

Evaluation of 40 km/h Speed Limits

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Executive Summary

The *NSW Road Safety Strategy 2012–2021* contains a vision to work towards Vision Zero. Consistent with other Australian and leading overseas jurisdictions, this strategy adopts a Safe System approach, which acknowledges that road users will make mistakes and that the road system should be designed to accommodate these mistakes.

A central concept of the Safe System approach is the recognition that, whatever the road and traffic environment, a speed can be set below which the consequences of road user mistakes will not be death or serious injury. The lowest of these speeds are for environments where vulnerable road users can interact with motor vehicles. Above 30–40 km/h the risk of death or serious injury in a pedestrian crash increases rapidly. In Australia, speeds are often restricted in these locations to 40 km/h, although most leading European jurisdictions have adopted 30 km/h as a more appropriate speed.

There are a number of circumstances in which 40 km/h speed limits are used in New South Wales (NSW), with the common feature being the presence of vulnerable road users such as pedestrians and bicycle riders. Types of 40 km/h speed zones include:

- High Pedestrian Activity Areas (HPAA) – operate on a permanent basis in areas of high pedestrian volume relative to the local area. The Centre for Road Safety manages a funded program for such areas.
- Local traffic areas and ordinary 40 km/h zones – operate on a permanent basis in areas that are primarily self-contained, residential precincts with networks of local streets used mainly for local access. Although recorded as different types of zones, in practice these two categories have no clear distinguishing features to discriminate them.
- School zones – operate in prescribed times on government gazetted school days.
- School bus zones – the 40 km/h limit applies to vehicles passing the rear of the bus when the alternating lights are flashing.
- Toll plazas in pedestrian access areas – operate on a permanent basis in toll plazas where toll operators require pedestrian access.
- Work zones – operate on a needs basis.

The launch of the HPAA program in 2003 initiated funding to assist in implementing full-time 40 km/h zones and guidelines to indicate where these should be and to provide technical requirements for their implementation. The HPAA program redirected the focus of 40 km/h zoning beyond local residential precincts, with relatively little traffic, towards busier environments where the safety benefits should be greater but where the challenge of managing roads with mixed uses was also greater.

This program now involves funding and guidelines by the Centre for Road Safety (CRS) to assist councils, in partnership with Roads and Maritime Services (RMS), to design and implement traffic calming treatments to create a self-enforcing 40 km/h speed environment in locations with more complex traffic issues to manage compared with a typical quiet residential precinct.

As at May 2016, there were over 900 km of roads in New South Wales with a permanent 40 km/h speed limit.

This report responds to a commitment in the NSW Pedestrian Safety Action Plan 2014–16 to evaluate the impact of the HPAA program. This evaluation also includes other permanent 40 km/h speed zones (local traffic areas and ordinary 40 km/h zones) and provides information to support other actions in this Plan to lower speeds to introduce safer speed limits. This evaluation, however, did not examine school zones or other non-permanent 40 km/h zones.

Evaluation outline

The purpose of the evaluation was to assess the effects of permanent 40 km/h speed zones in highly pedestrianised areas on road and roadside safety and on community amenity. The evaluation also examined the implementation factors contributing to effects, including the funded High Pedestrian Activity Areas (HPAA) Program.

The evaluation was designed to answer seven evaluation questions:

1. What is known about existing 40 km/h zones?
2. What effects have 40 km/h speed zones had on fatalities and injury crashes?
3. What other positive (public amenity, local economy) and negative effects have 40 km/h zones had?
4. How do effects differ by different site characteristics and other variables?
5. To what extent is there appropriate coverage of 40 km/h zones?
6. To what extent has the HPAA Program been designed and implemented effectively?
7. How might the implementation of low speed zones be improved to achieve better road safety outcomes for vulnerable road users?

Methodology

Information on 40 km/h speed zones was sourced from the CRS Speedlink database, reviewed and validated with Roads and Maritime officers where changes were required. Additional site information was obtained from site visits to approximately 40% of the HPAA zones, supplemented by desktop review of other sources.

The crash analysis was undertaken by matching crash data with known locations of relevant 40 km/h zones. The analysis was performed in two ways. Changes over the period of the HPAA program were measured for all zones and changes immediately before and after the installation of zones were measured, for the zones where this date was known. These changes were compared with other locations to seek to eliminate the impact of other changes over time.

Information about other impacts of 40 km/h limits, the effectiveness of HPAA program design and implementation, and views about potential improvements and future directions were sought in two ways. First, four workshops were held with 79

participants from RMS, councils and NSW Police. Two were held in Sydney, one in Coffs Harbour and one in Newcastle. These practitioner workshops collected a range of qualitative and quantitative data through facilitated discussions and individual questionnaires. Second, the views of 17 representatives of stakeholder organisations were obtained through semi-structured face to face or telephone interviews.

An online survey was conducted to gather information on the community's experience with 40 km/h speed limits, their views on the impact of 40 km/h limits, and their opinions about future options. The survey had 498 respondents, with quotas to ensure representative gender, age and location distributions.

A review of literature from a number of sources was undertaken, focussing in particular on other evaluations and evidence to supplement the information gathered through the discussions with stakeholders. To collect information from other jurisdictions, a questionnaire on their policy and practices was sent to members of the Austroads Safety Task Force, representing all Australian states and territories and New Zealand. Responses were received from all jurisdictions.

Effects on crashes

Both crash analysis methodologies – change in crashes over time for all zones and before and after crash analysis for HPAA zones with known implementation dates – showed statistically significant reductions in crashes and casualty crashes on the HPAA zone roads after the HPAA zones had been implemented.

The results of the analyses identified the following statistically significant effects of HPAA implementation:

- Casualty crashes: a 37.6% reduction in crashes 2002-2015 for HPAA compared to a 20.4% reduction on comparable 40/50/60 km/h roads elsewhere
- Serious casualty crashes: a 33.0% reduction in crashes 2005-2015 for HPAA compared to a 3.6% reduction on comparable 40/50/60 km/h roads elsewhere
- Pedestrian serious casualty crashes: a 46.4% reduction in crashes 2005-2015 for HPAA compared to a 19.1% reduction on comparable 40/50/60 km/h roads elsewhere
- For zones where implementation dates were known, a reduction of 12.5% to 16.4% in casualty crashes in the three to five years after implementation of HPAA zones compared to the three to five years before implementation.

The general reductions over the same time period in crashes and casualty crashes in the best available control group (the rest of NSW 40/50/60 km/h roads) suggests that part of the HPAA reduction may be due to other background factors. However, as the reductions in the HPAA zones were statistically significantly greater than for the control roads, this strongly suggests that the HPAA zones were effective in reducing crashes and casualty crashes.

Zones implemented under the HPAA program were responsible for most of the casualty reductions measured in the evaluation. HPAA zones demonstrated greater percentage reductions in casualty crashes compared with other permanent 40 km/h zones and also included roads with a far greater number of pedestrian and other crashes therefore achieving far greater reductions in absolute numbers of casualties.

The crash analysis did not identify any significant different outcomes according to the nature of the HPAA, its surrounding land use or other characteristics.

A key result is that the trauma reduction benefits applied to overall crashes. So, although the program is focused on vulnerable road users, it can contribute more broadly to the achievement of overall road safety objectives.

The crash analysis supports the view that there is significant opportunity for expanded coverage to generate increased benefits. With 84.4% of urban pedestrian trauma occurring outside 40 km/h zones, there remain many areas that would benefit from 40 km/h limits. While there will always remain some roads that require other treatments instead, a substantial proportion of these crashes are in clusters adjacent to existing HPAAAs.

Other impacts

Although quantitative traffic measures such as volumes or speed were not available for this evaluation, the views gathered from stakeholders were consistent with an extensive body of research that introduction of permanent 40 km/h zones results in a reduction in crashes, a reduction in travel speeds and some reduction in motorised traffic. It is also likely, supported by the literature, and information collected in this project, that road user behaviour has changed when 40 km/h zones have been implemented. In particular, lower speeds will result in the interactions between pedestrians and vehicles changing, with, for example, less likelihood for drivers to exploit a perceived right of way.

There was also a consensus, supported by the literature, that the creation of lower speed zones, such as through the HPAA, is associated with a number of other impacts in creating a road and roadside environment that supports increased pedestrian activity with a commensurate reduction in mobility for motorised traffic. This reduction would vary considerably according to the pre-existing traffic conditions. In some cases, the limit is merely reflecting previous traffic speeds and would therefore have little impact.

Overall opinions of 40 km/h zones were mixed depending on whether individuals placed greater value on mobility compared with safety and amenity. The results from the community survey, however, indicated strong support for 40 km/h on busy roads where lots of people were walking.

HPAA Program and Guidelines

The HPAA Guidelines, *"40 km/h Speed Limits in High Volume Pedestrian Areas"* (RTA, 2003), and current NSW and national speed zoning guidelines, are consistent with the predominant view amongst those implementing the program that speed limit changes in their own right are unlikely to achieve a reduction in speeds, and that greater use of

physical engineering treatments is needed. The cost of these treatments and the perception that they are not suitable for arterial roads has constrained the application of 40 km/h speed limits.

The HPAA Guidelines provide direction, and an original reference point, without being followed to the letter. However, the complex criteria for selection outlined in the Guidelines did not appear to be reflected in any differences in crash outcomes. There is some apparent difference between council and Roads and Maritime Services participants in their views regarding the potential application of HPAA's – the former appear more likely to see the guidelines and the need for RMS approval of speed limits and treatments as restricting options for a more extensive roll-out of HPAA's.

The need for, and nature of, traffic calming is a critical issue that needs further examination if lower speed limits in HPAA's or elsewhere are to become more widespread. Current HPAA and Austroads Guidelines and the need for total compliance by drivers were cited as factors that prevent the use of 40 km/h zones without traffic calming. The majority of practitioners expressed strong views that 40 km/h zones without traffic calming would not work. They also stressed the importance of the suitability of any treatment plan for the particular road and roadside environment and that these are unique for every site. However, there was general support for consistency to increase drivers' perceptions of the zone that they are in and, in particular, for the need for consistent threshold treatments.

Current traffic calming practices vary from geometric treatments, such as speed humps and horizontal deflection, that force a speed reduction, to just delineation and signage, such as is used in school speed zones. In some circumstances, where the road environment provides cues to a driver that it is an area of higher pedestrian activity, with narrow alignments or a well-defined urban precinct (such as the Sydney CBD), 40km/h limits should be feasible without geometric traffic calming. This would reduce cost, increase benefits more quickly, and still allow geometric treatments to target the highest risk areas and areas where significant changes are made to improve pedestrian amenity. Evaluations of trials of such zones can then inform future policy to consider adopting this approach more broadly.

Conclusions and recommendations

Many parts of the State's road network are now much safer and the HPAA program has contributed to this. The future approach to the program will need to be adjusted to capitalise on this progress, with consideration given to how to generalise the benefits to a much wider proportion of the road network and the communities who use it.

Councils and Roads and Maritime Services are managing multiple outcomes in a complex environment. It may be necessary to return to first principles regarding the safety and pedestrian outcomes being sought. The preparation in April 2016 of the draft NSW Road Planning Framework provides the opportunity to improve these outcomes through a framework that recognises that roads have different roles. Some should provide safe, reliable and efficient transport within urban areas whilst others, with higher pedestrian activity and lower levels of vehicle movement should create places of

value for local communities and visitors. This framework and the promotion of HPAA safety and pedestrian outcomes are mutually reinforcing. However, there remains the challenge of addressing pedestrian safety on busy, vibrant streets, particularly arterial roads, which have demands for movement, while managing significant pedestrian activity.

The conclusions and recommendations of this evaluation are as follows:

1. The results of this evaluation are consistent with previous studies of speed limit reductions – 40 km/h speed zones have reduced road trauma by significant amounts with roads now with HPAA experiencing almost double the reduction in casualty crashes compared to other urban roads since 2003.

It is recommended that programs to introduce safer speed limits in areas of high pedestrian activity should continue and that consideration should be given to expanding the scope of current programs to explore more opportunities for safer speed limits.

2. The HPAA program has successfully expanded the use of 40 km/h speed zones, and further expansion should be considered within a wider speed management and transport planning context.

It is recommended that the Centre for Road Safety works with Roads and Maritime Services, and with other functions in Transport for New South Wales, to develop a common understanding of the role of speed management in improving safety and supporting other programs to improve urban liveability.

3. The draft NSW Road Planning Framework provides a strong reference point for expanding speed limit zones below the urban default limit of 50 km/h, particularly where a location has a primary place function.

It is recommended that the Centre for Road Safety develops a strategy for future deployment of safer speed limits for pedestrian safety, and considers the following broad strategic options for doing so:

- a) *Business as usual*
 - i. *Minor adjustments and improvements to guidelines*
 - ii. *No change to council-led process*
- b) *Incremental increase*
 - i. *Increase council awareness*
 - ii. *Develop improved capacity and capability for Roads and Maritime Services to drive continued expansion in the number and size of sites*
 - iii. *Improve the funding and development process to provide more consistent support for councils to expand use of lower speed zones*
- c) *Strategic program*
 - i. *Establish strategic expectations for roads, whether controlled by Roads and Maritime Services or local councils, that targets vulnerable road user safety, while aligning with the development of successful places for people*

- ii. *Determine statewide rollout and priorities, similar to the process adopted for implementation of the 50 km/h urban default limit.*

4. The HPAA program guidelines are complex and put significant boundaries around implementation. They can be usefully revised to reflect learnings and support continued safety improvement.

It is recommended that, once the strategic direction for the program has been determined, the HPAA Guidelines, and other guidance, such as the Speed Zoning Guidelines, should be revised by:

- a) *Removing prescriptive criteria regarding different categories of land use for selecting sites*
- b) *Developing a prioritisation process for implementation that*
 - i. *Responds to community concerns regarding speed limits*
 - ii. *Addresses the risk of casualty crashes on roads with different movement functions, and*
 - iii. *Recognises other non-safety specific factors such as urban place-making needs*
- c) *Making the Guidelines more flexible and simple, and reflecting successful experience to date*
- d) *Ensuring compliance with improved program management requirements, including:*
 - i. *Improved implementation data for monitoring and evaluation*
 - ii. *Greater transparency of the funding and approval process*
 - iii. *Measurement of outcomes*
 - iv. *Regular review and improvement of the program.*

5. Change management is a critical element of any speed management reform, and should be a key consideration in implementing these recommendations.

It is recommended that a strategic communications and engagement program be implemented at a number of levels in order to:

- a) *Increase practitioners' understanding of the role of the program in achieving Safe System and place-making outcomes,*
- b) *Engage other stakeholders in the transport sector and elsewhere to gain their support in promoting the program*
- c) *Increase community understanding, and acceptance of, speed limits lower than the urban default limit of 50 km/h*
- d) *Increase the confidence of decision-makers that they can support lower speed limits while managing any adverse feedback.*

6. There is good potential in taking some smaller intermediate steps, ahead of a more significant program to capitalise upon the success of the HPAA program.

It is recommended that the following measures be considered for immediate action:

- a) *Improve consistency of zoning and signage by*

- i. *Reviewing current signposted 50 km/h local traffic areas and considering whether they are appropriate as 40 km/h areas*
 - ii. *Expanding existing 40 km/h zones, particularly into areas of significant pedestrian activity and/or on local cul-de-sac roads intersecting HPAA zones*
 - iii. *Rationalising overlapping school zones*
 - iv. *Replacing HPAA sign with standard 40 km/h sign to improve consistency and reduce visual clutter*
- b) *Relax pedestrian crossing warrants (criteria) in HPAA zones, possibly to the extent of removing the need for a warrant within an HPAA or 40 km/h zone, but including minimum spacings*
- c) *Trial 40 km/h zones without traffic calming treatments on both busy and quiet roads, considering a number of different options to create self explaining cues for drivers:*
 - i. *Speed zone signage alone*
 - ii. *Simple threshold treatments following standardised design principles*
 - iii. *Increased delineation*
- d) *Trial part-time zones that can allow the balance between movement and place to be altered at different times of day, or times of year, as traffic and pedestrian activity varies.*

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However, the conclusions and recommendations in this report are solely those of the authors and do not represent the views of either the Government of New South Wales or the Centre for Road Safety.

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Abbreviations and glossary

Casualty:	an injury or fatality
CRS:	Centre for Road Safety within Transport for NSW (TfNSW), formerly within the NSW Roads and Traffic Authority (RTA)
CrashLink:	the CRS database of crashes in NSW. Data was extracted from this database in November 2016, providing information on all crashes between 1998 and 2015
HPAA:	High Pedestrian Activity Area
LGA:	local government areas as defined prior to recent amalgamations to ensure consistency between crash and ABS data.
Permanent 40km/h zones	full-time 40km/h zones subject to this evaluation, include HPAA zones and other zones, generally in local traffic areas, defined as Local Traffic or Ordinary zones within the Speedlink database
RMS:	Roads and Maritime Services, formerly the NSW Roads and Traffic Authority and the NSW Maritime Authority
Serious injury:	an injury resulting in a person being admitted to hospital
Speedlink:	the CRS database of speed zone information. Data was extracted from this database in May 2016, providing location information of all 40 km/h zones as at that date.

Introduction

There are a number of circumstances in which 40 km/h speed limits are used in New South Wales (NSW), with the common feature being the presence of vulnerable road users, such as pedestrians and bicycle riders. Lower speed limits are designed to minimise crash risk and increase the survivability of crashes involving vulnerable road users. Types of 40 km/h speed zones include:

- High Pedestrian Activity Areas – operate on a permanent basis in areas of high pedestrian volume relative to local residential areas. The Centre for Road Safety (CRS) manages a funded program for such areas.
- Local and ordinary traffic areas – operate on a permanent basis in local traffic areas that are primarily self-contained, residential precincts with networks of local streets used mainly for local access.
- School zones – operate in prescribed times on government gazetted school days
- School bus zones – the 40 km/h limit applies to vehicles passing the bus in the same direction when the alternating lights are flashing.
- Toll plazas in pedestrian access areas – operate on a permanent basis in toll plazas where toll operators require pedestrian access.
- Work zones – operate on a needs basis.

This report responds to a commitment in the New South Wales Pedestrian Safety Action Plan 2014-16 to evaluate the impact of the High Pedestrian Activity Area (HPAA) program (TfNSW, 2014). This evaluation also includes other permanent, local and ordinary, 40 km/h speed zones and provides information to support other actions in this Plan to achieve safer speeds to improve pedestrian safety.

The HPAA program redirected the focus of 40 km/h zoning beyond local residential precincts, with relatively little traffic, towards busier environments where the safety benefits should be greater but where the challenge of managing roads with mixed uses was also greater.

Program context

In 1999, the Roads and Traffic Authority of NSW (RTA) published the State's strategic plan for road safety, *Road Safety 2010* and flagged the reduction of speed limits in urban areas as a means of improving road safety. By 2002, over 96% of the population resided within areas managed by councils that had introduced the 50 km/h default limit.

While the reduced 50 km/h default limit would provide benefits across all road user types, specific consideration was also given to pedestrians. Two key issues were identified for pedestrian safety:

- Increasing urban density, particularly in the Sydney, Central Coast and Wollongong areas, which was expected to increase exposure of pedestrians to injury

- Aging population, with the percentage of the NSW population aged 60 years or over projected to increase from 17% in 2001 to 25% in 2022, which would increase the proportion of more vulnerable older pedestrians.

