We're working for Western Australia.

Application and Technical Guidelines for Pedestrian Crossing Facilities

D24#590607
August 2025

Application and Technical Guidelines for Pedestrian Crossing Facilities

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

Authorisation

As Executive Director Network Operations, I authorise the issue and use of this document – *Application and Technical Guidelines for Pedestrian Crossing Facilities.*

EXECUTIVE DIRECTOR NETWORK OPERATIONS

25/08/25

All printed copies are uncontrolled.

Contents

Document Control

Owner	Manager Traffic Management Services
Custodian	Network Operations Planning Manager
Document Number	D24#590607
Issue Date	August 2025
Review Frequency	Every 3 years (or earlier if needed)

Amendments

Revision Number	Revision Date	Description of Key Changes	Section/Page No.
0	AUG 2025	NEW	ALL

1. Purpose

The purpose of this document is to provide best practice advice on the provision of the most suitable pedestrian crossing facilities for safer, accessible, and convenient pedestrian movements.

These guidelines are provided for practitioners in Main Roads WA (Main Roads), and other state and local government departments as well as private sector consultants involved in investigation, design and development of pedestrian crossing facilities.

2. Scope

2.1 Background

Pedestrians form the largest single road user group in Western Australia (WA). As a group, pedestrians are classified as vulnerable road users. This is due to the lack of physical protection and exposure to the high speeds and large volumes of vehicular traffic, often making it difficult, or unsafe, to cross a roadway.

Given the promotion of active mobility across WA, pedestrian safety must be a primary consideration in the design and function of the road network, to ensure appropriate facilities are provided.

Note: In these guidelines, the word pedestrian includes:

(a) any person on foot or in a perambulator or wheelchair; and

(b) a person pushing a perambulator or wheelchair; and

(c) a person wheeling or riding a bicycle, electric rideable device, wheeled recreational device, motorised scooter or wheeled toy.

2.2 Application

This document provides guidance on how to select appropriate pedestrian crossing facilities for different roads in Western Australia, along with any supporting treatments (where required) for the following facilities:

- Unmarked crossings
- Zebra crossings (also known as pedestrian crossings*)
- Signalised pedestrian crossings (also known as marked foot crossings*)
- Grade separated pedestrian crossings
- Traffic-warden-controlled children's crossings (also known as children's crossings*).

**As per the Road Traffic Code 2000*

The selection of the type of crossing, and any associated treatment/s, will depend upon the circumstances of each crossing location.

Note: These guidelines do not intend to prescribe a single approach or intervention for a pedestrian crossing, but presents options, along with any associated benefits and/or implications and the circumstances where each would be most appropriate. It also recognises that several factors can affect what might be achieved at any location.

Note: Guidance for circumstances not covered by this document

1: Pedestrian crossing facilities at signalised intersections (including their slip lanes) and pedestrian crossings at railway level crossings are not within the scope of these guidelines. For these instances refer to *Guidelines for Pedestrian Crossing Facilities at Traffic Control Signals*, *Austroads Guide to Road Design Part 4A: Un-signalised and Signalised Intersections* and *Main Roads Railway Crossing Control in Western Australia Policy and Guidelines*.

2: The references for roundabouts in these guidelines cover single lane roundabouts only. Guidance on dual lane roundabouts are under development and will be included in this document later.

3. Roles and Responsibilities

Under the Road Traffic Code 2000 Regulation 297 (1), the Commissioner of Main Roads is the sole authority with power to "*erect, establish or display, and may alter or take down any road sign, road marking or traffic-control signal*".

Furthermore, under Regulation 297 (2) the Commissioner of Main Roads may allow an authorised body to erect, establish, display, alter or take down any road sign, road marking or traffic-control signal, or road signs or traffic-control signals of a class or type of classes or types, and in the circumstances (if any), specified in the instrument of authorisation.

4. Definitions

Refer to *Main Roads Glossary of Terms* guideline. This glossary of terms provides the most common terminology used by Main Roads. Other terms used in these guidelines are defined below.

Term	Definition
Activity centre	Low movement, high place locations. Activity centres are mixed use urban areas where there is a concentration of commercial, residential and other land uses. They are multi-functional community focal points where people live, work, shop, meet and relax.
Approach Sight Distance (ASD)	ASD is the distance required for a driver approaching an intersection or crossing to see the presence of the intersection or crossing and respond appropriately. It ensures that the driver can detect pavement markings, signs, or pedestrians in time to take action.
At grade pedestrian crossing	Means the crossing is on the same level as the road, without a bridge or underpass.
Crossing Sight Distance (CSD)	CSD ensures pedestrians waiting to cross can see approaching vehicles in time to judge a safe gap and drivers can see pedestrians waiting to cross and respond appropriately.
Grade Separated Pedestrian Crossing	A type of pedestrian crossing that is either overpass or underpass, avoiding interaction with vehicular traffic.
Level of services - traffic	Qualitative measure that describes the operational conditions of a transportation facility and the perception of those conditions by its users. It categorises traffic flow into six levels, from A (minimal delay and high satisfaction) to F (excessive delay and dissatisfaction).
Level of service - pedestrian	The level of service (LOS) for pedestrian delay is a measure used to evaluate the quality of pedestrian movement and experience based on the average amount of time pedestrians are delayed while crossing a street. LOS is typically rated from A (minimal delay and high satisfaction) to F (excessive delay and dissatisfaction).
Mid-block	For reference, it is considered a midblock location if it is more than 50 metres from an intersection or cross street.
Operating speed	The speed most road users feel comfortable traveling. The operating speed is generally measured as the 85th percentile speed.
Pedestrian	(a) any person on foot or in a perambulator or wheelchair; and (b) a person pushing a perambulator or wheelchair; and (c) a person wheeling or riding a bicycle, electric rideable device, wheeled recreational device, motorised scooter or wheeled toy.
Pedestrian crossing treatments	A pedestrian crossing treatment refers to the design features and measures implemented at locations where pedestrians cross the road, to enhance safety and accessibility.

Term	Definition
Posted speed limit	Means the speed zone as indicated by compliant regulatory signage.
Road user	Any driver, rider, passenger, or pedestrian using a road.
Signalised pedestrian crossing	Also known as Marked Foot Crossings under the Road Traffic Code 2000, it is a type of pedestrian crossing controlled by traffic signals with pedestrian lights facing pedestrians crossing the carriageway, and traffic-control signals facing drivers driving on the carriageway.
Stopping Sight Distance (SSD)	SSD is the minimum distance required for a driver to perceive a hazard and come to a complete stop before reaching it.
Traffic-Warden-Controlled Children's Crossing	Also known as Children's Crossings under the Road Traffic Code 2000, it is a type of pedestrian crossing typically located near schools and operated by trained traffic wardens during a period of the day.
Unmarked Crossing	A pedestrian crossing where vehicles have priority (i.e. there are no formal pavement markings, signs or signals).
Vulnerable pedestrians	Refers to those over a certain age (elderly), younger than a certain age (primary school and below) and mobility impaired people.
Vulnerable road user (VRU)	A vulnerable road user (VRU) is an individual at a higher risk of injury or fatality in traffic situations, due to their mode of transportation or lack of protective measures.
Zebra crossing	Also known as pedestrian crossings under the Road Traffic Code 2000, it is a type of pedestrian crossing marked with white stripes on the road surface. Pedestrians have right of way, i.e., vehicles must stop when someone is waiting to cross or at the crossing.

5. General Considerations

Practitioners should consider a range of factors when selecting the most appropriate type of pedestrian crossing facility and/or any supporting treatment(s) for the crossing.

For example, these factors must include (but are not limited to):

- the road environment
- volume and characteristics of road users, and
- speed environment.

This section provides a range of these factors to be considered when selecting the most appropriate type of crossing.

5.1 Location

When selecting a type of pedestrian crossing facility, it is crucial to consider locational factors such as:

- road function
- hierarchy
- layout
- geometry
- conditions, and
- infrastructure.

Each of these factors will include further elements for consideration such as:

1. The number and width of traffic lanes in each direction (as this will directly influence the crossing distance for pedestrians).
2. The space available for specific types of crossings.
3. The surrounding land use e.g. parking areas, bus stops, driveways, and proximity to other pedestrian crossings.
4. Proximity to shops, parks, schools and medical facilities etc.

Careful evaluation of these elements is vital to achieve a balance between pedestrian safety and optimal safe mobility.

A site visit is essential to evaluate the location and ensure crossings are properly positioned in relation to road geometry, i.e. to avoid curves, the downhill sides of crests, and low points.

5.2 Visibility

At grade pedestrian crossing facilities should be placed where drivers can see a pedestrian and have sufficient time to stop before reaching the crossing. They should also be placed where pedestrians can see a vehicle far enough away to safely cross the road before the vehicle arrives.

Adequate and uninterrupted sight lines are essential at all *at grade* pedestrian crossing facilities.

In addition, parked vehicles, vegetation, landscaping, utility poles, and street furniture must not obscure or restrict this visibility. This may not always be achievable. In these cases, additional treatment should be provided.

Ensuring adequate sight distances for both pedestrians and drivers is crucial to maximising the safety and usability of a pedestrian crossing facility.

Three key visibility distances must be considered when designing and assessing an at grade pedestrian crossing facility.

Table 5-1: Definitions and applications of the three key visibility distances

ASD - Approach sight distance	The distance required for a driver approaching an intersection or crossing to see the presence of the intersection or crossing and respond appropriately. It ensures that the driver can detect pavement markings, signs, or pedestrians in time to take action.
SSD - Stopping sight distance	The distance for a driver to perceive, react and safely brake to a stop before reaching a hazard on the road ahead.
CSD - Crossing sight distance	The distance a pedestrian requires to see oncoming traffic and judge whether it is safe to cross

The table below shows which sight distances are required for each type of crossing:

	ASD	SSD	CSD
Unmarked crossing	NA	✓	✓
Zebra crossing	✓	✓	✓
Signalised pedestrian crossing	✓	✓	✓ *
Grade separated	NA	NA	NA
Children's crossing	✓	✓	✓

* *Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersections* - Section 3.3: It is desirable that CSD be provided at crossings controlled by signals in case of signal failure.

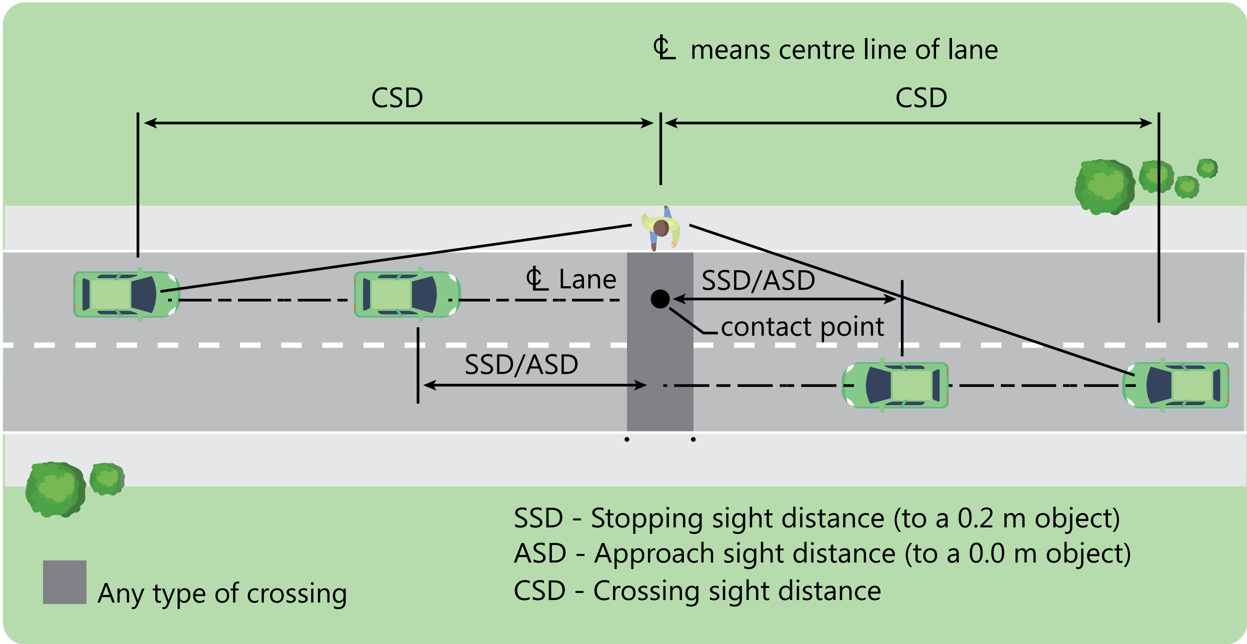


Figure 5-1 ASD, SSD and CSD

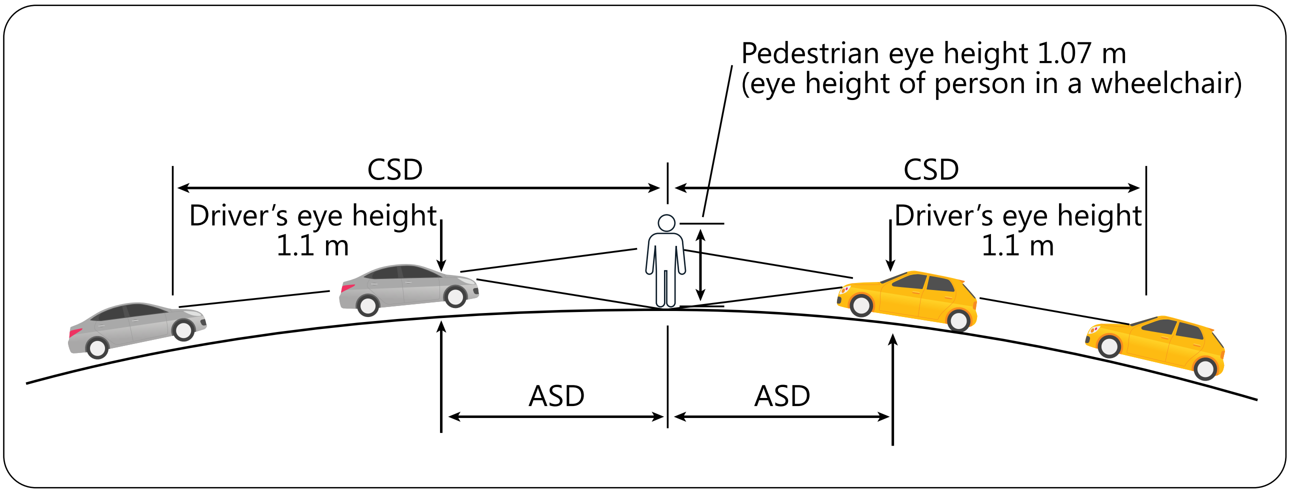


Figure 5-2 Longitudinal section – driver on major road

Source: Guide to Road Design Part 4A - Figure 3.7: Sight distance at pedestrian crossings

Note: Refer to Austroads', *Guide to Road Design Part 4A Section 3.3*, and, Main Roads', *Supplement to Part 4A - Section 3, for specific applications of ASD, SSD and CSD.*

5.3 Safe system approach

The National Road Safety Strategy 2021-30 outlines Australia's road safety goals for the next decade. The strategy aims to decrease annual fatalities by at least 50% and serious injuries by at least 30% by 2030.

The State of Western Australia has its own strategy, "*Driving Change – Road Safety Strategy for Western Australia 2020 – 2030*".

This strategy sets a more ambitious target of achieving zero fatalities or severe injuries on WA roads by 2050, whilst also aiming to reduce the number of fatal and seriously injured (FSI) crashes by 50-70% by 2030.

Main Roads' primary objective is to improve the safety of the road network to (as a minimum) meet the agreed road safety targets for road safety, by reducing the road environment contribution to fatal crashes.

The *Safe System* approach, as outlined by Austroads, is a comprehensive framework aimed at improving road safety by adopting a holistic perspective. Under the *Safe System* approach the key elements are:

Systemic Perspective: It views the road transport system as an interconnected network involving road users, vehicles, and infrastructure. The focus is on how these elements interact and contribute to safety.

Human Behaviour: Recognises that human error is inevitable. The system should be designed to accommodate mistakes without leading to fatal or serious injuries.

Shared Responsibility: Emphasizes that all stakeholders, including government, road authorities, vehicle manufacturers, and road users, share the responsibility for creating a safe road environment.

Data-Driven Approach: Supports the use of data and evidence-based practices to inform decision-making and continuously improve road safety interventions.

The pillars of the *Safe System Approach* are defined as:

Safe Roads: Advocates for designing and maintaining roads that reduce the likelihood of crashes and the severity of injuries when they occur. This includes appropriate signage, road conditions, and traffic management.

Safe Speeds: Highlights the importance of setting speed limits that are appropriate for the road environment, ensuring speeds are manageable for all road users (especially vulnerable road users).

Safe Vehicles: Encourages the use of vehicles equipped with modern safety technologies that protect occupants and reduce the risk of crashes.

Safe Road Use: Promotes safe behaviours amongst all road users through education, awareness campaigns, and enforcement of traffic laws.

Post-crash Care: Aims for a future where road traffic deaths and serious injuries are eliminated, aligning with broader public health and sustainability goals. Adopting the Safe Systems approach can help address both *national* and *state* level road safety targets, by creating a safer road environment that minimises risks and enhances the safety of all road users.

The following diagram demonstrates the pillars of the Safe System Approach.

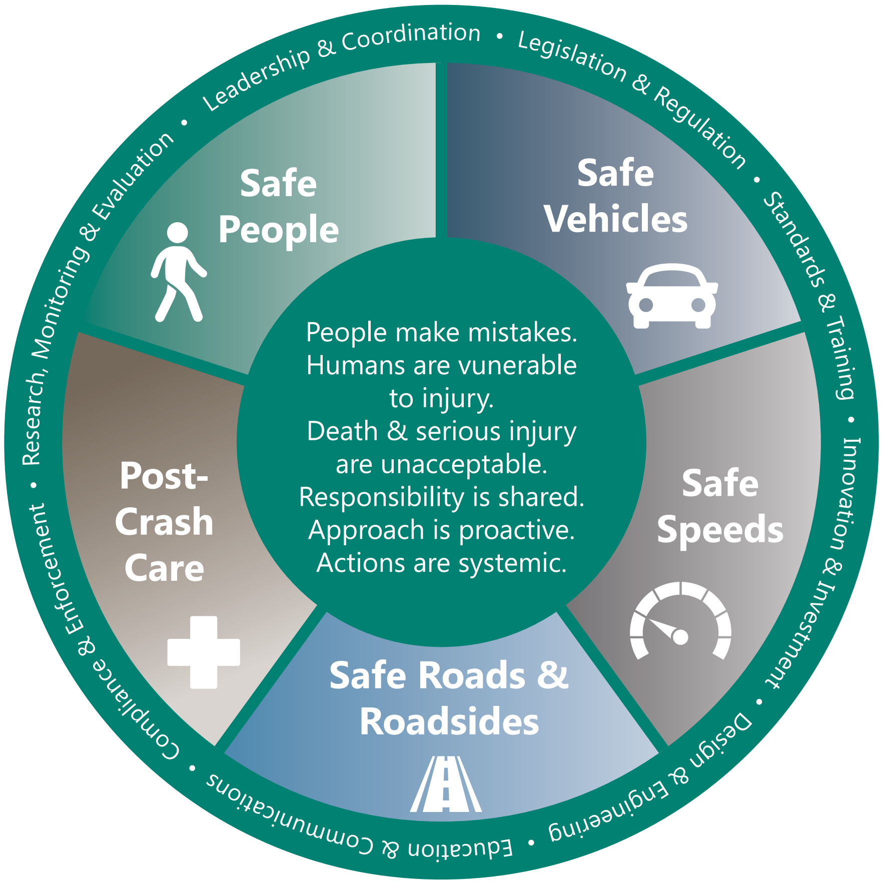


Figure 5-3 The pillars of the Safe System Approach

5.4 Traffic speed

Speed is of critical importance to pedestrian safety, as it is a major factor in both the likelihood of a collision occurring, and the resulting severity of injury.

Research shows the probability of a crash between a vehicle and a pedestrian resulting in a fatality or serious injury rises significantly if the impact speed of the vehicle is over 30 km/h. It is also more difficult for pedestrians to judge safe gaps in higher speed environments, which in turn impacts a driver’s ability to react.

If there are no suitable crossing types for the speed environment, or the only appropriate crossing type is not viable (due to costs, space constraints, etc.), treatments such as reduced speed limits, variable speed limits, traffic calming, and strategies to reduce traffic volumes and speeds can be applied along areas with a high number of pedestrians (current or desired).

In areas with high pedestrian activity (such as activity centres, or near schools), road environments may need to be modified by adding treatments such as reducing traffic speeds, or enhancing driver awareness of pedestrian activity, before a safe crossing can be implemented.

Note: These guidelines may refer to "desirable" and "required" speeds at the location of a pedestrian crossing. This does not necessarily refer to the free flow operating speed of the road, or the speed limit. The speed may be reduced at the location of the pedestrian crossing through the crossing itself, i.e. wombat crossing, the alignment of the road, or by the supporting treatments (as described in Section 9).

5.5 Crash history

Investigating the crash history at a specific location is crucial for identifying existing road safety issues.

This analysis should not be limited to recorded pedestrian crashes, and must also include other types of crashes and near misses in the vicinity. Understanding the broader context of crashes can provide valuable insights into potential hazards and inform necessary improvements.

By taking these steps, safer environments are created for all road users, particularly vulnerable pedestrians.

Note: Whilst investigating the crash history is important, it does not limit a decision to implement a crossing if it is deemed necessary (even if there are no crashes associated with the chosen location).

5.6 Street function

Street function strikes a balance between a roads' dual purposes of:

1. **Movement:** where people travel through to get from one place to another - movement of people and goods - rather than just vehicles.
2. **Place:** where people spend time undertaking everyday activities for recreational or social purposes - as a destination.

The main objective here is to align *movement* and *place* with an appropriate type of pedestrian crossing facility providing users of all ages and abilities with better, safer and healthier travel options, while creating vibrant places where people want to live, work and play.

5.6.1 Street function classifications

Pedestrian crossings assist a street in achieving its desired movement and place functions by prioritising movement according to its classification.

Metropolitan roads are categorised according to their functional hierarchy in WA, with a high correlation between the road hierarchy classification and movement value of the road.

Note: In WA, the '*Movement and Place Framework*' is currently being developed in consultation with key stakeholders. On completion, the framework will be incorporated into these guidelines. In the meantime, the Austroads' Movement and Place Matrix (refer to Figure 5-4) is to be adopted.

Figure 5-4 Austroads' Movement and Place Matrix

The ***strategic movement*** function of a segment of road or street is determined by the volume and mix of journey types (including through, access and local journeys in the subject network), with "journeys" including the movement of people and goods.

The strategic movement function commonly correlates with traditional road classification hierarchies, with adjustments made for strategic modal priorities (e.g. cycle or bus priority routes).

The ***place intensity*** of a segment of road or street is determined by:

- the mix of local activity
- meaning and use
- the physical form of the road or street; and
- the adjacent land use.

The overall place intensity is not a summation of these considerations, rather it is the interaction between them.

Locations with a high place value and low movement value tend to have a high number of pedestrians and lower speed environments. In these locations, drivers are more aware of pedestrians, and generally more cautious.

Locations with a low place value and high movement value (such as along primary distributor roads) generally have a low number of pedestrians and higher posted speeds. In these locations drivers only occasionally encounter pedestrians crossing the road.

Locations with low vehicle speeds and low volumes allow users to share the space.

There are also locations with a high place value and high movement value, such as town centres on primary distributor roads. In these locations, pedestrian safety must be the most important consideration - where every effort should be made to optimise safe mobility.

