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EVALUATION OF THE ROADSIDE DRUG TESTING EXPANSION AND ROADSIDE ALCOHOL TESTING ENFORCEMENT PROGRAMS IN VICTORIA

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Evaluation of the Roadside Drug Testing Expansion and Roadside Alcohol Testing Enforcement Programs in Victoria

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Abstract:

Drink and drug driving continue to be overrepresented in both serious and fatal injury crashes, in Victoria. To address the growing drug driving problem in Victoria, in 2015 the Transport Accident Commission (TAC) funded the Roadside Drug Testing Expansion Program, a program aimed at increasing the capacity of Victoria Police in the detection of drug drivers. The aims of the expansion were two-fold, the first being to train additional Victoria Police members to undertake RDT, the second to increase the annual number of POFTs conducted for drug driving to 100,000 per annum by 2017.

This project aimed to evaluate the road safety impacts of the TAC funded expansion in roadside drug testing in Victoria in 2015. To achieve this, research has focused on: measuring the increase in drug tests delivered; establishing the link between Victoria Police member training to deliver drug testing; establishing the association between measures of drug testing delivery and the presence of drugs and alcohol in fatally and seriously injured vehicle controllers; and, integrating these results into an updated Traffic Enforcement Resource Allocation Model (TERAM) to estimate the road trauma and economic impacts of measured increases in drug testing resulting from the TAC funded program. In addition, further application of the updated TERAM was able to estimate the benefits of further expansion of the drug testing program subsequent to the initial TAC funded increase, as well as estimating the point of diminishing returns for both the drug and alcohol enforcement programs. Finally, to assist with future enforcement and research, days and hours of the week where drugs and alcohol are more likely to be detected in crash involved vehicle controllers were estimated. Based on the results, implications for future drug and alcohol enforcement in Victoria have been identified.

Key words:

Random Drug Testing, RDT, roadside drug testing, drug driving enforcement, RBT random breath testing, BAC, blood alcohol content

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PREFACE

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Ethics Statement

Ethics approval was granted by:

- Monash University Human Research Ethics Committee (MUHREC)
- Victoria Police Research Coordinating Committee (RCC)

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INTRODUCTION

Drink and drug driving behaviours continue to be overrepresented in both serious and fatal injury crashes, in Victoria. There are well documented high risks associated with drink driving which led to the introduction of roadside Random Breath Testing (RBT) over 40 years ago, tests that are delivered through both car and bus enforcement operations. Based on a similar model to the Random Breath Testing (RBT) model, Roadside Drug testing (RDT) was introduced in 2004, as an enforcement countermeasure to address the increasing rate of drug driving.

In 2015 the Transport Accident Commission (TAC) funded the Roadside Drug Testing Expansion Program, a program aimed at increasing the capacity of Victoria Police in the detection of drug drivers. The aims of the expansion were two-fold, the first being to train additional Victoria Police members to undertake RDT, the second to increase the annual number of Preliminary Oral Fluid Tests (POFTs) conducted to test for presence of drugs in drivers to 100,000 per annum by 2017 (TAC, 2018).

MUARC was contracted by the TAC to conduct and outcome evaluation of the Roadside Drug Testing Expansion Program. Following the initial Project Steering Committee meeting, it was decided to expand the scope the research project to incorporate a review of the RBT enforcement program as well. The last time that RBT enforcement had been evaluated in Victoria was by MUARC in 2008, however this was only based on one inner city Melbourne Police Region. The Traffic Enforcement Resource Allocation Model (TERAM) was developed to estimate the crash reduction benefits of increases in each type of enforcement applied to an appropriate road environment. However, the current RDT enforcement data used in the TERAM is over a decade old and so it was decided that the outcomes from both the RDT and RBT evaluation components of this research would be used to update the TERAM. This report details the conduct and findings from this evaluation research.

The overall objectives of the project were:

1. Documentation of the key historical statistics and practices in drug and alcohol enforcement in Victoria over a period for which reliable data is available, including the mode of enforcement (e.g. HP, bus-based, random, targeted etc.) over time and by geographic area (e.g. Victoria Police Region).
2. Document the prevalence of illicit drugs and alcohol in road crashes. From this, develop new measures of high alcohol and high drug hours, including analysis of whether these hours differ by Victoria Police Region.
3. Undertake a limited process evaluation of the 2015 expansion of roadside drug enforcement including:
    a. Assessment of the impact on the number and proportion of Victoria Police members trained in roadside drug testing and the distribution in deployment of these members across the state.
    b. Relate the change in delivery of roadside drug testing over time, by region, to changes in available police members for testing resulting from additional training.
4. Undertake an outcome evaluation of the impact of changes in both roadside drug and alcohol enforcement on observed road trauma, specifically deaths and serious injuries where drugs and / or alcohol were detected in the injured vehicle controller, with a specific focus on measuring the road safety benefits associated with the 2015 expansion of roadside drug testing.
5. Synthesize the outcomes from objectives 1-4 to provide a summary of strategic learnings for future drug and alcohol enforcement in Victoria as well as providing updated drug and alcohol driving enforcement data for inclusion in the Traffic Enforcement Resource Allocation Model (TERAM) analysis.

DATA

Following investigations by the research team in consultation with various sections within Road Policing Command at Victoria Police, the most suitable data sources to support the conduct of the evaluation were identified and requested.

RDT shift data was received from Victoria Police covering the years 2004 to 2018, this data was collected at RDT operations and records shifts conducted by car and bus operations. Traffic Incident Systems (TIS) data on police reported crashes covering the years 2006 to 2016 including information on drug and alcohol presence in vehicle controllers (including drivers, motorcyclists and bicyclists) who were seriously injured. The fatality data was subsequently matched with the Victorian Coronial Data system containing toxicology results that identified the presence of drugs and alcohol in fatally injured crash involved vehicle controllers. Both the serious injury and fatality data was matched to the Victorian Road Crash Information System (RCIS) data, to support the final analysis design. Data relating to Preliminary Oral Fluid Tests (POFTs) and Oral Fluid Tests (OFTs), used for evidentiary purposes and designed to detect the presence of illicit drugs was analysed for the RDT phase of the evaluation. Preliminary Breath test (PBT) and Evidentiary Breath Test (EBT) data, from 2006 to 2016, was used in the drink driving enforcement analysis. Data regarding police member Training to undertake POFTs and/or OFTs was provided through Victoria Police.

The analysis of the relationship between levels of drug and alcohol enforcement and road safety outcomes focused on vehicle controllers killed or seriously injured with drugs or alcohol detected in their system. Consideration was given to an analysis of crashes involving drug presence in any involved driver but considered the identification of drug and alcohol involvement in drivers not killed or seriously injured might be incomplete if the other drivers were not rigorously tested. Consequently, estimates of the impact of enforcement on drug and alcohol on road trauma outcomes derived from the study are likely to be slightly conservative

KEY FINDINGS

Increase in Drug Testing and its Relationship to Drug Testing Training

- TAC funding allowed the annual number of POFTs for three proscribed drugs to increase from 42,000 during 2012/13 and 2013/14 to 82,383 in 2014/15 and then to 100,000 per year during 2015/16 and 2017/18.
- Increasing the annual rate of drug testing was facilitated through the additional training of Victoria Police members, in particular officers from Highway Patrol, to conduct roadside drug testing. During 2015 the number of RDT qualified Police members increased from approximately 110 to around 510 members, followed by a steady increase to approximately 700 members by the end of 2017.
- There was a strong correlation between the increase in the number of RDT qualified Police members and the increase in drug test delivery achieved. There was no identified correlation between the increase in drug testing and the level of delivery of roadside alcohol testing.

The relationship between drug and alcohol testing and drug and alcohol presence in crash involved vehicle controllers

A range of relationships between drug and alcohol enforcement, including roadside tests delivered and the test hit rate (offence detection rate per test), and the likelihood of drug and alcohol presence in fatally and seriously injured vehicle controllers were identified. A summary of the associations found is given in the following table. Outcomes considered were THC, Methamphetamine, alcohol at or above 0.05 g/100mL, and alcohol at or above 0.15 g/100mL presence in fatally and seriously injured vehicle controllers. Enforcement measures considered were annual number of POFTs or PBTs delivered per Region per year and the hit rate both in total and from car and bus operations separately. A tick in the table represents a statistically significant association whilst a question mark represents a marginally statistically significant association where the value of the odds ratio indicated an important relationship might exist and should be further explored.

	Number of Tests Delivered			Testing Hit Rate		
Outcome	Car and Bus Combined	Car	Bus	Car and Bus Combined	Car	Bus
Drug Presence in Crash Involved Vehicle Controllers						
Meth SI				☑		
Meth Fatal	?	?		☑	☑	
THC SI	☑					
THC Fatal	☑	☑		?	☑	
Alcohol Presence in Crash Involved Vehicle Controllers						
>= 0.05 SI	☑	☑	☑	☑		☑
>= 0.05 Fatal	?		☑	☑		☑
>= 0.15 SI	☑	☑	☑	☑		?
>= 0.15 Fatal			?	?		?

For each of the significant associations identified in the analysis, the study has estimated the specific relationship between an increase in the enforcement measure and the expected change in odds of the related outcomes. These relationships were then integrated into the updated TERAM to estimate the impact of changes in enforcement delivery on fatal and serious injuries from road crashes and their associated economic worth.

Estimation of drug and alcohol hours

Analysis was able to estimate days of the week and times of the day where alcohol and drugs was more prevalent in crash involved vehicle controllers. High Alcohol Hours have been defined as “any hour of the day/day of week in which 20% or more of seriously injured vehicle controllers have a BAC of 0.05 or greater”. High THC Hours (HTH) and High

Methamphetamine Hours (HMA) are "any hour of the day/day of week in which 20% or more of seriously injured vehicle controllers have THC or Methamphetamine (respectively) presence in their blood.

High alcohol times were identified similar to previously defined as:

- Sunday 6PM -Monday 9AM
- Monday 7PM -Tuesday 6AM
- Tuesday 7PM -Wednesday 5AM
- Wednesday 7PM -Thursday 5AM
- Thursday 7PM -Friday 5AM
- Friday 7PM -Saturday 6AM
- Saturday 6PM -Sunday 8AM

High THC hours were identified as:

- Sunday 3PM -Monday 9AM
- Monday 3PM -Tuesday 6AM
- Tuesday 11AM -Wednesday 5AM
- Wednesday 11AM -Thursday 5AM
- Thursday 7PM -Friday 4AM
- Friday 11AM -Saturday 5AM
- Saturday 2PM -Sunday 7AM

Methamphetamine presence in crash involved vehicle controllers was relatively uniform across the week.

Impacts of increased drug and alcohol testing on road trauma

Specifically related to the increase in drug testing achieved through the TAC funding, application of updated TERAM estimated the following benefits:

- The TAC funded increase in roadside drug tests from 42,000 to 100,000 per year was effective and highly cost-beneficial. It was estimated to have saved more than 33 fatal crashes and nearly 80 serious injury crashes per year[1].
- The estimated Benefit Cost Ratio (BCR) for the expansion valuing estimated road trauma savings using the Human Capital method was 9.17.
- Although not funded under the program being evaluated, a further increase in roadside drug tests to 150,000 during 2018/19 should have saved a further 23 fatal crashes and nearly 56 serious injury crashes. However, available data from the first 45 weeks of 2018/19 indicates that total roadside drug tests in 2018/19 were not increased as planned and not delivered in a way that would have achieved maximum road safety benefits. Actual increase in tests, when annualised, were estimated to have saved at least 3 fatal crashes and 16.5 serious injury crashes during 2018/19.

Further application of updated TERAM estimated the potential benefits of further expansion to drug and alcohol enforcement in Victoria including estimating the point of diminishing returns for each element of the program (the level of enforcement after which additional enforcement will cost more than the community cost savings achieved). Key findings were:

- Further increases in roadside drug tests are justified on economic criteria as well as the additional savings in fatal and serious injury crashes.
- Valuing the crash savings by Human Capital costs, roadside drug tests could increase up to 390,100 POFTs annually and are estimated to save 46 fatal crashes and 134.5 serious injury crashes per year.
- A 50% increase in roadside alcohol tests (composed of 30% and 60% increases in bus- and car-based tests, respectively) from 2014-2016 levels is estimated to save more than 8 fatal crashes and over 77 serious injury crashes per year.
- As with roadside drug tests, further increases in roadside alcohol tests are justified on economic criteria as well the additional savings in fatal and serious injury crashes.
- Valuing the crash savings by Human Capital costs, roadside alcohol tests could increase to 14.1 million PBTs annually in total and are estimated to save 32 fatal crashes and 268 serious injury crashes per year.

[1] Note that the savings estimated are relative to the (unobserved) trauma that would have been observed had the drug testing increase not occurred and not relative to observed trauma in the year prior to the testing increase.

- Investment in further roadside drug testing would achieve greater reduction in the social costs of crashes than roadside alcohol testing, relative to the operational costs of each program.

Estimates of potential road trauma savings related to further expansion of the drug and alcohol enforcement programs have assumed that the additional enforcement is delivered in an optimal way based on the relationships between enforcement modes and crash outcomes identified in this study (for example, prioritising targeted car-based testing for methamphetamine). If any future expansion of drug and alcohol testing is not deployed according to the optimal principles identified and summarised in the next section, the road safety benefits estimated in this study will not be realised.

Implications for future drug and alcohol enforcement

Results of the evaluation defined some principles for future drug and alcohol enforcement in Victoria to maximise road safety and associated economic benefits.

- Alcohol enforcement should:
  - Deliver a large number of tests from both car and bus operations
  - Be targeted to increase the testing hit rate. This could be achieved through the use of bus operations (which deliver large numbers of tests), with targeted placement in areas where alcohol prevalence in crash involved vehicle controllers is high or detected alcohol use amongst vehicle controllers is high.
  - Be largely conducted in high the identified high alcohol times, including from midnight to 6am.
- THC enforcement should:
  - Delivery of a large number of tests, primarily from car operations, with some weighting towards targeting to areas of high THC fatal crash involvement or detected use, is the key to reducing THC involved crashes.
  - Largely be delivered in high THC hours which are predominantly night-time hours but extend further into daytime hours than alcohol enforcement.
- Methamphetamine enforcement should
  - Focus on achieving high hit rates so should be targeted primarily at areas of high Methamphetamine involvement in crashes or established areas of high prevalence in vehicle controllers. Achieving the highest hit rate through detecting Methamphetamine affected vehicle controllers should be the primary aim.
  - Primarily be conducted from cars.
  - Be conducted throughout the day reflecting that there were no particular hours of the day where Methamphetamine was more prevalent in crash involved vehicle controllers.

From these principles a range of Key Performance Indicators (KPIs) and interim outcome measures can be defined.

Further research on the drug and alcohol enforcement program in Victoria is recommended including: ongoing monitoring of the delivery of the program to determine whether best practice delivery is being achieved and; periodic evaluation for the program, particularly to assess the road safety benefits of any planned future expansion of the program or changes in delivery practice.

GLOSSARY OF TERMS

BAC	Blood Alcohol content
BCR	Benefit Cost Ratio
EBT	*Evidentiary Breath Test (alcohol)*
HAH	High Alcohol Hours
HTH	High THC Hours
HMH	High Methamphetamine Hours
HP	Highway Patrol
HVU	Heavy Vehicle Unit
KPI	Key Performance Indicators
LGA	Local Government Area
MA	Methamphetamine
MDMA	3,4-methylenedioxymethamphetamine (ecstasy)
MUARC	Monash University Accident Research Centre
OFT	Oral Fluid Test (used for confirmation of POFT result)
PBT	*Preliminary Breath Test (alcohol)*
POFT	Preliminary Oral Fluid Test
RBT	Random Breath Test (alcohol)
RCIS	Road Crash Information System
RDT	Roadside Drug Test
RPDAS	Road Policing Drug and Alcohol Section
SHP	State Highway Patrol
TAS	Traffic Alcohol Section
TAC	Transport Accident Commission
TERAM	Traffic Enforcement Resource Allocation Model
THC	Tetrahydrocannabinol
TIS	Traffic Information System
VIFM	Victorian Institute of Forensic Medicine

1 INTRODUCTION

One of the most significant causes of deaths and serious injuries on Australasian roads is drink driving. Data show that up to 30 percent of drivers and motorcyclists killed on Australasian roads were driving with a Blood Alcohol Content (BAC) over the legal limit. Similarly, drug driving is a serious road safety issue with 41% of drivers / riders killed in Victoria identified as having drugs (legal and illegal) in their system (TAC, 2018). Victoria was the first state to introduce Random Breath Testing for drink driving in 1976. It was also one of the first locations in the world to introduce roadside drug testing (RDT), initially trialled from December 2004.

The extent and location of roadside enforcement, for both drugs and alcohol, plays a key role in detecting impaired drivers (specific deterrence) as well as deterring passing drivers from future impaired driving (general deterrence). Following its official adoption in 2006, the annual number of roadside tests to detect drivers under the influence of drugs, known as Preliminary Oral Fluid Tests (POFTs; preliminary roadside drug tests) and Oral Fluid Tests (OFTs; which serve as a confirmatory test for the POFT when the POFT is positive), have steadily climbed with over 40,000 tests were conducted. From 2015, the Transport Accident Commission (TAC) funded an expansion of the roadside drug testing program run by Victoria Police. The aims of the expansion were two-fold, the first being to train additional Victoria Police members to be qualified for undertaking roadside drug testing, the second to increase the annual number of roadside tests conducted for drug driving to 100,000 by 2017 (TAC, 2018). Victoria Police met this increased annual target in both 2015 and 2016. While training to administer RDTs is now part of new recruit training at the Victoria Police Academy, training existing Police members was required to facilitate a more geographically widespread roadside testing program for drug use, especially covering rural locations. Roadside blood alcohol testing in Victoria has fluctuated between 3.5M and 4M preliminary breath tests (PBT) per year from 2005 to 2014. In 2015 and 2016 this reduced to closer to 3M test per year.

In addition to detection and sanctions for detected drivers, change in both the extent and implementation of drug and alcohol enforcement by Victoria Police has the potential to affect the impact these activities have on road trauma outcomes. Understanding the impacts of these changes have on road trauma outcomes is important for optimizing the benefits of drug and alcohol testing, as well as for setting appropriate strategic targets aimed at meeting road trauma savings goals. Comprehensive evaluation of changes in drug and alcohol enforcement in Victoria is critical to providing this understanding.

Previous research provides an indication of the benefits of evaluation of drug and alcohol enforcement and the approaches taken. Research conducted in New Zealand identified an increase in drink driving on local streets (Keall & Frith, 1997). This increase was attributed to drivers attempting to avoid detection through booze bus operations on arterial roads. In 2008, MUARC (Clark, Diamantopoulou, & Cameron, 2009) conducted a research project to investigate if this phenomenon was occurring in Melbourne. It also assessed whether Victoria Police roadside alcohol testing was being delivered in a manner that would detect this occurrence. The research was conducted in Victoria Police Region 1 and involved analysis of existing booze bus and patrol RBT data, including PBT data. It also included roadside surveys that were conducted at a representative sample of both mini-bus and booze bus RBT site operations over a 3-month period (June–August 2008). It provided an overview of the allocation and scheduling of RBT operations across Region 1 and identified gaps in scheduling timeframes and locations. While this research provided valuable operations feedback to Victoria Police, it was limited to Region 1 (metro only) and occurred ten years ago. Evaluation of the roadside program of drug testing was explored at the time but was not considered feasible due to the limited experience with the program. Recommendations for future evaluation of drug testing were made, as well as an update of the previous RBT research expanded to include all Victoria Police regions. It was noted that this would provide valuable information to inform Victoria Police Roadside drug and alcohol testing resource allocation and scheduling, and identify gaps in the current testing programs.

To investigate the impacts of alcohol enforcement, Victorian road safety research has relied on a surrogate measure of the involvement of alcohol in crashes which divides the week into times associated with alcohol-related crashes (i.e. high alcohol hours) and other times (i.e. low alcohol hours). This method was first developed by David South (cited in Haque & Cameron, 1987). High alcohol times of the week were determined by examining the crashes in which driver blood alcohol concentrations (BACs) were known and finding those periods that had a relatively high proportion of drivers with a blood alcohol concentration greater than 0.05g/100ml. Harrison (1990) revised the alcohol times using more recent crash data and an analysis that was person-based rather than crash based. Harrison's definition of the high and low alcohol times of the week have been used as a surrogate measure for actual BAC data extensively in many research studies concerned with drink-driving in Victoria since the early 1990's. In 1995 Gantzer reviewed the high and low alcohol data for differences between Melbourne (metro) and the rest of Victoria (rural). As part of the MUARC Baseline Research Program, in 2008 the Victoria Police requested that MUARC re-examine the high alcohol times of the week to enable police to provide strategic deployment of booze buses to detect drink-drivers. This research was, however abandoned due to limitations at the time in the available forensic data on blood alcohol concentrations of fatally injured drivers. Improvements in the availability of such data in recent years may now mean this re-analysis is feasible.

The road safety risk posed by drink and drug drivers is well documented. Resources and funding, such as the Roadside Drug Testing Expansion Program, continue to be allocated in efforts to enhance and maximise countermeasures to address drug driving. Evaluation of these countermeasures plays a key role in ensuring program targets are met, resource allocation is maximised, and that desired outcome targets such as reductions in drink and drug driving and related road trauma are achieved.

While maximising the resource allocation associated with both RDT and RBT enforcement may be a desirable aim, Victoria Police are faced with numerous competing enforcement priorities, therefore it is important to ensure that resources are strategically allocated in the most beneficial way. The Monash University Accident Research Centre (MUARC) conducted a review of strategic approaches for choosing packages of road safety initiatives, this review included police enforcement programs (Diamantopoulou, Clark & Cameron, 2009). The greatest economic value was found to be associated with packages from which the components had marginal benefits (reductions in road trauma) that were greater than their marginal costs. This research highlighted the importance of analysing the variable levels of intensity within traffic enforcement initiatives to decide on the most appropriate types and levels of operation to be resourced in the final overall program (Cameron, Newstead & Diamantopoulou, 2016). In response to this finding, the Traffic Enforcement Resource Allocation Model (TERAM) was developed to estimate the crash reduction benefits of increases in each type of enforcement applied to an appropriate road environment.

The TERAM is based on numerous studies linking enforcement levels with road crashes and/or injury severity in the Australian States and internationally. Economic analysis of the crash savings and costs from investment in each type of traffic enforcement, identified that mobile speed cameras and random drug tests provided the highest benefit-cost ratios (Cameron, Newstead & Diamantopoulou, 2016). Figure 1 shows the relationship between the percentage of driver fatalities with a detected proscribed drug(s) or any impairing drug and the number of POFTs (RDTs conducted). The specific data used in this figure currently informs the RDT enforcement component of the TERAM and is based on the RDT enforcement and crash data from 2005-09 (Boorman, 2010).

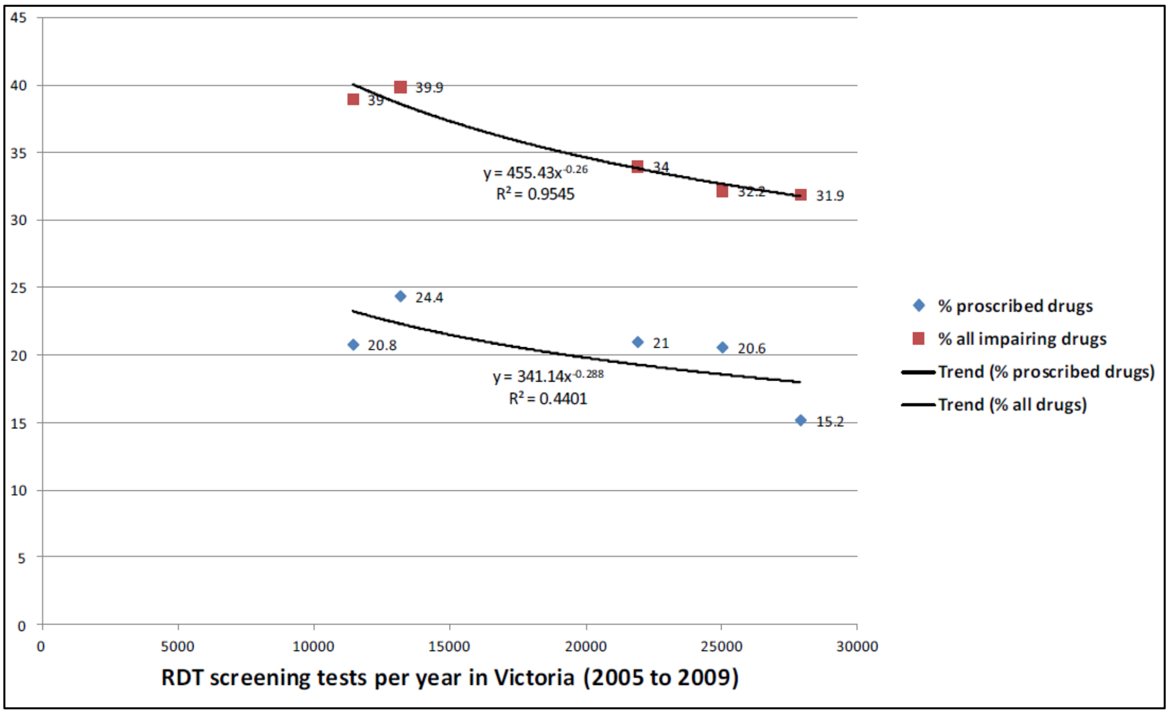

Figure 1 Relationship between percentage of driver fatalities with proscribed drugs, or any impairing drug, versus number of drivers screened by RDT (POFTs) in Victoria per year

Source: Cameron, Newstead & Diamantopoulou (2016)

Following the TAC funded RDT expansion program and taking into account that the RDT data used in the current TERAM is between 10 and 15 years old, it was considered timely to undertake an evaluation of the RDT enforcement program. An evaluation was considered critical for providing valuable information regarding the effectiveness of RDT enforcement from a road safety and associated cost-benefit perspective, from a general and specific deterrence perspective, and to ensure the TERAM modelling is based on the most current RDT and drug involved crash data available.

1.1 Project aims and objectives

The Transport Accident Commission and Victoria Police engaged MUARC to design and conduct an evaluation of the Roadside Drug Testing Expansion Program implemented in Victoria during 2015. In response MUARC have developed a multi-component Evaluation framework. This framework includes a process evaluation component to ascertain the relationship between training of Victoria Police members to undertake roadside drug testing and the number and geographical spread of tests subsequently delivered. It also includes an outcome evaluation to establish the relationship between the level of roadside drug testing and drug related road trauma outcomes. In response to recent changes in the roadside alcohol testing program regime and acknowledging that there has been no evaluation of the road safety benefits of alcohol testing for some years, it was requested that the evaluation framework also include an assessment of roadside alcohol testing.

An initial meeting of the Project Steering Committee identified the following objectives for the evaluation.

1. Documentation of the key historical statistics and practices in drug and alcohol enforcement in Victoria over a period for which reliable data is available, including the mode of enforcement (e.g. Highway Patrol, bus-based, random, targeted etc.) over time and by geographic area (e.g. Victoria Police Region).
2. Document the prevalence of illicit drugs and alcohol in road crashes. From this, develop new measures of high alcohol and high drug hours, including analysis of whether these hours differ by Victoria Police Region.
3. Undertake a limited process evaluation of the 2015 expansion of roadside drug enforcement including:
    a. Assessment of the impact on the number and proportion of Victoria Police members trained in roadside drug testing and the distribution in deployment of these members across the state.
    b. In reference to part a. above, relate the change in delivery of roadside drug testing over time, by region, to changes in available police members for testing resulting from additional training
4. Undertake an outcome evaluation of the impact of changes in both roadside drug and alcohol enforcement on observed road trauma, specifically deaths and serious injuries. The outcome evaluation should have a specific focus on measuring the road safety benefits associated with the 2015 expansion of roadside drug testing.
5. Synthesize the outcomes from objectives 1-4 to provide a summary of strategic learnings for future drug and alcohol enforcement in Victoria as well as providing updated drug and alcohol driving enforcement data for inclusion in the Traffic Enforcement Resource Allocation Model (TERAM) analysis.

2 DATA

2.1 RDT data

2.1.1 Data access

The MUARC research team liaised with Victoria Police representatives to explore the suitability and accessibility options of data for this research project. The research project and data access were approved through the Monash University Human Research Ethics Committee (MUHREC) and the Victoria Police Research Coordinating Committee (RCC).

Victoria Police data pertaining to RDT shifts, for the years 2004 to 2018, was accessed for the following variables: RDT shift date and time, number of drug driving RDTs (POFTs & OFTs) conducted, Police Division and Region in which the testing occurred. Traffic Incident System (TIS) data was used to identify drug affected vehicle controllers (including drivers, motorcyclists and bicyclists) who were seriously injured in a crash. TIS fatality related data was matched with the Victorian Coronial data system to identify drug affected vehicle controllers who were fatally injured in a crash. Victorian Road Crash Information System (RCIS) data was accessed and matched with both the serious injury and fatality data for the analysis.

2.1.2 Roadside drug enforcement data

RDT shift data was received from Victoria Police covering the years 2004 to 2018. This data corresponds directly with the 'Random Drug Testing' section on the RPDAS Site Summary Sheet Form and records shifts conducted by car and bus operations. Each row (record) of data corresponds to an individual shift operation.

Date and time of shift are presented alongside variables pertaining to the drug testing. The number of POFTs and OFTs are broken down by light/heavy vehicle, male/female, and metro/rural. RDT refusal offences are also recorded, although they are few in number.

Each shift is linked to the Police Work Unit, Police Region and Division where it was undertaken. As not all Police Work Units are contained within a set geographical boundary, the Region and Division variables were crucial for identifying where a shift took place. For shifts recorded before the end of the 2009/10 financial year the Regions and Divisions were numbered according to the 'old' Victoria Police five Region partitions. This earlier Regional and Division data was then transposed to align with the current four Police Regions. However, this re-assignment did not reflect a perfect correlation of old Region/Division to new so some assumptions were made when assigning these records (that aligned close to boundaries) into the current geographic Regions.

Shifts conducted by the Heavy Vehicle Unit (HVU) before July 2010 did not have a Police Division recorded, only broad geographical region. As such, it could not be established where the shifts took place, so data prior to 2010 was omitted from the analysis.

2.2 RBT data

2.2.1 Data access

Similar to the process of accessing random drug testing data, the MUARC research team liaised with Victoria Police representatives to identify the relevant data and the data access was approved through the Monash University Human Research Ethics Committee (MUHREC) and the Victoria Police Research Coordinating Committee (RCC).

2.2.2 Roadside alcohol enforcement data

2.2.2.1 Preliminary Breath Test Data

Preliminary Breath Test (PBT) device data from RBTs was obtained through Victoria Police for the years 2006 to 2016 (and partial data from early 2017). PBT data from these years spanned the changeover to a new PBT device. Phasing out of the earlier model, the 'SD400', began in 2010 and by the start of 2014 only the new model, the 'Touch 400', was in use.

The two devices record information in slightly different formats. Both devices record a unique device serial number, date and time, gender of tested person and BAC result but differ in how the capture geographic information. The SD400 devices records have numerically coded variables for Region, Division, District, Unit and Response Zone adhering to the old (pre-2009) Police partitioning of Victoria. A correspondence table of these values was provided although it was found that the coding was only accurate to a divisional level. Accordingly, there was a small concession in accuracy in converting test records to the new police format.

For the Touch 400 devices, the sole location variable is a free text field which typically describes the test location at a suburb level. While this eradicates any issues in regards to the conversion of regions, different problems present themselves in regard to the nature of a free text variable. Inconsistencies in capital lettering, spelling mistakes, additional suffixes and not all records being at a suburb level meant that all needed to be taken into consideration. With these issues overcome, allocation into region was a simple process with the aid of suburb postcodes.

The unique serial number of the testing device was used to match tests to bus site shifts. A data file was provided by Police listing, amongst other variables, each unique testing device used on each roadside bus site. This meant that for PBTs conducted from buses, the above Methods of identifying the Police Region of the test did not have to be employed as the geographic information could be taken directly from the bus site data file.

Any test not conducted at a bus site was assumed to be a car-based test. The only issue to arise from this was related to State Highway Patrols for the later (Touch 400) years of data. For these tests, instead of a suburb, the State Highway Patrol unit is recorded: SHP West, SHP North, SHP Solo etc. As State Highway Patrols do not operate within a fixed area, it is not reasonable to make assumptions as to where these tests were conducted.

Accordingly, all state highway patrol shifts using Touch 400 devices were excluded from analysis. These shifts account for 2% of the annual total number of tests at most, so the analysis results are unlikely to be significantly affected by their omission.

2.2.2.2 Evidentiary Breath Test Data

Data on Evidentiary Breath Tests (EBTs) was received covering the complete years of 2000 to 2017. Each record corresponds to an individual incident and contains variables recorded by means of the ‘RPDAS data sheet’.

Demographic variables of the offender are presented along with EBT result, details of the member undertaking the test and geographic variables. The EBT result in conjunction with the offender’s license type was used to determine whether the result would be treated as positive or negative for analysis. The location of the incident was recorded by a street name, suburb and postcode. The postcode enabled records to allocated in Police regions without any issue.

2.3 TIS and RCIS data

Data records from the Victoria Police Traffic Incident System (TIS) related to drug and alcohol involved crashes were extracted for the years 2006 to 2018.

In this data, one case corresponds to one drug test result for one person involved in a crash. Vehicle controllers detected with multiple drugs (including alcohol) in their system result in multiple data entries. For example, for one driver there were eight separate records, with each case corresponding to a different drug detected in that driver’s system. Cases that did not contain any drug or alcohol information were discarded from analysis.

Where a drug test has been conducted and a positive result recorded, a variable is present describing the drug(s) detected. This variable field is a free text descriptor. Any type of Methamphetamine identified in this field was included in the analysis under the label ‘Methamphetamine’. All forms of Tetrahydrocannabinol were classified as ‘THC’ (cannabis). The ten most frequently detected drug types identified in crash data are presented in Table 1.

TABLE 1 TEN MOST COMMONLY DETECTED DRUGS ASSOCIATED WITH CRASHES

Drug Name	Count
Methamphetamine	2961
Delta-9-tetrahydrocannabinol	2924
Morphine	397
MDMA	245
Metoclopramide	232
Diazepam	200
Amphetamines	179
Nordiazepam	157
Midazolam	132
Temazepam	95

Source TIS data (2006-2018)

The Road Crash Information System (RCIS) is an online database containing information from Victorian road accidents involving injury to at least one person. The information contained is derived from that collected by Victoria Police and entered into TIS which, for crashes resulting in at least one person being injured, are subsequently transferred to VicRoads where it is enhanced to become RCIS, the official database of road crash information in Victoria. For a crash to be recorded in the RCIS, Police must have attended the scene and at least one person involved in the crash must have sustained an injury. The Transport Accident Commission (TAC) validates the severity of all injuries sustained, and particularly admission to hospital, by matching back information from insurance claims lodged with the TAC following the incident.

MUARC receives this enhanced RCIS data directly from the TAC, with the injury severity variables included. Currently, MUARC has data complete to the end of 2016. In this RCIS data, one case corresponds to one person involved in a crash.

2.4 Victorian Coronial data

Victorian Coronial data pertaining to vehicle controllers fatally injured in a crash where toxicology identified the presence of drugs in their system. This data was requested by Victoria and extracted by staff at the Victorian Institute of Forensic Medicine (VIFM). MUARC received the de-identified data relating to fatal crashes that occurred in Victoria during 2006-2019.

2.5 Police member testing qualifications data

Records of Police members' training for conducting drug and alcohol tests were provided.

Data was separated by type of qualification (drug or alcohol) but in both files one case corresponds to one instance of training for one police member. Drug qualification records date back to the beginning of 2005 while alcohol qualification records began mid-1993. For all qualifications, member ID and demographics are presented as well as date of training.

A variable indicating the member's Police Service Area (PSA) shows clearly which region and division they are based in. Hence, assigning training records into police region and division was a straight forward task across the full range of data.

The main concern in using the training information is the lack of knowledge as to the movements of members in the years following their training. It is very possible that over the course of time members may move location, receive promotions (to a non-ground-based position) or retire. All of which would nullify their capacity to perform tests in the region/division of initial training.

For the analysis conducted in this project, to make any use of the member training data, the assumption had to be made that members stayed in the same geographic and organizational position throughout the analysis period.

3 CRASH IMPACTS OF ROADSIDE DRUG AND ALCOHOL ENFORCEMENT

3.1 Crash impacts of roadside drug testing

3.1.1 Annual RDT enforcement (POFTs & OFTs)

Figure 2 shows the annual number of Roadside Drug Tests (RDTs), as indicated by the number of Preliminary Oral Fluid Tests (POFTs), conducted in Victoria from 2005 to 2018. It was introduced in December 2004. As shown, the annual testing rates in the initial years were relatively low which is likely a reflection of the limited number of Police members formally trained to conduct RDT at that time and also funding issues associated with the higher costs of conducting RDTs (testing equipment costs) compared to roadside alcohol testing. The effects of the target of the TAC funded RDT expansion in 2015 are apparent, with annual roadside POFT rates increasing to around 100,000 per year or greater from 2015.

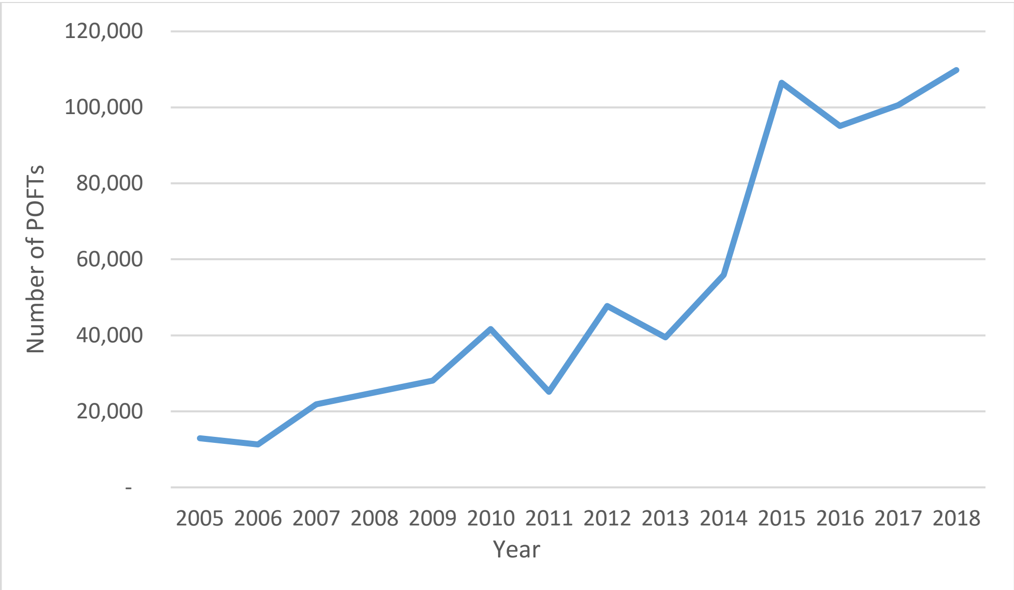

Figure 2 Annual number of Preliminary Oral Fluid Tests (POFTs) conducted, Victoria 2005-2018

From this data it was also evident that there was significant variation in the number of POFTs delivered annually between the four Victoria Police Regions (North West Metro, Southern Metro, Eastern, and Western), as well as different trends over time between Regions. Regional differences in the conduct of RDT (2010-2016) are illustrated in Figure 3 with these identified differences between Regions providing the rationale and motivation behind the roadside drug expansion in Victoria, namely to increase RDT across the entire state, especially addressing the low testing rates in rural regional areas.

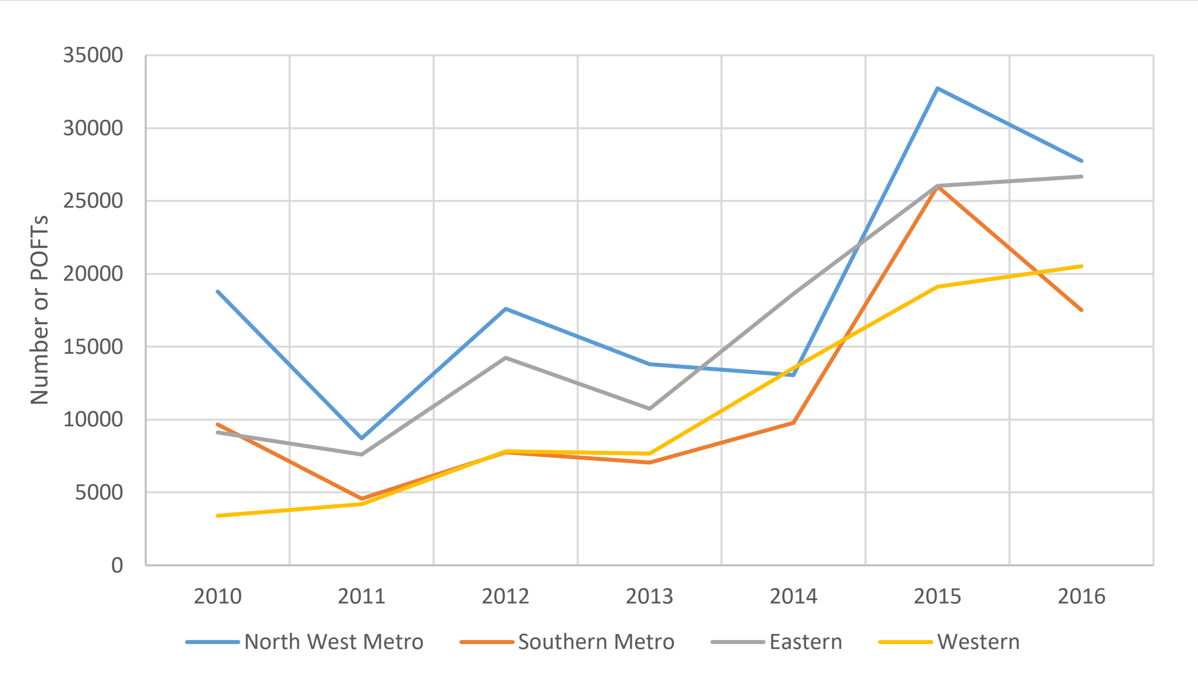

Figure 3 Annual number of Preliminary Oral Fluid Tests (POFTs) by Police Region, Victoria 2010-2016

Along with increases in the number of drug driving POFTs conducted over time, there appears to have been a change in the way police have targeted the delivery of roadside drug testing. In the initial years of the drug testing enforcement program, it was reported that the tests were delivered randomly, aiming for a 'general deterrence' effect on drug driving, similar to that achieved by bus-based Random Breath Testing (RBT) for alcohol. This is apparent in Figure 4 as indicated by the low rate of Oral Fluid Tests per 100 POFTs conducted from 2005 to 2010. OFTs are conducted when there is confirmed drug presence in the POFT.

Possibly due to the high costs associated with drug testing, the time implications associated with this more time-consuming testing protocol for police members, the lack of members formally trained to administer POFTs and OFTs, and a possible change in drug testing enforcement philosophy, the roadside drug testing practice appears to have become more targeted over time. More recent targeted testing has been reported to typically focus on high risk events, such as known 'rave' party locations and on high risk driver demographics e.g. young male, probationary drivers. From around 2010, the rate of confirmed OFTs per POFT rose sharply and continues to climb. Whilst this could indicate a sharp increase in drug use by vehicle controllers, it more likely indicative of the adoption of more targeted intelligence-based testing protocols (i.e. a more 'specific deterrence' based approach to testing) and increases in the number of Police members trained to conduct roadside drug testing.

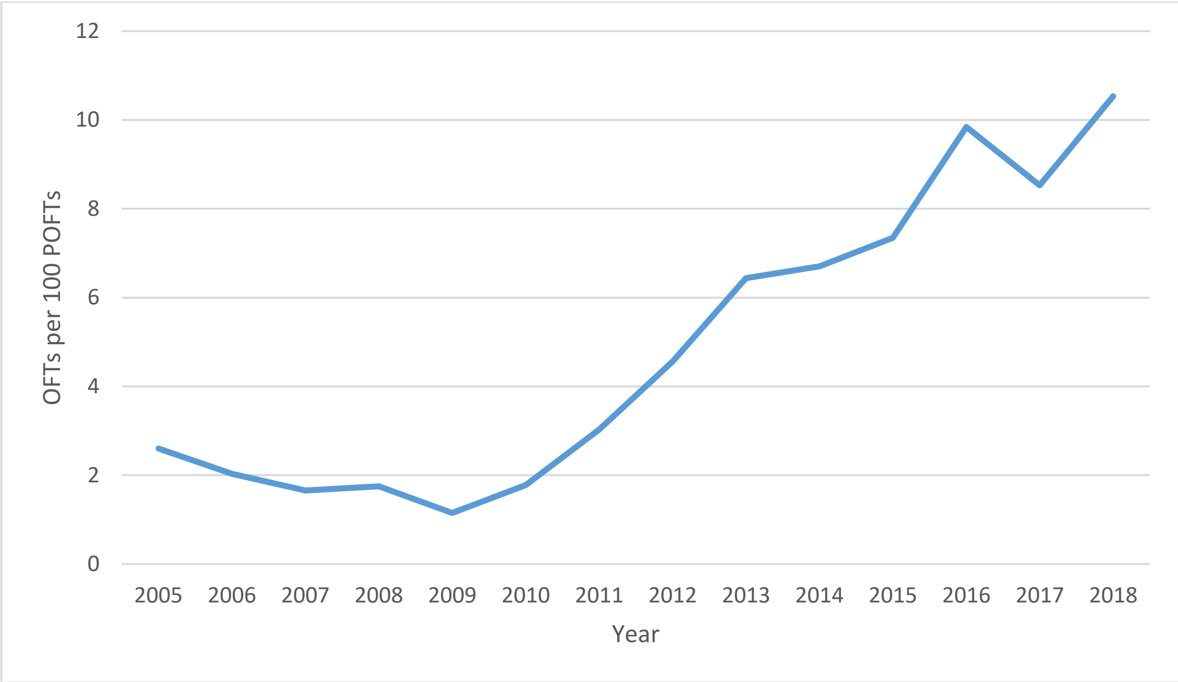

Figure 4 Rate of Oral Fluid Tests (OFTs) per 100 POFTs conducted, Victoria 2005-2018

Mirroring the analysis for annual POFTs delivered (see Figure 4), the variation in drug detection rate by year and Victoria Police Region (2010-2016) is shown in Figure 5. A significant difference in the detection rate from roadside drug testing between Regions in each year is apparent with trends also differing over time.

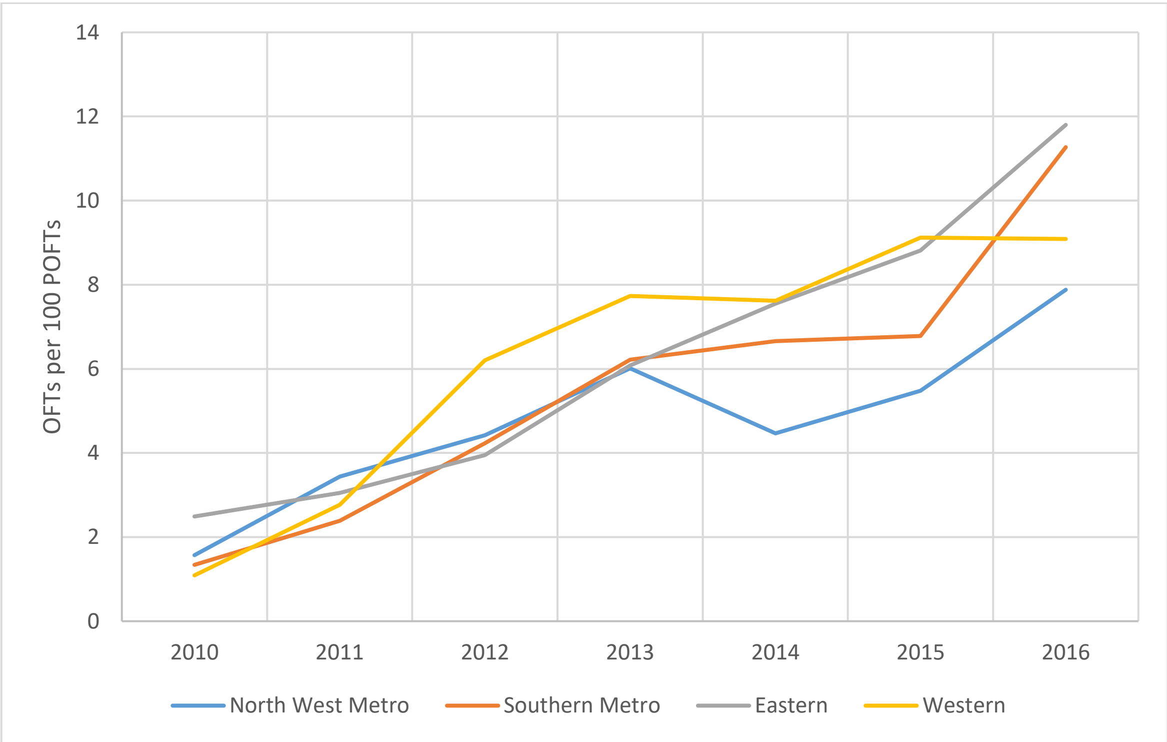

Figure 5 Rate of Oral Fluid Tests (OFTs) per 100 POFTs conducted by Police Region, Victoria 2005-2018

3.1.2 Illicit drug presence in crashes

Four data sets were used for the analysis of the relationship between roadside drug testing and drug involvement in crashes:

- Victoria Police sourced RDT operations (2004-2018)
- TIS crash data (2006-2018)
- RCIS crash data (with TAC validated injury severity level; 2006-2016)
- Coronial data (de-identified toxicology data in reference to illicit drugs and alcohol among deceased motorists for the period of 2006 – 2019).

Allowing for differences in years of data available in each specific dataset, the final analysis dataset created comprised both the drug and alcohol data provided by Victoria Police and the validated crash injury data provided by the TAC covered the years January 2006 until December 2016.

3.1.2.1 Serious injury crashes

Using the TAC validated RCIS data, all seriously injured vehicle controllers (those admitted to hospital with hospital admission validated using TAC hospital admissions claims data) were selected. A person was defined as a vehicle controller if they were in control of a car, truck or bus or they were the rider of a motorcycle or bicycle; train and tram driver records were excluded as were any passengers. Information pertaining to drug and alcohol involvement from the Victoria Police TIS data was merged on using the Incident ID number, vehicle controller age and gender.

Only about one-third of the vehicle controllers admitted to hospital had a blood screening sample taken and tested for drugs during 2010 to 2016. DiRago et al (2019) and Drummer et al (2020) give the impression that, by legislation since mid-2009, every vehicle controller admitted to hospital (includes attendance at hospital emergency units) had a blood sample taken to establish the presence of alcohol and the three proscribed drugs. However, it is *not* legislatively mandated that a sample of a crashed driver's blood must be taken. It is not known whether there was bias in the decisions to take a sample, such as the apparent impairment of the vehicle controller due to alcohol or drugs or other factors.

For crashes, the Local Government Area (LGA) variable was used to assign the crash to the corresponding Police Region and Division (see Appendix A). Although a division level was desirable for analysis, counts of incidence were deemed to be too low therefore limiting statistical power. Accordingly, analysis was undertaken at the Region level only.

Counts of all vehicle controller serious injuries, seriously injured vehicle controllers tested and found positive for THC, and seriously injured vehicle controllers tested and found positive for Methamphetamine were aggregated to a year level for each of the four Regions (there were insufficient vehicle controllers detected for MDMA and so this drug vehicle controller group was excluded from the analysis).

Annual counts across all Victoria are shown in Table 2. It can be seen that there is a large increase in the number of tested and drug positive vehicle controllers from 2008 to 2010. During this timeframe, responsibility for drug driving pharmacology analysis was re-assigned to VIFM. To address this, the analysis period for the assessment of the relationship between tests delivered and road trauma outcomes was based on data from 2010 onwards. Also evident in the data in Table 2 is the change in the mix of drug types detected. In the earlier years, THC was the predominant drug detected however, from 2013 on, Methamphetamine became the most common drug detected. Rates of drug detection in seriously injured vehicle controllers in Victoria over the years 2006-2016 are plotted in Figure 6 by drug type.

TABLE 2 PRESENCE OF THC AND METHAMPHETAMINES IN SERIOUSLY INJURED VEHICLE CONTROLLERS, VICTORIA 2006-2016

Year	Seriously injured vehicle controllers		
	Positive THC*	Positive Methamphetamine*	Total serious injury
2006	8	3	4388
2007	9	10	4820
2008	3	12	4546
2009	80	27	4504
2010	139	62	3967
2011	162	77	4208
2012	139	122	3894
2013	91	135	3955
2014	90	150	4238
2015	93	195	4243
2016	109	190	4460

*Note: Counts of THC and Methamphetamines are not necessary mutually exclusive (poly-drug detection can result in multiple counts).

The rates of THC and Methamphetamine presence in seriously injured vehicle controllers shown in Figure 6 are substantially lower than those presented by Liu and Fitzharris (2019) based on presentations at 118 hospitals during 2010-2018 and those presented by diRago et al (2019) based a sample of 5000 presentations during 2013/14 to 2017/18. This could be because the denominators of the rates in Figure 6 include seriously injured vehicle controllers who were not tested for drugs in hospital (about two-thirds of the seriously injured), or the less likely possibility that the non-admitted presentations had much higher levels of drug presence than the admitted.

Nevertheless, the rates shown in Figure 6 are likely to be conservative indicators of the prevalence of THC and Methamphetamine in the blood of all vehicle controllers admitted to hospital in Victoria during 2010-2016. The true levels of prevalence of these drugs in these seriously injured vehicle controllers admitted to hospital are likely to be higher, but not as high as those presented by Liu and Fizharris (2019) and diRago et al (2019) because of the possible bias in the selection of vehicle controller presentations for the taking of blood samples for drug testing.

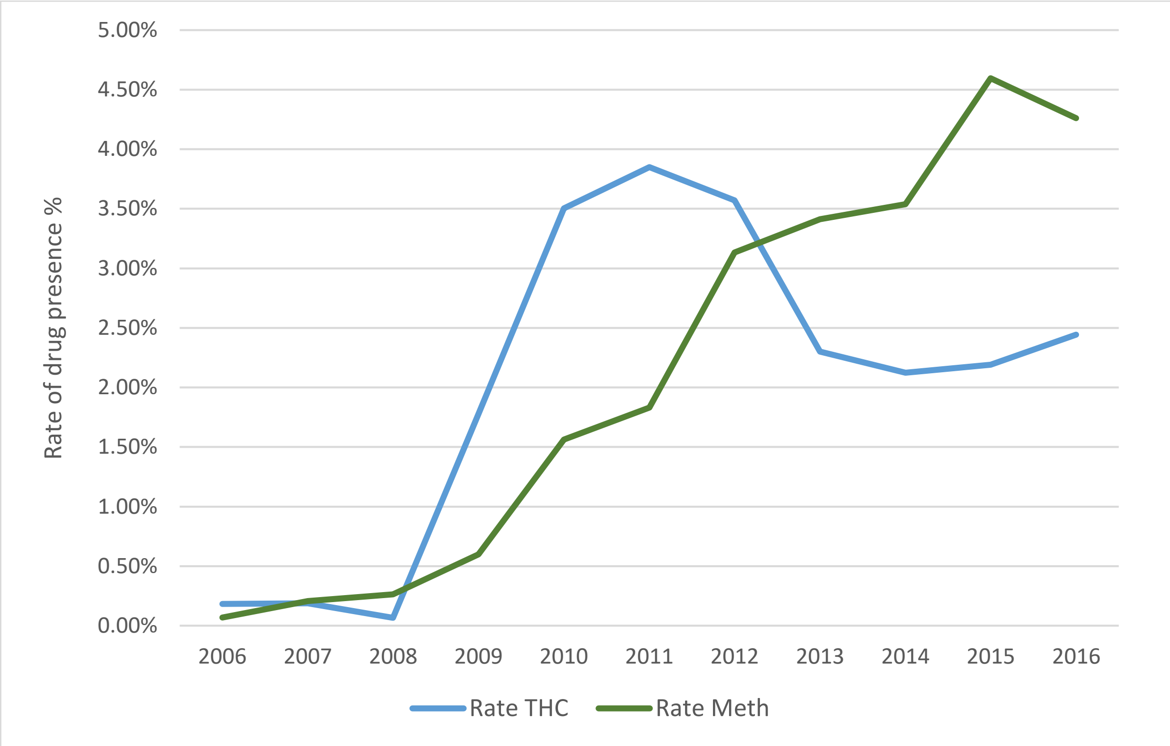

Figure 6 Rate (%) of THC and Methamphetamine (Meth) detected in seriously injured vehicle controllers, Victoria 2006-2016

3.1.2.2 Fatal injury crashes

Using the TAC validated RCIS data, all fatally injured vehicle controllers were selected. A person was defined as a vehicle controller in the same way as for the serious injury data. Information pertaining to drug and alcohol involvement from the Coroners data had previously been matched (de-identified data supplied to MUARC) to all fatally injured vehicle controllers in Victoria during these years using the Incident ID number, vehicle controller age and gender. It was assumed that all fatally injured vehicle controllers had a blood sample extracted and tested for the presence of alcohol and drugs.

