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# Peer-reviewed papers

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## Original Road Safety Research

### Infrastructure treatments for managing speeds on rural and urban arterial roads

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#### Key Findings

- Infrastructure treatments, many of them low cost, are available to better manage vehicle speeds on rural and urban arterial roads
- The reductions in speed from these treatments are associated with improvements in safety outcomes
- When combined with other safety approaches, management of speed through infrastructure measures has the potential to provide significant safety improvements with the potential of achieving Safe System outcomes
- Gaps in knowledge remain about the speed reducing impact and safety benefits for infrastructure measures.

#### Abstract

Core to the Safe System approach is management of vehicle speeds to reduce the likelihood of crashes occurring, and to ensure that those crashes that do occur, happen at survivable impact speeds. Although there is substantial guidance on infrastructure measures that can assist in the management of speed on the local road network (often under the heading of local area traffic management or traffic calming), there is little information on how to manage speeds on rural and urban arterial roads, locations where the majority of fatal and serious injury crashes occur. Austroads has funded research that was aimed at identifying infrastructure solutions for managing speeds in these environments. Results are presented indicating the effectiveness of infrastructure-based solutions for managing speeds.

#### Keywords

Speed, speed management, urban, rural, arterial, infrastructure, treatments.

#### Introduction

Excessive speed has been identified as a major factor in the occurrence and severity of road crashes (e.g. Turner & Makwasha, 2014; OECD, 2006; Elvik et al. 2004; Kloeden et al. 2002). While the management of speeds on urban local roads (typically residential streets or collector roads) using different types of infrastructure treatments is well established (e.g. Austroads 2008), less guidance is available for managing speeds on rural roads and higher volume urban arterial roads.

This paper presents the findings from two separate Austroads studies on effective speed management. The key objective of this Austroads funded research was to provide information on effective techniques to manage speed and reduce speed related crashes on roads in rural areas (Turner & Makwasha, 2014) and on urban arterial roads (Hillier, Makwasha & Turner, 2016). In order to achieve this objective, the projects

aimed to identify existing treatments, and quantify the benefits of these. In addition, there was also an objective to identify less well known or innovative approaches to speed management; to trial the most promising of these; and to identify the benefits of these.

Although the research concentrated on engineering based approaches to managing speed, it is recognised that non-engineering approaches also have a significant role to play in the management of speed on rural roads, either as a standalone or complementing the engineering treatments. The Austroads study also examined the role of in-vehicle technology, enforcement, and training, publicity and education programs in improving safety. A coordinated response using all of these approaches is essential to maximise the safety benefits for roads.

The Austroads research was set within the context of the Safe System approach (e.g. ITF, 2016). The approach accepts that humans will make errors while driving, and so crashes will continue to occur. In addition, humans are physically vulnerable, and are only able to withstand limited change in kinetic energy (e.g. during the rapid deceleration associated with a crash) before injury or death occurs. As well as measures to reduce the likelihood of crashes, there is also a requirement for infrastructure that takes account of these errors so that road users are able to avoid serious injury or death in the event of a crash. Within this context speeds need to be appropriate to the type of road and levels of risk present. This includes taking account of the function of a road and the road users present.

The purpose of this paper is to present a brief synthesis of the research conducted and to alert safety professionals to the engineering based countermeasures that have been identified for the management of speed on rural and urban arterial roads. In the context of this paper excessive speed (or ‘speed’) relates to any road user who is travelling above the posted speed limit, or who is driving at a speed that is dangerous for the conditions (whether that be above or below the posted speed limit). Although the focus of this paper is on speed-related solutions, it is also recognised that there are other measures to help improve safety in these environments. Practitioners are encouraged to explore the full range of options when seeking to improve safety outcomes.

## Method

Each of the two Austroads studies used a similar methodology. Details are provided in Turner & Makwasha (2014) and Hillier et al. (2016), but in each case included:

- literature reviews assessing the scale of the rural and urban arterial speed problem and possible speed based solutions
- contact with key international agencies and individuals to determine measures currently in use or under development to manage speeds
- data analysis of crashes on rural and urban arterial roads, highlighting situations where speed has been identified as a specific crash contributor
- site investigations at a sample of locations where high severity crashes have occurred in order to determine ways that speed may have contributed to crash outcomes, as well as potential ways that speed may be reduced at such locations
- workshops across Australia and New Zealand to discuss potential treatments, and issues with using such treatments
- trials of promising treatments where there are currently gaps in knowledge on effectiveness
- provision of guidance on good practice in managing speeds.

