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RAILWAY CROSSING CONTROL

IN WESTERN AUSTRALIA POLICY AND GUIDELINES

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Contents

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Authorisation

This document is owned and controlled by the Chief Operating Officer. The Level Crossing Safety and Policy Coordinator is the delegated custodian. All comments and requests for changes should be submitted to the Level Crossing Safety and Policy Coordinator.

Authorised by 25/6/2026
Chief Operating Officer

PREFACE

Main Roads Western Australia (Main Roads) and Local Governments directly manage more than 147,000 kilometres of public roads. This road network interfaces with approximately 8,100 kilometres of standard and narrow-gauge railway track at some 1,400 public railway crossings throughout Western Australia. There are a similar number of non-public (private, occupational or service) railway crossings.

This Policy and Guidelines provide direction and guidance on the management, design, and operation of railway crossings in Western Australia.

This document is reviewed and endorsed by the Strategy and Policy Railway Crossing Protection Sub-Committee with input from members of the Operational Railway Crossing Protection Sub-Committee and authorised by the Main Roads' Chief Operating Officer. The Strategy and Policy Railway Crossing Protection Sub-Committee is responsible for the review of policy related railway crossing matters, the Operational Railway Crossing Protection Sub-Committee are responsible for the review of technical railway crossing matters.

This document, along with the roles of the two sub-committees have no statutory or other legal effect on existing State Acts and/or Regulations, including those pertaining to roads and railways.

Users of this document are encouraged to provide comments to:

Level Crossing Safety and Policy Coordinator
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Alternatively, send an email to the following address: levelcrossings@mainroads.wa.gov.au (Attention: Level Crossing Safety and Policy Coordinator).

1 INTRODUCTION

1.1 Purpose

The purpose of this document is to detail the policy and guidelines for railway crossing control in Western Australia.

1.2 Scope

This document applies to all railway crossings on public roads throughout Western Australia and is a reference for managing and assessment of railway crossing control on non-public roads. Section 297 of the *Road Traffic Code 2000* empowers the Commissioner of Main Roads with the responsibility for all traffic signs and traffic control signals on roads in Western Australia. This includes any traffic signing, signalling devices or road markings installed at or on the approaches to railway crossings on public roads.

Part 1 of the *Main Roads Act 1930* defines a declared road as a road declared to be a highway, main road or secondary road under the *Main Roads Act 1930* and includes any part of any such road. For the purposes of this document, this definition includes pedestrian crossings adjacent to railway crossings and those not adjacent to railway crossings (mid-block locations). This definition is applicable throughout this document where the term Public Road is used.

Reference will need to be made to other publications such as the Australian Standard Manual of Uniform Traffic Control Devices Part 7: Railway Crossings (AS 1742.7) and the Australian Standard Railway Infrastructure: Railway Level Crossings (AS7658) for information on standards relating to the technical aspects of the various traffic control treatments and devices described in this document. Where not specified in other publications, all traffic control devices at railway crossings are to be installed in accordance with AS 1742.7. Should there be a conflict between this document and any referenced documents, this document takes precedence.

Traffic control devices on a road that does not fall under the definition of a 'public road' are not the responsibility of the Commissioner of Main Roads. In these situations, the road and rail owners are responsible for assessing the potential risks and implementing appropriate controls. However, it is within the Terms of Reference of the Strategy and Policy Railway Crossing Protection Sub-Committee and Operational Railway Crossing Protection Sub-Committee to review policy, operational and technical matters relating to the safety requirements for any railway level crossings on such roads

1.3 Background

In September 1964, Cabinet appointed an inter-departmental committee to review and make recommendations on the safety requirements for all level crossings in Western Australia. This was in response to several serious crashes at railway crossings.

The Committee published the *Report on Railway Crossing Protection in Western Australia* in December 1968 that contained findings agreed to by Cabinet. The report included an outline of criteria for determining the levels of control required at railway crossings and made several recommendations to ensure safety requirements. These included the appointment of a standing committee (Railway Crossing Protection Committee) to undertake further reviews of railway crossing control requirements. The Committee continued to review policies and guidelines and published a further report on railway crossing protection in December 1980.

Over time, the level of control on the rail network improved considerably and the rate of crashes occurring at railway crossings remains low. The progressive increase in the number and size of road freight vehicles and the introduction of high-speed passenger rail services in the metropolitan and regional areas demanded improved control requirements at railway crossings to maintain safety. This prompted the Committee to agree to the draft *Review of the Railway Crossing Protection Criteria* in November 1992 (revised edition in 1998), which, together with further consideration to factors effecting railway crossing safety, forms the basis of this document.

In January 1996, the Commissioner of Main Roads and the Commissioner of Railways agreed to restructure the roles and composition of the Committee to allow for the separation of the strategic and policy areas of railway crossing control from the operational areas. Formed were a Strategy and Policy Sub-Committee and an Operational Sub-Committee.

In 2004, the national Standing Council on Transport and Infrastructure (SCOTI) endorsed the Australian Level Crossing Assessment Model (ALCAM) as a nationally accepted method to measure risk at railway level crossings. In 2016, the national Transport and Infrastructure Senior Official's Committee (TISOC) gave unanimous support to the continued use and maintenance of the ALCAM.

In 2015, the *Rail Safety National Law (WA) Act 2015* became law in Western Australia providing for a national scheme to regulate rail safety, this Act was repealed by the *Rail Safety National Law (WA)* in 2024. The Act recognises the establishment, functions, and objectives of the Office of the National Rail Safety Regulator (ONRSR).

1.4 Australian Level Crossing Assessment Model

ALCAM is an assessment tool used to identify key potential risks at level crossings and to assist in the prioritisation of crossings for upgrades. The risk model is used to support a decision-making process for both road and pedestrian level crossings and to help determine the most appropriate treatments to improve safety.

The ALCAM model is managed nationally by organisations that cover all aspects of the model inclusive of road and rail authorities and key stakeholders to railway crossings across Australia and New Zealand.

Although it is a comprehensive tool for the assessment of railway crossing hazards, ALCAM cannot be applied in isolation and does not preclude the need for sound engineering judgement. Any risk assessment and treatment also need to consider other factors, including:

- Incident history
- Engineering (both rail and road)
- Local knowledge of driver or pedestrian behaviour
- Social and economic assessment
- Standards and best practice

ALCAM does not provide warrants for upgrades or attempt to define a 'safe' or acceptable level of risk.

To assist in decisions regarding warrants for upgrades it is essential that up-to-date records be maintained in the ALCAM Level Crossing Management System (LXM) for every level crossing on the public road network in Western Australia. It is recommended that an ALCAM assessment of each public road level crossing be undertaken at least once every five years.

To maintain a consistent approach to the assessment of risk at level crossings, Rail Infrastructure Managers shall, where requested provide the train information for the preceding 12-month period as required to undertake ALCAM ratings, on an annual basis.

2 DEFINITIONS

Term	Definition
AADT	Annual average daily vehicle traffic
AAWA	Active Advance Warning Assembly
Act	*Rail Safety National Law (WA)* (as amended from time to time)
ALCAM	Australian Level Crossing Assessment Model
Carriageway	The trafficable surface of a road, ordinarily used for vehicular traffic
CCTV	Closed Circuit Television
Danger Zone	The area encompassing the rail lines and extending 3 metres horizontally either side from the outer rails, including any distance above or below this area
Emergency	A serious, unexpected, or dangerous situation requiring immediate action
Footpath	An area that is open to the public that is designated for, or has as one of its main uses, use by pedestrians. This includes, but is not limited to, a shared path, dual use path and bicycle path
Incident	An occurrence at or affecting an Interface, which has the potential to adversely impact or has resulted in an adverse impact to the safety of persons or infrastructure or Road or train operations
Interface	The location where a rail line intersects or interacts with a road or footpath and includes level crossings, pedestrian crossings, and mid-block crossings
Level Crossing	An area where a road and a railway meet at substantially the same level, whether or not there is a "level crossing" sign on the road at all or any of the entrances to the area
Mid-block Crossing	An area where a footpath crosses a railway not adjacent to a level crossing that includes a carriageway
Operational Responsibilities	A party's responsibilities for undertaking physical works (whether on behalf of another party or not) and is the authority responsible for that relative asset. Note: operational responsibility is not associated with cost liability
Pedestrian Crossing	An area where a footpath crosses a railway adjacent to a level crossing that includes a carriageway
Proponent	The party responsible for carrying out the project
Public Road	A road owned by a Local or State Road Authority
Public Transport Authority	Public Transport Authority of Western Australia
Rail Infrastructure Manager	An organisation responsible for managing the safe operation of a railway. This is often separate to the rail owner

Term	Definition
Road	Any highway, road, or street open to, or used by, the public and includes every carriageway, footway, reservation, median strip, and traffic island thereon
Road Manager	An organisation responsible for managing and maintaining a roadway. This is usually Main Roads WA or a Local Government
RSMP	Rail Safety Management Plan. A document required for works, which may affect the safety of railway operations
TGSI	Tactile Ground Surface Indicators
TMP	Traffic Management Plan. A document required for works, which may affect the safety of road operations

3 RAILWAY CROSSING MANAGEMENT

3.1 Overview

It is important that the various levels of railway crossing control applied throughout Western Australia are consistent. To achieve this objective, it is necessary to establish a strategic approach for the installation of new railway crossing controls, upgrade of existing facilities and development or trials of new technologies relating to railway crossing controls. Additionally, it is necessary to react in a timely manner to changing circumstances and ensure control programs account for new technology and developments from interstate and overseas.

If the safety benefits of upgrading to higher levels of control are to be maximised, it is important they be installed at crossings where there is the highest risk or likelihood of a collision. If a lower level of control proves to be viable and a more proactive approach to control becomes possible, then it is essential that there is an objective and sound method of risk assessment used to determine priorities for installation. These and other issues are the responsibility of the Strategy and Policy Railway Crossing Protection Sub-Committee.

It is important that ongoing operational railway crossing control activities are discussed and resolved by those accountable for the safety and control of the road and rail networks. Where operational activities cannot be resolved between relevant parties, the Operational Railway Crossing Protection Sub-Committee provides a forum where the operational and technical functions of railway crossing control can be addressed.

3.2 Strategy and Policy Railway Crossing Protection Committee Terms of Reference

The Strategy and Policy Railway Crossing Protection Sub-Committee's Terms of Reference are as follows.

Objective

The objective of this Sub-Committee is to make policy decisions governing the control of railway crossings in Western Australia.