For crashes, the Local Government Area (LGA) variable was used to assign the crash to the corresponding Police Region and Division (see Appendix A). Although a division level was desirable for analysis, counts of incidence were deemed to be too low limiting statistical power. Accordingly, analysis was undertaken at the Region level only.

Counts of all vehicle controller fatalities, fatally injured vehicle controllers testing positive for THC and fatally injured vehicle controllers testing positive for Methamphetamine were aggregated to a year level for each of the four Regions (similar to the serious injury analysis, there were insufficient vehicle controllers detected for MDMA and so this drug vehicle controller group was excluded from the analysis).

Annual counts of THC and Methamphetamine involvement in fatally injured vehicle controllers across all Victoria are shown in Table 7. It can be seen that there is a spike in the number of THC positive vehicle controllers during 2010. As previously noted, during this timeframe responsibility for drug driving pharmacology analysis was re-assigned to VIFM. To address this, the analysis period was again based on data from 2010 onwards. Also evident in the data in Table 7 is the change in the mix of drug types detected. Similar to the findings of the seriously injured vehicle controller analysis, in the earlier years THC was the predominant drug detected, however there has been a steady increase in Methamphetamine detection since 2009, with Methamphetamine detection passing THC in 2016 following a rapid spike in detection rates in fatalities. Rates of drug detection in fatally injured vehicle controllers in Victoria over the years 2006-2016 are plotted in Figure 7 by drug type.

TABLE 3 PRESENCE OF THC AND METHAMPHETAMINES IN FATALLY INJURED VEHICLE CONTROLLERS, VICTORIA 2006-16

Year	Fatally injured vehicle controllers		
	Positive THC*	Positive Methamphetamine*	Total vehicle controller fatalities
2006	25	11	212
2007	30	14	220
2008	28	10	192
2009	21	9	184
2010	34	12	184
2011	28	16	176
2012	25	18	190
2013	25	19	167
2014	21	14	154
2015	26	17	162
2016	33	39	212

*Note: Counts of THC and Methamphetamines are not necessary mutually exclusive (poly-drug detection can result in multiple counts).

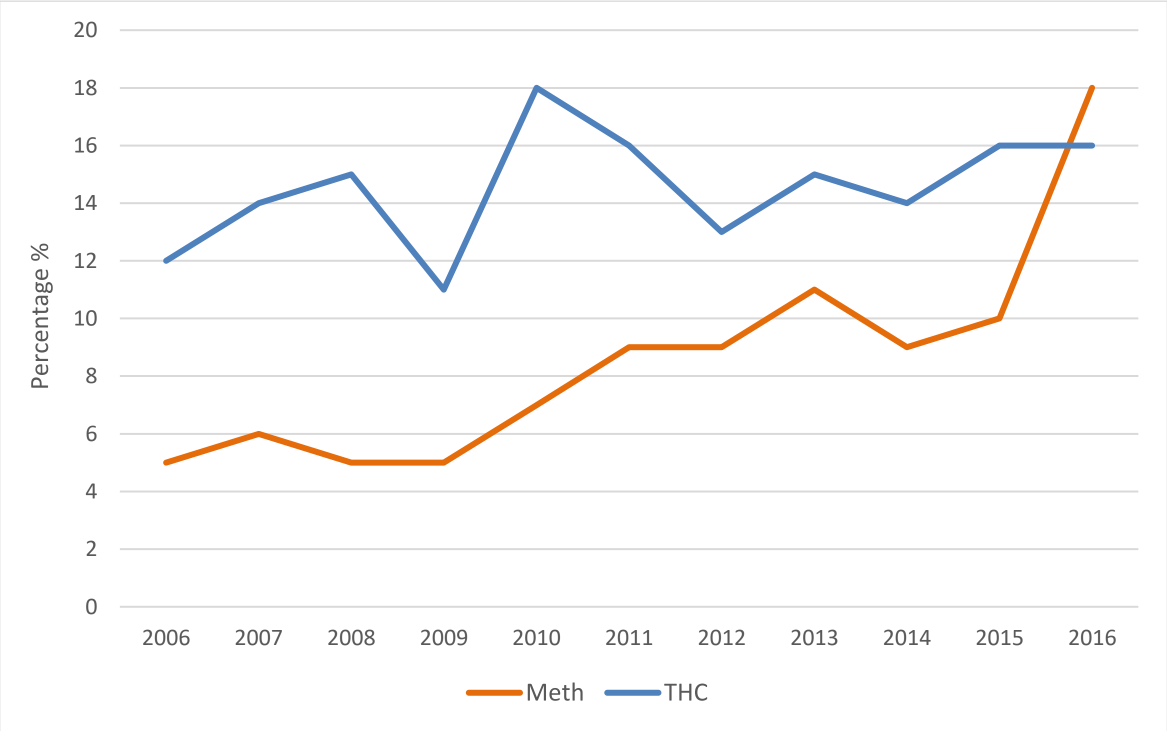

Figure 7 Rate (%) of THC and Methamphetamine detected in fatally injured vehicle controllers, Victoria 2006-2016

Annual counts of fatally injured vehicle controllers with involvement of 'any drug' and tested 'proscribed drugs' (THC & Meth only) across all Victoria are shown in Table 4. It can be seen that there has been a steady increase in the rate of drug (any drug) involvement in fatally injured vehicle controllers since 2006, with the spike in 2016 in the proscribed drugs, reflecting the increase in Methamphetamine involvement. Rates of drug detection (any drug & proscribed drugs) in fatally injured vehicle controllers in Victoria over the years 2006-2016 are plotted in Figure 8.

TABLE 4 PRESENCE OF 'ANY DRUG' AND PROSCRIBED DRUGS IN FATALLY INJURED VEHICLE CONTROLLERS, VICTORIA 2006-16

Year	Fatally injured vehicle controllers		
	Any drug detected†	Proscribed drug detected*	Total vehicle controller fatalities
2006	62	32	212
2007	69	34	220
2008	55	34	192
2009	59	24	184
2010	70	40	184
2011	69	37	176
2012	81	36	190
2013	71	33	167
2014	60	28	154
2015	72	36	162
2016	94	57	212

†Any drug not administered post incident

*THC, Methamphetamines or both, but not including MDMA

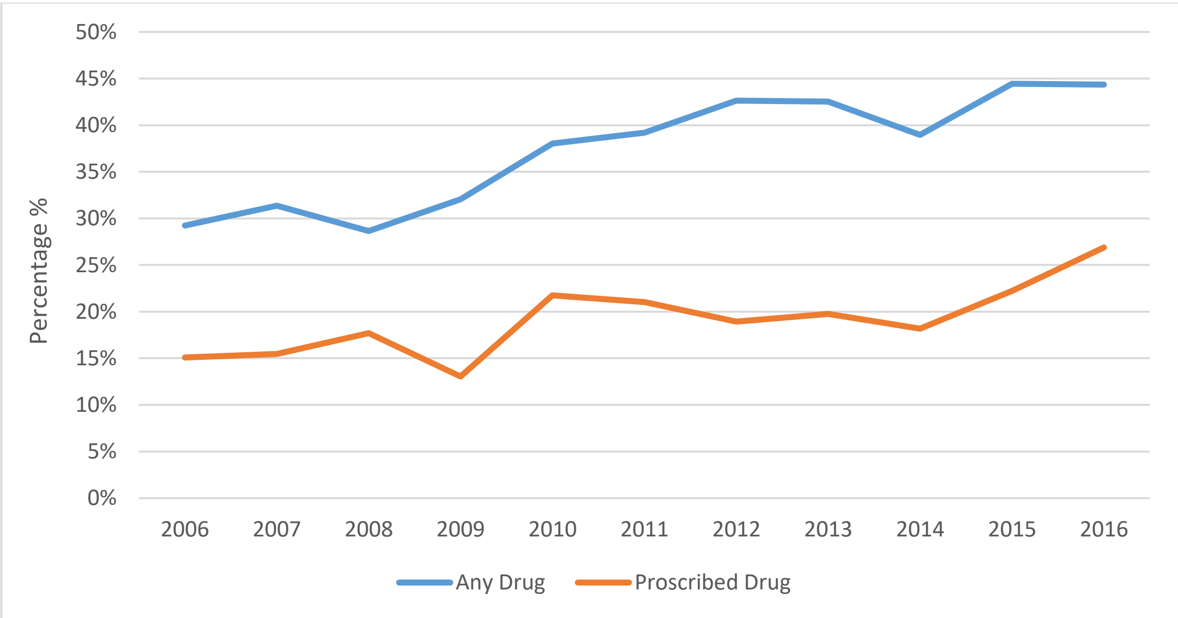

Figure 8 Rate (%) of any drug and proscribed drug presence detected in fatal injury crashes, Victoria 2006-2016

3.1.2.3 Poly drug/alcohol in fatally injured vehicle controllers

Total counts of polydrug detection for fatally injured vehicle controllers across all Victoria from 2006-2016 are shown in Table 5. It can be seen that of the 179 fatally injured vehicle controllers detected with Methamphetamines, almost 50% were also found to have cannabis in their system. Of the 296 fatally injured vehicle controllers detected with cannabis, almost 40% were also found to have alcohol in their system above the illegal 0.05% BAC level. Of these, 40% had illegal BACs between ≥0.05 and <0.15% and 60% had BACs ≥0.15.

TABLE 5 POLYDRUG/ALCOHOL DETECTION IN FATALLY INJURED VEHICLE CONTROLLERS, VICTORIA 2006-16

Substance		Additional substances detected									
		Meth-amphetamine				Cannabis		Alcohol			
		n	%	n	%	n	%	n	%	n	%
Methamphetamine		179	100.0	84	46.9	40	22.3	19	10.6	21	11.7
Cannabis		84	28.4	296	100.0	110	37.2	44	14.9	66	22.3
Alcohol Total ≥0.05%		40	10.2	110	28.1	391	100.0	-	-	-	-
	BAC≥0.05-<0.15	19	13.1	44	30.3	-	-	145	100.0	-	-
	BAC≥0.15	21	8.5	66	26.8	-	-	-	-	246	100.0

Data: VIFM all fatal vehicle controller test records, 2006-2016

Substance	Substance detected in conjunction with					
	Methamphetamines		THC		Alcohol	
	n	%	n	%	n	%
Methamphetamines	179	100.0%	84	46.9%	40	22.3%
THC	84	28.4%	296	100.0%	110	37.2%
Alcohol	40	10.2%	110	28.1%	391	100.0%

As shown in Table 6 of the 391 fatally injured vehicle controllers detected with an illegal BAC (≥0.05%), 22 (5.6%) also had both cannabis and Methamphetamines detected as well.

TABLE 6 POLYDRUG/ALCOHOL DETECTION IN FATALLY INJURED VEHICLE CONTROLLERS, VICTORIA 2006-16

BAC≥0.05		Methamphetamines		Total
		Absent	Present	
Cannabis	**Absent**	263	18	281
	Present	88	22	110
Total		**351**	**40**	**391**

3.1.3 Analysis approach

The analysis of the relationship between levels of drug and alcohol enforcement and road safety outcomes focused on vehicle controllers killed or seriously injured with drugs or alcohol detected in their system. Consideration was given to an analysis of crashes involving drug presence in any involved driver but considered the identification of drug and alcohol involvement in drivers not killed or seriously injured might be incomplete if the other drivers were not rigorously tested. Consequently, estimates of the impact of enforcement on drug and alcohol on road trauma outcomes derived from the study are likely to be slightly conservative

Design of the evaluation analysis investigating the relationship between roadside drug testing and drug presence in seriously or fatally injured crash-involved vehicle controllers used a cross-sectional comparison between Police Regions controlled by year of crash. The cross-sectional element of the evaluation design compares the level of drug enforcement with rates of drug presence in crash-involved and tested vehicle controllers (serious injuries or fatal) across Regions, capitalising on the variation in drug prevalence levels between Police Regions. It was necessary to control for year of crash in the analysis design due to the exposure of drug use in the driving population changing over time, which could confound the estimates of association.

The following four outcome measures were considered in the analysis, with separate analysis models estimated for each:

- the proportion of seriously injured vehicle controllers tested and found positive for THC
- the proportion of seriously injured vehicle controllers tested and found positive for Methamphetamines
- the proportion of fatally injured vehicle controllers detected positive for THC
- the proportion of fatally injured vehicle controllers detected positive for Methamphetamines

Counts of total POFTs and OFTs for each Region obtained from RDT shift information were merged with the aggregated vehicle controller casualty datasets (serious injury and fatal injury data). The two measures of drug enforcement defined as independent (predictor) variables in the analysis model were:

- total number of POFTs
- total number of OFTs per 100 POFTs.

The total number of POFTs delivered per year and Region was used as a measure of input related to general deterrence associated with roadside drug testing. This parallels research on the general deterrence found for roadside alcohol testing, where the number of preliminary breath tests delivered has been found to correlate most strongly with rates of alcohol involvement detected in crash involved vehicle controllers.

Total OFTs per 100 POFTs, the ‘hit rate’ (enforcement detection rate), was used as a measure of input associated with specific deterrence from the drug testing program as it provides a measure of the proportion of vehicle controllers detected for drug use, subsequently prosecuted, and likely to be specifically deterred from re-offending. The proportion of OFTs per POFT conducted was used in preference to the number of OFTs as it and POFTs represent two relatively independent measures of enforcement effort; this allowed simpler interpretation of the analysis results.

Logistic regression analysis was used to model the association between the proportion of injured vehicle controllers (serious or fatal) detected with drugs in their system and (a) the number of POFTs and (b) the rate of OFTs per POFT. ‘Year of crash’ was also included in the model to control for possible changes in vehicle controller drug use prevalence (unrelated to enforcement) over time.

The form of the model is as follows:

$$logit(p_{yr}) = \alpha + \beta_y + \gamma\, POFT_{yr} + \delta\, (\frac{OFT}{POFT})_{yr} \text{ ... (Equation 1)}$$

In the model:

p_{yr} is the proportion of injured (serious or fatal) vehicle controllers detected with the drug in year *y* and region r

$POFT_{yr}$ is the number of POFTs delivered in year *y* and region *r*

$(\frac{OFT}{POFT})_{yr}$ is the rate of drug detection per POFT year *y* and region *r*

β_y is the year effect parameter for year *y*

α, ϒ and δ are model parameters

Association between the rate of drug detection in injured (serious or fatal) vehicle controllers and annual POFTs delivered per region is measured by parameter ϒ in the model, with exp(ϒ) being the estimated change in odds of drug use in an injured (serious or fatal) crash involved vehicle controller per POFT delivered. Statistical significance of the association and confidence limit on the estimated odds can be calculated from the standard error of the parameter estimated in the model. Similarly, δ measures the association between injured (serious or fatal) vehicle controllers and annual average drug detection rate per region, with exp(δ) representing the change in odds of drug involvement in the injured (serious or fatal) vehicle controller per percentage increase in detection rate.

3.1.4 Analysis results

3.1.4.1 <u>Seriously injured vehicle controllers</u>

3.1.4.1.1 THC (Cannabis)

Estimates of the association, between the proportions of seriously injured crash involved vehicle controllers and (a) the annual number of POFTs and (b) the rate of drug detection per POFT, were derived through the application of Equation 1 for the rate of THC detection in crash-involved vehicle controllers. A summary of the estimated odds ratios from the analysis for the enforcement measure and the associated statistical significance probabilities are given in Table 7.

TABLE 7 SUMMARY RESULTS OF THE MODELS USED TO ASSESS THE RELATIONSHIP BETWEEN DRUG ENFORCEMENT AND THC PRESENCE IN SERIOUS INJURY CRASHED VEHICLE CONTROLLERS

	THC involvement	
Input variable	Significance	Relative Odds per unit input change
Number of POFTs (1000s)	<0.0001	0.962 (0.944, 0.980)
OFTs per 100 POFTs ('Hit rate')	0.818	1.008 (0.939, 1.083)

Based on a statistical significance threshold of 0.05, a highly statistically significant relationship was found between ‘total number of POFTs’ (input of general deterrence) and THC use (see Table 7). However, the relationship between ‘hit rate’ and THC was <u>not</u> statistically significant. For every 1000 additional POFTs delivered, the estimated odds of THC being detected in a seriously injured vehicle controller reduced by 3.8% (odds ratio 0.962). Complete outputs for each model are shown in Appendix B (B1 & B2).

The model for THC presence in seriously injured vehicle controllers explained 52% of the variation in in the annual counts by Region of seriously injured vehicle controllers detected with THC. Charts of fitted versus observed counts of drug affected seriously injured vehicle controllers by region and year for THC are shown in Figure 9.

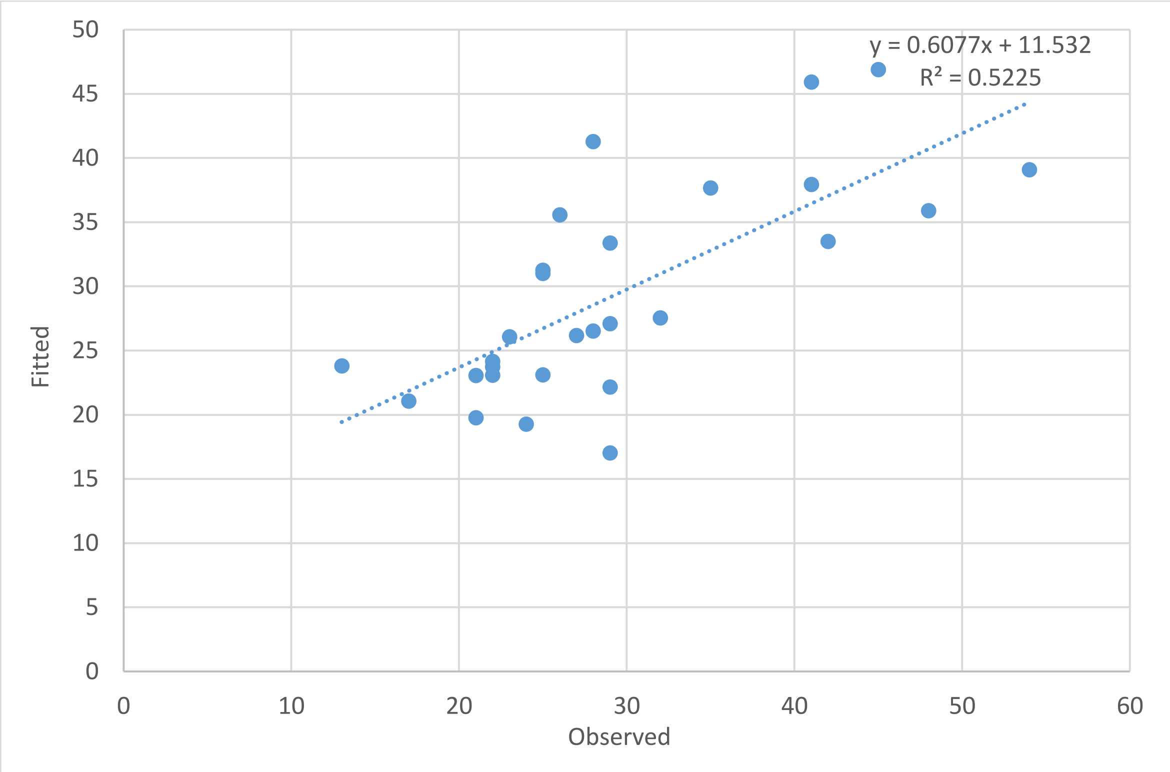

Figure 9 Model fit assessments – THC affected seriously injured vehicle controller counts

Figure 10 shows the relative odds of the presence of THC in seriously injured vehicle controllers given the annual number of POFTs conducted per region. The range of 10,000 to 25,000 POFTs per region, per year shown, corresponds to an increase from 40,000 to 100,000 POFTs delivered annually across the state as a result of the TAC funded drug testing expansion. The figure shows that increasing from 40,000 to 100,000 POFTs per annum was associated with a 44% reduction in the odds of detecting THC in seriously injured vehicle controllers.

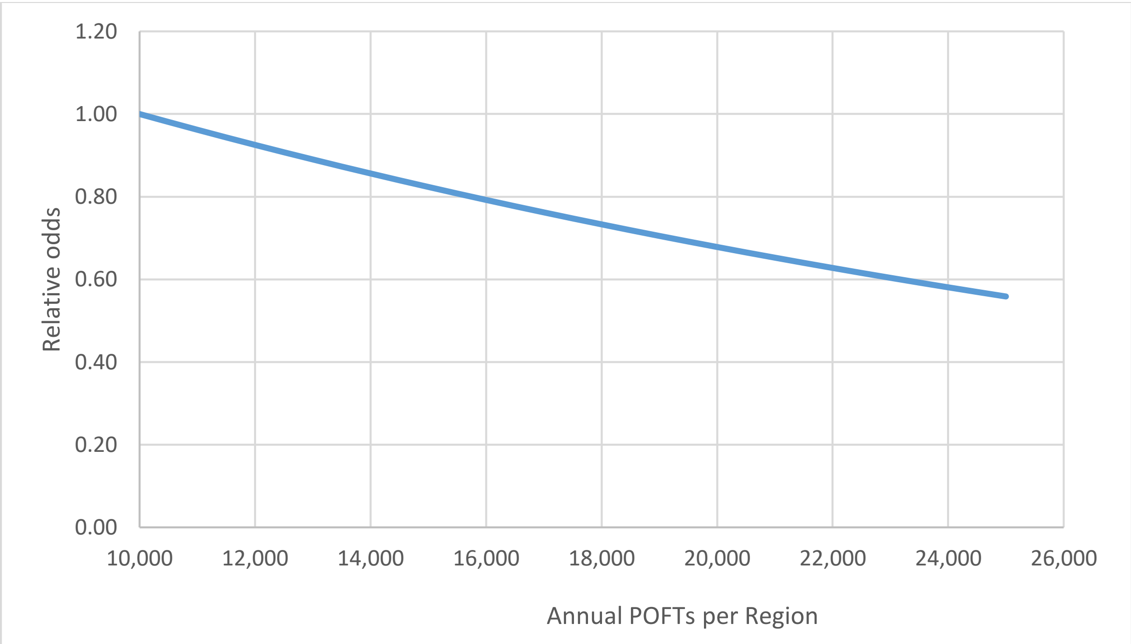

Figure 10 Relative odds of a seriously injured vehicle controller having THC in their system by number of POFTs, per Police Region

3.1.4.1.2 Methamphetamine

In contrast to the THC models (as shown in Table 7), analysis of Methamphetamine detection in seriously injured vehicle controllers showed no statistically significant relationship between Methamphetamine presence in seriously injured vehicle controllers and the total number of POFTs delivered annually (Table 8). But a statistically significant relationship was found with 'hit rate' (input of specific deterrence). Odds of Methamphetamine involvement in a seriously injured vehicle controller were found to decrease by 6.6% with every percentage point increase in the detection rate per roadside drug test administered (relative odds 0.934). Complete outputs for each model are shown in Appendix B (B3 & B4).

TABLE 8 SUMMARY RESULTS OF THE MODELS USED TO ASSESS THE RELATIONSHIP BETWEEN DRUG ENFORCEMENT AND METHAMPHETAMINE PRESENCE IN SERIOUS INJURY CRASHED VEHICLE CONTROLLERS

	Methamphetamine involvement	
Input variable	Significance	Relative Odds per unit input change
Number of POFTs (1000s)	0.102	1.007 (0.989, 1.025)
OFTs per 100 POFTs ('Hit rate')	**0.021**	**0.934 (0.882, 0.990)**

The model for Methamphetamine presence in seriously injured vehicle controllers explained 72% of the variation in the annual counts of seriously injured vehicle controllers detected with Methamphetamine. Charts of fitted versus observed counts of drug affected seriously injured vehicle controllers by region and year for Methamphetamine are shown in Figure 11.

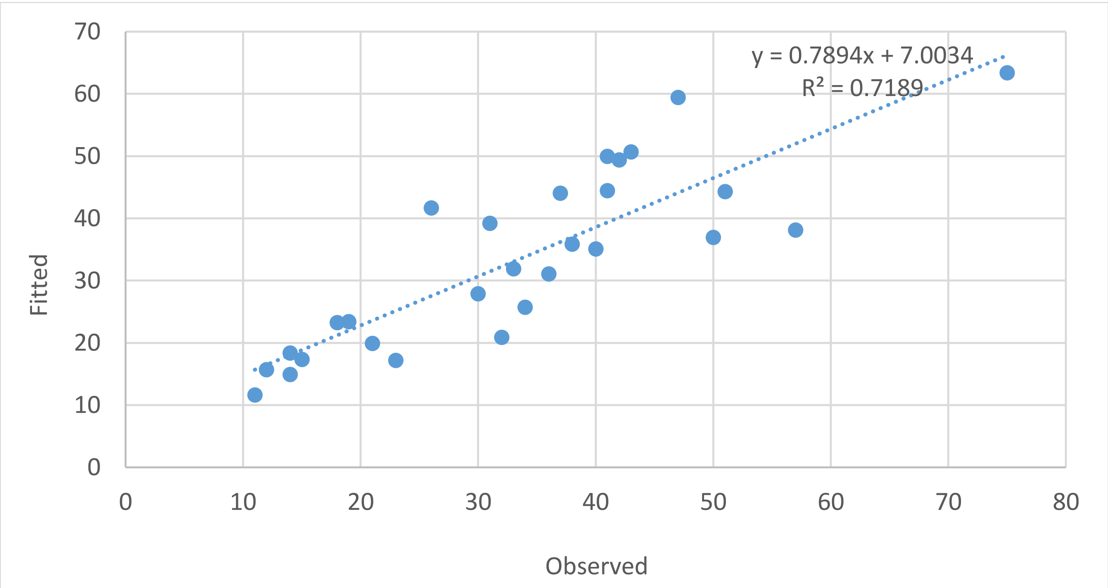

Figure 11 Model fit assessments – Methamphetamine affected seriously injured vehicle controller counts

The relationship between the relative odds of Methamphetamine detection in seriously injured vehicle controllers and the percentage positive drug test rate (hit rate) is illustrated in Figure 12. Over the period 2010 to 2016, the drug testing hit rate has increased from around 2% to around 10% which corresponds to a 37% reduction in the odds of Methamphetamine presence in seriously injured vehicle controllers.

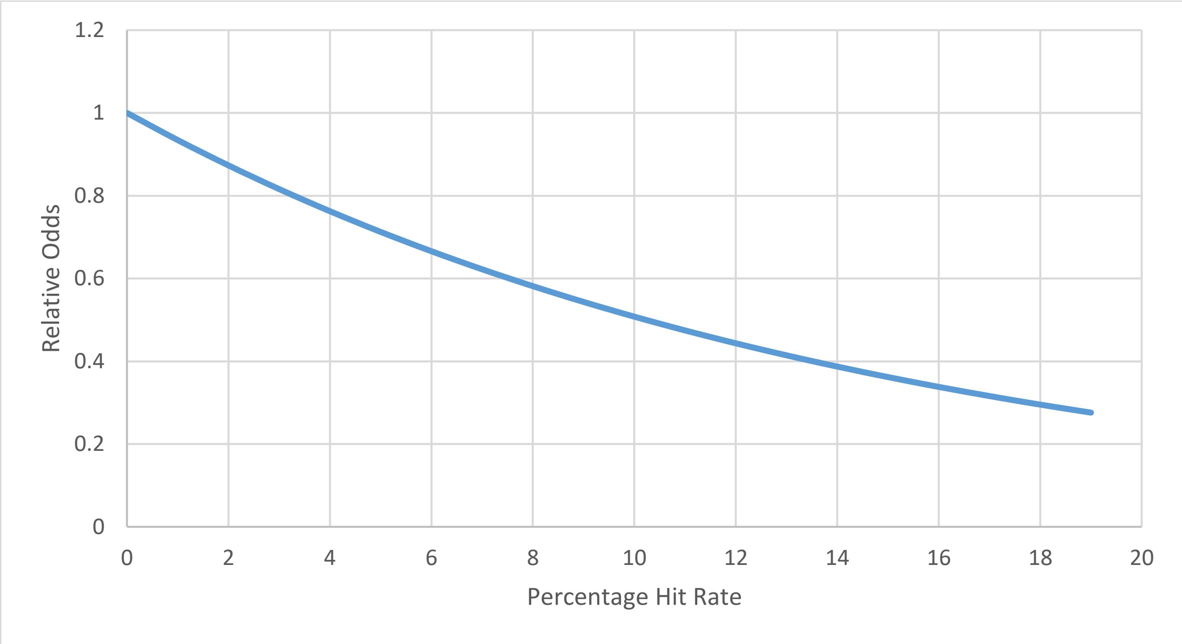

Figure 12 Relative odds of a seriously injured vehicle controller having Methamphetamine in their system by percentage detection rate of drug tests

3.1.4.2 Fatal crashes

3.1.4.2.1 THC (Cannabis)

Estimates of the association, between the proportions of fatally injured crash-involved vehicle controllers and (a) the annual number of POFTs and (b) the rate of THC detection per POFT, were derived through the application of Equation 1 for the rate of THC detection in crash-involved vehicle controllers. A summary of the estimated odds ratios from the analysis for the THC enforcement measures and the associated statistical significance probabilities are given in Table 9. Analysis was not only carried out using the total number of POFTs and the overall hit rate, but also with these two measures broken down by car and bus-based delivery. A similar analysis was attempted for the analysis of THC involvement in serious injury crashes but did not produce statistically robust results. In comparison, the fatal crash analysis was able to support this extension.

TABLE 9 SUMMARY RESULTS OF THE MODELS USED TO ASSESS THE RELATIONSHIP BETWEEN DRUG ENFORCEMENT AND THC DRUG PRESENCE IN FATALLY INJURED CRASHED VEHICLE CONTROLLERS

THC involvement		
Input variable	Significance	Relative Odds per unit input change
Car and Bus Operations Combined		
Number of POFTs (1000s)	0.047	0.958 (0.919, 0.999)
OFTs per 100 POFTs ('Hit rate')	0.099	0.877 (0.751, 1.025)
Car and Bus Operations Separately		
Number of car-based POFTs (1000s)	0.008	0.899 (0.831, 0.972)
Number of bus-based POFTs (1000s)	0.664	0.991 (0.950, 1.033)
Number of car-based OFTs (‘Hit rate’)	0.044	0.897 (0.807, 0.997)
Number of bus-based OFTs (‘Hit rate’)	0.401	1.121 (0.858, 0.997)

Based on a statistical significance threshold of 0.05, a statistically significant relationship (p=0.047) was found between the ‘total number of POFTs’ (input of general deterrence) and THC presence. The relationship between ‘hit rate’ and THC presence was marginally statistically significant when based on hit rate in tests overall. Consequently, interpretation of this results has also been provided from this analysis but should be treated with some caution. For every 1000 additional POFTs delivered, the estimated odds of THC being detected in a fatally injured vehicle controller reduced by 4.2% (odds ratio 0.958). Complete outputs for each model are shown in Appendix C (C1 & C2). Similarly, for every percentage increase in hit rate, the odds of a fatality involving THC reduced by 12.3%.

The model for THC presence in fatally injured vehicle controllers based on overall POFTs and hit rate explained 66% of the variation in the annual counts of fatally injured vehicle controllers detected with THC. Charts of ‘fitted’ versus ‘observed’ counts of THC affected fatally injured vehicle controllers by region and year, for the model are shown in Figure 13.

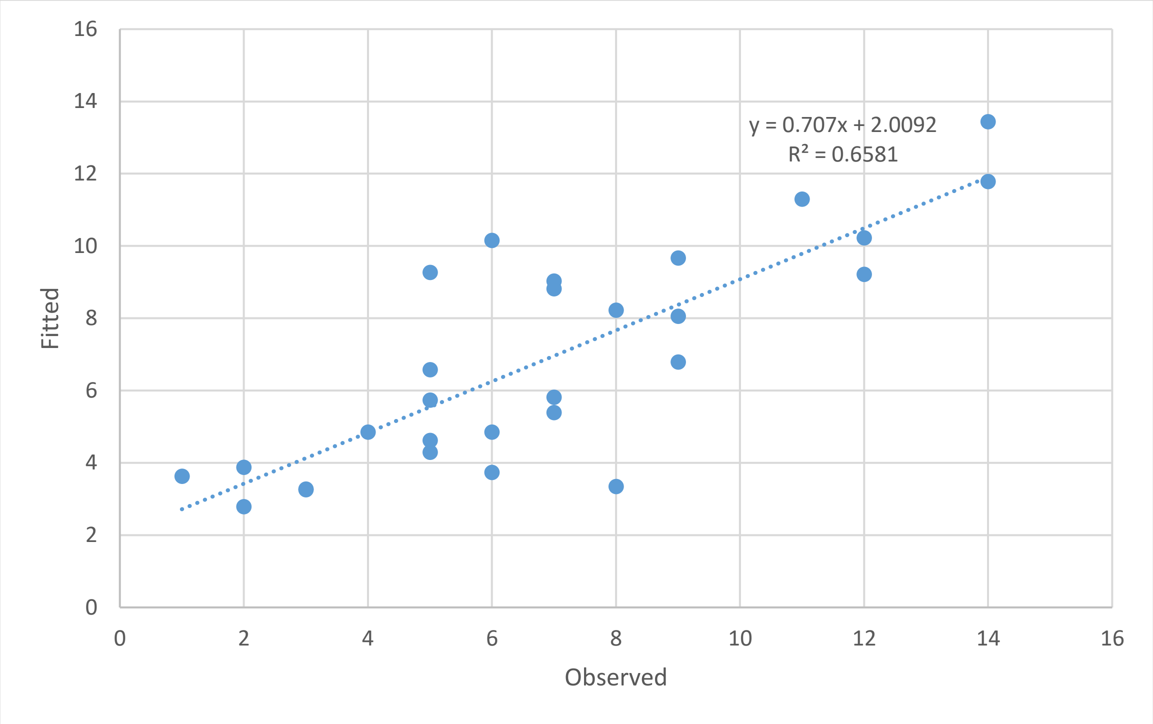

Figure 13 Model fit assessments – THC affected fatally injured vehicle controller counts by Region

Figure 14 shows the relative odds of the presence of THC in fatally injured vehicle controllers given the annual number of POFTs conducted per region. The range of 10,000 to 25,000 POFTs per region, per year shown, corresponds to an increase from 40,000 to 100,000 POFTs delivered annually across the state as a result of the TAC funded drug testing expansion. The figure shows that increasing from 40,000 to 100,000 POFTs per annum was associated with a 47% reduction in the odds of detecting THC in fatally injured vehicle controllers.

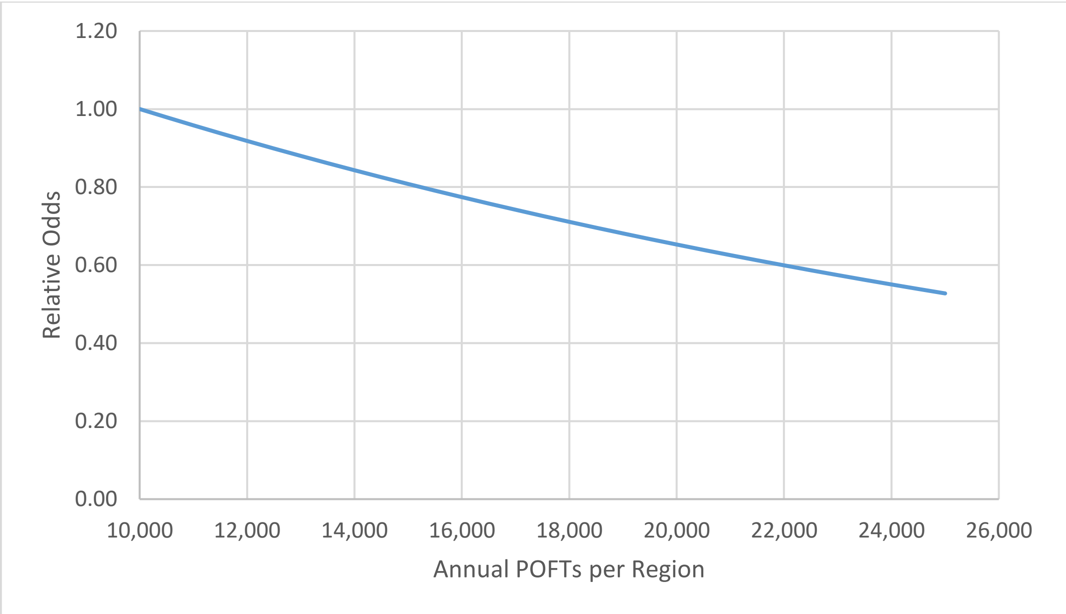

Figure 14 Relative odds of a fatally injured vehicle controller having THC in their system by annual number of POFTs, per Region

The relationship between the relative odds of THC detection in fatally injured vehicle controllers and the percentage positive drug test rate (hit rate) is illustrated in Figure 15. Over the period 2010 to 2016, the drug testing hit rate has increased from around 2% to around 10% which corresponds to a 49% reduction in the odds of THC presence in fatally injured vehicle controllers.

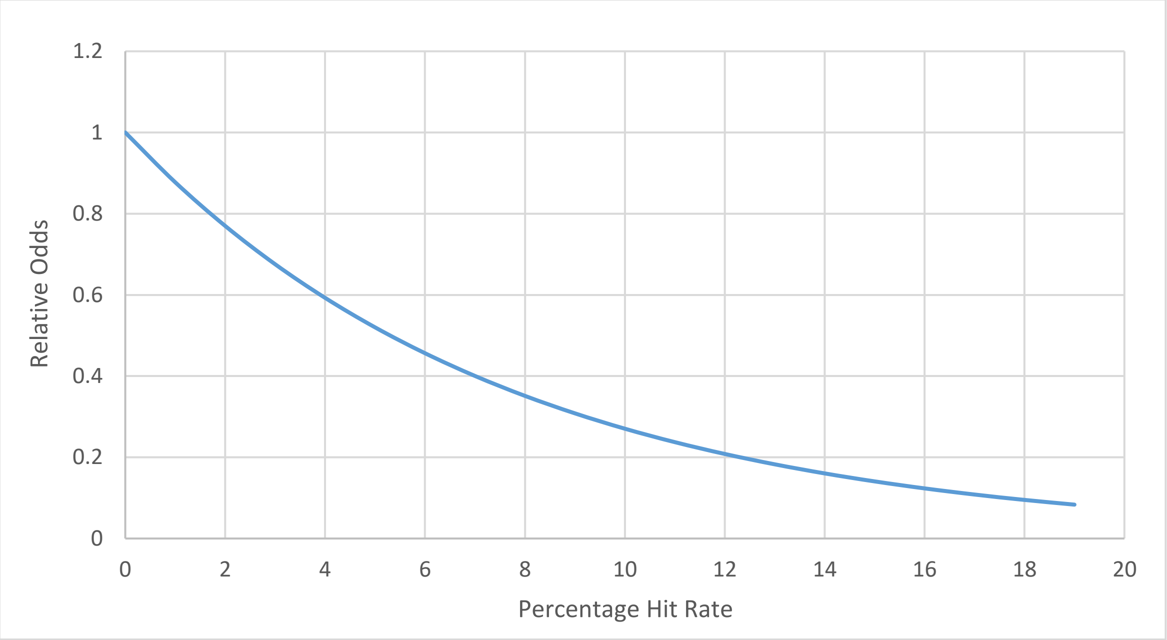

Figure 15 Relative odds of a fatally injured vehicle controller having THC in their system by percentage detection rate ('Hit rate'), by Region

Analysis by car and bus-based testing separately in Table 9 shows the overall association between enforcement delivery and the odds of THC presence in a fatality appears to stem from car-based testing. Car based POFTs and the hit rate from car-based tests were both statistically significantly associated with the odds of THC presence in a fatality. In contrast, neither of the bus-based measures were statistically significantly associated with the outcome and the estimated odds were both close to 1. The model for THC presence in fatally injured vehicle controllers by car and bus-based operations explained 77% of the variation in the annual fatal injury counts, much greater than for the overall tests model. Charts of 'fitted' versus 'observed' counts of THC affected fatally injured vehicle controllers by region and year for the model, for car and bus-based operations are shown in Figure 16.

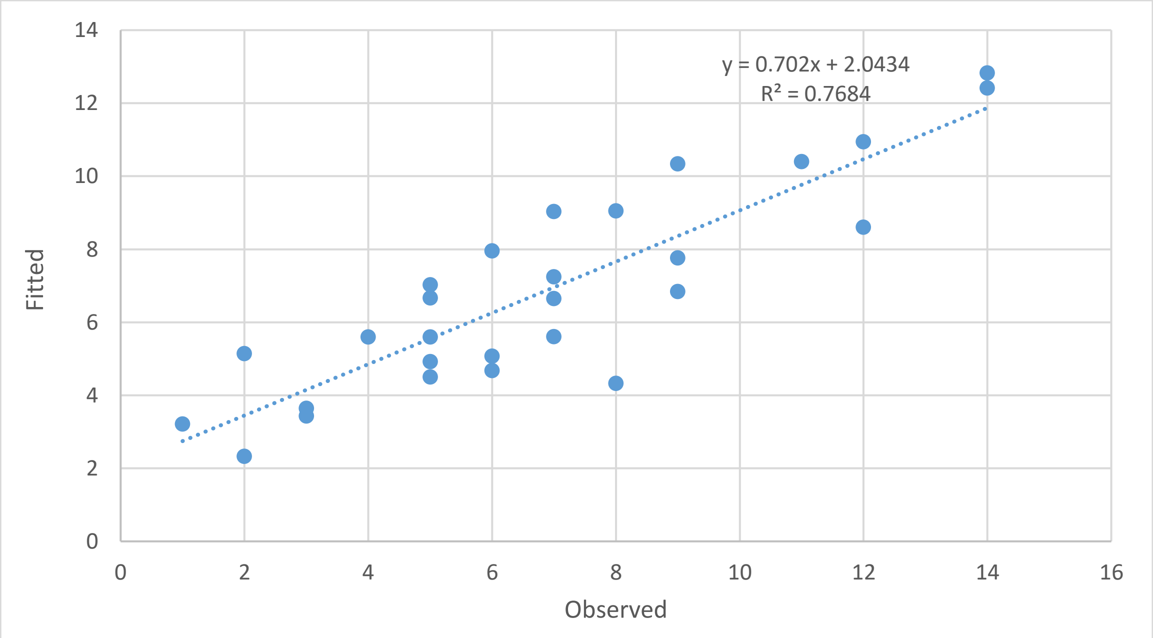

Figure 16 Model fit assessments – THC affected fatally injured vehicle controller counts by Region, car and bus-based operations

Figure 17 shows the relative odds of the presence of THC in fatally injured vehicle controllers against the annual number of POFTs conducted per region, through car-based operations. The figure shows that increasing from 40,000 to 100,000 car delivered POFTs per annum would be associated with a 47% reduction in the odds of detecting THC in fatally injured vehicle controllers. It should be noted that this is not the increase in car-based tests that was actually achieved given the increase was spread over both car and bus-based testing.

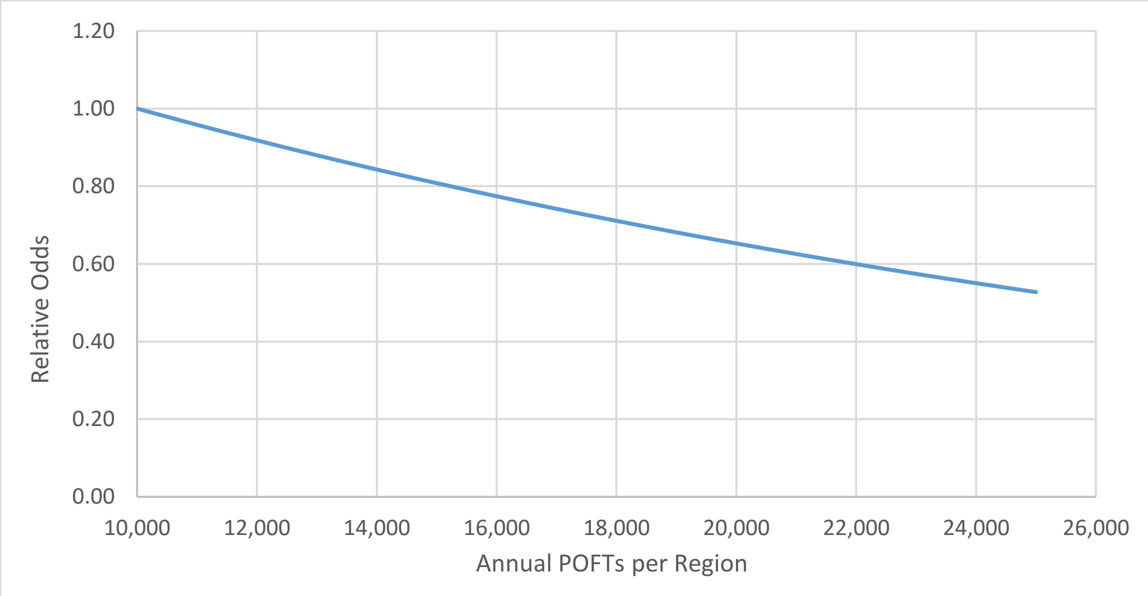

Figure 17 Relative odds of a fatally injured vehicle controller having THC in their system by annual number of POFTs, per Region, car-based operations

The relationship between the relative odds of THC car-based detection in fatally injured vehicle controllers and the percentage positive drug test rate (hit rate) is illustrated in Figure 18.

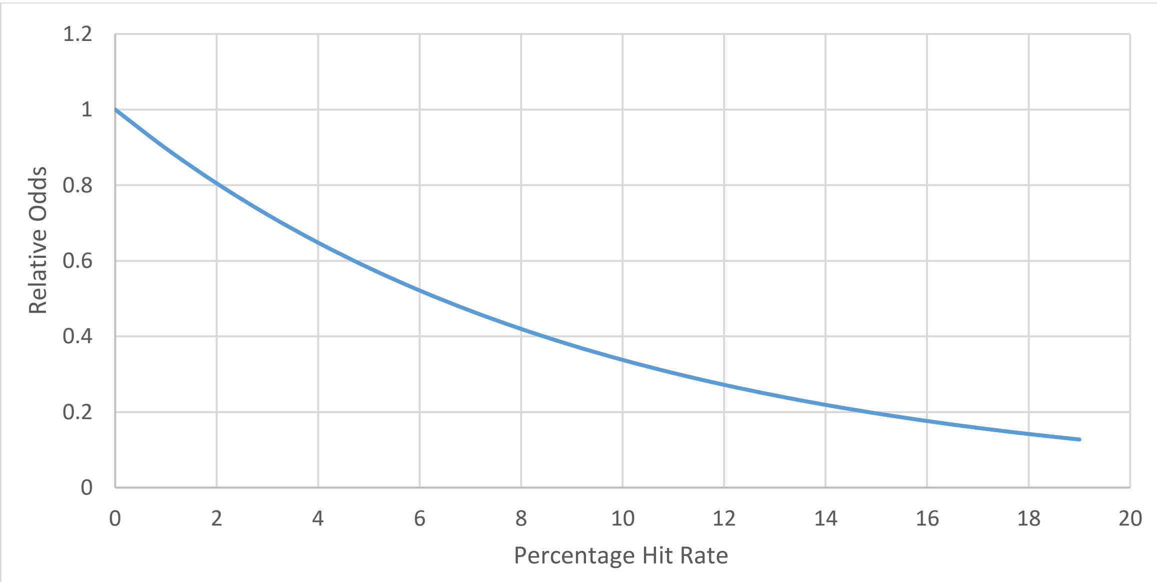

Figure 18 Relative odds of a fatally injured vehicle controller having THC in their system by percentage detection rate ('Hit rate') by Region, car-based operations

3.1.4.2.2 Methamphetamine

Estimates of the association between the proportions of fatally injured crash-involved vehicle controllers detected with Methamphetamine and both the annual number of POFTs and the rate of Methamphetamine detection per POFT in each

Region were derived through the application of Equation 1. The initial analysis considered the total tests and hit rates from all models of delivery whilst a second analysis considered each of these broken down by car and bus-based delivery. A summary of the estimated odds ratios from the analysis for the Methamphetamine enforcement measures and the associated statistical significance probabilities are given in Table 10.

TABLE 10 SUMMARY RESULTS OF THE MODELS USED TO ASSESS THE RELATIONSHIP BETWEEN DRUG ENFORCEMENT AND METHAMPHETAMINE DRUG PRESENCE IN FATALLY INJURED CRASHED VEHICLE CONTROLLERS

Methamphetamine involvement		
Input variable	Significance	Relative Odds per unit input change
Car and Bus Operations Combined		
Number of POFTs (1000s)	0.088	0.957 (0.910, 1.007)
OFTs per 100 POFTs ('Hit rate')	**0.007**	**0.790 (0.666, 0.938)**
Car and Bus Operations Separately		
Number of car-based POFTs (1000s)	0.054	0.909 (0.825, 1.002)
Number of bus-based POFTs (1000s)	0.588	1.014 (0.965, 1.065)
Number of car-based OFTs ('Hit rate')	**0.006**	**0.853 (0.761, 0.956)**
Number of bus-based POFTs ('Hit rate')	0.217	1.223 (0.888, 1.684)

Based on a statistical significance threshold of 0.05, analysis of Methamphetamine detection in fatally injured vehicle controllers showed a marginally statistically significant relationship ($0.05<p<0.1$) between Methamphetamine presence in fatally injured vehicle controllers and the total number of POFTs delivered annually per Region. A highly statistically significant relationship found between drug testing positive 'hit rate' (input of specific deterrence) and the odds of Methamphetamine presence in a fatally injured driver. Odds of Methamphetamine involvement in a fatally injured vehicle controller were found to decrease by 21% with every percentage point increase in detection rate per roadside drug test administered (relative odds 0.790). The comparable decrease in odds per 1000 tests delivered annually per region was less at 4.3%. Complete outputs for each model are shown in Appendix C (C3 & C4)

The model for Methamphetamine presence in fatally injured vehicle controllers based on total tests and overall hit rate across both cars and buses explained 67% of the variation in the annual counts of fatally injured vehicle controllers detected with Methamphetamine. Charts of 'fitted' versus 'observed' counts of Methamphetamine affected fatally injured vehicle controllers by region and year for the model are shown in Figure 19.

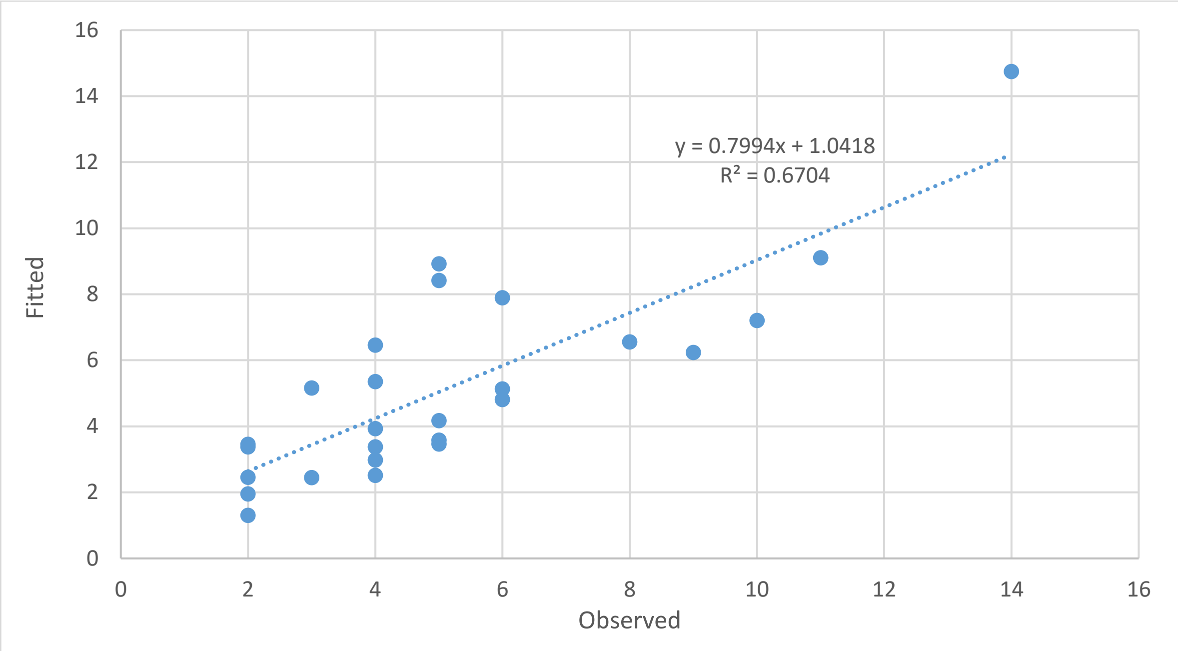

Figure 19 Model fit assessments – Methamphetamine affected fatally injured vehicle controller counts by Region

Figure 20 shows the relative odds of the presence of Methamphetamine in fatally injured vehicle controllers given the annual number of POFTs conducted per Region. The range of 10,000 to 25,000 POFTs per region, per year shown, corresponds to an increase from 40,000 to 100,000 POFTs delivered annually across the state as a result of the TAC funded drug testing expansion. The figure shows that increasing from 40,000 to 100,000 POFTs per annum was associated with a 38% reduction in the odds of detecting Methamphetamine in fatally injured vehicle controllers.

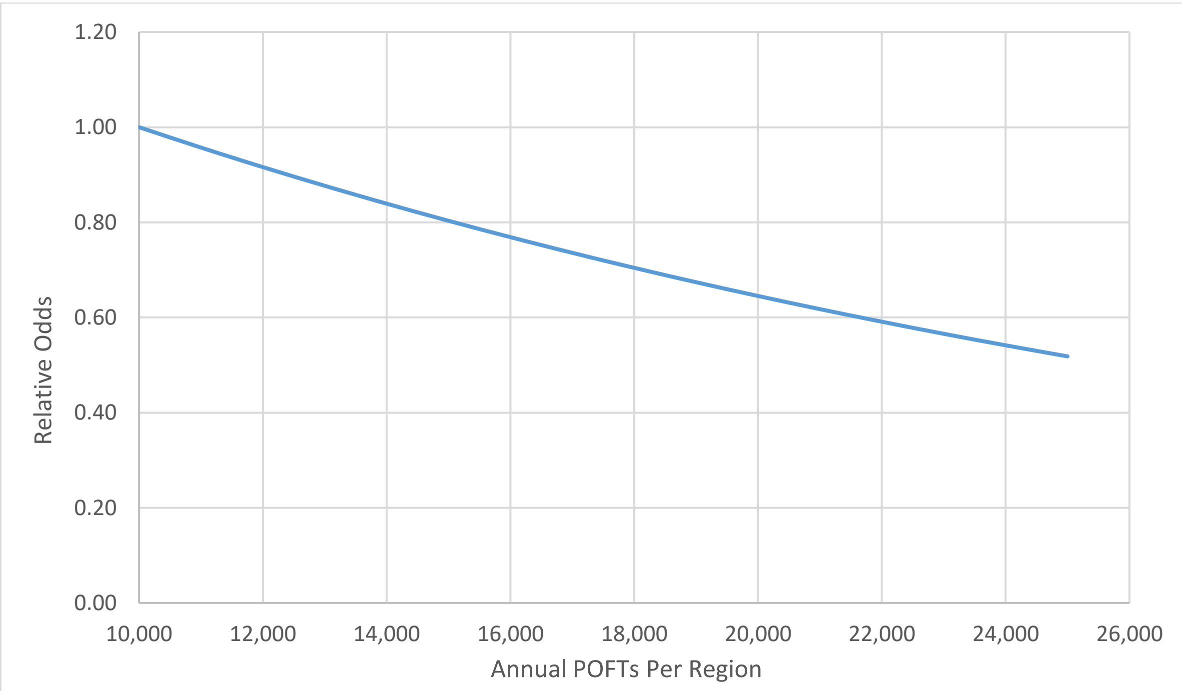

Figure 20 Relative odds of a fatally injured vehicle controller having Methamphetamine in their system by annual number of POFTs, per Region

The relationship between the relative odds of Methamphetamine detection in fatally injured vehicle controllers and the percentage positive drug test rate (hit rate) is illustrated in Figure 21. Over the period 2010 to 2016, the drug testing hit rate has increased from around 2% to around 10% which corresponds to a 53% reduction in the odds of Methamphetamine presence in fatally injured vehicle controllers.

