Speed Corridor Demonstration Project: Final Report

Ministry of Justice
Policing and Security Branch
Road Safety Unit
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List of Acronyms

BC	British Columbia
EAI	Enforcement Activity Indicator (form)
EE	Enhanced Enforcement
ETEP	Enhanced Traffic Enforcement Program
FV-IRSU	Fraser Valley Integrated Road Safety Unit
ICBC	Insurance Corporation of British Columbia
IMPACT	Integrated Municipal Provincial Auto Crime Team
IRSU	Integrated Road Safety Unit
ISA	Intelligent Speed Adaptation
JAG	Ministry of Justice
JIBC	Justice Institute of British Columbia
LMD	Lower Mainland District
MOU	Memorandum of Understanding
NRG	NRG Research Group
PRP	Photo Radar Program
PSB	Policing and Security Branch
RCMP	Royal Canadian Mounted Police
RSU	Road Safety Unit
SCDP	Speed Corridor Demonstration Project
SL	Speed Limit
SRB	Speed Reader Board
Surrey MT	Surrey Municipal Traffic (unit)
TSMIT	Traffic Services Management Information Tool
VT	Violation Ticket

List of Key Terms

Approximate speed limit	Under speed limit by 1 km/hr to over speed limit by 2 km/hr.
Average daily volume	Gross traffic volume captured by SRBs, expressed as a rate per day.
Average daily volume per SRB	Gross traffic volume captured by SRBs, expressed as a rate per day per single SRB.
Baseline phase	The time period in which only standard traffic enforcement was conducted on all three corridors. This was a two month period from March through April, 2014.
Comparison corridor	The corridors that did not receive the intervention.
Correlation	An analysis of the magnitude and direction of a relationship (association not causation) between two variables.
Enhanced enforcement	Enforcement delivered by Integrated Road Safety Units (IRSUs) that is above and beyond the standard baseline traffic enforcement provided by agencies throughout the province.
High crash corridor	A high crash corridor is an area of a corridor that receives a disproportionately high number of crashes.
The Intervention	Enhanced enforcement efforts by FV-IRSU plus standard traffic enforcement delivered by Surrey Municipal Traffic Units.
Intensity	A concept used to describe the variability in hours of EE.
Odds ratio	The ratio of two odds. That is, a comparison of the odds of improvement with the treatment to the odds of improvement without the treatment.
Percentage point change	The difference between two proportions.
Speed categories	The speed categories set by the speed reader boards.
Speed reader boards	The instrument that utilized to gather data on relative vehicle speed.
Standard deviation	Standard deviation is a measure of central tendency. The metric provides an illustration of the spread of the data in light of the average.
Standard traffic enforcement	Standard baseline traffic enforcement efforts by Surrey Municipal Traffic Units, delivered as usual.
Treatment corridor	The corridor that received the intervention.

Treatment effect	A metric derived from the odds ratio that provides the direction and magnitude of the change on the treatment relative to the comparison corridors.
Treatment phase	The time period in which the treatment corridor (only) received the intervention of EE. The other two corridors continued to receive only standard traffic enforcement. This was a four month period from May through August, 2014.
Under speed limit	The category "under speed limit" represents the proportion of vehicles travelling at least 2 km/hr under the posted speed limit.

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Executive Summary

Background

The mandate of Ministry of Justice, Policing and Security Branch (PSB) is to provide adequate, effective, accountable policing and law enforcement throughout British Columbia. PSB sets the provincial policing priorities and direction for the provincial police force, the Royal Canadian Mounted Police (RCMP). The RCMP, through the Provincial Police Services Agreement, manages the contractual arrangement for the Provincial and the Municipal RCMP. In addition, PSB conducts audits of Independent Municipal Police Agencies to ensure policing standards are maintained.

The Speed Corridor Demonstration Project (SCDP) was conducted by PSB, Road Safety Unit (RSU) under the enhanced traffic enforcement program of the Traffic and Road Safety Law Enforcement Funding Memorandum of Understanding (MOU) between the Insurance Corporation of British Columbia (ICBC) and the Ministry of Justice (JAG).

Objectives

The SCDP addresses the requirement of the April, 2012 *Traffic and Road Safety Law Enforcement Program Memorandum of Understanding (MOU)* between ICBC and the BC Ministry of Justice and Attorney General (JAG) to complete focused evaluations on JAG's Traffic and Road Safety Law Enforcement Program by March 31, 2015.

Specific objectives were to**:**

1. Document the delivery of enhanced enforcement (EE) efforts by an Integrated Road Safety Unit (IRSU) along the treatment corridor, including characteristics and quantity of deployment over a specified period of time.
2. Investigate whether a specific Enhanced Traffic Law Enforcement (ETLE) initiative can be shown to reduce driver speeds on a selected corridor, relative to two corridors with no ETLE.

Context

Speeding is one of the most frequently cited unsafe behaviours of drivers today—averaging nearly 200,000 violation tickets per year in BC—and often has devastating effects (PSB, RSU, 2014). According to ICBC (2014), speed is the leading contributor in fatalities resulting from motor vehicle collisions. Although collisions causing injury and damage have great financial impacts, the resulting trauma and loss of life is the greatest cost.

Recent analyses of motor vehicle incidents in BC from 2012 to 2013 reveal that both fatalities (-22%) and injuries (-7%) related to speeding have decreased (ICBC, 2014). However, speeding continues to be a dangerous driving behaviour; similar to previous years, speeding-related violation tickets made up 43 percent of all IRSU violation ticket outputs in 2013 (Policing and Security Branch, RSU, 2014). Within the provincial context, "enhanced enforcement contributed 23% of all speed-related violation tickets to the provincial total" (p. 21).

Various studies have shown an escalation in both injury severity and fatalities as driving speeds increase (Ossiander & Cumming, 2002; Rock, 1995). The greater the travelling speed of the vehicle, the greater the amount of energy that must be dissipated in stopping that vehicle, as compared to a slower travelling vehicle (Gimotty & Chirachavala, 1982). Speed impacts not only the probability of a crash, but the resulting severity as well (Sisiopiku & Patel, 1997). Increased speeds translate into decreased time for drivers to process information and make a decision, such as whether to brake (Arason, 2014). As a result, when it comes to speed, every second counts.

For that reason, speeding remains an important public safety concern. As such, numerous initiatives have been put forth in order to combat this hazardous, yet common, road behaviour. One of the most widely used and implemented techniques against speeding is EE. The exact condition under which EE is optimized continues to be a subject of study. The current study attempted to contribute to this topic by investigating enhanced traffic enforcement and driver speeds in specific corridors.

Study Overview

The SCDP examined an enhanced traffic enforcement initiative and driver speeds on a selected corridor. The study took place from March through August, 2014. A pre-post study design, with comparison groups, was used to describe and compare instances of speeding, with speeding being defined as travelling above the posted speed limit. Driver speed was observed along three corridors during the study period. One corridor was used as a treatment corridor (64th Avenue); two served as comparison corridors (32nd Avenue and 16th Avenue). Each study corridor ran east-west in Surrey, BC.

This was a descriptive study. Given the small number of corridors and that the sample was non-representative, it is not appropriate to generalize the results to circumstances or timelines beyond those of the study.

Study Design

The project involved two time periods. The first is a *baseline phase* from March through April, 2014. During the baseline phase, all three corridors experienced only standard traffic enforcement. The second is an *intervention phase* from May through August, 2014. During the intervention phase, the treatment corridor received an intervention in the form of EE. The comparison corridors continued to receive only standard traffic enforcement during this time. This represented a 'change/intervention' on the treatment corridor, in the form of EE.

The primary outcome measures were:

1. A reduction in the proportion of vehicles travelling at or greater than 15 km/hr above the speed limit on the treatment corridor from the baseline to the intervention as compared to the comparison corridors.

2. An increase in the proportion of vehicles travelling under the speed limit on the treatment corridor from the baseline period to the intervention period as compared to the comparison corridors.

Results

The SCDP was RSU's first attempt to investigate whether EE could be shown to reduce the proportion of drivers speeding on one corridor, relative to two corridors receiving baseline traffic enforcement only.

- All corridors experienced some increases in proportion of speeders from baseline to treatment. This was not unexpected and occurred perhaps as a result of seasonality (i.e., more opportunities to speed in summer months).
- We observed a *decrease* in proportion of vehicles exceeding the speed limit by 15 km/hr or greater on "enforcement days" as compared to "non-enforcement days" on the corridor that received enhanced enforcement.
- We observed a moderate inverse correlation between intensity (number of hours) of EE and proportion of speeders on the corridor that received enhanced enforcement, suggesting that as hours of EE increase, proportion of speeders decrease and vice versa.
- For the most part, *we were unable to observe the anticipated results*. Specifically, the results regarding vehicles exceeding the speed limit by 15 km/hr and greater suggest that the results seen in the analysis of "enforcement days" compared to the "non-enforcement days" on the Treatment (64th Ave) were not able to be observed over a longer term and relative to the Comparison corridors.
    - There are a number of likely factors that can help to explain why this occurred: (1) deflated speeds on the Treatment (64th Ave) during the baseline phase, (2) non-ideal comparisons; (3) the presence of other external factor(s) that impacted the treatment corridor differently than the comparisons.

As such, the following speed-related observations document what was observed, but cannot be said to have occurred as a result of EE.

Speed-Related Observations

- For the most part we were unable to observe the anticipated results.
  - However, relative to the comparison corridors, we observed an *increase* in the proportion of vehicles travelling *under* the speed limit on the corridor that received EE.
  - And relative to the comparison corridors, we observed a *decrease* in the proportion of vehicles travelling 15 km/hr or more *over* the speed limit on the corridor that received EE, specific to the overnight period (midnight to 6am).

Enforcement Indicator Observations

- Over the course of the 6-month study, 2,373 total VTs were issued by either FV-IRSU or Surrey MT.
  - Surrey MT issued 7 VTs during the 2-month baseline phase
  - Surrey MT issued 171 VTs during the 4-month intervention phase
  - FV-IRSU issued 2,195 VTs during the 4-month intervention phase
- FV-IRSU delivered 186.5 hours of enforcement during the 4-month intervention phase.

Discussion

Several limitations presented challenges in this study. For the most part, the limitations resulted from the researchers having very little control over the naturalistic study setting. This was exacerbated by the challenges posed by factors completely external to the study such as seasonal differences over the course of the study and construction that took place on the treatment corridor. Although the comparison corridors were selected to control for these variations, we anticipate that some variations may have affected the treatment corridor differently than the comparison corridors.

Despite the fact that some promise has been shown with targeted enforcement programs, many researchers have been unable to establish lasting effects: though interventions may show signs of success during the treatment period, these effects are often reduced or eliminated upon removal of the treatment. For example, in the short term, driver speed tends to return to normal once drivers leave an area that is being targeted with enforcement. For this reason, sustained long-term benefits are most likely gained from enforcement that is more constant and permanent. Davis et al. (2006) indicated that for this reason, enhanced enforcement initiatives should be part of the larger standard traffic enforcement routines that are committed to over the long term. This is consistent with how EE is deployed in BC.

Speeding is a particularly challenging behaviour to modify especially given its social acceptability and pervasiveness. The findings of the SCDP make an important contribution to the body of literature given that we observed a decrease in the proportion of vehicles speeding on enforcement days compared to non-enforcement days. However, except in limited cases, we were unable to observe similar effects when comparing the baseline to the treatment phase relative to the comparison corridors.

Recommendations

1. *Develop a better understanding of when EE can be most effective in reducing speed related crashes, and provide police with tools to deter speeding when the behaviour is most dangerous.*
2. *Gain a better understanding of the effects of EE intensity on speeding behaviour.*
3. *Examine EE utilizing a research protocol that permits province-wide generalizability.*
4. *Examine the effect of EE accompanied by public awareness.*

CHAPTER 1: Introduction

The mandate of the Policing and Security Branch (PSB) is to provide adequate, effective, accountable policing and law enforcement throughout British Columbia. PSB sets the provincial policing priorities and direction for the provincial police force, the Royal Canadian Mounted Police (RCMP). The RCMP, through the Provincial Police Services Agreement, manages the contractual arrangement for the Provincial and the Municipal RCMP. In addition, PSB conducts audits of Independent Municipal Police Agencies to ensure policing standards are maintained.

The Insurance Corporation of BC (ICBC), in their commitment to road safety, have invested in enhanced traffic enforcement since 1996 (Policing and Security Branch, RSU, 2007). From 1996 to 2002, ICBC delivered direct payments to individual police agencies for officer overtime. In 2003, the Ministry of Public Safety and the Solicitor General, on behalf of the Province of British Columbia, entered into an agreement with ICBC whereby ICBC provides funding for enhanced road safety through the provincial government. It is the responsibility of the provincial government to administer the program including its delivery, management and evaluation. The Road Safety Unit (RSU), PSB carries out this administrative function and ensures officers have access to appropriate training through the Justice Institute of BC (JIBC). In 2003, a memorandum of understanding (MOU) was signed to solidify this relationship for a period of five years. Since that time, the MOU has been re-signed in order to provide long term and stable funding for enhanced road safety and to enable the development of a strategic road safety initiative.

The Speed Corridor Demonstration Project (SCDP) has been conducted by RSU under the Enhanced Traffic Enforcement Program (ETEP) of the Traffic and Road Safety Law Enforcement Funding Memorandum of Understanding between ICBC and the Ministry of Justice (JAG). The mandate of ETEP is “to reduce harm on roads and vehicle crimes in BC through targeted enhanced enforcement and awareness efforts” (Policing and Security Branch, RSU, 2014, p. 2). Overall funding provides the following:

- Evaluation
- Dedicated traffic enforcement units
- Research related to road safety
- Policy and oversight
- Consultation and collaboration
- Communications and advertising
- Intelligence-led policing and
- Work advancing the use of new enforcement technologies

Road Safety Unit

RSU holds the responsibility of delivering ETEP throughout the province. In this role, the unit works with ICBC and also with RCMP “E” Division Traffic Services. RSU responsibilities include:

- Financial and administrative oversight of ETEP
- Funding management for IRSU's, IMPACT[1] and BaitCar[2]
- Intersection Safety Camera program operation
- Support to the BC Association of Chiefs of Police Traffic Safety Committee

Five strategic principles govern ETEP delivery, one of which is effective monitoring, measurement and evaluation. As such, this study—the Speed Corridor Demonstration Project (SCDP)—fits within this framework.

Integrated Road Safety Unit Model

Enhanced road safety enforcement initiatives are delivered primarily through BC’s Integrated Road Safety Units (IRSUs). The IRSU model was established in 2004 and is made up of both RCMP and independent municipal police officers located throughout the province. IRSU officers focus solely on targeting dangerous driving behaviours that contribute to injury and fatality collisions. These dedicated enforcement units, along with targeted overtime campaigns, deliver streamlined traffic enforcement to address this province’s most serious road safety issues. Because traffic problems do not stop at municipal boundaries, IRSUs work across traditional police jurisdiction boundaries.

IRSUs proactively focus on five specific dangerous driving behaviours that regularly lead to serious injury or fatal collisions. The five targeted behaviours are:

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[1] The Integrated Municipal Provincial Auto Crime Team (IMPACT) is BC’s only integrated auto crime unit, which consists of specialized auto theft investigators from seven police agencies in the Greater Vancouver area and serves all RCMP and independent municipal police jurisdictions in BC.

[2] The BaitCar Program is a province-wide enforcement strategy within IMPACT. A bait car is a police vehicle disguised as a regular citizen’s car; bait cars are equipped with real time video and tracking systems allowing for remote vehicle disabling through a dispatcher.

1. Speed
2. Intersections
3. Impaired Driving (alcohol and drugs)
4. Seatbelts (unrestrained occupants)
5. Distracted Driving (using a handheld electronic device)

To accomplish these goals, approximately 180 officers are dedicated to IRSUs throughout four regions of BC.[3] These resources are above and beyond the standard baseline traffic enforcement[4] provided by agencies throughout the province in the form of enhanced enforcement (EE).

The Speed Corridor Demonstration Project

To date, the effect of EE on road safety compared to standard traffic enforcement has not been systematically measured. The Speed Corridor Demonstration Project (SCDP) marks ETEP's first attempt to compare road safety outcomes between areas receiving EE (IRSU enforcement + standard traffic enforcement) versus those with only standard traffic enforcement.

The SCDP was structured as a 'demonstration project' to determine whether a reduction in driver speed could be achieved with EE on a specific corridor in Surrey, BC. As opposed to an impact evaluation involving a more systematic and rigorous study design that controls for extraneous variables, the SCDP is much smaller in scale, with limited generalizability and the inability to attribute cause and effect. Therefore, results stemming from the SCDP determine whether a change in driver speed was observed in the presence of EE, implying a *possible association only*. After significant consultation among stakeholders, this approach was identified as the optimal use of financial and time resources, with the core benefit of providing a strong first step in examining EE in a BC context.

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[3] The four regions are: North, Southeast, Vancouver Island and Lower Mainland.

[4] In this report, "standard baseline traffic enforcement" is referred to as "standard traffic enforcement" in order to avoid confusion between that type of enforcement and the *baseline* phase of the study.

Project Goals and Objectives

The SCDP addresses the requirement of the April, 2012 MOU between ICBC and JAG to complete focused evaluations on ETEPs by March 31, 2015.

The specific objectives of the project were to:

1. Document the delivery of EE, including characteristics and quantity of deployment over a specified period of time.
2. Investigate whether a specific ETEP can be shown to reduce driver speeds on a selected corridor, relative to two corridors receiving standard traffic enforcement only.

Collaborators

Support for this project was provided by a working group with representatives from RSU, ICBC and RCMP, "E" Division Traffic Services.

The SCDP also utilized a contractor, NRG Research Group to:

- Download all speed reader board data
- Consolidate driver speed and traffic volume data
- Conduct statistical analyses
- Provide a summary of key findings

This contract was valued at $32,500 and was covered under the existing 2013/2014 MOU operations budget. Additionally, the costs associated with the procurement of nine speed reader boards ($82,538.23)[5] were covered under ICBC's Road Improvement Program, along with support from the City of Surrey.

Report Structure

Following this chapter, Chapter 2 provides a review of the recent literature on speed and speed-related collisions, as well as the value of enforcement activities that target speeding behaviours. That chapter closes with a summary of speed related initiatives and their evaluations. In Chapter 3, the quasi-experimental pre-post evaluation approach used in the SCDP is outlined with attention given to how the key performance measures of enforcement activity (hours of standard and IRSU traffic enforcement) and speeding behaviour were assessed.

[5] This includes the speed reader boards, labour and installation.

The key enforcement activity indicators—the number of enforcement hours conducted by standard traffic services and IRSU members throughout the study period on each of the study corridors—are examined in Chapter 4. Chapter 5 presents the speed-related data, in particular the distribution of vehicles travelling specific speeds, the proportion of vehicles speeding and traffic volume. Speed-related findings, with a focus on changes across the baseline and intervention phases on the Treatment corridor, relative to the comparison corridors, are examined in Chapter 6. As stated, this study is the first of its kind to evaluate speed-reduction strategies by IRSUs in British Columbia. Accordingly, Chapter 7 not only presents key findings and concluding remarks, but also documents the key limitations and associated considerations of this study that are relevant not only to the present context, but are also expected to be meaningful in planning further evaluations.

CHAPTER 2: Literature Review and Context

Overview

This chapter provides context for the study of EE in relation to speed within the wide array of speed prevention initiatives and associated evaluations. The relationship between speed and collisions, notably, the fact that higher speeds lead to increases in both serious injuries and fatal collisions, is discussed to highlight the purpose and value of EE in BC. The point is made that speeding is not only an undesirable behaviour, but an exceedingly persistent and most importantly, dangerous one. A summary of the theoretical framework on which standard and enhanced enforcement rests—deterrence—is outlined to reiterate the assumption behind traffic enforcement that drivers are rational, decision-makers. Effective techniques such as visible enforcement have been found to promote driving at safe speeds.

This chapter also considers the research that shows that in addition to deterrent effects of enforcement, driver attitudes and levels of social acceptability also play important roles in speeding behaviour. For this reason, some studies have focused on the effects of public awareness campaigns in concert with targeted enforcement showing a re-doubled effect of both interventions. Although it is acknowledged throughout the literature that it is particularly challenging to change driver behaviour in relation to speed, some promise has been shown in relation to targeted efforts. The caveat to the promising results is that it has been very challenging to show lasting effects. That is, researchers have found that once the intervention is removed, speeding behaviour typically returns to levels seen prior to the intervention. This suggests the need for more continuous enforcement in giving speed reductions lasting power. This chapter concludes with an overview of perceptions and attitudes around speeding behaviour and enforcement in BC.

Speeding Behaviour, Collisions and Road Trauma

Recent analyses of motor vehicle incidents in BC from 2012 to 2013 reveal that both fatalities (-22%) and injuries (-7%) related to speeding have decreased (TAS Database from Policing and Security Branch, RSU, 2013). However, speeding continues to be a dangerous driving behaviour; similar to previous years, speeding-related violation tickets made up 43 percent of all IRSU violation ticket outputs in 2013 (Policing and Security Branch, RSU, 2014). Within the provincial context, "enhanced enforcement contributed 23 percent of all speed-related violation tickets to the provincial total" (p. 21).

Speeding is one of the most frequently cited unsafe behaviours of drivers—averaging nearly 200,000 violation tickets per year in BC—and often has devastating effects (PSB, RSU, 2014). According to ICBC, speed is the leading contributor in fatalities resulting from motor vehicle collisions (ICBC, 2014). Although collisions causing injury and damage have great financial impacts, the resulting trauma and loss of life is the greatest cost. More than half of deaths that occur as a result of speed-related collisions happen on Friday, Saturday or Sunday with peak hours from 6pm to midnight (ICBC, 2014).

Various studies have shown an escalation in both injury severity and fatalities as driving speeds increase (Ossiander & Cummings, 2002; Rock, 1995). The greater the travelling speed of the vehicle is, the greater the amount of energy that must be dissipated in stopping that vehicle, as compared to a slower travelling vehicle (Gimotty & Chirachavala, 1982). Speed impacts not only the probability of a crash, but the resulting severity as well (Sisiopiku & Patel, 1997). Increased speeds translate into decreased time for drivers to process information and make a decision, such as whether to brake (Arason, 2014). As a result, when it comes to speed, every second counts.

Researchers from the Institute of Transport Economics in Norway (Elvik, Christensen & Amundsen, 2004) conducted an extensive review on close to one hundred speed studies looking at the effect of speed on crashes. These researchers concluded that there is a strong statistical relationship between speed and road safety. Specifically, as mean vehicle speeds decrease, the number and severity of traffic-related injuries decrease as well.

An Australian study conducted by Kloeden, McLean & Glonek (2002) examined the risk of road crashes occurring as a function of speed. Findings demonstrated that the risk of a fatal crash almost doubled with each increase of 5 km/hr above the speed limit. Conversely, even small speed reductions resulted in a significant decrease in the number of traffic crashes. Kloeden et al.'s research helped to discount the misconception that accidents are caused by slower drivers, as vehicles travelling at a reduced speed simply do not create a higher risk of a crash. As Canadian road safety expert and author Neil Arason (2014) puts it, "… the relationship between speed and road safety is causal and can be explained in terms of the elementary laws of physics and biomechanics…" (p. 85).

Despite the well-documented and highly publicized devastating effects of speed, speeding behaviour continues as evidenced by the fact that speed limits are commonly and consistently violated, with some researchers finding that as many as 30-50 percent of drivers exceed the posted speed limit at any given time (Elvik et al., 2004).

In 2014 the province of BC authorized raising speed limits on 1,300 kilometres of highway. In a study on speeding and road trauma in BC, Brubacher, Chan and Erdelyi (2015) found early evidence that increases in motor vehicle related trauma may be associated with increases to speed limits as evidenced by ambulance dispatch data. Though these findings did not prove cause and effect, they highlight the importance of a continued focus on speeding behaviour and are supported by research linking higher driver speeds and increased road trauma as outlined below.

