Epping Town Centre

Commercial Floorspace Traffic Study

Prepared for City of Parramatta
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1 Introduction

1.1 Overview

City of Parramatta (the Council) has engaged EMM Consulting to assess and compare operational traffic results for the major road network based on two future (2026) Town Centre land use scenarios. The future base year scenario and two proposed future land use scenarios are summarised as follows. The relevant areas are illustrated in Figure 1.1 for the core Town Centre Study area (in blue) and the surrounding areas (in orange) which are relevant to the assessments in this traffic study report.

Throughout this report, the following terms are used.

- **Authorised development,** includes approved development (and approved development under construction) for the period from 2016 to 2026 in the Town Centre and surrounding areas in accordance with the current floor space ratio (FSR) planning controls. This equates to approximately 2,017 dwellings (refer to Appendix A).

- **Scenario 0 - base case,** authorised development + 12,232 m^2 retail area + 5,504 m^2 commercial office area + a potential 1,742 residential units based on 85 m^2 unit size (for the purpose of comparability between scenarios) under the current development controls. This scenario identifies the likely development patterns in the absence of any changes to development controls.

- **Scenario 1 - future land use with additional commercial development,** authorised development + 12,232 m^2 retail area + 43,551 m^2 commercial office area + a potential 1,310 residential units based on 85 m^2 unit size (for the purpose of comparability between scenarios). No change to current FSR planning controls. This scenario considers the future development pattern if an increase in commercial floorspace displaces some of the residential floorspace.

- **Scenario 2 - future land use with additional commercial development and revised FSR,** authorised development + 12,232 m^2 retail area + 43,551 m^2 commercial office area + a potential 1,808 residential units based on 85 m^2 unit size (for the purpose of comparability between scenarios). This scenario considers the outcome if the commercial component of future development is increased and an increase in FSR is also introduced which will provide for greater commercial development but without any displacement of residential floorspace.

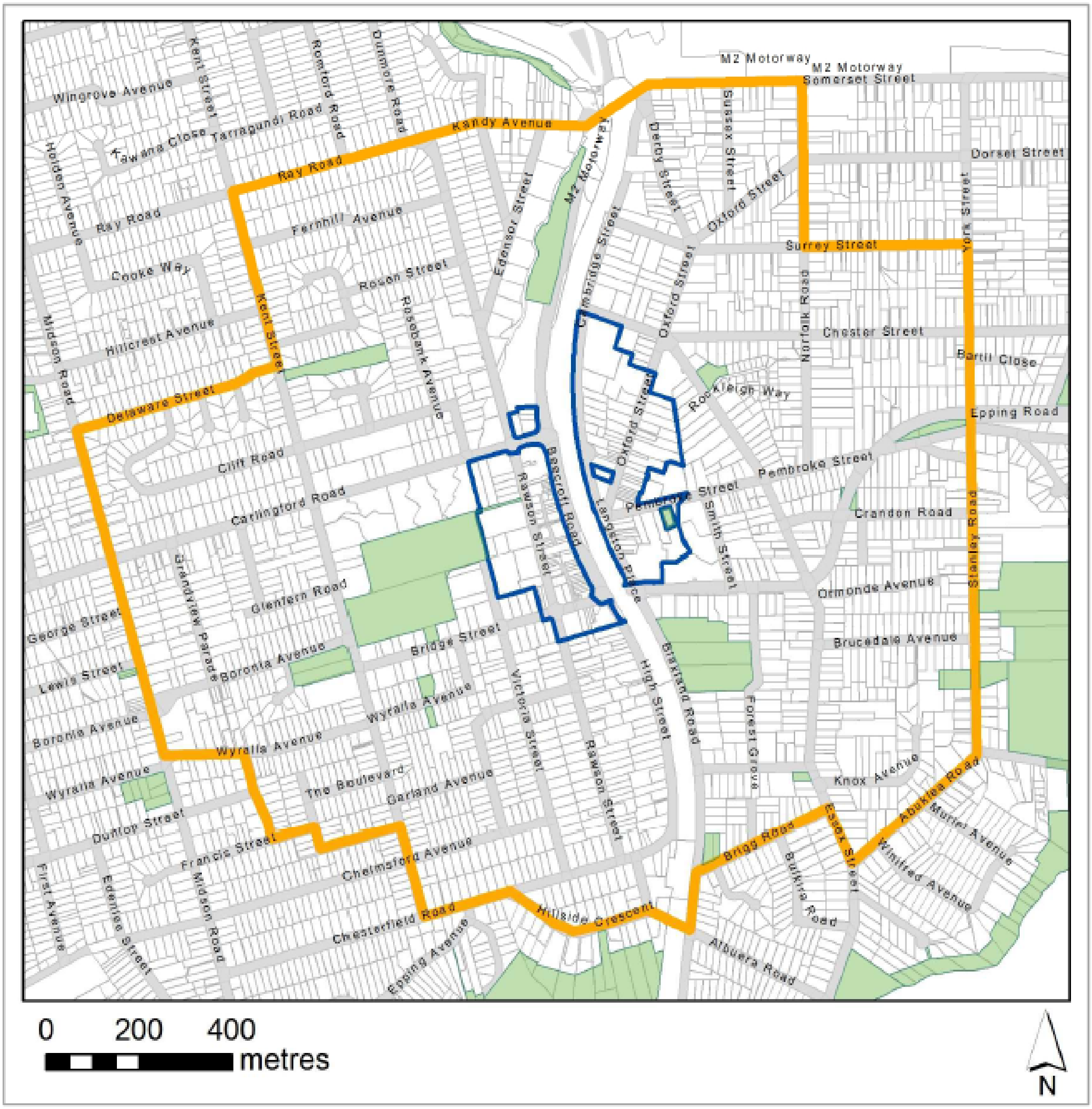


Figure 1.1 Map of the Epping Town Centre and surrounding study areas

1.2 Future base year and proposed future land use scenarios

The Council has provided EMM with a detailed list of properties that are either approved or under construction. These are considered to be 'authorised development' and represent development which is included under all scenarios and summarised at Table 1.1.

The locations of the future study area development sites outside the Town Centre are shown on the map in Appendix A.

The additional Town Centre potential development sites for Scenario 0 (future base year) and Scenario 1 and Scenario 2 (proposed future land uses) are shown in Appendix B.

Table 1.1 Authorised dwelling development within the Town Centre

Property address	Residential Units (@ 85 sqm each)
35 Oxford Street	54
18-28 Cambridge Street	501
30-42 Oxford Street	254
12-22 Langston Place;	464
24-36 Langston Place	101
37-41 Oxford Street	257
48-54 Beecroft Road and 52-54 Rawson Street	130
16-18 Cambridge Street	84
29-33 Oxford Street and 6-14 Cambridge Street (Catholic Church site)	172
Total All Sites	**2,017**

Source: City of Parramatta (2019)

The difference between the scenarios is based on changes to development controls, specifically the allowable commercial area and the FSR.

For the purposes of comparability between the various scenarios, we have assumed a standard residential unit size of 85 m^2 in all tables. Not all residential dwellings will be 85 m^2, but this is considered a reasonable standard for the purposes of this report.

1.2.1 Scenario 0: future base case

Scenario 0 is the base case for 2026, where the majority of authorised and future potential development is residential, with minimal commercial development. The majority of dwellings in the base case 2026 Scenario are located on sites within the core Epping Town Centre study area, which is shown in blue outline in Figure 1.1.

These sites are zoned B2 Local Centre under the Parramatta Local Environmental Plan 2011. These dwellings comprise 2,017 dwellings of 'authorised development' which are listed in Table 1.1, and a further potential 1,742 dwellings which are listed in Table 1.2. A further 1,334 dwellings are distributed in the area outside Epping Town Centre within the orange outline area in Figure 1.1. Under this scenario, there is also approximately 5,504 m2 of office gross floor area.

Table 1.2 Additional development within the Town Centre (Scenario 0)

Property address	Scenario 0	
	Residential Units (85 m^2)	Commercial Office GFA (m^2)
1-3 Oxford Street	0	0
18-24 Oxford Street	67	0
26-28 Oxford Street	34	0
50-50E Rawson Street; part 9 Bridge Street	91	0
41-47 Beecroft Road	99	0

Table 1.2 Additional development within the Town Centre (Scenario 0)

Property address	Scenario 0	
	Residential Units (85 m²)	Commercial Office GFA (m²)
51 Rawson Street	63	3,168
51A Rawson Street	372	0
36-38 Victoria Street	0	0
246-250 Carlingford Road	143	0
74-76 Rawson Street	0	2,336
53-61 Rawson Street	460	0
Lyon Site	413	0
All Sites	**1,742**	**5,504**

Source: City of Parramatta (2019)

1.2.2 Scenarios 1 and 2: Proposed future land use

Scenarios 1 and 2 are development scenarios for 2026. Both Scenarios include authorised development of 2,017 dwellings (listed in Table 1.3 and within the blue outline in Figure 1.1). For both Scenarios, a further 1,334 dwellings are distributed in the area outside Epping Town Centre within the orange outline area in Figure 1.1.

Scenario 1 represents a future potential development within the Epping Town Centre (within the blue outline in Figure 1.1) which assumes the development is:

1) consistent with the maximum floor space ratio controls within the Parramatta Local Environmental Plan (LEP) 2011 and Hornsby LEP 2013; and

2) comprise a minimum of two levels of commercial (office) floorspace within the development.

This totals 1,310 additional dwellings and approximately 43,551 m^2 of office gross floor area. The sites of potential development are listed in Table 1.3.

Scenario 2 represents a future potential development within the Epping Town Centre (within the blue outline in Figure 1.1) which assumes that development comprises a minimum of 2 levels of commercial (office) floorspace within the development which exceeds the current maximum floor space ratio controls within the Parramatta LEP 2011 and Hornsby LEP 2013. This totals 1,808 additional dwellings and approximately 43,551 m^2 of office gross floor area. The sites of potential development are listed in Table 1.3.

Table 1.3 Proposed future development within the Town Centre (Scenario 1 and Scenario 2)

Property address	Scenario 1		Scenario 2	
	Residential Units (@ 85 m² each)	Commercial Office GFA (m²)	Residential Units (@ 85 m² each)	Commercial Office GFA (m²)
1-3 Oxford Street	0	0	0	0
18-24 Oxford Street	46	1,888	67	1,888
26-28 Oxford Street	24	960	34	960

Table 1.3 Proposed future development within the Town Centre (Scenario 1 and Scenario 2)

Property address	Scenario 1		Scenario 2	
	Residential Units (@ 85 m^2 each)	Commercial Office GFA (m^2)	Residential Units (@ 85 m^2 each)	Commercial Office GFA (m^2)
50-50E Rawson Street;part 9 Bridge Street	63	2,032	91	2,032
41-47 Beecroft Road	71	2,254	99	2,254
51 Rawson Street	63	3,168	104	3,168
51A Rawson Street	294	6,666	372	6,666
36-38 Victoria Street	0	0	0	0
246-250 Carlingford Road	93	4,816	152	4,816
74-76 Rawson Street	0	2,336	0	2,336
53-61 Rawson Street	339	9,634	460	9,634
Lyon Site	318	9,797	429	9,797
All Sites	**1,310**	**43,551**	**1,808**	**43,551**

Source: City of Parramatta (2019)

1.3 Methodology

EMM Consulting engaged a Transport Modelling Specialist, Paul van Den Bos, to conduct the required major road network and intersection modelling analysis for the base year 2026 (Scenario 0) and the two proposed future 2026 land use scenarios (Scenario 1 and Scenario 2) to identify the additional peak hourly traffic volumes using the road network at each intersection and the mid-block traffic flow speeds and traffic queues (vehicles waiting) between each intersection.

In comparison to the historic Epping Town Centre major road network operations, where the peak period traffic volumes were initially surveyed in 2017 to develop the original baseline traffic network models for this study, a number of recent road network improvements (which have now either been completed since 2017, or their future construction timetable is now known) are included in all the 2026 road network traffic model scenarios which have been analysed. These road network improvements are listed in Table 1.4.

Table 1.4 Summary of committed RMS and Council road improvements

Number	Authority	Proposed road works
1	RMS	Additional capacity at the Beecroft Road and Carlingford Road intersection.
2	RMS	Widening the southern side of Epping Road by about 3.7 metres between Blaxland Road and Essex Street to provide an additional westbound lane.
3	RMS	Widening of railway bridge, additional westbound lane into Beecroft Road.
4	Council/RMS	Signalisation of Kent Street/Carlingford Road intersection.

Two levels of road network traffic modelling have been undertaken for this study using the Dynameq and SIDRA-8 road network and linked intersection traffic models.

Both these models are "mesoscopic" type road network models which take the basic road network output volumes from a regional traffic network model (in this case EMME/2) and use a more detailed "linked intersection" traffic flow and congestion model to identify specific road network performance outputs (eg travel speed and intersection delays) and the number of vehicles which cannot actually enter the road network when ‘gridlock’ traffic congestion occurs.

In the case of the Dynameq network model, the model was developed for the morning three-hour peak traffic period only and provided detailed outputs for the following road network operations:

- traffic volume demand, vehicles entering the road network at 15-minute intervals from 6:45 am;
- traffic volume throughput, vehicles exiting the road network at 15-minute intervals from 6:45 am;
- suppressed traffic, vehicles “waiting” to enter the road network at 15-minute intervals from 6:45 am, and
- traffic travel speeds eastbound through the road network at 15-minute intervals from 6:45 am.

In the case of the SIDRA network model, the model was developed for the morning and afternoon one-hour peak traffic periods and provided detailed outputs for the following road network operations for each of the seven major ‘traffic signal controlled’ intersections along the Epping Town Centre east-west through traffic route:

- overall network traffic volume, level of service and average travel speed;
- intersection peak hourly traffic volume demand and throughput (minus suppressed traffic);
- intersection peak hourly traffic degree of saturation;
- intersection peak hourly average traffic delay (seconds) for all vehicles using the intersection;
- intersection peak hourly level of service within the range ABCDEF which is defined according to RMS standards; and
- maximum peak hour (95^{th} percentile) traffic queue length (metres).

2 Traffic generation assumptions

2.1 Traffic generation rates

Traffic generation assumptions used in this study report are based on the RMS *Guide to Traffic Generating Developments* (RTA 2002) including the Technical Direction (TDT 2013 – 04a) updated surveys of August 2013.

The lowest peak hour vehicle trip generation rates for high density residential flat buildings in metropolitan regional (CBD) centres is now in the range 0.15 to 0.19 per unit. In other more suburban traditional medium density developments, the peak hour vehicle trip ratio is approximately 0.48 trips per unit. Traffic generation rates used in the traffic analysis network model for this study report for residential land use (ie primarily high density residential flat buildings in the core Epping Town centre area) are modified versions of the historic RTA-RMS rates adjusted according to the direct line distance from the Epping train station. They are:

- sector 1: 0 – 200 m to train station;
- sector 2: 200 – 400 m to train station;
- sector 3: 400 – 800 m to train station; and
- sector 4: 800 m or more to train station.

Within the core Epping Town Centre study area, the effective traffic generation rate per 100 sqm gross floor area for residential apartments would be approximately 0.22 AM and 0.18 PM peak hour car trips (Average 0.20).

For the same given amounts of future building gross floor area within the core Epping Town Centre study area (within 200m of the train station) the future commercial office/retail uses will generally have significantly higher car traffic generation rates than for residential uses as follows:

- The highest car traffic generation rates will generally occur with new town centre retail uses which will have approximately 0.80 AM and 2.30 PM peak hour car trips per 100 sqm (Average 1.55) which is approximately 7.75 times higher than for residential uses.
- Mid range traffic generation rates would typically occur for commercial office type uses which would be approximately 0.80 AM and 0.60 PM peak hour car trips per 100 sqm (Average 0.70). This is approximately 3.5 times higher than for residential uses. These rates are significantly lower than the historic standard RTA or RMS traffic generation rates for office development in suburban areas, which are 2.0 vehicle trips per 100 sqm in both the AM and PM peak hours.
- The commercial office traffic generation rates represent 'best practice' highest feasible levels of walking cycling and public transport usage for journeys to work and visitor access and corresponding minimum feasible level of car driver journey to work travel for any areas outside the Sydney CBD, which are currently approximately 25-30% in any comparable area.

The corresponding morning and afternoon peak hour vehicle trips per hour generated by each land use considered in the study for the core Town Centre and surrounding areas, are summarised in Table 2.1.

