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# Review of Road Safety Camera Siting Criteria and Locations

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## EXECUTIVE SUMMARY

Martin Small Consulting in association with the Centre for Automotive Safety Research at the University of Adelaide (CASR) was commissioned to develop siting criteria for each of the ACT's fixed speed camera enforcement technologies (midblock, red-light and point to point cameras), and provide advice on whether any existing cameras should be relocated to alternative locations.

Fixed speed cameras play an important role in maintaining a safe road environment. Options to extend the network of fixed midblock cameras in ACT should be considered as part of an overall speed management and enforcement program, and the best mix of investment in fixed and mobile camera enforcement.

Where fixed midblock camera investment is being considered, a weighted crashes per kilometer approach is recommended. In order to identify which section should have a speed camera installed, a number of other factors also need to be considered. These include:

- the presence of any other speed cameras in the nearby vicinity
- the number of vehicles passing the site
- the feasibility of placing and maintaining a camera on the road link
- the vehicle speeds on the road link
- the locations of vulnerable road users
- the effect of other engineering treatments to reduce speeds or potential for harm due to a crash.

Where fixed intersection camera investment is being considered, a weighted crashes approach is recommended. In order to identify which one is the most appropriate a number of other factors also need to be considered. These include:

- the presence of any other speed cameras nearby; where other cameras exist on a similar route, this would suggest a lower priority of camera placement
- the speeds that vehicles are travelling through the intersection; any that have higher speeds would indicate that a speed camera is an appropriate solution
- the engineering feasibility of installing and maintaining a camera at the location
- the possibility of other engineering treatments to resolve problem sites; where it is impossible to ban traffic movements such as uncontrolled right turns, or reduce the speed limit at an intersection a speed camera may be a good solution.
- Police and law enforcement information may make one spot preferable over another.

Point to point speed cameras typically enforce speed on lengths of road which have high traffic volumes and a significant crash history. They are predictable, and very effective in controlling speed over an extended distance. These cameras may be placed close together or cover long distances. Point to point speed cameras should only be placed on road sections where the road between the two points are free flowing (with no intersections, traffic lights etc) and do not have geometry such as hills and bends which substantially reduce speed in those areas. These characteristics are important for a point-to-point speed camera system to properly

identify speeding activity. Ideally, the speed limit is the same, although the precise measurements and timing required allow for some change.

The twenty most highly ranked midblock sections and intersections according to the recommended weighted crashes approach were identified and the top ten were analysed in further detail. Many of these are already fixed camera enforcement locations, and the remainder can be considered as candidates in any expansion of the fixed camera system.

Given the important role which they play, it is recommended that where midblock cameras are installed they remain. The existing midblock camera sites on Barton, Monaro and Federal Highways and Tuggeranong Parkway appear to be appropriately placed. In any expansion of the midblock system, it is recommended that specific consideration is given to the following four lengths of road:

- Parkes Way (from Glenloch Interchange to Edinburgh Avenue)
- Tuggeranong Parkway (from Sulwood Drive to Cotter Road)
- Northbourne Avenue (Ipima Street to Morphett Street)
- Belconnen Way (Haydon Drive to Benjamin Way).

Given the important role which they play, it is generally recommended that where intersection cameras are installed they remain. Overall, the intersection cameras are well placed: eight of the 12 sites appear on the top 20 ranked sites, and while two have notably lower rankings (Barry/Marcus Clarke, and Hindmarsh/Ball) they have unique circumstances that warrant more specific consideration before they would be shifted.

It is notable that many of the sites in the list of the 20 highest ranked intersections have a speed limit that is above 60 km/h (typically 80 km/h). It is recommended that speed cameras are considered at these sites where the main road speed is 80 km/h, ideally in conjunction with consideration of other primary safety measures such as lower speed limits, or right turn controls. It is recommended that specific consideration is given to:

- Hindmarsh Drive
- Belconnen Way.

Consideration should also be given to intersection safety at four of the ten highest ranked intersections within approximately 3.5 kilometres of each other on Northbourne Avenue (Antill/Mouat, Barry/Cooyong, MacArthur/Wakefield, and London). Cameras are currently installed at each intersection, except MacArthur and Wakefield. It is recommended that the planning and design of Stage 1 light rail from City to Gungahlin incorporates a full analysis of intersection and midblock safety and speed control along Northbourne Avenue.

There are two point to point speed enforcement systems operating in the ACT, on Hindmarsh Drive and on Athllon Drive. Hindmarsh Drive is a free flowing significant east-west road, and it would be useful to monitor and evaluate speed and safety performance on this section over time. Athllon Drive includes the 14$^{th}$ highest ranked midblock section according to the preferred weighted crashes per km approach (Beasley to Sulwood), but its suitability as a point to point site is questionable because it is interrupted by two roundabouts. These are designed in part to slow vehicle traffic and so reduces the effectiveness of the point to point

system.  The Athllon Drive point to point system could be better deployed elsewhere, and the Beasley to Sulwood section better controlled through a fixed midblock camera.

Two roads were identified in the analysis of fixed midblock speed cameras that have the characteristics necessary for successful treatment with a point-to-point speed camera – the Tuggeranong Parkway and Parkes Way.  Both of these roads have multiple midblocks which were ranked in the highest 20 roads suitable for a speed camera treatment. The Tuggeranong Parkway had four midblocks ranked in the highest 20, while Parkes Way had two midblocks ranked in the highest 20.

# INTRODUCTION

The Justice and Community Safety Directorate of the Australian Capital Territory (ACT) Government has commissioned a site selection study for its fixed camera program, as part of its Road Safety Camera Strategy. The strategy has the following goals:

- deliver an improved strategic management framework for the camera program
- improve the community's understanding of the purpose and the role of the camera program in supporting improved road safety outcomes for the Territory, and
- provide clear objectives and measurable targets for assessing the impact and contribution of the cameras to road safety in the Territory.

Within an overall speed management approach involving setting and enforcing speed limits, traffic calming and engineering treatments, and education and road safety awareness, the strategy supports camera enforcement as a means of encouraging drivers to comply with speed limits, and reduce the rate of right angle crashes arising from red-light running.

The strategy sets out a comprehensive schedule of actions, including the introduction of an "anytime, anywhere" approach to mobile camera enforcement, and the following strategic direction for fixed camera enforcement.

| Camera type | Objective | Strategic direction |
|---|---|---|
| Red-light / speed | Location specific treatment to address high risk intersections. | The ACT's red-light cameras will be kept at their current locations.<br>The criteria for red-light camera treatments will be reviewed, and if appropriate, amended to determine the basis for any expansion of these cameras. |
| Fixed midblock | Location specific treatment to address 'black spots' and high risk locations by reducing speed in the vicinity of the camera. | The ACT's existing fixed midblock cameras were deployed to provide a general deterrence across the network. However, it is recognised that the fixed mid-blocks cannot be used to achieve this effect unless there is a high density of cameras.<br>Any new or relocated fixed mid-block cameras will be deployed in accordance with the objective to address locations with a known crash history or that are identified as being high risk.<br>Methodology will be developed for identifying locations that are high risk or have a high frequency and severity of crashes for possible future deployment of fixed speed cameras. |
| Point to point | Route enforcement to address high speed roads with known crash history or high crash risk. | Revised siting criteria will be developed to ensure future point to point camera sites are located at sites that will provide the most effective road safety outcomes. The criteria will |

| | | |
|---|---|---|
| | | take account of the value for money relative to other speed management treatments by increasing the minimum length of point to point enforcement areas.<br>The locations of the existing point to point cameras will be reviewed and consideration given to relocation of those cameras to sites where they would make a more effective contribution to road safety outcomes. |

A 2014 review by the ACT Auditor-General into *Speed Cameras in the ACT* identified the following issues relevant to fixed camera site selection:

- the siting of mid-block cameras at locations which may not achieve the best road safety results
- the point to point cameras are experimental in an urban context and potentially not the best value for money compared with alternative treatments (as the length of the enforcement area is short), and
- the red-light/speed cameras may no longer be at the most high risk intersections.

Martin Small Consulting in association with the Centre for Automotive Safety Research at the University of Adelaide (CASR) was commissioned to:

- review the siting criteria for each of the ACT's fixed speed camera enforcement technologies (midblock, red-light and point to point cameras), and develop revised siting criteria for the cameras, consistent with the ACT Road Safety Camera Strategy, and
- provide advice on whether any existing cameras should be relocated to alternative locations, in accordance with revised siting criteria, taking into account the "life expectancy" of the fixed cameras.

This report begins by addressing site selection within an overall speed management context. It then discusses site selection criteria for ACT, and the application of that criteria within ACT, for each of the three fixed camera types – midblock, intersection, and point to point.

## SITE SELECTION IN SPEED CAMERA PROGAMS

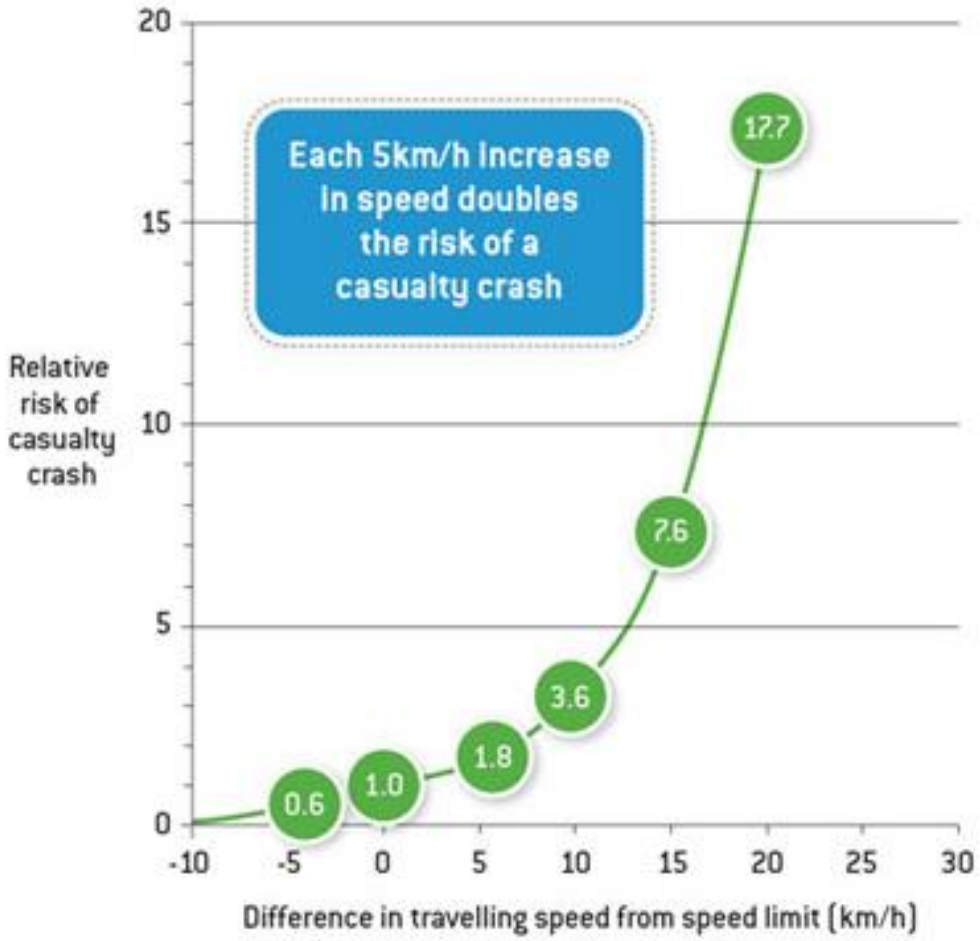
The purpose of speed cameras is to change the behavior of speeding motorists – more specifically, to deter motorists from driving over the speed limit, and prevent crashes, fatalities and injuries. Speed cameras can be very effective deterrence mechanisms. Careful program design and management is required to achieve the best safety results possible, and the siting and deployment of cameras is a critical part of this. It is important to first note some essential elements of good practice speed management and enforcement.[1]

### Speed management and enforcement

Speed camera programs should be designed and established in a way which recognises the central nature of speed control to road safety.

The speed being travelled by a motor vehicle in different road environments has a direct bearing on the risk of a crash occurring. The first rigorously controlled scientific study to demonstrate this crash risk relationship was conducted by CASR in Adelaide, and the key results are highlighted in Figure 1 below.

Figure 1: Speed and crash risk on 60 km/h roads




[1] This background and discussion of site selection in road safety camera programs draws on an Advisory Note prepared in 2015 for the World Bank's work in the Middle East and North Africa region by Martin Small, Soames Job and Said Dahdah.

The study found that each 5 km/h increase in speed over the speed limit in a 60 km/h zone doubles the risk of a casualty crash.[2] The increase in risk of travelling at 65 km/h in a 60 km/h zone is similar to the increase in risk of a driver being at the legal drink driving limit throughout Europe and Australasia, and highlights the safety impact of exceeding the speed limit by only a small amount.

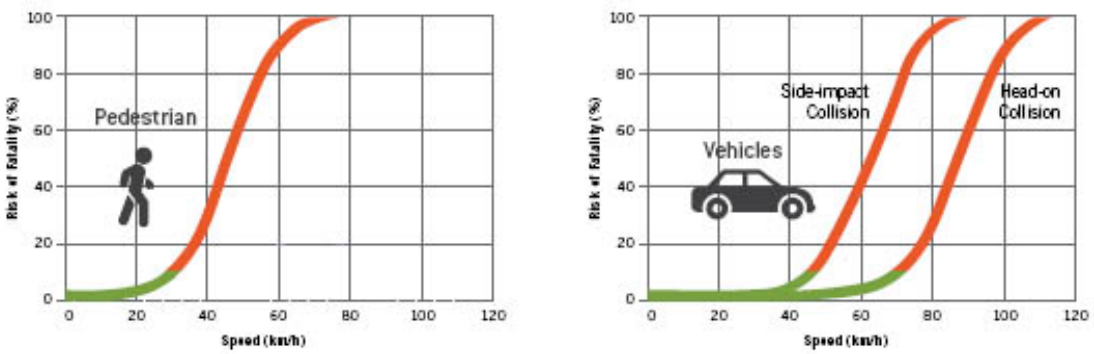
Determining a safe travelling speed for any road environment depends on the function, design and use of the road. The findings of the road safety research institute SWOV in the Netherlands are summarised in Table 1 below. It shows the safe speeds for a number of road types and potential conflicts – "safe" meaning a speed at which 90% of the crashes that take place will cause no serious injuries.[3]

Table 1: Safe speeds for road type and potential conflict

| Road Type and Potential Conflict | Safe Speed |
|---|---|
| Roads with possible conflicts between cars and unprotected road users | 30 km/h |
| Intersections with possible lateral conflicts between cars | 50 km/h |
| Roads with possible frontal conflicts between cars | 70 km/h |
| Roads on which frontal and flank conflicts with other road users are impossible | 100+ km/h |

The speed being travelled by a motor vehicle has a direct bearing on the risk of a fatality or serious injury occurring, whether the crash was caused by speeding or not. While different analyses will generate different risk curves, it is widely understood that the risk of a fatality for a pedestrian involved in a motor vehicle crash, for example, sharply escalates beyond an impact speed of approximately 30 km/h.

Figure 2: Risk curves for different crash types




Successful road safety enforcement is dependent upon specific deterrence (a person is deterred from speeding because of being personally caught and punished for speeding) and general deterrence (a person is deterred from speeding because they believe they *may* be caught with undesirable consequences). Both are needed to maximise the perceived risk of detection.

[2] Kloeden CN, McLean AJ, Glonek G (2002) Reanalysis of travelling speed and the risk of crash involvement in Adelaide South Australia. (CR207), Australian Transport Safety Bureau, Canberra.
[3] Wegman, F.C.M. & Aarts, L.T. (2006). *Advancing Sustainable Safety; National Road Safety Outlook for 2005-2020*. SWOV Institute for Road Safety Research, Leidschendam.

The following factors increase people's perceived risk of detection:

- high levels of perceived enforcement activity
- mix of stationary enforcement (in fixed locations and seen by more people) and moving enforcement (less predictable and affecting a larger area)
- mix of overt enforcement (visible to more people) and covert enforcement (not visible, less predictable and affecting a larger area)
- targeting enforcement activity to when and where the target behaviors are most likely to occur or the overall safety risk is highest, and
- use of road safety communications and advertising based on the risk of being detected by enforcement.

## Speed camera enforcement

Speed cameras are a relatively inexpensive method to dramatically reduce road deaths and injuries (provided the penalty is sufficient). The success of speed camera programs has been demonstrated in many countries. Numerous studies have been reviewed by the OECD[4] and by the Cochrane Collaboration[5] which conclude that speed cameras clearly provide substantial road safety gains in terms of reduced deaths and injuries.

The effectiveness of any camera program is constrained by the speed limit which is being enforced, the rules by which that enforcement takes place, and the level of program design analysis and investment that is undertaken. In summary, high performing camera programs:

- target speeding just over the speed limit rather than only speeding which is considered to be "extreme"
- target all crashes rather than only speed related crashes
- address a mix of road environments, and
- are managed as part of an overall behavior change program.

Based on the evidence regarding the effectiveness of the different camera systems in different situations, good practice programs include a mix of camera operations:

- a network of fixed cameras focused on high volume urban roads where there are significant crash histories or safety risks that are not susceptible to or have not yet received significant engineering safety treatments
- a network of fixed intersection cameras enforcing both red light running and speeding at the at-grade signalised intersections which have the highest frequencies of fatal and serious crashes that are not susceptible to or have not yet received significant engineering safety treatments
- a network of average speed cameras which enforce long lengths of high volume rural and regional roads (although some urban environments will also support successful deployment), between townships or other points where substantial traffic is likely to move on or off the roadway
- a large number of mobile cameras mounted in light vehicles which can be deployed on a randomised basis across a very large number of sites which

[4] Organisation for Economic Cooperation and Development (2006), Speed Management. Report of the Transport Research Centre, Paris.
[5] Wilson C, Willis C, Hendrikz JK, Le Brocque R, Bellamy N (2010). Speed cameras for the prevention of road traffic injuries and deaths. Cochrane Database of Systematic Reviews, Issue 11.

have been selected because they either present specific crash risks, or they will support an increased perception of detection.

While the deployment of a number of different camera systems is considered desirable, there is little evidence of the ideal mix of camera systems across a network. The next section discusses what can be deduced from evidence to be good practice in site selection for a speed camera program.

