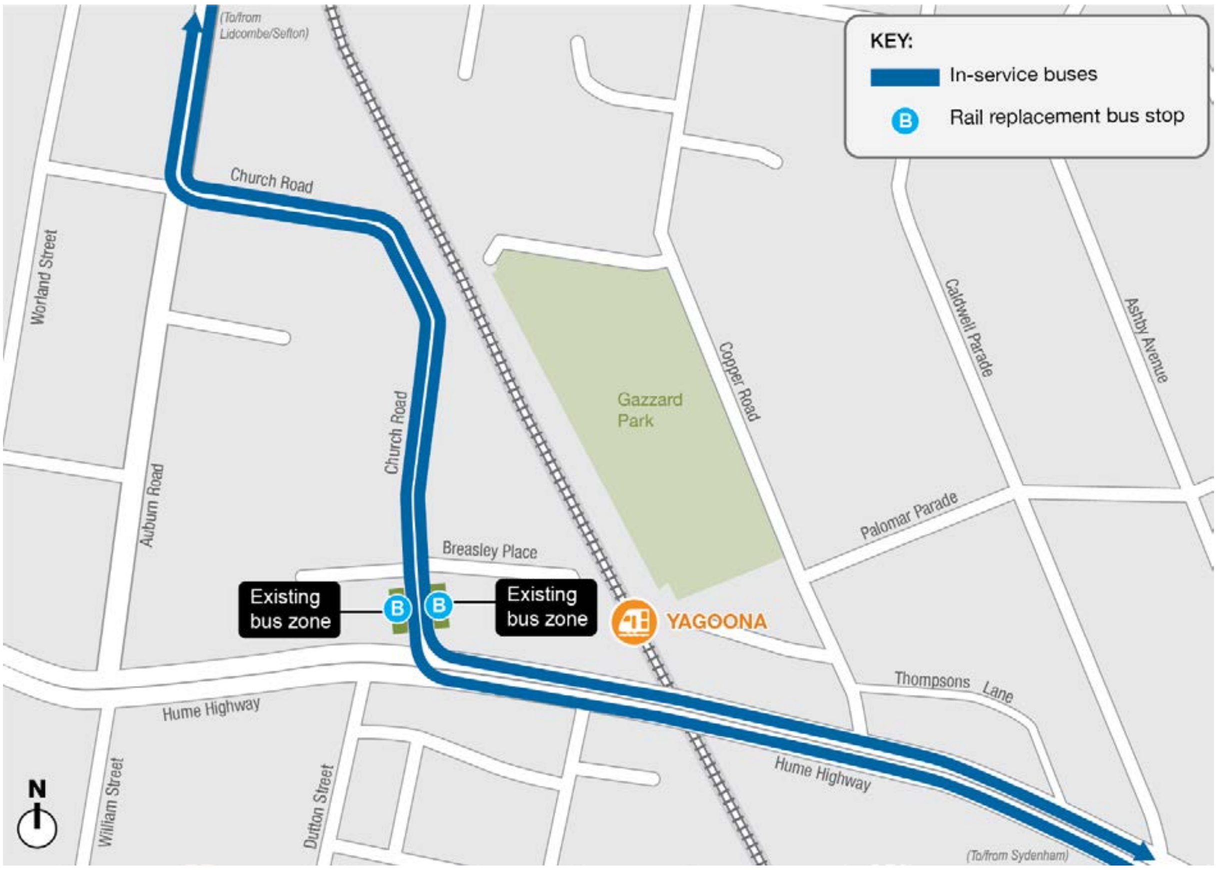

Figure 5.26 Temporary Transport Plan – Yagoona (Sydney Metro 2017)

The remaining bus routes originate east of Yagoona.

5.16.2 Road Network Performance – AM Peak

Table 5.47 below shows a summary of the intersection assessment undertaken for this station.

