MOTT MACDONALD

Base Year Model Technical Note

Epping Bridge Upgrade

TfNSW

Project:	Epping Bridge Replacement		
Our reference:	703100907	**Your reference:**	EBP150523-MOTTM-EPG-TP-RPT-000001 Rev D OFFICIAL
Prepared by:	Ayyappa Janga/ Gary See	**Date:**	17 March 2025
Approved by:	Matthew Stephens	**Checked by:**	Matthew Stephens
Subject:	Base Year Model Calibration and Validation Report		

1 Introduction

1.1 Background

This draft technical note documents the development, calibration, and validation of the 2023 Base Case VISSIM and SIDRA models for the Epping Bridge project.

We seek TfNSW review, comment and/or agreement to their fitness for purpose, prior to commencement of the end state scenario modelling and construction staging work for the Concept Design phase.

Traffic modelling is required to demonstrate the potential impacts of the project on the transport network, during construction and at end state, for the Review of Environmental Factors (REF).

This Technical Note has been structured in line with TTD2017/001.

1.2 Project Objectives

The proposed project will replace and widen the existing Epping Bridge across the combined T9 and Metro rail corridor. It will include the following upgrades to Epping Road and Beecroft Road:

- an additional eastbound right turn lane from Epping Bridge into Blaxland Road
- an additional westbound lane across the bridge deck
- widening of the traffic lanes on the bridge deck, continuing around the sharp curve in the Beecroft Road alignment, immediately west of the bridge
- adjustments to the Beecroft Road access with Bridge Street and High Street
- improved active transport facilities along the southern footpath of the bridge
- relocation of existing Beecroft Road bus stops north of the pedestrian overbridge

1.3 Scope of Work

Mott MacDonald has been engaged to develop a Preliminary Design Review (Concept Design) and develop the Review of Environmental Factors (REF) which will be used to seek Planning Approval for the project. The Concept Design would then be used as the reference design for the next phase of procurement for the Detailed Design and Construction of the works.

The concept design will be built upon the work completed in 2021 by Future Rail for the Definition Design of the Epping Bridge Project. The Future Rail Definition Design assessed both a widening and replacement option which was used to prepare the Final Business Case, which is now complete.

The purpose of the VISSIM and SIDRA modelling is to:

- Provide traffic analysis for the Review of Environmental Factors (REF) of the Epping Bridge Replacement proposal. The modelling will need to compare traffic performance With and Without Project at opening year 2028 and 10-years after opening.
- Assess the travel delay impacts, if any, of key traffic staging arrangements during construction of the project, to inform the Road User Delay Management Strategy.

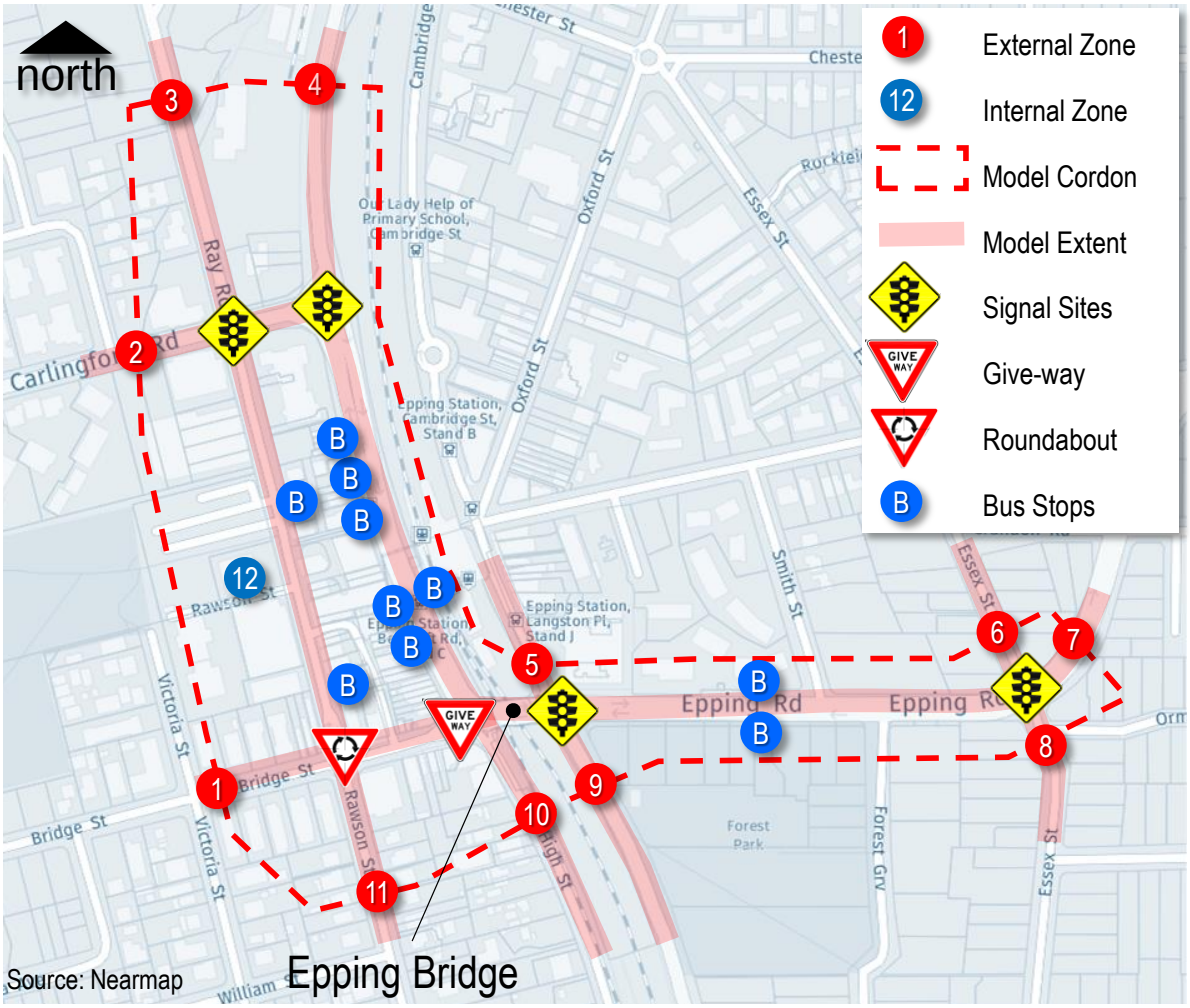
Whilst there may be minor design optimisation undertaken during the Concept Design phase, the design layouts were specified in the Concept Design brief. Optioneering and/or comparative assessments of alternate designs are not included in the Concept Design scope.

1.4 Study Area

The proposed extent of the VISSIM & SIDRA models is presented in **Figure 1-1** The 12x12 cordon zones, that were adopted for the previous VISSIM modelling during the Reference Design phase, are retained. The zone descriptions include:

1. Bridge Street (west)
2. Carlingford Road (west)
3. Ray Road (north)
4. Beecroft Road (north)
5. Langston Place (north)
6. Essex Street (south)
7. Epping Road (east)
8. Essex Street (north)
9. Rawson Street (south)
10. Blaxland Road (south)
11. High Street (south)
12. Rawson Street Carpark

Figure 1-1 Study Area



1.5 Report Outline

This report has been structured in accordance with TTD 2017/001 and includes:

Section 1 – Introduction

Section 2 – Existing Conditions

Section 3 – Model Development

Section 4 – Model Calibration and Validation

Section 5 – Summary and Conclusion

1.6 This revision

This revision of the technical note included updates to the calibration of the SIDRA modelling documented in Section 4.3, in response to TfNSW comments raised on 11 February 2025.

2 Existing Conditions

2.1 Traffic Surveys

The following data has been collected to undertake the development and calibration of the AM and PM peak Base Case models:

2.1.1 Traffic volume counts

- Classified Intersection Traffic Counts were obtained for following peak periods on Thursday 21/9/2023.
  - AM Peak Period (06:00-10:00)
  - PM Peak Period (15:00-19:00)
- Traffic data was collected at the following Intersections and details are given in **Appendix A.**
  - Epping Road and Essex Street
  - Epping Road, Langston Road and Blaxland Road
  - Epping Road, High Street and Bridge Street
  - Carlingford Road and Beecroft Road
  - Carlingford Road, Rawson Street and Ray Road
  - Bridge Street and Rawson Street

Based on traffic survey data, the following peak hours were identified in AM peak and PM peak:

- AM Peak Hour (07:30-08:30)
- PM Peak Hour (17:00-18:00)

2.1.2 SCATS Information

SCATS Signal operation data for 21/09/2024 was provided by TfNSW for the following signalised intersections:

- Carlingford Road / Ray Road/ Rawson Street (VV1015)
- Carlingford Road / Beecroft Road (VV0706)
- Epping Road / Langston Place/ Blaxland Road (VV0216)
- Epping Road / Essex Road (VV1338)

This SCATs information was analysed for the peak hours to understand the signal phasing times and cycle times. The signal phases given in the SCATS were coded in VISSIM including the alternate phases. The alternate phases were coded as a variable phase and some of these alternative phases were skipped based on the demand. The phases with green time have been retained in the modelling. It was observed that all signalised intersections in the study area are running with a cycle time of ~130 seconds. The user-given cycle time of approximately 130 seconds was adopted for all signalised intersections in the base case scenario.

2.1.3 Queue Length Survey

Intersection Queue Length Surveys at the same survey sites, on Thursday 21/9/2023, are presented in **Appendix B**. This queue length data was used for model validation.

A review of the queue length data revealed the following:

- IC01: Carlingford Road / Ray Road/ Rawson Street.
  - During the AM Peak, a substantial queue of 42 vehicles was observed on the west approach.
- IC02: Carlingford Road / Beecroft Road:

  - In both the AM and PM peaks, a maximum of 30 vehicles were observed queuing on the South approach through lanes.
- IC03: Epping Road / Blaxland Road:
  - During both the AM and PM Peaks, there were 30-35 vehicles queuing to turn right from Beecroft Road's west approach onto Blaxland Road.
  - In the PM peak, a maximum of 40 vehicles were observed queuing to turn left from Blaxland Road's south approach into Beecroft Road.
- IC04: Epping Road / Essex Road:
  - In both the AM and PM Peaks, 13-15 vehicles were observed queuing on the North approach attempting to turn right into Epping Road.

2.1.4 Travel Time Survey

Travel time data was collected on 21/09/2023 during the 4-hour AM and PM peak periods using the floating car method. The Base Case models are validated using this travel time data. The routes for the travel time assessments were:

- Route 1: Beecroft Road and Blaxland Road (Northbound and Southbound)
- Route 2: Carlingford Road, Beecroft Road and Epping Road (Eastbound and Westbound)

In addition to the primary travel time surveys above, HERE travel time data was sourced for the same road segments during the same periods. A summary of the travel time data is presented in **Table 2-1** and travel time graphs are presented in **Appendix C**.

Table 2-1: Travel Time Data

No	Route	Section		AM Peak (07:30 - 08:30)		PM Peak (17:00 - 18:00)	
		From	To	Survey	HERE	Survey	HERE
1	Beecroft Rd NB	Maida Rd	Epping Rd	0:00:29	0:00:43	0:03:06	0:00:55
		Epping Rd	Carlingford Rd	0:01:26	0:01:08	0:01:23	0:01:11
		Carlingford Rd	Kandy Ave	0:00:42	0:00:54	0:00:40	0:00:29
2	Beecroft Rd SB	Kandy Ave	Carlingford Rd	0:01:04	0:00:52	0:01:18	0:01:35
		Carlingford Rd	Blaxland Rd	0:02:54	0:01:34	0:06:09	0:01:35
		Blaxland Rd	Maida Rd	0:00:25	0:00:32	0:00:25	0:00:46
3	Carlingford Rd/Epping EB	Kent St	Beecroft Rd	0:03:49	0:03:24	0:01:27	0:01:36
		Beecroft Rd	Blaxland Rd	0:01:10	0:01:30	0:00:45	0:01:07
		Blaxland Rd	Essex St	0:00:43	0:00:40	0:00:25	0:00:35
4	Carlingford Rd/Epping WB	Essex St	Blaxland Rd	0:01:33	0:00:56	0:02:28	0:01:29
		Blaxland Rd	Carlingford Rd	0:00:47	0:01:05	0:01:19	0:01:29
		Carlingford Rd	Kent St	0:00:47	0:00:42	0:00:50	0:00:48

2.1.5 Public Transport

Existing bus service timetables and frequencies were obtained from public timetables. The study area is currently serviced by 11 bus routes as summarised in **Table 2-2.**

Table 2-2: Bus Routes

Route Number	From/To
550	Macquarie Park to Parramatta via Epping; Parramatta to Macquarie Park via Epping.
630	Epping to Blacktown; Blacktown to Epping
541	Epping to Eastwood; Eastwood to Epping.
718w	Epping Station, Beecroft Rd to James Ruse High School.
651	Rouse Hill Station to Epping via Castle Hill; Epping to Rouse Hill Station via Castle Hill.
546	Parramatta to Epping via Oatlands & North Rocks; Epping to Parramatta via Oatlands & North Rocks.
549	Parramatta to Epping via North Rocks; Epping to Parramatta via North Rocks.
726w	Epping Station, Beecroft Rd to Mount Saint Benedict High.
732w	Epping Station, Beecroft Rd to Baulkham Hills High.
3013	Epping Station to Baulkham Hills HS.
3014	Epping Station to Baulkham Hills HS.

2.2 Site Visit

Site visits were undertaken on the following occasions:

- 25 October 2023, AM Peak
- 14 November 2023, PM Peak

Photos from the site visits are presented in **Appendix D**. The main observations from the site visits are listed below.

2.2.1 Congestion Locations

The main areas of congestion in the AM Peak include:

- Carlingford Road eastbound approaching Ray Street and Beecroft Road
- Ray Street and Rawson Street approaches to Carlingford Road
- Beecroft Road southbound approaching Carlingford Road due to large weave movement across to the right lane, to turn into Blaxland Road.
- Essex Street approaching Epping Road.
- The westbound left turn lane in Epping Road, approaching Blaxland Road, is underutilised, whilst the adjacent through lanes experienced extensive queuing. Buses making a passenger stop on this approach, found it very difficult to merge back into the through lanes before Blaxland Road.
- 30min parking is allowed on Beecroft Rd NB.

The main areas of congestion in the PM peak include:

- Ray Street and Rawson Street approaches to Carlingford Road
- Essex Street approaching Epping Road.
- Blaxland Road northbound approaching Epping Road
- Bridge Street westbound approaching the Rawson Street roundabout.
- Parking is restricted on Beecroft Rd NB.

No school zones within the study area

3 Model Development

3.1 Modelling Platform

The modelling analysis for this project is undertaken using VISSIM (Version 2023 SP02) and SIDRA Intersection (Version 9.1.6.228) software.

3.2 Model Development

3.2.1 Road Types

The road network capacity and speeds are coded based on:

- Nearmap, spatially accurate aerial photography
- Roadway surveys
- Existing traffic signal layouts
- Existing speed limit zones including school zones, if any
- Site observations

3.2.2 Traffic Demands

Existing traffic demands and patterns for the network were derived from turning volumes. The traffic profile for the AM and PM peak periods are illustrated in **Figure 3.1** and **Figure 3.2** respectively. Based on these following peak hours for AM and PM peak hours were determined and used for VISSIM and SIDRA modelling.

- 7:30am to 8:30am
- 5:00pm to 6:00pm

The VISSIM model includes a warm-up and cool-down period along with the peak hours:

- a 60-minute warm-up period
- a 30-minute cool-down period.

Figure 3.1: AM Peak Traffic Profile

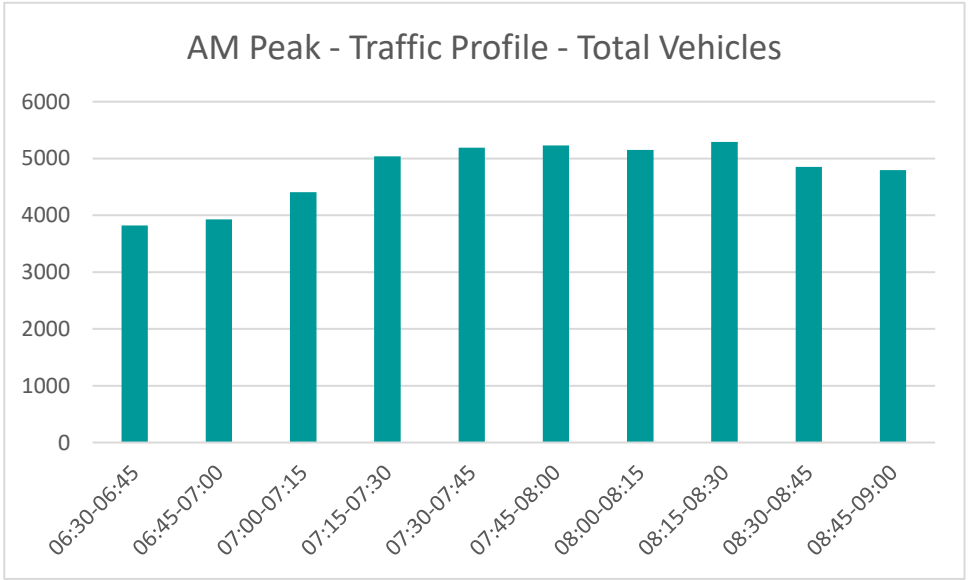
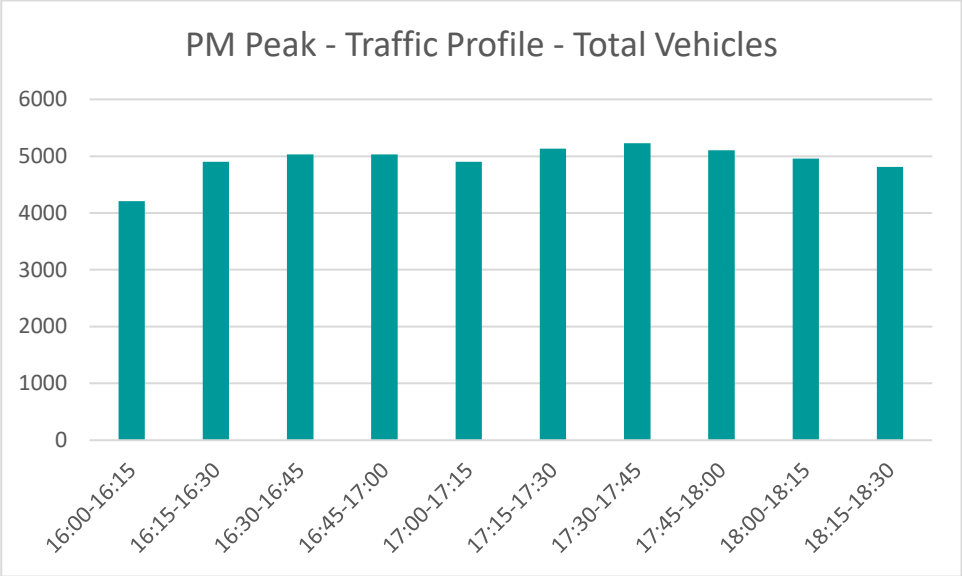


Figure 3.2: PM Peak Traffic Profile



3.2.3 Traffic Composition

The Base Case matrices were developed for the following vehicle types:

- Cars
- Trucks
- Buses

Additionally, pedestrian and cycle movements at crossing points are included in the VISSIM and SIDRA models.

The buses were modelled as a fixed route, as discussed in **Section 0**. The composition of vehicles in each peak hour is summarised in **Table 3-1**.

Table 3-1: Traffic Composition

Time Period	Cars	Trucks	Total
AM Peak			
07:30 -08:30	20,402	462	**20,864**
PM Peak			
17:00 -18:00	20,370	227	**20,370**

3.2.4 Speed Profiles

The models were developed using the VISSIM and SIDRA default values for driver behaviour and speed profiles for NSW, where available. Given that this is a low-speed environment, posted speed limits in the area are 60km/h or less, and the area is subject to congested traffic conditions, the respective default values in VISSIM and SIDRA are considered acceptable.

3.2.5 Traffic Signals

The VISSIM and SIDRA models were developed with fixed time signal operation. Signal timings, phases and offset data were derived from the SCATS data collected on the 21/9/2023. The SCATS timing data in **Appendix H** clearly shows that cycle and phase times remain very consistent during peak periods, so fixed time operation is justified.

SCATS detector Counts, SCATS signal data, SCATS History and Controller information are presented in **Appendices E, F, G** and **H**. Existing traffic signal drawings are presented in **Appendix I.** Phase and cycle time of each signal are presented in **Table 3-2.**

Table 3-2: Average Signal Phase Time (s) - AM and PM Peaks

Intersection	Phase	AM Peak (07:30-08:30)	PM Peak (17:00-18:00)
Carlingford Rd & Ray Rd & Rawson St	A	86	84
	B	44	46
	Total	**129**	**130**
Beecroft Rd & Carlingford Rd	A	47	57
	B	18	20
	C	64	52
	Total	**128**	**129**
Epping Rd & Blaxland Rd & Langston Pl	A	55	81
	B	23	23
	C	28	27
	D	24	-
	Total	**130**	**131**
Epping Rd & Essex St	A	82	79
	B	27	27
	C	21	23
	Total	**130**	**128**

3.2.6 Public Transport

Bus service arrivals and departures at Epping Station during the AM and PM peaks, to stands C, D, E, F and G were explicitly coded, based on service routes and timetables. Bus stands A and B, located in Cambridge Street on the east side of the station are excluded from the model.

The bus arrivals, dwell times and departure events are tabulated in **Appendix J.** The journey of each bus through the model was coded as a series of events (entries, bus stop dwells, layovers and/or exits).

3.2.7 Active Transport

Observed active transport crossing counts were included in all Base Case SIDRA and VISSIM models.

3.2.8 Matrix Estimation

Demand matrices for cars and trucks were generated at 15-minute intervals by applying the TFlowFuzzy methodology within the VISUM software. These matrices were derived from the observed turning traffic volumes (refer to Section 2.1.1), aiming to replicate the distribution of traffic demand and its changes throughout the modelling period. In this process, the 2021 STFM Base Case cordon matrices were utilized as the base travel pattern for the matrix estimation. The 2021 demand patterns are presented in **Appendix K.**

2023 Peak hour observed flows were coded directly into the Base case SIDRA models.

3.2.9 Assignment Type

Stochastic Route Choice was used to model the Epping Road in VISSIM. Given the lack of route choice available within the study area, the traffic assignment method effectively functions as ‘all or nothing’ assignment.

4 Model Calibration and Validation

4.1 Overview

The model calibration involves aligning observed traffic conditions with the modelled traffic conditions including vehicle behaviour observed on site. Turning counts and queue length, travel time have been selected as key performance indicators (KPI's) of model calibration for VISSIM Modelling and queue length for SIDRA modelling. Data collected from traffic surveys, as discussed in **Section 2.1** has been compared against model outputs. Furthermore, model stability has been tested against a set of criteria outlined below.

4.2 Model Calibration VISSIM Modelling

4.2.1 Model Calibration Criteria

This model is calibrated against the core area criteria:

- Core model tolerance criteria listed in **Table 4-1.**
- 100 per cent of observations to be within tolerance limits.
- R^2 value of observed versus modelled plots to be >0.95
- Average modelled cycle time for each 1-hour period to be within 10% of observed SCATS cycle time for the same period
- Total green-time over each 1-hour period to be within 10% of observed SCATS equivalent for each phase

Table 4-1 Core Area Tolerance Limits

Flow	Criteria
< 99	To be within 10 vehicles of observed
100-999	To be within 10% of observed
1000-1999	To be within 100 vehicles of observed
>2000	**To be within 5% of observed**

4.2.2 Turning Count Calibration Results

Table 4-1 describes the network wide criteria and measurement requirements set out by TfNSW in the Traffic Modelling Guidelines (2013) for turning and link counts.

The traffic flows for each modelled hour were calibrated against the observed turning counts. The calibration outcomes for the AM and PM peak periods are summarised in **Table 4-2** and **Table 4-3** respectively.