5.7 Pedestrian volumes and characteristics

When determining the type of pedestrian crossing facility, it is essential to consider the various pedestrian groups who will use the crossing.

Different groups of pedestrians have distinct needs and behaviours that can significantly influence the design and effectiveness of a crossing.

Young children may require additional safety measures due to their limited understanding of traffic rules and smaller stature (making them less visible to drivers). Therefore, crossings near schools should ideally be supervised and incorporate features to enable longer crossing times such as:

- traffic warden-controlled children's crossings
- raised platforms
- clear signage, and (potentially)
- traffic signals.

Older adults and mobility impaired pedestrians can face challenges including slower walking speeds. Crossings designed for this demographic should therefore feature:

- kerb ramps
- longer signal phases
- audio signals
- tactile paving
- wider crossing areas, and
- clear visibility.

Note: Assuring accessibility is not only a legal requirement, but also a moral imperative to promote inclusivity.

By understanding the diverse needs of pedestrian types, appropriate crossing designs can be selected to enhance safety and accessibility. This thoughtful consideration not only improves the overall pedestrian experience, but also fosters a culture of safety and respect amongst all road users.

Additionally, locations that experience periods of high demand (or overcrowding) may not be suitable for two-stage crossing facilities or left-turn slip lane crossings, as pedestrians may not have the space to wait safely within the median, or on the traffic island refuge provided.

If high pedestrian numbers are expected during normal day-to-day operation or frequent large-scale events, then wider crossings may also need to be considered.

5.8 Crossing sight distance and gap acceptance

Austroads *Guide to Road Design Part 4A – Unsignalised and Signalised Intersections* provides the following formula to calculate the Crossing Sight Distance (CSD) for pedestrians at a unmarked pedestrian crossing. This is the sight distance required for a pedestrian to cross the road safely.

$$\mathrm{CSD} = t_C \, x \, \frac{V}{3.6}$$

Figure 5-5 Sight distance formula

Where *CSD* = sight distance required for a pedestrian to safely cross the road

t_c = critical safe gap (sec) = (crossing length/walking speed) + 3 seconds for pedestrian start up and end clearance time (see Figure 5-6)

V = 85th percentile approach speed (km/h)

From Figure 5-5, the CSD is a direct function of the critical safe gap and the 85th percentile vehicle approach speed.

The Critical Safe Gap is the time required for a pedestrian to cross the road safely based on an assumed walking speed and includes start-up and clearance times. The Critical Safe Gap can be calculated as:

$$t_C = \textit{(Crossing length) / (Walking speed)} + 3.0$$

Figure 5-6 Critical Safe Gap formula

Note:

- The crossing length shall include a pedestrian set back of 1.6 m from the pavement edge or kerb line. i.e. crossing length = kerb-to-kerb crossing distance + 1.6 m
- Walking speed is taken to be 1.2 m/s. However, at locations where more than 15 per cent of pedestrians at any full hour of the day are children, elderly or mobility impaired, the walking speed should be 1.0 m/s rather than the standard 1.2 m/s.
- 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.
- The 3 seconds for pedestrian start-up and end clearance time may not be achievable in constrained situations. A risk assessment should be undertaken if the 3 second start-up and end clearance time is omitted.

For any given traffic stream, if the available gaps between successive vehicles are greater than the Critical Safe Gap, it is assumed that a waiting pedestrian will cross.

However, if the available gaps are less than the Critical Safe Gap, it is assumed the pedestrian will either take a risk by crossing in less than desirable gaps (with major safety implications), or will most likely give up after waiting for some time.

5.9 Pedestrian delay and critical safe gap

Table 5-2 below provides the level of service criteria for pedestrian delay for Give Way or Stop controlled intersections (which also applies to mid-block pedestrian crossings), as contained in the *Highway Capacity Manual, 2010*.

Table 5-2: Level of service criteria for pedestrian delay

Level of Service (LoS)	Average delay per pedestrian (seconds)
A	$d \leq 5$
B	$5 < d \leq 10$
C	$10 < d \leq 20$
D	$20 < d \leq 30$
E	$30 < d \leq 45$
F	$d > 45$

Source: Highway Capacity Manual, 2010

The values in Table 5-2 have been adopted to develop maximum average acceptable delays for pedestrians based on LoS by movement and place, as indicated in Figure 5-7.

Figure 5-7 Maximum average acceptable delays for pedestrians based on LOS by Movement and Place

Where the place function is high, i.e. there are a high number of pedestrians and the movement function is low, pedestrians should be prioritised and should experience minimal delays. This can be achieved through shared zones, or zebra crossings.

On the other hand, where the movement function is high, vehicles should have priority, and pedestrians would expect to experience longer delays.

When both movement and place are high along heavy vehicle routes, grade-separated pedestrian crossings are often the most effective approach. These crossings (i.e. overpasses and underpasses) eliminate conflicts between pedestrians and vehicles, ensuring safety and smooth traffic flow.

However, implementing grade separation requires careful consideration of factors like accessibility, cost, and potential impacts on pedestrian travel time.

Supporting treatments, such as exclusive pedestrian phases at signalised intersections, can also be effective in managing pedestrian and vehicle interactions.

5.9.1 Pedestrian delay based on Critical Safe Gap

Note: This methodology is normally applied to existing peak hour count data at a particular location, but may also be used with forecast traffic volumes to estimate the expected future pedestrian delay.

Based on the value of the Critical Safe Gap, the distribution of headways in the traffic stream can be examined to determine the number of available gaps (i.e. headways greater than the Critical Safe Gap) and hence the number of crossing opportunities. In addition, the average waiting time for a crossing opportunity (i.e. average delay) can also be determined.

5.9.1.1 Pedestrian delay based on a random arrival distribution

Austroads Guide to Traffic Management Part 2: Traffic Theory provides the following equation to calculate the average delay for side traffic at a T-junction (including those that experience no delay) based on a random arrival pattern using the Poisson distribution:

$$d_{av}(d \geq 0) = 1/(qe^{-qT}) - 1/q - T \text{ (sec/veh)}$$

Figure 5-8 Average delay for side traffic at a T-junction

Where, q = the volume of the conflicting major traffic stream in veh/sec
T = the size of the critical gap (or critical lag) in sec/veh

For a pedestrian waiting to cross a stream of traffic, the critical gap (tc) (provided in Figure 5-6) can be substituted for "T" (as shown in Figure 5-8), to determine the average pedestrian waiting delay.

Since the average delay is a function of the traffic volume and the critical gap/crossing time (which, in turn, is a function of the crossing distance), it is possible to construct delay curves for various combinations of crossing time and traffic volumes.

The following charts demonstrate pedestrian crossing delays for a single, two-way carriageway (Figure 5–9), and a dual carriageway (Figure 5-10).

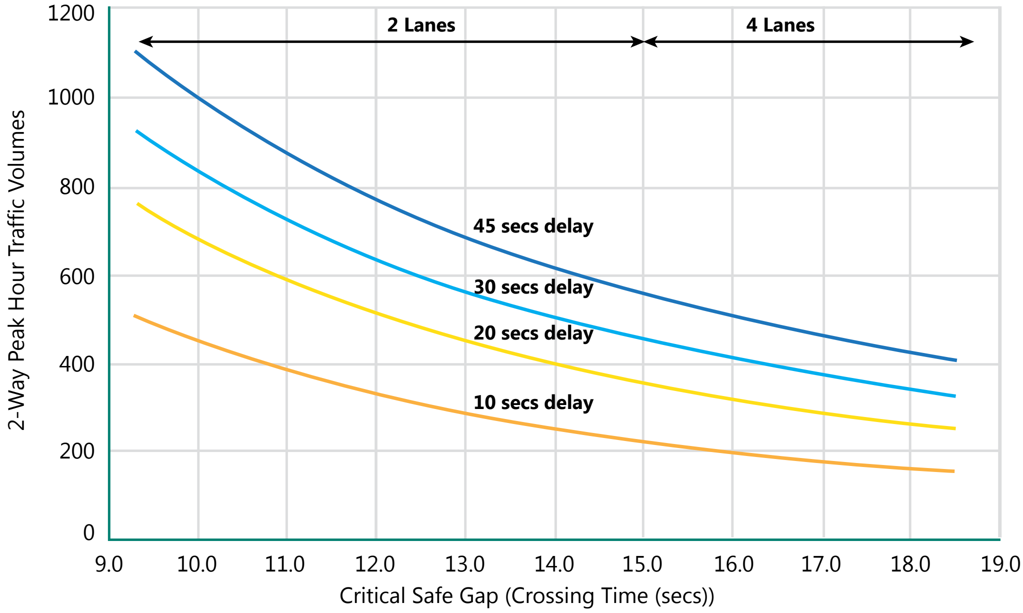


Figure 5-9 Pedestrian crossing delay for single, two-way carriageway

Notes for Figure 5-9:

1. Delay based on random arrivals (Poisson distribution).
2. Critical Safe Gap (crossing time) assumes an initial pedestrian setback of 1.6 m, 1.2 m/s walking speed and 3 sec start-up and clearance time.
3. Traffic volume to use is the higher of the AM or PM peak periods.

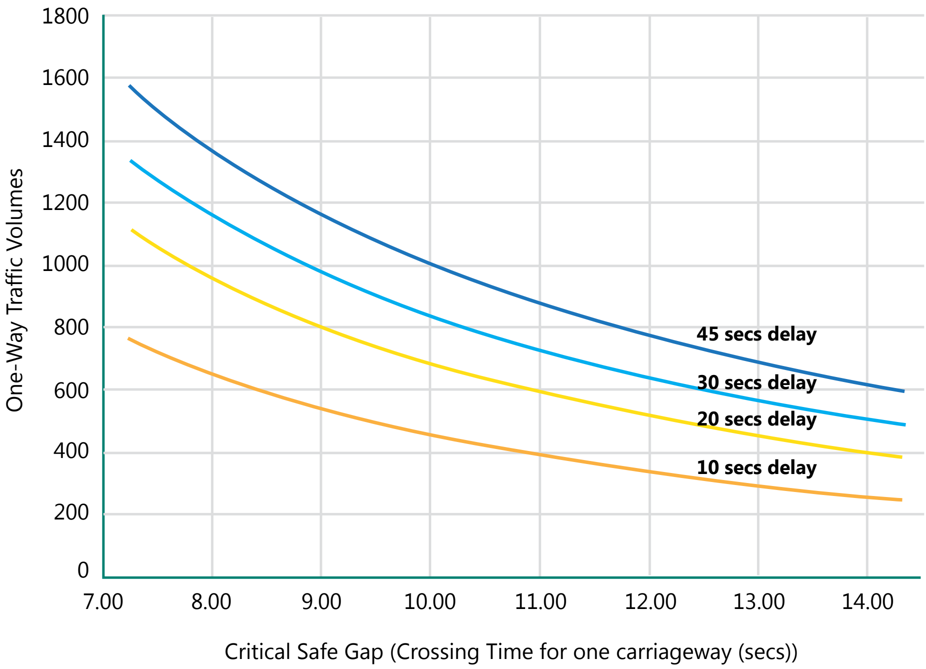


Figure 5-10 Pedestrian crossing delay for dual carriageway

Notes for Figure 5-10:

1. Delay based on random arrivals (Poisson distribution).
2. Critical Safe Gap (crossing time) calculated independently for each carriageway.
3. Crossing time assumes an initial pedestrian setback of 1.6 m for each separate crossing, 1.2 m/s walking speed and 3 second start-up and clearance time.
4. Calculate average delay for each carriageway separately for both AM and PM peak periods. If the directional distribution is not available, assume a 60:40 split.
5. Use the highest average delay to determine which pedestrian crossing facility is required (refer to Figure 5-7).

5.9.1.2 Pedestrian delay based on gap analysis

The methodology detailed in Section 5.9.1.1 works sufficiently well for a traffic distribution based on random arrivals. The methodology may be used in the first instance to determine whether the expected pedestrian delay based on Movement and Place is likely to be acceptable or not.

Where the traffic distribution is largely affected by the proximity to upstream traffic signals, the vehicles may arrive in platoons with little gaps between the individual vehicles, but with significant gaps between platoons.

The significant gaps between platoons often offer multiple pedestrian crossing opportunities. Under these circumstances, a gap analysis (based on the actual traffic flow) can be undertaken to determine the average pedestrian delay.

It should be noted that this is only possible based on measured data and cannot be extrapolated based on future traffic volumes.

Main Roads has developed a spreadsheet-based gap analysis methodology based on MetroCount data. This is detailed in Appendix 2.

A copy of the *MetroCount* data excel spreadsheet may be found here.

5.9.2 Pedestrian delay process

The process to determine whether the pedestrian delay based on Movement and Place is acceptable or not is shown in the following Figure 5-11 below:

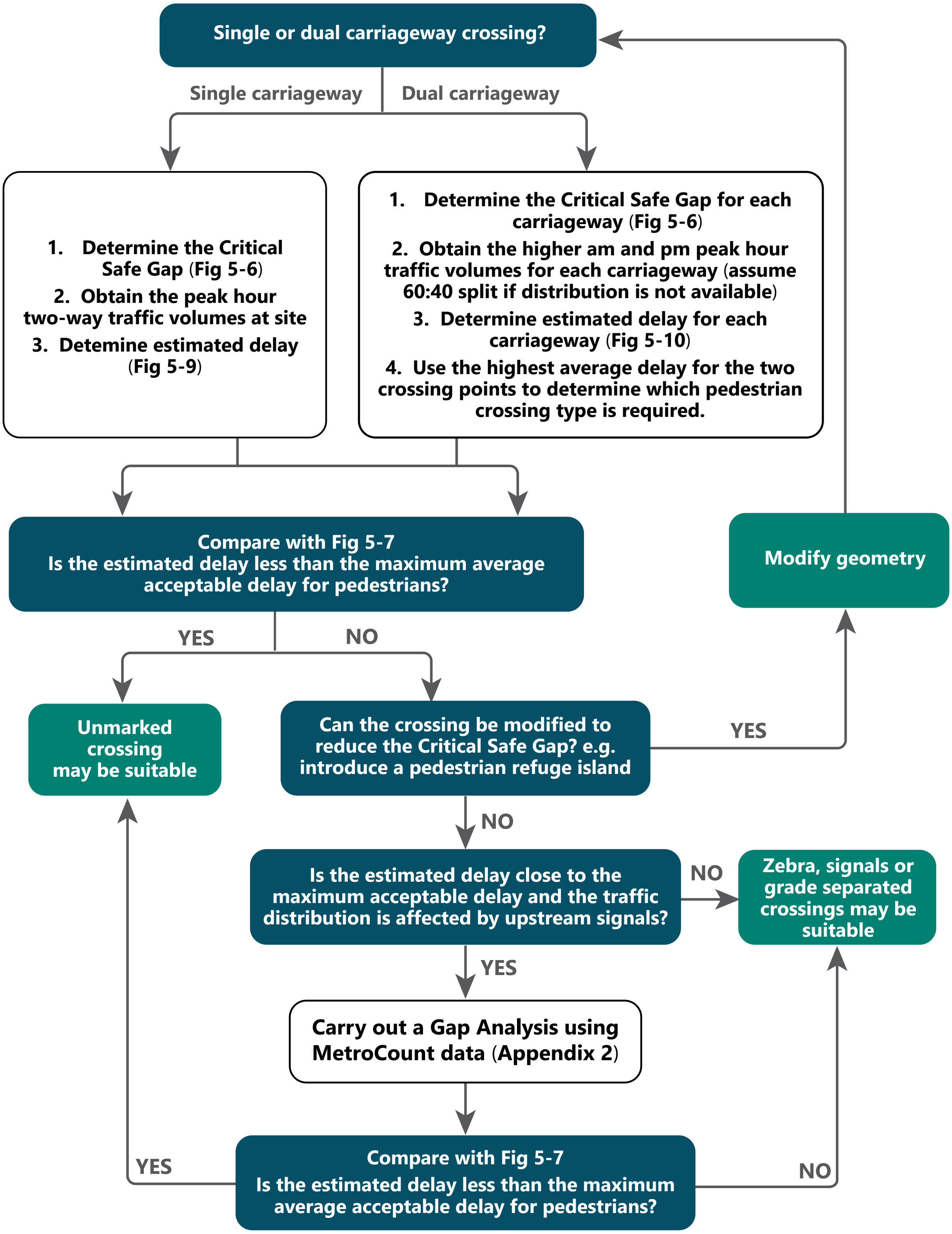


Figure 5-11 Pedestrian delay process

5.10 Traffic delay

Traffic volume affects delays experienced by pedestrians at unmarked pedestrian crossing sites.

Conversely, pedestrian crossing facilities providing priority to pedestrians may not only cause delays to car drivers and passengers, but also to other road users such as cyclists, buses, and public transport.

Table 5-3 provides the level of service criteria for vehicle delay for two-way stopped control intersections, as contained in the *Highway Capacity Manual, 2010*. The level of service (LoS) criteria may also be used to measure LoS for stopped vehicles at priority pedestrian crossings.

Table 5-3: LoS criteria for traffic delay for two-way stop-controlled intersections

Level of Service (LoS)	Average delay per pedestrian (seconds)
A	d ≤ 10
B	10 < d ≤ 15
C	15 < d ≤ 25
D	25 < d ≤ 35
E	35 < d ≤ 50
F	d > 50

Source: Highway Capacity Manual, 2010

When determining the appropriate crossing facility, consideration should be given to the delay caused to drivers stopping for:

- pedestrians at zebra crossings
- traffic-warden-controlled children's crossings
- shared zones, and
- signalised pedestrian crossing facilities.

Based on the target levels of service by *movement* and *place*, the maximum average acceptable delay for vehicles at zebra crossings is shown below in Figure 5-12.

Figure 5-12 Maximum average acceptable delays for vehicles at zebra crossings based on LoS by movement and place

The graph below provides an indication of the suitability of a 6 m wide zebra crossing, based on pedestrian and traffic volumes. It includes a curve for each quadrant in the movement and place framework, and varies depending on the crossing distances.

This analysis aims to guide decision-making for appropriate pedestrian crossing treatments in various contexts.

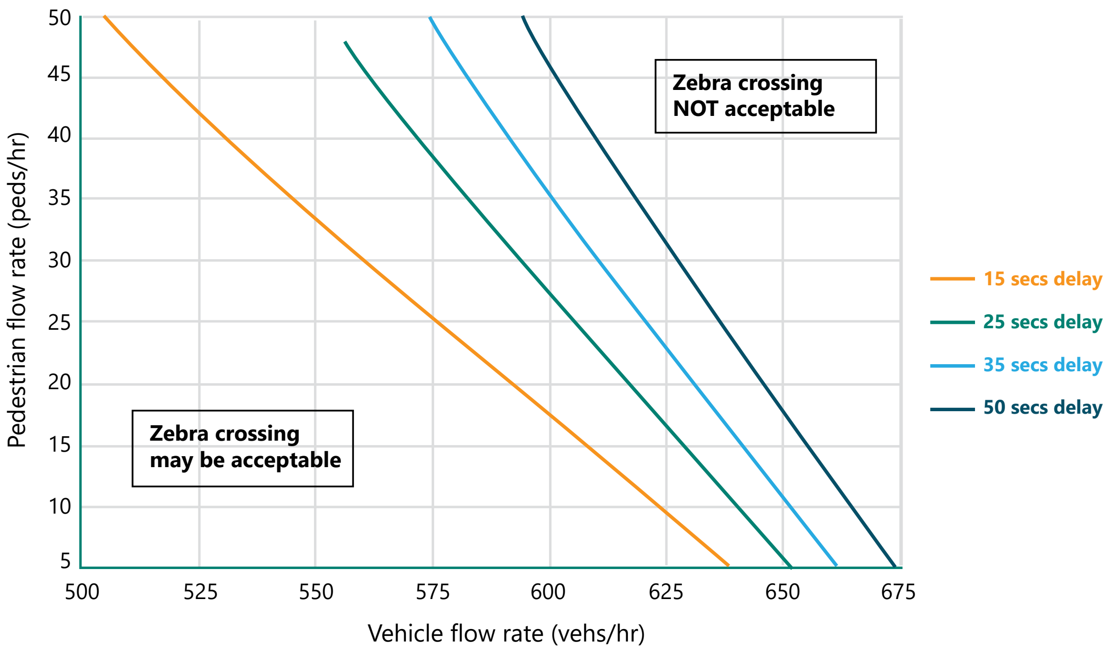


Figure 5-13 Average vehicle delays at a zebra crossing for a 6 m kerb-to-kerb crossing distance

Notes for Figure 5-13:

1. The graph has been created using SIDRA, with Critical Safe Gap calculated as per Section 5.8.
2. Crossing Distance refers to the actual kerb-to-kerb road width of the zebra crossing.
3. Where there is more than one vehicle lane, the vehicle flow rate of the lane with the highest flow rate is to be used, as this will result in the highest delay / vehicle LoS.
4. The vehicle flow rate values in the chart assume a peak hour factor of 100 per cent and a vehicle composition of 100 per cent light vehicles.

Refer to Appendix 3 for graphs illustrating different crossing distances to Figure 5-13 (i.e., 3, 4, 5, 6, 8, 10 and 12 metres.)

Where delays are considered unacceptable for vehicles, an alternative pedestrian crossing type (see Section 6) that can accommodate acceptable delays for both pedestrians and drivers should be considered (e.g. signalised pedestrian crossing facilities or grade separation).

5.11 Heavy vehicles

While heavy vehicles typically represent a small percentage of traffic composition, they can have a significant impact on pedestrian safety and must be considered when assessing a pedestrian crossing facility.

Heavy vehicles often have blind spots due to their size, resulting in drivers potentially not being able to observe a recently arrived pedestrian at a crossing point. They also require a longer distance for deceleration.

As such, the crossing geometry should be assessed with respect to the likelihood of conflicts between pedestrians and heavy vehicles.

If the percentage of heavy vehicles is greater than 10%, the sight distance requirements (ASD and CSD) should be checked for both cars and heavy vehicles, taking into consideration the respective vehicle deceleration and driver's eye height characteristics, i.e. use a driver's eye height of 1.1m for cars and 2.4m for trucks and a deceleration coefficient of 0.36 for cars and 0.22 for trucks. (Refer to Main Roads Supplement to the *Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersections* - Section 3.2).

5.12 Desire lines

Pedestrian desire lines are informal paths that people create based on natural movement patterns and preferences. They often represent the most direct route between two points - reflecting the actual behaviour of pedestrians.

Locating a crossing away from a pedestrian desire line may result in low usage (or create a road safety risk for all road users) if pedestrians continue to cross in accordance with preferred desire lines.

Providing crossings where pedestrians have created desire lines or as close as possible to desire lines, should be a primary consideration. Where this is not possible (or it is unsafe to do so), treatments can be used to mitigate the risks.

For existing locations, methods to assess whether pedestrians cross in one place, or if crossings are spread along a route or intersection include:

- conducting observational studies to monitor behaviours and
- examining worn surfaces and forced gaps in median landscaping.

For crossings in new developments, desire lines should be anticipated based on:

- an assessment of the proposed land uses
- proximity to schools, train stations, bus stops and trip attractors in the area
- current patterns of pedestrian movement in the surrounding area.

Understanding desire lines helps practitioners create more effective and user-friendly infrastructure, by aligning pathways and crossings with how people naturally navigate spaces.

Note: This proactive approach is vital for developing a master plan for higher-order roads, as it helps avoid ad hoc decisions that can lead to congestion, safety hazards, and inefficient land use.

By strategically planning these crossings, enhanced connectivity, improved accessibility, and a more organised urban environment can be achieved.

The ideal maximum allowable deviation from the desire line for pedestrians based on movement and place is shown in Figure 5-14, however, they may vary depending on the specific context and layout of each location.

