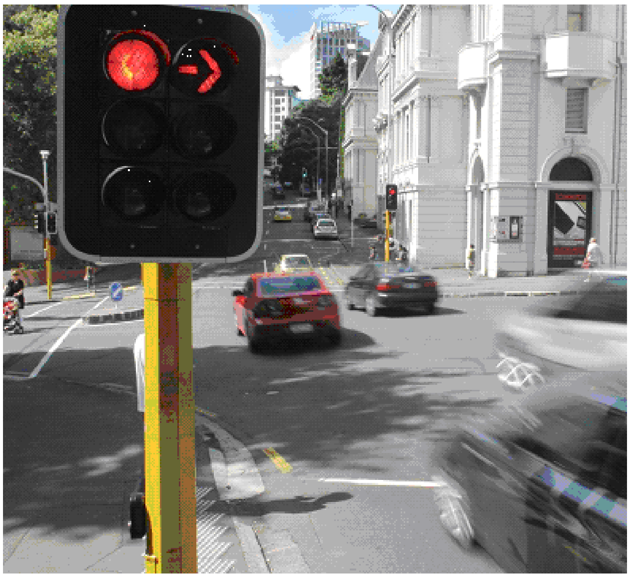
AUCKLAND RED LIGHT CAMERA PROJECT



FINAL EVALUATION REPORT

July 2011

Auckland Transport
An Auckland Council Organisation

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Auckland Transport governance

In November 2010, Auckland Transport was established as a Controlled Organisation (CCO) of Auckland Council**.** The new organisation combines the transport expertise and functions of eight local and regional councils and the Auckland Regional Transport Authority (ARTA).

Road safety is one of the key priorities for Auckland, and as such this red light camera project has continued to be a priority for Auckland Transport. The project commenced under the auspices of the legacy Auckland City Council. References within the document to Auckland City Council and/or the Auckland Regional Transport Authority (ARTA) are intended to refer to the work undertaken prior to amalgamation occurring in November 2010.

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1 Executive summary

Intersection crashes are the leading type of injury crash in Auckland and are often due to poor decision making, including drivers not stopping for a red light at a traffic signal.

As such, red-light running (RLR) at traffic signals is a long-standing crash risk behaviour among Auckland motorists and a variety of enforcement, education and engineering measures have been implemented over the past two decades to reduce the frequency of these crashes, including an experimental period of wet-film camera enforcement by New Zealand Police (NZ Police) in the 1990s. This previous attempt to reduce RLR crash risk through camera technology in Auckland encountered organisational, financial and evaluation challenges, and little evidence remains of its impact.

In 2006, RLR crash risk at traffic signals was again identified as a serious public concern, in particular for the Auckland central business district (CBD).

Subsequently, a collaborative red-light camera (RLC) project was initiated in 2006 by road safety stakeholders including Auckland City Council (ACC), NZ Police, Auckland Regional Transport Authority (ARTA), New Zealand Transport Agency (NZTA), Automobile Association (AA) and the Ministry of Transport (MoT) to assess the impact of RLC technology as a more cost effective means of reducing RLR crash risk.

The Auckland RLC project was also of national interest to the MoT in trialling the use of new technology to reduce intersection crashes in urban environments using a Safe System approach (Safer Journeys, 2010).

The first stage of the RLC project involved the formation of a project working group, a literature search, significant analysis of existing crash data, and a public perception survey.

The second stage of the project included the development of an evaluation methodology, site selection analysis to determine camera and comparison group locations, site safety audits, and the formation of a business case and procurement plan for purchasing three digital cameras and ten special purpose poles.

The third stage of the project included the testing and calibration of the RLCs by NZ Police and the establishment of infringement processes.

The fourth stage of the project included launching the RLCs at trial locations in the Auckland CBD in May 2008, along with an extensive public education campaign.

The fifth and final stage of the project included a quantitative analysis in 2011 of ‘before and after’ crash and traffic signal data between camera and comparison group locations, including tests for external statistical variations. A review of RLR infringement notices, operational processes, and public perception surveys was also completed.

Initial RLC project evaluation findings include:

- An average 43 per cent reduction in RLR behaviour at RLC sites
- An estimated 93 per cent reduction in the social cost of crashes at RLC sites
- An average 69 per cent decrease in RLR crashes at RLC sites
- An estimated 32% reduction in rear-end crashes at RLC locations

- A significant reduction in RLR infringements at one camera location
- An estimated RLC project economic benefit/cost ratio of 8.2: 1
- 75 per cent of Auckland public surveyed supported the use of RLCs

The initial evaluation results from the RLC project are very encouraging and support continuation of the project along with improvements to its operational implementation.

Annual quantitative analysis will continue to be completed on the Auckland RLC project sites to provide an overall sample of five year (2008 to 2013) post-implementation data.

2 Introduction

As New Zealand's largest urban city, Auckland continues to explore more efficient and cost-effective ways of preventing intersection crashes, including technology to deter red-light running (RLR).

Between 2001 and 2005, 689 RLR related crashes were recorded across Auckland City Council (ACC)[1], including 220 in the central business district (CBD). RLR crashes at thirteen intersections in the CBD resulted in an estimated social cost[2] of around $12.5 million, or nearly $1 million per intersection over five years.

In August 2007 a memorandum of understanding was signed between New Zealand Police (NZ Police) and ACC to undertake a RLC demonstration project within the Auckland CBD to reduce this significant social cost in a more effective way.

A project working group was established including ACC, NZ Police, the Ministry of Transport (MoT), NZ Transport Agency (NZTA), the Auckland Regional Transport Authority (ARTA) and NZ Automobile Association (AA).

The RLC project was implemented in five stages by the working group through problem definition, evaluation methodology, resource development, implementation of the RLCs, and post implementation analysis.

A RLC business case was prepared and funding approved by NZTA, with financial contributions from NZTA, ARTA and Auckland City to initiate and complete the Auckland RLC project.

This report summarises the Auckland RLC project to date including the extent of the Auckland RLR problem, the pre-implementation analysis of crash and traffic signal data, the evaluation methodology, site selection and audits, the analysis of post-implementation crash and traffic signal data, and a summary of results and economic benefits.

This report does not seek to comment on the choice of the RLC equipment itself or its limitations, as this is considered to be under the jurisdiction of NZ Police. Nevertheless, the equipment used was considered more than adequate for the task, with significant testing undertaken by NZ Police calibrations experts and Auckland City signals engineers.

The RLC equipment has been used effectively in both Australia and the United States of America and has the ability to download footage via a secure broadband connection and in some jurisdictions is also used for speed camera enforcement. For the purposes of the RLC project, it was decided that these options would not be pursued.

Further detail on the analysis of post-installation traffic signal data is available from the report written by OPUS International Consultants *Red Light Camera Demonstration Project Post-Installation Stage Evaluation* dated March 2011.

1 The document refers to the previous Auckland City Council which has since been incorporated within the newly formed Auckland Council and Auckland Transport. For the purpose of this report, Auckland City Council refers to the agency which undertook work prior to the 2010 amalgamation of the Auckland area local councils and the Auckland Regional Transport Authority (ARTA). Other former agencies are also mentioned.

2 Social cost of crashes includes loss of life, quality of life, hospital and rehabilitation costs, loss of income

3 Background

3.1 Project Framework

Given that the RLC project was a relatively new approach to improving safety at Auckland intersections it was important to develop a robust project that both Auckland and other New Zealand cities could gain insights from.

The RLC working group decided on a project framework, outlined below in Table 1, that included developing a better understanding of the nature of the RLR problem in Auckland, an insight into public perceptions of Auckland RLR, a literature search on the application of RLC technology in other international jurisdictions, an understanding of resources required to trial RLCs in Auckland, a RLC implementation plan, and an agreement on an evaluation methodology.

Table 1. Auckland RLC Project Framework

Problem Definition	Evaluation Methodology	Resource development	Implementation	Post-implementation
Literature search, crash and signal data analysis, public perception survey	Quantitative & qualitative evaluation scope set Business case Selection of camera and comparison sites Safety audits	Procurement of cameras Testing and calibration Infringement process developed Site development	Launch of RLCs Public education campaign Operational enforcement process	Quantitative analysis of 'pre & post' crash and traffic signal data Qualitative analysis of attitudes and infringements Operational refinement

It was clear from the outset of the RLC project that a collaborative use of resources and expertise would be critical to effectively trial the application of RLC technology in Auckland.

ACC would take a lead role in overall project management, traffic signal analysis, and procurement of RLCs, safety audits, site operations and funding. ARTA would provide a public perception survey of RLR and a business case for funding. NZTA would provide crash analysis and funding, subject to existing funding criteria. NZ Police would provide procurement advice, calibration testing of equipment, RLC site operation, and infringement processing. MoT would provide strategic advice from a national perspective. AA would provide strategic advice from a driver perspective.

The collaborative nature of the project was formalised through a high-level agreement between stakeholders in a signed Memorandum of Understanding and Terms of Reference outlining what each organisation would contribute and by when.

3.2 Literature review

Purpose of this Literature Review

This section is intended to identify the sometimes conflicting conclusions found in the RLC literature, the reasons for this, and to refer the reader to the latest available research and technical guidelines on RLC operations.

The primary document referenced for the Auckland RLC project is the *Guidelines for Setting-up and Operation of Signalised Intersections with Red Light Cameras AP-R247* (Austroads, 2004 – subsequently referred to as *Guidelines*).

Significant additional research has been undertaken since the *Guidelines* were published, including the *Safety Evaluation of Red Light Cameras* (FHWA, 2005) and statistical analysis of a much larger dataset. For example, the number of USA jurisdictions employing RLCs increased from 25 in 2000 to 501 in 2010 (Hu, McCartt, & Teoh, 2011).

Effects of red light running

RLR is one of the leading causes of crashes at signalised intersections. Retting et al. (1995) indicated that occupant injuries occurred in 45% of RLR crashes and accounted for 16% to 20% of all crashes at urban signalised intersections.

RLR can be particularly dangerous as many RLR crashes are right-angle collisions, which tend to be more severe than other types of crashes (FHWA, 2005). In the United States, RLR is a factor in an average 916 fatalities and 165,000 injuries annually (FHWA, 2009).

Research in Iowa, USA found that approximately 53 per cent of fatal and major-injury crashes were RLR crashes (Hallmark, 2007).

Crash involvement as a result of cyclist RLR is found to be low in the United Kingdom (1.8%) and Queensland (6%) as compared to motorist involvement (16-20% as noted above), and the rate of RLR by cyclists at a sample of 10 Melbourne intersections was 7%, markedly lower than the perceived rate reported by motorists in surveys (Johnson, et al., 2011).

Red light running countermeasures

In general, RLR can be addressed via engineering changes to specific intersections, educational campaigns targeted at road users throughout a jurisdiction, or enforcement measures. A combination of all three is preferable.

In 2009, the FHWA published guidance to help traffic professionals identify if RLR problems are due to intentional or unintentional (traffic operational or engineering and design) reasons and suggested engineering countermeasures as a first step, before considering automated red RLCs at an intersection. The FHWA guidance summarises 17 effective engineering measures ranging from signal timing and conspicuity to change of intersection control (FHWA, 2009).

When used for RLR enforcement purposes, RLC operations require careful site selection, equipment installation, and integration with the signal timing plan and intersection layout to ensure positive safety outcomes.

Meta-analysis of RLC effectiveness studies

A number of studies have been completed on the effectiveness of RLCs for reducing crashes attributed to RLR.

Two meta-analysis reviews of 'before and after' implementation of RLC studies have been published (Aeron-Thomas & Hess, 2005; Erke, 2009). In the 2005 review, 599 articles on RLC effectiveness were found and 30 studies identified, however only ten evaluations met the inclusion criteria.

Six studies were common to both reviews (including three based on Australian data). Both reviews highlighted the failure of most studies to control for regression to the mean (RTM)[3] and spill over[4] effects, which are likely to overestimate and underestimate the crash reduction effects of RLCs respectively (Erke, 2009, p. 898)[5].

Table 2 opposite presents the results of the two studies, sorted by type of crash and whether the studies controlled for these effects.

Negative changes indicate a reduction in crashes after implementation of RLCs. Changes in bold font are statistically significant at the 95% confidence level. Other values are not statistically significant (i.e. one cannot conclude that the change was not due to random variation) and therefore indicative only.

