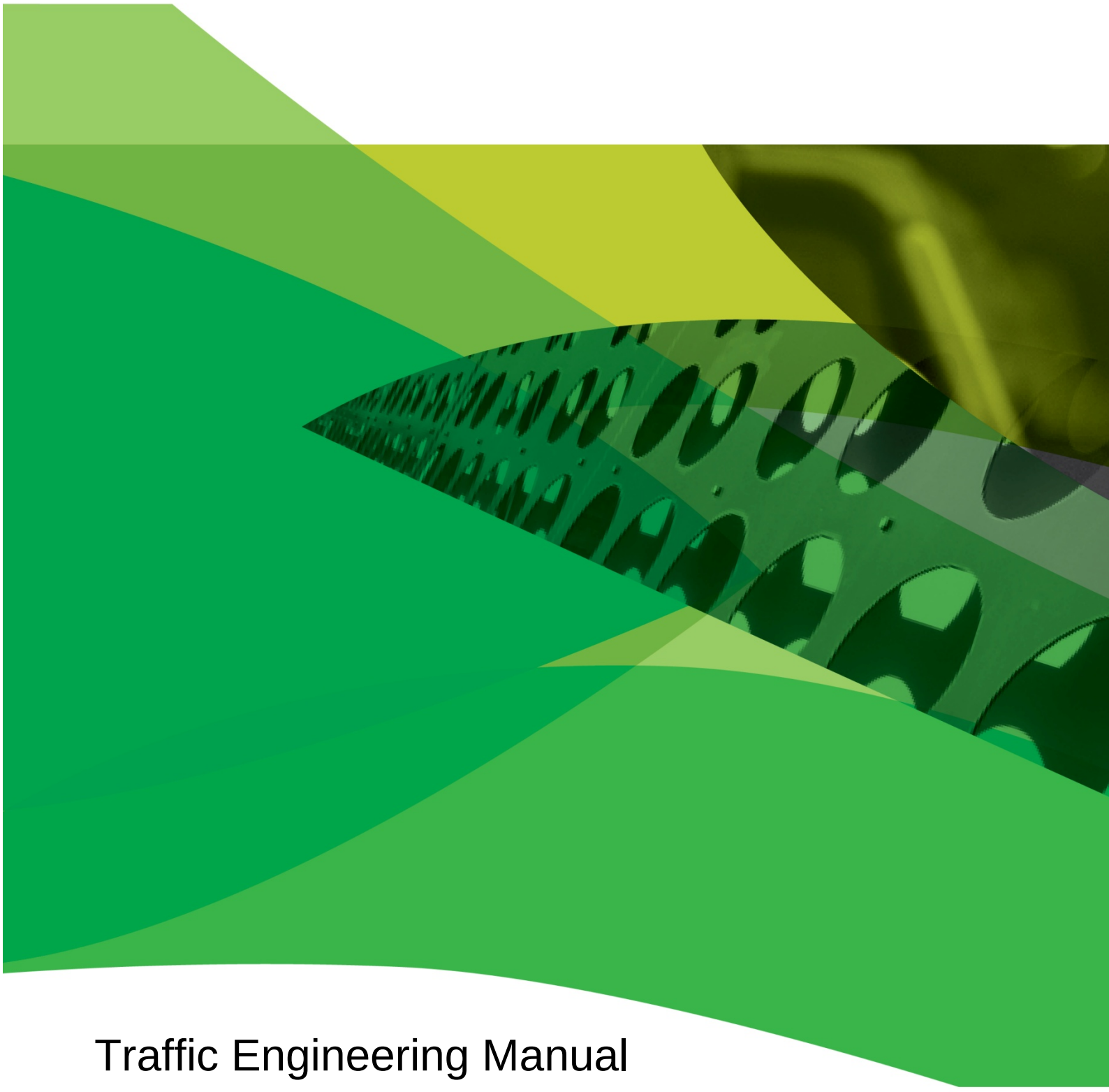

Traffic Engineering Manual

Volume 3 – Additional Network Standards & Guidelines

Guidance on Treating Pedestrian and Turning Vehicle Conflicts at Signalised Intersections

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1. Introduction

Signalised intersections are a common type of intersection control used throughout the road network, especially at intersections with high traffic volumes. Given the volume of road users at such intersections, it is critical to ensure that one particular transport mode – walking – can navigate such intersections in a safe and efficient manner, whether through the use of a signalised crossing facility or otherwise. In the event of a collision, pedestrians are the most vulnerable road users as serious injury or death is likely to occur when the impact speed is high and above the human tolerance for physical trauma.

This document lists possible treatments at signalised intersections to eliminate or minimise the risk of a collision involving a pedestrian crossing the road and a turning vehicle. The guidance contained in each treatment focuses on addressing the conflict between right turning vehicles and pedestrians crossing the intersection, where collisions can happen at high speed. Where there are wider applications, such as addressing conflicts with left turning vehicles or reducing vehicle approach speeds, these are detailed in the description of each treatment.

All treatments (and supporting treatments) in this document are to be considered and assessed, based on the information and guidance provided.

The treatments are classified as follows:

- **Elimination treatments** – these treatments virtually eliminate the risk of collisions between turning vehicles and pedestrians at signalised intersections.
- **Reduction treatments** – these treatments reduce the risk of collisions between turning vehicles and pedestrians at signalised intersections.
- **Supporting treatments** – these treatments enhance the safety benefits already provided by the 'elimination' and 'reduction' treatments. Multiple 'supporting' treatments may be used to improve pedestrian safety at signalised intersections.

The main issues between pedestrians and vehicles at signalised intersections include:

- conflicts between turning (especially right turning) vehicles and crossing pedestrians
- vehicle turn speeds and approach speeds to the intersection
- provision of pedestrian priority in high pedestrian activity areas
- provision of separation between turning vehicles and pedestrians crossing

Figure 1: Typical arterial road intersection showing a controlled right turn

Where vehicles are turning (left or right) at an intersection, a significant issue is that drivers fail to give way to pedestrians on the crossing. Road rule 62 of the Road Safety Road Rules 2009 stipulates: A driver turning at an intersection with traffic lights must give way to – any pedestrian at or near the intersection who is crossing the road the driver is entering However, if a collision were to occur, it would be at a relatively high turning speed (above 30 km/h; where, above this speed, the risk of pedestrian serious injury increases significantly[1]). Treatments that provide a physical means to slow down vehicles or provide separation between pedestrians and vehicles will result in better safety outcomes for pedestrians.

Where there is a history of pedestrian crashes, an 'elimination' treatment should be adopted rather than a 'reduction' treatment.

When assessing each treatment, practitioners should also consider the impact on intersection capacity, including on public transport modes, as well as whether the treatment will result in undesirable pedestrian and cyclist behaviour.

Refer to Appendix A for statistics on pedestrian casualties at signalised intersections in Victoria between 2003 and 2013.

VicRoads Movement & Place Framework and SmartRoads

The Movement and Place framework supports integrated transport and land use decision making by considering the variety of roles that roads and streets play. Many of Victoria's roads cater for high volumes of "movement" by various modes of transport, while others are quiet local streets. Streets and roads are also "places" such as shopping and leisure destinations, local neighbourhoods or tourist routes, and contribute to Victoria's liveability and character.

The primary objective of SmartRoads is to improve the long term operational management of arterial roads across Victoria by providing priority to modes of transport, on certain roads, and at

[1] Wramborg P, A New Approach to a Safe and Sustainable Traffic Planning and Street Design for Urban Areas, Road Safety on Four Continents Conference, Warsaw, 2005.

particular times of the day. SmartRoads recognises the increasing importance of public transport, walking and cycling as transport modes. Under SmartRoads, certain activity centres have been classified as pedestrian priority areas where there is a focus on providing facilities that promote and prioritise pedestrian movements.

Each treatment in this document will make reference to SmartRoads. This document will be updated further as the Movement and Place framework develops.

Safe System Approach

The Safe System approach to road safety is the key concept in Victoria's strategy to reduce fatalities and serious injuries from road crashes. The Safe System approach is built on the premise that people make mistakes which can lead to crashes and that there is a limit to the human body's tolerance to crash forces. Accordingly, the road transport system needs to be designed and managed to cater for human failure.

By applying the Safe System philosophy, the long term vision is to eliminate fatal and serious injuries arising from crashes. The achievement of a Safe System is a shared responsibility and it requires four interconnected cornerstones of safe travel to be working effectively together – safer people, safer vehicles, safer roads and safer speeds.

To create a Safe System, it is important to influence how people and vehicles can safely access the road system. Greater emphasis and effort need to be placed on developing and maintaining more forgiving roads and roadsides so both the likelihood of a crash occurring and the severity of crashes when they do occur are reduced.

