Road Safety Camera Commissioner

REPORT OF THE ROAD SAFETY CAMERA COMMISSIONER TO THE MINISTER FOR POLICE

Investigation into the road safety cameras operating along Peninsula Link

Date: 26 APRIL 2017

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EXECUTIVE SUMMARY

With the assistance of independent expert Mr Stuart McCormack of ByteSmart Pty Ltd, the office of the Road Safety Camera Commissioner has investigated the integrity, accuracy and efficiency of the road safety camera system on Peninsula Link. This investigation came about after public disquiet. After the most detailed analysis that this office has undertaken, no errors or faults were observed. The system is operating accurately, and its integrity has been validated.

Further, we are satisfied that the general driving public are either consciously, or unconsciously, slowing at each of the cameras until passing the camera and then speeding up after passing the camera, resulting in readings of higher point-to-point speed than instantaneous speed. We find there to be a pervasive culture in this regard amongst drivers, slowing at cameras and then speeding up.

PURPOSE

1 This report documents the findings of the Road Safety Camera Commissioner following an investigation into the accuracy, reliability and integrity of the road safety camera systems along the Peninsula Link freeway. For convenience, a not-to-scale schematic diagram can be found at **Appendix A**.

BACKGROUND

2 Peninsula Link is a dual carriageway freeway, with two traffic lanes in each direction, with an emergency lane on each carriageway. The speed limit is 100 km/h along its entire length. There are six fixed road safety camera sites operating along Peninsula Link.

The road safety camera sites along the freeway are located at:

a. Northbound at Skye Road Bridge, Frankston,

b. Northbound at Eramosa Road West Bridge, Moorooduc,

c. Northbound at Loders Road Bridge, Moorooduc,

d. Southbound at Skye Road Bridge, Frankston,

e. Southbound at Eramosa Road West Bridge, Moorooduc, and

f. Southbound at Mornington-Tyabb Road Bridge, Moorooduc.

3 The road safety cameras along Peninsula Link also operate as part of a **point-to-point** (**P2P**) or average speed road safety camera system. There are four P2P zones along Peninsula Link, between:

a. Loders Road Bridge in Moorooduc and Eramosa Road West Bridge in Moorooduc, northbound,

b. Eramosa Road West Bridge in Moorooduc and Sky Road Bridge in Frankston, northbound,

c. Skye Road Bridge in Frankston and Eramosa Road West Bridge in Moorooduc, southbound, and

d. Eramosa Road West Bridge in Moorooduc and Mornington-Tyabb Road Bridge in Moorooduc, southbound.

4 On 14 October 2016, the Mornington Peninsula Leader newspaper published an article by Allison Harding, entitled *More Than 60 drivers Query Same-Speed Fines on Peninsula Link*, detailing complaints made by motorists who had received traffic infringements for driving at 108 km/h along Peninsula Link. Some of those motorists formed a Facebook group, and at the date of publishing this report, the group comprised greater than 1,300 members.

5 My office contacted the Facebook group through the Mornington Peninsula Leader newspaper, and invited participation in this investigation. People who felt aggrieved were invited to register their grievance and to provide evidence, such as dash-cam, or data logs. There was news that a new smart-phone app called Fine Mate had been created, and I invited any information from this source. As will be described below, apart from two edited data logs, no other objective information was provided by motorists or members of this group.

6 I received a number of correspondences from aggrieved drivers, some of whom were involved in the Facebook group. These people wrote to me regarding their concerns about alleged infringements detected along Peninsula Link. My office and I telephoned a number of them to discuss their concerns.

7 The Minister for Police, the Honourable Lisa Neville, requested that I commence an investigation into the road safety camera system along Peninsula Link, which I have undertaken pursuant to section 10(c) of the *Road Safety Camera Commissioner Act* 2011.

8 We would like to thank the many people who have contributed to the preparation of this report including:

a. Mr Stuart McCormack of ByteSmart Pty Ltd,
b. More than 130 drivers who informed this office of their grievances,
c. Two drivers who volunteered data,
d. Department of Justice and Regulation,
e. Victoria Police,
f. A total of 31 motor vehicle manufacturers, including Mercedes Benz Australia and Ford Australia. Many manufacturers have also supplied information but asked not to be named,
g. Federal Chamber of Automotive Industries,
h. Linfox transport group,
i. VicRoads,
j. Ms Tia Gaffney, Senior Forensic Engineer, Delta-V Experts,
k. Professor Brian Fildes, Monash University, Accident Research Centre,
l. Professor Carolyn Unsworth, Central Queensland University, Melbourne,
m. A group of professional limousine drivers, and
n. Ms Allison Harding, Leader Community Newspapers.

THE ROAD SAFETY CAMERA SYSTEM – INSTANTANEOUS SPEED

9 All fixed road safety cameras monitoring the relevant speed limit in Victoria comprise two independently operating and calibrated systems: the primary device, also known as the primary speed calculation unit, and the secondary device, known as the secondary speed calculation unit. Speed measurements recorded by the primary device are compared with measurements made by the secondary device, to ensure that the two speeds correlate. If they do not, the measurement is automatically rejected by the camera and cannot be used as the basis for a speed infringement.

10 The six road safety camera sites operating along Peninsula Link use primary and secondary systems compliant with section 30(j) of the *Road Safety (General) Regulations* 2009.

THE ROAD SAFETY CAMERA SYSTEM – POINT-TO-POINT SPEED

11 Point-to-point road safety cameras in Victoria use speed calculation systems and are subject to being a prescribed device that must be calibrated, tested, sealed and certified. A prescribed process, outlined in sections 78 and 78A of the *Road Safety Act*

1986 is used to calculate the speed of the vehicle between the points; for an infringement to be issued, it must show that a vehicle travelled over a distance in excess of the speed limit using a formula. Sections 78 and 78A of the *Road Safety Act 1986* are included in **Appendix B** and **Appendix C**, respectively.

12 All the camera systems on the Peninsula Link Freeway utilise in-road sensors to **accurately** detect vehicles as they pass through the point or points. A digital image of the vehicle as it passes the camera point is captured along with all the relevant information including the GPS time stamp. As the vehicle travels along the roadway, the same is repeated for the next or second point as the vehicle passes through this camera point (i.e. a digital image of the vehicle as it passes the camera point is captured along with all the relevant information including the time stamp). These point vehicle digital images are then put through an Optical Character Recognition (**OCR**) software process to extract the registration number of the vehicle from the digital images. Once that has been determined, the system then matches the images from the first point to the next point based on the vehicle registration number and as a consequence determines the time taken for a vehicle to travel between the two points.

13 The fixed road distance between the camera points is accurately known and surveyed and as a result the Point-to-Point road safety camera system can utilise the vehicle travel time and the known fixed distance to accurately calculate the average vehicle speed.

14 The distance used to calculate the average speed, is the shortest distance between the two points within the zone and is measured by an approved surveyor (in accordance with the Act). If the calculated average speed exceeds the posted speed limit, an infringement notice is issued but only after it has gone through the quality assurance process.

15 Note: All Surveyor certificates for Peninsula Link road safety camera network are made available to the public via the Department of Justice and Regulation's website, refer to http://www.camerassavelives.vic.gov.au/

16 Images of vehicles that are not-matched or are non-speeding are discarded. Only images that are matched up and are deemed to be speeding are retained for further assessment.

TESTING AND MAINTENANCE OF ROAD SAFETY CAMERAS

17 All road safety cameras undergo and must pass three tests every quarter in order to remain operational, that includes their physical condition to ensure that no environmental factors affect their operation.

18 The reliability of the road safety camera's speed calculations is tested by temporarily installing a third independent speed measurement device at the camera site. This allows the speeds of many vehicles to be recorded over a reasonable period. The data acquired can be compared to show the accuracy of a road safety camera's primary and secondary devices. The speed measurements of the three independent devices must correlate. The accuracy of the primary and secondary speed calculation units are tested by driving a vehicle with a calibrated speedometer through each lane of the camera site. The speed at which the vehicle is travelling is displayed. Photographic evidence of the vehicle's speed and its speed calculated by the camera's primary and secondary devices are produced for comparison, and these measurements of each drive through of the vehicle, must correlate.

19 This process ensures that the testing of the accuracy of Fixed Digital Road Safety Camera (**FDRSC**) system timers used to determine the date and time of a test vehicle at a specific datum point or datum points. In addition, this test is also used to determine the accuracy of the measured time interval(s) between two (2) datum points (FDRSC sites) or within a specific zone. Comparisons shall be made between the measured time interval recorded by the FDRSC system and a test vehicle fitted with a calibrated interval timer display board (clock). The test vehicle shall be fitted with a calibrated interval timer display board of a suitable size and in a suitable location for it to be clearly visible in the images recorded by the FDRSC system. Depending on the FDRSC system, the interval timer display board may be fitted in a forward or rear position. The Testing Services Provider shall provide suitable images of the time interval comparison between the FDRSC system timer and the vehicle's calibrated interval timer display board.

20 In addition to the annual certification and calibration requirements, the Department of Justice and Regulation puts all fixed road safety cameras through a comprehensive program of maintenance and testing by independent qualified organisations. This testing and maintenance program is aimed at ensuring Victoria's fixed road safety cameras are operating continuously within the requirements set out in the *Road Safety (General) Regulations* 2009.

PROCESSING OF DETECTED INCIDENTS

21 No infringement notices may be automatically issued by Victoria's road safety cameras. When fixed road safety cameras detect vehicles exceeding the relevant speed limit, also known as "incidents", the recorded images and associated data are packaged into encrypted files for further processing, as long as they pass internal software checks.

22 All incidents that pass the internal software checks within automated fixed road safety cameras in Victoria will then undergo manual processing by an independent organization.

23 Each incident is assessed by at least two trained people, who must agree as to the validity of an incident independently, by applying high standards to ensure that the images and data recorded of each detected incident are correct and that an infringement notice based on that data is fair. If there is disagreement about the validity of an incident, a third person also makes an independent assessment.

24 If an incident is deemed as accepted after this process, it is then passed on to Victoria Police to ensure it is satisfied the evidence is accurate and fair before it authorises the issuing of an infringement notice to the registered owner of the vehicle.

INFRINGEMENTS ALONG PENINSULA LINK

25 There are three **instantaneous** road safety camera sites and two **point-to-point** (**P2P**) zones along Peninsula Link **in each direction**.

26 Generally, an infringement notice will reflect the 'worst' behaviour, either the highest speed alleged in that single journey, or the longest period of exceeding the speed limit if the speeds were constant. For example:

a. If the alleged speed at an instantaneous road safety camera was the same as the alleged speed for a P2P offence, the P2P infringement would be issued;

or

b. If an alleged speed of either P2P or instantaneous was higher than the other, that alleged offence would take precedence.

NATURE OF COMPLAINTS

27 The complaints received regarding this investigation relate to both instantaneous infringements and point-to-point infringements. Some asserted that there was an error in the system. Some asserted that the speed limit of 100 km/h was too low (which I took to be a statement that this is an excellent road, but that was not a complaint about the accuracy of the road safety camera systems). There were also technical complaints, such as assertions of road safety camera "clock error" for the point-to-point zones.

SCOPE OF INVESTIGATION

28 The approach taken for this investigation was: "Let's assume there's problem, what could that problem be, and how do we find it?"

29 The road safety camera system on Peninsula Link comprises many components. There are three camera sites heading southward, and three camera sites heading northward. At each camera site there are dual devices for measuring the speed of every vehicle at the instant it passes the camera. A photograph is taken of every vehicle passing through, regardless of that **instantaneous** speed. Additionally, the images of each individual vehicle's registration are matched up, together with observing the time at each point. The zones between cameras have been measured, and so the calculation of distance divided by time gives a minimum average speed between the two points. This is referred to as **point-to-point** speed.