Table 5.47 Yagoona Station Intersection Assessment – AM Peak

Yagoona Station – AM Peak					
Scenario	Existing	Future	Construction	Baseline TTP	Refined Baseline TTP
H.42 Chapel Road / Hume Highway (Signals)					**Year Capped: 2021**
Demand Flow (Veh)	4361	4666	No Vehicles	4706	4706
Average Delay per Vehicle (Average over all arms in seconds)	34	36		42	42
LoS (Overall)	C	C		C	C
DoS (Worst Movement)	0.82	0.83		0.90	0.90
H.43 Church Road / Hume Highway (Priority Controlled)					**Year Capped: 2023**
Demand Flow (Veh)	4031	4426	No Vehicles	4467	4467
Average Delay per Vehicle (Average over all arms in seconds)	4	19		27	27
Average Delay per Vehicle (Worst Movement in seconds)	608	943		778	778
LoS (Worst Movement)	F	F		F	F
DoS (Worst Movement)	0.91	1.10		1.76	1.76

Of the two intersections, Chapel Road / Hume Highway retains a LoS ‘C’ throughout all scenarios. A LoS ‘C’ would generally be considered reasonable during peak periods.

The Church Road /Hume Highway priority intersection has a current level of service F during the morning and afternoon peaks. The modelled average delay is likely to increase as a result of the future traffic from a predicted 10 minutes at present to 16 minutes with future traffic growth in the AM. These modelled delays reflect the demand at Church Road exceeding the capacity of gaps in the main flow. Where the demand exceeds capacity, driver behaviour potentially changes, resulting in the choice to pull into smaller gaps between vehicles on the main movement. Under the baseline TTP the modelled delays would actually decrease slightly reflecting the additional gaps in through traffic arising from increase turning traffic creating gaps for egressing vehicles.

However, the modelling does not take account of the signalled intersection to the east, and the queues / platooning effects which arise as a result. The ‘keep clear’ road markings mean that when the signals stop the flow along Hume Highway, and the queue extends to the Church Street intersection, it is possible for the movement into Church Street to occur, and likely that some vehicles would be able to egress.

5.16.3 Road Network Performance – PM Peak

Table 5.48 below shows a summary of the intersection assessment undertaken for this station.

Table 5.48 Yagoona Station Intersection Assessment – PM Peak

Yagoona Station – PM Peak					
Scenario	**Existing**	**Future**	**Construction**	**Baseline TTP**	**Refined Baseline TTP**
H.42 Chapel Road / Hume Highway (Signals)		**Year Capped: 2023**			
Demand Flow (Veh)	5059	5591	No Vehicles	5632	5632
Average Delay per Vehicle (Average over all arms in seconds)	35	38		41	41
LoS (Overall)	C	C		C	C
DoS (Worst Movement)	0.80	0.89		0.89	0.89
H.43 Church Road / Hume Highway (Priority Controlled)				**Year Capped: 2023**	
Demand Flow (Veh)	4176	4614	No Vehicles	4655	4655
Average Delay per Vehicle (Average over all arms in seconds)	3	4		23	23
Average Delay per Vehicle (Worst Movement in seconds)	317	284		926	926
LoS (Worst Movement)	F	F		F	F
DoS (Worst Movement)	0.91	0.91		1.79	1.79

The Chapel Road / Hume Highway retains a LoS ‘C’ throughout all scenarios. As with the AM assessment above, the PM modelling shows that without the keep clear markings and queues from the Chapel Road signals Church Road would be significantly over capacity when TTS services are running. Monitoring of the conditions and efficiency of the TTS would be required, and potential mitigations should the delays lead to significant delays for existing traffic or the buses on TTS could include alternate routes for some or all TTS services.

5.16.4 Active Transport Network

There are no proposed construction activities within this station catchment and therefore there are no expected effects on active transport modes.

5.16.5 Commuter and Short Term Parking

Dedicated commuter and other unrestricted parking spaces are not expected to be affected while the TTP is in operation.