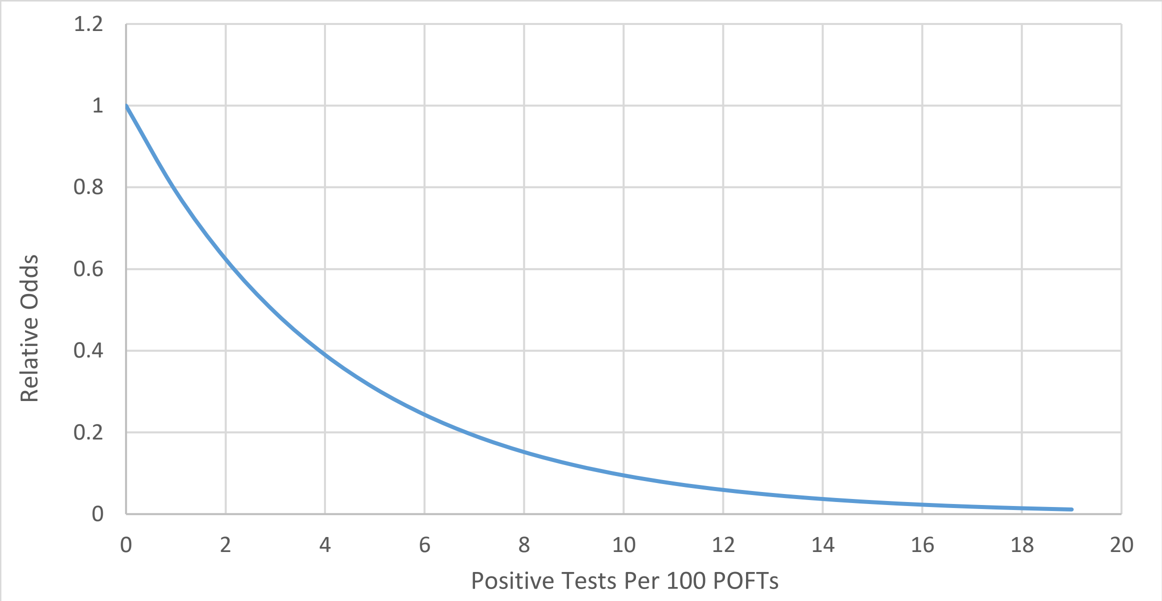

Figure 21 Relative odds of a fatally injured vehicle controller having Methamphetamine in their system by percentage detection rate ('Hit rate'), by Region

The model for Methamphetamine presence in fatally injured vehicle controllers as a function of annual POFTs and hit rate per region separated by cars and bus delivery explained 82% of the variation in the annual fatal injury counts. This is substantially greater than when using measures combined across car and bus-based modes suggesting a difference in the crash effects associated with car and bus-based testing. Charts of 'fitted' versus 'observed' counts of Methamphetamine affected fatally injured vehicle controllers by region and year for the model are shown in Figure 22, for car & bus-based operations.

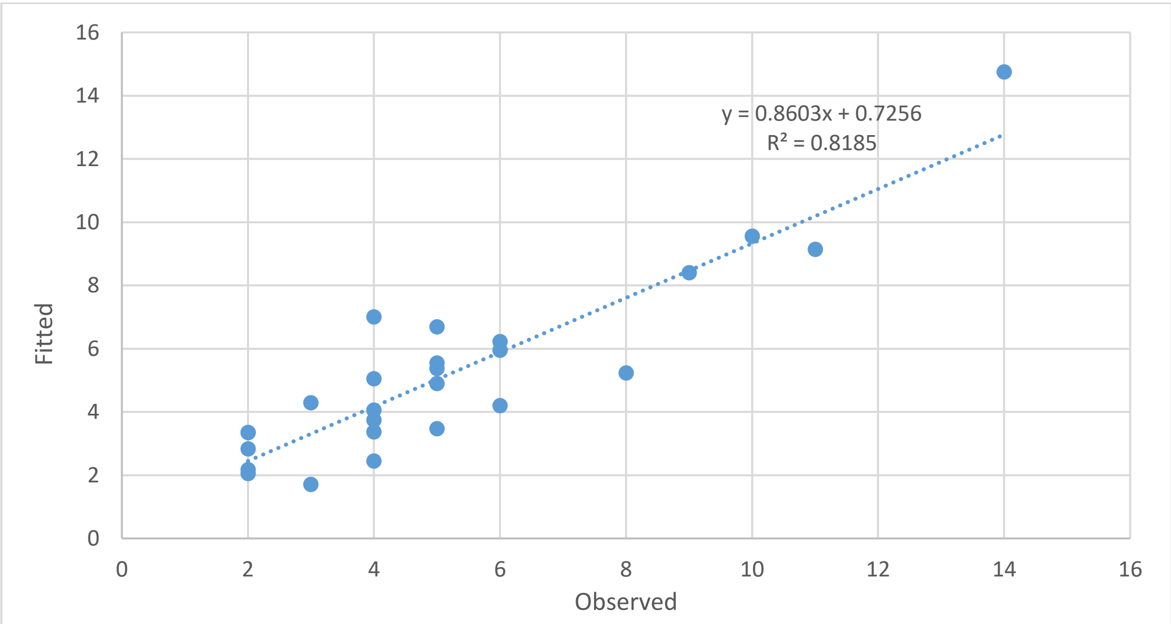

Figure 22 Model fit assessments – Annual Methamphetamine affected fatally injured vehicle controller counts by Region, car- and bus-based operations

Results presented in Table 10 show that the overall association between POFTs and drug testing hit rate overall and presence of Methamphetamine in fatalities stem largely from the association between this outcome and car-based testing. There was an almost statistically significant relationship between annual POFTs delivered per region and the outcome, with a 9.1% drop in the odds of Methamphetamine presence in a fatality per 1000 increase in car-based tests per region per annum. The association with testing 'hit rate' was highly statistically significant with a reduction in odds of 14.7% per percentage point increase in test hit rate from car-based tests.

Figure 23 shows the relative odds of the presence of Methamphetamine in fatally injured vehicle controllers given the annual number of POFTs conducted per region, through car-based operations.

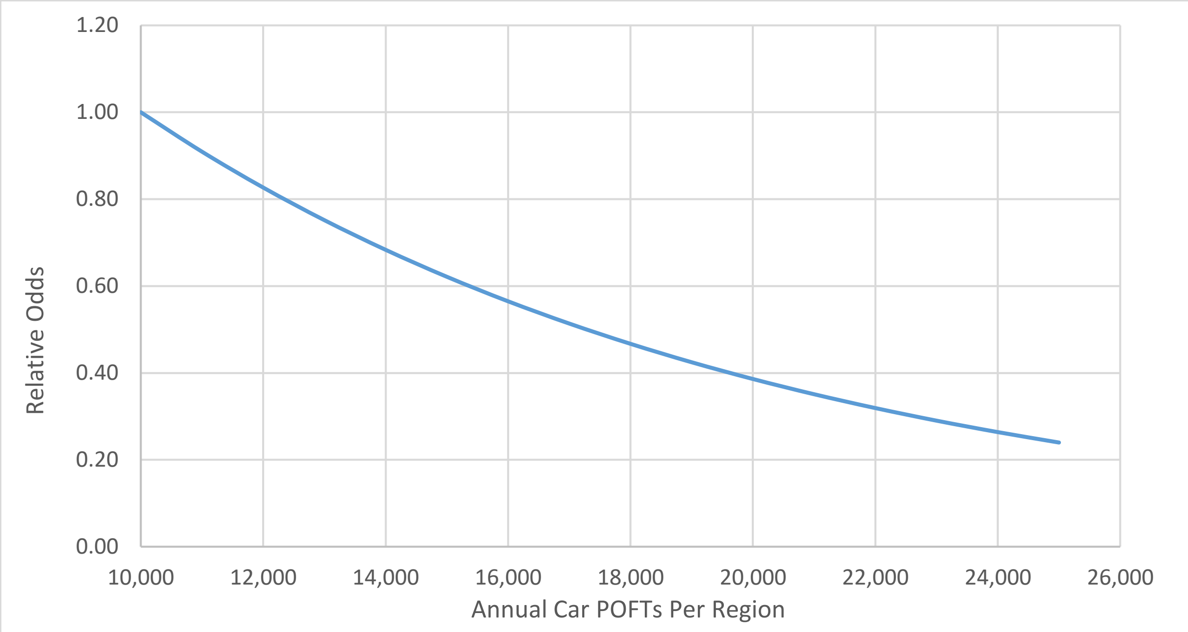

Figure 23 Relative odds of a fatally injured vehicle controller having Methamphetamine in their system by annual number of POFTs, per Region, car-based operations

The relationship between the relative odds of Methamphetamine car-based detection in fatally injured vehicle controllers and the percentage positive drug test rate (hit rate) is illustrated in Figure 24.

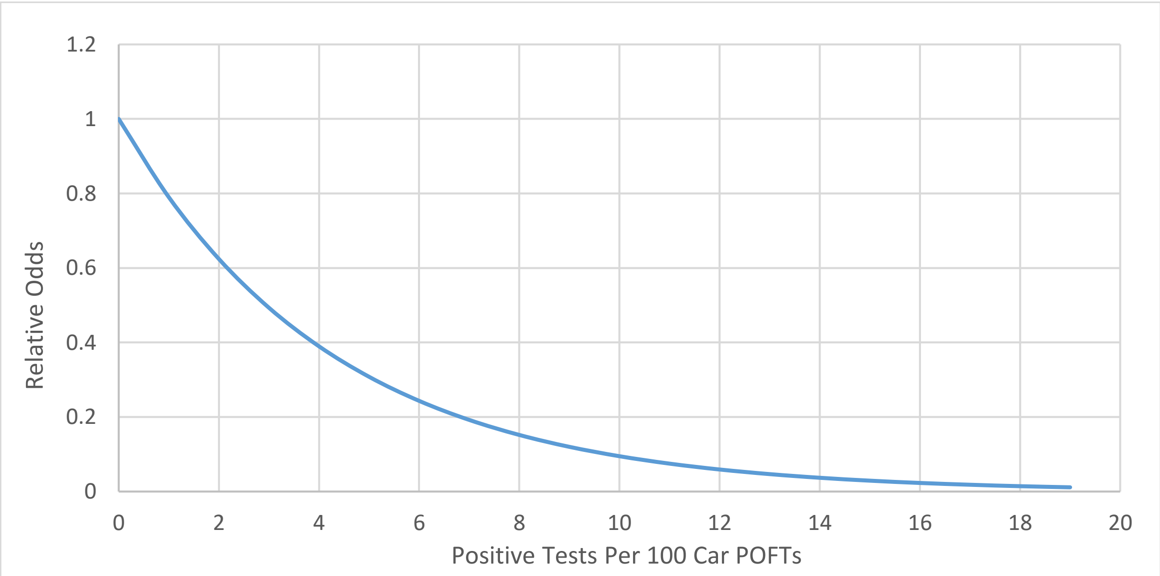

Figure 24 Relative odds of a fatally injured vehicle controller having Methamphetamine in their system by percentage detection rate ('Hit rate') by Region, car-based operations

3.2 Crash impacts of roadside alcohol testing

3.2.1 Annual RBT enforcement (PBTs & EBTs)

The annual number of random breath tests conducted in Victoria, identified through PBT data, from 2006 to 2016 is shown in Figure 25. Since 2006 the annual number of PBTs conducted in Victoria has ranged between approximately three to four-million tests. During 2015 and 2016 the number of tests decreased to operational levels similar to those reported back in 2007.

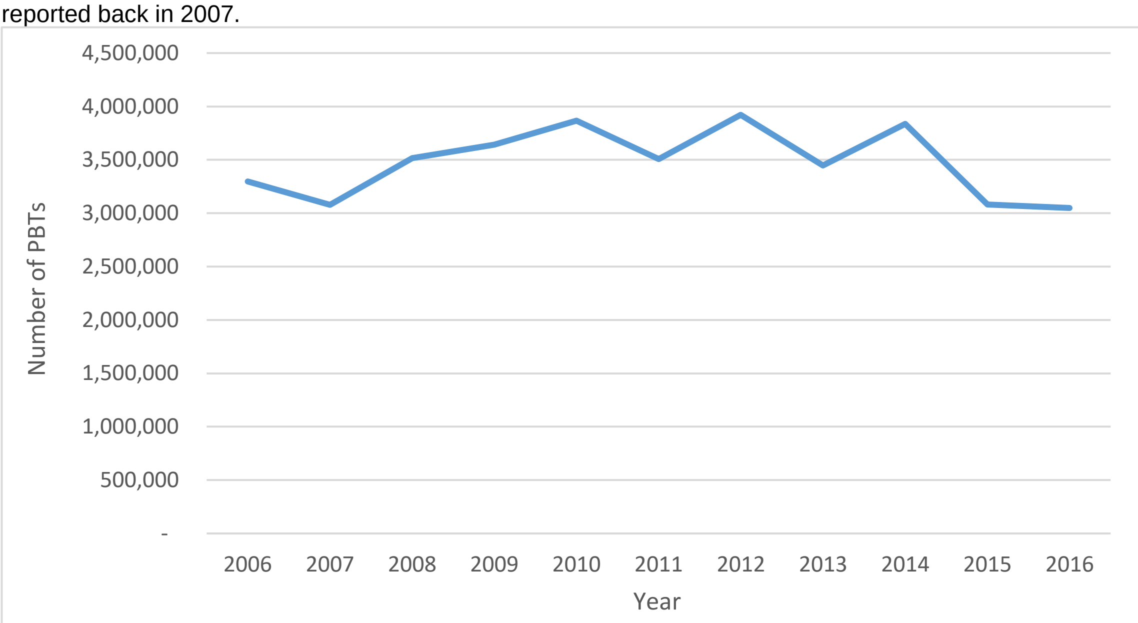

Figure 25 Annual number of Preliminary Breath Tests (PBTs) delivered, Victoria 2006-2016

From 2011 to 2014 there was a change in the preliminary breath testing equipment used by Victoria Police, transitioning from the SD400 to the Touch 400. As shown in Figure 26 the SD400 was no longer used after 2014, with all preliminary testing undertaken using the Touch 400.

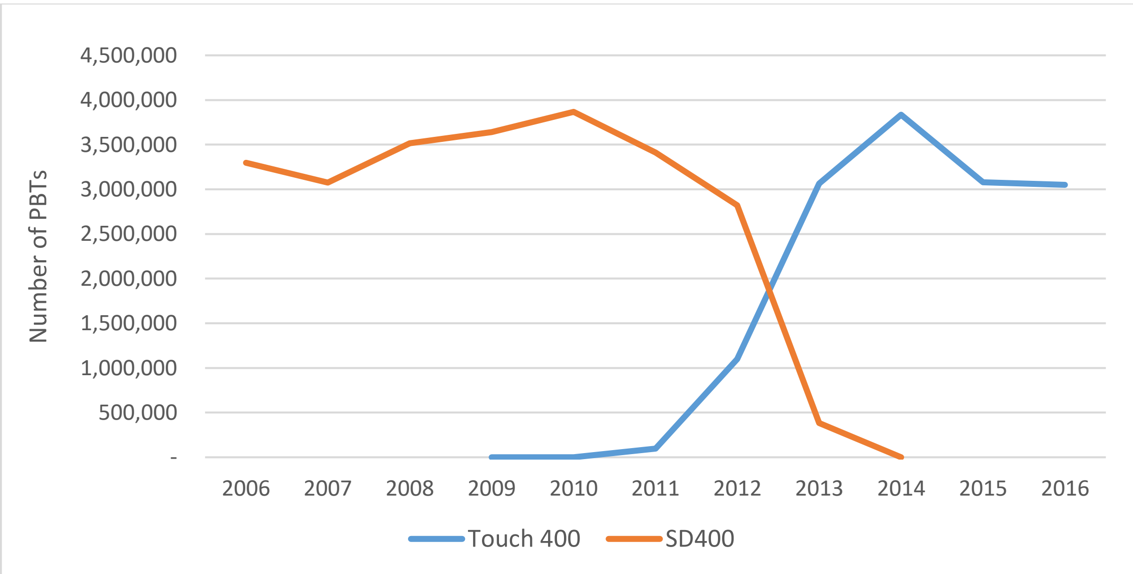

Figure 26 Annual number of PBTs delivered by testing device used, Victoria 2006-2016

The annual number of PBTs delivered in Victoria by Police Region is shown in Figure 27. Not all tests were able to be matched to the region in which they were conducted. Hence, Figure 27 does not represent the full set of tests. However, the proportion of tests not able to be matched was identified as approximately equal across regions, therefore the distribution of tests shown below is a fairly accurate reflection of the true distribution. As shown, the least number of RBTs have been conducted in the Southern Metro Region across all years, with the majority of testing occurring in the Eastern Region. The reductions in testing numbers during 2015 and 2016, mentioned above (see Figure 25) are mostly due to reductions occurring within the Eastern and Western Regions.

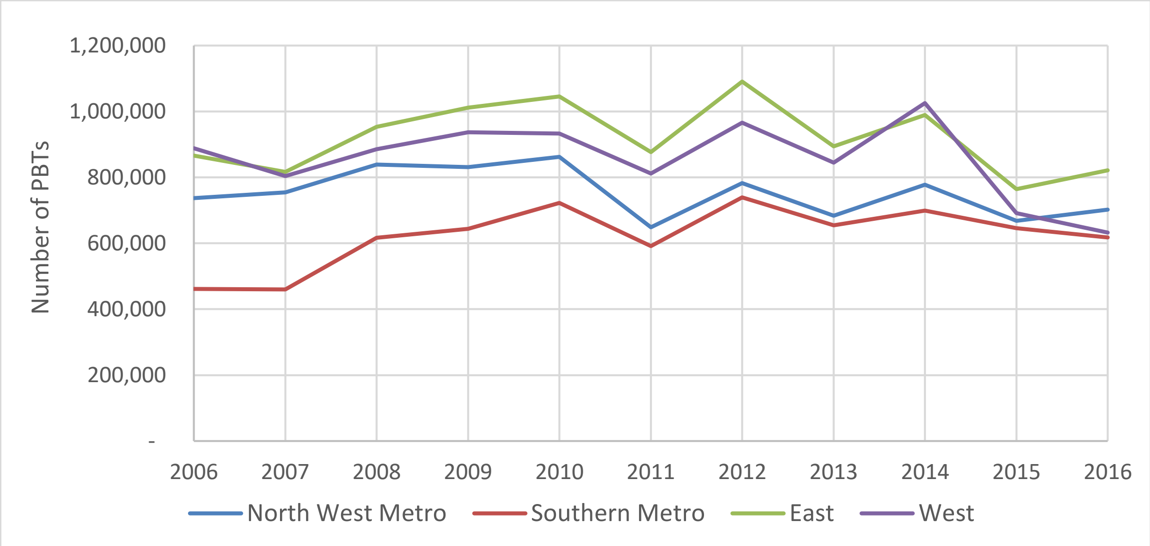

Figure 27 Annual number of PBTs delivered by Police Region, Victoria 2006-2016

The annual numbers of PBTs undertaken through car and bus-based operations are shown in Figure 28. There was a negligible number of tests excluded due to an inability to identify the operation type. It is likely that the declines in the number of PBTs conducted during 2015 and 2016 are attributable to declines in car-based testing rather than the bus-based possibly related to the move to the 2-up policy where all vehicles are required to have 2 officers on board when undertaking traffic duties to ensure safety.

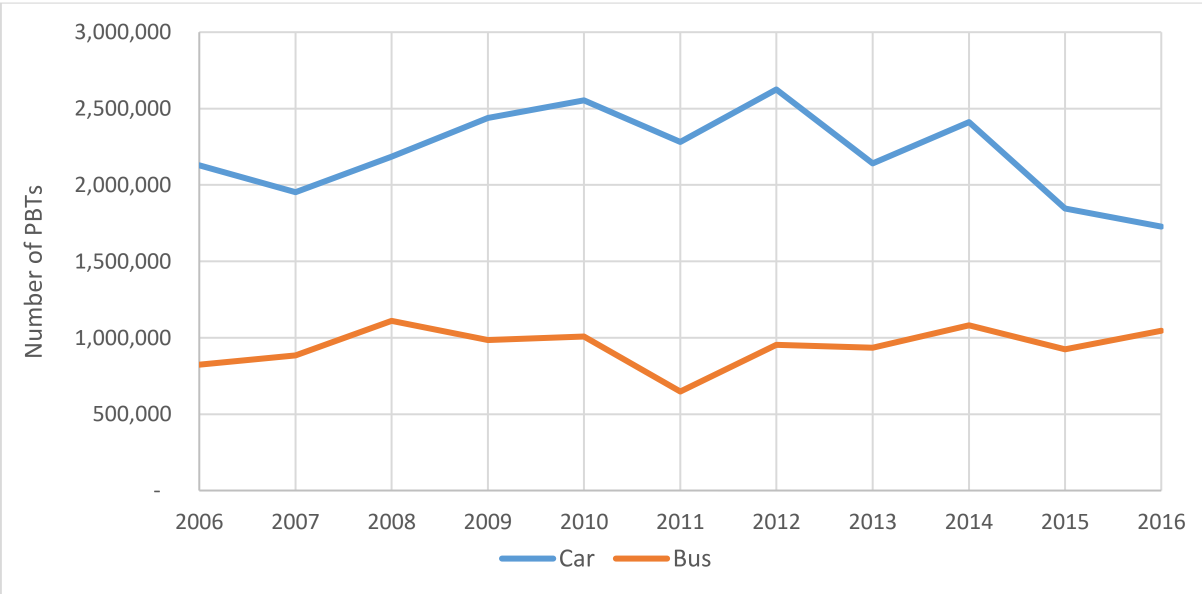

Figure 28 Annual number of PBTs delivered by car or bus operations, Victoria 2006-2016

Figure 29 shows the number of positive Evidentiary Breath Tests (EBTs) per 1000 PBTs, hereafter referred to as the 'hit rate', conducted in Victoria from 2006 to 2016. A gradual but constant decline can be observed from 2007 onwards for vehicle controllers returning illegal BAC level roadside PBTs and requiring EBTs to be taken from each driver.

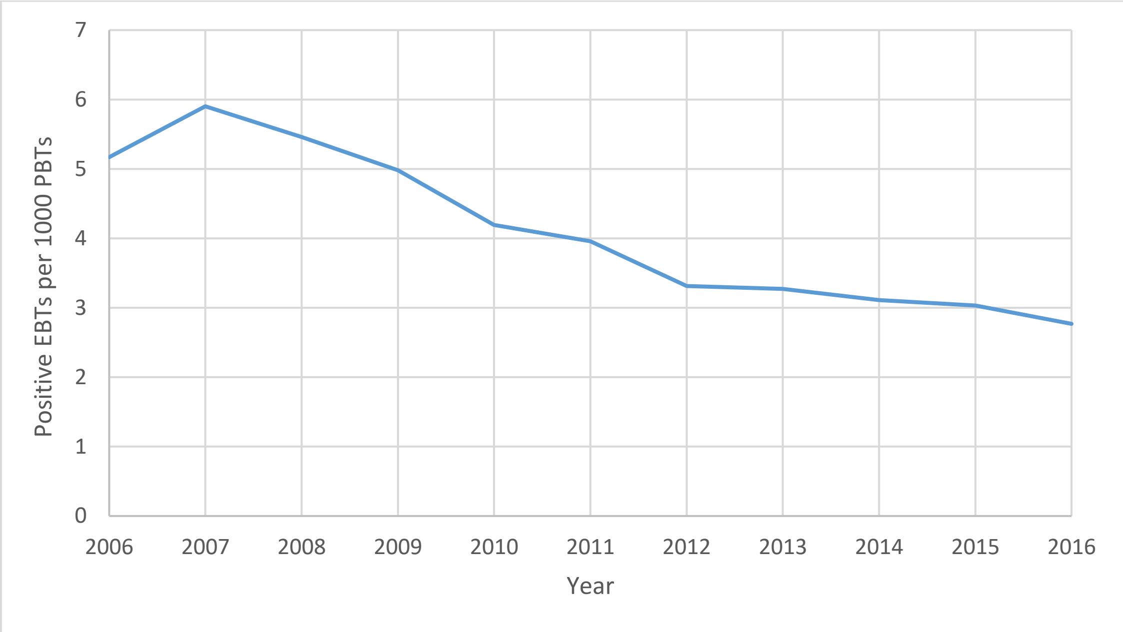

Figure 29 Annual number of positive EBTs per 1000 PBTs, Victoria 2006-2016

Figure 30 shows the hit rate for PBTs in each Police Region. It can be seen that the Metropolitan regions (North West Metro and Southern Metro) have a higher hit rate for alcohol testing than the primarily rural regions (East and West). Declines in hit rate over time have been observed in each region.

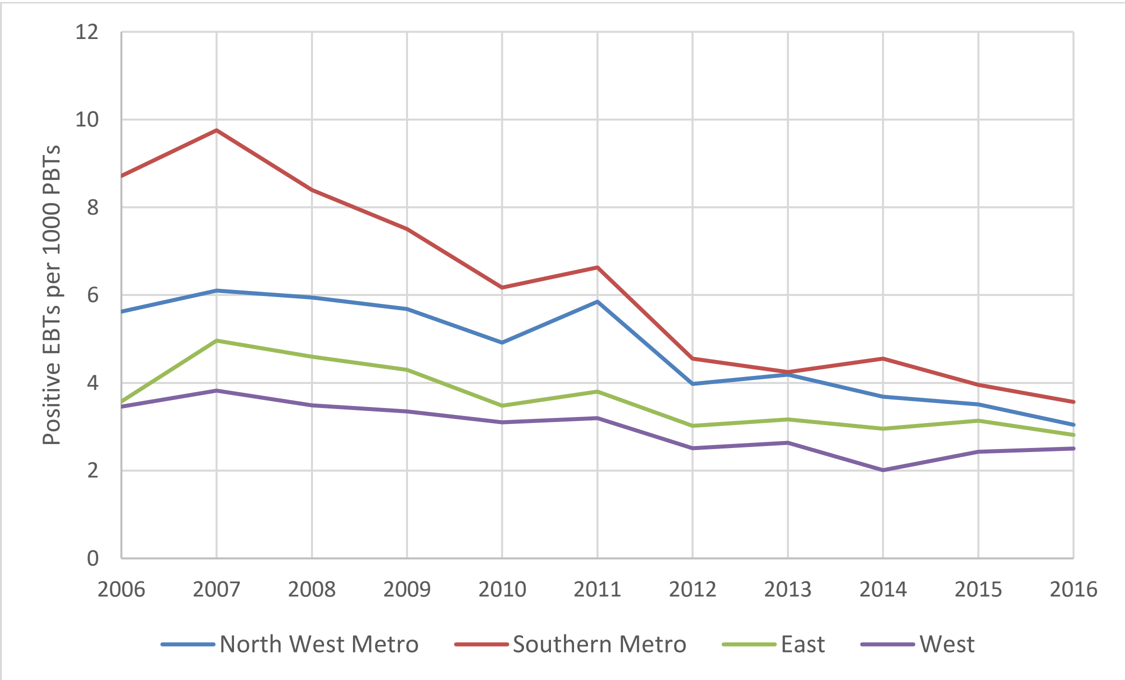

Figure 30 Annual number of positive EBTs per 1000 PBTs by Police Region, Victoria 2006-2016

Figure 31 shows the difference in alcohol testing hit rate associated with car and bus type operations. The hit rate is consistently much higher for cars than it is for buses. This is consistent with anecdotal reports that car-based operations are much less random (typically more targeted) than the bus-based operations which are designed to maximize general deterrence through principally random operations.

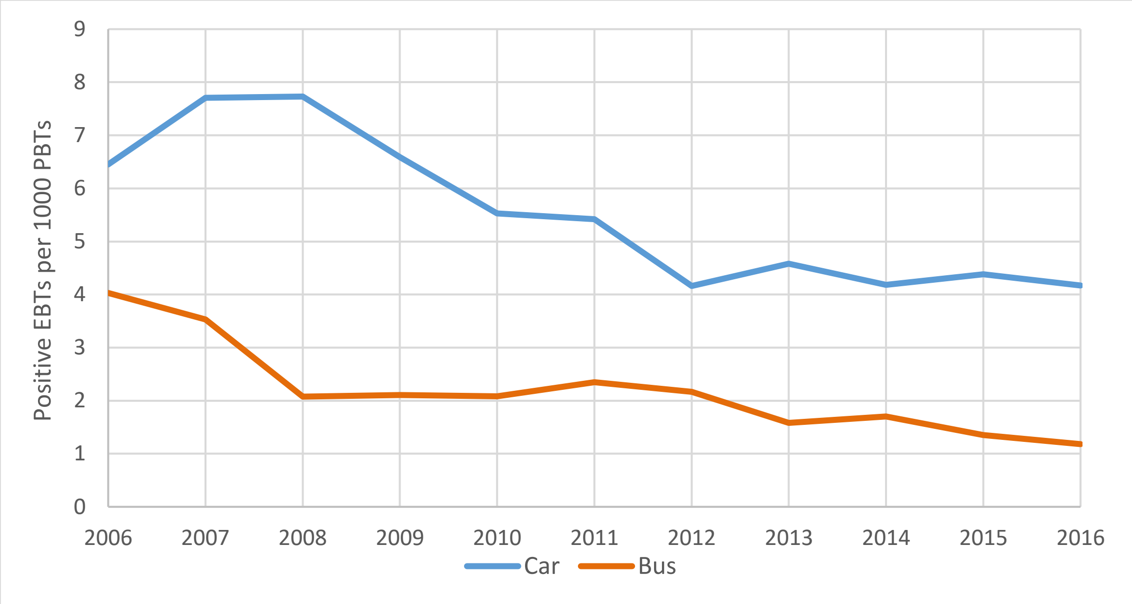

Figure 31 Annual number of positive EBTs per 1000 PBTs by mode of operation, Victoria 2006-2016

The annual number of PBTs within each Police Region from car-based operations are outlined in Table 11 and from bus-based operations in Table 12. As shown in these Tables, the Metro Regions utilise more bus-based RBT operations than car-based, with the Regions (East & West) that incorporate rural Divisions relying more on the car-based operations.

The annual number of positive EBTs per 1000 PBTs per Police Region resulting from car-based operations is outlined in Table 13 and those from bus-based operations are shown in Table 14, with both tables showing the intra and inter-regional average (mean hit rate) drink vehicle controller detection from each mode of operation. As shown the average drink vehicle controller detection rate has steadily decreased for both the car and bus-based operations over the decade. The tables also highlight the higher detection rate from car-based operations with a greater than 4:1 average detection rate compared to the bus in 2016. This higher detection rate is indicative of the more general deterrence profile of the buses compared to the target specific deterrence strategies associated with car-based drink driving operations.

TABLE 11 ANNUAL NUMBER OF BTS PER POLICE REGION FROM CAR-BASED OPERATIONS, VICTORIA 2006-16

Year	North West Metro	Southern Metro	East	West	Total
2006	367,248	221,956	727,312	811,969	2,128,485
2007	350,020	212,715	666,296	722,983	1,952,014
2008	328,265	306,786	754,981	794,603	2,184,635
2009	367,605	362,136	851,403	857,084	2,438,228
2010	410,883	424,082	881,624	837,729	2,554,318
2011	384,572	382,364	769,701	743,972	2,280,609
2012	393,705	450,504	935,247	845,621	2,625,077
2013	298,796	352,175	742,160	748,898	2,142,029
2014	343,979	376,804	803,512	886,417	2,410,712
2015	297,443	357,348	617,588	573,198	1,845,577
2016	322,150	315,433	615,123	474,934	1,727,640

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TABLE 12 ANNUAL NUMBER OF PBTS PER POLICE REGION FROM BUS-BASED OPERATIONS, VICTORIA 2006-16

Year	North West Metro	Southern Metro	East	West	Total
2006	369,377	239,142	138,927	76,520	823,966
2007	404,627	247,309	150,562	81,052	883,550
2008	510,984	310,241	198,098	91,195	1,110,518
2009	463,577	281,633	160,180	79,776	985,166
2010	451,461	298,516	163,545	95,279	1,008,801
2011	264,085	208,798	107,075	68,108	648,066
2012	388,679	288,897	155,565	120,616	953,757
2013	384,491	302,161	151,663	96,101	934,416
2014	433,527	322,915	185,548	139,032	1,081,022
2015	371,053	288,985	146,862	118,106	925,006
2016	380,401	301,851	206,415	157,604	1,046,271

TABLE 13 ANNUAL AND AVERAGE NUMBER OF POSITIVE EBTS PER 1000 TESTS PER POLICE REGION FROM CAR-BASED OPERATIONS, VICTORIA 2006-16

Year	North West Metro	Southern Metro	East	West	Mean Hit rate
2006	9.78	16.07	4.60	3.98	**8.6**
2007	10.81	17.68	6.35	4.52	**9.8**
2008	13.52	14.72	6.18	4.11	**9.6**
2009	11.19	11.40	5.29	3.87	**7.9**
2010	8.99	9.02	4.13	3.52	**6.4**
2011	8.37	8.61	4.25	3.46	**6.2**
2012	6.70	6.15	3.39	2.77	**4.8**
2013	8.37	6.70	3.77	2.87	**5.4**
2014	7.38	7.35	3.51	2.21	**5.1**
2015	6.60	6.21	3.73	2.80	**4.8**
2016	5.53	5.80	3.45	3.10	**4.5**
Regional Mean	**8.8**	**10.0**	**4.4**	**3.4**	**6.7**

TABLE 14 ANNUAL AND AVERAGE NUMBER OF POSITIVE PBTS PER 1000 TESTS PER POLICE REGION FROM BUS-BASED OPERATIONS, VICTORIA 2006-16

Year	North West Metro	Southern Metro	East	West	Mean Hit rate
2006	3.74	5.34	2.89	3.36	**3.8**
2007	3.05	4.58	3.95	1.95	**3.4**
2008	1.74	2.80	2.13	1.35	**2.0**
2009	1.82	2.71	2.33	1.18	**2.0**
2010	1.74	2.59	2.38	1.62	**2.1**
2011	2.20	2.91	2.29	1.32	**2.2**
2012	1.97	2.83	2.04	1.38	**2.1**
2013	1.49	1.86	1.50	1.21	**1.5**
2014	1.54	2.06	1.90	1.11	**1.7**
2015	1.40	1.49	1.32	0.88	**1.3**
2016	1.16	1.43	1.13	0.82	**1.1**
Regional Mean	**2.0**	**2.8**	**2.2**	**1.5**	**2.1**

3.2.2 Alcohol presence in crashes

The analysis undertaken to establish the effect of alcohol enforcement on the involvement of alcohol in crash-involved vehicle controllers was analogous to that used in the drug component of this project. The datasets employed were:

- Victoria Police sourced PBT data (2006-2016)
- Victoria Police sourced EBT data (2007-2017)
- TIS crash data (2006-2018)
- RCIS crash data (with TAC validated injury severity level; 2006-2016)

Once combined/matched the datasets presented a complete picture of the input and output measures of interest for period of January 2006 to December 2016 inclusive.

3.2.2.1 Serious injury crashes

The trends for the presence of illegal BAC levels in seriously injured vehicle controllers is shown in Figure 32 with the counts of vehicle controllers presented in Table 15. Overall, the rate of alcohol involvement has been consistently declining throughout the data period. Of note is that the gradient of this decline does not differ for high BAC level offences. Alarmingly, high level readings continue to remain as prominent as low-mid range ones.

Only about 30% of seriously injured vehicle controllers admitted to hospital had a blood sample taken and tested for alcohol during 2006-2016. Thus, the percentage of seriously injured vehicle controllers tested and found to have BAC in an illegal BAC range is likely to be a conservative estimate of the true prevalence of alcohol in all seriously injured vehicle controllers in Victoria.

TABLE 15 PRESENCE OF ALCOHOL BY LEVEL OF CONCENTRATION (BAC) IN SERIOUSLY INJURED VEHICLE CONTROLLERS, VICTORIA 2006-2016

Year	Seriously injured vehicle controllers		
	Low – mid range (BAC ≥0.05 - <0.15)	High range (BAC≥0.15)	Total
2006	172	199	4388
2007	186	217	4820
2008	204	191	4546
2009	208	205	4504
2010	154	158	3967
2011	199	139	4208
2012	149	129	3894
2013	114	126	3955
2014	118	111	4238
2015	106	111	4243
2016	104	106	4460

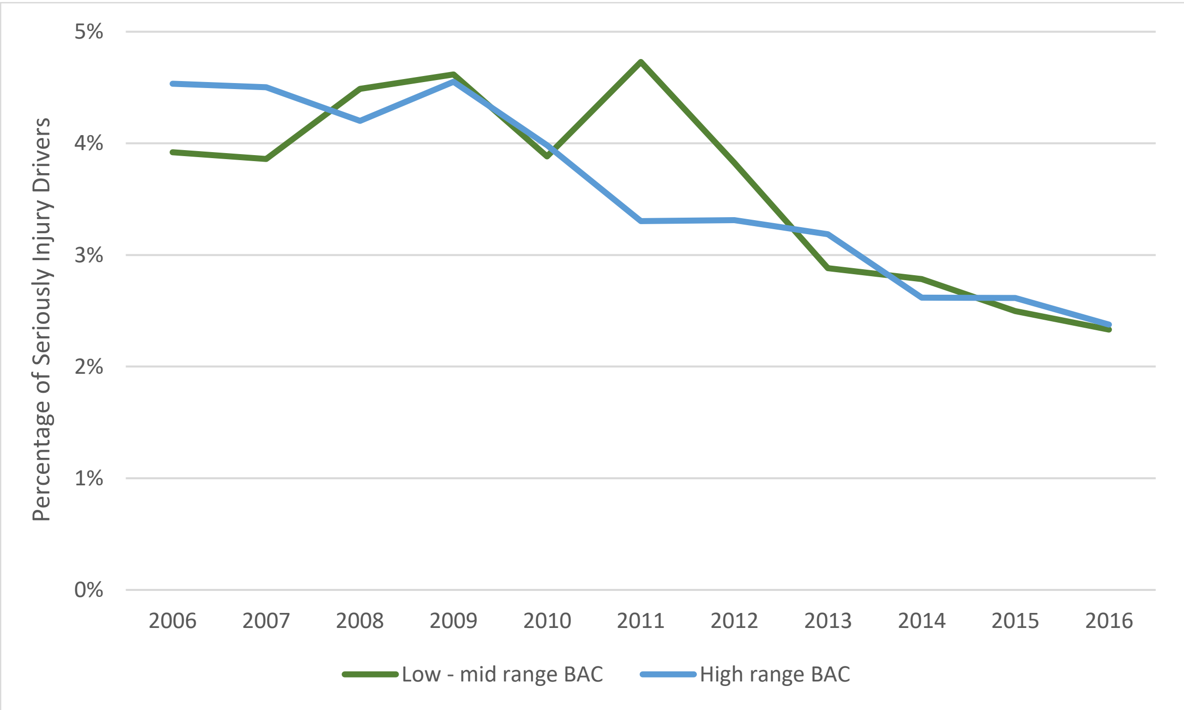

Figure 32 Percentage of seriously injured vehicle controllers by illegal BAC range

3.2.2.2 Fatal crashes

The trends for the presence of illegal BAC levels in fatal injury crashes is shown in Figure 33 with the counts of vehicle controllers (%) presented in Table 16. Overall, the rate of alcohol involvement has been consistently declining throughout the data period. Of note is that the gradient of this decline is less for high BAC level offences, with high level readings continuing to be overrepresented in fatal crashes across all data years.

TABLE 16 PRESENCE OF ALCOHOL BY LEVEL OF CONCENTRATION (BAC) IN FATALLY INJURED VEHICLE CONTROLLERS, VICTORIA 2006-2016

	Fatally injured vehicle controllers		
Year	Low-mid range (0.05≤BAC<0.15)	High range (BAC≥0.15)	Total
2006	13	21	212
2007	23	33	220
2008	14	32	192
2009	20	19	184
2010	11	22	184
2011	13	18	176
2012	13	25	190
2013	10	19	167
2014	10	14	154
2015	8	18	162
2016	10	25	212

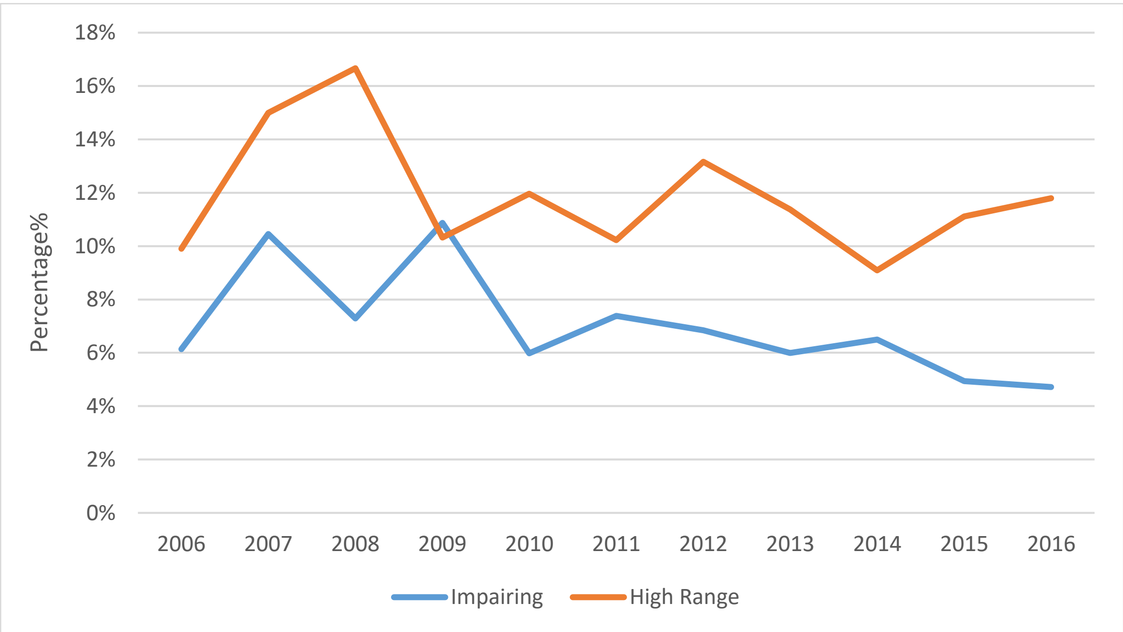

Figure 33 Percentage of fatally injured vehicle controllers by illegal BAC range

3.2.3 Analysis approach

As mentioned, the design of the analysis to establish the effect of roadside alcohol testing on alcohol crash involvement was comparable to that described for the roadside drug testing component of this project (see Section 3.1.2). The same cross-sectional design was used to identify the effects of roadside alcohol enforcement on crash outcomes at a Police Region level. Again, the analysis of the relationship between levels of alcohol enforcement and road safety outcomes focused on vehicle controllers killed or seriously injured with drugs or alcohol detected in their system rather than crashes where any driver was alcohol affected.

Two outcome measures were nominated to be investigated in analysis:

- The presence of a BAC reading at or above 0.05mg/L and
- The presence of a BAC reading at or above 0.15mg/L (high range)

The input variables included in the model were:

- Total number of PBTs
- Total number of positive EBTs per 1000 PBTs

Two types of models were considered for the predictor variables. The first included the two measures in total across both car and bus-based operations. The second considered the 2 measures split by car and bus-based operations.

The form of the model is as follows:

$$logit(p_{yr}) = \alpha + \beta_y + \gamma \, PBT_{yr} + \delta \left(\frac{EBT}{PBT}\right)_{yr} \ldots \text{(Equation 1)}$$

In the model:

p_{yr}	is the proportion of seriously injured vehicle controllers tested and found with given alcohol levels in year *y* and region *r*
PBT_{yr}	is the number of PBTs delivered in year *y* and region *r*
$\left(\frac{EBT}{PBT}\right)_{yr}$	is the rate of illegal BAC detection per PBT in year *y* and region *r*
β_y	is the year effect parameter for year *y*
α, ϒ and δ	are model parameters

3.2.4 Analysis results

3.2.4.1 <u>Serious injury crashes</u>

3.2.4.1.1 Seriously injured vehicle controllers with BAC at or above 0.05mg/L

Estimates of the association, between the proportions of seriously injured crash-involved vehicle controllers and (a) the annual number of PBTs and (b) the hit rate of illegal BAC detection (EBTs), were derived through the application of Equation 1 for the rate of illegal BAC detection (BAC ≥0.05%) in crash-involved vehicle controllers. A summary of the estimated odds ratios from the analysis for the roadside alcohol enforcement measures and the associated statistical significance probability are given in Table 17. The first model considered car and bus operations combined in the predictor variables whilst the second model considered the predictor variables separately for car and bus operations.

TABLE 17 SUMMARY RESULTS OF THE TWO MODELS USED TO ASSESS THE RELATIONSHIP BETWEEN ALCOHOL ENFORCEMENT AND THE PRESENCE OF ALL ILLEGAL ALCOHOL LEVELS (BAC≥0.05%), IN SERIOUSLY INJURED CRASH VEHICLE CONTROLLERS

OUTCOME VARIABLE	INPUT VARIABLES	SIGNIFICANCE	Relative Odds Per Unit Input Change
	Car and Bus Operations Combined		
All illegal alcohol involvement ≥0.05	Number of PBTs (1000s)	**<0.001**	**0.998** (0.998, 0.999)
	EBTs per 1000 PBTs ('Hit rate')	**<0.001**	**0.882** (0.841, 0.925)
	Car and Bus Operations Separately		
All illegal alcohol involvement ≥0.05	Number of Car-based PBTs (1000s)	**0.001**	**0.999** (0.998, 1.000)
	Number of Bus-based PBTs (1000s)	**<0.001**	**0.998** (0.997, 0.999)
	Car-based EBTs per 1000 PBTs ('Car Hit rate')	0.895	1.002 (0.968, 1.037)
	Bus-based EBTs per 1000 PBTs ('Bus Hit rate')	**0.005**	**0.861** (0.775, 0.956)

A statistically significant relationship at the 5% level was found between 'all illegal alcohol involvement (BAC ≥0.05)' in seriously injured vehicle controllers and 'total number of PBTs' (input for general deterrence) for both car and bus-based operations separately and combined. For every 1000 additional PBTs delivered per Region, the estimated odds of an illegal BAC (≥0.05%) being detected in a seriously injured vehicle controller reduced by 0.2% (odds ratio 0.998) for car and bus operations combined. When considered by car and bus tests separately, the relationship between car-based testing and illegal alcohol involvement in seriously injured vehicle controllers (0.1% reduction per 1000 test increase per Region) was half that for the bus-based tests delivered (0.2% reduction per 1000 test increase per Region).

The relationship between all illegal alcohol involvement (BAC ≥0.05)' in seriously injured vehicle controllers and 'Hit rate' (EBTs per 1000 PBTs) was statistically significant for car and bus tests combined. Odds of all illegal alcohol involvement (BAC ≥0.05) in a seriously injured vehicle controller detected were found to decrease by 11.8% with every 0.1 percentage point increase in the detection rate per PBT administered. This relationship appeared to stem largely from the statistically significant relationship identified for hit-rate in bus-based testing. Odds of all illegal alcohol involvement (BAC ≥0.05) in a seriously injured vehicle controller detected in a bus-based operation were found to decrease by 13.9% with every 0.1 percentage point increase in the detection rate per roadside drug test administered. The relationship with car-based test hit rate was not statistically significant. Complete outputs for each model are shown in Appendix D (D1 & D2).

The model for illegal alcohol levels (BAC ≥0.05) in seriously injured vehicle controllers for car and bus-based predictor measures combined explained 83% of the variation in the annual counts of seriously injured vehicle controllers detected with illegal alcohol levels. Charts of fitted versus observed counts of impairing alcohol affected (BAC ≥0.05) seriously injured vehicle controllers by Region and year for the model are shown in Figure 34.

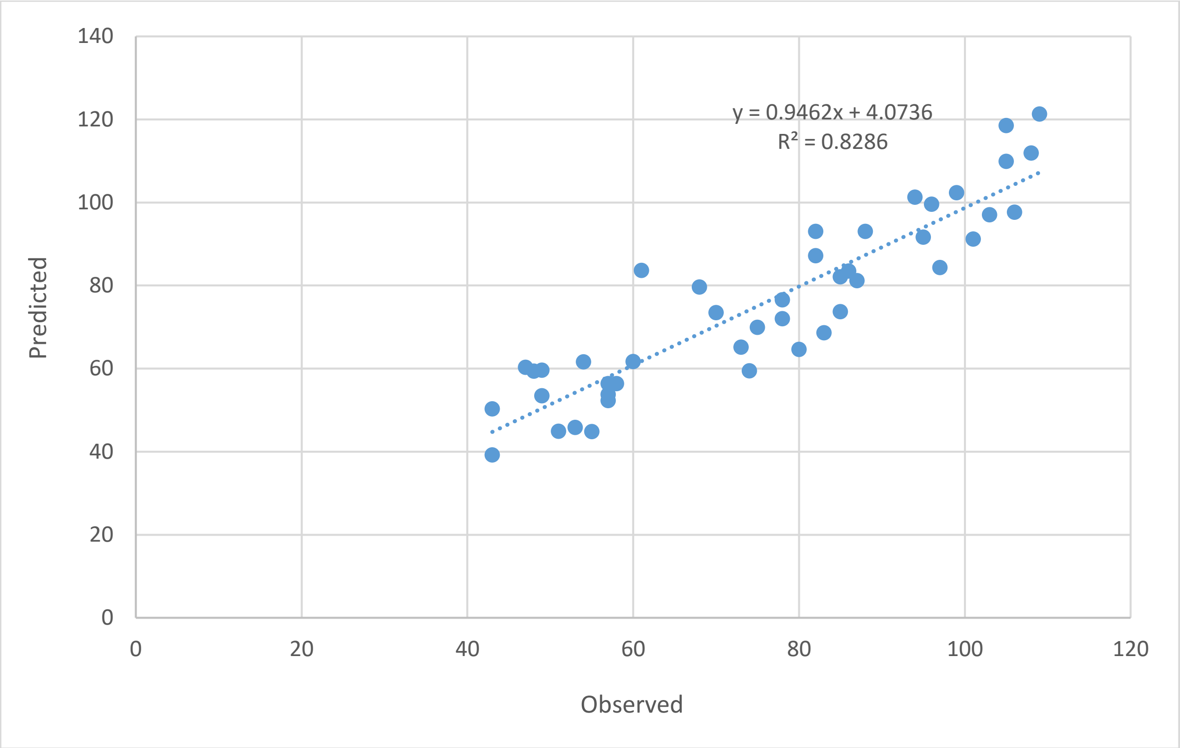

Figure 34 Model fit assessments – Illegal alcohol level (BAC≥0.05) seriously injured vehicle controller counts by year and Region

The relationship between the relative odds of illegal alcohol levels (BAC ≥0.05) detection in seriously injured vehicle controllers given the annual number of PBTs conducted per Police Region in both car and bus operations is illustrated in Figure 35.

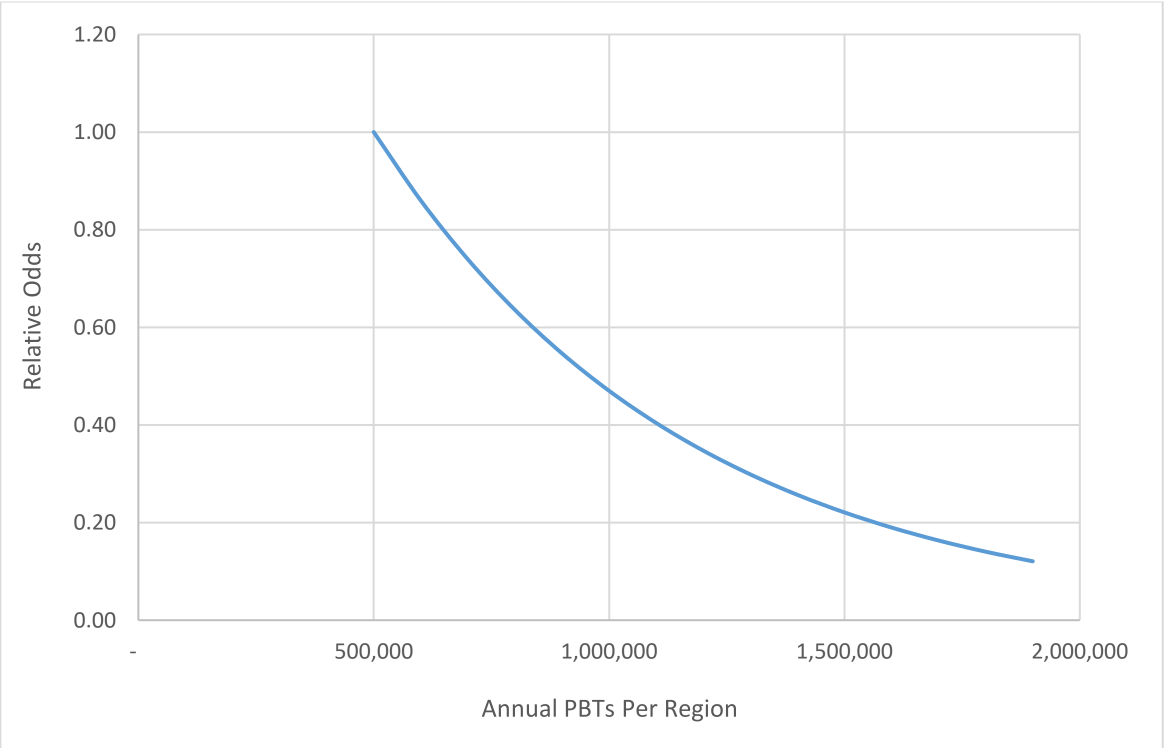

Figure 35 Relative odds of a seriously injured vehicle controller having illegal alcohol levels (BAC≥0.05) in their system by annual number of PBTs delivered, per Police Region

Figure 36 shows the relationship between PBT hit rate and the relative odds of any illegal alcohol presence in seriously injured vehicle controllers.

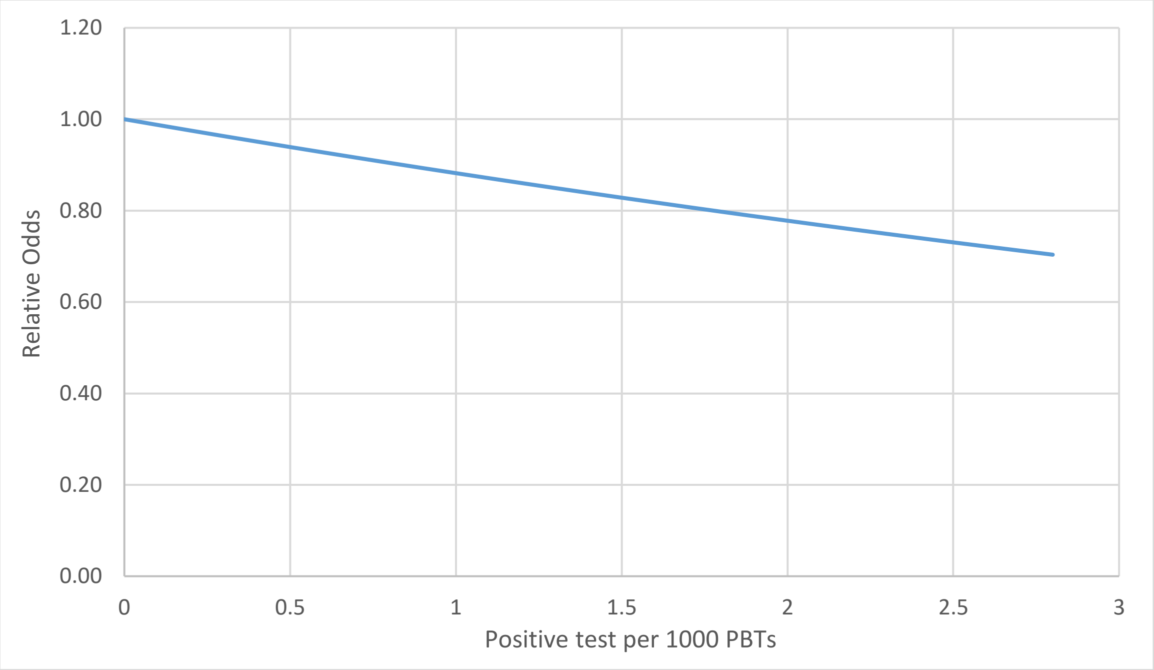

Figure 36 Relative odds of a seriously injured vehicle controller having illegal alcohol levels (BAC≥0.05) in their system by the Hit rate, per 1000 alcohol tests

The model for illegal alcohol levels (BAC ≥0.05) by car and bus-based operations in seriously injured vehicle controllers explained 88% of the variation in the annual counts of seriously injured vehicle controllers detected with illegal alcohol levels. This is slightly greater than the model for car and bus operations combined suggesting differential associations between car and bus operations and illegal alcohol involvement in seriously injured vehicle controllers. Charts of fitted versus observed counts of illegal alcohol affected (BAC ≥0.05) seriously injured vehicle controllers by Region and year for the model, for car and bus-based operations are shown in Figure 37.

