Austroads

Research Report
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On-Road Public Transport Priority Tool

On-Road Public Transport Priority Tool

Prepared by

David Green

Project Manager

Graham McCabe

Abstract

This report presents a practical process (referred to as a 'tool') to guide practitioners through the selection of the appropriate On-Road Public Transport (ORPT) priority treatments for any road scenario.

This step-by-step process can be used for applications relating to existing roads or a new/greenfield road development.

It considers all form of priority, ranging from road space, stop design and location, traffic signal priority, and traffic signal gating.

Using this guidance, practitioners will ensure the consistency, traceability, and robustness if their decision-making process.

Keywords

On-road public transport, priority treatments.

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Austroads Ltd.
Level 9, 287 Elizabeth Street
Sydney NSW 2000 Australia
Phone: +61 2 8265 3300
austroads@austroads.com.au
www.austroads.com.au

About Austroads

Austroads is the peak organisation of Australasian road transport and traffic agencies.

Austroads' purpose is to support our member organisations to deliver an improved Australasian road transport network. To succeed in this task, we undertake leading-edge road and transport research which underpins our input to policy development and published guidance on the design, construction and management of the road network and its associated infrastructure.

Austroads provides a collective approach that delivers value for money, encourages shared knowledge and drives consistency for road users.

Austroads is governed by a Board consisting of senior executive representatives from each of its eleven member organisations:

- Transport for NSW
- Department of Transport Victoria
- Queensland Department of Transport and Main Roads
- Main Roads Western Australia
- Department for Infrastructure and Transport South Australia
- Department of State Growth Tasmania
- Department of Infrastructure, Planning and Logistics Northern Territory
- Transport Canberra and City Services Directorate, Australian Capital Territory
- Department of Infrastructure, Transport, Regional Development and Communications
- Australian Local Government Association
- New Zealand Transport Agency.

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Summary

This report details a practical process (referred to as a 'tool') to guide practitioners through the selection of On-Road Public Transport (ORPT) priority treatments for any road scenario.

Key characteristics of the ORPT tool are as follows:

- It can be used for applications relating to an existing road or a future road that is going through the initial planning stages.
- The tool is a step-by-step process that assists practitioners in identifying the need for some form of ORPT priority, selecting the ORPT treatment with appropriate justifications, and handing over the decision to the project development group for prioritisation and implementation or incorporating it into planning permit approvals.
- It considers all form of priority, ranging from road space, stop design and location, traffic signal priority, and traffic signal gating.
- Where appropriate, the tool includes references to other Austroads frameworks and reference material to aid the practitioners in navigating through the process and making the decisions relevant to their situation. For instance, it leverages off the previous Austroads project titled Prioritising on-road public transport (Austroads 2017).

Users of the tool are expected to work through the process, keeping notes of completed tasks and summarised output of these tasks.

The ORPT tool should be viewed as guidance and not as a prescriptive instruction manual (unless directed to be used as such by the statutory authority that manage the roads which the ORPT operates on or is planned to operate on).

Beyond the use of the tool, it is recommended practitioners undertake post-evaluation to assess the impacts of the selected treatments, capture any stakeholder feedback, and consider this practical knowledge in future OPRT treatment selection.

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1. Introduction

1.1 Purpose

Public transport priority means priority over selected road users at a point in time and at a specific road location or road length. This does not mean priority over all road users but a priority hierarchy for all road users determined for different scenarios.

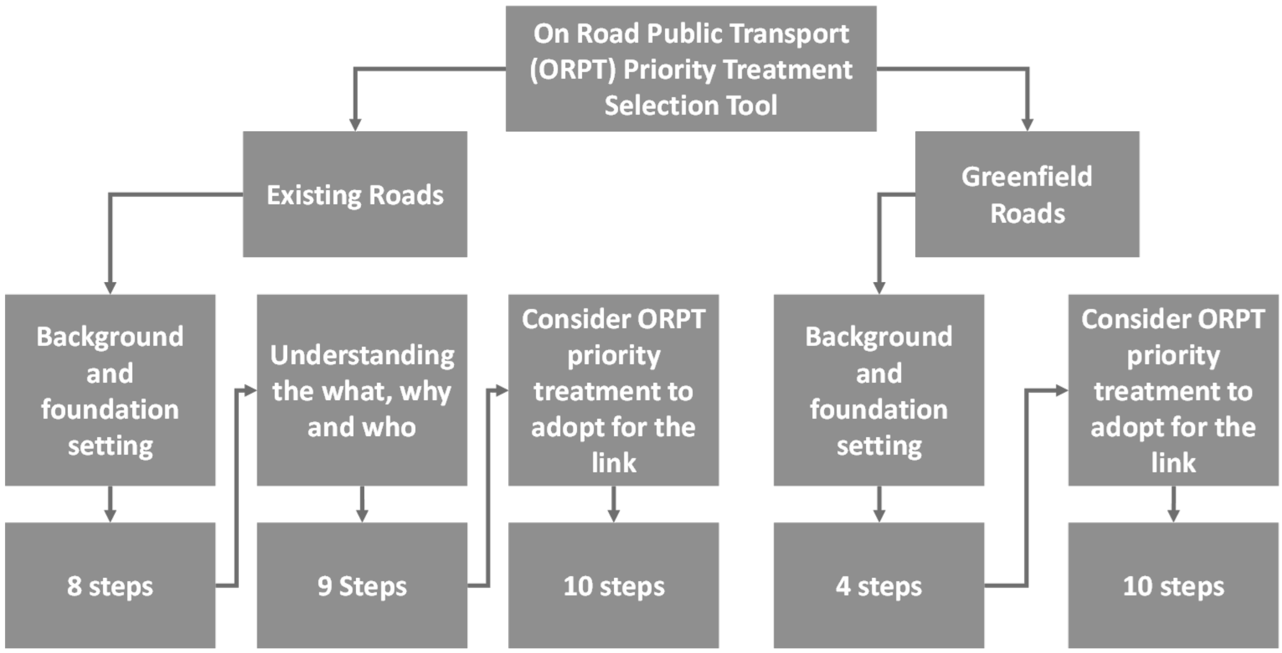
There are different On-Road Public Transport (ORPT) priority treatments available with different levels of suitability depending on the scenario and the hierarchy of priority.

This project leveraged off the previous Austroads project titled *Prioritising On-road Public Transport* (Austroads 2017) and developed a practical process (referred to as a 'tool') guiding practitioners through the selection of the appropriate ORPT priority treatments for any road scenario.

1.2 Scope

The ORPT tool has been split into two: one for existing roads applications, and the other simplified for greenfield roads applications. Both ORPT tools are divided into stages and steps as reflected in Figure 1.1.

Figure 1.1: Overall ORPT process



The different stages can be summarised as follows:

- Background and foundation setting: Identify the ORPT service of interest and location where ORPT priority is desired. Identify other road users, determine the operational policy for the link, and establish the priority hierarchy for the road link.
- Understanding what, why and who: Collect data about the ORPT service of interest and other road users using the link where ORPT priority is desired. Also identify the context of the road link where the ORPT priority is desired. This stage is not required for greenfield roads, as the road does not exist, and instead the operational policy as determined in the 'background and foundation setting' is used.

- Consider ORPT priority treatment to adopt for the link: Develop ORPT priority treatment options, present them to stakeholders and select the appropriate ORPT priority treatment for adoption.

The ORPT priority treatment selection process is shown in Table 1.1 for existing roads, and in Table 1.2 for greenfield roads.

1.3 Methodology

The ORPT priority tool has been developed through an iterative process involving representatives of the Austroads member agencies gathered in the project working group (PWG).

Sections 3 and 4 outlines the ORPT tool respectively for existing and greenfield roads applications, while the following report appendices include reference material supporting the use of the ORPT tools:

- Appendix A: LOS Framework as Outlined in Commentary 2 of GTM Part 4 provides a framework to help practitioners define the level of service (LOS) for different road users across various metrics.
- Appendix B: Movement and Place Framework helps practitioners define the movement and place role of the road network where the Movement and Place framework is adopted by their jurisdiction.
- Appendix C: Known ORPT Priority Treatments can be used as a reference to practitioners to aid them in their ORPT selection.
- Appendix D: Case Studies includes practical examples
- Appendix E: ORPT Analysis discusses the three main causes for problems relating to on-road public transport reliability and vehicle speed.

Table 1.1: ORPT process – high-level overview – existing roads

Stage & Flow	Step no.	High-level description ORPT process – existing roads	Links to other steps
Stage 1: Background and foundation setting ↓	1.1	Identify public transport service of interest to improve.	
	1.2	Identify the issues of concern for the public transport service.	
	1.3	Identify road corridors of operation for that service.	
	1.4	Identify the links of interest within the corridor identified in Step 1.3.	1.2, 1.3
	1.5	Identify other significant road users of the link.	1.5, 3.4
	1.6	Identify adjacent land uses of significance located along the link of interest.	
	1.7	Determine the short- and long-term network operation plan or policy for the link of interest.	
	HOLD POINT		
	1.8	Bring together representatives and confirm: • The hierarchy of priority of the significant road users. • The role for each road user. This may be based on the Movement and Place framework if adopted by the jurisdiction.	1.4, 1.5, 1.6, 1.7
Stage 2: Understanding the what, why and who ↓	2.1	Reconfirm the objectives of the on-road public transport priority.	1.2
	2.2	Obtain relevant public transport data for the operation of public transport service of interest (as identified in Step 1.1), for the issues identified (as identified in Step 1.2) for the links identified (as identified in Step 1.3).	1.1, 1.2, 1.3, 1.4
	2.3	Obtain data associated with other significant road users (as identified in Step 1.5 through to Step 1.8).	1.5, 1.6, 1.7, 1.8
	2.4	Utilise obtained data (from Step 2.2 and Step 2.3) to identify the likely factors causing the issue (as identified in Step 1.2) for the link of interest (identified in Step 1.4).	1.2, 1.4, 2.2, 2.3
	2.5	For the identified causal issues (as identified in Step 2.4) confirm the timeframes in which the issue is applicable.	2.4
	2.6	Confirm who are the current users of the public transport mode of interest and the future growth potential for the mode of public transport by users.	
	2.7	Confirm the current and future cross-section of the road reserve of the link of interest (identified in Step 1.4).	1.4
	2.8	For the existing cross-section (as identified in Step 2.7), confirm if the preferred ORPT priority treatment of a transit lane could be accommodated.	2.7
	2.9	Based on the preceding steps, practitioners should be able to identify the elements listed below: • Public transport and links of interest where ORPT priority treatment should be considered. • Who are the other road users and their priority position within the hierarchy of other road users. • The policy intention of the road link. • Public transport operational requirements.	All of the above

Stage & Flow	Step no.	High-level description ORPT process – existing roads	Links to other steps
		• Strategic operational public transport policy. • The issue with public transport vehicles including where and when. • The existing road cross-section and whether it is feasible to widen the cross-section, alter road space allocation and/or reallocate road space allocation.	
Stage 3: Consider ORPT priority treatment to adopt for the link	3.1	Based on the outcome of Stage 1 and Stage 2, as confirmed in Step 2.9, consider the appropriate category/categories of ORPT priority treatments or combination of ORPT priority likely to be suitable.	2.9
	3.2	Based on the selected category/categories of ORPT priority treatments as determined in Step 3.1, identify ORPT priority treatment/s options that best address the scenario being investigated.	3.1, 3.2, 3.4
	3.3	For the identified ORPT treatments (identified in Step 3.2) applied to the scenario, conceptually consider how this will fit into the existing road environment.	3.2
	3.4	Using the conceptual drawing (developed in Step 3.3), identify and articulate the benefits for the public transport vehicle while identifying the trade-offs for the other road users.	3.3
	3.5	Consider what road management systems need to be put in place to deliver the ORPT priority treatment and prepare indicative cost estimates of different options.	
	3.6	Based on the outcome of Step 3.4 and Step 3.5, undertake an assessment of the various conceptual options developed.	3.4, 3.5
	3.7	Based on the conceptual drawings of the different options (developed in Step 3.3), in addition to the trade-offs, determine the preferred option from the road/transport agency perspective.	1.8, 2.1, 3.3
	3.8	Bring back together representatives used in Step 1.8 and present conceptual drawings of the preferred and other options along with the articulated trade-offs for the other road users.	1.8, 3.1
	HOLD POINT		
	3.9	Based on an assessment of the feedback obtained in Step 3.8 along with the preferred option, decide on the ORPT priority treatment to proceed to a delivery stage.	3.8
	3.10	Hand project over to the project development group for prioritisation and implementation.	

Table 1.2: ORPT process – high-level overview – greenfield roads

Stage & Flow	Step no.	High-level description ORPT process – greenfield roads	Links to other steps
Stage 1: Background and foundation setting ↓	1.1	Plan at a conceptual level the road and transport network layout of the subdivision or new road/s.	
	1.2	For the roads, identify which road corridors will be used by which road users and in what hierarchy.	
	1.3	Determine network operation plan or policy for the link of interest.	
	HOLD POINT		
	1.4	Bring together representatives and confirm: • the hierarchy of priority of the road users • the role for each road user. This may be based on the Movement and Place framework if adopted by the jurisdiction.	1.2, 1.3
Stage 2: Consider ORPT priority treatment to adopt for the link ↓	2.1	Based on the outcome of Stage 1 as confirmed in Step 1.4, consider the appropriate category of ORPT priority treatments or combination of ORPT priority likely to be suitable.	1.4
	2.2	Based on the selected category/categories of ORPT priority treatments as determined in Step 2.1, identify ORPT priority treatment/s options that best address the scenario being investigated.	2.1, 2.4
	2.3	For the identified ORPT treatments (identified in Step 2.2) applied to the scenario, conceptually consider how they will fit into the proposed network and any implications associated with them (e.g. land requirement).	2.2
	2.4	Using the conceptual drawing, identify and articulate how the proposed road network meets the intended function as identified in Step 1.4 and the intended benefits for the ORPT.	1.4
	2.5	Consider what road reservation and construction is required along with road management systems that need to be put in place to deliver the ORPT priority treatment and prepare indicative cost estimates of the different options.	
	2.6	Based on the outcome of Step 2.4 and Step 2.5, undertake an assessment of the various conceptual options developed.	2.4, 2.5
	2.7	Based on the conceptual drawings of the different options, in addition to understanding the LOS for other road users, determine the preferred option from the road/transport agency perspective.	1.4
	2.8	Bring back together representatives used in Step 1.4 and present conceptual drawings of the preferred option along with the articulated LOS for the other road users. Present other options considered, including ‘no priority’ for comparison, in addition to providing a base case.	1.4
	HOLD POINT		
	2.9	Based on an assessment of the feedback obtained in Step 2.8 along with the preferred option, decide on the ORPT priority treatment to proceed to a delivery stage.	2.8
	2.10	Ensure any ORPT priority treatment arrangements as confirmed in Step 2.9 are incorporated into planning permit approvals.	2.9

2. ORPT Tool – Existing Roads

The tool for existing roads is split into three stages as follows:

- Stage 1: Background and foundation setting.
- Stage 2: Understanding what, why and who.
- Stage 3: Consideration of treatments to adopt for the link.

2.1 Stage 1: Background and Foundation Setting

Step 1.1

Identify the ORPT service of interest to improve.

In identifying the service of interest, consideration should be given to any proposed/planned role change for the service due to land-use changes or intensifications along the catchment of the service that would attract additional users and/or increase the importance of the service. This should also be considered in the following Stage 1 steps.

Step 1.2

Identify the issues of concern. For example:

- Reliability: Issues with adhering to schedule or adhering to headway spacing.
- Travel time/travel speed: Long travel time or low operating speed.
- Mode shift: Desirability to achieve a mode shift from personal motorised transport to more sustainable alternatives such as public transport. While this is related to the level of service (LOS) of the link and therefore the other issues identified in Step 1.2, it could be identified as a specific issue.
- Service: Access to public transport services for those who do not have access to personal transport, are unable to utilise personal transport and/or do not wish to use personal transport modes. This not only includes access to routes but access to services on a regular basis (low headway). Reliability and travel time/travel speed are additional issues but are captured in the previous points.
- Service coordination: Service coordination between the public transport service (ORPT and off-road public transport such as trains). While this is often related to reliability and travel time/travel speed, it could be identified as a specific issue.
- Accessibility: In addition to the service issues identified above, accessibility to ORPT services by all potential users (including disability access) and at key origins and destinations. Accessibility includes walking distances and walking routes to ORPT stops, including across roads and stop design.
- Safety: Low crash risk for the ORPT vehicle and users accessing and egressing the vehicle, while maintaining the other aspects identified above.
- Operational cost: Linking to some of the other issues above, operational costs may be an issue that drives the need to investigate ORPT priority.
- Amenity: Reducing ORPT noise and/or emissions may be an objective for implementing ORPT priority.
- Other.

Step 1.3

Identify road corridors of operation for the service.

Step 1.4

Identify the links of interest within the corridor identified in Step 1.3.

A link, or group of links, may be a length of similar roads between two major intersections or where the characteristics of the road significantly change.

Links of interest could be those which are performing poorly. This is discussed further below. In addition to poorly performing links, other links of interest could be those that are identified as presenting a strategic need to provide public transport priority on corridors in advance of any future issues materialising.

Poorly performing links could be those with a LOS of C or lower, as defined in the LOS framework outlined in Austroads (2020a) (as shown in Appendix A) for the issues identified in Step 1.2.

Jurisdictions may have their own metrics to help identify poorly performing links. If the jurisdiction does not have its own metrics, or to support the jurisdiction's metrics, practitioners may wish to refer to the LOS framework (as identified in Austroads (2020a)) which provides metrics for some of the issues listed in Step 1.2. These could be used to aid the practitioner in identifying poorly performing links. These include:

- For reliability: Transit users – mobility – service schedule reliability metric.
- For travel time/travel speed: Transit users – mobility – operating-speed metric.
- Accessibility: Transit users – access – level of disability access and access to transit user stops/stations from key origins and destinations.
- Safety: Transit users – safety – crash risk of transit vehicles and users while accessing/egressing.

It is noted that focusing on just poorly performing links may result in fragmented stretches of public transport priority. Practitioners should therefore assess what other links should be considered for ORPT priority at the same time as exploring priority for the main link of interest.

Step 1.5

Identify other significant road users of the link.

Other significant users include private motorists, other transit users (other buses and trams/light rail transit (LRT)), pedestrians, cyclists, and freight operators.

Practitioners may refer to the LOS framework outlined in Austroads (2020a) to identify other road users and metrics used to measure their LOS. In Step 3.4, the LOS framework is referred to as a framework to use to understand the impacts (trade-offs) to other road users because of the ORPT priority treatments.

For this step, a private motorist means a driver and/or passenger of a private vehicle (this includes a ride-share service and on-demand service providers) in addition to operators and passengers of motorcycles and powered scooters/mopeds.

Only significant road users should be identified. This needs to include consideration for the current and future 10- and 20-year timeframe usage. For future timeframe usage, consideration should be given to proposed/planned land-use changes or intensifications that would change travel volumes and modes, including any intensification that would attract growth and mode shift to ORPT usage.

Step 1.6

Identify adjacent land uses of significance located along the link of interest and understand the social context of the road. For example, this may include:

- Land uses that result in car parking (such as retail businesses and residential uses without off-street parking).
- Land uses that encourage pedestrian movement along the link and/or across the link.

Step 1.7

Determine the short- and long-term network operation plan or policy for the link of interest.

Check whether a network operation plan for the area where the link is located has been developed and identify the short- and long-term network operation policy for the link as specified in the already established network operation plan for the area.

If a network operation plan for the area has not been developed and therefore there is no specified network operation policy for the link, engage with the road/transport agency responsible for the operations of the link and determine the intended short- and long-term network operation policy.

The intended network operation policy could be based on the Movement and Place framework as outlined in Austroads (2020a) (as shown in Appendix B) where it is an adopted framework for use by a jurisdiction. Alternatively, a similar Movement and Place framework as adopted by the jurisdiction could be used. The framework as outlined in Austroads (2020a) provides a method for the intended network operation policy of the link to be defined. For example:

- Designated movement with no place aspects.
- Significant movement with some place aspects.
- Significant movement with significant place aspects.
- Some movement with significant place aspects.
- Some movement with some place aspects.
- Other.

Where the framework is not adopted by the jurisdiction, the short- and long-term intended role of the link should still be defined (e.g. major arterial, arterial, collector, local street, other). This should take into consideration the context that the link serves with respect to both the trafficable component of the road as well as the adjacent roadside usage. For example, explicit consideration should be given to those who live and work along the road (e.g. parking, servicing, severance and kerbside activity).

To assist with determining the short- and long-term network operation plan or policy, practitioners may wish to consider holding a workshop with local and state government agencies as well as the community, businesses, and other organisations connected with the study area. This is to establish the vision for the geographic area where the link of interest is located, if not already established. The vision for the area where the link is located goes beyond the planning intent for the network and might be an existing, strategic vision or one that needs to be agreed collectively with key stakeholders. The vision should apply to the defined geographic area and incorporate the aspirations of community representatives and stakeholders. The objectives of ORPT priority and the role that it takes in achieving the vision should be considered by asking questions such as:

- How do the objectives of ORPT priority contribute to the place vision?
- How can ORPT priority best support the vision?
- Has the local as well as strategic context been considered?

HOLD POINT

Where alignment is not achieved within the road/transport agency or between road and transport agencies about the intended function of the link, it is necessary to resolve and achieve alignment.

Step 1.8

Bring together participants from the road/transport agency, local government, and stakeholders representing the other significant road and adjacent land users identified in Step 1.5 and Step 1.6.

For each link of interest identified in Step 1.4 confirm the elements listed below for the current, 10- and 20-year timeframes.

- Confirm the hierarchy of priority of the significant road users based on the network operation plan already developed or developed as part of engagement with the road/transport agency responsible for the operations of the link as in Step 1.7.
- Confirm the role for each road user as in Step 1.7. This may be based on the Movement and Place framework if adopted by the jurisdiction or other definition as discussed in Step 1.7.

2.2 Stage 2: Understanding the What, Why and Who – Existing Roads

Step 2.1

Reconfirm the objectives of on-road public transport priority after having completed Stage 1.

This should come from having completed Stage 1 and tie back to addressing the issues of concern identified in Step 1.2.

Step 2.2

Obtain public transport data for the operation of the public transport service of interest as in Step 1.1, for the issues identified (refer to Step 1.2) and for the links (refer to Step 1.3).

Data collected should be based on the issues as in Step 1.2. Where used, consideration should be given to the LOS framework metric applicable to the issue (refer to Step 1.4).

Data collected should enable an understanding of the frequency of the ORPT service utilising the route of interest. This should be factored up using patronage data, or if not available, estimates of patronage. This is to get an approximate person throughput utilising the service. This will give a guide about the current use. However, future intended use (e.g. growth and mode shift) should also be considered.

Chapter 2 of Transport and Infrastructure Council (2018) also provides guidance on travel demand estimation for public transport and may be referred to.

Step 2.3

Obtain data associated with other significant road users and adjacent land users of significance as identified in Step 1.5 to Step 1.8.

This should include:

- Volume data of other road users travelling through the link with estimates applied to obtain an approximate person throughput in total and by transport mode.
- Volume data of other road users travelling to the link and using the link (e.g. number of users of the strip shopping centre) and their mode of travel.
- Car parking data including turnover and availability within the immediate area.

Step 2.4

Utilise the data from Step 2.2 and Step 2.3 to identify the likely factors causing the issue as identified in Step 1.2 for the link of interest identified in Step 1.4.

For example, a factor causing the issue may be associated with but not be limited to the following:

- A pinch point.
- General traffic congestion and queues resulting from a downstream intersection.
- Traffic interfering with the operation of public transport, hindering the public transport vehicle re-entering traffic flow after making a stop.
- Crashes. A site or link with frequent crashes could be adding to congestion issues at the location which subsequently delay public transport or further reduce available road space during key periods.