5.17 Summary of construction assessment - Station and Track Alignment works

5.17.1 Existing, Construction and TTP Scenario Average Daily Traffic

Table 5.49 below outlines the existing Average Daily Traffic (ADT) for construction haulage routes and TTP scenario routes, as well as the estimated construction haulage volumes and baseline TTP scenario bus volumes for the area surrounding each station. The method of calculating the ADTs from the peak hourly flow has been discussed in **Section 3.1.5** above.

Table 5.49 Existing, Construction and TTP ADT

Station	Road	Existing ADT (Vehicles per day)			Additional Construction Haulage ADT (Vehicles per day)			Additional Baseline TTP ADT (Vehicles per day)	Additional Refined Baseline TTP ADT (Vehicles per day)
		Total	LV	HV	Total	LV	HV	Buses	Buses
Marrickville	Myrtle Street	1,100	1,000	100	220	110	110	0	0
	Carrington Road (Between Schwebel Street and Myrtle Street)	8,800	8,000	800	220	110	110	0	0
	Richardson Crescent	18,600	17,400	1,200	220	110	110	0	0
	Illawarra Road (between Marrickville Road and Calvert Street)	11,900	11,100	800	330	110	220	500	230
	Marrickville Road (Between Illawarra Road and Silver Street)	16,200	14,100	2,100	0	0	0	1,590	860
	Victoria Road (Between Marrickville Road and Fernbank Street)	7,900	7,400	500	0	0	0	0	0
	Warren Road (Between Illawarra Road and Moyes Street)	11,000	9,600	1,400	220	110	110	570	260
Dulwich Hill	Livingstone Road (between Warren Road and Jersey Street)	12,200	11,800	400	40	0	40	0	0
	Marrickville Road (Between Darley Street and Wardell Road)	12,600	11,200	1,400	240	110	130	1,020	600
	Dudley Street (Between School Parade and Wardell Road)	4,300	4,100	200	40	0	40	570	40
	Bayley Street (Between Ewart Street and Dudley Street)	800	700	100	40	0	40	570	40
	Ewart Street (Between Bayley Street and Wicks Ave)	7,500	7,100	400	40	0	40	570	490

Station	Road	Existing ADT (Vehicles per day)			Additional Construction Haulage ADT (Vehicles per day)			Additional Baseline TTP ADT (Vehicles per day)	Additional Refined Baseline TTP ADT (Vehicles per day)
		Total	LV	HV	Total	LV	HV	Buses	Buses
	Beauchamp Street (Between School Parade and Ewart Street)	7,500	7,100	400	40	0	40	570	260
	Wardell Road (Between Marrickville Road and Pine Street)	14,400	14,000	400	240	110	130	0	230
	Terrace Road (Between New Canterbury Road and Consett Street)	1,300	1,300	0	460	220	240	0	0
	New Canterbury Road (Between Kintore Street and Terrace Road)	28,800	27,800	1,000	460	220	240	1,020	380
Hurlstone Park	Garnet Street (Between Canterbury Road and Hampden Street)	2,200	2,200	0	40	0	40	0	0
	New Canterbury Road (Between Wattle Lane and Old Canterbury Road)	25,100	24,000	1,100	460	220	240	1,020	380
	Duntroon Street	2,000	1,900	100	220	110	110	0	0
	Crinan Street (Between Floss Street and Fernhil Street)	8,500	7,800	700	360	220	140	240	260
	Canterbury Road (Between Queen Street and Wattle Ln)	25,400	23,500	1,900	480	220	260	1,020	600
	Dunstaffenage Street (Between Crinan Street and Floss Street)	300	300	0	70	0	70	0	0
	Crinan Street (Between Melford Street and Dunstaffenage Street)	6,700	6,000	700	480	220	260	240	260
	Canterbury Road (Between Queen Street and Princess Street)	29,800	27,600	2,200	480	220	260	1260	640

