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Title

A novel low-cost Safe System-aligned treatment for regional and remote intersections

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Abstract

An intersection active warning system aiming to improve vehicle safety at intersections has been developed and trialled. This system, named RJAWS Lite, is an advisory variation of the existing mandatory-speed based RJAWS and provides two major visual warnings: (i) speed advisory on major approaches and (ii) run-through prevention on the minor approach. A controlled before-after analysis conducted on speed data from a trial at six rural intersections in South Australia indicates that RJAWS Lite can provide substantial safety benefits, albeit to a lesser degree than the full version of the RJAWS. Nonetheless, the RJAWS Lite involves considerably lower equipment and installation costs, combined with less restrictive regulations, than the mandatory full version of the RJAWS and so could be expected to be suitable for more widespread installation, which could therefore effectively increase road safety at a larger number of rural junctions. Future streamlining of the current large billboard-style RJAWS signage may likely contribute to improve driver compliance with the advised speed and therefore further increase the predicted safety benefits.

Keywords

Road safety, speed management, advisory speed, active warning signs, rural junctions, run-through

Summary

A novel intersection active warning system aimed at improving vehicle safety at intersections has been developed and trialled through this project. This system is an advisory variation of the existing mandatory-speed Rural Junction Active Warning Sign (RJAWS) and provides two major visual warnings: (i) speed advisory on major approaches and (ii) run-through prevention on the minor approach. Given its functionality derivation from the existing RJAWS, the novel system designed in this project was named RJAWS Lite.

Two sets of the RJAWS systems have been designed and built as part of this project, and successfully deployed and trialled at six intersections during a period spanning almost two years. The system showed good durability and reliability throughout the entire trial, with only a handful of minor functionality issues being observed at any of the trial sites.

A summary of the major outcomes from the analysis of the trial data, including a side-by side comparison with previous trials on the full RJAWS, are shown in the table below.

Before-After Changes [2]	**RJAWS Lite [1]**				**RJAWS [1]**			
DEFAULT SPEED LIMIT OF 80 KM/H	***Site A1***	***Site A3***	***Site A5***	***AVERAGE***	***Site B1***	***Site B2***	***Site B3***	***AVERAGE***
Mean speed variation (Sign ON) (km/h)	-6.9	-1.6	-8.4	**-5.6**	-15.0	-11.3	-13.1	**-13.1**
Risk Variation (Sign ON) [3] (%)	-42.0	-8.5	-32.0	**-27.5**	-45.0	-42.0	-50.0	**-45.7**
Variation in vehicles travelling <= 50 [4] km/h (points %)	0.5	0.0	1.2	**0.6**	31.2	22.3	20.5	**24.7**
Variation in vehicles travelling <= 80 [5] km/h (points %)	14.0	4.2	20.1	**12.8**	9.5	9.2	15.2	**11.3**
Variation in vehicles travelling > 80 [5] km/h (points %)	-14.0	-4.2	-20.1	**-12.8**	-9.5	-9.2	-15.2	**-11.3**
DEFAULT SPEED LIMIT OF 100 KM/H	***Site A2***	***Site A4***	***Site A6***	***AVERAGE***	***Site B4***	***AVERAGE***		
Mean speed variation (Sign ON) (km/h)	-8.3	-9.9	-4.9	**-7.7**	-22.1	**-22.1**		
Risk Variation (Sign ON) [3] (%)	-29.0	-31.9	-14.1	**-25.0**	-64.5	**-64.5**		
Variation in vehicles travelling <= 70 [4] km/h (points %)	7.9	-0.1	1.5	**3.1**	61.9	**61.9**		
Variation in vehicles travelling <= 100 [5] km/h (points %)	7.4	5.2	8.2	**6.9**	27.2	**27.2**		
Variation in vehicles travelling > 100 [5] km/h (points %)	-7.4	-5.2	-8.2	**-6.9**	-27.2	**-27.2**		

[1] Systems trialled at different sites and periods
[2] Evaluation of full RJAWS conducted without control sites
[3] Speed and risk during before period not assessed by sign status in the evaluation of the full RJAWS
[4] Advisory Speed/Reduced Speed Limit
[5] Default Speed Limit on major road

In general, RJAWS Lite appears to be capable of effectively reducing the risk of casualty crashes by reducing the speed of vehicles travelling along the major road during conditions when there is a risk of a potential collision with another vehicle at the intersection. The activated major road advisory speed signage of the system can induce motorists to reduce their travel speed when approaching the treated intersections along the major road. Once accounting for the control, the reduction in the mean speed observed in proximity to the treated intersection ranged between 1.6 km/h and 9.9 km/h, with an average reduction of 6.7 km/h across all the six trial sites. Ultimately, this average reduction in travel speed observed across the trial sites can be related to a reduction in the risk of a potentially fatal or serious injury crash of 26.2%. This average risk reduction is lower than what was previously reported in a trial of the full RJAWS system in South Australia and is a trade-off to be expected from the advisory nature of the RJAWS Lite (as opposed to the mandatory signage of the full RJAWS). Nonetheless, increased compliance with the advised speed limit of the RJAWS Lite may likely be obtained by streamlining the current large billboard-style signage on the major road, using a more efficient and intuitive design in a similar fashion to the efficient electronic signage used for the full version of the RJAWS.

RJAWS Lite was less effective in moderating the speed of vehicles approaching the intersection along the minor road during the trial. Nevertheless, the minor reduction in speeds observed appears to indicate that the warning of a potential run-through is perceived by the motorists approaching the treated intersections.

Although the RJAWS Lite provides lower safety benefits when compared to the full version of the RJAWS, the considerably lower cost associated of this lite system can provide road agencies with a more affordable treatment, which could be deployed at a larger number of critical intersections across the rural road network and provide impetus for treating intersections where a larger expenditure may not be justified. Margin also exists for improving the safety benefits of RJAWS Lite by increasing compliance with the advisory speed through streamlining the current signage design. Therefore, the RJAWS Lite could be expected to provide an overall benefit-cost ratio comparable to the full RJAWS. Equally important, the lower cost of the RJAWS Lite compared to the full RJAWS, also in combination with its less restrictive implementation conditions because of the advisory nature of the signage, will make it a potentially affordable treatment for Local Government.

Overall, the evaluation conducted on the extensive data collected during the trial indicates that the RJAWS Lite can deliver substantial safety benefits albeit to a lesser degree than the full RJAWS system. Given the speed calming effect on the major approaches to the intersections and the consequent safety benefits, RJAWS Lite can be considered well-aligned to the principles of a Safe System approach to reduce the potential for harm. Additionally, RJAWS Lite may also contribute to educating motorists about the importance of moderating speed while transiting through intersections on high-speed rural roads.

Given the reasonable predicted safety benefits, installation flexibility, and reduced costs compared to the full version of the RJAWS, the RJAWS Lite would be an ideal treatment for improving the safety of a large number of rural intersections characterised by a high risk of casualty crashes. Additionally, RJAWS Lite may be also employed as an interim safety treatment before an intersection is treated with a primary safety treatment, such a compact roundabout in the long term. Criteria and approaches for selecting suitable intersections that could be treated with RJAWS Lite are proposed in the discussion section of this report.

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1. Introduction

Non-signalised intersections along the high-speed roads that are commonly found in regional and remote locations present a high level of safety risk. This risk is due to the high speeds of vehicles as they traverse the intersection, and the relatively low-level of control placed upon drivers as they navigate the intersection. Most crashes at these locations are a result of mistakes: it is common for drivers to misjudge or misunderstand the situation under which they are placed, leading to errors that in turn lead to the occurrence of a crash. Within the hundreds of crash investigations that the Centre for Automotive Safety Research (CASR) has undertaken in South Australia, two types of errors have commonly been identified: (1) a driver entering the intersection and colliding with another vehicle after having initially slowed and looked for other vehicles (commonly referred to as a 'look but did not see' crash); and (2) a driver not having recognised the need to give way and entering the intersection from the minor road at speed (commonly referred to as a 'run-through' or 'blow-through' crash).

The large collision forces induced by the high speeds of vehicles in these crashes commonly result in severe outcomes. As an example of the role that speed plays in determining crash severity, the risk of a fatal or serious injury outcome is 1.3% when a right-angle crash between two vehicles occurs at a collision speed of 50 km/h. This risk rises to 23.7% at a collision speed of 80 km/h and 75.8% at a collision speed of 100 km/h (Doecke et al., 2020).

Most safety treatments for high-speed non-signalised intersections aim to reduce the likelihood of a crash occurring. Examples of these treatments are improved sight lines/distance, reinforced signage, improved lighting, auxiliary turning lanes, channelisation and staggering of cross-roads. Despite the improvement in safety that these treatments may provide, none can be 100% effective and so a residual of crashes will remain. For these remaining crashes the same risk of resulting in fatal or serious injuries still exists, as the underlying risk of severe outcomes has not been addressed. On the other hand, there exists treatments that aim to reduce the severity of crashes when they do occur, as well as reducing their likelihood. Examples of these treatments are roundabouts and the Rural Junction Active Warning System (RJAWS) (Mongiardini et al., 2021), upon which the RJAWS Lite treatment was conceived. However, these treatments can be prohibitively expensive: RJAWS and equivalent systems in their most recent versions can cost near to $500k, while rural roundabouts can cost several million dollars. These high costs can only be justified at a minority of locations.

This leaves a gap in our ability to improve safety at intersections: there are few inexpensive intersection safety treatments that can substantially reduce the risk of fatal and serious injuries by treating both the likelihood and severity of crashes. RJAWS Lite is aimed towards filling this gap by providing a low-cost, technology-driven intersection safety treatment that reduces both the likelihood and severity of crashes at non-signalised intersections along high-speed roads. While RJAWS Lite is intended to be used at any suitable intersection, it may be particularly applicable to intersections controlled by local governments, who are less likely to be able to afford more expensive intersection treatments.

The trial documented here was aimed at providing design, construction and operational experience through the first installations of RJAWS Lite and providing evidence of the treatment's safety benefits. This trial was funded through the Australian Government's Road Safety Innovation Fund (RSIF) program, administered by the Office of Road Safety. The project number was RSIF2-74. In-

kind support was provided by the South Australian Department for Infrastructure and Transport (DIT), through both funding the construction of supporting infrastructure for the trial and allowing the trial to be undertaken on its roads. The project partners who undertook the trial were the Centre for Automotive Safety Research (lead organisation), DIT, and SAGE Automation (technology provider and operator). Artcraft supplied and installed the supporting infrastructure for the trial. Austraffic undertook the traffic surveys used to provide data for the evaluation. This report documents the undertaking of this trial and the results of its evaluation.

1.1. Safety outcomes

RJAWS Lite is aimed at reducing both the likelihood and severity of crashes at non-signalised intersections along high-speed roads in regional and remote areas. This is achieved with two safety systems: (1) a major road speed advisory system and (2) a minor road run-through prevention system. Both systems operate independently but use the same equipment to function.

The major road speed advisory is intended to reduce the likelihood and severity of crashes by warning drivers on the major road of traffic entering the intersection from the minor road(s) and advising them to reduce their speed as they traverse the intersection. This is achieved through the use of a modified advanced warning sign with flashing LED lights that illuminate when the speed advisory is required. A successful outcome consists of an appreciable reduction in travel speed along the major road when the major road speed advisory is activated. Reducing speed is the most effective tool that road designers can use to reduce the severity of crashes at intersections. Reducing speed along the major road is most important as this is generally where high speeds that lead to high severity crashes occur. It is therefore vital that speed be appropriately managed through effective application of the major road speed advisory. A heightened alertness and improved reaction time by a major road driver may also result.

The minor road run-through prevention is intended to reduce the likelihood of crashes by warning drivers along the minor road that they may be at a risk of running through the intersection. This system is intended as a last-chance warning for drivers who may not be aware that they are approaching an intersection at which they are required to give way to other traffic. This is achieved by illuminating a ring of flashing LED lights around the control sign. A successful outcome is to see a reduction in the number of vehicles that ‘run-through’ the intersection.

1.2. Background

The Rural Junction Active Warning System (RJAWS), upon which RJAWS Lite was conceived, was first installed in South Australia at four 3-leg intersections in 2018; three in 80 km/h speed limit zones and one in a 100 km/h speed limit zone (Mongiardini et al., 2021). A further fifth installation occurred at a 4-leg intersection within an 80 km/h speed limit zone in 2021. Note the name changed to Rural Intersection Active Warning System (RIAWS) for the 4-leg installation. Similar installations have been undertaken in New Zealand and Victoria, with the prior New Zealand examples being used as a key reference when designing the first RJAWS treatments in South Australia.

Positive results were shown during the evaluation of the South Australian RJAWS. An evaluation of the RJAWS treatments showed a reduction in average travel speed of between 11.3 km/h and 22.1 km/h when the systems were activated, corresponding to a reduction of the expected average casualty risk of between 42% and 65% compared to before the installation of RJAWS (Mongiardini

et al., 2021). Similar results are expected for the RIAWS installation. An evaluation of crash and injury reductions due to the installation of RJAWS and RIAWS has not yet been conducted, owing to the novelty of the treatments.

Despite the positive results of the RJAWS and RIAWS trials in South Australia, the applicability of the treatment is somewhat limited by the cost of installation, with the latest examples in South Australia and interstate costing several hundred-thousand dollars per intersection. These costs are in-part due to the need to install underground services to power and connect the different parts of the system, and the increased complexity of the system as more advanced technology has been sought to detect vehicle movements. The cost of RJAWS and RIAWS can prohibit their installation at lower volume intersections, where the high cost may not be warranted, and for local governments, who are unlikely to be able to afford the treatment.

To facilitate the use of the RJAWS/RIAWS concept across a larger spectrum of the road network, the Centre for Automotive Safety Research (CASR) at the University of Adelaide partnered with SAGE Automation to develop RJAWS Lite. Taking the objectives of RJAWS/RIAWS as the starting point, the concept was redeveloped with the goals of lowering the cost and reducing the time and complexity required to install the system. To achieve these goals, off-grid power and mobile network communications were utilised. Solar was chosen as a power source due to its low cost, simplicity and ease with which it could be adapted for RJAWS Lite. Mobile network communication was chosen for its ability to facilitate reliable wireless connections between the different parts of the system and to allow for back-to-base communications providing live updates on the condition of the system. Radar was chosen in place of inductive loops to detect traffic, avoiding the need for installation of physical sensors in the road surface and their consequent wired connection to the rest of the system. As part of this redevelopment process, an additional system, named the minor road run-through prevention, was developed to utilise the same power, communication and vehicle detection equipment while providing the additional benefit of reducing the risk of run-through crashes, which can be a common occurrence at regional and remote intersections.

2. Design of RJAWS Lite

This chapter provides a description of the major design principles of the RJAWS Lite system that was trialled during this project, including the various steps that led to its final design.

The RJAWS Lite is designed to provide the following two separate safety functionalities, which are delivered independently using the same backbone infrastructure: (i) a major road speed advisory (similar to the original RJAWS treatment) and (ii) a minor road run-through prevention (in addition to the original RJAWS). Each of these two capabilities are described in detail in the following sections.

2.1. Major road speed advisory

The major road speed advisory alerts drivers travelling on the major to reduce their speed when traversing the intersection if a potential crash with a minor road vehicle may occur. A warning is provided via activation of flashing lights on a sign located on the major road when a vehicle is detected to approach the intersection on the minor road, as depicted in Figure 2.1.

Figure 2.1
Example of a major road speed advisory sign

The operational sequence of the major road speed advisory system is shown in Figure 2.2. It consists of the following steps:

A. A vehicle on the minor road approaches the intersection and passes through the detection zone of the minor road radar

B. The minor road radar detects the vehicle on the minor road

C. The major road speed advisory signs are armed, but activated only in presence of through traffic

D. Traffic is detected on the major road approach by the major road radar (mounted to the same structure as the major road speed advisory signs)

E. Flashing lights on the major road speed advisory sign are activated for a pre-defined duration.

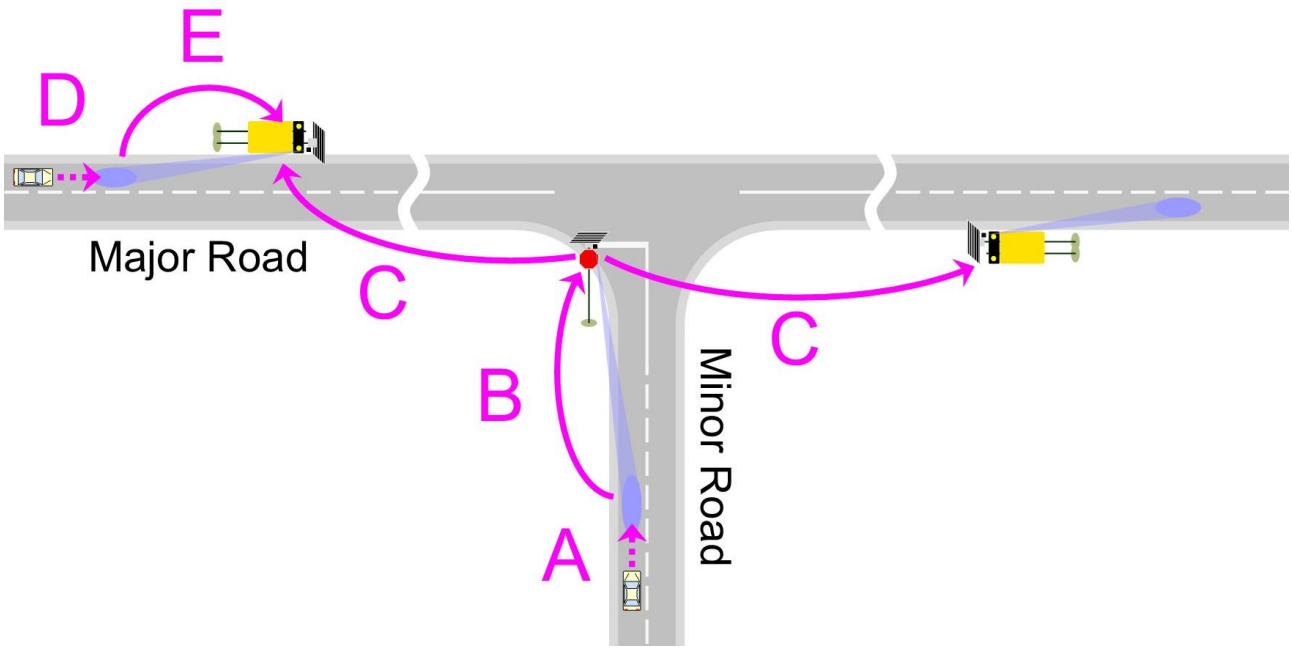


Figure 2.2
Diagram of the operational sequence of the major road speed advisory system

2.2. Minor road run-through prevention

The minor road run-through prevention is used to alert drivers that they are approaching the intersection along the minor road at a higher than appropriate speed and may therefore be at a risk of not stopping or adequately slowing before they traverse the intersection. This alert is provided via flashing lights around the control sign, as shown in the example in Figure 2.3.

Figure 2.3
Examples of control sign with flashing lights activated for minor road run-through prevention system

The operational sequence of the minor road run-through prevention is shown in the diagram in Figure 2.4. It consists of the following steps:

A. A vehicle on the minor road approaches the intersection and is detected as it passes through the detection zone of the minor road detection equipment. The vehicle is detected travelling at a speed above the threshold speed set to activate the flashing lights around the control sign
B. Flashing lights around the minor road control sign are activated for a pre-defined duration.

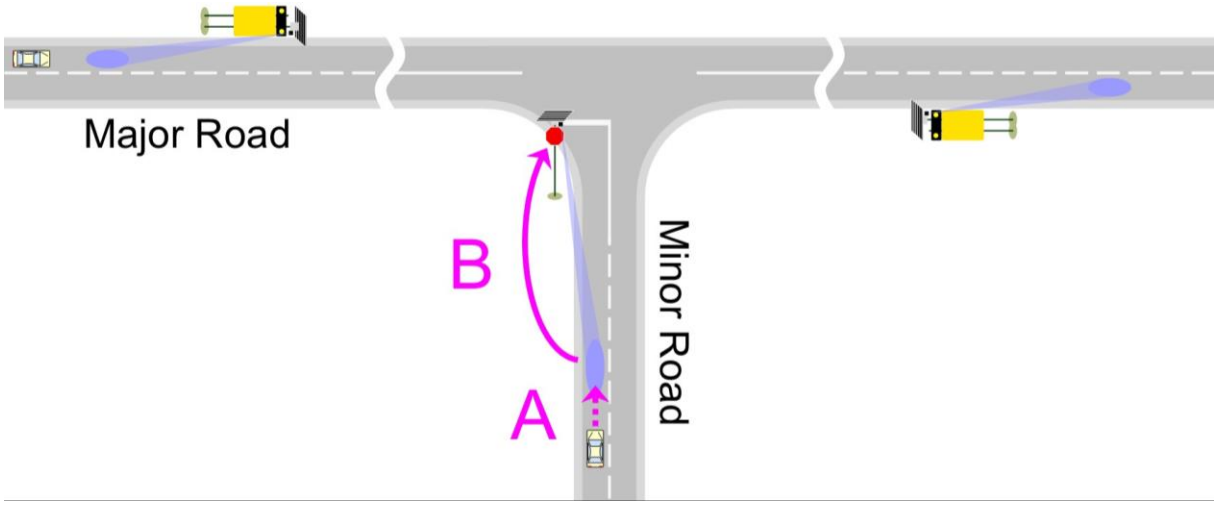


Figure 2.4
Diagram of the operational sequence of the minor road run-through prevention system

2.3. Treatment design

In this section the procedure used to design the treatment is discussed. This mainly concerns the timing of the vehicle detection and activation of the flashing lights, which requires careful

consideration to ensure coordination of timing between minor road vehicles that activate the treatment and major road vehicles that react to the activation of the treatment.

2.3.1. Design speed

Speeds used for the calculation of sign distances were based on the following assumptions:

- Vehicles travelling at speed: vehicles were assumed to be travelling at the speed limit. Note the 85thpercentile speed is commonly used for this purpose, but it was unknown for the roads used for this trial.
- Vehicles slowing due to activation of the major road speed advisory flashing lights: vehicles were assumed to be travelling at a speed of 10 km/h above the advisory speed when traversing the intersection, as shown by previous trials of RJAWS (Mongiardini et al., 2021).
- Vehicles traversing the control line: vehicles were assumed to roll through the intersection at a speed of 10 km/h.

2.3.2. Vehicle detection

Major road

Battery-saving was employed for the major road speed advisory by using a radar sensor mounted adjacent to each of the major road speed advisory signs to detect traffic presence along the major road and only activating the major road speed advisory sign flashing lights when a vehicle was present. Vehicles were detected at a distance on approach to the major road speed advisory signs. When a vehicle was present, the flashing lights were activated for a limited length of time, allowing the driver of the passing vehicle to see the activation of the flashing lights. The distance at which vehicles were detected and hence the flashing lights were activated was 100 m, allowing for sufficient time for the driver of the major road vehicle to see and respond to the flashing lights. Battery saving was used for all sites during the trial, as the needs of the system under operational load were not yet understood. Note that battery saving represents a meaningful option only if a substantial number of minor road vehicle detections will not coincide with vehicle presence on the major road. For future installations, use of radar sensors for battery saving may not be required if the power supply is adequate to support the major road speed advisory lights flashing by default at each detection of a minor road vehicle. The cost of increased solar panel/battery capacity to allow for this option versus the current cost for this additional radar system should be considered.

Minor road

The minor road radar served two functions. First, it acted to detect the presence of vehicles approaching the intersection from the minor road and activate the flashing lights on the major road speed advisory signs. Second, it acted to detect the speed of vehicles approaching the intersection from the minor road and activate the minor road run-through prevention flashing lights.

To activate the major road speed advisory sign flashing lights, the radar was directed such that vehicles approaching the intersection from the minor road were detected at a suitable distance. This distance was determined by a number of factors, including road geometry, vehicle speeds and that required to facilitate the appropriate distance of the major road speed advisory signs from the intersection, L_{max} (see Section 2.3.3).

To activate the minor road run-through prevention flashing lights, the radar was directed such that vehicles approaching the intersection from the minor road were detected at a suitable distance. The radar was angled so that it could reliably detect and track the speed of an approaching vehicle. As

tracking along the path of deceleration was required for evaluation purposes, the minor road radar was mounted to a pole separate from the control sign, on the opposite side of the intersection to the minor road, to facilitate a line of sight with a near-zero angle. Tracking of a minor road vehicle was achieved by setting up measurement locations ('gates') equally spaced every five metres, with the furthest at a distance no greater than where normal deceleration started and the closest up to where the sensor line-of-sight was lost (typically about 30 m from the control line). If a vehicle speed exceeded a set threshold while crossing the gate, the minor road run-through prevention flashing lights were activated for five seconds. For each trial installation, the threshold speed was set by considering an appropriate approach speed along the minor road. This was achieved through a combination of pragmatic driving testing during site visits and manual speed observations of vehicles as they approached the intersection. Details of threshold values used for activation of the minor road run-through prevention flashing lights are shown in Table 2.1.

Table 2.1
Threshold values used for the activation of the minor road run-through prevention flashing lights

Site	Distance to furthest gate (m)	Threshold speed (km/h)
1	90	65
2	85	70
3	Minor road run-through prevention system not installed	
4	85	70
5	88	65
6	90	70

2.3.3. Sign location

Road signs were located in accordance with the relevant standards and guidelines; namely *Australian Standard 1742.2* (Standards Australia, 2022), Austroads *Guide to Road Design Part 4A* (Austroads, 2023), and the Department for Infrastructure and Transport *Manual of Legal Responsibilities and Technical Requirements for Traffic Control Devices* (Government of South Australia, 2021). Deviation from these requirements was considered based on safety and site-specific requirements. The locations of all treatment designs, including the location of signs, were approved by DIT before installation commenced.

Major road speed advisory signs

Standards Australia (2022) provides different locations for warning signs based on the amount of speed reduction required by a driver. As RJAWS Lite is a novel treatment and the major road speed advisory signs are uncommon to other types of warning signs, it is unclear as to what category of speed reduction should be used. Based on the conservative assumption that, on activation, the major road speed advisory signs would lead to a moderate level of speed reduction, the respective category in Standards Australia (2022) was adopted. This meant that for sites 1, 3 and 5 (80 km/h speed limit) the major road speed advisory signs should be installed 60-80 metres from the intersection, while for sites 2, 4 and 6 (100 km/h speed limit) the signs should be installed 80-120 metres from the intersection. It was assumed that the 85thpercentile speed, which is used to assess distance requirements in Standards Australia (2022), was at the speed limit.

There are several other considerations that were made when locating the major road speed advisory signs, which were:

- The distance necessary for a driver to react and slow in accordance with the advisory speed (determined by calculating L_{min})
- The coordination of timing between the detection and then arrival of a minor road vehicle at the intersection and the ability of a driver on the major road to see and react to the major road speed advisory (determined by calculating L_{max})
- The size of the signs, which could obstruct the major and minor road drivers' view of one another's vehicles. Consideration was given to the obstruction of sight lines created by the signs and that their placement should not obstruct visibility within the minimum gap sight distance and safe intersection sight distance (Austroads, 2023).

The major road speed advisory signs were placed at a distance L from the intersection, which was between L_{min} and L_{max}, as depicted in Figure 2.5. The distances L_{min} and L_{max} were determined through analysis of the theoretical requirements for effectively locating the major road speed advisory sign, as detailed below.

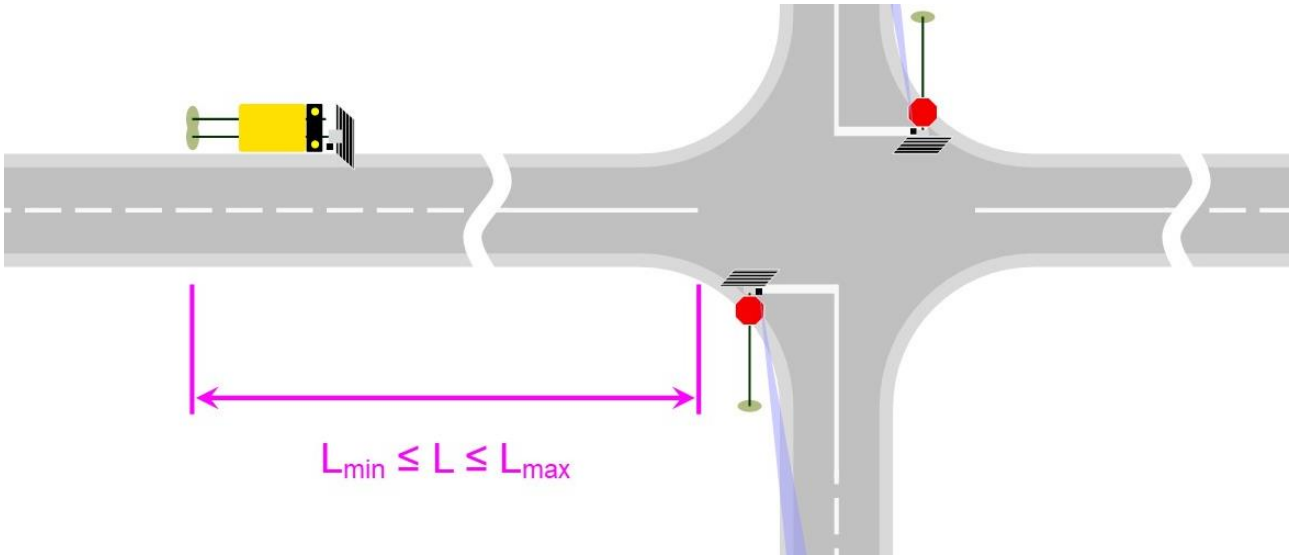


Figure 2.5
Major road speed advisory signs placement relative to the intersection

A summary of the respective distances considered when deciding on the location of the major road speed advisory signs is provided in Table 2.2. In-depth descriptions of the procedures used for calculating L_{min} and L_{max} are provided in the sections below.

Table 2.2
Summary of distance measurements considered when deciding the location of the major road speed advisory signs

Site	Standard Distance [1] (m)	L_{min} [2] (m)	L_{max} [2] (m)	L [2] (m)	d [3]
1	60-80	73/73	109/109	70/70	0.16/0.16
2	80-120	94/94	150/150	130/140	0.11/0.10
3	60-80	73/73	122/122	100/100	0.11/0.11
4	80-120	94/94	150/150	130/130	0.11/0.11
5	60-80	73/73	103/103	70/80	0.16/0.14
6	80-120	122/94	179/150	140/140	0.10/0.10

[1] Distance requirements stated in Standards Australia (2022), Table D1
[2] Cited for approach A/approach B, respectively
[3] Resulting coefficient of deceleration for major road vehicles on activation of the major road speed advisory flashing lights, with the major road speed advisory sign at a distance L from the intersection

Minimum distance (L_{min})

The major road speed advisory signs were located at least at a minimum distance from the intersection (L_{min}) such that a driver on the major road, on activation of the flashing lights, could react and safely slow in accordance with the advisory speed before traversing the intersection. Previous trials of similar systems have shown that most vehicles will slow to a fraction of that advised (Mongiardini et al., 2021). Therefore, the target speed of vehicles on activation of the major road speed advisory was regarded as pragmatic. It was therefore decided that the target speed be 10 km/h above the advisory speed – in-line with the upper limit of speed reductions reported by Mongiardini et al. (2021). For example, the maximum target speed for an intersection in an 80 km/h speed zone with a 50 km/h advisory speed was 60 km/h. Example calculations for L_{min} are shown in Appendix A. This length was calculated using a coefficient of deceleration d of 0.15, which is that given for comfortable deceleration for a bus in Austroads (2021). This value was chosen as it was likely to reflect the rate of deceleration that was adopted by most drivers on approach to the intersection when the flashing lights were activated (e.g. slowing with minimal active braking), as tested on-site during the design process. This was also considered to be less likely than higher rates of deceleration to lead to rear end collisions (i.e. due to heavy braking by a leading vehicle).

Maximum distance (L_{max})

When locating the major road speed advisory signs, there needed to be coordination so that the flashing lights were activated at the time necessary to warn vehicles on the major road that had the potential to collide with the minor road vehicle. The significant risk was that a sign would be placed too far from the intersection, so that when the lights were activated, a major road vehicle at risk of colliding with the minor road vehicle would have already passed the sign. The maximum distance at which the major road sign should be placed from the intersection was determined as L_{max}. Descriptions for coordinating the timing of the flashing light activation using L_{max} is given in Table 2.3, with a graphical representation provided in Figure 2.6. Example procedures for calculating these values are shown in Appendix A.

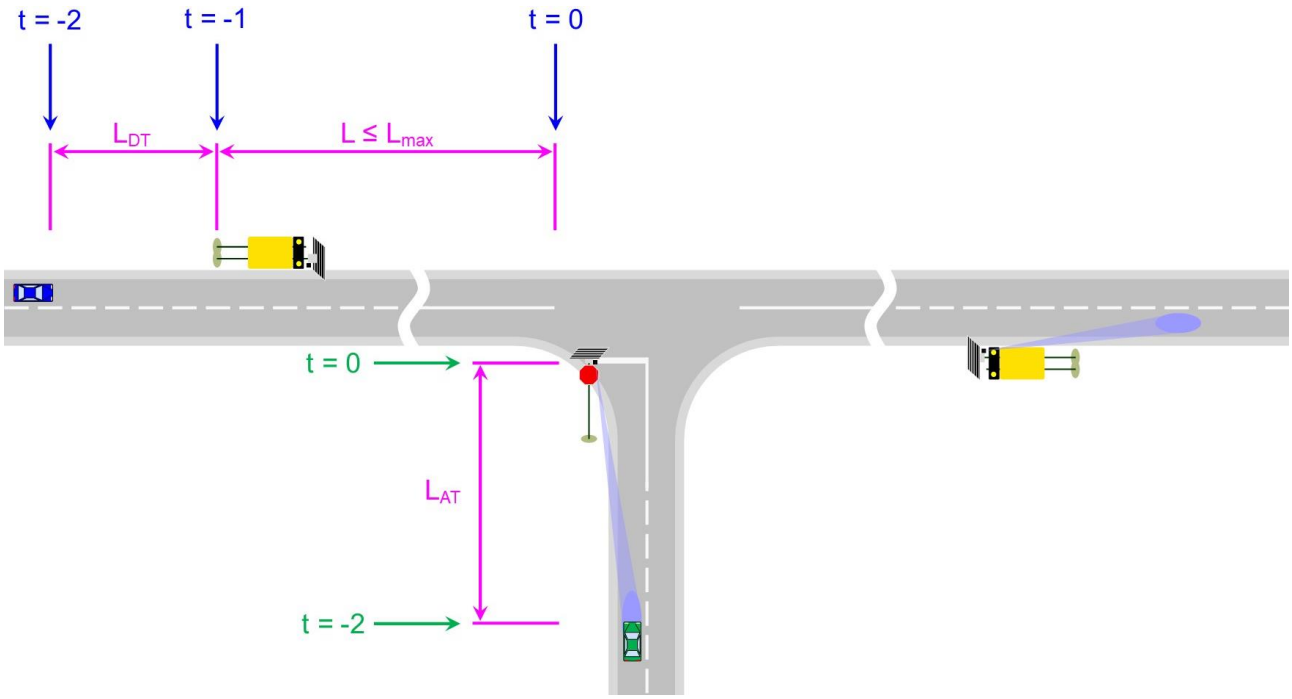


Figure 2.6
Graphical representation of the timesteps considered when determining placement of the major road speed advisory sign

Table 2.3
Timesteps considered for coordination of the minor road and major road vehicles when determining placement of the major road speed advisory sign

Timestep	Minor road vehicle	Major road vehicle
t = -2	The minor road vehicle is detected by the minor road radar at a distance LAT as it approaches the intersection. It was assumed that the minor road vehicle is decelerating at a constant rate. The approach time (AT) is the time required for the minor road vehicle to reach the intersection after detection from the minor road radar	The major road vehicle approaches the major road speed advisory sign, at a distance (LDT) corresponding to the decision time (DT) required for the driver to observe and react to the advisory speed displayed on the sign
t = -1	-	The major road vehicle passes the major road speed advisory sign, at a distance Lmax from the intersection, corresponding to the response time (RT) required for the driver to slow to the target speed at which it will traverse the intersection
t = 0	The minor road vehicle arrives at the intersection. It was assumed that the minor road vehicle is travelling at a low speed (e.g. 10 km/h) when it traverses the control line. This was chosen as a conservative value, which decreases the time required for the minor road vehicle to reach the intersection	The major road vehicle arrives at the intersection, having slowed to the target speed

Activation of the major road speed advisory flashing lights should occur at least a minimum distance before the major road vehicle passes the sign (L_{DT}). This distance corresponds to the decision time (*DT*) required for the driver to observe and react to the flashing lights. While a decision time of five seconds is recommended by Austroads (2021), this was determined infeasible due to the limited range of the minor road radar, which determined the distance at which a major road vehicle can be from the intersection when the major road speed advisory flashing lights are activated. Instead, a

decision time of three seconds was chosen. This was justified as acceptable as it would only limit the decision time available for a major road vehicle that traversed past the major road speed advisory

The maximum distance at which the major road speed advisory sign was placed from the intersection to allow for coordination (L_{max}) is dependent on several factors: initial speed; advisory speed (or target speed); decision time; minor road radar detection distance; and major and minor road vehicle deceleration characteristics. Ideally, RJAWS Lite should be designed to compensate for a minor road vehicle that does not slow at all on approach. However, this would result in the major road advisory speed sign being placed infeasibly close to the intersection. Instead, L_{max} was calculated while allowing for coordination with a vehicle that is slowing for the intersection.

The distances L_{max}, L_{DT} and L_{AT} are related through the time periods required for a car to travel their respective distances. These are RT, DT and AT, respectively. The relationship used to determine each distance can be expressed by the following equation

$$AT \geq DT + RT$$

where AT is the time required for the minor road vehicle to reach the intersection after being detected by the minor road radar; DT is the decision time required for the driver of the major road vehicle to observe and react to the major road speed advisory flashing lights; and RT is the response time required for the driver of the major road vehicle to slow to the speed at which it will traverse the intersection (the target speed).

Minor road run-through prevention

The minor road run-through prevention signage consisted of the control sign with imbedded LED flashing lights. This was placed in the same location where the existing control sign, which was being replaced, had resided.

The minor road run-through prevention system was not employed at treatment site 3, due to issues maintaining power to the minor road radar, which was then moved to the location of the minor road run-through sign that was, by necessitation, removed.

Additional signage

RJAWS Lite is an overlay treatment. The signage specific to RJAWS Lite is intended to replace specific signage at a standard non-signalised intersection. The following signage was replaced during the trial.

- The major road speed advisory signage replaced the primary W2-1 Cross Road or W2-4 (L or R) Side Road Intersection signs.
- The minor road run-through prevention signage replaced the primary R1-1 Stop or R1-2 Give Way control signs.

After the trial had concluded at a site, the above signs were placed back in their original locations.

2.4. Hardware requirements

2.4.1. RJAWS hardware and supporting roadside furniture

Sleeved frangible poles were used to support the signs and equipment. Depending on the specific part of the system, one or two poles were used to support solar panels, radar, communications

equipment, computational equipment, flashing lights and/or signs. Sleeved frangible poles allowed for quick installation using vacuum excavation methods and provided ease of deinstallation/reinstallation when the treatment needed to be moved to another location during the trial.

The RJAWS was designed to reduce the incidence of vandalism while allowing for ease of access for maintenance. This was achieved by:

- Placing all equipment at a height above ground level that is inaccessible without a ladder
- Enclosing batteries and electronic equipment in lockable enclosures
- Placing furniture in locations where a vehicle can be parked and used to protect personnel from passing traffic
- Placing roadside furniture in locations where a ladder can be safely used

The poles and equipment were up to six-metre tall. Many power lines are near this height from the ground. Careful consideration was made where poles and equipment were installed near power lines. Minimum required clearances were observed during both construction and operation (Government of South Australia 2011), including consideration to the safe clearance needs of installation/maintenance personnel and equipment, in addition to that of the installed infrastructure.

Additional signs and poles were installed where required signage was missing or additional signage was deemed necessary to conform to the design requirements of the treatment, e.g. adding control signs where the intersection was originally uncontrolled.

2.4.2. Vehicle detection

Radar sensors were used to detect vehicles. Radar detection can be achieved without contact and therefore does not need extensive roadworks that are otherwise required for inductive loops traditionally used for vehicle detection. However, sensors also require a clear line of sight and therefore it may not be suitable for locations with visual obstruction due to obstruction roadside objects or the road alignment. Therefore trial locations were chosen with consideration of the ability to use radar for vehicle detection. Occlusion by traffic crossing the path of the intended target was also an issue, due to the placement of the minor road radar on the far side of the intersection from the minor road. This was overcome by filtering out from the radar signal the ’noise’ that was created by detection of the major road traffic.

2.4.3. Power supply

Solar power was used to supply electrical power for all electrical equipment. Solar panels were installed at the top of each frangible pole to supply power to the radar, communications, computation, and flashing lights that is installed on the poles. Each pole contained a 150W solar panel and a 75Ah lithium-ion battery.

Power supply should be able to provide reliable operation of the treatment. Due to the trial nature of the treatment, outages were experienced and knowledge from these events was used to further refine design and installation considerations for later stages of the trial. Weather and the location of nearby trees were the major contributors to a lack of power. During the trial, weather or trees individually were not enough to completely drain the battery reserves. When combined with trees obstructing sunlight for part of the day, the batteries could be drained within a few days.

Power input should be enough to compensate for all power consumption over a 24-hour period. The wattage of the solar panels needs to be sufficient to supply enough electricity to restore batteries to their 'full' voltage by the end of the daylight period. It is understandable that this may not always be feasible, such as under extreme weather conditions as experienced during the trial. The battery capacity should be enough to maintain power supply for a reasonable amount of time without reliance on any charging from the solar panels.

Power consumption of most equipment (radar sensors, communication devices, etc.) was reasonably deterministic. Activation of flashing lights represented the most variable source of power consumption and was dependent on the number and length of activations. Capacity should be enough to power activation by a reasonable percentage of minor road vehicles plus a margin of safety. Battery saving was used to reduce the load through flashing light activations. This was achieved through the use of a radar aligned to detect vehicles approaching the major road signs. Once armed, the major road speed advisory flashing lights would only activate if a vehicle was detected within approximately 4 seconds from the sign. Using this method, solar panel and battery capacities were sufficient to provide reliable power, bar the occasions where both inclement weather and sunlight being blocked trees for an extended period of time reduced the battery capacity and ultimately led to a shutdown of the system until the battery was recharged by the solar panel.

2.4.4. Communications

Reliable communication was required between the different parts of the treatment and remotely for the purpose of operational oversight. The LTE-M cellular network was utilised for communications. While the trial was conducted near the metropolitan area of Adelaide, the LTE-M cellular network should be compatible with installations in many regional areas. According to a Telstra internet of things (IoT) network coverage map (Telstra, 2023), both the LTE-M cellular network and NB-IoT, an alternative cellular network, should be able to service locations within many populated areas of Australia.

While some communication lag occurred between different parts of the treatment during the trial, this was overcome through design considerations. For example, flashing light activation timing was adjusted to account for approximately half a second of lag between radar detection and activation. Communications were reliable during the trial, with no downtime of communications between the different parts of the treatment or with remote oversight of the treatment.

2.5. Constructed RJAWS Lite units

Two complete sets of the RJAWS Lite units were manufactured by SAGE Automation. The proper functionality of both systems before their deployment to the trial sites was confirmed through an initial Factory Acceptance Test (FAT) by the manufacturer. The full FAT report of one of the two RJAWS Lite units is provided in Appendix B. Additionally, field testing was also conducted by CASR researchers to confirm the functionality of the system once it was installed at each of the six trial sites (Figure 2.7). This additional field-testing activity involved checking that each of the signs were promptly activated and operating as per the expected system functionality and operational domain through. Common activation scenarios were tested through coordination of two test vehicles – a vehicle arming the system by approaching the intersection on the minor road and the other vehicle triggering the sign on the major road while approaching the intersection on one of the two major intersection approaches. Activation of the flashing give-way sign was also separately tested through

purposely approaching the intersection on the minor road at over the threshold speed. Each of these tests were repeated three times to confirm repeatability of the results.

Figure 2.7
Site testing for the major road speed advisory system (top) and minor road run-through prevention system (below)

3. Trial Design

This chapter provides a description of the trial objectives as well as the methodology used to conduct the trial and analyse the collected data.

3.1. Trial objectives

The evaluation of the RJAWS Lite focused on each of the two investigated safety objectives of the system, namely a reduction in travel speed for (a) vehicles approaching the intersection along the major road when the lights on the major-road signs are flashing and (b) vehicles approaching the intersection along the minor road when the give-way sign is flashing.