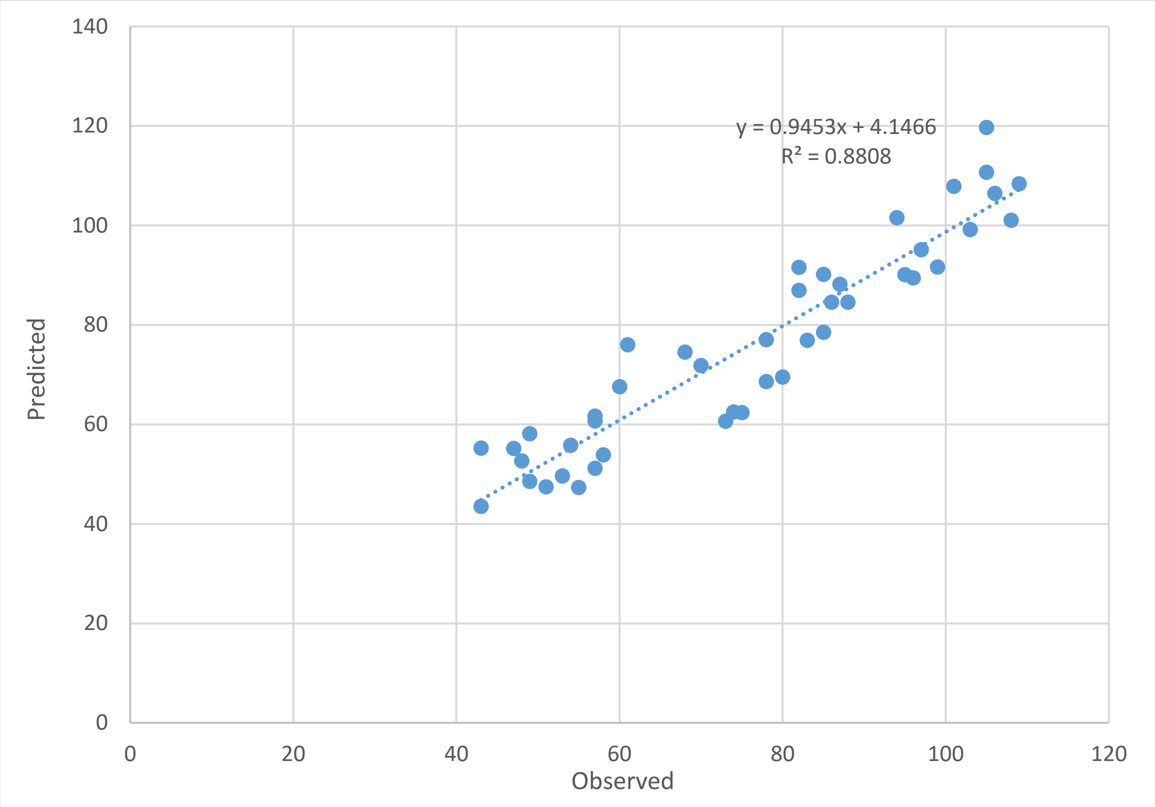

Figure 37 Model fit assessments – Illegal alcohol level (BAC≥0.05) seriously injured vehicle controller counts by year and Region, car and bus-based operations

The relationship between the relative odds of illegal level alcohol (BAC ≥0.05) detection in seriously injured vehicle controllers and RBTs delivered per year per Police Region by car-based operations and bus-based operations are illustrated below in Figure 38 and Figure 39 respectively. The stronger effects associated with bus-based operations can be seen through comparing the 2 figures.

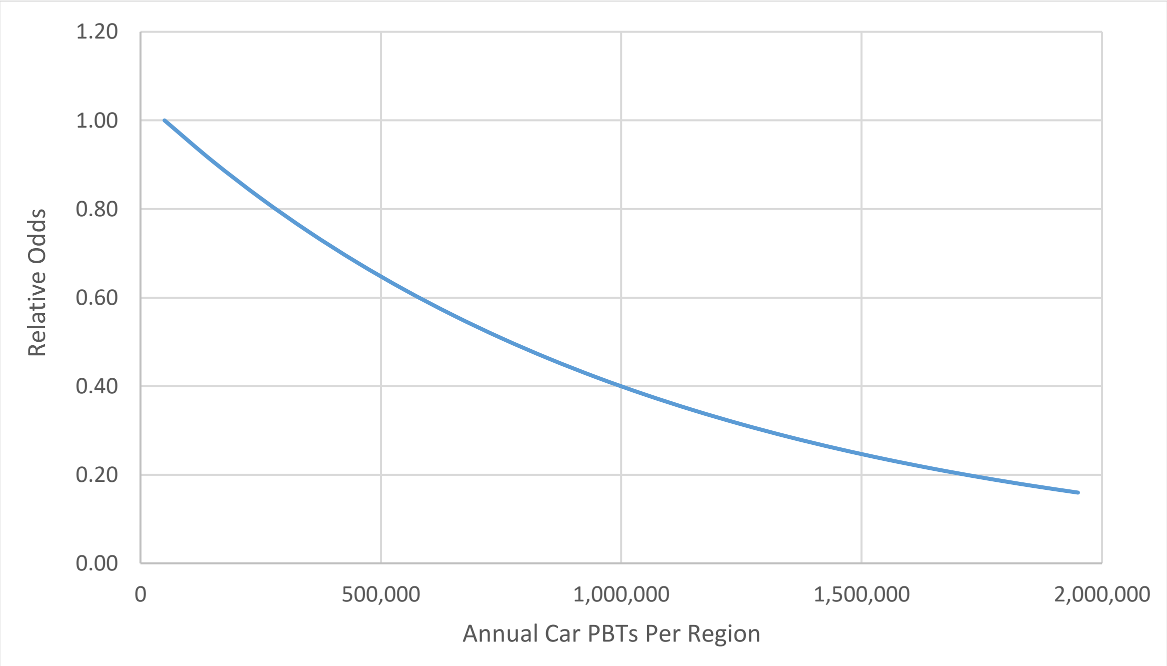

Figure 38 Relative odds of a seriously injured vehicle controller having illegal alcohol levels (BAC≥0.05) in their system by annual number of PBTs delivered, per Region, car-based operations

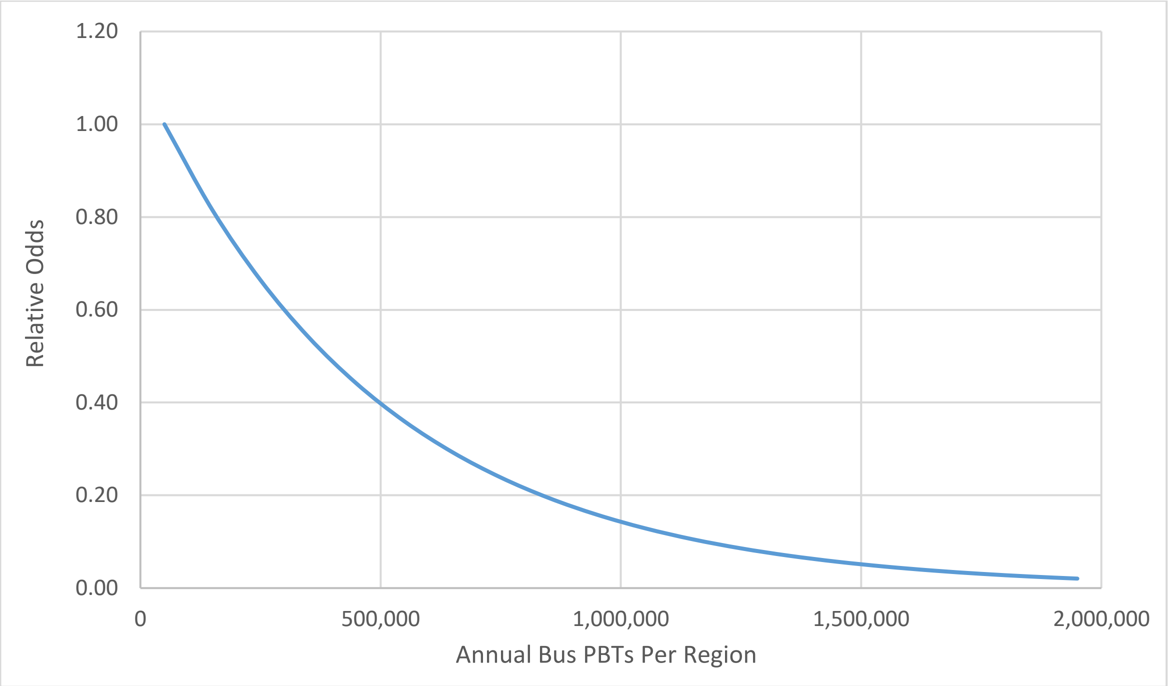

Figure 39 Relative odds of a seriously injured vehicle controller having illegal alcohol levels (BAC≥0.05) in their system by annual number of PBTs delivered, per Region, bus-based operations

Figure 40 shows the relationship between hit rate per 1000 RBTs delivered from bus operations and relative odds of illegal alcohol presence in seriously injured vehicle controllers.

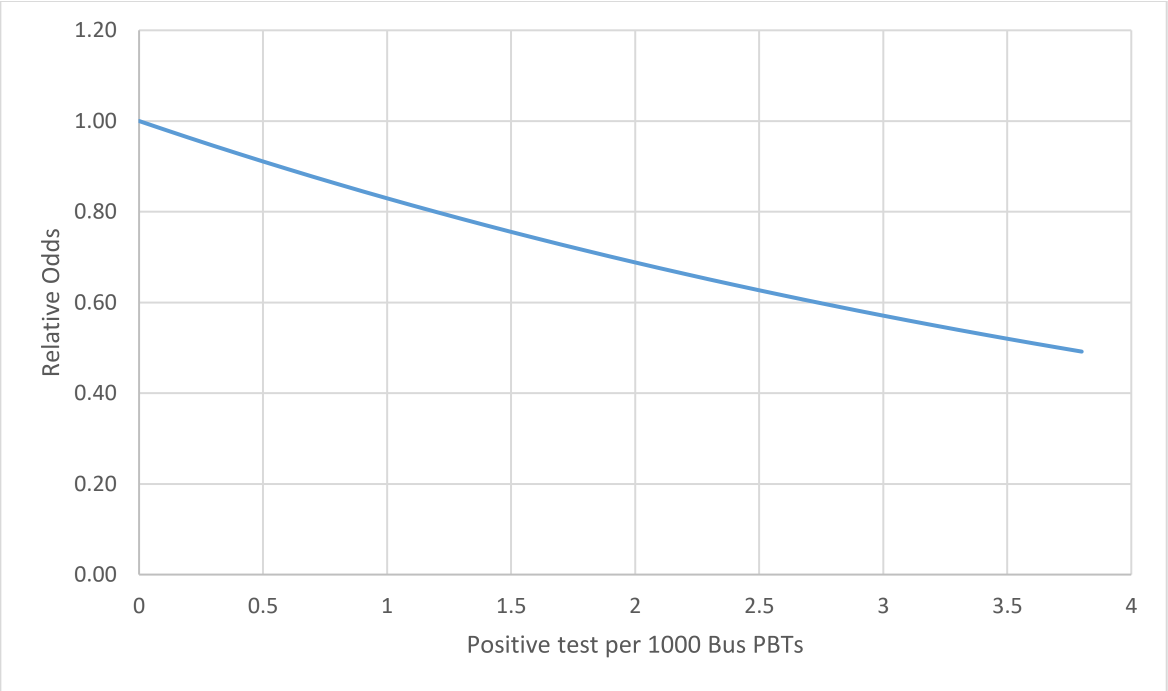

Figure 40 Relative odds of a seriously injured vehicle controller having illegal alcohol levels (BAC≥0.05) in their system by the hit rate, per 1000 alcohol tests, bus-based operations

3.2.4.1.2 Seriously injured vehicle controllers with BAC at or above 0.15mg/L (high-range)

Estimates of the association, between the proportions of seriously injured crash-involved vehicle controllers with a BAC of 0.15 or greater (≥0.15 – high range) and (a) the annual number of PBTs delivered per region and (b) the hit rate (EBTs per 1000 PBTs), were derived through the application of Equation 1. As before, separate models were fitted for bus and car-based operations combined and for bus and car-based operations separately. A summary of the estimated odds ratios from the analysis for the alcohol enforcement measures and the associated statistical significance probability are given in Table 18.

TABLE 18 SUMMARY RESULTS OF THE MODELS USED TO ASSESS THE RELATIONSHIP BETWEEN ALCOHOL ENFORCEMENT AND THE PRESENCE OF HIGH-RANGE ALCOHOL LEVELS (BAC≥0.15), IN SERIOUSLY INJURED CRASH VEHICLE CONTROLLERS

OUTCOME VARIABLE	INPUT VARIABLES	SIGNIFICANCE	Relative Odds Per Unit Input Change
	Car and Bus Operations Combined		
Alcohol Involvement ≥0.15 (High range)	Number of PBTs (1000s)	**<0.001**	0.998 (0.997, 0.999)
	EBTs per 1000 PBTs ('Hit rate')	**<0.001**	0.896 (0.838, 0.957)
	Car and Bus Operations Separate		
Alcohol Involvement ≥0.15 (High range)	Number of Car-based PBTs (1000s)	**<0.001**	0.999 (0.998, 0.999)
	Number of Bus-based PBTs (1000s)	**<0.001**	0.998 (0.997, 0.999)
	Car-based EBTs per 1000 PBTs ('Car hit rate')	0.817	0.994 (0.949, 1.042)
	Bus-based EBTs per 1000 PBTs ('Bus hit rate')	0.086	0.881 (0.763, 1.018)

A statistically significant relationship at the 5% level was found between 'high-range alcohol level (BAC ≥0.15)' in seriously injured vehicle controllers and number of PBTs delivered annually per region for car and bus-based tests combined as well as for car and bus-based tests separately (input for general deterrence). For every 1000 additional PBTs delivered per Region per annum, the estimated odds of a high-range illegal BAC being detected in a seriously injured vehicle controller reduced by 0.2% for combined car & bus operations, by 0.1% for car-based operations and 0.2% for bus-based operations.

A statistically significant relationship was found between high-range alcohol level (BAC ≥0.15) in serious injury vehicle controllers and 'Hit rate" (specific deterrence) from car and bus tests combined. Odds of high-range alcohol involvement (BAC ≥0.15) in a seriously injured vehicle controller detected were found to decrease by 10.4% with every 0.1 percentage point increase in the detection rate per roadside drug test administered. In the models that separated the car and bus-based operations, these relationships were not found to be significant. However, the estimated effect in this model was much higher for bus-based hit rate (which was marginally statistically significant) compared to car-based hit rate suggesting the overall result is mostly driven by the bus-based hit rate as was found for the all illegal alcohol analysis. Complete outputs for each model are presented in Appendix D (D3 & D4).

The model for high-range alcohol levels (BAC ≥0.15) in seriously injured vehicle controllers based on combined car and bus measures explained 81% of the variation in the annual counts per Region of seriously injured vehicle controllers detected with high-range alcohol levels. Charts of fitted versus observed counts of high-range alcohol level (BAC ≥0.15) affected seriously injured vehicle controllers by Police Region and year, for the model are shown in Figure 41.

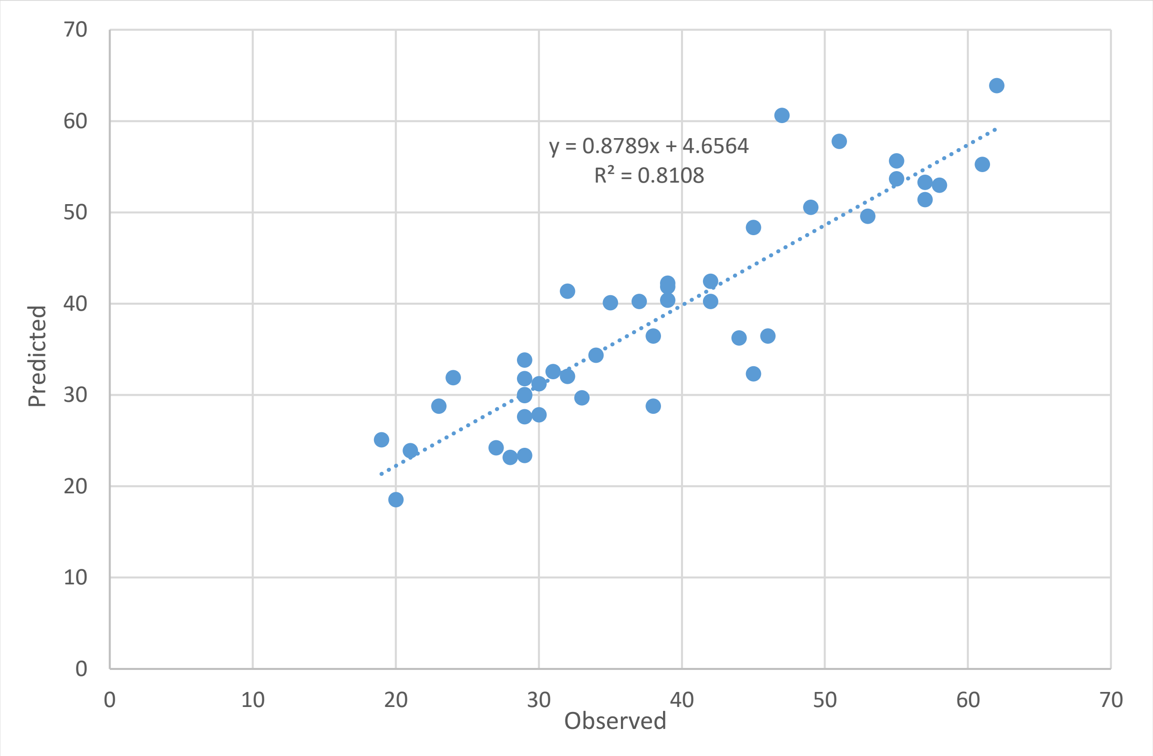

Figure 41 Model fit assessments – High-range alcohol level (BAC ≥0.15) seriously injured vehicle controller counts by year and Region: car and bus combined

The relationship between the relative odds of high-range alcohol level (BAC ≥0.15) detection in seriously injured vehicle controllers and the annual number of PBTs conducted per Police Region for car and busses combined is illustrated in Figure 42.

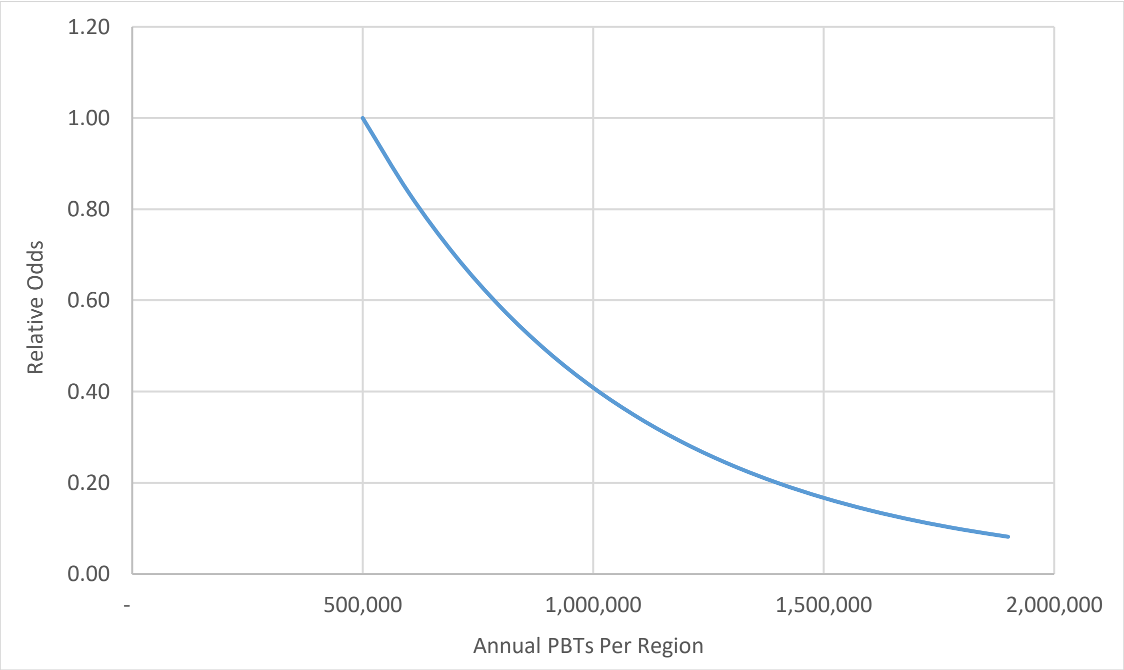

Figure 42 Relative odds of a seriously injured vehicle controller having high-range alcohol levels (BAC≥ 0.15) in their system by annual number of PBTs delivered, per Region

Figure 43 shows the relationship between the positive tests per 1000 PBTs from car and bus testing combined and the relative odds of high range alcohol in a seriously injured driver.

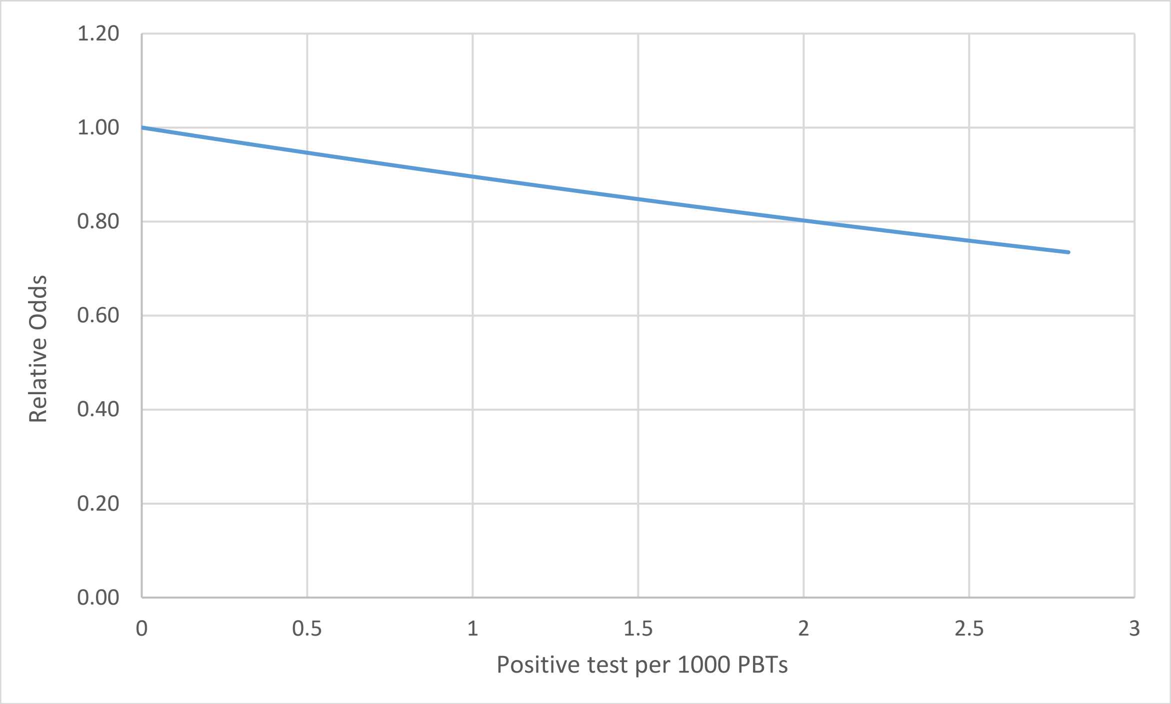

Figure 43 Relative odds of a seriously injured vehicle controller having high-range alcohol levels (BAC≥0.15) in their system by the hit rate, per 1000 alcohol tests

The model for high-range alcohol levels (BAC ≥0.15) in seriously injured vehicle controllers based on car and bus measures separately explained 80% of the variation in the annual counts per Region of seriously injured vehicle controllers detected with high-range alcohol levels. This is about the same as the model with car and bus operations combined suggestions there is not significant difference between car and bus-based operations in their impact on high range alcohol involved serious crashes. Charts of fitted versus observed counts of high-range alcohol level (BAC ≥0.15) affected seriously injured vehicle controllers by Police Region and year, for the model with car and bus operations considered separately are shown in Figure 44.

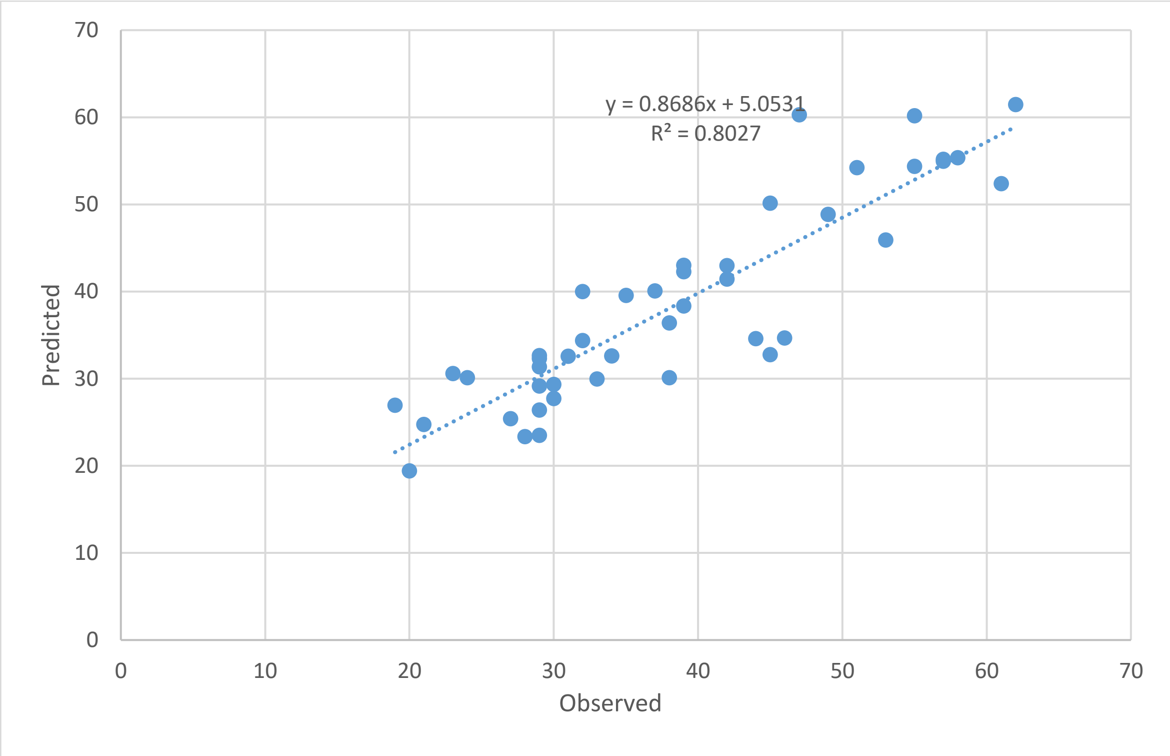

Figure 44 Model fit assessments – High-range alcohol level (BAC ≥0.15) seriously injured vehicle controller counts by year and Region: car and bus operations separate

The relationship between the odds of a seriously injured vehicle controller having a high range BAC and both car and bus based RBTs per region per year are shown in Figures 45 and 46 respectively. As evident, the relationships are very similar reinforcing the comparison of the goodness of fit assessments.

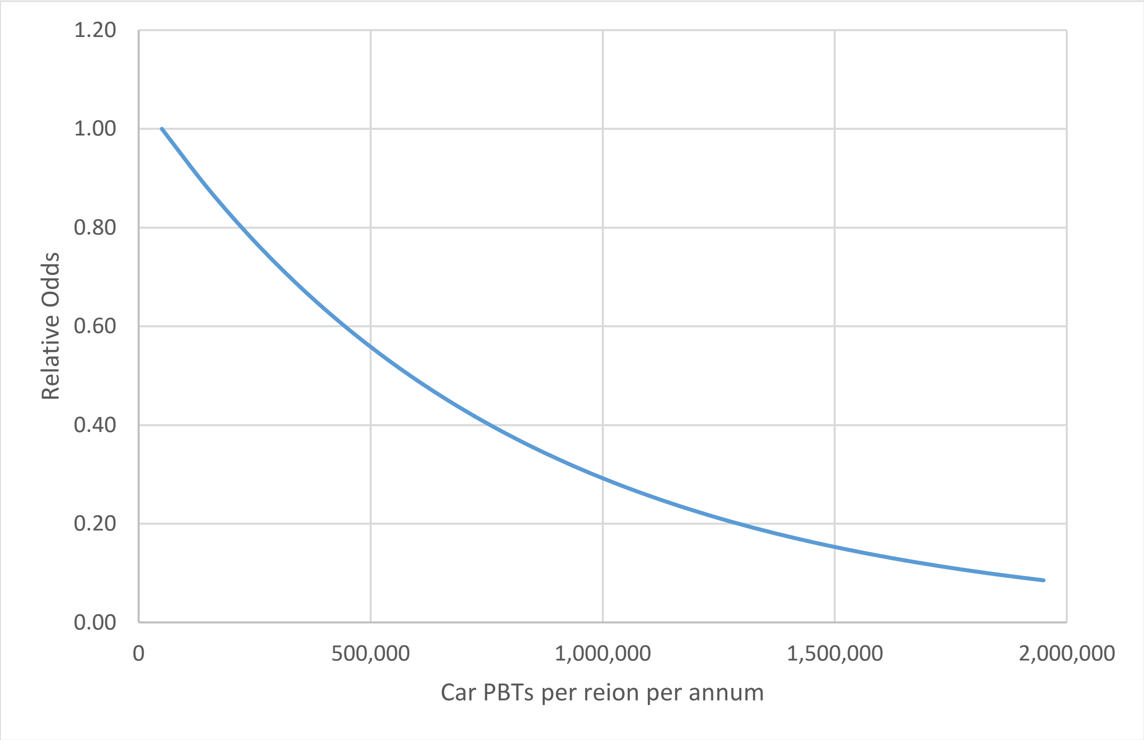

Figure 45 Relative odds of a seriously injured vehicle controller having high-range alcohol levels (BAC≥ 0.15) in their system by annual number of car PBTs delivered, per Region

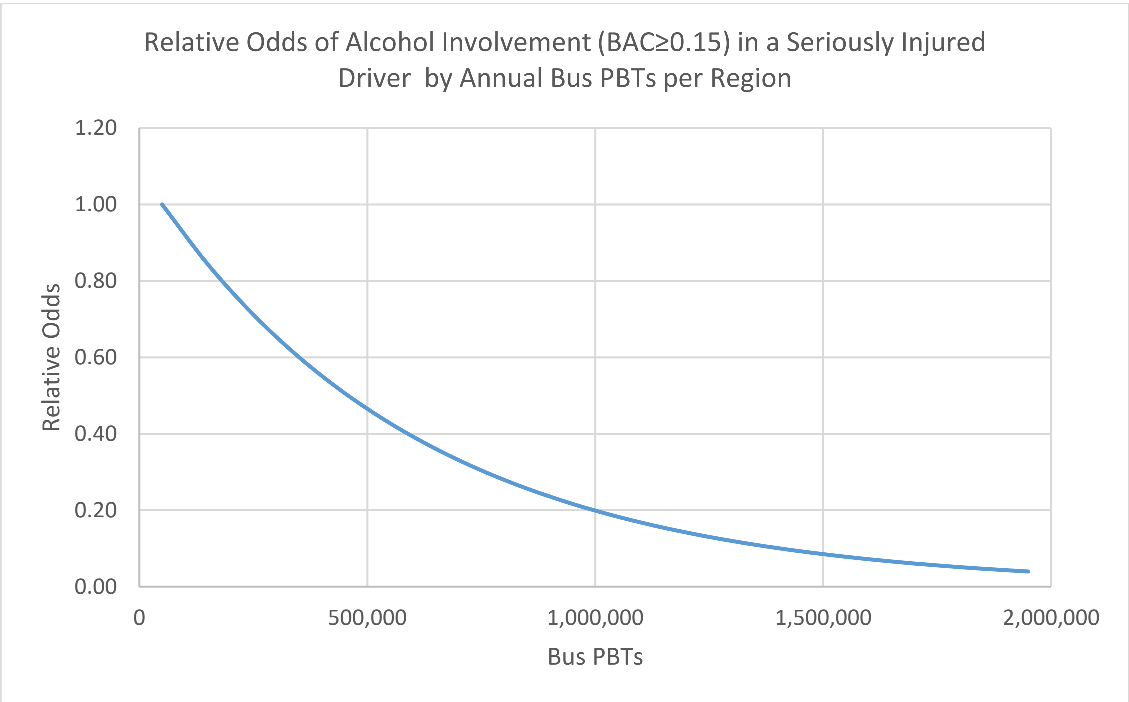

Figure 46 Relative odds of a seriously injured vehicle controller having high-range alcohol levels (BAC≥ 0.15) in their system by annual number of <u>bus</u> PBTs delivered, per Region

There was some marginally statistically significant evidence in Table 18 that the relationship between PBT hit rate and high range alcohol in seriously injured vehicle controllers was driven by the hit rate from bus testing. Since the result did not reach statistical significance, the relationship between bus test hit rate and odds of high range alcohol in seriously injured vehicle controllers has not been presented.

3.2.4.2 Fatal crashes

3.2.4.2.1 Fatally injured vehicle controllers with BAC at or above 0.05mg/L

Estimates of the association, between the proportions of fatally injured crash-involved vehicle controllers with illegal BAC (≥0.05) and (a) the annual number of PBTs and (b) the Hit rate (EBTs per 1000 PBTs), were derived through the application of Equation 1 to the rate of illegal BACs detected in crash-involved fatally injured vehicle controllers. A summary of the estimated odds ratios from the analysis for the alcohol enforcement measures and the associated statistical significance probability are given in Table 19. As before, 2 models were fitted, one considering car and bus delivered tests combine and the other considering each separately.

TABLE 19 SUMMARY RESULTS OF THE TWO MODELS USED TO ASSESS THE RELATIONSHIP BETWEEN ALCOHOL ENFORCEMENT AND THE PRESENCE OF ILLEGAL ALCOHOL LEVELS (BAC≥0.05), IN FATALLY INJURED CRASH VEHICLE CONTROLLERS

OUTCOME VARIABLE	INPUT VARIABLES	SIGNIFICANCE	Relative Odds Per Unit Input Change
	Car and Bus Operations Combined		
All illegal alcohol involvement ≥0.05	Number of PBTs (1000s)	0.196	0.999 (0.998, 0.997)
	EBTs per 1000 PBTs ('Hit rate')	**0.016**	**0.845** (0.737, 0.970)
	Car and Bus Operations Separate		
All illegal alcohol involvement ≥0.05	Number of Car-based PBTs (1000s)	0.764	1.000 (0.998, 1.002)
	Number of Bus-based PBTs (1000s)	**0.002**	**0.997** (0.995, 0.999)
	Car-based EBTs per 1000 PBTs ('Car hit rate')	0.281	1.064 (0.951, 1.191)
	Bus-based EBTs per 1000 PBTs ('Bus hit rate')	**0.046**	**0.750** (0.565, 0.995)

No statistically significant relationship was found between illegal alcohol involvement (BAC ≥0.05) in fatally injured vehicle controllers and total number of PBTs from both car and bus-based operations combined. However, when analysed separately by car and bus delivery, a statistically significant relationship was found for the bus-based PBTs delivered. For every 1000 additional PBTs delivered through bus-based operations, the estimated odds of an illegal BAC (≥0.05%) being detected in a fatally injured vehicle controller reduced by 0.3%.

A statistically significant relationship was found between 'hit rate' (EBTs per 1000 PBTs) and all illegal alcohol involvement (BAC ≥0.05) involvement. Odds of all illegal alcohol involvement (BAC≥0.05) in a fatally injured vehicle controller detected in a roadside alcohol testing operation were found to decrease by 15.5% with every 0.1 percentage point increase in the detection rate per roadside alcohol test administered. This statistically significant relationship appears to stem from a very strong association between hit rate from the bus-based testing with a statistically significant 25% reduction in odds of alcohol presence in a fatality for each 0.1 percentage point increase in bus based hot rate. Complete outputs for each model are presented in Appendix E (E1 & E2).

Overall fit of the model of illegal alcohol level in fatally injured vehicle controllers using bus and car-based operation outputs combined is given in Figure 47. It shows the model fitted the data well explaining 84% of the variation in the observed data.

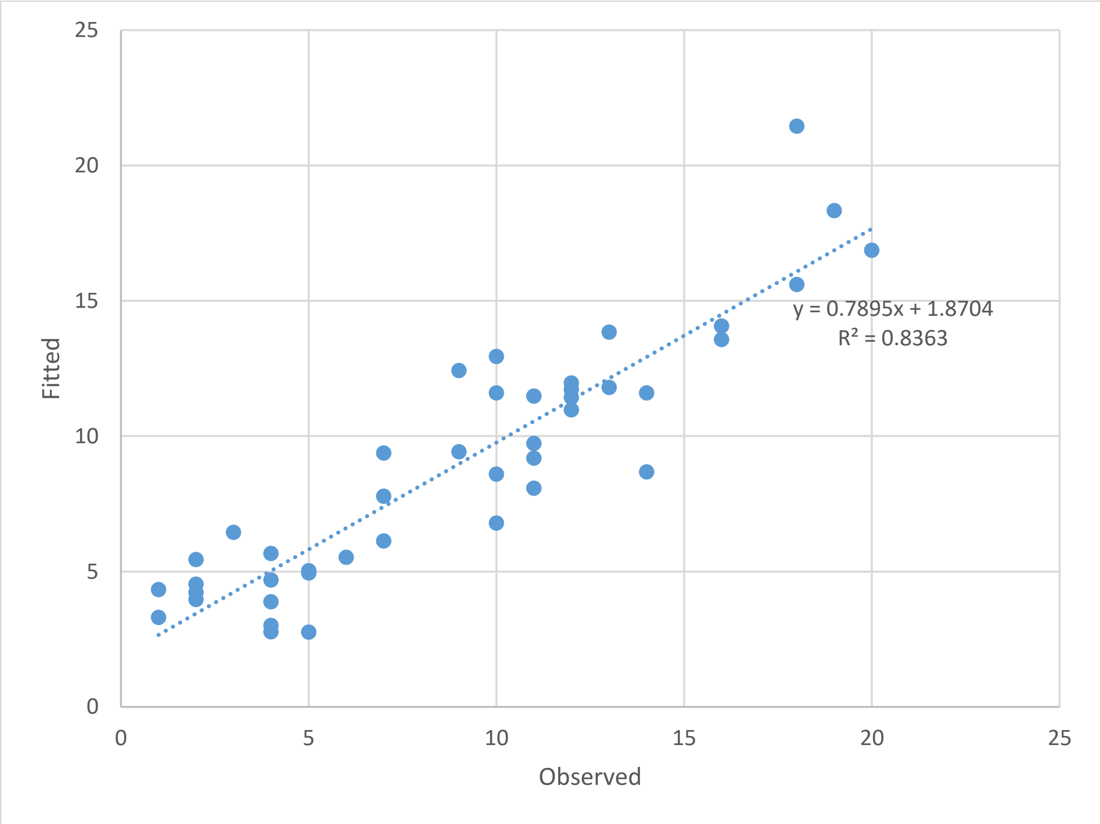

Figure 47 Model fit assessments – Illegal alcohol level (BAC ≥0.05) fatally injured vehicle controller counts by year and Region: car and bus operations combined

Figure 48 shows the relationship between testing hit rate from combined car and bus operations and the odds of illegal alcohol involvement in vehicle controller fatalities.

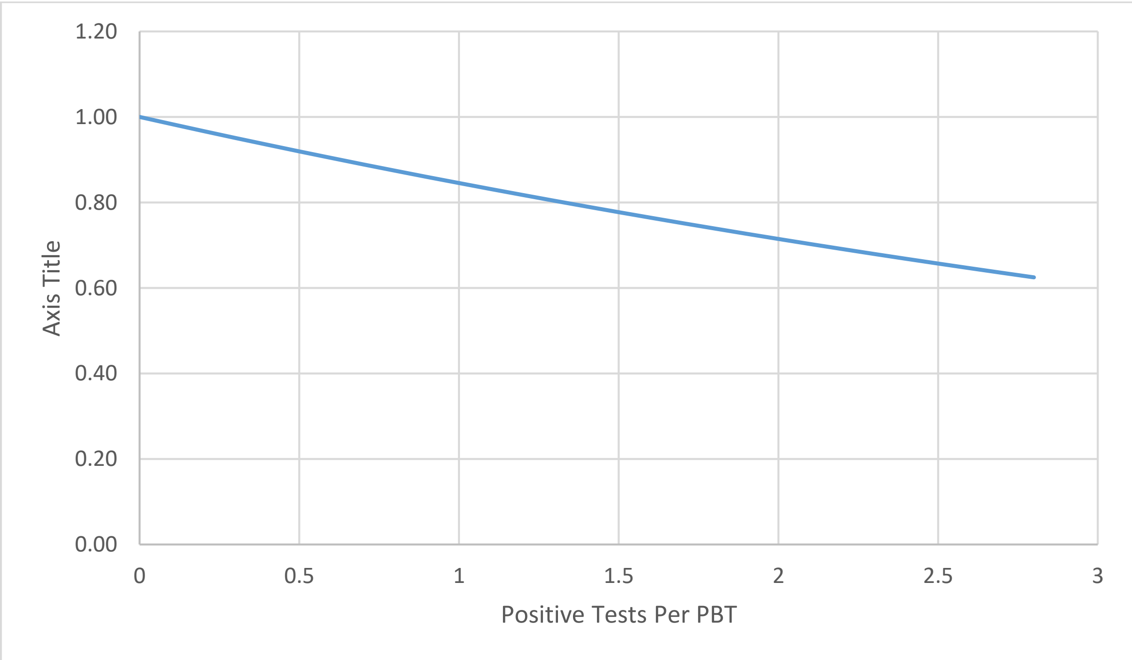

Figure 48 Relative odds of a fatally injured vehicle controller having illegal alcohol levels (BAC≥0.05) in their system by the hit rate, per 1000 alcohol tests: car and bus tests combined

Overall fit of the model of illegal alcohol level in fatally injured vehicle controllers using bus and car-based operation outputs separately is given in Figure 49. It shows the model fitted the data better than for the model using combined car and bus operations, explaining 90% of the variation in the observed data. This result suggests a significant difference in the relationship between car and based testing and fatally injured vehicle controller alcohol involvement.

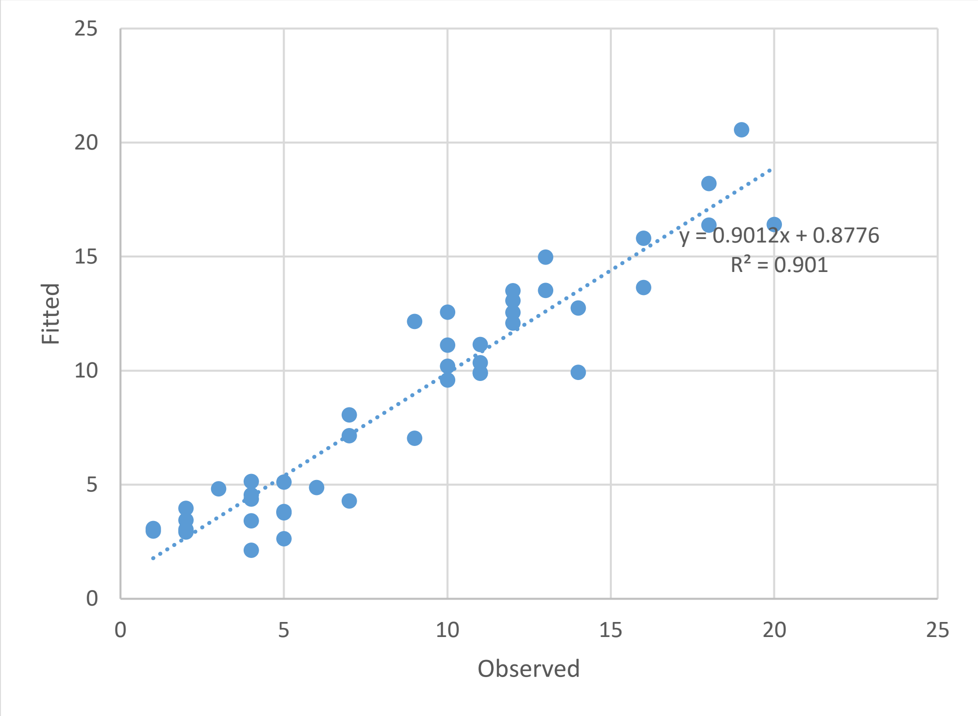

Figure 49 Model fit assessments – Illegal alcohol level (BAC ≥0.05) fatally injured vehicle controller counts by year and Region: car and bus operations combined: car and bus operation separate

The relationship between the relative odds of illegal level alcohol (BAC ≥0.05) detection in fatally injured vehicle controllers and bit number of tests and hit rate from bus-based operations is illustrated in Figure 50 and Figure 51 respectively.

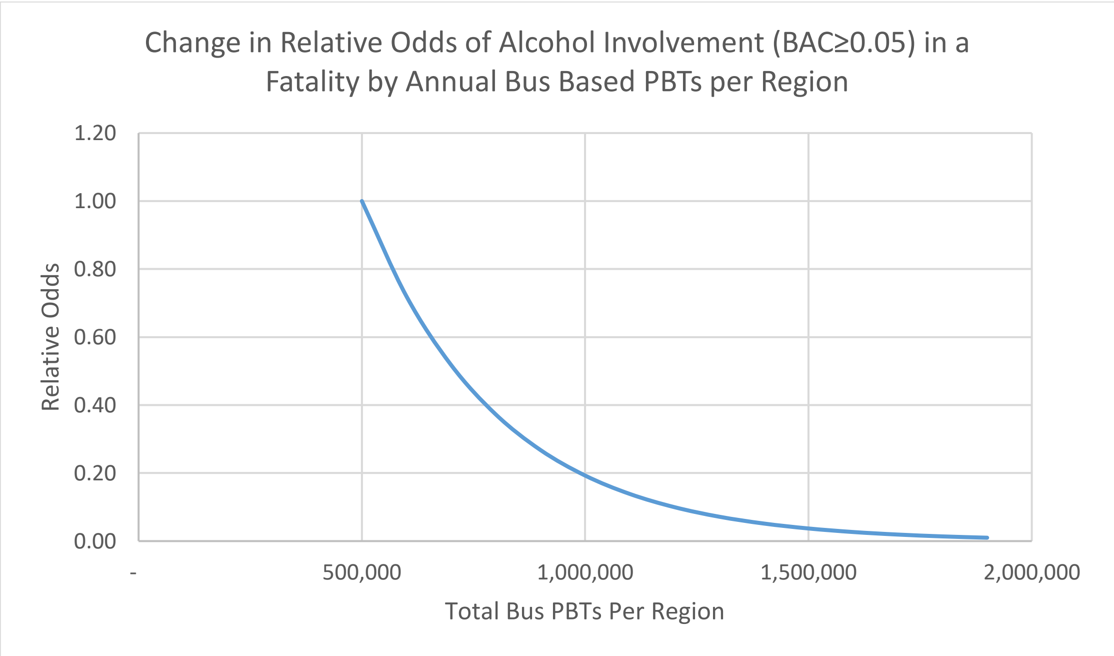

Figure 50 Relative odds of a fatally injured vehicle controller having illegal alcohol levels (BAC≥0.05) in their system by annual number of PBTs delivered, per Region, bus-based operations

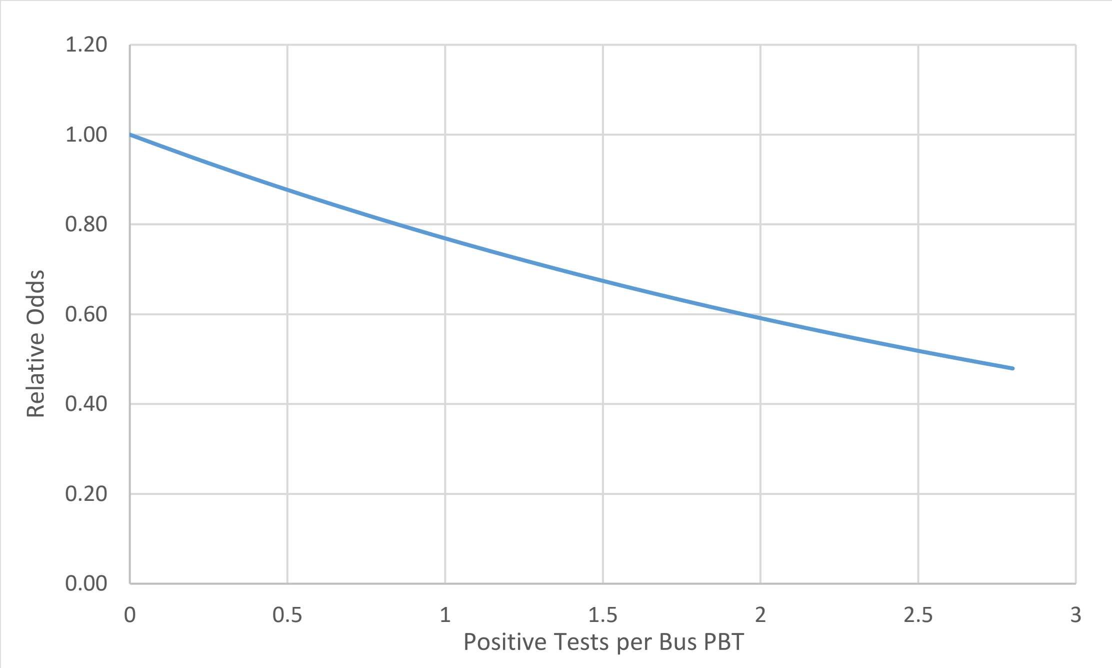

Figure 51 Relative odds of a fatally injured vehicle controller having illegal alcohol levels (BAC≥0.05) in their system by the hit rate, per 1000 alcohol tests, bus-based

3.2.4.2.2 Fatally injured vehicle controllers with BAC at or above 0.15mg/L (high-range)

Estimates of the association, between the proportions of fatally injured crash-involved vehicle controllers with high range BAC (≥0.15) and (a) the annual number of PBTs and (b) the Hit rate (EBTs per 1000 PBTs), were derived through the application of Equation 1 to the rate of high-range BACs detected in crash-involved fatally injured vehicle controllers. A summary of the estimated odds ratios from the analysis for the alcohol enforcement measures and the associated statistical significance probability are given in Table 19 for the 2 models fitted (car and bus delivered tests combined and each separately).

TABLE 20 SUMMARY RESULTS OF THE MODELS USED TO ASSESS THE RELATIONSHIP BETWEEN ALCOHOL ENFORCEMENT AND THE PRESENCE OF HIGH- RANGE ALCOHOL LEVELS (BAC≥0.15), IN FATALLY INJURED CRASH VEHICLE CONTROLLERS

OUTCOME VARIABLE	INPUT VARIABLES	SIGNIFICANCE	Relative Odds Per Unit Input Change
	Car and Bus Operations Combined		
Alcohol Involvement ≥0.15 (High Level)	Number of PBTs (1000s)	0.981	1.000 (0.998, 1.002)
	EBTs per 1000 PBTs ('Hit rate')	0.056	0.851 (0.720,1.004)
	Car and Bus Operations Separate		
Alcohol Involvement ≥0.15 (High Level)	Number of Car-based PBTs (1000s)	0.479	1.001 (0.999, 1.003)
	Number of Bus-based PBTs (1000s)	0.201	0.998 (0.996, 1.001)
	Car-based EBTs per 1000 PBTs ('Car hit rate')	0.436	1.058 (0.918, 1.218)
	Bus-based EBTs per 1000 PBTs ('Bus hit rate')	0.134	0.769 (0.545, 1.085)

Whilst none of the estimates in Table 20 reached statistical significance, the pattern of estimated odds ratios is highly consistent with the analysis of fatally injured vehicle controllers of all illegal blood alcohol levels analysed in the previous section. When considering car and bus tests combined, the testing hit rate is most strongly associated with high range blood alcohol levels in killed vehicle controllers with the estimate being marginally statistically significant. In addition, the separate analysis of car and bus operations shows the strongest effects associated with the outcome are with bus tests and hit rate, as with the all illegal alcohol analysis. There is also a high degree of consistency in the estimated odds ratios between the two outcomes.

For completeness, the following charts give the model fits for the analysis with car and bus outcomes combined (Figure 52) and for car and bus measures separately (Figure 54). The relationship between PBT hit rate and the odds of high range alcohol in a fatally injured vehicle controller is presented in Figure 53 whilst the relationship between this outcome and bus tests delivered per region each year and the hit rate from bus tests are given in Figures 55 and 56.