Table 2.1 Traffic generation rate adopted in the study report

Sector	AM peak traffic generation per unit							PM peak traffic generation per unit						
	Per sector	Residential land use generated traffic ratio		Commercial land use generated traffic ratio		Retail land use generated traffic ratio		Per sector	Residential land use generated traffic ratio		Commercial land use generated traffic ratio		Retail land use generated traffic ratio	
		80% outbound	20% inbound	20% outbound	80% inbound	20% outbound	80% inbound		40% outbound	60% inbound	80% outbound	20% inbound	50% outbound	50% inbound
Sector 1	0.19	0.152	0.06	0.16	0.64	0.16	0.64	0.15	0.06	0.09	0.48	0.12	1.15	1.15
Sector 2	0.23	0.184	0.092					0.23	0.092	0.138				
Sector 3	0.29	0.232	0.116					0.29	0.116	0.174				
Sector 4	0.48	0.384	0.192					0.48	0.192	0.288				

2.2 Traffic distribution pattern

It is assumed in the network traffic model future traffic distributions, particularly for the future commercial centre office and retail land use generated traffic movements, that the majority of the additional future traffic movements will be approaching the Epping Town Centre via the following routes:

- from north of Epping Town Centre: via Kent Street, Ray Road and Rawson Street;
- from west of Epping Town Centre: via Kent Street, Carlingford Road and Bridge Street;
- from south of Epping Town Centre: via Epping Avenue, Chesterfield Road and Rawson Street; and
- from east of Epping Town Centre: via Epping Road, Oxford Road, Pembroke Street, Blaxland Road and Beecroft Road.

These traffic distribution patterns for the additional Epping Town Centre retail and commercial traffic correspond to the existing retail and commercial traffic generation patterns for all sites within the western and the eastern parts of the Epping Town Centre (as divided by the railway line) which are an inbuilt assumption within the current RMS-TfNSW EMME/2 network traffic model.

These traffic distributions as shown in the attached plots in Figure 2.1 and Figure 2.2, show that the majority of the retail and commercial traffic movements which are currently accessing the areas of the Town Centre on each side of the railway line, will predominantly remain on that side of the railway line.

Figure 2.1 Commercial and retail trip origins for Epping Town Centre areas west of the railway line

Figure 2.2 Commercial and retail trip origins for Epping Town Centre areas east of the railway line

3 Future Road Network Operations

3.1 Dynameq network traffic model results

The Dynameq road network model was developed for both the morning and afternoon three-hour traffic peak periods. The detailed network traffic demand inputs and outputs from the source EMME2 model to the Dynameq network model are shown in Appendix C.

The Dynameq road network morning and afternoon peak period traffic demand which is trying to enter the road network is shown for 15-minute intervals in the various output plots in Appendix C, for the three separate 2026 land use scenarios which have been analysed, which are effectively:

- Scenario 0 = +5,093 additional dwellings in 2026, in comparison to the approximate year 2016 baseline traffic model conditions;
- Scenario 1 = +4,661 additional dwellings and +38,047 m^2 additional GFA commercial development floor area in comparison to the approximate year 2016 baseline traffic model conditions, and
- Scenario 2 = +5,159 additional dwellings and +38,047 m^2 additional GFA commercial development floor area in comparison to the approximate year 2016 baseline traffic model conditions.

In terms of the overall road network traffic demand input and output volumes, calculated for 15-minute intervals, the Dynameq traffic model output plots in Appendix C show that the future road network travel conditions will vary significantly within both the three-hour morning and afternoon peak traffic periods, and the levels of road network traffic congestion, travel time delays, and numbers of vehicles waiting to access the road network, will all continue to increase steadily over the full three-hour morning and afternoon peak traffic periods.

The Dynameq traffic delay results are more significant for the morning peak and these results show that in terms of overall traffic volumes entering the road network, the major road network will reach saturation relatively early in the three-hour morning peak period as follows:

- at approximately 7:45 am for the 2026 baseline traffic (Scenario 0);
- at approximately 7:15 am for the 2026 additional development traffic (Scenario 1); and
- at approximately 7:00 am for the 2026 additional development traffic (Scenario 2).

These results confirm the general effect of the additional development traffic which would be generated by the additional Town Centre development land use scenarios (Scenario 1 and Scenario 2), which would effectively cause the onset of peak traffic congestion to occur significantly earlier each morning and with more severe consequences, in terms of traffic movements blocked, in comparison to the assessed year 2026 baseline (Scenario 0) traffic conditions.

In comparison during the afternoon peak traffic period the differences will be much less noticeable in terms of the divergence of the network traffic congestion levels and peak hour traffic speeds for the three Scenarios and there would be generally much lower numbers of vehicles blocked from entering the Epping Town Centre road network, with either the assessed year 2026 baseline (Scenario 0) traffic conditions or the additional Town Centre development land use scenarios (Scenario 1 and Scenario 2).

The overall net effect of the resulting additional road network traffic congestion during the full three-hour morning peak period for the three development traffic scenarios is shown by the final charts of the Dynameq output traffic model results in Appendix C.

These results show the three assessed land use scenarios having overall network travel speeds which continue to decline throughout the three-hour morning peak travel periods and reaching the following respective minimum values at approximately 8:45 am:

- 8 km/h for the 2026 baseline (Scenario 0);
- 3 km/h for the 2026 additional development (Scenario 1); and
- 2 km/h for the 2026 additional development (Scenario 2).

In comparison the results for the three assessed land use scenarios for the three-hour afternoon peak travel periods show much less effect from either development scenario with the overall network travel speeds reaching the following respective minimum values at approximately 4:00 pm:

- 31 km/h for the 2026 baseline (Scenario 0);
- 31 km/h for the 2026 additional development (Scenario 1); and
- 30 km/h for the 2026 additional development (Scenario 2).

3.2 SIDRA network model results

The SIDRA network travel model results, which are included in Appendix D, are based on a one-hour peak period traffic analysis only and show similar trends to the Dynameq travel model results in terms of the overall network traffic operations for the three land use scenarios. In addition to the individual SIDRA intersection performance results for each of the seven major traffic signal-controlled intersections in the study area, the SIDRA network model also determines the overall network performance Level of Service (LOS) and average travel speed for each assessed traffic scenario.

The Epping Town Centre study area SIDRA traffic model shows the overall road network traffic congestion is lower and the network travel speeds are much higher in the afternoon peak hour compared to the morning peak hour. The morning traffic peak period is clearly the more critical of the two peak hour periods for major road intersection delays and other traffic congestion issues for traffic travelling on and traffic requiring access to the major road networks in the Epping Town Centre study area. The overall major road network average travel speeds for each of the assessed traffic scenarios are as follows:

- In the actual morning peak hour, the future overall network travel speeds will reduce from 9.4 km/h for the baseline (Scenario 0) land use to 9.3 km/h and 8.8 km/h with the future land uses of Scenarios 1 and 2.
- The equivalent SIDRA network level travel speed results in the actual afternoon peak hour show the future overall network travel speeds will reduce from 19.3 km/h for the baseline (Scenario 0) land use to 17.8 km/h and 17.4 km/h with the future land uses of Scenarios 1 and 2.

The significance of these overall SIDRA "network performance" travel speed results should also be considered in the context of the additional SIDRA traffic performance results for the seven individual intersections, which are summarised in further detail in Chapters 4, 5 and 6 of this report.

4 Network operational results for base year Scenario 0

The key finding of the 2026 SIDRA base year network model (Scenario 0) is that during the morning peak hour, the overall network performance will be LOS F with an average travel speed 9.4 km/h. The SIDRA intersection results for the future base year 2026 Scenario 0 operations are shown in Table 4.1. Four of the seven key traffic signal-controlled intersections will be operating at LOS F during the morning peak hour.

Table 4.1 Seven key traffic signal-controlled intersections for Scenario 0 during AM peak hour

Intersection	Vehicle demand	Supressed traffic[1]	Degree of saturation (DOS)	Average delay (seconds) (DEL)	Level of service (LOS)
Carlingford Road/Midson Road	2,968	81	1.335	379.8	F
Carlingford Road/Kent Street	2,837	421	0.802	18.2	B
Carlingford Road/Ray Road/Rawson Street	3,386	387	4.802	706.6	F
Carlingford Road/Beecroft Road	4,671	552	1.294	92.1	F
Epping Road/Blaxland Road/Langston Place	4,770	534	1.103	38.6	C
Epping Road/Essex Street	3,720	314	1.127	91.3	F
Epping Road/Pembroke Street	2,953	293	0.879	13.9	A

Note: 1. Hourly volume of suppressed traffic (suppressed at upstream intersections.

In the 2026 afternoon peak hour, the overall baseline network performance will be LOS D with travel speed 19.3 km/h. The SIDRA results for the baseline land use Scenario 0 traffic operations at the seven key traffic signal-controlled intersections are shown in Table 4.2. Only one intersection (Carlingford Road/Beecroft Road) will be operating at LOS F during the afternoon peak hour for Scenario 0.

Table 4.2 Seven key traffic signal-controlled intersections for Scenario 0 during PM peak hour

Intersection	Vehicle demand	Supressed traffic[1]	Degree of saturation (DOS)	Average delay (seconds) (DEL)	Level of service (LOS)
Carlingford Road/Midson Road	2,778	144	0.849	35.1	C
Carlingford Road/Kent Street	2,477	68	0.608	20.1	B
Carlingford Road/Ray Road/Rawson Street	2,815	189	0.901	25.0	B
Carlingford Road/Beecroft Road	4,065	0	2.344	241.6	F
Epping Road/Blaxland Road/Langston Place	4,294	0	1.132	43.3	D
Epping Road/Essex Street	3,266	0	0.931	36.2	C
Epping Road/Pembroke Street	2,302	0	0.907	13.0	A

Note: 1. Hourly volume of suppressed traffic (suppressed at upstream intersections.

The main reason for the better 2026 baseline traffic network performance in the afternoon peak is that the main RMS improvement (the extra lane westbound on the Epping Bridge) will have its greatest benefit in the afternoon peak hour and there will correspondingly be only one intersection operating at LOS F in the afternoon peak hour, at Carlingford Road/Beecroft Road, with an average traffic delay of 241.6 seconds.

This delay will nevertheless cause some afternoon peak hour traffic suppression at the three other downstream intersections for the main (westbound) traffic flow, which are at Carlingford Road/Ray Road/Rawson Street, Carlingford Road/Kent Street and Carlingford Road/Midson Road.

In contrast during the morning traffic peak hour, the much high number of intersections operating at LOS F, with much higher average traffic delays (up to 706.6 seconds) means that there will be more significant morning peak hour traffic suppression at all the major traffic signal controlled intersections in the road network along the main eastbound through traffic route from, Midson Road to Pembroke Street.

5 Network operational results for Scenario 1

The comparative findings of the 2026 SIDRA network model for Scenario 1 are that during the morning peak hour, the overall network performance will also be LOS F and the average travel speed will reduce from 9.4 km/h to 9.3 km/h. The Forecast SIDRA intersection performance for the seven key traffic signal-controlled intersections are shown in Table 5.1. Two intersections will experience a change in level of service, which is shown in **bold**.

Table 5.1 Seven key traffic signal-controlled intersections for Scenario 1 during AM peak hour

Intersection	Vehicle demand	Supressed traffic[1]	Degree of saturation (DOS)	Average delay (seconds) (DEL)	Level of service (LOS)
Carlingford Road/Midson Road	3,034	101	1.229	262.9	F
Carlingford Road/Kent Street	2,888	374	0.858	20.9	B
Carlingford Road/Ray Road/Rawson Street	3,478	355	5.392	765.9	F
Carlingford Road/Beecroft Road	4,698	500	1.383	109.9	F
Epping Road/Blaxland Road/Langston Place	**4,816**	**489**	**1.186**	**45.8**	**D**
Epping Road/Essex Street	3,747	275	1.144	109.0	F
Epping Road/Pembroke Street	**2,963**	**269**	**0.916**	**16.7**	**B**

Note: 1. Hourly volume of suppressed traffic (suppressed at upstream intersections.

In the 2026 afternoon peak hour for Scenario 1, the future network traffic performance will be LOS E with travel speed reduced from 19.3 km/h to 17.8 km/h. The SIDRA results for the 2026 Scenario 1 intersection operations at the seven key traffic signal-controlled intersections which are shown in Table 5.2 show no Intersections will experience any change in the level of service.

Table 5.2 Seven key traffic signal-controlled intersections for Scenario 1 during PM peak hour

Intersection	Vehicle demand	Supressed traffic[1]	Degree of saturation (DOS)	Average delay (seconds) (DEL)	Level of service (LOS)
Carlingford Road/Midson Road	2,796	154	0.859	35.2	C
Carlingford Road/Kent Street	2,503	179	0.607	19.8	B
Carlingford Road/Ray Road/Rawson Street	2,883	204	0.868	26.3	B
Carlingford Road/Beecroft Road	4,094	0	2.567	278.6	F
Epping Road/Blaxland Road/Langston Place	4,325	0	1.264	54.0	D
Epping Road/Essex Street	3,289	0	0.908	36.1	C
Epping Road/Pembroke Street	2,307	0	0.907	12.8	A

Note: 1. Hourly volume of suppressed traffic (suppressed at upstream intersections.

During the future morning peak hour for Scenario 1, two of the seven key traffic signal-controlled intersections will experience a change in the level of service, but this will have only a relatively minor effect on the overall network traffic operations as the respective level of service changes are from C to D at the Epping Road/Blaxland Road/Langston Place intersection and from A to B at the Epping Road and Pembroke Street intersection.

The four existing intersections where the morning peak hour traffic conditions are at LOS F under the year 2026 baseline land use 0 traffic scenario, will remain at LOS F under the year 2026 development land use 1 traffic scenario.

During the future afternoon peak hour for Scenario 1, there will be no change to the level of service operations at any of the seven key traffic signal-controlled intersections.

6 Network operational results for Scenario 2

The year 2026 SIDRA network model results for land use Scenario 2 show that during the morning peak hour, the overall network performance is still LOS F with average travel speed reducing marginally from a baseline of 9.4 km/h to 8.8 km/h. The SIDRA network operations results for the 2026 Scenario 2 traffic delays at the seven key traffic signal-controlled intersections are shown in Table 6.1.Two intersections will experience a change in level of service, which is shown in **bold.**

Table 6.1 Seven key traffic signal-controlled intersections for Scenario 2 during AM peak hour

Intersection	Vehicle demand	Supressed traffic[1]	Degree of saturation (DOS)	Average delay (seconds) (DEL)	Level of service (LOS)
Carlingford Road/Midson Road	3,045	103	1.232	266.4	F
Carlingford Road/Kent Street	2,905	381	0.859	20.5	B
Carlingford Road/Ray Road/Rawson Street	3,526	358	5.647	840.8	F
Carlingford Road/Beecroft Road	4,721	531	1.387	109.5	F
Epping Road/Blaxland Road/Langston Place	**4,840**	**520**	**1.193**	**50.5**	**D**
Epping Road/Essex Street	3,763	295	1.147	111.0	F
Epping Road/Pembroke Street	**2,971**	**287**	**0.916**	**16.7**	**B**

Note: 1. Hourly volume of suppressed traffic (suppressed at upstream intersections.

In the 2026 afternoon peak hour results for Scenario 2, the overall network performance is LOS E with travel speed reducing from a baseline of 19.3 km/h to 17.4 km/h. The SIDRA results at the seven key traffic signal-controlled intersections are shown in Table 6.2. No intersection will experience a change in the level of service.

Table 6.2 Seven key traffic signal-controlled intersections for Scenario 2 during PM peak hour

Intersection	Vehicle demand	Supressed traffic[1]	Degree of saturation (DOS)	Average delay (seconds) (DEL)	Level of service (LOS)
Carlingford Road/Midson Road	2,802	158	0.859	35.2	C
Carlingford Road/Kent Street	2,515	210	0.597	18.8	B
Carlingford Road/Ray Road/Rawson Street	2,910	209	0.876	27.1	B
Carlingford Road/Beecroft Road	4,103	0	2.635	291.1	F
Epping Road/Blaxland Road/Langston Place	4,342	0	1.270	54.7	D
Epping Road/Essex Street	3,298	0	0.885	35.4	C
Epping Road/Pembroke Street	2,310	0	0.907	12.9	A

Note: 1. Hourly volume of suppressed traffic (suppressed at upstream intersections.

Similar to the results for Scenario 1, the year 2026 afternoon peak hour traffic conditions for Scenario 2 will see no change to the level of service operations at any of the seven key traffic signal-controlled intersections considered.