Numerous theories exist as to why speeding is such a pervasive and persistent behaviour on the road. Shinar, Schechtman and Compton (2001) for example, suggest that inconsistent traffic enforcement, uncertain legal ramifications, insignificant penalties and permissive attitudes surrounding speeding play a role in promoting this dangerous behaviour. As such, much attention and resources have been put into helping to further understand and prevent speeding. Enhanced traffic enforcement has been one of the most popular methods to combat speeding (Davis et al., 2006). As discussed in Chapter 1, EE initiatives are delivered above and beyond standard traffic services and target specific driving behaviours such as speed.

General Theory of Deterrence

The general framework underlying both standard traffic enforcement and EE techniques is based on the theory of deterrence. Essentially, this theory states that behaviours are changed through an individual's perceived "cost" of engaging in a particular behaviour (Becker, 1968). Individuals are treated as rational beings, who weigh the potential rewards and punishments of their choices and decisions. When a person believes that the reward outweighs the punishment, they will engage in the behaviour. Alternatively, when they believe the opposite, they will not engage in the behaviour: the punishment will have a deterrent effect.

Key factors in the effectiveness of a deterrent include the perceived certainty, severity and swiftness of the punishment. In the case of speeding behaviour, when drivers believe they are likely to be caught and will receive a tough penalty immediately, the theory holds that they will be less likely to speed. The rationale is that this belief would be strengthened as visible enforcement is increased.

Value of Enforcement

In accordance with the deterrence theory, research shows that some of the most effective programs in reducing speeding behaviour include highly visible and increased levels of traffic enforcement. Indeed, enhanced enforcement has consistently shown a reduction in both injury and fatality crashes immediately after enforcement efforts have been increased, and for up to three to six months after (Arason, 2014; Redelmeier, Tibshirani & Evans, 2003; Davis et al., 2006; Blais & Gagne, 2010). What makes enforcement an attractive countermeasure to speeding is that it is a simple injury prevention option that can be fairly easily employed (Arason, 2014).

Enforcement Visibility

Visible enforcement is one way to deter drivers from disobeying speed limits. In 2009, the Illinois Department of Transportation conducted an evaluation of a Speed Enforcement Program administered by the Division of Traffic Safety. The main goal of the program was to decrease incidents of speeding through highly visible enforcement. Fifty-four county and municipal police agencies took part in this program for a six month period. Throughout the project, agencies logged over 30,000 hours of enforcement and wrote more than 63,000 citations, 82% of which were speed citations. Results of this study showed that, overall, average speeds were reduced after deployment of highly visible enforcement. The average reduction in speed ranged from 0.60 mph (just under 1 km/hr) in areas with a speed limit of 35 mph (approximately 56 km/hr) to 5.18 (8.3 km/hr) mph in areas with a 50 mph (80.5 km/hr) speed limit. It should be noted, that although average speeds decreased after the enforcement period overall, there were 11 agencies where speeds either did not change or increased slightly.

A 1977 report for the U.S. Department of Transportation (Graham, Paulsen & Gelennon, 1977) found that a stationary highway patrol car deployed on a two-lane rural freeway reduced speed by 4.5 km/hr as well as erratic vehicle maneuvers. Similarly, Richards, Wunderlich and Dudek (1985), in a report for the National Research Council, found that the most effective form of law enforcement was a visible uniformed police officer controlling traffic on the roadside.

In Sydney, Australia, Armour (1986) found that the presence of a visible police car stationed on an urban road reduced the number of speeding vehicles by approximately two-thirds. Whether the police actually stopped speeders or not did not appear to make a difference: the mere presence of the police seemed to act as a deterrent. However, Armour noted that drivers quickly returned to their normal driving behaviour after passing the police car, and suggested that in order to increase effectiveness, the police would need to increase the number of cars conducting enforcement. These studies demonstrate that having visible traffic enforcement is one way to positively manage driver speeds. That said, the optimal amount, and placement of the visible enforcement is a topic that requires more research.

Increased Enforcement

Increased traffic enforcement is an area that has shown particular promise with reducing driver speeds. Holland and Conner (1996) studied the effect of active police presence and intervention on speeding over a seven-week period. Results indicated that a decreased number of drivers broke the speed limit during the intervention period as compared to the baseline. This effect lasted, in a limited capacity, for up to nine weeks after the police presence was removed. The authors stated that though traffic flow was a significant contributor to the variance in vehicle speed, it could not account for the differences found between the various weeks examined, suggesting the intervention had been effective.

Vaa (1997) set out to reduce speeding by increasing levels of police enforcement, reaching a daily average of nine enforcement hours per day. Speeds for a two-week "before" period, six weeks of enforcement, and an eight-week "after" period were recorded and compared to speeds on another corridor. Vaa found a reduction in average speeds by 0.9 – 4.8 km/hr, depending on which speed zone was measured (i.e., 60 km/hr or 80 km/hr.) These average speed reductions held for all times of day, and lasted for up to eight weeks after the increased enforcement had ceased.

A 2006 study by Davis et al. (2006) concluded that "aggressive traffic enforcement" (such as using increased traffic patrol officers) had significant effects on motor vehicle crashes, including a three-fold decrease in fatalities related to speed. However, these authors maintain that to realize long-term benefits from aggressive enforcement, traffic patrol presence would need to be both constant and permanent. As such, future initiatives should note that in order for these positive effects to be sustained, the enhanced enforcement initiatives would ideally become a part of the larger standard traffic enforcement routines.

Other Speed Reduction Initiatives

Techniques other than EE have been utilized in attempts to decrease vehicle speed. It is possible that the use of EE initiatives combined with additional speed reduction techniques could offer the strongest potential for creating lasting effects with regards to vehicle speed.

Publicity and Media Campaigns

Along with EE, publicity and media campaigns are often used to educate and dissuade road users from unsafe road behaviours, with efforts mostly focused on anti-drunk driving and anti-speeding. One aim behind such campaigns is to increase awareness of road safety issues and gain public support in enforcement initiatives. By highlighting the dangers of speeding, public awareness campaigns help to link specific behaviours (such as speeding) to concrete negative outcomes (such as injuries, death, and punishment). Awareness campaigns help to shift social acceptability of dangerous behaviours, given the extreme damage that often results.

Tay (2005) re-evaluated the effectiveness of two such campaigns, with a specific focus on young male drivers and the combination of enforcement and awareness campaigns. His findings suggest a complementary effect between both anti-speeding enforcement and anti-speeding publicity campaigns. That is, neither was shown to be effective on their own, but together, they displayed an interactive effect. Tay explained that this result could be attributed to the fact that there are a variety of factors that contribute to speeding, and, as such, a combination of enforcement and education could lessen the limitations found in each individual technique. Tay also noted that many publicity campaigns are expected to have additional positive spill-over effects on different types of crashes.

Comparably, Illinois Department of Transportation's (2009) evaluation of their speed enforcement program (discussed above) also assessed a focused media campaign as part of the speed enforcement program. The campaign involved over 3,000 press conferences, radio and television pieces, banners, web announcements and distribution of posters to inform and educate the public about their project and the dangers of speeding. In fact, these researchers counted their media efforts as crucial to their program's overall accomplishments by maintaining that "effective speed programs depend on the interactions of laws and regulations, public awareness and attitudes, and high visibility enforcement programs" (p. 2).

Insurance and Financial-Based Programs

Speeding is a notoriously challenging behaviour to change, particularly with regard to creating lasting effects. Elvik et al. (2004) note that because most drivers who engage in speeding are often not caught, and thus only experience the "reward" of speeding and not the consequences, it is unsurprising that this behaviour is so difficult to adjust. As such, new programs, such as insurance and financially-based programs, that have been introduced to try to modify speeding behaviour have shown potential in reducing speeding.

A 2011 Bolderdijk, Knockaert, Steg and Verhoef examined the effects of "pay-as-you-drive" insurance fees on driving speed in the Netherlands. Specifically, drivers were offered explicit financial incentives for staying within the speed limit. Through collaboration with five Dutch car insurance companies, Bolderdijk et al. monitored driving speeds through GPS for a one year period. They found that, relative to both pre- and post-measurement periods, the pay-as-you-drive insurance fee meaningfully reduced young drivers' speed violations. This result suggests the merit of positive reinforcement initiatives on managing drivers' speeds, particularly among young drivers.

Lahrmann, Agerholm, Tradisauskas, Berthelsen and Harms (2012) studied "paying as you speed" in Denmark, where information of 153 drivers was linked to financial incentives during the periods when they did not speed. The link was done through "intelligent speed adaptation" (ISA) information. ISA links the speed of a vehicle with the speed limit of the road they are travelling on, and presents either advisory alerts or constriction on the vehicle's throttle. Lahrmann et al. found that ISA equipment was a particularly effective way to reduce speeds on rural roads. This equipment, however, was less effective at reducing mean free flow speeds and 85th percentile speeds. Further, when drivers turned the ISA equipment off, their speeds tended to revert back to baseline levels, suggesting a lack of general and long lasting deterrent effects.

Reagan, Bliss, Van Houten and Hilton (2013) tested the ISA system in the United States with the objective of reducing speeding that was more than 5mph above the posted limit. Their research followed 50 participants over the course of four weeks, alerting drivers who were speeding through auditory or visual advisory signals, with some drivers experiencing monetary incentives, or a combination of both signals and incentives. Results showed that the monetary incentive system had meaningful effects on speed, whereas the auditory and visual signals prompted only limited effects on speed reduction. Similar to Lahrmann et al.'s (2012) study, Reagan et al. also found that speeds reverted back to baseline measures after the intervention was removed. As found in other speed reduction programs, though interventions may show signs of success during the treatment period; these effects are often reduced or eliminated upon removal of the treatment. Again, due to the challenge of changing this persistent behaviour, these programs highlight the importance, within any program structure, of a long term commitment.

Automated Enforcement

Automated enforcement has also become fairly widespread and has shown encouraging results. In an evaluation out of BC, Chen, Wilson, Meckle and Cooper (2000) examined the effects of a photo radar program (PRP) on speed and traffic safety. The PRP was introduced as a response to unsafe speeding by the provincial government and ICBC in 1996. The stated objective of the PRP was to achieve a 3 percent decrease in average traffic speeds throughout the province. Researchers found that speeds were dramatically reduced at photo radar deployment sites, averaging a 50 percent decrease within seven months' time. Chen et al. also reported that the average speed at the monitoring sites declined by approximately 2.4 km/hr, which was attributed to the PRP. It is important to note however, that the PRP's success was also attributed to the public awareness that was raised throughout the program. That is, approximately 95 percent of insured BC vehicle owners were aware of the program prior to its introduction. Automated enforcement is especially beneficial in that it does not require the additional resources of individual officers, as drivers may automatically slow when they see the deployment sites.

In 2007, Carnis studied the effects of the introduction of automatic speed enforcement in the United Kingdom. Carnis notes that the UK currently has one of the largest automated enforcement programs in the world, along with some of the lowest numbers of traffic fatalities per capita, of any country. He estimated that as a result of the five thousand speed enforcement units, close to 1,800 people per year have been saved from serious injury or death.

In fact, in a systematic review of fourteen observational studies, Pilkington and Kinra (2005) found that the majority of automated enforcement cameras were effective to some level in reducing speeds and remained effective for up to three years after being introduced. Indeed, all of the reviewed studies reported a decrease in traffic fatalities and collisions, though these numbers varied significantly. Pilkington and Kinra also cautioned that most of the examined studies lacked a proper comparison group, and, thus, a more “controlled introduction of speed cameras was recommended…” (p. 333).

Public Attitudes

General attitudes and intentions towards exceeding the speed limits are important predictors in actual speeding behaviour (Kimura, 1993; Parker, Manstead, Stradling & Reason, 1992; Holland & Connor, 1996). Attitudes and intentions related to traffic safety have been examined across cultures, and remain an important area of study. These studies help to show why speeding behaviour can be so difficult to correct.

Shinar, Schechtman and Compton (2001; 1999) analyzed the relationship between self-reported safe driving behaviours (including, among other things, staying within the speed limits) and specific health and safety behaviours (such as not smoking, exercising, going to the dentist) among a representative sample of the US adult population (n=1250) from 1985 to 1995. Regarding speed, these researchers found that respondents viewed speeding as less of a safety threat than driving without wearing a seatbelt or driving while impaired. This finding is consistent with Harsha and Hedlund’s (2007) observation that the US media contributes to this road safety issue by suggesting that speeding is not only acceptable, but even desirable. In reference to these findings, Reagan et al. (2013) remark that there are important cultural differences in attitudes that relate to traffic safety.

In an Australian example, Tay (2002) found that many young, college-aged drivers held the belief that as long as they could “safely” speed and avoid detection, it was a socially acceptable behaviour. Even after holding both attitude and social norm constant, the risk of being caught for speeding was not shown to be a significant factor in reducing young drivers’ intention to speed. Many young drivers also held the belief that enforcement against speeding is mainly employed to raise revenue as opposed to increase road safety.

Warner, Ozkan and Lajunen (2009) examined whether there were any cross-cultural differences between Swedish and Turkish drivers’ ratings of their future compliance with the speed limit. Drivers from both countries completed a questionnaire which asked questions relating to attitudes, subjective norms, intentions and behaviour. Results from that study showed that drivers from Sweden (where there are fewer road fatalities and significant traffic safety initiatives when compared with Turkey) reported a more positive attitude and higher intention towards complying with the speed limit. Warner et al. reported that Turkey’s high road fatality rate is manifested in public attitude about road safety, where the violation of speed limits is the norm. The findings of these studies help to further illustrate the dangers of entrenched attitudes about speeding, across cultures. That is, any efforts that help to alter public attitudes towards speeding may have far-reaching effects.

BC Public Attitudes Survey

The attitude of BC drivers in relation to road safety and driving behaviours has also been measured. Specifically, RSU gathers information on self-reported driving behaviours and measures public attitudes regarding police traffic enforcement and road safety activities with the Public Attitudes Survey. The survey has been administered to drivers in six BC regions[6] annually from 2006 to 2012.

According to the results of 2012 survey, out of five driving infractions, such as driving a vehicle 20 km over the posted speed limit, running a red light, driving without wearing a seat belt, driving a vehicle while over a legal alcohol limit and driving a vehicle after consuming illegal drugs, speeding continues to be the most common self-reported driving infraction. Of all surveyed drivers, half (50%) reported that they drove a vehicle 20 km over the posted speed limit in the three months preceding the survey. This is in contrast to only 13 percent of drivers who reported that they failed to stop at a red light or a stop sign, the second most commonly self-reported infraction.

With respect to frequency, in 2012, 44 percent of all surveyed drivers in BC reported that they occasionally drove a vehicle 20 km over the posted speed limit; and 6 percent of all drivers reported that they did this regularly.

The perceived likelihood of a driver being caught for driving 20 km over the speed limit was assessed in the course of the survey. In 2012, 63 percent of all surveyed drivers believed that it was 'somewhat likely' or 'very likely' for a driver to be caught for engaging in this behaviour.

In response to a question regarding police enforcement, 91% of all surveyed drivers in 2012 viewed police as being either 'somewhat committed' or 'very committed' to enforcing traffic laws.

It is encouraging that nearly all of surveyed drivers find that police are committed to traffic enforcement; it is also reassuring that the majority of the drivers believe that speeders are likely to be caught. However, speeding continues to be the most common self-reported driving infraction, with half of drivers admitting that they continue to engage in unsafe speeding behaviour. These findings highlight the importance of effective speed enforcement projects and initiatives to identify issues, innovations and resources to target speeding, as it continues to be a serious concern and an evolving challenge.

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[6] Regions surveyed include: Vancouver Island/Coastal Region, the Capital Regional District, Fraser Valley Regional District, Metro Vancouver, Southern BC and Northern BC.

Summary

Speeding remains an important public safety concern. Studies have consistently shown that as driver speeds increase, the potential for, and severity of, collisions also increase. As such, numerous initiatives have been put forth in order to combat this hazardous, yet common, road behaviour. One of the most widely used and implemented techniques against speeding is EE. The exact condition under which EE is optimized continues to be a subject of study. The current study attempts to contribute to this topic and represents a first step in investigating enhanced traffic enforcement and driver speeds on one specific, urban corridor. Time of day, day of week, month, and type/amount of enforcement conducted will be examined in order to shed light on this important public safety issue.

CHAPTER 3: Study Design and Methods

Overview

The SCDP investigated an Enhanced Traffic Enforcement (ETE) initiative—EE—and driver speeds on a selected corridor. The study took place from March through August, 2014. A pre-post study design, with two comparison groups, was used to describe and compare instances of speeding,[7] with speeding being defined as travelling above the posted speed limit.[8] Driver speed was observed along three corridors during the study period. One corridor was used as a treatment corridor; two served as comparison corridors. Each study corridor ran east-west in Surrey, BC.

This was a descriptive study. Given the small number of corridors and that the sample was non-representative, it is not appropriate to generalize the results to circumstances or timelines beyond those of the study.

Study Design

The project involved two time periods. The first is a *baseline phase* from March through April, 2014. During the baseline period, all three corridors experienced only standard traffic enforcement. The second is an *intervention phase* from May through August, 2014. During the intervention phase, the treatment corridor received an intervention in the form of EE (IRSU traffic enforcement + standard traffic enforcement). The comparison corridors continued to receive only standard traffic enforcement during this time. This represented a 'change/intervention' on the treatment corridor, in the form of EE.

The primary outcome measures were:

1. A reduction in the proportion of vehicles travelling at or greater than 15 km/hr above the speed limit on the treatment corridor from the baseline to the intervention as compared to the comparison corridors.
2. An increase in the proportion of vehicles travelling under the speed limit on the treatment corridor from the baseline period to the intervention period as compared to the comparison corridors.

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[7] This study did not specifically examine excessive speed due to technical limitations of the speed reader boards.

[8] Posted speed limits represent the maximum speed that a vehicle may travel in ideal conditions.

This section will refer to the following terms:

- ***Baseline phase:*** The time period in which only standard traffic enforcement was conducted on all three corridors. This was a two month period from March through April, 2014.
- ***Intervention phase:*** The time period in which the treatment corridor (only) received the intervention of EE. The other two corridors continued to receive only standard traffic enforcement. This was a four month period from May through August, 2014.
- ***Treatment corridor:*** The one corridor that received EE during the intervention period.
- ***Comparison corridors:*** The two corridors that received only standard traffic enforcement throughout the entire study period.
- ***Standard Traffic Enforcement:*** Standard traffic enforcement efforts by Surrey Municipal Traffic Units (Surrey MT), delivered as usual.
- ***Intervention:*** EE efforts by FV-IRSU plus standard traffic enforcement delivered by Surrey MT.[9]

Table 1 outlines the baseline and intervention phases, and the type of traffic enforcement that occurred on each of the participating corridors during those phases.

Table 1: Enforcement Time Period[10]

	Baseline Phase *March 1st to April 30th*	***Intervention Phase*** *May 1st to August 31st*
Treatment Corridor	Standard Traffic Enforcement (delivered by Surrey MT)	IRSU Enforcement (FV-IRSU) + Standard Traffic Enforcement (delivered by Surrey MT)
Comparison Corridors	Standard Traffic Enforcement (delivered by Surrey MT)	Standard Traffic Enforcement (delivered by Surrey MT)

The Baseline Phase

The baseline phase involved only standard traffic enforcement along all three corridors. FV-IRSU did not conduct enforcement on any of the three corridors during the baseline phase. In this sense, the baseline phase does not represent a 'status quo' condition of the ETEP initiative

[9] For the purposes of this study, we have not separated IRSU and Surrey MT enforcement delivered on the Treatment, and instead included them both under the umbrella EE.

[10] According to the BC Association of Chiefs of Police enforcement calendar, the following Road Safety Provincial Enforcement Campaigns took place during the study period: *High Risk Driving Campaign* (May, 2014) and *Impaired Driving Campaign* (July, 2014).

as IRSU's are designed to augment standard traffic units on a regular basis. The removal of IRSU enforcement during the baseline phase does represent an irregularity; however, this was necessary in order to create a true 'intervention' on the treatment corridor during the intervention phase.

The Intervention Phase

The treatment delivered during the intervention phase consisted of EE efforts by FV-IRSU on top of standard traffic enforcement. FV-IRSU was directed to treat the treatment corridor (i.e., 64th Avenue) as a 'high crash corridor' in terms of operations and enforcement schedule/attention and to intensify their efforts in addressing speeding. As such, the IRSU enforcement, as an intervention, represented an intensified speed enforcement effort, and may not be representative of typical enforcement by IRSU's. Normally, IRSU's would target speeding behaviour in drivers on a periodic basis only; however, for the SCDP, they addressed speeding behaviour on a regular, weekly basis on the treatment corridor during the intervention period.

Enhanced Enforcement

The delivery of stationary speed enforcement by FV-IRSU was carried out in two separate manners throughout the intervention phase: uniformed and highly visible police using marked police vehicles and police motorcycles (visible) and covert members with unmarked covert vehicles and visible enforcement.

s.15

Despite the focus of officers on speeding behaviours, it was in the purview of FV-IRSU officers to enforce any illegal behaviours that they noticed (e.g., seatbelt infractions; running a red light).

Measurement of Enforcement Activity

Enforcement data along the corridors were gathered to quantify the levels of enforcement provided by FV-IRSU and Surrey MT. s.15

s.15

s.15

s.15 that reason, an enforcement activity indicator (EAI) form was developed specifically for use during this study (see Appendix E).

For the duration of the study, police were asked to complete a one-page electronic EAI form each time they conducted enforcement on any of the study corridors, with a separate form for each section of the corridor they were on. For example, if they conducted enforcement on two sections of 64th Avenue, they were asked to fill out two forms. Once per week, police emailed their completed forms to a member of the study working group.

These EAI forms collected data on:

- Hours, type, and location of EE or standard traffic enforcement
- Number of vehicles pulled over
- Number and type of violation tickets[11] and administrative sanctions issued, *Criminal Code* charges laid and vehicle impoundments ordered
- Visibility of enforcement (EE only)

At the outset of the study, presentations on the SCDP and the EAI forms were delivered to each shift of FV-IRSU and Surrey MT. Police were provided with instructions on study design and on how to complete the EAI forms.

The inclusion of the enforcement activity data enabled:

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[11] The EAI form included a section on "violation information" that asked police to select from a list the specific speed-related violations for which they issued tickets. In addition to specific speeding violations, the forms included a section on "all other charges" which included other non-speeding violations such as other violations against the *Motor Vehicle Act,* immediate roadside prohibitions (IRPs) and *Criminal Code* traffic violations. Because the focus of this study was speed, data on other violations was not broken down.

1. The documentation of the delivery of EE efforts by an IRSU along the treatment corridor including characteristics and quality of deployment over a specified period of time.
2. The quantification of the difference in enforcement efforts between the comparisons versus treatment corridors.

The Corridors

The SCDP took place in the Fraser Valley of BC (within the Lower Mainland District). The identification of the Fraser Valley was not intended to be representative of BC and its selection was made for the following reasons:

- Implementing the study within the Lower Mainland District (LMD) ensured that the project would not conflict with another demonstration project, which was planned to take place outside of the LMD during 2014.
- The region is policed by FV-IRSU and the Surrey RCMP Detachment traffic unit, both of which have ongoing communication with the lead agency, JAG.
- The RCMP "E" Division Traffic Services is a partner on the Steering Committee overseeing the SCDP which would assist with the liaising necessary to implement the study design with participating police and FV-IRSU.

The three specific study corridors were selected based on a number of considerations: each corridor is a municipal road in Surrey, providing East and West commuter access, minimal number of Intersection Safety Cameras and safe police enforcement zones. Due to limitations around corridor selection and placement of speed collection technology, it was not possible to select three corridors that were similar in length, traffic volume, and road characteristics. However, given the proximity of the corridors to one another, they shared weather patterns.