## Site selection as a factor in program design

The introduction and management of safety camera programs including site selection procedures and speed camera operations are often heavily negotiated in each jurisdiction. A summary of site selection practices in a number of countries is provided in Appendix 1. Looking at site selection specifically the design of the program needs to recognise two essential features.

The first is that camera operations should focus on the most highly trafficked routes, which is where road trauma tends to be heavily concentrated. One rule of thumb used internationally is that approximately 50% of fatalities and serious injuries occur on approximately 10% of the network. A safety camera program should include a focus on the main road network with a mix of rural and urban roads and, depending upon the structure of the network, possibly a mix of roads managed by the main road and local road provider.

The second is that camera operations should focus on road sections with high serious crash frequencies or serious crash rates – for a variety of reasons, some sections of road will have a higher density of fatal and serious injury crashes per kilometer, or a higher rate of crashes per vehicle kilometer travelled, than others. Ideally, the main road network is analysed section by section, although the exact length of road section analysed may vary. It may make more sense to analyse mid-block sections between intersections in urban environments, but typically an analysis of crashes per kilometer is advised.

However site selection is determined, it is important that the main road and enforcement agencies responsible document the network and crash analysis which they have used to determine the site selection, and match that analysis to the roll-out of camera systems and the sites where they are deployed. While the law should allow road and enforcement agencies to identify the best camera sites, it is important that the agencies take a disciplined approach that demonstrates the best possible use of public resources. This information should be able to be made public as required.

Once the data analysis has been undertaken, the suitability of a potential site needs to be assessed. The site needs to have clear and unimpeded vision of the traffic stream which is being enforced for the camera to capture clear photos of vehicle registration plates. It also needs to be accessible in a safe manner for installation, operations, and maintenance. Telecommunication systems and power must also be available to support the gathering of verifiable evidence from the site, and the site may need protection from vandalism.

Site suitability will likely be most constrained at urban intersections. There may be significant roadside furniture and infrastructural constraints to the physical

installation which need to be considered along with the crash history of the different traffic streams through the intersection.

Particular considerations also apply for the choice of average speed enforcement. The enforcement section ideally should not cover a section of road along which a large proportion of vehicles will turn off, and should not include a road environment (with for example many curves) which allows even speeding drivers to average speeds below the speed limit.

Finally, it should be recognised that a camera investment program may need to be fitted around an existing site or network of sites. In such cases, there may be a compelling case to take down a fixed installation, but integrating that installation into the new camera program may represent best safety value for money.

## Summary

The nature of the road network may impact upon the mix of cameras and individual site selection. Average speed cameras are very effective along corridors with few access points. Where major arterial roads in an urban environment are regularly punctuated with at-grade intersections, fixed cameras at mid-blocks on the highest volume or risk roads may be appropriate, as may cameras at the highest volume or risk intersections.

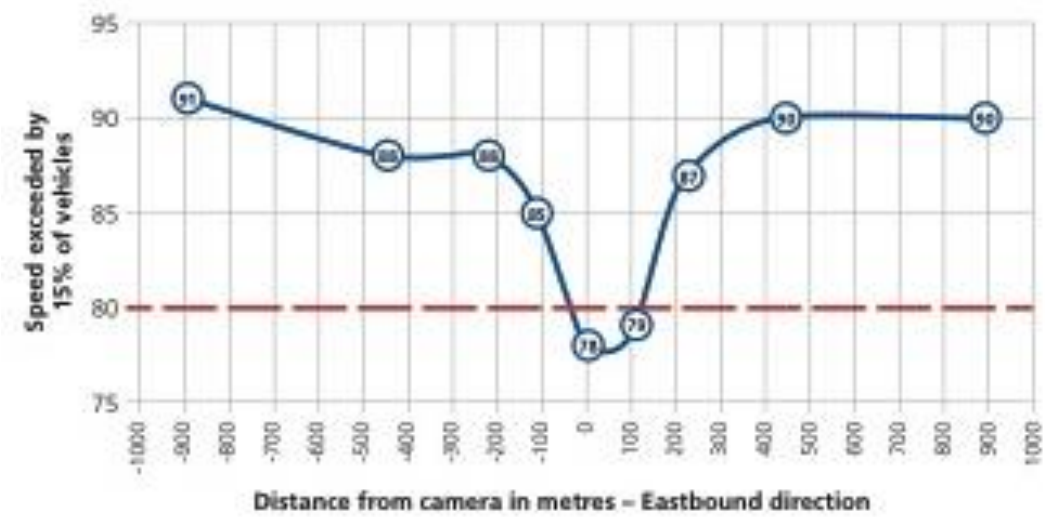
Whatever the nature of the network considerations in terms of systems and site selection, a sound crash analysis should be undertaken. Ideally, the serious crash profile can be assessed in one kilometer lengths, which has been found to be the extent to which fixed cameras can be effective in addressing speeding from a single point. When further differentiation beyond ranking of crash density is required, crashes per vehicle kilometer travelled can be used.

## MIDBLOCK SITE SELECTION

Fixed speed camera operations typically enforce speed on road sections with high volumes of traffic where there has been a cluster of casualty crashes.

Figure 3 shows the speed reduction effects of clearly visible fixed cameras. It shows speeds (in 85th percentile, or the speed exceeded by 15% of vehicles) on approach to, and departure from, a fixed speed camera in New South Wales and indicates that drivers slow down for around 500 metres around a fixed speed camera.

Figure 3: 85th percentile speeds around a fixed speed camera in New South Wales 80 km/h zone




Midblock speed cameras are ideally placed in locations where they will have the greatest effect in reducing crashes. The operations at these sites are highly predictable for drivers and deliver a specific deterrence effect within a set distance of the camera. That is, they create an additional reason for drivers to obey a speed limit because the driver is aware of the high probability of a penalty being given to them due to their speeding.

Fixed cameras can also reinforce the message that speeding is a major contributing factor to accidents, and that the government and police are committed to reduced road accident trauma through enforcement of speed limits. There is an inevitable degree of visibility in any camera program. For fixed cameras which are addressing known crash sites, the visibility may enhance the safety effect at that location by encouraging the driver to slow down when passing through the location. This may also have the unintended effect of the driver travelling over the speed limit once the site has been passed, perceiving the likelihood of detection to be much smaller.

The likelihood of having a crash is composed of two key components:

- the probability of a having a crash as the location is passed by each vehicle; and
- the number of vehicles that pass the crash location.

Using the number of crashes as a basis for determining the location of a speed camera allows both of these key components to be considered simultaneously.

The high number of crashes shows there is a specific crash probability for each vehicle that passes that location. In addition, compared with a location that has an

otherwise identical probability of a crash for each passing vehicle, the volume of vehicles passing that location amplifies the crash risk to one where there are more crashes that are happening. This means that a speed camera is being shown to higher numbers of vehicles each day, which enhances the specific deterrence effect and may also enhance the general deterrent effect.

## Approaches to finding the most appropriate sites for speed camera treatment

The most appropriate sites for a midblock speed camera are generally those with the highest numbers of crashes.

A database of all crashes in the years 2004-2013 was obtained from the ACT in order to determine the locations that had the highest number of crashes. The fields available include:

- crash year
- crash time
- crash severity
- crash type
- crash location (midblock identifier).

A supplementary database was obtained that included some attribute data for each of the road links in the crash database. This database included:

- road length
- an estimate of the average annual daily traffic (AADT) as modeled in 2006 (where multiple estimates of AADT for a particular road length existed, the highest value was used).

## Domain for counting the number of crashes

The road link, or road length between intersections, was considered to be the best region to count the number of crashes that have occurred. At the end of each road link there is typically an intersection, and at each intersection there are other traffic control measures that will influence vehicle speed choice. The major exception to this is the ACTs parkway system of high speed and high volume roads where there is no intersection at the end of a road link. Traffic that is joining or leaving these parkway roads does so via merging, and traffic that is crossing does so via an underpass or bridge. The road link on these parkway roads extends from each entry or exit point. Despite the absence of intersections that provide traffic control on these roads, the road link is still an appropriate length of evaluating a crash risk along each discrete road section to find those where the crash risk is highest.

Once the candidate links for fixed speed camera treatment are chosen, then a process of evaluating the suitability of each link needs to be undertaken. A fixed, midblock, speed camera has a specific deterrence effect that is approximately 1 km in length. The best site along the road link will be where the most crashes occur along that section of road. For the parkway system of roads there may be cases where a nearby road link provides the best place to put a camera from a practical engineering standpoint.

## Selecting the location for speed cameras

Four approaches were considered for the ideal placement of speed cameras, as set out in Table 2 below:

Table 2: Site selection approaches considered

| Approach | Method |
|---|---|
| 1 Count of injury crashes | Count of all Fatality and Injury crashes over the last ten years |
| 2 Count of all crashes | Count of all Fatality, Injury and Property Damage crashes over the last ten years |
| 3 Weighted count of crashes | Five times the count of all Fatality and Injury Crashes<br>PLUS<br>The count of all Property Damage Crashes over the last ten years |
| 4 Weighted count of crashes per km | Five times the count of all Fatality and Injury Crashes<br>PLUS<br>The count of all Property Damage Crashes over the last ten years<br>ALL DIVIDED BY<br>Length of the road link |

All roads, regardless of the average daily traffic volumes were considered initially, but only arterial roads were considered for treatment with fixed speed cameras. These are the roads that are designed as routes to transport traffic. Other types of roads were excluded because they are better candidates for mobile speed camera enforcement techniques. Short road links (less than 500 meters) were excluded due to their length.

### *1 Count of Injury Crashes*

The first approach considered for ranking speed camera locations was a count of the number of injury and fatal crashes that have occurred on each road link over the last ten years.

This approach considers only the most severe crashes. These are the crashes were a reduced speed is likely to have the most benefit.

In the ten years from 2004 to 2013 there were 2240 injury crashes and 76 fatal crashes in ACT. These crashes occurred on 1239 unique road link sections. The midblock section with the highest number of injury and fatal crashes over ten years had 24 such crashes, or less than 2.5 per year.

With low numbers of injury crashes like these, it is likely that random effects dominate the road links that appear highest on this list. Consequently, this is not the best approach to determine the road links where a speed camera is most appropriate.

### 2 Count of all crashes

The second approach to be considered was to count all crashes. This reduces the random effects that are likely to dominate with the low numbers of crashes seen when only injury and fatality crashes are counted.

This approach yields one road link that has had 273 crashes over the ten year period under consideration. All of the road links ranked in the highest 20 had more than 80 crashes.

This approach, however, does not account for the greater consequences of crashes that result in injuries or fatalities.

### 3 Weighted count of crashes

The third approach weights injury and fatality crashes higher than property damage only crashes due to their greater consequences for the community.

Many weighting ratios could be applied to the crash numbers. Ratios that weight injury and fatal crashes much higher than property damage only crashes will result in a ranked list of priority sites that is similar to the ranked list according to injury and fatal crashes only. On the other hand, a weighting ratio that weights injury and fatal crashes the same as property damage crashes will result in a ranked list of priority sites that is the same as that found when all crashes are counted. In between these two extremes, the sites that have a high proportion of injury crashes, as well as a moderate number of property damage crashes will tend to be ranked higher on a list of priority sites.

The United Kingdom previously used this method of weighting high severity crashes differently to low severity crashes to determine sites that are suitable for speed camera treatment. They used a weighted ratio of five times fatal and serious injury crashes to one times the minor injury crashes. Without more justifiable values, this is an appropriate ratio to apply to injury and property damage only crashes in the ACT crash data set.

Appendix 2 includes tables with the ranked list of midblock sections using each of these first three approaches.

A deficiency of all these methods is that long road links have a much longer distance to accumulate a high number of crashes compared with shorter road links.

### 4 Weighted count of crashes per km

The fourth considered option to rank road links is to assess the crash rate per kilometer of roadway.

There are many options for determining a crash rate per kilometer. All of them use the road link length as a divisor of the number of crashes on each road link.

The various options for calculating a crash rate per kilometer come from the different methods of calculating the number of crashes on each road link. Three such options have been described as the first three approaches considered above. The crash rate per kilometer can be easily calculated for just injury and fatal crashes (approach 1), for all crashes (approach 2), or for a weighted sum of crashes (approach 3). Of these, the weighted count of crashes, with injury and fatality crashes being weighted as five times the value of property damage only crashes provides a good balance of high crash numbers and consideration of crash severity.

The former UK model for speed camera placement required that the number of weighted crashes per km exceeded 18/km in non-built up areas and 22/km in built up areas over a three year period. Over ten years these values equate to 60/km in non-built up areas and 73/km in built up areas.

The former UK model for speed camera placement also required that very short sections of road, those under 1 km, had their crash numbers divided by a minimum length of 1km.

## Selected approach

All of the road links that were ranked in the highest 20 (including ties) using each of the approaches are shown in Table 3 below.

There are eight road links that are ranked in the top 20 with each of the approaches, and an additional nine that are ranked in the top 20 with three of the four approaches. This demonstrates that the list of possible locations of speed cameras is somewhat insensitive to the approach used to select it. This analysis also shows that, in general, the roads that are identified as being most likely for speed camera treatment are those roads that have a high AADT value. This demonstrates that the desired general effect can also be captured with this approach as large numbers of vehicles will encounter the speed cameras if they are placed in these locations.

Given this analysis, the approach considered to be most appropriate is the weighted crashes per kilometer approach. This is the one that accounts for all types of crashes and adds a weighting to those crashes that are more serious. It also accounts for the length of road on which the crashes are occurring.

## Site selection criteria for placement of midblock cameras

Fixed speed cameras play an important role in maintaining a safe road environment. Options to extend the network of fixed midblock cameras in ACT should be considered as part of an overall speed management and enforcement program, and the best mix of investment in fixed and mobile camera enforcement.

Where fixed midblock camera investment is being considered, a weighted crashes per kilometer approach is recommended, and a schedule of the highest ranked midblock sections using this process is found in Table 4 below. In order to identify which section should have a speed camera installed, a number of other factors also need to be considered. These include:

- the presence of any other speed cameras in the nearby vicinity
- the number of vehicles passing the site
- the feasibility of placing and maintaining a camera on the road link
- the vehicle speeds on the road link
- the locations of vulnerable road users
- the effect of other engineering treatments to reduce speeds or potential for harm due to a crash.

Each of the top ten midblock sections are addressed more fully in Appendix 3 for consideration regarding the installation of additional fixed midblock cameras.

Table 3: Road links ranked according to all approaches

| Road Link | Length | AADT ('000) | Injury & Fatality Crashes | PDO Crashes | Rank Approach 1 | Rank Approach 2 | Rank Approach 3 | Rank Approach 4 | Times Ranked in Top 20 |
|---|---|---|---|---|---|---|---|---|---|
| TUGGERANONG PARKWAY (HINDWTUGGSRM -> DRAKEFORD/SULWOOD) | 2.57 | 29 | 24 | 238 | **1** | **2** | **1** | **7** | 4 |
| TUGGERANONG PARKWAY (COTTWTUGGSRM/TUGGNCOTTWRM -> TUGGSHINDERM) | 2.14 | 25 | 17 | 256 | **6** | **1** | **2** | **6** | 4 |
| PARKES WAY (GLENLOCH INTERCHANGE -> PARKWLADYSRM) | 1.59 | 32 | 21 | 189 | **3** | **4** | **4** | **5** | 4 |
| TUGGERANONG PARKWAY (GREEWTUGGSRM -> TUGGSCOTTERM) | 2.68 | 31 | 22 | 193 | **2** | **3** | **3** | **12** | 4 |
| GUNDAROO DRIVE (GUNGAHLIN -> GINN/NARI) | 0.67 | 9 | 11 | 198 | **17** | **5** | **5** | **1** | 4 |
| NORTHBOURNE AVENUE (CONDAMINE/IPIMA -> MACARTHUR/WAKEFIELD) | 0.64 | 25 | 13 | 150 | **12** | **7** | **7** | **3** | 4 |
| PARKES WAY (CLUNSPARKERM -> PARKEEDINNRM/LAWSNPARKWRM) | 0.72 | N/A | 14 | 136 | **9** | **8** | **8** | **4** | 4 |
| ATHLLON DRIVE (SULWOOD -> BEASLEY) | 1.38 | 21 | 12 | 72 | **15** | **18** | **12** | **14** | 4 |
| COMMONWEALTH AVENUE (FLYNWCOMMNRM -> ALBERT) | 0.7 | 32 | 9 | 199 | 22 | **6** | **6** | **2** | 3 |
| MONARO HIGHWAY (MUGGA -> ISABELLA) | 1.13 | 33 | 7 | 95 | 34 | **13** | 14 | **11** | 3 |
| BELCONNEN WAY (BINDUBI/EASTERN VALLEY -> HAYDON) | 1 | 20 | 7 | 84 | 29 | **16** | **20** | **10** | 3 |
| WILLIAM HOVELL DRIVE (BINDUBI -> GLENLOCH INTERCHANGE) | 0.71 | 28 | 6 | 91 | 40 | **14** | **18** | **9** | 3 |
| WILLIAM HOVELL DRIVE (DRAKE BROCKMAN/KINGSFORD SMITH -> COPPINS CROSSING) | 4.66 | 12 | 18 | 104 | **5** | **10** | **9** | 62 | 3 |
| MONARO HIGHWAY (HINDWMONASRM ->PRISON ACCESS ROAD) | 3.07 | 30 | 11 | 75 | **19** | **17** | **15** | 65 | 3 |
| MAJURA ROAD (MUSTANG -> AVONLEY) | 3.23 | 6 | 12 | 71 | **16** | **19** | **13** | 72 | 3 |
| COPPINS CROSSING ROAD (WILLIAM HOVELL -> URIARRA) | 5.67 | 3 | 16 | 96 | **7** | **12** | **10** | 104 | 3 |
| NORTHBOURNE AVENUE (MACARTHUR/WAKEFIELD -> MORPHETT) | 0.78 | 25 | 1 | 123 | 194 | **9** | **16** | **8** | 3 |
| WILLIAM HOVELL DRIVE (COULTER -> BINDUBI) | 2.18 | 21 | 8 | 111 | 24 | **11** | **11** | 29 | 2 |
| KURINGA DRIVE (KINGSFORD SMITH -> TILLYARD) | 1.46 | 3 | 13 | 51 | **11** | 33 | 22 | **20** | 2 |
| LADY DENMAN DRIVE (BARRENJOEY -> COTTER) | 2.98 | 6 | 11 | 68 | **18** | 22 | **17** | 69 | 2 |
| MAJURA ROAD (AVONLEY -> MOUNT MAJURA ACCESS) | 5.24 | 6 | 13 | 56 | **14** | 30 | **19** | 144 | 2 |
| TUGGERANONG PARKWAY (COTTETUGGNRM -> TUGGNCOTTWRM) | 1 | 24 | 8 | 55 | 28 | 36 | 30 | **15** | 1 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| DRAKEFORD DRIVE (BODDINGTON/MARCONI -> SULWOOD/TUGGERANONG) | 0.59 | 28 | 5 | 71 | 53 | 25 | 29 | **13** | 1 |
| HINDMARSH DRIVE (TAMAR -> TYAGARAH) | 2.21 | 22 | 8 | 73 | 27 | **20** | 23 | 51 | 1 |
| BELCONNEN WAY (BENJAMIN -> BINDUBI/EASTERN VALLEY) | 0.8 | 20 | 6 | 55 | 39 | 40 | 36 | **16** | 1 |
| GUNGAHLIN DR (BARTSGUNGERM -> SANDFORD) | 0.78 | 15 | 5 | 56 | 59 | 41 | 42 | **19** | 1 |
| BARRY DRIVE (BARRNDRYASRM -> CLUNIES ROSS/FROGGATT) | 0.68 | 22 | 4 | 61 | 87 | 32 | 41 | **18** | 1 |
| CANBERRA AVENUE (TOM PRICE -> WOODS) | 1.61 | N/A | 3 | 92 | 125 | **15** | 25 | 31 | 1 |
| ATHLLON DRIVE (BEASLEY -> BEASLEY/MAWSON) | 0.84 | 20 | 2 | 74 | 146 | 24 | 38 | **17** | 1 |
| COTTER ROAD (PICNIC -> MT STROMLO RD) | 7.53 | N/A | 19 | 22 | **4** | 60 | 21 | 188 | 1 |
| POINT HUT ROAD (FRESHFORD -> JIM PIKE) | 4.55 | N/A | 15 | 16 | **8** | 78 | 32 | 160 | 1 |
| KINGS HIGHWAY PROPERTY 5893 -6394 (ACT/NSW BORDER -> HQJOC ACCESS RD).S.END_31102012 | 6 | N/A | 14 | 15 | **10** | 87 | 37 | 201 | 1 |
| PADDYS RIVER ROAD (COTTER -> LAUREL CAMP) | 2.76 | N/A | 10 | 11 | **20** | 128 | 56 | 148 | 1 |
| PADDYS RIVER ROAD (LAUREL CAMP -> TIDBINBILLA) | 11.02 | N/A | 13 | 16 | **13** | 85 | 40 | 246 | 1 |