During the future morning peak hours for Scenario 2, two of the seven key traffic signal-controlled intersections will experience a change in the level of service (Similarly to the results for Scenario 1), but this will have only a relatively minor effect on the overall network traffic operations as the respective intersection level of service changes are from LOS C to D at the Epping Road/Blaxland Road/Langston Place intersection and from LOS A to B at the Epping Road and Pembroke Street intersection.

However as four of the existing intersections will have morning peak hour traffic conditions at LOS F under all the three year 2026 land use traffic scenarios considered, it would be appropriate for the Council to seek to minimise the future vehicular traffic generated by future residential or commercial development in the core Epping Town Centre area, during the future morning peak hour traffic periods. The future Town Centre vehicular traffic congestion and accessibility constraints would be less significant during the future afternoon peak hour traffic periods.

7 Comparison and conclusion

In comparison to the base year 2026 traffic conditions for Scenario 0, both the new Commercial + Residential land use scenarios (Scenarios 1 and 2) are showing some increased traffic volumes (and traffic impacts).

However these additional traffic impacts are in most cases relatively minor (in particular for land use Scenario 1) as there will be only minor traffic delay changes at the four existing intersections which will already be operating at highly congested traffic operating conditions during the future year 2026 baseline traffic conditions, during the morning peak hour.

The summary comparison of the future Scenario 1 and Scenario 2 forecast intersection traffic operations relative to Scenario 0 is shown in Table 7.1 for the morning peak hour and in Table 7.2 for the afternoon peak hour. Changes to LOS are shown in **bold** and existing LOS F congested intersection operations are highlighted in grey.

Table 7.1 Comparison of SIDRA traffic impact for various scenarios during the AM peak hour

Intersection	Scenario 0			Scenario 1			Scenario2		
	DOS	DEL	LOS	DOS	DEL	LOS	DOS	DEL	LOS
Carlingford Road/Midson Road	1.335	379.8	F	1.229	262.9	F	1.232	266.4	F
Carlingford Road/Kent Street	0.802	18.2	B	0.858	20.9	B	0.859	20.5	B
Carlingford Road/Ray Road/Rawson Street	4.802	706.6	F	5.392	765.9	F	5.647	840.8	F
Carlingford Road/Beecroft Road	1.294	92.1	F	1.383	109.9	F	1.387	109.5	F
Epping Road/Blaxland Road/Langston Place	1.103	38.6	C	**1.186**	**45.8**	**D**	**1.193**	**50.5**	**D**
Epping Road/Essex Street	1.127	91.3	F	1.144	109.0	F	1.147	111.0	F
Epping Road/Pembroke Street	0.879	13.9	A	**0.916**	**16.7**	**B**	**0.916**	**16.7**	**B**

Note: DOS = Degree of Saturation, DEL = Average Vehicle Delay (seconds), LOS = Level of Service

Table 7.2 Comparison of SIDRA traffic impact for various scenarios during the PM peak hour

Intersection	Scenario 0			Scenario 1			Scenario 2		
	DOS	DEL	LOS	DOS	DEL	LOS	DOS	DEL	LOS
Carlingford Road/Midson Road	0.849	35.1	C	0.859	35.2	C	0.859	35.2	C
Carlingford Road/Kent Street	0.608	20.1	B	0.607	19.8	B	0.597	18.8	B
Carlingford Road/Ray Road/Rawson Street	0.901	25.0	B	0.868	26.3	B	0.876	27.1	B
Carlingford Road/Beecroft Road	2.344	241.6	F	2.567	278.6	F	2.635	291.1	F
Epping Road/Blaxland Road/Langston Place	1.132	43.3	D	1.264	54.0	D	1.270	54.7	D
Epping Road/Essex Street	0.931	36.2	C	0.908	36.1	C	0.885	35.4	C
Epping Road/Pembroke Street	0.907	13.0	A	0.907	12.8	A	0.907	12.9	A

Note: DOS = Degree of Saturation, DEL = Average Vehicle Delay (seconds), LOS = Level of Service

In the morning peak hour, under the future baseline (Scenario 0) traffic conditions, four of the Epping study area intersections will already be operating at highly congested traffic conditions (Level of Service F), in particularly the most congested intersection, which is at Carlingford Road/Ray Road/Rawson Street.

However as this intersection will effectively be operating at delays approximately ten times higher than the specified average traffic delay threshold limit, which is 70 seconds, for LOS F, the effect of the further significant increase in delay by 60 and 135 seconds respectively for Scenario 1 and Scenario 2 may not actually be that noticeable as the future delays will increase from ten to either eleven or twelve times the minimum delay threshold limit for LOS F. Although still a potentially significant delay increase in actual terms, in proportional terms the additional delay increase may not be particularly noticeable to most road users.

However as two of the seven intersections, which are not currently operating at LOS F will also experience changes to the level of service (Epping Road/Blaxland Road/Langston and Epping Road/Pembroke Street) there will effectively be a significant overall worsening of the future baseline traffic conditions and traffic delays at all the assessed future Epping Town Centre intersections for the future increased residential and commercial development scenarios (Scenario 1 and Scenario 2) in comparison to Scenario 0.

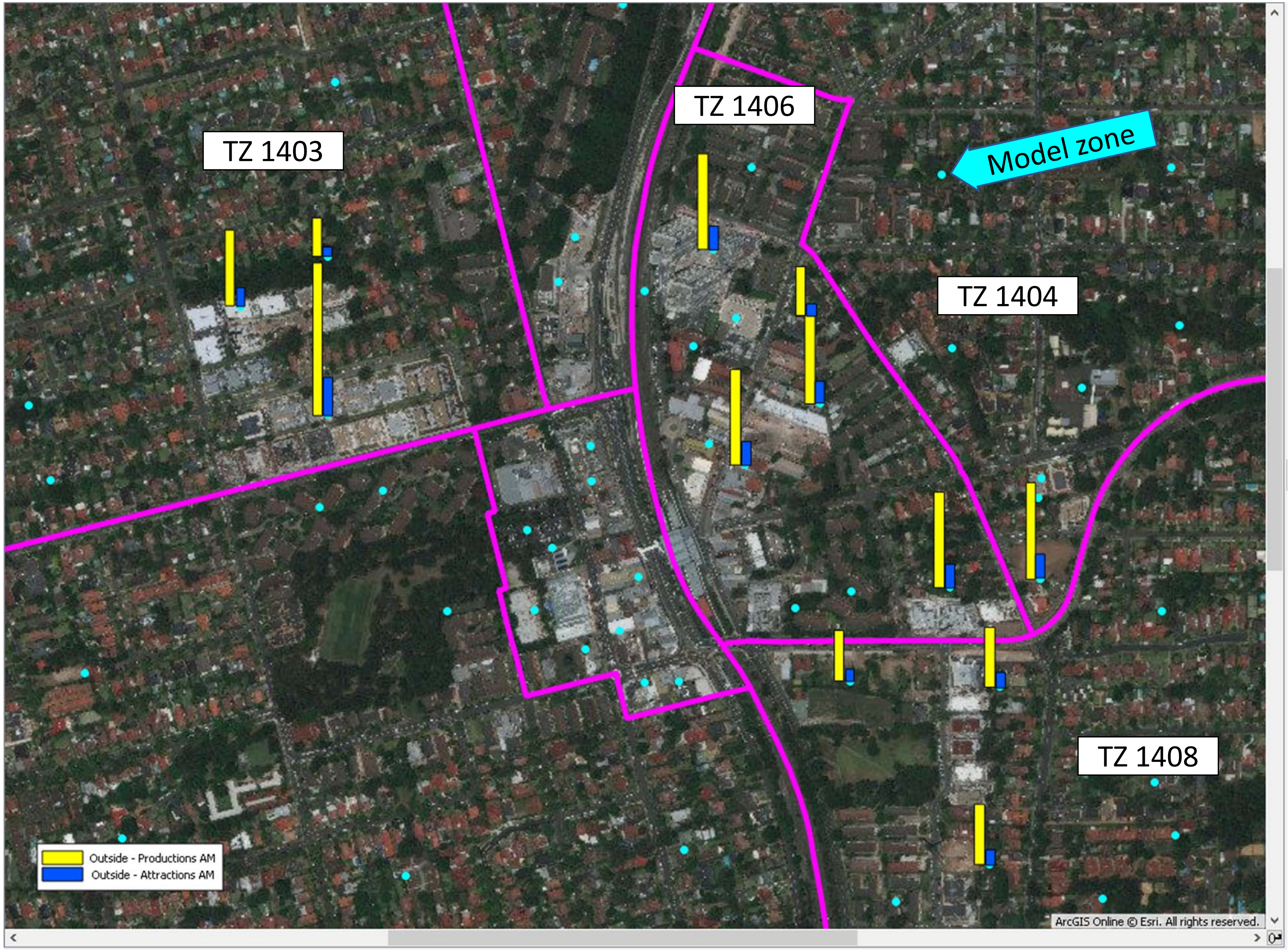
In comparison, during the future afternoon peak hour assessed traffic conditions for Scenario 1 and Scenario 2, as summarised in Table 7.2, there will be much less noticeable changes to the future traffic delays at the seven assessed intersections will see no significant material change to the future intersection operations under Scenario 1 and Scenario 2, compared to the future baseline Scenario 0. At the one intersection (Carlingford Road/Beecroft Road) which will be operating at over capacity traffic conditions (LOS F) under the future baseline Scenario 0, there will be further average delay increases of 37 and 49.5 seconds respectively for Scenario 1 and Scenario 2, which may be considered a significant further worsening of the assessed future baseline intersection traffic delay of 241.6 seconds, but this is only a potentially significant impact at one intersection

In general, during the assessed future afternoon peak hour traffic conditions, the overall network travel speeds intersection performance are much better than during the morning peak hour, which is believed to be primarily a result of the assumed future Epping Bridge widening, which is only by a single lane and in the westbound direction only. This assumed future widening will therefore primarily only relieve the existing afternoon peak hour (westbound) traffic delays and will do little to improve the current morning peak hour traffic congestion.

Consequently the future Epping morning peak hour traffic conditions will be much more susceptible and vulnerable to additional traffic delay increases as a result of increased town centre development (either residential, commercial office or retail uses) in comparison to the future Epping afternoon peak hour traffic conditions.

Appendix A

Baseline residential sites


TZ 1403
TZ 1406
Model zone
TZ 1404
TZ 1408
Outside - Productions AM
Outside - Attractions AM
ArcGIS Online © Esri. All rights reserved.

Appendix B

Proposed commercial site details

BASE CASE - GROUND FLOOR RETAIL -+ RESIDENTIAL TOWER ABOVE

	Address	FSR	HOB	Site Area	Podium Footprint	Retail GFA (35%)	Comm. 2 levels GFA (80%)	Res. Footprint	Storeys	Res. GFA (75%)	Units (85sqm)	Total GFA	FSR	Height [(retail4.5m) + (res storeys x 3.1m)]
A1	1-3 Oxford	4.5	48	990	strata	300								
C1	**18-24 Oxford Street**	4.5	48	1350	1180	**413**	**0**	585	**13**	5704	67	6117	4.5	44.8
C2	**26-28 Oxford Street**	4.5	48	700	600	**210**	**0**	226	**17**	2882	34	3092	4.4	57.2
F	**50-50E Rawson Street & part 9 Bridge Street**	6	72	1370	1270	**445**	**0**	355	**29**	7721	91	8166	6.0	94.4
I	**41-47 Beecroft Road**	6	72	1475	1409	**493**	**0**	450	**25**	8438	99	8931	6.1	82
M	**51 Rawson Street**	4.5	48	2060	1980	**693**	**3168**	789	**9**	5326	63	9187	4.5	39.9
N	51A Rawson Street	4.5	48	7445		2083	0	2220	**19**	31635	372	33718	4.5	2+ towers
Q	**36-38 Victoria Street**	4.5	48	4465	strata	**0**	**0**			0	0	0		
R	**246-250 Carlingford Road**	4.5	48	3010	3010	**1054**	**0**	955	**17**	12176	143	13230	4.4	57.2
S	74-76 Rawson St	6	72	4141	strata	1061	2336							
T	**53 -61 Rawson Street**	4.5	48	9021	6021	**2107**	**0**	2745	**19**	39116	460	41224	4.6	2+ towers
V	**Lyon Site**	6	72	6584	6123	**3674**	**0**	1800	**26**	35100	413	38774	5.9	2 towers
	Total					**12232**	**5504**			**148097**	**1742**	**162437**		

SCENARIO 1 - GROUND FLOOR RETAIL + 2 LEVELS COMMERCIAL IN PODIUM + RESIDENTIAL TOWER

ID	Address	FSR	HOB	Site Area	Podium Footprint	Retail GFA (35%)	Comm. 2 levels GFA (80%)	Res. Footprint	Storeys	Res. GFA (75%)	Units (85sqm)	Total GFA	FSR	Height [(retai/commercial 12m) + (res storeys x 3.1m)]
A1	1-3 Oxford	4.5	48	990	strata	300								
C1	18-24 Oxford Street	4.5	48	1350	1180	413	1888	585	9	3949	46	6250	4.6	39.9
C2	26-28 Oxford Street	4.5	48	700	600	210	960	226	12	2034	24	3204	4.6	49.2
F	50-50E Rawson Street & part 9 Bridge Street	6	72	1370	1270	445	2032	355	20	5325	63	7802	5.7	74
I	41-47 Beecroft Road	6	72	1475	1409	493	2254	450	18	6075	71	8823	6.0	67.8
M	51 Rawson Street	4.5	48	2060	1980	693	3168	789	9	5326	63	9187	4.5	39.9
N	51A Rawson Street	4.5	48	7445		2083	6666	2220	15	24975	294	33724	4.5	2+ towers
Q	36-38 Victoria Street	4.5	48	4465	strata	0	0			0	0	0		
R	246-250 Carlingford Road	4.5	48	3010	3010	1054	4816	955	11	7879	93	13748	4.6	46.1
S	74-76 Rawson St	6	72	4141	strata	1061	2336							
T	53 -61 Rawson Street	4.5	48	9021	6021	2107	9634	2745	14	28823	339	40563	4.5	2+ towers
V	Lyon Site	6	72	6584	6123	3674	9797	1800	20	27000	318	40471	6.1	2 towers
	Total					12232	43551			111385	1310	163771		

SCENARIO 2- GROUND FLOOR RETAIL + 2 LEVELS COMMERCIAL IN PODIUM (not included in FSR) + RESIDENTIAL TOWER

ID	Address	FSR	HOB	Site Area	Podium Footprint	Retail GFA (35%)	Comm. 2 levels GFA (80%)	Res. Footprint	Res storeys if commercial levels are not included in FSR	Res. GFA (75%)	Units (85sqm)	GFA retail + res	FSR retail + res	Total GFA retail + res + comm	FSR retail + res + comm	Height [(retai/commercial 12m) + (res storeys x 3.1m)]	Extra res. storeys required
A1	1-3 Oxford	4.5	48	990	strata	300											
C1	18-24 Oxford Street	4.5	48	1350	1180	**413**	**1888**	585	**13**	**5704**	67	6117	4.5	8005	5.9	52.3	4
C2	26-28 Oxford Street	4.5	48	700	600	**210**	**960**	226	**17**	**2882**	34	3092	4.4	4052	5.8	64.7	5
F	50-50E Rawson Street & part 9 Bridge Street	6	72	1370	1270	**445**	**2032**	355	**29**	**7721**	91	8166	6.0	10198	7.4	101.9	9
I	41-47 Beecroft Road	6	72	1475	1409	**493**	**2254**	450	**25**	**8438**	99	8931	6.1	11185	7.6	89.5	7
M	51 Rawson Street	4.5	48	2060	1980	**693**	**3168**	789	**15**	**8876**	104	9569	4.6	12737	6.2	58.5	6
N	51A Rawson Street	4.5	48	7445		**2083**	**6666**	2220	**19**	**31635**	372	33718	4.5	40384	5.4	2+ towers	4
Q	36-38 Victoria Street	4.5	48	4465	strata	**0**	**0**			0	0	0					
R	246-250 Carlingford Road	4.5	48	3010	3010	**1054**	**4816**	955	**18**	**12893**	152	13946	4.6	18762	6.2	67.8	7
S	74-76 Rawson St	6	72	4141	strata	1061	2336										
T	53 -61 Rawson Street	4.5	48	9021	6021	**2107**	**9634**	2745	**19**	**39116**	460	41224	4.6	50857	5.6	2+ towers	5
V	Lyon Site	6	72	6584	6123	**3674**	**9797**	1800	**27**	**36450**	429	40124	6.1	49921	7.6	2 towers	7
	Total					**12232**	**43551**			**153714**	**1808**			**206100**			