3.1.1. Methodology

The evaluation of the safety benefits conducted in this study is based on an approach that previously successfully adopted by CASR to assess the safety benefits of the full version of the RJAWS at a series of T-junctions (Mongiardini et al., 2020). Based on this approach, the effectiveness of the RJAWS Lite in this project has been evaluated based on the traffic speeds measured during the trial. The choice of using travel speed as a proxy measurement for evaluating the potential safety benefits of the RIAWS Lite was motivated by the intrinsic stochastic nature of crashes. Indeed, it would have been unlikely to observe any crashes at any of the trial sites given the probabilistic nature of crash events across the road network, even at locations which are characterised by a relatively high level of risk. Additionally, the choice to use speed was also motivated by practical limitations of this trial. In fact, both the relatively short evaluation period as well as the limited number of the treatment/control paired sites further contributed to limit the exposure of a crash to occur during the trial period at any of the trial sites, practically making unfeasible to perform a safety benefit analysis based on crash data.

The analysis included a comparison of both the mean and 85thpercentile values of the vehicle speeds before and after the treatment implementation. Distributions of the travel speed during the before and after periods were compared as well. Additionally, a threshold analysis was conducted to identify the percentage of vehicles travelling within various speed ranges. This speed analysis was conducted on an aggregation of all type of observed vehicles as well as their categorical break-down into light and heavy vehicles. Note that no statistical significance could be drawn throughout this analysis due to the small number of trial intersections (i.e. small sample size).

3.1.1.1. Controlled before-after investigation

A before-after analysis was conducted, meaning that the evaluation was performed comparing the observed speed of vehicles driving through the trial intersections before as well as after the treatment was activated. This before-after analysis was conducted separately for each of the two possible scenarios regarding the activation of the RJAWS Lite; namely, (i) warning lights flashing and (ii) no blank lights. Note that this approach was applied separately throughout the investigation of each of the two RJWAS Lite safety features (i.e. major road speed advisory and minor road run-through prevention).

To perform a before-after comparison, vehicle detections had to be classified consistently under each of these two scenarios also during the period before the RJAWS Lite was operational. Therefore, the RJAWS Lite system was installed at the treated sites since the beginning of the trial

but operated in ‘silent’ mode during the before period (i.e. signs and lights were not shown to motorists at any time during that period, but the system logged any of these silent activations). Note that a habituation period was set in place after the RJAWS Lite switched from silent to normal mode so that motorists could familiarise with the system before their speed behaviour was observed during the post-activation period. Additionally, no informational road signage was provided to notify motorists of the ongoing trial in order to avoid biasing their speed behaviour throughout any period of the trial.

During the trial, travel speed was also monitored at additional control intersections that were specifically paired to each of the treated site. The speed data collected at these additional control sites were used to account for the potential effect of external factors that could affect the speed behaviour at both the treated and control paired sites (e.g. weather, traffic conditions). To eliminate the effect of such potential external factors, the before-after difference of speeds measured at each treated site was discounted by any corresponding difference found at the paired control sites. Note that this methodology assumes that any such controlled factors that may have influenced the speed behaviour of road users would have acted simultaneously at both the treatment and control sites.

Traffic factors may also contribute to affect the speed behaviour when approaching an intersection, such as the presence of vehicles closely travelling in the same direction. Therefore, vehicles observed on the major road during the trial were initially pre-filtered so that only motorists travelling in a free flow condition were included in the analysis (i.e. no other vehicle immediately leading or following). Nonetheless, an additional specific investigation was also conducted considering only vehicles travelling on the major road which were disrupted by the presence of traffic entering the intersection.

3.1.1.2. Analysed traffic events

The analysis of the travel speed along the major road was conducted under the following two scenarios:

- General scenario with free-flow traffic on the major road
- Specific scenario with traffic on major road disrupted by an entering vehicle

The specific rate of occurrence for each of those two conditions are expected to be unaltered after the installation of the RJAWS Lite. Therefore, any speed change that may be observed at the treated sites is expected to be associated to the presence of the treatment rather than to a change in the rate at which any of those two scenarios may occur.

The analysis of this general scenario included any vehicle that was deemed to be travelling in a free-flowing condition. To identify those vehicles which were travelling in a free-flow fashion along the major road an elimination process was adopted, which consisted of discarding the following types of events from the initial sample of all the vehicles detected by the traffic count:

- Vehicles closely following each other (platooning)
  [Exclusion criterion: headway smaller than 4 seconds]
- Vehicles that turned in/out of the intersection
  [Exclusion criteria: travel speed below 40 km/h (turn out) and below 45 km/h (turn in)]

Note that the general scenario with free-flow traffic included vehicles travelling on the major road under the cases of either another vehicle waiting at the control line on the minor road or having enter

the intersection through a right-turn manoeuvre into the far-side lane (i.e. a potentially disrupting event), Nonetheless, in the latter case, only traffic approaching on the major road with enough headway from the disrupting vehicle to be considered travelling at free flow were included in this general scenario.

Apart from the analysis of all the free-flowing vehicles, a separate more specific analysis was also conducted in which only traffic that was disrupted by another vehicle entering the far-side lane of the major road through a right-turn manoeuvre. This additional analysis served to investigate the potential effect of the RJAWS Lite during this potentially disrupting situation, which could result in a crash with high severity due to a right-angle configuration. Differently from the previous general scenario, the analysis of this particular scenario included mainly vehicles that were not travelling in a free-flow fashion in order to account for those potential close proximity cases where the disrupting vehicle may have entered the intersection with a small gap. Only major road vehicles that were deemed to be slowing to turn out of the intersection were excluded from the analysis of this disrupted scenario.

3.1.2. Trial staging

The RJAWS Lite was installed and trialled at six separate intersections. To reduce the number of devices required to conduct the trial as well as to avoid the large effort of treating all the designated sites at the same time, the trial was conducted in three consecutive stages. At each stage, two sites were treated and monitored, along with the concurrent monitoring of the corresponding paired control sites. When a phase of the trial terminated, the equipment was relocated to the sites for the next planned stage. To reduce the number of de-installations required between sequential stages of the trial, in a couple of cases the designated control site for the previous stage was then converted into a treated site during the following stage. Details of the six pairs of treatment/control trial intersections are provided in the Chapter 3.1.4.1.

3.1.3. Data collection

During each of the three trial stages, the two treated sites as well as their paired control sites were monitored and relevant data was collected for the trial evaluation.

3.1.3.1. Measurements

Speed and traffic data in proximity to each trial intersection, both at the treated and paired control sites, were collected using dedicated traffic data loggers which were connected to pneumatic tubes installed across the road section. This setup allowed to measure vehicle travel speed as well as classify vehicle types. An example of installation of the pneumatic tubes at one of the treatment/control paired intersections in this trial is shown in Figure 3.1.

Treatment Site	Control Site
	

Figure 3.1
Example of an installed pneumatic tube used for conducting traffic survey in proximity to each trial intersection

Additional speed measurements were also collected using the radar sensors of the RJAWS Lite along any of the three intersection approaches. The following specifications for the data collection were applied based on the type of approach:

- **Major approaches** – Speed measured around 50 m upstream of each sign on the major road (measured only at treated sites)
- **Minor approach** – Speed measured along various locations spaced 10 m from each other, with exact locations varying between sites (measured at both treated and control sites)

An example of the radar sensors required for the RJAWS Lite functionality which were also used to measure vehicle speeds along the major and minor intersection approaches is shown in Figure 3.2. Note that at control sites only a single radar unit was deployed to detect vehicles on the minor road. Therefore, at control sites collection of additional speed measurement using the RJAWS sensors was possible only for the minor approach to the intersection.

Major Approaches	Minor Approach
	

Figure 3.2
Example of RJAWS Lite radar sensors used to measure vehicle speeds on each intersection approach

3.1.3.2. Collection periods

A summary of the RIAWS Lite activation dates and the periods considered for the analysis of both the treatment and control site is provided in Table 3.1. For each of the tree trial stages, the post-treatment data collection took place at least one month after the activation of the systems (i.e.

uncovered signs on the major road and lights flashing when the system was triggered). This temporal gap from the initial system activation was deemed to be sufficient to allow motorists to familiarise with both the sign and the system functionality and therefore assess the speed behaviour expected after any initial novelty reaction had subsided.

Table 3.1
Data collection periods and date of RJAWS Lite activations for each of trial stage

Trial Stage	Before			System Activation *	After		
	Start date	***End date***	***Duration (days)***		***Start date***	***End date***	***Duration (days)***
I	14/11/2021	12/12/2021	28	14/12/2021	21/02/2022	20/03/2022	27
II	14/06/2022	12/07/2022	28	20/07/2022	21/08/2022	18/09/2022	28
III	13/11/2022	11/12/2022	28	19/12/2021	2/02/2023	2/03/2023	28

*** Signs on major road uncovered with flashing lights connected and give-way flashing sign installed on minor road**

3.1.4. Installed RJAWS Lite

A typical RJAWS Lite system installation at one of the six treated sites is shown in Figure 3.3. As mentioned in the previous section, during the before period of each trial stage the RJAWS Lite was operating in silent mode. During that period, the signs located along each of the major road approaches to the treated intersections were kept fully covered with an opaque plastic film in order to prevent motorists to see any of the signage content, including the advisory speed and the two amber light beacons installed on the top portion of the signage. Reflection from the signs could have potentially biased the behaviour of approaching motorists at nigh time. Therefore, care was taken to avoid that any surface of the signage, including the edges, was effectively covered. A special grey-coloured film specifically designed to cover retroreflective road signage was used. At the end of the before period the plastic film was removed, and the signage made fully visible to the approaching motorists. An example of a fully covered sign along the major approach is also shown in Figure 3.3 (before period). Similarly, a standard give-way sign was installed in proximity to the intersection control line on the minor road approach during the before period. This sign was then replaced with the RJAWS Lite enhanced give-way sign with flashing capability at the end of the before period.

Figure 3.3
Typical RJAWS Lite system installed at treatment sites during the before and after periods of the trial stages

3.1.4.1. Trial sites

This chapter provides a description of the various aspects associated with the planning and implementation of the RJAWS Lite trial, ranging from the trial logistics and the selection of appropriate sites to the installation of the RJAWS Lite and the collection of data.

3.1.5. Site selection process

Trial sites were selected through a two-stage process. First, a desktop study was undertaken to identify possible sites. Second, site visits were undertaken at shortlisted locations. The site selection process was primarily used to identify treatment sites, though the selection of control sites was also made using this process (and selected from the same group as used to select treatment sites). The desktop study was achieved by assessing each site against the selection criteria detailed in Table 3.2. Location SA map viewer (2023) was used as a primary source of information. Intersections between state-controlled roads were primarily targeted as the necessary information available to undertake the assessment was mostly available only for this type of roads. This was also beneficial as DIT provided support for the project, hence making the approval process for installing the treatment potentially easier than at local government intersections. Where promising sites were identified and relevant information could be sourced, intersections on local government roads were also assessed. A total of 157 intersections were assessed during the desktop study. Of these, 44 sites were shortlisted for further investigation.

Table 3.2
Criteria for site selection

Criteria	Requirement
Intersection type	Three-leg intersection between sealed roads
Intersection control	Give way controlled or uncontrolled with ability to convert to give way control
Geometry	Suitable for use of radars, considering the required range and line of sight. Most desirable were straight and level-approach roads, though some horizontal or vertical curvature was tolerable. This was especially stringent for minor roads in order to allow for radar detection of vehicles at five-metre increments
Horizontal curvature	Horizontal curves with speed advisory signs along the major road were avoided, due to the complexity and unknown way to have a speed advisory for the curve and the RJAWS Lite treatment
Speed limit	80 km/h or 100 km/h, with same speed limit along all roads. No speed limit changes close to the intersection
Traffic volume	No specific requirement, though a volume of at least 1,000 vehicles per day on the major road and 100 vehicles per day on the minor road used as minimum desirable bounds. Where traffic volume information was not available through Location SA (2023), estimates were acquired by counting vehicles on the intersecting roads using satellite images from the Location SA map viewer (2023)
Turning from minor road	Majority right turns. This requirement was stipulated as the treatment is most beneficial when being triggered by right-turning vehicles. This was rudimentarily assessed using volume differentials on each major approaches (where information was available) and confirming on-site
Traffic speed	Geometry suitable for travel speeds at or near the speed limit on approach to the intersection. This requirement was stipulated to allow for sites where the greatest benefit of the treatment may be seen

Site visits were performed at the shortlisted intersections. At these intersections, drive-throughs were performed to verify the likely travel speed of vehicles as they traversed the intersection. Volume counts were also taken to verify traffic volumes, and turning counts were performed to assess the proportion of right turning vehicles from the minor road. The surrounding area to the intersection was assessed to make sure no features were present that could create bias during the trial (e.g. speed limit changes near the intersection, other intersections or major entry/exit points nearby). Range and line of site requirements for the radars were checked. Finally, potential locations for the infrastructure were identified, making sure safe off-road access would be available for the installation/removal phases.

3.1.6. Selected sites

The six pairs of treatment and control intersections selected for this trial were located in various rural areas scattered north, east, and south of Adelaide, as shown in the map of Figure 3.4. These trial sites are placed along rural routes across the Adelaide Hills as well as the two wine making regions of McLaren Vale and Barossa Valley in South Australia. These areas are characterised by a mix of traffic purpose ranging from local commuting, rural business activities (including heavy vehicles for harvesting and live stocks) as well as tourist transit. Each intersection was a T-junction between two-lane roads, with the major road having a speed limit of either 80 km/h (Site Pairs 1, 3, 5) or 100 km/h (Site Pairs 2, 4, 6). A summary of the six pairs of trial site are shown in Table 3.3 and aerial views are shown in Figure 3.5. Specific details for each trial site, both treatment and paired control intersections, are also provided in Sections 3.1.6.1 through 3.1.6.6.

Note that the following definitions have been used throughout the report to define the travel directions on the major road:

- Near side - Travel lane on major road close to the minor road
- Far side - Travel lane on major road further from the minor road

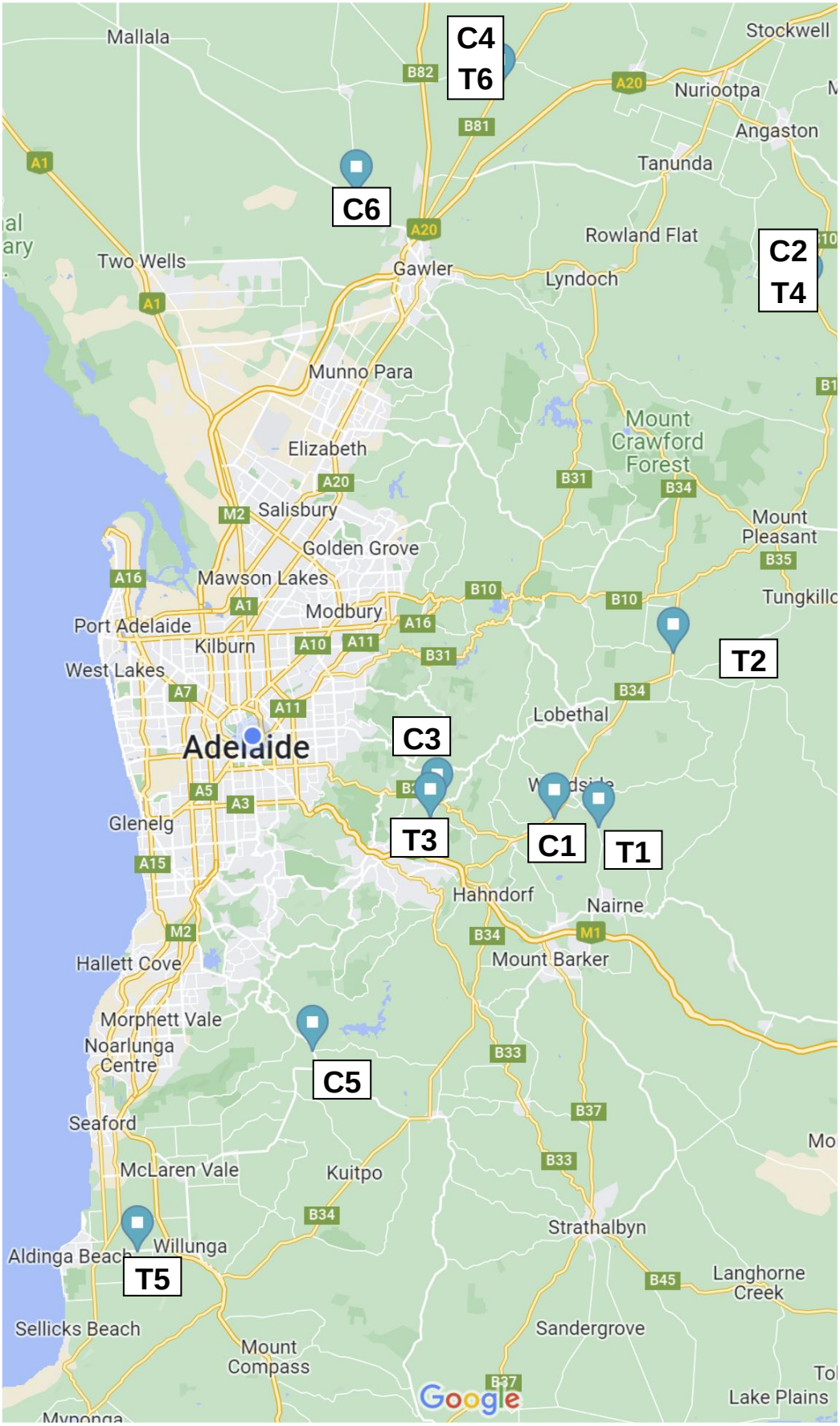


Figure 3.4
Location of each trial intersection (Google Maps, 2023; accessed 12 Jul. 2023)

Table 3.3
Details for each trial location

Trial Stage	Trial Pair	Type	Lat, Lon	Road name		Major Road Details			
				Major	Minor	Near Side [1]	Far Side [2]	Speed Limit (km/h)	RJAWS Lite Advisory Speed (km/h)
I	1	T	-34.980877, 138.898135	Nairne Rd	Mappinga Rd	N	S	80	50
		C	-34.974757, 138.860801	Onkaparinga Valley Rd	Mappinga Rd	S	N	80	-
	2	T	-34.860331, 138.960472	Onkaparinga Valley Rd	Burfords Hill Rd	N	S	100	70
		C	-34.613962, 139.070848	Eden Valley Rd	Seven Steps Rd	N	S	100	-
II	3	T	-34.974553, 138.756309	Range View Dr	Carey Gulley Rd	S	N	80	50
		C	-34.964755, 138.761942	Greenhill Rd	Rangeview Dr	W	E	80	-
	4	T	-34.613962, 139.070848	Eden Valley Rd	Seven Steps Rd	N	S	100	70
		C	-34.471658, 138.812094	Thiele Hwy	Gray St	N	S	100	-
III	5	T	-35.274126, 138.509341	Aldinga Rd	Ryan Rd	W	E	80	50
		C	-35.135598, 138.657229	Kangarilla Rd	Saddlebags Rd	S	N	80	-
	6	T	-34.471658, 138.812094	Thiele Hwy	Gray St	N	S	100	70
		C	-34.545541, 138.692475	Mudla Wirra Rd	Redbanks Rd	N	S	100	-

[1] Travel lane on major road that is close to the minor road
[2] Travel lane on major road that is further from the minor road

Trial Pair	Treatment Site	Control Site
1		
2		
3		
4	Same as Control Site for Trial Pair 2	
5		
6	Same as Control Site for Trial Pair 4	

Figure 3.5
Aerial views of each trial intersection (Google Earth, 2023; accessed 12 Jul. 2023)

3.1.6.1. Trial Pair 1

Trial Pair 1 was located near the town of Woodside in the Adelaide Hills region. The major roads for both sites are DIT controlled roads, while the minor roads are local government controlled roads. Both the treatment and control intersect with the same minor road, Mappinga Rd. Use of the same minor road for both treatment and control sites was assumed to not bias the trial as the traffic for each site was independent of one-another (traffic in either direction) and the sites at a large enough distance to have little if any halo effect. The major roads for both the treatment and control are significant routes through the region, with the former acting as a north-south corridor through the townships of the region and the latter being the main route between Nairne, Woodside, and the northern region.

Statistics for the treatment and control sites are given in Table 3.4 while satellite images are shown in Figures 3.6 and 3.7. The major road for the control site had a traffic volume approximately two times higher than for the treatment site. Apart from this, both sites were largely similar in traffic composition, with similar volumes of traffic noticed on the minor roads during the trial. While the major road for the control site had a slight horizontal curvature, this did not noticeably affect traffic speed. The curvature on the minor road for the control site affected approach speeds, though this was deemed to not adversely impact the trial as, being a control, the absolute speed was less important than the relative difference in speed during the before and after survey periods. While the minor road for both sites did not have a signposted speed limit (defaulting to the 100 km/h default outside of built-up areas), traffic speed along the road was noticed to be close to that expected along an 80 km/h signposted road. This is likely because most roads in the area are signposted as 80 km/h and therefore there is an expectation of this along the minor road. The control site had an additional temporary lane on the far side of the major road, which in practice acts as a right turn lane. Apart from this, there were no auxiliary lanes at either site.

Table 3.4
Information pertaining to Trial Pair 1

Item	Treatment	Control
Coordinates	-34.980877, 138.898135	-34.974757, 138.860801
Major road	Nairne Rd	Onkaparinga Valley Rd
Minor road	Mappinga Rd	Mappinga Rd
Major road speed limit	80 km/h	80 km/h
Minor road speed limit	Not signposted (100 km/h default)	Not signposted (100 km/h default)
Major road volume [(1)]	4,100/4,600 (2022)	9,300/9,500 (2022/2018)
Minor road volume [(1)]	Not available	Not available
Major road proportion CVs [(2)]	10%/12% (2022)	9.5%/10% (2022/2018)
Minor road proportion CVs [(2)]	Not available	Not available
Intersection control	Uncontrolled, upgraded to give way control for the trial	Uncontrolled, upgraded to give way control for the trial
Auxiliary turning lanes (major road)	None	Right turn
Separate turning lanes (minor road)	None	None
Horizontal curvature (major road)	Straight	Curve at intersection
Horizontal curvature (minor road)	Straight	Curve before intersection

[(1)] Daily two-way traffic volume from Location SA for both major approaches where available (survey year in backets)
[(2)] Proportion of commercial vehicles from Location SA for both major where available (survey year in brackets)

Roadside space on the major road at the treatment site was somewhat constrained by vegetation and, on the opposite approach, the installation of a roadside barrier. Placement of the major road speed advisory signs was closer than ideal in order to avoid these constraints. It is not believed that this decision adversely affected the trial and there was no indication that traffic was unduly impacted. It should be noted that while the distance between the major road speed advisory signs and the intersection was slightly below the minimum distance (L_{min}) calculated using the method described in Section 2.3.3, the deceleration required by vehicles to meet the target speed was deemed to be safe as no heavy braking would be required (theoretical coefficient of deceleration was 0.16, as opposed to 0.15 used to calculate L_{min}).

Figure 3.6
Satellite image of Treatment Site 1 (Location SA, Government of South Australia, 2023)

Figure 3.7
Satellite image of Control Site 1 (Location SA, Government of South Australia, 2023)

3.1.6.2. Trial Pair 2

Trial Pair 2 was located north-east of the Adelaide metropolitan area. The control site was located approximately 29 km north of the treatment site. Despite this, both treatment and control sites were located in similar pastoral areas. The major roads at both sites are DIT controlled roads, while the minor roads at both sites are local government-controlled roads. Both the treatment and control sites are located along the north-south corridor for traffic commuting between the Adelaide Hills and Barossa Regions.

Statistics for the treatment and control sites are given in Table 3.5 while satellite images are shown in Figures 3.8 and 3.9. Traffic along the major road for the treatment site was higher than for the control site, though traffic volumes at both sites were among the lowest of that seen at the sites used for the trial. Minor road volumes were not measured before the trial but were observed to be low – both minor roads were not parts of significant traffic routes. The major road for the control site had a gradual horizontal curvature, though this did not reduce traffic speeds below the speed limit. The sharp curvature or "kink" at the intersection on the minor road did not appear to affect the approach speeds of vehicles.

Table 3.5
Information pertaining to Trial Pair 2

Item	Treatment	Control
Coordinates	-34.860331, 138.960472	-34.613962, 139.070848
Major road	Onkaparinga Valley Rd	Eden Valley Rd
Minor road	Burfords Hill Rd	Seven Steps Rd
Major road speed limit	100 km/h	100 km/h
Minor road speed limit	Not signposted (100 km/h default)	Not signposted (100 km/h default)
Major road volume [(1)]	2,500 (2018)	1,500 (2018)
Minor road volume [(1)]	Not available	Not available
Major road proportion CVs [(2)]	9% (2018)	9.5% (2018)
Minor road proportion CVs [(2)]	Not available	Not available
Intersection control	Uncontrolled, upgraded to give way control for the trial	Give way
Auxiliary turning lanes (major road)	None	None
Separate turning lanes (minor road)	None	None
Horizontal curvature (major road)	Straight	Curve at intersection
Horizontal curvature (minor road)	Straight	Curve at intersection

[(1)] Daily two-way traffic volume from Location SA for both major approaches where available (survey year in backets)
[(2)] Proportion of commercial vehicles from Location SA for both major where available (survey year in brackets)

Both sites provided ample space for the installation of the equipment. Installation of the major road speed advisory signs at the treatment site were at different distances from the intersection, being 130m for the northbound and 140m for the southbound approaches. This was necessitated by rock formations on the roadside along the northbound approach and existing signage along the southbound approach. The "kink" at the intersection on the minor road for the control site necessitated placement of the minor road radar at a different location compared to other sites. Instead of being placed opposite the minor road as at all other sites, it was instead placed adjacent to the minor road, as shown by the 'X' symbol in Figure 3.9. This placement did not adversely affect the functionality of the radar.

Figure 3.8
Satellite image of Treatment Site 2 (Location SA, Government of South Australia, 2023)

Figure 3.9
Satellite image of Control Site 2 (Location SA, Government of South Australia, 2023)
(unorthodox placement of minor road radar indicated by the 'X' symbol)

3.1.6.3. Trial Pair 3

Trial Pair 3 was located in Carey Gully, within the Adelaide Hills region. The major road for the control site is a DIT controlled road. All other roads are local government-controlled roads. This means that

the control site was at a DIT controlled intersection (as were all other sites for the trial), while the treatment was at an intersection controlled by the local government. While this required an additional layer of administration, it did not disrupt the project. Both the Adelaide Hills council and DIT were helpful in administering this trial site. Both treatment and control intersections are through-routes for traffic accessing the local and surrounding areas. The control intersection receives more traffic, due to the major being an access route from the Adelaide metropolitan area. The treatment intersection, while receiving less traffic, is an access route from the Bridgewater exit of the South Eastern Freeway.

Statistics for the treatment and control sites are given in Table 3.6 while satellite images are shown in Figures 3.10 and 3.11. All approaches at both intersections are signposted at 80 km/h. Speeds for both the treatment and control intersection major roads were substantially below the speed limit due to the constrained road environment – horizontal and vertical curves were present for both intersections, as well as narrow lanes. This was known when selecting these sites and as such Trial Pair 3 was used as a test of the treatment's ability to affect safety at such intersections. While traffic volumes for both intersections were different, with the control intersection receiving more traffic, they both experienced similar daily peaks during the morning and afternoon as commuter traffic travelled through the area.

Table 3.6
Information pertaining to Trial Pair 3

Item	Treatment	Control
Coordinates	-34.974553, 138.756309	-34.964755, 138.761942
Major road	Rangeview Dr	Greenhill Rd
Minor road	Carey Gully Rd	Rangeview Dr
Major road speed limit	80 km/h	80 km/h
Minor road speed limit	80 km/h	80 km/h
Major road volume [(1)]	Not available/1,800 (2020)	2,900/3,300 (2020)
Minor road volume [(1)]	1,300 (2020)	1,800 (2020)
Major road proportion CVs [(2)]	Not available/6.5% (2020)	6%/6% (2020)
Minor road proportion CVs [(2)]	6% (2020)	6.5% (2020)
Intersection control	Uncontrolled, upgraded to give way control for the trial	Uncontrolled, upgraded to give way control for the trial
Auxiliary turning lanes (major road)	None	None
Separate turning lanes (minor road)	None	None
Horizontal curvature (major road)	Curves near intersection	Curve at intersection
Horizontal curvature (minor road)	Straight	Straight

[(1)] Daily two-way traffic volume from Location SA for both major approaches where available (survey year in backets)
[(2)] Proportion of commercial vehicles from Location SA for both major where available (survey year in brackets)

Installation of the treatment was more difficult than for any other site. It was known that the density of trees would make the reliable use of solar power difficult to achieve, a factor made more difficult due to the trial being conducted over the winter months. As such, the site was used as a test of the treatment's ability to function in low and indirect sunlight. The minor road radar, which was located under the densest foliage (Figure 3.12), did not cope with the power demand placed upon it and was subsequently moved to the location of the control sign. This in-turn meant that the minor road run-through prevention system was unable to be used at this site. As an additional reliability measure, power consumption was reduced by installing time-controllers for both major road speed advisory systems to limit their function to between 7am and 7pm, which encompassed approximately 96% of all traffic traversing the major road. Access to the equipment was also more difficult at the treatment

site, when compared to other sites during the trial, due to the narrow and uneven roadside areas at some locations. Nonetheless, safe access was maintained throughout the trial.

Figure 3.10
Satellite image of Treatment Site 3 (Location SA, Government of South Australia, 2023)

Figure 3.11
Satellite image of Control Site 3 (Location SA, Government of South Australia, 2023)

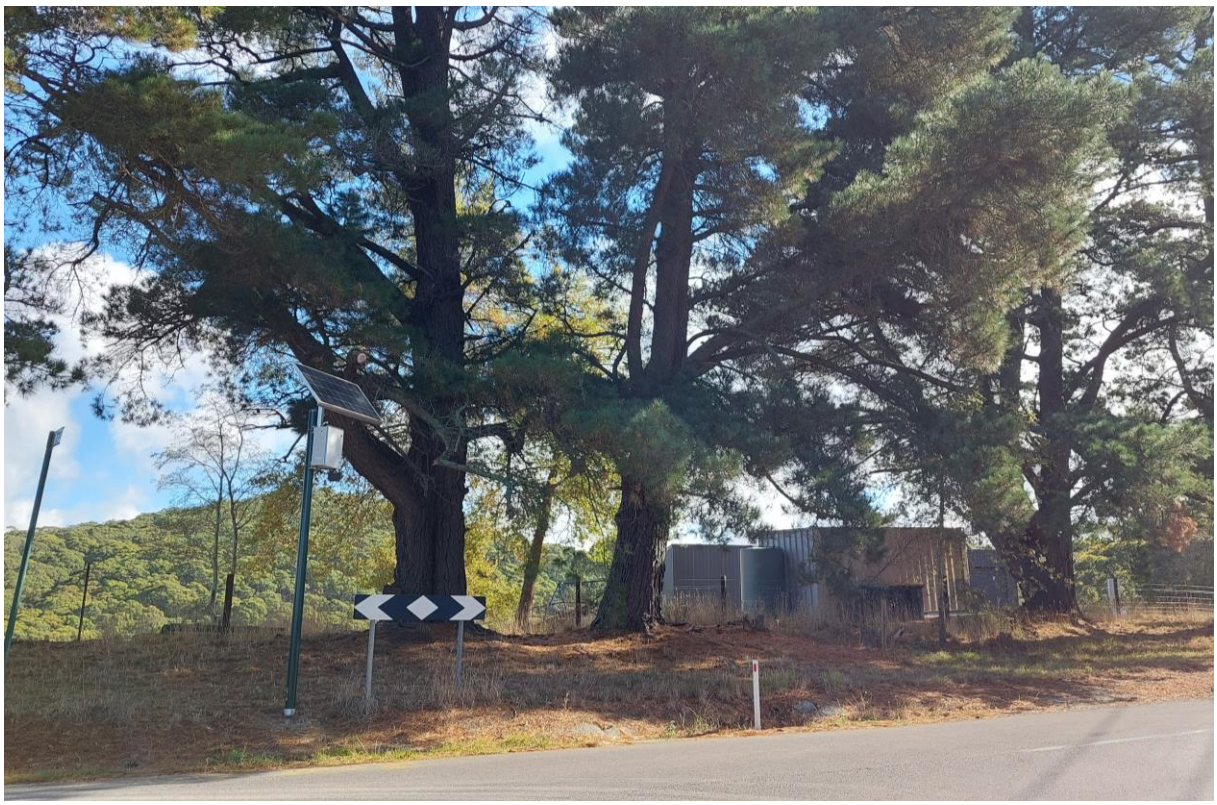


Figure 3.12
The minor road radar before it was moved, showing the density of foliage above the solar panel

3.1.6.4. Trial Pair 4

Trial Pair 4 was located north of the Adelaide Metropolitan area, near the Barossa region (treatment) and township of Freeling (control). The treatment site was the same intersection used as a control for Trial Pair 2. As there was minimal physical change to the intersection when it was used as a control, it was determined that this prior use would not bias its use as a treatment. The control intersection was noticeably more trafficked than the treatment intersection, due to its role as a major route for traffic travelling north of Adelaide. The control intersection also has an auxiliary left turn lane, which is not present at the treatment intersection. The northbound approach for the major road at the control site has a relatively steep downward grade, though this did not appear to affect the effectiveness of the treatment to reduce speeds. Despite these differences, this was decided upon as the most appropriate control that was situated within a reasonable distance from the treatment site.

Statistics for the treatment and control sites are given in Table 3.7 while satellite images are shown in Figures 3.13 and 3.14. Major roads for both the treatment and control site are signposted at 100 km/h. While the minor roads are not signposted, they default to a 100 km/h speed limit. Speeds along the major roads are close to the speed limit. As previously stated, traffic volumes at the control intersection were noticeably greater than at the treatment intersection. The major road volume for the control was two-and-a-half to three-and-a-half times greater than for the treatment site, dependent on the approach road being considered. While traffic volumes for the minor roads were not available prior to the trial, volumes at the control site were estimated to be at least twice those of the treatment site.

Table 3.7
Information pertaining to Trial Pair 4

Item	Treatment	Control
Coordinates	-34.613962, 139.070848	-34.471658, 138.812094
Major road	Eden Valley Rd	Thiele Hwy
Minor road	Seven Steps Rd	Gray St
Major road speed limit	100 km/h	100 km/h
Minor road speed limit	Not signposted (100 km/h default)	Not signposted (100 km/h default)
Major road volume [1]	1,500 (2018)	3,800/5,000 (2019/2022)
Minor road volume [1]	Not available	Not available
Major road proportion CVs [2]	9.5% (2018)	8.5%/11% (2019/2022)
Minor road proportion CVs [2]	Not available	Not available
Intersection control	Give way	Give way (Control sign installed for trial)
Auxiliary turning lanes (major road)	None	Left turn lane
Separate turning lanes (minor road)	None	None
Horizontal curvature (major road)	Curve at intersection	Straight
Horizontal curvature (minor road)	Curve at intersection	Curve before intersection

[1] Daily two-way traffic volume from Location SA for both major approaches where available (survey year in backets)
[2] Proportion of commercial vehicles from Location SA for both major where available (survey year in brackets)

Installation was largely straight-forward for both the treatment and control. It was discovered before the trial surveys that the amount of sunlight reaching the solar panel at the treatment site's northbound major road speed advisory system was insufficient. It was decided that the best approach was to install an additional 60W solar panel and battery unit to supplement the power supply, which were retrieved from other unused research equipment available to CASR. This arrangement proved effective during the trial. As discussed in Section 3.1.6.2, the minor road radar at the treatment site was installed on the near side of the intersection, rather than the far side as for all other treatment sites. This was needed to accommodate the presence of a 'kink' at the end of the minor road.

Figure 3.13
Satellite image of Treatment Site 4 (Location SA, Government of South Australia, 2023)

Figure 3.14
Satellite image of Control Site 4 (Location SA, Government of South Australia, 2023)

3.1.6.5. Trial Pair 5

Trial Pair 5 was installed south of the Adelaide metropolitan area. The treatment site was installed between the townships of Willunga and Aldinga, while the control was installed near Kangarilla. Despite the distance of 20 km between the treatment and control sites, the control was decided to be the best match for the treatment of any nearby intersections. Major roads for both intersections act as substantial traffic routes. At the treatment site, the major road acts as a route between Aldinga

and Willunga. At the control site, the major road acts as a route for traffic travelling south towards Kangarilla and subsequent townships. At both sites, the minor roads were observed to have substantially lower traffic volumes, relative to the major roads, that apparently served their respective local areas more than through traffic. Interestingly, the minor road for the control intersection was paved for a distance of 750m beyond the intersection and then becoming an unsealed road. Despite this, the intersection itself was a good comparison for the treatment intersection.

Statistics for the treatment and control sites are given in Table 3.8 while satellite images are shown in Figures 3.15 and 3.16. Both the treatment and control sites had similar traffic volumes. While volume data was not available for the minor roads before the trial, they appeared to have similar volumes and this was confirmed during the trial. All roads bar the minor road at the control site are signposted as 80 km/h. The minor road for the control site is not signposted and therefore defaults to 100 km/h, though the speeds of vehicle approaching the intersection were well matched to those of the treatment site with a speed limit of 80 km/h.

Table 3.8
Information pertaining to Trial Pair 5

Item	Treatment	Control
Coordinates	-35.274126, 138.509341	-35.135598, 138.657229
Major road	Aldinga Rd	Kangarilla Rd
Minor road	Ryan Rd	Saddle Bags Rd
Major road speed limit	80 km/h	80 km/h
Minor road speed limit	80 km/h	Not signposted (100 km/h default)
Major road volume [(1)]	5,500 (2021)	4,700 (2021)
Minor road volume [(1)]	Not available	Not available
Major road proportion CVs [(2)]	5% (2021)	9% (2021)
Minor road proportion CVs [(2)]	Not available	Not available
Intersection control	Give way	Give way
Auxiliary turning lanes (major road)	None	None
Separate turning lanes (minor road)	None	None
Horizontal curvature (major road)	Straight	Straight
Horizontal curvature (minor road)	Straight	Straight

[(1)] Daily two-way traffic volume from Location SA for both major approaches where available (survey year in backets)
[(2)] Proportion of commercial vehicles from Location SA for both major where available (survey year in brackets)

Installation of one major road speed advisory sign at the treatment site occurred close to an overhead powerline, an issue which had been avoided for the previous sites but was unavoidable here. While the sign, and in particular the solar panel, were installed close to the minimum distance required between that and the powerlines, no modification of the system was required to come within these distance requirements (Figure 3.17). Otherwise, there were no issues with the installation at the treatment or control sites.

Figure 3.15
Satellite image of Treatment Site 5 (Location SA, Government of South Australia, 2023)

Figure 3.16
Satellite image of Control Site 5 (Location SA, Government of South Australia, 2023)

Figure 3.17
Westbound major road speed advisory sign, which was installed under overhead powerlines

3.1.6.6. Trial Pair 6

Trial Pair 6 was located north of the Adelaide metropolitan area. The treatment site was the same intersection previously used as Control Site 4, near the township of Freeling. The control site was located in Kangaroo Flat. Both intersections act as major traffic corridors with a high proportion of commercial vehicle traffic. Whereas the treatment intersection carries traffic predominantly through the major road, a substantial proportion of traffic traversing the control intersection turns in or out of the minor road. While this constitutes a difference between the traffic environments of the two intersections, it was not considered to adversely bias the trial – while the greater proportion of traffic using the minor road could increase the rate of minor road detections, this did not appear to translate to an increase during the trial. Both intersections have left-turn auxiliary lanes on the major road, while the control has a right-turn auxiliary lane on the major road. The control also has a left-turn slip lane on the minor road – the only intersection throughout the trial with such traffic feature.

Statistics for the treatment and control sites are given in Table 3.9 while satellite images are shown in Figures 3.18 and 3.19. The speed limit for all approaches at both the treatment and control sites is 100 km/h, signposted for all but the minor road for the treatment site (which defaults to 100 km/h). Speeds were in line with what would be expected for these speed zones. Traffic volumes along the minor road for the control site were observed to be greater than for the treatment site, though both intersections had similar traffic volumes traversing the intersection.

Table 3.9
Information pertaining to Trial Pair 6

Item	Treatment	Control
Coordinates	-34.471658, 138.812094	-34.545541, 138.692475
Major road	Thiele Hwy	Redbanks Rd/Mudla Wirra Rd
Minor road	Gray St	Redbanks Rd
Major road speed limit	100 km/h	100 km/h
Minor road speed limit	Not signposted (100 km/h default)	100 km/h
Major road volume [(1)]	3,800/5,000 (2019/2022)	Not available/3,300 (2019)
Minor road volume [(1)]	Not available	1,700 (2019)
Major road proportion CVs [(2)]	8.5%/11% (2019/2022)	Not available/12% (2019)
Minor road proportion CVs [(2)]	Not available	12% (2019)
Intersection control	Give way	Uncontrolled
Auxiliary turning lanes (major road)	Left turn lane	Left/right turn lanes
Separate turning lanes (minor road)	None	Left turn slip lane
Horizontal curvature (major road)	Straight	Straight
Horizontal curvature (minor road)	Curve before intersection	Straight

[(1)] Daily two-way traffic volume from Location SA for both major approaches where available (survey year in backets)
[(2)] Proportion of commercial vehicles from Location SA for both major where available (survey year in brackets)

Installation at the treatment site was made more difficult by the presence of a high-pressure gas main. The vacuum excavation method used during the trial, which is a common method of excavation for the installation of roadside poles, was instrumental with allowing correct placement of the northbound major road speed advisory sign. Mechanical excavation methods would not have been possible as close to the gas main and would have necessitated relocating the major road speed advisory sign to a less desirable location. The major road radar for this approach also proved to be difficult to align, resulting in a poor detection rate of traffic approaching along the major road in a northbound direction. This was likely a result of the crest approximately 200m before the major road speed advisory sign, upon which the major road radar was placed. Because of this, the battery saving mode was disabled for this sign, meaning the flashing lights operated for a duration of 30 seconds after each detection of a minor road vehicle. This change did not adversely affect the operation of the system.

Figure 3.18
Satellite image of Treatment Site 6 (Location SA, Government of South Australia, 2023)

Figure 3.19
Satellite image of Control Site 6 (Location SA, Government of South Australia, 2023

3.1.7. Site design

Site layout design was undertaken by CASR. Technical design was undertaken by SAGE Automation (technology provider). Infrastructure design was undertaken by Artcraft (infrastructure installer). All design work was approved by DIT before being installed. Infrastructure design was relatively straight-forward, though careful supervision was required to ensure correct placement of

the infrastructure to ensure that the treatment operated as expected. The technology set-up was more difficult and required close communication and testing with SAGE Automation to ensure the correct setup of the system. An example of a site layout design drawing is shown in Figure 3.20. Site layout drawings for all treatment and control sites are presented in Appendix C.

Item	Description	Action	Action date
4	Major Road Activated System with TES19975(L) (see Item 13, page 5)	Install with all signage and lights to remain covered with appropriate protective film. Pole locations noted with pink tape. Remove signage/light coverings. To be removed at conclusion of trial.	13/10/22 05/12/22 27/02/23
5	W2-4(L) (side road ahead—left)	Existing at site. Sign to be removed when coverings on Item 4 are removed (post to stay in-situ). Reinstall W2-4(L) sign on post.	05/12/22 27/02/23
6	Major Road Activated System with TES19975(R) (see Item 13, page 5)	Install with all signage and lights to remain covered with appropriate protective film. Pole locations noted with pink tape. Remove signage/light coverings. To be removed at conclusion of trial.	13/10/22 05/12/22 27/02/23
7	W2-4(R) (side road ahead—right)	Existing at site. To remain during trial.	13/10/22
8	Minor Road Activated System radar (see Item 14, page 5)	Install. Pole location noted with pink tape. To be removed at conclusion of trial.	13/10/22 27/02/23
9	Minor Road Activated System sign (see Item 15, page 5)	Install with standard R1-2 (give way) sign. Pole location noted with pink tape. Note R1-2 on standard pole existing at site. Replace standard R1-2 with flashing R1-2. To be removed at conclusion of trial.	13/10/22 05/12/22 27/02/23

Figure 3.20
Example of a site layout design drawing (Treatment site 5)

4. Results

This chapter provides the results of the analysis conducted on the data that were collected at each of the six treatment/control site pairs during the trial of the RJAWS Lite. Results of the evaluation for each of the two RJAWS Lite features are organised into the following separate sections:

- *Major Road* – Evaluation of the effect of the advisory signage on travel speed on the major road when another vehicle approaches the intersection on the minor road (including an evaluation of the associated risk of a casualty crash to occur)
- *Minor Road* – Evaluation of the effect of the run-through prevention feature on the minor road traffic approaching the intersection control line

4.1. Major road

4.1.1. Traffic survey

The daily average vehicle traffic volumes on each leg of the trial intersections for both periods before and after the RIAWS installation are listed in Tables 4.1 and 4.2.