This current paper presents findings relating to effective infrastructure treatments, based primarily on the literature review task and trials of promising treatments. Readers

are directed to the source documents for information on limitations of different treatments, and issues such as cost and implementation issues.

In order to identify relevant research, a literature review was conducted using the resources of ARRB Group’s MG Lay Library. The Australian Transport Index (ATRI) was used in identifying literature, as was TRID, an integrated database that combines the records from the US Transportation Research Board’s Transportation Research Information Services (TRIS) Database and the OECD’s International Transport Research Documentation (ITRD) Database. This information was supplemented with searches using Google Scholar.

As indicated above, literature was also supplemented with several retrospective before and after evaluations using comparison sites to minimise the impact of changes beyond the infrastructure improvements. The methodology adopted for each is available in Makwasha & Turner (under review).

## Results

This results section provides information on the engineering-based treatments that have been identified from these two Austroads studies. Reference is made to well-established treatments, but greater attention is given to emerging treatments and those that have been found to be highly effective. Some of the key rural treatments are presented first, with a review of speed management approaches at rural curves, intersections, transition zones (from high speed to low speed environments and for routes. This is followed by treatments that can be used to address speed on urban arterial roads, including at intersections and for routes. Of particular interest is information on the speed and crash reduction potential of these treatments. Although information was sought on the fatal and serious injury reduction from each treatment (in line with Safe System objectives to eliminate these more severe crashes) research typically provides information on the casualty reduction (i.e. fatal, serious and minor crash reductions combined) and so it is typically these results that are provided. In some cases there is substantial information on these factors, while for many there is evidence base is less robust.

### Rural bends

Traditional infrastructure improvements at bends have included advanced warning signs, chevron alignment markers, and speed advisory signs. Each of these treatments were seen to provide safety improvements ranging from 25 to 40% casualty crash reduction (Turner & Makwasha, 2014.), although less is known about the speed reducing potential of each. Other delineation devices (e.g. line markings, guideposts etc.) were found to have lessor safety benefits (5 to 20%; Turner & Makwasha, 2014) and typically operated through provision of better advanced warning rather than speed reduction. Indeed in some cases the introduction of this improved delineation resulted in slight increases in speed (presumably offset by the benefits to road users through clear guidance on the road direction (Elvik & Vaa, 2004).

There has been an increase in the use of Vehicle Activated Signs (VAS) at rural curves in recent years. These signs are usually activated for a short time (around 4 seconds) when an approaching vehicle exceeds a threshold speed limit (normally set at the 50th percentile speed as measured prior to the introduction of the signs). Once triggered, the sign displays the hazard, and may include a message to slow down. These signs have had wide application in the United Kingdom for many years, with demonstrated benefit. Winnett and Wheeler (2002) found mean speed reductions of between 3.4 km/h and 11.3 km/h at rural curves. A study in Queensland found similar reductions; between 5 km/h and 10 km/h (Burbridge et al. 2010) while a New Zealand study reported more modest speed reductions of up to 5 km/h (Gardener & Kortegast 2010). Makwasha and Turner (2014), as part of the Austroads rural speed management project, found an average mean speed reduction of 2 km/h and a 4 km/h reduction in 85<sup>th</sup> percentile speed for 16 sites across Australia. The crash evaluation showed a reduction of around 35% in casualties across these sites.

Although many existing treatments provide benefit in reducing speeds at curves and improving safety, it is apparent that these are often installed in an ad hoc manner, often in response to high crash locations. A key finding of the rural research (Turner & Makwasha, 2014) was the need for a consistent approach, whereby whole routes (or better still, whole networks) are assessed to determine the severity of curves, and a consistent signing regime used based on this severity. The approaches documented by Cardoso (2005) and Herrstedt & Greibe (2001) were recommended by Turner & Makwasha (2014). These involve the assessment, and then categorisation of curve risk into 'bands'. Each band is then treated in a consistent way with the same package of treatments. As an example, low risk curves (typically identified through risk factors such as the requirement for speed reduction on approach and through the curve) are treated with more modest infrastructure solutions (e.g. guide posts) while more severe curves receive more significant treatment (e.g. guideposts, advance warning and curve advisory speed signs, chevron alignment markers, and enhanced line marking). Each curve type is treated in a consistent way, assisting road users to determine the curve severity and appropriate response for safely negotiating the curve. Based on the findings of Turner & Makwasha (2014), this approach has now been adopted by some jurisdiction in Australia (Jurewicz et al., 2014), while a similar approach has also been used in New Zealand (Durdin & Harris, 2015).

