Figure 5 Lady Denman Drive southbound queueing (looking from Cotter Road signalised intersection)

3.3 Dudley Street

Dudley Street is a two-lane road section, and operates at 60 km/h road speed limit. Similar to Cotter Road on-ramp issue at Yarra Glen, traffic on Dudley Street is also experiencing difficulties to exit the roundabout intersection at Kent Street. As such, the eastbound traffic often extends back to Cotter Road intersection, with occasional spilling onto through traffic lanes (see **Figure 6**).

Figure 6 Dudley Street queueing towards Yarralumla (looking from Cotter Road signalised intersection)

4 Cotter Road On-ramp Option

4.1 On-ramp Option

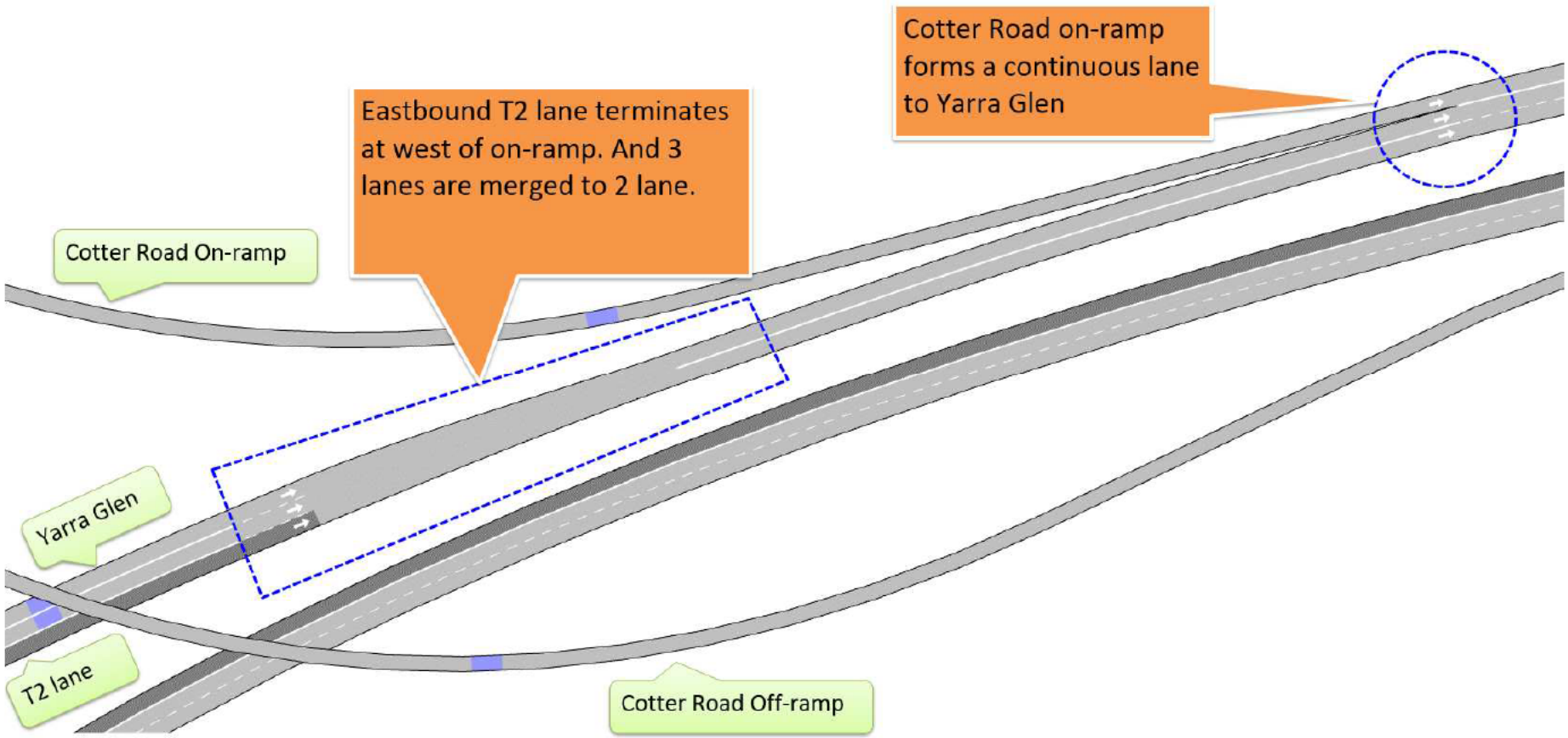
To alleviate the congestion issue, an option of replacing the existing give-way on-ramp merging lane with a continuous lane is considered (see **Figure 7**). With this option, it is anticipated the traffic will flow freely onto Yarra Glen and therefore improves traffic flow conditions on Cotter Road.

4.2 T2 lane changes

In order to form Cotter Road on-ramp to a continuous lane, it is also proposed to terminate the eastbound T2 lane on Yarra Glen section between the west of Cotter Road on-ramp merge and the east of Hopetoun Circuit on-ramp, and merge 3 lanes into 2 lane. This way the on-ramp lane can be aligned to Yarra Glen left lane to form a continuous lane (see **Figure 7**).

The lane transition and merging arrangements should be examined in the design stage.

Figure 7 Cotter Road on-ramp option – A continuous lane to Yarra Glen



(Note: This is a conceptual layout only. The lane merging arrangements and alignments should be further examined during the Design Stage.)

5 Modelling Study

5.1 Microsimulation Modelling

A microsimulation modelling study was undertaken to assess the effectiveness of proposed on-ramp option. As part of the study, the following models are developed:

- Base model – a traffic network model which represents the existing road lane infrastructure, traffic management & operation. This base model generally mimics the current traffic flow conditions on the road network such as queueing, delays, travel times.
- Option model – a traffic network model which includes the 'continuous on-ramp lane connection to Yarra Glen' option to the base model.

Upon developing the base and option models, the key traffic flow outputs such as queues, delays, density, travel speed are compared to assess the effectiveness of on-ramp continuous lane option.

5.2 Base Model

5.2.1 Road network

Figure 8 shows the modelling road network which includes:

- Cotter Road section from the west of Ladyman Drive
- Yarra Glen from south of Carruthers Street to east of Hopetoun Circuit ramps
- Dudley Street
- Kent Street near the bridge section and ramps
- Hopetoun Circuit and ramps

The modelled road network is included current lane infrastructure, capacity, and the road speed limits. All the non-signalised intersections are modelled with appropriate give-way and right of way parameters to ensure queues and delays are replicated as per the existing traffic conditions.

5.2.2 Public transport

Based on the information available from Transport Canberra and Google, public transport services and frequencies are included in the models.

5.2.3 Signalised intersections

Based on the SCATS data the intersections at Lady Denman Drive and Dudley Street are modelled to ensure models are replicating the current signals operation.

Figure 8 Modelled road network

5.2.4 Calibration and validation

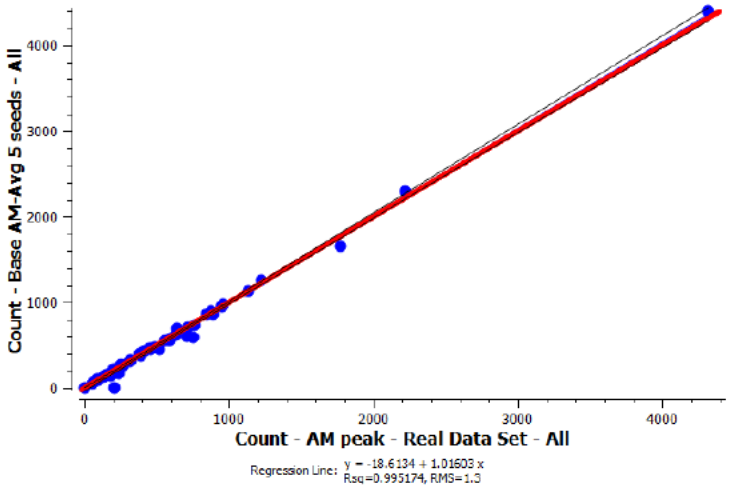
To ensure the base model is replicating the 'real' traffic flow conditions, the modelled traffic volume outputs are compared against the observed traffic data. This process is known as Model Validation. For this purpose, RMS Traffic Modelling Guidelines (2013) details on the GEH [1] and R^2 statistics [2] criteria, and the required targets.

The modelled traffic data volumes from the base model are compared with the observed traffic data using GEH and R^2 statistic criteria. The validation outcomes are illustrated in **Table 1** and **Figure 9**. The results clearly show that the base model met all criteria and therefore considered as 'fit for purpose'.

Table 1 Calibration & Validation criteria

Criteria	Target	Achieved	Criteria met
Percentage of link volumes with GEH ≤ 5	85%	94.55%	Yes
Percentage of link volumes with GEH ≤ 10	100%	100%	Yes
R^2 statistic for observed vs modelled traffic data volumes	0.95	0.995	Yes

Figure 9 R^2 statistic Regression Line for observed and modelled traffic flow



[1] GEH Statistic is a performance measure based on Chi-Square statistic.

$$GEH=\sqrt{\frac{2(M-C)^2}{(M+C)}}$$

where:

M is the modelled traffic flow and
C is the observed traffic flow

GEH less than 5.0 indicates a good match between modelled and observed volumes.
GEH between 5.0 and 10.0 may warrant investigation.
GEH greater than 10.0 indicates a high probability that there is a problem and so requires investigation.

[2] R^2 statistic is also called as Coefficient of Determination and provides a measure of how well the observed outcomes are predicated by the model.

5.2.5 Queuing outputs

The queues displayed in the model simulations are compared with the site observations (**Figure 10** to **Figure 13**), and appear replicating the existing traffic conditions satisfactorily.

Figure 10 Cotter Road on-ramp – Observed vs model queues

Figure 11 Lady Denman Drive southbound (from Cotter Road) – Observed vs model queues

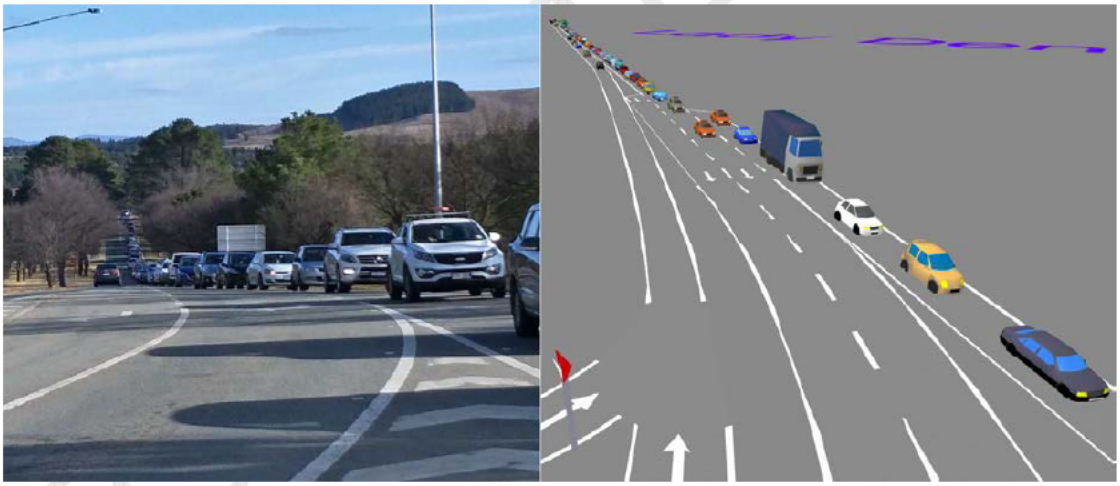


Figure 12 Cotter Road eastbound (from Lady Denman Drive signals) – Observed vs model queues

Figure 13 Dairy Road eastbound (from Cotter Road signals) – Observed vs model queues

5.3 Option Model

Upon validating the base model and confirming that it is replicating the existing traffic flow conditions on the road network with a higher degree of confidence, the proposed on-ramp continuous lane is included to the modelled road network (as shown in **Figure 7**).