In the event of a crash, pedestrians and cyclists are more vulnerable than vehicle occupants because they have little or no protection. Well designed and maintained paths will help in the safety of pedestrians and cyclists and also encourage more walking and cycling as the best way to stay healthy and get around.

VicRoads' key role is to help provide Victorians with safe and easy connections to the people and places that matter most to them. As part of the VicRoads' aim to achieve ongoing reductions in the number and severity of road crashes and the resultant cost of road trauma, several treatments have been developed to help improve the safety of pedestrians and cyclists. This document aims to eliminate or reduce the risk of collisions between turning vehicles and pedestrians at signalised intersections.

Each treatment in this document will make reference to the Safe System approach.

Crash Reduction Factors

For the crash reduction factors for the various treatments listed in this document, practitioners should refer to the latest available research. At the time of publication, the following documents may be useful in providing guidance for these factors:

- Austroads Technical Report AP-T151/10: Road Safety Engineering Risk Assessment Part 6: Crash Reduction Factors (2010)
- Austroads Research Report AP-R422-12: Effectiveness of Road Safety Engineering Treatments (2012)

It should be noted that other research may be available and practitioners may use this information where appropriate.

2. Summary of treatments

The following tables provide a brief overview of the treatments and their use in certain road environments.

For full details regarding a treatment's effectiveness and appropriateness in certain road environments, please refer to the detailed section for each treatment.

Table 1: Overview of treatments and their use in certain road environments

	Treatments to eliminate pedestrian and turning vehicle conflicts at signalised intersections				
Road Use Classification (including SmartRoads Road Use Hierarchy categories)	Grade separation of pedestrian crossing	Scramble crossing	Exclusive pedestrian phase	Fully controlled turns	Dwell on walk
Preferred traffic route					
Tram priority route					
Bus priority route					
Pedestrian priority area (or network)					
Bicycle priority route					
Traffic route					
Freight route					
Collector road (without specific traffic priority)					
Local road (without specific traffic priority)					

KEY:

 Appropriate May be appropriate Unlikely to be appropriate

Table 2: Overview of treatments and their use in certain road environments

	Treatments to reduce pedestrian and turning vehicle conflicts at signalised intersections			
Road Use Classification **(including SmartRoads Road Use Hierarchy categories)**	Early start green for pedestrians	Partially controlled right and left turns with red arrow drop out	Split phasing	Right turn prohibition
Preferred traffic route				
Tram priority route				
Bus priority route				
Pedestrian priority area (or network)				
Bicycle priority route				
Traffic route				
Freight route				
Collector road (without specific traffic priority)				
Local road (without specific traffic priority)				

KEY:

 Appropriate  May be appropriate  Unlikely to be appropriate

3. Elimination treatments

3.1 Grade separation of pedestrian crossing

Full grade separation of pedestrians, above or below an intersection, eliminates the conflict between motorists and pedestrians at a signalised intersection. A pedestrian overpass or underpass allows pedestrians to cross the road independently of the traffic signals.

Due to the significant cost of providing the required infrastructure (including ongoing maintenance) these types of treatments are best utilised in heavy pedestrian areas. These sites include:

- At intersections within pedestrian priority areas as defined in the VicRoads SmartRoads strategy.
- Within central activities areas (including hospital and university campuses) where pedestrian volumes are significant in all directions of the intersection.
- Where an at-grade crossing is not desirable or where it is preferred that pedestrians be able to cross the intersection at any time.
- Where the intersection is located between public transport nodes (e.g. a connection between a railway station and a bus interchange).
  Where pedestrian paths or desire lines already take them over or under the road (e.g., at an elevated railway station).

Other treatments may be more appropriate than grade separation, and may provide a better outcome for pedestrian amenity. This includes:

- Providing an at-grade crossing with pedestrian priority may be more cost effective or provide better pedestrian amenity (e.g. shorter walking distance).

Where such a treatment is to be considered, the following should be taken into account:

- The geometry of the overpass / underpass will appropriately cater for the expected volume of pedestrians.
- Designing to maximise pedestrian convenience, minimising the vertical extent of changes in level and minimising additional travel time to encourage the use of the facility.
- The impact on travel times for users of the grade separated facility which may not be favourable for pedestrians where the walking distance is perceived to be significantly greater than the at-grade distance.
- Providing facilities for cyclists - this may be in the form of a segregated path along the overpass / underpass connecting to an on-road bicycle lane. Refer to guidance for Pedestrians and Cyclists Treatments at Roundabouts for further details.
- The land acquisition that may be required in order to build the structure – including provision of land for ramps and other supporting bridge or tunnel structures.
- Provision of Disability Discrimination Act (DDA) compliant infrastructure – refer to Australian Standards AS 1428.4 series. This includes providing ramps and possibly lifts that are accessible by all users.
- Whether the design of the infrastructure leads to the creation of an environment that is ‘unsafe’ or ‘unwelcoming’ for pedestrians or other users. To overcome this, several measures can be implemented:
  - Provision of lighting - refer to VicRoads TCG 006 and AS/NZS 1158.5: Lighting for road and public places – Tunnels and underpasses (2014).
  - Graffiti prevention measures.
- The design of overpasses should consider the following:
  - The visual impact on the surrounding environment.
  - Provision of side barriers to prevent rock throwing or falls.

- The clear width of walkway should be 1.8 m minimum for pedestrians[2].
- Vertical clearance over roadways shall be 5.5 m minimum with no adjacent bridges and 6.0 minimum on designated high clearance routes.[3]
- The clear width of bicycle paths on the carriageway should be 2.0 m minimum, 3.0 m minimum on separated bicycle path and two-way shared path.[4]
- Appropriate lighting - refer to AS/NZS 1158 series

- The design of underpasses should consider the following:
  - Provision for drainage
  - Security and vandalism issues
  - Underpasses should be constructed with a maximum change in level of 3.5m[5]
  - Appropriate lighting - refer to Section 4 of AS/NZS 1158.5:2014
- On-going maintenance costs.

Design concepts

Figure 2 below shows an example of a pedestrian overpass at an intersection. An underpass or overpass may be provided for all movements or it may be limited to certain key directions.

Figure 2: Pedestrian overpass – Maroondah Highway, Ringwood

[2] Clause 9.10 of AS5100.1-2004 Bridge Design Part 1: Scope and general principles

[3] Clause 9.11 of AS5100.1-2004 Bridge Design Part 1: Scope and general principles

[4] Clause 9.13 of AS5100.1-2004 Bridge Design Part 1: Scope and general principles

[5] Section 4.4.1 of Austroads Guide to Road Design Part 4C Interchanges

Summary

This particular treatment has the following pros and cons:

Pros

- Pedestrians are fully separated from other transport modes – no conflicts with vehicles at road level.
- Pedestrians can cross the intersection at any time without being delayed by traffic signals.
- The treatment can become a landmark for the local area through a prominent design.

Cons

- Potential high cost in provision of infrastructure (overpass or underpass).
- Potential increase in pedestrian travel time.
- Poorly designed infrastructure may create an environment that is unwelcoming to pedestrians or cause other safety issues (e.g. rock throwing).
- Potential high cost in the event of land acquisition.

Further reading

- Austroads Guide to Road Design Part 4: Intersections and Crossings – General (2009).
- Pedestrian planning and design guide (2004): Section 15.4 (Land Transport New Zealand).
- Lighting: VicRoads TCG 006, AS/NZS 1158.3.1 (2005), AS/NZS 1158.5 (2014).
- DDA: AS 1428.4 series.

3.2 Scramble crossing

A scramble crossing involves an exclusive pedestrian signal phase being provided at an intersection to allow pedestrians to cross to any leg of the intersection in any direction. This type of crossing may be appropriate in locations where each corner has a high pedestrian volume.

An example of a scramble crossing is at the intersection of Flinders Street and Elizabeth Street in the Melbourne Central Business District as shown in Figure 3.

Potential locations for a scramble crossing include:

- At intersections within pedestrian priority areas as defined in the VicRoads SmartRoads strategy, where pedestrian volumes are high and there is a demand for the ability to cross in any direction.
- Within central activities areas including hospitals, educational facilities and busy shopping strips on local roads where it is desired to give pedestrians the highest priority over other traffic modes.
- Where the intersection is located between public transport nodes (e.g. a connection between a railway station and a bus interchange).
- Intersections where there is a history of pedestrian crashes, especially if there is no clear pattern that can be addressed by a more targeted treatment.
- Where there are high numbers of particularly vulnerable pedestrians – children, disabled or older people.
- Where intersection geometry allows high speed turning movements.
- Where the desired crossing line for pedestrians is predominately in the diagonal direction.
- Other locations where it would be beneficial to allow pedestrians to cross to any point of the intersection and the regular perpendicular crossing arrangement is insufficient.