## Rural intersections

Several engineering treatments were identified as being potentially useful for moderating vehicle speeds on the approach to rural intersections. The most substantial safety benefit was from the installation of well-designed roundabouts (defined here as providing adequate deflection on approach and through the roundabout), with this treatment reducing fatal and serious injury crashes by around 70% (Turner & Makwasha, 2014). Benefits are derived by the reduction in speeds on approach and through roundabouts, as well as by fewer conflict points and lower

impact angles when crashes do occur compared to the alternative intersections.

VAS at intersections were also identified as providing substantial benefits (also up towards 70%; Turner & Makwasha, 2014; Makwasha & Turner, 2014). It is interesting to note that the speed reduction using VAS at intersections was similar to that at curves, although the safety benefits were substantially greater. One possible reason is that other safety benefits are derived from VAS at intersections besides the speed reduction (for example greater alertness of drivers to the potential risk of vehicles entering).

One variety of VAS identified in Turner et al. involved the use of vehicle activated speed limits at intersections. These are triggered by vehicles approaching the intersection from the side road. Trials indicated quite substantial benefits in speed reduction (up to 17 km/h) from this treatment overseas (Tempo, 2006), although at the time of the review, less was known about the actual crash reduction. A recent trial in New Zealand has identified sustained reductions in speed at sites where rural intersection active warning systems were introduced as well as substantial safety improvements (from 0.34 fatal and serious injury crashes per month before installation to 0.04 in the after period; Mackie et al., 2016). Further trials of vehicle activated speed limits signs are now planned for several Australian states.

Several other treatments showed promise at intersections, including the use of advanced warning signs, perceptual countermeasures, lane narrowing, and increasing the prominence of the intersection. Each of these, along with other possible treatments are described in Turner & Makwasha, 2014).

## Transitions from high speed to low speed environments

A number of techniques were assessed at locations where there is a requirement to transition from high speed roads to low speed environments (e.g. on the entry to a rural town). Treatments included the use of static signage alone (e.g. advanced warning signs, buffer zones and count-down signs), although each of these were assessed as having a limited impact on speed reduction and safety improvement.

More promising was the use of rural threshold or gateway treatments. These typically use a combination of signs and road markings to indicate a significant change in the characteristics and usage of the road environment ahead. Such treatments appear to produce reductions in speed of up to 15 km/h at the transition point (LTSA, 2002). Research highlights the need to sustain speed reductions by implementing further measures within a town or village (Kennedy, 2005). These are used widely in New Zealand and the UK, but until recently have had limited use in Australia.

As part of the Austroads research, Makwasha & Turner (2013) reported on an analysis of gateways in New Zealand. The study indicated a 26% reduction in overall crashes, with higher reductions (35% reduction in casualty crashes, and a

41% reduction in serious injury crashes) at locations where pinch points were used to restrict lane width. Substantial speed reductions were also identified (up to 25 km/h). These threshold treatments are now being assessed for their potential use in the urban arterial environment by several road agencies.

## Rural routes and networks

Fewer options were identified that can be used to slow speeds on a rural route or network-wide basis. Speed limits are the most widely applied approach for addressing speeds on rural routes. The research by Turner & Makwasha (2014) identified a number of studies that examined the topic of an appropriate rural speed limit. To summarise this work, it appears that rural limits in Australia and New Zealand are generally higher than the safest countries in the world. It is very likely that there would be large safety benefits from a reduction in the default rural speed limit, particularly for undivided roads. Speed limits less than the default rural limit (i.e. for specific sections of road, rather than for the rural network as a whole) have traditionally been applied when there is an increase in roadside development and activity (e.g. a small township). More recently, lower speed limits have been applied in locations where there is no, or very little roadside development, but rather due to other types of risk (for instance, adverse horizontal alignment). Evaluations were undertaken as part of the Austroads research (Turner & Makwasha, 2014). Despite some promising evidence for safety improvements and speed reduction (around 4 km/h), there are still gaps in the knowledge base regarding the most effective way to implement lower speeds for different rural environments.

Road narrowing has been used for rural roads in a number of countries. Perhaps most widely reported is the '2 – 1' (two minus one) system used in some European countries. This system involves the removal of the road centreline, and installation of a broken edgeline. The road is effectively narrowed to one lane in total (e.g. Herrstedt; 2006). To date there has been little in the way of evaluation of this approach.

