City of Woodland

REPORT TO MAYOR AND CITY COUNCIL

AGENDA ITEM

TO: THE HONORABLE MAYOR
AND CITY COUNCIL

DATE: OCTOBER 16, 2007

SUBJECT: USE OF AUTOMATED ENFORCEMENT DEVICES AT INTERSECTIONS

Report in Brief

In July 2007, the City Council requested that the Police Department report on the feasibility of using automated enforcement devices to reduce red light violations at intersections throughout the City. The Police Department has studied the feasibility of these automated enforcement devices and prepared a white paper on the topic. This Council item will introduce the white paper.

Staff recommends that the City Council approve further study of automated enforcement devices and if deemed effective, authorize staff to issue a Request for Proposals to seek vendors to provide a system(s) in Woodland.

Background

An automated enforcement device is defined by the California Vehicle Code as :

> "…any system operated by a governmental agency, in cooperation with a law enforcement agency, that photographically records a driver's responses to a rail or rail transit signal or crossing gate, or both, or to an official traffic control signal described in Section 21450, and is designed to obtain a clear photograph of a vehicle's license plate and the driver of the vehicle." VC § 210

Automated enforcement devices have been in use for many years though their use in California has increased dramatically since the early 1990s. The primary use for the devices is intersection control, though they can also be used from railroad crossings. In prior years, they were also used for speed enforcement but that is no longer permitted in California. To control an intersection, cameras are placed on poles near the intersection. Triggers are placed on the roadway which coordinates with the traffic light controls to determine when a movement is prohibited. When a vehicle enters an intersection against a red light it will activate the trigger which will cause the camera to photograph the vehicle, the driver and the light. This information is compared with registration information held by the Department of Motor Vehicles and reviewed by a law enforcement officer. If the information is verified, a notice to appear is sent to the alleged violator. The alleged violator would be able to contest the offense in court.

Only a governmental entity, in cooperation with a law enforcement agency, may operate an automated enforcement system (VC§ 21455.5 (c)). Most cities enter into a contract with a private vendor to place these automated enforcement devices. The vendor generally provides the equipment, and under contract will provide some maintenance and support functions. By law, certain functions such as ensuring that the equipment is properly functioning, maintain proper posting, and law enforcement review cannot be contracted out.

The purpose of any automated enforcement device is traffic safety through enforcement. All enforcement activities cost money whether it is a police officer or an automated device. Therefore, in analyzing automated enforcement devices you need to consider the costs involved versus the costs of other enforcement activities. Prior to 2004, many of the contracts for these devices were done on a percentage basis. That is, the private vendor would be compensated with a certain percentage of the local revenue generated through fines paid. Effective January 1, 2004, a change in state law no longer permits this method of compensation. Private vendors now charge a “flat rate” to place the cameras, maintain the system, and other contracted services. Depending on contract terms, this may mean that enough revenue may not be generated from the device to pay the flat rate.

The Department’s white paper, authored by Sgt. Derrek Kaff and Sgt. Don Beal, describes several studies that have been done on the use of these automated enforcement devices. The studies results indicate that these automated enforcement devices generally have a positive impact on traffic safety. Results from a majority of the studies indicate that these devices do reduce traffic violations and therefore collisions, though one study suggests that these results might be short lived.

Department statistics indicate certain intersections that may be suitable for an automated enforcement device. The intersections are Pioneer and E. Main Street, and Pioneer and Gibson. Over two years, we have had 42 and 32 reported collisions at these intersections, respectively. During the same time, we have issued 15 and 18 citations for red light violations at these intersections. These intersections have the highest issue rate of any in the city which would suggest red light violations are a factor in many of these collisions.

The use of “cameras” by law enforcement can be a concern to some in the community. In August 2007, the ACLU of Northern California published a report titled "Under the Watchful Eye." Though the report focused on surveillance cameras used to monitor public areas, it did express concern over the increasing use of photographic monitoring being done by government agencies. In addition, many persons do not like the “impersonal” approach of automated enforcement devices, and some will claim their purpose is only to generate revenue. While these concerns exist, the Department’s white paper cites various surveys which show that between 60-80% of the public supports automated enforcement devices.

Discussion

Automated enforcement devices can be an effective traffic safety tool. The benefit from such devices is that they can be placed at locations with higher violation frequencies for specific offenses thus freeing officers to monitor other locations.