Consequently, the RTA stated its intention to work with councils to implement 40 km/h zones in areas of high pedestrian and vehicle conflict (Rouse, 2002).

In 2001, the Government also announced initiatives to install 40 km/h school zones outside all schools, and to standardise operating hours on school days in the morning and afternoons when pedestrian activity around schools was at its greatest. School zones were introduced in 1992. By 2003, around 10,000 school zones were in place servicing over 3,150 schools in the State (Staysafe, 2012).

The launch of the HPAA program in 2003 initiated funding to assist in implementing full-time 40 km/h zones and guidelines to indicate where these should be and to provide technical requirements for their implementation (RTA, 2003). This redirected the focus of 40 km/h zoning beyond local residential precincts, with relatively little traffic, where 40 km/h zones were introduced in the 1980s, towards busier environments where the safety benefits should be greater but where the challenge of managing roads with mixed uses was also greater. The HPAA program built on earlier work by the RTA in providing guidelines for main street adaptation and limited funding for a number of demonstration projects (RTA, 2000a).

This program now involves funding and guidelines by the Centre for Road Safety to assist councils, in partnership with Roads and Maritime Services (RMS), to design and implement traffic calming treatments to create a self-enforcing 40 km/h speed environment in locations with more complex traffic issues to manage compared with a typical quiet residential precinct. Regular funding and continuing work by councils and RMS has seen a gradual increase in the installation of 40 km/h zones.

As of May 2016, there were over 900 km of roads in New South Wales with a permanent 40 km/h speed limit.

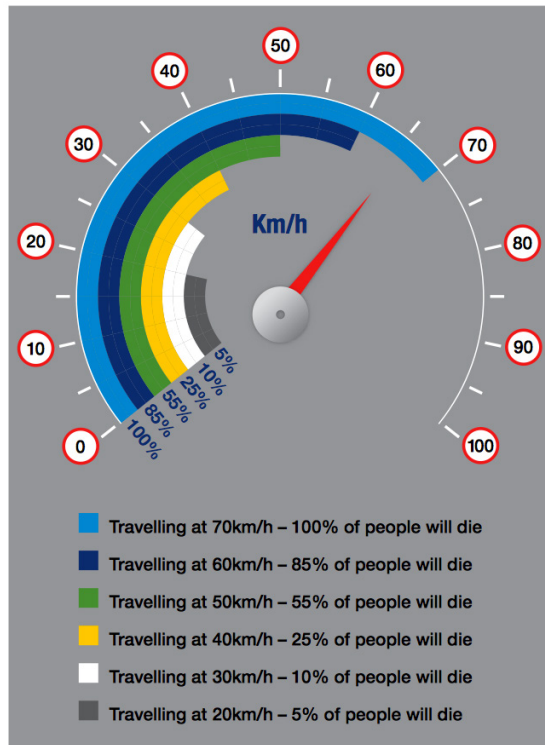
Pedestrians and speed management

The *NSW Road Safety Strategy 2012–2021* contains a vision to work towards Vision Zero. The strategy uses the Safe System approach as a “...pathway that has an end goal of no death or serious injury occurring on the road transport network. Crashes may continue to occur because, as humans, we make mistakes but the consequences need not be death or life disabling injury” (TfNSW, 2012c, p16).

A number of interventions can support a Safe System for pedestrians (Alavi & Corben, 2016). However a central concept of the Safe System approach is the recognition that, whatever the road and traffic environment, a speed can be set below which the consequences of road user mistakes will not be death or serious injury. The lowest of these speeds are for environments where vulnerable road users can interact with motor

vehicles. As shown in Figure 1, above 30-40 km/h the risk of death in a pedestrian crash increases rapidly. In Australia, speeds are often restricted in these locations to 40 km/h, although most leading European jurisdictions have adopted 30 km/h or 20 mph as a more appropriate speed.

Figure 1. Pedestrian fatality risk at different impact speeds (TfNSW, 2014)



In addition to these absolute Safe System speeds, there is also strong evidence that small reductions in travel speed can lead to significant reductions in the number of crashes and the severity of those crashes that do occur. Cameron and Elvik's review of Nilsson's speed:crash relationship for urban settings indicates that a 10 km/h speed reduction on urban arterials would reduce mean speeds by 4.2% and serious casualties by 6.5% (Cameron and Elvik, 2008).

It should be noted that these benefits accrue for all crashes, not just those for which a judgement has been made that they are speed related. They accrue from relatively small reductions in speed and do not rely on total compliance with limits (although, obviously, the quantum of benefits would increase if compliance were absolute). The introduction of the default 50 km/h urban limit across New South Wales was associated with a 25% reduction in the risk of being in a reported crash, despite a reduction in speeds on 50 km/h roads of only 0.94 km/h (RTA, 2000c). Similarly, Doecke, Kloeden and McLean (2011) reported significant crash reductions from relatively small reductions in speed.

When applied effectively, speed reduction measures can yield very large benefits at relatively low cost. For example, evaluation of speed reduction measures within the urban area of Gothenberg indicated a benefit cost ratio of 21.7 (Larsson & Carlsson, 2013).

Evaluation purpose and scope

While there is a strong body of evidence to indicate the benefits from lower speeds and supporting environments, this evaluation has sought to assess the effects of permanent 40 km/h speed zones in highly pedestrianised areas on road and roadside safety and on community amenity. The evaluation also examined the implementation factors contributing to effects, including the funded HPAA program. The evaluation also investigated whether the application of full-time 40 km/h speed limits in NSW has been done in a way that has yielded these benefits and how these benefits might be maximised in the future. The specific research questions the evaluation sought to answer are shown in Table 1.

It should be noted that, while the case for lower speeds is often based on safety benefits, as noted above, there are other potential positive impacts. This evaluation has therefore looked more broadly to an examination of the other benefits such as urban amenity and other community outcomes. This works both ways: lower speeds can encourage increased walking and use of spaces around roads (Heydecker & Robertson, 2009); and urban form can affect safety (Dumbaugh & Rae, 2009) and provision for pedestrians can increase walking with consequent benefits (Gould, 2011).

Included in this evaluation are all permanent full-time 40 km/h zones that apply to general traffic. For the most part, these have been installed with the prime objective of improving safety for vulnerable road users. School zones were not included in the evaluation nor were other 40 km/h zones installed for other purposes, such as limits for heavy vehicles on roads with steep gradients.

Evaluation framework

The first step in this project was the establishment of an evaluation framework to define the process for answering the key evaluation questions.

A draft evaluation framework was prepared and discussed at a workshop on 18 May 2016 with CRS and RMS officers to gain input to the framework. One of the main considerations in these discussions was the availability of data, particularly historical data regarding the installation of zones and to allow their impacts to be measured.

The final evaluation framework is provided as Appendix A to this report. The evaluation questions are shown in Table 1. This table also includes a number of guiding questions developed as part of the evaluation framework to provide further background on the issues to be addressed through each question.

Table 1: Evaluation Questions

Evaluation question	Guiding questions
1. What is known about existing 40 km/h zones?	<p>What permanent 40 km/h speed zones are in place?</p> <p>Which of these have been implemented under the HPAA program?</p> <p>What are the characteristics of these zones?</p>
2. What effects have 40 km/h speed zones had on fatalities and injury crashes?	<p>Have the numbers of crashes per year changed on roads after the introduction of the 40 km/h speed limit on those roads?</p> <p>What are the changes by crash severity (all crashes, injury crashes, serious injury crashes, fatal crashes)?</p> <p>What are the changes for pedestrian crashes by crash severity?</p> <p>How do these changes compare to general and comparable crash reductions in NSW?</p>
3. What other positive and negative effects have 40 km/h zones had?	<p>What effects have 40 km/h speed zones had on traffic speed and volume?</p> <p>What effects have 40 km/h speed zones had on road user behaviour?</p> <p>What effects have 40 km/h speed zones had on public amenity?</p> <p>What effects have 40 km/h speed zones had on local economies?</p> <p>What effects have 40 km/h speed zones had on the number and frequency of walking trips?</p>
4. How do effects differ by: different site characteristics and implementation circumstances?	<p>In particular:</p> <ul style="list-style-type: none"> • existence and type of traffic calming measure • whether funded under the HPAA program • road user group • other circumstances (e.g. nature and volume of pedestrian activity and traffic activity; surrounding environment). <p>To what extent are appropriate traffic calming treatments implemented in HPAAAs?</p>
5. To what extent is there appropriate coverage of 40 km/h zones?	<p>To what extent do HPAAAs cover appropriate areas across NSW?</p> <p>To what extent are individual HPAAAs effectively located?</p> <p>What role has the HPAA program played to this end?</p>
6. To what extent has the HPAA program been designed and implemented effectively?	<p>Development and implementation</p> <p>How well do the guidelines and processes for nominating, selecting and approving an HPAA support the program purpose?</p> <p>To what extent are these processes implemented effectively?</p> <p>To what extent are alternative solutions utilised when HPAAAs are not appropriate?</p> <p>To what extent does the HPAA program interact effectively with other speed zones and speed management tools?</p>
	<p>Promotion</p> <p>How has the HPAA been promoted within Roads and Maritime, and with councils?</p> <p>To what extent are HPAA public education resources and the media information package designed and delivered to their target audiences effectively?</p>
	<p>Governance and Funding</p> <p>To what extent is HPAA program governance designed appropriately and implemented as planned?</p> <p>How has HPAA activity and investment been monitored and audited?</p> <p>What has been the total investment in HPAAAs by Roads and Maritime, and by councils?</p> <p>To what extent does the HPAA funding model facilitate effective implementation?</p> <p>To what extent does actual program expenditure reflect planned program expenditure?</p> <p>Are there agreed implementation or delivery mechanisms between Roads and Maritime and councils?</p>

7. How might the implementation of low speed zones be improved to achieve better road safety outcomes for vulnerable road users?	To consider: policies and programs relating to speed zoning, infrastructure treatments and other supporting activities
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Structure of this report

This report follows the structure of this framework.

The following section describes the overall project methodology and the subsequent sections address each of the evaluation questions in turn. The last section provides overall conclusions and recommendations for the future for this program and for speed management for vulnerable road users, in general.

The report also contains a reference list that contains documents cited in the report as well as other relevant sources that may assist in deeper understanding of particular issues.

The appendices contain much of the information gathered during the evaluation and provide a more detailed analysis of this. They are as follows.

- **Appendix A: Evaluation framework.** The full evaluation framework approved as part of this project. This also contains detail of the project methodology.
- **Appendix B: Case studies.** A more detailed description of particular sites in order to provide a fuller understanding of the range of 40 km/h zones and to illustrate some of the issues raised in the report.
- **Appendix C: Crash analysis and zone information.** The full crash analysis and a description of the site parameters for each 40 km/h zone.
- **Appendix D: Project exhibits.** Copies of survey instruments, interview outlines etc that were used in the evaluation.
- **Appendix E: HPAA Program guidelines.** This document (RTA, 2003) is included for reference.
- **Appendix F: Community survey.** Results from an online survey that captured the views of 498 residents of New South Wales regarding 40 km/h speed zones and their implementation.
- **Appendix G: Policy and programs in other Australasian jurisdictions.** A summary of information collected from other road safety agencies in Australia and New Zealand about their policies and programs to reduce speed to protect vulnerable road users.

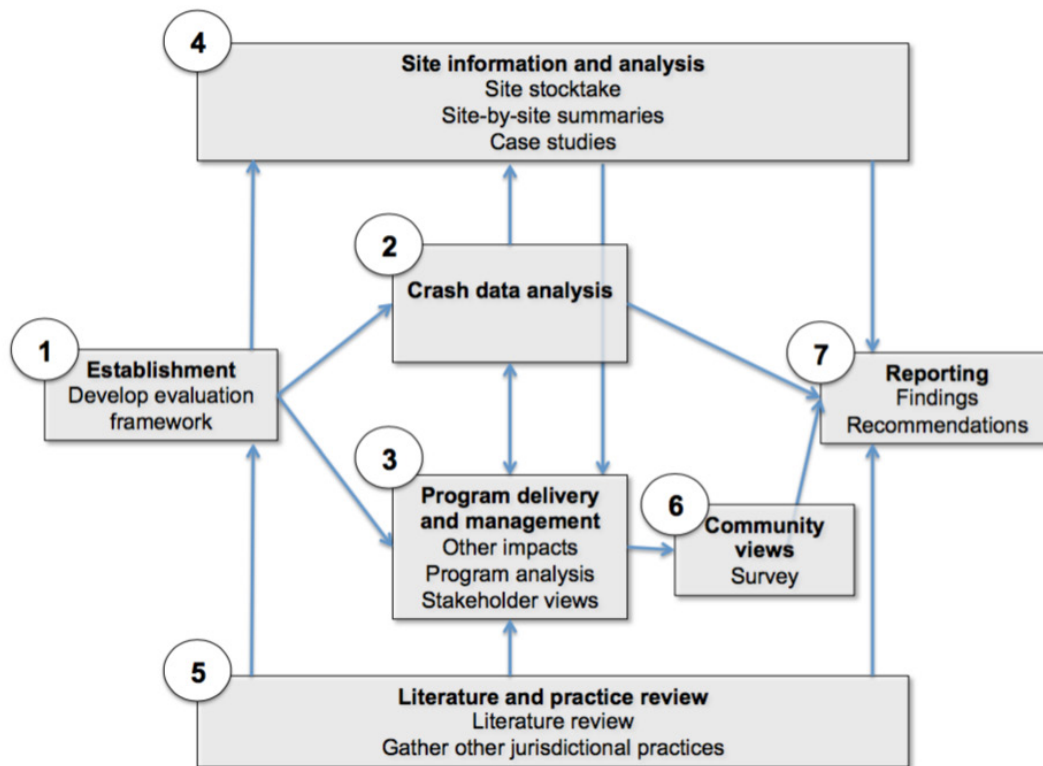
Methodology

The overall methodology proceeded in parallel streams to develop conclusions from crash data analysis with other conclusions based on program analysis and input from stakeholders – particularly Roads and Maritime Services and councils. These two streams supported each other and were also supported by investigation into sites, and a review of relevant literature and practice.

The project methodology, as shown in Figure 2, therefore combined a conventional crash analysis process with a number of processes to collect stakeholders' views of, and experience with, the program.

The evaluation in areas of program management, including the preparation of case studies and other inventory information to describe recent work, focused on the HPAA program as most recent implementations of 40 km/h areas have been undertaken through this program.

Figure 2: Evaluation project components



A summary of the methodology for each of these components is provided below. The detailed methodology is described in Appendix A. The application of this methodology to each of the evaluation questions is described at the beginning of each of relevant section.

Crash data analysis

The crash analysis was undertaken in two ways. For all sites where a date was known for the installation of the 40 km/h limit, a comparison was made of the crashes before and after this date. Crash numbers were compared for periods of one, two, three, four and five years before and after installation – that is, one year before installation compared to one year after; two years before compared to two years after; and so on. A second methodology was used to cover all sites, regardless of whether their installation date was known. This compared the latest available data, when all HPAA zones had been installed, with the data for 2002 on the same lengths of road, when none of the HPAA zones had been installed. These changes were compared with other locations to seek to eliminate the impact of other changes over time. Details of the methodology and analysis results are provided in Appendix C.

Program delivery and management

Information about other impacts of 40 km/h limits, the effectiveness of the program development and delivery processes, and views of potential future directions were sought in two ways. Four workshops were held with 79 practitioners from Roads and Maritime Services, councils and NSW Police. Two were held in Sydney, one in Coffs Harbour and one in Newcastle. These workshops collected a range of qualitative and quantitative data through facilitated discussions and individual questionnaires.

The views of representatives of stakeholder organisations were obtained through semi-structured face to face or telephone interviews: 17 individuals participated from a number of areas within the government agencies as well from peak bodies representing the interests of various road user groups.

Site information and analysis

Information on sites was sourced from the Speedlink database. This was reviewed by the authors and validated with Roads and Maritime officers where changes were required. Additional site information was obtained from site visits to approximately 40% of the HPAA zones, supplemented by desktop review of other sources.

Literature and practice review

A review of literature from a number of sources was undertaken, focussing in particular on other evaluations and evidence to supplement the information gathered through the discussions with stakeholders. To collect information from other jurisdictions, a questionnaire on their policy and practices was sent to members of the Austroads Safety Task Force, representing all Australian states and territories and New Zealand. This questionnaire also sought other jurisdictions' views on future speed management practices. Responses were received from all jurisdictions, and are reported in Appendix G.

Community views

An online survey was conducted to gather information on the community's experience with 40 km/h speed limits, their views on the impacts of these limits, and their opinions about future options. A sample size of 498 was collected with quotas to ensure representativeness according to gender, age and location. A report of the survey design, delivery and results is provided in Appendix F.

Limitations

As the evaluation proceeded, the methodology was adjusted to cater for two major limitations in the information available to support the analysis: lack of data in Speedlink and limited historical data relating to individual projects. These also affected the extent to which some of the evaluation questions could be answered as well as the precision of these answers.

While CrashLink is well established, one of the limitations to Speedlink is that it was only populated with historical implementation data in 2012 and, although it contains data that pre-date this, it is not complete, particularly in relation to installation dates for speed zones, critical information if before and after differences are to be assessed. To minimise the impact of this, the evaluation team reviewed the data from other public sources, including Open Street Maps and Google Earth, and also sought clarification of specific data issues from RMS. The two crash analysis methodologies, described above, were developed to cater for the differences in data availability for different sites.

The evaluation team also had access to very little historical data covering other aspects. This was due both to the lack of quantitative before and after data to assess impacts such as traffic speed and traffic volume and an inability to access project or program files due to changes in records management systems being concurrently implemented. Throughout the project this remained a significant factor in requiring an approach that relied on gathering post hoc information from those involved in, or with an interest, in this program.

Evaluation Question 1: What is known about existing 40 km/h zones?

The response to this question has two purposes. Firstly, it provides a stocktake of the 40 km/h zones currently in place and explains their nature in order to describe the implementation of these zones generally and, specifically, those implemented under the HPAA program. Secondly, it provides the data that forms the basis of subsequent analysis, particularly the crash analysis.

A review of current information held in the Speedlink speed zone database was undertaken and compared with other known sources. Speedlink contains a record of individual zones and road segments in NSW and their speed limit. In June 2016, an extract was made from the database for all identified 40 km/h speed zones and the individual road segments making up each zone.

This database analysis was supplemented by a review of zones using current and historical data from Google Earth as well as visits to a large sample (approximately 40%) of the HPAA sites.

Number of HPAA and other permanent zones

A total of 5,650 40 km/h records were identified from Speedlink. From this list, only zones that were noted as existing at the time of the extract were selected (this excludes “Proposed”, “Authorised” and “Revoked” zones). Since only permanent 40 km/h speed zones (as opposed to time based zones such as school zones) are of interest in the current evaluation, only 40 km/h speed zones of the types “High Pedestrian”, “Local Traffic” and “Ordinary Permanent” were selected.

Speedlink includes 194 HPAA zones. However, six of these recorded zones are either duplicates or could not be matched with any actual signage installed. Hence, there are 188 actual HPAA zones and these are shown in Figures 3 and 4. Overall, the HPAA zones cover 343 km of roads.