Table 4: Road links ranked according to the weighted count of crashes per km approach

| Road Link | Suburb | Length | AADT ('000) | Fatal Crashes | Injury Crashes | PDO Crashes | *Weighted Crashes | **Weighted Crashes per km |
|---|---|---|---|---|---|---|---|---|
| GUNDAROO DRIVE (GUNGAHLIN -> GINN/NARI) | NGUNNAWAL | 0.67 | 9 | 0 | 11 | 198 | 253 | 253 |
| COMMONWEALTH AVENUE (FLYNWCOMMNRM -> ALBERT) | ACTON | 0.70 | 32 | 0 | 9 | 199 | 244 | 244 |
| NORTHBOURNE AVENUE (CONDAMINE/IPIMA -> MACARTHUR/WAKEFIELD) | BRADDON | 0.64 | 25 | 1 | 12 | 150 | 215 | 215 |
| PARKES WAY (CLUNSPARKERM -> PARKEEDINNRM/LAWSNPARKWRM) | ACTON | 0.72 | N/A | 0 | 14 | 136 | 206 | 206 |
| PARKES WAY (GLENLOCH INTERCHANGE -> PARKWLADYSRM) | ACTON | 1.59 | 32 | 0 | 21 | 189 | 294 | 185 |
| TUGGERANONG PARKWAY (COTTWTUGGSRM/TUGGNCOTTWRM -> TUGGSHINDERM) | CURTIN | 2.14 | 25 | 1 | 16 | 256 | 341 | 159 |
| TUGGERANONG PARKWAY (HINDWTUGGSRM -> DRAKEFORD/SULWOOD) | CHIFLEY | 2.57 | 29 | 0 | 24 | 238 | 358 | 139 |
| NORTHBOURNE AVENUE (MACARTHUR/WAKEFIELD -> MORPHETT) | LYNEHAM | 0.78 | 25 | 0 | 1 | 123 | 128 | 128 |
| WILLIAM HOVELL DRIVE (BINDUBI -> GLENLOCH INTERCHANGE) | MOLONGLO VALLEY | 0.71 | 28 | 0 | 6 | 91 | 121 | 121 |
| BELCONNEN WAY (BINDUBI/EASTERN VALLEY -> HAYDON) | ARANDA | 1.00 | 20 | 1 | 6 | 84 | 119 | 118 |
| MONARO HIGHWAY (MUGGA -> ISABELLA) | TUGGERANONG (RURAL) | 1.13 | 33 | 0 | 7 | 95 | 130 | 115 |
| TUGGERANONG PARKWAY (GREEWTUGGSRM -> TUGGSCOTTERM) | WESTON CREEK (RURAL) | 2.68 | 31 | 0 | 22 | 193 | 303 | 113 |
| DRAKEFORD DRIVE (BODDINGTON/MARCONI -> SULWOOD/TUGGERANONG) | KAMBAH | 0.59 | 28 | 0 | 5 | 71 | 96 | 96 |
| ATHLLON DRIVE (SULWOOD -> BEASLEY) | TORRENS | 1.38 | 21 | 1 | 11 | 72 | 132 | 96 |
| TUGGERANONG PARKWAY (COTTETUGGNRM -> TUGGNCOTTWRM) | CURTIN | 1.00 | 24 | 0 | 8 | 55 | 95 | 95 |
| BELCONNEN WAY (BENJAMIN -> BINDUBI/EASTERN VALLEY) | MACQUARIE | 0.80 | 20 | 0 | 6 | 55 | 85 | 85 |
| ATHLLON DRIVE (BEASLEY -> BEASLEY/MAWSON) | TORRENS | 0.84 | 20 | 0 | 2 | 74 | 84 | 84 |
| BARRY DRIVE (BARRNDRYASRM -> CLUNIES ROSS/FROGGATT) | ACTON | 0.68 | 22 | 0 | 4 | 61 | 81 | 81 |
| GUNGAHLIN DR (BARTSGUNGERM -> SANDFORD) | MITCHELL | 0.78 | 15 | 0 | 5 | 56 | 81 | 81 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| KURINGA DRIVE (KINGSFORD SMITH -> TILLYARD) | BELCONNEN (RURAL) | 1.46 | 3 | 1 | 12 | 51 | 116 | 79 |
| MONARO HIGHWAY (LANYON -> SHEPPARD) | HUME | 1.23 | 28 | 0 | 4 | 77 | 97 | 79 |
| BELCONNEN WAY (GUNGAHLIN DR -> BARRY DR) | BRUCE | 1.33 | 27 | 0 | 9 | 60 | 105 | 79 |

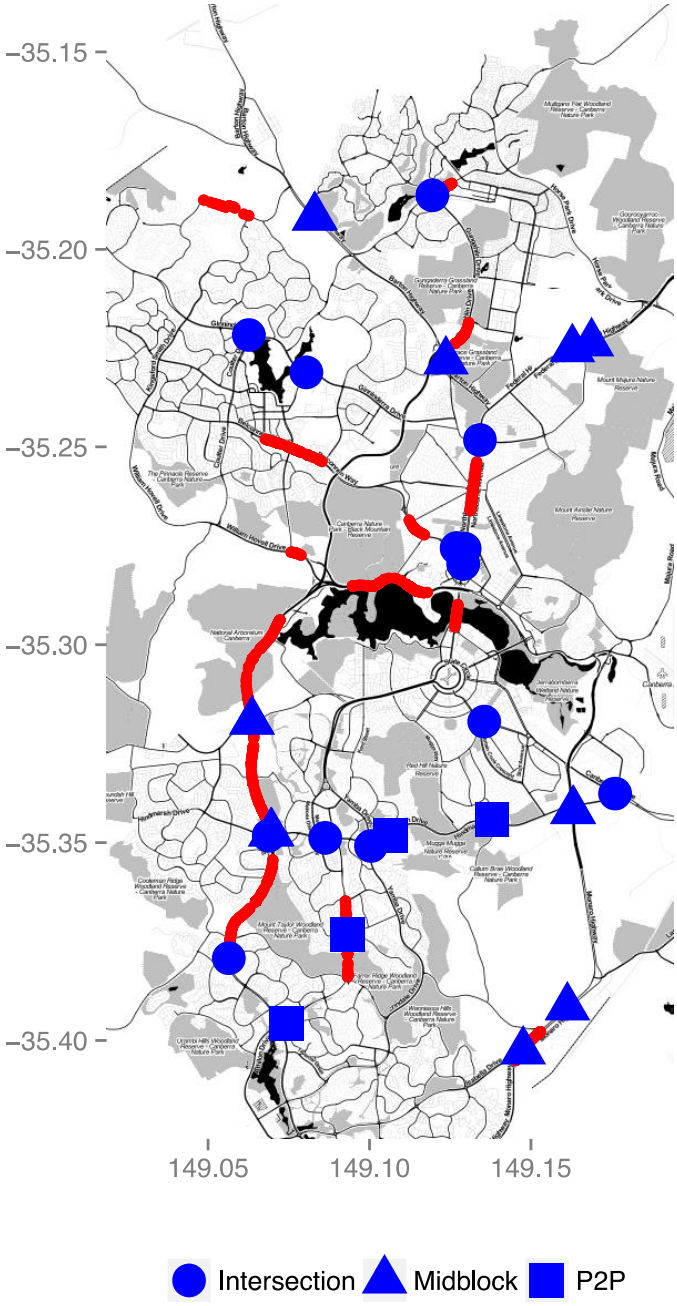
* Weighted Crashes = 5 * (Fatalities + Injuries) + PDOs

** Weighted Crashes per km = Weighted Crashes / Length; where length is a minimum of 1.0

## Placement of midblock cameras

Figure 4 below shows each of the fixed camera installations against the highest ranked midblock sections (using the weighted crashes per km method).

Figure 4: Current speed camera installation (blue) and highest ranked midblock sections




Given the important role which they play, it is recommended that where midblock cameras are installed they remain. The existing midblock camera sites on Barton, Monaro and Federal Highways and Tuggeranong Parkway are addressed in Appendix 5, and appear to be appropriately placed. Figure 4 provides some graphical insight into where future investment in the camera program can be best directed, depending on site specific matters which would require specific investigation.

### *Potential placement of further midblock cameras*

Notwithstanding consideration of each of the midblock sections set out in Table 6, it is recommended that specific consideration is given to the following four lengths of road, which each comprise adjacent sections in the 20 highest ranked midblock sections:

- Parkes Way – the length from Glenloch Interchange to Edinburgh Avenue comprises the 4th and 5th highest ranked midblock sections, and given the high level of uniformity in east-west traffic is addressed further in the report in relation to possible point to point speed enforcement (there are no fixed camera installations here)
- Tuggeranong Parkway – the length from Sulwood Drive to Cotter Road comprises the 6th and 7th highest ranked midblock sections, and given the high level of uniformity in north-south traffic is addressed further in the report in relation to possible point to point speed enforcement (there are two midblock and two intersection cameras here)
- Northbourne Avenue – the length from Ipima Street to Morphett Street comprises the 3rd and 8th highest ranked midblock sections, includes the 9th highest ranked intersection (MacArthur/Wakefield), and has the 2nd highest ranked intersection to the north (Mouat/Antill) and the 4th ranked intersection (Barry/Cooyong) to the south (there are several intersection cameras at either end of this midblock length)
- Belconnen Way – the length from Haydon Drive to Benjamin Way comprises the 10th and 16th highest ranked midblock sections, includes the 11th (Eastern Valley/Bindubi) and 14th (Benjamin Way) highest ranked intersections, and has the 13th ranked intersection to the west (there are no fixed camera installations here).

The best mix of camera treatments on these roads requires more site specific investigation, and is addressed further in the report as intersection and point to point sites are considered.

## INTERSECTION SITE SELECTION

Safety cameras at intersections were originally developed to detect red light running, but high performing camera programs now enforce both red light running and speeding by using dual function cameras.

As with the placement of speed cameras on midblocks, the placement of these speed cameras should be done in a manner that is likely to affect the highest number of crashes.

Instead of a speed camera, consideration should be give to other engineering treatments as a preference. These treatments, such as banning uncontrolled right turns, may lead to lower crash numbers. Where these other engineering treatments are not possible then a speed camera may be most effective solution for reducing the incidence and severity of crashes that occur at an intersection.

Three approaches were considered to determine the intersections in the ACT that had the highest crash risk.

- the number of injury and fatality crashes
- the number of all crashes
- the number of weighted crashes.

### Approaches for selecting a site for intersection speed camera placement

A database of all crashes in the years 2004-2013 was obtained from the ACT in order to determine the locations that had the highest number of crashes. The fields available included:

- crash year
- crash time
- crash severity
- crash type
- crash location (intersection identifier)
- traffic control measure.

Some additional data was made available and used to supplement the analysis too, including road links that connected with each intersection, and speed limit data for some road links.

### Identifying intersections that are controlled by traffic lights

The data supplied by the ACT identified all crashes that occurred at an intersection using an intersection identifier. The data did not have a direct method of determining which of the intersections was controlled by traffic lights.

To determine which intersections were controlled by a traffic light every crash that occurred at each intersection was examined. From these crashes the type of traffic control that was most commonly reported as part of the crash report was determined. When the most commonly reported traffic control was a traffic light, the intersection was considered to be a traffic light intersection.

Some other traffic controls that occurred on the intersections that were considered to be controlled by a traffic light included:

- police control, presumably because police were in control of the intersection at the time of the crash

- uncontrolled, presumably because the crash report suggested that the traffic lights played no role in the cause of the crash.

## Number of injury and fatal crashes

The number of injury and fatal crashes at an intersection is a count of all of the injury and fatal crashes that are coded with a specific intersection identifier. The ranked list of the intersections that have the highest number of injury and fatal crashes is shown in Table 7 below.

Over the ten year period considered, the intersection that had the highest number of injury and fatal crashes was the Lanyon and Monaro Highway. In that time it had 22 injury crashes, or 2.2 per year.

This relatively small number of injury and fatal crashes at each location means that random effects may dominate the intersections that have the highest rank according to this method.

As with the selection of the sites that are most suitable for midblock speed camera treatment, it is better to use a larger number of crashes to select sites that are most suitable for speed camera treatment.

## Number of all crashes, and the number of weighted crashes

The total number of all crashes is determined by counting all of the crashes that have occurred on the intersection. Just as in the analysis of the midblock road links, a weighted number of crashes is determined by counting the crashes that have happened on an intersection and then weighting them based on the severity of the crash.

In the United Kingdom, a weighted method was used where fatal and severe injury crashes were weighted at five times the value of minor injury crashes. For the ACT data a similar weighting can be achieved with fatal and injury crashes rated at five times the value of property damage only crashes.

Both of these approaches (the total number of all crashes, and the weighted number of crashes) give a ranked list of intersections with the highest crash risk that are quite similar. The top ten sites in both lists is the same except for some minor changes in ranking values of up to two places only. The biggest differences between the lists of the top 20 are near the end of the list, with six different sites filling places 18 through 20 in the different lists. The similarity between the ranked lists arises because of the relatively small numbers of fatal and injury crashes that occur at any one intersection.

Because the lists are quite similar, both are shown in Table 6 below with their rankings also shown for comparison. The locations of these sites are shown in Figure 5 below. Eight of the intersections ranked inside the highest 20 according to these measures already have a speed camera installed, including five of the highest ten.