6 Analysis

6.1 Analysis

To assess the effectiveness of continuous on-ramp option, key traffic flow outputs such as queues, delays, density, travelling speed from base and option models are compared. The analysis is carried out at:

- Network level – in which whole road network operation is assessed by examining the 'accumulated time spent' and 'average travel speed experienced' by all vehicles when travelling across the network.
- Individual section level – in which traffic operation on a specific road section is assessed by examining the key parameters such as maximum queueing (m), delay (sec/ min), density (vehicles per km), travelling speed (km/h).

6.2 Network Level Analysis

Figure 14 and **Figure 15** illustrate the overall traffic operation across the modelled road network. The results clearly indicate that the traffic flow conditions on Cotter Road eastbound are expected to improve significantly, with less congestion and delays. When compared to the existing/ base operation:

- The total travel time spent (by all vehicles) in the option model has significantly improved by 40 to 70 hours, during the peak of period.
- Also, the average travel speed has improved by 10-15 km/h.

However, with the improved traffic congestion Cotter Road in the option scenario, the destined Dudley Street traffic is expected to reach Cotter Road signalised intersection quickly and join the queuing. As a result, the Dudley Street queueing often expected to spill onto Cotter Road and likely to impede through traffic.

Figure 14 Base Vs Option model – Whole network – Traffic operation

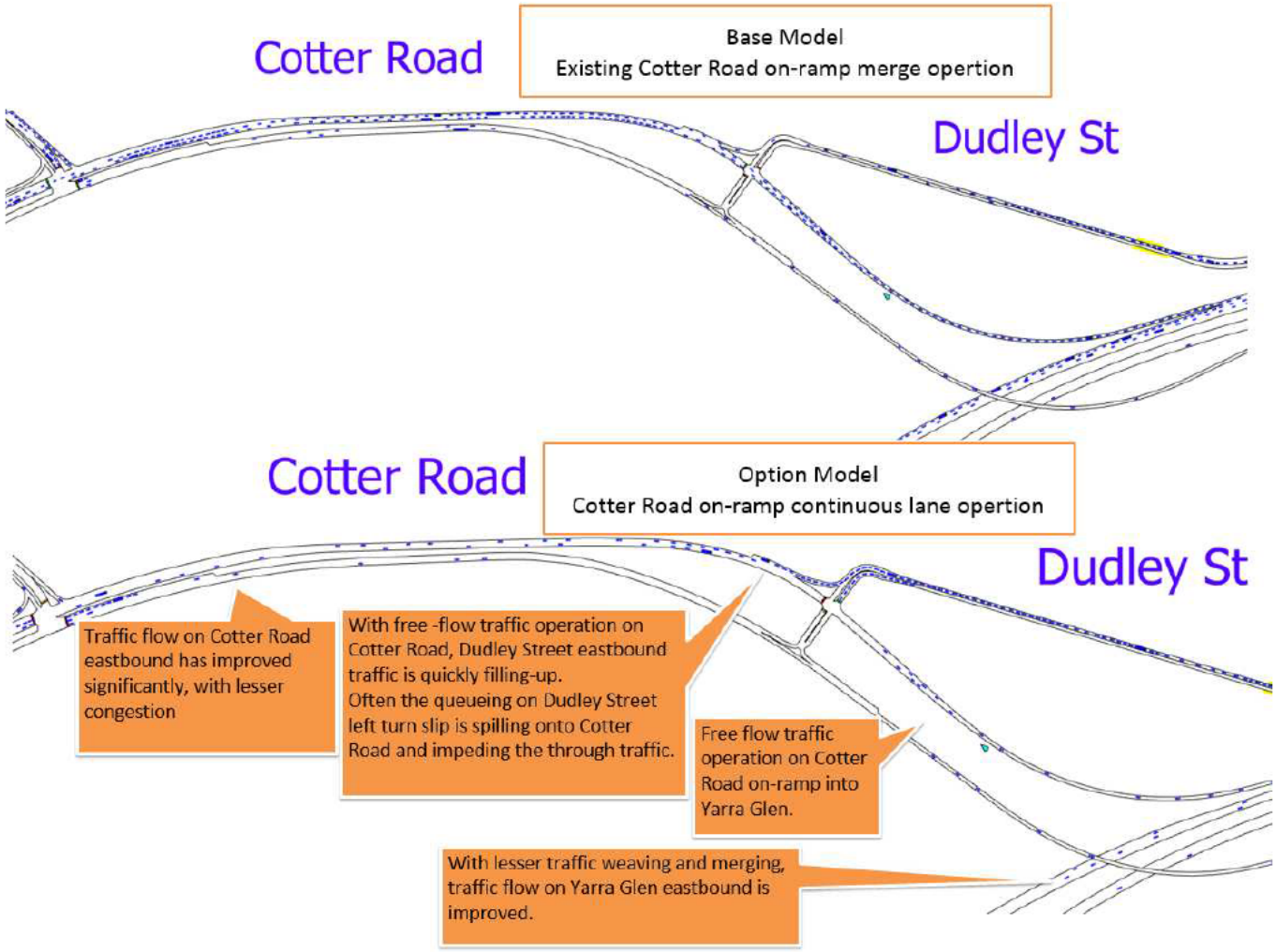
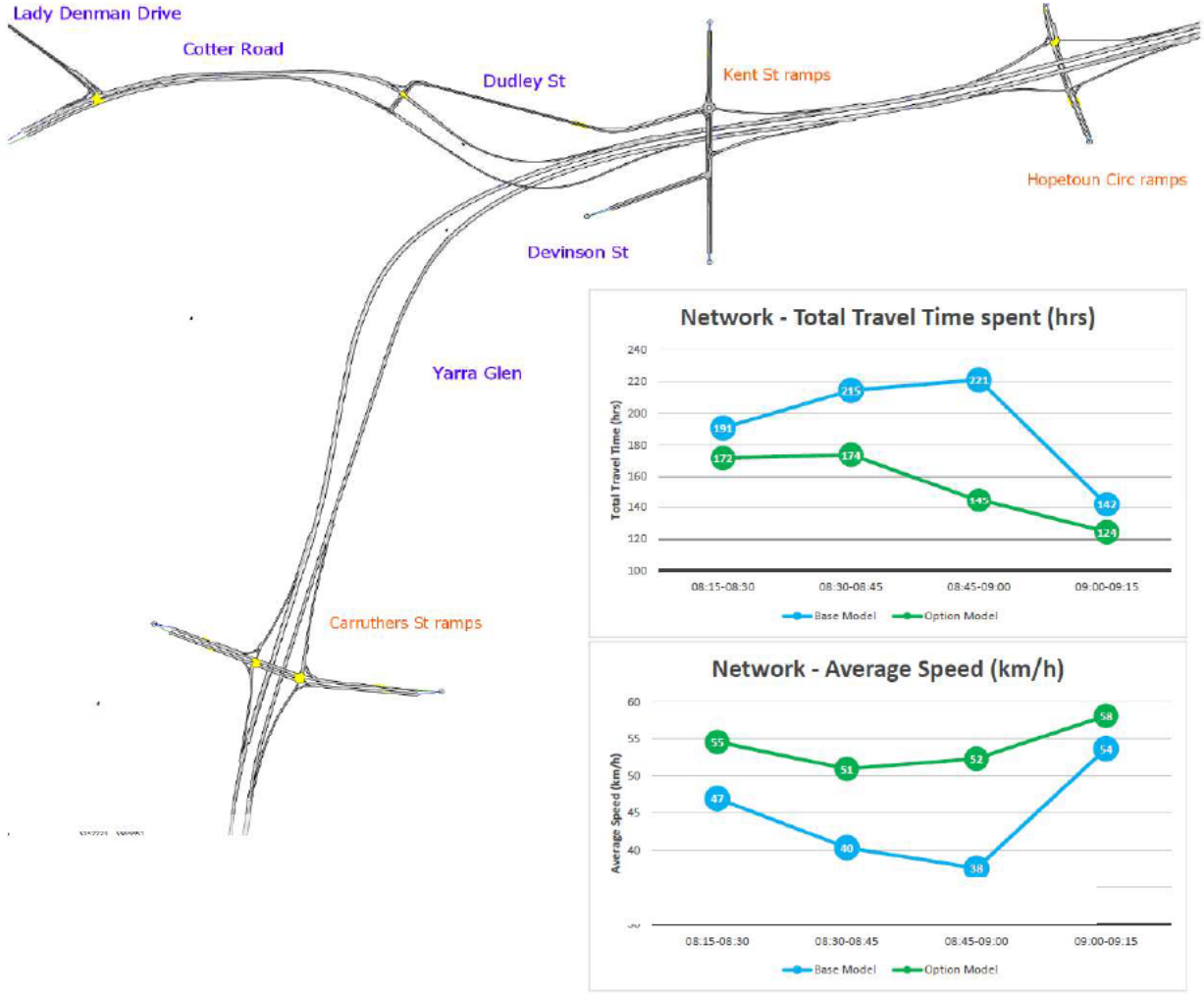


Figure 15 Base Vs Option model – Whole Network – Total Travel Time & Total Hours Spent on the network



6.3 Cotter Road Traffic Operation

Figure 16 to Figure 18 show Cotter Road traffic operation in the existing and option model scenarios. In the option scenario, the traffic operation between Lady Denman Drive and Yarra Glen on-ramp is significantly improved with no congestion. Some of the key improvements in the option scenario model are (shown in **Figure 19**):

- Travel speed is improved from 10-30 km/h to 60 km/h, which suggesting an improved traffic flow conditions.
- Traffic queueing is reduced from 700-850 m to 120-200m.
- Delay time is reduced from 6 minutes to 1 minute, which suggesting an improved traffic flow conditions.
- Traffic density is reduced from 70-105 vehicles per kilometre to 20-25 vehicles, which suggesting the improved traffic congestion.

6.3.1 Public transport Bus operation

Under the option scenario, the public transport bus service is also improved with the reduced delays from 6-8 minutes to 1 minute, and travel speed from 14 km/h to 60 km/h (see **Figure 20**).