The number of separate areas that these zones define is less than this. In some cases a small network of roads would be described in Speedlink as a single zone, in others a similar area would be defined by a collection of individual road lengths, each with its own unique zone identification. Grouping these zones together would then define an area. An objective count of the number of areas could be obtained from HPAA project approval documentation. However, this documentation was not available to the project due to current records management changes being introduced by Roads and Maritime Services, and program finance data is not sufficiently disaggregated to provide individual project counts.

In the absence of these sources, estimates of the number of areas were made and these vary according to the purpose of the estimate and are dependent on subjective assessments. In this section, the purpose of the estimate is to provide a snapshot of the

current state of the road network as observable by the community. The criterion to determine whether adjacent zones formed a single area was whether they would appear contiguous to a driver. This was assessed by site visits and a desktop mapping review. 131 discrete areas were identified and these are the basis of the discussion in this section.

For the crash analysis, slightly different criteria were used as it was necessary to separate zones where they had different implementation dates. This process identified 155 discrete areas, 75 in the Sydney Metropolitan area and 80 elsewhere.

Figure 3: Location of HPAA zones – New South Wales

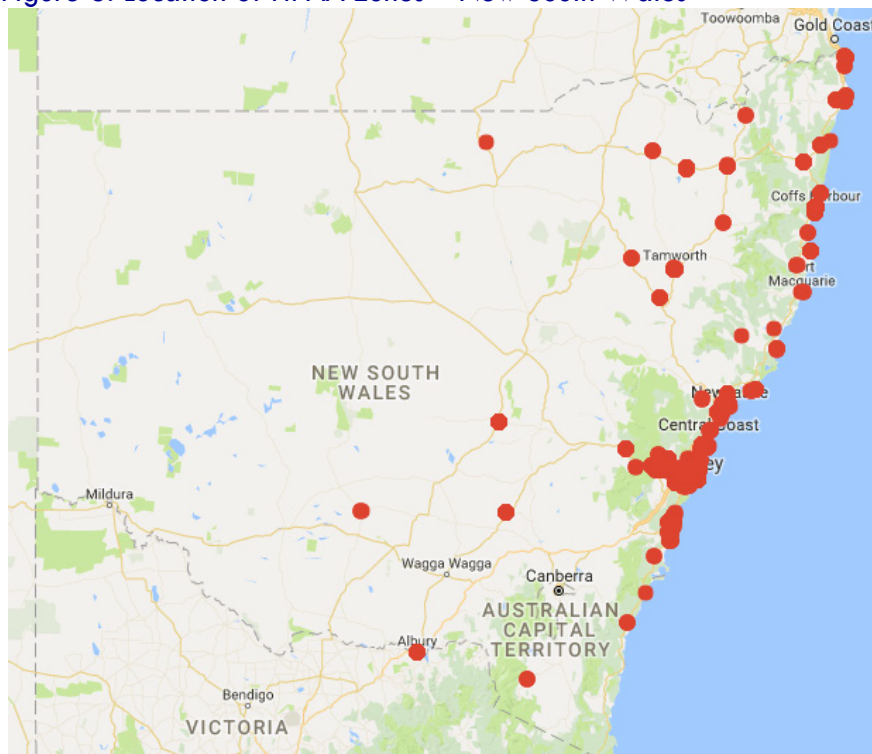
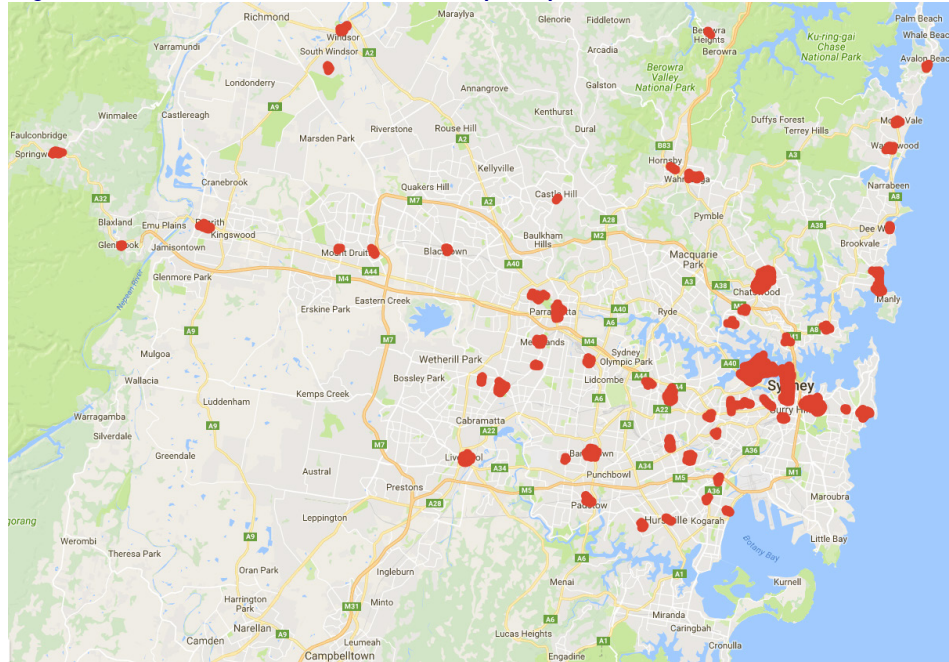
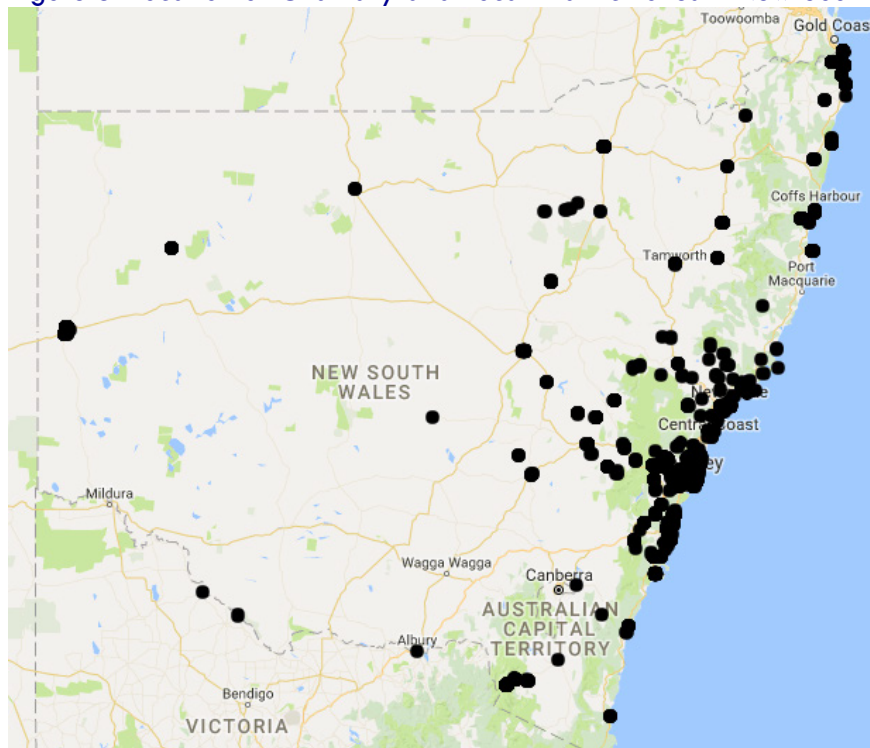


Figure 4: Location of HPAA zones – Sydney



There were 431 other Ordinary Permanent and Local Traffic 40 km/h zones, covering 582 km of roads. These are shown in Figures 5 & 6. Together with the HPAAs, these cover over 900 km of roads. Although “Local Traffic” and “Ordinary Permanent” zones were recorded as different types of zones, in practice these two categories have no clear distinguishing features to discriminate them.

Figure 5: Location of Ordinary and Local Traffic zones – New South Wales



A detailed map of Sydney, Australia, and its surrounding regions, including parts of New South Wales and Victoria. The map is overlaid with numerous black dots of varying sizes, representing the locations of bushfires. The dots are densely clustered in the central and eastern parts of Sydney, particularly in the areas around the city center, the harbor, and the Blue Mountains. The map also shows major roads, parks, and other geographical features. The legend indicates that the dots represent bushfires, with the size of the dot corresponding to the number of bushfires in that area. The map is titled 'Sydney, Australia' and includes a scale bar and a north arrow.

Further refinement of the speed zone data was undertaken to enable the crash analysis to be undertaken and this is described in Appendix C.

Characterisation of HPAA Zones

The Guidelines include a decision tree to determine whether a location meets the criteria. An assessment of all HPAA zones was made against these criteria.

- Category A
 - Servicing a business or commercial area
 - Servicing a shopping strip greater than 1km
- Category B
 - Adjacent to a railway station
 - Adjacent to a bus interchange
 - Servicing a small shopping strip less than 1km
- Category C
 - Servicing a restaurant area
 - Servicing a hotel or entertainment area
 - Adjacent to a social security office or medical centre
 - Adjacent to a pre-school
 - Adjacent to a retirement village
 - Servicing a sporting complex
 - Adjacent to a recreational area/beach or park.

The Guidelines effectively set three classes of sites suitable for a pedestrian precinct treatment:

Class 1: Meets at least one of Category A,

Class 2: Meets at least two of Category B, or

Class 3: Meets one of Category B and at least four of Category C.

A review of each site was undertaken to determine which of these three classes the area was in, or whether it appeared not to meet any of them (Not classified). For the purpose of the review, any site meeting one of Category B was assumed to also have the required Category C surrounding land use.

The current HPAA areas were classified as shown in Table 2:

Table 2. HPAA Classification according to HPAA Guidelines criteria

	Areas	HPAA zones	
HPAA Classification		Zones	Length (km)
Class 1	25	49	133
Class 2	13	20	15
Class 3	69	83	155
Not classified	24	36	40
Total	131	188	343

Note: An area may consist of a number of connected zones

Land use type

A further characterisation was undertaken to identify different land use types associated with the HPAA zones. These categories were developed by the authors based on site visits of a sample HPAA locations. They overlap the above classifications, to some extent. However, whereas the HPAA classification relates to scale, the land use

characterisation considered the nature of the land use as well as its scale, as these are partially interdependent.

- **Commercial centre**
Zones in areas of substantial mixed commercial land use - likely to be a major traffic attractor and generator of pedestrian traffic
- **Commercial / Transport - Major**
Zones in a commercial centre also managing significant pedestrian traffic from transport interchanges
- **Commercial / Transport - Minor**
Zones in commercial areas with adjoining railway station
- **Commercial**
Other zones in areas of substantially retail, commercial or tourism land use
- **Parking access**
Zones in roads near commercial or other areas that mainly provide access to parking around shopping centres or other facilities
- **Recreation / Sport**
Zones on roads adjoining sporting or recreational areas, may be some incidental commercial or residential land use
- **Residential**
Zones in roads servicing local residential access, may be some incidental commercial land use
- **Urban Village**
Extensive areas encompassing, residential, retail, dining, etc. Little through traffic.

Appendix B provides some further detail of these different characteristics through the description of a number of illustrative case studies. While this characterisation illustrates the range of different applications of HPAAAs, the crash analysis was unable to measure any significant differences in outcomes between these, due to small sample sizes.

Topology

HPAA zones were also assessed from a desktop review to determine whether they were predominantly linear or formed a small network. Linear zones are, typically, one or two road lengths with short lengths on intersecting streets. Zones on these intersecting streets function just to establish the limit on approach to the main zone and would have little effect on speeds as the intersection itself requires traffic to slow down to prepare to give way. Networks cover a number of interconnected streets such that some of the streets can only be entered from another 40 km/h street.

As shown in Table 3, approximately two thirds of the HPAAAs are linear, on the other hand, a large majority of HPAA road lengths are in networks, due to a number of very large treatments.

Table 3. HPAA Classification according to topology

	Areas	HPAA zones	
Topology		Zones	Length (km)
Linear	87	107	79
Network	44	81	264
Total	131	188	343

Note: An area may consist of a number of connected zones

Sydney Central Business District

Although the Sydney Central Business District (CBD) includes only two of the 188 HPAA zones, its significance to the program is far more than that and represents a single unique area within the HPAA program. In length, the HPAA zones in the CBD cover 28 km – 8% of the total length covered by the HPAA program or just 3% of the length of permanent 40 km/h zones across the state. On the other hand the pedestrian activity and traffic interactions that need to be managed in this area represent its far greater importance to pedestrian safety in New South Wales.

The CBD is diverse with some of the HPAA zones covering multi-lane roads, such as George Street, which pose a particular challenge in promoting safer walking while managing significant traffic flows, older narrow streets in The Rocks with a greater need for pedestrian amenity, and a number of areas of full pedestrianisation. In addition, the HPAA zones have been installed with no additional traffic calming.

As described in the following section, the situation in the Sydney CBD results in it seeing a far greater proportion of the crashes in 40 km/h zones and pedestrian trauma represents a greater proportion of all trauma in the CBD, compared with elsewhere.

The CBD is also in a state of change with the 40 km/h limit only installed in 2014, with an expansion in 2016 and is also now subject to significant developments, including the completion of Barangaroo and the installation of the George Street light rail.

Discussion

Speed zones do not occur in isolation. The characteristics of individual zones are determined more by the road function and design, traffic, and surrounding land use than by the design of the speed zone and associated treatments themselves.

Separating these design elements for the purpose of a program evaluation is therefore not feasible. For example, while there is an interest in understanding the impacts of different traffic calming treatments, in practice the design and even the presence of treatments may have less of an impact than road alignment, road cross section and traffic. Some zones, such as in Paddington, will experience low speeds as the nature of the streets provides no other option for drivers. Others, with wide, straight streets and a significant through traffic function, such as Coffs Harbour or Warriewood, will rely on

traffic calming to moderate speeds. More information on these treatments can be found in Appendix B.

Sometimes, 40 km/h zones address safety objectives, at other times they address amenity objectives. While safety is the main objective and for some zones, such as George Street in Sydney (see Figure 7), the only objective, considerable investment has also been made to improve amenity in other zones, such as Kiama, Parramatta and Castle Hill (see Figure 8), with infrastructure to support a variety of roadside activities, such as dining or shopping.

Figure 7: George Street – 40 km/h to manage pedestrian interactions with traffic



Figure 8: Parramatta – 40 km/h to support improved pedestrian amenity



This difference is particularly noticeable at Bankstown where, within one 40 km/h area, the objectives of safety, on a road with a significant movement function and separation of pedestrians (Figure 9), and amenity, on a road through a local shopping strip (Figure 10), each take prominence in different streets.

Figure 9: Restwell Street, Bankstown



Figure 10: Bankstown City Plaza



For each of the currently installed zones across NSW, the relative importance of these two objectives lies on a continuum between these two extremes and is therefore difficult to parameterise for the purpose of evaluation. Nevertheless, the importance of

these two objectives for different stakeholders was a key point of discussion throughout this evaluation and informs the options for the future.

Observations on implementation

In examining a number of the HPAAAs and their surrounding environments, observations were made regarding consistency and relationship with other zones.

Local Traffic Areas

The use of Local Traffic Area signs to indicate a 50 km/h limit is widespread (see Figure 11). These were installed at the time the limit was dropped from 60 km/h before there was a 50 km/h default limit.

Figure 11: 50 km/h Local Traffic Area, Dulwich Hill



This legacy has a number of implications. First, there is the potential for confusion and diluting the impact of the HPAA sign to emphasise the need for 40 km/h to protect pedestrians. Secondly, it dilutes the understanding that the general urban default limit is 50 km/h, and that the limit would be 50 km/h even without the signs. However, this situation creates an opportunity. If 40 km/h is now promoted as the appropriate speed for pedestrian precincts, then converting these 50 km/h zones to 40 km/h would support this, particularly where these zones already have traffic calming installed, such as through footpath widening creating an entrance threshold (see Figure 12).

Figure 12: 50 km/h zone with mild traffic calming, Milton



School zones

In a number of places, for example North Sydney (see Figure 13), the full-time 40 km/h zone overlaps a part-time school zone. This could give rise to significant confusion when entering the school zone, as there could be a justifiable inference at non-school times that the limit is no longer 40 km/h.

Figure 13: Miller Street, North Sydney



Local streets intersecting HPAA zones

In a number of cases, the HPAA zone along a shopping strip, for example, intersects with some short, residential streets with narrow alignment, frequently cul-de-sacs (see Figure 14). These are signed as 50 km/h. While this is consistent with current guidelines, it is counter-intuitive as the road standard and function is clearly below the road zoned at 40 km/h.

Figure 14: Glebe Point Road, Sydney



This could be changed with no traffic impact, would reduce speed limit complexity and reinforce 40 km/h as the standard limit for such environments.

Evaluation Question 2: What effects have 40 km/h speed zones had on crashes?

NSW crash data for the years 1998-2015 were extracted from the CrashLink database for this project on 14 November 2016. The data included the precise location of each crash. A method was developed to check if each crash happened within 15 metres of a road segment defining any of the permanent 40 km/h zones extracted from the Speedlink database. Using this method, each crash was classified as occurring in a specific current 40 km/h speed zone or as not being in any such zone. Note that this is independent of the actual speed limit in a given zone at the time of the crash.

The permanent 40 km/h zones were put into two groups. The zones implemented under the HPAA program were placed in the HPAA zones group and the remaining zones (local and ordinary) were placed in the other permanent 40 km/h zones group. Note that non-permanent 40 km/h speed zones (such as those around schools) were not part of the evaluation but were included in the comparison group.

Two broad methodologies were adopted. The first was to examine changes in crashes over time for all zones (155 HPAA zones and 431 other permanent 40 km/h zones). By comparing the number of crashes in 2002 (when no HPAA zones had been installed) to 2015 (when all had been installed) the cumulative effect of HPAA zone installation on crashes in HPAA zones was examined. Changes over the same time period were also examined for the other permanent 40 km/h zones group and for a comparison group consisting of crashes in the rest of NSW on 40/50/60 km/h roads. Due to a change in the reporting criteria for non-casualty crashes at the end of 2014, the total number of crashes (including non-casualty crashes) for 2015 is not comparable to earlier years so comparisons for all crashes were between 2002 and 2014. Serious casualty crash data were only coded for crashes in NSW from 2005 so comparisons for serious casualty crashes were between 2005 and 2015.

The second methodology involved a before and after crash analysis for HPAA zones with known implementation dates. This method reduces the confounding effects of long term trends and allows direct comparison of the number of crashes in a given number of years before HPAA implementation with the same number of years after implementation. It is, however, limited by the number of HPAA sites with a known implementation date. Many of the earlier year HPAA sites did not have an implementation date recorded in the CRS Speedlink database and only a few of the unknown ones could be obtained from the regions. This resulted in 75 HPAA zones with a known implementation date. Additionally, the more recently implemented HPAA zones do not have enough post-implementation crash data to allow analysis in some cases and the limited availability of serious casualty crash data precludes some others when examining changes in serious casualties. The other permanent 40 km/h zones group only had 31 zones with a known implementation date which provided no meaningful results (see Appendix C for the analysis conducted on this group).