Role of the Sub-Committee

The role of this Sub-Committee is to:

- Provide relevant advice to the Managing Director of Main Roads and the Managing Director of the Public Transport Authority of Western Australia (PTA).
- Set and review policy for the control of road and rail users at public road crossings on all rail networks.
- Identify long-term funding requirements for appropriate railway crossing control.
- Identify and respond to the impacts of changes to road-use policy.
- Consider and respond to new or emerging risk reduction treatments at railway crossings.
- Discuss and review standards for railway crossing controls.
- Discuss national and international developments in respect of railway crossing control technology and equipment.
- Review applications to install new level crossings.
- Review and endorse any changes or revisions to the Railway Crossing Control in Western Australia Policy and Guidelines

Membership

- Chair
  - Chief Operating Officer, Main Roads WA
- Sub-Committee Representatives
  - Main Roads WA
  - Public Transport Authority of Western Australia
  - Arc Infrastructure Pty Ltd
  - Western Australian Local Government Association
  - Office of the National Rail Safety Regulator (Observer)
- Industry Sector Representatives
  - Private railway infrastructure owners/operators including:
    - Heavy Haul Freight, and
    - Tourist and Heritage
  - Occupational Crossing (Pastoralists and Graziers Association of WA)

Each organisation will nominate one member or as agreed to represent their views and interests. The Sub-Committee with nominate industry sector representatives to provide an industry perspective. If a member is unable to attend any meeting, that member may nominate a proxy representative.

Meetings

Meetings should be held bi-annually.

Support / Secretariat

The Level Crossing Safety and Policy Coordinator, Main Roads WA provides administrative support.

Agenda and Minutes

- Members shall forward to the Level Crossing Safety and Policy Coordinator, Main Roads WA any items for the agenda ten working days prior to the meeting.
- Distribution of the agenda and supporting papers will occur five working days prior to the meeting.
- The Level Crossing Safety and Policy Co-ordinator (or the nominated person) shall minute the meeting. Circulation of the minutes will occur within ten working days of the meeting.

Reporting

Sub-Committee members are encouraged to report on the meeting outcomes to their organisations.

3.3 Operational Railway Crossing Protection Sub-Committee Terms of Reference

The Operational Railway Crossing Protection Sub-Committee's Terms of Reference are as follows.

Objective

The objective of this Sub-Committee is to improve the operational and technical aspects of railway crossings in Western Australia.

Role of the Sub-Committee

The role of this Sub-Committee is to:

- Act as a point of coordination between Main Roads WA, Rail Infrastructure Managers, Road Managers, and other stakeholders on operational matters.
- Provide a forum to discuss and provide advice on operational and technical matters relating to railway crossings and the rail network in general.
- Monitor incident data from the rail networks to identify trends and develop strategies or improvements to mitigate risk. Incident data shall be provided for all railway crossing related incidents and will include.
  - Location of incident
  - Description of incident
  - Time and date of incident
- This data shall be presented to this Sub-Committee at each meeting and a report be emailed to the Level Crossing Safety and Policy Coordinator, Main Roads WA within 5 business days of the meeting.
- Provide advice to the Strategy and Policy Railway Crossing Protection Sub-Committee regarding:
  - Level crossing sites requiring a coordinated response to mitigate risk.
  - Knowledge and lessons learnt from level crossing treatments.
  - Research and/or trials as necessary to develop enhancements to control levels.
  - Recommend amendments to the Railway Crossing Control in Western Australia Policy and Guidelines.

Membership

- Chair
  - Level Crossing Safety and Policy Coordinator, Main Roads WA.
- Sub-Committee Representatives
  - Main Roads WA,
  - Public Transport Authority of Western Australia,
  - Arc Infrastructure Pty Ltd, and
  - Western Australian Local Government Association.
- Industry Sector Representatives
  - Private railway infrastructure owners/operators including:
    - Heavy Haul Freight, and
    - Tourist and Heritage.

Each organisation will nominate one member or as agreed to represent their views and interests. The Sub-Committee with nominate industry sector representatives to provide an industry perspective. If a member is unable to attend any meeting, that member may nominate a proxy representative.

Meetings

Meetings should be held quarterly.

Support / Secretariat

The Level Crossing Safety and Policy Coordinator, Main Roads WA provides administrative support.

Agenda and Minutes

- Members shall forward to the Level Crossing Safety and Policy Coordinator, Main Roads WA any items for the agenda ten working days prior to the meeting.
- Distribution of the agenda and supporting papers will occur five working days prior to the meeting.
- The Level Crossing Safety and Policy Co-ordinator (or the nominated person) shall minute the meeting. Circulation of the minutes will occur within ten working days of the meeting.

Reporting

Sub-committee members are encouraged to report on the meeting outcomes to their organisations.

4 RAILWAY CROSSINGS STATUS

Railway crossings can be closed and removed subject to agreement between the Rail Infrastructure Manager and the Road Manager, typically Main Roads or the Local Government.
The authority to approve the installation, removal of or to change the level of control for railway crossing controls on the public road network is the responsibility of the Main Roads' Chief Operating Officer, as delegated by the Commissioner of Main Roads in accordance with section 10B(1) of the *Main Roads Act 1930*.

4.1 Rail Line Status

The following terms and definitions are used to determine a hierarchy of control.

Open (Operational)

Train and maintenance services are being run (either regular or seasonal).

Dormant (Non-Operational)

A railway line with rail infrastructure that remains in place which under current network operations does not carry routine freight or passenger rail traffic, but which does regularly carry machines, vehicles, and equipment for railway maintenance and/or inspection.

Disused (Non-Operational)

A railway line with rail infrastructure that remains in place, which under current network operations no rail traffic, is expected but which may carry machines, vehicles, and equipment for minimal railway maintenance and/or inspection.

Closed (Discontinued)

A railway line, which is permanently out of service, with crossing related infrastructure completely removed, ideally with the tracks removed, or bund installed.

Rail Infrastructure Managers may have different definitions for the status of lines on their network i.e., operational, non-operational, active, seasonal, not in use, inactive, discontinued, etc. Ensure definitions of status are understood when dealing with other organisations.

4.2 Cessation of Railway Operations

From time to time, rail traffic on railway lines ceases either permanently, or temporarily. To ensure railway crossing control devices are effective they should only be installed in situations where they are required; otherwise, motorists can become complacent and may ignore them.

On Dormant railway lines, consideration should be given to removing the regulatory level crossing signage and disabling active controls, replacing them with "Railway Crossing Ahead" (W7-8 or W7-9) and "Railway Not In Use" (MR-WDRC-3) signage.

On Disused railway lines, the railway crossing controls should be removed and "Railway Crossing Ahead" (W7-8 or W7-9) and "Railway Not In Use" (MR-WDRC-3) signage installed. In addition, signage (hump, dip, rough surface, etc.) is to be installed to warn motorists of the uneven surface at the railway crossing.

In situations where crossing controls are removed or re-instated due to changes in rail line status, local media campaigns alerting the community to these changes should be considered.

Changes to crossing controls should be undertaken in accordance with section 297 of the *Road Traffic Code 2000*.

4.3 New Level Crossings

The State Government does not support the introduction of new level crossings on the public road network.

Investment in early planning to avoid the creation of railway crossings has long-term safety benefits. Where a new road level crossing is required on a public road and all alternate options have been considered, the crossing will need to be proven to have significant benefits to the State e.g., town bypass for a new heavy vehicle route. Other options, which must be considered prior to applying for a new level crossing, include Grade Separation, realignment of road or rail, or the relocation of an existing level crossing.

For the introduction of new level crossings, the Proponent must seek all necessary approvals from the relevant Road Manager, Rail Infrastructure Manager, MRWA and the Office of National Rail Safety Regulator. It should be noted that ONRSR does not support the construction of new railway crossings and strongly encourages governments and industry to commit to a firm policy of 'no new railway crossings'. Several Rail Infrastructure Managers also maintain the position of no new railway crossings on their respective networks.

Any costs associated with the introduction of a new level crossing are to be borne by the Proponent.

5 ROAD AND RAIL WORKS

5.1 Interface Agreements

The *Rail Safety National Law (WA)* outlines the responsibility of Rail Infrastructure Managers and Road Managers to identify, assess and determine measures to manage risks to safety that may arise from railway operations because of the existence of rail or road crossings in Western Australia. To manage those risks the Act requires a Rail Infrastructure Manager and a Road Manager to enter into an Interface Agreement. Refer to individual Interface Agreements for the responsibilities of a Rail Infrastructure Manager and Road Manager.
In WA, all Interface Agreements for public road level crossings include the following parties:

- Main Roads WA as the regulatory authority,
- Rail Infrastructure Manager, and
- Road Manager (Main Roads WA or Local Government for public roads).

In WA all Interface Agreements for private and occupational crossings are between the Rail Infrastructure Manager and the respective Road Manager

5.2 Costs

Funds for public railway crossing controls on the State Government owned rail networks are provided by the State Government as road funds and are administered by Main Roads WA. Where not otherwise subject to separate agreements and conditions, responsibilities for meeting the costs for railway crossing controls are in Table 1.

Circumstance	Cost met by
Improving crossing controls, including pedestrian facilities, at existing railway level crossings on the State-owned freight network	Main Roads WA
Improving crossing controls, including pedestrian facilities, at existing railway level crossings on the State-owned passenger network	Public Transport Authority
Maintaining and operating crossing control devices on public roads intersecting with State-owned railways e.g., PTA and Arc Infrastructure networks	Shared equally between Main Roads WA and the Rail Infrastructure Manager
Maintaining and operating crossing control devices on public roads intersecting with Federal Government or privately owned railways e.g., mining companies, ARTC	Rail Infrastructure Manager
Installing, improving, or modifying railway crossing control, including pedestrian facilities, required due to a specific network improvement i.e., road, rail, land-use improvements, or land developments	The Proponent of the change. i.e., the developer. The costs are to include maintenance requirements extending five years beyond the completion of the development, new construction, or upgrade

Circumstance	Cost met by
Removing vegetation and/or other visibility obstructions in the road reserve to provide adequate sight distances for drivers approaching a public road crossing (including any negotiations with adjacent private property owners if required)	Road Manager
Removing vegetation and/or other visibility obstructions in the rail reserve to provide adequate sight distances for drivers	Rail Infrastructure Manager
Controlling crossings on non-public roads	As agreed between the Road Manager and Rail Infrastructure Manager

Table 1 – Responsibilities for meeting costs of railway crossing control in WA

5.3 Operational responsibilities

Where not otherwise subject to separate agreements and subject to the approval of the Commissioner of Main Roads where appropriate, operational responsibilities for railway crossings are as follows.

Main Roads WA

- Install and maintain appropriate regulatory signs, warning signs, road markings and Active Advance Warning Assemblies on public road approaches to railway crossings - excludes signage affixed to active crossing controls (unless otherwise agreed within the relevant Interface Agreement).
- Administering access for Restricted Access Vehicles (RAVs).

