Guidelines for Pedestrian Crossing Facilities at Traffic Control Signals

Network Operations Directorate

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This document is authorised by the Executive Director Network Operations. Please submit all comments and requests to the Manager Traffic Management Services.

Authorisation

As Executive Director Network Operations, I authorise the issue and use of this document:

Guidelines for Pedestrian Crossing Facilities at Traffic Control Signals.

Mehdi Langroudi – Executive Director Network Operations

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Contents

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1. PURPOSE

The purpose of these guidelines is to provide best practice advice on the provision of pedestrian crossing facilities at traffic control signals, for safe and efficient operation benefitting all road users.

2. SCOPE

These guidelines, and criteria specified herein, apply to pedestrian crossing facilities at all permanent traffic control signals on public roads in Western Australia (WA). Other facilities such as non-signalised pedestrian crossings, traffic warden controlled children crossings, and pedestrian crossing facilities at railway crossings, are not within the scope of these guidelines.

These guidelines outline possible treatments, criteria and operational considerations that facilitate safe and efficient pedestrian movements at traffic control signals whilst balancing the needs of other road users such as buses and general traffic.

These guidelines should be read in conjunction with Main Roads Traffic Signal Approval Policy (TSAP), and with reference to all other documents listed in Section 9.

3. ROLES AND RESPONSIBILITES

Under the *Road Traffic Code 2000*, Regulation 297, the Commissioner of Main Roads, has the sole authority to erect, establish or display, and alter or remove any traffic control signal in WA. Notwithstanding the above, it should be noted that the Commissioner of Main Roads has delegated authority for approval of traffic control signals exclusively to the Executive Director of Network Operations (EDNO).

Main Roads' Network Operations Directorate (NOD) must formally approve all traffic signal installations and modifications on public roads in WA. For signalised intersections located on local roads, the Local Government Authorities (LGAs) should be consulted and involved in the decision making process.

For further clarification on roles and responsibilities related to the review and approval of Traffic Control signals in Western Australian, refer to document Traffic Signals Approval Policy (D17#582749).

4. DEFINITIONS

The following definitions apply in this document:

Term	Definition
ASD	Approach Sight Distance
AWFS	Advance Warning Flashing Signals
Pedestrian Clearance Time	The time period for pedestrians, having stepped off the kerb at the end of the Invitation-to-Cross period, to safely complete their crossing. During this time, a flashing red symbol, or countdown timer, is displayed on pedestrian lanterns (see Section 6.1.2)
CSD	Crossing Sight Distance
Critical Gap	The time in seconds below which a pedestrian will not attempt to begin crossing the road (see Section 7.5.1)
Cycle	Time required to complete the sequence of traffic signal phases
DOA	Main Roads' Delegation of Authority
DOA-NOD	Delegation of Authority - Network Operations Clarifications
Exclusive Pedestrian Phase	A phase in which only Signal Groups for pedestrians operate (see Section 7.2)
EDNO	Executive Director Network Operations
FYCL	Flashing Yellow Caution Light(s) (see Section 6.2.1)
FSI	Fatal and serious Injury
Invitation-to-Cross	The period allocated to pedestrians to begin their crossing movement whilst a green symbol is displayed on pedestrian lanterns (see Section 6.1.1)
KSILG	Local Government
LM Drawings	Lights Maintenance drawings which commonly consist of: - LMxxxx-A Phasing and Electrical Drawing (where xxx is the TCS number) - LMxxxx-B Signs and Lines Drawing (where xxx is the TCS number)
LPI	A Leading Pedestrian Interval (LPI) allows the signalised pedestrian movement to start before a green light is given to conflicting vehicular traffic (see Section 6.1.3)
Main Roads	Main Roads Western Australia
Method of Control (MoC)	Method of Control (MoC) changes at traffic signals include (but are not limited to): - Banning or allowing banned movements - Adding, removing of altering Signal Groups - Adding, removing or altering traffic signal phases - Adding, removing or altering signal displays such as AWFS, PCaTS and/or FYCL - Changing type of control for pedestrian facilities (e.g. timed control, timed red arrow control) - Changing type of control for turning movements (e.g. filter, controlled movement)
NOD	Network Operations Directorate
Pedestrian Protection	Term now known as Pedestrian Control
Phase	A phase is defined as any combination of signal groups that occur at the same time

Phasing Sequence	A phasing sequence is defined as any unique combination of phases that are run in a cycle
PCaTS	Pedestrian Countdown at Traffic Signals
Road Hump	Vertically displaced road carriageway. Also known and referred to as Raised Platform
Safe Gaps	Gaps equal or larger that the Critical Gap likely to be accepted by pedestrians for crossing traffic lanes (see Section 7.5.1)
Safe System	The Safe System approach, comprising of Safe Roads, Safe Vehicles, Safe People, Safe Speeds, and Post-crash care, is a method of road safety management based on the principle that human bodies can only withstand limited forces before injury or death occurs.
Shared Lane	A lane that shares multiple (e.g. straight-ahead and left or right-turn) movements
Short Red Arrow Protection	Term now known as Timed Red Arrow Control
Signal Group	A set of lanterns that share the same colour sequence within each phase. A Signal Group may control one movement or a number of movements
Slip Lane	As defined in the *Road Traffic Code 2000,* Regulation 3, means an area of carriageway for vehicles turning left that is separated, at some point, from other parts of the road by some form of painted or traffic island
Timed Separation	Term now known as Timed Control
Traffic Control Signal (TCS)	As defined in Regulation 3 of the *Road Traffic Code 2000* means any light or lights (coloured or otherwise), however operated, for the control or regulation of traffic, by the use of an illuminated word or words, an illuminated symbol or symbols, a coloured light or coloured lights or any combination of those things
Traffic Island	As defined by the *Road Traffic Code 2000*, this means any physical provision, other lane lines, marks, or other indications on a carriageway, made at or near an intersection, to guide vehicular traffic
TSAP	Main Roads' Traffic Signal Approval Policy
Walk-for-Green	Function to extend the Invitation-to-Cross period

5. GENERAL CONSIDERATIONS

When assessing pedestrian crossing facilities at traffic control signals, the process should focus on why it is considered desirable to provide specific assistance to pedestrians at a particular location, and the likely safety and efficiency impacts for pedestrians and other road users. In addition to assessing the need, and the impacts on pedestrian safety and delay, practitioners should consider safety and the impacts on intersection efficiency and capacity, as well as whether the facility will result in undesirable road user behaviour.

A range of factors must be considered as part of the overall process for determining the most appropriate type and operation of pedestrian crossing facilities at traffic control signals. The primary factors are discussed in this section.

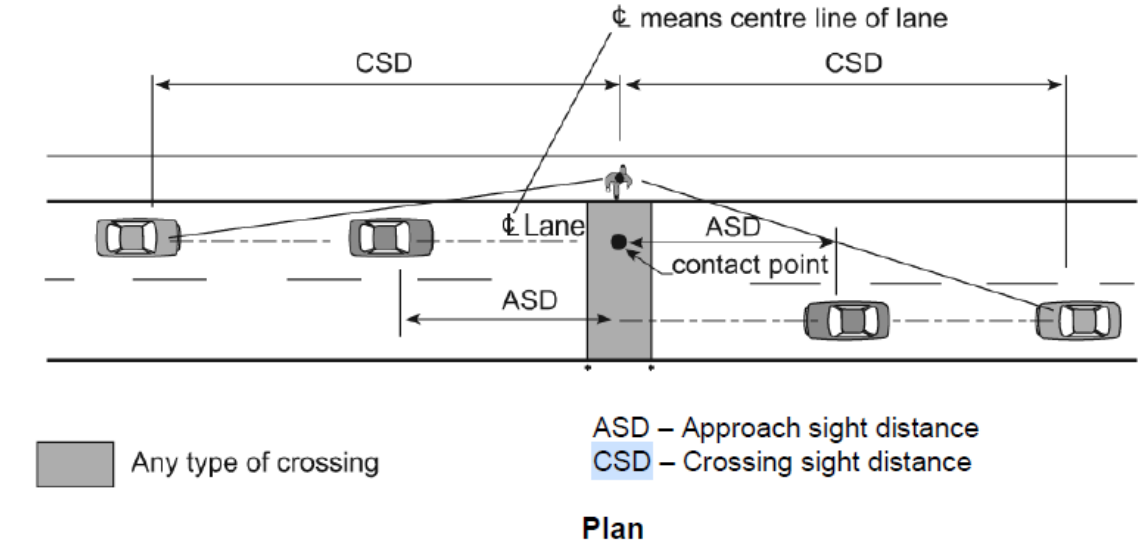
5.1 Location

The primary factors affecting selection of appropriate pedestrian crossing facilities are the environment in which the crossing facility is located, the intersection geometry and the level of safety for vulnerable road users.

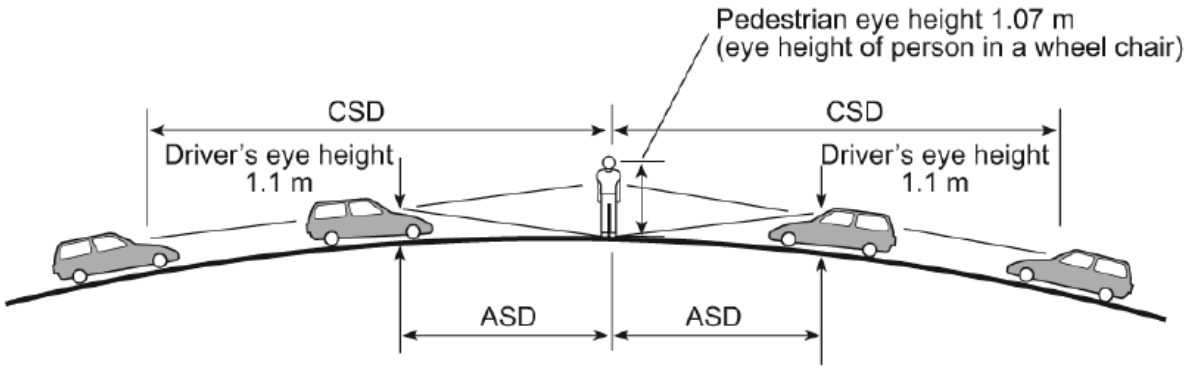
City centre environments are frequently characterised by lower speeds, higher levels of congestion, and with many pedestrians, cyclists, public transport and other road users. This often requires pedestrian priority measures to balance competing demands between different road users. In contrast, rural environments are typically characterised by higher speeds, lower levels of congestion, and fewer pedestrians and cyclists. As a result, signal operation for rural environments typically focusses on safely managing high-speed approaches, and/or providing for higher numbers of heavy vehicles. In this context, suburban environments present a challenging mix of characteristics as they are often characterised by free-flowing high speeds during the off-peak periods, whilst capacity constrained conditions may exist during the peak periods leading to lower speeds. This requires careful consideration as it is critical to ensure an appropriate balance of both safety and operational efficiency for all road users.

5.2 Visibility

Pedestrians must have visibility of, and be visible to, approaching traffic (i.e. see and be seen). Parked vehicles, vegetation or street furniture must not obscure or restrict visibility of pedestrians. Consideration of specific visibility concerns for wheelchair users, children and other vulnerable road users is required. Refer to Austroads *Guide to Road Design Part 4A: Unsignalised and Signalised Intersections* as well as Main Roads Supplement to the Austroads Guide to Road Design: Part 4A: Unsignalised and Signalised Intersections (D23#1315195 Section 3.3).



Plan



There are two key sight distance requirements at pedestrian crossing facilities:

- Approach sight distance (ASD) ensures that approaching drivers are aware of the presence of a crossing. The line of sight must not be obstructed as it ensures that the driver is aware of the crossing by seeing the pavement markings and other cues even if there is no pedestrian on the crossing, and is therefore alerted to take the appropriate action if a pedestrian steps onto the crossing. ASD should be provided at all formal, marked pedestrian crossings.
- Crossing sight distance (CSD) ensures that people about to cross can see approaching traffic in sufficient time to judge a safe gap and cross the roadway. It also ensures a clear view for approaching drivers to see people waiting to cross the road.

Both Approach Sight Distance (ASD) and Crossing Sight Distance (CSD) are to be provided at all marked (zebra/wombat) pedestrian crossings.

CSD shall be provided at all unmarked pedestrian crossings as well as:

- where the pedestrian does not have the priority, or
- where the pedestrian has the priority and must be seen by approaching drivers/riders who must give way (e.g. a zebra crossing).

CSD is desirable at crossings controlled by signals in case of signal failure.

Where the required unobstructed sight distances outlined in Austroads *Guide to Road Design Part 4A* and Main Roads Supplement to it cannot be achieved for the expected turning speeds, full control of pedestrian crossing facilities, or geometric changes to reduce turning speeds should be considered. Refer to Section 7 of this document.

5.3 Traffic Speed

One of the cornerstone components of the Safe System approach is to limit traffic speeds through intersections so that any crashes that occur do so below critical speed thresholds: 30km/h for vulnerable road users which includes vehicle-pedestrian and vehicle-bicycle collisions and vehicle-motorcycle collisions

Research clearly and consistently demonstrates that road crash frequency and severity are closely related to speed: the faster a driver travels, the more likely they are to crash and the greater the risk of serious injury or death. Vehicle speed directly affects the force of the impact and the resulting trauma outcome. The relationship between speed and crash occurrence has been modelled to show that a 1% increase in average speed can result in a 4% increase in fatal crash frequency.

Where pedestrians and cyclists are expected to cross a slip lane the crossing point should be designed to achieve low vehicle speeds; using high entry angles, raised safety platforms and other speed reduction devices, ensuring that drivers have a clear view of conflicting traffic, pedestrians and cyclists.

Similarly, where pedestrians are expected to cross in parallel with turning vehicles, lower vehicle speeds should be encouraged through appropriate design that incorporates smaller turning radii for left and right turning movements.

Guidance is provided Sections 7 and 8 for locations where turning vehicle speeds are in excess of 30 km/h and the geometry cannot be modified to reduce the speed.

5.4 Crash Record

When upgrading an existing signalised intersection, or a signalised mid-block pedestrian crossing, the relevant crash record involving pedestrians must be examined as part of the design process.