Utilization of these devices was often seen as “no cost” to the City (since the systems were paid for through a percentage of fines originating from the system). Though the systems were never “no cost,” they certainly are not so today. There have always been the personnel cost needed to monitor the program and the costs for court appearances when violations are challenged. Now there is the “flat costs” to run the system. Evaluating any system must include an examination of expenses versus the net impact on traffic safety. In order to identify the costs for installing any system, staff would need to engage vendors to do an analysis of specific intersections. Staff believes some vendors will perform a preliminary analysis in advance of any formal RFP. Though this work should not involve any disruption in traffic, it would need to be coordinated between the vendor, traffic engineering, and the police department.

Our Community Oriented Policing and Problem Oriented Policing programs emphasize personal contact between police personnel and our community. In order to maintain that posture, it is important that policy decisions regarding automated enforcement devices place the emphasis on traffic safety. The Department will also have to ensure that a mechanism exists for violators to speak with someone regarding the procedure.

Fiscal Impact

There would be no fiscal impact to study the feasibility of using automated enforcement devices. Depending on the proposals received, there may be a cost impact if a system is installed and activity does not cover the “flat cost.”

Public Contact

This item was included in the posting of the City Council agenda. A public hearing would need to be held prior to awarding any contract to install an automated enforcement system (VC §21455.6) should the Council desire to move forward.

Commission Recommendation

If the Council desires to move forward, identification of intersections and implementation of the system would be presented to the Traffic Safety Commission.

Alternative Courses of Action

1. Approve further study of automated enforcement devices and if deemed effective, authorize staff to issue a Request for Proposals to seek vendors to provide a system(s) in Woodland.
2. Direct staff to conduct further study without issuing a Request for Proposals.
3. Direct staff to do no further study.

Recommendation for Action

Staff recommends that the City Council approve Alternative No. 1.

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Red Light Camera Programs: Woodland Police Department
Sgt. Derrek Kaff and Sgt. Don Beal

Red Light Camera Programs

Sgt. Derrek Kaff
Sgt. Don Beal

Executive Summary

Implementation of automated enforcement programs for traffic signals is increasing in the United States. Fines assessed by the programs, which are based on photographs or videos captured automatically when a vehicle enters the intersection after the signal has changed to red, range from $50 to $271 dollars. The cameras used in the systems cost about $50,000 to $60,000, with installation, including detectors, equipment cabinet, and mounting pole, adding approximately an additional $25,000. Monthly operating costs are approximately $5,000. In the U.S., a private sector contractor that receives a portion of the fine revenue collected from the systems typically undertakes installation and operation. Public opinion surveys reported in the literature indicate significant public support for the programs. The percentage of survey respondents approving of the systems ranges from approximately 60% to 80%.

Impacts of the systems on the safety of the transportation system are difficult to assess. There is substantial literature documenting a significant decline in the number of vehicles committing traffic signal violations at enforcement sites, ranging from 20% to 87%. However, the few independent analyses of the occurrence of crashes at these sites offer no definitive indication of whether the camera systems impact this important measure of transportation safety. An early Australian study indicated significant reductions in crashes due to implementation of camera enforcement, while a later study found that over time there were no significant changes in crash behavior due to the systems (though the small number of crashes experienced at the studied sites clouded the results). Studies of the systems in use in Scotland found both a significant crash reduction and that the most significant impact on violation behavior was a decrease in vehicles entering the intersection between 0.5 and 5 seconds into the red phase. A study of citywide crashes over the same time period found that red light cameras were likely one of several factors contributing to the overall decline in accidents. A graduate student study of two intersections with automated enforcement in Howard County, Maryland indicated a positive impact of the systems on right-angle crashes. An analysis of data provided by Howard County on crash experience at each of the 25 enforced intersections in that county indicated that the reported reduction in both right-angle and rear-end collisions were statistically significant. Several factors were identified that cloud the interpretation of reported safety impacts, including study design issues and the influence of other traffic safety improvements concurrent with the implementation of red light cameras.

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1. Overview

This document presents the result of an extensive review of available documents regarding automated enforcement of traffic signal compliance. The literature regarding the operation and impacts of systems that automatically enforce driver compliance with the red phase of traffic signals is extensive. However, reviewing the available documents for independent analyses of these systems yields very few examples. Efforts to assess the safety impacts of these systems by independent evaluators (not connected to the agencies or vendors operating the programs) have been made in Australia, the United Kingdom, and, to a lesser extent Howard County, MD. Each of these studies, as well as the remainder of the sources reviewed during this effort, indicate a significant reduction in the number of drivers running the red light. Crash reduction results are mixed and generally inconclusive. An early Australian study (South, *et al.*, 1988) indicated significant reduction in crashes several years after the initiation of the program in Melbourne, Australia, while a follow-up study (Andreassen, 1995) several years later found no significant reduction in collisions due to the system. Two studies in Scotland (Halcrow Fox, 1996 and Ray, 1995) indicate significant benefits from the cameras. A graduate student project assessing the system in Howard County, MD (Butler, 2001) also indicated positive impacts of that system on crashes and violations. The remainder of the literature consists primarily of statistics reported by the operating agencies and press reports of camera program results.