Table 5: Intersections with the highest number of injury and fatality crashes in the years 2004-2013

| Intersection Name | Camera Installed | Fatal Crashes | Injury Crashes | PDO Crashes | Injury/Fatality Rank |
|---|---|---|---|---|---|
| LANYON/MONARO | | 0 | 22 | 145 | 1 |
| BELCONNEN/BINDUBI/EASTERN VALLEY | | 0 | 16 | 247 | 2 |
| BARRY/COOYONG/NORTHBOURNE | Yes | 0 | 15 | 361 | 3 |
| GINNINDERRA/KINGSFORD SMITH | | 0 | 15 | 161 | 3 |
| ANTILL/MOUAT/NORTHBOURNE | Yes | 1 | 12 | 398 | 5 |
| DRAKEFORD/ERINDALE/SOWARD | | 1 | 12 | 184 | 5 |
| HINDMARSH/YAMBA | Yes | 0 | 13 | 521 | 5 |
| LONDON/NORTHBOURNE | Yes | 0 | 12 | 284 | 8 |
| MACARTHUR/NORTHBOURNE/WAKEFIELD | | 0 | 12 | 300 | 8 |
| BELCONNEN/BELCEGUNGNRM RAMP/GUNGNBELCWRM RAMP | | 1 | 10 | 170 | 10 |
| ANZAC/CONSTITUTION | | 0 | 11 | 62 | 10 |
| ATHLLON/DRAKEFORD | | 0 | 11 | 403 | 10 |
| HINDMARSH/MELROSE | | 0 | 11 | 381 | 10 |
| ATHLLON/BEASLEY (SW) | | 0 | 10 | 85 | 14 |
| BALDWIN/GINNINDERRA/HAYDON | | 0 | 10 | 380 | 14 |
| BELCONNEN/BENJAMIN | | 0 | 10 | 236 | 14 |
| DAVID/MACARTHUR/WATTLE | | 0 | 10 | 135 | 14 |
| DRAKEFORD/O"HALLORAN/SUMMERLAND (SW) | | 0 | 10 | 87 | 14 |
| BELCONNEN/COULTER | | 1 | 8 | 250 | 19 |
| CANBERRA/MONANCANBWRM | | 1 | 8 | 63 | 19 |
| COWPER/IPIMA/LIMESTONE | | 1 | 8 | 79 | 19 |
| ATHLLON/CALLAM/HINDMARSH | | 0 | 9 | 326 | 19 |
| BODDINGTON/DRAKEFORD/MARCONI | Yes | 0 | 9 | 212 | 19 |
| BUNDA/NORTHBOURNE/RUDD | | 0 | 9 | 105 | 19 |
| CANBERRA/HINDMARSH/NEWCASTLE | Yes | 0 | 9 | 318 | 19 |
| COLLEGE/HAYDON | | 0 | 9 | 109 | 19 |
| COOYONG/MORT | | 0 | 9 | 125 | 19 |
| GUNGAHLIN/KOSCIUSZKO/THE VALLEY | | 0 | 9 | 52 | 19 |
| GUNGAHLIN/SANDFORD | | 0 | 9 | 95 | 19 |
| KINGSFORD SMITH/SOUTHERN CROSS | | 0 | 9 | 209 | 19 |

Table 6: Intersections ranked by number of crashes or weighted number of crashes

| Intersection Name | Camera Installed | Fatal Crashes | Injury Crashes | PDO Crashes | Total Crashes | Rank | Weighted Crashes | Rank | Speed Limits |
|---|---|---|---|---|---|---|---|---|---|
| HINDMARSH/YAMBA | Yes | 0 | 13 | 521 | 534 | 1 | 586 | 1 | 60/80 |
| ANTILL/MOUAT/ NORTHBOURNE | Yes | 1 | 12 | 398 | 411 | 3 | 463 | 2 | 60 |
| ATHLLON/DRAKEFORD | | 0 | 11 | 403 | 414 | 2 | 458 | 3 | 80 |
| BARRY/COOYONG/ NORTHBOURNE | Yes | 0 | 15 | 361 | 376 | 6 | 436 | 4 | 60 |
| HINDMARSH/MELROSE | | 0 | 11 | 381 | 392 | 4 | 436 | 4 | 60 |
| BALDWIN/GINNINDERRA/ HAYDON | | 0 | 10 | 380 | 390 | 5 | 430 | 6 | 80 |
| ATHLLON/CALLAM/ HINDMARSH | | 0 | 9 | 326 | 335 | 7 | 371 | 7 | 60/80 |
| CANBERRA/HINDMARSH/ NEWCASTLE | Yes | 0 | 9 | 318 | 327 | 8 | 363 | 8 | 60/80 |
| MACARTHUR/ NORTHBOURNE/ WAKEFIELD | | 0 | 12 | 300 | 312 | 9 | 360 | 9 | 60 |
| LONDON/NORTHBOURNE | Yes | 0 | 12 | 284 | 296 | 10 | 344 | 10 | 60 |
| BELCONNEN/BINDUBI/ EASTERN VALLEY | | 0 | 16 | 247 | 263 | 12 | 327 | 11 | 60/70 /80 |
| DRAKEFORD/SULWOOD/ TUGGERANONG | | 0 | 5 | 274 | 279 | 11 | 299 | 12 | 80 |
| BELCONNEN/COULTER | | 1 | 8 | 250 | 259 | 13 | 295 | 13 | 60/80 |
| BELCONNEN/BENJAMIN | | 0 | 10 | 236 | 246 | 14 | 286 | 14 | 60/80 |
| GUNDAROO/GUNGAHLIN | Yes | 0 | 5 | 236 | 241 | 15 | 261 | 15 | 80 |
| COULTER/LUXTON/ SOUTHERN CROSS | | 0 | 6 | 229 | 235 | 16 | 259 | 16 | 60/80 |
| BODDINGTON/ DRAKEFORD/ MARCONI | Yes | 0 | 9 | 212 | 221 | 17 | 257 | 17 | 60/80 |
| LANYON/MONARO | | 0 | 22 | 145 | 167 | 27 | 255 | 18 | 80 |
| KINGSFORD SMITH/SOUTHERN CROSS | | 0 | 9 | 209 | 218 | 18 | 254 | 19 | 60/80 |
| DRAKEFORD/ERINDALE/ SOWARD | | 1 | 12 | 184 | 197 | 19 | 249 | 20 | 60/80 |

## Site selection criteria for placement of intersection cameras

Intersection cameras play an important role in maintaining a safe road environment. Options to extend the network of fixed intersection cameras in the ACT should be considered as part of an overall speed management and enforcement program, and the best mix of investment in fixed and mobile camera enforcement.

Where fixed intersection camera investment is being considered, a weighted crashes approach is recommended, and a schedule of the highest ranked intersections using this method is found in Table 6 above. In order to identify which one is the most appropriate a number of other factors also need to be considered. These include:

- the presence of any other speed cameras nearby; where other cameras exist on a similar route, this would suggest a lower priority of camera placement
- the speeds that vehicles are travelling through the intersection; any that have higher speeds would indicate that a speed camera is an appropriate solution
- the engineering feasibility of installing and maintaining a camera at the location
- the possibility of other engineering treatments to resolve problem sites; where it is impossible to ban traffic movements such as uncontrolled right turns, or reduce the speed limit at an intersection a speed camera may be a good solution.
- Police and law enforcement information may make one spot preferable over another.

Each of the top ten intersections are addressed more fully in Appendix 4 for consideration regarding the installation of additional intersection cameras.

## Placement of intersection cameras

Given the important role which they play, it is generally recommended that where intersection cameras are installed they remain. The existing intersection camera sites are addressed in Appendix 5. Overall, the intersection cameras are well placed: eight of the 12 sites appear on the top 20 ranked sites, and while two have notably lower rankings (Barry /Marcus Clarke, and Hindmarsh/Ball) they have unique circumstances that warrant more specific consideration before they would be shifted. Figure 5 provides some graphical insight into where future investment in the camera program can be best directed, depending on site specific matters which require further investigation

### *Potential placement of further intersection cameras*

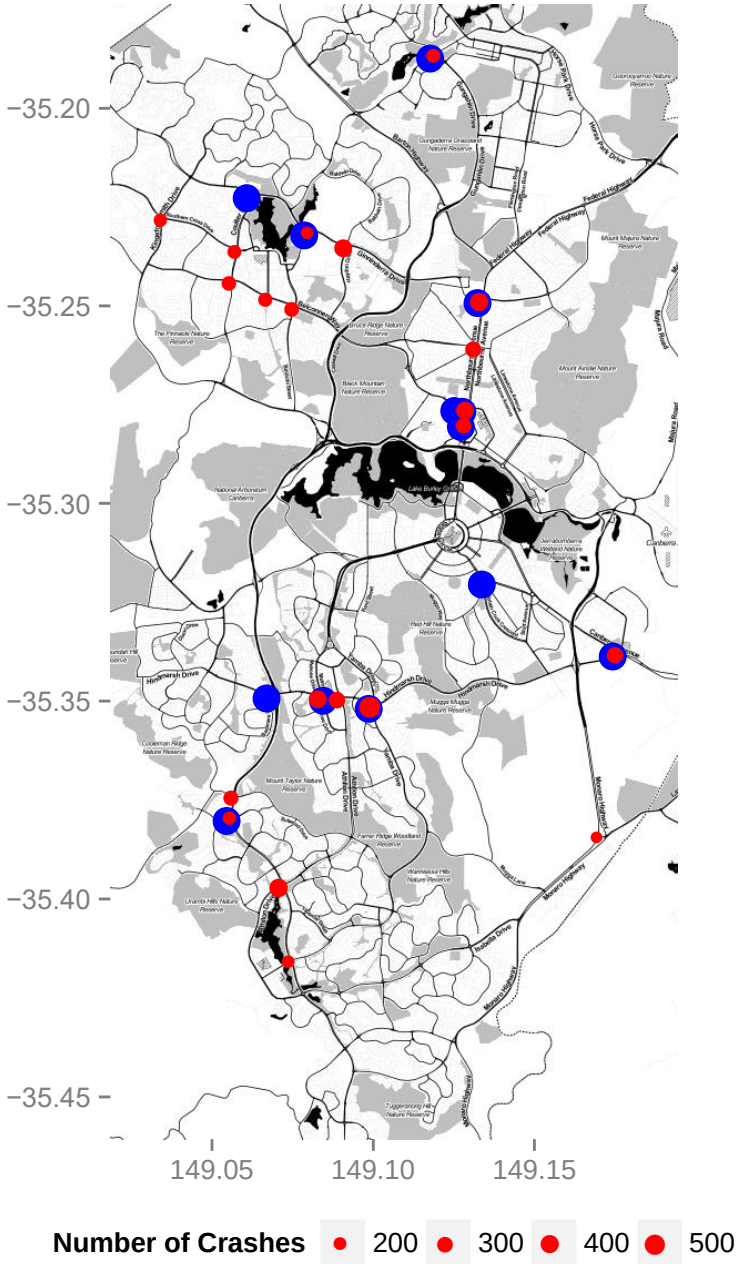
It is notable that many of the sites in the list of the 20 highest ranked intersections have a speed limit that is above 60 km/h (typically 80 km/h). As noted earlier in this report, the protection of users from serious trauma arising from a side impact crash typically requires limiting the speed to no more than 50 km/h. At 80 km/h, there is little safety margin for error at these signalised sites.

It is recommended that speed cameras are considered at these sites where the main road speed is 80 km/h, ideally in conjunction with consideration of other primary safety measures. These include lowering the speed limit which is likely to be the most cost effective treatment at these signalised intersections, controlling all right turns, or infrastructure design to increase the angle of deflection in crashes (for example through a roundabout).

Particular consideration should be given to:

- Hindmarsh Drive, which has three of the ten highest ranked intersections (Yamba Drive 1st which already has a camera installed, Melrose Drive 5th, and Callam Street / Athllon Drive 7th) within approximately two kilometres of each other
- Belconnen Drive, which has three of the 20 highest ranked intersections (Bindubi Stree / Eastern Valley Way 11th, Coulter Drive 13th, and Benjamin Drive 14th) within approximately two kilometres of each other.

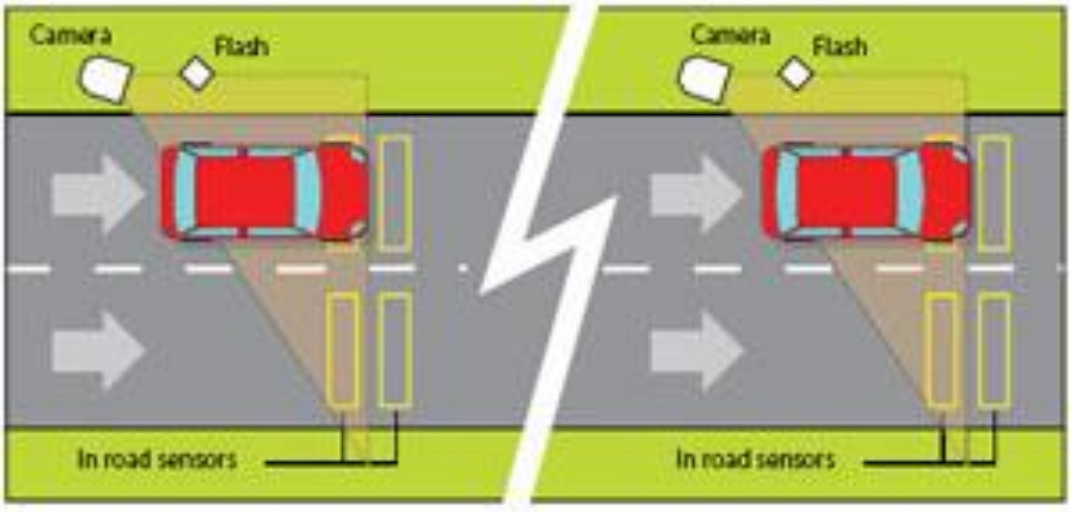
Figure 5: Existing intersection cameras (blue) and highest 20 intersections for total crashes and/or weighted crashes (red)




Consideration should also be given to intersection safety at four of the ten highest ranked intersections within approximately 3.5 kilometres of each other on Northbourne Avenue (Antill / Mouat 2nd, Barry / Cooyong 4th, MacArthur / Wakefield 9th, and London 10th). Cameras are currently installed at each intersection, except MacArthur and Wakefield. It is recommended that the planning and design of Stage 1 light rail from City to Gungahlin incorporates a full analysis of intersection and midblock safety and speed control along Northbourne Avenue.

## POINT TO POINT SITE SELECTION

Point to point speed cameras are typically deployed as a type of fixed speed camera involving two cameras (as illustrated below) measuring the average speed between the two cameras, based on a calculation of the distance between the cameras and the time taken to travel it. The systems which are installed can connect a number of different enforcement sections together.




Point to point speed cameras typically enforce speed on lengths of road which have high traffic volumes and a significant crash history. They are predictable, and very effective in controlling speed over an extended distance. These cameras may be placed close together or cover long distances. Average speed systems are more complex than other speed camera systems because they require highly synchronised time measures at very precise distances.

Point to point speed cameras should only be placed on road sections where the road between the two points are free flowing (with no intersections, traffic lights etc) and do not have geometry such as hills and bends which substantially reduce speed in those areas. These characteristics are important for a point-to-point speed camera system to properly identify speeding activity. Ideally, the speed limit is the same, although the precise measurements and timing required allow for some change.

The length of the roadway over which these characteristics occur influences the relative cost of enforcing an average speed. Due to the fixed cost of installation, longer sections of road have a lower cost per enforced kilometer than shorter sections of road if all other variables remain the same. Consequently, a longer road section is likely to be better enforced by a point-to-point speed camera than a shorter one.

### Placement of point to point cameras

Point to point average speed systems are typically used on high volume, high speed, regional or national roads, but there is no logical impediment to their use in an urban setting, as in the ACT. They can be expected to be effective in achieving high levels of compliance with the speed limit on high volume and uniform sections of road. There are two systems operating in the ACT: eastbound and westbound on Hindmarsh Drive from the intersection with Dalrymple/Mugga to between the intersections with Palmer and Tyagarah, and northbound

and southbound on Athllon Drive between the intersections with Drakeford and Beasley. Both systems are approximately 3.5 km long.

Hindmarsh Drive is a free flowing significant east-west road, and the point to point system covers a section of road (Tamar to Tyagarah) which is referenced in Table 3 covering all ranking approaches for midblock sections. It is an appropriate site, and it would be useful to monitor and evaluate speed and safety performance on this section over time. Athllon Drive is a north-south road which includes the 14th highest ranked midblock section according to the preferred weighted crashes per km approach (Beasley to Sulwood). However its suitability as a point to point site is questionable because it is interrupted by two roundabouts, which are designed in part to slow vehicle traffic and so reduces the effectiveness of the point to point system. The Athllon Drive point to point system could be better deployed elsewhere, and the Beasley to Sulwood section better controlled through a fixed midblock camera.

Two roads were identified in the analysis of fixed midblock speed cameras that have the characteristics necessary for successful treatment with a point-to-point speed camera – the Tuggeranong Parkway and Parkes Way. Both of these roads have multiple midblocks which were ranked in the highest 20 roads suitable for a speed camera treatment. The Tuggeranong Parkway had four midblocks ranked in the highest 20, while Parkes Way had two midblocks ranked in the highest 20.

## Tuggeranong Parkway

The Tuggeranong Parkway has a section that extends over most of its length from the Sulwood and Drakeford intersection in the South to the overpass of Forest Drive and Barrenjoey Drive in the North with a consistent speed limit (approximately 10 km at 100 km/h). Between these endpoints are two access points providing access to Cotter Road and Hindmarsh Drive.

Data was not able to be retrieved about how many vehicles travel the entire length of the 100 km/h speed limited section of the Tuggeranong Parkway each day. However, for the road links making up this larger section the approximate number of vehicles using the roads was modeled in 2006. The daily traffic on each of the lengths on this section of the road are shown in Table 7 below.

For the links shown, the maximum number of vehicles on any road section is over 30,000. The minimum number is just over 20,000. This difference demonstrates there is a large number of vehicles moving on and off the parkway at each of the entry and exit points.

On the basis of this data, certainly no more than 20,000 vehicles travel the entire length each day (the minimum AADT of any of the links). It may be that just half of that number travel the entire length each day because from these 20,000 vehicles some will exit at intermediate access points.

Table 7: Road links with a 100 kph speed limit on the Tuggeranong Parkway (links are arranged from north at the top to south at the bottom)

| Road Link | Length | AADT | Weighted Crashes/km | Speed Limit |
|---|---|---|---|---|
| TUGGERANONG PARKWAY (GREEWTUGGSRM -> TUGGSCOTTERM) | 2683 | 30860 | 113 | 100 |
| TUGGERANONG PARKWAY (TUGGSCOTTERM -> COTTETUGGNRM) | 35 | #N/A | 3 | 100 |
| TUGGERANONG PARKWAY (COTTETUGGNRM -> TUGGNCOTTWRM) | 995 | 24475 | 95 | 100 |
| TUGGERANONG PARKWAY (TUGGNCOTTWRM -> COTTWTUGGSRM) | 143 | #N/A | 19 | 100 |
| TUGGERANONG PARKWAY (COTTWTUGGSRM/TUGGNCOTTWRM -> TUGGSHINDERM) | 2139 | 25040 | 159 | 100 |
| TUGGERANONG PARKWAY (TUGGSHINDERM -> HINDETUGGNRM) | 110 | #N/A | 8 | 100 |
| TUGGERANONG PARKWAY (HINDETUGGNRM -> TUGGNHINDWRM) | 985 | 20500 | 14 | 100 |
| TUGGERANONG PARKWAY (TUGGNHINDWRM -> HINDWTUGGSRM) | 112 | 28700 | 6 | 100 |
| TUGGERANONG PARKWAY (HINDWTUGGSRM -> DRAKEFORD/SULWOOD) | 2574 | 28700 | 139 | 100 |

If the average speed camera was to be placed on this road very few vehicles would travel from end to end, and consequently the speed of very few vehicles would be monitored by the system. It may therefore be most appropriate to consider one of two options to bring more vehicles into the enforcement range:

1) place one or more intermediate average speed cameras between the two endpoint cameras to measure the speeds of vehicles as they pass between any two cameras along the route, or
2) shorten the enforcement area to only a couple of the links along the route.

Both of these options would make the system more expensive in terms of cost per kilometer of enforcement. Without additional data about the number of vehicles that travel between which road links, it is beyond the scope of this report to determine which of these options may be more preferable.

## Parkes Way

Parkes Way has a section that extends from the Glenloch interchange in the West to beyond the Liversidge Road underpass in the East at a consistent speed limit (approximately 3 km at 90 km/h). There is one main access and exit point from Lady Denman Drive for traffic coming from or travelling to the East. This section of road also has a bike path running parallel with it.

The road links that make up this section of Parkes Way are shown in Table 8 below. Unlike the Tuggeranong Parkway, it appears that a very high proportion of vehicles using this section of road use all of the road, with few leaving at the intermediate exit point.