ALL SCENARIOS EXISTING RETAIL/COMMERCIAL/RESIDENTIAL IN TOWN CENTRE (APPROVED DAs OR DAs UNDER ASSESSMENT)

Site No.	Site	FSR	HOB	Site Area		Proposed /actual retail	Proposed/actual comm	Res. Footprint	Storeys	Res. GFA (75%)	Units (85sqm)	Total GFA	FSR	Height
33	35 Oxford Street	4.5	72			115	0			4259	**54**		**4.5:1**	
35	18-28 Cambridge	4.5	72			1154	0			36259	**501**			
40	30-42 Oxford Street	4.5	48			625	0			22640	**254**			
42	12-22 Langston Place	6	72			1681	0			41394	**464**			
44	24-36 Langston Place	6	72			256	559			7645	**101**			
46	37-41 Oxford Street *	4.5	72			150	1133			21000	**257**			
50	48-54 Beecroft Road & 52-54 Rawson Street **	6	72	2062		1033	0		21	11334	**130**	**12367**	**6:01**	
59	16-18 Cambridge Street	4.5	72	1971		396.93	823.71		22	6,091.00	**84**	**7311.51**	**3.8:1**	**73.83**
60	29-33 Oxford Street & 6-14 Cambridge Street Catholic Church Site					200	0		29	14620	**172**			
	Total					**5611**	**2515.71**				**2017**			

Appendix C

EMME2 and Dynameq network outputs

Dynameq – network characteristics AM

In Dynameq we need integers to represent vehicles

Mathematics
Imagine 10 trips going to 19 zones: each cell would contain 10/19 = 0.526 trips
If we applied normal rounding – each number in the cell would be rounded up to an integer: 1
In this case each cell would have a "1" and the total for this row = 19 * 1 = 19 (we started with 10 trips)

Mathematically – "before" and "after" totals must be the same
Instead we use "bucket rounding" – so that the total = 10, but some cells have "0" and others have a "1"

Issues of bucket rounding process
Since we do this for 15 minute slices – numbers are multiplied by 4:

- the smallest number in the "hour" matrix is "0" followed by "4"

(The ABS uses something similar and the smallest is "0" and then a "3")

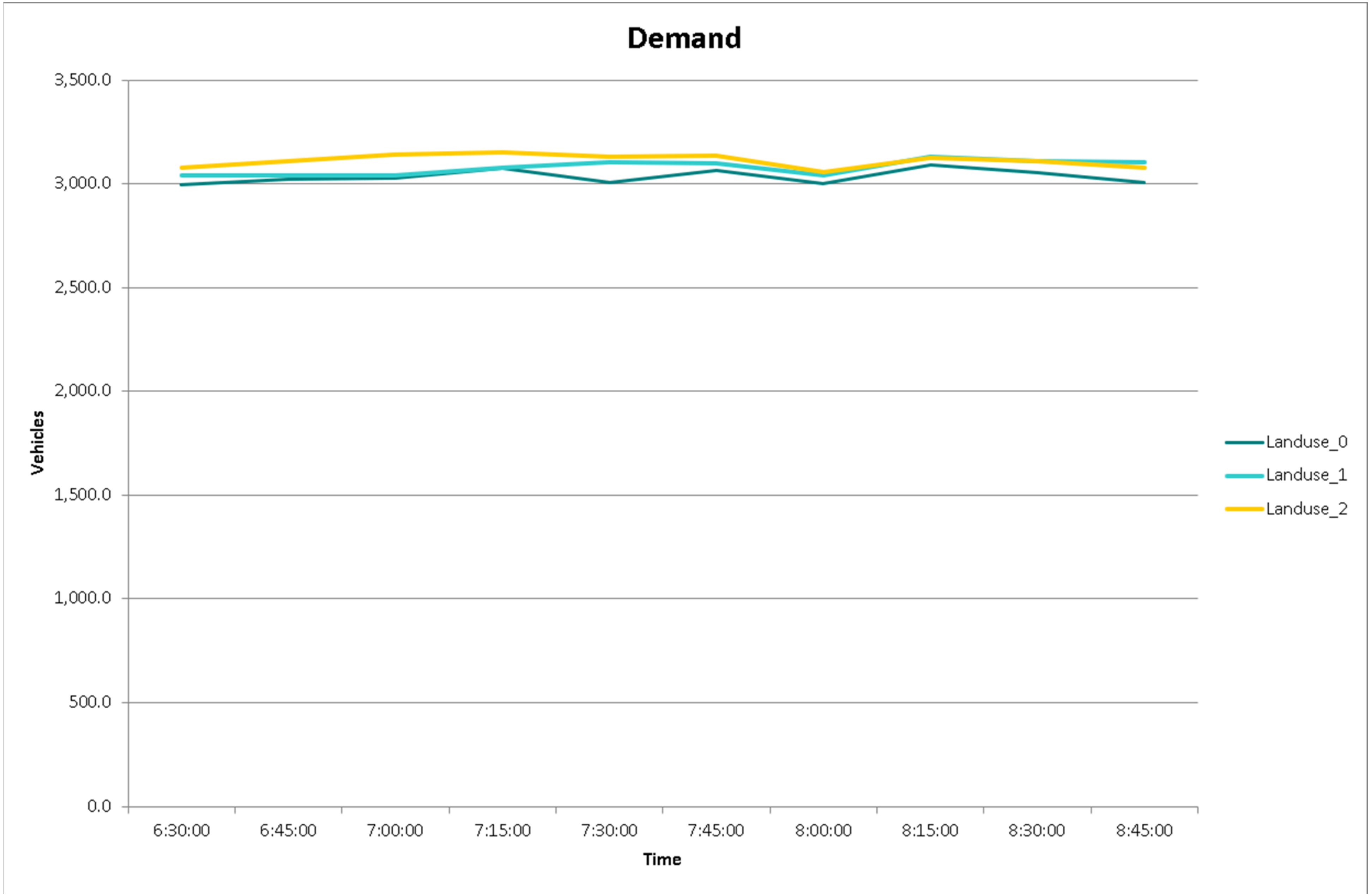
In this study the future travel demand is split into equal 15 minute slices

- the totals are "hourly flows"
- should be uniform for the hour

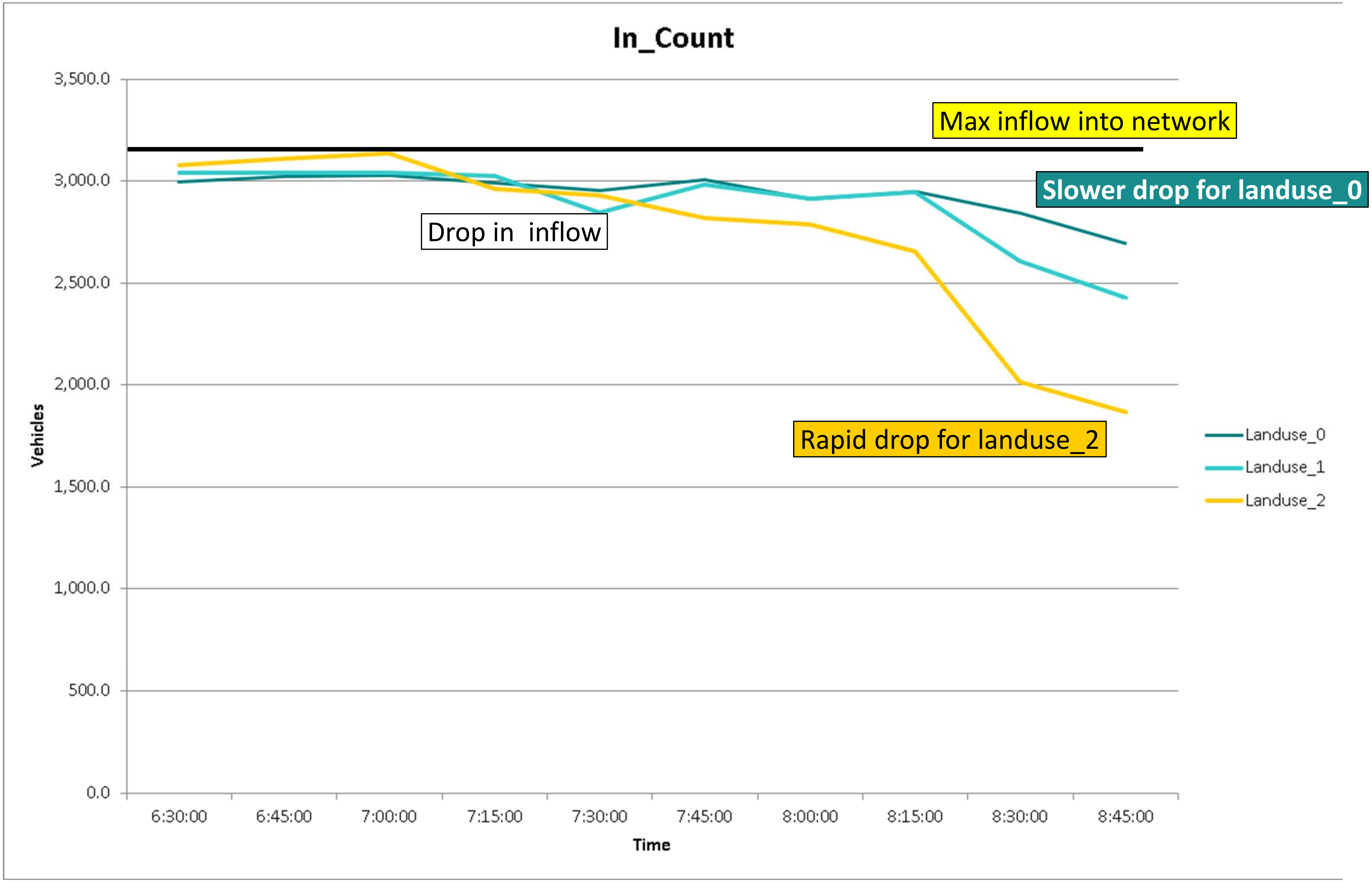
The "wobbling" in the Demand plot is the result of the background manipulations – nothing too serious!

The tiny kink at 08:00:00 is like to come from the random number generator

- The random number is used to generate the actual number of vehicles from the chosen probability function

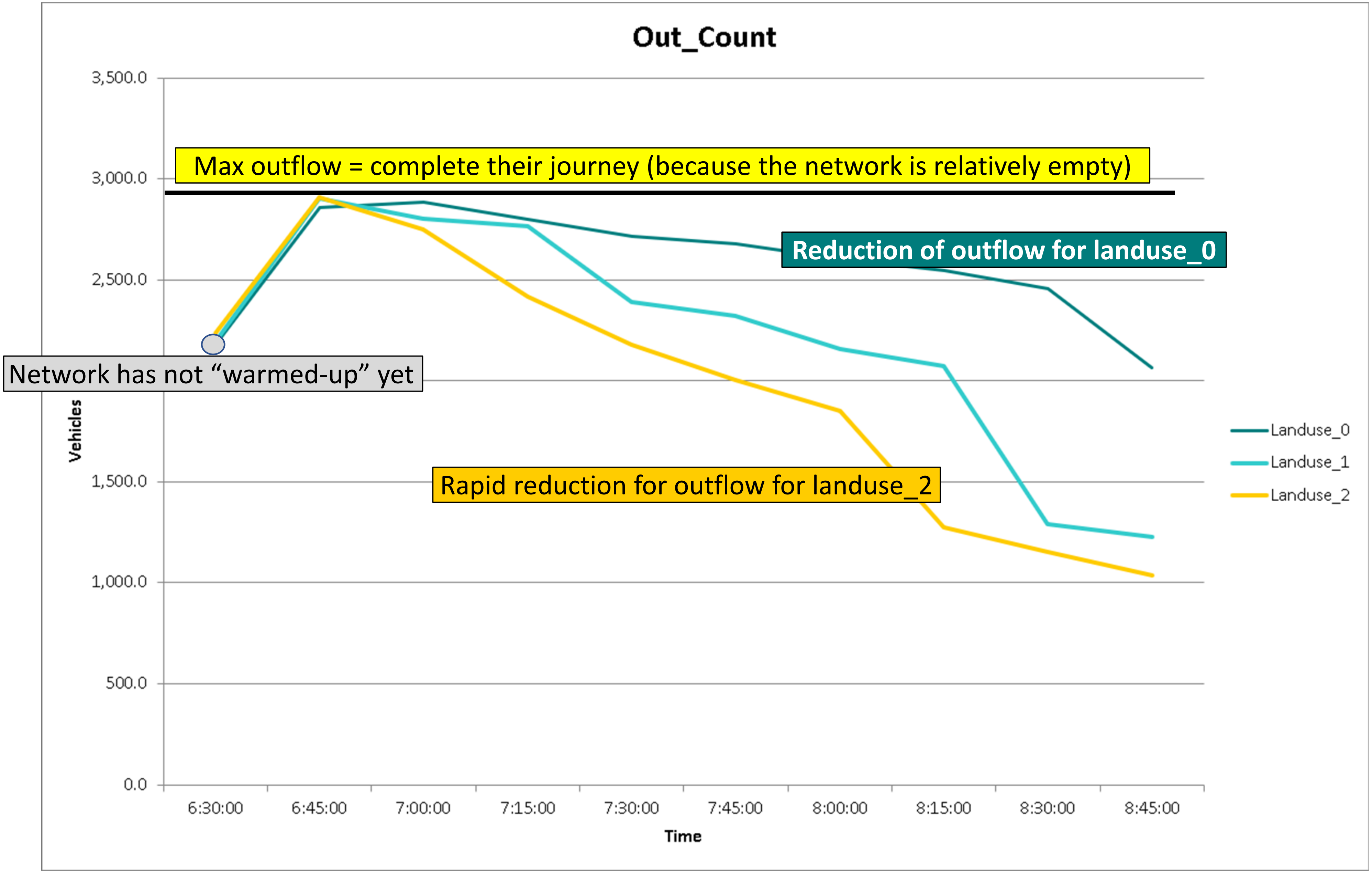


Demand
3,500.0
3,000.0
2,500.0
2,000.0
1,500.0
1,000.0
500.0
0.0
Vehicles
6:30:00
6:45:00
7:00:00
7:15:00
7:30:00
7:45:00
8:00:00
8:15:00
8:30:00
8:45:00
Time
Landuse_0
Landuse_1
Landuse_2

