OUTCOMES OF A WORKSHOP TO DETERMINE CRITERIA FOR PLACEMENT OF FIXED SPEED CAMERAS AND RED LIGHT SPEED CAMERAS UNDER THE AUTOMATED TRAFFIC ENFORCEMENT PROGRAM IN WESTERN AUSTRALIA

by
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Outcomes of a workshop to determine criteria for placement of fixed speed cameras and red light speed cameras under the automated traffic enforcement program in Western Australia.

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**Sponsoring Organisation(s):**
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**Abstract:**
The W.A. Government is committed to improving road safety through *The Towards Zero Road Safety Strategy for Western Australia 2008-2020* which sets a target to reduce the number of killed and seriously injured (KSI) on W.A. roads by 40 per cent by 2020. The Safe Speed cornerstone of the Towards Zero Strategy 2008-2020 highlights that speeding is a major contributor to deaths and serious injuries on Western Australian roads. The Automated Traffic Enforcement (ATE) program in Western Australia is one of the programs that will deliver against the objectives of the Towards Zero Strategy 2008-2020. The ATE program will expand mobile, fixed and red light speed cameras in W.A. A need was identified for review of the criteria for camera site selection as part of planned expansion of the ATE program to ensure that any planned future expansion achieves the Government’s priority to improve road safety and saves lives.

Reflecting its role as the lead road safety agency in W.A., the Road Safety Commission has assumed responsibility for ownership of the speed camera selection criteria and applying these criteria to place ATE resources in W.A. This report outlines the outcomes from a workshop initiated by the Road Safety Commission to determine criteria for placement of new fixed traffic enforcement cameras under the expansion of the ATE program, funded from the Road Trauma Trust Account. The objective of the workshop was to review the criteria for camera site selection under the ATE in order to determine a set of new or modified criteria that will maximise the road safety benefits of the program. The workshop aimed to develop recommendations for new or modified criteria for camera placement under the ATE program through review of current research evidence on road safety benefits from cameras in conjunction with expert input from key stakeholders in the W.A. ATE program. The workshop was to focus primarily on criteria for fixed cameras but also included discussion on placement of mobile cameras which support fixed cameras in the ATE program.

**Key Words:** speed camera, crash analysis, enforcement, road safety strategy

**Disclaimer**
This report is disseminated in the interest of information exchange. The views expressed here are those of the authors, and not necessarily those of Monash University.
Preface

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**Research Team:**
- Stuart Newstead

**Contributor Statement**
Stuart Newstead - Entire Project

**Ethics Statement**
Ethics approval was not required for this project.
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1 WORKSHOP BACKGROUND OBJECTIVES AND SCOPE

The W.A. Government is committed to improving road safety through *The Towards Zero Road Safety Strategy for Western Australia 2008-2020* which sets a target to reduce the number of killed and seriously injured on W.A. roads by 40 per cent by 2020. The W.A. Government is also signatory to the National Road Safety Strategy 2011-2020, which sets out targets to adopt best practice enforcement and reduce the national annual number of deaths and serious injuries by 30 per cent by 2020.

The Safe Speed cornerstone of the Towards Zero Strategy 2008-2020 highlights that speeding is a major contributor to deaths and serious injuries on Western Australian roads and incorporates initiatives that have the potential to save 3,200 people from being killed or seriously injured over the life of the strategy, saving the community around $1,920 million.

Ensuring all road users behave within the design parameters of the road transport system is a key pillar in ensuring the realisation of the safe system objectives for road safety management. Road traffic enforcement is a key strategic tool within the Western Australian road safety strategy to target illegal behaviours. Within the area of speed behaviour compliance and red light compliance, the Automated Traffic Enforcement (ATE) program in Western Australia is a flagship program for delivering the objectives of the Towards Zero Strategy 2008-2020.

As part of the Towards Zero Strategy 2008-2020 Road Safety Strategy, W.A. State Cabinet provided in principle approval for a five year expansion program of the ATE. This program will substantially increase the State’s fixed site and red light speed camera program. Ultimately it is desired to increase the levels of automated speed enforcement in Western Australia over the next 5 years to:

- Around 3,800 hours of mobile camera activity per month.
- 30 fixed speed cameras on freeways and major routes.
- 90 speed and red light cameras at signalised intersections.
- 1 length of Point to Point speed enforcement (measuring average speed over distance), operating as a trial.

The expansion program is scheduled to be rolled out in stages over the five year program. Stage 1 camera site selection has been completed and endorsed by the ATE Steering Committee, whose membership includes WA Police, Main Roads WA, Department of Transport, Public Transport Authority, the office of the Minister for Transport and Minister for Police and Road Safety and is chaired by the Road Safety Commissioner. Stage 2 camera site selection has commenced, using existing selection criteria.

A need for review of the camera site selection criteria was identified to ensure that placement of the cameras for the remaining Stages of the ATE expansion program, and the ongoing review of speed camera placement, achieves the Government’s priority to improve road safety and saves lives.

**Workshop Objective:** The objective of the workshop was to review the criteria for camera site selection under the ATE in order to determine a set of new or modified criteria that will maximise the road safety benefits of the program. The workshop aimed to develop recommendations for new or modified criteria for camera placement under the ATE program through review of current research evidence on road safety benefits from cameras in
conjunction with expert input from key stakeholders in the W.A. ATE program. The workshop was to focus primarily on criteria for fixed cameras but also included discussion on placement of mobile cameras which support fixed cameras in the ATE program.

The report presents a summary of outcomes from discussion at the workshop including recommendations made on site selection criteria for future camera operations.

1.1 WORKSHOP TIME, AGENDA AND PARTICIPANTS

The workshop was held on Friday 3rd June, 2016 at the offices of the Road Safety Commission. The agenda for the workshop is shown in Table 1.

Participants in the workshop were drawn from the agencies that are stakeholders in the ATE program which are Main Roads W.A., W.A. Police, Department of Transport and the Road Safety Commission.