Erke concludes that "RLCs may reduce crashes under some conditions, but on the whole RLCs do not seem to be a successful safety measure" and suggests longer yellow phases should be investigated (p. 904).

Aeron-Thomas & Hess conclude that "the results show red-light cameras are effective in reducing total casualty crashes at signalised intersections" (p. 8).

Table 2. Meta-analysis reviews of effectiveness studies

	Aeron-Thomas & Hess 2005	Erke 2009
Number of studies	10	21
Most recent study	2002	2008
Studies controlled for	Results in % change	
	All crashes	
No spillover or RTM	-26%	**-16%**
Spillover	no data	**-16%**
RTM	**-8%**	**-19%**
Spillover and RTM	-7%	15%
	All injury crashes	
No spillover or RTM	-20%	-17%
Spillover	no data	**-25%**
RTM	**-13%**	**-21%**
Spillover and RTM	**-29%**	13%
	Rear-end crashes	
No spillover or RTM	-1%	**17%**
Spillover	no data	**13%**
RTM	-18%	-4%
Spillover and RTM	no data	**43%**
	Right-angle crashes	
No spillover or RTM	-26%	-14%
Spillover	no data	**-49%**
RTM	-24%	-18%
Spillover and RTM	no data	-10%

Individual studies of RLC effectiveness

In the *Guidelines* review of RLC trials in Victoria, Queensland and Christchurch, crash patterns at camera and non-camera sites "were not noticeably different", due to a variety of factors in the camera and traffic environment (Austroads, 2004, p. 110).

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[3] Regression to the mean (RTM) is the statistical tendency for locations chosen because of high crash histories to have lower crash frequencies in subsequent years even without treatment.

[4] Spill over effect is the expected effect of RLCs on intersections other than the ones actually treated because of jurisdiction-wide publicity and the general public's lack of knowledge of where RLCs are installed, or the effect upon adjacent intersections to those with RLCs.

[5] Erke cites the work of Shin and Washington, 2007; Hauer, 1997; and Elvik 1997

A study of seven US cities on the Red Light Running Source Page (FHWA) finds that "overall, angle crashes decreased by 25 per cent, while rear-end collisions increased by 15 per cent". In general, rear-end collisions tend to be less severe, so in terms of economic costs of crashes, the authors concluded that "the costs from the increase in rear-end crashes were more than offset…" and the economic savings per site per year were found to average US$38,845 (FHWA, 2005).

Another study on RLC effectiveness involved comparing crash trend data from intersections with cameras in two cities, Davenport and Council Bluffs, in the US state of Iowa (Hallmark, 2007). Control intersections in each city had similar characteristics but no cameras. For the duration of the Davenport study (eight quarters of study crash data compared with 12 quarters of pre-study data), there was a 20 per cent reduction in total crashes and a 40 per cent reduction in RLR-related crashes. Similarly, in Council Bluffs (where four quarters of study data were compared with 12 quarters of pre-study data), there was a 44 per cent reduction in total crashes and an average decrease of 90 per cent of RLR-related crashes.

An increase in rear-end crashes is usually (but not always) found. In addition to the reduction noted in the 2005 meta-analysis in Table 2, a 2010 study of 44 intersections in Calgary using data from the 5th to the 7th years after RLC implementation[6] found a 40% (non-significant) reduction in rear-end crashes (Malone, Hadayeghi, & White, 2010).

In contrast to the typical 'before and after' studies, a 2011 study compared the overall 2004-2008 RLR crash patterns of 14 large US cities with RLCs (population greater than 200,000) to 48 large cities without RLCs and found that "camera programs were associated with statistically significant citywide reductions of 24 per cent in the rate of fatal RLR crashes and 17 per cent in the rate of all fatal crashes at signalized intersections, when compared with rates that would have been expected without cameras" (Hu et al., 2011, p. 8). Study limitations included the exclusion of potentially correlated variables other than population density and land area, and the lack of data on the proportion of signalised intersections with RLCs in each city.

Public Attitude Studies on RLCs

A critical component in effective RLC projects is the public perception of the efficacy of RLCs. In 2011, a public attitude survey was conducted using random samples of landline and cellphone numbers with 3,111 drivers in 14 large US cities (population greater than 200,000) with long-standing RLC programs (McCartt & Eichelberger, June 2011).

Among drivers in the cities with RLC programs, two-thirds favour the use of cameras for RLR enforcement and recognize their safety benefits. The chief reasons for those drivers opposing cameras were the perceptions that cameras make mistakes and that the motivation for installing them is revenue, not safety.

Effectiveness summary

As a result of the aforementioned methodological difficulties, no consensus view can be determined from the literature on statistically significant reductions in 'RLR and/or intersection crashes' due to the implementation of RLCs. However, it may be concluded that:

[6] This study did not control for RTM but did control for spill over

- RLCs may reduce right-angle crashes but conversely may increase rear-end crashes, with the net effect being a reduction in the severity of crashes;
- RLCs are acknowledged by Austroads and the FHWA as one of many potentially cost effective tools to address RLR.

Implementation

The *Guidelines* note that deterrence to RLR "has been shown to increase by rotating a small number of cameras through a large number of sites, as it maintains a high level of perceived risk of detection" (p. 16).

The most important determinant of site choice is a "high ratio of right-angle crashes to rear-end crashes" (FHWA, 2005, p. 75).

Policies on warning signs and camera site selection should aim to maximise the casualty reduction impact, including nearby non-camera sites that may benefit from spill over effects (Aeron-Thomas & Hess, 2005).

RLC approval procedures should also include proper monitoring and evaluation requirements (ibid).

3.3 Red light running in Auckland

A clear understanding of the nature of Auckland RLR was critical to the projects potential success.

Intersection crashes have remained the leading type of injury crash in Auckland City throughout the last two decades. Contributing factors include the large number of urban intersections, the level of complexity involved in negotiating movements at intersections, vehicle speeds, and the increasing levels of vehicle flow through intersections as Auckland's population continues to grow.

Traditional road safety approaches to intersection crash prevention involve designing and building intersections to a prescribed level of safety through improved signage, automated signals, sight-lines, vehicle approach speeds, separation of road users, controlled use of turns, and levels of annual average daily traffic (AADT). The built design is also supported by mobile road policing enforcement of road safety laws at intersections, and regular public education campaigns.

Auckland City has 279 urban signalised intersections. In response, local NZ Road Policing teams traditionally deliver three mobile 'seven day' intersection enforcement campaigns in Auckland City each year (NZ Police, 2009) in combination with restraint and other general road safety enforcement activities. This enforcement activity is typically supported by council education campaigns.

Despite significant investment in traditional safety engineering, road policing and education, intersection injury crashes have increased in Auckland City by 47 per cent in the last decade. A significant number of these intersection crashes occur on high volume arterial roads with large numbers of signalised intersections, and many result from drivers not stopping for a red light.

Previous attempts to introduce Auckland RLCs using wet film were not continued due to a number of operational and financial challenges, and little record of their impact remains.

In 2006, RLR crash risk at traffic signals was again identified as a serious public concern in the New Zealand Transport Agency road safety briefing notes for 2005.

The briefing notes showed Auckland City had a similar proportion of RLR injury crashes at traffic signals as Waitakere City, Manukau City and Wellington City from 2001 to 2005 (see Table 3 below).

Traffic signal crashes at major cities in New Zealand 2001 - 2005								
	Red light running type crashes*			All crashes with traffic signal control			% of crashes associated with RLR	
Local Body	Injury	Non-injury	Grand Total	Injury	Non-injury	Grand Total	% all crashes	% injury crashes
Auckland CBD	166	233	399	335	1559	1894	21%	50%
Auckland City	387	617	1004	871	4308	5179	19%	44%
Waitakere City	88	121	209	200	782	982	21%	44%
Manukau City	189	267	456	431	1934	2365	19%	44%
Wellington City	109	8	117	251	656	907	13%	43%
North Shore City	94	122	216	256	910	1166	19%	37%
Dunedin City	69	6	75	298	429	727	10%	23%
Christchurch City	128	27	155	938	2145	3083	5%	14%
Tauranga District	6	1	7	47	200	247	3%	13%
Hamilton City	20	7	27	194	762	956	3%	10%
Hutt City	7		7	72	208	280	3%	10%

* Using method explained in Section 4.2 Site Selection of this report

Table 3. Traffic signal crashes at major cities in New Zealand 2001-2005

The highest proportion of RLR crashes in Auckland City occurred in the Auckland CBD where 50 per cent of all injury crashes were associated with RLR.

A further analysis of RLR crashes at thirteen of the intersections in the Auckland CBD produced an estimated social cost[7] of around $12.5 million, or nearly $1 million per intersection over five years.

7 Social cost of crashes includes loss of life, quality of life, hospital and rehabilitation costs, loss of income etc.

4 Evaluation methodology and results

4.1 Introduction to evaluation methodology

Before accepting new technology for widespread application, it is essential that a robust analysis is undertaken to determine if RLCs are effective in changing behaviour and whether or not safety benefits are being achieved.

Ideally, a five year sample of post-implementation crash data is required to determine any robust impact from RLC installation. The use of 'spill over' and comparison sites is also recommended to examine RLR changes at intersections without RLCs.

The working group explored traffic signal technology as an additional measurement to assist in determining the initial effectiveness of RLC equipment. They subsequently agreed that both a quantitative and qualitative evaluation process was required to determine if RLCs are an effective tool in improving safety.

The working group agreed on the following quantitative evaluation processes:

i. An analysis of pre-existing crash data to select primary RLC installation sites, a group of nearby secondary 'spill over' sites, and 'distant' comparison group sites. Refer Sections 4.2 and 4.3 of this report on **Site Selection**,

ii. An analysis of RLR rates using traffic signal loops at RLC and secondary and comparison sites across Auckland City. This process evaluates RLR rates three months prior to installation of RLC equipment and seven months after the installation of RLC equipment. Refer Section 4.4 and 4.5 of this report on **Evaluation of Traffic Signal Data**,

iii. An analysis of RLR crashes for five years prior to RLC installation and for 21 months after RLC installation at primary RLC sites and secondary and comparison sites. Though it would be preferable to consider five year post evaluation data, this exercise would be useful to determine initial outcomes. This crash analysis would also include rear-end crashes both prior and post installation. Refer Section 4.6, 4.7 and 4.8 of this report on **Evaluation of Crash Data**.

The working group also agreed on the following qualitative evaluation processes:

i. A survey of public support for the installation and continued use of red light cameras, both prior and post installation of the cameras. Refer Section 6 of this report **Public Awareness and Education,**

ii. An overview of infringement data was considered with the expectation being that infringements may reduce over time. Refer Section 5 of this report **Infringement Data,**

iii. The documentation of operational insights. Refer Section 8 of this report **Ownership and Operation of RLCs**.

4.2 Site selection crash analysis

NZTA undertook a RLR crash analysis to determine potential Auckland RLC sites. The data was retrieved using the MoT Crash Analysis System (CAS) which codes traffic crash reports completed by the NZ Police.

Sites initially selected were those that had the greatest crash risk according to CAS, and where the potential for the greatest safety benefits could be derived from the RLC project.

The crash data was retrieved using the New Zealand Accident Movement Classification (Land Transport NZ, 2004) outlined in Figure 1 below which classifies crashes according to an alphabetical combination of different movement types.