30 We invited public contribution of objective evidence, such as dash-cam footage, data log from smart-phones, logs from specialised smart phone apps etc.

31 We have had access to data from authorities including Department of Justice and Regulation and Victoria Police, and full cooperation from other road authorities.

32 We have analysed the integrity, accuracy and efficiency of the road safety camera systems on Peninsula Link.

DATA FROM DRIVERS

33 We received data from a total of two (2) drivers regarding their infringements. One driver provided a log from a smartphone, but that data had been edited. In both drivers' GPS data logs the GPS locations were not time stamped. The absence of time stamps prevents the calculation of a precise speed at a point, but instead could best be used, if at all, for a broad average speed.

34 Using the data logs supplied by the authorities, we were able to track these two vehicles' journeys as well as the journeys of vehicles which were travelling in these drivers' vicinity. The data recorded these vehicles overtaking numerous other vehicles but not being overtaken.

35 A third driver, who has not contacted my office, made various assertions in the media and provided limited data to the media. His matter is apparently before the courts.

36 No other complainant provided any data, or dash-cam footage, or the like. Only two sets were received, both GPS data logs were of little or no probative value.

RESULTS OF INVESTIGATION

CRUISE CONTROL SYSTEMS

37 Many motorists wrote to my office protesting that they were wrongly accused of driving faster than the speed limit asserted that they were using the cruise control systems in their vehicles, and asserted that the use of their cruise control meant the road safety cameras were incorrectly measuring their speeds.

38 There was a spectrum of cruise control speeds used by these motorists, with most motorists advising that their vehicles were set at 100 km/h (the speed limit along Peninsula Link) or within 5 km/h below the speed limit.

39 A few motorists advised they set their cruise control systems to a speed slightly above the speed limit. The highest self-reported cruise control speed setting that I was informed of was 103 km/h.

40 Given the number of complaints I received relating to cruise control, I wrote to 31 car companies in Australia. I wanted to understand how each manufacturer's cruise control systems work, their accuracy, especially in relation to gradients and how the cruise control technology had evolved over time.

41 I also wrote to the Federal Chamber of Automotive Industries (FCAI) to see if there were any agreed standards or other engineering factors relating to cruise control systems used in Australian vehicles.

42 In response, I received many detailed and thorough responses from vehicle manufacturers about their vehicles. These responses outlined how the cruise control system functioned in relation to a vehicle's speedometer, optimal operating ranges, manual overrides and the conditions in which the systems would go from active to standby mode. Each manufacturer also advised of the limitations of cruise control, especially in relation to gradients and other circumstances, including driver inputs.

43 In Australia speedometers depict a higher speed than the true vehicle speed. This is in compliance with Australian Design Rule (**ADR**) 18/03, formally known as *Vehicle Standard (Australian Design Rule 18/03 - Instrumentation) 2006* found at https://www.legislation.gov.au/Details/F2006L01392

44 All vehicles in Australia are permitted to have speedometers that state the true speed or over state vehicle speed within an acceptable range. Under the Australia Design Rules, speedometers are **not** permitted to understate vehicle speed at any time.

45 The formula for the allowable range for most vehicles of over reading a true vehicle speed in ADR 18/03 is: $0 \leq (V1 - V2) \leq 0.1 * V2 +$ either 4, 6 or 8 km/h (depending on vehicle type), where:

a. V1 is the indicated speed, and

b. V2 is the true speed of the vehicle.

46 The over reading tolerance permitted by the formula is 10 per cent of the vehicle's true speed, plus an additional amount, upto 8 km/h, depending on the vehicle. For example, when a vehicle is travelling at a true speed of 100 km/h, the speedometer might indicate a range between 100 km/h and 116 km/h, inclusive.

47 Of interest to readers, many vehicle manufacturers advised me that there are no Australian Design Rules relating to cruise control systems.

48 I wish to thank each car manufacturer that replied, and the FCAI for their detailed and helpful responses to my questions.

TYPES OF CRUISE CONTROL SYSTEMS

49 There are three categories of cruise control systems. The first is **passive cruise control**, which is the original type of cruise control. Passive cruise control systems relied solely on automating throttle inputs to maintain a speed. This affects system performance on gradients due to the nature of the system. This is evident when going downhill, as the vehicle relies exclusively on engine braking to slow down. On gradients that are too steep for engine braking to curtail the speed of the vehicle, the travelling speed will increase over time. When going up an incline, these systems would increase the throttle input, down-gear (if the vehicle had an automatic transmission) or a combination of the two, in order to maintain the speed set by the driver. It is possible that the vehicle's efforts to accelerate up a steep hill will result in the vehicle exceeding the set speed.

50 A second kind of cruise control is known as **active cruise control**. This is a more modern cruise control system, which can use the vehicle's brakes to slow down if a variation from the set speed has been detected. In this case, the brakes will slow the vehicle down when engine braking is insufficient to curtail the speed of the vehicle. When going up an incline, these systems can increase the throttle input, drop down in gear (if the vehicle has an automatic transmission) or a combination of the two, in order to maintain the speed set by the driver.

51 The third type of cruise controls is **adaptive cruise control**. Vehicles equipped with these systems use front facing radar and in some cases, additional camera systems. Adaptive cruise control systems will aim to maintain travel at the set speed. Further, it will aim to maintain a safe following distance to a vehicle travelling ahead on the road, especially if the vehicle in front is travelling slower than the set speed. This type of cruise control is more capable, and will decelerate using the brakes to a set following distance – nominated by the driver - should another vehicle move in front of it, or a vehicle in front slows down. Adaptive cruise control systems will also accelerate to the previously set speed once the vehicle in front changes lanes or accelerates.

52 Newer **adaptive cruise control** systems can also follow a vehicle in front down to a complete stop. The cruise control system will also automatically drive off and resume following a vehicle, or return to the previously set speed, once the driver confirms it is safe to do so, either by pressing the accelerator pedal or by pressing a button.

OPERATION OF CRUISE CONTROL SYSTEMS

53 Irrespective of the type, capability or sophistication of the cruise control system available to a driver, he or she must turn the cruise control system on in their vehicle, before setting the speed according to the vehicle's speedometer. This is done either from buttons located on the steering wheel, or a stalk located on the steering column.

54 Generally the cruise control system will calculate the difference between the vehicle's current speed, as provided by the vehicle's speed sensor, and that set by the driver. It will then match the vehicle's speed to the set speed by automating the throttle input.

55 Once the cruise control system is set, the driver can manually adjust the set speed of the vehicle, either up or down. Using these controls, drivers can also manually cancel the cruise control. They can also reset the cruise control to the previous set speed. This may be known as the "Resume" function in some vehicles. If the driver chooses

to return to the previous set speed, the vehicle will gradually accelerate or decelerate towards the target speed.

56 There are actions a driver may take that will disengage the cruise control and return it to standby mode, without turning the system off. These include, but are not limited to:

a. Using the brakes,

b. Pressing the accelerator for longer than a predetermined period of time (this is manufacturer specific),

c. Electronic speed limiting systems are turned on (as these are mutually exclusive systems in some vehicles),

d. If the vehicle falls below the minimum operating speed for the cruise control system, such as when climbing a steep hill,

e. (For manual or semi-automatic transmissions) if the gear selected is less than third ,

f. If the gear selected is N or Neutral. This is true for all transmission types,

g. If the clutch is depressed (manual transmission only), or

h. If the vehicle's speed drops from the set speed by a predetermined amount, such as when going up a steep incline (this value is manufacturer specific).

57 There are also instances where a vehicle will automatically return the cruise control system to standby mode, but not turn the system off. These include, but are not limited to:

a. Activation of the Autonomous Emergency Braking (AEB) system when the vehicle detects a hazard ahead,

b. The engine speed becomes too low or too high,

c. The vehicle detects a yaw control event (such as suddenly avoiding an object on the road), or

d. Electronic Stability Control (ESC) and similar electronic safety measures such as Traction Control are activated.

FACTORS AFFECTING ACCURACY OF CRUISE CONTROL SYSTEMS

58 Most manufacturers advised that, in general, gradients affected the ability of cruise control systems to maintain a constant speed. Few were able to provide specific information regarding the extent of a gradient's effect on the ability for a cruise control system to maintain the set speed. Mercedes-Benz advised that the *active cruise control* systems installed in current vehicles would begin to reduce engine torque or apply the brakes when a variation of up to 4 km/h was detected.

59 Other manufacturers were also able to provide a general indication of how much speed could vary when cruise control was engaged and their vehicles were travelling up or down a gradient. One company stated its systems would begin to take measures to maintain set speed when a ±5 per cent change was detected by the cruise control system.

60 All manufacturers emphasised that the indicated speed displayed on the speedometers would always be higher than that of the vehicle's true speed, in accordance with *ADR 18/03*.

61 One manufacturer noted that in the case of using engine braking to curtail acceleration when travelling downhill, diesel engines provide more braking force compared to petrol engines.

62 While gradients were the biggest factor in the ability of cruise control systems to maintain speed accurately, other factors were named by manufacturers that could affect cruise control operation and accuracy. These include, but are not limited to:

a. Vehicle load, including when towing a trailer,
b. Hot ambient temperatures,
c. Wind conditions,
d. Tyre pressures,
e. Excessive tyre wear, or
f. Fitting wheels that are not factory standard sizes and not adjusting the speedometer calibration.

OTHER LIMITATIONS OF CRUISE CONTROL SYSTEMS

63 Cruise control systems take readings from the vehicle's speed sensors, and attempt to match the set speed as closely as possible. Each cruise control system is able to maintain a constant speed on level terrain, with one manufacturer stating its systems could maintain speed to within ±1 km/h of the set speed, and another stating its systems could maintain speed to within a small variant of the set speed. Both companies qualified their statements by advising that tolerance level related to travel on flat terrain only.

64 One vehicle manufacturer emphasised that cruise control systems "do not operate as a speed limiter and the driver should always obey the speed limit." This is because cruise control systems will allow the driver to manually accelerate beyond the set speed. Once the driver has stopped accelerating, the system will return to maintaining the speed set previously.

65 Every manufacturer stressed that irrespective of the type of cruise control system installed in a motor vehicle, cruise control systems remained a driver's aid. Such information included:

a. Cruise control is a customer convenience feature that allows the customer to maintain a set speed without keeping their foot on the accelerator pedal.
b. Conventional cruise control systems are not connected to the vehicle's brakes, so they are restricted from preventing a vehicle from over-speeding when travelling down a steep hill. This driver must monitor road speed and apply the brakes where necessary.
c. Whilst the cruise control systems are intended as a driver aid, it is always the driver's responsibility to regulate the vehicle's speed to ensure compliance with the Australian Road Rules applicable in the state or territory in which the vehicle is being driven. It is also important to note that cruise control systems are specifically designed in such a way that any driver input whilst in cruise control mode, will always override any parameters set in the cruise control system, ensuring the driver always has full control over the vehicle.
d. Cruise control systems fitted to vehicles are a drivers' aid and work in conjunction with the speedometer to provide information to the driver on the vehicle's speed. The driver should be continually monitoring the vehicle (and

surrounding traffic and road conditions) to fulfil their responsibility to drive safely and within the speed limit.

e. Numerous vehicle owners manuals provide clear reminders to drivers that cruise control is a driver assist device only, and should not replace actual driver involvement.

f. Guidance is provided to the driver in the owner hand book, indicating the system may require driver intervention to ensure driving within set speed limits. The owner hand book clearly advises maintaining a safe speed within the legal limit, while taking account of traffic and road conditions, is the driver's responsibility.

g. Mercedes-Benz Australia/Pacific stated that "cruise control is considered to be a driving aid. The driver is responsible for maintaining a safe distance from the vehicle in front, for vehicle speed, for braking in good time and for staying in lane."