Station	Road	Existing ADT (Vehicles per day)			Additional Construction Haulage ADT (Vehicles per day)			Additional Baseline TTP ADT (Vehicles per day)	Additional Refined Baseline TTP ADT (Vehicles per day)
		Total	LV	HV	Total	LV	HV	Buses	Buses
Canterbury	Crinan Street (Between Melford Street and Dunstaffenage Street)	6,700	6,000	700	480	220	260	240	260
	Canterbury Road (Between Close Street and Broughton Street)	51,300	47,840	3,530	260	110	150	1,260	640
	Close Street	800	600	200	410	240	170	0	0
	Broughton Street (Between Canterbury Road and Robert Street)	3,600	3,200	400	260	110	150	0	0
	Canterbury Road (Between Jeffrey Street and Minter Street)	35,740	32,970	2,770	530	220	310	1,260	640
	Charles Street	930	760	170	44	22	22	0	0
	Charles Street (Between Canterbury Road and Broughton Street)	1,000	800	200	260	110	150	0	0
	Canterbury Road (Between Charles Street and Close Street)	51,300	47,800	3,500	260	110	150	1,260	640
	Wairoa Street (between Wonga Street and Nowra Street)	10,100	10,000	100	0	0	0	0	0
	Canterbury Road (Between Wonga Street and Cooks Avenue)	38,600	35,400	3,200	350	110	240	500	0
	Canterbury Road (Between Fore Street and Charles Street)	51,600	48,100	3,500	350	110	240	1,260	640
	Canterbury Road (Between Wonga Street and Fore Street)	44,500	41,200	3,300	350	110	240	500	0
	Wonga Street	13,000	12,800	200	0	0	0	0	0
	Canterbury Road	51,600	48,100	3,500	260	110	150	500	0

Station	Road	Existing ADT (Vehicles per day)			Additional Construction Haulage ADT (Vehicles per day)			Additional Baseline TTP ADT (Vehicles per day)	Additional Refined Baseline TTP ADT (Vehicles per day)
		Total	LV	HV	Total	LV	HV	Buses	Buses
Campsie	South Parade (Between Beamish Street and Harold Street)	6,900	6,500	400	20	0	20	760	740
	Canterbury Road (Between Beamish Street and Scahill Street)	41,200	38,200	3,000	120	60	60	500	0
	Beamish Street (Between Ninth Ave and Campsie Street)	14,500	14,100	400	120	60	60	760	640
	North Parade (Between Browning Street and Beamish Street)	2,400	2,400	0	0	0	0	0	0
	Beamish Street (Between South Parade and Amy Street)	18,900	18,500	400	120	60	60	0	0
	Brighton Ave (Between Browning Street and Shakespeare Street)	12,700	12,600	100	120	60	60	0	0
	Ninth Avenue (Between Beamish Street and Fifth Avenue)	16,300	15,900	400	20	0	20	760	260
	Loch Street (Between Evaline Street and Lillian Street)	15,600	14,300	1,300	20	0	20	0	0
	Evaline Street (Between Loch Street and Beamish Street)	5,500	5,300	200	20	0	20	0	0
	Thorncraft Parade (Between Canterbury Road and Claremont Street)	8,200	7,600	600	20	0	20	0	0
	Palmer Street	10,300	9,600	700	0	0	0	0	0
Belmore	Redman Parade (Between Burwood Road and Sudbury Street)	6,200	6,100	100	0	0	0	0	0
	Burwood Road (Between Redman Parade and Bridge Road)	19,700	17,600	2,100	440	220	220	760	260