Where such a treatment is to be considered, the following should be taken into account:

- The geometry of the intersection needs to allow pedestrians to cross safely to any part of the intersection.
- Sufficient footpath space is needed to store waiting pedestrians
- Kerb ramps need to be wider than at a standard intersection to cater for the various movements across the intersection.

- Provision of an automatic call for the pedestrian phase, so that pedestrians do not manually have to press a button to activate the phase.
- Wait times for pedestrians at the intersection should not be long because:
    - given the potential high volume of pedestrians, the wait time needs to be reasonably short to clear waiting pedestrians (see discussion below)
    - a long wait time may result in jaywalking across the intersection.
- This type of crossing may not be appropriate at extremely wide intersections where a diagonal crossing may take a significant time to complete.
- Additional delays to trams, buses and other road users may occur due to the prolonged pedestrian phase - appropriate cycle lengths need to be determined to balance the requirements of crossing pedestrians and vehicle throughput (see discussion below). In some cases, a higher priority may be given to public transport modes which may make a scramble crossing undesirable.
- Additional pedestrian signal lanterns are required to face the opposite diagonal corner.

The implementation of a scramble crossing needs to be carefully considered, as research has shown that a scramble crossing may lead to slight increases in overall average pedestrian delay[6], mainly because pedestrians can only cross during the exclusive pedestrian phase and cycle times may be too lengthy. As also mentioned above, the additional cycle time for a scramble crossing will result in vehicle delays, which could have a significant effect on high volume public transport corridors.

Guidance on the installation of scramble crossings is found in Australian Standards AS 1742.14 (2014) Clause 6.2.2 and VicRoads Supplement to AS 1742.14 (2015).

[6] Nash, D., & Smith, W. (2010). The Efficiency of Scramble Crossings. AITPM Annual Conference Proceedings.

Design concepts

Figures 3 and 4 show a typical scramble crossing layout at a signalised intersection.

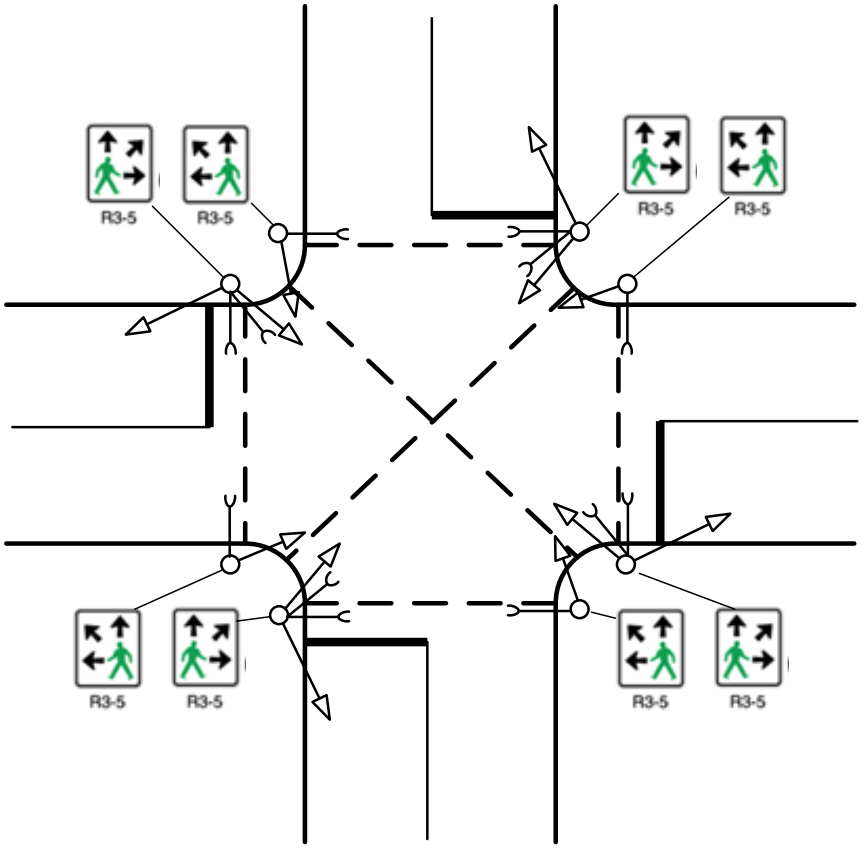

Figure 3: Scramble crossing layout showing signs and lantern placement.

Figure 4: Scramble crossing at the intersection of Flinders Street and Elizabeth Street in the Melbourne Central Business District.

Supporting treatments

Listed below are supporting treatments that can be used with this primary treatment. For full details on each supporting treatment (including appropriate locations and other considerations), refer to the main 'supporting treatments' section (Section 5).

Raised platform on approach

A raised platform on the approach to the intersection may be considered as a measure to reduce vehicle approach speeds.

Raised intersection / pedestrian crossing

Placing the intersection on a raised platform may raise the prominence of the intersection as well as the pedestrians who are crossing. This physical treatment may also assist in reducing the operating speed through the intersection.

Summary

This particular treatment has the following pros and cons:

Pros

- Pedestrians are given an exclusive signal phase; virtually eliminating conflicts with turning vehicles
- Pedestrians can cross in all directions eliminating the need to wait for multiple phases in order to negotiate the intersection.

Cons

- Increased wait times for vehicles and other road users (e.g. trams) through longer pedestrian phase (resulting in reduced intersection capacity)
- May not be appropriate at extremely wide intersections where a diagonal crossing may take a significant time to complete, impacting on overall efficiency of the intersection.

Further reading

- Austroads Guide to Traffic Management Part 10 (2016) Section 8.8.2 - further guidance on the principles of scramble crossings.
- Australian Standards AS 1742.14 (2014) Clause 6.2.2 - guidance on the installation of scramble crossings.

3.3 Exclusive pedestrian phase

In this type of treatment, all pedestrian crossings are simultaneously given a green phase and all vehicle approach legs are given a red phase until the conclusion of the pedestrian phase. After the completion of the exclusive pedestrian phase, the pedestrian signal will become red while the vehicle phase begins. This is similar to a scramble crossing except that pedestrians are permitted only to cross in perpendicular directions to the roadway instead of in any direction.

An exclusive pedestrian phase may be programmed to only be active at certain times of the day (e.g. during peak pedestrian periods).

Potential locations for an exclusive pedestrian phase:

- At intersections within pedestrian priority areas as defined in the VicRoads SmartRoads strategy.
- Within central activities areas where pedestrian volumes are significant in all directions of the intersection and a scramble crossing is deemed undesirable (e.g. the geometry of the intersection prevents a diagonal crossing to made safety or in a timely manner).
- Where the intersection is located between public transport nodes (e.g. between a railway station and a bus interchange) and priority is to be given to pedestrians crossing at an intersection between these nodes.

- Where pedestrian priority is only beneficial at certain times of the day, allowing an exclusive pedestrian phase to be activated during those times (as opposed to a scramble crossing, where signage and diagonal linemarking indicates to pedestrians that they are able to cross in all directions at all times).
- At locations with a high level of conflict between turning vehicles and pedestrians where either mode is significantly delayed by one another.Intersections where there is a history of pedestrian crashes, especially if there is no clear pattern that can be addressed by a more targeted treatment.
- Where there are high numbers of particularly vulnerable pedestrians – children, disabled or older people.
- Where intersection geometry allows high speed turning movements.
- At other locations where it would be beneficial to allow pedestrians to cross simultaneously across the intersection.

Where such a treatment is to be considered, the following should be taken into account:

- Appropriate pedestrian phase timings based on the volume of pedestrians.
- Implementing this treatment on a full-time or part-time basis, to reflect pedestrian volume and activity.
- Additional delays to trams, buses and other road users may occur due to the prolonged pedestrian phase - to minimise the delay, shorter cycle times (e.g. 30 seconds for each phase) may need to be implemented to balance the needs of pedestrians and other road users. In some cases, a higher priority may be given to public transport modes which may make an exclusive pedestrian phase undesirable (especially in peak times).
- Potential for increased wait times for pedestrians as pedestrians are only allowed to cross during the exclusive pedestrian phase.
- Pedestrians illegally crossing against the red signal when the parallel vehicle phase is green – in situations when there are no vehicles present at that particular moment; pedestrians may feel that they are able to cross.
- The number of crossings able to be completed in one phase – whether there is a need to allow more time for pedestrians to complete two or more crossing movements.
- Auto-introduction of the pedestrian phase at locations with a constant volume of crossing pedestrians.
- The number of times that this phase will operate in a cycle, based on pedestrian volumes, intersection capacity and geometric layout.