ANALYSIS

66 We analysed the rate that the infringers overtook other vehicles and how that compared with the norm. We have analysed both the journeys on which infringements were alleged and other journeys by the vehicle bearing the same registration number.

67 Many infringers complained that they had relied on cruise control. We have analysed whether there is any link between their infringements and the reliance on cruise control.

68 The effect of the instantaneous cameras is to measure the speed at that instant as the vehicle passes that point. The effect of point-to-point system is to measure the driving speed between the points.

69 After exhaustive analysis, we have no evidence of any failures in the road safety camera system; and no evidence of reliance upon cruise control leading to adverse outcomes.

DISCUSSIONS WITH DRIVERS

70 In the course of preparing this report my office and I have held discussions with many drivers who use Peninsula Link. It was clear that very few had an understanding of the way that the point-to-point road safety camera system records the average speed of all vehicles.

71 Many drivers expressed the erroneous belief that the point-to-point system would average the speeds at the two instantaneous ends of the zone; others thought that the point-to-point measure would be avoided by travelling at or below the speed limit at the instantaneous cameras.

72 These beliefs are wrong and misconceived. The point-to-point system will measure the average speed of all vehicles' journeys between the two instantaneous cameras, regardless of the speed of entry and exit from the point-to-point zone.

IS THERE A CLOCK ERROR?

73 The point-to-point system relies on the accurate detection of vehicles as their registration number plates are photographed, information is recorded into a data log, and a matching time is locked into each image.

74 As part of the investigation, we needed to look at reasonable amounts of unhindered traffic. We chose to look at complete journeys beginning between 10:00 PM and 1:00 AM, when traffic is generally light and unhindered. Altogether, 127,914 candidate journey records were assembled.

75 Average instantaneous speeds Southbound are marginally higher than Northbound except at Mornington-Tyabb Road Bridge, Moorooduc, southbound. There is no evidence of clock error in these results.

76 I am satisfied that the "clocks" are as accurate as the satellite navigation system permits; they are very accurately synchronised by reliance on satellite data which is constantly maintaining identical accurate timing at each location.

77 Furthermore, for the avoidance of any doubt, the Linfox experience (see below) further supports the absence of error in the point-to-point system

PENINSULA LINK DATA

78 Most complaints have been made for infringements issued since January 1, 2016. The primary data used in these analyses comprise:

a. SmartDip ("system") records, 1 Jan 2016 to 31 Jan 2017 (60,242,662 records)

b. MatchLog ("matched") records, 1 Jan 2016 to 31 Jan 2017 (15,406,268 records)

c. Peninsula Link Infringements, 2016 (67,235 records)

d. In-period Complaints registered before 15 March 2017 (See **Complaints Analysis**)

79 Other sources include:

a. Installation, test and calibration reports,

b. Requests for information put to IMES,

c. Relevant infringement images,

d. SGS Australia Pty Ltd site test and calibration reports, and

e. Surveyors reports and similar.

80 In analysing data for this report we have considered a total of over 60 million records. We have analysed the 67,235 infringement records. Our investigation has included analysis of many millions of individual journeys through the Peninsula Link road safety camera system. We have analysed the driving behaviour of the alleged infringing vehicles ("the infringers") against all other drivers. We have used the data to assess whether there is any anomaly (or spike in the graph) for infringements at any particular speed (the 108 km/h Facebook group had been especially vocal).

81 The data which was obtained from authorities was used to identify a select group of journeys. This is depicted graphically in the histogram shown in Figure 2 on page 19.

82 Figure 2 depicts the journeys of a selected group of vehicles; these are the vehicles in which complainants were alleged to infringe the speed limit by the road safety camera system on Peninsula Link. This histogram depicts the aggregation of every journey by these vehicles that we could find. The blue columns represent the speeds of these vehicles at the instant that they pass the road safety camera. The orange columns

represent the average speeds of these vehicles as they travel between the cameras in the point-to-point system.

83 I have no doubt that these data, as portrayed in the graph, show a behaviour by drivers which is inconsistent with the claimed "set my cruise control and maintained constant speed". On the contrary, they depict a behaviour of altering speed at the cameras. This is consistent with a repeated comment from complainants of "I know where the cameras are", which seems to imply some conscious or unconscious driving modification at the cameras.

84 These data show that this group of drivers, all of whom have received Peninsula Link infringements, are likely to be regular faster-than-the-limit travellers in the point-to-point, and have significantly slower (and compliant) speeds at the instantaneous zone. Their average "speed at camera" in blue and the graphical distribution at camera shows only a very small number of readings above 100 km/h. The graph looks like a bell-curve with a mean around 97 km/h, and a significant majority of detections at 100 km/h or less. This is in stark comparison to the orange columns which show data of point-to-point measurements **for these same journeys**. The orange columns show a curve which has a mean at 100 km/h, and a significant number of journeys at greater than the speed limit.

COMPLAINTS ANALYSIS

85 By mid-March 2017, the Road Safety Camera Commissioner had received 135 written complaints and comments regarding the speed detection systems on the Peninsula Link Freeway. Of these, 98 were from drivers ("the ***2016/17 Complainants***" in paragraph 95) who had been issued infringements in the period 1 January 2016 through 31 January 2017; the period for which we have sourced data for analysis.

86 Between them, these 98 *2016/17 Complainants* had received a total of 167 infringements during that period. They comprised 63 instantaneous infringements and 104 point-to-point infringements.

87 Of the 135 Complainants, 62 reported that they used cruise control on the Peninsula Link freeway. Most said the cruise control was continuous and untouched. None admitted to speeding.

88 Members of the Peninsula Link 108 Facebook group asserted that the detection systems are faulty; that at some point system or systems were not operating to specification.

89 We have reviewed the calibration of all of the road safety camera system, and found no error.

90 We looked at the observed behaviour of the infringing drivers. We examined the details of every infringement-related event. To see more evidence of Complainant behaviour, we looked at every Peninsula Link event for every *2016/17 Complainant* on every day in our data. We then examined the details of every vehicle in a two-minute window either side of every event. In other words, we search the data for records of vehicles which had been travelling in the vicinity of the infringing drivers, both those ahead and those following.

91 The Peninsula Link 108 Facebook group asserted that the detection system was reporting incorrect speeds or times. Our analysis was that the road safety camera system was accurate. However, as a second measure, knowing that the cameras effectively create a digital "roll of film" in sequence, we used information to analyse the driving behaviour.

92 Our analysis was to consider other traffic. For example, if five vehicles that were recorded preceding a Complainant through Site A are subsequently recorded following the Complainant through Site B, then we can be confident that the Complainant overtook at least those five vehicles in the course of the trip. Similarly, we can calculate how many vehicles overtook the Complainant by looking at data regarding the vehicles which had followed the Complainant to Site A.

93 For 16 of the *2016/17 Complainants* with instantaneous infringements we were unable to detect any same-day trip details.

94 For another *2016/17 Complainant*, we were unable to extract trip data in the same direction (Southbound) as the infringement, but we did detect a complete journey Northbound. The details of the non-infringing journey are included in the results below.

P2P	Inst.	Complainant Behaviour
104	47	Infringements with trip data
246	103	Same day trips
204	52	Same day trips above 101 km/h
235	96	Same day trips above 80 km/h
947	249	Vehicles overtaken (>= 80 km/h trips)
25	31	Vehicles overtaken by (>= 80 km/h trips)

95 In total, in 331 trips averaging above 80 km/h on the day of infringement, we detect the *2016/17 Complainants* overtaking 1,196 vehicles while being overtaken on 56 occasions.

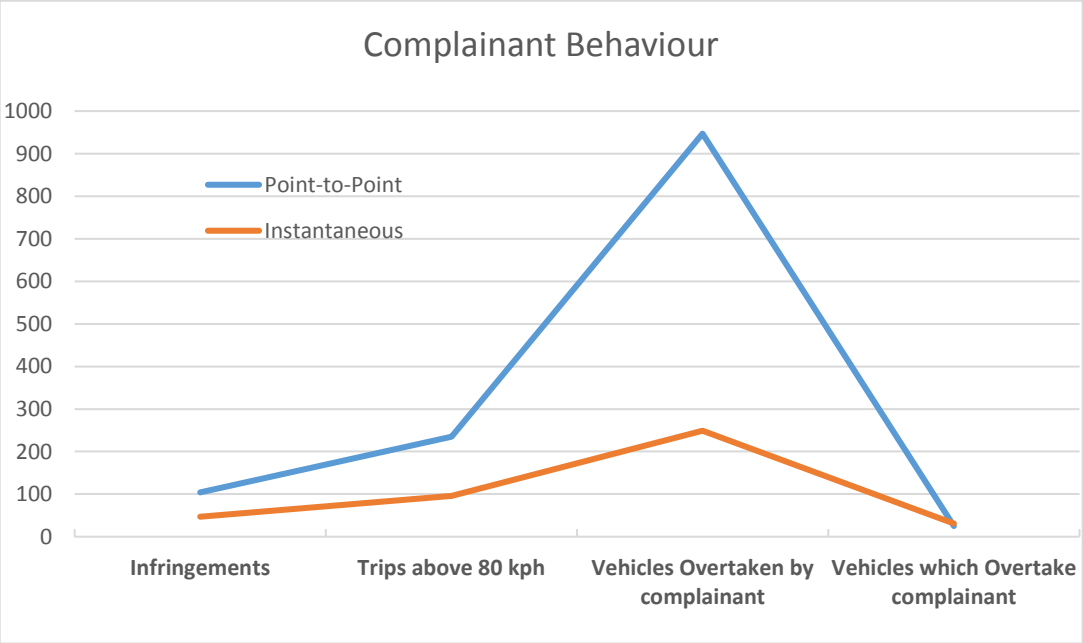


Figure 1: Aspects of complainant driver behaviour on Peninsula Link

96 Overall, the *2016/17 Complainants* are **21 times more likely** to overtake vehicles than to be overtaken. This figure is too large to ignore.

97 We looked at the details of every trip made by every *2016/17 Complainant* on Peninsula Link in 2016. We found details of 84 Complainants making 5,143 such trips and 9,164 associated instantaneous events.