Road Manager

- Maintain the road surface (unless otherwise agreed within the relevant Interface Agreement).
- Arrange, undertake, and maintain any vegetation clearing and/or removal of other physical obstructions on roads to provide requisite driver visibility sightlines on the road approaches to level crossings (including any negotiations with private property owners if required).
- Notify the Rail Infrastructure Manager of any works planned, either of a temporary or permanent nature, in the vicinity of a crossing. (See "Roadworks in the Vicinity of Railway Crossings" below).
- When made aware of any change in land use adjacent to an interface or any change in crossing use, notify the Rail Infrastructure Manager.
- Report to Main Roads WA any damaged and unserviceable line marking and signage associated with a crossing identified during inspection of the local road network in accordance with normal maintenance regimes.

Rail Infrastructure Manager

- Arrange and coordinate application designs for the installation of flashing lights, boom barriers, warning bells and Active Advance Warning Assembly control devices.
- Maintain and install flashing lights, boom barriers, warning bells and Active Advance Warning Assembly interfaces with active level crossing controls.

- Notify the Road Manager of any works planned, either of a temporary or permanent nature, in the vicinity of a crossing. (See "Roadworks in the Vicinity of Railway Crossings" below).
- Install and maintain appropriate regulatory signage affixed to active crossing controls.
- Undertake and maintain any vegetation clearing and/or removal of other physical obstructions within the rail reserve to provide adequate visibility sightlines on the rail approaches to level crossings.
- Assist the Road Manager in maintaining the road surface within three metres (3m) of the outside running rails (unless otherwise agreed within the relevant Interface Agreement).
- At pedestrian crossings, install and maintain flashing lights, warning bells, pedestrian mazes, gates and crossing paths (excludes approach paths) as applicable, including any signage affixed to these devices.

Reciprocal Action for All Parties

- Notify each other party of changes to usage of an Interface of which a party is aware, such as changes to traffic volumes.

5.4 Road Works in The Vicinity of Railway Crossings

Road and other service-related works being undertaken in the vicinity of railway level crossings could have adverse impacts on the level of safety at the crossings.
Subject to the nature of planned works, the Rail Infrastructure Manager may determine that a Safety Management Plan (SMP) is required. Prior to commencing the works, the Road Manager will prepare and submit an SMP to the Rail Infrastructure Manager for approval. The Road Manager should liaise with the Rail Infrastructure Manager for assistance in developing the SMP and obtain an estimate of the approval timeframe for the SMP. The Rail Infrastructure Manager may review any traffic management plan associated with the works if necessary. The development of an overarching SMP for standard maintenance activities within the vicinity of Railway Crossings should be considered by Road Managers to streamline approvals for their works.

Planned Maintenance Works

Road Managers are responsible for advising the appropriate Rail Infrastructure Manager of planned maintenance work within the road reserve and within 200m of a railway level crossing, either of a temporary or permanent nature, where the works may impact on the railway level crossing. The Rail Infrastructure Manager shall be notified a minimum of two (2) weeks[1] prior to the commencement of such works. Some examples of planned maintenance works include, but are not limited to:

- Pavement marking,
- Resurfacing, and
- Installation of signage

[1] Notification timeframes and application processes may vary from one rail network to another, the relevant Rail Infrastructure Manager should be consulted for confirmation of the timeframes and processes specific to their network.

Unplanned Maintenance Works

Where unplanned works within the road reserve and within 200m of railway crossings which if left untreated have the potential to become Emergency Works are identified, Road Managers are responsible for advising the appropriate Rail Infrastructure Manager of the required works as soon as practicably possible. The respective parties shall then work together to establish a solution which is acceptable to the relevant safety requirements of the parties to rectify the issue. Subject to the required works, unplanned maintenance works may be required to be actioned within a few days. Some examples of unplanned maintenance works include, but are not limited to:

- Pothole repairs; and
- Storm damage repairs such as removing fallen vegetation and clearing blocked drains.

Emergency Works

In the case of an Emergency, the Road Manager is to notify the Rail Infrastructure Manager immediately advising of the situation and the required course of action.

Project Works

Where a Road Manager intends to undertake road improvement works, in the vicinity of railway crossings as part of a road improvement project the Road Manager shall liaise with the appropriate Rail Infrastructure Manager in advance of their project. The safety of the railway crossing impacted by the works needs to be considered in both the final project deliverable and during the construction of the project, as there is the potential for a reduction of safety at the railway crossing to occur while works are in progress. Examples of such situations include, but are not limited to:

- Widening a carriageway without providing for additional clearances to railway crossing control equipment and other railway infrastructure.
- Road realignments or modifications requiring adjustment to the focal alignment or repositioning of flashlight signals.
- Changes to the approach angle of the road; and
- Visibility obstructions due to the placement of roadside furniture, bus shelters, etc.

5.5 Railway Works in The Vicinity of Road Crossings

Rail related works being undertaken in the vicinity of railway level crossings could also have adverse impacts on the level of safety at the crossings.
Any party undertaking work on a road must prepare a Traffic Management Plan (TMP) that adequately provides for the safety of workers and road users while maintaining an adequate level of service to road users. Traffic management planning should be undertaken in accordance with the Austroads Guide to Temporary Traffic Management Part 2: Traffic Management Planning. TMPs must be approved for implementation by the road authority prior to the works.

Planned Maintenance Works

Rail Infrastructure Managers are responsible for advising the appropriate Road Manager of planned maintenance work within the vicinity of a railway level crossing, either of a temporary or permanent nature, where the works may impact on the railway level crossing. The Rail Infrastructure Manager shall be notified a minimum of two (2)[2] weeks prior to the commencement of such works.

More significant planned maintenance works such as re-railing through a level crossing require longer notification periods to provide motorists with the necessary forewarning of the extended road closure require to undertake these works. The Rail Infrastructure Manager shall work with the Road Manager as soon as practicably possible to ensure the necessary approvals can be obtained.

Unplanned Maintenance Works

Where unplanned works within the road reserve, in the vicinity of railway crossings which if left untreated have the potential to become Emergency Works are identified, Rail Infrastructure Managers are responsible for advising the appropriate Road Manager of the required works as soon as practicably possible. The respective parties shall then work together to establish a solution which is acceptable to the relevant safety requirements of the parties to rectify the issue. Subject to the required works, unplanned maintenance works may be required to be actioned within a few days.

Emergency Works

In the case of an Emergency, the Rail Infrastructure Manager is to notify the Road Manager immediately advising of the situation and the required course of action.

5.6 Track Access Permit Requirements

Track Access Permits (TAP) are required when working within the railway reserve. TAP accreditation is undertaken to ensure those working within the rail reserve are aware of hazards and safe working procedures specific to the rail environment. Accreditation requires passing the relevant mandatory health assessment applicable to the level of accreditation sought and successfully completing applicable training module(s). Successful candidates receive the relevant level of TAP. TAPs are for people who work in the rail industry, not for one-off visitors or workers doing specialist activities. For brief works, specialists or one-off visitors, a Rail Infrastructure Manager may issue a written exemption to the requirement for TAPs, providing alternate safe working procedures or supervision by appropriately accredited rail safety workers are in place as per the relevant Rail Infrastructure Manager rules. For specific TAP requirements, refer to the relevant Rail Infrastructure Manager.

[2] Notification timeframes and application processes may vary from one road to another, the relevant Road Manager should be consulted for confirmation of the timeframes and processes specific to their network.

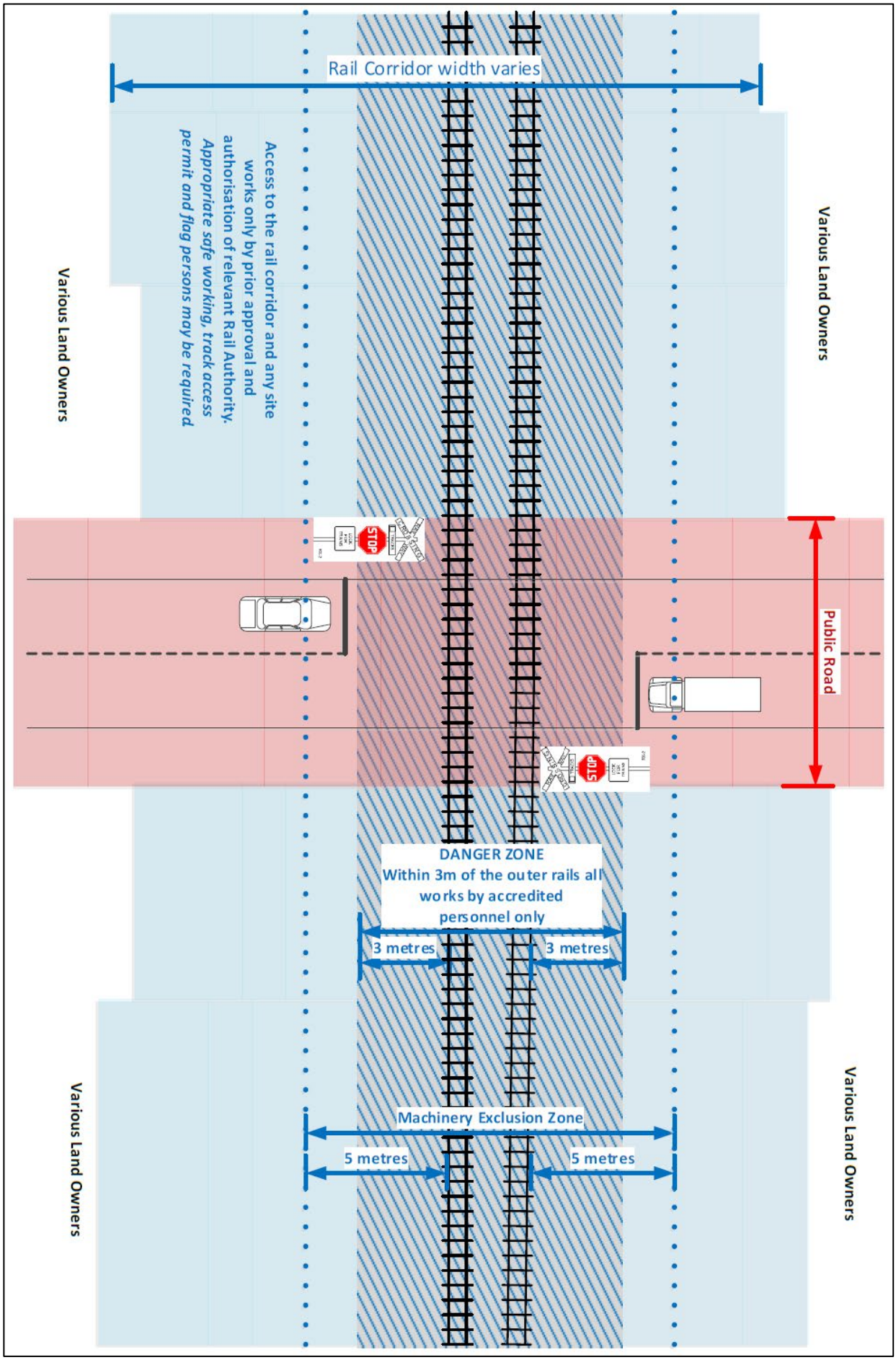


Figure 1 – Example Interface Demarcation

6 LEVELS OF CONTROL

There are five levels of control used at operational level crossings in this State. In ascending order, they are:

- Give Way Signs.
- Stop Signs.
- Flashing Lights.
- Boom Barriers.
- Grade Separation.