Monash University Accident Research Centre

   Stuart NEWSTEAD, Associate Professor and Workshop Facilitator

Road Safety Commission

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   Matthew LEGGE, Data Analyst
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   Scott BRANCH, State Traffic Intelligence, Planning and Co-ordination Unit
   Tony O’DONOGHUE, Assistant Director, Infringement Management Operations
   Vince LA ROSA, Infringement Management and Operations
   Tia KRUY, Senior Research Analyst
   Jade SMITH, Superintendent

Department of Transport

   Dianne LYSLE
   Samantha JOHNSTON
Table 1  
Agenda for the W.A. ATE Camera Placement Workshop

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Facilitator / Presenter</th>
<th>Time Allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00am</td>
<td>Welcome and workshop overview</td>
<td>Mel Watts</td>
<td>15 mins</td>
</tr>
<tr>
<td>9:15am</td>
<td>Overview of the W.A. Automated Traffic Enforcement Program</td>
<td>Stuart Newstead</td>
<td>15 mins</td>
</tr>
<tr>
<td>9:30am</td>
<td>Research evidence on the effectiveness of various automated enforcement types</td>
<td>Stuart Newstead</td>
<td>30mins</td>
</tr>
<tr>
<td>10:00am</td>
<td>Review of current site selection criteria used for each automated enforcement type.</td>
<td>Stuart Newstead, Tony O’Donoghue (mobile cameras)</td>
<td>30mins</td>
</tr>
<tr>
<td>10:30</td>
<td>Morning Tea</td>
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<tr>
<td>10:45am</td>
<td>Potential factors to be considered in revised criteria for selection of automated enforcement sites for each enforcement type.</td>
<td>Stuart Newstead</td>
<td>60mins</td>
</tr>
<tr>
<td>11:45am</td>
<td>Available and desired data to support potential new criteria</td>
<td>Stuart Newstead</td>
<td>45mins</td>
</tr>
<tr>
<td>12:30pm</td>
<td>Methods for ranking site priority.</td>
<td>Stuart Newstead</td>
<td>30mins</td>
</tr>
<tr>
<td>13:00pm</td>
<td>Lunch</td>
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<tr>
<td>13:30pm</td>
<td>Secondary validation of site suitability.</td>
<td>Stuart Newstead</td>
<td>30mins</td>
</tr>
<tr>
<td>14:00</td>
<td>Formulation of final recommendations on selected criteria and its application.</td>
<td>Stuart Newstead</td>
<td>60mins</td>
</tr>
<tr>
<td>15:00</td>
<td>Wrap-up/Next Steps</td>
<td>Stuart Newstead</td>
<td></td>
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2 OVERVIEW OF THE W.A. ATE PROGRAM AND RESEARCH EVIDENCE INFORMING CAMERA SITE SELECTION

2.1 OVERVIEW OF THE W.A. ATE PROGRAM

The W.A. ATE program currently comprises 4 elements;

- Intersection speed and red light
- Fixed speed cameras enforcing at a single mid-block point
- Point to point speed camera system enforcing over a length of road (not yet operational - trial to commence in October 2016)
- Mobile speed cameras

The size and composition of the program is ultimately approved by the W.A. Government Cabinet but has been informed by two studies undertaken by Max Cameron estimating optimal traffic camera resources in W.A. (Cameron and Delaney 2006, Cameron 2008). The most recent expansion of the ATE program was approved by the W.A. Cabinet in December 2014. An overview of the W.A. ATE including operations to the end of 2013 has been further documented in a recent evaluation of the W.A. ATE program (Newstead, Diamantopoulou et al. 2015).

2.1.1 Intersection and Red Light Cameras

Intersection and red light cameras are used at signalised intersections to address both red light running and speeding at the intersection. W.A. currently has 29 signalised intersections where cameras are installed. Each of these intersections is in metropolitan Perth although W.A. Police advised that some are encroaching the boundaries of the regional areas. Some of these previously had red light only cameras which have all been upgraded to combined speed and red light cameras. Others are new installations. Generally only one leg of the intersection is enforced by a camera however signage was reported to be used on all intersection legs warning of presence of the camera. The cameras are operated continuously apart from at times when repairs or maintenance of the cameras are required.

2.1.2 Fixed speed cameras enforcing at a single mid-block point

There are currently 5 fixed speed cameras in operation on urban freeway environments in metropolitan Perth. All lanes of the freeway are enforced by the camera and accompanying signage is included. Up until 2015, only a single camera was in use across all freeway sites in use up to that time. The single camera was rotated between each of the 4 operational sites. In 2015 the fifth site was commissioned and cameras installed at each of the sites in replacement of the rotational system. This change was made despite the recommendation in the 2007 camera resource allocation analysis (Cameron and Delaney 2006) that rotating cameras between sites is likely to be as effective as having permanent cameras providing the public are not aware which site the camera is located at. It was reported at the workshop that the move to permanent cameras at each site has had little impact on the overall number infringements detected by the cameras.

2.1.3 Point to Point Speed Cameras

Point to Point (P2P) camera technology is currently active in all other Australian states outside W.A. except Tasmania. The first Australian system was installed on the Hume Hwy
in Victoria in 2005. The first P2P speed camera system in Western Australia is being trialled on the Forrest Hwy south of Perth (between Old Coast Road and Noble Street) from October 2016. The workshop reported that to date there have been legislative difficulties in W.A. concerning the rollout of Point to Point cameras hence the first W.A. installation will be operated as a non-enforcing trial to learn about the operation of the system. The configuration of the system might be changed prior to it being made an enforcing system based on what is learned from the trail. Preferred start and finish points for the trial camera system are being determined based on considerations such as space and power availability with the system to cover around 30km of the highway detecting vehicles both north and south bound. Signage will identify the presence of the system and the trial and site details will be publicized through the media with Ministerial awareness of the information communications and program area. Geo-surveying of the site is required to accurately place the cameras and to give defensible enforcement through identifying the minimum possible travel distance between cameras. The system will be operated in both point to point mode as well as in spot speed enforcement mode at camera gantry sites. Enforcement tolerances are yet to be determined. It was reported that the system can operate across multiple speed zones but could not operate during periods of roadworks.

