# Guide to Road Safety Part 3
## Safe Speed Management

Austroads

# Guide to Road Safety Part 3: Safe Speed Management

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# Guide to Road Safety Part 3: Safe Speed Management

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**Abstract**

Speed management to ensure safe travel speeds is fundamental to achieving Safe System and ensuring that people do not die on our roads (Vision Zero). The *Guide to Road Safety Part 3: Safe Speed Management* provides an overview of the importance of speed management for road safety, of speed limit reviews, changes, and application as a speed management tool, as well as interventions to ensure compliance with safe speed limits. Speed limits are a foundational tool is speed management and the use of appropriate speed limits forms an integral part of a safe road system. They are one of many speed management tools used to improve road safety, while maintaining the efficiency of the road network. The guide also addresses the complexity of manage speed across disparate pillars of road safety management, with vital roles being played by Safe Roads and Roadsides, Safe Vehicles, and Safe People, as well as Safe Speeds.

Within the context of a safe road system, speed limits must accommodate the varying types of road users, the road and roadside environment, possible crash types, types of vehicles driven and the safety, amenity and economic needs of the community.

The general philosophy adopted to date when setting speed limits is that when they are being assessed they take into consideration a comprehensive range of factors. These factors include the safety record of the road, the road's operating performance, the road and roadside infrastructure, geometry and roadside development. For Safe System, safety must be the dominant factor, with speed limits set to provide safety for the existing infrastructure and road users present.

This Guide is intended for road authorities to use when undertaking a speed limit review, considering a speed limit change or preparing and delivering a speed management policy through road infrastructure, vehicle technology, and behaviour change. The guide will also be valuable to road safety practitioners who are investigating speed limit changes as part of a solution to a road safety problem. Speed management is so fundamental to the Safe System approach that this Guide should be read in conjunction with all other Parts of the Austroads *Guide to Road Safety*.

**Keywords**

Harm minimisation, safe road system, speed, speed limits, speed limit review, speed management, speed zones, speed enforcement, traffic calming, road safety.

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This edition includes:

- updates throughout, reflecting new research findings and recent Austroads reports
- expanded content on the co-benefits of speed management, beyond road safety
- insights addressing common myths about speed management
- material on leadership and management in speed policy, as well as the psychology behind risk misperception.

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**About Austroads**

Austroads is the association of Australasian transport agencies.

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

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

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

- Transport for NSW
- Department of Transport and Planning (Transport Victoria)
- Queensland Department of Transport and Main Roads
- Main Roads Western Australia
- Department for Infrastructure and Transport South Australia
- Department of State Growth Tasmania
- Department of Logistics and Infrastructure Northern Territory
- City and Environment Directorate, Australian Capital Territory
- Department of Infrastructure, Transport, Regional Development, Communications, Sport and the Arts
- Australian Local Government Association
- NZ Transport Agency Waka Kotahi.



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# 1. Introduction

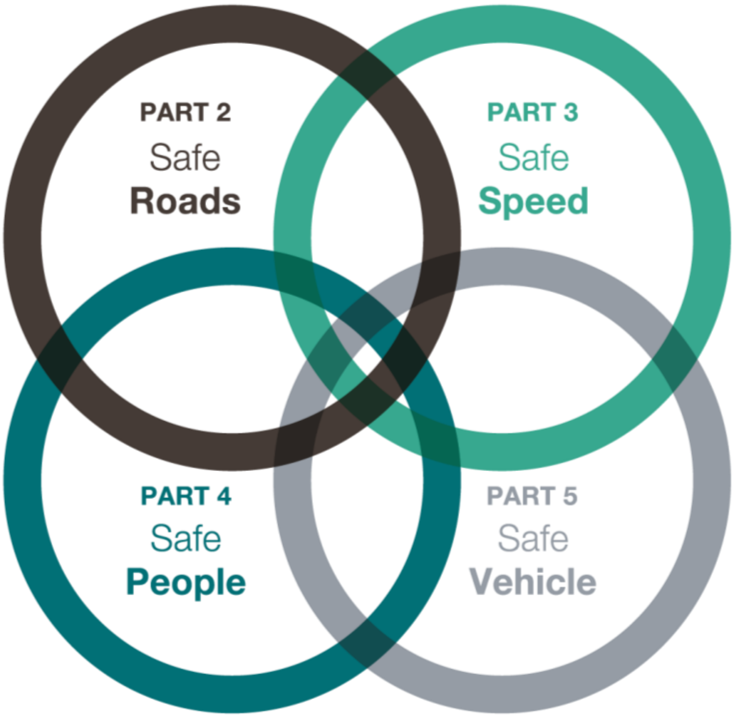
This Austroads *Guide to Road Safety* (AGRS) (The Guide) has been structured to reflect the Safe System which has been adopted by Australia and New Zealand as part of their overall road safety strategy. The Guide consists of the parts as documented in Table 1.1.

**Table 1.1: Parts of the Guide to Road Safety**

| Part | Title | Content |
|---|---|---|
| Part 1 | Introduction and The Safe System | An overview of the *Guide to Road Safety* and the Safe System philosophy. |
| Part 2 | Safe Roads | Guidance on safe road design. |
| **Part 3** | **Safe Speed Management** | **Guidance on the application and delivery of safe speeds.** |
| Part 4 | Safe People | Information on safe people and communities. |
| Part 5 | Safe Vehicles | Information on safe vehicles and vehicle safety features. |
| Part 6 | Road Safety Audit | Guidance on the procurement, management and implementation of road safety audits. |
| Part 7 | Road Safety Strategy and Management | Guidance on road safety strategies and road safety management. |

The 4 pillars of the Safe System are reflected in this Guide through the aforementioned structure and also through the contents of the Guide. It is noted that each pillar does not stand on its own but, rather, interlinks with other pillars to form the Safe System (Figure 1.1). As such, readers of this Guide are encouraged to refer to multiple pillars when reading this Guide, even though this AGRS Part focuses on Safe Speed.

**Figure 1.1: AGRS Part 2 to Part 5 interlink with each other**



## 1.1 Purpose of this Guide

The Guide, in association with other key Austroads publications, will provide road safety practitioners with the knowledge and techniques to enable the application of Safe System principles.

The purpose of this part of the Guide is to provide an overview of speed management and the application of methods to manage speed, including speed limits, enforcement, infrastructure countermeasures and vehicle features. This Guide recognises that many readers already have significant knowledge in the area, and part of the purpose is to provide information to assist in addressing barriers and challenges from some key decision makers, and some sectors (often a vocal minority) of the community.

What we know:

- Speed management is at the core of a forgiving road transport system.
- Impact speed is the primary determinant of injury outcome.
- Travelling speed also influences vehicle controllability and crash likelihood.
- Both the risk of loss of control and injury severity increase with travelling speed.
- In a 60 km/h speed limit zone, the risk of involvement in a fatal or injury crash doubles with each 5 km/h increase in travelling speed above 60 km/h.
- Reducing rural speeds by 5 km/h is likely to reduce rural fatal and injury crashes by about 30%.
- Reducing urban speeds by 5 km/h is likely to reduce urban fatal and injury crashes by 26%.
- Reducing urban speed limits would lead to major reductions in pedestrian and cyclist injury.
- In various circumstances, reducing speed limits can also reduce travel times (details are provided later).
- Speeds limits have usually been regarded as a trade-off between desired mobility function and other competing demands including safety. Australia's commitments to targets in trauma saved by 2030, as well as Safe System and Vision Zero by 2050, mean that safety is the dominant consideration in this balance. New Zealand has moved to an approach which aims to balance road safety and other objectives (New Zealand Government 2024a).
- The speed threshold for serious injury is around 20 km/h.
- Aspirational speeds aligned to Safe System performance are:
  - 30 km/h where pedestrians and cyclists interact with traffic
  - 50 km/h where cars may collide at right angles at intersections
  - 70 km/h where cars can collide head-on.
- Lower speeds generally contribute to other vital agenda, including reducing the substantial health harm caused by road transport through noise and air pollution, as well as reducing greenhouse gas emissions, social inequity and social isolation.
- The effect of reducing speed limits on travel times is commonly over-estimated.
- The economic disbenefits of travel time arising from lower speeds are generally more than compensated by savings in costs from crashes, noise, air pollution, and vehicle running costs, meaning that lower speeds generally deliver a net economic gain.
- Road users can be poor at assessing risk on the road especially in relation to speed so infrastructure elements and deterrence to support road user behaviours are required.
- Any way in which planning, road design and traffic management can guarantee safe speeds at facilities will be highly beneficial (e.g. raised pedestrian crossings) and aligned with harm minimisation principles.
- Small changes in speed can have large benefits so any reductions are better than nothing at all.

- Speed management has the potential to deliver the highest injury reductions at the lowest cost when compared to other safety interventions; however, this can only be regarded as a primary treatment if reductions are achieved down to survivable impact speeds.
- Road function (especially with a focus on the presence of vulnerable road users) and speed management are inextricably linked; the best features of self-explaining road design, which are often misunderstood, are likely to maximise the ability to achieve harm minimisation outcomes in the context of 'Movement and Place' considerations.
- Safe Speed is only one of the four pillars of the Safe System and overlaps with the other three pillars of the Safe System as shown in Figure 1.1. (Austroads 2018)

## 1.2 Why is speed management important?

Speed management is a key factor in the safe and efficient operation of the road network. Speed limits need to accommodate the safety of the road user types who are using the road, while also considering road environments, possible crash types, vehicle types and community needs such as safety, amenity and economics. Speed management is much more than just legal speed limits and signs.

The travel or operating speed of vehicles has a number of effects relating to vehicle emissions, traffic flow, user costs and safety. Reduced travel speeds can help reduce harmful emissions, enhance traffic flow, decrease user costs and improve safety.

Speed limit management is about meeting an acceptable compromise across a wide range of objectives and a diverse group of road users and communities. Safe and efficient travel contributes to a healthy and prosperous society.

Effective speed management needs appropriate infrastructure, accompanied by education and enforcement to maximise compliance and appropriate travel speeds. It is important that drivers and riders are aware of the speed limits that apply on the roads that they use. It is also important that the community understands why speed limits apply, the reasoning behind any changes to speed limits and benefits of travelling at safe speeds. It is critical that police enforce all speed limits.

## 1.3 Speed and the Safe System

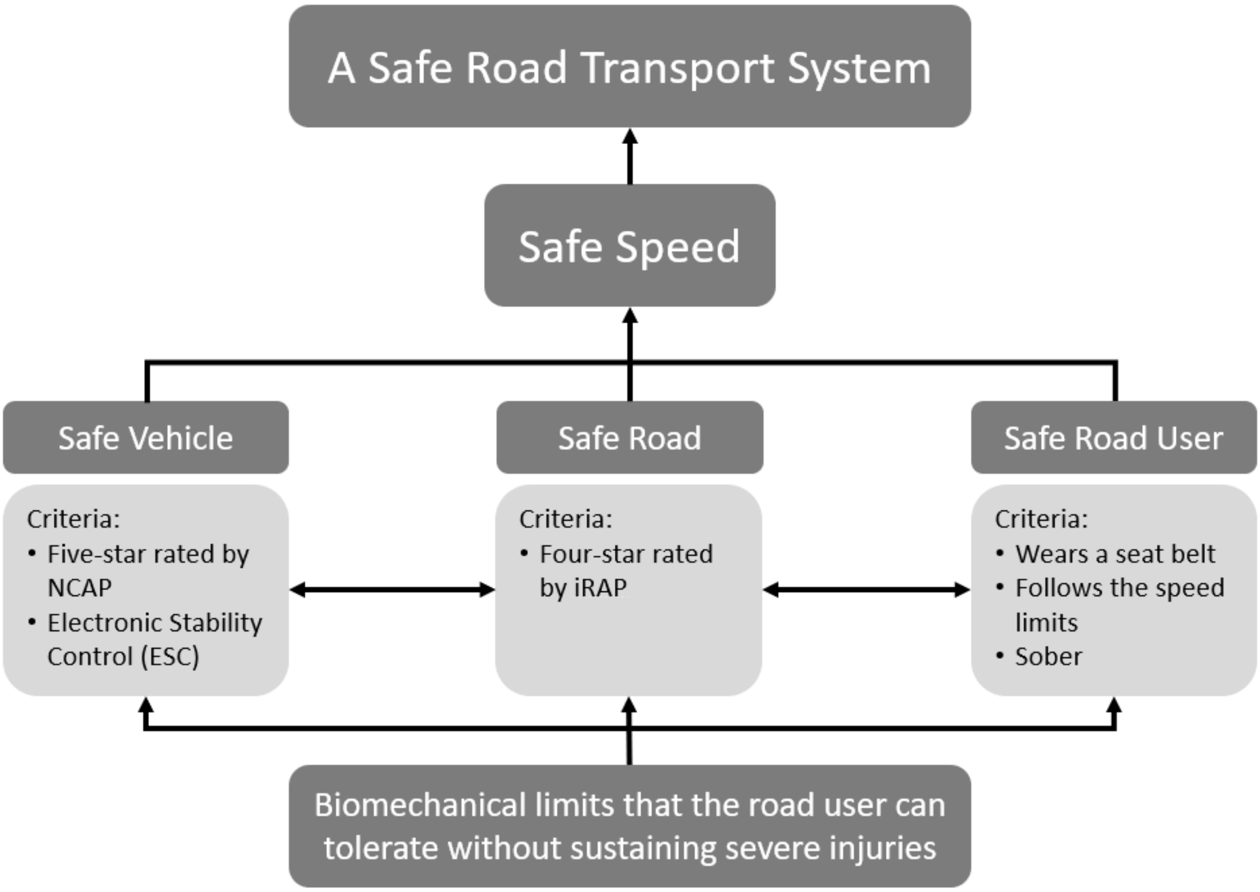
The appropriate management of safe speed is an integral part of the Safe System approach to road safety.

An explanation of the Safe System approach can be found in the *Guide to Road Safety Part 1: Introduction and the Safe System* (Austroads 2021).

Some jurisdictions around the world graphically depict the importance of speed within a Safe System by recognising speed as the regulating element of the system (Stigson et al. 2008). Figure 1.2 below is an example of that representation from Sweden (Panel A) and the integration of speed management with Movement and Place (Panel B).

**Figure 1.2: Speed represented as the regulating element of a Safe System**

**Panel A:**




*Source: Adapted from Stigson et al. (2008)*

**Panel B:**


*Source: Commonwealth of Australia (2021).*

The practical consequences of the Safe System approach are profound for speed management. First, as expressed in Figure 1.3, speed management is central to Safe System, which cannot be delivered within the forseeable future without the effective management of speed. Second, the System approach highlights the need for components of activity across multiple pillars to work in unison towards the same objective, in order to achieve effective outcomes. Practical examples for implementation include:

- The effective mangement of speed requires both safe speed limits, and compliance with those limits. The latter can be improved by road features and/or vehicle technologies such as speed governing ISA, and/or effective general deterrence. The latter requires enforcement process, campaigns and communicatiosn workig together to increase the perceived risk of beign caught. Thus, the pillars of Speed, Road Engineering and Design, Vehicles, and People all play key roles and must work in unison the deliver the most effective efficient speed management.
- The lowering of speed limits: This is not simply a technical issue involving identifying the safe spped in order to set the speed limit. This can also be a consultation, advocacy, and communciations issue. It is common to find that a vocal minority of people will resist lower speed limits, while a silent majority (especially of relevant residents and locals) support it. In these circumstances, consultation with those affected can be valuable, as can surveying the relevant people showing that the majority of people support the revised speed limit. This information, along with the clear evidence for the safety and other values of lower speeds (see Section 3) can be invaluable in advocacy and commications to both the community and elected decision makers.

# 2. Speed and Harm

Speed is at the core of a forgiving road transport system. While many can relate to the physics of stopping associated with travelling speed, the intricate and non-linear relationship with crash energy and consequent injury is more difficult to appreciate.

**Figure 2.1: Effect of a small travelling speed change on injury**

**The effect of a small travelling speed change on injury outcome**

**A small** change in travel speed

↓

**A relatively large** change in stopping distance

↓

**A much larger** change in impact speed

↓

**A still larger** change in impact energy

↓

**A very large** change in probability of death and serious injury

In this context, all aspects associated with speed are important. Even small reductions in travelling speed can have large effects on injury outcomes and the creation of an inherently safe road system is largely dependent on the kinetic energy in the system. The transition towards the Safe System will depend not only on adopting speed limits compatible with harm minimisation but also on integrating solutions that guarantee safe interaction speeds where conflict occurs or where lane departure is possible (e.g. driver assist technologies). From a road infrastructure perspective, this means the greater use of design features to ensure that survivable interaction speeds are actually being achieved.

Speed is the toxin in crashes. Speed is fundamental to the risk of a crash as well as its severity due to the basic laws of physics, with many mechanisms contributing to crash occurrence as well as crash severity (Job and Brodie 2022). The evidence for road safety benefits from lower speeds is categorical and well known, with many peer-reviewed meta-analysis and literature reviews pointing to the evidence. Many hundreds of evaluation studies of interventions to reduce speeds, show profound reductions in deaths, serious injuries, and crashes overall. These include evaluations of the benefits of: Speed cameras (for review see Wilson et al. 2010); Speed limit reductions (for review see Job and Brodie 2022); and speed reducing road engineering such as speed humps, raised platforms, chicanes, and gateway treatments (for review see Turner et al. 2021).

The most credible global organisations identify the fundamental value of lower speed in saving lives and avoiding serious injuries. Among them are the World Bank (Turner et al. 2021), the World Health Organization (WHO 2008), the International Red Cross (Global Road Safety Partnership 2023), the OECD (2006), the Cochrane Library (Wilson et al. 2010), and, in Australia and New Zealand, Austroads. Thus, the evidence is only briefly referenced here.

This section examines the relationships between speed and trauma and how speeds influence crash likelihood and severity.

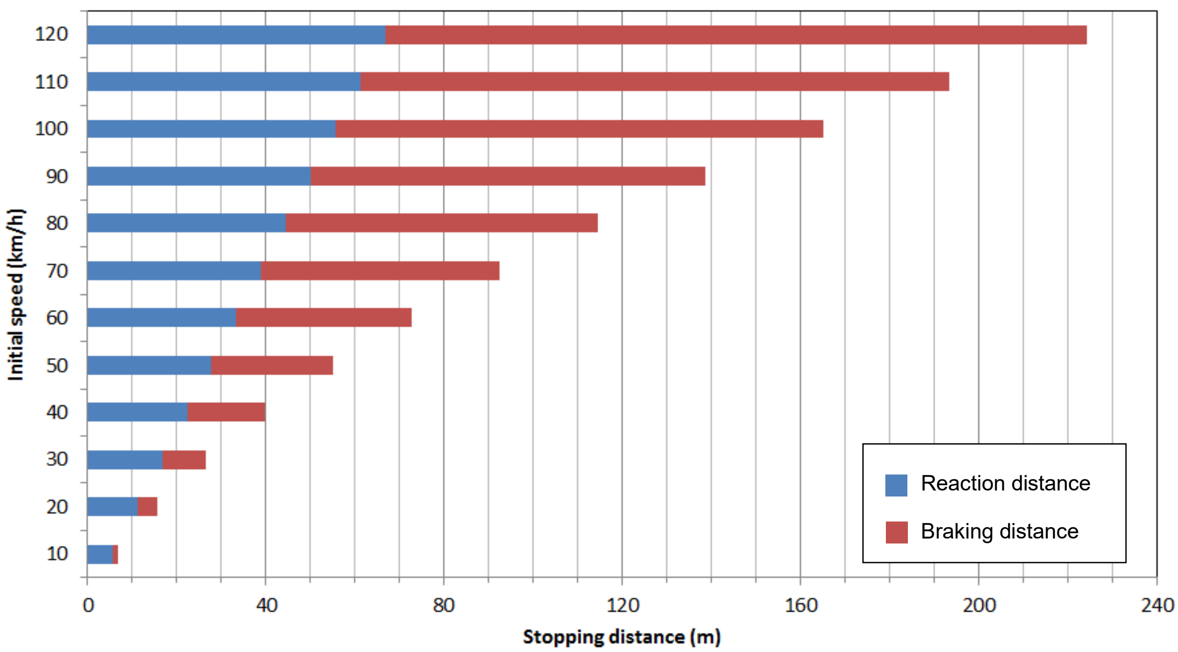
## 2.1 The relationship between impact speed and injury

A number of studies have shown the relationship between speed, crash likelihood and severity, with increases in speed increasing both the likelihood of a casualty crash occurring and the severity of injury to the crash participants (Jurewicz et al. 2015). It should be noted that research in this area is ongoing and while the specific definitions of tolerable risk and the shapes of curves may be refined (see Hussain et al. 2019 – covered in detail later), current indications are that impact speeds below 20 km/h are necessary to minimise the risk of severe injury or death, though impacts at 30 km/h still result in around 10% of pedestrians being killed. Thus, Safe System speeds are already a compromise, rather than being fully Safe System. It may be valuable to appreciate and present this in discussions with political and senior public service decision makers, because in th face of presentation opf principles, a compromise is often demanded. Thus, presenting the recommended speed limits as already containing the compromise may help. As occupant and vulnerable road user protection improves amongst the vehicle fleet, the relationships are likely to change over time; however, the needs of the most vulnerable (the elderly and children) will need to be understood and considered as the aspirational governing design consideration.