The following section of this report describes the operational arrangements surrounding camera programs in the United States, including typical contracting arrangements and the fines and penalties associated with the programs. The third section of the document describes the reported impacts of the systems on violations and collisions, including a more detailed discussion of the few independent analyses of red light camera programs. Next, this report briefly summarizes the results of several public opinion surveys described in the literature.

2. Operation of Red Light Camera Programs

2.1 Background

States with legislation authorizing the use of photo or automated enforcement of red-light running (RLR) include, but may not be limited to: Arizona, California, Colorado, Delaware, Georgia, Hawaii, Illinois, Maryland, New York, North Carolina, Ohio, Oregon, Virginia, Washington, and the District of Columbia. Some states (Ohio, for example) have "home rule" wherein a local ordinance is all that is needed to enact a camera enforcement program.

In most cases, once authorized by the state legislature, a municipality determines whether or not to use automated RLR enforcement. Federal Highway Administration guidance recommends that localities perform an engineering review of intersections selected for enforcement, including "approach geometry, signal timing details, and other relevant engineering features." This review will help ensure that the red light running problem at the identified intersections is due to driver behavior rather than engineering shortcomings (FHWA, undated). Most municipalities contract with a vendor(s) to install the camera system with associated infrastructure, and to operate the back office processing. A police officer typically reviews violation photos prior to a citation being mailed to the vehicle owner. Requirements for proving and adjudicating the violation vary from state to state. Some states require only pictures taken of the rear of the vehicle while others require rear photos as well as pictures of the driver. These requirements factor into the cost of the camera system and the back office processing. Two-to-three pictures are usually taken of the violation. Some states require that only color photos be taken while others permit color (to prove red phase) and monochrome (vehicle license plate).

Red-light systems rely on some sophisticated technology, but conceptually they are very simple. The system includes only three essential elements:

- One or more **cameras**
- One or more **triggers**
- A **computer**

In a typical system, cameras are positioned at the corners of an intersection, on poles a few yards high. The cameras point inward, so they can photograph cars driving through the intersection. Generally, a red-light system has cameras at all four corners of an intersection, to photograph cars going in different directions and get pictures from different angles. Some systems use film cameras but most new systems use digital cameras.

There are a number of trigger technologies, but they all serve the same purpose: They detect when a car has moved past a particular point in the road. Red-light systems typically have two **induction-loop triggers** positioned under the road near the stop line.

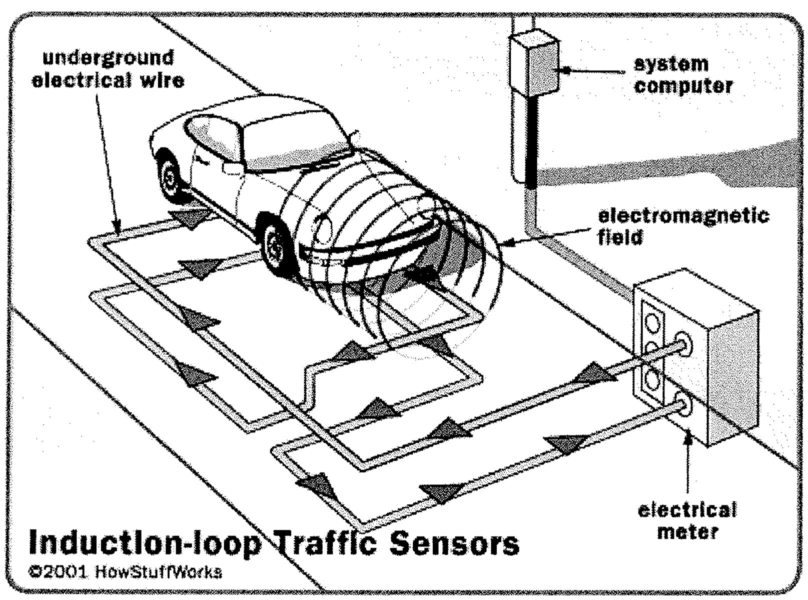
The computer is the brains behind the operation. It is wired to the cameras, the triggers and the traffic-light circuit itself. The computer constantly monitors the traffic signal and the triggers. If a car sets off a trigger when the light is red, the computer takes **two pictures** to document the violation. The first picture shows the car just on the edge of the intersection and the second picture shows the car in the middle of the intersection.