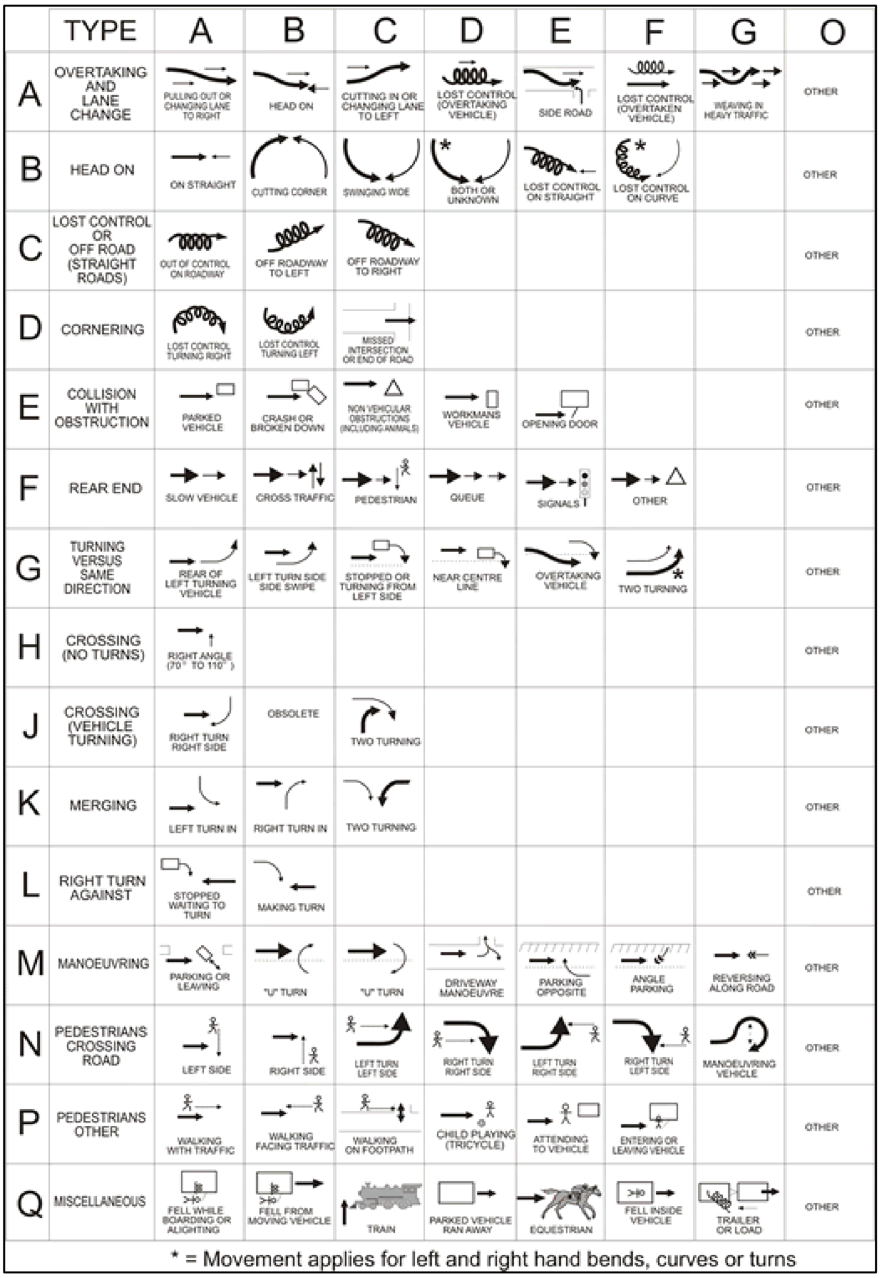


Figure 1. New Zealand CAS Accident Movement Classification

While CAS does include a specific driver factor for ‘not stopping at a red or yellow traffic signal’, this factor has not been coded against non-injury crashes prior to 2007.

Given the large amount of pedestrian activity in the CBD, the project team decided to identify any motor vehicle crashes involving pedestrians at traffic signals. Pedestrian crashes typically involve more serious injuries and it would be useful to determine to what degree RLR is involved, if any, with such crashes.

To include as many of the pedestrian or non-injury crashes that could be associated with this behaviour, three separate crash queries were retrieved from CAS as follows:

1. All injury crashes in the 5 year period 2001 to 2005 involving the driver factors 322 to 325

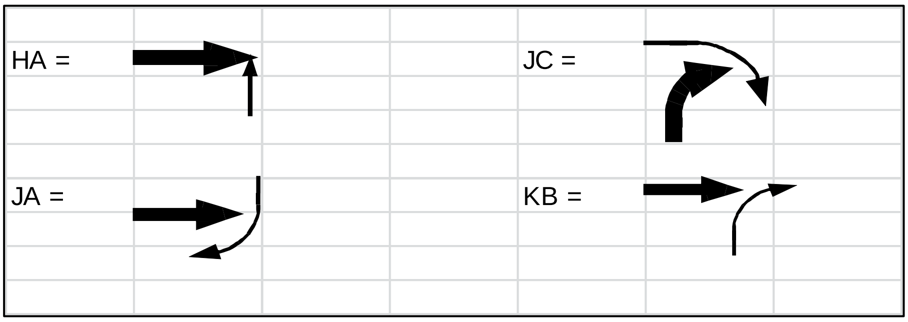
   322 = Did not stop at a steady red light

   323 = Did not stop at a steady red arrow

   324 = Did not stop at a steady amber light

   325 = Did not stop at a steady amber arrow

2. All crashes in the same 5 year period (both injury and non-injury) with traffic control = traffic signals, and movement codes HA, JA, JC and KB as outlined below.



3. All crashes in the same 5 year period (injury and non-injury) with traffic control = traffic signals, and road user type = pedestrian

These three crash lists were then combined using a standard CAS process which removes duplicate crashes.

The final crash list was then grouped into crash cluster sites using a 50 metre radius. A site summary table showing crashes per year, injuries, non-injuries, pedestrians, social cost etc. was exported to an Excel spreadsheet for sorting and analysis.

Additional location data was manually added to a shortlisted group of potential RLC sites.

Potential issues in using crash data for RLC site selection include the lack of information on ‘near miss’ situations involving RLR and the phenomenon of ‘regression to the mean’ (RTM) whereby sites initially identified with high crash records could be likely to experience fewer subsequent crashes.

4.3 Site safety audit procedure

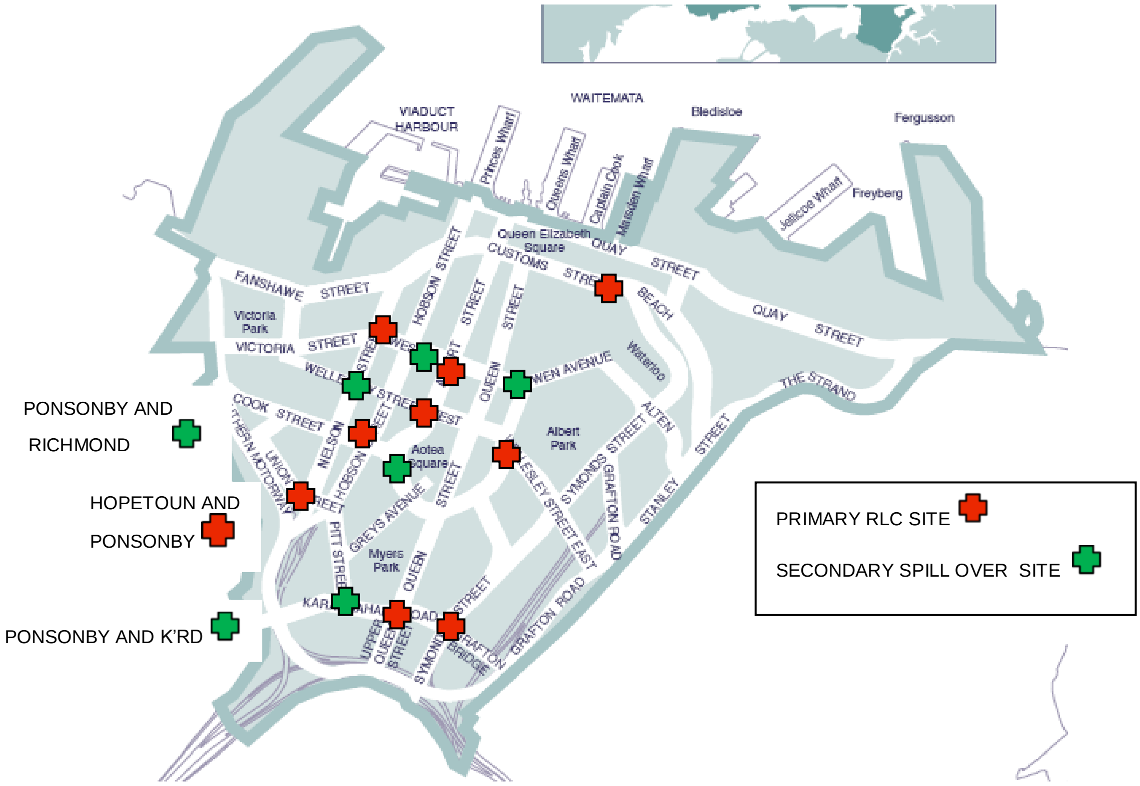
The *Guidelines* recommend a safety audit be undertaken at potential RLC intersection sites to ensure that any sites with existing engineering or signal deficiencies contributing to RLR were excluded.

Subsequently, a formal safety audit procedure was undertaken by Auckland City traffic signal engineers at each potential RLC site to ensure that the signal operations were best practice and that that the traffic signal inter-green time conformed to current standards. Refer to *Appendix C: Site audit record sheet for selecting RLC sites.*

NZ Police also participated in the site safety audit to consider whether the physical environment was suitable for the erection of the camera and its housing and flash units. This audit process did identify some sites where physical limitations imposed by heritage buildings and building canopies meant that the **f**lash unit or camera housing could not be installed.

As a result of the site safety audit process a number of sites were eliminated, leaving 10 primary RLC sites, 7 secondary sites located close to the RLC sites to monitor 'spill over' effects from RLCs, and 7 comparison sites located several kilometres away from the RLC sites to monitor any changes in RLR. See *Appendix A: Crash Data analysis detail associated with red light running* for a complete list of site locations.

Map 1 below shows the Auckland CBD location of the 10 primary RLC sites and 7 secondary 'spill over' sites.



Map 1. RLC primary and secondary site locations in Auckland CBD

4.4 Red light camera approach selection

Once the 10 primary RLC sites were selected, further analysis was undertaken to determine the best intersection approach for RLC installation by using crash data supplemented with overall traffic volume data (see Figure 2 below).

If the numbers of crashes on each approach of an individual intersection are equal, then the RLC approach site was chosen based on the highest traffic volume during peak traffic times.

The *Guidelines* suggest this selection procedure, as studies have found that crash risk increases on high traffic volume roads as a result of fewer gaps for right turning opposing traffic, and subsequently drivers take more risks. It can also highlight any high ratios of right-angle crashes to rear-end crashes.

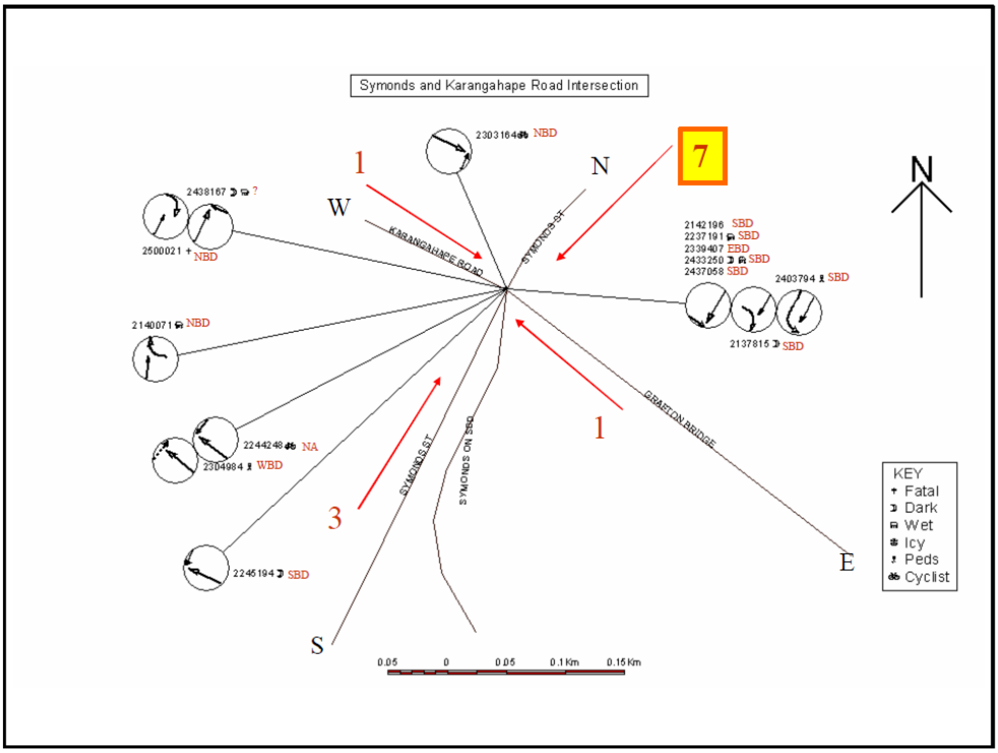


Figure 2: Example of crash and traffic volume analysis to determine RLC intersection approach

4.5 Evaluation methodology using traffic signal data

Signalised intersections in New Zealand operate on the Sydney Coordinated Adaptive Traffic System (SCATS), a software control computer system that operates in real-time, adjusting traffic signal timings to suit prevailing traffic conditions.