In undertaking the above steps, the use of traffic assessments of the link and intersections should be considered to define and understand the magnitude of the problem.

Step 2.5

For the causal issues as identified in Step 2.4, confirm the timeframes for which the issue is applicable.

For example, this may include but not be limited to the following:

- morning peak
- evening peak
- morning and evening peak
- morning
- business and evening peaks
- weekend peak
- weekday
- special event periods
- holiday periods
- all day.

Step 2.6

Confirm who are the current users of the public transport mode of interest and the future growth potential (growth should consider additional growth due to improved LOS of the ORPT service) for the mode of public transport.

The types of users of interest could include but not be limited to the following:

- Those using the on-road public transport mode to connect to an off-road public transport mode (i.e. train).
- Those using on-road public transport for long journeys.
- Those using on-road public transport for short journeys but not to connect to other modes.

Examples of sources of data that may provide insights into these issues include but are not limited to the following:

- Public transport customer satisfaction surveys.
- Census data.
- Household travel surveys.

Step 2.7

Confirm the current and 10- to 20-year planned future cross-section of the road reserve of the link of interest (identified in Step 1.4).

This should include identifying:

- The cross-section of the road within the total road reservation, including the uses of the cross-section (e.g. pedestrian footpath, nature strip, parking lane, bicycle lane, bus lane, general trafficable lane, median) and the width of the allocation (e.g. 3.5 m general traffic lane width). Consideration should be given to the road configuration required to enable safe access for maintenance of assets (e.g. landscape areas, electrical/ communications pits and cabinets, lighting).
- Whether widening of the existing road and/or road reservation is feasible or not and to what extent (e.g. isolated at an intersection or along a length of the link).
- Existing utilities (power poles, underground utilities) in addition to property boundaries and the feasibility and cost of service relocation and/or land acquisition.

Step 2.8

For the existing cross-section (as identified in Step 2.7), confirm if the preferred ORPT priority treatment of a dedicated lane could be accommodated. This can be undertaken through confirming whether the cross-section:

- has enough space to accommodate an additional lane
- could be altered (e.g. reducing lane widths) to accommodate an additional lane
- can have lane usage reallocated to accommodate an additional lane (e.g. a vehicle lane or parking lane removed to cater for a bus lane either for a short or long distance).

Step 2.9

Based on the preceding Stages 1 and 2, practitioners should be able to identify the elements listed below. If not, it is recommended that practitioners repeat the preceding steps and stages if required. Proceed to Stage 3 if able to identify the following elements:

- Public transport and links of interest where ORPT priority treatment should be considered.
- Who are the other road users and their priority position within the hierarchy of other road users.
- The policy intention of the road link.
- Public transport operational requirements.
- Strategic public transport operational policy.
- The issue with public transport vehicles including where the issue may be caused and when.
- The existing cross-section of the road and what is feasible with respect to widening, alteration to road space allocation width and reallocating of road space allocation.

2.3 Stage 3: Consider ORPT Priority Treatments to Adopt for the Link – Existing Roads

Step 3.1

Based on the outcome of Stage 1 and Stage 2, as confirmed in Step 2.9, consider the appropriate category of ORPT priority treatments, or their combination, likely to be suitable. The categories could include:

- Road space: Dedicated right of way (ROW) – long length
- Road space: Dedicated lanes – short length
- Road space: Selectively shared ROW – long length
- ORPT stops: Bus stop design
- ORPT stops: Tram/light rail transit (LRT) stop design
- ORPT stops: Bus/tram/LRT stop relocation
- Traffic signal: Passive priority
- Traffic signal: Active priority
- Traffic signal gating of general traffic.

Appendix C.1 provides an overview of the categories of ORPT treatments outlined above.

Practitioners should consider the categories and identify them as being suitable or unsuitable for the given situation. This will aid in short-listing suitable treatments based on the category.

In addition to the treatments, practitioners could also consider alternative ORPT services and the treatments associated with the services. For example, replacing a heavily used bus route with a light rail in a dedicated ROW.

Step 3.2

Based on the selected category of treatments as determined in Step 3.1, identify treatments/options that best address the scenario being investigated.

Appendix C.2 provides a list of known treatments.

In addition, treatments that are not listed in Appendix C.2 could also be considered. This may include new treatments developed by the road operator which may not have yet been used.

Identify the treatment options for discussion later. One option should include ‘do nothing’.

In undertaking this step, consider other case studies and use examples to assist in confirming the priority treatment options (a list of case studies is outlined in Appendix D).

In addition, also consider undertaking a quantitative analysis of different treatments to aid in the identification of options. It is noted that modelling of person throughput is suggested in Step 3.4 where further details are provided. Modelling, as a form of quantitative analysis, could be brought forward to Step 3.2 to assist with this.

Step 3.3

For the identified treatments (Step 3.2) applied to the scenario, consider how this will fit into the current and 10- to 20-year planned future road environment.

Develop conceptual drawings (e.g. websites such as Streetmix (2020) may be useful) showing how the treatment would fit into the existing road environment.

This step should also consider supporting measures such as footpaths and pedestrian access (both adjacent to and along the road as well as across the road) for ORPT stops. This is in addition to the stop design. These elements are important as they can impact the attractiveness and therefore the take-up of the service.

Step 3.4

Using the conceptual drawings developed in Step 3.3, identify, articulate, and quantify the benefits for the public transport users while identifying the trade-offs for the other road users. This should be undertaken for the current day, and 10- and 20-year forecasts.

The LOS framework outlined in Austroads (2020a) (refer to Appendix A) provides an agreed framework to enable this to be undertaken consistently across projects. While there are various LOS needs and measures for various road users, only those metrics which will be impacted because of the proposed treatment should be assessed. For most metrics, this will be mainly those associated with mobility, but in some cases may extend to safety and other considerations.

Modelling that provides estimates on person throughput can assist in articulating the impact of treatments on person throughput and the potential impacts on other road users. Appropriate transport models need to be selected by the practitioner based on the scenario. The model may range from a simple spreadsheet to a transport model. The need for modelling and the type of model used will need to be determined by the practitioner based on the scenario. Practitioners can refer to the *Guide to Traffic Management Part 3: Traffic Study and Analysis Methods* (Austroads 2020b) which provides guidance on:

- selection of the appropriate modelling approach
- organising a modelling study:
  - this includes guidance on selecting a software platform
  - application of microsimulation modelling
  - use of modelling outputs.

A road safety audit or Safe System assessment should be undertaken at this point to ensure that any changes proposed in the conceptual drawings could be undertaken without introducing avoidable road safety risks to any road user. In addition, it could also identify if there are any existing safety deficiencies that could be addressed at the same time as implementing the ORPT priority treatment.

Chapter 4 of Transport and Infrastructure Council (2018) provides guidance on the benefits of public transport initiatives which may assist in this step.

Step 3.5

Consider what road management systems need to be put in place to deliver the treatment and prepare indicative cost estimates of the different options. This should include costs associated with:

- widening
- alteration to road space allocation width
- reallocating of road space (for example reallocating a parking lane to a bus lane or reallocating a trafficable lane to a bus lane etc.)
- ongoing operational cost for the current day, and 10- and 20-year forecasts
- construction process and its impact on all transport modes
- costs associated with mitigating safety risks.

Chapters 5 to 7 of Transport and Infrastructure Council (2018) provide guidance on the following factors with respect to public transport which may assist in this step:

- benefits that can arise from public transport initiatives
- public transport resource estimation, vehicle, and operating costs
- fixed infrastructure capital costs and travel demand estimation for public transport.

Step 3.6

Based on the outcome of Step 3.4 and Step 3.5, undertake an assessment of the conceptual options developed.

This should include a benefit-cost analysis. When assessing the benefits, consideration should be given to the following:

- mobility benefits for the public transport user
- mobility benefits for other road users resulting from mode shift
- societal benefits associated with providing mobility access for those who do not have personal transport
- environmental benefits (e.g. lower emissions including CO_2 and other emissions)
- other benefits as identified.

Chapter 3 of Transport and Infrastructure Council (2018) provides guidance on the benefit-cost analysis methodology for public transport which may assist in this step.

Step 3.7

Based on the conceptual drawings of the different options (developed in Step 3.3), in addition to the trade-offs, determine the preferred option from the road/transport agency perspective.

The preferred option should be that which best addresses the confirmed objectives and policy intention for the road link for the current, and 10- and 20-year timeframes as defined in Step 1.8 and Step 2.1. Consideration needs to be given to total person throughput for the link by all road users.

Consideration needs to be given to previous treatment applications which have worked well.

Step 3.8

Reconvene the representatives used in Step 1.8 and present the conceptual drawings of the preferred option along with the articulated trade-offs for the other road users. Present the other options considered including do nothing for comparison in addition to providing a base case.

Where available, provide details of post-evaluations undertaken on previous similar treatment implementations. This is so the impacts (both positive and negative) can be understood. This will help in obtaining considered feedback on the options as it can be based on the evidence from real-world experience. This highlights the importance of undertaking post-evaluations of treatments.

Discuss the options and obtain feedback with the aim to come to an agreed position.

HOLD POINT

If agreement cannot be achieved either:

- Go back to Step 3.1.
- Implement conflict resolution processes as recognised by the jurisdiction.
- Note the disagreement and proceed as planned.

A determination on the appropriate steps forward if agreement cannot be achieved will need to be made by the practitioner based on judgement of all the circumstances.

Step 3.9

Based on an assessment of the feedback obtained in Step 3.8 along with the preferred option, decide on the treatment to proceed to a delivery stage.

Step 3.10

Hand the project over to the project development group for prioritisation and implementation.

3. ORPT Tool – Greenfield Roads

The tool for greenfield roads would be applied in new subdivisions. It is recommended that statutory authorities (local government and road and transport agencies) consider its inclusion in planning guidelines with respect to land development planning permit approvals.

It is recommended that its inclusion occurs at an early stage of the subdivision planning process (e.g. structure planning stage) when the general layout, including the road network of the subdivision, is being planned. This is so adequate road space can be assigned.

Consideration should be given to when the guidelines would be applied. For example, this could include:

- subdivision of a certain size including the number of lots
- number of potential occupants
- combination of size and number of occupants against land-use type.

The tool for greenfield roads is split into two stages as follows:

- Stage 1: Background and foundation setting.
- Stage 2: Consider ORPT priority treatments to adopt for the link.

3.1 Stage 1: Background and Foundation Setting

Step 1.1

Plan at a conceptual level, the road and transport network layout of the subdivision or new roads for the short- and long-term.

Step 1.2

Identify which road corridors will be used by which road users and in what hierarchy.

Identify which public transport services are to utilise the road corridor. Consideration should be given to existing public transport available within the neighbouring area.

This should be based on the future 20-year intention for the road. Consideration should be given to the land uses and trip attractors that will be adjacent to the proposed road network. In addition, consideration should be given to how the proposed road network connects with adjacent existing road networks located in neighbouring subdivisions.

Step 1.3

Determine the network operation plan or policy for the link of interest.

It is recommended that a network operation plan for the new subdivision for the short- and long-term be developed early in the planning stage so that appropriate networks can be planned for all transport modes. This will include allocation of road space.

Check whether a network operation plan for the area has been developed and identify the network operation policy for the road of interest as specified in the established network operation plan.

If a network operation plan has not been developed and therefore there is no specified policy for the roads, engage with the road/transport agency that would be responsible for the operation of the link and determine the intended network operation policy for it.

The intended network operation policy could be based on the Movement and Place framework as outlined in Austroads (2020a) (as shown in Appendix B) where it is an adopted framework for use by a jurisdiction. Alternatively a similar framework as adopted by the jurisdiction could be used. The framework as outlined in Austroads (2020a) provides for the intended network operation policy of the link to be defined. For example:

- Designated movement with no place aspects.
- Significant movement with some place aspects.
- Significant movement with significant place aspects.
- Some movement with significant place aspects.
- Some movement with some place aspects.
- Other.

Where the framework is not adopted by the jurisdiction, the intended role of the link should still be defined (e.g. major arterial, arterial, collector, local street, other). This should take into consideration the purpose that the link is intending to serve with respect to both the trafficable component of the road as well as the adjacent roadside usage. For example, explicit consideration should be given to those who may live and work along the road (e.g. parking, servicing, severance and kerbside activity).

HOLD POINT

Where alignment is not achieved within the road/transport agency or between agencies about the intended function of the link, resolve this and achieve alignment.

Step 1.4

Bring together participants from road/transport agencies, local government and stakeholders representing the road users identified in Step 1.2.

For each link or, where appropriate, group of links, confirm the elements listed below for a 20-year timeframe (this will be largely shaped by the policy of the body responsible for the link (road/transport agency or local government) with input from the relevant stakeholders):

- Confirm the hierarchy of priority of the significant road users based on the network operation plan already developed or developed as part of engagement with the road/transport agency responsible for the operations of the link as in Step 1.3.
- Confirm the role for each road user as in Step 1.3. This may be based on the Movement and Place framework if adopted by the jurisdiction or other definition as discussed in Step 1.3.

3.2 Stage 2: Consider ORPT Priority Treatments to Adopt for the Link

Step 2.1

Based on the outcome of Stage 1 as confirmed in Step 1.4, consider the appropriate category of ORPT priority treatments or their combination likely to be suitable. Categories of treatment could include:

- Road space – Dedicated ROW – long length
- Road space – Dedicated lanes – short length
- Road space: Selectively shared ROW – long length

- ORPT stops: Bus stop design
- ORPT stops: Tram/light rail transit (LRT) stop design
- Traffic signal: Passive priority
- Traffic signal: Active priority
- Traffic signal gating of general traffic.

Appendix C.1 provides an overview of the categories of treatments outlined above.

It is noted that as this stage applies to greenfield roads, bus and LRT stop relocation cannot be performed. Practitioners, however, need to consider stop location in planning greenfield roads using the guidance outlined previously with respect to stop relocation.

Practitioners should consider the categories of ORPT and identify them as being suitable or unsuitable for the given situation. This will aid in short-listing suitable treatments based on the category.

In addition to the treatments, practitioners could also consider the most appropriate ORPT service and the treatments associated with the service. For example, if it is envisaged that a bus service will be heavily used, a light rail in a dedicated ROW may be more appropriate.

Step 2.2

Based on the selected category of treatments as determined in Step 2.1, identify the preferred treatments/options that best address the scenario being investigated.

Appendix C.2 provides a list of known ORPT treatments.

In addition, innovative treatments should also be considered.

Identify the preferred options for discussion later. One option should include no ORPT priority.

In undertaking this step, consider other case studies and use examples to assist in confirming the treatment options (a list of case studies is outlined in Appendix D).

In addition, also consider undertaking a quantitative analysis of different treatments to aid in identification of the preferred options. It is noted that modelling of person throughput is suggested in Step 2.4 which provides further details. Modelling, as a form of quantitative analysis, could be brought forward to Step 2.2 to assist in this.

Step 2.3

For the identified treatments (refer to Step 2.2) applied to the scenario, consider how this will fit into the proposed network in the short- and long-term, and any implications associated with this (e.g. land requirements).

Develop conceptual drawings (e.g. websites such as Streetmix (2020) could be used for this purpose) showing how the ORPT priority treatment would fit into the road environment.

This step should also consider supporting measures such as footpaths and pedestrian access (both adjacent to and along the road as well as across the road) for the ORPT stops. This is in addition to stop design. These elements are important as they can impact the attractiveness and therefore take-up of the ORPT service.

Step 2.4

Using the conceptual drawings, identify, articulate, and quantify how the proposed road network meets the intended functions as identified in Step 1.4 and the intended benefits for the ORPT.

The LOS framework outlined in Austroads (2020a) (refer to Appendix A) provides an agreed framework to enable this to be undertaken consistently across projects. While there are different LOS needs and measures for the various road users, only those metrics which will be impacted because of the proposed treatment should be assessed. For most metrics this will be mainly those associated with mobility but in some cases may extend to safety and other considerations.

Modelling that provides estimates on person throughput can assist in articulating the impact of priority treatments on person throughput and the potential impact on other road users. Appropriate transport models need to be selected by the practitioner based on the scenario. It is noted that the appropriate model may range from a simple spreadsheet to a transport model. The need for modelling and the type of model used will need to be determined by the practitioner based on the scenario. Practitioners may wish to refer to the *Guide to Traffic Management Part 3: Transport Study and Analysis Methods* (Austroads 2020b) which provides guidance on:

- Selection of an appropriate modelling approach.
- Organising a modelling study. This includes guidance on selecting a software platform.
- Application of microsimulation modelling.
- Use of modelling outputs.

In addition, Chapter 4 of the Transport and Infrastructure Council (2018) document provides guidance on the benefits of public transport initiatives which may assist in this step.

Step 2.5

Consider what road reservation and construction is required along with road management systems that need to be put in place to deliver the ORPT priority treatments and prepare indicative cost estimates of the different options.

Chapters 5 to 7 of Transport and Infrastructure Council (2018) provides guidance on the following factors with respect to public transport which may assist in this step:

- User benefit parameter values.
- Public transport resource estimation, vehicle, and operating costs.
- Fixed infrastructure capital costs and travel demand estimation for public transport.

Step 2.6

Based on the outcome of Step 2.4 and Step 2.5 undertake an assessment of the conceptual options developed.

This should include a benefit-cost analysis. When assessing the benefits, consideration should be given to the following:

- Mobility benefits for the public transport user.
- Mobility benefits for other road users resulting from mode shift.
- Societal benefits associated with providing mobility access for those who do not have personal transport.
- Environmental benefits (e.g. lower emissions including CO2 and other emissions).
- Other benefits as identified.

Chapter 3 of Transport and Infrastructure Council (2018) provides guidance on benefit-cost analysis methodology for public transport which may assist in this step.

Step 2.7

Based on the conceptual drawings of the different options in addition to understanding the LOS for other road users, determine the preferred option from the road/transport agency perspective.

The preferred option should be that which best addresses the confirmed objectives and policy intention for the road link for the 20-year timeframe as defined in Step 1.4.

Step 2.8

Reconvene the representatives used in Step 1.4 and present the conceptual drawings of the preferred option along with the articulated LOS for the other road users. Also present the other options considered, including no ORPT priority for comparison in addition to providing a base case.

Discuss the options and obtain feedback with the aim to come to an agreed position.

HOLD POINT

If agreement cannot be achieved either:

- go back to Step 3.1
- implement a conflict resolution process as recognised by the jurisdiction
- note the disagreement and proceed as planned.

A determination on the appropriate step forward if agreement cannot be achieved will need to be made by the practitioner based on their judgement of the circumstances.

Step 2.9

Based on an assessment of the feedback obtained in Step 2.8 along with the preferred option, decide on the treatment to proceed with and incorporate it into the subdivision planning, design, and land allocation.

This should include ensuring that adequate land space is set aside for the construction of the treatment and that financial arrangements are put in place to fund the implementation.

Step 2.10

Ensure that any ORPT priority treatment arrangements as confirmed in Step 2.9 are incorporated in planning permit approvals.

4. Conclusion

The practical process presented in this report (referred to as a 'tool') guide practitioners through the selection of the appropriate On-Road Public Transport (ORPT) priority treatments for any road scenario:

- It can be used for applications relating to an existing road or a future road that is going through the initial planning stages.
- The tool is a step-by-step process that assists practitioners in identifying the need for some form of ORPT priority, selecting the ORPT treatment with appropriate justifications, and handing over the decision to the project development group for prioritisation and implementation or incorporating it into planning permit approvals.
- It considers all form of priority, ranging from road space, stop design and location, traffic signal priority, and traffic signal gating.
- Where appropriate, the tool includes references to other Austroads frameworks and reference material to aid the practitioners in navigating through the process and making the decisions relevant to their situation. For instance, it leverages off the previous Austroads project titled Prioritising on-road public transport (Austroads 2017).

Users of the tool are expected to work through the process, keeping notes of completed tasks and summarised output of these tasks.

The ORPT tool should be viewed as guidance and not as a prescriptive instruction manual (unless directed to be used as such by the statutory authority that manage the roads which the ORPT operates on or is planned to operate on).

For greenfield roads, it is recommended that statutory authorities (local government and road transport agencies) consider its inclusion in planning guidelines with respect to land development planning permit approvals. Its inclusion should occur at an early stage of the subdivision planning process when the general layout, including the road network, is being planned. This is so that adequate road space can be assigned. Consideration should be given to when the guidelines would be applied. For example, this could include:

- a subdivision of a certain size including the number of lots
- the number of potential occupants
- a combination of the size and number of occupants against the land-use type.

Beyond the use of the tool, it is recommended to undertake post-evaluation to assess the impacts of the selected treatments, capture any stakeholder feedback, and consider this practical knowledge in future OPRT treatment selection.

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Appendix A LOS Framework as Outlined in Commentary 2 of GTM Part 4

Outlined below is a reproduction of the LOS framework as outlined in Commentary 2 of the Austroads *Guide to Traffic Management Part 4* (GTM Part4) (Austroads 2020a).

This commentary presents the LOS framework defined as part of Austroads project NT1788 (Austroads 2015a). The LOS framework allows users to make an assessment of various LOS measures of five road users (private motorist, transit users, pedestrians, cyclists and freight operators) and across five needs (mobility, safety, access, information and amenity).

The LOS assessment is undertaken for the scenario of without the proposed works and then a hypothetical assessment of the scenario with the proposed works. The user uses the LOS framework to determine which of the six LOS levels is assigned for each measure for both scenarios. Completion of the LOS framework allows the user to understand the LOS measurements of various measures and then to understand the LOS trade-offs of either scenario.

While the LOS framework follows a step-function approach of six LOS levels the framework permits the use of sub-levels in between LOS levels (e.g. LOS B+ or LOS B++, in practice).

The LOS framework utilises objective and subjective measures as follows:

- Objective measures (e.g. 50 to 67% of free flow operating speed) were utilised where suitable information is readily available in existing LOS frameworks. Objective measures (e.g. possibility for a maximum of 25% increase in travel time) were also established in cases where the panel of reviewers suggested and agreed to specific estimates.
- Subjective measures (e.g. good wheelchair access and meets Disability Discrimination Act (DDA) requirements) were used in cases where no suitable objective measure can be determined or agreed upon by the panel of reviewers. In network operation planning, the LOS assessment is reviewed and agreed by planners and stakeholders. The reasons and justifications of subjective LOS assessments are documented and well-understood by the planners and the stakeholders.

The LOS framework is outlined in Table C2 1.

Table A 1: LOS framework and worksheet for network operation planning

Road user	LOS needs	LOS measure	Rating	Service measure values
Private motorists	Mobility	Congestion	A	• For motorways a condition of free-flow in which drivers are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to manoeuvre within the traffic stream is extremely high, and the general level of comfort and convenience provided is excellent(1). • For arterial roads generally free flow conditions with operating speeds at least 80% of the free flow speed. Vehicles are unimpeded in manoeuvring in the traffic stream and delay at intersections is minimal.
			B	• For motorways a condition of stable flow where drivers still have reasonable freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is a little less than with level of service A(1). • For arterial roads relatively unimpeded flow with operating speeds between 50–80% of the free flow speed. Manoeuvring in the traffic stream is only slightly restricted and intersection delays are low.
			C	• For motorways a condition of stable flow, but where most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience declines noticeably at this level(1). • For arterial roads stable operating conditions but with manoeuvring becoming more restricted and motorists experiencing appreciable tension in driving. Operating speeds are between 30–50% of the free flow speed. At signalised intersections, vehicles generally have to stop in a queue but clear the intersection in one signal cycle.
			D	• For motorways a condition that is close to the limit of stable flow and approaching unstable flow. All drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is poor, and small increases in traffic flow will generally cause operational problems(1). • For arterial roads small increases in traffic volumes can significantly increase delay. Operating speeds are between 20–30% of the free flow speed. At signalised intersections, vehicles always join the back of an existing queue and take about two signal cycles to clear the intersection.
			E	• For motorways a condition where traffic volumes are at or close to capacity, and there is virtually no freedom to select desired speeds or to manoeuvre within the traffic stream. Flow is unstable and minor disturbances within the traffic stream will cause breakdown(1). • For arterial roads conditions are characterised by significant delays with operating speeds between 10–20% of the free flow speed. At signalised intersections, vehicles take three or more signal cycles to clear the intersection(1).
			F	• For motorways a condition of forced flow, where the amount of traffic approaching the point under consideration exceeds that which can pass it. Flow breakdown occurs, and queuing and delays result(1). • For arterial roads traffic flow at this level is at very low speeds (less than 10% of the free flow speed). At signalised intersections, vehicles can take three or more signal cycles to clear the intersection and backups from downstream significantly impact traffic flow.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
			A	• Travel time is nearly always the same.

