Picton Town Centre Road Improvements

Future Modelling Report

17/10/2023

Prepared for:

Wollondilly Shire Council

Prepared by:

Stantec

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Executive Summary

Picton faces significant challenges to its transport network. The town is located at the intersection of three major transport corridors and forms a major hub for traffic travelling between Sydney or Wollongong and surrounding regions in the Wollondilly Shire. Combined with significant land development and population growth in the surrounding region, the Picton town centre is expected to experience significant traffic congestion and elevated heavy vehicle volumes in the near future.

With these challenges in mind, Wollondilly Shire Council developed the Picton Town Centre Transport Plan 2026, which proposed short-term, low-cost upgrades to provide sufficient network capacity until at least 2026. The Transport Plan identified that Menangle Street / Prince Street intersection would fail in both the AM and PM peaks in 2026. Upgrade options were proposed at six intersections in the town centre, including the signalisation of Menangle Street / Prince Street and the addition of turning lanes at Argyle Street and Prince Street.

Following the development of the Picton Town Centre Transport Plan 2026, community feedback was received that questioned the need to signalise the Menangle Street / Prince Street intersection, particularly in regard to the impact of the COVID-19 pandemic on traffic volumes and possible changes to development forecasts. Additional community engagement was conducted in 2022. Additionally, momentum made by TfNSW with looking at options for a potential 'Picton Bypass' should be looked at in context with the study findings and the relative benefits and timings.

Following further community engagement, outcomes included the provision for new traffic modelling of the upgrade options to be undertaken, incorporating new traffic survey data, updated land use development assumptions and the impact of the proposed Picton Bypass.

This report outlines the findings of an updated transport study of the Picton town centre. The study aims to develop new traffic models of the town centre to obtain a current view of existing traffic operations and draw on updated land use development assumptions to understand future traffic network performance, with a particular focus on the Menangle Street / Prince Street intersection.

Assessment approach

The Picton Town Centre Transport Plan 2026 and associated traffic modelling work was based on 2016 traffic data. The assessment described in this report consists of a revised traffic modelling assessment based on data collected in 2022. Both rounds of modelling are reliant on two models:

- The Macarthur Regional Transport Model (MRTM) is a large, broad scale regional model that forecasts existing and future traffic demands across the Macarthur metropolitan region and is based on existing and future land use and infrastructure information. MRTM outputs were used for future-year demand estimation.
- Based on the MRTM outputs, further detailed microsimulation traffic modelling using Aimsun was used to assess the existing and future performance of the town centre and key intersections. The AM and PM peak periods were identified and modelled for a typical mid-year weekday.

New traffic counts carried out in 2022 were used in the revised Aimsun model. This model was validated in consultation with TfNSW prior to assessing potential scenarios.

Future road network performance

Future road network performance was assessed for a Do Nothing scenario and four upgrade scenarios in 2026 and 2036, and the Do Nothing with Picton Bypass scenario was modelled for 2036.

The Do Nothing scenario did not include any infrastructure changes except those that have already been completed between the base year (2022) and future years. The Do Nothing scenario indicates:

- In 2026, most assessed intersections in the study area will operate satisfactorily in all modelled peaks and hours, including;
  - Menangle Street / Prince Street
  - Argyle/ Prince Street

  These intersections were forecast to fail and require upgrading in the original 2016 study
- However, Argyle/ Barkers Lodge Road starts to experience level of service D by 2026.
- In 2036, several intersections within the town centre operate unsatisfactorily in one or more peak hours, including Argyle/ Prince Street, Menangle Street / Prince Street & Argyle/Barkers Lodge

Transport for NSW are developing options for a future bypass of the Picton town centre. The proposed bypass would connect Remembrance Driveway with Picton Road. The Do Nothing with Picton Bypass scenario assesses the operation of the Picton town centre road network with the proposed Picton Bypass operational. The model outputs of the scenario indicate that in 2036:

- The scenario provides the highest network average speeds out of all future scenarios.
- All assessed intersections in the study area will operate satisfactorily in all modelled peaks and hours, with the exception of Argyle Street / Barkers Lodge Road.
- The scenario generally provides the most benefits to travel time, including on the Prince Street eastbound and westbound routes, when compared with the other modelled scenarios.

An elliptical roundabout upgrade connecting Menangle Street, Prince Street and Station Street generally provides the second-best network, intersection and travel time performance, behind the Do Nothing with Picton Bypass scenario. The scenario:

- Achieves the second-best network trip length and congestion benefits
- Records the best performance at Menangle Street / Prince Street, and second-best intersection performance across the network
- Provides the second-best Prince Street eastbound travel times.

However, a roundabout has other significant impacts, including;

- Largest footprint, requiring acquisition and likely demolition of private property
- Poor pedestrian connectivity – particularly near Picton main public transport hub
- Poor amenity impacts including 24-hour braking noise
- Loss of on street parking

A signalised intersection upgrade connecting Menangle Street, Prince Street and Station Street:

- Provides satisfactory intersection performance at Menangle Street / Prince Street
- Records significant improvements in Prince Street eastbound travel times
- Provides benefits to network performance and trip lengths, especially in the AM peak.

A one way flow scenario for Prince Street was modelled. Westbound was chosen to divert traffic away from the Prince St approach on Menangle St as this is the critical failure modelled. The scenario was found to:

- Provide disbenefits to network trip lengths, travel times and congestion levels
- Increase traffic volumes in the Picton town centre and increase delay at intersections including Argyle/ Menangle Street.

A final scenario was tested consisting of the adopted future treatment of the Argyle Street / Prince Street intersection to a seagull configuration (from the original Picton Town Centre Masterplan 2026). The “Do Nothing with Seagull” scenario:

- Records the best intersection performance at Argyle Street / Prince Street out of the non-Bypass scenarios
- Provides improvements to network trip length and congestion levels in the PM peak, and performs similarly to the Do Nothing scenario in the AM peak
- The scenario provides the most benefits to travel times on Prince Street westbound out of the non-Bypass scenarios.

Conclusion

The results of the Picton Town Centre Road Improvements study suggest that the Menangle Street / Prince Street intersection will operate satisfactorily with no action prior to 2026.

With the proposed Picton Bypass operational, the Menangle Street / Prince Street intersection will operate satisfactorily with no action in 2036.

However, if the Picton Bypass is not implemented, additional measures will be required to allow the Menangle Street / Prince Street intersection to maintain satisfactory performance in 2036. From interpolating the model results we would expect issues to occur consistently from 2031.

The intersection of Argyle St with Barkers Lodge Road is modelled to reach poor levels of service prior to 2036 irrespective of Picton Bypass and is likely required to be significantly upgraded prior to this occurring.

The intersection of Argyle St and Prince St is modelled to reach poor levels of service prior to 2036 if a Picton Bypass is not operational and upgrading to a ‘seagull’ is modelled to address these issues.

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Abbreviations

Del	Delay
DUE	Dynamic user equilibrium
hr	Hour
km	Kilometre
LOS	Level of service
MRTM	Macarthur Regional Transport Model
NSW	New South Wales
QL	Queue length
s	Second
SCATS	Sydney Coordinated Adaptive Traffic System
SRC	Stochastic route choice
veh	Vehicle
VHT	Vehicle hours travelled
VKT	Vehicle kilometres travelled
Vol	Volume

1.0 INTRODUCTION

1.1 BACKGROUND

Picton is situated in the Wollondilly Shire local government area, within the Macarthur region of New South Wales. The town is located at the intersection of three major transport corridors, which include Argyle Street, Menangle Street and Barkers Lodge Road, and therefore forms a major hub for traffic travelling between Sydney or Wollongong and surrounding regions in the Wollondilly Shire. **Figure 1** shows the regional context of Picton.

The Wollondilly Shire is expected to undergo significant land development and population growth in the near future. Combined with further development in the Greater Macarthur region and its location along major transport corridors, these factors place significant challenges on Picton's transport network, including traffic congestion and elevated heavy vehicle volumes through the Picton town centre. With these challenges in mind, Wollondilly Shire Council commissioned TDG to develop the Picton Town Centre Transport Master Plan in 2017. The Transport Master Plan recommended upgrades to several intersections and other road infrastructure in Picton.

Council identified that a number of items in the Picton Town Centre Transport Master Plan would require significant resources to implement and would be influenced by re-zoning and development in the region. Therefore, Council engaged Cardno in 2018 to develop the Picton Town Centre Transport Plan 2026, which proposed short-term, low-cost upgrades to provide sufficient network capacity until at least 2026. The Transport Plan identified that Menangle Street / Prince Street intersection would fail in both the AM and PM peaks in 2026, and also indicated several other intersections would also perform unsatisfactorily. Upgrade options were proposed at six intersections in the town centre, including the signalisation of Menangle Street / Prince Street and the addition of turning lanes at Argyle Street / Prince Street.

Following the development of the Picton Town Centre Transport Plan 2026, community consultation was undertaken regarding the items identified in the Transport Plan 2026. Consultation on the Menangle Street / Prince Street intersection upgrade was conducted in 2019. After further community feedback was received that questioned the need to signalise the Menangle Street / Prince Street intersection, Council resolved to undertake additional community engagement in February 2022. The key outcomes from the first round of community engagement were summarised in the *Prince and Menangle Streets Intersection Community Workshop Outcomes Report – Interim* (WSP, July 2022). The outcomes included the provision for new traffic modelling of the upgrade options to be undertaken, incorporating new traffic survey data, updated land use development assumptions and the impact of the proposed Picton Bypass.

As a result of the interim community engagement outcomes, Wollondilly Shire Council has re-engaged Stantec (previously Cardno) to undertake an updated transport study of the Picton town centre. The study aims to develop new traffic models of the town centre to obtain a current view of existing traffic operations and draw on updated land use development assumptions to understand future traffic network performance, with a particular focus on the Menangle Street / Prince Street intersection.

Introduction

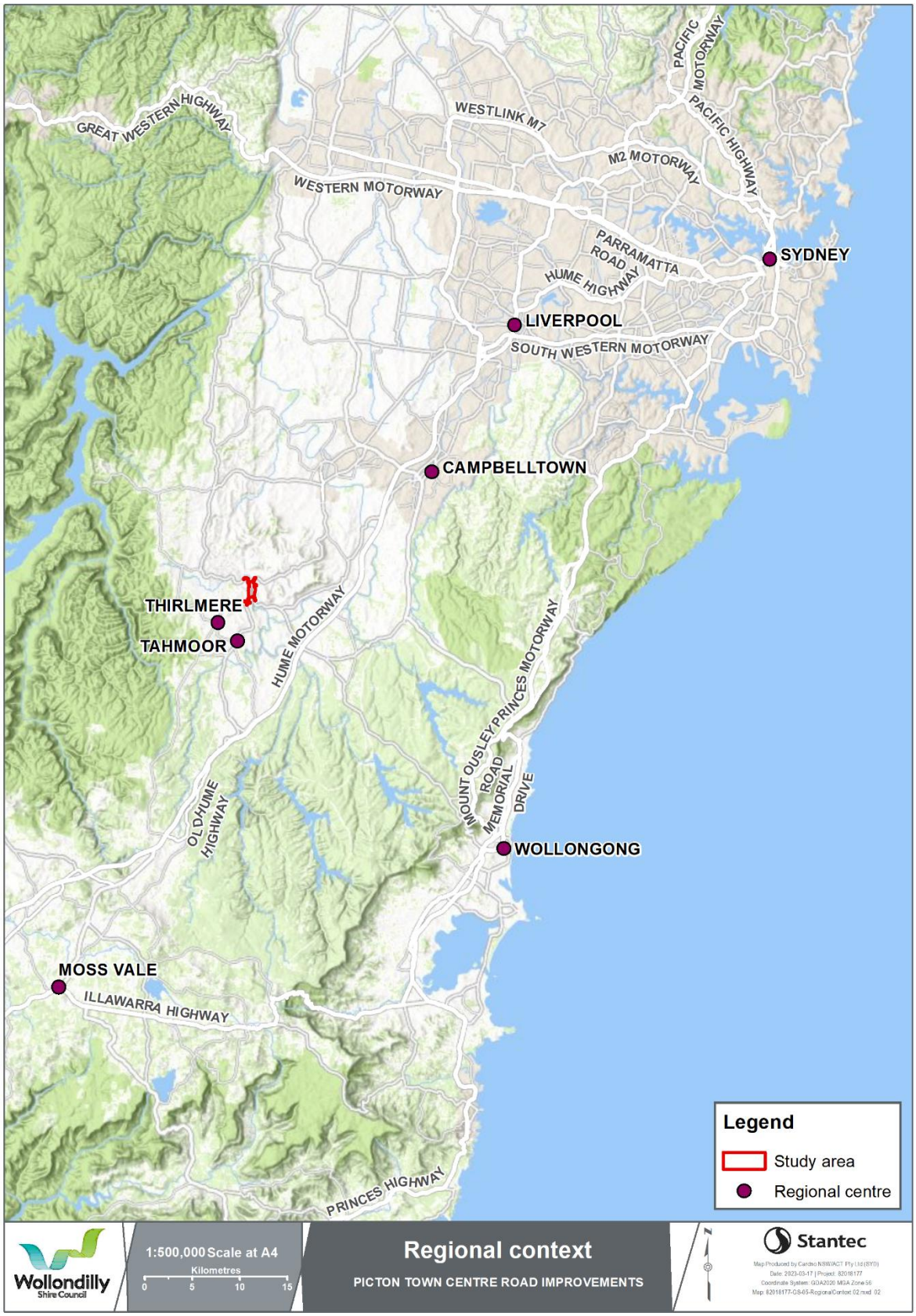


Figure 1: Regional context

1.2 MODELLING OBJECTIVES

The primary objectives of the traffic modelling for this project are to:

- Develop, calibrate and validate a microsimulation base model to replicate and provide an understanding of existing network performance in the Picton town centre
- Investigate and quantify existing traffic performance of the road network at key intersections and sections
- Utilise current land use projections and strategic modelling forecasts to model the impact of traffic growth on road network performance in the Picton town centre, including at Prince Street / Menangle Street
- Assess the need for network and intersection upgrades, including at Prince Street / Menangle Street and provide recommendations to improve traffic efficiency and maintain road safety under existing or predicted future network conditions.

1.3 SCOPE OF WORKS

Stantec's scope of works for the traffic modelling services includes the following steps:

- Develop a 2022 base model for AM and PM peak periods
- Calibrate and validate the base model in accordance with:
  - *Traffic Modelling Guidelines* (Roads and Maritime Services, 2013)
  - *Technical Direction 2018/002: Traffic Signals in Microsimulation* (Roads and Maritime Services, 2018)
- Prepare the Base Model Development Report in accordance with:
  - *Technical Direction 2017/001: Operational Modelling and Reporting Structure* (Roads and Maritime Services, 2017)
  - *Editorial Style Guide* (Roads and Maritime Services, 2014)
- Assess the existing traffic performance of the road network at key intersections and sections
- Develop future year 2026 and 2036 models for AM and PM peak periods to assess the impact of proposed network upgrades, identify network deficiencies and pinch points and provide modelling outputs which inform level of service and intersection performance
- Provide recommendations to improve traffic efficiency and maintain road safety under existing or predicted future network conditions.

The Base Model development was completed and documented in the *Base Model Development Report* (Cardno, February 2023), which is attached to this report as **Appendix A**. The model files and report were reviewed and endorsed by Transport for NSW as fit for the purpose of assessing future year traffic conditions and conducting options testing.

1.4 STUDY AREA

The study area is centred on the Picton town centre. Argyle Street runs in a north-south direction through the study area, forming the primary access route to and from the study area. Menangle Street, Thirlmere Way and Barkers Lodge Road are also major access links to the study area. Margaret Street and Colden Street border major retail and commercial destinations within the Picton town centre. The study area is shown in **Figure 2** below.

1.5 REPORT OUTLINE

The structure of this report is outlined below:

- **Section 1.0 – Introduction**: Outline of background, project objectives and study area
- **Section 2.0 – Option testing**: Describes in detail the modelling options tested
- **Section 3.0 – Assumptions**: Describes all assumptions adopted as part of the process of assessing future year scenario(s)
- **Section 4.0 – Future demand development**: Describes the process applied to derive future year trip demands
- **Section 5.0 – Base model operational results**: Outlines the base year model operational results
- **Section 6.0 – Future base case operational results**: Describes the performance of the future Do Nothing model testing
- **Section 7.0 – Option operational results**: Describes the performance of the option model testing
- **Section 8.0 – Operational assessment comparison**: Outlines a comparison of the modelling outputs between all the assessed scenarios
- **Section 9.0 – Conclusions**: Outlines main outcomes, results and recommendations.

The structure of this report follows *Technical Direction 2017/001: Operational Modelling and Reporting Structure* (Roads and Maritime Services, 2017).

Introduction

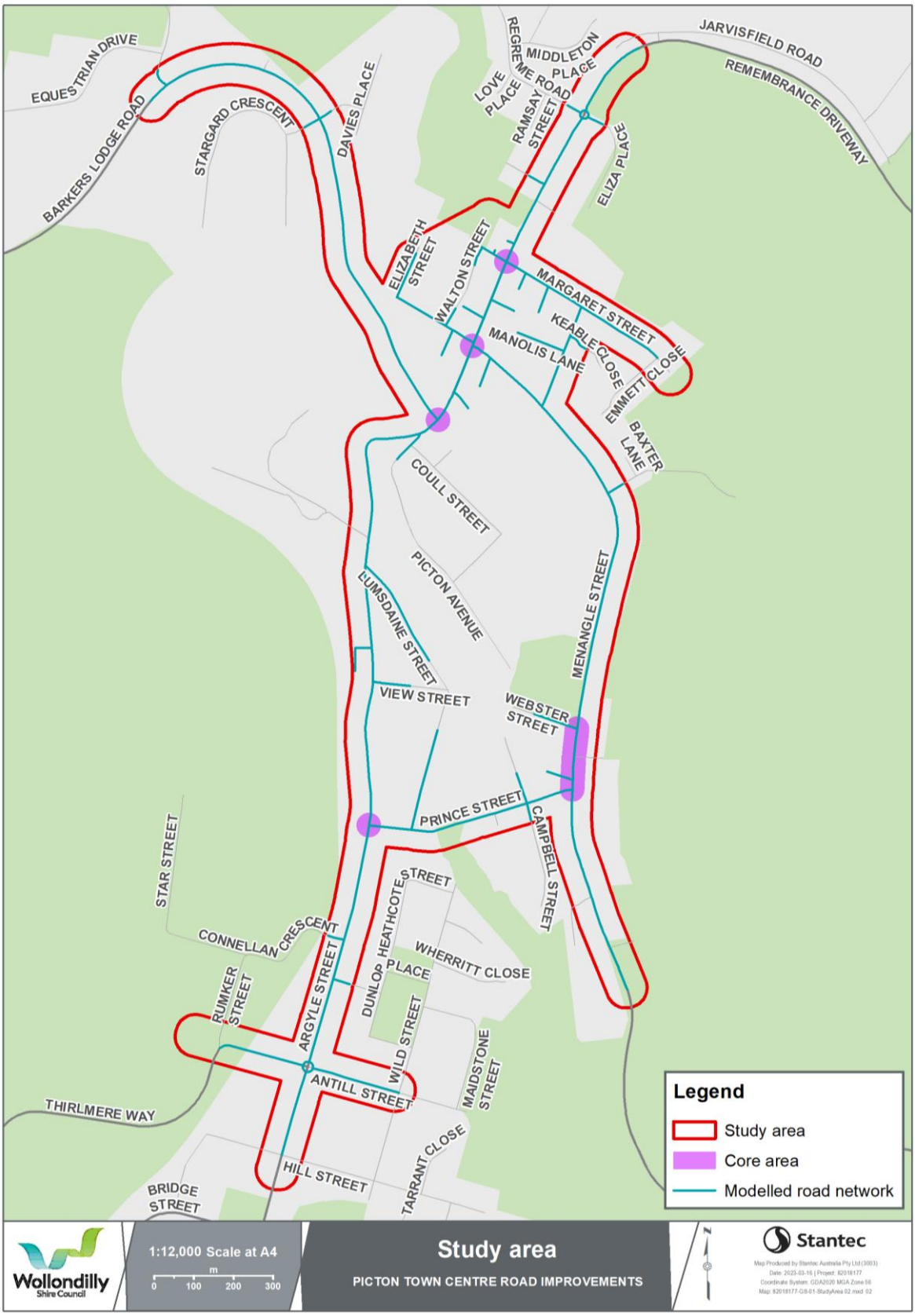


Figure 2: Study area

2.0 OPTION TESTING

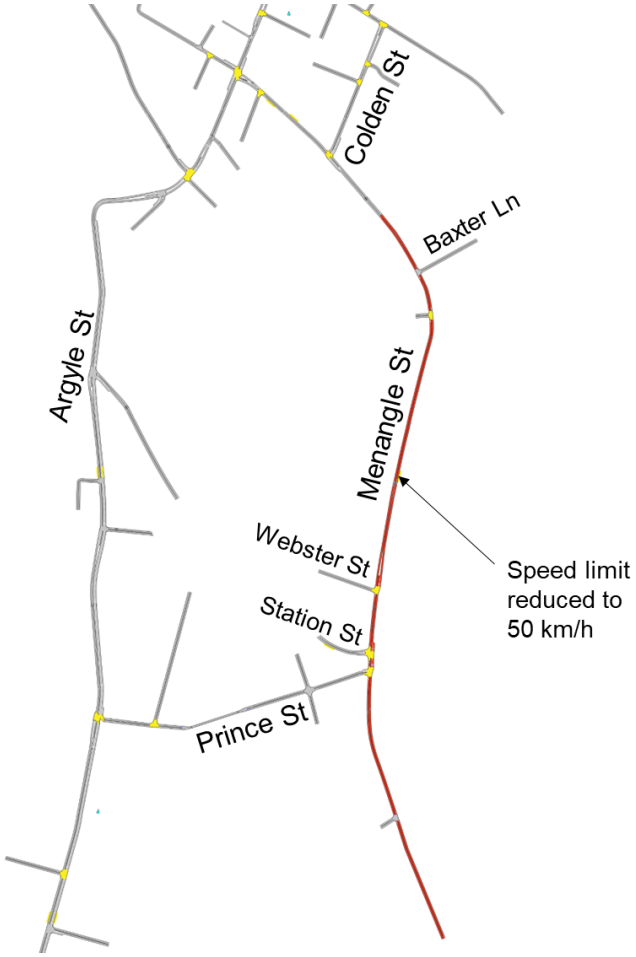
This section outlines the infrastructure changes included in the future models, the scenarios assessed and the assessment years and time periods modelled.