Table 8: Road links with a 90 kmh speed limit on Parkes Way (inks are arranged from west at the top to east at the bottom)

| Road Link | Length | AADT | Weighted Crashes per km | Speed Limit |
|---|---|---|---|---|
| PARKES WAY (GLENLOCH INTERCHANGE -> PARKWLADYSRM) | 1593 | 31935 | 185 | 90 |
| PARKES WAY (PARKWLADYSRM -> CLUNSPARKERM) | 72 | 33840 | 1 | 90 |
| PARKES WAY (CLUNSPARKERM -> PARKEEDINNRM/LAWSNPARKWRM) | 715 | N/A | 206 | 90 |
| PARKES WAY (LAWSNPARKWRM/PARKEEDINNRM -> PARKWLAWSSRM) | 590 | 27780 | 45 | 90 |

The route has two sections of road with very high weighted crashes per km, and one section with a lower value. All of them could be enforced with one set of average speed camera equipment.

The entire route, however, is only about 3 km in length, and the technical requirements for siting the camera equipment may make the measurement section even shorter. At this length one or two fixed speed cameras may have a similar effect at a reduced cost. This alternative option should be explored at the same time that an average speed camera option is being investigated.

## Potential point to point camera sites

A point to point speed camera setup requires a special set of circumstances for it to be an effective tool, including that the road is free flowing and does not have traffic controls. The analysis of midblock sections revealed two separate road lengths that met these criteria. Each of these road lengths had more than one road link inside the highest 20 road links ranked for suitability of fixed speed camera treatment. These were the Tuggeranong Parkway and Parkes Way.

The choice of one of these over the other for an average speed camera, or indeed the choice to put an average speed camera in at all, should be subject to further feasibility analysis. This feasibility analysis should include the number of vehicles that would pass between the two endpoints (or intermediate points) of the system along with the total distance covered and the number of weighted crashes that have occurred on the roads of interest. This analysis, however, has highlighted that the Tuggeranong Parkway and Parkes Way are two of the most likely candidates that would show benefit from such a camera system given their crash history.

# APPENDIX 1 – SITE SELECTION PRACTICES

A summary of site selection practices in a number of countries is provided here.[6]

## France

The national allocation of speed cameras in France is set by each department (sub-national jurisdiction) and primarily relies on the crash rate observed in each department. Within each department, the prefect (departmental administrator) defines the location of the radar according to criteria established nationally in 2004:

- Road sections where most casualty crashes occur
- Road sections where speeding is more often involved in casualty crashes
- Road sections where it is physically difficult for officers to enforce speed.

Speed camera site selection is the subject of local discussion between Police and road agencies based on their respective expertise and knowledge of the area. Two indicators are analysed over a five year period, and compared with national averages:

- Crash density (number of crashes per kilometer of road per year)
- Crash rate (number of crashes per vehicle kilometers travelled per year).

## United Kingdom

Local decision-making is also central in the speed camera programs implemented in the United Kingdom. A detailed set of guidelines for site selection was issued by the Department for Transport in 2004, and updated in 2007.[7] The aim of the guidelines was to specify the situations when cameras should be installed, and how sites should be selected, monitored and evaluated.

The guidelines recommended that speed camera site selection be based on three to five years of crash data. A feature of the guidance was the specification of minimum casualty crashes (killed or seriously injured) at each type of camera site, summarised in the table below.

Lengths of sites and crashes required (UK)

| Camera Type | Length of Site | Casualty Crashes Required |
|---|---|---|
| Fixed camera sites | 0.4 – 1.5 km | at least 3/km |
| Mobile camera sites | 0.4 – 5 km | at least 1/km |
| Average camera sites | 5 – 20 km | at least 1/km |

It is notable that these criteria do not refer to 'speed related crashes' but use crashes and speed as separate criteria. This is recommended, as many speed related crashes are not able to be identified as such in police reports.

A summary table from the guidelines is shown below. The guidance included detailed rules to constrain the program which was managed by local government. This approach required a

[6] This summary of site selection practices draws on an Advisory Note prepared in 2015 for the World Bank's work in the Middle East and North Africa region by Martin Small, Soames Job and Said Dahdah.

[7] Department for Transport (2007), Use of speed and red-light cameras for traffic enforcement: Guidance on deployment, visibility and signing, DfT Circular 01/2007, London.

certain number of injuries and a certain level of speeding to be reached before enforcement action was taken, and is not recommended as it does not allow for a safety focused approach to be pursued. Instead, a set of documented criteria for ranking and prioritizing sites for camera enforcement are put forward below.

Site selection criteria that applied at the end of the National Safety Camera Programme (UK)

| *Rule* | | *Fixed speed camera sites* | *Mobile speed camera sites* | *Routes* | *Red-light or combined red-light speed* |
|---|---|---|---|---|---|
| 1 | Site or route length requirements | Between 0.4 km and 1.5 km | Between 0.4 km and 5km | Between 5 km and 20 km | From stop line to stop line in direction of travel |
| 2 | Number of KSI (killed or seriously injured) collisions | At least 3 KSI collisions per km in the baseline period.* | At least 1 KSI collision per km (average) in the baseline period.* | A minimum of 3 existing core sites within the length. (There are no further requirements.)<br>OR<br>Has at least 1 KSI collision per km (average) in the baseline period* and meets the PIC total value below. | At least 1 KSI collision within the junction in the baseline period.*<br>Selection must be based upon a collision history of red-light running. |
| | | *The baseline period is the most recent 36-month period available when proposal is submitted, where the end date is within 12 months of the date of submission. | | | |
| 3 | Total value required | Built-up 22/km; Non-built-up 18/km | Built-up 11/km; Non-built-up 9/km | Built up 8/km; Non built up 6/km | 10 |
| | | For sites up to 1 km, the above value is required.<br>For sites longer that 1 km, the value is per km. | | | |
| 4 | 85th percentile speed at proposed sites | Speed survey shows free-flow 85th percentile speed is at or above ACPO enforcement threshold in built-up areas and 5 mph over maximum speed limit in non-built-up areas. This can apply to all vehicles or a vehicle class but must be compared consistently. | | | Not applicable |
| 5 | Site conditions that are suitable for the type of enforcement proposed | Loading and unloading of camera can take place safely. | Location for mobile enforcement is easily accessible and there is space for enforcement to take place in a visible, legal and safe manner. | The location of collisions in the baseline period will determine the length of route. | Loading and unloading the camera can take place safely. |
| 6 | Suitability of site for camera enforcement | The highway authority must undertake a site survey, demonstrating the following:<br>(a) the speed limit has been reviewed, confirming that camera enforcement is the right solution;<br>(b) there is no other cost-effective engineering solution that is more appropriate;<br>(c) that the Traffic Regulation Order (where applicable) and signing are lawful and correct. | | | |
| New camera sites will be selected using an assessment that includes the level of fatal, serious and slight collisions. The combined level of collisions will be expressed as a numerical scale (see below) and assessed relative to the road classification for the site – whether it is either a 'built-up' or 'non-built-up' area and according to the type of site, i.e. route, fixed, mobile or red-light.<br>Fatal or serious injury collision = 5 (i.e. 2 serious collisions = 10)<br>Slight injury collision = 1 (i.e. 5 slight collisions = 5)<br>**'Built-up area'** is defined as a road with a speed limit of 40 mph or less.<br>**'Non-built-up area'** is defined as a road with a speed limit of 50 mph or more. | | | | |

## United States of America

While retaining a relatively open set of advice on site selection, which supports deployment for the purposes of general deterrence, the National Highway Traffic Safety Administration (NHTSA) in the United States of America promotes consideration of a number of other factors which bear consideration.[8]

The NHTSA guidelines:

- Advise that the highest priority enforcement sites should be located where there is the greatest risk for speeding-related crashes, injuries, and fatalities. As noted previously, targeting speed related crashes is not advisable, for two reasons. The first is that motor vehicle speed is implicated in the severity of every injury, making the cause of the crash (excess or inappropriate speed, fatigue etc) much less important than the outcome. The second reason speed related crashes is not a useful measure is that the judgement by attending Police officers of whether or not speed was a contributing factor in a crash is often unreliable.
- Advise against selecting sites where speeding is common and crashes are rare because of negative public perceptions of speed traps. However, they recognise the need for exceptions in high pedestrian locations. While each jurisdiction must be able to justify the expense associated with installing and deploying speed cameras, the recognition of pedestrian safety in urban areas is very important because their safety is heavily reliant on motor vehicle speed control.
- Advise consideration of citizen complaints because they may be the first to notice a developing safety problem, but recommend professional site evaluations and speed surveys to determine whether the sites warrant speed enforcement. The use of citizen complaints may assist in promoting the legitimacy of a safety camera program, but is far less likely to be effective in generating the general deterrent effect which is sought.
- Recognise that distribution of enforcement sites throughout the jurisdiction can increase the overall deterrent effect of the safety camera program by increasing the perceived likelihood that drivers can be caught speeding anywhere. This is an important design consideration for any speed camera program.

## Australia

Widespread use is made of speed cameras in Australian States and Territories, and a published summary of good practice can be found in New South Wales.[9]

As fixed speed cameras reduce speeding in the immediate vicinity of the camera, the strategy establishes the most prescriptive site selection criteria. However, it clarifies that fixed speed cameras are also used on freeways and motorways as they carry high volumes of traffic at high speeds, requiring speed compliance along the entire length of the road to ensure the inherent safety of these roads is maintained.

[8] National Highway and Traffic Safety Administration (2008), *Speed Enforcement Camera Systems Operational Guidelines*, US Department of Transportation, Washington DC.
[9] Transport for New South Wales (2012), *New South Wales Speed Camera Strategy*, Sydney.

The fixed speed camera criteria in New South Wales are:

- High frequency and severity of crashes over a length of road no longer than 1000m or 
- School zone with a high frequency and severity of crashes and/or high risk of a pedestrian crash or 
- High risk location that is difficult for Police to enforce using traditional methods such as tunnels. 

Intersections are prioritised for the installation of red-light speed cameras based on the frequency and severity of crashes and a risk assessment of the intersection in relation to the broader road network. Consideration is also given to placing red-light speed (safety) cameras at locations where there is a potential for severe crashes, and to the location of other camera enforcement sites. The stated purpose of these wider criteria is to ensure there is a sufficient geographic spread and a minimum amount of deployment in regional areas.

# APPENDIX 2 – MIDBLOCKS RANKED USING DIFFERENT APPROACHES

## *Count of Injury crashes*

| Road Link | SUBURB | LENGTH | AADT ('000) | Fatal Crashes | Injury Crashes | PDO Crashes | Injuries and Fatalities |
|---|---|---|---|---|---|---|---|
| TUGGERANONG PARKWAY (HINDWTUGGSRM -> DRAKEFORD/SULWOOD) | CHIFLEY | 2.57 | 29 | 0 | 24 | 238 | 24 |
| TUGGERANONG PARKWAY (GREEWTUGGSRM -> TUGGSCOTTERM) | WESTON CREEK (RURAL) | 2.68 | 31 | 0 | 22 | 193 | 22 |
| PARKES WAY (GLENLOCH INTERCHANGE -> PARKWLADYSRM) | ACTON | 1.59 | 32 | 0 | 21 | 189 | 21 |
| COTTER ROAD (PICNIC -> MT STROMLO RD) | STROMLO (RURAL) | 7.53 | #N/A | 0 | 19 | 22 | 19 |
| WILLIAM HOVELL DRIVE (DRAKE BROCKMAN/KINGSFORD SMITH -> COPPINS CROSSING) | BELCONNEN (RURAL) | 4.66 | 12 | 1 | 17 | 104 | 18 |
| TUGGERANONG PARKWAY (COTTWTUGGSRM/TUGGNCOTTWRM -> TUGGSHINDERM) | CURTIN | 2.14 | 25 | 1 | 16 | 256 | 17 |
| COPPINS CROSSING ROAD (WILLIAM HOVELL -> URIARRA) | MOLONGLO VALLEY | 5.67 | 3 | 0 | 16 | 96 | 16 |
| POINT HUT ROAD (FRESHFORD -> JIM PIKE) | TUGGERANONG (RURAL) | 4.55 | #N/A | 2 | 13 | 16 | 15 |
| PARKES WAY (CLUNSPARKERM -> PARKEEDINNRM/LAWSNPARKWRM) | ACTON | 0.72 | #N/A | 0 | 14 | 136 | 14 |
| KINGS HIGHWAY PROPERTY 5893 -6394 (ACT/NSW BORDER -> HQJOC ACCESS RD).S.END_31102012 | KOWEN (RURAL) | 6 | #N/A | 1 | 13 | 15 | 14 |
| KURINGA DRIVE (KINGSFORD SMITH -> TILLYARD) | BELCONNEN (RURAL) | 1.46 | 3 | 1 | 12 | 51 | 13 |
| NORTHBOURNE AVENUE (CONDAMINE/IPIMA -> MACARTHUR/WAKEFIELD) | BRADDON | 0.64 | 25 | 1 | 12 | 150 | 13 |
| PADDYS RIVER ROAD (LAUREL CAMP -> TIDBINBILLA) | PADDYS RIVER (RURAL) | 11.02 | #N/A | 0 | 13 | 16 | 13 |
| MAJURA ROAD (AVONLEY -> MOUNT MAJURA ACCESS) | MAJURA (RURAL) | 5.24 | 6 | 1 | 12 | 56 | 13 |
| ATHLLON DRIVE (SULWOOD -> BEASLEY) | TORRENS | 1.38 | 21 | 1 | 11 | 72 | 12 |
| MAJURA ROAD (MUSTANG -> AVONLEY) | PIALLIGO | 3.23 | 6 | 0 | 12 | 71 | 12 |
| GUNDAROO DRIVE (GUNGAHLIN -> GINN/NARI) | NGUNNAWAL | 0.67 | 9 | 0 | 11 | 198 | 11 |
| LADY DENMAN DRIVE (BARRENJOEY -> COTTER) | YARRALUMLA | 2.98 | 6 | 0 | 11 | 68 | 11 |
| MONARO HIGHWAY (HINDWMONASRM ->PRISON ACCESS ROAD) | SYMONSTON | 3.07 | 30 | 0 | 11 | 75 | 11 |
| PADDYS RIVER ROAD (COTTER -> LAUREL CAMP) | PADDYS RIVER (RURAL) | 2.76 | #N/A | 1 | 9 | 11 | 10 |

## *Count of All Crashes*

| Road Link | SUBURB | LENGTH | AADT ('000) | Fatal Crashes | Injury Crashes | PDO Crashes | Total Crashes |
|---|---|---|---|---|---|---|---|
| TUGGERANONG PARKWAY (COTTWTUGGSRM/TUGGNCOTTWRM -> TUGGSHINDERM) | CURTIN | 2.14 | 25 | 1 | 16 | 256 | 273 |
| TUGGERANONG PARKWAY (HINDWTUGGSRM -> DRAKEFORD/SULWOOD) | CHIFLEY | 2.57 | 29 | 0 | 24 | 238 | 262 |
| TUGGERANONG PARKWAY (GREEWTUGGSRM -> TUGGSCOTTERM) | WESTON CREEK (RURAL) | 2.68 | 31 | 0 | 22 | 193 | 215 |
| PARKES WAY (GLENLOCH INTERCHANGE -> PARKWLADYSRM) | ACTON | 1.59 | 32 | 0 | 21 | 189 | 210 |
| GUNDAROO DRIVE (GUNGAHLIN -> GINN/NARI) | NGUNNAWAL | 0.67 | 9 | 0 | 11 | 198 | 209 |
| COMMONWEALTH AVENUE (FLYNWCOMMNRM -> ALBERT) | ACTON | 0.70 | 32 | 0 | 9 | 199 | 208 |
| NORTHBOURNE AVENUE (CONDAMINE/IPIMA -> MACARTHUR/WAKEFIELD) | BRADDON | 0.64 | 25 | 1 | 12 | 150 | 163 |
| PARKES WAY (CLUNSPARKERM -> PARKEEDINNRM/LAWSNPARKWRM) | ACTON | 0.72 | #N/A | 0 | 14 | 136 | 150 |
| NORTHBOURNE AVENUE (MACARTHUR/WAKEFIELD -> MORPHETT) | LYNEHAM | 0.78 | 25 | 0 | 1 | 123 | 124 |
| WILLIAM HOVELL DRIVE (DRAKE BROCKMAN/KINGSFORD SMITH -> COPPINS CROSSING) | BELCONNEN (RURAL) | 4.66 | 12 | 1 | 17 | 104 | 122 |
| WILLIAM HOVELL DRIVE (COULTER -> BINDUBI) | BELCONNEN (RURAL) | 2.18 | 21 | 0 | 8 | 111 | 119 |
| COPPINS CROSSING ROAD (WILLIAM HOVELL -> URIARRA) | MOLONGLO VALLEY | 5.67 | 3 | 0 | 16 | 96 | 112 |
| MONARO HIGHWAY (MUGGA -> ISABELLA) | TUGGERANONG (RURAL) | 1.13 | 33 | 0 | 7 | 95 | 102 |
| WILLIAM HOVELL DRIVE (BINDUBI -> GLENLOCH INTERCHANGE) | MOLONGLO VALLEY | 0.71 | 28 | 0 | 6 | 91 | 97 |
| CANBERRA AVENUE (TOM PRICE -> WOODS) | SYMONSTON | 1.61 | #N/A | 0 | 3 | 92 | 95 |
| BELCONNEN WAY (BINDUBI/EASTERN VALLEY -> HAYDON) | ARANDA | 1.00 | 20 | 1 | 6 | 84 | 91 |
| MONARO HIGHWAY (HINDWMONASRM ->PRISON ACCESS ROAD) | SYMONSTON | 3.07 | 30 | 0 | 11 | 75 | 86 |
| ATHLLON DRIVE (SULWOOD -> BEASLEY) | TORRENS | 1.38 | 21 | 1 | 11 | 72 | 84 |
| MAJURA ROAD (MUSTANG -> AVONLEY) | PIALLIGO | 3.23 | 6 | 0 | 12 | 71 | 83 |
| HINDMARSH DRIVE (TAMAR -> TYAGARAH) | GARRAN | 2.21 | 22 | 0 | 8 | 73 | 81 |
| MONARO HIGHWAY (LANYON -> SHEPPARD) | HUME | 1.23 | 28 | 0 | 4 | 77 | 81 |