Table 4-2: Base Model Turning Flows Calibration - AM Peak

AM Peak (07:30-08:30) – Calibration Results	
Plot	**Results**
Percentage of turn/link volumes	75/77 (97%)
R-square value	1.00

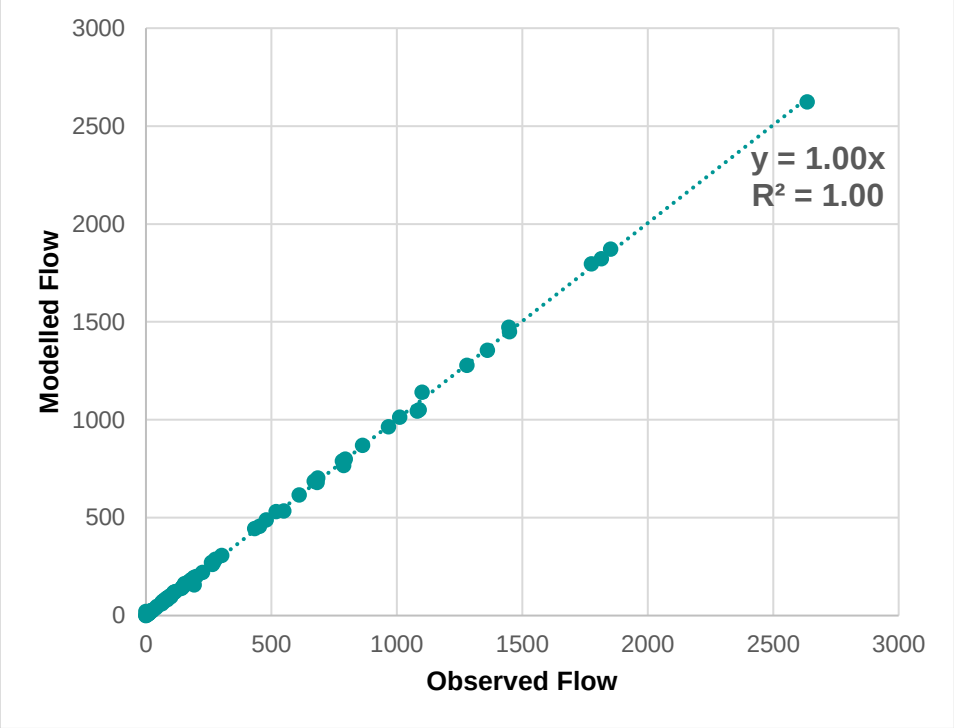
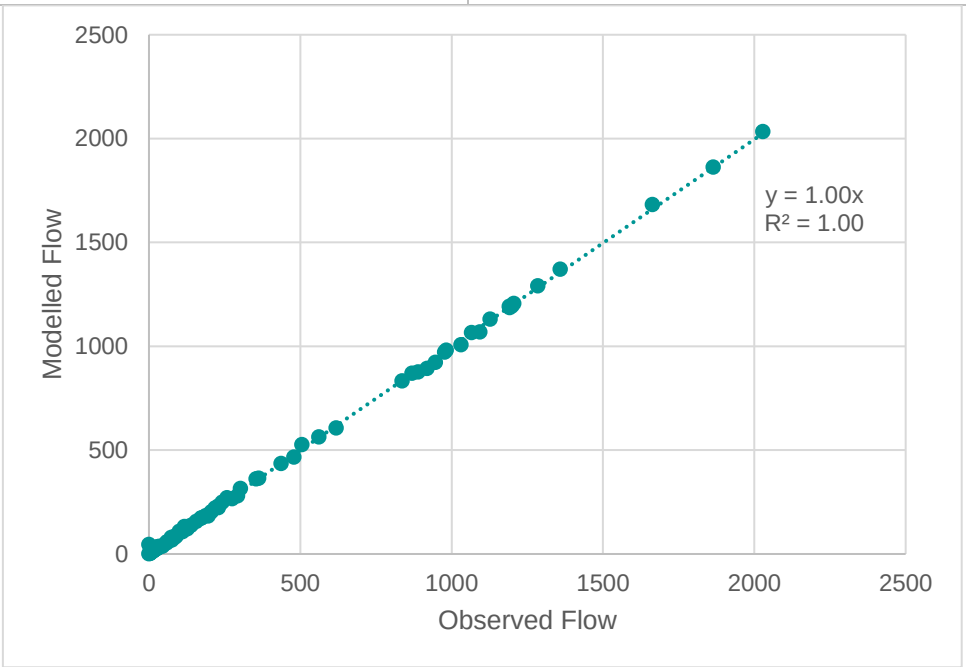


Table 4-3: Base Model Turning Flows Calibration - PM Peak

PM Peak (17:00-18:00) – Calibration Results	
Plot	**Results**
Percentage of turn/link volumes	75/77 (97%)
R-square value	1.00



Based on the above results, the Base Case models of Epping Road bridge were well calibrated using the turning movements at each intersection and all cordon entry/exit points against the observed traffic turning counts. However, there are two turning fail to meet the criteria due to traffic imbalances created by Hunts La street.

4.2.3 Signal Time Calibration Results

A comparison of observed and modelled signal times at each intersection is presented **Table 4-4.**

During the AM and PM peaks, the modelled average cycle time and phase times shows a good match with the observed times (within 10%).

Table 4-4 Signal Time Comparison – AM and PM Peaks

Intersection	Phase	AM Peak (07:30-08:30)			PM Peak (17:00-18:00)		
		Observed	Modelled	Diff %	Observed	Modelled	Diff %
Carlingford Rd & Ray Rd & Rawson St	A	86	83	3%	84	84	0%
	B	44	47	-7%	46	46	0%
	Total	**129**	**130**	**-1%**	**130**	**130**	**0%**
Beecroft Rd & Carlingford Rd	A	47	47	0%	57	57	0%
	B	18	18	-3%	20	21	-8%
	C	64	64	-1%	52	52	0%
	Total	**128**	**129**	**-1%**	**129**	**130**	**-1%**
Epping Rd & Blaxland Rd & Langston Pl	A	55	55	1%	81	81	0%
	B	23	25	-7%	23	24	-2%
	C	28	29	-2%	27	26	6%
	D	24	23	6%	-	-	-
	Total	**130**	**130**	**0%**	**131**	**130**	**1%**
Epping Rd & Essex St	A	82	81	2%	79	77	3%
	B	27	29	-7%	27	29	-9%
	C	21	21	2%	23	25	-8%
	Total	**130**	**130**	**0%**	**128**	**130**	**-1%**

4.2.4 Model Stability

The model statistics for assessing calibration and validation were based on a median run selected from five model seed values (560, 28, 7771, 86524 and 2849). An analysis of VHT and VKT results for the five seed values was used to demonstrate model stability.

4.2.5 Demonstration of Model Stability

The ability of a model to produce consistent results for several seed values is referred to as model stability. The stability of the model is assessed by comparing the total vehicle hours travelled (VHT) network performance indicator between the five model seed runs undertaken for each period.

Based on this, and as indicated in the TfNSW Traffic Modelling Guidelines (2013), the representative seed run is selected (median VHT value). All results reported are based on this single representative seed run. As such, **Figure 4.1** and **Figure 4.2** illustrate the VHT during the AM and PM peak periods respectively.

Figure 4.1: Total Vehicle Hours Travelled (VHT) - AM Peak

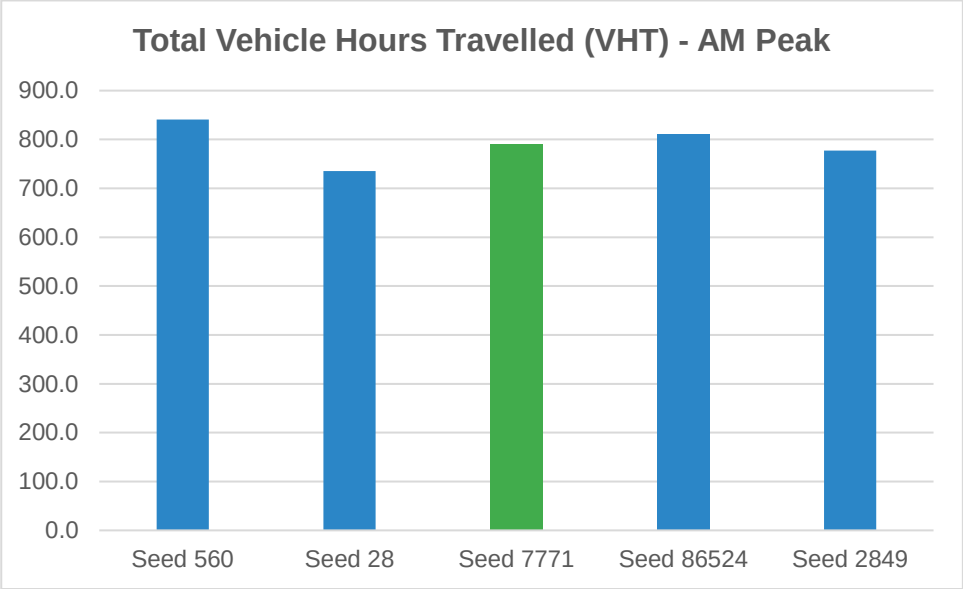
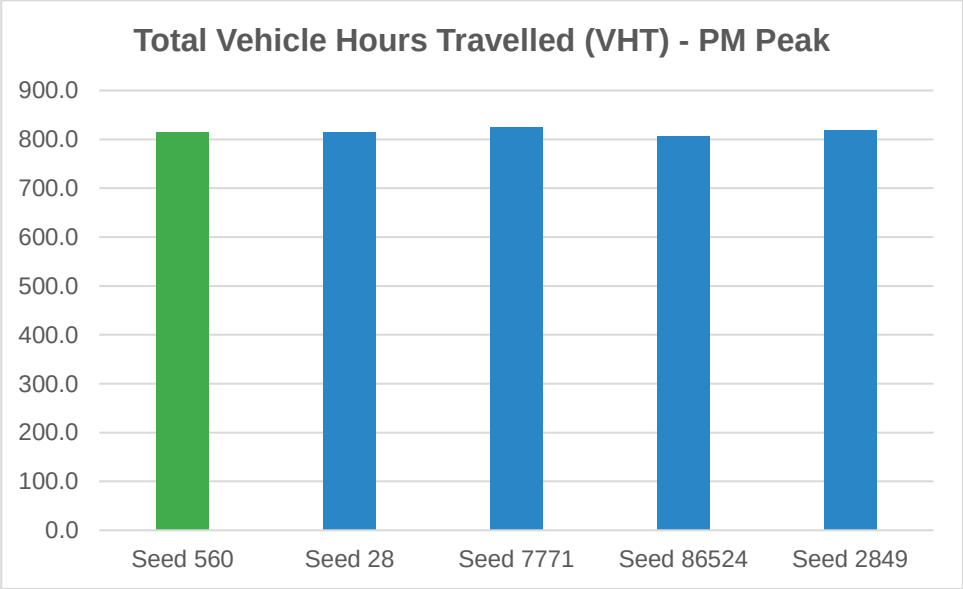


Figure 4.2: Total Vehicle Hours Travelled (VHT) - PM Peak



The difference between the results produced by each seed was within 7% and 1% in the AM and PM peaks compared to the respective median values. Hence, the AM and PM peak modelling show that both models are stable. The median seed value (in green) for AM Peak is 7771 and for PM Peak the median seed value is 560.

4.2.6 Model Validation

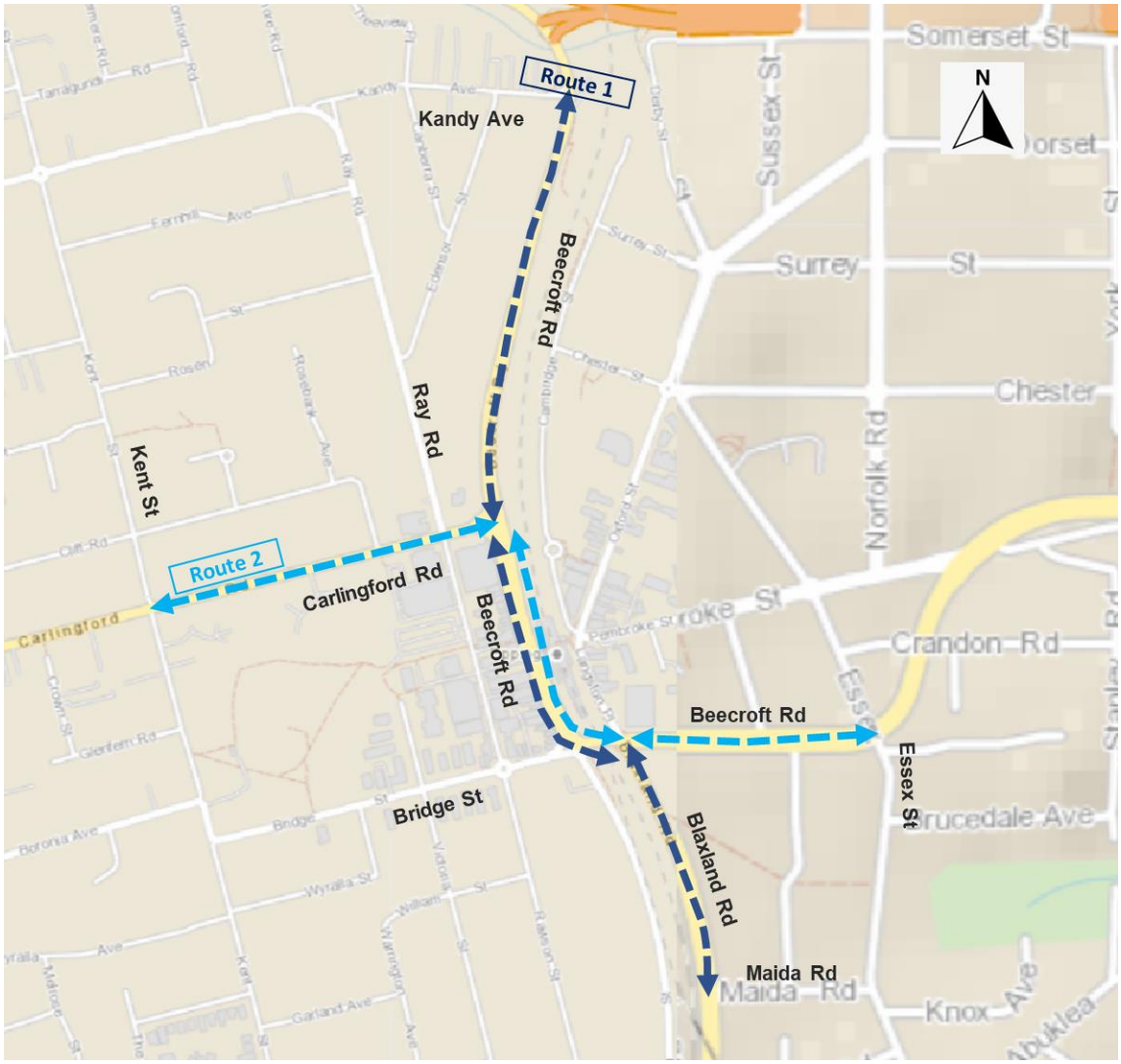
VISSIM Model validation has been undertaken using observed travel time data. The objective is to achieve modelled travel times within 15% of observed travels times, or within 1-minute, whichever is the highest.

4.2.7 Travel Time Validation

The model validation has been undertaken based on the observed travel time (Refer to **Section 2.1.4** for details). Travel time data has been collected during AM and PM peak periods for two routes within the model area which are shown in **Figure 4-3** and listed below:

- Route 1: Beecroft Road, Blaxland Road (Northbound and Southbound)
- Route 2: Carlingford Road, Beecroft Road and Epping Road (Eastbound and Westbound)

Figure 4-3 Travel Time Routes



The travel time comparison for the above-mentioned routes are provided in **Table 4-5**. Also, the cumulative travel time graphs for each route are provided in **Figure 4-4** to **Figure 4-11**.

Table 4-5 Travel Time Validation Results - AM and PM Peaks

Route	From	To	AM Peak (07:30-08:30)			PM Peak (17:00-18:00)		
			Observed	Modelled	Diff %	Observed	Modelled	Diff %
Beecroft Rd (Northbound)	Maida Rd	Epping Rd	00:29	00:45	-53%	03:06	01:11	62%
	Epping Rd	Carlingford Rd	01:26	00:55	36%	01:23	00:57	31%
	Carlingford Rd	Kandy Ave	00:42	00:40	6%	00:40	00:40	2%
	Overall		**02:37**	**02:20**	**11%**	**05:10**	**02:48**	**46%**
Beecroft Rd (Southbound)	Kandy Ave	Carlingford Rd	01:04	01:04	1%	01:18	00:54	31%
	Carlingford Rd	Blaxland Rd	02:54	02:34	11%	06:09	07:00	-14%
	Blaxland Rd	Maida Rd	00:25	00:25	-1%	00:25	00:25	1%
	Overall		**04:23**	**04:03**	**8%**	**07:52**	**08:19**	**-6%**
Carlingford Rd/Epping Rd (Eastbound)	Kent St	Beecroft Rd	03:49	03:34	6%	01:27	01:30	-4%
	Beecroft Rd	Blaxland Rd	01:10	00:54	23%	00:45	00:40	11%
	Blaxland Rd	Essex St	00:43	00:48	-11%	00:25	00:42	-65%
	Overall		**05:42**	**05:16**	**8%**	**02:37**	**02:52**	**-10%**
Carlingford Rd/Epping Rd (Westbound)	Essex St	Blaxland Rd	01:33	01:32	1%	02:28	01:20	46%
	Blaxland Rd	Carlingford Rd	00:47	00:49	-3%	01:19	01:07	15%
	Carlingford Rd	Kent St	00:47	00:46	2%	00:50	00:46	8%
	Overall		**03:07**	**03:07**	**0%**	**04:36**	**03:13**	**30%**

Figure 4-4 Travel Time Plot - Beecroft Rd (Northbound) - AM Peak (07:30 - 08:30)

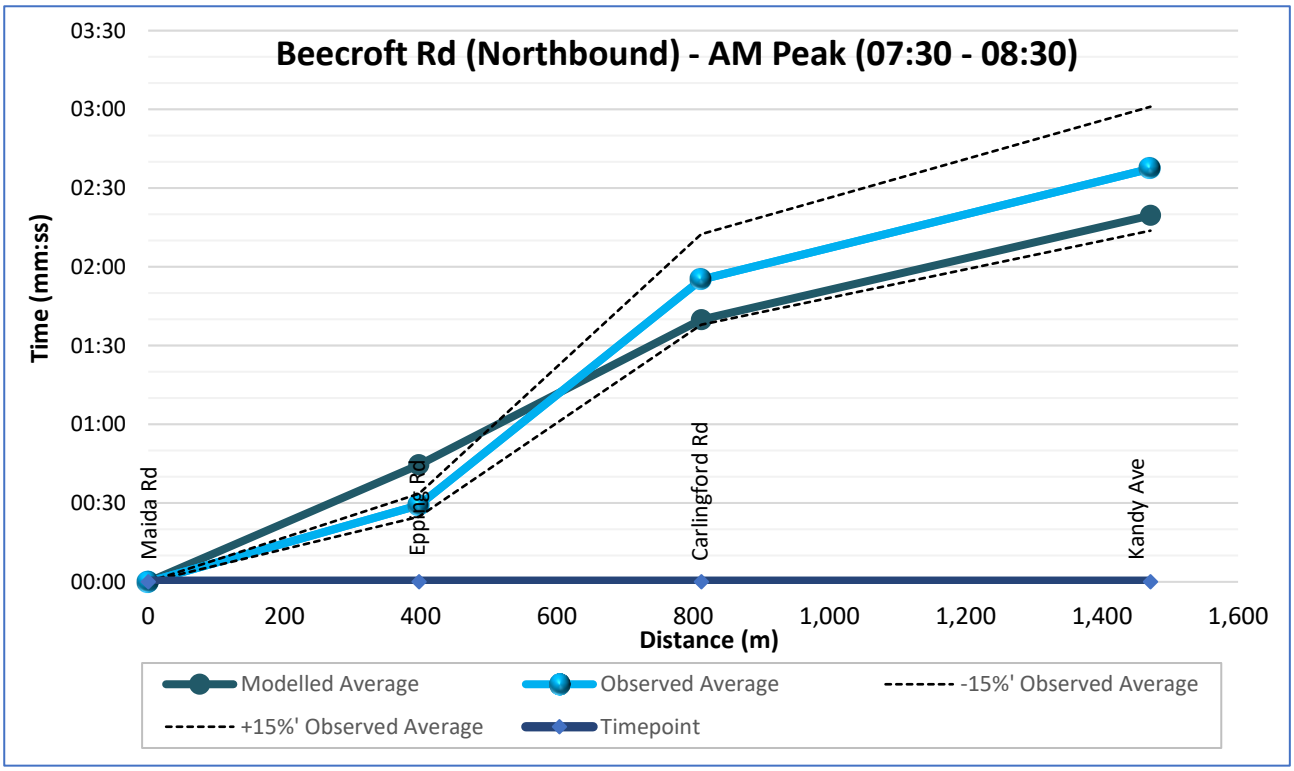


Figure 4-5 Travel Time Plot - Beecroft Rd (Southbound) - AM Peak (07:30 - 08:30)

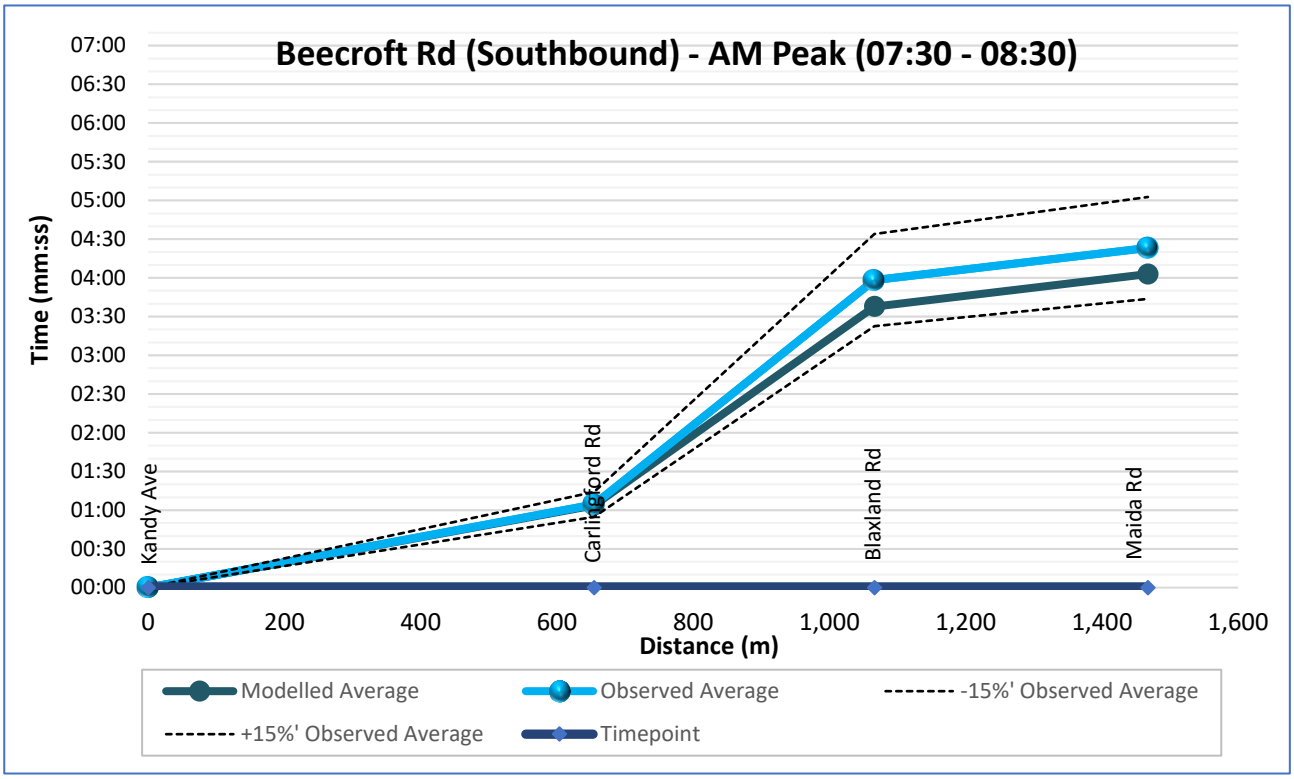


Figure 4-6 Travel Time Plot - Beecroft Rd (Northbound) - PM Peak (17:00 - 18:00)

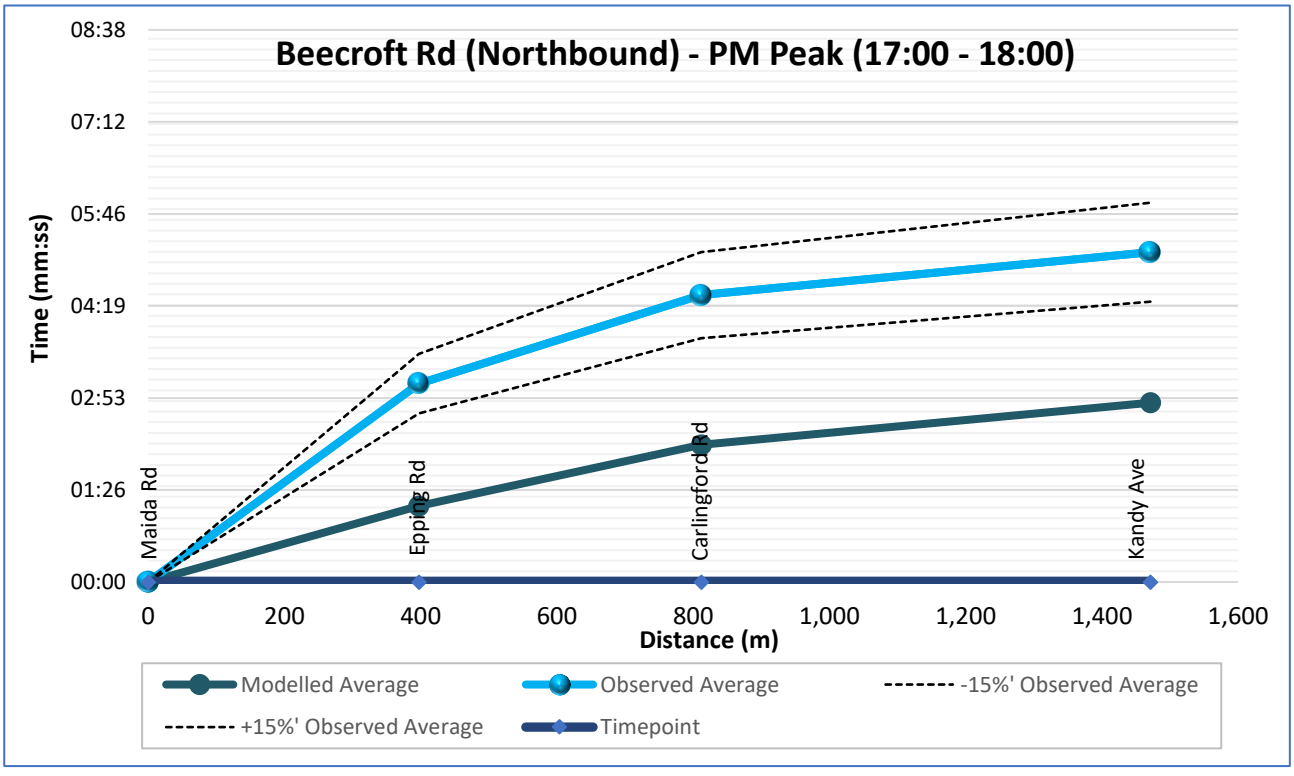


Figure 4-7 Travel Time Plot - Beecroft Rd (Southbound) - PM Peak (17:00 - 18:00)