2.1 FUTURE INFRASTRUCTURE

Infrastructure upgrades were considered across the study area for the future year modelling.

A speed limit reduction along Menangle Street was introduced between the base year (2022) and the future years. This infrastructure change is described in **Table 1**.

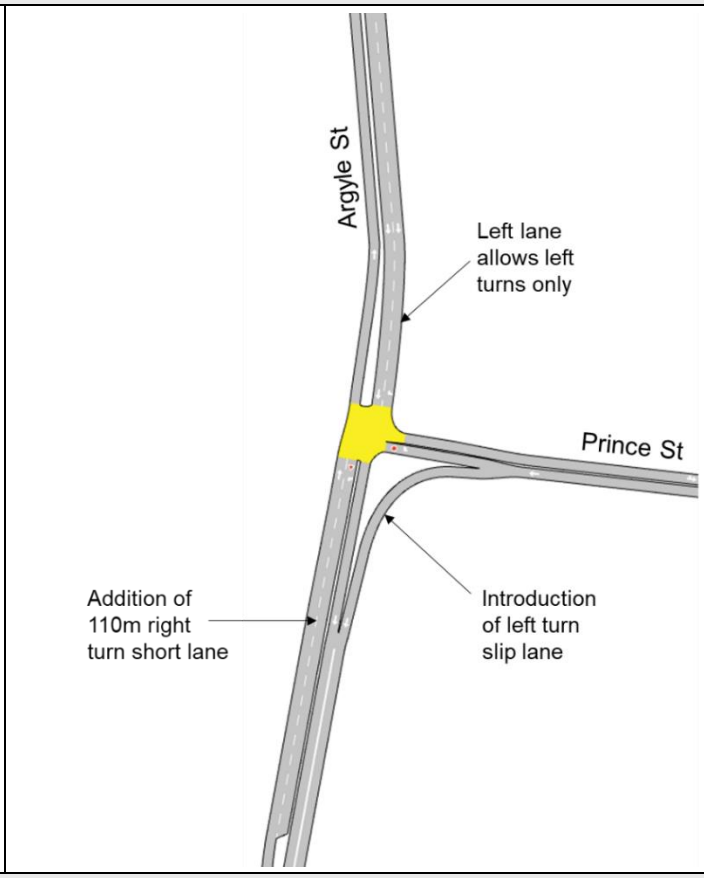
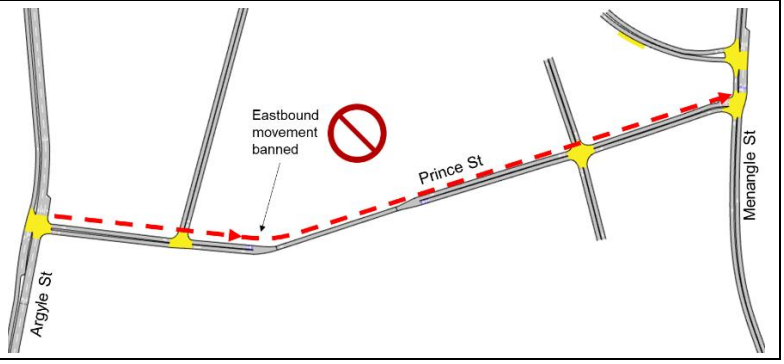
Table 1: Infrastructure upgrades completed since base year

#	Description	Configuration
1	Menangle Street speed limit reduction	
	• Menangle Street speed limit south of Colden Street reduced from 60 kilometres per hour to 50 kilometres per hour in both directions	

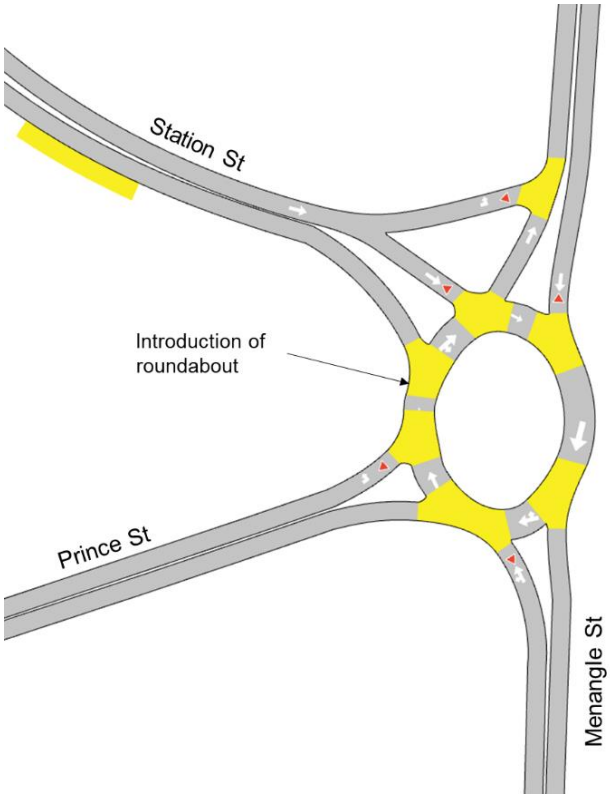
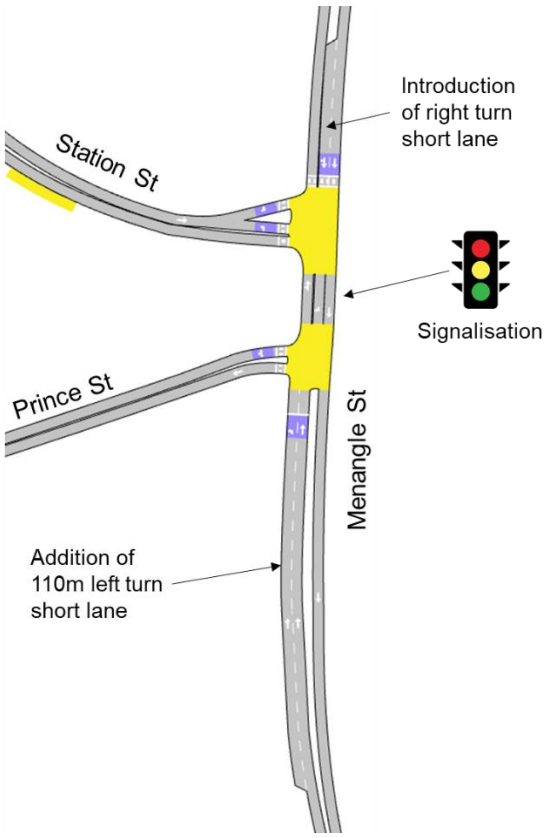
Option testing

Infrastructure upgrades were considered across the study area for the future year modelling. These infrastructure changes are described in **Table 2**.

Table 2: Proposed infrastructure upgrades

#	Description	Configuration
1	Argyle Street / Prince Street seagull intersection	
	• Upgrade of Argyle Street / Prince Street priority-controlled intersection to a seagull intersection layout	
2	Prince Street westbound only traffic flow	
	• Banning of eastbound traffic movements from Argyle Street to Menangle Street	

Option testing

	Menangle Street / Prince Street / Station Street elliptical roundabout	
3	• Installation of elliptical roundabout, connecting Menangle Street, Prince Street and Station Street	
	Menangle Street / Prince Street / Station Street signalised intersection	
4	• Signalisation of Menangle Street, Prince Street and Station Street intersection	

2.2 ASSESSMENT SCENARIOS

The following scenarios were assessed:

- Base Model
- Do Nothing
- Do Nothing with Seagull Intersection
- Do Nothing with Picton Bypass
- Prince Street westbound only traffic flow
- Menangle Street / Prince Street / Station Street elliptical roundabout
- Menangle Street / Prince Street / Station Street signalised intersection

These scenarios are described in the following sections.

2.2.1 Base Model

The Base Model was developed using data inputs from traffic surveys on Thursday 23 June 2022 to represent the existing conditions in the Picton town centre during the typical weekday AM and weekday PM peak periods. The model was calibrated and validated in accordance with the *Traffic Modelling Guidelines* (Roads and Maritime Services, 2013) and *TTD 2018/002 Traffic Signals in Microsimulation Modelling* (Roads and Maritime Services, 2018). Further details of the model development, calibration and validation process has been documented in the *Base Model Development Report* (Cardno, February 2023), provided in **Appendix A**.

2.2.2 Do Nothing

The Do Nothing scenario does not include any infrastructure upgrades from the Base Model, except those that have already been completed between the base year (2022) and the future years as outlined in **Table 1**.

The traffic demand for this scenario includes the growth from the Macarthur Regional Transport Model (MTRM) TRACKS strategic model applied to the Base Model demands.

2.2.3 Do Nothing with Seagull Intersection @ Argyle St / Prince St Intersection

This scenario includes the upgrade of the Argyle Street / Prince Street intersection to a seagull intersection layout as outlined in **Upgrade 1, Table 2**, as well as the infrastructure upgrades included in the Do Nothing scenario.

The traffic demand for this scenario is the same as the Do Nothing scenario, which uses the growth from the MRTM TRACKS strategic model applied to the Base Model demands.

2.2.4 Do Nothing with Picton Bypass

Transport for NSW has proposed a future bypass of the Picton town centre. The proposed bypass would connect Remembrance Driveway with Picton Road, providing an alternate route for heavy vehicles travelling between Thirlmere and Tahmoor to the Hume Motorway. The Do Nothing with

Picton Bypass scenario assesses the operation of the Picton town centre road network with the proposed Picton Bypass operational.

The alignment of the Picton Bypass will lie outside the study area. Therefore, the Do Nothing with Picton Bypass scenario does not include any infrastructure upgrades except for the Menangle Street speed limit reduction included in the Do Nothing scenario.

To evaluate the impact of the Picton Bypass on traffic demands in the Picton town centre, Stantec developed a Picton Bypass scenario in the MRTM TRACKS strategic model. The Picton Bypass scenario was developed to account for the reduced attractiveness of routes through the study area with the Picton Bypass operational, and considers the reassignment of traffic to routes outside the study area. The growth from the Picton Bypass strategic model scenario was applied to the Base Model demands to determine the Do Nothing with Picton Bypass traffic demands.

2.2.5 Prince Street westbound only traffic flow

This scenario models the banning of eastbound traffic movements from Argyle Street to Menangle Street, as shown in **Upgrade 2, Table 2**. The scenario also includes the infrastructure upgrades included in the Do Nothing scenario.

The traffic demand for this scenario is the same as the Do Nothing scenario, which uses the growth from the MTRM TRACKS strategic model applied to the Base Model demands.

2.2.6 Menangle Street / Prince Street / Station Street elliptical roundabout

This scenario includes an elliptical roundabout infrastructure upgrade connecting Prince Street, Menangle Street and Station Street, as shown in **Upgrade 3, Table 2**, as well as the infrastructure upgrades included in the Do Nothing scenario.

The traffic demand for this scenario is the same as the Do Nothing scenario, which uses the growth from the MTRM TRACKS strategic model applied to the Base Model demands.

2.2.7 Menangle Street / Prince Street / Station Street signalised intersection

This scenario includes a signalised intersection infrastructure upgrade connecting Prince Street, Menangle Street and Station Street, as shown in **Upgrade 4, Table 2**, as well as the infrastructure upgrades included in the Do Nothing scenario.

The traffic demand for this scenario is the same as the Do Nothing scenario, which uses the growth from the MTRM TRACKS strategic model applied to the Base Model demands.

2.3 ASSESSMENT YEARS AND TIME PERIODS

All future scenarios were assessed for the short-term (2026) and long-term (2036) time horizon, with the exception of the Do Nothing with Picton Bypass scenario. If approved, the Picton Bypass is not expected to be operational before 2026, and therefore the Do Nothing with Picton Bypass scenario was only assessed for the long-term (2036) time horizon.

Each scenario was modelled for two peaks, which were consistent with those used for the Base Model:

- AM peak: 7:15am to 9:15am
- PM peak: 3:15pm to 5:15pm.

Table 3 summarises the scenarios and years assessed.

Table 3: Summary of assessment years and time periods

Scenario	2022		2026		2036	
	AM	PM	AM	PM	AM	PM
Base	✓	✓	-	-	-	-
Do Nothing	-	-	✓	✓	✓	✓
Do Nothing with seagull intersection	-	-	✓	✓	✓	✓
Do Nothing with Picton Bypass	-	-	-	-	✓	✓
Prince Street westbound only traffic flow	-	-	✓	✓	✓	✓
Elliptical roundabout	-	-	✓	✓	✓	✓
Signalised intersection	-	-	✓	✓	✓	✓

3.0 ASSUMPTIONS

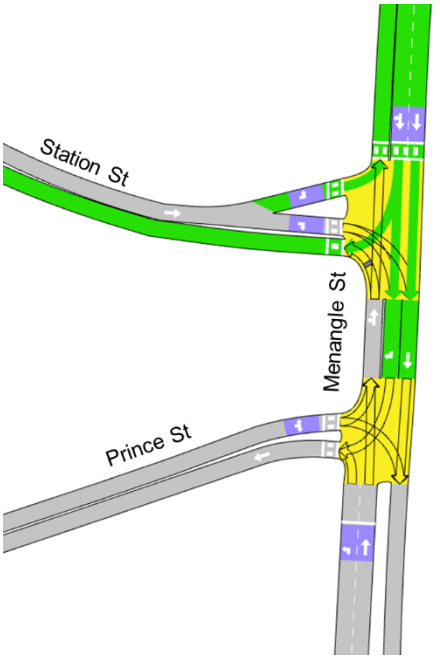
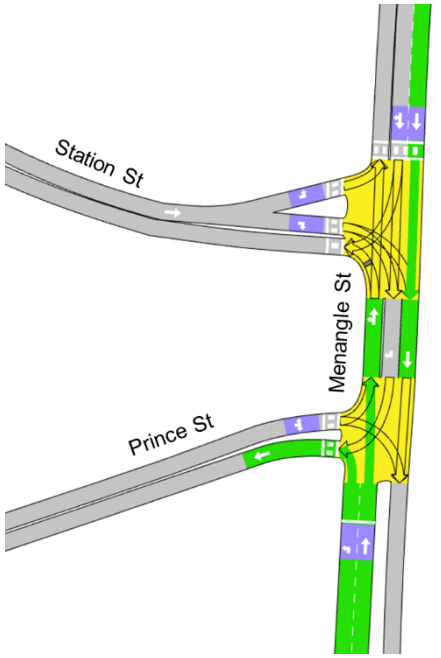
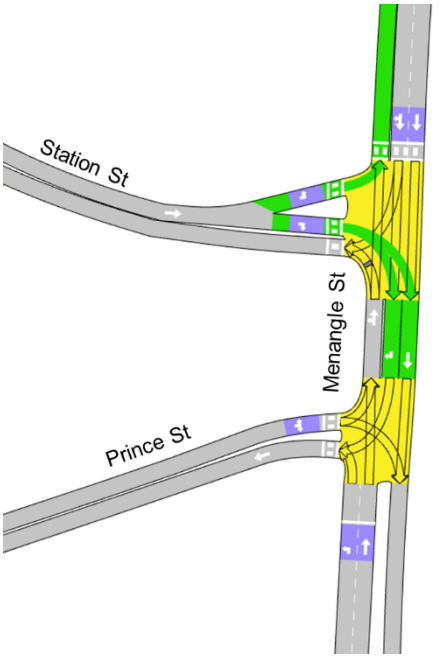
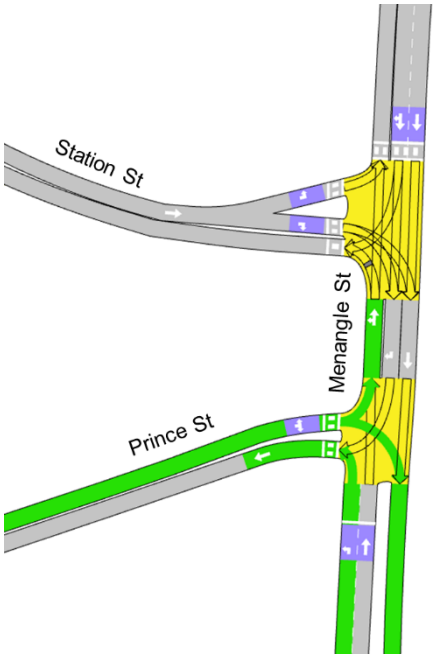
This section outlines the assumptions underlying the Future Models and the metrics for assessing network and intersection performance.

3.1 FUTURE MODEL ASSUMPTIONS

The assumptions adopted in the development of the Future Models are listed below:

- The Future Models were developed atop the calibrated and validated 2022 Base Model. Further details can be found in the *Base Model Development Report* (Cardno, February 2023) provided in **Appendix A**.
- The Aimsun Next 20.0.3 (2021-05-04) software package was used to develop the Future Models, consistent with the Base Model
- Public transport services and frequency in the Future Models were assumed to remain the same as in the Base Models
- Pedestrian volumes at pedestrian crossings were assumed to remain the same as in the Base Model
- Parking turnover on Argyle Street and Menangle Street was assumed to remain the same as in the Base Model
- The peak periods for the AM and PM peaks were assumed to remain consistent with the Base Model for each peak
- The traffic profile for the Future Models was assumed to remain consistent with the Base Model
- The posted speed limits in the Future Models were assumed to remain consistent with the Base Model with the exception of the Menangle Street speed limit reduction outlined in **Table 1**
- The Future Models retained the vehicle composition used in the Base Model, which included the following vehicle types:
  - Light vehicles (cars and light vans)
  - Rigid heavy vehicles (Austroads Classes 3-5)
  - Articulated heavy vehicles (Austroads Classes 6-9)
  - B-Doubles (Austroads Classes 10)
  - Buses.
- Signal phase times and cycle times at Argyle Street / Margaret Street / Cliffe Street were assumed to remain the same as in the Base Model
- Split approach phasing was implemented for the Menangle Street / Prince Street / Station Street signalised intersection. The cycle time adopted was 90 seconds in both the AM and PM peaks. Intergreen time was assumed to be seven seconds, consisting of four seconds of yellow time and three seconds of all-red time. **Table 4** shows the signal phasing implemented.
- The MRTM TRACKS demand data was assumed to include any changes to existing land uses within the study area
- Assessment of intersections and travel times not calibrated/validated in the Base Model is not recommended.

Table 4: Menangle Street / Prince Street / Station Street signal phasing

D phase		A phase	
B phase		C phase	

3.2 PERFORMANCE METRICS

This section outlines the performance metrics used for assessing the Base and Future Models.

3.2.1 Network performance metrics

Model operation is quantified based on a number of statistical outputs. **Table 5** summarises the network performance statistics reported for this study.

Table 5: Network performance metrics

Metric	Unit	Description
Total traffic demand	veh	• The total number of trips that intend to enter the network in the modelled period
Vehicle kilometres travelled (VKT)	km	• The distance travelled by all vehicles in the network • Useful for identifying savings in road user and external costs
Vehicle hours travelled (VHT)	hrs	• The total travel time of all vehicles that completed a trip • Useful for identifying network efficiency and performance, possible congestion issues and future travel time savings
Total number of stops	stops	• The number of times a vehicle stops across all vehicles in the model
Average trip length	km	• Average number of kilometres travelled by all vehicles in the network
Average time travelled in network	s	• Average time spent in the network across all vehicles
Average number of stops	stops	• Average number of stops per vehicle
Average speed	km/hr	• Average speed for all vehicles in the network
Unreleased demand	veh	• The number of vehicles that were unable to enter the modelled network during the modelled period • Unreleased demand is caused by queueing that extends to the edge of the modelled network

3.2.2 Intersection performance metrics

Intersection performance was assessed for the intersections shown in **Figure 3**. Intersection performance is quantified using:

- Delay time: average delay experienced by vehicles at the intersection
- Level of service (LOS): an intersection performance metric that is based on delay per vehicle
- Queue length: maximum queue length on each approach.