More recently, wide centreline treatments have been applied (Beck, 2016; Bobbermen, 2016). There are positive indications regarding the safety benefits of such treatments (up to 60% reductions), and this is in part due to the speed reduction. Combining the wide centreline with a lower speed limit has been identified as a particularly promising treatment in some higher risk rural road environments.

## Urban intersections

As indicated for rural environments, roundabouts are a very effective treatment in the management of speed at intersections. They also reduce the number of conflict points and the angle of impact when collisions do occur. Hyden and Varhelyi (2000) found that roundabouts reduced vehicles speeds considerably at intersections and on links between roundabouts. Roundabouts are especially effective at reducing fatal and serious injury crashes (up to 75% reductions), and also have a net benefit in terms of minor crashes.

Concerns have been raised in a number of studies about the safety of pedestrians at roundabouts. However, several studies have addressed this issue and it appears that roundabouts, in general, do have the potential for improving pedestrian safety with reduction of up to 75% in pedestrian casualties (Brilon et al. in Retting, Ferguson & McCartt 2003; Schoon & van Minnen in Retting, Ferguson & McCartt 2003; Midson 2009). However, roundabouts have a mixed record in relation to the safety of cyclists. Recent efforts have attempted to address this issue of cyclist safety, for example through a reduction in speed (e.g. Campbell et al. 2006; Asmus et al. 2012). Current research by Austroads is also addressing this issue.

The Austroads project on urban arterial speed (Hillier et al., 2016) also reviewed the benefits of signalised roundabouts, turbo roundabouts (which typically operate by reducing lane changes within the roundabout) and mini roundabouts. All of these designs appear to have benefits in terms of speed reduction and safety improvement. Signalised roundabouts were seen as a viable option for many urban arterial intersections, with the potential for maintaining higher traffic volumes than traditional roundabouts while providing even greater benefits (an estimated 30% reduction in casualty crashes compared with standard roundabouts; Hillier et al., 2016).

Raised intersections (also known as platform intersections, raised junctions or plateaus) are a speed management and safety device generally used on local roads, although there are increasing examples on arterials, particularly through activity centres. The entire intersection acts as a type of extended speed hump, with the aim of reducing speed.

Much of the research on raised intersections comes from the Netherlands. For example, Van der Dussen (2002) studied 82 intersections studied, of which 10 were treated with raised plateaus. The raised plateaus reduced injury crashes reduced by 80%.

The safety performance of raised intersections on urban roads, evaluated as part of the Austroads urban arterial speed project was reported in Makwasha & Turner (under review). There was an indicative casualty crash reduction of 55%. This reduction was not statistically significant, most likely due to the small sample size. On the other hand, the study found a statistically significant reduction of 7.5 km/h in 85<sup>th</sup> percentile speeds.

Several traffic signal based options were assessed as part of the Austroads research (Hillier et al., 2016), including 'rest on red' or 'dwell on red' signals. This involves including an additional phase so that a red traffic signal is displayed to all vehicle and pedestrian directions. This treatment has typically been applied on roads passing through entertainment precincts where there are likely to be high volumes of potentially distracted (often alcohol-affected) pedestrians, and is only activated late at night and into the early morning. The overall aim of rest-on-red signals is to reduce vehicle speeds and bring down the proportion of vehicles travelling at a speed that threatens severe pedestrian injury.

Lennè et al. (2007) installed a dwell-on-red treatment at an intersection in Ballarat, Victoria, on a section of road that reported a high number of pedestrian casualty crashes during high alcohol hours. The treatment was associated with mean speed reductions of 3.9 km/h at the 30 m detector point and 11.0 km/h at the stop line detector. Archer et al. (2008) trialled a similar treatment at an intersection in metropolitan Melbourne and also found significant reductions in average speed. Combining these results with more recent data from eight sites in Victoria indicated that casualty crash reductions of 45% and 85<sup>th</sup> percentile speed reductions of up to 11 km/h could be expected this treatment.

Other treatments with speed reducing potential at intersections reviewed as part of the Austroads study included road narrowing and deflection; other traffic signal treatments; and urban vehicle activated signs. Each of these treatments appear to have some speed reduction benefit, although in some cases this is quite limited.

### Urban arterial midblock treatments

A variety of midblock treatments were identified, including vertical deflection treatments (humps and platforms) and raised pedestrian ('Wombat') crossings. There is relatively limited data on the effectiveness of these on urban arterial roads, with most studies focussing on local and collector roads. Several international studies identify potential benefits. For example Elvik et al. (2009) reported that installing a raised crosswalk instead of an ordinary marked crosswalk decreased pedestrian-related injury crashes by 42%, and in cases with no existing crosswalk the reduction in all injury crashes was 65%.