In some states, a ticket is issued to the car's owner, no matter who's actually driving. In these states, the red-light camera only needs to photograph the car from behind, since the authorities only need a clear view of the rear **license plate**. In other states, the actual driver is responsible for paying the ticket. In this case, the system needs a second camera in front of the car, in order to get a shot of the **driver's face**. The ticket is still sent to the car's owner, but the authorities have the information available if there is any disagreement down the line.

Induction Loop Triggers

As we discussed previously, the main trigger technology used in red-light systems is the **induction loop**. An induction-loop trigger is a length of electrical wire buried just under the asphalt. Usually, the wire is laid out in a couple of rectangular loops resting on top of each other (see diagram below).

This wire is hooked up to an electrical power source and a **meter**. When you send electrical current through a wire, it generates a **magnetic field**. Positioning the wire in concentric loops, as in any electromagnet, amplifies this field.



When a car drives over an induction loop, it disturbs the loop's electromagnetic field. This changes the total inductance of the loop circuit.

This sort of field affects not only objects around the loop, but also the loop itself. The magnetic field **induces** an electrical voltage in the wire that is counter to the voltage of the circuit as a whole. This significantly alters the flow of current through the circuit.

The intensity of this induction depends on the structure and composition of the loop; changing the layout of the wires or using a different conductive material (metal) will change the loop's inductance. You can also change the inductance by introducing additional conductive materials into the loop's magnetic field. This is what happens when a car pulls up to the intersection. The huge mass of metal that makes up your car alters the magnetic field around the loop, changing its inductance.

The meter in the system constantly monitors the total inductance level of the circuit. When the inductance changes significantly, the computer recognizes this shift and knows that a car has passed over the loop.

Other Triggers

This is the most common trigger mechanism, but it's not the only one in use. Some areas have had success with radar, laser or air-tube sensors.

One emerging trigger mechanism is the **video loop**. In this system, a computer analyzes a video feed from the intersection. As the computer receives each new video frame, it checks for substantial changes at specific points in the image. The computer is programmed to recognize the particular changes that indicate a car moving through the intersection. If the light is red and the computer recognizes this sort of change, it activates the still cameras. The main advantage of this system is you don't have to dig up the road to install it, and you can adjust the trigger areas at any time. Essentially, it is a virtual inductive-loop trigger.

When the light is green or yellow for incoming traffic, the computer ignores the triggers and does not activate the cameras. The system doesn't "turn on" until it receives a signal that the light is **red**. If you're already in the middle of the intersection when the light turns red, the system will not activate the cameras (this is not a traffic violation in most areas). Some systems wait a fraction of a second after the light turns red, to give drivers a "**grace period**."

In most systems, the computer will not activate the cameras if a car is just sitting over the induction loops. To trigger the cameras, you have to move over the loops at a **particular speed**. In most systems, there are two loop triggers for each lane of traffic. When the triggers are both activated in quick succession, the computer knows a car has moved into the intersection at high speed. If there is more of a delay, the computer knows the car is moving more slowly. If the car activates only the first trigger, the computer knows it is stopped at the edge of the intersection.

Caught Red-handed

When a car activates both triggers after the light is red, the computer automatically takes a picture. This first shot shows the car just as it is entering the intersection. The computer then hesitates briefly and takes another shot. This catches the car in the middle of the intersection. The computer calculates the length of the delay based on the measured speed of the car. It's important to get **two pictures** of the car to show that it entered the intersection when the light was red and then proceeded through the intersection.

To fully document the violation, the computer **superimposes** some extra information on these two photos. It includes:

- The **date**
- The **time**
- The **intersection location**
- The **speed of the car**
- The **elapsed time** between when the light turned red and the car entered the intersection

No Escape

With all of the information superimposed on the picture, along with photos of the infraction, the police have everything they need to charge the driver. In most areas, the police, or a private firm hired to maintain the system, simply look up the license plate and send the ticket in the mail. The driver (or car owner) can pay the fine through the mail and be done with it or he or she can try to contest the ticket in court. Of course, the police send the photos along with the ticket, so most drivers end up just paying the fine.