## *Weighted count of crashes (*Weighted Crashes = 5 * (Fatalities + Injuries) + PDOs)*

| Road Link | SUBURB | LENGTH | AADT ('000) | Fatal Crashes | Injury Crashes | PDO Crashes | *Weighted Crashes |
|---|---|---|---|---|---|---|---|
| TUGGERANONG PARKWAY (HINDWTUGGSRM -> DRAKEFORD/SULWOOD) | CHIFLEY | 2.57 | 29 | 0 | 24 | 238 | 358 |
| TUGGERANONG PARKWAY (COTTWTUGGSRM/TUGGNCOTTWRM -> TUGGSHINDERM) | CURTIN | 2.14 | 25 | 1 | 16 | 256 | 341 |
| TUGGERANONG PARKWAY (GREEWTUGGSRM -> TUGGSCOTTERM) | WESTON CREEK (RURAL) | 2.68 | 31 | 0 | 22 | 193 | 303 |
| PARKES WAY (GLENLOCH INTERCHANGE -> PARKWLADYSRM) | ACTON | 1.59 | 32 | 0 | 21 | 189 | 294 |
| GUNDAROO DRIVE (GUNGAHLIN -> GINN/NARI) | NGUNNAWAL | 0.67 | 9 | 0 | 11 | 198 | 253 |
| COMMONWEALTH AVENUE (FLYNWCOMMNRM -> ALBERT) | ACTON | 0.7 | 32 | 0 | 9 | 199 | 244 |
| NORTHBOURNE AVENUE (CONDAMINE/IPIMA -> MACARTHUR/WAKEFIELD) | BRADDON | 0.64 | 25 | 1 | 12 | 150 | 215 |
| PARKES WAY (CLUNSPARKERM -> PARKEEDINNRM/LAWSNPARKWRM) | ACTON | 0.72 | #N/A | 0 | 14 | 136 | 206 |
| WILLIAM HOVELL DRIVE (DRAKE BROCKMAN/KINGSFORD SMITH -> COPPINS CROSSING) | BELCONNEN (RURAL) | 4.66 | 12 | 1 | 17 | 104 | 194 |
| COPPINS CROSSING ROAD (WILLIAM HOVELL -> URIARRA) | MOLONGLO VALLEY | 5.67 | 3 | 0 | 16 | 96 | 176 |
| WILLIAM HOVELL DRIVE (COULTER -> BINDUBI) | BELCONNEN (RURAL) | 2.18 | 21 | 0 | 8 | 111 | 151 |
| ATHLLON DRIVE (SULWOOD -> BEASLEY) | TORRENS | 1.38 | 21 | 1 | 11 | 72 | 132 |
| MAJURA ROAD (MUSTANG -> AVONLEY) | PIALLIGO | 3.23 | 6 | 0 | 12 | 71 | 131 |
| MONARO HIGHWAY (MUGGA -> ISABELLA) | TUGGERANONG (RURAL) | 1.13 | 33 | 0 | 7 | 95 | 130 |
| MONARO HIGHWAY (HINDWMONASRM ->PRISON ACCESS ROAD) | SYMONSTON | 3.07 | 30 | 0 | 11 | 75 | 130 |
| NORTHBOURNE AVENUE (MACARTHUR/WAKEFIELD -> MORPHETT) | LYNEHAM | 0.78 | 25 | 0 | 1 | 123 | 128 |
| LADY DENMAN DRIVE (BARRENJOEY -> COTTER) | YARRALUMLA | 2.98 | 6 | 0 | 11 | 68 | 123 |
| WILLIAM HOVELL DRIVE (BINDUBI -> GLENLOCH INTERCHANGE) | MOLONGLO VALLEY | 0.71 | 28 | 0 | 6 | 91 | 121 |
| MAJURA ROAD (AVONLEY -> MOUNT MAJURA ACCESS) | MAJURA (RURAL) | 5.24 | 6 | 1 | 12 | 56 | 121 |
| BELCONNEN WAY (BINDUBI/EASTERN VALLEY -> HAYDON) | ARANDA | 1 | 20 | 1 | 6 | 84 | 119 |

# APPENDIX 3 – TOP 10 MIDBLOCK SECTIONS

In this Appendix each of the ten highest ranked midblock sections according to weighted crashes per km are briefly evaluated for their suitability for a speed camera placement.

Annual Average Daily Traffic (AADT) counts, where available, were obtained from a 2006 network analysis. The data was obtained from the Asset Information and Management Services Branch, Infrastructure, Roads and Public Transport Division, Territory & Municipal Services.

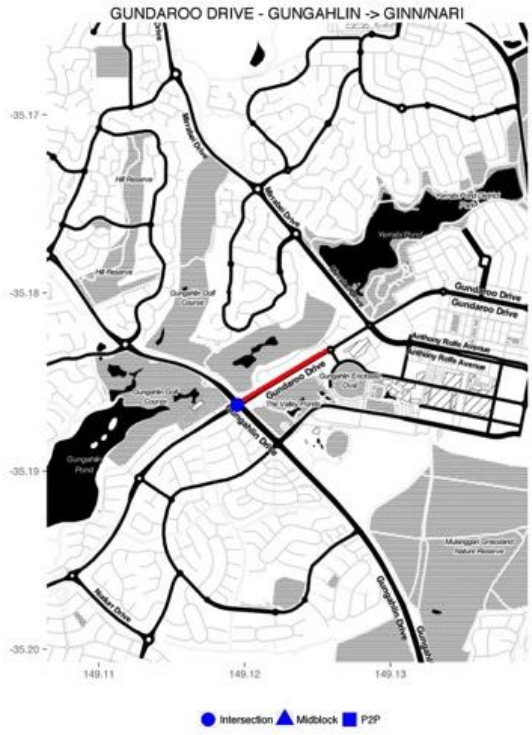
Travel speed information, where available, was obtained from an unpublished data source provided by ACT Justice and Community Services. Some of the unpublished data was subsequently published in a University of NSW, TARS research report: Evaluation of the ACT Road Safety Camera Program. The data available was typically only available on a road length (a series of road links connected by intersections and with the same name) so may not accurately reflect the travel speeds on the individual links of interest.

Speed limits were sourced from Google Maps.

### *Midblock 1 – Gundaroo Drive (Gungahlin to Ginn St/Nari St)*

| Speed Limit | Length | Volume | Injury and Fatal | Property Damage | Weighted Crashes/km |
|---|---|---|---|---|---|
| 80 | 0.67 | 9000 | 11 | 198 | 253 |

https://www.google.com.au/maps/dir/-35.1860853,149.1199657/-35.1833528,149.1255305/@-35.1840574,149.1192522,16z/data=!4m2!4m1!3e0




*1.*

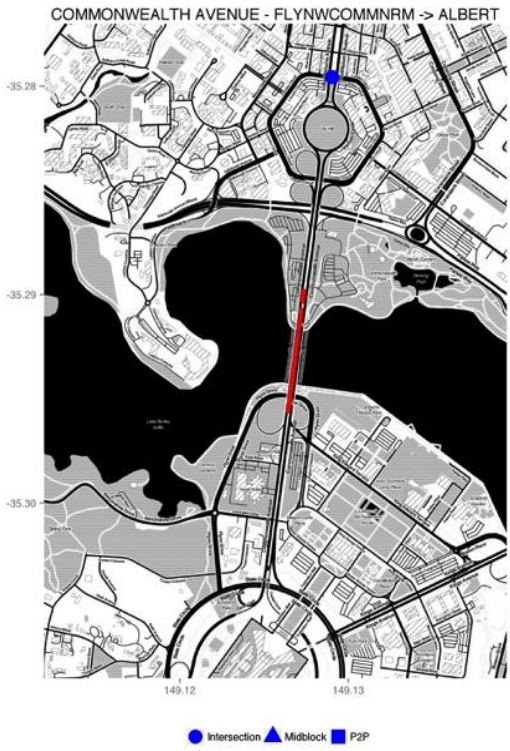
*Suitability for a camera*

This site has a low AADT. Its speed limit is relatively high (80 km/h), but travel speeds were typically (2011) at or below the speed limit. There are no fixed cameras in place near this site. Due to its low AADT, it is likely that its best form of speed camera treatment is for a high frequency of mobile speed camera presence if speeds are high, and then ongoing regular mobile speed camera presence to reinforce any changed behavior.

### *Midblock 2 – Commonwealth Avenue (Flynn Ramp to Albert St)*

| Speed Limit | Length | Volume | Injury and Fatal | Property Damage | Weighted Crashes/km |
|---|---|---|---|---|---|
| 70 | 0.70 | 32000 | 9 | 199 | 244 |

https://www.google.com.au/maps/dir/-35.2960873,149.1263965/-35.2898886,149.1273046/@-35.2931733,149.1238168,15.06z

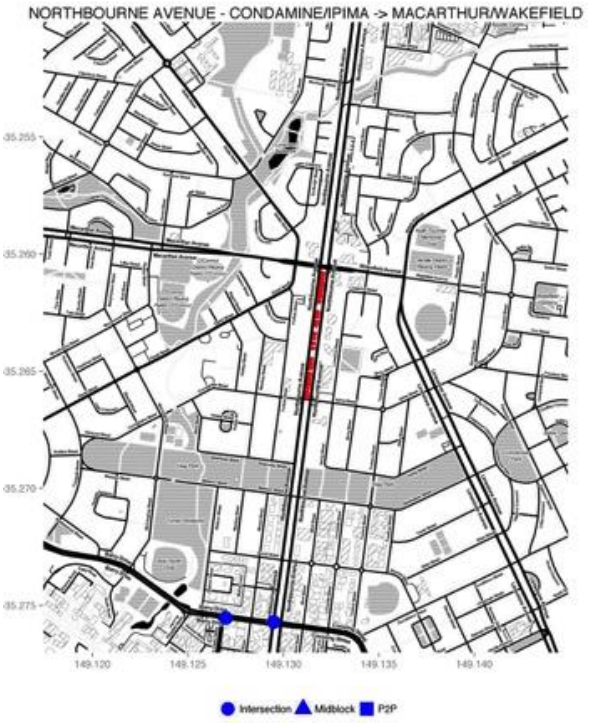

#### *Suitability for a camera*

This site has a high AADT and a moderately high speed limit. There are no fixed cameras at any point on this road. A speed camera would be an appropriate safety treatment for this site. A reduction in speed limit could also be an appropriate safety treatment.

### *Midblock 3 – Northbourne Avenue (Condamine/Ipima to Macarthur/ Wakefield)*

| Speed Limit | Length | Volume | Injury and Fatal | Property Damage | Weighted Crashes/km |
|---|---|---|---|---|---|
| 60 | 0.64 | 25000 | 13 | 150 | 215 |

https://www.google.com.au/maps/dir/-35.26625,149.1309622/-35.2608175,149.1318903/@-35.265884,149.131061,16.83z/data=!4m2!4m1!3e2




### *Suitability for a camera*

The AADT of this site is high with a moderate speed limit. At its last speed survey point Northbourne Avenue retained a high proportion of high speed vehicles. There are speed cameras at intersections to the north and south of this site, but not at the closest intersections. This could be a good site for camera placement. Consideration should also be given to placing a camera at the intersections on the northern end of this section of road, as this intersection is a candidate for intersection speed camera treatment.

### *Midblock 4 – Parkes Way (Clunies Ross St to Lawson Cres)*

| Speed Limit | Length | Volume | Injury and Fatal | Property Damage | Weighted Crashes/km |
|---|---|---|---|---|---|
| 80 | 0.72 | | 14 | 136 | 206 |

https://www.google.com.au/maps/dir/-35.2845962,149.1115023/-35.2864754,149.1188692/@-35.2856323,149.111225,16z/data=!3m1!4b1!4m2!4m1!3e0

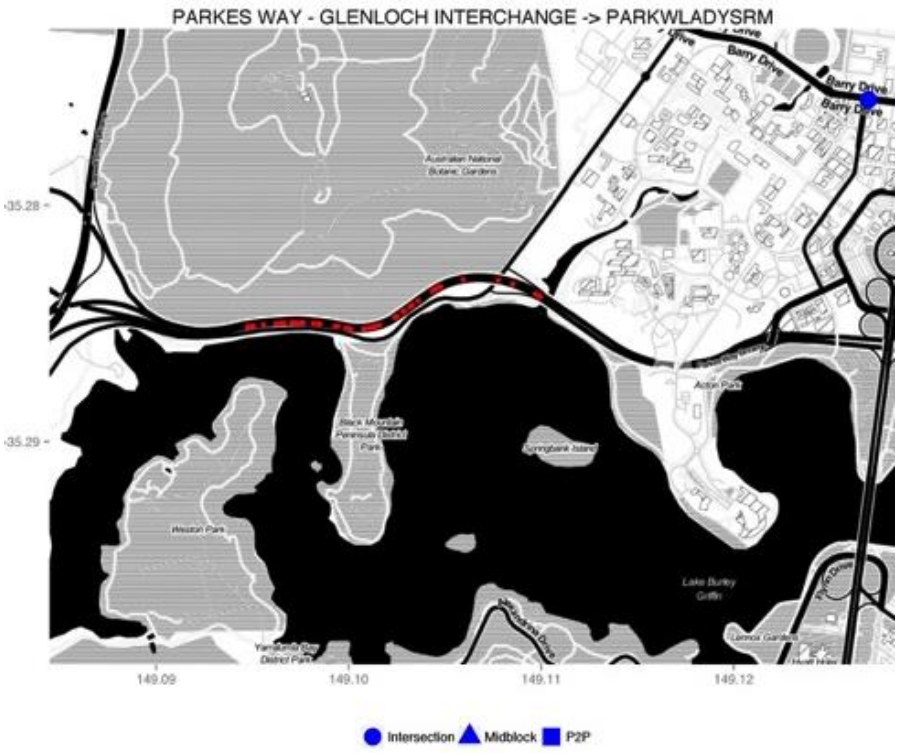

### *Suitability for a camera*

This site has a presumed high AADT (the data for this site was not available) and an assumed relatively free traffic flow. It has a speed limit of 90 and at the last speed survey (2004) there is an indication that a reasonable proportion of vehicles (more than 15%) were exceeding the speed limit. There have been a high number of injury and fatal crashes and there is a bike lane running on the road. There are no speed cameras on this road. This site is likely to be a good candidate for fixed speed camera treatment.

### *Midblock 5 – Parkes Way (between Glenloch interchange and Lady Denman Drive)*

| Speed Limit | Length | Volume | Injury and Fatal | Property Damage | Weighted Crashes/km |
|---|---|---|---|---|---|
| 90 | 1.59 | 32000 | 21 | 189 | 185 |

2. https://www.google.com.au/maps/dir/-35.26625,149.1309622/-35.2608175,149.1318903/@-35.265884,149.131061,3a,75y,288.18h,78.49t/data=!4m2!4m1!3e2

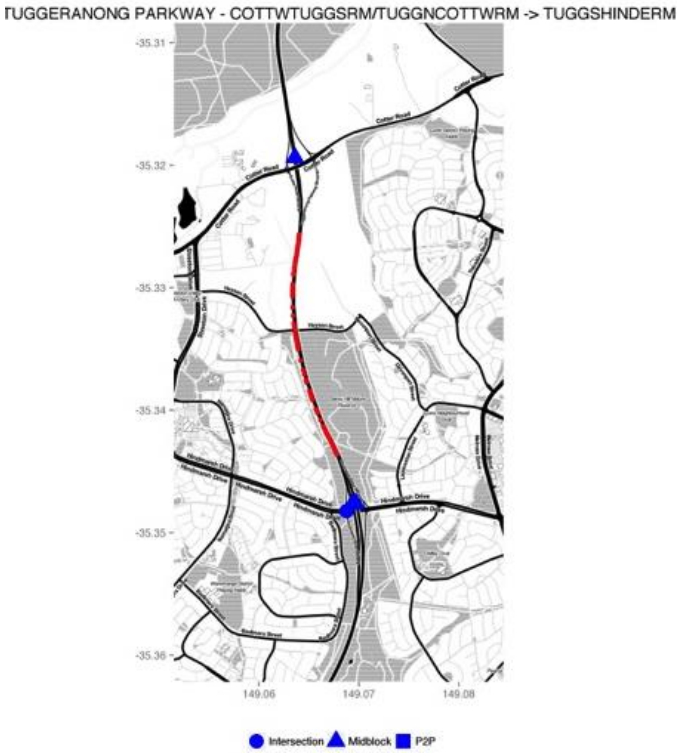

*Suitability for a camera*

This site, like its neighbour above, is likely to be a good candidate for fixed speed camera treatment. It has a high AADT and an assumed relatively free flowing traffic at a high speed limit. There have been a high number of injury and fatal crashes and there is a bike lane running on the road. It is likely to be a good location for a speed camera.

### *Midblock 6 – Tuggeranong Parkway (Cotter to Hindmarsh)*

| Speed Limit | Length | Volume | Injury and Fatal | Property Damage | Weighted Crashes/km |
|---|---|---|---|---|---|
| 100 | 2.14 | 25000 | 17 | 256 | 160 |

https://www.google.com.au/maps/dir/-35.3250524,149.064263/-35.3460305,149.0691376/@-35.3320791,149.0561726,15.17z/data=!4m2!4m1!3e0



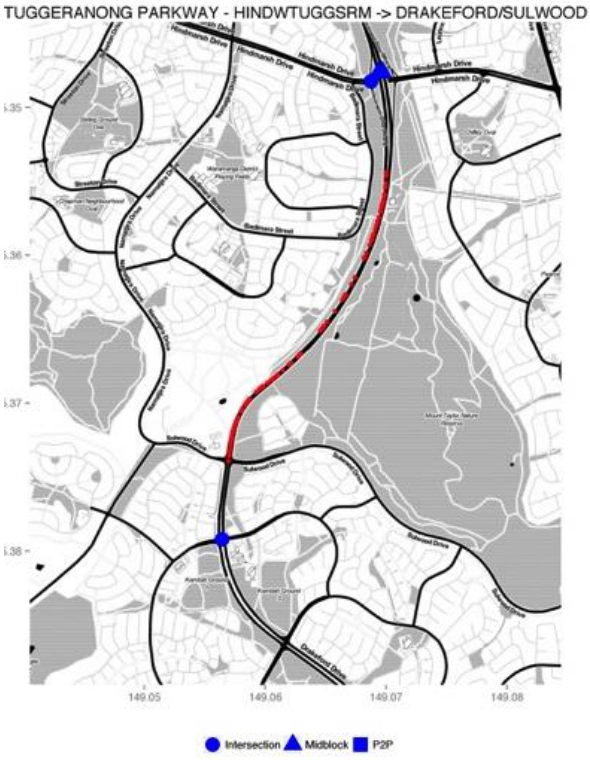

### *Suitability for a camera*

This site has a high AADT and there are two existing speed camera treatment sites at either end of the length. It is likely that these other cameras are affecting travel speeds on this section of road and they should be retained. The most recent speed survey on the Tuggeranong parkway (2011) indicates that the majority of vehicles are travelling under the speed limit. This section of road could be installed with an additional speed camera.