Figure 16 Base Vs Option model – Cotter Road on-ramp traffic operation (looking towards Cotter Road off-ramp bridge)

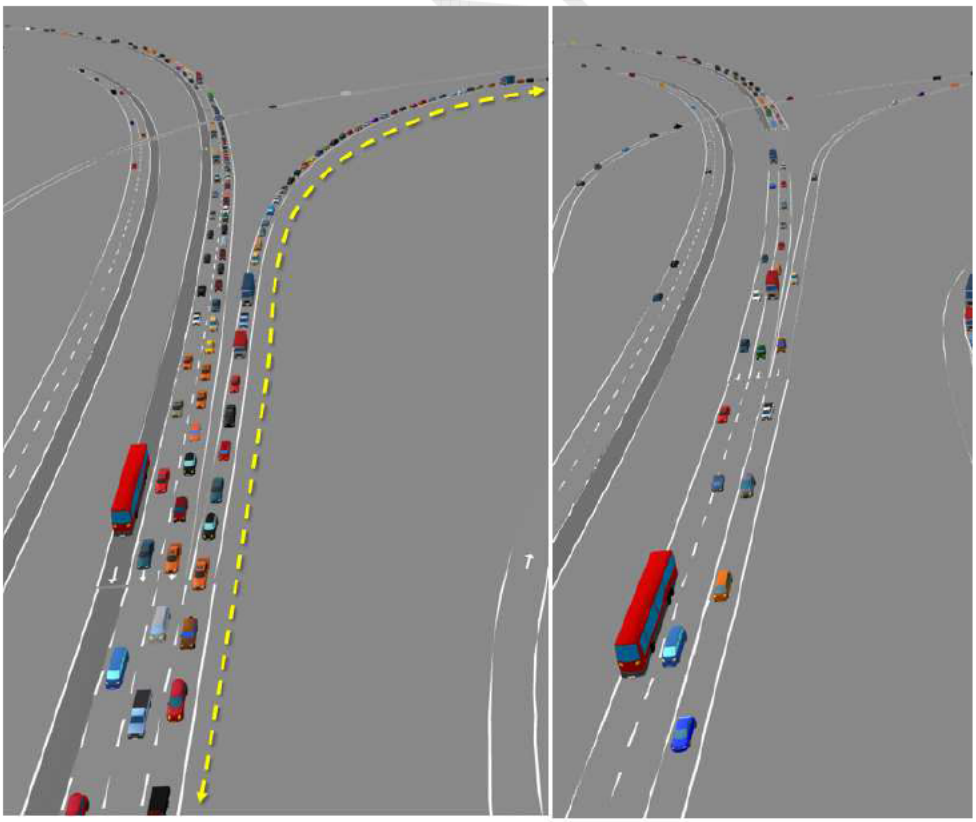


Figure 17 Base Vs Option model – Cotter Road traffic operation near Daley Road (looking towards Lady Denman Drive)

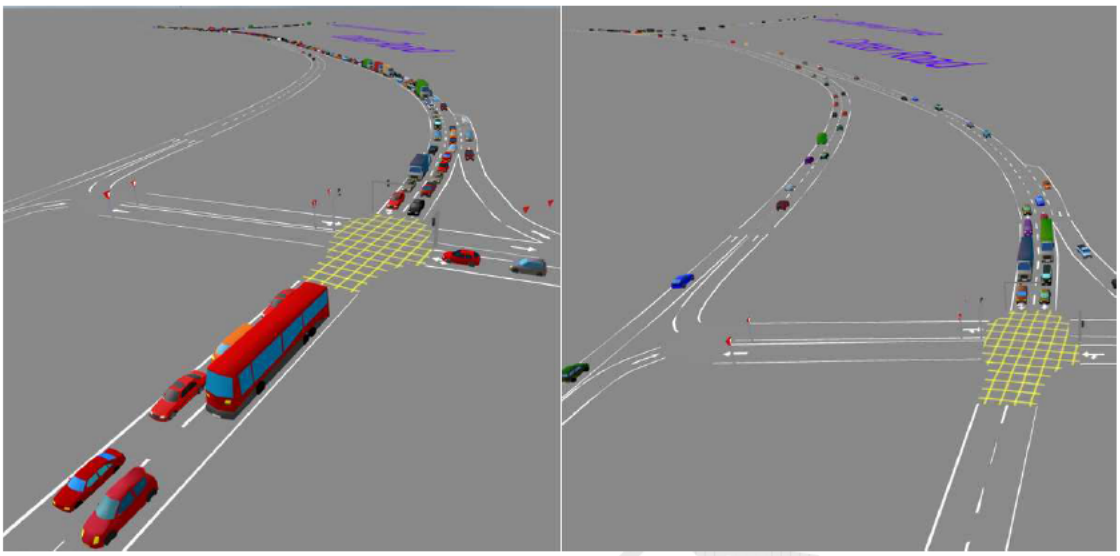


Figure 18 Base Vs Option model – Cotter Road traffic operation near Lady Denman Drive (looking towards McCulloch Street)

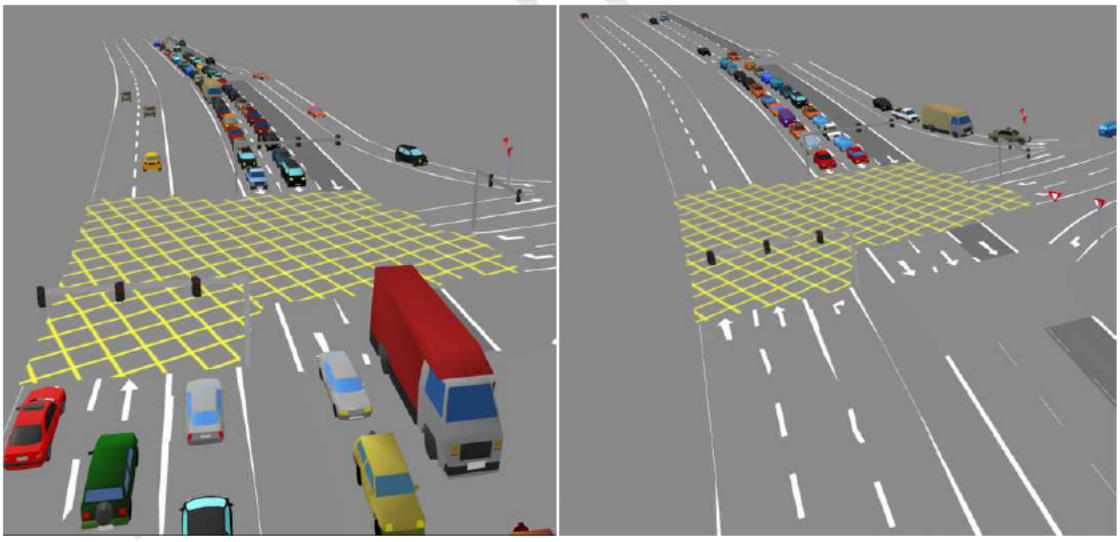


Figure 19 Base Vs Option model – Cotter Road – Travel Speed & Max Queue & Delay Time & Density

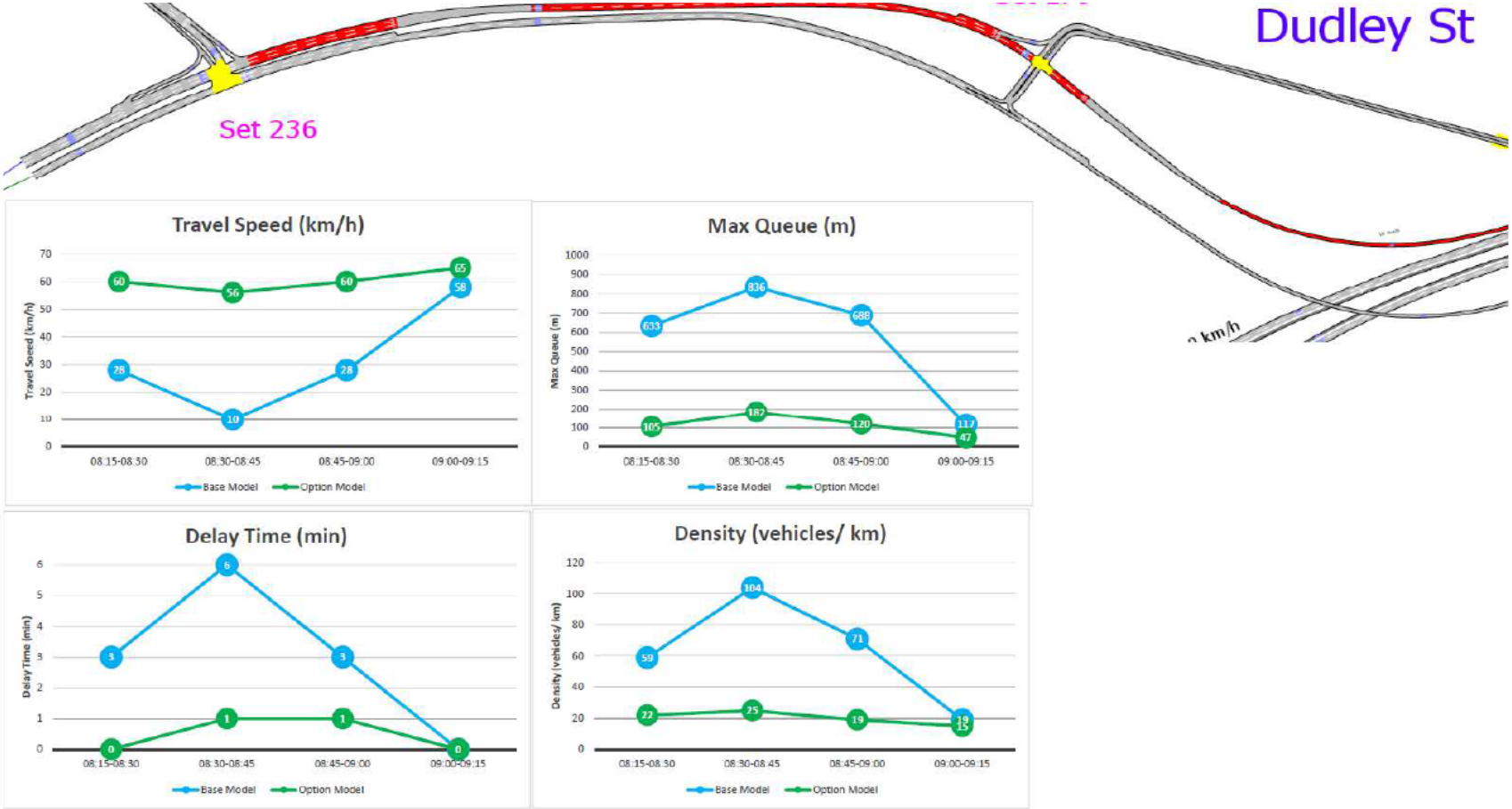
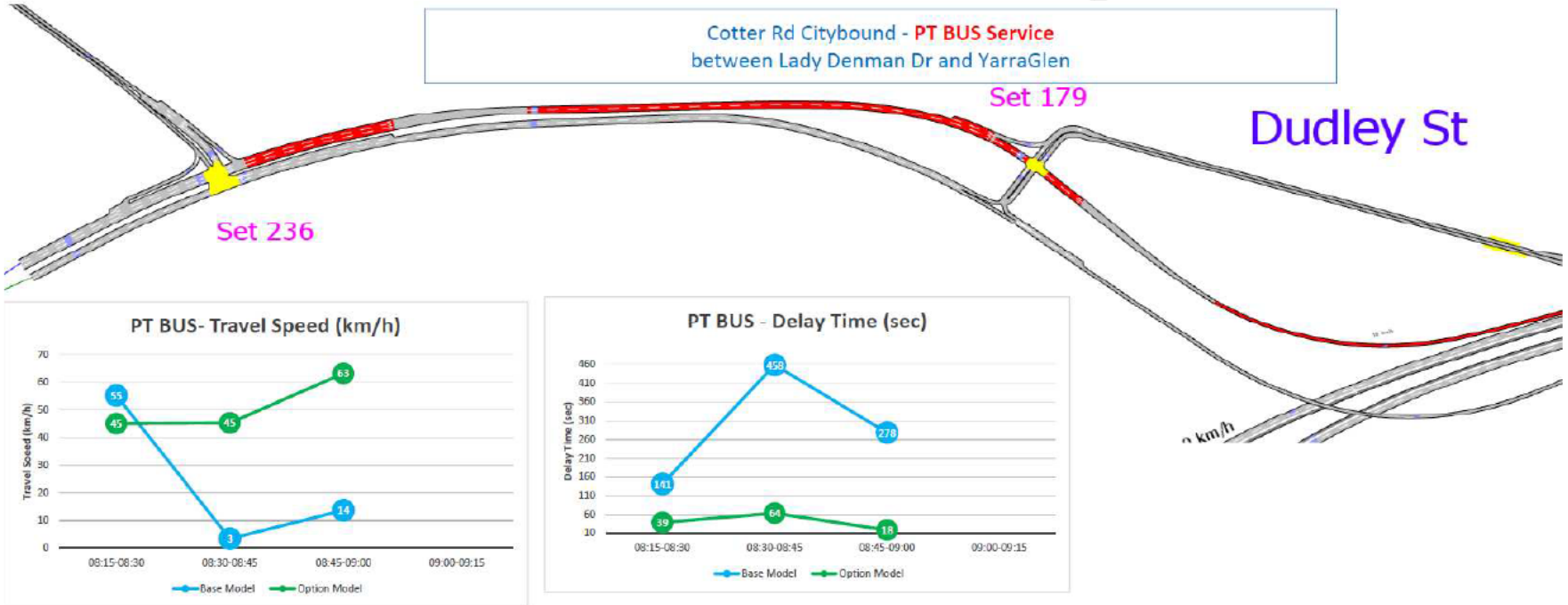


Figure 20 Base Vs Option model – Cotter Road – Public Transport Bus Service - Travel Speed & Delay Time



6.4 Yarra Glen Traffic Operation

Due to the Cotter on-ramp merging traffic, Yarra Glen eastbound traffic is currently experiencing interference and therefore undergoing traffic disruption (especially on left lane) such as lane changing, weaving, merging, and vehicles breaking. Whereas with the proposed option, this traffic disruption is expected to disappear fully as the Cotter Road on-ramp vehicles remain on continuous lane(see **Figure 21**). As a result, the delays are expected to reduce from 1 minute to less than 5 seconds, and travel speed to increase from 45-55 km/h to 70km/h (see **Figure 22**).