Road user	LOS needs	LOS measure	Rating	Service measure values
		Travel time reliability	B	• Travel may possibly encounter unexpected delays but there is no need to adjust expected travel time for time sensitive journeys.
			C	• Travel is likely to encounter unexpected delays and there is a possibility for a maximum of 25% increase in travel time.
			D	• Travel is likely to encounter unexpected delays and there is a possibility for a maximum of 50% increase in travel time.
			E	• Travel is likely to encounter unexpected delays and there is a possibility for a maximum of 75% increase in travel time.
			F	• Travel is likely to encounter unexpected delays and there is a possibility for a greater than 75% increase in travel time.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
		Travel speed	A	• High travel speeds of over 80 km/h.
			B	• Medium to high travel speeds of 70 to 80 km/h.
			C	• Medium travel speeds of 60 to 70 km/h.
			D	• Low to medium travel speeds of 50 to 60 km/h.
			E	• Low speeds of 40 to 50 km/h.
			F	• Very low speeds of less than 40 km/h.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
	Safety	Crash risk	A	• Roads that have the following: - road design appropriate for the intended and actual road use and speed environment - minimal instances of conflict. Conflict refers to times where vehicles can potentially collide with another vehicle, pedestrian or cyclist. Conflicts can be mitigated, for example, by grade separation, divided roads, separating movements, controlling movements through signalisation or restricting direct access. There are also low instances of conflict in low congestion conditions - forgiving road environment relative to the speed environment (i.e. in case of a crash or potential crash there is limited risk or there is sufficient protection against serious injury or death). • Examples of rural road features that could achieve a LOS A are outlined in Austroads (2015a). • Examples of the combination of intersection features that could achieve a LOS A are outlined in Austroads (2015a).
			B	• Roads that have the following: - minimal to some instances of conflict but there is good visibility/sight distance (including potential visual obstruction caused by other vehicles) - minimal instances of conflict and there is poor visibility, however measures are in place to mitigate crash risks due to poor visibility (such as a low speed limit) - generally forgiving road environment relative to the speed environment but there are minor factors that may cause serious injury or death in case of a crash. • Examples of rural road features that could achieve a LOS B are outlined in Austroads (2015a). • Examples of the combination of intersection features that could achieve a LOS B are outlined in Austroads (2015a).

Road user	LOS needs	LOS measure	Rating	Service measure values
			C	• Roads that have the following: - some to frequent instances of conflict but there is good visibility/sight distance (including potential visual obstruction caused by other vehicles) - some instances of conflict and there is poor visibility, however measures are in place to mitigate risks due to poor visibility (such as a low speed limit) - generally forgiving road environment relative to the speed environment but there are some factors that may cause serious injury or death in case of a crash. • Examples of rural road features that could achieve a LOS C are outlined in Austroads (2015a). • Examples of the combination of intersection features that could achieve a LOS C are outlined in Austroads (2015a).
			D	• Roads that have the following: - frequent instances of conflict but there is good visibility/sight distance (including potential visual obstruction caused by other vehicles) - some to frequent instances of conflict and there is poor visibility, however measures are in place to mitigate risks due to poor visibility (such as a low speed limit) - unforgiving road environment relative to the speed environment with frequent roadside hazards. • Examples of rural road features that could achieve a LOS D are outlined in Austroads (2015a). • Examples of the combination of intersection features that could achieve a LOS D are outlined in Austroads (2015a).
			E–F	• Roads that have the following: • frequent instances of conflicts and poor visibility/sight distance (including potential visual obstruction caused by other vehicles) • unforgiving road environment relative to the speed environment with frequent and severe roadside hazards. • Examples of rural road features that could achieve a LOS E-F are outlined in Austroads (2015a). • Examples of the combination of intersection features that could achieve a LOS E-F are outlined in Austroads (2015a).
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed
	Access	Ability to park close to destination (on-road or off-road)	A	• For the majority, parking is readily available within close walking distance to key destinations on the road.
			B	• For the majority, parking is readily available within some walking distance to key destinations on the road.
			C	• For the majority, parking is available within some walking distance to key destinations on the road but may require some queuing, waiting or looking for an available parking slot.
			D	• For the majority, restricted parking is available within some walking distance to key destinations on the road or may require substantial queuing, waiting or looking for an available parking slot.
			E	• For the majority, free parking is not available but reasonably priced paid parking is available within some walking distance to key destinations on the road.
			F	• For the majority, free parking is not available and expensive paid parking is available within some walking distance to key destinations on the road or may require substantial queuing, waiting or looking for an available parking slot.

Road user	LOS needs	LOS measure	Rating	Service measure values
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
		Ability to access near-road land or ability to access departures at an intersection	A–B	• Partial to full access at mid-blocks and access to all departures at an intersection.
			C–D	• Limited to partial access at mid-blocks and access to some minor street departures restricted at an intersection.
			E–F	• No access at mid-blocks (e.g. freeway with long distances between ramps) and access to some major departures restricted at an intersection.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
	Information	Traveller information available	A–B	• Real-time traveller information (with respect to road works, traveller information and travel time) is available. • Adequate and suitable directional, regulatory and traffic information signage is available for the road environment.
			C–D	• No real traveller information (with respect to road works, traveller information and travel time) is available. • Adequate and suitable directional, regulatory and traffic information signage is available for the road environment.
			E–F	• Signage is inadequate or missing (e.g. some or many directional, regulatory or traffic information signage are missing or in poor condition).
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
	Amenity	Aesthetics	A–B	• Clean and aesthetically pleasing (e.g. greenery, view, etc.).
			C–D	• Clean.
			E–F	• Unclean (graffiti, garbage, etc.).
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
		Driving stress	A–B	• Low stress road environment (e.g. average 3.3 to 3.5 m lane widths, signalised intersections where vehicles exiting a link can rely on the signals to stop opposing traffic, vehicles do not need to manoeuvre across a path used by other road users as manoeuvres are fully controlled or separated, no obstruction, e.g. right-turning vehicles blocking through movement, to desired movement).
			C–D	• Medium stress road environment (e.g. average 3 to 3.3 m lane widths, non-signalised intersections where vehicles exiting a link may have some difficulty picking a gap, vehicles need to manoeuvre across a path lightly used by other road users such as performing a filtered right turn across a path lightly used by cyclists and/or pedestrians, some obstructions to desired movement and obstructions are relatively easy to go around).
			E–F	• High stress road environment (e.g. narrow < 3.0 m lane widths, non-signalised intersections where vehicles exiting a link may find it hard to find a gap, vehicles need to manoeuvre across a path heavily used by other road users such as performing a filtered right turn across a path heavily used by cyclists and/or pedestrians, frequent obstructions that are difficult to go around).
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
			A–B	• Smooth ride.

Road user	LOS needs	LOS measure	Rating	Service measure values
		Pavement ride quality	C–D	• Road defects noticeable only at high speeds.
			E–F	• Road defects or poor pavement conditions noticeable at low speeds.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
Transit users	Mobility	Service schedule reliability	A	• Headway < 10 min. • Transit vehicle travel time is nearly always the same where headway schedule is > 10 min.
			B	• Transit vehicle may possibly encounter unexpected delays but generally users would not need to adjust expected travel time where headway schedule is > 10 min.
			C	• Transit vehicle is likely to encounter unexpected delays and there is a possibility for a maximum 25% increase in travel time where headway schedule is > 10 min.
			D	• Transit vehicle is likely to encounter unexpected delays and there is a possibility for a maximum 50% increase in travel time where headway schedule is > 10 min.
			E	• Transit vehicle is likely to encounter unexpected delays and there is a possibility for a maximum 75% increase in travel time where headway schedule is > 10 min.
			F	• Transit vehicle is likely to encounter unexpected delays and there is a possibility for a greater than 75% increase in travel time where headway schedule is > 10 min.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
		Operating speed	A	• Exclusive right of way with infrequent stops.
			B	• Exclusive right of way with frequent stops.
			C	• Non-exclusive right of way on a moderately congested road with infrequent stops.
			D	• Non-exclusive right of way on a moderately congested road with frequent stops.
			E	• Non-exclusive right of way on a congested road with infrequent stops.
			F	• Non-exclusive right of way on a congested road with frequent stops.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.

Road user	LOS needs	LOS measure	Rating	Service measure values
	Safety	Crash risk of transit vehicle	A	• Roads that have the following: - road design appropriate for the intended and actual road use and speed environment - minimal instances of conflict. Conflict refers to times where vehicles can potentially collide with another vehicle, pedestrian or cyclist. Conflicts can be mitigated, for example, by grade separation, divided roads, separating movements, controlling movements through signalisation or restricting direct access. There are also low instances of conflict in low congestion conditions - forgiving road environment relative to the speed environment (i.e. in case of a crash or potential crash there is limited risk or there is sufficient protection against serious injury or death). • Examples of rural road features that could achieve a LOS A are outlined in Austroads (2015a). • Examples of the combination of intersection features that could achieve a LOS A are outlined in Austroads (2015a).
			B	• Roads that have the following: - minimal to some instances of conflict but there is good visibility/sight distance (including potential visual obstruction caused by other vehicles) - minimal instances of conflict and there is poor visibility, however measures are in place to mitigate crash risks due to poor visibility (such as a low speed limit) - generally forgiving road environment relative to the speed environment but there are minor factors that may cause serious injury or death in case of a crash. • Examples of rural road features that could achieve a LOS B are outlined in Austroads (2015a). • Examples of the combination of intersection features that could achieve a LOS B are outlined in Austroads (2015a).
			C	• Roads that have the following: - some to frequent instances of conflict but there is good visibility/sight distance (including potential visual obstruction caused by other vehicles) - some instances of conflict and there is poor visibility, however measures are in place to mitigate risks due to poor visibility (such as a low speed limit) - generally forgiving road environment relative to the speed environment but there are some factors that may cause serious injury or death in case of a crash. • Examples of rural road features that could achieve a LOS C are outlined in Austroads (2015a). • Examples of the combination of intersection features that could achieve a LOS C are outlined in Austroads (2015a).
			D	• Roads that have the following: - frequent instances of conflict but there is good visibility/sight distance (including potential visual obstruction caused by other vehicles) - some to frequent instances of conflict and there is poor visibility, however measures are in place to mitigate risks due to poor visibility (such as a low speed limit) - unforgiving road environment relative to the speed environment with frequent roadside hazards. • Examples of rural road features that could achieve a LOS D are outlined in Austroads (2015a). • Examples of the combination of intersection features that could achieve a LOS D are outlined in Austroads (2015a).

Road user	LOS needs	LOS measure	Rating	Service measure values
			E–F	• Roads that have the following: • frequent instances of conflicts and poor visibility/sight distance (including potential visual obstruction caused by other vehicles) • unforgiving road environment relative to the speed environment with frequent and severe roadside hazards. • Examples of rural road features that could achieve a LOS E-F are outlined in Austroads (2015a). • Examples of the combination of intersection features that could achieve a LOS E-F are outlined in Austroads (2015a).
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
		Crash risk of transit users while accessing/ egressing	A	• Fully protected to access both sides of the road where the station/stop is located (e.g. located at a signalised pedestrian crossing).
			B	• Fully protected to access one side of the road where the station is located and with protected pedestrian crossing facilities nearby.
			C–D	• Fully protected to access one side of the road where the station is located and with no protected pedestrian crossing facilities located nearby; but, there are low-to-medium speeds and traffic volumes on the road (such as a residential street).
			E–F	• Fully protected to access one side of the road where the station is located but with no protected pedestrian crossing facilities nearby; and, there are high speeds and high traffic volumes on the road (such as a primary arterial road).
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
	Access	Service availability (urban services only)	A	• 10 min headway.
			B	• 10 to 15 min headway.
			C	• 15 to 25 min headway.
			D	• 25 to 40 minute headway.
			E	• 40 to 60 minute headway.
			F	• > 60 minute headway.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
		Level of disability access	A–C	• Good wheelchair access and meets DDA requirements.
			D–F	• Poor wheelchair access and does not meet DDA requirements.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
			A	• Stop or station located at the key origin or destination.
			B	• Stop or station located within 200 m of the key origin or destination.
			C	• Stop or station located between 200 m and 400 m of the key origin or destination.
			D	• Stop or station located between 400 m and 600 m of the key origin or destination.

Road user	LOS needs	LOS measure	Rating	Service measure values
		Access to transit user stops/stations from key origins and destinations	E	• Stop or station located between 600 m and 800 m of the key origin or destination.
			F	• Stop or station located in excess of 800 m of the key origin or destination.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
	Information	Traveller information available	A–B	• On-board and roadside traveller information including reliable real-time traveller information, in addition to information on timetable, fare, directions and maps.
			C–D	• On-board and roadside traveller information, in addition to information on timetable, fare, directions and maps; but no real-time traveller information.
			E–F	• Limited, incomplete or missing traveller information on the roadside and no on-board traveller information on the transit vehicle.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
	Amenity	Pedestrian environment (also refer to pedestrian LOS)	A–B	• Good to very good pedestrian environment (e.g. sealed path, well lit, good drainage).
			C–D	• Fair to good pedestrian environment (e.g. sealed path but with some defects or unsealed but well maintained, fair to good lighting, fair to good drainage).
			E–F	• Poor pedestrian environment (e.g. sealed path but with significant defects or unsealed and poorly maintained, poor drainage and poor lighting).
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
		On-board congestion	A–B	• Transit vehicle not crowded.
			C–D	• Transit vehicle moderately crowded.
			E–F	• Transit vehicle crowded.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
		Seat availability	A–B	• Easy to find and select a seat on the transit vehicle.
			C–D	• Only a few seats available on the transit vehicle.
			E–F	• Difficult to obtain a seat.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
		Security	A–C	• Good to high level of security (well-lighted, security personnel presence, security cameras, no or limited history of criminality or disturbance, sufficient number of transit users, etc.).
			D–F	• Poor to fair level of security.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
			A–B	• Good comfort and convenience features (e.g. a shelter and seat with additional amenities such as a toilet, noise protection, food/newspaper stalls, cycle facilities, park-and-ride, etc.).

Road user	LOS needs	LOS measure	Rating	Service measure values
		Comfort and convenience features	C–D	• Adequate comfort and convenience features (e.g. includes a shelter and seat).
			E–F	• Poor to fair comfort and convenience features (e.g. sign only and no shelter and seat).
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
		Aesthetics	A	• Clean and aesthetically pleasing (e.g. greenery, view, design, artwork, etc.).
			B–C	• Clean.
			D–F	• Unclean (graffiti, garbage, etc.).
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
		Ride quality	A–B	• Smooth ride.
			C–D	• Road defects noticeable only at high speeds.
			E–F	• Road defects or poor pavement conditions noticeable at low speeds.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
Pedestrians	Mobility	Footpath congestion	A	• Ability to move in desired path, no need to alter movements (e.g. > 5.6 m^2 per pedestrian etc.).
			B	• Occasional need to adjust path to avoid conflicts (e.g. 3.7–5.7 m^2 per pedestrian etc.).
			C	• Frequent need to adjust path to avoid conflicts (e.g. 2.2–3.7 m^2 per pedestrian etc.).
			D	• Speed and ability to pass slower pedestrians restricted (e.g. 1.4–2.2 m^2 per pedestrian etc.).
			E	• Speed restricted, very limited ability to pass slower pedestrians (e.g. 0.75–1.4 m^2 per pedestrian etc.).
			F	• Speed severely restricted, frequent contact with other users (e.g. < 0.75 m^2 per pedestrian etc.).
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
		Grade of path	A–B	• Flat grades.
			C–D	• Flat to steep grades.
			E–F	• Steep grades, including long stretches of stairs.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
		Crossing delay or detour	A	• On average no or little delay and/or detour required to cross where there is demand to cross – refer to Austroads (2015a).
			B	• On average minor delay and/or detour required to cross where there is a demand to cross – refer to Austroads (2015a).
			C	• On average minor to medium delay and/or detour required to cross where there is a demand to cross – refer to Austroads (2015a).

Road user	LOS needs	LOS measure	Rating	Service measure values
			D	• On average medium to major delay and/or detour required to cross where there is a demand to cross – refer to Austroads (2015a).
			E	• On average major delay and/or detour required to cross where there is a demand to cross – refer to Austroads (2015a).
			F	• On average significant delay and/or detour required to cross where there is a demand to cross – refer to Austroads (2015a).
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
	Safety	Exposure to vehicles at mid-blocks	A	• No or limited exposure to vehicles. • Separate path from bicycles (i.e. not a shared path with bicycles) where located on a principal bicycle network or shared path away from the principal bicycle network. • Clear separation (in excess of clear zone requirement for the speed environment) between motor vehicles and pedestrians. • None or limited driveway access along the mid-block.
			B	• Clear separation between pedestrians and motor vehicles with a buffer between pedestrians and vehicles such as a nature strip and/or bicycle lane. However the separation is less than the clear zone requirement for the speed environment. • Separate path from bicycles (i.e. not a shared path with bicycles) where located on a principal bicycle network or shared path away from the principal bicycle network.
			C	• Clear separation between pedestrians and motor vehicles, however separation is less than the clear zone requirement for the speed environment.
			D	• No separation between pedestrians and motor vehicles within a low volume and low speed motor vehicle environment (e.g. a typical minor residential street).
			E	• No separation between pedestrians and motor vehicles within a low to medium volume and low speed motor vehicle environment (e.g. a typical collector/sub-arterial road).
			F	• No separation between pedestrians and motor vehicles within a medium to high volume and medium to high speed motor vehicle environment (e.g. a primary arterial road).
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
		Exposure to vehicles at crossings	A	• Fully protected crossings (e.g. pedestrian operated signalised crossings, signalised intersection with fully controlled right turns or signalised intersections with filtered right turns but with low pedestrian numbers). • Regulated crossings (e.g. zebra and pelican crossings) in a low volume and low speed motor vehicle environment such as a residential street).
			B	• Uncontrolled crossing in a low volume and low speed motor vehicle environment such as a residential street. • Regulated crossings (e.g. zebra and pelican crossings) in a low to medium volume and low to medium speed motor vehicle environment such as a typical collector or sub-arterial road.
			C	• Uncontrolled crossing in a low to medium volume and low to medium speed motor vehicle environment such as a typical collector or sub-arterial road.

Road user	LOS needs	LOS measure	Rating	Service measure values
				• Regulated crossing (e.g. zebra and pelican crossings) in a medium volume and medium speed motor vehicle environment such as a minor arterial road. • No crossing facility at a major crossing point in a low volume, low speed, and one lane each way motor vehicle environment (e.g. strip shopping centre in a residential street).
			D	• Uncontrolled crossing in a medium to high volume and medium speed motor vehicle environment (e.g. arterial road). • No crossing facility at a major crossing point in a medium volume, medium speed, in a two lane each way motor vehicle environment (e.g. strip shopping centre on a minor arterial road). • Signalised intersection with high vehicle volumes and high pedestrian volumes located on the through movement which a filtered right turn crosses.
			E	• Uncontrolled crossing in a high volume and high speed motor vehicle environment (e.g. major high speed arterial road). • Inappropriate crossing treatment on a medium to high volume and medium to high speed motor vehicle environment (e.g. zebra crossing on an arterial road).
			F	• No crossing facility at a major crossing point in a high volume and high speed multi-lane motor vehicle environment (e.g. strip shopping centre on a major high speed arterial road).
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
		Trip hazards	A–B	• Well-maintained pavement with good drainage and clear of debris. • Kerb ramps provided. • Tactile indicators for stairs and hazards. • No or limited pavement defects, trip hazards or other miscellaneous hazards that may impact on safety (e.g. clear of street furniture (signage, poles, seats, bins), trees, garbage, parked cars, etc.).
			C–D	• Paved with good drainage with minor defects. • Some debris on path. • Tactile indicators not provided. • Occasional pavement defects, trip hazards or other miscellaneous hazards that may impact on safety (e.g. street furniture (signage, poles, seats, bins), trees, garbage, parked cars etc.).
			E–F	• Footpath that is unpaved, or paved with significant defects such as tree roots, potholes and very uneven surfaces. • Significant debris on path. • Poor drainage. • Frequent or high density of pavement defects, trip hazards, or stationary hazards obstructing the footpath (e.g. street furniture (signage, poles, seats, bins), trees, garbage, parked cars).
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.

Road user	LOS needs	LOS measure	Rating	Service measure values
	Access	Crossing opportunities	A	• Ability to safely cross the road within 25 m from an origin anywhere along the road (e.g. low speed shopping strip or shared zone where people can safely and freely cross at any location along the road).
			B	• Ability to safely cross the road within 50 m from an origin anywhere along the road.
			C	• Ability to safely cross the road within 100 m from an origin anywhere along the road.
			D	• Ability to safely cross the road within 200 m from an origin anywhere along the road (e.g. medium speed, medium volume sub-arterial road where pedestrians may need to walk 200 m in order to avoid a physical obstruction such as a fence in order to cross the road).
			E	• Ability to safely cross the road within 400 m from an origin anywhere along the road.
			F	• Ability to safely cross the road requires a detour of more than 400 m from an origin anywhere along the road (e.g. high speed, high volume arterial road where pedestrians may need to walk in excess of 400 m to a signal in order to cross the road, or to be able to avoid obstructions preventing a pedestrian from crossing such as a fence or barrier in the median).
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
		Level of disability access	A–C	• Good wheelchair access and meets DDA requirements.
			D–F	• Poor wheelchair access and does not meet DDA requirements.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
	Information	Traveller information available including signposting	A–C	• Adequate and suitable traveller information is fully available (with consideration to the nature of pedestrians and the area, e.g. a tourist area would require more information than a local neighbourhood). • Complete and clear signposting with routes and distances.
			D–F	• Traveller information is incomplete, inadequate or missing. • Limited or non-existent route signposting.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
	Amenity	Footpath pavement conditions	A–B	• Sealed with good drainage, and comfortable to walk on (e.g. smooth).
			C–D	• Sealed with fair to good drainage, and slightly uncomfortable to walk on (e.g. some small bumps or undulations). • Unsealed but well maintained.
			E–F	• Sealed with significant defects, drainage problems and uncomfortable to walk on (e.g. significant bumps and undulations such as tree roots, potholes). • Unsealed and poorly maintained. • Significant debris on path.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
			A–C	• Good comfort and convenience features (shelter, noise protection, benches, food/newspaper stalls, etc.).