Seven groups of crashes were examined:

All crashes - crashes of any severity including those where there was no injury (tow away) (2015 not comparable to previous years)

Casualty crashes - crashes in which at least one person was injured or killed

Pedestrian casualty crashes - crashes in which at least one pedestrian was injured or killed

Serious casualty crashes - crashes in which at least one person was seriously injured (admitted to hospital) or killed (only known for crashes from 2005 onwards)

Pedestrian serious casualty crashes - crashes in which at least one pedestrian was seriously injured (admitted to hospital) or killed (only known for crashes from 2005 onwards)

Fatal crashes - crashes in which at least one person was killed

Pedestrian fatal crashes - crashes in which at least one pedestrian was killed

A more detailed description of the methodologies and additional results are provided in Appendix C.

Change in crashes over time for all zones

Changes in crashes of the various types over time are shown in Table 4 and graphically in Figures 15-19 for both HPAA zones and other permanent 40 km/h zones. For comparison, changes in crashes in the rest of NSW 40/50/60 km/h zones (as reported by police¹) that did not occur in any of the identified 40 km/h zones in each year are also shown. This is not an ideal comparison group as many of these roads had their speed limits reduced during the period examined (specifically with the progressive introduction of 50 km/h speed limits from 1997 to 2003). However, it is the most comparable group available given the constraints of this study.

From 2002 (when there were no HPAA zones) there have been statistically significant reductions in the number of crashes (40.3%), casualty crashes (37.6%) and pedestrian casualty crashes (49.2%) at the sites that would eventually become HPAA zones. Compared to the reductions over the same time period in the rest of NSW (40/50/60 km/h zones) the reductions in HPAA sites were statistically significantly larger for all crashes and casualty crashes but not for pedestrian casualty crashes.

Analysis of serious casualty crash trends was limited by data only being available from 2005, at which point many of the HPAA sites would have already been implemented (thus underestimating the benefits of introducing the HPAA zones). Nevertheless, from 2005 there have been statistically significant reductions in the number of both serious casualty crashes (33.0%) and pedestrian serious casualty crashes (46.4%) with the reductions being statistically significantly larger than the rest of NSW (40/50/60 km/h zones) over the same time period.

¹ Crashes identified by police as occurring in a 40 km/h speed limit but that are not in any of the identified HPAA or permanent 40 km/h zones will be included in this comparison group. This includes non-permanent speed limits such as school zones, 40 km/h speed zones not identified and cases where the police incorrectly recorded the speed limit.

Although reductions in the number of fatal crashes and pedestrian fatal crashes in HPAA zones were observed, the numbers were too low to show any statistically significant results (there were only 3 fatal crashes, all involving pedestrian fatalities, in 2002 and none in 2015).

This analysis suggests that the installation of HPAA zones reduces crashes and casualty crashes (especially where the reduction in HPAA zones is greater than for the rest of NSW). However, there are a number of uncertainties that limit the conclusions:

- It is not clear what is driving the general reduction in crashes
- It is not clear that these factors have influenced the HPAA zones and the rest of NSW in the same way.

Possible factors are:

- Newer vehicles providing greater protection for occupants and pedestrians
- The amount of vehicle travel
- Changes in vehicle travel patterns
- The amount of pedestrian traffic
- Changes in speed limits
- The amount of speed enforcement
- Changes in vehicle speeds for other reasons
- Changes in road infrastructure
- The implementation of other road safety programs.

Differences in these factors over time between HPAA zones and the rest of NSW could be masking or exaggerating the apparent effects and differences. While these issues cannot currently be resolved, the data at present does indicate that HPAA zones are effective at producing safety benefits.

Impacts in the other permanent 40 km/h speed zones (local and ordinary) are more difficult to assess as many of them may have been introduced in unknown years prior to 2002. This means there is no single reference year for this group. The number of crashes is also much lower which means that observed differences need to be much larger to be statistically significant. Statistically significant reductions were observed for all crashes (35.3%), casualty crashes (30.0%) and pedestrian casualty crashes (46.1%) but these were not statistically significantly different from the reductions in the rest of NSW (40/50/60 km/h zones). There were only two fatal crashes in other permanent 40 km/h zones in 2002, both involving pedestrian fatalities, and only one pedestrian fatality in 2015.

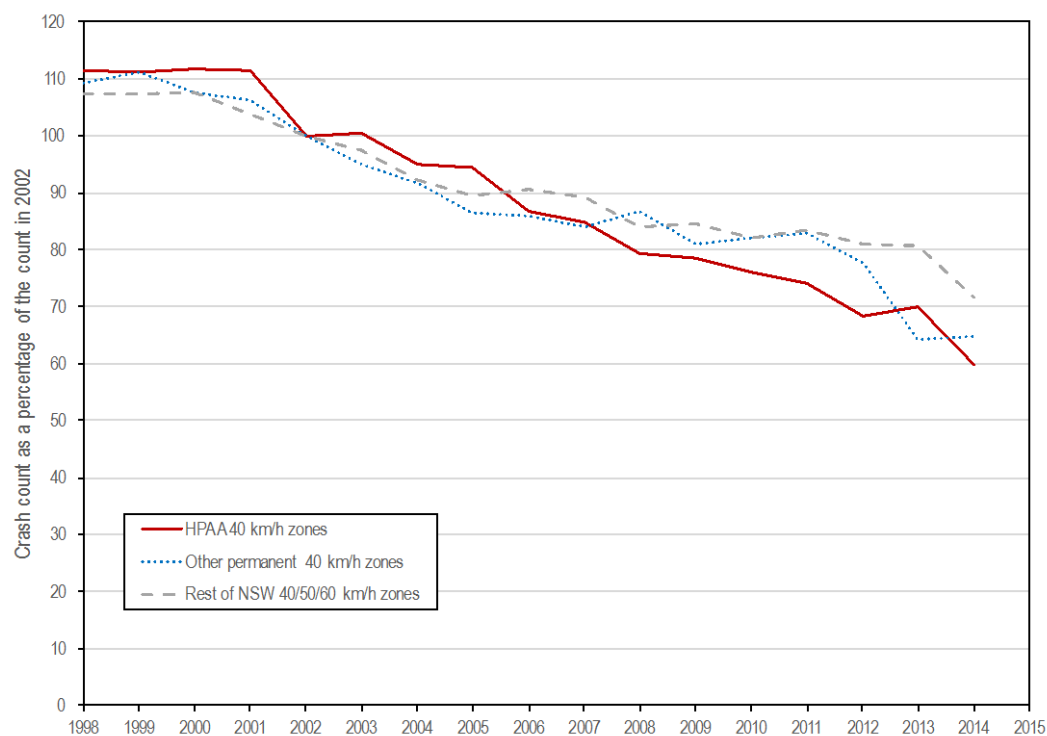
Table 4: Crash reductions over time by crash type and area

Crash type (years compared)	HPAA 40 km/h zones (% reduction)	Other permanent 40 km/h zones (% reduction)	Rest of NSW 40/50/60 km/h zones (% reduction)
All crashes (2002-2014)	40.3*^	35.3*	28.4*
Casualty crashes (2002-2015)	37.6*^	30.0*	20.4*
Pedestrian casualty crashes (2002-2015)	49.2*	46.1*	46.0*
Serious casualty crashes (2005-2015)	33.0*^	11.4	3.6
Pedestrian serious casualty crashes (2005-2015)	46.4*^	22.6	19.1*
Fatal crashes (2002-2015)	100.0	50.0	29.2*
Fatal pedestrian crashes (2002-2015)	100.0	100.0	18.9

* Crash reduction between the two years in that area is statistically significant (chi square test at 5% level)

^ Crash reduction in HPAA zones is statistically significantly greater than in the Rest of NSW reduction (chi square test at 5% level)

Figure 15: All crashes – trends by zone type



2015 data for all crashes is not comparable to previous years and so is not plotted

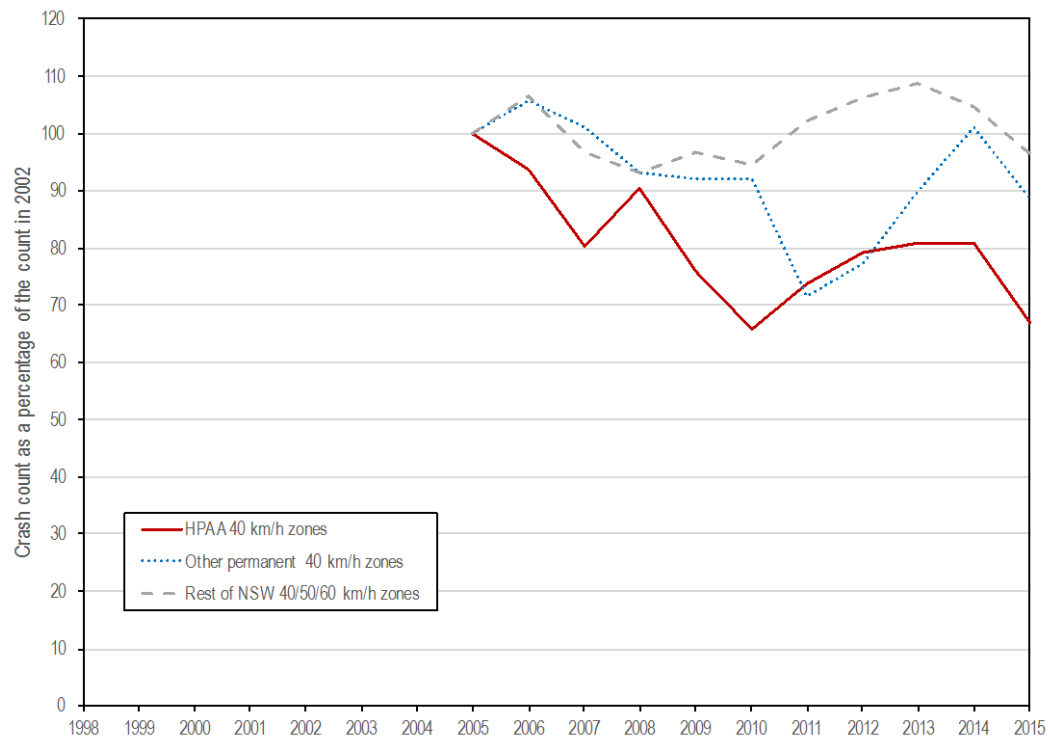
Figure 16: Casualty crashes – trends by zone type



Figure 17: Pedestrian casualty crashes – trends by zone type



Figure 18: Serious casualty crashes – trends by zone type



Serious injury only coded in NSW from 2005 onwards

Figure 19: Pedestrian serious casualty crashes – trends by zone type



Serious injury only coded in NSW from 2005 onwards

Before and after crash analysis for HPAA zones with known implementation dates

For the 40 km/h zones with a known year of implementation, comparisons were made between the number of crashes in the years before implementation with the number of crashes in the years after. Crashes during the year of implementation were ignored as implementation can take some time and crash patterns may have changed during the implementation phase.

Comparing crashes in the one year before implementation with the one year after minimises the effect of long term trends on the results but only provides a limited amount of crash data. Comparing multiple years before and after provides more crash data in each zone but limits the number of zones that can be considered as only those that have existed long enough for multiple years of post-implementation crash data to exist can be analysed. In addition, long term trends become increasingly important. Results for one to five years of pre- and post-crash data are presented to illustrate the differences.

Analyses were carried out on all HPAA zones, other permanent 40 km/h zones and both zone types combined. It was found that the other permanent zones with known dates were few in number, were relatively recent and contained few crashes. This meant that the results for other permanent zones were particularly random and the results for both zone types combined were very similar to those for HPAA zones. For these reasons, only the results for the HPAA zones are presented here (the results for other permanent 40 km/h zones can be found in Appendix C).

Tables 5-11 present before-after crash number comparisons for the HPAA zones using one to five years of pre- and post-crash data and the percentage change in those crash numbers (a chi-square test was used to determine statistical significance of the change). Also presented are the number of individual zones that had sufficient crash data available and that had at least one crash in the before or after periods. This number will always be less than the 75 HPAA sites with known implementation dates, as some sites did not have recent or historical crash data available for the given periods. This number also tends to decrease for longer analysis periods as more sites had insufficient crash data available. It can increase in some circumstances where sites with no crashes in a short before/after period can have crashes in a longer before/after period (sites with no crashes before or after for a given period provide no useful data).

Nearly all percentage changes for all crash types and comparison lengths showed reductions in the number of crashes in the after period. These reductions were statistically significant for: periods of two or more years for all crashes (13.4% to 21.7% reduction); three or more years for casualty crashes (12.5% to 16.4% reduction); five years for pedestrian casualty crashes (15.2% reduction); and five years for fatal crashes (72.7% reduction).

Since the number of crashes is just the sum of crashes from all the relevant zones, it is possible that a small number of zones with many crashes can dominate the before and

after counts. If these zones exhibit anomalous behaviour, not seen in other zones, they can create a biased impression. To give an overview of how consistent the zones are, the number of zones with: more crashes in the after period than the before period; no change in crash numbers; fewer crashes in the after period than the before period are presented in the tables. In the majority of cases, the number of zones where crashes went down exceeded the number of zones where crashes went up.

While this is suggestive of the HPAA zones having a positive road safety effect, it does not provide unequivocal evidence of this. The general increase in the size of the reductions with an increasing number of years considered may imply a general downward trend giving reductions unrelated to HPAA implementation. Alternatively, it could indicate that the benefits of an HPAA zone take some years to be fully realised meaning that short term calculations of the benefits will be underestimates. Attempts were made to discern these effects but there were insufficient available data to draw any conclusions.

Possible factors affecting crashes over time that could lead to a background downward trend or be masking more positive effects include:

- Newer vehicles providing greater protection for occupants and pedestrians
- Changes in the amount of vehicle travel
- Changes in vehicle travel patterns
- The amount of pedestrian traffic (HPAA zones may be attracting pedestrians)
- Changes in speed limits before HPAA implementation
- The amount of speed enforcement
- Changes in vehicle speeds for other reasons
- Changes in road infrastructure before and after HPAA implementation
- Regression to mean where HPAA zones are chosen because they have a high number of crashes.

No reliable measures of these factors are easily available so their effects could not be examined.

Such inconclusive results are typical in the road safety area where evaluation is only considered after the fact. In an ideal experimental scenario, a large number of potential zones would have been selected and then randomly allocated to either receiving the HPAA treatment or being left alone. Any crash differences between the two groups could then have been directly attributed to the HPAA treatment.

Table 5: Crash numbers in HPAA zones before and after implementation

Number of years before/after	Number of crashes 1-5 years before/after ^a		% Change ^b	Number of zones with ^c			
	Before	After		Any crashes	More crashes	No change	Fewer crashes
1 year	488	453	-7.2	61	21	12	28
2 years	937	811	-13.4*	61	17	8	36
3 years	1,149	934	-18.7*	53	12	4	37
4 years	1,505	1,207	-19.8*	52	11	6	35
5 years	1,784	1,396	-21.7*	47	10	3	34

^a Total number of crashes in the years before and years after HPAA implementation, summed for all zones with crash data available.

^b Percentage change in number of crashes in the after period compared to the before period.

^c Number of zones with: at least one crash in the before or after period; more crashes in the after period than the before period; no change in crash numbers; fewer crashes in the after period than the before period. Highlighted cells indicate the greater number of zones in either more crashes or fewer crashes.

* Statistically significant change (chi square test at 5% level)

Table 6: Casualty crash numbers in HPAA zones before and after implementation

Number of years before/after	Number of crashes 1-5 years before/after ^a		% Change ^b	Number of zones with ^c			
	Before	After		Any crashes	More crashes	No change	Fewer crashes
1 year	408	384	-5.9	59	21	15	23
2 years	538	516	-4.1	62	22	13	27
3 years	790	691	-12.5*	62	17	11	34
4 years	828	696	-15.9*	54	16	8	30
5 years	1,036	866	-16.4*	52	17	5	30

^a Total number of crashes in the years before and years after HPAA implementation, summed for all zones with crash data available.

^b Percentage change in number of crashes in the after period compared to the before period.

^c Number of zones with: at least one crash in the before or after period; more crashes in the after period than the before period; no change in crash numbers; fewer crashes in the after period than the before period. Highlighted cells indicate the greater number of zones in either more crashes or fewer crashes.

* Statistically significant change (chi square test at 5% level)

Table 7: Pedestrian casualty crash numbers in HPAA zones before and after implementation

Number of years before/after	Number of crashes 1-5 years before/after ^a		% Change ^b	Number of zones with ^c			
	Before	After		Any crashes	More crashes	No change	Fewer crashes
1 year	178	145	-18.5	46	13	8	25
2 years	190	188	-1.1	49	16	10	23
3 years	265	259	-2.3	53	25	6	22
4 years	278	251	-9.7	46	16	7	23
5 years	355	301	-15.2*	45	14	8	23

^a Total number of crashes in the years before and years after HPAA implementation, summed for all zones with crash data available.

^b Percentage change in number of crashes in the after period compared to the before period.

^c Number of zones with: at least one crash in the before or after period; more crashes in the after period than the before period; no change in crash numbers; fewer crashes in the after period than the before period. Highlighted cells indicate the greater number of zones in either more crashes or fewer crashes.

* Statistically significant change (chi square test at 5% level)

Table 8: Serious casualty crash numbers in HPAA zones before and after implementation

Number of years before/after	Number of crashes 1-5 years before/after ^a		% Change ^b	Number of zones with: ^c			
	Before	After		Any crashes	More crashes	No change	Fewer crashes
1 year	100	95	-5.0	31	14	5	12
2 years	89	86	-3.4	30	15	3	12
3 years	94	89	-5.3	25	12	2	11
4 years	68	57	-16.2	13	6	0	7
5 years	23	17	-26.1	5	2	1	2

^a Total number of crashes in the years before and years after HPAA implementation, summed for all zones with crash data available.

^b Percentage change in number of crashes in the after period compared to the before period.

^c Number of zones with: at least one crash in the before or after period; more crashes in the after period than the before period; no change in crash numbers; fewer crashes in the after period than the before period. Highlighted cells indicate the greater number of zones in either more crashes or fewer crashes.

* Statistically significant change (chi square test at 5% level)

Table 9: Pedestrian serious casualty crash numbers in HPAA zones before and after implementation

Number of years before/after	Number of crashes 1-5 years before/after ^a		% Change ^b	Number of zones with: ^c			
	Before	After		Any crashes	More crashes	No change	Fewer crashes
1 year	63	48	-23.8	24	9	3	12
2 years	48	47	-2.1	21	10	0	11
3 years	47	52	10.6	18	10	2	6
4 years	32	29	-9.4	10	4	3	3
5 years	9	7	-22.2	4	3	0	1

^a Total number of crashes in the years before and years after HPAA implementation, summed for all zones with crash data available.

^b Percentage change in number of crashes in the after period compared to the before period.

^c Number of zones with: at least one crash in the before or after period; more crashes in the after period than the before period; no change in crash numbers; fewer crashes in the after period than the before period. Highlighted cells indicate the greater number of zones in either more crashes or fewer crashes.

* Statistically significant change (chi square test at 5% level)

Table 10: Fatal crash numbers in HPAA zones before and after implementation

Number of years before/after	Number of crashes 1-5 years before/after ^a		% Change ^b	Number of zones with: ^c			
	Before	After		Any crashes	More crashes	No change	Fewer crashes
1 year	3	2	-33.3	4	1	1	2
2 years	5	3	-40.0	7	2	1	4
3 years	8	4	-50.0	7	2	1	4
4 years	10	3	-70.0	7	1	1	5
5 years	11	3	-72.7*	8	1	1	6

^a Total number of crashes in the years before and years after HPAA implementation, summed for all zones with crash data available.