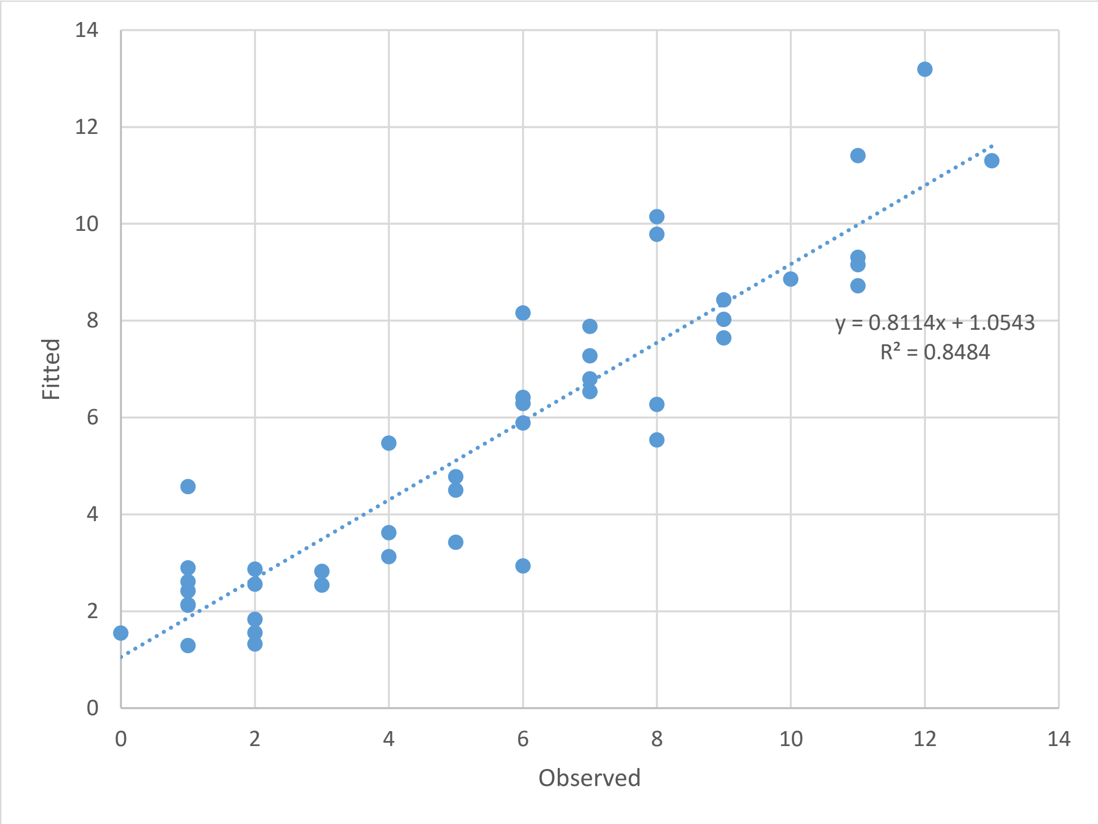

Figure 52 Model fit assessments – High-range alcohol level (BAC≥0.15) fatally injured vehicle controller counts by year and Region: car and bus combined

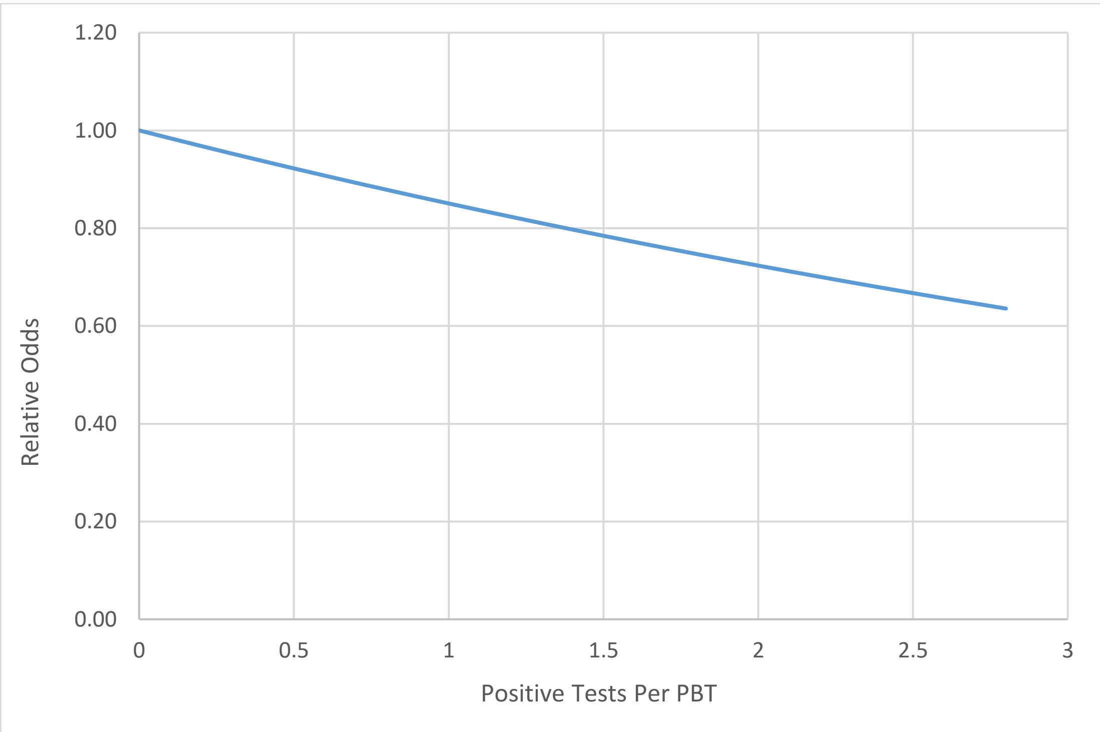

Figure 53 Relative odds of a fatally injured vehicle controller having high-range alcohol levels (BAC≥0.15) in their system by the hit rate, per 1000 alcohol tests: car and bus combined

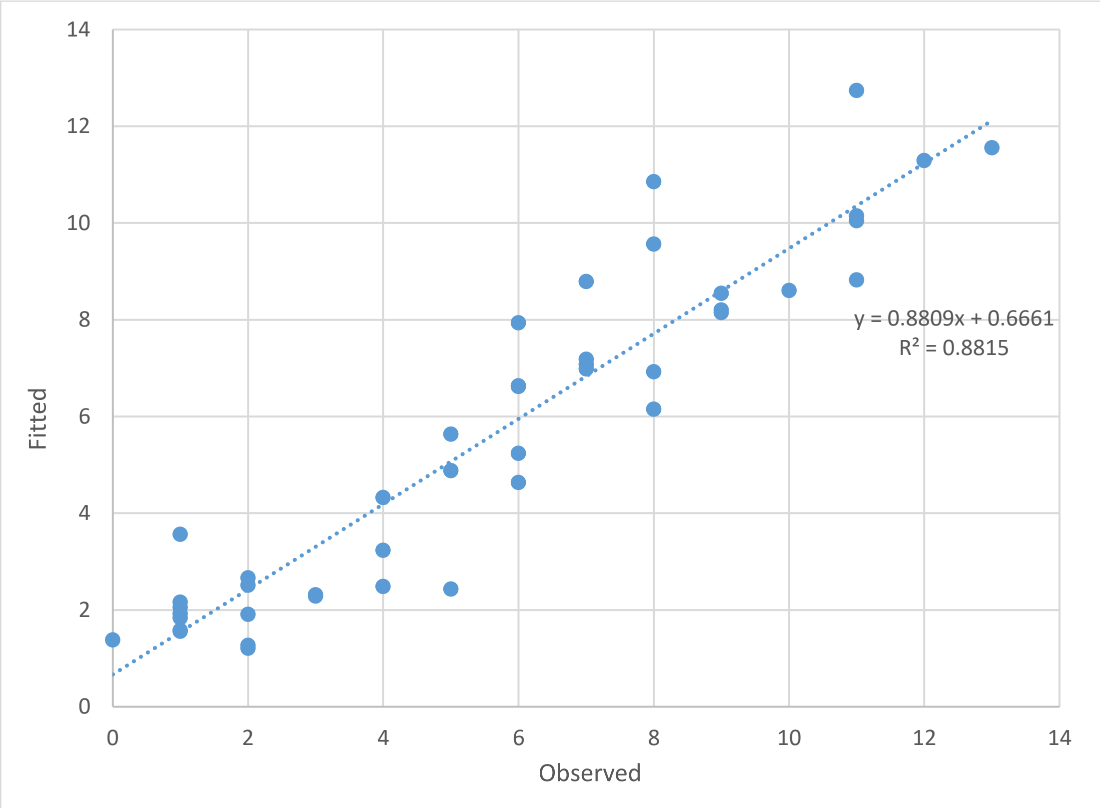

Figure 54 Model fit assessments – High-range alcohol level (BAC≥0.15) fatally injured vehicle controller counts by year and Region: car and bus-separate

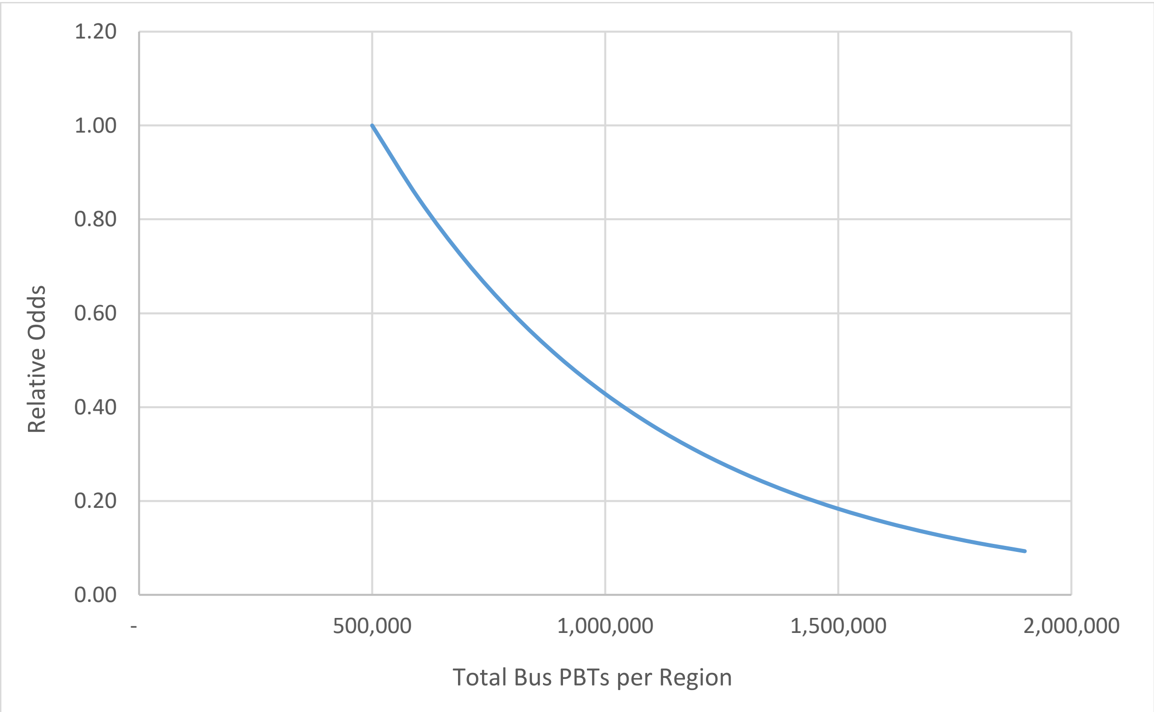

Figure 55 Relative odds of a fatally injured vehicle controller having high-range alcohol levels (BAC≥0.15) in their system by annual number of PBTs delivered, per Region, bus-based

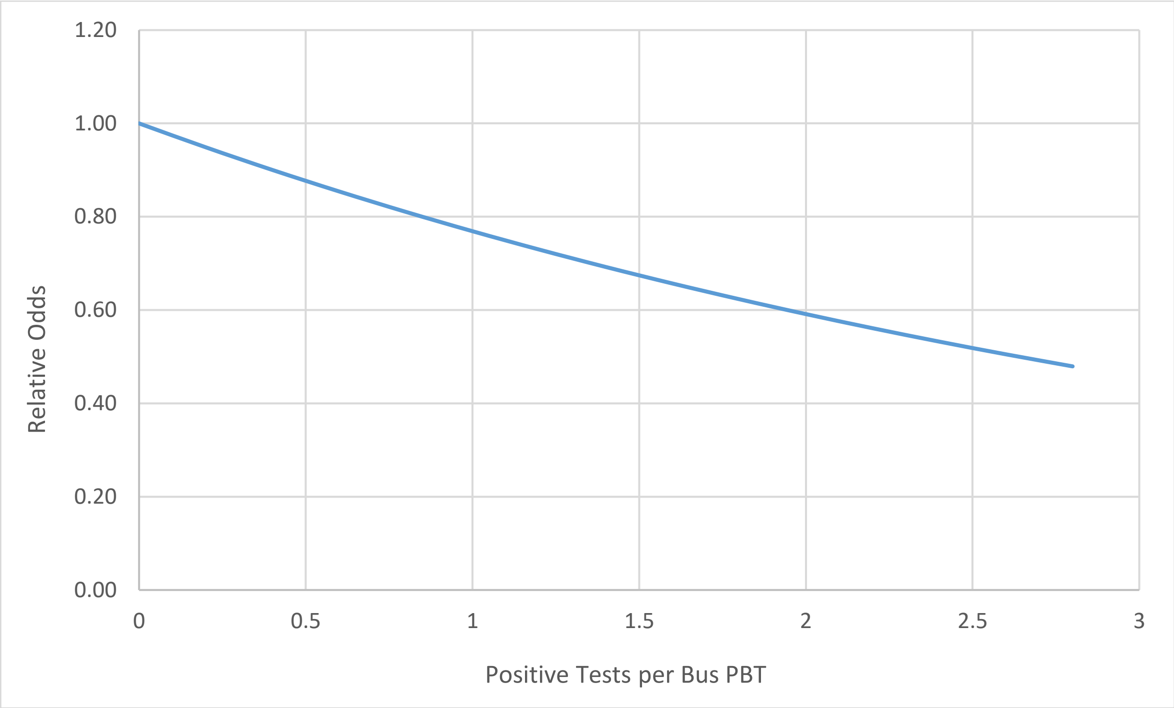

Figure 56 Relative odds of a fatally injured vehicle controller having high-range alcohol levels (BAC≥0.15) in their system by the hit rate, per 1000 alcohol tests, bus-based

4 HIGH AND LOW DRUG AND ALCOHOL HOURS

Victorian drink driving related road safety measures, many research studies and enforcement resourcing, have relied on the calculation of high and low alcohol hours, based on times of the day and days of the week associated with alcohol involved crashes. Originally developed by South (cited in Haque & Cameron, 1987) and later refined by Harrison (1990), high alcohol times of the week were determined by examining the crashes in which vehicle controller Blood Alcohol Concentrations (BACs) were known and finding those periods that had a relatively high proportion of vehicle controllers with a BAC greater than 0.05g/100ml. The only revision of these original hours occurred back in 1995 in Gantzer's analysis that explored high and low alcohol hours from a metro - rural comparison. MUARC did attempt to review these hours in 2008 but limitations in the availability of crash data with accurate BAC reporting preventing this from occurring. The following section outlines the analysis undertaken to identify current high and low alcohol hours in Victoria.

4.1 Data preparation

The same data used in the previous chapters to evaluate drug and alcohol enforcement effects was used for this analysis into high and low alcohol times for Victoria. Namely, TIS drug and alcohol affected crash information merged with TAC validated RCIS crash data. The original high and low alcohol calculations were based on all casualty crashes. However, this analysis has been based on crashes with seriously injured vehicle controllers for the years 2006 to 2016. Focus on serious injury crashes is justified by these crashes being a focus of the road safety strategy in Victoria. In addition, for the analysis presented here there were sufficient numbers of seriously injured vehicle controllers with and without drug and alcohol involvement to produce meaningful analysis results.

For analysis presented in this section, the data was structured differently. Records were retained at a unit level where one case corresponds to one seriously injured driver. Each record held information on the location of the crash, the time of day, day of the week, and any test result recorded for drugs and alcohol.

Figures 57, 58 and 59 show the percentage of seriously injured vehicle controllers with positive levels of alcohol, THC and Methamphetamine respectively by time of day and day of week for the full 11 years of data available. On inspection, across all times of the day alcohol involvement is seen to be most prevalent in the early hours of the morning (1am to 5am), with particularly high prevalence on weekend days (Saturday and Sunday), peaking at over 50% (see Figure 57).

Drug prevalence times do not appear to be as clearly demarcated as alcohol times. Weekend peaks are still apparent but overall the figures are much more sporadic, although similarly to alcohol, peaks are noted in the early hours of the morning most notably on Wednesday morning (see Figures 58 & 59).

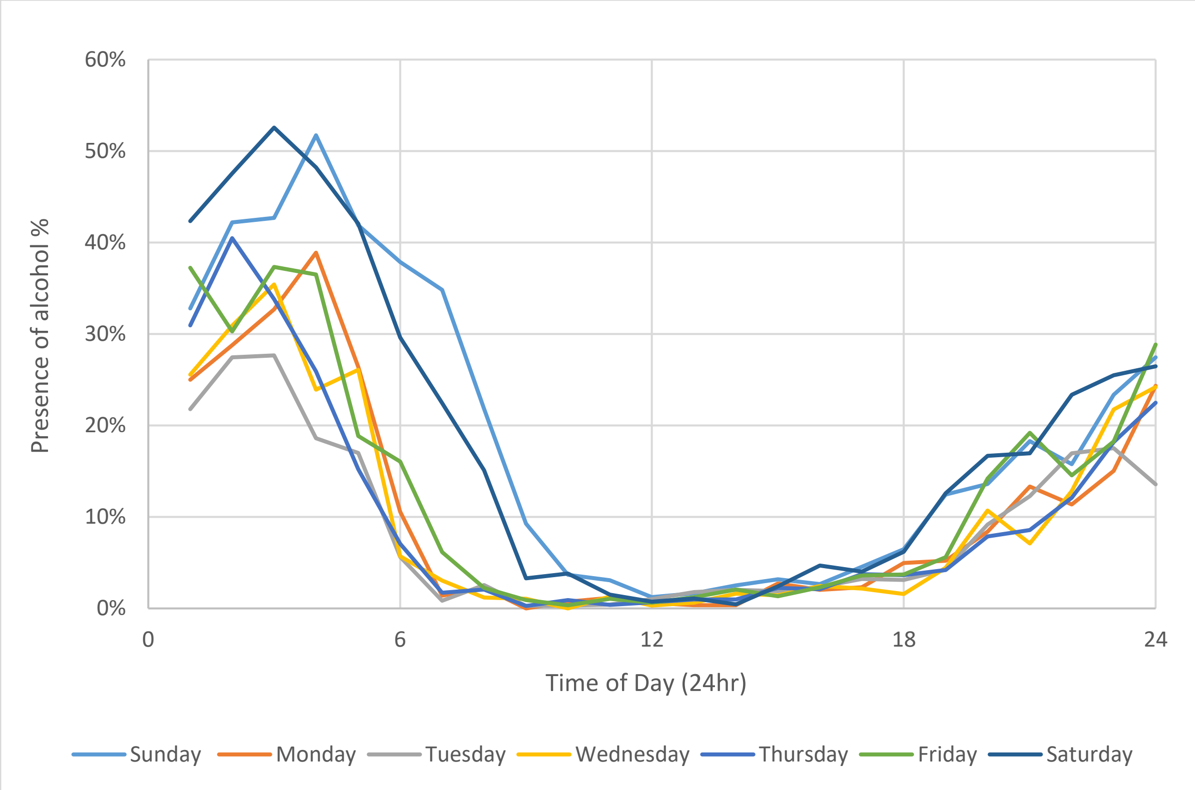

Figure 57 Presence of alcohol (BAC≥0.05) in seriously injured vehicle controllers by time of day and day of week, Victoria 2006-2016

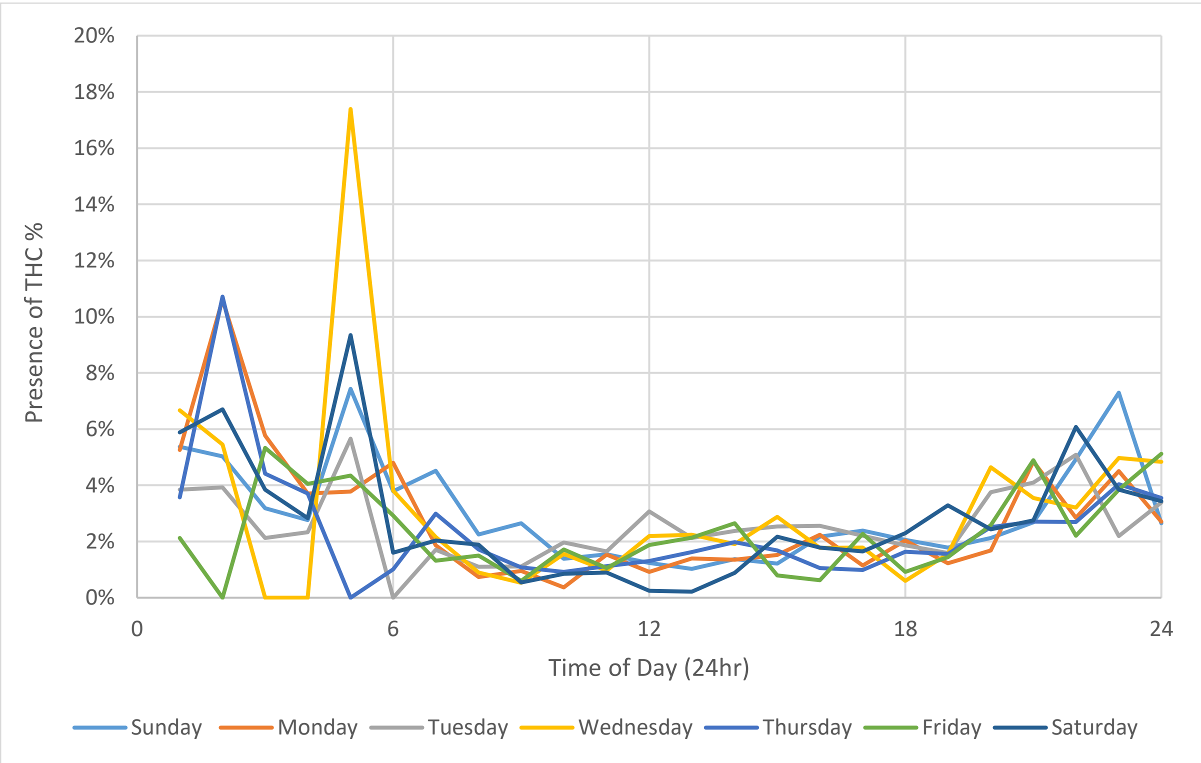

Figure 58 Presence of THC in seriously injured vehicle controllers by time of day and day of week, Victoria 2006-2016

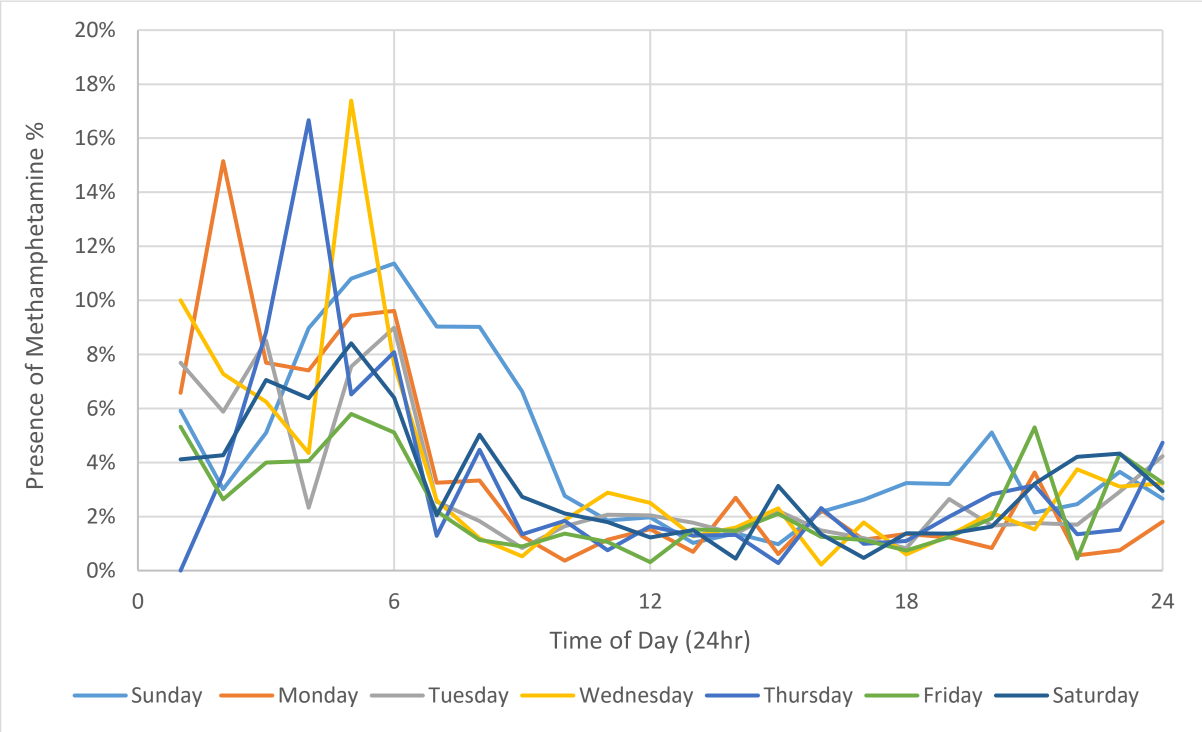

Figure 59 Presence of Methamphetamines in seriously injured vehicle controllers by time of day and day of week, Victoria 2006-2016

4.2 Analysis approach

The Methodology employed in previous evaluations of high and low alcohol times established proportions of vehicle controllers with an illicit BAC (as displayed in Figure 60) and applied a chosen threshold proportion above which times of day/ day of week are defined as high alcohol times/days.

Figure 60 illustrates the principle of this Methodology by applying it with a nominal threshold of 20% to the data available for this current evaluation. With this approach, any hour of day/day of week in which 20% or more of seriously injured vehicle controllers have a BAC of 0.05 or greater is considered a High Alcohol Hour (HAH).

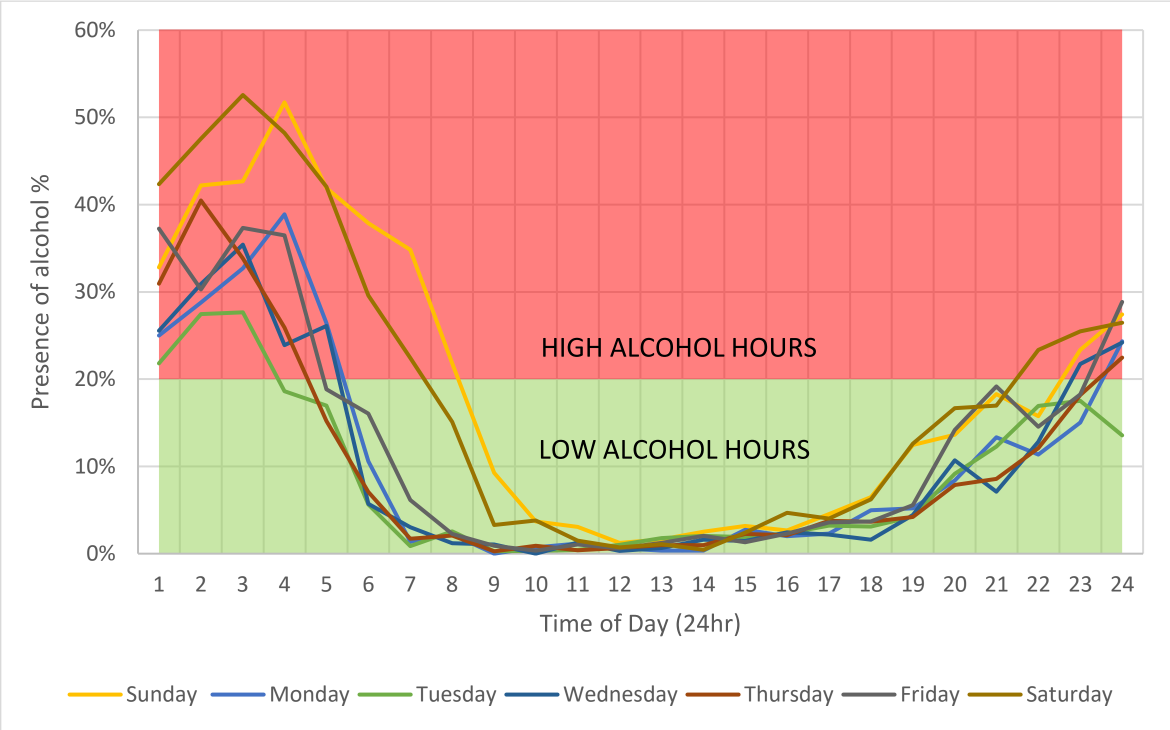

Figure 60 Presence of alcohol (BAC≥0.05) in seriously injured vehicle controllers by time of day and day of week, Victoria 2006-2016, illustrating previous Method for defining high and low alcohol hours

A limitation of this previous Methodology is its inability to justify the choice of partitioning threshold. In Harrison's (1990) original work this threshold was chosen purely to ensure the data was split into two evenly numbered groups.

To overcome this limitation a new, more robust Methodology has been developed. The new Methodology uses a logistic regression model of the form:

$$logit(p) = \alpha + \beta_y + \gamma\, DAY + \delta\, TIME + \varepsilon\, DAY * TIME \ldots \text{(Equation 1)}$$

Where:

p	is the probability of a seriously injured vehicle controller having a BAC≥0.05
DAY	is the day of the week, holding 7 unique values for each day of the week
$TIME$	is the time of day, holding 24 unique values for each hour of the day
β_y	is the year effect parameter for year *y*
α, Υ, δ and ε	are model parameters

The model is used to produce a probability of alcohol involvement for each case (a seriously injured driver) in the context of the whole ten year set of data and the chosen input variables. Values of model sensitivity (rate of true positives being identified) and specificity (rate of true negatives being identified) for each classification probability cut-off level (i.e. the predicted probability above which the case is classified as likely to be alcohol involved) can be plotted to give a receiver operating characteristic (ROC) curve, as shown in Figure 61. The inflection point of this curve (point at which the curve direction changes and is furthest away from the 45-degree straight line) represents the probability classification cut-off point with optimal compromise between sensitivity and specificity, i.e. the most accurate in diagnosing the outcome variable; alcohol involvement.

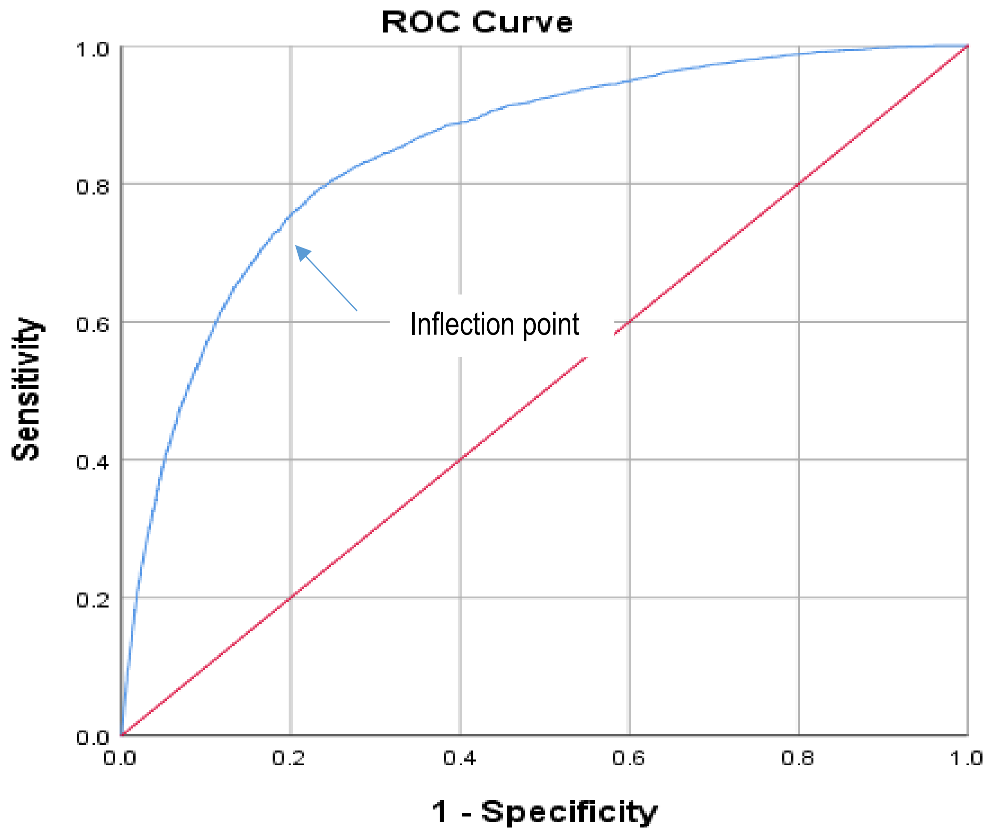

Figure 61 ROC curve produced from logistic regression model for alcohol presence, in seriously injured vehicle controllers

Using the defined cut-off from the ROC analysis, each case is classified as likely alcohol involved by the optimal sensitivity/specificity thresholds. Cases are then cross tabulated by day and time and the mean value of their alcohol classification (1- prone, 0- not prone) is calculated. If the mean predicted probability from the model is greater than 0.5 it means that more often than not, the given day/week combination is predicted to be prone to alcohol involvement. Accordingly, all day/week combinations with a mean value greater than 0.5 are classified as High Alcohol Hours (HAH). Table 21 presents the crosstabulation described and shows how high and low alcohol times are established.

TABLE 21 CROSSTABULATION OF DAY OF WEEK BY TIME OF DAY WITH CELLS POPULATED BY MEAN VALUE OF ALCOHOL CLASSIFICATION

	Hour of day (24hr)																							
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	Mean																							
SUN	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.0	1.0	1.0	1.0	1.0	1.0
MON	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.0	1.0	1.0	1.0
TUES	1.0	1.0	1.0	1.0	1.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.0	1.0	1.0	1.0
WED	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.6	1.0	1.0	1.0
THUR	1.0	1.0	1.0	1.0	1.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.8	1.0	1.0	1.0
FRI	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.0	1.0	1.0	1.0	1.0
SAT	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.0	1.0	1.0	1.0	1.0	1.0

4.3 Analysis results

The Methodology described above was used to establish current high alcohol, THC and Methamphetamine hours for Victoria. High Alcohol Hours were also established specifically for metropolitan Victoria (Melbourne), rural Victoria, and each of the individual four Victoria Police Regions. There was insufficient data available to calculate drug hours to this same level.

4.3.1 High and low alcohol hours: Victoria

As shown in Figure 62, there are 81 hours of the week defined to be High Alcohol Hours for Victoria.

These hours are:

- Sunday 6PM -Monday 9AM
- Monday 7PM -Tuesday 6AM
- Tuesday 7PM -Wednesday 5AM
- Wednesday 7PM -Thursday 5AM
- Thursday 7PM -Friday 5AM
- Friday 7PM -Saturday 6AM
- Saturday 6PM -Sunday 8AM

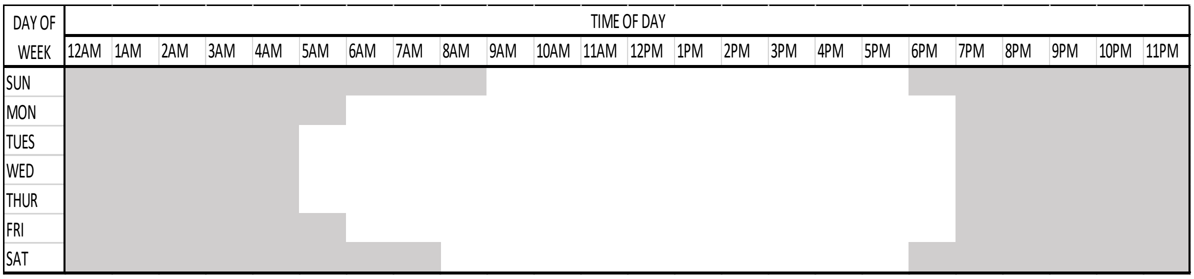

Figure 62 High alcohol hours (shaded grey) for Victoria, based on data from 2006-2016

As shown in grey shading in Table 22, the previously defined HAH for all Victoria spanned 98 hours of a week, whereas the newly analysed data (2006-2016) identifies them spanning 81 hours of the week. The differences in hours are negligible during the week days, typically an hour difference in start and finish times however, the most notable updates occur on Friday and Saturday with HAH now commencing several hours later.

TABLE 22 COMPARISON OF PREVIOUSLY DEFINED HIGH ALCOHOL HOURS (1988-1989) WITH CURRENTLY IDENTIFIED HOURS (2006-2016), ALL VICTORIA

Previous High and low alcohol hours (Harrison, 1988-1989)	Current high and low alcohol calculations (2006 – 2016)
Sunday 4 PM – 6 AM Monday	Sunday 6PM -Monday 9AM
Monday 6 PM – 6 AM Tuesday	Monday 7PM -Tuesday 6AM
Tuesday 6 PM – 6 AM Wednesday	Tuesday 7PM -Wednesday 5AM
Wednesday 6 PM – 6 AM Thursday	Wednesday 7PM -Thursday 5AM
Thursday 6 PM – 6 AM Friday	Thursday 7PM -Friday 5AM
Friday 4 PM – 8 AM Saturday	Friday 7PM -Saturday 6AM
Saturday 2 PM – 10 AM Sunday	Saturday 6PM -Sunday 8AM
Total high alcohol hours – 98 hours	**Total high alcohol hours – 81 hours**

4.3.2 High and low THC hours: Victoria

As shown in Figure 63, there are 100 hours of the week defined to be high THC hours (HTH) for Victoria.

These hours are:

- Sunday 3PM -Monday 9AM
- Monday 3PM -Tuesday 6AM
- Tuesday 11AM -Wednesday 5AM
- Wednesday 11AM -Thursday 5AM
- Thursday 7PM -Friday 4AM
- Friday 11AM -Saturday 5AM
- Saturday 2PM -Sunday 7AM

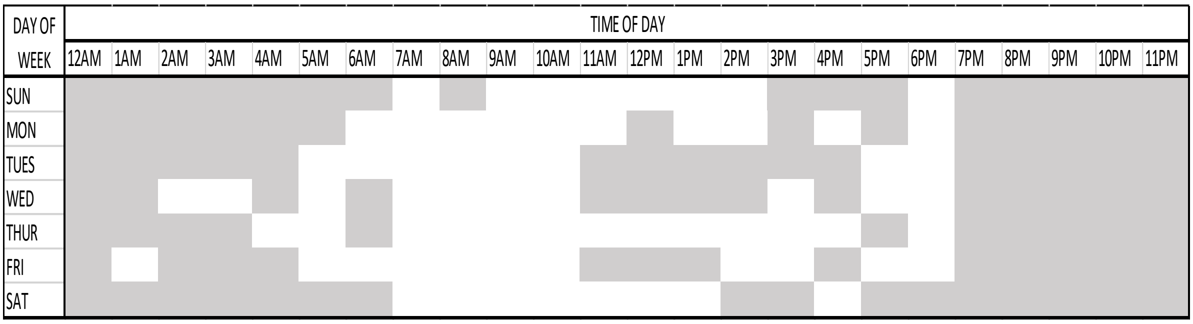

Figure 63 High THC hours (shaded grey) for Victoria, based on data from 2006-2016

Similar to the HAH, estimated HTH shows a pattern evident in the evening hours after 7pm through to the early hours of the morning. Differing from the HAH, there are also periods apparent during the day especially mid to late afternoon. This is the first-time HTH have been calculated so there are no previously defined HTH to compare these latest results with.

4.3.3 High and low Methamphetamine hours: Victoria

As shown in Figure 64, there are 120 hours of the week defined as High Methamphetamine Hours (HMH) for Victoria.

These hours are:

- Sunday 3PM -Monday 12PM
- Monday 3PM -Tuesday 12PM
- Tuesday 1PM -Wednesday 12PM
- Wednesday 1PM -Thursday 12PM
- Thursday 1PM -Friday 10AM
- Friday 6PM -Saturday 7AM
- Saturday 5PM -Sunday 11AM

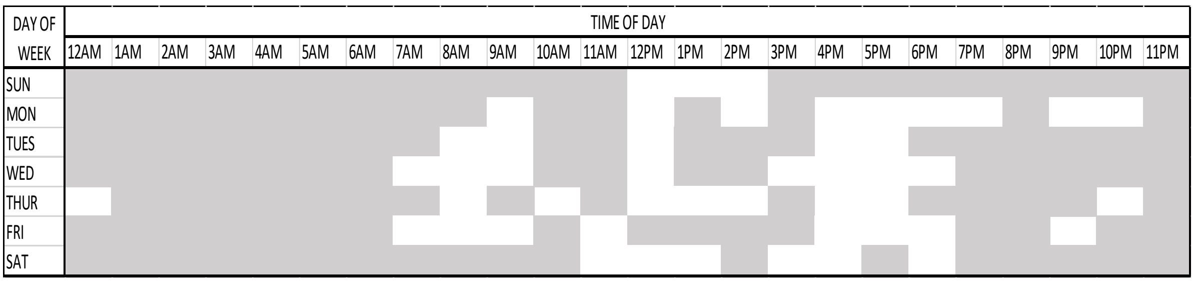

Figure 64 High Methamphetamine hours (shaded grey) for Victoria, based on data 2006-2016

Similar to the high alcohol and high THC hours, there is a pattern of Methamphetamine involved driving evident in the evening hours after 7pm through to the early hours of the morning (Monday evening is less evident). Differing from the high alcohol and THC hours, the High Methamphetamine Hours are consistent across the early mornings to 6am on all days of the week. Of notable difference is that the HMH are evident across the majority of the hours in a day and days of the week, with just a scattering of hours on particular days where this is not the case. This is the first-time HMH have been calculated so there are no previously defined HMH to compare these latest results with.

4.3.4 High and low alcohol hours: Metropolitan Melbourne

As shown in Figure 65, there are 80 hours of the week defined as high alcohol hours for metropolitan Victoria.

These hours are:

- Sunday 6PM -Monday 9AM
- Monday 7PM -Tuesday 6AM
- Tuesday 7PM -Wednesday 5AM
- Wednesday 7PM -Thursday 5AM
- Thursday 7PM -Friday 5AM
- Friday 7PM -Saturday 6AM
- Saturday 6PM -Sunday 8AM

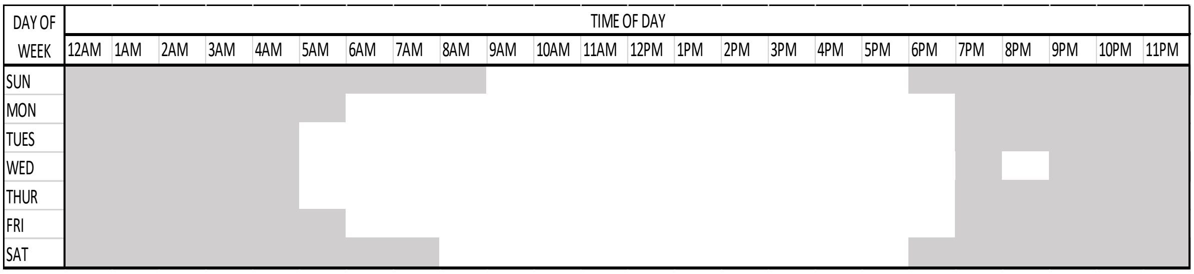

Figure 65 High alcohol hours (shaded grey) for metropolitan Victoria, based on data 2006-2016

4.3.5 High and low alcohol hours: Rest of Victoria

As shown in Figure 66 there are 76 hours of the week defined as high alcohol hours for rural Victoria.

These hours are:

- Sunday 5PM -Monday 8AM
- Monday 8PM -Tuesday 5AM
- Tuesday 7PM -Wednesday 5AM
- Wednesday 7PM -Thursday 5AM
- Thursday 7PM -Friday 4AM
- Friday 7PM -Saturday 5AM
- Saturday 6PM -Sunday 8AM

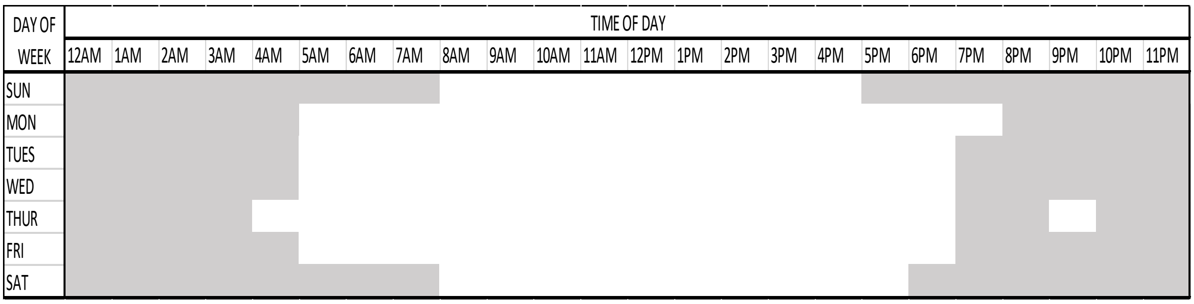

Figure 66 High alcohol hours (shaded grey) for rural Victoria based on data 2006-2016

Break down of the total Victorian HAH (see Figure 62) into Melbourne and rest of Victoria indicates that the overall HAH remain comparable. There are only a couple of slight differences such as: on weekdays the rural HAH tend to cease at 4am (3am Thurs.) compared to 5am (6am Mon. & Fri.); and, on Monday evening the rural HAH commence an hour later at 8pm. Appendix F shows the HAH by Victoria Police Region which are again similar to those estimated for the Victoria as a whole.

5 IMPACT OF POLICE MEMBER TRAINING ON TEST DELIVERY

5.1 Data preparation

To establish the effect of an increase in police member drug test training on drug enforcement, member training records were utilized in conjunction with RDT shift information. Data available on these two elements was provided by Victoria Police that covered the period of 2005 to 2018. Records of member drug testing training were allocated into the region and division in which the member was shown to be based in. Records of members from special operational units like the Heavy Vehicle Unit could not be assigned a divisional location and were not included in analysis.

For most of the data period, counts of members trained at a region/division and month of training level were very low (if not zero). To maintain statistical power and avoid aggregating into higher levels, a cumulative count of the number of members trained was adopted as a measure of capacity for drug testing. As mentioned in the Data Description section of this report (see Section 2.5), there was no way of identifying the movements of a trainee past the time of their training. The assumption that a member maintains their ability for conducting tests in the region/division in which they were trained many years past the date of training is undoubtedly limited. Despite this, the cumulative count is the best approach possible with the information at hand.

Counts of the number of POFTs conducted at a region/division, month-based level was merged on to the training information described. These records had already been prepared in this format for use in the evaluation of roadside drug enforcement on drug involvement in crashes.

5.2 Analysis approach

Only training records relating to drug testing were considered in this analysis. Police members have been receiving training for roadside alcohol testing many years prior to the program RDT expansion in 2015. As such, the effect of alcohol related training on test delivery was not a priority for investigation.

Focusing on drug related training, the analysis employed sought to establish whether there was a relationship between an increase in the number of members trained with an increase in drug test delivery. If so, the aim was then to quantify this relationship.

To undertake this, a simple linear regression model was employed. In this model, number of POFTs delivered was treated as the response variable and cumulative number of police members qualified in RDT was the predictor variable.

Another aspect of interest relating to drug training, was whether an increase in conducting RDT capacity would in turn result in an associated decrease in alcohol testing (RBT), due to the potential prioritising of drug testing over alcohol testing. To test this hypothesis, another linear model was used with cumulative number of members trained as the input variable and number of PBTs delivered as the outcome. For this model, it was only possible to use data aggregated to a region, year level.

5.3 Analysis results

Figure 67 shows that in line with the funding objectives, around the time the expansion was implemented in 2014 there was a sharp rise in the number of police members trained for drug testing.

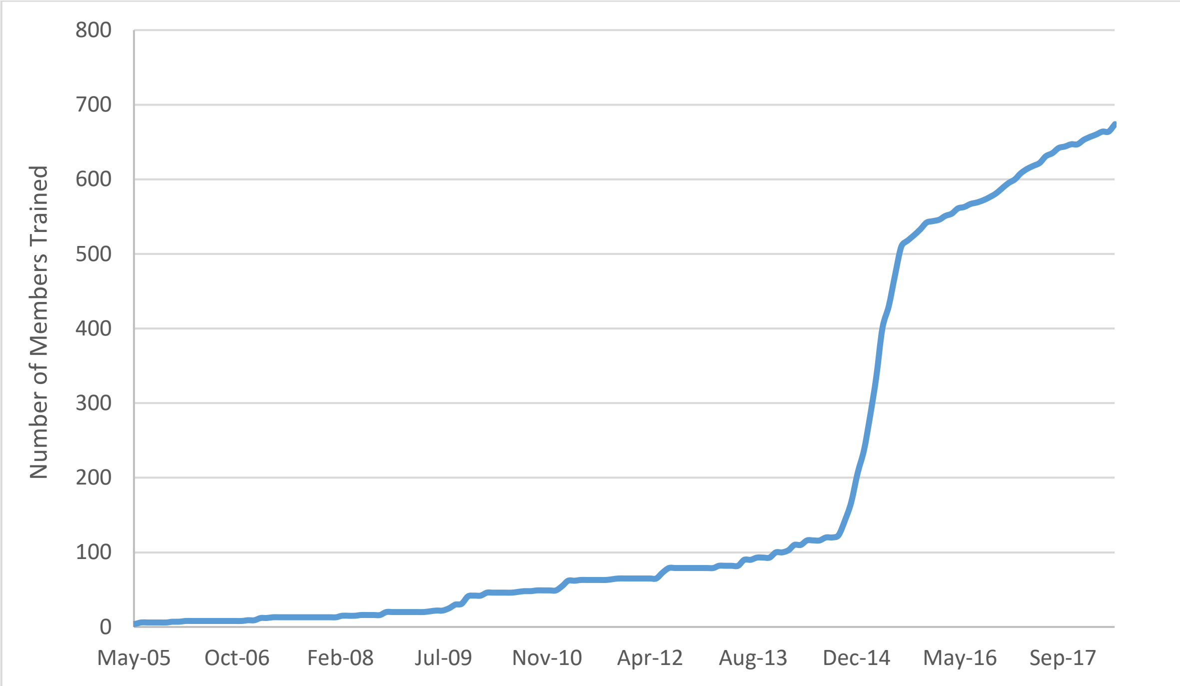

Figure 67 Cumulative number of police members trained for drug testing across all of Victoria, 2005-2018

This increased training (RDT) capacity was reflected in a greater number of RDTs being delivered. Figures 68-71 show the relationship between member training and RDT delivery at a regional level. Note that the data provided had a gap in records for the months of July, August and September 2011. For all regions, there was a spike in the number of POFTs conducted at the time the expansion was implemented and more members were trained. For the metro regions, 2014 reported the peak of drug testing to date. Since then, RDT delivery has remained relatively high. For rural regions, testing has continued to increase, with clear spikes in test delivery around Christmas holiday periods.

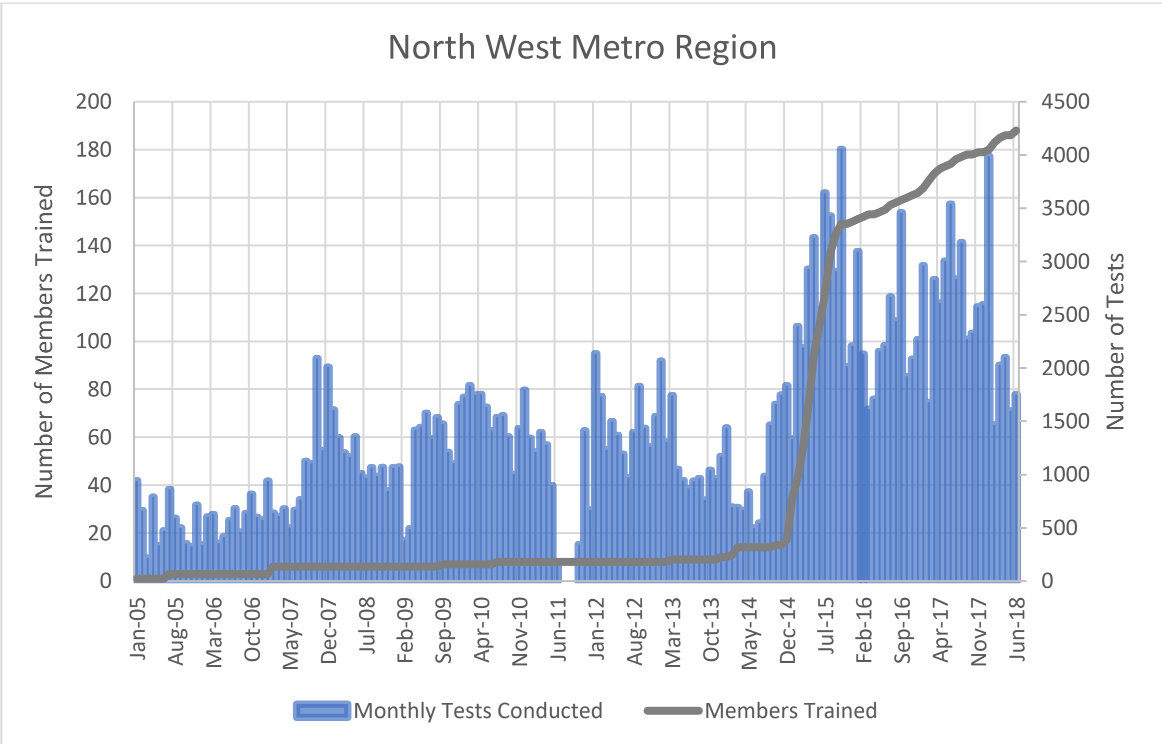

Figure 68 Number of POFTs delivered relating to number of members trained in the North West Metro Region of Victoria, 2005-2018

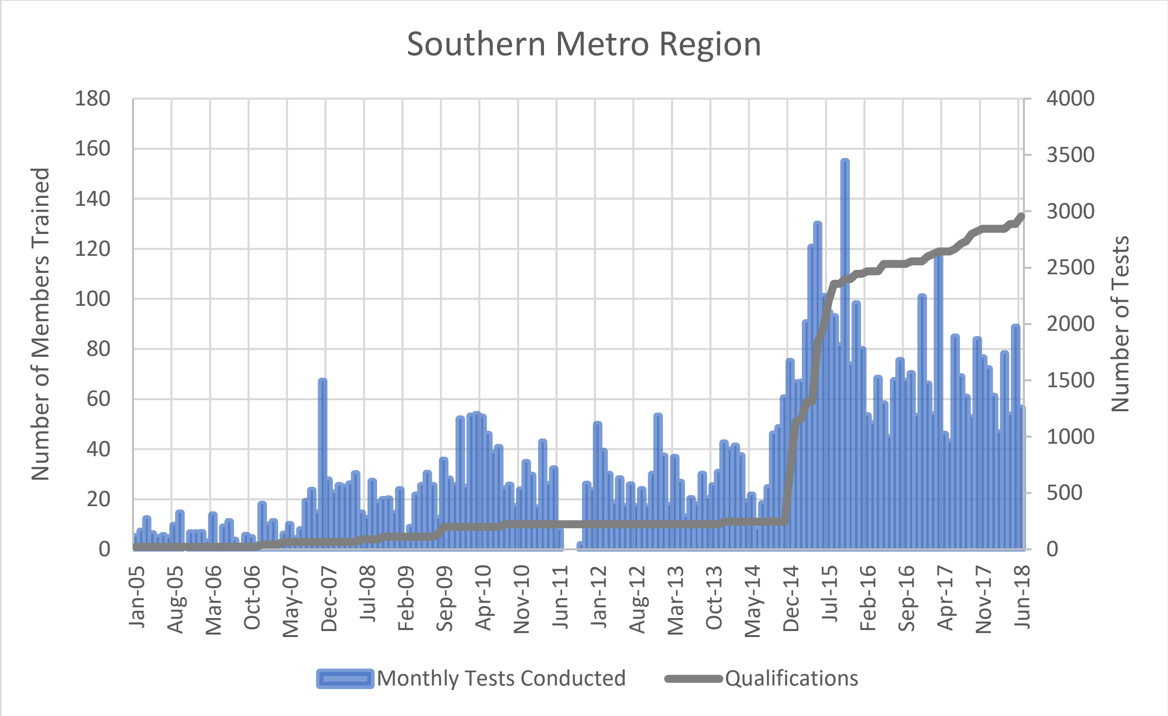

Figure 69 Number of POFTs delivered relating to number of members trained in the Southern Metro Region of Victoria, 2005-2018

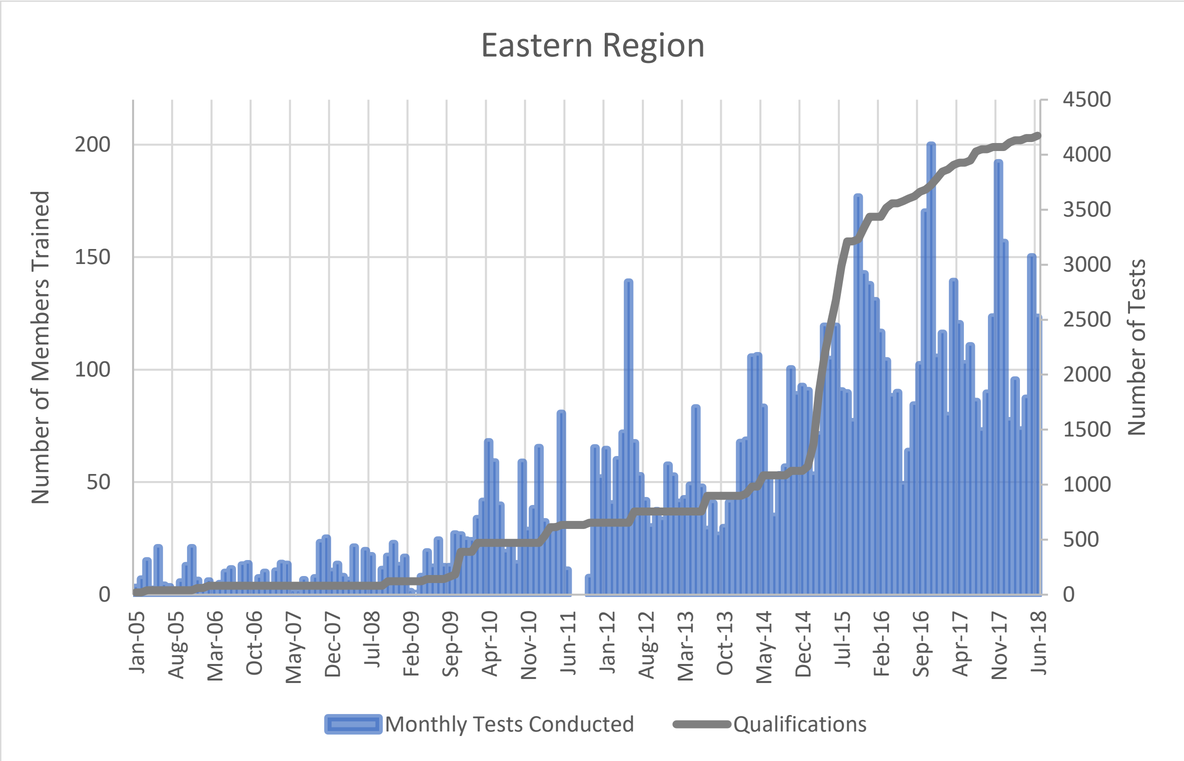

Figure 70 Number of POFTs delivered relating to number of members trained in the Eastern Region of Victoria, 2005-2018

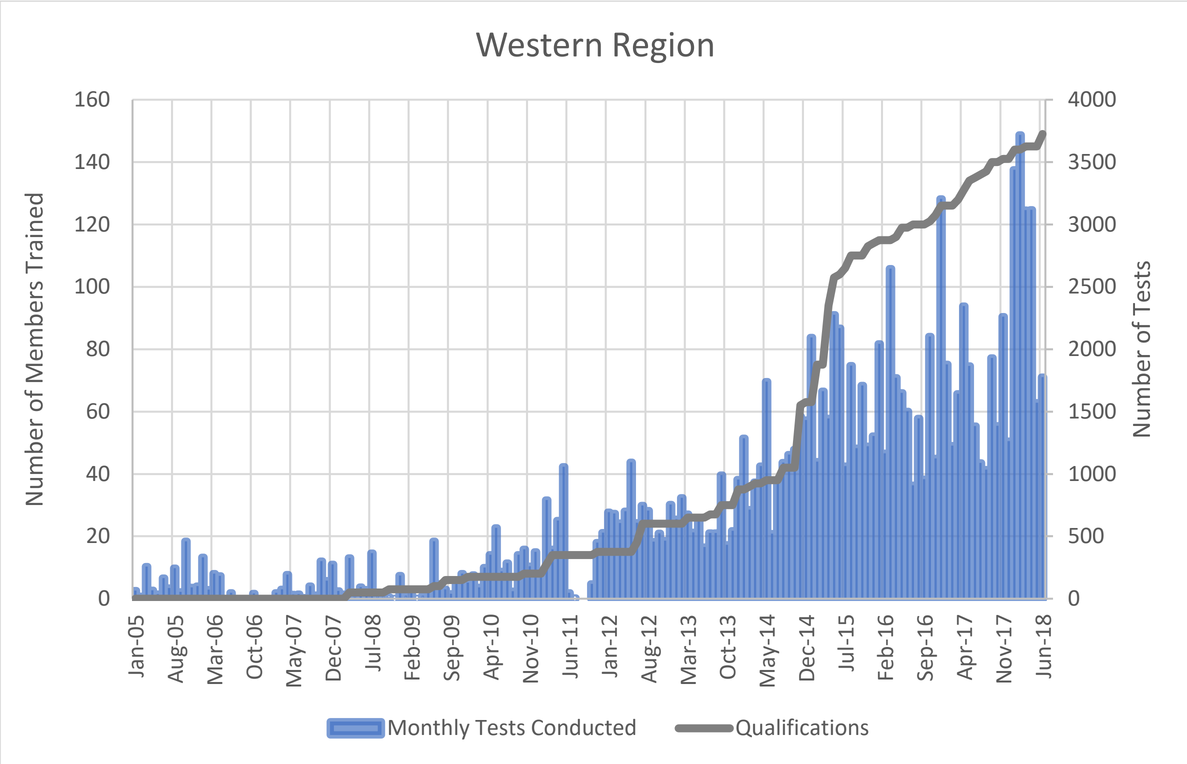

Figure 71 Number of POFTs delivered relating to number of members trained in the Western Region of Victoria, 2005-2018

Figure 72 shows a simple scatter plot of the relationship between number of members qualified and tests delivered with a trend line fitted. The plot clearly confirms the positive trend that more members qualified to conduct RDT is associated with more testing being conducted.