Road user	LOS needs	LOS measure	Rating	Service measure values
		Comfort and convenience features	D–F	• Poor to fair comfort and convenience features.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
		Security	A–C	• Good to high level of security (well-lighted, security personnel presence, security cameras, no or limited history of criminality or disturbance, sufficient number of pedestrians, etc.).
			D–F	• Poor to fair level of security.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
		Aesthetics	A–B	• Clean and aesthetically pleasing (e.g. greenery, view, design, artwork, etc.).
			C–D	• Clean.
			E–F	• Unclean (graffiti, garbage, etc.).
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
Cyclists	Mobility	Travel speed	A–B	• High quality, high priority links which permit quick, unhindered travel by bicycle. • Typical cyclist operating speeds are largely unconstrained (e.g. can travel at speeds greater than 25 km/h). • No or minimal delay at intersections (e.g. grade separated crossing or at-grade crossing of minor local road).
			C–D	• High quality routes with seamless connections that permit somewhat unhindered travel by bicycle. • Typical cyclist operating speeds are somewhat constrained (e.g. cyclist limited to a speed range from 20 to 25 km/h). • Some delay at intersections (e.g. at-grade crossing of collector road or minor arterial; short signal phase at signalised intersections or cyclists rarely made to wait a full cycle based on arrival).
			E–F	• Low speed, shared environment which permits only hindered travel by bicycle. • Typical cyclist operating speeds are constrained (e.g. cyclist speed less than 20 km/h. • Significant delay at intersection (e.g. at-grade crossing of busy arterial road and therefore gap times are long; cyclists likely to wait a full cycle based on arrival).
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
		Congestion	A–B	• Cyclists are unimpeded or only slightly restricted to choose their speed.
			C–D	• Cyclists are somewhat impeded in their choice of speed.
			E–F	• Cyclists are restricted and their choice of speed is dictated by others.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.

Road user	LOS needs	LOS measure	Rating	Service measure values
		Grades	A–B	• Flat grades (e.g. 0 to 2%).
			C–D	• Flat to steep grades (e.g. 2 to 5%).
			E–F	• Steep grades; steps or stairs (e.g. > 5% sustained for 50 to 100 m).
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
	Safety	Risk of cycle-to-cycle/ pedestrian crash	A–B	• No to limited risk. • Good line of sight. • Speed differential low (e.g. similar cyclist type such as all recreational cyclists).
			C–D	• Medium risk, some platooning of cyclists and cyclists slowing down for pedestrians. • Good to fair line of sight. • Speed differential medium (e.g. some mixture in cyclist type such as predominantly recreational cyclists with some commuter cyclists).
			E–F	• High risk, crashes can result in several upstream cyclists to brake abruptly or crash. • Poor line of sight (e.g. blind curves). • Speed differential high (e.g. mixture in cyclist type such as recreational cyclists combined with family cyclists, commuter cyclists and training cyclists).
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
		Risk of crash caused by surface unevenness or slippage	A–B	• Sealed pavement that is well-maintained with good drainage.
			C–D	• Sealed pavement with good drainage but with some defects. • Some debris on path.
			E–F	• Unsealed pavement or sealed pavement with significant defects. • Significant debris on path. • Poor drainage. • Significant slippery pavement materials (e.g. tram rails or road markings).
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
		Risk of crash with stationary hazards	A–B	• No or limited stationary hazards on the path and adjacent to the path (e.g. clear of street furniture (poles, seats, bins), trees, garbage, parked cars etc.).
			C–D	• Occasional or a low density of stationary hazards on the path or adjacent to the path (e.g. parked cars that are frequently accessed such as in strip shopping centres, street furniture (poles, seats, bins), trees, garbage, etc.). • Occasional parked cars or cars coming off parking that can block or hinder the natural path of cyclists.

Road user	LOS needs	LOS measure	Rating	Service measure values
			E–F	• Frequent or a high density of stationary hazards on the path or adjacent to the path (e.g. parked cars that are frequently accessed such as in strip shopping centres, street furniture (poles, seats, bins), trees, garbage, etc.). • Frequent parked cars or cars coming off parking that can block or hinder the natural path of cyclists.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
		Risk of cycle-to-motor vehicle crash at mid-blocks	A	• Exclusive bicycle facility in a low risk road environment – refer to Austroads (2015a).
			B	• Exclusive bicycle facility in a low to medium risk road environment or no bicycle facility in a low risk road environment – refer to Austroads (2015a).
			C	• Exclusive bicycle facility in a medium to high risk road environment or no bicycle facility in a low to medium risk road environment – refer to Austroads (2015a).
			D	• Exclusive bicycle facility in a medium to high risk road environment or no bicycle facility in a medium risk road environment – refer to Austroads (2015a).
			E	• Bicycle-only lane (not Copenhagen style facility where the bicycle facility is behind a kerb) in a high risk road environment or no bicycle facility in a medium to high risk road environment – refer to Austroads (2015a).
			F	• No bicycle facility in a high risk road environment – refer to Austroads (2015a).
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
		Risk of cycle-to-motor vehicle crash at intersections and/or driveways	A	• No crossings of motor vehicles or fully separated crossings (including no or limited driveways). • Fully controlled crossings of motor vehicles at low to medium volume roads, without concurrent movements (e.g. exclusive bicycle movement).
			B	• Crossings limited to driveway crossing only.
			C	• Uncontrolled motor vehicle crossings at low volume, low speed roads (e.g. give way or roundabout residential street intersection). • Fully controlled crossings of motor vehicles at high volume roads, without concurrent movements (e.g. exclusive bicycle movement). • Signalised intersection with high volumes, large numbers of cyclists on the through movement but fully controlled right turns.
			D	• Uncontrolled motor vehicle crossing at medium volume, medium speed roads (e.g. give way or roundabout collector, sub-arterial road intersection). • Fully controlled crossings of motor vehicles at medium volume roads, with concurrent movements (e.g. no exclusive bicycle movement). • Signalised intersection with high volumes, large numbers of cyclists on the through movement and filtered right turns.
			E	• Uncontrolled motor vehicle crossing at medium to high volume roads (e.g. non-signalised arterial road intersection).
			F	• Uncontrolled vehicles at high volume, high speed intersecting roads (e.g. major high speed arterial road roundabout).

Road user	LOS needs	LOS measure	Rating	Service measure values
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
	Access	Access to and ability to park close to destination	A	• Proper bicycle parking facilities are readily available immediately adjacent to key destinations and can be accessed directly from the bicycle network. Parking is suitable for likely trip purpose (racks for occasional or short-term users, secure cages/lockers for regular or long-term users).
			B	• Proper bicycle parking facilities are readily available within close walking distance to key destinations and can be accessed directly from the bicycle network. Parking is suitable for likely trip purpose.
			C	• Proper bicycle parking facilities are readily available within a moderate walking distance to key destinations and can be accessed directly from the bicycle network.
			D	• Proper bicycle parking facilities are somewhat available within a moderate walking distance to key destinations, or parking at or near a location is a moderate walking distance from the bicycle network.
			E	• Proper bicycle parking facilities are somewhat available within a long walking distance to key destinations, or parking at or near a location is a long walking distance from the bicycle network.
			F	• Proper bicycle parking facilities are not available.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
		Suitability	A	• Cycling highly suitable as follows: - off-road facility for use by bicycles only (e.g. off-road bicycle only path).
			B	• Cycling suitable as follows: - off-road shared-use path with low pedestrian numbers - on-road bicycle lane separated from car parking or road shoulder with no car parking on a low-volume road - on-road shared-traffic environment marked on a low-speed or low-volume road.
			C	• Cycling moderately suitable as follows: - off-road shared-use path with medium pedestrian numbers - on-road bicycle lane shared with minimal car parking or road shoulder with minimal car parking on a low-volume road - on-road shared-traffic environment on a medium-volume road or low speed road.
			D	• Cycling moderately unsuitable as follows: - off-road shared-use path/zone with high pedestrian numbers or speed restrictions (e.g. 10 km/h) - on-road bicycle lane or road shoulder on high-volume road - on-road shared-traffic environment on a medium to high volume or medium to high speed road.
			E	• Cycling unsuitable as follows: - cycling significantly impeded due to physical obstructions that require getting off the bike (e.g. steps) - cycling is unsuitable due to inadequate separation from traffic that is either high speed or high volume.
			F	• Cycling highly unsuitable or prohibited - cycling prohibited - cycling is unsuitable due to inadequate separation from traffic that is both high speed and high volume.

Road user	LOS needs	LOS measure	Rating	Service measure values
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
	Information	Traveller information available, including signposting	A–B	• Complete and clear signposting with routes and distances is fully available (with consideration to the nature of cyclists and the area, e.g. a tourist area would require more information than a local neighbourhood).
			C–D	• Signposting with routes and distances is partially available.
			E–F	• Signposting with routes and distances is inadequate or missing.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
	Amenity	Aesthetics	A–B	• Clean and aesthetically pleasing (e.g. greenery, view, design, artwork, etc.).
			C–D	• Clean.
			E–F	• Unclean (graffiti, garbage, etc.).
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
		Comfort and convenience features	A–C	• Good comfort and convenience features (bike parking, noise protection, change facilities, lockers, etc.).
			D–F	• Poor to fair comfort and convenience features (no parking, excessive noise, no change facilities, no lockers, etc.).
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
		Security	A–C	• Good to high level security (e.g. well-lighted, no or limited history of criminality or disturbance, sufficient number of cyclists, etc.).
			D–F	• Poor to fair level security (e.g. not well-lighted, with history of criminality or disturbance, low number of cyclists, etc.).
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
		Pavement ride quality	A–B	• Road surface is smooth and even.
			C–D	• Road surface is moderately smooth and even.
			E–F	• Road surface is not smooth and even.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
Freight operators	Mobility	Congestion	A	• For motorways a condition of free-flow in which drivers are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to manoeuvre within the traffic stream is extremely high, and the general level of comfort and convenience provided is excellent[(2)]. • For arterial roads generally free flow conditions with operating speeds at least 80% of the free flow speed. Vehicles are unimpeded in manoeuvring in the traffic stream and delay at intersections is minimal.
			B	• For motorways a condition of stable flow where drivers still have reasonable freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is a little less than with level of service A[(2)]. • For arterial roads relatively unimpeded flow with operating speeds between 50–80% of the free flow speed. Manoeuvring in the traffic stream is only slightly restricted and intersection delays are low.

Road user	LOS needs	LOS measure	Rating	Service measure values
			C	• For motorways a condition of stable flow, but where most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience declines noticeably at this level(2). • For arterial roads stable operating conditions but with manoeuvring becoming more restricted and motorists experiencing appreciable tension in driving. Operating speeds are between 30–50% of the free flow speed. At signalised intersections, vehicles generally have to stop in a queue but clear the intersection in one signal cycle.
			D	• For motorways a condition that is close to the limit of stable flow and approaching unstable flow. All drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is poor, and small increases in traffic flow will generally cause operational problems(2). • For arterial roads small increases in traffic volumes can significantly increase delay. Operating speeds are between 20–30% of the free flow speed. At signalised intersections, vehicles always join the back of an existing queue and take about two signal cycles to clear the intersection.
			E	• For motorways a condition where traffic volumes are at or close to capacity, and there is virtually no freedom to select desired speeds or to manoeuvre within the traffic stream. Flow is unstable and minor disturbances within the traffic stream will cause breakdown(2). • For arterial roads conditions are characterised by significant delays with operating speeds between 10–20% of the free flow speed. At signalised intersections, vehicles take three or more signal cycles to clear the intersection(1).
			F	• For motorways a condition of forced flow, where the amount of traffic approaching the point under consideration exceeds that which can pass it. Flow breakdown occurs, and queuing and delays result(2). • For arterial roads traffic flow at this level is at very low speeds (less than 10% of the free flow speed). At signalised intersections, vehicles can take three or more signal cycles to clear the intersection and backups from downstream significantly impact traffic flow.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
		Travel time reliability	A	• Travel time is nearly always the same.
			B	• Travel may possibly encounter unexpected delays but there is no need to adjust expected travel time for time sensitive journeys.
			C	• Travel is likely to encounter unexpected delays and there is a possibility for a maximum 25% increase in travel time.
			D	• Travel is likely to encounter unexpected delays and there is a possibility for a maximum 50% increase in travel time.
			E	• Travel is likely to encounter unexpected delays and there is a possibility for a maximum 75% increase in travel time.
			F	• Travel is likely to encounter unexpected delays and there is a possibility for a greater than 75% increase in travel time.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
		Travel speed	A	• High travel speeds of over 80 km/h.
			B	• Medium to high travel speeds of 70 to 80 km/h.

Road user	LOS needs	LOS measure	Rating	Service measure values
			C	• Medium travel speeds of 60 to 70 km/h.
			D	• Low to medium travel speeds of 50 to 60 km/h.
			E	• Low speeds of 40 to 50 km/h.
			F	• Very low speeds of less than 40 km/h.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
	Safety	Crash risk	A	• Roads that have the following: – road design appropriate for the intended and actual road use and speed environment – minimal instances of conflict. Conflict refers to times where vehicles can potentially collide with another vehicle, pedestrian or cyclist. Conflicts can be mitigated, for example, by grade separation, divided roads, separating movements, controlling movements through signalisation or restricting direct access. There are also low instances of conflict in low congestion conditions – forgiving road environment relative to the speed environment (i.e. in case of a crash or potential crash there is limited risk or there is sufficient protection against serious injury or death). • Examples of rural road features that could achieve a LOS A are outlined in Austroads (2015a). • Examples of the combination of intersection features that could achieve a LOS A are outlined in Austroads (2015a).
			B	• Roads that have the following: – minimal to some instances of conflict but there is good visibility/sight distance (including potential visual obstruction caused by other vehicles) – minimal instances of conflict and there is poor visibility, however measures are in place to mitigate crash risks due to poor visibility (such as a low speed limit) – generally forgiving road environment relative to the speed environment but there are minor factors that may cause serious injury or death in case of a crash. • Examples of rural road features that could achieve a LOS B are outlined in Austroads (2015a). • Examples of the combination of intersection features that could achieve a LOS B are outlined in Austroads (2015a).
			C	• Roads that have the following: - some to frequent instances of conflict but there is good visibility/sight distance (including potential visual obstruction caused by other vehicles) - some instances of conflict and there is poor visibility, however measures are in place to mitigate risks due to poor visibility (such as a low speed limit) - generally forgiving road environment relative to the speed environment but there are some factors that may cause serious injury or death in case of a crash. • Examples of rural road features that could achieve a LOS C are outlined in Austroads (2015a). • Examples of the combination of intersection features that could achieve a LOS C are outlined in Austroads (2015a).

Road user	LOS needs	LOS measure	Rating	Service measure values
			D	• Roads that have the following: - frequent instances of conflict but there is good visibility/sight distance (including potential visual obstruction caused by other vehicles) - some to frequent instances of conflict and there is poor visibility, however measures are in place to mitigate risks due to poor visibility (such as a low speed limit) - unforgiving road environment relative to the speed environment with frequent roadside hazards. • Examples of rural road features that could achieve a LOS D are outlined in Austroads (2015a). • Examples of the combination of intersection features that could achieve a LOS D are outlined in Austroads (2015a).
			E–F	• Roads that have the following: • frequent instances of conflicts and poor visibility/sight distance (including potential visual obstruction caused by other vehicles) • unforgiving road environment relative to the speed environment with frequent and severe roadside hazards. • Examples of rural road features that could achieve a LOS E-F are outlined in Austroads (2015a). • Examples of the combination of intersection features that could achieve a LOS E-F are outlined in Austroads (2015a).
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
	Access	Level of freight access	A	• Road permitting A-triple ≤ 53.5 m freight vehicles (e.g. Level 4 access road according to the National Heavy Vehicle Regulator Performance-Based Standards (PBS) scheme).
			B	• Road permitting A-double ≤ 36.5 m freight vehicles (e.g. Level 3 access according to PBS).
			C	• Road permitting B-double ≤ 26 m freight vehicles (e.g. Level 2 access according to PBS).
			D	• Road permitting rigid ≤ 20 m freight vehicles (e.g. Level 1 access according to PBS).
			E–F	• No freight vehicles allowed or highly regulated access only.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
	Information	Traveller information	A–B	• Real-time traveller information is available. • Good signage.
			C–D	• Adequate signage.
			E–F	• Signage is inadequate or missing.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.
	Amenity	Pavement ride quality	A–B	• Smooth ride.
			C–D	• Road defects noticeable only at high speeds.
			E–F	• Road defects or poor pavement conditions noticeable at low speeds.
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.

Road user	LOS needs	LOS measure	Rating	Service measure values
		Stress	A–B	• Low stress road environment (e.g. average 3.3 to 3.5 m lane widths, signalised intersections where vehicles exiting a link can rely on the signals to stop opposing traffic, vehicles do not need to manoeuvre across a path used by other road users as manoeuvres are fully controlled or separated).
			C–D	• Medium stress road environment (e.g. average 3 to 3.3 m lane widths, non-signalised intersections where vehicles exiting a link may have some difficulty picking a gap, vehicles need to manoeuvre across a path lightly used by other road users such as performing a filtered right turn across a path lightly used by cyclists and/or pedestrians).
			E–F	• High stress road environment (e.g. narrow < 3.0 m lane widths, non-signalised intersections where vehicles exiting a link may find it hard to find a gap, vehicles need to manoeuvre across a path heavily used by other road users such as performing a filtered right turn across a path heavily used by cyclists and/or pedestrians).
			N/A	• N/A – The measure is not applicable to the site and the proposal being assessed.

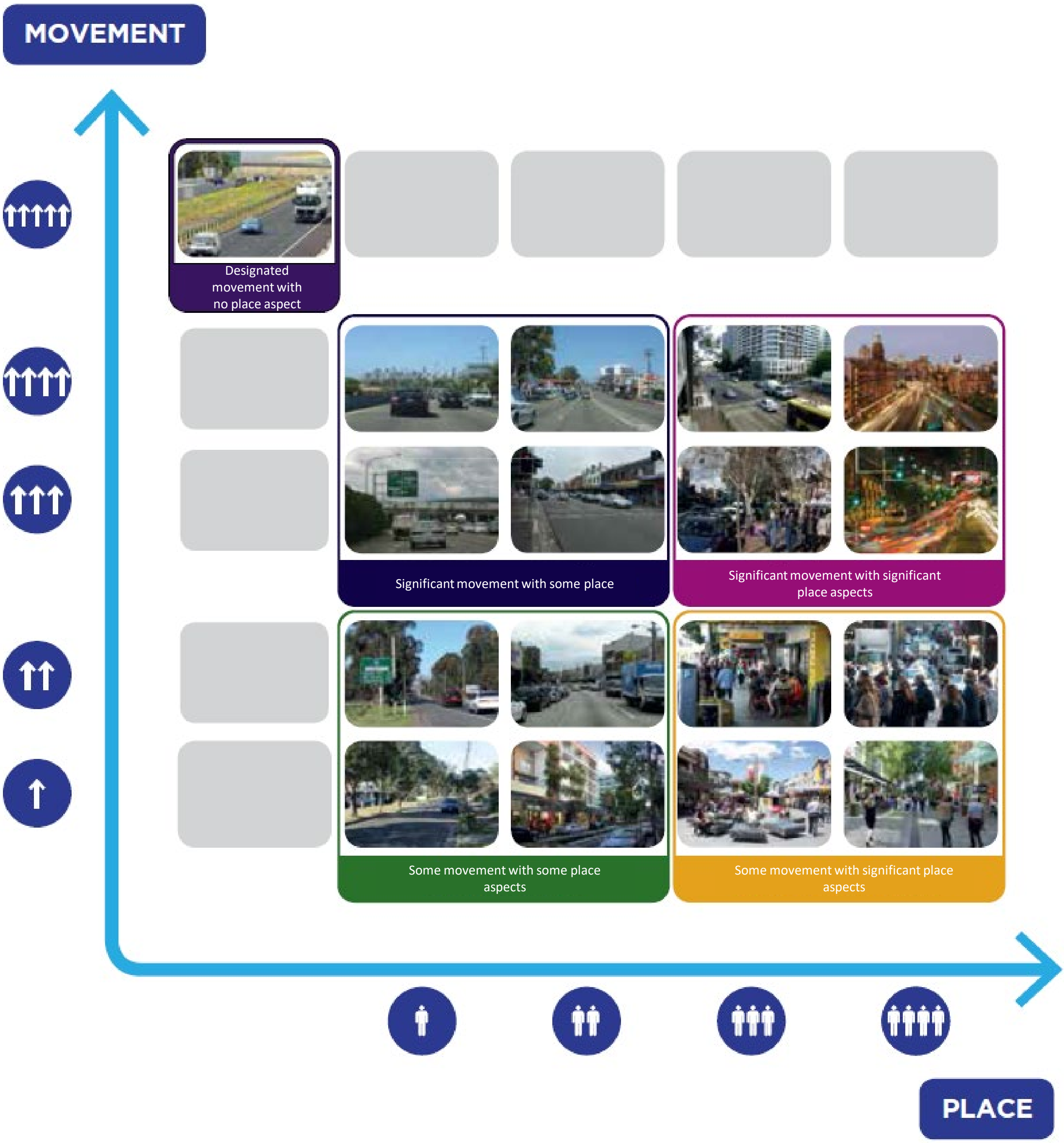
Appendix B Movement and Place Framework

Outlined below is a reproduction of the Movement and Place Framework as outlined in the Austroads *Guide to Traffic Management Part 4* (GTM Part4) (Austroads 2020a).

The framework identifies the role of each road through a movement and place matrix (as shown in Figure B 1). This is based on the strategic significance of the road to move people and goods and the strategic significance of the land use interacting with the road. With respect to Figure B 1:

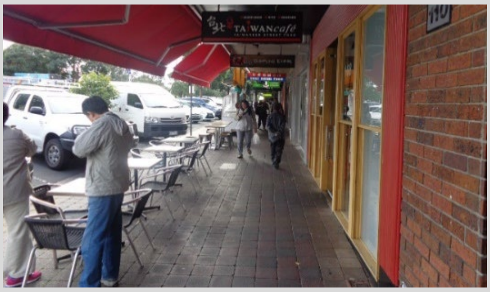
- The position of a road or street on the **movement axis** is determined by its strategic significance within the road network as indicated by Table B 1. The strategic significance of a road is identified by its role in the broader road network, the overall volume of people and goods it moves and the proportion of longer-distance journeys it serves. It is noted that movements include all movements not just car-based, so some roads may be high on the movement axis because of the strategic significance and intensity of cycling or pedestrian flows.
- The position of a road or street on the **place axis** is determined by the strategic significance and community value of a place as indicated by Figure B 2. Places can be urban activity centres that generate pedestrian activity, traditional strip shopping centres, transport hubs such as airport precincts or central railway stations, educational institutions, and community centres.