The P2P trial system will also incorporate Automatic Number Plate Recognition (ANPR) capability, the first such ATE element to have this capability. W.A. Police advised that they will also continue non-automated enforcement for non-speed related offences within the P2P system area to counter the possible driver perception that only speed is enforced in the P2P area.

2.1.4 Mobile Speed Cameras

Mobile speed cameras have been in operation in W.A. for over 2 decades. Camera units are operated in car, tripod or sometime cabinet mounted configuration with signage advertising the presence of the camera having been utilised at times throughout the program. In addition, the public are advised of mobile camera sites to be used over the following week by a W.A. police issued bulletin which is generally also broadcast by local media. As such, the W.A. mobile camera program is considered largely overt in its mode of operation (Cameron and Delaney 2006). It was advised that more recently signage of mobile camera speed cameras has been removed due to threats to mobile operator safety.

Evaluation of the W.A. ATE program (Newstead, Diamantopoulou et al. 2015) identified that mobile speed cameras have been used at nearly 10,000 different locations since 1995. W.A. Police advise that approximately 4000 mobile camera locations are currently in use which all comply with one or more of the mobile camera criteria for site selection. Mobile cameras are operated by civilian (non-sworn) employees of W.A. Police in 3 rostered shifts rotating 7 days a week with each staff member working 2 locations per shift. The operation of the cameras by W.A. police staff was considered important to counter the argument of revenue raising which might arise through the use of external contractors to run the cameras as in Victoria. Standard operational hours are from 0600-2200 with additional hours worked outside of standard hours for special operations. The operation KPI is 3500 camera hours per month delivered from 23 camera vehicles, 18 operated in metropolitan Perth and 5 in regional areas. Other remote regions have camera operations scheduled in them periodically by sending resources from the regions with permanent resources to undertake enforcement for a period of time. Enforcement is often undertaken during the journey to and from the remote region.
2.1.5 Supporting Manual Speed Enforcement and Other Issues

Manual police operations (Blue-shirt operations) are scheduled to support and compliment the ATE camera operations. Easter was offered as an example of how manual operations integrate at Williams between Albany and Perth. Mobile camera operations were on the road enforcing speed and were supplemented by manual operations including drug and alcohol testing, seat belt wearing and mobile phone use. The police also supplement ATE operations with ANPR operations which enforcing unregistered and unlicensed driving as well as a range of other non-road safety related offences.

It was noted that W.A. has an active group, called the Revenue Raising Resistance (RRR), who protests against the use of ATE cameras. The group often protest around the sites of operational mobile cameras. Police have met with the RRR to articulate the boundaries of acceptable behaviour stressing that if these boundaries are breeched, then police will take action. Despite the presence of groups such as the RRR, police report little incidence of vandalism of fixed ATE camera infrastructure or violence against mobile camera operators. Safety of mobile camera operators is considered a priority and protocols are in place should any incident escalate including support from uniform police and defined procedures to evacuate from an operation.

2.2 RESEARCH EVIDENCE ON THE EFFECTIVENESS OF VARIOUS AUTOMATED ENFORCEMENT TYPES

A brief summary on research evidence supporting the mechanisms and scope of effectiveness of the various ATE camera types was provided by the workshop facilitator based on local and international research.

2.2.1 Fixed Freeway Speed Cameras

There are relatively few published evaluations of the crash effects of fixed speed cameras located in non-intersection locations from which to glean information on likely effects and information relevant to placement site selection. From those that are published, it appears that:

- Fixed speed cameras are generally used as a black spot type treatment at locations where speeding has been identified as a primary driver of identified elevated crash risk (Cameron and Delaney 2006, Wilson, Willis et al. 2010).

- Based on evaluation of the NSW fixed speed camera program (ARRB 2005), effects are highly localised to within 3km or less of the camera site, possibly reflecting the high visibility signage used in conjunction with the cameras as part of this program. The high visibility of the NSW program also suggests the primary mechanism of deterrence is the presence of the camera, with infringement notices issued acting as a secondary deterrence for infringing drivers.

- Deterrence related to camera visibility is also demonstrated in the Norwegian program (Elvik 1997) where, similar to Western Australia, speed cameras are not always present in the fixed roadside boxes. Whether strongly localised deterrence is maintained when accompanying signage of the cameras is not used is unknown but considered likely. Freeway cameras in W.A. are signed so it is likely that the hypothesis of crash effects localised to the site applies.
• Evaluations of fixed speed cameras in the U.K. camera program (Gains 2005) estimated crash effects in close proximity of the cameras (within 0.5km) but because of the number of cameras in the region, there was some suggestion that the program may have achieved generalised effects (that is effects beyond the areas local to the camera sites).

Evaluation of the W.A. fixed speed cameras (Newstead, Diamantopoulou et al. 2015) also suggested strongly localised crash effects at the camera site with deterrence primarily driven by the presence of the camera. Evaluation results estimated a 39% reduction in KSI crashes although the result was not significant due to the short after implementation period available for analysis. This estimate is similar to that recently obtained from MUARC evaluation of fixed freeway cameras in Victoria.

Sweden use a different approach to fixed speed camera placement with cameras placed every 4.5 km along a road length (operating in spot mode and not P2P mode). Currently, around 750km of main roads are covered by a network of 335 cameras. Not all cameras are active all of the time to limit the total number of fines issued by the system to make back office processing manageable. Injury crash reductions of about 25% are reported to be associated with the camera network.