The longest and most northerly corridor was assigned to the EE intervention. The other corridors served as comparisons, and did not receive an IRSU intervention. Regular, standard traffic enforcement occurred on all three corridors (see SRB coordinates in Table 2).[12]

- ***Treatment:*** 64th Avenue (120th Street to 196th Street)
- ***Comparison 1:*** 32nd Avenue (152nd Street to 184th Street)
- ***Comparison 2:*** 16th Avenue (140th/Nichol street to 172nd Street)

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[12] See Appendix A for a map of study corridor locations.

Table 2: Study Coordinates and Speed Reader Board (SRB) Locations

	Corridor	Section	Coordinates	SRB Location	Speed Limit	Vehicle Direction
Treatment	64th Ave.	West	120th St. to 144th St.	121st St.	50	WB
Treatment	64th Ave.	Middle	144th St. to 172nd St.	146th St.	60	WB
Treatment	64th Ave.	East	172nd St to 196th St	189th St.	50	EB
Comparison 1	32nd Ave.	West	152nd St to 168th St	162nd St.	60	WB
Comparison 1	32nd Ave.	East	168th St to 184th St	172nd St.	60	EB
Comparison 2	16th Ave.	East	King George Blvd. to 172nd St.	170th St.	60	WB

The Treatment Corridor: 64th Avenue

64th Avenue is an east-west running corridor between 120th Street (Scott Road) and 196th Street. Spanning 15.4 km, it is bordered by the cities of Langley to the east and Delta to the west. This corridor travels through the Surrey communities of Cloverdale in the east and Newton in the west.

Within the corridor, lanes vary from one lane each way to two lanes per direction alternatingly along the corridor. About half of the corridor consists of a two lanes per direction divided by a low median. While most users of 64th Avenue are motorists, sections of the corridor also have separate bike lanes. A number of bus routes are located on the corridor with approximately 30 bus stops along the corridor (there is a bus stop within approximately 30 metres past one of the SRBs, located at 64th Avenue and 146th Street). Posted speed limits along the corridor vary from 50 km/hr to 70 km/hr with SRBs placed in two 60 km/hr zones and one 50 km/hr zone.

Development along 64th Avenue is mixed-use including single-family residential, low-rise medium density residential, commercial, and public spaces such as parks. 64th Avenue also runs through some agricultural land between 165th Street and 152nd Street. It has several public buildings and commercial centres of small to medium capacity as well as schools and a fire station.

Comparison 1: 32nd Avenue

32nd Avenue is approximately 6.5km south of 64th Avenue and also runs east-west. The section of the corridor that served as a comparison spans 8.9km and travels through the community of South Surrey. It is bordered by 152nd Street to the west and 184th Street to the east.

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This corridor mostly accommodates one lane of traffic in either direction and is alternatingly divided by low medians, center turning lanes, center painted medians and center double lines (one section of 32nd Avenue between 152nd Street and 154th Street has two lanes per direction). The speed limit is 60 km/hr along the entire corridor. In addition to regular motorists, the corridor also sees heavy truck volume and has separated bicycle lanes. 32nd Avenue has intersection lights in five locations along the corridor (154th, 160th, 168th, 176th and 184th).

Development along the corridor is primarily comprised of multi-family residential and large rural properties with driveways onto the corridor. 32nd Avenue also has parks, a cemetery, a fire hall and a golf course.

Comparison 2: 16th Avenue

16th Avenue is also an east-west running corridor, and is just less than 10km south of 64th Avenue. The section of the corridor that served as a comparison spans 2.1 km and is located in South Surrey between King George Boulevard on the west and 172nd on the east.

16th Avenue, for the most part, accommodates one lane of traffic in either direction, except for a short stretch between King George Boulevard and 162nd Street (which has two lanes of traffic in either direction). Small portions of the corridor are divided by center turning lanes and center painted medians, specifically, at the intersection with 168th Street; this intersection is the only intersection with traffic lights along the corridor. The speed limit is 60 km/hr throughout the entire corridor. 16th Avenue is also a designated truck route.

Development along 16th Avenue consists mainly of large rural properties and agricultural land and parks with some single-family residential and low-rise multi-residential housing. There is also a park east of the intersection at 168th Street.

The three study corridors are each main Surrey corridors, with the Treatment (64th Ave) experiencing more volume as measured by speed reader boards and higher density. The roads are used by commuters and are impacted by increased volumes during rush hours.

Speed Reader Boards and Site Selection

A preliminary analysis was conducted in order to assess the best technology to measure vehicle speeds and the appropriate placement of speed reader technology. During this analysis, several different technologies were considered including the installation of permanent inductive speed loops, the installation of temporary pneumatic hoses and the placement of electronic speed reader boards (SRB). It was ultimately decided that physical SRBs would be the most cost-effective and would provide the least disruption to roads. Please refer to Appendix F for more information pertaining to the selected SRBs.

Initially, nine sites were selected for SRB placement: three SRBs on each corridor. Ultimately, six SRBs were placed within the corridor boundaries as set out in the study design.

- 3 SRBs on the treatment corridor
- 3 SRBs on the comparison corridors

See Appendix C for descriptions of each SRB location and Appendix D for photos of each SRB location.

Capturing Traffic Data

Collection

SRBs were set up along each corridor to record traffic volume data as well as driver speeds for the duration of the study period. SRBs captured vehicles travelling in one direction only (see Table 2). The SRBs operated continuously throughout the six-month study period in "night-mode" so as to reduce impact on driver behaviour. In night-mode, the SRBs appear to be turned off and do not display driver speed. It is anticipated that operating in this mode helped to prevent driver reactivity (i.e., correcting speed due to the deterrent effects of the reader boards), although the SRBs were mounted on street light poles in visible locations and were trimmed with reflective materials.

It should be noted that SRBs capture *actual speeds* relative to the posted speed limits rather than *free flow vehicle* speeds.[13] The technology allowed vehicle speeds to be captured in ten categories in 15 minute intervals:

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[13] This is an important distinction as free flow vehicle speeds represent "the speeds at which drivers *choose* to travel when not hindered by obstacles; these obstacles include congestion, roundabouts, hills, or traffic enforcement cameras" (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/209104/free-flow-vehicle-speeds-2012.pdf) whereas actual speeds give a picture of driver speeds in light of restrictions that would be typical (i.e. an inability to speed during congestion). Although free flow speeds are better reflections of driver choice, it can be exceedingly difficult to approximate these conditions in a naturalistic setting. However, SRBs were located with attention to *approximating free flow speeds as best as possible* (placing SRBs away from intersections, roundabouts and other impediments where possible). A complete description of SRB sites is provided in Appendix C. In addition to road use information, this description identifies some of the obstacles drivers were presented with surrounding the SRBs.

1. Under speed limit by 2 km/hr or more
2. Approximate speed limit (under speed limit by 1 km/hr to over speed limit by 2 km/hr)
3. Exceeding speed limit by 3-6 km/hr
4. Exceeding speed limit by 7-10 km/hr
5. Exceeding speed limit by 11-14 km/hr
6. Exceeding speed limit by 15-18 km/hr
7. Exceeding speed limit by 19-22 km/hr
8. Exceeding speed limit by 23-26 km/hr
9. Exceeding speed limit by 27-30 km/hr
10. Exceeding speed limit by over 30 km/hr

Given the speed categories recorded by the SRBs, we were unable to capture absolute speed. Furthermore, speed data was captured relative to the posted speed limit in which it was placed (50 km/hr or 60 km/hr).

External Factors

A key challenge considered in the SCDP was the presence of external factors (e.g., traffic volume and weather), and how these might impact the study corridors. The comparison corridors were chosen to aid in controlling for the following external confounding factors:

- Weather/Seasonality
- Amount and type of media related to speeding
- Other events that might impact public attitudes, behaviours, and speeding within the study regions
- Other activities (e.g., surveys, campaigns) targeting drivers and/or driver behaviours

With respect to seasonality and weather-related changes, given that the baseline phase took place during the Winter/Spring and the intervention phase took place during the Spring/Summer, seasonal changes were expected. Weather variations mean that weather improves in the Spring and Summer consisting of less rain and more daylight hours. Seasonal variations contribute to traffic volume variations when public school is not in session during July and August and a large proportion of commuters take summer vacations. Together, weather and seasonal variations were anticipated to contribute to lower traffic volumes and more days of optimal road conditions, resulting in a greater opportunity to speed. *For these reasons, it was expected that the proportion of vehicles speeding from baseline to intervention would increase* *across all study corridors*. The advantage of including the comparisons is that given the expectation that this factor would affect all corridors, it could be controlled for.

Likewise, given the proximity of the study corridors and that they were located in the same city, we would expect publicity and other activities targeting driver behaviour (e.g., Road Safety Provincial Enforcement Campaigns) to affect each corridor similarly.

Despite the use of the comparison corridors, however, road construction was an important external factor, that occurred to a degree that was unanticipated by the study design and that appeared to have impacted the Treatment (64^{th} Ave) differently than the comparisons. Furthermore, the lack of specific data around the road construction that did occur was also unanticipated. This is discussed more fully in Chapters 5 and 7.

CHAPTER 4: Results Related to Enforcement Activity

Overview

As discussed, data on traffic enforcement activities were collected using Enforcement Activity Indicator (EAI) forms completed by both FV-IRSU and Surrey MT. EAI forms documented the date, time of day and location of the enforcement and also provided information on the number and types of violation tickets issued during the shift. EAIs completed by FV-IRSU members also included information on visibility of enforcement.

This chapter describes the data gathered by EAI forms. Specifically:

1. Enforcement hours per month
2. Enforcement hours per week
3. Visibility
4. Enforcement hours per corridor section
5. Enforcement hours per traffic unit
6. Number and type of violation tickets (VTs)

This chapter fulfills **Objective 1** of the SCDP as identified on page 10: to document the delivery of EE, including characteristics and quantity of deployment over a specified period of time.

Overall this chapter documents a wide variability of enforcement hours across the Treatment (64th Ave) with little (Comparison 1-32nd Ave) to no (Comparison 2-16th Ave) enforcement delivered on the comparison corridors. Within the SCDP, Enhanced Enforcement (EE) consisted of a much higher concentration of enforcement as compared to standard enforcement. Furthermore, EE resulted in 2,361 VTs in the intervention phase.

Key Concepts

Key concepts utilized in this chapter include:

- Enforcement hours
- Violation tickets

Enforcement Hours

This refers to the number of hours of traffic enforcement delivered to the quarter hour.

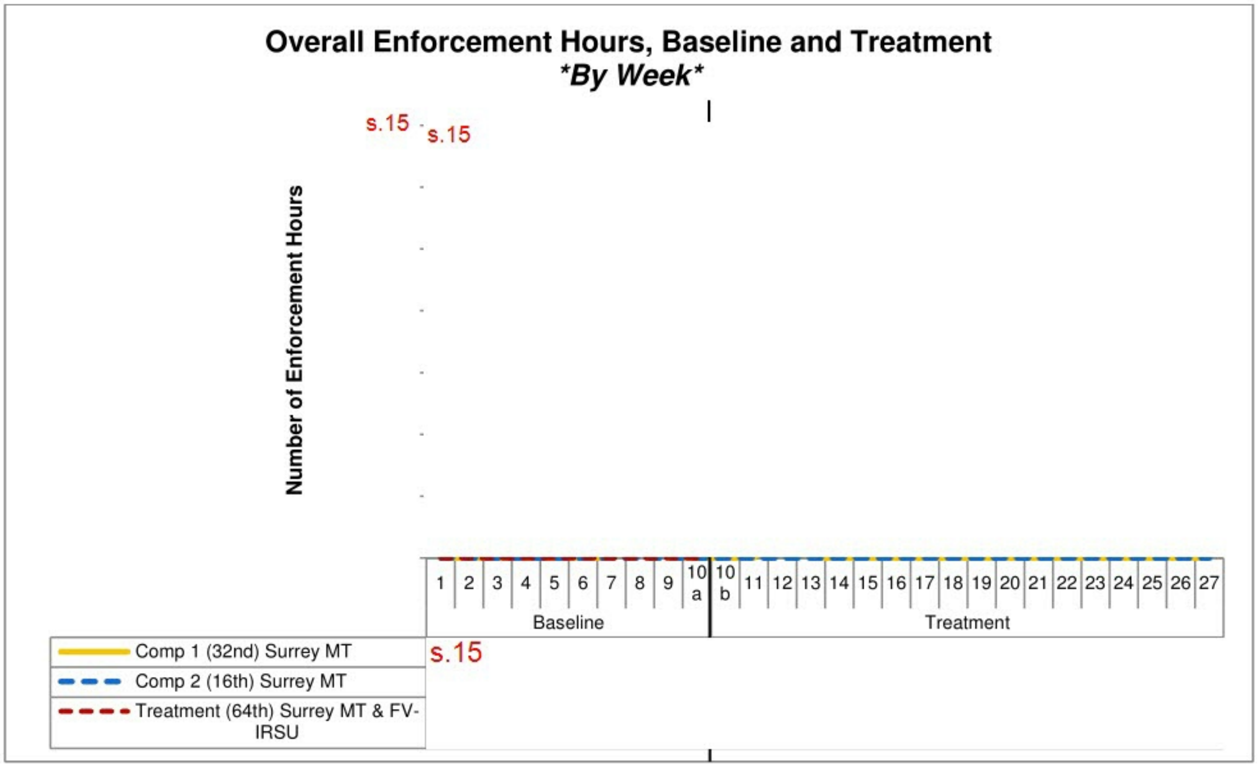
Violation Tickets

Violation tickets are those tickets administered by traffic enforcement officers for any traffic violation.

Overall Enforcement

The number of enforcement hours delivered on the study corridors throughout the SCDP varied widely week-by-week and across corridors (See Figure 1).

Figure 1: Overall Enforcement by Week[14] [15]



With respect to the Treatment (64th Ave), no traffic enforcement was delivered during the baseline phase. During the intervention phase, as expected, FV-IRSU delivered traffic enforcement in conjunction with Surrey MT's standard enforcement. This amounted to a total of s.15 of enforcement during the 17.5-week treatment (mean= s.15 per week; range s.15).

[14] See Appendix B for calendar dates for each week.

[15] Note: hours have been rounded.

Enforcement during the baseline phase amounted to:

- Treatment (64th Ave): s.15
- Comparison 1 (32nd Ave): s.15
- Comparison 2 (16th Ave): s.15

Enforcement during the intervention phase amounted to:

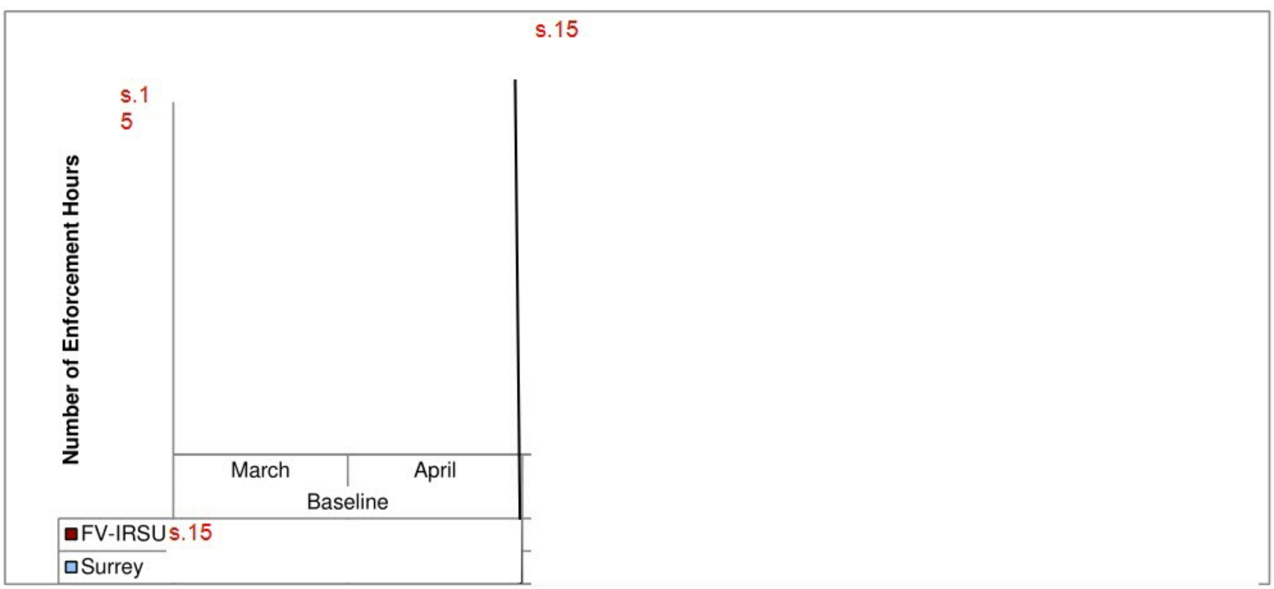
- Treatment (64th Ave): s.15 of standard traffic enforcement
- Treatment (64th Ave): s.15 of FV-IRSU enforcement
- Comparison 1 (32nd Ave): s.15 of enforcement
- Comparison 2 (16th Ave): s.15 of enforcement

It is typical to present data on the treatment (EE in this case) across the baseline and intervention phases for the Treatment (64th Ave). However, s.15 occurred on that corridor during the baseline. As such, data in this section focus exclusively on the intervention phase; data reported describes the treatment, which was up from s.15 in the baseline.

Enforcement by Month

During the intervention phase, Surrey MT delivered s.15 of standard traffic enforcement, primarily in June, in conjunction with an additional s.15 of enforcement delivered by FV-IRSU. FV-IRSU undertook the majority of their enforcement activities in May through July, with only s.15 in the month of August (see Figure 2).

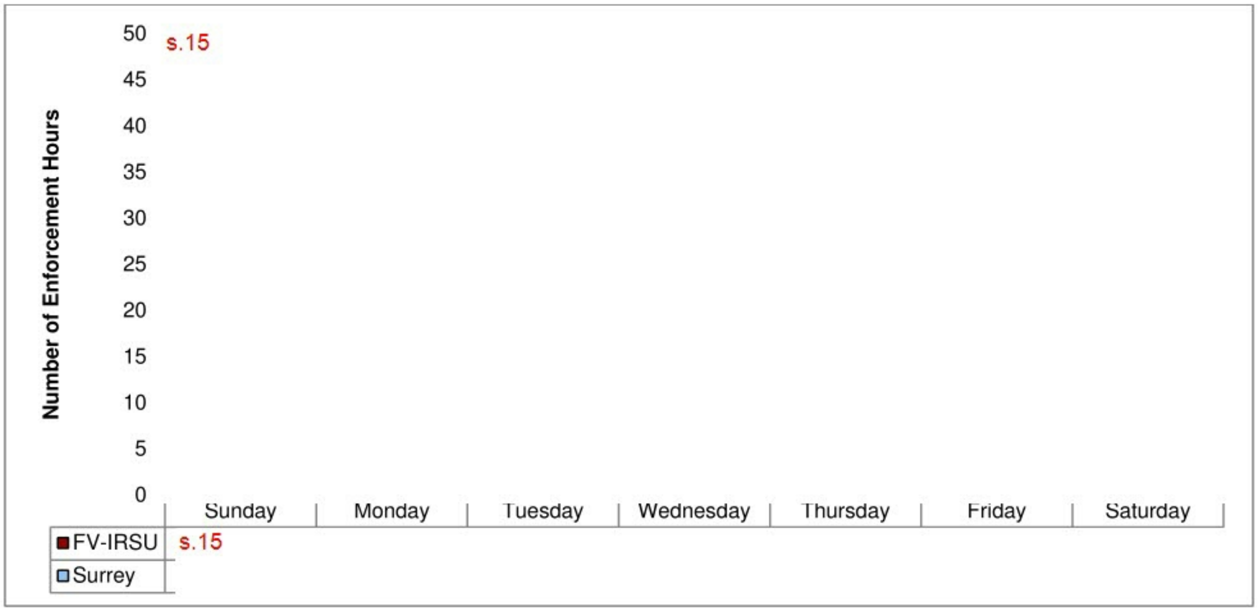
Figure 2: Enforcement Hours, Treatment Corridor, FV-IRSU and Surrey Traffic, By Month



Enforcement by Week

For the most part, enforcement was delivered on weekdays with FV-IRSU delivering the most hours on s.15 and an average of just over s.15 on each of s.15 s.15. Surrey MT, on the other hand, delivered the majority of their enforcement efforts on s.15), s.15 and s.15 (see Figure 3).

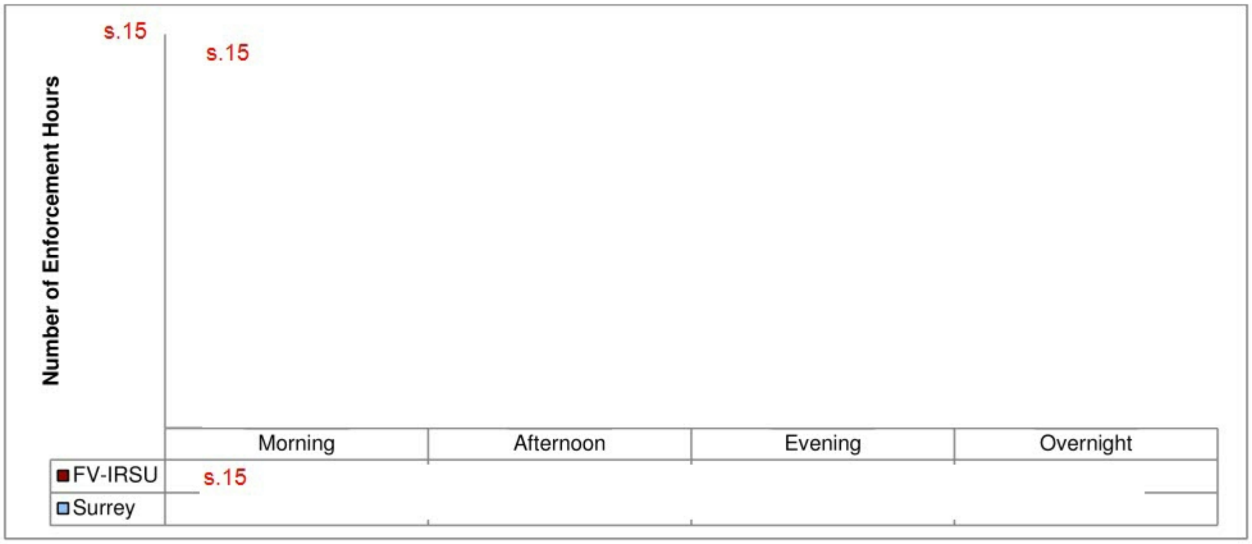
Figure 3: Enforcement Hours, Treatment Corridor by Day of the Week



Enforcement by Time of Day

As illustrated by Figure 4 below, there was a wide variation in the time of day during which enforcement was delivered. FV-IRSU primarily delivered enforcement during the s.15 s.15 and s.15 periods, with very minimal enforcement during the s.15 s.15 and nearly none s.15 during the s.15 period. Surrey MT delivered the majority of their enforcement during the s.15 period, amounting to s.15 with s.15 of enforcement being delivered in the s.15 and minimal s.15 in the s.15. Surrey MT did not deliver any enforcement during the s.15 period.