Austroads *Guide to Traffic Management Part 9: Transport Control Systems – Strategies and Operations* notes that a safety evaluation should be a key consideration in selecting an appropriate control method and phasing arrangement. Relevant factors that may contribute to significant increases in crash risk include, but are not limited to:

- turning movements that filter through opposing vehicle and pedestrian movements;
- where sight distances between vehicles and pedestrians are inadequate;
- where parallel pedestrian movements are exposed to high volumes of turning traffic; and
- where turning traffic speeds are above 30 km/h.

As part of any upgrade at a signalised intersection, or signalised mid-block pedestrian crossing, designers must consider modifications to the type of control, and the geometric design, where a FSI crash involving pedestrians has occurred over the previous five-year period (which can be linked to the design of the intersection and/or the method of control). Pedestrian related crashes within 50 m of the specified crossing site should be included in this analysis.

5.5 Pedestrian Volumes and Characteristics

The physical and cognitive characteristics of people, including movement ability, speed and decision-making capabilities, varies considerably amongst the population. As such, pedestrian crossings should be designed to be as accessible as possible for the entire community whilst maintaining a balance between the needs of all other road users.

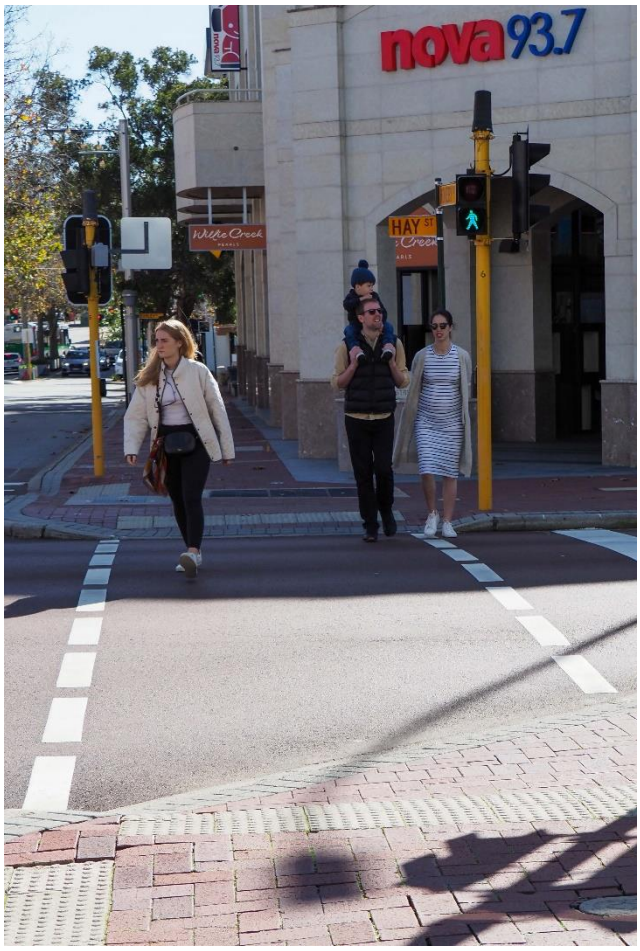
The needs of people with disability should be considered when designing the layout of crossings. The elderly and people with limited vision may have problems identifying where to cross, whilst people who use wheelchairs, and those with limited mobility, may have trouble moving on and off crossings or require special considerations related to calculation of appropriate Clearance Times (Section 6.1.2).

The safety needs of younger school children at specific crossing locations should be considered as part of a comprehensive management plan for child safety in the surrounding area. This plan should include appropriate engineering solutions to provide a safe environment at all times of the day, as a child's smaller physicality limits their ability to see and be seen. Additionally, where pedestrian crossings are predominantly used by young children, special considerations should be given to operational settings and an appropriate Control Type (Sections 6 and 7).

The Invitation-to-Cross period is the time allocated to pedestrians to begin their crossing movement and is indicated by the green symbol for pedestrians waiting at the kerbside. Following the Invitation-to-Cross period, a pedestrian Clearance Time ensues.

The pedestrian Clearance Time is the time period for pedestrians, having stepped off the kerb at the end of the Invitation-to-Cross period (green walking pedestrian symbol), to safely complete their crossing. During this time, a flashing red standing pedestrian symbol, or countdown timer (at PCaTS), is displayed on the relevant pedestrian lanterns. The Clearance Time is determined based on the width of the road to be crossed (also referred to as Crossing Length) and the pedestrian walking speed. Sections 6.1.1 and 6.1.2 of these guidelines provide further information and guidance on appropriate calculation of Invitation-to-Cross and Clearance Times.

When assessing different pedestrian crossing facilities, it is also important to consider the crossing distance and the number of traffic lanes pedestrians need to cross, storage space requirements at each end of the crossing, or on a central median for staged crossings. Locations that experience periods of high demand or overcrowding may not be suitable for staged crossing facilities, or left-turn slip lane crossings, as pedestrians may not have space to safely store within the median or the traffic island refuge provided. Conversely, staged crossing facilities might be recommended over standard crossings where overcrowding is not expected, but crossing distances are excessive. Section 6.3 provides more information and guidance on these scenarios.

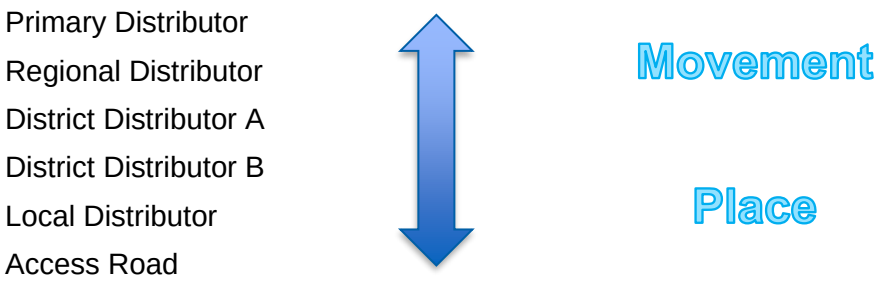


Where high pedestrian volumes are expected during normal day-to-day operation, or frequent large-scale events are expected, wider pedestrian crossings may need to be considered. Under these circumstances, cycle times play an important role as the lower the cycle time, the more frequent the pedestrian demand can be serviced which subsequently reduces the risk of pedestrian overcrowding as a result of less frequent activation of the pedestrian crossing.

Pedestrian volumes for sites without existing pedestrian crossing facilities, or with inadequate pedestrian crossing facilities, may be subject to suppressed pedestrian demand. The level of suppressed demand is highly site-specific. Where no current, or inadequate crossing facility exists, pedestrians crossing within 50 m of the proposed location should be included in the assessment of pedestrian demand for crossing.

5.6 Movement and Place

Roads serve two main purposes; as a conduit facilitating the movement of people, goods and services, as places for people, or often as a mix of these two. For decades, the primary concern on urban streets was to design for traffic movement, often resulting in poor road environments for pedestrians. Understanding the characteristics of the location, the intersection's strategic significance within the road network and the community value of a place, will allow designers to choose the appropriate type of pedestrian crossing facility that meets the balanced needs of all users. In this respect, 24/7 operation needs to be factored catering to different times of day.



In WA, Metropolitan roads are categorised according to a functional hierarchy. In terms of the concept of movement and place, generally, the higher the road hierarchy classification, the greater the movement value of the roadway.

The Movement and Place Framework (*Figure 1*) provides a basis for considering a road against key characteristics associated with movement (also known as transport, link or similar) and place (also known as location, land use, access, or similar) and promotes a strategic, integrated approach to guide corridor planning across the Planning and Transport portfolios.

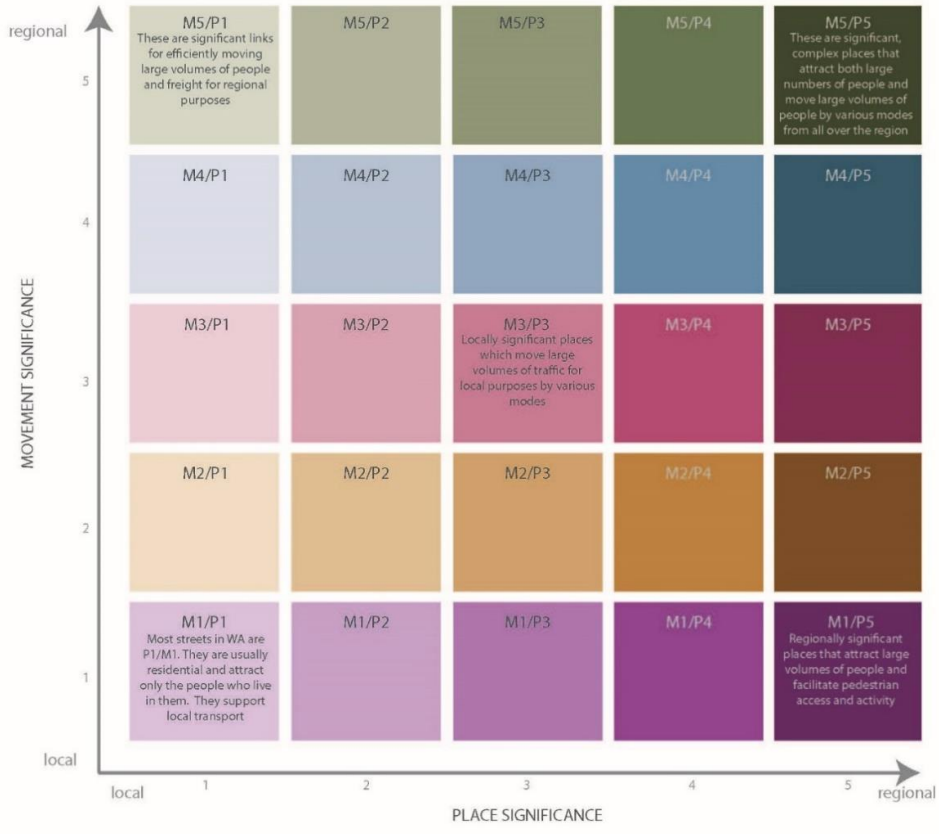


Figure 1: Movement and Place Framework

Locations with a high place value and low movement value, such as café strips or Central Business District environments, generally have a high number of pedestrians. At these

locations, drivers are more aware of pedestrians and are generally more cautious. Therefore, a lower level of vehicular control for pedestrian crossings may be appropriate at these locations.

Conversely, locations with a low place value and high movement value, such as at intersections along primary distributor roads, generally have a low number of pedestrians. At these locations drivers may rarely encounter pedestrians crossing the road. Therefore, a higher level of vehicular control for pedestrian crossings may be appropriate at these locations.

There are also locations with a high place value and high movement value, such as town centres on primary distributor roads. At these locations, the safety of the pedestrians must be the most important consideration whilst every effort should be made to minimise the impact of the pedestrian crossings on operational efficiency of the intersection in order to provide the right balance between safety and operational efficiency.

The practicality of providing a balanced solution for suitable pedestrian crossing facilities at traffic control signals diminishes as the ‘movement’ value increases, and other options such as grade separation and/or dedicated staged signalised mid-block pedestrian crossings may need to be considered where this occurs.

Currently, a whole of WA Government approach to a ‘Movement and Place Framework’ is being developed in consultation with a number of key stakeholders. Once developed, this framework shall be incorporated within this guideline. Until such time, it is important to acknowledge the basis of movement and place characteristics.

For further explanatory information about the Movement and Place Framework, refer to Austroads *Guide to Traffic Management Part 4: Network Management Strategies*.

5.7 Heavy Vehicles

Heavy vehicles typically account for only a small percentage of traffic composition; however, they can have a significant impact on pedestrian safety, and this must be considered when assessing a pedestrian crossing facility at traffic control signals. Heavy vehicles often have 'blind spots' to the front and sides due to their size, resulting in drivers potentially not being able to observe a recently arrived pedestrian at a crossing point. As such, the intersection geometry should be assessed with respect to the likelihood of conflicts between pedestrians and turning heavy vehicles, with the design and phasing options ensuring such risks are minimised.

Where there is a high likelihood of conflict between turning heavy vehicles and pedestrians, fully controlled pedestrian crossing facilities (Section 7.4) should be considered to address known visibility constraints from a heavy vehicle driver's position when turning.

In addition, as part of the overall design process, where heavy vehicle aprons are installed at slip lanes to cater for the wider swept path of large turning vehicles, there may be a need to discourage pedestrians from standing in the area of the apron due to the possibility of conflicts with turning vehicles. Refer to Main Roads Guidelines Drawing No. *200331-0015 - Typical Corner Treatments On Heavy Combination Vehicle Routes*.

Figure 2: Balancing the needs of pedestrians at intersections with a large proportion of heavy vehicles

5.8 Site Context

The installation, modification, or removal of traffic control signals is primarily driven by the guidelines and requirements set out in Main Roads Network Operations *Traffic Signals Approval Policy (TSAP)*. The TSAP provides guidance on the approval process for traffic control signals in relation to the need, functional classification of roads, as well as alternative types of control.

At signalised facilities, pedestrian routes must be direct and match pedestrian desire lines as closely as possible, and the pedestrian networks need to connect with one another. When installing signalised mid-block pedestrian crossing facilities, it is important to consider the proximity of adjacent at-grade or grade separated crossing facilities, as well as the form of control at neighbouring intersections. Where a signalised mid-block pedestrian crossing is proposed at a location close to a signalised intersection, consideration should be given to coordinating traffic movement platoons between the two traffic control signals in order to balance efficiency and safety.

The minimum distance between traffic control signals is based on guidance shown in *Table 1*. Where operating speeds are in between those values shown in the table, the upper speed value should be used unless justification can be provided otherwise.

85th percentile operating speed (km/h)	Minimum Spacing between Traffic Control Signals (metres)
40	100
50	125
60	150
70	175

Table 1: Minimum spacing between traffic control signals

Table 1 is based on the current operating conditions in Perth Central Business District with regards to intersection spacing and should only be considered as a guide related to the close proximity of traffic signals. More critically, sufficient spacing must be provided between signalised intersections in order to prevent queues at one intersection extending back and adversely affecting an upstream intersection for safety and efficiency. It is also very important to avoid safety issues arising due to factors such as the ‘see through effect’; whereby a driver mistakenly focuses on the green signal display at the furthest intersection and drives through the closer intersection when it is not safe to do so.