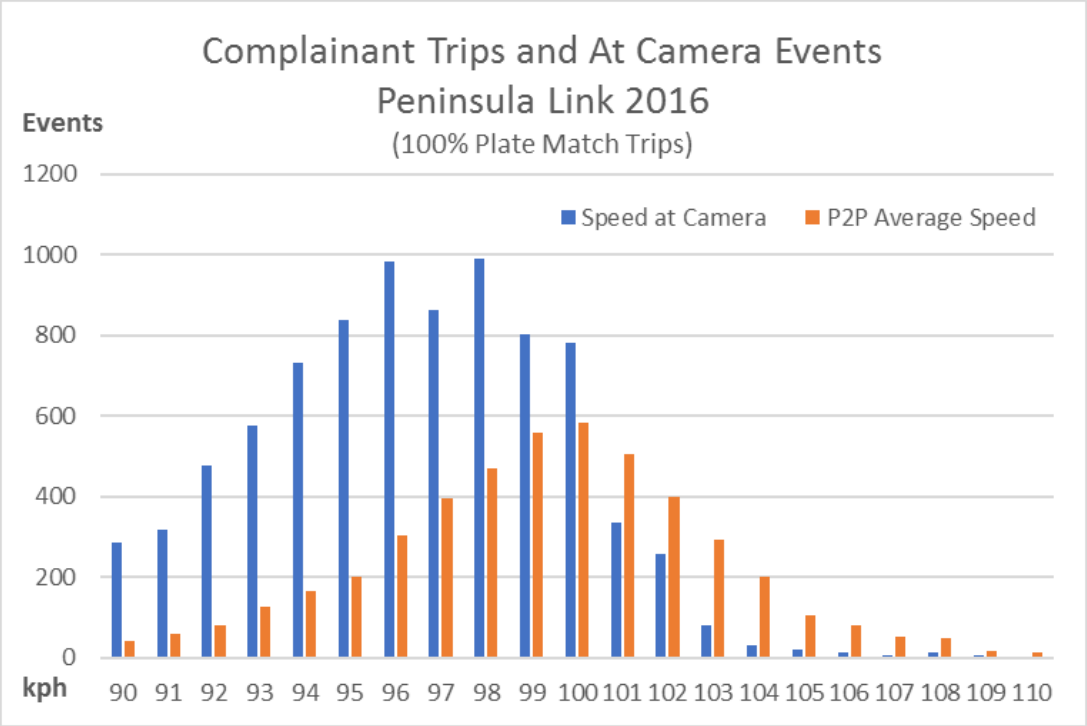


Figure 2: Histogram of Complainant speed events with a 100% Number Plate match, 2016

98 We also looked at the individual long term behaviour of 21 of the 98 *2016/17 Complainants*, examining details of all trips made in 2016 and January 2017. The investigation took us to draw up P2P histories of this group. The following table summarises a sample of the histories:

Complainant #	**1**	**3**	**16**	**75**	**92**	**123**
P2P Trips	477	200	303	22	158	77
Trips above 101 km/h	88	128	31	3	77	1
P2P Compliance (101 km/h)	81.6%	36.0%	89.8%	86.4%	51.3%	98.7%
> 101 km/h at Camera	1	142	3	4	0	3

99 For Complainant #123 an infringement event does seem out of character. Complainant #75 is one of the drivers for whom we have no same-day trip data.

100 Complainant #3 self-describes as a professional driver. The infringements received were all in a private capacity, none were in the course of professional driving.

101 My predecessor, the Honourable Gordon Lewis, made findings regarding driving behaviour (7 May 2014) and in particular about cars accelerating after passing cameras. That conclusion informed our investigation, and appears to be confirmed in this report.

102 People have complained about being wrongly accused of speeding. We have very thoroughly looked for every possible basis of error but could not find one. Importantly

we also could not repeat the claimed situation of driving at 100 km/h and being assessed at a faster speed.

103 In summary, generalising from the aggregate numbers, a picture emerges of a trend in driver behaviour. Their vehicles slow as they approach and pass the road safety camera, and then accelerate between cameras. They slow again at the next camera. The instantaneous speed will likely be 100 km/h or less. In order to achieve an average point-to-point speed of greater than 100 km/h but having an instantaneous speed of 100 km/h or less, the vehicle will need to travel faster than the average point-to-point speed. Further, if the speedometer in the vehicle is compliant with Australian Design Standards then it will be showing a speed substantially greater than the true speed.

IS THERE A PROBLEM AT 108 KM/H ?

104 This investigation commenced because a group of people had noted that they all were assessed as travelling at 108 km/h. They asserted that they were not travelling at this speed, and asserted that the assessments of their speed was incorrect.

105 The data of all journeys by all vehicles over the sample period for speeds of 90 km/h to 115 km/h was compiled. The table of this data is shown here:

Speed	Ratio - 2016	Speed	Ratio - 2016
90	4.979%	101	2.812%
91	5.330%	102	1.791%
92	8.149%	103	0.670%
93	8.510%	104	0.351%
94	10.176%	105	0.197%
95	11.586%	106	0.118%
96	12.290%	107	0.072%
97	9.482%	108	0.047%
98	10.480%	109	0.025%
99	6.858%	110	0.024%
100	6.015%	111	0.016%
		112	0.009%
		113	0.009%
		114	0.005%
		115	0.005%

106 The data, when graphed, presents as a curve:

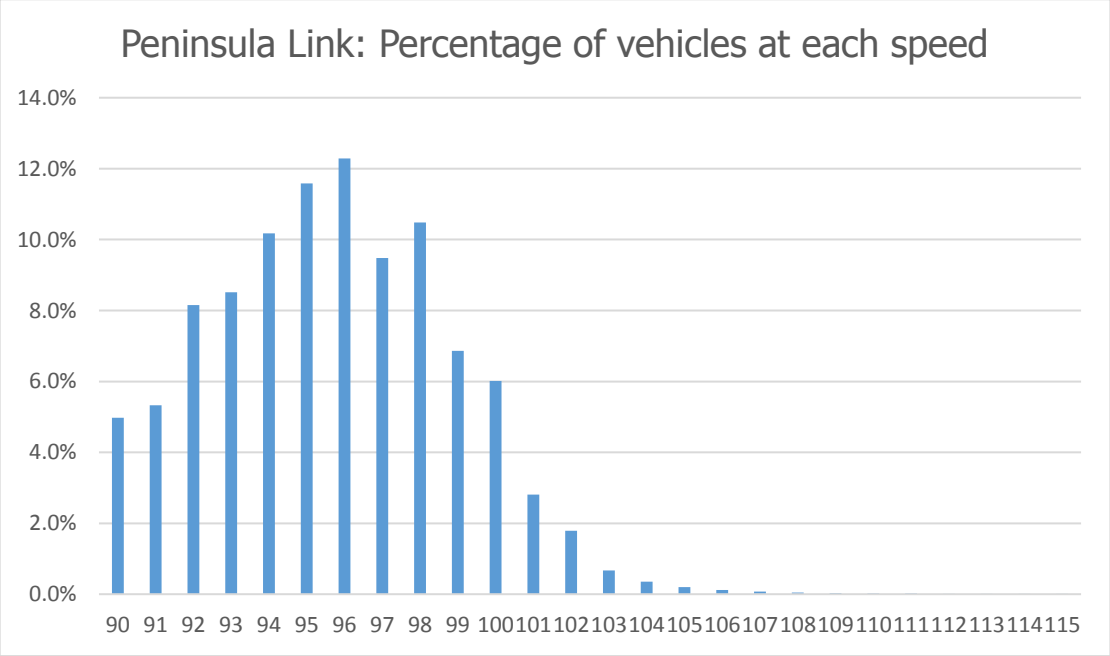


Figure 3 – All vehicles detected (instantaneous) at each speed on Peninsula Link

107 At first blush, this shows, as expected, that the very large majority of vehicles are recorded at legal speeds, with a peak of 96 km/h.

108 A further graph was prepared, based on the higher speeds, from 104 km/h and above:

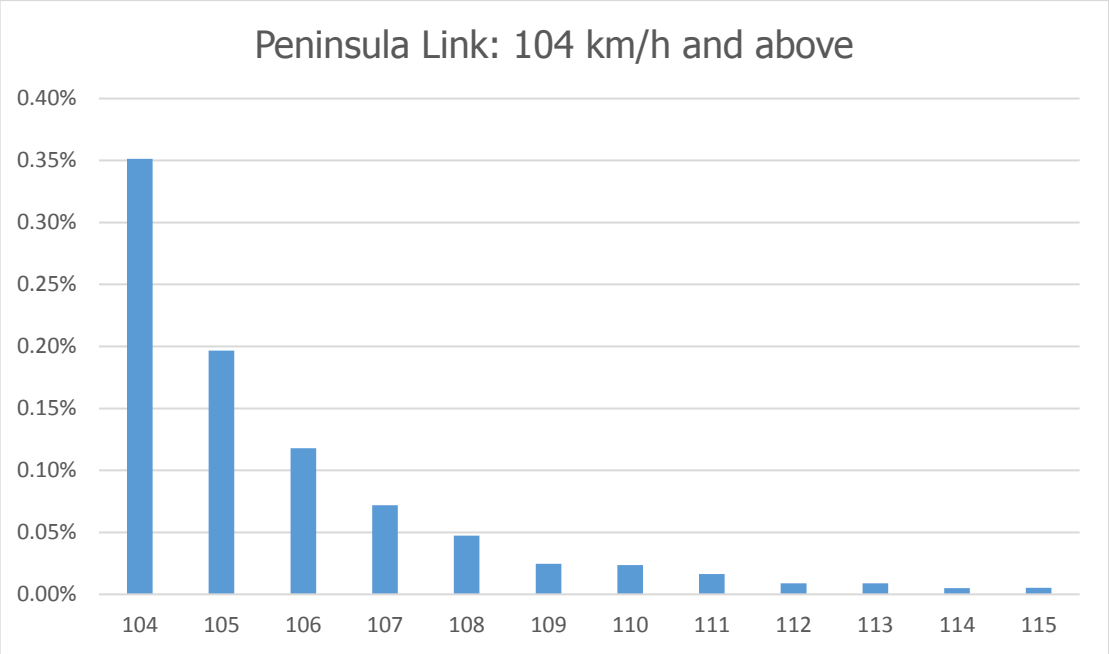


Figure 4 – As per Figure 3 for speeds from 104 km/h to 115 km/h

109 A further graph was prepared for 106 km/h and above:

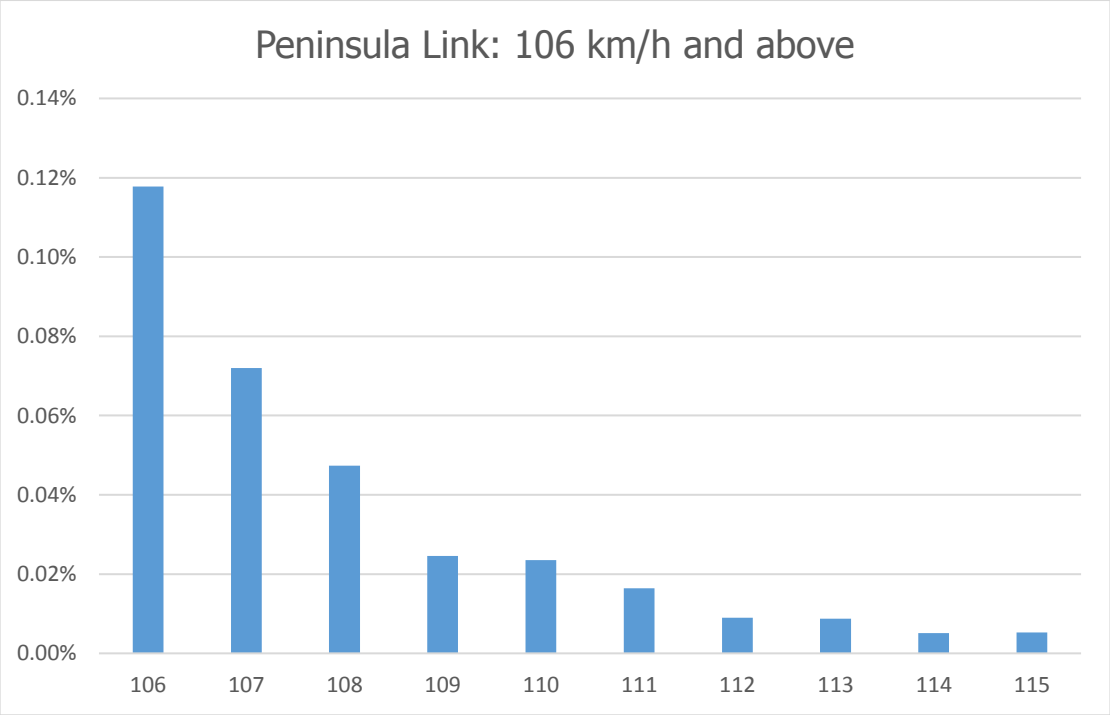


Figure 5 – As per Figure 3 for speeds from 106 km/h to 115 km/h

110 As we focussed increasingly on the higher speeds, the data continued to produce tapering curves, with no apparent spike at 108 km/h.