Figure 4: Enforcement Hours, Treatment Corridor by Time of Day

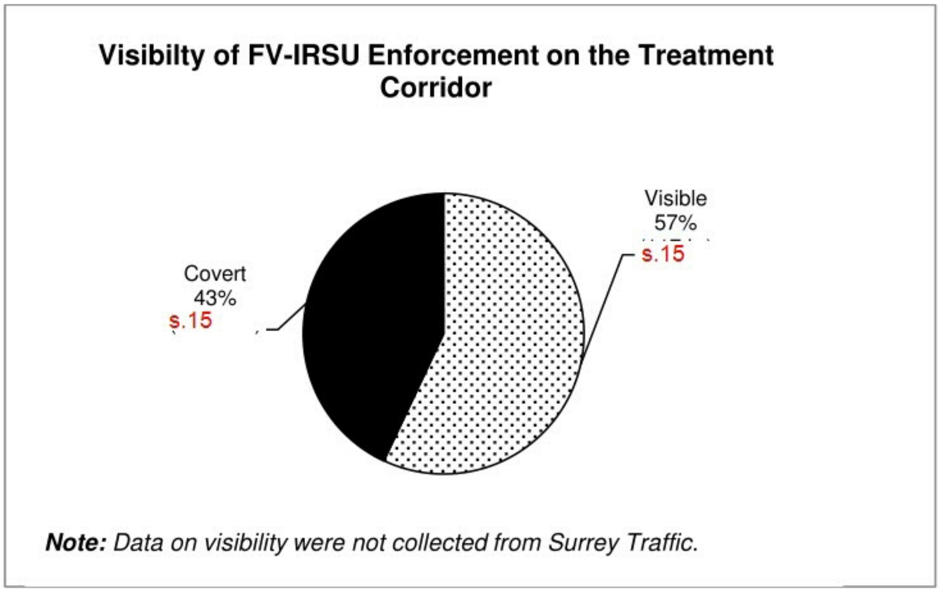


As stated, more than half of deaths that occur as a result of speed-related collisions happen on Friday, Saturday or Sunday, with peak hours from 6pm to midnight (ICBC, 2014), suggesting that these days and time periods have the highest risk. In contrast, the majority of enforcement occurred from Monday through Thursdays in the morning and afternoon. While it is beyond the scope of this research to direct future enforcement efforts, this discrepancy does suggest the need to develop a better understanding of speed enforcement can prove to be the most effective in reducing speed-related crashes.

Visibility

As discussed in Chapter 3, data on the visibility of enforcement teams were collected from FV-IRSU, but not from Surrey MT. Visible enforcement was slightly more common than covert enforcement, with 57% of enforcement hours being visible and 43% being non-visible or covert (see Figure 5).

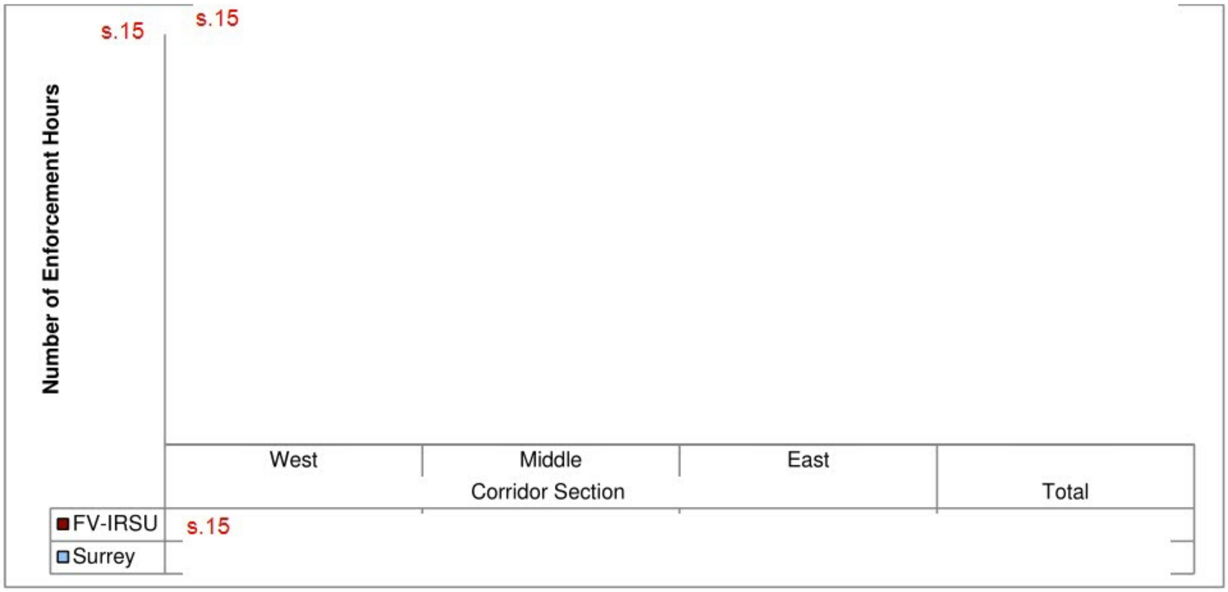
Figure 5: Visibility of FV-IRSU Enforcement on the Treatment (64th Ave)



Enforcement by Treatment Corridor Section

Along the Treatment (64th Ave), a total of s.15 of enforcement was delivered by FV-IRSU. The majority of these hours were delivered on the west (s.15 and middle portions (s.15 of the corridor. s.15 of FV-IRSU enforcement was delivered to the east portion of the corridor. Surrey MT conducted a total of s.15 of standard traffic enforcement during the intervention period. The majority of their enforcement was delivered in the west section of the corridor (s.15, with s.15 being delivered in the east section and s.15 delivered in the middle section (see Figure 6).

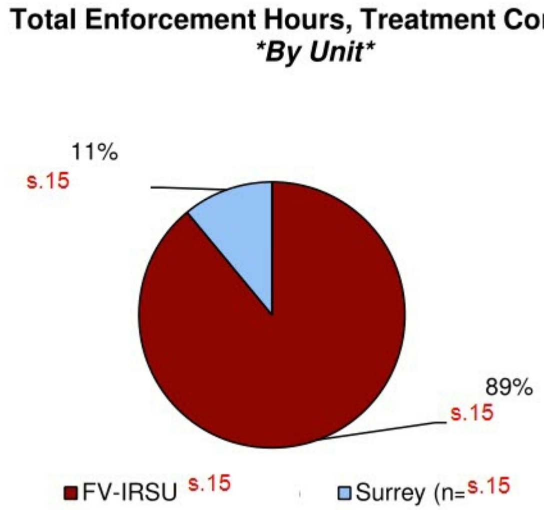
Figure 6: Enforcement Hours, Treatment Corridor by Corridor Section



Enforcement by Traffic Unit

A grand total of 231.5 hours of enforcement was conducted along the treatment corridor during the intervention phase of the study. Of the 231.5 hours, the vast majority (89%) was delivered by FV-IRSU. The remaining 11 percent was delivered by Surrey MT in the form of standard traffic enforcement (see Figure 7).

Figure 7: Total Enforcement Hours, Treatment Corridor by Unit



Note: *A total of* s.15 *of enforcement was conducted on the treatment corridor, all during the intervention period.*

Violation Tickets

During traffic enforcement, FV-IRSU and Surrey MT issued violation tickets (VTs) to drivers where appropriate, for speeding and other behaviours (e.g., speed relative to conditions, speed in municipality, speed against municipal sign, speed against area sign, excessive speed and a category that included all other charges). For the purpose of this study, we focused on the number of overall violation tickets that were issued, and the number of these that were speed-related violation tickets. This information is presented below in Table 3 and Figure 8.

Types of Tickets Issued

Over the course of the entire study period, 2,373 total VTs were issued by either FV-IRSU or Surrey MT (See Table 3). Specifically:

- Surrey MT issued 7 VTs during the baseline phase on any of the three study corridors—all 7 related to speed
- Surrey MT issued 5 VTs during the intervention phase on the comparison corridors—all 5 related to speed and 166 during the intervention phase on the Treatment (64th), one of which was speed related
- FV-IRSU (only out during the intervention phase on 64th) issued 2,195 VTs, 1,694 of which were speed-related

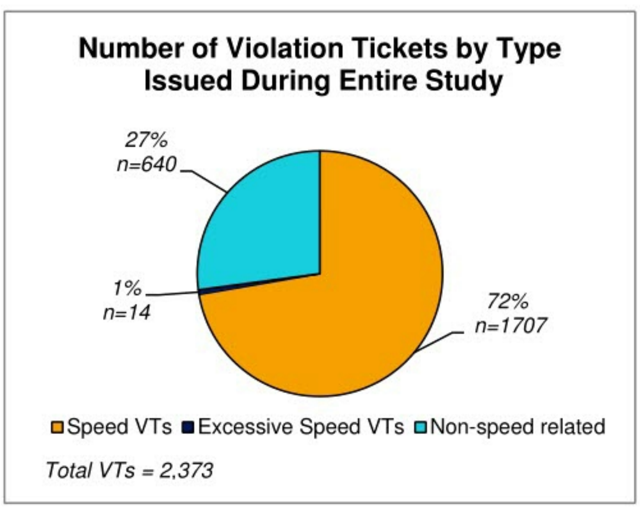
Table 3: Total Violation Tickets Issued

Total Violation Tickets Issued				
BASELINE				
Corridor		Comp 1 (32nd)	Comp 2 (16th)	Treatment (64th)
Non speed-related	*Surrey MT*	0	0	0
Speed Related	*Surrey MT*	7	0	0
Excessive Speed	*Surrey MT*	0	0	0
TOTAL VTs Issued in Baseline phase	***Surrey MT***	**7**	**0**	**0**
INTERVENTION				
Corridor		Comp 1 (32nd)	Comp 2 (16th)	Treatment (64th)
Non speed-related	*Surrey MT*	0	0	165
	FV-IRSU	*n/a*	*n/a*	487
Speed Related	*Surrey MT*	5	0	1
	FV-IRSU	*n/a*	*n/a*	1694
Excessive Speed	*Surrey MT*	0	0	0
	FV-IRSU	*n/a*	*n/a*	14
TOTAL VTs Issued in Intervention phase	***Surrey MT***	**5**	**0**	**166**
	FV-IRSU	*n/a*	*n/a*	**2195**

This represents **enhanced enforcement** delivered by Surrey MT + FV-IRSU

As discussed earlier in this chapter, 231.5 hours of EE took place on the Treatment (64th Ave) during the intervention phase. Accordingly, during the four month intervention phase, EE generated an estimated $350,000[16] in traffic fine revenue and consisted of an average of just over 10 VTs per working hour.

Figure 8 Type of VT Issued – Entire Study



Although officers continued issuing VTs for any traffic offence, nearly three-quarters (72%) of all VTs were speed-related with an additional 1 percent that were issued for excessive speed (in excess of 41 km/hr over the posted speed limit) (See Figure 8).

[16] Estimated revenue based on an average of $150.00 per traffic fine. This does not include the additional revenues associated with Immediate Roadside Prohibitions (IRP) as the IRP breakdown was not collected for the SCDP.

Summary

As discussed in Chapter 2, the theoretical framework that underpins traffic enforcement is deterrence—when applied to traffic enforcement, this theory assumes that in order to correct driver behaviour, drivers must be able to make the rational decision that such behaviour is overwhelmingly likely to have negative results (e.g. monetary fines). To achieve a deterrent effect, penalties must be certain, severe and swift. Although driver behaviour, and in particular speeding, is a challenging one to correct, especially over a longer term, when traffic enforcement is visible and when drivers are penalized for illegal and unsafe behaviour, these behaviours have been shown to be modified.

This chapter has helped to show the efforts of EE to influence drivers to maintain safe and legal road behaviour and has demonstrated the specific characteristics of EE deployment over a particular period of time on a single corridor when officers were asked to treat the corridor as they would a high-collision location.

Determinations as to the appropriate amount of enforcement were beyond the scope of this study. Instead, a key aim of the SCDP was to document the delivery of EE, including characteristics and quantity of deployment over a specific period of time. In this study, we were able to observe that EE appears to be considerably different than standard traffic enforcement, particularly due to the number of hours of enforcement. While very few hours of enforcement were delivered throughout the baseline and on the comparison corridors, in excess of 200 hours of EE were delivered on the Treatment (64th Ave) during the intervention. While this does not speak to whether this was the optimal amount of EE in order to achieve the desired results, it does suggest that EE, and in particular the activities of FV-IRSU, do indeed represent an enhancement over standard traffic enforcement.

CHAPTER 5: Speed Reader Board Data

Overview

This chapter is based on the analysis and summary of findings prepared by NRG Research Group.

As stated in Chapter 3, SRBs recorded data on vehicle speeds in ten speed categories. Given that SRBs captured the speeds of every vehicle that passed (one direction), data on traffic volume were also captured. This descriptive chapter summarizes the data related to vehicle speed and traffic volumes as captured by the SRBs. Data are presented on the following:

1. Distribution of all vehicle speeds, broken down by study phase for all three corridors
2. Average traffic volume by speed reader board, broken down by month, day of week, time period and study phase for all three corridors
3. Proportion of vehicles exceeding the speed limit by 15 km/hr+, broken down by day of the week and study phase in the Treatment (64th Ave)

With respect to distribution of vehicles throughout the ten speed categories, this chapter shows that proportions were, for the most part, stable (with some small increases) from baseline to intervention on all corridors. From this we can conclude that vehicles travelled at similar (or slightly increased) speeds across the entire study period within each corridor.

With respect to traffic volume, this chapter shows that the Treatment (64th Ave) had higher average traffic volumes than each of the comparisons—an expected finding given the road composition and motorist uses as described in Chapter 3.

The examination of speed distributions shows that on the Treatment (64th Ave) and Comparison 2 (16th Ave) more than half of vehicles were travelling at or lower than 6 km/hr over the speed limit. Conversely, only about a third of vehicles on Comparison 1 (32nd Ave) were travelling at or lower than 6 km/hr over the speed limit. This gives the overall sense that relative to the Treatment and Comparison 2, vehicles on Comparison 1 were moving faster throughout the entire study period.

Metrics and Key Terms

The following metrics and key terms are used in this chapter:

- Average daily volume
- Average daily volume per SRB

- Standard deviation
- Under speed limit
- Approximate speed limit

Average Daily Volume

Average daily volume is the gross traffic volume captured by SRBs, expressed as a rate per day.

Average Daily Volume per SRB

Average daily volume per SRB is the gross traffic volume captured by SRBs, expressed as a rate per day per single SRB. Because the corridors each have a different number of SRBs (a single SRB, two SRBs or three SRBs), there was a need to prepare an average per single SRB to permit comparisons of traffic volume across corridors.

Standard Deviation

Standard deviation is a measure of central tendency. The metric provides an illustration of how spread out the data are in light of the average (i.e., are the proportions of speeders similar across days? Or is there a large variation?). A standard deviation close to zero indicates that the data are not spread out and are very similar to average, whereas a standard deviation that is larger is found in datasets that have a high variance.

Within normal distributions, 95% of scores are within two standard deviations of the average. In this study, we have identified scores outside of two standard deviation from the average to derive a list of days deemed to have a significantly higher or lower than average proportion of vehicles exceeding the speed limit by 15 km/hr or greater.

Under Speed Limit

The category "under speed limit" represents the proportion of vehicles travelling at least 2 km/hr under the posted speed limit.

Approximate Speed Limit

The category "approximate speed limit" represents the proportion of vehicles travelling from 1 km/hr below to 2 km/hr above the posted speed limit.

Distribution of Vehicles by Speed Category

As shown in Table 4, *within each corridor*, fairly stable distributions of vehicle speeds from the baseline and intervention phase were observed. However, a different pattern emerges *between* *corridors*. Data show that the Treatment (64th Ave) and Comparison 2 (16th Ave) share similar traffic volume patterns, whereas Comparison 1 (32nd Ave) acts quite differently.

Table 4: Proportion of Vehicles per Speed Category on Each Corridor by Study Period

Corridor	Study Period	Under Speed Limit	Approx. Speed Limit	3 - 6 km/hr +	7 – 10 km/hr +	11 - 14 km/hr +	15 – 18 km/hr +	19 – 22 km/hr +	23 – 26 km/hr +	27 - 30 km/hr +	>30 km/hr +
Comparison 1 (32nd Ave)	Baseline	9.1%	5.5%	14.1%	17.3%	22.0%	13.7%	10.1%	4.0%	2.3%	1.6%
	Intervention	6.8%	6.4%	15.3%	17.8%	22.2%	13.6%	10.0%	4.0%	2.3%	1.7%
Comparison 2 (16th Ave)	Baseline	24.3%	11.0%	19.4%	16.7%	15.2%	7.0%	4.0%	1.3%	0.7%	0.3%
	Intervention	16.6%	13.2%	22.8%	18.8%	15.9%	7.0%	3.8%	1.2%	0.6%	0.3%
Treatment (64th Ave)	Baseline	21.2%	13.1%	20.9%	16.6%	14.6%	6.7%	4.1%	1.4%	0.8%	0.5%
	Intervention	18.3%	12.8%	21.2%	17.3%	15.7%	7.3%	4.4%	1.5%	0.8%	0.6%

Both the Treatment (64th Ave) and Comparison 2 (16th Ave) showed similar proportions of vehicles travelling either under the speed limit (21.2% vs. 24.3%, respectively), at the speed limit (13.1% vs. 11.0%, respectively), or 3 km/hr and above the speed limit (65.6% vs. 64.6%, respectively) during the baseline phase. This pattern holds for the intervention phase, where 18.3 percent of vehicles were observed travelling under the speed limit on the Treatment (64th Ave) versus 16.6 percent on Comparison 2 (16th Ave). We saw 12.8 percent of vehicles travelling at the speed limit on the Treatment versus 13.2 percent in Comparison 2 (16th Ave). Similar to the baseline phase, when examining the intervention phase, 68.8 percent of vehicles on the Treatment were observed exceeding the speed limit by 3 km/hr+ compared with 70.4 percent in Comparison 2 (16th Ave).

Conversely, Comparison 1 (32nd Ave) showed considerably differently patterns than the other two corridors, with only 9.1 percent of vehicles travelling under the speed limit in the baseline phase, 5.5 percent travelling at the speed limit, and 85.1 percent travelling above 3 km/hr over the speed limit. Similar proportions were recorded during the intervention phase, with 6.8 percent of vehicles travelling under the speed limit, 6.4 percent travelling at the speed limit and 86.9 percent travelling 3 km/hr and above.

It is encouraging to note that across corridors and study phases, very few cars were shown to be travelling at 27 km/hr and greater over the speed limit. That is, throughout the study, between 0.9 percent and 1.4 percent on both the Treatment (64th Ave) and Comparison 2 (16th Ave), and approximately 4 percent on Comparison 1 (32nd Ave) were dramatically exceeding the speed limit. The majority of vehicles (over 50%) were exceeding the speed limit by 6 km/hr or less throughout the entire study for the Treatment (64th Ave) and Comparison 2 (16th Ave). Just over one quarter of the vehicles on Comparison 1 (32nd Ave) were exceeding the speed limit by 6 km/hr or less, again demonstrating the different speed qualities that this corridor possesses.

Proportion of Speeders

In this section, the proportion of speeders exceeding the speed limit by 15 km/hr or greater on the Treatment (64th Ave) is discussed. Both the baseline and intervention phase are examined in order to display patterns observed.

Caveats to the Treatment Corridor

The average proportion of vehicles exceeding the speed limit by 15 km/hr or greater on the Treatment (64th Ave) for all of the days during the study period was 19.9 percent (SD=2.78%). In order to identify extreme values, it was imperative to use a metric to detect those values that were considerably higher or lower than what was expected. For this reason, all values outside of two standard deviations from the average were identified (two SD=5.56, so the normal range was considered to be 14.34% to 25.46%).

From the data on proportion of vehicles exceeding the speed limit by 15 km/hr or greater on Treatment (64th Ave), it can be observed that several days had a considerably lower than expected proportion of speeders (reflected in orange in Table 5), whereas very few days had a considerably higher than expected proportion of speeders (reflected in green in the Tables).

Table 5: Proportion of Vehicles Exceeding SL by 15 km/hr and Greater during Baseline—Treatment

Week	Mon	Tue	Wed	Thu	Fri	Sat	Sun
1	—	—	—	—	—	21.00%	11.60%
2	17.40%	15.90%	13.80%	14.20%	19.30%	13.70%	23.20%
3	20.80%	20.80%	21.30%	20.20%	15.60%	16.40%	19.00%
4	21.80%	23.10%	15.20%	22.00%	21.10%	23.60%	26.40%
5	21.40%	16.40%	17.80%	19.50%	17.10%	22.70%	23.10%
6	22.70%	20.50%	20.30%	17.50%	18.70%	20.40%	23.90%
7	19.20%	18.50%	20.40%	19.60%	19.20%	22.60%	24.00%
8	20.10%	19.50%	13.80%	12.10%	23.80%	22.10%	23.10%
9	23.40%	20.50%	17.10%	15.00%	20.90%	22.50%	21.30%
10	21.00%	20.80%	19.40%	—	—	—	—

Table 5 shows that within the 9.5 week baseline phase, six days experienced lower than expected proportions of speeders (ranging from 11.6% to 14.2% of vehicles), whereas only one day experienced a higher than expected proportion of speeders (26.4% of vehicles exceeding 15 km/hr). As shown in Table 6, on the other hand, only two days in the 17.5 week treatment phase had lower than expected proportions of speeders, while three days saw greater proportions of speeders than expected.

Table 6: Proportion of Vehicles Exceeding SL by 15 km/hr and Greater during Intervention—Treatment

Week	Mon	Tue	Wed	Thu	Fri	Sat	Sun
10	—	—	—	19.60%	17.50%	19.00%	10.60%
11	22.10%	21.10%	20.50%	15.00%	18.10%	21.30%	21.60%
12	18.90%	18.30%	18.10%	17.30%	17.90%	23.60%	24.90%
13	26.20%	22.30%	19.70%	18.20%	15.20%	21.30%	20.40%
14	18.70%	19.40%	18.00%	15.20%	19.30%	20.40%	21.60%
15	18.80%	18.80%	18.20%	18.90%	18.80%	20.00%	21.80%
16	18.50%	16.90%	18.30%	16.90%	14.30%	19.20%	20.80%
17	17.90%	19.90%	18.40%	15.90%	18.90%	18.30%	20.70%
18	17.90%	18.10%	19.00%	19.60%	16.50%	19.20%	22.10%
19	22.10%	22.10%	19.60%	19.40%	17.20%	18.90%	18.40%
20	17.60%	19.20%	19.30%	19.80%	19.80%	21.30%	23.20%
21	19.80%	21.20%	19.70%	20.40%	18.00%	22.90%	23.10%
22	21.30%	20.00%	14.80%	16.90%	20.70%	21.40%	23.30%
23	21.30%	21.30%	21.10%	21.70%	20.10%	24.30%	24.50%
24	25.90%	21.20%	20.50%	21.40%	21.00%	24.50%	25.70%
25	21.20%	17.50%	16.40%	18.60%	20.50%	21.90%	23.90%
26	21.10%	21.40%	21.20%	21.10%	20.20%	23.10%	23.60%
27	20.20%	21.10%	20.40%	20.60%	20.90%	23.10%	24.80%

The greater number of days with considerably lower than expected proportions of speeders during the much shorter baseline (in contrast to fewer days with lower than expected proportions of speeders during the intervention) may signal the presence of an external factor that deflated speeds on some days on the Treatment (64th Ave), primarily during the baseline.

In attempting to identify potential causes of these lowered proportions of speeders, there is at least one factor to consider: It is known that the Treatment (64th Ave) was the site of at least two capital construction projects (water main replacement and paving activities) in addition to other building projects during the study period. It is expected that this work resulted in lane closures and other disruptions that may have impacted the baseline phase more than the treatment phase by deflating the proportion of speeders. However, specific data on time and road closure activity is unavailable. As such, while we can assume that the anomalies present in the data point towards external factors—perhaps construction—this is not certain. Therefore, caution must be used in any comparisons between baseline and intervention phases on the treatment corridor.

Proportion of Vehicles Exceeding the Speed Limit by 15 km/hr and Greater

Chapter 6 includes a fulsome discussion of the proportion of vehicles exceeding the speed limit by 15 km/hr and greater. However, at this point, it is worth noting that, as demonstrated by

Table 7, the proportion of vehicles travelling in this category varied throughout the day. The largest proportion of speeders on the Treatment (64th Ave) and Comparison 1 (32nd Ave) were observed during the overnight period. In contrast, the largest proportion of speeders on Comparison 2 (16th Ave) was observed in the morning period during the baseline phase and the overnight during the intervention phase.