Station	Road	Existing ADT (Vehicles per day)			Additional Construction Haulage ADT (Vehicles per day)			Additional Baseline TTP ADT (Vehicles per day)	Additional Refined Baseline TTP ADT (Vehicles per day)
		Total	LV	HV	Total	LV	HV	Buses	Buses
	Bridge Road (Between Marie Lane and Burwood Avenue)	10,500	10,000	500	0	0	0	760	260
	Burwood Road (Between Bridge Road and Collins Street)	21,500	19,300	2,200	480	220	260	0	0
Lakemba	The Boulevarde (Between Haldon Street and Croydon Street)	8,100	7,900	200	120	60	60	730	260
	Moreton Street (Between Lakemba Street and The Boulevarde)	16,800	15,600	1,200	90	0	90	0	0
	Lakemba Street (Between King Georges Road and Shadforth Street)	3,600	3,500	100	220	110	110	0	0
	Burwood Road (Between Redman Parade and Bridge Road)	19,700	17,600	2,100	440	220	220	760	260
	Railway Parade (Between Haldon Street and Croydon Street)	4,500	4,400	100	80	40	40	0	0
	Haldon Street (Between Railway Parade and The Boulevarde)	15,000	14,100	900	220	110	110	0	0
	The Boulevarde (Between Haldon Street and Croyden Street)	8,100	7,900	200	60	30	30	730	260
	Haldon Street (Between The Boulevarde and Oneata Street)	9,800	8,900	900	500	170	330	500	0
	Canterbury Road (Between Haldon Street and Legge Street)	43,900	40,000	3,900	40	0	40	500	0
Wiley Park	The Boulevarde (Between Renown Avenue and King Georges Road)	13,900	13,500	400	220	110	110	730	260

Station	Road	Existing ADT (Vehicles per day)			Additional Construction Haulage ADT (Vehicles per day)			Additional Baseline TTP ADT (Vehicles per day)	Additional Refined Baseline TTP ADT (Vehicles per day)
		Total	LV	HV	Total	LV	HV	Buses	Buses
	King Georges Road (Between The Boulevarde and Mary Street)	88,000	78,100	9,900	240	110	130	0	0
	Lakemba Street (Between King Georges Road and Shadforth Street)	3,600	3,500	100	220	110	110	0	0
	King Georges Road (Between Lakemba Street and The Boulevarde)	96,800	86,700	10,100	220	110	110	0	0
Punchbowl	Dudley Street (Between School Parade and Wardell Road)	4,300	4,100	200	40	0	40	570	40
	Punchbowl Road (Between The Boulevarde and Acacia Ave)	50,500	47,000	3,500	180	90	90	0	0
	The Boulevarde (Between Punchbowl Road and Arthur Street)	24,800	23,400	1,400	80	40	40	730	260
	South Terrace (Between Loder Lane and Punchbowl Road)	14,000	13,600	400	80	40	40	730	260
	Punchbowl Road (Between South Terrace and The Boulevarde)	60,700	56,600	4,100	80	40	40	0	0
	Wattle Street (Between Highclere Ave and Acacia Ave)	18,400	18,100	300	80	40	40	0	0
Bankstown	South Terrace (Between West Terrace and East Terrace)	12,000	11,800	200	120	60	60	730	260
	Stacey Street (Between Verbena Avenue and Stanley Street)	66,000	56,300	9,700	500	130	370	0	0
	Restwell Street (Between Stewart Lane and Raymond Street)	8,800	8,500	300	120	60	60	730	260

Station	Road	Existing ADT (Vehicles per day)			Additional Construction Haulage ADT (Vehicles per day)			Additional Baseline TTP ADT (Vehicles per day)	Additional Refined Baseline TTP ADT (Vehicles per day)
		Total	LV	HV	Total	LV	HV	Buses	Buses
	Raymond Street (Between Restwell Street and West Terrace)	3,200	3,000	200	120	60	60	730	260
	South Terrace (Between West Terrace and Restwell Street)	6,300	6,000	300	120	60	60	730	260
	North Terrace (Between The Appian Way and Fetherstone Street)	9,000	9,000	0	120	60	60	660	230
	Wattle Street (Between Stacey Street and North Terrace)	12,400	12,100	300	120	60	60	0	0
	Marion Street (Between Bungalow Cres and Meredith Street)	34,800	30,700	4,100	0	0	0	0	0
	Meredith Street (Between Marion Street and Gordon Street)	24,600	21,100	3,500	0	0	0	0	0
	Rickard Road (Between Jacobs Street and Chapel Road)	6,100	5,700	400	0	0	0	0	0

5.17.2 Summary of intersection performance assessments

The assessment above shows that there are several intersections that are forecast to develop deteriorating levels of service through the growth in traffic volumes that are expected regardless of the project. These are noted, but are considered to be part of the 'baseline'.