111 We had anticipated that if the Peninsula Link 108 Facebook group had a valid complaint then their numbers would be disproportionate; we had looked to see if a spike might exist in the graph at 108 km/h. However, as we repeatedly drilled down, the curve remained a smooth taper, with no apparent spike at any speed. None of the data suggests any anomalies at 108 km/h or any other speed.

112 In the circumstances, I conclude that the Peninsula Link 108 Facebook group is simply a matter of chance, or their concerns are a matter of chance. The group has asserted that because of their number, there must be an error. However, in our analysis it was equally possible (and potentially self-justified) that drivers at any of a number of speeds could have considered their speed to be incorrect, basing that assertion on sheer numbers. However, the data shows that there are enormous numbers of vehicles travelling and being recorded at a range of speeds. Social media has proved an echo chamber for infringers to meet and complain. There is no evidence of error in the road safety camera system.

ALL DRIVERS ON PENINSULA LINK

113 We then depict the data regarding **all journeys** by **all vehicles** on Peninsula Link, graphically:

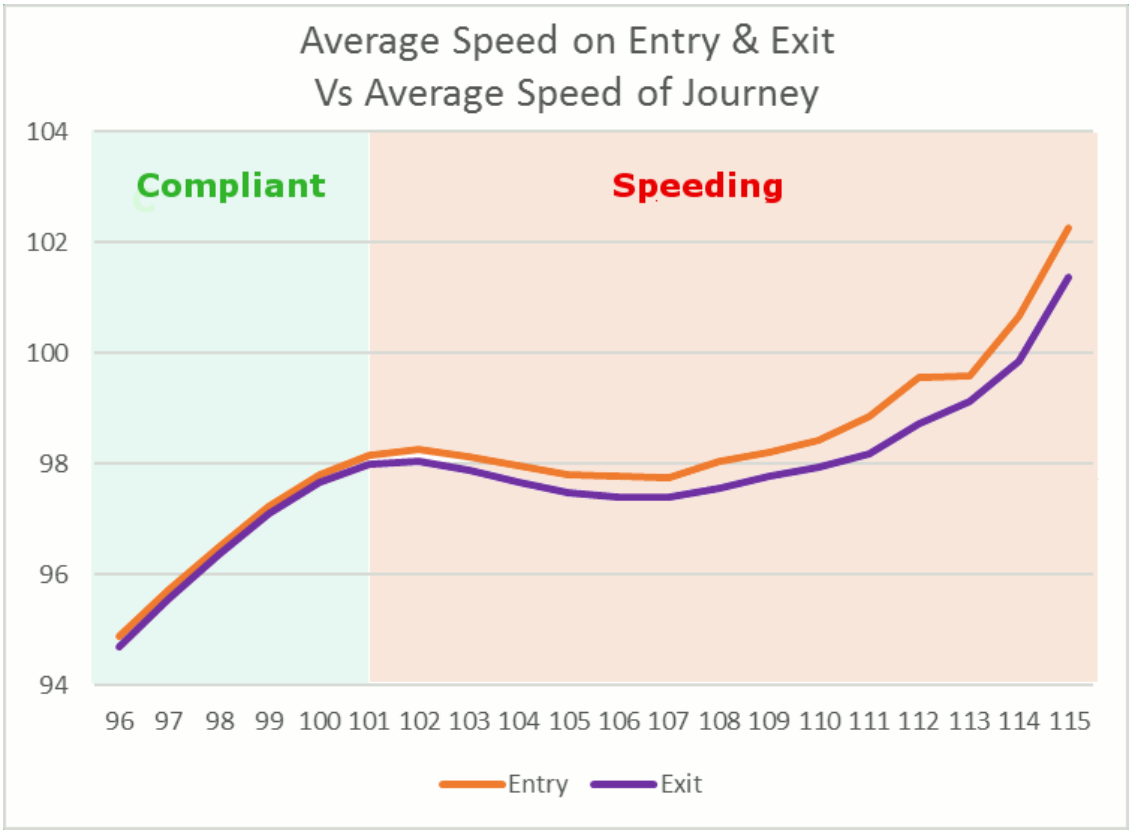


Figure 6 – Comparison of entry and exit speeds into a point-to-point zone along Peninsula Link for each P2P speed

114 In this graph we have compared data of all complete and traceable Peninsula Link journeys in 2016. At the left of the graph, drivers travelling at speeds of up to 100 km/h. The entry to the zone is the orange line, the exit from the zone is the purple line. The graph shows that at the below speed limit speeds along the horizontal axis, the vehicles travel at an average of a small amount slower at the instantaneous

cameras. However, the speeds of entry and exit become significantly unaligned when the average point-to-point speed exceeds 100 km/h. Indeed, right up to 113 km/h both entry and exit speeds average under 100 km/h.

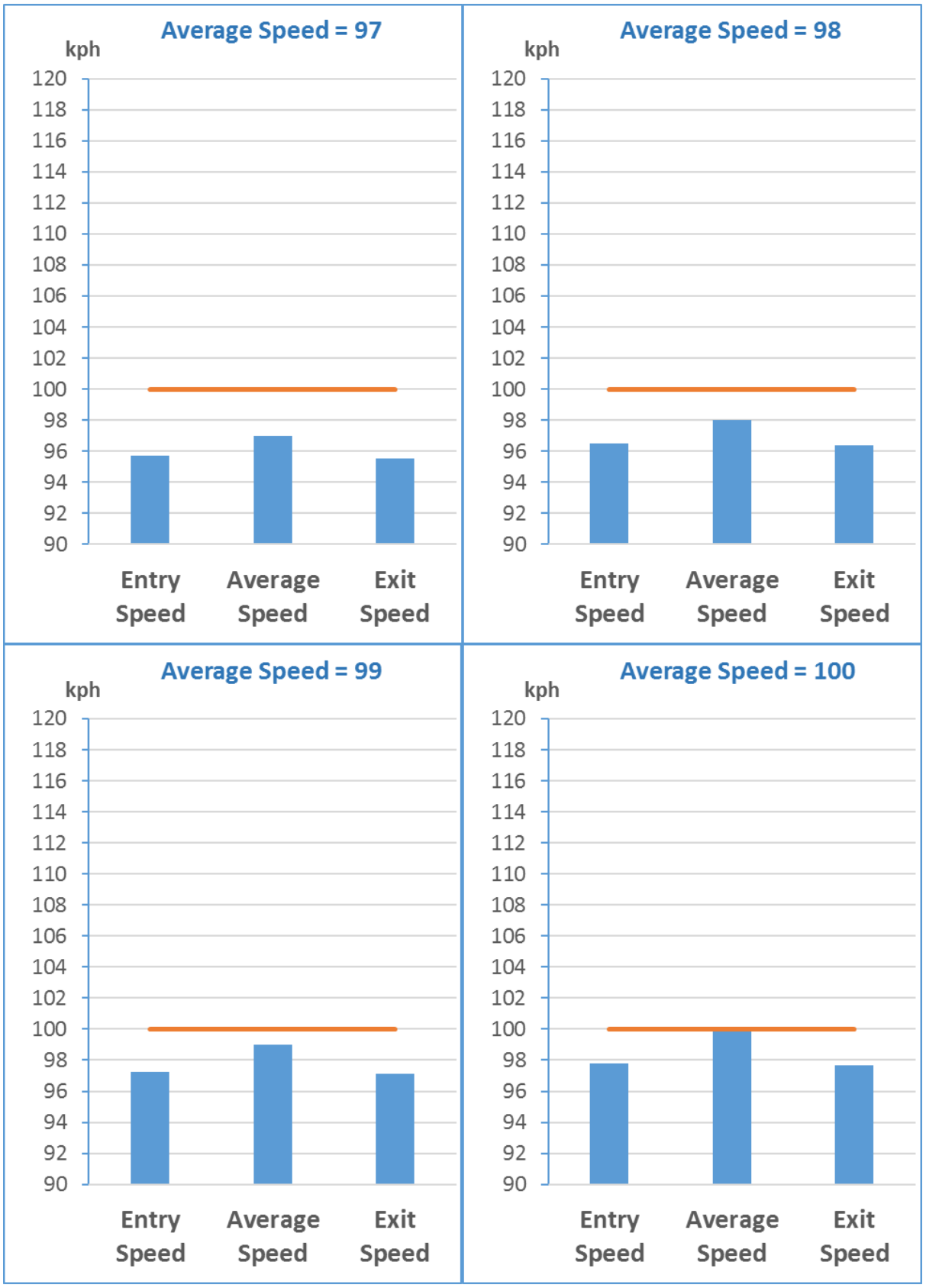
Note: The numbers travelling at each speed are not the same.

115 Driver behaviour can also be depicted in a series of graphs. Each graph represents a set of data for a nominated point-to-point average speed. The point-to-point speed is the column in the middle. The left column is the average speed of entry to the point-to-point zone across the aggregate of those journeys. The column on the right is the average speed of exit from the point-to-point zone for that aggregate of journeys. For example, the first graph shows all vehicles with an average point-to-point speed of 97 km/h. On average these vehicles enter the point–to-point zone at a little under 96 km/h, and they exit the point-to-point zone at a little under 96 km/h.

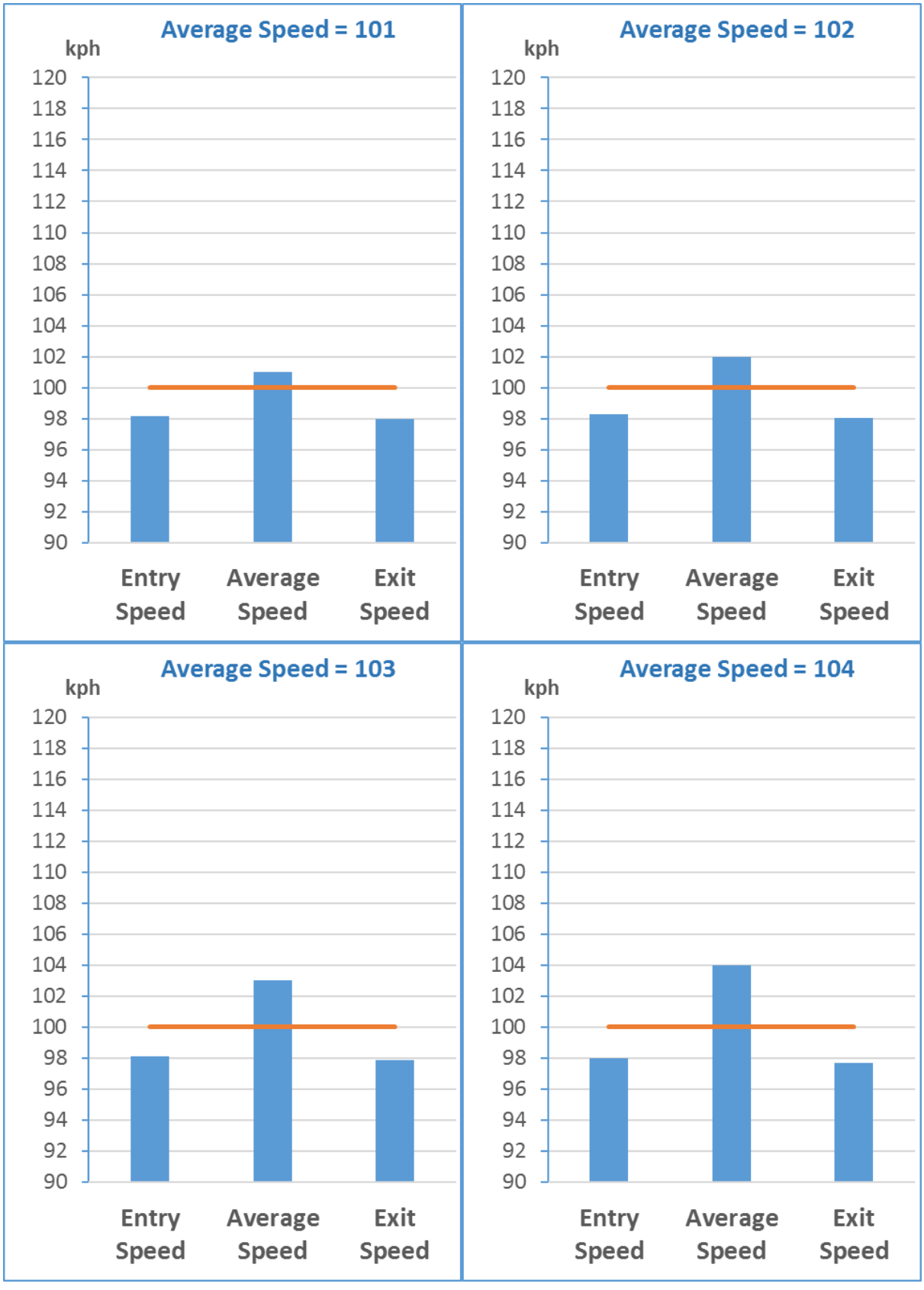
Again, note: The numbers travelling at each speed are not the same.