### 2.1.1 Stopping distance

A fundamental aspect of safe road design is the provision of adequate sight distances where conflict between road users can occur or where there might be an object lying on the road. In Figure 2.2, assumptions are made that drivers and riders can recognise a safety critical situation and respond to the situation in a timely manner (usually a 1.5 to 2.5 second reaction time). If braking, the distance required to bring a vehicle to rest to avoid a collision is reliant on the judgement and reaction time, travelling speed of the vehicle and the condition of the pavement surface. As shown in Figure 2.2, higher speeds result in exponentially longer stopping distances.

**Figure 2.2: Stopping distance as a function of reaction time and braking on a wet sealed pavement surface***

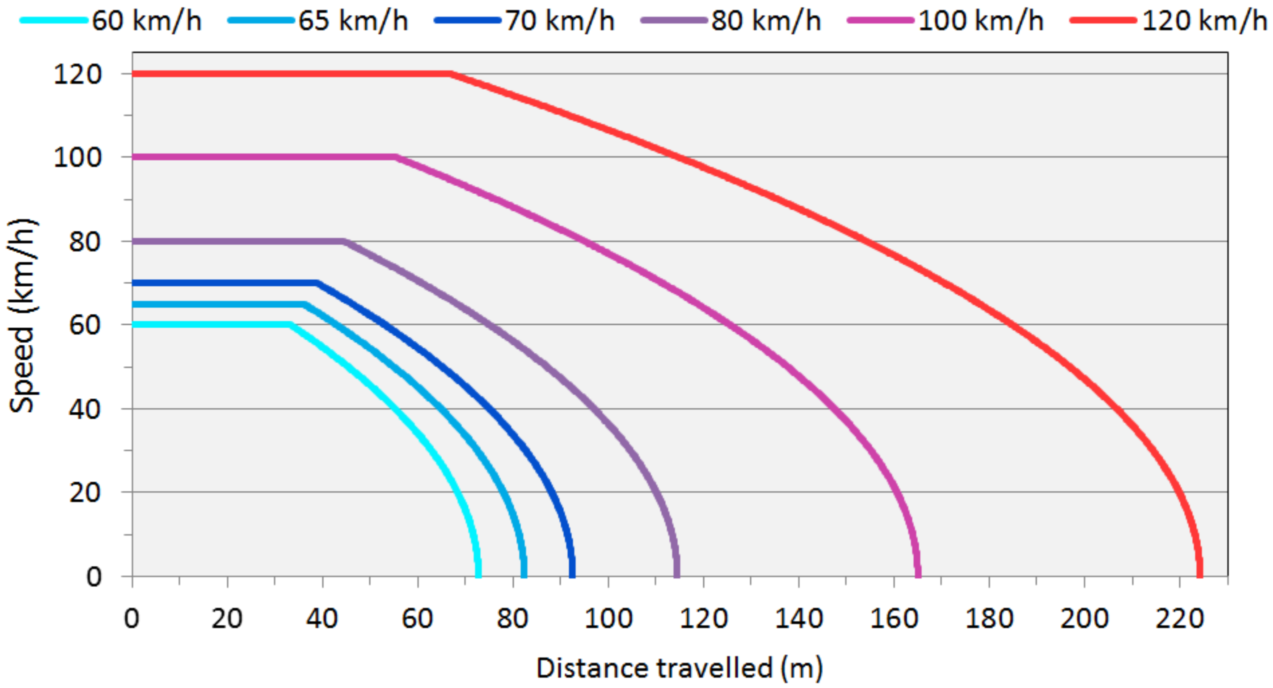



*Note: * Combined distance travelled by a vehicle during the time it takes for a driver to react (blue segment) and then brake (red segment) at different initial travelling speeds. A judgement and reaction time of 2.0 seconds and a friction factor of 0.36 are assumed constant. Situation represents a 90th percentile value and a wet sealed pavement.*

The first component of stopping, reaction time, includes the time it takes for a driver to see the risk, determine the need to brake, and react to it by initialising braking. During this time, no braking is actually performed and the vehicle's speed does not change noticeably. The distance covered during the reaction time is linearly proportional to the initial travel speed. The second component of stopping is braking. This is the time from when the driver initialises braking to the time the vehicle stops. Braking distance is proportional to the square of the initial travel speed.

While an increase in travel speed of 5 or 10 km/h may not seem substantial, it has a considerable effect on stopping distance. Figure 2.3 shows how speed decreases under typical braking conditions on a wet sealed pavement. Very little speed is actually lost in the early stages of braking and most speed is lost in the final stages of braking once a considerable amount of distance has been covered. Therefore any late detection of risk, reaction and braking is likely to generate disproportionately higher impact speeds.

**Figure 2.3: Speed versus distance travelled for vehicles travelling at different initial speeds before braking on a wet sealed pavement surface***




*Note: * A reaction time of 2.0 seconds and a friction factor of 0.36 are assumed constant.*

While the various sight distance considerations form an essential foundation of road design, from a Safe System perspective allowance is still required for the scenario that a driver or rider does not react in time or at all and impact forces are still beyond the threshold of serious injury or death.

### 2.1.2 Energy transfer

Kinetic energy is the energy associated with the movement of an object and is determined by a combination of speed and mass such that:

$$E_k = \frac{1}{2} m\, v^2 \qquad (1)$$

where

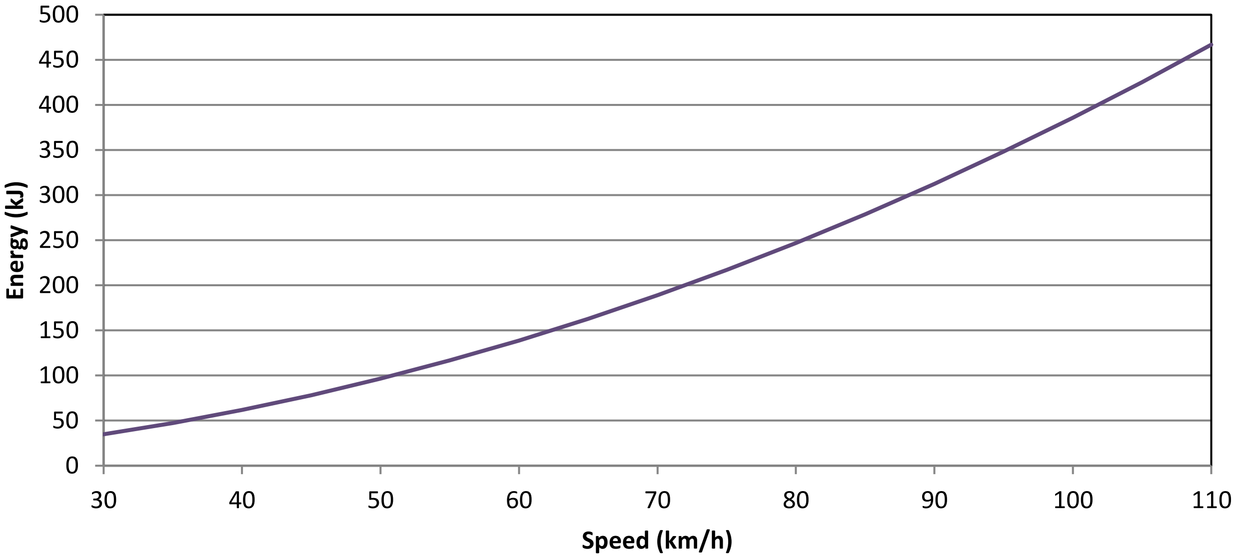
$E_k$ = Kinetic energy (Joules)

$m$ = Mass (kg)

$v$ = Velocity (m/s)

A 1,000 kg vehicle travelling at 60 km/h will have 139 Kilojoules (kJ) of kinetic energy. The same vehicle travelling at 80 and 100 km/h will have 247 and 386 kJ of kinetic energy respectively. A plot of the relationship between speed and kinetic energy is shown in Figure 2.4. As a comparison, in terms of potential energy, this is the equivalent to the same car falling vertically 14 m, 25 m and 40 m respectively.

**Figure 2.4: The relationship between speed and kinetic energy (assuming constant mass)**




The squared relationship with speed means that there is a proportionately higher increase in energy as speed increases. Doubling the speed will result in four times the kinetic energy and tripling the speed will result in nine times the kinetic energy. It is therefore apparent that small changes in speed can have large effects on crash energy (a large determiner of crash severity).

Figure 2.5 demonstrates this in the context of frontal deformation between identical vehicles striking an object at 60 and 100 km/h. Assuming equal mass, the faster vehicle at 100 km/h has 3.4 times more kinetic energy than the slower vehicle at 60 km/h and the deformation outcomes are apparent. Note that the collision scenario represents a full frontal collision where the load is distributed across the full front of the vehicle. Such a collision with a tree or an offset with another vehicle would be much more severe.

Kinetic energy has a linear relationship with mass and a doubling of mass doubles the kinetic energy. Therefore an 8 tonne truck will have 8 times the kinetic energy of a 1 tonne car for the same collision.

> *"In road injury epidemiology, kinetic energy is the pathogen"*
> *(LS Robertson – epidemiologist).*

The exchange of energy in collisions between vehicles, objects and people is more complicated and there can be many determinants of specific injury such as vehicle orientation in car to car crashes. However, managing energy in the road transport system is a key to managing injury outcomes. Outside of vehicle design, speed management and safety barriers provide a key way to manage kinetic energy. With unprotected road users, safe speeds remain the most practical way for addressing safety. Due to their mass, the consequences of crashes involving heavy vehicles are difficult to mitigate if speed is not well managed.

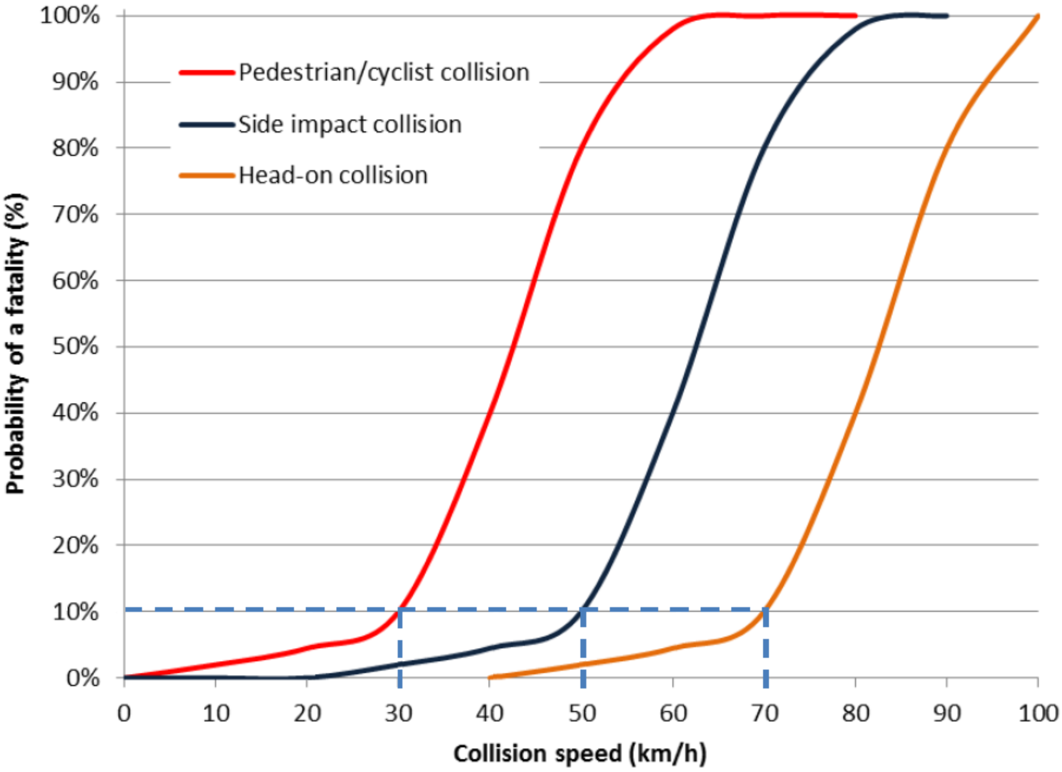
**Figure 2.5: Difference in deformation striking a solid object at 60 and 100 km/h**


*Source: Transport for NSW – CrashLab.*

### 2.1.3 Safe System speeds

The Wramborg curves (Wramborg 2005) have been adopted internationally to illustrate 'survivable' thresholds against impact speeds as shown in Figure 2.6. A 10% threshold for fatal outcomes was used as the basis for establishing a Safe System performance threshold. There is nothing to say that a threshold less than 10% would be inappropriate; however, given the initial illustrative purpose of the curves, the 10% appears to have been almost universally adopted.

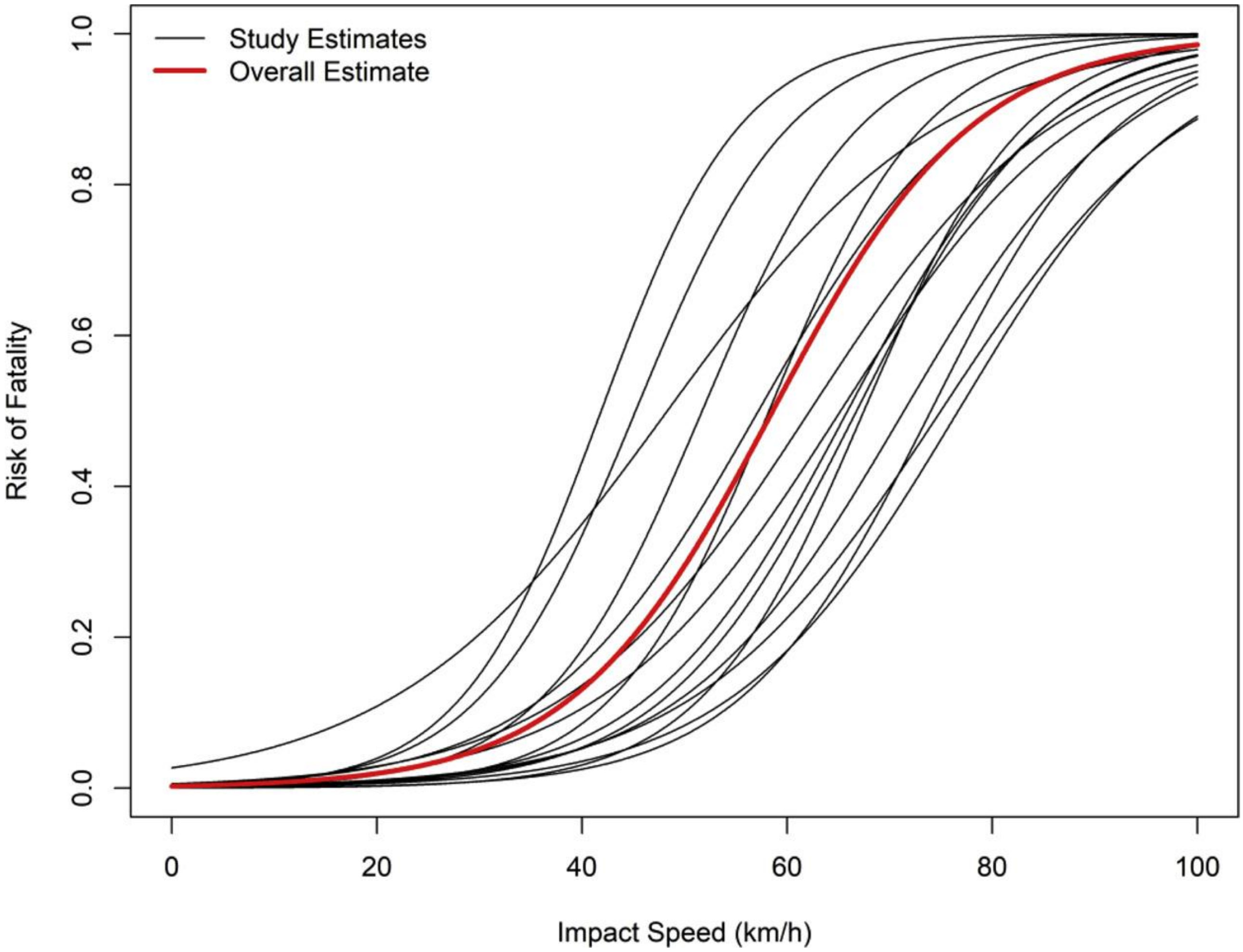
Figure 2.6: **Relationships between a motorised vehicle collision speed and probability of a fatality for different crash configurations**




*Source: Jurewicz et al. (2015), based on Wramborg (2005).*

Updated research since Wramborg's 2005 analysis, suggests slightly different speeds. Hussain et al. (2019) examined impact speeds in pedestrian crashes via a meta-analysis of 20 studies, selected for methodological rigour. Hussain et al. found that at 30km/h around 5% of pedestrians will be killed, with the arbitrary threshold of 10% killed reached at around 37km/h impact speed (see Figure 2.7). Avoiding serious injury requires lower speeds. Right angle and head-on impact speeds of 30 km/h will result in serious injuries (a maximum abbreviated injury scale (MAIS) 3+, which is a measure of traumatic injury) in around 10% of those involved, and around 10% of pedestrians will be seriously injured at 20 km/h impact speeds (Jurewicz et al. 2016). These speeds reflect the evolution of the human body to withstand impacts at the speeds we could naturally achieve – with most of us not likely to reach 20 km/h in running, a few exceptional athletes reaching around 30 km/h.

**Figure 2.7: Curves showing estimates of the impact speed – risk of death relationship for pedestrians impacts, for each included study with the red curve showing the overall estimate from the meta-analysis**




*Source: Hussain et al. (2019).*

Often referred to as the Safe System speeds, the following aspirational operating speeds are as follows (OECD 2006):

- 30 km/h where there is the possibility of a collision between a vulnerable road user and a passenger vehicle or where there is the possibility of a side impact with a fixed object such as a tree or pole
- 50 km/h where there is the possibility of a right angle collision between passenger vehicles
- 70 km/h where there is the possibility of a head on collision between passenger vehicles
- ≥100 km/h where there is no possibility of side or frontal impact between vehicles or impacts with vulnerable road user impacts.

Note that, at present, there is only limited evidence on cyclist and motorcyclist injury thresholds and an assumption is often made that their injury potential is the same as the pedestrian curve.

The curves only represent passenger car interactions and do not account for young and elderly people and heavy vehicles. The curves are also limited in that they only provide the probability of fatality and not serious injury and there is little published evidence demonstrating the origins of the curves. Despite this, the Wramborg curves have become the aspirational criteria for Safe System speeds and have achieved practical application in the Netherlands and Sweden – though, increasingly, leading road safety countries are adopting 20 km/h limits (see Figure 3.4 for an example). Research since Wamborg developed these curves has indicated some variations from them (as noted above), though Wamborg deserves significant credit for the shape of the curves, their overall thrust, and their importance to road safety policy.

### Pedestrian groups at increased risk

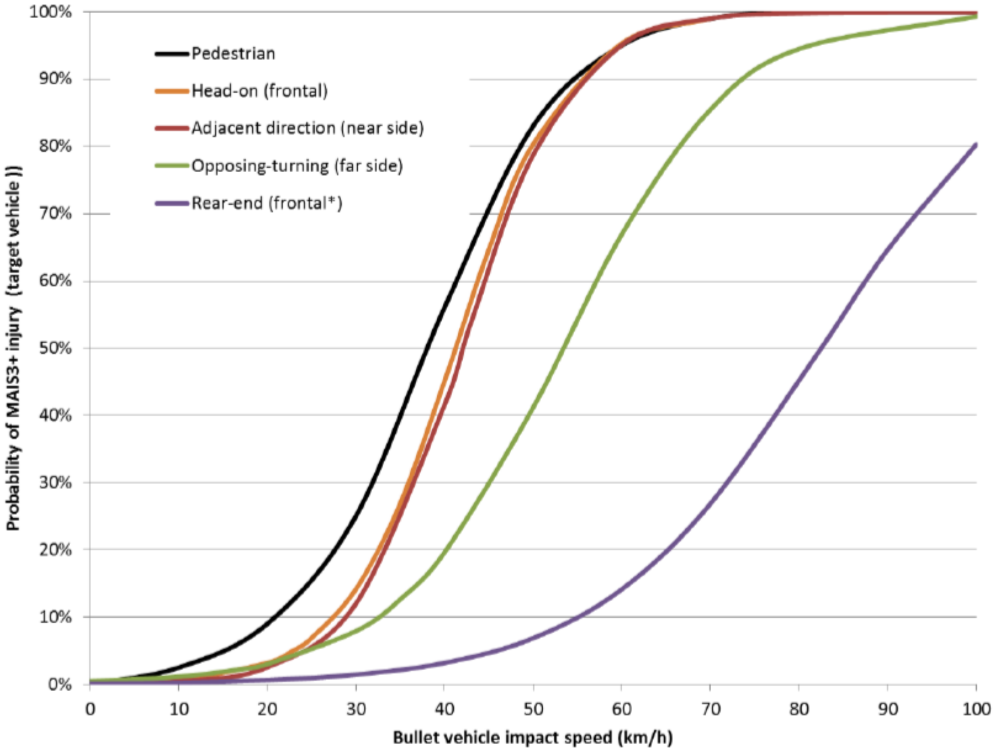
As described above, pedestrian (and cyclist) safety require lower travel speeds wherever pedestrians are present. In addition, children and older pedestrians are at greater risk than average. A study by Corben et al. (2006) found that pedestrian fatal crash risk could be reduced by around 75% if travel speeds were 40 km/h instead of 50 km/h, and by around 95% if speeds were 30 km/h instead of 50 km/h.