Figure B 1: Movement and place framework



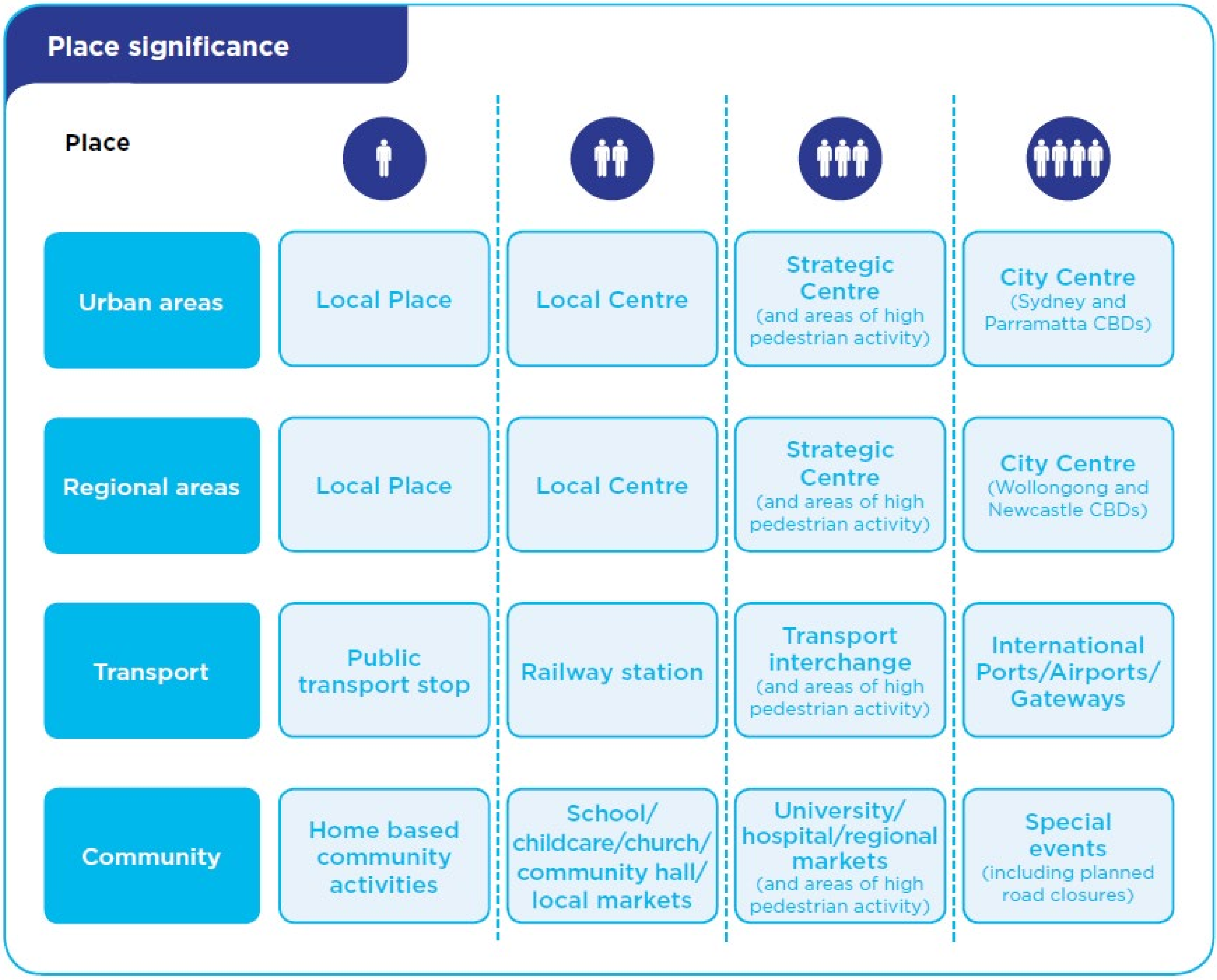
Source: Adapted from Transport for NSW (2016).

Table B 1: Functions of the road types used in the movement and place framework

Type	Image	Colour	Description
Designated movement with no place aspects			Move people and goods rapidly over long distances with motorways playing a strategically significant function within the road network.
Significant movement with some place aspects			Provide safe, reliable, and efficient movement between and within regional centres and urban areas.
Significant movement with significant place aspects			High demand for movement and high pedestrian activity with often limited road space result in vibrant streets within urban and regional areas.
Some movement with significant place aspects			High pedestrian activity and lower levels of vehicle movement create places people enjoy, attract visitors and are places communities value.
Some movement with some place aspects			The streets where people live their lives and that facilitate local access to their communities.

Source: Adapted from Transport for NSW (2016).

Figure B 2: Strategic significance of the place



Source: Transport for NSW (2016).

Appendix C Known ORPT Priority Treatments

Outlined in this appendix is an overview of available ORPT priority treatments. It is split into three sub-sections as follows:

1. ORPT category
2. ORPT priority treatments by category
3. Example images of ORPT priority treatments.

C.1 ORPT Category

Outlined is Table C 1 is a description of the different categories available. The tool refers to this table to enable users to select the category appropriate to the scenario being assessed. Treatments within the category are outlined in Appendix C.2.

Table C 1: ORPT category

ORPT category	Description
Road space: Dedicated right of way (ROW) – long length	These treatments require space that could be utilised by other road users. Alternatively, the road space could be reallocated for the purpose of ORPT. Dedicated ROW for long lengths is the preferred type of priority treatment as it gives the most priority to the ORPT. To further enhance the benefits to ORPT, the treatment can be used in conjunction with other priority measures. However, to implement them in existing links they can have a significant negative impact on the LOS of other road users and result in significant trade-offs. Long lengths of dedicated ROW treatments are the preferred approach and should always be considered. Scenarios where they are most appropriate include where the treatment can be: • demonstrated that it will achieve the objectives of the treatments and address the existing identified issues with the ORPT • implemented in accordance with the road user hierarchy and policy intention of the road link, noting that in some scenarios the existing cross-section may need to be widened, altered and/or road space reallocated. Dedicated ROW treatments that can be implemented during the peak hour provide an opportunity to implement priority for the peak period but allowing the space to be utilised by other road users during the non-peak period (e.g. for parking), therefore minimising the trade-offs. Austroads (in internal report titled 'Prioritising On-road Public Transport: Updating the Guide to Traffic Management' – IR-259-17) developed guidance on the provision of designated space for ORPT for a 60 km/h corridor and with different ORPT frequency (refer to Appendix E). This can aid in understanding the impacts of traffic congestion on ORPT and the benefits of dedicated road space treatments and stop relocation.
Road space: Dedicated lanes – short length	Unlike dedicated lanes for a long length, short length road space treatments have less impact on other road users and/or the road reservation. Therefore this minimises the negative trade-offs associated with road space treatments. Short length road space treatments can be implemented at significantly less cost than long length treatments. Dedicated lanes for a short length are the next best preferred treatment ranking behind dedicated lanes for a long length as they have the potential to deliver significant benefits depending on the scenario. They should be implemented where ORPT priority is required and justified but where long length treatments cannot be justified due to associated negative trade-offs to the other road users. Use of a dedicated lane for a short length should be considered with other treatments such as stop design, stop relocation, and traffic signal priority where possible.

ORPT category	Description
Road space: Selectively shared ROW – long length	Unlike dedicated lanes, selectively shared ROW are lanes that can be used by other road users such as vehicles with two or more occupants (T2) and three or more occupants (T3). T2 and T3 lanes can be used where bus-only lanes and bus lanes may not be warranted, justified or able to be implemented due to the impact on the other road users. T2 and T3 lanes could be considered when the vehicles make the facility more utilised without compromising the performance of the ORPT. Consideration should be given to how the use of the T2 and T3 lanes will be enforced. If it is unable to be effectively enforced and, as a result, improvements to the ORPT level of service is limited then the facility should be converted to a bus lane.
ORPT stops: Bus stop design	Bus stop design can be altered to aid ORPT progression. Altering the design can include raising them to enable users to board and disembark the bus in a quicker manner. This in turn reduces the dwell time of the ORPT at the public transport stop. The bus stop can also be made flush with the trafficable lane (using a non-indented bus bay or using a kerb outstand). The treatment provides priority to ORPT by enabling it to not have to give way to general vehicles in the trafficable lane to depart from the stop. An alteration to the bus stop design is not as preferred as dedicated lanes for a long length. Its use should be considered where long length road space priority treatments cannot be justified due to the associated negative trade-offs to the other road users. Use of bus stop design treatments should be considered along with other treatments such as dedicated lanes for a short length, bus stop relocation and traffic signal priority where possible.
ORPT stops: Tram/light rail transit (LRT) stop design	As trams traditionally travel on the centre of the road tracks, the design of the tram/LRT stops can have a significant impact on their operations. Stop design has the potential to alleviate some of these issues. The stop design can provide a raised platform that enables public transport users to get on and off the tram/LRT in a quicker manner, therefore reducing the dwell time. Modification to the tram/LRT stop to make it raised can have a significant impact on other road users. The stops can therefore be trafficable or non-trafficable. For trafficable platforms, the public transport users still must walk the width of the trafficable platform to get on and off the tram/LRT and therefore must be mindful of traffic which is required to give way to the public transport user. Getting on and off the tram/LRT is not as quick compared to non-trafficable platforms. However, it provides a trafficable lane for other road users and therefore should be considered where there is insufficient space to install a non-trafficable platform stop. Non-trafficable platform stops require space for their installation. For existing sites, this may require the use of lane space or parking space for a short length. Being non-trafficable, it enables the public transport users to get on and off the ORPT directly in a quicker manner compared to a trafficable platform. As tram/LRT stops are not as preferred as dedicated lanes for a long length, their use should be considered where long length road space priority treatments cannot be justified due to the associated negative trade-offs to the other road users. Use of tram/LRT stop treatments should be considered along with other treatments such as dedicated lanes for a short length, tram/LRT stop relocation and traffic signal priority where possible.
ORPT stops: Bus/tram/LRT stop relocation	ORPT stops can be relocated and/or consolidated to help aid ORPT progression as follows. • Relocating the tram/LRT stops from the stop line of the signalised intersection (either upstream or downstream to the departure side of the signalised intersection) allows for improved network efficiency particularly where on-road public transport signal priority is implemented. Depending on the signal priority system used, having the stop relocated allows the priority vehicle to take advantage of the priority to get through the signalised intersection, without being hindered by having to stop at the stop line to allow passengers to get on and off the tram. • ORPT stops can be consolidated to increase the distances between stops, therefore reducing the number of stops the ORPT needs to make while travelling along the route. Decreasing the number of stops has the potential to reduce total dwell time and therefore decrease overall travel time. Relocating bus/tram/LRT stops has a small potential to provide priority to ORPT. Stop relocation and/or consolidation should be viewed as a supporting measure that is used with other treatments. Austroads (in internal report titled 'Prioritising On-road Public Transport: Updating the Guide to Traffic Management' – IR-259-17) developed guidance on the provision of bus stop frequency (stop consolidation) for ORPT within a 60 km/h corridor and with different ORPT frequency (refer to Appendix E). This can aid in understanding the impacts of traffic congestion on ORPT and the benefits of dedicated road space treatments and stop relocation.

ORPT category	Description
Traffic signal: Passive priority	Traffic signal ORPT passive priority treatments can be a cost-effective way of delivering priority to ORPT as they require no additional systems and therefore can be undertaken at a low cost. The priority can be delivered in either a conservative or aggressive mode. The more aggressive the priority settings the greater the benefits to the ORPT vehicle, but also the greater the impacts on the other road users. Passive priority is only suitable for scenarios where the ORPT travels along each link in a consistent manner. Their use is likely to be only applicable where dedicated ROW long lengths can be implemented.
Traffic signal: Active priority	Traffic signal active priority requires a system to be implemented to be able to detect the ORPT vehicle and initiate a priority request. Depending on the system it can be set up to initiate a priority request based on specific conditions being met (e.g. running late). The priority request can then initiate different actions in the signal phasing subject to the signal operating system in use. Examples include green extension, green early start, special phase (B-light/T-light), phase suppression, priority phase sequences, phase compensation and flexible window stretching. The smarter the system, the more customisable the priority actions can be and therefore enable increased benefits to be able to be delivered to ORPT with less impact on other road users. The priority can be delivered in either a conservative or aggressive mode. The more aggressive the priority settings the greater the benefits to the ORPT vehicle, but also the greater the impacts on the other road users. Active signal priority is not as preferred as road space treatments. Therefore active signal priority should be considered where road space treatments cannot be implemented. In addition, active signal priority should be considered where road space ORPT priority is implemented to further enhance the benefits of the treatment. Where road space treatments cannot be implemented, the use of active signal treatments should be considered along with other treatments such as tram/LRT stop relocation and traffic signal priority where possible.
Traffic signal gating of general traffic	Traffic signal gating requires using signal timings to restrict vehicles entering a link which is being utilised by the ORPT, therefore reducing the level of congestion downstream of the ORPT vehicle. Gating can also be undertaken by some ORPT without the use of traffic signals. For example when a tram/LRT is operating on the centre of the road tracks of a multi-lane road, in a shared road environment, with kerbside parking, the following vehicles can be gated by the tram. In this scenario the presence of parked vehicles along the kerb restricts the ability for vehicles to pass the tram/LRT on the left, noting that a vehicle cannot pass on the left when the tram/LRT is stopped at a tram/LRT stop with the door open. Gating by itself will only be able to provide a small level of priority and therefore should be considered as a supporting measure and utilised with other priority measures and/or where other measures cannot be implemented.

C.2 ORPT Priority Treatments by Category

Outlined in Table C 2 is a description along with implementation considerations for treatments grouped according to category. Table C 2 is based on Austroads internal report titled ‘Prioritising on-road public transport: updating the guide to traffic management’ – IR-259-17. Example images of the treatments are provided in Table C 3.

Table C 2: ORPT priority treatments by category

Cat.	Treatment	Description	Implementation considerations
Road space: Dedicated ROW – long length	Dedicated busways	Bus facilities that are physically separated from the surrounding road network but are linked at key points to allow access for permitted vehicles.	• Cyclists: Provision of safe and secure end-of-trip facilities for cyclists for first/last mile connections. • Parking: Significant associated land for parking is required if the busway is to be accompanied with park and ride facilities. • Public transport users: Busways offer a very high level of service standards and have been shown to create mode shift from car to bus travel. • Operations: Running times may be decreased by 50%, or more, compared with a conventional bus service. • Operations: Busways have a capacity that is considerably greater than a four-lane arterial road. • Amenity: Land immediately adjacent to busways can be negatively impacted due to visual and noise impacts as well as increased traffic accessing the busway park and ride stations (if present). • Capital costs: Costs are relatively high and are dependent on the degree of grade-separation used, the use of traffic signal priority, the number and quality of specialised on-route stopping facilities, and other busway system components.
Road space: Dedicated ROW – long length	Tram/LRT dedicated ROW (including tramway with low or high vertical elements)	This treatment can be implemented with varying levels of segregation. The segregation can be demarked with low or high vertical elements and can utilise soft or hard elements. The types of vertical elements would depend: • on whether they can be mounted to undertake a manoeuvre or if they should be able to only be occasionally mounted in special circumstances (e.g. emergency vehicles undertaking a U-turn) • on the allocated cost to implement the treatment. Examples of low vertical elements that may be mounted to undertake a manoeuvre include green transitways or alternative paving. Examples of low vertical elements that may be mountable in special circumstances include concrete kerbs, rubber kerbs, semi-mounted kerbs, barrier, and semi-mountable kerbs and low domes. Examples of high vertical elements include bollards and hedges/planter strips.	• Traffic (right-hand turning): Physical priority will require alternative arrangements to be made for right-turning traffic. Where there are low vertical elements, this may be a ‘break’ in these elements (such as rubber kerbs) to allow access for turning traffic into side streets. • Traffic (signals): Improvements in signal priority provided at intersections will be limited unless mid-block priority is also provided. • Traffic (emergency vehicles): A route-by-route assessment is required of the actual need for emergency vehicles to use tram/LRT priority road space. It is often incorrectly assumed that without access to this road space, emergency vehicles will be significantly delayed. • Traffic (emergency vehicles) and operational cost: Products such as lawn pavers can make trafficable surfaces for the use of emergency vehicles if required and provide easier maintenance. • Amenity: Dividers that introduce more landscaping such as lawn treatments, alternative paving, or planter strips, can offer a high level of visual amenity in the appropriate location. Implementation of treatment should be undertaken in association with urban design authorities.

Cat.	Treatment	Description	Implementation considerations
Road space: Dedicated ROW – long length	Bus-only streets/Tram /LRT-only streets	A dedicated bus-only street and/or tram/LRT-only street is used exclusively for ORPT and provides a comprehensive ORPT priority measure. Bus-only streets/tram/LRT-only streets provide a dedicated facility for the ORPT service. In some cases their use may be combined as a transit mall.	• Operations: Only suitable in locations where there are regular services. • Operations: Provide improved travel time reliability to keep services to their timetables. • Safety: Where bus-only/tram/LRT-only streets also act as transit malls in town centres, appropriate speed limits on the ORPT should be applied to ensure appropriate safety. This is due to the potential exposure to vulnerable road users (e.g. pedestrians).
Road space: Dedicated ROW – long length	Bus-only lanes and bus lanes	Bus lanes are for the exclusive use of buses but in some jurisdictions can be used by other vehicle types, including: • taxis/hire cars • motorcycles • bicycles • emergency vehicles. In Auckland and NSW, lanes for the exclusive use of buses are called bus-only lanes. Enforcement of these lanes can significantly improve their effectiveness.	• Traffic/public transport users: Dedicated phases or turning restrictions for left-turning movements across the bus lane reduce conflicts and improve through movement for buses. • Traffic: Where general vehicles can enter the bus lane to undertake a left-turn movement there can be issues with left turners queuing when the general vehicles are required to give way to pedestrians crossing the side street. This can be an issue where there are high pedestrian movements, such as in central business districts. In this scenario, consideration may need to be given to signal phasing and/or implementation of a left-turn lane to allow the general vehicles to store, clear of the bus lane. • Pedestrians: Kerbside bus lanes typically preclude installation of kerb extensions. • Cyclists: Over half of all cyclists and bus drivers feel 'slightly uncomfortable' or 'very uncomfortable' when interacting with each other. This is of relevance to cycle lanes which may be present or where cyclists are permitted to use the bus lane. • Access to driveways: Vehicles that are turning into adjacent properties are permitted to do so from the bus lane. This may cause delay to buses. Consideration should be given to the number of driveways as well as the frequencies with which properties are likely to be accessed. Options may include signal phasing which ensures buses have a head start and are not delayed by turning vehicles. • Enforcement: Bus priority enforcement continues to be a challenge in some jurisdictions. Lane enforcement, ideally automated enforcement, is preferable in areas with high parking demand and traffic congestion, as lanes are susceptible to blocking by illegal users of the bus lanes. This includes double-parked vehicles such as delivery vehicles and cars making a pick-up or drop-off of passengers as well as drivers avoiding more congested general traffic lanes.
Road space: Dedicated ROW – long length	Tram/LRT kerbside running	Tram/LRT tracks are located such that they run along the kerbside lane of the road corridor. The key advantage of this treatment is that it offers good passenger accessibility. Passengers can wait for the tram/LRT in a protected environment without additional road width being required for safety zones. It also avoids the tram/LRT being delayed by right-turning traffic.	• Cyclists/pedestrians: While there may be visual, noise and safety benefits for pedestrians in locating the tram/LRT kerbside rather than as a traffic lane, there are challenges in them accommodating cyclists with kerbside running. This can be overcome by designating a cycling path, designed for slower cycling, through the provision of alternative paving at tram/LRT stops. However, there are challenges in accommodating high numbers of cyclists and pedestrians. Visual cues are required for pedestrians to inform pedestrians that they are not on a footpath but in fact a cycle path and for cyclists to be respectful of boarding passengers.

Cat.	Treatment	Description	Implementation considerations
			• Parking: The implementation of parking controls and relocation of existing kerbside parking is a fundamental aspect of the implementation of this treatment. • Public transport passengers: The key advantage of this treatment is that it offers good passenger accessibility. The introduction of kerbside running allows or simplifies the implementation of a variety of improved passenger features including raised platform loading, passenger shelters and improved passenger information systems. • Traffic: It also avoids the tram/LRT being delayed by right-turning traffic. • Traffic: To achieve the anticipated benefits of this treatment, the tram/LRT tracks should be configured in such a way that it provides full priority. A high degree of physical separation is essential to ensure that no vehicles can encroach on the tram/LRT tracks. • Traffic: This treatment can provide significant benefit in situations where there is insufficient road width for two traffic lanes beside the tram/LRT tracks but enough for three lanes between kerbside lanes. If there is only enough space for two traffic lanes between the tracks, then right-turn bans can be implemented, or a one-way system introduced. • Enforcement: Unlike centre-of-the-road tracks, there is a greater temptation for the kerbside track to be used for parking by emergency vehicles, delivery vehicles, taxis and broken-down vehicles. • Enforcement or segregation of kerbside lanes is essential to ensure that tram/LRT operations are not severely disrupted by stationary (or abandoned) vehicles encroaching onto the tram/LRT track. • Parking: This is particularly sensitive in locations where businesses and residents do not have access to off-street parking or rear lane access. • Access to driveways, amenity, and parking: Kerbside running will have significant impact on property access and existing kerbside parking. Proposals to introduce kerbside running are generally met with strong resistance from affected property owners, retail traders and motorists. It is essential to consult with property owners and businesses in areas that will require modifications to parking and traffic operations. This is to explain the full range of issues involved in such proposals. It is often easier to deliver major alterations such as kerbside running in conjunction with other benefits such as urban renewal programs, streetscape improvements, and provision of off-street parking.

Cat.	Treatment	Description	Implementation considerations
Road space: Dedicated ROW – long length	Peak bus lane	Kerbside bus lanes typically operating during peak periods but allow usage of the space by other road users during non-peak periods (e.g. parking).	• Traffic capacity: Peak kerbside lanes usually replace parking and have neutral traffic impact or may even increase traffic capacity. For this reason it is necessary to adjust signalling to ensure buses are not delayed by increased traffic at intersections. • Enforcement: Enforcement of these lanes can significantly improve their effectiveness. Bus priority enforcement continues to be a challenge in some jurisdictions. Lane enforcement, ideally automated enforcement, is indispensable in areas with high parking demand and traffic congestion, as lanes are susceptible to blocking by illegal users of bus lanes including double-parked vehicles such as deliveries and cars making a pick-up or drop-off of passengers. • Pedestrians: Kerbside bus lanes typically preclude installation of kerb extensions. • Pedestrians/amenity/parking: Peak kerbside lanes typically replace on-street parking, which may have an impact on adjacent businesses if they are dependent on ‘drive up’ customers. On-street parking also provides a buffer between moving traffic and pedestrians with amenity and safety benefits.

Cat.	Treatment	Description	Implementation considerations
Road space: Dedicated lanes – short length	Queue jump	Traditional bus queue-jump lanes are often provided on the approach to congested intersections. They can be set up to allow the ORPT to go straight, turn left or turn right. They also include a dedicated lane downstream of a controlled intersection, to allow the ORPT to merge back with the general traffic stream. These treatments are often supported by a designated traffic light for the ORPT vehicle (e.g. B-light or T-light). This allows the ORPT to get a head start from the general traffic, enabling the ORPT vehicle to undertake the merge in an easier and safer manner. In addition to dedicated queue-jump facilities, where suitable, queue-jump facilities can be implemented through the implementation of a dedicated left-turn lane, which the bus may be able to use but is exempted from the left-turn requirement and can proceed straight ahead.	• Infrastructure design: The length of queue-jump lanes is governed by traffic queue length and road reservation capacity per 100 m (recommended minimum) length. • Infrastructure design and signal operations: Need to consider whether buses can access the queue-jump facility due to other vehicles queuing and the level of actual use. Buses may not use the facility if the main signal is green while the B-signal is red. Preferably, the bus-stop lay-by should be located on the approach side of the intersection where a queue-jump facility is used. If the queue jump is coupled with a bus stop lay-by on the exit, consideration needs to be given to what impact this has on the bus operation and whether it negates any positive impacts to the ORPT obtained through the queue-jump facility. • Infrastructure design and signal operations: Use of the left lane must turn left, buses exempted treatment, works well where side streets have high green time and a left-turn arrow on the main route. As a result, left-turning traffic can generally be done unimpeded or with very little delay, resulting in minimal queuing or queues that disperse quickly. The treatment allows the bus to jump ahead of the queue associated with the through movement, while enabling the infrastructure space to be used as a left-turn lane. The treatment like other queue-jump treatments is often combined with bus priority B-signals. • Parking: May require the removal of kerbside parking for a distance from the intersection. • Policy (counting people not vehicles)/infrastructure design: The person throughput of an intersection can be improved by counting passengers in public transport versus in cars. Some traditional LOS measures do not recognise this aspect because they only account for individual vehicles passing through an intersection. • Traffic: When used with signal phasing/priority, advanced green time for on-road public transport has been shown to impact general traffic journey times on some cross streets. • Traffic/pedestrian: When used to cater for right-turning ORPT, this treatment may require the carriageway to be widened to provide two right-turn lanes, one for buses and one for traffic. However, care needs to be taken to ensure this does not have a detrimental impact on pedestrians through additional crossing distances and potential impacts on footpaths.
Road space: Selectively shared ROW – long length	T2 and T3 lanes	Lanes used by vehicles with 2 or more occupants (T2) and 3 or more occupants (T3).	• Operational: Finding the balance between opening the lane up to other vehicles (two or more occupancy) can be difficult. There needs to be a balance between having a lane under-utilised versus over-utilised and impacting on ORPT operation. • Enforcement: Enforcement of vehicle occupancy of private vehicles can be difficult to implement. Consideration should therefore be given to how the use of the T2 and T3 lanes will be enforced. If it is unable to be effectively enforced, and as a result, improvements to the ORPT level of service is limited, then the facility should be converted to a bus lane.