2.2.2 Intersection Speed and Red Light Cameras

Cameras at signalised intersections which detect both red-light running and speeding infringements are a recent technology. The principal reasons for installing these combination cameras is to reduce red-light running crashes and also to reduce the risk and severity of the remaining crashes. The first objective is the same as that of traditional red-light cameras and in addition it could also be expected that the threat of detection for speeding by the cameras may encourage a proportion of motorists to travel at lower speeds through the intersection. As such the cameras appear to be consistent in objective with both the red light and fixed spot-speed cameras. Geographical reach in effectiveness and likely deterrence mechanism is likely to be similar to both single function camera types.

The only two published evaluations of the effects of this enforcement method is for three such cameras in Canberra (Brinson 2002) and the Victorian intersection combined red light and speed camera program (Budd, Scully et al. 2011). The main findings from these evaluations were:

• Results of the Canberra study, in terms of changes in speeds and reductions in crashes, varied from site to site and results from the analysis were deemed inconclusive.

• The Victorian study focused only on crash effects and found the installations to be highly effective at reducing crashes in the area local to the intersection on which they were installed (25% casualty crash reduction across the whole intersection, 47% reduction on the enforced leg).

• Information on red light only cameras evaluations are summarised by Retting and colleagues (Retting, Ferguson et al. 2003), and show the effects of red light only cameras also to be localised at or within close proximity of the camera site. Crash
reduction effects for red light cameras only are less than for the combined speed and red light cameras due to increases in rear end crashes from the camera, a problem solved in the combined cameras through the speed enforcement component. Primary mechanisms of deterrence associated with red light cameras identified in the evaluation studies are the overt physical presence of the camera and accompanying signage and the receipt of a traffic infringement by offending motorists. This is also likely for the combined speed and red light cameras.

Evaluation of the combined speed red light cameras in W.A. (Newstead, Diamantopoulou et al. 2015) estimated a 36% reduction in KSI crashes and 18% reduction in all casualty crashes local to the intersections where cameras were installed.

2.2.3 Point to Point Cameras

There are few published evaluations of P2P camera systems. The most detailed of these is the evaluation the U.K. P2P system installed on Nottingham’s main link road from the M1 Motorway in July 2000 (Keenan 2002). Two cameras were mounted along the enforced 40 mph road length approximately 0.5 kilometres apart. Compared with traditional wet-film spot-speed fixed cameras, the study found that the spot-speed fixed cameras have a site-specific effect whereas the point-to-point camera system has a link-long influence on drivers and their speeds, despite enforcement being visible only at the start and end of the enforced road length.

In July 2005, the Scottish government launched a pilot scheme of P2P cameras on a 46 km section of the A77 highway in the Strathclyde area including 14 camera sections, averaging 0.5 mile in length, between which the pairs of cameras are switched on periodically. The cameras are supported by around 50 safety camera warning signs with the message “average speed – speed cameras” and a camera symbol. The intention is to deter speeding along the full length of the route. A preliminary evaluation of the Strathclyde A77 system by Transport Scotland has found that there was a statistically significant 20% reduction in reported injury crashes (including fatal) during the first two years of operation on the route, compared with crash experience during the previous three years (A77SG 2007). After three years of operation, fatal and serious injury crashes were reduced by 29.3% and slight injury crashes were reduced by 15.6% (A77SG 2008).

A recent evaluation of the P2P camera system on the Hume Hwy in Victoria found similar effects to the UK evaluations. Casualty crash reductions of around 30% were estimated along the full length of the camera system. This evidence indicated that P2P cameras provide deterrence along the full length of road between the P2P start and end gantries. If the cameras are also operated in spot mode there may also be some additional deterrence effects at the camera gantry sites.

2.2.4 Mobile Speed Cameras

As noted, the use of mobile speed cameras in W.A. can generally be described as overt in nature. Initially this was due to cameras operating with accompanying signs advising motorists of the camera, although this practice ceased due to concerns for operator safety. However, camera locations are still routinely advertised to the public. The mobile speed camera program in Queensland, which is also run largely in overt mode, has the most relevance for comparison with the W.A. program.
Evaluation of the Queensland mobile speed camera program (Newstead and Cameron 2003, Newstead 2006) has identified a strong spatial correlation with the mobile camera zones of operation and the bulk of crash effects being measured in areas within 1 kilometre of the operational camera zone centroids. Queensland employs randomised scheduling for its speed camera program to maximise uncertainty on timing of camera placement to give crash reduction effects which are maximised over time. Evaluation found a strong correlation between the adherence to the randomised scheduler and crash effects obtained. As such the Queensland program relies less on specific deterrence through issuing fines and more on general deterrence through strategic camera placement and randomised scheduling of operations. Sites for enforcement are chosen through applying a strict criteria based on crash rates surrounding the site which manages to cover over 85% of the crash population in Queensland within 1km of a camera site using around 2,500 operational sites. State-wide, the Queensland mobile camera program has achieved over 25% reduction in casualty crash frequency through the mobile camera program.

Providing a contrast is the Victorian mobile speed camera program where crash effects are largely generalised in space and time, due to the covert nature of the program (Cameron, Cavallo et al. 1992, Rogerson, Newstead et al. 1994, Newstead, Mullan et al. 1995). The program relies heavily on specific deterrence through fining large number of drivers and does not employ randomised scheduling. Sites are chosen based on road safety criteria (crash history, speeding etc.) with around 1,500 sites currently in operation. Randomisation is not used for scheduling. A recent trial in Victoria broadening the scope for site selection and moving closer to random scheduling showed additional crash reductions in urban areas in response to the change.

Evaluation of the W.A. mobile camera program (Newstead, Diamantopoulou et al. 2015) found strong crash reductions in an area of influence of radius 1km from the camera site similar to those identified in the Queensland program although smaller in magnitude due to the smaller number of hours enforced. Camera site selection under the W.A. mobile program covers a high proportion of the crash population in metropolitan Perth (>90%) but less so in regional W.A. (<50%) reflecting the diffuse nature of the crash population outside of Perth. The W.A. program is also reported to employ randomised scheduling of operations. Although this aspect of the program has not been specifically evaluated, based on the Queensland evaluation it is likely that this also contributes to generalised effects of the program in space and time.