6.4.1 Public transport bus transit operation

Figure 23 shows the public transit operation under the existing and option scenarios. The model outputs clearly indicate that the removal T2 lane along Cotter Road eastbound will not impact PT Bus transit operation. Under the option scenario, the travel speed is expected to reduce by 2 km/k (from 67 to 65 km/h), and travel delays by 4 sec max.

Figure 21 Base Vs Option model – Yarra Glen traffic operation near Cotter Road on-ramp (looking towards Cotter Road off-ramp)

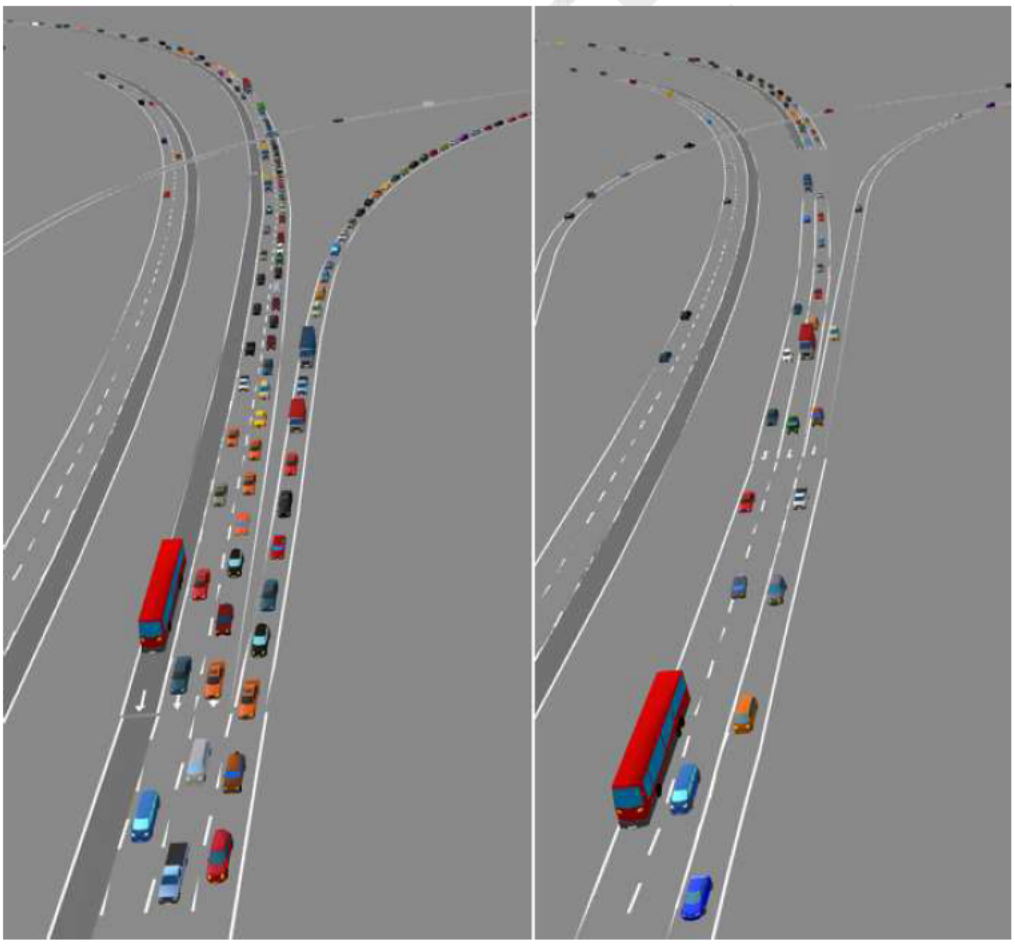
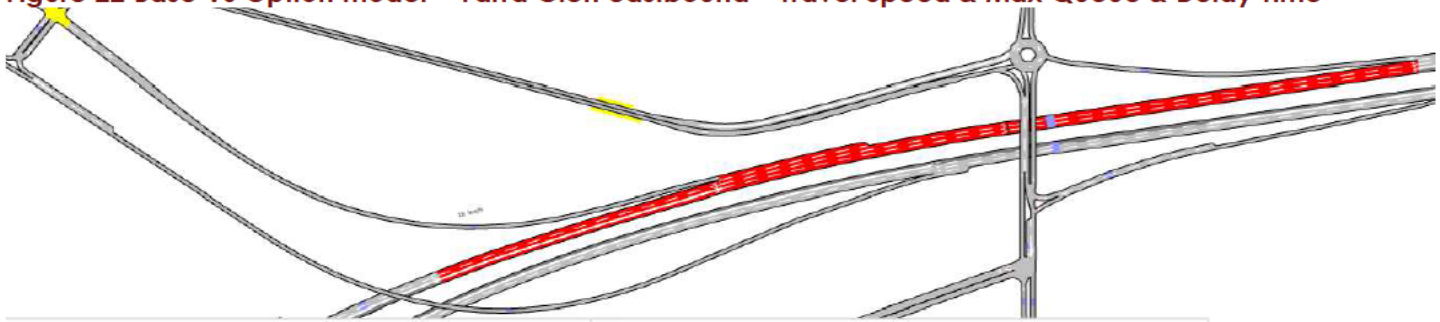
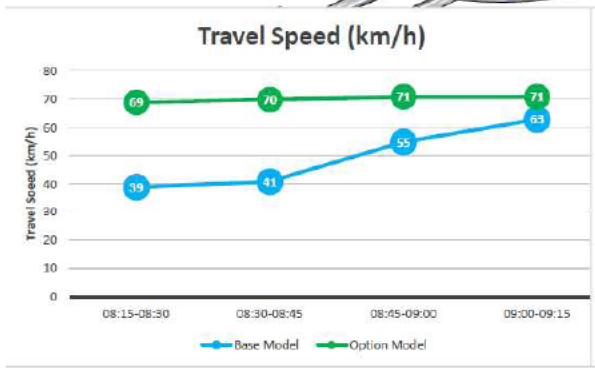


Figure 22 Base Vs Option model – Yarra Glen eastbound – Travel Speed & Max Queue & Delay Time





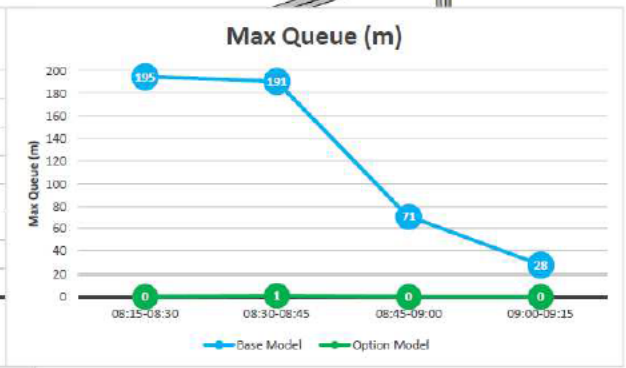
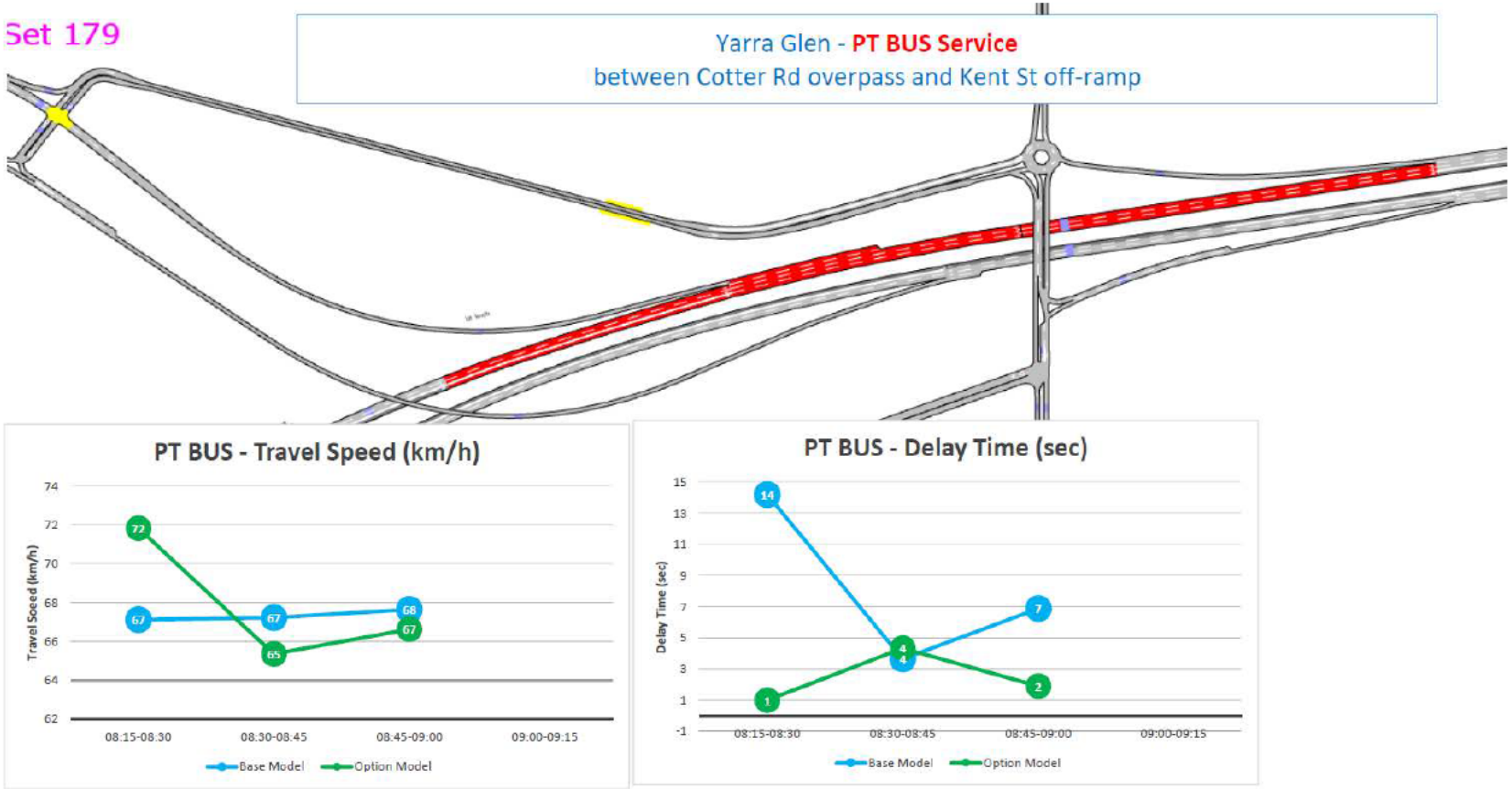


Figure 23 Base Vs Option model – Yarra Glen – Public Transport Bus Service - Travel Speed & Delay Time



6.5 Lady Denman Drive Traffic Operation

With the Cotter Road operation improved (in the option scenario), the traffic on Lady Denman Drive will be able to access Cotter Road without any delays. (see **Figure 24**).