Table 6 shows the level of service categories for intersections in NSW from the *Guide to Traffic Generating Developments* (Roads and Traffic Authority, 2002).

For signalised intersections, level of service is based on the weighted average delay of all approaches. For unsignalised intersections (priority-controlled and roundabouts), level of service is based on the maximum delay across all movements.

Table 6: Level of service criteria for intersections

Level of service	Description	Delay
A	Good operation	Less than 14 seconds
B	Good operation, with acceptable delays and spare capacity	15 – 28 seconds
C	Satisfactory operation	29 – 42 seconds
D	Near capacity	43 – 56 seconds
E	At capacity	57 – 70 seconds
F	Capacity exceeded	More than 70 seconds

Source: Guide to Traffic Generating Developments (Roads and Traffic Authority, 2002)

Intersections operating at LOS C or better are usually considered satisfactory. LOS D indicates that the intersection is approaching capacity and an accident study may be required. LOS E indicates that the intersection is at capacity, and this level of service is generally unsuitable for unsignalised intersections. LOS F indicates that the intersection is failing and requires additional capacity.

The average delay on each approach is measured from the preceding intersection. Consequently, if the queue from one intersection spills back to the preceding intersection, this delay is captured at the second intersection and not the first. Where intersections are closely spaced, this may result in the intersection that is causing the delay appearing to perform better than other intersections nearby.

3.2.3 Travel times

Travel times were assessed for the routes shown in **Figure 4**. Travel times provide an indication of congestion hotspots along a particular route within a network and can be used to compare the performance of future options.

The speed ratio is calculated by dividing the average speed on a route by the posted speed limit. To assist with comparing and identifying the performance of travel time routes, Stantec has used the colour code shown in **Table 7** in this report.

Table 7: Travel time route speed ratio colour code

Speed ratio					
Less than 0.30	0.30 – 0.40	0.40 – 0.50	0.50 – 0.67	0.67 – 0.80	Greater than 0.80

Based on Highway Capacity Manual midblock level of service criteria (Transportation Research Board, 2016)

Assumptions

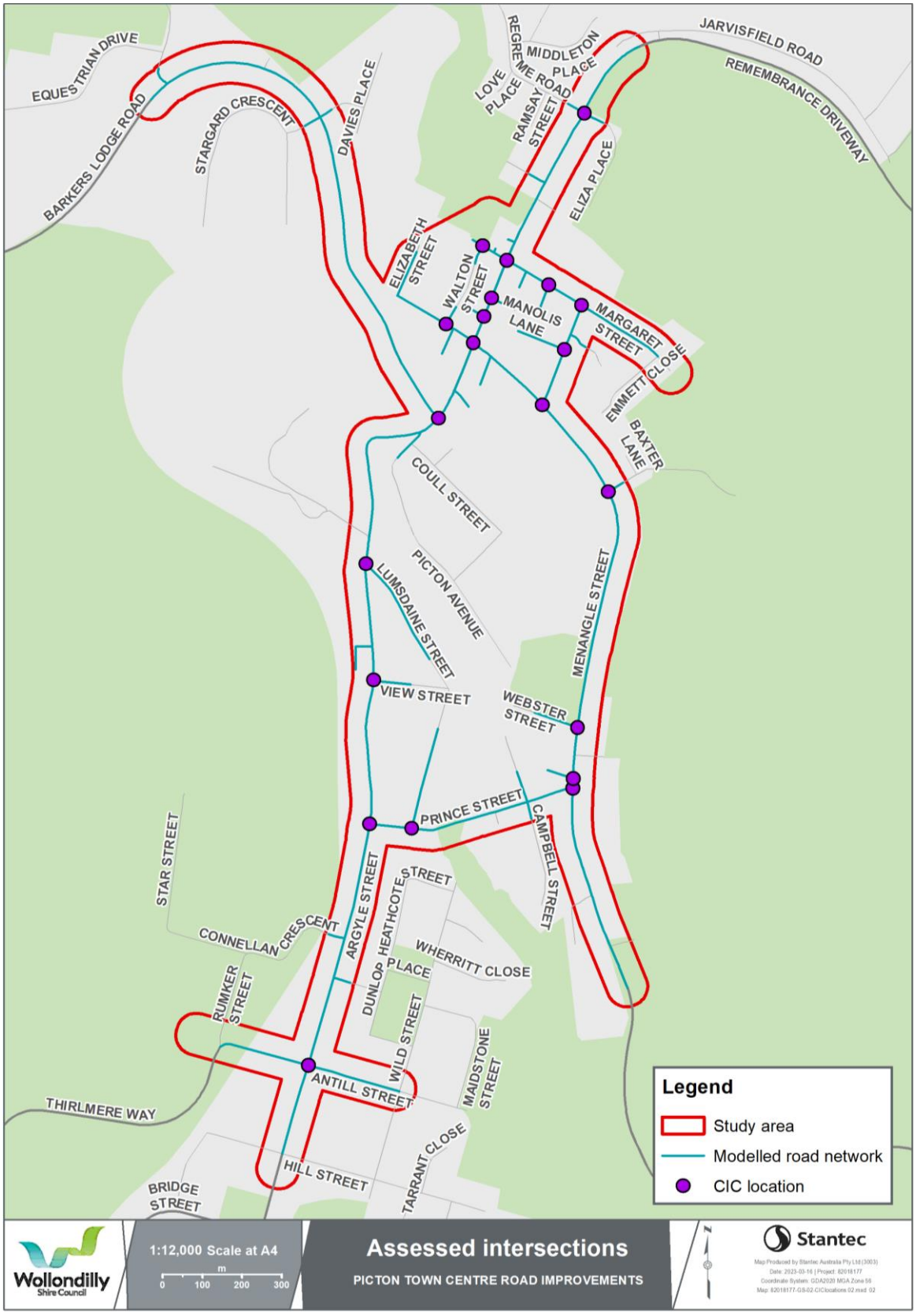


Figure 3: Assessed intersections

Assumptions

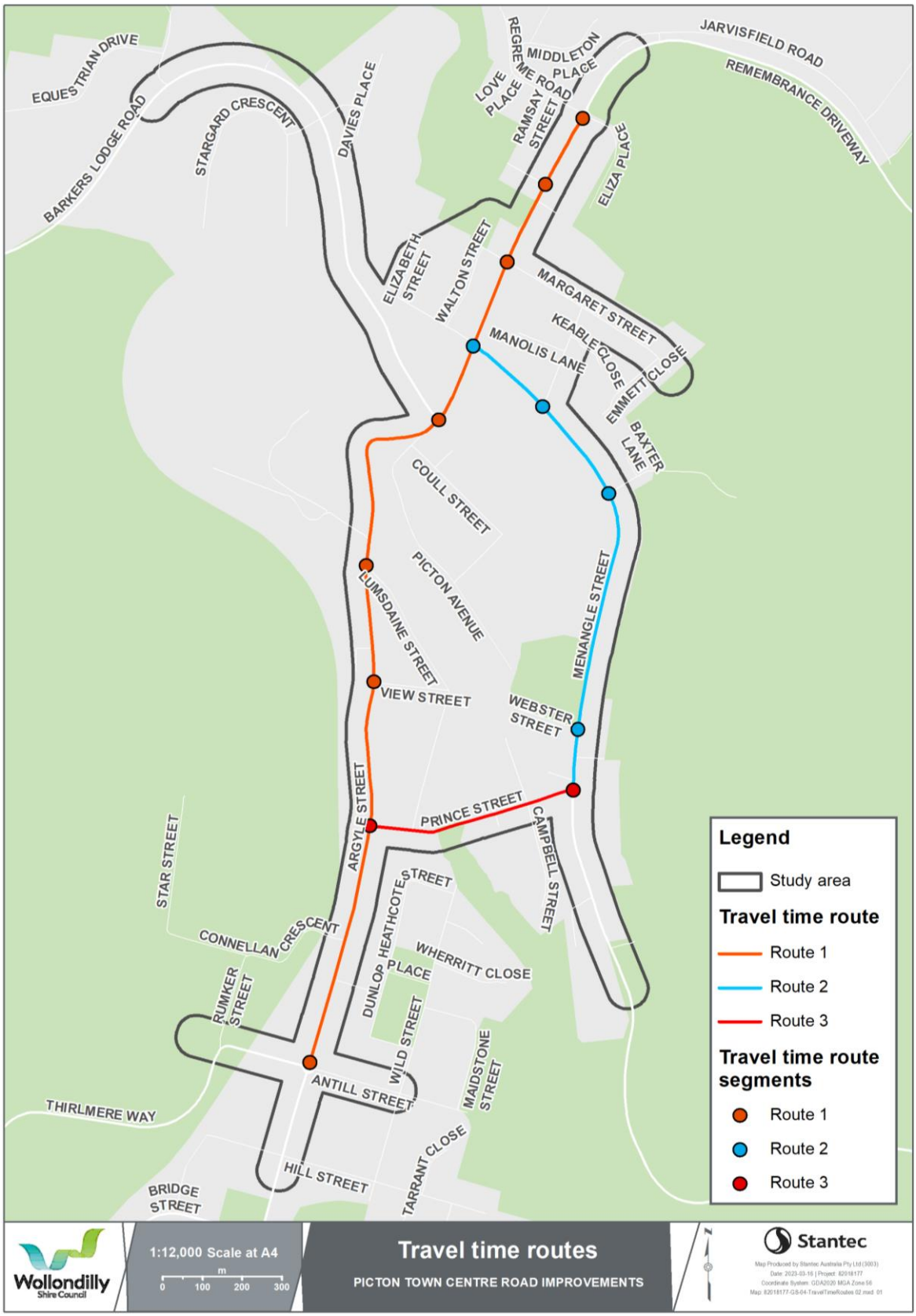


Figure 4: Travel time routes

4.0 FUTURE DEMAND DEVELOPMENT

This section describes the procedure for future-year demand estimation. The future traffic demands were based on the following inputs:

- Demands from the Base Model developed using traffic survey data
- Strategic demands from the 2016, 2026, and 2036 MRTM

The future-year demand development process is outlined in greater detail in the following sections.

4.1 STRATEGIC DEMANDS

The process for developing the Base Model demands were previously described in Section 3.11 of the *Base Model Development Report* (Cardno, February 2023). Stantec established a cordon for the study area boundary in the MRTM TRACKS strategic model and extracted cordon matrices. The cordon matrices were comprised of:

- 8 external zones representing destinations outside the study area along major roads
- 37 internal zones representing destinations within the study area

MRTM cordon matrices were extracted for the AM peak and PM peak in the following scenarios and years:

- Do Nothing scenario
  - 2016
  - 2026
  - 2036
- Picton Bypass scenario
  - 2036

The strategic zones were disaggregated to match the Aimsun zoning structure. **Figure 5** shows the Aimsun zoning structure alongside the MRTM zones, and **Table 8** shows the correspondence between the MRTM and Aimsun zones.

Future demand development

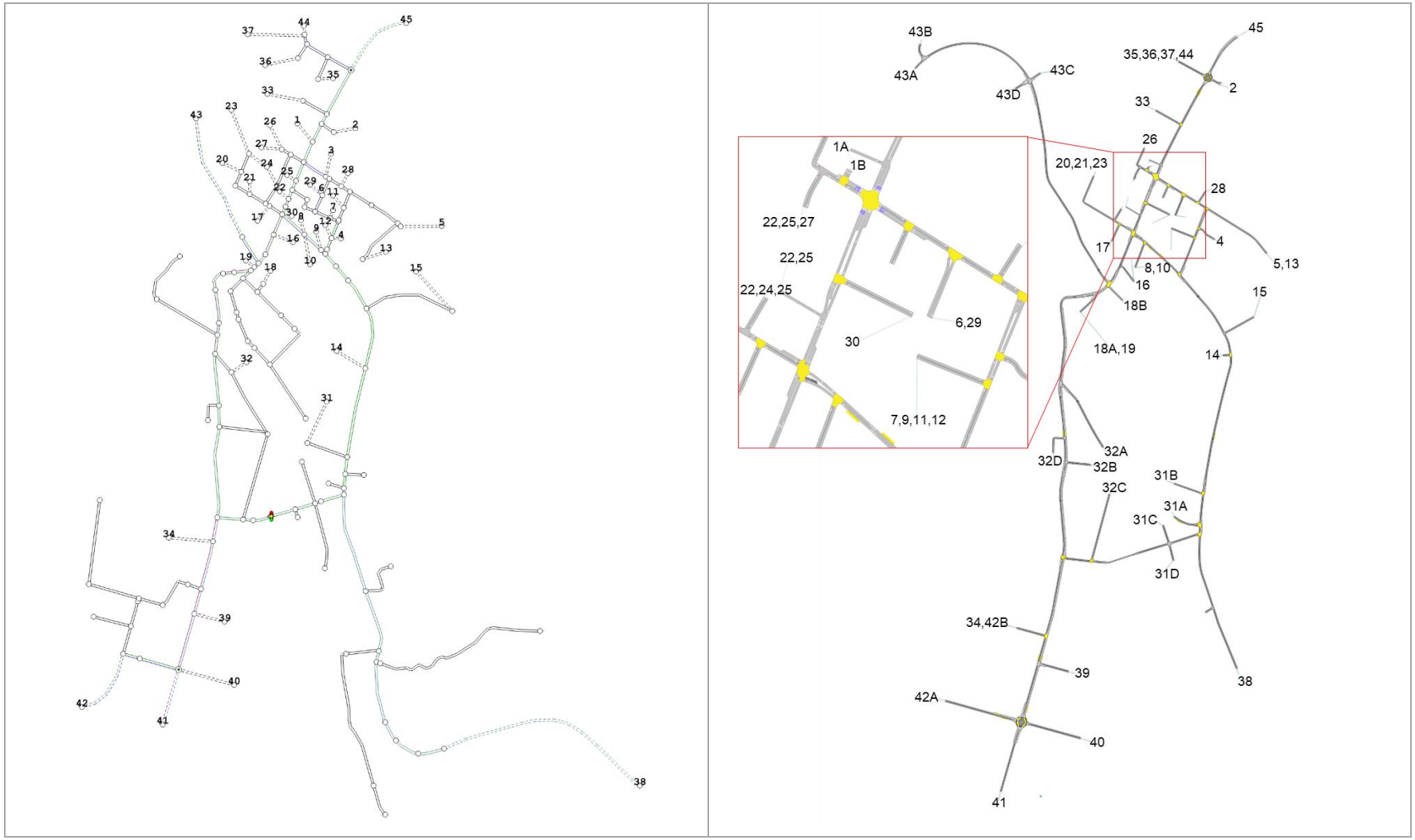


Figure 5: MRTM zoning structure (left) and Aimsun model zoning structure (right)

Table 8: MRTM and Aimsun zone correspondence

MRTM zone ID	Description	Aimsun zone ID
1	Picton Bowling Club, restaurants and shops	1A
		1B
2	Residential along Argyle Street	2
3	Residential and commercial along Margaret Street	3
4	St. Vincent De Paul Family Centre and residential along Colden Street	4
5	Margaret Street	5,13
6	Picton Mall Shopping Centre	6,29
7	Picton Mall Shopping Centre	7,9,11,12
8	Wollondilly Library Picton Branch	8,10
9	Wollondilly Shire Council and Wollondilly School Holiday Care	7,9,11,12
10	St. Anthony's Catholic Parish Primary School	8,10
11	Picton Mall Shopping Centre	7,9,11,12
12	Picton Rural Fire Brigade and Picton Masonic Centre	7,9,11,12
13	Emmett Close	5,13
14	Residential along Menangle Street	14
15	Baxter Lane	15
16	Picton Town Square	16
17	Davidson Lane	17
18	Crankanthorp Lane	18A,19
		18B
19	Commercial along Argyle Street	18A,19
20	Elizabeth Street	20,21,23
21	Menangle Street W	20,21,23
22	Walton Lane	22,24,25
		22,25
23	Elizabeth Street	20,21,23
24	Walton Street	22,24,25
25	Commercial along Argyle Street	22,24,25
		22,25
26	Picton Bowling Club and McDonald's	26
27	Walton Street	22,25,27
28	Council Works Depot	28
29	Picton Service Centre	6,29
30	Commercial along Argyle Street	30
31	Webster Street	31A
		31B
		31C
		31D

32	Lumsdaine Street	32A
		32B
		32C
		32D
33	Downing Street	33
34	Cornnellan Crescent	34,42B
35	Ramsay Street	35,36,37,44
36	Love Place	35,36,37,44
37	Picton Botanic Gardens	35,36,37,44
38	Menangle Street	38
39	Cowper Street	39
40	Antill Street	40
41	Argyle Street	41
42	Thirlmere Way	42A
		34,42B
43	Barkers Lodge Road	43A
		43B
		43C
		43D
44	Regreme Road	35,36,37,44
45	Argyle Street	45

Figure 6 and **Figure 7** show the MRTM demands in the AM and PM peaks for light vehicles and heavy vehicles, respectively. The MRTM demands are one-hour demands and consider light and heavy vehicles.

Future demand development

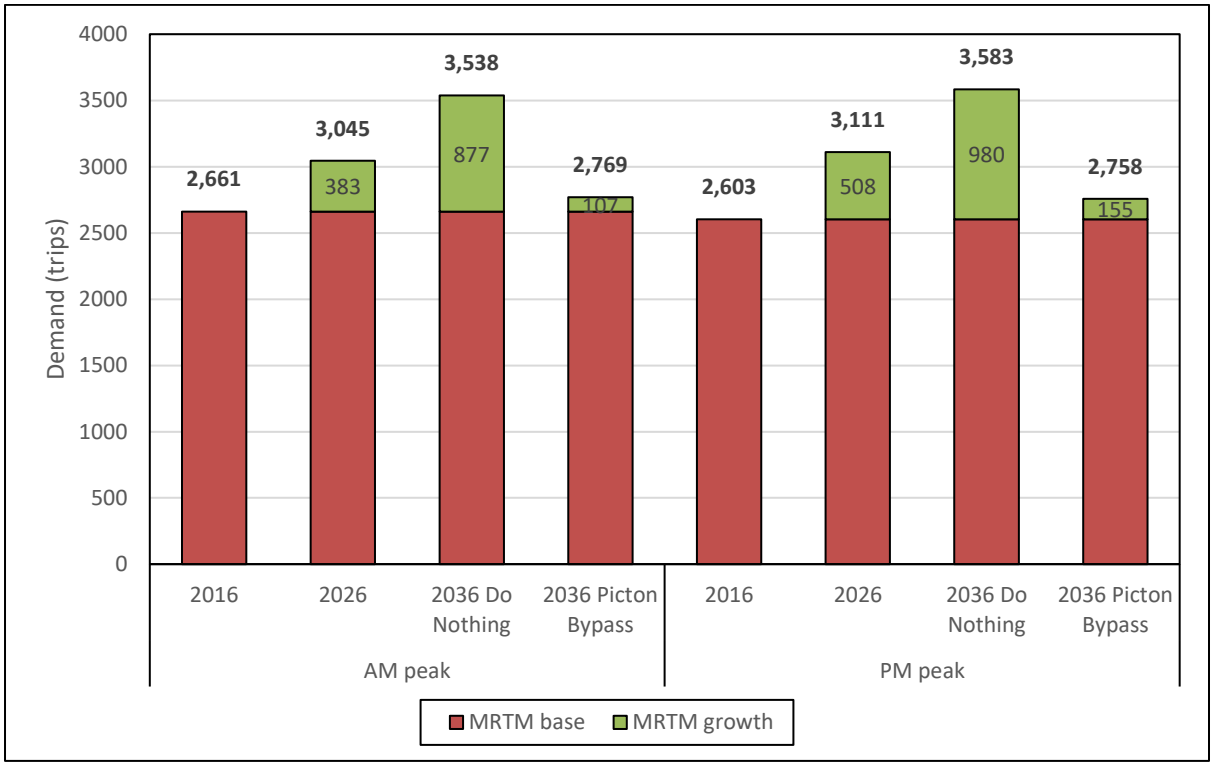


Figure 6: MRTM light vehicle growth summary

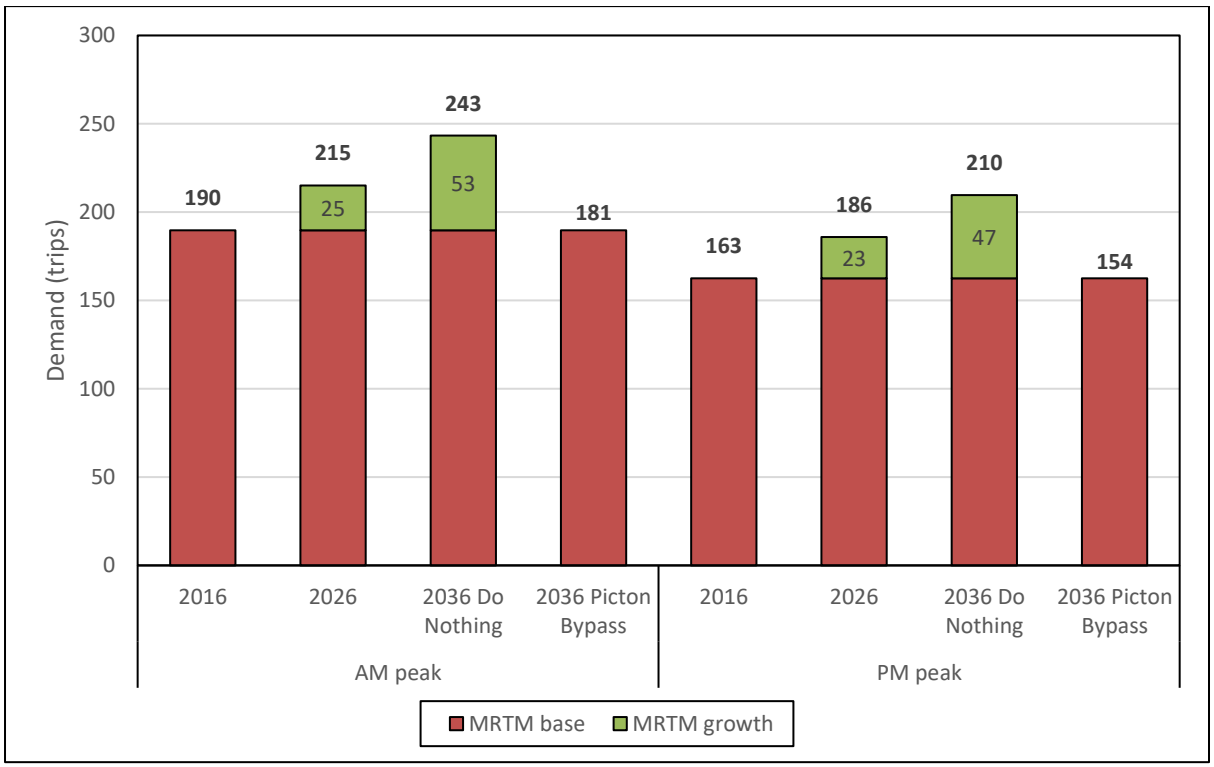


Figure 7: MRTM heavy vehicle growth summary

4.2 FUTURE DEMAND ESTIMATION METHODOLOGY

The methodology to develop the Future Model demands is outlined below. This procedure was repeated for each vehicle type, peak hour, assessment year and scenario separately.