SCATS uses inductive loop detectors installed beneath the road surface slightly behind the intersection stop-line to detect the presence and passage of individual vehicles. This allows measures of vehicle flows and lane occupancy over time, which SCATS uses to determine signal settings in response to traffic demands.

SCATS loops can also be configured to count the passage of vehicles illegally passing a red signal, and separate from vehicles passing legally on a green signal. This count of vehicles illegally passing a red commences 1.0 second after the onset of the red signal, and requires the rear of the vehicle to clear the leading edge of the loop (the edge closest to the stop line). Any vehicles passing the loop prior to this are not counted[8].

For the purpose of this evaluation, RLR software together with inductive loops configured as above were installed at 20 Auckland intersections to measure the number of vehicles running illegally through the red signal phase. At intersections where RLCs have been installed the SCATS loops and RLC loops are completely separate from each other.

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8 Refer Opus report Section 4.6.1

The specific objectives of this traffic signal evaluation were to:

1. Review and analyse the level of RLR at the intersection approaches where RLC equipment was installed, both before and after installation.
2. Review and analyse the level of RLR at non-camera approaches of which received RLCs, both before and after installation.
3. Review and analyse the level of RLR at ‘spill over’ intersections neighbouring RLC intersection sites, before and after installation.
4. Review and analyse the level of RLR at comparison intersections as far as possible from the RLC intersections sites, before and after installation.

In total, 20 intersections were evaluated using SCATS based RLR software as outlined above: 6 primary, 7 secondary, and 7 comparison. The remaining 4 intersection sites did not have data available for the evaluation timeframe.

4.6 Results of evaluation utilising traffic signal data

RLR data results were collected from the SCATS system for the 20 intersection sites and compared with ‘before’ and ‘after’ periods.

The before period contained SCATS data for 59 days in two collection periods: 7 January to 10 February 2008, and 21 April to 14 May 2008. The after period contained SCATS data for 38 days in two collection periods: 15 May to 1 June 2008, and 3 to 23 November 2008.

The ‘before’ and ‘after’ data sets were also grouped according to intersection sites as follows:

Primary group	Approaches at the intersection where cameras were installed
Primary group	All approaches at a RLC intersection combined
Secondary group	All approaches combined at intersections adjacent to the RLC sites
Comparison group	All approaches combined outside the central business district

The results data in Table 4 below indicate that where RLCs are installed an average reduction in RLR rates of 43 per cent was achieved at all intersection approaches. At intersections where no RLCs were installed, an average reduction of 7 per cent was achieved which is not considered statistically significant.

It is important to note that while these results indicate that RLCs appear to influence RLR, some intersections are more sensitive to treatment with RLCs than others.

One approach adjacent to where a RLC was installed experienced significant reductions in hourly RLR during all periods of the day and days of the week, further supporting the proposal that RLCs can result in consistent positive changes in RLR behaviour.

An associated positive result from the individual intersection data was the tendency for the frequency of ‘RLR per 15 minutes’ to reduce at times of relatively high conflicting traffic flow on some of the intersection approaches where RLCs were installed.

	Before installation of RLC	After installation of RLC	

Group							
	Number of vehicles	Number of vehicles through red	Overall RLR rate per 100 vehicles	Number of vehicles	Number of vehicles through red	Overall RLR rate per 100 vehicles	% Change from Before to After
Primary Group (Camera Approaches Only)	1,021,508	27,514	2.69	801,352	15,945	1.99	**-26%**
Primary Group (All Approaches Combined)	4,562,502	146,149	3.20	3,226,904	58,897	1.83	**-43%**
Secondary Group (All Approaches Combined)	4,296,507	137,251	3.19	3,382,713	99,275	2.93	**-8%**
Comparison Group (All Approaches Combined)	6,158,926	231,596	3.76	3,542,505	123,898	3.50	**-7%**

Table 4. Overview of red light running rates for all intersection within each group

4.6.1 Statistical validity of RLR behaviour changes

The initial RLR behaviour results gathered from the SCATS system are outlined in more detail in the comprehensive 2011 report by Opus Internatioanl Consultants: *Red Light Camera Demonstration Project Post-Installation Stage Evaluation*.

The results have been tested for statistical significance in terms of spill over and ‘regression to the mean’ using t-tests and were peer reviewed by consultant statistician Dr M K Mara.

The SCATS RLR data did not screen for ‘roll forwards’ whereby a vehicle passes the front loop triggering the RLC but does not continue into the main area of the intersection. The number of vehicle ‘roll forwards’ incorrectly counted as genuine RLR is negligible.

The traffic signal data has proven to be a valuable method for analysing RLR as it is able to collect a significant amount of data over a short period including vehicle numbers, signal changes and discrete time periods.

4.7 Evaluation methodology for analysis of crash data

The working group agreed it would be valuable to evaluate initial ‘before and after’ crash data results even though the ideal five year post-implementation period had not lapsed.

This review of crash data was undertaken in November 2010 to determine any initial changes in RLR crash numbers, social cost of crashes and rear-end crashes at the RLC sites.

Prior to this, previous ‘site selection’ crash data was manually reviewed to ensure that factors associated with ‘failing to stop at a steady amber light or arrow’ and 'pedestrians running heedless of traffic' were removed as neither of these was considered to be a RLR crash. This resulted in a small reduction of the overall number of RLR crash numbers as compared to the initial 2006/2007 crash analysis at the beginning of the project.

RLR sites were then analysed and compared in the following three groupings:

10 Primary group sites	All approaches at a RLC intersection combined
7 Secondary 'spill over' group sites	All approaches combined at intersections adjacent to the RLC sites
7 Comparison 'distant' group sites	All approaches combined outside the central business district

It is important to note that only two actual cameras were in operation at any one time at the commencement of the project, with a further camera deployed at a later stage. These cameras were rotated between the 10 sites by NZ Police during the evaluation period as per the *Guidelines*.

It is not possible by external visual inspection of the camera housing to determine whether a camera is present at a site; however the flash is not triggered on site if a camera is not present in the housing.

The primary group crash data therefore reflects the sites where camera equipment was installed, regardless of whether a camera was operating at the time or not. The schedule for camera rotation and the impact of the camera operation itself have not been considered in the analysis contained in this report.

4.8 Results of evaluation of crash data

4.8.1 Red light running related crash changes

The results of the changes in RLR related crashes are outlined in Table 5 below for the 'primary group' and combined 'secondary group and comparison groups'.

The comparisons are between annual average RLR crash numbers in the 'before' period from 2001 to 2005, and in the 'after' period from April 2008 to December 2010. Percentage change in RLR crash rates from 2001/05 to 2008/10 is also indicated.

Group	RLR Annual Crash Rates Before and After RLC Installation		
	Number of average annual RLR crashes **Before RLCs: 2001 to 2005**	**Number of average annual RLR crashes** **After RLCs: 1 April 2008 to 31 December 2010**	**% Change from Before to After**
Primary Group (All approaches)	**23.8**	**7.3**	**-69.4%**
Secondary and Comparison Groups (All approaches)	**11.6**	**9.5**	**-18.5%**

Table 5. Comparison of RLR crash data before and after RLC treatment at intersections

The crash data evaluation indicates that a reduction in RLR crashes of 69.4 per cent has occurred at primary group sites where RLC equipment was installed. A decrease in RLR crashes of 18.5 per cent occurred at the secondary and comparison sites.

4.8.2 Statistical validity of crash changes

Using crash data to demonstrate the effectiveness of RLC treatment has 3 major challenges:

- A long reporting cycle necessary to allow any effects of treatment to be reliably reflected (several years),
- Crash data only records reported crashes so no information is gathered on near-misses which are likely to out-number minor injury crashes by around 10 to 1 (Opus, 2011),
- Selecting sites with the worst crash records over the recent past can result in a data set that is after treatment unrepresentative because of a natural regression to the mean.

Flow Transportation were therefore engaged by the working group to determine both the statistical significance of the positive reduction in red light crashes within the 'primary group' in Table 4 above, and to also examine the effects of 'regression to the mean' (RTM) on this outcome.

The 69 per cent reduction in annual RLR crash rates in the 'primary group' was tested firstly for statistical significance using the Paired Students t-Test. The t-Test indicated a clear and strong statistical significance that shows that the reduction in RLR crashes at 'primary group' sites was very much unlikely to be a statistical anomaly.

RTM is a statistical phenomenon that may occur when a small initial sample has been drawn, resulting in a data set that is, by chance, unexpectedly high and unrepresentative of the population. If the variable being measured is extreme on its first measurement, it will tend to be closer to the mean on its second. As such, the second and any subsequent measurement may falsely appear to be the consequence of an applied treatment. Two key factors that together may allow this to occur are that the initial data set must be small, and that the data within this sample must be unrepresentative of the population by chance.

Tests for the influence of RTM on the 69 per cent reduction in RLR crashes within the 'primary group' indicated that the initial sample was neither small, nor unrepresentative of the population, and that RTM was unlikely to be an evident factor in the reduction in RLR crashes within the 'primary group' of sites.

4.8.3 Social cost of crash changes

'Before and after' implementation changes in crash costs at RLC sites were determined using the nationally accepted NZTA 2008 Economic Evaluation Manual with a July 2009 update factor of 1.14.

The social costs of crashes[9] used for the analysis are listed below for the four main crash types;

Fatal	$3,819,000	Table A6.21(a)

[9] The social cost of a crash includes the estimated cost of loss of life, quality of life, hospital and rehabilitation costs, and loss of income, and is based on an estimated value of statistical life.

Serious	$399,000	Table A6.21(b)
Minor	$25,080	Table A6.21(c) [10]
Non-injury	$2,508	Table A6.21(d)

The social costs were analysed according to the number of crashes at the RLR sites and not the total number of casualties. Social costs were calculated for the total number of crashes at site groupings and for RLR related crashes as a proportion of the total social cost of crashes.

Results of the changes in RLR related social costs for the two site groupings are outlined in Table 6 below. It indicates that RLR crashes result in a higher proportion of social cost than other crashes at these sites. It also indicates that the proportion of RLR crash costs have dropped significantly since the implementation of RLCs at these sites.

Group	RLR Annual Social Cost			Proportion of All Annual Crash Costs Attributed to RLR		
	Before Installation of RLCs 2001 to 2005	After Installation of RLCs 1 April 2008 to 31 Dec 2010	% Change	Before Installation of RLCs 2001 to 2005	After Installation of RLCs 1 April 2008 to 31 Dec 2010	% Change
Primary Group	$ 1,565,722	$ 100,320	-93.6%	54.6%	5.1%	-90.7%
Secondary and Comparison Groups	$ 334,704	$ 105,792	-68.4%	10.2%	6.9%	-31.7%

Table 6. Comparison of annual social cost and proportion of social cost associated with RLR

A post-installation reduction of 90 per cent is estimated in the proportion of all crash costs associated with RLR at the primary group sites as compared to the secondary and comparison sites, where a reduction of 31 per cent was noted.

For the ten sites that received RLC equipment, the annual social cost reduction is estimated at nearly $1.4 million per year, an overall reduction of 93%.

It is important to note that crash cost data is skewed by the average social cost being applied over five years for 2001 to 2005 as opposed to 2.75 years for the post evaluation data from April 2008 to December 2010. Crash cost data would be more accurately defined over a five year period after RLC implementation. See *Appendix E: Red light running crash cost as a proportion of all crash costs.*

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[10] assumed average between 'rear-end, crossing' and 'rear-end, queuing' crashes

4.8.4 Rear-end crash changes

Given that the literature had indicated an increase in rear-end crashes in some RLC projects, the working group undertook a crash comparison exercise to determine if there was an increase in rear-end crashes at the Auckland intersections that received RLC equipment.