The four levels of 'at-grade' control fall into two categories:

- Passive devices, which include Give Way and Stop Signs; and
- Active devices, which include Flashing Lights and Boom Barriers.

The treatments for each level of passive and active controlled crossings are provided in AS 1742.7. The process of determining the appropriate level of control for any railway crossing entails systematically checking the adequacy of each level of control, starting with Give Way Sign control, and working down the five levels of control until an adequate level is determined. This is done in accordance with AS 1742.7, along with the criteria set out in Sections 7 to 11 of this document, considering safety and risk flags highlighted by the ALCAM and using appropriate safety consideration. The full range of variables should be used in the detailed assessment process, which will often require calculations to be performed in conjunction with an on-site investigation of the crossing.

In making an assessment as to the appropriate level of control for any railway crossing, the basic philosophy is to provide an adequate level of safety with the minimum amount of disruption to road or rail traffic and at the lowest cost. Often these requirements conflict, as evidenced by the fact that Flashing Lights provide less disruption to road traffic than Stop Signs, however at a much greater cost.

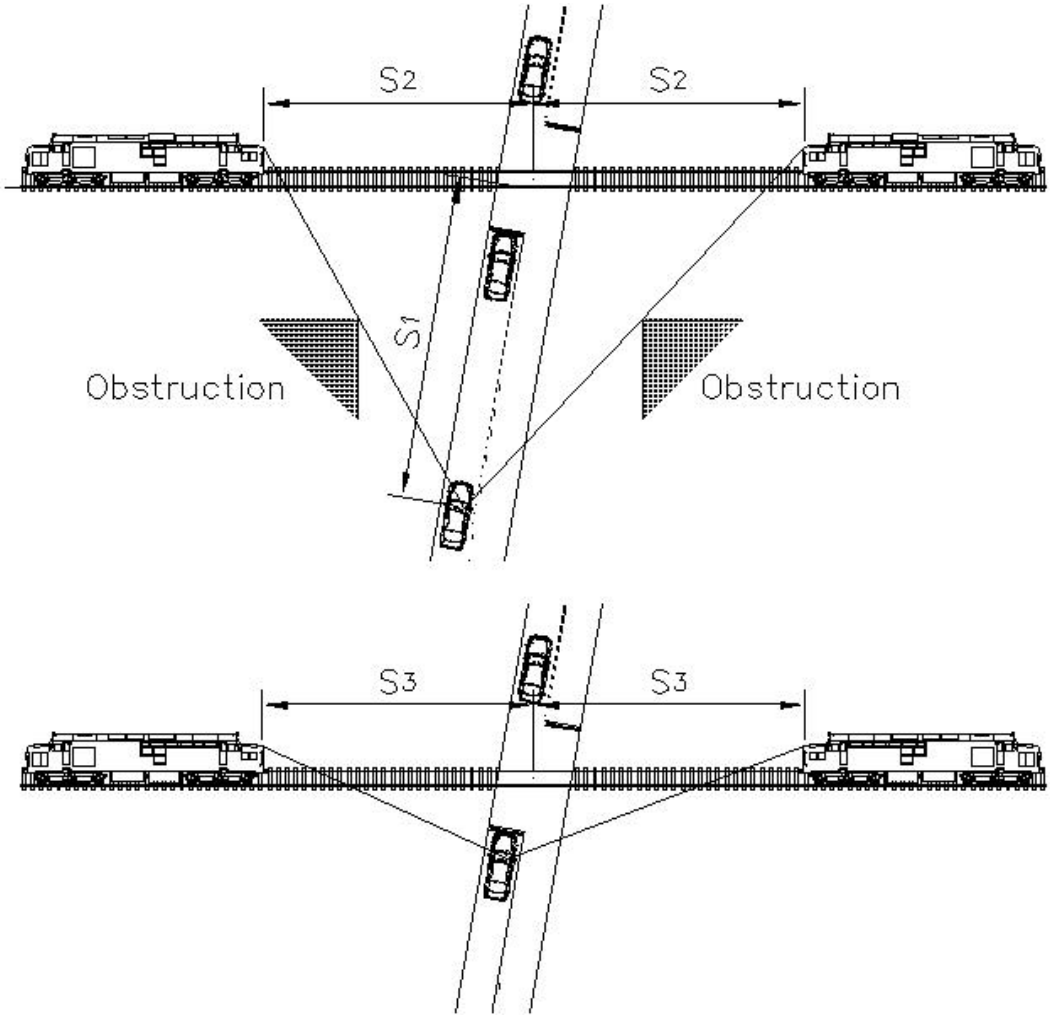
Additional treatments, which are also detailed in AS 1742.7, may be necessary to further highlight to a driver of a motor vehicle a potentially hazardous situation ahead. These include:

- Railway crossing width marker assemblies (RX-9)
- Active Advanced Warning Assemblies (RX-11)
- Reduced speed zoning of the road approaches to the level crossing.
- 'RAIL X' pavement markings

6.1 Sight Distance Requirements

Sighting distance is measured for 3 key aspects of the road approach to railway crossings:

- S1 (SSD) - distance from the crossing on each approach that the driver of a vehicle can first sight the crossing control and safely stop.
- S2 - distance from the crossing on each quadrant that an approaching train can be first sighted by the driver of a vehicle located at S1; and
- S3 - distance from the crossing on each quadrant that an approaching train can be first sighted by the driver of a vehicle stopped at the crossing.



Sight distance requirements for each type of control are derived from AS 1742.7, these requirements can be calculated using the formulas, factors and coefficients contained within Appendix D of AS1742.7 or by utilising ALCAM's LXM system. Some of the key elements considered include reaction time, 85th percentile speed of vehicles, vehicle types and road surface materials. Where a sighting deficiency is identified, a risk assessment shall be carried out to determine if further risk controls need to be applied. Options include but are not limited to:

- Rerouting classes of road vehicle
- Provision of active control
- Closure or relocation of the crossing
- Reduction of train speed
- Grade separation

It should be noted that sight lines are required to be unobstructed for the full length of the required sighting distance. Where an obstruction is observed along the required sight line then there is a sighting deficiency. The sight lines must also follow the curvature in the road or rail as it represents the distance travelled by the approaching road vehicle or train.

6.2 Warrant Due to Conflict Exposure

The volume and frequency of trains and vehicles, otherwise known as level of conflict, between trains and vehicles influences the potential conflict at a railway crossing. The conflict is normally expressed as the product of the number of trains and vehicles using the crossing. Given that potential conflicts can also be influenced by the speed at which trains, and vehicles approach a crossing, it is appropriate to assume that crossings having the same level of conflict, but different train and vehicle speeds, present different levels of potential conflict. To account for these differences, it is necessary to apply weighting factors to the level of conflict based on the speed of trains and vehicles to establish the weighted conflict at a crossing to assess its level of potential conflict.

The level of exposure at a railway level crossing is based on three factors:

- Weighted conflict (Cw) –

$$C_w = \frac{V_t}{60} * N_t * \frac{V_v}{60} * AADT$$

The product of the average annual daily traffic (AADT), and the average number of train movements per week (N_t), with weighting factors applied for 85th percentile vehicle approach speeds (V_v) in km/h, and maximum train speeds (V_t) in km/h.

When calculating C_w:

- the minimum speed to be used for V_t is to be 60km/h, and
- for crossings controlled by Stop Signs, the value of V_v is to be 60 km/h

- Heavy vehicle factor (Hv) –

$$H_v = \frac{\left[1 + \left(Pv/5\right)\right]}{2} * \left[1 + \frac{Gr}{10}\right]$$

Is based on the percentage of heavy vehicles (P_v), as a whole number (Note: 5% as the default value). This is multiplied by a road grade factor (G_r), as a whole number. P_v must be adjusted where there are road trains (Austroads class 10 and above). The class 10-12 (RAV 5-10) vehicles are multiplied by a factor of 1.5.

Take for example a crossing has a total of 30% heavy vehicles with 10% of all vehicles being class 10 and above. The adjusted P_v is (20 + (10 x 1.5)) = 35. G_r is the largest average road grade (measured over the Safe Stopping Distance) of any approach to the crossing measured over the safe stopping distance of the largest permitted road vehicle of said approach.

- Vehicle delay factor (Dv) –

$$D_v = \frac{\left[1 + \left(21 + 3.6L_{tl}/0.9V_{tl}\right)/25\right]}{2}$$

Determined from the length of the longest train (L_{tl}) in metres, and the maximum speed of the longest train (V_{tl}) in km/h that travels over the crossing. (Note: Unless subject to shunting operations, 0.9 V_{tl} can be assumed to be representative of the slowest train speed through a crossing.)

Flashing Lights

When assessing the installation of flashing lights, the conflict exposure is the weighted conflict, C_w. If C_w is greater than **14 000**, consideration should be given to the installation of Flashing Lights.

Boom Barriers

When assessing the installation of boom barriers, the conflict exposure (C_{wb}) is derived from the following formula.

$$C_{wb} = Cw * H_v$$

If C_{wb} is greater than **700,000**, consideration should be given to the installation of Boom Barriers.

Grade Separation

When assessing the installation of grade separation, the conflict exposure (C_{wgr}) is derived from the following formula.

$$C_{wgr} = Cw * H_v * D_v$$

If C_{wgr} is greater than **5,000,000**, grade separation shall be pursued.

In addition to the above conflict exposure, grade separation shall be pursued in the following scenarios:

- Railway crossings on all freeways and controlled access highways.
- Where new level crossings are proposed within the State-owned rail networks which results in an increase in the total number of level crossings.
- Where the Road Manager determines that a proposed crossing location presents an intolerable risk to road users and / or network efficiency (this will generally be due to factors such as road and rail geometry and alignment, which are not fully encapsulated by the exposure level formula).
- Where there is, a dual track crossing proposed on a highway or high-volume road of strategic importance to the State.

Note: Where the crossing is an existing public rail and public road interface that exceeds the 5 million exposure level, further investigation into project cost, traffic impacts, pedestrian activity, safety risks, ALCAM scores, recorded crashes, incidents, and project feasibility should be used to adjust grade separation priorities prior to seeking government funding.
There may be certain scenarios where the 5 million exposure level is reached, however grade separation may not be an appropriate treatment. Refer to Section 9.1.