Table 4.1
Daily average vehicle traffic volumes observed on each leg of the trial intersections - Trial Pairs 1 & 3

Trial Pair	Site Type [1]	Period [2]	Near Side [3]		Far Side [4]	
			Light Vehicles	*Heavy Vehicles*	*Light Vehicles*	*Heavy Vehicles*
1	T	BF	2,235	245	2,097	210
		AF	2,197	137	1,928	273
	C	BF	4,310	424	4,146	525
		AF	4,078	476	3,578	543
2	T	BF	1,216	178	1,223	179
		AF	1,172	202	1,208	179
	C	BF	652	73	578	149
		AF	662	72	569	170
3	T	BF	593	111	710	44
		AF	602	109	712	38
	C	BF	1,024	133	971	100
		AF	952	98	1,109	101

[1]) Site Type: Treatment (T) / Control (T)
[2] Trial Period: Before (BF) / After (AF)
[3] Travel lane on major road that is close to the minor road
[4] Travel lane on major road that is further from the minor road

Table 4.2
Daily average vehicle traffic volumes observed on each leg of the trial intersections - Trial Pairs 4 & 6

Trial Pair	Site Type [1]	Period [2]	Near Side [3]		Far Side [4]	
			Light Vehicles	*Heavy Vehicles*	*Light Vehicles*	*Heavy Vehicles*
4	T	BF	597	71	528	128
		AF	610	82	559	134
	C	BF	1,815	127	2,380	216
		AF	1,670	225	2,374	264
5	T	BF	2,185	226	2,454	152
		AF	2,330	295	2,610	183
	C	BF	1,896	215	1,987	183
		AF	1,994	150	1,947	235
6	T	BF	1,967	235	2,743	251
		AF	1,815	240	2,633	240
	C	BF	850	113	1,756	160
		AF	974	106	1,875	185

[1] Site Type: Treatment (T) / Control (T)
[2] Trial Period: Before (BF) / After (AF)
[3] Travel lane on major road that is close to the minor road
[4] Travel lane on major road that is further from the minor road

4.1.2. Analysis of free-flowing vehicles

This section provides the results of the analysis conducted considering those vehicles detected to travel in a *free-flow* fashion during the trial period.

Vehicle detections

The amount of free-flow traffic travelling along the major road at each of the six treated as well as control sites before and after the RJAWS Lite installation is visually represented by the bar plots in Figures 4.1 and 4.2, respectively. Free-flow traffic is shown for each travel direction as well as for the aggregation of both directions. Additionally, traffic is broken down by the on/off status of the RJAWS Lite major road signs for each travel direction.

The following aspects are noted across all the six pairs of trial sites:

- In general, a comparable number of free-flowing vehicles was observed along each travel direction on the major road.
- Observed volumes of free-flowing vehicles at any of the trial sites were consistent across the before and after periods.
- The amount of free-flowing traffic approaching the intersection along the major road when the RJAWS signs were flashing accounted for a small proportion of the entire traffic. This disproportion was expected, as the signs are activated only when side traffic is also detected concurrently to traffic on the major road
- The amount of traffic observed when the major road signs were flashing during the after period was generally slightly lower than in the before period.

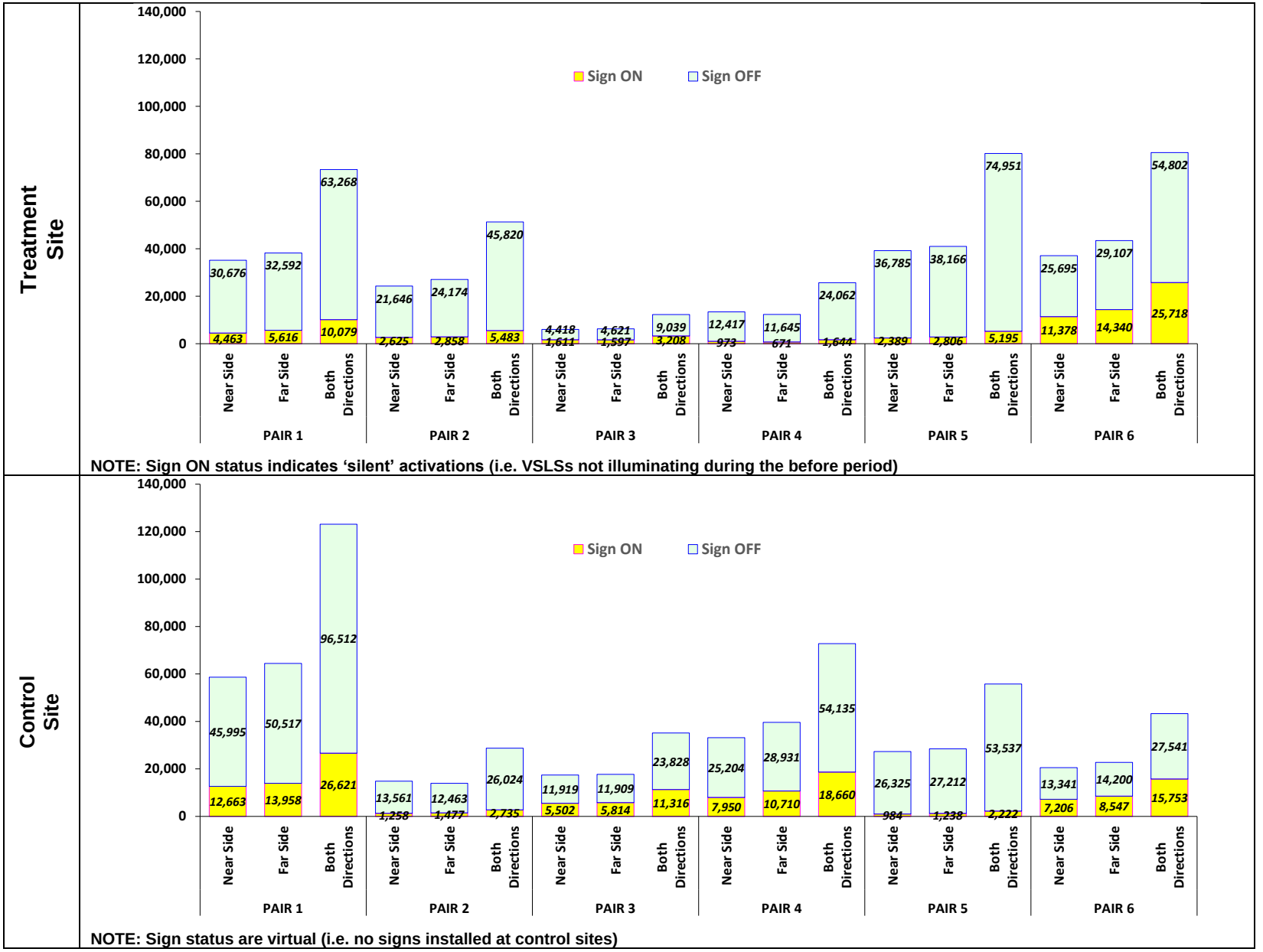


Figure 4.1
Free-flowing traffic observed at each treatment and control intersections in the before period grouped by status of the minor road sign (each travel directions and their aggregation)

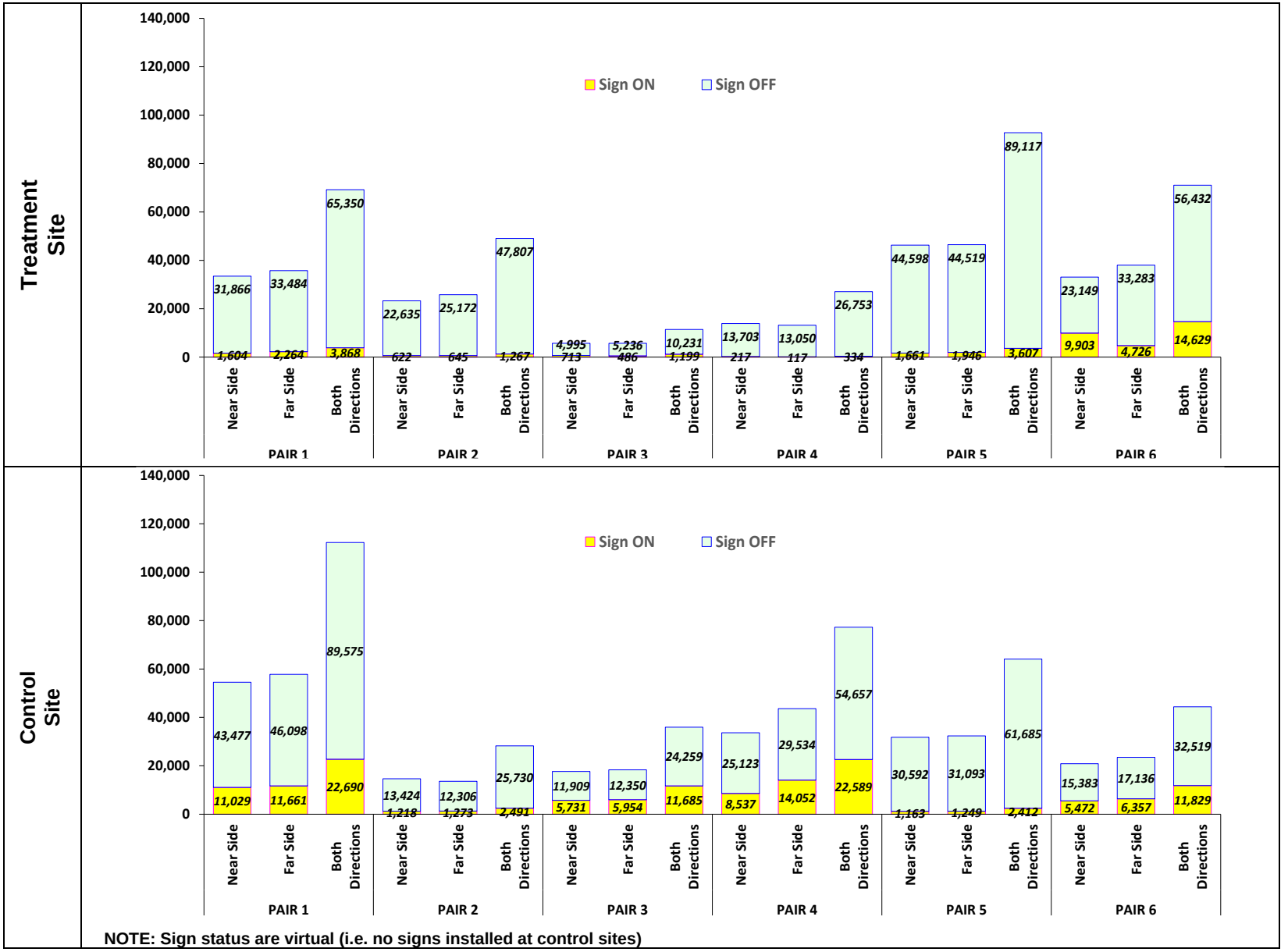


Figure 4.2
Free-flowing traffic observed at each treatment and control intersections in the after period grouped by status of the minor road sign (each travel directions and their aggregation)

Speed along major road approaches

This section provides the results of the speed analysis for free-flow traffic travelling along the major road at each of the trial sites. The following data are provided:

- Distribution
- Descriptive statistics
- Compliance with advised speed limit

Distribution

The speed distributions for all relevant traffic observed in proximity to the treatment and control trial sites with a posted speed limit of 80 km/h and 100 km/h are shown in the histogram plots of Figures 4.3 and 4.4, respectively. Separate plots for the specific cohort of medium and heavy vehicles are also provided in Figures 4.5 and 4.6. Each plot provides the speed distributions before and after the installation of the RIAWS for both cases with flashing and blank lights (i.e. ON or OFF). These plots allow for an intuitive visual comparison of changes that may occur in travel speed between the case with flashing and blank sign lights through each of the two trial periods (i.e. Before or After). Additionally, the speed distribution along the approach to each treated intersection is reported in Appendix D.

In general, distributions for the treated sites in the after period showed a shift towards lower speed values (i.e. shifted towards left compared to the distribution for the before period). Conversely, a negligible change can be noticed between the distributions of before and after periods at the control sites. The fact that travel speeds tended to reduce at the treated sites whereas they remained unchanged at the corresponding paired control sites, is a strong indication that that any of the change observed at the treated sites is not due to controlled factors and therefore may be likely due to the presence of the treatment.

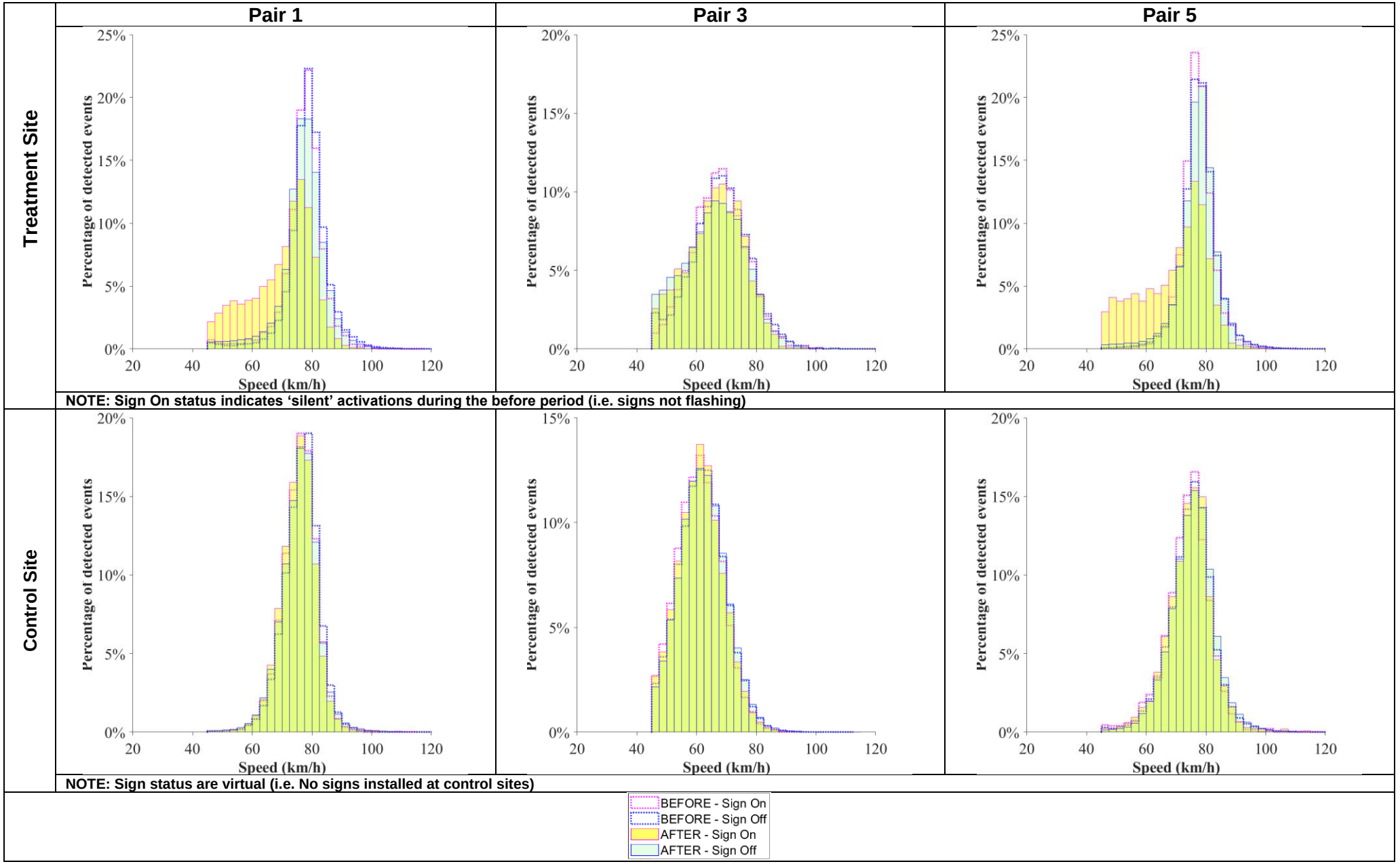


Figure 4.3
Distributions of travel speeds in **proximity** to the intersection for <u>all vehicles</u> – Trial sites with 80km/h speed limit (Pairs 1, 3, 5)

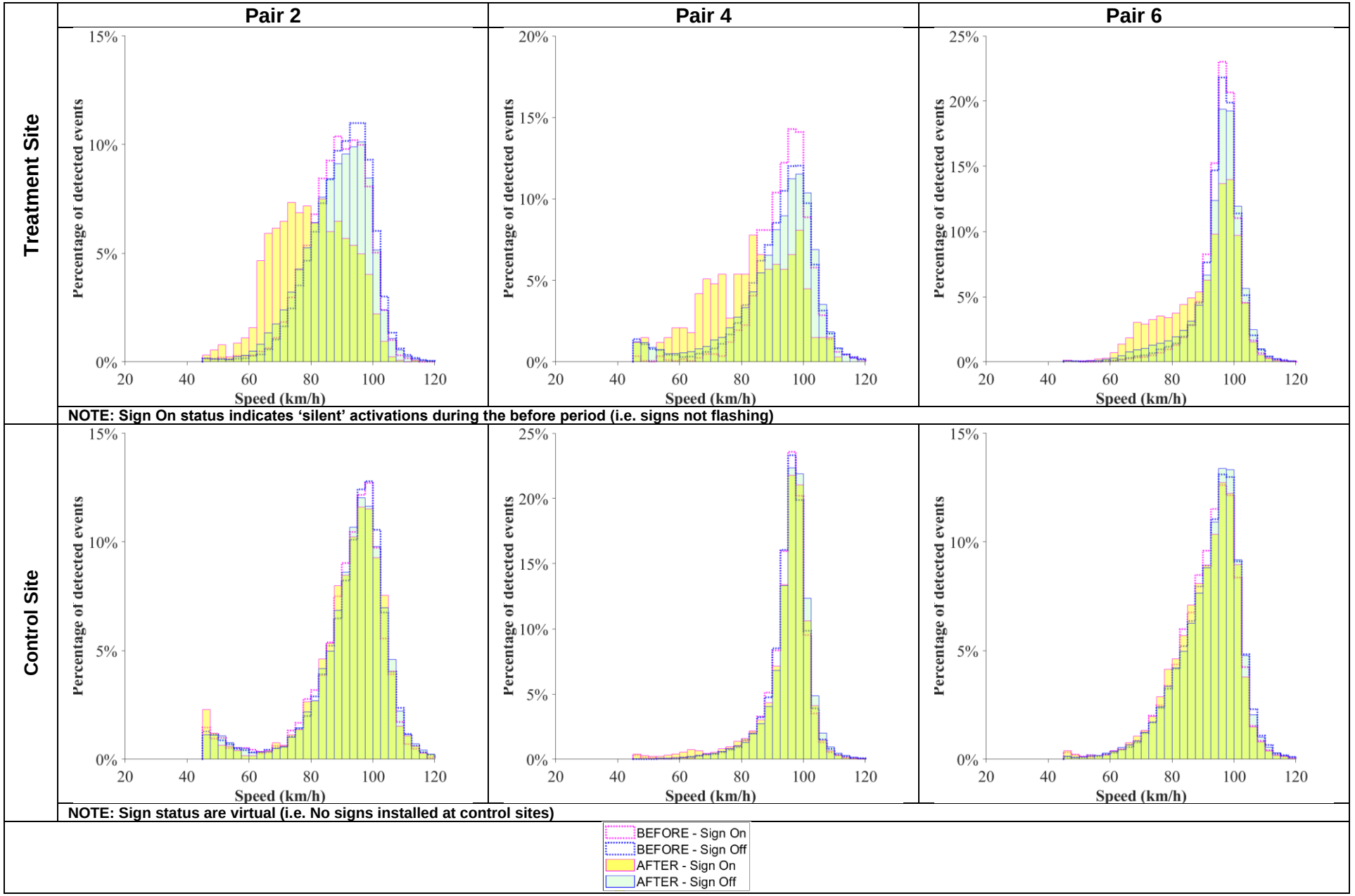


Figure 4.4
Distributions of travel speeds in **proximity** to the intersection for <u>all vehicles</u> –Trial sites with 100km/h speed limit (Pairs 2, 4, 6)

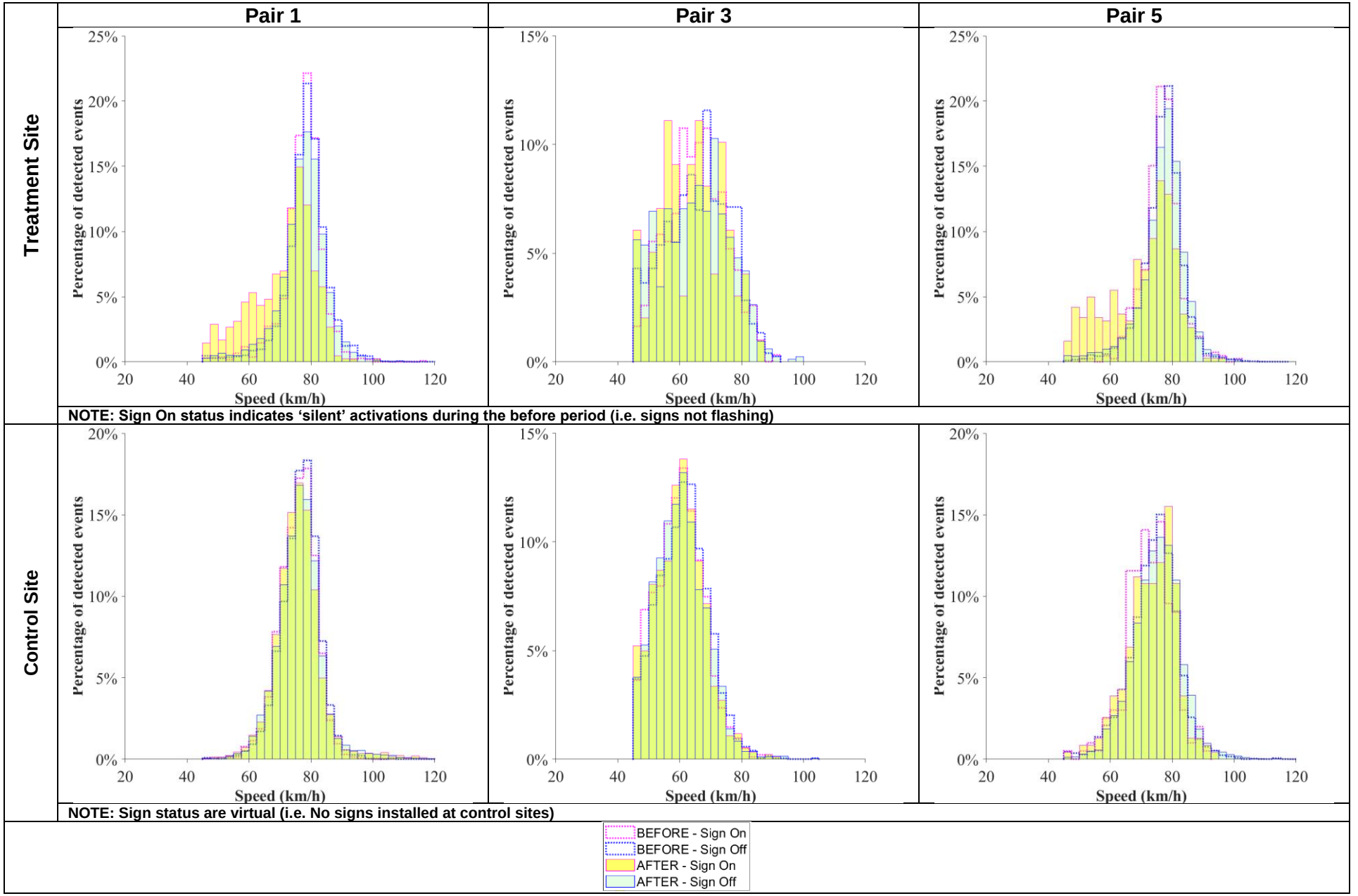


Figure 4.5
Distributions of travel speeds in **proximity** to the intersection for medium-heavy vehicles only – Trial sites with 80km/h speed limit (Pairs 1, 3, 5)

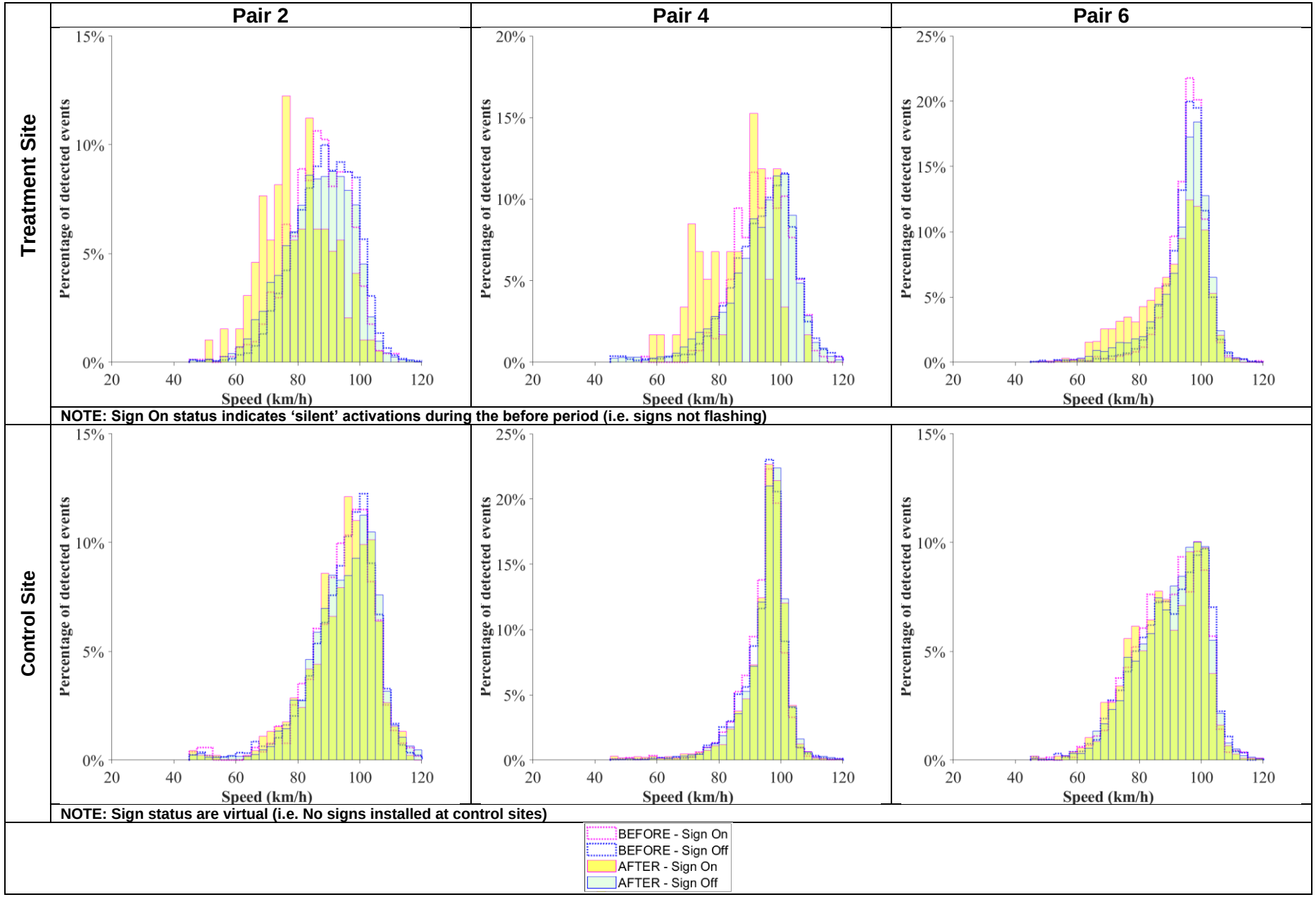


Figure 4.6
Distributions of travel speeds in **proximity** to the intersection for medium-heavy vehicles only –Trial sites with 100km/h speed limit (Pairs 2, 4, 6)

Descriptive statistics

The mean speeds calculated in proximity as well as on the approach to each of the six treated intersections are reported in Tables 4.3 and 4.4, respectively. The 85thpercentile speeds are also reported in Tables 4.5 and 4.6. Speeds are reported for each separate travel direction as well aggregating them together. They are also separately reported for either the case with flashing (i.e. ON) or a blank (i.e. OFF) lights on the major road signs, both before and after the installation of the RJAWS Lite. The before-after variation (D) of the speed is also reported. Additionally, speeds measured in proximity to the paired control intersections are reported and the resulting controlled before-after variation is provided for each treatment site. Note that speed at the control sites was measured only in proximity to the intersection but not along the approach. Therefore, no controlled variation could be evaluated for the speed along the approach to the treated intersections.

Table 4.3
Mean speed of all vehicles on approach and proximity to intersections with 80km/h speed limit (free flow) - Trial Pairs 1, 3, 5

Site Type [1]	Sign Status [2]	Trial Period [3]	Pair 1						Pair 3						Pair 5					
			Approach (km/h)			Proximity (km/h)			Approach (km/h)			Proximity (km/h)			Approach (km/h)			Proximity (km/h)		
			Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides
T	ON	BF	78.6	77.1	77.9	77.2	77.2	77.2	70.7	65.0	70.1	68.8	66.0	67.4	78.3	78.5	78.4	78.0	76.4	77.1
		AF	74.9	71.4	73.1	68.5	71.1	70.0	68.7	63.7	68.2	66.6	65.5	66.1	73.0	72.3	72.7	69.2	69.2	69.2
		D	-3.7	-5.6	-4.8	-8.7	-6.0	-7.1	-2.0	-1.3	-1.8	-2.2	-0.6	-1.3	-5.3	-6.3	-5.7	-8.7	-7.2	-7.9
	OFF	BF	79.7	78.1	79.0	78.5	78.5	78.5	72.4	66.7	71.0	69.0	66.7	67.8	79.0	78.9	78.9	78.3	77.0	77.6
		AF	79.8	77.8	78.9	75.7	78.3	77.0	72.7	66.5	71.4	67.7	64.5	66.1	78.5	79.1	78.8	78.1	76.4	77.3
		D	0.1	-0.3	-0.1	-2.9	-0.2	-1.5	0.3	-0.2	0.3	-1.3	-2.2	-1.7	-0.5	0.2	-0.1	-0.3	-0.6	-0.4
C	ON	BF	-	-	-	73.8	77.4	75.7	-	-	-	62.4	59.8	61.1	-	-	-	72.6	75.1	74.0
		AF	-	-	-	73.7	77.2	75.5	-	-	-	60.6	62.1	61.4	-	-	-	72.8	76.2	74.5
		D	-	-	-	-0.2	-0.2	-0.2	-	-	-	-1.8	2.3	0.3	-	-	-	0.2	1.1	0.5
	OFF	BF	-	-	-	74.5	78.0	76.3	-	-	-	63.2	60.8	62.0	-	-	-	73.7	76.1	74.9
		AF	-	-	-	74.2	77.5	75.9	-	-	-	61.5	62.8	62.1	-	-	-	73.5	77.5	75.5
		D	-	-	-	-0.3	-0.4	-0.4	-	-	-	-1.7	2.0	0.2	-	-	-	-0.3	1.4	0.5
Controlled D		***ON***		**-**	**-**	***-8.6***	***-5.8***	***-6.9***	**-**	**-**	**-**	***-0.4***	***-2.9***	***-1.6***	**-**	**-**	**-**	***-8.9***	***-8.3***	***-8.4***
		OFF		**-**	**-**	***-2.6***	***0.2***	***-1.1***	**-**	**-**	**-**	***0.4***	***-4.2***	***-1.9***	**-**	**-**	**-**	***0.0***	***-1.9***	***-0.9***

[1] Site Type: Treatment (T) / Control (T)
[2] Sign status 'ON' indicates 'silent' activations for treatment sites in the before period / 'virtual' activations for control sites at any period
[3] Trial Period: Before (BF) / After (AF) / Variation (D)
[4] Travel lane on major road that is close to the minor road
[5] Travel lane on major road that is further from the minor road

Table 4.4
Mean speed of all vehicles on approach and proximity to intersections with a 100km/h speed limit (free flow) - Trial Pairs 2, 4, 6

Site Type [1]	Sign Status [2]	Trial Period [3]	Pair 2						Pair 4						Pair 6					
			Approach (km/h)			Proximity (km/h)			Approach (km/h)			Proximity (km/h)			Approach (km/h)			Proximity (km/h)		
			Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides
T	ON	BF	86.3	90.4	88.0	88.3	88.4	88.4	89.7	90.2	89.9	91.6	96.5	93.6	92.7	98.4	94.4	95.2	95.4	95.3
		AF	80.2	84.4	81.8	80.5	79.7	80.1	86.1	89.1	86.7	81.5	85.2	82.8	89.0	94.1	90.3	89.8	90.3	90.0
		D	-6.1	-6.0	-6.2	-7.9	-8.7	-8.3	-3.7	-1.1	-3.2	-10.0	-11.3	-10.7	-3.8	-4.4	-4.1	-5.4	-5.1	-5.3
	OFF	BF	87.9	91.7	89.9	89.7	89.6	89.7	93.1	90.9	92.2	88.0	95.1	91.4	93.3	98.6	96.6	95.5	95.0	95.2
		AF	87.4	91.0	89.2	88.5	87.8	88.1	93.2	90.9	92.3	87.9	94.5	91.1	93.6	98.1	96.3	95.6	93.5	94.3
		D	-0.5	-0.7	-0.6	-1.2	-1.8	-1.5	0.1	0.0	0.1	-0.1	-0.6	-0.3	0.3	-0.5	-0.4	0.0	-1.5	-0.9
C	ON	BF	-	-	-	88.3	94.4	91.6	-	-	-	93.6	95.4	94.6	-	-	-	92.6	89.9	91.2
		AF	-	-	-	88.5	94.7	91.7	-	-	-	94.7	93.2	93.8	-	-	-	92.0	89.7	90.8
		D	-	-	-	0.2	0.3	0.1	-	-	-	1.1	-2.1	-0.8	-	-	-	-0.6	-0.3	-0.4
	OFF	BF	-	-	-	88.9	96.3	92.5	-	-	-	93.9	96.1	95.1	-	-	-	93.5	90.7	92.1
		AF	-	-	-	88.4	96.7	92.4	-	-	-	95.2	96.0	95.6	-	-	-	92.8	91.1	91.9
		D	-	-	-	-0.5	0.4	-0.1	-	-	-	1.2	-0.1	0.5	-	-	-	-0.7	0.4	-0.2
Controlled D		***ON***	**-**	**-**	**-**	**-8.0**	**-9.0**	**-8.3**	**-**	**-**	**-**	**-11.1**	**-9.1**	**-9.9**	**-**	**-**	**-**	**-4.8**	**-4.8**	**-4.9**
		OFF	**-**	**-**	**-**	**-0.7**	**-2.2**	**-1.5**	**-**	**-**	**-**	**-1.3**	**-0.5**	**-0.9**	**-**	**-**	**-**	**0.8**	**-1.9**	**-0.7**

[1] Site Type: Treatment (T) / Control (T)
[2] Sign status 'ON' indicates 'silent' activations for treatment sites in the before period / 'virtual' activations for control sites at any period
[3] Trial Period: Before (BF) / After (AF) / Variation (D)
[4] Travel lane on major road that is close to the minor road
[5] Travel lane on major road that is further from the minor road

Table 4.5
85th percentile speed of all vehicles on approach and proximity to intersections with a 50km/h speed limit (free flow) - Trial Pairs 1, 3, 5

Site Type [1]	Sign Status [2]	Trial Period [3]	Pair 1						Pair 3						Pair 5					
			Approach (km/h)			Proximity (km/h)			Approach (km/h)			Proximity (km/h)			Approach (km/h)			Proximity (km/h)		
			Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides
T	ON	BF	84.0	83.0	83.0	82.6	82.8	82.7	79.0	71.0	79.0	78.0	75.0	76.9	83.0	83.0	83.0	82.9	81.0	81.9
		AF	82.0	80.0	81.0	77.4	81.2	79.9	77.0	73.0	76.0	76.8	74.4	76.0	80.0	80.0	80.0	80.0	79.4	79.7
		D	-2.0	-3.0	-2.0	-5.2	-1.5	-2.8	-2.0	2.0	-3.0	-1.2	-0.6	-0.9	-3.0	-3.0	-3.0	-2.9	-1.6	-2.2
	OFF	BF	86.0	83.0	85.0	84.2	83.8	84.0	81.0	75.0	80.0	78.5	76.3	77.5	84.0	84.0	84.0	83.5	81.9	82.7
		AF	86.0	83.0	84.0	81.4	84.5	83.3	81.0	75.0	80.0	78.4	74.9	76.8	84.0	84.0	84.0	83.7	81.9	82.9
		D	0.0	0.0	-1.0	-2.8	0.7	-0.6	0.0	0.0	0.0	-0.2	-1.4	-0.6	0.0	0.0	0.0	0.2	-0.1	0.1
C	ON	BF	-	-	-	78.9	82.4	81.1	-	-	-	69.9	67.4	68.8	-	-	-	79.2	81.7	80.9
		AF	-	-	-	79.0	82.2	80.9	-	-	-	68.5	69.8	69.2	-	-	-	79.1	82.9	81.1
		D	-	-	-	0.0	-0.3	-0.2	-	-	-	-1.4	2.4	0.5	-	-	-	-0.1	1.2	0.2
	OFF	BF	-	-	-	79.7	83.0	81.8	-	-	-	71.0	68.6	69.9	-	-	-	80.4	82.7	81.6
		AF	-	-	-	79.7	82.8	81.5	-	-	-	69.7	70.5	70.1	-	-	-	79.9	84.0	82.3
		D	-	-	-	0.0	-0.2	-0.3	-	-	-	-1.3	1.9	0.2	-	-	-	-0.5	1.4	0.7
Controlled D		***ON***	***-***	***-***	***-***	***-5.2***	***-1.3***	***-2.6***	***-***	***-***	***-***	***0.2***	***-3.0***	***-1.3***	***-***	***-***	***-***	***-2.7***	***-2.8***	***-2.4***
		OFF	***-***	***-***	***-***	***-2.8***	***0.9***	***-0.3***	***-***	***-***	***-***	***1.1***	***-3.3***	***-0.8***	***-***	***-***	***-***	***0.8***	***-1.5***	***-0.5***

[1] Site Type: Treatment (T) / Control (T)
[2] Sign status 'ON' indicates 'silent' activations for treatment sites in the before period / 'virtual' activations for control sites at any period
[3] Trial Period: Before (BF) / After (AF) / Variation (D)
[4] Travel lane on major road that is close to the minor road
[5] Travel lane on major road that is further from the minor road

Table 4.6
85th percentile speed of all vehicles on approach and proximity to intersections with a 100km/h speed limit (free flow) - Trial Pairs 2, 4, 6

Site Type [1]	Sign Status [2]	Trial Period [3]	Pair 2						Pair 4						Pair 6					
			Approach (km/h)			Proximity (km/h)			Approach (km/h)			Proximity (km/h)			Approach (km/h)			Proximity (km/h)		
			Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides
T	ON	BF	97.0	99.0	99.0	98.1	98.1	98.1	100.0	99.0	99.4	99.0	104.0	101.3	102.0	103.0	103.0	101.3	100.0	100.6
		AF	91.0	95.0	92.0	94.6	93.5	94.2	99.0	98.6	99.0	96.1	100.2	98.2	100.0	103.0	101.0	100.8	99.4	100.4
		D	-6.0	-4.0	-7.0	-3.4	-4.6	-3.9	-1.0	-0.4	-0.4	-2.9	-3.9	-3.1	-2.0	0.0	-2.0	-0.5	-0.6	-0.2
	OFF	BF	99.0	100.0	99.0	99.1	99.0	99.0	102.0	99.0	101.0	99.2	103.7	101.8	102.0	103.0	103.0	101.6	100.3	101.0
		AF	98.0	99.0	99.0	98.8	98.0	98.4	102.0	99.0	101.0	100.0	104.0	102.3	102.0	103.0	103.0	102.5	100.1	101.2
		D	-1.0	-1.0	0.0	-0.3	-1.0	-0.7	0.0	0.0	0.0	0.8	0.3	0.5	0.0	0.0	0.0	1.0	-0.2	0.3
C	ON	BF	-	-	-	99.1	103.7	101.9	-	-	-	99.3	100.6	100.1	-	-	-	101.3	98.9	100.2
		AF	-	-	-	98.5	104.7	102.6	-	-	-	100.4	100.4	100.4	-	-	-	100.9	99.4	100.2
		D	-	-	-	-0.6	1.0	0.7	-	-	-	1.1	-0.2	0.3	-	-	-	-0.4	0.5	0.0
	OFF	BF	-	-	-	99.8	104.8	102.7	-	-	-	99.4	101.1	100.4	-	-	-	102.0	99.6	100.9
		AF	-	-	-	99.2	105.4	103.0	-	-	-	100.8	101.2	101.0	-	-	-	101.2	100.3	100.8
		D	-	-	-	-0.6	0.5	0.3	-	-	-	1.4	0.1	0.7	-	-	-	-0.7	0.7	-0.1
Controlled D		***ON***	**-**	**-**	**-**	**-2.8**	**-5.5**	**-4.5**	**-**	**-**	**-**	**-4.0**	**-3.7**	**-3.4**	**-**	**-**	**-**	**-0.1**	**-1.1**	**-0.1**
		OFF	**-**	**-**	**-**	**0.3**	**-1.5**	**-1.0**	**-**	**-**	**-**	**-0.6**	**0.2**	**-0.2**	**-**	**-**	**-**	**1.7**	**-1.0**	**0.4**

[1] Site Type: Treatment (T) / Control (T)
[2] Sign status 'ON' indicates 'silent' activations for treatment sites in the before period / 'virtual' activations for control sites at any period
[3] Trial Period: Before (BF) / After (AF) / Variation (D)
[4] Travel lane on major road that is close to the minor road
[5] Travel lane on major road that is further from the minor road

Compliance to advised speed limit when lights are flashing

The proportions of vehicles travelling on the major road at speeds equal or below various threshold values when travelling in proximity to the trial intersections with a speed limit of 80 km/h and 100 km/h are provided in Tables 4.7 and 4.8, respectively. Vehicle proportions are presented separately for the cases of flashing or blank lights on the major road signs. For the sake of simplicity and conciseness, speeds measured along the two directions of travel along the major road have been aggregated together. Similar proportions based on speeds observed while vehicles were approaching the trial intersections are provided in Appendix D.

Additionally, a visual representation of the speed ranges at which vehicle were travelling on the major road is provided by the bar plots shown in Figures 4.7 and 4.8. The sequential coloured segments used in each bar plot represent different speed ranges at increments of 10 km/h. These bar plots allow to intuitively identify the proportion of vehicles travelling within each of the selected speed ranges as well as the proportion of vehicles whose speed was below or above any of the range thresholds. These plots also provide a side-by-side visual comparison of the distributions for each status of the flashing signs (ON vs OFF).

The following two major points can be derived from the analysis of the provided results:

- **Speed limit compliance:**
  The proportion of vehicles travelling at or below the advised speed when the lights of were flashing on the major road at the treated sites remained fairly similar to what observed before the RJAWS Lite was installed. Nonetheless, there was a systematic increase in the proportion of vehicles travelling at speeds below the posted speed limit (at least 10 km/h below for the sites with a limit of 50 km/h, and at least 20 km/h below for sites with a higher speed limit of 100 km/h). This trend was almost negligible when the signs were not flashing as well as at any time at the control sites.
- **Over-speeding:**
  The proportion of vehicles which were travelling over the posted speed limit when lights on the major road signage were flashing reduced by a considerable amount compared to what observed before the RJAWS Lite was installed. This trend was almost negligible when the signs were not flashing at the treated sites as well as at any time at the control sites.