Design concepts

The layout of an intersection with an exclusive pedestrian phase consists of standard crosswalk lines across each leg of the intersection. During the pedestrian phase, all crossings are given a green signal (and all vehicles phases are red), as shown in the traffic signal phasing diagram in Figure 5.

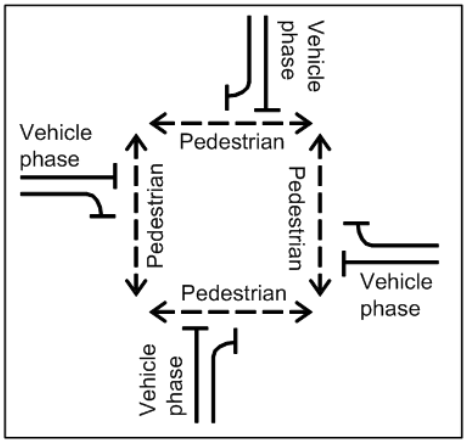

Figure 5: Phasing diagram for an exclusive pedestrian phase - all vehicle phases are red

Supporting treatments

Listed below are supporting treatments that can be used with this primary treatment. For full details on each supporting treatment (including appropriate locations and other considerations), refer to the main 'supporting treatments' section (Section 5).

Raised platform on approach

A raised platform on the approach to the intersection may be considered as a measure to reduce vehicle approach speeds.

Raised intersection / pedestrian crossing

Placing the intersection on a raised platform may raise the prominence of the intersection as well as the pedestrians who are crossing. This physical treatment may also assist in reducing the operating speed through the intersection.

Puffin crossing

A pedestrian detector may be installed to dynamically shorten or lengthen the pedestrian phase based on the presence of pedestrians on the crossings.

Summary

This particular treatment has the following pros and cons:

Pros

- Virtually eliminates the conflict between turning vehicles and pedestrians through the exclusive pedestrian signal phase – all vehicle movements are stopped.
- Pedestrians can cross in all perpendicular directions at the intersection.
- Allows all pedestrians to clear the intersection simultaneously. This is useful in high pedestrian areas or where there are high volumes of turning vehicles (high potential for conflict).

Cons

- Potential increase in intersection cycle times (to cater for a longer pedestrian phase), may reduce intersection throughput for other modes.

- May not be appropriate at extremely wide intersections where a crossing may take a significant amount of time to complete.
- Potential issue of pedestrians crossing against a red pedestrian signal when the parallel vehicle phase is green.

Further reading

- Austroads Guide to Traffic Management Part 10 (2016) – further guidance regarding phasing design.
- VicRoads Supplement to Austroads Guide to Traffic Management Part 10 (2015) – further guidance regarding phasing design.

3.4 Fully controlled right and left turns

Fully controlling turns at an intersection will remove the conflict between turning vehicles and crossing pedestrians as the vehicle turn phase will be separate to the pedestrian phase.

Potential locations for fully controlling turns:

- At intersections within pedestrian priority areas as defined in the VicRoads SmartRoads strategy.
- Within central activities areas (including hospital and university campuses) where pedestrian volumes are significant.
- At intersections with multiple turn lanes.
- At intersections with a history of crashes between turning vehicles and pedestrians.
- At intersections with a high number of turning heavy vehicles.
- Where there are high numbers of disabled or older pedestrians.
- Where intersection geometry allows high speed turning movements.

Where such a treatment is to be considered, the following should be taken into account:

- Additional delays to trams where the tram tracks are shared with the right turn lane.
- Additional delays to buses – e.g. where buses are delayed by traffic turning left or the bus route requires a left turn at the intersection.
- Reduced intersection throughput due to increased waiting time - appropriate cycle lengths need to be determined.
- Where the left turn is fully controlled, the potential negative perception from drivers while waiting to turn at times when there are no pedestrians crossing.
- Implementing this treatment on a full-time or part-time basis, to reflect pedestrian volume and activity.
- Auto-introduction of the pedestrian phase at locations with a constant volume of crossing pedestrians.
- Sufficient vehicle storage capacity is required in the turn lane or bay to cater for turning vehicles.

It should be noted that the pedestrian phase does not have to begin immediately after the completion of the turn phase, but can be introduced later in the cycle, such as when a pedestrian makes a call for the pedestrian signal, provided there is enough time available for the pedestrian movement to be completed within that phase.

Design concepts

Details on providing a separate turn phase are documented in Section 7 of the Austroads Guide to Traffic Management Part 9 (2014) and Section 8 of the Austroads Guide to Traffic Management Part 10 (2016), plus in the VicRoads Supplements to those two documents.

Signal lanterns at the intersection will need arrow aspects.

From a road design perspective, provision needs to be made at the intersection for appropriate turning lanes or bays.

Figure 6 shows a typical arrangement of traffic signals for a fully controlled right turn.

Figure 6: Fully controlled right turn (Waverley Road / Huntingdale Road intersection, Mount Waverley)

Supporting treatments

Listed below are supporting treatments that can be used with this primary treatment. For full details on each supporting treatment (including appropriate locations and other considerations), refer to the main 'supporting treatments' section (Section 5).

Raised platform on approach

A raised platform on the approach to the intersection may be considered as a measure to reduce vehicle approach speeds.

Raised intersection / pedestrian crossing

Placing the intersection on a raised platform may raise the prominence of the intersection as well as the pedestrians who are crossing (especially to left turning traffic if only the right turn is fully controlled). This physical treatment may also assist in reducing the operating speed through the intersection.

Puffin crossing

A pedestrian detector may be installed to dynamically shorten or lengthen the pedestrian phase based on the presence of pedestrians on the crossings.

Summary

This particular treatment has the following pros and cons:

Pros

- Virtually eliminates the conflict between turning vehicles and pedestrians as vehicles have a separate turning phase.
- The pedestrian movement can be as long as the vehicle through movement (i.e. 'run with green') phase.

Cons

- Increased intersection cycle times, may reduce intersection throughput for other modes.
- Increased wait times for turning vehicles.
- Potential delays to public transport modes, especially if they are trapped behind vehicles waiting to turn.
- Increased queuing in the through lanes where there are short turn lanes with limited storage capacity.

Further reading

- Austroads Guide to Traffic Management Part 9 (2014) Section 7.3.3 – further guidance regarding signal design.
- Austroads Guide to Traffic Management Part 10 (2016) – further guidance regarding signal displays.

3.5 Dwell on walk (vehicle 'rest on red')

In situations where pedestrian priority is required, the traffic signal can dwell on the pedestrian walk green until a vehicle is detected. The vehicle phase is generally short and the pedestrian phase would normally be called in automatically at the end of the vehicle phase.

The pedestrian phase would usually not operate during the vehicle phase. This treatment may be used in conjunction with a scramble crossing.

Potential locations for dwell on walk operation:

- At intersections within pedestrian priority areas as defined in the VicRoads SmartRoads strategy.
- Within central activities areas (including hospital and university campuses) where pedestrian volumes are significant.
- During periods when vehicle traffic volumes are low or not a priority (e.g. at night).

Where such a treatment is to be considered, the following should be taken into account:

- Significant delays to all vehicles during the pedestrian phase as all approaching vehicles are required to stop.
- Adequate clearance times are required for the vehicle phases.
- Additional delays to public transport modes.
- When the pedestrian phase operates separately to the vehicle phase, there is a risk of pedestrians crossing against the red pedestrian signal during the vehicle phase.
- Operation times (e.g. at night only).
- Noise emitted by audio tactiles, which may become an issue for nearby residents (the length of time and/or volume of the tone may need to be adjusted if issues arise).

Dwell on walk / rest on red has been shown to be an effective way to reduce casualty rates among pedestrian/vehicle crashes when used in conjunction with other intersection supporting treatments. A study was undertaken in the United Kingdom as a part of the 'Mixed Priority Route Demonstration Project' which saw a reduction of 60% in casualty crashes. The mean and 85th percentile vehicle speeds were also observed to be significantly reduced along the route[7].

Austroads Guide to Traffic Management Part 9 (2014) recommends that this treatment may be appropriate during situations where pedestrian volumes are high and vehicle volumes are low (e.g. late at night near areas of alcohol consumption). The Austroads Guide also states a trial of this treatment was conducted and it was found that vehicle approach speeds to the intersection were reduced.

[7] Turner, B., Makwasha, T., Pratt, K., & Beecroft, A (2014). Methods for reducing speeds on urban arterial roads. Proceedings of the 2014 Australasian Road Safety Research, Policing & Education Conference.

Design concepts

Dwell on walk requires programming of the traffic signals to accommodate this phasing design. Figure 7 shows the traffic signal phasing diagram for dwell on walk.