6.6 Dudley Street Traffic Operation

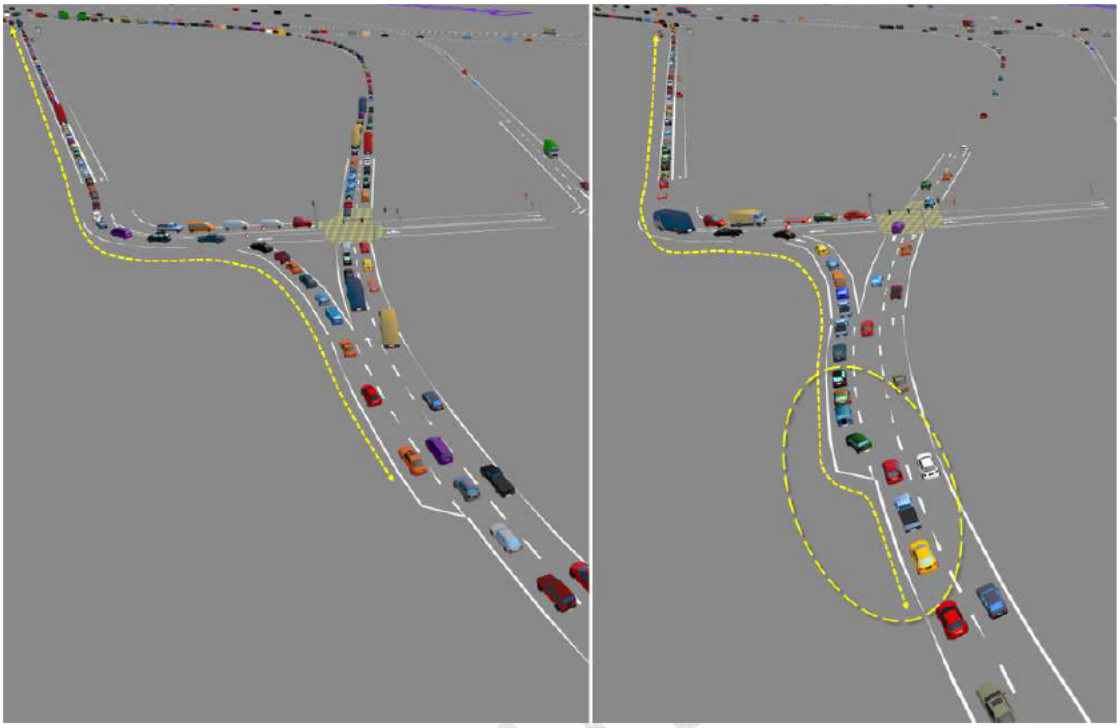
At present, the eastbound queuing on Dudley Street reaches close to Cotter Road signalised intersection, because of difficulties on exiting the Kent Street roundabout intersection. However, with the improved traffic congestion Cotter Road in the option scenario, the destined Dudley Street traffic is expected to reach Cotter Road signalised intersection quickly and join the queuing. As a result, the Dudley Street queueing often expected to spill onto Cotter Road and likely to impede through traffic (see **Figure 24**).

Figure 24

6.7 Dudley Street Traffic Operation

At present, the eastbound queuing on Dudley Street reaches close to Cotter Road signalised intersection, because of difficulties on exiting the Kent Street roundabout intersection. However, with the improved traffic congestion Cotter Road in the option scenario, the destined Dudley Street traffic is expected to reach Cotter Road signalised intersection quickly and join the queuing. As a result, the Dudley Street queueing often expected to spill onto Cotter Road and likely to impede through traffic (see **Figure 24**).

Figure 24 Base Vs Option model – Dudley Street traffic operation near Cotter Road signalised intersection



7 Summary an Conclusions

7.1 Summary

The analysis outputs have clearly indicated that the proposed option (i.e. Cotter Road on-ramp continuous lane into Yarra Glen) will significantly improve the traffic operation not only on Cotter Road (eastbound) section, but also cross whole road network. The simulations from the option scenario models have clearly show less traffic congestion, when compared to the base model.

The traffic flow improvements under the option scenario are summarised below:

- Whole network
  - The total travel time spent by all vehicles in the option model is expected to improve by 40 to 70 hours.
  - The average travel speed has improved by 10-15 km/h.

- Cotter Road
  - Travel speed will improve from i0-30 km/h to 60 km/h.
  - Traffic queues will reduce from 700-850 m to 120-200m.
  - Traffic delays will reduce from 6-8 minutes to 1 minute.
  - Traffic density will reduce from 70-105 vehicles per kilometre to 20-25 vehicles.

- Lady Denman Drive
  - Traffic delays are expected to reduce from 1 minute to less than 5 seconds.
  - Travel speed will increase from 45-55 km/h to 70km/h.

- Dudley Street
  - with the improved traffic congestion Cotter Road in the option scenario, the destined Dudley Street traffic is expected to reach Cotter Road signalised intersection quickly and join the queuing. As a result, the Dudley Street queueing often expected to spill onto Cotter Road and likely to impede through traffic.

Also, the PT bus transit services along Cotter Road are expected to improve significantly, with the reduced delay time from 6-8 minutes to 1 minute, and increased travel speed from 14 km/h to 60km/h.

The model outputs clearly indicate that the removal T2 lane along Cotter Road eastbound will not impact PT Bus transit operation. Under the option scenario, the travel speed is expected to reduce by 2 km/k (from 67 to 65 km/h), and travel delays by 4 sec max.

7.2 Conclusions

Based on the analysis outputs, the proposal of replacing the Cotter Road on-ramp merge with a continuous lane will significantly improve the traffic operation not just on Cotter Road, but also across the road network. Also, the PT bus service on Cotter Road is expected to improve by reduced delays up to 5-7 minutes and increased travel speeds by 45km/h.

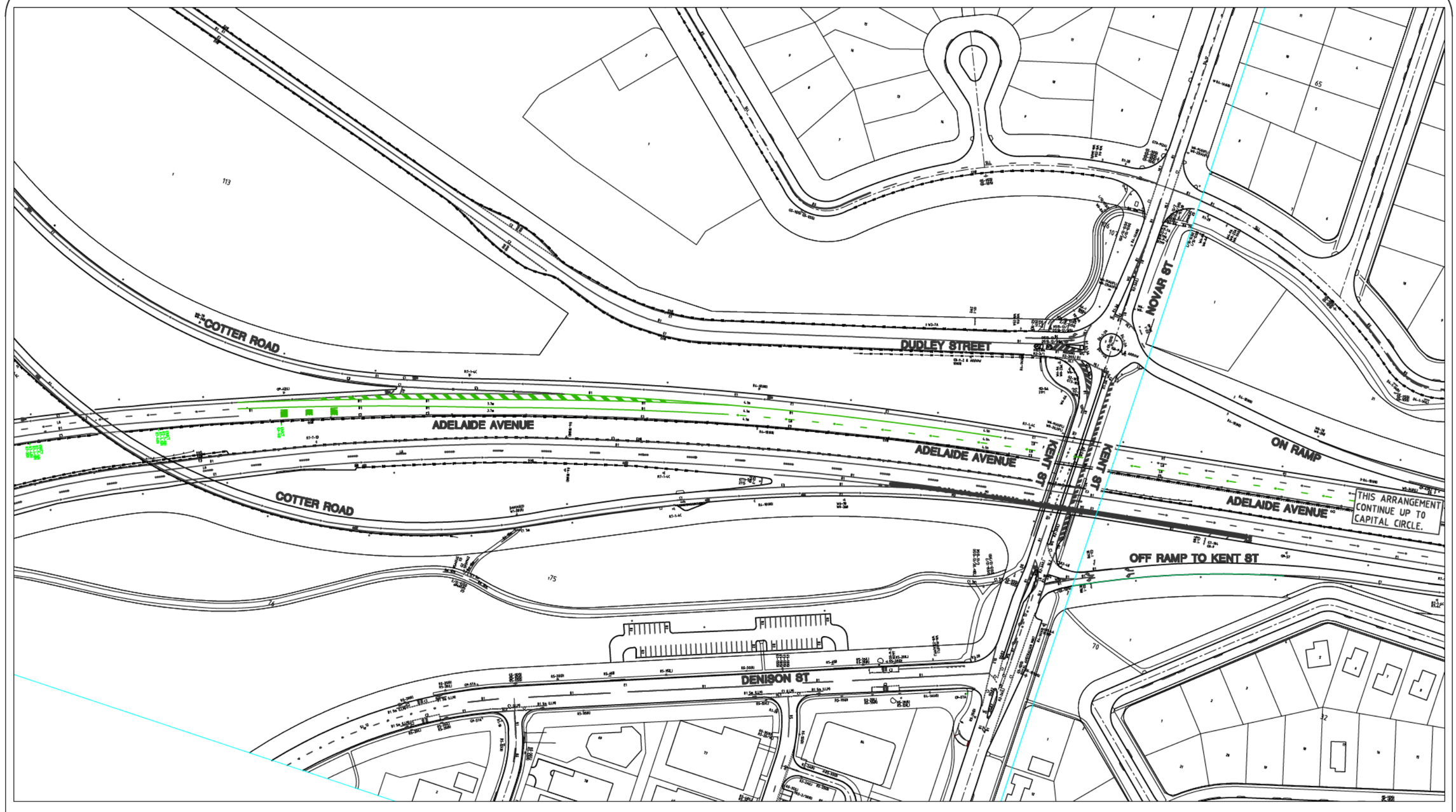
To cater the Cotter Road on-ramp to a continuous lane, it is also proposed to terminate the eastbound T2 lane on Yarra Glen section between the west of Cotter Road on-ramp merge and the east of Hopetoun Circuit on-ramp, and merge 3 lanes into 2 lane. This way the on-ramp lane can be aligned to Yarra Glen left lane to form a continuous lane.

The analysis results also showed that, the removal of this T2 lane section will not affect the bus transit operation.

7.3 Other Suggestions

At present, the eastbound queuing on Dudley Street reaches close to Cotter Road signalised intersection, because of difficulties on exiting the Kent Street roundabout intersection. However, with the improved traffic congestion Cotter Road in the option scenario, the destined Dudley Street traffic is expected to reach Cotter Road signalised intersection quickly and join the queuing. As a result, the Dudley Street queueing often expected to spill onto Cotter Road and likely to impede through traffic.

Therefore to avoid the queue spilling, it is suggested to consider extending the left turn slip lane storage capacity.