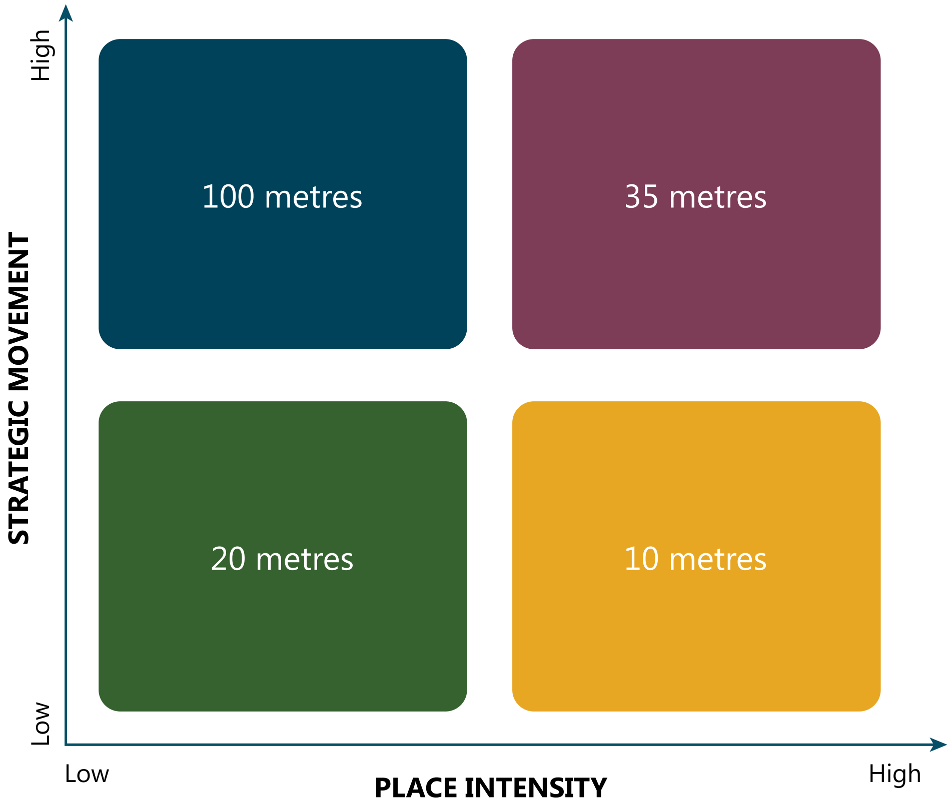


Figure 5-14 Ideal maximum allowable deviation from pedestrian desire line

5.13 Lighting

Adequate lighting at pedestrian crossing facilities is essential to provide drivers advanced warning of a crossing and to enhance pedestrian visibility. Lighting also enhances safety by enabling pedestrians to orientate themselves and identify hazards at a crossing point.

The following documents provide guidance on lighting requirements for pedestrian crossings:

- *Australian Standard 1158.1.1*
- *Australian Standard 1158.3.1*
- *Australian Standard 1158.4 Lighting for Roads and Public Spaces, and*
- *Main Roads' Road Lighting - Part B - Application Approval Guidelines*

Local government: The Local Government Authority shall provide advice of the applicable lighting category for the location of the proposed zebra crossing within their jurisdiction.

Main Roads: Main Roads shall comply with the Main Roads' Lighting Design Guidelines for Roadways and Public Spaces.

6. Types of Crossings

6.1 Unmarked crossings

Unmarked crossings are the most basic provision of crossing types to aid pedestrians. They usually consist of kerb ramps and cut-throughs to allow easier access from the path to the road.

In most instances, vehicles on the road have the right of way and pedestrians must wait for a gap in traffic. The objectives of unmarked crossings are to:

- Indicate that the location is a safe place to cross.
- Provide an accessible path of travel for mobility impaired pedestrians, and those pushing or operating wheeled devices (e.g. prams, shopping trolleys, suitcases, bicycles, electric rideable devices, wheeled recreational devices, motorised scooters or wheeled toys).
- Reduce the trip hazard associated with kerbs.

Under the *Road Traffic Code 2000 Regulation 199(1)*, "*A pedestrian must not cross a carriageway, or part of a carriageway, within 20 m of a children's crossing, marked foot crossing or pedestrian crossing on the carriageway, except at the crossing or another crossing, unless the pedestrian is -*

(a) *crossing at an intersection with traffic control signals and a "pedestrians may cross diagonally" sign; or*

(b) crossing in a shared zone; or

(c) crossing a carriageway, or a part of a carriageway, from which vehicles are excluded, either permanently or temporarily; or

(d) alighting from or boarding a public bus in a bus stop, bus zone or other authorised stopping place."

Therefore, the provision of an unmarked crossing does not legally change a pedestrian's permission to cross.

Table 6-1 Unmarked crossing applications

Application	
Average pedestrian delay	Minimum unmarked crossing must be provided if pedestrian delay is not beyond the limits shown in Section 5.9.
Spacing between unmarked crossings	In general, unmarked crossings can be located every 100 m, subject to site constraints.
Spacing between unmarked crossings and other crossings	An unmarked crossing can be provided if it is more than 200m away from an existing crossing, unless it is adjacent to an activity centre, in which case it may be located within 100m of an existing crossing.
Pedestrian volume	Low to medium volumes of pedestrians crossing. Should a zebra, signals or grade separated crossings not be warranted, an unmarked crossing may be provided.
Desire line	Noticeable pedestrians' desire line or cycle path route.

Below are the requirements that apply to all unmarked crossings. Additional requirements related to each location are included in each section, accordingly.

Table 6-2 Unmarked crossing requirements

Requirements	
Sight distance	CSD and SSD must be available as per Section 5.2.
Number of lanes	Unmarked crossings should not be installed across 3 or more lanes unless combined with additional treatments.
Speed limit	Unmarked crossing should not be installed on roads with the posted speed limit more than 70 km/h, unless combined with additional treatments.
Lighting	As per section 5.13
Median	Provision of a median where there is difficulty crossing the full width of the road in one stage due to: • long delays or insufficient number of suitable gaps, as per section 5.9 • long crossing length or multiple lanes • high vehicle flows or high speed • insufficient sight distance to enable a crossing length of both directions of traffic.
Desire lines	Unmarked crossings should not be located further than the maximum deviation from the desire line of pedestrians as per Section 5.12.

6.1.1 Mid-block

An unmarked crossing on a mid-block refers to designated locations along a carriageway where a road crossing treatment is provided on either side of the carriageway for pedestrians to cross, but no formal markings or signs are provided as per Figure 6-1.

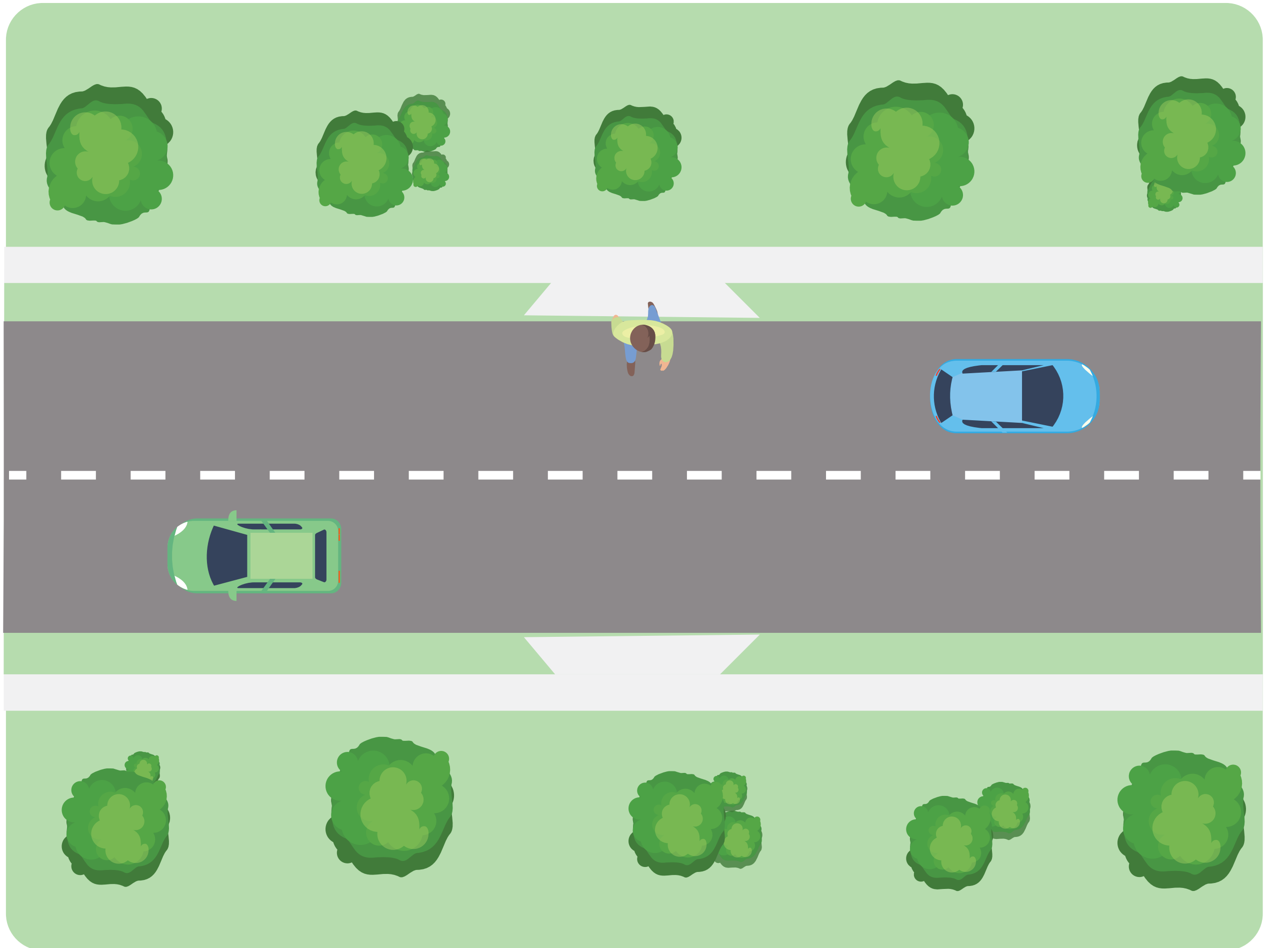


Figure 6-1 Unmarked crossing at mid-block

Refer to Table 6-2 for requirements.

6.1.2 Unsignalised intersection

Unmarked crossings are the default treatment for pedestrian crossings on the side road(s) of unsignalised intersections. As a minimum, unmarked crossings must be provided across all side roads where there is a path that continues across the side road.

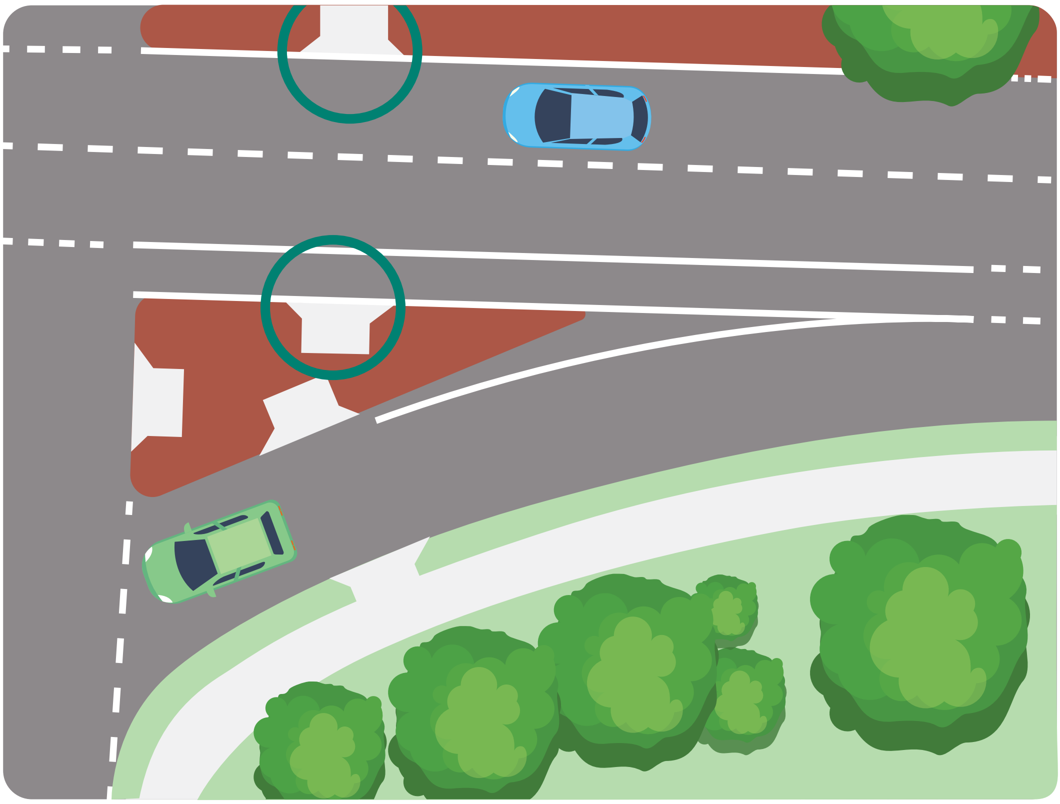


Figure 6-2 Unmarked crossing at unsignalised intersection

Refer to Table 6-2 for requirements. Additional requirements for unmarked crossings at unsignalised intersections are set out in the following table.

Table 6-3 Additional requirements for unsignalised intersections

Requirements	
Distance from intersection	Side road pedestrian crossings must be within 10 m of the intersection. Unmarked crossings preferably should not be located within 6 m of the holding line to enable pedestrians to pass behind a vehicle. (Main Roads acknowledges that a 6 m clearance may not always be possible given site-specific constraints.)
Operating speed	It is desirable to reduce the turning vehicles operating speeds at or prior to the crossing points. Ideally, operating speed should be reduced to 30 km/h or less.

6.1.3 Single lane roundabouts

Unmarked pedestrian crossings are the default treatment for pedestrian crossings at roundabouts.

Unlike other intersections, on single lane roundabouts, turning vehicles are not required to give way to pedestrians on the carriageway, unless there is a formal crossing, such as a zebra crossing. As a minimum, unmarked crossing must be provided on all legs of a roundabout where there is a path that continues across the roundabout.

An important consideration for unmarked pedestrian crossings at roundabouts is the distance from the roundabout to the kerb ramps. The closer the kerb ramps are to the holding lines, the worse the effect of rolling queues (unless close enough that queues are stationary), which means pedestrians are required to see further down the side roads to observe oncoming traffic.

The further the kerb ramps are from the roundabout, the less convenient it becomes for pedestrians (as the detour from the desire lines becomes greater as do the vehicle speeds).

Practitioners should therefore look to minimise the deviation from a pedestrian's desire line, while maintaining an appropriate number of gaps in traffic to ensure pedestrian delays are below the levels deemed acceptable. This should be determined using the methods described in Section 5.9.

Figure 6-3 Unmarked crossings at single lane roundabout

Refer to Table 6-2 for requirements. Additional requirements for unmarked crossings at roundabouts are set out in the following table.

Table 6-4 Additional requirements for single lane roundabouts

Requirements	
Distance from holding line	On the approach, ideally unmarked crossings should not be located within 6 m of the holding line, to enable pedestrians to pass behind a vehicle. This may be difficult to achieve at roundabouts with a small splitter island
Operating speed	It is desirable to reduce the vehicle operating speeds at, or prior to, the crossing points. Ideally, operating speed should be reduced to 30 km/h or less.

6.1.4 Slip lanes at unsignalised intersections

As per *Road Traffic Code 2000 Regulation 55 (5)*, if a driver at an intersection is turning left using a slip lane, the driver shall give way to any pedestrian on the slip lane.

However, it should also be noted that, while pedestrians may have priority over vehicles at slip lanes, very few drivers in WA give way to pedestrians under such circumstances.

A slip lane is defined by the *Road Traffic Code 2000 Regulation 3*, as 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 island or traffic island.

Slip lanes at unsignalised intersections can be categorised into two types:

1. **High entry angle slip lanes** (unsignalised intersections with give-way control) - speeds should already be slow, therefore it should not be difficult to reduce traffic speeds to below 30 km/h.
2. **Free flow slip lanes** (unsignalised intersections and roundabouts) - traffic speeds can be high, therefore reducing traffic speeds to below 30 km/h may be difficult.

Unmarked crossings are a default treatment for pedestrian crossings on unsignalised slip lanes. They allow pedestrians to cross from the kerbside to an island, separating the left turning traffic from through traffic.

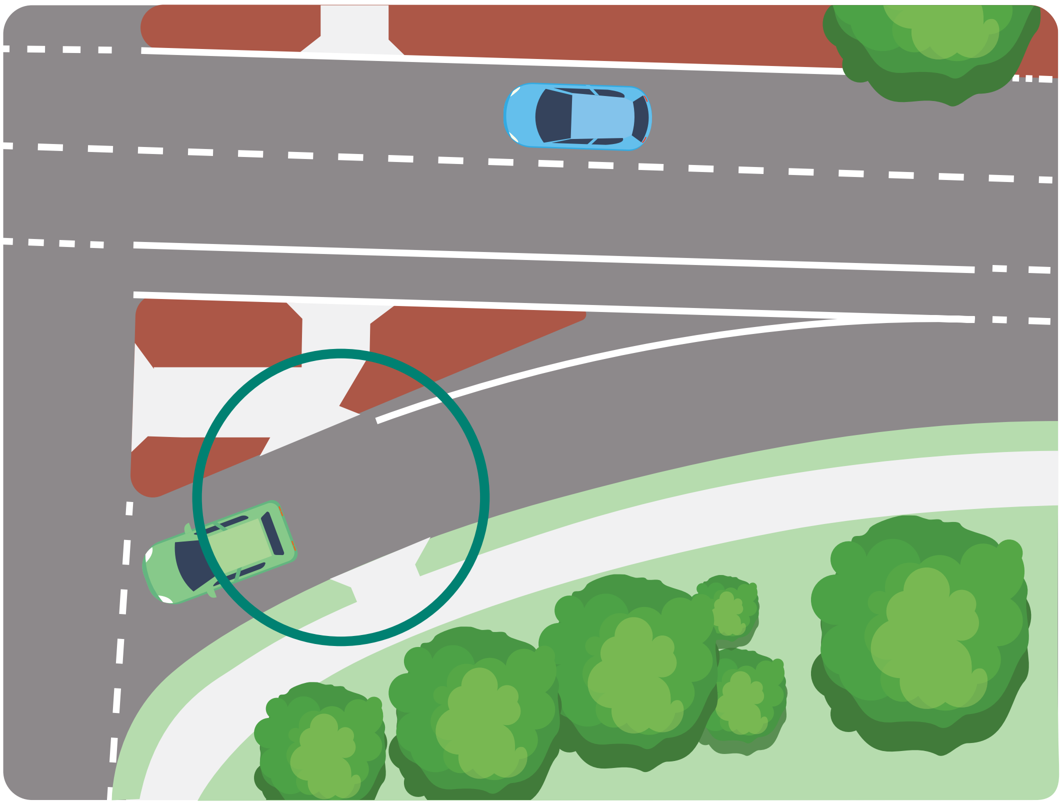


Figure 6-4 Unmarked crossing at unsignalised slip lane

Refer to Table 6-2 for requirements. Additional requirements for unmarked crossings at unsignalised slip lanes are set out in the following table.

Table 6-5 Additional requirements for unsignalised slip lanes

Requirements	
Distance from holding line	Preferably, unmarked crossings of high-angle-entry slip lanes should not be located within 6 m of the holding line, to enable pedestrians to pass behind a vehicle. Unmarked crossings at free flow slip lanes should not be located further than the maximum deviation from the desire line of pedestrians as per Section 5.12.
Operating speed	It is desirable to reduce the operating speeds at, or prior to, the crossing points. Ideally, operating speed should be reduced to 30 km/h or less. High-entry-angle slip lanes should generally achieve this, as vehicles are required to slow down for the upcoming holding line. For free-flow slip lanes, the radius of the curve should be minimised to help lower speeds, and additional treatments may be considered.

6.2 Zebra crossings

A zebra crossing is a type of pedestrian crossing marked by white parallel stripes on the road. Drivers are required to give way to pedestrians who are on or entering the crossing.

Additionally, vehicles must approach at a speed that allows them to stop safely before the crossing if necessary.

A wombat crossing refers to a raised pedestrian crossing that combines the features of a zebra crossing with a raised platform.

This design not only gives pedestrians priority but also encourages vehicles to slow down as they approach the crossing. The raised platform enhances visibility and safety for pedestrians.

The objectives of zebra crossings are to:

- Minimise conflict between pedestrians crossing the road and vehicles travelling along the road.
- Enhance the visibility of the location where pedestrians are crossing.
- Provide pedestrians priority.
- Improve accessibility for pedestrians.

Note: From the Safe System Approach, the probability of a collision between a vehicle and a pedestrian resulting in a fatality rises significantly if the impact speed of the vehicle is over 30 km/h. Furthermore, at lower speeds, drivers have more opportunity to stop or give way.

As such, wombat crossings are preferred over zebra crossings.

The only scenarios where the wombat crossing can be inappropriate are:

- where property access may be significantly affected
- on bus and designated cycle routes unless an acceptable sympathetic design is used
- where access by emergency vehicles would be adversely affected.

If a wombat crossing cannot be installed, the operational speed of vehicles must still be reduced below 30 km/h at the point of the zebra crossing by other treatments, with justification given as to why a wombat crossing is not feasible.

This may be achieved by reducing speed limits, including physical speed reduction aids (preferred), and/or by using additional signs and pavement markings.

Table 6-6 Zebra crossing applications

Application	
Average vehicle delay	The average delay for vehicles do not exceed the values as per Figure 5-12, Section 5-10.
Average pedestrian delay	If the average delay for pedestrians exceeds the values as per Figure 5-7, Section 5.9, a zebra crossing may be considered.
Spacing between zebra crossings and other crossings	Zebra crossings should not be installed where there is a suitable zebra crossing, signalised pedestrian crossing, or grade separated pedestrian crossing within 200 m, unless it is adjacent to an activity centre, in which case it may be located within 100 m of an existing pedestrian crossing.
Pedestrian volume	High pedestrian volume areas such as activity centres, schools, shopping centres and within 500 m along routes leading to these areas. Locations that have noticeable peak crossing demand. Minimum pedestrian volumes are five per hour (in any hour) – vulnerable pedestrians are counted as two pedestrian.
Signs and pavement markings	Signs and pavement markings for wombat crossings are to be in accordance with Main Roads' *Standard Drawing 200631-0001, 202431-000203 and 202231-3010*. Signs and pavement markings for zebra crossings should be in accordance with Main Roads' *Standard Drawing 200331-0164*.
Number of lanes	Zebra crossings are only suitable for roads with a single traffic lane of traffic in each direction, as vehicles in adjacent lanes on roads with more than one lane of traffic in the same direction block visibility of people crossing or waiting to cross.

Below are the requirements applying to all zebra crossings. Additional requirements related to each location are included in each section, accordingly.