^b Percentage change in number of crashes in the after period compared to the before period.

^c Number of zones with: at least one crash in the before or after period; more crashes in the after period than the before period; no change in crash numbers; fewer crashes in the after period than the before period. Highlighted cells indicate the greater number of zones in either more crashes or fewer crashes.

* Statistically significant change (chi square test at 5% level)

Table 11: Pedestrian fatal crash numbers in HPAA zones before and after implementation

Number of years before/after	Number of crashes 1-5 years before/after ^a		% Change ^b	Number of zones with: ^c			
	Before	After		Any crashes	More crashes	No change	Fewer crashes
1 year	2	1	-50.0	3	1	0	2
2 years	3	2	-33.3	5	2	0	3
3 years	6	3	-50.0	6	2	1	3
4 years	7	2	-71.4	6	1	1	4
5 years	8	2	-75.0	7	1	1	5

^a Total number of crashes in the years before and years after HPAA implementation, summed for all zones with crash data available.

^b Percentage change in number of crashes in the after period compared to the before period.

^c Number of zones with: at least one crash in the before or after period; more crashes in the after period than the before period; no change in crash numbers; fewer crashes in the after period than the before period. Highlighted cells indicate the greater number of zones in either more crashes or fewer crashes.

* No changes were statistically significant change (chi square test at 5% level)

Conclusions about crashes

Both crash analysis methodologies showed statistically significant reductions in crashes and casualty crashes on the HPAA zone roads after the HPAA zones had been implemented. Analysis of a comparison group (the rest of NSW 40/50/60 km/h roads) in the trends analysis also found general large reductions over the same time period in crashes and casualty crashes suggesting that part of the HPAA reduction may be due to other background factors. However, the reductions in the HPAA zones were statistically significantly greater than for the comparison roads, which strongly suggests that the HPAA zones were effective in reducing crashes and casualty crashes.

Pedestrian casualty crashes also showed statistically significant reductions on the HPAA zone roads after the HPAA zones had been implemented using both methodologies. However, the trend difference was not statistically different from the comparison group making interpretation less clear.

Serious casualty crashes and pedestrian serious casualty crashes both showed statistically significant reductions on the HPAA zone roads after the HPAA zones had been fully implemented in the trend analysis (although available data was limited). Furthermore, the reductions were statistically significantly greater than the reductions observed in the comparison group over the same time period. This strongly suggests that the HPAA zones were effective in reducing serious casualty and pedestrian serious casualty crashes. The before/after analysis showed general reductions but no statistically significant results.

The number of fatal crashes and pedestrian fatal crashes in HPAA zones were very small and failed to produce any statistically significant results apart from an apparent reduction in fatal crash numbers from 5 years before to 5 years after in the before/after analysis (11 fatal crashes before to 3 fatal crashes after).

In interpreting these results, a number of considerations need to be taken into account: this was not a true experiment; the data were limited by unknown implementation dates; the comparison group was not ideal; and there are many factors that may have influenced the results that are not easily measurable.

However, this study does build upon a large body of literature that shows that small reductions in speed lead to large reductions in crashes and particularly casualty crashes. The results found here are certainly consistent with those findings: 40 km/h speed zones have reduced road trauma by significant amounts, with roads now with HPAAAs experiencing almost double the reduction in casualty crashes compared to other urban roads since 2003. These results are also consistent with the views collected through the community survey that the lower speed zones led to safety benefits.

Evaluation Question 3: What have been the other positive and negative effects of 40 km/h speed zones?

While the 40 km/h limits have generally been introduced as a road safety measure, the evaluation examined other impacts that might result. These may, in some cases, reduce the acceptability of the road safety treatment or, in other cases, provide additional benefits that strengthen the case for these limits.

The potential impacts include traffic impacts such as speed, volume and congestion, as well as impacts that relate to the amenity of the environment and consequent changes in walking or other roadside activities. These impacts could also be seen in neighbouring streets if there were significant traffic diversion.

No data were available for the project to undertake quantitative before-after analyses of either traffic or other impacts. As outlined in the Evaluation Framework (Appendix A), views on the impacts were obtained from the practitioners responsible for development and implementation of 40 km/h zones through a series of workshops as well as from interviews with other stakeholders. A sample of community views was also collected through an online survey, and a report of these results is at Appendix F.

Information was also sourced from published literature to supplement the data gathered through these channels.

Traffic impacts

Findings

Workshop participants generally expressed a consensus that 40 km/h zones resulted in reduced traffic speeds and lower traffic volumes. The extent of this depended on a number of factors, discussed in the following section.

Speed reduction was clearly observed with views expressed that this was a benefit for pedestrians but also led to a reduction in traffic efficiency. However, some views were expressed that efficiency reduction was marginal and that the impact of longer travel times was largely one of driver perception rather than a significant delay.

Lower speed limits were seen to have the benefit of diverting through traffic away from pedestrian precincts to more appropriate by-pass routes. However, where suitable bypass routes were not available, the traffic diversion could cause concern if it increased traffic on back streets.

The stakeholders interviewed had mixed views. While some supported this concern at increased congestion, and perceptions of congestion, some vulnerable road user groups expressed the view that lower limits could improve traffic by smoothing flow.

When asked to name up to three adverse impacts, 52.8% of respondents to the community survey nominated traffic congestion making it the most common negative

impact. Respondents from Sydney (56.8%) were significantly more likely to nominate congestion than those from elsewhere (43.6%). People in the 18-24 age group (67.7%) were much more likely to include this impact. Longer traveling times were also nominated by 38.1%.

Discussion

These evaluation findings are consistent with a large body of evidence that lower speed zones reduce traffic speed.

An evaluation of a 40 km/h residential area in Rosebud, Victoria found a modest reduction in mean speeds, from 43.3 km/h to 41.3 km/h. The percentage of vehicles exceeding the 40 km/h limit dropped from 65% to 55% (Pyta and Pratt, 2013). This modest drop may reflect the low speeds before treatment. Similarly, the study found little change in traffic volumes.

Evaluation of the 40 km/h speed limit in Unley, South Australia, found a speed reduction of 2.2 km/h where mean speeds before the 40 km/h installation exceeded 40 km/h and a slight increase on roads with pre-treatment mean speeds of less than 40 km/h (Woolley, Dyson and Taylor, 2001).

Webster and Mackie (1996) completed a comprehensive review of 20 mph zones in the UK and identified, across 34 zones, average speed changes from 25.2 mph to 15.9 mph and traffic reductions of 27% across 20 zones. This study also observed some traffic diversion. While a number of these zones coincided with the opening of bypass routes, the routes around seven other zones experienced traffic increases of between 4% and 23%.

Other impacts – effects on behaviour, amenity etc

Findings

Workshop participants were asked to rank a list of potential benefits on a scale from one to six, with one being most beneficial. They very strongly believed that safety was the main benefit from these zones (see Table 12).

Table 12: Workshop participants' ranking of benefits (mean ranking, N=64)

Benefit	Mean ranking (where 1=most beneficial)
Safety	1.2
Improved environment for roadside activities	3.5
Improved amenity	3.5
Increased walking	3.6
Commercial growth	4.5
Reduced noise and pollution	4.9

Participants identified a number of positive and negative impacts. The most commonly cited positive impacts were:

- Improved amenity for pedestrians and cyclists
- Support for good urban design
- Satisfied community expectations
- Increased walking
- Improved visual landscape
- Improved or changed commercial activity.

Negative impacts were seen as:

- Loss of parking spaces
- Poor pedestrian behaviour
- False sense of safety
- Poor driver behaviour
- Driver frustration
- Maintenance costs.

There is a perception among practitioners that the zones do alter road user behaviour, positively and negatively. For motor vehicle drivers, practitioners cited: frustration, complacency and driving around speed cushions etc, but also improved awareness of pedestrians. For pedestrians, common negative impacts they cited included jay walking and having a false perception of safety. The stakeholders interviewed provided a similar range of views to the practitioners.

The results from the community survey indicate a similar perception that the bulk of the benefits relate to safety. Table 13 shows that when asked to rank a range of potential benefits, respondents clearly identified safety outcomes. When considering only those respondents who reported that their nearest shopping area had a 40 km/h speed limit, there was a slight increase in identifying amenity benefits, consistent with a positive personal experience.

Table 13: Percentage of survey respondents ranking each benefit in their top three choices

Benefit of 40 km/h zones	All respondents (N=493)	Respondents with local 40 km/h area (N=169)
Safer for people walking	73.8%	72.8%
Less chance of accidents or crashes	69.6%	69.8%
Safer for people cycling	36.9%	37.9%
More pleasant for walking	19.5%	23.1%
More pleasant for shopping or dining near the road	17.8%	20.7%
Good for businesses	7.5%	10.1%
None of the above	6.7%	4.1%

The chosen disadvantages focused on traffic congestion and delay and also concerns about pedestrians taking less care (see Table 14). In this case the results for those with local experience showed little difference, possibly because experience as drivers is more

even. Similarly, the results for respondents living in Greater Sydney did not show any greater concerns about these traffic impacts.

Table 14: Percentage of survey respondents ranking each disadvantage in their top three choices

Disadvantage of 40 km/h zones	All respondents (N=494)	Respondents with local 40 km/h area (N=168)	Respondents living in Greater Sydney (N=345)
More traffic congestion	52.8%	48.8%	56.8%
People are less careful when crossing the road	38.9%	44.3%	38.9%
Longer travelling times for vehicles	38.1%	40.5%	39.4%
Changes in speed limits are confusing	31.2%	33.3%	32.5%
Too many speed limits	22.3%	21.4%	22.3%
Drivers and motorcyclists are less careful	12.8%	13.7%	12.2%
Less parking	8.1%	7.1%	9.3%
None of these	14.8%	13.1%	13.3%

When asked, unprompted, to describe the benefits and disadvantages of 40 km/h zones, people responded with a similar range of issues, as illustrated in the word clouds shown in Figures 20 and 21. The impacts were stated as being relevant to pedestrians with safety the main benefit. Particular mention was made by a number of respondents of the increased ability to stop safely if necessary. Adverse impacts focused on traffic and congestion, with mention of consequent driver frustration. However, of the 460 who responded to the question about disadvantages, 34% wrote that there were none or they couldn't think of any.

Figure 20: Benefits described by all respondents (N=466)



Data processed at www.wordle.net

[illegible]

Practices in other jurisdictions indicate limited consideration of other benefits from the creation of lower speed zones. Most of the 40 km/h installations in other jurisdictions were targeted at road safety improvements in local traffic areas, around schools or in town centres. More information on these practices is provided in Appendix G.

Discussion

Previous observational and focus group research for Transport for NSW supported the view that pedestrians would take more conscious risks on quiet roads and an over-reliance on vehicles to give way at pedestrian crossings. This research also pointed out the difficulty in using behavioural programs to change the largely unconscious risks that pedestrians take (Smith and Hodgen, 2016).

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explored in a New South Wales study that indicated that the presence of paving without a crossing increased the perception that the pedestrian has right of way from 8% to 40% (Hatfield, Job & Smith, 2004). However, while that study indicated that this ambiguity could improve safety where there is high pedestrian activity, actual risk was not examined. The current practice of requiring fencing at thresholds and speed humps is governed by a Technical Direction, introduced by the then Roads and Traffic Authority to allay concerns of litigation (RMS personal communication).

The views of those representing different stakeholders in the transport system varied and in many cases reflected their own objectives for the system. Whereas representatives of motorised modes raised similar concerns to the traffic practitioners, representatives of people walking and cycling saw benefits from the zones in creating streets that encouraged these activities. Others, including the Pedestrian Council of Australia and transport planners within TfNSW, took this further in supporting the benefits that lower speeds provided as a component of strategies to recognise the need for place-making as well as safe mobility as objectives for the road system.

This trade-off between designing for mobility and designing for pedestrian amenity and its consequent social benefits has been recognised and reported for decades (for example, Jarvis, 1979). The chain of outcomes is consistent: lower speeds lead to improved amenity, which leads to improved use of the road as a place for pedestrians, which in turn can lead to social benefits.

Evaluation of the 20 mph Home Zone program in Bristol, UK (Sherwin, Parkhurst & Chattergee, 2008) noted the community expressing agreement with statements such as more street activity and people interacting more in the street, and reduced concerns with issues such as crime, noise and vandalism.

As with the anecdotal reports described above, displaced parking was the key concern expressed by community in the Bristol study. While this related to residential parking, the issue is also a sensitive one in other jurisdictions, such as Paris (Dabanc & Gallez, 2008). On the other hand, the views expressed by the practitioners were not held by those responding to the community survey, only 8.1% of whom cited parking reduction as a potential negative impact of these schemes.

Similar synergies between traffic interventions and broader regeneration and improved social capital were found in the evaluation of the Streets Ahead on Safety project in Birmingham, UK (University of Birmingham, 2011).

Evaluation of a wide area 40 km/h implementation in Montreal concluded: *"...the 40 km/h project will have a positive impact on the living conditions of current and future generations, while providing favorable conditions for their development in terms of economic viability and preservation of the environment. ...The result will be a more equitable sharing of public roads"* (Montreal, 2011 p8).

Conclusions

The views gathered in this evaluation are consistent with an extensive body of research that introduction of permanent 40 km/h zones results in a reduction of travel speeds and some reduction (through re-direction) in motorised traffic, or different mode choice, such as walking.

It is also likely, supported by the literature, and information collected in this project, that road user behaviour has changed. In particular, lower speeds will result in the interactions between pedestrians and vehicles changing, the lower the speed, the more that these interactions will be safely negotiated between road users rather than controlled by prescriptive rules. One issue not resolved in this evaluation was whether any increased tendency of pedestrians to take priority, even though not supported by traffic regulation, represented an increased risk that needed to be addressed through measures such as pedestrian fencing. Overall, as demonstrated in the previous section, risks and crash outcomes are reduced and it appeared from discussions with practitioners, particularly, that expressed concerns about potential risks in these situations may relate more to concerns about pedestrians interrupting traffic flow.

There is a consensus, supported by the literature, that the creation of lower speed zones, such as through the HPAA, leads to a number of other impacts in creating a road and roadside environment that supports increased pedestrian activity with a commensurate reduction in mobility for motorised traffic. There are, however, a range of views as to whether these changes can be considered a benefit or not, depending on what the overall objectives for the road network are and what role that part of the road network plays in supporting these objectives. Different views of the strategic objectives lead to different views of the benefits.

Evaluation Question 4: How do effects differ by different site characteristics and implementation circumstances?

The previous two sections describe the overall results for the evaluation of permanent 40 km/h zones as a whole. This section explores how the road safety and other impacts vary according to different characteristics of the zones.

In particular, the project sought to evaluate differences according to:

- Whether the zone was funded under the HPAA program
- Existence and type of traffic calming measures used
- Road user group
- Other circumstances.

The effect of these parameters on crash outcomes as well as other impacts is considered.

Crash analysis

HPAA Program

As indicated in the response to Evaluation Question 2, roads that had HPAA zones installed during the period of analysis experienced statistically significant crash reductions at all severities. These were also consistently greater than the reductions experienced in other permanent 40 km/h zones. However, as many of these 40 km/h zones may have been installed before the period of analysis, the impact of the speed reduction may have predated this period.

An analysis of crashes before and after installation, where this was known, did not show any significant difference between HPAA zones and other permanent 40 km/h zones. However, the number of these latter zones was very small and only provided a maximum of 18 crashes before and 23 crashes after installation for analysis. With this sample size, lack of statistical significance is not surprising. Appendix C provides more detail of this analysis.

Traffic calming measures

It was not feasible to segment the crash analysis by the presence or design of traffic calming features. There were a number of reasons for this.

It was not within the scope of this evaluation to locate treatments accurately to match crash locations. So, matching of crashes with the presence of a nearby treatment could not be done. When examining crashes within the whole lengths of a zone, the range of treatment types, their frequency and location within zones cannot be reduced to a single variable that would allow for the wide variation in other parameters that also influence traffic speed and the appropriate treatments that are feasible.

For example, the HPAA zones covering most of Balmain and Paddington are on very narrow streets with tight alignments and frequent intersections and other interruptions to free flowing traffic. The use of traffic calming treatments is very limited in these zones as they are unnecessary. On the other hand, George Street, Sydney is a wide multi-lane, heavily trafficked thoroughfare with significant pedestrian risk but it also has little traffic calming. A crash analysis by traffic calming features would attempt to group these two zones, ignoring the fundamental differences in road environment.

However, a number of the studies, such as those referenced below in the discussion of the effect of different treatment types on other impacts, have evaluated the traffic and safety impacts of a wide variety of devices.

Road User Groups

The analysis described above, for Evaluation Question 2, separated pedestrian crashes from all road user crashes. The differences between HPAA zones and either the rest of NSW or the control sites, indicate that, for both casualty and serious casualty crashes, the differences are less for pedestrians than for other road users. In other words the benefits of HPAA zones appear to be greater for the general road user population than for the pedestrians who are the target of this intervention. This may have been due to increases in pedestrian activity due to the better environment. However potential causes were not examined as the differences are slight. The key result is that benefits are seen as overall crash reductions.

The implications of this are considerable. First, while it is likely that the rationale for the program will remain pedestrian protection and amenity, the justification for projects can consider these broader impacts. Secondly, at a more strategic level, the results have demonstrated the potential for speed reductions to help address the overall serious casualty targets that are a challenge for all jurisdictions.

Further analysis of other road user groups was not undertaken due to the small sample sizes involved.

Other characteristics

Alternative characterisations were used to seek to determine whether crash impacts varied with the type of zone. As described in Evaluation Question 1, the HPAA zones were characterised according to a number of parameters.

- Urbanisation
 - Metropolitan Sydney
 - The rest of NSW
- Zone topology
 - Linear 40 km/h zone – essentially a single length of road
 - 40 km/h network – an area of interconnected roads
- HPAA Classification:
 - 1 – meets Category A
 - 2 – meets two criteria in Category B
 - 3 – meets one criterion in Category B

- Not classified– meets no criterion in Category B
- Zone character
 - Commercial centre
 - Commercial/Transport - Major
 - Commercial/Transport - Minor
 - Commercial
 - Parking access
 - Recreation/Sport
 - Residential
 - Urban Village.

This characterisation was limited to HPAA zones. As the HPAA zones include the majority of crashes observed in permanent 40 km/h zones, the inclusion of other zones would not have materially altered this analysis.

The methodologies used for the overall crash analysis were repeated with data segmented by the above parameters, except for zone character as there were too many categories for effective analysis. In addition, an analysis was also carried out to assess whether the impact differed with mid-block or intersection locations.

Generally, this analysis failed to identify any statistically significant differences except in the following few cases.

- The reduction in pedestrian casualty crashes from 2002 to 2015 in non-metropolitan HPAAAs (73.9%) was significantly greater at 5% level to the reduction for Sydney metropolitan area (44.6%).
- The reduction in all crashes from 2002 to 2014 in linear 40 km/h zones (50.6%) was significantly greater at 5% level than the reduction for network (non-linear) 40 km/h areas (36.3%).

Both these changes could be the result of a real effect or possibly an artefact of when the sites were implemented combined with background trends.

Detailed results are presented in Appendix C.