It should be noted dwell on walk is an exclusive pedestrian phase which is the default or 'pivot' phase for an intersection.

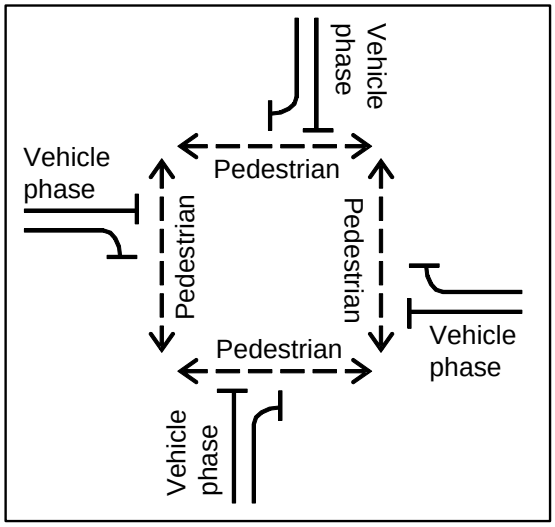

Figure 7: Phasing diagram for dwell on walk – showing when dwell on walk is active

Supporting treatments

Listed below are supporting treatments that can be used with this primary treatment. For full details on each supporting treatment (including appropriate locations and other considerations), refer to the main 'supporting treatments' section (Section 5).

Raised platform on approach

A raised platform on the approach to the intersection may be considered as a measure to reduce vehicle approach speeds.

Raised intersection / pedestrian crossing

Placing the intersection on a raised platform may raise the prominence of the intersection as well as the pedestrians who are crossing. This physical treatment may also assist in reducing the operating speed through the intersection.

Summary

This particular treatment has the following pros and cons:

Pros

- Pedestrians always have priority at a signalised intersection.
- Pedestrians are usually given an exclusive signal phase, no conflicts with turning vehicles.
- May be used in conjunction with a scramble crossing.

Cons

- Significant delays to all vehicles during the pedestrian phase as all vehicles are required to stop.
- Delays to public transport modes.

Further reading

- Austroads Guide to Traffic Management Part 9 (2014).
- VicRoads Supplement to Austroads Guide to Traffic Management Part 9 (2015).

4. Reduction treatments

4.1 Early start green for pedestrians (late start for vehicles)

This treatment involves the pedestrian phase starting prior to parallel vehicle phases (including any turn phases). This allows pedestrians to establish themselves on the crossing before turning traffic reaches the crossing (the point of conflict), thus increasing the prominence of pedestrians on the crossing and reducing the chance of a collision.

The pedestrian phase is usually activated two seconds before the vehicle phase; however this may be lengthened to suit the individual needs of the crossing.

Potential locations for pedestrian early start:

- At intersections within pedestrian priority areas as defined in the VicRoads SmartRoads strategy.
- Within central activities areas (including hospital and university campuses) where pedestrian volumes are significant.
- Where the presence of crossing pedestrians is unexpected.
- At intersections with multiple turn lanes (and partially controlled turn phases).
- At intersections with a history of crashes between turning vehicles and pedestrians.
- At intersections with a high number of turning vehicles where it is not desirable to fully control the turn (e.g. allow the left turn to occur simultaneously with the through vehicle phase).

Where such a treatment is to be considered, the following should be taken into account:

- Conflict remains between turning vehicles and pedestrians albeit delayed (more likely to occur later in the phase).
- Depending on how early the pedestrian phase starts, delays to public transport modes where these modes operate from a shared lane that allows through and turning traffic and uses the same signal displays as other vehicles.
- Whether additional lanterns are required to allow other modes to start simultaneously with the early start for pedestrians (e.g. allow an early start also for bicycles).
- Auto-introduction of the pedestrian phase at locations with a constant volume of crossing pedestrians.
- May not be appropriate at hook turn intersections where there is the potential of a collision between vehicles completing the hook turn and pedestrians on the perpendicular crossing[8].

Design concepts

For guidelines on early start for pedestrians refer to Section 7 of the Austroads Guide to Traffic Management Part 9 (2014) plus in the VicRoads Supplement to Austroads Guide to Traffic Management Part 9 (2015).

Supporting treatments

Listed below are supporting treatments that can be used with this primary treatment. For full details on each supporting treatment (including appropriate locations and other considerations), refer to the main ‘supporting treatments’ section (Section 5).

Raised platform on approach

A raised platform on the approach to the intersection may be considered as a measure to reduce vehicle approach speeds.

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[8] Nash, D (2014). Review of Signal Operations for Pedestrians in the City of Melbourne (for City of Melbourne, Transport Planning Unit)

Raised intersection / pedestrian crossing

Placing the intersection on a raised platform may raise the prominence of the intersection as well as the pedestrians who are crossing. This physical treatment may also assist in reducing the operating speed through the intersection.

Puffin crossing

Under certain conditions, a pedestrian detector may be installed to dynamically shorten or lengthen the pedestrian phase based on the presence of pedestrians on the crossings.

Give way to pedestrian sign

A give way to pedestrian sign may be installed to highlight the presence of pedestrians on the crossing.

Summary

This particular treatment has the following pros and cons:

Pros

- Allows pedestrians to establish themselves on the crossing before turning vehicles
- Reduces the incidence and severity of collisions between pedestrians and vehicles.
- Minimal delays to vehicles compared with 'elimination' treatments.

Cons

- A conflict remains between turning vehicles and pedestrians (albeit delayed).
- Additional delays to public transport modes – e.g. trams where the tram tracks are shared with the right turn lane or buses delayed by turning vehicles
- Slightly reduced intersection throughput due to increased waiting time.

Further reading

- Austroads Guide to Traffic Management Part 9 (2014) Section 7.
- VicRoads Supplement to Austroads Guide to Traffic Management Part 9 (2015).

4.2 Partially controlled right and left turns ('red arrow drop out')

Partially controlled turns, also known as 'red arrow drop out' operation, provides a red period to vehicles during which the pedestrian movement can be established before the filter right and/or left turn movement commences. The intention is that pedestrians can establish themselves on the crossing before turning vehicles reach the crossing.

This phasing design is similar to early start for pedestrians except that the green pedestrian phase occurs concurrently with the through vehicle green phase (i.e. the pedestrian phase is not started early).

Potential locations for partially controlled turns:

- At intersections within pedestrian priority areas as defined in the VicRoads SmartRoads strategy.
- Within central activities areas (including hospital and university campuses) where pedestrian volumes are significant.
- Where the presence of crossing pedestrians is unexpected.
- At intersections with a history of crashes between turning vehicles and pedestrians, where it is not desirable to introduce an early start for pedestrians.
- At intersections with a high number of turning vehicles where it is not desirable to fully control the turn (e.g. allow the left turn to occur simultaneously with the through vehicle phase).

Where such a treatment is to be considered, the following should be taken into account:

- A conflict remains between turning vehicles and pedestrians, albeit delayed (more likely to occur later in the phase).
- Additional delays to trams may occur where the tram tracks are shared with the right turn lane (usually mitigated through tram priority signalling).
- Additional delays to buses may occur – e.g. where buses are delayed by traffic turning left or the bus route requires a left turn at the intersection.
- Slightly reduced intersection vehicle throughput may occur due to increased waiting times.
- Implementing this treatment on a full-time or part-time basis, to reflect pedestrian volume and activity.
- Auto-introduction of the pedestrian phase at locations with a constant volume of crossing pedestrians.
- Late introduction of the pedestrian phase where there is sufficient remaining time for a crossing to be made.

Phasing design can be found in Section 7.3.3 of the VicRoads Supplement to Austroads Guide to Traffic Management Part 9 (2015). The red arrow is generally held for two seconds, but can be extended.

Design concepts

Details on partially controlled turn operation can be found in Section 7.3.3 of the VicRoads Supplement to AGTM Part 9 (2015). An example of 'red arrow drop out' operation is shown in Figure 8.

Figure 8: Partially controlled left turn ('red arrow drop out' operation) (Carlisle Street / Nepean Highway, St Kilda)

Supporting treatments

Listed below are supporting treatments that can be used with this primary treatment. For full details on each supporting treatment (including appropriate locations and other considerations), refer to the main 'supporting treatments' section (Section 5).

Raised platform on approach

A raised platform on the approach to the intersection may be considered as a measure to reduce vehicle approach speeds.

Raised intersection / pedestrian crossing

Placing the intersection on a raised platform may raise the prominence of the intersection as well as the pedestrians who are crossing. This physical treatment may also assist in reducing the operating speed through the intersection.

Give way to pedestrian sign

A give way to pedestrian sign may be installed to highlight the presence of pedestrians on the crossing.