Table 4.7
Vehicle proportion below various speed thresholds in **proximity** to intersections with 80km/h speed limit (free flow) - Trial Pairs 1, 3, 5

c	Sign Status [2]	Trial Period [3]	Pair 1					Pair 3					Pair 5				
			<= 50 km/h	<= 60 km/h	<= 70 km/h	<= 80 km/h	> 80 km/h	<= 50 km/h	<= 60 km/h	<= 70 km/h	<= 80 km/h	> 80 km/h	<= 50 km/h	<= 60 km/h	<= 70 km/h	<= 80 km/h	> 80 km/h
T	ON	BF	0.4	2.4	10.9	68.9	31.1	1.8	12.5	48.8	90.3	9.7	0.3	1.1	7.3	67.2	32.8
		AF	1.0	8.2	32.8	85.0	15.0	1.5	18.7	60.0	94.3	5.7	1.1	9.5	32.9	86.0	14.0
		D	0.6	5.8	21.9	16.1	-16.1	-0.3	6.2	11.2	4.0	-4.0	0.8	8.4	25.6	18.8	-18.8
	OFF	BF	0.2	1.7	8.2	63.2	36.8	1.3	11.9	46.4	86.8	13.2	0.1	1.0	7.0	64.3	35.7
		AF	0.1	1.1	7.9	64.5	35.5	1.1	10.7	45.1	86.4	13.6	0.1	1.0	7.5	65.4	34.6
		D	-0.1	-0.6	-0.3	1.3	-1.3	-0.2	-1.2	-1.3	-0.4	0.4	0.0	0.0	0.5	1.1	-1.1
C	ON	BF	0.1	1.0	14.7	78.4	21.6	6.9	45.0	88.6	99.3	0.7	0.9	4.5	25.4	81.7	18.3
		AF	0.2	1.3	16.6	80.5	19.5	6.6	43.1	87.2	99.1	0.9	0.5	3.9	24.4	80.4	19.6
		D	0.1	0.3	1.9	2.1	-2.1	-0.3	-1.9	-1.4	-0.2	0.2	-0.4	-0.6	-1.0	-1.3	1.3
	OFF	BF	0.1	1.0	13.2	74.8	25.2	5.9	40.9	85.2	98.7	1.3	0.5	3.4	22.4	78.0	22.0
		AF	0.2	1.3	15.6	76.9	23.1	5.6	40.5	84.6	98.6	1.4	0.3	2.6	20.9	75.4	24.6
		D	0.1	0.3	2.4	2.1	-2.1	-0.3	-0.4	-0.6	-0.1	0.1	-0.2	-0.8	-1.5	-2.6	2.6
Controlled D		***ON***	**0.5**	**5.5**	**20.0**	**14.0**	**-14.0**	**0.0**	**8.1**	**12.6**	**4.2**	**-4.2**	**1.2**	**9.0**	**26.6**	**20.1**	**-20.1**
		OFF	**-0.2**	**-0.9**	**-2.7**	**-0.8**	**0.8**	**0.1**	**-0.8**	**-0.7**	**-0.3**	**0.3**	**0.2**	**0.8**	**2.0**	**3.7**	**-3.7**

[1] Site Type: Treatment (T) / Control (T)
[2] Sign status 'ON' indicates 'silent' activations for treatment sites in the before period / 'virtual' activations for control sites at any period
[3] Trial Period: Before (BF) / After (AF) / Variation (D)

Table 4.8
Vehicle proportion below various speed thresholds in **proximity** to intersections with 100km/h speed limit (free flow) - Trial Pairs 2, 4, 6

Site Type [1]	Sign Status [2]	Trial Period [3]	Pair 2					Pair 4					Pair 6				
			<= 50 km/h	<= 60 km/h	<= 70 km/h	<= 80 km/h	> 80 km/h	<= 50 km/h	<= 60 km/h	<= 70 km/h	<= 80 km/h	> 80 km/h	<= 50 km/h	<= 60 km/h	<= 70 km/h	<= 80 km/h	> 80 km/h
T	ON	BF	4.5	22.9	54.6	92.1	7.9	4.7	18.7	45.3	88.3	11.7	2.2	8.5	25.7	76.2	23.8
		AF	12.8	44.9	78.8	97.4	2.6	7.3	28.2	58.1	91.5	8.5	4.3	18.5	44.6	84.4	15.6
		D	8.3	22.0	24.2	5.3	-5.3	2.6	9.5	12.8	3.2	-3.2	2.1	10.0	18.9	8.2	-8.2
	OFF	BF	2.9	17.2	47.5	89.6	10.4	2.9	11.7	35.4	84.0	16.0	1.0	4.8	16.3	69.6	30.4
		AF	3.3	18.8	50.4	91.0	9.0	2.4	11.6	35.3	83.7	16.3	1.1	5.4	17.9	71.0	29.0
		D	0.4	1.6	2.9	1.4	-1.4	-0.5	-0.1	-0.1	-0.3	0.3	0.1	0.6	1.6	1.4	-1.4
C	ON	BF	6.6	13.1	32.9	77.4	22.6	1.6	4.4	16.4	84.5	15.5	3.4	12.6	38.2	84.1	15.9
		AF	7.0	12.8	33.4	75.3	24.7	4.3	8.0	19.1	82.5	17.5	4.0	14.4	39.9	84.1	15.9
		D	0.4	-0.3	0.5	-2.1	2.1	2.7	3.6	2.7	-2.0	2.0	0.6	1.8	1.7	0.0	0.0
	OFF	BF	6.5	11.6	30.1	73.7	26.3	1.2	3.8	15.2	83.1	16.9	2.9	11.5	35.2	81.2	18.8
		AF	6.6	11.8	30.6	73.5	26.5	1.4	4.3	14.3	78.7	21.3	3.4	12.1	35.2	81.6	18.4
		D	0.1	0.2	0.5	-0.2	0.2	0.2	0.5	-0.9	-4.4	4.4	0.5	0.6	0.0	0.4	-0.4
Controlled D		***ON***	**7.9**	**22.3**	**23.7**	**7.4**	**-7.4**	**-0.1**	**5.9**	**10.1**	**5.2**	**-5.2**	**1.5**	**8.2**	**17.2**	**8.2**	**-8.2**
		OFF	**0.3**	**1.4**	**2.4**	**1.6**	**-1.6**	**-0.7**	**-0.6**	**0.8**	**4.1**	**-4.1**	**-0.4**	**0.0**	**1.6**	**1.0**	**-1.0**

[1] Site Type: Treatment (T) / Control (T)
[2] Sign status 'ON' indicates 'silent' activations for treatment sites in the before period / 'virtual' activations for control sites at any period
[3] Trial Period: Before (BF) / After (AF) / Variation (D)

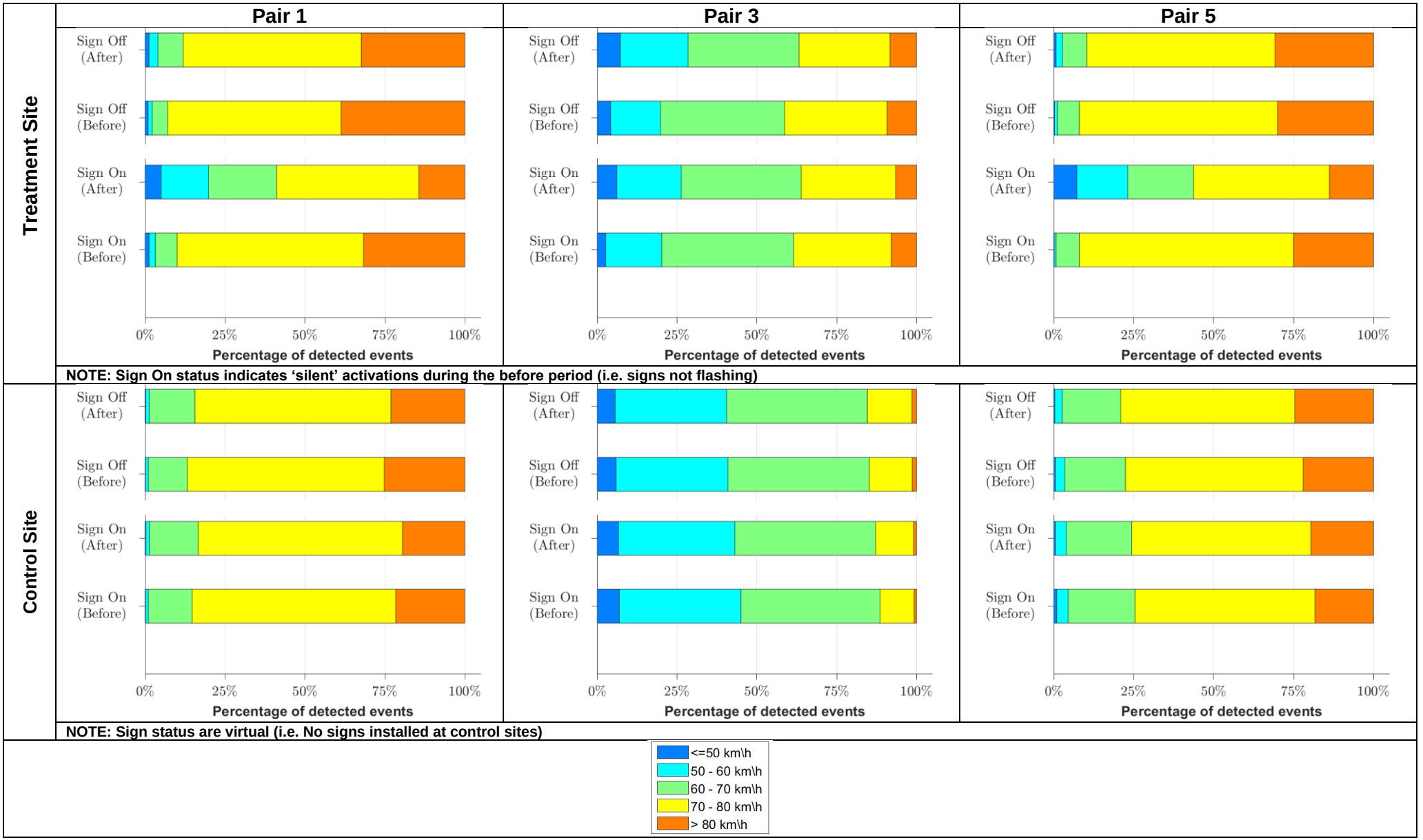


Figure 4.7
Visual breakdown of travel speeds in **proximity** to the intersection by incremental speed ranges (free flow) –Trial sites with 80km/h speed limit (Pairs 1, 3, 5)

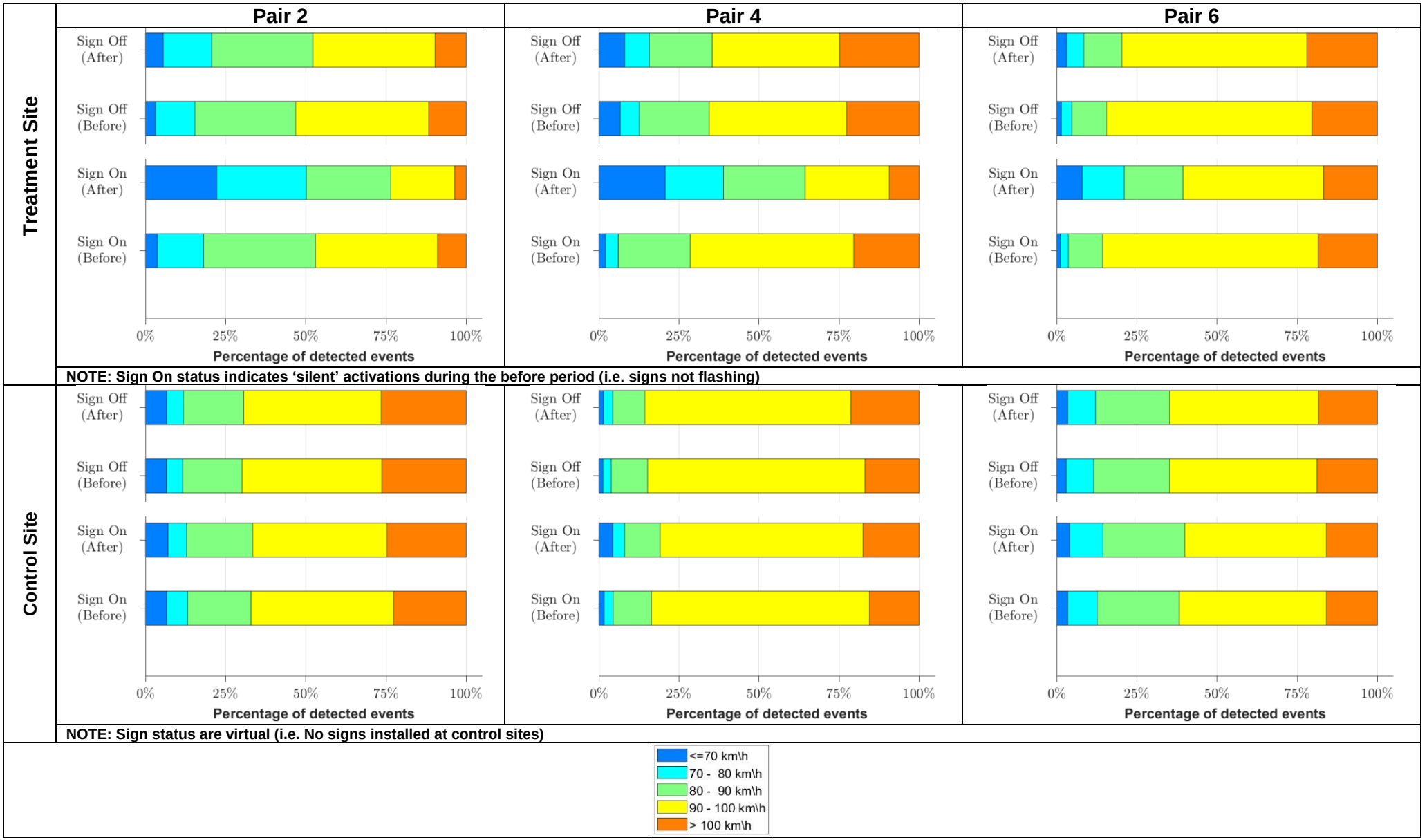


Figure 4.8
Visual breakdown of travel speeds in **proximity** to the intersection by incremental speed ranges (free flow) –Trial sites with 100km/h speed limit (Pairs 2, 4, 6)

Risk of casualty crashes

The potential risk for a crash between the major road traffic and a vehicle entering the intersection to result in fatality or serious injury at each of the six pairs of trial sites is listed in Table 4.9. The table provides the average risk of being involved in a casualty crash relative to a baseline risk associated to travelling through the intersection at the default speed limit. The relative risk was calculated separately for the two scenarios of vehicles travelling through the intersection with either the major road sign illuminated or blank. However, the baseline risk was based on the default speed limit independently of the sign status.

A comparison of the casualty risk between the two scenarios for the light status is provided by the ratio of the risks with illuminated and blank signs (column *ONvsOFF Ratio* in the table). Most importantly, the table also provides the risk evaluated before as well as after the activation of the RJAWS Lite at the six treatment sites. A comparison of the risk between these two periods is provided by their ratio and the associated change (row *Before-After change* in the table).

Table 4.9
Average relative risks of being involved in a casualty crash before and after the RJAWS Lite activation (with corresponding ratios)

Site Type [1]	Trial Period [2]	Average Relative Risk (%)																	
		Trial Pair 1			Trial Pair 2			Trial Pair 3			Trial Pair 4			Trial Pair 5			Trial Pair 6		
		Risk ON	Risk OFF	ONvsOFF Ratio	Risk ON	Risk OFF	ONvsOFF Ratio	Risk ON	Risk OFF	ONvsOFF Ratio	Risk ON	Risk OFF	ONvsOFF Ratio	Risk ON	Risk OFF	ONvsOFF Ratio	Risk ON	Risk OFF	ONvsOFF Ratio
T	BF	95.0	109.6	0.87	59.6	66.3	0.90	57.4	62.1	0.93	79.7	81.0	0.98	93.7	99.8	0.94	82.7	86.0	0.96
	AF	67.8	98.9	0.69	43.9	62.0	0.71	53.4	57.2	0.93	54.2	85.2	0.64	66.9	100.0	0.67	70.5	84.0	0.84
	Ratio	0.71	0.90	-	0.74	0.94	-	0.93	0.92	-	0.68	1.05	-	0.71	1.00	-	0.85	0.98	-
	Before-After change ***D*** (%)	-28.6	-9.8	-	-26.3	-6.5	-	-7.0	-7.9	-	-32.0	5.2	-	-28.6	0.2	-	-14.8	-2.3	-
C	BF	82.8	88.3	0.94	79.6	87.2	0.91	39.6	42.0	0.94	80.6	83.8	0.96	83.6	90.0	0.93	72.0	78.8	0.91
	AF	93.9	93.6	1.00	81.7	88.7	0.92	40.2	42.3	0.95	80.5	87.6	0.92	86.4	93.9	0.92	71.5	77.7	0.92
	Ratio	1.13	1.06	-	1.03	1.02	-	1.02	1.01	-	1.00	1.05	-	1.03	1.04	-	0.99	0.99	-
	Before-After change ***D*** (%)	13.4	6.0	-	2.6	1.7	-	1.5	0.7	-	-0.1	4.5	-	3.3	4.3	-	-0.7	-1.4	-
Controlled D (%)		**-42.0**	**-15.8**	**-**	**-29.0**	**-8.2**	**-**	**-8.5**	**-8.6**	**-**	**-31.9**	**0.7**	**-**	**-32.0**	**-4.1**	**-**	**-14.1**	**-0.9**	**-**

[1] Site Type: Treatment (T) / Control (T)
[2] Trial Period: Before (BF) / After (AF)

4.1.3. Comparison between free-flow and disrupted traffic conditions

This section provides a comparison of the overall observed speed behaviour of vehicles travelling along the major road approaches between the two cases of free-flow and traffic conditions disrupted by another vehicle entering the intersection through a right-turn manoeuvre. Both uncontrolled and controlled variations in the mean speed calculated for free-flowing and disrupted traffic are summarised in Table 4.10. Similarly, the variations in the 85thpercentile speeds are presented in Table 4.11. Specific speed values observed in the analysis of the disrupted scenario are provided in Appendix E.

Table 4.10
Before-after variation of mean travel speed for free-flowing and disrupted traffic in proximity to the trial intersections – Uncontrolled and controlled variations

Variation type	Traffic flow	Speed Limit = 80 km/h									Speed Limit = 100 km/h								
		Pair 1 (km/h)			Pair 3 (km/h)			Pair 5 (km/h)			Pair 2 (km/h)			Pair 4 (km/h)			Pair 6 (km/h)		
		Near Side [1]	Far Side [2]	Both Sides	Near Side [1]	Far Side [2]	Both Sides	Near Side [1]	Far Side [2]	Both Sides	Near Side [1]	Far Side [2]	Both Sides	Near Side [1]	Far Side [2]	Both Sides	Near Side [1]	Far Side [2]	Both Sides
NO control	*Free*	-8.7	-6.0	-7.1	-2.2	-0.6	-1.3	-8.7	-7.2	-7.9	-7.9	-8.7	-8.3	-10.0	-11.3	-10.7	-5.4	-5.1	-5.3
	Disrupted	-9.3	-7.6	-8.1	-2.1	-1.8	-0.4	-10.2	-20.0	-14.8	-10.5	-23.4	-11.4	-8.0	14.1	-5.7	-5.2	-10.7	-5.5
Controlled	*Free*	*-8.6*	*-5.8*	*-6.9*	*-0.4*	*-2.9*	*-1.6*	*-8.9*	*-8.3*	*-8.4*	-8.0	-9.0	-8.3	-11.1	-9.1	-9.9	-4.8	-4.8	-4.9
	Disrupted	-9.1	-8.5	-8.5	-0.1	-2.1	1.1	-11.2	-20.1	-15.6	-12.5	-11.3	-12.0	-9.0	29.2	0.7	-4.6	-10.3	-5.4

[1] Travel lane on major road that is close to the minor road
[2] Travel lane on major road that is further from the minor road

Table 4.11
Before-after variation of 85th percentile travel speed for free-flowing and disrupted traffic in proximity to the trial intersections – Uncontrolled and controlled variations

Variation type	Traffic flow	Speed Limit = 80 km/h									Speed Limit = 100 km/h								
		Pair 1 (km/h)			Pair 3 (km/h)			Pair 5 (km/h)			Pair 2 (km/h)			Pair 4 (km/h)			Pair 6 (km/h)		
		Near Side (1)	Far Side (2)	Both Sides	Near Side (1)	Far Side (2)	Both Sides	Near Side (1)	Far Side (2)	Both Sides	Near Side (1)	Far Side (2)	Both Sides	Near Side (1)	Far Side (2)	Both Sides	Near Side (1)	Far Side (2)	Both Sides
NO control	*Free*	-5.2	-1.5	-2.8	-1.2	-0.6	-0.9	-2.9	-1.6	-2.2	-3.4	-4.6	-3.9	-2.9	-3.9	-3.1	-0.5	-0.6	-0.2
	Disrupted	-5.3	-4.8	-4.5	2.1	-1.6	-0.2	-3.6	-10.5	-4.8	-7.7	-11.6	-7.8	-3.9	-13.2	-5.4	-0.2	-2.6	-0.4
Controlled	*Free*	-5.2	-1.3	-2.6	0.2	-3.0	-1.3	-2.7	-2.8	-2.4	-2.8	-5.5	-4.5	-4.0	-3.7	-3.4	-0.1	-1.1	-0.1
	Disrupted	-5.4	-3.1	-4.0	2.2	-1.6	1.5	-5.1	-11.3	-6.3	-7.5	0.7	-5.0	-5.0	0.8	-5.9	-0.2	-3.3	-0.6

(1) Travel lane on major road that is close to the minor road
(2) Travel lane on major road that is further from the minor road

4.2. Minor road

This section provides the results of the analysis conducted on vehicles approaching the intersection along the minor road at each trial site.

4.2.1. Vehicle detections

4.2.1.1. Traffic detected in proximity to control line

The number of vehicles observed at the measuring location closest to the control line before and after the activation of the RJAWS Lite is provided in Figure 4.9. For each period, the detected vehicle events have been grouped by the on/off status of the minor road sign at the time they reached the control line. Note that the ‘ON’ status of the flashing give-way sign during the before period refers to silent activations (i.e. no flashing light shown to approaching road users).

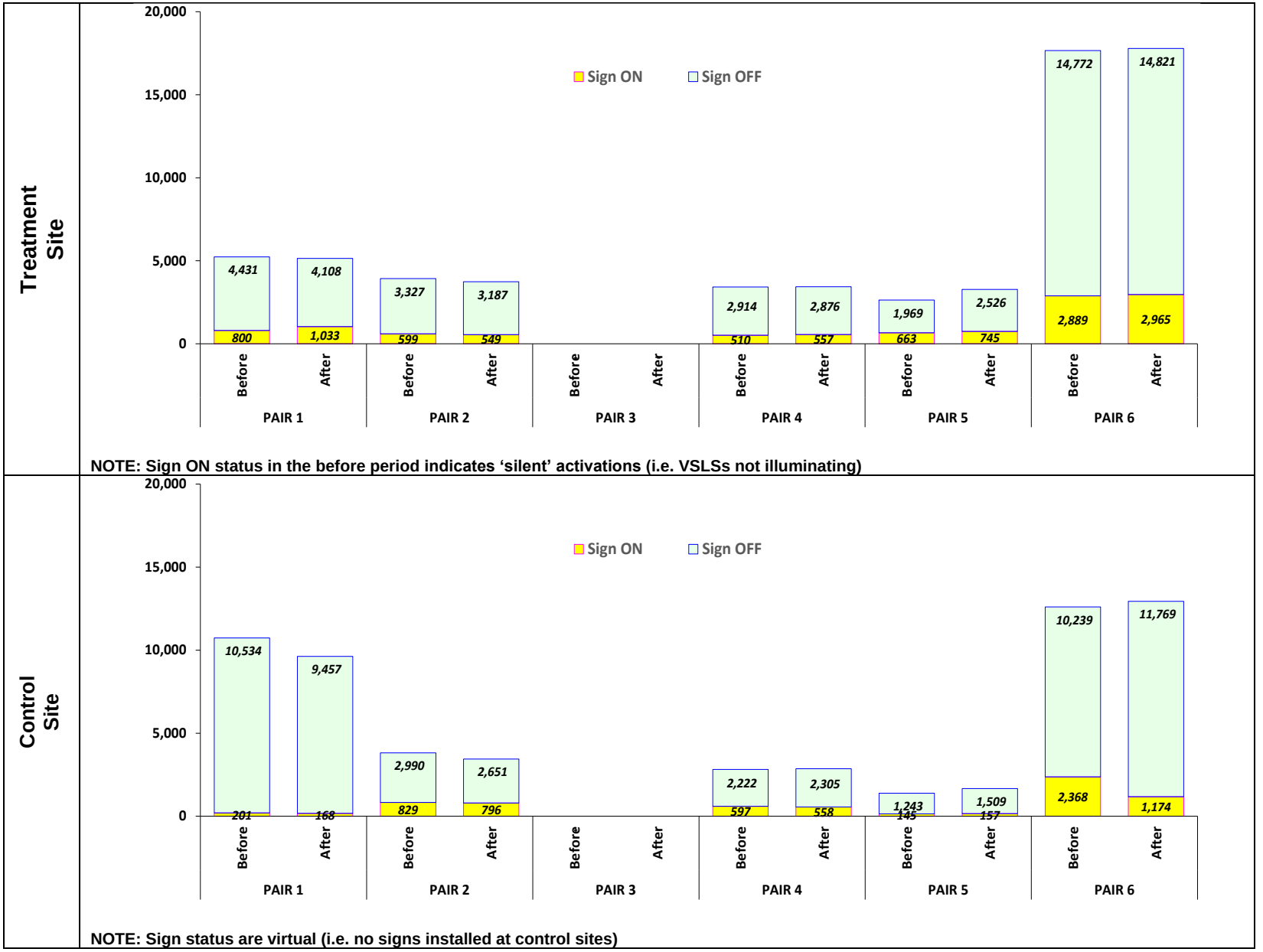


Figure 4.9
Side road traffic observed at location closest to the control line at each of the trial sites (grouped by status of the minor road sign)

4.2.1.2. Proportions of vehicles with flashing signs

A visual representation of the proportion of all the vehicles that were detected to approach the intersection while the sign was flashing is provided in the bar plots in Figure 4.10. Vehicle detections across any of the measurement locations on the minor road were accounted both before and after the activation of the RJAWS Lite. Note that no results are available for Pair 3 due the need to redeploy elsewhere the solar panel unit powering the flashing give-way sign during that phase of the trial.

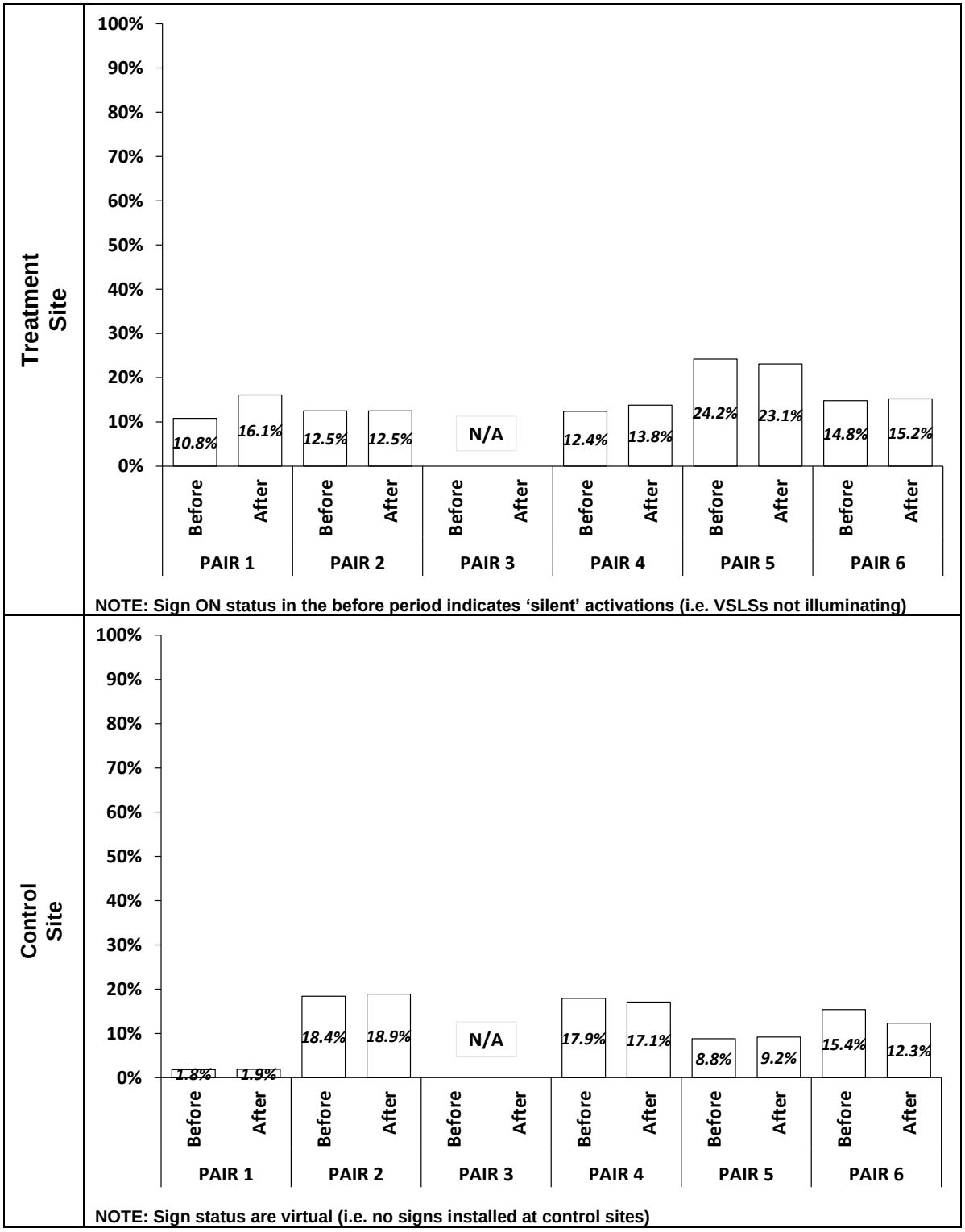


Figure 4.10
Proportion of side road traffic approaching the intersection with a flashing give-way sign (across any measured locations)

The before-after change of these proportions at each of the treatment and control sites as well as the resulting controlled variation after accounting for changes at the paired control sites are reported in Table 4.12.

Table 4.12
Proportion of vehicles approaching the intersection with a flashing give-way sign (along any monitored locations)

Trial Pair	Site Type	Proportion Before (%)	Proportion After (%)	Variation (% points)	Controlled Variation (% points)
1	Treatment	10.8	16.1	5.3	**5.2**
	Control	1.8	1.9	0.1	
2	Treatment	12.5	12.5	0.0	**-0.5**
	Control	18.4	18.9	0.5	
3	Treatment	-	-	-	**-**
	Control	-	-	-	
4	Treatment	12.4	13.8	1.4	**2.2**
	Control	17.9	17.1	-0.8	
5	Treatment	24.2	23.1	-1.1	**-1.5**
	Control	8.8	9.2	0.4	
6	Treatment	14.8	15.2	0.4	**3.5**
	Control	15.4	12.3	-3.1	

4.2.2. Speed along minor road approach

This section provides the results of the speed analysis for traffic travelling along the minor road at each of the trial sites.

Travel speed along the minor road approach

The plots in Figures 4.11 and 4.12 show the mean travel speed observed at any of the measurement locations across the approach to the control line. Speed is reported for both the trial periods before and after the activation of the RJAWS Lite. The mean speed is reported for either status of the flashing give-way sign installed in proximity to the intersection control line. Similar results were obtained from the analysis of the 85thpercentile speed, which are provided in E.3. The mean and the 85thpercentile speeds as well as their before-after difference measured at locations of 75 m, 50 m and 25 m from the control line are provided in Tables 4.13 and 4.14.

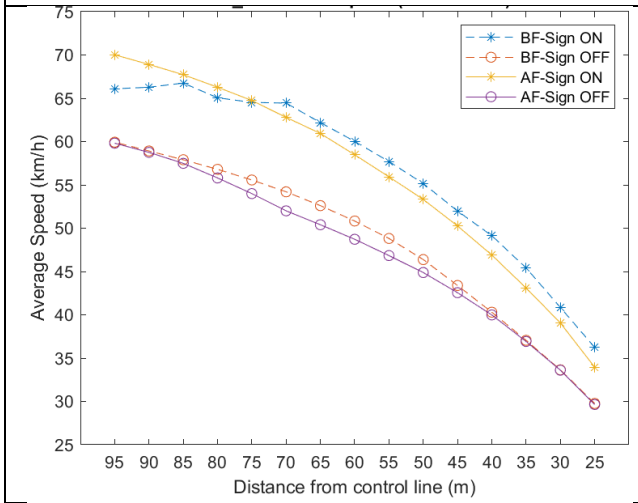
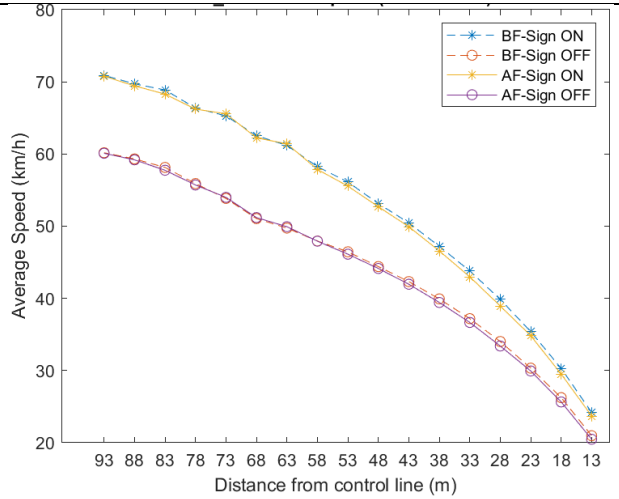
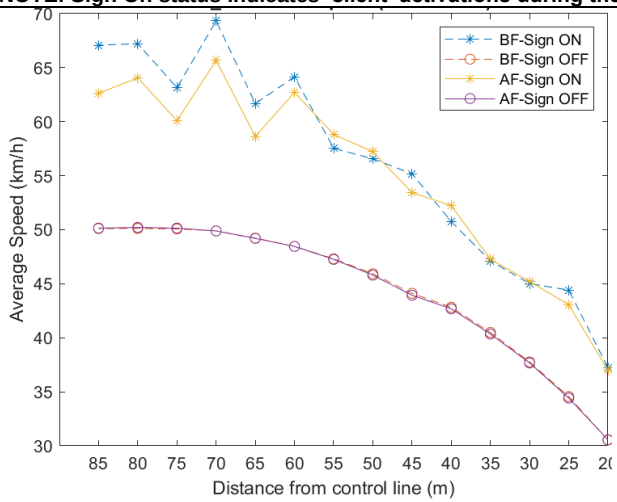
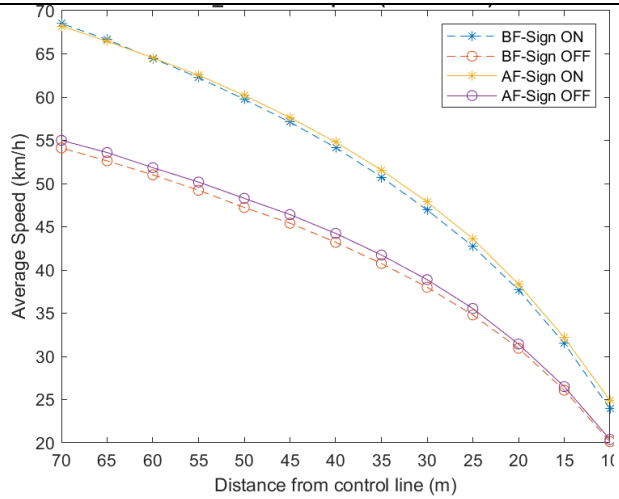
	Pair 1	Pair 3	Pair 5
Treatment Site		N/A	
	NOTE: Sign On status indicates 'silent' activations during the before period (i.e. signs not flashing)		
Control Site		N/A	
	NOTE: Sign status are virtual (i.e. No signs installed at control sites)		

Figure 4.11
Mean speed along the minor road at various locations from the control line - Trial sites with 80km/h speed limit on major road (Pairs 1, 3, 5)

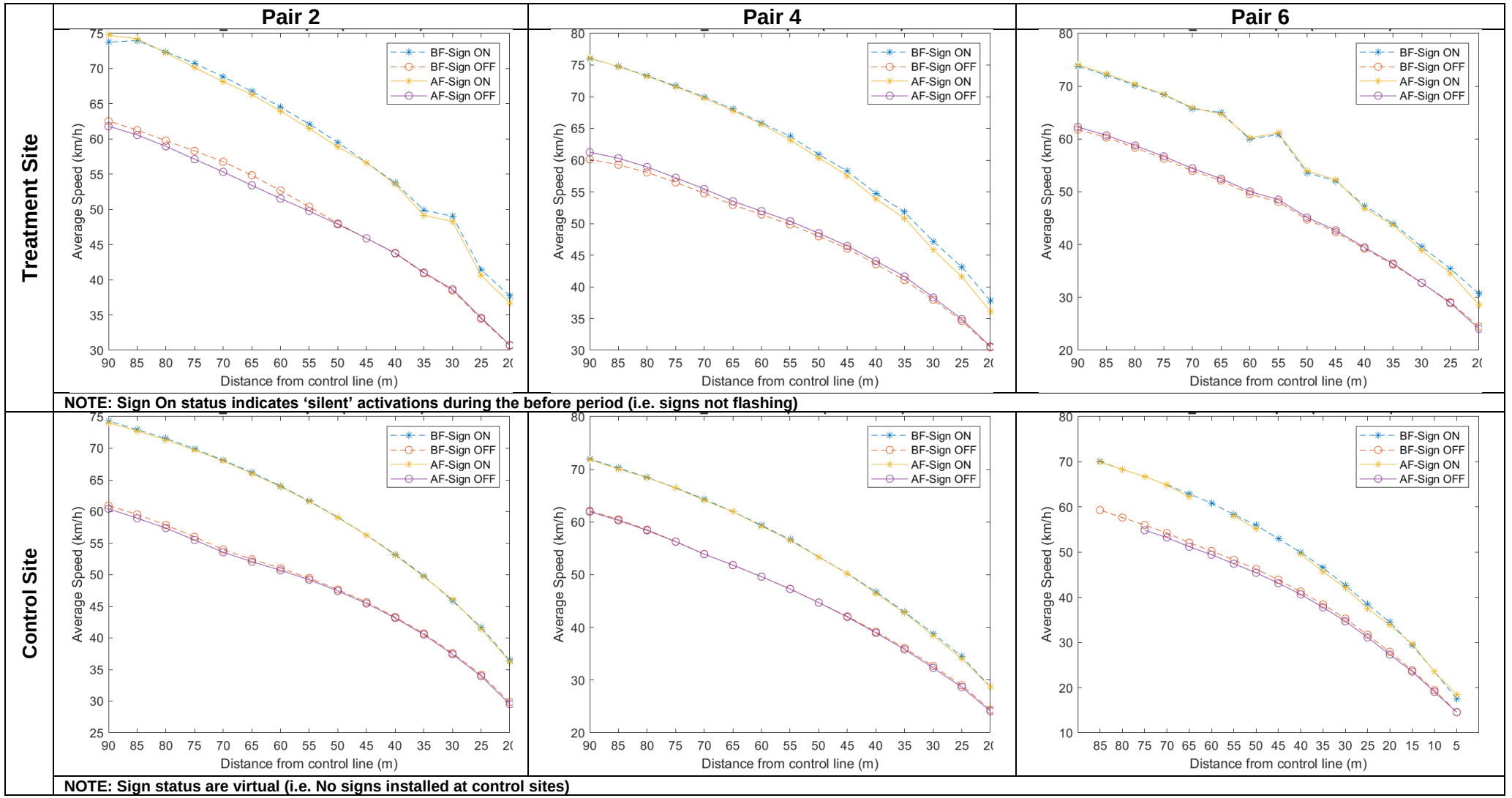


Figure 4.12
Mean speed along the minor road at various locations from the control line - Trial sites with 100km/h speed limit on major road (Pairs 2, 4, 6)

Table 4.13
Mean speed along the minor road at selected distances from the control line

Site Type [1]	Sign Status [2]	Trial Period [3]	Mean Speed (km/h)																	
			Trial Pair 1			Trial Pair 2			Trial Pair 3			Trial Pair 4			Trial Pair 5			Trial Pair 6		
			@ 25 m	@ 50 m	@ 75 m	@ 25 m	@ 50 m	@ 75 m	@ 25 m	@ 50 m	@ 75 m	@ 25 m	@ 50 m	@ 75 m	@ 25 m	@ 50 m	@ 75 m	@ 25 m	@ 50 m	@ 75 m
T	ON	BF	36.2	55.2	64.5	41.4	59.5	70.7	-	-	-	43.1	60.9	71.7	35.4	53.1	35.4	35.4	53.6	68.4
		AF	34.0	53.3	64.7	40.6	58.9	70.1	-	-	-	41.6	60.4	71.6	34.8	52.7	34.8	34.5	54.0	68.5
		Variation	-2.3	-1.8	0.2	-0.8	-0.7	-0.6	-	-	-	-1.5	-0.5	-0.1	-0.6	-0.4	-0.6	-0.9	0.4	0.0
	OFF	BF	29.8	46.4	55.6	34.5	48.0	58.3	-	-	-	34.6	48.0	56.5	30.3	44.4	30.3	29.1	44.8	56.3
		AF	29.6	44.9	54.0	34.6	47.9	57.1	-	-	-	34.9	48.5	57.2	29.9	44.1	29.9	28.9	45.1	56.7
		Variation	-0.1	-1.5	-1.6	0.1	-0.1	-1.2	-	-	-	0.3	0.5	0.7	-0.4	-0.3	-0.4	-0.2	0.4	0.4
C	On	BF	44.4	56.6	63.2	41.7	59.1	69.9	-	-	-	34.5	53.4	66.5	42.7	59.7	42.7	38.4	56.0	64.9
		AF	43.0	57.2	60.1	41.4	59.0	69.7	-	-	-	34.1	53.4	66.4	43.6	60.2	43.6	37.5	55.2	64.9
		Variation	-1.4	0.6	-3.1	-0.3	-0.1	-0.2	-	-	-	-0.4	0.0	-0.1	0.9	0.5	0.9	-0.9	-0.8	-0.1
	OFF	BF	34.6	45.9	50.1	34.2	47.7	56.0	-	-	-	29.0	44.7	56.3	34.8	47.2	34.8	31.7	46.2	54.2
		AF	34.4	45.8	50.1	34.0	47.4	55.5	-	-	-	28.7	44.7	56.3	35.5	48.3	35.5	31.1	45.4	53.2
		Variation	-0.1	-0.1	0.1	-0.2	-0.2	-0.5	-	-	-	-0.4	0.0	0.0	0.7	1.1	0.7	-0.6	-0.8	-1.0
Controlled D		**ON**	**-0.9**	**-2.5**	**3.3**	**-0.5**	**-0.6**	**-0.4**	**-**	**-**	**-**	**-1.1**	**-0.5**	**0.0**	**-1.5**	**-0.9**	**-1.5**	**0.0**	**1.2**	**0.1**
		OFF	**0.0**	**-1.4**	**-1.6**	**0.4**	**0.1**	**-0.7**	**-**	**-**	**-**	**0.7**	**0.5**	**0.8**	**-1.1**	**-1.3**	**-1.1**	**0.4**	**1.2**	**1.4**

[1] Site Type: Treatment (T) / Control (T)
[2] Sign status 'ON' indicates 'silent' activations for treatment sites in the before period / 'virtual' activations for control sites at any period
[3] Trial Period: Before (BF) / After (AF)

Table 4.14
85th percentile speed along the minor road at selected distances from the control line

Site Type [1]	Sign Status [2]	Trial Period [3]	85th percentile Speed (km/h)																	
			Trial Pair 1			Trial Pair 2			Trial Pair 3			Trial Pair 4			Trial Pair 5			Trial Pair 6		
			@ 25 m	@ 50 m	@ 75 m	@ 25 m	@ 50 m	@ 75 m	@ 25 m	@ 50 m	@ 75 m	@ 25 m	@ 50 m	@ 75 m	@ 25 m	@ 50 m	@ 75 m	@ 25 m	@ 50 m	@ 75 m
T	ON	BF	38.7	57.5	70.7	45.7	63.0	74.7	-	-	-	47.4	65.0	75.6	39.0	57.1	68.7	39.7	58.7	72.2
		AF	37.7	56.9	68.1	45.0	62.9	74.1	-	-	-	45.9	64.6	75.7	38.0	56.9	69.1	38.5	58.8	72.3
		Variation	-1.0	-0.6	-2.6	-0.7	-0.1	-0.6	-	-	-	-1.6	-0.4	0.1	-1.0	-0.2	0.4	-1.2	0.1	0.1
	OFF	BF	33.6	51.9	62.6	39.1	54.0	66.6	-	-	-	39.5	54.7	65.5	34.7	50.0	60.7	33.6	50.3	62.9
		AF	33.7	50.0	60.1	39.3	54.1	64.8	-	-	-	39.8	55.0	65.7	33.9	49.5	60.7	33.4	50.6	63.3
		Variation	0.1	-1.9	-2.5	0.2	0.1	-1.8	-	-	-	0.3	0.3	0.2	-0.8	-0.5	0.0	-0.2	0.3	0.4
C	On	BF	46.9	62.9	68.4	45.9	63.6	75.1	-	-	-	38.7	58.2	71.5	45.5	62.8	71.7	43.5	61.5	70.9
		AF	45.5	62.1	67.5	45.9	64.2	74.8	-	-	-	38.4	58.2	71.6	47.1	63.4	71.3	42.6	60.7	70.2
		Variation	-1.5	-0.8	-0.9	0.0	0.5	-0.3	-	-	-	-0.3	0.0	0.1	1.6	0.6	-0.4	-0.9	-0.8	-0.7
	OFF	BF	39.4	52.4	56.7	39.1	54.3	64.5	-	-	-	33.5	50.4	63.0	39.6	53.8	62.9	37.3	53.0	62.1
		AF	39.4	52.4	56.8	38.9	54.2	64.4	-	-	-	33.2	50.2	62.8	40.1	54.3	63.5	36.6	52.2	61.2
		Variation	0.0	0.0	0.1	-0.2	-0.1	-0.1	-	-	-	-0.3	-0.2	-0.2	0.5	0.5	0.6	-0.7	-0.8	-0.9
Controlled D		**ON**	**0.5**	**0.2**	**-1.7**	**-0.7**	**-0.6**	**-0.3**	**-**	**-**	**-**	**-1.3**	**-0.4**	**0.0**	**-2.6**	**-0.8**	**0.8**	**-0.3**	**0.9**	**0.8**
		OFF	**0.1**	**-1.9**	**-2.6**	**0.4**	**0.2**	**-1.7**	**-**	**-**	**-**	**0.6**	**0.5**	**0.4**	**-1.3**	**-1.0**	**-0.6**	**0.5**	**1.1**	**1.3**

[1] Site Type: Treatment (T) / Control (T)
[2] Sign status 'ON' indicates 'silent' activations for treatment sites in the before period / 'virtual' activations for control sites at any period
[3] Trial Period: Before (BF) / After (AF)

Proportion of events by speed thresholds and ranges

The proportions of vehicles travelling on the minor road at speeds equal or below various threshold values when in proximity to the control line are provided in Tables 4.15 and 4.16. Vehicle proportions are presented separately for the cases with a flashing or blank give-way sign. Additionally, a visual representation of the speed ranges at which vehicles were reaching close to the control line is provided by the bar plots shown in Figures 4.13 through 4.14. Detected vehicles were grouped into five equal speed ranges up to 50 km/h as well as in an additional range for vehicles travelling over 50 km/h.