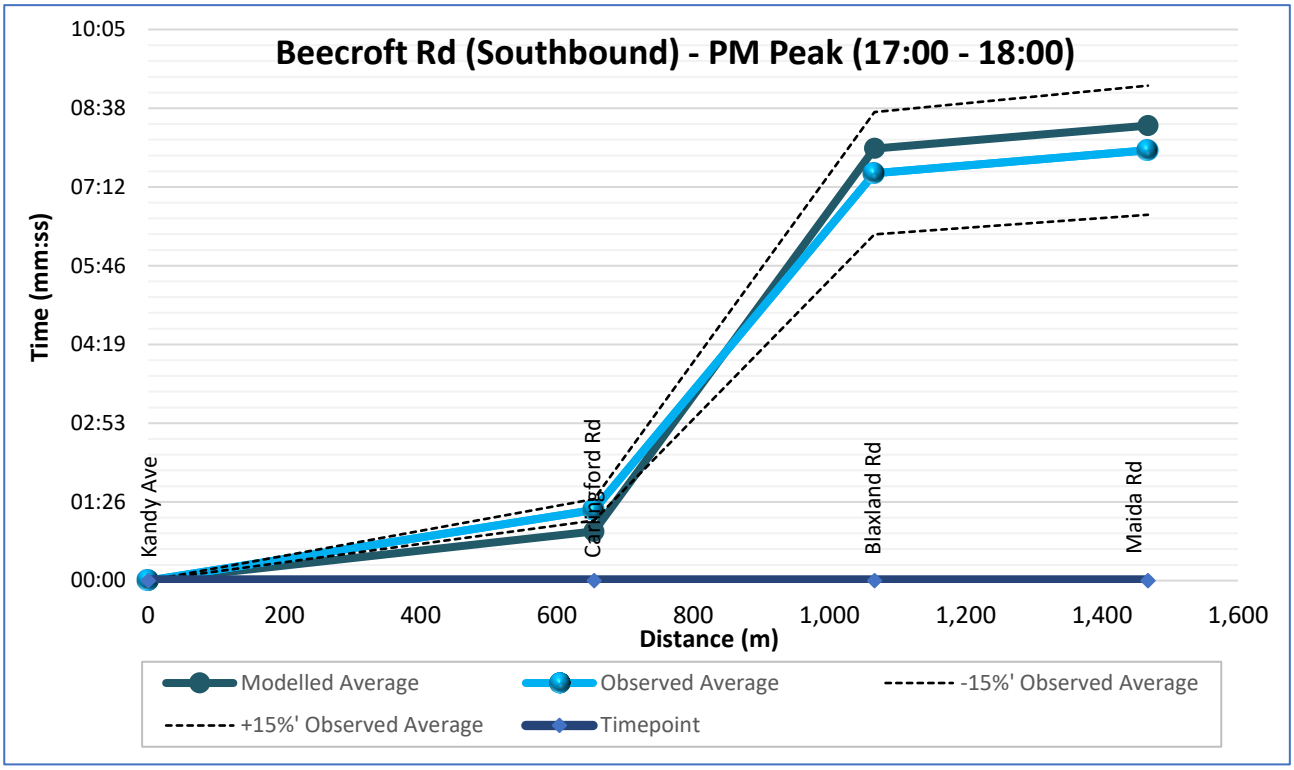


Figure 4-8 Travel Time Plot - Carlingford Rd/Epping Rd (Eastbound)- AM Peak (07:30 - 08:30)

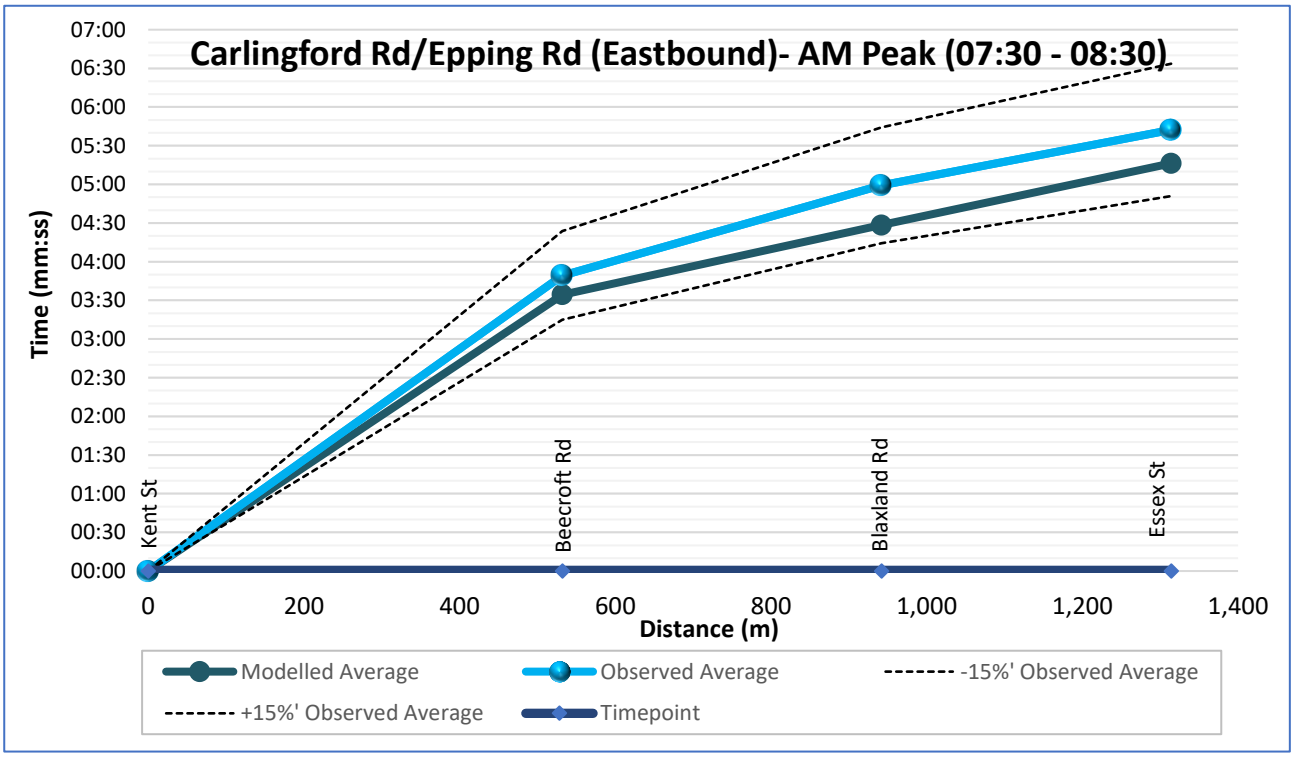


Figure 4-9 Travel Time Plot - Carlingford Rd/Epping Rd (Westbound)- AM Peak (07:30 - 08:30)

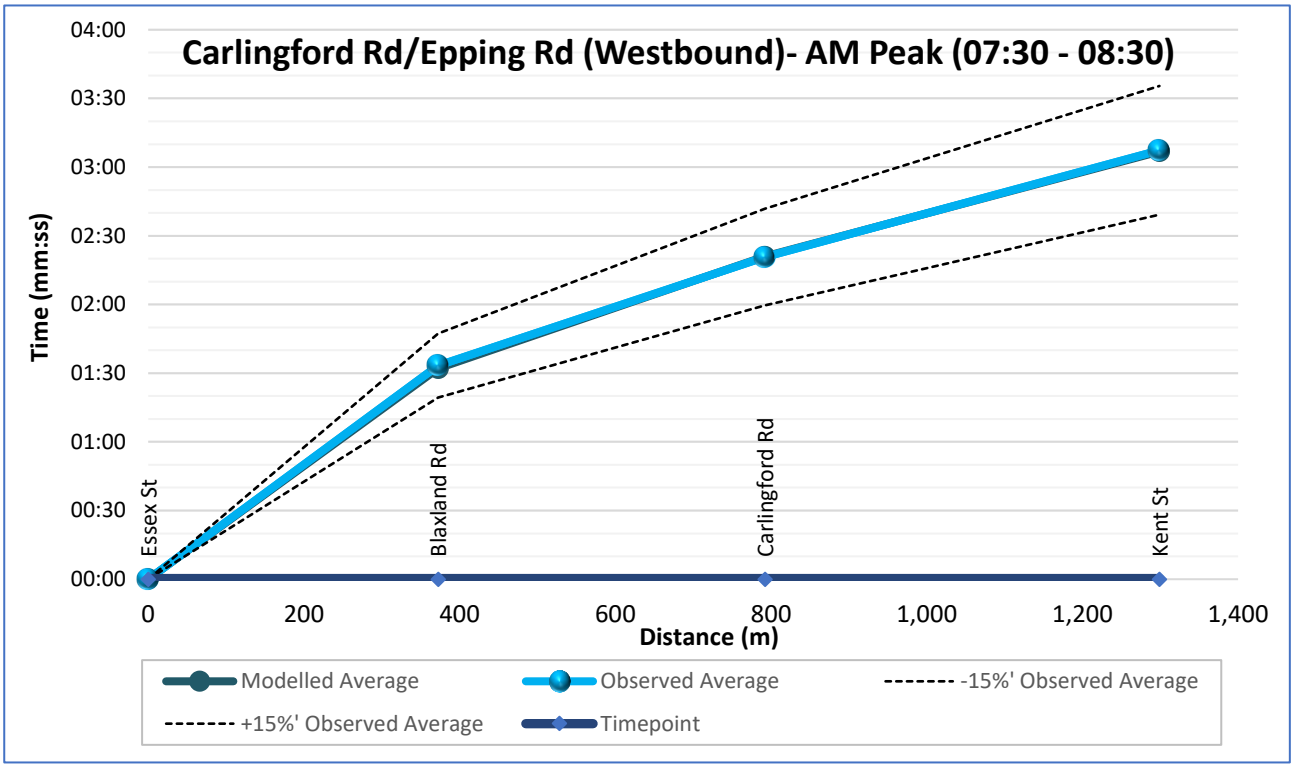


Figure 4-10 Travel Time Plot - Carlingford Rd/Epping Rd (Eastbound)- PM Peak (17:00 - 18:00)

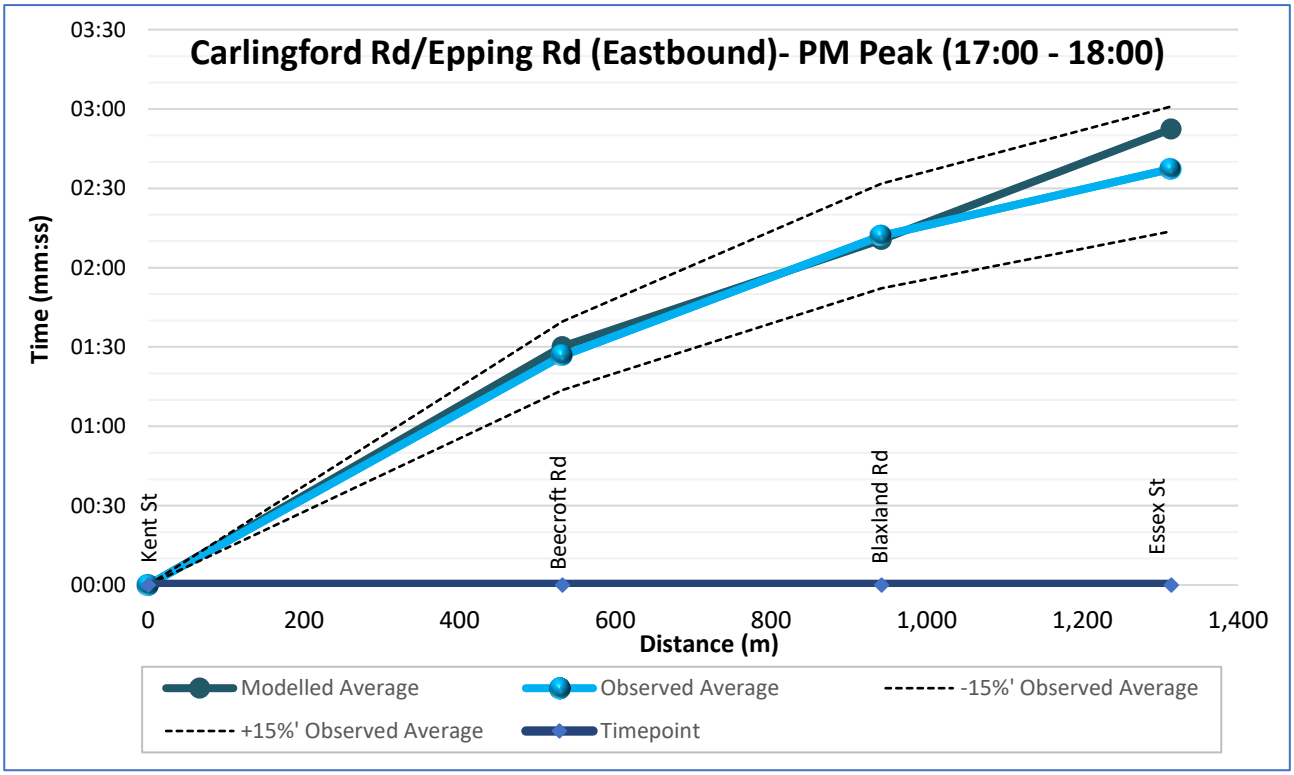
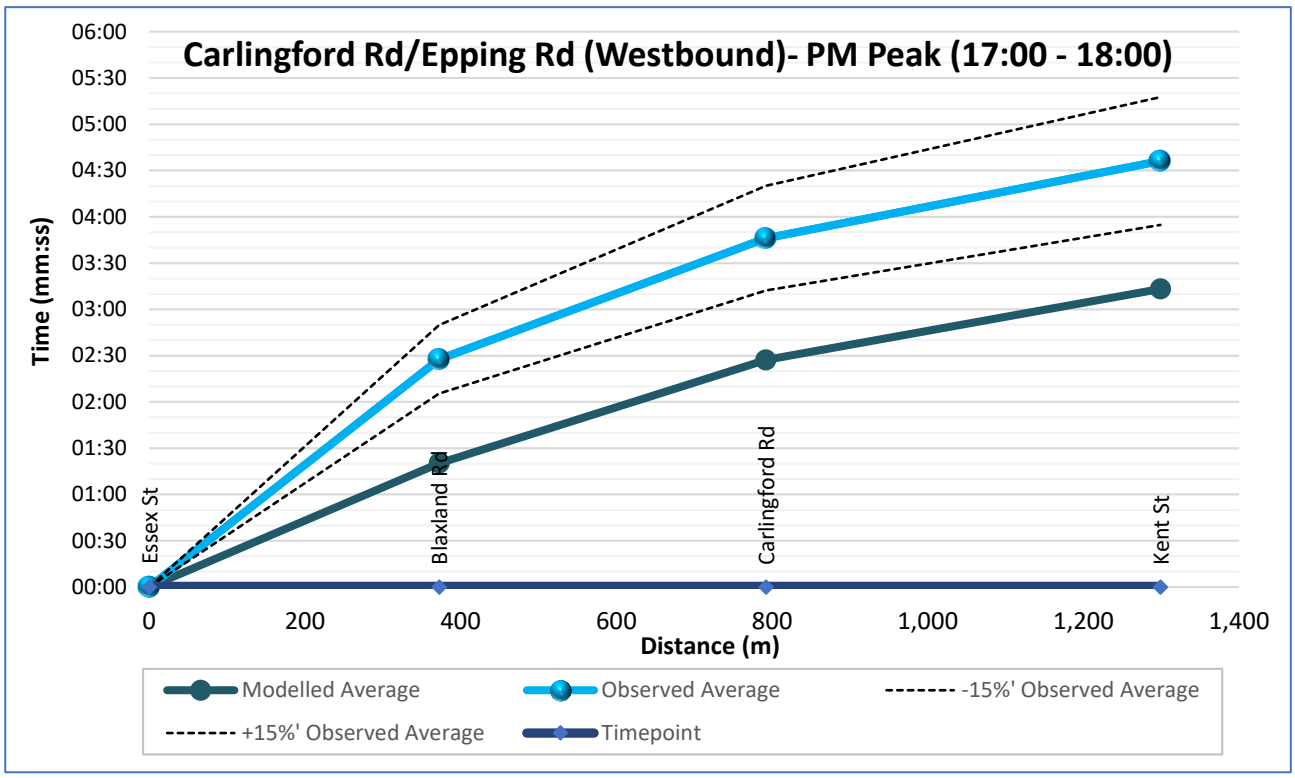


Figure 4-11 Travel Time Plot - Carlingford Rd/Epping Rd (Westbound)- PM Peak (17:00 - 18:00)



The key findings from the analysis of VISSIM model travel time calibration include:

- The analysis reveals that most travel times align well with the observed data, with most sections differing by less than 15%. Instances where the threshold is exceeded typically involve differences of less than 25 seconds, mainly in shorter or relatively low travel time sections.
- During the PM peak, Beecroft Rd (Northbound) and Carlingford Rd/Epping Rd (Westbound) are noted as not meeting the criteria due to long observed travel times on individual sections within the overall survey route. The uncharacteristically long travel times in these segments seemed inconsistent with travel times in adjacent time periods, the observed traffic queueing and the short travel distances involved. Such inconsistencies can occur when the number of data samples is low. The data may have been influenced by a specific traffic event, data collection errors, or the behaviour of the surveyor (driver).
- To check the perceived inconsistencies in the floating car surveys, a secondary data source was used to check the validation. HERE data was sourced, for the same period, to check the segments in question. The HERE data provides a larger sample of travel times in those segments and confirmed that the floating car data was uncharacteristically high. The modelled flows were consistent with the HERE travel time data (refer Table 4-6).
- Based on the review against multiple travel time validation data sources, the analysis confirmed that the modelled travel times are consistent with observed travel times and that the model is well calibrated and validated.

Table 4-6: Comparison of PM Peak Floating Car, Modelled and HERE travel times (mm:ss)

Route Segment	Direction	Floating Car	Modelled	HERE
Blaxland Road, Maida Road to Epping Road	Northbound	3:00	1:10	0:55
Epping Road, Essex Street to Blaxland Road	Westbound	2:28	1:20	1:29

4.2.8 Queue Length Validation

A summary of modelled and observed average queue lengths (vehicles) for each approach are provided in **Table** 4-7.

Table 4-7 Average Queue Length (meters) Validation Summary - AM and PM Peaks

Intersection	Phase	AM Peak (07:30-08:30)			PM Peak (17:00-18:00)		
		Observed	Modelled	Diff	Observed	Modelled	Diff
Carlingford Rd & Ray Rd & Rawson St	South	27	21	-6	77	17	-60
	East	40	11	-29	46	16	-30
	North	63	37	-26	67	34	-33
	West	292	234	-58	106	40	-66
Beecroft Rd & Carlingford Rd	South	97	25	-72	129	59	-70
	East	-	-	-	-	-	-
	North	62	24	-38	40	14	-26
	West	54	20	-34	60	19	-41
Beecroft Road / High Street / Bridge Street	South	5	0	-5	4	0	-4
	East	-	-	-	-	-	-
	North	-	-	-	-	-	-
	West	23	5	-18	26	7	-19
Bridge Street / Rawson Street	South	18	2	-16	18	4	-14
	East	23	1	-22	33	2	-31
	North	26	12	-14	21	4	-17
	West	23	8	-15	18	2	-16
Epping Rd & Blaxland Rd & Langston Pl	South	38	20	-18	244	42	-202
	East	113	75	-38	164	98	-66
	North	31	12	-19	30	13	-17
	West	145	157	12	204	165	-39
Epping Rd & Essex St	South	13	12	-1	22	15	-7
	East	10	7	-3	131	19	-112
	North	39	47	8	50	101	51
	West	88	74	-14	76	25	-51

The key findings from the analysis of VISSIM model queue length calibration include:

- In the AM peak, the modelled queue lengths are generally a good match to the observed queue lengths. The largest AM Peak average queue length inconsistencies occurred on the southern approach to the Beecroft Rd / Carlingford Rd intersection. The modelled queues were slightly lower than modelled.
- In the PM peak, the modelled queue lengths are generally a good match to the observed in most of the approaches. The largest PM Peak average queue length inconsistencies occurred on the southern approach to Epping Road / Blaxland Road / Langston Place intersection. The modelled queues were lower than the observed.

4.2.9 Network Performance

The network performance statistics indicate the efficiency of road network. For instance, models showing a comparatively higher level of vehicle stops typically represent high levels of congestion, which generally reduce throughput and increase greenhouse emissions (due to the increased stop/start nature of the driving). Conversely, a comparatively low VHT typically represents a network with a relatively low level of congestion and is generally be correlated with a low level of vehicle stops.

Table 4-8 presents the key network performance parameters for the following:

- Total distance travelled by all vehicles within the modelled network (VKT);
- Total travel time by all vehicles within the modelled network (VHT); and
- The average speed of vehicle trips on all roads within the microsimulation model;
- The average delay of vehicle trips on all roads within the microsimulation model;
- The total completed vehicle trips on all roads within the microsimulation model;
- Unreleased trips (Latent Demand) – demand that could not be released in the peak hour;
- The average number of vehicle stops on all roads within the microsimulation models.

Table 4-8 Network Performance Summary - AM and PM Peaks

Model Performance Parameters	AM Peak (07:30-08:30)	PM Peak (17:00-18:00)
Vehicle kilometres travelled (VKT) km	9651	9563
Vehicle hours travelled (VHT) Hours	369	345
Average network speed (km/h)	26	28
Average network delay (s)	111.9	97.5
Completed trips	6119	6252
Unreleased trips	5	0
Number of vehicle stops Average	3.12	2.29

The average network speeds are comparatively lower in both AM and PM peaks. This indicates the increased congestion levels with the future demand growth.

4.2.10 Intersection Performance

Table 4-9 summarises approach and overall intersection performance in terms of Average queue, delay and LOS based on the TfNSW method, indicated below.

LOS	Delay (sec) - Low	Delay (sec) -High
A	0	14
B	15	28
C	29	42
D	43	56
E	57	70
F	>71	>71

Table 4-9: Intersection Performance – AM and PM Peak

		AM Peak (07:30-08:30)				PM Peak (17:00-18:00)			
Intersection	**Approach**	**Traffic Volume**	**Delay (s)**	**LOS**	**Average Queue (m)**	**Traffic Volume**	**Delay (s)**	**LOS**	**Average Queue (m)**
Carlingford Rd & Ray Rd & Rawson St	South	269	73	F	21	356	50	D	17
	East	876	9	A	11	1,184	8	A	16
	North	483	62	E	37	234	40	C	10
	West	1098	146	F	234	952	50	D	40
	Overall	**2,726**	**80**	**F**	**107**	**2,726**	**31**	**C**	**24**
Beecroft Rd & Carlingford Rd	South	1,668	31	C	25	2,168	34	C	59
	North	1,452	31	C	24	1,194	32	C	14
	West	1,410	10	A	20	1,061	14	A	19
	Overall	**4,530**	**25**	**B**	**23**	**4,423**	**28**	**B**	**37**
Bridge Street / Rawson Street	South	191	13	A	2	196	16	B	4
	East	198	9	A	1	369	8	A	2
	North	293	26	B	12	230	13	A	4
	West	305	15	B	8	174	9	A	2
	Overall	**987**	**41**	**C**	**12**	**969**	**45**	**D**	**4**
Beecroft Road / High Street / Bridge Street	South	24	9	A	0	17	11	A	0
	East	1716	1	A	0	2,500	1	A	0
	West	207	12	A	5	128	26	B	7
	Overall	**1,947**	**12**	**A**	**5**	**2,645**	**26**	**B**	**7**
Epping Rd & Blaxland Rd & Langston Pl	South	794	27	B	20	977	47	D	42
	East	1,118	54	D	75	1696	48	D	98
	North	265	49	D	12	242	54	D	13
	West	2,640	42	C	157	1,867	57	D	165
	Overall	**4,817**	**43**	**C**	**107**	**4,782**	**52**	**D**	**108**
Epping Rd & Essex St	South	185	57	E	12	293	53	D	15
	East	690	14	A	7	1,202	21	B	19
	North	519	74	F	47	562	120	F	101
	West	1843	25	B	74	1,121	20	B	25
	Overall	**3,237**	**32**	**C**	**52**	**3,178**	**41**	**C**	**35**

The key observations of the VISSIM analysis of the Base Case model intersection performance includes:

- All the intersections perform satisfactorily at LOS D or better in both AM and PM peaks except Carlingford Road / Ray Road / Rawson Street intersection, in the AM peak.
- The north approach at the Epping Road / Essex Street intersection is performing at LOS F in both AM and PM peaks, South approach in the AM peak operates with LOS E.