The risk of a fatal outcome reaches 10% at significantly different speeds, depending on pedestrian age, rising rapidly with speed above these thresholds (Davis 2001). While it is evident that younger road-user groups may have a higher biomechanical tolerance (more capacity to withstand impacts without death or serious injury), the Safe System aims to protect all road-user groups. Moreover, since Davis conducted the research (2001), the proportion of sport utility vehicles (SUVs) and large utility vehicles has increased significantly on Australian roads. This class of vehicle, with its typically higher mass and more aggressive and rigid frontal structures, is likely to be driving fatality thresholds down compared with the 30 km/h and 20 km/h limits considered above. Furthermore, SUVs have the potential to 'run over' children – especially young children due to their lower height – which may result in fatality at much lower speed thresholds.

## 2.1.4 Further insights on speed and injury severity

There is strong evidence to indicate that the part of the vehicle struck will tend to determine the injury outcomes for the occupants. A number of studies have presented relationships between the change in velocity during a crash for a given vehicle and MAIS3+. Figure 2.8 shows curves derived by Jurewicz et al. (2015) based on pedestrian crash models by Davis (2001) and vehicle crash models by Bahouth et al. (2014). The bullet vehicle referred to in Figure 2.8 is the vehicle that impacts another vehicle, person or object.

**Figure 2.8: Relationships between bullet vehicle impact speed and probability of a MAIS3+ injury to a target vehicle occupant for different crash configurations**




*Source: Jurewicz et al. (2015).*

The modelling shows that when considering (serious) injury in addition to fatality risk, the speed thresholds communicated by Wramborg decrease. For example, the equivalent speeds to those shown previously become 20 km/h for pedestrians, 30 km/h for side impact (near side) and also 30 km/h for a head on collision.

These relationships provide a good indication of the changing nature of injury severity with increasing speeds. They are, however, limited to certain road user cohorts (e.g. adult front seat occupants) and further work is required to provide more generalised relationships that consider the effects of collisions for all road users of all ages.

These relationships are also generally only indicative of situations where mass inequality does not play a role. Mass inequality will play a large role in the severity of collisions between vehicles of substantially different masses. This is most clearly seen with vehicle/pedestrian collisions but is also relevant to collisions where heavy vehicles are involved.

## 2.2 The relationships between travel speed, crash risk and injury risk

The above section considered ‘impact speed’ and injury risk. It is also important to appreciate that there are close relationships between mean ‘travel speeds’ and crash risk, injury risk, and risk of fatality. These relationships highlight the importance of travel speed for road safety and that we cannot rely on drivers consistently wiping off enough speed prior to impact to deliver safety.

Meta-analyses and reviews of research from many studies and many countries show a consistent exponential relationship between average travel speeds and both crash risk and crash severity. These studies control for infrastructure and other safety factors by considering changes in mean speed (created in various ways, including lower speed limits and enforcement initiatives). The first such meta-analysis by Nilsson (2004) and other analyses (Elvik et al. 2004, 2019; and for brief review see Job and Brodie 2022), reveal the following powerful relationships between mean travel speed and crashes:

- Each 1% decrease in speed results in around 4–5% decrease in crash deaths.
- Each 1% decrease in speed results in around 2.5–3% decrease in serious injuries.
- Each 1% decrease in speed results in around 1% decrease in property damage crashes.

## 2.3 Brief notes on implementation issues from Safe System speeds and Vision Zero

It is vital to appreciate that improvements to roads and vehicles can influence the speeds at which Safe System can be achieved. As clear examples, on non-urban roads the addition of median and shoulder barriers lifts the safe speed from those required to avoid serious trauma in head-on or run-off-road crashes to significantly higher speeds (details of these speeds are provided later in this Guide). Thus, the commitment to Vision Zero as yet in the absence of Safe System level safety improvements to many roads or vehicles creates profound policy implications for speed management and road safety. This section briefly considers some of these implications.

Multiple factors are particularly relevant to the research on impact speeds and the derivation of Safe System speeds for the choice of target speeds for safety. These are noted below.

First, the implication of Safe System is that Safe System speeds are the target maximum speeds to be achieved on all roads of Australia and New Zealand, if the vision of zero deaths is to be achieved (Austroads 2021), noting that these will increase over time on specific roads as they are fitted with safety infrastructure.

Second, the adoption of impact speeds which are shown to result in around 10% of victims being killed means that in current circumstances the accepted ‘Safe System Speeds’ are a compromise and not Safe System. These speeds will result in many deaths (and many more serious injuries) in relevant crashes at the specified impact speeds, whereas Vision Zero sets the objective of eliminating deaths and serious injuries. This presents a challenge to delivery of Vision Zero, which may to some extent (depending on fleet penetration) be managed by increasing vehicle safety and safer road infrastructure.

Third, this research relates trauma risk to impact speed, not travel speed. In some (not all) crashes drivers will break and reduce crash impact speed below travel speed. On this basis, an argument may be mounted that the travel speed can be above the ‘safe’ impact speed. However, in order to achieve vision zero this would only apply if braking down to safe system impact speeds occurred in all crashes. Accepting the Safe System premise that people make mistakes acknowledges that elimination of deaths and serious injuries cannot be achieved by relying on drivers to reduce speeds before crash impacts. Autonomous emergency braking will bring this closer to reality for some crash types.

Fourth, crashes involving heavy vehicles and those involving motorcycles are not accommodated in ‘Safe System’ speeds, presenting a significant challenge to be managed for delivery of Vision Zero.

Last – but perhaps most importantly – there are political challenges and community acceptance issues to be managed in order to achieve even the Safe System speeds noted above. Examples are provided in Section 7.4.7: *What does the community think about speed risks and speed management?* Allowing an unfettered role of the public sector to perform its key function of providing frank and fearless advice will be vital to addressing this and other road safety challenges. This capacity will be facilitated by processes which ensure that Austroads is able to provide full rigorously evidence-based advice in reports, rather than being restricted by political concerns with that advice.

# 3. Co-Benefits of Speed Management for Other Critical Agenda

The evidence from a wide range of disciplines shows that improved speed management not only reduces crashes, deaths and injuries, but also delivers and facilitates vital synergies with other Australian and New Zealand agendas. These include:

1. reduced greenhouse gases and air pollution
2. health benefits by encouraging active transport and mass transit/public transport use
3. reduced noise pollution (noting the extensive evidence for the substantial hidden health effects of noise on people)
4. reduced vehicle running costs
5. improved equity and social cohesion
6. net economic improvements.

The evidence for each of these effects of speed is briefly reviewed below.

## 3.1 GHG and air pollution reductions from lower speeds

The effects on greenhouse gases (GHGs) and other air pollutants are covered together here due to overlapping features: GHGs may also be relevant air pollutants. The main mechanism of production is the same – the burning of fossil fuels with the extent of fuel burning required being greatly influenced by travel speed. Thus, improved management of travel speeds presents a significant opportunity to reduce GHGs from road transport and can be expected to facilitate modal shift away from roads by allowing for the time efficiency of other travel models to be improved relative to roads. Lower speeds will also reduce GHGs in less time than relying on fleet change over to electric power.

Reducing climate change gasses is critical for both New Zealand and Australia. For New Zealand, transport, contributed 17.5% of the total greenhouse gas emissions in 2022, with over 90% arising from road transport (New Zealand Government 2024b). Transport is a major and growing source of GHG emissions in Australia (Stanley et al. 2011; Government of Victoria 2021).

Evidence clearly demonstrates that both air pollution and GHG emissions from road transport are generally reduced by lower speeds (Lopez-Aparicio et al. 2020; Madireddy et al. 2011). This occurs primarily because at higher speeds there is more aerodynamic drag on the vehicle and thus more fuel burning (which emits GHGs and other pollutants) is required to overcome this drag at higher speeds. For example, one study assessed the effects of a 10mph increase in Highway speed limits in multiple states of the USA. It found that a 10 mph speed limit increase on highways leads to a 3–4 mph increases in travel speed, and because of increased fuel burning, elevated emission concentrations of 14–24% for carbon monoxide, 8–15% for nitrogen oxides, and 1–11% for ozone (Van Benthem 2015).

At very low speed of travel if the travel is smooth, further lowering of speed can reverse fuel efficiency and so this might be expected to reduce air pollution. However, in urban environments travel is often not smooth, with stopping or slowing for intersections, stop signs, lights, slowing for turns, giving way to traffic and pedestrians, as well as slowing or stopping for other vehicles which are turning or stopping. Congestion adds to the stop start nature of traffic. Thus, there is more acceleration and more braking when maximum speeds are higher between these stopping or slowing events. Increases in acceleration and deceleration (as well as higher speeds) induce another mechanism of air pollution – particulate emission from the increased frictions of tyres with roads and of brake pads. Due to changes in combustion efficiency and reduced tyre and brake wear at low speeds, changes in air pollution are not the same across different air pollutants. Analysis shows that lowering urban speeds from 30 mph or 20 mph (approximately 48 km/h to 32 km/h) substantially reduces particulate pollution, though it increases nitrogen dioxide. However, this still yield a substantial reduction in lives lost due to air pollution-related health harm overall, as particulate emissions are more strongly linked to adverse health outcomes than nitrogen dioxide.

Higher travel speeds results in more GHGs being emitted by motor vehicles, and thus even reductions from 50 km/h to 30 km/h in stop-start urban traffic reduce GHGs by reducing acceleration and deceleration (Jones and Brunt 2017; Madireddy et al. 2011). Significantly lower rural road, highway, and motorway speeds than current speeds limits (including in Australia and New Zealand) will provide reduced GHG emissions (Fontaras et al. 2017; Ahn et al. 2022; Joumard et al. 1995). For example, one study found that the ideal speed for minimum fuel consumption and thus emissions) on motorways was around 75 km/h (Hosseinlou et al. 2015), well below prevailing motorway speed limits all over the world, including in Australia.

Recently, Yannis and Michelaraki (2024) presented a systematic review of evidence on expansion of 30 km/h speed limits in Europe. Effects of the 30 km/h limits in 40 cities were included. On average, results of lowering speed limits to 30 km/h demonstrated a 23%, 37%, and 38% reduction in road crashes, fatalities, and injuries, respectively. Lower speed limits also yielded environmental benefits, with emissions decreasing on average by 18%, noise pollution levels by 2.5 dB (a practically impoprtant reduction, noting that a doubling of noise equals a 3dB increase, because of the log scale of dB), and fuel consumption by 7%, indicating enhanced fuel efficiency and reduced environmental impact, as well as encouraging citizens to embrace walking, cycling and utilising public transit.

Health harm from GHGs and air pollution: Lower speeds reduce air pollution and associated health effects and deaths. The World Health Organization (WHO) assesses air pollution as the largest environmental health problem on earth (WHO Regional Commission for Europe 2018). Air pollution generates a huge burden of deaths, disease, and disability globally (Cohen et al. 2017) killing over 7 million people each year (Neira 2019). Increased speed limits in the USA were found to increase air pollution which led to 9% higher foetal death rates around the affected freeways (Van Benthem 2015). Other studies also find significant effects of carbon monoxide and particulate pollution on infant mortality (Currie and Neidell 2005; Currie et al. 2009), with each 10% reduction in total suspended particulates resulting in a 3.5% decline in the infant mortality rate at the county level (Currie et al. 2009). A study in Australia found that even low levels of ambient air pollution were associated with significant adverse foetal outcomes, including growth restriction (Melody 2022).

Road transport is the largest single contributor to this (Tian et al. 2019) causing 50% of air pollution deaths in Europe (OECD 2014). A recent study of the road transport in Melbourne confirmed the substantial role of road transport in the production of air pollution (Alvarado-Molina et al. 2023).

Many lives could be saved by lowering speeds through reduced air pollution alone (Baldasano et al. 2010), even to speeds well below the supposedly most efficient speeds for vehicles in terms of air pollution. This is because these ideal speeds are based on deliberately stable speeds of travel, which are not realistic for real-world conditions. For example, lowering urban speeds from 30 mph (48 km/h) to 20 mph (32 km/h) in Wales would save 54 lives per year through reduced air pollution, in addition to further savings through other mechanisms associated with lower speed (Jones and Brunt 2017; also see Yannis and Michelaraki 2024).

Climate change also harms health, yet this receives minimal attention. Unsurprisingly, evidence supports a link between climate change and skin cancer (Parker 2021), which is of more importance to Australia than any other country – see the report from the Intergovernmental Panel on Climate Change (Creutzig et al. 2022).

The evidence unambiguously indicates that any policy – including lower speeds – that reduces air pollution and GHGs will save lives and improve health, even when existing levels are within guideline limits. Local studies also show that, as expected, these patterns apply in Australia.

The evidence of health effects may deserve more attention, as part of the case for decarbonisation, to support improved speed management.

## 3.2 Active transport for health benefits and to Facilitate mass transit/public transport use

Lower speeds (especially with other incentive policies) facilitate increased use of public and active transport by making walking and cycling safer and by reducing or eliminating the time-saving incentive to drive, whereas higher speeds reduce walking and cycling (Cohen et al. 2014).

Active transport saves lives lost to heart disease, diabetes, low bone density, high blood pressure, and respiratory problems (Cohen et al. 2014). Substantial health gains, healthcare cost reductions, and reduced GHGs are achieved by switching short car trips to walking and cycling (Mizdrak et al. 2019).

## 3.3 Reduced noise and its benefits (noting the extensive evidence for the substantial hidden health effects of noise on people)

Road traffic is a major contributor to noise, and the scientific evidence shows that higher traffic speeds result in more traffic noise, and that noise substantially harms health and reduces quality of life. Furthermore, traffic noise arises from the interaction of tyres and the road surface as well as engine noise, and both increase with higher engine revolutions and faster tyre impacts on the road. Thus, lower speeds are established to significantly decrease road traffic noise (Freitas et al. 2012; Subramani et al. 2012; Yannis and Michelaraki 2024). In addition, because of the primary contribution to noise of the interaction of tyres and the road surface, lower speeds will remain useful for reducing the health harm of noise even for electric vehicles (EVs).

Hearing loss is just one of many harmful effects of noise, which are well established in scientific research yet largely unrecognised by the community and by governments. Some of these proven effects are: Noise causing annoyance and stress, and disrupts many core activities in homes affected by road (or other) noise sources, thus reducing life quality (Berglund and Lindvall 1995; Job 1988, 1996); Noise impairs sleep architecture/rhythm, causes awakenings and these sleep disturbances are associated with substantial long-term physical health effects (Cappuccio et al. 2010; Munzel et al. 2021); Noise exposure is associated with less physical activity (Foraster et al. 2016); Noise causes many health effects- cardiovascular damage, metabolic disruption (Hahad et al. 2019; Lercher et al. 1993), and digestive system disruption (Mehra et al. 2022). Increased noise is associated with reduced brain size in children (Simon et al. 2022), and retards learning in children (Haines et al. 2001).

The WHO estimated that transport noise kills more people in Europe than road crashes (WHO 2011; also see Job 1996). The WHO identifies noise as the second largest environmental health problem on earth, behind air pollution (WHO Regional Office for Europe 2018). Finally, these effects of noise on health are chronic (Haines et al. 2001) (i.e. people do not simply get used to the noise). The effects described herein are after any habituation to the noise has occurred (Job and Hatfield 2003).

## 3.4 Vehicle running cost reductions

The evidence demonstrates that higher traffic speeds result in higher vehicle running costs, reducing the supposed economic benefits of high speed road travel. This is consistent with the broad effects of higher speeds which require more fuel, and burning more fuel emits more air pollution and more GHGs.

Higher speeds increase fuel consumption. Thus, policies that reduce travel speeds generally reduce fuel costs – even including reductions from 50 km/h to 30 km/h in urban traffic – where lower maximum speeds reduce acceleration and deceleration (Madireddy et al. 2011), and reduce fuel use (Yannis and Michelaraki 2024). For higher speed roads, the ideal speed for minimum fuel consumption on motorways (in Iran, in this case) was around 75 km/h (Hosseinlou et al. 2015), well below Australian motorway speed limits. The evidence for higher speeds contributing to transport costs is extensive (Fontaras et al. 2017; Ahn et al. 2002; Joumard et al. 1995). Australian research (for motorways and rural roads) also found increasing vehicle running costs will be reduced with lower speeds on these roads (Cameron 2012). Higher speeds also generate additional vehicle maintenance costs, particularly including tyre wear (Braghin et al. 2006), and thus also more dust and particles from tyres and roads (Lee et al. 2013). Note that congestion is considered in section 3.7: *Speed management myths*.

## 3.5 Equity and social cohesion improvements

Higher traffic speeds result in more social and economic inequity, and these inequities harm health and the economy.

The personal benefits of higher speeds are much more effectively accessed by those with more wealth, who can afford safer personal motorised transport or who gain from the profitability of transport and other companies for which many of the cost of higher speed through crashes, health harm, and environmental damage are externalised to government and the community. However, those with the less financial resources are less able to afford safe personalised motor transport and do not gain from transport and related company profitability and so do not receive the benefits of higher speed (Litman 2021). In addition, those with the least financial resources suffer more of the costs of higher motorised speed: poorer people are more likely to be the victims of serious crashes. Research also shows that reducing transport pollution and reducing serious crashes effects (achieved by lower speeds) benefits the economically disadvantaged the most, thus improving equity (Randal et al. 2022). Another confirmation of these inequitable effects of higher speed comes from a study in Brazil which found that the benefits of lower speed limits especially accrue most for low-income pedestrians and motorcyclists (Ang et al. 2020).

Reducing urban speeds from 30 mph or 20 mph (approximately 48 km/h to 32 km/h) results in greater social inclusion, greater community cohesion and improved local business viability (Jones and Brunt 2017). Note that this study is in a high income country (UK). This is as would eb expected because the mechanisms by which inequity is generated by higher speeds apply everywhere.

Social and economic inequity harm health and the economy: Inequity is well recognised as harmful to societies and economically costly in both highly developed and low or middle income countries (Glyn and Miliband 1994; Mackenbach et al. 2011; Omoeva et al. 2018), making improved equity a core value for public health (Fagliano and Diez Roux 2018) as well as delivering cost savings (Glyn and Miliband 1994; Mackenbach et al. 2011).