Cat.	Treatment	Description	Implementation considerations
ORPT stops: Bus stop design	Non-indented bus stops or kerb outstands	Non-indented bus stops do require the bus to depart from the trafficable lane to stop at the bus stop. Kerb outstands are kerb extensions that align the bus stop with the parking lane, allowing buses to stop and board passengers without ever leaving the travel lane. Both provide priority for the bus, by ensuring that the bus does not need to give way to vehicles in the trafficable lane to depart from the bus stop.	• Traffic (single traffic lane)/pedestrians and cyclists: Vehicles may be required to wait behind buses at bus stops. This may provide a traffic calming effect that could benefit the safety and amenity of cyclists and pedestrians. • Traffic (double traffic lane): General traffic capacity is lowered as one lane of traffic becomes less productive with buses using it as a stopping lane. Total throughput of people may or may not be impacted however as there is increased efficiency of people movement on buses. • Public transport users/pedestrians: Kerb outstands provide more space for bus stops including seating, shelters, and signage, without impeding footpath space.
ORPT stops: ORPT stop design	Raised trafficable kerbside platform stop – alternative to raised non-trafficable lane	Provides a raised platform for passengers to board the ORPT (applicable to both buses and tram/LRT). This platform is trafficable by general traffic and enables a path for the ORPT to be maintained while still providing a raised platform for passengers. This treatment is a compromise to a non-trafficable platform which may not be able to be installed within the existing road while still maintaining a separate trafficable lane for general traffic, due to the lack of available road space.	• Cyclists/pedestrians: There are challenges in accommodating cyclists and pedestrians. Visual cues are required for cyclists to be respectful of boarding and waiting passengers. • Public transport user (accessibility): These stops allow for compliance under the Disability Discrimination Act (DDA). In partnership with low-floor public transport vehicles they allow accessibility for people using wheelchairs and easier access for people with other forms of reduced mobility and people with children in prams.
ORPT stops: ORPT stop design	Raised centre island platform stops – non-trafficable and requiring trafficable lane space	Provides a raised platform for passengers to board the ORPT (applicable to both buses and tram/LRT). This platform is non-trafficable by general traffic and therefore requires road space for its installation to maintain a trafficable lane. Once implemented, enables a separate path for the ORPT to be maintained while still providing a raised platform for passengers.	• Public transport user (accessibility): These stops allow for compliance under the Disability Discrimination Act (DDA). In partnership with low-floor public transport vehicles they allow accessibility for people using wheelchairs and easier access for people with other forms of reduced mobility and people with children in prams. • Pedestrians: Pedestrians benefit through more crossing points as centre-island platform stops often require additional pedestrian crossings at mid-block locations, including with zebra crossings.
ORPT stops: Tram/LRT stop relocation	Stop relocation	Relocating stops to locations away from the stop line of the signalised intersection (either upstream or downstream to the departure side of signalised intersection).	• Operations: Departure-side stops may be problematic where the tram/LRT is not located within its own ROW. Locating the tram/LRT stop upstream of the intersection may be preferred. • Public transport user: Where public transport users may be changing modes at the intersection, relocating the tram/LRT may result in longer transfer times and may be difficult for mobility impaired users.

Cat.	Treatment	Description	Implementation considerations
ORPT stops: Bus/tram/LRT stop relocation	Stop consolidation	Consolidate stops along a route therefore reducing the distance between stops (e.g. increase distance between stops from 400 m to 800 m by merging stops).	• Operations: Stop consolidation increases the distance between stops, therefore reducing the number of stops the ORPT needs to make while travelling along the route. Decreasing the number of stops has the potential to reduce total dwell time and therefore decrease overall travel time. • Public transport user: There is a trade-off between the journey time improvements and an individual user's convenience. Stop consolidation requires significant public engagement to increase the understanding of the benefits. • Design: Consideration of adjacent land users, intersection locations and key destinations should also be a factor in stop spacing and consolidation. • Public transport user: Stop consolidation is often undertaken as part of an improvement program of bus or tram/LRT stops. When undertaken together, public transport users may benefit from additional amenities (such as seating, shelter, and real-time information) at stops. • Amenity: Consolidated stops may result in increased stopping at a single stop. Some adjacent sensitive land uses (such as dwellings) may be impacted negatively by this, whereas others such as shops may benefit from having more people deposited or waiting outside their premises.
Traffic signal: Passive priority	Conservative passive priority	Signal timings to suit ORPT progression full-time or for time of day settings (includes banned right turns for trams).	• Overall: Can be a cost-effective way of delivering priority to ORPT as it requires no additional systems and therefore can be undertaken at a low cost. However it is only suitable for where the ORPT travels along each link in a consistent manner (see operations comment below). • System: Requires a coordinated traffic signal system to be able to coordinate traffic signal timings. • Operations: Requires consistent operation of the ORPT and therefore may not be suitable where ORPT operations vary (i.e. where the ORPT shares the same space with general traffic and/or where dwell times at stops vary). Where ORPT operations vary, passive priority can have a negative impact on other road users without providing the designated benefits to the ORPT. That is, the negative impacts may outweigh the benefits.
Traffic signal: Passive priority	Aggressive passive priority	Same as conservative just more aggressive priority settings	• Overall: Same as conservative, but the benefits and impacts are magnified under aggressive operations compared to conservative operations.

Cat.	Treatment	Description	Implementation considerations
Traffic signal: Active priority	Conservative active priority	Signal timings adjusted based on active detection of the ORPT priority vehicle. Can utilise special signal phasing such as B-lights/T-lights to issue the priority to the ORPT priority vehicle.	• Overall: Requires a system to be implemented to be able to detect the ORPT vehicle and initiate a priority request. Depending on the system it can be set up to initiate a priority request based on specific conditions being met (e.g. running late). The priority request can then initiate different actions in the signal phasing subject to the signal-operating system in use. Examples include green extension, green early start, special phase (B-light/T-light), phase suppression, priority phase sequences, phase compensation and flexible window stretching. The smarter the system, the more customisable the priority actions can be and therefore enable increased benefits to be able to be delivered to ORPT with less impact on other road users. • System: Requires a system to be set up to detect the ORPT, initiate the priority request based on the algorithm used to request priority and undertake the priority action. • Operations: Priority set-up depends on how much impact is acceptable to other road users as determined by the functional policy of the road link.
Traffic signal: Active priority	Aggressive active priority	Same as conservative just more aggressive priority settings.	• Overall: Same as conservative, but the benefits and impacts are magnified under aggressive operations compared to conservative operations.
Traffic signal gating of general traffic	Conservative gating	Modify signal timings to hold back general traffic for the purpose of favouring public transport vehicles.	• Operations: Can be implemented using existing adaptive traffic control systems and does not require new systems. Priority set up depends on how much impact is acceptable to other road users as determined by the functional policy of the road link. Operation may also negatively impact on other ORPT, if gating is undertaken on movements utilised by other ORPT. Therefore it may not be suitable where ORPT is operated on all links within the road network.
Traffic signal gating of general traffic	Aggressive gating	Same as conservative just more aggressive priority settings.	• Overall: Same as conservative but the benefits and impacts are magnified under aggressive operations compared to conservative operations.

Source: Adapted from Austroads internal report titled 'Prioritising On-road Public Transport: Updating the Guide to Traffic Management' – IR-259-17.

C.3 Example Images of ORPT Priority Treatments

Table C 3 provides example images of the treatments outlined in Table C 2.

Table C 3: ORPT priority treatment images

ORPT treatment	Pictures of applications	
Dedicated busways	 *Source: NSW Roads and Maritime Services.*	
Tram/LRT dedicated ROW (including tramway with low or high vertical elements)	 *Source: Getty images.*	 *Source: Austroads.*
	 *Source: Getty images.*	 *Source: Getty images.*

ORPT treatment	Pictures of applications
Bus-only streets	 *Source: Getty images.*
Bus-only lanes and bus lanes	 *Source: Getty images.*  *Source: Getty images.*
Tram/LRT kerbside running	 *Source: Getty images.*

ORPT treatment	Pictures of applications	
Peak bus lane	 Source: Austroads.	
Queue jump	 Source: Austroads (2017).	 Source: Austroads.
	 Source: Austroads (2017).	

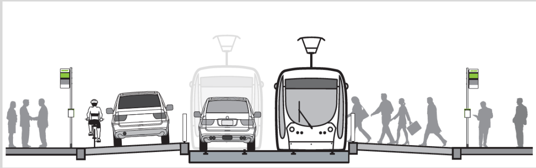
<table>
<tr><th>ORPT treatment</th><th colspan="2">Pictures of applications</th></tr>
<tr><td>Queue jump (left lane must turn left, buses excepted)</td><td colspan="2">

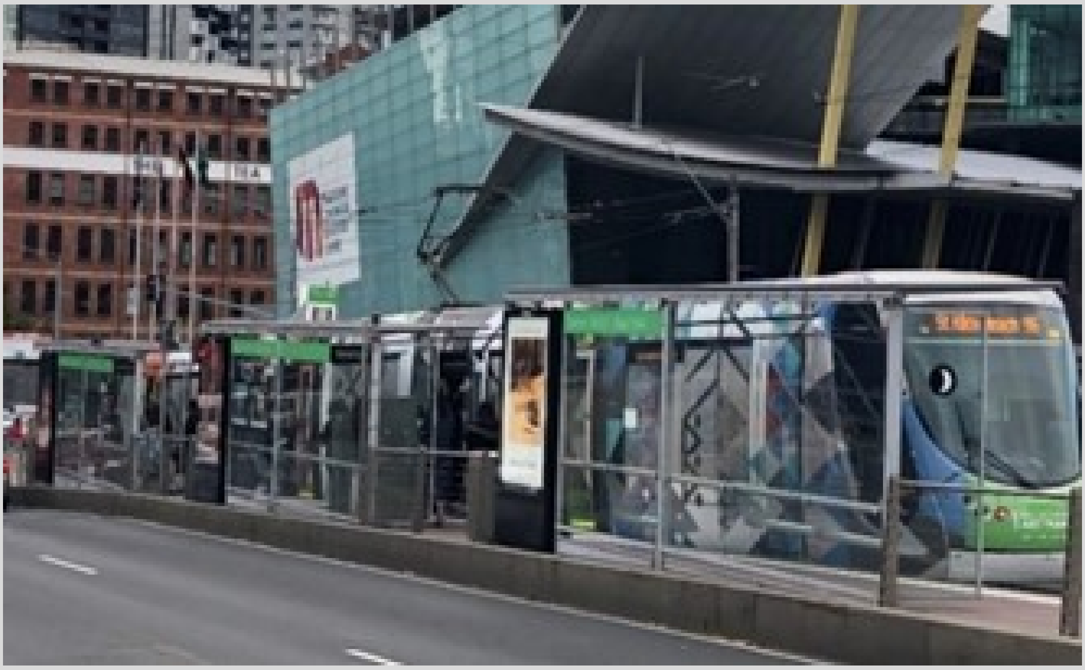
Source: Transport for NSW.</td></tr>
<tr><td>T2/T3 lane</td><td>

Source: Austroads.</td><td>

Source: Austroads.</td></tr>
<tr><td>Non-indented bus stops or kerb outstands</td><td colspan="2">

Source: Austroads.</td></tr>
</table>

ORPT treatment	Pictures of applications	
Raised trafficable kerbside platform stop – alternative to non-raised trafficable lane	 *Source: Austroads.*	 *Source: VicRoads (n.d.).*
Raised centre island platform stops – non-trafficable and requiring trafficable lane space	 *Source: VicRoads (2015).*	
Stop relocation		

ORPT treatment	Pictures of applications
Stop consolidation	
Traffic signal priority (passive and/or active, conservative, and/or aggressive)	System based. No infrastructure unless utilising a queue jump and B-light/T-light (refer to ‘queue jump’ examples).
Traffic signal gating of general traffic (conservative and/or aggressive)	System based. No infrastructure.

Appendix D Case Studies

This appendix describes some case studies of treatments which are listed in Table D 1.

Table D 1: Case studies

Cast study	Infrastructure type	Appendix section
Auckland: Manukau Road T3 Lane	T3 lane (am and pm peak) and associated signal optimisation	Appendix D.1
Adelaide: Currie, Grenfell Streets and East Terrace Bus Lanes	Peak-period bus lanes	Appendix D.2
Perth: Beaufort Street Bus Lanes	Peak-period bus lanes	Appendix D.3
Sydney: Liverpool to Parramatta T-way	A mixture of on-street bus-only lanes	Appendix D.4
Melbourne: Victoria Parade, Bus Lane Project	Bus lanes	Appendix D.5
Melbourne: Smith Street Part-time Tram Lane Improvements Trial	Line marking for tram priority	Appendix D.6
Melbourne: Active Traffic Signal Bus Priority	Active traffic signal priority	Appendix D.7
Gold Coast, G: Link LRT, Stage 1	The combination of low and high vertical elements to separate LRT in road space. Absolute signal priority	Appendix D.8

D.1 Auckland: Manukau Road T3 Lane Corridor

The case study description is reproduced from Austroads (2017).

D.1.1 The Problem

This route provides a linkage between Auckland's city centre and the airport and is part of the frequent service network for public transport. Auckland Transport had been monitoring the corridor and it was known to suffer from congestion, particularly at peak times. This undermines the journey time and reliability of all modes. The ORPT priority project was undertaken with a view to better manage road space priority and improve the productivity on the network.

D.1.2 Project Description

The project is part of a move by Auckland Transport to undertake 'corridor-wide' public transport improvements to create a step change in bus priority in Auckland.

The project has seen the introduction of a continuous 2 km long transit lane (T3 Lane) on both sides of Manukau Road. The T3 lanes operate in the peak, Monday to Friday, as follows:

- The northbound (inbound) lane from 7 am to 9 am and 4 pm to 6 pm.
- The southbound (outbound) lane from 4 pm to 6 pm.

T3 Lanes can be used by buses, taxis, bicycles, motorcycles/mopeds, and private vehicles with three or more people in them. The project was undertaken at a relatively low cost with the scope being limited to the line marking and parking removal. There was significant engagement with the community around the issue of parking removal. It remained a contentious issue 6 months after implementation (at the time of evaluation). Table D 2 summarises key points about the case study with images shown in Figure D 1.

Table D 2: Manukau Road T3 lane corridor – project description

Classification	Details
Authority	Auckland Transport with the Albert-Eden Local Board
Implementation date	29 July 2016
Capital cost	NZ $700–800 k (AUD $650–745)
Length of infrastructure	2 km
Infrastructure type	Transit T3 lane and signal optimisation

Source: Austroads (2017).

Figure D 1: Auckland: Manukau Road T3 lane corridor: route map (left), infrastructure (right)

Source: Austroads (2017).

D.1.3 Project Outcomes

Table D 3 provides data on the outcomes of the project. Overall, there were significant improvements in inbound travel time savings although this was not replicated for travel time savings in the outbound direction. There has been evidence of people adjusting their travel behaviour as follows:

- Increased use of carpooling and use of the T3 lane.
- Evidence of mode shift through increased bus patronage data.
- Some route diversion with some increased traffic reported in Gillies Avenue.

Table D 3 quantifies the key outcomes for the project. The data is from an evaluation undertaken 6 months after the project was completed.

Table D 3: Manukau Road T3 lane: project outcomes

Criteria	Outcome
Journey time changes – for on-road public transport	Inbound: Reduction from 29 minutes to 15 minutes (48% reduction). Outbound: 3-minute savings.
Journey times – for other road users	AM peak: No change. PM peak: 2–3-minute delay. Note: Auckland Transport worked hard to ensure minimal negative effects on other road users though implementing a signal optimisation plan.
Journey time reliability – for on-road public transport	No data available on journey time reliability but users of the T3 lane have anecdotally more reliable trip times due to the continuous nature of infrastructure.
Journey time reliability – for other road users	
Patronage changes of on-road public transport	Bus occupancy up 20%. The use of the T3 Lane increased between 100–200 vehicles per hour.
Required road space	One lane, previously used for parking/traffic.
Pedestrian connectivity	Some impacts on pedestrian amenity with pedestrians walking closer to the traffic lane (as parking is no longer a buffer due to its removal). All refuge islands changed to signalised mid-block crossings.
Congestion impacts and flow-on effects across modes	Gillies Avenue (a parallel route) has experienced some increased traffic.
Integration with other modes of transport	N/A.

Source: Austroads (2017).

D.2 Adelaide: Currie and Grenfell Streets and East Terrace Bus Lanes

The following case study is reproduced from Austroads (2017).

D.2.1 The Problem

Grenfell Street is one of Adelaide's key arterial east-west CBD road links, which carries about 18 000 vehicles per day. It is also a key bus link that connects a significant number of bus services from the surrounding suburbs of Adelaide to the CBD. Due to the mixed use of general traffic and buses, this has led to Grenfell Street being a congested corridor and a significant contributor to the unreliability of bus services.

D.2.2 Project Description

Dedicated bus lanes were installed in July 2012 on:

- Grenfell Street
- Currie Street
- a section of East Terrace between Grenfell Street and North Terrace in the CBD.

The buses' priority measure operates between 7 am and 7 pm Monday to Friday for one lane in both directions. One lane is also dedicated to general traffic in both directions. Table D 4 summarises key points about this case study with an image shown in Figure D 2.

Table D 4: Curie and Grenfell Streets and East Terrace bus lanes – project description

Classification	Details
Authority	Government of South Australia, Department of Planning, Transport and Infrastructure
Implementation date	1 July 2012
Capital cost	$200 000
Length of infrastructure	2.4 km
Infrastructure type	Bus lane*, 7 am to 7 pm

** Note: Bus lanes in Adelaide are permitted to be used by taxis, cyclists, and emergency vehicles.*

Source: Austroads (2017).

Figure D 2: Adelaide: Currie and Grenfell Streets bus lanes: route map (left), infrastructure (right)

Source: Austroads (2017).

D.2.3 Project Outcomes

Table D 5 provides data on the outcomes of this project. Overall, there were some improvements to travel time and reliability. There has been evidence of people adjusting their travel behaviour as follows:

- Some route diversion with some increased traffic on parallel roads to Currie Street and Grenfell Street.
- Reduction in queue length at intersections along Currie Street and Grenfell Street.

Table D 5 quantifies the key outcomes for the case study. The evaluation shows that it achieved its objective of improving travel time reliability for buses.

Table D 5: Grenfell Street, Currie Street and East Terrace bus lanes: project outcomes

Criteria	Outcome
Journey time changes – for on-road public transport	The following journey times are for travel between West Terrace and Pulteney St (1.6 km): • AM peak (eastbound): 3-second saving. • Outbound (eastbound): 15 to 30-second saving. • AM peak (westbound): 60-second saving. • Outbound (westbound): between 40 second and 3 minutes 9-second saving.
Journey times – for other road users	The following journey times are for travel between West Terrace and Pulteney St (1.6 km): • PM peak (eastbound): 64-second saving. • Off-peak (eastbound): 74-second saving. • AM peak (westbound): 40-second delay. • PM peak (westbound): 50-second delay. • Off-peak (westbound): 56-second delay.
Journey time reliability – for on-road public transport	To and from the eastern and western suburbs: An 83% on-time running rate, a 12% improvement on the previous 3 months and 16% improvement on the same time the previous year. To and from The Hills: A 91% on-time running rate, 10% up on the previous 3 months and 6% up on the same time the previous year.
Journey time reliability – for other road users	O-Bahn services have an 86% on-time running rate for July 2012, 15% up on the previous 3 months and 6% up on the same time the previous year.
Patronage changes of on-road public transport	Bus patronage was not assessed.
Required road space	One lane each way – previously used for general traffic.
Pedestrian connectivity	No significant changes to pedestrian connectivity.
Congestion impacts and flow-on effects across modes	Traffic on Currie St/Grenfell St has reduced in the range of 200 to 520 vehicles per hour (AM peak between June 2012 and Oct. 2012) with proportional increases seen on parallel roads such as North Terrace, Pirie St and Flinders St.
Integration with other modes of transport	N/A

Source: Austroads (2017).

D.3 Perth: Beaufort Street Peak Bus Lanes

The following case study is reproduced from Austroads (2017).

D.3.1 The Problem

Beaufort Street was known to suffer from traffic congestion, particularly at peak times increasing journey times and reliability of all modes. The bus lanes project was undertaken to improve the bus services to meet the demands of public transport users and improve the productivity of the public transport network.

D.3.2 Project Description

Beaufort Street is approximately 5.4 km long and links the strategic metropolitan centre of Morley with central Perth. Beaufort Street is one of Perth's best-known activity corridors.

Over a 10-year period from 2004 to 2014 bus lanes were constructed on Beaufort Street in four stages. The introduction of these lanes required the negotiation, support and financial assistance of the City of Stirling, City of Vincent, and City of Perth. To align the expectations of these authorities, a significant portion of the cost of the project related to streetscape and services enhancements. Buses utilise the lanes in the peak direction on weekdays. Table D 6 summarises key points about this case study with an image shown in Figure D 3.

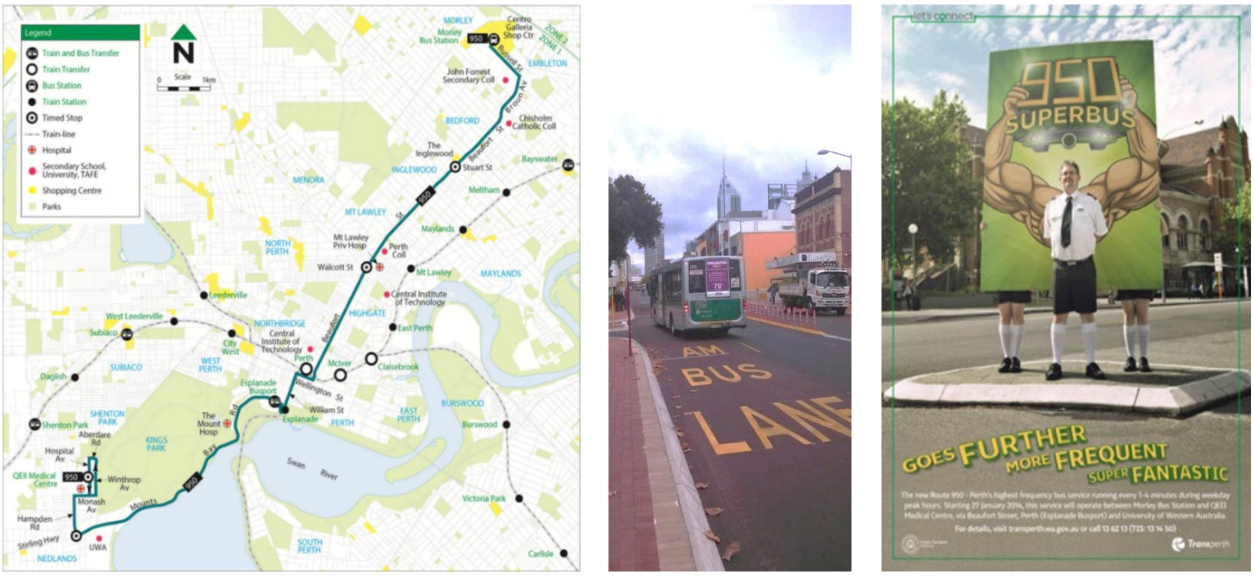
Table D 6: Beaufort Street peak period bus lanes – project description

Classification	Details
Authority	Government of Western Australia, Public Transport Authority
Implementation date	25 July 2014
Capital cost	$14.2 million
Length of infrastructure	4.8 km
Infrastructure type	Peak period bus lane*, 6:30 am to 9 am and 4 pm to 6:30 pm

** Note: Bus lanes in WA are permitted to be used by taxis, cyclists, and motorcycles where signed.*

Source: Austroads (2017).