As part of the Austroads research, Makwasha & Turner (under review) assessed the safety performance of raised platforms at midblock and wombat crossings. The study found significant casualty crash reductions of 47% and 63%, respectively. There were reductions in 85<sup>th</sup> percentile speeds of 5 km/h and 6 km/h, respectively.

Speed limits are a widely applied speed management method on urban arterial roads. Elvik et al. (2004) conducted a meta-analysis of speed limit changes in order to identify the actual change in speed and crashes. The findings show that it is rare for the mean speed to change by the same amount as the speed limit, although it almost always moves in the same direction. On average, the change in speed is around 25% of the change in speed limit. Therefore, a 10 km/h reduction in speed limit could be expected to bring about a 2.5 km/h reduction in mean speed. Given the link between speed reduction and positive safety outcomes, especially for higher severity crashes, it is likely that reduction in speed limits that bring about subsequent changes in speed will have a positive safety benefit. It should be noted that the influence of speed limit change on safety is often a complex issue. The eventual change in speed is dependent on a number of factors, and not just the posted speed limit. Therefore, changes in speed limit may need to be supported with other measures.

Variable speed limits (VSL) are dynamic road signs displaying variable statutory speed limits depending on

prevailing traffic, weather and road conditions. Austroads (2009a) provided a detailed review on the implementation of VSL across Australia and New Zealand, showing a wide variety of uses for this treatment. Several states across Australia are trialling VSL systems on urban arterial roads in high pedestrian activity centres (Scully et al. 2008; Main Roads Western Australia 2013; Austroads 2009b). The aim of the trials is to improve pedestrian safety during peak pedestrian activity periods.

A wide-scale international and domestic practice literature review on the application of VSL was undertaken by Han et al. (2008). The study outlined the application, effectiveness and operation of different VSL signs in Australia, New Zealand and internationally. The applications included school zones, shopping precincts, tunnels, bridges, motorways/highways/freeways and roadworks.

Scully et al. (2008) assessed the implementation of VSL treatments at 18 strip shopping centres across metropolitan Melbourne. The aim of the study was to evaluate the effectiveness of VSL in terms of overall crash reductions and reductions in crashes involving pedestrians. The study included control sites from the same local government areas as the treated sites. The data indicated reductions of 8% in all casualty crashes and 17% in casualty crashes involving pedestrians. Overall crash impacts ranged from an increase of 4.5% to a 19% reduction while crashes involving pedestrians ranged from an increase of 8% to a 36% reduction. The reductions in all crashes and pedestrian-related crashes were not statistically significant.

Several methods of managing speeds on urban arterial roads through road narrowing were identified. Perhaps most effective on urban arterial roads was the use of 'road diets'. This treatment involves converting a four-lane road (two each way) into a road with only one lane in each direction, and a two-way left turn lane (TWLTL, two-way *right* turn lane in Australia/NZ) in the centre. A road diet can also provide enough space to install a bicycle lane or on-street parking.

Several overseas studies have identified significant safety benefits from the use of these road diets. Stout et al. (2006) analysed the effect of 15 road diet projects in the United States. They found an overall 25% reduction in crash frequency per mile and a 19% reduction in crash rate.

Another study of multiple road diets in the United States found a more modest but statistically significant 6% crash reduction in the after period compared to the after period at control sites (Huang et al. 2002).

There is also evidence of speed reduction from the use of this treatment. An evaluation of a version of a road diet in New Zealand revealed that there were reduced speeds after the project was completed, although precise data on changes in mean and 85<sup>th</sup> percentile speed were not provided. Before the road diet, 21.1% of vehicles exceeded 60 km/h. After completion, this rate dropped to 5.1%. The rate of crashes dropped from approximately 8 to 7 per year (Rosales 2006).

Makwasha and Turner (2016) analysed the safety performance of 11 road diet sites across New South Wales and Victoria. Combining data from the 11 sites and results from leading international literature, the study suggested a reduction of 35% in casualty crashes could be achieved, and that average speed reductions of 4 km/h in 85<sup>th</sup> percentile speed and a 5 km/h reduction in mean speed could be expected. The results also showed improvements in traffic flow and reduced crossing distances for pedestrians.

Other treatments reviewed through the Austroads research (Hillier et al., 2016) for use on urban arterial road midblocks include other forms of road narrowing, including reduced lane width, pedestrian refuge islands, median treatments; use of deflection; vehicle activated signs; road surface and tactile treatments; transverse rumble strips; and shared spaces/naked roads. Many of these treatments have shown positive but modest reductions in speed and safety improvement as reported in Turner & Makwasha.