Average annual 'rear-end' crash data for the period 2001-2005 was compared with post implementation average annual crash data from April 2008 to December 2010. See Table 7 below.

The average annual crash rate at RLC sites before RLC installation was 20.4 crashes per year compared to a post installation crash rate of 13.8 per year. This 32% reduction in rear-end crashes at the primary group sites is considered statistically significant. See *Appendix B: Rear-end crash comparisons at RLR sites.*

Group	Annual Rear-end Crash Rate		
	Before Installation of RLCs 2001 to 2005	After Installation of RLCs 1 April 2008 to 31 December 2010	% Change
Primary Group	**20.4**	**13.8**	**-32.3%**
Secondary and Comparison Groups	**19.2**	**19.6**	**2%**

Table 7. Comparison of annual rear-end crash rates associated with RLR

4.9 Conclusion of evaluation results

The following conclusions are drawn from the quantitative evaluation of the crash data and traffic signal data from primary and secondary/comparison group sites:

- Ideally, a five year period of crash data is required to provide a good insight into the trends associated with RLC implementation. However, initial 33 month crash data does indicate a positive benefit from RLC implementation,
- RLR contributes to a significantly higher proportion of social cost and RLCs appear to have had a positive impact in reducing this cost at RLC sites,

- Traffic signal software has proved a useful additional evaluation tool and also indicates a reduction in RLR from RLC installation, with some sites more sensitive to RLCs than others,
- There is some initial evidence to suggest that RLC sites have contributed to a decrease in rear-end crashes.

Quantitative evaluation of the RLC primary, secondary and comparison sites will continue into the future including refinement of site selection and data collection.

5 Infringement data

No significant evaluation of infringement data has been undertaken. This is largely due to the two camera's being rotated across various sites making it difficult to identify an overall infringement trend.

Infringement data has been provided for the intersection of Symonds St and Karangahape Road. The 2008 results in Figure 3 below show a reduction from an average of 37 infringements per day during the 'before implementation' period to an average of eight infringements per day in the post-implementation period.

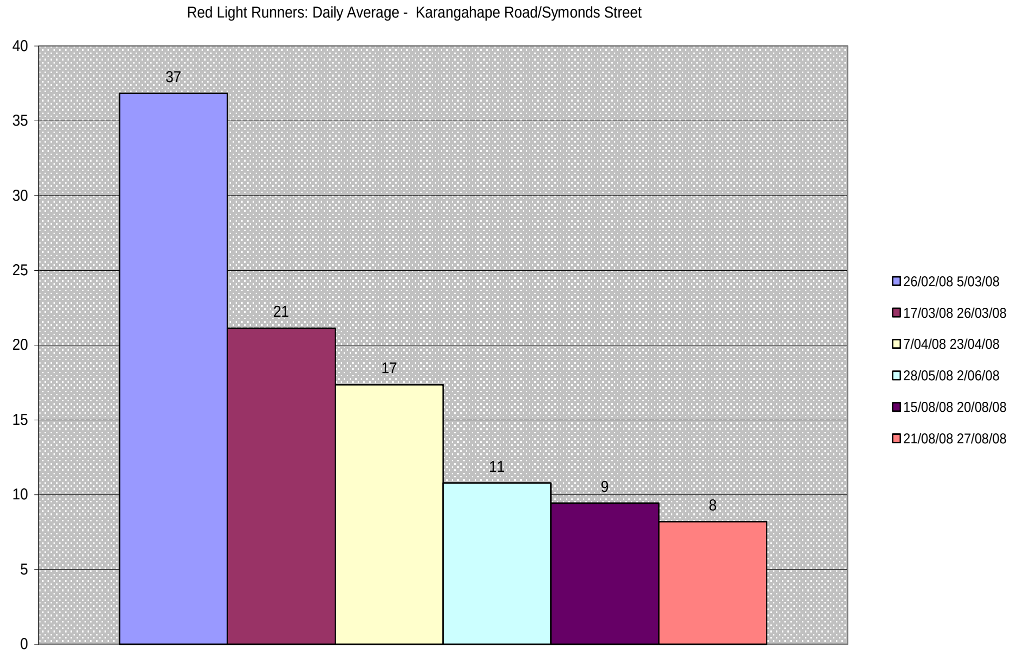

Figure 3. Daily average RLR infringements at intersection of Symonds St and Karangahape Road

Infringement data needs further analysis and refinement, including a more robust data collection process and appropriate controls. This could include cameras not being rotated as frequently and instead remaining at a particular site for an extended period of time to enable improved trend analysis. This would require more cameras to be made available.

NZ Police are carrying out their own evaluation of the Auckland RLC project as relates to infringement data and RLC operational aspects.

6 Public awareness and education

The working group believed that public acceptance of RLCs would be a critical aspect to successfully implementing RLCs for safety purposes.

A public perception survey was conducted by ARTA in 2006 before the implementation of RLCs. Survey results indicated that:

- 75 per cent of people surveyed wanted red light cameras in the CBD,
- 41 per cent of people surveyed said the CBD intersections were unsafe or sometimes unsafe for pedestrians,
- 12 per cent of people surveyed said they see red light running in the CBD at least on a weekly basis, with 34 per cent indicating that they observe red light running on a daily basis.

An '0800 Stop 4 Red' education campaign was launched by Auckland City Council in March 2007 asking people to report RLR behaviour through a dedicated phone line and the council website. More than 2,600 instances of RLR behaviour were reported throughout the four-week campaign. The council issued offending RLR motorists with warning letters urging them to respect the road rules and other road users in an attempt to dissuade RLR.

Manukau City and NZ Police undertook a similar campaign and received good support from the public for improving RLR enforcement. The campaign was in response to an increase in RLR crashes in Counties Manukau from 238 between 2003 and 2008, to 458 from 2004 to 2009.

The New Zealand Herald ran an on-line poll in 2008 asking the public what they thought of the crackdown on RLR. Out of 2,940 votes polled, 86 percent indicated that red light cameras were a good safety measure.14 per cent of those polled believed the installation of RLCs was a revenue collecting exercise.

In December 2009, a post implementation public perception survey was undertaken using similar questions to the 2007 ARTA survey. The results indicated that:

- 73 percent of people surveyed wanted RLCs in the CBD,
- 44 percent of people surveyed said the CBD intersections were unsafe or sometimes unsafe for pedestrians,
- 13 percent of people surveyed said they see red light running in the CBD at least on a weekly basis, with 48 per cent indicating that they observe RLR on a daily basis.
- 66 percent indicated that that they believe having RLCs installed would make intersections safer. (*This question was not included in the 2007 survey*).

In March 2007 the "Red light cameras are here" campaign was launched within Auckland City to notify the public that RLCs were operating.

Overall, the 'before and after' perception surveys and polls indicate that the Auckland public perceive RLR as a real road safety issue and they support the use of red light cameras to address RLR.

7 Benefits and costs of RLCs

Economic evaluation processes are valuable for determining the wider benefits from a project associated with crash reduction.

The benefits of the Auckland RLC project were evaluated using an economic evaluation procedure produced by the New Zealand Transport Agency[11]. In this procedure the overall cost of the programme, including installation and ongoing maintenance, is compared to projected crash savings. The evaluation outcome determines if a project will proceed or not and which options would provide the greatest benefit.

Installation costs

The RLCs and associated equipment are owned by Auckland Transport. The costs associated with installing RLCs at signalised intersections vary, depending on the type of camera used and the nature of the intersection in which the camera is being installed e.g. geometry, underground services, signal software changes and road layout changes.

Installation costs typically incorporate the following: ducting for cables, pole(s) for the camera, camera housing units, cables (loops), connections to the signal poles, and the installation of a flash unit(s).

The economic evaluation process has specifically excluded the costs associated with auditing of the sites and renewal work as this is considered part of the regular renewal programme for signal installation.

The overall installation costs utilised in determining the benefit cost evaluation of the RLC project are outlined in *Appendix D: Economic evaluation worksheet associated with red light camera project*.

Operating costs

The operating costs associated with the issuing of infringements and infringement collections are the responsibility of NZ Police. NZ Police operating costs included in the economic evaluation process only include the current costs of the existing operation of the cameras in Auckland CBD.

Auckland City maintains the RLCs and SCATS system and resources any adjustments that need to be made to the cameras on a daily basis. The overall operational costs utilised in determining the benefit cost evaluation of the RLC project are outlined in *Appendix D: Economic evaluation worksheet associated with red light camera project*.

Overall benefit/cost ratio

An initial economic evaluation was produced for the original RLC business case in 2007. Another revised economic evaluation was undertaken in 2010 as a result of some costs being more clearly identified after the implementation of the project.

The outcomes of the two economic evaluations are as follows:

- The initial 2007 RLC economic evaluation included an expected spend of $1,060,000 including $130,000 operational costs against projected savings in crashes of 20%, which produced an overall benefit/cost ratio of **3.5**
- The revised 2010 economic evaluation, utilising updated crash data and total costs of $904,800 including $130,000 operational costs against projected savings in crashes of 40%, which produced an overall benefit/cost ratio of **8.2** for the RLC project.

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11 Please refer NZTA Economic Evaluation Procedures for crash reduction – simplified procedures or Project evaluation manual

A projected crash reduction rate of 40% was applied to the economic evaluation process. This is a conservative figure in comparison to the estimated 69% reduction identified in the 'before and after' crash data evaluation in Section 4.8 **Crash data and evaluation**.

8 Ownership and operation of RLCs

The options for future ownership and operation of RLCs are not part of the scope of this report and it is expected that these options would be further evaluated by the MoT and other key government agencies.

However, it is the working groups' view that the collaborative approach to RLC enforcement including the development of appropriate equipment, sites, evaluation and operational processes has been a productive approach.

The working group also acknowledges that the MoT has identified the development of a national policy on the use of red light cameras as part of the Safer Journeys Action Plan 2011/12 (MoT, 2011).

A significant amount of valuable expertise has been developed across the stakeholders involved in the Auckland RLC project and will be made available to other jurisdictions looking to efficiently treat high-risk intersection RLR issues.

9 Recommendations

Through the Auckland RLC project, the working group has developed a number of insights into RLCs as a treatment intervention for preventing RLR crashes and enhancing safety at signalised urban intersections.

This report summarises the extent of the Auckland RLR problem, the 'before-implementation' analysis of crash and traffic signal data, the evaluation methodology, site selection and audits, the analysis of post-implementation crash and traffic signal data, and economic benefits.

Based on the experience of the Auckland RLC project, the working group suggests the following recommendations for future use of RLC technology:

1. Initial evaluation results suggest RLC technology can provide a very cost effective treatment of RLR crash risk at high-risk urban intersections,
2. Not all urban intersections respond well to RLCs as a RLR deterrent and site selection analysis is a critical task for identifying intersections with high RLR crash-risk that will benefit most from RLC technology,
3. Existing SCATS traffic signal technology can provide large amounts of valuable RLR data that can be used with crash data to select the most appropriate treatment sites for RLC interventions and examine their effect,
4. The evaluation of the Auckland RLC project should continue to examine the treatment effects at RLC sites on an annual basis taking into account the development of a national red light camera policy,
5. The use of fixed cameras at high-risk RLR sites should be explored as an alternative to rotating a few cameras around sites,
6. Infringement processes can be made more efficient and cost-effective through the use of dedicated data lines to automatically download offence data. This would also improve the consistency of the deterrent effect of RLCs,

7. Public awareness of the risk involved in RLR is critical to the acceptance and support of RLC technology as a legitimate treatment.
8. Auckland Transport will continue to operate the existing cameras in collaboration with New Zealand Police, and will be reviewed on completion of the development of national policy.