Length of zones

An analysis of the crash data was undertaken to determine how crash reductions in HPAAAs differed according to the length of the zone (see Figure 22).

Figure 22: Change in injury crashes for different HPAA lengths



While the sample size is not sufficient to demonstrate a definite relationship, the data is consistent with shorter zones achieving smaller reductions, with the drop off at the longer end consistent with many of these longer zones being introduced into areas where travel speeds were already low.

Sydney CBD

In terms of its scale and character, the Sydney CBD is quite different from any other location in the HPAA program. Furthermore, it is an area currently experiencing significant change with major new development and traffic disruption. For this evaluation it is prudent therefore to check whether the benefits measured for the whole program also apply to the Sydney CBD and, conversely, whether the effect in the CBD is swamping the effects measured elsewhere.

In 2015, there were 1383 pedestrian casualty crashes in New South Wales. Of these, 151 occurred in an HPAA, including 52 in the HPAA located within the Sydney CBD. This represents 34% of all crashes in HPAA's.

As this HPAA was installed in 2014, there is only one year of available data to assess the effect. Comparing 2015 with 2013 showed a 28% reduction in pedestrian crashes and a 21% reduction in all casualty crashes. Tables 15 and 16 show the effect of removing the Sydney CBD from the analysis described above in Tables 6 and 7.

Table 15: Casualty crashes in HPAA zones 1 year before and after implementation

				Number of zones with: ^c			
	Before	After	% Change	Any crashes	More crashes	No change	Fewer crashes
NSW including CBD zone	408	384	-5.9	59	21	15	23
NSW excluding CBD zone	269	274	1.8%	58	21	15	22

Table 16: Pedestrian casualty crashes in HPAA zones 1 year before and after implementation

				Number of zones with: ^c			
	Before	After	% Change	Any crashes	More crashes	No change	Fewer crashes
NSW including CBD zone	178	145	-18.5	46	13	8	25
NSW excluding CBD zone	106	93	-12.3%	45	13	8	24

These indicate that the CBD made a large contribution to the one year before and after analysis for pedestrian casualty crashes. However, there were no statistically significant changes in either pedestrian casualty or all casualty crashes. On the other hand, the longer-term comparisons shown in Tables 6 and 7, for two or more years before and after implementation, do not include the CBD due to its recent installation date. The dominant result in the CBD therefore has had no impact on those conclusions. It can be concluded, therefore, that the effects seen for the program as a whole apply across different areas and not just the CBD.

Other impacts

The views of workshop participants and stakeholders regarding overall broader impacts, such as on traffic or amenity, are described in the previous section. These discussions also sought views on the relative impact of different traffic calming treatments and characteristics of zones.

Explicit information to compare zones implemented under the HPAA program compared with other zones was not collected as, for many participants, this was not known. On the road, they just observe 40 km/h zones. Views expressed therefore related to 40 km/h zones as a whole. However, some inferences can be made by examining comments relating to transport interchanges or shopping strips, which were probably funded by the HPAA program, compared to comments about residential areas, which probably were not.

Traffic calming

Whereas the crash analysis could not be applied to traffic calming type and extent, the views of practitioners were sought on this matter.

There was a strong consensus among the traffic practitioners that the installation of 40 km/h zones without traffic calming would have less impact than if traffic calming were implemented.

When asked to comment on the need for traffic calming in general, 67% of workshop participants believed that it was essential to emphasise the low speed zone and moderate speeds, 29% believed that it should be used only when needed to reduce free speeds and 4% believed that it was unnecessary, as a speed limit sign should be sufficient. The majority of this small last group were Police officers, who are responsible for user compliance, rather than the traffic practitioners who made up the bulk of the workshop participants.

Community views were sought through the online survey and when asked how necessary traffic calming devices were, views were mixed: 36.3% thought that devices were very or extremely necessary, with 26.9% believing that they were not or slightly necessary. On the other hand, in considering school zones, where there is generally less traffic calming, 74.5% of respondents reported that they were very much or extremely in favour of 40 km/h limits and 90.0% believed that this limit was either too fast or about right (see Appendix F). These school zone 40 km/h speed limit installations therefore show exceptionally high rates of acceptance and support, despite their lack of traffic calming.

Roads and Maritime Services workshop participants indicated their previous studies showed that, without significant traffic calming, mean speeds in 40 km/h zones, while reduced, were still in excess of 40 km/h. With the strong speed:crash risk relationship, it could also be assumed that crash reductions would also be greater where traffic calming leads to greater speed reductions.

This is supported by the literature, with extensive research findings on the impact of different traffic calming devices on speed profiles at, near and remotely from the devices. This work includes examination of the benefits of street design to provide continuous speed reduction (Hidas, 1993) compared with the more severe reductions necessary at discrete locations to provide acceptable speeds between treatments. It is notable that Hidas also expressed the view that a 40 km/h zone on its own would only be effective with significant enforcement, probably exceeding the cost of traffic calming treatments.

This work coincided with a trial in Unley, South Australia, where a 40 km/h area was installed without traffic calming, but with camera speed enforcement. Median speeds fell by 5 km/h following the launch of the trial but did not fall much further, despite high levels of enforcement at times. Median speeds stabilised at approximately 44 km/h (Cairney and Harwood, 1994). This is similar to the experience reported anecdotally by Roads and Maritime Services workshop participants.

However, since the 1990s the impact of low levels of speed reductions on crash risk is now much better understood. The speed:crash risk relationship also indicates that even modest speed reductions can lead to significant crash reductions. So, whereas many practitioners saw the average speed as a rationale for mandating traffic calming treatments, there would be safety benefits from any speed reduction.

Information gathered from other Australasian jurisdictions indicated different positions on this issue. While most did not prescribe specific traffic calming in 40 km/h zones, there was an expectation that the zones would be largely self-enforcing through the natural road environment or add-on treatments. However, South Australia and to a much greater extent Victoria have both introduced 40 km/h zones on arterial roads with no traffic calming. An evaluation of the Victoria scheme indicated an 8.1% reduction in casualty crashes and a 16.9% reduction in pedestrian casualty crashes, compared with control sites. This evaluation, however, had insufficient data to demonstrate statistical significance of any change (Scully, Newstead & Corben, 2008).

Different treatment types

Workshop participants reported effective use of chicanes, narrow carriageways and half openings; pedestrian fencing, refuges and raised crossings; gateway treatments including differentiation through painting, paving and raised platforms; kerb extensions, blisters and good landscaping; illuminated or flashing lights.

There was some disagreement about the use of speed humps (which were said to generate noise and complaints).

Among workshop participants, the most favoured treatment of raised platform with pedestrian crossing and kerb blisters was considered effective, particularly at thresholds to a zone. However, there was no consensus identifying other treatments as particularly effective or ineffective. Many of the treatment types were cited by workshop participants as ones that work well and also do not work well. These ambivalent views were often put forward by the same groups, saying that effectiveness depends on context.

The over-riding view was that most treatments had their place and that the most effective approach was to develop a complete treatment plan, taking into account the particular characteristics of the site in question.

Practitioners pointed out concerns with maintenance costs and deterioration, particularly of linemarking and speed cushions. Some concerns were also expressed about chicanes which might encourage drivers to seek a challenge by speeding through them. Motorcycle representatives also expressed a concern at head on crash risks caused by oncoming drivers encroaching across the centreline when swerving around speed cushions.

These concerns are consistent with the view that the best schemes are integrated designs that do not rely on separate “clip-on” devices.

There is a wide range of different interventions that can lead to speed reductions (Simcic & Townsend, 2008). Physical design of the road alignment, cross section and its appearance can moderate speeds (Austroads, 2016a), as can the reduction of speed limits and their enforcement (Woolley & Dyson, 2003).

There is a significant body of research over many years covering the performance of different traffic calming treatments (Webster, 2000) as well as to public attitudes to them (Webster, 2003).

A number of Austroads reports provide advice on the impacts of different devices (Austroads, 2016a, Austroads, 2016c). In addition, some reports (Daniel, Chien and Liu, 2005, and Berthod, 2011) report on the impacts of individual measures, while other research has examined area-wide impacts (Gitelman & Shalom, 2003).

A number of evaluations of threshold treatments have focused on rural/urban transitions in New Zealand (Makwasha & Turner, 2013), and Queensland (Peterson, 2016). These evaluations showed significant reductions in speed and, across New Zealand, a 23% reduction in serious casualty crashes.

Locations

Workshop participants and stakeholders were asked whether the benefits of 40 km/h zones varied according to the type of location, its surrounding land use or other aspects. There were no definitive views expressed on this. However, a number of respondents commented that the zones worked better where the environment supported lower speeds, although this could occur in any type of location as it related more to detailed design and implementation. There was a perception amongst some workshop participants that the zones were more effective where they were in locations with visible pedestrian activity and therefore in smaller concentrated zones rather than as broad areas or longer strips.

A number of stakeholders expressed the view that a more strategic approach would help to generate pedestrian and roadside activity by providing greater areas of reduced speed, not just as a local countermeasure to address specific risks. This more comprehensive approach is outlined in a number of papers, including Jones, Marchall and Boujenko (2008) and Dumbaugh and Li (2010); while work in New Zealand indicates the potential of a strategic approach based on risk assessment (Durdin et al., 2016). This NZ approach uses a framework to integrate speed management, infrastructure improvement and network planning.

Conclusions

In relation to the issues explored in this evaluation question the following conclusions can be made.

Whether the zone was funded under the HPAA program

Zones implemented under the HPAA program were responsible for most of the crash reductions measured in the evaluation. HPAA zones demonstrated greater percentage reductions in casualty crashes (37.6%) compared with other 40 km/h zones (30.0%) and also included roads with a far greater number of pedestrian and other crashes.

Existence and type of traffic calming measures used

This evaluation was not able to identify a particular treatment type to recommend. More important is the suitability of any treatment plan for the particular road and roadside environment and these are unique for every site. However, there was general support for consistency to increase drivers' perceptions of the zone that they are in and, in particular, the need for consistent threshold treatments.

The need for, and nature of, traffic calming is a key issue. Current HPAA and Austroads Guidelines and the need for total compliance by drivers were cited as factors that prevent the use of 40 km/h zones without traffic calming. The majority of practitioners expressed strong views that 40 km/h zones without traffic calming would not work. On the other hand, other stakeholders were of the view that any speed reduction would be beneficial. As the literature indicates benefits without traffic calming, and the cost of traffic calming is cited by practitioners as the single greatest constraint to more zones being installed, it may be timely to reconsider these Guidelines.

Current practices across Australasia, although generally governed by the relevant Austroads Guide (Austroads, 2008), vary from geometric treatments, such as speed humps and horizontal deflection, that force a speed reduction, to just delineation and signage, such as is used in school speed zones. In some circumstances, where the road environment provides cues to a driver that it is an area of higher pedestrian activity, with narrow alignments or a well-defined urban precinct (such as the Sydney CBD), 40km/h limits should be feasible without geometric traffic calming. This would reduce cost, increase benefits more quickly, and still allow geometric treatments to target the highest risk areas and areas where significant changes are made to improve pedestrian amenity. The locations at which conditions change, at the thresholds, will be particularly important in ensuring that the road communicates this change effectively and consistently. Evaluations of trials of such zones can then inform future policy to consider adopting this approach more broadly.

Road user group

While these zones have been introduced to benefit vulnerable road users, the data show that benefits are provided more generally. This is an important result as it

increases the potential payback for any investment in these schemes and it also helps address the need to reduce serious casualties for all road users.

Pedestrians and other users of the roadside space are the main beneficiaries of the amenity improvements that result from lower speeds. On the other hand, users of motorised traffic, while experiencing safety benefits, may perceive an adverse impact due to increased travel times and changes in priority to encourage walking.

Other observations

Owing to the general lack of statistically significant results from this analysis, few conclusions can be stated. However there are two observations that can be made.

The assessment of some of these subtle effects would demand larger sample sizes than were available and would also require a more tightly controlled experimental design than the ex-post program-wide evaluation of this current project. It illustrates the benefits of integrating evaluation processes into the design and implementation of projects from the start.

Although sample sizes were limited, the lack of significant differences between the different subsets of data is consistent with the hypothesis that the implementation of 40 km/h zones provides benefits that can be achieved regardless of different characteristics of individual sites.

Evaluation Question 5: To what extent is there appropriate coverage of 40 km/h zones?

For the purpose of this evaluation “appropriate” coverage has been defined as coverage that is both necessary and sufficient. In other words, have zones been installed where they have been or will be of benefit, and are there remaining benefits to be achieved from installing new, or extending existing, zones?

Coverage to improve safety

The crash analysis indicates that the zones implemented under the HPAA program have been significantly more effective than other permanent 40 km/h zones in targeting pedestrian safety. They have therefore been better located to improve safety in these areas, noting that the benefits of these, generally older, zones, may have been seen before the evaluation period of this project.

However, the proportion of pedestrian crashes being targeted by these zones, while significant, remains low. Of the 1,276 pedestrian casualty crashes in 2015 in New South Wales on roads with a speed zone of no more than 60 km/h, 84.4% occurred outside permanent 40 km/h zones and there remain many areas outside current zones in which pedestrian activity and crashes remain clustered. In some cases, these are adjacent to existing HPAA zones indicating that although their location is appropriate, further benefits may be gained from expansion of the zone.

There are also a number of localities which are experiencing significant pedestrian trauma but where HPAA zones have not been implemented. In 2015, for the whole of New South Wales, there were 20.1 pedestrian crashes per 100,000 population. A number of local government areas, such as Botany Bay and Ryde, experienced rates higher than this, and have not implemented any HPAA zones. While the reasons for this were not explored in this project, these data do indicate the potential for further coverage.

On the other hand, a number of HPAA zones and many of the other permanent 40 km/h zones have seen no pedestrian trauma in the last fifteen years. This may indicate a successful intervention for zones that have been in place for that long but, in other cases including the HPAA sites, they may not have been installed to treat a demonstrated crash problem. However, this does not demonstrate that the zones were not necessary, either to treat a potential risk or, particularly for zones in local areas, to provide other benefits, such as improved amenity, for local residents.

Perception of coverage

Of the workshop participants, 36% believed that the HPAA Guidelines were too restrictive compared to 16% who believed that they were too liberal. For council officers, these percentages were 57% and 3%, respectively, indicating a strong local

demand for increased coverage. Similarly, 47% believed that zones should be expanded, compared with 3% who believed that they should be removed (see Appendix D).

When asked whether more zones would be implemented if there were no resource constraints, 93% indicated that there would be (a few more 66%, many more 16%, generally applied to local streets 11%).

Stakeholders did not generally express a strong view about current coverage, except to indicate that they believed that HPAA zones generally were in the right places, subject to the data showing this. The representatives of active transport modes were unanimous in stating that coverage was inadequate and that they should be located wherever they were necessary to address risks.

In terms of future coverage, many of the stakeholders favoured a more strategic approach with improved links to urban planning. However, a small minority expressed concerns at these zones. One commented that the need for a 40 km/h zone as a traffic treatment reflected a failure in urban planning, which should make such measures unnecessary. As noted elsewhere, the attitudes to coverage reflected the objectives of the organisations they represented and the relative importance they gave to urban and pedestrian amenity compared with traffic mobility.

Despite this range of views, no HPAA zone was mentioned as being in the wrong place or not warranted.

When asked where they would support more 40 km/h zones, more respondents to the online community survey supported the sort of areas covered by the HPAA program than other areas and this was particularly strong amongst those who were more likely to have used a local 40 km/h shopping area. Notably, the support for more 40 km/h limits in residential areas showed the lowest support (see Table 17).

Table 17: Percentage of online survey respondents supporting more 40 km/h zones

Locations of 40 km/h zones	All respondents (N=498)	Respondents with local 40 km/h area (N=169)
Roads near parks where children play	51.6%	56.2%
Roads with a lot of traffic where people gather to shop, dine etc	40.8%	54.4%
Roads with a lot of traffic where people want to cross the road	36.1%	40.8%
Roads with not much traffic where people gather to shop, dine etc	20.5%	29.0%
Roads with bicycle lanes	16.5%	21.3%
Roads with not much traffic in residential areas	15.5%	18.9%
Other	2.6%	1.2%
Nowhere else	19.9%	9.5%

Information from jurisdictions (see Appendix G) also indicated an expectation that the use of 40 km/h, or lower, limits would increase in the future.

Conclusions

Necessary coverage

The crash data and feedback from practitioners and other stakeholders supported the view that the current coverage of the HPAA program has generated benefits that indicate that the existing areas have been generally in places where speed reduction was necessary.

There are a small number of HPAA zones and many of the other 40 km/h zones that do not cover areas of particular risk for pedestrians. Nevertheless, there was little demand to remove these. Particularly where there is a good match of road environment to support lower speeds, the benefit of these zones is to create a consistency of approach, with strong amenity values to support local activity.

Sufficient coverage

The crash data supports the view that there is significant opportunity for expanded coverage to generate increased benefits. With 84.4% of urban pedestrian casualty crashes occurring outside 40 km/h zones, there remain many areas that would benefit from 40 km/h limits, noting that there will always remain some roads that require other treatments instead. The expansion of the program into roads with more traffic and clear pedestrian activity will maximise crash benefits and is also likely to receive the strongest community support.

Many of the practitioners and stakeholders in New South Wales and in other jurisdictions support the view that coverage of 40 km/h zones will increase in the future. Similarly, proponents of active transport modes and improved urban place-making believe that further coverage is warranted to achieve the urban design outcomes that support more vibrant cities.

Evaluation Question 6: To what extent has the HPAA program been designed and implemented effectively?

In considering the design and implementation of the HPAA program, the original program guidelines (RTA, 2003) were reviewed, and augmented with one on one and workshop discussions with RMS and council officers. Examples of Roads and Maritime Services project documentation were assessed, and project expenditures collated.

The program design and implementation was evaluated in terms of site selection, project preparation, treatments, promotion, governance management and funding.

Findings

The intended development and implementation of the HPAA is set out in *“40 km/h speed limits in high volume pedestrian areas: A guide to identifying and implementing 40 km/h speed limits in high volume pedestrian areas”* (the Guidelines) (RTA, 2003). For ease of reference, the Guidelines are provided in Appendix E. The Guidelines were prepared for the Roads and Traffic Authority (now Roads and Maritime Services, which is referred to from this point on) and council officers involved in identifying and implementing 40 km/h speed limits in high volume pedestrian areas on local, regional and state roads. The Guidelines do not address ordinary permanent 40 km/h speed zones, or 40 km/h speed limits relating to schools, school buses or work zones.

Site selection

The Guidelines identified central business district areas, suburban shopping strips, areas where land use or facilities generate significant pedestrian traffic (for example, beach-side or park-side reserves), and significant pedestrian traffic generators such as medical centres, hospitals, and Government service agencies as appropriate sites for consideration of a 40 km/h speed limit.

As described in the response to Evaluation Question 1, the Guidelines provide for site selection for an HPAA according to one of three scenarios. These scenarios and categories of land use outlined are quite specific, but implementation appears to have allowed for quite broad interpretation, allowing councils a relatively wide degree of freedom to begin scoping projects.

A combination of site inspections and a desktop audit of sites indicated that the application of the criteria is quite subjective and also that, from the point of view of the authors, approximately 24 out of the 131 areas (comprising about 10% of the total length of zones) did not obviously meet the criteria (see section above “Characteristics of HPAA Zones”). However, the crash analysis failed to demonstrate any statistical difference between the performance of these different sites (see section in Appendix C “HPAA Sites”), supporting the view that these criteria are perhaps unnecessarily complex or not necessary at all.