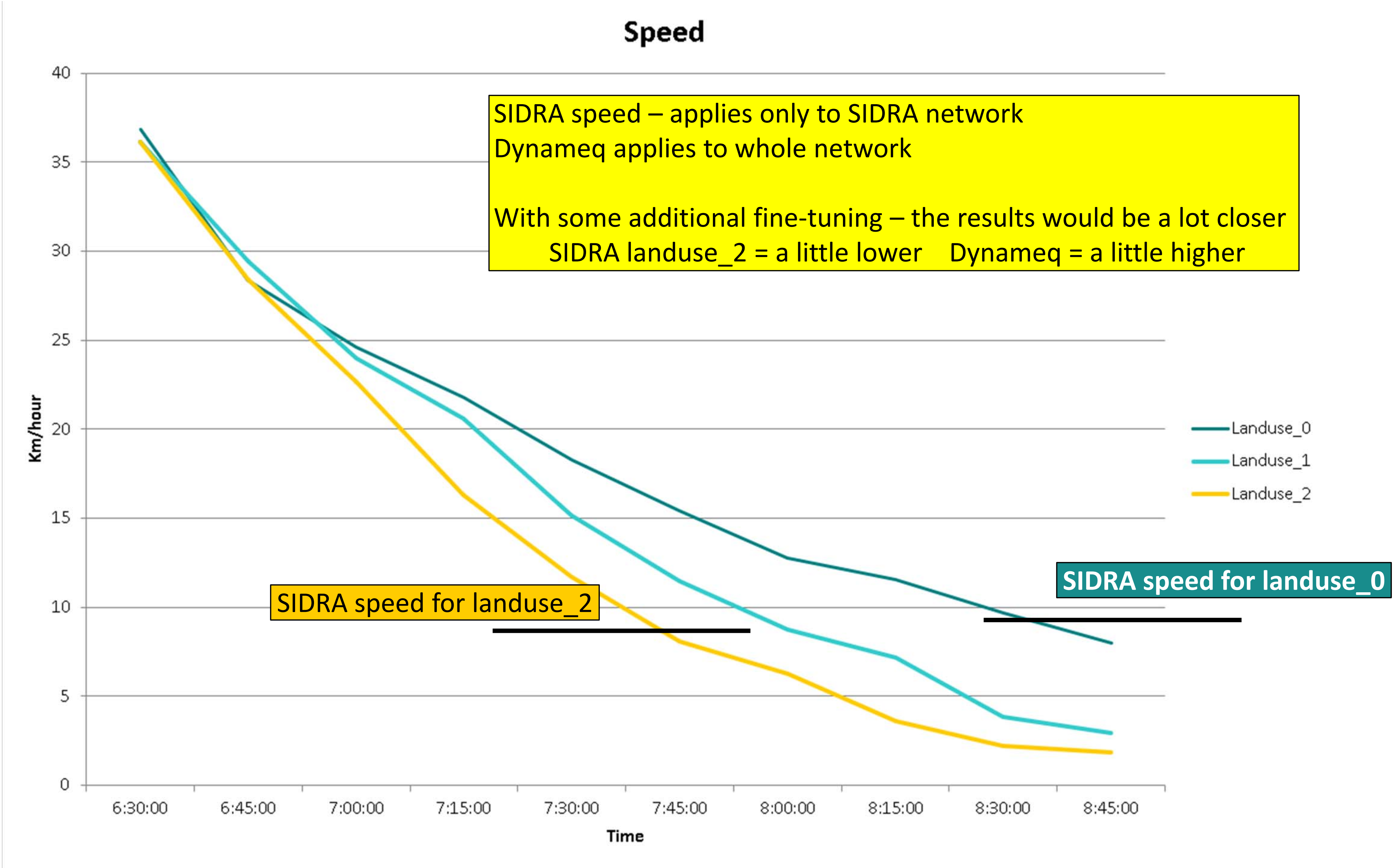

In_Count
Max inflow into network
Slower drop for landuse_0
Drop in inflow
Rapid drop for landuse_2
Vehicles
3,500.0
3,000.0
2,500.0
2,000.0
1,500.0
1,000.0
500.0
0.0
6:30:00
6:45:00
7:00:00
7:15:00
7:30:00
7:45:00
8:00:00
8:15:00
8:30:00
8:45:00
Time
Landuse_0
Landuse_1
Landuse_2

Most of those who start “early” in the first time-slice are able to complete their journey
Those who start “late” in the first time-slice would not reach their end point – they are still travelling
In the next time-slice, the inflow (=same are previous inflow in this case) and outflow are a more valid

Modellers normally do not show the first point as it only causes confusion
They diplomatically refer to this as point as the “warm-up” period (a science in its own right)

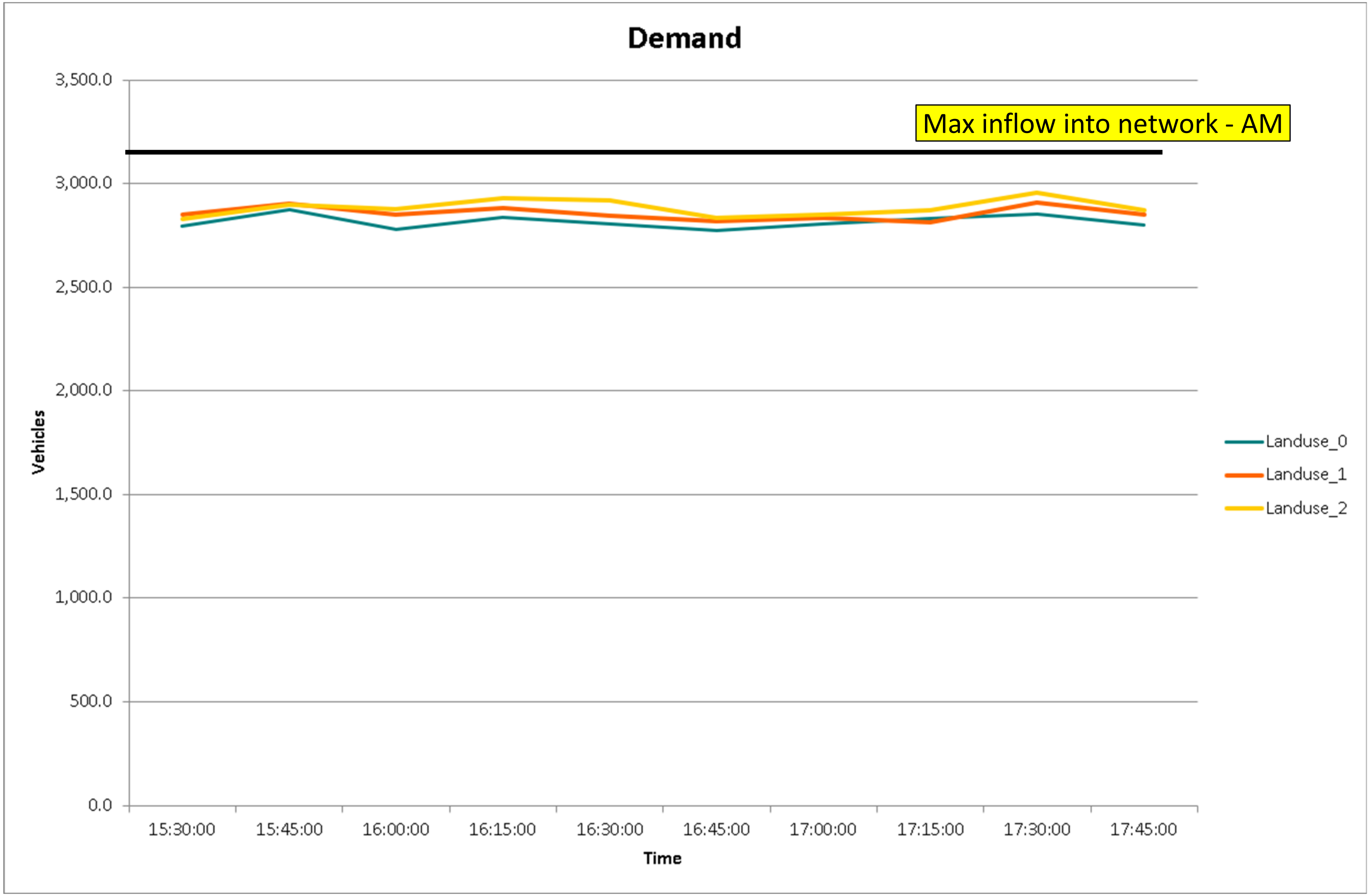


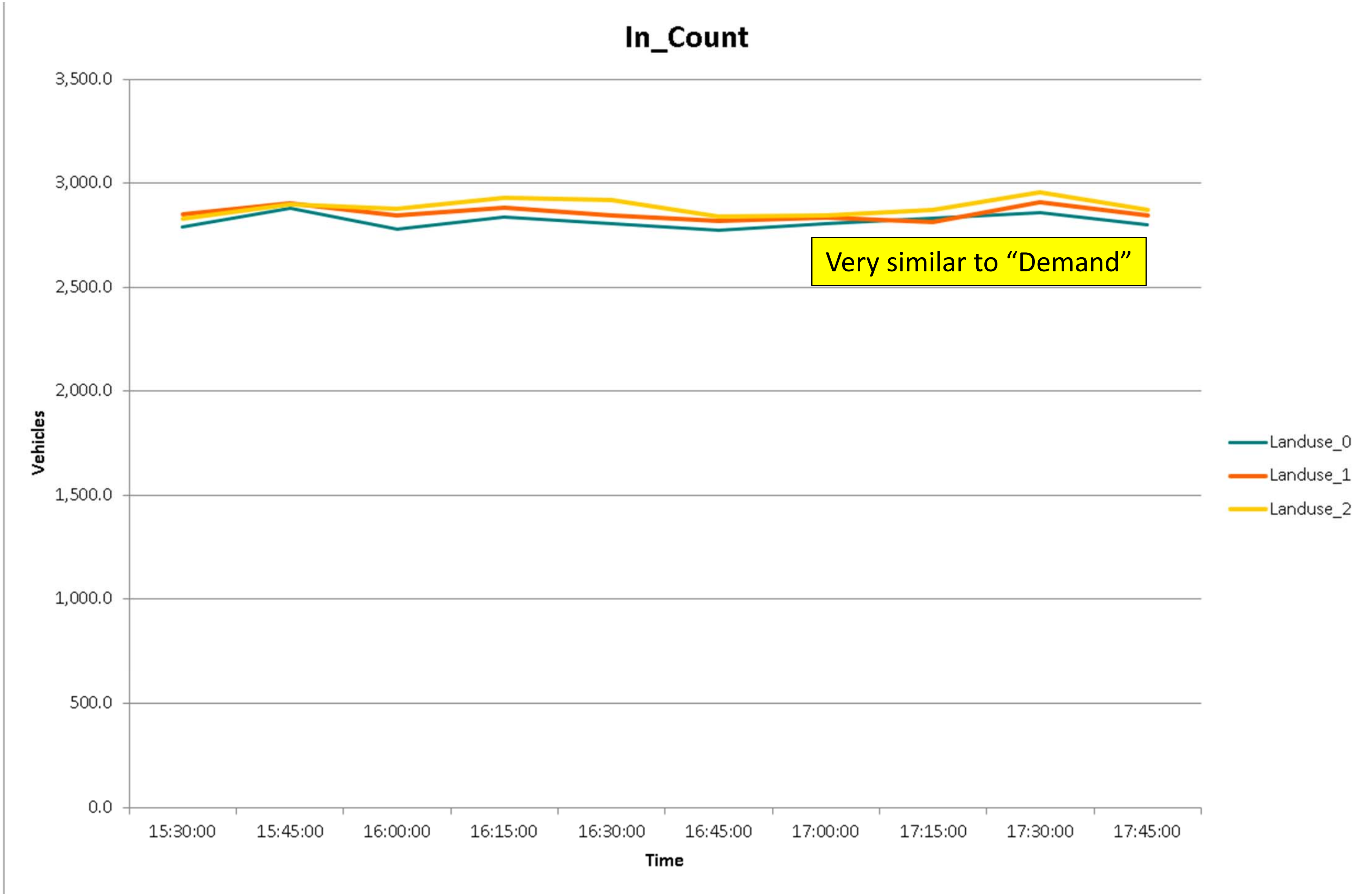
Out_Count
Max outflow = complete their journey (because the network is relatively empty)
Reduction of outflow for landuse_0
Network has not “warmed-up” yet
Rapid reduction for outflow for landuse_2
3,500.0
3,000.0
2,500.0
1,500.0
1,000.0
500.0
0.0
Vehicles
6:30:00
6:45:00
7:00:00
7:15:00
7:30:00
7:45:00
8:00:00
8:15:00
8:30:00
8:45:00
Time
Landuse_0
Landuse_1
Landuse_2


Speed
SIDRA speed – applies only to SIDRA network
Dynameq applies to whole network
With some additional fine-tuning – the results would be a lot closer
SIDRA landuse_2 = a little lower
Dynameq = a little higher
SIDRA speed for landuse_2
SIDRA speed for landuse_0
Km/hour
Time
40
35
30
25
20
15
10
5
0
6:30:00
6:45:00
7:00:00
7:15:00
7:30:00
7:45:00
8:00:00
8:15:00
8:30:00
8:45:00
Landuse_0
Landuse_1
Landuse_2

The network needs a couple more days for this fine-tuning
This allows the speeds and “suppressed traffic” to be a lot closer