### 2.3 CURRENT SITE SELECTION CRITERIA USED FOR EACH AUTOMATED ENFORCEMENT TYPE IN W.A.

The current criteria for camera site selection was collated through input from workshop participants.

#### 2.3.1 Intersection Speed and Red Light Cameras

Selection of locations for intersection speed and red light cameras in W.A. has been largely informed by the list generated in the supplement study to the resource allocation calculations (Cameron 2008). In this study, unenforced signalized intersections were -ranked according to the community cost of crashes occurring at the intersection which was then converted to
a benefit to cost ratio using the estimated Red Light Speed (RLS) camera installation cost in order to rank the sites for priority camera placement. This list has informed all intersection camera installations to date with 29 of the highest priority sites treated. To date all sites where cameras have been placed are in metropolitan Perth or on the urban fringe reflecting the list of priority sites identified which are all relatively high exposure sites.

It was reported to the workshop that other criteria are also used for fixed intersection camera placement including:

- 2 KSI crashes over the past 2 years defining a site as a candidate for a camera.
- Ranking within the candidate list based on the total number of casualty and all reported crashes over the last 5 years.
- Consideration of the number of target crash types including right angle and right turn against crashes and speed related KSI crashes.
- The intersection leg to be treated by the camera in based on 5 years of crash data being analyzed to determine the primary direction of red light running.

Exceptions to using this criteria were sites where a red light only camera was upgraded to speed and red light capability.

It was also reported that expansion sites were chosen based on the following criteria which are in essence the same as those defined above.

- Right angle and right turn Killed and Seriously Injured (KSI) crashes (MRWA data) over the past 5 years at intersections (red light speed); or
- Speed related Killed and Serious Injury crashes for main arteries (fixed site) over the past 5 years (MRWA data).

An alternative criteria for intersection camera site selection has been developed by the Western Australian Police, State Traffic Intelligence, Planning and Coordination Unit (STIPCU) based on analysis of data from the past 2 years relating to:

- Top 40 speed locations by suburb and street based on traffic infringements.
- STIPCU top 40 complaints by suburb and by street.
- MRWA top 40 all crashes by suburb and street.
- WAPOL top 40 fatal and critical by suburb and by street.

Two sites have been chosen based on the STIPCU criteria to relocate 2 camera sites from Tonkin/Collier Road due to the Commonwealth funded North Link Project which is installing a flyover at the existing red light speed camera location. It was noted in the workshop that historically responsibility for site selection has not rested in one place, explaining the variation in selection criteria given.

In addition to the road safety based site selection criteria for intersection cameras there are also operational criteria which must be satisfied including:

- Consulting with LGA’s and other stakeholders to identify whether there are other planned works in place such as engineering treatments to address the crash problem (e.g. full right turn control or signal phasing changes).
• Recent and planned road works that may result in service outages or costly speed camera reinstatement.

• Subsequent site assessment based on technical/operational requirements including accessibility of the site and road conditions assessing where the camera might be located etc.

Secondary speed validation (via TIRTL) is not used as either intersection or freeway fixed camera sites. Cameras are regularly checked and maintained to ensure speed measurement accuracy. TIRTLs can be employed in response to complaints.

2.3.2 Fixed Spot Speed Cameras

Placement of fixed spot speed cameras to date has been based on the recommendation of the 2006 resource allocation analysis (Cameron and Delaney 2006) which recommended fixed spot speed cameras be used in urban Perth freeways. The exact sites chosen were based on crash frequency criteria across 10km leg and access points of the freeway.

Freeway cameras also require a number of operational criteria to be satisfied including:

• Power accessibility.
• Optimisation of laser systems over the full 24 hours.
• Accessibility for repair and maintenance teams.
• Sites are required to be fully controlled by MRWA to limit interference from other parties.
• Road lengths must be straight legs, not close to bridges with consideration of barrier placements.
• Location of on and off ramps (to avoid detecting vehicles trying to accelerate past other vehicles to enter or exit).

2.3.3 Point to Point Camera System

The reason for selection of the Forrest Hwy site was based on the high traffic volume and subsequently high crash rates per km of roadway as well as an observed level of speeding. Given the trial nature of the site, a number of the reasons for site selection seemed to be pragmatic rather than strictly road safety based. In addition, the camera site needed to have access to appropriate services (electricity etc.) to support the cameras as well as appropriate space to install the camera gantries and the facility to geo-survey the road.

2.3.4 Mobile Speed Cameras

Sites for the operation of mobile speed cameras in W.A. are chosen according to the following criteria:

• On a road where a fatal or serious crash has occurred within the last 3 years or where speed is an element.
• At locations of 'speed related complaint' (including complaints derived from the Hoon Hotline).
• At sites where the percentage of road users exceeding the posted speed limit exceeds 15%.
• In School Zones.
Based on analysis of traffic data from W.A. Local Government Association (WALGA).

The placement of mobile cameras considers fixed camera technologies in the vicinity of potential sites with the mobile camera program generally supporting the fixed camera operations for locations where a fixed camera is not installed or warranted for installation.

Operational criteria for camera placement also exist including adequate space to place the vehicle and/or camera tripod on the roadside and considerations of operator safety (uniform police provide support to ensure safety). There are also geographical constraints on camera placement based on the distance from the camera operator base. As noted, operations in remote areas are commissioned periodically with a pair of camera operators travelling to the remote regions with a camera undertaking enforcement at the destination as well as at selected locations on the journey.

2.3.5 Camera Site Selection Criteria in Other Australian Jurisdictions

A review of selection criteria across Australia revealed consistency in the criteria used to determine camera site locations, with frequency of ‘all reported crashes’ being the primary criteria. Additional analysis is then conducted to determine the suitability of the site including, technical and environmental requirements for the speed camera equipment. New South Wales, Tasmania and Victoria also consider public nominations for camera sites which are assessed for site suitability.