Consideration of the construction traffic, specifically the haulage of materials, shows that across all of the stations and intersections modelled, there is only one which is forecast to become oversaturated as a result of the construction haulage traffic, and in that case it is by a relatively small degree. It is expected that changes in commuter behaviour would lead to the delays being managed (travel earlier or later, avoid peak periods etc.) without the need for specific interventions over and above notifications to the travelling public informing people of the potential issues that may be experienced during each phase of the works.

However, the assessment of the TTS (Baseline TTP) has forecast levels of delay which would have the potential to lead to delays and diversions that extend well beyond the immediate vicinity of the project area. In addition these delays would be experienced by the existing buses on orbital and radial routes, leading to significant journey time delay and variability on public transport as a whole in the region. The Refined Baseline TTP reduces the delays at a number of the modelled intersections, but the reduction is mostly insufficient to improve the level of service.

Table 5.50 provides a summary of the intersections which are modelled to have a LoS of 'E' or 'F' in the Future, Construction, Baseline or Refined Baseline TTP scenarios as a consequence of the project. The degree of saturation of each critical intersection is also displayed below.

As noted in **Section 3.1.6**, variations in traffic volumes and flows may be significant during some school break periods, with the term 4 break resulting in the greatest reductions. In the morning peak, term 1-3 breaks lead to a reduction typical reduction of some 5-6% in the AM peak, and 1.4% in the PM peak. However, the Term 4 break has been shown to provide the opportunity to undertake works with some 34% reduction in the AM flows and 16% in the PM peak.

It is recommended that where practicable, the works that are forecast to result in lowest levels of service should be programmed to be undertaken during the term 4 break, with those with lesser impacts undertaken during breaks 1 to 3.

Table 5.50 Summary of intersections modelling where an LoS of 'E' or 'F' resulted from the Future, Construction, Baseline or Refined Baseline TTP scenarios

Station	Scenario							
	Future		Construction		Baseline TTP		Refined Baseline TTP	
	AM	PM	AM	PM	AM	PM	AM	PM
Sydenham	-	-	-	-	-	-	-	-
Marrickville	-	B.18 Marrickville Road / Victoria Road (DoS 1.07)	-	B.18 Marrickville Road / Victoria Road (DoS 1.07)	B.17 Marrickville Road / Illawarra Road (DoS 1.09) B.18 Marrickville Road / Victoria Road (DoS 1.38)	B.17 Marrickville Road / Illawarra Road (DoS 1.08) B.18 Marrickville Road / Victoria Road (DoS 1.18)	B.18 Marrickville Road / Victoria Road (DoS 1.38)	B.18 Marrickville Road / Victoria Road (DoS 1.05)
Dulwich Hill	B.15 Wardell Road / Ewart Street (DoS 1.10) H.16 Wardell Road / Dudley Street (DoS 0.91)	H.16 Wardell Road / Dudley Street (DoS 0.82)	B.15 Wardell Road / Ewart Street (DoS 1.13) H.37 Wardell Road / Marrickville Road (DoS 1.14) H.16 Wardell Road / Dudley Street (DoS 0.91)	B.15 Wardell Road / Ewart Street (DoS 1.03) H.16 Wardell Road / Dudley Street (DoS 0.82)	B.15 Wardell Road / Ewart Street (DoS 1.32) H.37 Wardell Road / Marrickville Road (DoS 1.17) H.16 Wardell Road / Dudley Street (DoS 1.00)	B.15 Wardell Road / Ewart Street (DoS 1.11) H.37 Wardell Road / Marrickville Road (DoS 1.31) H.16 Wardell Road / Dudley Street (DoS 0.82)	B.15 Wardell Road / Ewart Street (DoS 1.28) H.37 Wardell Road / Marrickville Road (DoS 1.20) H.16 Wardell Road / Dudley Street (DoS 0.99)	B.15 Wardell Road / Ewart Street (DoS 1.11) H.37 Wardell Road / Marrickville Road (DoS 1.25) H.16 Wardell Road / Dudley Street (DoS 0.85)
Hurlstone Park	-	-	-	-	-	-	-	-