### *Midblock 7 – Tuggeranong Parkway (Hindmarsh to Drakeford)*

| Speed Limit | Length | Volume | Injury and Fatal | Property Damage | Weighted Crashes/ km |
|---|---|---|---|---|---|
| 100 | 2.57 | 29000 | 24 | 238 | 140 |

https://www.google.com.au/maps/dir/-35.3490681,149.0700954/-35.3734167,149.0572003/@-35.3675566,149.0518771,14.8z/data=!4m2!4m1!3e0



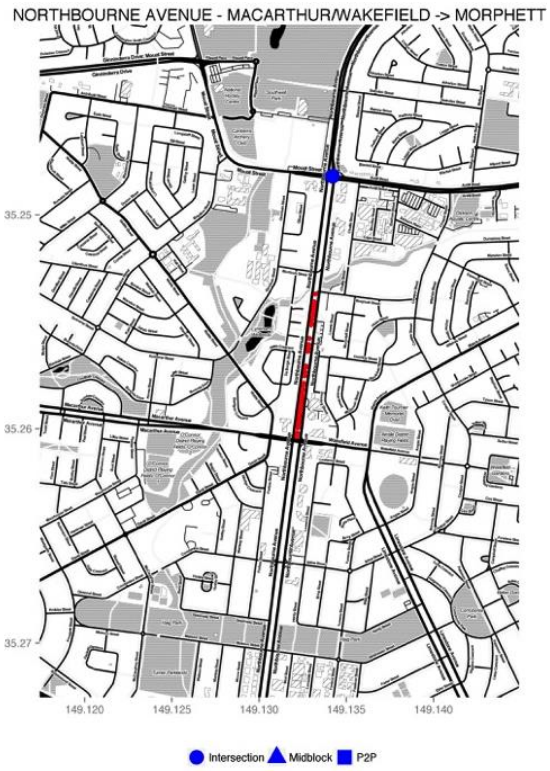

*Suitability for a camera*

This site, like other parts of the Tuggeranong parkway has a high AADT. It has an existing nearby speed camera treatment site at the Northern end (a midblock camera). It is possible that this camera is contributing to lower speeds on this section of road. An additional camera placed on this midblock will further contribute to enforcing the speed limit by all vehicles.

### *Midblock 8 – Northbourne Avenue (Between Macarthur/Wakefield and Morphett St)*

| Speed Limit | Length | Volume | Injury and Fatal | Property Damage | Weighted Crashes/km |
|---|---|---|---|---|---|
| 60 | 0.78 | 25000 | 1 | 123 | 128 |

https://www.google.com.au/maps/dir/-35.26625,149.1309622/-35.2608175,149.1318903/@-35.265884,149.131061,3a,75y,288.18h,78.49t/data=!4m2!4m1!3e2



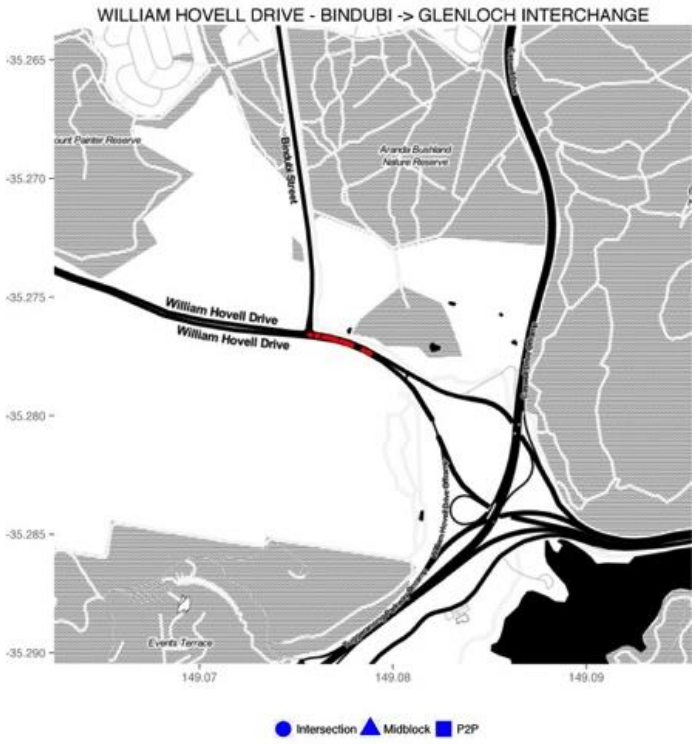

*Suitability for a camera*

Like the previous Northborne Avenue site, the AADT of this site is high and it has a moderate speed limit. At its last speed survey point it retained a high proportion of high speed vehicles. Once again, there are speed cameras at intersections to the North and South of this site, but not at the closest intersection. This midblock could be a good site for camera placement. Consideration should also be given to placing a camera at the intersections on the Southern end of this section of road, as this intersection is one of the candidates for intersection speed camera treatment.

### *Midblock 9 – William Hovell Drive (Between Bindubi St and Glenloch Interchange)*

| Speed Limit | Length | Volume | Injury and Fatal | Property Damage | Weighted Crashes/ km |
|---|---|---|---|---|---|
| 80 | 0.71 | 28000 | 6 | 91 | 121 |

https://www.google.com.au/maps/dir/-35.26625,149.1309622/-35.2608175,149.1318903/@-35.265884,149.131061,3a,75y,288.18h,78.49t/data=!4m2!4m1!3e2




*Suitability for a camera*

This site is relatively short but is at a relatively high speed limit near a traffic light controlled intersection on the Western End. Much of the traffic is either about to enter or has just exited from the higher speed Tuggeranong Parkway on the Eastern End. It has a high AADT. It is likely to be a suitable site for a speed camera.

### *Midblock 10 – Belconnen Way (Bindubi St to Haydon Dr)*

| Speed Limit | Length | Volume | Injury and Fatal | Property Damage | Weighted Crashes/ km |
|---|---|---|---|---|---|
| 80 | 1.00 | 20000 | 7 | 84 | 118 |

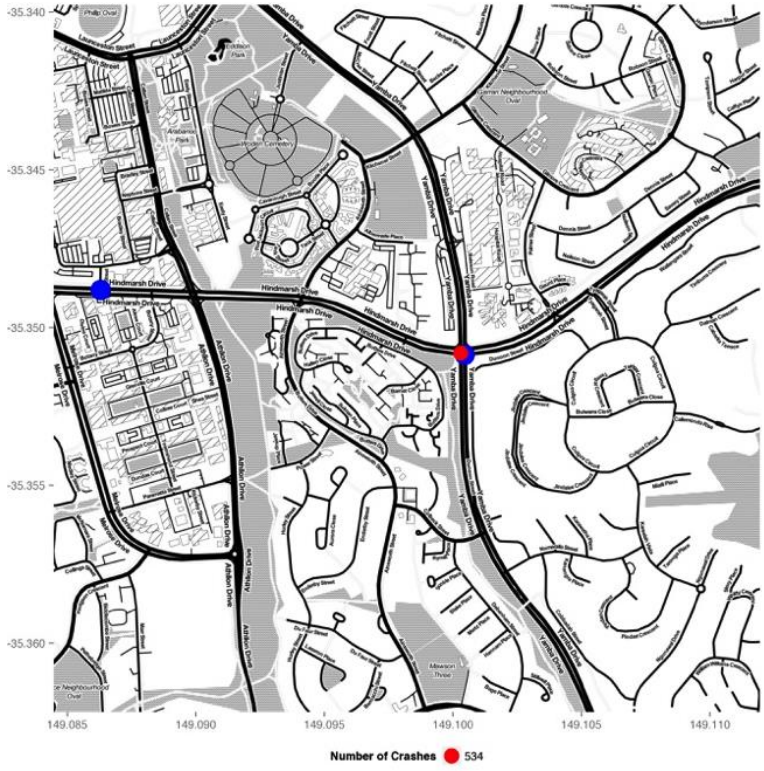
https://www.google.com.au/maps/dir/-35.2539849,149.0853232/-35.2505006,149.0760667/@-35.2538225,149.0780849,15.43z/data=!4m2!4m1!3e0


*Suitability for a camera*

This site has a reasonably high AADT. It has a moderately high speed limit. At the last known speed survey point (2011) a majority of the vehicles on Belconnen Way were exceeding the speed limit. There are no nearby cameras and there are several intersections along the road. A speed camera is suited for this site.

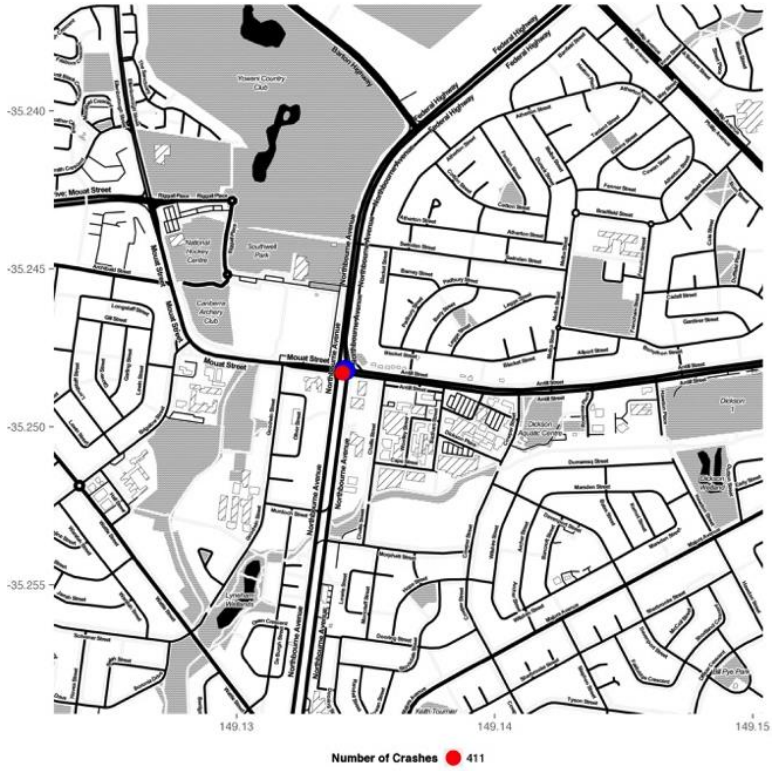
# APPENDIX 4 – TOP 10 INTERSECTIONS

## *HINDMARSH/YAMBA*




This site has a camera installed and has both 60 km/h and 80 km/h speed limits. The crash analysis suggests the camera should remain in place.

## *ANTILL/MOUAT/NORTHBOURNE*

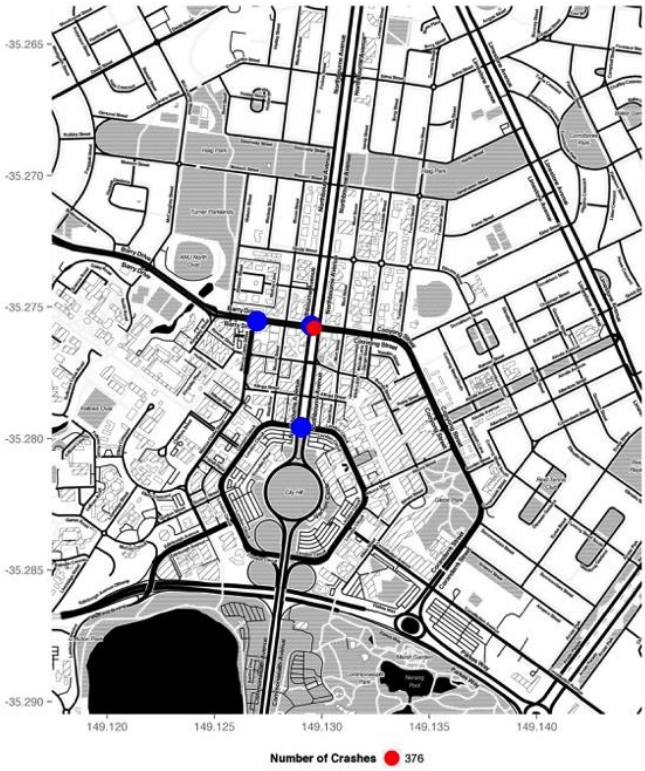



This site has a camera and speed limits of 60 km/h. The crash analysis suggests the camera should remain in place.

### *ATHLLON/DRAKEFORD*

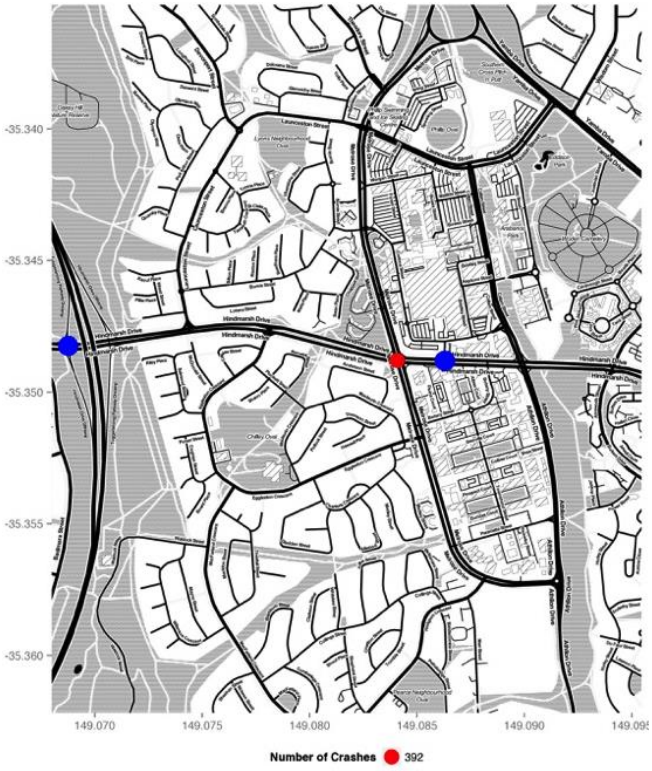

This site does not have a camera and has a speed limit of 80 km/h. There are no nearby cameras. The crash analysis suggests it is a suitable site for a speed camera.

## *BARRY/COOYONG/NORTHBOURNE*



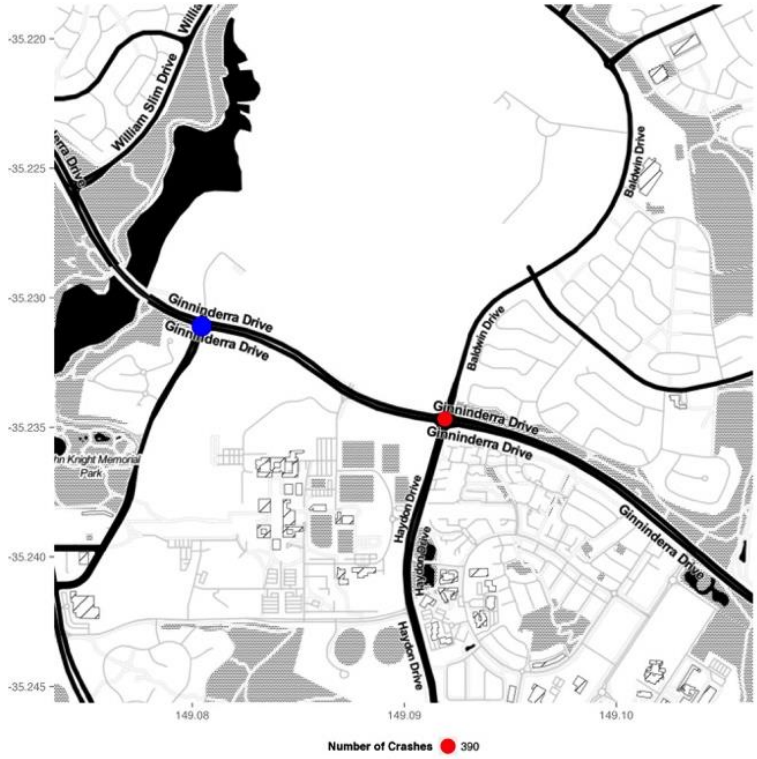

This site has a speed camera and has a low speed limit. The crash analysis suggests the camera should remain in place.

### *HINDMARSH/MELROSE*



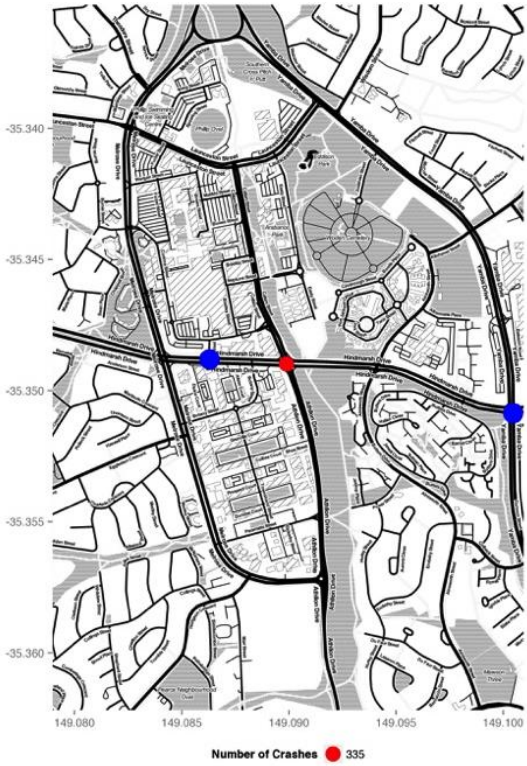

This site does not have a speed camera with speed limits of 60 km/h. There is a camera installed at a nearby intersection. Crash analysis suggests that a camera would be suitable at this site. If necessary, consideration could be given to moving the speed camera at the nearby intersection to this site.

## *BALDWIN/GINNINDERRA/HAYDON*




This site has a speed limit of 80 km/h. There is a nearby camera to the west of this site. The crash analysis suggests that a camera would be suitable at this site.