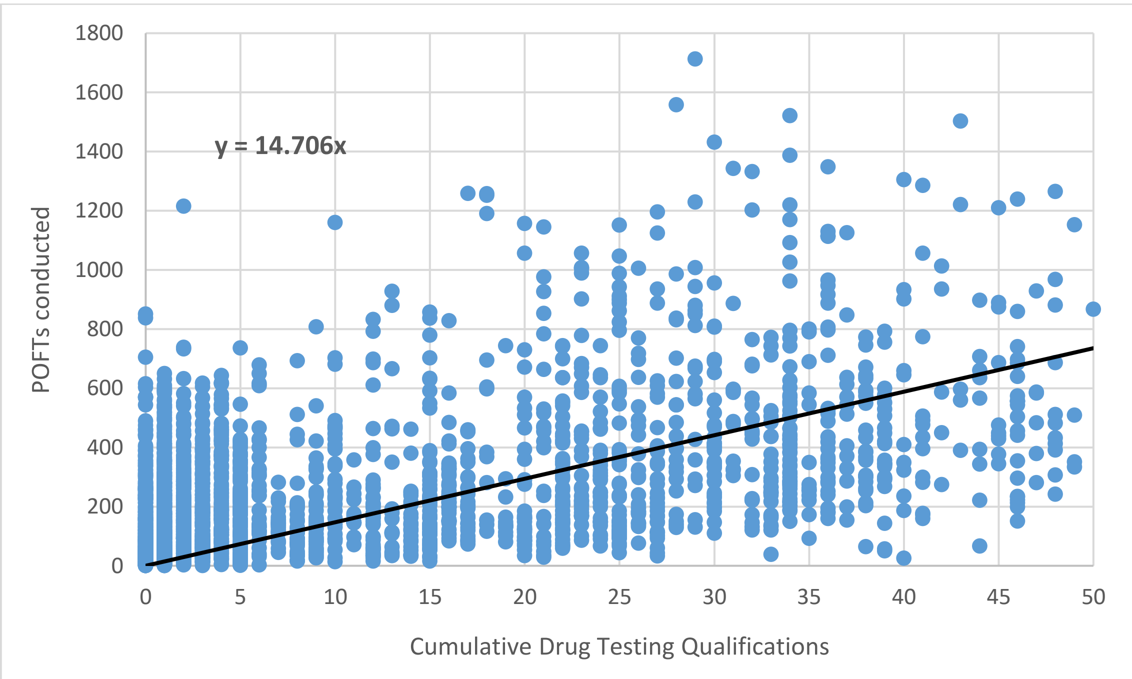

Figure 72 Scatter plot of Cumulative Drug Testing Qualifications by POFTs delivered in Victoria at a Police Division, Month based level, 2005-2018

Table 23 presents outputs of key model values. The slope of the trend line is approximately 15, implying that for an additional member trained, it can be expected that 15 extra tests per month will be delivered. The model is statistically significant and the R-Squared indicated that 54% of the observed variation in the response is explained by the model input.

TABLE 23 OUTPUTS OF LINEAR REGRESSION MODEL OF POFTS CONDUCTED BY CUMULATIVE TESTING QUALIFICATIONS

Predictor Variable	Response Variable	Model Coefficient	Model Significance	R-squared Value
Cumulative Number of Qualifications	Number of POFTs Delivered	14.706	<0.001	0.539

Figure 73 shows a simple scatter plot of the relationship between number of members qualified and roadside alcohol tests delivered. A slight negative trend can be observed but a low number of data points restricts interpretation and model fitting.

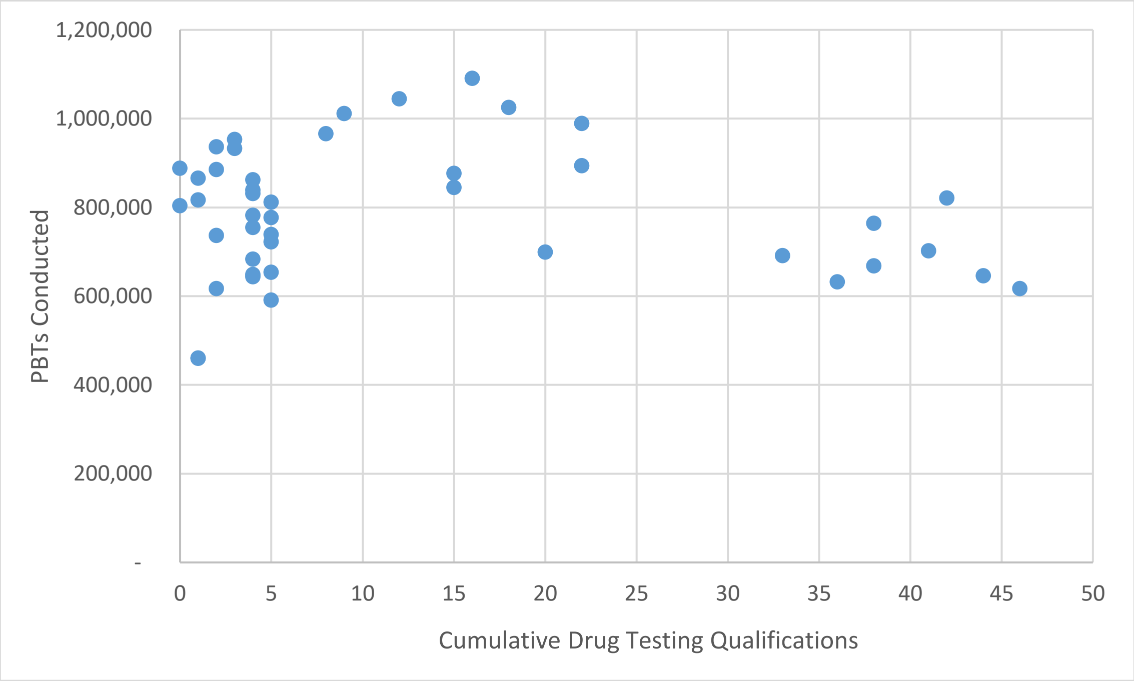

Figure 73 Scatter plot of Cumulative Drug Testing Qualifications by PBTs delivered in Victoria at a Police Region, Year based level, 2006-2016

Table 24 presents outputs of key model values. The slope of the trend line is approximately negative, implying that an increase in drug testing qualifications results in a decrease in roadside alcohol test delivery. However, this relationship is far from statistically significant and the R-squared value of the model is very poor leading to the conclusion of no association between member training for drug testing and the number of PBTs delivered.

TABLE 24 OUTPUTS OF LINEAR REGRESSION MODEL OF CUMULATIVE DRUG TESTING QUALIFICATIONS BY PBTS DELIVERED

Predictor Variable	Response Variable	Model Coefficient	Model Significance	R-squared Value
Cumulative Number of Qualifications	Number of PBTs Delivered	-1205.116	0.452	0.014

To further investigate the impact of the drug program expansion on alcohol testing, the direct relationship between alcohol test delivery and drug test delivery was investigated. Figure 74 shows a simple scatter plot of the relationship between number of POFTs conducted and number of PBTs conducted. As with the model of cumulative drug testing qualifications by POFTs conducted, there is a slight negative correlation between these two variables. Once again however, this result is not significant and the R-squared value is low (see Table 25). Consequently, the analysis does not support the conclusion that additional drug testing led to lower levels of alcohol testing.

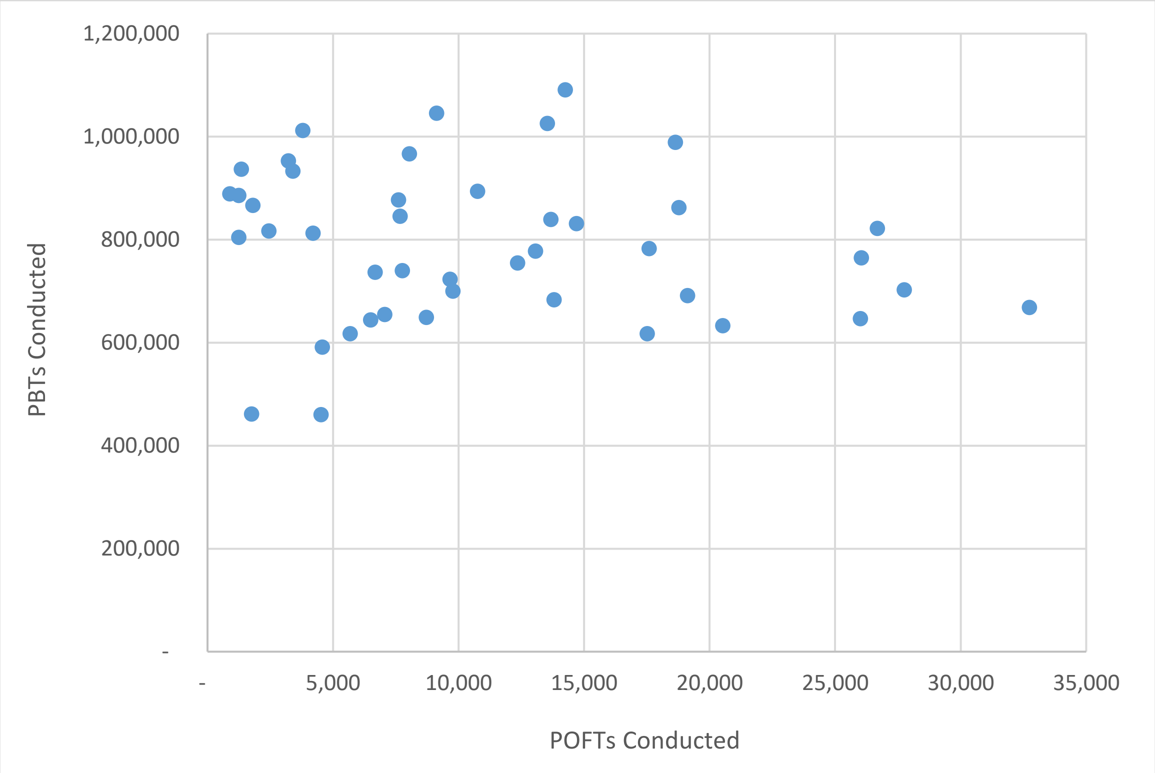

Figure 74 Scatter plot of RDTs (POFTs) delivered by RBTs (PBTs) delivered in Victoria at a Police Region, Year based level, 2006-2016

TABLE 25 OUTPUTS OF LINEAR REGRESSION MODEL OF POFTS DELIVERED BY PBTS DELIVERED

Predictor Variable	Response Variable	Model Coefficient	Model Significance	R-squared Value
Number of POFTs Delivered	Number of PBTs Delivered	-2.251	0.417	0.016

6 IMPACT OF TAC-FUNDED ROADSIDE DRUG TESTING INCREASES ON ROAD TRAUMA

6.1 Planned increases in roadside drug testing

Preliminary Oral Fluid Tests (POFTs) to detect drug driving were introduced in Victoria in December 2004 and 8,000 tests were allocated for the 2004/05 financial year, principally for operations in Melbourne. The planned growth in test allocation for each financial year is shown in Figure 75, together with the actual number of POFTs conducted each year.

The actual number of tests closely followed that planned from 2004/05 up until 2012/13. Similar to 2012/13, there had been 42,000 tests allocated for each of the following two years (2013/14 and 2014/15). However, in November 2014 the Transport Accident Commission funded the Expansion of the Roadside Drug Testing Program, which aimed to increase drug testing in Victoria to 100,000 per year. As shown in Figure 75, in 2014/15 the number of POFTs rose to 82,383, nearly doubling the tests undertaken during the previous two years. The planned 100,000 tests per annum (or greater) were achieved during each of the following three financial years (2015/16 to 2017/18).

In 2018/19, the number of planned tests was further increased to a target of 150,000 per year. At the time of analysis, data on the actual number of POFTs achieved was only available up until the 14 May 2019, reporting 122,140 tests during these first 45 weeks of 2018/19. On a pro rata basis, this suggests around 141,140 tests for the year, approximately 9,000 less than the 150,000 planned tests target.

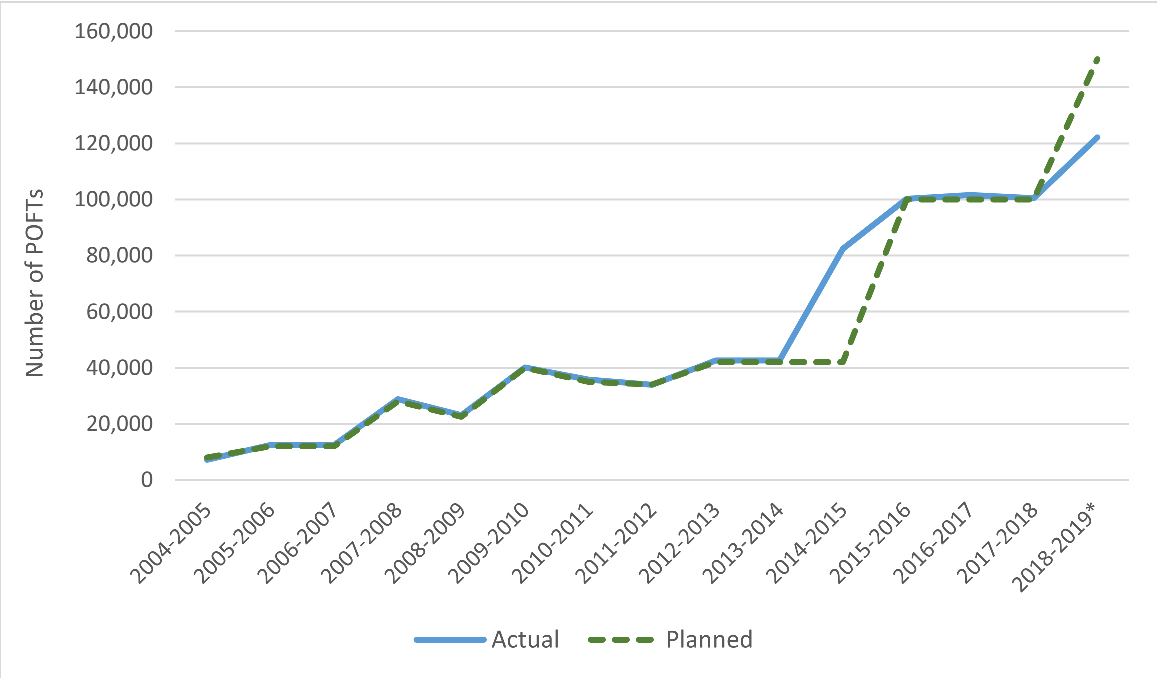

Figure 75 Planned total allocation of POFTs and actual numbers achieved, 2004/05 to 2018/19 (part)*

6.2 Trends in preliminary oral fluid tests (POFTs) and detection rates

Initially POFTs were carried out by the Road Policing Drug and Alcohol Section (RPDAS), mainly at bus-based testing stations in conjunction with random breath testing. From 2006/07, an increasing number of POFTs were carried out by Highway Patrols (HP) and the Heavy Vehicle Unit (HVU). These tests were more targeted at locations and times where they were more likely to detect vehicle controllers for one or more of the proscribed drugs (THC, Methamphetamine or MDMA).

Figure 76 shows the number of POFTs conducted per year during 2004/05 to 2018/19 by operation unit in the Melbourne metropolitan (Metro) and rural police divisions, with the positive POFT detection rates shown in Figure 77. From 2010/11, the detection rate from the HP/HVU targeted operations increased more rapidly than from RPDAS operations which were mainly random drug tests (RDTs) at bus-based stations. The increases in detection rates during 2010/11 to 2014/15 have been attributed to apparent increases in the prevalence of THC and Methamphetamine use by vehicle controllers (see Figure 78). These figures give further validation of the impact of officer training on drug test delivery considered in the previous section. Training focused on increasing drug testing capacity outside of RPDA and particularly in rural areas. The greater proportion of drug tests delivered by HP/HVU and outside of Melbourne highlights the effectiveness of the training in meeting the objectives of program expansion.

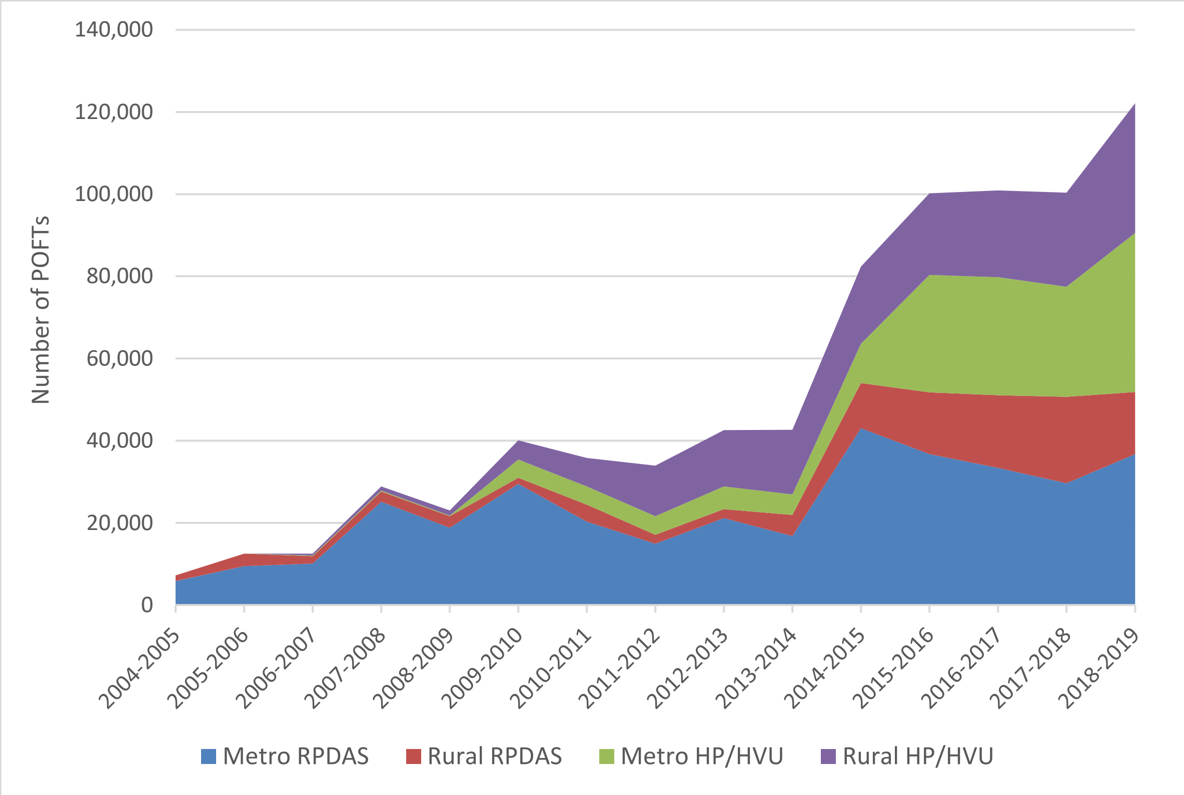

Figure 76 Roadside drug tests conducted by operation type, location and year, Victoria 2004/05 to 2018/19

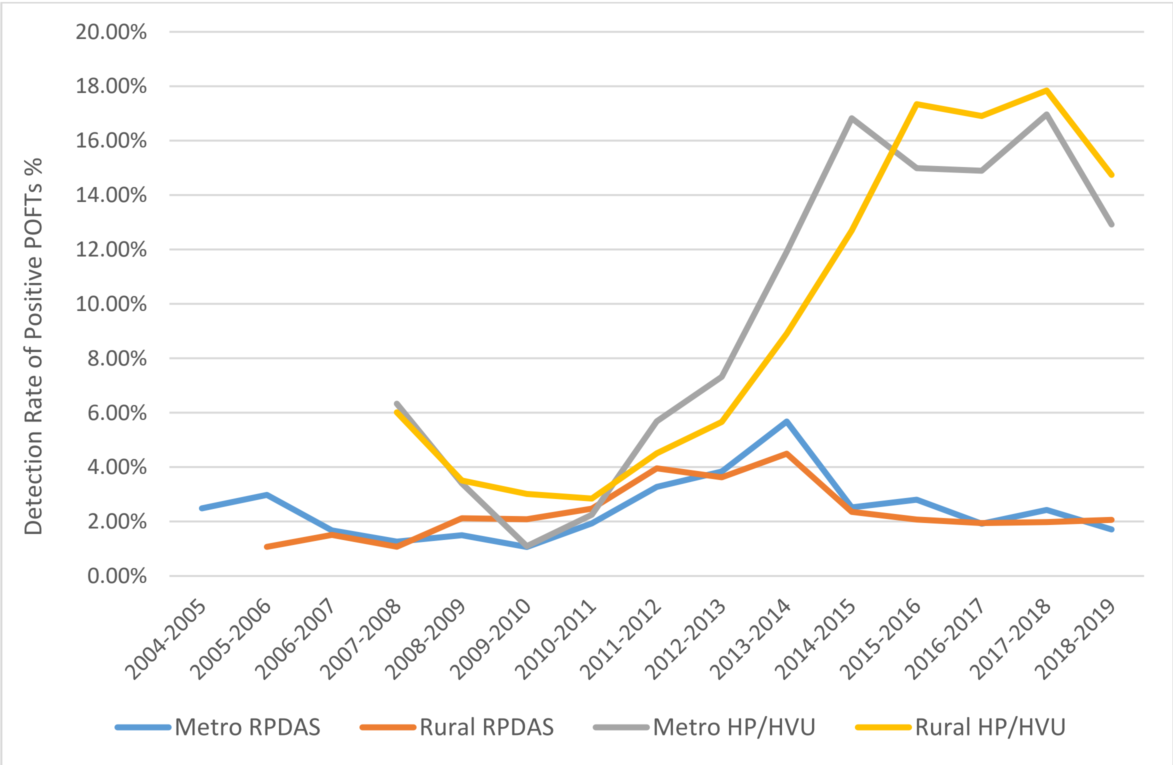

Figure 77 Positive roadside drug tests (detection rates) by operation type, location and year, Victoria 2004/05 to 2018/19

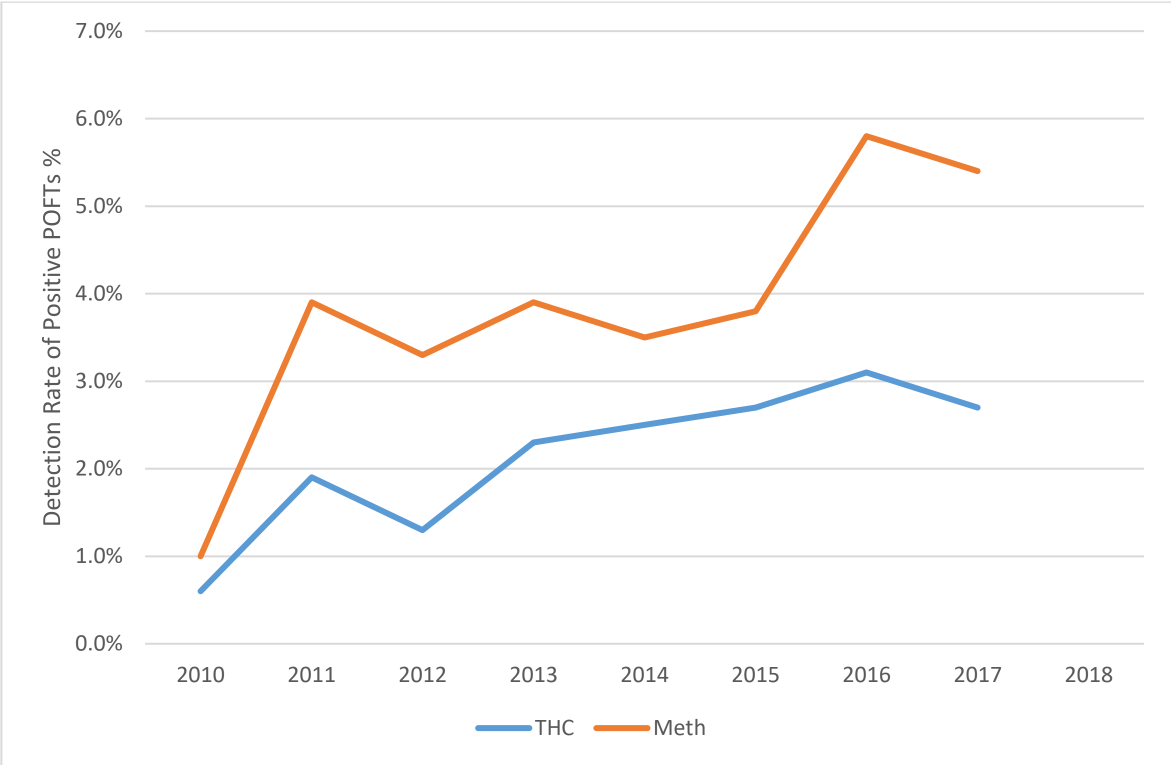

Figure 78 Detection rates of THC and Methamphetamine from roadside drug tests, Victoria 2010-2017
Data sourced from: Liu and Fitzharris (2019)

6.3 Trends in vehicle controller serious injuries and fatalities involving drugs

As noted in Section 3.1.2.1, the rates of THC and Methamphetamine associated with seriously injured vehicle controllers are likely to be conservative indicators of the prevalence of these drugs in all vehicle controllers admitted to hospital in Victoria during 2010-2016 because only about one-third of those vehicle controllers were tested via a blood sample.

However, confirmation of the increased role of Methamphetamine in drug driving is shown in Figure 79 and Figure 80. The presence of Methamphetamine in seriously injured vehicle controllers has increased consistently whereas after an initial increase (2008-11), the presence of THC has decreased. The presence of Methamphetamine in fatally injured vehicle controllers has also increased during 2006-2016 to a rate of over 18% in 2016, while the presence of THC has varied between 12% and 18% with little trend (see Figure 80).

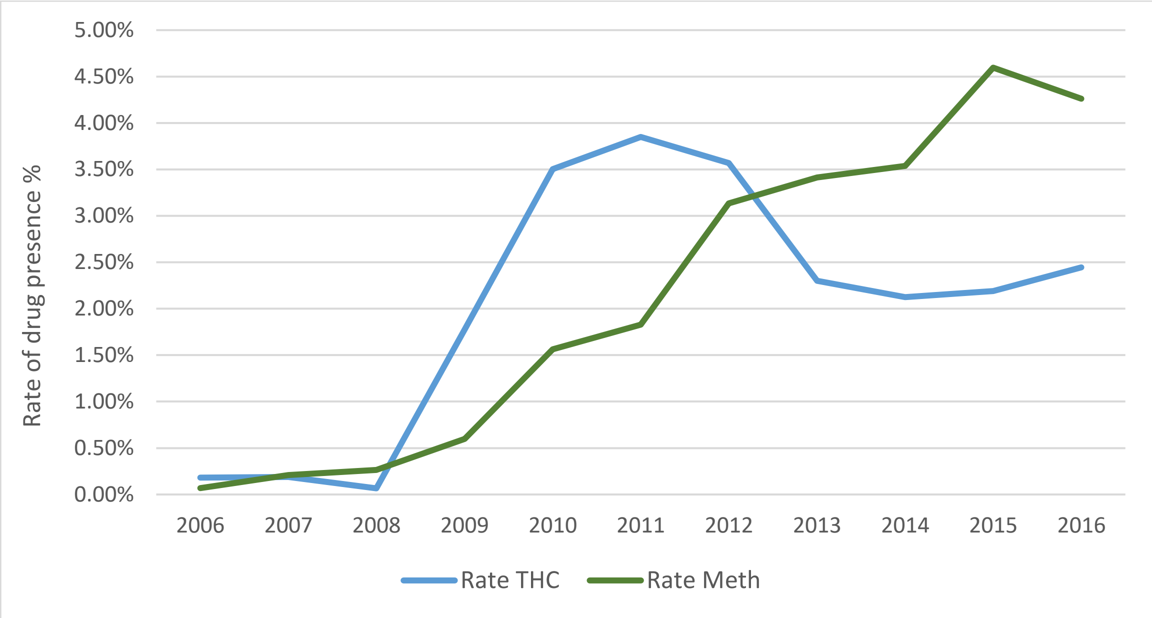

Figure 79 Rate (%) of THC and Methamphetamine presence detected in seriously injured vehicle controllers, Victoria 2006-16

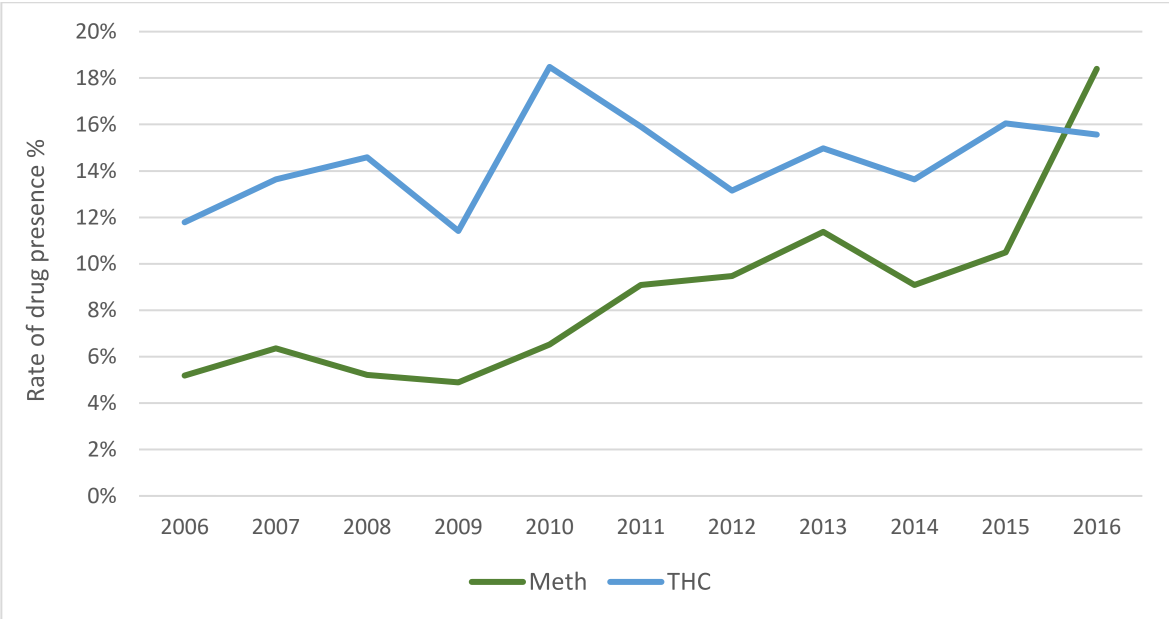

Figure 80 Rate (%) of THC and Methamphetamine presence detected in fatally injured vehicle controllers in Victoria, 2006-2016

6.4 Relationships between roadside drug testing and drug involvement in seriously and fatally injured vehicle controllers 2006-2016

Section 3.1.4 presented research modelling the relationships between drug presence in seriously injured and fatally injured vehicle controllers, separately, and (a) increased POFTs during 2006-2016 and (b) the positive detection rates from these tests. The analysis made use of the information in Figures 76 to 80 within each Police Region, allowing greater sensitivity to establish the relationships. The analysis found that:

- Relative odds of THC involvement in seriously injured and fatally injured vehicle controllers decreases with increased total POFTs (random and targeted)

- Relative odds of Methamphetamine involvement in seriously injured and fatally injured vehicle controllers decreases with the increase in the positive detection rate of any of the proscribed drugs (THC, Meth and MDMA) from the combined random and targeted POFTs.

The statistical significance, estimated relative odds, and the implied reduction in drug involvement per unit increase in enforcement level (POFTs and detection rate) are shown in Table 26for each drug and vehicle controller injury severity. The relative odds of THC involvement in seriously injured vehicle controllers decreased by 3.81% per 1000 annual POFTs in each Police Region. The relative odds of Methamphetamine involvement in seriously injured vehicle controllers decreased by 6.55% per 1%-point increase in the percentage detection rate.

TABLE 26 RELATIVE ODDS OF THC AND METH INVOLVEMENT IN VEHICLE CONTROLLER CASUALTIES RELATED TO POFTS AND DETECTION RATES (STATISTICALLY SIGNIFICANT & NEAR SIGNIFICANT)

DRUG involved in vehicle controller casualties	Input variable	Significance in seriously Injured vehicle controllers (p)	Relative Odds Per Unit Input Change	Reduction per Unit Input (%)	Significance in fatally injured vehicle controllers (p)	Relative Odds Per Unit Input Change	Reduction per Unit Input (%)
THC	Number of POFTs (1000s)	**<0.0005**	**0.962**	-3.81%	**0.047**	**0.958**	-4.18%
THC	Detection rate (percent points)	0.818	1.008	NA	**0.099**	0.877	-12.26%
Meth	Number of POFTs (1000s)	0.474	1.007	NA	**0.088**	0.957	-4.29%
Meth	Detection rate (percent points)	**0.021**	**0.934**	-6.55%	**0.007**	**0.790**	-20.99%

For seriously injured vehicle controllers, the relative odds (essentially the risk) of THC involvement related to the annual POFTs is shown in Figure 81. The relative odds of Methamphetamine involvement related to the detection rate is shown in Figure 82. Both relationships are of the diminishing-returns type, suggesting that the reduction in risk continues but becomes smaller for each increase in the POFTs or detection rate. Similar types of relationships were found for drug involvement in fatally injured vehicle controllers, as indicated by their relative odds in Table 26. This implies that future increases in the roadside drug testing program and its detection rates may reach a point where the savings in fatally and seriously injured vehicle controllers and their crashes no longer justify further increase in the program.

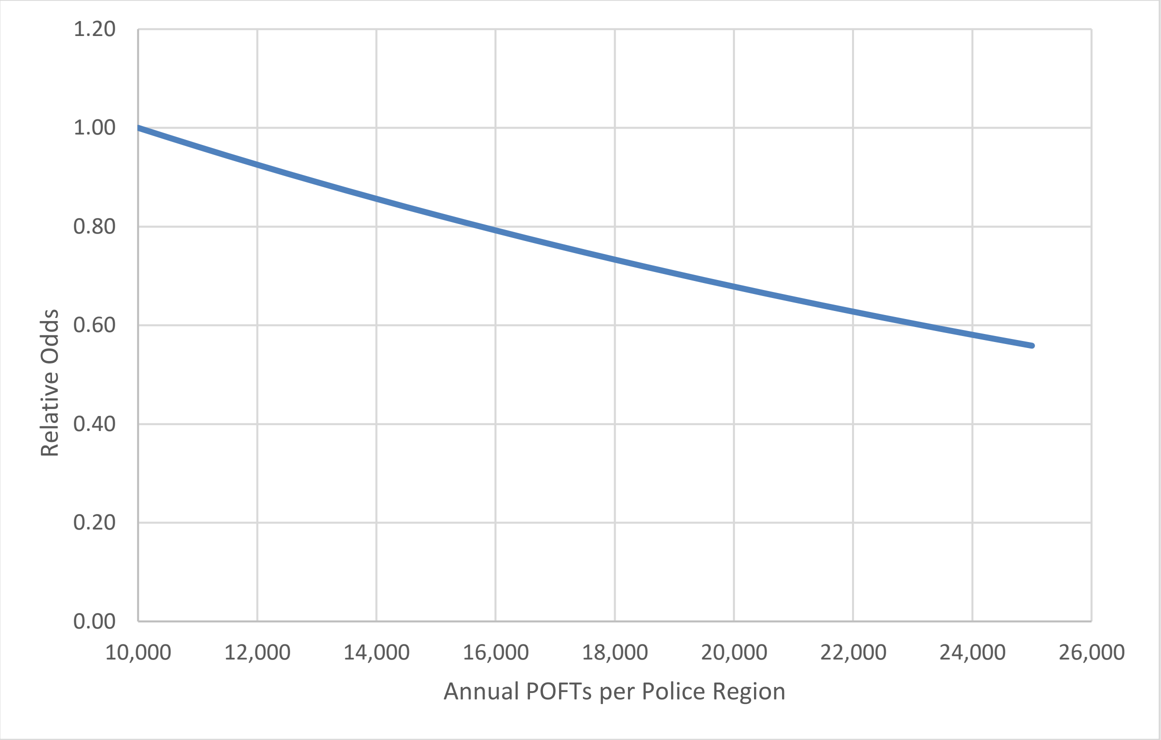

Figure 81 Relative odds of a seriously injured vehicle controller having THC in their system by annual number of POFTs delivered, per Police Region

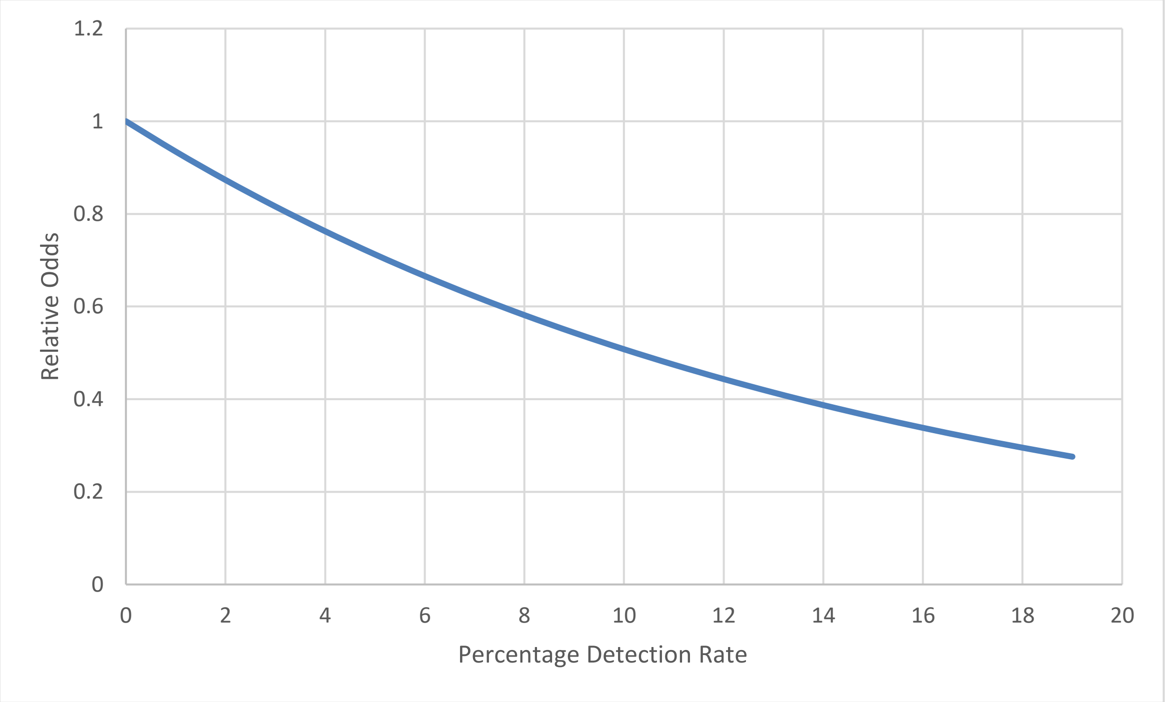

Figure 82 Relative odds of a seriously injured vehicle controller having Methamphetamine in their system by detection rate of positive POFTs

6.5 Traffic Enforcement Resource Allocation Model (TERAM)

TERAM was originally developed for Victoria Police to assist them in planning levels of enforcement of speeding, drink and drug driving, and unlicensed driving (Cameron, Newstead & Diamantopoulou, 2016; Cameron & Newstead, 2018). When first developed, TERAM was used to estimate the fatal crash savings from increases in random POFTs. No relationship with targeted POFTs was available for use in the model. Savings in non-fatal serious injury crashes due to increased POFTs were estimated, based on analogy with RBT and the comparative effects of annual breath tests on fatal and non-fatal crashes.

The new relationships outlined in Section 3.1.4 have now been included in TERAM. The roles of both random and targeted POFTs have been included, as well as their effect on overall detection rates because of the much higher detection rate of the targeted (HP/HVU) operations compared with the mainly random (RPDAS) operations since about 2013 (see Figure 77). From this section onward the term TERAM will be referring to the updated TERAM based on data from this research project.

6.6 Effects of TAC-funded increased roadside drug testing

In late 2014, TAC funded an increase in roadside drug testing from the planned (and achieved) level of 42,000 POFTs per year in 2012/13 and 2013/14 to 100,000 POFTs per year. This new level was only partially achieved in 2014/15, but was fully achieved in each financial year 2015/16 to 2017/18. For these reasons, the assessment of the effects of the TAC funding was based on the estimated fatal and serious injury crash savings due to the increased POFTs and changed detection rates, between the two base financial years (2012/13 and 2013/14), and the three financial years (2015/16 to 2017/18) when more than 100,000 POFTs per year were achieved.

Table 27 shows the growth in POFTs and positive oral fluid tests (OFTs) between the base financial years (hereafter called 2012-2014) average per year and the full increase financial years (hereafter called 2015-2018) average, together with the changes in detection rates. It can be seen that RPDAS operations were increased substantially in rural Victoria and the targeted HP/HVU operations were increased substantially in the Melbourne metro area, much greater than the increase from 42,000 POFTs to 100,000 POFTs required (138% increase).

Detection rates from the mainly random RPDAS operations fell, as could be expected, and increased for the targeted operations. There was an increase in overall detection rates from the random and targeted operations combined, in part due to the greater growth in targeted operations compared with random.

Table 28 shows the results from the TERAM analysis based on the new relationships outlined in Section 6.4. The increase in the total number of POFTs (random or targeted) drives the savings in fatal and hospitalisation crashes due to reductions in THC presence in fatally injured and seriously injured vehicle controllers. The increase in the detection rate from all testing operations (random or targeted) drives the savings in crashes due to reductions in Methamphetamine (Meth) presence in the vehicle controller casualties.

TERAM estimated that more than 33 fatal crashes and nearly 80 hospitalisation crashes per year were saved due to the increase in roadside drug testing between 2012-2014 and 2015-2018, from the TAC funding.

The social cost savings resulting from the savings in fatal and hospitalisation crashes were valued based on the unit costs of crashes, at each injury severity level, using the Human Capital Method (TIC 2015). Each fatal crash was valued at $2.653 million and each serious injury crash was valued at $677,859. The cost of the additional POFTs and, where applicable, the secondary OFTs and laboratory processing, took into account the increases in detected offences due to increases in targeted POFTs.

The benefit-cost ratio (BCR) is the ratio between the social cost savings and costs associated with the increase in RDT from the annual base level in 2012-2014 to the increased annual level in 2015-2018. Note that it is not the BCR of the full roadside drug testing program at the level in 2015-2018; it is the BCR of the program expansion associated with the TAC funding.

The marginal BCR is the ratio of the benefits to costs, estimated for the next small (1%) additional increase, in each of the base levels of random and targeted RDTs (POFTs), shown in Table 28. The estimates indicate that there would be additional social cost savings, well in excess of the additional costs, if the roadside drug testing program was increased beyond the annual level operated during 2015-2018.

TABLE 27 GROWTH IN POFTS AND POSITIVE OFTS BETWEEN BASE FYS (2012-2014) AND INCREASE FYS (2015-2018)

	FY group	POFTs			Positive oral fluid tests (OFTs)			Detection rates (%)		
		Metro	Rural	TOTAL	Metro	Rural	TOTAL	Metro	Rural	TOTAL
RPDAS operations (mainly random)	2012-2014	37906	7397	45303	1763	313	2076	4.65%	4.23%	4.58%
	Annual average	18953.0	3698.5	22651.5	881.5	156.5	1038.0			
	2015-2018	99718	53717	154226	2386	1071	3495	2.39%	1.99%	2.27%
	Annual average	33239.3	17905.7	51408.7	795.3	357.0	1165.0			
	Growth (%)	**75.4%**	**384.1%**	**127.0%**	**-9.8%**	**128.1%**	**12.2%**			
HP/HVU operations (targeted)	2012-2014	10474	29416	39890	997	2174	3171	9.52%	7.39%	7.95%
	Annual average	5237.0	14708.0	19945.0	498.5	1087.0	1585.5			
	2015-2018	84188	63866	148054	13123	11100	24223	15.59%	17.38%	16.36%
	Annual average	28062.7	21288.7	49351.3	4374.3	3700.0	8074.3			
	Growth (%)	**435.9%**	**44.7%**	**147.4%**	**777.5%**	**240.4%**	**409.3%**			
All operations	2012-2014	48380	36813	85193	2760	2487	5247	5.70%	6.76%	6.16%
	Annual average	24190.0	18406.5	42596.5	1380.0	1243.5	2623.5			
	2015-2018	183906	117583	302280	15509	12171	27718	8.43%	10.35%	9.17%
	Annual average	61302.0	39194.3	100760.0	5169.7	4057.0	9239.3			
	Growth (%)	**153.4%**	**112.9%**	**136.5%**	**274.6%**	**226.3%**	**252.2%**			

TABLE 28 CRASH SAVING PER YEAR, COST SAVINGS, BCR AND MARGINAL BCR FROM POFT INCREASES ASSOCIATED WITH TAC FUNDING

Enforcement type	Base level 2012-14 (*Tests* pa)	Increase in level (%)	Increase (*Tests* pa)	Offence detected rate with increased POFTs	Fatal crashes saved per year	Serious injury crashes saved per year	Crash cost saving per year ($m)	Total additional cost ($m pa)	BCR (Increase benefits/ increase costs)	Marginal BCR
RURAL										
Random POFT	3,699	**384.1%**	14,207	1.41%	3.80	6.91				
Targeted POFT	14,708	**44.7%**	6,581	39.71%	12.89	14.25				
Random + Targeted	18,407	112.9%	**20,788**	13.53%	16.69	21.16	58.609	5.926	**9.89**	10.60
Increased total POFT			39,194	**10.35%**						
METRO										
Random POFT	18,953	**75.4%**	14,286	NA	6.12	29.62				
Targeted POFT	5,237	**435.9%**	22,826	16.98%	10.50	28.82				
Random + Targeted	24,190	153.4%	**37,112**	10.21%	16.62	58.45	83.702	9.194	**9.10**	13.33
Increased total POFT			61,302	**8.43%**						
ALL VICTORIA										
Random POFT	22,652	125.8%	28,494	0.4%	9.92	36.53				
Targeted POFT	19,945	147.4%	29,406	22.1%	23.39	43.07				
Random + Targeted	42,597	135.9%	57,900	11.4%	33.31	79.60	142.311	15.120	**9.41**	12.25
Increased total POFT			**100,496**	**9.18%**						

6.7 Effects of increased POFTs and detection rates during 2018/19

6.7.1 Planned increases in random and targeted POFTs

During the 2018-19 financial year, Victoria Police planned to increase the annual RDTs to 150,000 (POFTs) from the 100,000 tests per year goal of the three previous years. TERAM was used to estimate the savings in fatal and serious injury crashes during 2018-19 (150,000 POFTs) from a base level in the 2015-2018 financial years (average 100,496 POFTs per year).

The number of POFTs allocated to RPDAS operations (mainly random testing) was scheduled to increase by 14.15% compared with 2015-2018. Targeted POFTs were scheduled to increase by 83.52% at rural HP/HVU operations and by 86.82% at metro operations, during 2018-19. Apparently, Victoria Police had planned to substantially increase targeted POFTs to more than the approximate 50% of total POFTs that was achieved in 2015-2018. This increase in targeted POFTs should have increased the overall detection rate of positive OFTs from the POFTs. Together the increases in all POFTs and the detection rates should have reduced the number of fatally injured and seriously injured vehicle controllers with drugs during 2018-19, based on the relationships outlined in Section 6.4.

The estimated savings in fatal and serious injury crashes during 2018-19 are shown Table 29 together with their economic value and benefit-cost ratio (BCR).

As shown, the increase in planned POFTs during 2019 could be expected to have saved just over 23 fatal crashes and nearly 56 serious injury crashes. It also shows that the increased POFTs would return social cost benefits of nearly 7 times the increased program cost, even using the conservative Human Capital cost of crashes.

The marginal benefit-cost ratio (BCR) is the ratio of benefits to costs of the next increases in POFTs above the level planned for 2018-19 (150,000 tests). Marginal BCRs in Table 29 indicate that there is further economic value (and fatal and serious injury savings) if the annual POFTs were increased further, particularly in rural Victoria.

TABLE 29 CRASH SAVINGS PER YEAR, COST SAVINGS, BCR AND MARGINAL BCR FROM PLANNED POFT INCREASES IN 2018-19

Enforcement type	Base level 2015-18 (*Tests* pa)	Increase in level (%)	Increase (*Tests* pa)	Offence detected rate with increased POFTs	Fatal crashes saved per year	Serious injury crashes saved per year	Crash cost saving per year ($m)	Total additional cost ($m pa)	BCR (Increase benefits/ increase costs)	Marginal BCR
RURAL										
Random POFT	17,906	**14.15%**	2,534	1.99%	3.72	6.76				
Targeted POFT	21,289	**83.52%**	17,780	17.38%	7.60	7.35				
Random* + *Targeted	39,194	51.8%	**20,314**	15.46%	11.32	14.11	39.603	6.231	**6.36**	4.22
Increased total POFT			59,508	**12.10%**						
METRO										
Random POFT	33,239	**14.15%**	4,703	2.39%	4.99	24.08				
Targeted POFT	28,063	**86.82%**	24,364	15.59%	7.00	17.70				
Random* + *Targeted	61,302	47.4%	**29,067**	13.45%	12.00	41.77	60.139	8.260	**7.28**	5.17
Increased total POFT			90,369	**10.05%**						
ALL VICTORIA										
Random POFT	51,145	14.2%	7,237	2.3%	8.71	30.84				
Targeted POFT	49,351	85.4%	42,144	16.3%	14.61	25.04				
Random* + *Targeted	100,496	49.1%	49,381	14.3%	23.32	55.88	99.741	14.490	**6.88**	4.76
Increased total POFT			**149,878**	**10.86%**						

6.7.2 Actual increase in POFTs during 2018/19 to 14 May 2019

POFT data was available to 14 May 2019 to examine the actual increase in roadside drug testing in 2018/19 compared with the previous three financial years. During the first 45 weeks of 2018/19 there were 122,140 POFTs conducted which, when annualised to 141,140 estimated POFTs, represents 40% increase compared with 2015-2018 (average 100,496 POFTs per year).

Based on the annualised POFTs, it appears that random RDTs in rural Victoria decreased by nearly 3% while targeted RDTs increased by 71.5% (see Table 30). Offence detection rates from the targeted RDTs decreased compared with 2015-2018, resulting in the overall detection rate in rural Victoria rising only from 10.35% to 10.65%. This in turn was estimated to result in relatively small savings in fatal and serious injury crashes associated with Methamphetamine presence in the vehicle controller casualties.

In metro Melbourne, it appears that annualised random RDTs increased by 27.8% but apparently these additional POFTs did not detect any additional offences. The targeted metro RDTs increased by 59.5% but similar to rural Victoria, their offence detection rates also fell. Together these changes resulted in the overall detection rate in metro Melbourne falling from 8.43% to 7.46%. It was estimated that this decrease in detection rate was counter-productive and resulted in additional fatal and serious injury crashes due to increased prevalence of drugs in the vehicle controller casualties (see Table 30).

Notwithstanding the counter-productive effects of reduced detection rates, it appears that the overall effects of the 40% increase in RDTs during 2018/19 should have produced savings of at least 3 fatal crashes and 16.5 serious injury crashes. These crash cost savings were more than twice the cost associated with the increased POFTs, as indicated by the estimated BCR of 2.23 for the increase in the drug testing program.

It should be noted that the reductions in the detection rates during 2018/19 (or at least its first 45 weeks) may have been an outcome of the deterrent effect of the roadside drug testing program during 2018/19 and the substantially increased program during the previous three years. However, there was no evidence that detection rates decreased each year during 2015/16 to 2017/18 in either region of Victoria and for either random or targeted operations (see Figure 77). A short-term effect of the 40% increase in RDTs during 2018/19, which resulted in reduced on-road prevalence of THC and Methamphetamine and hence reduced detection rates, seems unlikely.

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TABLE 30 CRASH SAVINGS PER YEAR, COST SAVINGS, BCR AND MARGINAL BCR FROM ACTUAL POFT INCREASES IN 2018-19 TO 14 MAY 2019

Enforcement type	Base level 2015-18 (*Tests* pa)	Base offence detected rate (% of POFTs)	Increase in annualised level (%)	Increase in annual level (*Tests* pa)	Offence detected rate with increased POFTs	Fatal crashes saved per year	Serious injury crashes saved per year	Crash cost saving per year ($m)	Total additional cost ($m pa)	BCR (Increase benefits/ increase costs)
RURAL										
Random POFT	17,906	1.99%	**-2.89%**	**-517**	NA	2.77	5.03			
Targeted POFT	21,289	17.38%	**71.53%**	15,228	11.06%	1.55	1.34			
Random + Targeted	39,194	**10.35%**	37.5%	**14,711**	11.46%	4.33	6.37	15.796	3.851	**4.10**
Increased total POFT				53,906	**10.65%**					
METRO										
Random POFT	33,239	2.39%	**27.78%**	9,233	NK	4.53	21.79			
Targeted POFT	28,063	15.59%	**59.51%**	16,699	8.43%	-5.69	-11.62			
Random + Targeted	61,302	**8.43%**	42.3%	**25,932**	5.17%	-1.17	10.18	3.805	4.955	**0.77**
Increased total POFT				87,234	**7.46%**					
ALL VICTORIA										
Random POFT	51,145	2.25%	17.0%	8,716	NK	7.30	26.82			
Targeted POFT	49,351	16.36%	64.7%	31,927	9.68%	-4.14	-10.28			
Random + Targeted	100,496	**9.18%**	40.4%	40,643	7.44%	3.16	16.54	19.601	8.806	**2.23**
Increased total POFT				**141,140**	**8.68%**					

6.8 Effects of further increases in roadside drug testing

The roadside drug testing program in Victoria has achieved substantial reductions in fatal and serious injury crashes, but could be expanded further. Further expansion is justified not only by its potential savings in serious road trauma, but also because it would be a good economic investment up to a level where the social cost savings still exceed the costs at the margin. The extent of the additional investment depends on the method used to value the social cost savings from the reductions in fatal and serious injury crashes.

6.8.1 Social costs of crash savings valued by Human Capital Method

From the annual average base levels of RDTs in 2015-2018 (Table 27), a range of percentage increases in the random and targeted RDTs were considered until increases were found that produced a marginal BCR just below one (see Table 31). This maximum level was indicated if the random RDTs were increased by 190% and 175% in rural and metro Victoria, respectively, and the targeted RDTs were increased by 400% throughout the State. The total POFTs per year would increase by nearly 290% to 390,090. In the short term, the positive detection rate would increase from 9.2% to 11.2%, reflecting the greater percentage increase in the targeted operations.

For the given percentage increases in random and targeted RDTs, TERAM estimated that 46 fatal crashes and 134.5 serious injury crashes would be saved per year (see Table 31).

6.8.2 Social costs of crash savings valued by Willingness-to-Pay Method

An analysis also considered the maximum level, if the crashes were valued using the Willingness-to-Pay (WTP) method ($9.166 million per fatal crash and $611,718 per serious injury crash; TIC 2015).

Table 32 shows the percentage increases in RDTs of each type in each region that would produce a marginal BCR just below one. In this case, the random RDTs could be increased by 265% and the targeted RDTs increased by 643%, to a total of 553,460 POFTs per year, an increase of 450% on the 2015-2018 level. TERAM estimated that this would save 53 fatal crashes and 157 serious injury crashes per year (see Table 32).

6.8.3 Impacts on other traffic enforcement programs

Estimates of road safety benefits calculated in this analysis assume that the expansion of the roadside drug testing program has no negative impacts on the delivery of other police enforcement programs, such as roadside alcohol testing, due to constraints on overall human resources. This assumption is particularly pertinent given the requirement for high levels of targeted enforcement which have historically been delivered by the Highway Patrols or the Heavy Vehicle Unit.