New South Wales

Red-light speed camera criteria
- Frequency and severity of crashes at an intersection and/or
- Assessment of high road safety risk and/or
- Regional priority.

Fixed speed camera criteria
- High frequency and severity of crashes over a length of road no longer than 100km.
- School zone with a high frequency and severity of crashes and/or high risk of pedestrian crash or
- High risk location that is difficult for Police to enforce using traditional methods, such as tunnels.

Point-to-point speed camera criteria (heavy vehicle speeding only)
- High frequency and severity of heavy vehicle crashes and/or
- Evidence of heavy vehicle speeding problem.

Victoria

Fixed Cameras
- Location crash history.
- Road type where there is a history of speed-related crashes, written complaints of excessive speeding or identification by Victoria Police of a speed-related problem.
- Demonstrated accident risk that poses a risk to public safety, such as high pedestrian activity.
**ACT**

The ACT commissioned a consultant to develop strict criteria for fixed speed camera technologies. Based on national and international research the report recommends that camera site selection is based on:

- Count of injury crashes
- Count of all crashes
- Weighted count of crashes
- Weighted count of crashes per kilometre.

All roads were considered initially however only arterial roads are considered for fixed cameras. Other road types were more suitable for mobile speed cameras and short roads were excluded due to their length.

**Queensland**

*Speed and Red Light Cameras*

- The number of crashes on a section of road in the last 5 years.
- The causes of crashes that have occurred.
- The severity of crashes that have occurred.
- How common high risk speeding behaviour is in an area.

*Point to Point*

- Analysis of lengths of road with a history of crashes caused by speeding.
- Analysis of lengths of road with the potential for crashes caused by speeding.

**Tasmania**

- Speed camera public site nomination.
- Crash data in respect to fatal or serious injury crashes.
- Intelligence indicating speed enforcement activities involving camera deployment would be appropriate in a particular area.
- High risk school zones where other deterrent/detection methods are not viable.
- High risk road works where other deterrent/detection methods are not viable.

A comparison of the criteria used for mobile camera operations across the jurisdictions considered is given in the following table.
<table>
<thead>
<tr>
<th>WA</th>
<th>NSW</th>
<th>VIC</th>
<th>ACT</th>
<th>QLD</th>
</tr>
</thead>
<tbody>
<tr>
<td>On a road where a fatal or serious crash has occurred where speed is an element. Crash to have occurred within last 3 years.</td>
<td>Frequency and severity of crashes and/or Risk of road trauma or previous fatal crash</td>
<td>Documented history of serious and major injury collision within the previous 3 years</td>
<td>Roads with a history of Fatal/Serious crashes and speeding</td>
<td>Crash History</td>
</tr>
<tr>
<td>At locations of 'speed related complaint' (including complaints derived from the Hoon Hotline)</td>
<td>Community nominated</td>
<td>Public complaints</td>
<td>Public complaints</td>
<td>Public complaints</td>
</tr>
<tr>
<td>Percentage of road users exceeding the posted speed limit exceeds 15%</td>
<td>Police nominated</td>
<td>Identified by police to be a speed-related problem site</td>
<td>Locations that complement and support police enforcement</td>
<td>Roadwork sites where the workplace health and safety of workers is at risk.</td>
</tr>
<tr>
<td>School Zones</td>
<td>School Zones</td>
<td>School Zones</td>
<td>School Zones</td>
<td>School Zones</td>
</tr>
<tr>
<td>Traffic data from WA Local Government Association (WALGA)</td>
<td>Subject of a validated complaint of excessive speeds, for example feedback from local councils</td>
<td>Randomly selected roads, in support of the “anywhere, anytime” approach</td>
<td>High-risk speeding</td>
<td></td>
</tr>
<tr>
<td>Location is difficult to enforce by Police using conventional methods</td>
<td>Alternate speed enforcement by non-camera devices within a specified site deemed not practicable/unsuitable</td>
<td>Road Safety policy area has people to conduct speed surveys</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3 FORMULATION OF SITE SELECTION CRITERIA FOR THE W.A. ATE PROGRAM

3.1 FACTORS TO BE CONSIDERED IN THE ATE SITE SELECTION PROCESS

Workshop participants discussed the key criteria for selection of sites for enforcement by fixed cameras under the ATE program. The following were identified:

- Road safety criteria were considered the most important basis for selecting camera sites, primarily crash history at candidate sites. In considering crash history:
  - KSI crashes are the most important but minor injury crashes should also be included since they are an indicator of a safety problem at a site and provide a broader base from which to make more reliable conclusions about the worth of a site.
  - Use of both KSI and minor injury crashes should consider the relative social costs of each crash type as a potential weighting to give an aggregate safety performance for a site across all crash severity levels. A methodology for aggregating crashes across different severity levels by social cost weights is presented in Section 3.2.
  - All crashes at a site should be considered as the primary measure. Secondary consideration could be given to target crash types relevant for the camera type (for intersection cameras these were right angle and right turn against, for mid-block cameras these were speed related crashes) if sufficient numbers of target crashes are available for meaningful analysis.
  - Crash history needs to be long enough to give robust evidence on the safety performance of a site. Potentially 2 time periods should be examined, recent history (say 5 years) and longer term history (say 10 years) to ascertain whether the site has been a consistent problem or whether it is an emerging or growing problem. Average ranking across the 5 and 10 year periods could be combined to give an overall rank (this process has been used for ranking intersection speed camera sites in Victoria).
  - The geographical criteria which defined the sites for which crashes were to be ranked should be informed by the camera type and the research evidence on its area of influence.
    - For intersection cameras, this is crashes at the intersection.
    - For spot speed cameras at mid-blocks crashes within 2km road segment partitions of the road network in urban areas and 8km segments in rural areas
    - For P2P cameras, crashes on road lengths suitable for end to end coverage by a P2P camera system (these could also be identified by road lengths that had a large number of candidate sites identified through the spot speed camera road segment analysis)

- In line with the safe system approach to road safety management, predicted economic performance was not seen as a primary criterion for camera site selection. Instead it was identified that a resource allocation analysis such as
presented by Cameron and Delaney (2006) should be undertaken periodically to identify the level of investment warranted in the ATE program as a whole and the balance of investment between camera types. Sites should then be ranked within camera types and treated in rank order up to the level of funding available for each camera type.