1. Prior and future year matrices were extracted from the MRTM for the years of 2016, 2026 and 2036.
2. The strategic model absolute growth (the difference between the future-year and base-year matrices) for each future year was calculated.
    a. As MRTM matrices for the base year (2022) were not available, the growth between 2016 and 2026 was linearly interpolated to calculate the absolute growth.
3. The strategic model absolute growth was added to the calibrated Base Model traffic demand matrices to obtain the future year demand matrices. As the MRTM provides demands for a one-hour period in each of the AM and PM peaks, the following procedure was used to derive the two-hour future year demand matrices:
    a. The traffic demand in the first hour and second hour of the Base Model modelled period was calculated, and the busiest hour identified.
    b. The full strategic model absolute growth was added to the busiest hour.
    c. The reduction factor was calculated as the ratio between the traffic volume in the second-busiest hour and the busiest hour. This reduction factor was applied to the full strategic model absolute growth to find the reduced strategic model absolute growth.
    d. The reduced strategic model absolute growth was added to the second-busiest hour.
4. The 2022 base demand traffic profile obtained from the traffic surveys (in 15-minute segments) was applied to the future demand total calculated in step 3.

As the MRTM only considers one class for all heavy vehicles, the traffic composition percentages from the Base Model were used to derive the growth for rigid heavy vehicles, articulated heavy vehicles, and B-doubles separately.

Figure 8 shows the traffic growth demand estimation procedure.

Future demand development

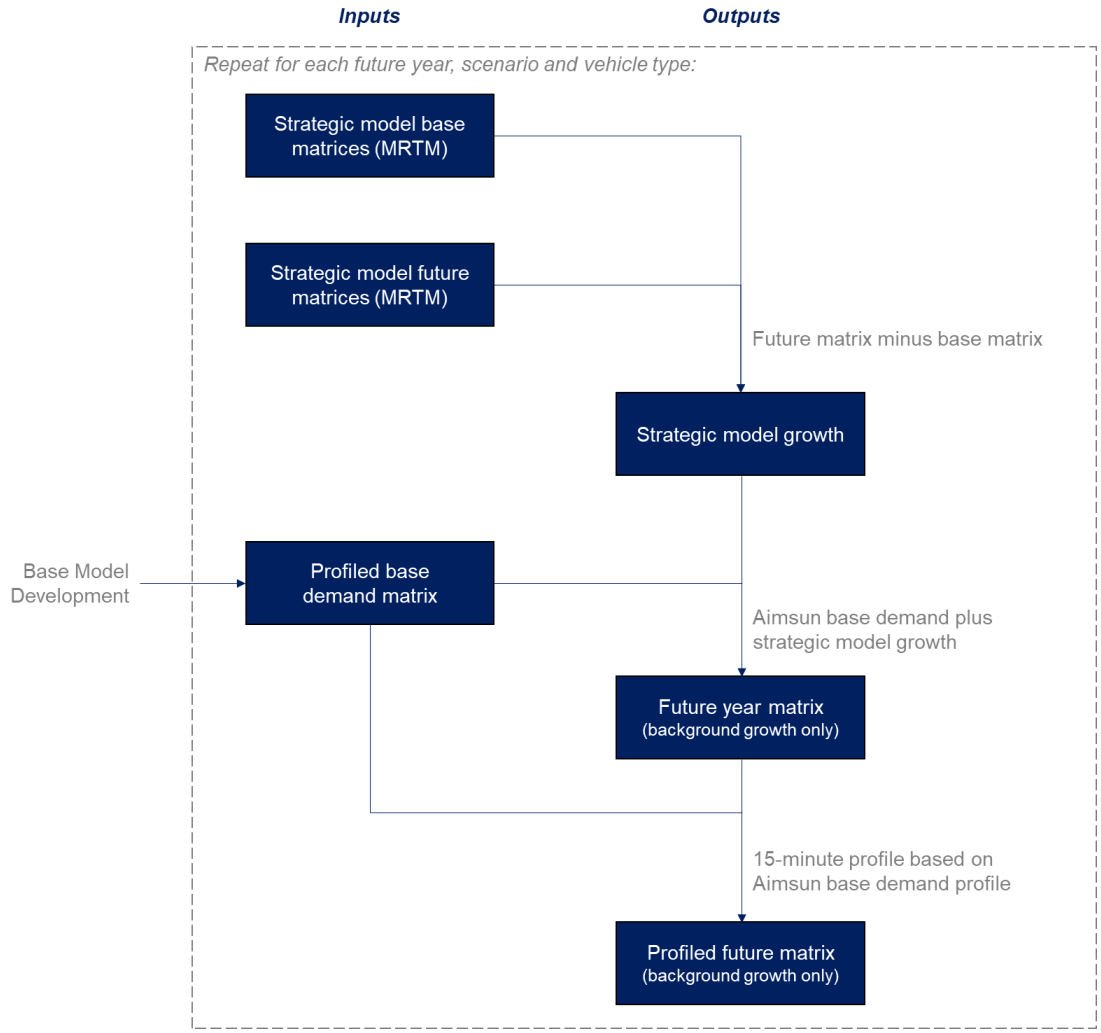


Figure 8: Background growth demand estimation procedure

4.3 FUTURE TRAFFIC DEMAND SUMMARY

Table 9 summarises the future light vehicle and heavy vehicle demand for the Aimsun model, and **Figure 9** summarises the total traffic demand.

- Traffic demands are highest in the PM peak in all base and future years
- Total traffic demand grows by six per cent in the AM peak and PM peak between 2022 and 2026
- In the 2036 Do Nothing scenario, total traffic demand grows by 24 per cent in the AM peak and 21 per cent in the PM peak, when compared to 2022 volumes.
- In the 2036 Picton Bypass scenario, total traffic demand grows by three per cent in the AM peak and is practically unchanged in the PM peak when compared to 2022 volumes.

Future demand development

Table 9: Aimsun traffic demand summary

Vehicle type	2022	2026		2036			
				Do Nothing		Picton Bypass	
	Demand	Demand	Growth from 2022	Demand	Growth from 2022	Demand	Growth from 2022
AM peak							
Light vehicles	5353	5673	+320 *(+6%)*	6667	+1313 *(+25%)*	5515	+162 *(+3%)*
Heavy vehicles	455	476	+21 *(+5%)*	545	+90 *(+20%)*	483	+28 *(+6%)*
Total	5808	6149	+341 *(+6%)*	7212	+1404 *(+24%)*	5998	+190 *(+3%)*
PM peak							
Light vehicles	6248	6654	+406 *(+6%)*	7601	+1353 *(+22%)*	6211	-37 *(-1%)*
Heavy vehicles	379	395	+16 *(+4%)*	437	+58 *(+15%)*	398	+19 *(+5%)*
Total	6627	7049	+422 *(+6%)*	8038	+1411 *(+21%)*	6609	-18 *(0%)*

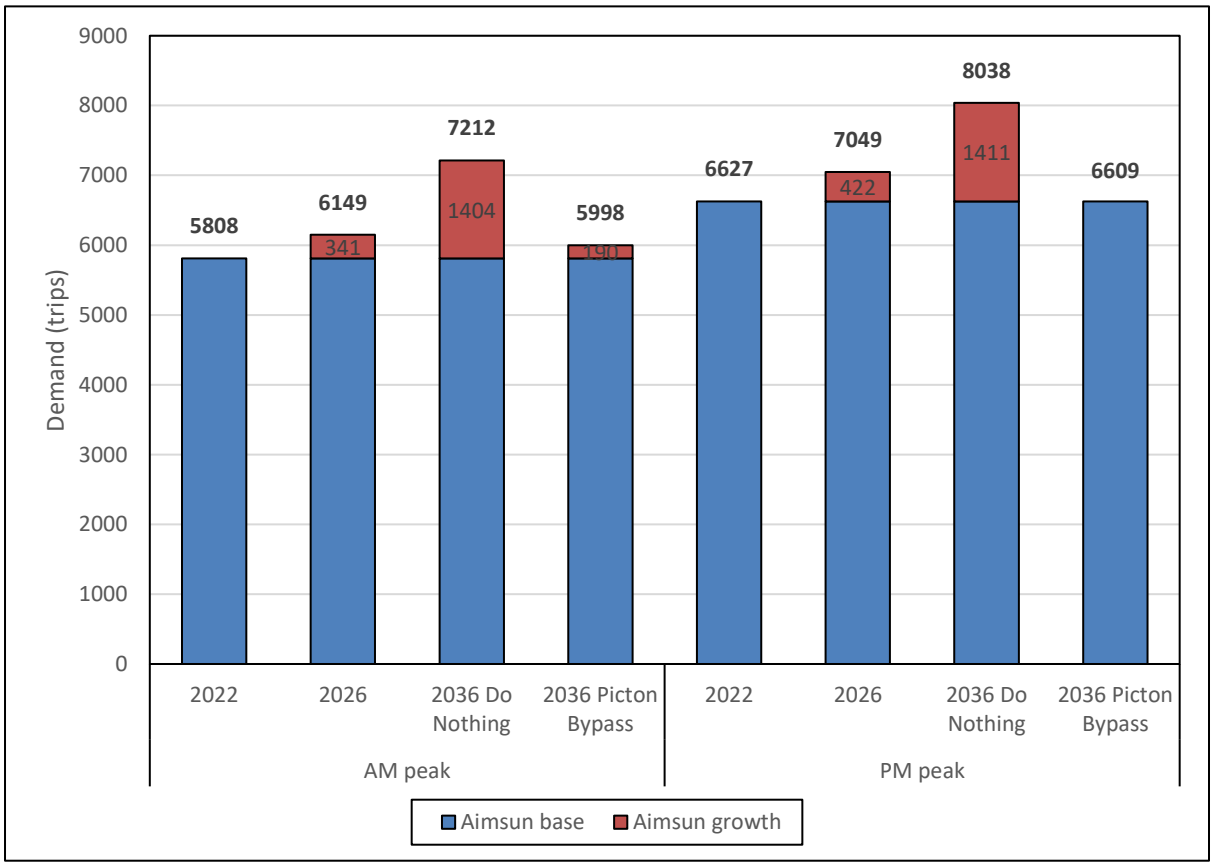


Figure 9: Aimsun traffic demand summary

4.3.1 Picton Bypass traffic demand impacts

The Picton Bypass provides an alternative route for vehicles travelling between Thirlmere and Tahmoor to the Hume Motorway. Under current conditions, these vehicles travel via Prince Street, Menangle Street and Picton Road to access the Motorway at the Picton Road / M31 Interchange. Alternatively, vehicles travel through the Picton town centre via Argyle Street, and use the Camden Bypass and Narellan Road to access the Motorway at the Narellan Road / M31 Interchange. With the Picton Bypass operational, these vehicles now travel between Picton Road and Remembrance Driveway directly, avoiding the Picton town centre.

Within the study area, this translates to a reduction in vehicles travelling between Menangle Street and the south-eastern accesses to the study area, and between the northern Argyle Street entrance to Picton and the south-eastern accesses to the study area. **Figure 10** shows these routes. When compared to the 2036 Do Nothing scenario, the following traffic volume impacts are observed:

Across the two-hour AM peak,

- 674 fewer vehicles travel between Menangle Street and Argyle Street (south)
- 270 fewer vehicles travel between Menangle Street and Thirlmere Way
- 148 fewer vehicles travel between Argyle Street (north) and Argyle Street (south).

Across the two-hour PM peak,

- 881 fewer vehicles travel between Menangle Street and Argyle Street (south)
- 281 fewer vehicles travel between Menangle Street and Thirlmere Way
- 250 fewer vehicles travel between Argyle Street (north) and Argyle Street (south).

Future demand development

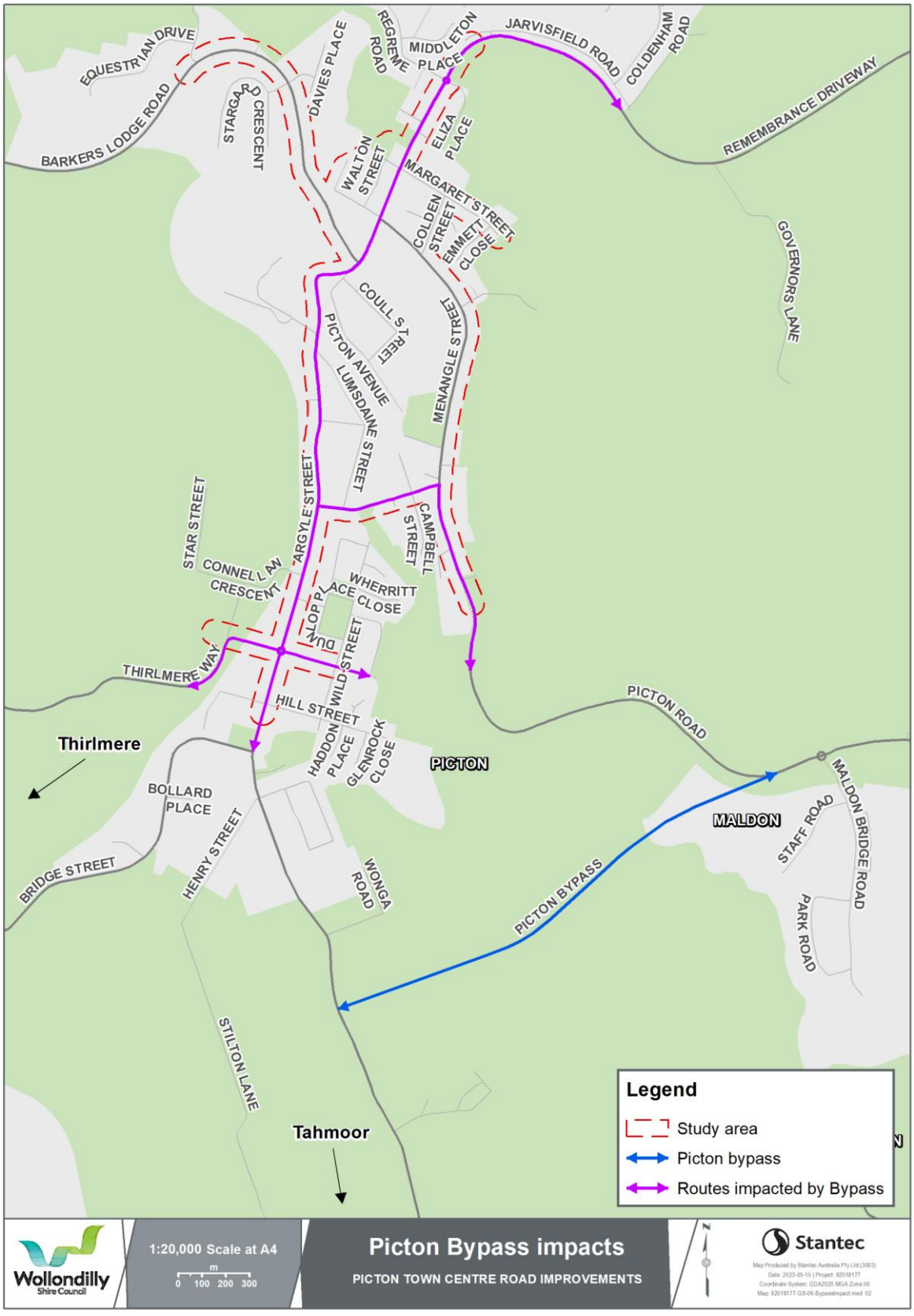


Figure 10: Picton Bypass traffic route impacts

5.0 BASE MODEL OPERATIONAL RESULTS

This section outlines the Base Model operational results. The development, calibration and validation of the Base Model was previously reported in the *Base Model Development Report* (Cardno, February 2023).

The results presented in this section establish the reference case for comparative assessment with the future base case scenario.

5.1 DATA INPUTS

The Base Models were developed using the following inputs:

- Classified intersection counts
- Queue length surveys
- Automated tube counts
- Travel time surveys and TomTom travel time data
- Traffic signal data, including historical phase times, cycle times and offsets
- Strategic model outputs.

5.2 MODEL SPECIFICATIONS AND ASSUMPTIONS

The Base Model was calibrated and validated to the network conditions observed in June 2022. The settings and parameters of note from the Base Model are:

- Aimsun Next 20.0.3 (2021-05-04) was used to develop the Base Model
- The vehicle experiment results were calculated from stochastic route choice (SRC) using vehicle paths derived from dynamic user equilibrium (DUE) assignment
- Signals were coded as actuated at one-hour intervals using traffic signal data, including historical timings from SCATS data and settings from the Region LX files.
- The following peak periods were identified from the classified intersection counts within the Picton town centre study area:
  - AM peak: 7:15am to 9:15am
  - PM peak: 3:15pm to 5:15pm

The Base Models were developed in accordance with *Traffic Modelling Guidelines* (Roads and Maritime Services, 2013). A statistical analysis of stability indicated an acceptable degree of confidence in the results. The calibration and validation results showed that the Base Models provided an acceptable representation of existing conditions, including:

- High network-wide calibration with 100 per cent of turning movements having a GEH of less than five, and no turning movements having a GEH greater than 10 across all peaks
- Adherence to the core calibration criteria in all hours for light and heavy vehicle types
- High statistical correlation between modelled and observed turning volumes with $R^2 > 0.99$ across all modelled peaks
- Modelled travel times on key routes fit well with observed data
- Sufficient representation of signal timing at signalised intersections.

The Base Models were accepted by Transport for NSW as fit for the purpose of future scenario testing. The *Base Model Development Report* (Cardno, February 2023) has been attached to this report as **Appendix A**.

5.3 EXISTING NETWORK PERFORMANCE

Table 10 summarises the Base Model network performance results for both peaks. The results indicate that:

- The PM peak is the critical peak, with the highest traffic demand, VKT and VHT
- The network is more congested in the PM peak, with higher average travel times and number of stops, and lower average speed in this peak
- There are no unreleased vehicles in both the AM and PM peaks of the Base Model.