Table 4.15

Proportions of vehicles travelling at or below various speed thresholds in **proximity** to the intersection control line – Trial sites with 80km/h speed limit (Pairs 1, 3, 5)

Site Type [1]	Sign Status [2]	Trial Period [3]	Trial Pair 1					Trial Pair 3					Trial Pair 5				
			<= 10 km/h	<= 20 km/h	<= 30 km/h	<= 40 km/h	<= 50 km/h	<= 10 km/h	<= 20 km/h	<= 30 km/h	<= 40 km/h	<= 50 km/h	<= 10 km/h	<= 20 km/h	<= 30 km/h	<= 40 km/h	<= 50 km/h
T	ON	BF	0.0	0.1	2.9	93.4	99.6	0.0	1.7	8.2	77.8	98.0	-	-	-	-	-
		AF	0.0	0.3	14.5	95.6	99.7	0.0	1.5	9.5	84.7	98.5	-	-	-	-	-
		Variation	0.0	0.2	11.6	2.2	0.1	0.0	-0.2	1.3	6.9	0.5	-	-	-	-	-
	OFF	BF	0.0	2.0	49.6	99.9	100.0	0.0	3.8	39.2	99.2	99.7	-	-	-	-	-
		AF	0.0	2.6	50.1	99.7	100.0	0.0	3.2	40.9	99.2	99.8	-	-	-	-	-
		Variation	0.0	0.6	0.5	-0.2	0.0	0.0	-0.6	1.7	0.0	0.1	-	-	-	-	-
C	On	BF	0.0	2.0	16.9	73.1	98.0	0.0	0.8	7.2	80.9	99.6	-	-	-	-	-
		AF	0.0	3.0	21.4	84.5	97.6	0.0	0.4	8.0	81.5	99.4	-	-	-	-	-
		Variation	0.0	1.0	4.5	11.4	-0.4	0.0	-0.4	0.8	0.6	-0.2	-	-	-	-	-
	OFF	BF	0.0	3.7	40.8	98.8	100.0	0.0	4.0	47.9	99.1	100.0	-	-	-	-	-
		AF	0.0	3.8	41.1	98.9	100.0	0.0	4.7	52.0	99.2	100.0	-	-	-	-	-
		Variation	0.0	0.1	0.3	0.1	0.0	0.0	0.7	4.1	0.1	0.0	-	-	-	-	-
Controlled D		**ON**	**0.0**	**-0.8**	**7.1**	**-9.2**	**0.5**	**0.0**	**0.2**	**0.5**	**6.3**	**0.7**	**-**	**-**	**-**	**-**	**-**
		OFF	**0.0**	**0.5**	**0.2**	**-0.3**	**0.0**	**0.0**	**-1.3**	**-2.4**	**-0.1**	**0.1**	**-**	**-**	**-**	**-**	**-**

[1] Site Type: Treatment (T) / Control (T)

[2] Sign status 'ON' indicates 'silent' activations for treatment sites in the before period / 'virtual' activations for control sites at any period

[3] Trial Period: Before (BF) / After (AF)

Table 4.16

Proportions of vehicles travelling at or below various speed thresholds in **proximity** to the intersection control line – Trial sites with 100km/h speed limit (Pairs 2, 4, 6)

Site Type [1]	Sign Status [2]	Trial Period [3]	Trial Pair 2					Trial Pair 4					Trial Pair 6				
			<= 10 km/h	<= 20 km/h	<= 30 km/h	<= 40 km/h	<= 50 km/h	<= 10 km/h	<= 20 km/h	<= 30 km/h	<= 40 km/h	<= 50 km/h	<= 10 km/h	<= 20 km/h	<= 30 km/h	<= 40 km/h	<= 50 km/h
T	ON	BF	0.0	0.2	4.5	70.8	98.6	0.0	10.3	95.3	99.8	99.8	0.0	6.4	56.2	95.6	97.4
		AF	0.0	0.9	8.8	81.7	99.3	0.0	13.6	96.6	99.5	99.5	0.0	7.5	67.0	97.7	99.1
		Variation	0.0	0.7	4.3	10.9	0.7	0.0	3.3	1.3	-0.3	-0.3	0.0	1.1	10.8	2.1	1.7
	OFF	BF	0.0	3.0	44.4	98.3	99.9	0.0	37.3	99.7	99.9	99.9	0.0	18.2	91.3	99.4	99.7
		AF	0.0	3.0	43.7	98.3	100.0	0.0	45.0	99.4	99.6	99.8	0.0	18.7	92.6	99.6	99.8
		Variation	0.0	0.0	-0.7	0.0	0.1	0.0	7.7	-0.3	-0.3	-0.1	0.0	0.5	1.3	0.2	0.1
C	On	BF	0.0	6.0	60.3	97.8	99.5	0.0	13.1	95.9	100.0	100.0	0.0	84.7	98.8	99.2	99.3
		AF	0.0	7.0	62.4	97.0	98.7	0.0	7.6	96.2	100.0	100.0	0.0	85.1	97.8	98.4	98.5
		Variation	0.0	1.0	2.1	-0.8	-0.8	0.0	-5.5	0.3	0.0	0.0	0.0	0.4	-1.0	-0.8	-0.8
	OFF	BF	0.0	16.6	91.4	99.7	100.0	0.0	48.5	99.7	99.8	100.0	0.0	96.0	99.8	99.9	99.9
		AF	0.0	17.7	91.8	99.5	100.0	0.0	47.6	99.5	99.9	100.0	0.0	96.3	99.7	99.8	99.8
		Variation	0.0	1.1	0.4	-0.2	0.0	0.0	-0.9	-0.2	0.1	0.0	0.0	0.3	-0.1	-0.1	-0.1
Controlled D	**ON**		**0.0**	**-0.3**	**2.2**	**11.7**	**1.5**	**0.0**	**8.8**	**1.0**	**-0.3**	**-0.3**	**0.0**	**0.7**	**11.8**	**2.9**	**2.5**
	OFF		**0.0**	**-1.1**	**-1.1**	**0.2**	**0.1**	**0.0**	**8.6**	**-0.1**	**-0.4**	**-0.1**	**0.0**	**0.2**	**1.4**	**0.3**	**0.2**

[1] Site Type: Treatment (T) / Control (T)

[2] Sign status 'ON' indicates 'silent' activations for treatment sites in the before period / 'virtual' activations for control sites at any period

[3] Trial Period: Before (BF) / After (AF)

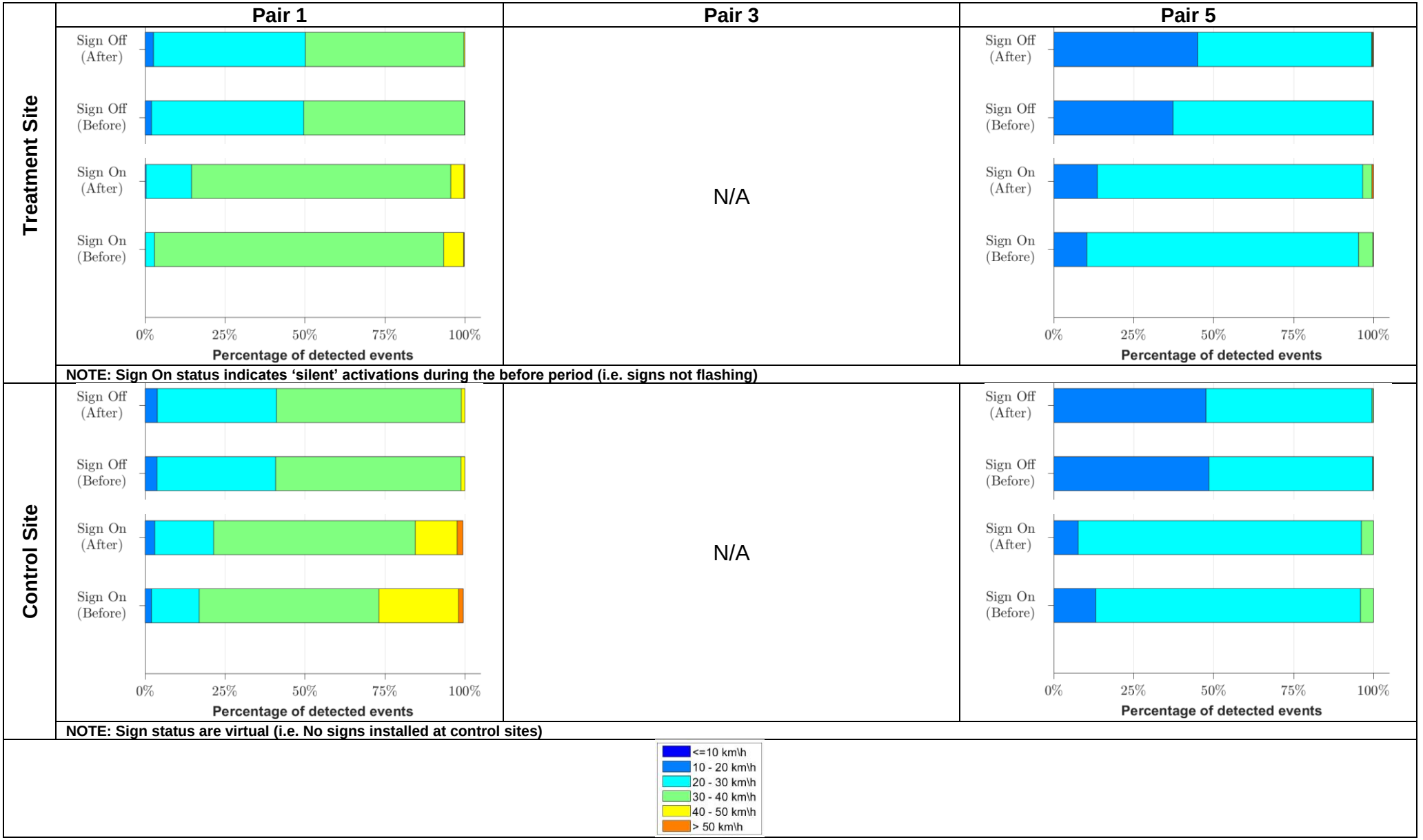


Figure 4.13
Visual breakdown of travel speeds in **proximity** to the intersection control line by incremental speed ranges –Trial sites with 80km/h speed limit (Pairs 1, 3, 5)

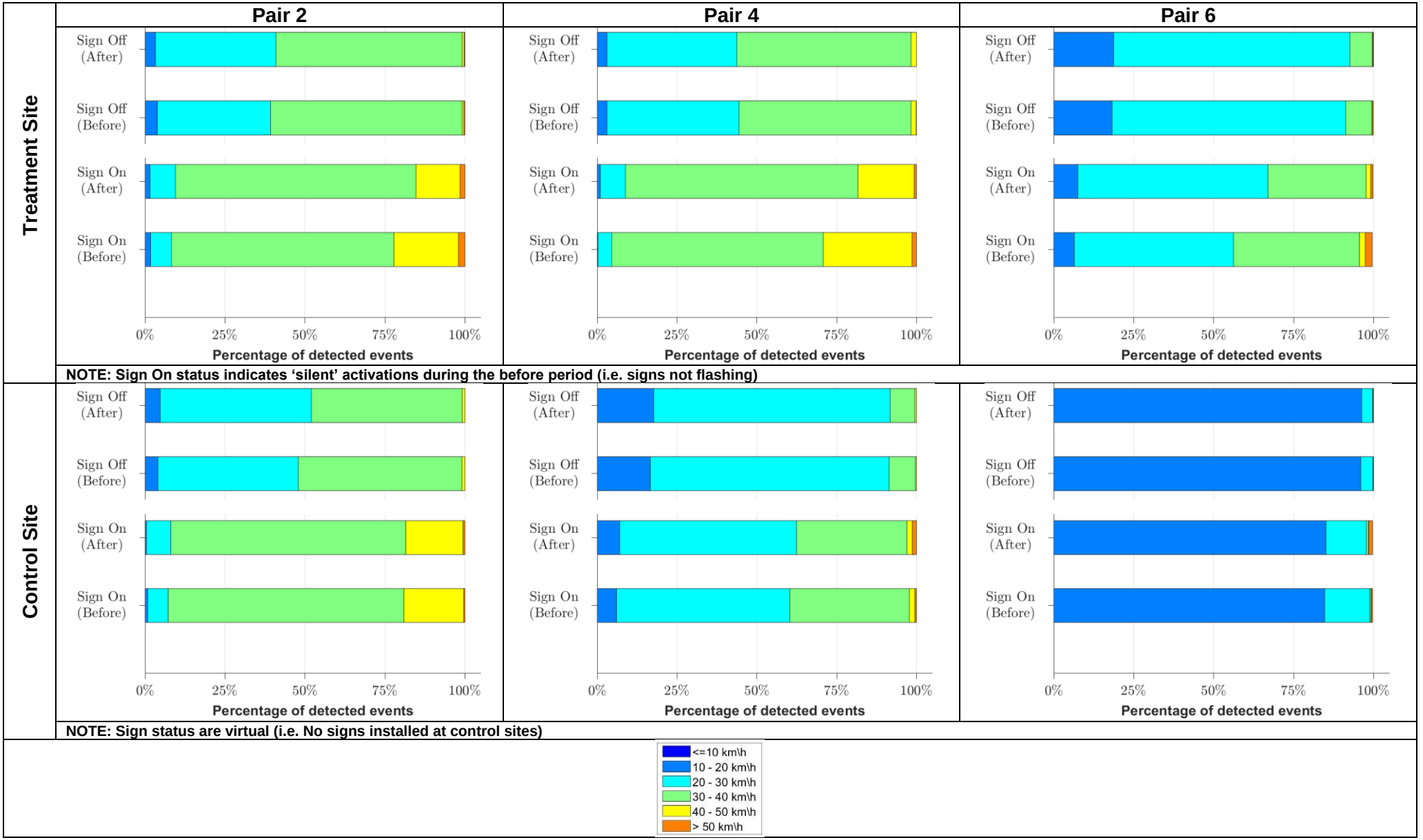


Figure 4.14
Visual breakdown of travel speeds in **proximity** to the intersection control line by incremental speed ranges –Trial sites with 100km/h speed limit (Pairs 2, 4, 6)

5. Discussion

This chapter provides a discussion of the results obtained from the trial, which includes a comparison of the predicted safety benefits of the RJAWS Lite and the full version of the RJAWS, where it is applicable. Considerations for the selection of appropriate sites and suggestions for the installation of the RJAWS Lite are also provided.

5.1. Safety benefits

This section provides a discussion of the following two objectives of the RJAWS Lite that have been assessed throughout this project:

- Major road speed reductions
- Minor road run-through prevention

It is worth noting that the before-after variation of the observed phenomena during the trial tended to be negligible or marginal at the control sites. This indicates that the variations observed after the activation of the RJAWS at the treated sites are most likely to be attributed to the presence of the treatment.

5.1.1. Major road speed advisory signs

The analysis of the data collected during the trial indicates that the RJAWS Lite has a positive effect on the travel speed (I.e., reduced speeds) of vehicles approaching the treated intersection on the major road. This section provides a discussion of various aspects pertaining to these speed effects and their potential safety benefits.

Speed reduction and compliance

After the RJAWS Lite was activated, both reductions in travel speeds and increased compliance to the posted speed limits were consistently observed along the major road of each trial site when lights were flashing on the speed advisory sign. The observed average reduction in the mean travel speed varied across each site, with changes ranging from -1.6 km/h to -9.9 km/h after accounting for the relevant control. Generally, at trial sites with a high speed limit of 100 km/h, the mean travel speed tended to reduce slightly more than at sites with a limit of 80 km/h. It is likely that drivers may be more inclined to reduce their speed when they travel at high speed compared to when they travel at lower speeds.

An equally important safety benefit that was observed during this trial is a generalised increase in the rate of compliance to the posted speed limit after intersections were treated with the RJAWS Lite. In general, the rate of compliance increased at any of the trial sites after the treatment, with increments varying between 4.2 and 20.1 percentage points after accounting for the relevant control sites.

Disrupted traffic on major road

An analysis of the speed on the major road was also conducted under the specific condition of traffic being disrupted by the presence of another vehicle entering the intersection into the far-side lane. This scenario is potentially dangerous as the vehicle will need to cross the entire major road and therefore could be exposed to a right-angle crash with traffic travelling on the major road.

Right-angle crashes tend to be characterised by a high risk of severity due to the larger amount of energy that is transferred to the impacted vehicle.

The observed speed reduction for vehicles travelling on the major road tended to be slightly smaller when their traffic flow was disrupted by another vehicle entering the intersection on the far-side lane. This trend is likely caused by the fact that a disrupting vehicle which has entered the intersection ahead of the approaching traffic may be perceived as a more predictable and therefore less risky event compared to a vehicle waiting at the control line. Generally, the movement of a vehicle that has already entered the intersection can be monitored in a predictable and therefore low-risk manner. Conversely, uncertainty tends to arise when a vehicle is waiting at the control line due to a potential unexpected entering manoeuvre at the last second caused by an incorrect decision or gap misjudgement by the driver. Given a generally controlled risk when a vehicle entered the intersection ahead of approaching traffic on the major road, the slightly lower speed reductions in that scenario does not appear to be a particularly concerning issue. Indeed, the larger speed reductions that were observed for the general scenario appear to indicate that the RJAWS Lite can be more effective under conditions where a higher level of uncertainty and risk of crash may arise.

Speed calming effect

In general, RJAWS Lite appears to induce a speed moderating effect on vehicles approaching a treated intersection on the major road. Indeed, after the RJAWS Lite was activated a marginal speed reduction was consistently observed across all trial sites, including when major road speed advisory signs were not flashing. This behaviour suggests that the presence of the RJAWS Lite signage as well as potential previous experience of approaching the intersection when lights were flashing may educate motorists about the importance of moderating speed while transiting through intersections on high-speed rural roads. A confirmation of the speed calming effect of RJAWS Lite is the noticeable increase in the proportion of vehicles that were observed to travel at speeds below the posted speed limit on the major road (by up to 20 km) when lights on the advisory signage were flashing. Similar trends were also observed for the full version of the RJAWS system, therefore further confirming the comparable benefits that can be obtained using the proposed RJAWS lite design.

Predicted reduction in risk of casualty crashes

Overall, the observed reduction in travel speed in combination with the speed calming effect when vehicles were transiting through the trial intersections has been estimated to effectively contribute to reducing the risk of being involved in a casualty crash. After accounting for the control, the average risk of casualty crash calculated based on the travel speed of each observed vehicle reduced by between 8.5 and 42.0 points percentage across the trial intersections with an 80km/h speed limit, and by between 14.1 and 31.9 points percentage across the trial intersections with an 100km/h speed limit. Note that the variability in the risk reduction across the various trial sites is directly linked with the associated mean travel speed in proximity to the intersections, which may not be necessarily directly linked with the extent of the variation in the decrease in travel speed.

5.1.2. Minor road run-through prevention

In general, after the activation of RJAWS Lite, a marginal reduction in the mean and 85thpercentile speeds was observed close to the control line across almost all the trial sites. Although this reduction in the travel speed was limited in its extent to no more than 1.2 km/h after accounting for the control sites (2.2 km/h for the 85thpercentile speed), it appears that motorists who were approaching the intersection at a risky speed have become aware of the warning message provided by the flashing give-way sign. It could be further speculated that most motorists who triggered the run-through

prevention were confident that they would be able to stop before reaching the intersection control line and therefore only marginally reduced their speed. This assumption appears to be consistent with the observed decrease in the proportion of vehicles that approached the control line at speeds within 40 km/h to 50 km/h in favour of an increase in the proportion for the speed range between 30 km/h and 40 km/h after the activation of the RJAWS Lite minor road warning sign.

Overall, motorists' recognition of the warning message delivered by the RJAWS Lite minor road sign can be considered an important step forward in reducing the risk of unintentional run-through events as it contributes to raise awareness of a potentially dangerous scenario. Nonetheless, additional detailed investigation of motorists' driving behaviour and reactions is required to confirm this hypothesis, including collection of feedback through direct interviews or surveys.

5.2. Comparison between RJAWS Lite and full RJAWS

The summary in Tables 5.1 and 5.2 provides a side-by-side comparison of the outcomes from the investigation conducted during this trial of the RJAWS Lite and the corresponding results reported in a previous trial of the full version of the RJAWS in South Australia. The comparison covers the before-after variation of the following three major outcome measures investigated in proximity to the intersection during both trials (when signs are illuminated/flashing):

- Travel speed on major road
- Risk of casualty crashes
- Compliance to advisory speed/reduced speed limit

Table 5.1
Summary of safety benefits for RJAWS Lite and the full version of RJAWS – Sites with default speed limit of 80 km/h

Before-After Changes [2]	RJAWS Lite [1]				RJAWS [1]			
	Site A1	*Site A3*	*Site A5*	*AVERAGE*	*Site B1*	*Site B2*	*Site B3*	*AVERAGE*
Mean speed variation (Sign ON) (km/h)	-6.9	-1.6	-8.4	**-5.6**	-15.0	-11.3	-13.1	**-13.1**
Risk Variation (Sign ON) [3] (%)	-42.0	-8.5	-32.0	**-27.5**	-45.0	-42.0	-50.0	**-45.7**
Variation in vehicles travelling <= 50 [4] km/h (points %)	0.5	0.0	1.2	**0.6**	31.2	22.3	20.5	**24.7**
Variation in vehicles travelling <= 80 [5] km/h (points %)	14.0	4.2	20.1	**12.8**	9.5	9.2	15.2	**11.3**
Variation in vehicles travelling > 80 [5] km/h (points %)	-14.0	-4.2	-20.1	**-12.8**	-9.5	-9.2	-15.2	**-11.3**

[1] Systems trialled at different sites and periods
[2] Evaluation of full RJAWS conducted without control sites
[3] Speed and risk during before period not assessed by sign status in the evaluation of the full RJAWS
[4] Advisory Speed/Reduced Speed Limit
[5] Default Speed Limit on major road

Table 5.2
Summary of safety benefits for RJAWS Lite and the full version of RJAWS – Sites with default speed limit of 100 km/h

Before-After Changes [2]	RJAWS Lite [1]				RJAWS [1]	
	Site A2	*Site A4*	*Site A6*	*AVERAGE*	*Site B4*	*AVERAGE*
Mean speed variation (Sign ON) (km/h)	-8.3	-9.9	-4.9	**-7.7**	-22.1	**-22.1**
Risk Variation (Sign ON) [3] (%)	-29.0	-31.9	-14.1	**-25.0**	-64.5	**-64.5**
Variation in vehicles travelling <= 70 [4] km/h (points %)	7.9	-0.1	1.5	**3.1**	61.9	**61.9**
Variation in vehicles travelling <= 100 [5] km/h (points %)	7.4	5.2	8.2	**6.9**	27.2	**27.2**
Variation in vehicles travelling > 100 [5] km/h (points %)	-7.4	-5.2	-8.2	**-6.9**	-27.2	**-27.2**

[1] Systems trialled at different sites and periods
[2] Evaluation of full RJAWS conducted without control sites
[3] Speed and risk during before period not assessed by sign status in the evaluation of the full RJAWS
[4] Advisory Speed/Reduced Speed Limit
[5] Default Speed Limit on major road

5.2.1. Speed Variation (Sign ON)

Speed reductions observed across the trial sites of the RJAWS Lite were lower than what was reported for the full version of the RJAWS. On average, the mean travel speed for roads with a posted speed limit of 80 km/h and 100 km/h reduced by 5.6 km/h and 7.7 km/h, respectively (as opposed to reported average reductions of 13.1 km/h and 22.1 km/h for the full RJAWS). Similar to what was reported for the full RJAWS, the average speed reduction associated with RJAWS Lite was greater for roads with a default speed limit of 100 km/h than for roads with a limit of 80 km/h.

5.2.2. Compliance to advisory speed / reduced speed limit

The average proportion of vehicles travelling at or below the advised travel speed only marginally increased after installation of the RJAWS Lite signs on the major road, while a substantial increase was reported for the full version of the RJAWS. The considerable increase in the compliance to the reduced speed limit reported after the installation of the full version of the RJAWS is a direct consequence of the mandatory nature of the signage for this type of system. Additionally, compliance with the advised speed was found to be lower on roads with a default speed limit of 100 km/h than for roads with a limit of 80 km/h in the case of the RJAWS Lite, while, for the full version of the RJAWS, the observed increase in the compliance to the reduced speed limit was larger on the high-speed road. Although these differences in outcomes were observed, a key finding is that icompliance to the posted speed limit increased in both speed environments.

The proportion of vehicles travelling at or below the default speed limit increased noticeably after the activation of the RJAWS Lite, which consequently means that the RJAWS Lite appears capable of lowering the proportion of vehicles that are speeding, although also in this case to a lesser degree than the full version of the RJAWS.

5.2.3. Risk of casualty crashes in proximity to intersection

Consistent with the smaller reductions in the mean travel speed observed for the RJAWS Lite, the corresponding evaluated reductions in the risk of casualty crashes were also smaller than for the full version of the RJAWS. This is particularly evident for intersections with a high default speed limit of 100 km/h. However, it must be noted that the risk for the full RJAWS system was evaluated based on results observed at a single intersection, while the RJAWS Lite was trialled at a larger sample of three high-speed intersections sites.

5.3. Future improvements

The current advisory signage along the major road consists of a large billboard-style sign that comprises two separate signs, for which the advisory sign requires reading the additional text ‘when lights flashing’. Additionally, the warning flashing lights are located on the top edge, making them physically separate from the advisory sign, and therefore potentially resulting in information and warning being disconnected from each other. A smaller and more intuitive design of the RJAWS Lite major road signs may potentially improve the delivery of the advisory speed message when lights are flashing and therefore contribute to improve both compliance and the safety effectiveness of RJAWS Lite. Further research would be needed to identify suitable improved designs and investigate their effectiveness. Beside potentially improving safety benefits, a streamlined major road signage design will also provide the following additional logistical and economic benefits:

- Reduce costs and time associated with both construction and installation of smaller signage (e.g., installed on a single pole, easier and quicker installation)
- Allow for installation at a larger number of sites due to a less restrictive lateral distance requirement for the installation of smaller signage on the side of the road

Another suggested feature that may improve public confidence and compliance with the advisory speed would be an added capability for the RJAWS Lite to detect when the vehicle on the minor road that armed the system has cleared the control line and entered the intersection. This additional capability would allow RJAWS Lite to provide its context-based warning to the major road traffic with

better accuracy than with the current design (i.e., it would avoid raising a warning for periods that are either too short or too long).

5.4. Suitability considerations

Part of the purpose of this trial was to understand the suitability of RJAWS Lite as a treatment for intersections along high-speed regional and remote roads. A range of factors were considered during the trial and, by using the experienced gained in designing, developing, installing and operating RJAWS Lite. A list of suitability considerations that have been developed is provided in Table 5.3. These considerations include factors that were encountered during the trial and are therefore unlikely to be exhaustive. However, they provide a reasonable first iteration of indicators of what factors need to be considered when assessing the suitability of RJAWS Lite as a potential treatment.

Table 5.3
Factors pertaining to the suitability of RJAWS Lite as a potential treatment

Factor	Suitable environment	Notes
Communication	Locations with suitable mobile network coverage	RJAWS Lite has been trialled using mobile network communication. Note that communication over different networks, such as the cellular 4G, NB-IoT or LTE-M networks, may affect the choice of suitable locations.
Traffic volumes	Low to moderate traffic volumes	Substantially high traffic volumes on the minor road may inhibit the effectiveness of RJAWS Lite; too many activations of the major road speed advisory flashing lights may make their dynamic nature redundant. In this case, other treatments or static reduced speed advisory/speed limit signs on approach to the intersection may be economically justified. Very low minor road traffic volumes may also make activation a rare event, which could lead some drivers to misunderstand the purpose of the treatment. RJAWS Lite is not intended to be installed at intersections with very low traffic volumes, where the safety benefit of the treatment may be substantially outweighed by its economic cost; or at intersections with very high traffic volumes, where higher cost treatments may be economically justified by their greater safety benefits.
Roadside environment	Non-built up roadside environments	RJAWS Lite has been trialled on roads with limited roadside access, no pedestrian facilities and little infrastructure (such as lighting and overhead power utilities). Use within built up roadside environments has not been tested and the limitations of such applications are not understood.
Intersection type	3-leg and 4-leg intersections	RJAWS Lite has been trialled at three-leg intersections and has, outside of this trial, been installed at a four-leg intersection. Use at intersections with more than four legs has not been tested and the limitations of such applications are not understood.
Intersection control	Stop-controlled, give way-controlled and non-controlled intersections	RJAWS Lite has been trialled at give-way controlled intersections and, outside of this trial, at a stop-controlled intersection. Its use at non-controlled (3-leg) intersections is possible, though installation of the minor road run-through prevention system requires the use of a Stop or Give Way control sign. RJAWS Lite is not intended to be used at intersections with signalisation or roundabout control.
Intersection channelisation	No/limited channelisation	RJAWS Lite has been trialled at intersections with no or limited channelisation. Though plausible, its use at intersections with substantial channelisation has not been tested.
Intersection geometry	Few limitations	RJAWS Lite has been trialled at locations with acute/obtuse and perpendicular intersection geometries. Note that some intersection geometries, such as that of Treatment Site 4 in this trial, may require an adjusted design.

Table 5.3
Factors pertaining to the suitability of RJAWS Lite as a potential treatment [continued]

Approach geometry	Straight or with minor to moderate curvature	RJAWS Lite has been tested at intersections where the approach roads are either straight or have minor to moderate horizontal and vertical curvature. The extent of curvature which can be facilitated depends on the ability of the vehicle detection radars to detect vehicles at an appropriate range. Use of other vehicle detection equipment may change these requirements, though this has not been tested.
Number of lanes	2-lane/2-way on all approach roads	RJAWS Lite has been trialled on two-lane/two-way roads. RJAWS Lite was not intended for use on multi-lane roads and modification of the concept is likely to be required to facilitate its use on such roads.
Auxiliary lanes	Auxiliary turning lanes on the major or minor road may be present	RJAWS Lite has been trialled at intersections with auxiliary right turn and left turn lanes on the major road. While it has not been trialled at intersections with auxiliary turn lanes on the minor road, this is unlikely to impede its use.
Speed limit zone	High speed limit zones	RJAWS Lite has been trialled in both 80 km/h and 100 km/h speed limit zones. RJAWS Lite is not intended for use in low speed limit zones or with substantially restricted speeds, due to the limited effect it is likely to induce in such locations.
Overhead vegetation	Low levels of foliage	RJAWS Lite has been trialled at locations with low and high levels of foliage. Its use at locations with high levels of foliage can result in lower reliability, due to premature depletion of the batteries and the inability to recharge them during inclement weather conditions or shorter winter days. Note that tolerance to foliage will depend on several factors such as the power consumption of the system, both due to background consumption (e.g. radar and communication systems) and dynamic consumption (e.g. flashing lights); capacity of the batteries; and wattage of the solar panels. Note that use of non-solar power sources may facilitate installation at high foliage locations, though this has not been tested.
Weather	All weather conditions	RJAWS Lite has been trialled during both fine and inclement weather conditions. The main limitation during inclement weather conditions is the ability to maintain electrical capacity due to the reduced charging provided by the solar panels.

5.5. Trial learnings

Communication played a major role in the successful completion of the trial. Early on it became clear that the novelty of the treatment required a level of communication that is not normally necessary for civil works. For example, CASR were present during the entirety of construction, both due to the need to translate the design drawings and to ensure construction occurred as required. This was not due to a lack of knowledge or experience on the part of the construction crew but instead due to their lack of experience with this treatment, its specific requirements, and the need to translate unusual design documents.

The need for precision because of the technology used for RJAWS Lite also led to a need for good communication and direct oversight. This was true during the design, construction and evaluation phases. During construction, for example, the alignment of the radar required a level of precision that was not usually thought about by the construction crew. With all project partners on site and working together, alignment and reliable detection of vehicles was able to be achieved with few issues. As another example, the evaluation of RJAWS Lite required the exact synchronisation of clocks between each of the traffic loggers used for the survey and between the treatment itself. This issue was previously discovered during the evaluation of RJAWS treatments in South Australia and employed to good effect here.

While none of these learnings are revolutionary, they are a testament to the requirements for successfully undertaking such a trial. There are two aspects of these learnings: that which can be learned through reading and that which can only be learned by doing. The aspects that can be learned through reading are stated here, but it also takes a degree of experience – trial and error – to fully grasp what is needed to successfully complete such an undertaking. This itself means that any trail of such a novel treatment should be undertaken with the firm assumption that the trail will not always go smoothly, changes may be needed along the way (as was the case for this trial) and, contrary to the intentions of all involved, the outcomes may not be as they were intended. Thankfully, the outcomes of this trial are considered by all involved a success. This is in large part due to the experience and professionalism, but also the flexibility and open-mindedness, of all the project partners.

5.6. Cost considerations

When initiating this project, it was estimated that the base cost of installing RJAWS Lite at a three-leg intersection would be approximately $70,000. This cost was based on discussions between CASR and the project partners, SAGE Automation (technology provider and operator) and Artcraft (infrastructure supplier and installer). This base price was estimated for the installation of RJAWS Lite itself at a site with reasonable conditions, such as the ability to use vacuum excavation for installing the poles, the ability to use a two-person traffic management team and no requirements for additional infrastructure (e.g., additional signage other than the RJAWS Lite signs).

For the trial, the costs of the first two treatment sites were used to estimate the cost of RJAWS Lite, as these costs incorporated the supply of materials and equipment in addition to labour costs. There are several conditions that come with these costs, and these are discussed below. Two costs are presented: the upper cost estimate that comprises that of the initial treatment site, which includes initial development costs for the technology, and the higher cost of infrastructure supply and installation; and the lower cost estimate that comprises the cost of technology, without initial development, and uses the lower infrastructure supply and installation cost. It should also be noted that these reflect the technology cost based on the initial design of the system, which called for the use of three solar/battery/controller systems, and not the design ultimately used for the trial, which called for four. The fourth system was required for the evaluation and so it is unlikely to be required in practice. The costs seen during the trial were:

- Lower cost: $56,316 per intersection (ex GST)
- Upper cost: $65,584 per intersection (ex GST)

In addition to the up-front cost of installation, RJAWS Lite as trialled here required network communication that comes with an ongoing fee. For this trial the cost was $24/month per unit for 5G IoT communication. For a setup utilising three communication devices (one for each major road speed advisory system and one for a combined minor road run-through prevention system and minor road radar), the ongoing annual cost would be $864.

While these costs undercut the initial estimate, the following conditions should be noted that may affect the price of another RJAWS Lite installation:

- Installation was near the Adelaide metropolitan area within a 1-hour drive (one-way) for both the technology provider and the infrastructure supplier.

- Supply and installation were undertaken using the aforementioned project partners, who undertook the work through non-competitive agreements.
- The cost of the treatment layout design drawings (developed by CASR) and CASR's time on the project are not included.
- Costs associated with the evaluation of RJAWS Lite are not included.
- Negotiations were undertaken between CASR and SAGE Automation to provide a technology solution at a price able to be covered by the grant funding.
- Infrastructure supply and installation was undertaken by Artcraft, who have a previous relationship with the in-kind contributory funder for this aspect of the project, the South Australian Department for Infrastructure and Transport.
- The cost of the technology is reflective of the specific equipment that was used, including the use of previously developed and proprietary equipment developed by SAGE Automation.
- The cost of the infrastructure supply and installation includes that for the supply and installation of one additional pole to support the separated minor road radar at the treatment site and one additional pole to support a minor road radar at the control site, which both would not be required for a future installation.
- The quotes used for the above cost estimates were received in August/September 2021.
- The infrastructure supply and installation quote contained additional items not considered to be generally necessary for RJAWS Lite installations (inclusion of new control signs, advanced warning signs and replacing signage moved or removed for the duration of the trial).

Considering the cost estimates and the conditions stated above, it is reasonable to expect treatment of a three-leg intersection similar to those used here for the trial would be possible within a budget of $70,000 ex. GST. A four-leg intersection would require an additional minor road radar and associated technology and infrastructure, which would increase the cost proportionally.

6. Conclusions

The objective of this research was to develop and evaluate a low-cost version of the RJAWS system, which has been named RJAWS Lite. The evaluation included assessing whether this novel system would be able to provide any of the similar safety benefits that have been previously reported for the full version of RJAWS. The RJAWS Lite system is comprised of two separate functionalities, (i) an advisory speed along the major approaches to the intersection and (ii) a run-through warning for vehicles approaching the intersections on the minor road at too high a speed.

Two sets of the RJAWS systems have been designed and built as part of this project, and successfully deployed and trialled throughout a total of six intersections during a period spanning almost two years. The system showed good durability and reliability throughout the entire trial, with only a handful of minor functionality issues being observed at any of the trial sites.

In general, RJAWS Lite appears to be capable of effectively reducing the risk of casualty crashes by reducing the speed of vehicles travelling along the major road during conditions when there is a risk of a potential collision with another vehicle at the intersection. The activated major road advisory speed signage of the system can induce motorists to reduce their travel speed when approaching the treated intersections along the major road. Once accounting for the control sites, the reduction in the mean speed observed in proximity to the treated intersection ranged between 1.6 km/h and 9.9 km/h, with an average reduction of 6.7 km/h across all the six trial sites. Ultimately, this average reduction in travel speed observed across the trial sites can be related to a reduction in the risk of a potentially fatal or serious injury crash of 26.2%. This average risk reduction is lower than what was previously reported in a trial of the full RJAWS system in South Australia and is a trade-off to be expected from the advisory nature of the RJAWS Lite (as opposed to the mandatory signage of the full RJAWS). Nonetheless, increased compliance with the advised speed limit of the RJAWS Lite may likely be obtained by streamlining the current large billboard-style signage on the major road using a more efficient and intuitive design in a similar fashion to the efficient electronic signage used for the full version of the RJAWS.

RJAWS Lite was less effective at moderating the speed of vehicles approaching the intersection along the minor road during the trial. Nevertheless, the minor reduction in speeds observed appears to indicate that the warning for a potential run-through is received by motorists approaching the treated intersections.

Although the RJAWS Lite provides lower safety benefits when compared to the full version of the RJAWS, the considerably lower cost associated with this lite system can provide road agencies with a more affordable treatment, which could be deployed at a larger number of critical intersections across the rural road network. Margin also exists for improving the safety benefits of RJAWS Lite by increasing compliance to the advisory speed through streamlining the current signage design. Therefore, the RJAWS Lite could be expected to provide an overall benefit-cost ratio comparable to the full RJAWS. Equally important, the lower cost of the RJAWS Lite compared to the full RJAWS, also in combination with its less restrictive implementation conditions because of the advisory nature of the signage, could make it a potentially affordable treatment for Local Government.

Overall, the evaluation conducted on the extensive data collected during the trial indicates that the RJAWS Lite can deliver substantial safety benefits albeit to a lesser degree than the full RJAWS system. Given the speed calming effect on the major approaches to the intersections and the

consequent safety benefits, RJAWS Lite can be considered to be well-aligned to the principles of a Safe System approach to reduce the potential for harm. Its installation at rural intersections characterised by a high risk of casualty crashes is expected to provide long-term safety benefits and therefore contribute to the overall strategic goal of reducing road trauma to zero by 2050. Additionally, RJAWS Lite may be also employed as an interim safety treatment before an intersection is treated with a primary safety treatment such a compact roundabout in the long term.

Expanding the RJAWS Lite installation to additional sites and conducting relevant traffic surveys will increase the robustness of the current evidence, as would potentially including evaluations at crossroad junctions. Future research activities on the RJAWS Lite include evaluating whether the use of streamlined designs for the major road signage and/or additional capability to detect vehicles waiting at the control line may improve compliance to the advised speed limit.

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Appendix A Design calculations

The following sections outline the procedure for calculating L_{min} and L_{max}.

A.1 Calculating L_{min}

L_{min} is the minimum distance that the major road speed advisory sign should be placed from the intersection. L_{min} is dependent on the rate of deceleration of the major road vehicle. The braking component equation adopted by Austroads (2021, 2023) and used for sight distance calculations is used here. The equation for calculating the braking distance is

$$L = \frac{V^2}{254(d + 0.01a)}$$

where L is the braking distance; V is the vehicle's initial speed (km/h); d is the coefficient of deceleration; and a is the longitudinal grade (%). As L is being calculated for between two points at which the vehicle is at a speed above zero (V_1 = initial speed; V_2 = target speed), the braking component of V_2 must be deducted from the braking component of V_1, such that

$$L_{min} = \frac{V_1^2 - V_2^2}{254(d + 0.01a)}$$

For this example, the following values are assumed: V_1 = 80 km/h; V_2 = 60 km/h; d = 0.15; and a = 0%.

$$L_{min} = \frac{80^2 - 60^2}{254(0.15 + 0.01 \times 0)} = 73m$$

A.2 Calculating $L_{AT\text{-}A}$ and $L_{AT\text{-}B}$

L_{AT} will generally be determined by the range of the minor road radar. L_{AT} comprises two components: an approach phase ($L_{AT\text{-}A}$) and a braking phase ($L_{AT\text{-}B}$). $L_{AT\text{-}B}$ is the critical phase and can be calculated using the same equation as used for L_{min} (see Section A.1), such that

$$L_{AT\text{-}B} = \frac{V_1^2 - V_2^2}{254 \times (d + 0.01a)} - \frac{V_2^2}{254 \times (d + 0.01a)}$$

where L is the braking distance; V_1 is the vehicle's initial speed (km/h); V_2 is the vehicle's final speed; d is the coefficient of deceleration; and a is the longitudinal grade (%).

For this example, the following values are assumed: V_1 = 80 km/h; V_2 = 20 km/h; d = 0.2; and a = 0%.

$$L_{AT\text{-}B} = \frac{80^2 - 20^2}{254 \times (0.2 + 0.01 \times 0)} = 124m$$

And hence, assuming a radar range (L_{AT}) of 130 m

$$L_{AT\text{-}A} = L_{AT} - L_{AT\text{-}B} = 130 - 124 = 6m$$

A.3 Calculating *AT*

AT is the sum of *AT-A* and *AT-B*, the respective time periods required to traverse $L_{AT\text{-}A}$ and $L_{AT\text{-}B}$. *AT-A* can be calculated using the following equation, with the assumption that the vehicle's speed while traversing $L_{AT\text{-}A}$ is constant

$$AT\text{-}A = \frac{3.6 \times L_{AT\text{-}A}}{V}$$

where *AT-A* is the time period required to traverse $L_{AT\text{-}A}$; $L_{AT\text{-}A}$ is the distance travelled before the initial point of braking; and *V* is the speed of the vehicle over the distance $L_{AT\text{-}A}$, which is assumed to be constant (km/h).

For this example, the following values are assumed: $L_{AT\text{-}A}$ = 6m (from Section A.2); and *V* = 80 km/h.

$$AT\text{-}A = \frac{3.6 \times 6}{80} = 0.3s$$

The following equation can be used to calculate *AT-T*, with the assumption that the vehicle's rate of deceleration remains constant between the initial point of braking and the intersection

$$AT\text{-}B = \frac{7.2 \times L_{AT\text{-}B}}{(V_1 + V_2)}$$

where *AT-B* is the time taken to travel from the initial point of braking to the intersection (s); $L_{AT\text{-}B}$ is the distance traversed between the initial point of braking and the intersection (the braking distance) (m); V_1 is the initial speed (km/h); and V_2 is the final speed (km/h).

For this example, the following values are assumed: $L_{AT\text{-}B}$ = 124m; V_1 = 80 km/h; and V_2 = 20 km/h.

$$AT\text{-}B = \frac{7.2 \times 124}{(80 + 20)} = 9.9s$$

AT is equal to the sum of *AT-A* and *AT-B*. For this example, *AT* = 9.9 + 0.3 = 10.2 s.

A.4 Calculating L_{DT}

L_{DT} is calculated assuming the vehicle's speed remains constant. The following equation can be used to calculate L_{DT}

$$L_{DT} = \frac{DT \times V}{3.6}$$

where L_{DT} is the distance travelled during the time *DT*; *DT* = observation time + reaction time (s); and *V* is the speed of the vehicle (km/h).