4.3 Model Calibration SIDRA Modelling

4.3.1 Calibration Process

The following parameters have been changed to calibrate the surveyed queue lengths recorded on-site.

Carlingford Road / Ray Road / Rawson Street

Blocking Calibration (AM Peak):

- This includes filtering effects in the B phase where vehicles clear at the end of the phase.
- Blocking calibration to reduce queueing from Ray Road (0.2).
- Blocking calibration to reduce queueing from Rawson Street (0).
- Blocking calibration to increase queueing from the West (1.04).

Peak Flow Factor (PFF) and Flow Scale % (PM Peak):

- The PFF on the southern, northern and eastern approaches changed from 95% to 100% to reduce the modelled queue
- Flow Scale on the left turn from the northern approach changed from 245% from 100%; the right turn from the southern approach changed to 80%

Lane Utilisation:

- 90% Lane Utilisation on the kerbside lane from the south approach.
- West appr adjusted coordination arrival type to 5 to reduce the blockage right turn from Beecroft Road.

Phase Timing:

- SCATS History shows a fixed split plan configured during peaks.
- It is assumed a priority green split was locked given to Carlingford Road over the side streets.

Beecroft Road and Carlingford Road

Signal coordination calibration:

- Increased the rating to 6 and 85% arrived during Green on the Southern approach (AM).
- Increased the rating to 6 and 86% arrived during Green on the Southern approach (PM).
- The lane utilisation on the northern approach changed to match the observed queue length (PM) - 55% and 65% on Lane 1 and 2 respectively.

Epping Road / Blaxland Road / Langston Place

Signal coordination calibration:

- increased the Arrival during Green of the east approach, to 70% and 80% for AM and PM respectively.

Lane Capacity Adjustment:

- Increased the south approach queue via capacity reduction, -58%. It is assumed that the queue did not dissipate before the PM peak due to the split plan locked from 3:15 pm

Phase Timing:

- SCATS History shows a fixed split plan configured during peaks.
- It is assumed a priority green split was locked given to Epping Road over the side streets.

Epping Road / Essex Street

Signal coordination calibration:

- AM peak - increased the rating to 6 with coordination on the west approach.
- PM Peak - increase the % arrival during green for westbound to 80% and reduced the arrival rating to 2 on the east approach.

Lane Utilisation:

- Lane 1 utilisation east approach is adjusted with lane-by-lane queue length. 5%
- Lane 1 utilisation south approach is adjusted with lane-by-lane queue length. 95%

Beecroft Road / High Street / Bridge Street

Lane Capacity - The capacity on the High Street (left into Beecroft Road) was reduced to 70%. It is due to limited sight visibility and high speed on the main road.

Bridge Street / Rawson Street Roundabout

The environment factors were adjusted to simulate the limited visibility of the roundabout approaches:

- Southern / eastern / northern / western approaches to 1.4 / 1.2 / 2.0 / 1.2 respectively
- The AM flow scale on the raised zebra crossing east of the roundabout increased to 150% to simulate the blockage between the roundabout and the pedestrian crossing.

4.3.2 Signal Time Calibration Results

A comparison of observed and modelled signal times at each intersection is presented in **Table 4-10**.

Table 4-10 SIDRA Signal Time Calibration (seconds)

Intersection	Phase	AM Peak (07:30-08:30)			PM Peak (17:00-18:00)		
		Observed (sec)	Modelled (sec)	Diff %	Observed (sec)	Modelled (sec)	Diff %
Carlingford Rd & Ray Rd & Rawson St	A	84	85	1.2%	84	85	1.2%
	B	45	45	0.0%	46	45	-2.2%
	Total	**129**	**130**	**0.8%**	**130**	**130**	**0.0%**
Beecroft Rd & Carlingford Rd	A	45	45	0.0%	57	59	3.5%
	B	18	18	0.0%	20	20	0.0%
	C	65	67	3.1%	52	51	-1.9%
	Total	**128**	**130**	**1.6%**	**129**	**130**	**0.8%**
Epping Rd & Blaxland Rd & Langston Pl	A	55	56	1.8%	81	81	0.0%
	B	24	24	0.0%	23	23	0.0%
	C	26	26	0.0%	25	26	4.0%
	D	24	24	0.0%	0	0	0%
	Total	**129**	**130**	**0.8%**	**129**	**130**	**0.8%**
Epping Rd & Essex St	A	80	79	-1.3%	80	80	0.0%
	B	27	28	3.7%	27	28	3.7%
	C	22	23	4.5%	23	22	-4.3%
	Total	**129**	**130**	**0.8%**	**130**	**130**	**0.0%**

The key findings from the analysis of SIDRA model signal timing calibration include:

- During the AM and PM peaks, the modelled average cycle time and phase times shows a good match with the observed times (within 10%).
- The only exception is phase B during the AM Peak at Beecroft Road and Carlingford Road, where the absolute difference is only 2 seconds.
- The modelled signal timings are considered well calibrated with observed.

4.3.3 SIDRA Queue Length Calibration

A summary of modelled and observed queue lengths (in vehicles) for each approach is provided in **Table 4-11.** The modelled queue lengths for both peaks show a good match with the observed queues.

It is noted that the observed queue length comparison for VISSIM models are different because the approach queue length is an average across all the lanes. In contrast the SIDRA's approach queue length is taken from the maximum queue length of all the lanes. The SIDRA modelled maximum queue lengths (95th percentile queues) are consistent with the observed queue lengths.

Table 4-11 SIDRA Queue Length Calibration (Vehicles)

Intersection	Approach	AM Peak (07:30-08:30)		PM Peak (17:00-18:00)	
		Observed Queue	Modelled Queue (95th%)	Observed Queue	Modelled Queue (95th%)
Carlingford Rd & Ray Rd & Rawson St	South	8	11	14	17
	East	8	11	8	8
	North	18	21	22	22
	West	51	58	28	31
Beecroft Rd & Carlingford Rd	South	24	29	29	26
	East	NA	NA	NA	NA
	North	16	23	15	15
	West	9	11	9	12
Beecroft Road / High Street / Bridge Street	South	11	12	44	43
	East	27	29	33	31
	North	10	11	9	10
	West	35	42	36	36
Bridge Street / Rawson Street	South	7	5	8	11
	East	5	8	36	31
	North	12	19	15	19
	West	16	16	13	12
Epping Rd & Blaxland Rd & Langston Pl	South	1	0	1	0
	East	NA	NA	NA	NA
	North	NA	NA	NA	NA
	West	5	3	6	7
Epping Rd & Essex St	South	6	4	4	4
	East	8	8	7	10
	North	6	8	4	4
	West	5	7	2	2

4.3.4 SIDRA Intersection Performance

The SIDRA performance estimates for the calibrated AM and PM Peak Hour Base Year Models are presented in **Table 4-12**.

Table 4-12: SIDRA Base year Intersection Performance

Intersection	Approach	AM Peak (07:30-08:30)				PM Peak (17:00-18:00)			
		DOS	Delay (sec)	LOS	95%th Q (veh)	DOS	Delay (sec)	LOS	95%th Q (veh)
Carlingford Rd & Ray Rd & Rawson St	South	0.8	53	D	5	1.0	55	D	3
	East	0.5	6	A	11	0.6	3	A	8
	North	0.9	83	F	14	1.0	99	F	8
	West	1.0	107	F	58	0.9	35	C	31
	Overall	**1.0**	**64**	**E**	**58**	**1.0**	**32**	**C**	**31**
Beecroft Rd & Carlingford Rd	South	0.9	9	A	20	0.9	8	A	26
	North	0.8	40	C	7	0.9	36	C	13
	West	0.9	41	C	11	1.0	80	F	12
	Overall	**0.9**	**29**	**C**	**24**	**1.0**	**33**	**C**	**26**
Bridge Street / Rawson Street	South	0.7	19	B	4	0.7	20	B	4
	East	0.5	9	A	8	0.6	11	A	10
	North	0.8	21	B	8	0.6	7	A	5
	West	0.8	10	A	7	0.5	5	A	2
	Overall	**0.8**	**18**	**B**	**8**	**0.7**	**10**	**A**	**10**
Beecroft Road / High Street / Bridge Street	South	0.0	5	A	0	0.0	6	A	0
	East	0.5	4	NA	0	0.7	4	NA	0
	North	0.7	6	NA	27	0.5	6	NA	21
	West	0.9	19	B	3	1.0	65	E	7
	Overall[1]	**0.9**	**19**	**B**	**3**	**1.0**	**65**	**E**	**7**
Epping Rd & Blaxland Rd & Langston Pl	South	0.7	31	C	12	1.0	106	F	9
	East	0.8	20	B	29	0.8	10	A	31
	North	0.6	59	E	11	0.6	58	E	10
	West	1.1	42	C	42	1.2	41	C	35
	Overall	**1.1**	**33**	**C**	**29**	**1.2**	**42**	**C**	**43**
Epping Rd & Essex St	South	0.4	74	F	5	0.9	103	F	4
	East	0.2	15	B	8	0.6	34	C	31
	North	0.9	93	F	19	0.9	91	F	19
	West	0.9	5	A	16	0.5	8	A	12
	Overall	**0.9**	**25**	**B**	**19**	**0.9**	**41**	**C**	**31**

[1] Level of Service (LOS) of worst movement

The key observations of the SIDRA analysis of the Base Case model intersection performance includes:

- All the intersections perform satisfactorily at LOS C or better in both peaks, except Carlingford Road, Ray Road and Rawson Street, LOS E, in the AM peak.
- The poor performance of Carlingford Road, Ray Road and Rawson Street, is caused by the congestion at Beecroft Road and Carlingford Road. In addition, the pedestrian activity is high in the morning peak which increases the complexity of filtering between vehicles and pedestrians.
- Intersection performance in the SIDRA models is consistent with the VISSIM models despite the software packages applying different approaches to calculating delay. The calibrated SIDRA models will be used to generate the signal timing for future scenarios, which in turn used as a starting point in VISSIM.

5 Summary and Conclusion

The purpose of this modelling was to develop a calibrated and validated 2023 base model for VISSIM and SIDRA models for the Epping Bridge project. The base model was developed to represent the typical 2023 weekday AM and PM peak periods.

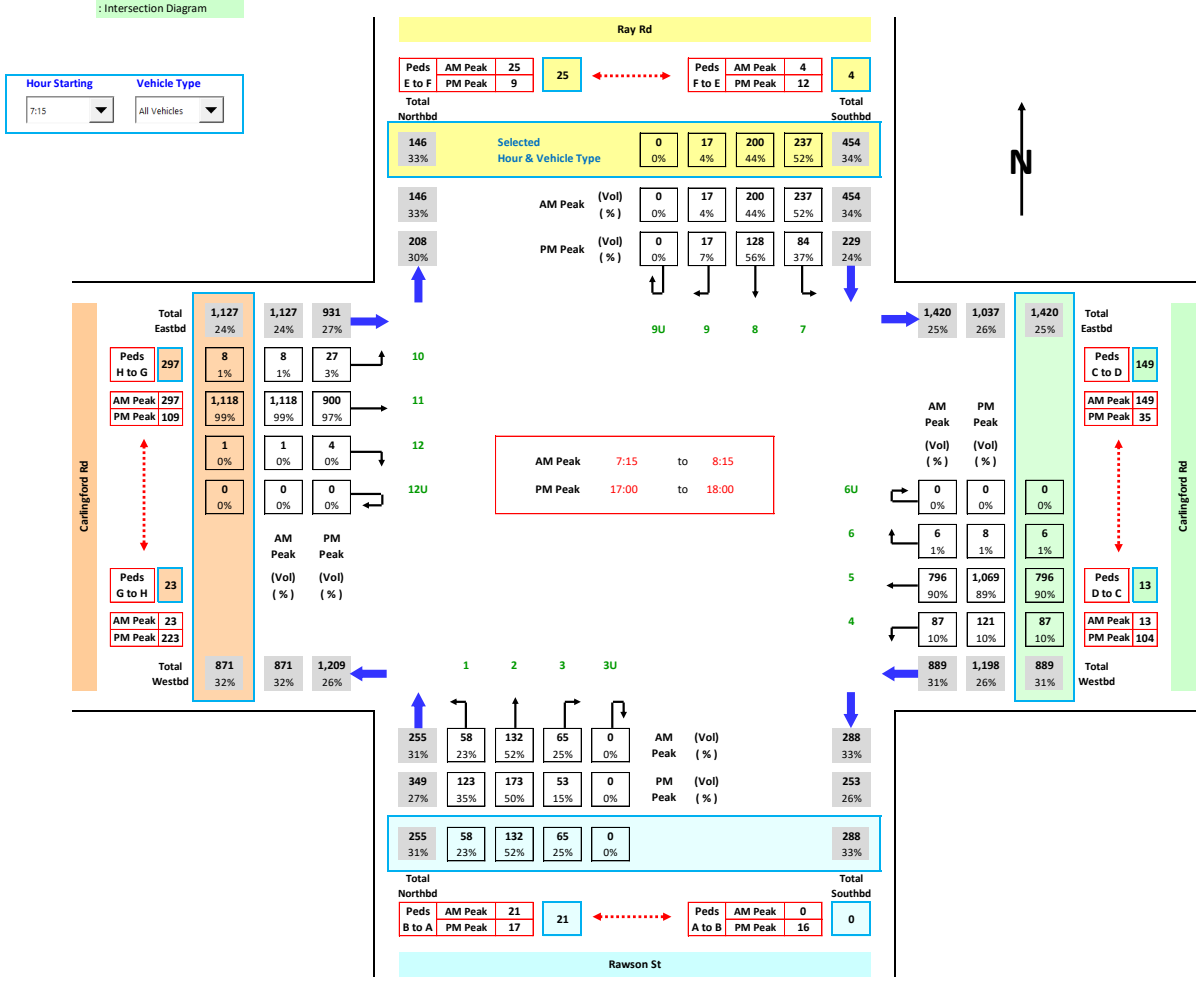
The AM and PM peak models are suitably calibrated for the 2023 weekday AM and weekday PM peak periods. Comparing the turning movement counts in the VISSIM model to the observed counts, it was concluded that the models conform with the calibration criteria set out in the TfNSW Traffic Modelling Guidelines (2013) for microsimulation models.

The queue lengths and travel times are satisfactorily validated against the observed queues recorded on site for VISSIM modelling. The SIDRA Model was validated against observed queue lengths, and it found to be satisfactory. The 2023 AM and PM Peak base models were therefore considered fit-for-purpose for use in end state scenario testing.

A. Classified Intersection Traffic Counts (21/9/2023)

Job No. : AUNSW7783
Client : Transport for NSW
Suburb : Epping
Location : 1. Carlingford Rd & Ray Rd & Rawson St

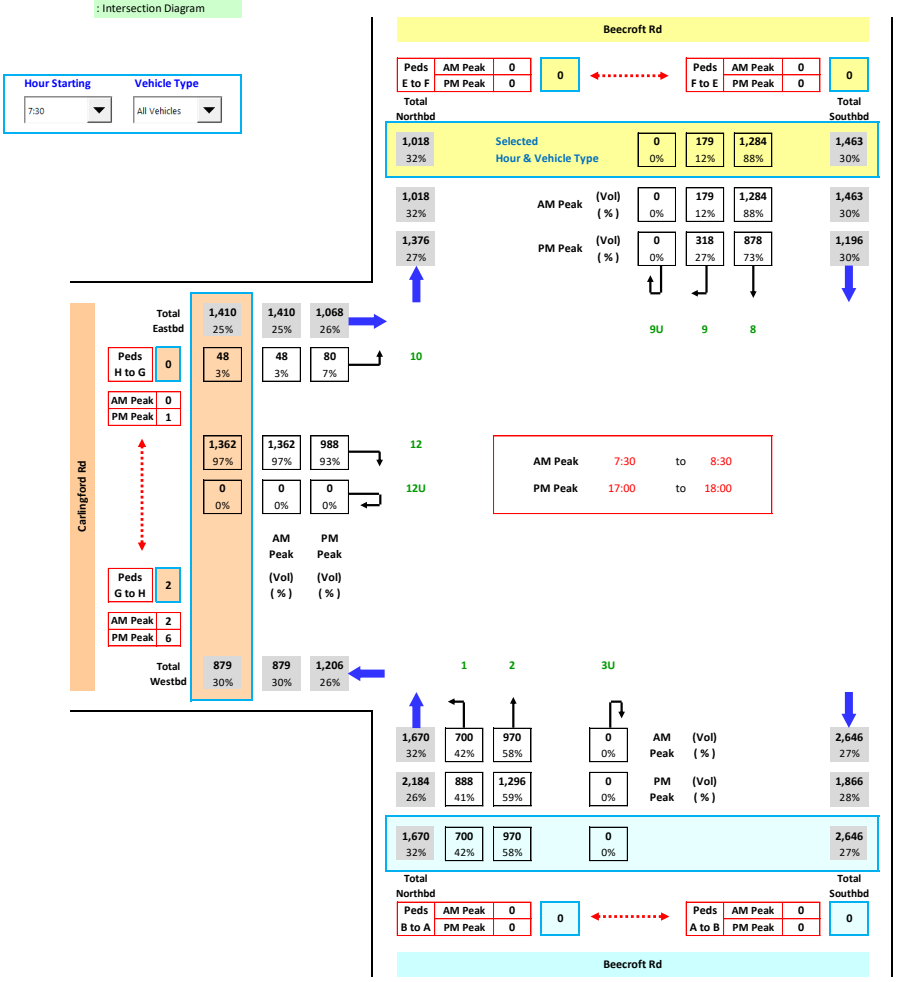
Day/Date : Thu, 21 Sep 2023
Weather : Fine
Description : Classified Intersection Count
: Intersection Diagram



Job No. : AUNSW7783
Client : Transport for NSW
Suburb : Epping
Location : 2. Carlingford Rd & Beecroft Rd

Day/Date : Thu, 21 Sep 2023
Weather : Fine
Description : Classified Intersection Count
: Intersection Diagram

MATRIX Traffic and Transport Data

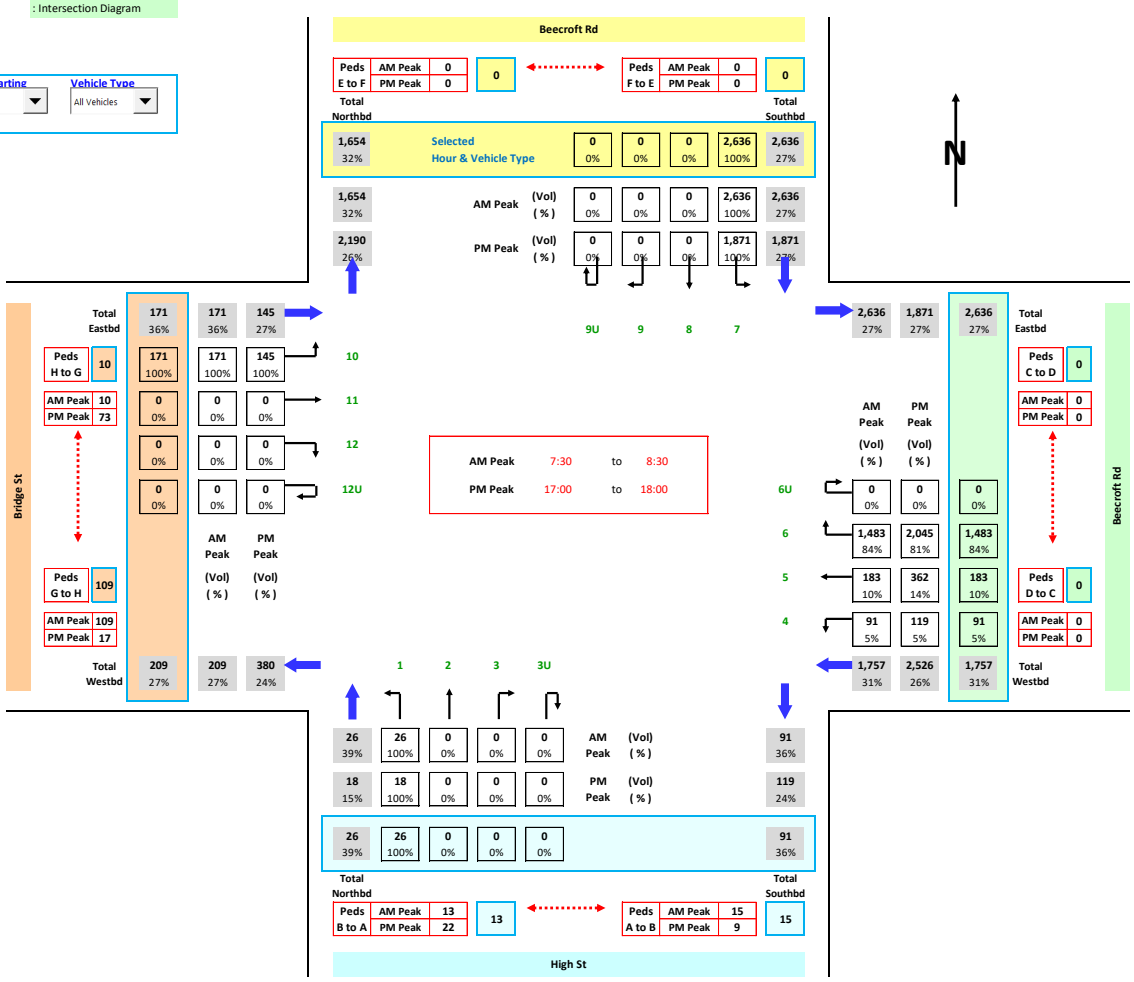


Job No. : AUNSW7783
Client : Transport for NSW
Suburb : Epping
Location : 3. High St & Bridge St & Beecroft Rd

Day/Date : Thu, 21 Sep 2023
Weather : Fine
Description : Classified Intersection Count
: Intersection Diagram

MATRIX Traffic and Transport Data

Hour Starting 7:30 | Vehicle Type All Vehicles

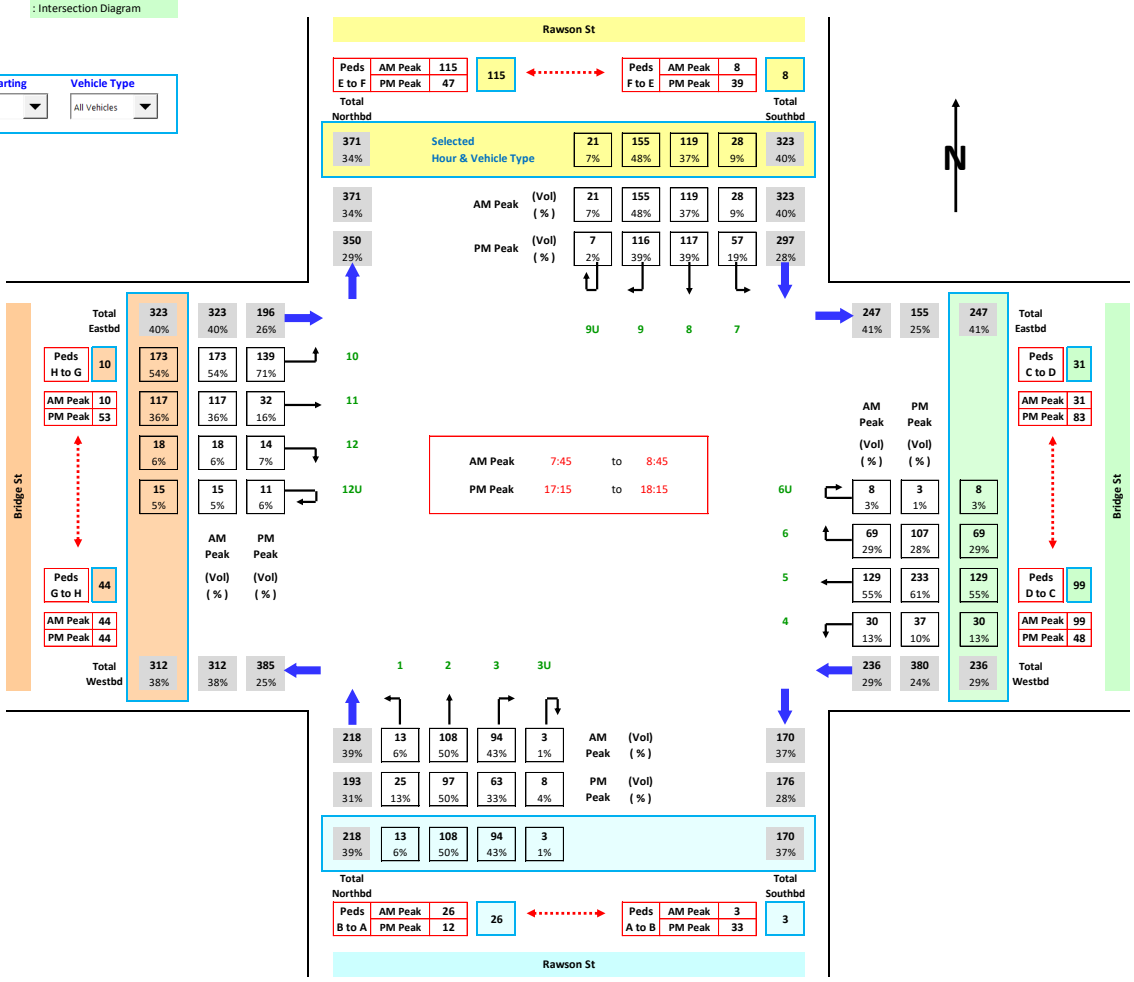


Job No. : AUNSW7783
Client : Transport for NSW
Suburb : Epping
Location : 4. Bridge St & Rawson St