2.2 Costs

RLR fines associated with photo enforcement systems vary by state and city. Review of the literature indicates that these fines range anywhere from $50 to $271. Depending on the state's law, a portion of the fine goes to the state treasury with the remainder going to the municipality. The contractor receives a percentage, ranging anywhere from 15% - 56%, of the municipality's portion of the fine in return for installation of the camera system, leasing the equipment, and providing the violation processing. Some states do not receive a portion of the fine, with all revenue going to the municipality and vendor. Some states, California, for instance, use frontal photography to acquire an image of the driver and use this to assess negative points on a driver's driving record for red-light violations.

Most contracts are based on a sliding scale fee wherein as the number of violations processed increase, the percentage of the fine to the contractor decreases. Information is available for fines and percentage paid to vendors as well as for camera system and equipment installation; however, no specific information is available for the cost of the back office processing. The cost of this processing as well as for the camera and associated equipment are folded into the negotiated cost per violation fee charged by the vendor. See Table 1 for additional information. Based on a literature search, the major vendors active in photo RLR enforcement include: Peek Traffic Inc., EDS, U.S. Public Technologies (USPT) - purchased by Lockheed Martin IMS and soon to be purchased by Affiliated Computer Services (ACS), Traffipax, Redflex Traffic Systems, Nestor Traffic Systems, and LaserCraft. Contractor teams may also form to implement these systems. For example, EDS, whose role tends to be in performing the back office processing, may team with a camera vendor. Camera vendors are typically European including: Gatsometer's Gatso RLC, Robot (distributed in the U.S. by Traffipax), and Peek's Guardian. Lockheed Martin tends to purchase the 35-mm wet film Gatsometer camera systems. Many of the first cameras used for RLR enforcement are 35-mm wet-film; however, the trend is to move to digital technology which alleviates the need to retrieve and replenish film as in the wet-film technology cameras. Peek cameras are digital; Gatso are available in both wet-film and digital. Digital and standard video systems are also available. Nestor Traffic Systems provides video camera detection and photo technologies.

Wet-film, 35-mm red-light cameras range in cost from $50K - $60K. Installation costs are around $25K and include installation of the camera, and associated equipment (e.g., pole, loop detectors, cabinet foundation). Monthly operating costs are approximately $5K per camera system. The standard digital red-light camera system from Peek Traffic is for a three-lane approach and includes a total of four cameras: 3 monochrome and 1 color. Each of the three monochrome cameras are trained on a single lane, and the color camera is pointed to photograph the entire intersection and to show color of traffic signal. The cost of the camera system is approximately $100K and includes the camera and installation of associated equipment (e.g., poles, loop detectors, cabinet). Costs decrease by $2.5K for a two-lane approach and $5K for a one-lane approach.

Table 1. Operating vendors, fines, and revenue distribution for several U.S. cities with automated RLR enforcement.

Site	Vendor	Fine	Fine Split
Phoenix, AZ	Lockheed Martin	$175	$93 vendor, $82 city
Mesa, AZ	Lockheed Martin	$170	$74.01 state, $95.99 city with $48.50 going to vendor
San Francisco, CA		$271	$123 state, $148 city/county Split to city/county: $48.50 vendor, $99.50 to further program, educational campaign, and equipment vendor
Santa Rosa, CA		$271	$100 vendor
San Diego, CA	Lockheed Martin	$271	$70 vendor
Baltimore, MD	Lockheed Martin	$75	15% - 35% of fine to vendor
Howard County, MD	Traffipax/EDS	$75	Sliding scale. State receives no revenue from fines.
Washington, DC	Lockheed Martin	$75	$26 vendor (as much as 40%), $49 city
Lakewood, WA		$71	
Marietta, GA	LaserCraft	$70	
Garland, TX*	Lockheed Martin	$75	$74.50 vendor, $0.50 city
Wilmington, NC	Peek Traffic	$50	$35 vendor, $15 city
Greensboro, NC	Peek Traffic	$50	$35 vendor, $15 city
High Point, NC	Peek Traffic	$50	$35 vendor, $15 city
Charlotte, NC	Lockheed Martin	$50 $50 $100	1st notice: $28 vendor, $22 city 2nd notice: $23 vendor, $27 city 3rd notice: $76 vendor, $24 city
Oahu, Hawaii*	Lockheed Martin	$77	As much as $50 vendor, $27 city
Fairfax, VA	USPT	$50	$20.85 vendor, $29.15 city

* Automated camera enforcement program in start-up phase.

3. Transportation Safety Impacts of Red Light Cameras

This section discusses the impact of red light camera systems on safety at intersections. The statistics used to describe the performance of the systems are violation and crash reductions. This section first presents reported reductions for many of the locations making use of red light cameras. The section concludes with a review of the few independent analyses of these systems.