For this example, the following values are assumed: *DT* = 3 s; and *V* = 80 km/h.

$$L_{DT} = \frac{3 \times 80}{3.6} = 67m$$

A.5 Calculating *RT*

RT can be calculated using the following equation

$$RT = AT - DT$$

where *RT* is the time taken for the major road vehicle to arrive at the intersection after passing the major road speed advisory sign (s); *AT* is the time taken for the minor road vehicle to arrive at the intersection after detection by the minor road radar (s) (see Section A.3); and *DT* is the decision time (s) (see Section A.4). For this example, *RT* is calculated to be 10.2 – 3.0 = 7.2 s

A.6 Calculating L_{max}

The following equation can be used to calculate L_{max}, with the assumption that the vehicle's rate of deceleration remains constant between the initial point of deceleration and the intersection

$$L_{max} = \frac{RT \times (V_1 + V_2)}{7.2}$$

where *RT* is the time taken for the major road vehicle to arrive at the intersection after passing the major road speed advisory sign (s); V_1 is the initial speed (km/h); and V_2 is the target speed as the vehicle traverses the intersection (km/h).

For this example, the following values are assumed: *RT* = 7.2s; V_1 = 80 km/h; and V_2 = 60 km/h.

$$L_{max} = \frac{7.2 \times (80 + 60)}{7.2} = 140m$$

Once L_{max} is calculated, it is advisable to calculated the coefficient of deceleration to ensure it is within tolerable limits. This can be done using the following equation

$$d = \frac{V_1^2 - V_2^2}{254 \times L_{max}} - 0.01a$$

where *d* is the coefficient of deceleration; V_1 is the initial speed (km/h); V_2 is the target speed as the vehicle traverses the intersection (km/h); L_{max} is the distance between the major road speed advisory sign (m); and *a* is the longitudinal grade (%).

For this example, the following values are assumed: V_1 = 80 km/h; V_2 = 60 km/h; L_{max} = 88.8m; and *a* = 0%.

$$d = \frac{80^2 - 60^2}{254 \times 140} - 0.01 \times 0 = 0.08$$

A.7 Selecting a value for *L*

Once L_{min} (see Section A.1) and L_{max} (see Section A.6) have been calculated, the distance of the major road speed advisory sign from the intersection (*L*) can be selected. For the example given above, *L* can be selected between a value of 73m (L_{min}) and 140m (L_{max}).

Appendix B Factory Acceptance Tests

This appendix provides the report of the Factory Acceptance Test (FAT) conducted by SAGE Automation to verify the proper functionality of one of the two RJAWS Lite units used throughout the trial in this project. Similar testing outcomes were also obtained for the second set of RJAWS Lite units used in this trial. For sake of conciseness, only the report for one of the two sets of equipment is provided.

SAGE Automation Pty Ltd
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RJAWS – Hardware FAT Specification

Subject	RJAWS – Hardware FAT Specification – Site 12, 144		
Date	15 October 2021		
Reference	2	Rev.	A
Project	74637		
Customer	CASR		

1 System Setup & Test

1.1.1 Personnel Required

Item	Provided By	Ready
Test engineer	SAGE	OK
Vehicle driver	SAGE	OK

1.1.2 Equipment Required

Item	Provided By	Ready
RJAWS Minor Radar Device • **150W Solar Panel** • **75AH Battery** • **Battery Charger** • **Vdirect USB cable** • **Edge** • **AGD318 Radar**	SAGE	OK
RJAWS Minor Sign Activation Device • **150W Solar Panel** • **75AH Battery** • **Battery Charger** • **Vdirect USB cable** • **Edge** • **Logo**	SAGE	OK

Printed: 9 November 2021

RJAWS Major Sign Activation/Radar Device • **150W Solar Panel** • **75AH Battery** • **Battery Charger** • **Vdirect USB cable** • **Edge** • **Logo** • **AGD335 Radar** • **2x 12V Orange LED flasher wigwag**	SAGE	OK. Wigwags will be installed on site. Not included in FAT.
2x Car/Vehicle for test	SAGE	OK

2 Test Safety Plan

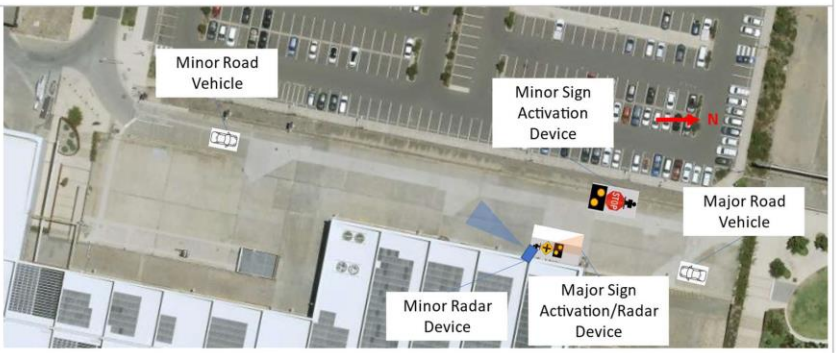
Testing of devices containing a radar will require the movement of a vehicle past the point of detection.

To ensure a safe test of this equipment, the following steps must be followed:

- Test engineer must perform a site risk assessment considering current conditions (including weather, personnel and other movements in the area) prior to moving hardware to the test site
- Ensure all test personnel and observers are wearing high-viz PPE
- Ensure traffic cones are around the testing devices
- Ensure positive 2-way communication between the driver and test engineer for the duration of the test

3 Test Specification

3.1.1

Site under test (eg: oakbank)	Mount Torrens, Flaxman Valley
Test Personnel Present (name, organisation)	Jak Collins, Jianguo Liu from SAGE Automation
Date & Time	1-2 Nov 2021
Weather conditions	Fair, 1 Nov 2021 Overcast, 2 Nov 2021
Test site layout	

3.1.2 Test Setup

Action	Expected outcome	Actual outcome	P/F/O
Confirm versions of software under test	Edge firmware versions recorded in this test sheet Software versions are consistent and current	RJAWS Minor Radar Device Edge deviceid __BT9924, BT9893___ firmware version __Edge_Buster_V4.3_21.05.5 serial no __BT9924, BT9893_ RJAWS Minor Sign Activation Device Edge deviceid _BT9922___ firmware version __Edge_Buster_V4.3_21.05.5 serial no _BT9922____ RJAWS Major Sign Activation/Radar Device Edge A deviceid ___BT9889__ firmware version _Edge_Buster_V4.3_21.05.5 serial no __BT9889____ RJAWS Major Sign Activation/Radar Device Edge B deviceid ___BT9888___ firmware version _Edge_Buster_V4.3_21.05.5 serial no __BT9888___ RJAWS Minor Radar Device treatment service version __41768dbc_____ RJAWS Minor Sign Activation Device treatment service version _ffa35e25___ RJAWS Major Sign Activation/Radar Device treatment service version _46081cd4 / f2f71895_	P
Configure 335 radar with detection gate of 5 m.	New configuration is confirmed from radar in the terminal.		P
Access Edge device via remote SSH.	Edge can be remote accessed via SSH.	Edge accessed? (Yes /No) Yes to all Edges Date: _1/11/2021_	P

Confirm the commit SHA of the device treatment code is consistent with current git repo.	The SHA of the device treatment on Edge is the same as the current git repo.	Major road radar: Edge SHA: __f2f71895___ Git SHA: __f2f71895_____ Major road sign: Edge SHA: __46081cd4____ Git SHA: __46081cd4_____ Minor road radar: Edge SHA: __41768dbc___ Git SHA: __41768dbc____ Minor road sign: Edge SHA: __ffa35e25_____ Git SHA: __ffa35e25_____	
Check the logrotate status	Logrotate is running in pm2 for all devices	Treatment: Minor Radar, Minor Sign, Major A Radar/Sign Control: Minor Radar	P
Make sure each Edge is using appropriate testing configuration and certificate.		Treatment: Minor Radar, Minor Sign, Major A Radar/Sign Control: Minor Radar	P
Set up devices to the positions indicated in the layout.		Treatment: Minor Radar, Minor Sign, Major A Radar/Sign Control: Minor Radar	P

3.1.3 Test of minor site radar (AGD 318) detection to MQTT (rjaws-minor-road-radar)

This test confirms that the ability for the AGD318 radar to detect approaching vehicles, and SAGE Edge to process radar messages and publish MQTT messages.

Action	Expected outcome	Actual outcome	P/F/O
Power up RJAWS Minor Radar Device, and check the health status from Dashboard. https://smartcity.sageautomation.com/d /OHXQkxD7z/edge-health-stats-by-deviceid?orgId=1	The dashboard indicates the last update happened a less than 10 minutes ago.	ok	P
Record the configuration parameters in testing-config.js file.	measureZoneLength: 40 Gates: [20, 30, 40, 50]	measureZoneLength: 40 Gates: [20, 30, 40, 50]	P
Subscribe “json/project/74637/mount-torrens/minor/a/radar /status” topic from MQTTX on a laptop.	N/A	N/A	N/A
Drive a vehicle through 318 radar detection zone.	MQTTX receives radar messages {"uuid": "77d3a2d6-957f-4a15-a5ed-50b3e84e7363", "direction": "A", "speed": 35, "distance": 120 }, ...	OK	P
Confirm that speeds are consistent with the speed reported by the vehicle driver moving through the zones	Speeds are consistent within +-10km/h	OK	P
Unsubscribe “json/project/74637/mount-torrens/minor/a/radar/status” topic.	N/A	N/A	N/A

3.1.4 Test of major site radar (AGD 335) detection to MQTT (rjaws-major-road-radar)

This test confirms the ability for the AGD335 radar to detect approaching vehicles, and SAGE Edge to process radar messages and publish MQTT messages.

Action	Expected outcome	Actual outcome	P/F/O
Power up RJAWS Major Radar Device, and check the health status from Dashboard. https://smartcity.sageautomation.com/d /OHXQkxD7z/edge-health-stats-by-deviceid?orgId=1	The dashboard indicates the last update happened a less than 10 minutes ago.	BT9889, OK BT9888, OK	P
Record the configuration parameters in config.js file.	site: {road: "major", end: "b", intersection: "mount-torrens"}, "testMode": false	site: {road: "major", end: "b", intersection: "mount-torrens"}, "testMode": false	P
Subscribe “json/project/74637/ mount-torrens/major/a/radar/status” topic.	N/A	N/A	N/A
Drive a vehicle through 335 radar detection zone.	MQTTX receives radar messages {"speed": 35, "gateCounted": true}	OK	P
Confirm speed reported correlates with the speed reported by the driver.	Speed is with +- 10km/h	OK	P
Unsubscribe “json/project/74637/ mount-torrens/major/a/radar/status” topic.	N/A	N/A	N/A

3.1.5 Test of minor site MQTT to sign activation (rjaws-minor-road-sign)

This test demonstrates that an approaching vehicle with a speed over the speed limit (60km/h) will activate the sign, and that a vehicle with a speed below the speed limit will NOT activate the sign.

Action	Expected outcome	Actual outcome	P/F/O
Power up RJAWS Major Radar Device, and check the health status from Dashboard. https://smartcity.sageautomation.com/d /OHXQkxD7z/edge-health-stats-by-deviceid?orgId=1	The dashboard indicates the last update happened a less than 10 minutes ago.	BT9922	P
Record the configuration parameters in config.js file.	minorRoadLightsDistance: 30, minorRoadSpeedThreshold: 30	minorRoadLightsDistance: 30 minorRoadSpeedThreshold: 30	P
Subscribe "json/project/74637/mount-torrens/ minor/a/sign/status" topic in MQTTX.	N/A	N/A	N/A
Test with MQTT message. Publish {"uuid": "77d3a2d6-957f-4a15-a5ed-50b3e84e7363", "direction": "A", "speed": 78, "distance": 50) to json/project/74637/ mount-torrens/minor/a/radar/status	Sign is activated for 10 seconds	OK	P
Test with MQTT message. Publish {"uuid": "77d3a2d6-957f-4a15-a5ed-50b3e84e7363", "direction": "A", "speed": 50, "distance": 50) to json/project/74637/ mount-torrens/minor /a/radar/status	Sign is not activated	OK	P
Test with MQTT message. Publish {"uuid": "77d3a2d6-957f-4a15-a5ed-50b3e84e7363", "direction": "A", "speed": 98, "distance": 50) to	Sign is activated for 10 seconds then reactivated for a total sign on time of 15 seconds	Sign is activated for 15 seconds in total.	P

json/project/74637/ mount-torrens/minor/a/radar/status then after 5 seconds, send another message {"uuid": "77d3a2d6-957f-4a15-a5ed-50b3e84e7363", "direction": "A", "speed": 77, "distance": 50 } to json/project/74637/ mount-torrens/minor/a/radar/status			
Unsubscribe “json/project/74637/mount-torrens/minor/a/sign/status” topic in MQTTX.	N/A	N/A	N/A

3.1.6 Test of major site MQTT to sign activation (rjaws-major-road-sign)

This test demonstrates that within 30 seconds of 335 radar detection on the major road, a minor road vehicle detection will trigger the major road sign. And the major road sign stays off in other scenarios.

Action	Expected outcome	Actual outcome	P/F/O
Record the configuration parameters in config.js file.	site: {road: "major", end: "a", intersection: "mount-torrens"}	ok	P
Subscribe “json/project/74637/mount-torrens/major/a/sign/status” topic in MQTTX.	N/A	N/A	N/A
Test with MQTT message. 1. Send “{"uuid":"79af3885-c861-4c6c-883e-ac39b58ab370","direction":"A","speed":65, "distance":80}” to topic “json/project/74637/mount-torrens/minor/a/radar/status” via MQTTX; 2. Within 15 seconds of Step 1, send “{"speed":85.5}” to topic “json/project/74637/mount-torrens/major/a/radar/status” via MQTTX.	The sign on major road is turned on for 10 seconds and off. MQTTX receives light ON message like {"active": true}, followed by light OFF message {"active": false}	The sign on major road is turned on for 10 seconds and off. MQTT messages are correct. BT9889 BT9888	P
Test with MQTT message. 1. Send “{"uuid":"79af3885-c861-4c6c-883e-ac39b58ab370","direction":"A","speed":65, "distance":80}” to topic “json/project/74637/mount-torrens/minor/a/radar/status” via MQTTX; 2. After 35 seconds of Step 1, send “{"speed":85.5}” to topic “json/project/74637/mount-torrens/major/a/radar/status” via MQTTX.	The sign on major road stays off.	The sign on major road stays off. BT9889 BT9888	P
Test with MQTT message. Send “{"speed":98.5}” to topic “json/project/74637/mount-torrens/major/a/radar/status” via MQTTX.	The sign on major road stays off.	The sign on major road stays off. BT9889 BT9888	P
Test with MQTT message. Send “{"uuid":"79af3885-c861-4c6c-883e-ac39b58ab370","direction":"A","speed":87, "distance":80}” to topic “json/project/74637/mount-torrens/minor/a/radar/status” via MQTTX.	The sign on major road stays off.	The sign on major road stays off. BT9889 BT9888	P

Test with MQTT message. 1. Send “{"speed":41.5}” to topic “json/project/74637/mount-torrens/major/ a/radar/status” via MQTTX. 2. Within 15 seconds of Step 1, send “{"uuid":"79af3885-c861-4c6c-883e-ac39b58ab370","direction":"A","speed":25, "distance":80}” to topic “json/project/74637/mount-torrens/minor/ a/radar/status” via MQTTX.	The sign on major road stays off.	The sign on major road stays off. BT9889 BT9888	P
Unsubscribe “json/project/74637/mount-torrens/ major/a/sign/status” topic in MQTTX.	N/A	N/A	N/A

3.1.7 Test of radar detections on dashboard

This test demonstrates the dashboard can present correct vehicle count and speed.

Action	Expected outcome	Actual outcome	P/F/O
Test minor 318 radar. send “{"uuid":"79af3885-c861-4c6c-883e-ac39b58ab370","direction":"A","speed":45, "distance":30}” to topic “json/project/74637/mount-torrens/minor/ a/radar/status” via MQTTX. send “{"uuid":"79af3885-c861-4c6c-883e-ac39b58ab370","direction":"A","speed":35, "distance":30}” to topic “json/project/74637/mount-torrens/minor/ a/radar/status” via MQTTX. send “{"uuid":"79af3885-c861-4c6c-883e-ac39b58ab370","direction":"A","speed":25, "distance":30}” to topic “json/project/74637/mount-torrens/minor/ a/radar/status” via MQTTX.	The dashboard will show corresponding detections in a heatmap.	The dashboard presents the corresponding detections.	P
Test major 335 radar. Send “{"speed":42}” to topic “json/project/74637/mount-torrens/major/ a/radar/status” via MQTTX. Send “{"speed":32}” to topic “json/project/74637/mount-torrens/major/ a/radar/status” via MQTTX. Send “{"speed":22}” to topic “json/project/74637/mount-torrens/major/ a/radar/status” via MQTTX.	The dashboard will show corresponding detections in a heatmap.	The dashboard presents the corresponding detections.	P

3.1.8 Test of sign activations on dashboard

This test demonstrates the dashboard can present correct vehicle count and speed.

Action	Expected outcome	Actual outcome	P/F/O
Test minor 318 radar. Send "{"uuid":"79af3885-c861-4c6c-883e-ac39b58ab370","direction":"A","speed":45, "distance":30}" to topic "json/project/74637/mount-torrens/minor/ a/radar/status" via MQTTX for 3 times with interval over 20 seconds.	The dashboard will show that the minor road sign has been activated for 3 times.	The dashboard shows the corresponding minor road sign activations.	P
Repeat the following steps for 3 times: 1. Send "{"uuid":"79af3885-c861-4c6c-883e-ac39b58ab370","direction":"A","speed":25, "distance":30}" to topic "json/project/74637/mount-torrens/minor/ a/radar/status" via MQTTX; 2. Within 15 seconds of Step 1, send "{"speed":41.5}" to topic "json/project/74637/mount-torrens/major/ a/radar/status" via MQTTX.	The dashboard will show that the major road sign has been activated for 3 times.	The dashboard shows the corresponding major road sign activations.	P

3.1.9 Test of system health stats to dashboard

This test demonstrates the dashboard can present correct system health stats.

Action	Expected outcome	Actual outcome	P/F/O
Check the system health stats in the dashboard after a device is powered on.	The health stats have been updated on the dashboard.	Major road radar/sign: Deviceid: BT9889, BT9888 Yes Minor road radar: Deviceid: BT9924, BT9893 Yes Minor road sign: Deviceid: BT9922	P

		Yes	

3.1.10Test of solar stats to dashboard

This test demonstrates the dashboard can present correct solar stats.

Action	Expected outcome	Actual outcome	P/F/O
Check the solar stats in the dashboard after a device is powered on.	The solar stats have been updated on the dashboard.	Major road radar/sign: Deviceid: BT9889, BT9888 Yes Minor road radar: Deviceid: BT9924, BT9893 Yes Minor road sign: Deviceid: BT9922 Yes	P

3.1.11Test of solar/battery correct charging behaviour

This test demonstrates the charging behaviour is in accordance with the configuration.

Action	Expected outcome	Actual outcome	P/F/O
Place the devices in the sun for one day. Power on the devices. Check solar/battery stats in the dashboard.	The dashboard indicates that solar charging started when the battery capacity was below the threshold.	Major road radar/sign: Deviceid: BT9889, BT9888 Yes Minor road radar: Deviceid: BT9924, BT9893 Yes Minor road sign: Deviceid: BT9922 Yes	P

3.1.12Test of system restart/recovery

This test demonstrates the system will function as expected after restart/recovery.

Action	Expected outcome	Actual outcome	P/F/O
Unplug the fuse. Wait for 5 minutes. And plug the fuse.	The health stats have been updated on the dashboard after the restart. All the pm2 services are online.	Major road radar/sign: Deviceid: BT9889, BT9888 Yes Minor road radar: Deviceid: BT9924, BT9893 Yes Minor road sign: Deviceid: BT9922 Yes	P

Appendix C Site diagrams

This appendix contains the treatment layout design drawings used to install and operate RJAWS Lite during this trial.

C.1 Treatment Site 1

RJAWS Lite Site 105—Site design for before and after trial surveys (treatment site)

All locations and distances are approximate. Locations and distances shall be determined on site before commencement of any works.

All dates are approximate. Dates shall be confirmed before commencement of any works.

All drawings shall be read in conjunction with the notes provided on this page.

NOTES:

(1) Existing W2-4(L) sign and post.

(2) Major road activated system (northbound lane) (**Notes 15, 16 and 20**).

(3) Vehicle location at which major road activated system flashing lights (northbound lane) are activated (**Note 20**).

(4) Existing duplicate W2-4(R) sign and post.

(5) Existing W2-4(R) sign and post.

(6) Major road activated system (southbound lane) (**Notes 15, 16 and 20**). **NOTE POSSIBLE BURIED SERVICES.**

(7) Vehicle location at which major road activated system flashing lights (southbound lane) are activated (**Note 20**).

(8) Radar cone (approximately 7 degrees*).

(9) Give way control line (**Note 15**).

(10) Minor road activated system sign (eastbound lane) (**Notes 15, 17 and 21**). **NOTE POSSIBLE BURIED SERVICES.**

(11) Minor road activated system radar (eastbound lane) (**Notes 15, 18, 20, 21 and 22**). **NOTE POSSIBLE BURIED SERVICES.**

(12) Existing W2-3 sign and post — to be replaced by W3-2 sign (**Note 15**).

(13) Vehicle location at which major road activated system "wig wag" flashing lights (southbound and northbound lanes) are activated (**Note 20**).

(14) Vehicle location at which minor road activated system R1-2 flashing lights (westbound lane) are activated (**Note 21**).

(15) Details for new infrastructure installed as part of this trial:

Item	Latitude	Longitude	Installation details
Major road activated system (southbound lane) (**Note 2**)	-34.981476	138.898269	To be installed before 22/10/21. Covering film to be placed over front of TES19975 sign—to be removed 6 Dec 2021.
Major road activated system (northbound lane) (**Note 6**)	-34.980230	138.898034	To be installed before 22/10/21. Covering film to be placed over front of TES19975 sign—to be removed 6 Dec 2021.
Give way line (eastbound lane) (**Note 9**)	As instructed by DIT		To be installed before 22/10/21.
Minor road activated system sign (eastbound lane) (**Note 10**)	-34.980814	138.897932	To be installed before 22/10/21.
Minor road activated system radar (eastbound lane) (**Note 11**)	-34.980904	138.898238	To be installed before 22/10/21.
Give way ahead (W3-2) sign and post (eastbound lane) (**Note 12**)	As instructed by DIT		To be installed before 22/10/21.

(16) Example of major road activated system with TES19975(R) sign mounted to pole.

(17) Example of minor road activated sign with activated R1-2 sign mounted to pole.

(18) Example of minor road activated radar.

(19) Design drawing for TES19975 sign.

(20) **Major road activated system "wig wag" flashing light activation:** When the minor road activated system radar (**Note 11**) detects a vehicle on the minor road at the far detection location (**Note 13**), the "wig wag" flashing lights (**Notes 2 and 6**) are armed for 30 seconds. When the "wig wag" flashing lights are armed and a major road activated system radar (**Notes 2 and 6**) detects a major road vehicle at the detection location (**Notes 3 and 7**, respectively), the respective "wig wag" flashing lights (**Notes 2 and 6**) are activated for a period of 10 seconds. When the "wig wag" flashing lights are already active and another detection event activates the flashing lights, the flashing lights will remain active for a further 10 seconds.

(21) **Minor road activated system R1-2 flashing light activation:** When the minor road activated system radar (**Note 11**) detects a vehicle on the minor road at the near detection location (**Note 14**) at a speed above 60 km/h, the R1-2 flashing lights (**Note 10**) are activated for a period of 10 seconds. When the R1-2 flashing lights are already active and another detection event activates the flashing lights, the flashing lights will remain active for a further 10 seconds.

(22) Continuous vehicle speeds to be logged by the minor road activated system radar (**Note 11**) while a minor road vehicle remains within the radar line-of-sight.

As specified in AGD 318 Traffic Control Radar Product Manual.

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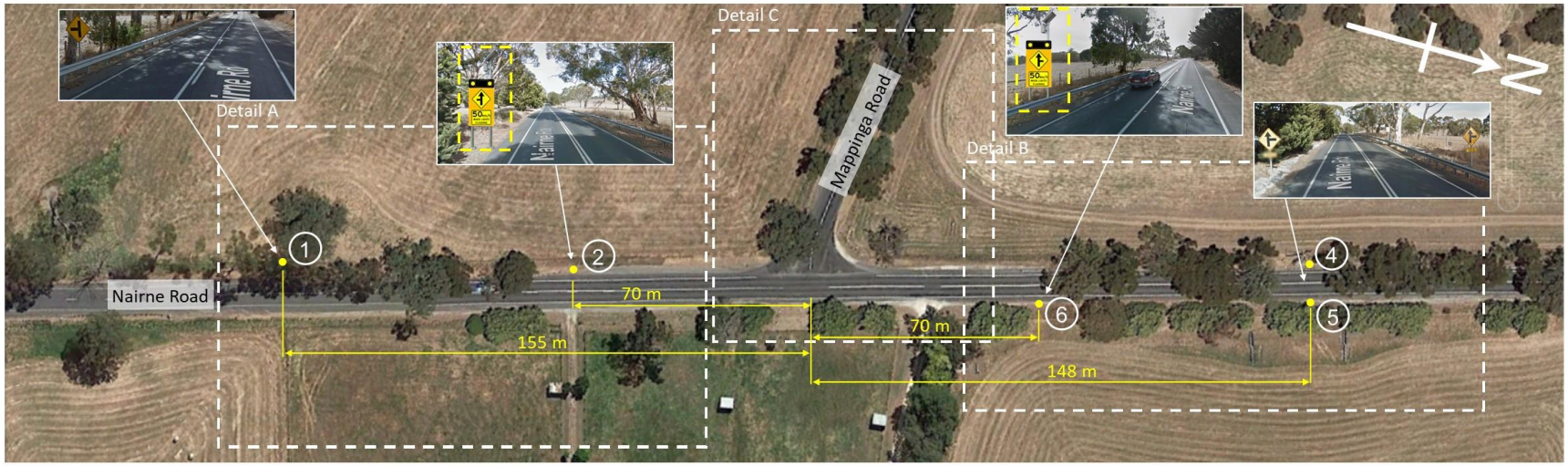

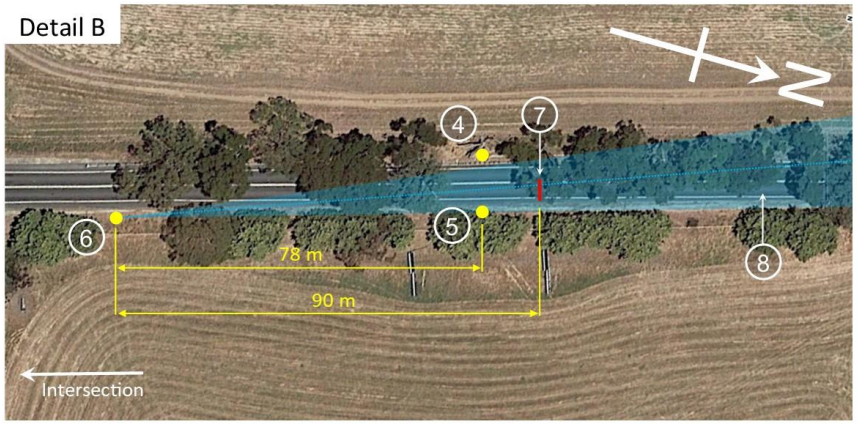

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16

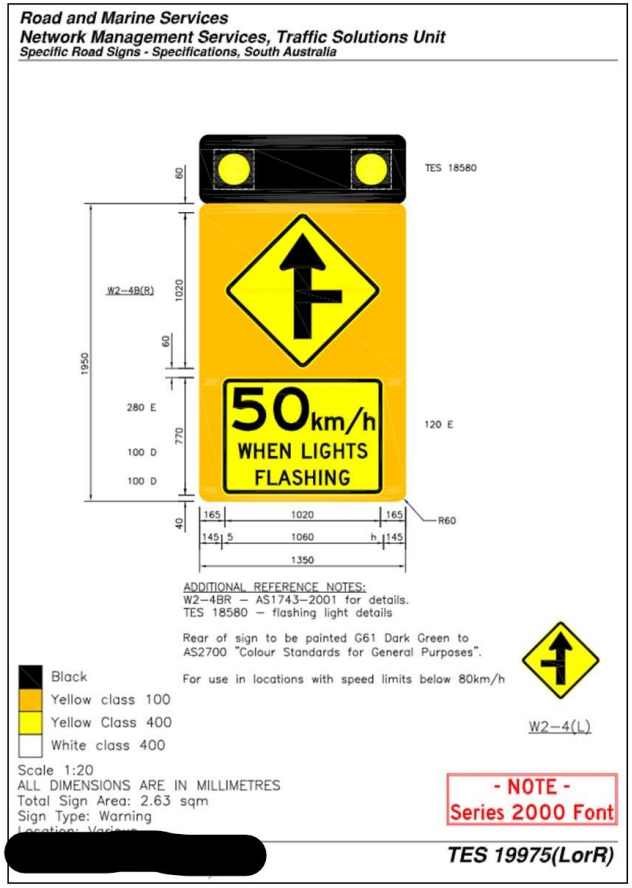

50km/h
WHEN LIGHTS
FLASHING

17


GIVE
WAY

18

19


Road and Marine Services
Network Management Services, Traffic Solutions Unit
Specific Road Signs - Specifications, South Australia
TES 18580
60
1020
60
770
40
1950
W2-4B(R)
280 E
100 D
100 D
120 E
50km/h
WHEN LIGHTS
FLASHING
165
1020
165
R60
145
5
1060
h
145
1350
ADDITIONAL REFERENCE NOTES:
W2-4BR - AS1743-2001 for details.
TES 18580 - flashing light details
Rear of sign to be painted G61 Dark Green to AS2700 "Colour Standards for General Purposes".
For use in locations with speed limits below 80km/h
W2-4(L)
Black
Yellow class 100
Yellow Class 400
White class 400
Scale 1:20
ALL DIMENSIONS ARE IN MILLIMETRES
Total Sign Area: 2.63 sqm
Sign Type: Warning
- NOTE -
Series 2000 Font
TES 19975(LorR)

C.2 Control Site 1

RJAWS Lite Site 6—Site design for before and after trial surveys (control site)

All locations and distances are approximate. Locations and distances shall be determined on site before commencement of any works.

All dates are approximate. Dates shall be confirmed before commencement of any works.

All drawings shall be read in conjunction with the notes provided on this page.

NOTES:

(1) Give way control line (westbound lane) (**Note 8**).

(2) R1-2 sign and post (westbound lane) (**Note 8**).

(3) Minor road activated system radar (westbound lane) (**Notes 8, 9, 10, 11 and 12**).

(4) W3-2 sign and post (westbound lane) (**Note 8**).

(5) Vehicle location at which major road activated system "wig wag" flashing lights "dummy" activation is logged (**Note 10**).

(6) Vehicle location at which minor road activated system R1-2 flashing lights "dummy" activation is logged (**Note 11**).

(7) Radar cone (approximately 7 degrees*).

(8) Details for new infrastructure installed as part of this trial:

Item	Latitude	Longitude	Installation details
Give way line (eastbound lane) (**Note 1**)	As instructed by DIT		To be installed before 22/10/21.
Give way (R1-2) sign and post (westbound lane) (**Note 2**)	As instructed by DIT		To be installed before 22/10/21.
Minor road activated system radar (westbound lane) (**Note 3**)	-34.974678	138.860746	To be installed before 22/10/21.
Give way ahead (W3-2) sign and post (eastbound lane) (**Note 4**)	As instructed by DIT		To be installed before 22/10/21.

(9) Example of minor road activated radar.

(10) **Major road activated system "wig wag" flashing lights dummy armament:** When the minor road activated system radar (**Note 3**) detects a vehicle on the minor road at the far detection location (**Note 5**), the "wig wag" flashing lights are armed for 30 seconds. **NOTE:** "Wig wag" flashing lights are not installed at this control site — Dummy armament is used to log the dates and times when the major road activated system "wig wag" flashing lights would be armed, if they were installed.

(11) **Minor road activated system R1-2 flashing lights dummy activation:** When the minor road activated system radar (**Note 3**) detects a vehicle on the minor road at the near detection location (**Note 6**) at a speed above 60 km/h, the R1-2 flashing lights are activated for a period of 10 seconds. **NOTE:** R1-2 flashing lights are not installed at this control site — Dummy activation is used to log the dates and times when the minor road activated system R1-2 flashing lights would be armed, if they were installed.

(12) Continuous vehicle speeds to be logged by the minor road activated system radar (**Note 3**) while a minor road vehicle remains within the radar line-of-sight.

*As specified in AGD 318 Traffic Control Radar Product Manual.

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C.3 Treatment Site 2

RJAWS Lite Site 12—Site design for before and after trial surveys (treatment site)

All locations and distances are approximate. Locations and distances shall be determined on site before commencement of any works.

All dates are approximate. Dates shall be confirmed before commencement of any works.

All drawings shall be read in conjunction with the notes provided on this page.

NOTES:

(1) Existing directional sign and posts.

(2) Major road activated system (northbound lane) (**Notes 16, 17 and 21**). NOTE: STEEP ROCKFACE ON ROADSIDE NEXT TO SIGN

(3) Vehicle location at which major road activated system flashing lights (northbound lane) are activated (**Note 21**).

(4) Existing W2-4(R) sign and post (current location — sign to be removed, pole to remain in situ) (**Note 5**).

(5) Note removed.

(6) Existing directional sign and post.

(7) Major road activated system (southbound lane) (**Notes 16, 17 and 21**). NOTE: ROADSIDE TERRIAN DOWNWARD SLOPE

(8) Vehicle location at which major road activated system flashing lights (southbound lane) are activated (**Note 21**).

(9) Radar cone (approximately 7 degrees*).

(10) Give way control line (**Note 16**).

(11) Minor road activated system sign (eastbound lane) (**Notes 16, 18 and 22**).

(12) Minor road activated system radar (eastbound lane) (**Notes 16, 19, 21, 22 and 23**).

(13) Existing W2-3 sign and post — to be replaced by W3-2 sign (**Note 16**). NOTE: POLE AND SIGN TO BE MOVED APPROX. 80 m UPSTREAM AS MARKED ON ROAD BY DIT

(14) Vehicle location at which major road activated system "wig wag" flashing lights (southbound and northbound lanes) are activated (**Note 21**).

(15) Vehicle location at which minor road activated system R1-2 flashing lights (westbound lane) are activated (**Note 22**).

(16) Details for new infrastructure installed as part of this trial:

Item	Latitude	Longitude	Installation details
Major road activated system (southbound lane) (**Note 2**)	-34.861459	138.960393	To be installed before 22/10/21. Covering film to be placed over front of TES19976 sign—to be removed 6 Dec 2021.
Major road activated system (northbound lane) (**Note 7**)	-34.859034	138.960754	To be installed before 22/10/21. Covering film to be placed over front of TES19976 sign—to be removed 6 Dec 2021.
Give way line (eastbound lane) (**Note 10**)	As instructed by DIT		To be installed before 22/10/21.
Minor road activated system sign (eastbound lane) (**Note 11**)	-34.860255	138.960391	To be installed before 22/10/21.
Minor road activated system radar (eastbound lane) (**Note 12**)	-34.860293	138.960636	To be installed before 22/10/21.
Give way ahead (W3-2) sign and post (eastbound lane) (**Note 13**)	As instructed by DIT		To be installed before 22/10/21.

(17) Example of major road activated system with TES19976(R) sign mounted to pole.

(18) Example of minor road activated sign with activated R1-2 sign mounted to pole.

(19) Example of minor road activated radar.

(20) Design drawing for TES19976 sign.

(21) **Major road activated system "wig wag" flashing light activation:** When the minor road activated system radar (**Note 12**) detects a vehicle on the minor road at the far detection location (**Note 14**), the "wig wag" flashing lights (**Notes 2 and 7**) are armed for 30 seconds. When the "wig wag" flashing lights are armed and a major road activated system radar (**Notes 2 and 7**) detects a major road vehicle at the detection location (**Notes 3 and 8**, respectively), the respective "wig wag" flashing lights (**Notes 2 and 7**) are activated for a period of 10 seconds. When the "wig wag" flashing lights are already active and another detection event activates the flashing lights, the flashing lights will remain active for a further 10 seconds.

(22) **Minor road activated system R1-2 flashing light activation:** When the minor road activated system radar (**Note 12**) detects a vehicle on the minor road at the near detection location (**Note 15**) at a speed above 75 km/h, the R1-2 flashing lights (**Note 11**) are activated for a period of 10 seconds. When the R1-2 flashing lights are already active and another detection event activates the flashing lights, the flashing lights will remain active for a further 10 seconds.

(23) Continuous vehicle speeds to be logged by the minor road activated system radar (**Note 12**) while a minor road vehicle remains within the radar line-of-sight.

**As specified in AGD 318 Traffic Control Radar Product Manual.*

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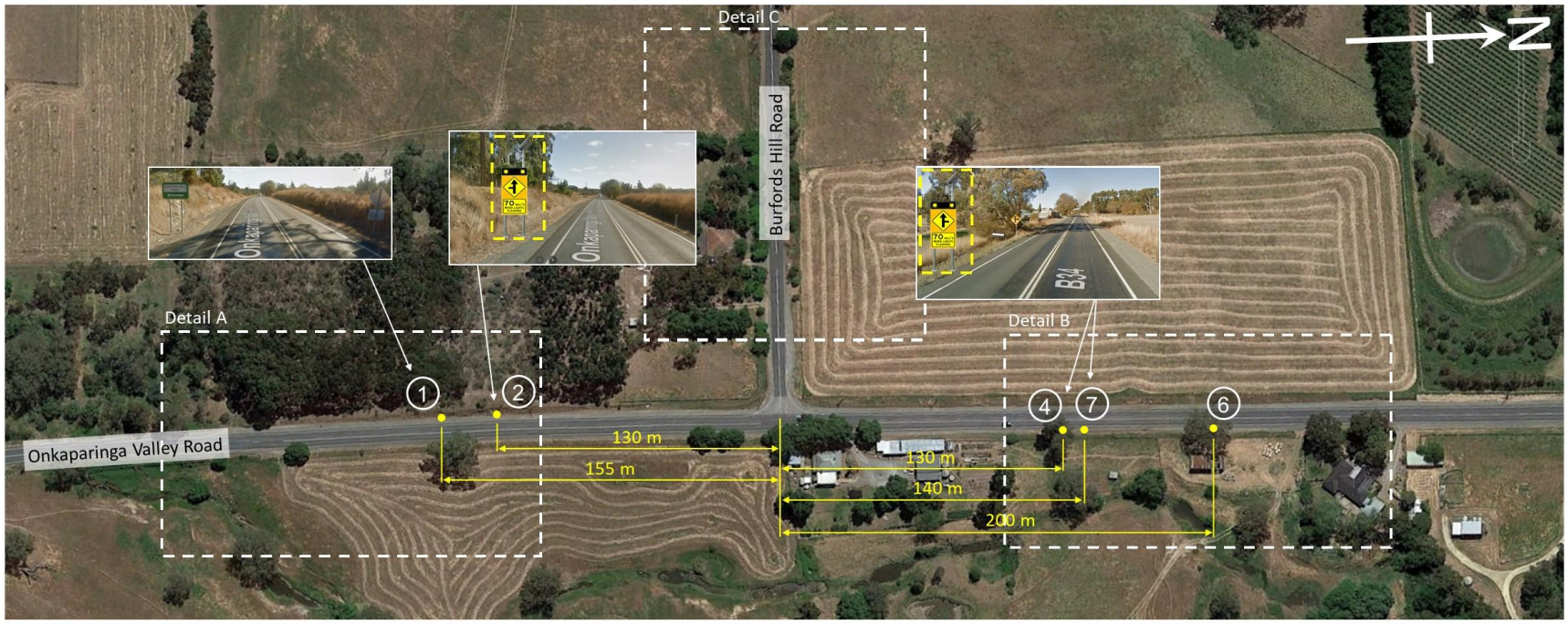

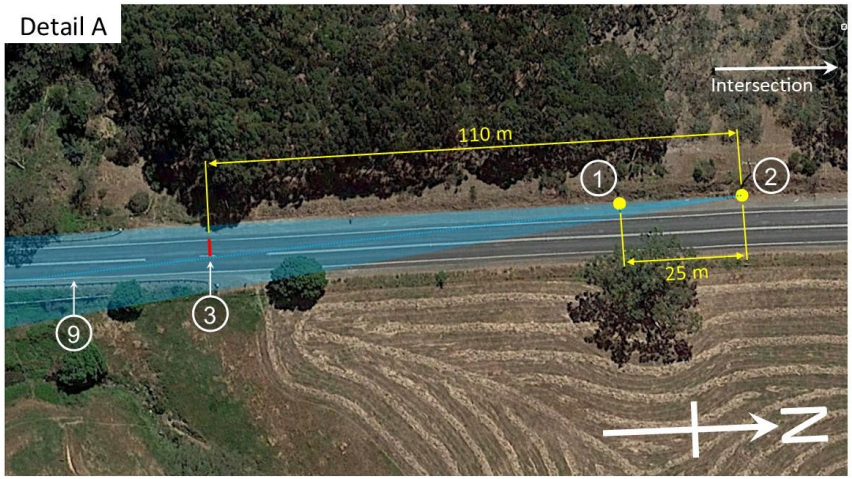

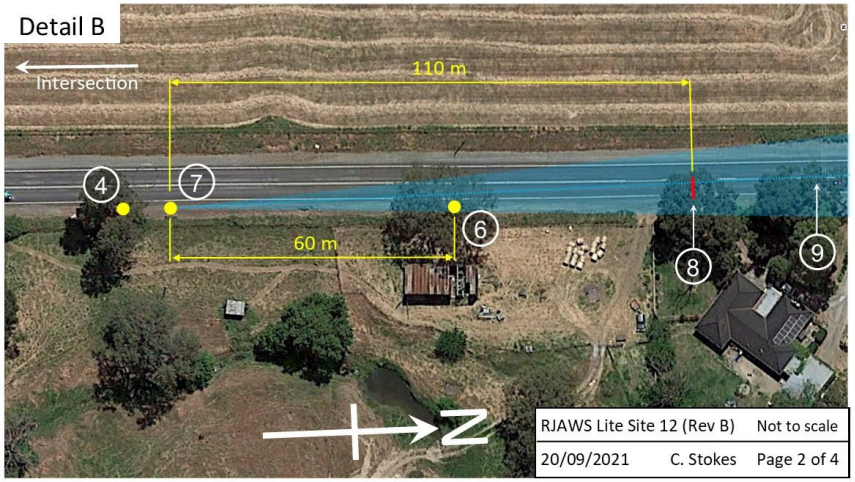

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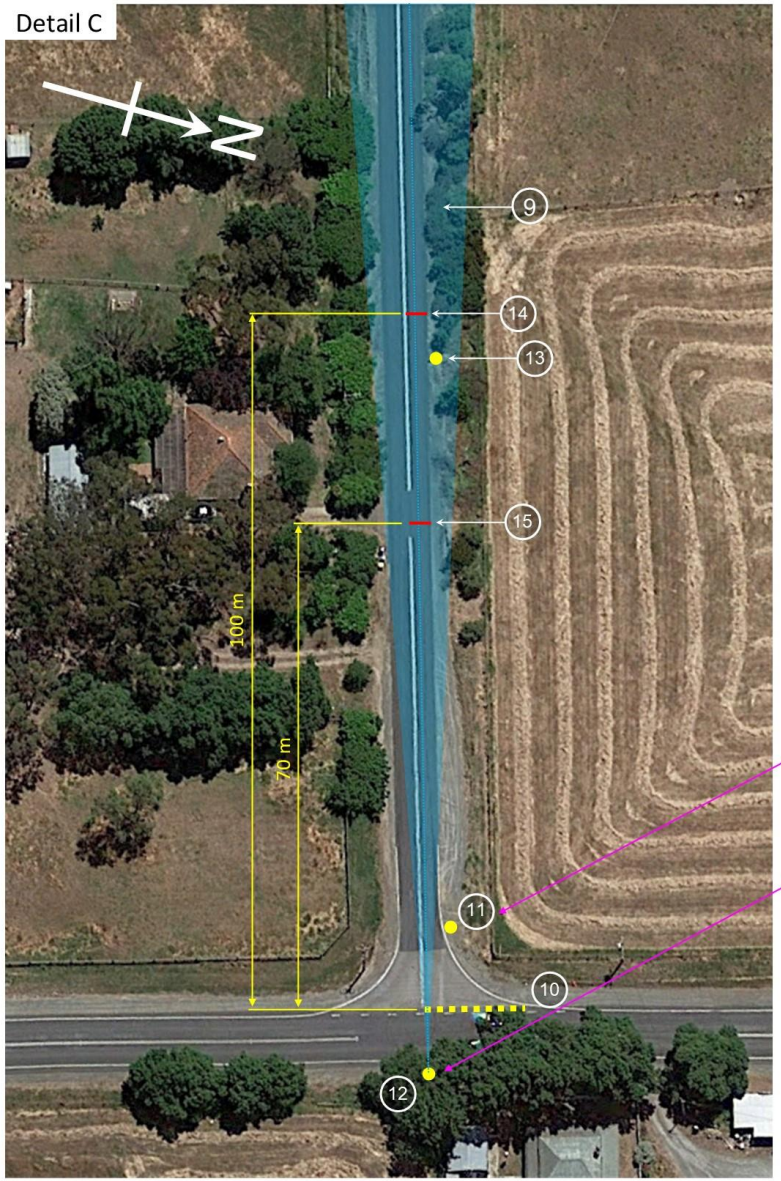

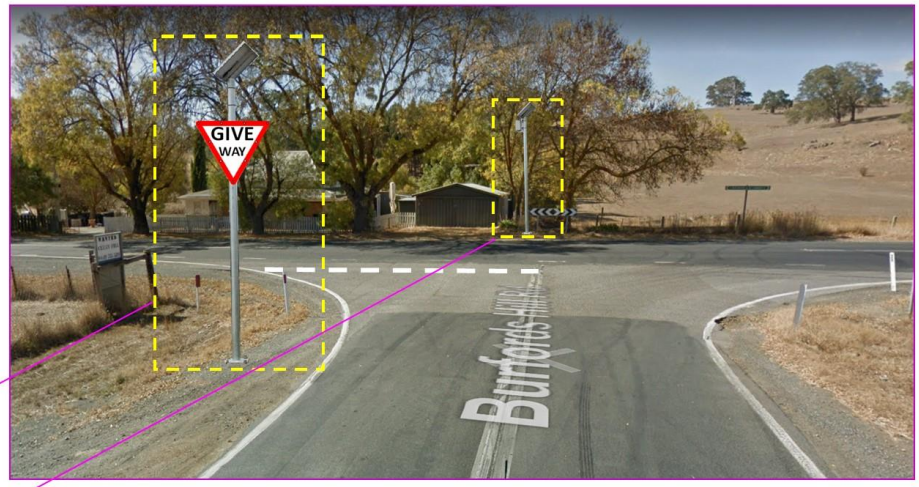

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17

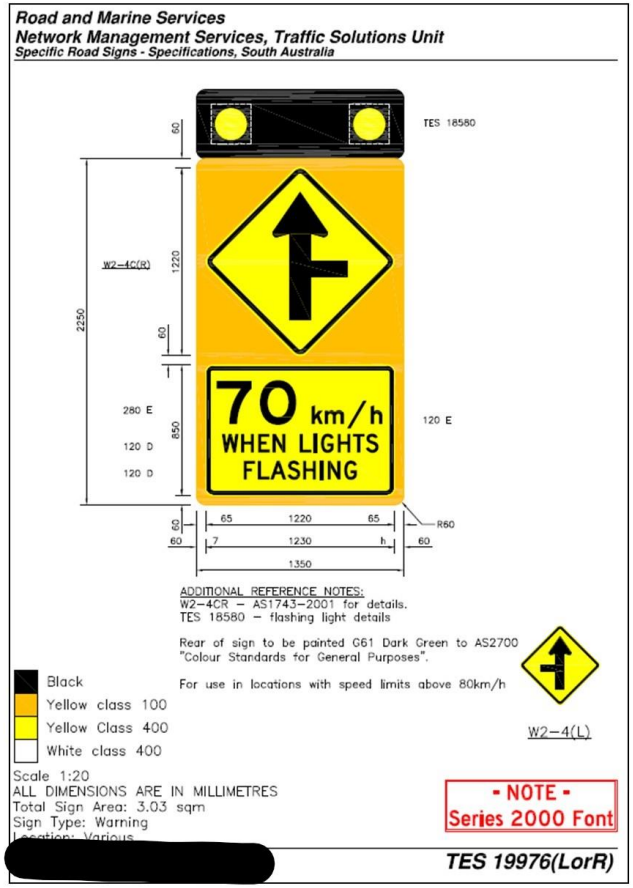

70 km/h
WHEN LIGHTS
FLASHING

18


GIVE
WAY

19

20


Road and Marine Services
Network Management Services, Traffic Solutions Unit
Specific Road Signs - Specifications, South Australia
TES 18580
W2-4C(R)
2250
1220
60
850
280 E
120 D
120 D
120 E
70 km/h
WHEN LIGHTS
FLASHING
65
1220
65
R60
7
1230
h
1350
ADDITIONAL REFERENCE NOTES:
W2-4CR - AS1743-2001 for details.
TES 18580 - flashing light details
Rear of sign to be painted G61 Dark Green to AS2700
"Colour Standards for General Purposes".
For use in locations with speed limits above 80km/h
W2-4(L)
Black
Yellow class 100
Yellow Class 400
White class 400
Scale 1:20
ALL DIMENSIONS ARE IN MILLIMETRES
Total Sign Area: 3.03 sqm
Sign Type: Warning
- NOTE -
Series 2000 Font
TES 19976(LorR)

C.4 Control Site 2

RJAWS Lite Site 144—Site design for before and after trial surveys (control site)

All locations and distances are approximate. Locations and distances shall be determined on site before commencement of any works.