Table 10: 2022 Base Model network performance

Network performance metric		2022 Base Model	
		AM peak	PM peak
All vehicles			
Total demand	veh	5808	6627
Completed trips	veh	5751	6652
Vehicle kilometres travelled	km	12008	13958
Vehicle hours travelled	hr	299	351
Total number of stops	stop	7028	8822
Averages per vehicle			
Average trip length	km	2.09	2.10
Average travel time in network	sec	187	190
Average number of stops	stop	1.22	1.33
Average speed	km/h	40.1	39.7
Unreleased demand			
Unreleased vehicles	veh	0	0
Proportion of demand unreleased	%	0%	0%

5.4 EXISTING INTERSECTION PERFORMANCE

Table 11 and **Table 12** show the Base Model intersection performance results for the AM peak and PM peak, respectively. **Figure 11** shows the Base Model intersection LOS results. The intersection performance results indicate that:

- All assessed intersections perform satisfactorily at LOS C or better in all modelled hours of the AM and PM peaks.

Base model operational results

Table 11: 2022 Base AM peak intersection performance

Intersection	2022 Base AM peak							
	7:15am-8:15am				8:15am-9:15am			
	Vol (veh)	Delay (s)	LOS	QL (veh)	Vol (veh)	Delay (s)	LOS	QL (veh)
Regreme Rd / Argyle Street / Eliza Pl	963	2.4	A	3	906	1.4	A	3
Margaret St / Argyle Street	1079	11.8	A	13	1066	14.0	A	11
Manolis Ln / Argyle Street	997	9.9	A	6	909	14.0	B	4
Walton Ln / Argyle Street	985	5.1	A	4	887	1.8	A	5
Argyle Street / Menangle St	1316	13.1	A	17	1370	20.3	B	26
Menangle St / Walton St	53	1.6	A	0	87	1.8	A	0
Cliffe St / Walton St	72	2.1	A	0	154	2.3	A	1
Colden St / Menangle St	545	5.8	A	7	698	11.9	A	12
Colden St / Manolis Ln	233	3.0	A	1	399	3.3	A	1
Colden St / Margaret St	150	2.1	A	2	263	2.1	A	3
Margaret St / Manolis Ln	200	2.8	A	2	288	2.8	A	3
Argyle Street / Barkers Lodge Rd	1180	32.8	C	13	1277	34.3	C	14
Argyle Street / Lumsdaine St	993	12.4	A	2	1089	26.1	B	2
Argyle Street / View St	1004	7.2	A	1	1116	22.5	B	2
Lumsdaine St / Prince St	576	18.5	B	5	547	19.8	B	5
Argyle Street / Prince St	1505	8.5	A	14	1576	8.8	A	17
Prince St / Menangle St	1058	23.5	B	11	1141	22.5	B	7
Menangle St / Station St	532	2.9	A	1	653	5.2	A	1
Menangle St / Webster St	497	2.5	A	2	617	3.3	A	3
Argyle Street / Thirlmere Way	1485	6.4	A	4	1609	6.2	A	4
Baxter Ln / Menangle St	1051	2.6	A	1	1150	4.4	A	1

Base model operational results

Table 12: 2022 Base PM peak intersection performance

Intersection	2022 Base PM peak							
	3:15pm-4:15pm				4:15pm-5:15pm			
	Vol (veh)	Delay (s)	LOS	QL (veh)	Vol (veh)	Delay (s)	LOS	QL (veh)
Regreme Rd / Argyle Street / Eliza Pl	1155	2.5	A	3	1141	12.2	A	3
Margaret St / Argyle Street	1343	20.7	B	15	1289	20.0	B	14
Manolis Ln / Argyle Street	1256	9.6	A	10	1191	9.4	A	12
Walton Ln / Argyle Street	1231	2.8	A	7	1157	1.9	A	6
Argyle Street / Menangle St	1597	27.5	B	21	1469	18.7	B	18
Menangle St / Walton St	64	2.0	A	0	53	1.6	A	0
Cliffe St / Walton St	149	2.3	A	2	155	2.3	A	1
Colden St / Menangle St	757	7.6	A	10	679	7.5	A	3
Colden St / Manolis Ln	523	3.8	A	3	446	2.7	A	2
Colden St / Margaret St	337	1.9	A	2	258	2.1	A	2
Margaret St / Manolis Ln	402	4.2	A	2	354	4.1	A	3
Argyle Street / Barkers Lodge Rd	1550	40.9	C	22	1406	31.4	C	13
Argyle Street / Lumsdaine St	1278	24.6	B	2	1165	17.5	B	2
Argyle Street / View St	1313	6.7	A	2	1176	5.6	A	2
Lumsdaine St / Prince St	644	25.6	B	14	601	26.3	B	8
Argyle Street / Prince St	1843	16.9	B	24	1716	23.9	B	12
Prince St / Menangle St	1236	24.0	B	6	1195	18.1	B	6
Menangle St / Station St	727	4.3	A	4	662	5.3	A	2
Menangle St / Webster St	699	6.5	A	7	618	2.1	A	3
Argyle Street / Thirlmere Way	1848	10.4	A	6	1685	8.6	A	3
Baxter Ln / Menangle St	1380	5.8	A	2	1243	3.7	A	2

Base model operational results

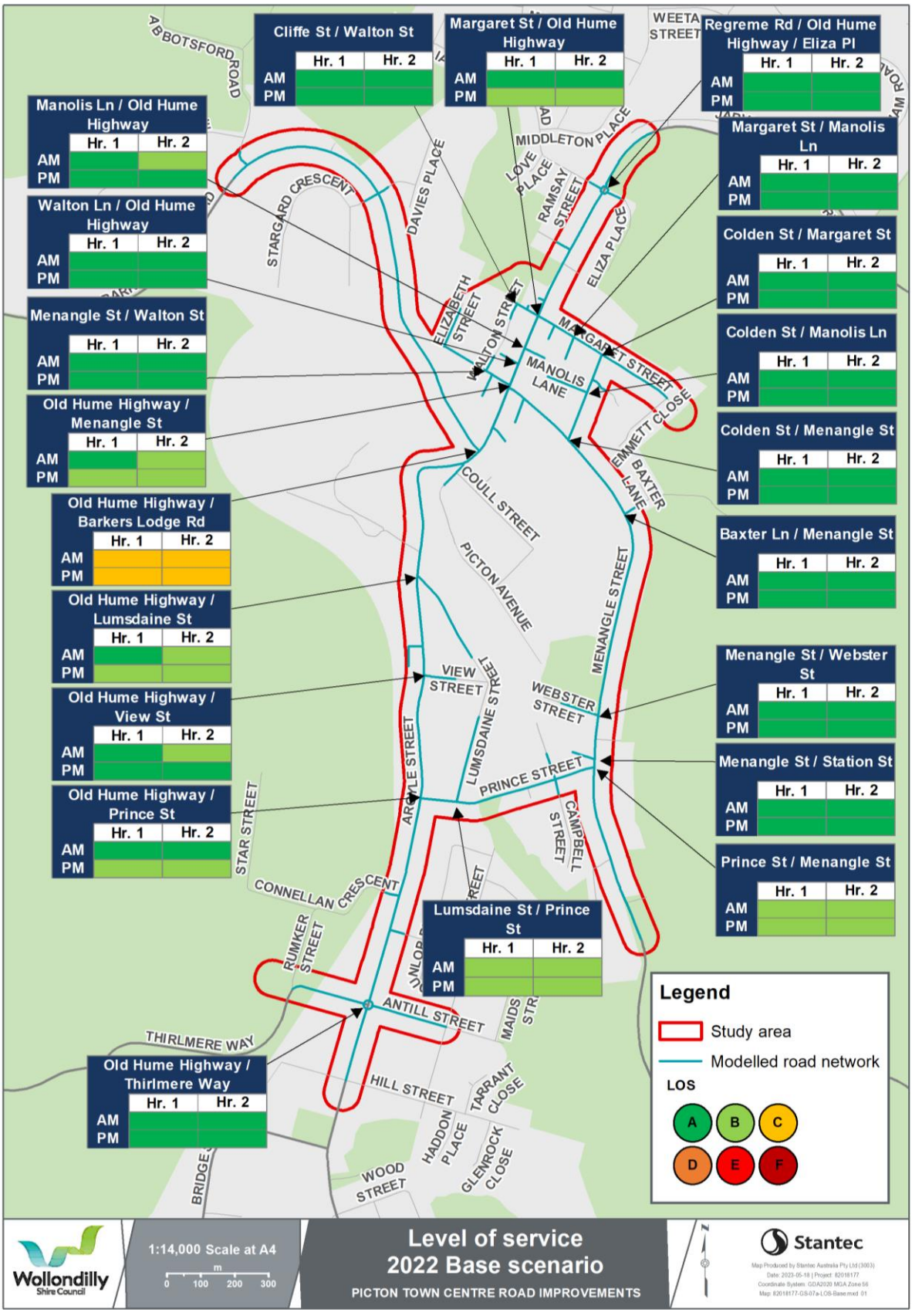


Figure 11: 2022 Base scenario intersection level of service

5.5 EXISTING TRAVEL TIMES

Table 13 and **Table 14** show the existing travel times and average speeds on each travel time route described in **Section 3.2.3** for the AM peak and PM peak, respectively. The results indicate:

- Average speeds on Argyle Street are similar between the AM and PM peaks, with speeds of around 40 kilometres per hour in both directions.
- On Prince Street, average speeds are lower and travel times are higher in the eastbound direction than in the westbound direction in both peaks. In the both hours of the AM peak, travel times are 18 seconds longer in the eastbound direction. In the first hour of the PM peak, travel times are 14 seconds longer in the eastbound direction.
- Average speeds on Menangle Street northbound fall to 38 kilometres per hour in the first hour of the PM peak, as higher vehicle volumes on the route result in increased queuing at the Argyle Street / Menangle Street intersection. Average speeds are above 40 kilometres per hour in all other modelled peaks and hours.

Table 13: 2022 Base AM peak travel times and average speeds

Route	Dir.	2022 Base AM peak			
		Travel time (mm:ss)		Average speed (km/hr)	
		7:15am-8:15am	8:15am-9:15am	7:15am-8:15am	8:15am-9:15am
Argyle Street	NB	3:30	3:49	43	39
	SB	3:21	3:35	45	41
Menangle Street	NB	1:40	1:44	44	42
	SB	1:31	1:37	48	45
Prince Street	EB	1:22	1:22	23	23
	WB	1:04	1:04	28	28

Table 14: 2022 Base PM peak travel times and average speeds

Route	Dir.	2022 Base PM peak			
		Travel time (mm:ss)		Average speed (km/hr)	
		3:15pm-4:15pm	4:15pm-5:15pm	3:15pm-4:15pm	4:15pm-5:15pm
Argyle Street	NB	3:38	3:33	41	42
	SB	3:37	3:29	41	43
Menangle Street	NB	1:55	1:45	38	42
	SB	1:35	1:31	46	48
Prince Street	EB	1:24	1:19	22	23
	WB	1:10	1:11	26	26

6.0 FUTURE BASE CASE OPERATIONAL RESULTS

This section outlines the Do Nothing operational results for the future years of 2026 and 2036. As outlined in **Section 2.0**, the Do Nothing scenario does not include any infrastructure changes except for the Menangle Street speed limit reduction. The future traffic demand for the scenario is described in **Section 4.0**.

The results presented in this section establish the reference case for comparative assessment with future option scenarios.

6.1 DO NOTHING NETWORK PERFORMANCE

Table 15 summarises the Do Nothing network performance results for the AM peak and PM peak in 2026 and 2036. The results indicate that:

- Between 2022 and 2036, traffic demand increases by 24 per cent in the AM peak and 21 per cent in the PM peak.
- In the 2036 AM peak, VKT increases by 28 per cent, while VHT increases by 46 per cent. VHT increases by a larger magnitude than VKT, indicating road users experience more delay in the network. Similarly, VKT increases by 25 per cent in the PM peak, while VHT increases by 39 per cent.
- In in the 2026 AM and PM peaks, average travel times and average number of stops increase by approximately four per cent, and average speeds decrease by approximately four per cent.
- In in the 2036 AM and PM peaks, average travel times increase by around 15 per cent, average number of stops increase by approximately 19 per cent, and average speeds decrease by around 10 per cent.
- There are no unreleased vehicles across all peaks in 2026 and 2036.

Future base case operational results

Table 15: Do Nothing network performance

Network performance		Do Nothing results				Compared to 2022 Base			
		2026 AM	2026 PM	2036 AM	2036 PM	2026 AM	2026 PM	2036 AM	2036 PM
All vehicles									
Total demand	veh	6149	7049	7212	8038	+341 (+5.9%)	+422 (+6.4%)	+1404 (+24.2%)	+1411 (+21.3%)
Completed trips	veh	6107	7048	7215	8087	+356 (+6.2%)	+396 (+6%)	+1464 (+25.5%)	+1435 (+21.6%)
Vehicle kilometres travelled	km	12721	14734	15453	17518	+713 (+5.9%)	+776 (+5.6%)	+3445 (+28.7%)	+3560 (+25.5%)
Vehicle hours travelled	hr	330	388	440	490	+31 (+10.2%)	+36 (+10.4%)	+141 (+46.9%)	+139 (+39.6%)
Total number of stops	stop	7601	9734	10870	12691	+573 (+8.2%)	+912 (+10.3%)	+3842 (+54.7%)	+3869 (+43.9%)
Averages per vehicle									
Average trip length	km	2.08	2.09	2.14	2.17	0 (-0.2%)	-0.01 (-0.4%)	+0.05 (+2.6%)	+0.07 (+3.2%)
Average travel time in network	sec	195	198	219	218	+7 (+3.8%)	+8 (+4.2%)	+32 (+17.1%)	+28 (+14.8%)
Average number of stops	stop	1.24	1.38	1.51	1.57	+0.02 (+1.8%)	+0.05 (+4.1%)	+0.28 (+23.3%)	+0.24 (+18.3%)
Average speed	km/h	38.6	38.0	35.1	35.7	-1.6 (-3.9%)	-1.7 (-4.4%)	-5 (-12.4%)	-4 (-10.1%)
Unreleased demand									
Unreleased vehicles	veh	0	0	0	0	+0	+0	+0	+0
Proportion of demand unreleased	%	0%	0%	0%	0%				

6.2 DO NOTHING INTERSECTION PERFORMANCE

Table 16 and **Table 17** show the Do Nothing intersection performance results for the AM and PM peaks for the future years of 2026 and 2036 respectively. **Figure 12** and **Figure 13** show the Do Nothing intersection LOS results for the AM peak and PM peak, respectively. The intersection performance results indicate that:

- Argyle Street / Barkers Lodge Road operates at LOS D in the first hour of the 2026 Do Nothing scenario PM peak as vehicles experience average delays of 43 seconds when turning right from Barkers Lodge Road.
- All other intersections in the 2026 Do Nothing scenario perform satisfactorily at LOS C or better in all modelled hours of the AM and PM peaks.
- Argyle Street / Menangle Street performs at LOS E in the first hour of the 2036 Do Nothing scenario PM peak.

  - Pedestrian activity on Argyle Street pedestrian crossings, and on-street parking manoeuvres are high in the first hour of the PM peak. These activities result in momentary queues along Argyle Street southbound, increasing delay for vehicles turning left from Menangle Street to Argyle Street.
- In the 2036 Do Nothing scenario, the Argyle Street / Barkers Lodge Road intersection performs at LOS E or worse in the second hour of the AM peak and both hours of the PM peak.
  - Road users experience average delays of over 100 seconds on the Barkers Lodge Road approach, as high volumes along Argyle Street reduce opportunities to turn out of Barkers Lodge Road.
- Argyle Street / Prince Street performs at LOS E in the first hour of the 2036 Do Nothing scenario PM peak. High volumes along Argyle Street reduce opportunities to turn out of Prince Street, resulting in average delays of 59 seconds.
- In the 2036 Do Nothing scenario, Prince Street / Menangle Street performs at LOS F in both hours of the AM peak and at LOS D the first hour of the PM peak.
  - In the AM peak, high demand for the right turn movement from Prince Street into Menangle Street results in queuing on Prince Street eastbound which extends onto Victoria Bridge, blocking westbound movements.
  - In the first hour of the PM peak, high traffic volumes on Menangle Street reduce opportunities for vehicles to turn out of Prince Street.

Future base case operational results

Table 16: 2026 Do Nothing scenario intersection performance

Intersection	2026 Do Nothing scenario AM peak								2026 Do Nothing scenario PM peak							
	7:15am-8:15am				8:15am-9:15am				3:15pm-4:15pm				4:15pm-5:15pm			
	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)
Regreme Rd / Argyle Street	1043	3.6	A	3	1001	7.3	A	4	1238	6.5	A	4	1226	3.4	A	3
Margaret St / Argyle Street	1148	12.5	A	13	1143	14.6	B	13	1401	21.9	B	14	1361	22.1	B	13
Manolis Ln / Argyle Street	1048	4.8	A	3	984	4.1	A	6	1298	12.8	A	10	1273	19.2	B	10
Walton Ln / Argyle Street	1040	5.9	A	3	957	2.0	A	4	1270	7.1	A	7	1235	2.5	A	6
Argyle Street / Menangle St	1351	21.9	B	16	1440	15.1	B	28	1673	36.6	C	19	1573	22.3	B	11
Menangle St / Walton St	60	1.9	A	1	116	2.7	A	1	88	1.7	A	0	72	1.5	A	1
Cliffe St / Walton St	73	2.0	A	1	149	2.5	A	1	154	2.2	A	1	151	2.0	A	1
Colden St / Menangle St	589	8.2	A	9	736	11.1	A	8	815	8.8	A	10	760	6.6	A	7
Colden St / Manolis Ln	263	2.4	A	1	428	3.7	A	2	538	5.4	A	2	488	2.9	A	3
Colden St / Margaret St	187	1.9	A	1	284	2.0	A	2	355	2.1	A	2	289	2.0	A	2
Margaret St / Manolis Ln	217	2.9	A	2	299	2.9	A	2	410	4.1	A	4	355	2.6	A	2
Argyle Street / Barkers Lodge Rd	1217	27.5	B	11	1325	35.5	C	18	1608	45.2	D	22	1476	33.6	C	12
Argyle Street / Lumsdaine St	1040	12.6	A	2	1147	24.5	B	2	1340	22.0	B	2	1187	9.1	A	2
Argyle Street / View St	1044	6.8	A	1	1176	29.4	C	2	1367	8.2	A	3	1200	6.7	A	3
Lumsdaine St / Prince St	624	19.0	B	5	613	27.8	B	8	675	32.1	C	10	652	35.7	C	13
Argyle Street / Prince St	1584	8.9	A	8	1670	11.0	A	11	1918	16.0	B	22	1786	27.0	B	14
Prince St / Menangle St	1124	30.8	C	11	1184	31.0	C	12	1302	34.7	C	10	1263	24.7	B	7
Menangle St / Station St	588	3.5	A	2	696	2.7	A	1	777	3.1	A	3	728	3.9	A	1
Menangle St / Webster St	549	5.2	A	2	664	11.3	A	4	754	11.2	A	5	689	1.5	A	3
Argyle Street / Thirlmere Way	1555	7.9	A	0	1673	10.0	A	0	1923	13.2	A	0	1765	9.6	A	0
Baxter Ln / Menangle St	1133	2.8	A	0	1233	3.4	A	0	1461	8.1	A	0	1309	9.6	A	0

Future base case operational results

Table 17: 2036 Do Nothing scenario intersection performance

Intersection	2036 Do Nothing scenario AM peak								2036 Do Nothing scenario PM peak							
	7:15am-8:15am				8:15am-9:15am				3:15pm-4:15pm				4:15pm-5:15pm			
	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)
Regreme Rd / Argyle Street	1193	3.9	A	5	1155	4.1	A	3	1324	7.7	A	6	1351	2.2	A	3
Margaret St / Argyle Street	1297	12.2	A	13	1304	16.3	B	16	1539	22.5	B	17	1517	23.1	B	12
Manolis Ln / Argyle Street	1210	13.4	A	7	1158	9.5	A	6	1428	11.1	A	12	1386	10.2	A	11
Walton Ln / Argyle Street	1191	8.4	A	6	1130	6.3	A	8	1414	16.2	B	8	1339	2.6	A	4
Argyle Street / Menangle St	1644	29.9	C	26	1781	23.3	B	30	1995	66.5	E	35	1851	29.9	C	29
Menangle St / Walton St	94	1.9	A	1	161	1.7	A	1	111	1.8	A	1	103	1.9	A	1
Cliffe St / Walton St	77	2.1	A	0	140	2.4	A	1	143	2.3	A	2	154	2.1	A	1
Colden St / Menangle St	883	13.1	A	14	1032	14.9	B	11	1094	23.0	B	15	1017	9.2	A	11
Colden St / Manolis Ln	353	2.8	A	1	506	3.7	A	1	597	4.2	A	2	555	3.9	A	2
Colden St / Margaret St	245	2.2	A	2	323	2.1	A	1	436	2.2	A	2	360	2.1	A	1
Margaret St / Manolis Ln	242	3.3	A	3	316	3.1	A	3	488	6.0	A	3	427	3.0	A	3
Argyle Street / Barkers Lodge Rd	1468	38.7	C	17	1620	91.0	F	23	1931	106	F	24	1731	56.3	E	23
Argyle Street / Lumsdaine St	1204	14.0	A	2	1360	17.4	B	2	1590	19.9	B	3	1377	24.5	B	2
Argyle Street / View St	1223	6.6	A	1	1393	25.3	B	2	1616	8.7	A	3	1395	13.1	A	1
Lumsdaine St / Prince St	663	32.9	C	18	671	24.9	B	10	692	30.3	C	21	694	21.1	B	8
Argyle Street / Prince St	1776	23.7	B	22	1909	17.8	B	18	2173	59.5	E	30	2006	31.3	C	13
Prince St / Menangle St	1501	224	F	38	1534	76.6	F	18	1663	54.5	D	21	1602	38.7	C	8
Menangle St / Station St	884	5.9	A	3	972	10.7	A	2	1098	5.3	A	7	999	4.0	A	3
Menangle St / Webster St	835	2.4	A	6	921	18.3	B	3	1071	15.4	B	16	949	20.5	B	7
Argyle Street / Thirlmere Way	1720	10.5	A	0	1864	9.6	A	0	2137	12.2	A	0	1960	8.8	A	0
Baxter Ln / Menangle St	1212	4.4	A	0	1332	6.4	A	0	1640	8.6	A	0	1482	7.4	A	0