3.1 Reported Safety Impacts

Table 2 lists the cited violation and crash reduction figures revealed in this research effort for many of the jurisdictions using red light cameras. Reported violation reductions range from 20% to 87%, with half of the jurisdictions reporting between 40% and 62% reductions in red light violations. The quality of sources for the data in Table 2 varies widely. Violation reduction figures are typically from newspaper or trade press articles, cited as obtained during interviews with representatives of the operating agency, or cited in secondary sources referencing these types of sources. As described in a few of these sources, violation reductions are most often computed by comparing the number of violations recorded by the camera systems during the first months of operation with the same statistics from later time periods. A few of the studies collected data on the number of transgressions prior to commencing enforcement, either with the enforcement camera itself or through review of video recordings of the intersections. Despite the general lack of data collection during a true "before" period, there has been widespread reporting of large violation reductions.

Most of the crash reduction figures cited in Table 2 come from sources similar to those for the violation reductions, and therefore should not be taken as reliable independent evaluations of the systems, with several notable exceptions (discussed in Section 3.2). The agencies responsible for the camera programs in Howard County, MD, Wilmington, NC, and Charlotte, NC, have released documents citing reductions in right-angle collisions at the enforced intersections. Discussions with local transportation engineers in Howard County and Wilmington indicate that these figures were based on review of police reported incidents at the intersections before and after the implementation of the camera systems. The Wilmington data indicates an increase in rear-end collisions at enforced intersections, similar to the impact described by many other locations. Howard County data indicates a reduction in rear-end collisions at the majority of the 25 enforced intersections at that county. In Wilmington, staff reviewed the police reports to eliminate collisions occurring at driveways near the enforced intersection.

While conflicting results sometimes appear in the crash reduction figures cited in Table 2, the majority of the reported cases indicated some reduction in crashes. An important issue clouding the results of these reports is the lack of a significant amount of experience with the camera systems. The figures given are based on one to two years of experience with little to no analysis of trends over time, and therefore cannot reveal whether the programs have a lasting impact. In addition to these local reports, there have been several attempts to independently assess the impacts of red light camera systems on crashes at enforced intersections, as described below.

Table 2. Violation and crash reductions for various RLR enforcement programs.

Site	Violation Reduction	Crash Reduction	Source Type(s)	Source(s)
Arizona				
Scottsdale, AZ	62%		Trade Press Article	"Applications Increase…", 2000
California				
Oxnard, CA	42%[1]	29% reduction injury crashes, 32% reduction right-angle crashes[2]	Insurance Institute for Highway Safety (IIHS) Studies	[1] Retting, 1999 [2] Retting, 2001
San Francisco, CA	42%		Conference Paper	Fleck and Smith, 1999
Santa Rosa, CA	yes	yes	Newspaper Article	"Exposed: SR…", 2001
Los Angeles, CA	75%		Conference Paper	Rocchi, 1999
Colorado				
Boulder, CO	37%	57%	Newspaper Article	"Speeders may be…", 2001
District of Columbia				
Washington, DC	56%		Newspaper Article	"Red-light Cameras.", 2001
Florida				
Polk County, Florida		7.3%	FHWA Synthesis Report	*Synthesis and Evaluation…*, 1999
Fort Meade, FL	50%		Conference Paper	Rocchi, 1999
Maryland				
Howard County, MD	42-62%	21-44% at individual intersections	Agency Data	"Maryland House of Delegates…", 2001
Michigan				
Jackson, MI	83%		Synthesis Report	ITE, 1999
New York				
New York, NY	34%	60-70% reduction in angle crashes at one site	FHWA Website	FHWA, *undated*
North Carolina				
Charlotte, NC	20%	24% reduction at enforced intersections, 20% reduction in crashes caused by RLR	Agency Report	"Safelight Charlotte: First-Year Report.", *undated*
Greensboro, NC	20-25%		Newspaper Article	"Cameras curb red…", 2001
High Point, NC	20%		Newspaper Article	"City Shoots for…", 2001
Wilmington, NC	40-60%	26% reduction in right-angle and 8% increase in rear end, 22% decline in total collisions	Agency Brochure	"Safelight Wilmington: First Year in Review.", 2001
Virginia				
Fairfax, VA	44%		IIHS Study	Retting, August 1999

Table 2. Violation and crash reductions for various RLR enforcement programs. (cont.)