It is also imperative to note that the proportion of speeders on the Treatment (64th Ave) is much more similar to Comparison 2 (16th Ave) throughout both study phases (except overnight and morning during baseline) where about 10-25% of vehicles were speeding at any time of day on those corridors. This contrasts with about 25-50% of vehicles observed speeding in contrast to Comparison 1 (32nd Ave), another demonstration of the different speed qualities that the corridors possess.

Table 7: Proportion of Vehicles Exceeding the Speed Limit by 15 km/hr and Greater by Time of Day

Corridor	Time of Day	Speeders 15 km/hr + Baseline	Speeders 15 km/hr + Intervention
Treatment (64th Ave)	Overnight	20.70%	24.10%
	Morning	13.60%	14.70%
	Afternoon	10.40%	11.60%
	Evening	14.10%	14.20%
Comparison 1 (32nd Ave)	Overnight	39.10%	47.60%
	Morning	29.90%	29.10%
	Afternoon	27.70%	26.70%
	Evening	37.50%	35.60%
Comparison 2 (16th Ave)	Overnight	11.30%	21.70%
	Morning	14.30%	13.20%
	Afternoon	11.60%	9.80%
	Evening	15.90%	15.00%

It is also important to note that save for Comparison 2 (16th Ave) during the overnight period, the period of day with the greatest proportion of speeders was consistently the overnight period, followed by the evening period, on all corridors during both study phases. However, as we have discussed, s.15 [redacted] 6pm to midnight is the peak time for speed-related collisions resulting in fatalities. This suggests further research be conducted s.15 [redacted]
s.15 [redacted]

Traffic Volume

The following section provides descriptive data concerning the traffic volume observed on each corridor by:

- Month
- Study phase (Baseline/Intervention)
- Day of the week
- Time of day

Because each corridor had a different number of SRBs, total corridor volume is not an appropriate metric. For this reason, average daily volume per SRB is used. Recall, as discussed in Chapter 3, each SRB captured vehicles travelling in one direction only.

Average Daily Traffic Volume per SRB, by Month

Table 8 shows that the average daily volume per SRB varied within and across corridors by month. During the baseline phase of March and April, the Treatment (64th Ave) saw heavier volume than either of the Comparison corridors, with an average volume of 5,434 per SRB observed on the Treatment (64th Ave). In contrast, an average volume of 4,844 per SRB was observed on Comparison 1 (34th Ave) and an average volume of 3,799 per SRB was observed on Comparison 2 (16th Ave). That is, Comparison 2 (16th Ave) displayed the least traffic volume—the lower traffic density was an expected finding given geographic location, road use and that the corridor is almost exclusively made up of one lane of traffic in either direction whereas the Treatment (64th Ave) alternated from one to two lanes in either direction.

Table 8: Traffic Volume per Corridor by Month

Corridor	Month of Observation	Total Vehicle Count	Average Daily Volume Per SRB
Treatment (64th Ave)	March	492,039	5,291
	April	501,869	5,576
	May	493,294	5,478
	June	504,160	5,602
	July	512,297	5,509
	August	505,686	5,437
Comparison 1 (32nd Ave)	March	292,731	4,721
	April	297,955	4,966
	May	307,993	4,968
	June	293,727	4,895
	July	295,233	4,762
	August	292,716	4,721
Comparison 2 (16th Ave)	March	113,336	3,656
	April	118,241	3,941
	May	119,359	3,850
	June	111,413	3,714
	July	113,709	3,668
	August	107,550	3,469

During the intervention phase of May through August, this pattern continued, with an average volume of 5,507 per SRB observed on the Treatment (64th Ave) compared to an average volume of 4,837 per SRB on Comparison 1 (34th Ave), and an average volume of 3,675 per SRB on Comparison 2 (16th Ave).

Overall, throughout the entire study period there was minimal variation in average daily volume per SRB within each study corridor. For example, the range of average daily volume per SRB in the Treatment (64th Ave) was 5,291 to 5,602, compared to a range of 4,721 to 4,968 on Comparison 1 (32nd Ave) and 3,469 to 3,941 on Comparison 2 (16th Ave). Differences in average daily volume across the three corridors, however, were observed.

Average Daily Traffic Volume per SRB, Baseline to Intervention

It was also important to examine the average daily volume per SRB from the baseline to intervention phases. As shown in Table 9, the average daily volume per SRB was comparable between the baseline and intervention phase, within each corridor. That is, during the baseline phase, the Treatment (64th Ave) saw an average daily volume of 5,431 vehicles per SRB, compared with 5,508 vehicles during the intervention phase. Similarly, Comparison 1 (32nd Ave) saw an average daily volume of 4,842 vehicles per board in the baseline phase, compared to 4,836 vehicles during the intervention phase. Comparison 2 (16th Ave) saw an average daily volume of 3,796 vehicles per board in the baseline phase compared to 3,675 vehicles in the intervention phase.

Table 9: Traffic Volume per Corridor by Study Phase

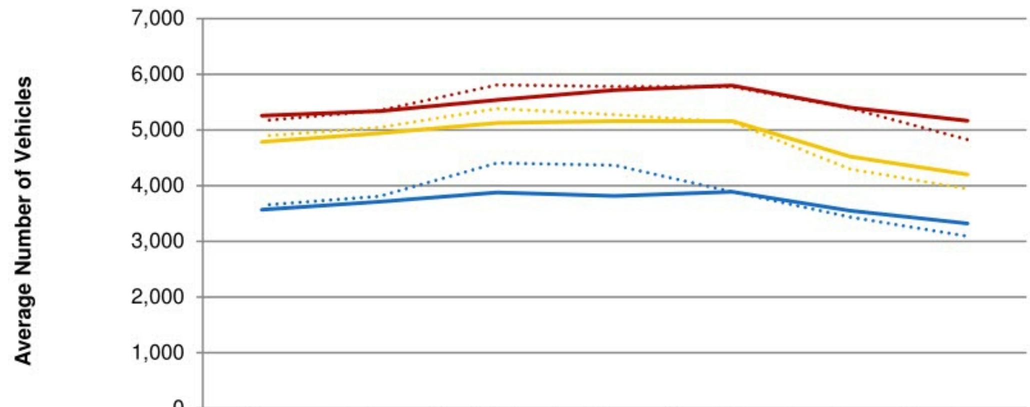
Corridor	Study Phase	Total Vehicle Count	Average Monthly Volume Per SRB	Average Daily Volume Per SRB
Treatment (64th Ave)	Baseline	993,908	165,651	5,431
	Intervention	2,015,437	167,953	5,508
Comparison 1 (32nd Ave)	Baseline	590,686	147,672	4,842
	Intervention	1,189,669	148,709	4,836
Comparison 2 (16th Ave)	Baseline	231,577	115,789	3,796
	Intervention	452,031	113,008	3,675

Average Daily Traffic Volume per SRB, by Day of the Week

A similar pattern emerged both between and within corridors when examining the daily traffic volume among the three corridors. Clearly, the Treatment (64th Ave) experienced more volume throughout both study phases than the Comparisons. Nevertheless, the daily volume along the Treatment (64th Ave) was fairly similar with the daily volume experienced in Comparison 1 (32nd

Ave). Throughout the entire study, an average daily volume of 5,451 vehicles in the Treatment (64th Ave) and 4,847 vehicles in Comparison 1 (32nd Ave) was observed. Comparison 2 (16th Ave) showed the least amount of daily traffic volume, with an average of 3,742 vehicles per SRB throughout the study (see Figure 9).

Figure 9: Average Daily Traffic Volume per SRB by Day of Week, Baseline and Intervention



	Mon	Tues	Wed	Thurs	Fri	Sat	Sun
Treatment baseline	5,166	5,348	5,807	5,782	5,774	5,389	4,828
Treatment intervention	5,257	5,338	5,541	5,714	5,800	5,401	5,165
Comp 1 baseline	4,888	5,042	5,385	5,273	5,144	4,300	3,941
Comp 1 intervention	4,784	4,941	5,125	5,159	5,159	4,519	4,198
Comp 2 baseline	3,649	3,807	4,407	4,369	3,891	3,433	3,092
Comp 2 intervention	3,570	3,711	3,876	3,813	3,892	3,550	3,321

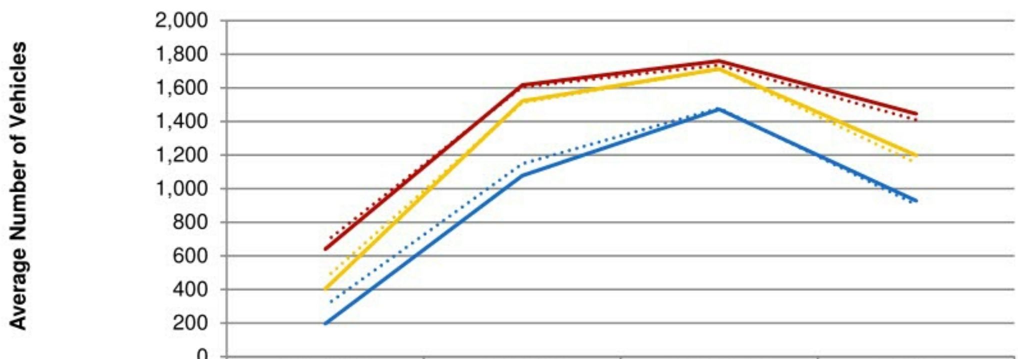
As illustrated by Figure 9, throughout the entire study period, all three corridors experienced the highest daily traffic volume on Wednesdays (average of 5,024 across all SRBs and all study phases) and Thursdays (5,018). The lowest traffic volume was observed on weekends, particularly Sundays; this pattern held across SRBs and across study phases (Saturdays average 4,432; Sundays average 4,091).

Upon further inspection of Wednesdays and Thursdays, we noted a seasonal pattern, particularly so for Comparison 2 (16th Ave). That is, average daily traffic volume decreased from the baseline phase to the intervention phase, across all corridors on these two days as would be expected given the shift from Spring to Summer. As the intervention phase took place during the summer months, this decrease in volume may be explained, at least in part, due to less predictable work schedules throughout the summer and varying traffic flows as a result.

Average Daily Traffic Volume per SRB, by Time of Day

Regarding average daily traffic volume per SRB by time of day, there were similar trends both within and between corridors from the baseline to intervention. Specifically, all corridors throughout the entire study experienced lower average daily traffic volume during the overnight period (midnight – 6am) when compared with the rest of the day. Comparison 2 (16th Ave) saw the largest decrease between baseline and intervention, with an average daily volume of 304 vehicles during the baseline and 196 during the intervention. This dramatic decrease was unique to Comparison 2 with Comparison 1 (34th Ave) and the Treatment (64th Ave) showing more modest decreases. As would be expected given commuter traffic, all corridors consistently experienced the highest traffic volumes during the afternoon period (noon – 6pm), followed by the morning (6am – noon) and evening periods (6pm – midnight) (see Figure 10).

Figure 10: Average Daily Volume per SRB by Time of Day, Baseline and Intervention



	Overnight	Morning	Afternoon	Evening
Treatment baseline	682	1,606	1,735	1,409
Treatment intervention	640	1,616	1,760	1,446
Comp 1 baseline	465	1,513	1,710	1,153
Comp 1 intervention	404	1,522	1,712	1,198
Comp 2 baseline	304	1,149	1,479	904
Comp 2 intervention	196	1,078	1,472	928

Summary

These data show that although traffic volumes varied by month, they did not dramatically change from baseline to intervention phase. It appears that there was some shift of traffic volume from mid-week (Wednesday and Thursday) during the baseline phase to the weekend during the intervention phase. However, Monday, Tuesday and Friday traffic remained relatively consistent throughout the study. Regarding changes by time of day, all corridors saw a decrease in the average daily volume per SRB for overnight periods although Comparison 2 saw a much larger decrease than Comparison 1 (32nd Ave) and the Treatment (64th Ave).

We expected that seasonal variations would decrease traffic volumes and perhaps provide an increased opportunity to speed due to more "room on the road." However, overall, the volume changes do not indicate a considerable change that would drastically impact the speed of traffic. All boards experienced similar patterns across the three corridors, though higher volume was noted for every period of the day/day of week in the Treatment (64th Ave).

CHAPTER 6: Results Related to Vehicle Speed

Overview

This chapter is based on the analysis and summary of findings prepared by NRG Research Group.

This chapter examines the key observations that emerged from this study. As discussed in Chapter 5, caution must be utilized when making any comparisons between the Treatment (64th Ave) and Comparison corridors given the differences between the corridors and the strong possibility that vehicle speeds on the Treatment (64th Ave) were deflated due to external variables during the baseline period. Furthermore, as discussed in Chapter 4, caution should be used when making comparisons between the baseline and intervention phases on the Treatment (64th Ave) given the presence of external factors (e.g., possibility of lane closures due to construction) that may have impacted the baseline differently than the intervention phase.

Additionally, given possible effects of seasonality on vehicle speeds as discussed, it is not surprising that proportion of speeders increased on all corridors from baseline to intervention. Although the comparison corridors were used to control for seasonality—and we would expect the Treatment (64th) to show more modest increases in proportion of speeders in light of enforcement activity—this caveat should also be kept in mind when interpreting results.

This chapter fulfills **Objective 2** of the SCDP as identified on page 10: to investigate whether a specific ETEP can be shown to reduce driver speeds on a selected corridor, relative to two corridors receiving standard traffic enforcement only.

The results in this chapter are organized into three parts as follows:

1. Enforcement days compared to non-enforcement days on the Treatment (64th Ave)
2. Change in vehicles exceeding the speed limit by 15 km/hr or greater on the Treatment (64th Ave) relative to the Comparison corridors
3. Change in vehicles travelling under the speed limit on the Treatment (64th Ave) relative to the Comparison corridors

With respect to enforcement days compared to non-enforcement days along the Treatment (64th Ave), this chapter will discuss two particularly encouraging findings: we observed a *decrease* in proportion of vehicles travelling greater than 15 km/hr over the speed limit on “enforcement days” as compared to “non-enforcement days” on the corridor that received enhanced enforcement. Furthermore, the results do suggest the presence of a moderate relationship between intensity of EE and a reduction in the proportion of speeders such that as the number of hours of EE increases, the proportion of speeders decreases.

Beyond that finding, this study shows that for the most part, a treatment effect that is the inverse of what would be expected was observed. We expected to observe a decrease in the proportion of speeders on the Treatment (64th Ave) relative to the comparison corridors (subject to enforcement inputs)[17]. However, as this chapter will show, in all but one specific time of day, the opposite was observed.

The exception to this finding was specific to the overnight period (midnight to 6am), relative to the comparison corridors, where we observed a *decrease* in the proportion of vehicles travelling 15 km/hr or more *over* the speed limit on the corridor that received enhanced enforcement.

Another encouraging finding was in respect to vehicles travelling under the speed limit. Relative to the comparison corridors, we observed an *increase* in the proportion of vehicles travelling *under* the speed limit on the corridor that received enhanced enforcement.

As this chapter will discuss, it is exceedingly difficult to attribute changes in proportion of vehicles speeding from the baseline to the treatment phases to EE given some of the complexities surrounding confounding variables and comparison corridor appropriateness.

Metrics and Key Terms

The following metrics are used in this chapter:

- Speeders
- Enforcement Days and Non-enforcement Days
- Percentage Point Change
- Odds Ratio and Treatment Effect

Speeders

In this chapter, "speeders" is used to refer to the category of vehicles exceeding the speed limit by 15 km/hr and greater.

Enforcement Days and Non-Enforcement Days

As stated, caution must be exercised when comparing the baseline and intervention phases on the Treatment (64th Ave). For this reason, we compared "enforcement days" and "non-

[17] We did not have control over the amount of enforcement delivered during the study, and thus could not predict the amount of enforcement that would be delivered and the amount of change expected.

enforcement days" on the Treatment (64th Ave) during the intervention phase *only*. "Enforcement days" are days that received any traffic enforcement from FV-IRSU and/or Surrey MT. "Non-enforcement days" received no traffic enforcement.

Intensity

The number of hours of EE delivered throughout the study varied from week to week as discussed in Chapter 4. This variation is understood as the "intensity" of enforcement. We utilize this concept in the examination of the relationship between intensity of EE and proportion of speeders.

Correlation

A correlation analysis illustrates the magnitude and direction of the relationship (association, not causation) between the intensity of EE and the proportion of speeders.

Percentage Point Change

In order to reflect the difference in proportions between the baseline phase and the intervention phase, and also between enforcement days and non-enforcement days, percentage point changes were calculated. This is, simply, the proportion in the intervention phase minus the proportion in the baseline phase. Consider the hypothetical example provided in Table 10:

Table 10: Illustration of Percent Point Change Metric

	Baseline	*Intervention*	***Percent point change***
Treatment	*15.1% (A)*	*14.5% (B)*	*(B-A) = -0.6*
Comparison	*27.3% (C)*	*27.6% (D)*	*(D-C) = 0.3*

As is evident in the hypothetical above, this metric is useful in examining a single corridor over time, but cannot establish change relative to a comparison.

Odds Ratio

In order to establish the direction and magnitude of the change from baseline to intervention on the Treatment corridor *relative* to the comparison corridors, we utilized the odds ratio (OR) metric. The OR provides the ratio of two odds. That is, a comparison of the odds of improvement with the treatment to the odds of improvement without the treatment. The formula is as follows:

$$OR = (Comparison_{Baseline} / Comparison_{Intervention}) / (Treatment_{Baseline} / Treatment_{Intervention})$$

Utilizing the example provided in Table 10 above, the formula is

$OR = (C/D)/(A/B) = (27.3/27.6)/(15.1/14.5) = 0.99/1.04 = 0.95$

Treatment Effect

The OR minus 1 provides the direction and magnitude of the change on the treatment relative to the comparison corridors.

$TE = 0.95 - 1 = -0.048$

In the Table 10 hypothetical, the direction and magnitude of the change on the treatment relative to the comparison is -4.8%. In both the hypothetical and in the SCDP, a negative treatment effect would be expected/desired, as it would signify a decrease in the proportion of speeders relative to the comparison corridors.

Typically, the statistic derived from this calculation is referred to as the *treatment effect* (TE) and is understood as a metric that refers to the direction and magnitude of the change on the treatment relative to the comparison. However, given the SCDP data, the TE is better understood as a reflection of observed change only and cannot necessarily be related to the delivery of the treatment itself. For this reason, caution must be used in the interpretation of the TE as it cannot indicate the effect of EE.

Enforcement Days Compared to Non-Enforcement Days

As stated, caution must be exercised when comparing the baseline and intervention phases on the Treatment (64th Ave). For this reason, we compared "enforcement days" and "non-enforcement days" on the Treatment (64th Ave) during the intervention phase *only*. "Enforcement days" are days that received any traffic enforcement from FV-IRSU and/or Surrey MT at any place on the Treatment (64th). "Non-enforcement days" received no enforcement.

Table 11: Proportion of Vehicles Exceeding the Speed Limit by 15 km/hr and Greater, EE Days vs Non-EE Days

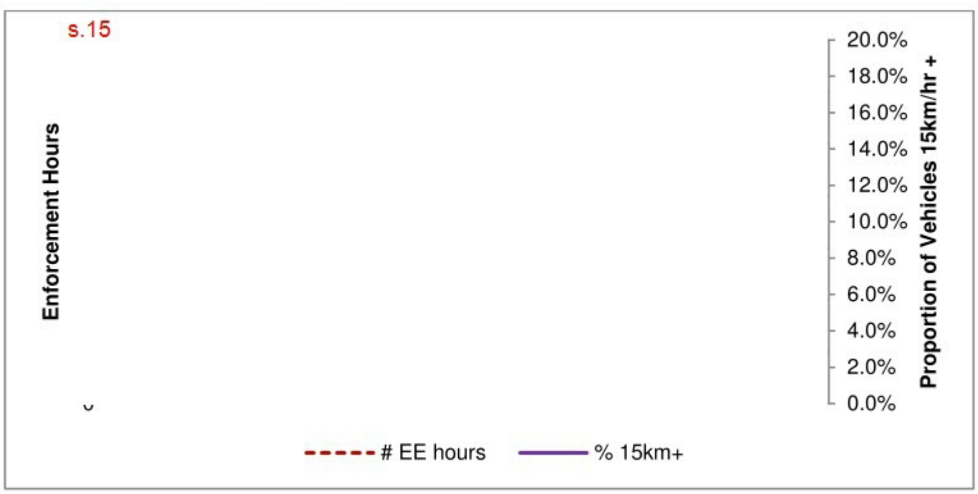
		Non-Enhanced Enforcement Day	Enhanced Enforcement Day	% Point Change
Vehicles exceeding SL by 15 km/hr and greater	Treatment (64th Ave)	15.3%	13.9%	**-1.37**

As demonstrated in Table 11, we observed a *decrease* in proportion of vehicles exceeding the speed limit by greater than 15 km/hr on "enforcement days" as compared to "non-enforcement days" on the corridor that received EE.

Relative to Comparison 1 (32nd Ave), the TE on the Treatment (64th Ave) was -3.3%; relative to Comparison 2 (16th Ave), the TE on the Treatment (64th Ave) was -2.36%. These results show that the proportions of speeders on the Treatment (64th Ave) were lower than would be expected based on the results of the Comparisons. Given that negative TEs would be expected/desired, the results suggest that the effect of the intervention of EE were indeed able to be observed. Furthermore, on enforcement days, decreases were seen on all SRBs regardless of enforcement location and enforcement time. This suggests that enforcement activity may have ripple and spillover effects allowing EE at one point on the corridor to impacted driver behaviour at each SRB location throughout that day.[18] This findings regarding enforcement days compared to non-enforcement days in particular signal an important association between EE and decreased proportions of speeders. Beyond the analysis of enforcement days compared with non-enforcement days, the data also permitted a calculation of the correlation between the number of enforcement hours and the proportion of vehicles exceeding the speed limit by 15km/hr and greater. This analysis helps to understand the impact of EE *intensity* (intensity is defined as the number of hours of EE).

Given the findings above, and the connection between enforcement and deterrence, we would expect an inverse relationship between the variables—that is, as the number of EE hours increased (representing the intensity of the enforcement), we would expect the proportion of speeders to decrease. Likewise, as the intensity of the enforcement decreased, we would expect an increase in the proportion of speeders. Figure 11 illustrates a moderate relationship whereby low points in the proportion of speeders are associated with high points in the number of enforcement hours and vice versa. This suggests that intensity of EE does share a relationship with proportion of speeders.