NO	AMENDMENTS	APPROVED	DATE

SIGNS TO BE ERECTED

SIGNS TO BE REMOVED OR RELOCATED

SIGN	DESCRIPTION	HAND	SIZE	NO. OF

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PRW NUMBER: 1057555
DOCUMENT STATUS: APPROVED
PROJECT OFFICER: BM/BH
PHONE NO | SIGNATURE
DRAFTED: JM
ACTION DATE: 13-08-2018
DATE PLOTTED: 13-07-2018
SCALE: NTS
DOCUMENT NUMBER: TC-599878
SHEET No: 2/2
REVISION

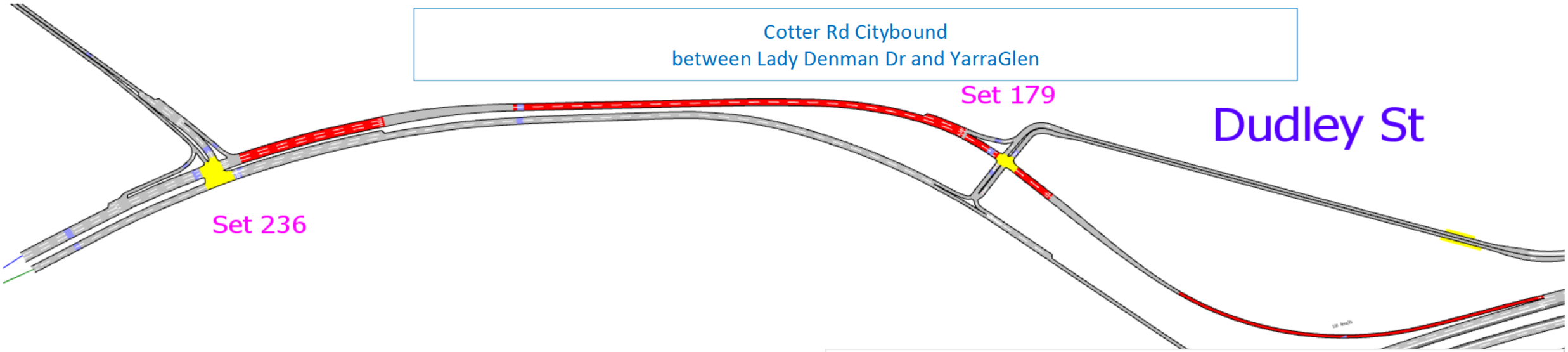
ACT GOVERNMENT

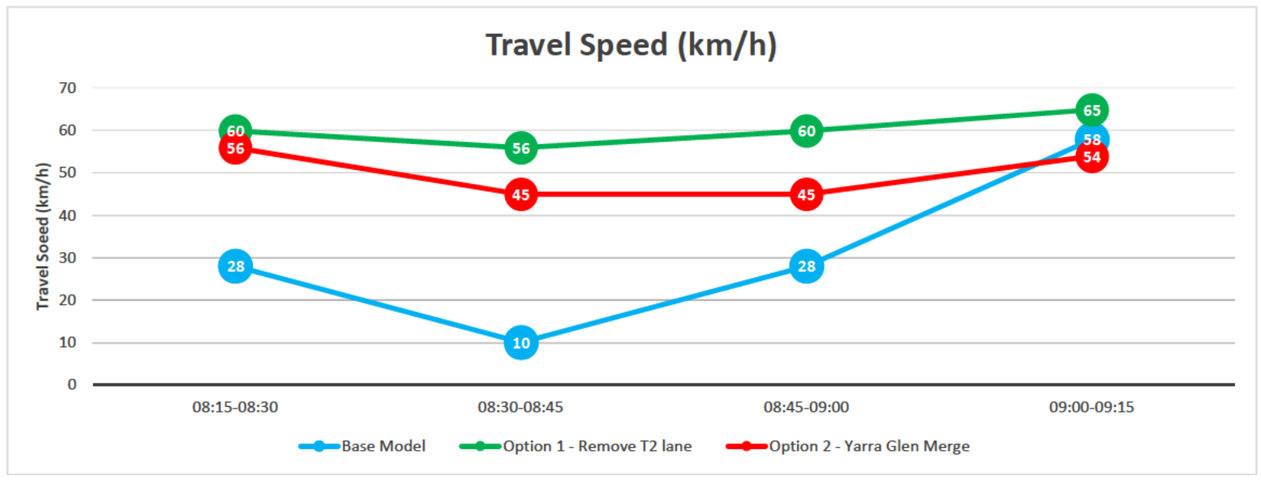
Authorised pursuant to Part 5 of Road Transport (Safety and Traffic Management) ACT 1999
Authorising Signature

ACT Government
Transport Canberra and City Services

DEAKIN

Cotter Rd/Adelaide Av
Traffic Control Devices


Cotter Rd Citybound
between Lady Denman Dr and YarraGlen
Set 179
Dudley St
Set 236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Travel Soeed (km/h)
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20
10
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08:30-08:45
08:45-09:00
09:00-09:15
60
56
56
45
60
45
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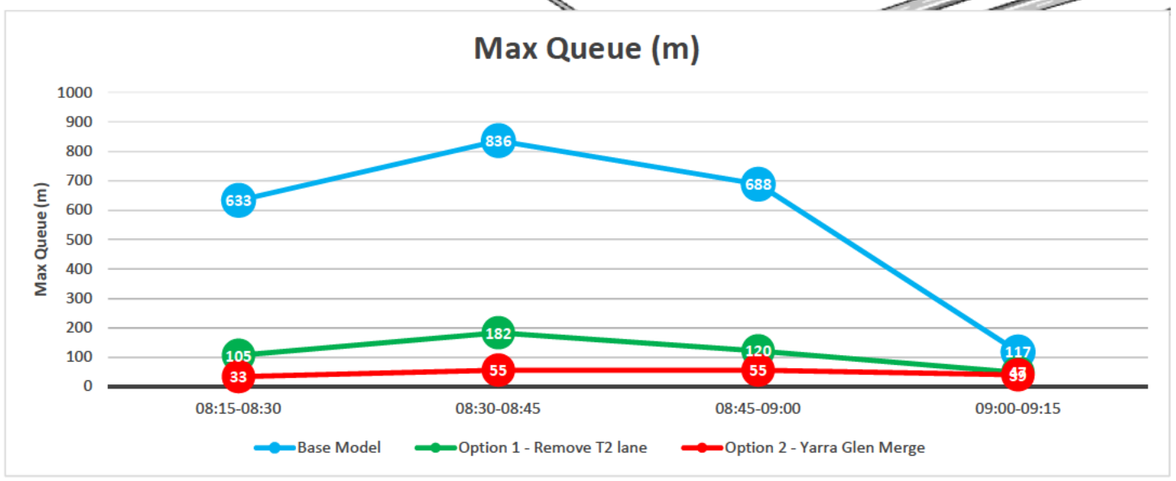
28
10
28
58
Base Model
Option 1 - Remove T2 lane
Option 2 - Yarra Glen Merge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Max Queue (m)
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800
700
600
500
400
300
200
100
0
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08:45-09:00
09:00-09:15
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688
105
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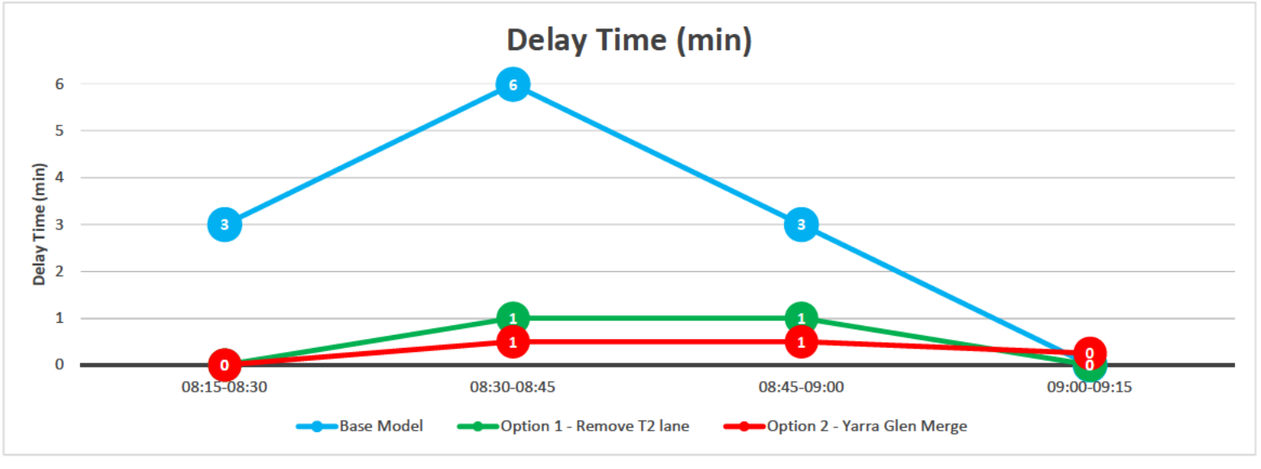
120
33
55
55
117
Base Model
Option 1 - Remove T2 lane
Option 2 - Yarra Glen Merge