Station	Scenario							
	Future		Construction		Baseline TTP		Refined Baseline TTP	
	AM	PM	AM	PM	AM	PM	AM	PM
Canterbury	H.14 Canterbury Road / Charles Street (DoS 0.57)	H.14 Canterbury Road / Charles Street (DoS 0.60)	H.14 Canterbury Road / Charles Street (DoS 0.58)	H.14 Canterbury Road / Charles Street (DoS 0.61)	H.14 Canterbury Road / Charles Street (DoS 0.62)	H.14 Canterbury Road / Charles Street (DoS 0.66) H.14 Canterbury Road / Close Street (Dos 0.63)	H.14 Canterbury Road / Charles Street (DoS 0.60)	H.14 Canterbury Road / Charles Street (DoS 0.64)
Campsie	-	B.11 Beamish Street / Clissold Parade (DoS 1.05)	-	B.11 Beamish Street / Clissold Parade (DoS 1.07)	H.34 Ninth Avenue / Loch Street (DoS 1.10)	B.11 Beamish Street / Clissold Parade (DoS 1.41) H.34 Ninth Avenue / Loch Street (DoS 1.04) B.12 Beamish Street / South Parade (DoS 1.88) H.11 Beamish Street / North Parade (DoS 0.78)	H.34 Ninth Avenue / Loch Street (DoS 1.01)	B.11 Beamish Street / Clissold Parade (DoS 1.35) B.12 Beamish Street / South Parade (DoS 1.79) H.11 Beamish Street / North Parade (DoS 1.78)

Station	Scenario							
	Future		Construction		Baseline TTP		Refined Baseline TTP	
	AM	PM	AM	PM	AM	PM	AM	PM
Belmore	B.08 Burwood Road / Bridge Road (DoS 1.03) B.09 Burwood Road / Redman Parade (DoS 0.69)	B.08 Burwood Road / Bridge Road (DoS 1.05) B.09 Burwood Road / Redman Parade (DoS 0.72)	B.08 Burwood Road / Bridge Road (DoS 1.39) B.09 Burwood Road / Redman Parade (DoS 0.72)	B.08 Burwood Road / Bridge Road (DoS 1.39) B.09 Burwood Road / Redman Parade (DoS 0.74)	H.20 Burwood Road / Lakemba Street (DoS 1.30) B.08 Burwood Road / Bridge Road (DoS 1.44) B.09 Burwood Road / Redman Parade (DoS 0.78)	H.20 Burwood Road / Lakemba Street (DoS 1.44) B.08 Burwood Road / Bridge Road (DoS 1.44) B.09 Burwood Road / Redman Parade (DoS 0.80)	H.20 Burwood Road / Lakemba Street (DoS 1.51) B.08 Burwood Road / Bridge Road (DoS 1.46) B.09 Burwood Road / Redman Parade (DoS 0.74)	H.20 Burwood Road / Lakemba Street (DoS 1.56) B.08 Burwood Road / Bridge Road (DoS 1.46) B.09 Burwood Road / Redman Parade (DoS 0.76)
Lakemba	B.07 The Boulevarde / Haldon Street (DoS 1.05) H.08 Haldon Street / Railway Parade (DoS 1.03)	B.07 The Boulevarde / Haldon Street (DoS 1.10) H.08 Haldon Street / Railway Parade (DoS 1.06)	B.07 The Boulevarde / Haldon Street (DoS 1.12) H.08 Haldon Street / Railway Parade (DoS 1.22)	B.07 The Boulevarde / Haldon Street (DoS 1.16) H.08 Haldon Street / Railway Parade (DoS 1.18)	B.07 The Boulevarde / Haldon Street (DoS 1.47) H.08 Haldon Street / Railway Parade (DoS 1.22)	B.07 The Boulevarde / Haldon Street (DoS 1.32) H.08 Haldon Street / Railway Parade (DoS 1.18)	B.07 The Boulevarde / Haldon Street (DoS 1.21) H.08 Haldon Street / Railway Parade (DoS 1.22)	B.07 The Boulevarde / Haldon Street (DoS 1.18) H.08 Haldon Street / Railway Parade (DoS 1.18)
Wiley Park	-	-	-	-	B.06 King Georges Road / The Boulevarde (DoS 1.01)	B.06 King Georges Road / The Boulevarde (DoS 1.02)	B.06 King Georges Road / The Boulevarde (DoS 0.96)	-