- Secondary criteria for site selection were also identified to refine the primary ranking within sites of similar primary rank including:
  - School zones.
  - Police Intelligence (potentially based on Police STIPCU data and other intelligence based on operational officer inputs etc.).
  - Community Complaints (potentially based on records of complaints collected through an appropriate forum).
  - Historic speeding data (i.e. 15% of vehicles speeding through regular speed surveys or data from the mobile camera program).
  - Regional Priority based on Local Government feedback and political imperative to balance investment between Perth and regional W.A.

A number of other operational criteria were identified as being important considerations:

- Consulting with LGA’s and other stakeholders to identify whether there are other planned works in place or likely to be possible such as engineering treatments to address the crash problem (e.g. full right turn control or signal phasing changes). This could take the form of a risk assessment or road safety audit.
- Planned future road works that may result in service outages or costly speed camera reinstatement.
- Site assessment based on technical/operational requirements including accessibility of the site and road conditions assessing where the camera might be located including:
  - Power accessibility.
  - Optimisation of laser systems.
  - Accessibility for repair and maintenance teams and OHS considerations.
  - Site controlled by MRWA to limit interference from other parties.
  - Appropriate road geometry and proximity to access points.
  - Difficulty in enforcing a site either with mobile cameras or manual police enforcement due to OHS constraints.

Although the purpose of this workshop did not include the ranking of sites for mobile speed camera operation, the workshop identified the general principle that mobile camera operations should geographically complement the fixed camera network. The mobile camera program should be used to cover those sites where a fixed camera is not justified based on the ranking criteria and available funding or cannot be installed due to operational limitations with the site or for crash problems that are transient (for example due to holidays or special events). It was also identified that manual police enforcement operations should be overlaid
on camera based enforcement sites to enforce illegal behaviours other than speeding in order to reinforce with the public that these other behaviours are not acceptable at camera sites.

3.2 METHODS FOR RANKING SITE PRIORITY

Three options were identified for ranking site priority based on crash outcomes. Options 1 and 2 have been used in camera site selection at various stages over the program history so are amenable to immediate implementation. Of these, Option 2 was preferred as it made use of more crash data and was less susceptible to high variation in the rankings produced. Option 3 was identified as a potential refinement to Option 2 but its application in practice would need to be established and tested to ensure its viability through further research.

Option 1

Frequency of KSI crashes at each candidate camera site is used to produce site rankings.

Option 2

Frequency of all reported crashes at each candidate camera site is used to produce site rankings with KSI crashes used as a secondary criteria for ranking.

Option 3

Option 3 ranks sites not on simple frequencies of KSI or all reported crashes but on a weighted average of crashes at each severity level defined in the Main Roads police crash data as a summary of safety performance. Basing a ranking only on KSI crashes (Option 1) is likely to produce excessive variation in the ranking due to the relative small number of KSI crashes observed at a specific site level. Ranking of sites based on a simple sum of all reported crashes (Option 2) might highly rank sites that have a high number of minor crashes over those which have a high number of more serious crashes. Using KSI crashes as a secondary ranking criterion under Option 2 may not fully mitigate this problem. Workshop participants identified that greater weight needs to be given to KSI crashes in the ranking process due to their greater relevance to the W.A. road safety strategy goals.

One way to weigh crashes in a ranking process is to use the relative social costs of the crashes as the weights either based on the human capital approach (BITRE 2010) or the more recently adopted willingness to pay approach. However, whichever costing scheme is adopted, weighting the ranking using social costs directly is likely to also produce excessive variation in the data due to the relatively high costs assigned to fatal crashes over serious injury crashes (each severity differing in estimated cost by a factor of 8 or more).

A current study on fixed mid-block speed camera placement in Victoria has used a weighting system for different severity crashes based on principles of the “Equivalent Property Damage Only” (EPDO) method of Deacon, Zegeer and Dean (1975) (Deacon 1975). Analysis of this methodology in practice showed that it produced better economic returns from hazardous road location treatments than simply aggregate crash numbers or crash rates per vehicle kilometer but is less subject to excessive variation in rankings due to the weights not being as disparate as those produced by social cost weightings. Importantly, it was found that the methodology provided a good correlation with social cost weightings but without the excessive variation. The following weights were given to the crashes at each injury severity level when summing the crashes for site selection when using the EPDO method:

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ATE CAMERA SITE SELECTION WORKSHOP 17
16: Fatal crashes.
8: Hospitalisation crashes.
4: Medical treatment crashes.
2: Minor injury crashes.
1: Property damage only crashes.

In the Victorian analysis it was decided instead to rank sites by the Equivalent Property Damage Only (EPDO) number of crashes per kilometre of road. The EPDO is the weighted sum of the crashes on the link, with weights given to each type of crash as follows:

16: Fatal crashes
8: Crashes resulting in hospitalisation
4: Crashes resulting in medical treatment without hospitalisation
2: Crashes resulting in minor injury not requiring medical treatment
1: Crashes resulting in property damage only.

This methodology could readily be adapted to the W.A. context. A key difference is that crashes in W.A. are only classified for injury severity based on different 5 point scale to that described above (Fatal, Hospital Admission, Medical Attention, PDO Major, PDO Minor). Consistent with the intent of the EPDO, the following weightings could be used for W.A.:

16: Fatal.
8: Hospital Admission.
3: Medical Attention.
1: PDO Major.
1: PDO Minor.