The only exception to the minimum spacing distances shown in *Table 1* is where signal controlled intersections are located adjacent to each other at a grade separated interchange, or a staged T-intersection. Departures from the provided guidance will be at Main Roads’ discretion, subject to careful consideration of safety and efficiency impacts on all road users.

5.9 Safe System Approach

Main Roads has a commitment to contribute to road safety targets to reduce fatal and serious injuries by 50 to 70 % by 2030 on roads in Western Australia in alignment with National and State Road Safety Strategies.

The Safe System approach, comprised of Safe Roads, Safe Vehicles, Safe People, Safe Speeds, and Post-crash care, is a method of road safety management based on the principle that human bodies can only withstand limited forces before injury or death occurs. The Safe System approach has been adopted by all Australian jurisdictions to support road safety outcomes in jurisdictional and national road safety action plans. It underpins the 2020-2030 Road Safety Strategy – Driving Change.

Road safety is a shared responsibility. Decisions should be made with safety in mind, from the design of roads and vehicles, investments, legislation and education, to each road user acting safely every day.

While the Safe System approach to road safety recognises the need for responsible road user behaviour, it accepts that human error is inevitable. It aims to create a road transport system that makes allowances for errors and minimises the consequences, in particular the risk of death or serious injury. By taking a total view of the combined factors involved in road safety, the Safe System encourages a better understanding of the interaction between the key elements of the road systems: road users, roads and roadsides, vehicles, and travel speeds.

The main objective of the Safe System is to ensure that in the event of a crash the impact forces released are within the bounds of human tolerance, no fatalities occur, and serious injuries are reduced. The chances of surviving a crash decrease rapidly above certain impact speeds, depending on the nature of the collision.

Main Roads has a Road Safety Policy, and has set a new Commitment as a call to action for the organisation to foster cultural change around valuing road safety, and reduce deaths and serious injuries by 50% by 2030.

5.10 Lighting Requirements

All signalised and unsignalised pedestrian crossings will require compliant lighting in accordance with AS/NZS1158.1.1 and AS/NZS1158.4 standards and Main Roads Lighting Design Guidelines for Roadway and Public Spaces.

5.11 Other Considerations

Other design considerations include street furniture, bus stop locations, pavement marking and signage as well as facilities for mobility-impaired pedestrians.

6. OPERATIONAL CONSIDERATIONS

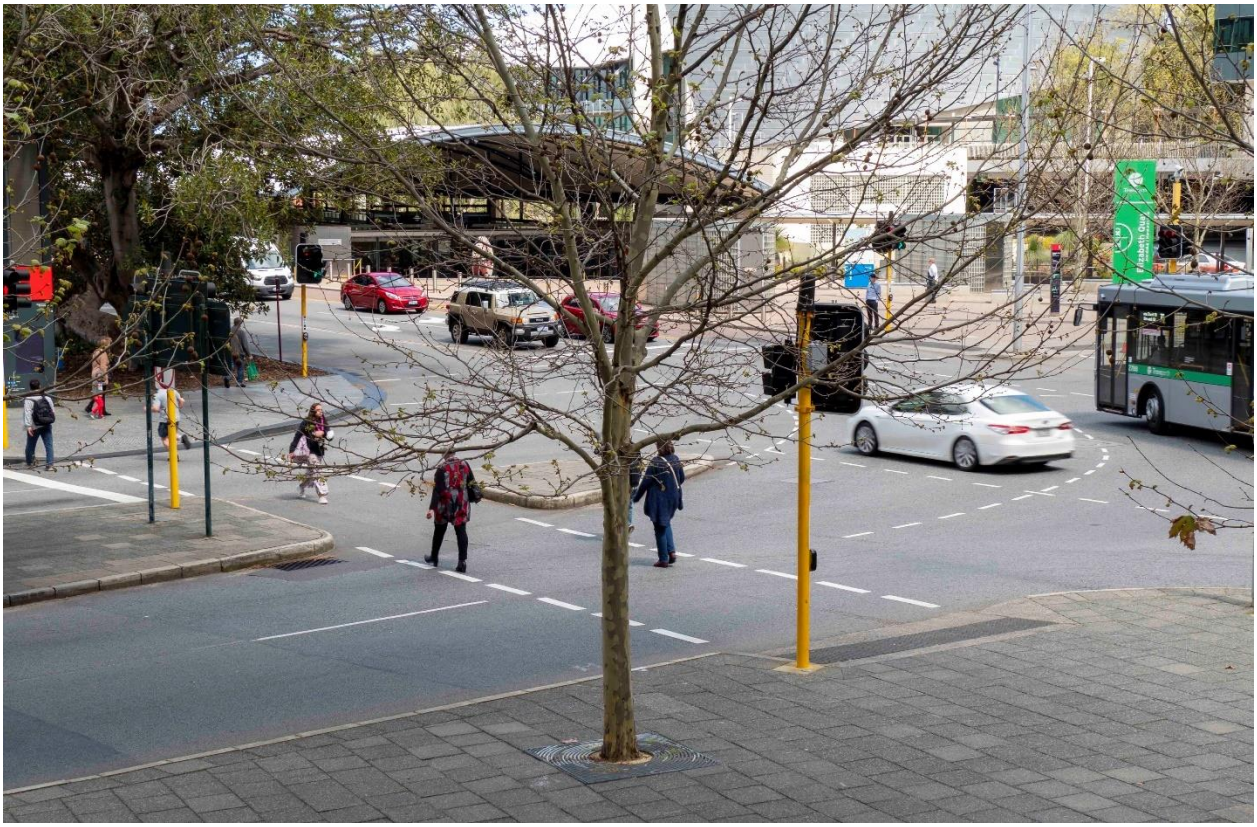
For the purpose of these guidelines, operational considerations for pedestrian crossing facilities at traffic control signals are grouped into three general categories:

- Traffic Control Signal Timings (Section 6.1)
- Pedestrian Display Features (Section 6.2)
- Standard / Staged Crossings (Section 6.3)

Along with General Considerations (Section 5), the Operational Considerations are important in ensuring safe and efficient operation of traffic control signals for all road users.

6.1 Traffic Control Signal Timings

Determining appropriate types of pedestrian crossing facilities at traffic signals, and selecting the appropriate method of control, requires an in-depth understanding of a number of fundamental concepts related to traffic control signal timing periods for pedestrians and traffic. Austroads *Guide to Traffic Management Part 9: Transport Control Systems – Strategies and Operations* provides detailed information on pedestrian timings whilst the following sections provide an overview of important time periods related to pedestrian crossings which need careful consideration.



6.1.1 Invitation-to-Cross Period

The Invitation-to-Cross period is the time allocated to pedestrians to begin their crossing movement, and is indicated by the green symbol for pedestrians waiting at the kerbside. The purpose of the Invitation-to-Cross period is to establish the pedestrian movement, and clear the waiting pedestrian queue if any. This Invitation-to-Cross period is not to be confused with the period needed for completion of the crossing, which is the pedestrian "Clearance Time", as outlined in Section 6.1.2.

The duration of the Invitation-to-Cross period is set at a standard of six (6) seconds in WA.

At locations where pedestrian overcrowding creates safety concerns, design solutions such as increased safe storage space, wider crossings, and/or operational solutions such as more frequent activation of the pedestrian Invitation-to-Cross should be considered to resolve overcrowding issues. Where overcrowding issues cannot be overcome through design or operational solutions, the Invitation-to-Cross period may be extended to address safety concerns in line with Austroads Guidelines. In these rare instances, it is recommended that the Invitation-to-Cross period be fully controllable, and to revert to the standard six seconds outside of the high pedestrian density period(s).

The standard length of Invitation-to-Cross period can be extended when Walk-for-Green (also known as rest in walk/extended walk/stretch walk) is in operation. In these instances, the Invitation-to-Cross period for a pedestrian movement with no conflicting traffic movement is variably extended as driven by the length of the traffic movement phase.

6.1.2 Pedestrian Clearance Time

The pedestrian Clearance Time is the time period for pedestrians, having stepped off the kerb at the end of the Invitation-to-Cross period, to safely complete their crossing. During this time a flashing red symbol, or countdown timer (at PCaTS), is displayed for pedestrians. The Clearance Time is determined based on the width of the road to be crossed (also referred to as Crossing Length), measured from the push button pole to the kerb ramp at the opposite side of the road (as shown in *Figure 3*), and the pedestrian walking speed.

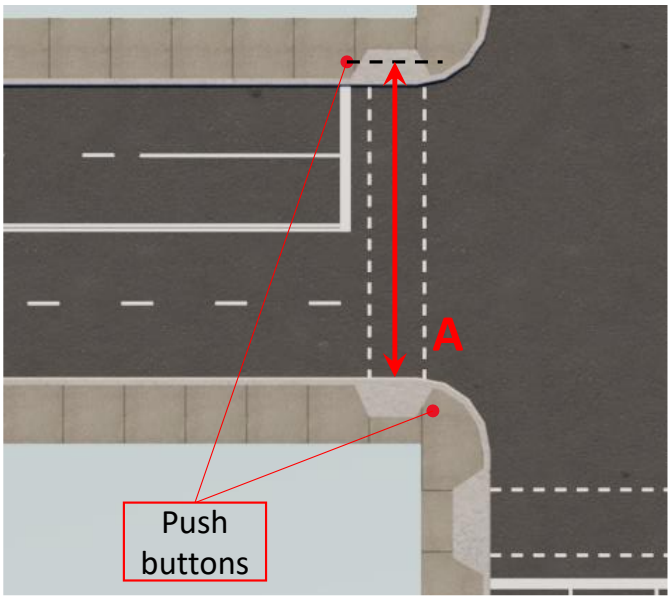


Figure 3: Measurement of standard total Clearance Time.

A: Crossing Length, from the near-side push button to the far-side kerb is generally used to calculate the standard total Clearance Time.

A walking speed of 1.2 m/s is used as a standard value in WA, as it represents the 15th percentile walking speed of pedestrians, meaning 85 per cent of pedestrians walk at a higher speed.

At locations where more than 15 percent of pedestrians are children, elderly or mobility impaired, the Clearance Time may be calculated using a lower walking speed of 1.0 m/s rather than the standard 1.2 m/s. Pedestrian surveys are required at these locations to demonstrate that either:

a) A minimum pedestrian demand of 20 pedestrians over any full hour of the day is present, out of which more than 15 per cent are children, elderly or mobility impaired; or,
b) More than 15 per cent of all-day demand consists of children, elderly or mobility impaired pedestrians.

At all existing sites being upgraded, or new sites, if the proposed pedestrian crossing facility is within 250 m walking distance of the primary access point of a school, aged care facility or hospital, Main Roads may consider a lower walking speed of 1.0 m/s.

A walking speed of 1.0 m/s represents the 5th percentile walking speed, meaning 95 per cent of pedestrians walk at a higher speed.

For ease of reference, *Table 2* provides Clearance Times for a range of different Crossing Lengths.

DISTANCE (Metres)	CLEARANCE TIME (Seconds)		DISTANCE (Metres)	CLEARANCE TIME (Seconds)
4.00	4		25.00	21
5.00	5		26.00	22
6.00	5		27.00	23
7.00	6		28.00	24
8.00	7		29.00	25
9.00	8		30.00	25
10.00	9		31.00	26
11.00	10		32.00	27
12.00	10		33.00	28
13.00	11		34.00	29
14.00	12		35.00	30
15.00	13		36.00	30
16.00	14		37.00	31
17.00	15		38.00	32
18.00	15		39.00	33
19.00	16		40.00	34
20.00	17		41.00	35
21.00	18		42.00	35
22.00	19		43.00	36
23.00	20		44.00	37
24.00	20		45.00	38

Table 2: Clearance Time settings

6.1.3 Leading Pedestrian Interval

A Leading Pedestrian Interval (LPI) allows the signalised pedestrian movement to start before a green signal is given to conflicting vehicular traffic. Fundamentally, LPI is not a pedestrian timing period but describes the method of phase operation, where general traffic is effectively delayed to give pedestrians a "head start" to establish themselves on the crossing, making it more likely that drivers will see them whilst turning. The duration of the LPI is dependent on the type of control at a parallel walk signalised pedestrian crossing (Section 7) shown in *Table 3*.

Type of Parallel Walk Pedestrian Control	Leading Pedestrian Interval (LPI) duration (s)
Time Control	5s *(Section 6.1.3.1)*
Timed Control with FYCLs	3s *(Section 6.1.3.1)*
Timed Red Arrow Control	*As per Section 6.1.3.2*
Timed Red Arrow Control with FYCLs	*As per Section 6.1.3.2*

Table 3 – LPI duration based on Parallel Walk Type

6.1.3.1 Parallel Walks with Timed Control

Where turning traffic shares a lane with through traffic and no arrow control is used for traffic, the LPI must be either 5 or 3 seconds depending on the use of Flashing Yellow Caution Lights (FYCLs), as discussed in Section 6.2.1. Without FYCL, LPI is set at a standard 5 seconds in WA whilst the LPI is reduced to 3 seconds where FYCLs are used to improve conspicuity.

Where FYCLs are used, the flashing yellow for conflicting traffic commences at the same time as the green for the that traffic movement and continues until the end of the pedestrian Clearance Time.

6.1.3.2 Parallel Walks with Timed Red Arrow Control

The duration of LPI at intersections with timed red arrow control, with or without FYCL, is determined by the distance of the pedestrian crossing and the appropriate walking speed (Section 6.1.2). During this LPI period, vehicles are held by a red arrow display preventing them from making any turning movements. After the arrow control is extinguished, vehicles are permitted to proceed, but must give way to any pedestrians that are crossing.