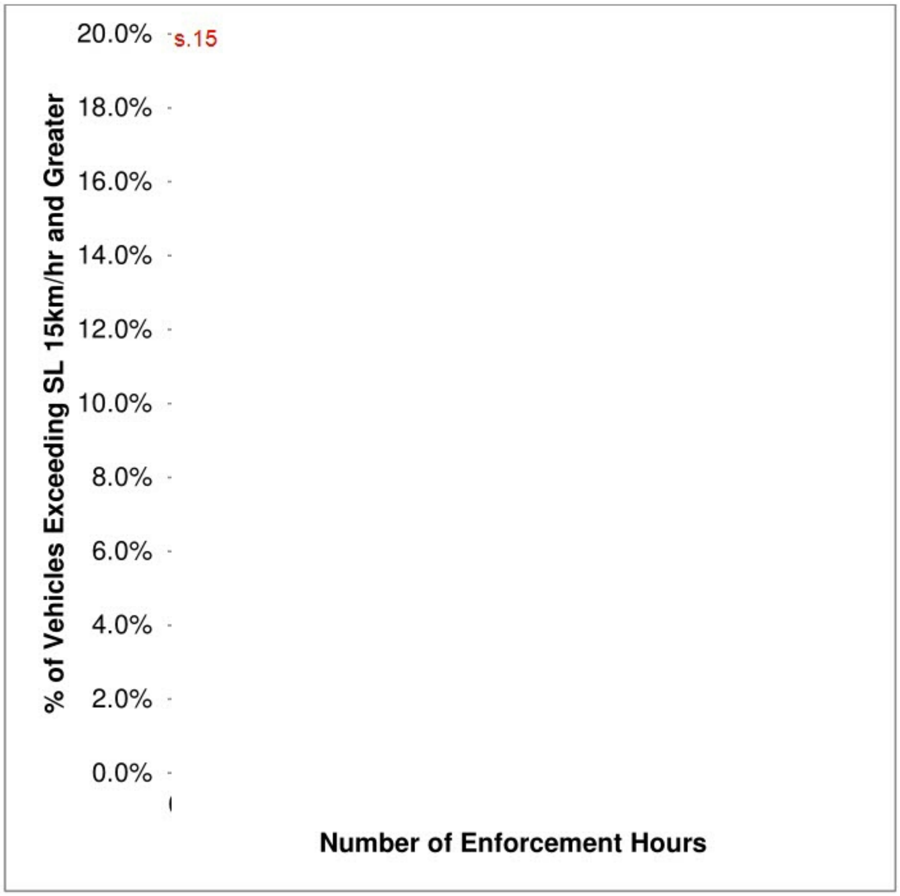
Figure 11: Number of EE Hours and Proportion of Vehicles Exceeding the Speed Limit by 15 km/hr and Greater, 64th Ave, May to August



[18] More precise analyses of EE location and its impact on driver behaviour was not undertaken as the EAI forms did not collect pinpoint location information and we were unable to specify that enforcement be conducted in specific corridor locations.

A Pearson product-moment correlation coefficient was computed to more precisely assess the relationship depicted above utilizing the scores per week during the intervention phase. Figure 12 illustrates the presence of a moderate inverse correlation[19] between the two variables, suggesting that as the intensity of EE increases, the proportion of speeders decreased along the Treatment (64th Ave) and that in this case, nearly 18% of the variation is related.

Figure 12: Correlation—Intensity of EE and Proportion of Vehicles Exceeding the Speed Limit by 15 km/hr and Greater, 64th Ave, May to August



These findings are especially important and encouraging, and suggest that had a greater intensity of EE taken place on the Treatment (64th Ave) throughout the intervention phase, more promising results relative to the comparison corridors would likely have been observed. This should be kept in mind and will be taken up within the last chapter. A prediction of the most ideal intensity of EE was beyond the scope of this study, and bears further research.

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[19] r=.421, n = 18, p = <0.5. EE does not approximate a normal distribution—an important consideration in this computation given that *Pearson's R* assumes normality (significance value for non-normal distributions may be overstated). However, given the use of the population (rather than a sample), and that these results are not intended to be generalized beyond these data, the use of this statistic is appropriate.

Baseline Compared to Treatment, Relative to Comparison Corridors

The following section in this chapter examines two specific groups of vehicles observed across the baseline and treatment periods:

- Vehicles exceeding the speed limit by 15 km/hr and greater (as represented by the red bubble in Table 12)
- Vehicles travelling under the speed limit (as represented by the blue bubble in Table 12).

Vehicles travelling under the speed limit are an especially important group to analyze given that slower vehicles are a desired effect of EE. Further, any shift in proportion is easily interpreted: a decrease in proportion of vehicles travelling under the speed limit means that vehicles were driving faster in the treatment phase. Correspondingly, an increase in proportion of vehicles travelling under the speed limit means that more vehicles were travelling slower during the treatment phase. For the SCDP, an increase in the proportion of vehicles travelling under the speed limit relative to the comparison corridors was desired.

Table 12: Proportion of Vehicles per Speed Category on Each Corridor by Study Period

Corridor	Study Period	1	2	3	4	5	6	7	8	9	10
		Under Speed Limit	Approx. Speed Limit	3 - 6 km/hr +	7 – 10 km/hr +	11 - 14 km/hr +	15 – 18 km/hr +	19 – 22 km/hr +	23 – 26 km/hr +	27 - 30 km/hr +	>30 km/hr +
Treatment	Baseline	21.2%	13.1%	20.9%	16.6%	14.6%	6.7%	4.1%	1.4%	0.8%	0.5%
(64th Ave)	Intervention	18.3%	12.8%	21.2%	17.3%	15.7%	7.3%	4.4%	1.5%	0.8%	0.6%
Comparison 1	Baseline	9.1%	5.5%	14.1%	17.3%	22.0%	13.7%	10.1%	4.0%	2.3%	1.6%
(32nd Ave)	Intervention	6.8%	6.4%	15.3%	17.8%	22.2%	13.6%	10.0%	4.0%	2.3%	1.7%
Comparison 2	Baseline	24.3%	11.0%	19.4%	16.7%	15.2%	7.0%	4.0%	1.3%	0.7%	0.3%
(16th Ave)	Intervention	16.6%	13.2%	22.8%	18.8%	15.9%	7.0%	3.8%	1.2%	0.6%	0.3%

As discussed in Chapter 5, a small proportion of vehicles were observed in the categories 7, 8, 9 and 10, particularly on the Treatment (64th Ave). For this reason, these categories were rolled together for analysis. The category of vehicles exceeding the speed limit by at least 15 km/hr is theoretically meaningful given the dangerous road behaviour. Similar to the under speed limit category, this category is analytically useful because it represents a key group whose behaviour EE is intended to correct. Additionally, shifts in proportions can be easily understood: movement out of this category translates to slower vehicles and vice versa. In contrast, it is difficult to derive meaning from changes to mid categories because the direction of movement is unclear.

Vehicle Exceeding the Speed Limit by Greater than 15 km/hr

This section examines the category of vehicles exceeding the speed limit by 15 km/hr or greater (see Table 13). Results compare the proportion of vehicles in this category on the Treatment (64^{th} Ave) during the intervention phase with the baseline phase *relative* to each Comparison.

Table 13: Proportion of Vehicles per Speed Category on Each Corridor by Study Period

Corridor	Study Period	Under Speed Limit	Approx. Speed Limit	3 - 6 km/hr +	7 – 10 km/hr +	11 - 14 km/hr +	15 – 18 km/hr +	19 – 22 km/hr +	23 – 26 km/hr +	27 - 30 km/hr +	>30 km/hr +
Treatment	Baseline	21.2%	13.1%	20.9%	16.6%	14.6%	6.7%	4.1%	1.4%	0.8%	0.5%
(64th Ave)	Intervention	18.3%	12.8%	21.2%	17.3%	15.7%	7.3%	4.4%	1.5%	0.8%	0.6%
Comparison 1	Baseline	9.1%	5.5%	14.1%	17.3%	22.0%	13.7%	10.1%	4.0%	2.3%	1.6%
(32nd Ave)	Intervention	6.8%	6.4%	15.3%	17.8%	22.2%	13.6%	10.0%	4.0%	2.3%	1.7%
Comparison 2	Baseline	24.3%	11.0%	19.4%	16.7%	15.2%	7.0%	4.0%	1.3%	0.7%	0.3%
(16th Ave)	Intervention	16.6%	13.2%	22.8%	18.8%	15.9%	7.0%	3.8%	1.2%	0.6%	0.3%

As discussed in Chapter 5, during both the baseline and treatment phases, the proportion of vehicles exceeding the speed limit by 15 km/hr and greater was much larger on Comparison 1 (32^{nd} Ave) than on Comparison 2 (16^{th} Ave) and the Treatment (64^{th} Ave). From baseline to intervention, all corridors underwent minor changes in proportion of vehicles travelling in this category as illustrated in Table 14. Specifically, the percent point change metric illustrates that both Comparisons had lower proportions of speeders during the intervention phase and that the Treatment (64^{th} Ave) underwent an increase of just over 1 percent.

Table 14: Proportion of Vehicles Exceeding the Speed Limit by 15 km/hr and Greater

Corridor	Baseline	Intervention	% Point Change
Treatment (64^{th} Ave)	13.60%	14.60%	1.05
Comparison 1 (32^{nd} Ave)	31.80%	31.40%	-0.36
Comparison 2 (16^{th} Ave)	13.40%	12.80%	-0.62

As mentioned earlier in this chapter, the odds ratio metric was utilized in order to produce a value that could show the magnitude and direction of the observed change on the Treatment (64^{th} Ave) relative to the Comparisons. A negative treatment effect (TE) was desired; however, relative to Comparison 1 (32^{nd} Ave) the proportion of speeders on the Treatment (64^{th} Ave) saw an increase (TE 8.72%). Relative to Comparison 2 (16^{th} Ave), the proportion of speeders on the Treatment (64^{th} Ave) saw an increase (TE 12.39%).

The results in Table 14 regarding vehicles exceeding the speed limit by 15 km/hr and greater suggest that the results seen in the analysis of "enforcement days" compared to the "non-enforcement days" on the Treatment (64th Ave) were not able to be observed over a longer term and relative to the Comparisons. There are a number of likely factors that can help to explain why this occurred:

- Deflated speeds on the Treatment (64th Ave) during the baseline phase
- Non-ideal Comparisons
- Presence of other external factor(s) that impacted the treatment differently

As such, the following results document what was observed and cannot be said to have occurred as a result of the intervention of EE.

Day of Week

The proportion of vehicles exceeding the speed limit by 15 km/hr and greater varies by day of week. It appears that there are fewer vehicles in this category mid-week (Tuesday, Wednesday and Thursday) in all corridors. Within Comparison 1 (32nd Ave) we see this proportion range from 29.5% midweek (Tues-Thurs) to 35.4% on the weekends (Sat & Sun) during the baseline phase. Comparison 2 (16th Ave) ranged from 12.5% midweek (Tues-Thurs) to 14.3% at the beginning and end of the work week (Mon and Fri) during the baseline. The Treatment (64th Ave) saw similar baseline proportions with a low of 12.4% midweek (Tues-Thurs) to 15.1% on the weekends (Sat and Sun) (see Table 15).

When looking at the change from baseline to intervention, increases in percent point change were observed on the Treatment (64th Ave), on all days of the week, with the mid-week period increasing the most (1.79 percent point change).

Conversely, a 0.42 percent point change increase in proportion of vehicles exceeding the speed limit by 15 km/hr and greater was observed on Comparison 1 (32nd Ave) during the midweek; with decreases observed on all other days. Similarly, Comparison 2 (16th Ave) saw decreases in the proportion of these speeders on all days of the week.

As discussed in Chapter 5, four of the six days where anomalously low proportions of speeders were observed during the baseline for the Treatment (64th Ave) were during the midweek. This may have contributed to an inordinately low proportion of vehicles exceeding the speed limit by 15 km/hr and greater during the Baseline midweek and to the increase in proportion of speeders on the treatment during mid-week observed in the intervention phase.

Table 15: Corridor Comparison by Day of Week

Corridor	Day of Week	Speeders 15 km/hr + Baseline	Speeders 15 km/hr + Intervention	% Point Change
Treatment (64th Ave)	Tues -Thurs	12.40%	14.20%	1.79
	Mon & Fri	14.00%	14.30%	0.31
	Sat & Sun	15.10%	15.70%	0.6
Comparison 1 (32nd Ave)	Tues -Thurs	29.50%	29.90%	0.42
	Mon & Fri	32.40%	30.40%	-1.96
	Sat & Sun	35.40%	35.10%	-0.25
Comparison 2 (16th Ave)	Tues -Thurs	12.50%	12.20%	-0.29
	Mon & Fri	14.30%	12.70%	-1.63
	Sat & Sun	14.00%	13.70%	-0.29

The relative change from baseline to treatment can, as explained above, also be examined with the TE metric to show magnitude and direction of relative change. As displayed in Figure 11, relative to Comparison 1 (32^{nd} Ave), the TE on the Treatment (64^{th} Ave) ranges from 4.7% on the weekend (Sat and Sun) to 12.8% midweek (Tues-Thurs); relative to Comparison 2 (16^{th} Ave), the TE on the Treatment (64^{th} Ave) ranges from 6.2% on the weekend to 17.10% midweek. These results show that the proportions of speeders on the Treatment (64^{th} Ave) were higher than would be expected based on the results of the Comparisons. Given that negative TEs would be desired, the results suggest that the effect of the intervention of EE were not able to be observed over entire study phase and point to the presence of external factors.

Figure 13: Treatment Effect on Speeders on Treatment (64^{th} Ave) Relative to Comparisons, Day of Week

	Tues, Wed, Thurs	Mon & Fri	Sat & Sun
Comp 1 (32nd Ave)	12.80%	8.80%	4.70%
Comp 2 (16th Ave)	17.10%	15.30%	6.20%

Time of Day

Given variations in traffic volume throughout the course of the day, Time of Day was an important factor to analyze. As such, this section discusses the results by time of day with subsections to examine changes by speed zone (60 km/hr specifically) and day of week.

Overall, variations in proportion of speeders were observed through the different time periods of the day with highest proportion of these speeders observed overnight (overnight during the baseline phase in Comparison 2 (16th Ave) is the exception and may be an anomaly) (see Table 16).

On the Treatment (64th Ave), increases in proportion of vehicles exceeding the speed limit by 15 km/hr and greater were observed at all times of the day. In contrast, and consistent with other results, decreases in the proportion of these speeders were observed during all times of the day (with the exception of Overnight) on Comparison 1 (32nd Ave) and Comparison 2 (16th Ave).

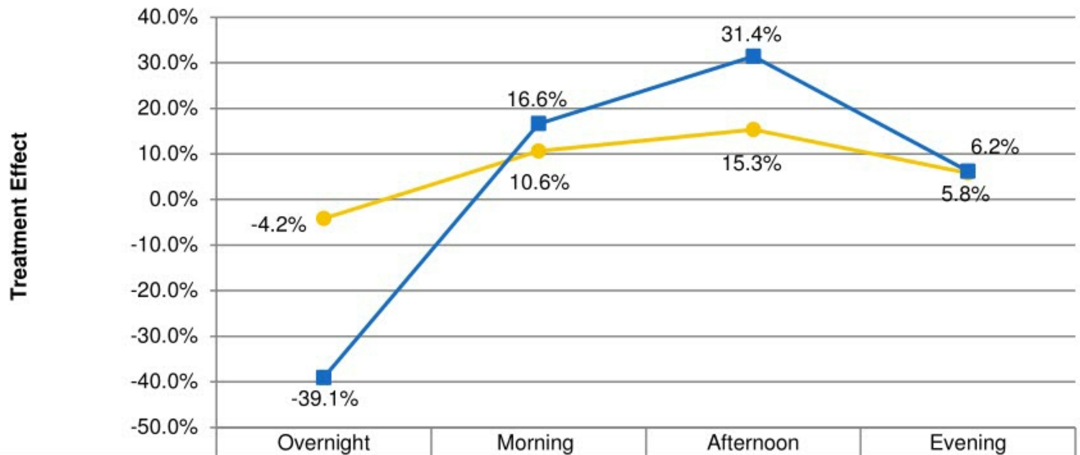
Table 16: Corridor Comparison by Time of Day

Corridor	Time of Day	Speeders 15 km/hr + Baseline	Speeders 15 km/hr + Intervention	% Point Change
Treatment (64th Ave)	Overnight	20.70%	24.10%	3.41
	Morning	13.60%	14.70%	1.07
	Afternoon	10.40%	11.60%	1.2
	Evening	14.10%	14.20%	0.06
Comparison 1 (32nd Ave)	Overnight	39.10%	47.60%	8.46
	Morning	29.90%	29.10%	**-0.73**
	Afternoon	27.70%	26.70%	**-0.91**
	Evening	37.50%	35.60%	**-1.92**
Comparison 2 (16th Ave)	Overnight	11.30%	21.70%	10.34
	Morning	14.30%	13.20%	**-1.07**
	Afternoon	11.60%	9.80%	**-1.75**
	Evening	15.90%	15.00%	**-0.87**

Figure 14 displays the TE in relative to each of the Comparisons. From that graph, we can see that the overnight period behaved in an expected/desired way. That is, relative to the comparison corridors, we observed a decrease in the proportion of vehicles exceeding the speed limit by 15 km/hr and greater on the Treatment during the overnight period (TE -4.2 relative to Comparison 1; TE -39.1% relative to Comparison 2).

However, all other times of day do have a TE reflecting an increase the proportion of speeders relative to the comparisons, most dramatically during the afternoon. As stated, these results may reflect the presence of external factors.

Figure 14: Treatment Effect on Speeders on Treatment (64th Ave) Relative to Comparisons, Time of Day



	Overnight	Morning	Afternoon	Evening
Comp 1 (32nd Ave)	-4.2%	10.6%	15.3%	5.8%
Comp 2 (16th Ave)	-39.1%	16.6%	31.4%	6.2%

Changes in Speeders in 60 km/hr Zones

Across the study corridors, two speed zones are represented: 50 km/hr and 60 km/hr. Because SRBs in both comparison corridors are located within 60 km/hr zones, the below section discusses 60 km/hr only.

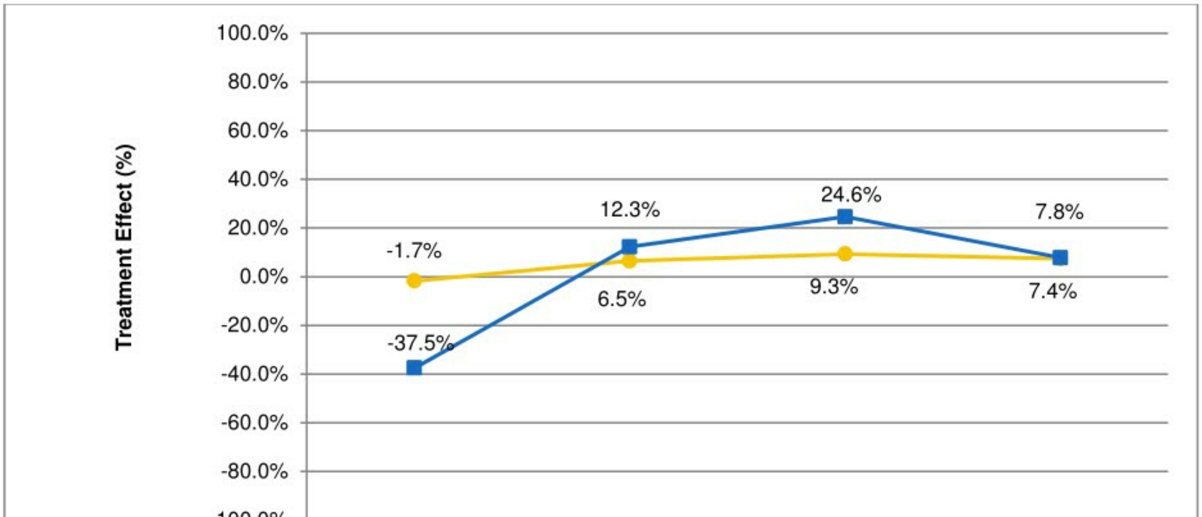
The proportion of vehicles travelling 75 km/hr or greater in 60 km/hr zones increased during the intervention phase on the Treatment (64th Ave) for all times of the day (see Table 17). While increases in this the proportion of vehicles travelling at least 75 km/hr were observed on Comparison 1 (32nd Ave) and Comparison 2 (16th Ave) during the overnight, all other periods of the day saw decreases in the proportion of this category of speeder.

Table 17: Corridor Comparison by Time of Day, 60 km/hr zones only

Corridor	Time of Day	75 km/hr + Baseline	75 km/hr + Intervention	% Point Change
Treatment (64th Ave)	Overnight	17.20%	20.60%	3.37
	Morning	13.10%	13.60%	0.52
	Afternoon	9.90%	10.50%	0.57
	Evening	11.20%	11.40%	0.21
Comparison 1 (32nd Ave)	Overnight	39.10%	47.60%	8.46
	Morning	29.90%	29.10%	-0.73
	Afternoon	27.70%	26.70%	-0.91
	Evening	37.50%	35.60%	-1.92
Comparison 2 (16th Ave)	Overnight	11.30%	21.70%	10.34
	Morning	14.30%	13.20%	-1.07
	Afternoon	11.60%	9.80%	-1.75
	Evening	15.90%	15.00%	-0.87

Figure 15 displays the TE for the 60 km/hr zones and follows a similar pattern to that described above. Specifically, a negative TE was observed relative to each Comparison, denoting a decrease in the proportion of vehicles travelling at least 75 km/hr on the Treatment during the overnight relative to the comparisons. At the same time, a positive TE was observed in all other periods of the day. Although the change observed in the overnight was a desired, we are not able to conclude that this occurred due to the EE treatment.

Figure 15: Treatment Effect on Speeders on Treatment (64th Ave) Relative to Comparisons, 60 km/hr Zones



	Overnight	Morning	Afternoon	Evening
Comp 1 (32nd Ave)	-1.7%	6.5%	9.3%	7.4%
Comp 2 (16th Ave)	-37.5%	12.3%	24.6%	7.8%

Day of Week

In this subsection, we examine the changes in the proportion of vehicles exceeding the speed limit by 15 km/hr and greater by time of day and by three groupings of day of week:

1. Weekdays - Midweek (Tues to Thurs)
2. Weekdays – beginning and end of week (Mon and Fri)
3. Weekend (Sat and Sun)

Weekdays – Midweek (Tues - Thurs)

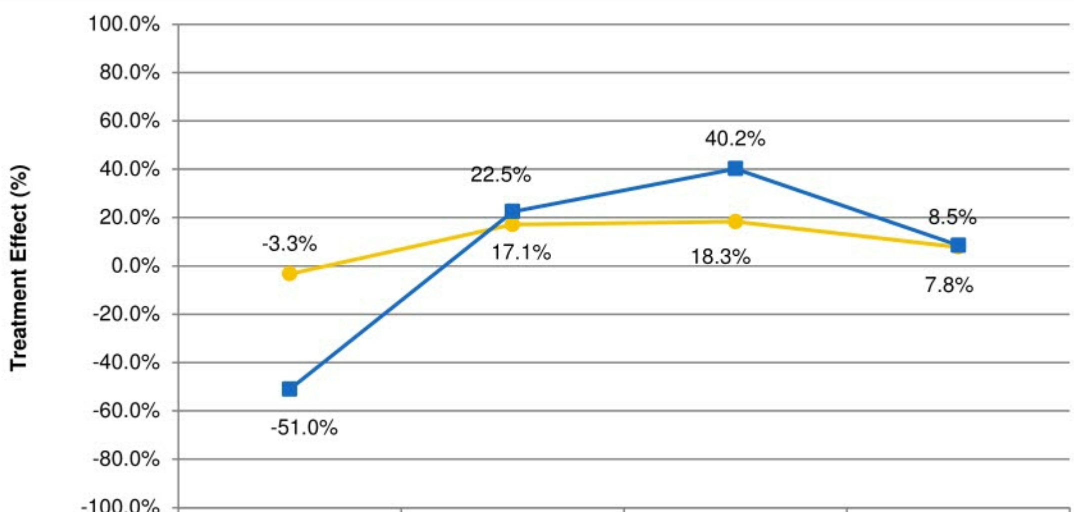
Midweek changes follow a pattern similar to the overall results (see Table 18); however, a slight increase in the proportion of vehicles in this category was observed on Comparison 1 (32nd Ave). The increases in the Treatment are the highest of any subsection breakout. This further supports the suggestion that the baseline for midweek is artificially low (or the Intervention is artificially high), as discussed in Chapter 5 (four of the six anomalously low speed days during the baseline for the Treatment occurred midweek).