Day/Date : Thu, 21 Sep 2023
Weather : Fine
Description : Classified Intersection Count
: Intersection Diagram

MATRIX Traffic and Transport Data

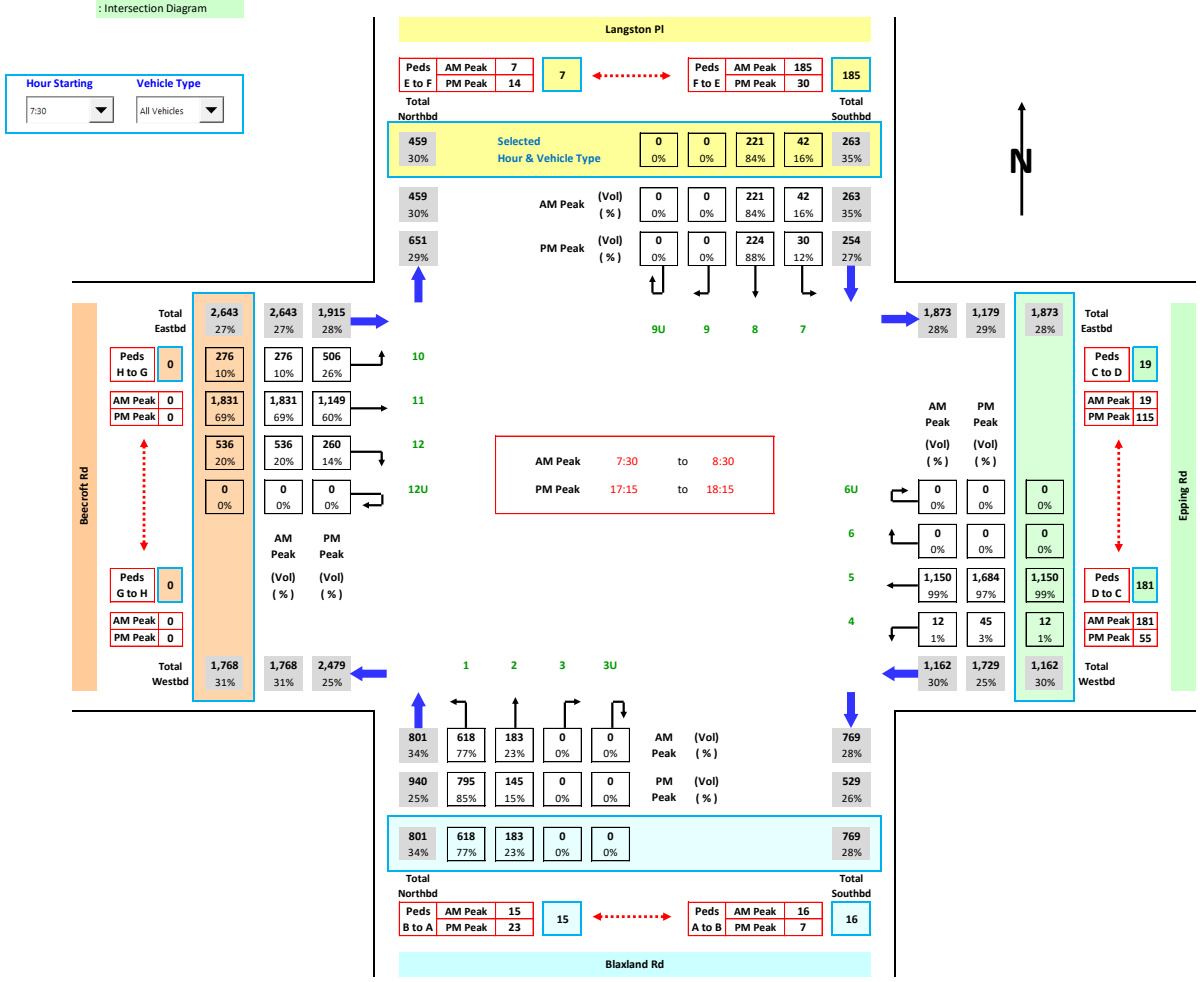
Hour Starting 7:45 **Vehicle Type** All Vehicles



Job No. : AUNSW7783
Client : Transport for NSW
Suburb : Epping
Location : 5. Epping Rd & Blaxland Rd & Langston Pl & Beecroft Rd

Day/Date : Thu, 21 Sep 2023
Weather : Fine
Description : Classified Intersection Count
: Intersection Diagram

MATRIX Traffic and Transport Data

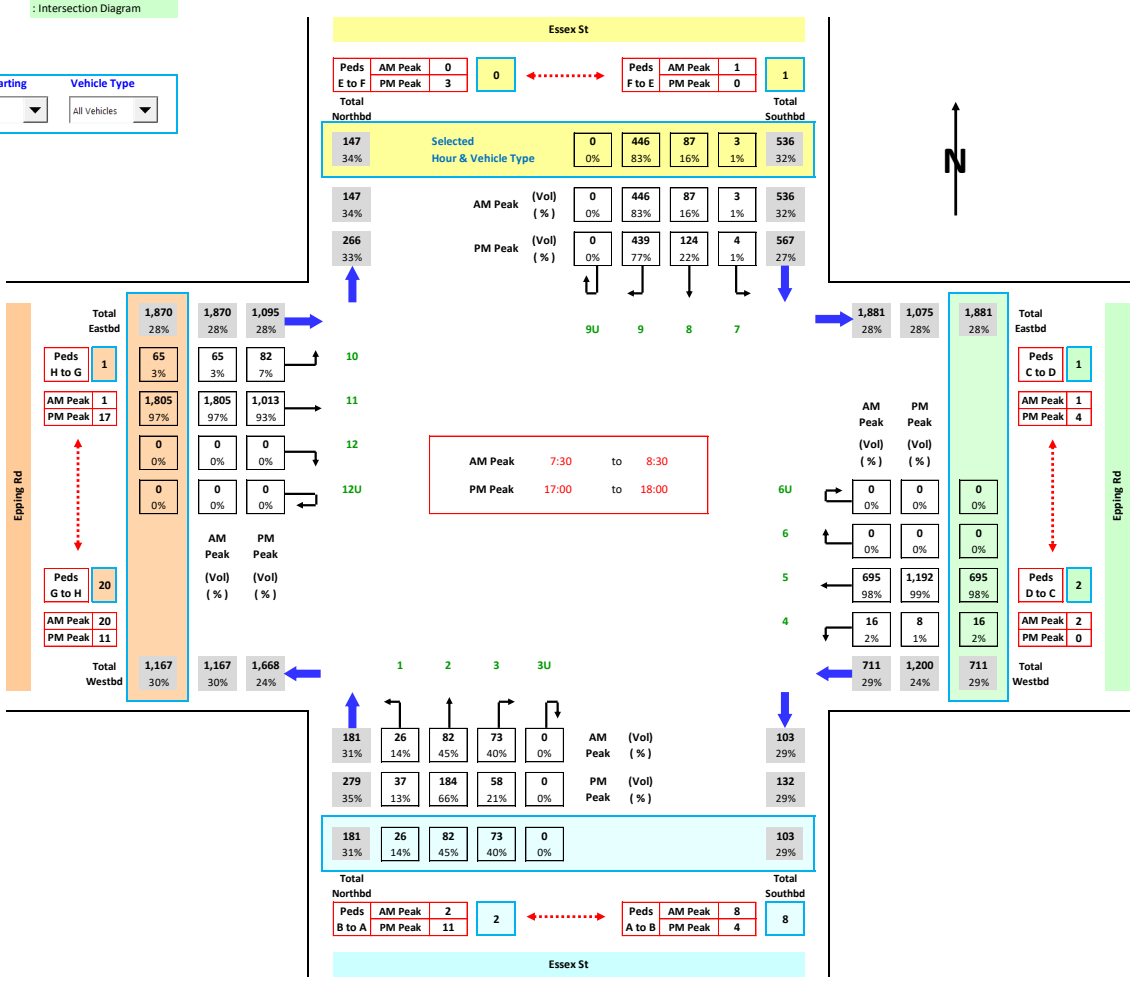


Job No. : AUNSW7783
Client : Transport for NSW
Suburb : Epping
Location : 6. Epping Rd & Essex St

Day/Date : Thu, 21 Sep 2023
Weather : Fine
Description : Classified Intersection Count
: Intersection Diagram

MATRIX Traffic and Transport Data

Hour Starting 7:30 **Vehicle Type** All Vehicles



B. Average Queue Length Data (21/9/2023)

Table B1: Carlingford Road, Ray Road and Rawson Street, Average Queue Length (Vehicles)

15-min Period Starting	Rawson Street (S)		Carlingford Road (E)		Ray Road (N)		Carlingford Road (W)	
	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2
6:30	1	2	2	1	3	2	10	10
6:45	2	3	2	2	4	2	12	10
7:00	3	3	2	2	4	3	10	10
7:15	4	4	5	4	6	5	18	19
7:30	4	3	7	7	9	7	40	38
7:45	6	3	6	6	11	7	40	42
8:00	6	4	6	6	11	7	47	49
8:15	5	5	7	5	17	6	40	39
8:30	6	10	8	6	21	6	33	30
8:45	5	5	7	6	19	7	17	16
16:00	10	14	6	7	9	4	7	6
16:15	8	14	6	6	9	3	11	8
16:30	7	14	7	7	6	4	9	6
16:45	8	14	6	6	5	2	10	9
17:00	11	14	7	7	15	4	23	20
17:15	7	14	6	6	20	6	17	12
17:30	9	12	7	8	17	6	15	12
17:45	8	14	8	6	8	4	14	11
18:00	7	14	7	8	14	4	15	11
18:15	9	14	7	7	17	5	11	7

Source: Matrix, Traffic & transport Data, 21/9/2023, 6am-10am and 3pm-7pm

Table B2: Carlingford Road and Beecroft Road, Average Queue Length (Vehicles)

15-min Period Starting	Beecroft Road (S)				Beecroft Road (N)					Carlingford Road (W)		
	Lane 1	Lane 2	Lane 3	Lane 4	Lane 1	Lane 2	Lane 3	Lane 4	Lane 5	Lane 1	Lane 2	Lane 3
6:30	1	1	9	8	8	9	9	2	1	1	7	7
6:45	1	1	8	7	7	7	9	2	1	1	8	8
7:00	1	1	8	8	8	10	12	2	2	1	8	7
7:15	1	1	12	12	9	9	11	4	3	0	8	8
7:30	1	1	13	12	9	10	11	3	3	0	8	9
7:45	1	1	10	10	8	9	9	4	3	0	8	8
8:00	1	1	20	20	7	8	11	5	4	0	7	8
8:15	1	1	14	15	8	9	11	5	3	1	9	8
8:30	2	1	12	13	7	8	10	6	5	0	9	8
8:45	1	1	9	10	7	9	8	5	4	0	9	8
16:00	3	4	14	17	4	4	4	6	3	1	9	9
16:15	2	3	22	25	4	3	2	5	4	1	9	9
16:30	3	3	20	23	4	3	3	6	5	0	9	9
16:45	4	3	19	24	5	4	5	7	5	0	9	8
17:00	4	4	16	21	4	3	4	7	5	0	9	9
17:15	3	3	17	21	5	4	4	6	5	0	9	9
17:30	4	4	18	24	7	5	8	8	6	1	9	9
17:45	4	4	15	19	4	4	6	8	4	1	9	9
18:00	2	3	13	16	4	4	3	5	3	0	9	9
18:15	2	2	12	15	5	5	4	4	3	1	9	8

Source: Matrix, Traffic & transport Data, 21/9/2023, 6am-10am and 3pm-7pm

Table B3: High Street, Beecroft Road & Bridge Street, Average Queue Length (Vehicles)

15-min Period Starting	High Street (S)	Bridge Street (W)
	Lane 1	Lane 1
6:30	0	1
6:45	0	1
7:00	1	2
7:15	0	4
7:30	1	4
7:45	1	4
8:00	1	3
8:15	1	5
8:30	1	4
8:45	1	2
16:00	1	4
16:15	1	4
16:30	1	4
16:45	1	4
17:00	1	4
17:15	1	5
17:30	1	3
17:45	0	5
18:00	2	4
18:15	2	3

Source: Matrix, Traffic & transport Data, 21/9/2023, 6am-10am and 3pm-7pm

Table B4: Rawson Street and Bridge Street, Average Queue Length (Vehicles)

15-min Period Starting	Rawson Street (S)	Bridge Street (E)	Rawson Street (N)	Bridge Street (W)
	Lane 1	Lane 1	Lane 1	Lane 1
6:30	1	0	1	1
6:45	1	1	1	1
7:00	2	2	1	2
7:15	2	2	6	3
7:30	2	2	4	2
7:45	3	2	5	3
8:00	2	3	4	5
8:15	4	7	4	4
8:30	3	2	2	3
8:45	2	4	3	3
16:00	9	6	4	9
16:15	3	4	3	5
16:30	7	8	7	8
16:45	2	6	3	2
17:00	3	4	4	2
17:15	3	4	3	3
17:30	2	7	2	2
17:45	4	5	4	4
18:00	4	5	3	5
18:15	2	4	2	3

Source: Matrix, Traffic & transport Data, 21/9/2023, 6am-10am and 3pm-7pm

Table B5: Epping Road, Blaxland Road and Langston Place, Average Queue Length (Vehicles)

15-min Period Starting	Blaxland Road (S)			Epping Road (E)			Langston Place (N)		Beecroft Road (W)			
	Lane 1	Lane 2	Lane 3	Lane 1	Lane 2	Lane 3	Lane 1	Lane 2	Lane 1	Lane 2	Lane 3	Lane 4
6:30	3	2	4	1	4	3	1	2	2	6	5	11
6:45	5	1	2	1	11	8	1	3	1	4	5	6
7:00	4	3	3	0	12	7	2	3	0	11	5	13
7:15	5	2	5	1	20	14	3	5	1	16	11	31
7:30	7	4	4	1	16	11	2	4	1	23	22	28
7:45	8	5	5	1	20	13	5	6	6	23	23	27
8:00	6	3	7	1	20	15	4	8	12	10	10	15
8:15	7	5	7	1	22	16	3	7	4	10	9	14
8:30	8	5	5	1	14	11	4	4	5	12	12	26
8:45	7	3	5	1	10	8	2	4	7	20	17	20
16:00	37	36	4	1	31	26	3	4	4	5	4	25
16:15	36	36	4	1	24	17	3	4	4	6	6	27
16:30	23	20	4	1	26	21	3	4	4	4	4	28
16:45	37	34	4	2	25	22	5	5	1	6	7	32
17:00	40	37	3	1	26	20	3	5	3	4	3	26
17:15	43	43	4	2	25	20	4	6	5	4	5	31
17:30	41	38	5	2	29	23	4	6	8	7	9	28
17:45	22	20	5	2	25	23	4	6	5	9	7	33
18:00	15	11	3	3	23	15	2	5	7	4	5	31
18:15	12	7	4	1	14	7	2	4	4	7	7	13

Source: Matrix, Traffic & transport Data, 21/9/2023, 6am-10am and 3pm-7pm.

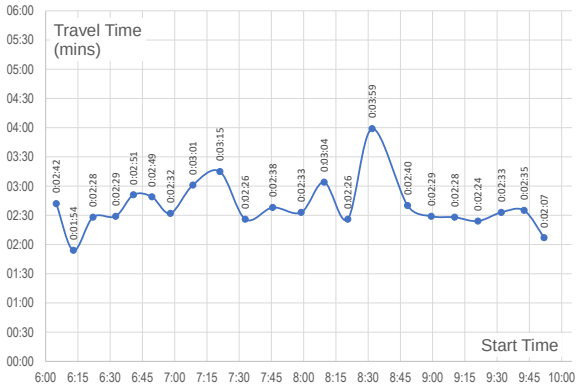
Table B6: Epping Road and Essex Street, Average Queue Length (Vehicles)

15-min Period Starting	Essex Street (S)			Epping Road (E)			Essex Street (N)			Epping Road (W)	
	Lane 1	Lane 2	Lane 3	Lane 1	Lane 2	Lane 3	Lane 1	Lane 2	Lane 3	Lane 1	Lane 2
6:30	1	1	2	1	3	3	1	3	3	12	12
6:45	1	1	1	0	3	2	2	4	4	13	12
7:00	1	1	3	1	2	2	1	5	6	12	13
7:15	1	1	3	1	3	3	2	9	10	14	13
7:30	1	1	3	1	2	1	2	6	8	14	14
7:45	2	1	4	1	3	2	1	9	8	14	13
8:00	1	2	5	1	3	2	2	9	9	12	13
8:15	1	2	4	1	4	3	2	9	8	13	12
8:30	1	3	6	1	3	3	3	7	7	10	13
8:45	1	3	5	1	4	4	3	7	7	11	12
16:00	1	2	4	2	31	28	2	10	9	12	11
16:15	2	2	4	1	30	27	4	6	8	12	12
16:30	3	1	3	1	31	27	4	7	7	12	12
16:45	2	2	5	1	30	29	2	8	7	12	12
17:00	1	3	4	1	32	27	3	12	13	11	12
17:15	1	4	6	0	31	27	2	6	6	11	11
17:30	2	5	7	1	30	28	5	10	11	12	12
17:45	1	3	5	1	29	24	4	10	8	11	11
18:00	1	2	4	1	22	18	2	11	11	10	9
18:15	1	2	4	1	8	7	2	6	5	6	6

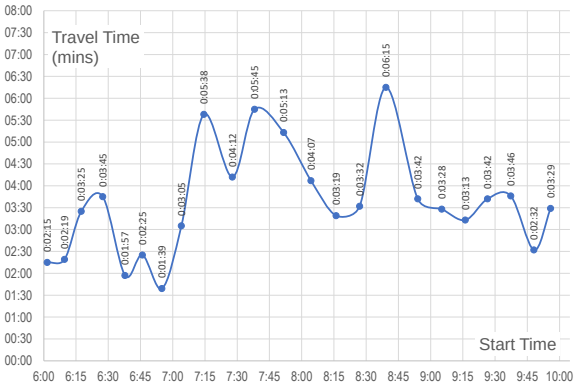
Source: Matrix, Traffic & transport Data, 21/9/2023, 6am-10am and 3pm-7pm

C. Travel Time Data (21/9/2023)

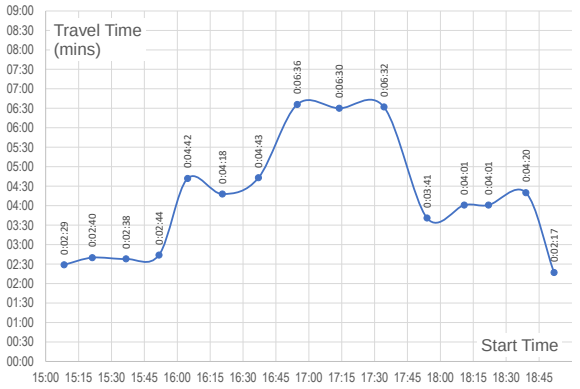
Beecroft Road, Epping Road and Blaxland Road, Northbound Travel Time



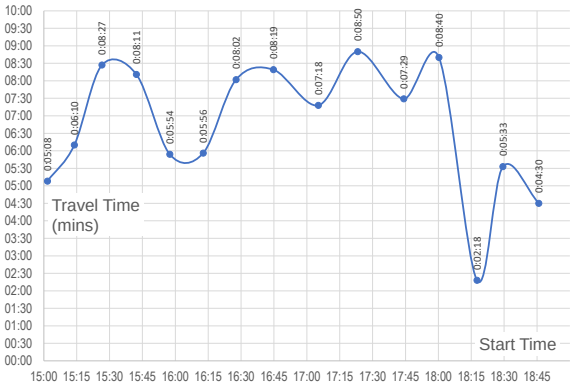
Beecroft Road, Epping Road and Blaxland Road, Southbound Travel Time



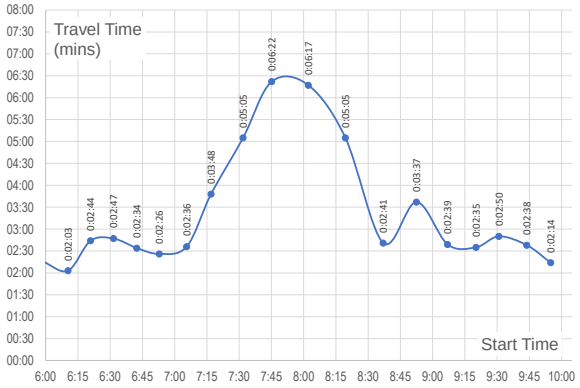
Beecroft Road, Epping Road and Blaxland Road, Northbound Travel Time



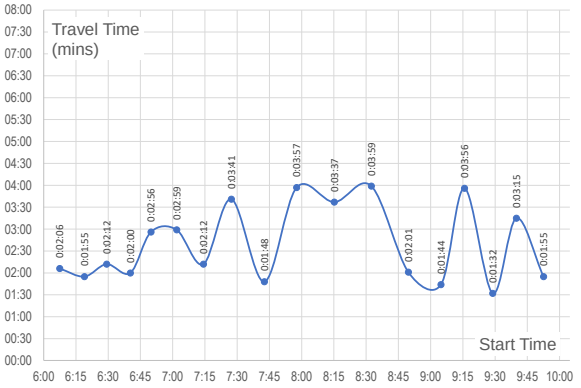
Beecroft Road, Epping Road and Blaxland Road, Southbound Travel Time



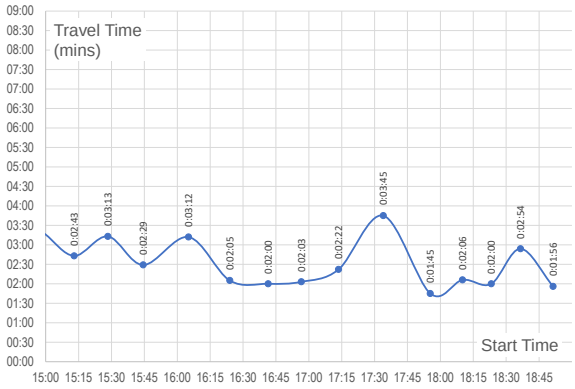
Carlingford Road, Beecroft Road and Epping Road, Eastbound Travel Time



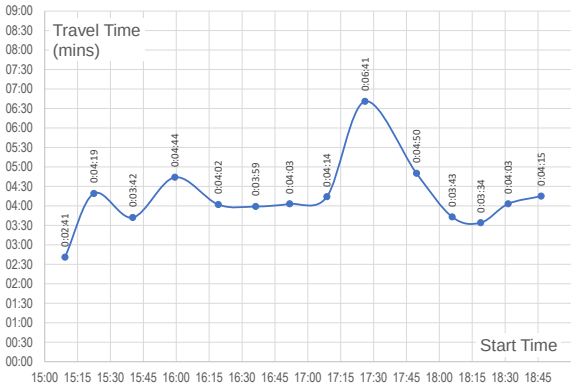
Carlingford Road, Beecroft Road and Epping Road, Westbound Travel Time



Carlingford Road, Beecroft Road and Epping Road, Eastbound Travel Time

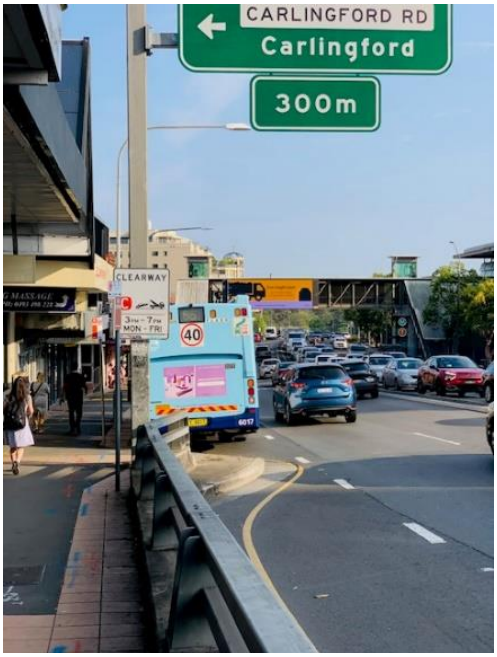


Carlingford Road, Beecroft Road and Epping Road, Westbound Travel Time

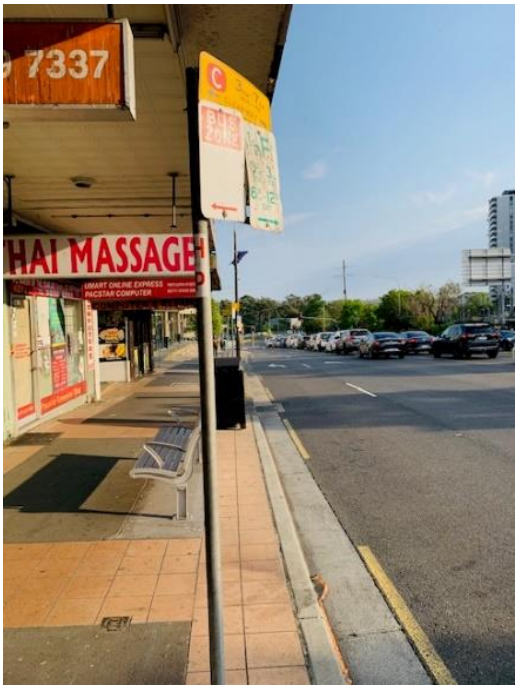


D. Site Visit Photographs

Beecroft Road NB at Carlingford Rd / Beecroft Road Intersection



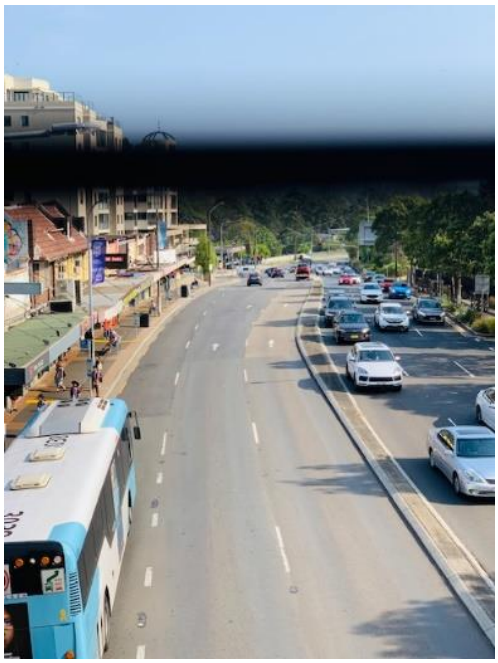
Beecroft Road NB at Carlingford Rd / Beecroft Road Intersection