Two types of measurements need to be considered as shown in *Figure 4:*

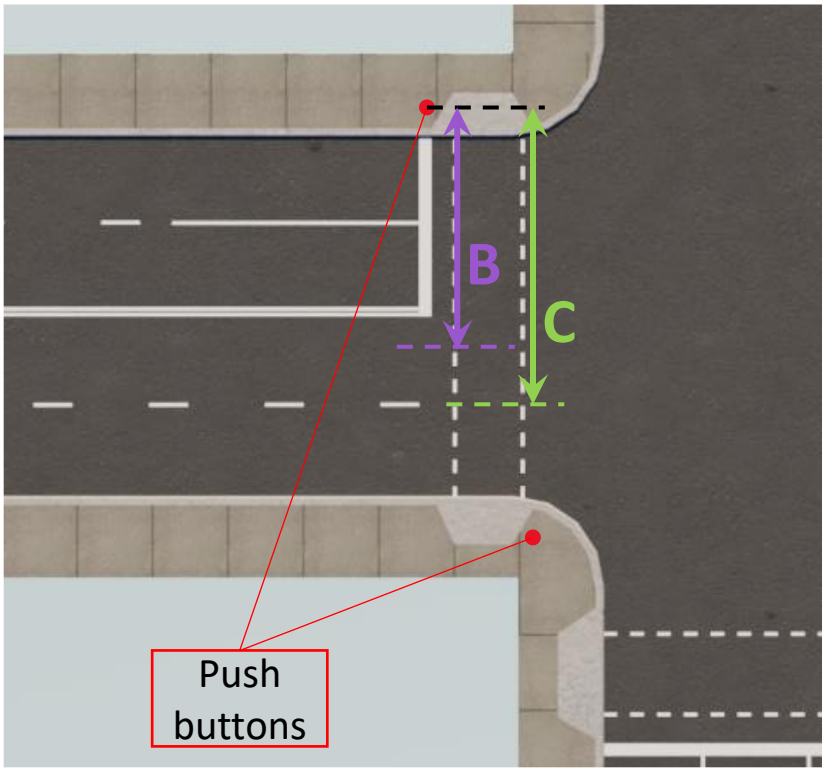


Figure 4: Measurement types for pedestrian establishment time

B: Distance from the near-side push button to 1.0 m past the median, or 55 per cent of the full Crossing Length **A** (See Section 6.1.2), (whichever is greater), is used to calculate LPI for timed red arrow control **with FYCL**.

C: Distance from the near-side push button to the middle of the road on the exit lane(s) is used to calculate LPI for timed red arrow control **without FYCL**.

Distances **A**, **B** and **C** must be measured parallel to the pedestrian guidelines.

Based on the existence of FYCLs, LPI at parallel walks with timed red arrow control is calculated by dividing the relevant distance (B or C) by the appropriate walking speed (Section 6.1.2). During the LPI period, turning traffic is held using a red arrow display.

6.2 Pedestrian Display Features

Pedestrian display features are used at traffic control signals with signalised pedestrian crossing facilities to improve safety, efficiency and amenity of traffic control signals for all road users.

6.2.1 Flashing Yellow Caution Lights

Flashing Yellow Caution Lights (FYCLs) are displayed facing in the direction of drivers of conflicting, turning vehicles at parallel walks. The flashing yellow display reinforces road traffic rules to turning drivers that pedestrians have right of way. Even if a green circular aspect is displayed (but not a green turning arrow), FYCLs reinforce that the driver must allow pedestrians to cross before completing their conflicting, turning movement.

FYCLs may only be installed where parallel walks are in operation, and should not be used in lieu of exclusive pedestrian phases or full control, where such crossings are deemed warranted and justified based on the information contained in these guidelines.

FYCLs are warranted for use at locations where the typical pedestrian demands during peak times is more than 20 pedestrians per hour, for any one crossing. This is to minimise the risk of FYCLs being ignored by drivers due to infrequent demand of pedestrian crossings outside of city centres or urban areas with low pedestrian demands, noting that whilst FYCLs increase the conspicuity of the pedestrian crossing, LPI (See 6.1.3) is reduced for pedestrians.

6.2.2 Pedestrian Countdown at Traffic Signals

Pedestrian Countdown at Traffic Signals (PCaTS) are used to help improve pedestrian amenity by giving pedestrians more information and greater awareness to assess their ability to cross the road. Where installed, the yellow countdown timer replaces the flashing red pedestrian symbol and displays to pedestrians how many seconds they have left to cross the road (otherwise known as pedestrian Clearance Time) following the green symbolic figure for the Invitation-to-Cross period. On the basis that pedestrians are less likely to cross when there is not enough time to finish the crossing movement safely, PCaTS aim to enhance pedestrian amenity and improve intersection efficiency for both pedestrians and motorists.

PCaTS are required at all intersections with exclusive pedestrian phases, at intersections where all signalised pedestrian crossings are fully controlled (with no conflict between pedestrians and vehicle movements), and all signalised mid-block pedestrian crossing with consideration for presence of school children.

Where school children are the predominant users of a pedestrian crossing, PCaTS may not suitable. This is because the cognitive skills of some school children may not be developed enough to estimate the time they require to safely complete their crossing. This will be assessed on a case-by-case basis depending on the total pedestrian demand at the intersection, and the percentage, age and composition of children using the pedestrian crossing facilities.

PCaTS should not be installed at intersections with parallel walks, where conflicts between pedestrian and traffic movements exist. Similarly, where different types of signalised pedestrian crossing facilities exist at an intersection (i.e. a mix of parallel and full control), PCaTS should not be used to avoid confusion for pedestrians.

6.3 Standard and Staged Crossings

Where pedestrians are required to cross a multi-lane road at a signalised pedestrian crossing facility, the amenity and safety of the crossing is often impacted by the conflicting turning movements. Additionally, wide multi-lane signalised pedestrian crossings are often deemed to be daunting for vulnerable road users, due the perception of safety and the cognitive load involved in the crossing movement. At these crossings, pedestrian Clearance Times are often long, leading to inefficiencies for both pedestrians and general road traffic.

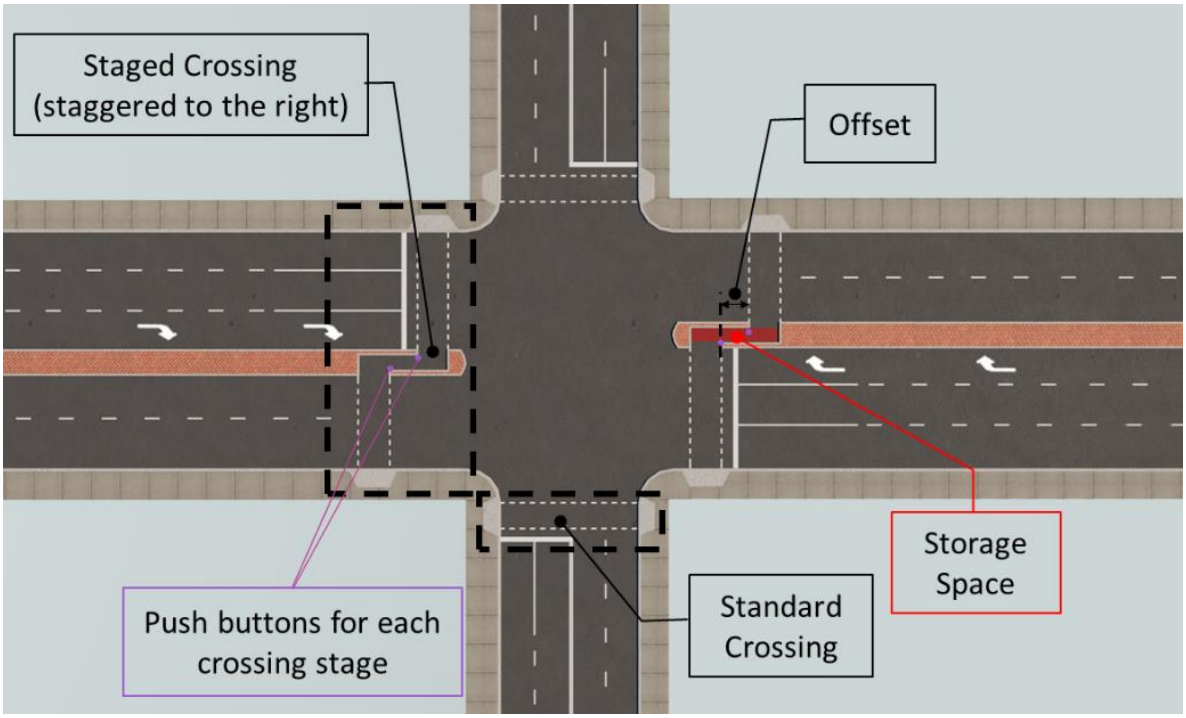


Figure 5: Staged crossings vs standard crossings at traffic control signals

6.3.1 Standard Crossings

Standard crossings are where the signalised pedestrian crossing facility allows pedestrians to cross the entire length of the signalised crossing (excluding slip lanes) as a single continuous movement, using pedestrian displays at either end of the crossing facility. At small to medium-sized intersections with lower cycle times and little congestion, standard crossings are the default design unless clear benefits can be identified for more efficient operation of the traffic control signals for pedestrians and general traffic, balanced against safety and amenity. When crossing lengths get longer across multiple lanes in two directions, standard crossings become less desirable and inviting for pedestrians to use, whilst also contributing to increased delays to both pedestrians and traffic.

6.3.2 Staged Crossings

Staged crossings divide the pedestrian crossing movement into smaller, more manageable movements across different traffic movements. Staged crossings may be installed at mid-block, or intersection locations, with a common element being a refuge (or median) between different signalised crossing movements to allow safe pedestrian storage. Staged crossings have two or more crossing stages for pedestrians with separate push button(s) and lanterns for each stage of the crossing.

Where appropriate, staged crossing provide safety, amenity and reduced delay benefits to pedestrians whilst also improving the efficiency of the operation for other modes of transport using the traffic control signals. Key features and benefits include:

- Simplifying the crossing task in complex road environments by breaking it down to shorter crossing distances for pedestrians where traffic approaches from a single direction
- Providing opportunities for elderly and mobility impaired pedestrians to rest in the median
- Providing more opportunities for pedestrians to cross with flexible phasing arrangements
- Allowing lower cycle times which will improve the overall intersection efficiency for all users.

Where staged crossings are appropriate, traffic signal design and operations should consider call-ahead demands for pedestrians, to minimise the delay and time spent within the median.

6.3.3 Considerations

Staged crossings are often required where there is a need to balance pedestrian safety and general intersection efficiency, usually on wide multi-lane roads, which would require long pedestrian Clearance Times otherwise. Considerations for the installation of staged crossings is shown in *Table 4*.

Considerations	Standard Crossing	Staged Crossing
Crossing Length	Full crossing distance from the near-side push button to the far-side kerb is less than 14 m.	Full crossing distance from the near-side push button to the far-side kerb is greater than 24 m.
Phase length		Where pedestrian crossing time would govern the phase time and dominate the cycle time requirements.
Special condition at the signalised intersection		Where early termination of a phase is expected such as a signalised intersection at a railway level crossing (to dissipate the risk posed by early phase termination during pedestrian Clearance Times when an approaching train is detected).
Left-turn splitter islands	Where left turn islands are present on both sides of the crossing and neither island could be removed.	

Table 4: Considerations for the installation for standard and staged crossings

Where the Crossing Length from the near-side push button to the far-side kerb is between 14m and 24m, consideration should be given to both standard and staged crossings. Design options should be evaluated with traffic modelling to make well informed and balanced decisions with respect to intersection safety, pedestrian amenity and efficiency for all road users.

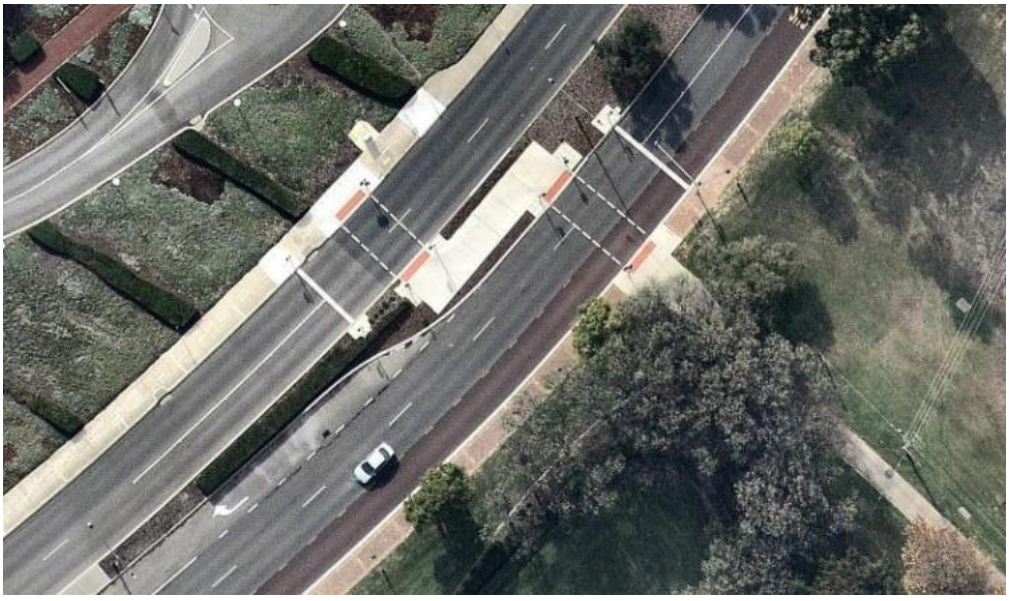


Figure 6: Staged Crossing (Aerial Image from Stirling, WA)

6.3.4 Design Elements

In addition to the design standard for pedestrian crossings in Austroads *Guide to Road Design Part 4A: Unsignalised and Signalised Intersections*, considerations shown in *Table 5* should be noted in the design process for staged crossings.

Design component	Requirement
Pedestrian crossing alignment	Pedestrian crossing guidelines for each stage must be provided parallel to the stop line, and where possible, at or close to right angle to the carriageway.
Push button facilities	Push buttons for both stages of the crossing must be installed in the median.
Median Width	A minimum median width of 2.7 m should be provided to cater for a staged crossing (1.5 cut-through and 0.6 m clearance on each side) noting the requirement for appropriate pedestrian Storage space.
Stagger type	At signalised intersections, where possible, staged crossings should be staggered to the right, away from the intersection. *(Figure 5).* At mid-block locations, staged crossings should be staggered to the left so that pedestrians turn to face oncoming traffic. *(Figures 6 and 7).*
Stagger distance	If the median is less than 6 m wide, a minimum offset of 3 m must be provided. If the median is more than 6 m wide, a straight walkway with no offset may be considered on a case-by-case basis if design constraints exist. In such cases, mitigation measures may need to be considered to compensate for the lack of offset.
Storage space	At heavily used pedestrian crossings, careful consideration needs to be given to the requirement for pedestrian storage space if a staged crossing is being considered. A minimum of 1 m^2 storage space should be provided for each person expected to queue within the median in each cycle. *(Figure 7)*.