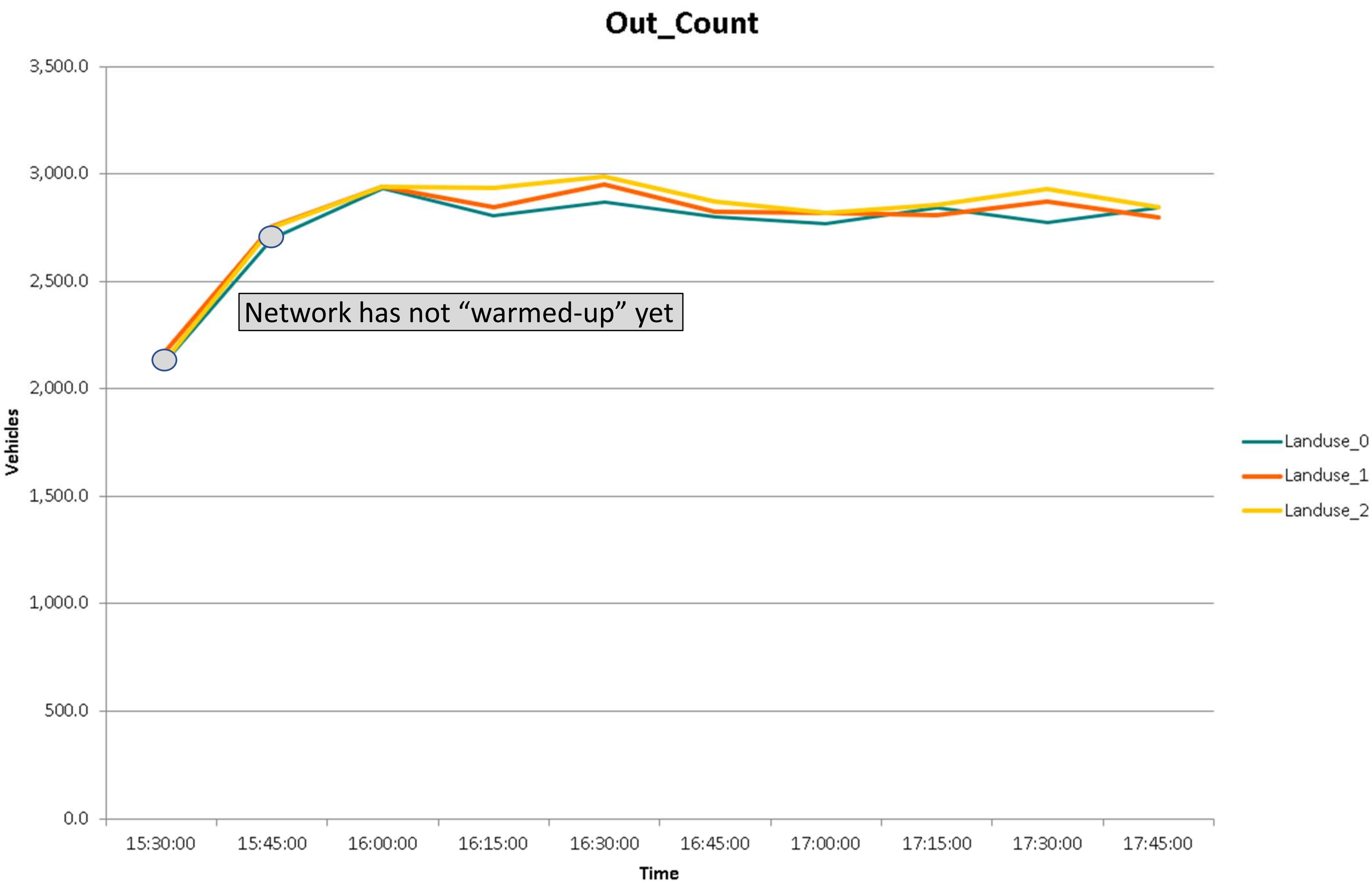
Dynameq – network characteristics PM

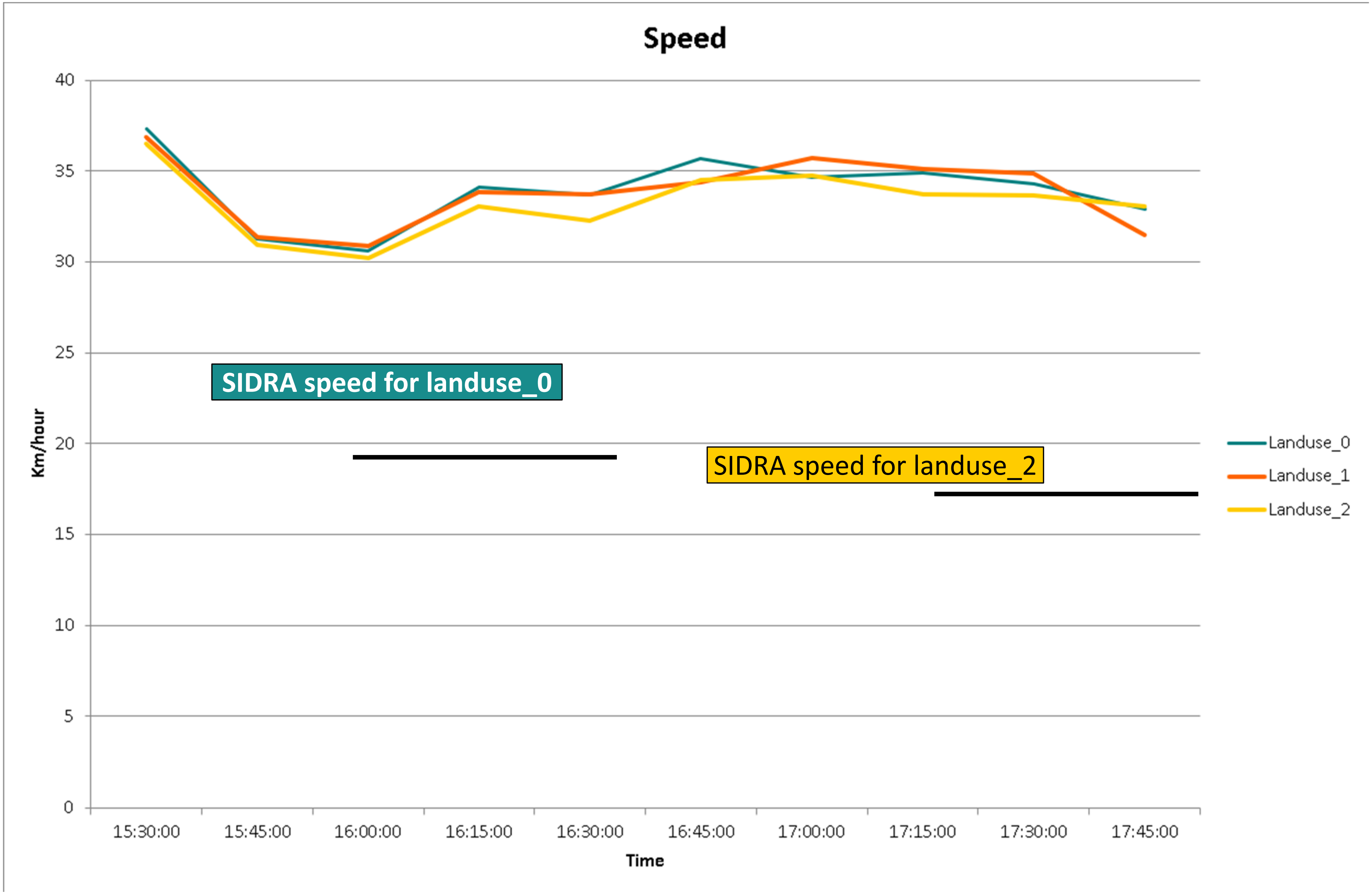

Demand
Max inflow into network - AM
Vehicles
3,500.0
3,000.0
2,500.0
2,000.0
1,500.0
1,000.0
500.0
0.0
15:30:00
15:45:00
16:00:00
16:15:00
16:30:00
16:45:00
17:00:00
17:15:00
17:30:00
17:45:00
Time
Landuse_0
Landuse_1
Landuse_2


In_Count
Vehicles
3,500.0
3,000.0
2,500.0
2,000.0
1,500.0
1,000.0
500.0
0.0
15:30:00
15:45:00
16:00:00
16:15:00
16:30:00
16:45:00
17:00:00
17:15:00
17:30:00
17:45:00
Time
Very similar to "Demand"
Landuse_0
Landuse_1
Landuse_2

When a network is relatively free-flowing – we can observe the impact of impact loading
The first couple of data points shows the “warm-up period
The next couple of points shows the bounce up and then it is “normal”

I am not sure why the SIDRA results show such low speeds with a relatively “low” demand
This requires more work on my part

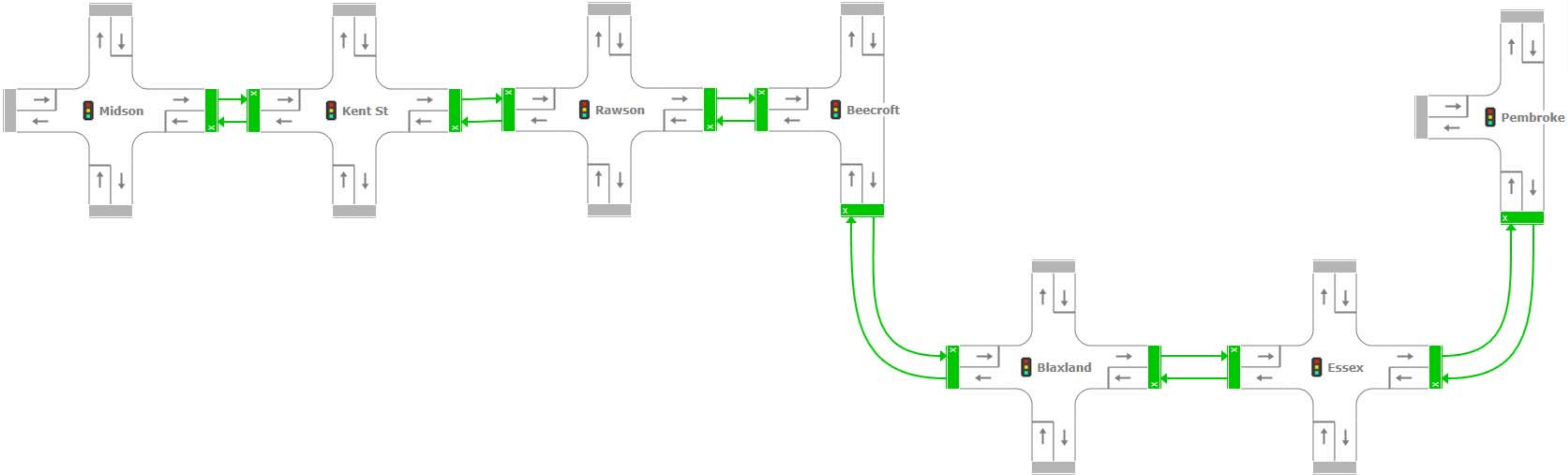

Out_Count
3,500.0
3,000.0
2,500.0
2,000.0
1,500.0
1,000.0
500.0
0.0
Vehicles
Network has not “warmed-up” yet
15:30:00
15:45:00
16:00:00
16:15:00
16:30:00
16:45:00
17:00:00
17:15:00
17:30:00
17:45:00
Time
Landuse_0
Landuse_1
Landuse_2


Speed
40
35
30
25
20
15
10
5
0
Km/hour
SIDRA speed for landuse_0
SIDRA speed for landuse_2
15:30:00
15:45:00
16:00:00
16:15:00
16:30:00
16:45:00
17:00:00
17:15:00
17:30:00
17:45:00
Time
Landuse_0
Landuse_1
Landuse_2

Appendix D

SIDRA network model outputs

NETWORK CONFIGURATION



Summary of overall network performance and SIDRA Intersection Delays (AM Peak Hour)

Intersection	Vehicle Performance	AM Peak hour 2026 Baseline Landuse_0	AM Peak hour 2026 Option Landuse_1	AM Peak hour 2026 Option Landuse_2
Overall Network Performance	LOS and Travel Speed (km/hr)	F 9.4 km/hr	F 9.3 km/hr	F 8.8 km/hr
Carlingford Road and Midson Road	Vehicle Demand Suppressed Traffic D-SAT AV-Delay (secs) LOS	2,968 81 1.335 379.8 F	3,034 101 1.229 262.9 F	3,045 103 1.232 266.4 F
Carlingford Road and Kent Street	Vehicle Demand Suppressed Traffic D-SAT AV-Delay (secs) LOS	2,837 421 0.802 18.2 B	2,888 374 0.858 20.9 B	2,905 381 0.859 20.5 B
Carlingford Road Ray Road and Rawson Street	Vehicle Demand Suppressed Traffic D-SAT AV-Delay (secs) LOS	3,386 387 4.802 706.6 F	3,478 355 5.392 765.9 F	3,526 358 5.647 840.8 F
Carlingford Road and Beecroft Road	Vehicle Demand Suppressed Traffic D-SAT AV-Delay (secs) LOS	4,671 552 1.294 92.1 F	4,698 500 1.383 109.9 F	4,721 531 1.387 109.5 F
Epping Road Blaxland Road and Langston Place	Vehicle Demand Suppressed Traffic D-SAT AV-Delay (secs) LOS	4,770 534 1.103 38.6 C	4,816 489 1.186 45.8 D	4,840 520 1.193 50.5 D
Epping Road and Essex Street	Vehicle Demand Suppressed Traffic D-SAT AV-Delay (secs) LOS	3,720 314 1.127 91.3 F	3,747 275 1.144 109.0 F	3,763 295 1.147 111.0 F
Epping Road and Pembroke Street	Vehicle Demand Suppressed Traffic D-SAT AV-Delay (secs) LOS LOS	2,953 293 0.879 13.9 A	2,963 269 0.916 16.7 B	2,971 287 0.916 16.7 B

Hourly Volume of Suppressed Traffic (Blocked at Upstream Intersections)

Change in Level of Service Compared to the Base Case

Summary of overall network performance and SIDRA Intersection Delays (PM Peak Hour)

Intersection	Network Performance	PM Peak hour 2026 Baseline Landuse_0	PM Peak hour 2026 Option Landuse_1	PM Peak hour 2026 Option Landuse_2
Overall Network Performance	LOS and Travel Speed (km/hr)	D 19.3 km/hr	E 17.8 km/hr	E 17.4 km/hr
Carlingford Road and Midson Road	Vehicle Demand Suppressed Traffic D-SAT AV-Delay (secs) LOS	2,778 144 0.849 35.1 C	2,796 154 0.859 35.2 C	2,802 158 0.859 35.2 C
Carlingford Road and Kent Street	Vehicle Demand Suppressed Traffic D-SAT AV-Delay (secs) LOS	2,477 68 0.608 20.1 B	2,503 179 0.607 19.8 B	2,515 210 0.597 18.8 B
Carlingford Road Ray Road and Rawson Street	Vehicle Demand Suppressed Traffic D-SAT AV-Delay (secs) LOS	2,815 189 0.901 25.0 B	2,883 204 0.868 26.3 B	2,910 209 0.876 27.1 B
Carlingford Road and Beecroft Road	Vehicle Demand Suppressed Traffic D-SAT AV-Delay (secs) LOS	4,065 0 2.344 241.6 F	4,094 0 2.567 278.6 F	4,103 0 2.635 291.1 F
Epping Road Blaxland Road and Langston Place	Vehicle Demand Suppressed Traffic D-SAT AV-Delay (secs) LOS	4,294 0 1.132 43.3 D	4,325 0 1.264 54.0 D	4,342 0 1.270 54.7 D
Epping Road and Essex Street	Vehicle Demand Suppressed Traffic D-SAT AV-Delay (secs) LOS	3,266 0 0.931 36.2 C	3,289 0 0.908 36.1 C	3,298 0 0.885 35.4 C
Epping Road and Pembroke Street	Vehicle Demand Suppressed Traffic D-SAT AV-Delay (secs) LOS LOS	2,302 0 0.907 13.0 A	2,307 0 0.907 12.8 A	2,310 0 0.907 12.9 A

Hourly Volume of Suppressed Traffic (Blocked at Upstream Intersections)

Change in Level of Service Compared to the Base Case

AM SIDRA yellow numbers for Suppressed Traffic at Intersections

= Calculated Total Length of all Intersection Traffic Queues

Landuse_0 AM
Av vehicle length 6.5 m => 16.8 km
271
489
116
93
372
98
81
293
460
74
314


Landuse_1 AM
Av vehicle length 6.5 m => 15.4 km
211
427
114
73
256
118
101
402
87
275
269
Appleseed Childcare
ALPL Australia Pty
7-Eleven Epping
Intuition Education
Arden Anglican School
Epping Public School
Design Roller Shutters Sydney
Epping Community Centre
Coles Epping
Chemist Warehouse Epping
Pembroke St Park
Epping
Epping Veterinary Clinic (NSW)
The Epping Club
Beschico
Epping Church of Christ
Epping Seventh-day Adventist Church
Epping Aquatic and Leisure Centre
Forest Park
Computer store
Epping Driving
David Scott Reserve
Carlingford Rd
Epping Rd
Beecroft Rd
Blaxland Rd
Google
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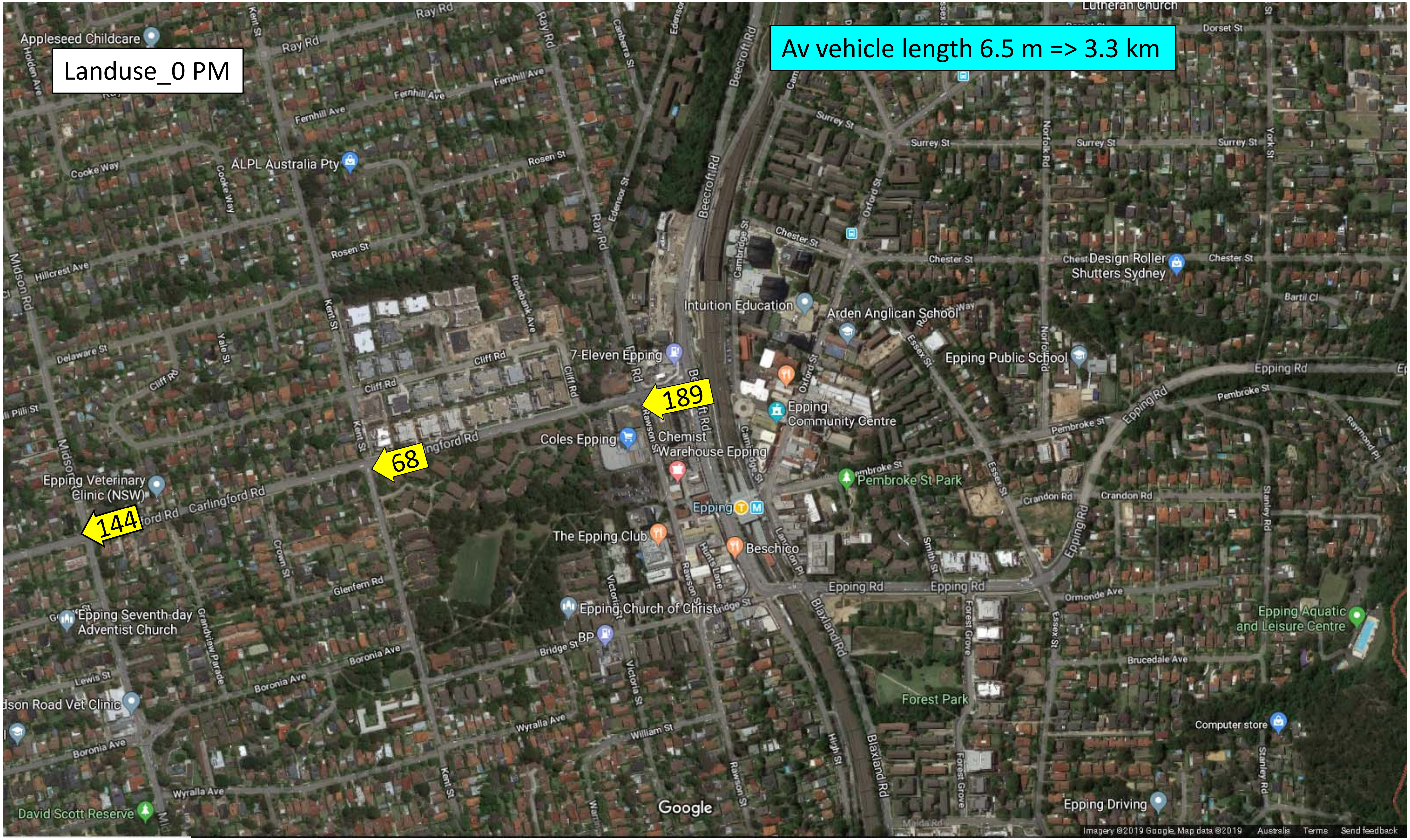
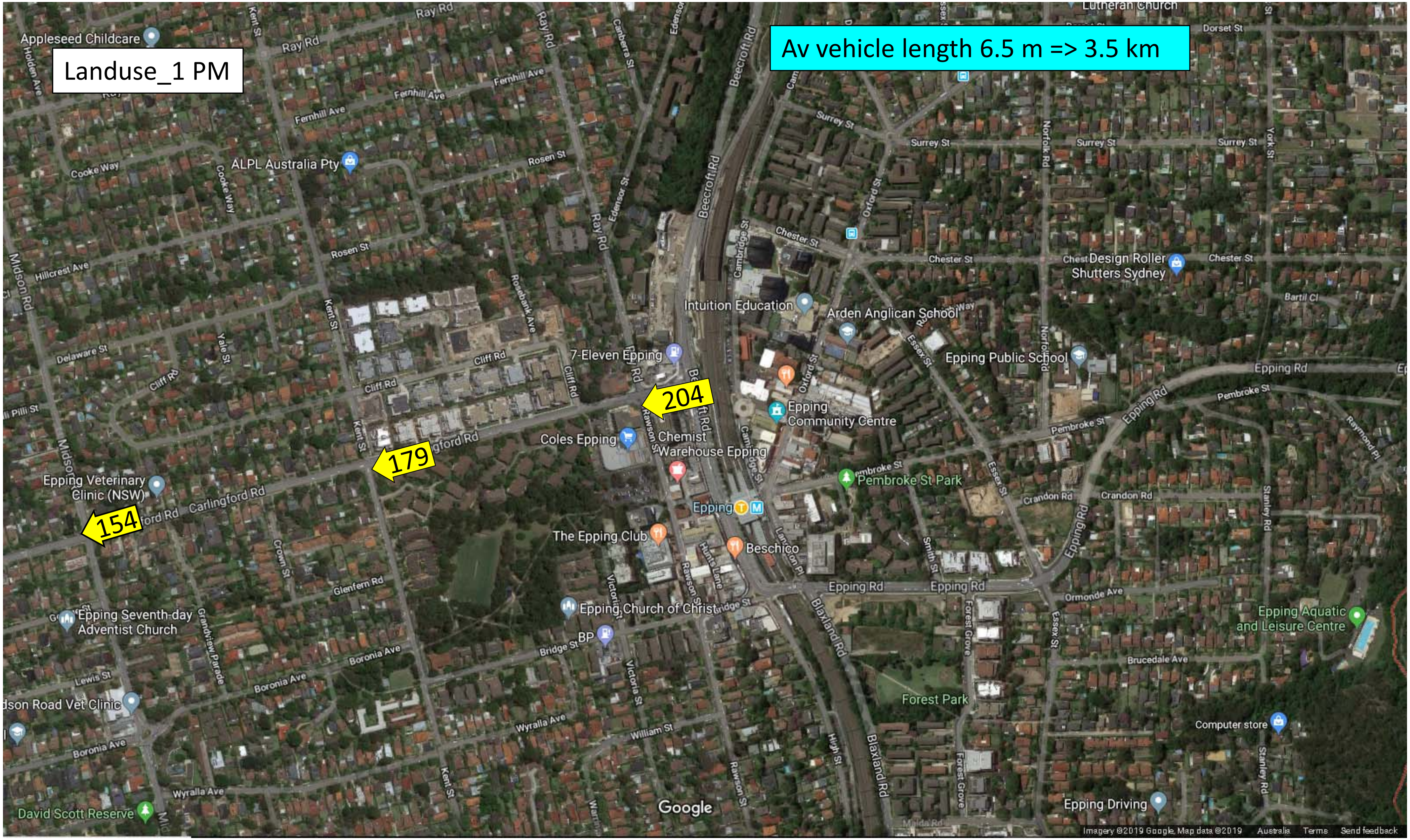
Landuse_2 AM
Av vehicle length 6.5 m => 16.1 km
214
457
144
74
260
171
103
430
90
295
287
Google
Imagery ©2019 Google, Map data ©2019