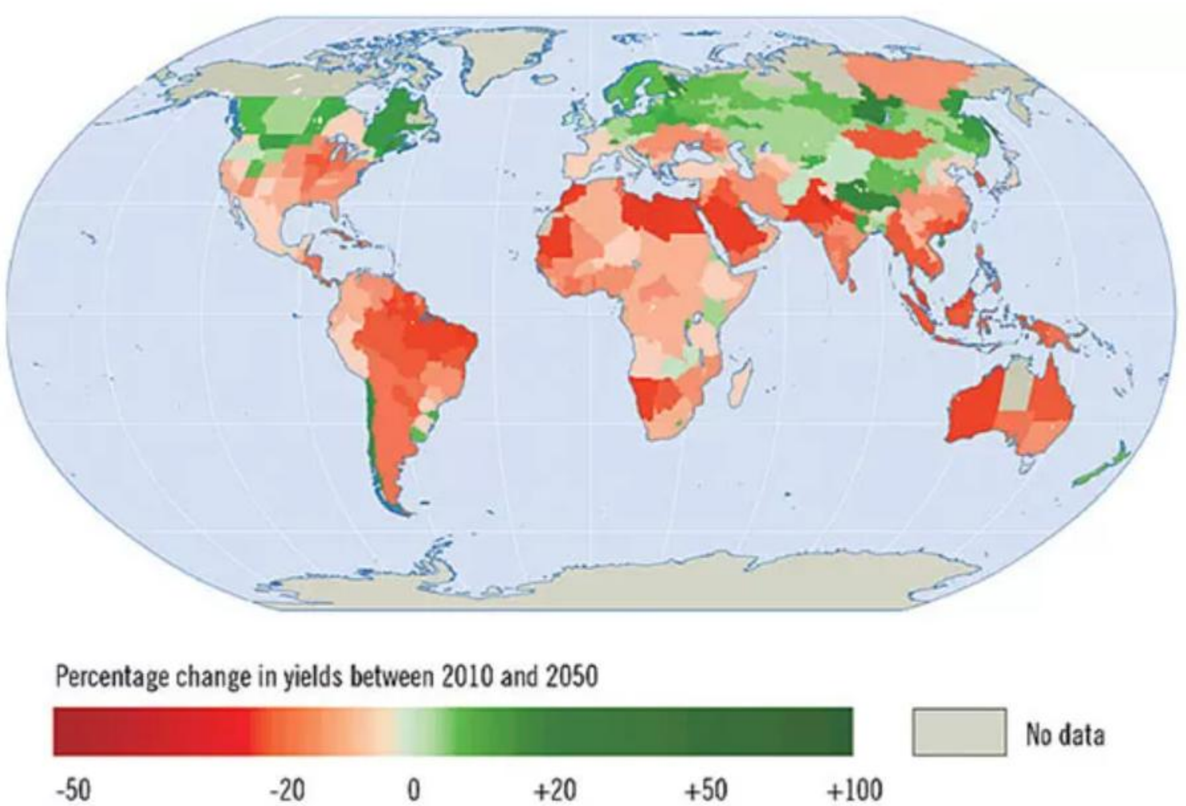
Lower speeds and less noise and pollution also lead to substantial increases in social networks in neighbourhoods, because people walk more, talk to neighbours more, play outside more, and overall socialise more (Appleyard and Appleyard 2021), and increased networks of social contacts reduce crime.

## 3.6 Net economic improvements from lower speeds

The evidence shows that higher traffic speeds generally result in net economic loss for nations.

Climate change harms economies (Bauer and Rudebusch 2023), through higher infrastructure costs for climate adaption and resilience, population movements within countries, increased weather event damage, and reducing agricultural productivity (World Bank 2010). The latter is identified especially in Australia. Figure 3.1 presents predictions by the World Bank showing that climate change will produce a substantial loss of agricultural productivity in Australia overall. Lower travel speeds can reduce Australia's GHG contribution more immediately than many other interventions.

**Figure 3.1: Predicted effects of climate change on agricultural productivity, showing substantial net losses for Australia**

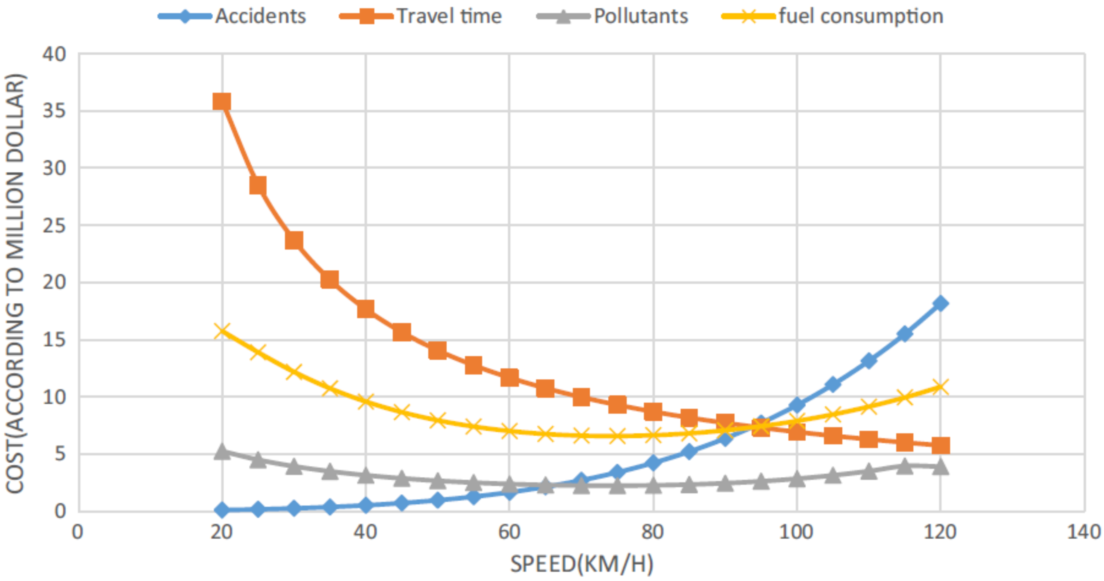



*Source: World Bank (2010).*

As the Intergovernmental Panel on Climate Change observed: "Climate action has myriad co-benefits from health to the economy" (Creutzig et al. 2022).

Studies in various countries consistently find that the economically optimal speed is below the prevailing speed limits. Examples are provided below. A study found that for motorways in Iran the economically optimal speed is 76 km/h, well below the prevailing speed limit (Houseinlou et al. 2015; also see Figure 3.2). This is also an under-estimate of the full costs of higher speed because various aspects of cost (including GHGs, noise, and inequity) are not considered. The increases in pollution and fuel costs at very low speeds may apply on a motorway, where travel can generally be quite smooth, but as explained in the section above, with the heading

Figure 3.2: Economically ideal speed on a motorway in Iran




*Source: Hosseinlou et al. (2015).*

Analysis of the effects of wide speed limit increases in the western United States (Van Benthem 2015) found that a 10 mph increase in speed limits leads to 3–4 mph increases in travel speed. However, much smaller increase in speed still generated 34–60% more fatal crashes, elevated pollutant concentrations, and 9% higher foetal death rates around the affected freeways. On this basis, the social costs of speed limit increases are 2 to 7 times larger than the social benefits. The optimal speed limit is lower than 55 mph (88 km/h). Again, this study left aside some of the costs of higher speeds and so is an over-estimate the real economically optimal speed.

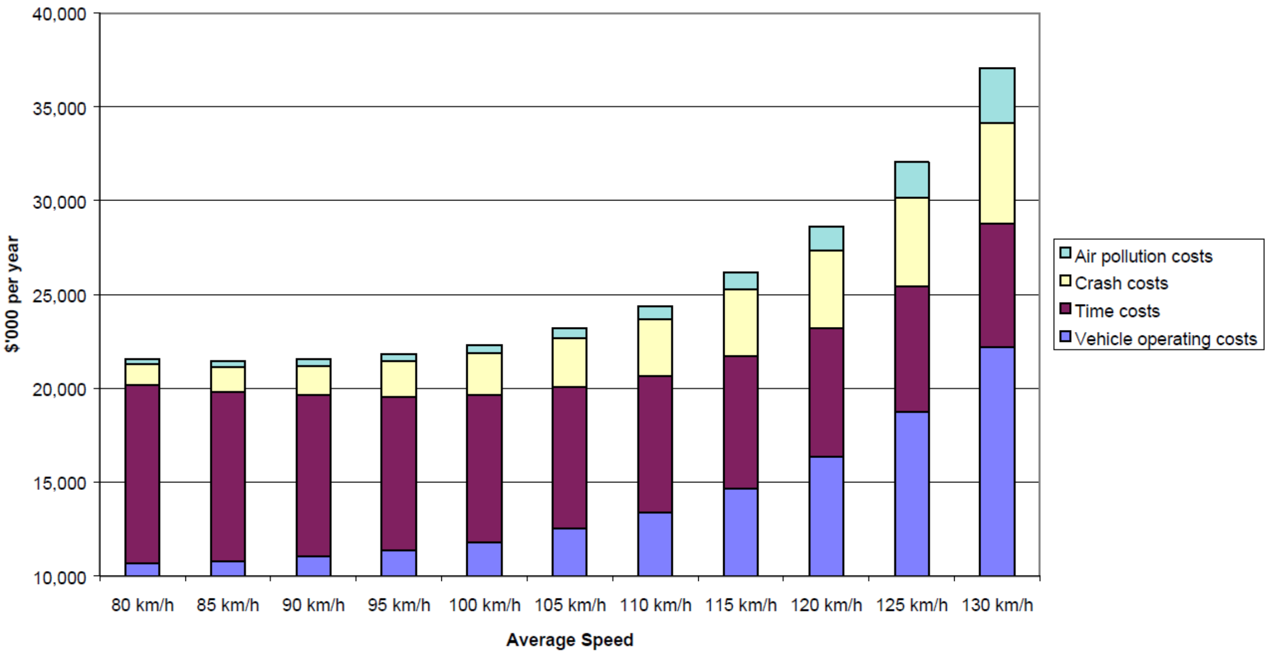
Similarly, in Sao Paulo, Brazil the costs of increased crashes were significantly larger than the social costs of longer trip times (Ang et al. 2020), and a study in Turkey found that the economic costs of increasing the speed limit from 90 to 100 km/h outweighed the benefits (Cetin et al. 2018). Costs considered included travel time, crash costs, fuel consumption and environmental damage, again leaving some costs out of consideration (such as noise or inequity).

Studies of economically optimal speeds in Europe show that while these speeds are close to speed limits in urban settings, ideal speeds for motorways and rural roads are 15–25 km/h below existing speed limits (for a brief review, see Cameron 2012).

Victorian research reveals a similar picture in Australia. Assessing the costs of travel time, crashes, air pollution, and vehicle operation revealed different economically optimal speed for different roads (see Table 1 in Cameron 2012). Figure 3.3 presents an example graph of economically ideal speeds for one type of rural road in Victoria. The results generally identify economically ideal speeds that are below existing speed limits. Several factors also indicate that this study proves a significant over-estimate of current economically optimum speeds. First, as with other studies, some costs are not considered (noise pollutions and GHGs). Second, fuel costs have risen dramatically since this study was undertaken. Third, as with many analyses of the cost of travel time, the benefit of reductions in travel time assumes that there is real economic value in savings of even a few seconds for each driver multiplied by the large numbers of vehicles involved, even though these may not deliver productive time gains for anyone.

One reason for the over-estimated benefit of higher speed limits is that when speed limits are changed the mean travel speed changes less than the speed limit change. For example, Dutschke and Woolley (2010) studied the effects on travel times from the change in speed limit from 110 km/h to 100 km/h along a number of rural highways in South Australia. The study found that increases in travel times were proportionally less than the decreases in speed limit. The 10% decrease in speed limit increased travel times by 2–8% for higher density traffic (6000 vehicles per day) and 4–10% for lower density traffic (1000 vehicles per day). In relative terms, this means that a journey that took 60 minutes at 110 km/h would take between 61 to 66 minutes at 100 km/h.

**Figure 3.3: Monetary impacts of different average speeds on rural undivided roads with a 7.0m sealed width, 1,000 vehicles per day, curves, crossroads, and towns in Victoria**




*Note: With the costs of noise pollution and GHGs considered, ideal speeds are likely to decrease.*

*Source: Cameron (2003).*

**Table 3.1: Economically optimal speeds in Victoria, with some costs of speed omitted***

| Road environment | Optimal speeds for cars and light commercial vehicles | Optimal speeds for trucks |
|---|---|---|
| Rural freeways | 110 | 95 |
| Rural divided roads | 95 | 90 |
| Standard sealed two-way undivided rural roads | 90 | 85 |
| Sealed two-way undivided rural roads with crossroads, towns and curvy alignment | 85 | 85 |
| Shoulder sealed two-way undivided rural roads | 90 | 90 |
| Shoulder sealed two-way undivided rural roads with crossroads, towns and curvy alignment | 85 | 85 |

** See Section 3.6 for context.*

*Source: Cameron (2012).*

Finally, a similar study of New Zealand roads reveal a similar picture, of economically optimum speeds being below typical speed limits (Cameron 2024[1]).

Two caveats are noted on studies of economically optimal speeds. First, pure economic analyses place no explicit priority on avoiding deaths. Rather, these studies in effect trade off human life for human time, despite Australia's commitment to Vision Zero crash deaths and serious injuries. Second, the value of travel time savings may combine tiny increments of even just several seconds per vehicle by adding these over many motorists and many repeat uses of the road. Thus, what are in effect meaningless time savings can be made to seem meaningful.

Finally, it is important to appreciate that available analyses, as presented here, omit costs which would add further to the costs of higher speeds, and thus reduce the observed optimal speeds. Omitted costs across various studies include the costs of GHGs and climate change often because the studies were conducted prior to a fuller understanding and acceptance of the costs of GHGs and climate change, the costs of inequity, and in some cases the costs of noise.

## 3.7 Speed management myths

This section will address the myths that often hold back effective speed management, including referencing the existing evidence base. Examples of common myths include:

1. People do not obey speed limits, so there is no point in lowering them.
2. Speeding is not a substantial cause of crashes.
3. 'I am a highly skilled driver, so I am safe to drive at high speeds'.
4. Speed limits on roads in Australia and New Zealand are already lower than most leading road safety countries, so we do not need them lowered.
5. The problem is bad drivers, not high speed.
6. Higher speeds are better for the economy.
7. Higher speeds are a solution to congestion.
8. People do not want lower speed limits.

Myths 5, 6, and 7 are each considered in more detail below. The first 5 are only briefly addressed, because the evidence relating to them has already been covered in this Guide and the Austroads *Guide to Road Safety Part 4*. Myth 8 is covered later in this Guide in Section 7.4.7: *What does the community think about speed risks and speed management?*

### 3.7.1 People do not obey speed limits so there is no point in lowering them

The evidence shows that this is a myth. Many studies around the world have found that lowering speed limits reduces travel speeds (for example, Transport Qatar 2016; World Bank 2019). Examples also exist in Australia and New Zealand (Bhatnagar et al. 2010; Kloeden et al. 2006, 2007).

In addition, the multiple examples of reductions in deaths and injuries when speed limits are lowered are achieved through speed limit reduction, not other changes (de Pauw et al. 2014; McCulloch 2020; Vadeby and Forsman 2018) and see the reports of success of speed limits on the German Autobahns (European Transport Safety Commission 2007). Clear examples in Australia and New Zealand include studies in Auckland (Auckland Transport 2021), NSW (Bhatnagar 2010; Graham and Sparkes 2010), South Australia (Kloeden et al. 2006, 2007; Mackenzie et al. 2015), and Victoria (Sliogeris 1992)

1 For upcoming update see: https://www.nzta.govt.nz/resources/economic-analysis-of-optimum-speeds-on-rural-state-highways-in-nz/

Many drivers aim to avoid speeding, and as shown in relevant studies noted in this guide, for many this is due to the risk of being caught (i.e. general deterrence). In addition, many drivers who speed are prepared to risk a certain level of speeding, and thus most drivers reduce their speed when speed limits are lowered.

### 3.7.2 Speeding is not a substantial cause of crashes

The research report in many parts of this Guide show that higher speeds dramatically increase serious crash risk; speeding is a major contributor to crashes and their severity, and is under-estimated not over-estimated in crash data in Australia and New Zealand (Job and Brodie 2022). Globally, 54% of crash deaths involve speeding (Fondzenyuy et al. 2024), and this may also be an under-estimate based on the level of omission of speed as a factor in crashes (Job and Brodie 2022).

### 3.7.3 'I am a highly skilled driver, so I am safe to drive at high speeds'

Driving skill has surprisingly little to do with crash risk. More skilled drivers tend to have more crashes than average because their overconfidence means that take more risks (Turner et al. 2021). Serious crash risk is more determined by motivation (Job 1999), which is apparent in the main behavioural causes of deaths and injuries (speeding, drink-driving, drug-driving, failing to wear a seatbelt or helmet, mobile phone use). These behaviours are largely motivated choices, not skill or knowledge problem. Most relevant to speed, for example, choosing to drive below the speed limit does not take more skill than speeding.

### 3.7.4 Speed limits on roads in Australia and New Zealand are already lower than most good road safety countries, so we do not need them lowered

Many well-performed road safety countries have generally lower speed limits than in Australia and New Zealand. Many such countries – including the leaders, i.e. Switzerland and the Netherlands – have 30 km/h default urban speed limits, while in Australia and New Zealand default urban limits are 50 km/h. The 30 km/h limits are expanding in Europe, including as school zone speeds, whereas most of Australia and New Zealand have 40 km/h school zones. Even in Asia, countries are moving from 40 km/h to 30 km/h in school zones (Zolkepli 2024). Some strong performing countries, such as Spain, have also moved to more 20 km/h residential streets, with traffic calming (see Figure 3.4) Many strong performing European countries have increasingly introduced lower rural road speed limits, such as the major life saving changes in France from 90 km/h to 80 km/h (McCulloch 2020); whereas in Australia and New Zealand, similar roads commonly have 100 km/h limits.

**Figure 3.4: 20 km/h limit in a residential street in Spain**


*Source: Soames Job.*

### 3.7.5 The problem is bad drivers, not high speed

A small proportion of drivers regularly take risks, but humans inevitably make mistakes, and thus many serious crashes are caused by drivers who are not doing anything deliberately wrong at the time – not speeding, not impaired, not distracted. Higher speeds greatly increase both crash risk and crash severity as shown in many places in this Guide.

### 3.7.6 Higher speeds are better for the economy

As shown in Section 3.6, this is false – in general lower speeds improve overall economies.

### 3.7.7 Higher speeds are a solution to congestion

Higher speed limits generally not only fail to improve congestion, but make it worse. This is because, in most speed ranges, as speeds increase less vehicles can go through a given location on the road (for direct evidence for speeds above 50 km/h, see Job and Mbugua 2020). The reason for this is apparent by considering the number of vehicles that can pass a given location, such as an intersection, per minute. As speeds increase, drivers should, and generally do, leave longer time gaps between themselves and the vehicle in front. Thus, at high speed, vehicles are travelling at larger time gaps apart, and less vehicles will pass a given point each minute. Evidence directly supports this, by showing that 'lane occupancy' increasing with lower speed limits (Soriguera et al. 2017).

# 4. Management and Leadership on Speed

## 4.1 Aligning structures and process in the management of speed

The processes, staff, and structures for managing speed may be developed effectively along the lines of the key road safety pillars – particularly the Safe Speed, Safe People, Safe Roads, and Safe Vehicles pillars – as outlined in parts of Austroads *Guide to Road Safety*. Structuring teams based on these pillars allows the development and concentration of relevant expertise, building a critical mass that supports effective road safety action. However, even in management structures that are based on these pillars, *Speed* is often omitted as a distinct team.

Powerful opportunities for speed management exist across all the key road safety pillars (as referenced in many places in this Guide), and yet their roles in speed management can be suboptimal without a dedicated *Speed Management Pillar* and section to manage policy and implementation. This association arises from the not uncommon approach of basing the road safety management structure on the strategy or plan. Two common approaches to road safety strategy and management present road safety without a *Speed Management Pillar*. These are described below, with brief description of the weaknesses of these approaches.

**Problematic approach 1:** Leave speed management entirely (or largely) as a matter for the *Safe People* or *Safe Road User Pillar* – as did the first Global Plan for Road Safety, which does not mention speed management in relation to vehicles (WHO 2011). The primary problems for speed management with this approach arise from the perception that speed management is handled through road user-related interventions. This leads to a failure to maximise the use of road infrastructure or vehicle technology opportunities for speed management, and failure to compare opportunities across the pillars to find the most suitable solutions. In addition, strategies, targets, actions and even measurement opportunities developed to monitor and manage speed do not sufficiently involve relevant staff and opportunities. Finally, highly relevant non-government stakeholders – such as private enterprise related to vehicle technology or fleet driver management – may not be identified as relevant to speed management.

**Problematic approach 2:** Rely on each pillar to consider speed management in their development of road safety interventions – as did the second Global Plan for Road Safety 2021-2030 (WHO and United Nations Regional Commissions 2021). The approach has the advantage over ‘problematic approach 1’ of including all relevant pillars. However, it fails to deliver management processes which facilitate combinations of, comparison of, opportunities across pillars for the selection of most effective interventions for specific challenges, regardless of the pillar from which they come. Further, it does not allow for structures and staff with responsibility for setting strategic targets and broad monitoring of speed. Instead, it leaves staff in each pillar to do this in isolation, noting that these other pillars ahev priorties of their own.

Management structures that bring these elements together are needed for *Speed*, to avoid the pillars each working in isolation. This will allow for better selection of solutions across the pillars for particular circumstances and challenges, improved monitoring and evaluation on speed management, reduced duplication of solutions, better integrated policy and communications with the community and decision makers.

### 4.1.1 Speed information management

Extensive guidance on speed information management is provided in a comprehensive Austroads report: *Best Practice Speed Information Management* (Austroads, 2022). This report is focused on the management and recording of implementation, vital components of effective management. In addition, for strong speed information management, data on actual speeds and community attitudes to speeding are also essential to guiding management and policy. Collecting travel speed data should take place at locations that are distinct from speed enforcement locations, to avoid the well-established local effect of speed cameras (especially fixed ones). Community attitude surveys on speed and speeding are common best practice in most jurisdictions in Australia and New Zealand.