Table 5: Staged crossing design requirements

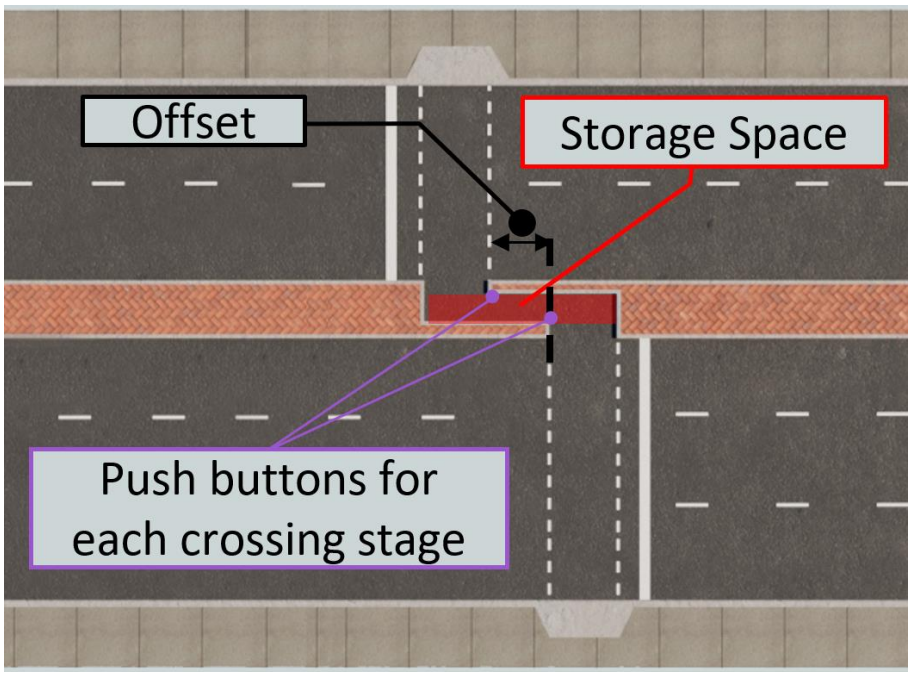


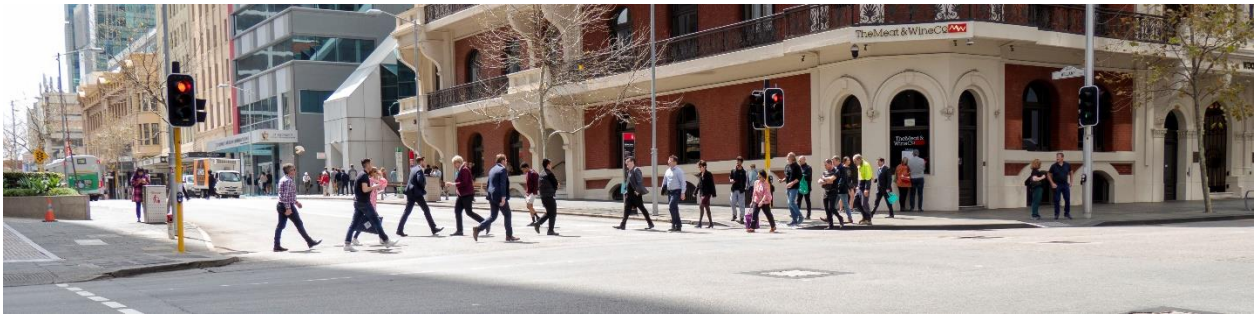
Figure 7: Staged crossing staggered to the left at a mid-block location

7. SIGNALISED PEDESTRIAN CROSSING CONTROL TYPES

Pedestrian crossing facilities must be provided at all new and upgraded signalised intersections in urban and suburban areas to cater for existing and future demand for pedestrian access, with the exception of the following circumstances:

1. At locations with significant road safety concerns, such as insufficient sight distance or adverse geometry, in which case additional measures should be considered to discourage pedestrians using that particular location to cross the road over other alternative crossing points.
2. At locations where the crossing would terminate in an area that is not possible for pedestrians to access. However, lack of existing or adequate connecting facilities are not considered as sufficient reasons to disregard the provision of a pedestrian crossing facility and all efforts should be made to cater for the crossing needs whilst ensuring connected facilities also exist.
3. At T-intersections where there is an existing crossing to the left-hand side of the intersecting road, and there is low existing or predicted future pedestrian demand for a crossing to the right-hand side of the intersecting road.
4. At locations where there are alternative grade-separated pedestrian facilities provided nearby (within 100 m).

Provision of pedestrian crossing facilities at signalised intersections in rural areas should be considered on a case-by-case basis, in relation to the existing and potential pedestrian activity, nearby land uses (within 400 m), and local public transport stops. This must include consideration of planned future land use within a 10 year horizon.



The following types of signalised pedestrian crossing facilities at traffic control signals currently exist in WA:

1. Pedestrian crossings with no pedestrian aspects (Section 7.1)
2. Exclusive pedestrian phases (Section 7.2)
3. Parallel Walks (Section 7.3)
   a. With timed control (with or without FYCLs)
   b. With timed red arrow control (with or without FYCLs)
4. Fully controlled crossings (Section 7.4)
5. Mid-block pedestrian crossings (Section 7.5)

7.1 Pedestrian Crossings with No Pedestrian Aspects

At intersections with crossing facilities that have no pedestrian aspects, pedestrians are required to observe the traffic roundel aspect and cross the road in parallel with vehicular traffic (see *Figure 8*).

This type of signalised pedestrian crossing facility is a legacy that still exists on the network in WA. However, Main Roads no longer supports the installation of this type of facility at new signals. All existing intersections with this type of facility will be gradually upgraded, with the availability of funding, to ensure appropriate pedestrian facilities are provided at all signalised intersections to ensure safety, amenity and operational efficiency.

Figure 8: An example pedestrian crossing with no pedestrian aspects, with a traffic roundel display for pedestrians

7.2 Exclusive Pedestrian Phases

Intersections with an exclusive pedestrian phase require all conflicting vehicle movements, from all directions at the intersection, to be stopped by a red aspect and pedestrians are then permitted to cross in all designated directions.

A standard exclusive pedestrian phase is designed and configured to allow pedestrians to complete any single crossing movement during the one pedestrian phase. During this time, a green figure is shown for the duration of the Invitation-to-Cross period, followed by a flashing red figure, or countdown timer (at PCaTS) during the Clearance Time (Figure *9)*.

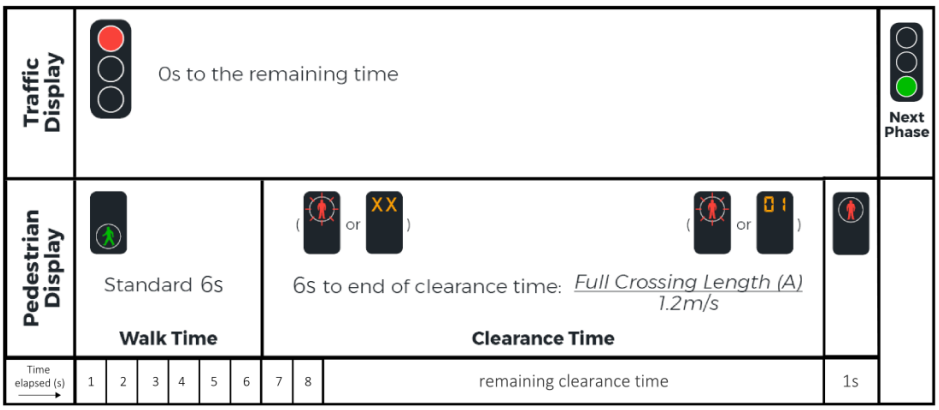


Figure 9: Exclusive pedestrian phase

The longest pedestrian Clearance Time of the individual crossings must be used as the overall Clearance Time for the exclusive pedestrian phase. It should be noted that diagonal crossings are not legal unless signed and displayed in accordance with the *Road Traffic Code 2000* and Section 7.2.1.

Intersections with an exclusive pedestrian phase will only be considered on rare occasions where the benefits for the significant number of pedestrians waiting to cross the intersection in

all directions can be clearly established, and the impact on all road users is appropriately assessed as part of the decision-making process. PCaTS must be used at all intersections with an exclusive pedestrian phase. Where legacy exclusive pedestrian phases exist and PCaTS are not present, the phasing arrangement must be reassessed and PCaTS must be installed as part of any future upgrade.

It should be noted that exclusive pedestrian phases often result in operational inefficiencies that impact all road users, including longer waiting times for pedestrians. This is due to the existence of a single exclusive pedestrian crossing phase that often leads to a higher cycle time and subsequently increases delay for pedestrians (and thereby increases probability of illegal crossing movements by pedestrians). Exclusive pedestrian phases can also result in additional delays to other modes of transport, including public transport and general traffic, and as such, they are not appropriate at large intersections due to long Clearance Times, or where pedestrian crossing demand is not consistently high for all crossing movements.

Traffic modelling should be undertaken to assess both pedestrian and traffic delays compared to other types of signalised pedestrian crossing facilities. This assessment should consider the impacts on the surrounding road network, factoring in the impact over 24/7 operations.

This type of pedestrian control is not appropriate at intersections involving Primary or District / Regional Distributor Roads unless a strong justification is provided in terms of tangible safety and efficiency benefits supported by thorough analysis.

7.2.1 Diagonal Crossings Under Exclusive Pedestrian Phases

Pedestrians may cross diagonally at a signalised intersection, provided there is a 'PEDESTRIANS MAY CROSS DIAGONALLY' sign, in accordance with the *Road Traffic Code 2000*, Regulation 196 and Regulation 199. Two regulatory sign options are allowed to permit diagonal crossings, and must be displayed on all diagonal crossing approaches (*Figure 10*) where permitted.

Figure 10: Regulatory sign options to permit a diagonal crossing

Diagonal (otherwise known as scramble) pedestrian crossings should be installed only where there is demonstrated need for pedestrians to cross diagonally and there are delay reductions to vehicles and pedestrians. Where a diagonal crossing is permitted during an exclusive pedestrian phase, the pedestrian Clearance Time for that phase must be calculated using the longest diagonal crossing, as this will often be the longest designated crossing at the intersection. It should be noted that this would significantly increase the duration of the exclusive pedestrian phase and the associated delays to all users at the intersection.

In addition, pedestrian ramps and pavement markings must be designed and installed for all crossings, including diagonally, in accordance with Main Roads standards.

7.3 Parallel Walks

At intersections with parallel walks, pedestrians cross in parallel with conflicting turning traffic, with vehicles being required to give way to pedestrians when turning left or right through the path of the crossing facility. Currently in WA, pedestrians start crossing prior to vehicles turning with a LPI duration (Section 6.1.3) to allow pedestrians to establish their crossing movement in advance of any conflicting turning vehicle movements. “GIVE WAY TO PEDESTRIANS” signs (MR-RP-11) must be installed on traffic control signal poles nearest to the left or right-turn movement where the rule applies.

Intersections with parallel walks typically experience less delay compared to sites with an exclusive pedestrian phase or fully controlled crossings. Traffic delays will primarily occur where traffic lanes are shared between turning and through movements. Therefore, where appropriate, Parallel Walk crossing facilities are Main Roads’ preferred method of operation whilst considerations outlined in Sections 7.3.1 and 7.3.2 should be noted.

Parallel Walk pedestrian crossing facilities must not be installed where:

1. Two or more lanes of traffic are permitted to turn through the crossing facility.
2. Conflicting turning traffic is controlled by a green arrow aspect, as this display indicates right of way for turning vehicles.

There are two types of parallel walk signalised pedestrian crossing facilities in WA:

1. With Timed Control (Section 7.3.1)
2. With Timed Red Arrow Control (Section 7.3.2)

7.3.1 Parallel Walks with Timed Control

Guidance for the installation criteria of parallel walk pedestrian crossings with timed control is shown in *Table 6*.

Criteria	May Be Appropriate	Not suitable
Turning Speed	Locations where the turning speed is below 25 km/h, which can be achieved if the turning radius is smaller than 15 m.	Locations where the turning speed is above 25 km/h, which can be achieved if the turning radius is larger than 15 m.
Distance of Crossing	Locations where there are three or less lanes on the approach at the stop line.	Locations where there are more than three lanes on the approach at the stop line.
Vulnerable Road Users	At existing locations where less than 15 per cent of pedestrians using the crossing facility are children, elderly or mobility impaired. At new sites, if the proposed facility is more than 250 m walking distance from the primary access route of a school, aged care facility or hospital.	
Movement & Place Function	Where the existing or the aspirational location has a high place value.	
Heavy Vehicles	Locations where there are less than 10 per cent of Heavy Vehicles (including buses) turning and conflicting with pedestrians. Consideration should be given to the vehicle classification.	Locations where there are more than 10 per cent of Heavy Vehicles (including buses) turning and conflicting with pedestrians. Consideration should be given to the vehicle classification.
Turning lanes	Locations with one right or left-turning lane.	Locations with more than one right or left-turning lane.

Table 6: Considerations for the installation of parallel walk pedestrian crossings with timed control.

Notes:

- *All percentages are based on peak periods*
- *Turning radii for left-turning movements (curve radius) is measured using nearside kerblines (raised or painted) as per AGRD Part 4A*
- *Turning radii for right-turning movements is measured using the centre of the travelled path for turning vehicles.*

At parallel walks with timed control, pedestrians are currently given a LPI of **five** seconds (*Image 1*) to establish themselves on the crossing, thereby reducing the risk of conflicts with conflicting turning vehicles. During these five seconds, vehicles are held by a red roundel display (i.e. not a red arrow display) preventing them from making any turning or through movements. After this period, vehicles are permitted to proceed, but must give way to any pedestrians that are crossing (*Image 2)*. Pedestrians are invited to cross the road for a period of six seconds (Invitation-to-Cross period) as indicated by a green symbol, followed by a flashing red symbol during the Clearance Time *(Figure11).*

A video demonstration can be found here.