TABLE 31 CRASH SAVING PER YEAR, HUMAN CAPITAL COST SAVINGS, BCR AND MARGINAL BCR FROM MAXIMUM POFT INCREASES

Enforcement type	Base level 2015-18 *(Tests)*	Increase in level (%)	Increase (*Tests* pa)	Offence detected rate with increased POFTs	Fatal crashes saved per year	Serious injury crashes saved per year	Crash cost saving per year ($m)	Total additional cost ($m pa)	BCR (Increase benefits/ increase costs)	Marginal BCR
RURAL										
Random POFT	17,906	**190.0%**	34,021	1.99%	13.74	25.91				
Targeted POFT	21,289	**400.0%**	85,155	17.38%	8.43	8.29				
Random + Targeted	39,194	304.1%	**119,175**	12.99%	22.16	34.20	81.976	33.242	**2.47**	0.99
Increased total POFT			158,370	**12.34%**						
METRO										
Random POFT	33,239	**175.0%**	58,169	2.39%	15.69	79.21				
Targeted POFT	28,063	**400.0%**	112,251	15.59%	8.15	21.13				
Random + Targeted	61,302	278.0%	**170,420**	11.08%	23.84	100.34	131.260	43.891	**2.99**	0.99
Increased total POFT			231,722	**10.38%**						
ALL VICTORIA										
Random POFT	51,145	180.3%	92,190	2.25%	29.43	105.12				
Targeted POFT	49,351	400.0%	197,405	16.36%	16.58	29.42				
Random + Targeted	100,496	288.2%	289,595	11.87%	46.00	134.54	213.236	77.133	**2.76**	0.99
Increased total POFT			**390,091**	**11.18%**						

TABLE 32 CRASH SAVINGS PER YEAR, WTP COST SAVINGS, BCR AND MARGINAL BCR FROM MAXIMUM POFT INCREASES

Enforcement type	Base level 2015-18 (*Tests*)	Increase in level (%)	Increase (*Tests* pa)	Offence detected rate with increased POFTs	Fatal crashes saved per year	Serious injury crashes saved per year	Crash cost saving per year ($m)	Total additional cost ($m pa)	BCR (Increase benefits/ increase costs)	Marginal BCR
RURAL										
Random POFT	17,906	**345.0%**	61,775	1.99%	17.08	32.91				
Targeted POFT	21,289	**700.0%**	149,021	17.38%	8.89	8.84				
Random + Targeted	39,194	537.8%	**210,795**	12.87%	25.96	41.75	263.521	58.522	**4.50**	0.99
Increased total POFT			249,990	**12.48%**						
METRO										
Random POFT	33,239	**222.0%**	73,791	2.39%	17.32	88.61				
Targeted POFT	28,063	**600.0%**	168,376	15.59%	9.86	26.62				
Random + Targeted	61,302	395.0%	**242,167**	11.57%	27.17	115.23	319.519	63.684	**5.02**	0.99
Increased total POFT			303,469	**10.93%**						
ALL VICTORIA										
Random POFT	51,145	265.1%	135,566	2.21%	34.39	121.52				
Targeted POFT	49,351	643.1%	317,397	16.43%	18.74	35.46				
Random + Targeted	100,496	450.7%	452,963	12.17%	53.14	156.98	583.040	122.206	**4.77**	0.99
Increased total POFT			**553,459**	**11.63%**						

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7 INTEGRATION OF ESTIMATED RELATIONSHIPS BETWEEN DRUG AND ALCOHOL TESTING INTO TERAM

Section 6.5 detailed the modelling of the relationships between roadside drug testing and the presence of drugs in fatally injured and seriously injured vehicle controllers and their integration into the Traffic Enforcement Resource Allocation Model (TERAM), developed for Victoria Police. The effects of roadside alcohol testing on vehicle controller casualties were included in the original TERAM (Cameron, Newstead & Diamantopoulou, 2016) and its 2018 update. The relationship between random breath tests (RBTs) and casualty crashes were based on numerous studies in Victoria, NSW and Western Australia. Bus-based RBT was considered to be random, but car-based PBTs were considered to be a mixture of random and targeted operation. Boorman (2014; Section 8.1.2) considered that the non-random PBTs were likely to achieve general and specific deterrence effects because of the volume of non-random tests in Victoria.

7.1 Relationships with roadside alcohol testing

The new relationships between roadside alcohol testing and alcohol involvement in crashes have now been added to TERAM. The proportions of fatally injured or seriously injured, crash-involved vehicle controllers were found to be related to (a) the annual number of PBTs (bus- and car-based) and (b) the hit rate of illegal BAC detection (EBTs per 1000 PBTs) from those operations (see Section 3.2.4).

Table 33 shows the results from Table 17 and Table 19 for the relationships connecting the prevalence of BAC levels at or above 0.05 g/100mL in vehicle controller casualties with PBTs and hit rates, except that the relative odds per change in PBTs relate to 100,000 PBTs input so that the magnitude of effect can be more clearly seen. The reduction in odds for fatally injured vehicle controllers per 100,000 PBTs (10.3%), while not statistically significant, is similar in magnitude to that for seriously injured vehicle controllers (14.0%). The absence of statistical significance may have been due to the relatively small number of fatally injured vehicle controllers in the analysis compared with the seriously injured. For these two reasons, the relationship with PBTs for fatally injured vehicle controllers was included in TERAM together with the hit rate.

TABLE 33 RELATIVE ODDS OF ILLEGAL ALCOHOL INVOLVEMENT IN VEHICLE CONTROLLER CASUALTIES RELATED TO PBTS AND DETECTION RATES (STATISTICALLY SIGNIFICANT & NOT SIGNIFICANT)

Alcohol involved in vehicle controller casualties	INPUT VARIABLE	Significance level (p)	Relative Odds Per Unit Input Change	Lower confidence limit on Relative Odds	Upper confidence limit on Relative Odds	Reduction per Unit Input (%)
Seriously injured vehicle controllers with illegal BAC	Number of PBTs (100,000s)	**<0.0005**	**0.8598**	0.8118	0.9106	-14.02%
	Detection rate (EBTs per 1000 PBTs)	**<0.0005**	**0.8820**	0.841	0.925	-11.80%
Fatally injured vehicle controllers with illegal BAC	Number of PBTs (100,000s)	**0.196**	**0.8969**	0.7605	1.0579	-10.31%
	Detection rate (EBTs per 1000 PBTs)	**0.016**	**0.8454**	0.737	0.970	-15.46%

The relative odds of a seriously injured vehicle controller having an illegal BAC, related to the annual PBTs per Police Region ranging from 500,000 to 2 million, are shown in Figure 35. The same relative odds related to the hit rate (EBTs per 1000 PBTs), ranging from zero to 2.8 per 1000, are shown in Figure 36. The relative odds for fatally injured vehicle controllers related to the hit rate are shown in Figure 48. No graph of the relative odds for fatally injured vehicle controllers related to annual PBTs was presented in section 3.2.4; however, the relationship was included in TERAM as explained above (see Figure 83).

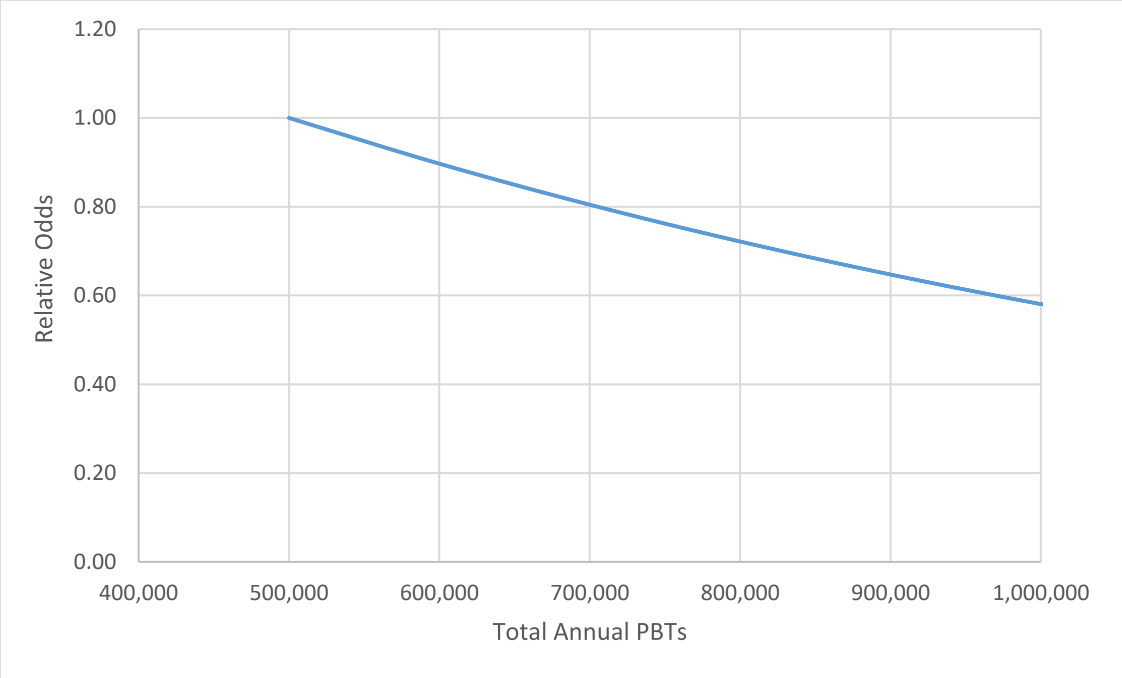

Figure 83 Relative odds of fatally injured vehicle controllers having an illegal BAC level by annual PBTs, per Police Region

7.2 Roadside alcohol testing inputs to TERAM

7.2.1 Annual PBTs and detection rates 2006-2016

Figure 25 in Section 3.2.1 showed that the trend in PBTs fluctuated annually during 2006 to 2016 and averaged about 3 million tests per year near the end of the period. Figure 27 showed some variation in annual PBTs by Police Region, and Figure 28 showed about twice the number of car-based PBTs compared with bus-based each year.

The number of positive evidentiary breath tests (EBTs) per 1000 PBTs has declined slowly over the period (see Figure 29) with similar trends in each Police Region (see Figure 30). The detection rate (hit rate per 1000 PBTs) has generally been higher for car-based PBTs compared with bus-based PBTs, probably reflecting the mix of random and targeted operations normally conducted by car-based alcohol testing operations.

Annual PBTs and detection rates during 2014-2016 (averaged) were used as the base level of roadside alcohol testing operations in TERAM. This corresponded with the base level of crashes in Victoria also used in the current TERAM. On average, 3,321,411 PBTs per year were conducted. Of these, 3,010,792 PBTs (90.6%) were in known Region-Divisions for TERAM analysis in rural and metro regions of Victoria. The detection rate with positive EBTs was 0.142% at buses and 0.424% from cars, with an overall detection rate of 0.329%. The relationships in Table 33 indicate that increasing the overall detection rate has a significant role in reducing illegal BAC levels in vehicle controller casualties. This can be achieved by further increasing the proportion of PBTs from cars while increasing the total PBTs from car- and bus-based operations.

7.2.2 Illegal alcohol presence in vehicle controller casualties

Figure 32 in Section 3.2.2.1 shows the trends in percentages of seriously injured vehicle controllers in the BAC range from 0.05 to 0.149 g/100mL and the range at and above 0.15 g/100mL. The trends are similar and decrease to about 2.5% each in 2016. The relative odds of a seriously injured vehicle controller with any illegal BAC (at or above 0.05 g/100mL) is the subject of the relationship in TERAM with parameters in Table 33. Seriously injured vehicle controllers with illegal BACs averaged 5.07% during 2014-2016.

Section 3.2.2.1 noted that only about 30% of vehicle controllers admitted to hospital had a blood sample taken and tested for alcohol during 2006-2016. Thus, the percentage of seriously injured vehicle controllers tested and found to have BAC in an illegal BAC range is likely to be a conservative estimate of the true prevalence of alcohol in all seriously injured vehicle controllers in Victoria.

Figure 33 shows the trends in fatally injured vehicle controllers with BAC levels in the same two ranges. The percentage of fatally injured vehicle controllers with a BAC at or above 0.15 g/100mL was substantially higher than the percentage fatally injured with a BAC in the lower illegal BAC range. Again, the relative odds of a fatally injured vehicle controller having any illegal BAC is the subject of the TERAM modelling. Fatally injured vehicle controllers with illegal BACs averaged 16.1% during 2014-2016.

7.3 Estimated crash savings from increases in PBTs and detection rates

TERAM can be used to estimate the savings in fatal and serious injury crashes from any given percentage increases in bus- and car-based PBTs in rural Victoria and metropolitan Melbourne. Rural PBTs were those conducted in the West and East Police Regions, excluding those conducted in Divisions ED1 and ED2 which were included with those in the two Metro Police Regions to represent metro Melbourne (see Table 34).

To illustrate the effects on crashes, bus PBTs were increased by 30% in each region of Victoria. Car PBTs were increased by 60% to produce an increase in the overall detection rate (expressed as a percentage of PBTs in Table 34 rather than hit rate per 1000 PBTs). The increase in the overall detection rate illustrates the impact of the reduction in relative odds, due to this factor, as well as the impact due to increased PBTs in total. Under this scenario, the overall detection rate in rural Victoria was calculated to rise from 0.248% to 0.252%, and in metro Melbourne to rise from 0.388% to 0.412%. While these increases in detection rate seem small, Table 33 indicates that they produce significant reductions in the relative odds of illegal BAC presence in vehicle controller casualties per 0.1% increase in detection rate.

Across Victoria, there would be nearly a 50% increase in all PBTs with the annual total rising to over 4.5 million and a detection rate of 0.341% (see Table 34). TERAM estimated that more than 8 fatal crashes and over 77 serious injury crashes would be saved per year.

Social cost savings valued by the Human Capital method were estimated to be $73.8 million per annum and the benefit-cost ratio (BCR) of the increased roadside testing was estimated to be 3.1. The marginal BCR was slightly higher indicating that further increases in PBTs (with greater increases in car PBTs compared with bus PBTs) would be economically justified as well as saving additional serious casualty crashes.

TABLE 34 CRASH AND SOCIAL COST SAVINGS, BCR AND MARGINAL BCR FROM 30% INCREASE IN BUS PBTS AND 60% INCREASE IN CAR PBTS

Enforcement type	Base level 2014-16 (*Tests* pa)	Increase in level (%)	Increase (*Tests* pa)	Offence detected rate with increased PBTs (%)	Fatal crashes saved per year	Serious injury crashes saved per year	**Crash cost saving per year ($m)**	**Total additional cost ($m pa)**	**BCR** (Increase benefits/ increase costs)	Marginal BCR
RURAL										
Bus PBT	174,054	**30%**	52,216	0.098%						
Car PBT	1,101,834	**60%**	661,100	0.272%						
Bus + Car PBT	1,275,888	55.9%	**713,317**	0.259%	3.61	18.90	22.391	11.954	**1.87**	2.00
Increased total PBT			1,989,205	**0.252%**						
METRO										
Bus PBT	842,049	**30%**	252,615	0.151%						
Car PBT	892,855	**60%**	535,713	0.612%						
Bus + Car PBT	1,734,904	45.4%	**788,328**	0.464%	4.49	58.27	51.419	11.837	**4.34**	4.24
Increased total PBT			2,523,232	**0.412%**						
ALL VICTORIA										
Bus PBT	1,016,103	30%	304,831	0.142%						
Car PBT	1,994,689	60%	1,196,813	0.424%						
Bus + Car PBT	3,010,792	49.9%	1,501,644	0.367%	8.11	77.17	73.810	23.791	**3.10**	3.14
Increased total PBT			**4,512,436**	**0.341%**						

7.4 Effects of further increases in roadside alcohol testing

Further expansion in roadside alcohol testing is justified not only by its potential savings in serious road trauma, but also because it would be a good economic investment, up to a level where the social cost savings still exceed the costs at the margin. The extent of the additional investment depends on the method used to value the social cost savings from the reductions in fatal and serious injury crashes.

7.4.1 Social costs of crash savings valued by Human Capital method

From the annual average base levels of PBTs in 2014-2016, a range of percentage increases in the bus- and car-based PBTs were considered until increases were found that produced a marginal BCR just below one (Table 35). This maximum level was indicated if the bus PBTs were increased by 190% and 250% in rural Victoria and metro Melbourne, respectively. Aiming to produce a significant increase in overall detection rates, car PBTs were increased by 380% and 500% in the rural and metro regions, respectively (double the bus PBT increases).

The total PBTs per year would increase by 368% to 14.1 million. In the short term, the positive detection rate would increase from 0.329% to 0.355%, reflecting the greater percentage increase in the car-based operations.

For the given percentage increases in the bus and car PBTs, TERAM estimated that more than 32 fatal crashes and 266 serious injury crashes would be saved per year (Table 35).

7.4.2 Social costs of crash savings valued by Willingness-to-Pay method

An analysis also considered the maximum level if the crashes were valued using the Willingness-to-Pay (WTP) method ($9.166 million per fatal crash and $611,718 per serious injury crash; TIC 2015).

Table 36 shows the percentage increases in PBTs of each type in each region that would produce a marginal BCR just below one. Coincidentally, the bus PBTs could be increased by 335% and the car PBTs increased by 670%, the same in each region, to a total of 19.8 million PBTs per year, an increase of 557% on the 2014-2016 level. TERAM estimated that this would save more than 37 fatal crashes and 289 serious injury crashes per year (Table 36).

Under this scenario, the greater increase in rural PBTs is justified because of the larger proportion of serious casualty crashes that are fatal on rural roads compared with metro roads, magnified by the higher unit value associated with a fatal crash using the WTP method compared with the Human Capital cost.

TABLE 35 CRASH SAVINGS PER YEAR, HUMAN CAPITAL COST SAVINGS, BCR AND MARGINAL BCR FROM MAXIMUM PBT INCREASES

Enforcement type	Base level 2014-16 (*Tests* pa)	Increase in level (%)	Increase (*Tests* pa)	Offence detected rate with increased PBTs (%)	Fatal crashes saved per year	Serious injury crashes saved per year	**Crash cost saving per year ($m)**	**Total additional cost ($m pa)**	**BCR** (Increase benefits/ increase costs)	Marginal BCR
RURAL										
Bus PBT	174,054	**190%**	330,703	0.098%						
Car PBT	1,101,834	**380%**	4,186,969	0.272%						
Bus + Car PBT	1,275,888	354.1%	**4,517,672**	0.259%	14.25	65.00	81.857	49.369	**1.66**	0.99
Increased total PBT			5,793,560	**0.257%**						
METRO										
Bus PBT	842,049	**250%**	2,105,123	0.151%						
Car PBT	892,855	**500%**	4,464,275	0.612%						
Bus + Car PBT	1,734,904	378.7%	**6,569,398**	0.464%	17.99	200.92	183.904	63.532	**2.89**	1.00
Increased total PBT			8,304,302	**0.448%**						
ALL VICTORIA										
Bus PBT	1,016,103	240%	2,435,825	0.142%						
Car PBT	1,994,689	434%	8,651,244	0.424%						
Bus + Car PBT	3,010,792	368.2%	11,087,069	0.362%	32.23	265.92	265.761	112.901	**2.35**	0.99
Increased total PBT			**14,097,861**	**0.355%**						

TABLE 36 CRASH SAVINGS PER YEAR, WTP COST SAVINGS, BCR AND MARGINAL BCR FROM MAXIMUM PBT INCREASES

Enforcement type	Base level 2014-16 (*Tests* pa)	Increase in level (%)	Increase (*Tests* pa)	Offence detected rate with increased PBTs (%)	Fatal crashes saved per year	Serious injury crashes saved per year	**Crash cost saving per year ($m)**	**Total additional cost ($m pa)**	**BCR** (Increase benefits/ increase costs)	Marginal BCR
RURAL										
Bus PBT	174,054	**335%**	583,081	0.098%						
Car PBT	1,101,834	**670%**	7,382,288	0.272%						
Bus + Car PBT	1,275,888	624.3%	**7,965,369**	0.259%	17.79	75.46	209.254	74.359	**2.81**	0.98
Increased total PBT			9,241,257	**0.258%**						
METRO										
Bus PBT	842,049	**335%**	2,820,864	0.151%						
Car PBT	892,855	**670%**	5,982,129	0.612%						
Bus + Car PBT	1,734,904	507.4%	**8,802,993**	0.464%	19.56	211.40	308.611	78.725	**3.92**	1.01
Increased total PBT			10,537,897	**0.451%**						
ALL VICTORIA										
Bus PBT	1,016,103	335%	3,403,945	0.142%						
Car PBT	1,994,689	670%	13,364,416	0.424%						
Bus + Car PBT	3,010,792	556.9%	16,768,361	0.367%	37.36	286.86	517.865	153.084	**3.38**	0.996
Increased total PBT			**19,779,153**	**0.361%**						

7.5 Comparison of maximum savings and costs of roadside alcohol and drug testing

It is of interest to compare the crash savings and operational costs of the two roadside testing programs in Victoria. This is done in Table 37 in which the all Victoria results from Table 31 and Table 35 have been brought together, with the social costs of the crash savings valued using the Human Capital method in each case. In these tables, the increases in annual testing levels were chosen so that their marginal BCR is just below one, i.e. any further increases above the maximum level of PBTs and POFTs would not be justified by their increased operational costs.

Substantial increases in both roadside testing programs are justified, with alcohol tests increasing up to 368% and drug tests up to 288% above their annual average levels in the base years used (noting that some increases have already occurred). At these levels of increase, it is estimated that the increased POFTs would save 46 fatal crashes and the increased PBTs would save 32 fatal crashes per year. However, it is estimated they would save 135 and 266 serious injury crashes, respectively, nearly double the saving from the PBTs compared with the POFTs.

These crash savings would result in a greater saving in social costs from the increase in the roadside alcohol testing compared with the drug testing ($265.8 million compared with $213.2 million per year), however its operational costs would be greater ($112.9 million compared with $77.1 million per year). The increase in roadside drug testing up to the maximum (economically-justifiable) level would also be a better investment, with an estimated BCR of 2.76 compared with 2.35 for the alcohol testing. Whether this differential in the BCRs is maintained at lower levels of increase for each program requires further TERAM analysis, but a comparison of Table 29 and Table 34 (in which base levels of POFTs and PBTs were increased Victoria-wide by 50%) suggests that the roadside drug testing would maintain its advantage as a better investment.

TABLE 37 CRASH AND HC COST SAVINGS, BCRS & MARGINAL BCRS FROM MAXIMUM INCREASED LEVELS OF PBTS AND POFTS (ALL VICTORIA)

Enforcement type	Base level (*Tests* pa)	Increase in level (%)	Increase (*Tests* pa)	Offence detected rate with increased tests (%)	Fatal crashes saved per year	Serious injury crashes saved per year	**Crash cost saving per year ($m)**	**Total additional cost ($m pa)**	**BCR** (Increase benefits/ increase costs)	Marginal BCR
ALCOHOL TESTING										
Bus PBT	1,016,103	**240%**	2,435,825	0.142%						
Car PBT	1,994,689	**434%**	8,651,244	0.424%						
Bus + Car PBT	3,010,792	**368%**	11,087,069	0.362%	32.23	265.92	265.761	112.901	**2.35**	0.99
Increased total PBT			**14,097,861**	**0.355%**						
DRUG TESTING										
Random POFT	51,145	**180%**	92,190	2.25%						
Targeted POFT	49,351	**400%**	197,405	16.36%						
Random + Targeted	100,496	**288%**	289,595	11.87%	46.00	134.54	213.236	77.133	**2.76**	0.99
Increased total POFT			**390,091**	**11.18%**						

8 DISCUSSION

Crash statistics in Victoria show that drug involvement in crashes remains a major road safety problem. Most recent data available for this study showed 18% of fatally injured vehicle controllers in Victorian road crashes tested positive for Methamphetamine whilst 16% tested positive for THC. Combined, proscribed illicit drugs were present in over 25% of fatally injured vehicle controllers. In comparison, alcohol was present in around 17% of fatally injured vehicle controllers in the most recent year of data although disturbingly over two thirds of these had high range readings (above 0.15%). When considering seriously injured vehicle controllers, Methamphetamine was present in around 4.3% in the most recent data compared to 2.5% recording THC. Over the past decade, Methamphetamine has rapidly become the most common proscribed drug in killed and seriously injured vehicle controllers, overtaking THC which was more predominant in earlier years. In comparison, illegal alcohol was present in around 5% of seriously injured vehicle controllers with around half of these being high range BAC.

Clearly, illicit proscribed drugs and alcohol, both known risk factors for crashes, remain commonly present in fatally injured and seriously injured vehicle controllers in Victorian road crashes with Methamphetamine use becoming a particular problem. Consequently, enforcement of drug and alcohol use has significant potential to reduce exposure of these risk factors amongst vehicle controllers and hence reduce the incidence of crashes where use of these substances is a contributing factor. Prior to 2015 significant efforts to enforce maximum blood alcohol limits amongst Victorian vehicle controllers has been undertaken by Victoria Police with between 3 and 4 million roadside preliminary breath tests undertaken each year. Although roadside drug testing for Methamphetamine and THC presence in vehicle controllers has been carried out in Victoria since 2004, in comparison to alcohol testing, the level of drug testing, although increasing, has been far more modest with around 55,000 preliminary oral fluid tests conducted in 2014. The reasons for lower levels of drug testing were two-fold being a consequence not only of the significantly higher cost of the testing regime but also the limited training of Victoria Police members to undertake roadside drug tests. Prior to 2015, roadside drug testing capability was limited largely to members in RPDAS.

Acknowledging this, commencing in late 2014, the TAC invested in a program to increase roadside testing of proscribed illicit drugs in Victorian vehicle controllers. Investment covered 2 aspects being the training of additional Victoria Police members to conduct roadside drug testing as well as funding an increase in the number of tests to be delivered to 100,000 per annum. The primary aim of the study documented in this report was to conduct a limited process and comprehensive outcome evaluation of the TAC's investment in enhanced roadside drug enforcement in Victoria. The study had a number of specific objectives being to:

1. Document the key historical statistics and practices in drug and alcohol enforcement in Victoria and the prevalence of illicit drugs and alcohol in road crashes.
2. Undertake a limited process evaluation of the 2015 expansion of roadside drug enforcement including assessment of the impact on the number and proportion of Victoria Police members trained in roadside drug testing and the distribution in deployment of these members across the state and relate this to changes in delivery of roadside drug testing over time.
3. Develop new measures of high alcohol and high drug hours.
4. Undertake an outcome evaluation of the impact of changes in both roadside drug and alcohol enforcement on road deaths and serious injuries including establishing the relationship between enforcement delivery and the presence of drugs and alcohol in seriously injured and fatally injured vehicle controllers.
5. Using the outcomes from objectives 1-4, update the TERAM model to both estimate the impact of the TAC funded drug expansion program as well as the potential trauma benefits from further expansion of the drug and alcohol enforcement programs. From this, provide strategic learnings for future drug and alcohol enforcement in Victoria.

The success of the evaluation in meeting each of these key objectives will be explored in the following sections along with the key learnings from the study.

8.1 Evaluation data

Detail in and quality of data available for an evaluation determines the success of the evaluation in being able to identify the outcomes associated with a road safety program and to identify the specific mechanisms responsible for achieving the outcome. The range and quality of data that this evaluation was able to access undoubtable led to its success in being able to measure the road safety benefits of the TAC funded roadside drug testing enhancements.

Compared to past research on drug and alcohol enforcement, this evaluation was able to assemble a wider range of data for analysis. Previous research has found access to drug and alcohol testing data from buses has been readily accessible and this proved to be the case again for this study. Bus testing sessions were well documented and it was possible to link infringements stemming from these sessions reasonable accurately since the devices allocated to the busses were accurately recorded. One difficulty in using this data was that when a bus was used in multiple locations during a shift, of which up to 4 could be used but usually at least 2, it was sometimes difficult to associate an infringement with a particular location within a shift without complex comparison of timings. Since locations within a shift were generally within the same police Region, locating infringements within a Region was reasonably straight forward.

Enhancing the drug and alcohol testing data from busses would be made more accurate if a simple means of relating tests to locations within shift was considered in the data. Another smaller problem with the bus data was the recording of postcode of operation location in the data. For many rural towns, the postcode for the post office boxes was used rather than the postcode of the town centre itself which created some difficulty in locating operations from standardised postcode tables. Ideally, GPS location data would be recorded for all bus operation locations and carried over to the infringement data resulting from those shifts.

For the first time, this evaluation was able to access drug and alcohol test data for car operations. Previous evaluations have been able to consider this data for a single police region but not on a state-wide basis. Access to this data was critical for being able to undertake this evaluation. Location data from car alcohol test operations was recorded as a suburb name which could be readily converted to a police Region although with a small level of inaccuracy when a suburb overlapped police Regions. Car based drug test data was more often associated with a highway patrol area with no specific location recorded. Whilst these generally allowed accurate allocation of a test to a Region, there was a small percentage of the test data that could not be allocated. This meant that analysis of drug testing at a level lower than the Region, such as the police Division or LGA, was generally not possible. Enhancing the drug testing data to include a specific location of the drug test would significantly enhance the ability to undertake specific location-based analysis. Furthermore, Heavy Vehicle Unit shifts generally lacked any sort of location information meaning these operations could not be included in the analysis. Recording location information for HVU operations would also enhance analysis capability.

For crash data recorded in TIS, it was unclear how complete the matching of drug and alcohol testing outcomes for crash involved vehicle controllers would be, since this matching was not undertaken by MUARC. Labelling of specific drugs detected in the TIS data is important for understanding the prevalence of different drug types in crashes but lacked some consistency in the data. Whilst this could be overcome through re-coding, allocation of consistent naming conventions to drugs detected would enhance the quality and accuracy of the data. One limitation in the seriously injury data was the apparent limited testing of killed and seriously injured vehicle controllers for drug presence in particular as indicated by the low prevalence recorded and the step increase in 2010. To overcome this, the decision to only use data from 2010 and after in the analysis was taken. Notwithstanding this, only about one-third of seriously injured vehicle controllers admitted to hospital had a blood sample taken and tested for drugs during 2010-2016.

Lack of drug and alcohol test results for fatalities in the TIS data was an initial major limitation identified in the data resulting from the Victorian Coroner being the custodian of toxicology results for fatalities. Cooperation from the Victorian Coroner and VIFM staff overcame this problem and was greatly appreciated by the authors to enable analysis of fatally injured vehicle controllers to be undertaken in the evaluation. It was reported that coding and matching of this data to the information in TIS and subsequently RCIS took considerable effort. In order for future drug and alcohol analysis to be readily able to consider both fatally injured and seriously injured vehicle controllers in crashes, a process of automatically coding and matching of fatally injured vehicle controller toxicology results to police reported crash data should be instituted. Appending of toxicology results for non-fatally injured vehicle controllers to the crash data is also important for fully understanding the role of drugs and alcohol in serious road crashes. A potential enhancement to this process would be to include an indicator of when an injured vehicle controller presented to hospital and did not have a blood sample taken and, if possible, the reason why.

A final limitation of the study data related to the recording of data on police member training to undertake roadside drug testing. It was possible in this evaluation to know where each member was located when initially trained but not where they were subsequently posted. Consequently, analysis has focused only on the correlation between location of original member posting when trained and drug test delivery. This is not considered a major limitation since analysis only correlated the data over a relatively short time period and ultimately at an aggregate level. Being able to match subsequent member locations to training status would allow the ongoing analysis of testing capacity versus output. However, this will not be of ongoing interest since it is understood all new police members are now trained to deliver roadside drug testing.

8.2 Relationship between enforcement effort and drug and alcohol presence in crash involved vehicle controllers

Access to the detailed data for this evaluation outlined in the previous section allowed the important first step in the evaluation of being able to relate enforcement delivery to drug and alcohol presence in crash involved vehicle controllers. More specifically, it capitalised on the variation in enforcement effort between police Regions over years and the corresponding variation in drug and alcohol presence in fatally and seriously injured vehicle controllers to be able to establish the association between these two measures. Establishing this relationship was critical in being able to assess the impact of the drug enforcement increase on crash outcomes which was subsequently used to estimate the crash reduction benefits of increased drug testing in the enhanced TERAM.

Analysis has focused on the prevalence of drugs and alcohol in fatally and seriously injured divers as the primary analysis outcome and has measured the change in this outcome in response to various drug and alcohol enforcement levels. To infer crash savings benefits from such an analysis, it is assumed that drug and alcohol presence in crash involved vehicle controllers is the primary risk factor causing the crash. Presence of drugs or alcohol in the crash becomes a proxy for crash risk associated with drug and alcohol presence, risks which have been clearly demonstrated in a number of prior studies. By reducing the prevalence of drugs and alcohol involvement in serious casualty crashes through enforcement, it is assumed through the established risks associated with substance presence that reducing the presence will reduce the number of resulting crashes proportionately. It is on this basis that the associations between enforcement and drug and alcohol presence in serious crashes have been applied to estimate crash savings using TERAM.

Analysis presented in this study has identified a number of clear associations between both enforcement levels and the rate of identifying infringing vehicle controllers per enforcement effort (the 'hit rate'). Established associations for both drug and alcohol presence in fatally and seriously injured vehicle controllers are discussed in the following sections.

8.2.1 Drug enforcement and crashes

Analysis undertaken during this phase of the research indicates clear associations between roadside drug testing and the rate of THC and Methamphetamine presence in vehicle controllers injured, both seriously and fatally, in road crashes, in Victoria. An important finding has been that the presence of different drug types in crash involved vehicle controllers has corresponded to different aspects of the RDT enforcement program. In relation to serious injury crashes, analysis showed that increases in the number of roadside preliminary drug tests (POFTs) administered was associated with reductions in THC detection. As such, similar to that known about roadside alcohol testing, it appears that in relation to RDT a general deterrence model applies to deterring THC use by vehicle controllers. The absence of any association between Methamphetamine detection in serious or fatally injured vehicle controllers and the number of POFTs administered suggests that the general deterrence model does not apply to Methamphetamine, whilst THC users are more deterred by the perceived threat of detection (general deterrence) based on the number of roadside POFTs conducted.

In relation to fatal crashes, some additional observations on the relationships between enforcement and drug presence in serious crashes were made. As for the serious injury analysis, THC presence in fatal crashes had a strong negative association with the number of POFTs conducted. Further analysis shows the relationship stemmed primarily from the POFTs conducted from cars and not with those conducted from busses. In addition, there was a significant association between hit rate and THC presence in fatal crashes with the suggestion that this relationship also stemmed largely from car-based testing. These findings suggested that while the general deterrence theory around drug testing is effective with some user populations, there appears to be a more "chronic" cannabis user population, ant particularly those likely to be involved in fatal crashes, that is additionally deterred following actual detection. The drug testing hit rate had a strong association with Methamphetamine presence in both serious and fatally injured vehicle controllers suggesting RDT enforcement based on a specific deterrence model is more appropriate for reducing Methamphetamine use by vehicle controllers and subsequent crash involvement. Deterring Methamphetamine use appears to be associated with actually 'catching' affected vehicle controllers (specific deterrence) although analysis also identified a weak association between the number of POFTs delivered from cars and Methamphetamine presence in fatal crashes. Furthermore, analysis indicated that, like for THC, car-based testing resulting in detection is the primary mechanism of deterrence.

These results suggest a two-pronged approach to drug enforcement is optimal. An element of extensive testing, likely random, is required to deter THC use amongst vehicle controllers, the more tests delivered the greater the deterrence. To deter Methamphetamine, and some cannabis use associated with fatal crashes, a component of the RDT enforcement program aimed at specifically targeting the interception of drug affected vehicle controllers is required, with these increases in detection rates then leading to reductions in crash involvement. These increased detection rates could be achieved through incorporation of intelligence based RDT enforcement strategies targeting the time, locations and demographics most likely associated with Methamphetamine use. For deterrence of drug use, car-based delivery of testing seems to be optimal.

Interpreting the relationship between drug testing and THC involvement in serious crashes shows that the TAC funded drug testing expansion program has been associated with a 44% reduction in the presence of THC in vehicle controller serious injuries and a 47% reduction of THC presence in fatally injured vehicle controllers. This reduction can be directly attributed to the expansion program which led to the increase in drug testing from 42,000 to 100,000 per annum. In contrast, the increase in testing hit rate from 2% to 11% during 2010 to 2016 has reduced the odds of Methamphetamine detection in seriously injured vehicle controllers by 37%. Whether this increased detection rate can be directly attributed to the drug testing program expansion is less clear and will require further research. A greater emphasis on targeted testing by police is apparently the key factor behind this improvement. It is likely that the expansion of the program, and in particular the training of additional Highway Patrol Officers to undertake drug testing, has increased the capacity for more targeted testing from cars in particular.

Identification of the relationship between test hit rate and Methamphetamine involvement in crashes is a new finding that was not identified in previous relationships used to inform previous iterations of TERAM. Assessment of the drug prevalence data in fatally and seriously injured vehicle controllers over time shows why this was the case. Previous calibration of the relationship between drug enforcement and the presence of drugs in crash involved vehicle controllers was calibrated from data prior to 2010. In this period, THC was the predominantly detected drug, explaining why the relationship with enforcement was identified as with the number of tests delivered, as also identified in this study. With the prevalence of Methamphetamine being low during this time, the association between test hit rate and Methamphetamine presence in crashes would not have been identified. This highlights the importance of the current evaluation in identifying effective enforcement strategies for proscribed illicit drugs as the drug landscape changes. It also identifies the need to modify enforcement strategies according to the mix of proscribed illicit drugs present in the community at any point in time.

8.2.2 Alcohol enforcement and crashes

This research explored roadside alcohol breath testing operations in Victoria from 2006 to 2016, which included the transition from the previous PBT equipment (SD400) to the adoption of the Touch 400. During these years there was an average of 3 to 4 million roadside alcohol breath tests were conducted annually. However, declines in testing numbers were identified during the later years (2015 & 2016). These declines are predominantly linked with declines in car based-testing operations and particularly in the Eastern and Western Regions. These two regions had reported the highest number of testing (car and bus-based combined) across all data years and the noted declines during 2015 and 2016 reflected a decrease that brought them in line with testing numbers of the North West Metro and Southern Metro Regions, so it is unknown whether this decrease was intentional or warrants further investigation. However, it is also possible that the declines in the number of car-based PBTs conducted during 2015 and 2016 are related to the move to the 2-up policy where all vehicles are required to have 2 officers on board when undertaking traffic duties to ensure safety.

Data on alcohol enforcement analysed also showed that the rate of positive tests per test administered (the 'hit rate') has been steadily dropping over time. There are a number of possible reasons for this. First, alcohol testing might be becoming more random over time, particularly from car administered tests. Alternatively, the rate of alcohol use by vehicle controllers might be declining. Declining hit rates from bus-based testing, which is likely to be more random, suggest the latter possibility is more likely. Despite the general drop in alcohol detection, a more concerning trend is the proportion of crash involved vehicle controllers that fall in the high range BAC level with 50% of seriously injured vehicle controllers with alcohol in their system falling in to the high range and an even higher proportion of fatally injured vehicle controllers. These figures support the continued need for alcohol enforcement.

In relation to alcohol enforcement operations, there was an approximate 1:2 ratio of bus to car testing operations. The detection of drink vehicle controllers ('hit rate') is higher for car-based operations, at least double. There are several possible explanations for the greater detection rates from car-based operations. Firstly, car-based operations are possibly targeted to known locations and times, in comparison to bus-based operations that represent random testing of a broad range of vehicle controllers. As noted in earlier research, both types of operation play important roles in the drink driving enforcement regime, with bus-based operations playing a key role in general deterrence, while the more covert car-based operations can detect vehicle controllers attempting to avoid detection through travel in local streets (Clark et al., 2009; Keall & Frith, 1997).

Reflecting the previously established model of general deterrence for vehicle controller alcohol use, a strong association was found in this study between the number of PBTs conducted and the proportion of seriously injured vehicle controllers detected with both illegal and high range alcohol levels. There was strong association with both car and bus-based tests delivered. For fatally injured vehicle controllers, the number of bus-based tests delivered had the strongest association with alcohol presence. In contrast to previous studies, this study also identified a strong association between the alcohol testing hit rate and the presence of both high and low range alcohol in both fatally and seriously injured vehicle controllers. This result stemmed largely from the strong correlation with testing hit rate from bus-based testing. Identification of a relationship with testing hit rate suggests both general and specific deterrence models now have application to alcohol enforcement in Victoria. The addition of a role for specific deterrence not observed previously may reflect the change in sanctions for alcohol detection in Victoria having become more severe including large fines, longer license suspension periods and, importantly, the introduction of alcohol interlocks firstly for high range and then also low range alcohol detected vehicle controllers. Each of these sanctions is likely to have had a significant impact in reducing the exposure of drink driving on the road, reflecting the increased value of specific deterrence that leads to application of thee sanctions. In combination, these results suggest the use of a mixed random and targeted enforcement model in Victoria with busses providing the key tool for its delivery.

8.2.3 Summary of relationships between enforcement and drug and alcohol presence in crashes

A range of relationships between drug and alcohol enforcement, including tests delivered and the test hit rate, and the likelihood of drug and alcohol presence in fatally and seriously injured vehicle controllers were identified. A summary of the associations found is given in Table 38 for each of the outcomes and enforcement measures considered. A tick represents a statistically significant association whilst a question mark represents a marginally statistically significant association where the value of the odds ratio indicated an important relationship might exist and should be further explored.

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TABLE 38 SUMMARY OF RELATIONSHIPS IDENTIFIED BETWEEN DRUG AND ALCOHOL TESTING MEASURES AND THE PRESENCE OF PROSCRIBED ILLICIT DRUGS AND ILLEGAL OR HIGH RANGE ALCOHOL IN FATALLY (F) AND SERIOUSLY INJURED (SI) VEHICLE CONTROLLERS.

	Number of Tests Delivered			Testing Hit Rate		
Outcome	Car and Bus Combined	Car	Bus	Car and Bus Combined	Car	Bus
Drug Presence in Crash Involved Vehicle Controllers						
Meth SI				☑		
Meth Fatal	?	?		☑	☑	
THC SI	☑					
THC Fatal	☑	☑		?	☑	
Alcohol Presence in Crash Involved Vehicle Controllers						
>= 0.05 SI	☑	☑	☑	☑		☑
>= 0.05 Fatal	?		☑	☑		☑
>= 0.15 SI	☑	☑	☑	☑		?
>= 0.15 Fatal			?	?		?

The summary presented in Table 38 highlights the strong relationships identified between car-based testing and drug presence in fatally or seriously injured vehicle controllers. Drug test numbers were most strongly associated with THC presence and testing hit rate was most strongly associated with Methamphetamine presence in crash involved vehicle controllers. In contrast, for alcohol presence in crash involved vehicle controllers, the table highlights the strong association with alcohol tests delivered, particularly from busses but also the newly identified relationship with test hit rate, particularly stemming from bus delivered tests.

8.3 Times of alcohol and drug prevalence in crashes

Analysis discussed in the previous section established a clear relationship between enforcement effort and drug and alcohol presence in crashes, and in particular has established a number of strong relationships between detection of drug and alcohol affected vehicle controllers and presence of drugs and alcohol in serious casualty crashes. Reflecting the importance of specific deterrence suggested by these relationships, it was important to establish times of high drug and alcohol presence in crashes so that future enforcement can be effectively targeted at times when the outcome of interest is most prevalent. Understanding times at which drug and alcohol use is most likely to be identified as a prominent contributing factor to crashes also assists in macro level strategic analysis and research focused on these problems to inform the crash sub populations on which drug and alcohol enforcement and other countermeasures are most likely to be effective.

The concept of High and Low Alcohol Hours (HAH & LAH), through the identification of the days of the week and hours of the day with increased drink driving associated crash rates, was introduced in Victoria in 1987 (South), and further refined in 1990 (Harrison) and 1995 (Gantzer). Since their development, High and Low Alcohol Hours have played an important role in informing Police drink driving enforcement strategies and RBT resource allocation and scheduling. In recognition of the changes in alcohol consumptions patterns associated with changes in population demographics; increases in shift work; and, the permitting of late-night entertainment venues, the need to review High and Low Alcohol Hours across Victoria has been on the agenda of road safety agencies. However, data limitations have prevented this from occurring, as was the case when MUARC attempted to review the hours in 2008. The data used within this research provided the opportunity to review the High and Low Alcohol Hours in Victoria based on drink driving serious injury crash data for the years 2006 to 2016. In addition, the analysis was adapted to explore drug driving patterns and resulted in the calculation of High and Low THC Hours, as well as High and Low Methamphetamine hours. While the calculation of high and low drug driving hours in this report is based on Victorian data, it is the first time (globally) that this type of analysis has been undertaken in relation to drug driving.

A full description of the analysis design and outcomes have been provided in Chapter 4, including comparison with any variation from the previous HAH and LAH hours. Enhancements to the analysis methodology including the employment of logistic regression to estimate the probability of alcohol involvement in crashes by time of day and day of week, along with setting of cut-off values for classification of alcohol or drug presence in the crash, represents a much more sophisticated and robust methodology to what has been used previously. From this methodology, High Alcohol Hours have been defined as “any hour of the day/day of week in which 20% or more of seriously injured vehicle controllers have a BAC of 0.05 or greater”. High THC Hours (HTH) and High Methamphetamine Hours (HMH) are “any hour of the day/day of week in which 20% or more of seriously injured vehicle controllers have THC or Methamphetamine (respectively) presence in their blood.

Overall, the High Alcohol Hours predominantly span the evening to early morning hours across all nights of the week. The current High Alcohol Hours were found to be very similar to the previously identified HAH, with only a few minor changes. Some of these changes may be attributable to the updated calculation process, namely the use of serious injury crash data compared to the previous reliance on fatal injury data. However, this current analysis is considered to be more robust. There are now 81 HAHs identified compared to the previous 98 hours. Apart from a few single hours either side of the previous start and finish times, the majority of the reduction in hours was attributable to the later commencement of HAH on the weekend commencing Friday night (previously 4pm, now 7pm), Saturday (previously 2pm, now 6pm) and Sunday (previously 4pm, now 6pm). Similar HAHs were identified across the four Victoria Police Regions and in Rural verses Metro comparisons, with the only notable difference being on weekdays when rural HAHs cease around an hour earlier in the morning and commence an hour later on a Monday evening compared to Metro HAH patterns. Comparison with licensed alcohol venues in the rural area compared to the Metro area may provide further insight into these slight variations. It may also reflect early morning crash risk in rural areas compared to higher traffic conditions in metro areas.

Not surprisingly, as both drink and drug driving patterns typically reflect common socializing patterns, similar to the HAHs, both High THC and Methamphetamine Hours also spanned the evening and early morning hours. Of concern was the greater number of hours associated with high drug driving hours over and above the HAHs, as well as including hours during the day. HTHs spanned 100 hours of the week and included several hour blocks across the afternoon period, HMHs spanned a total of 120 hours of the week including the mornings. In fact, there were only intermittent hours across the week that were not defined as HMHs. The disparity between HAH, HTH and HMHs further highlights the importance of, not merely replicating alcohol enforcement strategies for drug driving enforcement but, to target enforcement to the specific impairing substance and the demographics of the user populations.

8.4 Impacts of increased drug testing training

A major component of the TAC drug testing expansion project was the training of additional police members to increase the number of police members formally qualified to deliver roadside drug testing. Most commonly these were members working within the highway patrol units, with the aim of expanding and increasing the number of RDTs conducted in regional and rural areas of Victoria. This phase of the research focussed on assessing the effectiveness of the increased member training on: the number of RDTs delivered; the increasing of RDTs in rural/regional locations; and, the effects on drug driving associated crashes (serious and fatal injury). To achieve these research aims, data regarding the number of additional police members trained to undertake RDT during the TAC funded expansion project was analysed against the number of RDTs undertaken across Victoria and at a Police Region level.

The findings showed that following the TAC expansion funding there was a corresponding sharp increase in the number of Police members trained to undertake RDTs. During 2015 the number of RDT qualified Police members increased from approximately 110 to around 510 members, followed by a steady increase to approximately 700 members by the end of 2017. This sharp increase in RDT trained members was reflected in corresponding spikes in the number of RDTs delivered within all four Police Regions. While overall RDT delivery typically fluctuates over the year, with more notable spikes during the festive season, and other significant calendar events, the increase that resulted from the TAC funding associated with additional member training has been maintained. On average the Police Regions (Eastern and Western) that contain regional and rural areas have continued to maintain these higher RDT levels.

Analysis confirmed the statistically significant, positive relationship, between increased member training and increased delivery of RDTs (number of POFTs), finding that each additional police member trained in RDT resulted in an additional 15 RDTs (POFTs) per month. Another important finding was the lack of identified relationship between Police member RDT training and Random Breath Testing operations (RBT) for alcohol. Although a slight negative trend was observed, this relationship was not statistically significant indicating no reliable evidence that increased member training for drug testing has had a measurable impact on RBT delivery. Instead, recent drops in RBT delivery, particularly from cars, more likely reflects the change to the 2-up policy for members in highway patrol cars.

8.5 Overall impact of the TAC funded increase in roadside drug testing

8.5.1 TAC funding from 2014/15 to 2017/18

TAC funding allowed the annual number of Preliminary Oral Fluid Tests (POFTs) for three proscribed drugs to increase from 42,000 during 2012/13 and 2013/14 to 100,000 per year during 2015/16 to 2017/18. The increased rate started during 2014/15 when 82,383 POFTs were conducted.

Relationships had been found connecting the presence of THC and Methamphetamine (MA) in vehicle controller casualties (separately for fatally and seriously injured vehicle controllers) with the increased POFTs during 2006-2016 and the positive detection rates for proscribed drugs from those tests.

TERAM analysis of the actual increases in POFTs and detection rates from random and targeted roadside drug testing operations in urban Melbourne and rural Victoria found that the TAC-funded increase was estimated to have saved more than 33 fatal crashes and nearly 80 serious injury crashes per year. Economic analysis of these savings compared with the increased Police operational costs indicated that further increases in POFTs would be economically justified.

8.5.2 Increased POFTs during 2018/19

It was planned that annual POFTs would be increased to 150,000 during 2018/19, with much larger percentage increase in targeted operations compared with random drug tests. TERAM estimated that this plan would have saved just over 23 fatal crashes and nearly 56 serious injury crashes.

During the first 45 weeks of 2018/19, available data suggested that actual POFTs did not increase as planned, especially in Melbourne where positive detection rates fell. The reduction in the detection rates may have been an outcome of the deterrent effect of the roadside drug testing program during 2018/19 and the substantially increased program during the previous three years. However, there was no evidence that detection rates decreased each year during 2015/16 to 2017/18 and a short-term effect of the increase in POFTs during 2018/19 seems unlikely. TERAM estimated that the actual increase in POFTs, when annualised, would have saved at least 3 fatal crashes and 16.5 serious injury crashes.

8.5.3 Further increases in POFTs to economically-justified maximum levels

Further increases in the roadside drug testing program in Victoria are justified up to the point where the crash savings still exceed the costs at the margin. If the savings in fatal and serious injury crashes are valued using the Human Capital method, TERAM estimated that the annual POFTs (with appropriate random/targeted mix in urban and rural regions) could be increased by 288% or to 390,100 in total. Operations at this maximum level were estimated to save 46 fatal crashes and 134.5 serious injury crashes per year. If the crash savings are valued using the Willingness-to-Pay method, TERAM estimated that annual POFTs could be increased by 450% or to 553,500 in total and save an additional 7 fatal crashes and 22.5 serious injury crashes per year.

The estimation of these crash savings relies on the relationships like those in Figure 59 (with key parameters given in Table 19) being still applicable for increases in POFTs per Police Region of up to 70,000-110,000 per year from a base of 25,000-35,000 in recent years.

8.6 The enhanced TERAM

8.6.1 Inclusion of roadside alcohol testing with drug testing in TERAM

TERAM was enhanced in this project by the inclusion of new relationships connecting the presence of drugs, and separately illegal BAC, in vehicle controller casualties with the numbers of roadside tests of each type and the positive detection rates from those tests. For roadside drug testing, the original TERAM and its 2018 update included relationships only for fatally injured vehicle controllers and random POFTs (and an estimated relationship for seriously injured vehicle controllers based on an analogy with random breath testing). The original TERAM also included relationships for both fatally and seriously injured vehicle controllers with random PBTs and assumed that they were equally applicable to non-random PBTs, based on advice from Victoria Police.

Roadside alcohol tests at bus-based operations are considered to be random (i.e., randomly selected from the traffic stream, but locations and times of operation are not necessarily random). Car-based tests are considered to be a mixture of random breath tests and targeted tests conducted for various reasons such as investigations of crashed vehicle controllers or interception of vehicle controllers suspected of illegal BAC. The much higher detection rate from car-based PBTs compared with bus-based PBTs supports the fact that car-based operations conduct a mix of random and targeted PBTs. If car-based PBTs had been separated into these two operations types, it could be expected that the random PBTs would have detection rates much closer to the bus-based PBTs. In addition, it may have been possible to develop superior models connecting illegal BAC in vehicle controller casualties with the three types of PBTs: bus-based, random car-based, and non-random car-based PBTs.

It should be noted that estimates of the potential benefits of increased drug and alcohol testing derived from TERAM are generated from the recent crash cohort and hence estimated crash savings are relative to that cohort. They do not account for future increased population levels (if relevant) or any potential underlying changes in the population rate of drug usage and driving. If the drug and alcohol using driver population increases in the future, the associated benefits in terms of total trauma savings of additional enforcement estimated from TERAM will be greater (i.e. the current estimates will be conservative)

8.6.2 Increases in PBTs to economically-justified maximum levels

The relationships connecting the prevalence of illegal BAC in fatally and seriously injured vehicle controllers (separately) with each of the bus- and car-based PBT levels during 2006-2016 were used by TERAM to estimate the crash savings if the PBTs were increased from their average levels during 2014-2016.

A preliminary analysis of 30% and 60% increases in bus-based and car-based PBTs, respectively, indicated that more than 8 fatal crashes and over 77 serious injury crashes would be saved per year. Total annual PBTs would rise by nearly 50% to more than 4.5 million per year, but the analysis indicated that further increases would be economically justified as well as saving additional serious casualty crashes.

If the savings in casualty crashes were valued by the Human Capital method, TERAM indicated that the total PBTs could be increased by 368% to 14.1 million per year before marginal costs exceed marginal benefits. Operations at this level, with appropriate mix of bus- and car-based PBTs, could be expected to save 32 fatal crashes and 268 serious injury crashes per year. If the crash savings were valued using the Willingness-to-Pay method, TERAM estimated that annual PBTs could be increased by 557% to 19.8 million and save an additional 5 fatal crashes and 23 serious injury crashes per year.

8.6.3 Comparison of savings from roadside alcohol and drug testing

The integration of the two Victorian roadside impaired vehicle controller testing programs in TERAM has allowed their respective savings in crashes and their social costs, and the operational costs, to be compared. Similar relationships connecting the presence of impairment in vehicle controller casualties with the corresponding levels of roadside testing are used by TERAM to estimate the crash savings in each case. The crash savings have also been valued in the same way in each case, most commonly using the Human Capital cost of crashes. The comparison does differ regarding the unit cost of each roadside test, with the PBT unit cost reflecting economies-of-scale (Cameron et al 2016) and the POFT unit cost including the additional costs of a secondary OFT and the laboratory test, related to the positive detection rate. The cost of further processing an apprehended offending vehicle controller is not included in TERAM for either program, due to the absence of reliable data on these costs.

A comparison was made in which the benefits and costs of each program were calculated by TERAM on the basis of the maximum roadside tests per year before the marginal costs exceeded the marginal benefits. These levels were 390,100 POFTs and 14.1 million PBTs (with appropriate operational mixes to increase offence detection rates in each case), substantially greater than the base levels used in the analysis. For increases to these levels, it is estimated that the increased POFTs would save 46 fatal crashes and the increased PBTs would save 32 fatal crashes per year. However, it is estimated they would save 135 and 266 serious injury crashes, respectively, nearly double the saving from the PBTs compared with the POFTs.

The increase in roadside drug testing up to the maximum level would be a better investment, with estimated BCR of 2.76 compared with 2.35 for the alcohol testing. A comparison of TERAM analyses of smaller increases (base levels of POFTs and PBTs increased Victoria-wide by 50%) suggests that the roadside drug testing would maintain its advantage as a better investment across the full range of increases.

8.7 Implications for future drug and alcohol enforcement practice

Results from this evaluation have provided some clear directions for future drug and alcohol enforcement in Victoria.

In terms of optimum operational practice, Table 38 along with the analysis of high alcohol and drug hours gives clear indications on how drug and alcohol enforcement should be conducted.

- Alcohol enforcement: delivery of a large number of tests from both car and bus operations is a primary key to reducing alcohol involvement in crashes. In addition, new evidence suggests alcohol enforcement should be targeted to increase the testing hit rate. This should be achieved, primarily through the targeted placement of bus operations to deliver large numbers of tests with a weighting to placing operations in areas where alcohol prevalence in crash involved vehicle controllers is high or detected alcohol use amongst vehicle controllers is high. Alcohol enforcement should be largely conducted in the identified high alcohol times, including from midnight to 6am.
- THC enforcement: delivery of a large number of tests, primarily from car operations, with some weighting towards targeting to areas of high THC fatal crash involvement or detected use is the key to reducing THC involved crashes. Tests should largely be delivered in high THC hours which are predominantly night-time hours but extend further into daytime hours than alcohol enforcement.
- Methamphetamine enforcement: should focus on achieving high hit rates and so should be targeted primarily at areas of high Methamphetamine involvement in crashes or established areas of high driver prevalence. Achieving the highest hit rate through detecting Methamphetamine affected vehicle controllers should be the primary aim. Testing should primarily be conducted from cars. Methamphetamine testing should be conducted throughout the day reflecting that there were no particular hours of the day where Methamphetamine was more prevalent in crash involved vehicle controllers.