Table 6-7 Zebra crossing requirements

Requirements	
Sight distance	ASD, SSD and CSD must be available as per Section 5.2.
Posted speed limit	The maximum posted speed limit appropriate for zebra crossings is 50 km/h.
Operating speed	The operating speed at the location of the crossing must be 30 km/h or less.
Parking	ASD and CSD must be available, and not be blocked by parked cars. Therefore, parking should be restricted to a minimum of 20 m before the crossing and 10 m after the crossing, unless the pedestrian crossing is located adjacent to kerb protrusions (nibs) and a parking control sign applies.
Lighting	As per Section 5.13

6.2.1 Mid-Block

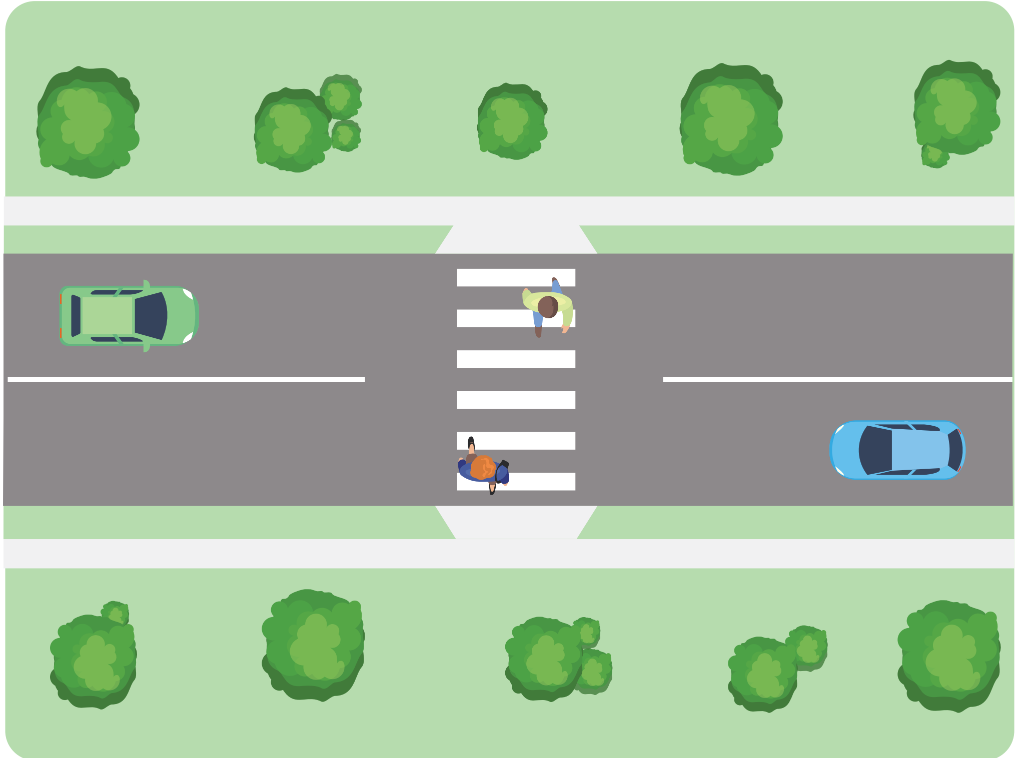


Figure 6-5 Zebra crossing

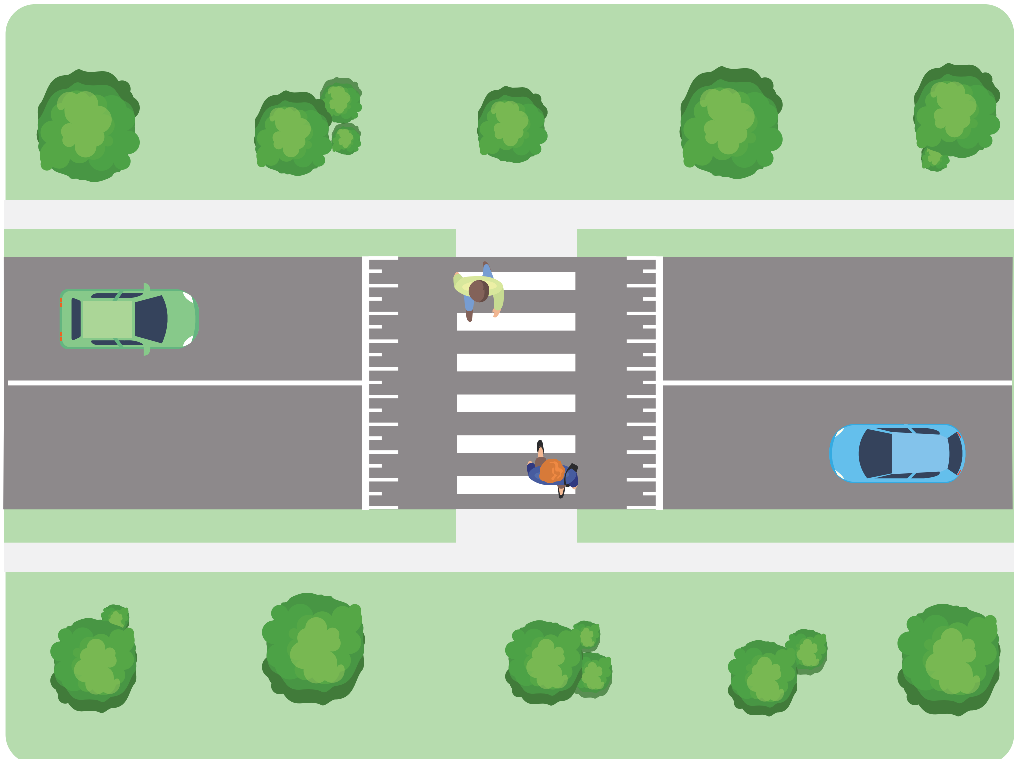


Figure 6-6 Wombat crossing

Refer to Table 6-7 for zebra crossings at mid-block requirements.

6.2.2 Unsignalised intersections

The placement of a zebra crossing on a side road introduces the requirement for vehicles on the side road approaching the intersection (including on the far side of cross intersections) to give way to pedestrians on the zebra crossing.

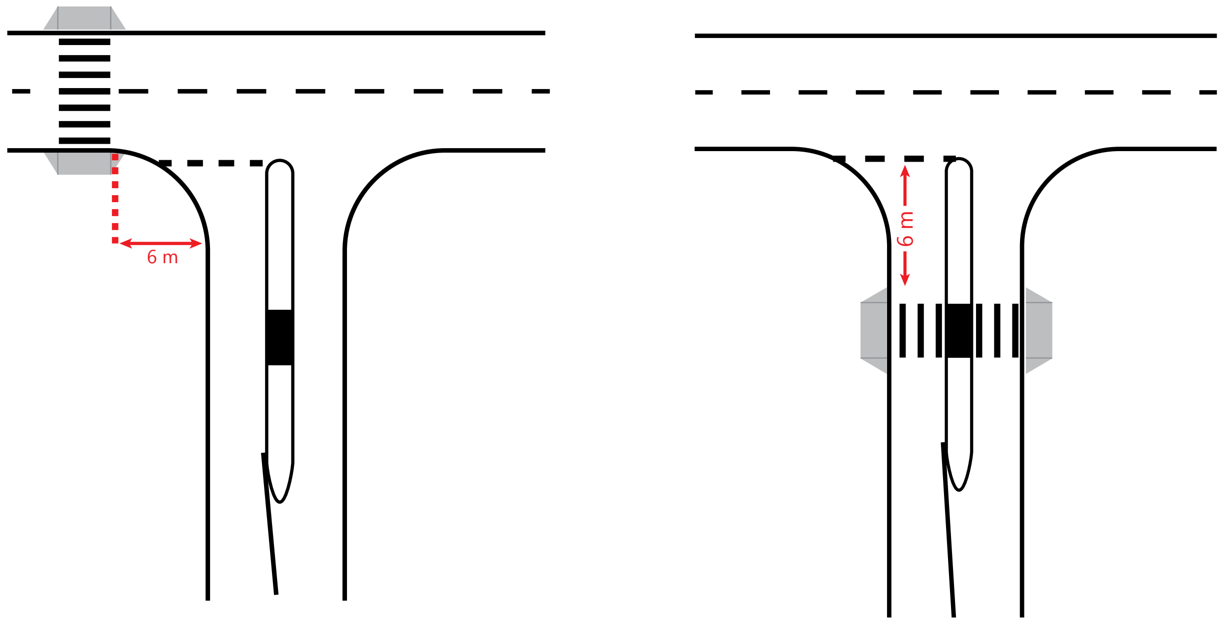
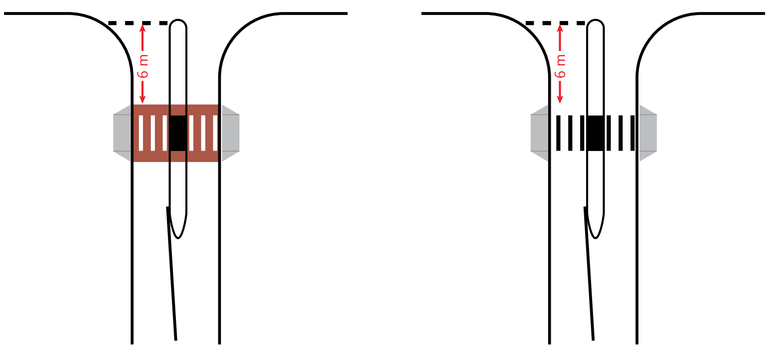
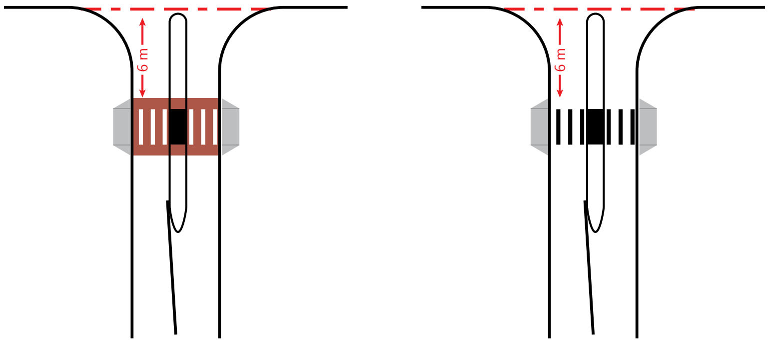
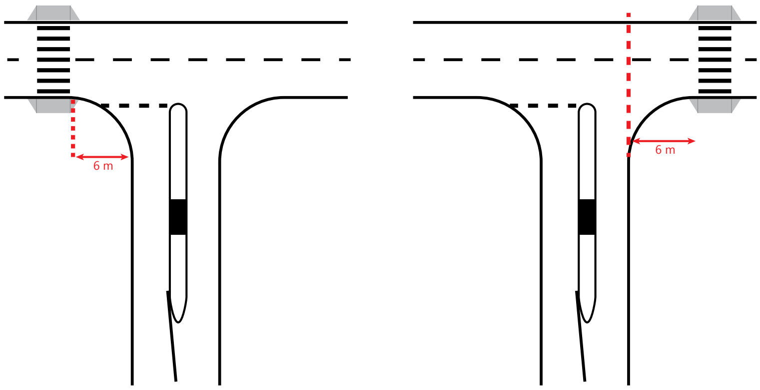


Figure 6-7 Zebra crossings near unsignalised intersections

Refer to Table 6-7 for requirements. Additional requirements for zebra crossings at unsignalised intersections are show below.

Table 6-8 Additional requirements for zebra crossings at unsignalised intersections

Requirements	
Distance from intersection	Preferably, there should be 6 m clear space between the holding line and the wombat or zebra crossing and should best fit the desire line of pedestrians. For a wombat crossing, 6 m to be to the start of the ramp. For a zebra crossing, the distance is to be 6 m to the zebra markings. 

Requirements	
	If there is no give way or stop line, 6 m is measured to the edge of the road (kerb extension), as shown below: 
	For crossings on a major road, the 6 m is measured to the edge of the road (kerb extension), as shown below: 

6.2.3 Single lane roundabout

Zebra crossings may be provided on legs of a roundabout where unmarked crossings are deemed inappropriate. These require drivers to give way to pedestrians on the crossing, hence removing potentially lengthy delays for pedestrians, which can be common at roundabouts.

An important consideration for zebra crossings at roundabouts, is the distance from the roundabout to kerb ramps.

On the approach leg, if the zebra crossing is too close to the give way line, stopped vehicles would block the crossing for pedestrians.

On the departure leg, zebra crossings too close to the roundabout can cause vehicle queuing into the circulating carriageway.

However, the further away a zebra crossing is from the roundabout, the less convenient it becomes for pedestrians (as the greater the detour from desire lines, and the higher the vehicle speeds become). Both scenarios reduce pedestrian safety and the likelihood that drivers will stop for pedestrians.

Practitioners should therefore generally seek to minimise the distance of the zebra crossing from the roundabout.

Distances may need to be increased on departure legs of roads with a higher movement function under the Movement and Place Framework, to limit vehicular queuing into the circulating carriageway.

Zebra crossings on the approach and departure of the same leg of a roundabout should generally be aligned with each other, so far as is reasonably practicable.

Figure 6-8 Zebra crossings on approach to roundabouts

Refer to Table 6-7 for requirements. Additional requirements for zebra crossings at single lane roundabouts are shown in the following table.

Table 6-9 Additional requirements for zebra crossings at single lane roundabouts

Requirements	
Distance from hold line	Zebra crossings may be placed at the location of the roundabout (i.e., directly adjacent the give way line) where there are few vehicle movements and high number of pedestrians. Otherwise, preferably, there should be 6 m clear space between the give way line and the wombat or zebra crossing and should best fit the desire line of pedestrians. For a wombat crossing, 6 m to be to the start of the ramp. For a zebra crossing, the distance to be 6 m to the white strip markings.

6.3 Signalised pedestrian crossing facilities

Signalised pedestrian crossing facilities are installations that provide a dedicated phase for pedestrians to cross. The signals are activated by pedestrians resulting in vehicles being stopped, pedestrians crossing, and then vehicles being allowed to proceed.

To further improve safety, the addition of a raised safety platform crossing should be considered.

This section should be read in conjunction with Main Roads' Traffic Signals Approval Policy as the approval of any new, modification to, or removal of a signalised pedestrian crossing facility is subject to this policy.

Advantages	Disadvantages
• Clearly show pedestrians when to cross, which means lower pedestrian judgment required. • Pedestrians are guaranteed a protected phase, even though they may have to wait. (Generally, pedestrians would accept the longer wait, compared to unmarked facilities.) • Greater guarantee at-grade, that traffic will stop for pedestrians to cross. • Allows provision for audio-tactile cues suitable for visibility impaired pedestrians. • May be acceptable where sight distance is insufficient for an unmarked or zebra crossing. • Pedestrians group and cross together, instead of crossing intermittently. • Where pedestrian streams on high trafficked multi-lane roads would cause unacceptable traffic delays using a zebra crossing, mid-block pedestrian signals may be the only option.	• Pedestrians may walk into the road when the signal changes without checking vehicular traffic has come to a complete stop. • Pedestrians who are slower than average, such as those with mobility impairments, children, or elderly, may still be on the road when vehicles are released. • Pedestrians must wait for the signal before crossing. (Whereas it may take considerably less time to cross at a zebra crossing.) • More expensive to install, operate, and maintain over other types of crossings.

Locations:

- Mid-block – refer to *Guidelines for Pedestrian Crossing Facilities at Traffic Control Signals*
- Roundabout – refer to *Signalised Roundabouts Guidelines*
- Slip lanes – refer to *Guidelines for Pedestrian Crossing Facilities at Traffic Control Signals*

6.4 Grade separated pedestrian crossings

Grade separation refers to a structure that removes pedestrians from the road and eliminates interface by placing pedestrians and vehicles in physically different positions. This is usually either a pedestrian underpass or overpass.

Figure 6-10 Overpasses

Figure 6-11 Underpasses

Advantages	Disadvantages
• Allows pedestrians to cross the road freely, with no interruptions. • Significantly reduces conflicts and collisions with vehicles. • Allows for the uninterrupted flow of vehicle traffic. • Can be integrated with existing developments. *Overpasses:* • Usually cheaper than an underpass in an existing/brownfield environment. • Can be covered to protect against the weather. *Underpasses:* • Can be cost-effective when part of a new development. • Reduces user effort. • Increases network connectivity by providing direct connections. • Reduces travel time delays.	• Expensive to construct and maintain. • May need long ramps, resulting in longer travel times and more effort, thereby reducing pedestrian usage. • It is only effective where pedestrians perceive it is easier and faster to use than crossing at-grade. • May require the relocation of utilities. • May create an unsafe walking environment as it is removed from street-level activity and the passive surveillance it provides. *Overpasses:* • More likely to be open to the weather. • Potential for thrown/dropped objects on the road. • Require greater vertical separation than underpasses and, therefore, longer ramps and travel distance. • May overlook residential properties. *Underpasses:* • Less personal security than overpasses due to lower natural surveillance. • Can have drainage problems. • Uninviting environmental conditions due to irregular maintenance or cleaning.

Recommended parameters

The use of grade separation, (via an underpass or overpass) to separate vehicles from pedestrians (who remain at-grade) are the most desirable. This overcomes issues such as greater travel distances and minimised elevations for pedestrians. This should be used as preference where feasible.

Where the above is not feasible, a grade-separated route for pedestrians must be more desirable to the pedestrian than any other option. This may require restricting other pedestrian's options, e.g., by installing fencing around dangerous potential at-grade crossing areas, or by improving the convenience and aesthetics of the grade-separated option.

Grade separation often causes significant deviations from pedestrian desire lines (vertically and horizontally). The design must therefore be careful to limit inconvenience for pedestrians.

Crime prevention through environmental design (CPTED) should also be applied to the design of underpasses, to improve physical and perceived safety for users.

These principles include:

- improving surveillance
- maintaining legibility of movement
- defining territory
- encouraging community ownership and legitimate users
- improving management
- reducing vulnerability.

The provision of grade separated pedestrian crossings must also ensure the walkways/ramps are in accordance with *AS1428.1 – Access for Design and Mobility – New Building Work*.

Grades should be limited to the values considered a “walkway” rather than a ramp.

6.5 Traffic warden-controlled children's crossings

A traffic warden-controlled children’s crossing is a warden or guard-controlled crossing point, where children crossing the road are assisted by a warden or guard who stops traffic to give pedestrians priority over the traffic. The crossing is generally attended by wardens in the hours prior to and after school hours.

The Western Australian Police Force (WA Police) is responsible for the warrants, approvals and operation of warden-controlled children’s crossings.

This type of crossing can only be applied for by either a school principal or a recognised school/parent organisation, by contacting the Children’s Crossings Unit at WA Police.

All applications are referred to the *Children's Crossings and Road Safety Committee* for consideration. The committee includes representatives from the WA Police, Main Roads, Department of Education, Association of Independent Schools of WA, Catholic Education Office of WA, WA Council of State Schools Organisations, and the WA Local Government Association.

There are two types of traffic warden-controlled children's crossings, Type A and Type B.

Type A

Type A children's crossings have wardens supplied by the WA Police.

Primary school or combined primary/high school requirement:
A minimum of 20 students and 200 vehicle movements within the hour immediately before and immediately after school.

High school only requirement:
A minimum of 20 students and 700 vehicle movements occurs within the hour immediately before and immediately after school.

Type B

Type B children's crossings require a warden to be supplied by an applicant.

Primary school or combined primary/high school requirement:
A minimum of 10 students and 100 vehicle movements occurs within the hour immediately before and immediately after school.

High school only requirement:
A minimum of 10 students and 350 vehicle movements occurs within the hour immediately before and immediately after school.

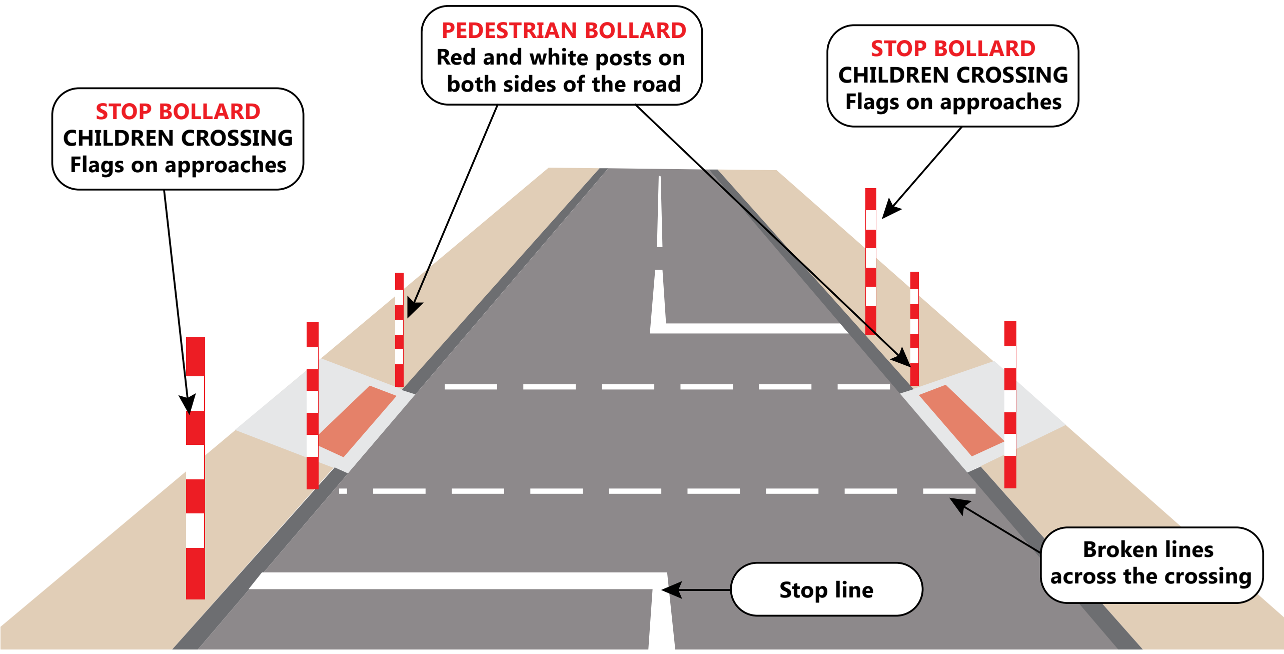


Figure 6-12 Traffic warden-controlled children's crossings

Advantages	Disadvantages
• Pedestrians using the crossing are offered greater protection than zebra or unmarked crossing. • Traffic wardens can confidently assess vehicle traffic and find suitable gaps to assist children with crossing. • Traffic wardens balance the flow of traffic against the demand to cross the road. • Unnecessary restrictions are not imposed on drivers outside the start and finish of normal school hours. • Drivers are less likely to assume no one will be crossing the road, and children are less likely to cross the road where it is unsafe to do so. • Maximum posted speed is 40 km/h	• Requires undertaking to manage a traffic warden. • Potentially expensive to fund a traffic warden. • More expensive than zebra or unmarked crossings to install and maintain. • More than one warden may be required on a busy road. • No priority crossing outside warden manned hours. Some pedestrians may expect to have priority outside school hours. • Potential challenge to find wardens, including finding replacements with short notice.

Recommended parameters

- A refuge in the median is desirable for multi-lane roads.
- Avoid installing too close to the exit or approach side of intersections.
- Ensure crossing is located within the field of view of approaching drivers, particularly for turning vehicles.
- Wig wags may be used where installation may be of benefit. They are only considered where prior approval has been granted by Main Roads, refer to Main Roads' Wig Wags Policy, Application and Technical Guidelines.
- To remain effective, a guard (where warranted) must be available and present during operation.

Requirements	
Sight distance	ASD, SSD and CSD must be available as per Section 5.2.
Posted speed limit	The maximum posted speed limit for traffic warden-controlled children's crossings is 40 km/h.
Parking	ASD and CSD must be available, and not be blocked by parked cars. Therefore, parking should be restricted to a minimum of 20 m before the crossing and 10 m after the crossing, unless the pedestrian crossing is located adjacent to kerb protrusions (nibs) and a parking control sign applies.
Design	Signs and pavement markings for traffic warden controlled children's crossings should be in accordance with Main Roads' *Standard Drawings 9120-0174 and 9531-2169*.
Lighting	As per Section 5.13.