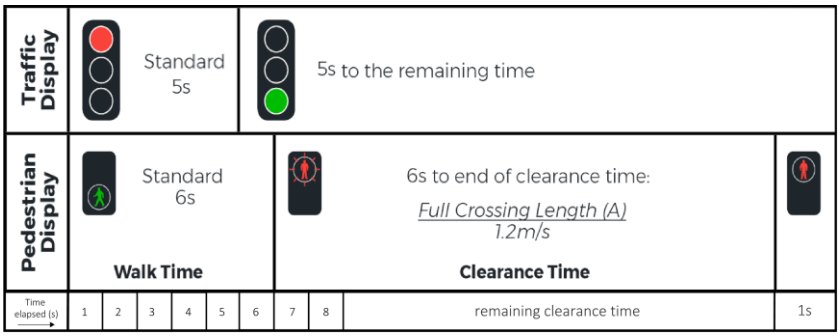


Figure11: Parallel walk with timed control (no FYCL)

Image 1: Five seconds LPI

Image 2: Conflicting, turning vehicles giving way to pedestrians after the LPI period

Where FYCL are used at parallel walks with timed control, pedestrians are given a LPI of **three** seconds (*Image 3 and 4*) to establish themselves on the crossing before traffic is released whilst the FYCLs are displayed towards the turning vehicles during the remainder of the Invitation-to-Cross time and Clearance Time to warn conflicting, turning drivers to proceed with caution (*Figure12*).

A video demonstration can be found here.

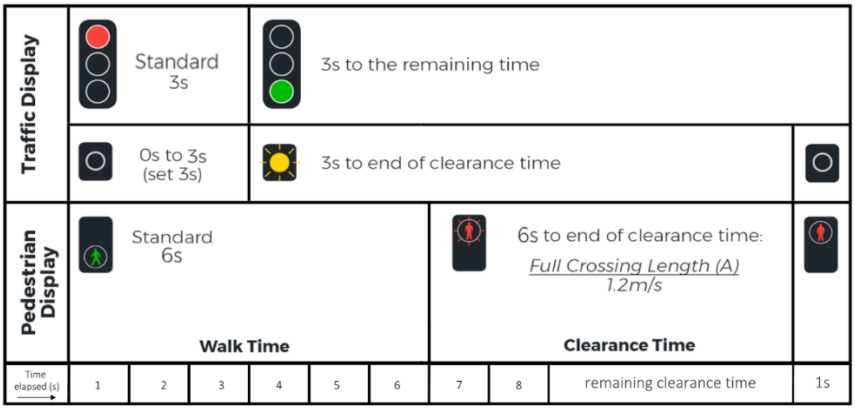


Figure 12: Parallel walk with timed control and flashing yellow

Image 3: Three seconds LPI

Image 4: *Conflicting, turning vehicles giving way to pedestrians after the LPI period with FYCL in operation*

7.3.2 Parallel Walks with Timed Red Arrow Control

Parallel walks with timed red arrow control are appropriate where separate turning lanes exist. In some constrained locations, parallel walk with timed red arrow control may be used on shared lanes (shared straight-ahead and left or right-turn movements) but this is discouraged as it results in delays to the through traffic if the vehicle at the front of the queue is held by the red arrow and increases the risk of accidents due to sudden lane change at the stop line.

The operation of the red arrow control should be considered with respect to the operation of the entire intersection including the turning traffic from the opposite approach.

Guidance for the installation criteria of timed red arrow control is shown in *Table 7.*

Criteria	May Be Appropriate	Not suitable
Turning Speed	Locations where the turning speed is between 25 km/h and 30 km/h, which can be achieved if the turning radius is between 15 m and 20 m.	Locations where the turning speed is above 30 km/h, which can be achieved if the turning radius is larger than 20 m.
Distance of Crossing	Locations where there are more than three lanes on the approach at the stop line.	
Vulnerable Road Users	At existing locations where more than 15 per cent of pedestrians using the crossing facility are children, elderly or mobility impaired. At new sites, if the proposed facility is less than 250 m walking distance from the primary access route of a school, aged care facility or hospital.	
Movement & Place Function	Where the existing or the aspirational location has a medium place value.	
Heavy Vehicles	Locations where there are more than 10 per cent of Heavy Vehicles (excluding buses) turning and conflicting with pedestrians. Consideration should be given to the vehicle classification.	
Turning lanes	Locations with one right or left-turning lane.	Locations with more than one right or left-turning lane.

Table 7: Considerations for the installation of parallel walk pedestrian crossings with timed red arrow control

Notes:

- *All percentages are based on peak periods*
- *Turning radii for left-turning movements (curve radius) is measured using nearside kerblines (raised or painted) as per AGRD Part 4A*
- *Turning radii for right-turning movements is measured using the centre of the travelled path for turning vehicles.*

At locations where timed red arrow control is provided, staged crossings may be investigated for safety and efficiency gains.

At intersections with parallel walks with timed red arrow control, pedestrians are given a LPI as calculated in accordance with Section 6.1.3.1, with this time being a minimum of six seconds. During this period, vehicles are held by a red arrow display preventing them from making the conflicting turning movement (*Image 5*). After the arrow control extinguishes, vehicles are permitted to proceed, but must give way to any pedestrians that are crossing (*Image 6*).

Pedestrians are invited to cross the road for a period of six seconds (Invitation-to-Cross period) as indicated by a green symbol, followed by a flashing red symbol during the Clearance Time *(Figure 13*). A video demonstration can be found here.

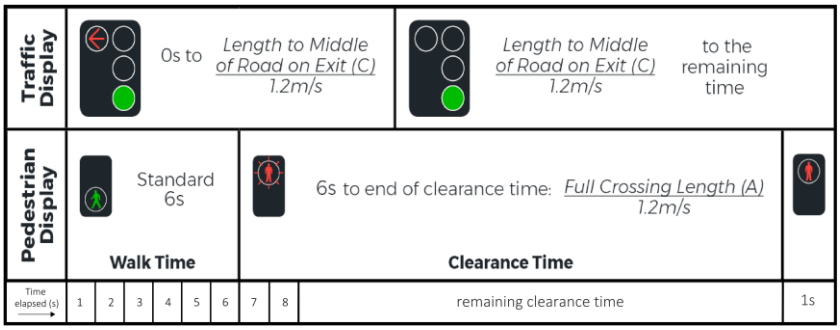


Figure 13: Parallel walk with timed red arrow control

Image 5: Traffic held by an arrow during Invitation-to-Cross plus LPI

Image 6: *Conflicting, turning vehicles giving way to pedestrians after the LPI period*

Where FYCLs are used at parallel walks with timed red arrow control, the LPI is reduced as calculated in accordance with Section 6.1.3.2 and shown on Figure 14, with this time being a minimum of six seconds.

A video demonstration can be found here.

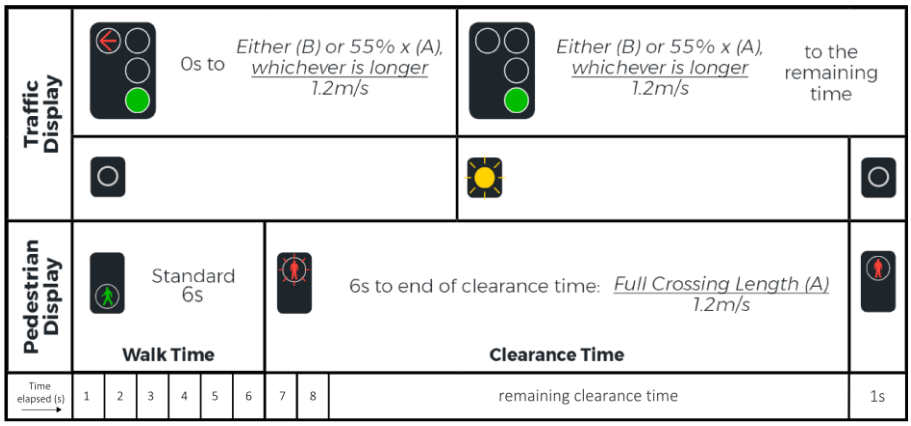


Figure 14: Parallel walk with timed red arrow control and flashing yellow

7.4 Fully Controlled Crossings

Intersections with fully controlled pedestrian crossings are typically provided where separate turning lanes exist. At these intersections, vehicles are held by a red aspect, or red arrow display, (*Image7 & Image 8*) for the entire pedestrian Invitation-to-Cross and Clearance Time periods, thereby preventing conflict between pedestrians and turning vehicles. During this time, pedestrians are invited to cross the road for a period of six seconds (Invitation-to-Cross), as indicated by a green symbol, followed by a flashing red symbol, or countdown timer (at PCaTS), during the Clearance Time (*Figure 15*). A video demonstration can be found here.

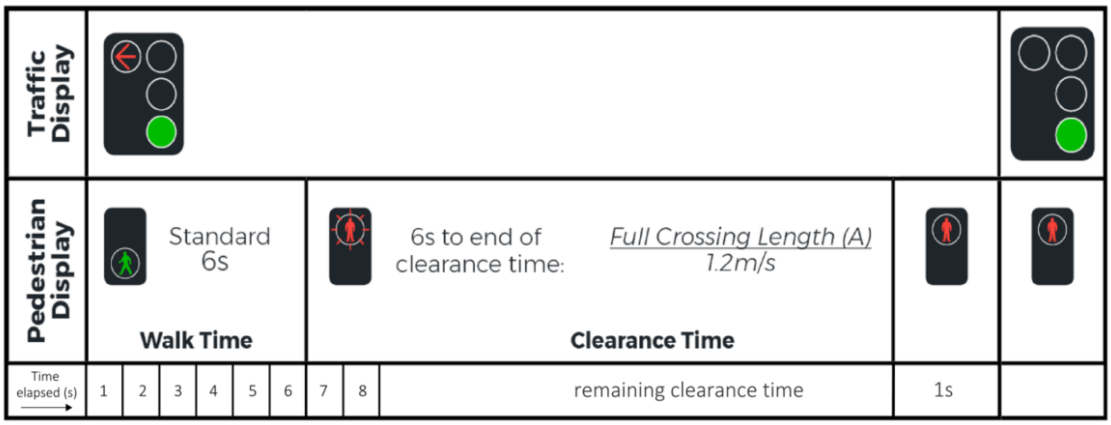


Figure 15: Fully controlled crossings

Image 7: Six seconds Invitation-to-Cross for pedestrians

Image 8: Flashing red symbol Clearance Time and red arrow display for vehicles for duration of crossing movement

Guidance criteria for the installation of fully controlled pedestrian crossing facilities is shown in *Table 8*.

Criteria	May Be Appropriate	Not suitable
Turning Speed	Locations where the turning speed is more than 30 km/h, which can be achieved if the turning radius is larger than 20 m.	Locations where the turning speed is below 30 km/h, which can be achieved if the turning radius is smaller than 20 m, unless operational or safety conditions require traffic to turn under protected conditions with a green arrow.
Length of Crossing	Locations where there are more than three lanes on the approach at the stop line.	
Vulnerable Road Users	At existing locations where more than 15per cent of pedestrians using the crossing facility are children, elderly or mobility impaired. At new sites, if the proposed facility is less than 250 m walking distance from the primary access route of a school, aged care facility or hospital.	
Movement & Place Function	Where the existing or the aspirational location has a low place value combined with high movement value.	Where the existing or the aspirational location has a low movement value combined with a high place value.
Heavy Vehicles	Locations where there are more than 10 per cent of Heavy Vehicles (excluding buses) turning and conflicting with pedestrians. Consideration should be given to the vehicle classification.	
Turning lanes	Locations with more than one right or left-turning lane.	

Table 8: Considerations for the installation of fully controlled pedestrian crossings

Notes:

- *All percentages are based on peak periods*
- *Turning radii for left-turning movements (curve radius) is measured using nearside kerblines (raised or painted) as per AGRD Part 4A*
- *Turning radii for right-turning movements is measured using the centre of the travelled path for turning vehicles.*

These considerations should not preclude the installation of a fully controlled crossing at locations where pedestrian safety can be clearly improved, without impact to the overall operational efficiency. At such locations, vehicle and pedestrian delays must be carefully considered and assessed using traffic modelling.

7.5 Signalised Mid-Block Pedestrian Crossings

Signalised mid-block pedestrian crossings incorporate an exclusive pedestrian phase whereby the conflicting vehicle movement at the crossing is stopped by a red display. Pedestrians are invited to cross the road during the Invitation-to-Cross period (typically 6 seconds) as indicated by a green symbol. This is followed by a pedestrian countdown timer during the Clearance Time (*Figure 16*).

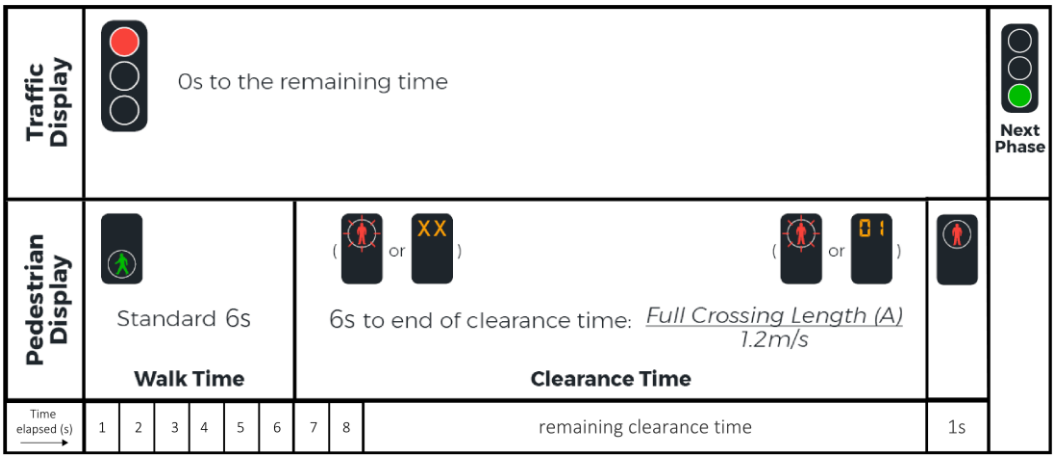


Figure 16: Mid-Block pedestrian crossing

Thorough consideration of safety, accessibility, amenity, and efficiency issues for the selection of an appropriate crossing facility is necessary to ensure safe operation, to avoid proliferation of unnecessary infrastructure, and to balance the needs of all road users 24/7. The *Pedestrian Crossing Facilities Policy* (currently under development) provides detailed guidance on the requirements for all pedestrian crossing facility types and should be referred to for further advice.