All dates are approximate. Dates shall be confirmed before commencement of any works.

All drawings shall be read in conjunction with the notes provided on this page.

NOTES:

(1) Minor road activated system radar (westbound lane) (**Notes 5, 6, 7, 8 and 9**).

(2) Vehicle location at which major road activated system "wig wag" flashing lights "dummy" activation is logged (**Note 7**).

(3) Vehicle location at which minor road activated system R1-2 flashing lights "dummy" activation is logged (**Note 8**).

(4) Radar cone (approximately 7 degrees*).

(5) Details for new infrastructure installed as part of this trial:

Item	Latitude	Longitude	Installation details
Minor road activated system radar (westbound lane) (**Note 3**)	-34.614109	139.070926	To be installed before 22/10/21.

(6) Example of minor road activated radar.

(7) **Major road activated system "wig wag" flashing lights dummy armament:** When the minor road activated system radar (**Note 1**) detects a vehicle on the minor road at the far detection location (**Note 2**), the "wig wag" flashing lights are armed for 30 seconds. **NOTE:** "Wig wag" flashing lights are not installed at this control site — Dummy armament is used to log the dates and times when the major road activated system "wig wag" flashing lights would be armed, if they were installed.

(8) **Minor road activated system R1-2 flashing lights dummy activation:** When the minor road activated system radar (**Note 1**) detects a vehicle on the minor road at the near detection location (**Note 3**) at a speed above 60 km/h, the R1-2 flashing lights are activated for a period of 10 seconds. **NOTE:** R1-2 flashing lights are not installed at this control site — Dummy activation is used to log the dates and times when the minor road activated system R1-2 flashing lights would be armed, if they were installed.

(9) Continuous vehicle speeds to be logged by the minor road activated system radar (**Note 1**) while a minor road vehicle remains within the radar line-of-sight.

*As specified in AGD 318 Traffic Control Radar Product Manual.

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C.5 Treatment Site 3

RJAWS Lite Site 155—Site design for before and after trial surveys (Treatment site)

All locations and distances are approximate. Locations and distances shall be determined on site before commencement of any works.

All dates are approximate. Dates shall be confirmed before commencement of any works.

All drawings shall be read in conjunction with the notes provided on this and subsequent pages.

Item	Description	Action
1	Major Road Activated System "wig wag" flashing light activation	When the Minor Road Activated System radar (Item 8, page 2) detects a vehicle on the minor road at the detection location (Item 14, page 4), the "wig wag" flashing lights (Items 4 and 6, page 2) are armed (but not illuminated) for 30 seconds. When the "wig wag" flashing lights are armed and a Major Road Activated System radar (Items 4 and 6, page 2) detects a major road vehicle at the detection location (Items 12 and 13, page 3), the respective "wig wag" flashing lights (Items 4 and 6, page 2) are (activated) illuminated for a period of 10 seconds. When the "wig wag" flashing lights are already active and another detection event activates the flashing lights, the flashing lights will remain active for a further 10 seconds from the time of the subsequent activation.
2	Minor Road Activated System R1-2 flashing light activation	When the minor road activated system radar (Item 8, page 2) detects a vehicle on the minor road at the near detection location (Item 14, page 4) at a speed above 65 km/h, the R1-2 flashing lights (Item 9, page 2) are activated (illuminated) for a period of 5 seconds. When the R1-2 flashing lights are already active and another detection event activates the flashing lights, the flashing lights will remain active for a further 5 seconds from the time of the subsequent activation.
3	Minor Road Activated System radar data logging	Continuous vehicle speeds to be logged by the minor road activated system radar (Item 8, page 2) while a minor road vehicle remains within the radar line-of-sight.

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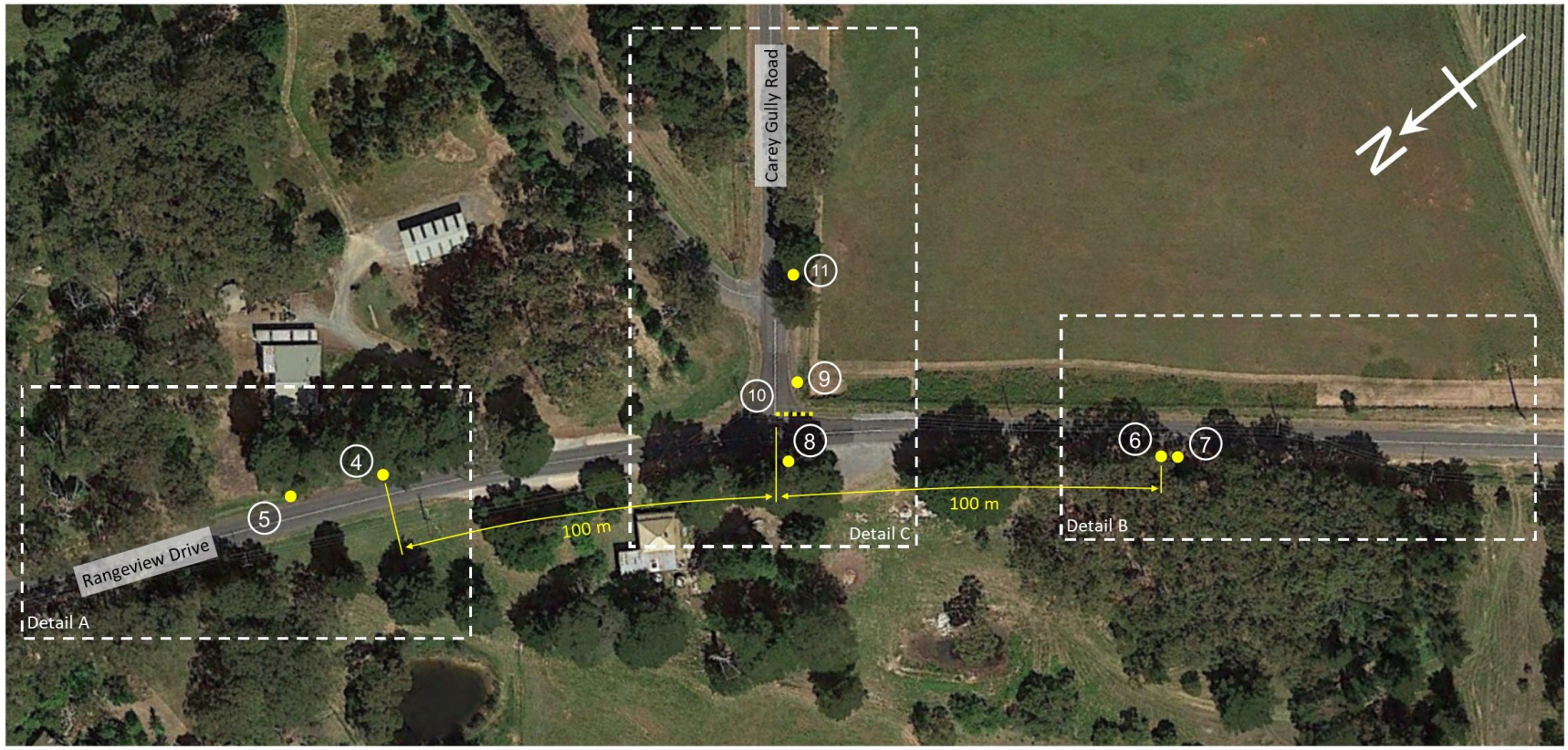

Item	Description	Action
4	Major Road Activated System (see Item 15, page 5)	To be installed on or before 15/04/2022. All signage and lights to remain covered with appropriate protective film. Pole locations noted with pink tape.
5	W2-4(L) (side road ahead—left)	Existing at site. To be removed and kept on site for reinstallation after trial.
6	Major Road Activated System (see Item 15, page 5)	To be installed on or before 15/04/2022. All signage and lights to remain covered with appropriate protective film. Pole locations noted with pink tape.
7	W2-4(R) (side road ahead—right)	Existing at site. To be removed and kept on site for reinstallation after trial.
8	Minor Road Activated System radar (see Item 16, page 5)	To be installed on or before 15/04/2022. Pole locations noted with pink tape.
9	Minor Road Activated System sign (see Item 17, page 5)	To be installed on or before 15/04/2022. To be installed with standard R1-2 (give way) sign.
10	Give way control line	To be installed on or before 15/04/2022.
11	W2-3 (T-intersection ahead)	Existing at site. To be replaced by W3-2 (give way ahead) on or before 15/04/2022.

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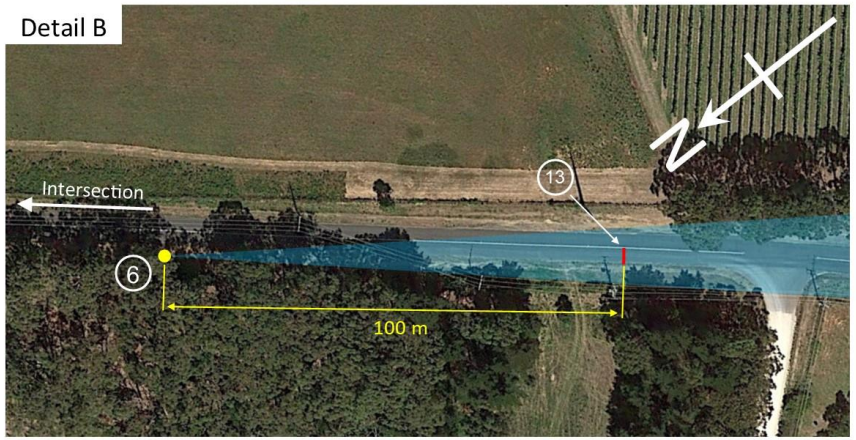
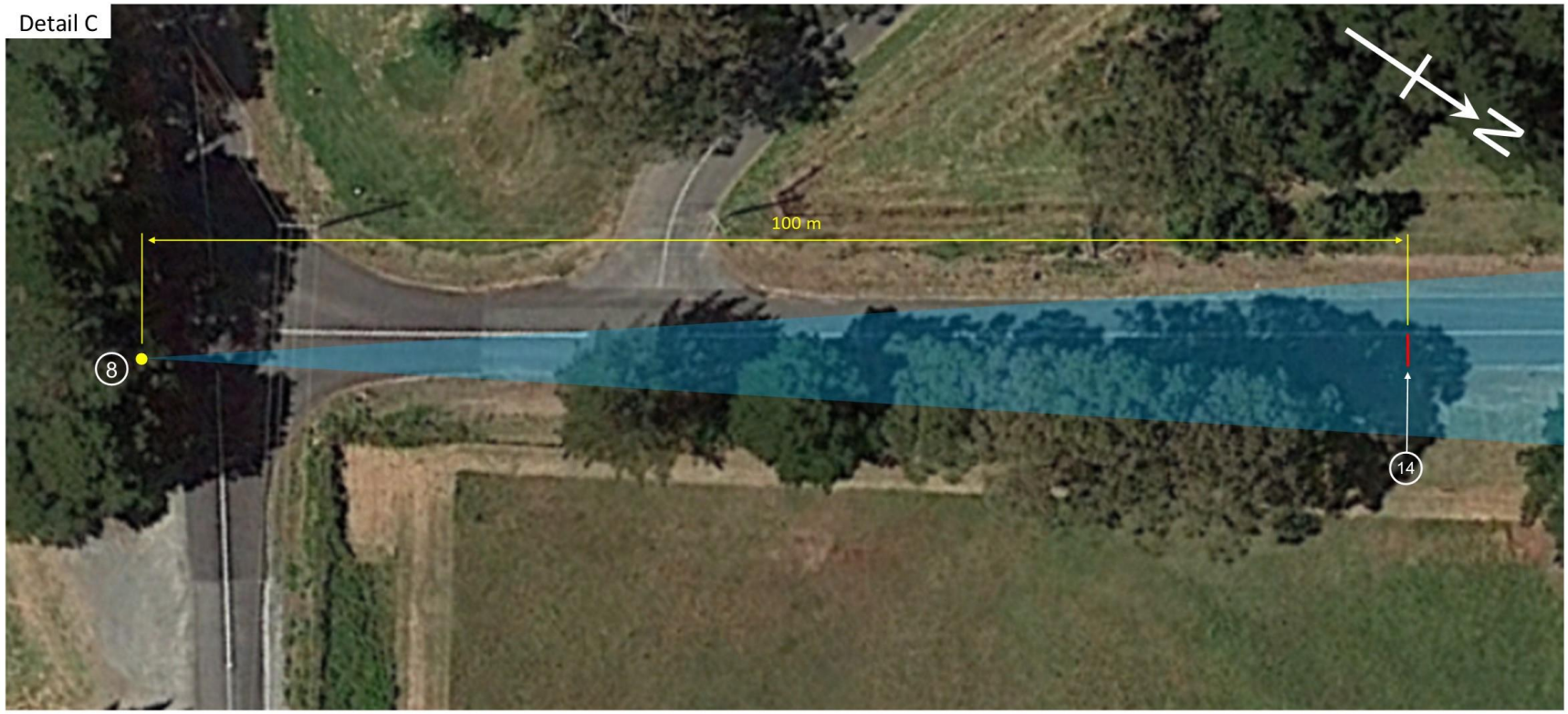
Detail A

Detail B



Item	Description	Action
12	Radar target location for Major Road Activated System	Radar to be aimed such that Major Road Activated System lights are activated when vehicle is 100m upstream
13	Radar target location for Major Road Activated System	Radar to be aimed such that Major Road Activated System lights are activated when vehicle is 100m upstream

Detail C



Item	Description	Action
14	Radar target location for Minor Road Activated System	Radar to be aimed such that Major and Minor Road Activated System lights are armed/activated, respectively, when vehicle is 100m upstream

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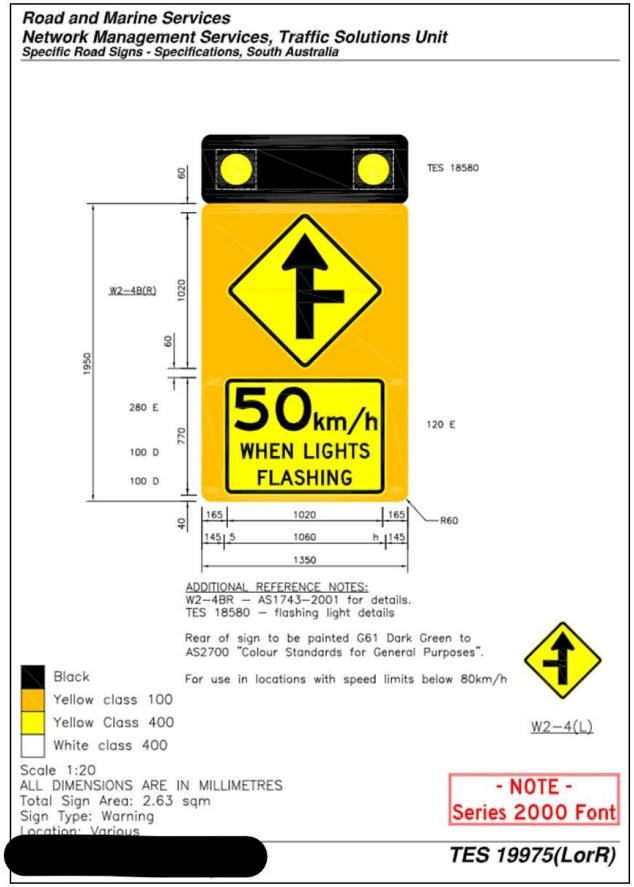


Item	Description	Action
15	Example of Major Road Activated System with TES19975(R) sign mounted to pole.	For noting.
16	Example of Minor Road Activated Radar.	For noting.
17	Example of Minor Road Activated Sign with activated R1-2 sign mounted to pole.	For noting.
18	Design drawing for TES19975 sign.	For noting.

C.6 Control Site 3

RJAWS Lite Site 52—Site design for before and after trial surveys (Control site)

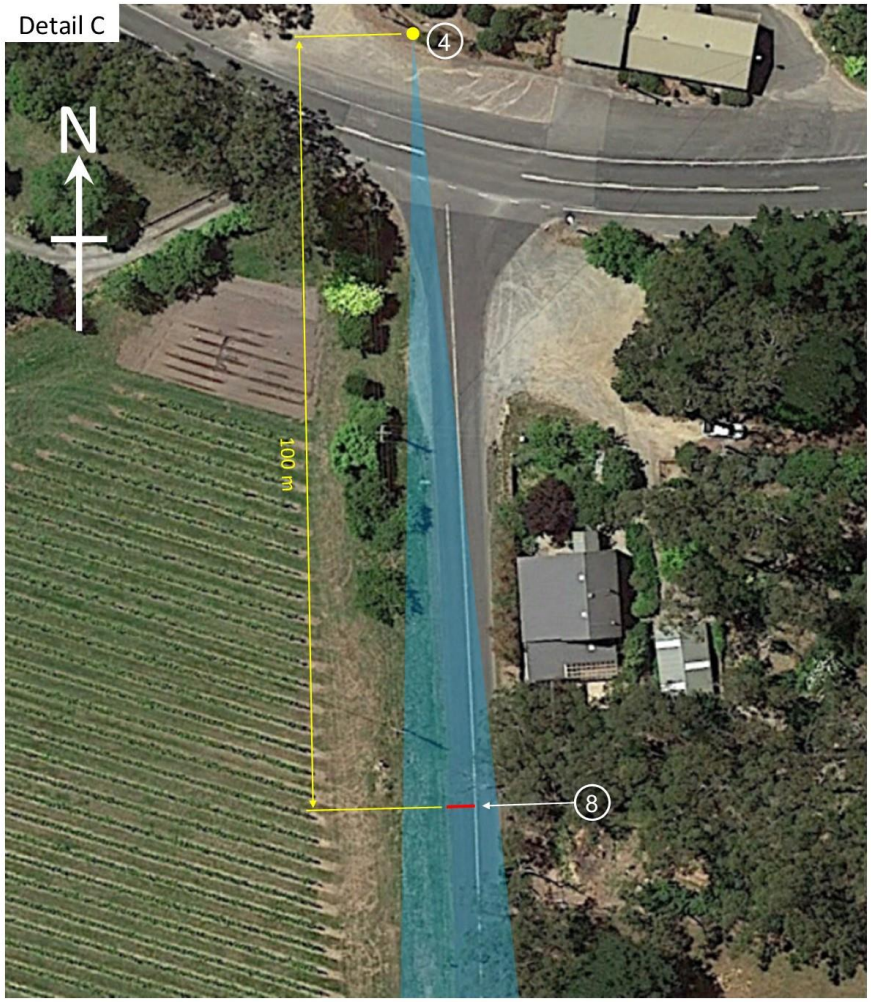
All locations and distances are approximate. Locations and distances shall be determined on site before commencement of any works.

All dates are approximate. Dates shall be confirmed before commencement of any works.

All drawings shall be read in conjunction with the notes provided on this and subsequent pages.

Item	Description	Action
1	Major Road Activated System "wig wag" flashing light DUMMY activation	When the Minor Road Activated System radar (Item 4, page 2) detects a vehicle on the minor road at the detection location (Item 8, page 3), the "wig wag" flashing lights are armed for 30 seconds. NOTE: "Wig wag" flashing lights are not installed at this control site — Dummy armament is used to log the dates and times when the major road activated system "wig wag" flashing lights would be armed, if they were installed.
2	Minor Road Activated System R1-2 flashing light DUMMY activation	When the Minor Road Activated System radar (Item 4, page 2) detects a vehicle on the minor road at the detection location (Item 8, page 3) at a speed above 65 km/h, the R1-2 flashing lights are activated for a period of 10 seconds. NOTE: R1-2 flashing lights are not installed at this control site — Dummy activation is used to log the dates and times when the minor road activated system R1-2 flashing lights would be armed, if they were installed.
3	Minor Road Activated System radar data logging	Continuous vehicle speeds to be logged by the Minor Road Activated System radar (Item 4, page 2) while a minor road vehicle remains within the radar line-of-sight.

Item	Description	Action
4	Minor Road Activated System radar (see Item 9, page 4)	To be installed on or before 15/04/2022. Pole locations noted with pink tape.
5	R1-2 (give way)	To be installed on or before 15/04/2022. Pole locations noted with pink tape.
6	Give way control line	To be installed on or before 15/04/2022.
7	W2-3 (T-intersection ahead)	Existing at site. To be replaced by W3-2 (give way ahead) on or before 15/04/2022



Item	Description	Action
8	Radar target location for Minor Road Activated System	Radar to be aimed such that Major and Minor Road Activated System lights are armed/activated, respectively, when vehicle is 100m upstream

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Item	Description	Action
9	Example of Minor Road Activated Radar.	For noting.

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C.7 Treatment Site 4

RJAWS Lite Site 144—Site design for before and after trial surveys (Treatment site)

All locations and distances are approximate. Locations and distances shall be determined on site before commencement of any works.

All dates are approximate. Dates shall be confirmed before commencement of any works.

All drawings shall be read in conjunction with the notes provided on this and subsequent pages.

Item	Description	Action
1	Major Road Activated System "wig wag" flashing light activation	When the Minor Road Activated System radar (Item 6, page 2) detects a vehicle on the minor road at the detection location (Item 11, page 4), the "wig wag" flashing lights (Items 4 and 5, page 2) are armed (but not illuminated) for 30 seconds. When the "wig wag" flashing lights are armed and a Major Road Activated System radar (Items 4 and 5, page 2) detects a major road vehicle at the detection location (Items 9 and 10, page 3), the respective "wig wag" flashing lights (Items 4 and 5, page 2) are (activated) illuminated for a period of 10 seconds. When the "wig wag" flashing lights are already active and another detection event activates the flashing lights, the flashing lights will remain active for a further 10 seconds from the time of the subsequent activation.
2	Minor Road Activated System R1-2 flashing light activation	When the Minor Road Activated System radar (Item 6, page 2) detects a vehicle on the minor road at the near detection location (Item 11, page 4) at a speed above 70 km/h, the R1-2 flashing lights (Item 7, page 2) are activated (illuminated) for a period of 5 seconds. When the R1-2 flashing lights are already active and another detection event activates the flashing lights, the flashing lights will remain active for a further 5 seconds from the time of the subsequent activation.
3	Minor Road Activated System radar data logging	Continuous vehicle speeds to be logged by the Minor Road Activated System radar (Item 6, page 2) while a minor road vehicle remains within the radar line-of-sight.

Item	Description	Action
4	Major Road Activated System (see Item 9, page 5)	To be installed on or before 15/04/2022. All signage and lights to remain covered with appropriate protective film. Pole locations noted with pink tape.
5	Major Road Activated System (see Item 9, page 5)	To be installed on or before 15/04/2022. All signage and lights to remain covered with appropriate protective film. Pole locations noted with pink tape.
6	Minor Road Activated System radar (see Item 10, page 5)	Existing at site.
7	Minor Road Activated System sign (see Item 11, page 5)	To be installed on or before 15/04/2022. To be installed with standard R1-2 (give way) sign. Install at location of existing R1-2 (give way) sign (Item 8, page 2).
8	R1-2 (give way)	Existing at site. To be removed and kept on site for reinstallation after trial.

Detail A

Detail B

Item	Description	Action
9	Radar target location for Major Road Activated System	Radar to be aimed such that Major Road Activated System lights are activated when vehicle is 100m upstream
10	Radar target location for Major Road Activated System	Radar to be aimed such that Major Road Activated System lights are activated when vehicle is 100m upstream

Detail C

Item	Description	Action
11	Radar target location for Minor Road Activated System	Radar to be aimed such that Major and Minor Road Activated System lights are armed/activated, respectively, when vehicle is 100m upstream

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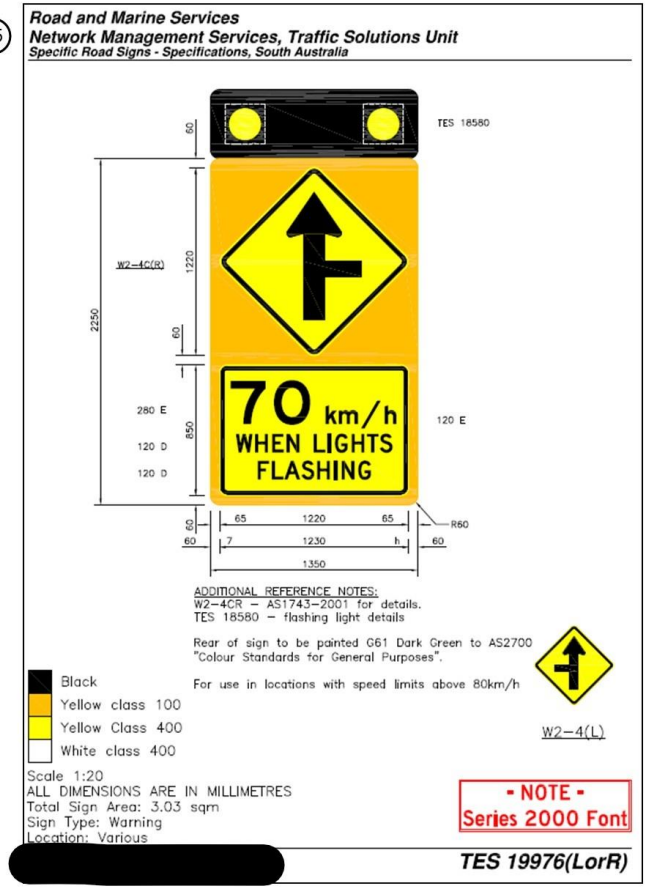

Item	Description	Action
12	Example of Major Road Activated System with TES19976(R) sign mounted to pole.	For noting.
13	Example of Minor Road Activated Radar.	For noting.
14	Example of Minor Road Activated Sign with activated R1-2 sign mounted to pole.	For noting.
15	Design drawing for TES19976 sign.	For noting.

C.8 Control Site 4

RJAWS Lite Site 154—Site design for before and after trial surveys (Control site)

All locations and distances are approximate. Locations and distances shall be determined on site before commencement of any works.

All dates are approximate. Dates shall be confirmed before commencement of any works.

All drawings shall be read in conjunction with the notes provided on this and subsequent pages.

Item	Description	Action
1	Major Road Activated System "wig wag" flashing light DUMMY activation	When the Minor Road Activated System radar (Item 4, page 2) detects a vehicle on the minor road at the detection location (Item 7, page 3), the "wig wag" flashing lights are armed for 30 seconds. NOTE: "Wig wag" flashing lights are not installed at this control site — Dummy armament is used to log the dates and times when the major road activated system "wig wag" flashing lights would be armed, if they were installed.
2	Minor Road Activated System R1-2 flashing light DUMMY activation	When the Minor Road Activated System radar (Item 4, page 2) detects a vehicle on the minor road at the detection location (Item 7, page 3) at a speed above 70 km/h, the R1-2 flashing lights are activated for a period of 10 seconds. NOTE: R1-2 flashing lights are not installed at this control site — Dummy activation is used to log the dates and times when the minor road activated system R1-2 flashing lights would be armed, if they were installed.
3	Minor Road Activated System radar data logging	Continuous vehicle speeds to be logged by the Minor Road Activated System radar (Item 4, page 2) while a minor road vehicle remains within the radar line-of-sight.

Item	Description	Action
4	Minor Road Activated System radar (see Item 8, page 4)	To be installed on or before 15/04/2022. Pole locations noted with pink tape.
5	R1-2 (give way)	To be installed on or before 15/04/2022. Pole locations noted with pink tape.
6	W2-3 (T-intersection ahead)	Existing at site. To be replaced with W3-2 (give way ahead) on or before 15/02/2022.

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Detail C

Item	Description	Action
7	Radar target location for Minor Road Activated System	Radar to be aimed such that Major and Minor Road Activated System lights are armed/activated, respectively, when vehicle is 100m upstream

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Item	Description	Action
8	Example of Minor Road Activated Radar.	For noting.

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C.9 Treatment Site 5

RJAWS Lite Site 156—Site design for before and after trial surveys (Treatment site)

All locations and distances are approximate. Locations and distances shall be determined on site before commencement of any works.

All dates are approximate. Dates shall be confirmed before commencement of any works.

All drawings shall be read in conjunction with the notes provided on this and subsequent pages.

Item	Description	Action
1	Major Road Activated System "wig wag" flashing light activation	When the Minor Road Activated System radar (Item 8, page 2) detects a vehicle on the minor road at the detection location (Item 12, page 4), the "wig wag" flashing lights (Items 4 and 6, page 2) are armed (but not illuminated) for 30 seconds. When the "wig wag" flashing lights are armed and a Major Road Activated System radar (Items 4 and 6, page 2) detects a major road vehicle at the detection location (Items 10 and 11, page 3), the respective "wig wag" flashing lights (Items 4 and 6, page 2) are activated (illuminated) for a period of 10 seconds. When the "wig wag" flashing lights are already active and another detection event activates the flashing lights, the flashing lights will remain active for a further 10 seconds from the time of the subsequent activation.
2	Minor Road Activated System R1-2 flashing light activation	When the minor road activated system radar (Item 8, page 2) detects a vehicle on the minor road at the near detection location (Item 12, page 4) at a speed above 65 km/h, the R1-2 flashing lights (Item 9, page 2) are activated (illuminated) for a period of 5 seconds. When the R1-2 flashing lights are already active and another detection event activates the flashing lights, the flashing lights will remain active for a further 5 seconds from the time of the subsequent activation.
3	Minor Road Activated System radar data logging	Continuous vehicle speeds to be logged by the minor road activated system radar (Item 8, page 2) while a minor road vehicle remains within the radar line-of-sight.

Item	Description	Action	Action date
4	Major Road Activated System with TES19975(L) (see Item 13, page 5)	Install with all signage and lights to remain covered with appropriate protective film. Pole locations noted with pink tape. Remove signage/light coverings. To be removed at conclusion of trial.	13/10/22 05/12/22 27/02/23
5	W2-4(L) (side road ahead—left)	Existing at site. Sign to be removed when coverings on Item 4 are removed (post to stay in-situ). Reinstall W2-4(L) sign on post.	05/12/22 27/02/23
6	Major Road Activated System with TES19975(R) (see Item 13, page 5)	Install with all signage and lights to remain covered with appropriate protective film. Pole locations noted with pink tape. Remove signage/light coverings. To be removed at conclusion of trial.	13/10/22 05/12/22 27/02/23
7	W2-4(R) (side road ahead—right)	Existing at site. To remain during trial.	13/10/22
8	Minor Road Activated System radar (see Item 14, page 5)	Install. Pole location noted with pink tape. To be removed at conclusion of trial.	13/10/22 27/02/23
9	Minor Road Activated System sign (see Item 15, page 5)	Install with standard R1-2 (give way) sign. Pole location noted with pink tape. Note R1-2 on standard pole existing at site. Replace standard R1-2 with flashing R1-2. To be removed at conclusion of trial.	13/10/22 05/12/22 27/02/23

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Item	Description	Action
10	Radar target location for Major Road Activated System	Radar to be aimed such that Major Road Activated System lights are activated when vehicle is 100m upstream
11	Radar target location for Major Road Activated System	Radar to be aimed such that Major Road Activated System lights are activated when vehicle is 100m upstream

Detail C

Item	Description	Action
12	Radar target location for Minor Road Activated System	Radar to be aimed such that Major and Minor Road Activated System lights are armed/activated, respectively, when vehicle is 100m upstream

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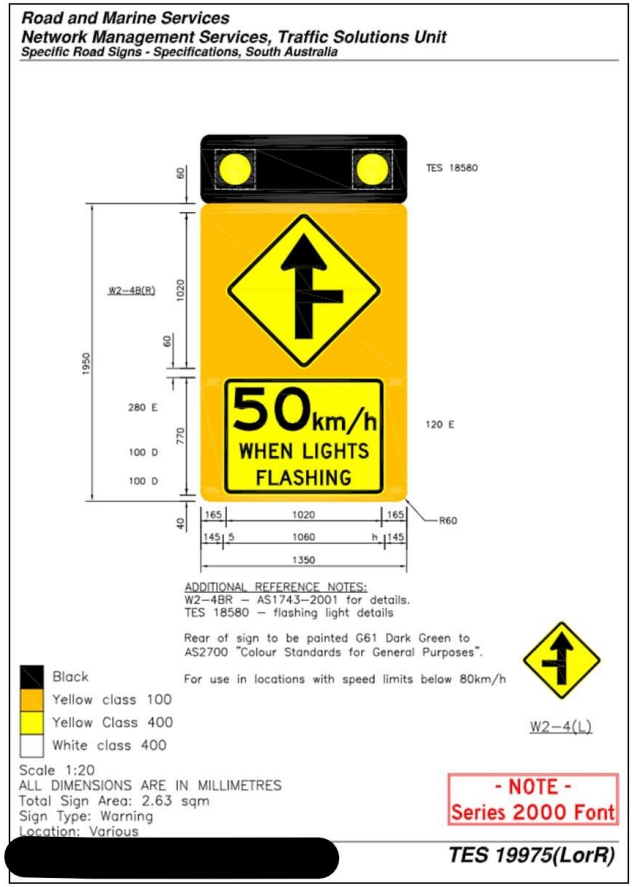

Item	Description	Action
13	Example of Major Road Activated System with TES19975(R) sign mounted to pole.	For noting.
14	Example of Minor Road Activated Radar.	For noting.
15	Example of Minor Road Activated Sign with activated R1-2 sign mounted to pole.	For noting.
16	Design drawing for TES19975 sign.	For noting.

C.10 Control Site 5

RJAWS Lite Site 157—Site design for before and after trial surveys (Control site)

All locations and distances are approximate. Locations and distances shall be determined on site before commencement of any works.

All dates are approximate. Dates shall be confirmed before commencement of any works.

All drawings shall be read in conjunction with the notes provided on this and subsequent pages.

Item	Description	Action
1	Major Road Activated System "wig wag" flashing light DUMMY activation	When the Minor Road Activated System radar (Item 4, page 2) detects a vehicle on the minor road at the detection location (Item 5, page 3), the "wig wag" flashing lights are armed for 30 seconds. NOTE: "Wig wag" flashing lights are not installed at this control site — Dummy armament is used to log the dates and times when the major road activated system "wig wag" flashing lights would be armed, if they were installed.
2	Minor Road Activated System R1-2 flashing light DUMMY activation	When the Minor Road Activated System radar (Item 4, page 2) detects a vehicle on the minor road at the detection location (Item 5, page 3) at a speed above 65 km/h, the R1-2 flashing lights are activated for a period of 10 seconds. NOTE: R1-2 flashing lights are not installed at this control site — Dummy activation is used to log the dates and times when the minor road activated system R1-2 flashing lights would be armed, if they were installed.
3	Minor Road Activated System radar data logging	Continuous vehicle speeds to be logged by the Minor Road Activated System radar (Item 4, page 2) while a minor road vehicle remains within the radar line-of-sight.

Item	Description	Action	Action date
4	Minor Road Activated System radar (see Item 6, page 4)	Pole locations noted with pink tape. To be placed behind existing road safety barrier.	13/10/22

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Detail A

Item	Description	Action
5	Radar target location for Minor Road Activated System	Radar to be aimed such that Major and Minor Road Activated System lights are armed/activated, respectively, when vehicle is 100m upstream

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Item	Description	Action
6	Example of Minor Road Activated Radar.	For noting.

C.11 Treatment Site 6

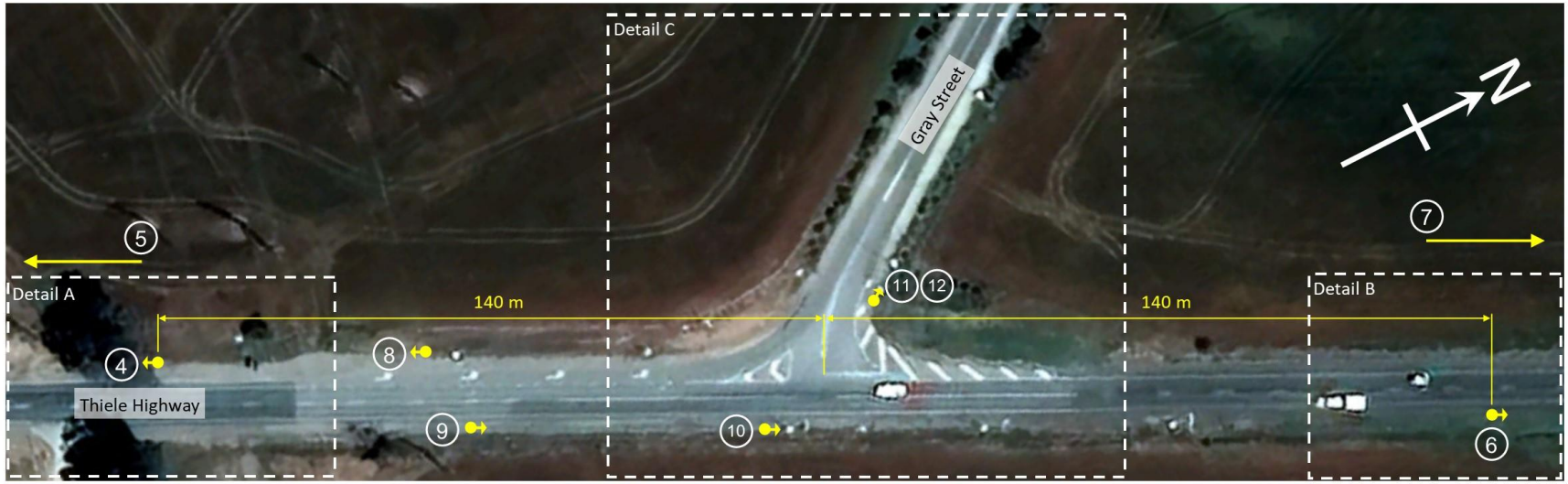
RJAWS Lite Site 154—Site design for before and after trial surveys (Treatment site)

All locations and distances are approximate. Locations and distances shall be determined on site before commencement of any works.

All dates are approximate. Dates shall be confirmed before commencement of any works.

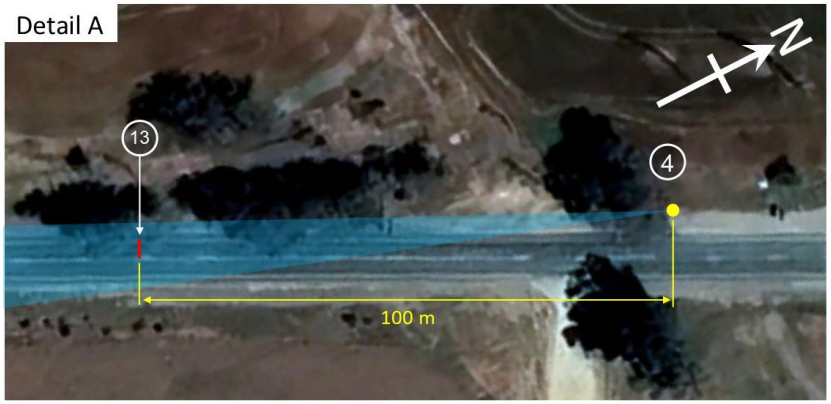
All drawings shall be read in conjunction with the notes provided on this and subsequent pages.

Item	Description	Action
1	Major Road Activated System "wig wag" flashing light activation	When the Minor Road Activated System radar (Item 10, page 2) detects a vehicle on the minor road at the detection location (Item 15, page 4), the "wig wag" flashing lights (Items 4 and 6, page 2) are armed (but not illuminated) for 30 seconds. When the "wig wag" flashing lights are armed and a Major Road Activated System radar (Items 4 and 6, page 2) detects a major road vehicle at the detection location (Items 13 and 14, page 3), the respective "wig wag" flashing lights (Items 4 and 6, page 2) are activated (illuminated) for a period of 10 seconds. When the "wig wag" flashing lights are already active and another detection event activates the flashing lights, the flashing lights will remain active for a further 10 seconds from the time of the subsequent activation.
2	Minor Road Activated System R1-2 flashing light activation	When the Minor Road Activated System radar (Item 10, page 2) detects a vehicle on the minor road at the near detection location (Item 15, page 4) at a speed above 70 km/h, the R1-2 flashing lights (Item 11, page 2) are activated (illuminated) for a period of 5 seconds. When the R1-2 flashing lights are already active and another detection event activates the flashing lights, the flashing lights will remain active for a further 5 seconds from the time of the subsequent activation.
3	Minor Road Activated System radar data logging	Continuous vehicle speeds to be logged by the Minor Road Activated System radar (Item 10, page 2) while a minor road vehicle remains within the radar line-of-sight.