Summary

This particular treatment has the following pros and cons:

Pros

- Allows pedestrians to establish themselves on the crossing before turning vehicles (at the start of the phase) making them more prominent to drivers.
- Vehicle through phase may still occur with the pedestrian phase.

Cons

- A conflict remains between turning vehicles and pedestrians (albeit delayed).
- Possible additional delays to public transport modes – e.g. trams where the tram tracks are shared with the right turn lane or buses delayed by turning vehicles
- Slightly reduced intersection throughput (predominately the turn movement) due to increased waiting times.

Further reading

- Austroads Guide to Traffic Management Part 9 (2014).
- VicRoads Supplement to Austroads Guide to Traffic Management Part 9 (2015).

4.3 Split phasing

Split phasing operation allocates separate phases to opposing approaches at the intersection. The vehicle through and turning movements from each approach operate simultaneously. Right turn movements are unopposed under this phasing.

The pedestrian phase is also split – the closest parallel crossing to the carriageway with the active green vehicle phase also receives a green pedestrian signal. As a result, the conflict between pedestrians and right turning traffic from the opposing approach is virtually eliminated. It should be noted that the general arrangement also allows the left turn to proceed, so a conflict between pedestrians on the crossing and left turning traffic is still present (unless the left turn is controlled or pedestrians are crossing at another location).

Potential locations for split phasing:

- At intersections within pedestrian priority areas as defined in the VicRoads SmartRoads strategy.
- Within central activities areas (including hospital and university campuses) where pedestrian volumes are unbalanced, i.e. one side of the intersection has a higher volume of pedestrians than the other.
- At intersections with a history of crashes between right turning vehicles and pedestrians.
- At intersections where the traffic volume on one approach leg is unbalanced (e.g. higher than on the other legs).

Where such a treatment is to be considered, the following should be taken into account:

- A conflict remains between left turning vehicles and pedestrians (unless the turn is controlled).
- Additional delays to public transport modes
    - delays to trams may occur where the tram tracks are shared with the right turn lane (usually mitigated through tram priority signalling).

- Sufficient vehicle storage capacity is required in the turn lane or bay to cater for turning vehicles.
- Intersection vehicle throughput may be reduced due to increased waiting and cycle times.
- Implementing this treatment on a full-time or part-time basis, to reflect pedestrian volume and activity.
- Auto-introduction of the pedestrian phase at locations with a constant volume of crossing pedestrians.
- Late introduction of the pedestrian phase where there is sufficient remaining time for a crossing to be made.

Design concepts

Details on split phase operation can be found in Section 7.3.3 of the VicRoads Supplement to Austroads Guide to Traffic Management Part 9 (2015).

Figure 9 below shows a traffic signal phasing diagram for split phasing.

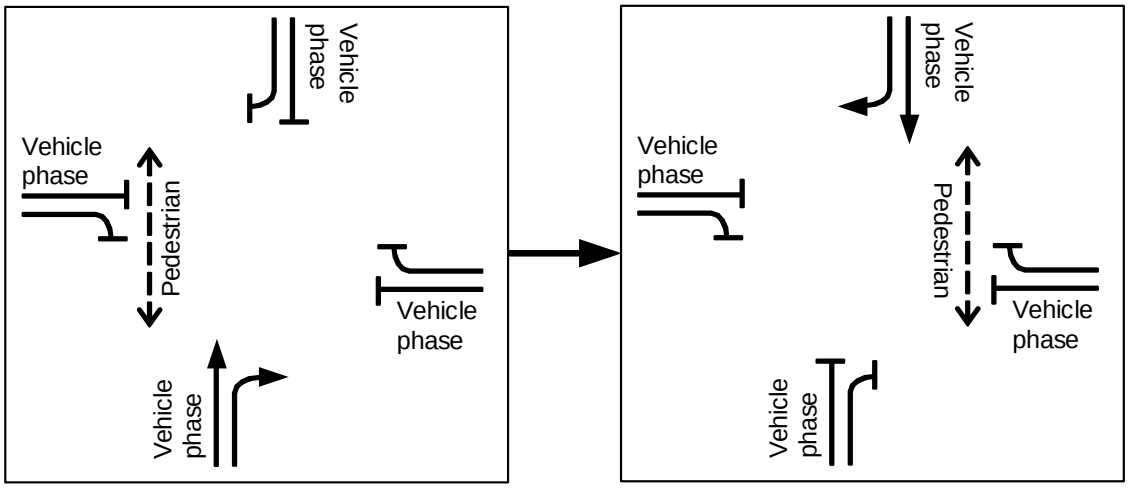

Figure 9: Split phasing operation – showing two of the phases where the right-turn does not conflict with pedestrians

As can be seen in Figure 9, the right turn movement does not conflict with crossing pedestrians.

Supporting treatments

Listed below are supporting treatments that can be used with this primary treatment. For full details on each supporting treatment (including appropriate locations and other considerations), refer to the main 'supporting treatments' section (Section 5).

Raised platform on approach

A raised platform on the approach to the intersection may be considered as a measure to reduce vehicle approach speeds.

Raised pedestrian crossing

Placing the intersection on a raised platform may raise the prominence of the intersection as well as pedestrians who are crossing (especially to left turning traffic if only the right turn is fully controlled). This physical treatment may also assist in reducing the operating speed through the intersection.

Puffin crossing

A pedestrian detector may be installed to dynamically shorten or lengthen the pedestrian phase based on the presence of pedestrians on the crossings.

Give way to pedestrian sign

A give way to pedestrian sign may be installed to highlight the presence of pedestrians on the crossing.

Summary

This particular treatment has the following pros and cons:

Pros

- Virtually eliminates the conflict between right turning vehicles and pedestrians as vehicles have a separate turning phase.
- The pedestrian movement can be as long as the vehicle through movement phase.
- Can be applied to left and right turn movements.

Cons

- Increased intersection cycle times, overall possible reduction in intersection throughput.
- Potential increase in wait time for the vehicle through movements.
- Potential increase in wait time for pedestrians in the perpendicular crossing.

Further reading

- Austroads Guide to Traffic Management Part 9 (2014) Section 7.3.3 – detail on split phasing design.
- VicRoads Supplement to Austroads Guide to Traffic Management Part 9 (2015) – additional detail on split phasing design.

4.4 Prohibiting right turns

Prohibiting rights turns at an intersection will eliminate conflicts between right turning vehicles and crossing pedestrians.

An alternative location or arrangement will be needed to cater for drivers who wish to travel in the direction of the prohibited right turn. Examples include making a series of left turns at alternative intersections that lead back to the intended road into which the right turn was prohibited.

Potential locations for prohibiting the right turn:

- At intersections with a history of crashes between right turning vehicle and pedestrians.
- At intersections where prohibiting the right turn would have operational benefits (e.g. through traffic requires the longest cycle time possible).
- Within pedestrian priority areas as defined in the VicRoads SmartRoads strategy.
- At scramble crossings.

Where such a treatment is to be considered, the following should be taken into account:

- A safe alternative route to compensate for the right turn ban – a series of roads near the intersection would be required if it is desired to allow vehicles to travel in the direction of that right turn (including connecting back to that road).
- Implementing this treatment on a full-time or part-time basis, to reflect pedestrian volume and activity.
- Whether the selected alternative route is safe and can cater for the additional and expected type of traffic.
- Moving vehicles to an alternative route may result in conflicts with pedestrians on the alternative route.
- Whether a hook turn operation would be a feasible alternative to fully banning the right turn
- Operation times for the right turn ban.
- Enforcement of the right turn ban at the intersection may be required.
- Signing of the right turn ban.
- Preventing vehicles from U-turning beyond the intersection.

Design concepts

Figure 10 below shows a number of options for alternative (detour) routes to cater for the prohibited right turn. The alternative routes are dependent on the structure of the surrounding road network.

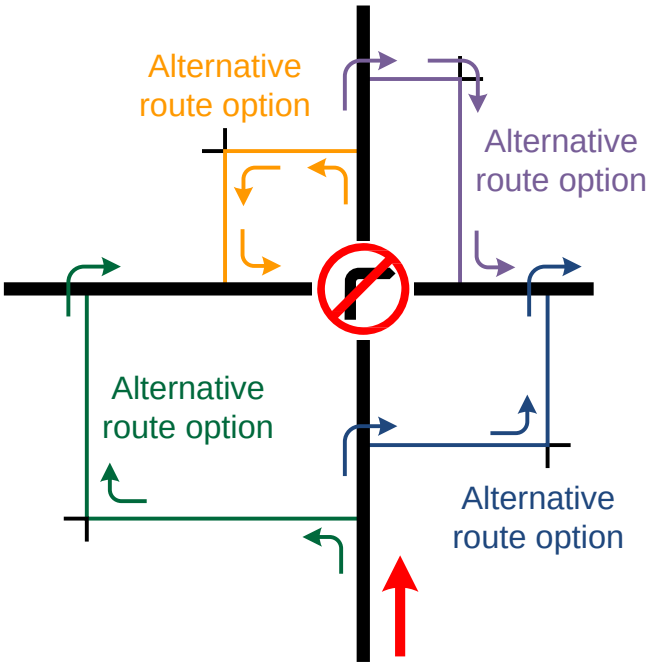

Figure 10: Options for alternative routes to cater for the prohibited right turn

To warn motorists of the right turn prohibition, advance warning signs will need to be provided before the intersection similar to that shown in Figure 11. Signs will also need to be provided before, at and along the alternative route.