Signalised mid-block pedestrian crossings may be provided as standard crossings, or staged crossings. Guidance on criteria and design requirements for standards or staged crossings is included in Section 6.3.

At standard crossings, traffic in both directions (where applicable) is stopped for the pedestrian movement. At staged crossings, traffic in one-direction is stopped first to allow pedestrians to cross over onto the central median island (pedestrian refuge) prior to traffic in the other direction being stopped, allowing pedestrians to complete the second stage of the crossing.

7.5.1 Selection Considerations

Main Roads considers a wide range of factors in determining the appropriateness of signalised mid-block pedestrian crossings. These factors include, but are not limited to:

- the movement and place function of the road section,
- peak hour, and daily, pedestrian and vehicle movements at the site (for the purpose of assessing the need for a signalised mid-block pedestrian crossing, a pedestrian demand lower than 20 in the peak hour is considered to be low),
- safety, amenity and accessibility issues,
- delay and efficiency impacts on all road users,
- the overall costs associated with the life of the installation.

To assist practitioners, *Table 9* provides guidance on a number of factors that should be considered for a signalised mid-block pedestrian crossing. These key factors are discussed in more detail in Sections 7.5.1.1 to 7.5.1.4.

Gap Availability[*1]	Crossing Lanes[*2]	Traffic Speed[*3] (kph)	Rating[*4]
Yes / No	1	<=50	×
Yes	2	<=50	×
No	2	<=50	+
Yes	>= 3	<=50	+
No	>= 3	<=50	✓
Yes	1	60 / 70	×
No	1	60 / 70	+
Yes	>= 2	60 / 70	+
No	>= 2	60 / 70	✓
Yes / No	-	=> 80	×

Table 9: Guidance for consideration of a Signalised Mid-Block Pedestrian Crossing

[*1] See Section 7.5.1.1 Gap Availability
[*2] See Section 7.5.1.2 Crossing Lanes
[*3] See Section 7.5.1.3 Traffic Speed

[*4] Rating:

✓ Likely to supported - High Merit
+ May be supported - Some Merit
× Likely to be not supported - Low Merit

Further factors which may be considered as part of the assessment for an appropriate pedestrian crossing facility can be found via the *Australasian Pedestrian Facility Selection Tool* (AP-R472-15). Where a signalised facility is "Likely to be supported", requirements set out in Main Roads Network Operations *Traffic Signals Approval Policy (TSAP)* should be followed by the project sponsor who will be required to carry out further project development and design.

Where alternative pedestrian crossing facilities exist within 100 m of the recommended location for a signalised mid-block pedestrian crossing, consolidation and upgrade of those facilities should be considered as part of the assessment process. Proposed signalised mid-block pedestrian crossings within 100 m of a pedestrian underpass or overpass will not be supported without strong justification for their need.

7.5.1.1 Gap Availability

Making the decision to cross a road safely in relation to available traffic gaps is a complex task for pedestrians, particularly at unsignalised mid-block locations. Gaps are defined by the characteristics of the site and are dependent on the conditions present at the time a pedestrian attempts to cross. The adequate gap (also known as Critical Gap) for a site is determined by dividing the Crossing Length + 1.6m pedestrian set back by the appropriate walking speed (Section 6.1.2) and adding an appropriate Safety Margin (also known as start-up or reaction time).

The *Highway Capacity Manual (HCM, 2016 Section 5 Pedestrian Mode)* defines the Critical Gap as "the time in seconds below which a pedestrian will not attempt to begin crossing the road. If the available gap is greater than the Critical Gap, it is assumed that the pedestrian will cross; but if the available gap is less than the Critical Gap, it is assumed that the pedestrian will not cross".

The Western Australian Planning Commission (WAPC) *Transport Impact Assessment Guidelines Volume 5: Technical Guidance* provides a methodology to assess the suitability of mid-block pedestrian crossing locations based on a pedestrian's ability to cross major roads by selecting gaps in the traffic of sufficient length to allow them to cross, and sufficient frequency to keep delays to acceptable levels.

The ability for pedestrians to cross a road safely is linked to the size of the Critical Gap and availability of Safe Gaps, which are related to a range of factors such as the traffic volumes on the road, number of traffic lanes, existence of vehicle platoons, traffic composition and speed. At low, dispersed traffic volumes, there are typically regular gaps of sufficient length (Safe Gaps) for pedestrians to cross safely with minimal delay. When volumes are high and pedestrians need to cross a road with multiple lanes in both directions, the number of Safe Gaps in traffic decreases, and this may lead to pedestrians attempting to cross during smaller gaps, choosing an alternative longer route, or choosing not to walk altogether. This impacts road safety and does not promote active travel as a viable option.

Figure 17 shows the indicative thresholds for the provision of signalised mid-block crossing facilities for different road types, based on a random traffic arrival rate. According to the *Highway Capacity Manual (HCM, 2016)*, average pedestrian delays greater than 45 seconds are not desirable at mid-block locations on Primary and Regional Distributor roads as they may lead to pedestrians taking risks by accepting smaller gaps in traffic. The target average pedestrian delay values in Figure 17 should be considered as a guide and used only for establishing the potential need for a signalised mid-block pedestrian crossing.

Example:

Road A is a Primary Distributor carrying approximately 3000 veh/hr in the peak period and currently has an unsignalised mid-block pedestrian crossing facility with a Crossing Length of 13.4m over both carriageways.

The crossing time for this facility assuming a standard walking speed of 1.2 m/s is (13.4+1.6)/1.2 = 12.5 seconds. Assuming the crossing time equals Critical Gap, using the graph above (blue 'x' indicated), this crossing on Road A slightly exceeds the desirable 45 second delay level for a Primary Distributor and may require the provision of signalised mid-block pedestrian crossing facilities.

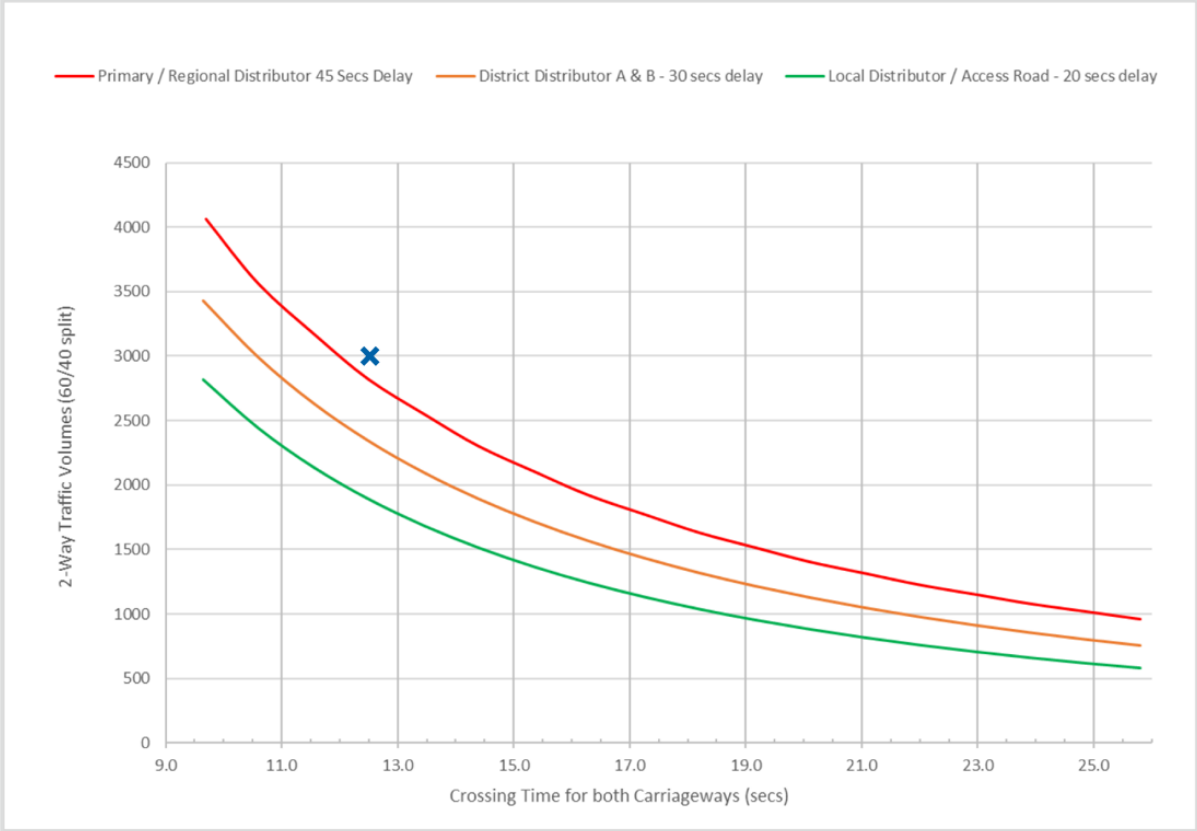


Figure 17: Threshold for mid-block pedestrian facilities for different road function types.

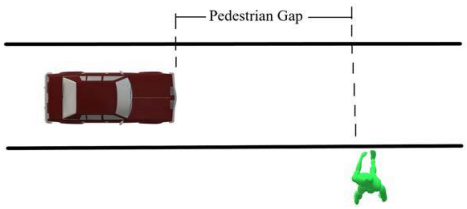
It is important to note that the delay thresholds provide only an indicative assessment of pedestrian delay and should not be used as a definitive warrant for a signalised mid-block crossing facility. A number of factors can influence the actual pedestrian delay, such as the directional split of traffic, heavy vehicle composition and any platooning effects created by upstream intersections. Therefore, video surveys of traffic volume, speed and average gap duration by time of day can assist in determining the difficulty in crossing the road for various types of pedestrians throughout the day.

Improvements to existing mid-block crossings may be viable, such as the provision of storage space within a median to allow crossings to be completed in multiple stages (i.e. staged crossings). Proximity to other pedestrian crossing facilities, pedestrian crossing demand and impact to the surrounding road network should also be thoroughly investigated when considering a signalised mid-block pedestrian crossing.

The total pedestrian wait time (delay) to cross a road is related to the number and frequency of safe crossing opportunities at that location. As well as the Critical Gap, factors such as the rate of traffic flow, whether interrupted or uninterrupted, road capacity and environment, traffic speed and composition, and crossing sight distance contribute to waiting time for a safe gap (a gap larger than the Critical Gap). When assessing availability of Safe Gaps, consideration should be given to all relevant times of the day where high levels of pedestrian and vehicular demands exist at that specific site.

The following assessments apply in considering Gap Availability (*Table 9*) at a specific site:

1. Critical Gap is calculated using the Crossing Length + 1.6m pedestrian set back (i.e. 1.6m from the pavement edge or kerb line) divided by the appropriate walking speed (Section 6.1.2) plus a Safety Margin (otherwise known as start-up or reaction time):
    a. A Safety Margin of 3 seconds should be used for standard crossings
    b. A Safety Margin of 4 seconds should be used where more than 15 per cent of pedestrians at any full hour of the day are children, elderly or mobility impaired



2. Safe Gaps are available gaps equal or larger than Critical Gap measured on-site:
    a. Where a single Safe Gap is bigger than the Critical Gap by multiples of a whole number (e.g. 3 times bigger), it should be considered as multiple Safe Gaps (e.g. 3 Safe Gaps rather than a single Safe Gap of 3 times the length).
3. Gap Availability is assessed by:
    a. Where there are **X** or more Safe Gaps available in 5 minutes to cross to a safe refuge, the location is considered to have sufficient Gap Availability (i.e. Yes).
    b. Where there are less than **X** Safe Gaps available in 5 minutes to cross to a safe refuge, the location is considered to have insufficient Gap Availability (i.e. No).
    c. **X** is defined as:
        i. 5 for Primary and Regional Distributers
        ii. 7 for District Distributer A and B
        iii. 9 for Local Distributor and Access Roads

7.5.1.2 Crossing Lanes

Pedestrians have a wide range of cognitive and physical characteristics affecting Critical Gaps, whilst the frequency of Safe Gaps decreases with additional lanes and longer crossing distances as the risk of mis-judging the length of a gap also increases.

The frequency of safe crossing opportunities (Safe Gaps) significantly decreases where pedestrians are required to judge gaps in two directions with multiple lanes without a safe refuge (median island). Therefore, it is strongly recommended that pedestrian refuges, or median islands, are provided to reduce the cognitive demand on pedestrians and reduce the crossing lengths in each stage of the crossing. This would often minimise delays and improve safety in both signalised and unsignalized crossings.

7.5.1.3 Traffic Speed

There are two primary reasons for traffic speed being considered as a key factor for appropriate assessment and selection of a mid-block pedestrian crossing facility:

- Higher traffic speeds impair the judgment of pedestrians in assessing gaps and therefore accepting Safe Gaps
- Traffic speed relates directly to frequency and severity of crashes, leading to more severe injuries at higher speeds

Where pedestrian facilities are highly used, consideration should be given to appropriate selection of crossing facilities and their location, along with potential speed management measures.

7.5.1.4 Other Considerations

In rare situations where a signalised mid-block pedestrian crossing facility is being considered with low levels of expected pedestrian use (less than 20 in an hour), potential additional measures may be appropriate to improve safety as outlined in *Table 10*.