Delay Time (min)
Delay Time (min)
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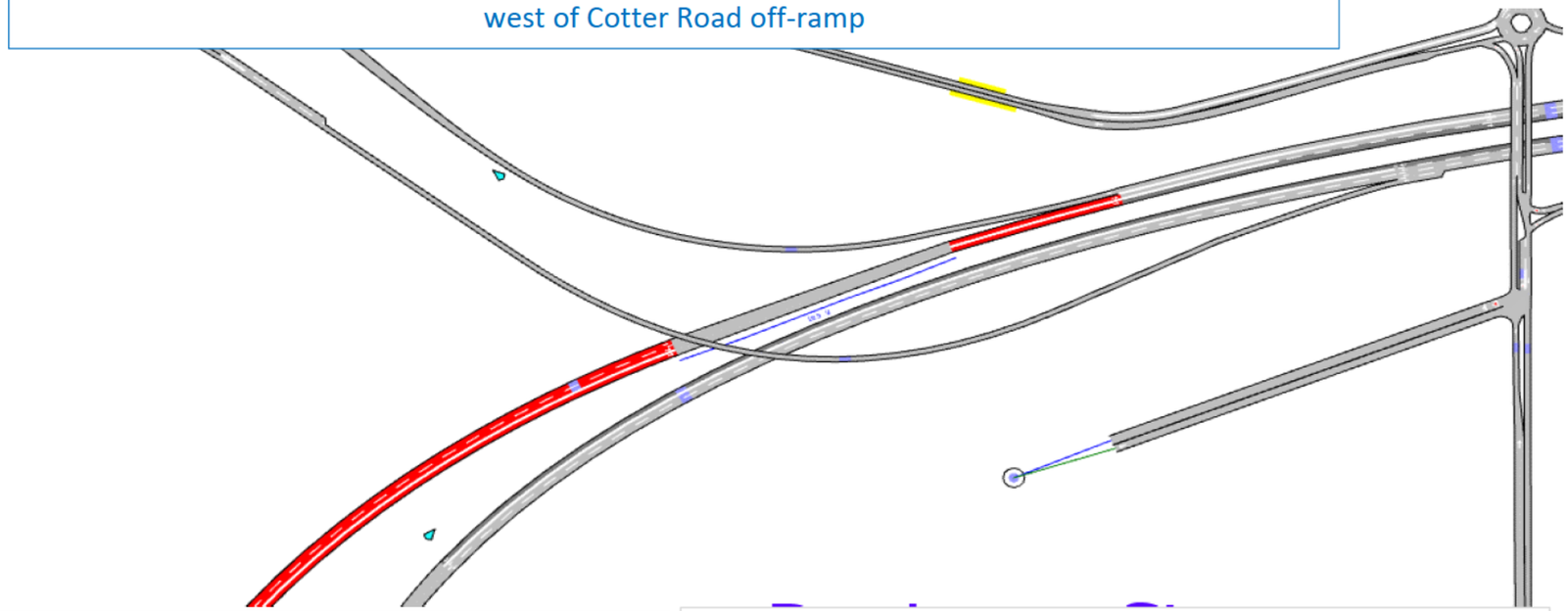
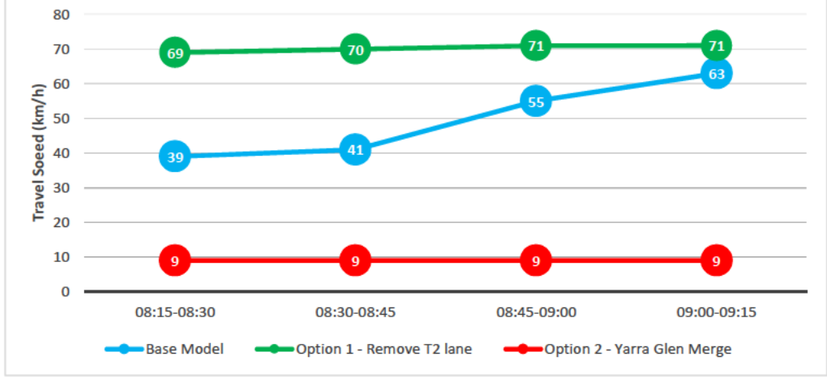
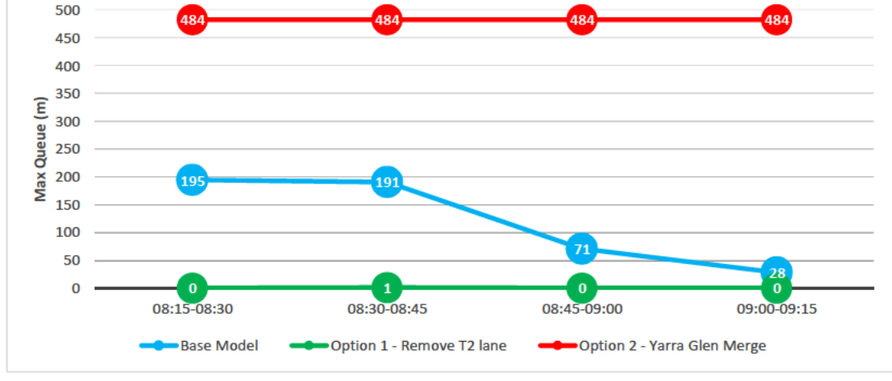
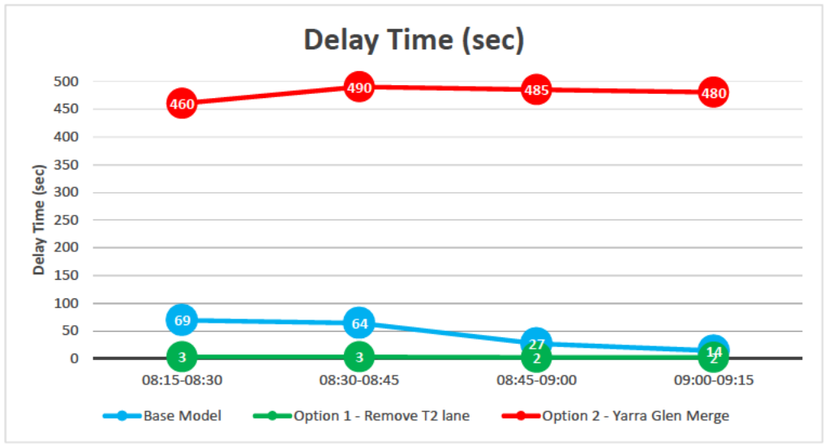
3
2
1
0
08:15-08:30
08:30-08:45
08:45-09:00
09:00-09:15
3
6
3
0
1
1
1
1
0
0
Base Model
Option 1 - Remove T2 lane
Option 2 - Yarra Glen Merge

Yarra Glen eastbound
west of Cotter Road off-ramp

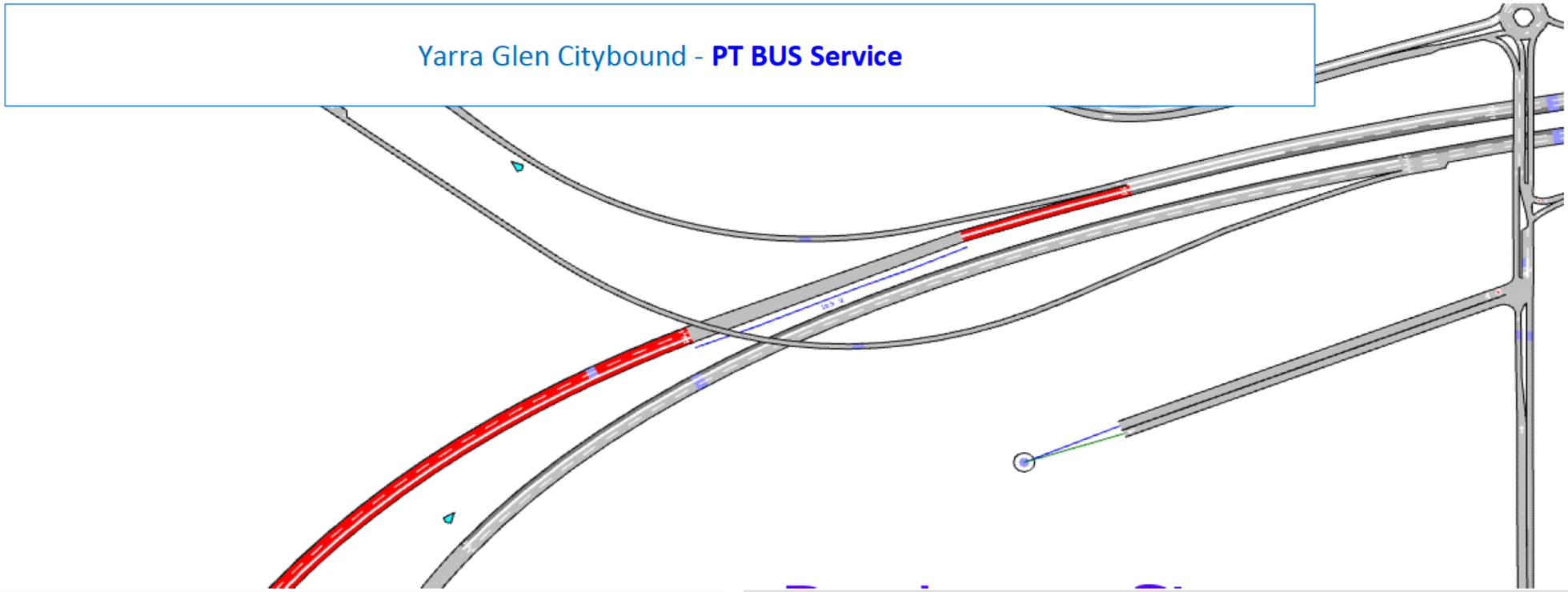


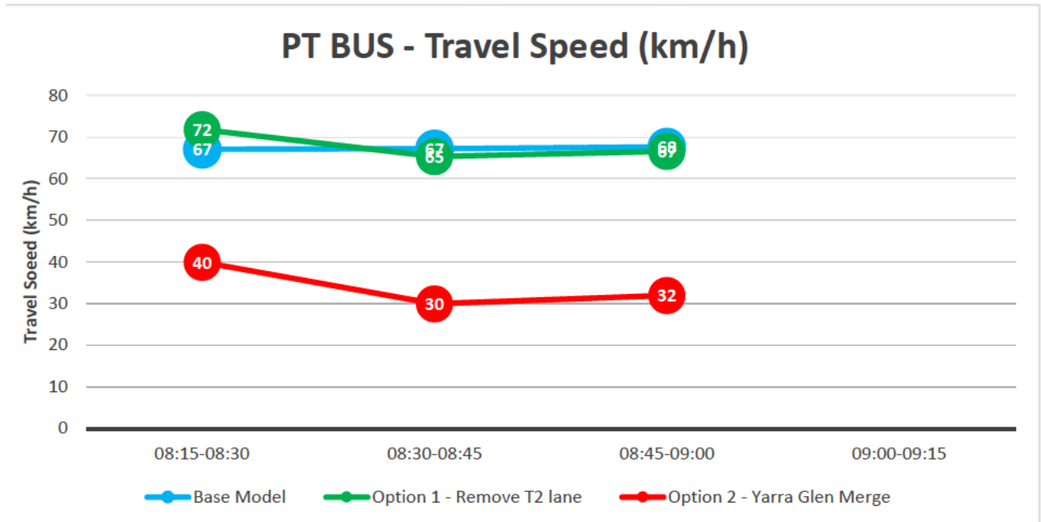


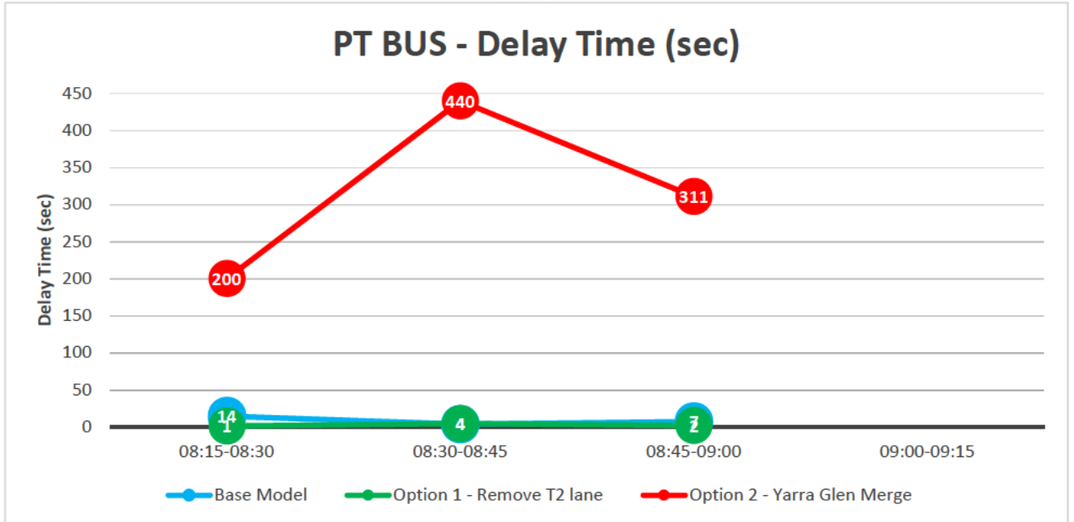




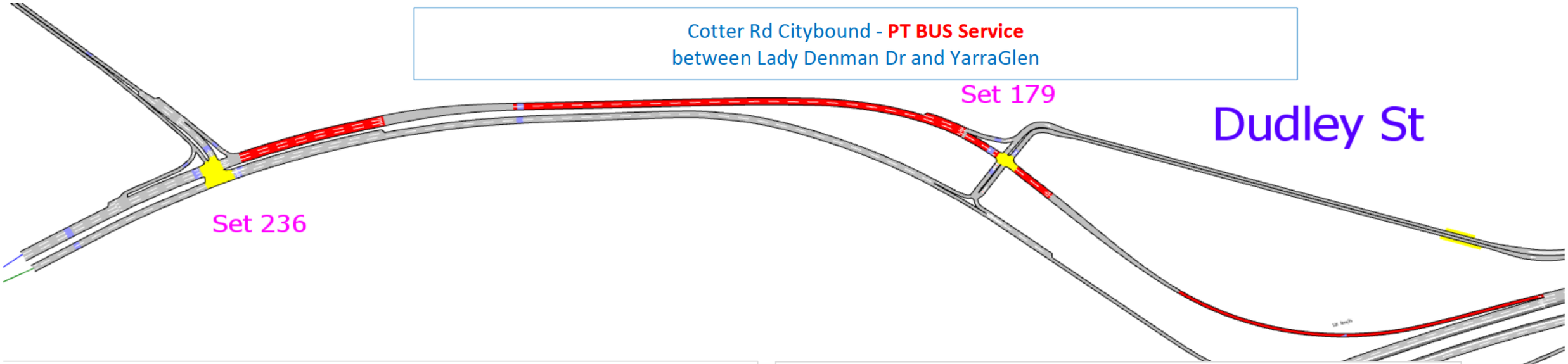
Yarra Glen Citybound - **PT BUS Service**