# 5. Speed Behaviour on Roads

When considering the safety and mobility implications of speed it is important to recognise that a posted speed limit does not mean that all road users will be travelling at that speed. Multiple factors will influence travel speeds besides the speed limit, including road and traffic conditions, environmental conditions (such as weather and landscape) and driver perceptions and behaviours.

## 5.1 Range of speeds on the road network

In most situations vehicle speeds on the road network tend to follow a normal distribution with the bulk of vehicles slightly above or slightly below the speed limit . It is usual that mean speeds are several kilometres per hour below the posted speed limit and there is a tail of a few vehicles travelling at high speeds and vehicles at low speeds. It therefore follows that the same situation will exist on the approaches to intersections or on mid-block sections of road. Although the planning, design and management of the road network is based on certain operating speeds, historically less was done from the engineering side to guarantee that speeds of interaction were actually safe.

In this context, road users are expected to make critical decisions at intersections or when overtaking, and perceive and compensate for the range of speeds usually encountered on the network. Some of the best speed management treatments provide very clear guidance on the appropriate speed, guarantee safe speeds of interaction and also narrow the range in speeds encountered.

## 5.2 Complications in perceiving speed risk

Speed limits were initially adopted with little understanding of safety in relation to crash incidence, vehicle occupant protection and vulnerable road users. A range of limits were historically fixed according to an adopted hierarchy and roads were generally designed to maintain these operating speeds with less consideration given to the benefits of adopting lower speed limits as a means of achieving lower operating speeds on the basis of safety or infrastructure cost. These practices have resulted in a legacy that is taking considerable effort to change, mainly because the population has been living with ‘high’ speed limits not aligned with injury reduction for many decades. Given that many in the population have personal experience travelling at a high speed, it has been difficult to communicate in a credible manner the scientific evidence that population risk can be lowered through speed management.

One of the reasons why the communication on speed limits may appear contradictory is shown in FigureFigure 5.1: Six different road environments in Australia and New Zealand, all with a 100 km/h speed limit. Portrayed are 6 different road environments, each with different traffic conditions and safety features. It is evident to road users that risk on the road is not managed in a consistent manner across the network as each of the 6 road environments has a 100 km/h speed limit. In fact, on this basis a counter argument could be made that because the speed limit is the same in each environment, speed is actually not regarded as a critical variable. Alternatively, the response may be that if 100 km/h is safe on unsealed roads then it’s safe to drive at higher speeds on sealed better alignment roads. Reconsideration of the default 100 km/h limit on the poorer standard roads may be broadly helpful.

Drivers and riders become habituated to risk as they repeatedly perform tasks within the road system with little or no ill-consequence over a lifetime. The fact is there is very little feedback in relation to risk when using the road system. Given that the individual risk of crashing is small, a doubling of this small risk is also likely to go un-noticed. Often people build up a perception over a lifetime of driving or riding that travelling above the speed limit has very little or no negative safety consequence. See Section 5.2.1 for more on risk judgements.

**Figure 5.1: Six different road environments in Australia and New Zealand, all with a 100 km/h speed limit**

By contrast, people are generally aware of the risk associated with heights (i.e. potential energy) as the risk is reinforced over a lifetime of feedback. It is appreciated that trips and falls – even at ground level – can cause severe and sometimes permanent injury. It is therefore unacceptable to rely solely on training and education to prevent people from falling off unprotected balconies. Instead, a forgiving, error-tolerant environment is created, where balconies are lined with barriers that prevent falls – even if people are young, old, distracted, or impaired. Extending this analogy further, there is no specific cost-benefit analysis for individual balconies that consider factors such as height and width of balconies, wind exposure, age and experience of users, or the opinions of people in the neighbourhoodon whether protection is needed. There is an expectation that designers will provide balcony protection regardless of circumstance.

Taking this perspective into account, Figure 5.2 shows how a road network appears in terms of the kinetic energy converted to potential energy. If road users were to perceive the energy in the road transport system as potential energy, it is likely that behaviours would be very different. When considering the driver in the car approaching the bridge with no guardrails, a universal response would be to slow down in the interests of self-preservation to maintain control of the vehicle so it did not fall off the bridge. This provides a stark contrast to the comfort people feel when passing other vehicles only divided by a painted centreline or trees close to the edge of the road.

These factors combined with personal risk mis-judgement (as explained in Section 5.2.1) makes it unlikely that individuals will effectively mitigate their behaviour in relation to speed and crash risk. Despite these challenges, speed management continues to be one of the most effective ways a transition towards a Safe System. In these circumstances, deterrence provides a vital and effective alternative motivation for compliance with speed limits. In addition, although much focus has been placed on better aligning speed limits with injury reduction, there is significant opportunity to further support road users through road design features at locations of elevated risk in the network.

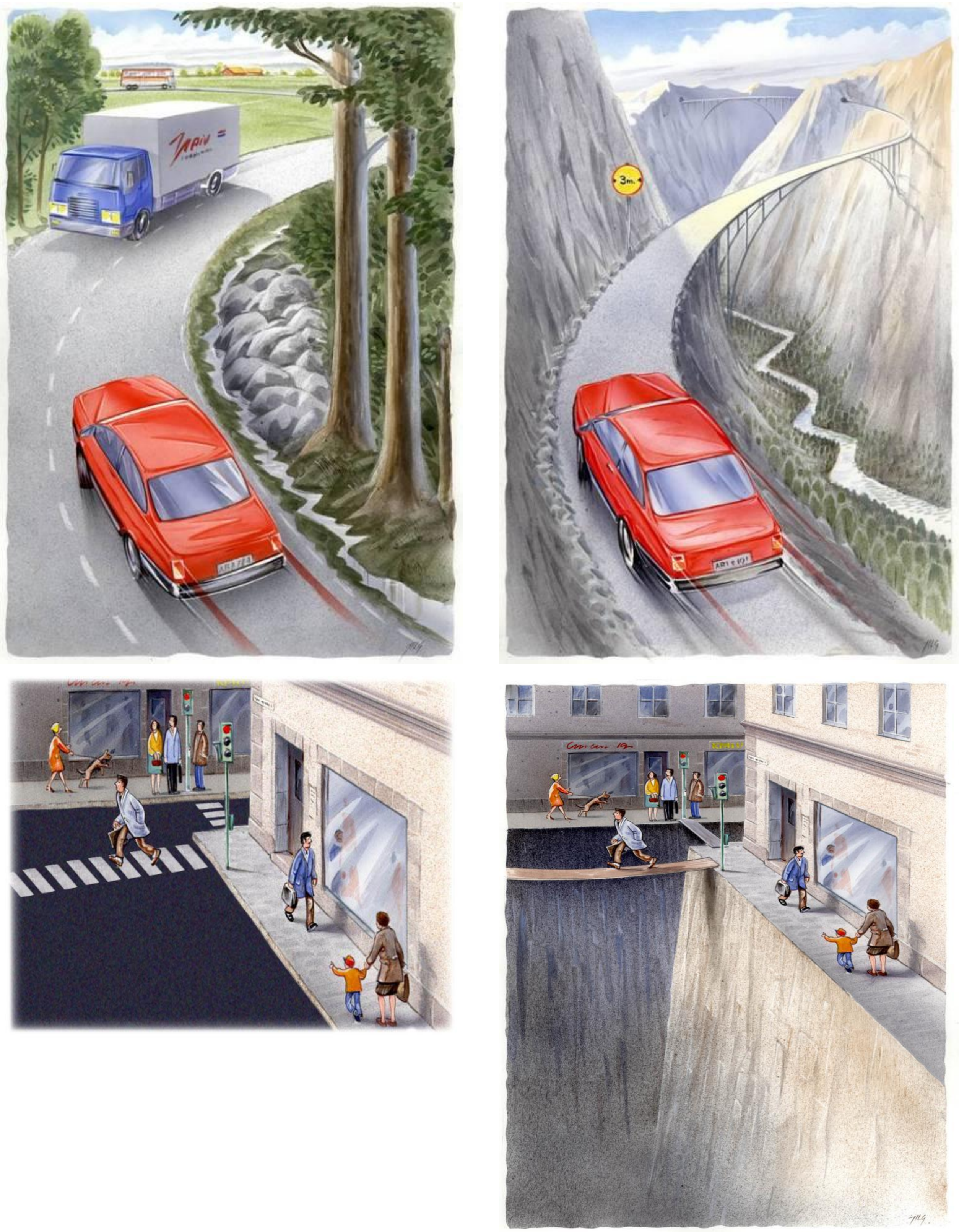
### 5.2.1 The psychology of risk misperception

Humans, in general, are poor at judging risk. This is due to several well-established psychological phenomena common to most people – as described in detail in AGRS Part 4. In brief, risk misperception arises from:

- Optimism bias: A systematic psychological bias where we generally expect to have better lives than our peers – those similar to ourselves. We expect that our futures will contain more positive events (being successful or having a long happy relationship) and less negative events (fired from work, early heart attack, or causing a serious car crash) than the average for our peers. This bias has been found in scientific studies across many countries, including Australia (Chua and Job 1999; Harre and Sibley 2007; McColl et al. 2021).
- Driver over-confidence: This is the related phenomenon where most drivers believe that they are better and safer than average drivers. This has been identified in many studies across multiple countries, including Australia (Jonah 1986; Dalziel and Job 1997).
- Personal experience forms part of the basis of optimism. In the case of driving, the errors of drivers around us are visible and often noted (including the common practice of referring to such drivers as idiots or in similar terms), whereas our own errors are excused or even undetected by ourselves. Thus, we see ourselves as making less errors than others. Our personal experiences also dismiss personal risk, in part because the road system offers few warnings of risk, except a crash itself and thus drivers may drive for many years without any indication of the risk applying to themselves. Humans are poor at probabilities of risk (Job 2000).

The critical relevance of these biases is that they powerfully influence precaution-adoption, and thus greater overconfidence predicts higher crash rates (Mohammadpour and Nassiri 2021).

**Figure 5.2: Perceived and actual risk in terms of energy transfer**



*Source: Claes Tingvall, Swedish Road Administration.*

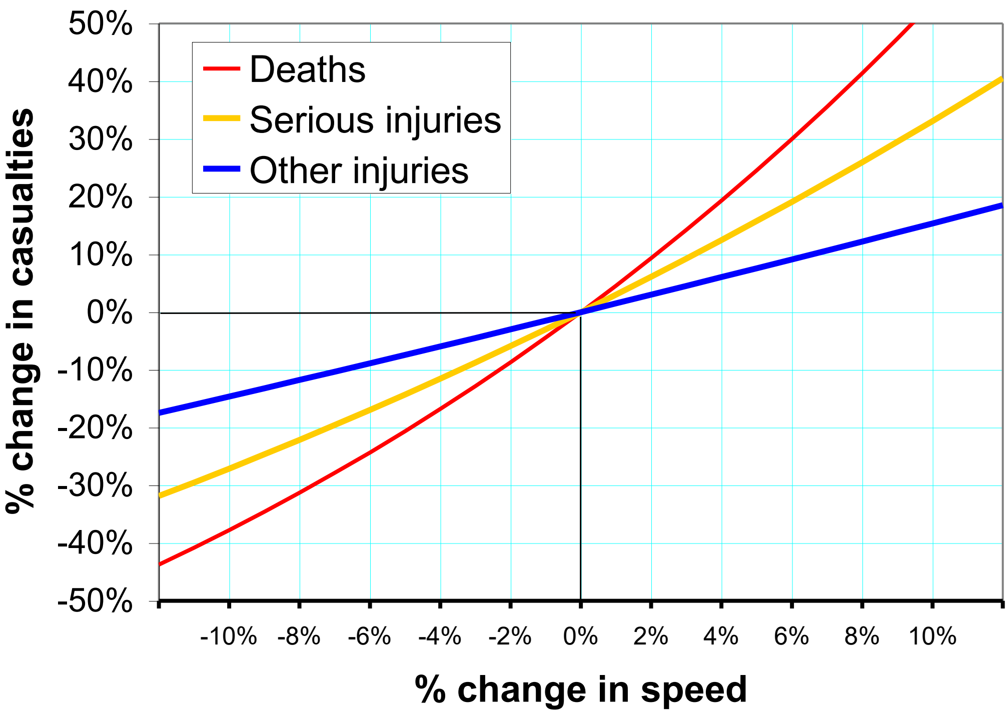
# 6. The Case for Safe Speeds

There exists a large body of evidence associating lower speeds with reductions in injury crashes and injury severity. The following sections outline the most commonly referenced studies and the basis for their established relationships.

## 6.1 Nilsson's power model

A number of studies have modelled the change in crash and casualty numbers with a change in average travel speed. The power models presented by Nilsson (2004) describe the relationships between average speed, the number of injury or fatal crashes and the number of injuries or fatalities. These relationships are shown graphically in Figure 6.1.

**Figure 6.1: Relationship speed changes and changes in casualty rates**




*Source: Elvik et al. (2004).*

These models were validated against a number of speed limit changes in Sweden from 1967 to 1972. The initial speed limits were mainly 90 km/h and included one of 130 km/h. Changes in speed limits were a 20 km/h decrease, no change (control), or a 20 km/h increase in speed limit.

While Nilsson's power models are generally accepted as accurate for speed limit changes on high speed rural roads, their relevance to urban roads and within lower speed environments has been questioned by Cameron and Elvik (2008 2010) and Elvik (2013). In a re-evaluation, Elvik (2013) constructed a model with a crash modification factor that was better at estimating the change in the number of injury crashes but worked less well for estimating the change in the number of fatal crashes. It was concluded that the power model provides a good estimate of the change in serious injuries and fatality numbers associated with traffic speed changes on rural highways. However, it is limited in its applicability to urban roads, where it overestimates the change in crashes for a particular change in traffic speed (Cameron and Elvik 2010), though speed remains a key risk factor.

Elvik et al. (2004) conducted a meta-analysis of research on the relationship between travel speeds and casualty rates. The analysis included 98 separate studies which provided a total of 460 estimates of the relationship between changes in the mean speed of traffic on a road and changes in the casualty rate. Data from 20 countries were included. Studies conducted between 1966 and 2004 were included; about half the estimates came from studies conducted after 1990. The estimates were based on both rural and urban roads, and covered a speed range from about 25 km/h to about 120 km/h.

This meta-analysis provided strong support for the 'power model' originally proposed by Nilsson (1981, 2004). The model parameters estimated by Elvik et al. (2004) differ slightly from those in the original power model, but they are close, and show a similar pattern: a small percentage change in travel speeds typically results in a similar percentage change in property damage crashes, but a larger percentage change in casualties – particularly severe casualties. For small speed changes, the percentage change in deaths is typically about four times the percentage change in speed.

Table 6.1 and Figure 6.1 summarise these results. The power model exponents estimated from the meta-analysis were: fatalities: 4.5, fatal crashes: 3.6, people seriously injured: 3.0, serious injury crashes 2.4, people with minor injuries 1.5, other injury crashes 1.2, property damage crashes 1.0 and total people injured (severity unspecified) 2.7.

**Table 6.1: Relationship speed changes and changes in casualty rates**

| Change in: | Change in mean speed | | | | | |
|---|---|---|---|---|---|---|
| | Speed reduction | | | Speed increase | | |
| | -10% | -5% | -1% | +1% | +5% | +10% |
| Deaths | -38% | -21% | -4% | +5% | +25% | +54% |
| Serious injuries | -27% | -14% | -3% | +3% | +16% | +33% |
| Other injuries | -15% | -7% | -1% | +2% | +8% | +15% |
| Property damage crashes | -10% | -5% | -1% | +1% | +5% | +10% |

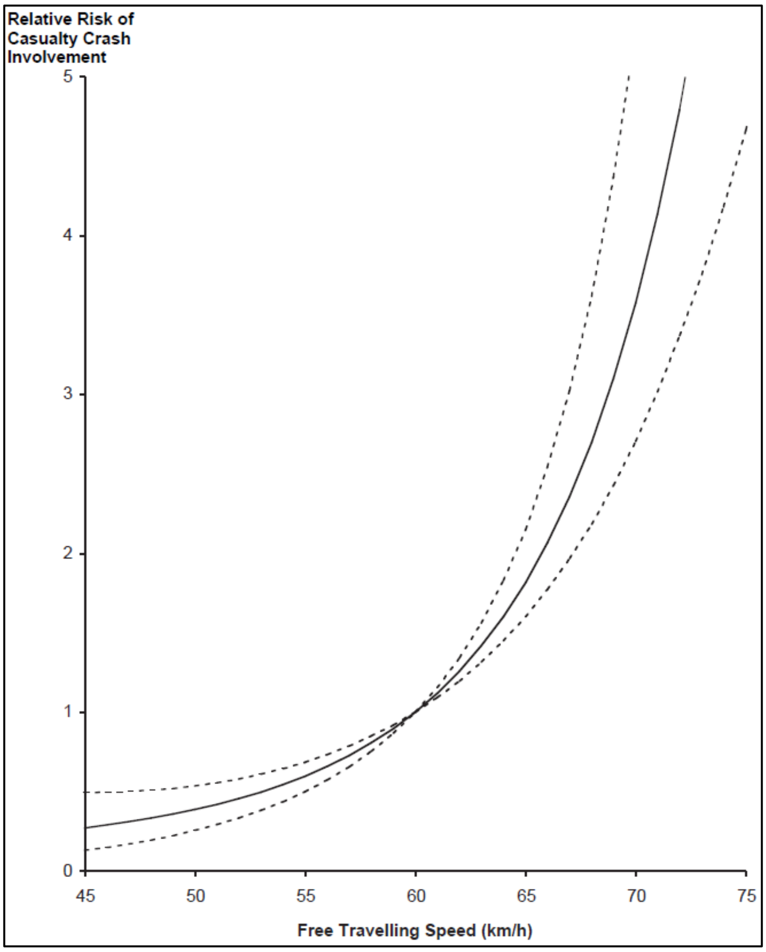
*Note: Severity categories are mutually exclusive (for example, serious injuries exclude deaths).*

*Source: Elvik et al. (2004).*

## 6.2 Curves from in-depth crash investigations of speed

Kloeden et al. (2002) used in-depth crash investigations as part of a case control study in Adelaide to describe the relationship between a change in travel speed and the relative risk of being involved in a casualty crash. The first of their results relates the risk of being involved in a casualty crash relative to travelling at 60 km/h in a 60 km/h speed limit zone in urban areas (Figure 6.2). Confidence intervals are shown as dashed lines on the graph.

**Figure 6.2: Risk of being involved in a casualty crash relative to travelling at 60 km/h in a 60 km/h speed limit zone**




*Source: Kloeden et al. (2002).*

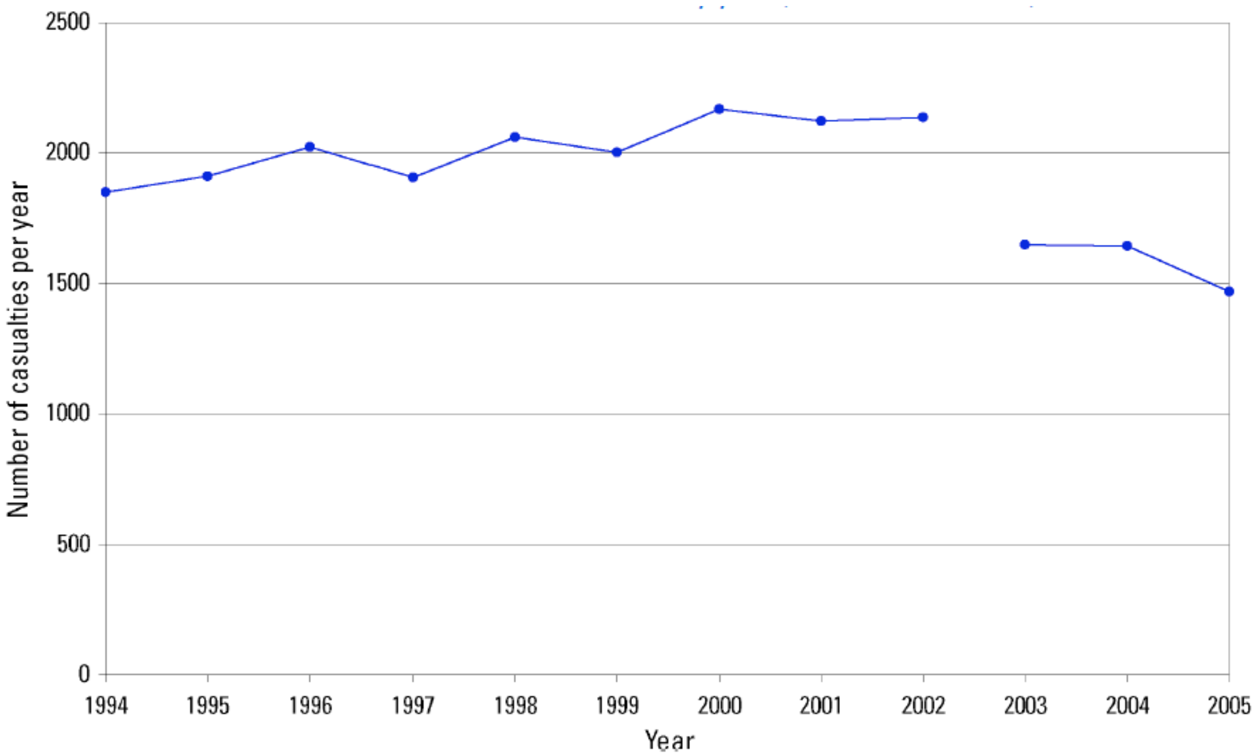
A second study derived a relationship for rural roads in South Australia. This was considered in terms of average speed because the roads studied had varying speed limits ranging from 80 km/h to 110 km/h, finding a similarly shaped curve.