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Appendix A: Crash Data analysis detail associated with red light running

Red Light Running Crashes at Red Light Camara Sites - Evaluation Comparison June 20 (Excludes Pedestrians Crossing Heedless of Traffic)

Group	Site ID	Intersection Descriptions	Current RLC 2010	2001 - 2005 (5 year period)											1 April 2008 to 31 December 2010 (2.75 year period)											
				Number of RLR Crashes											Number of RLR Crashes											
				5 year RLR crashes total[1]	Fatal Crashes[1]	Serious Injury Crashes[1]	Minor Injury Crashes[1]	5 year injury crashes total[1]	5 year non-injury crashes[1]	Pedestrians involved	Cyclists involved	Crash Cost (per annum) 2001-2005[2]	Total crash cost 2001-2005[2]	Number of crashes (per annum) 2001-2005	Total 2.75 year RLR crashes[1]	Fatal Crashes[1]	Serious Injury Crashes[1]	Minor Injury Crashes[1]	Total 2.75 year injury crashes[1]	Total 2.75 year non-injury crashes[1]	Pedestrians involved	Cyclists involved	Crash Cost (per annum) April 2008-2010[2]	Total crash cost April 2008 - 2010[2]	Number of crashes (per annum) 01 April 2008 to 31 December 2010	% Change before and after RLC introduction
Primary Group (All Approach Combined)	2004	Symonds / Karangahape Rd	Yes	14	1	0	3	4	10	2	2	$783,864	$3,919,320	2.8	0	0	0	0	0	0	0	0	$0	$0	0.0	-100%
	2008	Queen / Karangahape Rd	Yes	10	0	1	3	4	6	2	1	$97,858	$489,288	2	6	0	0	1	1	5	1	0	$13,680	$37,620	2.2	9.1%
	2042	Nelson St / Victoria Str West	Yes	11	0	1	2	3	8	1	1	$93,845	$469,224	2.2	3	0	0	2	2	1	1	1	$19,152	$52,668	1.1	-50.4%
	2077	Wellesley E /Mayoral/Kitchner	Yes	12	0	0	2	2	10	1	0	$15,048	$75,240	2.4	0	0	0	0	0	0	0	0	$0	$0	0.0	-100%
	2105	Customs St East / Gore St	Yes	3	0	2	1	3	0	1	0	$164,616	$823,080	0.6	0	0	0	0	0	0	0	0	$0	$0	0.0	-100%
	2902	Union Street / Nelson Street	Yes	14	0	2	2	4	10	0	0	$174,648	$873,240	2.8	0	0	0	0	0	0	0	0	$0	$0	0.0	-100%
	2035	Ponsonby Rd / Hopetoun St	Yes	12	0	2	3	5	7	0	0	$178,159	$890,796	2.4	1	0	0	1	1	0	0	0	$9,120	$25,080	0.4	-84.8%
	2041	Albert St / Victoria St West	Yes	13	0	0	4	4	9	3	0	$24,578	$122,892	2.6	5	0	0	5	5	0	2	0	$45,600	$125,400	1.8	-30.1%
	2057	Wellesley W / Mayoral / Albert	Yes	16	0	0	3	3	13	2	0	$21,569	$107,844	3.2	3	0	0	1	1	2	0	0	$10,944	$30,096	1.1	-65.9%
	2097	Hobson Street / Cook Street	Yes	14	0	0	1	1	13	2	0	$11,537	$57,684	2.8	2	0	0	0	0	2	0	0	$1,824	$5,016	0.7	-74.0%
Sub Total Redlight camera sites only				**119**	**1**	**8**	**24**	**33**	**86**	**14**	**4**	**$1,565,722**	**$7,828,608**	**23.8**	**20**	**0**	**0**	**10**	**10**	**10**	**4**	**1**	**$100,320**	**$275,880**	**7.3**	**-69.4%**
Secondary Group (All Approaches Combined)	2003	Ponsonby / Karangahape Rd	No	3	0	0	1	1	2	1	0	$6,019	$30,096	0.6	5	0	0	1	1	4	0	1	$12,768	$35,112	1.8	203%
	2005	Karangahape Rd / Pitt Street	No	4	0	0	1	1	3	0	0	$6,521	$32,604	0.8	2	0	0	1	1	1	1	0	$10,032	$27,588	0.7	-9.1%
	2051	Ponsonby Rd / Richmond Rd	No	3	0	0	1	1	2	2	0	$6,019	$30,096	0.6	0	0	0	0	0	0	0	0	$0	$0	0.0	-100%
	2099	Wellesley St West / Nelson St	No	10	0	0	4	4	6	1	0	$23,074	$115,368	2	3	0	0	2	2	1	1	0	$19,152	$52,668	1.1	-45.5%
	2102	Cook / Vincent / Mayoral Dr	No	4	0	0	1	1	3	0	0	$6,521	$32,604	0.8	1	0	0	1	1	0	1	0	$9,120	$25,080	0.4	-54.5%
	2245	Victoria St West / Federal St	No	12	0	1	2	3	9	6	0	$94,346	$471,732	2.4	4	0	0	2	2	2	0	0	$20,064	$55,176	1.5	-39.4%
	2291	Victoria E / Lorne St / High St	No	1	0	0	0	0	1	0	0	$502	$2,508	0.2	3	0	0	2	2	1	0	0	$19,152	$52,668	1.1	445%
Comparison Group (All Approach Combined)	2050	Rosebank/Grt North	No	7	0	1	1	2	5	1	0	$87,324	$436,620	1.4	3	0	0	1	1	2	0	0	$10,944	$30,096	1.1	-22.1%
	2195	Pilkington/Queens	No	0	0	0	0	0	0	0	0	$0	$0	0	1	0	0	0	0	1	0	0	$912	$2,508	0.4	
	2217	Great South/Atkinson	No	3	0	0	1	1	2	0	0	$6,019	$30,096	0.6	0	0	0	0	0	0	0	0	$0	$0	0.0	-100%
	2220	Avenue/Atkinson	No	9	0	1	3	4	5	1	2	$97,356	$486,780	1.8	3	0	0	0	0	3	0	0	$2,736	$7,524	1.1	-39.4%
	2228	St Lukes/Cornwallis	No	1	0	0	0	0	1	1	0	$502	$2,508	0.2	0	0	0	0	0	0	0	0	$0	$0	0.0	-100%
	2230	St Lukes/Morningside	No	1	0	0	0	0	1	0	1	$502	$2,508	0.2	1	0	0	0	0	1	0	0	$912	$2,508	0.4	81.8%
	2289	St Lukes/Wagener	No	0	0	0	0	0	0	0	0	$0	$0	0	0	0	0	0	0	0	0	0	$0	$0	0.0	0%
Sub Total secondary and comparitve sites				**58**	**0**	**3**	**15**	**18**	**40**	**13**	**3**	**$334,704**	**$1,673,520**	**11.6**	**26**	**0**	**0**	**10**	**10**	**16**	**3**	**1**	**$105,792**	**$290,928**	**9.5**	**-18.5%**

Notes

- Pink denotes an increase in post 01 Apr 2008 to 31 Dec 2010 data evaluation numbers
- Crashes have been filtered using a 50m radius from the centre of intersections
- Crash cost data is scewed given average applied over five years as opposed to 2.75. Crash data would be more accurately defined over a five year period

[1] List includes the number of crashes at the site, not the total number of casualties.

[2] Crash cost for all sites have been determined using EEM tables from section A6.9 with July 2009 update factor of 1.14.

Source		Base Value	After update
Table A6.21(a)	Fatal	$3,350,000	$3,819,000
Table A6.21(b)	Serious	$350,000	$399,000
Table A6.21(c) - assumed averag	Minor	$22,000	$25,080
Table A6.21(d)	Non-inj	$2,200	$2,508

Appendix B: Rear end crash comparisons at RLR sites

Red Light Running Crashes at Red Light Camara Sites - Evaluation Comparison June 2011

				2001 - 2005 (5 year period)											1 April 2008 to 31 December 2010 (2.75 year period)										
				Number of Rear End Crashes											Number of Rear End Crashes										
Group	Site ID	Intersection Descriptions	Current RLC 2010	5 year rear end crashes total[1]	Fatal injuries[2]	Serious injuries[2]	Minor injuries[2]	5 year injury crashes total[1]	5 year non-injury crashes[1]	Pedestrians Involved	Cyclists involved	Crash Cost (per annum) 2001-2005[3]	Total Crash cost	Number of crashes (per annum) 2001-2005	Total 2.75 year rear end crashes[1]	Fatal injuries[2]	Serious injuries[2]	Minor injuries[2]	Total 2.75 year injury crashes[1]	Total 2.75 year non-injury crashes[1]	Pedestrians Involved	Cyclists involved	Crash Cost (per annum) April 2008-2010[3]	Number of crashes (per annum) April 2008-2010	% Change before and after RLC introduction
Primary Group (All Approach Combined)	2004	Symonds / Karangahape Rd	Yes	14	0	0	2	2	12	0	1	$70,405	$352,027	2.8	10	0	0	0	0	10	0	0	$41,030	3.6	30%
	2008	Queen / Karangahape Rd	Yes	19	0	0	0	0	19	0	0	$63,731	$318,657	3.8	6	0	0	1	1	5	0	0	$13,677	2.2	-43%
	2042	Nelson St / Victoria Str West	Yes	3	0	0	0	0	3	0	0	$9,216	$46,080	0.6	3	0	0	0	0	3	1	1	$103,331	1.1	82%
	2077	Wellesley E /Mayoral/Kitchner	Yes	6	0	0	0	0	6	0	0	$19,436	$97,181	1.2	2	0	0	0	0	2	0	0	$0	0.7	-39%
	2105	Customs St East / Gore St	Yes	3	0	0	0	0	3	0	0	$10,075	$50,373	0.6	0	0	0	0	0	0	0	0	$0	0.0	-100%
	2902	Union Street / Nelson Street	Yes	15	0	0	1	1	14	0	0	$77,079	$385,395	3	2	0	0	1	1	1	0	0	$55,462	0.7	-76%
	2035	Ponsonby Rd / Hopetoun St	Yes	7	0	0	1	1	6	0	0	$34,688	$173,441	1.4	2	0	0	0	0	2	0	0	$0	0.7	-48%
	2041	Albert St / Victoria St West	Yes	14	0	0	0	0	14	0	0	$47,873	$239,365	2.8	5	0	0	1	1	4	2	0	$123,295	1.8	-35%
	2057	Wellesley W / Mayoral / Albert	Yes	10	0	0	0	0	10	0	0	$31,353	$156,765	2	5	0	0	1	1	4	0	0	$41,408	1.8	-9%
	2097	Hobson Street / Cook Street	Yes	11	0	0	1	1	10	0	1	$48,895	$244,474	2.2	3	0	0	2	1	2	0	0	$34,569	1.1	-50%
Sub total RLC camera sites only				**102**	**0**	**0**	**5**	**5**	**97**	**0**	**2**	**$412,752**	**$2,063,758**	**20.4**	**38**	**0**	**0**	**6**	**5**	**33**	**3**	**1**	**$412,771**	**13.8**	**-32%**
Secondary Group (All Approaches Combined)	2003	Ponsonby / Karangahape Rd	No	21	0	0	1	1	20	0	0	$81,368	$406,838	4.2	8	0	0	1	1	7	0	0	$47,869	2.9	-31%
	2005	Karangahape Rd / Pitt Street	No	15	0	1	0	1	14	0	1	$155,856	$779,280	3	11	0	0	3	3	8	0	1	$69,139	4.0	33%
	2051	Ponsonby Rd / Richmond Rd	No	6	0	0	1	1	5	0	0	$31,972	$159,862	1.2	3	0	0	0	0	3	0	0	$13,677	1.1	-9%
	2099	Wellesley St West / Nelson St	No	3	0	0	0	0	3	0	0	$9,904	$49,519	0.6	3	0	0	1	1	2	0	0	$0	1.1	82%
	2102	Cook / Vincent / Mayoral Dr	No	7	0	0	1	1	6	0	0	$36,346	$181,729	1.4	6	0	0	2	1	5	0	0	$41,408	2.2	56%
	2245	Victoria St West / Federal St	No	4	0	0	1	1	3	0	0	$24,282	$121,410	0.8	0	0	0	0	0	0	0	0	$0	0.0	-100%
	2291	Victoria E / Lorne St / High St	No	1	0	0	1	1	0	0	0	$0	$0	0.2	3	0	0	0	0	3	0	0	$0	1.1	445%
Comparison Group (All Approach Combined)	2050	Rosebank/Grt North	No	15	0	0	0	0	15	0	0	$48,947	$244,736	3	5	0	0	1	1	4	0	0	$117,385	1.8	-39%
	2195	Pilkington/Queens	No	4	0	0	0	0	4	0	0	$13,664	$68,318	0.8	2	0	0	0	0	2	0	0	$0	0.7	-9%
	2217	Great South/Atkinson	No	4	0	0	0	0	4	0	0	$12,288	$61,440	0.8	1	0	0	0	0	1	0	0	$0	0.4	-55%
	2220	Avenue/Atkinson	No	5	0	0	0	0	5	0	0	$16,997	$84,987	1	2	0	0	0	0	2	0	0	$0	0.7	-27%
	2228	St Lukes/Cornwallis	No	0	0	0	0	0	0	0	0	$0	$0	0	1	0	0	0	0	1	0	0	$0	0.4	
	2230	St Lukes/Morningside	No	9	0	0	3	3	6	0	0	$67,482	$337,411	1.8	8	0	0	0	0	8	0	0	$13,677	2.9	62%
	2289	St Lukes/Wagener	No	2	0	0	1	1	1	0	0	$19,610	$98,051	0.4	1	0	0	0	0	1	0	0	$0	0.4	-9%
Sub total comparison sites only				**96**	**0**	**1**	**9**	**10**	**86**	**0**	**1**	**$518,716**	**$2,593,581**	**19.2**	**54**	**0**	**0**	**8**	**7**	**47**	**0**	**1**	**$303,153**	**19.6**	**2%**
Totals				**198**	**0**	**1**	**14**	**15**	**183**	**0**	**3**	**$931,468**	**$4,657,339**	**39.6**	**92**	**0**	**0**	**14**	**12**	**80**	**3**	**2**	**$715,924**	**33.5**	**26%**