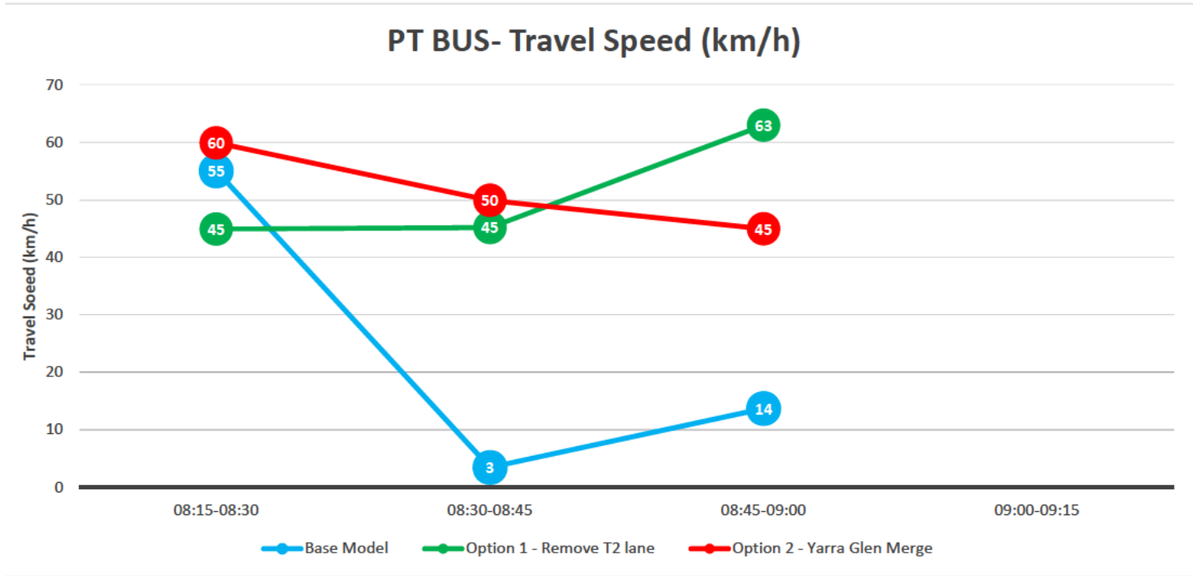


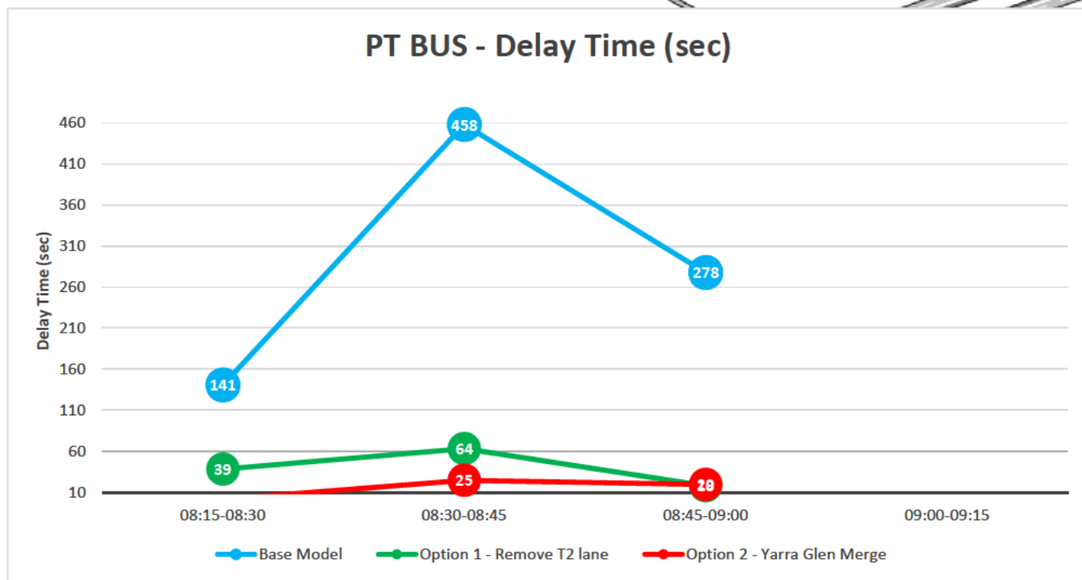




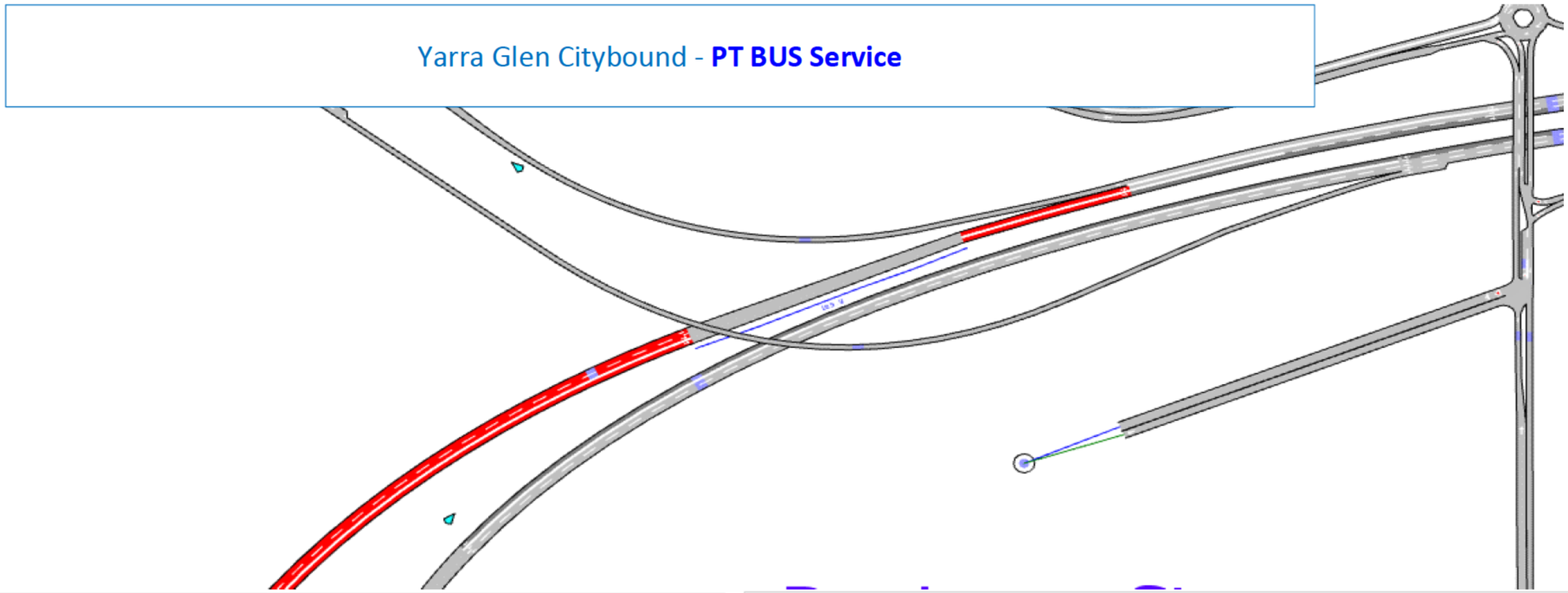
Cotter Rd Citybound - **PT BUS Service**
between Lady Denman Dr and YarraGlen

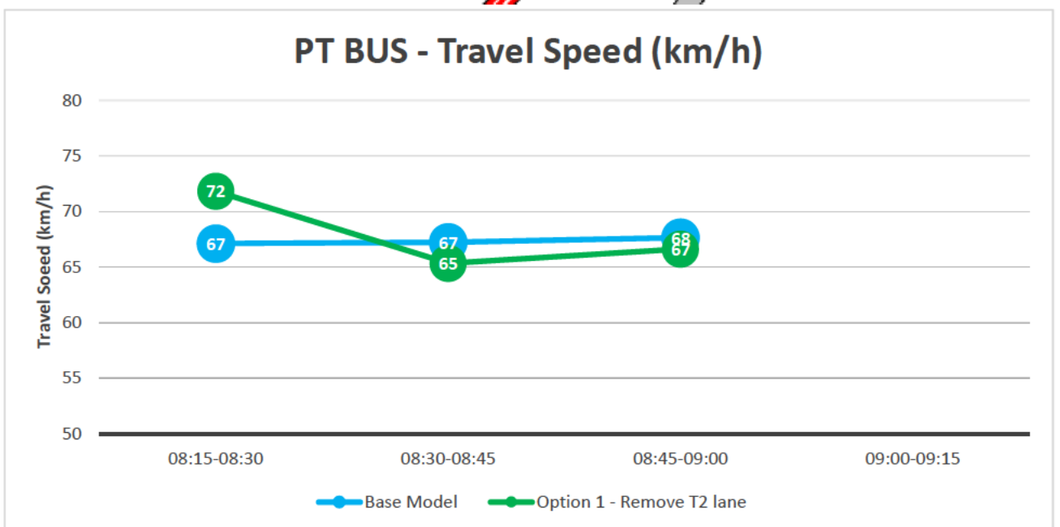


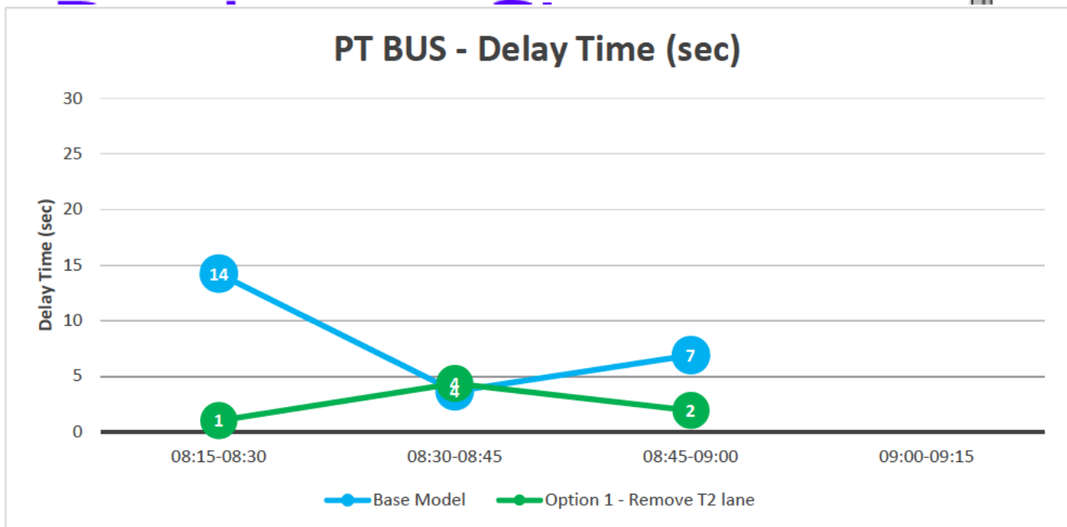




Yarra Glen Citybound - **PT BUS Service**







Cotter Rd Citybound - **PT BUS Service**
between Lady Denman Dr and YarraGlen