PM SIDRA yellow numbers for Suppressed Traffic at Intersections

= Calculated Total Length of all Intersection Traffic Queues


Landuse_0 PM
Av vehicle length 6.5 m => 3.3 km
189
68
144
Appleseed Childcare
ALPL Australia Pty
7-Eleven Epping
Coles Epping
Chemist Warehouse Epping
Intuition Education
Arden Anglican School
Epping Public School
Epping Community Centre
Pembroke St Park
Design Roller Shutters Sydney
Epping Veterinary Clinic (NSW)
The Epping Club
Beschico
Epping
Epping Church of Christ
BP
Epping Seventh-day Adventist Church
Epping Aquatic and Leisure Centre
Forest Park
Computer store
Epping Driving
David Scott Reserve
Lutheran Church
Carlingford Rd
Epping Rd
Beecroft Rd
Blaxland Rd
Rawson St
Kent St
Midson Rd
Ray Rd
Chester St
Surrey St
Pembroke St
Crandon Rd
Boronia Ave
Wyralla Ave
Google
Imagery ©2019 Google, Map data ©2019 Australia Terms Send feedback


Landuse_1 PM
Av vehicle length 6.5 m => 3.5 km
204
179
154
Appleseed Childcare
ALPL Australia Pty
7-Eleven Epping
Coles Epping
Chemist Warehouse Epping
Intuition Education
Arden Anglican School
Epping Public School
Epping Community Centre
Design Roller Shutters Sydney
Pembroke St Park
Epping Veterinary Clinic (NSW)
The Epping Club
Beschico
Epping
Epping Church of Christ
BP
Epping Seventh-day Adventist Church
Forest Park
Epping Aquatic and Leisure Centre
Computer store
Epping Driving
David Scott Reserve
Ray Rd
Fernhill Ave
Rosen St
Cooke Way
Hillcrest Ave
Delaware St
Cliff Rd
Kent St
Carlingford Rd
Beecroft Rd
Rawson St
Chester St
Surrey St
Oxford St
Essex St
Epping Rd
Pembroke St
Crandon Rd
Blaxland Rd
Boronia Ave
Wyralla Ave
William St
Victoria St
Bridge St
Glenfern Rd
Midson Rd
Brucedale Ave
Ormonde Ave
Stanley Rd
Norfolk Rd
Google
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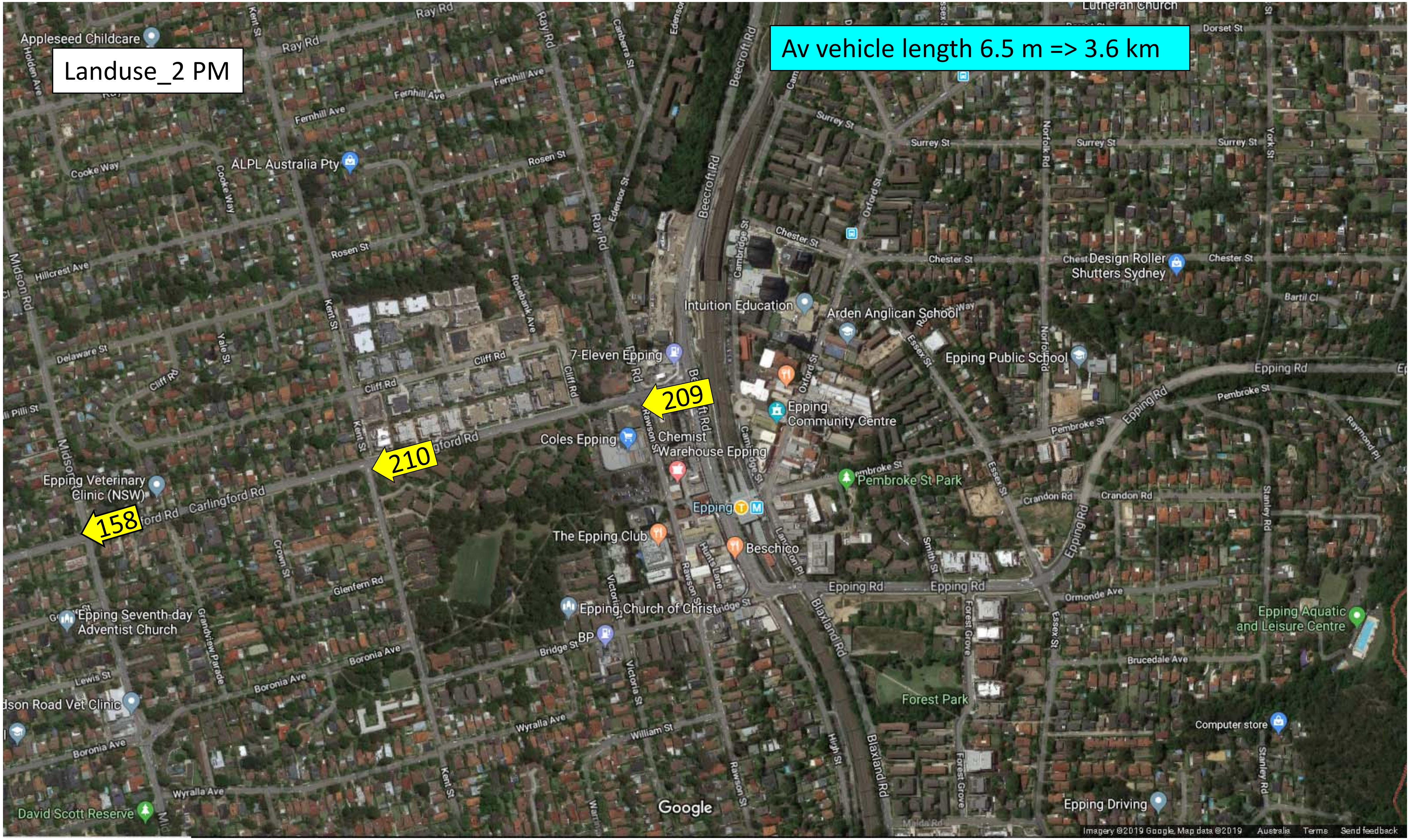
Landuse_2 PM

Av vehicle length 6.5 m => 3.6 km



NETWORK SUMMARY

Network: N101 [2026_am_landuse_0_AM_signals_only]

2026_am_landuse_0_AM_signals_only
Network Category: (None)
Network Cycle Time = 72 seconds (Network Optimum Cycle Time - Minimum Delay)

Network Performance - Hourly Values

Performance Measure	Vehicles	Per Unit Distance	Pedestrians	Persons
Network Level of Service (LOS)	LOS F			
Travel Time Index	1.50			
Speed Efficiency	0.24			
Congestion Coefficient	4.25			
Travel Speed (Average)	9.4 km/h		2.7 km/h	9.4 km/h
Travel Distance (Total)	13085.8 veh-km/h		10.3 ped-km/h	15713.2 pers-kn
Travel Time (Total)	1390.2 veh-h/h		3.8 ped-h/h	1672.1 pers-h/l
Desired Speed	40.0 km/h			
Demand Flows (Total for all Sites)	25305 veh/h		342 ped/h	30708 pers/h
Arrival Flows (Total for all Sites)	22722 veh/h		342 ped/h	27608 pers/h
Demand Flows (Entry Total)	8259 veh/h			
Midblock Inflows (Total)	81 veh/h			
Midblock Outflows (Total)	-302 veh/h			
Percent Heavy Vehicles (Demand)	0.0 %			
Percent Heavy Vehicles (Arrival)	0.0 %			
Degree of Saturation	4.802			
Control Delay (Total)	1152.85 veh-h/h		1.62 ped-h/h	1385.04 pers-h/l
Control Delay (Average)	182.7 sec		17.1 sec	180.6 sec
Control Delay (Worst Lane)	6872.8 sec			
Control Delay (Worst Movement)	6872.8 sec		30.3 sec	6872.8 sec
Geometric Delay (Average)	0.7 sec			
Stop-Line Delay (Average)	182.0 sec			
Queue Storage Ratio (Worst Lane)	1.77			
Total Effective Stops	26783 veh/h		217 ped/h	32357 pers/h
Effective Stop Rate	1.18	2.05 per km	0.63	1.17
Proportion Queued	0.74		0.63	0.82
Performance Index	2359.7		5.0	2364.7
Cost (Total)	46996.61 $/h	3.59 $/km	96.52 $/h	47093.13 $/h
Fuel Consumption (Total)	2660.8 L/h	203.3 mL/km		
Fuel Economy	20.3 L/100km			
Carbon Dioxide (Total)	6252.9 kg/h	477.8 g/km		
Hydrocarbons (Total)	0.666 kg/h	0.051 g/km		
Carbon Monoxide (Total)	5.259 kg/h	0.402 g/km		
NOx (Total)	1.459 kg/h	0.111 g/km		

Network Model Variability Index (Iterations 3 to N): 16.8 %
Number of Iterations: 20 (Maximum: 50)
Largest change in Lane Degrees of Saturation or Queue Storage Ratios for the last three Network Iterations: 0.8% 0.7% 0.6%
Network Level of Service (LOS) Method: SIDRA Speed Efficiency.
Software Setup used: New South Wales.

Network Performance - Annual Values

Performance Measure	Vehicles	Pedestrians	Persons
Demand Flows (Total for all Sites)	12,146,490 veh/y	164,004 ped/y	14,739,800 pers/y
Delay	553,368 veh-h/y	777 ped-h/y	664,819 pers-h/y
Effective Stops	12,855,960 veh/y	104,087 ped/y	15,531,240 pers/y
Travel Distance	6,281,161 veh-km/y	4,935 ped-km/y	7,542,327 pers-km/y
Travel Time	667,310 veh-h/y	1,832 ped-h/y	802,604 pers-h/y
Cost	22,558,370 $/y	46,330 $/y	22,604,700 $/y
Fuel Consumption	1,277,189 L/y		
Carbon Dioxide	3,001,394 kg/y		
Hydrocarbons	319 kg/y		
Carbon Monoxide	2,524 kg/y		
NOx	700 kg/y		

NETWORK SUMMARY

Network: N101 [2026_am_landuse_0_PM_signals_only]

2026_am_landuse_0_PM_signals_only
Network Category: (None)
Network Cycle Time = 110 seconds (Network Optimum Cycle Time - Minimum Delay)

Network Performance - Hourly Values

Performance Measure	Vehicles	Per Unit Distance	Pedestrians	Persons
Network Level of Service (LOS)	LOS E			
Travel Time Index	4.26			
Speed Efficiency	0.48			
Congestion Coefficient	2.07			
Travel Speed (Average)	19.3 km/h		2.3 km/h	19.2 km/h
Travel Distance (Total)	12313.2 veh-km/h		10.3 ped-km/h	14786.2 pers-km
Travel Time (Total)	637.4 veh-h/h		4.5 ped-h/h	769.4 pers-h/l
Desired Speed	40.0 km/h			
Demand Flows (Total for all Sites)	21997 veh/h		342 ped/h	26738 pers/h
Arrival Flows (Total for all Sites)	21496 veh/h		342 ped/h	26137 pers/h
Demand Flows (Entry Total)	7436 veh/h			
Midblock Inflows (Total)	124 veh/h			
Midblock Outflows (Total)	-500 veh/h			
Percent Heavy Vehicles (Demand)	0.0 %			
Percent Heavy Vehicles (Arrival)	0.0 %			
Degree of Saturation	2.344			
Control Delay (Total)	422.68 veh-h/h		2.32 ped-h/h	509.54 pers-h/l
Control Delay (Average)	70.8 sec		24.5 sec	70.2 sec
Control Delay (Worst Lane)	2485.2 sec			
Control Delay (Worst Movement)	2485.2 sec		49.3 sec	2485.2 sec
Geometric Delay (Average)	0.7 sec			
Stop-Line Delay (Average)	70.1 sec			
Queue Storage Ratio (Worst Lane)	1.00			
Total Effective Stops	15805 veh/h		199 ped/h	19165 pers/h
Effective Stop Rate	0.74	1.28 per km	0.58	0.73
Proportion Queued	0.71		0.58	0.72
Performance Index	1254.0		5.6	1259.6
Cost (Total)	22071.26 $/h	1.79 $/km	114.40 $/h	22185.66 $/h
Fuel Consumption (Total)	1631.6 L/h	132.5 mL/km		
Fuel Economy	13.3 L/100km			
Carbon Dioxide (Total)	3834.4 kg/h	311.4 g/km		
Hydrocarbons (Total)	0.379 kg/h	0.031 g/km		
Carbon Monoxide (Total)	3.773 kg/h	0.306 g/km		
NOx (Total)	1.056 kg/h	0.086 g/km		

Network Model Variability Index (Iterations 3 to N): 9.2 %
Number of Iterations: 18 (Maximum: 50)
Largest change in Lane Degrees of Saturation or Queue Storage Ratios for the last three Network Iterations: 0.9% 0.5% 0.2%
Network Level of Service (LOS) Method: SIDRA Speed Efficiency.
Software Setup used: New South Wales.