Application of the TERAM showed that, using the above principles, there is significant potential for road trauma reductions through further expansion of both the drug and alcohol testing programs. Expansions of both programs up to 4 or more times the current level of enforcement produce marginal benefit-cost ratio estimates that are still greater than 1 (higher economic return to the community than invested in the program). Application of TERAM also showed that expansion of the drug program is economically more beneficial than expanding the alcohol enforcement program.

Based on the results of the evaluation, there are also some key program delivery KPIs that are relevant for the program including:

- Total number of PBTs delivered in high alcohol hours in total
- Percentage of PBTs delivered from buses in high alcohol hours
- PBT hit rate from bus operations in high alcohol hours
- Total number of POFTs delivered from cars across the whole day
- POFT hit rate from car delivery across the whole day

Increasing each of these KPI measures should be the goal, although specific target values for each KPI could be set after application of TERAM to set strategic targets for drug and alcohol related road trauma reduction.

8.8 Future research

Research undertaken as part of this study has provided a large range of new information to both measure the success of the TAC's investment in expanding roadside drug testing as well as to inform future drug and alcohol enforcement in Victoria. It has also identified a range of future priorities for drug and alcohol research in Victoria. Possible future research areas include:

- Development of a data framework for the collection of road safety drug and alcohol related data including:
    - enhancement of information collected to drug and alcohol enforcement to accurately measure where, when and how drug and alcohol enforcement is conducted (e.g. GPS location, car or bus delivery mode, random or targeted operation, device used, linking information etc.)
    - enhancement of road crash information to include comprehensive and consistent information on drug and alcohol involvement in all crash involved vehicle controllers for all severity of injury including fatalities.
- Development and collection of a range of KPIs, intermediate and final outcome measures on drug and alcohol enforcement to provide ongoing measures on the success of program delivery.
- Undertake further application of TERAM to set specific goals for further expansion of the drug and alcohol testing program to Victorian road safety goals.
- Undertake further investigation into the relationship between drug and alcohol enforcement and drug and alcohol presence in fatally injured vehicle controllers based on extended linking of coronial toxicology data with fatal crash records. This should include understanding of the collection of injured vehicle controller blood samples at hospitals, their submission to VIFM for analysis, and their linking to injured vehicle controller crash records, including reasons for non-linking in the case of seriously injured vehicle controllers.
- Undertake regular review of the relationship between drug and alcohol enforcement and drug and alcohol presence in all vehicle controllers in order to provide the most up to date and accurate information for strategic modelling as well as to provide ongoing evaluation of the impact of the enforcement program.
- Undertake specific research to ascertain the requirements for the balance of drug and alcohol enforcement between the various police Regions and Divisions in Victoria to maximise road safety benefits for a given investment.
- Implement an ongoing evaluation process for the Victorian roadside drug and alcohol enforcement program that would both monitor delivery of the program against best practice guideline and set strategic objectives as well as estimate the road safety benefits achieved by any future expansion of or operational changes to the program. Periodic re-evaluation of the program is recommended, particularly following major changes to operation practices in program delivery or significant expansion of the level of operation of the program.

9 CONCLUSIONS

This project aimed to evaluate the road safety impacts of the TAC funded expansion in roadside drug testing in Victoria in 2015. To achieve this, research has focused on: measuring the increase in drug tests delivered, establishing the link between Victoria Police member training to deliver drug testing, establishing the association between measures of drug testing delivery and the presence of drugs and alcohol in fatally and seriously injured vehicle controllers, and integrating these results into the TERAM strategic enforcement model to estimate the road trauma and economic impacts of measured increases in drug testing resulting from the TAC funded program. In addition, further application of TERAM was able to estimate the benefits of further expansion of the drug testing program subsequent to the initial TAC funded increase as well as estimating the point of diminishing returns for both the drug and alcohol enforcement programs. Finally, to assist with future enforcement and research, days and hours of the week where drugs and alcohol are more likely to be detected in crash involved vehicle controllers were estimated.

Specific conclusions from the project are as follows:

9.1 Increase in drug testing and its relationship to drug testing training

- TAC funding allowed the annual number of Preliminary Oral Fluid Tests (POFTs) for three proscribed drugs to increase from 42,000 during 2012/13 and 2013/14 to 100,000 per year during 2015/16 to 2017/18. The increased rate started during 2014/15 when 82,383 POFTs were conducted.
- Increasing the annual rate of drug testing was facilitated through the additional training of Victoria Police members, in particular offices from Highway Patrol, to conduct roadside drug testing. During 2015 the number of RDT qualified Police members increased from approximately 110 to around 510 members, followed by a steady increase to approximately 700 members by the end of 2017.
- There was a strong correlation between the increase in the number of RDT qualified Police members and the increase in drug test delivery achieved. There was no identified correlation between the increase in drug testing and the level of delivery of roadside alcohol testing.

9.2 The relationship between drug and alcohol testing and drug and alcohol presence in crash involved vehicle controllers

A range of relationships between drug and alcohol enforcement, including tests delivered and the test hit rate, and the likelihood of drug and alcohol presence in fatally and seriously injured vehicle controllers were identified. A summary of the associations found is given in the following table. Outcomes considered were THC, Methamphetamine, alcohol at or above 0.05 g/100mL, and alcohol at or above 0.15 g/100mL presence in fatally and seriously injured vehicle controllers. Enforcement measures considered were annual number of POFTs or PBTs delivered per Region per year and the hit rate (rate of positive tests per test delivered) both in total and from car and bus operations separately. A tick in the table represents a statistically significant association whilst a question mark represents a marginally statistically significant association where the value of the odds ratio indicated an important relationship might exist and should be further explored.

	Number of Tests Delivered			Testing Hit Rate		
Outcome	Car and Bus Combined	Car	Bus	Car and Bus Combined	Car	Bus
Drug Presence in Crash Involved Vehicle Controllers						
Meth SI				☑		
Meth Fatal	?	?		☑	☑	
THC SI	☑					
THC Fatal	☑	☑		?	☑	
Alcohol Presence in Crash Involved Vehicle Controllers						
>= 0.05 SI	☑	☑	☑	☑		☑
>= 0.05 Fatal	?		☑	☑		☑
>= 0.15 SI	☑	☑	☑	☑		?
>= 0.15 Fatal			?	?		?

9.3 Estimation of drug and alcohol hours

Analysis was able to estimate days of the week and times of the day where alcohol and drugs was more prevalent in crash involved vehicle controllers. High Alcohol Hours have been defined as "any hour of the day/day of week in which 20% or more of seriously injured vehicle controllers have a BAC of 0.05 or greater". High THC Hours (HTH) and High Methamphetamine Hours (HMH) are "any hour of the day/day of week in which 20% or more of seriously injured vehicle controllers have THC or Methamphetamine (respectively) presence in their blood.

High alcohol times were identified similar to previously defined as:

- Sunday 6PM -Monday 9AM
- Monday 7PM -Tuesday 6AM
- Tuesday 7PM -Wednesday 5AM
- Wednesday 7PM -Thursday 5AM
- Thursday 7PM -Friday 5AM
- Friday 7PM -Saturday 6AM
- Saturday 6PM -Sunday 8AM

High THC hours were identified as:

- Sunday 3PM -Monday 9AM
- Monday 3PM -Tuesday 6AM
- Tuesday 11AM -Wednesday 5AM
- Wednesday 11AM -Thursday 5AM
- Thursday 7PM -Friday 4AM
- Friday 11AM -Saturday 5AM
- Saturday 2PM -Sunday 7AM

Methamphetamine presence in crash involved vehicle controllers was relatively uniform across the week.

9.4 Impacts of increased drug and alcohol road trauma

Specifically related to the increase in drug testing achieved through the TAC funding, application of TERAM estimated the following benefits:

- The TAC funded increase in roadside drug tests from 42,000 to 100,000 per year was effective and highly cost-beneficial. It was estimated to have saved more than 33 fatal crashes and nearly 80 serious injury crashes per year.[2]
- The estimated BCR for the expansion valuing estimated road trauma savings using the Human Capital method was 9.17.
- Although not funded under the program being evaluated, planned further increase in roadside drug tests to 150,000 during 2018/19 should have saved a further 23 fatal crashes and nearly 56 serious injury crashes. However, available data from the first 45 weeks of 2018/19 indicates that roadside drug tests were not increased as planned. Actual increases, when annualised to the full year, were estimated to have saved at least 3 fatal crashes and 16.5 serious injury crashes during 2018/19.

Further application of TERAM estimated the potential benefits of further expansion to drug and alcohol enforcement in Victoria including estimating the point of diminishing returns for each element of the program (the level of enforcement after which additional enforcement will cost more than the community cost savings achieved). Key findings were:

- Further increases in roadside drug tests are justified on economic criteria as well as the additional savings in fatal and serious injury crashes.
- Valuing the crash savings by Human Capital costs, roadside drug tests could increase up to 390,100 POFTs annually and are estimated to save 46 fatal crashes and 134.5 serious injury crashes per year.
- A 50% increase in roadside alcohol tests (composed of 30% and 60% increases in bus- and car-based tests, respectively) from 2014-2016 levels is estimated to save more than 8 fatal crashes and over 77 serious injury crashes per year.
- As with roadside drug tests, further increases in roadside alcohol tests are justified on economic criteria as well the additional savings in fatal and serious injury crashes.
- Valuing the crash savings by Human Capital costs, roadside alcohol tests could increase to 14.1 million PBTs annually in total and are estimated to save 32 fatal crashes and 268 serious injury crashes per year.
- Investment in further roadside drug testing would achieve greater reduction in the social costs of crashes than roadside alcohol testing, relative to the operational costs of each program.
- At the maximum levels of each program indicated by Human Capital crash valuation, the roadside drug testing program is estimated to save an additional 14 fatal crashes per year compared with the roadside alcohol testing. However, it would save only about half the number of serious injury crashes.

Estimates of potential road trauma savings related to further expansion of the drug and alcohol enforcement programs have assumed that the additional enforcement is delivered in an optimal way based on the relationships between enforcement modes and crash outcomes identified in this study (for example, prioritising targeted car-based testing for methamphetamine). If any future expansion of drug and alcohol testing is not deployed according to the optimal principles identified and summarised in the next section, the road safety benefits estimated in this study will not be realised.

9.5 Implications for future drug and alcohol enforcement

Results of the evaluation defined some principles for future drug and alcohol enforcement in Victoria to maximise road safety and associated economic benefits.

- Alcohol enforcement should:
    - Deliver a large number of tests from both car and bus operations
    - Be targeted to increase the testing hit rate. This could be achieved through the use of bus operations (which deliver large numbers of tests), with targeted placement in areas where alcohol prevalence in crash involved vehicle controllers is high or detected alcohol use amongst vehicle controllers is high.
    - Be largely conducted in high the identified high alcohol times, including from midnight to 6am.
- THC enforcement should:
    - Delivery of a large number of tests, primarily from car operations, with some weighting towards targeting to areas of high THC fatal crash involvement or detected use is the key to reducing THC involved crashes.
    - Should largely be delivered in high THC hours which are predominantly night-time hours but extend further into daytime hours than alcohol enforcement.
- Methamphetamine enforcement should:
    - Focus on achieving high hit rates so should be targeted primarily at areas of high Methamphetamine involvement in crashes or established areas of high prevalence in vehicle controllers. Achieving the

[2] Note that the savings estimated are relative to the (unobserved) trauma that would have been observed had the drug testing increase not occurred and not relative to observed trauma in the year prior to the testing increase.

highest hit rate through detecting Methamphetamine affected vehicle controllers should be the primary aim.

- Should primarily be conducted from cars.
- Should also be conducted throughout the day reflecting that there were no particular hours of the day where Methamphetamine was more prevalent in crash involved vehicle controllers.

From these principles a range of KPIs and interim outcome measures can be defined.

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APPENDIX A VICTORIA POLICE REGION AND DIVISION CORRESPONDING TO LOCAL GOVERNMENT AREA (LGA)

Region	Division	Local Government Area
North West Metro	Division 1	MELBOURNE
		YARRA
	Division 2	HOBSONS BAY
		MARIBYRNONG
		WYNDHAM
	Division 3	BRIMBANK
		MELTON
	Division 4	HUME
		MOONEE VALLEY
		MORELAND
	Division 5	BANYULE
		DAREBIN
		NILLUMBIK
		WHITTLESEA
Southern Metro	Division 1	PORT PHILLIP
		STONNINGTON
	Division 2	BAYSIDE
		GLEN EIRA
		KINGSTON
	Division 3	CARDINIA
		CASEY
		GREATER DANDENONG
	Division 4	FRANKSTON
		MORNINGTON PENINSULA
Eastern	Division 1	BOROONDARA
		MANNINGHAM
		MONASH
		WHITEHORSE
	Division 2	KNOX
		MAROONDAH
		YARRA RANGES
	Division 3	BENALLA
		GREATER SHEPPARTON
		MANSFIELD

Region	Division	Local Government Area
		MITCHELL
		MURRINDINDI
		STRATHBOGIE
		MURRINDINI
		SHEPPARTON
	Division 4	ALPINE
		INDIGO
		MOIRA
		TOWONG
		WANGARATTA
		WODONGA
	Division 5	BASS COAST
		BAW
		LATROBE
		SOUTH GIPPSLAND
		LA TROBE
	Division 6	EAST GIPPSLAND
		WELLINGTON
Western	Division 1	COLAC-OTWAY
		GREATER GEELONG
		QUEENSCLIFFE
		SURF COAST
	Division 2	CORANGAMITE
		GLENELG
		MOYNE
		SOUTHERN GRAMPIANS
		WARRNAMBOOL
	Division 3	BALLARAT
		GOLDEN PLAINS
		HEPBURN
		MOORABOOL
		PYRENEES
	Division 4	ARARAT
		HINDMARSH
		HORSHAM
		NORTHERN GRAMPIANS

Region	Division	Local Government Area
	Division 5	WEST WIMMERA
		YARRIAMBIACK
		CAMPASPE
		CENTRAL GOLDFIELDS
		GREATER BENDIGO
		LODDON
		MACEDON RANGES
		MOUNT ALEXANDER
	Division 6	BULOKE
		GANNAWARRA
		MILDURA
		SWAN HILL

APPENDIX B MODEL OUTPUT – RDT SERIOUS INJURY

B.1 Model output for effect of total number of POFTs on presence of THC in seriously injured drivers

Parameter Estimates										
			95% Wald Confidence Interval		Hypothesis Test				95% Wald Confidence Interval for Exp(B)	
Parameter	B	Std. Error	Lower	Upper	Wald Chi-Square	df	Sig.	Exp(B)	Lower	Upper
(Intercept)	-2.778	0.2303	-3.229	-2.327	145.573	1	0.000	0.062154	0.039580	0.097603
[acc_year=2010]	-0.132	0.1765	-0.478	0.214	0.562	1	0.453	0.876040	0.619811	1.238192
[acc_year=2011]	-0.177	0.1956	-0.560	0.207	0.818	1	0.366	0.837876	0.571043	1.229392
[acc_year=2012]	-0.038	0.1639	-0.359	0.284	0.053	1	0.819	0.963135	0.698515	1.328000
[acc_year=2013]	-0.574	0.1862	-0.939	-0.209	9.505	1	0.002	0.563273	0.391062	0.811319
[acc_year=2014]	-0.510	0.1666	-0.836	-0.183	9.368	1	0.002	0.600610	0.433325	0.832476
[acc_year=2015]	0.011	0.1457	-0.275	0.296	0.005	1	0.941	1.010855	0.759759	1.344936
[acc_year=2016]	0[a]							1		
Number of POFTs conducted	-3.936E-05	9.2016E-06	-5.739E-05	-2.132E-05	18.295	1	0.000	0.999961	0.999943	0.999979
(Scale)	1[b]									

Events: Number of Seriously Injured Drivers with positive drug result (THC)
Trials: Number of Seriously Injured Drivers
Model: (Intercept), Number of POFTs conducted (1000), acc_year

a. Set to zero because this parameter is redundant.

b. Fixed at the displayed value.

B.2 Model output for effect of total number of POFTs and OFTs per POFT (Hit Rate) on presence of THC in seriously injured drivers

Parameter Estimates										
			95% Wald Confidence Interval		Hypothesis Test				95% Wald Confidence Interval for Exp(B)	
Parameter	B	Std. Error	Lower	Upper	Wald Chi-Square	df	Sig.	Exp(B)	Lower	Upper
(Intercept)	-2.876	0.4839	-3.824	-1.927	35.318	1	0.000	0.056	0.022	0.146
[acc_year=2010]	-0.054	0.3838	-0.806	0.698	0.020	1	0.888	0.947	0.446	2.010
[acc_year=2011]	-0.107	0.3612	-0.815	0.601	0.088	1	0.767	0.898	0.443	1.823
[acc_year=2012]	0.015	0.2817	-0.537	0.567	0.003	1	0.957	1.015	0.584	1.763
[acc_year=2013]	-0.536	0.2504	-1.026	-0.045	4.576	1	0.032	0.585	0.358	0.956
[acc_year=2014]	-0.474	0.2288	-0.922	-0.025	4.287	1	0.038	0.623	0.398	0.975
[acc_year=2015]	0.030	0.1690	-0.301	0.362	0.032	1	0.857	1.031	0.740	1.436
[acc_year=2016]	0[a]							1		
Number of POFTs conducted	-3.882E-05	9.4906E-06	-5.742E-05	-2.022E-05	16.732	1	0.000	1.000	1.000	1.000
HIT_RATE	0.008	0.0365	-0.063	0.080	0.053	1	0.818	1.008	0.939	1.083
(Scale)	1[b]									

Events: Number of Seriously Injured Drivers with positive drug result (THC)
Trials: Number of Seriously Injured Drivers
Model: (Intercept), acc_year, Number of POFTs conducted (1000), HIT_RATE

a. Set to zero because this parameter is redundant.

b. Fixed at the displayed value.

B.3 Model output for effect of total number of POFTs on presence of Methamphetamine in seriously injured drivers

Parameter Estimates										
			95% Wald Confidence Interval		Hypothesis Test				95% Wald Confidence Interval for Exp(B)	
Parameter	B	Std. Error	Lower	Upper	Wald Chi-Square	df	Sig.	Exp(B)	Lower	Upper
(Intercept)	-3.437	0.2139	-3.857	-3.018	258.143	1	0.000	0.0321460	0.0211356	0.0488922
[acc_year=2010]	-0.852	0.1824	-1.210	-0.495	21.826	1	0.000	0.4264493	0.2982539	0.6097458
[acc_year=2011]	-0.629	0.1992	-1.019	-0.238	9.965	1	0.002	0.5332833	0.3609387	0.7879207
[acc_year=2012]	-0.166	0.1503	-0.461	0.129	1.221	1	0.269	0.8469464	0.6308087	1.1371406
[acc_year=2013]	-0.042	0.1619	-0.359	0.275	0.067	1	0.796	0.9589589	0.6982583	1.3169942
[acc_year=2014]	-0.065	0.1373	-0.334	0.204	0.224	1	0.636	0.9371034	0.7159467	1.2265757
[acc_year=2015]	0.034	0.1078	-0.178	0.245	0.097	1	0.756	1.0341227	0.8371822	1.2773919
[acc_year=2016]	0[a]							1		
Number of POFTs conducted	1.388E-05	8.4881E-06	-2.757E-06	3.052E-05	2.674	1	0.102	1.0000139	0.9999972	1.0000305
(Scale)	1[b]									

Events: Number of Seriously Injured Drivers with positive drug result (Methamphetamine)
Trials: Number of Seriously Injured Drivers
Model: (Intercept), Number of POFTs conducted (1000), acc_year

a. Set to zero because this parameter is redundant.

b. Fixed at the displayed value.

B.4 Model output for effect of total number of POFTs and OFTs per POFT (Hit Rate) on presence of Methamphetamine in seriously injured drivers

Parameter Estimates

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)	95% Wald Confidence Interval for Exp(B)	
			Lower	Upper	Wald Chi-Square	df	Sig.		Lower	Upper
(Intercept)	-2.585	0.4268	-3.422	-1.749	36.686	1	0.000	0.075	0.033	0.174
[acc_year=2010]	-1.508	0.3381	-2.171	-0.846	19.903	1	0.000	0.221	0.114	0.429
[acc_year=2011]	-1.232	0.3288	-1.877	-0.588	14.048	1	0.000	0.292	0.153	0.556
[acc_year=2012]	-0.618	0.2464	-1.101	-0.135	6.291	1	0.012	0.539	0.333	0.874
[acc_year=2013]	-0.386	0.2197	-0.817	0.044	3.090	1	0.079	0.680	0.442	1.045
[acc_year=2014]	-0.373	0.1928	-0.751	0.005	3.744	1	0.053	0.689	0.472	1.005
[acc_year=2015]	-0.124	0.1274	-0.374	0.125	0.954	1	0.329	0.883	0.688	1.133
[acc_year=2016]	0[a]							1		
Number of POFTs conducted	6.525E-06	9.1089E-06	-1.133E-05	2.438E-05	0.513	1	0.474	1.000	1.000	1.000
HIT_RATE	-0.068	0.0294	-0.125	-0.010	5.319	1	0.021	0.934	0.882	0.990
(Scale)	1[b]									

Events: Number of Seriously Injured Drivers with positive drug result (Methamphetamine)
Trials: Number of Seriously Injured Drivers
Model: (Intercept), acc_year, Number of POFTs conducted (1000), HIT_RATE

a. Set to zero because this parameter is redundant.

b. Fixed at the displayed value.

APPENDIX C MODEL OUTPUT – RDT FATAL INJURY

C.1 Model output for effect of total number of POFTs and OFTs per POFT (Hit Rate) on presence of THC in fatally injured drivers

Parameter Estimates										
			95% Wald Confidence Interval		Hypothesis Test				95% Wald Confidence Interval for Exp(B)	
Parameter	B	Std. Error	Lower	Upper	Wald Chi-Square	df	Sig.	Exp(B)	Lower	Upper
(Intercept)	0.643	1.0657	-1.446	2.732	0.364	1	0.546	1.902	0.235	15.357
[Year of Crash=2010]	-1.532	0.8516	-3.201	0.137	3.237	1	0.072	0.216	0.041	1.147
[Year of Crash=2011]	-1.648	0.7989	-3.213	-0.082	4.254	1	0.039	0.192	0.040	0.921
[Year of Crash=2012]	-1.389	0.6069	-2.579	-0.200	5.241	1	0.022	0.249	0.076	0.819
[Year of Crash=2013]	-1.085	0.5297	-2.123	-0.046	4.193	1	0.041	0.338	0.120	0.955
[Year of Crash=2014]	-0.968	0.4704	-1.889	-0.046	4.231	1	0.040	0.380	0.151	0.955
[Year of Crash=2015]	-0.159	0.3204	-0.787	0.469	0.247	1	0.619	0.853	0.455	1.598
[Year of Crash=2016]	0[a]							1		
TOTAL_POFTs_1000	-0.043	0.0214	-0.085	-0.001	3.958	1	0.047	0.958	0.919	0.999
DRUG_HIT	-0.131	0.0794	-0.286	0.025	2.715	1	0.099	0.877	0.751	1.025
(Scale)	1[b]									
Events: Number of Fatally Injured Drivers with positive drug result (THC) Trials: Number of Fatally Injured drivers Model: (Intercept), Year of Crash, Number of POFTs conducted (1000), HIT_RATE										
a. Set to zero because this parameter is redundant.										
b. Fixed at the displayed value.										

C.2 Model output for effect of total number of POFTs and OFTs per POFT (Hit Rate) on presence of THC in fatally injured drivers, by car and bus operations

Parameter Estimates										
			95% Wald Confidence Interval		Hypothesis Test				95% Wald Confidence Interval for Exp(B)	
Parameter	B	Std. Error	Lower	Upper	Wald Chi-Square	df	Sig.	Exp(B)	Lower	Upper
(Intercept)	1.294	1.2489	-1.154	3.742	1.073	1	0.300	3.646	0.315	42.161
[Year of Crash=2010]	-2.395	1.0081	-4.371	-0.419	5.642	1	0.018	0.091	0.013	0.658
[Year of Crash=2011]	-2.463	0.9185	-4.263	-0.662	7.189	1	0.007	0.085	0.014	0.516
[Year of Crash=2012]	-2.136	0.7143	-3.536	-0.736	8.941	1	0.003	0.118	0.029	0.479
[Year of Crash=2013]	-2.198	0.7637	-3.695	-0.701	8.282	1	0.004	0.111	0.025	0.496
[Year of Crash=2014]	-1.308	0.4750	-2.239	-0.377	7.586	1	0.006	0.270	0.107	0.686
[Year of Crash=2015]	-0.187	0.3128	-0.800	0.426	0.359	1	0.549	0.829	0.449	1.531
[Year of Crash=2016]	0[a]							1		
CAR_POFTs_1000	-0.107	0.0402	-0.186	-0.028	7.046	1	0.008	0.899	0.831	0.972
BUS_POFTs_1000	-0.009	0.0213	-0.051	0.032	0.189	1	0.664	0.991	0.950	1.033
Car_Hit	-0.109	0.0538	-0.214	-0.003	4.066	1	0.044	0.897	0.807	0.997
Bus_Hit	0.115	0.1364	-0.153	0.382	0.706	1	0.401	1.121	0.858	1.465
(Scale)	1[b]									

Events: Number of Fatally Injured Drivers with positive drug result (THC)
Trials: Number of Fatally Injured Drivers
Model: (Intercept), Year of Crash, CAR_POFTs_1000, BUS_POFTs_1000, Car_Hit, Bus_Hit

a. Set to zero because this parameter is redundant.

b. Fixed at the displayed value.

C.3 Model output for effect of total number of POFTs and OFTs per POFT (Hit Rate) on presence of Methamphetamine in fatally injured drivers

Parameter Estimates										
			95% Wald Confidence Interval		Hypothesis Test				95% Wald Confidence Interval for Exp(B)	
Parameter	B	Std. Error	Lower	Upper	Wald Chi-Square	df	Sig.	Exp(B)	Lower	Upper
(Intercept)	1.907	1.2149	-0.474	4.288	2.465	1	0.116	6.734	0.623	72.843
[Year of Crash=2010]	-3.795	0.9898	-5.735	-1.855	14.702	1	0.000	0.022	0.003	0.156
[Year of Crash=2011]	-3.089	0.9060	-4.864	-1.313	11.622	1	0.001	0.046	0.008	0.269
[Year of Crash=2012]	-2.510	0.6835	-3.850	-1.171	13.492	1	0.000	0.081	0.021	0.310
[Year of Crash=2013]	-1.810	0.5898	-2.966	-0.654	9.422	1	0.002	0.164	0.051	0.520
[Year of Crash=2014]	-1.973	0.5391	-3.030	-0.917	13.398	1	0.000	0.139	0.048	0.400
[Year of Crash=2015]	-1.048	0.3502	-1.735	-0.362	8.961	1	0.003	0.350	0.176	0.696
[Year of Crash=2016]	0[a]							1		
TOTAL_POFTs_1000	-0.044	0.0257	-0.094	0.007	2.911	1	0.088	0.957	0.910	1.007
DRUG_HIT	-0.236	0.0873	-0.407	-0.065	7.285	1	0.007	0.790	0.666	0.938
(Scale)	1[b]									
Events: Number of Fatally Injured Drivers with positive drug result (Methamphetamine) Trials: Number of Fatally Injured Drivers Model: (Intercept), Year of Crash, TOTAL_POFTs_1000, DRUG_HIT										
a. Set to zero because this parameter is redundant.										

b. Fixed at the displayed value.										

C.4 Model output for effect of total number of POFTs and OFTs per POFT (Hit Rate) on presence of Methamphetamine in fatally injured drivers, by car and bus operations

Parameter Estimates										
			95% Wald Confidence Interval		Hypothesis Test				95% Wald Confidence Interval for Exp(B)	
Parameter	B	Std. Error	Lower	Upper	Wald Chi-Square	df	Sig.	Exp(B)	Lower	Upper
(Intercept)	1.702	1.4219	-1.085	4.489	1.433	1	0.231	5.487	0.338	89.052
[Year of Crash=2010]	-4.208	1.1296	-6.422	-1.994	13.875	1	0.000	0.015	0.002	0.136
[Year of Crash=2011]	-3.498	1.0053	-5.469	-1.528	12.111	1	0.001	0.030	0.004	0.217
[Year of Crash=2012]	-3.114	0.7610	-4.605	-1.622	16.745	1	0.000	0.044	0.010	0.197
[Year of Crash=2013]	-3.097	0.8353	-4.734	-1.460	13.745	1	0.000	0.045	0.009	0.232
[Year of Crash=2014]	-2.074	0.5240	-3.101	-1.047	15.669	1	0.000	0.126	0.045	0.351
[Year of Crash=2015]	-0.958	0.3507	-1.645	-0.270	7.456	1	0.006	0.384	0.193	0.763
[Year of Crash=2016]	0[a]							1		
CAR_POFTs_1000	-0.095	0.0495	-0.192	0.002	3.702	1	0.054	0.909	0.825	1.002
BUS_POFTs_1000	0.014	0.0252	-0.036	0.063	0.294	1	0.588	1.014	0.965	1.065
Car_Hit	-0.159	0.0583	-0.274	-0.045	7.451	1	0.006	0.853	0.761	0.956
Bus_Hit	0.201	0.1631	-0.118	0.521	1.525	1	0.217	1.223	0.888	1.684
(Scale)	1[b]									

Events: Number of Fatally Injured Drivers with positive drug result (Methamphetamine)
Trials: Number of Fatally Injured Drivers
Model: (Intercept), Year of Crash, CAR_POFTs_1000, BUS_POFTs_1000, Car_Hit, Bus_Hit

a. Set to zero because this parameter is redundant.

b. Fixed at the displayed value.										

APPENDIX D MODEL OUTPUT – RBT SERIOUS INJURY

D.1 Model output for effect of total number of PBTs and EBTs per PBT (Hit Rate) on presence of all illegal alcohol (≥0.05 BAC) in seriously injured drivers

Parameter Estimates										
			95% Wald Confidence Interval		Hypothesis Test				95% Wald Confidence Interval for Exp(B)	
Parameter	B	Std. Error	Lower	Upper	Wald Chi-Square	df	Sig.	Exp(B)	Lower	Upper
(Intercept)	-1.458	0.2684	-1.985	-0.932	29.520	1	0.000	0.233	0.137	0.394
[Year of Crash=2006]	1.266	0.1368	0.998	1.534	85.749	1	0.000	3.548	2.714	4.638
[Year of Crash=2007]	1.262	0.1393	0.989	1.535	82.046	1	0.000	3.531	2.687	4.639
[Year of Crash=2008]	1.370	0.1482	1.079	1.660	85.367	1	0.000	3.934	2.942	5.260
[Year of Crash=2009]	1.395	0.1427	1.115	1.674	95.534	1	0.000	4.034	3.050	5.336
[Year of Crash=2010]	1.165	0.1365	0.897	1.432	72.796	1	0.000	3.205	2.452	4.187
[Year of Crash=2011]	0.932	0.1095	0.718	1.147	72.583	1	0.000	2.541	2.050	3.149
[Year of Crash=2012]	0.911	0.1206	0.675	1.148	57.077	1	0.000	2.487	1.964	3.151
[Year of Crash=2013]	0.504	0.1062	0.296	0.713	22.560	1	0.000	1.656	1.345	2.039
[Year of Crash=2014]	0.520	0.1194	0.286	0.754	18.961	1	0.000	1.682	1.331	2.126
[Year of Crash=2015]	0.148	0.1008	-0.050	0.345	2.142	1	0.143	1.159	0.951	1.412
[Year of Crash=2016]	0a							1		
PBTs_1000	-0.002	0.0003	-0.002	-0.001	26.573	1	0.000	0.998	0.998	0.999
Hit_Rate	-0.126	0.0244	-0.173	-0.078	26.446	1	0.000	0.882	0.841	0.925
(Scale)	1[b]									
Events: Number of Seriously Injured Drivers with BAC≥0.05 Trials: Number of Seriously Injured Drivers Model: (Intercept), Year of Crash, PBTs_1000, Hit Rate										
a. Set to zero because this parameter is redundant.										
b. Fixed at the displayed value.										

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D.2 Model output for effect of number of PBTs and EBTs per PBT (Hit Rate) on presence of all illegal alcohol (≥0.05 BAC) in seriously injured drivers, by car and bus operations

Parameter Estimates										
			95% Wald Confidence Interval		Hypothesis Test				95% Wald Confidence Interval for Exp(B)	
Parameter	B	Std. Error	Lower	Upper	Wald Chi-Square	df	Sig.	Exp(B)	Lower	Upper
(Intercept)	-1.776	0.2364	-2.239	-1.313	56.463	1	0.000	0.169	0.107	0.269
[Year of Crash=2006]	1.026	0.1244	0.783	1.270	68.074	1	0.000	2.791	2.187	3.561
[Year of Crash=2007]	0.941	0.1247	0.697	1.185	56.960	1	0.000	2.563	2.007	3.272
[Year of Crash=2008]	0.951	0.1481	0.661	1.241	41.255	1	0.000	2.589	1.937	3.461
[Year of Crash=2009]	0.989	0.1312	0.732	1.246	56.772	1	0.000	2.688	2.078	3.476
[Year of Crash=2010]	0.903	0.1238	0.660	1.146	53.240	1	0.000	2.467	1.936	3.144
[Year of Crash=2011]	0.643	0.1042	0.439	0.847	38.039	1	0.000	1.902	1.550	2.333
[Year of Crash=2012]	0.778	0.1156	0.552	1.005	45.301	1	0.000	2.178	1.736	2.731
[Year of Crash=2013]	0.336	0.1067	0.127	0.545	9.933	1	0.002	1.400	1.136	1.725
[Year of Crash=2014]	0.422	0.1163	0.194	0.650	13.185	1	0.000	1.525	1.214	1.916
[Year of Crash=2015]	0.065	0.1018	-0.135	0.264	0.403	1	0.525	1.067	0.874	1.303
[Year of Crash=2016]	0a							1		
CAR_PBTs_1000	-0.001	0.0003	-0.002	0.000	11.638	1	0.001	0.999	0.998	0.999
BUS_PBTs_1000	-0.002	0.0003	-0.003	-0.001	40.343	1	0.000	0.998	0.997	0.999
CAR_HIT_RATE	0.002	0.0175	-0.032	0.037	0.018	1	0.895	1.002	0.968	1.037
BUS_HIT_RATE	-0.187	0.0535	-0.254	-0.045	7.816	1	0.005	0.861	0.775	0.956
(Scale)	1[b]									

Events: Number of Seriously Injured Drivers with BAC≥0.05
Trials: Number of Seriously Injured Drivers
Model: (Intercept), Year of Crash, CAR_PBTs_1000, BUS_PBTs_1000, CAR_HIT_RATE, BUS_HIT_RATE

a. Set to zero because this parameter is redundant.

b. Fixed at the displayed value.

D.3 Model output for effect of total number of PBTs and EBTs per PBT (Hit Rate) on presence of high range (≥0.15 BAC) alcohol in seriously injured drivers

Parameter Estimates										
			95% Wald Confidence Interval		Hypothesis Test				95% Wald Confidence Interval for Exp(B)	
Parameter	B	Std. Error	Lower	Upper	Wald Chi-Square	df	Sig.	Exp(B)	Lower	Upper
(Intercept)	-2.162	0.3747	-2.896	-1.427	33.291	1	0.000	0.115	0.055	0.240
[Year of Crash=2006]	1.245	0.1893	0.874	1.616	43.276	1	0.000	3.474	2.397	5.034
[Year of Crash=2007]	1.229	0.1929	0.851	1.607	40.628	1	0.000	3.419	2.343	4.989
[Year of Crash=2008]	1.259	0.2062	0.855	1.663	37.315	1	0.000	3.523	2.352	5.278
[Year of Crash=2009]	1.317	0.1976	0.929	1.704	44.398	1	0.000	3.731	2.533	5.496
[Year of Crash=2010]	1.121	0.1889	0.751	1.492	35.224	1	0.000	3.069	2.119	4.445
[Year of Crash=2011]	0.652	0.1553	0.347	0.956	17.610	1	0.000	1.919	1.415	2.601
[Year of Crash=2012]	0.796	0.1685	0.466	1.126	22.330	1	0.000	2.217	1.593	3.084
[Year of Crash=2013]	0.536	0.1448	0.252	0.820	13.684	1	0.000	1.709	1.286	2.270
[Year of Crash=2014]	0.499	0.1655	0.174	0.823	9.075	1	0.003	1.646	1.190	2.277
[Year of Crash=2015]	0.147	0.1383	-0.124	0.419	1.138	1	0.286	1.159	0.884	1.520
[Year of Crash=2016]	0a							1		
PBTs_1000	-0.002	0.0004	-0.002	-0.001	20.057	1	0.000	0.998	0.998	0.999
Hit_Rate	-0.110	0.0337	-0.176	-0.044	10.684	1	0.001	0.896	0.838	0.957
(Scale)	1[b]									

Events: Number of Seriously Injured Drivers with BAC≥0.15
Trials: Number of Seriously Injured Drivers
Model: (Intercept), Year of Crash, PBTs_1000, Hit Rate

a. Set to zero because this parameter is redundant.

b. Fixed at the displayed value.

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D.4 Model output for effect of number of PBTs and EBTs per PBT (Hit Rate) on presence of high range (≥0.15 BAC) alcohol in seriously injured drivers by car and bus operations

Parameter Estimates										
			95% Wald Confidence Interval		Hypothesis Test				95% Wald Confidence Interval for Exp(B)	
Parameter	B	Std. Error	Lower	Upper	Wald Chi-Square	df	Sig.	Exp(B)	Lower	Upper
(Intercept)	-2.438	0.3307	-3.086	-1.790	54.335	1	0.000	0.087	0.046	0.167
[Year of Crash=2006]	1.067	0.1719	0.730	1.404	38.491	1	0.000	2.906	2.074	4.070
[Year of Crash=2007]	0.999	0.1720	0.662	1.336	33.723	1	0.000	2.715	1.938	3.804
[Year of Crash=2008]	0.936	0.2053	0.534	1.338	20.787	1	0.000	2.550	1.705	3.813
[Year of Crash=2009]	1.007	0.1806	0.653	1.361	31.079	1	0.000	2.737	1.921	3.899
[Year of Crash=2010]	0.922	0.1708	0.587	1.257	29.156	1	0.000	2.515	1.799	3.514
[Year of Crash=2011]	0.462	0.1477	0.173	0.752	9.802	1	0.002	1.588	1.189	2.121
[Year of Crash=2012]	0.698	0.1610	0.383	1.014	18.828	1	0.000	2.010	1.467	2.756
[Year of Crash=2013]	0.410	0.1451	0.126	0.694	7.988	1	0.005	1.507	1.134	2.002
[Year of Crash=2014]	0.416	0.1606	0.101	0.731	6.717	1	0.010	1.516	1.107	2.077
[Year of Crash=2015]	0.090	0.1396	-0.184	0.363	0.412	1	0.521	1.094	0.832	1.438
[Year of Crash=2016]	0a							1		
CAR_PBTs_1000	-0.001	0.0004	-0.002	-0.001	12.382	1	0.000	0.999	0.998	0.999
BUS_PBTs_1000	-0.002	0.0004	-0.002	-0.001	18.249	1	0.000	0.998	0.998	0.999
CAR_HIT_RATE	-0.006	0.0239	-0.052	0.041	0.053	1	0.817	0.994	0.949	1.042
BUS_HIT_RATE	-0.126	0.0736	-0.271	0.018	2.954	1	0.086	0.881	0.763	1.018
(Scale)	1[b]									

Events: Number of Seriously Injured Drivers with BAC≥0.15
Trials: Number of Seriously Injured Drivers
Model: (Intercept), Year of Crash, CAR_PBTs_1000, BUS_PBTs_1000, CAR_HIT_RATE, BUS_HIT_RATE

a. Set to zero because this parameter is redundant.

b. Fixed at the displayed value.

APPENDIX E MODEL OUTPUT – RBT FATAL INJURY

E.1 Model output for effect of total number of PBTs and EBTs per PBT (Hit Rate) on presence of all illegal alcohol (≥0.05 BAC) in fatally injured drivers

Parameter Estimates										
			95% Wald Confidence Interval		Hypothesis Test				95% Wald Confidence Interval for Exp(B)	
Parameter	B	Std. Error	Lower	Upper	Wald Chi-Square	df	Sig.	Exp(B)	Lower	Upper
(Intercept)	-0.354	0.7907	-1.904	1.196	0.201	1	0.654	0.702	0.149	3.305
[Year of Crash=2006]	0.464	0.3520	-0.226	1.154	1.738	1	0.187	1.591	0.798	3.171
[Year of Crash=2007]	1.148	0.3540	0.454	1.842	10.520	1	0.001	3.152	1.575	6.309
[Year of Crash=2008]	1.086	0.3869	0.328	1.844	7.879	1	0.005	2.962	1.388	6.324
[Year of Crash=2009]	0.883	0.3992	0.101	1.666	4.897	1	0.027	2.419	1.106	5.290
[Year of Crash=2010]	0.563	0.3774	-0.177	1.303	2.223	1	0.136	1.756	0.838	3.679
[Year of Crash=2011]	0.399	0.3128	-0.214	1.012	1.630	1	0.202	1.491	0.808	2.752
[Year of Crash=2012]	0.575	0.3501	-0.111	1.261	2.699	1	0.100	1.778	0.895	3.530
[Year of Crash=2013]	0.253	0.3003	-0.336	0.841	0.708	1	0.400	1.287	0.715	2.319
[Year of Crash=2014]	0.208	0.3503	-0.478	0.895	0.354	1	0.552	1.232	0.620	2.447
[Year of Crash=2015]	0.006	0.2836	-0.550	0.562	0.000	1	0.983	1.006	0.577	1.754
[Year of Crash=2016]	0[a]							1		
PBTs_1000	-0.001	0.0008	-0.003	0.001	1.669	1	0.196	0.999	0.997	1.001
HIT_RATE1	-0.168	0.0700	-0.305	-0.031	5.756	1	0.016	0.845	0.737	0.970
(Scale)	1[b]									

Events: Number of Fatally Injured Drivers with BAC≥0.05
Trials: Number of Fatally Injured Drivers
Model: (Intercept), Year of Crash, PBTs_1000, HIT_RATE1

a. Set to zero because this parameter is redundant.

b. Fixed at the displayed value.

E.2 Model output for effect of number of PBTs and EBTs per PBT (Hit Rate) on presence of all illegal alcohol (≥0.05 BAC) in fatally injured drivers by car and bus operations

Parameter Estimates										
			95% Wald Confidence Interval		Hypothesis Test				95% Wald Confidence Interval for Exp(B)	
Parameter	B	Std. Error	Lower	Upper	Wald Chi-Square	df	Sig.	Exp(B)	Lower	Upper
(Intercept)	-0.652	0.7593	-2.140	0.836	0.737	1	0.391	0.521	0.118	2.308
[Year of Crash=2006]	0.312	0.4070	-0.485	1.110	0.589	1	0.443	1.367	0.615	3.035
[Year of Crash=2007]	0.778	0.3763	0.041	1.516	4.277	1	0.039	2.178	1.042	4.553
[Year of Crash=2008]	0.507	0.3988	-0.274	1.289	1.618	1	0.203	1.661	0.760	3.629
[Year of Crash=2009]	0.349	0.3966	-0.428	1.127	0.776	1	0.378	1.418	0.652	3.085
[Year of Crash=2010]	0.259	0.3749	-0.475	0.994	0.479	1	0.489	1.296	0.622	2.703
[Year of Crash=2011]	-0.014	0.3257	-0.652	0.625	0.002	1	0.966	0.986	0.521	1.868
[Year of Crash=2012]	0.401	0.3606	-0.305	1.108	1.239	1	0.266	1.494	0.737	3.029
[Year of Crash=2013]	-0.009	0.3110	-0.619	0.601	0.001	1	0.977	0.991	0.539	1.823
[Year of Crash=2014]	0.101	0.3585	-0.601	0.804	0.080	1	0.778	1.106	0.548	2.234
[Year of Crash=2015]	-0.139	0.2874	-0.702	0.424	0.233	1	0.629	0.870	0.496	1.529
[Year of Crash=2016]	0[a]							1		
CAR_PBTs_1000	0.000	0.0009	-0.002	0.002	0.090	1	0.764	1.000	0.998	1.002
BUS_PBTs_1000	-0.003	0.0011	-0.005	-0.001	9.306	1	0.002	0.997	0.995	0.999
CAR_HIT_RATE	0.062	0.0576	-0.051	0.175	1.163	1	0.281	1.064	0.951	1.191
BUS_HIT_RATE	-0.288	0.1443	-0.571	-0.005	3.974	1	0.046	0.750	0.565	0.995
(Scale)	1[b]									

Events: Number of Fatally Injured Drivers with BAC≥05
Trials: Number of Fatally Injured Drivers
Model: (Intercept), Year of Crash, CAR_PBTs_1000, BUS_PBTs_1000, CAR_HIT_RATE, BUS_HIT_RATE

a. Set to zero because this parameter is redundant.

b. Fixed at the displayed value.

E.3 Model output for effect of total number of PBTs and EBTs per PBT (Hit Rate) on presence of high range (≥0.15 BAC) alcohol in fatally injured drivers

Parameter Estimates										
			95% Wald Confidence Interval		Hypothesis Test				95% Wald Confidence Interval for Exp(B)	
Parameter	B	Std. Error	Lower	Upper	Wald Chi-Square	df	Sig.	Exp(B)	Lower	Upper
(Intercept)	-1.519	0.9445	-3.370	0.332	2.586	1	0.108	0.219	0.034	1.394
[Year of Crash=2006]	0.166	0.4131	-0.644	0.976	0.161	1	0.688	1.181	0.525	2.653
[Year of Crash=2007]	0.799	0.4133	-0.011	1.609	3.738	1	0.053	2.223	0.989	4.998
[Year of Crash=2008]	0.853	0.4489	-0.027	1.733	3.609	1	0.057	2.346	0.973	5.656
[Year of Crash=2009]	0.185	0.4831	-0.762	1.132	0.147	1	0.701	1.204	0.467	3.103
[Year of Crash=2010]	0.229	0.4436	-0.640	1.099	0.268	1	0.605	1.258	0.527	3.001
[Year of Crash=2011]	0.066	0.3749	-0.669	0.801	0.031	1	0.860	1.068	0.512	2.227
[Year of Crash=2012]	0.191	0.4148	-0.622	1.004	0.213	1	0.645	1.211	0.537	2.730
[Year of Crash=2013]	0.030	0.3526	-0.661	0.721	0.007	1	0.932	1.031	0.516	2.057
[Year of Crash=2014]	-0.251	0.4249	-1.083	0.582	0.348	1	0.555	0.778	0.338	1.790
[Year of Crash=2015]	-0.025	0.3290	-0.670	0.620	0.006	1	0.939	0.975	0.512	1.858
[Year of Crash=2016]	0[a]							1		
PBTs_1000	-2341E-05	0.0010	-0.002	0.002	0.001	1	0.981	1.000	0.998	1.002
HIT_RATE1	-0.162	0.0847	-0.328	0.004	3.646	1	0.056	0.851	0.720	1.004
(Scale)	1[b]									

Events: Number of Fatally Injured Drivers with BAC≥0.15
Trials: Number of Fatally Injured Drivers
Model: (Intercept), Year of Crash, PBTs_1000, HIT_RATE1

a. Set to zero because this parameter is redundant.

b. Fixed at the displayed value.

E. 4 Model output for effect of number of PBTs and EBTs per PBT (Hit Rate) on presence of high range (≥0.15 BAC) alcohol in fatally injured drivers by car and bus operations

Parameter Estimates										
			95% Wald Confidence Interval		Hypothesis Test				95% Wald Confidence Interval for Exp(B)	
Parameter	B	Std. Error	Lower	Upper	Wald Chi-Square	df	Sig.	Exp(B)	Lower	Upper
(Intercept)	-1.950	0.9226	-3.758	-0.141	4.465	1	0.035	0.142	0.023	0.868
[Year of Crash=2006]	0.030	0.4851	-0.921	0.981	0.004	1	0.950	1.031	0.398	2.667
[Year of Crash=2007]	0.461	0.4468	-0.415	1.337	1.065	1	0.302	1.586	0.661	3.807
[Year of Crash=2008]	0.297	0.4725	-0.629	1.223	0.396	1	0.529	1.346	0.533	3.399
[Year of Crash=2009]	-0.332	0.4899	-1.293	0.628	0.461	1	0.497	0.717	0.275	1.873
[Year of Crash=2010]	-0.073	0.4471	-0.950	0.803	0.027	1	0.870	0.929	0.387	2.233
[Year of Crash=2011]	-0.307	0.3972	-1.085	0.472	0.596	1	0.440	0.736	0.338	1.603
[Year of Crash=2012]	-0.002	0.4331	-0.851	0.847	0.000	1	0.996	0.998	0.427	2.332
[Year of Crash=2013]	-0.217	0.3689	-0.940	0.506	0.346	1	0.556	0.805	0.391	1.659
[Year of Crash=2014]	-0.383	0.4377	-1.241	0.475	0.767	1	0.381	0.682	0.289	1.607
[Year of Crash=2015]	-0.149	0.3339	-0.804	0.505	0.200	1	0.654	0.861	0.448	1.657
[Year of Crash=2016]	0[a]							1		
CAR_PBTs_1000	0.001	0.0012	-0.001	0.003	0.501	1	0.479	1.001	0.999	1.003
BUS_PBTs_1000	-0.002	0.0013	-0.004	0.001	1.633	1	0.201	0.998	0.996	1.001
CAR_HIT_RATE	0.056	0.0721	-0.085	0.197	0.607	1	0.436	1.058	0.918	1.218
BUS_HIT_RATE	-0.263	0.1755	-0.607	0.081	2.240	1	0.134	0.769	0.545	1.085
(Scale)	1[b]									

Events: Number of Fatally Injured Drivers with BAC ≥0.15
Trials: Number of Fatally Injured Drivers
Model: (Intercept), Year of Crash, CAR_PBTs_1000, BUS_PBTs_1000, CAR_HIT_RATE, BUS_HIT_RATE

a. Set to zero because this parameter is redundant.

b. Fixed at the displayed value.

APPENDIX F HIGH AND LOW ALCOHOL HOURS BY POLICE REGION

F.1 High and low alcohol hours: North West Metro Region

As shown in Figure 84 there are 77 hours of the week defined as high alcohol hours for the North West Metro region of Victoria.

These hours are:

- Sunday 7PM -Monday 9AM
- Monday 7PM -Tuesday 6AM
- Tuesday 8PM -Wednesday 6AM
- Wednesday 9PM -Thursday 5AM
- Thursday 8PM -Friday 5AM
- Friday 7PM -Saturday 6AM
- Saturday 6PM -Sunday 8AM

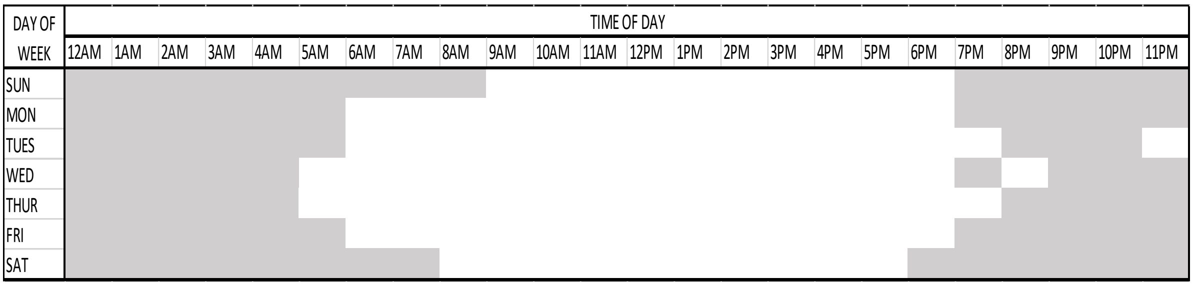

Figure 84 High alcohol hours (shaded grey) for Victoria- Northern Metro region, based on data 2006-2016

F.2 High and low alcohol hours: Southern Metro Region

As shown in Figure 85 there are 84 hours of the week defined as high alcohol hours for the Southern Metro region of Victoria.

These hours are:

- Sunday 6PM -Monday 9AM
- Monday 7PM -Tuesday 6AM
- Tuesday 7PM -Wednesday 5AM
- Wednesday 7PM -Thursday 6AM
- Thursday 7PM -Friday 5AM
- Friday 6PM -Saturday 6AM
- Saturday 5PM -Sunday 8AM

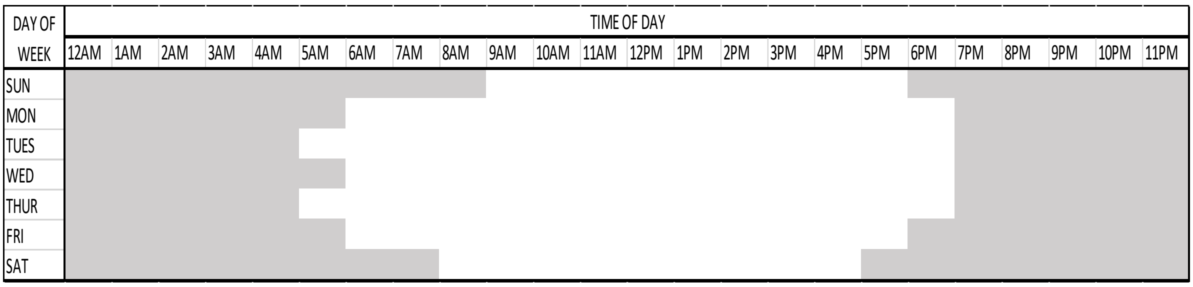

Figure 85 High alcohol hours (shaded grey) for Victoria- Southern Metro region, based on data 2006-2016

F.3 High and low alcohol hours: Eastern Region

As shown in Figure 86 there are 80 hours of the week as defined to be high alcohol hours for the Eastern region of Victoria.

These hours are:

- Sunday 6PM -Monday 7AM
- Monday 8PM -Tuesday 5AM
- Tuesday 6PM -Wednesday 6AM
- Wednesday 7PM -Thursday 5AM
- Thursday 7PM -Friday 6AM
- Friday 7PM -Saturday 7AM
- Saturday 6PM -Sunday 8AM

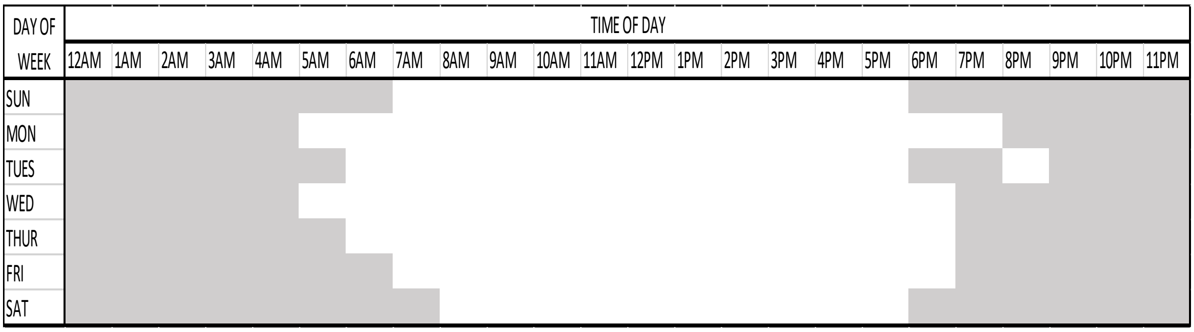

Figure 86 High alcohol hours (shaded grey) for Victoria- Eastern region, based on data 2006-2016

F.4 High and low alcohol hours: Western Region

As shown in Figure 87 there are 80 hours of the week defined as high alcohol hours for the Western region of Victoria.

These hours are:

- Sunday 5PM -Monday 9AM
- Monday 8PM -Tuesday 6AM
- Tuesday 7PM -Wednesday 5AM
- Wednesday 9PM -Thursday 6AM
- Thursday 8PM -Friday 6AM
- Friday 7PM -Saturday 6AM
- Saturday 6PM -Sunday 8AM

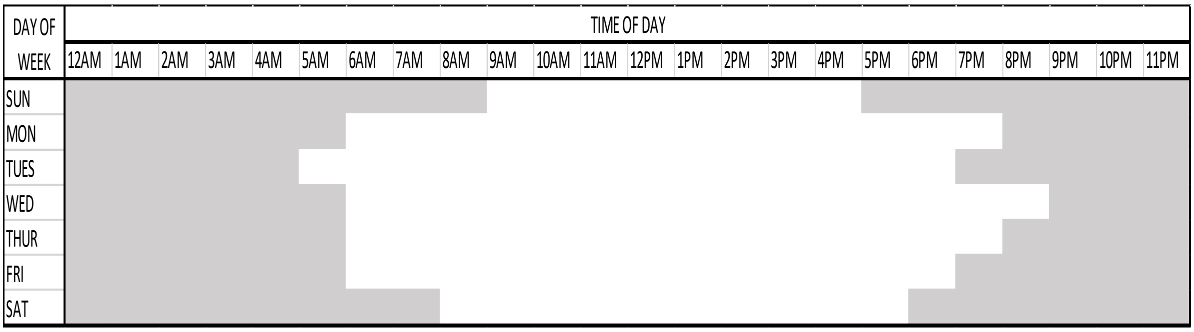

Figure 87 High alcohol hours (shaded grey) for Victoria- Western region, based on data 2006-2016

Further information

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