## Conclusion

Road users travelling above the speed limit, or too fast for the prevailing conditions are a significant safety problem on rural and urban arterial roads. In order to deliver Safe System outcomes on roads, there is a requirement to either improve the quality of road infrastructure in order to support current speeds, or to reduce speeds to a level where death or serious injury is minimised. Where this is not possible in the short to medium term, incremental safety improvements can be made through more moderate reductions in speed and/or through less substantial infrastructure improvements. These changes can be low cost and very cost effective.

**Table 1. Summary of treatment effectiveness**

Location	Treatment	Crash modification factor (CMF)	Speed reduction
Rural bends	Advance warning signs, chevrons and speed advisory signs	0.60-0.75	-
	Other delineation	0.80-0.95	-
	Vehicle activated signs	0.65	6 km/h
Rural intersections	Roundabouts	0.30	4 km/h
	Vehicle activated signs	0.30	5 km/h
Transition zones	Gateways	0.65	25 km/h
Rural routes and networks	Speed limit	-	4 km/h
	Wide centrelines	0.40	-
Urban intersections	Roundabouts	0.25	10 km/h
	Raised intersections	0.60	8 km/h
	Dwell-on-red signals	0.55	11 km/h
Urban arterial midblock	Humps/platforms	0.50	5 km/h
	Wombat crossing	0.40	6 km/h
	Speed limit	0.75	6 km/h
	Variable speed limits	0.92	-
	Road diet	0.65	5 km/h

**Source: Adapted from Hillier, Makwasha & Turner (2016), Makwasha & Turner (under review) and Turner & Makwasha (2014).**

The objective of this paper has been to highlight infrastructure-related treatments that can be used to reduce speeds where required. Table 1 summarises the effectiveness of the rural and urban speed management treatments discussed in this paper. Crash modification factors (CMFs) are provided for each. When multiplied by the number of crashes in the before period, these indicate the expected number of crashes in the after period (i.e. a CMF of 0.6 indicates a 40% reduction).

It is likely that combinations of treatments will have the greatest impact on safety. This may include combinations of different engineering solutions, as well as combination of engineering treatments along with non-engineering based solutions (e.g. education, enforcement and vehicle-based solutions). Suitability of these treatments will depend on the road environment, with more research required on treatments (including some widely used treatments) to determine how to maximise the safety benefits.

It is clear from the evidence presented in this paper that substantial safety benefits can be obtained using infrastructure treatments, in some cases up to around 70% reductions in casualty crashes. All of the treatments presented here operate (at least in part) through reductions in speed. One interesting conclusion to be drawn is that these findings provide further support for the relationship between speed and safety outcomes. In situations where speed reduction is obtained (especially many of the high-risk situations described above), substantial safety benefits are also observed.

During the research it has been a challenge in many situations to identify robust data relating to likely speed and crash reduction. This related both to emerging treatments as well as some established ones. On-going evaluation of measures is crucial. There is also the need for a repository of information on effective treatments (including speed and non-speed related) to inform expenditure on infrastructure improvements. This repository needs to be dynamic and regularly updated so that new or emerging measures are captured and disseminated to practitioners.

## Acknowledgements

The authors acknowledge the support of Austroads and road agency staff in providing information used in this study.

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## Safety of raised platforms on urban roads

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### Key Findings

- raised platforms at pedestrian crossings (wombat crossings) lead to a casualty crash reductions of 63%;
- platforms at midblocks reduce casualty crashes by 47%;
- raised priority controlled intersections reduce casualty crashes by 55% (p = 0.1),
- raised platforms also lead to speed reductions; 85<sup>th</sup> percentile speed reductions ranged between 5 km/h and 8 km/h for all platform types.

### Abstract

A recently concluded Austroads study identified effective and innovative countermeasures for improving safety outcomes on urban arterial roads. Included in the study were raised platforms at priority controlled intersections (raised intersections), midblock and pedestrian crossings (wombat crossings). While these treatments have been widely applied overseas and, to an extent, across Australia and New Zealand (especially wombat crossings and at midblock sections on local and collector roads), a measure of effectiveness in mixed use and high volume environments in an Australian context was required. Using available speed and crash data from across Australia, this paper applied Poisson regression analysis in a retrospective quasiexperimental study to determine the effect of raised platforms on crash occurrence and severity. The results showed that