**Crash time period for rankings**

The workshop also identified the need to look at both short and medium term crash history whichever option above was adopted. A mechanism for doing this would be to calculate the rank for each site over the five most recent years and over the 10 most recent year period and then combine the ranks according to some weighting. Given the most recent 5 year period is more relevant, higher weighting might be used for this data, say:

\[
\text{Final Rank} = 0.7 \times \text{Rank (5 Year)} + 0.3 \times \text{Rank (10 Year)}
\]

For intersection cameras, the final rank is best calculated based on crashes targeted by the cameras (right angle, right turn against) if there are a sufficient number of crashes for reliable analysis. For all other cameras the final rank could be based on all crashes or speed related crashes if these can be reliably identified and are sufficient in number, or a weighted average of both. Research would also need to be conducted to determine the most appropriate weightings.
3.3 DOCUMENTATION OF THE IDENTIFIED SITE SELECTION PROCESS

Subsequent to defining the key factors to inform site selection criteria, participants in the workshop identified a process for site selection based on the important factors identified in Section 3.1 above. The process is described as follows:

1. A new resource allocation analysis needs to be undertaken to determine the level of investment in the ATE program to achieve strategic road safety targets determined by the W.A. Government through its road safety strategy. The balance between investment in metropolitan, rural and remote areas can be determined as part of the analysis.

2. Using the chosen option for summarizing crashes at a location, rank candidate sites relevant to each ATE camera type and in each jurisdiction of focus in the resource allocation analysis noting the sphere of influence for each camera type identified in the research. For example:
   a. Speed red light cameras
      i. Perth signalised intersections (target crashes at intersection)
      ii. Regional W.A. signalised intersections (target crashes at intersection).
   b. Mid-block spot speed cameras
      i. Perth arterial road mid-blocks (speed related and all crashes within 2km road segment partitions of the road network)
      ii. Rural and remote W.A. arterial road mid-blocks (speed related and all crashes within 8km road segment partitions of the road network).
   c. P2P speed cameras
      i. Rural and remote W.A. arterial roads suitable for end to end coverage by a P2P potentially identified by road lengths that had a large number of candidate sites identified through the spot speed camera road segment analysis (speed related and all crashes along the defined road segment).

3. Within the top sites on the ranked list identify priority sites based on secondary road safety criteria including:
   a. School zones.
   b. Police Intelligence (potentially based on Police STIPCU data and other intelligence based on operational officer inputs etc.).
   c. Community Complaints (potentially based on records of complaints collected through an appropriate forum).
   d. Historic speeding data (i.e. 15% of vehicles speeding through regular speed surveys or data from the mobile camera program).
   e. Regional Priority based on Local Government feedback and political imperative to balance investment between Perth and regional W.A.

4. From steps 2 and 3 identify a set of candidate sites for camera installation.
From the list of candidate sites, eliminate those unsuitable for camera treatment based on operational criteria:

a. Other planned works are in place or likely to be possible such as engineering treatments to address the crash after consulting with LGA’s and other stakeholders or through targeted risk assessment or audit.

b. Planned future road works that may result in service outages or costly speed camera reinstatement.

c. Site assessed as inappropriate based on technical/operational requirements including accessibility of the site and road conditions assessing where the camera might be located including:
   i. Power accessibility.
   ii. Optimisation of laser systems.
   iii. Accessibility for repair and maintenance teams and OHS considerations.
   iv. Site controlled by MRWA to limit interference from other parties.
   v. Appropriate road geometry and proximity to access points.
   vi. Difficulty in enforcing a site either with mobile cameras or manual police enforcement due to OHS constraints.

6. Produce a final list of priority sites for treatment and treat in order of initial ranking.

7. Provide a list of high ranking sites unable to be treated with a camera to W.A. police for priority enforcement via the mobile speed camera program or manual police enforcement.

The process described is reflected in the following flow chart.
The workshop identified that being able to implement the recommended ATE fixed camera site selection process was dependent on the availability and analysis of key road safety data sources in W.A. The key data requirements identified were:
- **Main road IRIS crash database**: will be the primary informant database for the crash based site ranking analysis by region and road type. Issues with the identification of speed related crashes and the long term consistency of reporting minor crashes was noted as was linkage work underway to improve data quality.

- **Speed surveys**: network representative speed surveys are conducted by MRWA which are useful for monitoring general trends. Whether these are useful for assessment of speeding at individual priority sites was questioned. It was suggested there is a need to potentially undertake targeted speed measurement at candidate camera sites using tools such as the TIRTL as a form of secondary site suitability assessment for camera placement.

- **Mobile speed camera data**: could be used to identify sites with a high rate of speeding as a secondary road safety criteria assessment. This was considered possible given the high coverage of sites by the mobile speed camera program.

- **STIPCU analysis output**: to inform secondary validation or corroboration of candidate site suitability.

- **LGA feedback**: to collate information on planned road safety treatments at specific sites or future issues potentially affecting site suitability.

- **Police intelligence data**: to identify secondary criteria of speed or ‘hooning’ behavior at candidate sites.

- **Main Roads WA**: future and programed works.

### 3.5 RECOMMENDATIONS FOR TESTING AND EVALUATING THE SITE SELECTION PROCESS

The final point acknowledged by the workshop participants was a need to bench test and evaluate the process defined by the workshop for selecting locations for fixed camera under the ATE program. The following future activities were recommended:

1. The process for site selection defined by the workshop needs to be bench tested and refined if necessary to make sure the process is clearly understood and produces meaningful outcomes that can be translated into defined actions.

2. Ongoing Evaluation needs to be undertaken in two areas:
   a. A process evaluation to review the implementation of all steps of the site selection process once implemented subsequent to bench testing.
   b. Further outcome evaluation of the ATE program to make sure the resource allocation analysis and associated site selection methodology are delivering the road safety outcomes predicted for the ATE program in W.A.
4 BIBLIOGRAPHY