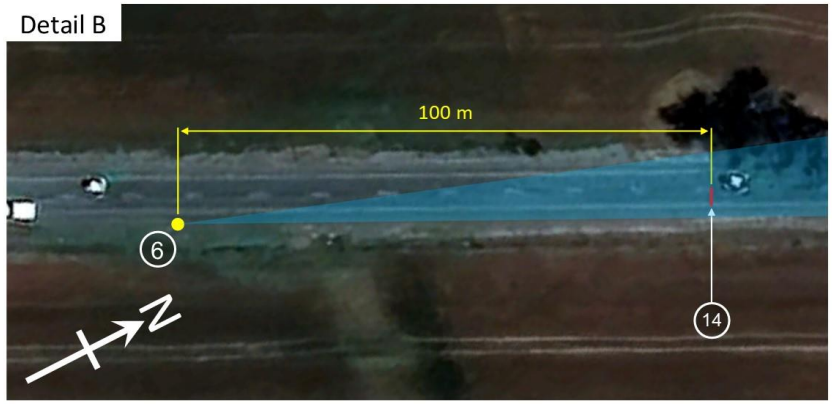


Item	Description	Action	Action date
4	Major Road Activated System with TES19976(L) (see Item 16, page 5)	Install, with all signage and lights to remain covered with appropriate protective film. Pole locations noted with pink tape. Remove signage/light coverings. To be removed at conclusion of trial.	13/10/22 05/12/22 27/02/23
5	W2-8(R) (staggered side road ahead)	Existing at site. To be replaced with W2-4(R) sign. Reinstall W2-8(R) sign at conclusion of trial.	13/10/22 27/02/23
6	Major Road Activated System with TES19976(R) (see Item 16, page 5)	Install, with all signage and lights to remain covered with appropriate protective film. Pole locations noted with pink tape. Remove signage/light coverings. To be removed at conclusion of trial.	13/10/22 05/12/22 27/02/23
7	W2-8(R) (staggered side road ahead)	Existing at site. To be replaced with W2-4(R) sign. Reinstall W2-8(R) sign at conclusion of trial.	05/12/22 27/02/23
8	W2-4(L) (side road ahead)	Install. Location to be determined on site—80-120m from intersection (1742.2-2009-Table D1). To be removed when Item 4 is uncovered.	13/10/22 05/12/22
9	W2-4(L) (side road ahead)	Install. Location to be determined on site—80-120m from intersection (1742.2-2009-Table D1). To be removed at conclusion of trial.	13/10/22 27/02/23
10	Minor Road Activated System radar (see Item 17, page 5)	Existing at site. To be removed at conclusion of trial.	27/02/23
11	Minor Road Activated System sign (see Item 18, page 5)	Install with standard R1-2 (give way) sign. Pole location noted with pink tape. Note R1-2 on standard pole existing at site. Replace standard R1-2 with flashing R1-2. To be removed at conclusion of trial.	13/10/22 05/12/22 27/02/23
12	R1-2 (give way)	To be removed. To be reinstalled at conclusion of trial.	13/10/22 27/02/23

Detail A



Detail B



Item	Description	Action
13	Radar target location for Major Road Activated System	Radar to be aimed such that Major Road Activated System lights are activated when vehicle is 100m upstream
14	Radar target location for Major Road Activated System	Radar to be aimed such that Major Road Activated System lights are activated when vehicle is 100m upstream

Detail C

Item	Description	Action
15	Radar target location for Minor Road Activated System	Radar to be aimed such that Major and Minor Road Activated System lights are armed/activated, respectively, when vehicle is 102m upstream

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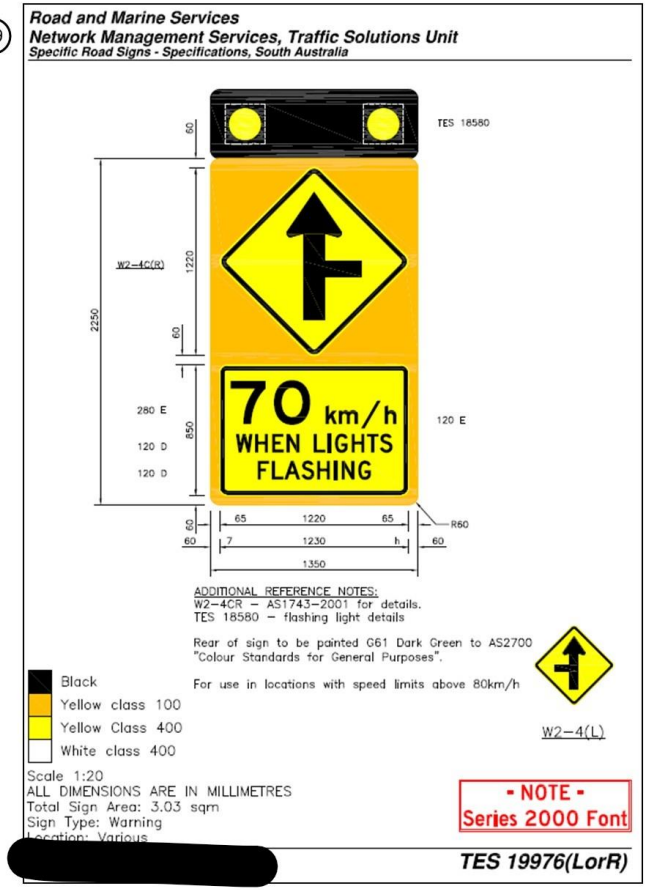


Item	Description	Action
16	Example of Major Road Activated System with TES19976(R) sign mounted to pole.	For noting.
17	Example of Minor Road Activated Radar.	For noting.
18	Example of Minor Road Activated Sign with activated R1-2 sign mounted to pole.	For noting.
19	Design drawing for TES19976 sign.	For noting.

C.12 Control Site 6

RJAWS Lite Site 88—Site design for before and after trial surveys (Control site)

All locations and distances are approximate. Locations and distances shall be determined on site before commencement of any works.

All dates are approximate. Dates shall be confirmed before commencement of any works.

All drawings shall be read in conjunction with the notes provided on this and subsequent pages.

Item	Description	Action
1	Major Road Activated System "wig wag" flashing light DUMMY activation	When the Minor Road Activated System radar (Item 4, page 2) detects a vehicle on the minor road at the detection location (Item 5, page 3), the "wig wag" flashing lights are armed for 30 seconds. NOTE: "Wig wag" flashing lights are not installed at this control site — Dummy armament is used to log the dates and times when the major road activated system "wig wag" flashing lights would be armed, if they were installed.
2	Minor Road Activated System R1-2 flashing light DUMMY activation	When the Minor Road Activated System radar (Item 4, page 2) detects a vehicle on the minor road at the detection location (Item 5, page 3) at a speed above 65 km/h, the R1-2 flashing lights are activated for a period of 10 seconds. NOTE: R1-2 flashing lights are not installed at this control site — Dummy activation is used to log the dates and times when the minor road activated system R1-2 flashing lights would be armed, if they were installed.
3	Minor Road Activated System radar data logging	Continuous vehicle speeds to be logged by the Minor Road Activated System radar (Item 4, page 2) while a minor road vehicle remains within the radar line-of-sight.

Item	Description	Action	Action date
4	Minor Road Activated System radar (see Item 6, page 4)	Pole locations noted with pink tape. To be placed behind existing road safety barrier.	13/10/22

Detail A

Item	Description	Action
5	Radar target location for Minor Road Activated System	Radar to be aimed such that Major and Minor Road Activated System lights are armed/activated, respectively, when vehicle is 100m upstream

Appendix D Additional speed data on major road

This appendix provides additional analysis of the data collected on the approach to the major road.

Table D.1
Vehicle proportion below various speed thresholds on **approach** to intersections with 80km/h speed limit (free flow) - Trial Pairs 1, 3, 5

Site Type [1]	Sign Status [2]	Trial Period [3]	Pair 1					Pair 3					Pair 5				
			<= 50 km/h	<= 60 km/h	<= 70 km/h	<= 80 km/h	> 80 km/h	<= 50 km/h	<= 60 km/h	<= 70 km/h	<= 80 km/h	> 80 km/h	<= 50 km/h	<= 60 km/h	<= 70 km/h	<= 80 km/h	> 80 km/h
T	ON	BF	1.2	3.2	10.0	68.3	31.7	2.6	20.2	61.6	92.1	7.9	0.1	0.7	8.0	75.0	25.0
		AF	5.0	19.8	41.1	85.6	14.4	6.1	26.3	63.9	93.5	6.5	7.2	23.1	43.7	86.2	13.8
		D	3.8	16.6	31.1	17.3	-17.3	3.5	6.1	2.3	1.4	-1.4	7.1	22.4	35.7	11.2	-11.2
	OFF	BF	0.9	2.2	7.1	61.3	38.7	4.2	19.8	58.7	90.8	9.2	0.2	1.1	8.0	70.0	30.0
		AF	1.2	4.0	11.9	67.6	32.4	7.2	28.4	63.2	91.7	8.3	0.7	2.7	10.3	69.2	30.8
		D	0.3	1.8	4.8	6.3	-6.3	3.0	8.6	4.5	0.9	-0.9	0.5	1.6	2.3	-0.8	0.8
C	ON	BF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		AF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OFF	BF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		AF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Controlled D		***ON***	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
		OFF	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

[1] Site Type: Treatment (T) / Control (T)
[2] Sign status 'ON' indicates 'silent' activations for treatment sites in the before period / 'virtual' activations for control sites at any period
[3] Trial Period: Before (BF) / After (AF) / Variation (D)

Table D.2
Vehicle proportion below various speed thresholds on **approach** to intersections with 100km/h speed limit (free flow) - Trial Pairs 2, 4, 6

Site Type [1]	Sign Status [2]	Trial Period [3]	Pair 2					Pair 4					Pair 6				
			<= 50 km/h	<= 60 km/h	<= 70 km/h	<= 80 km/h	> 80 km/h	<= 50 km/h	<= 60 km/h	<= 70 km/h	<= 80 km/h	> 80 km/h	<= 50 km/h	<= 60 km/h	<= 70 km/h	<= 80 km/h	> 80 km/h
T	ON	BF	3.7	18.1	53.0	91.1	8.9	2.0	6.0	28.5	79.6	20.4	1.1	3.6	14.3	81.5	18.5
		AF	22.2	50.1	76.5	96.4	3.6	20.7	38.9	64.4	90.7	9.3	7.9	21.0	39.4	83.2	16.8
		D	18.5	32.0	23.5	5.3	-5.3	18.7	32.9	35.9	11.1	-11.1	6.8	17.4	25.1	1.7	-1.7
	OFF	BF	3.1	15.4	46.8	88.3	11.7	6.6	12.6	34.4	77.4	22.6	1.4	4.7	15.5	79.6	20.4
		AF	5.5	20.6	52.2	90.3	9.7	8.0	15.7	35.4	75.2	24.8	3.1	8.4	20.3	78.0	22.0
		D	2.4	5.2	5.4	2.0	-2.0	1.4	3.1	1.0	-2.2	2.2	1.7	3.7	4.8	-1.6	1.6
C	ON	BF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		AF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OFF	BF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		AF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Controlled D		***ON***	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
		OFF	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

[1] Site Type: Treatment (T) / Control (T)
[2] Sign status 'ON' indicates 'silent' activations for treatment sites in the before period / 'virtual' activations for control sites at any period
[3] Trial Period: Before (BF) / After (AF) / Variation (D

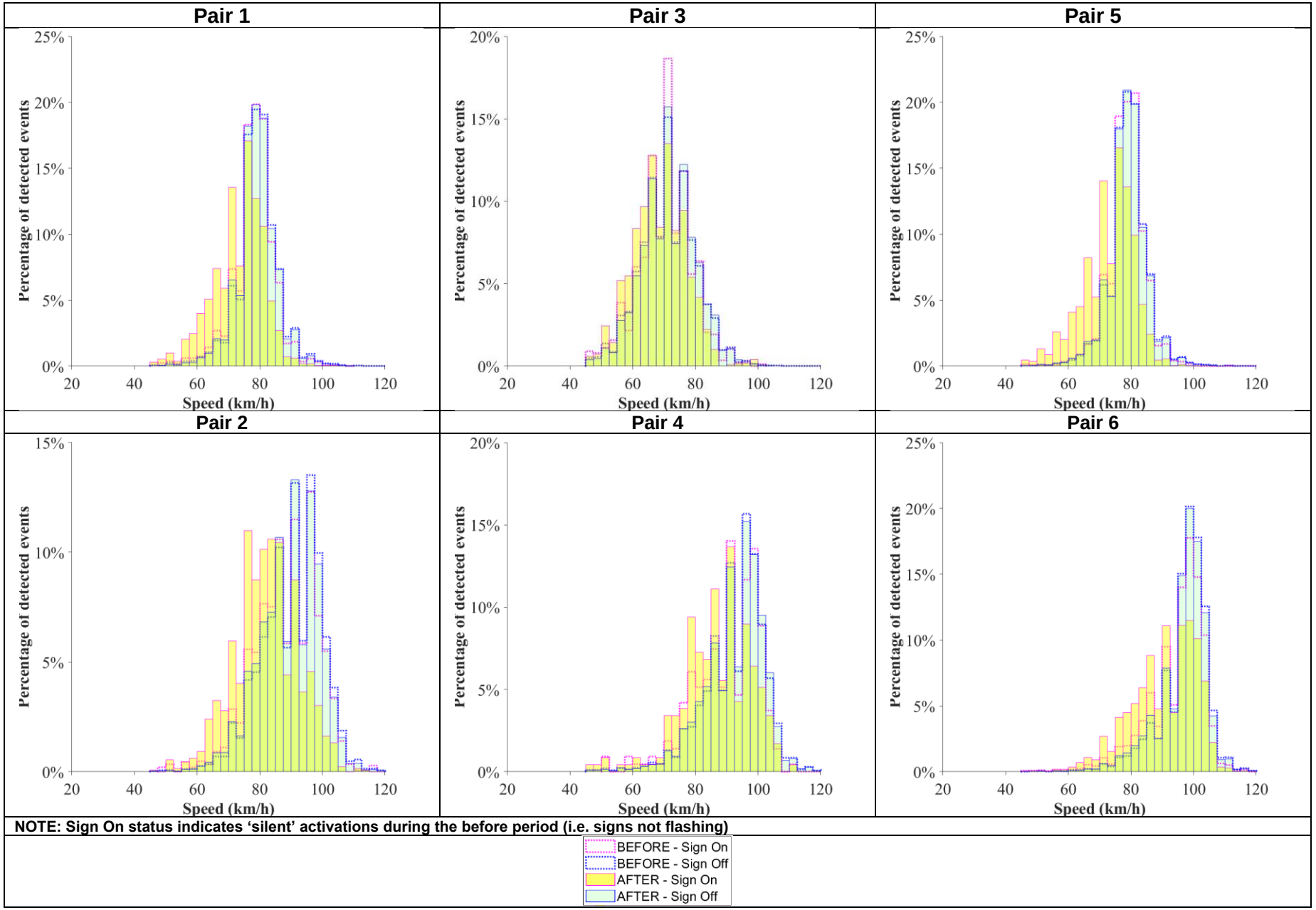
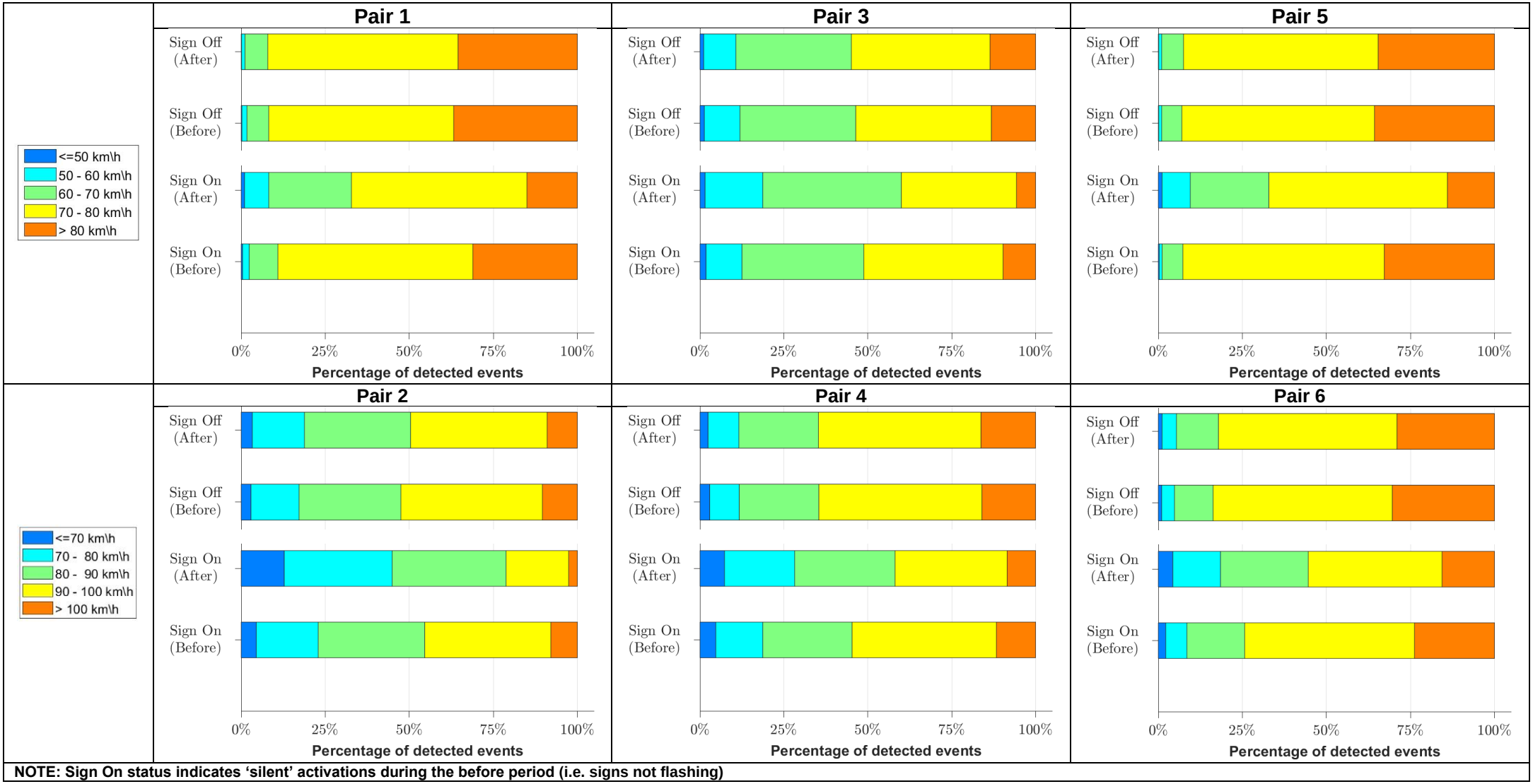


Figure D.1
Distributions of travel speeds on **approach** to treatment intersections for all vehicles – (Note: no data measured at approach to control intersections)



NOTE: Sign On status indicates 'silent' activations during the before period (i.e. signs not flashing)

Figure D.2
Visual breakdown of travel speeds on the **approach** to treatment intersection by incremental speed ranges (Note: no data measured at approach to control intersections)

Appendix E Analysis of disrupted traffic

This appendix provides the results of the specific analysis on the portion of traffic travelling along the major road which was disrupted by the presence of other vehicles entering the intersection through a right-turn manoeuvre.

E.1 Vehicle detections

The amount of traffic travelling on the major road while another vehicle was entering the intersection is summarised in Tables E.1 and E.2. As previously mentioned, the analysis of disrupted major road traffic was specifically limited to the case of vehicles entering the intersection far-side lane through a right-turn manoeuvre, therefore it was limited to the period when the signs of the RJAWS Lite were activated (i.e. vehicle activity was detected along the minor approach as well as along the major road). The small amount of traffic that was detected to be affected by this type of disruption reflects the relative low frequency at which type of situations occurred.

Table E.1
Disrupted traffic on major road observed at treatment and control intersections for each travel direction
Trial sites with speed limit of 80 km/h (Pairs 1, 3, 5)

Trial Pair	Site Type [1]	Period [2]	Near Side [3]	Far Side [4]
1	T	BF	351	330
		AF	117	80
	C	BF	157	103
		AF	71	38
3	T	BF	103	143
		AF	68	44
	C	BF	239	265
		AF	128	246
5	T	BF	137	18
		AF	74	47
	C	BF	100	22
		AF	108	32

[1] Site Type: Treatment (T) / Control (T)
[2] Trial Period: Before (BF) / After (AF)
[3] Travel lane on major road that is close to the minor road
[4] Travel lane on major road that is further from the minor road

Table E.2
Disrupted traffic on major road observed at treatment and control intersections for each travel direction
Trial sites with speed limit of 80 km/h (Pairs 2, 4, 6)

Trial Pair	Site Type [1]	Period [2]	Near Side [3]	Far Side [4]
2	T	BF	221	11
		AF	46	3
	C	BF	52	8
		AF	41	5
4	T	BF	32	4
		AF	11	1
	C	BF	705	81
		AF	603	262
6	T	BF	1,045	78
		AF	731	51
	C	BF	568	131
		AF	473	89

[1]) Site Type: Treatment (T) / Control (T)
[2] Trial Period: Before (BF) / After (AF)
[3] Travel lane on major road that is close to the minor road
[4] Travel lane on major road that is further from the minor road

E.2 Speed along major road approaches

This section provides the results of the speed analysis for **disrupted** traffic travelling along the major road at each of the trial sites.

E.2.1 Descriptive statistics

The values of the mean speeds that were measured either in proximity or along the approach to each of the six treated intersections are reported in Tables E.3 and E.4. The 85thpercentile speeds are also reported in Tables E.5 and E.6.

Table E.3
Mean speed of all vehicles on approach and proximity to intersections with 80km/h speed limit (disrupted flow) - Trial Pairs 1, 3, 5

Site Type [1]	Sign Status [2]	Trial Period [3]	Pair 1						Pair 3						Pair 5					
			Approach (km/h)			Proximity (km/h)			Approach (km/h)			Proximity (km/h)			Approach (km/h)			Proximity (km/h)		
			Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides
T	ON	BF	78.6	77.1	77.9	76.5	69.6	73.2	70.7	65.0	70.1	67.0	58.7	62.2	78.3	78.5	78.4	76.9	73.9	76.5
		AF	74.9	71.4	73.1	67.2	62.0	65.1	68.7	63.7	68.2	65.0	56.9	61.8	73.0	72.3	72.7	66.7	53.9	61.7
		D	-3.7	-5.6	-4.8	-9.3	-7.6	-8.1	-2.0	-1.3	-1.8	-2.1	-1.8	-0.4	-5.3	-6.3	-5.7	-10.2	-20.0	-14.8
	OFF	BF	79.7	78.1	79.0	78.5	78.5	78.5	72.4	66.7	71.0	69.0	66.7	67.8	79.0	78.9	78.9	78.3	77.0	77.6
		AF	79.8	77.8	78.9	75.7	78.3	77.0	72.7	66.5	71.4	67.7	64.5	66.1	78.5	79.1	78.8	78.1	76.4	77.3
		D	0.1	-0.3	-0.1	-2.9	-0.2	-1.5	0.3	-0.2	0.3	-1.3	-2.2	-1.7	-0.5	0.2	-0.1	-0.3	-0.6	-0.4
C	ON	BF	-	-	-	72.3	67.7	70.4	-	-	-	62.3	54.7	58.3	-	-	-	70.9	70.9	70.9
		AF	-	-	-	72.0	68.6	70.8	-	-	-	60.3	55.0	56.8	-	-	-	71.9	71.0	71.7
		D	-	-	-	-0.2	0.9	0.4	-	-	-	-2.0	0.3	-1.5	-	-	-	1.0	0.1	0.8
	OFF	BF	-	-	-	74.5	78.0	76.3	-	-	-	63.2	60.8	62.0	-	-	-	73.7	76.1	74.9
		AF	-	-	-	74.2	77.5	75.9	-	-	-	61.5	62.8	62.1	-	-	-	73.5	77.5	75.5
		D	-	-	-	-0.3	-0.4	-0.4	-	-	-	-1.7	2.0	0.2	-	-	-	-0.3	1.4	0.5
Controlled D		***ON***	**-**	**-**	**-**	**-9.1**	**-8.5**	**-8.5**	**-**	**-**	**-**	**-0.1**	**-2.1**	**1.1**	**-**	**-**	**-**	**-11.2**	**-20.1**	**-15.6**
		OFF	**-**	**-**	**-**	**-2.6**	**0.2**	**-1.1**	**-**	**-**	**-**	**0.4**	**-4.2**	**-1.9**	**-**	**-**	**-**	**0.0**	**-1.9**	**-0.9**

[1] Site Type: Treatment (T) / Control (T)
[2] Sign status 'ON' indicates 'silent' activations for treatment sites in the before period / 'virtual' activations for control sites at any period
[3] Trial Period: Before (BF) / After (AF) / Variation (D)
[4] Travel lane on major road that is close to the minor road
[5] Travel lane on major road that is further from the minor road

Table E.4
Mean speed of all vehicles on approach and proximity to intersections with a 100km/h speed limit (disrupted flow) - Trial Pairs 2, 4, 6

Site Type [1]	Sign Status [2]	Trial Period [3]	Pair 2						Pair 4						Pair 6					
			Approach (km/h)			Proximity (km/h)			Approach (km/h)			Proximity (km/h)			Approach (km/h)			Proximity (km/h)		
			Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides
T	ON	BF	86.3	90.4	88.0	88.9	83.0	88.6	89.7	90.2	89.9	89.4	72.6	87.5	92.7	98.4	94.4	94.8	86.5	94.3
		AF	80.2	84.4	81.8	78.4	59.5	77.2	86.1	89.1	86.7	81.4	86.7	81.8	89.0	94.1	90.3	89.6	75.8	88.7
		D	-6.1	-6.0	-6.2	-10.5	-23.4	-11.4	-3.7	-1.1	-3.2	-8.0	14.1	-5.7	-3.8	-4.4	-4.1	-5.2	-10.7	-5.5
	OFF	BF	87.9	91.7	89.9	89.7	89.6	89.7	93.1	90.9	92.2	88.0	95.1	91.4	93.3	98.6	96.6	95.5	95.0	95.2
		AF	87.4	91.0	89.2	88.5	87.8	88.1	93.2	90.9	92.3	87.9	94.5	91.1	93.6	98.1	96.3	95.6	93.5	94.3
		D	-0.5	-0.7	-0.6	-1.2	-1.8	-1.5	0.1	0.0	0.1	-0.1	-0.6	-0.3	0.3	-0.5	-0.4	0.0	-1.5	-0.9
C	ON	BF	-	-	-	88.9	81.8	87.9	-	-	-	93.4	81.0	92.1	-	-	-	92.9	77.9	90.1
		AF	-	-	-	90.9	69.6	88.6	-	-	-	94.3	65.9	85.7	-	-	-	92.3	77.5	89.9
		D	-	-	-	2.0	-12.2	0.6	-	-	-	0.9	-15.1	-6.4	-	-	-	-0.6	-0.4	-0.1
	OFF	BF	-	-	-	88.9	96.3	92.5	-	-	-	93.9	96.1	95.1	-	-	-	93.5	90.7	92.1
		AF	-	-	-	88.4	96.7	92.4	-	-	-	95.2	96.0	95.6	-	-	-	92.8	91.1	91.9
		D	-	-	-	-0.5	0.4	-0.1	-	-	-	1.2	-0.1	0.5	-	-	-	-0.7	0.4	-0.2
Controlled D		***ON***	**-**	**-**	**-**	**-12.5**	**-11.3**	**-12.0**	**-**	**-**	**-**	**-9.0**	**29.2**	**0.7**	**-**	**-**	**-**	**-4.6**	**-10.3**	**-5.4**
		OFF	**-**	**-**	**-**	**-0.7**	**-2.2**	**-1.5**	**-**	**-**	**-**	**-1.3**	**-0.5**	**-0.9**	**-**	**-**	**-**	**0.8**	**-1.9**	**-0.7**

[1] Site Type: Treatment (T) / Control (T)
[2] Sign status 'ON' indicates 'silent' activations for treatment sites in the before period / 'virtual' activations for control sites at any period
[3] Trial Period: Before (BF) / After (AF) / Variation (D)
[4] Travel lane on major road that is close to the minor road
[5] Travel lane on major road that is further from the minor road

Table E.5

85th percentile speed of all vehicles on approach and proximity to intersections with a 50km/h speed limit (disrupted flow) - Trial Pairs 1, 3, 5

Site Type [1]	Sign Status [2]	Trial Period [3]	Pair 1						Pair 3						Pair 5					
			Approach (km/h)			Proximity (km/h)			Approach (km/h)			Proximity (km/h)			Approach (km/h)			Proximity (km/h)		
			Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides
T	ON	BF	84.0	83.0	83.0	81.5	77.7	80.3	79.0	71.0	79.0	74.0	66.4	71.7	83.0	83.0	83.0	82.4	79.6	81.9
		AF	82.0	80.0	81.0	76.2	72.9	75.8	77.0	73.0	76.0	76.1	64.8	71.5	80.0	80.0	80.0	78.7	69.1	77.0
		D	-2.0	-3.0	-2.0	-5.3	-4.8	-4.5	-2.0	2.0	-3.0	2.1	-1.6	-0.2	-3.0	-3.0	-3.0	-3.6	-10.5	-4.8
	OFF	BF	86.0	83.0	85.0	84.2	83.8	84.0	81.0	75.0	80.0	78.5	76.3	77.5	84.0	84.0	84.0	83.5	81.9	82.7
		AF	86.0	83.0	84.0	81.4	84.5	83.3	81.0	75.0	80.0	78.4	74.9	76.8	84.0	84.0	84.0	83.7	81.9	82.9
		D	0.0	0.0	-1.0	-2.8	0.7	-0.6	0.0	0.0	0.0	-0.2	-1.4	-0.6	0.0	0.0	0.0	0.2	-0.1	0.1
C	ON	BF	-	-	-	77.5	79.2	78.2	-	-	-	69.6	62.1	66.3	-	-	-	77.1	78.1	77.2
		AF	-	-	-	77.7	77.5	77.6	-	-	-	69.5	62.0	64.6	-	-	-	78.6	78.9	78.7
		D	-	-	-	0.2	-1.7	-0.6	-	-	-	-0.2	-0.1	-1.7	-	-	-	1.5	0.8	1.5
	OFF	BF	-	-	-	79.7	83.0	81.8	-	-	-	71.0	68.6	69.9	-	-	-	80.4	82.7	81.6
		AF	-	-	-	79.7	82.8	81.5	-	-	-	69.7	70.5	70.1	-	-	-	79.9	84.0	82.3
		D	-	-	-	0.0	-0.2	-0.3	-	-	-	-1.3	1.9	0.2	-	-	-	-0.5	1.4	0.7
Controlled D		***ON***	**-**	**-**	**-**	**-5.4**	**-3.1**	**-4.0**	**-**	**-**	**-**	**2.2**	**-1.6**	**1.5**	**-**	**-**	**-**	**-5.1**	**-11.3**	**-6.3**
		OFF	**-**	**-**	**-**	**-2.8**	**0.9**	**-0.3**	**-**	**-**	**-**	**1.1**	**-3.3**	**-0.8**	**-**	**-**	**-**	**0.8**	**-1.5**	**-0.5**

[1] Site Type: Treatment (T) / Control (T)

[2] Sign status 'ON' indicates 'silent' activations for treatment sites in the before period / 'virtual' activations for control sites at any period

[3] Trial Period: Before (BF) / After (AF) / Variation (D)

[4] Travel lane on major road that is close to the minor road

[5] Travel lane on major road that is further from the minor road

Table E.6

85th percentile speed of all vehicles on approach and proximity to intersections with a 100km/h speed limit (disrupted flow) - Trial Pairs 2, 4, 6

Site Type [1]	Sign Status [2]	Trial Period [3]	Pair 2						Pair 4						Pair 6					
			Approach (km/h)			Proximity (km/h)			Approach (km/h)			Proximity (km/h)			Approach (km/h)			Proximity (km/h)		
			Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides	Near Side [4]	Far Side [5]	Both Sides
T	ON	BF	97.0	99.0	99.0	97.7	93.8	97.5	100.0	99.0	99.4	98.2	99.8	98.4	102.0	103.0	103.0	100.9	99.4	100.9
		AF	91.0	95.0	92.0	90.0	82.2	89.7	99.0	98.6	99.0	94.3	86.7	93.0	100.0	103.0	101.0	100.7	96.8	100.5
		D	-6.0	-4.0	-7.0	-7.7	-11.6	-7.8	-1.0	-0.4	-0.4	-3.9	-13.2	-5.4	-2.0	0.0	-2.0	-0.2	-2.6	-0.4
	OFF	BF	99.0	100.0	99.0	99.1	99.0	99.0	102.0	99.0	101.0	99.2	103.7	101.8	102.0	103.0	103.0	101.6	100.3	101.0
		AF	98.0	99.0	99.0	98.8	98.0	98.4	102.0	99.0	101.0	100.0	104.0	102.3	102.0	103.0	103.0	102.5	100.1	101.2
		D	-1.0	-1.0	0.0	-0.3	-1.0	-0.7	0.0	0.0	0.0	0.8	0.3	0.5	0.0	0.0	0.0	1.0	-0.2	0.3
C	ON	BF	-	-	-	100.4	103.4	101.8	-	-	-	98.9	98.3	98.9	-	-	-	101.5	95.7	100.9
		AF	-	-	-	100.2	91.0	99.0	-	-	-	100.0	84.4	99.4	-	-	-	101.5	96.5	101.1
		D	-	-	-	-0.2	-12.3	-2.7	-	-	-	1.1	-13.9	0.5	-	-	-	-0.1	0.8	0.2
	OFF	BF	-	-	-	99.8	104.8	102.7	-	-	-	99.4	101.1	100.4	-	-	-	102.0	99.6	100.9
		AF	-	-	-	99.2	105.4	103.0	-	-	-	100.8	101.2	101.0	-	-	-	101.2	100.3	100.8
		D	-	-	-	-0.6	0.5	0.3	-	-	-	1.4	0.1	0.7	-	-	-	-0.7	0.7	-0.1
Controlled D		***ON***	**-**	**-**	**-**	**-7.5**	**0.7**	**-5.0**	**-**	**-**	**-**	**-5.0**	**0.8**	**-5.9**	**-**	**-**	**-**	**-0.2**	**-3.3**	**-0.6**
		OFF	**-**	**-**	**-**	**0.3**	**-1.5**	**-1.0**	**-**	**-**	**-**	**-0.6**	**0.2**	**-0.2**	**-**	**-**	**-**	**1.7**	**-1.0**	**0.4**

[1] Site Type: Treatment (T) / Control (T)

[2] Sign status 'ON' indicates 'silent' activations for treatment sites in the before period / 'virtual' activations for control sites at any period

[3] Trial Period: Before (BF) / After (AF) / Variation (D)

[4] Travel lane on major road that is close to the minor road

[5] Travel lane on major road that is further from the minor road

E.2.2 Compliance to advised speed limit when lights are flashing

The proportions of vehicles travelling on the major road at speeds equal or below various threshold values when travelling in proximity to the trial intersections with a speed limit of 80 km/h and 100 km/h are provided in Tables E.7 and E.8, respectively. Vehicle proportions are presented separately for the cases with flashing and blank lights on the major road advisory signs. For simplicity and conciseness, speeds measured along the two directions of travel along the major road have been aggregated together.

Table E.7
Vehicle proportion below various speed thresholds in **proximity** to intersections with 80km/h speed limit (disrupted flow) - Trial Pairs 1, 3, 5

c	Sign Status [2]	Trial Period [3]	Pair 1					Pair 3					Pair 5				
			<= 50 km/h	<= 60 km/h	<= 70 km/h	<= 80 km/h	> 80 km/h	<= 50 km/h	<= 60 km/h	<= 70 km/h	<= 80 km/h	> 80 km/h	<= 50 km/h	<= 60 km/h	<= 70 km/h	<= 80 km/h	> 80 km/h
T	ON	BF	0.4	2.4	10.9	68.9	31.1	1.8	12.5	48.8	90.3	9.7	0.3	1.1	7.3	67.2	32.8
		AF	1.0	8.2	32.8	85.0	15.0	1.5	18.7	60.0	94.3	5.7	1.1	9.5	32.9	86.0	14.0
		D	0.6	5.8	21.9	16.1	-16.1	-0.3	6.2	11.2	4.0	-4.0	0.8	8.4	25.6	18.8	-18.8
	OFF	BF	0.2	1.7	8.2	63.2	36.8	1.3	11.9	46.4	86.8	13.2	0.1	1.0	7.0	64.3	35.7
		AF	0.1	1.1	7.9	64.5	35.5	1.1	10.7	45.1	86.4	13.6	0.1	1.0	7.5	65.4	34.6
		D	-0.1	-0.6	-0.3	1.3	-1.3	-0.2	-1.2	-1.3	-0.4	0.4	0.0	0.0	0.5	1.1	-1.1
C	ON	BF	5.0	10.4	36.9	90.8	9.2	15.1	57.9	93.5	99.6	0.4	2.5	7.4	38.5	92.6	7.4
		AF	3.7	8.3	36.7	91.7	8.3	20.3	68.4	93.6	99.5	0.5	2.1	7.9	33.6	90.7	9.3
		D	-1.3	-2.1	-0.2	0.9	-0.9	5.2	10.5	0.1	-0.1	0.1	-0.4	0.5	-4.9	-1.9	1.9
	OFF	BF	0.1	1.0	13.2	74.8	25.2	5.9	40.9	85.2	98.7	1.3	0.5	3.4	22.4	78.0	22.0
		AF	0.2	1.3	15.6	76.9	23.1	5.6	40.5	84.6	98.6	1.4	0.3	2.6	20.9	75.4	24.6
		D	0.1	0.3	2.4	2.1	-2.1	-0.3	-0.4	-0.6	-0.1	0.1	-0.2	-0.8	-1.5	-2.6	2.6
Controlled D		***ON***	**1.9**	**7.9**	**22.1**	**15.2**	**-15.2**	**-5.5**	**-4.3**	**11.1**	**4.1**	**-4.1**	**1.2**	**7.9**	**30.5**	**20.7**	**-20.7**
		OFF	**-0.2**	**-0.9**	**-2.7**	**-0.8**	**0.8**	**0.1**	**-0.8**	**-0.7**	**-0.3**	**0.3**	**0.2**	**0.8**	**2.0**	**3.7**	**-3.7**

[1] Site Type: Treatment (T) / Control (T)
[2] Sign status 'ON' indicates 'silent' activations for treatment sites in the before period / 'virtual' activations for control sites at any period
[3] Trial Period: Before (BF) / After (AF) / Variation (D)

Table E.8
Vehicle proportion below various speed thresholds in **proximity** to intersections with 100km/h speed limit (disrupted flow) - Trial Pairs 2, 4, 6

c	Sign Status [2]	Trial Period [3]	Pair 2					Pair 4					Pair 6				
			<= 50 km/h	<= 60 km/h	<= 70 km/h	<= 80 km/h	> 80 km/h	<= 50 km/h	<= 60 km/h	<= 70 km/h	<= 80 km/h	> 80 km/h	<= 50 km/h	<= 60 km/h	<= 70 km/h	<= 80 km/h	> 80 km/h
T	ON	BF	4.5	22.9	54.6	92.1	7.9	4.7	18.7	45.3	88.3	11.7	2.2	8.5	25.7	76.2	23.8
		AF	12.8	44.9	78.8	97.4	2.6	7.3	28.2	58.1	91.5	8.5	4.3	18.5	44.6	84.4	15.6
		D	8.3	22.0	24.2	5.3	-5.3	2.6	9.5	12.8	3.2	-3.2	2.1	10.0	18.9	8.2	-8.2
	OFF	BF	2.9	17.2	47.5	89.6	10.4	2.9	11.7	35.4	84.0	16.0	1.0	4.8	16.3	69.6	30.4
		AF	3.3	18.8	50.4	91.0	9.0	2.4	11.6	35.3	83.7	16.3	1.1	5.4	17.9	71.0	29.0
		D	0.4	1.6	2.9	1.4	-1.4	-0.5	-0.1	-0.1	-0.3	0.3	0.1	0.6	1.6	1.4	-1.4
C	ON	BF	16.7	23.3	40.0	83.3	16.7	3.9	10.3	23.0	90.2	9.8	6.6	14.9	39.9	81.8	18.2
		AF	8.7	21.7	37.0	87.0	13.0	25.0	28.7	40.5	89.0	11.0	7.1	17.8	39.0	80.6	19.4
		D	-8.0	-1.6	-3.0	3.7	-3.7	21.1	18.4	17.5	-1.2	1.2	0.5	2.9	-0.9	-1.2	1.2
	OFF	BF	6.5	11.6	30.1	73.7	26.3	1.2	3.8	15.2	83.1	16.9	2.9	11.5	35.2	81.2	18.8
		AF	6.6	11.8	30.6	73.5	26.5	1.4	4.3	14.3	78.7	21.3	3.4	12.1	35.2	81.6	18.4
		D	0.1	0.2	0.5	-0.2	0.2	0.2	0.5	-0.9	-4.4	4.4	0.5	0.6	0.0	0.4	-0.4
Controlled D		***ON***	**16.3**	**23.6**	**27.2**	**1.6**	**-1.6**	**-18.5**	**-8.9**	**-4.7**	**4.4**	**-4.4**	**1.6**	**7.1**	**19.8**	**9.4**	**-9.4**
		OFF	**0.3**	**1.4**	**2.4**	**1.6**	**-1.6**	**-0.7**	**-0.6**	**0.8**	**4.1**	**-4.1**	**-0.4**	**0.0**	**1.6**	**1.0**	**-1.0**

[1] Site Type: Treatment (T) / Control (T)
[2] Sign status 'ON' indicates 'silent' activations for treatment sites in the before period / 'virtual' activations for control sites at any period
[3] Trial Period: Before (BF) / After (AF) / Variation (D)

E.3 Risk of casualty crashes

The potential risk of a crash between the major road traffic and a vehicle entering the intersection to result in fatality or serious injury at each of the six pairs of trial sites is listed in Table E.9. The table provides the average risk of being involved in a casualty crash relative to a baseline risk associated to travelling through the intersection at the default speed limit. Note that the baseline risk used in the calculation of the relative risk was based on the default speed limit independently of the sign status. This relative risk was calculated separately for the two scenarios of vehicles travelling through the intersection with either the major road sign illuminated or blank. A comparison of the casualty risk between these two scenarios is provided by the ratio of the risks with illuminated and blank signs (see column *ONvsOFF Ratio* in the table). Most importantly, the table also provides the risk evaluated before as well as after the activation of the RJAWS Lite at the six treatment sites. A comparison of the risk between these two periods is provided by their ratio and the associated change (see row *Before-After change* in the table).

Table E.9
Average relative risks of being involved in a casualty crash before and after the RJAWS Lite activation (with corresponding ratios) – Disrupted traffic

Site Type [1]	Trial Period [2]	Average Relative Risk (%)																	
		Trial Pair 1			Trial Pair 2			Trial Pair 3			Trial Pair 4			Trial Pair 5			Trial Pair 6		
		Risk ON	Risk OFF	ONvsOFF Ratio	Risk ON	Risk OFF	ONvsOFF Ratio	Risk ON	Risk OFF	ONvsOFF Ratio	Risk ON	Risk OFF	ONvsOFF Ratio	Risk ON	Risk OFF	ONvsOFF Ratio	Risk ON	Risk OFF	ONvsOFF Ratio
T	BF	77.0	109.6	0.70	59.3	66.3	0.90	43.0	62.1	0.93	61.9	81.0	0.98	86.0	99.8	0.94	81.0	86.0	0.96
	AF	51.9	98.9	0.52	37.0	62.0	0.71	43.1	57.2	0.93	53.9	85.2	0.64	49.3	100.0	0.67	72.3	84.0	0.84
	Ratio	0.67	0.90	-	0.62	0.94	-	1.00	0.92	-	0.87	1.05	-	0.57	1.00	-	0.89	0.98	-
	Before-After change (%)	-32.6	-9.8	-	-37.6	-6.5	-	0.2	-7.9	-	-12.9	5.2	-	-42.7	0.2	-	-10.7	-2.3	-
C	BF	63.7	88.3	0.94	75.7	87.2	0.91	35.7	42.0	0.94	70.5	83.8	0.96	64.7	90.0	0.93	71.2	78.8	0.91
	AF	63.9	93.6	1.00	68.6	88.7	0.92	34.1	42.3	0.95	63.8	87.6	0.92	66.9	93.9	0.92	72.4	77.7	0.92
	Ratio	1.00	1.06	-	0.91	-		0.96	1.01	-	0.90	1.05	-	1.03	1.04	-	1.02	0.99	-
	Before-After change (%)	0.3	6.0	-	-9.4	1.7		-4.5	0.7	-	-9.5	4.5	-	3.4	4.3	-	1.7	-1.4	-
Controlled D		**-32.9**	**-15.8**	**-**	**-28.2**	**-8.2**		**4.7**	**-8.6**	**-**	**-3.4**	**0.7**	**-**	**-46.1**	**-4.1**	**-**	**-12.4**	**-0.9**	**-**

[1] Site Type: Treatment (T) / Control (T)
[2] Trial Period: Before (BF) / After (AF)