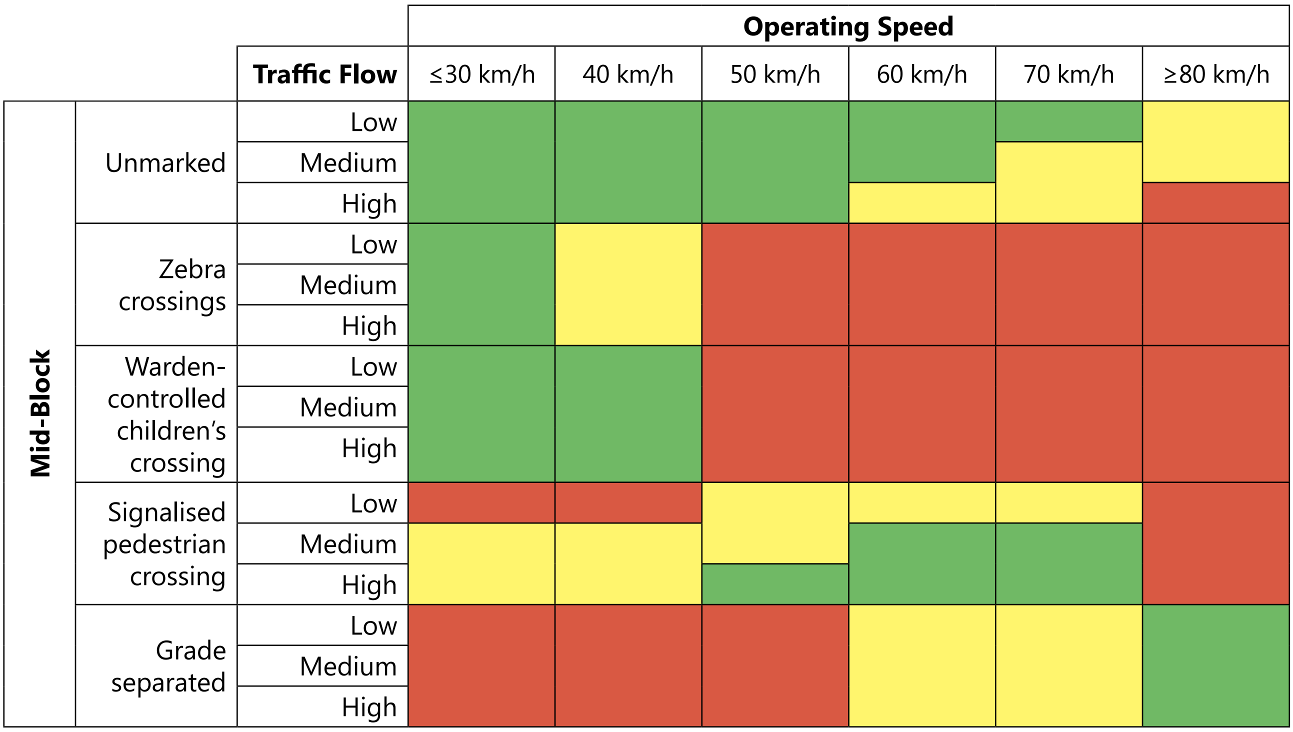
7. Crossing Type Evaluation Tool

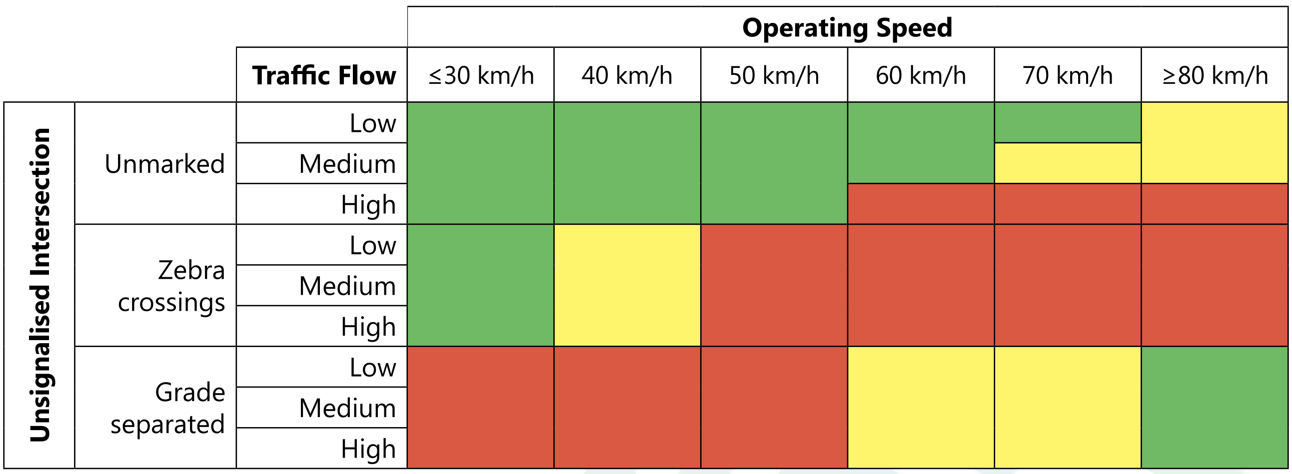
This crossing type evaluation tool (Figure 7.1) can be used to eliminate certain crossing types, according to a road's traffic flow and traffic speed.

Practitioners should use this tool to qualitatively assess their site for what may be an appropriate crossing type, and to limit the scope of the detailed analysis required when selecting the appropriate crossing type (as per Section 6).

The figure below shows the general suitability of each crossing type on a road, based on the traffic speed and traffic flow.

> **Note:** This section refers to the operating speed at the location of a pedestrian crossing. This does not necessarily refer to the posted speed limit. The speed may be reduced at the location of the pedestrian crossing through the crossing itself, the alignment of the road, or by the supporting treatments (as described in Section 9).





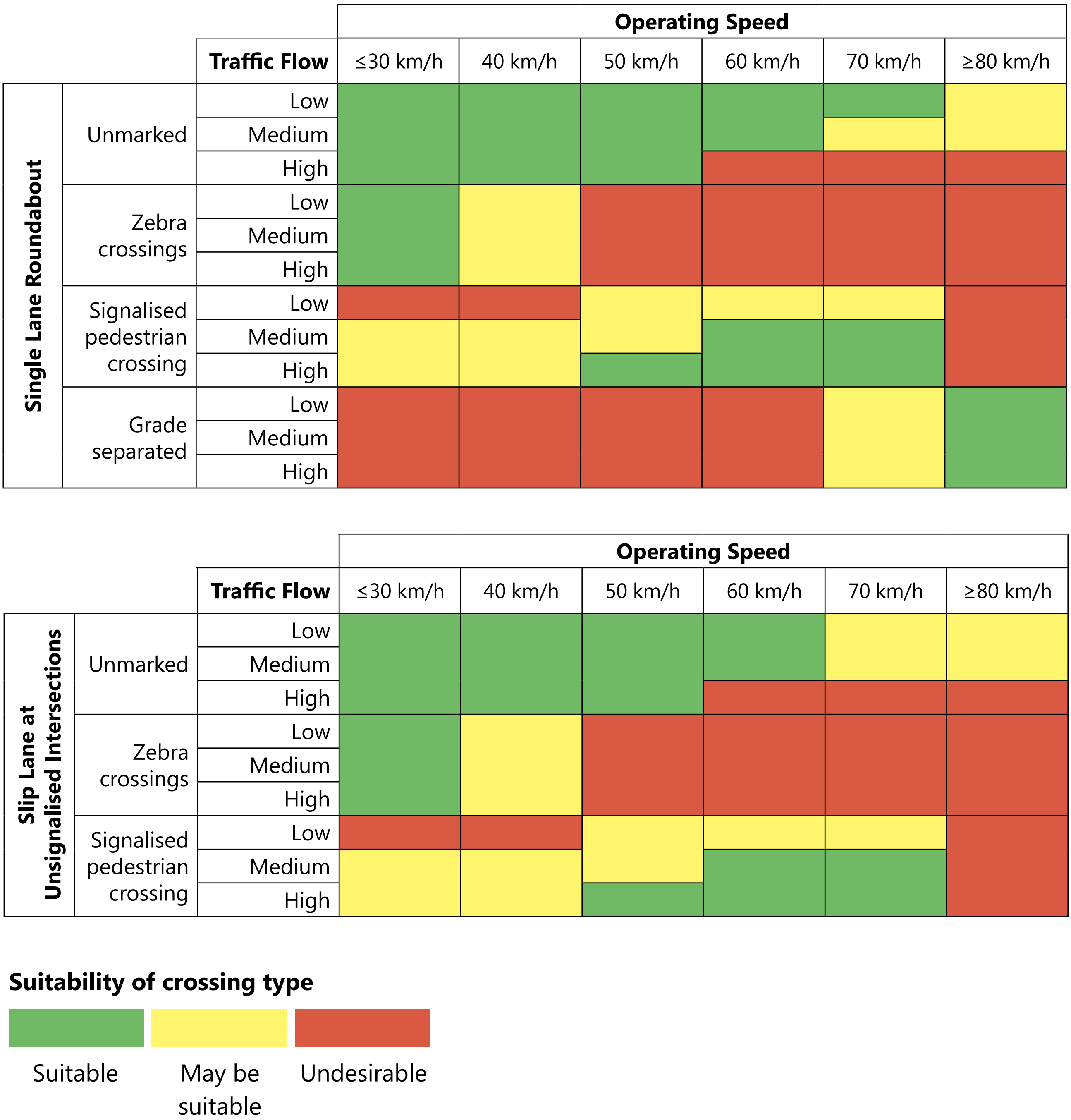


Fig 7-1 Crossing type evaluation tool

8. Selection of Crossing Types

The selection of a crossing type should first establish the strategic function of the road, i.e. whether it is appropriate to give pedestrians priority over vehicular traffic.

It is not necessary to perform an analysis for an unmarked crossing where a crossing is intended for pedestrian priority (e.g., places where people spend time recreating, socialising and/or going about their everyday activities; or places of high place function, but lower movement function).

Where pedestrian priority is not appropriate, consider whether an unmarked crossings will be acceptable from both a pedestrian's safety and delay points of view.

Where it is determined this is not acceptable, then determine an appropriate type of controlled crossing as a solution. This would typically be either a zebra crossing, or signalised pedestrian crossing facilities.

This decision-making process is shown in Figure 8-1.

Note: The appropriateness and acceptability of different options will be unique to the local context.

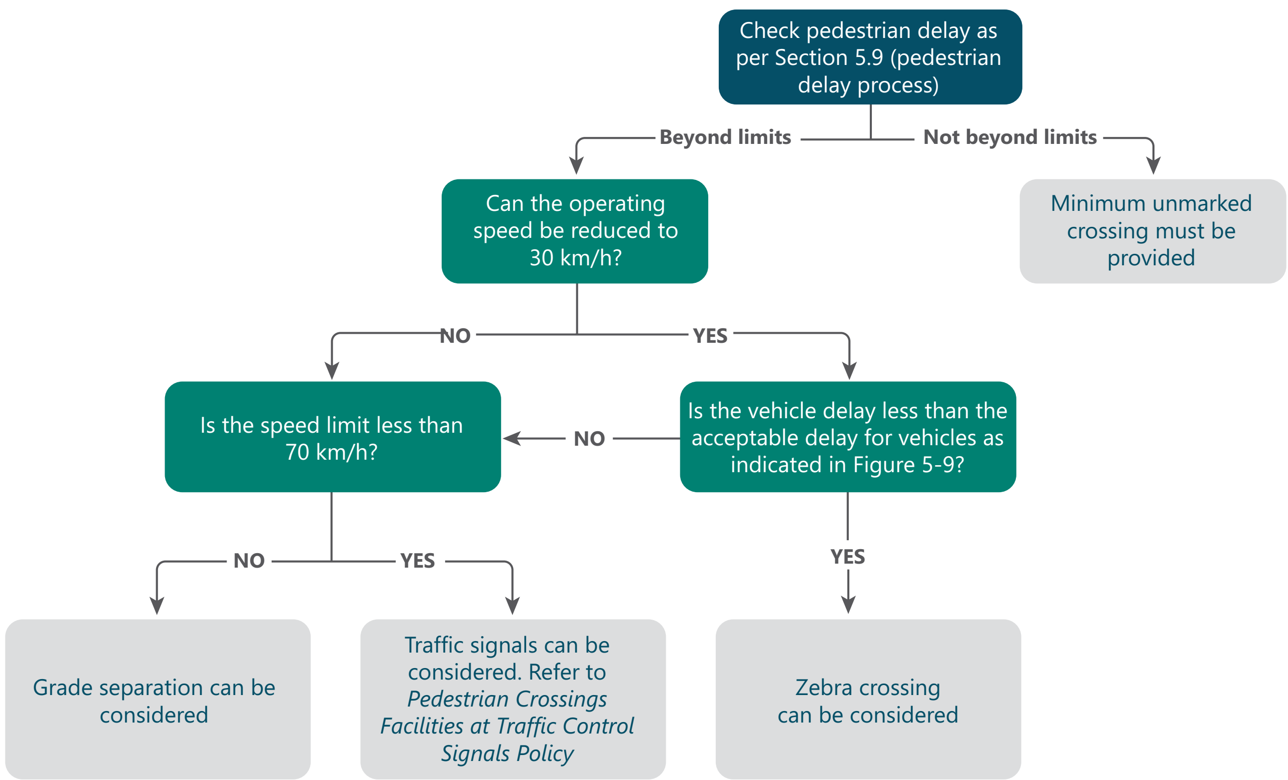


Figure 8-1 Decision-making process flow chart

9. Supporting Treatments

Once a suitable pedestrian crossing facility has been selected, a supporting treatment, or treatments, should be chosen to achieve the desired outcome of making the pedestrian crossing (regardless of the type) as safe as possible.

Treatments are imperative to the safe operation of an at-grade pedestrian crossing, regardless of the type. Supporting treatments improve the safety or functionality of all different at-grade pedestrian crossing types.

Treatments typically:

1. Reduce speed at or before the crossing point which:
   - Reduces the severity of crashes should they occur.
   - Increases the likelihood of drivers stopping to give way (at zebra crossings).
   - Creates an environment that encourages low vehicle speeds and promotes pedestrian activity.
2. Raise awareness for the potential for pedestrians crossing.
3. Reduce the crossing distance and typically improve sight distance to/from pedestrians.

Should further analysis deem the crossing unsuitable (e.g., due to insufficient gaps in traffic for pedestrians, excessive speed at the crossing location, etc.), then the supporting treatments may need to be revisited.

If all appropriate supporting treatments have been implemented, but the pedestrian crossing cannot achieve the relevant parameters to be considered a safe crossing, then practitioners should consider a different pedestrian crossing type.

Different treatments along with applicable location and detailed information on benefits, implications, parameters, and design considerations are described in Appendix 1.

- Kerb extensions
- Raised medians
- Pedestrian refuge island
- Raised platform
- Speed cushions
- Continuous footpath
- Rumble strips
- Reduced corner radius
- Alternative pavement material/colour
- Wigwags
- VAS

10. Applicable Drawings

Drawing Number	Description
0448-3011	Main Roads' Standard Drawing – Underpass Lighting Layout and Construction Detail
200331-0128	Main Roads' Guideline Drawing – Road Humps Watts Profile
200331-0129	Main Roads' Guideline Drawing – Road Humps Flat Top Plateau Profile
200331-0135	Main Roads' Guideline Drawing – Blister Islands
200331-0139	Main Roads' Guideline Drawing – Pedestrian Refuge Island (Lane Width ≤5.5m)
200331-0140	Main Roads' Guideline Drawing – Pedestrian Refuge Island (Lane Width >5.5m)
200331-0164	Main Roads' Standard Drawing – Pavement Marking Pedestrian Zebra Crossing
200331-0184	Main Roads' Standard Drawing – Pavement Marking Splitter Islands (≤3.0m wide; ≤60km/h posted speed)
200331-0191	Main Roads' Standard Drawing – Pavement Marking Raised Medians (>3.0m wide)
200431-0116	Main Roads' Standard Drawing – Pavement Marking PUFFIN and PELICAN Crossings
200531-0038	Main Roads' Standard Drawing – Pavement Marking Zebra Crossing at Slip Lane
200631-0001	Main Roads' Guideline Drawing – Pavement Marking Road Humps Wombat Crossing
200931-0004	Main Roads' Guideline Drawing – Speed Cushions on Local Roads (Road Widths 5.8m to 7.4m)
200931-0005	Main Roads' Guideline Drawing – Speed Cushions on Local Roads (Road Widths 7.6m to 10.6m)
200931-0089, 200931-0090, 200931-0091	Main Roads' Standard Drawing – Tactile Ground Surface Indicators
201031-0004	Main Roads' Standard Drawing – Pavement Marking Splitter Islands (≤3.0m wide; ≥70km/h posted speed)
201031-0171	Main Roads' Standard Drawing – Pavement Marking Roundabout Metering
202131-0030	Main Roads' Standard Drawing – Pavement Marking Raised Pavements Shark Teeth
9120-0174	Main Roads' Standard Drawing – Pavement Marking School Crossing
9531-2169	Main Roads' Standard Drawing – Pavement Marking Traffic Warden Controlled Children Crossing (Wig Wags)

11. References and Related Documents

Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersections
Austroads Guide to Road Safety Part 1: Introduction & The Safe System
Austroads Guide to Traffic Management Part 3: Transport Study and Analysis
Austroads Guide to Traffic Management Part 7: Activity Centres
Austroads Guide to Traffic Management Part 8: Local Street Management
Australian Standard – Lighting for Roads and Public Spaces
Australian Standard – Tunnels and Underpasses.
Australian Standard – Design for Access and Mobility – New Building Work
Australian Standard – Design for Access and Mobility – Tactile Ground Surface Indicators
Australian Standard 1742 Manual of Uniform Traffic Control Devices Part 10: Pedestrian Control and Protection
Australian Standard 1742 Manual of Uniform Traffic Control Devices Part 13: Local Area Traffic Management
Highway Capacity Manual 2010
Main Roads Guidelines on Pedestrians Crossing Facilities at Traffic Signals
Main Roads Lighting Design Guidelines for Roadway and Public Spaces
Main Roads Local Area Traffic Management Policy
Main Roads Operational Modelling Guidelines
Main Roads Railway Crossing Control in Western Australia Policy and Guidelines
Main Roads Strategy and Implementation Framework Low Cost Urban Road Safety Program
Main Roads Supplement Guide to Road Design Part 4A: Unsignalised and Signalised Intersections
Main Roads Speed Zones Policy
Main Roads Speed Zoning: Application and Guidelines Policy
Main Roads Traffic Warden Controlled Children's Crossing Guideline
Main Roads Vehicular Signals Policy
New Zealand Transport Agency Guidelines for the Selection of Pedestrian Facilities
Road Traffic Code 2000
SIDRA Intersection User Guide
Western Australia Police Force Children's Crossings

Appendix 1: Pedestrian Crossing Treatments

Treatment	Description	Advantages	Disadvantages	Recommended parameters	Design considerations
Kerb extensions	Kerb extensions involve local widening of the footpath into the carriageway using an adjacent shoulder or parking lane. The intention is to shorten the crossing distance and help make pedestrians more visible to approaching drivers, as well as making vehicles more visible to pedestrians (i.e. to improve CSD and ASD). Kerb extensions can be constructed at intersections or mid-block locations. They can be on their own, or in conjunction with other treatments such as zebra crossings, medians, and signalised intersections. These treatments should also be installed within the kerb extension at the crossing point. It is important to ensure sufficient kerb extension width for safe active mobility.	• Reduces crossing distance and crossing time, which permits pedestrians to select a smaller gap. • Improves pedestrian safety as they are more visible to oncoming drivers and have a better view of approaching traffic. • Creates space for pedestrians to wait without blocking others walking past. • Physically prevents drivers from parking and blocking the crossing point. • May reduce the speed environment by narrowing the road. • Increases available space for street furniture and vegetation. (However, designers should ensure any street furniture or vegetation will not obstruct any pedestrian view, which would negate a key reason for implementing the treatment.)	• Does not give pedestrians priority. • Can expose cyclists to traffic on narrower roads. • Can create an obstruction that may be struck by cyclists and vehicles. • Where a kerb alignment is being altered, drainage should be included in the design considerations.	• Primary treatment if operating speeds are below 30 km/h. Supporting treatment if operating speeds are between 30 km/h and 50 km/h. • Operating speed 50 km/h or less. • Only appropriate on their own for low pedestrian demands and low traffic volumes. • Appropriate in shopping areas and other locations where there is high pedestrian demand and the kerbside lane is used for parking and is not required as a traffic lane. • Appropriate in combination with local area traffic management treatments such as slow points. • Should not be used: - on roads where the kerbside lane is needed by moving traffic during peak periods - at locations where the number of pedestrians and vehicles justify a higher level of pedestrian crossing - on bicycle routes where there is inadequate space for cycle lanes alongside the kerb extension.	Should not narrow or remove a cycle lane or otherwise reduce width available to cyclists. If there are to be potential impacts on cyclist infrastructure, then appropriate supporting treatments should be implemented.

Treatment	Description	Advantages	Disadvantages	Recommended parameters	Design considerations
Raised medians	Medians separate the road into two separate carriageways, enabling pedestrians to cross the road as two one-way roads (regardless of the direction of the traffic) using the median as a refuge, which provides a place for pedestrians to wait before crossing the other side of the roadway.	• Reduces the crossing distance for pedestrians. • Simplifies the crossing task into one direction of traffic at a time. • Can considerably reduce pedestrian delays on unmarked crossings. • Can often be retrofitted to existing roads. • Are particularly helpful to pedestrians unable to judge distances accurately, or who have slower walking speeds. • Improves pedestrian safety as a result of increased visibility of, and from, approaching vehicles. • Can reduce vehicle speeds through the crossing point by narrowing traffic lanes. • Provides a stopping/resting point for mobility impaired pedestrians.	• Need a wide roadway to ensure adequate space after installation. • May reduce on-street parking. • Island may be struck by vehicles and may give pedestrians a false sense of security. • May restrict vehicle access to adjacent driveways, leading to more U-turns at intersections. • Can expose cyclists to traffic on narrower roads.	• Desirable at all distributor unmarked crossings and undivided two-way roads where space permits • Minimum treatment when pedestrian delays exceed target and higher-order pedestrian crossings are not viable. • Typically, not used on access roads. **Appropriate:** • In existing roads where the pavement width is wider than necessary. • In existing roads with wide road reservations where road widening is feasible. • Where there is a high pedestrian movement which is not necessarily concentrated at any particular location. • Where minimal vehicular access is required to frontage properties. **Not appropriate:** • On narrow roads which cannot be widened. • Along cycle routes with inadequate space to retain cycle lanes alongside a raised median. • Where there is a high concentration of pedestrians crossing the road, and where more secure pedestrian crossing treatments should be examined.	• Minimum median width ≥2.0 m • Desirable width ≥2.5 m The following minimum lane widths should be provided: 1. Local road (not a bus or cycle route and where significant numbers of child and/or inexperienced cyclists are unlikely to occur) = 2.5 m. 2. Bus route but not a cycle route = 3.5 m 3. Bus and cycle route = 5.0 m Must neither narrow nor remove a cycle lane or otherwise reduce the available width for cyclists.