Bus Stop Stand on Beecroft Road

Midblock location on Beecroft Road

Midblock location on Beecroft Road



E. SCATS Traffic Count Data (21/9/2023)

Table E1: TCS216, AM Peak, 15-min Detector Counts (Vehicles)

15-min Period Starting	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	Total
6:30	3	98	73	204	248	56	26	115	22	8	15	868
6:45	2	113	82	186	232	62	25	129	20	7	17	875
7:00	1	125	101	208	249	65	32	121	26	13	24	965
7:15	5	145	137	207	277	76	40	139	32	19	39	1116
7:30	4	148	143	217	286	94	51	133	36	12	36	1160
7:45	4	149	123	202	276	102	64	136	40	17	45	1158
8:00	4	137	140	198	274	97	51	134	55	23	56	1169
8:15	3	152	156	205	264	97	55	120	50	16	52	1170
8:30	10	129	124	191	235	78	44	125	38	19	39	1032
8:45	6	134	110	190	256	111	48	132	29	14	32	1062

Table E2: TCS216, PM Peak, 15-min Detector Counts (Vehicles)

15-min Period Starting	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	Total
17:00	8	206	211	119	147	103	95	65	39	21	32	1046
17:15	13	209	215	139	164	104	118	70	41	20	32	1125
17:30	9	203	215	132	157	109	115	61	38	18	33	1090
17:45	10	214	204	140	175	101	109	67	33	22	46	1121
18:00	8	231	221	107	151	101	111	62	30	20	38	1080
18:15	10	208	214	131	170	94	108	60	33	24	48	1100
18:30	12	199	204	170	196	100	106	65	31	28	37	1148
18:45	13	205	204	157	187	103	102	61	44	19	44	1139
19:00	17	219	214	149	150	95	80	58	35	17	34	1068
19:15	3	198	179	136	147	106	84	78	37	12	23	1003

Table E3: TCS706, AM Peak, 15-min Detector Counts (Vehicles)

15-min Period Starting	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	TOTAL
6:30	62	75	76	72	85	45	58	14	3	167	208	23	888
6:45	67	68	62	76	98	56	80	8	8	157	185	24	889
7:00	64	89	100	94	110	60	81	11	9	159	199	30	1006
7:15	86	107	108	104	111	76	97	25	17	167	204	21	1123
7:30	100	123	100	122	136	86	127	23	17	152	179	10	1175
7:45	102	118	89	96	113	84	116	21	16	163	191	12	1121
8:00	118	147	101	111	101	72	74	29	21	142	179	12	1107
8:15	121	141	93	118	102	84	94	27	19	159	180	19	1157
8:30	96	121	92	120	113	65	98	41	32	159	176	10	1123
8:45	94	101	88	96	93	55	84	36	20	159	166	11	1003

Table E4: TCS706, PM Peak, 15-min Detector Counts (Vehicles)

15-min Period Starting	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	TOTAL
17:00	124	168	53	63	62	112	124	36	22	115	125	25	1029
17:15	158	193	56	77	67	110	109	36	25	115	124	27	1097
17:30	152	183	52	79	65	119	119	37	40	116	138	15	1115
17:45	161	183	73	73	59	104	113	36	31	117	127	20	1097
18:00	152	187	61	64	52	120	120	39	34	102	122	30	1083
18:15	155	186	74	80	64	104	117	41	36	108	125	20	1110
18:30	140	172	96	122	49	85	123	48	45	120	127	23	1150
18:45	148	183	72	91	57	106	122	40	31	132	138	11	1131
19:00	139	179	64	69	45	107	114	30	23	113	133	15	1031
19:15	116	149	60	65	50	107	112	32	18	124	132	11	976

Table E5: TCS1015, AM Peak, 15-min Detector Counts (Vehicles)

15-min Period Starting	D1	D2	D3	D4	D5	D6	D7	D8	Total
6:30	170	186	56	62	22	10	5	11	522
6:45	151	167	70	84	27	17	12	18	546
7:00	162	178	69	85	32	21	19	19	585
7:15	163	169	90	113	44	39	31	18	667
7:30	125	139	114	136	65	44	32	17	672
7:45	122	144	103	125	60	55	45	15	669
8:00	114	134	94	101	64	48	45	19	619
8:15	122	136	106	114	62	51	43	17	651
8:30	117	130	101	124	52	41	43	13	621
8:45	123	123	88	107	62	48	39	20	610

Table E6: TCS1015, PM Peak, 15-min Detector Counts (Vehicles)

15-min Period Starting	D1	D2	D3	D4	D5	D6	D7	D8	Total
16:00	118	108	144	150	21	32	61	7	641
16:15	116	101	153	128	16	24	55	10	603
16:30	121	105	153	148	23	31	48	6	635
16:45	117	109	131	146	28	14	55	14	614
17:00	114	98	157	157	7	23	77	10	643
17:15	125	107	136	153	8	43	59	7	638
17:30	114	111	147	149	15	35	71	8	650
17:45	136	109	145	141	31	37	57	6	662
18:00	119	113	136	128	7	28	62	11	604
18:15	122	114	129	126	27	35	50	8	611

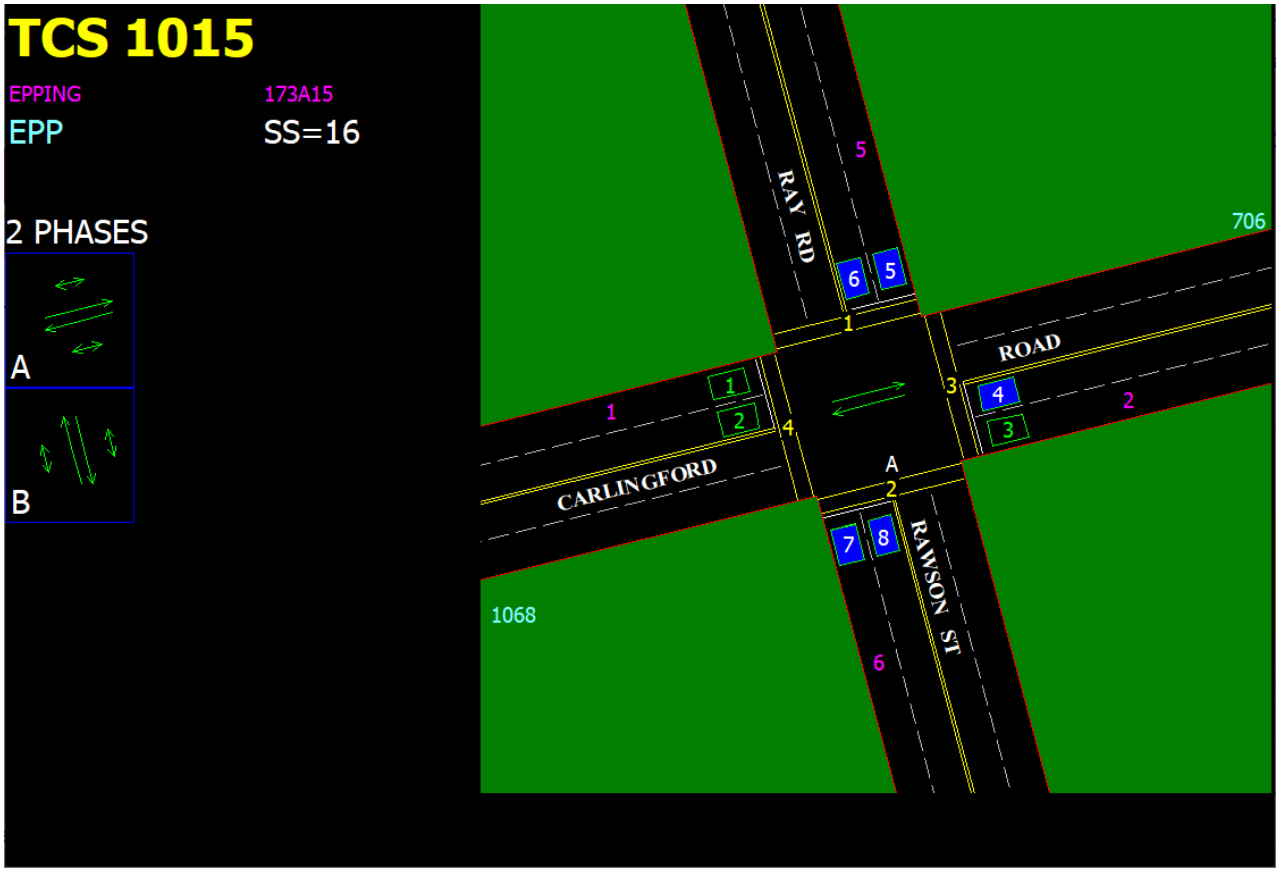
Table E7: TCS1338, AM Peak, 15-min Detector Counts (Vehicles)

15-min Period Starting	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	Total
6:30	193	231	4	72	53	8	19	19	2	4	12	617
6:45	202	205	1	81	52	9	24	25	2	2	8	611
7:00	212	224	3	83	54	10	36	49	4	8	15	698
7:15	218	234	7	92	88	22	52	59	4	8	24	808
7:30	242	248	5	97	86	26	40	50	3	6	22	825
7:45	221	232	6	97	68	15	52	54	7	10	31	793
8:00	222	234	5	91	73	20	50	57	8	13	36	809
8:15	229	227	8	97	78	24	58	63	6	12	28	830
8:30	206	198	6	87	72	28	35	45	6	14	48	745
8:45	217	211	12	69	61	24	39	46	4	16	39	738

Table E8: TCS1338, PM Peak, 15-min Detector Counts (Vehicles)

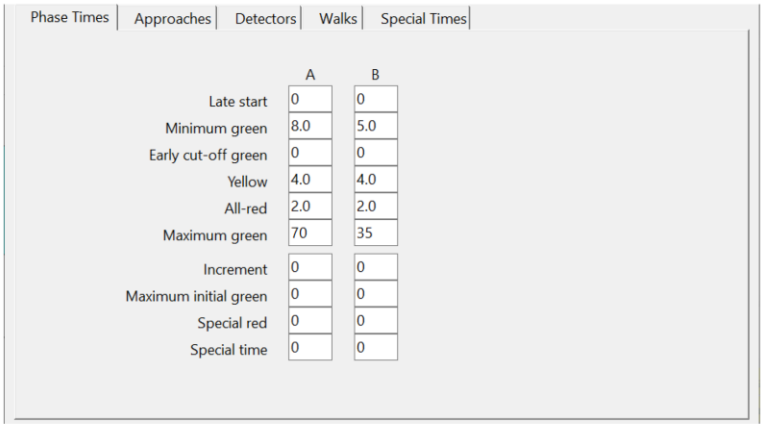
15-min Period Starting	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	Total
16:00	124	103	13	130	159	26	47	58	2	13	27	702
16:15	131	132	13	146	180	29	40	52	9	16	28	776
16:30	120	122	18	149	175	29	37	47	16	8	27	748
16:45	134	138	9	133	159	20	48	48	12	15	32	748
17:00	127	105	10	134	163	31	58	79	9	18	30	764
17:15	132	116	12	138	172	22	33	43	11	20	41	740
17:30	148	158	9	109	142	35	47	72	10	33	42	805
17:45	153	147	9	136	146	35	43	52	4	19	39	783
18:00	131	114	16	139	157	28	55	60	2	15	31	748
18:15	136	106	10	147	148	22	36	40	5	14	29	693

F. SCATS Intersection and Subsystem Data

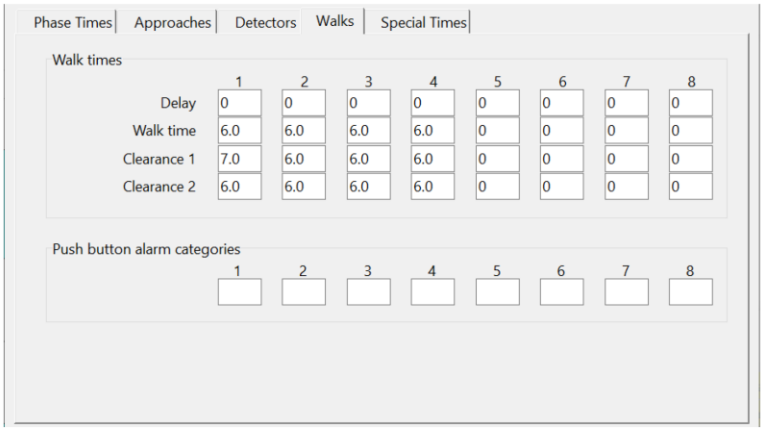


TCS 1015

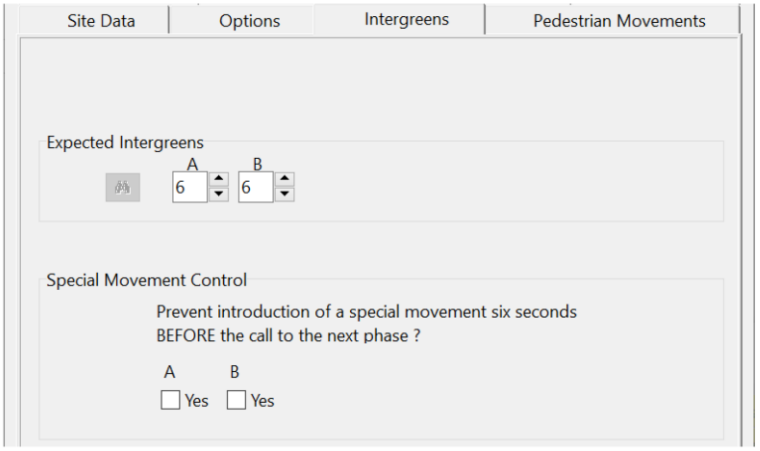
1. Phase Times

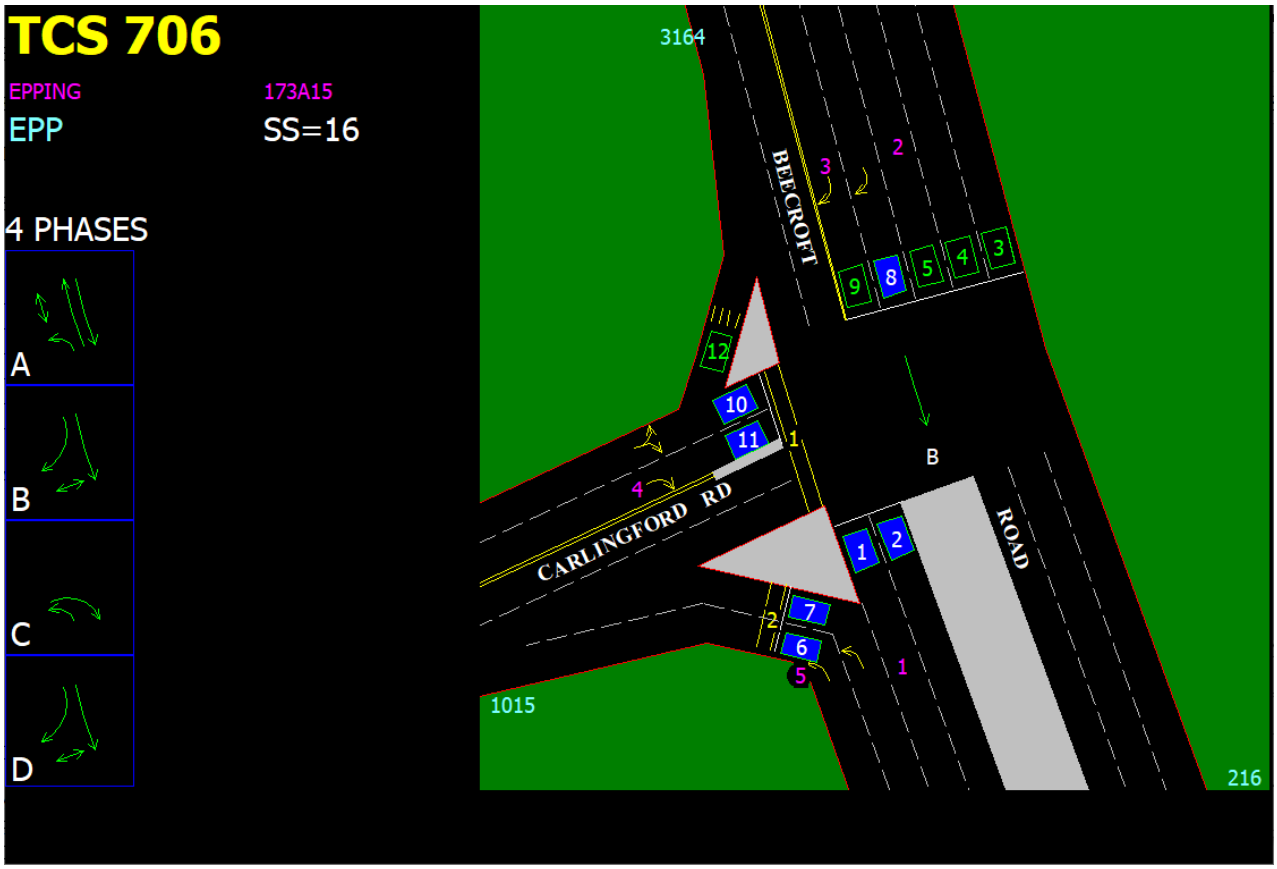


2. Walk Times



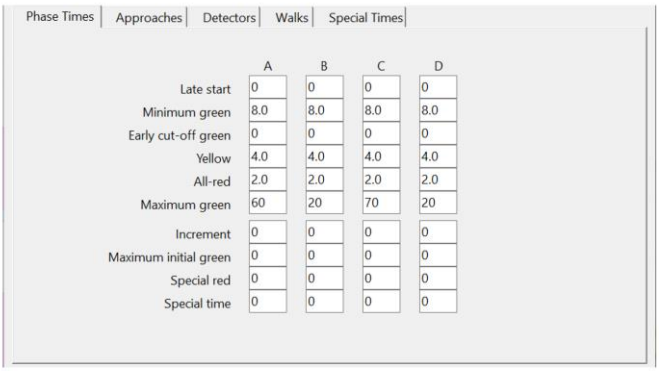
3. Intergreens



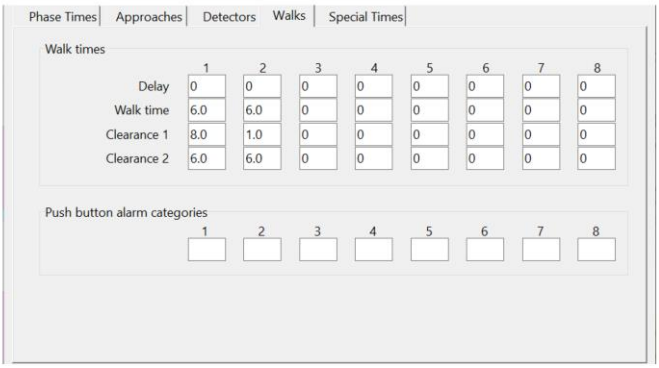

TCS 706
EPPING
173A15
EPP
SS=16
4 PHASES
A
B
C
D
3164
BEECROFT
CARLINGFORD RD
ROAD
B
1015
216

TCS 706

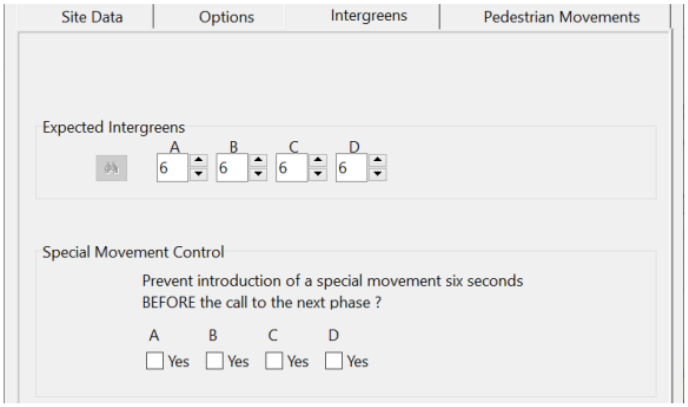
1. Phase Times

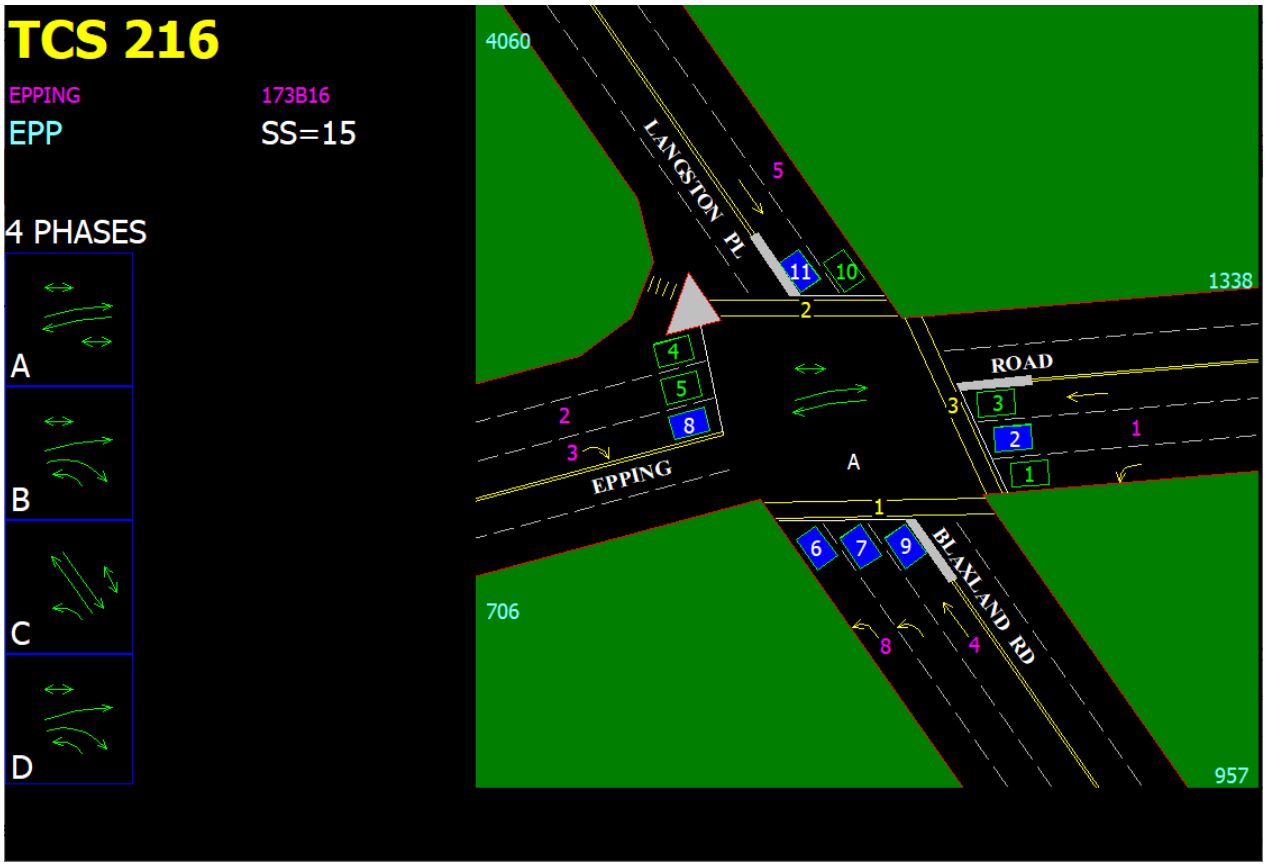


2. Walk Times



3. Intergreens




TCS 216
EPPING
173B16
EPP
SS=15
4 PHASES
A
B
C
D
4060
LANGSTON PL
5
11
10
2
1338
ROAD
3
2
1
4
5
8
2
3
EPPING
A
1
6
7
9
BLAXLAND RD
8
4
706
957