The work of Kloeden et al. (2002) has led to an understanding that for every 5 km/h increase in travelling speed, the risk of being involved in a casualty crash doubles.

## 6.3 Evidence from Speed Limit Reductions

Studies by Kloeden et al. (2006, 2007) reported on the effect of a change in the South Australian default urban speed limit from 60 km/h to 50 km/h in March 2003. The results of this study suggested a statistically significant reduction in the number of injuries, injury crashes and fatal crashes associated with the reduction in speed limit. The overall reduction in the number of casualty crashes was found to be 23.4% with an overall reduction in the number of casualties of 25.9%. While crashes along control roads (i.e. those where the speed limit did not change) also reduced after the speed limit reduction came into effect, a substantial step-change in the number of crashes on those roads affected by the change in speed limit could be seen (Figure 6.3. The actual reductions in mean free travel speed associated with the speed limit change were found to be 2.19 km/h (from 51.76 km/h to 49.58 km/h) one year after the change in speed limit, and 3.62 km/h (51.76 km/h to 48.14 km/h) 3 years after the change in speed limit. These findings not only show a reduction in casualty crashes, they suggest that the number of people being injured in each casualty crash also reduced as there was a greater reduction of casualties compared to casualty crashes.

**Figure 6.3: Casualties per year on affected roads before and after the introduction of a 50 km/h urban speed limit (formerly 60 km/h) in South Australia**




*Source: Kloeden et al. (2006, 2007).*

Another study (Mackenzie et al. 2015) reported on the effect of a change in speed limit of 110 km/h to 100 km/h along 1,100 km of rural roads in South Australia which occurred in July 2003. The results of this study suggested statistically significant reductions in the numbers of casualties and casualty crashes of 25.56% and 27.40%, respectively. These figures represented reductions beyond those found for the control roads (rural roads where the speed limit of 110 km/h did not change), suggesting that the change in speed limit alone had a real and substantial effect of reducing the number of casualties and casualty crashes. An initial reduction in mean travel speed of 1.9 km/h was found (Long et al. 2006), with continuing reductions in mean and 85th percentile speeds in the preceding 10 years after the change in speed limit (Mackenzie et al. 2015).

The examples presented here are replicated in multiple jurisdictions all over the world as shown in Table 6.2 and Table 6.2. The association between speed and crashes is arguably one of the most robust relationships established in road safety. The encouraging fact is that even small reductions can result in considerable safety benefits and such benefits continue to accrue over time.

**Table 6.2: Synthesis of trauma reductions from speed limit changes (international literature)**

| Jurisdiction | Extent | Observations | Reference |
|---|---|---|---|
| United States | 55 mph (89 km/h) national speed limit on interstate and primary and secondary state controlled highways (latterly 65–75 mph (105–121 km/h) introduced in 1974 and repealed in full in 1995 | • 18% reduction in fatalities<br>• 5–9% reduction in injuries<br>• No reduction in non-casualty crashes (after introduction)<br>• 17% increase in fatalities on interstate highways (after repeal) | Kamerud (1983)<br>Farmer et al. (1999) |
| Israel | 100 km/h speed limit on 115 km of interurban highways (formerly 90 km/h) introduced in 1993 | • 2.5 additional fatalities per month | Friedman et al. (2007) |
| Belgium | 70 km/h speed limit along 116 km of Flemish roads (formerly 90 km/h) introduced in 2001 | • 33% reduction in severe (fatal and serious injury) crashes | De Pauw et al. (2014) |
| Iowa, United States | 70 mph (113 km/h) speed limit along interstate highways (formerly 65 mph, or 105 km/h) introduced in 2005 | • 25% increase in all casualty and non-casualty crashes<br>• 52% reduction in night-time fatal crashes | Souleyrette and Cook (2010) |

**Table 6.3: Synthesis of trauma reductions from speed limit changes (Australian literature)**

| Jurisdiction | Extent | Observations | Reference |
|---|---|---|---|
| Victoria | 50 km/h default speed limit in built-up areas (formerly 60 km/h), introduced 22 January 2001 | • 21% reduction in fatal crashes<br>• 3% reduction in serious injury crashes<br>• 12% reduction in all casualty crashes<br>• 41% reduction in fatal and serious injury crashes involving pedestrians | Hoareau et al. (2006) |
| South-east Queensland | 50 km/h default speed limit in built-up areas (formerly 60 km/h), introduced March 1999 | • 88% reduction in fatal crashes<br>• 20% reduction in serious injury crashes<br>• 23% reduction in all casualty crashes<br>• 2.2 km/h reduction in mean speed | Hoareau et al. (2002) |
| Western Australia (metropolitan Perth area) | 50 km/h default speed limit in built-up areas (formerly 60 km/h), introduced December 2001 | • 25% reduction in fatal crashes<br>• 4% reduction in serious injury crashes<br>• 21% reduction in all casualty crashes<br>• 51% reduction in all crashes involving pedestrians | Hoareau and Newstead (2004) |
| Victoria | 110 km/h speed limit on rural and outer Melbourne freeways (formerly 100 km/h), introduced June 1987, with 100 km/h speed limit reintroduced September 1989 | • 21% increase in fatal and serious injury crashes (100 to 110 km/h)<br>• 25% increase in all casualty crashes (100 to 110 km/h)<br>• 18% reduction in fatal and serious injury crashes (110 to 100 km/h)<br>• 19% reduction in all casualty crashes (110 to 100 km/h) | Sliogeris (1992) |

| Jurisdiction | Extent | Observations | Reference |
|---|---|---|---|
| South Australia | 100 km/h speed limit along 1,100 km of rural roads (formerly 110 km/h), introduced July 2003 | • 29% reduction in fatal crashes<br>• 28% reduction in admitted to hospital severity crashes<br>• 27% reduction in all casualty crashes | Mackenzie et al. (2015) |
| South Australia | 50 km/h default speed limit in urban areas (formerly 60 km/h), introduced 1 March 2003 | • 37% reduction in fatal crashes<br>• 20% reduction in admitted to hospital severity crashes<br>• 23% reduction in all casualty crashes<br>• 3.7 km/h reduction in mean speed | Kloeden et al. (2006) |

## 6.4 The case for addressing low level speeding

The previous studies point to a common conclusion: increasing speed increases the relative risk of being involved in a casualty crash. A positive relationship between increased speeds and increased crash severity has also been shown (Kloeden et al. 2002; Elvik 2013). The studies suggest reducing any level of speeding will decrease casualty crashes. Due to the non-linear relationship between speed and relative risk, reducing a driver's speed from 75 to 74 km/h has a greater effect on personal risk (i.e. the effect on that individual) than reducing his or her speed from 65 to 64 km/h. However, the substantially larger population of low level speeders (such as those travelling at 65 km/h in a 60 km/h speed limit zone) means that reducing their speed will have a greater collective effect (i.e. an effect over the entire population) than reducing the speeds of the smaller number of drivers involved in higher level speeding (such as those travelling at 75 km/h in the same speed limit zone). Studies in NSW, South Australia, and Victoria (Doecke et al. 2011; Gavin et al. 2010) confirm this claim: For example, in NSW, low level speeding (1 to 10 km/h over the limit) contribute 43–67% of speeding deaths; whereas extreme speeders (46+ km/h above the limit) are rare and contribute 1–2% of speeding deaths (Gavin et al. 2010).

Low level speeding (e.g. even up to 10 km/h above the speed limit) is often perceived by the wider community as being inconsequential. The reality of low level speeding is very different, as the evidence above demonstrates.

# 7. Ways to Manage Speed

There are different ways to manage speeds on roads and they are usually inter-related and apply concurrently. Once a road is built and in use, drivers and riders will adopt a travel speed that is managed by a road authority either actively through interventions (such as speed enforcement) or passively by allowing users to make their own choice of travel speed (for example, based on the type of road environment). Therefore, in practice, a road authority will always, to some degree, influence travel speeds whether they do so actively or passively. Methods to manage speed include:

- roads and roadside infrastructure – such as speed calming treatments
- speed limits and speed enforcement
- people – such as influencing people's attitudes and behaviours regarding risk and safety
- vehicles – such as speed limiter devices, adaptive cruise control.

## 7.1 Roads and roadside infrastructure

The link between the road and roadside environment and travel speed is well known. In recent years, this concept has been clarified and expanded in the concept of a 'self-explaining' road (e.g. Schermers 1999; Theeuwes and Godthelp 1995; Wegman et al. 2006). Application of the concept of self-explaining roads seeks to provide road features and characteristics that encourage speed choices consistent with the safe speed for the function and design of a road. The ultimate self-explaining road is one for which the road elements inform motorists as to the required safe speed. In order to recognise the current road function and to predict road elements, the following features are required (World Bank 2005):

- clear design, marking and signing
- recognisable road categories
- design elements for each road category that are uniform.

However, it is vital for improved speed management that the concept of credible speed limits is not adopted in a way that restricts speed limit changes to those which are seen as credible. Rather speed limit changes must be based on safety risks, noting that adapting relevant roads to encourage compliance with revised limits is an important additional step. Many of the features (or alterations) to the road and roadside environment that can influence travel speed are discussed in depth in the *Guide to Road Safety Part 2: Safe Roads* (Austroads 2024a).

In addition to facilitating compliance through many features (signage, gateway treatments), travel speeds can be directly and more forcefully influenced though effective traffic calming measures. The following examples are shown to have sound speed reduction and crash modification outcomes. These are presented in relation to specific locations for use (from the Urban Arterial Roads Compendium Report: Austroads, 2016):

*For Intersections*: Vehicle activated signs, ro variable speed limits, roundabouts, raised intersections, horizontal deflection on approaches, perceptual countermeasures, transverse rumble strips, reduce excessive sight distance, lower speed limits, lane narrowing, green wave signals, and dwell on red signals.

*For Midblocks*: Humps/platforms, vehicle activated signs, raised pedestrian crossings/wombat crossings, road diets, pedestrian refuge, medians, gateway treatments, transverse rumble strips, shared spaces/naked roads, lower speed limits, variable speed limits, and variable message signs, repeater signs.

*For Roadworks*: Vehicle activated signs, variable message signs, variable speed limit signs, speed limit signs, lane narrowing, portable rumble strips, vehicle activated signs, variable message signs, variable speed limit signs, speed limit sign, lane narrowing, and portable rumble strips.

*For School Zones:* Flashing lights, static speed limit signs, variable speed limit signs, vehicle activated signs, wombat crossing, and advance warning signs.

## 7.2 Vehicles

Vehicle technology offers key opportunities for speed management. Several Austroads reports (2016, 2024b) identify and recommend the following,

- Intelligent Speed Adaptation (ISA) in various forms, but at its greatest strength when it is not possible for users to disable it, and when it directly influences the speed of the vehicle rather than only warning the driver. The adoption of the this as a requirement in the EU generates interesting opportunities for Australia and New Zealand, despite our small market share.
- Speed governing (already in use in heavy vehicles in Australia, with significant enforcement experience available in Australia and New Zealand).
- Better speedometer displays.
- Automated Emergency Braking (AEB).

## 7.3 Speed limits and speed enforcement

There is potential for obtaining community support for road function and consequently infrastructure that manages safe speeds in the context of “movement and place.” When speed limits are supported in this context, there is a potential for greater compliance, safety improvement and community acceptance.

In many communities there is also growing acceptance for lower speed limits, particularly at locations where there is higher risk. This started at schools, has migrated to shopping strips and pedestrian areas, and now is gaining acceptance for lower quality rural roads. Such support has been demonstrated, for example, with the adoption of 80 km/h on rural roads in the Mornington Peninsula in Victoria (Pyta et al. 2014) and the adoption of 20 mph zones amongst local authorities in the United Kingdom, and the use of 20 km/h in residential areas in Spain.

Travelling speed reductions and consequent reductions in road trauma can be achieved virtually instantaneously when a speed limit is changed. This contrasts with a reliance on safe infrastructure treatments that can take considerable time to plan, design and implement. Similarly, vehicle technology to improve speed compliance may take many years to infiltrate the majority of the vehicle fleet. This relationship between speed and road trauma is being increasingly considered by road authorities; Austroads (2010) provides advice on speed limit setting based around the Safe System principles of harm minimisation and with consideration of road function, road infrastructure and driver selection of speeds. Austroads ongoing Path to Zero project consider speed as key, as do studies of residual deaths and serious injuries as jurisdictions move closer to safe system (Truong et al. 2022).

Speed limit reductions remain one of the single most cost-effective countermeasures available to practitioners for reducing death and serious injury on the road system compared with infrastructure costs (Doecke et al. 2011). As can be seen in Table 7.1, multiple millions and sometimes billions of dollars of infrastructure expenditure would be necessary to achieve the equivalent reductions that a speed limit change could achieve. Many existing infrastructure treatments are unable to deliver the equivalent 20% reduction expected with a 10 km/h reduction in speed limit on 100 km/h roads. For those treatments that can match the 20% reduction, approximately eight billion dollars in expenditure would be required on the 110 km/h state road network. This compares with an assumed cost of less than a million dollars to lower the speed limit and change signage accordingly on the state’s road network.

**Table 7.1: Cost of obtaining reductions on state controlled roads in South Australia with infrastructure changes or speed limits**

| Speed limit | Treatment option | Serious casualty crash reduction | Cost of treatment ($M) | Cost of 20% serious casualty crash reduction ($M) |
|---|---|---|---|---|
| 100 km/h | 10 km/h speed limit reduction | 20% | < 1 | < 1 |
| | Shoulder sealing | 14% | 104 | NA |
| | Roadside barriers | 18% | 526 | NA |
| | Median barriers | 14% | 2,142 | NA |
| | Clear zones | 9% | 545 | NA |
| 110 km/h | 10 km/h speed limit reduction | 20% | < 1 | < 1 |
| | Shoulder sealing | 25% | 427 | 338 |
| | Roadside barriers | 35% | 2,404 | 1,367 |
| | Median barriers | 26% | 9,540 | 7,235 |
| | Clear zones | 18% | 2,428 | NA |

*Source: Doecke et al. (2011).*

These results challenge the notion that road authorities can continue to build and retrofit high quality roads to safely maintain high speed limits. Appropriate speed management is essential in any transition towards Safe System performance. It is also important to note that unless speeds are reduced to survivable levels in the event of a crash, (most effective with the support of engineering treatments), a speed limit reduction can only be considered a supporting treatment and not a primary Safe System solution in its own right.

The following guidance in Table 7.2 briefly summarises design philosophies towards specific road user types and situations in the context of the South Australian 'Link and Place' approach (Government of South Australia 2012).

**Table 7.2: Design philosophies aimed towards specific road user and road user interaction types**

| Road user/ interaction type | Design philosophy |
|---|---|
| Cars | • Establish appropriate speed environment, in accordance with street's strategic role.<br>• Good connections from 'slow' local networks of 30 km/h and below to faster arterial networks.<br>• Preference for passive speed control measures.<br>• Use urban design techniques for speed control: minimising carriageway width, limiting visual length of street sections, varying surface materials at intersections and crossings, etc. |
| Cycling | • Cyclists considered and incorporated into all streets, as priority street users.<br>• Preference for sharing street space in low speed environments.<br>• On busier streets: segregated continuous lanes and safe crossing points.<br>• Cycle paths should be direct, continuous, smooth and barrier-free.<br>• Good connections to important destinations and end-of-trip facilities.<br>• The optimum position for locating a cycle lane is between the pedestrian footway and any car parking spaces. |

| Road user/ interaction type | Design philosophy |
|---|---|
| Walking | • Pedestrians should be prioritised in most street environments, with facilities such as footways of 1.5 m and wider, crossing facilities at appropriate locations and waiting times at signals not exceeding much beyond 60 seconds, climate protection, seating at frequent intervals, good levels of lighting, etc.<br>• Pedestrian needs should be considered for all street types.<br>• Streets should be designed on a 'human/pedestrian scale', responding to the needs of pedestrians.<br>• Streets should offer good connections of small grain.<br>• Streets should encourage staying activities and interaction for a diverse range of users.<br>• Street environments should be adaptable and flexible. |
| Shared Streets | • An alternative approach to street design suitable for streets with 'design' speeds below 25 km/h.<br>• 'Shared streets' integrate street functions by removing barriers separating users.<br>• It calls for a different design approach, avoiding conventional signage, traffic islands and markings, etc.<br>• Local expression within the street space should be enhanced and encouraged. |

Sections 6, 7 and 8 of this Guide expand on speed limits and their application.

The Austroads research report on Driver Attitude to Speed Enforcement (Austroads 2013) found that safety concerns influence drivers' choice of speed, but those concerns are primarily considered in a narrow range of circumstances. In discussion groups, drivers indicated that the fear of being caught was usually the most salient negative consequence of speeding, and was therefore the most prominent consideration in choosing driving speed. Although 92% of survey respondents agreed with the statement 'if I regularly speed, there's a good chance I'll be caught sooner or later', 24% agreed with the statement 'I drive faster than the speed limit when I know it's unlikely I'll get caught'. Similarly, Ipsos Social Research Institute (2009) found in NSW that 29% of participants agreed that they tended to drive faster than the speed limit when they believed it was unlikely they would be caught.The influence of enforcement on travel speed is discussed in more depth in the *Guide to Road Safety Part 4: Safe People* (Austroads 2024c).

### 7.3.1 The roles of local government

Local government has many roles and opportunities to improve speed management (through policies for the vehicle fleets they control, road engineering opportunities on local roads, and in some cases lowering speed limits. In support of these activities, national and state governments should provide support for local government to undertake more effective speed management (Austroads 2019).

The roles of local government in determining speed limits vary across jurisdictions. For example, in New Zealand to date (with changes mooted by the Government in 2024) local councils are able to lower speed limits on their roads, which has been done extensively including with great safety success in Auckland. Overall, advances in reducing speed limits to Safe System levels have been most pronounced in local settings, including noteworthy examples in Mornington Peninsula, Victoria, Manly, NSW with significant areas of 30mk/h limits, and Auckland where lower limits resulted in a 67% reduction in fatalities and a 20% reduction in all injury crashes (Auckland Transport, 2021). These experiences indicate that provision of greater powers to local councils to reduce speed limits can lead to significant safe gains through limits closer to Safe System speeds.

## 7.4 People

Ultimately, the success of any speed management measure (be it in the road environment, the vehicle or through legislation) is with the impact on travel speed within the driving or riding task. In most cases this is dictated by the human's choice of travel speed, though opportunities to exercise more system control over speeds are increasing (through vehicle technology and traffic calming) and warrant more development in the Safe System context.

There are a variety of factors that influence a driver's choice of travel speed in relation to the posted speed limit.

### 7.4.1 Personal factors

The key personal factors that have been found to be associated with speeding behaviour include age and gender, with speeding more prevalent among males and younger drivers (Harrison et al. 1998; Williams et al. 2006). In addition, speeding has been reported as being more prevalent among individuals with crash and infringement histories (Watson et al. 2015), a greater propensity for sensation-seeking and risk taking behaviours (Stradling et al. 2003) and more positive attitudes toward speeding behaviour (De Pelsmacker and Janssens 2007; Austroads 2013). Of relevance is the consideration that young males also tend to score higher on these latter measures. Since this demographic group also represents a high risk road user group, they should be a particular target group for future interventions.

### 7.4.2 Legal factors

The key legal factors that have been found to influence driving speeds are related to concepts from deterrence theory and include perceptions of risk of detection and punishment, as well as the perceived certainty, swiftness and severity of punishment, and the perceived ability to avoid punishment (Cedersund and Forward 2007; Stafford and Warr 1993). Specifically, it is argued that speeding behaviour is more likely when individuals perceive the risk of detection and punishment to be low and that experiences of punishment avoidance (i.e. speeding and not getting detected or penalised) are a strong reinforcing factor which leads to continued speeding behaviour (Fleiter et al. 2013).

### 7.4.3 Situational factors

Key situational factors associated with a greater propensity to speed include time pressures (Stradling et al. 2003), perceptions that posted speed limits are too low (Austroads 2005), opportunities to speed (Richard et al. 2012), when driving for work-related purposes (Glendon 2007), and when the perceived risk of detection is low (Austroads 2013).