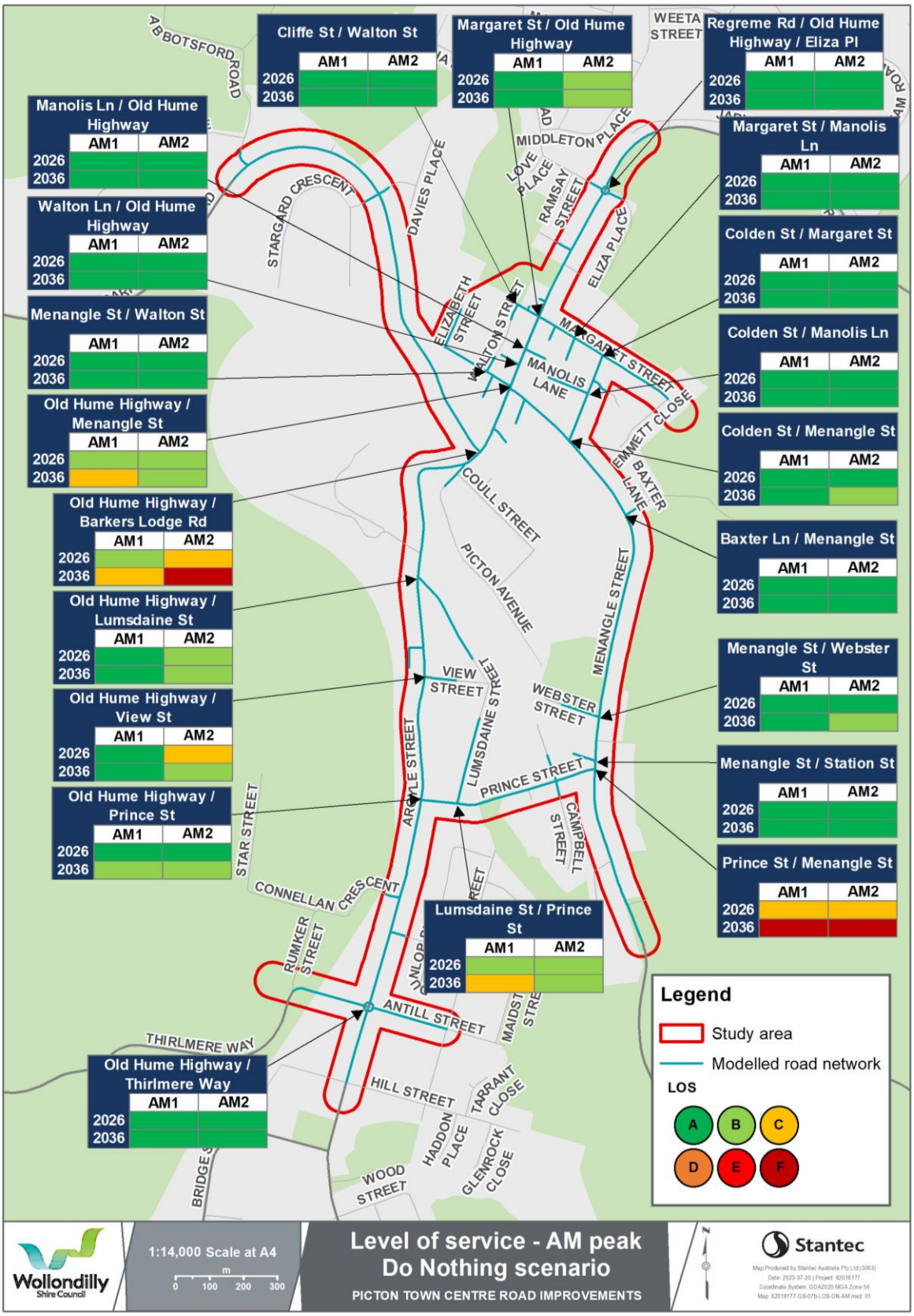


Figure 12: Do Nothing AM peak intersection level of service

Future base case operational results

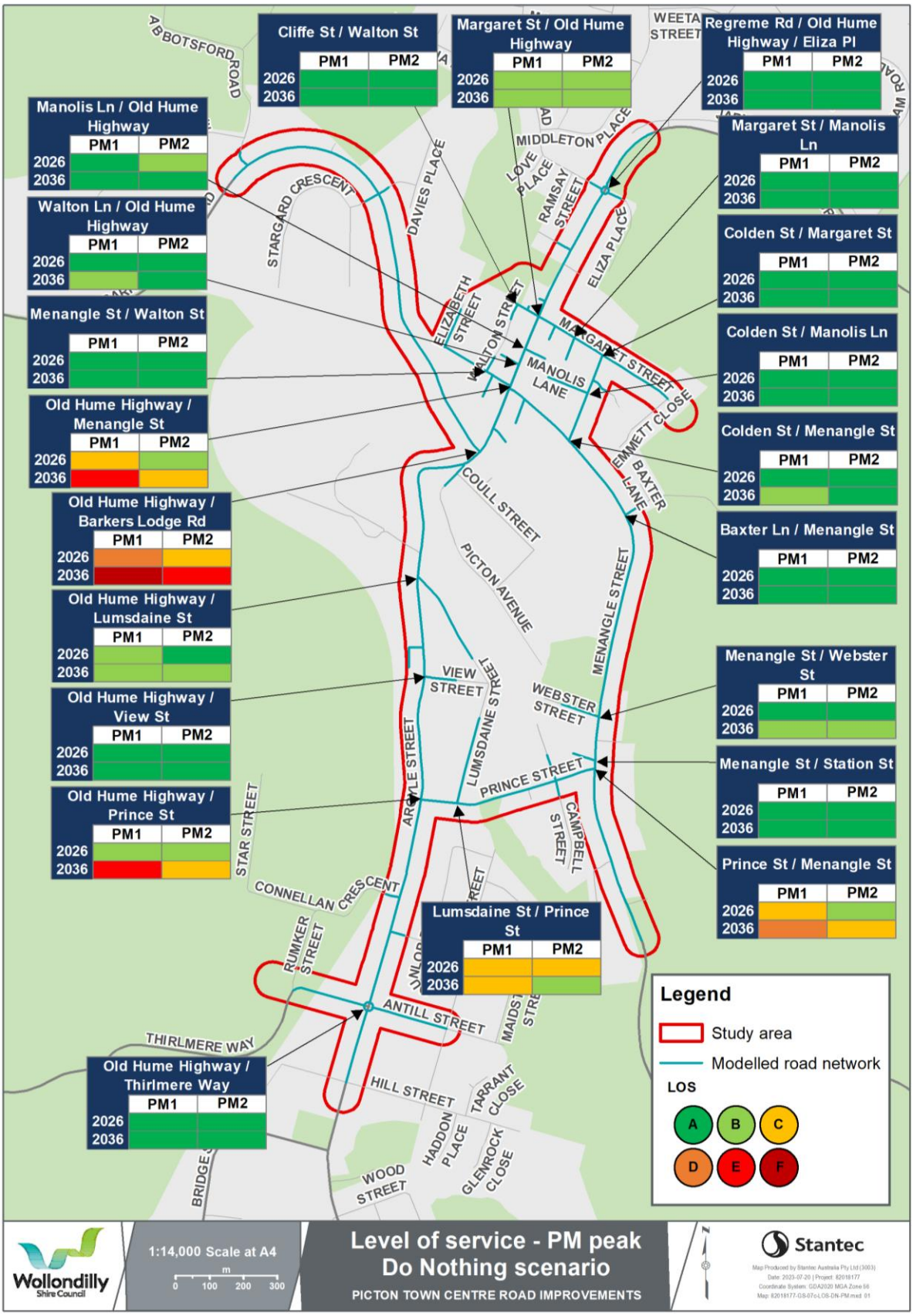


Figure 13: Do Nothing PM peak intersection level of service

6.3 DO NOTHING TRAVEL TIMES

Table 18 to **Table 21** show the Do Nothing travel times and average speeds for each two-hour peak for the travel time routes presented in **Section 3.2.3**. The main findings are:

- Average travel times and speeds on Argyle Street remain similar between the 2022 Base and 2026 Do Nothing scenarios in both the AM and PM peaks.
- In the first hour of the 2036 PM peak, travel times on Argyle Street northbound increase by 19 seconds, primarily due to delays in the Picton town centre from Barkers Lodge Road to Menangle Street. Otherwise, travel times remain similar between the 2022 Base scenario and the 2036 Do Nothing scenario.
- In the 2026 Do Nothing scenario, travel times on Prince Street remain similar to the 2022 Base scenario in both the AM and PM peaks. Increases of between seven and eight seconds are observed in the eastbound direction in the AM peak, and increases of between six and eight seconds are observed in the westbound direction in the PM peak.
- In the 2036 Do Nothing scenario, travel times on Prince Street eastbound increase by over two minutes in the first hour of the AM peak when compared to the 2022 Base scenario, and average speeds of seven kilometres per hour are observed. Travel times on Prince Street westbound increase by one minute in the first hour of the PM peak.
- In the first hour of the 2036 Do Nothing PM peak, travel times on Menangle Street northbound increase by 58 seconds over the 2022 Base scenario, primarily driven by delays exiting from Menangle Street to Argyle Street. Otherwise, travel times in the 2036 Do Nothing scenario increase by between 13 and 19 seconds over the 2022 Base scenario.

Table 18: 2026 Do Nothing AM peak travel times and average speeds

Route	Dir.	2026 Do Nothing AM peak					
		Travel time (mm:ss)		Compared to 2022 Base		Average speed (km/hr)	
		7:15am-8:15am	8:15am-9:15am	7:15am-8:15am	8:15am-9:15am	7:15am-8:15am	8:15am-9:15am
Argyle Street	NB	3:29	3:49	-00:00	-00:00	43	39
	SB	3:20	3:37	-00:00	+00:02	45	41
Menangle Street	NB	1:52	1:55	+00:11	+00:11	39	38
	SB	1:43	1:48	+00:12	+00:11	42	40
Prince Street	EB	1:29	1:30	+00:07	+00:08	21	21
	WB	1:06	1:09	+00:01	+00:04	28	27

Future base case operational results

Table 19: 2026 Do Nothing PM peak travel times and average speeds

Route	Dir.	2026 Do Nothing PM peak					
		Travel time (mm:ss)		Compared to 2022 Base		Average speed (km/hr)	
		3:15pm-4:15pm	4:15pm-5:15pm	3:15pm-4:15pm	4:15pm-5:15pm	3:15pm-4:15pm	4:15pm-5:15pm
Argyle Street	NB	3:41	3:32	+00:03	-00:00	41	42
	SB	3:40	3:33	+00:03	+00:04	41	42
Menangle Street	NB	2:11	2:00	+00:16	+00:14	33	37
	SB	1:48	1:43	+00:13	+00:12	41	42
Prince Street	EB	1:33	1:24	+00:10	+00:05	20	22
	WB	1:16	1:19	+00:06	+00:08	24	23

Table 20: 2036 Do Nothing AM peak travel times and average speeds

Route	Dir.	2036 Do Nothing AM peak					
		Travel time (mm:ss)		Compared to 2022 Base		Average speed (km/hr)	
		7:15am-8:15am	8:15am-9:15am	7:15am-8:15am	8:15am-9:15am	7:15am-8:15am	8:15am-9:15am
Argyle Street	NB	3:38	3:57	+00:09	+00:08	41	38
	SB	3:21	3:42	+00:01	+00:06	44	40
Menangle Street	NB	1:56	2:03	+00:16	+00:19	38	36
	SB	1:45	1:50	+00:14	+00:13	42	40
Prince Street	EB	4:12	2:16	+02:50	+00:54	7	14
	WB	1:31	1:18	+00:27	+00:14	20	23

Table 21: 2036 Do Nothing PM peak travel times and average speeds

Route	Dir.	2036 Do Nothing PM peak					
		Travel time (mm:ss)		Compared to 2022 Base		Average speed (km/hr)	
		3:15pm-4:15pm	4:15pm-5:15pm	3:15pm-4:15pm	4:15pm-5:15pm	3:15pm-4:15pm	4:15pm-5:15pm
Argyle Street	NB	3:57	3:37	+00:19	+00:05	38	41
	SB	3:39	3:33	+00:02	+00:05	41	42
Menangle Street	NB	2:53	2:05	+00:58	+00:19	25	35
	SB	1:47	1:47	+00:13	+00:15	41	41
Prince Street	EB	1:55	1:40	+00:31	+00:21	16	19
	WB	2:11	1:29	+01:01	+00:18	14	20

7.0 OPTION OPERATIONAL RESULTS

This section outlines the operational results for the Option scenarios described in **Section 2.0**.

7.1 DO NOTHING WITH SEAGULL INTERSECTION

As outlined in **Section 2.0**, the Do Nothing with Seagull Intersection scenario includes the following infrastructure upgrade from the Do Nothing scenario:

- Argyle Street / Prince Street seagull intersection

The traffic demand for the scenario is the same as the Do Nothing scenario and is described in **Section 4.0**.

7.1.1 Do Nothing with Seagull Intersection network performance

Table 22 summarises the Do Nothing with Seagull Intersection network performance results for the AM peak and PM peak in 2026 and 2036. The results indicate that:

- Trip demand remains the same in each peak between the Do Nothing and Do Nothing with Seagull Intersection scenarios.
- VHT decreases by a larger magnitude than VKT in the 2026 AM, 2026 PM and 2036 PM peaks, indicating road users experience a reduction in delay in the network. In the 2036 AM peak, VKT and VHT are similar to the Do Nothing scenario.
- Average travel times decrease by between 0.2 per cent and 4.6 per cent, and the average number of stops decrease by between 4.5 per cent and 9.1 per cent across all peaks, as the seagull intersection reduces conflicting movements at Argyle Street / Prince Street.
- There are no unreleased vehicles in each of the peak periods.

Option operational results

Table 22: Do Nothing with Seagull Intersection network performance

Network performance		Do Nothing with Seagull Intersection results				Compared to Do Nothing			
		2026 AM	2026 PM	2036 AM	2036 PM	2026 AM	2026 PM	2036 AM	2036 PM
All vehicles									
Total demand	veh	6149	7049	7212	8038	0 (+0%)	0 (+0%)	0 (+0%)	0 (+0%)
Completed trips	veh	6109	7064	7207	8060	+2 (+0%)	+16 (+0.2%)	-8 (-0.1%)	-27 (-0.3%)
Vehicle kilometres travelled	km	12738	14774	15374	17156	+17 (+0.1%)	+40 (+0.3%)	-79 (-0.5%)	-362 (-2.1%)
Vehicle hours travelled	hr	329	381	439	467	-1 (-0.3%)	-6 (-1.7%)	-1 (-0.3%)	-24 (-4.9%)
Total number of stops	stop	7206	8918	10369	11499	-395 (-5.2%)	-816 (-8.4%)	-501 (-4.6%)	-1192 (-9.4%)
Averages per vehicle									
Average trip length	km	2.09	2.09	2.13	2.13	0 (+0.1%)	0 (+0%)	-0.01 (-0.4%)	-0.04 (-1.7%)
Average travel time in network	sec	194	194	219	208	-1 (-0.4%)	-4 (-1.9%)	0 (-0.2%)	-10 (-4.6%)
Average number of stops	stop	1.18	1.26	1.44	1.43	-0.07 (-5.2%)	-0.12 (-8.6%)	-0.07 (-4.5%)	-0.14 (-9.1%)
Average speed	km/h	38.7	38.7	35.1	36.8	+0.2 (+0.5%)	+0.7 (+2%)	-0.1 (-0.2%)	+1.1 (+2.9%)
Unreleased demand									
Unreleased vehicles	veh	0	0	0	0	+0	+0	+0	+0
Proportion of demand unreleased	%	0%	0%	0%	0%				

7.1.2 Do Nothing with Seagull Intersection intersection performance

Table 23 and **Table 24** show the Do Nothing with Seagull Intersection intersection performance results for the AM and PM peaks for the future years of 2026 and 2036 respectively. **Figure 14** and **Figure 15** show the Do Nothing with Seagull Intersection intersection LOS results for the AM peak and PM peak, respectively. The intersection performance results indicate that:

- All intersections in 2026 perform satisfactorily at LOS C or better in all modelled hours of the AM and PM peaks.
- Argyle Street / Menangle Street performs at LOS D in the first hour of the 2036 Do Nothing scenario PM peak, due to a combination of high opposing traffic volumes along Argyle Street and parking activity in the town centre.
- In 2036, the Argyle Street / Barkers Lodge Road intersection performs at LOS D or worse in the second hour of the AM peak and both hours of the PM peak.

  - Road users experience average delays of over 100 seconds on the Barkers Lodge Road approach, as high volumes along Argyle Street reduce opportunities to turn out of Barkers Lodge Road.
- In 2036, Prince Street / Menangle Street performs at LOS F in both hours of the AM peak, and LOS D or worse in both hours of the PM peak.
  - In the AM peak, high demand for the right turn movement from Prince Street into Menangle Street results in queuing on Prince Street eastbound which extends onto Victoria Bridge, blocking westbound movements.
  - In the PM peak, high traffic volumes on Menangle Street reduce opportunities for vehicles to turn out of Prince Street.