TCS 216

1. Phase Times

Phase Times | Approaches | Detectors | Walks | Special Times

	A	B	C	D
Late start	0	0	0	0
Minimum green	8.0	8.0	5.0	8.0
Early cut-off green	0	0	0	0
Yellow	4.0	4.0	4.0	4.0
All-red	2.5	2.5	3.0	2.5
Maximum green	80	50	15	20
Increment	0	0	0	0
Maximum initial green	0	0	0	0
Special red	0	0	0	0
Special time	0	0	0	0

2. Walk Times

Phase Times | Approaches | Detectors | Walks | Special Times

Walk times

	1	2	3	4	5	6	7	8
Delay	0	0	0	0	0	0	0	0
Walk time	6.0	6.0	6.0	0	0	0	0	0
Clearance 1	13	4.0	12	0	0	0	0	0
Clearance 2	6.0	6.0	7.0	0	0	0	0	0

Push button alarm categories

1	2	3	4	5	6	7	8

3. Intergreens

Site Data | Options | Intergreens | Pedestrian Movements

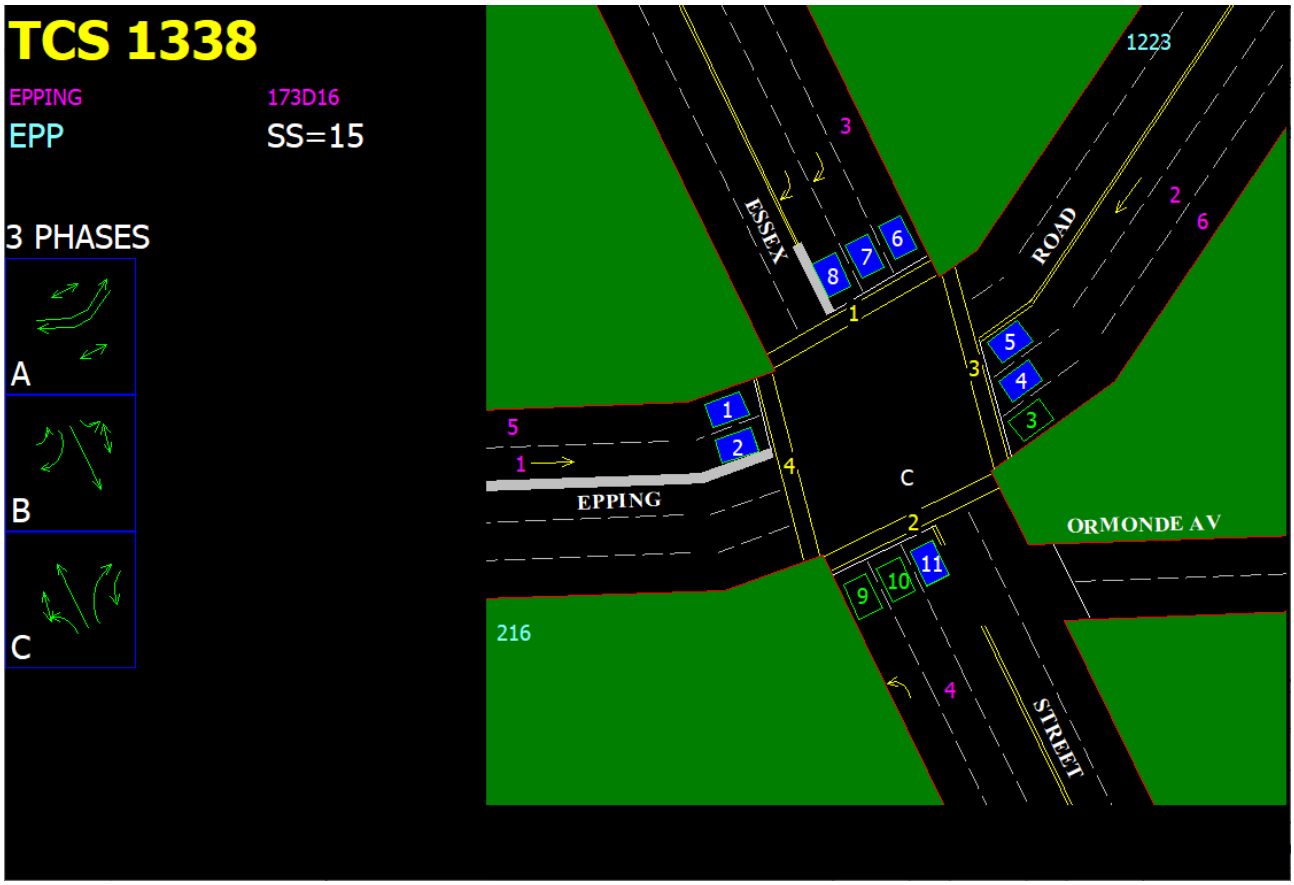
Expected Intergreens

A	B	C	D
7	7	7	7

Special Movement Control

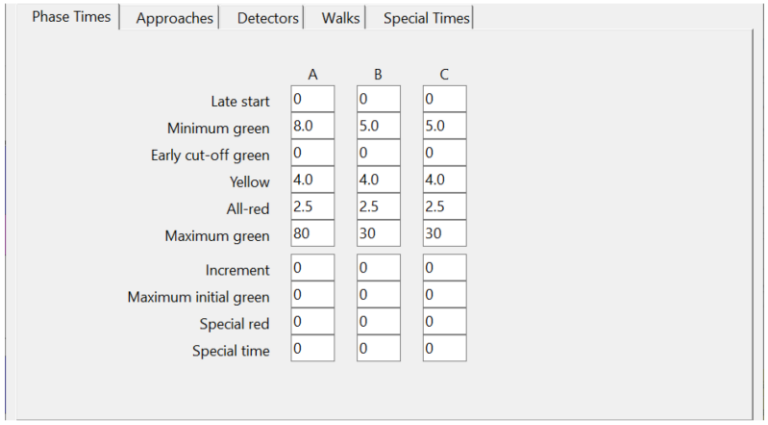
Prevent introduction of a special movement six seconds BEFORE the call to the next phase ?

A	B	C	D
☐ Yes	☐ Yes	☐ Yes	☐ Yes

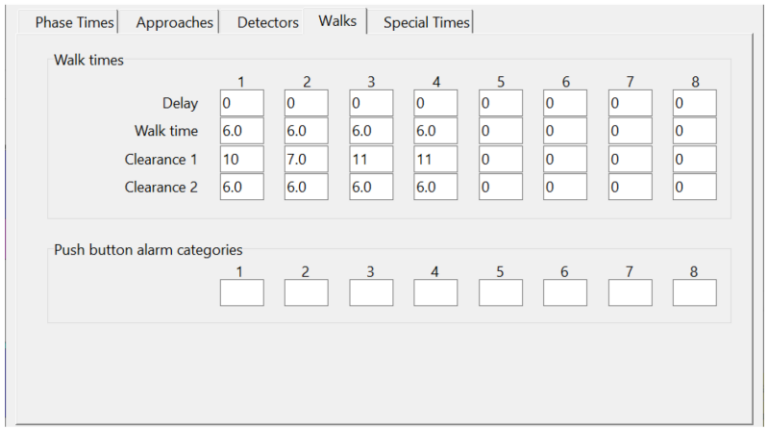

TCS 1338
EPPING
173D16
EPP
SS=15
3 PHASES
A
B
C
ESSEX
ROAD
1223
EPPING
ORMONDE AV
STREET
C
216

TCS 1338

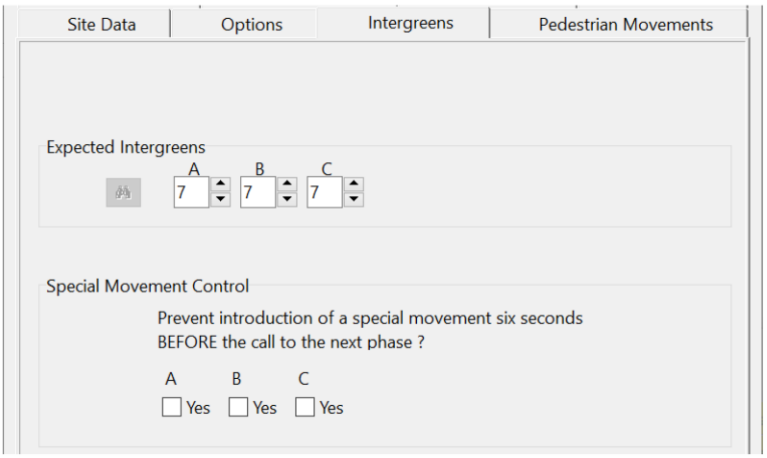
1. Phase Times



2. Walk Times



3. Intergreens



G. SCATS Region LX File

[Site 1338 has the same Subsystem with 216, coordinated with offset plans. Both 706 and 1015 are linked to 216].

1338

SLOT15=3,1,4!INT=1338!VC=6.1!CS=16!PK=/ZSL=0! [Controller and software Information – No subsystem data is assigned to this site]
COM=DO,P,1:4,H!BPS=1200!PH=0298686232!DD=0!CTYPE=C29V6.1R20S18!
LS=ON!
IK=!
S#=15!LM=MF^!RMN=0!DCL=0!
VOLS=1-24!
AT=7!BT=7!CT=7!
W1=6!W1T=16!W1F=!W2=6!W2T=13!W2F=! [Pedestrian Walk and Clearance]
W3=6!W3T=17!W3F=!W4=6!W4T=17!W4F=!
PP1=22,22^A!PP2=-8,-13^A! [Offset Plan data]
PP3=39,9^A!PP4=17,22^A!
VAR1=47!VAR1.0=!
VAR1.1=2!VAR1.2=136!VAR1.3=20!VAR1.4=0!
VAR2=47!VAR2.0=!
VAR2.1=3!VAR2.2=128!VAR2.3=20!VAR2.4=0!
VAR3=10!VAR3.0=!
VAR4=75!VAR4.0=!
VAR4.1=1287!

I=1338!PLAN=1!SF=!XSF=0! [Split plan data]
A=0PDFGC!
C=20FGB!
B=20TGA!

1015

SLOT18=2,1,4!INT=1015!VC=6.1!CS=354!PK=/ZSL=0! [Controller and Software Information]
COM=DO,P,3:2,H!BPS=1200!PH=0298770813!DD=0!CTYPE=C29V6.1R20S18!
LS=ON!
IK=!
S#=16!LM=MF^!RMN=0!DCL=0! [Subsystem 16 assigned to this site]
VOLS=1-24!
AT=6!BT=6! [Phase intergreen]
W1=8!W1T=13!W1F=!W2=8!W2T=12!W2F=! [Pedestrian Walk and Clearance]
W3=6!W3T=12!W3F=!W4=6!W4T=12!W4F=!

PP1=-7,-7A!PP2=-7,-7A! [Offset Plan Data]
PP3=-7,-7A!PP4=-7,-7A!
VAR1=47!VAR1.0=!
VAR1.1=2!VAR1.2=142!VAR1.3=30!VAR1.4=30!
VAR2=75!VAR2.0=!
VAR2.1=1283!

I=1015!PLAN=1!SF=!XSF=0! [Split plan data]
A=0PDFGB!
B=35A!

SS=16!LCL=40!HCL=130!SCL=72,0!KCL=0!ZSS=0! [Subsystem Data assigned to Site 1015, with Min / Max Cycle Length = 40 seconds / 130 seconds. Stopper 1 = 72 seconds]

SK=NSDDNAOVIFBF!
XCL=110!SZ=88,94!SMX=/ [Stretch Cycle Time and its cycle length calibration factors]
FCL=30,40,45,50,60,70,75,80,90,100,110,115,120,125,130,140!
PS1=40^,72!PS2=82,110!PS3=82,110!PS4=82,110!

LP1=-24,-24^D216! [Link Plan Data – Site 1015 is linked to Site 216]
LP2=30,16^A216!
LP3=9,3^D216!
LP4=8,39^D216!

706

SLOT17=4,4,2!INT=706!VC=5!CS=21!PK=/ZSL=0!
COM=NET,H!CTYPE=C18V5R20S24!
LS=ON!
IK=!
S#=16!LM=MF^!RMN=0!DCL=0! [Subsystem assigned to this site.
VOLS=1-24!
AT=6!BT=6!CT=6!DT=6! [Phase intergreen]
W1=6!W1T=14!W1F=!W2=6!W2T=7!W2F=! [Pedestrian Walk and Clearance]
PP1=0,0^B!PP2=0,0^B! [Offset Plan data]
PP3=0,0^B!PP4=0,0^B!
VAR1=35!VAR1.0=!
VAR1.1=1!VAR1.2=3!VAR1.3=0!VAR1.4=0!VAR1.5=0!
VAR1.6=0!VAR1.7=0!VAR1.8=0!VAR1.9=37!VAR1.10=147!
VAR1.11=0!VAR1.12=0!VAR1.13=0!
VAR2=11!VAR2.0=!
VAR2.1=127!VAR2.2=10!VAR2.3=0!VAR2.4=19!VAR2.5=0!
VAR3=3!VAR3.0=!
VAR3.1=0!VAR3.2=1!
VAR4=49!VAR4.0=!
VAR4.1=65!VAR4.2=0!
VAR5=10!VAR5.0=!
VAR6=11!VAR6.0=!
VAR6.1=383!VAR6.2=7!VAR6.3=0!VAR6.4=19!VAR6.5=0!
VAR7=90!VAR7.0=!
VAR7.1=1!
VAR8=10!VAR8.0=!
VAR9=75!VAR9.0=!
VAR9.1=1295!

I=706!PLAN=1!SF=!XSF=0! [Split plan data]
A=49TGC!
C=0PDFGB!
B=15FGA!
D=1A!

I=706!PLAN=2!SF=!XSF=0!
A=45TGC!
C=0PDFGB!
B=15FGA!
D=1A!

I=706!PLAN=3!SF=!XSF=0!
A=41TGC!
C=0PDFGB!
B=15FGA!
D=1A!

I=706!PLAN=4!SF=!XSF=0!
A=37TGC!
C=0PDFGB!
B=15FGA!
D=1A!

SS=16!LCL=40!HCL=130!SCL=72,0!KCL=0!ZSS=0! [Subsystem Data assigned to Site 706, with Min / Max Cycle Length = 40 seconds / 130 seconds. Stopper 1 = 72 seconds]
SK=NSDDNAOVIFBF!
XCL=110!SZ=88,94!SMX=/ [Stretch Cycle Time and its cycle length calibration factors]
FCL=30,40,45,50,60,70,75,80,90,100,110,115,120,125,130,140!
PS1=40^,72!PS2=82,110!PS3=82,110!PS4=82,110!
LP1=-24,-24^D216! [Link Plan Data Site 706 is linked to Site 216]
LP2=30,16^A216!

LP3=9,3^D216!
LP4=8,39^D216!

216

SLOT16=4,8,3!INT=216!VC=6.1!CS=345!PK=/ZSL=0! [Controller and Software Information]
COM=NET,H!CTYPE=C29V6.1R20S18!
LS=ON!
IK=!
S#=15!LM=MI^!RMN=0!DCL=80! [Subsystem 15 Assigned to this Site]
VOLS=1-24!
AT=7!BT=7!CT=7!DT=7! [Phase intergreen]
W1=6!W1T=19!W1F=!W2=0ABD!W2T=10!W2F=! [Pedestrian Walk and clearance]
W3=6!W3T=19!W3F=!
PP1=0,0^D!PP2=0,0^A! [Offset plan data]
PP3=0,0^D!PP4=0,0^D!

VAR1=35!VAR1.0=!
VAR1.1=1!VAR1.2=2!VAR1.3=3!VAR1.4=0!VAR1.5=0!
VAR1.6=4!VAR1.7=0!VAR1.8=0!VAR1.9=158!VAR1.10=19!
VAR1.11=145!VAR1.12=0!VAR1.13=107!
VAR2=14!VAR2.0=!
VAR2.1=0!VAR2.2=15!
VAR3=14!VAR3.0=!
VAR3.1=0!VAR3.2=7!
VAR4=19!VAR4.0=!
VAR5=14!VAR5.0=!
VAR5.1=0!VAR5.2=3!
VAR6=36!VAR6.0=!
VAR6.1=300!VAR6.2=301!
VAR7=10!VAR7.0=!
VAR8=11!VAR8.0=!
VAR8.1=383!VAR8.2=7!VAR8.3=0!VAR8.4=19!VAR8.5=0!
VAR9=90!VAR9.0=!
VAR9.1=2!
VAR10=75!VAR10.0=!
VAR10.1=1311!

I=216!PLAN=1!SF=!XSF=0! [Split plan data]
A=0PDFGB!
B=19FGC!
C=17A!
D=1A!

I=216!PLAN=2!SF=!XSF=0!
A=0PDFGB!
B=22FGC!
C=17A!
D=1A!

I=216!PLAN=3!SF=!XSF=0!
A=0PDFGB!
B=25FGC!
C=17A!
D=1A!

I=216!PLAN=4!SF=!XSF=0!
A=0PDFGB!
B=28FGC!
C=17A!
D=1A!

I=216!PLAN=5!SF=Z+!XSF=0!
A=0PDFGB!

B=14FGC!
C=17D!
D=17TGA!

I=216!PLAN=6!SF=Z+!XSF=0!
A=0PDFGB!
B=17FGC!
C=17D!
D=17TGA!

I=216!PLAN=7!SF=Z+!XSF=0!
A=0PDFGB!
B=17FGC!
C=17D!
D=20TGA!

I=216!PLAN=8!SF=Z+!XSF=0!
A=0PDFGB!
B=20FGC!
C=17D!
D=20TGA!

SS=15!LCL=40!HCL=130!SCL=72,0!KCL=0!ZSS=0! [Subsystem Data assigned to Site 216, with Min / Max Cycle Length = 40 seconds / 130 seconds. Stopper 1 = 72 seconds]
SK=NSDDNAOVIF!
XCL=110!SZ=88,94!SMX=/ [Stretch Cycle Time and its cycle length calibration factors]
FCL=30,40,45,50,60,70,75,80,90,100,110,115,120,125,130,140!
PS1=40^,72!PS2=82,110!PS3=82,110!PS4=82,110!

LP1=0! [Link Plan Data]
LP2=0!
LP3=0!
LP4=0!

H. SCATS History Files

Periodic statistics for TCS sites 216, 706, 1015 and 1338, at 15-min intervals from Thursday, 21 September 2023, 12:00 AM AEST to Thursday, 21 September 2023, 11:59:59 PM AEST.

TCS 216	Observed Average Phase Times (secs) for the 15-min period starting									
	6:30	6:45	7:00	7:15	7:30	7:45	8:00	8:15	8:30	8:45
A-phase	55	47	55	53	55	54	52	58	55	53
B-phase	31	35	27	26	23	23	23	23	23	26
C-phase	24	24	24	25	26	26	27	26	26	26
D-phase	20	22	23	23	24	25	25	22	24	24
Cycle Length	129	125	127	130	130	130	130	132	130	130

TCS 216	Observed Average Phase Times (secs) for the 15-min period starting									
	16:00	16:15	16:30	16:45	17:00	17:15	17:30	17:45	18:00	18:15
A-phase	81	81	81	80	81	80	81	81	81	73
B-phase	23	23	23	23	23	23	23	23	23	30
C-phase	25	25	26	26	25	25	25	26	25	25
D-phase	-	-	-	-	-	-	-	-	-	-
Cycle Length	129	129	130	130	129	130	130	130	130	129

TCS 706	Observed Average Phase Times (secs) for the 15-min period starting									
	6:30	6:45	7:00	7:15	7:30	7:45	8:00	8:15	8:30	8:45
A-phase	32	32	37	41	48	46	47	47	43	43
B-phase	14	15	15	16	17	18	18	17	19	19
C-phase	82	77	78	70	63	65	63	63	66	67
Cycle Length	130	124	129	130	129	127	129	127	128	129

TCS 706	Observed Average Phase Times (secs) for the 15-min period starting									
	16:00	16:15	16:30	16:45	17:00	17:15	17:30	17:45	18:00	18:15
A-phase	60	60	57	57	58	59	56	56	59	52
B-phase	19	19	19	19	20	19	20	19	18	19
C-phase	50	50	52	52	50	49	54	54	52	58
Cycle Length	129	130	129	132	129	128	130	130	130	128

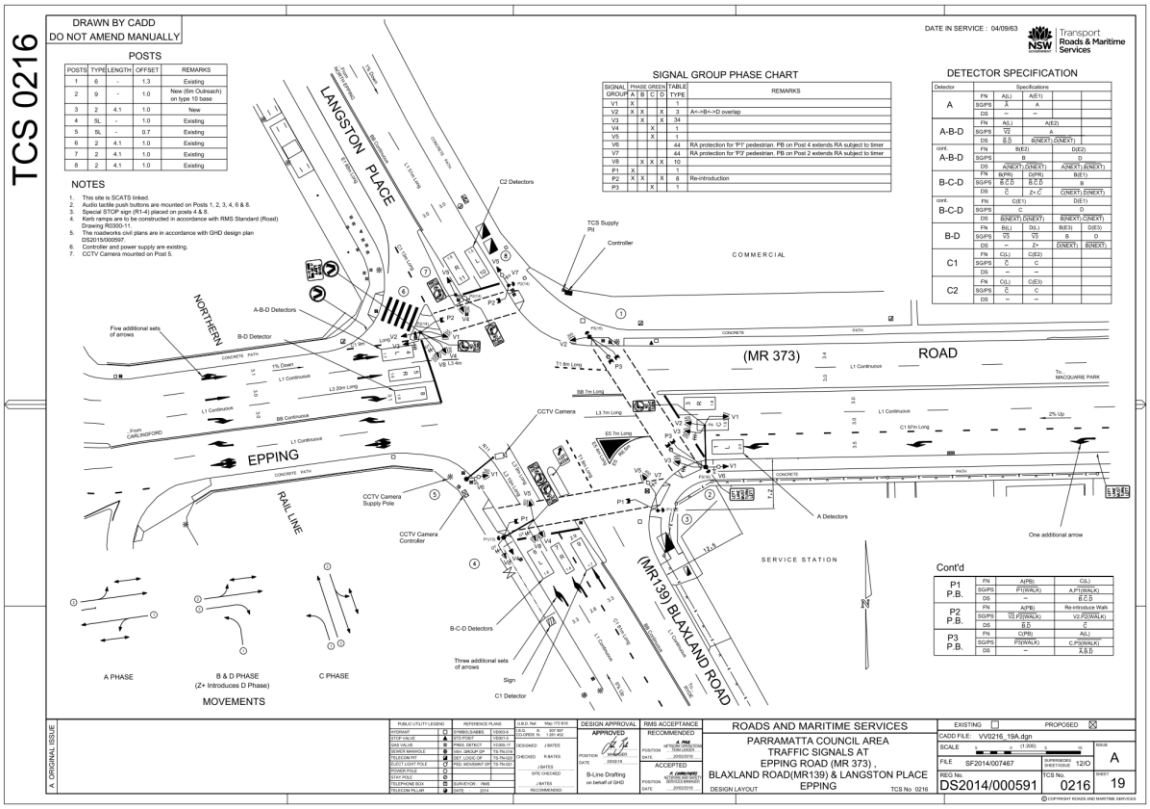
TCS 1015	Observed Average Phase Times (secs) for the 15-min period starting									
	6:30	6:45	7:00	7:15	7:30	7:45	8:00	8:15	8:30	8:45
A-phase	104	96	100	91	87	86	85	84	84	84
B-phase	24	28	28	37	43	43	44	45	46	46
Cycle Length	129	124	132	128	131	129	129	130	130	130

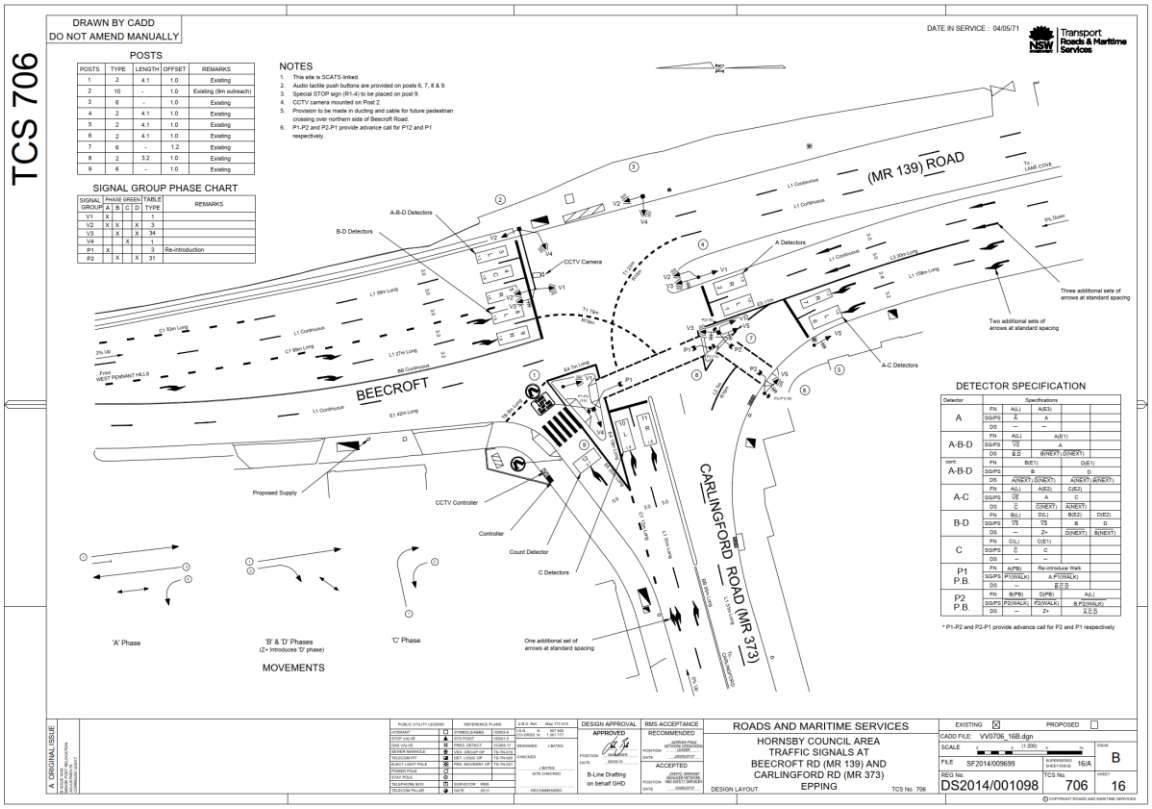
TCS 1015	Observed Average Phase Times (secs) for the 15-min period starting									
	16:00	16:15	16:30	16:45	17:00	17:15	17:30	17:45	18:00	18:15
A-phase	84	84	84	84	84	84	84	85	84	84
B-phase	46	46	46	46	46	46	46	45	46	46
Cycle Length	130	130	130	130	130	130	130	130	130	130