Site	Violation Reduction	Crash Reduction	Source Type(s)	Source(s)
Australia				
Melbourne, Victoria, Australia (1995)		0% reduction in right-angle crashes at enforcement locations, *increase* in rear-end collisions	Independent Evaluation	Andreassen, 1995
Melbourne, Victoria, Australia (1988)		32% decrease in right-angle crashes and 10% decline in injuries	Independent Evaluation	South, 1988
Perth, WA, Aus		40% right-angle crash reduction at enforced intersections, little change in average number of rear-end crashes	Independent Evaluation	Office of the Auditor General, 1996
Queensland, Australia	70%		Agency Website	"Technology versus the Lawbreakers.", *undated*
South Australia		33% reduction in serious right-angle crashes, 5-10% increase in rear-ends	Conference Paper	Rocchi, 1999
Sydney, Australia		50% reduction in angle and right-turn opposing collisions, 20-60% increase in rear-end collisions	Conference Paper	Rocchi, 1999
Victoria, Australia	30%		Synthesis Report	ITE, 1999
Canada				
Victoria, BC	73%		Conference Paper	Rocchi, 1999
Hong Kong				
Hong Kong	40%		Conference Paper	Rocchi, 1999
Singapore				
Singapore	40%		Conference Paper	Rocchi, 1999
United Kingdom				
Essex, England		88% reduction in injury collisions	Conference Paper	Rocchi, 1999
Glasgow, Scotland	69%	62% reduction in injury accidents	Independent Evaluation	Winn, 1995
Nottinghamshire, UK	60%			Rocchi, 1999

3.2 Review of Independent Analyses

An early Australian study (South, *et al.*, 1988) indicated significant reduction in crashes two years after the initiation of the program in Melbourne, Australia. This study considered data from five years prior to installation of cameras and two years following installations between August 1983 and November 1984. A follow-up study (Andreassen, 1995) several years later, considering after data through 1989 to provide equal five year "before" and "after" periods, found no significant reduction in collisions due to the system, and an increase in rear-end collisions similar to that described in the first study. The study was based on comparisons of police reported crashes at each of 41 enforcement sites. Due to several changes in the police report format during the study periods, individual crash reports were reviewed to classify crashes appropriately. The study attempted to compare crashes at the selected sites with crashes in all of Victoria; however, problems with the database reports for red light running crashes and crash coding on the reports obtained led the author to conclude that results of this analysis were unreliable. Notably, Andreassen also stated that the low crash frequencies at the camera installations in Melbourne made them poor locations for the assessment of safety impacts due to the camera program.

A report by the Office of the Auditor General for Western Australia (Office of the Auditor General, 1996), describes a significant benefit of a 40% reduction in right angle crashes at the 44 enforced intersections in Perth over a ten-year period. This was compared to very little change in the rate of such collisions over all 920 signalized intersections in the city. The study also found no significant change in the frequency of rear-end collisions at the locations. The report includes a chart presenting the right angle crash frequency at each set of intersections; however, it gives no description of the technique used to develop the statistics presented.

Studies performed in Scotland (Halcrow Fox, 1996 and Winn, 1995) indicate significant benefits from the cameras. The Winn study found a 62% reduction in collisions caused by RLR at camera sites in Glasgow when comparing data from police accident records from "before" and "after" periods of 3 years each. The accident records tallied for each site were filtered to include only those reports that indicated RLR contributed to the crash. A second component of the Winn study was an analysis of the change over time in the number of vehicles violating the signal during various segments of the red phase. The study used data collected by observers and records from the automated camera systems to document the time into the red phase that violations occurred. Data gathered during before, interim, and after surveys periods including manual observation revealed that the decline in violations was most significant during the periods 0.5 to 1 second into the red and in the period 1-5 seconds into the red. These time periods accounted for 42% and 29%, respectively, of the total number of infringements at the sites and the number of infringements in these time bands declined by 69% and 67% between the before and interim surveys. Violation rates remained approximately the same between the interim period, when only warning notices were issued, and after periods. The only time band surveyed that did not show a decline in violations was the period greater than 5 seconds into the red phase. Violations in this segment of the phase accounted for less than 1% of the recorded infringements, while the remaining 29% of violations occurred during the period at the beginning of the red phase (0 to 0.5 seconds into the phase).