Option operational results

Table 23: 2026 Do Nothing with Seagull Intersection scenario intersection performance

Intersection	2026 Do Nothing with Seagull Intersection AM peak								2026 Do Nothing with Seagull Intersection PM peak							
	7:15am-8:15am				8:15am-9:15am				3:15pm-4:15pm				4:15pm-5:15pm			
	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)
Regreme Rd / Argyle Street	1044	3.2	A	3	1003	9.0	A	3	1249	2.5	A	5	1260	2.2	A	3
Margaret St / Argyle Street	1148	11.5	A	13	1138	14.1	B	12	1405	20.4	B	18	1396	21.0	B	13
Manolis Ln / Argyle Street	1056	4.6	A	4	995	6.6	A	5	1315	12.4	A	11	1275	15.5	B	10
Walton Ln / Argyle Street	1047	5.9	A	3	968	2.0	A	6	1284	12.9	A	10	1242	2.0	A	7
Argyle Street / Menangle St	1358	22.2	B	15	1458	18.1	B	29	1667	37.4	C	22	1557	19.1	B	10
Menangle St / Walton St	61	1.9	A	1	117	1.6	A	1	71	1.7	A	0	69	1.7	A	1
Cliffe St / Walton St	74	2.0	A	0	151	2.5	A	1	137	2.2	A	1	170	2.2	A	2
Colden St / Menangle St	589	13.1	A	10	747	8.8	A	9	794	8.5	A	9	753	6.4	A	8
Colden St / Manolis Ln	258	2.4	A	1	424	3.2	A	2	530	3.8	A	2	503	3.5	A	2
Colden St / Margaret St	182	1.8	A	1	277	2.1	A	1	357	2.1	A	3	300	2.0	A	2
Margaret St / Manolis Ln	208	2.7	A	2	291	2.9	A	2	422	4.6	A	4	368	3.0	A	2
Argyle Street / Barkers Lodge Rd	1222	22.9	B	11	1339	40.7	C	16	1616	38.5	C	22	1483	31.7	C	17
Argyle Street / Lumsdaine St	1044	13.4	A	2	1148	23.2	B	2	1345	21.2	B	2	1199	13.6	A	2
Argyle Street / View St	413	2.6	A	2	497	30.2	C	2	752	11.0	A	2	735	1.1	A	1
Lumsdaine St / Prince St	631	19.6	B	6	622	24.9	B	6	702	17.5	B	9	658	21.1	B	7
Argyle Street / Prince St	1586	9.1	A	5	1680	9.6	A	4	1955	16.6	B	8	1798	11.6	A	5
Prince St / Menangle St	1129	37.4	C	14	1184	31.8	C	11	1300	32.9	C	12	1257	24.5	B	7
Menangle St / Station St	581	2.9	A	1	696	5.5	A	2	772	10.7	A	3	741	6.3	A	3
Menangle St / Webster St	543	5.2	A	4	661	11.3	A	2	740	8.8	A	6	698	15.9	B	3
Argyle Street / Thirlmere Way	990	4.9	A	0	1001	5.3	A	0	923	8.4	A	0	731	7.2	A	0
Baxter Ln / Menangle St	672	3.7	A	0	673	3.5	A	0	678	8.4	A	0	545	7.2	A	0

Option operational results

Table 24: 2036 Do Nothing with Seagull Intersection scenario intersection performance

Intersection	2036 Do Nothing with Seagull Intersection AM peak								2036 Do Nothing with Seagull Intersection PM peak							
	7:15am-8:15am				8:15am-9:15am				3:15pm-4:15pm				4:15pm-5:15pm			
	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)
Regreme Rd / Argyle Street	1193	3.3	A	4	1144	3.6	A	4	1363	8.5	A	3	1333	5.9	A	4
Margaret St / Argyle Street	1288	12.4	A	14	1289	15.8	B	17	1540	22.9	B	16	1497	21.3	B	19
Manolis Ln / Argyle Street	1192	19.2	B	6	1158	7.4	A	5	1430	17.3	B	11	1371	11.5	A	8
Walton Ln / Argyle Street	1176	3.2	A	6	1130	4.0	A	6	1398	19.4	B	5	1335	7.9	A	7
Argyle Street / Menangle St	1614	34.7	C	24	1763	27.5	B	28	1961	53.3	D	30	1806	27.9	B	13
Menangle St / Walton St	96	1.9	A	1	159	5.0	A	2	125	1.6	A	1	103	1.9	A	1
Cliffe St / Walton St	78	2.1	A	0	140	2.4	A	1	145	2.1	A	1	154	2.1	A	1
Colden St / Menangle St	875	15.7	B	12	1011	13.7	A	16	1050	18.7	B	15	973	11.4	A	12
Colden St / Manolis Ln	357	3.2	A	1	491	3.8	A	1	590	3.9	A	2	534	4.5	A	2
Colden St / Margaret St	246	2.0	A	2	314	2.2	A	1	410	2.2	A	2	343	2.2	A	1
Margaret St / Manolis Ln	231	3.4	A	3	309	3.8	A	2	457	5.9	A	2	407	4.8	A	3
Argyle Street / Barkers Lodge Rd	1431	39.7	C	14	1609	82.9	F	23	1850	157	F	26	1684	51.8	D	18
Argyle Street / Lumsdaine St	1173	12.3	A	2	1362	28.1	C	3	1506	18.0	B	2	1349	18.5	B	1
Argyle Street / View St	458	4.5	A	1	555	32.9	C	3	838	11.8	A	2	803	1.9	A	1
Lumsdaine St / Prince St	694	40.5	C	10	697	32.2	C	12	789	24.9	B	11	703	17.3	B	9
Argyle Street / Prince St	1773	10.4	A	8	1928	13.9	A	12	2161	21.3	B	7	1987	17.2	B	5
Prince St / Menangle St	1502	206	F	41	1540	98.5	F	22	1656	55.4	D	13	1573	56.7	E	11
Menangle St / Station St	874	4.9	A	3	964	8.6	A	4	1005	5.4	A	7	927	8.7	A	5
Menangle St / Webster St	823	2.5	A	6	915	13.6	A	4	977	6.9	A	15	882	5.7	A	5
Argyle Street / Thirlmere Way	1067	9.1	A	0	1086	7.8	A	0	967	8.7	A	0	808	19.7	B	0
Baxter Ln / Menangle St	688	4.9	A	0	705	6.3	A	0	714	7.7	A	0	593	5.9	A	0

Option operational results

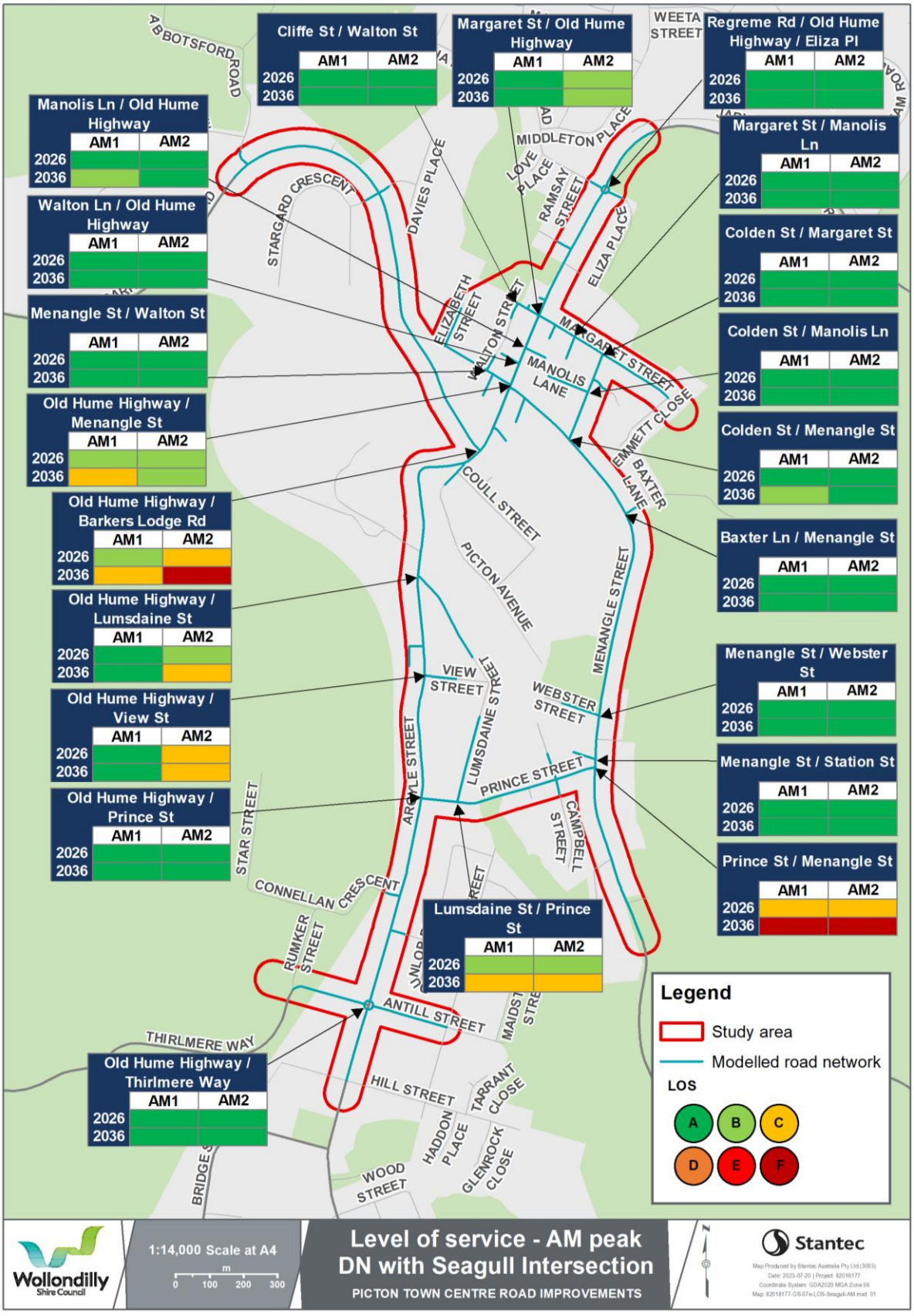


Figure 14: Do Nothing with Seagull Intersection AM peak intersection level of service

Option operational results

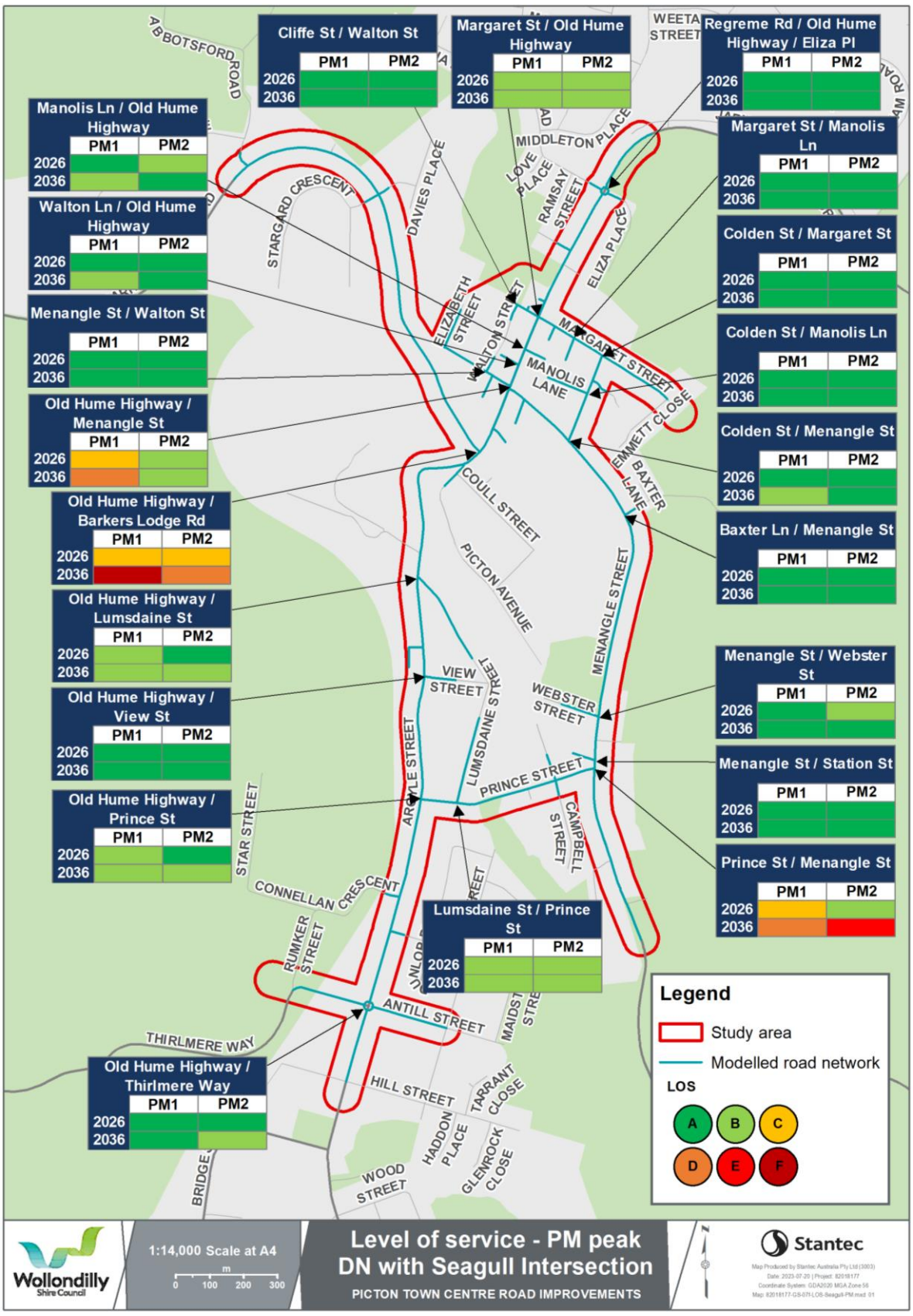


Figure 15: Do Nothing with Seagull Intersection PM peak intersection level of service

7.1.3 Do Nothing with Seagull Intersection travel times

Table 29 to **Table 32** show the Do Nothing with Seagull Intersection travel times and average speeds for each two-hour peak for the travel time routes presented in **Section 3.2.3**. The main findings are:

- Average travel times and speeds on Argyle Street remain similar between the Do Nothing and Do Nothing with Seagull Intersection scenarios in both the 2026 and 2036 AM and PM peaks.
- In the 2036 AM peak, travel times on Prince Street eastbound increase by approximately 25 seconds when compared to the Do Nothing scenario.
  - The Argyle Street / Prince Street seagull intersection upgrade marginally increases the attractiveness of the right turn from Argyle Street northbound to Prince Street eastbound. The slight increase in vehicles using Prince Street to access Menangle Street results in a significant increase in delay along Prince Street eastbound, due to the highly congested conditions under the 2036 AM peak.
- Average travel times and speeds on Prince Street eastbound remain similar between the Base and Do Nothing with Seagull Intersection scenarios in the 2026 AM, 2026 PM and 2036 PM peaks.
- Average travel times and speeds on Prince Street westbound improve in all modelled future years and peaks. A travel time reduction of over one minute is observed in the first hour of the 2036 PM peak.
  - The seagull intersection upgrade allows vehicles to turn freely onto Argyle Street southbound, resulting in reduced delay on this route.
- In the 2036 PM peak, travel times on Menangle Street northbound reduce by 17 seconds when compared to the Do Nothing scenario.
  - In the Do Nothing scenario, vehicles exiting Prince Street westbound onto Argyle Street experienced high delay in the first hour of the PM peak. Some vehicles travelling to Argyle Street south, Thirlmere Way and Antill Street would instead travel north to the Argyle Street / Menangle Street intersection to access Argyle Street southbound. The Argyle Street / Prince Street seagull intersection upgrade reduces delay on the Prince Street westbound route, and as a result reduces the volume of vehicles detouring via Menangle Street northbound.
- Average travel times and speeds on Menangle Street remain similar between the Base and Do Nothing with Seagull Intersection scenarios in the 2026 AM, 2026 PM and 2036 AM peaks.

Option operational results

Table 25: 2026 Do Nothing with Seagull Intersection AM peak travel times and average speeds

Route	Dir.	2026 Do Nothing with Seagull Intersection AM peak					
		Travel time (mm:ss)		Compared to Do Nothing		Average speed (km/hr)	
		7:15am-8:15am	8:15am-9:15am	7:15am-8:15am	8:15am-9:15am	7:15am-8:15am	8:15am-9:15am
Argyle Street	NB	3:30	3:48	+00:00	-00:01	43	39
	SB	3:23	3:41	+00:02	+00:03	44	40
Menangle Street	NB	1:53	1:55	+00:01	-00:00	39	38
	SB	1:43	1:47	-00:00	-00:01	42	41
Prince Street	EB	1:33	1:32	+00:04	+00:02	20	20
	WB	1:04	1:04	-00:01	-00:04	31	31

Table 26: 2026 Do Nothing with Seagull Intersection PM peak travel times and average speeds

Route	Dir.	2026 Do Nothing with Seagull Intersection PM peak					
		Travel time (mm:ss)		Compared to Do Nothing		Average speed (km/hr)	
		3:15pm-4:15pm	4:15pm-5:15pm	3:15pm-4:15pm	4:15pm-5:15pm	3:15pm-4:15pm	4:15pm-5:15pm
Argyle Street	NB	3:40	3:33	-00:01	+00:00	41	42
	SB	3:40	3:31	+00:01	-00:02	41	42
Menangle Street	NB	2:17	1:58	+00:06	-00:02	32	37
	SB	1:46	1:45	-00:02	+00:02	41	42
Prince Street	EB	1:34	1:23	+00:00	-00:01	20	22
	WB	1:03	1:04	-00:13	-00:15	32	31

Table 27: 2036 Do Nothing with Seagull Intersection AM peak travel times and average speeds

Route	Dir.	2036 Do Nothing with Seagull Intersection AM peak					
		Travel time (mm:ss)		Compared to Do Nothing		Average speed (km/hr)	
		7:15am-8:15am	8:15am-9:15am	7:15am-8:15am	8:15am-9:15am	7:15am-8:15am	8:15am-9:15am
Argyle Street	NB	3:36	3:57	-00:03	+00:01	42	38
	SB	3:23	3:48	+00:01	+00:07	44	39
Menangle Street	NB	1:57	2:03	+00:01	+00:00	38	36
	SB	1:45	1:52	-00:00	+00:02	42	39
Prince Street	EB	4:32	2:41	+00:20	+00:25	7	12
	WB	1:08	1:06	-00:23	-00:12	29	30

Table 28: 2036 Do Nothing with Seagull Intersection PM peak travel times and average speeds

Route	Dir.	2036 Do Nothing with Seagull Intersection PM peak					
		Travel time (mm:ss)		Compared to Do Nothing		Average speed (km/hr)	
		3:15pm-4:15pm	4:15pm-5:15pm	3:15pm-4:15pm	4:15pm-5:15pm	3:15pm-4:15pm	4:15pm-5:15pm
Argyle Street	NB	3:52	3:31	-00:05	-00:06	39	43
	SB	3:45	3:36	+00:07	+00:03	40	41
Menangle Street	NB	2:36	2:06	-00:17	+00:01	28	35
	SB	1:51	1:47	+00:03	+00:00	39	41
Prince Street	EB	1:56	1:55	+00:02	+00:16	16	16
	WB	1:05	1:03	-01:06	-00:26	31	32

7.2 DO NOTHING WITH PICTON BYPASS

As outlined in **Section 2.0**, the Do Nothing with Picton Bypass scenario does not include any infrastructure changes except for those included in the Do Nothing scenario. The traffic demand for the scenario reflects the reassignment of traffic to routes outside the study area with the Picton Bypass operational, and is described in **Section 4.0**.

7.2.1 Do Nothing with Picton Bypass network performance

Table 29 summarises the Do Nothing with Picton Bypass network performance results for the AM peak and PM peak in 2036. Compared to the 2036 Do Nothing scenario, the results indicate that:

- Total traffic demand decreases by 16 per cent in the AM peak and 17 per cent in the PM peak. The alternate route provided by the Picton Bypass allows traffic to avoid the Picton town centre, as explained in **Section 4.3.1**.
- In the AM peak, VKT decreases by 20 per cent, while VHT decreases by 28 per cent. Similarly, VKT decreases by 21 per cent and VHT decreases by 28 per cent in the PM peak. VHT decreases by a larger magnitude than VKT in both peaks, indicating road users experience a reduction in delay in the network.
- In both peaks, average travel times reduce by 13 per cent, average stops decrease by 27 per cent, and average speeds increase by ten per cent, due to a reduction in congestion across the network.
- There are no unreleased vehicles in each of the peak periods.

Option operational results

Table 29: Do Nothing with Picton Bypass network performance

Network performance		Do Nothing with Picton Bypass results		Compared to 2036 Do Nothing	
		2036 AM	2036 PM	2036 AM	2036 PM
All vehicles					
Total demand	veh	5998	6609	-1214 (-16.8%)	-1429 (-17.8%)
Completed trips	veh	5984	6645	-1231 (-17.1%)	-1442 (-17.8%)
Vehicle kilometres travelled	km	12367	13756	-3086 (-20%)	-3762 (-21.5%)
Vehicle hours travelled	hr	315	350	-125 (-28.4%)	-140 (-28.6%)
Total number of stops	stop	6420	7548	-4450 (-40.9%)	-5143 (-40.5%)
Averages per vehicle					
Average trip length	km	2.07	2.07	-0.08 (-3.5%)	-0.1 (-4.4%)
Average travel time in network	sec	189	190	-30 (-13.7%)	-29 (-13.1%)
Average number of stops	stop	1.07	1.14	-0.43 (-28.8%)	-0.43 (-27.6%)
Average speed	km/h	39.3	39.3	+4.1 (+11.8%)	+3.6 (+10%)
Unreleased demand					
Unreleased vehicles	veh	0	0	+0	+0
Proportion of demand unreleased	%	0%	0%		

7.2.2 Do Nothing with Picton Bypass intersection performance

Table 30 shows the Do Nothing with Picton Bypass intersection performance results for the AM and PM peaks for the future year of 2036. **Figure 16** shows the Do Nothing with Picton Bypass intersection LOS results. The intersection performance results indicate that:

- Argyle Street / Barkers Lodge Road operates at LOS D in the second hour of the AM peak and in both hours of the PM peak.
  - Road users experience average delays of approximately 50 seconds on the right turn movement from Barkers Lodge Road to Argyle Street, due to high opposing traffic volumes along Argyle Street.
- All other intersections perform satisfactorily at LOS C or better in all modelled hours of the AM and PM peaks.