Notes

- Pink denotes an increase in post 01 Apr 2008 to 31 Dec 2010 data evaluation numbers
- Crashes were filtered by Traffic Signal control, and for all rear end crashes (F category)

[1] List includes the number of crashes at the site.

[2] List includes the number of casualties resulting from crashes at each site. This number may be higher than the number of crashes

[3] Crash cost for sites with 1 crash only is not available from CAS. In these instances crash costs have been determined using EEM tables from section A6.9 with July 2009 update factor of 1.14.

Fatal	$3,819,000	Table A6.21(a)
Serious	$399,000	Table A6.21(b)
Minor	$25,080	Table A6.21(c) - assumed average between 'rear end, crossing' and 'rear end, queuing' crashes
Non-inj	$2,508	Table A6.21(d)

Appendix C: Site audit record sheet for selecting RLC sites

Intersection Audit Form for selection of red light camera locations

Intersection Id:	
Location of Site:	
Route Id:	

Traffic Signal Engineer:	
TMU Reference Number:	

Date On Site	Time Start	Time End	Weather Conditions

Type of Visit	Initial Source	Job Status	Job Received

Request for Service Details:

Category	OK	Site Notes	Photo Number	Issues to be addressed	Suggested Action	Who Authorises Action	Issue Severity	Initiation Resolve Date	Issue Type	Issue Status
1. Operation - SCATS										
1.1 CIS vs SCATS data - Check that CIS data matches SCATS data. Etc...	☐ ☐									
1.2 Split Plans - Are split plans reasonable in terms of split percentages and features. Etc...	☐									
1.3 Variation Routines - What do the variation routines do. Remove any redundant routines. Etc...	☐									
1.4 Cycle Time - Check cycle times are reasonable for traffic demand. Etc...	☐									
1.5 Link Plans - Are link plans reasonable for traffic demand. Are link plans set to TMU standard? Etc...	☐									
1.6 Detector Operation - Check detector layout is correct. Check VO/VK etc...	☐									
1.7 Schedular/Action Routines - Are any action routines used on the site? What do they do. Remove any redundant schedules or action routines. Etc...	☐									
1.8 SCATS Graphic - Check that the SCATS graphic is up to date. Etc...	☐									
1.9 SCATS Notes - Check SCATS notes. Remove any redundant notes. Add any relevant notes.	☐									
1.10 Other										
2. Software Operation										
2.1 Phase Sequence - Is the phase sequence correct. Check split data/site variation data to ensure repeat phase sequence options is formatted correctly. Etc...	☐									
2.2 Movement Overlaps - Check delay/late start times are set to TMU standard. Check phase termination for overlapping signal groups are to TMU standard. Etc...	☐									
2.3 Flags/XFS - What do the flags/XSF bits do? Confirm operation on site. Enter information in SCATS site data. Etc..	☐									
2.4 Pedestrian Clearance - Measure pedestrian crossing distance. Calculate and check walk and clearance times. Etc...	☐									
2.5 Pedestrian Protection - What sort of pedestrian protection is provided? Check pedestrian protection operation. Etc...	☐									
2.6 Filter/Non Filter - Does the site filter? When does the site filter? Check that the site filter according to TMU standard. Etc...	☐									
2.7 Other										
3. Flow Observations From SCATS Data										
3.1 AM Peak - Does traffic clear the intersection in 1,2 or more than 2 cycles (for all approaches). What are the main movements during the time interval. Is the intersection operation meeting traffic demand. Etc...	☐									
3.2 Mid Day - Does traffic clear the intersection in 1,2 or more than 2 cycles (for all approaches). What are the main movements during the time interval. Is the intersection operation meeting traffic demand. Etc...	☐									
3.3 PM Peak - Does traffic clear the intersection in 1,2 or more than 2 cycles (for all approaches). What are the main movements during the time interval. Is the intersection operation meeting traffic demand. Etc...	☐									
3.4 Off Peak - Does traffic clear the intersection in 1,2 or more than 2 cycles (for all approaches). What are the main movements during the time interval. Is the intersection operation meeting traffic demand. Etc...	☐									
3.5 Lane Usage - Are lanes fully utilised. Could improvements be made if lanes reconfigured. Etc...	☐									
3.6 Network Interaction - How does the intersection operate with adjacent intersections and trip generators. Etc...	☐									
3.7 Intersection Constraints - factors limiting the intersections capacity. Etc..	☐									
3.8 Other										
4. Asset Inspection	☐									
4.1 Poles	☐									
4.2 Lanterns	☐									
4.3 Lamps	☐									
4.4 Pedestrian Buttons	☐									
4.5 Controller Cabinet	☐									
4.6 Road Marking	☐ ☐									
4.7 RRPMs' Installed on Multi Lane Approaches	☐									
4.8 Signage	☐									
4.9 Clearways	☐ ☐									
4.10 Lane Markings	☐									
4.11 Roadmarking	☐									
4.12 Signage Issues	☐									
4.13 Pedestrian Issues	☐ ☐									
4.14 Cyclist Issues	☐									
4.15 Geometry Issue	☐									
4.16 Bus Stops	☐ ☐									
4.17 Access Issues	☐									
4.18 Road Side Vegetation	☐									
4.19 Other										

Appendix D: Economic evaluation worksheet associated with red light camera project

AUCKLAND TRANSPORT

SIMPLIFIED PROCEDURES BENEFIT COST ANALYSIS RED LIGHT CAMERA

2001-2005 ACC CRS TEN RED LIGHT CAMERA SITES - REVISED ACTUAL COSTS

ACCIDENT COSTS

Movement Category	Crossing / Turning from BP
Traffic Growth	3.0%

Speed Limit	50 km/hr
Veh Entering Per Day	-

DO MINIMUM:		Fatal	Serious	Minor	All Injury	Non-Injury	Total	Reference
Nº of Years of TARS		5	5	5	5	5		
Nº of Reported Accidents		1	8	24	33	86		
Propn Fatal/Serious, Non-Inj/Inj		0.03	0.97					Tables A6.19(a)
Nº Acc. Adjusted by Severity		0.27	8.73	24	33	86		
Reported Accidents / Year		0.05	1.75	4.80	6.60	17.20		
Adjustment factor		0.93	0.93	0.93	0.93	0.93		Table A6.1(a)
Adjusted Accidents / Year		0.05	1.62	4.46	6.14	16.00		
Under Reporting Factors		1.0	1.5	2.8		7.0		Tables A6.20(a) and (b)
Total estimated Acc. / Year		0.05	2.44	12.50		111.97		
Cost per Accident		$3,150,000	$345,000	$21,000		$2,200		Table A6.21
Total Accident Cost/ Year		$158,193	$840,306	$262,483		$246,338	$1,507,321	

OPTION:								
Percentage Acc Reduction		**40%**	40%	40%		40%		
Predicted Accidents / Year		0.03	1.46	7.50		67.18		step19
Cost per Accident		$3,150,000	$345,000	$21,000		$2,200		Table A6.21
Total Acc Cost per Year		$94,916	$504,184	$157,490		$147,803	$904,392	
Total Cost Adj for Speed				(mean speed change =)			$904,392	Step 23

Accident Cost : Do Minimum	$1,507,321
Accident Cost : Option	$904,392
Accident Saving (First Year)	$602,928

Discount Factor	10.74

Design life accident cost savings:		6,475,450
Design life accident cost savings **x 2009 update factor (1.14):**	**1.14**	**7,382,013**

	Discount Factors for Traffic Growth Rate and Speed for years 2 to 30 (adjusted according to Table 1)								
Speed Limit	0.0%	0.5%	1.0%	1.5%	2.0%	2.5%	3.0%	3.5%	4.0%
50 and 60 km / h	7.35	7.92	8.48	9.05	9.61	10.18	10.74	11.3	11.87
>=70km / h	9.61	10.18	10.74	11.3	11.87	12.43	13	13.56	14.13

SUMMARY SHEET

2001-2005 ACC CRS TEN RED LIGHT CAMERA SITES - REVISED ACTUAL COSTS

COSTS OF THE OPTION

Cost Of Works As Per Attached Estimate Sheets		**620,000**
Costs Updated to 2009 costs, constructed in 2008 (X 1.04)	1.04	644,800
Estimated PV Of Maintenance Costs In Year 1		130,000
Estimated PV Of Maintenance Costs In Years 2 To 30 Following Completion Of Works (=$ X 10.74)		**130,000**
TOTAL OPTION COSTS		**904,800**

BENEFIT COST ANALYSIS

Benefit Cost Ratio ((Design Life Accident Cost Savings inc. update factor) / (Total Option Costs)	**8.2**
First Year Rate Of Return	**111%**

Notes

Conservative crash savings of 40% applied while evaluation of red light running rates indicated 43% reduction and crash data analysis a 69% reduction over 2.75 years

Actual costs have been revised and vary from the original pilot project estimate of NZ$800.000. Detailed evaluation on project costs has been excluded

Includes the updated 2010 factor for crash costs

Does not include 2010 construction cost factor because sites were constructed in 2008

Please note sensitivity testing v savings claimed. 40% is recommended. Original site was based on 20% saving

Savings Claimed	BCR	FYRR (%)
20%	4.1	55
40%	8.2	111
60%	12.2	166

Implementation costs associated with red light camera pilot in Auckland (2007-2008)

Site	Installation costs at the intersection	Flash unit	Camera housing and pole	Software average	Contract supervision and project management	Site audits average	Cameras x3	Incidental	Total
Ponsonby Road/Hopetoun Street/Crummer Road	$21,290.51	$5,577.00	$8,459.00	$3,500.00		$4,000.00			
Wellesley Street/Kitchener St/Mayoral Drive	$16,944.25	$5,577.00	$8,459.00	$3,500.00		$4,000.00			
Customs Street/Gore Street	$22,292.78	$5,577.00	$8,459.00	$3,500.00		$4,000.00			
Queen Street/Upper Queen Street/Karangahape Road	$21,432.21	$5,577.00	$8,459.00	$3,500.00		$4,000.00			
Victoria Street/Albert Street	$19,219.93	$5,577.00	$8,459.00	$3,500.00		$4,000.00			
Hobson Street/Cook Street	$21,843.67	$5,577.00	$8,459.00	$3,500.00		$4,000.00			
Nelson Street/Union Street/NW & SW Mway ramps	$17,985.14	$5,577.00	$8,459.00	$3,500.00		$4,000.00			
Victoria Street/Nelson Street	$21,306.09	$5,577.00	$8,459.00	$3,500.00		$4,000.00			
Wellesley Street/Albert Street/Mayoral Drive	$13,567.00	$5,577.00	$8,459.00	$3,500.00		$4,000.00			
Symonds Street/Karangahape Road/Grafton Bridge	$17,452.13	$5,577.00	$8,459.00	$3,500.00		$4,000.00			
TOTAL	**$193,333.71**	**$55,770.00**	**$84,590.00**	**$35,000.00**	**$44,255.16**	**$40,000.00**	**$96,000.00**	**$71,051.13**	**$620,000.00**