7 GIVE WAY SIGNS (RX-1)

A railway crossing protected by Give Way Signs works on the principle that sufficient visibility is provided to the driver of a road vehicle approaching the crossing to enable them to see an approaching train in time to stop, if necessary, before reaching the crossing and allow the train to pass. This level of control generally applies to crossings where train and/or vehicle volumes are relatively low.

Give Way Sign controls are not to be used for main-line level crossings in Western Australia.

The use of Give Way Sign controls may only be considered for level crossings located on low-volume sidings where additional controls such as traffic management are used for the passage of rolling stock over the crossing.

8 STOP SIGNS (RX-2)

A railway crossing controlled by Stop Signs works on the principle that visibility restrictions on the road approaches to the crossing, either by virtue of the crossing geometry or adjacent development / vegetation, are such that a motorist is not able to make an appropriate decision on proceeding over the crossing without first stopping on the approach side to assess the conditions. However, there is sufficient visibility from the stopped position to an approaching train to enable the driver to decide whether the distance to the train is such that it will not be a collision threat and it is safe to cross or if they must wait until the train has passed. Like Give Way sign control, this level of control generally applies at locations where train and/or vehicle volumes are relatively light. The following conditions are to be satisfied before Stop Sign control may be an adequate level of control:

- Stop Signs are not appropriate where the train speed is more than 100 km/h due to the difficulties faced by a motorist to view and perceive the rate of approach of a high-speed train over long distances. However, it is not expected that this condition would apply to non-public crossings where drivers would generally be familiar with the conditions and exercise a greater level of caution when negotiating these crossings.
- The extent of clear visibility either available or that could be made available by clearing works to a motorist at the stopped position at the crossing must be at least equal to the minimum level necessary, as determined from consideration of train speeds over the crossing, vehicle length and acceleration, grade and surface of the road, and geometry of the crossing. Refer to S3 calculation given in AS 1742.7.
- The clear visibility required must be available through a range of angles that does not require excessive rotation of the driver's head when stopped at the crossing or that may be obscured by parts of the vehicle. Refer to AS 1742.7 for angle requirements.
- The level of train and vehicle activity should be below that warranting active control to be installed.

8.1 Sight Distance Requirements for Stop Signs

In addition to the S_1 Sighting requirement to the crossing controls, for Stop Sign controlled crossings, motorists must be able to see any approaching train that represents a potential conflict, while stopped at the hold line. In the absence of a hold line, the sight distance shall be measured at a distance 1.5m back from the Stop Sign (generally 5 m from the outside edge of the rail); this distance represents the location of the driver within the stationary vehicle.

The minimum distance down the track, S_3, at which a motorist stopped at the hold line, needs to be able to see an approaching train is measured from the centre of the crossing. The S_3, calculation including factors and coefficients can be found in AS 1742.7.

Adequate visibility is defined as a driver's ability to view at least two thirds of the frontage area, inclusive of any warning or headlight/s, of the approaching locomotive (assumed to be 2.4 m above the rail from a driver eye height of 1.1 metres above the road surface).

The sight triangles should be clear of any obstructions to ensure drivers are able to readily detect the presence of an approaching train within the distance S_3 from the crossing.

8.2 Angle Requirements for Stop Signs

In addition to needing clear visibility of trains at S_3, drivers cannot be expected to turn their heads excessively to see the train. Maximum angles are set out in AS 1742.7.

9 FLASHING LIGHTS (RX-5)

Flashing Lights are an active form of control at a railway crossing that alert the vehicle driver of an approaching train and their need to stop. If any of the following conditions apply at a railway crossing, consideration should be given to the installation of Flashing Lights:

- The geometry of the road and rail alignment does not provide the sighting requirements for passive controls.
- The volumes and speeds of trains and vehicles create a potential conflict at a level that justifies the installation of Flashing Lights.
- The replacement of Stop Signs with Flashing Lights may be shown to have a cost benefit.
- The road is of a classification that drivers would generally expect to have priority travel i.e., a declared highway or main road.
- The road is a heavy vehicle routes, where maintenance costs caused by constant heavy vehicle start-up at Stop Signs are onerous on the road manager

Meeting any of the above conditions does not automatically lead to the installation of Flashing Lights. Additionally on major roads or within town sites, provision of active control devices is encouraged and should be considered.

9.1 Visibility Requirements for Flashing Lights

The operating flashing light signals should be clearly visible to approaching motorists from a distance of at least equal to the stopping sight distance (SSD) applicable for the section of road for the largest vehicle type.

Since the crossing may also generate a queue of vehicles, it is important that an approaching motorist can also see the end of the queue from a distance of at least equal to the SSD from wherever the end of the queue may be.

The required minimum driver visibility distance to the flashing light signals, Svf, is therefore made up of the following components:

- S1 can be calculated from AS 1742.7; and
- The average maximum length of any queue of vehicles, Lq, which may have formed from the stop line following commencement of the lights flashing.

S_{vf} can then be calculated as follows:

$$S_{vf} = S_1 + L_q$$

The length of vehicle queues that can form at a crossing is influenced by several factors including arrival rates, the type of traffic flow (i.e., random, bunched or platooned), number of lanes, vehicle types, crossing closure times, etc. Appendix 1 can be used as a guide for estimating values for Lq in the absence of measured data or observations to determine the average maximum vehicle queue length. Should the required visibility distance, Svf, not be available, one or a combination of the following measures should be considered:

- Geometric modifications to the road alignment.
- Reduce speed of approaching road vehicles.
- Remove obstructions such as vegetation, embankments, structures.
- Modifications to the flashing light signal displays such as additional, taller, or offset masts; or
- Active Advance Warning Assemblies (Refer to Section 9).

9.2 Other Safety Considerations

The ability of a driver to view flashing lights can be adversely affected by various traffic and environmental conditions.

- Rectangular back boards should be installed, and consideration should be given to installing overhead cantilever flashing light displays to address visibility obstructions caused by:
  - Traffic congestion on multi-lane roads, where slow moving or queued vehicles in one lane can obstruct visibility for drivers in an adjacent lane.
  - Large vehicles regularly stopping at nearby side roads or driveways and blocking sight lines.
  - Distractions in the form of other signal displays and illuminated signs and devices.
  - Sight lines regularly obstructed by kerbside or verge parking.
- On unsealed roads there is the possibility of dust obscuring the signals. Therefore, the installation of Flashing Lights on unsealed road crossings should be accompanied by the sealing of the road approaches either side of the railway. The recommended minimum seal length on all road approaches should be no less than 400m.
- On routes approved for use by 'oversize' vehicles, investigations should be undertaken to determine if any safety requirements need to be incorporated into the operation of the Flashing Lights e.g., longer pre-warning times and sight distances to the signals, allowance for greater safe stopping distances by installing Active Advance Warning Assemblies or an oversized vehicle by-pass may be required.

9.3 Design and Operation of Active Flashing Light Signals

Design and operational requirements for flashing light protection are outlined in Railway Infrastructure: Railway Level Crossings (AS 7658) and supplemented by the relevant Rail Infrastructure Manager's design documents.

10 BOOM BARRIERS (RX-5)

Boom Barriers are installed to supplement the level of control provided by Flashing Lights. They are an active control device providing a visual barrier between the movement of vehicles and trains, typically comprising of a boom spanning from the left-hand kerb to:

- Right hand kerb or edge of one-way roadway,
- Edge of physical median island or centre of island depicted only by road marking, or
- Dividing line or centre of roadway.

The boom includes red and white bands as well as three red lamps as per AS 1742.7.
The effectiveness of this barrier in improving safety is particularly realised at crossings subject to heavy and often congested vehicle flows.
If any of the following conditions apply at a railway crossing, then consideration should be given to the installation of Boom Barriers:

- The volumes and speeds of trains and vehicles create a potential conflict at a level that justifies the installation of Boom Barriers.
- The crossing is located on a railway with multiple through tracks and it is possible for more than one train to approach the crossing at the same time. This is to prevent drivers falsely anticipating the crossing is safe after the passage of one train and proceeding to cross by anticipating a light change.

Meeting any of the above conditions does not automatically lead to the installation of Boom Barriers. Additionally on major roads, within regional townsites, provision of active control devices is encouraged and should be considered.

10.1 Other Safety Considerations

In conjunction with the installation of Boom Barriers in urban areas, particularly at multiple track crossings, it is desirable that suitably designed traffic islands be installed to provide a barrier between opposing carriageway approaches. The islands assist in preventing motorists from driving around the ends of the boom arms to bypass delays which can be caused by the approach of a second train and serve to highlight the location of the crossing.
Interconnection between active control devices (such as boom barriers) and road traffic signals is required where a car may be trapped within a level crossing due to traffic lights and a lowered boom barrier. On routes approved for use by 'oversize' vehicles, investigations should be undertaken to determine if any safety requirements need to be incorporated into the operation of the Boom Barriers such as extended boom arm descend time to avoid potential damage to the boom arms.

10.2 Operational Sequences and Timing

Recommended operational sequence and timing for active control containing boom barriers are contained within AS 7658 and supplemented by the relevant Rail Infrastructure Manager's design documents.

11 GRADE SEPARATION

Grade separation using a bridge, or an underpass offers the safest but most expensive treatment at a rail crossing. Justification of the high expenditure involved with grade separation is required before replacing an existing level crossing or constructing a new grade separated crossing.

11.1 Investigation

In certain scenarios where the exposure level is exceeded, grade separation may still be deemed inappropriate. These locations will only be considered in instances where the below criteria are met for level crossings:

- Where the warrant for grade separation will only be exceeded for a relatively short period of time in relation to the design life of a bridge or underpass; and
- Most road users are not ordinary members of the public (e.g., from one company) and therefore the exposure can be managed by other means.

These scenarios will generally only occur on Local Government or private roads because of activities such as mining projects with limited mine life. Additional controls will need to be put in place to ensure safety and efficiency is not compromised. These controls may include:

- additional overtaking lanes,
- additional seal lengths,
- inductions for road drivers from the mining company using the road,
- obstruction detection systems,
- staggered departure times for controlled vehicles including GPS tracking,
- CCTV at the crossing,
- radio messaging to heavy vehicles through the two-way radio, or
- recourse for drivers that disobey the induction.

These level crossings will be subject to reassessment for grade separation if the additional controls fail to mitigate the risk.

These level crossings must have the highest level of active control and advanced warning installed. Where there are existing level crossings on the public rail network and the exposure level is exceeded, grade separation may be cost prohibitive in the short to medium term. In some instances, grade separations will not be able to be contained within existing reservations and may impact on landowners and businesses or require significant cost implications to mitigate impacts. In such cases, investigations into other measures to reduce traffic impacts and improve safety should be investigated and implemented where appropriate.