Treatment	Description	Advantages	Disadvantages	Recommended parameters	Design considerations
Pedestrian refuge island	Pedestrian refuge islands are isolated islands located centrally in the road, enabling pedestrians to cross one direction of traffic at a time - similar to medians. This is relatively low-cost and one of the most effective treatments to assist pedestrians in crossing the road. They are suitable for wide roads that are difficult to cross in one stage, and where pedestrian crossing movements are concentrated. They are also more appropriate than a median in most instances than a median.	• Reduces crossing distance for pedestrians. • Simplifies the crossing task into one direction of traffic at a time. • Can considerably reduce pedestrian delays on unmarked crossings. • Can often be retrofitted to existing roads. • Are particularly helpful to pedestrians unable to judge distances accurately or who have slower walking speeds. • Improves pedestrian safety as a result of increased visibility of, and from, approaching vehicles. • Can reduce vehicle speeds through a crossing point by narrowing traffic lanes. • Provides a stopping/resting point for mobility impaired pedestrians.	• May require minor road widening in certain situations. • Need a wide roadway to ensure adequate space after installation. • May reduce on-street parking. • May restrict vehicle access to adjacent driveways, leading to more U-turns at intersections. • Can expose cyclists to traffic on narrower roads. **Blister:** • Requires more land than a conventional pedestrian refuge. • Causes safety concerns for on-road cyclists as drivers tend to cut corners while cyclists are unlikely to follow kerb line. • May reduce footpath width or otherwise brings vehicles closer to the footpath. **Splitter:** • May increase the kerb radius at the intersection and create a wider total crossing to allow for large vehicles. • May limit the size of vehicles which can access the side road. • Can cause safety concerns for on-road cyclists if lanes (normal lanes and bicycle lanes) are narrowed or removed.	**Appropriate:** • On roads with wide lanes or where short sections of road widening is feasible. • Where pedestrian crossing movements are concentrated. **Not appropriate:** • On roads with restricted visibility. • On locations where the number of pedestrians and vehicles justify a higher level of pedestrian crossing. • On narrow roads or cycle routes with inadequate space for cycle lanes. **Blister:** • Only on two-lane-two-way roads. • Where there is a need to break long straight lines of sight. • Speed limit ≤50 km/h. • Local distributors and access roads. **Not appropriate:** • On narrow carriageways where substantial islands cannot be fitted • On district distributor roads where the geometry will likely result in a transference of traffic to adjacent routes • On primary distributor roads. **Splitter:** • At roundabouts for undivided roads. • Where a side road is a lower classification of road than the through road. • Where the side road pedestrian crossing distance is long.	Grab rails on medians and median islands are to be in accordance with Main Roads' Standard Drawing 9831-5649. **Blister:** • Designed in accordance with Main Roads' Standard Drawing 200331-0135. • Pedestrian cut-through may be required. • Designed such that the resultant speed of traffic past the pedestrian crossing point is 30 km/h or less. • Refer to Main Roads' Treatment Resource Guide. **Splitter:** • Designed in accordance with Main Roads' Standard Drawings 200331-0184 and 201031-0004. • Minimum width ≥2.0 m • Desirable width ≥2.5 m • Must not narrow or remove bicycle lane or otherwise reduce width available to cyclists

Treatment	Description	Advantages	Disadvantages	Recommended parameters	Design considerations
Raised platform	This treatment is a raised surface that aims to reduce the operational speed of vehicles prior to a crossing.	• Relatively low cost to install and maintain. • Reduces or helps reinforce slower vehicle speeds. • Reduces both the likelihood and severity of potential crashes.	• Pedestrians can assume they have right of way at unmarked crossing points (if incorrectly designed). • May increase traffic noise. • May have adverse impacts for bus passengers and ambulances.	May be suitable prior to signalised pedestrian crossing facilities where reducing vehicle speeds to 30 km/h is practicable.	Refer to *LATM Guidelines (Supplement to GTM Part 8*). Drainage needs to be included in the design considerations.
Speed cushions	This treatment is a raised surface that aims to reduce the operational speed of vehicles prior to a crossing.	• Can reduce the speed of vehicles over the length of a road, not just at a crossing. • May discourage through traffic from using the route. • They do not restrict or discomfort cyclists and can be designed so they do not inconvenience buses, commercial or emergency vehicles. • Inexpensive to install. • May be used as a short-term/ temporary measure.	• May increase vehicle noise. • Less effective at slowing wide vehicles and motorcyclists. • May shift through traffic onto other less desirable routes.	• Only used on roads with a speed limit of ≤50 km/h. • Typically, not used on the departure side of unsignalised side roads and roundabouts. • On bus routes where a raised platform would otherwise be warranted.	Speed cushions designed in accordance with Main Roads' *Standard Drawings 200931-0004 to 200931-0007*. Low cost URSP drawings: 202231-3005 - Speed Cushion - Road Width 7.6 m to 10.6 m and 202231-3004 - Speed Cushion - Road Width 5.8 m to 7.4 m.
Continuous footpath	This treatment is a raised surface that aims to reduce the operational speed of vehicles and improve the visibility of the crossing. However, should not be used on routes leading to emergency facilities.	• Eliminates grade changes for pedestrians, a particular benefit for mobility impaired pedestrians. • The vertical deflection for vehicles reduces their speed. • Provides a visual reminder to drivers on the through road that they need to give way when turning.	• Pedestrians may falsely believe they have right-of-way over vehicles on the side road approaching the intersection. • May have adverse impacts for bus passengers and ambulances.	• Used on unmarked side road crossings only (i.e. not used with zebra crossings, signalised pedestrian crossing facilities or traffic warden-controlled children's crossings). • Typically, only across access roads. • Most suitable in high pedestrian volume areas, such as activity centres.	• Material across unmarked crossings shall be the same as the longitudinal footpath. • Ramps may require "piano key" markings in accordance with *AS1742.13 Manual of Uniform Traffic Control Devices Part 13*.

Treatment	Description	Advantages	Disadvantages	Recommended parameters	Design considerations
Rumble strips	Rumble strips consist of narrow raised or specially textured strips placed on a pavement or sealed shoulder, generating noise and vibrations through vehicles to alert drivers and encourage them to slow down.	• Rumble strips reduce the likelihood of accidents by alerting drivers when they are drifting out of their lane or approaching a dangerous area. • They are relatively inexpensive to install compared to other safety measures. • The tactile and auditory feedback from rumble strips can prompt immediate corrective action from drivers. • They can be applied in various settings, such as highways, rural roads, and near intersections.	• Rumble strips can create significant noise, which may disturb nearby residents and wildlife. • They can cause discomfort for drivers, especially those in smaller vehicles or on motorcycles. • Drivers may become overly reliant on rumble strips, potentially neglecting other important driving cues.	In WA, rumble strips may be used on the secondary road approach to rural intersections and on the approaches to railway crossings. Rumble strips should only be used under some conditions at railway crossings and at intersections of a primary rural arterial road with a secondary rural road. Should be avoided in residential areas due to noise.	Refer to Main Roads' *Rumble Strips Guidelines*' for additional information.
Reduced corner radius	This treatment is a raised surface that aims to reduce the operational speed of vehicles and improve the visibility of the crossing.	• Reduces the vehicle turning speed, hence reducing the likelihood and severity of collisions with pedestrians. • Reduces the total crossing distance for pedestrians. • Reduces the land requirement for the intersection.	• May increase the likelihood of rear-end crashes on the through road. • May limit the size of the design vehicle. • May increase the risk of vehicles running over the inside kerb.	• Minimum corner radius that permits the design vehicle "lane-correct" should be adopted. • Care needs to be taken to ensure that the design vehicle is not over designed.	
Alternative pavement material/ colour	This treatment refers to pavement with different colour and/or material that aims to provide visual and tactile clues to drivers, alerting them that they are entering a driving environment that is different from the one they have just left. This treatment does not include the use of decorative pavement markings.	• Heightens a driver's awareness that there may be pedestrians crossing. • Heightens a driver's awareness that they are entering a different road environment when used as a threshold treatment. • Can reduce speed as drivers are more cautious about driving on a different material.	• May lead to some confusion about whom must give way. • Risk of overuse which may reduce their impact and effectiveness.	• At boundaries between different land uses. • At boundaries between different classifications of streets. • At boundaries of local area speed limits. • Should not be used at the junction of two access roads, unless one of the access roads has a markedly different speed environment. • Should not be used on wide carriageways unless road narrowing is provided. • Should not be used on roads with more than 4,000 vpd.	• As per with Main Roads' *Treatment Resource Guide*. • Designed in accordance with Main Roads' *Standard Drawings 200331-0126*.

Treatment	Description	Advantages	Disadvantages	Recommended parameters	Design considerations
Wig Wags	Wig wags can be used to alert drivers to the presence of a pedestrian crossing and potential pedestrians on/or crossing a carriageway, where the conflict between vehicles and pedestrians may be unexpected, or of higher-than-normal potential risk. In Western Australia, typical locations for wig wags include: • Zebra crossings • In advance of signalised pedestrian crossings (mid-block) • Unmarked crossings • Traffic warden-controlled children's crossings. The signals take the form of twin two-way, diagonally opposed, alternate flashing yellow displays. They are situated either at the conflict area between pedestrians and general traffic, or in advance of the conflict area to provide additional warning of the potential presence of pedestrians on the road.	• The alternating light pattern is more noticeable than steady lights and naturally attracts the eye, making drivers and pedestrians more aware of their surroundings. • Wig wag lights are a widely recognised signal of caution and/or call to action to slow down or stop as required.	May not be well received by local residents in residential areas, especially if they operate on a permanent basis. • If wig-wag lights are used too frequently or in situations where they aren't strictly necessary, drivers may become less responsive to them over time, reducing their effectiveness in critical scenarios. • At night, overly bright wig-wags might temporarily impair vision or cause discomfort, particularly for drivers with light sensitivity. • Drivers unfamiliar with Australian road rules or wig-wag signals (e.g., tourists) may not immediately understand their meaning, leading to hesitation or inappropriate reactions. • Wigwags can be expensive to install and maintain. • Wig-wags near intersections or traffic signals may compete for attention with standard traffic lights, creating confusion.	• Zebra crossings: can be provided at the crossing or at the crossing + in advance on both sides of the road to increase visibility. • Signalised crossings: integrate wig-wags with existing traffic signals, positioning in advance to the signals for enhanced awareness. • Unmarked crossings: can be provided in advance to unmarked crossings. • Traffic warden-controlled children's crossings: can be provided at the crossing or at the crossing + in advance on both sides of the road with school crossing signs. • Lights can be activated manually or automatically depending on the location and required need. • Lighting requirements.	Refer to Main Roads' *Wig Wags Policy, Application and Technical Guidelines*' for additional information.

Treatment	Description	Advantages	Disadvantages	Recommended parameters	Design considerations
VAS	A vehicle activated sign (VAS) is a mechanism for imparting information to road-users that reduces an identified risk by influencing behaviour. VAS is usually activated (triggered) by a vehicle approaching a hazardous situation. The sign is then activated for a short period of time before returning to a blank condition after the message is no longer required. There are three types of VAS: • Those activated by vehicle speed • Those activated by vehicle presence • Those activated by a third party, i.e. a non-road-user (e.g. weather).	• Provides timely, situation-specific information, reducing the likelihood of accidents. • Encourages compliance with speed limits and other road rules. • Reduces the need for constant human intervention or static signage updates.	• Frequent activation in non-critical situations may reduce the impact on driver behaviour. • Initial setup, including sensors and power supply, may be expensive in remote areas.	**Appropriate:** • School zones. • Areas with frequent speeding incidents. • Sharp curves or downhill sections where excessive speed increases risk. • As a supporting treatment for pedestrian crossings.	VAS must comply with: • AS 1742.14: Manual of Uniform Traffic Control Devices – Traffic signals • AS 1742.2: Traffic control devices for general use and • specific guidelines issued by Main Roads WA.

Appendix 2: Gap analysis method based on MetroCount data

Overview

The gap analysis method based on MetroCount data measures actual gaps in traffic flow enabling estimation of average pedestrian delay at uncontrolled crossings.

While traditional traffic theory often relies on random traffic arrival assumptions, these assumptions are invalid near signalised intersections due to the platooning effect. Consequently, standard traffic theory can produce unreliable delay estimates in such locations.

The gap analysis method based on MetroCount data addresses this shortcoming, by providing a more accurate assessment of uncontrolled pedestrian crossings near signalised intersections.

Note: The gap analysis method based on MetroCount data is only applicable to current traffic conditions, as it relies on observed gaps in traffic flow to indicate pedestrian delays. It cannot be used to predict future pedestrian delays under projected traffic conditions, as the gap distribution would be unknown.

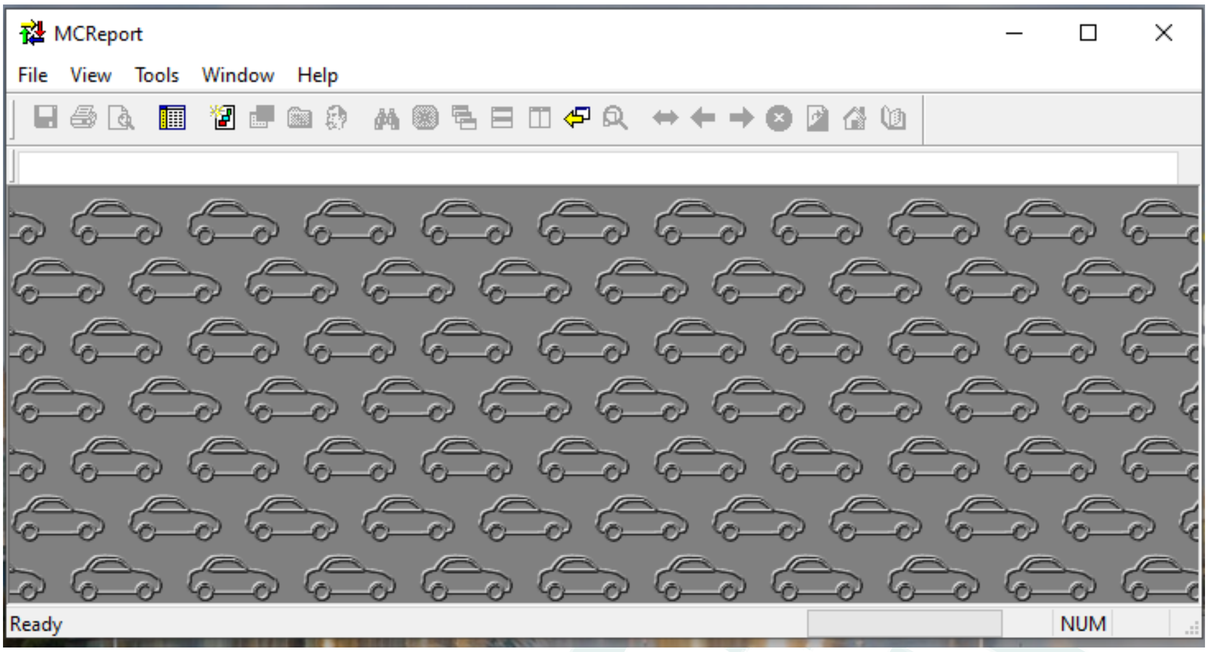
Extraction of MetroCount data

The gap analysis method based on MetroCount data uses data from pneumatic tubes for traffic surveys undertaken using MetroCount.

The following steps outline the process of extracting vehicle separation data from the MetroCount data files.

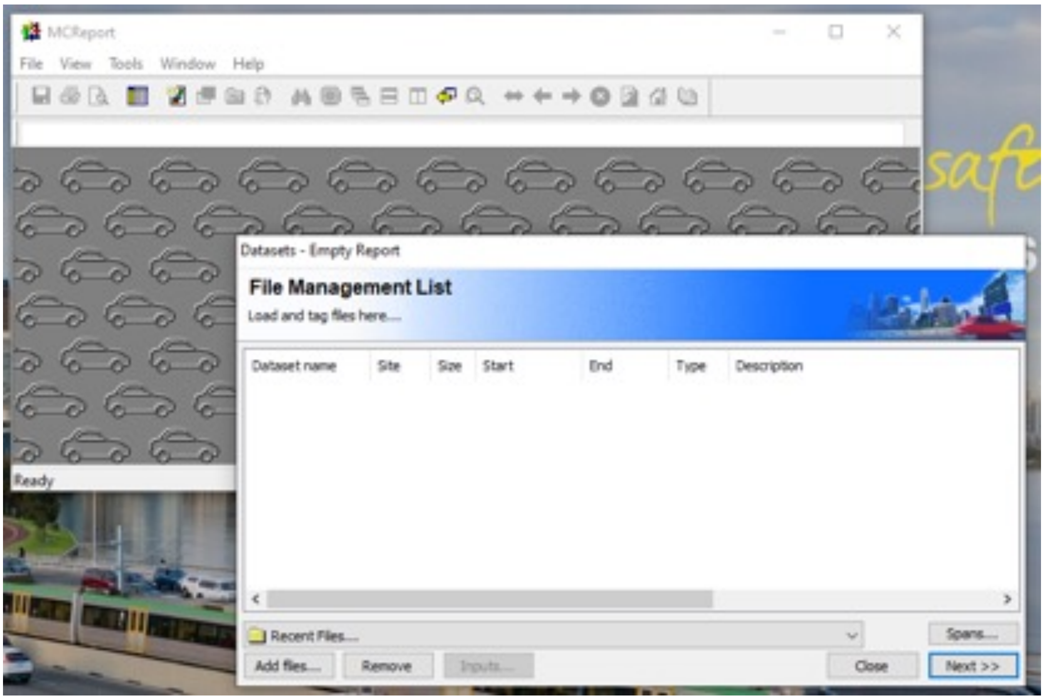
Step 1

Ensure MetroCount software is installed on your computer and open the software via the start icon and by selecting MCReport. (This will open the MCReport page as seen below.)



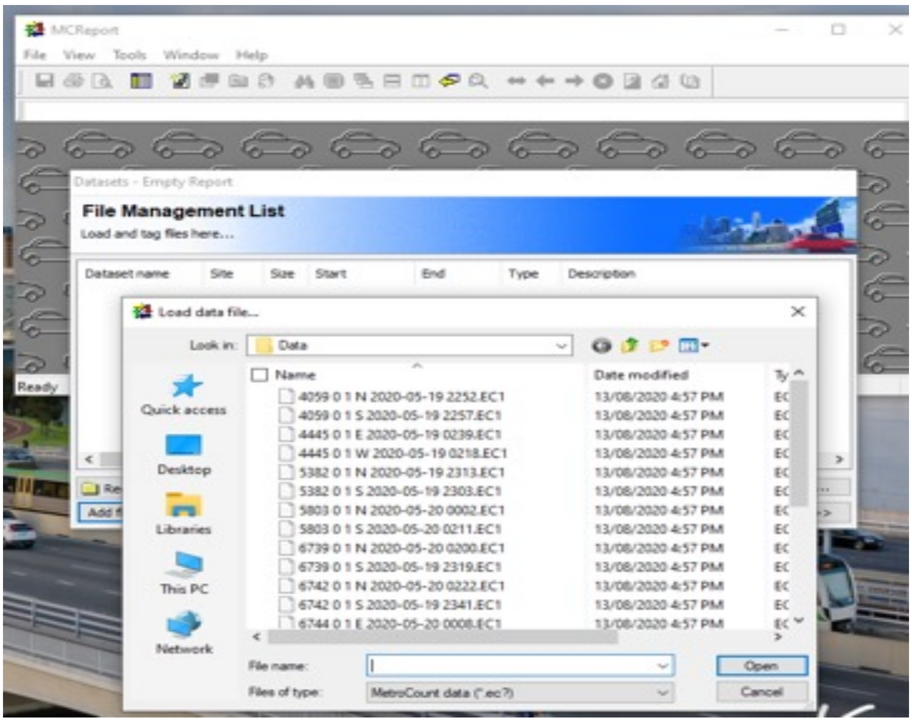
Step 2

Click on file at the top left corner of the MCReport and then click on *New Report* to open the *File Management List.*



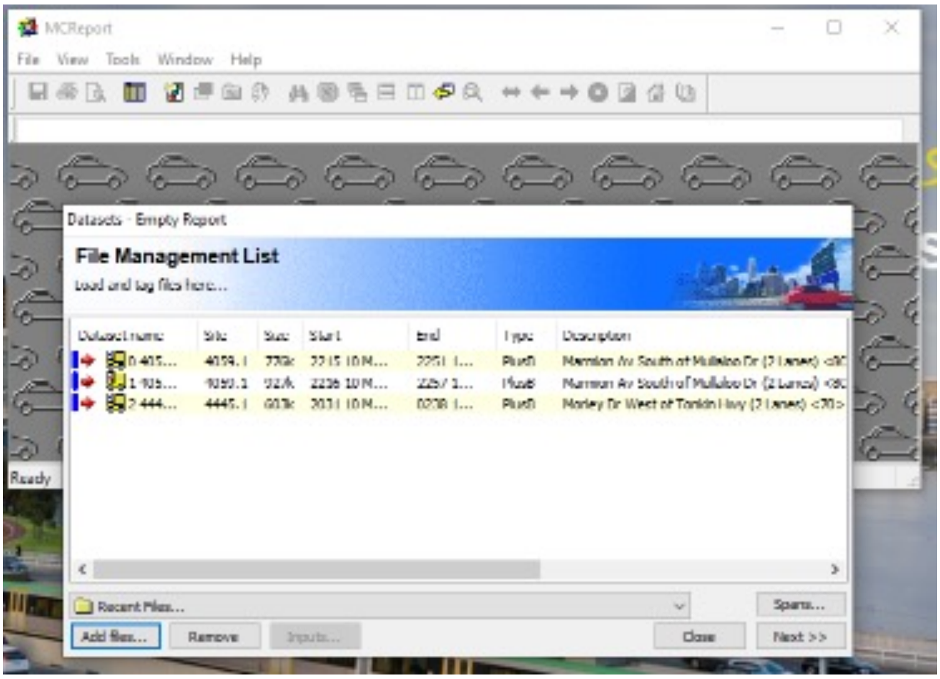
Step 3

At the bottom left corner of the *File Management List*, you can add the files from the traffic survey. Click on *add files* and select the location where your traffic survey data is stored on your laptop or desktop.



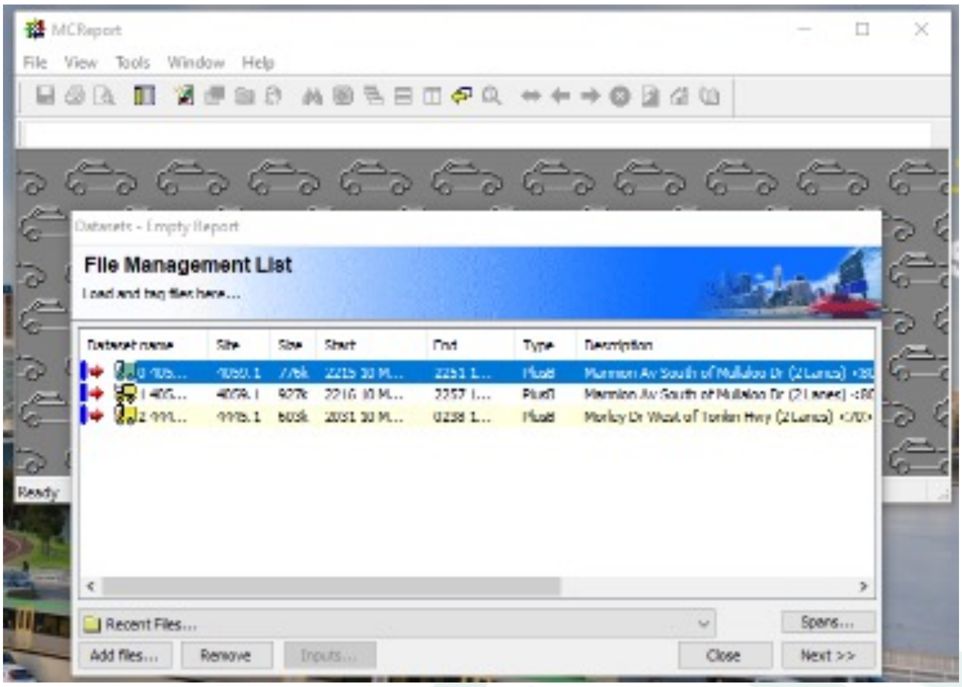
Step 4

Select the files you want to import into MCReport for analysis and click *Open*. (You should have a screen as shown below.) In the example shown in the figure below, three files were selected.