Treatment	Speed Zone				Preferred Usage and General Comments
	<=40	50	60	70	
Red asphalt on approaches	Y	Y	Y	Y	Treatment may be appropriate where traffic signals cannot be clearly seen at Traffic Signal Warning sign location. Where appropriate, red asphalt should start at the point where Traffic Signal Warning signs are / would normally be placed on approaches to traffic signals. This will vary depending on the speed zone. This treatment is currently not supported on state roads but may be considered on LG roads.
Surface treatment (e.g. Streetprint decorative asphalt)	Y	Y	Y	Y	Treatment must not compromise skid resistance on approach to signals.
Mast arms	N*	N*	Y	Y	Mast arms must be installed as per Austroads Guidelines and MRWA Standards. The need for mast arms is primarily based on: • where the stopping sight distance to the post-mounted signal face is inadequate, e.g. because of vertical or horizontal alignment, awnings, poles, trees or similar sight obstructions • where the roadway is too wide for kerb mounted signal faces to fall within the driver's line of sight
Traffic Signal advisory signs on side roads	Y	Y	Y	Y	Appropriate in locations where side roads are in close proximity (<50 m) to the mid-block crossing facility.
Signage de-cluttering	Y	Y	Y	Y	Appropriate at all locations and should be completed as a matter of course.
Red Light Speed Camera	Y	Y	Y	Y	Treatment may be considered at locations with a history of consistent red light running and requires WA Police Force support.
Vertical deflection	Y	Y	Y	N	Treatment is generally not appropriate on roads with high movement value. Please refer to the appropriate Main Roads guidelines and standard drawings.
Lane narrowing	Y	Y	Y	Y	Treatment is recommended at all locations to reduce the distance pedestrians need to cross. Lane widths must be appropriate for the design vehicle and speed of the road. Cycling facilities, such as sealed shoulders or bike lanes, should be maintained through the intersection to ensure continuity.
Speed reduction	N	Y	Y	Y	Treatment might be appropriate subject to Main Roads Speed Zoning Policy.
Wig Wags	Y	Y	Y	Y	As per *Wig Wags at Pedestrian Crossings Policy and Application Guidelines*.
Red Light Runner detection	Y	Y	Y	Y	Appropriate at all locations and should be implemented as a matter of course.
Sight distance improvements	Y	Y	Y	Y	Clear vegetation and signage de-cluttering to maximise sightlines. Appropriate at all locations and should be completed as a matter of course.

Table 10 – Potential measures to improve safety at low-use signalised mid-blocking pedestrian crossing facilities

7.6 Signalised T Intersections

Signalised T intersections commonly provide two pedestrian crossing facilities, as illustrated in Figure 18:

1. One across the intersecting road (crossing A) and,
2. One across one side of the intersecting road (typically left side – crossing B).

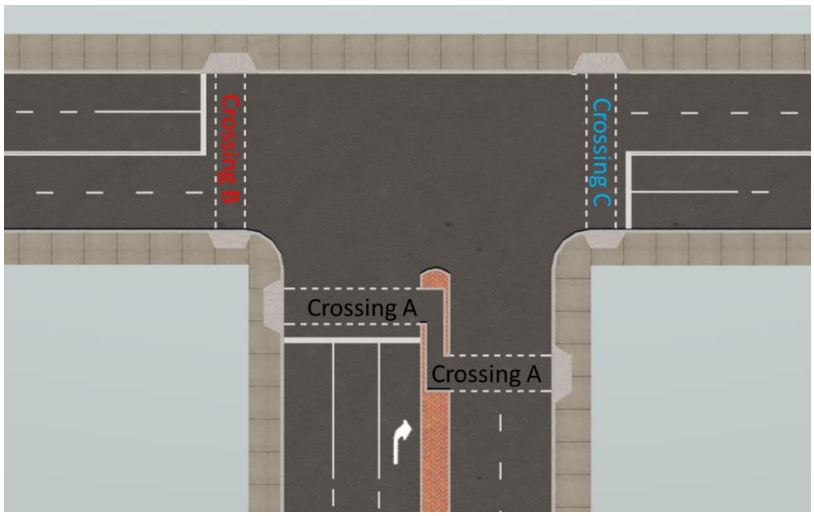


Figure 18: Example layout of a T intersection

Provision of pedestrian crossings on both sides of the intersecting road (crossing B and crossing C) may be supported if:

1. Existing or future pedestrian desired routes are demonstrated on both sides with such information as development plans;
2. Typical pedestrian demand during peak times is more than 20 pedestrians per hour on each crossing; or
3. Pedestrian crossing facilities are currently provided on both sides and are used by more than 20 pedestrians in an hour.

A higher level of control, beyond what is required as a minimum, shall be considered for the pedestrian crossing facility on the right side of the intersecting road (crossing C) when visibility issues are precluding the pedestrian to have visibility of, and be visible to drivers making the conflicting right turn.

7.6.1 Signal Displays

Based on the control type selections for the left and right crossings, signal lanterns facing the intersecting road will require different signal display configurations, as summarised in *Table 11*. Note that there are further considerations to take into account with the signal displays:

1. Roundel aspects can only be used to provide timed control (i.e. LPI of 5 seconds, or 3 seconds if flashing yellow 'caution' lights are installed);
2. Red arrows can be used to provide timed red arrow control or full control;
3. Green arrows are to be provided only for turning movements that can be released without conflict with crossing pedestrians, as they indicate right of way for turning vehicles;
4. A maximum of two columns of aspects is preferred on one target board to avoid confusion for road users.

It is not possible to provide signal display for certain combinations of control as listed in *Table 11*. If those combinations of control are required based on the criteria in previous sections, fully controlled facilities should be considered for both crossings.

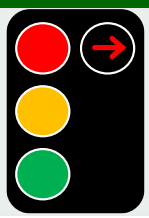
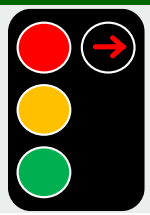
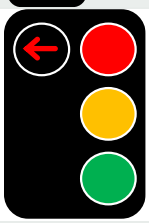
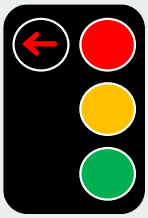
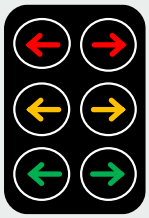
Left crossing (Crossing B)	**Right Crossing (Crossing C)**		
	Timed control	**Timed red arrow Control**	**Fully controlled**
Timed control			
Timed red arrow control	* 	Not permissible	Not permissible
Fully controlled		Not permissible	

Table 11: Recommended signal display facing intersecting roads at T-intersections

** Arrow aspects should stay on for the duration of Leading Pedestrian Interval (LPI) as recommended in Section 6.1.3.2*

8. ASSOCIATED CROSSING FACILITIES AT INTERSECTIONS

8.1 Slip Lanes

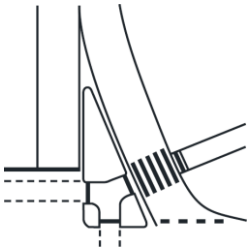
Appropriate pedestrian crossing facilities should always be considered across left-turn slip lanes at signalised intersections using the same general considerations identified in Section 5 of this guideline. Consideration of sight distances and vehicle approach speeds are particularly critical, as drivers are more likely to be focussed on the driving task, gap finding and conflicting traffic movement than on pedestrians crossing the road.

Road Traffic Code 2000, Regulation 52(3) states that if a driver at an intersection is turning left with a "give way sign" or give way line, the driver shall give way to any pedestrian on the slip lane.

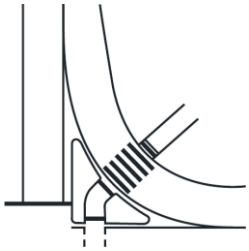
Three potential types of treatment exist for left-turn slips lanes:

1. Zebra crossings
   a. Zebra crossings on high entry angle / give-way slip lanes
   b. Zebra crossings on low entry angle / free flow slip lanes
2. Signalised crossings
3. Uncontrolled crossings

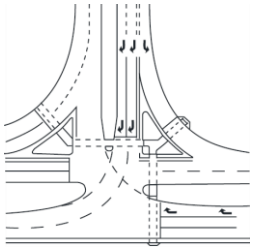
The type of control at a left-turn slip lane crossing facility must be considered with respect to speed limit, approaching vehicle operating/collision speed (which may be relative to the design), pedestrian volume, and the type of slip lane (high entry angle / give-way movement, low entry angle / free-flow movement).



1a. Zebra crossing at high entry angle slip lanes



1b. Zebra crossing at free flow slip lanes



2. Signalised Slip Lanes

Figure 18: Options at slip lanes

Any upgrade or modification to an existing left-turn slip lane crossing facility should consider:

1. The number of killed or seriously injured (FSI) crashes;
2. The number of crashes involving pedestrians;
3. Whether a change in the type of slip lane crossing facility or geometry would address the crash problem or reduce vehicle speeds,
4. The number and proportion of heavy vehicles using the left-turn slip lane; and
5. Lighting requirements (Section 5.11).

The default control type for pedestrian crossing facilities across slip lanes should be a zebra crossing, unless the location does not meet sight distance requirements at the design speed, or where substandard lighting exists.

If heavy vehicles percentage exceeds 10 per cent of all traffic using the slip lane, measures to enhance safety and conspicuity of the pedestrian crossing facility must be investigated.

Where heavy vehicle aprons or over-run areas are provided (raised or painted), pedestrians may be unsure where to position themselves at unsignalised locations. Main Roads Guidelines

Drawing No. 200331-0015 - Typical Corner Treatments On Heavy Combination Vehicle Routes demonstrates how a heavy vehicle apron should be installed to ensure pedestrians know where to position themselves whilst signal posts can provide clearer guidance as to where pedestrians should wait before crossing.

Kerb ramps and street lighting must always be installed as per Main Roads Standards and Guidelines and Australian Standards at zebra crossings.

Small traffic island refuges associated with left-turn slip lanes should be avoided in locations that experience high pedestrian numbers or periods of overcrowding as they can have limited storage space. At signalised intersections that experience high pedestrian demands, appropriate storage space must be designed in or removal of the left-turn slip lane and accommodating the left-turn movement within the main carriageway and signal phasing should be considered.

A wombat crossing is a zebra crossing on a raised platform. This raised platform is generally effective at reducing the operational speed of vehicles, it improves the visibility of the crossing, and provides a footpath-level crossing, which removes unnecessary grade changes for pedestrians. Wombat crossing might be preferred over zebra crossings where there is a need to reduce vehicle speeds at a pedestrian crossing, in accordance with Main Roads *Policy and Guidelines for Pedestrian Crossing Facilities*.

Guidance criteria for the installation of slip lane pedestrian crossing facilities at intersections are shown in *Table 12.*

Type of Crossing	May Be Appropriate	Not Suitable
Zebra crossings at high entry angle / give-way slip lanes	At locations where street lighting, sight lines, ASD and the deceleration length of the slip lane meet the Austroads standards; and the turning speed is less than 30 km/h. The use of a Raised Safety Platforms may be considered to reduce speeds to an appropriate level.	At multi-lane left-turn slip lanes or where there are visibility issues or turning speed is more than 30 km/h and it is not appropriate to install Raised Safety Platforms to reduce the turning speed. Locations where there are more than 10 per cent of HV (excluding buses) turning and conflicting with pedestrians. Consideration should be given to the vehicle classification.
Zebra crossings at Low entry angle / free flow slip lanes	At locations where street lighting, sight lines, ASD and the deceleration length of the slip lane meet the Austroads standards; and the turning speed is less than 30 km/h. Measures to improve safety and awareness of the zebra crossing must be included. The use of a Raised Safety Platforms may be considered to reduce speeds to an appropriate level.	At multi-lane left-turn slip lanes or where there are visibility issues or turning speed is more than 30 km/h and it is not appropriate to install Raised Safety Platforms to reduce the turning speed. Locations where there are more than 10 per cent of HV (excluding buses) turning and conflicting with pedestrians. Consideration should be given to the vehicle classification.
Signalised crossings at slip lanes	At multi-lane left-turn slip lanes or where there are visibility issues or turning speed is more than 30 km/h and it is not appropriate to install Raised Safety Platforms to reduce the turning speed. Locations where there are more than 10 per cent of HV (excluding buses) turning and conflicting with pedestrians. Consideration should be given to the vehicle classification.	
Uncontrolled crossing at slip lanes	Provision of uncontrolled pedestrian crossings across slip lanes is typically only supported on a case-by-cases basis outside of urban areas where the below criteria are met: a) Very low pedestrian demands for the crossing (less than 10 in a full average day); and, b) Turning speeds are low, sight distances are adequate and there are sufficient Safe gaps (see Section 7.5.1.1 for Gap Availability) for pedestrians to cross the slip lane; and	

	c) A Zebra crossing is not appropriate due to safety risks to pedestrians, a demand dependent signalised facility cannot be provided and a signalised facility would result in major efficiency issues at the intersection due to traffic demands and/or existence of heavy vehicles and road trains; or, d) A Zebra crossing is appropriate but cannot be provided (for example due to disproportionately high lighting upgrade until such time as appropriate funding is identified)	

Table 12: Considerations for the installation of left-turn slip lane pedestrian crossing facilities

9 REFERENCES AND RELATED DOCUMENTS

Document Number	Description
AP-R472-15	Austroads Australasian Pedestrian Crossing Facility Selection Tool
AGTM03-13	Austroads Guide to Traffic Management Part 3: Transport Studies and Analysis Methods
AGTM06-17	Austroads Guide to Traffic Management – Part 6: Intersections, Interchanges and Crossings Management
AGTM09-16	Austroads *Guide to Traffic Management Part 9: Transport Control Systems – Strategies and Operations*
AGTM10-16	Austroads Guide to Traffic Management Part 10: Transport Control – Types of Devices
AP-R472A-18	Austroads Australasian Pedestrian Facility Selection Tool – User Guide (and Tool)
AP-R560-18	Austroads Towards Safe System Infrastructure: A Compendium of Current Knowledge
AGRD04-17	Austroads Guide to Road Design - Part 4: Intersections and Crossings
AGRD04A-17	Austroads Guide to Road Design - Part 4A: Unsignalised and Signalised Intersections
D24#590607	Main Roads' Policy and Guidelines for Pedestrian Crossing Facilities (to be published)
D25#138868	Main Roads' Selection of Intersection Control Guidelines
D25#77071	Main Roads' Signalised Roundabouts Guidelines
D23#1315195	Main Roads' Supplement to the Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersections
D17#502268	Main Roads Network Operations Operational Modelling Guidelines
D15#68384	Main Roads' Road Trauma Treatments Guideline
D17#582749	Main Roads' Traffic Signals Approval Policy
D17#104381	Main Roads' Railway Crossing Control in Western Australia - Policy and Guidelines
AS/NZS1158.1.1	Vehicular Traffic (category V) lighting – Performance and design requirements
AS/NZS1158.4	Lighting of Pedestrian crossings
N/A	Western Australian Legislation - Road Traffic Code 2000
N/A	Western Australian Planning Commission (WAPC) Draft Liveable Neighbourhoods 2015