11.2 Funding

For private railways, existing private rail/public road crossing, the funding of grade separation must be by agreement between the respective Road Manager & Rail Infrastructure Manager. The costs are to include maintenance requirements extending five years beyond the completion of the development, new construction or upgrading.

For public railway crossings, any grade separation which is required because of specific road, rail or land-use improvements or development must be funded by the instigator of the project, i.e., the Road Manager or Rail Infrastructure Manager or the developer, as appropriate.

11.3 Additional Safety Considerations

Consideration of the following grade separation safety issues is required:

- Protection of people and property from objects or material falling, suspended, or thrown from one level to another.
- Protection of traffic on either the upper or lower facility from any consequences of incidents such as road crashes or train derailments on the other facility.
- Provision of safe clearances or low clearance warnings for road traffic under railway structure gantries on approaches to be installed.
- Provision of safe clearances for railway traffic under railway, road, or other facility structures; and
- Protection from contact with live electrical equipment.

Refer to AS 5100.1 and the Main Roads WA Structures Engineering Design Manual for bridge design specification and general principles for more information.

12 ACTIVE ADVANCE WARNING ASSEMBLIES (RX-11)

Active Advance Warning Assemblies (AAWA) are installed to supplement the level of control provided by Flashing Lights and Boom Barriers. They are an active warning device incorporating the message 'Prepare to Stop' and provide visual advance warning to motorists that there is a requirement to stop for the flashing light signals at the railway crossing ahead.

The effectiveness of this advance warning in improving safety is particularly realised on high-speed road approaches where the required visibility to the flashing lights cannot be attained by normal measures. Heavy vehicles, particularly road trains may derive significant benefit from the AAWA.

The decision to install AAWA should be based upon sound traffic engineering judgement which includes consideration to factors such as traffic speeds, traffic volumes, heavy vehicle composition, road geometry, visibility, possible road user fatigue zones and vehicle crash history.

To ensure some uniformity in vehicle operating speeds, the road should comply with the requirements of Main Roads' Speed Zoning: Policy and Application Guidelines. At least one of the following minimum conditions would be met:

- The road is a designated heavy vehicle route or a specified road train route.
- The railway crossing has a known history of vehicle crashes, which cannot reasonably be alleviated by other warning signs or devices.
- Available driver sight distance to the primary flashing lights at the railway crossing is below that specified in Section 8.1 and the available sight distance cannot be reasonably increased by other measures.
- Driver visibility of the operating railway crossing flashing lights can at times be severely reduced by sun-glare, either because of the sun shining directly on the signal lenses or due to the sun shining directly into the driver's line of vision.

Location and Operational Timing

The AAWA signs should be located sufficiently in advance of the railway crossing to enable drivers travelling at the 85th percentile speed for the road to stop at the stop line safely and comfortably after viewing the AAWA commence operation. The Longitudinal Location of AAWA provided in AS 1742.7 uses an average coefficient of deceleration of 0.29 on a wet sealed road surface.

Longitudinal Location of AAWA (B-Double)									
Speed	**Average Approach Grade (%)**								
(km/h)	**-8%**	**-6%**	**-4%**	**-2%**	**0**	**2%**	**4%**	**6%**	**8%**
60	109	103	98	94	91	87	85	82	80
70	140	132	126	120	115	111	107	104	101
80	176	165	156	149	142	137	132	128	124
90	214	201	190	181	172	165	159	154	149

The following table is provided for larger road vehicle braking characteristics.

Longitudinal Location of AAWA (Triple Road Train and AAB Quad)									
Speed	**Average Approach Grade (%)**								
(km/h)	**-8%**	**-6%**	**-4%**	**-2%**	**0**	**2%**	**4%**	**6%**	**8%**
60	160	143	130	120	113	106	101	96	92
70	209	186	169	156	145	136	129	123	118
80	266	236	213	196	182	170	161	152	146
90	328	290	262	240	222	207	195	185	176

Note: the above values have been derived using a Coefficient of Deceleration of 0.20 on sealed roads from Austroads Guidelines for RAVs Categories 9-10.
Refer to Appendix E of AS 1742.7 for the length of time in seconds, T, at which the advance signals flash before the railway crossing flashing lights begin to operate. To allow for major obstacles and other physical features, which may affect the on-site location of the AAWA, a 5% tolerance can be applied to the values of S without the need to recalculate the length of time, T. For AAWA sign installation outside of this 5% tolerance, a new value for T, must be determined and applied.
Vehicles traveling at slower speeds may pass the AAWA signs prior to them activating and still be able to sight the control or queue in time to stop.
The lights shall have a flashing rate of between 35 and 65 flashes per minute. This is the same as the RX-5 level crossing controls, which the AAWAs are interfaced with.

Sign Size Selection

AAWA comprise of a standard diamond-shaped railway level crossing symbolic with flashing lights and "Prepare to Stop Ahead" text signs on a yellow rectangular background. Refer to Section 17 for Main Roads standard drawing. Sign size selection is related to the posted speed limit of the road with the minimum sizes applied as follows:

- Type C sign shall be used on roads where the posted speed limit is 80km/h.
- Type B sign shall be used on roads where the posted speed limit is below 80 km/h, OR where it is impractical to provide sufficient space for a Type C.

Sign Type	Sign Width	Sign Height	Diamond Size	Text Size
B	1100	1600	750 x 750	120 DM
C	1350	1950	900 x 900	160 DM

13 OTHER SAFETY CONSIDERATIONS

13.1 Maximum Road Speed Limit at Level Crossings

Road users and train occupants are exposed to risk at level crossings due to the possibility of a collision. Road users are required to stop or give way to all rail traffic at level crossings. The most significant variable in the distance required for a road vehicle to stop at a level crossing is its velocity (or speed). Therefore, reducing road speeds at level crossings decreases the likelihood of vehicles being unable to stop at level crossings. Studies have shown that road user compliance with a reduction in speed at level crossings is good.
A maximum speed limit of 80km/h is applied to level crossings in Western Australia to decrease the risk at railway level crossings. Further detail can be found in the "Speed Zoning Policy and Application Guidelines" on the Main Roads WA website: https://www.mainroads.wa.gov.au.
Speed zoning the road at 80km/h is not applicable on unsealed roads or approaching level crossings:

- within 300 metres of a road terminating; or
- where the crossing is under Stop Sign control.

To be able to speed zone a section of road there are several road design factors to be satisfied such as the design speed, seal width (greater than 5.5 metres), length of seal and road geometry

13.2 R6-25 Signage

To increase the conspicuity of a crossing and its associated controls, R6-25 signage shall be fitted in a back-to-back arrangement on all primary crossing control assemblies.

13.3 RAIL X Pavement Markings

Where installed, 'RAIL X' pavement markings shall comply with the requirements of AS1742.7, the marking is to read sequentially. For roads with a seal width of less than 3m, the message may be reduced in height (3m for 'X', 2.5m for 'RAIL').

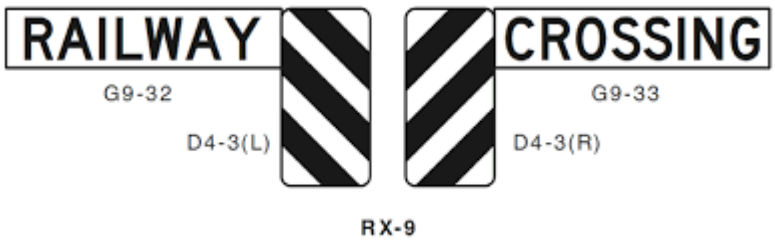
13.4 Whistle Boards

Where there is the likelihood of pedestrian movements at or other extraneous activity at or near a railway crossing that does not have audible warning bells associated with the road crossing, warning can be provided by the sounding of the approaching train's siren or horn at a distance determined by the relevant Rail Infrastructure Manager.

13.5 Street Lighting

The installation of suitable street lighting can reduce the problem of trains already on the crossing not being visible to approaching drivers at night. This particularly applies where night-time shunting activities occur. It is desirable that the lighting include illumination on both sides of the railway for a short distance on either side of the crossing.

13.6 Width Markers



'Railway Crossing' boards along with the associated width markers (RX-9 Assembly) provide additional warning to drivers of the approaching railway crossing and highlight the position of the crossing. The width markers provide vertical delineation of the width of crossing, and thus offer safe guidance past potential roadside hazards associated with railway crossings, such as flashing light masts, boom arm equipment, exposed rails, sleepers, etc. In all cases, Railway Crossing boards should not obstruct visibility from nearby intersecting roads or driveways.

Width Markers should be erected on the line of the vertical obstruction in conjunction with the signs RAILWAY (G9-32) and CROSSING (G9-33). Where there are kerbs or footways, the width markers should be erected so that they indicate the width of the pavement. In this context, the pavement is the trafficable road surface, whether it is a constructed gravel formation or sealed road surface.

Where the pavement width narrows over a railway crossing and a reduction of the pavement width may constitute a hazard, Road Narrows signs (W4-3) should be used. Specific conditions for its use are.

- where the width of any lane is reduced by 600 mm or more in the direction of travel, or
- The pavement width is reduced to 5.5 m or less.

Note: Narrowing the pavement width may involve a reduction in width of a single carriageway, with or without a reduction in the number of lanes.

W4-3

The Road Narrows sign (W4-3) shall be installed in advance of the lateral transition of the edge of the pavement, as per AS 1742.2.

13.7 Rumble strips

Rumble strips can be effective at warning drivers of a hazard. Rumble strips in advance of railway crossings can be used in areas prone to driver fatigue or where a rail crossing is not expected.

13.8 Seal Road Approaches

On unsealed roads, sealing the approaches to the level crossing will reduce dust and improve visibility of the crossing. This will also improve the maintenance life of level crossing assets. The recommended minimum seal length on the approach to a level crossing is 400m in each direction.

13.9 Site Monitoring and CCTV

At locations prone to vandalism or noncompliance with the *Road Traffic Code 2000*, CCTV can be installed to assist law enforcement. Prior arrangement with the WA Police is required where prosecution will be sought, to ensure the image quality and other specific requirements are met.

14 PRIORITISING LEVEL CROSSINGS

Whilst there are several crash prediction models available to determine relative hazard and hence priorities for upgrading control levels, these are largely based upon or compared to some historical measure of crash occurrences. Crashes at railway crossings in Western Australia are widely dispersed. Given the diversity of the road and railway network and the continuing changes occurring in the transport area, the ranking or prioritising of control requirements based upon previous or predicted crash levels is not considered an effective method of identifying or forecasting hazards at railway crossings in this State. Nevertheless, a crossing having a continuing history of train-vehicle crashes or near misses obviously demands attention. There are other factors, including social and economic considerations, which can also influence the priority given to the upgrading of controls at level crossings.