Figure 11: Example of a sign advising motorists of the right turn prohibition and the alternative route

Supporting treatments

Listed below are supporting treatments that can be used with this primary treatment. For full details on each supporting treatment (including appropriate locations and other considerations), refer to the main ‘supporting treatments’ section (Section 5).

Raised platform on approach

A raised platform on the approach to the intersection may be considered as a measure to reduce vehicle approach speeds.

Puffin crossing

A pedestrian detector may be installed to dynamically shorten or lengthen the pedestrian phase based on the presence of pedestrians on the crossings.

Summary

This particular treatment has the following pros and cons:

Pros

- Virtually eliminates the conflict between right turning vehicles and pedestrians.
- Increases vehicle through movement throughput through the intersection.
- May be used in conjunction with a scramble crossing.
- Potentially shorter waiting times for pedestrians due to removal of the vehicle right turn phase.

Cons

- Requires a series of other roads to compensate for the right turn ban at the intersection (e.g. a grid road network that vehicles can use to access the intersecting road).
- Increase in travel time for ‘right turning’ traffic taking the detour.
- Right turn conflict may be transferred to another nearby intersection.
- Where a substitute route is not provided, increase in traffic on other nearby roads as drivers find an alternative way to connect to the road with the turn ban. Also, there could be an increase in U-turning traffic beyond the intersection.

5. Supporting treatments

The following treatments listed in this section are supporting treatments that may be used in conjunction with the primary treatments listed in this document.

It should be noted that some supporting treatments may be used in combination; while others may only be appropriate for some primary treatments. This information will be covered in the details for each supporting treatment.

5.1 Raised crossing treatment

There are three main types of raised treatments available to be used at intersections. These treatments can be used in conjunction with one another:

- Raised platform on approach to the intersection.
- Raised intersection.
- Raised pedestrian crossing.

Raised platform on approach to the intersection

This treatment involves placing a raised platform on the vehicle approach to the intersection. The intention is to reduce vehicle approach speeds, so that in the event of a collision between a pedestrian and a vehicle, the vehicle operating speed is low (below 40 km/h) and the likelihood of pedestrian serious injury is reduced. The design of the raised platform will need to slow vehicles to the desirable speed while also being traversable by heavy vehicles.

A Dutch study on this type of treatment found that there was a reduction of between 40-50% in all casualty crashes for all crash types[9].

This treatment has been adopted at the intersection of Surfcoast Highway (B100) and Kidman Avenue in Belmont near Geelong. The raised platform design (see Figure 12) consists of a very gradual profile of around 3%, with on and off ramp lengths of 3 and 3.5 m, and an overall length of 13.5 m[9].

Figure 12: Raised platform approach to the intersection of Surfcoast Highway and Kidman Avenue, Belmont (source: VicRoads).

[9] Effect of Safety Platforms on Speed and Driver Behaviour at a Trial Site in Belmont, Victoria, Monash University Accident Research Centre, December, 2015

Raised intersection

This treatment involves placing a raised platform at the intersection itself. The intention is to reduce vehicle approach speeds through the intersection so that the vehicle operating speed is low, thus reducing pedestrian serious injury in the event of a collision. The design also includes the pedestrian crossings being on the raised platform.

The design of the raised platform will need to slow vehicles to the desirable speed while also being traversable by heavy vehicles.

Raised pedestrian crossing

The pedestrian crossing may be placed on a raised platform of similar design to flat top road humps as a way to elevate the prominence of the crossing to vehicles. The raised platform is also intended to slow down motorists travelling across the pedestrian crossing. It should be noted that raising the entire intersection (see above) may be more practicable or preferable from a design perspective.

Examples of raised pedestrian crossings are shown in Figures 13 and 14.

Figure 13: Raised pedestrian crossing at pedestrian operated signals (Maroondah Highway, Ringwood)

Figure 14: Raised pedestrian crossing at Lennox Street / Elizabeth Street intersection, Richmond

Locations and considerations for raised platforms

Potential locations for raised platforms:

- Where it is desirable to raise the profile of crossing pedestrians.
- Where vehicle speeds before or through the intersection are unacceptably high, however careful consideration is required when using raised platforms on high speed roads.
- Where the presence of crossing pedestrians is unexpected.
- Where there are a high proportion of older pedestrians or pedestrians with mobility aids.
- At intersections with a high history of crashes between turning vehicle and pedestrians.
- Before or/at the pedestrian crossing point on left turn slip lanes.

A raised platform on the approach to an intersection may be used for other primary treatments as a way to lower vehicle approach speeds to improve overall safety for all road users.

Where such a treatment is to be considered, the following should be taken into account:

- The approach speed to the intersection – vehicles should be able to cross the raised platform safely.
- The design of the raised platform should have the ability to slow down vehicles to an appropriate operating speed (which, in many situations, is below 40 km/h).
- Where raised platforms are to be used on medium and high speed roads, there may be a need to reduce the speed limit to ensure the raised platform can be safely traversed.
- The design of the raised platform needs to accommodate heavy vehicles (e.g. buses).
- Although the raised platform has the ability to assist in slowing down vehicles, there is still the possibility of a collision at speed between a vehicle and pedestrian.
- Appropriate drainage to reduce vehicle and pedestrian slip hazard.

Where such a supporting treatment is to be considered, it may be used with the following primary treatments:

- Intersections with partially controlled turns or early start for pedestrians.
- Fully controlled left and/or right turns.

- Scramble crossing.
- Dwell on walk.
- Exclusive pedestrian phase.
- Split phasing.

Summary

This supporting treatment has the following pros and cons:

Pros

- Raises the prominence of the pedestrian crossing and/or of the intersection.
- Aids in the slowing down of vehicles before the intersection and/or through the intersection.

Cons

- Although the raised platform assists in slowing down vehicles, there is still the possibility of a collision between a vehicle and pedestrian.

5.2 Warning messages

The use of a flashing 'GIVE WAY TO PEDESTRIANS' sign (see Figure 15 below) may be considered as a supporting treatment at an intersection to warn turning motorists of pedestrians on the crossing. The sign dynamically triggers whenever the pedestrian movement is activated - the benefit being to increase motorist awareness of an active pedestrian movement.

Figure 15: 'GIVE WAY TO PEDESTRIANS' LED display

Potential locations for a 'GIVE WAY TO PEDESTRIANS' flashing sign:

- Turning traffic experiences an unexpected conflict with a signalised pedestrian movement.
- Turning vehicles are observed not giving way to pedestrians.
- At intersections with a history of crashes between turning vehicles and pedestrians.
- Where a static version of the sign (sign R2-10) does not provide sufficient conspicuity.

Where such a dynamic sign is to be considered, the following should be taken into account:

- The electronic sign only warns motorists of pedestrians – there is a possibility that the message may be missed by turning vehicles.
- For crossings that involve a bicycle lantern (e.g. if the crossing is along a shared path), consideration can be made to include 'AND CYCLISTS' in the sign.
- The cost of installation and maintenance.

Where such a supporting treatment is to be considered, it may be used with the following primary treatments:

- Intersections with partially controlled turns.
- Intersections with early start for pedestrians or late start for turning vehicles.
- Intersections with split phasing.

Summary

This supporting treatment has the following pros and cons:

Pros

- Raises prominence of the crossing through the flashing message.
- May aid in the slowing down of vehicles across the crossing.

Cons

- Although the electronic sign has the ability to raise the awareness of crossing pedestrians, there is still the possibility of a collision between a vehicle and pedestrian.

Further Reading

- Austroads Guide to Traffic Management Part 10 (2016) Section 8.8.2 – guidance on the usage of this sign.
- Australian Standards AS 1742.14 (2014) Clause 6.1.2.

5.3 Puffin crossing

The puffin crossing, where pedestrian presence on the crossing is detected and crossing timings adjust accordingly in real time, may be installed in high pedestrian areas to cater for high crossing volumes.