COMPARING ENTRY AND EXIT SPEEDS WITH AVERAGE POINT-TO-POINT SPEED

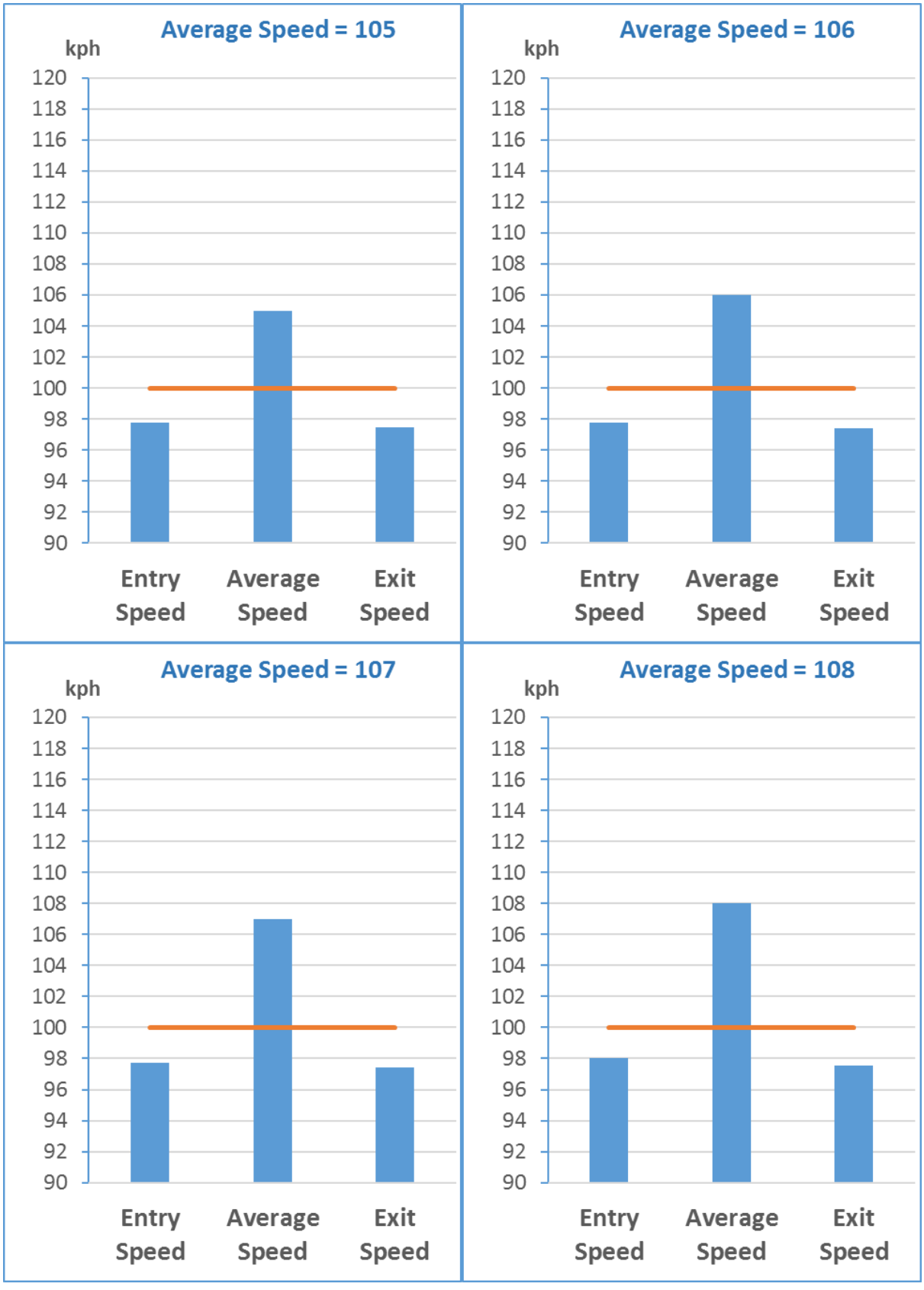
Peninsula Link 2016 (Again note the numbers travelling at each speed are not the same)



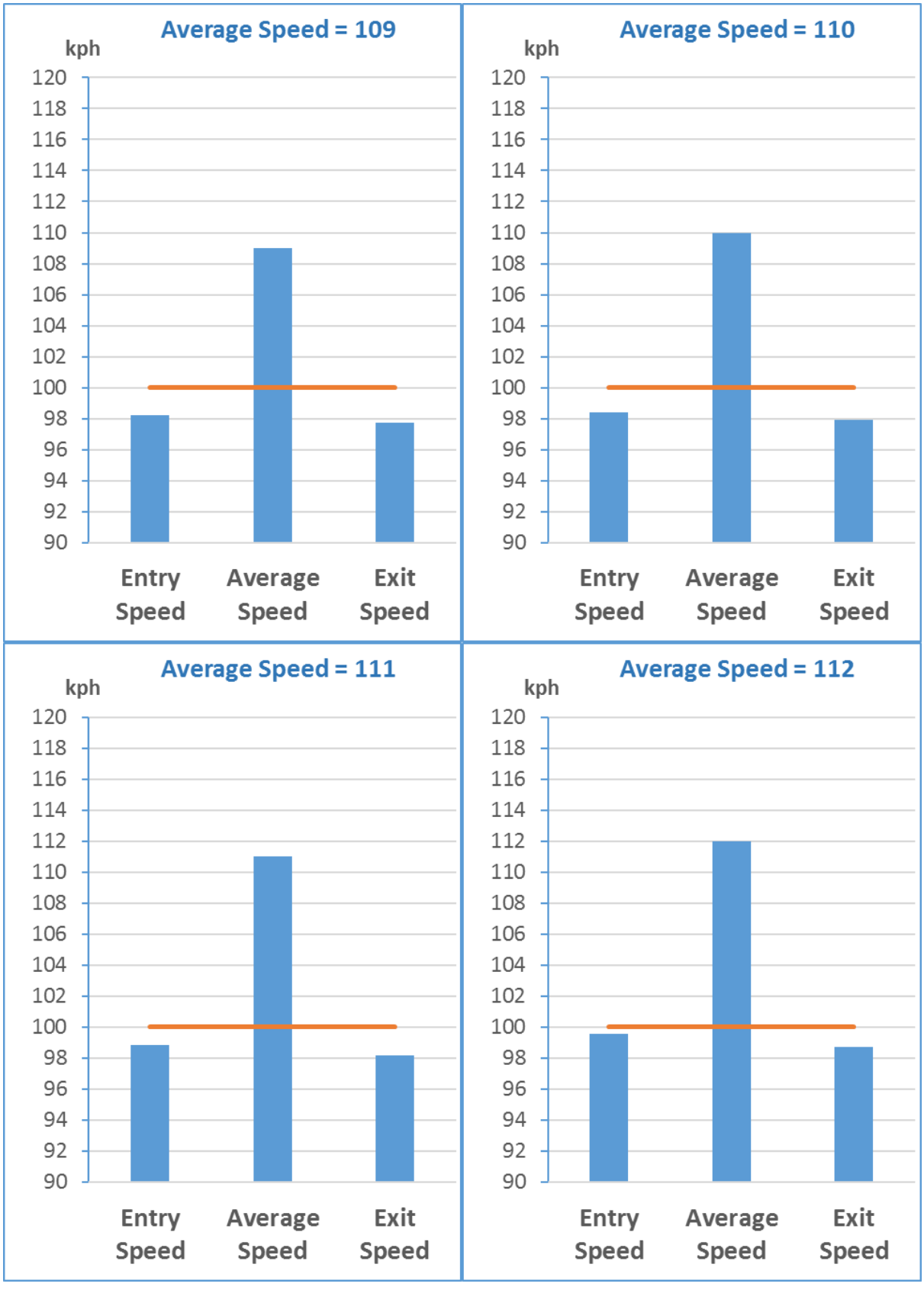
Peninsula Link 2016 (Again note the numbers travelling at each speed are not the same)



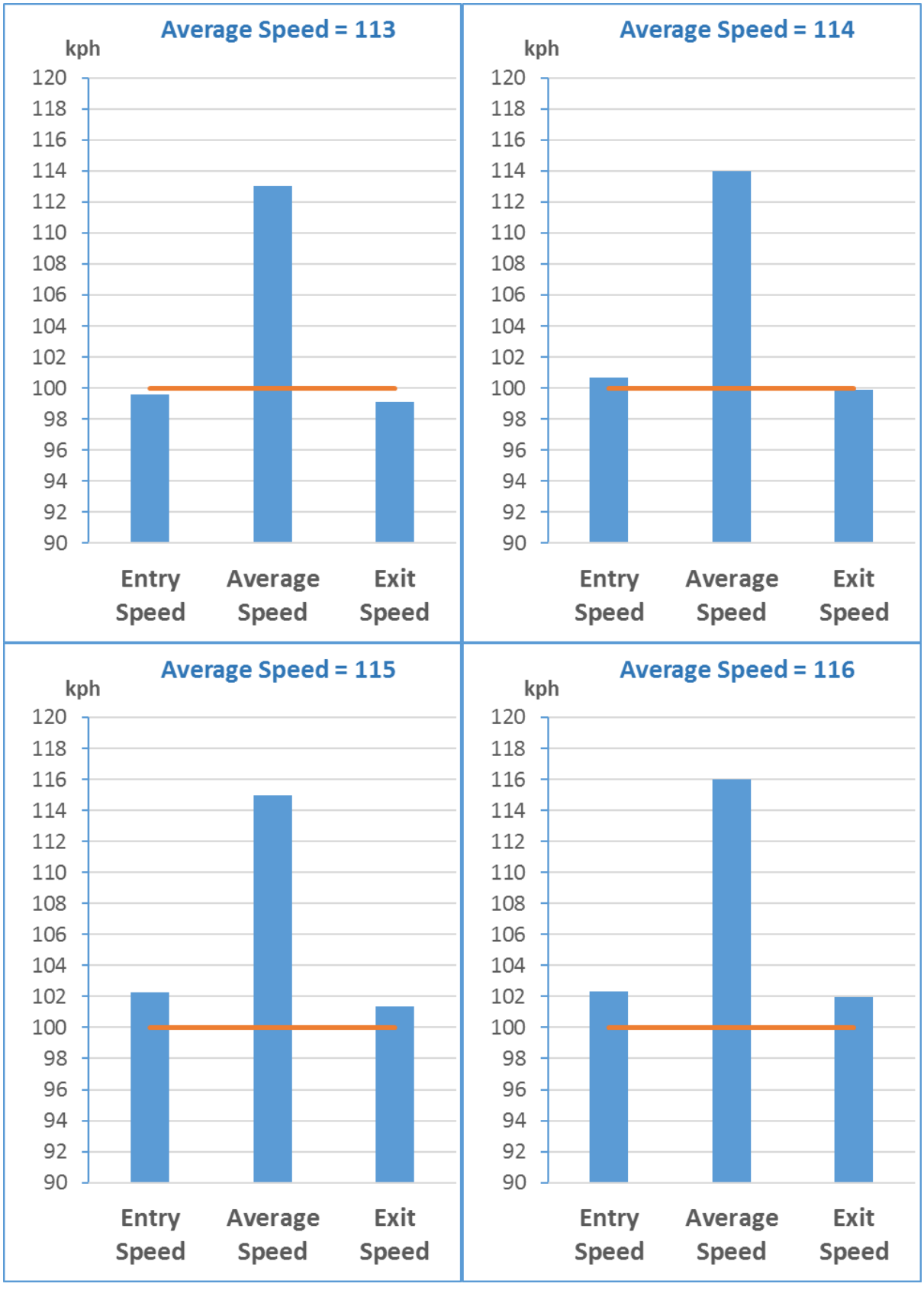
Peninsula Link 2016 (Again note the numbers travelling at each speed are not the same)