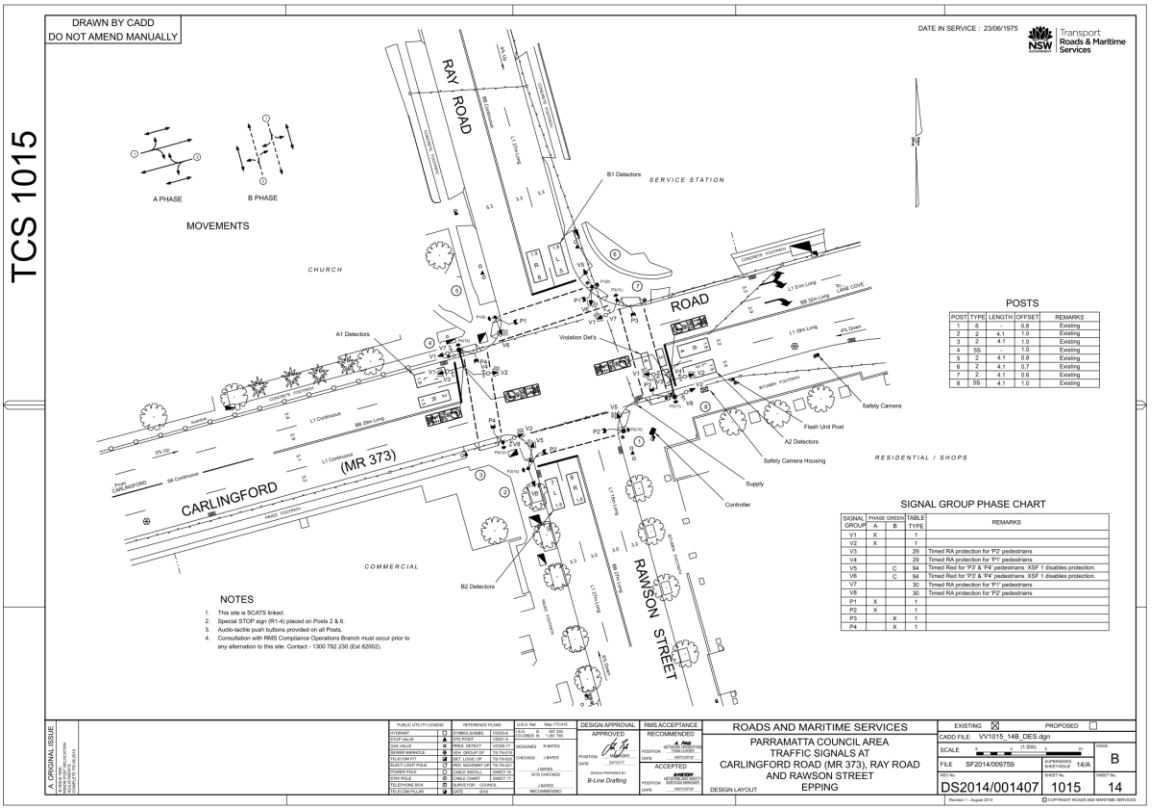
TCS 1338	Observed Average Phase Times (secs) for the 15-min period starting									
	6:30	6:45	7:00	7:15	7:30	7:45	8:00	8:15	8:30	8:45
A-phase	95	94	85	81	87	80	81	79	80	80
B-phase	18	19	25	28	26	27	26	29	25	26
C-phase	16	15	18	21	19	22	22	21	24	22
Cycle Length	130	127	129	131	129	130	130	129	130	130

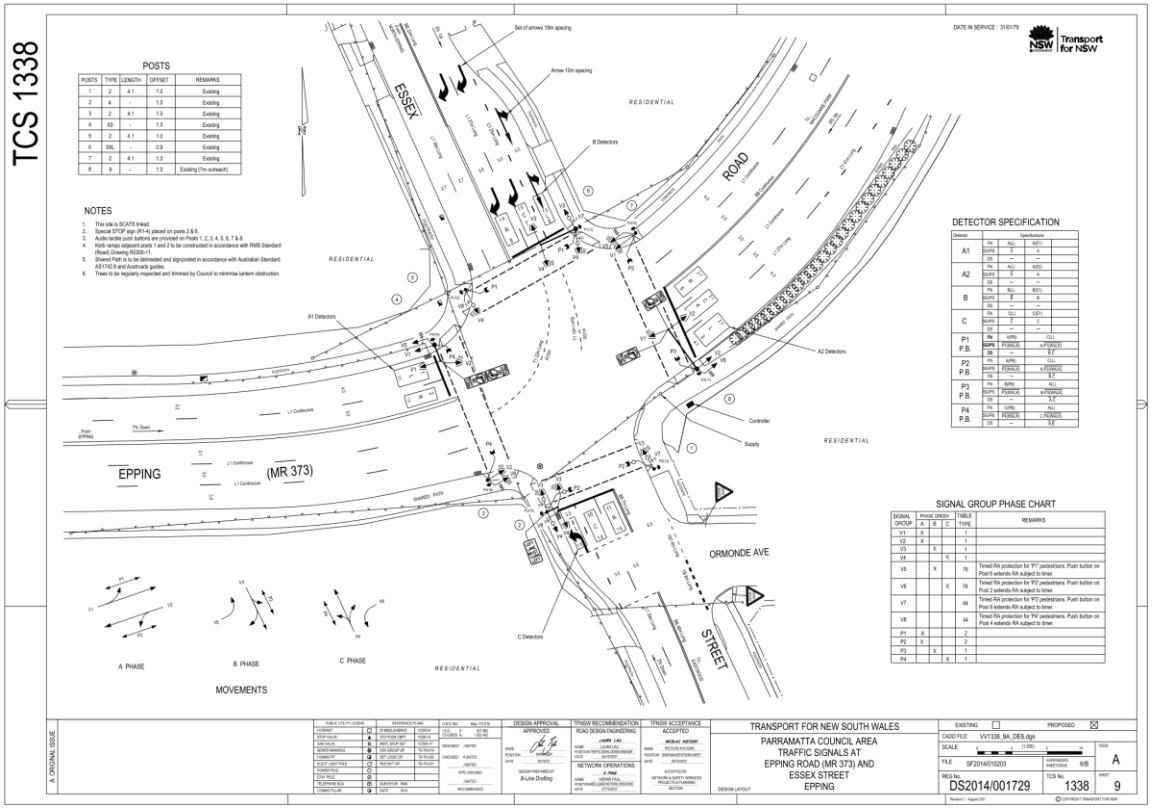
TCS 1338	Observed Average Phase Times (secs) for the 15-min period starting									
	16:00	16:15	16:30	16:45	17:00	17:15	17:30	17:45	18:00	18:15
A-phase	81	81	82	79	78	81	78	79	80	83
B-phase	26	26	25	26	29	24	27	26	27	26
C-phase	22	20	20	22	21	23	24	23	21	21
Cycle Length	130	127	128	129	129	131	130	130	130	130

I. Existing Traffic Signal Plans






TCS 1015
DRAWN BY CADD
DO NOT AMEND MANUALLY
DATE IN SERVICE : 23/06/1975
Transport Roads & Maritime Services
RAY ROAD
RAWSON STREET
CARLINGFORD (MR 373)
EPPING ROAD
SERVICE STATION
CHURCH
COMMERCIAL
RESIDENTIAL / SHOPS
A PHASE
B PHASE
MOVEMENTS
A1 Detectors
B1 Detectors
B2 Detectors
A2 Detectors
Violation Del's
Flash Unit Post
Safety Camera
Safety Camera Housing
Supply
Controller
POSTS
SIGNAL GROUP PHASE CHART
NOTES
1. This site is SCATS linked.
2. Special STOP sign (R1-4) placed on Posts 2 & 6.
3. Audio-tactile push buttons provided on all Posts.
4. Consultation with RMS Compliance Operations Branch must occur prior to any alternation to this site. Contact - 1300 782 230 (Ext 62002).
A. ORIGINAL ISSUE
ROADS AND MARITIME SERVICES
PARRAMATTA COUNCIL AREA
TRAFFIC SIGNALS AT
CARLINGFORD ROAD (MR 373), RAY ROAD
AND RAWSON STREET
EPPING
DESIGN LAYOUT
CADD FILE: VV1015_14B_DES.dgn
SCALE
FILE SF2014/009759
REG No. DS2014/001407
TCS No. 1015
SHEET No. 14
ISSUE B


TCS 1338
DATE IN SERVICE : 31/01/79
Transport for NSW
ESSEX STREET
EPPING (MR 373)
ORMONDE AVE
RESIDENTIAL
A1 Detectors
B Detectors
C Detectors
A2 Detectors
Controller
Supply
A PHASE
B PHASE
C PHASE
MOVEMENTS
POSTS
DETECTOR SPECIFICATION
SIGNAL GROUP PHASE CHART
NOTES
1. This site is SCATS linked.
2. Special STOP sign (R1-4) placed on posts 2 & 6.
3. Audio tactile push buttons are provided on Posts 1, 2, 3, 4, 5, 6, 7 & 8.
4. Kerb ramps adjacent posts 1 and 2 to be constructed in accordance with RMS Standard (Road) Drawing RG300-11.
5. Shared Path is to be delineated and signposted in accordance with Australian Standard AS1742.9 and Austroads guides.
6. Trees to be regularly inspected and trimmed by Council to minimise lantern obstruction.
A. ORIGINAL ISSUE
TRANSPORT FOR NEW SOUTH WALES
PARRAMATTA COUNCIL AREA
TRAFFIC SIGNALS AT
EPPING ROAD (MR 373) AND
ESSEX STREET
EPPING
DESIGN LAYOUT
CADD FILE: VV1338_9A_DES.dgn
SCALE
FILE SF2014/010203
REG No. DS2014/001729
TCS No. 1338
SHEET 9
ISSUE A

J. 2023 Bus Service Coding Summary

Table J1: AM Peak Bus Services

Route	Start		Event 1		Event 2		Event 3		Event 4		Event 5		Event 6		End
	Start Time	Cordon Entry	Bus Stop	Dwell (sec)	Bus Stop	Dwell (sec)	Bus Stop	Dwell (sec)	Bus Stop	Dwell (sec)	Bus Stop	Dwell (sec)	Bus Stop	Dwell (sec)	Cordon Exit
541	06:47	1	212112	300	212114	300	212190	10	212115	10	-	-	0	0	1
541 (EB)	07:35	1	212112	300	212114	-	-	-	-	-	-	-	0	0	1
541	08:02	1	212112	240	212114	300	212190	10	212115	10	-	-	0	0	1
541	08:54	1	212112	300	212114	300	212190	10	212115	10	-	-	0	0	1
541 (WB)	07:28	1	212114	300	212190	10	212115	10	-	-	-	-	0	0	1
546	06:37	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
546	07:05	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
546	07:35	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
546	08:21	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
546	08:54	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
549 (NB)	06:44	3	212140	300	2121163	10	-	-	-	-	-	-	-	-	3
549	06:52	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
549 (NB)	07:14	3	212140	300	2121163	10	-	-	-	-	-	-	-	-	3
549	07:20	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
549	07:49	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
549	08:05	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
549	08:38	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
549 (SB)	08:58	3	2121155	10	212190	10	212115	10	212112	300	-	-	0	0	3
550 (EB)	06:54	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	07:03	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	07:15	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	07:25	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	07:47	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	07:57	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	08:10	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	08:20	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	08:31	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	08:41	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	08:53	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (WB)	06:35	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	06:46	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	06:56	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	07:06	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	07:14	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	07:25	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	07:37	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	07:49	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	08:01	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	08:11	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	08:22	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	08:44	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	08:53	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
630 (WB)	06:32	2	212114	300	212129	10	-	-	-	-	-	-	0	0	2
630	07:20	2	212123	10	212190	10	212115	10	212114	300	212129	10	-	-	2
630	07:50	2	212123	10	212190	10	212115	10	212114	300	212129	10	-	-	2
630	08:36	2	212123	10	212190	10	212115	10	212114	540	212129	10	-	-	2
651 (NB)	06:30	4	212113	300	-	-	-	-	-	-	-	-	0	0	4
651	06:47	4	212190	10	212115	10	212113	300	-	-	-	-	0	0	4
651	07:10	4	212190	10	212115	10	212113	300	-	-	-	-	0	0	4
651	07:35	4	212190	10	212115	10	212113	300	-	-	-	-	0	0	4
651	08:03	4	212190	10	212115	10	212113	300	-	-	-	-	0	0	4
651 (SB)	08:25	4	212190	10	212115	10	212113	300	0	0	0	0	0	0	4
651	08:50	4	212190	10	212115	10	212113	300	-	-	-	-	0	0	4
718w	08:25	1	212114	300	212190	10	212115	10	-	-	-	-	0	0	1
726w	07:33	2	212114	300	212129	10	-	-	-	-	-	-	0	0	2
732w	07:50	2	212114	300	212129	10	-	-	-	-	-	-	0	0	2
3013	08:02	2	212114	300	-	-	-	-	-	-	-	-	0	0	2
3014	07:57	2	212114	300	-	-	-	-	-	-	-	-	0	0	2

Table J2: PM Peak Bus Services

Route	Start		Event 1		Event 2		Event 3		Event 4		Event 5		Event 6		End
	Start Time	Cordon Entry	Bus Stop	Dwell (sec)	Bus Stop	Dwell (sec)	Bus Stop	Dwell (sec)	Bus Stop	Dwell (sec)	Bus Stop	Dwell (sec)	Bus Stop	Dwell (sec)	Cordon Exit
541	16:22	1	212112	300	212114	300	212190	10	212115	10	-	-	0	0	1
541	17:07	1	212112	300	212114	-	-	-	-	-	-	-	0	0	1
541	17:37	1	212112	300	212114	300	212190	10	212115	10	-	-	0	0	1
541	18:24	1	212112	300	212114	300	212190	10	212115	10	-	-	0	0	1
546	16:23	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
546	16:53	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
546	17:23	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
546	17:53	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
546(SB)	18:23	3	2121155	10	212190	10	212115	10	212112	300	-	-	0	0	3
549	16:08	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
549	16:38	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
549	17:08	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
549	17:38	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
549 (NB)	18:00	3	212140	300	2121163	10	-	-	-	-	-	-	-	-	3
549	18:08	3	2121155	10	212190	10	212115	10	212112	120	212140	300	2121163	10	3
550 (EB)	16:17	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	16:26	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	16:36	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	16:46	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	16:56	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	17:16	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	17:37	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	17:57	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	18:17	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (WB)	16:00	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	16:24	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	16:36	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	16:46	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	16:56	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	17:16	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	17:37	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	17:57	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	18:17	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
630 (EB)	16:25	2	212123	10	212190	10	212115	10	212114	300	-	-	0	0	2
630 (EB)	16:55	2	212123	10	212190	10	212115	10	212114	300	-	-	0	0	2
630	17:25	2	212123	10	212190	10	212115	10	212114	300	212129	10	-	-	2
630	17:55	2	212123	10	212190	10	212115	10	212114	300	212129	10	-	-	2
630	18:25	2	212123	10	212190	10	212115	10	212114	300	212129	10	-	-	2
651 (NB)	16:00	4	212113	300	-	-	-	-	-	-	-	-	0	0	4
651	16:17	4	212190	10	212115	10	212113	300	-	-	-	-	0	0	4
651	16:43	4	212190	10	212115	10	212113	300	-	-	-	-	0	0	4
651	17:12	4	212190	10	212115	10	212113	300	-	-	-	-	0	0	4
651 (NB)	17:40	4	212113	300	-	-	-	-	-	-	-	-	0	0	4
651	17:41	4	212190	10	212115	10	212113	300	-	-	-	-	0	0	4
651 (SB)	18:11	4	212190	10	212115	10	212113	300	0	0	0	0	0	0	4
733	16:14	1	212114	300	-	-	-	-	-	-	-	-	0	0	4

K. 2021 AM & PM STFM Link Flow Plots & Cordon Matrices

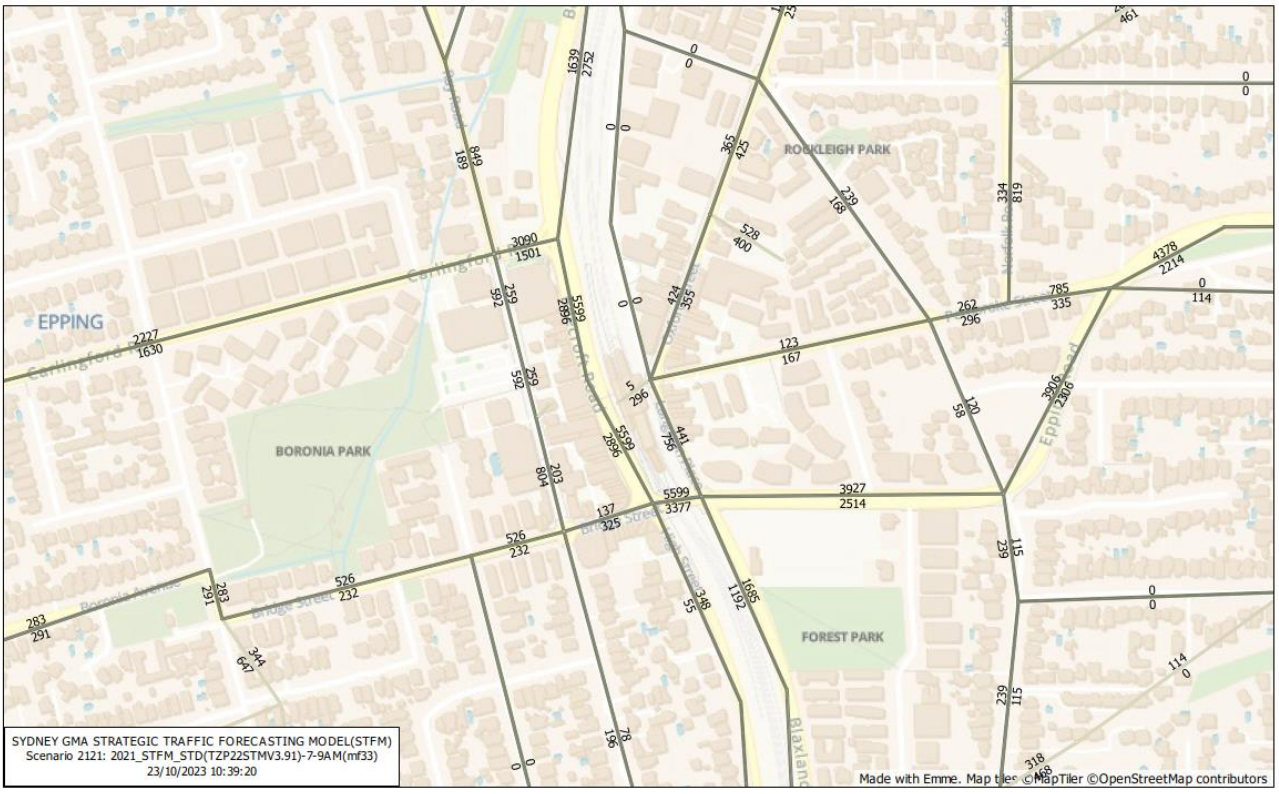
Table K1: STFM 2021 AM Peak 2-hour Cordon Matrices (Vehicles)

ID	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
1		743	59	46	1684		6		119	89	5		2752
2	698		37	72				1	318	36		30	1192
3	106	94			144		1		24	142		15	526
4	30	152			1793		7		207			38	2227
5	585	11	86	1096			93	337		57		41	2306
6	51		6	51				3		5		4	120
7	70		8	82		58		7		9		5	239
8	55												55
9		437					4						441
10	31	21	16	40	27		1		7		31	13	187
11		2			46		1		32	73		44	196
12	14	224	19	243	211		2		51	44	42		849
TOTAL	1639	1685	232	1630	3906	58	115	348	756	455	78	189	11091

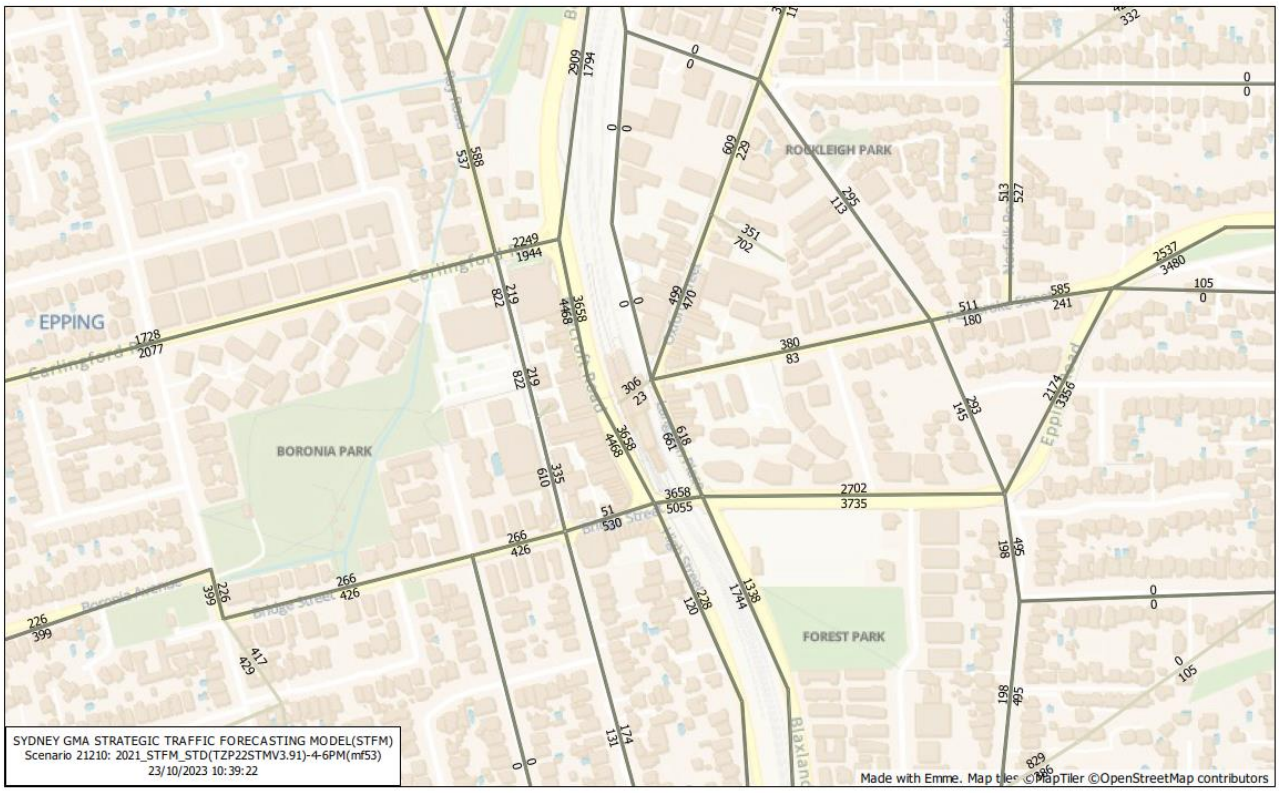
Table K2: STFM 2021 PM Peak 2-hour Cordon Matrices (Vehicles)

ID	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
1		619	43	74	680	44	173		94	36	31		1794
2	896		165	140				3	424	24		92	1744
3	16	16			115	4	17		8	70		21	266
4	102	65			1040	38	132		100			251	1728
5	1511		92	1479				199		23		52	3356
6	87		37	116				23		5		24	293
7	43		8	24	70	41		4		4		4	198
8	120												120
9		512					107						618
10	114	39	59	94	81	6	28		12		80	42	554
11		2			27	1	4		5	41		51	131
12	21	85	23	149	161	10	36		17	23	63		588
TOTAL	2909	1338	426	2077	2174	145	495	228	661	226	174	537	11390

2021 AM Peak



2021 PM Peak



L. TfNSW Operational Transport Forecasting Team Review Comments on Draft Issue