Network Performance - Annual Values

Performance Measure	Vehicles	Pedestrians	Persons
Demand Flows (Total for all Sites)	10,558,640 veh/y	164,004 ped/y	12,834,380 pers/y
Delay	202,885 veh-h/y	1,115 ped-h/y	244,578 pers-h/y
Effective Stops	7,586,501 veh/y	95,326 ped/y	9,199,128 pers/y
Travel Distance	5,910,355 veh-km/y	4,935 ped-km/y	7,097,361 pers-km/y
Travel Time	305,950 veh-h/y	2,170 ped-h/y	369,310 pers-h/y
Cost	10,594,210 $/y	54,912 $/y	10,649,120 $/y
Fuel Consumption	783,191 L/y		
Carbon Dioxide	1,840,498 kg/y		
Hydrocarbons	182 kg/y		
Carbon Monoxide	1,811 kg/y		
NOx	507 kg/y		

NETWORK SUMMARY

Network: N101 [2026_am_landuse_1_AM_signals_only]

2026_am_landuse_1_AM_signals_only
Network Category: (None)
Network Cycle Time = 75 seconds (Network Optimum Cycle Time - Minimum Delay)

Network Performance - Hourly Values

Performance Measure	Vehicles	Per Unit Distance	Pedestrians	Persons
Network Level of Service (LOS)	LOS F			
Travel Time Index	1.48			
Speed Efficiency	0.23			
Congestion Coefficient	4.28			
Travel Speed (Average)	9.3 km/h		2.7 km/h	9.3 km/h
Travel Distance (Total)	13392.0 veh-km/h		10.3 ped-km/h	16080.7 pers-km
Travel Time (Total)	1434.6 veh-h/h		3.9 ped-h/h	1725.4 pers-h/l
Desired Speed	40.0 km/h			
Demand Flows (Total for all Sites)	25624 veh/h		342 ped/h	31090 pers/h
Arrival Flows (Total for all Sites)	23259 veh/h		342 ped/h	28253 pers/h
Demand Flows (Entry Total)	8416 veh/h			
Midblock Inflows (Total)	87 veh/h			
Midblock Outflows (Total)	-318 veh/h			
Percent Heavy Vehicles (Demand)	0.0 %			
Percent Heavy Vehicles (Arrival)	0.0 %			
Degree of Saturation	5.392			
Control Delay (Total)	1193.86 veh-h/h		1.68 ped-h/h	1434.31 pers-h/l
Control Delay (Average)	184.8 sec		17.7 sec	182.8 sec
Control Delay (Worst Lane)	7928.6 sec			
Control Delay (Worst Movement)	7928.6 sec		31.8 sec	7928.6 sec
Geometric Delay (Average)	0.7 sec			
Stop-Line Delay (Average)	184.1 sec			
Queue Storage Ratio (Worst Lane)	1.73			
Total Effective Stops	26634 veh/h		215 ped/h	32176 pers/h
Effective Stop Rate	1.15	1.99 per km	0.63	1.14
Proportion Queued	0.74		0.63	0.82
Performance Index	2447.1		5.1	2452.2
Cost (Total)	48503.46 $/h	3.62 $/km	97.95 $/h	48601.41 $/h
Fuel Consumption (Total)	2735.5 L/h	204.3 mL/km		
Fuel Economy	20.4 L/100km			
Carbon Dioxide (Total)	6428.4 kg/h	480.0 g/km		
Hydrocarbons (Total)	0.685 kg/h	0.051 g/km		
Carbon Monoxide (Total)	5.398 kg/h	0.403 g/km		
NOx (Total)	1.491 kg/h	0.111 g/km		

Network Model Variability Index (Iterations 3 to N): 30.2 %
Number of Iterations: 17 (Maximum: 50)
Largest change in Lane Degrees of Saturation or Queue Storage Ratios for the last three Network Iterations: 0.9% 0.7% 0.6%
Network Level of Service (LOS) Method: SIDRA Speed Efficiency.
Software Setup used: New South Wales.

Network Performance - Annual Values

Performance Measure	Vehicles	Pedestrians	Persons
Demand Flows (Total for all Sites)	12,299,350 veh/y	164,004 ped/y	14,923,220 pers/y
Delay	573,053 veh-h/y	804 ped-h/y	688,468 pers-h/y
Effective Stops	12,784,550 veh/y	103,083 ped/y	15,444,550 pers/y
Travel Distance	6,428,169 veh-km/y	4,935 ped-km/y	7,718,738 pers-km/y
Travel Time	688,599 veh-h/y	1,859 ped-h/y	828,178 pers-h/y
Cost	23,281,660 $/y	47,015 $/y	23,328,680 $/y
Fuel Consumption	1,313,032 L/y		
Carbon Dioxide	3,085,625 kg/y		
Hydrocarbons	329 kg/y		
Carbon Monoxide	2,591 kg/y		
NOx	716 kg/y		

NETWORK SUMMARY

Network: N101 [2026_am_landuse_0_PM_signals_only]

2026_am_landuse_0_PM_signals_only
Network Category: (None)
Network Cycle Time = 110 seconds (Network Optimum Cycle Time - Minimum Delay)

Network Performance - Hourly Values

Performance Measure	Vehicles	Per Unit Distance	Pedestrians	Persons
Network Level of Service (LOS)	LOS E			
Travel Time Index	3.83			
Speed Efficiency	0.44			
Congestion Coefficient	2.25			
Travel Speed (Average)	17.8 km/h		2.3 km/h	17.7 km/h
Travel Distance (Total)	12420.1 veh-km/h		10.3 ped-km/h	14914.4 pers-km
Travel Time (Total)	698.2 veh-h/h		4.5 ped-h/h	842.3 pers-h/l
Desired Speed	40.0 km/h			
Demand Flows (Total for all Sites)	22197 veh/h		342 ped/h	26978 pers/h
Arrival Flows (Total for all Sites)	21659 veh/h		342 ped/h	26333 pers/h
Demand Flows (Entry Total)	7528 veh/h			
Midblock Inflows (Total)	126 veh/h			
Midblock Outflows (Total)	-510 veh/h			
Percent Heavy Vehicles (Demand)	0.0 %			
Percent Heavy Vehicles (Arrival)	0.0 %			
Degree of Saturation	2.567			
Control Delay (Total)	481.11 veh-h/h		2.33 ped-h/h	579.65 pers-h/l
Control Delay (Average)	80.0 sec		24.5 sec	79.2 sec
Control Delay (Worst Lane)	2884.6 sec			
Control Delay (Worst Movement)	2884.6 sec		49.3 sec	2884.6 sec
Geometric Delay (Average)	0.7 sec			
Stop-Line Delay (Average)	79.3 sec			
Queue Storage Ratio (Worst Lane)	1.00			
Total Effective Stops	16126 veh/h		199 ped/h	19550 pers/h
Effective Stop Rate	0.74	1.30 per km	0.58	0.74
Proportion Queued	0.70		0.58	0.72
Performance Index	1329.5		5.6	1335.2
Cost (Total)	24075.14 $/h	1.94 $/km	114.48 $/h	24189.63 $/h
Fuel Consumption (Total)	1713.1 L/h	137.9 mL/km		
Fuel Economy	13.8 L/100km			
Carbon Dioxide (Total)	4025.8 kg/h	324.1 g/km		
Hydrocarbons (Total)	0.401 kg/h	0.032 g/km		
Carbon Monoxide (Total)	3.894 kg/h	0.314 g/km		
NOx (Total)	1.083 kg/h	0.087 g/km		

Network Model Variability Index (Iterations 3 to N): 7.9 %
Number of Iterations: 22 (Maximum: 50)
Largest change in Lane Degrees of Saturation or Queue Storage Ratios for the last three Network Iterations: 0.6% 0.5% 0.3%
Network Level of Service (LOS) Method: SIDRA Speed Efficiency.
Software Setup used: New South Wales.

Network Performance - Annual Values

Performance Measure	Vehicles	Pedestrians	Persons
Demand Flows (Total for all Sites)	10,654,530 veh/y	164,004 ped/y	12,949,440 pers/y
Delay	230,931 veh-h/y	1,117 ped-h/y	278,234 pers-h/y
Effective Stops	7,740,514 veh/y	95,473 ped/y	9,384,089 pers/y
Travel Distance	5,961,651 veh-km/y	4,935 ped-km/y	7,158,917 pers-km/y
Travel Time	335,119 veh-h/y	2,171 ped-h/y	404,314 pers-h/y
Cost	11,556,070 $/y	54,951 $/y	11,611,020 $/y
Fuel Consumption	822,282 L/y		
Carbon Dioxide	1,932,362 kg/y		
Hydrocarbons	193 kg/y		
Carbon Monoxide	1,869 kg/y		
NOx	520 kg/y		

NETWORK SUMMARY

Network: N101 [2026_am_landuse_2_AM_signals_only]

2026_am_landuse_2_AM_signals_only
Network Category: (None)
Network Cycle Time = 75 seconds (Network Optimum Cycle Time - Minimum Delay)

Network Performance - Hourly Values

Performance Measure	Vehicles		Per Unit Distance		Pedestrians		Persons	
Network Level of Service (LOS)	LOS F							
Travel Time Index	1.34							
Speed Efficiency	0.22							
Congestion Coefficient	4.53							
Travel Speed (Average)	8.8	km/h			2.7	km/h	8.8	km/h
Travel Distance (Total)	13424.7	veh-km/h			10.3	ped-km/h	16120.0	pers-kn
Travel Time (Total)	1521.1	veh-h/h			3.9	ped-h/h	1829.2	pers-h/I
Desired Speed	40.0	km/h						
Demand Flows (Total for all Sites)	25770	veh/h			342	ped/h	31266	pers/h
Arrival Flows (Total for all Sites)	23295	veh/h			342	ped/h	28296	pers/h
Demand Flows (Entry Total)	8469	veh/h						
Midblock Inflows (Total)	88	veh/h						
Midblock Outflows (Total)	-320	veh/h						
Percent Heavy Vehicles (Demand)	0.0	%						
Percent Heavy Vehicles (Arrival)	0.0	%						
Degree of Saturation	5.647							
Control Delay (Total)	1279.46	veh-h/h			1.67	ped-h/h	1537.02	pers-h/I
Control Delay (Average)	197.7	sec			17.6	sec	195.6	sec
Control Delay (Worst Lane)	8389.2	sec						
Control Delay (Worst Movement)	8389.2	sec			31.8	sec	8389.2	sec
Geometric Delay (Average)	0.7	sec						
Stop-Line Delay (Average)	197.0	sec						
Queue Storage Ratio (Worst Lane)	1.83							
Total Effective Stops	27147	veh/h			214	ped/h	32791	pers/h
Effective Stop Rate	1.17		2.02	per km	0.63		1.16	
Proportion Queued	0.75				0.63		0.82	
Performance Index	2558.6				5.1		2563.7	
Cost (Total)	51334.01	$/h	3.82	$/km	97.83	$/h	51431.85	$/h
Fuel Consumption (Total)	2845.5	L/h	212.0	mL/km				
Fuel Economy	21.2	L/100km						
Carbon Dioxide (Total)	6686.9	kg/h	498.1	g/km				
Hydrocarbons (Total)	0.715	kg/h	0.053	g/km				
Carbon Monoxide (Total)	5.554	kg/h	0.414	g/km				
NOx (Total)	1.527	kg/h	0.114	g/km				

Network Model Variability Index (Iterations 3 to N): 32.4 %
Number of Iterations: 36 (Maximum: 50)
Largest change in Lane Degrees of Saturation or Queue Storage Ratios for the last three Network Iterations: 0.3% 0.0% 0.0%
Network Level of Service (LOS) Method: SIDRA Speed Efficiency.
Software Setup used: New South Wales.

Network Performance - Annual Values

Performance Measure	Vehicles		Pedestrians		Persons	
Demand Flows (Total for all Sites)	12,369,760	veh/y	164,004	ped/y	15,007,710	pers/y
Delay	614,140	veh-h/y	802	ped-h/y	737,770	pers-h/y
Effective Stops	13,030,450	veh/y	102,898	ped/y	15,739,440	pers/y
Travel Distance	6,443,876	veh-km/y	4,935	ped-km/y	7,737,586	pers-km/y
Travel Time	730,142	veh-h/y	1,857	ped-h/y	878,027	pers-h/y
Cost	24,640,330	$/y	46,961	$/y	24,687,290	$/y
Fuel Consumption	1,365,836	L/y				
Carbon Dioxide	3,209,715	kg/y				
Hydrocarbons	343	kg/y				
Carbon Monoxide	2,666	kg/y				
NOx	733	kg/y				

NETWORK SUMMARY

Network: N101 [2026_am_landuse_2_PM_signals_only]

2026_am_landuse_2_PM_signals_only
Network Category: (None)
Network Cycle Time = 110 seconds (Network Optimum Cycle Time - Minimum Delay)

Network Performance - Hourly Values				
Performance Measure	**Vehicles**	**Per Unit Distance**	**Pedestrians**	**Persons**
Network Level of Service (LOS)	LOS E			
Travel Time Index	3.73			
Speed Efficiency	0.44			
Congestion Coefficient	2.29			
Travel Speed (Average)	17.4 km/h		2.3 km/h	17.4 km/h
Travel Distance (Total)	12468.7 veh-km/h		10.3 ped-km/h	14972.7 pers-kn
Travel Time (Total)	714.8 veh-h/h		4.5 ped-h/h	862.3 pers-h/l
Desired Speed	40.0 km/h			
Demand Flows (Total for all Sites)	22281 veh/h		342 ped/h	27079 pers/h
Arrival Flows (Total for all Sites)	21731 veh/h		342 ped/h	26419 pers/h
Demand Flows (Entry Total)	7572 veh/h			
Midblock Inflows (Total)	127 veh/h			
Midblock Outflows (Total)	-517 veh/h			
Percent Heavy Vehicles (Demand)	0.0 %			
Percent Heavy Vehicles (Arrival)	0.0 %			
Degree of Saturation	2.635			
Control Delay (Total)	496.82 veh-h/h		2.33 ped-h/h	598.51 pers-h/l
Control Delay (Average)	82.3 sec		24.5 sec	81.6 sec
Control Delay (Worst Lane)	3006.0 sec			
Control Delay (Worst Movement)	3006.0 sec		49.3 sec	3006.0 sec
Geometric Delay (Average)	0.7 sec			
Stop-Line Delay (Average)	81.6 sec			
Queue Storage Ratio (Worst Lane)	1.00			
Total Effective Stops	16210 veh/h		199 ped/h	19650 pers/h
Effective Stop Rate	0.75	1.30 per km	0.58	0.74
Proportion Queued	0.70		0.58	0.72
Performance Index	1348.2		5.6	1353.8
Cost (Total)	24618.43 $/h	1.97 $/km	114.50 $/h	24732.93 $/h
Fuel Consumption (Total)	1736.3 L/h	139.3 mL/km		
Fuel Economy	13.9 L/100km			
Carbon Dioxide (Total)	4080.3 kg/h	327.2 g/km		
Hydrocarbons (Total)	0.408 kg/h	0.033 g/km		
Carbon Monoxide (Total)	3.931 kg/h	0.315 g/km		
NOx (Total)	1.091 kg/h	0.088 g/km		

Network Model Variability Index (Iterations 3 to N): 8.4 %
Number of Iterations: 20 (Maximum: 50)
Largest change in Lane Degrees of Saturation or Queue Storage Ratios for the last three Network Iterations: 0.8% 0.5% 0.3%
Network Level of Service (LOS) Method: SIDRA Speed Efficiency.
Software Setup used: New South Wales.

Network Performance - Annual Values			
Performance Measure	**Vehicles**	**Pedestrians**	**Persons**
Demand Flows (Total for all Sites)	10,694,830 veh/y	164,004 ped/y	12,997,790 pers/y
Delay	238,472 veh-h/y	1,117 ped-h/y	287,284 pers-h/y
Effective Stops	7,780,613 veh/y	95,494 ped/y	9,432,230 pers/y
Travel Distance	5,984,984 veh-km/y	4,935 ped-km/y	7,186,917 pers-km/y
Travel Time	343,104 veh-h/y	2,172 ped-h/y	413,896 pers-h/y
Cost	11,816,850 $/y	54,960 $/y	11,871,810 $/y
Fuel Consumption	833,422 L/y		
Carbon Dioxide	1,958,541 kg/y		
Hydrocarbons	196 kg/y		
Carbon Monoxide	1,887 kg/y		
NOx	524 kg/y		