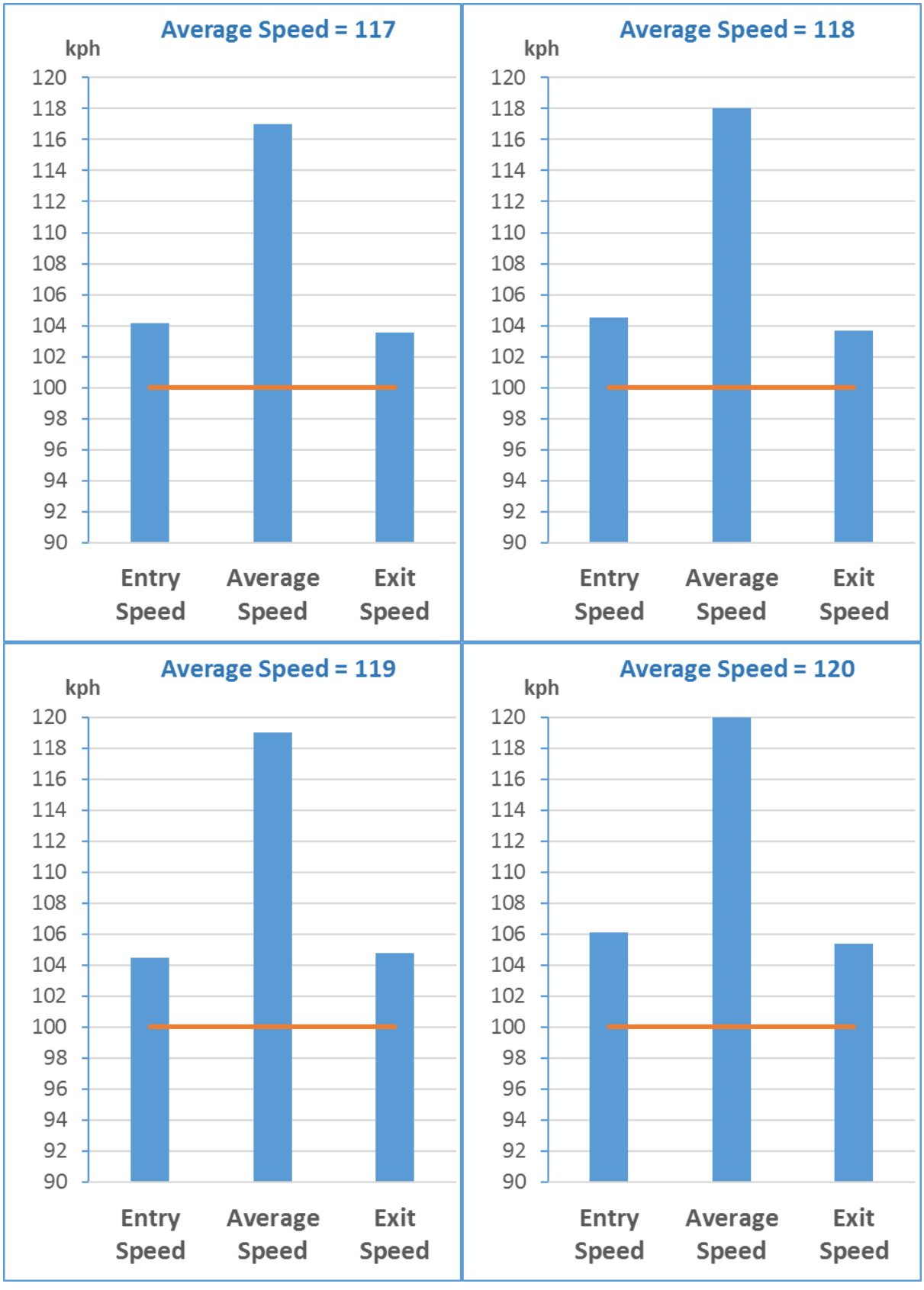
Peninsula Link 2016 (Again note the numbers travelling at each speed are not the same)



Peninsula Link 2016 (Again note the numbers travelling at each speed are not the same)



Peninsula Link 2016 (Again note the numbers travelling at each speed are not the same)



116 In **conclusion** I am satisfied that the general driving public, either consciously, or unconsciously, are slowing at each of the cameras until passing the camera and then speeding up after passing the camera, resulting in readings of higher point-to-point speed than instantaneous speed. **I find there to be a pervasive culture in this regard amongst drivers, slowing at cameras and then speeding up after passing the camera**.

117 For the purposes of comparison, we have received the cooperation of a substantial-sized group whose speeds are independently monitored, the Linfox Transport group. Each vehicle is independently monitored by the firm. Further, the registration number plates are easy to identify. We investigated the data associated with this group of vehicles travelling on Peninsula Link.

LINFOX TRUCKS

118 Linfox has established a safety culture over the past decade through its *Vision Zero* program. As part of this it invests in safe driver training and 'in cab' technology to ensure driver behaviour is both compliant and consistent with legislation and the company values.

119 As a result, Linfox vehicles form an excellent study group. The data demonstrates Linfox vehicles are:

- Unlikely to speed;
- Easy to find in the data (registration number plates are typically FOXnnn where 'n' is a digit.)

120 So we were drawn to seek information from the data in relation to the Linfox vehicles. We considered that if the Peninsula Link P2P systems were operating incorrectly, we would detect higher than expected calculated speeds. If there were any Linfox infringements alleged then that might be evidence of the inaccuracy of the road safety camera system on Peninsula Link.

121 FOXnnn-plated vehicles were recorded on **21,367** occasions on Peninsula Link in 2016. There were a total of **zero** infringements.

122 Of that 21,367, a total of 133 events returned an instantaneous speed result above 100 km/h. Allowing for a 1 km/h margin for error, Linfox speed compliance rates at the Peninsula Link sites approach 99.8%.

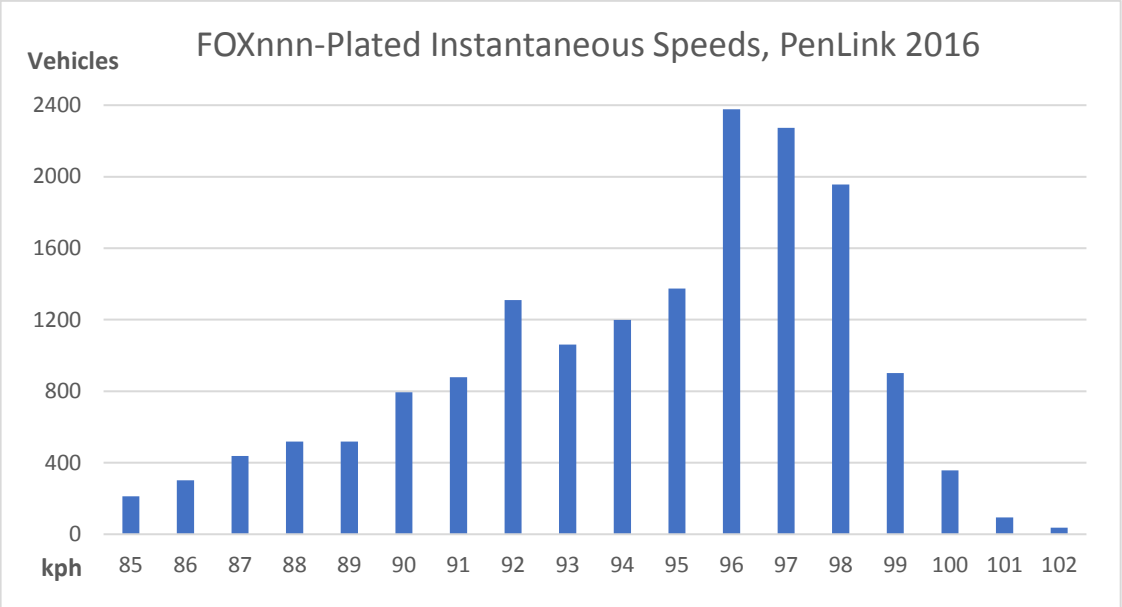


Figure 7– 'Linfox' speed histogram, 85 to 102 km/h

123 916 events below 85 km/h are not shown in the above graph.

124 MatchLog ("matched") data reports 3,994 P2P 'Linfox' trips on Peninsula Link in 2016, where:

a. The vehicle's plate is of the form FOXnnn,

b. There is a 100% plate match at both sites.

125 There were 22 P2P trips reported with an average speed above 100 km/h.

126 We were aware that the pervasive culture of non-Linfox drivers had produced a graph of the kind in Figure 6 (on page 23) and also the graphs on pages 25 to 30 inclusive, showing markedly lower averages of instantaneous speeds than point-to-point. We investigated, from Department of Justice and Regulation data, whether the Linfox vehicles had a similar dichotomy.