Table 18: Corridor Comparison by Time of Day, Midweek Only

Corridor	Time of Day	Speeders 15 km/hr + Baseline	Speeders 15 km/hr + Intervention	% Point Change
Treatment (64th Ave)	Overnight	18.30%	25.40%	7.02
	Morning	11.30%	13.40%	2.08
	Afternoon	9.80%	11.00%	1.21
	Evening	13.60%	14.20%	0.57
Comparison 1 (32nd Ave)	Overnight	35.80%	51.30%	15.43
	Morning	26.10%	26.40%	0.28
	Afternoon	25.60%	24.30%	-1.3
	Evening	36.80%	35.60%	-1.23
Comparison 2 (16th Ave)	Overnight	8.50%	24.00%	15.48
	Morning	12.40%	12.00%	-0.41
	Afternoon	12.00%	9.60%	-2.39
	Evening	15.20%	14.60%	-0.6

Figure 16 shows that the TE follows a pattern very similar to those discussed above where the expected TE was observed during the overnight period only, and where the inverse was observed at all other times of day.

Figure 16: Treatment Effect on Speeders on Treatment (64th Ave) Relative to Comparisons, Mid-week



	Overnight	Morning	Afternoon	Evening
Comp 1 (32nd Ave)	-3.3%	17.1%	18.3%	7.8%
Comp 2 (16th Ave)	-51.0%	22.5%	40.2%	8.5%

Weekdays (Monday and Friday)

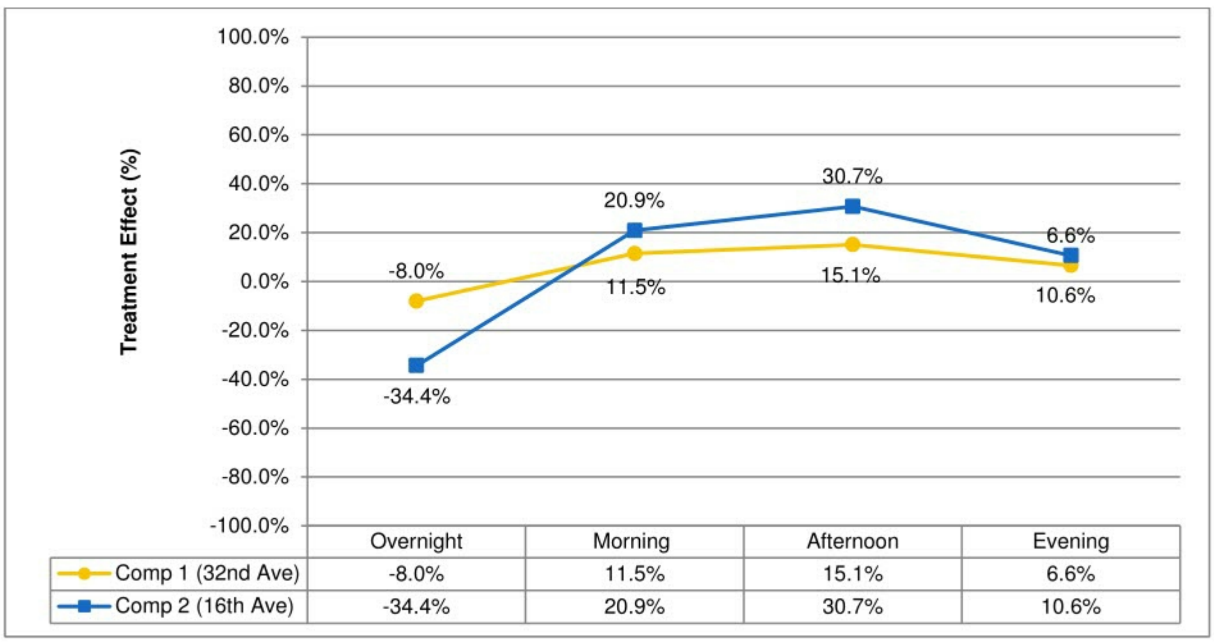
The changes observed on the Treatment (64th Ave) for Monday and Friday only are less than one percentage point (see Table 19). This contrasts with upwards of a seven percent point difference for overnight Midweek as discussed above. Importantly, the changes in the comparisons do not follow this pattern. This lack of consistent pattern between corridors may indicate that the corridors are not similar enough for direct comparison.

Table 19: Corridor Comparison by Time of Day, Monday and Friday

Corridor	Time of Day	Speeders 15 km/hr + Baseline	Speeders 15 km/hr + Intervention	% Point Change
Treatment (64th Ave)	Overnight	23.10%	23.80%	0.76
	Morning	13.20%	13.90%	0.72
	Afternoon	10.70%	11.30%	0.55
	Evening	14.80%	14.10%	-0.72
Comparison 1 (32nd Ave)	Overnight	40.90%	45.90%	5.04
	Morning	29.20%	27.60%	-1.58
	Afternoon	27.90%	25.50%	-2.41
	Evening	40.30%	36.00%	-4.36
Comparison 2 (16th Ave)	Overnight	11.60%	18.30%	6.66
	Morning	14.40%	12.60%	-1.84
	Afternoon	12.30%	9.90%	-2.41
	Evening	18.60%	16.00%	-2.61

As shown in Figure 17, the TE follows a pattern similar to that previously noted with a decrease relative to the comparisons in the proportion of vehicles exceeding the speed limit by 15 km/hr or greater on the Treatment (64th Ave) during the overnight hours. The TE is inverse to the desired outcome for all other times of the day.

Figure 17: Treatment Effect on Speeders on Treatment (64th Ave) Relative to Comparisons, Mondays and Fridays



Weekends

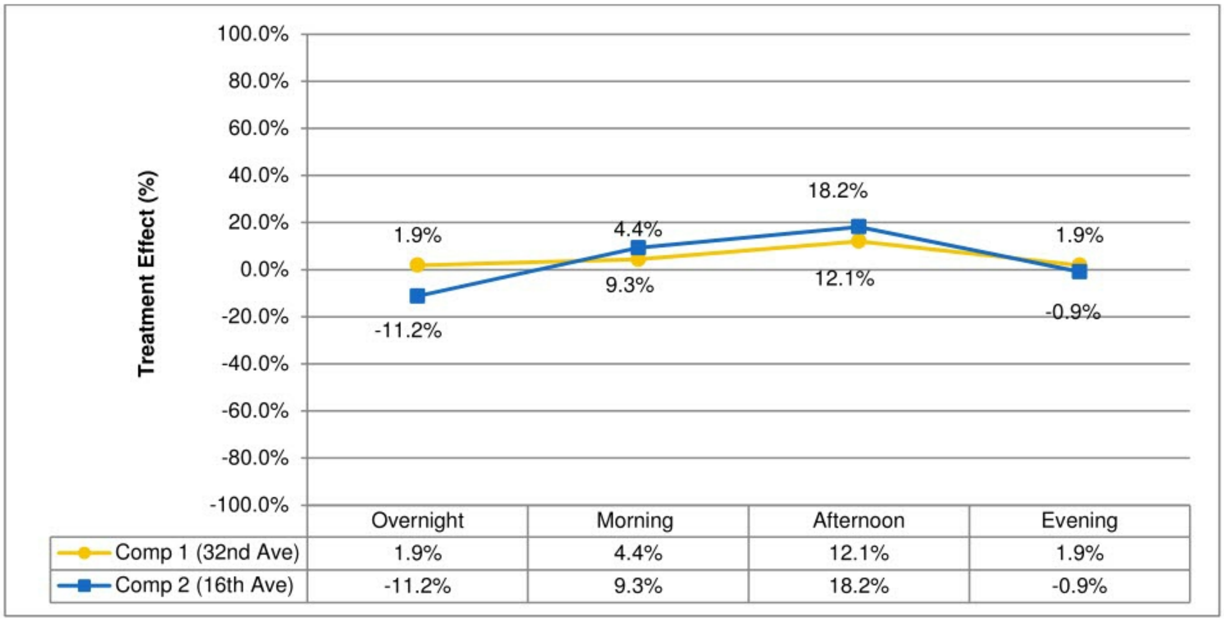
As illustrated by Table 20, weekends appear to have a very different pattern of change for all corridors. In fact, there much less of a difference between baseline and intervention with the size of the differences observed being much lower than those seen at other times of the week. The Treatment (64th Ave) saw little to no change in the proportion of vehicles exceeding the speed limit by 15 km/hr and greater with the exception of during the afternoon.

Table 20: Corridor Comparison by Time of Day, Weekends

Corridor	Time of Day	Speeders 15 km/hr + Baseline	Speeders 15 km/hr + Intervention	% Point Change
Treatment (64th Ave)	Overnight	22.50%	22.50%	0.02
	Morning	17.90%	17.60%	-0.25
	Afternoon	10.90%	12.70%	1.8
	Evening	14.20%	14.20%	0.06
Comparison 1 (32nd Ave)	Overnight	44.50%	43.70%	-0.78
	Morning	38.60%	36.40%	-2.15
	Afternoon	30.70%	31.90%	1.2
	Evening	35.80%	35.30%	-0.51
Comparison 2 (16th Ave)	Overnight	19.90%	22.40%	2.52
	Morning	18.50%	16.70%	-1.81
	Afternoon	10.20%	10.10%	-0.14
	Evening	14.50%	14.70%	0.2

Despite the different pattern seen in the above table, the TE does follow a pattern similar to that previously noted (see Figure 18); however, the magnitude of the TE is much smaller. In addition, the TE relative to Comparison 2 (16th Ave) saw a 0.9% decrease in the proportion vehicles exceeding the speed limit by 15 km/hr and greater during the evening on the weekend. Like the trends discussed throughout this chapter, it is likely that external factors impacted vehicle speeds in a way not captured by the data we examined.

Figure 18: Treatment Effect on Speeders on Treatment (64th Ave) Relative to Comparisons, Weekends



Overall, baseline data for the Treatment (64th Ave) appears to be inordinately low in terms of the proportion of speeders. As such, changes from the baseline to the treatment phase cannot be attributed to the treatment of EE.

Vehicles Travelling under the Speed Limit

Another important way to understand the changes from baseline to intervention is to analyze the proportion of vehicles travelling under the speed limit. In this analysis, a relative growth in the proportion of vehicles travelling under the speed limit is a desirable outcome. As Table 21 shows, on each corridor, the proportion of vehicles travelling under the speed limit decreased from baseline to intervention. This indicates that overall, vehicles were travelling faster in the Intervention period. The shift appears to be to an increase in mid-level speeders (3 km/hr over the speed limit to 14 km/hr over the speed limit) for the two Comparisons; however, the Treatment (64th Ave) saw increases in mid and higher-level speeders (15 km/hr+).

Table 21: Proportion of Vehicles per Speed Category on Each Corridor by Study Period

Corridor	Study Period	Under Speed Limit	Approx. Speed Limit	3 - 6 km/hr +	7 – 10 km/hr +	11 - 14 km/hr +	15 – 18 km/hr +	19 – 22 km/hr +	23 – 26 km/hr +	27 - 30 km/hr +	>30 km/hr +
Treatment	Baseline	21.2%	13.1%	20.9%	16.6%	14.6%	6.7%	4.1%	1.4%	0.8%	0.5%
(64th Ave)	Intervention	18.3%	12.8%	21.2%	17.3%	15.7%	7.3%	4.4%	1.5%	0.8%	0.6%
Comparison 1	Baseline	9.1%	5.5%	14.1%	17.3%	22.0%	13.7%	10.1%	4.0%	2.3%	1.6%
(32nd Ave)	Intervention	6.8%	6.4%	15.3%	17.8%	22.2%	13.6%	10.0%	4.0%	2.3%	1.7%
Comparison 2	Baseline	24.3%	11.0%	19.4%	16.7%	15.2%	7.0%	4.0%	1.3%	0.7%	0.3%
(16th Ave)	Intervention	16.6%	13.2%	22.8%	18.8%	15.9%	7.0%	3.8%	1.2%	0.6%	0.3%

Table 22 shows the percentage point change observed from baseline to intervention.

Table 22: Proportion of Vehicles Travelling Under the Speed Limit

Corridor	Study Period	Under Speed Limit	% Point Change
Treatment (64th Ave)	Baseline	21.2%	-2.91
	Treatment	18.3%	
Comparison 1 (32nd Ave)	Baseline	9.1%	-2.31
	Treatment	6.8%	
Comparison 2 (16th Ave)	Baseline	24.3%	-7.73
	Treatment	16.6%	

Like the above analyses, the TE helps to show the direction and magnitude of the change relative to the comparison corridors. In relation to Comparison 1 (32nd Ave), we observed a 15.5% TE. In relation to Comparison 2 (16th Ave), we observed a 26.4% TE. This pattern does indeed follow the expected/desired outcome by illustrating an increase in proportion of non-speeders on the Treatment (64th Ave).

That is, relative to the comparison corridors, we observed an *increase* in the proportion of vehicles travelling *under* the speed limit on the corridor that received the treatment, EE. Actual proportions of vehicles travelling under the speed limit decreased across all corridors (perhaps due to seasonality), but, the proportion of vehicles under the speed limit on the treatment corridor decreased *less than* on the comparison corridors from baseline to treatment (as shown by the TE that illustrates this *relative* change).

Summary

Given the limitations of the SCDP, changes in proportion of vehicles speeding from the baseline to the treatment phases cannot be attributed to EE. That said, two promising findings emerged in the examination of the Treatment (64th Ave) exclusively within the intervention phase: we observed a *decrease* in proportion of vehicles travelling greater than 15 km/hr over the speed limit on "enforcement days" as compared to "non-enforcement days" on the Treatment (64th Ave). Secondly, findings point to a moderate inverse relationship between the intensity of EE and a reduction in proportion of speeders such that as EE hours increase, proportion of speeders decrease and vice versa. Beyond those findings, this study shows a treatment effect that is the inverse of what would be expected. We expected to observe a decrease in the proportion of speeders on the Treatment (64th Ave) relative to the comparison corridors. However, as shown in this chapter, in all but one specific time of day, the opposite was observed. The exception to this finding was specific to the overnight period (midnight to 6am), relative to the comparison corridors, where we observed a *decrease* in the proportion of vehicles travelling 15 km/hr or more *over* the speed limit on the corridor that received enhanced enforcement. Another encouraging finding was in respect to vehicles travelling under the speed limit, relative to the comparison corridors, we observed an *increase* in the proportion of vehicles travelling *under* the speed limit on the corridor that received enhanced enforcement.

CHAPTER 7: Conclusions

The SCDP was RSU's first attempt to investigate whether EE (IRSU + Standard Traffic Enforcement) could be shown to reduce the proportion of drivers speeding on one corridor, relative to two corridors receiving standard traffic enforcement only.

Main Results

- All corridors experienced some increases in proportion of speeders from baseline to treatment. This was not unexpected and may have occurred as a result of seasonality (i.e., more opportunities to speed in summer months).
- We observed a *decrease* in proportion of vehicles exceeding the speed limit by 15 km/hr or greater on "enforcement days" as compared to "non-enforcement days" on the corridor that received enhanced enforcement.
- We observed a moderate inverse correlation between intensity (number of hours) of EE and proportion of speeders on the corridor that received enhanced enforcement, suggesting that as hours of EE increase, proportion of speeders decrease and vice versa.
- The results regarding vehicles exceeding the speed limit by 15 km/hr and greater suggest that the results seen in the analysis of "enforcement days" compared to the "non-enforcement days" on the Treatment (64th Ave) were not able to be observed over a longer term and relative to the Comparisons.
    - There are a number of likely factors that can help to explain why this occurred: (1) deflated speeds on the Treatment (64th Ave) during the baseline phase, (2) non-ideal comparisons; (3) the presence of other external factor(s) that impacted the treatment differently.

As such, the following speed-related observations document what was observed, but cannot be said to have occurred as a result of enhanced enforcement.

Speed-Related Observations

- Most results show a treatment effect that is the inverse of what would be expected.
    - However, relative to the comparison corridors, we observed an *increase* in the proportion of vehicles travelling *under* the speed limit on the corridor that received enhanced enforcement.
    - And relative to the comparison corridors, we observed a *decrease* in the proportion of vehicles travelling 15 km/hr or more *over* the speed limit on the corridor that received enhanced enforcement, specific to the overnight period (midnight to 6am).

Enforcement Indicator Observations

- Over the course of the 6-month study, 2,373 total VTs were issued by either FV-IRSU or Surrey MT.
    - Surrey MT issued 7 VTs during the 2-month baseline phase
    - Surrey MT issued 171 VTs during the 4-month intervention phase
    - FV-IRSU issued 2,195 VTs during the 4-month intervention period
- FV-IRSU delivered s.15 of enforcement during the 4-month intervention period.

Changing Driver Behaviour with Enhanced Enforcement

As discussed in Chapter 2, research shows that speeding is a particularly challenging behaviour to modify especially given its social acceptability, and the pervasiveness with which it affects the driver population. The findings of the SCDP make an important contribution to the body of literature given that we observed a decrease in the proportion of vehicles speeding on enforcement days compared to non-enforcement days. However, except in limited cases, we were unable to observe similar effects when comparing the baseline to the treatment phase relative to the comparison corridors (as per the initial study design) for a combination of reasons that will be elaborated upon later in this section.

Even if these limitations had not presented themselves in this study, research has shown that changes to speeding behaviour are exceedingly difficult to make through enforcement activities and that improvements are challenging to maintain over the long term in absence of a saturation of permanent, visible enforcement.

While some promise has been shown with targeted enforcement programs, many researchers have been unable to establish lasting effects: interventions may show signs of success during the treatment period, but these effects are often reduced or eliminated upon removal of the treatment. For example, in the short term, driver speeds tend to return to normal once drivers leave an area that is being targeted with enforcement. As a result, sustained long-term benefits are most likely gained from enforcement that is more constant and permanent. With this in mind, Davis et al. (2006) found that enhanced enforcement initiatives should be part of the larger standard traffic enforcement routines that are committed to over the long term. This is consistent with how EE is deployed in BC.

Beyond consistency and permanency of EE, amount/concentration is another variable to consider. The design utilized in this study did not allow for the examination of the optimal number of hours of EE that would be required in order to observe the expected effect. As reported, EE during the treatment phase in the SCDP consisted of an average of s.15 s of enforcement per week or less than s.15 per day. This is in contrast to other studies that have found promising results with EE delivered for upwards of s.15 per week. Accordingly, the benefits of EE may only be observed with the delivery of an increased number of enforcement hours. This is a vitally important area that requires significantly more research.

Discussion

Several limitations presented challenges in this study. For the most part, the limitations resulted from the researchers having very little control over the naturalistic study setting. This was exacerbated by the challenges posed by factors completely external to the study such as construction that took place on the treatment corridor over the course of the study. Although the comparison corridors were selected to control for variations such as seasonality, we anticipate that other discrepancies may have affected the treatment corridor differently than the comparison corridors.

Quasi-Experimental Design

An overarching limitation is the design of this study consisting of a small number of study corridors and no random selection. Although this is one of the most appropriate designs given the naturalistic study setting and given time and financial restrictions, it does preclude generalization to circumstances and timelines beyond those in the study.

High Collision Locations

The IRSU model is based on the delivery of EE at high collision locations as determined by ICBC data. The benefits of IRSU above and beyond standard traffic enforcement may not be reflected when they are delivered at locations that have not been shown to fit into this category. This represents a second limitation to the study, but not one that is easily addressed given a pre/post design and the requirement for SRBs to be placed prior to the commencement of the study.

The Independent Variable

A third limitation of this research was the lack of control researchers had over the independent variable, enforcement time. Police function independently from government in setting their operational priorities. For this reason, the study design did not permit any specification on the number of hours or locations of enforcement, simply that standard enforcement be conducted "as usual" and that enhanced enforcement occur only during the intervention phase and exclusively on the treatment corridor. As a result, while the study would have benefited from the delivery of some standard traffic enforcement (to better establish the comparison between standard traffic enforcement and EE), as outlined in Chapter 4, s.15

s.15

This limitation significantly restricts the findings, in effect preventing the comparison of EE to standard enforcement as planned. Instead, data permitted only a comparison of no/minimal enforcement with enforcement. As explained in Chapter 1, IRSU operates a level of EE that is designed to supplement regular standard traffic services delivered by municipal traffic services. IRSU is thus not designed to operate as a standalone unit. Furthermore, traffic enforcement delivered by both types of units are designed to be flexible and able to change given their deployment is intelligence-led and strategic, with a focus on those areas and locations that have been identified as having a high number of collisions resulting in injuries.[20]

As demonstrated in this study, standard traffic enforcement and IRSU traffic services vary widely in delivery, as choices on frequency and locations for deployment must be flexible and responsive. The SCDP showed that these services lack predictability to a degree that could not be anticipated by the study design. Though this feature is a key strength of both the IRSU model and of the delivery of standard traffic services, it makes evaluation of such initiatives extremely complex.

Given the consequences to the evaluation realized in this study, more control over enforcement hours and location might be sought in future studies. One way to increase control would be by setting a threshold or range for hours of enforcement. This would allow police to retain final control over deployments, but would lend some predictability to the study.

Self-Report of Enforcement Data

A fourth limitation was the data collection method for enforcement data. As discussed, both standard traffic officers and IRSU officers were asked to complete a form each time they conducted enforcement activities within the study corridors. Self-report tools are known to be subject to error if participants forget or miss-record information. There was no reliable mechanism by which to assess compliance with this data collection tool. That said, the detailed explanation of the overarching study and the tool itself is expected to have minimized this limitation.

Corridor Comparability

As discussed, the Comparison corridors may not have been similar enough to the Treatment (64th Ave) to adequately control for the effects of extraneous and confounding variables. This represents a significant limitation.

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s.15

For example, in the SCDP, each corridor was divided into sections; some sections were different in speed limits and road composition. Furthermore, SRBs captured different directions of travel, and as such, different traffic volumes given the time of day. Given these variations, it is difficult to isolate the treatment effect. In future, it may be advantageous to match corridor sections by key variables known to impact driver behaviour such as volume, direction of observation, road composition, road use and speed limits and also be proportion of speeders at baseline.

For Comparison 1 (32nd Ave), for example, approximately 85% of vehicles were travelling at least 3 km/hr over the speed limit during the baseline whereas this was true of a much smaller percentage (approximately 65%) of vehicles on the Treatment (64th Ave) and Comparison 2 (16th Ave). For this reason, whereas the proportion of speeders on the Treatment and Comparison 2 had "room to increase," this was much less true of Comparison 1 (32nd Ave).

Speed Data Collection

Relative Speed

Theoretically "average corridor speed" might have been included as part of the speed measures in addition to "speed relative to the speed limit". However, SRBs were not equipped to capture actual vehicle speed, thus there is no way to accurately calculate the average speed for each corridor.[21]

Placement

As discussed in Chapter 3, the functionality of the SRBs restricted their placement to locations where power could be accessed. As a result, the placement of these data collection tools was partially governed out of technical considerations of the equipment rather than strictly analytic value.

Excessive Speed

The inability to isolate the proportion of drivers travelling at more than 40 km/hr over the speed limit (excessive speeding) was another limitation of the SRBs. As discussed, the SRBs collected the number of vehicles travelling in pre-set categories based on vehicle speed relative to the speed limit, rather than absolute speed of each vehicle. This method grouped vehicles travelling at or above 31 km/hr over the speed limit and did not allow for the separation of excessive speeders.

[21] Technically a mean can be approximated by assigning the middle speed to all vehicles in the category, and using this as a proxy for actual vehicle speed (weighted midpoint counts). However, this method is highly susceptible to error and as such, was not utilized in this study.

Although the category of excessive speeders is of importance, the data were encouraging in that fewer than 1% of vehicles on the Treatment (64th Ave) and Comparison 2 (16th Ave) and fewer than 2% of vehicles on Comparison 1 (32nd Ave) were found to be travelling at or greater than 31 km/hr over the speed limit. By extension, excessive speeders could only represent a smaller portion of these figures.

Unforeseen External Factors

In addition to some inconsistencies across corridors, it is now known that construction involving water main replacement and paving work took place on the Treatment (64th Ave) throughout the study period. As discussed in Chapter 5, researchers were unable to gather detailed data such as specific dates and locations on actions like lane closures, and were thus unable to exclude data that were affected by this variable. As a result, it may be the case that construction and related activities drew down the proportion of speeders during the baseline phase on the treatment corridor. This unknown is an important limitation to consider.