Project Preparation

The Guidelines set out the broad responsibilities between the RMS and councils. The project development, delivery and maintenance responsibilities vary from scheme to scheme depending on whether or not the road is managed by the RMS or the council. The RMS retains approval of all speed limits and councils will be consulted about treatments on RMS managed roads.

The Guidelines set out 12 specific steps to implement a 40 km/h speed limit, as well as a post installation review to be conducted within one month of completion. The Guidelines also place particular implementation attention on stakeholder consultation for which a model process is prepared. The RMS assumes responsibility for ensuring Police are included in the community consultation phase, and the Regional Traffic Coordinator is informed in writing after consideration by the Local Traffic Committee.

Officers engaged in the program advise that in practice, the project development and consultation process is much more iterative than this. They reported that preparation of an HPAA relies on the ongoing relationships between council and RMS region staff, and does not follow any particular element of the Guidelines. That is, the focus is on installing effective HPAA's rather than following a specific checklist or process.

The HPAA in St Marys, Penrith, is an example of how the program has been implemented. Penrith Council undertook an RMS funded traffic and pedestrian study in June 2008, and subsequently requested implementation of an HPAA in and around St Marys Town Centre. A speed limit review was conducted, along with speed surveys at eight sites. A crash analysis showed 21 injuries over a five year period including 10 pedestrian injury crashes. An HPAA scheme was developed with eight raised gateway treatments, two raised pedestrian crossings, and kerb blisters. The Federal Blackspot Program contributed \$200,000 for two raised pedestrian crossings in 2012/13, and RMS contributed 50% of the remaining works to the value of \$300,000. 40 km/h limits on approximately 2.5 km of road were approved by RMS in April 2013 with the strong support of Penrith Council, which consulted with the community on the proposal and notified residents and shop owners prior to the changes being signposted.

Table 18: Workshop participants' individual ratings of project identification and approval (N=66)

Rate the process to identifying and gaining approval for new 40 km/h zones			
	RMS	Council	Total
Very difficult	1	2	3
Difficult	10	11	21
Acceptable	12	17	29
Easy	4	3	7
Very easy	0	0	0
Don't know	3	3	6

As shown in Table 18, out of 60 workshop participants who expressed a view, 24 found the process for identifying and gaining approval for new 40 km/h zones either Difficult or Very Difficult, while 36 found the process either Acceptable or Easy. There was not a substantial difference in responses between council and RMS staff.

Treatments

The Guidelines give considerable direction and guidance on engineering works. At an overall level a distinction is drawn between local and state roads:

- If the existing local/regional road under consideration produces low speeds, a 40 km/h area may be introduced with a gateway treatment. If not, traffic calming is considered appropriate.
- If the state road under consideration is a Principal Travel Route, the treatments should focus on pedestrian and vehicle separation. If not, a 40 km/h area may be introduced with a gateway treatment and traffic calming.

Direction is provided in relation to the use of the standard 40 km/h speed sign, the “Pedestrian Activity” plate (used with 40 km/h speed sign), and 40 km/h pavement numerals. The requirement for regulatory signage is one of the few elements of the Guidelines which is explicitly followed in the installation of HPAAAs, which is appropriate given it relates to legally enforceable requirements on users.

Guidance is provided on linear and area gateway and traffic calming treatments, whether on local, regional or state roads. This includes reference to further RMS or Austroads guidance documents, typical layouts of various schemes and illustrations and discussion of treatments. A typical set of traffic calming measures are referenced with consideration given to consulting user groups such as transport and emergency services. Substantial guidance is provided on undertaking speed surveys. The range of treatment options are appropriate given the overall design of the program to improve the safety of the physical environment for pedestrians in conjunction with speed limit reductions.

Promotion

The HPAA program was introduced in 2003 with a range of supporting promotional activity by the RTA. Aside from the Guidelines, a more specific question and answer brochure was provided to councils (Waverley Council, 2004). An updated factsheet with questions and answers was published in August 2012. RMS officers advised that as the Guidelines were originally published and promoted through established council engagement processes, they specifically raised the options available with councils, and schedules of potential sites were developed within regions. This resulted in a sustained period in which HPAA schemes were developed and implemented, in keeping with the demand driven nature of the program.

Workshop participants reported the use of roadside signage, letter box drops, local media coverage and campaigns to make the local population and traffic aware of the HPAA zones as they were introduced (Table 19).

Table 19: Workshop participants' identification of promotional channels (N=66)

How are any new 40km/h zones promoted? (tick any that apply)			
	RMS	Council	Total
None apart from the signs	2	7	9
Roadside signage, VMS etc	16	18	34
Letter box drops	20	21	41
Local press advertisements	14	25	39
Media campaign	16	9	25

This is consistent with the intended mix of information support within the community to support implementation.

Of the 498 respondents to the online community survey, 39% could recall seeing media about 40 km/h limits in their area. This increased to 50% amongst those who live near a local shopping centre with a 40 km/h zone. Understanding of the meaning of the HPAA sign appeared high, with 86.4% of respondents correctly stating that it imposed a 40 km/h limit at all times. However, this is probably lower than understanding of the generic speed limit sign. Of the respondents, 12.0% believed that this limit only applied when pedestrians were present. This percentage is slightly higher, at 15.4%, among those respondents under 25 years of age.

Governance

The HPAA program did not seek to apply a generalised reform across the road network. While this would have likely led to greater safety benefits, this would also have likely been much harder to introduce, and more costly. Rather, the program focused on transforming specific parts of the road network. A council-led approach has led to a variety of different schemes being introduced by many different councils.

This approach may also have led to a relatively hands off approach to the program from the various parties. The introduction of lower speed environments for pedestrians is the goal of the program, and this has been demonstrably achieved. However, good program governance is lacking in several areas – for example:

- there are no outcome or delivery goals within the program, such as coverage across all local council areas, or definable parts of the State's road network
- while there were financial audits in 2009 and 2011, there has been no observable monitoring of the implementation of the program other than as part of standard audit processes after installation of treatments.

This is not to imply that the program has been mismanaged in any way. Rather, it reinforces the way it has developed on a largely demand-driven basis. It can be difficult to develop and implement meaningful reform in road safety. This approach has allowed road users throughout the State to observe, become acclimatised to, and see the benefits of the program. This represents useful strategic progress in a critical area of

road safety reform, and provides a platform for further improvement in safety and pedestrian outcomes.

Management

Participants at the regional workshops were invited to discuss the management of the program. From a safety perspective, the Guidelines were regarded as positive because they provided consistent and flexible guidance to councils on how to support pedestrian safety. This assists councils in setting priorities and decision making.

The Guidelines were seen as supporting discussion within the community, and helped set driver expectations. Another stated positive was that the Guidelines were a basis upon which requests for lower speed limits could be declined, and so assisted Council or RMS officers in their interaction with the community.

While flexibility was regarded as a positive, it was seen as a negative in that it also leads to inconsistency. Some felt that more flexibility was required, and that the program was too prescriptive and narrow in its range of treatments (examples given were planting and pedestrian crossings), and discouraged innovation (examples given were seasonal demand or tourism generators).

Other negative responses to the Guidelines were that they were confusing to navigate, out of date, and vague (leaving too much room for interpretation). They were regarded as having insufficient information on community engagement or complementary behavioural programs, little linkage with other guidelines such as shared zones, and no resources for evaluation.

Council and RMS officers differed in responses to how well targeted the Guidelines are. Council officers were more likely to say the Guidelines were too restrictive, and RMS officers were more likely to say the Guidelines were too liberal. About half of all participants said the Guidelines were about right (Table 20).

Table 20: Workshop participants' individual ratings of guideline targeting (N=66)

How well-targeted are the guidelines (tick one)			
	RMS	Council	Total
Much too restrictive	0	0	0
Too restrictive	5	17	22
About right	17	12	29
Too liberal	7	1	8
Much too liberal	2	0	2

Funding

The HPAA program began with an offer to fund construction and installation of 40 km/h pedestrian zones, specifically including civil engineering works, signs and line markings.

This 100% funding was subsequently reduced to 50%. Over time, this is reported to have had the effect of reducing the level of funding involvement by Roads and Maritime Services, as councils can receive 100% funding from the Federal Blackspot program for example.

In addition to funding for engineering works, the Guidelines make specific reference to the RTA providing:

- a grant of up to \$20,000 to engage a consultant to prepare a detailed traffic calming design and to liaise with stakeholders affected by the changes in road environment.
- a \$3,000 grant to support the public education delivery of the message at the local level, such as local advertising or letter box drops.

Roads and Maritime Services still makes contributions to councils but there does not appear to be any systematic accounting for this.

Roads and Maritime Services provided a spreadsheet of expenditure on speed related projects over the 14 years 2002/03 through to 2015/16. There was \$5.936 million expenditure on speed related projects recorded over the first four years of 2002/03 through to 2005/06. This included \$362,000 in 2005/06 on 40 km/h signs in HPAA's in Sydney region, although a number of HPAA's are known to have been installed in other regions. Much more consistent reporting of expenditure on 40 km/h zones was recorded from 2007 onwards. This expenditure is reported in Table 21, broken down by Roads and Maritime Services region, with an accounting adjustment recorded in 2016 for South-Western region. This table also shows the length of HPAA zones installed as at 2016 but it should be noted that an unknown proportion of this would have been installed with earlier expenditure than that shown in this table.

Table 21: Regional expenditure in \$000 on 40 km/h speed zones (Roads and Maritime personal communication)

Year	Hunter	Northern	South-Western	Southern	Sydney	Western	Total (\$000)
2007		363			1,003		1,366
2008		526			864		1,390
2009	253	410			944		1,607
2010	619	430	16	50	1,260	33	2,409
2011	330	371	16	62	1,375	67	2,221
2012	114	147		100	707		1,068
2013	16	201	17	112	1,000		1,346
2014	3	171	30	96	618		915
2015	200	60	180		572		812
2016	114	7	-28		568		660
Total	1,649	2,686	231	420	8,911	100	13,997
HPAA km installed 2007-16	38	36	6	14	246	4	

The record shows average expenditure of \$1.4 million per annum on 40 km/h zones over the ten years 2006/07 to 2015/16. It is assumed that this expenditure is on direct costs associated with the installation of 40 km/h zones (including grants to councils), and does not include a wide range of other indirect costs such as staff and internal development or project preparation. The ten year figure of \$13.997 million is approximately 25% of the total \$56.895 million expenditure on speed management, which also includes items such as speed zoning database, assessment, review, and mapping; speed surveys, behavioural projects, assessment of mobile speed camera sites, and corporate speed management programs.

The extent to which HPAAAs have been introduced across state and local road networks in New South Wales is the result of many different factors. This is illustrated by responses by workshop participants when asked why are there not more 40 km/h zones (Table 22). Out of a total of 145 responses, approximately 20% referenced lack of community support or concern from road users, and another 20% indicated that they were not necessary or justified. Approximately half of the responses referenced insufficient funding for planning and treatments.

Table 22: Workshop participants' individual identification of barriers to 40 km/h installation (N=66)

Why are there not more 40km/h zones? (tick any that apply)			
	RMS	Council	Total
Not necessary or justified	15	13	28
Lack of community support	6	8	14
Concerns from road users	8	5	13
Insufficient funds for treatments	27	20	47
Insufficient resources for planning	14	12	26
Lack of awareness of guidelines	9	8	17

Discussion

The treatment guidance provides an appropriate range of options, underpinned by some core requirements. The Guidelines are consistent with the predominant view amongst participants in the program that speed limit changes in their own right are unlikely to achieve a reduction in speeds, and that greater use of physical engineering treatments are needed. To some extent at least, this constrains the application of 40 km/h speed limits.

The Guidelines provide direction, and an original reference point, without being followed to the letter. There is, however, some apparent difference between council and Roads and Maritime Services participants in their views regarding the potential application of HPAAAs – the former appear more likely to see the Guidelines as restricting the options available for their management of local roads, rather than facilitating change.

While the implementation of any road safety reform, and speed management reform in particular, requires good justification and implementation, it is of concern that, as noted earlier, some workshop participants saw the Guidelines as useful for turning down speed reform proposals rather as the basis for seeking solutions. Traffic speeds on the State's road network are likely to need to be reduced in order to meet the State's road safety goals, and the interaction on speed limits and safety between Roads and Maritime Services, councils and the community should seek to harness interest in this. The program leverages well understood safety and network management principles, and the treatment of speed limits below the urban default limit of 50 km/h may need further specification and direction in order for the State to achieve its road safety goals.

The HPAA program does not appear to have a high profile in the safety toolbox for councils or Roads and Maritime Services. This may be due to the program sitting alongside a number of other different but related programs with which Roads and Maritime Services regions are working with local councils. This includes pedestrian and cyclist active transport programs and school zones, and it is noted that the publication of the Guidelines followed closely after the 2002 production of a guide to preparing a Pedestrian Access and Mobility Plan.

The promotion of HPAA is thus taking place within quite a disaggregated environment for the support and management of safe pedestrian movements. A review of the documentation for six HPAA approval decisions between 2012 and 2015 which was provided by RMS showed that the HPAA approval for one zone actually related to a LATM scheme that had been largely completed, and for another zone to the improvement of a school zone. Two of the six HPAA zone approvals were new, and two were extensions to existing zones. RMS officers are responding to multiple issues in local areas, and using the Guidelines as they see necessary to find solutions.

The program can be observed to have, from a strategic perspective:

- capitalised on a period of reform in urban speed limits
- capitalised on interest from councils in main street re-design for local amenity
- focused on a substantial safety issue which could be easily explained
- created a mechanism for encouraging external partners to generate change.

To achieve this, significant boundaries were put around the implementation of the HPAA, reinforced by guidelines on how the program will be implemented. This approach of both initiating significant change, yet limiting the scope of the change has worked. Many parts of the State's road network are now much safer. The approach will need to be adjusted to capitalise on this progress, with consideration given to how to generalise the benefits to a much wider proportion of the road network and the communities who use it.

Councils and Roads and Maritime Services are each managing multiple outcomes in a complex environment. It may be necessary to return to first principles regarding what safety and pedestrian outcomes are being sought, and where. The Future Transport Strategy, building on the April 2016 draft NSW Road Planning Framework, provides the opportunity to improve these outcomes through more deliberate disaggregation and

treatment of different roads. For example, by setting out five functions of the NSW road network – motorways, movement corridors, vibrant streets, places for people, and local streets – the framework infers the potential establishment of pedestrian safety as the primary design issue for roads where the latter three functions dominate. As a basis for facilitating movement in major transport corridors and activity in local places, this framework would support much stronger promotion of HPAA safety and pedestrian outcomes across the road network.

Evaluation Question 7: How might the implementation of low speed zones be improved to achieve better road safety outcomes for vulnerable road users?

The previous evaluation questions have looked retrospectively to answer the broad question: “Have these zones, and the High Pedestrian Activity Area program, in particular, been successful?” This question looks forward at whether and how programs for safer speeds around vulnerable road users should be implemented in the future.

Information to answer this question was obtained from the practitioners’ workshops, interviews with other stakeholders, and from interstate jurisdictions, to gain insights about their experiences. The community survey was also used to gain a measure of the community’s appetite for further zones. Finally a review of literature provided some examples of how this issue is being tackled elsewhere.

Participants at the workshops were asked to consider two aspects relating to this question. Following on from their views on how the HPAA program was designed and implemented (see Evaluation Question 6), they were asked to propose ways that it could be improved. They were also asked to consider more broadly what actions should be considered to improve the safety of vulnerable road users, particularly in relation to speed management. Detailed responses to these issues are contained in Appendix E.

Discussions with stakeholders focused less on the details of program implementation, in which many had no involvement. The key issues identified through these processes are discussed below.

Improving the design and implementation of the HPAA program

Practitioners report that the Guidelines are not closely followed currently, yet many of the key features of the Guidelines regarding development and implementation of HPAAAs, such as close working together of Councils and Roads and Maritime Services, and providing information in the community, appear to be working as expected. There appears to be some natural variation in the level of detail that practitioners consider the Guidelines should provide – some seek further direction, and some see too much prescription.

The Guidelines appear to strike a reasonable balance, given they were developed close to 15 years ago. Any review of the Guidelines should follow the overall judgements made as a result of this evaluation. Key matters to address in providing guidance are:

- the extent to which the land use criteria for HPAA projects are relaxed, for example in order to allow greater use of 40 km/h zones wherever there is a demonstrated need.
- the extent to which the lowering of speed limits to 40 km/h can be undertaken without supporting infrastructure treatments.

More broadly, the planning and approval process was an area where practitioners saw significant potential for improvement. The general view expressed was that there should be a focus on integrating the HPAA process within longer term planning processes, and the advance preparation of candidate sites, rather than just reacting to local opportunities or issues.

More structured prioritisation tools were raised, so that information on pedestrian/vehicle counts, crashes and speeds could be better brought together for project design. Blackspot program processes were identified as a good way of developing and prioritising sites. Using multiple sources (including developers) to identify sites was raised, as was consideration of how to respond to community inputs.

Better visibility and integration of HPAA projects within funding processes were also regarded as important. Packaging up information for Councils could be supported by introducing yearly funding applications, for example. The funding cycle within the Active Transport program was regarded as a positive model.

At a wider program level, a number of workshop participants identified promotion as a matter of concern within the program. Clearer communication between Roads and Maritime Services and councils was seen as being important by a number of participants. Another identified a need for greater promotion of HPAA's by Roads and Maritime Services and TfNSW as part of major projects such as WestConnex and light rail.

Initiatives to consider for improved protection of vulnerable road users

Expansion of HPAA zones and full-time 40 km/h zones in general

Given the benefits of these zones, a number of strategies for their increased coverage were discussed with practitioners and other stakeholders.

While there were a few dissenting views, the majority of workshop participants and stakeholders believed that these zones should be expanded. However, a number of different views were expressed about how this should occur. The different approaches are described below. They are not mutually exclusive.

Follow the data

One sub-group of stakeholders worked on the assumption that the installation of 40 km/h zones was driven purely by safety needs, and so suggested that crash data should determine where future zones should be installed. It was suggested that this could follow the current approach driven by crash data but there was strong support for a more proactive approach that predicted risk and treated sites to address this. One benefit of this was that it would allow the installation of HPAA's into new precincts that did not have any crash history to help develop a case for funding.

Do it everywhere

This view was expressed by a small group, mainly those representing the interests of vulnerable road users, although there were some other practitioners who also shared it. This view was that, as 40 km/h (or 30 km/h) was the appropriate speed limit for high pedestrian activity precincts, it should be introduced wherever these were. A few suggested an approach of making 40 km/h the default limit in local areas, with 30 km/h applied with traffic calming in busy precincts.

Be strategic

This view applied to the implementation of the HPAA program, which many practitioners felt would benefit from a more strategic approach to determine a state-wide program to prioritise future investments. However, there was also a strong view, particularly among Transport for NSW officers, that the development of a network strategy to recognise both the movement and place functions of roads would benefit from more use of 40 km/h zones as one of the tools to achieve desired outcome of improved place-making.