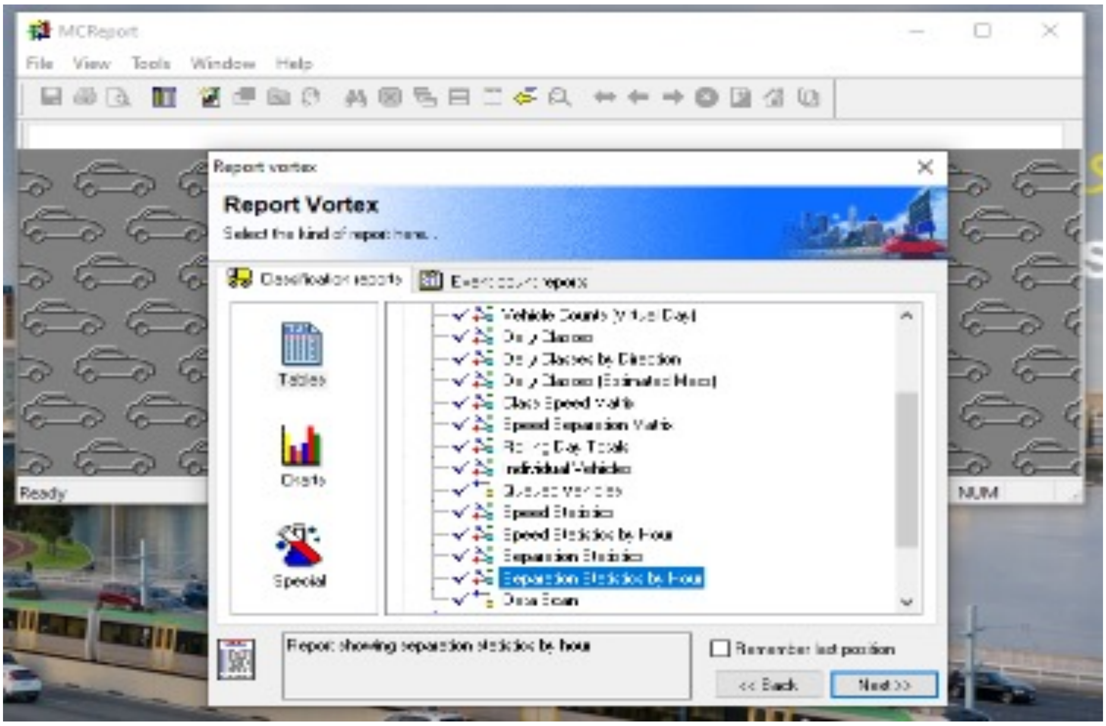
Step 5

Select which file(s) you want to open for visualisation and analysis. (You should have a similar page as per the page below.) Here, we have selected the first of the three files we imported to MCReport. The selected file now has a blue colour.



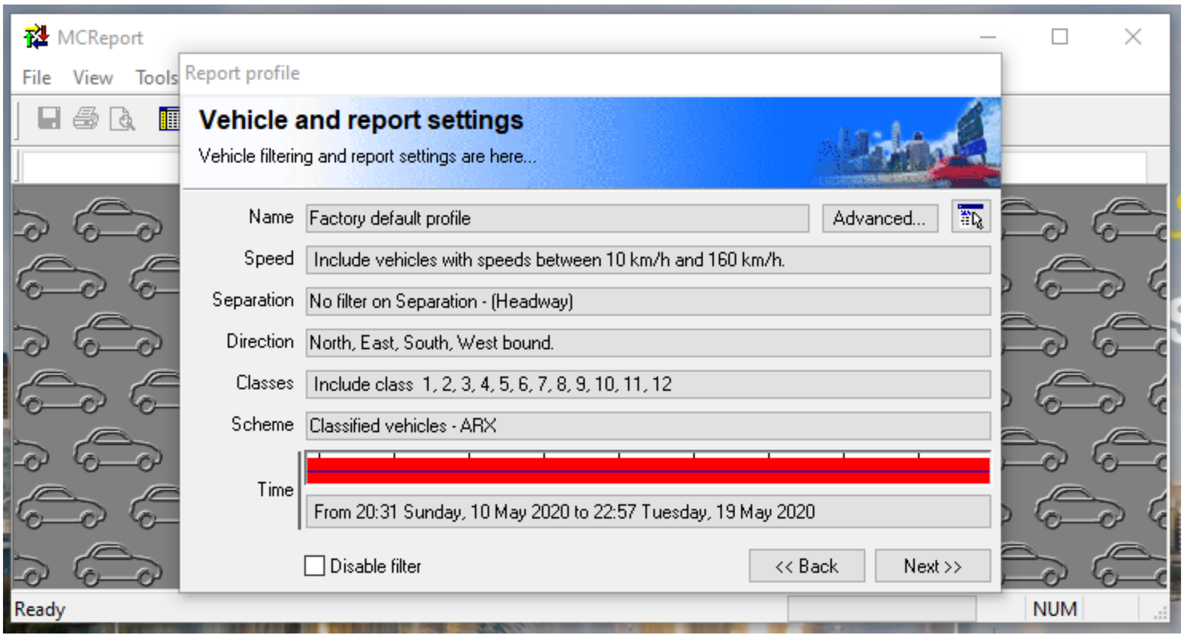
Step 6

After selecting the file of interest, click *Next* to open the Report Vortex. Select *Separation Statistic by Hour*, and click *Next* to open the *Vehicle and report* settings.



Step 7

Clicking *Next* after selecting *Separation Statistic by Hour* opens the *Vehicle and Report* settings. The opened *Vehicle and report* settings page should look like below:



Step 8

Under the *Vehicle and report* settings, you can change the time, day, direction, vehicle classes, etc

Of interest to the gap analysis is the time and day of the survey. To change the time and day do the following:

Click on the time (below the red line) and change the days to be used for analysis (weekdays, weekends, etc). You can set the start time and day as well as end time and day.

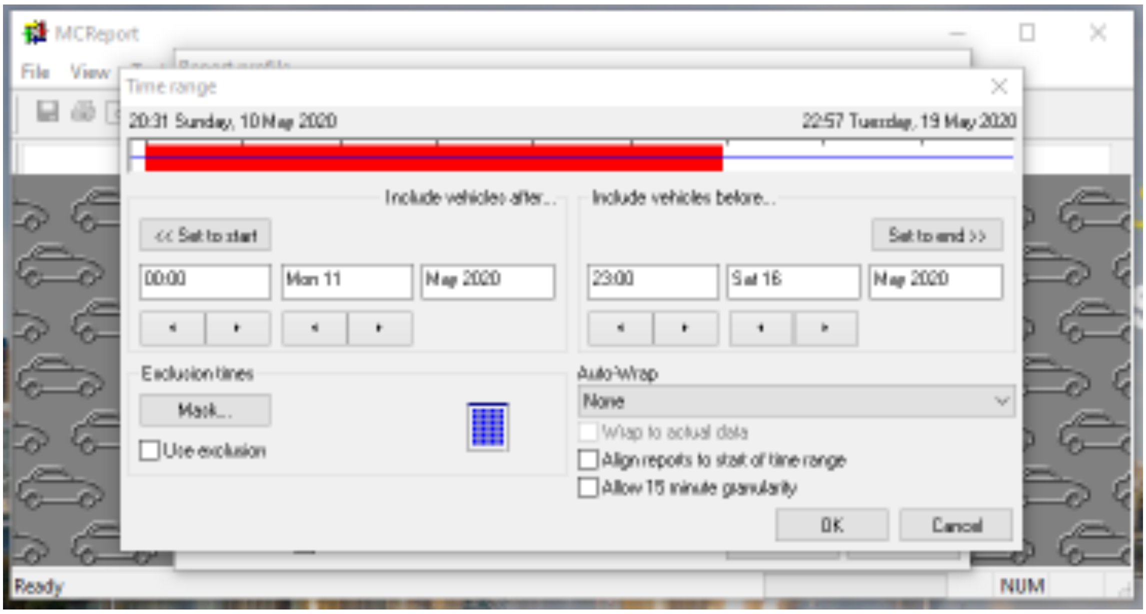
In the example below, the default days (the entire days for the survey) have been changed from:

20:31 Sunday, 10 May 2020 - 22:57 Tuesday, 19 May 2020 (as shown in Step 7)

to

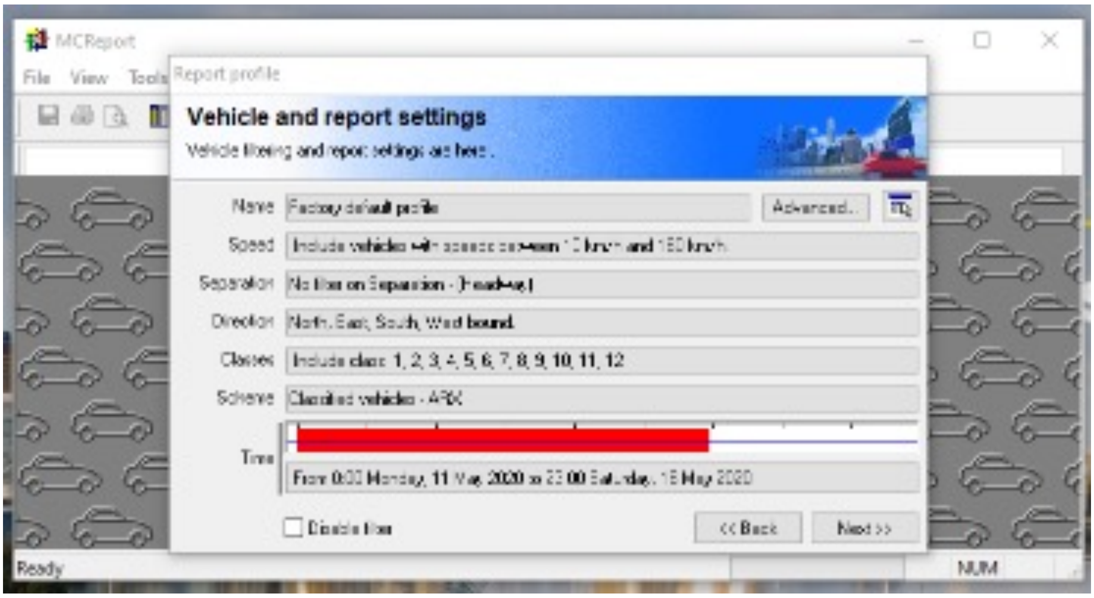
00:00 Monday, 11 May 2020 to 00:00 Saturday, 16 May 2020.

This assesses the five working days (Monday to Friday). You can change the day and time by using the arrows under time and day below.



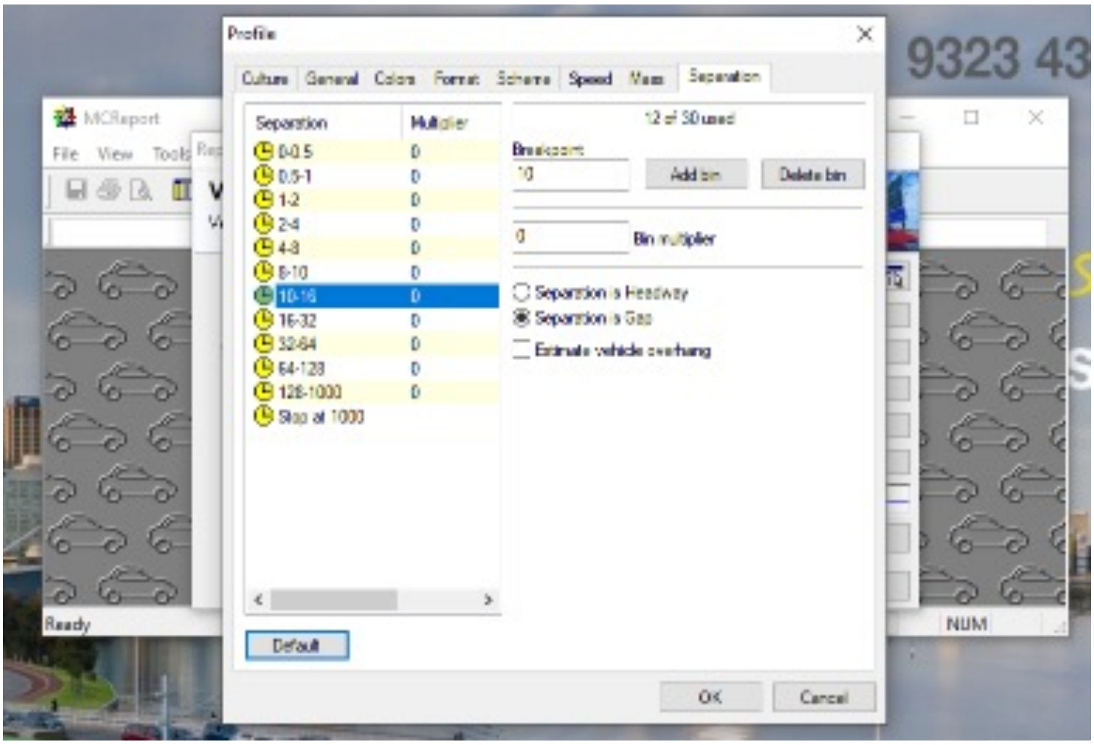
Step 9

After making the necessary changes in time and day, click *Okay* to go back to the *Vehicle and report* settings page.



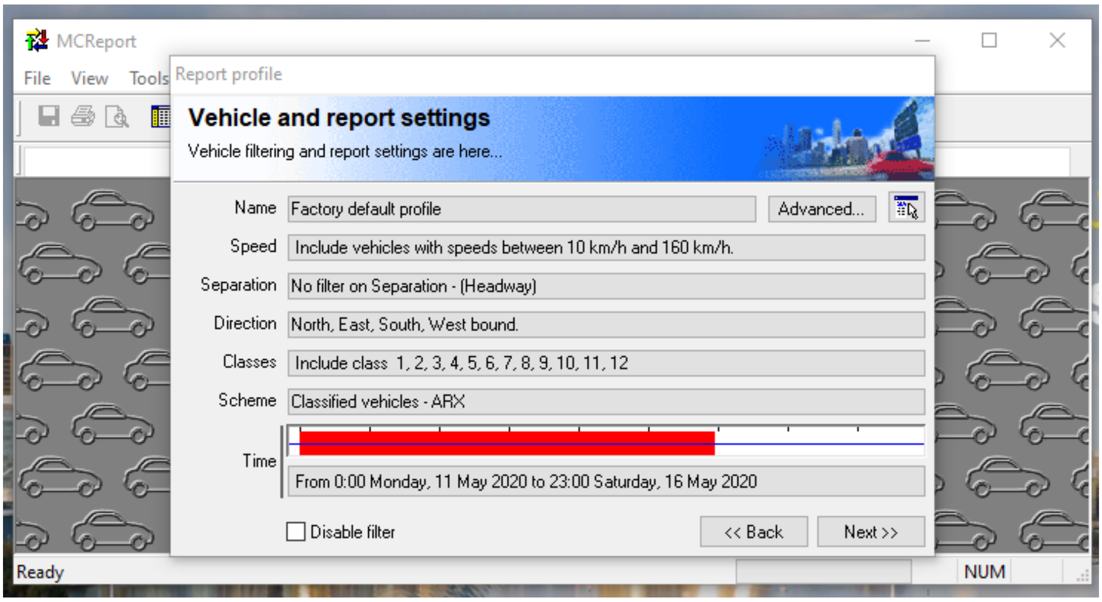
Step 10

Back on the *Vehicle and report* settings page, click on *Advanced* at the right top corner to open the profile page, and select *Separation* at the top right-hand corner. (The separation has been set to start from 0.0 seconds to 1,000 seconds.) Set the breakpoint to 10 seconds (or as will fit the project objectives) and click on *Add bin*. Also, change the default, *Separation is Headway*, to *Separation is Gap*.



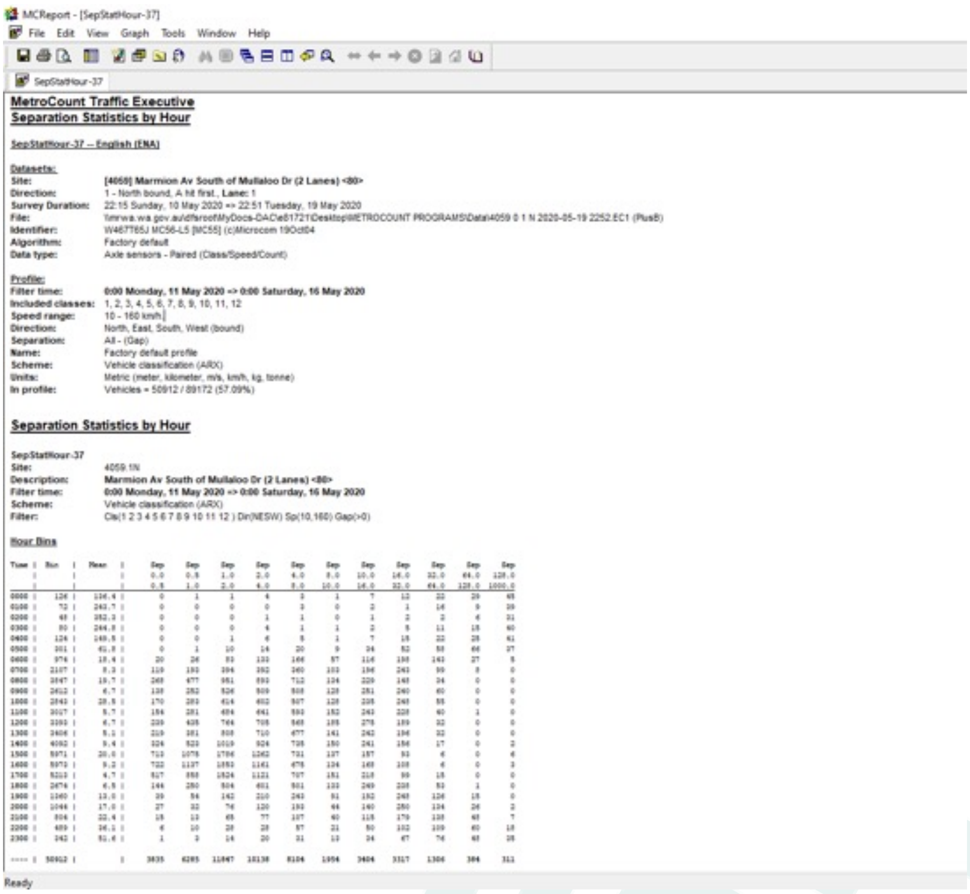
Step 11

After the changes are completed in the profile page, click *OK* to take you to the *Vehicle and report settings* page.



Step 12

Click *Next* to get the *Separation Statistics by Hour* Report. The report should look like below.



- Import/copy the Hour Bins (as per the table below) into a spreadsheet for further analysis.

Hour Bins

Time	Bin	Mean	Sep 0.0 0.5	Sep 0.5 1.0	Sep 1.0 2.0	Sep 2.0 4.0	Sep 4.0 8.0	Sep 8.0 10.0	Sep 10.0 16.0	Sep 16.0 32.0	Sep 32.0 64.0	Sep 64.0 128.0	Sep 128.0 1000.0
0000	126	136.4	0	1	1	4	3	1	7	12	22	29	45
0100	72	243.7	0	0	0	0	3	0	2	1	16	9	39
0200	48	352.3	0	0	0	1	1	0	1	2	2	6	31
0300	80	244.8	0	0	0	4	1	1	2	5	11	15	40
0400	124	149.5	0	0	1	6	5	1	7	15	22	25	41
0500	301	61.8	0	1	10	14	20	9	34	52	58	66	37
0600	974	18.4	20	26	83	133	166	57	116	198	143	27	5
0700	2107	8.3	119	193	394	392	360	103	196	243	99	8	0
0800	3847	19.7	268	477	961	893	712	134	229	148	34	0	0
0900	2612	6.7	138	252	526	509	508	128	251	240	60	0	0
1000	2843	28.5	170	283	614	602	507	128	235	248	55	0	0
1100	3017	5.7	154	201	604	641	593	152	243	228	40	1	0
1200	3393	6.7	239	435	764	705	568	185	275	189	32	0	0
1300	3406	5.1	219	381	808	710	677	141	242	196	32	0	0
1400	4092	9.4	324	523	1019	924	735	150	241	156	17	0	2
1500	5971	20.0	713	1075	1706	1262	731	137	157	93	6	0	6
1600	5973	9.2	722	1137	1853	1161	675	134	160	100	6	0	3
1700	5213	4.7	517	858	1524	1121	707	151	218	99	15	0	0
1800	2674	6.5	144	250	504	601	501	133	249	238	53	1	0
1900	1360	13.0	39	54	142	210	243	91	192	248	126	15	0
2000	1044	17.0	27	32	76	120	193	44	140	250	134	26	2
2100	804	22.4	15	13	65	77	107	40	115	179	138	48	7
2200	409	36.1	6	10	28	28	57	21	50	102	109	60	18
2300	342	51.6	1	3	14	20	31	13	34	67	76	48	35
----	50912		3835	6285	11847	10138	8104	1954	3404	3317	1306	384	311

Analysis using a spreadsheet

Once data has been extracted from MetroCount into a spreadsheet, the following steps can be undertaken to estimate the average pedestrian delay.

1. Input the time/hour, bin size, mean gap, the gap in each bin and number of days the data is collected over.

2. Determine the total time in seconds where the gaps were less than 128 seconds. Calculate as follows:

   [Sum of (hourly gaps x midpoint of separation data)] / no. of days

   Note: it is possible that the time could exceed 3600 seconds due to mathematical skew. Subsequent steps help smoothen this anomaly.

3. Determine the midpoint of the largest bin 128-1000. Calculate as follows:

   (3600 – total time gaps < 128) / (raw data for 128-1000 bin / no. of days)

4. Assuming a crossing time of 10 seconds with approx 5 seconds start-up loss, calculate the number of instances that 15 second gaps were present over the entire data collection period. Calculated as follows:

   Sum of [(gaps per separation > 10sec) x (respective midpoints)] / 15

   Note: This returns the total number of hourly gaps across total days of data collection.