Figure D 3: Beaufort Street: peak period bus lanes



Source: Austroads (2017).

D.3.3 Project Outcomes

The project saw benefits to public transport users with improved journey times and reliability. There was evidence of mode shift with more people using public transport than prior to the infrastructure upgrade and subsequent service improvements. The construction of the bus lanes facilitated the introduction of a new high-frequency bus, the 950 'Superbus' service, which replaced four existing routes, expanding on their service frequencies and hours of operation. The 950-bus service achieved 39% more patrons than that achieved the previous year by the four routes it directly replaced. There were 17 000 patrons recorded on weekdays within 2 months of it commencing operation, compared to a forecast for up to 15 000 patrons.

Customer satisfaction on the 950 service achieved a high satisfaction level with 95% of passengers satisfied with peak-time service levels.

There has been evidence of general traffic adjusting its travel behaviour and using alternative routes without a significant impact on the alternate routes.

Table D 7 quantifies the key project outcomes for this case study.

Table D 7: Beaufort Street peak period bus lanes: project outcomes

Criteria	Details
Journey time changes – for on-road public transport	Journey time changes include: • AM peak (inbound): 1 min. and 27 sec. saving. • PM peak (outbound): 15 sec. saving.
Journey time reliability – for on-road public transport	Journey time reliability changes include: • AM peak (inbound): 29% improvement. • All day (inbound): 3% improvement. • PM peak (outbound): 35% improvement. • All day (outbound): 2% improvement.
Patronage changes of on-road public transport	Bus usage of the 950 service in 2015 was 39% higher than the four routes that it replaced. Since then, patronage has continued to increase.
Required road space	Peak direction: a bus lane and one general traffic lane. Off-peak direction: two lanes used by buses and general traffic.
Pedestrian connectivity	A signalised pedestrian crossing was implemented near James Street after project completion to improve pedestrian connectivity.
Congestion impacts and flow-on effects across modes	Traffic on Beaufort Street fell in 2014 with proportional increases seen on parallel roads. However, in the following years with metropolitan area traffic growth illegal use of the bus lanes by general traffic was also increasing.
Integration with other modes of transport	Strong integration between new 950 bus service with other bus services as well as train and ferry services in the CBD.

Source: Austroads (2017).

D.4 Sydney: Liverpool to Parramatta T-Way

The following case study is reproduced from Austroads (2017).

D.4.1 The Problem

The government committed to building the Liverpool to Parramatta T-Way in 1998 in response to the growing need to improve transport services and infrastructure in south-western Sydney. The T-Way was created to provide better access to employment, training, and other facilities within and near the Parramatta and Liverpool hubs. The aim was to also enhance road-based public transport by improving efficiency and reliability. It was intended also to minimise the use of private cars on the road through mode shift.

D.4.2 Project Description

The project is a 31 km route comprising a dedicated busway (20 km) and priority lanes (11 km). The route has 35 stations, including the Liverpool and Parramatta bus terminals, spaced approximately every 800 m. These stations have a greater level of amenity than a regular bus stop with features such as real-time information displays and announcements of approaching services. Table D 8 summarises key points about this case study.

Table D 8: Liverpool to Parramatta T-Way – project description

Classification	Details
Authority	Built and owned by the State Government of NSW
Implementation date	February 2003
Capital cost	$346 million for 31 km
Length of infrastructure	31 km (20 km of dedicated busway and 11 km of priority lanes)
Infrastructure type	A mixture of on-street bus-only lanes

Source: Austroads (2017).

D.4.3 Project Outcomes

Ridership on the services operating on the T-Way was initially low. An Auditor General report from 2005 stated that the T-Way service opened before the infrastructure was completed. The low patronage of less than a million passenger trips in the first year of operations was attributed to this decision. Analysis of the service published in 2016 showed that since that time ridership grew at a rate that was higher than the Sydney-wide non-bus rapid transit transport growth. Table D 9 quantifies the key project outcomes for this case study.

Table D 9: Liverpool to Parramatta T-Way: project outcomes

Criteria	Details
Journey time changes – for on-road public transport	The following journey times are for travel between Parramatta and Liverpool and compare the T-Way and 804 timetabled service in 2016 in the AM peak: • Parramatta and Liverpool 804 bus service: 1 hour and 45 min. • Parramatta and Liverpool T-Way: 1 hour and 4 min. (41 minutes saving).
Journey times changes – for other road users	N/A.
Journey time reliability – for on-road public transport	N/A.
Journey time reliability – for other road users	No data available on journey time reliability for other road users but an increase in patronage on the T-Way from 2005 may suggest a greater journey time reliability than other modes of transport.
Patronage changes of on-road public transport	Annual ridership: • 2005: 1.9 million. • 2010: 2.6 million. • 25% increase in patronage growth observed in April 2015 (compared to 2010).
Required road space	One lane in each direction (constructed T-Way lanes for 20 km and priority bus-only lanes for 11 km previously used by general traffic).
Pedestrian connectivity	Mostly grade-separated pedestrian crossings.
Congestion impacts and flow-on effects across modes	Potentially increased congestion at at-grade intersections where the T-Way crosses arterial roads due to longer signalling times for the general vehicular traffic to give priority to buses.
Integration with other modes of transport	Some sections constructed to LRT standards for potential long-term integration subject to financial viability. Connecting train services available at the Liverpool and Parramatta bus interchanges.

Source: Austroads (2017).

D.5 Melbourne: Victoria Parade Bus Lane Project

The following case study is reproduced from Austroads (2017).

D.5.1 The Problem

This project came about based on a need to deliver more efficient transport services and move more people. The project scope focused on reducing travel times and increasing the reliability of the system by reducing the delays caused by the general traffic and elevating priority to buses.

D.5.2 Project Description

The project focused on upgrading the transport network for approximately 2 km on Victoria Parade, between Spring Street and Hoddle Street. As part of the project, Victoria Parade saw the construction of new bus lanes, upgrades to existing public transport stops and enhancements to traffic signalling systems to reflect the prioritisation of public transport. General vehicle traffic lanes were also resurfaced in both directions between Hoddle Street and Spring Street to coincide with the upgrade works. Table D 10 summarises key points about this case study with an image shown in Figure D 4.

Table D 10: Victoria Parade bus lane project – project description

Classification	Details
Authority	Owned and operated by VicRoads and Public Transport Victoria
Implementation date	October 2016
Capital cost	$5 million
Length of infrastructure	Approximately 2 km (Victoria Parade from Spring Street to Hoddle Street)
Infrastructure type	Bus lanes*

** Note: Bus lanes in Victoria are permitted to be used by taxis, cyclists, and emergency vehicles.*

Source: Austroads (2017).

Figure D 4: Victoria Parade section, before/after

Source: Austroads (2017).

D.5.3 Project Outcomes

The project has resulted in shorter AM peak inbound journeys for bus passengers. The project has brought this section of Melbourne's bus network up to a comparable standard of priority infrastructure to the joining section of the network on Hoddle Street. Table D 11 quantifies the key project outcomes for this case study.

Table D 11: Victoria Parade bus lane project: project outcomes

Criteria	Details
Journey time changes – for on-road public transport	The following journey times are for travel between a slightly larger area than this project encompasses (data from between intersection of Hoddle Street with Johnston Street and the intersection of Swanston Street with Little Lonsdale Street (3.60 km)): • AM peak (outbound): 54-second delay. • AM peak (inbound): 168-second saving. • PM peak (outbound): 108-second saving. • PM peak (inbound): 138-second saving.
Journey time changes – for other road users	No data available, but travel times for general vehicle traffic were expected to have improved with a smoother traffic flow due to the removal of the parking lane in each direction.
Journey time reliability – for on-road public transport	The target is to improve the travel time reliability by 20% and 30% during the AM and PM peak periods, respectively.
Journey time reliability – for other road users	No data available.
Patronage changes of on-road public transport	No data available.
Required road space	One 'lane' of parking was removed for the project.
Pedestrian connectivity	Pedestrian connections improved to asphalt paths and mostly signalised crossings at intersections.
Congestion impacts and flow-on effects across modes	N/A
Integration with other modes of transport	N/A

Source: Austroads (2017).

D.6 Melbourne: Smith Street Part-time Tram Lane Improvements Trial

The following case study is reproduced from Austroads (2017).

D.6.1 The Problem

The project aimed to raise awareness of the part-time tram lanes amongst drivers and other road users. Although there had been a part-time tram lane on Smith Street for some time, general traffic often used the tram lane during peak times. This was causing delays to city-bound commuters during the morning peak.

D.6.2 Project Description

As part of the trial enhancements, the following changes were made to the existing part-time priority tram lanes:

- New and improved lane and road markings with four high visibility 'stamps' advising drivers of the existence of the priority to trams in the AM peak period (7–9 am).
- Overhead and road signage indicating the changes to road traffic conditions and the period during which these changes were applicable (Monday to Friday 7–9 am).

The enhancements were introduced to make expectations clearer to general traffic that trams are to be a priority during the indicated hours. Table D 12 summarises key points about this case study with an image shown in Figure D 5.

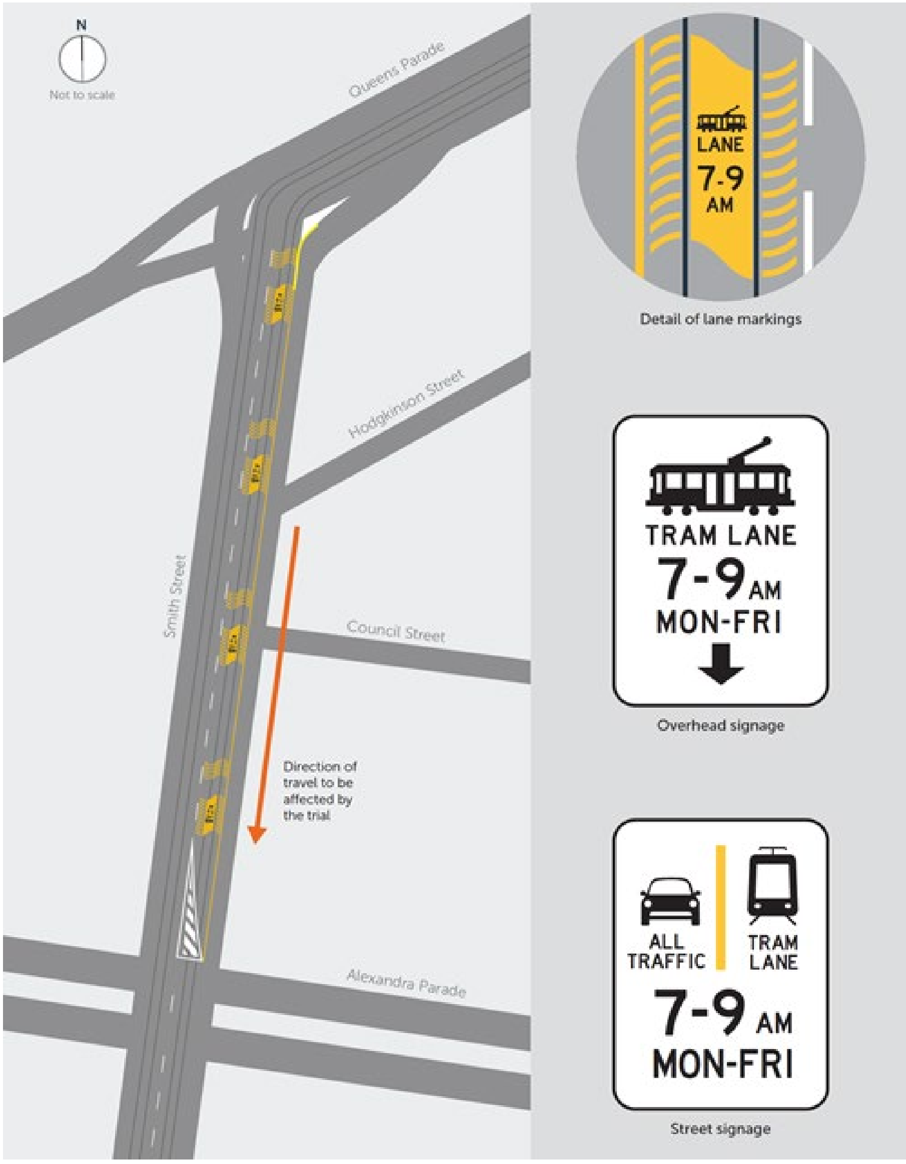
Table D 12: Smith Street part-time tram lane improvements trial – project description

Classification	Details
Authority	VicRoads, Public Transport Victoria, and Yarra Trams
Implementation date	Late January 2016 (trial lasting a period of 6 months)
Capital cost	$100 000 to $150 000
Length of infrastructure	Approximately 350 m (Smith Street between Queens Parade and Alexandra Parade)
Infrastructure type	Line marking for tram priority (Monday to Friday 7–9 am) *

** Note: During the indicated operation times, motorists can use the tram lane only if avoiding an obstacle or turning left/right within 50 m.*

Source: Austroads (2017).

Figure D 5: Smith Street part-time tram lane improvements trial



Source: VicRoads (2020).

D.6.3 Project Outcomes

Table D 13 quantifies the key project outcomes for this case study. The data is from an evaluation undertaken by VicRoads after the project was completed.

Table D 13: Smith Street part-time tram lane improvements trial: project outcomes

Criteria	Details
Journey time changes – for on-road public transport	The trial resulted in a 42-second travel time saving for trams travelling into the city on Smith Street between Queens Parade and Alexandra Parade (350 m) during the AM peak. It is noted that the part-time priority tram lane only operates on the city-bound lane from Monday to Friday from 7 to 9 am. Outside these times, normal operating conditions apply.
Journey time changes – for other road users	No data available on journey times for other road users but it has been suggested that although travel times have improved for trams, other motorists have experienced the adverse effect with greater congestion.
Journey time reliability – for on-road public transport	Journey time reliability for tram travel has increased since the trial with trams becoming 24% more reliable.
Journey time reliability – for other road users	No data available on journey time reliability but increased congestion for city-bound general vehicle traffic during the AM peak period has decreased reliability for personal vehicles as a mode of transport.
Patronage changes of on-road public transport	No data available to provide a quantitative measure of patronage change from personal vehicles to trams but a transport mode shift was observed during the trial period.
Required road space	Nil: Part-time tram lane was already in existence.
Pedestrian connectivity	No changes to pedestrian connectivity.
Congestion impacts and flow-on effects across modes	Possible increase in congestion because of the priority tram lane operation during the AM peak period with general vehicle traffic being forced to use only one lane.
Integration with other modes of transport	N/A

Source: Austroads (2017).

D.7 Melbourne: Active Traffic Signal Bus Priority

D.7.1 The Problem

Buses experience delays at traffic signal sites. Signal priority is used to aid the bus pass through the signal site. Traditionally physical detectors are used; however, there is maintenance and operational issues associated with physical detectors. A project was undertaken to trial the use of 'virtual detection' technology to implement active traffic signal priority. This is instead of the use of physical detectors. In addition, the project trialled whether the technology could initiate a priority request based on various performance conditions including schedule adherence.

D.7.2 Project Description

TRANSnet by Advantech was the technology trialled. The technology was trialled on Bus Route 201 which is a 5 km route operating between Box Hill Interchange to Deakin University in the eastern suburbs of Melbourne. Two buses normally operate on the route from Monday to Friday.

Three buses were fitted with TRANSnet GPS transponders, which communicated the timestamp position of the bus along the route.

Virtual detectors were set up at various approaches to the signalised intersections along the route. The purpose of the virtual detector was to identify the bus, determine if the bus needs priority, submit a priority request to SCATS (the adaptive traffic signal operating system) via the SCATS Action list and for SCATS to initiate the action. The SCATS action can include an alteration to the signal phasing to favour the progression of the bus.

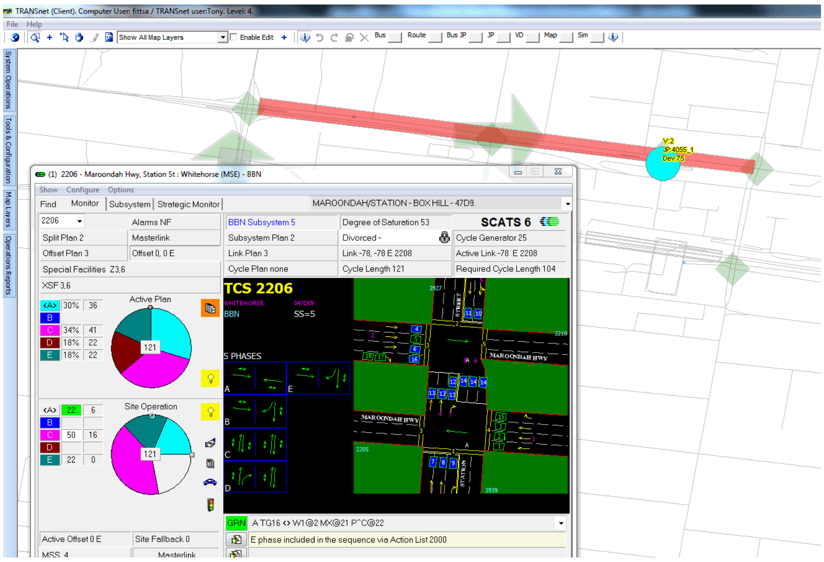
Table D 14 summarises key points about this case study with images shown in Figure D 6.

Table D 14: Active traffic signal bus priority – project description

Classification	Details
Authority	VicRoads
Implementation date	March to April 2017
Capital cost	$1000 for a TRANSnet transponder Subscription to TRANSnet
Length of infrastructure	5 km
Infrastructure type	Active traffic signal priority

Figure D 6: Active traffic signal bus priority

Virtual detector set-up and integration with SCATS



TRANSnet GPS transponders

Source: Provided by A Fitts, VicRoads (2020).

D.7.3 Project Outcomes

Overall, the technology was shown to have operated successfully with the ability for the technology to identify an ORPT vehicle, request traffic signal priority through SCATS based on specified conditions being met (e.g. time in the virtual detector, bus schedule adherence, number of other ORPT vehicles requesting priority in the virtual detector) and for SCATS to action the priority request.

The setting up and configuring of virtual detectors instead of using physical detectors and reprogramming signal controllers is the greatest benefit compared to current public transport priority systems. Setting priority via SCATS action lists provides much flexibility that is not possible with traditional physical detectors. This enables priority to be initiated when the bus is delayed or running late. This allows priority to be implemented when required but not implemented when it is not, therefore minimising the impact on other modes and traffic signal approaches. Due to the flexibility in which priority can be set up, policy is needed to govern how conservative or aggressive the priority settings are made at each individual approach to the signalised intersection.

D.8 Gold Coast: G: Link LRT, Stage 1

The following case study is reproduced from Austroads (2017).

D.8.1 The Problem

The Gold Coast G: Link Light Rail Transit (LRT), Stage 1 was constructed to serve the growing population within the city (an expected increase of 320 000 by 2035) by providing a more connected public transport network. G: Link focused on increasing the positive social, economic, and environmental impact on the community by acting as a fast, reliable, and affordable public transport option. The light rail option was introduced to encourage commuters to avoid using their personal vehicles and free up road space due to existing congestion and projected increased congestion associated with population growth.

D.8.2 Project Description

G: Link Stage 1 consists of a 13 km route starting from Gold Coast University Hospital and ending at Broadbeach South. The construction of the network saw the use of 14 light rail transit (LRT) vehicles operating within a route consisting of 16 stations. The planning and design stages of the project began in June 2011 with the light rail network open to the public in July 2014, taking three years to construct. The infrastructure allows for light rail to be entirely separated from general traffic. Light rail vehicles have absolute signal priority via a loop system which detects vehicles on their approach to intersections, triggering traffic signals to allow priority at signals, always. Table D 15 summarises key points about this case study.

Table D 15: G: Link LRT Stage 1 – project description

Classification	Details
Authority	GoldLinQ consortium in conjunction with Gold Coast City Council
Implementation date	20 July 2014
Capital cost	$1.6 billion
Length of infrastructure	13 km (including 14 LRT vehicles and 16 stations)
Infrastructure type	The combination of low and high vertical elements to separate LRT in road space. Absolute signal priority

Source: Austroads (2017).

D.8.3 Project Outcomes

Table D 16 quantifies the key project outcomes for this case study. As the project created a mode of on-road public transport where there was previously no light rail, it was not possible to do a 'before and after' analysis of journey time and journey time reliability improvements.

The major impact which can be measured as an effect of the light rail and its associated pedestrian/cyclist bridges and cyclist routes has been mode shift. There has been an overall decrease in private vehicle traffic counts in the vicinity of the light rail network, indicating that G: Link Stage 1 has created a mode shift from car to LRT and car to bike.

Table D 16: G: Link LRT Stage 1 – project outcomes

Criteria	Details
Journey time changes – for on-road public transport	Travel time from the start of the network to the end (end-to-end journey) is approximately 37 minutes.
Journey time changes – for other road users	No data available.
Journey time reliability – for on-road public transport	No data available.
Journey time reliability – for other road users	No data available.
Patronage changes of on-road public transport	15.26% increase in average daily trips on the light rail network from 6.28 million to 7.68 million trips in 2014–15 and 2015–16, respectively.
Patronage changes of private vehicle users	The overall decrease in private vehicle movements except for one section of the Gold Coast Highway can be seen from the following statistics before (2011–12) and after (2015–16): • Scarborough St (between Young St and Short St) – 49% decrease. • Gold Coast Highway (south of Ada Bell Way) – 6% decrease. • Gold Coast Highway (south of Tedder Ave) – 17% decrease. • Thomas Drive (between East Bridge and Stanhill Dr) – 3% decrease. • Gold Coast Hwy (between Elkhorn and Cavill Aves) – 15% increase. • Gold Coast Hwy (between Roma St and Thornton St) – 26% decrease. • Gold Coast Hwy (between Elizabeth and Margaret Aves) – 21% decrease.
Patronage changes of cyclists	The steady increase in growth in cyclist patronage in areas surrounding the light rail network and substantial expansion of bicycle routes. Overall 35% increase in bicycle routes from 83.3 km in 2013 to 112.6 km in 2015. A 32% increase in cyclist numbers.
Required road space	One lane in each direction – previously used for general vehicle traffic.
Pedestrian connectivity	Removal of 11 crossings to make way for traffic signals because of the light rail network was rectified by the introduction of 12 new crossings to increase access to and from the light rail stations. Construction of three new pedestrian and cyclist-only bridges to supplement access to and from the light rail network. 29% increase in pedestrians at the Thomas Drive Bridge to and from Chevron Island.
Congestion impacts and flow-on effects across modes	Gold Coast Highway between Elkhorn Avenue and Cavill Avenue has experienced a 15% increase in private vehicle traffic since the operation of the light rail. This may be traffic transferred from other routes, which have experienced a decline.
Integration with other modes of transport	Connecting bus routes available to patrons at the major light rail stations of: • Gold Coast University Hospital/Griffith University. • Southport. • Surfers Paradise (Cypress Avenue). • Broadbeach South.

Source: Austroads (2017).

Appendix E ORPT Analysis

This section discusses the three main causes of problems relating to on-road public transport reliability and vehicle speed. They include traffic congestion, bus/light rail transit (LRT) congestion and stop frequency. The information is based on Austroads internal report titled ‘Prioritising On-road Public Transport: Updating the Guide to Traffic Management’ – IR-259-17.