After establishing in previous sections that the upgrading of control from passive control to active control or from Flashing Lights to Boom Barriers is warranted, it is often a requirement that the installation be incorporated into a funding program. In many cases, there are more installations identified as meeting the warrants at any one time that budget allocations can fund. In these circumstances, it is necessary to establish priorities for the works to determine which installations should be programmed ahead of others.

14.1 Methodology

The accepted method of prioritising warranted Flashing Light and Boom Barriers installations is to consider the degree to which the warrants are exceeded, or the geometric requirements are deficient and consider any other peripheral safety hazards associated with a crossing. These additional hazards can arise from the geometric layout of the crossing and its approaches, operational and physical aspects of the site, as well as any environmental factors, which should be considered. The following should be noted in respect to prioritising crossing upgrades:

- ALCAM risk score.
- Flags generated by the ALCAM or failings in the crossings layout/control in relation to AS 1742.7.
- The exposure level of the crossings in question.
- Crossings should only be compared with the same proposed level of control, i.e., a crossing to be provided with Flashing Lights should not be scored against a crossing that is proposed to be upgraded to Boom Barriers.

14.2 ALCAM Assessment Frequency

Road Managers and Rail Infrastructure Managers undertake routine inspections of their assets and notify each other of any changes to the usage of an Interface as per their Interface Agreement. To have confidence in level crossing asset data, regular ALCAM assessments are required; however, due to the number of crossings in Western Australia, it is impractical to reassess all crossings on a regular basis. Level crossings in the rapidly changing metro areas should be resurveyed more frequently than level crossings in rural areas, which are not as likely to change over time. Regardless of location, it is recommended that Level Crossings be assessed at intervals no greater than 5 years.

If a crossing is required to be ALCAM assessed prior to its reassessment date, due to a change in the crossing control, specific land development in the area, or reinstatement of rail traffic on a Dormant or Disused rail line, the Proponent will pay for the reassessment.

An ALCAM reassessment shall record all necessary information required to ensure that the ALCAM risk score is reflective of the existing site-based scenario. This includes but is not limited to rail

traffic speeds & volumes, road traffic speeds & volumes, available sighting of crossing controls and to approaching rail traffic, location & condition of all signage & pavement markings and condition of road and crossing panel surface.

15 SHORT STACKING AND QUEUING HAZARDS

Short stacking occurs when there is insufficient distance between the outer rail and an adjacent intersection to accommodate a road vehicle, which will result in.

- the vehicle 'fouling' the tracks or the area directly adjacent to the tracks whilst stopped at the adjacent intersection whereby the vehicle could be struck by a moving train, or
- the vehicle 'fouling' the through road whilst stopped at the railway crossing on a side road whereby the vehicle could be struck by a vehicle travelling along the through road.

The available stacking distance is the distance between the outer rail and adjacent intersection minus a 5m safety margin which represents the distance from the outer rail (3m) and the distance from the intersection (2m).

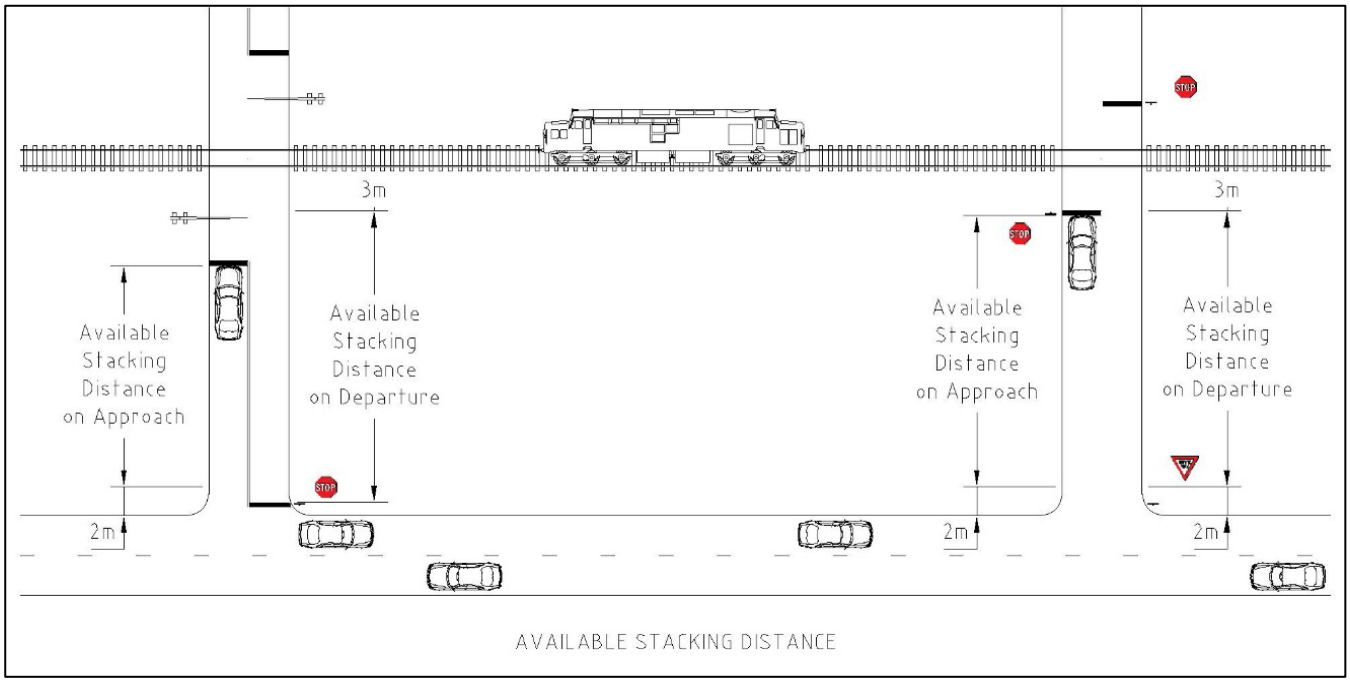


Figure 3 – Available Stacking Distance

General access vehicles are vehicles which do not require a permit or notice to run on the road networks. These vehicles have as-of-right access to the public road network unless otherwise sign posted. Larger vehicles are permitted to operate on the public road network under Restricted Access Vehicle (RAV) permits issued by Main Roads WA's Heavy Vehicle Services Branch (HVS). HVS should be consulted for up-to-date information on the RAV network that applies to a particular crossing. The Heavy Vehicle Services page can be found on the Main Roads WA website: https://www.mainroads.wa.gov.au

Queuing occurs when traffic constriction from a nearby intersection causes vehicles to queue back across the crossing, fouling the tracks.

Both short stacking and queuing are hazardous situations, which require suitable treatment to be implemented to eliminate or reduce the likelihood of an incident.

15.1 Possible Treatments for Short Stacking

A range of treatments for short stacking at railway crossings that can be implemented include.

a) Installation of signage identifying available stacking distance at crossing.
b) Installation of 'Keep Clear' yellow box marking and signage on sealed roads.
c) Linking of adjacent traffic light controls to active level crossing controls where available.
d) Restricting access to RAVs

Where short stacking exists AS1742.7 states that one or more of the following measures must be taken.

a) Establishing a detour and regulatory sign posting for long vehicles
b) Providing appropriate emergency escape, refuge areas of slip lanes for long vehicles
c) Changing priority of road traffic movements
d) Realigning of roads to provide sufficient length to accommodate the design vehicle
e) Any other measures determined through risk assessment to be appropriate given the circumstances.

The preferred treatment cannot always be implemented immediately due to timing, financial and other constraints. In these cases, an interim treatment should be considered as a first stage to reduce the risk of a collision occurring at the crossing.

15.2 Management of Queuing Hazards

The *Road Traffic Code 2000* makes it an offence to enter a railway crossing if the vehicle cannot be immediately driven clear of the crossing. In many instances, observations indicate that vehicles stopping on the track during traffic congestion are not stopping deliberately. Rather, vehicles are stopping because of the driver's inability to anticipate the forming of a queue ahead. Drivers' inability to accurately perceive the extent or limits of the crossing zone beyond the tracks can be compounded at multi-track or skew angle crossings.

Where elimination of the cause of the queuing cannot be implemented, measures to manage these hazards shall be implemented. These measures may include.

a) Installation of 'Keep Clear' yellow box marking and/or signage on sealed roads.
b) Linking of adjacent traffic light controls to active level crossing controls where available.
c) Utilisation of traffic light controls on approach to the level crossing to stop road vehicles prior and to prevent vehicles entering and queuing over the crossing
d) Road widening or realignment to remove the constriction or increasing capacity to the constriction.
e) Emergency escape or refuge area

15.3 Road Markings and Signage

Yellow box markings shall be used to discourage traffic from fouling the tracks, where short stacking or queuing has been identified. Yellow box markings are to be installed symmetrical to the centre of the carriageway and finish with full or half diamonds to a minimum of 5m from outer rail. For crossings with short stacking on departure the length of yellow box marking can be reduced to a minimum of 3m from outer rail. Where queuing is a problem in one direction only, yellow box markings are only required on that side of the pavement.

Where yellow box markings are installed, 'Keep Clear' signage (MR-RD-5A) shall be installed on both the approach and departure of the box marking.

Details of the yellow box markings and 'Keep Clear' signage to be used can be found on MRWA drawing 200731-0040-1.

16 PEDESTRIAN CROSSINGS

At level crossings where facilities are to be provided for pedestrians to cross the tracks, an appropriate treatment selected from the hierarchy of controls set out below is required. The treatment shall provide for all pedestrians including cyclists, people with disabilities, including ambulant, vision and hearing impairment. There are six levels of control used in normal circumstances for pedestrians at railway crossings in this State. In ascending order, they are:

- Passively Signed Crossing.
- Pedestrian Maze Crossing.
- Adjacent Active Control.
- Actively Signed Crossing (with or without maze).
- Gated Maze Crossing.
- Grade Separation (Underpass or Overpass).

In making an assessment as to an appropriate level of control for any railway crossing, the basic philosophy is to provide an adequate level of safety with the minimum amount of disruption to pedestrian movements and at the lowest cost.

Note: Warrants for the installation and level of control for pedestrian crossings that not located adjacent to a public road level crossings (i.e., at a midblock pedestrian crossing) are determined by the rail and adjacent landowners. It is recommended that devices should be installed in accordance with AS 1742.7 as a minimum and this section of this document can be taken as a guide.

Note: Pedestrian and train volumes shall be calculated based on yearly averages and should be seasonally adjusted.