Note* The costs exclude any upgrades or renewals associated with the traffic signals. This work is undertaken as part of the renewal programme for traffic signals.
The costs outlined above excludes any costs associated with evaluation of the pilot, estimated to be $200,000

Appendix E: Red light running crash cost as a proportion of all crash costs

Red Light Running Crashes at Red Light Camara Sites - Evaluation Comparison June 2011 (Excludes pedestrians crossing heedless of traffic)

				Red Light Running Crashes																						All Crashes within 50m						Proportion Red Light Running Crashes (%)			
				2001 - 2005 (5 year period)											1 April 2008 to 31 December 2010 (2.75 year period)											2001 - 2005 (5 year period)			1 April 2008 to 31 December 2010 (2.75 year period)			2001 - 2005 (5 year period)		1 April 2008 to 31 December 2010 (2.75 year period)	
Group	Site ID	Intersection Descriptions	Current RLC 2010	5 year RLR crashes total[1]	Fatal Crashes[1]	Serious Injury Crashes[1]	Minor Injury Crashes[1]	5 year injury crashes total[1]	5 year non-injury crashes[1]	Pedestrians involved	Cyclists involed	Crash Cost (per annum) 2001-2005[2]	Total crash cost 2001-2005[2]	Number of crashes (per annum) 2001-2005	Total 2.75 year RLR crashes[1]	Fatal Crashes[1]	Serious Injury Crashes[1]	Minor Injury Crashes[1]	Total 2.75 year injury crashes[1]	Total 2.75 year non-injury crashes[1]	Pedestrians involved	Cyclists involved	Crash Cost (per annum) April 2008-2010[2]	Total crash cost April 2008 - 2009[2]	Number of crashes (per annum) April 2008-2010	Total 5 year RLR crashes[1]	Crash Cost (per annum) 2001-2005[2]	Number of crashes (per annum) 2001-2005	Total 2.75 year RLR crashes[1]	Crash Cost (per annum) April 2008-2010[2]	Number of crashes (per annum) April 2008-2010	Proportion Total RLR crashes by Total Number of All Crashes	Proportion Total RLR Social Crash Cost by Total Social Crash Cost of All Crashes (per	Proportion Total RLR crashes by Total Number of All Crashes	(Per Annum) Proportion Total RLR Social Crash Cost by Total Social Crash Cost of All Crashes (Post implement
Primary Group (All Approach Combined)	2004	Symonds / Karangahape Rd	Yes	14	1	0	3	4	10	2	2	$783,864	$3,919,320	2.8	0	0	0	0	0	0	0	0	$0	$0	0.0	79	$1,024,723	15.8	22	$36,480	8.0	17.7%	76.5%	0%	0%
	2008	Queen / Karangahape Rd	Yes	10	0	1	3	4	6	2	1	$97,858	$489,288	2	6	0	0	1	1	5	0	0	$13,680	$37,620	2.2	112	$282,492	22.4	37	$124,032	13.5	8.9%	34.6%	16.2%	11.0%
	2042	Nelson St / Victoria Str West	Yes	11	0	1	2	3	8	1	1	$93,845	$469,224	2.2	3	0	0	2	2	1	1	1	$19,152	$52,668	1.1	35	$189,696	7.0	12	$27,360	4.4	31.4%	49.5%	25.0%	70.0%
	2077	Wellesley E /Mayoral/Kitchner	Yes	12	0	0	2	2	10	1	0	$15,048	$75,240	2.4	0	0	0	0	0	0	0	0	$0	$0	0.0	34	$44,141	6.8	8	$1,539,290	2.9	35.3%	34.1%	0%	0%
	2105	Customs St East / Gore St	Yes	3	0	2	1	3	0	1	0	$164,616	$823,080	0.6	0	0	0	0	0	0	0	0	$0	$0	0.0	24	$347,290	4.8	18	$32,832	6.5	12.5%	47.4%	0%	0%
	2902	Union Street / Nelson Street	Yes	14	0	2	2	4	10	0	0	$174,648	$873,240	2.8	0	0	0	0	0	0	0	0	$0	$0	0.0	71	$230,326	14.2	10	$17,328	3.6	19.7%	75.8%	0%	0%
	2035	Ponsonby Rd / Hopetoun St	Yes	12	0	2	3	5	7	0	0	$178,159	$890,796	2.4	1	0	0	1	1	0	0	0	$9,120	$25,080	0.4	30	$200,731	6.0	11	$34,656	4.0	40.0%	88.8%	9.1%	26.3%
	2041	Albert St / Victoria St West	Yes	13	0	0	4	4	9	3	0	$24,578	$122,892	2.6	5	0	0	5	5	0	2	0	$45,600	$125,400	1.8	64	$170,088	12.8	17	$81,168	6.2	20.3%	14.5%	29.4%	56.2%
	2057	Wellesley W / Mayoral / Albert	Yes	16	0	0	3	3	13	2	0	$21,569	$107,844	3.2	3	0	0	1	1	2	0	0	$10,944	$30,096	1.1	76	$237,348	15.2	19	$50,160	6.9	21.1%	9.1%	15.8%	21.8%
	2097	Hobson Street / Cook Street	Yes	14	0	0	1	1	13	2	0	$11,537	$57,684	2.8	2	0	0	0	0	2	0	0	$1,824	$5,016	0.7	63	$142,500	12.6	26	$40,128	9.5	22.2%	8.1%	7.7%	4.5%
Sub Total Redlight camera sites only				**119**	**1**	**8**	**24**	**33**	**86**	**14**	**4**	**$1,565,722**	**$7,828,608**	**24**	**20**	**0**	**0**	**10**	**10**	**10**	**3**	**1**	**$100,320**	**$275,880**	**7.3**	**588**	**$2,869,334**	**117.6**	**180**	**$1,983,434**	**65.5**	**20.2%**	**54.6%**	**11.1%**	**5.1%**
Secondary Group (All Approaches Combined)	2003	Ponsonby / Karangahape Rd	No	3	0	0	1	1	2	1	0	$6,019	$30,096	0.6	5	0	0	1	1	4	0	1	$12,768	$35,112	1.8	53	$58,186	10.6	29	$203,459	10.5	5.7%	10.3%	17.2%	6.3%
	2005	Karangahape Rd / Pitt Street	No	4	0	0	1	1	3	0	0	$6,521	$32,604	0.8	2	0	0	1	1	1	1	0	$10,032	$27,588	0.7	74	$227,316	14.8	34	$232,643	12.4	5.4%	2.9%	5.9%	4.3%
	2051	Ponsonby Rd / Richmond Rd	No	3	0	0	1	1	2	2	0	$6,019	$30,096	0.6	0	0	0	0	0	0	0	0	$0	$0	0.0	37	$283,541	7.4	9	$8,208	3.3	8.1%	2.1%	0%	0%
	2099	Wellesley St West / Nelson St	No	10	0	0	4	4	6	1	0	$23,074	$115,368	2	3	0	0	2	2	1	1	0	$19,152	$52,668	1.1	32	$56,681	6.4	14	$45,600	5.1	31.3%	40.7%	21.4%	42.0%
	2102	Cook / Vincent / Mayoral Dr	No	4	0	0	1	1	3	0	0	$6,521	$32,604	0.8	1	0	0	1	1	0	1	0	$9,120	$25,080	0.4	56	$152,532	11.2	18	$57,456	6.5	7.1%	4.3%	5.6%	15.9%
	2245	Victoria St West / Federal St	No	12	0	1	2	3	9	6	0	$94,346	$471,732	2.4	4	0	0	2	2	2	0	0	$20,064	$55,176	1.5	37	$129,458	7.4	17	$336,694	6.2	32.4%	72.9%	23.5%	6.0%
	2291	Victoria E / Lorne St / High St	No	1	0	0	0	0	1	0	0	$502	$2,508	0.2	3	0	0	2	2	1	0	0	$19,152	$52,668	1.1	30	$28,591	6.0	9	$24,624	3.3	3.3%	1.8%	33.3%	77.8%
Comparison Group (All Approach Combined)	2050	Rosebank / Grt North	No	7	0	1	1	2	5	1	0	$87,324	$436,620	1.4	3	0	0	1	1	2	0	0	$10,944	$30,096	1.1	60	$215,779	12.0	28	$194,339	10.2	11.7%	40.5%	10.7%	5.6%
	2195	Pilkington / Queens	No	0	0	0	0	0	0	0	0	$0	$0	0	1	0	0	0	0	1	0	0	$912	$2,508	0.4	39	$187,188	7.8	12	$19,152	4.4	0.0%	0.0%	8.3%	4.8%
	2217	Great South/Atkinson High St	No	3	0	0	1	1	2	0	0	$6,019	$30,096	0.6	0	0	0	0	0	0	0	0	$0	$0	0.0	37	$45,646	7.4	20	$187,043	7.3	8.1%	13.2%	0%	0%
	2220	Avenue / Atkinson	No	9	0	1	3	4	5	1	2	$97,356	$486,780	1.8	3	0	0	0	0	3	0	0	$2,736	$7,524	1.1	41	$117,922	8.2	9	$160,595	3.3	22.0%	82.6%	33.3%	1.7%
	2228	St Lukes / Cornwallis	No	1	0	0	0	0	1	1	0	$502	$2,508	0.2	0	0	0	0	0	0	0	0	$0	$0	0.0	13	$774,334	2.6	3	$10,944	1.1	7.7%	0.1%	0%	0%
	2230	St Lukes / Morningside	No	1	0	0	0	0	1	0	1	$502	$2,508	0.2	1	0	0	0	0	1	0	0	$912	$2,508	0.4	61	$825,497	12.2	18	$41,040	6.5	1.6%	0.1%	5.6%	2.2%
	2289	St Lukes / Wagener	No	0	0	0	0	0	0	0	0	$0	$0	0	0	0	0	0	0	0	0	0	$0	$0	0.0	21	$191,702	4.2	3	$2,736	1.1	0.0%	0.0%	0%	0%
Sub Total secondary and comparitve sites				**58**	**0**	**3**	**15**	**18**	**40**	**13**	**3**	**$334,704**	**$1,673,520**	**11.6**	**26**	**0**	**0**	**10**	**10**	**16**	**3**	**1**	**$105,792**	**$290,928**	**9.5**	**591**	**$3,294,372**	**118.2**	**223**	**$1,524,532**	**81.1**	**9.8%**	**10.2%**	**11.7%**	**6.9%**
Totals				**177**	**1**	**11**	**39**	**51**	**126**	**27**	**7**	**$1,900,426**	**$9,502,128**	**35**	**46**	**0**	**0**	**20**	**20**	**26**	**6**	**2**	**$206,112**	**$566,808**	**16.7**	**1179**	**$6,163,706**	**236**	**403**	**$3,507,967**	**146.5**	**15.0%**	**30.8%**	**11.4%**	**5.9%**

Notes

- Pink denotes an increase in post 01 Apr 2008 to 31 Dec 2010 data evaluation numbers
- Crashes have been filtered using a 50m radius from the centre of intersections
- Crash cost data is scewed given average applied over five years as opposed to 2.75. Crash data would be more accurately defined over a five year period

[1] List includes the number of crashes at the site, not the total number of casualties.
[2] Crash cost for all sites have been determined using EEM tables from section A6.9 with July 2009 update factor of 1.14.

Fatal	$3,819,000	Table A6.21(a)
Serious	$399,000	Table A6.21(b)
Minor	$25,080	Table A6.21(c) - assumed average between 'rear end, crossing' and 'rear end, queuing' crashes
Non-inj	$2,508	Table A6.21(d)

Comments / Observations
RLR crashes result in a higher proportion of social costs than number of crashes.
Proportion of RLR crash costs have dropped significantly since implementation of cameras.
Trial duration is not yet long enough to obtain any meaningful results.
5 years worth of results would be preferable.