E.1 Traffic Congestion

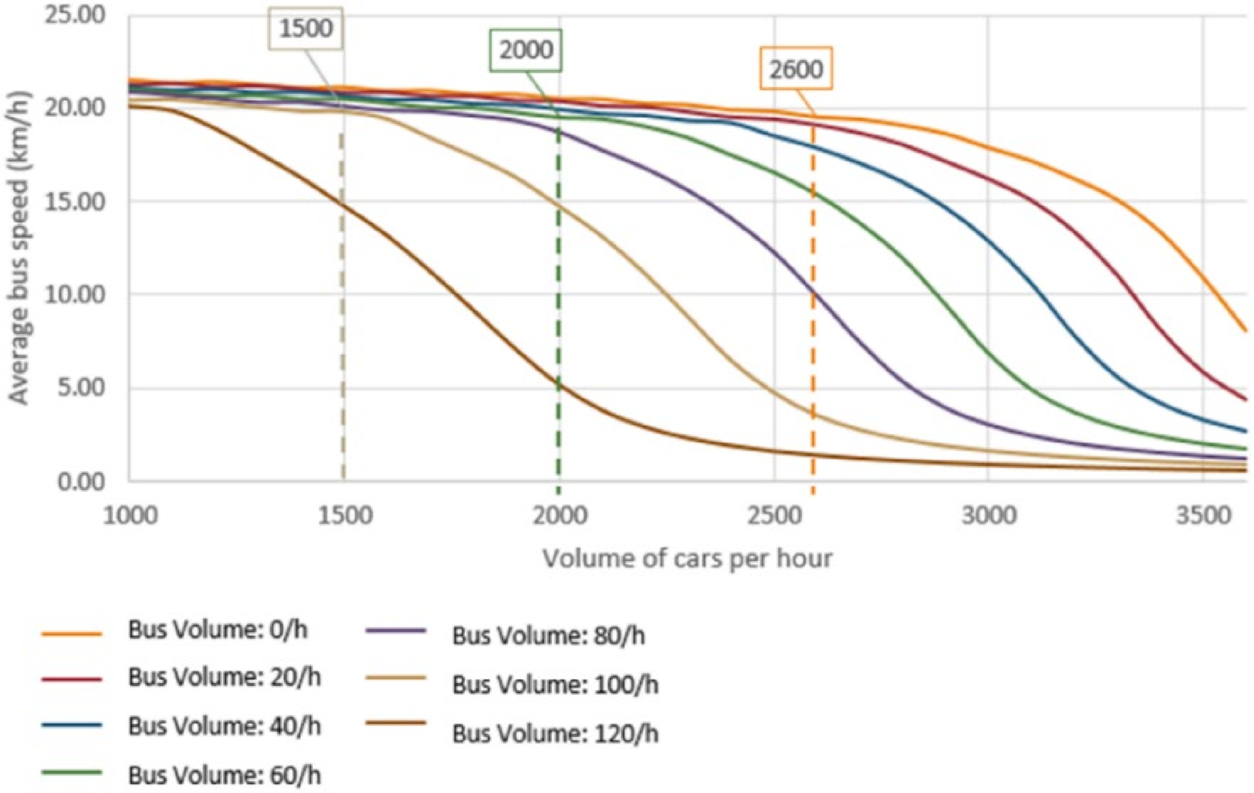
Traffic congestion can be the cause of both vehicle speed and reliability problems. Assuming a corridor carrying three lanes in one direction, with a speed limit of around 60 km/h and where the green time ratio for the bus movement is 0.64, Figure E 1 shows the average travel speed of buses and LRT. Figure E 2 shows the average travel speed of the non-bus/LRT vehicles for the same scenario. Figure E 1 should be used in conjunction with Figure E 2 to determine the relative merits of introducing bus lanes versus the impacts the bus lanes would have on other forms of traffic respectively.

Figure E 1 shows various scenarios for the case study corridor:

- When there is a negligible number of buses or LRT vehicles (i.e. between 0 and 20 buses per hour) the corridor will experience an exponentially decreasing vehicle speed when traffic volumes reach 2600 cars per hour.
- When there are 60 buses or LRT vehicles per hour, the corridor will experience an exponentially decreasing vehicle speed when traffic volumes reach 2000 cars per hour.
- When there are 100 buses or LRT vehicles per hour, the corridor will experience an exponentially decreasing vehicle speed when traffic volumes reach 1500 cars per hour.

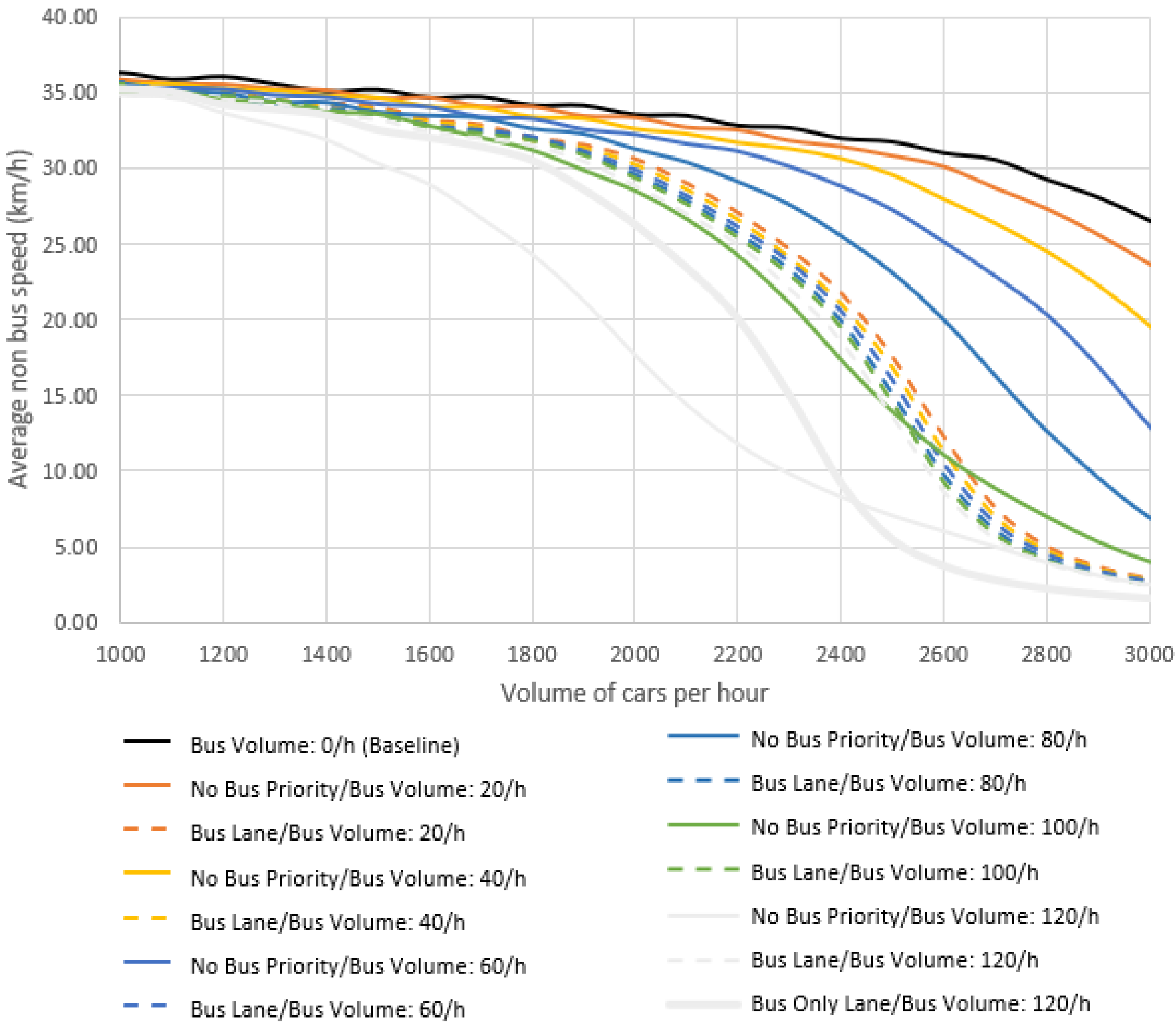
Similarly, Figure E 2 shows various scenarios on the corridor, with increasing volumes of bus/LRT and comparison between no priority and a bus/LRT lane. With the inclusion of a bus/LRT lane, the average travel speed of non-bus/LRT vehicles decreases, for the same volume of bus/LRT. At 120 bus/LRT per hour, the no bus/LRT priority speed for non-bus/LRT is approximately the same as for the bus/LRT lanes.

Figure E 1: Bus and LRT vehicle speed and traffic volume over 5 km per hour



Note: Scenarios for a corridor carrying three lanes in one direction, with a speed limit of around 60 km/h and where traffic signals have a green time ratio of 0.64.
Source: Austroads internal report titled 'Prioritising On-road Public Transport: Updating the Guide to Traffic Management' – IR-259-17.

Figure E 2: Non-bus travel speed over 5 km per hour



Note: Scenarios for a corridor carrying three lanes in one direction, with a speed limit of around 60 km/h and where traffic signals have a green time ratio of 0.64. Volume delay curves have been developed using ARR123 Traffic Signal Timing, Capacity and Analysis and Transit Capacity and Quality of Service Manual.
Source: Austroads internal report titled 'Prioritising On-road Public Transport: Updating the Guide to Traffic Management' – IR-259-17.

E.2 Bus/LRT Congestion

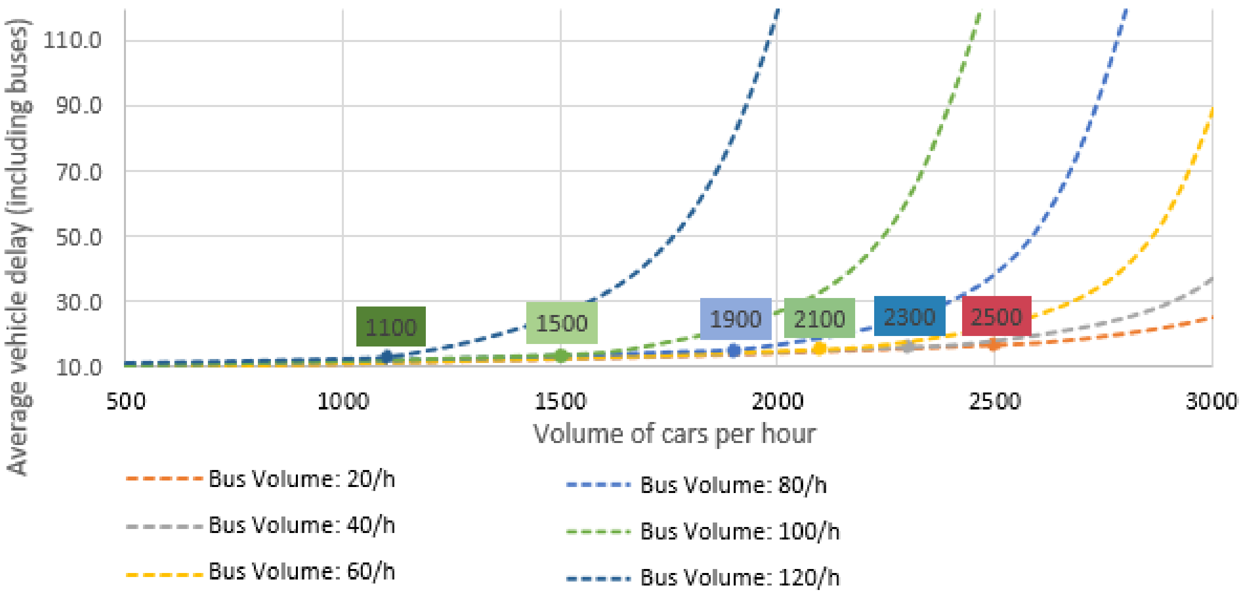
Bus and LRT congestion can be the cause of problems including slower public transport vehicle speed and poor reliability. Bus and LRT congestion results from several factors, which include not enough dedicated road space, issues with bus or LRT stops (placement within the road reserve, location along the road corridor, capacity or design) or issues relating to policy, such as timetabling and vehicle capacity.

Figure E 3 shows a range of on-road public transport volume scenarios where there is no road space priority infrastructure for on-road public transport. Intervention should be based on thresholds for reliability and vehicle speed. In lieu of a threshold, the point at which the average vehicle delay of kerbside lane begins to increase exponentially could be used. Figure E 3 shows the following:

- When there are 20 buses or LRT vehicles per hour, the corridor will begin to experience an exponentially increasing bus and LRT vehicle congestion when traffic volumes reach 2500 cars per hour.

- When there are 40 buses or LRT vehicles per hour, the corridor will begin to experience an exponentially increasing bus and LRT vehicle congestion when traffic volumes reach 2300 cars per hour.
- When there are 60 buses or LRT vehicles per hour, the corridor will begin to experience an exponentially increasing bus and LRT vehicle congestion when traffic volumes reach 2100 cars per hour.
- When there are 80 buses or LRT vehicles per hour, the corridor will begin to experience an exponentially increasing bus and LRT vehicle congestion when traffic volumes reach 1900 cars per hour.
- When there are 100 buses or LRT vehicles per hour, the corridor will begin to experience an exponentially increasing bus and LRT vehicle congestion when traffic volumes reach 1500 cars per hour.
- When there are 120 buses or LRT vehicles per hour, the corridor will begin to experience an exponentially increasing bus and LRT vehicle congestion when traffic volumes reach 1100 cars per hour.

Figure E 3: Thresholds for ORPT congestion: kerbside lane delay at intersection (no priority)



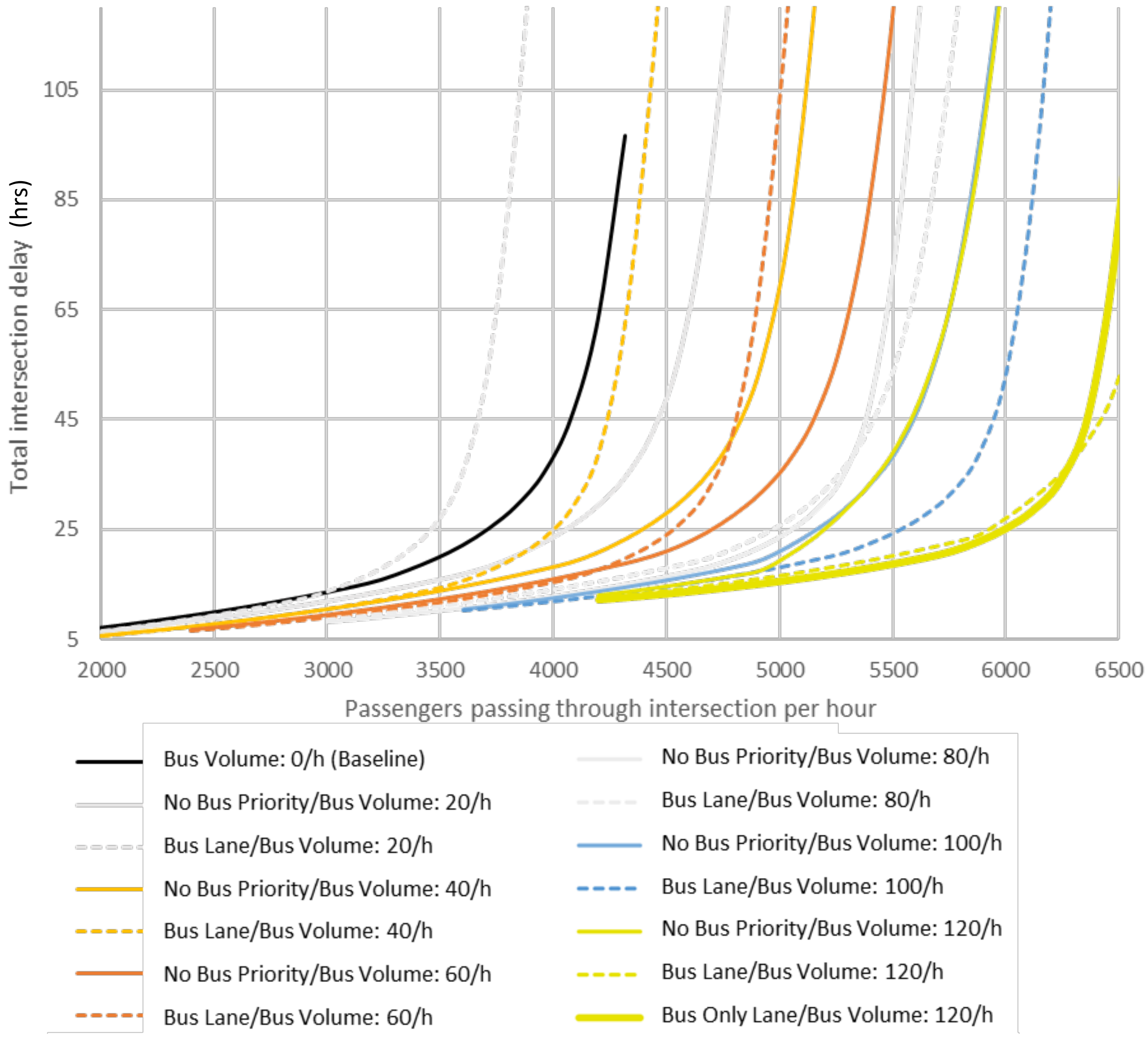
Note: Scenarios for a corridor carrying three lanes in one direction, with a speed limit of around 60 km per hour and where traffic signals have a green time ratio of 0.64. Volume delay curves have been developed using ARR123 Traffic Signal Timing, Capacity and Analysis and Transit Capacity and Quality of Service Manual.

Source: Austroads internal report titled 'Prioritising On-road Public Transport: Updating the Guide to Traffic Management' – IR-259-17.

Figure E 4 shows a range of scenarios of bus and LRT volumes where there is existing priority lane infrastructure for on-road public transport. In this scenario a bus lane refers to a lane for buses which can be used by taxis/hire cars, motorcycles, bicycles, and emergency vehicles. Compared to Figure E 3 where there is no bus or LRT road space priority, the thresholds for intervention are much higher where there is the presence of existing road space priority infrastructure for buses and LRT. Figure E 4 shows that for:

- 100 buses or LRT vehicles per hour, and with the presence of a bus lane or equivalent LRT infrastructure there is an exponential increase in passenger delay when passenger throughput is greater than 5500 per hour.
- 120 buses or LRT vehicles per hour, and with the presence of a bus lane or equivalent LRT infrastructure there is an exponential increase in passenger delay when passenger throughput is greater than 6200 per hour.

Figure E 4: Total passenger delay (hours)



Note: Scenarios for a corridor carrying three lanes in one direction, with a speed limit of around 60 km/h and where traffic signals have a green time ratio of 0.64.

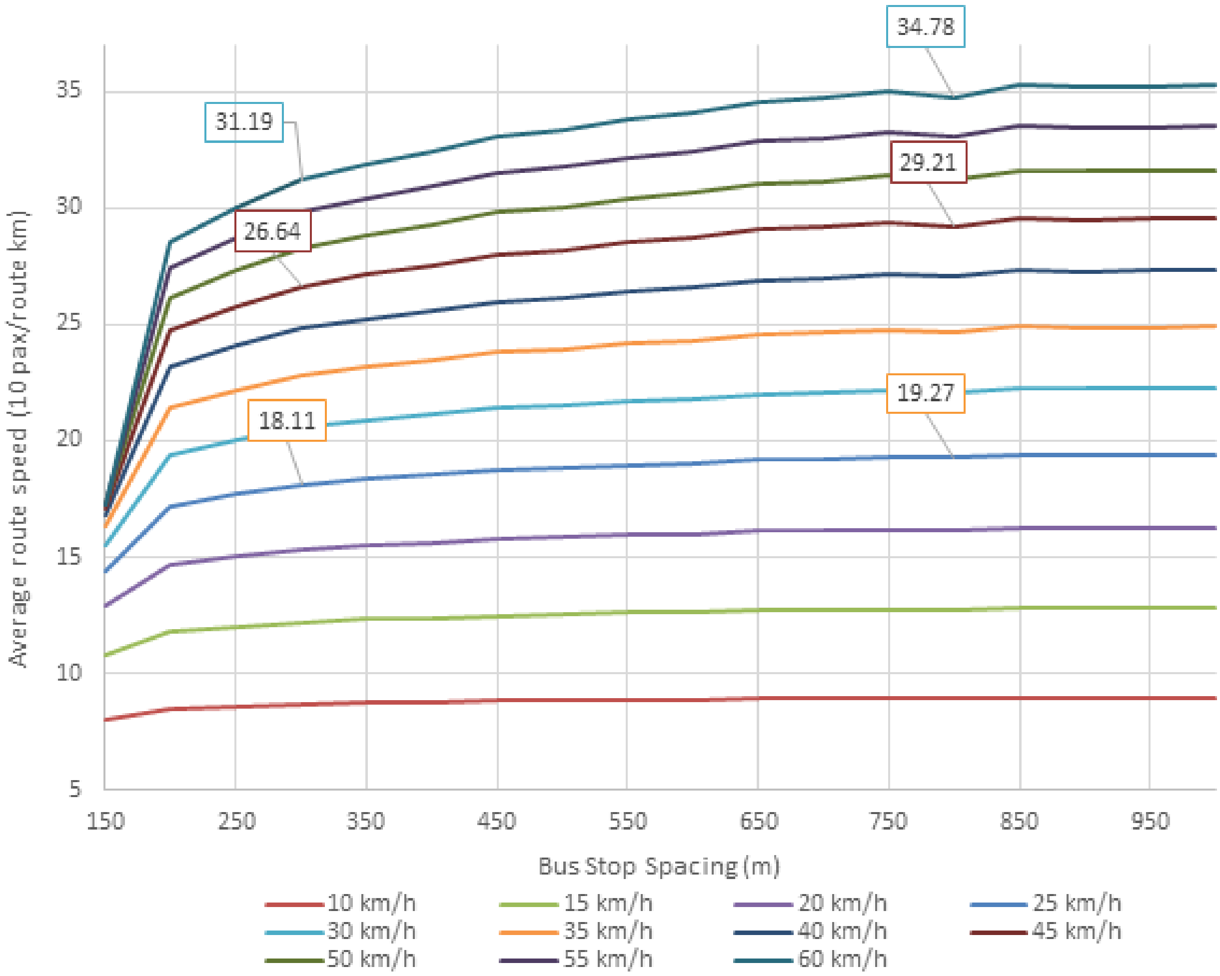
Source: Austroads internal report titled 'Prioritising On-road Public Transport: Updating the Guide to Traffic Management' – IR-259-17.

E.3 Stop Frequency

Figure E 5 shows a range of scenarios with varying average speeds of on-road public transport vehicles. As the bus and LRT stop spacing increases so too does the on-road public transport vehicle speed. Figure E 5 shows that there are travel speed improvements when the stop spacing changes increases from 300 to 800 m. As stop spacing changes increases from 300 to 800 m Figure E 5 shows the following:

- A bus or LRT vehicle with an average moving speed of 25 km per hour will likely see an improvement in average route speed from 18.11 to 19.27 (6%).
- A bus or LRT vehicle with an average moving speed of 45 km per hour will likely see an improvement in average route speed from 26.64 to 29.21 (10%).
- A bus or LRT vehicle with an average moving speed of 60 km per hour will likely see an improvement in average route speed from 31.19 to 34.78 (12%).

Figure E 5: Average route speed over 20 km (based on stop spacing and moving speed)



Note: Based on bus stop spacing using the Transit Capacity and Quality of Service Manual.

Source: Austroads internal report titled 'Prioritising On-road Public Transport: Updating the Guide to Traffic Management' – IR-259-17

Austroads

Level 9, 287 Elizabeth Street
Sydney NSW 2000 Australia

Phone: +61 2 8265 3300

austroads@austroads.com.au
www.austroads.com.au