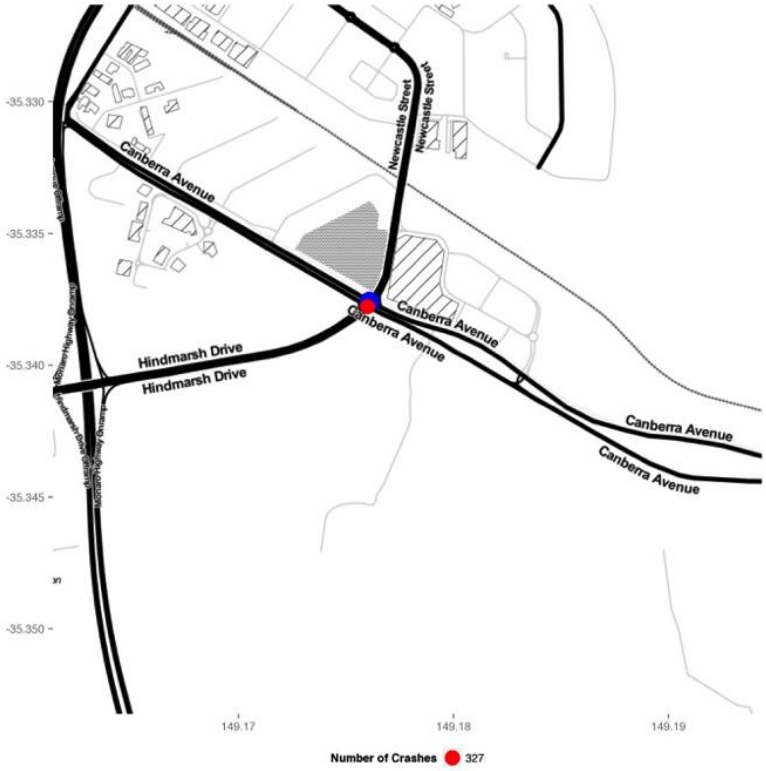
### *ATHLLON/CALLAM/HINDMARSH*




This site does not have a speed camera with speed limits of 60 km/h. There is a camera installed at a nearby intersection. Crash analysis suggests that a camera would be suitable at this site.

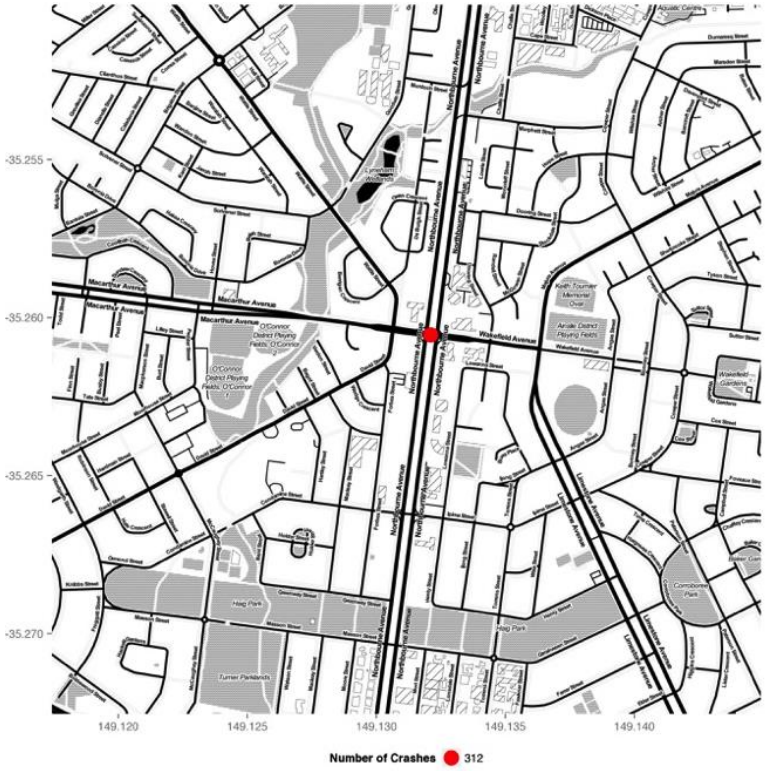
This site is near another site with a high crash history (Athlon/Callam/Melrose). Due to the high number of crashes on this route, a lower speed limit (from 80 km/h down to 60 km/h) may be an effective solution for reducing the number of crashes.

## *CANBERRA/HINDMARSH/NEWCASTLE*




This site has a speed camera in place with speed limits of 60 km/h and 80 km/h. The crash analysis suggests the camera should remain in place.

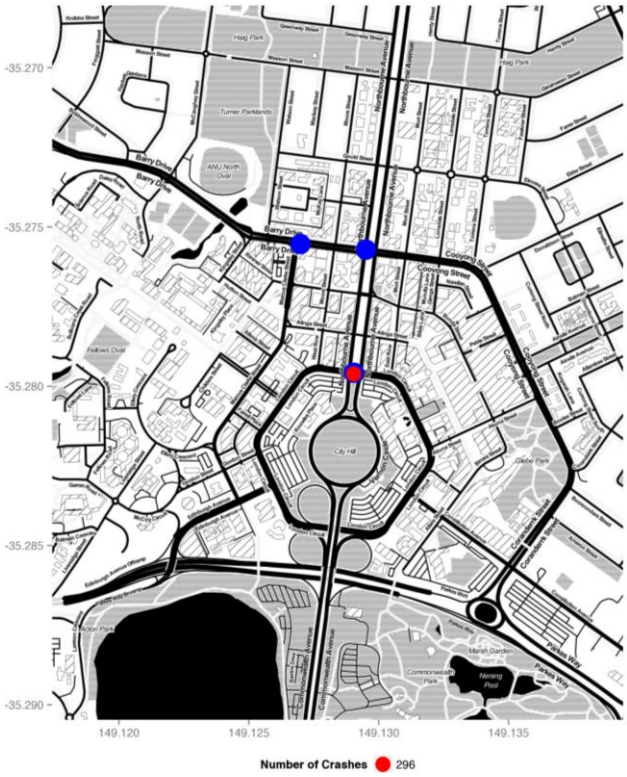
## *MACARTHUR/ NORTHBOURNE/ WAKEFIELD*




This site does not have camera and has a speed limit of 60 km/h. Crash analysis suggests it is a suitable site for a speed camera.

In addition, there are two Northbourne Ave road sections on either side of this intersection that are ranked amongst the 10 highest for possible treatment by a fixed speed camera. Placing a speed camera at this intersection may be a suitable treatment for these sites too.

## *LONDON/NORTHBOURNE*




This site has a speed camera in place and a speed limit of 60 km/h. The crash analysis suggests the camera should remain in place.

# APPENDIX 5 – EXISTING CAMERA SITES

## Existing Midblock Cameras

Existing midblock cameras are sited on the Barton, Monaro and Federal Highways and the Tuggeranong Parkway.

### *Barton Highway*

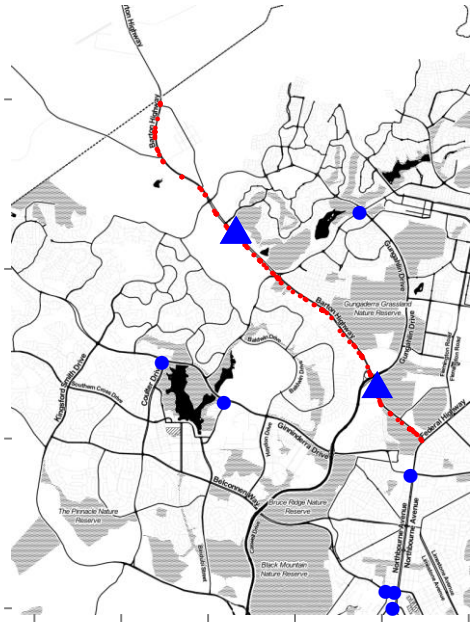
There are four midblock speed cameras on the Barton Highway. There are two sites, each capturing traffic in both Northbound and Southbound directions.

The road carries a high amount of traffic (more than 19000 vehicles per day at one site, and more than 8000 at the other). Each site has a moderately high weighted crashes per kilometer value of 28 and 30. These are the 2nd and 3rd highest rated sections out of 19 sections along the 16.45 km length analysed.

All cameras on the Barton Highway appear to be appropriately placed.

*Between Curran Dr and Gold Creek Rd (Northbound and SouthBound)*

*Between Gungahlin Dr & Ellenborough Street (Northbound and SouthBound)*



### *Monaro Highway*

There are four midblock speed cameras on the Monaro Highway. There are three sites arranged so that northbound and southbound traffic each pass through two cameras when traversing the whole route.

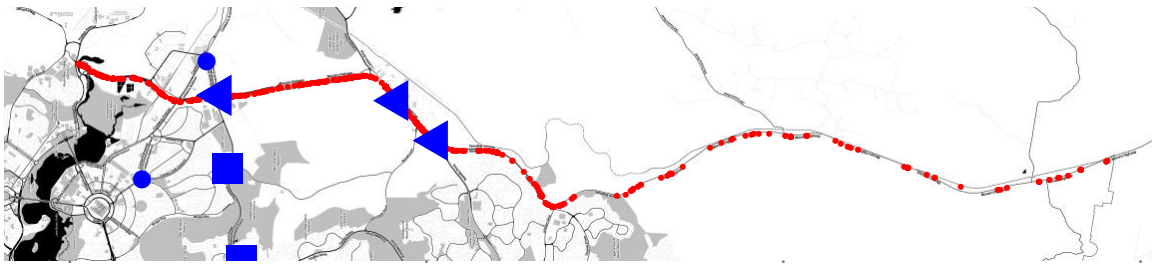
The road carries a high number of vehicles (on many sections more than 20000 vehicles per day). Each of site is located on or near road sections that have a high number of weighted crashes. This includes two sites at the two highest sections (Lanyon-Sheppard, and Mugga-Isabella), and a third site (near Hindmarsh) which is adjacent to the 5th and 6th highest sections out of 29 sections along the 19.87 km length analysed.

All cameras on the Monaro Highway appear to be appropriately placed.

*Between Lanyon Dr & Sheppard St (Northbound)*

*Between Mugga Lane and Isabella Dr (Southbound)*

*Monaro Hwy near Hindmarsh Drive (Northbound and Southbound)*



### *Federal Highway*

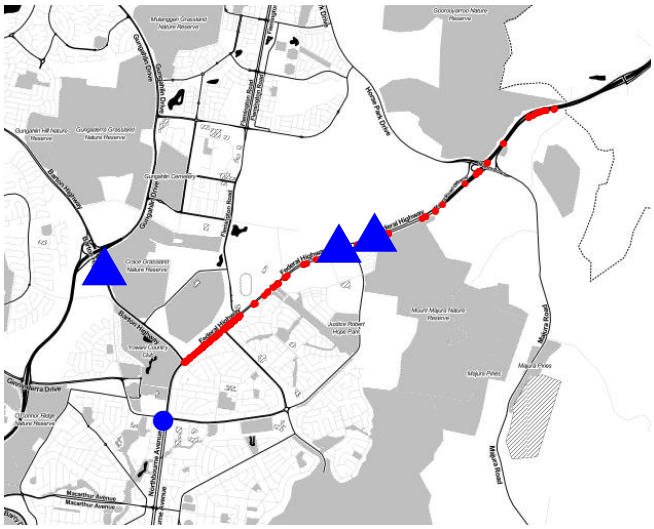
There are two midblock speed cameras on the Federal Highway, sited in 2 locations. One captures northbound traffic, the other southbound traffic.

The cameras are located on sections which carry a moderate number of vehicles and on roads that have moderate weighted crash risk – the sites are in the 4th and 6th highest sections out of 18 sections on the 15.46 km length analysed. Each camera, however, is located prior to the roundabout intersection between with Antill St. This intersection has had 11 fatal crashes and 89 injury crashes in the years the data was analysed, and these cameras are likely to have some effect at this intersection as well.

All cameras on the Federal Highway appear to be appropriately placed.

*Between Zelling St & Antill Street (Northbound)*

*Between Antill St & Majura Rd (Southbound)*



### *Tuggeranong Parkway*

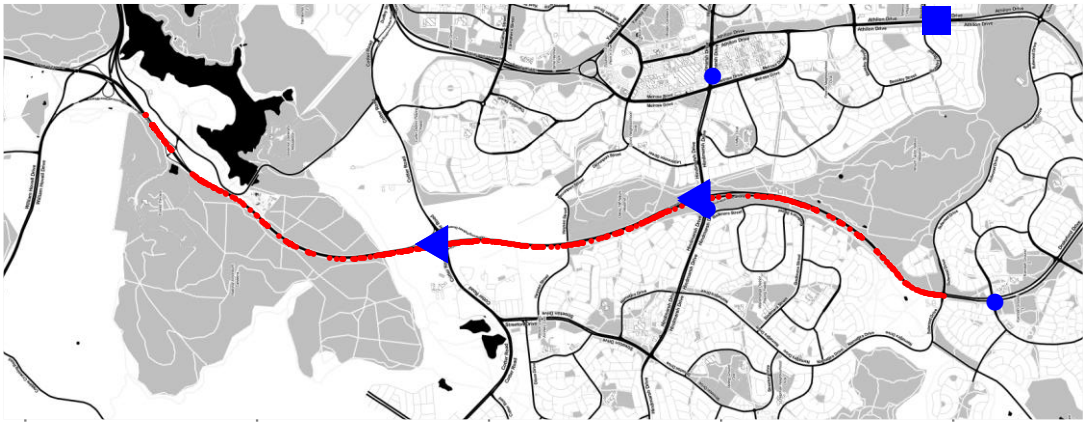
There are four midblock speed cameras on the Tuggeranong Parkway. There are two sites each capturing traffic in both Northbound and Southbound directions.

Tuggeranong Parkway carries a high volume of traffic. In each location the vehicles per day exceed 24000. The camera locations are at or near one or more road sections with very high weighted crash values, including three of the 22 highest rated sections in the Territory.

All cameras on the Tuggeranong Parkway appear to be appropriately placed.

*Near Hindmarsh Dr Underpass Northside of Hindmarsh Underpass (Northbound and Southbound)*

*Near Cotter Rd overpass (Northbound and Southbound)*



## Existing Intersections Cameras

Each of the safety camera equipped intersections is shown below in order of weighted number of crashes over the past 10 years.

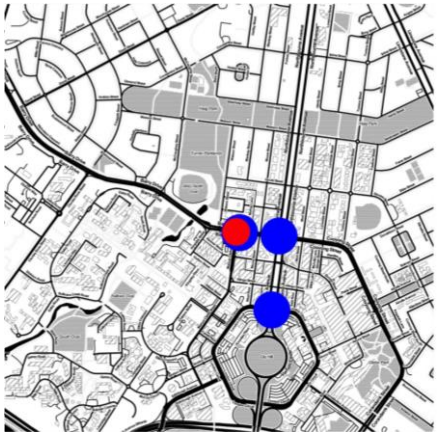
### *Existing Intersection Camera Locations*

| Intersection Name | Camera Installed | Fatal Crashes | Injury Crashes | PDO Crashes | Total Crashes | Rank | Weighted Crashes | Rank | Speed Limits |
|---|---|---|---|---|---|---|---|---|---|
| HINDMARSH/YAMBA | Yes | 0 | 13 | 521 | 534 | 1 | 586 | 1 | 60/80 |
| ANTILL/MOUAT/ NORTHBOURNE | Yes | 1 | 12 | 398 | 411 | 3 | 463 | 2 | 60 |
| BARRY/COOYONG/ NORTHBOURNE | Yes | 0 | 15 | 361 | 376 | 6 | 436 | 4 | 60 |
| CANBERRA/ HINDMARSH/ NEWCASTLE | Yes | 0 | 9 | 318 | 327 | 8 | 363 | 8 | 60/80 |
| LONDON/ NORTHBOURNE | Yes | 0 | 12 | 284 | 296 | 10 | 344 | 10 | 60 |
| GUNDAROO/ GUNGAHLIN | Yes | 0 | 5 | 236 | 241 | 15 | 261 | 15 | 80 |
| BODDINGTON/ DRAKEFORD/ MARCONI | Yes | 0 | 9 | 212 | 221 | 17 | 257 | 17 | 60/80 |
| AIKMAN/ GINNINDERRA | Yes | 1 | 7 | 184 | 192 | 20 | 224 | 23 | 80 |
| COULTER/ GINNINDERRA | Yes | 0 | 7 | 132 | 139 | 32 | 167 | 31 | 80 |
| CANBERRA/ CAPTAIN COOK/MANUKA | Yes | 0 | 2 | 117 | 119 | 42 | 127 | 52 | 60 |
| BARRY/MARCUS CLARKE | Yes | 0 | 5 | 71 | 76 | 80 | 96 | 78 | 50 |
| BALL/HINDMARSH | Yes | 0 | 3 | 81 | 84 | 75 | 96 | 78 | 60 |

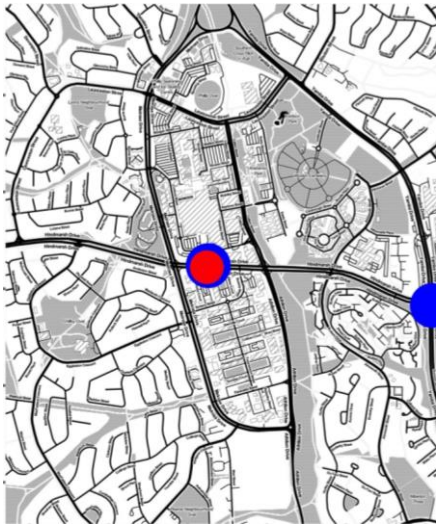
Eight of the 12 sites appear on the list of the top 20 sites ranked by either number of total crashes or weighted number of crashes.

Of the four that do not appear in the top 20 list, the two cameras at intersections with the lowest rankings are placed at the intersection of Barry Drive and Marcus Clarke Street, and the intersection of Ball St and Hindmarsh Drive. These are less well placed, and their movement to other intersections might be considered under certain circumstances.

The camera at the intersection of Barry Drive and Marcus Clarke Street (right) may be a candidate for movement to another site because of its low crash numbers and the higher safety effect that it may have at another location. However, the reason for its low crash numbers may be the presence of the camera. It is placed near the Australian National University and this site may have a high level of pedestrian activity as a consequence. It is recommended that this camera stay in place unless a more detailed report into this camera, in particular, is completed.



The camera at the intersection of Ball Street and Hindmarsh Drive (right) is also at a location of relatively low crash numbers. However, both intersections on either side of it on Hindmarsh Drive have high crash rates (amongst the top ten ranked sites). This camera may have a halo effect that is contributing to an increase in safety at those other intersections. Consequently, the only circumstance where movement of this camera should be considered is in conjunction with the placement of cameras at one or both of these other nearby intersections.



Overall, the intersection cameras are well placed. There are two that may be considered for movement to other intersections, however, these both have unique circumstances that warrant more specific consideration before that were to occur.