Seasonality

As stated, the baseline phase began at the end of winter and carried on into early spring while the treatment phase began in the spring, and was primarily conducted during the summer. Variations in weather and volume are expected to occur along with seasonal variations. For example, as the weather improves, we experience more daylight hours and less precipitation, potentially affecting driver behaviour as road conditions improve. Furthermore, traffic volumes are also expected to decrease and fluctuate in the summer season given public school closures and summer vacations. Given these changes in road conditions and traffic volume, research shows that motorists have a greater opportunity to speed in the summer months. As such, we expected to see some decreases in volume at peak times along with some increases in proportion of speeders. As discussed in Chapter 5, however, volume across the corridors did not decrease during the summer months as expected, but instead remained steady across the study period. The variations in road conditions expected due to seasonality did occur as usual.

The effects of seasonality were expected during the design phase of this study. It was anticipated that the use of comparison corridors would be instrumental in controlling for these features. However, given the variability in corridors, it is now thought that seasonality may not have affected the corridors in a consistent fashion. Instead, seasonality may have played a part in driving up the proportion of speeders in the treatment corridor during the intervention, but may not have had the same degree of impact on the comparison corridors. For example, the treatment corridor travels through more urban areas than the comparison corridors and all three of the SRBs gather data from areas of the corridor with two lanes each way. This is in contrast to the comparison corridors that each travel through less dense areas and where SRBs were placed on areas with one lane each way.

Speeding is a particularly challenging behaviour to modify especially given its social acceptability and pervasiveness. The findings of the SCDP make an important contribution to the body of literature given that we observed a decrease in the proportion of vehicles speeding on enforcement days compared to non-enforcement days. However, except in limited cases, we were unable to observe similar effects when comparing the baseline to the treatment phase relative to the comparison corridors.

Recommendations

The findings point to a number of recommendations relating to further research.

1. ***Develop a better understanding of when speed enforcement can be most effective in reducing speed related crashes, and provide police with tools to deter speeding when the behaviour is most dangerous (e.g. night-time enforcement, automated enforcement where its dangerous to set up or there aren't sufficient resources to police during those hours).*** As stated, enforcement during this study tended to be concentrated on Mondays through Thursdays in the morning and afternoon. However, more than half of deaths that occur as a result of speed-related collisions occur on Friday, Saturday or Sunday. The discrepancy between these high risk times and the delivery of enforcement forms an important area for further research.
2. ***Gain a better understanding of the effects of enforcement intensity on speeding behaviour.*** The moderate relationship between intensity of EE and proportion of speeders identified in this study should be examined in further depth. Such an examination would be able to identify the optimal threshold that represents the best EE investment.
3. ***Examine EE utilizing a research protocol that permits province-wide generalizability.*** A similar study, but on a larger scale examining more corridors selected via random sample, and with more control over the amount of EE delivered could better illuminate the benefits of EE. Such a strategy could better quantify the return on investment, particularly if collision data including fatalities and injuries, was monitored.
4. ***Examine the effect of speed enforcement accompanied by public awareness.*** Past studies have shown that effects of enforcment can be magnified when coupled with public awareness. Undoubtedly, awareness through mainstream and social media has the potential to magnify the impacts of EE and re-double any positive effects of enforcement activity with minimal further investment.

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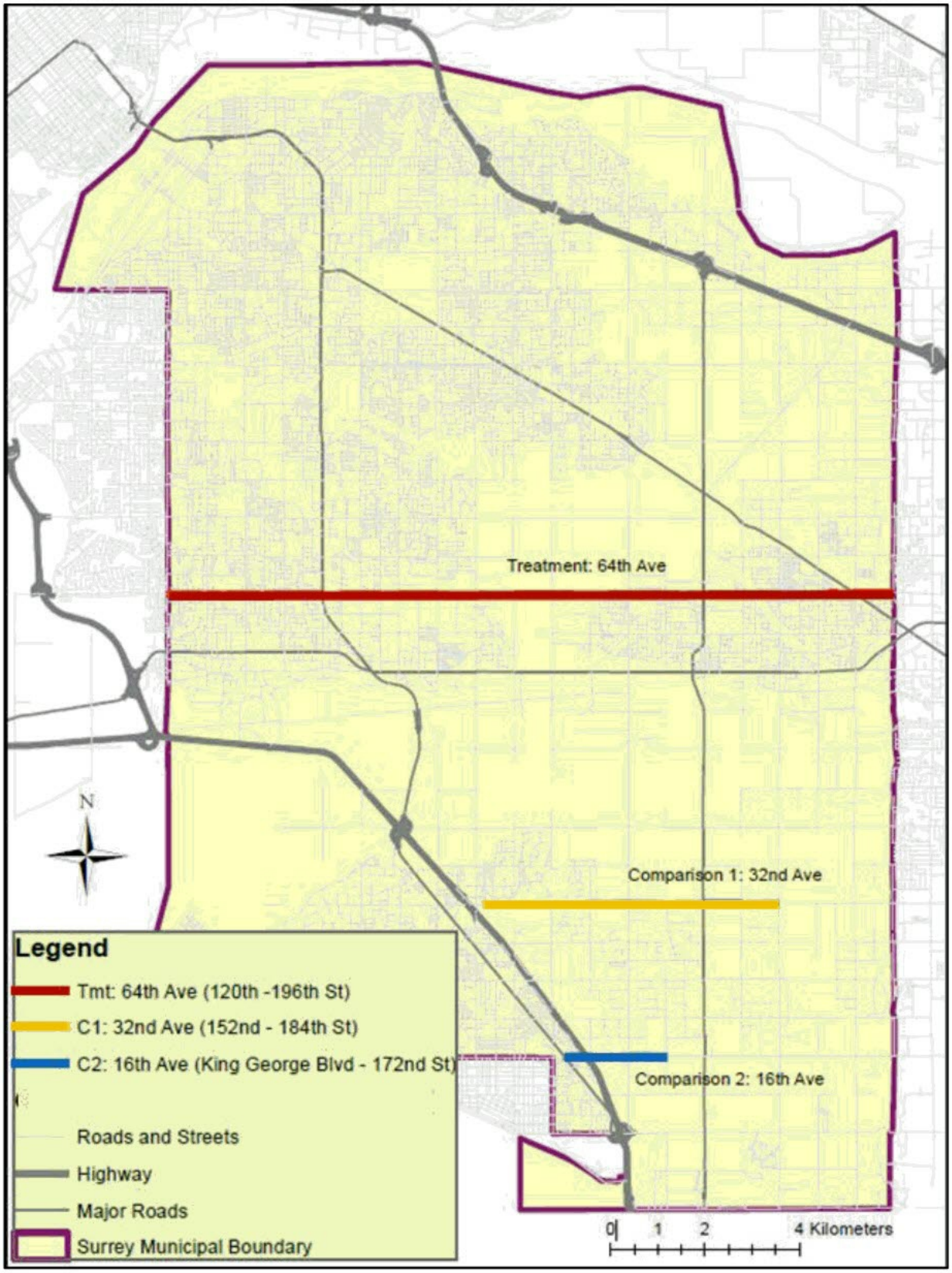
Appendix A: Study Corridor Locations



Appendix B: Study Calendar Dates

Week	Phase	Calendar Dates
1	Baseline	Mar 1-2
2		Mar 3-9
3		Mar 10-16
4		Mar 17-23
5		Mar 24-30
6		Mar 31-Apr 6
7		Apr 7-13
8		Apr 14-20
9		Apr 21-27
10a		Apr 28-30

Week	Phase	Calendar Dates
10b	Treatment	May 1-May 4
11		May 5-11
12		May 12-18
13		May 19-25
14		May 26-Jun 1
15		Jun 2-8
16		Jun 9-15
17		Jun 16-22
18		Jun 23-29
19		Jun 30-Jul 6
20		Jul 7-13
21		Jul 14-20
22		Jul 21-27
23		Jul 28-Aug 2
24		Aug 3-10
25		Aug 11-17
26		Aug 18-24
27		Aug 25-31

Appendix C: Description of Speed Reader Board Locations

Treatment

64th Avenue at 121st Street west-bound: The SRB is located a few meters prior to the intersection of 64th Avenue and 121st Street. There are no traffic lights at this intersection. 64th Avenue has two lanes per direction and a left turning lane onto 121st Street south. There is a bicycle lane and a low median. 250 meters after passing SRB, traffic moving west-bound on 64th Avenue approaches the intersection with 120th Street, which has traffic lights, pedestrian crossings, left turning lanes, businesses on all sides and a mall.

64th Avenue at 146th Street west-bound: The SRB is located a few meters past the 146th intersection Street, a T-intersection. 146th Street goes south only. There are no traffic lights at this intersection. 64th Avenue has two lanes per direction and a left turning lane onto 146th Street south. There is a business/industrial park located on the south side of 64th Avenue at the intersection with 146th Street. There is a bus stop within approximately 30 meters beyond the SRB, located at 64th Avenue and 146th Street.

64th Avenue at 189th Street east-bound: The SRB is located at the T-intersection with 189th Street, across from a fire hall. The SRB is situated on the north side of 64th Avenue immediately before the intersection. 64th Avenue has one lane of traffic in each direction with a double centre line. There is a painted shoulder line on the south side of 64th Avenue eastbound, but there is no sidewalk. There is residential single detached development in the vicinity of the intersection.

Comparison 1

32nd Avenue at 162nd Street west-bound: The SRB is located along the stretch of 32nd Avenue around 162nd Street; however, there is no actual intersection with 162nd street. 32nd Avenue has one lane in each direction with double painted lines in the center. There is a bicycle lane west-bound and a painted shoulder line; and there is no sidewalk west-bound. A golf course is located on the north side of 32nd Avenue and single detached houses on the south side. SRB is located at the bottom of a small hill for traffic travelling west-bound.

32nd Avenue at 172nd Street east-bound: The SRB is located on the south-east corner of the intersection with 172nd Street, a T-type intersection. 172nd street goes south only. 32nd Avenue has one lane of traffic in each direction with double painted center lines. There is a painted shoulder on the south side of 32nd Avenue. There is a stretch of green space along 32nd Avenue east-bound with no driveways to residential properties on the south side of 32nd Avenue. There are driveways off 32nd Avenue on the north side.

Comparison 2

16th Avenue at 170th Street west-bound: The SRB is located on the north-west corner of the intersection with 170th Street, a T-type intersection. 170th Street goes north only. 16th Avenue has one lane of traffic in each direction separated by broken painted center line. There is a church located on the north side of 16th Avenue with the entry driveway to the parking lot less than 50 meters prior to the intersection.

Appendix D: Photos of SRB Locations

Treatment Corridor[22]

Figure 19: 64th Avenue at 121st Street

Copyright

[22] All street view images photo credit: Google Map https://map.google.ca.

Figure 20: 64th Avenue at 146th Street

Figure 21: 64th Avenue at 189th Street

Comparison 1 32nd Avenue

Figure 22: 32nd Avenue at 162nd Street

Copyright

Figure 23: 32nd Avenue at 172 Street

Comparison 2: 16th Ave

Figure 24: 16th Avenue at 146th Street

Appendix E: EAI Forms

SPEED CORRIDOR DEMONSTRATION PROJECT
FRASER VALLEY IRSU: ENFORCEMENT TRACKING SHEET
MARCH 1 – AUGUST 31, 2014

Please follow these instructions:

1. Once you obtain this form from your traffic commander, **save it to your jump/flash drive** as you will need to fill it out on either your MSW or desktop computer.

2. Fill out the form using **ADOBE READER** **each time** you conduct enforcement on **any** of the following corridors:
   64th AVENUE (120th Street to 196th Street)
   - **West – 120th up to 144th Street**
   - **Middle – 144th up to 172nd Street**
   - **East – 172nd to 196th Street**

3. You will need to fill out a new form for each corridor and each segment you conduct enforcement on; even if these corridors and sections are enforced on the same shift.

   Example 1: You conducted enforcement on two sections of 64th Avenue; East and West. You will need to fill out two forms, one for the East section of 64th Avenue and one for the West section of 64th Avenue.

4. All fields are mandatory.

5. Save the file on your jump/flash drive with the following format:
   "Your name – FV IRSU – Date of Enforcement"

6. **Once per week** email your completed forms to:
   Xxxxxxxxxxxxxxxxxx
   xxxxxxxxxxxxxxxxxx

7. **If you have questions, please contact:**
   XXXXXXXXXXXXXXXXXXXX

SHIFT and LOCATION INFORMATION

	YEAR	MONTH	DAY
DATE (fill in columns)	2014		

	HOUR (00 is midnight)	**MINUTE**
START TIME ON CORRIDOR (fill in columns)		
END TIME ON CORRIDOR (fill in columns)		

CORRIDOR	**SECTION** (Fill out a new forms for each section enforced)
64th Avenue	

POSTED SPEED LIMIT AT LOCATION (please specify in km/hr)	

ENFORCEMENT INFORMATION

STATIONARY or MOBILE ENFORCEMENT?	
VISIBLE or COVERT ENFORCEMENT?	
TYPE OF SPEED ENFORCEMENT TOOL USED?	

TOTAL NUMBER OF VEHICLES PULLED OVER	

VIOLATION INFORMATION

VIOLATION	NUMBER OF CHARGES ISSUED
Speed Relative to Conditions (s. 144(1)(c))	
Speed in Municipality (s. 146(1))	
Speed Against Municipal Sign (s. 146(7))	
Speed Against Area Sign (s. 146(7))	
Excessive Speed (s.148(1))	
All Other Charges (MVA, CDSA, CC, etc.)	

SPEED CORRIDOR DEMONSTRATION PROJECT
SURREY RCMP TRAFFIC: ENFORCEMENT TRACKING SHEET
MARCH 1 – AUGUST 31, 2014

Please follow these instructions:

1. Once you obtain this form from your traffic commander, **save it to your jump/flash drive** as you will need to fill it out on either your MSW or desktop computer.

2. Fill out the form using **ADOBE READER** <u>**each time**</u> you conduct enforcement on <u>**any**</u> of the following corridors:
   CORRIDOR A – 64th AVENUE (120th Street to 196th Street)
   SECTIONS
   - **A West – 120th up to 144th Street**
   - **A Middle – 144th up to 172nd Street**
   - **A East – 172nd to 196th Street**

   CORRIDOR B – 32nd AVENUE (152nd Street to 196th Street)
   SECTIONS
   - **B West – 152nd up to 168th Street**
   - **B Middle – 168th up to 184th Street**
   - **B East – 184th to 196th Street**

   CORRIDOR C – 16th AVENUE (King George Blvd to 196th Street)
   SECTIONS
   - **C West – King George Blvd up to 172nd Street**
   - **C Middle – 172nd up to 184th Street**
   - **C East – 184th to 196th Street**

Note: Comparison Corridor Coordinates were revised in the final study analysis.

3. You will need to fill out a new form for each corridor and each segment you conduct enforcement on; even if these corridors and sections are enforced on the same shift.

   Example 1: You conducted enforcement on Corridor A and Corridor B. You will need to fill out two forms; one for Corridor A and one for Corridor B.

   Example 2: You conducted enforcement on two sections of Corridor A; East and West. You will need to fill out two forms, one for the East section of Corridor A and one for the West section of Corridor A.

4. All fields are mandatory.

5. Save the file on your jump/flash drive with the following format:
   "Your name – Surrey MT – Date of Enforcement"

6. **Once per week** email your completed forms to:
   Xxxxxxxxxxxxxxxxxx
   xxxxxxxxxxxxxxxxxx

7. **If you have questions, please contact:**
   XXXXXXXXXXXXXXXXXXXX

SHIFT and LOCATION INFORMATION

	YEAR	MONTH	DAY
DATE (fill in columns)	2014		

	HOUR (00 is midnight)	MINUTE
START TIME ON CORRIDOR (fill in columns)		
END TIME ON CORRIDOR (fill in columns)		

CORRIDOR (Fill our new form for each corridor enforced. For corridor boundaries, please refer to #2 on previous instruction page)	SECTION (Fill our new form for each corridor enforced. For corridor boundaries, please refer to #2 on previous instruction page)

POSTED SPEED LIMIT AT LOCATION (please specify in km/hr)	

ENFORCEMENT INFORMATION

DID YOU CONDUCT ENFORCEMENT WITH FRASER VALLEY IRSU ON THIS CORRIDOR?	

TYPE OF ENFORCEMENT CONDUCTED	

TOTAL NUMBER OF VEHICLES PULLED OVER	

VIOLATION INFORMATION

VIOLATION	NUMBER OF CHARGES ISSUED
Speed Relative to Conditions (s. 144(1)(c))	
Speed in Municipality (s. 146(1))	
Speed Against Municipal Sign (s. 146(7))	
Speed Against Area Sign (s. 146(7))	
Excessive Speed (s.148(1))	
All Other Charges (MVA, CDSA, CC, etc.)	

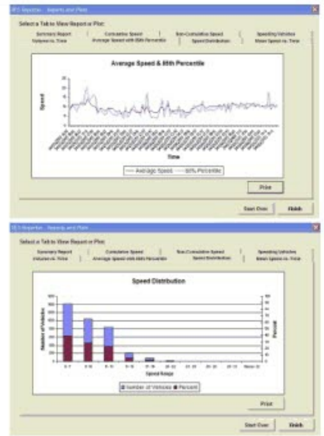
Appendix F: SRB Manufacturer Information

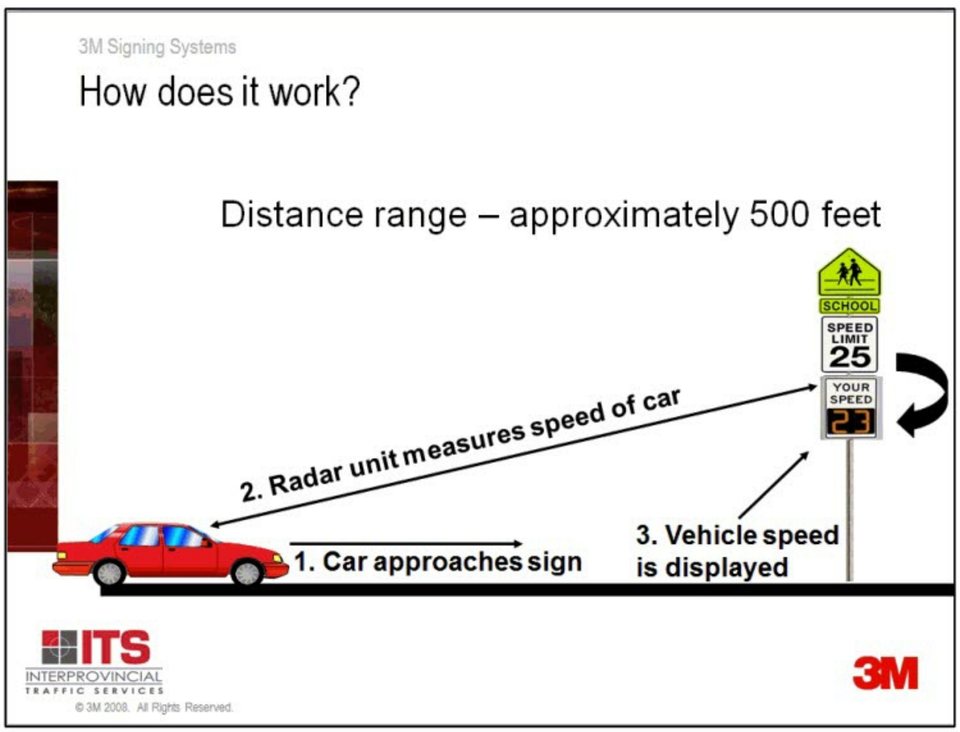
SRBs were sourced from 3M Signing Systems.

Driver Feedback Sign Models	Stock Number
Urban Driver Feedback Sign (30" X 41") 15" high speed display	
Available in: White	75-0301-6563-5
Fluorescent Yellow-Green	75-0301-6564-3
Fluorescent Orange	75-0301-6565-0
Fluorescent Yellow	75-0301-6665-8
Highway Driver Feedback Sign (48" X 60") 22" high speed display	
Available in: White	75-0301-6569-2
Fluorescent Yellow-Green	75-0301-6570-0
Fluorescent Orange	75-0301-6572-6
Fluorescent Yellow	75-0301-6666-6
Driver Feedback Sign Power Options	**Stock Number**
AC Power Module	
Urban	75-0301-6576-7
Highway	75-0301-7833-1
DC Solar Kit	75-0301-6578-3
DC Battery Charger Kit A	75-0301-6579-1
DC Battery Charger Kit B	75-0301-6580-9

Configuration and Data Collection Software

With 3M's Bluetooth enabled software, users can easily configure the display (amber or red speed display, white strobe), schedule on/off operation times, and download speed data from the sign. Speed data is nalyzed using the 3M™ DFS Reporter Macro.





Specifications	Urban Sign (30 X 41 inches)	Highway Sign (48 X 60 inches)
Applications	For speeds under 80 km/h	For speeds over 80 km/h
LEDs (Light Emitting Diodes) 1/2 cone angle	30°	
Amber LED intensity @ 30°	10,000 CDA/Square Meter	
Red LED intensity @ 30°	8000 CDA/Square Meter	
Display height	15 inches	22 inches
Front face reflective sheeting	3M™ Diamond Grade™ DG³ full cube prismatic, meets ASTM Type XI	
Front face color options	White, fluorescent yellow-green, fluorescent orange, fluorescent yellow	
"YOUR SPEED" Legend	5 inch high Series E letters	8 inch high Series E letters
Photocell controlled brightness	Automatic brightness control for excellent visibility in all lighting conditions	
Cabinet dimensions	30 inches wide by 41 inches high by 3 inches deep	48 inches wide by 60 inches high by 4 inches deep
Construction	Sealed Electronics Control System (ECS) with high impact polycarbonate face. Removable ECS slides into sign chassis when retainer bar is removed. Retainer bar is lockable with user supplied lock.	
Weight	36 pounds	90 pounds
Operating temperature	Minus -34 degrees C to +74 degrees C	
Electronics Enclosure	The ECS enclosure meets NEMA 3R for environmental protection.	
Real Time Display	The display updates once per second to provide dynamic feedback to the driver.	
Programmable display speed thresholds	Minimum display speed - no speeds displayed below this threshold to limit non-vehicle signals Speed limit - set at posted speed limit to alert drivers that they are over the speed limit Excessive speed - typically set at 10 to 20 km/h over the speed limit for additional attention getting Maximum display speed - no speeds displayed above this threshold to limit drivers racing the speed display	
Programmable display modes	Amber numerals Amber flashing numerals Amber flashing numerals with synchronized built-in white strobe Red numerals Red flashing numeral Red flashing numerals with synchronized built-in white strobe	
Radar	K-band (24.150 GHz ± 100 MHz) license free	
Sign configuration and speed data collection software	Program sign parameters including speed thresholds, display modes and schedule on times. Download speed data and sign event data. Software included with sign.	
DFS reporter	Excel™ software-based macro formats speed data into charts for analysis. Software included with sign	
Communication	Standard: Bluetooth® wireless up to 30 feet from sign (19.2 K-baud)	
Power Requirements	12VDC nominal (10.5V – 16V, MAX: 24V) 54W maximum 15W day typical 6W night typical Typical Daily Average (24 hour operation): 216 WH/Day Stealth Mode (logging information, but no display): 2W Standby (schedule off): 0.5W	12VDC nominal (10.5V – 16V, MAX: 24V) 115W maximum 30W day typical 11W night typical Typical Daily Average (24 hour operation): 432 WH/Day Stealth Mode (logging information, no display): 2W Standby (schedule off): 0.5W
Power Options	AC Power Module Solar Kit (128 watt solar pannels) Battery Charger Kit A (AC input: 190, 208, 220, 240, 380, 416, 440, 480 VAC) Battery Charger Kit B (AC input: 120, 208, 240, 277 VAC)	