The later Halcrow Fox study (Halcrow Fox, 1996), which included a review of police accident reports and traffic volume data covering the period from 1989 to 1995, found that camera enforcement was just one of several traffic safety improvements contributing to a citywide reduction in collisions at signalized intersections in Glasgow. For example, the study notes a significant reduction in accidents caused by pedestrians crossing carelessly, and cites engineering and education efforts as possible reasons for this portion of the overall decline in crashes. With regard to accidents caused by RLR, the study found that both injury and non-injury crashes caused by this behavior declined between 32% and 35% citywide, accounting for a similar percentage of the total crashes in the analysis periods before and after camera enforcement began. The decline in RLR crashes accounted for 20% of the decline in all crashes at signalized intersections. Another notable finding of the study was that "injury accidents caused by red light running declined more sharply at junctions away from the camera sites suggesting that factors such as junction improvement, traffic management and increased vigilance may have been important in reducing red light running accidents across the whole area."

A graduate student thesis assessing the system in Howard County, MD (Butler, 2001) indicated positive impacts of that system on right-angle crashes. This study involved comparison of police reported right-angle collisions at two camera locations for before and after periods of 18 months. The number of crashes occurring at these sites was compared to totals from a sample of non-enforced intersections in Howard County and a "control" group of intersections along arterials of similar traffic volumes and development patterns in Pennsylvania. The study found that the improvement between the before and after period at red light camera (RLC) intersections in the county was not significant at a 95% confidence level, but was significant at the less stringent 90% confidence level. Due to small reductions in the number of crashes at the other sites, the study found no statistically significant differences between the changes at the RLC and non-RLC intersections in Howard County, nor between the non-RLC sites in Howard County and several control sites in Pennsylvania.

Analysis of data provided by Howard County ("Maryland House of Delegates Commerce and Government Matters Committee Automated Enforcement Review: Red-Light Running Detection Camera Systems", 2001) indicated statistically significant reductions in the total number of both right-angle and rear-end crashes at camera enforced intersections. The analysis excluded 3 atypical intersections located at the terminus of freeway sections (though each of these locations recorded reductions in crashes as well). Telephone interviews with the Howard County Traffic Engineer revealed that the data was obtained from queries of a database of crashes recorded at the enforced intersections. The measured reductions were a 42.5% decline in right-angle collisions and a 29.5% reduction in rear-end crashes at the enforcement sites. Chi-squared and paired-T statistical analysis found these results to be significant at a confidence level of 1%. Chi-squared analysis did not find the 21.8% decrease in "other" types of crashes at the enforced intersections to be statistically significant, however the paired-T test did indicate the change was significant. Data used in this analysis reflected crashes occurring at each site during "before" and "after" periods that varied from one intersection to the next. All "after" time periods concluded on 15 December 2000, while before periods began on appropriate dates before the implementation of cameras in order to provide "before" and "after" periods of equal duration at each site. The date of implementation of the enforcement program at each intersection varied from 18 February 1998 to 26 August 1999, resulting in "before" and "after" periods ranging from 15 to 32 months at each intersection.

4. Public Opinion of Red Light Cameras

Reports in the literature have demonstrated strong public support for red-light camera enforcement programs, ranging from roughly 60% to 80% of survey respondents favoring the systems. Again, the quality of the references providing these statistics varies widely, with few providing details on sample size or survey techniques. Results of an opinion survey of AAA members indicate 77% of the organization's membership supported RLC programs (Anderson). A trade journal article mentions that a 1999 survey found 78% support for RLC enforcement in Scottsdale, Arizona, where cameras have been in operation since 1997 ("Applications Increase for Automated Traffic Violation Enforcement", 2000). Charlotte, North Carolina's first annual report on their red light camera program reported that in 1997, prior to implementation of the program, 80% of Charlotte citizens felt that camera enforcement would be beneficial in reducing red light running ("SafeLight Charlotte: First-Year Report", *undated*).

Random sample surveys conducted by the Insurance Institute for Highway Safety (IIHS) in five cities with RLC programs and five cities without programs found that, in each city, over 75% of respondents favored the camera programs (Retting and Williams, 2000). A 2000 journal article (Wissinger, 2000) cited a 1995 IIHS nationwide survey that found 66% of respondents were in favor of the programs. The most recent national survey identified in this literature review, a 1999 survey sponsored by the organization Advocates for Highway and Auto Safety, found 74% of those surveyed in favor of the programs (Harris, 1999). Reports of public opinion of red light camera enforcement programs in the literature reveal strong support for the programs. However, it is also noteworthy that very few people are undecided about their position on red light cameras. This is reflected in the generally low numbers of people responding with no opinion in the surveys (Polk, 2000).

Information for this paper was gathered from a number of printed materials including the U.S. Department of Transportation Highway Safety Administration, the Metrek Co. and Howstuffworks.com as well as personal interviews.