16.1 Sight Distance

At pedestrian railway crossings the required minimum sight distance (SD) in metres for a person to see an oncoming train shall be calculated as follows:

$$SD = \frac{V_t}{3.6} * \left(\frac{d}{V_p} + MS \right)$$

V_t is the maximum speed of trains in km/h.

d is the pedestrian crossing distance in metres measured between pedestrian holding lines/locations if they exist, or 1.5 m from the outside edge of rail on each side. At crossings with train speeds greater than 80 km/h the total distance shall be extended by 1 m.

V_p is the pedestrian walking speed, usually taken to be 1.0 m/s. On crossings where there is likely to be significant use by high-risk pedestrians (people with ambulant disabilities, using perambulators, school aged children or the elderly) the walking speed shall be reduced to 0.8 m/s.

MS is a margin of safety of 2, as a minimum. It is required to increase the margin of safety, where the pedestrian crossing is narrow, uneven, on a grade or where 'platoons' of pedestrians are present.

16.2 Warrants

Safety requirements of pedestrian movements will have to be assessed at each site individually. There are many design and geographical issues with retrofitting new pedestrian crossings at existing level crossings. While pedestrian control requirements are listed below, they are not all inclusive, as other factors may affect the appropriate level of control required. Typical arrangements are included in AS 1742.7.

Level 1 – Passively Signed Crossings

A passively signed crossing is a formalised path with signs as per AS 1742.7. As the simplest and cheapest option in most cases, passively signed crossings are considered to provide the lowest level of protection. Level 1 is only recommended where the location meets sight distance requirements, is a single-track line and all the following conditions apply:

- Low pedestrian volumes (less than 50 pedestrians per day),
- Low train volumes (less than 30 trains per week), and
- Low train speeds (less than 80km/h).

At Level 1 pedestrian crossings adjacent to a kerbed road vehicular crossing, the general arrangement is to provide additional width on the roadway to include a path within the shoulder, with a clear width of 1200 mm, defined by tactile ground surface indicators (TGSI) and pedestrian holding markings, and install "Look For Train" signs (W7-14-5). Unkerbed road approaches require a path to be positioned at a minimum of 2500mm from the road edge as per AS 1742.7.

Level 2 – Pedestrian Maze Crossing

A pedestrian maze crossing is a formalised path, which includes pedestrian mazes on both approaches to the crossing. The general arrangement requires a defined footway with an enclosed maze, which shall be designed so that pedestrians are forced to make at least one 180-degree turn when walking through the maze. This results in the pedestrian looking alternatively in the up and down direction of the railway line increasing the likelihood of sighting oncoming trains that may approach the level crossing from either direction. Pedestrian maze crossings are recommended where the location meets sight distance requirements, is a single-track line, and any of the following conditions are not exceeded:

- Moderate pedestrian volumes (between 50 and 100 pedestrians per day),
- Moderate train volumes (between 30 and 50 trains per week), or
- High train speeds (greater than 80km/h).

See AS 1742.7 for general maze layouts and dimensions. The width shall be sufficient to allow wheelchairs and mobility scooters (gophers) sufficient room to negotiate through the maze. The treatment also includes the provision of "Look For Trains" signs (W7-14-5).

Level 3 – Adjacent Active Control

Where the site distance requirements are not met, passively protected crossings with or without mazes (as detailed above) which are adjacent to vehicular roads which have active controls are considered to have a higher level of protection in the following circumstances:

- Where audible warning from the adjacent crossing sounds continuously during the approach of an oncoming train and until such time as the train has passed and is no longer a collision threat; and
- Where the flashing lights from the vehicle crossing are visible to approaching pedestrians and can provide warning of the need to wait until the train has cleared before commencing crossing.

Signage requirement for pedestrian crossing (with or without mazes) with active control for vehicular traffic only are outlined in AS 1742.7.

Level 4 – Actively Signed Crossing

Actively signed crossings provide additional control to crossings with poor sight distance. Actively signed crossings are recommended where the following conditions apply:

- Insufficient sight distance (refer to Section 14.1),
- Two or more operational tracks,
- Moderate to high pedestrian volumes (50 or more pedestrians per day), and
- Moderate to high train volumes (30 or more trains per week).

The general arrangement requires a defined footpath with a clear width of 1800 mm. A control point including a hold line, TGSI, a red symbolic standing pedestrian signal assembly (RX-12), associated alarms or bells, and "Do Not Cross While Lights Are Displaying or Alarm Sounding" signs (W7-14-6) are required. Refer to AS 1742.7 for general arrangements.

Level 5 – Gated Maze Crossing

Gated maze crossings are considered the highest level of at-grade protection and are typically the most expensive at-grade crossing to install. Gated maze crossings are recommended where any of the following conditions apply:

- High pedestrian volumes (100 or more pedestrians per day),
- High train volumes (50 or more trains per week), or
- Volume factor greater than 500 (N_p x N_t > 500).

Note: where N_p is the number of people per day and N_t is the number of trains per day.

The general arrangement requires a defined footpath with an enclosed maze as required in Level 2; and the installation of a pedestrian gate that is remotely controlled and lockable (activated by the presence of an approaching train). The treatment also includes the provision of red symbolic standing pedestrian signal assembly (RX-12), associated alarms or bells, and "Do Not Cross While Lights Are Displaying or Alarm Sounding" signs (W7-14-6).

Level 6 – Grade Separation

Grade separation is considered the ultimate pedestrian treatment. If appropriately designed, it removes all conflict between pedestrians and other active transport users and trains. Additionally, pedestrian delays because of train movements are eliminated. Consequently, the following should be included in assessment for grade separation:

- Total closure times for a pedestrian level crossing, and
- How motivated pedestrians are to disobey level crossing control (e.g., proximity to train station).

While all grade separation treatments must be individually designed and assessed, the following should be considered for pedestrian grade separation:

- Protection of people and property from objects or material falling, suspended, or thrown from one level to another.
- Protection from contact with live electrical equipment.
- Perceived safety of pedestrians (due to crime) using the crossing (particularly for underpasses); and
- Additional lighting requirements.

16.3 Other Safety Considerations

In addition to the levels of pedestrian control, some safety items should be considered:

- Location may meet sight distance requirements as a single-track line; however, a siding or additional track may be located within the required length of sighting distance. Where this occurs, active control should be considered to acknowledge that a train on one line may mask another train approaching on the other line.
- Rationalisation of pedestrian crossings should be carried out where multiple crossings are in close succession.
- Corral fencing along the edge of the approach footways or along the rail reserve shall be provided to guide pedestrians to the designated pedestrian crossing in instances where it is likely that pedestrians will short-cut the crossing.
- One or more active warning devices shall be provided at a pedestrian crossing location where pedestrians would not have time to cross the tracks safely before the arrival of a previously unseen train.
- A sign should be installed to indicate an alternate crossing option when the crossing has a history of being temporarily blocked by shunting operations.
- In areas subject to large amounts of visual and audible distraction, which may include pedestrians using mobile devices, a physical barrier may be required to direct the attention away from the distraction and promote observation of the rail tracks.

17 REFERENCES AND RELATED DOCUMENTS

Document Number	Description
	Road Traffic Code 2000
	Main Roads Act 1930
	Rail Safety National Law (WA)
AS1742.7	Australian Standard Manual of Uniform Traffic Control Devices Part 7: Railway Crossings
AS7658	Australian Standard Railway Infrastructure: Railway Level Crossings
AS5100.1	Australian Standard Bridge Design Part 1: Scope and general principles
202331-000047	Standard Drawing – Railway Crossings – Post and Footing Details for Railway Crossing Sign Assembly (Main Roads WA)
202031-0014	Guide Sign – Traffic Instruction Series – Limited Clearance to Tracks– T-Intersection - MR-GT-37 (Main Roads WA)
202031-0081	Guide Sign – Traffic Instruction Series – Limited Clearance to Tracks on Side Road – MR-GT-38(L) & MR-GT-38(R) (Main Roads WA)
201631-0091	Guideline Drawing – Rural Railway Crossing Pavement Marking & Signing – Give Way Control (Main Roads WA)
201631-0092	Guideline Drawing – Rural Railway Crossing Pavement Marking & Signing – Stop Control (Main Roads WA)
201631-0093	Guideline Drawing – Railway Crossing Pavement Marking & Signing – Flashing Lights Control (Main Roads WA)
201531-0036	Guideline Drawing – Railway Crossing & Side Track Pavement Marking & Signing (Main Roads WA)
201531-0037	Guideline Drawing – Railway Crossing & Side Track Pavement Marking & Signing (Main Roads WA)
201531-0038	Guideline Drawing – Railway Crossing & Side Track Pavement Marking & Signing (Main Roads WA)
201531-0041	Guideline Drawing – Railway Crossing Pavement Marking & Signing (Main Roads WA)
201531-0042	Guideline Drawing – Railway Crossing Pavement Marking & Signing (Main Roads WA)
200731-0040-2	Standard Drawing – Railway Level Crossing Layout of Yellow Cross Hatching Markings and Keep Clear Signs at Crossings Without Boom Barriers (Main Roads WA)
200331-0004-2	Warning Sign – Diamond Railway Level Crossing Series – Railway Not In Use – Supplementary Plate – MR-WDRC-3 (Main Roads WA)

Document Number	Description
9731-1096-6	Regulatory Sign – Direction Series – Railway Level Crossing – Keep Clear Sign – MR-RD-5 (Main Roads WA)
9731-2493-7	Standard Drawing – Railway Level Crossing – Layout of Yellow Cross Hatch Markings and Keep Clear Signs at Crossings Controlled by Boom Gates (Main Roads WA)
	Austroads Guide to Road Design
	Traffic Management for Works on Roads Code of Practice (Main Roads WA)
	Structures Engineering Design Manual (Main Roads WA)
	Speed Zoning Policy and Application Guidelines (Main Roads WA)
	MRWA Supplement to Austroads Guide to Road Design

18 APPENDICES

Appendix	Title
Appendix 1	Estimation of Vehicle Queue Lengths at Railway Crossings

Appendix 1: Estimation of Vehicle Queue Lengths at Railway Crossings

Annual Average Daily Traffic (AADT)	Crossing Closure Times (Minutes)									
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
0 – 2 000	7	14	21	28	35	42	49	56	63	70
2 001 – 4 000	14	28	42	56	70	84	98	113	127	141
4 001 – 6 000	21	42	63	84	106	127	148	169	190	211
6 001 – 8 000	28	56	84	113	141	169	197	225	253	281
8 001 – 10 000	35	70	106	141	176	211	246	281		
10 001 – 12 000	42	84	127	169	211	253	295			
12 001 – 14 000	49	98	148	197	246	295				
14 001 – 16 000	56	113	169	225	281					
16 001 – 18 000	63	127	190	253						
18 001 – 20 000	70	141	211	281						

To Note: Values based upon random arrivals on a single lane approach to a typical crossing. A 7% heavy vehicle composition has been assumed.