As a puffin crossing uses a detector to determine when pedestrians are present, this treatment is generally not appropriate for scramble crossings due to the potential size of the crossing.

Balancing the need of vehicular traffic with pedestrian traffic will need to be considered. Signal timings (including the extension of the pedestrian phase) will need to be adjusted and monitored accordingly.

Appropriate locations for a puffin operated crossing:

- At intersections where a variable crossing time is desired.
- At intersections with a high pedestrian volume, and where pedestrians are to be given priority.

The following should be considered:

- Amount of extension time available for the pedestrian phase.
- Where necessary, capping the maximum crossing time.
- Interference from other modes, whereby the detector inadvertently extends the pedestrian phase due to detecting an 'object' and considering it a pedestrian.

Where such a supporting treatment is to be considered, it may be used with the following primary treatments:

- Intersections with early start for pedestrians or late start for turning vehicles.

- Intersections with fully controlled turns.
- Intersections where turns are banned.

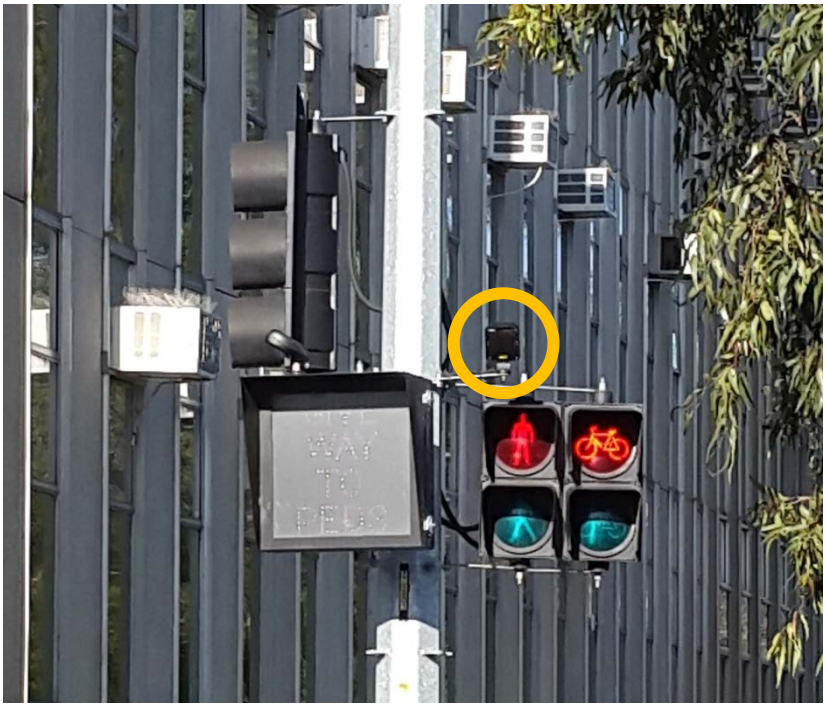

Figure 16: Puffin detector located above pedestrian signal (circled).

Summary

This supporting treatment has the following pros and cons:

Pros

- Extends the pedestrian phase to suit the current crossing volume.
- Longer crossing times, especially helpful for more vulnerable pedestrians (including those with a mobility impairment and older and child pedestrians).
- Ability for early termination of the pedestrian phase when all pedestrians have completed their crossing, thus increasing the available throughput for other modes.

Cons

- May reduce intersection throughput for other modes if the pedestrian phase is of a significant length.
- Increased wait time for vehicles and other road users through a longer pedestrian phase.

Further Reading

- Austroads Guide to Traffic Management Part 9 (2014) Section 7.9 – guidance on puffin operation.

5.4 Extension of pedestrian phase

The pedestrian phase may be extended through manual programming of the traffic signal.

Appropriate locations for extension of pedestrian phase:

- At intersections where a varied crossing time is desired.
- At intersections with a high pedestrian volume, and where pedestrians are to be given priority.

The following should be considered:

- Amount of extension time available for the pedestrian phase.
- Where necessary, capping the maximum crossing time.

Noise emitted by audio tactiles, which may become an issue for nearby residents (the length of time and/or volume of the tone may need to be adjusted if issues arise).Where such a supporting treatment is to be considered, it may be used with the following primary treatments:

- Intersections with partially controlled turns.
- Intersections with early start for pedestrians or late start for turning vehicles.

Summary

This supporting treatment has the following pros and cons:

Pros

- Extends the pedestrian phase to suit the crossing volume.
- Longer crossing times, especially helpful for more vulnerable pedestrians (including those with mobility impairment).

Cons

- The timing is usually fixed and does not change based on crossing volume.
- May reduce intersection throughput for other modes if the pedestrian phase is of a significant length.
- Increased wait time for vehicles and other road users through a longer pedestrian phase.

5.5 Left turn slip lanes

For guidance regarding the use of left turn slip lanes at signalised intersections, practitioners should refer to the guidance in the following documents:

- Austroads Guide to Traffic Management Part 6: Intersections, Interchanges and Crossings
- AS 1742.10: Pedestrian control and protection
- Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersections

Practitioners should consider the operational benefits and risks of this treatment when implementing at signalised intersections, including from a Safe System perspective.

6. Appendix A

Statistics – Pedestrian crashes

Pedestrian casualties at signalised intersections continue to be a significant road trauma issue. In the period between 2003 and 2013, there were a total of 3147 reported pedestrian crashes in Victoria, of which 66 were fatalities and 1428 were serious injuries[10].

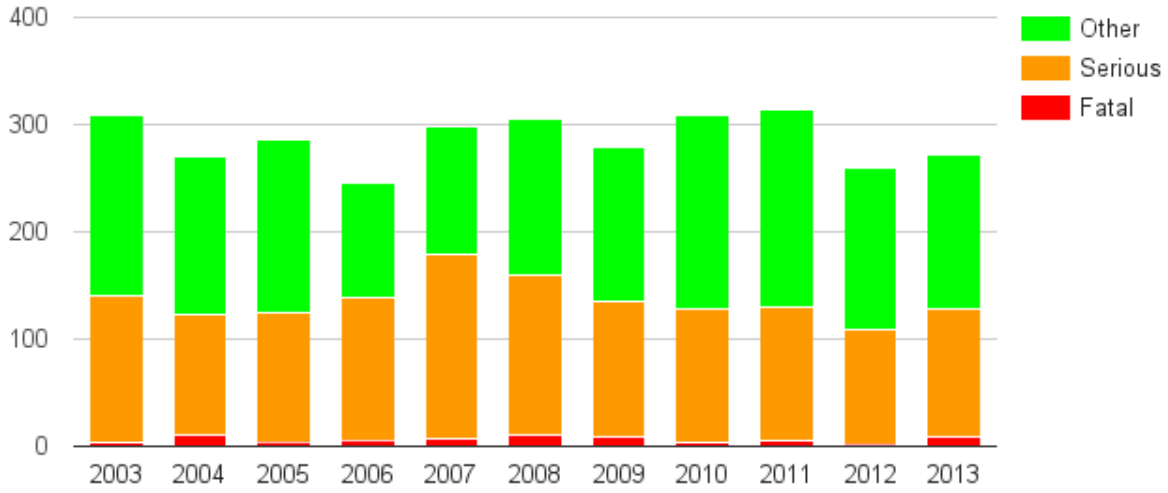

Figure 17: Pedestrian crashes at signalised intersections in Victoria: 2003 to 2013

[10] VicRoads CrashStats data – 2003 to 2013

The top Victorian locations for pedestrian crashes (2003 – 2013) are listed in Table 3.

Table 3: Top crash locations in Victoria (2003 – 2013)

Ranking	Intersection		Suburb	Total (2003-2013)	Fatal	Serious
1	Flinders Street	St Kilda Road	Melbourne CBD	21	0	13
2	Elizabeth Street	La Trobe Street	Melbourne CBD	19	1	4
3	Flemington Road	Grattan Street	Parkville	13	1	6
4	Lonsdale Street	Swanston Street	Melbourne CBD	15	0	8
5	Ascot Vale Road	Mount Alexander Road	Moonee Ponds	15	1	8
6	La Trobe Street	Swanston Street	Melbourne CBD	14	0	9
7	Princes Highway	Webb Street	Narre Warren	13	0	8
8	Warrigal Road	Batesford Road	Chadstone	13	0	5
9	Elizabeth Street	Lonsdale Street	Melbourne CBD	13	0	7
10	High Street	Chapel Street	South Yarra	12	0	6
11	Canterbury Road	Fitzroy Street	St Kilda	12	0	6
12	St Kilda Road	Linlithgow Avenue	Southbank	12	0	4
13	Spencer Street	Collins Street	Melbourne CBD	12	0	4

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