Station	Scenario							
	Future		Construction		Baseline TTP		Refined Baseline TTP	
	AM	PM	AM	PM	AM	PM	AM	PM
Punchbowl	B.04 Punchbowl Road / South Terrace (DoS 1.02)	-	B.04 Punchbowl Road / South Terrace (DoS 1.03)	-	B.04 Punchbowl Road / South Terrace (DoS 1.09)	-	B.04 Punchbowl Road / South Terrace (DoS 1.03)	
Bankstown	-	H.03 North Terrace / Wattle Street (DoS 0.99) H.30 The Appian Way / North Terrace (DoS 1.07)	-	H.03 North Terrace / Wattle Street (DoS 0.99) H.30 The Appian Way / North Terrace (DoS 1.07)	-	H.03 North Terrace / Wattle Street (DoS 0.99) H.30 The Appian Way / North Terrace (DoS 1.25)	-	H.03 North Terrace / Wattle Street (DoS 0.99) H.30 The Appian Way / North Terrace (DoS 1.25)
Regents Park	-	-	-	-	-	-	-	-
Lidcombe	-	-	-	-	-	H.29 Olympic Drive / Church Street (DoS 0.97)	-	H.29 Olympic Drive / Church Street (DoS 0.97)
Birrong	-	-	-	-	-	-	-	-
Yagoona	H.43 Church Road / Hume Highway (DoS 1.10)	H.43 Church Road / Hume Highway (DoS 0.91)	-	-	H.43 Church Road / Hume Highway (DoS 1.76)	H.43 Church Road / Hume Highway (DoS 1.79)	H.43 Church Road / Hume Highway (DoS 1.76)	H.43 Church Road / Hume Highway (DoS 1.79)

5.17.3 Summary of intersection mitigation measures

From the results summarised in **Table 5.51**, the following intersections have been identified as having particularly high congestion and delays due to the addition of the Refined Baseline TTP scenario assessed:

- Belmore: Burwood Road / Bridge Road
- Belmore: Burwood Road / Lakemba Street
- Lakemba: Haldon Street/ Railway Parade
- Marrickville: Marrickville Road / Victoria Road
- Dulwich Hill: Wardell Road / Ewart Street
- Dulwich Hill: Wardell Road / Marrickville Road.

Typical mitigation measures tested included:

- running optimised phase times
- re-phasing to run highest volume approach twice
- lane re-arrangement to better separate heavy traffic flow movements.

Overall, the mitigation measures result in improved intersection operation from the Refined Baseline TTP scenario, indicating that the additional traffic volumes can be managed during possession periods. This mitigated intersection modelling and the interaction with other mitigations is discussed further in Chapter 9 – Mitigation Measures.