### 7.4.4 Social factors

Finally, key social factors found to be associated with increased speeding behaviour include having a greater number of significant others (e.g. family, peers) who hold favourable attitudes toward speeding or engage in the behaviour more frequently (Fleiter et al. 2006) as well as the influence of passengers in a vehicle. The evidence regarding the role of passengers is somewhat mixed with family members and siblings likely to serve a protective function for some drivers (Walker et al. 2009), whereas same age peers may increase risk. Importantly, the potential for other people to model un/safe driving behaviours, including speeding, is an area worthy of consideration when attempting to change community attitudes, particularly in light of the extensive input parents have in providing instruction and supervision to learner drivers via graduated driver licensing programs in Australia and New Zealand (Bates et al. 2009; Beck et al. 2003; Begg and Stephenson 2003).

### 7.4.5 Implementation intentions and pledges to counter speeding

Implementation intentions represent a way to assist people to change their behaviour based on the concept of predetermining a plan to implement when a particular situation arises in order to attain a certain goal (goal intention). In relation to speeding, an example of a goal intention may be 'I intend to comply with all posted speed limits'. Beyond this goal, it is argued that a volitional phase is also needed in order for people to be able to translate this goal into action. This is where implementation intentions are used.

Pledges have also been used in a speeding context. Delhomme, Kreel and Ragot (2008b) recruited 624 driving offenders to examine the effectiveness that a public commitment had on speeding behaviour. Participants were assigned to one of three groups: the experimental group involved making a public commitment to comply with the speed limit each time that they drove a vehicle over the next six months, the comparison group, and the control group. Of the 271 participants allocated to the experimental group, 53% committed to comply with the speed limit for each driving trip over the following six months. Findings revealed that the committed group were more likely to comply with the speed limit (49%) 5.5 months after marking the pledge compared to the control group (20%), comparison group (29%), and non-committed group (9%). In a follow-up study, Delhomme, Grenier and Kreel (2008a) reported that the use of an action sheet where drivers had to report the actions that they had planned to implement to keep their safe driving commitments were more likely to comply with the speed limit at the 5.5 month follow-up (53%), compared to those drivers who undertook the pledge but did not complete an action sheet (41%). The above positive results for those who pledged are confounded by self-selection bias (with almost half those offered the pledge condition not pledging). More rigorous evaluations of pledges are needed before these are interpreted as useful.

### 7.4.6 People's attitudes towards speeding

When analysing people's attitudes to speed and speeding, a noteworthy paradoxical phenomenon that is apparent from examining community reactions to speed management initiatives is the concept of agreeing with the use of speed control initiatives where one lives, and/or where one's children go to school (i.e. 'in my community to protect me and those important to me'), but at the same time, disagreeing with speed control in other areas (e.g. reduced speed limits on roads used for commuting, even if these roads are where other people's children attend school or where other people live). This phenomenon has been described in a range of ways, including as an example of 'the JIMBY effect - Just In My Back Yard' (Tapp 2015), and as 'YIMBY – Yes In My Back Yard' (Fleiter 2013), where agreement with speed management measures are viewed as acceptable within one's own community, but generally not supported elsewhere. These phrases are variations of the more well-known phrase, 'NIMBY – Not In My Back Yard', and are of relevance to the current project in that they represent contradictory beliefs about where speed management measures, and therefore, speeding, may be deemed appropriate by the community.

Garnering support and compliance from the community for speed limits can be achieved by:

- Awareness – making people aware of the specific speed limit on the sections of road that they use, and of the broad principles of speed zoning.
- Understanding – why speed limits apply and the relationship to risk and safety.
- Support – building support (or at least acceptance) for speed limit setting principles and the Safe System approach.
- Communicating and engaging – with people on a policy and project level, via campaigns, education and training (e.g. GLS).

### 7.4.7 What does the community think about speed risks and speed management?

Community attitude surveys show growing public understanding of speed risks, and majority support for strict approaches to speed management.

For example, the ATSB's national survey of community attitudes to road safety (Pennay 2006) shows that:

- Agreement with the statement 'If you increase your driving speed by 10 km/h you are significantly more likely to be involved in a car accident' has increased from 55% in 1995 to 74% in 2006.
- An overwhelming majority (94%) of people surveyed in 2006 agreed that 'an accident at 70 km/h will be a lot more severe than an accident at 60 km/h'. (Compared to 80% in 1995).
- In 1995, 1 in 4 people (26%) believed motorists should not be booked for driving at 70 km/h in a 60 km/h zone; by 2006, only 1 in 10 (10%) still held this view.
- Half the people surveyed in 2006 (49%) believed that drivers should be booked for travelling at 65 km/h in a 60 km/h zone.
- In 2006, most people believed that the amount of speed enforcement activity should be either maintained (44%) or increased (44%); only 11% favoured a decrease.

For further relevant research on community support for lower speed limits, see Global Road Safety Facility (2023).

# 8. Types of Speed Limit

Under the Australian and New Zealand road rules a driver must not drive at a speed over the speed-limit applying to the length of road where the driver is driving. Speed limits apply when regulatory speed limit signposting is provided. Sign posted speed limits should reflect particular road attributes such as the role and function of the road, type of road users, abutting land and access, road geometry, roadside hazards and crash risk.

Road users understand that there must be a range of speed limits depending on the road and traffic situation. Across Australia and New Zealand a number of common types of speed limits apply as outlined below.

## 8.1 Default speed limits

As a means of implementing speed limits, when there is no speed limit sign, the default legal speed limits apply. There are two general 'default' (unsigned) speed limits in Australia and New Zealand, one that applies within the urban or 'built-up' area, and the other that is applicable within a 'rural' open-road environment. Generally, the default limit in urban areas is 50 km/h and in rural areas 100 km/h[2].

Default limits generate various challenges. First, as an implementation risk, setting these results in resistance to determining non-default limits where they are needed, suggesting the need to emphasise that lower limits are often warranted and acceptable for safety reasons. Second, as a compliance risk, reliance on default limits is less clear than the full provision of speed limit signs because the default limit may not be known to all, especially visiting drivers.

## 8.2 Signed speed limits

Speed limits also apply when regulatory speed limit sign posting is provided. There are a variety of applications of signed speed limits as follows:

- Shared road space speed limits. This includes car parks and pedestrian malls and the speed limit is typically 10 km/h but can vary from 4 or 5 km/h up to 20 km/h. In shared zones, pedestrians have priority over vehicles. The road layout/infrastructure should be such as to limit the travel speed of vehicles.
- Linear speed limits. In this situation a speed limit is applied along a road and any change in the nature of the road such as moving into a residential area, would be indicated with a different speed limit sign. Speed limits can vary from 110 km/h in the rural areas to 50 km/h in built up areas. Speed limits, such as 60, 70 km/h, 80 km/h and 90 km/h, are applied depending on traffic volumes, roadside development and the nature of the road (e.g. is it divided, is the alignment simple etc.).
- Area-wide residential or commercial speed limits. In some situations, a speed limit, generally 40 km/h, is applied to a broad zone such as a residential area or shopping/business district. All entry and exit roads need to be signed to give legal effect.

[2] Exceptions:

- Western Australia rural default 110 km/h
- Northern Territory urban default 60 km/h
- Northern Territory rural default 110 km/h
- Tasmania unsealed roads default 80 km/h.

- Time-based speed limits. These are applied in various situations including adjacent to schools, in work zones, shopping precincts, during seasonal holiday activities, special events and if there are marked changes in the season (e.g. snow and ice are present in winter) and for congestion management. Speed limits generally vary from 25 km/h to 40 km/h.
- Variable speed limits. In some cases, the normal speed limit may need to be lowered (electronically or manually) for a variety of reasons including:
  – to reflect changes in traffic flow conditions
  – to cater for adverse weather conditions (e.g. high crosswinds on an elevated structure, fog)
  – as an incident management tool (i.e. a lower speed limit may be applied when an incident, such as a vehicle breakdown or road crash has occurred)
  – where periodic activity, such as the opening and closing of a heavy vehicle inspection station, may warrant a reduction in general traffic speed past the site when heavy vehicles are entering/leaving.
- Heavy vehicle speed limits. While regulations stipulate that the maximum speed limit for heavy vehicles (i.e. trucks and buses) to be 100 km/h (or 90 km/h in New Zealand and for road trains in parts of Australia), there are some circumstances where a reduced speed limit may need to be applied. This may be due to:
  – steep down grades
  – substandard horizontal alignment.
- Reduced speed limits for trucks and buses on sections of road with steep down grades or substandard horizontal alignment may be considered where:
  – there is an over representation of trucks/buses in crashes
  – the speed of descent exceeds safe values for steep grades
  – heavy vehicles experience difficulties negotiating the road alignment.

Reduced speed limits for trucks and buses on roads should, however, be applied with caution, as creating a large speed limit differential with other road users may increase the risk of crashes. Where a lower speed limit is applied, treatments to provide safe passing opportunities (e.g. passing lanes, and truck and bus turn-out bays) should be considered for other road users.

In some cases, lower speed limits can apply to certain licence holders. For example, in some parts of Australia, a lower limit applies to a novice driver, such as a learner or provisional licence holder.

# 9. How Do You Choose the Speed Limit?

Each Austroads member jurisdiction has its own prescribed process and procedure for setting/reviewing speed limits, based on local requirements. Movement and Place requires increased attention in speed limit setting.

In general, when setting speed limits, a range of factors need to be considered, yet within the context of the Safe System and the ambitious 2030 targets and Vision Zero aspirations, safety must be a prevailing priority. This applies especially for pedestrians. As Austroads (2020) report on Movement and Place noted consideration should be given to further reducing the inherent levels of risk to pedestrians and cyclists in the vicinity of schools by using 30 km/h (or even, as more and more countries are doing, adopting more 20 km/h limits) instead of the current 40 km/h limits. As an example, New Zealand has established a new regulatory and guidance framework for assessing and setting safe and appropriate speed limits that are aligned with the Safe System and is preparing speed management plans. These measures are intended to create an enabling approach that will help road controlling agencies to change speed limits so that they increasingly align with the Safe System over time. They also aim to make it easier for communities and political leaders to understand the process and rationale for achieving safe and appropriate speed limits.

## 9.1 Crash risk

The most important consideration in the assessment or review of a speed zone should be the determination of the crash risk on that road. The most common way to determine the crash risk is the crash history, however risk can be determined in a variety of other ways, as crash history is heavily influenced by the volume of road users using that road. Other opportunities include Infrastructure Risk Ratings to determine relative individual risk.The challenge for Australia is profound for meeting the 2030 target of reducing deaths by 50% and serious injuries by 30%, as it is for New Zealand. It is true that both the continued installation of safety infrastructure and the incremental growth of new vehicles with the most advanced safety technologies will make a significant contribution to reaching that target, but much of the burden still rests with setting speed limits that conform with Safe System principles. On this basis crash risk deserves clear priority in speed limit setting in Australia and New Zealand.

Meeting the challenge rests with decision-makers committing to the approach required for delivery of agreed safety targets, as well as for many other co-benefits as described earlier. Road safety leaders and advocates will need to be armed with the required information and be prepared to be frank and fearless in their advice.

The crash history can be viewed in two ways: the risk faced by individuals, which is measured by the casualty crash rate per 100 million vehicle kilometres, and the collective risk, which is measured by the casualty crash rate per kilometre of road.

Collective risk represents the total risk along a length of road, as opposed to the risk faced by each individual driver. For example, a link might experience a relatively low number of crashes. Other things being equal, this low number of crashes would equate to a relatively low collective risk. However, if this link also carried very low traffic volumes, then the few motorists that use the link might actually face a relatively high personal risk. Conversely, if that link carried a high traffic volume, then the risk to each individual motorist would be low.

Using collective risk as a basis for setting speed limits can create anomalies. Roads with higher traffic volumes tend to be built to higher standards, but these roads can still have higher collective risk statistics than lower standard roads with low traffic volumes. Therefore, a strong emphasis on collective risk in setting limits can lead to relatively safe roads attracting lower limits than relatively unsafe roads.

A focus on individual risk is likely to provide a more consistent relationship between speed limits and characteristics of the road and road environment, giving a hierarchy of limits that makes more sense to most road users.

Lowering limits on roads with high collective risk can bring safety benefits, but these are the roads where safety-focused road improvements are likely to be most cost-effective.

Enforcement is usually limited on low volume roads, and this limits the extent to which reduced speed limits alone can reduce individual risk on these roads.

## 9.2 Current operating performance

The physical and operating environment of a road section is a major influencing factor on risk. Driver speed behaviour is also influenced by the road user activity and visual cues associated with differing road locations. Speed zone assessments or reviews of a road need to take these factors into account. The road environment factors which have a marked influence on risk include roadside hazards, uncontrolled intersections and other access points (such as driveways) and opportunities for collisions between motor vehicles and pedestrians and cyclists.

The function of a road is one consideration in the determination of the most appropriate speed limit that should apply. The assessment should also recognise that roads may have more than one function and that there is a need to identify the primary function of the length of road under review. The issues that need to be considered include:

- the presence of pedestrian and cyclist facilities (controlled and uncontrolled)
- the volume and composition of traffic (i.e. heavy and over dimensional vehicles, cyclists and pedestrians)
- traffic patterns or the presence of any special activities (e.g. schools and school crossings, frequent regular bus stops, extensive periods of large numbers of pedestrians/cyclists, etc.), that may have an impact on traffic flow and speed
- forms part of a residential precinct (i.e. a network of local roads bounded by collector and arterial roads) or local traffic area (i.e. a network of local and collector roads bounded by arterial roads)
- is a shared zone road (i.e. an area or length of road that is shared by vehicles and pedestrians)
- is a major traffic route (i.e. a road whose primary function is to move traffic between regions or centres – these roads are typically primary arterials or secondary/sub-arterial roads)
- is a freeway or motorway (i.e. a high standard divided road whose primary function is to carry high volumes of traffic)
- is a local collector (i.e. a non-arterial road that distributes traffic from local roads onto the arterial road network).

Road authorities seek to achieve a good match between road function and road design: as far as possible, major traffic routes are designed to reduce collision risks, so that higher vehicle speeds can be sustained without unacceptable risk. However, this is not always possible in practice. Where a road does not meet the safety standards appropriate to its function, the speed limit should reflect the road and the safety risk it presents to all and any road user as it is, not the road as it ought to be.

A traditional, unhelpful consideration in assessing or reviewing speed limits was the determination of the 85th percentile speed of the road.

The use of 85th percentile speed has been discontinued by many road authorities as a key factor in speed limit setting and is not supported by the Safe System approach to road safety. Should it be found that the travel speed is markedly higher than the assessed speed limit then it may be necessary to consider establishing engineering measures designed to constrain vehicle speeds. Targeted speed enforcement (including automatic enforcement, where appropriate) may also be considered as a means by which vehicle speeds may be reduced.

The level of distraction from the surrounding environment (remarkable views, unexpected wildlife, etc.) is another factor considered during speed zone assessments and reviews.

## 9.3 Road and roadside infrastructure, geometry and roadside development

The geometric features of a road strongly influence the speed at which motorists travel and the level of risk. When assessing or reviewing a speed zone, the following geometric features are considered:

- Alignment of the road (i.e. whether it is straight or curved, flat or steep). Short sections of a road with an adverse alignment should be treated with advisory warning signs.
- Road cross-section. Characteristics can include:
  - whether the road is divided or undivided
  - where divided, the width of the median
  - whether there is provision for protected right turn movement
  - number of lanes and their widths
  - presence of bus lanes/bicycle lanes
  - the presence of edgelines, and whether there are sealed (i.e. minimum 0.6 m width) or unsealed shoulders
  - the offset to roadside features.

A key factor that influences vehicle speeds relates to the level of activity generated by the abutting roadside properties. When assessing or reviewing speed zones, the following factors need to be considered:

- whether there is restricted access on one or both sides of the road. This may result from the presence of service roads, parkland, railways, river, beach, etc.
- whether the development on each side of the road is similar or vastly different
- the number of at-grade intersections (controlled and uncontrolled)
- the frequency and set back of driveways
- the nature and level of the roadside environment (i.e. residential, commercial/shopping or industrial).

A speed zone is generally not applied as a means of addressing isolated roadside hazards (e.g. unprotected bridge end, tree or pole, intersection), or ‘black spot’ site (i.e. high crash locations). The more appropriate course of action is to undertake appropriate remedial work to ameliorate the problem. The corrective work may include improvements such as the installation of suitable advance warning signs and the installation of safety barriers. The treatment of hazardous road locations will be expected to be undertaken as part of a road safety program at either the local, State or Federal government level.

A lower speed zone may, however, be applied where there are a series of hazards that prevail along an extended length of road.

The speed limit on adjacent road sections requires consideration when conducting a speed zone assessment. Many motorists object to frequent speed zone changes over a short distance. A short section of a lower limit can be appropriate (e.g. within a shopping precinct or around a school) but if a number of such locations are fairly close together, consideration should be given to extending the reduced speed zone to a longer stretch of road.

Most jurisdictions have identified that lower speed limits are required on much of their road network to better align with Safe System principles. As a transition measure, there is growing support for a process of identifying roads with existing lower travel speeds and starting with these for speed limit reductions (as they are seen by some of the community as 'credible' and will still achieve significant cash risk reductions).

## 9.4 Unsealed roads

While the default rural speed limit on unsealed roads may be the same as for sealed roads (with the exception of Tasmania), consideration could be given to lower speed limits where there is direct roadside development, the road has a poor crash history or poor alignment.

Factors that should be considered when investigating the appropriateness of applying a lower speed limit on unsealed roads include:

- function of the road (e.g. arterial, collector road, local road)
- type and volume of traffic using the road
- alignment of the road
- climatic variation the road is likely to experience
- crash history of the road
- likelihood of compliance/enforcement
- amenity of the driving environment, such as dust.

**Speed limits based on the 85th percentile speed – not a recommended approach**

The 85th percentile speed is the speed at or below which 85% of motorists travel under free flow conditions. Some existing guidelines specify that it is one of a number of factors that should be considered when setting a speed limit. However, setting the speed limit based on unconstrained speed choices is unlikely to deliver an optimum balance between costs and benefits, either for individual drivers, or the community as a whole. (For further discussion, see Appendix A.)

# 10. Safe Speed for Regional and Remote Areas

There are clear differences between regional and remote roads, and urban roads. The default speed limit on regional and remote roads is 100 km/h in all states and territories other than WA and the NT (where it is 110 km/h). Even in other states, numerous undivided rural highways have 110 km/h limits. In urban areas the default speed limit is 50 km/h, but can range from 25 km/h to 90 km/h. Irrespective of whether drivers follow the law or exceed the speed limit, higher travel speeds increase both the likelihood that a crash will occur and the severity of injuries in crashes.

An analysis of speed-related crashes in regional and remote Australia for the period 2003-2007 suggested that speed contributed to around 28% of fatal crashes and 20% of injury, although there was considerable variation by jurisdiction, probably as a result of reporting practices (Austroads 2014a). Fatal injuries were greatest when the speed limit was 110 km/h. Factors increasing the risk of a speed-related crash in regional and remote areas included the road being curved, the road being flat and not hilly, wet road conditions, and the occurrence of mid-block. Speed-related crashes at intersections were most likely to occur at T-junctions. Speed is a major contributor to 'off-path, on-curve' casualty crashes, which form 78% of speed-related casualty crashes (versus 20% of non-speed crashes) and 63% of fatal speed-related crashes (versus 14% of non-speed related crashes) (Austroads 2014a). Males, young drivers (17-24 years old), motorcyclists, and rigid truck drivers are also over-represented in regional and remote speed-related crashes (Austroads 2014a).

The effects of higher travelling speeds in regional and remote areas are exacerbated by other factors, particularly the characteristics of the driving environment. Many regional and remote roads are undivided or of poor quality. There is also a higher share of unsealed roads in regional and remote areas. Furthermore, roadsides can be more hazardous due to the absence of shoulders, narrow or unsealed shoulders, limited or no clear zones, and features such as embankments, culverts, and trees at the side of the road. Road geometry may also be more challenging due to poor curve alignment and changing gradient. For these reasons, many roads in regional and remote areas would be better suited to a lower speed limit. In addition to the nature of regional and remote roads, there is also a greater likelihood of encountering livestock and wildlife, and heavy vehicles, including mining vehicles, agricultural vehicles, and road trains (National Rural Health Alliance 2015). Undivided regional and remote roads are known to have higher fatal crash rates than other road types (Austroads 2021d).

Vehicles can also moderate the relationship between travel speed and crash outcome. Compared to vehicles in metropolitan areas, vehicles in rural and remote areas are generally older, less well maintained, and have fewer safety features such as electronic stability control. As such, vehicles in regional and remote areas are less crashworthy and less able to ameliorate the consequences of high-speed crashes.