5. Determine the average number of gaps per hour, calculated as follows:

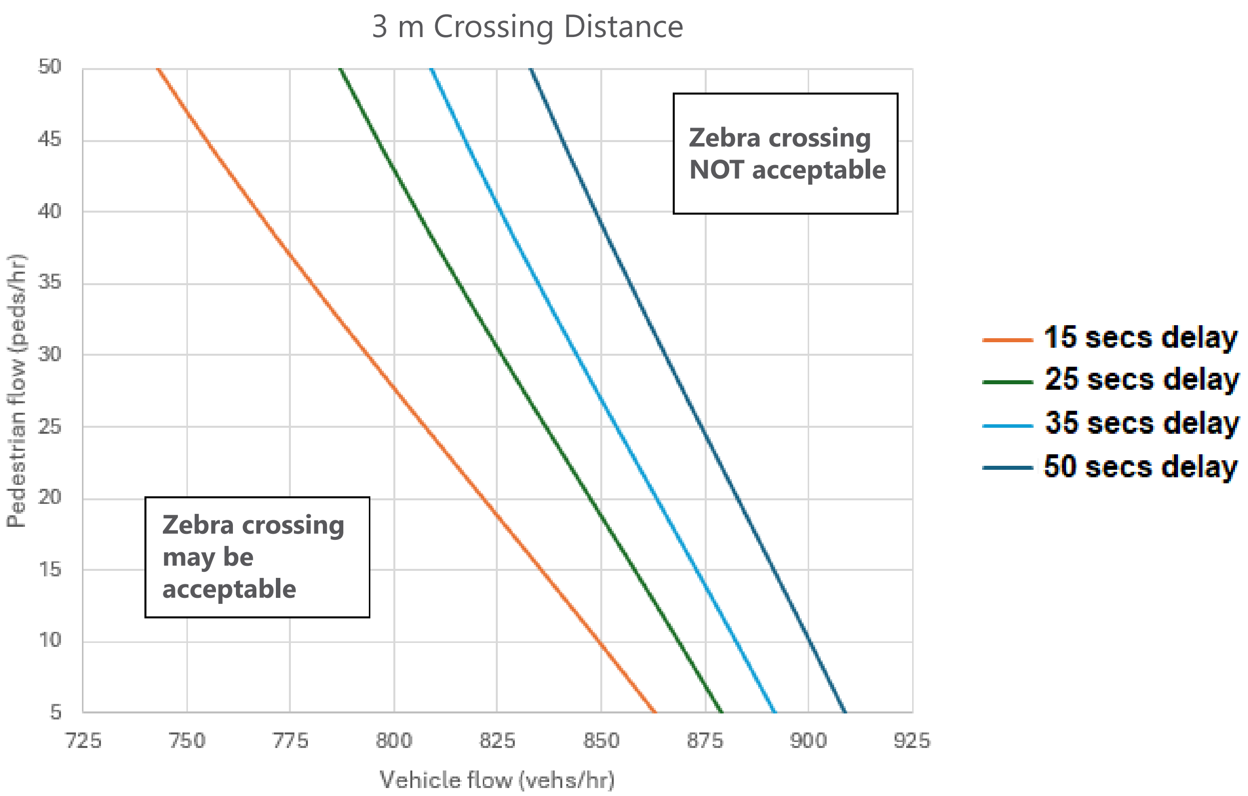
   (result of step 4) / (no. of days)

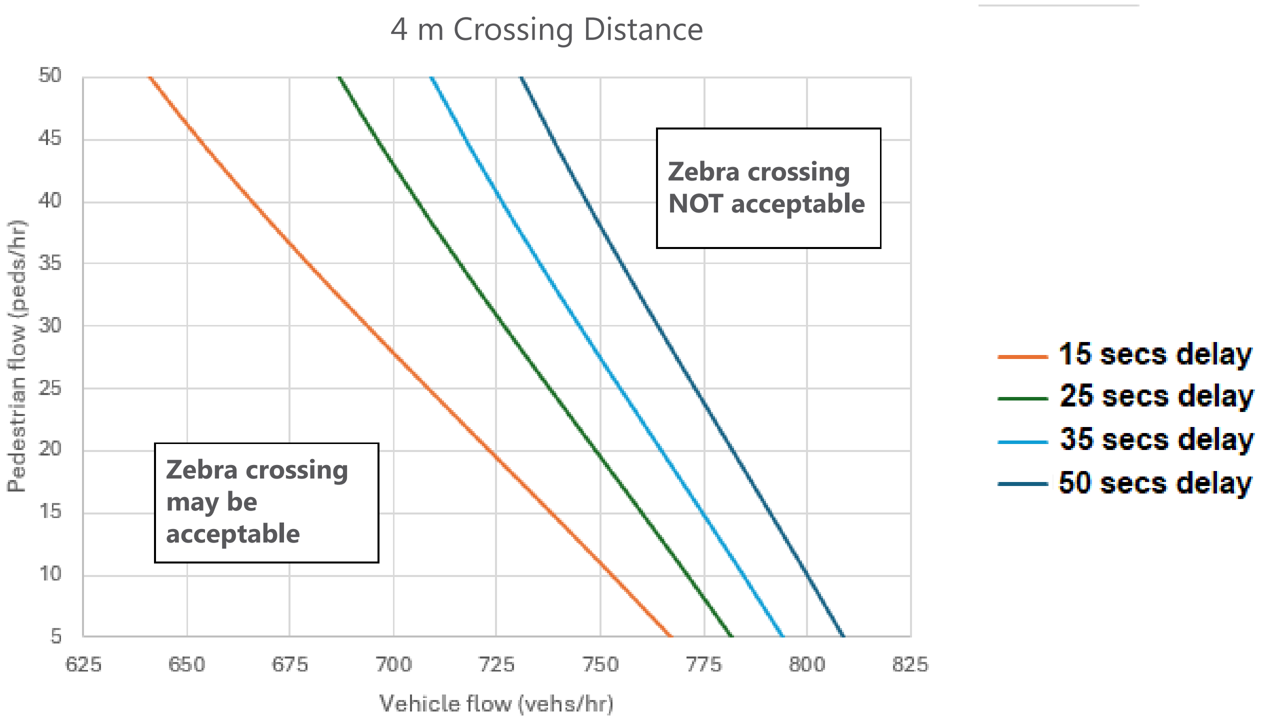
6. Estimate the average waiting time for pedestrians, calculate as follows:

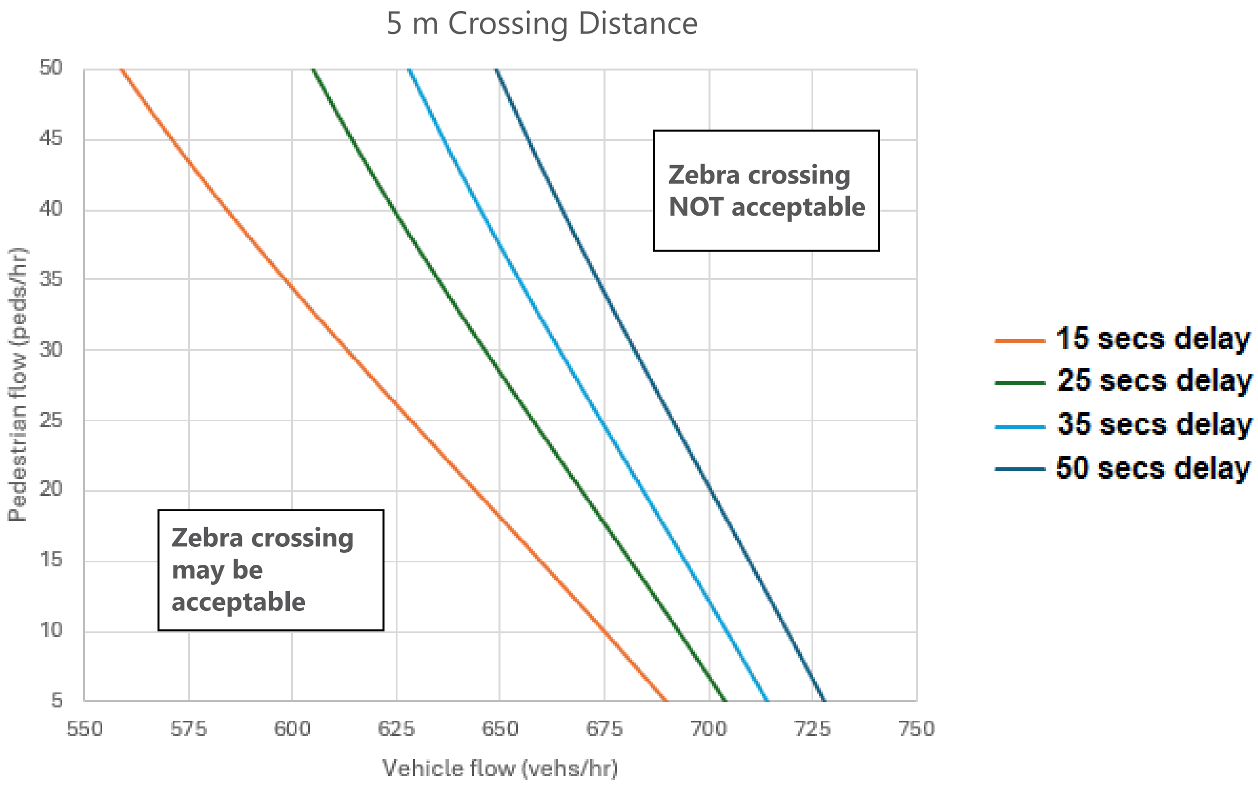
   3600 / (result of step 5)

An excel based spreadsheet template with the above methodology is available here.

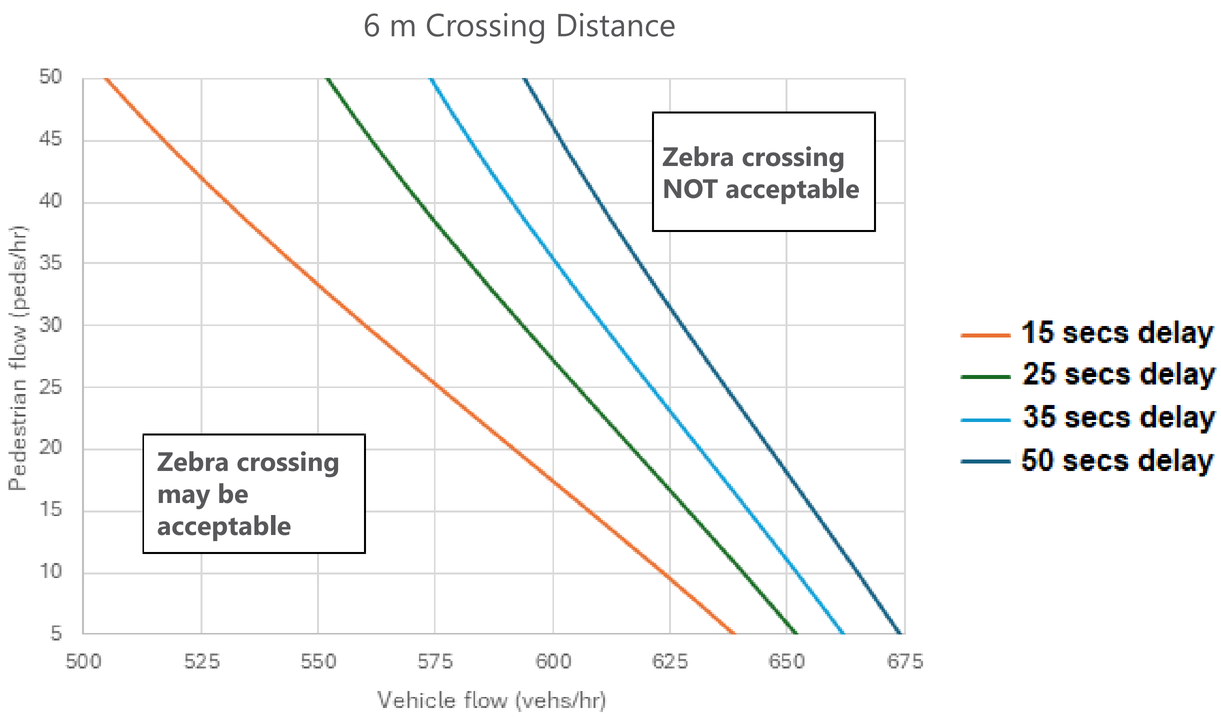
Appendix 3: Average Vehicle Delays at Zebra Crossings for Various Crossing Distances



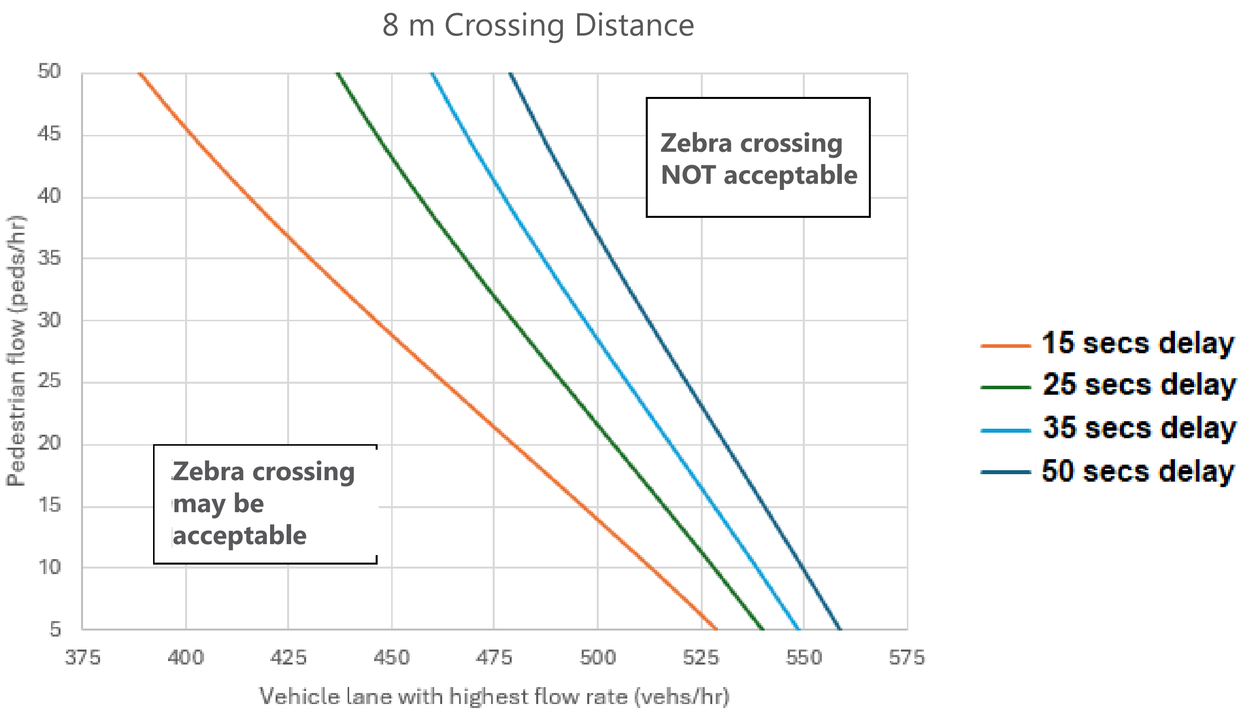




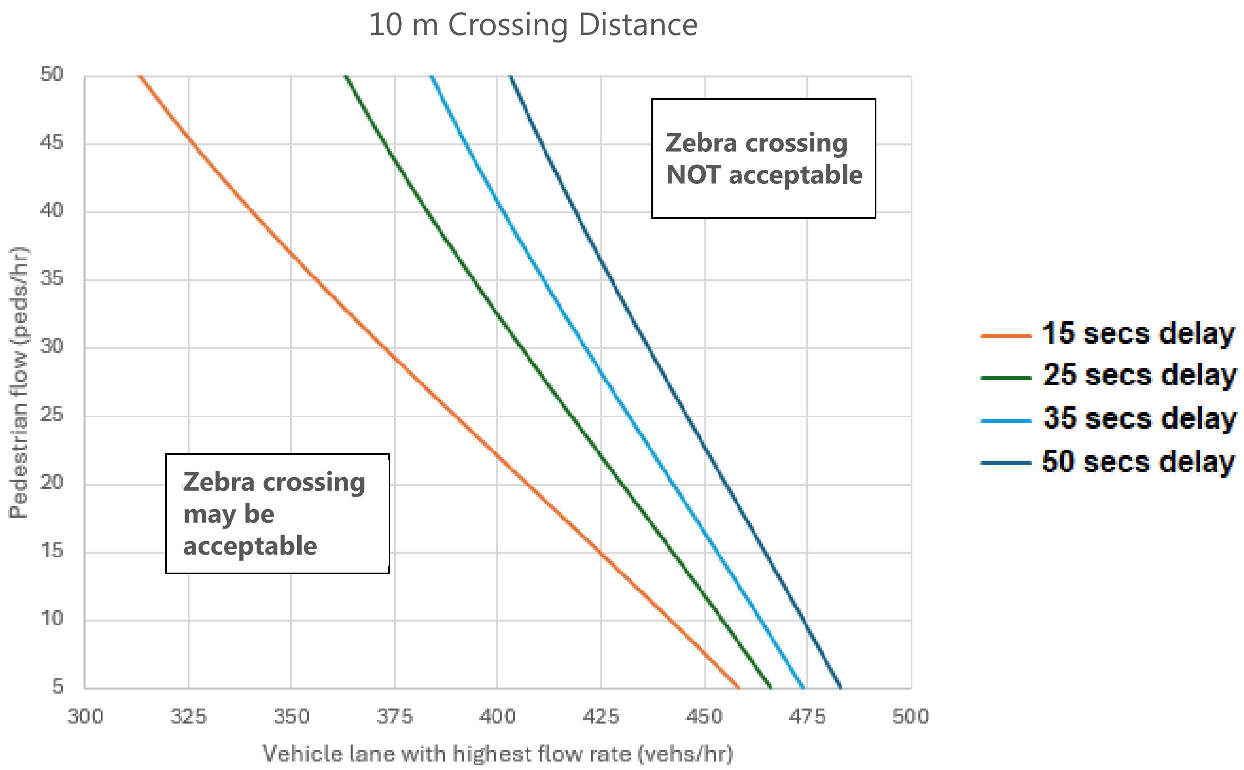
5 m Crossing Distance
Zebra crossing NOT acceptable
Zebra crossing may be acceptable
Pedestrian flow (peds/hr)
50
45
40
35
30
25
20
15
10
5
550
575
600
625
650
675
700
725
750
Vehicle flow (vehs/hr)
15 secs delay
25 secs delay
35 secs delay
50 secs delay



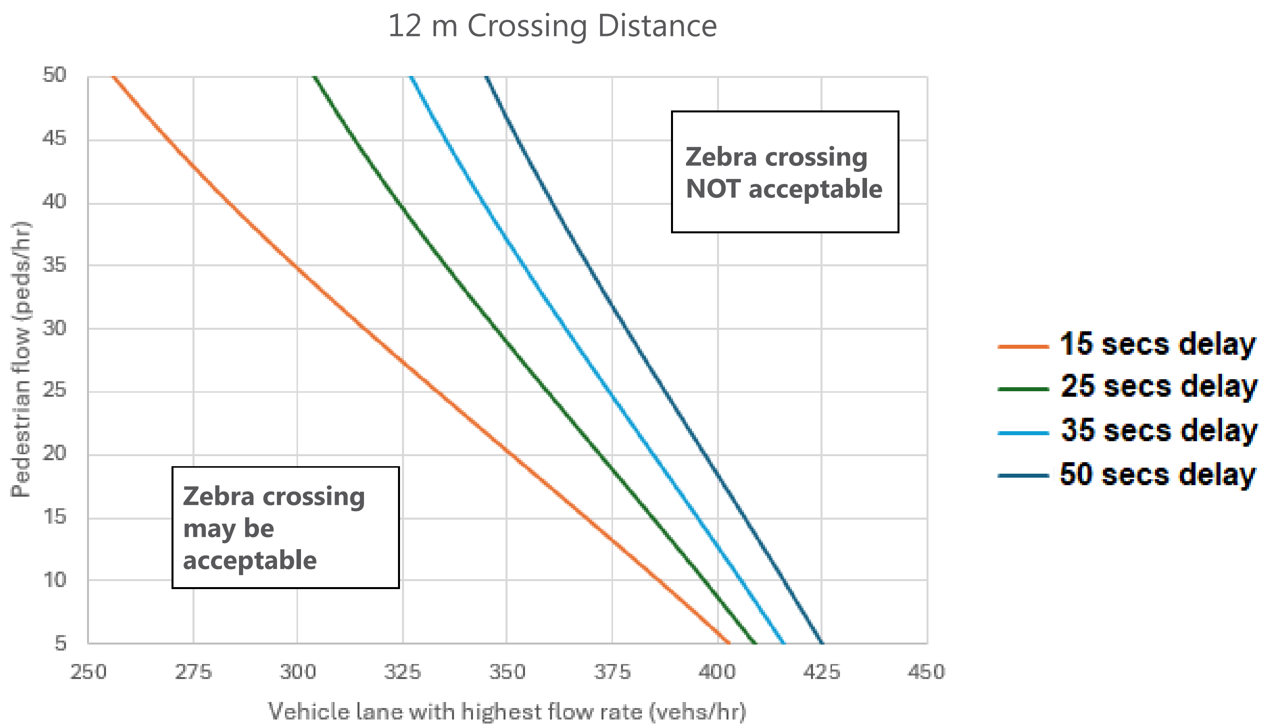
6 m Crossing Distance
Zebra crossing NOT acceptable
Zebra crossing may be acceptable
Pedestrian flow (peds/hr)
50
45
40
35
30
25
20
15
10
5
500
525
550
575
600
625
650
675
Vehicle flow (vehs/hr)
15 secs delay
25 secs delay
35 secs delay
50 secs delay



8 m Crossing Distance
Pedestrian flow (peds/hr)
Vehicle lane with highest flow rate (vehs/hr)
Zebra crossing NOT acceptable
Zebra crossing may be acceptable
15 secs delay
25 secs delay
35 secs delay
50 secs delay



10 m Crossing Distance
Pedestrian flow (peds/hr)
Vehicle lane with highest flow rate (vehs/hr)
Zebra crossing NOT acceptable
Zebra crossing may be acceptable
15 secs delay
25 secs delay
35 secs delay
50 secs delay



Notes:

1. Graphs created using SIDRA with Critical Safe Gap calculated as per Section 5.8.
2. Crossing distance refers to the actual kerb-to-kerb road width of the zebra crossing.
3. Where there is more than one vehicle lane, the vehicle flow rate of the lane with the highest flow rate is to be used as this will result in the highest delay / vehicle LoS.
4. The vehicle flow rate values in the chart assumes a peak hour factor of 100 per cent and a vehicle composition of 100 per cent light vehicles.

Appendix 4: Zebra Crossing Application Form

ZEBRA CROSSING APPLICATION FORM				
General Information				
Proposed Location				
Street Function *(section 5.6)*	☐ Main Roads	☐ Main Streets	☐ Local Streets	☐ Civic Places
Number of Lanes *(each direction)*				
Type *(section 6.2)*	☐ Mid-block	☐ Roundabout	☐ Unsignalised Intersection	
Raised Platform (wombat)	☐ Yes	☐ No		
Posted Speed Limit *(section 5.4)*	☐ 30km/h	☐ 40km/h	☐ 50km/h	☐ 60km/h
Crash History *(pedestrian related) (section 5.5)*	☐ Yes	☐ No		
Heavy Vehicles Route *(section 5.11)*	☐ Yes	☐ No		
Attach an aerial image showing the location of the proposed crossing, and sorrounding land use				
Pedestrian delay *(section 5.8)*				
PedestrianVolume *(1h - any hour)*				
Critical Safe Gap *(Figure 5-6)*				
Peak hour two-way traffic volumes				
Estimated Delay *(Fig 5-9 and 5-10)*				
Comparison with M&P *(Fig 5-7)*	☐ Acceptable	☐ Not acceptable		
Vehicle delay *(section 5.10)*				
Traffic Volume				
Estimated Delay				
Comparison with M&P *(Fig 5-12)*				
Criteria				
Sight Distance *(section 5.2)*	☐ ASD	☐ CSD	☐ SSD	
Operating Speed *(85th percentile)*				
Parking *(restricted to a minimum of 20 m before the crossing and 10 m after the crossing)*	☐ Adequate	☐ Inadequate		
Lighting *(section 5.13)*	☐ Adequate	☐ Inadequate		
Additional Information				
Include here any proposed additional treatment (Section 9, Appendix 1)				