The Ashford Ring Road project (Pillory Barn Creative, 2009) was cited by one workshop participant as an example of how changing strategic priorities between movement and place can transform a road. In this case, a one-way ring road was converted to a two-way street, with extensive re-design to improve shared spaces, with a speed limit of 20 mph, including the removal of unnecessary street furniture and the visual cues, such as linemarking, on which drivers normally rely for guidance and regulation.

Make sense

A number of practitioners and stakeholders expressed the view that any new zoning needed to “make sense” to drivers. However, while it is recognised that speed limits need to reflect the road environment and the benefits that come from matching these two, this view does not recognise that the social factors that influence what drivers see as an appropriate limit may have changed and are likely to change in the future. If a Safe System is to be achieved, it may be necessary to introduce limits that drivers are initially uncomfortable with until, supported by communications and enforcement, new habits lead to new norms being established. Findings in Europe that traffic calming is unnecessary or not effective at 40 km/h but necessary at 30 km/h (MASTER, 1998), is a reflection that the social beliefs and driver habits in Europe have set these norms at a lower speed than is general in Australia.

The relative success of school speed zones is a useful case study for this approach with demonstrated speed reductions (Ellison, Greaves & Daniels, 2011), with higher acceptance of enforcement in these zones (Ipsos, 2017) and lower self-reporting of speeding (Austroads, 2013) demonstrating their higher social acceptability. However, this could also be influenced by a perception that the risk of being caught is higher in these zones (Walker et al., 2009).

The use of the HPAA program and other programs to alter perceptions about what “makes sense” has the potential to obtain significant network-wide benefits. This

change in community perceptions is an important prerequisite in the achievement of strategic goals (Austroads, 2016b).

Regulation and enforcement

A number of practitioners expressed the view that the benefits from lower speed limits were being constrained by poor road user behaviour.

Most common was the belief that pedestrians were putting themselves at risk by not giving way to motorised traffic. It was suggested that enforcement would improve these behaviours and reduce risk.

More enforcement of the 40 km/h speed limit was also suggested by a number of stakeholders with others suggesting that enforcement of other risky behaviours, such as U-turns, would be beneficial.

It should be noted that, while poor behaviour does undoubtedly remain a significant cause of crashes, in a safe system these mistakes should be managed through the design and operation of the system. In this context, residual risks arising from poor behaviour could also reflect deficiencies in design.

Education and promotion

Similarly, education of pedestrians about their obligations in these pedestrian areas was seen as necessary to avoid the misconception that vehicles had to yield within the zone.

However, as stated earlier, the fact that many of these risk-taking behaviours are sub-conscious will limit the benefits from these education and promotion activities (Smith and Hodgen, 2016).

Different limits

30 km/h

A number of workshop participants and all stakeholders representing active transport groups expressed their view that 40 km/h is too fast for adequate protection of cyclists and pedestrians. One comment in particular was that at 40 km/h the road was for cars, at 30 km/h active transport becomes prioritised or, at 30 km/h or lower, “the car becomes a guest”.

Currently the use of 30 km/h limits elsewhere in Australia is limited to a few isolated cases. Information from these other jurisdictions showed an understanding that 30 km/h represented the logical next step. Some cautioned, however, that 40 km/h was the current pragmatic speed balancing safety with community expectations and provides greater consistency. There is general interest in seeing the results of any future use of this speed limit. New Zealand appears to be leading the way with 30 km/h adopted in main urban centres.

A number of authors have stressed the point that 40 km/h is too high and inconsistent with Safe System principles, which indicate that, at 40 km/h, the risk of serious injury is already significant (Mooren, Grzebieta & Job, 2014, Austroads, 2016a).

While there are a number of risk estimates, there is a consistent view that 40 km/h may be too high. A review of pedestrian crash risk (Rosen & Sander, 2009) indicated that the mean risk of fatality when struck at 40 km/h increased by 130% compared with the risk at 30 km/h. An analysis of a range of crash types suggested that 20 km/h was a more appropriate speed for a Safe System (Jurewicz et al., 2015).

It is notable that evidence from Europe on the impact of 40 km/h zones was very limited as 30 km/h (or 20 mph) has been used as the standard for pedestrian areas for many years. An approach to implementing 30 km/h zones was described in full over thirty years ago (Kraay, 1985).

In Sweden for example, standard practice is to adopt 30 km/h for residential streets and, for urban arterials, engineering treatments to prevent speeds exceeding 30 km/h wherever pedestrians or cyclists cross (Wrangborg, 2005). Also in Sweden, 30 km/h has been adopted as the limit around school buses (Anund, Viklund & Apeldoorn, 2012).

There are now more than 2,000 20 mph zones in the UK (DfT, 2013). The UK Department of Transport's circular on *Setting Local Speed Limits* provides guidance for the installation of "zones" (areas with traffic calming) and "limits" (lengths of road without traffic calming where speeds are already low) (DfT, 2013). It also represents a relaxation of requirements to reduce the cost associated with traffic calming treatments compared to the previous guidelines (DfT, 2006).

It should be noted, however, that the majority of full time 30 km/h zones in the UK have been implemented in residential areas. Nevertheless, the Swedish method of introducing the speed at certain locations on arterial roads indicates potential solutions.

Variable limits

Victoria has introduced a program to install variable 40 km/h zones on arterial roads through shopping strips, which have limited periods of pedestrian activity, corresponding to shopping hours or evening entertainment. This provides safety benefits when the risks are higher but also allows increased mobility at times when pedestrian volumes are lower. An evaluation of this scheme indicated an 8.1% reduction in total casualty crashes compared to control sites, although the short analysis period did not allow this to demonstrate statistical significance. Reductions during the times that the limit was 40 km/h were not measured due to the small sample size expected (Scully, Newstead & Corben, 2008). These zones are regulated through highly visible LED signs but no other traffic calming is used. Use of variable speed limits that improves the perceived match of driving conditions with the prevailing limit can improve drivers' acceptance, and hence compliance (MASTER, 1998).

Some workshop participants also suggested the trialling of seasonal limits to reduce limits in certain areas, for example during school holidays or public holidays.

Technology

Vehicles

As described by a number of workshop participants and well-established in the literature, such as Edwards et al, 2014 and Searson and Anderson, 2009, improved vehicle design and new technologies have the potential to greatly reduce risks for pedestrians. These include:

- Reduced vehicle aggressivity, including external airbags
- Pedestrian detection and collision warning
- Autonomous emergency braking, and
- Intelligent speed assist.

New ANCAP protocols to be introduced from 2018 will recognise the current pace of vehicle development and a 5-star vehicle after this date will be required to have a number of these technologies. However, as these will be introduced only on new vehicles, for many years there will still be a need for the road and speed environment to accommodate the current fleet of vehicles. These technologies, and ultimately autonomous vehicles, have the potential to change thinking about speed zoning but, for many years to come, the current thinking will still be applicable. These technologies can therefore provide additional benefits alongside programs such as HPAA rather than supplanting them.

More rapid benefits can result from requirements to retrofit vehicles. One example of this is the Transport for London Safe Lorry Scheme, introduced in 2015, which requires all heavy vehicles on defined roads to be fitted with blind-spot monitors and side-underrun guards to protect pedestrians and cyclists. This has been introduced as a traffic ordinance, to immediately regulate older vehicles not covered by vehicle standards requirements (Transport for London, 2015).

Intelligent transport systems (ITS) – vehicle activated signs

Workshop participants mentioned ITS as a growing opportunity. Although specific suggestions were not made in this area, an evaluation of speed indicator devices in 50 km/h zones in London (Walter & Knowles, 2008), showed statistically significant reductions in mean speed of approximately 1 to 3 km/h where the signs were operating and, more notably, significant reductions in the proportion of drivers speeding. However, these effects dissipated fairly quickly beyond the sign and after the sign was removed.

Infrastructure

Workshop participants suggested a number of infrastructure treatments to improve the operation of 40 km/h zones, and pedestrian safety in general. These included:

- Separation, particularly on State Roads
- Standardisation, particularly at thresholds to provide consistent cues for drivers

- Improved delineation.

One particular issue raised a number of times was that warrants (criteria) for pedestrian facilities, such as crossings, are too high and cannot be achieved even though there is a pedestrian risk, particularly in new areas. It was suggested that these warrants should be relaxed inside 40 km/h zones to reflect the greater priority being given to pedestrians. Some stakeholders also commented that such a relaxation would also allow latent demand for walking to be realised.

Design for cyclists

Stakeholders representing cyclists noted that when 40 km/h areas were implemented, there was a mistaken assumption that if it were well-designed for pedestrians then it would be suitable for cyclists. Attention to detailed design was seen as important, such as providing mountable kerbs to allow cyclists to avoid hazards at choke points.

Self-explaining roads

A number of workshop participants and stakeholders mentioned the benefits of a more holistic view to traffic calming through measures such as self-explaining roads.

An evaluation in New Zealand has indicated the potential for self-explaining road treatments to produce homogeneous speed profiles that reflect the function of the road more effectively than traffic calming treatments alone, with mean speeds on local roads falling from 44 km/h to 30 km/h (Charlton et al., 2010).

Conclusions and recommendations

Conclusions

While the amount of data available to respond to each evaluation question has varied considerably, the following summary conclusions can be made.

Evaluation Question 1: What is known about existing 40 km/h zones?

The evaluation completed a stocktake indicating that there are 619 permanent 40 km/h zones across New South Wales, covering 925 km of road length as at May 2016. Of these, 188 are HPAA zones, covering 343 km of road length.

The HPAA zones, collectively, form 131 separate areas that vary in nature, from short lengths through small shopping strips to large areas covering locations such as the Sydney CBD and other inner urban suburbs.

There are significant gaps in the Speedlink database recording the installation dates of zones. While more complete data would have allowed a more segregated analysis to be undertaken, the available data was sufficient to demonstrate statistically significant crash reductions. There may therefore be little benefit in a costly exercise of cleansing this data. Nevertheless, this evaluation demonstrated the value that can be extracted from the database and the need to ensure accurate and complete Speedlink data into the future.

Evaluation Question 2: What effects have 40 km/h speed zones had on crashes?

Roads that had 40 km/h limits imposed since 2002 have experienced statistically significant reductions in crashes since then. These reductions exceeded the reductions experienced on other permanent 40 km/h roads and on urban roads with other 40, 50 or 60 km/h limits, which were the best available control group.

The results of the analyses identified the following statistically significant effects of HPAA implementation:

- Casualty crashes: a 37.6% reduction in crashes 2002-2015 for HPAA compared to a 20.4% reduction on comparable 40/50/60 km/h roads elsewhere
- Serious casualty crashes: a 33.0% reduction in crashes 2005-2015 for HPAA compared to a 3.6% reduction on comparable 40/50/60 km/h roads elsewhere
- Pedestrian serious casualty crashes: a 46.4% reduction in crashes 2005-2015 for HPAA compared to a 19.1% reduction on comparable 40/50/60 km/h roads elsewhere
- For zones where implementation dates were known, a reduction of 12.5% to 16.4% in casualty crashes in the three to five years after implementation of HPAA zones compared to the three to five years before implementation.

Where a start date of an HPAA was known, nearly all HPAAs showed reductions in the number of crashes after the installation of HPAA for all crash types and comparison

periods. There were statistically significant reductions after installation for the following time periods, compared to the equivalent time period before installation:

- periods of two or more years for all crashes
- periods of three or more years for casualty crashes
- periods of five years for pedestrian casualty crashes
- periods of five years for fatal crashes.

It was more common for individual zones to experience crash reductions than crash increases.

The number of fatal crashes in 40 km/h zones is too low to allow any further conclusions to be made regarding effects on these crashes.

While there were many other factors influencing crash numbers in this period, the consistency of these results with previous studies on the impacts of speed reductions provide confidence that the 40 km/h zones have successfully reduced road crashes and consequent casualties by significant amounts.

Evaluation Question 3: What other positive and negative effects have 40 km/h zones had?

While safety benefits have been the most significant effects reported by practitioners and stakeholders, their comments support the published evidence that lower speeds, particularly in association with attractive roadside spaces, have a positive impact on amenity and walkability.

Although changes in traffic movements have not been measured in NSW, it is probable that there has been traffic diversion, particularly where alternative provision for through traffic has been provided. While this can cause delay if not managed, it also contributes to improved amenity in the treated areas.

A number of stakeholders consulted pointed out the strategic benefits that would result from this change in priority from movement to place and a number of published sources also indicated that this in turn could lead to improved community perceptions about social issues such as crime. On the other hand, stakeholders who held the view that the primary role of the road network was to provide mobility for motorised traffic had some concerns regarding these effects.

Evaluation Question 4: How do effects differ by: different site characteristics and implementation circumstances?

Zones implemented under the HPAA program have targeted many more areas of pedestrian risk than the other types of permanent of 40 km/h zones, implemented largely in local traffic areas. The HPAA zones have also achieved greater reductions in injuries than these areas.

Safety benefits accrue as much or more to other road users, mainly vehicle occupants, as they do to pedestrians. This indicates that 40 km/h zones can have a role in

contributing to overall road safety objectives and not just pedestrian safety. Nevertheless, at present, the perceived rationale for the zones is the protection of vulnerable road users.

The crash results did not indicate any significant differences in benefits between different site characteristics within the HPAA program. There were some HPAA sites that did not meet the criteria in the HPAA Guidelines, suggesting the criteria are perhaps unnecessary and could be replaced by simpler risk assessment tools to target areas of greatest need, regardless of their character.

Evaluation Question 5: To what extent is there appropriate coverage of 40 km/h zones?

Although a few HPAA zones have been installed where there is little risk for pedestrians, there is little demand for removal. The success of the program in achieving significant crash reductions indicates that the zones have generally covered necessary areas of risk.

However, there remains significant pedestrian road trauma on roads not covered by 40 km/h zones. In a number of cases, these are adjacent to, or of similar nature to, roads already limited to 40 km/h. In addition, the program has relatively few sites on State Roads, which represent a large proportion of pedestrian crashes. Community views indicated stronger support for 40 km/h limits on busy roads than on quiet ones.

Evaluation Question 6: To what extent has the HPAA program been designed and implemented effectively?

The success of the HPAA program is testament to its original design and to the long-term funding commitment to it.

However the program and the Guidelines are now 15 years old and warrant, at the least, an update of the Guidelines and program development process. There is an opportunity, now, to consider whether the role of the program is to continue to address localised road safety concerns or whether it is part of a broader strategy for the network as a whole.

One specific issue raised by many practitioners was the financial constraint that is increased by the need to include traffic calming treatments. While this was a necessary policy 15 years ago, and is still generally accepted by a significant proportion of the community, changing perceptions of appropriate speeds may enable a less stringent application, or removal of, this requirement. The very high community acceptance of school speed zones provides an example of effective speed management for vulnerable road users with much less reliance on physical devices.

Recommendations

1. The results of this evaluation are consistent with previous studies of speed limit reductions – 40 km/h speed zones have reduced road trauma by significant amounts

with roads now with HPAAAs experiencing almost double the reduction in casualty crashes compared to other urban roads since 2003.

It is recommended that programs to introduce safer speed limits in areas of high pedestrian activity should continue and that consideration should be given to expanding the scope of current programs to explore more opportunities for safer speed limits.

2. The HPAA program has successfully expanded the use of 40 km/h speed zones, and further expansion should be considered within a wider speed management and transport planning context.

It is recommended that the Centre for Road Safety works with Roads and Maritime Services, and with other functions in Transport for New South Wales, to develop a common understanding of the role of speed management in improving safety and supporting other programs to improve urban liveability.

3. The draft NSW Road Planning Framework provides a strong reference point for expanding speed limit zones below the urban default limit of 50 km/h, particularly where a location has a primary place function.

It is recommended that the Centre for Road Safety develops a strategy for future deployment of safer speed limits for pedestrian safety, and considers the following broad strategic options for doing so:

- d) *Business as usual*
 - iii. *Minor adjustments and improvements to guidelines*
 - iv. *No change to council-led process*
- e) *Incremental increase*
 - iv. *Increase council awareness*
 - v. *Develop improved capacity and capability for Roads and Maritime Services to drive continued expansion in the number and size of sites*
 - vi. *Improve the funding and development process to provide more consistent support for councils to expand use of lower speed zones*
- f) *Strategic program*
 - iii. *Establish strategic expectations for roads, whether controlled by Roads and Maritime Services or local councils, that targets vulnerable road user safety, while aligning with the development of successful places for people*
 - iv. *Determine statewide rollout and priorities, similar to the process adopted for implementation of the 50 km/h urban default limit.*

4. The HPAA program guidelines are complex and put significant boundaries around implementation. They can be usefully revised to reflect learnings and support continued safety improvement.

It is recommended that, once the strategic direction for the program has been determined, the HPAA Guidelines, and other guidance, such as the Speed Zoning Guidelines, should be revised by:

- e) *Removing prescriptive criteria regarding different categories of land use for selecting sites*
- f) *Developing a prioritisation process for implementation that*
 - iv. *Responds to community concerns regarding speed limits*
 - v. *Addresses the risk of casualty crashes on roads with different movement functions, and*
 - vi. *Recognises other non-safety specific factors such as urban place-making needs*
- g) *Making the Guidelines more flexible and simple, and reflecting successful experience to date*
- h) *Ensuring compliance with improved program management requirements, including:*
 - v. *Improved implementation data for monitoring and evaluation*
 - vi. *Greater transparency of the funding and approval process*
 - vii. *Measurement of outcomes*
 - viii. *Regular review and improvement of the program.*

5. Change management is a critical element of any speed management reform, and should be a key consideration in implementing these recommendations.

It is recommended that a strategic communications and engagement program be implemented at a number of levels in order to:

- e) *Increase practitioners' understanding of the role of the program in achieving Safe System and place-making outcomes,*
- f) *Engage other stakeholders in the transport sector and elsewhere to gain their support in promoting the program*
- g) *Increase community understanding, and acceptance of, speed limits lower than the urban default limit of 50 km/h*
- h) *Increase the confidence of decision-makers that they can support lower speed limits while managing any adverse feedback.*

6. There is good potential in taking some smaller intermediate steps, ahead of a more significant program to capitalise upon the success of the HPAA program.

It is recommended that the following measures be considered for immediate action:

- e) *Improve consistency of zoning and signage by*
 - v. *Reviewing current signposted 50 km/h local traffic areas and considering whether they are appropriate as 40 km/h areas*
 - vi. *Expanding existing 40 km/h zones, particularly into areas of significant pedestrian activity and/or on local cul-de-sac roads intersecting HPAA zones*
 - vii. *Rationalising overlapping school zones*
 - viii. *Replacing HPAA sign with standard 40 km/h sign to improve consistency and reduce visual clutter*
- f) *Relax pedestrian crossing warrants (criteria) in HPAA zones, possibly to the extent of removing the need for a warrant within an HPAA or 40 km/h zone, but including minimum spacings*

- g) Trial 40 km/h zones without traffic calming treatments on both busy and quiet roads, considering a number of different options to create self explaining cues for drivers:
 - iv. Speed zone signage alone*
 - v. Simple threshold treatments following standardised design principles*
 - vi. Increased delineation**
- h) Trial part-time zones that can allow the balance between movement and place to be altered at different times of day, or times of year, as traffic and pedestrian activity varies.*

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Appendices

A: Evaluation framework

B: Case studies

C: Crash analysis and zone information

D: Project Exhibits

E: HPAA program guidelines

F: Community survey

G: Policy and programs in other Australasian jurisdictions