Enforcement plays an important part in speed management in general but faces a number of challenges in regional and remote areas, including low traffic volumes and limited resources. Police in regional and remote areas are also responsible for general duties and may have limited time to dedicate to traffic enforcement. Also, due to geography, large road networks with low traffic volume, and personnel limitations, police presence may not be economically justifiable. Other factors that impact on enforcement include size of regional and remote communities, which means that information about the location of speed enforcement spreads quickly via word-of-mouth, and some police officers may be reluctant to enforce unpopular road rules for fear of being ostracised from the community in which they live. Nevertheless, lower speed limits on regional and remote roads will not get compliance unless there is significantly increased enforcement.

Many evidence based interventions to address speed on rural and remote roads have been identified for adoption (Austroads 2014a).

## 10.1 Speed limits

As described in Section 6, the relationships between higher vehicle speed, increased crash rates and injury severity are well established (Aarts et al. 2009; Nilsson 2004). Nilsson (2004) modelled the relationship between speed and crash risk and showed that a 5% increase in mean speed leads to around a 10% increase in all injury crashes and a 20% increase in fatal crashes. Kloeden et al. (2001) showed there is a greater than exponential increase in the risk of a casualty crash for vehicles travelling above the mean traffic speed on regional and remote roads in South Australia with a speed limit of 80 km/h or more.

Within the Safe System approach, it is acknowledged that humans will continue to make mistakes and that road infrastructure and vehicles should be designed to minimise the effect of a crash. Similarly, speeds should be set such that they minimise the effect of a crash, given the prevailing road infrastructure. Research studying the biomechanical tolerance of humans in crashes suggests speed limits should ideally be set within these tolerance limits. For poor quality undivided roads, the target speed limit should be around 70 km/h, as currently used in Sweden (Austroads 2005). A more recent model proposes an alternate relationship between speed and fatality or serious injury (Jurewicz et al. 2015). Based on this model critical impact speeds were estimated at which 10% of people aged 15-55 years may be seriously injured. This model indicated ideal speed limits should be even lower than those proposed by Austroads (2005).

The most obvious method of managing speed is by setting appropriate speed limits. However, when speed limits were initially introduced there was little knowledge of the relationship between speed, crash risk, vehicle safety and vulnerable road users (Austroads 2018). Over time the population has become accustomed to driving at high speeds and undoing this practice requires long term, ongoing strategies.

In many cases, the current road infrastructure does not support the speed limit on regional and remote roads in Australia. A speed of 70 km/h or less is currently recommended on the basis of Safe System principles to improve the chance of survival in the case of a head-on crash. Given that many such roads currently have a 100 km/h speed limit, a reduction to 70 km/h is unlikely to gain solid community support and thus smaller reductions in speed may need to be used to bring about incremental improvements. This may be done in conjunction with infrastructure upgrades as discussed in the Safe Roads section.

The choice between lowering the speed limit or improving infrastructure is strongly influenced by budget. Victorian data suggest that infrastructure solutions are cost-effective on roads with high traffic volumes (>4000 vehicles per day) whereas speed limit solutions may be more cost-effective on low traffic volume roads (<2000 vehicles per day) (Australian Transport Council 2011).

A review of speed limits on the national rural road network in Sweden in 2008–09 resulted in rural roads with a low traffic safety standard and sub-standard roadsides having reduced speed limits, while a smaller proportion of roads with a good traffic safety record received an increase in speed limits. The long-term effects of the speed limit changes were evaluated by means of a before and after study with a control group (Vadeby and Forsman 2018). The study found that on rural roads with a reduced speed limit from 90 to 80 km/h, fatalities decreased by 41% (14 deaths per year) while the number of seriously injured did not change significantly. Reductions in the speed limit were also associated with statistically significant decreases in mean speeds. On motorways where the speed limit was increased from 110 to 120 km/h, the number of seriously injured increased by about 15 per year. Similar results have been found internationally where increasing speed limits has been shown to increase the number of crashes and deaths (De Pauw et al. 2014; Jaarsma et al. 2011; Farmer et al. 1999; Souleyrette and Cook 2010).

Trials of lower speed limits in regional and remote areas in Australia have generally demonstrated reductions in casualty crashes. For example, speed reductions on roads in South Australia and New South Wales from 110 km/h to 100 km/h were associated with reductions in casualty crashes of just over 25% (Mackenzie et al. 2015; Bhatnagar et al. 2010). In Queensland reductions in speed limits on high-risk rural corridors (known as black links), accompanied by signage denoting crash history and increased police enforcement, were associated with an 11% reduction in fatal and serious injury crashes and a 17% reduction in all crashes (Edgar and Tripathi 2011). The Mornington Peninsula Safer Speeds Project in Victoria resulted in a 20% reduction in fatal and serious injuries, consistent with the with 20–37% reduction predicted by the observed change in mean speed. There have been no fatal crashes in the nearly 4 years since the speed limit was introduced on the trial roads (information from Department of Transport and Planning 2023).

Unsealed roads in regional and remote areas present a further challenge. The default speed limit applies to unsealed roads but this is unlikely to be consistent with the increased risk resulting from the unpredictable nature of the road which will be affected by condition of the road surface, volume of traffic and environmental conditions (e.g. dust, flooding). In 2014, Tasmania implemented a reduction in the default limit on unsealed roads from 100 to 80 km/h. The effects of this change have not yet been evaluated.

## 10.2 Engineering treatments

In addition to speed limits, alternative speed countermeasures include engineering treatments and enforcement related options. Engineering based countermeasures aim to force speed reductions to negotiate the traffic calming or alert the driver to potential hazards so that they reduce their speed sufficiently before encountering the hazard. Potential hazards include curves, intersections, approaches to towns, railway level crossings and work sites (Austroads 2014a). A list of successful traffic calming measures for this purpose was provided in Section 7.1: *Roads and Roadside Infrastructure*.

Countermeasures that may alert drivers to these hazards include:

- advance warning signs
- chevron alignment markers
- speed advisory signs/speed limits/variable speed limits
- vehicle activated signs, including speed limit signs
- transverse rumble strips
- perceptual countermeasures
- slow markings
- lane narrowing
- adequate sight and stopping distance (for railway level crossings)
- specifically for worksites:
- workers holding slow-down and stop signs
- use of cones or barrier devices to reduce lane width.

Countermeasures for risky curves have been associated with a reduction in crashes of up to 40% and for hazardous intersections a reduction in crashes of up to 70% (Austroads 2014a).

When entering a town, advance warning signs advising that the speed limit is about to change, buffer zones where there is a staged reduction in the speed limit and count-down signs to the new speed limit have been shown to be marginally effective in reducing speeds and crashes (Austroads 2014a; Turner 2009; information provided by Department of Transport and Planning Victoria 2023). Rural thresholds are designed to provide a gateway between high and low speed environments using a combination of signs and road markings and have been trialled in New Zealand. They are most effective when they include road narrowing and have been shown to reduce fatal and serious injury crashes by up to 40% (Charlton and Baas 2006).

Recent trials have pointed to the effectiveness of vehicle activated signs to reduce speeds at intersections on high-speed roads when the risk of a serious injury crash is elevated (e.g. Department of Transport 2020; Mackie et al. 2016, 2017; Mongiardini et al. 2021). These systems work by detecting the presence of vehicles on the side road/turning vehicles on the major road and warning drivers on the major road to slow down, either through regulatory or warning signs.

Finally, choice of interventions should consider the greater assurance provided by traffic calming interventions which force driver to slow down, rather than informing the driver in the hope of them being alert, undistracted, and compliant.

## 10.3 Enforcing safe speeds

Enforcing vehicle speeds to the posted limit contributes to uniform travel speeds and reduces the risk of a serious injury collision across the network. Excess speeding by drivers in regional and remote areas entails considerable risks, largely because of the typically higher speed limits in these areas to begin with, and the significant risk of injury associated with higher speed collisions in these locations. Unsurprisingly, speeding has been identified as a significant contributor to fatal crashes in rural Australia (Siskind et al. 2011). However, enforcing safe speeds in non-urban areas can be problematic. Certain policing and enforcement strategies that are successful in major cities are often unsuccessful or considered unsuitable for use in regional and remote areas. For instance, the effectiveness of speed cameras and random breath testing (e.g. through booze buses) is reportedly diminished outside major cities, which can be due to their high visibility and/or the influence of drivers alerting others of operation locations via word-of-mouth (Rural and Regional Affairs and Transport References Committee 2016). Therefore, there is a need for unique deterrent measures in regional and remote areas, given the enforcement and speed monitoring challenges. Speed enforcement programs should also ideally be conducted in tandem with education and publicity campaigns in rural areas where speeding is common and seen as socially acceptable (Austroads 2014a).

Mobile speed cameras are another example of automated speed enforcement that can be adapted to the regional and remote environment. The benefits of mobile camera operations in regional areas have most recently been demonstrated in Queensland (Newstead et al. 2017). In 2013, when a high level of activity was undertaken in rural areas (1,749 hours per month), estimated crash reductions up to 4 kms from rural camera sites were 41% for fatal crashes, 30% for serious injury crashes and 27% for all casualty crashes. The success of this mobile speed camera program was attributed to:

- new sites selection based on a criterion of 2 crashes (speed related serious casualty or out of control/off path on curve crash type) in the last 5 years within a 5-kilometre diameter
- random scheduling of new sites during each operators shift
- each new site operated for at least 35 hours per site, per year (average intensity in 2015) (Cameron and Newstead 2021, p18).

An advance on single point speed cameras is the use of point-to-point (P2P) or average speed cameras that measure the average speed of vehicles travelling between two fixed camera systems on a road. P2P camera systems are an enforcement measure that is particularly suited to regional and remote areas as they can cover significant distances on the road network, rather than a single point. There is a growing body of evidence supporting the road safety benefits of P2P speed enforcement along the roads where it is used. A meta-analysis conducted by Høye (2014) found that P2P enforcement was associated with reductions of 56% for fatal and serious crashes and 30% for crashes of all severities based on four studies. These effects were greater than those found for fixed speed cameras (51% and 20%, respectively). P2P enforcement also has a positive influence on vehicle speeds and has been shown to reduce the mean and 85th percentile speeds by up to a third (Soole et al. 2013). Where fixed P2P enforcement is limited to the roads on which it is used, mobile average speed enforcement technology has the potential to provide more substantial and sustained enforcement activity across the rural road network and potentially deliver benefits in excess of the costs (Cameron and Newstead 2021). Mobile P2P camera systems are a new technology that uses two units parked at each end of a road length to measure the average speed in the same way as fixed P2P camera systems. They can be deployed by either a two vehicle based speed cameras with ANPR capability or as a trailer-based systems that can be left in place for longer periods of time (Raftery, 2021). Mobile P2P technology is still in its infancy so it is important to trial and evaluate the devices to ensure they are feasible and effective methods of enforcement.

Combined red light and speed cameras also provide strong speed deterrence as well as red-light disobedience. These are effective in improving intersection safety (for review see Retting et al. 2003).

Speed enforcement is a key part of speed management. I suggest expansion of this section. It could more comprehensively point to the uses of fixed, P2P, red light-speed, and mobile enforcement.

### 10.3.1 Covert and overt speed enforcement

Debate continues, often in a vacuum of knowledge of evidence, as to whether covert or overt enforcement is better. Overt is said to be superior because it advertises its presence to motorists to increase compliance. It is also often confused with high-visibility enforcement. Covert is said to be more effective because detection is less avoidable.

Fortunately, the evidence provides a clear answer: the mix of overt and covert enforcement works best. A strong evaluation in New Zealand was reported by Keall et al. (2001). This study assessed the benefits of adding covert (hidden) mobile speed camera enforcement to existing overt (visible) mobile speed camera enforcement, on 100 km/h roads in New Zealand. The addition of hidden camera enforcement was preceded by substantial publicity. The evaluation compared one region in which covert enforcement was added compared with control regions in which no hidden enforcement occurred. Results demonstrated that the covert camera enforcement was associated with net reductions in speeds, crashes and casualties both in speed camera areas and on 100 km/h speed limit roads generally. The additional finding that hidden cameras created broader suppression of speed and thus improved safety more broadly on rural roads (not just near speed camera locations) is to be expected from drivers not knowing the locations of the cameras. This is one of the major benefits of hidden enforcement. Finally, community surveys showed that in the hidden enforcement trial area (but not other areas) there was a decrease in support for the idea that cameras should always be visible. In all areas most people did not feel that cameras should always be visible.

## 10.4 Vehicle countermeasures – ISA

Vehicle technologies that control speed or assists the driver to comply were covered in Section 7.2: *Vehicles*. These can be of particular value for rural and remote settings, where other interventions like traffic calming and enforcement are more difficult to deploy.

## 10.5 Speed management – community consultation and engagement

To address any community concerns, speed management and enforcement programs should be conducted in conjunction with education and publicity campaigns, particularly in regional and remote areas where speeding is common and viewed as socially acceptable (Austroads 2014b).

An essential element for progressing speed management involves consulting stakeholders and communities about their concerns and priorities. Importantly, a strong evidence base is critical to bring the community along and to assist them in understanding what speed management is and what the problems may be. Keeping stakeholders and the community informed and involved in speed management issues can build support, improve decision making and lead to ownership and responsibility for positive road safety outcomes.

An example of successful community engagement that facilitated speed management is the Mornington Peninsula Shire in Victoria, where a 2-year trial was implemented. In the trial, the speed limits at 38 high-risk sealed rural roads were reduced from 90 and 100 km/h to 80 km/h. A positive community response and acceptance of the change in speed limits was attributed to community consultation at a grassroots level and the provision of evidence for the benefits of reduced speeds that were relevant to the local area (Mornington Peninsula Shire 2020). Community attitudes and, hence, political considerations represent important barriers to more rapid progress in delivering speed limits that are consistent with Safe System principles and therefore able to prevent deaths and serious injuries on roads. In addressing community acceptance, it is important to appreciate that more representative surveys often show broader support for speed management than is apparent in media coverage. There is often a 'silent majority' of support.

Community engagement on speed management is important, and is ideally undertaken in a manner and with sufficiently representative community members as to reflect the common silent majority support (possibly through surveys) and thus does not facilitate resistance.

A process improvement cycle for engagement on speed management could include the following:

- Step 1: Develop a formal speed management strategy
- Step 2: Engage internal stakeholders, influencers, and decision makers
- Step 3: Engage road safety partners inside government
- Step 4: Form a multi-agency/stakeholder communications and engagement working group.
- Step 5: Engage road safety partners outside government
- Step 6: Engage other relevant non-road safety policy groups
- Step 7: Engage Politicians
- Step 8: Engage the community
- Step 9: Monitor and evaluate.

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# Appendix A Meaning of the 85th Percentile Speed

One of the oldest least helpful criteria for setting speed limits is the 85th percentile speed (the speed at or below which 85% of motorists travel under free flow conditions – when their speed choice is not constrained by vehicles in front of them).

The view that limits should be set at or close to the 85th percentile speed dates back to the early 1940s in the USA (Transportation Research Board 1998).

The political appeal of 85th percentile speed limits is clear: this criterion produces limits that are, by design, acceptable to the great majority of drivers. If the limits are enforced with a fairly broad tolerance, and not very intensively, not many drivers will be penalised, or even inconvenienced. The behavioural impact will be minimal, but authorities will be able to claim that compliance is generally good.

However, the traditional arguments for 85th percentile speed limits assert that such limits are not merely expedient: they actually produce the best attainable safety outcomes. The first argument predicts that speed limits below the 85th percentile will not improve safety (since only drivers who are already ‘safe’ will be affected, and reducing their speeds will not make them safer). The second argument predicts that lower limits may actually increase crashes and casualties. The third predicts that attempts to reduce speeds by lowering limits will fail because enforcement is too difficult.

When the 85th percentile criterion was first adopted, there was relatively little direct scientific evidence about the consequences of different travel speeds, or even the extent to which changing limits would affect travel speeds.

There is now ample evidence that setting and enforcing lower speed limits is feasible, sustainable, and produces safety benefits (see reviews and research cited in Sections 2, 4 and 6 of this report).

In Australia this was recognised in the early 1980s and the use of the 85th percentile speed has been largely discontinued by many road authorities as a key factor in speed limit setting.

It is true that benefits from speed limit reductions may be very limited if enforcement and public education efforts are minimal. It is also true that actual speed reductions have typically been less than the nominal reduction in speed limit. However, substantial benefits have been observed even when enforcement was not very rigorous and initial speed compliance was poor (by contemporary Australian standards).

For example, the National Maximum Speed Limit of 55 mph (89 km/h) that was introduced in the United States in 1973 as a fuel-saving measure was well below previous 85th percentile speeds on most rural roads. It was actually below prevailing median speeds on rural interstate and rural primary roads, and well below typical design speeds of the rural Interstate system. After the limit was imposed, a majority of drivers exceeded it. But mean speeds, 85th percentile speeds and speed variance were reduced on all three major rural road classes (interstate highways, rural primaries and rural secondaries). There was a substantial reduction in the number of deaths, and the death rate per distance travelled (Transportation Research Board 1998; Evans 2004).

Apart from the direct evidence that safety can be improved by setting limits below 85th percentile speeds, there have been other critiques of the arguments for 85th percentile speeds.

## A.1 Driver selection of safe (or optimum) speeds

Speeds selected by the majority of drivers are not safe in any absolute sense. At current 50th or 70th percentile free speeds on most roads, the risk of a serious crash is small, but not zero. Lower speeds would reduce that risk.

There are even grounds to doubt that most drivers will select speeds that represent a good balance between the advantages and disadvantages of different speeds.

Drivers may not consider all the relevant costs and benefits when they make their speed choices.

The main benefits of higher speeds (reduced actual or perceived travel times, competition, enjoyment) accrue to the driver; some potential negative consequences are borne by others (environmental impacts, loss of amenity, injuries to others, crash costs covered by insurance).

Drivers' subjective assessments of risk, and the relationship between speed and risk, are likely to be inaccurate

Personal experience is a poor guide to understanding the links between travel speed and risk for the following reasons:

- Although serious crashes happen every day, they are rare in the experience of individual drivers.
- The personal experience of most drivers convinces them that the speeds at which they usually drive are 'safe'.[3]
- Many people find the objective data on speed risks surprising and counter-intuitive.[3]

For these reasons, limits based on drivers' unconstrained speed choices are unlikely to deliver an optimum balance between costs and benefits for the community as a whole, or even individual drivers.

It follows that when the authorities responsible for the regulation of road traffic engage in speed management, that is, in policies and measures to influence drivers' choice of speed, they are usually seeking to reduce speeds. Speed regulation can also be seen as persuading vehicle users to forego some of the perceived advantages to them of higher speeds, in order to reduce some of the less well-perceived disadvantages to themselves and many disadvantages to others (VTT Communities and Infrastructure 1999).

## A.2 Speed dispersion

Research conducted in the 1960s (Transportation Research Board 1998) appeared to show that vehicles travelling at speeds that were close to average had the lowest crash risk, while both slower vehicles and faster vehicles were more at risk of crashing. This was interpreted as providing support for the speed dispersion argument, but there are a number of caveats to this interpretation:

There were a number of methodological flaws in these studies which may have inflated risk estimates for lower speed vehicles (see Kloeden et al. 1997; Kloeden, Ponte and McLean 2001; Transportation Research Board 1998).

[3] The effect of travel speed on risk shows up clearly in aggregate data based on very large numbers of drivers, but when individual drivers take decisions that increase their risk, most will not experience a crash. If they do crash, they are unlikely to carry out detailed calculations to work out how the outcome might have changed if their speed had been slightly lower.

The crashes studied were mainly low severity property damage crashes. Hence the risk curves would not have reflected the effects of speed on crash severity and injury/fatality risk. Moreover, Evans (2004) has noted that the types of crash that might be affected by speed dispersion (such as rear end and side-swipe crashes) form a very small proportion of high-severity crashes; the bulk of fatal crashes are events where speed dispersion is a most unlikely factor: single vehicle crashes, non-overtaking head-on crashes and intersection crashes on rural roads; side impacts, frontal crashes and pedestrian crashes on urban roads.

More recent, better designed case control studies based on casualty crashes (Koeden et al. 1997, 2001, 2002) did not find an inverted-U risk function: the results show a rapid monotonic increase in risk as speed increases.

Many correlational studies have found a relationship between aggregate measures of speed dispersion and aggregate crash rates, but when the study design controls for other variables the relationship can vanish (Taylor et al. 2002).

The question of whether speed dispersion is a significant causal factor in serious crashes remains controversial. Even if it is a factor, the available evidence does not indicate that raising speed limits in the hope of reducing speed variance will improve safety. As Evans (2004) and Baruya (1997) have noted, the more logical solution, with much stronger research backing, is to reduce limits and use enforcement backed by public education to reduce the speeds of the fastest vehicles. This will reduce speed variance, mean speeds, and crash risk.

Austroads' **Guide to Road Safety Part 3: Safe Speed** provides an overview of speed limits and their application as a speed management tool. The use of appropriate speed limits forms an integral part of a safe road system. They are a speed management tool used to improve road safety, while maintaining the efficiency of the road network.

**Guide to Road Safety Part 3**

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