127 Absent from Figure 8, there are 231 P2P trips with an average speed below 85 km/h are not shown.

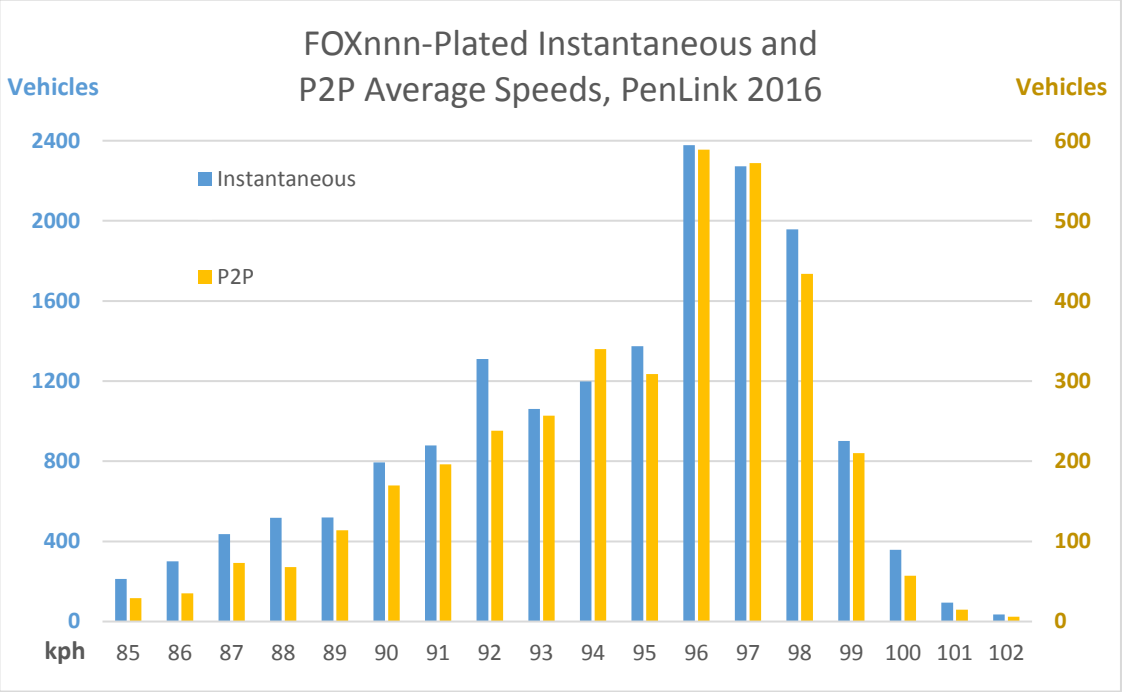


Figure 8– 'Linfox' Instantaneous & P2P average speed histograms, 85 to 102 km/h

128 Figure 7 and Figure 8 show remarkable similarity. There is no evidence that Linfox drivers slow for the cameras and no evidence of P2P average speed calculation errors. There are no incorrect infringement notices.

129 We consider that this supports the high safety standards adhered to by heavy haulage vehicles by Linfox, and supports the accuracy and integrity of the road safety camera system on Peninsula Link.

130 We have compared the average speed (point-to-point) data against the instantaneous speeds, for the public generally, for the complainants, and for Linfox vehicles. We are satisfied that the exemplary record of the Linfox fleet, supported by independent data, and its stark contrast to the depiction of all drivers, highlights that in the general driving public there is a pervasive, ingrained and repeated driver behaviour of slowing at the camera locations, and speeding up in between.

LODERS ROAD BRIDGE

131 In the course of these investigations, we observed that larger ratio of infringements per vehicle at Loders Road Bridge, Moorooduc, northbound, than at the other sites. A larger percentage of vehicles recorded travelling through the Loders Road Bridge camera site are detected at a speed greater than 100 km/h compared with all other sites.

132 We have analysed the workings of the road safety camera at this location in as much detail as was possible, however the vandalism at that site has significantly impaired the independent analysis.

133 We are satisfied that on the data and certifications supplied, there is no technical or mechanical error at the Loders Road Bridge site. On the evidence in our possession, and hampered by any opportunity to analyse the mechanism due to vandalism, it

appears that this significantly higher ratio of infringements per vehicle reflects driver behaviour. Drivers travelling northward, entering the road safety camera system, are seen to be entering at a faster speed than elsewhere in the system in either direction.

CONCLUSIONS

134 The general driving public are either consciously, or unconsciously, slowing at each of the cameras until passing the camera and then speeding up after passing the camera, resulting in readings of higher point-to-point speed than instantaneous speed. **We find there to be a pervasive culture in this regard amongst drivers, slowing at cameras and then speeding up after passing the camera**.

135 There is substantial misunderstanding by Victorian drivers of the way that the point-to-point road safety camera system on Peninsula link operate.

136 There is one camera which has a larger number of infringements than average, at Loders Road. However there is no evidence of mechanical or technical error.

RECOMMENDATIONS

137 There is a need for greater public awareness of the manner in which point-to-point road safety camera systems operate. There are many misconceptions which need to be better informed.

138 There is a need for better education of drivers regarding the risks associated with speed. There is an unceasing need for drivers to understand that speed diminishes control and reaction time, and speed results in more severe outcomes in collisions.

139 There is a need for a transparent system for determining and imposing speed limits.

140 Combining these three recommendations, I recommend that there be a road safety campaign to better inform drivers of the reasons for particular speed limits, the manner in which speed limits are determined, and the manner in which speed limits (especially point-to-point) are enforced.

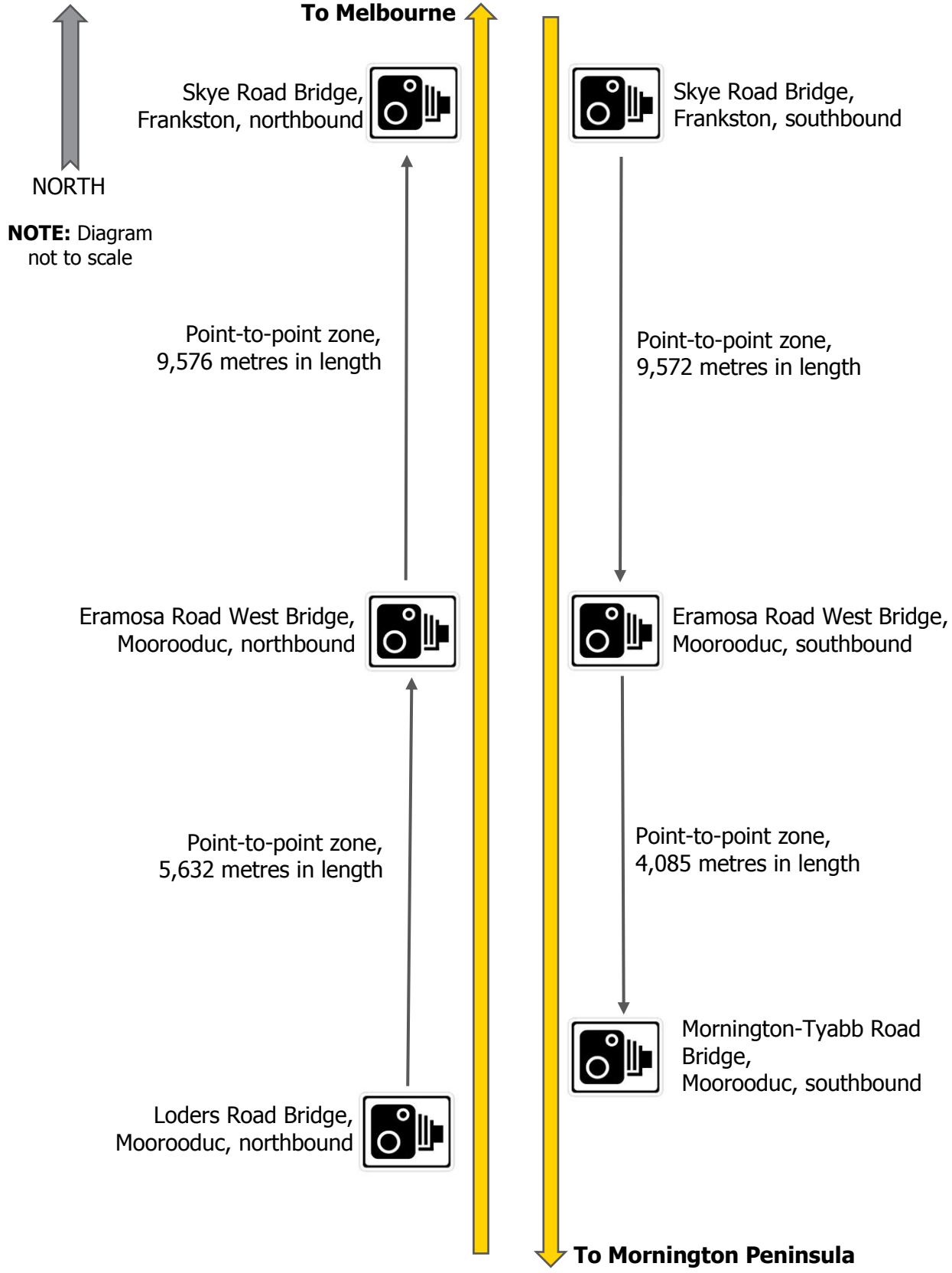
ACKNOWLEDGMENT

141 We have benefited from having reference to many research papers, including the report *The Effectiveness of Average Speed Cameras in Great Britain* by Owen Ursachi and Allsop (RAC Foundation, Sep 2016) http://www.racfoundation.org/research/safety/effectiveness-average-speed-cameras-great-britain

142 We thank the many individuals, groups, and authorities who have supported this investigation.

APPENDIX A - SCHEMATIC DIAGRAM

Diagram of road safety cameras along Peninsula Link



APPENDIX B - LEGISLATION

Road Safety Act 1986

Section 78 - Average speed evidence of actual speed in certain circumstances

(1) If, in any proceedings for an offence against this Act or the regulations –

a. The speed at which a motor vehicle or trailer travelling is relevant; and

b. The prosecution relies on the average speed of the motor vehicle or trailer between 2 points on a road as determined in accordance with subsection (2)-

The average speed so determined is evidence, and in the absence of evidence of the actual speed of the motor vehicle of trailer to the contrary is proof, of the speed of the motor vehicle or trailer.

(2) For the purposes of subsection (1), the average speed of a motor vehicle or trailer between 2 points on a road expressed in kilometres per hour is calculated in accordance with the following formula and rounded down to the next whole number-

$$\frac{D \times 3.6}{T}$$

Where-

D is the shortest distance, expressed in metres that would be travelled by motor vehicle or trailer on the road between the 2 points;

T is the time, expressed in seconds, that has elapsed between the motor vehicle or trailer passing the first and second points.

(3) This section does not derogate from any other mode of proof of the speed of the motor vehicle or trailer.

(4) For the purpose of any proceedings for an offence against this Act or the regulations in which the speed at which a motor vehicle or trailer travelled is relevant, if a trailer of a motor vehicle that is being towed is attached to a motor vehicle, the trailer or towed motor vehicle and the towing motor vehicle are to be taken to be travelling at the same speed.

APPENDIX C - LEGISLATION

Road Safety Act 1986

Section 78A – Evidence of road distance

(1) A certificate in the prescribed form purporting to be issued by an approved surveyor certifying as to the shortest distance, expressed in metres, that would be travelled by a motor vehicle or trailer on a road between 2 points is admissible in evidence in any proceedings and, in the absence of evidence to the contrary, is proof of that distance.

(2) In this section, ***approved surveyor*** means a licensed surveyor within the meaning of the **Surveying Act 2004** who is approved for the purposes of this section by the Surveyor-General of by the Corporation.

APPENDIX D - GLOSSARY

Glossary of terms

Adaptive cruise control – an advanced cruise control system incorporating radar and/or cameras to monitor traffic ahead and keep a constant distance to the vehicle in front in the same lane.

Cruise control – a driver's aid installed in a vehicle aimed at maintaining a constant speed without throttle or brake input from the driver.

Incident – where a road safety camera has detected a vehicle exceeding the speed limit and recorded images and data that will be manually reviewed.

Infringement – a motorist has received notice they have committed an offence in the mail, either for exceeding the speed limit at a point or over a significant distance, or for running a red light.

Instantaneous speed – where a road safety camera calculates a motorist's travelling speed as they drive past a point in the roadway.

Matchlogs – a combination of two Smartdip records from successive sites to record a trip.

Peninsula Link – a freeway between the Frankston Freeway and the Mornington Peninsula Freeway.

Point-to-point speed – where road safety cameras calculate a motorist's travelling speed over a significant distance between two points on the road.

Primary system – a road safety camera's primary speed calculation and vehicle presence detection device. This must be on the list of prescribed devices contained in the *Road Safety (General) Regulations* 2009.

Secondary system – a road safety camera's independently operating and calibrated secondary speed calculation and vehicle presence detection devices.

Smartdip – logged detail of instantaneous vehicle detection.