Option operational results

Table 30: 2036 Do Nothing with Picton Bypass scenario intersection performance

Intersection	2036 Do Nothing with Picton Bypass scenario AM peak								2036 Do Nothing with Picton Bypass scenario PM peak							
	7:15am-8:15am				8:15am-9:15am				3:15pm-4:15pm				4:15pm-5:15pm			
	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)
Regreme Rd / Argyle Street	1092	4.1	A	3	1048	4.1	A	4	1165	2.1	A	4	1203	2.4	A	4
Margaret St / Argyle Street	1176	13.1	A	14	1177	17.0	B	15	1320	22.1	B	15	1342	21.1	B	15
Manolis Ln / Argyle Street	1072	9.9	A	5	1007	11.9	A	5	1215	6.8	A	4	1220	21.3	B	8
Walton Ln / Argyle Street	1054	2.6	A	5	980	2.7	A	5	1191	12.0	A	6	1174	6.8	A	5
Argyle Street / Menangle St	1428	16.5	B	16	1504	25.9	B	29	1693	27.0	B	26	1609	20.5	B	16
Menangle St / Walton St	104	1.6	A	2	162	2.6	A	1	117	1.8	A	1	100	1.8	A	1
Cliffe St / Walton St	77	2.1	A	0	151	2.2	A	1	137	2.3	A	1	154	2.1	A	1
Colden St / Menangle St	778	16.3	B	7	924	14.4	B	8	969	13.0	A	12	911	9.0	A	8
Colden St / Manolis Ln	357	3.0	A	1	513	4.3	A	2	558	5.7	A	2	517	3.7	A	2
Colden St / Margaret St	238	1.9	A	1	330	2.1	A	2	381	2.1	A	2	329	1.9	A	2
Margaret St / Manolis Ln	245	2.6	A	3	327	4.4	A	3	421	3.7	A	5	393	3.1	A	4
Argyle Street / Barkers Lodge Rd	1290	32.4	C	18	1399	46.1	D	19	1629	48.5	D	20	1521	45.5	D	16
Argyle Street / Lumsdaine St	1067	13.8	A	2	1167	19.3	B	2	1289	15.5	B	2	1162	7.6	A	2
Argyle Street / View St	1111	5.8	A	1	1224	11.1	A	2	1326	15.1	B	2	1193	7.1	A	1
Lumsdaine St / Prince St	232	18.2	B	2	226	21.0	B	3	210	17.2	B	5	176	15.5	B	4
Argyle Street / Prince St	1202	7.7	A	4	1296	9.3	A	6	1399	10.0	A	4	1273	9.9	A	5
Prince St / Menangle St	910	14.7	B	4	982	14.5	B	4	1049	9.2	A	3	1003	10.6	A	2
Menangle St / Station St	783	4.0	A	1	905	5.9	A	3	992	4.3	A	3	939	3.6	A	1
Menangle St / Webster St	735	2.0	A	4	864	2.9	A	6	959	13.4	A	6	890	2.4	A	4
Argyle Street / Thirlmere Way	1193	6.6	A	0	1323	9.6	A	0	1463	8.2	A	0	1290	10.8	A	0
Baxter Ln / Menangle St	806	2.7	A	0	909	3.0	A	0	1052	3.8	A	0	940	5.5	A	0

Option operational results

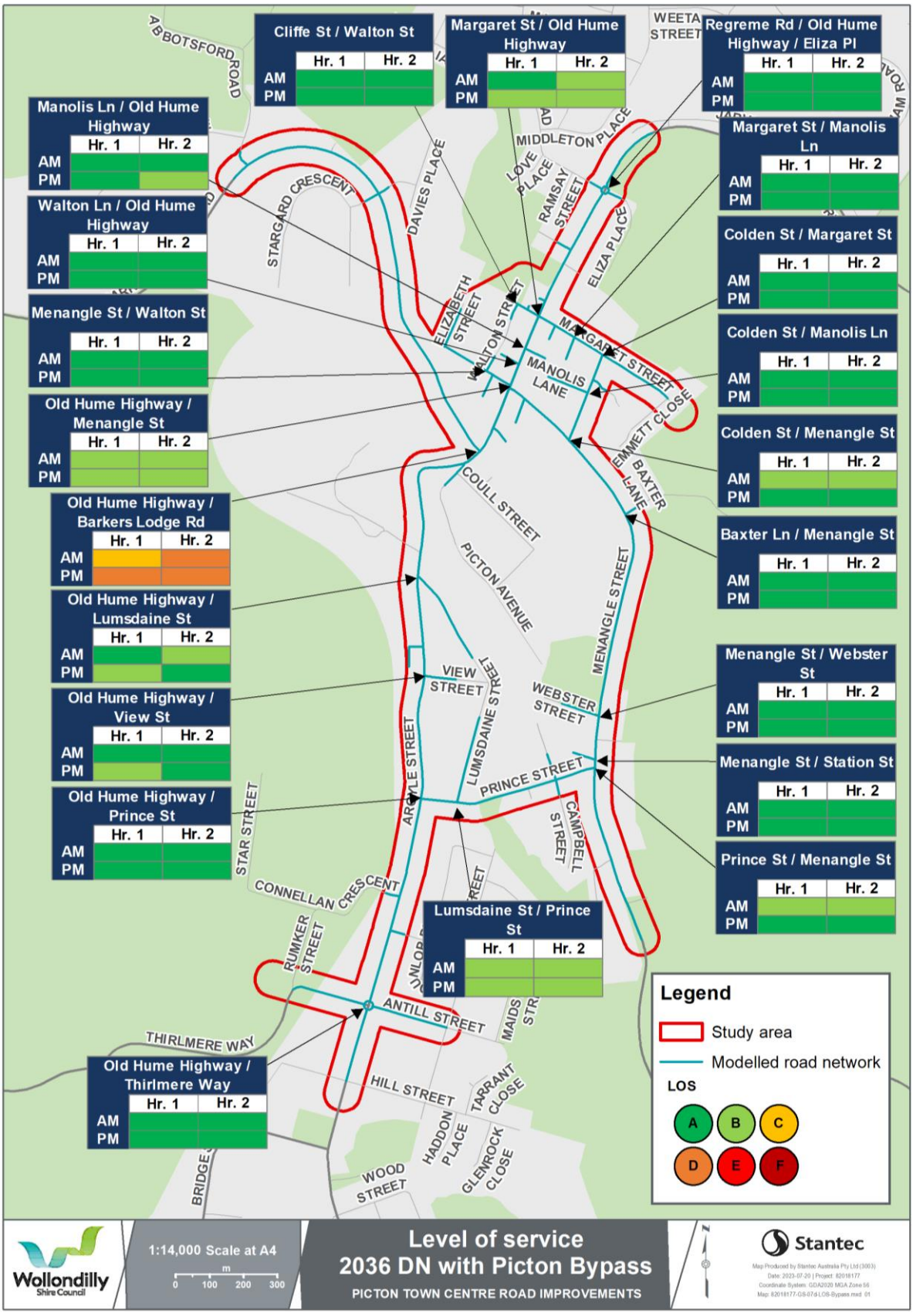


Figure 16: 2036 Do Nothing with Picton Bypass scenario intersection level of service

7.2.3 Do Nothing with Picton Bypass travel times

Table 31 and **Table 32** show the Do Nothing with Picton Bypass travel times and average speeds for each two-hour peak for the travel time routes presented in **Section 3.2.3**. The main findings are:

- Vehicles experience travel time reductions on all routes due to the reduction in traffic demand and congestion in the network.
- Travel times on Argyle Street northbound decrease by 18 seconds in the first hour of the PM peak, as reduced traffic volumes along the Argyle Street corridor reduce queuing in the Picton town centre.
- Travel times on Prince Street eastbound decrease by over three minutes in the first hour of the AM peak. The introduction of the Picton Bypass results in a reduction in vehicles travelling eastbound along Prince Street to reach the Hume Motorway.
- Travel times on Prince Street westbound decrease by over one minute in the first hour of the PM peak. The introduction of the Picton Bypass results in a reduction in vehicles travelling westbound along Prince Street to reach areas such as Thirlmere and Tahmoor.
- Travel times on Menangle Street northbound decrease by 45 seconds in the first hour of the PM peak, as reduced volumes on Argyle Street provide more opportunities for vehicles to turn out of Menangle Street.

Table 31: 2036 Do Nothing with Picton Bypass AM peak travel times and average speeds

Route	Dir.	2036 Do Nothing with Picton Bypass AM peak					
		Travel time (mm:ss)		Compared to Do Nothing		Average speed (km/hr)	
		7:15am-8:15am	8:15am-9:15am	7:15am-8:15am	8:15am-9:15am	7:15am-8:15am	8:15am-9:15am
Argyle Street	NB	3:32	3:51	-00:06	-00:06	42	39
	SB	3:22	3:40	+00:01	-00:01	44	41
Menangle Street	NB	1:53	1:58	-00:03	-00:05	39	37
	SB	1:44	1:49	-00:01	-00:01	42	40
Prince Street	EB	1:01	1:02	-03:11	-01:14	30	30
	WB	0:59	1:03	-00:32	-00:15	31	29

Table 32: 2036 Do Nothing with Picton Bypass PM peak travel times and average speeds

Route	Dir.	2036 Do Nothing with Picton Bypass PM peak					
		Travel time (mm:ss)		Compared to Do Nothing		Average speed (km/hr)	
		3:15pm-4:15pm	4:15pm-5:15pm	3:15pm-4:15pm	4:15pm-5:15pm	3:15pm-4:15pm	4:15pm-5:15pm
Argyle Street	NB	3:39	3:32	-00:18	-00:05	41	42
	SB	3:33	3:28	-00:06	-00:05	42	43
Menangle Street	NB	2:08	2:01	-00:45	-00:03	34	36
	SB	1:44	1:43	-00:03	-00:04	42	43
Prince Street	EB	1:04	0:58	-00:51	-00:41	29	32
	WB	1:00	0:55	-01:11	-00:35	30	33

7.3 PRINCE STREET WESTBOUND ONLY TRAFFIC FLOW

As outlined in **Section 2.0**, the Prince Street westbound only scenario includes the following infrastructure upgrade from the Do Nothing scenario:

- Banning of eastbound traffic movements from Argyle Street to Menangle Street

The traffic demand for the scenario is the same as the Do Nothing scenario and is described in **Section 4.0**.

7.3.1 Prince Street westbound only network performance

Table 33 summarises the Prince Street westbound only network performance results for the AM peak and PM peak in 2026 and 2036. The results indicate that:

- Trip demand remains the same in each peak between the Do Nothing and Prince Street westbound only scenarios.
- In 2026, VKT and average trip length increase by around 11 per cent in the AM peak and seven per cent in the PM peak.
  - Vehicles reroute through the Picton town centre to travel from Argyle Street to Menangle Street, due to the eastbound movement ban on Prince Street. This leads to an increase in average trip length.
  - In both peaks, VKT and VHT increase in a similar proportion to the increase in average trip length. This indicates that congestion within the network remains similar to the Do Nothing scenario.
- In 2036, VHT increases by a larger magnitude than VKT in the AM and PM peaks, indicating that road users are experiencing an increase in delay in the network.
  - Vehicles rerouting through the Picton town centre turn right at the Argyle Street / Menangle Street intersection. Higher volumes for this movement result in queuing and delay along Argyle Street northbound, increasing congestion in the town centre.
- Average travel time and number of stops increase, and average speed decreases across the 2036 AM and PM peaks.
- There are no unreleased vehicles in each of the peak periods.

Option operational results

Table 33: Prince Street westbound only network performance

Network performance		Prince Street westbound only results				Compared to Do Nothing			
		2026 AM	2026 PM	2036 AM	2036 PM	2026 AM	2026 PM	2036 AM	2036 PM
All vehicles									
Total demand	veh	6149	7049	7212	8038	0 (+0%)	0 (+0%)	0 (+0%)	0 (+0%)
Completed trips	veh	6085	7061	7092	8099	-22 (-0.4%)	+13 (+0.2%)	-123 (-1.7%)	+12 (+0.1%)
Vehicle kilometres travelled	km	14156	15823	16592	18304	+1435 (+11.3%)	+1089 (+7.4%)	+1138 (+7.4%)	+786 (+4.5%)
Vehicle hours travelled	hr	371	412	511	671	+41 (+12.4%)	+24 (+6.3%)	+71 (+16.2%)	+181 (+36.8%)
Total number of stops	stop	6873	9452	10887	15066	-728 (-9.6%)	-282 (-2.9%)	+17 (+0.2%)	+2375 (+18.7%)
Averages per vehicle									
Average trip length	km	2.33	2.24	2.34	2.26	+0.24 (+11.7%)	+0.15 (+7.2%)	+0.2 (+9.2%)	+0.09 (+4.3%)
Average travel time in network	sec	219	210	259	298	+25 (+12.8%)	+12 (+6.1%)	+40 (+18.2%)	+80 (+36.6%)
Average number of stops	stop	1.13	1.34	1.54	1.86	-0.12 (-9.3%)	-0.04 (-3.1%)	+0.03 (+1.9%)	+0.29 (+18.5%)
Average speed	km/h	38.2	38.4	32.5	27.3	-0.4 (-1%)	+0.4 (+1%)	-2.7 (-7.6%)	-8.4 (-23.6%)
Unreleased demand									
Unreleased vehicles	veh	0	0	0	0	+0	+0	+0	+0
Proportion of demand unreleased	%	0%	0%	0%	0%				

7.3.2 Prince Street westbound only intersection performance

Table 34 and **Table 35** show the Prince Street westbound only intersection performance results for the AM and PM peaks for the future years of 2026 and 2036 respectively. **Figure 17** and **Figure 18** show the Prince Street westbound only intersection LOS results for the AM peak and PM peak, respectively. The intersection performance results indicate that:

- Argyle Street / Menangle Street performs at LOS D in the first hour of the 2026 AM peak and at LOS E in the first hour of the 2026 PM peak, as vehicles travelling eastbound from Argyle Street to Menangle Street reroute to turn right at the intersection, due to the eastbound movement ban on Prince Street.
- Argyle Street / Barkers Lodge Road operates at LOS D or worse across all hours of the 2026 AM and PM peaks.

  - Volumes on Argyle Street northbound increase, due to the rerouting caused by the Prince Street eastbound movement ban. As a result, there are fewer opportunities for vehicles to turn out of Barkers Lodge Road, resulting in increased delay at the intersection.
- Manolis Lane / Argyle Street performs at LOS D in the first hour of the 2026 PM peak. A small number of vehicles experience delays turning right out of Manolis Lane.
- All other intersections in 2026 perform satisfactorily at LOS C or better in all modelled hours of the AM and PM peaks.
- In 2036, the Argyle Street / Menangle Street intersection performs unsatisfactorily at LOS D or worse in the first hour of the AM peak, and both hours of the PM peak, due to the rerouting explained above.
- Argyle Street / Barkers Lodge Road operates at LOS F across all hours of the 2036 AM and PM peaks, as a result of high northbound volumes on Argyle Street. Queue spillback from the Argyle Street / Menangle Street intersection also blocks movements out of Barkers Lodge Road.
- In the 2036 PM peak, Argyle Street / Prince Street performs unsatisfactorily at LOS F in the first hour of the PM peak, as there are limited opportunities to turn out of Prince Street onto Argyle Street.

Option operational results

Table 34: 2026 Prince Street westbound only scenario intersection performance

Intersection	2026 Prince Street westbound only AM peak								2026 Prince Street westbound only PM peak							
	7:15am-8:15am				8:15am-9:15am				3:15pm-4:15pm				4:15pm-5:15pm			
	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)
Regreme Rd / Argyle Street	1039	7.3	A	3	1000	2.2	A	4	1217	4.4	A	4	1259	2.1	A	3
Margaret St / Argyle Street	1137	10.8	A	13	1120	13.1	A	11	1399	21.4	B	14	1388	19.9	B	12
Manolis Ln / Argyle Street	1053	4.8	A	3	993	5.1	A	7	1332	44.7	D	13	1271	10.7	A	9
Walton Ln / Argyle Street	1048	5.9	A	3	964	2.0	A	4	1305	20.7	B	8	1228	1.9	A	7
Argyle Street / Menangle St	1738	45.6	D	28	1766	36.0	C	31	1989	60.0	E	33	1809	25.0	B	24
Menangle St / Walton St	61	1.9	A	0	117	1.6	A	0	85	1.6	A	1	71	1.8	A	1
Cliffe St / Walton St	73	2.0	A	1	143	2.5	A	0	136	2.3	A	1	162	2.3	A	0
Colden St / Menangle St	938	20.6	B	16	1018	21.6	B	15	1056	21.7	B	17	951	10.3	A	12
Colden St / Manolis Ln	246	2.4	A	1	393	3.3	A	3	498	4.1	A	3	475	2.5	A	2
Colden St / Margaret St	172	1.8	A	2	250	2.0	A	1	327	2.1	A	3	292	2.2	A	2
Margaret St / Manolis Ln	208	2.6	A	3	279	3.5	A	2	410	3.3	A	4	369	2.8	A	3
Argyle Street / Barkers Lodge Rd	1604	55.0	D	11	1641	144	F	28	1919	88.7	F	26	1741	50.4	D	12
Argyle Street / Lumsdaine St	1436	22.2	B	4	1474	29.4	C	2	1652	25.9	B	2	1453	20.3	B	2
Argyle Street / View St	1432	9.5	A	1	1490	16.8	B	2	1649	15.0	B	2	1464	11.0	A	1
Lumsdaine St / Prince St	236	2.2	A	1	296	2.4	A	1	388	2.5	A	1	399	3.9	A	1
Argyle Street / Prince St	1590	8.9	A	5	1688	13.0	A	7	1943	20.8	B	15	1795	12.7	A	8
Prince St / Menangle St	1101	4.6	A	1	1157	8.1	A	2	1268	12.8	A	3	1213	11.6	A	3
Menangle St / Station St	920	2.3	A	1	956	4.4	A	2	976	3.9	A	4	871	4.8	A	1
Menangle St / Webster St	884	5.2	A	4	924	12.1	A	5	951	17.2	B	3	829	2.1	A	3
Argyle Street / Thirlmere Way	1554	9.5	A	0	1671	10.0	A	0	1940	11.4	A	0	1775	6.5	A	0
Baxter Ln / Menangle St	1129	3.3	A	0	1232	4.5	A	0	1468	6.6	A	0	1322	5.9	A	0

Option operational results

Table 35: 2036 Prince Street westbound only scenario intersection performance

Intersection	2036 Prince Street westbound only AM peak								2036 Prince Street westbound only PM peak							
	7:15am-8:15am				8:15am-9:15am				3:15pm-4:15pm				4:15pm-5:15pm			
	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)
Regreme Rd / Argyle Street	1172	2.3	A	3	1150	4.0	A	2	1321	2.9	A	4	1337	13.9	A	4
Margaret St / Argyle Street	1276	12.7	A	14	1278	14.9	B	14	1518	22.9	B	15	1525	21.7	B	16
Manolis Ln / Argyle Street	1182	26.3	B	7	1131	15.0	B	3	1401	16.1	B	12	1401	14.0	B	10
Walton Ln / Argyle Street	1162	8.5	A	6	1098	1.8	A	6	1368	14.5	B	9	1364	3.6	A	8
Argyle Street / Menangle St	1967	65.4	E	34	1951	40.9	C	35	2145	69.8	E	35	2081	55.9	D	34
Menangle St / Walton St	103	1.8	A	1	158	1.6	A	1	124	1.6	A	1	103	1.9	A	1
Cliffe St / Walton St	67	2.1	A	1	141	2.2	A	1	139	2.1	A	0	154	2.1	A	2
Colden St / Menangle St	1149	34.4	C	17	1233	41.0	C	17	1262	29.0	C	18	1216	19.2	B	15
Colden St / Manolis Ln	312	3.8	A	1	472	3.4	A	1	584	4.0	A	2	537	4.2	A	3
Colden St / Margaret St	209	2.0	A	1	305	2.0	A	2	428	2.1	A	2	357	2.1	A	1
Margaret St / Manolis Ln	244	2.6	A	1	323	3.1	A	2	477	4.5	A	5	429	4.8	A	4
Argyle Street / Barkers Lodge Rd	1808	181	F	27	1787	701	F	76	2022	1372	F	80	2013	820	F	45
Argyle Street / Lumsdaine St	1605	26.1	B	2	1660	31.7	C	4	1788	25.9	B	5	1627	21.7	B	3
Argyle Street / View St	1603	10.1	A	2	1666	12.3	A	3	1790	20.1	B	1	1630	10.8	A	2
Lumsdaine St / Prince St	306	2.3	A	1	384	2.9	A	1	465	19.8	B	15	469	2.3	A	1
Argyle Street / Prince St	1822	9.0	A	11	1935	12.8	A	7	2128	72.9	F	16	2013	39.2	C	13
Prince St / Menangle St	1414	7.0	A	2	1484	11.6	A	2	1622	25.1	B	3	1609	21.6	B	3
Menangle St / Station St	1156	4.5	A	3	1207	4.4	A	4	1241	10.8	A	9	1192	7.6	A	6
Menangle St / Webster St	1106	4.4	A	10	1156	6.7	A	5	1208	19.2	B	20	1147	5.7	A	14
Argyle Street / Thirlmere Way	1723	8.4	A	0	1859	12.3	A	0	2094	12.3	A	0	1973	9.3	A	0
Baxter Ln / Menangle St	1210	4.2	A	0	1325	5.0	A	0	1599	8.5	A	0	1493	9.3	A	0

Option operational results

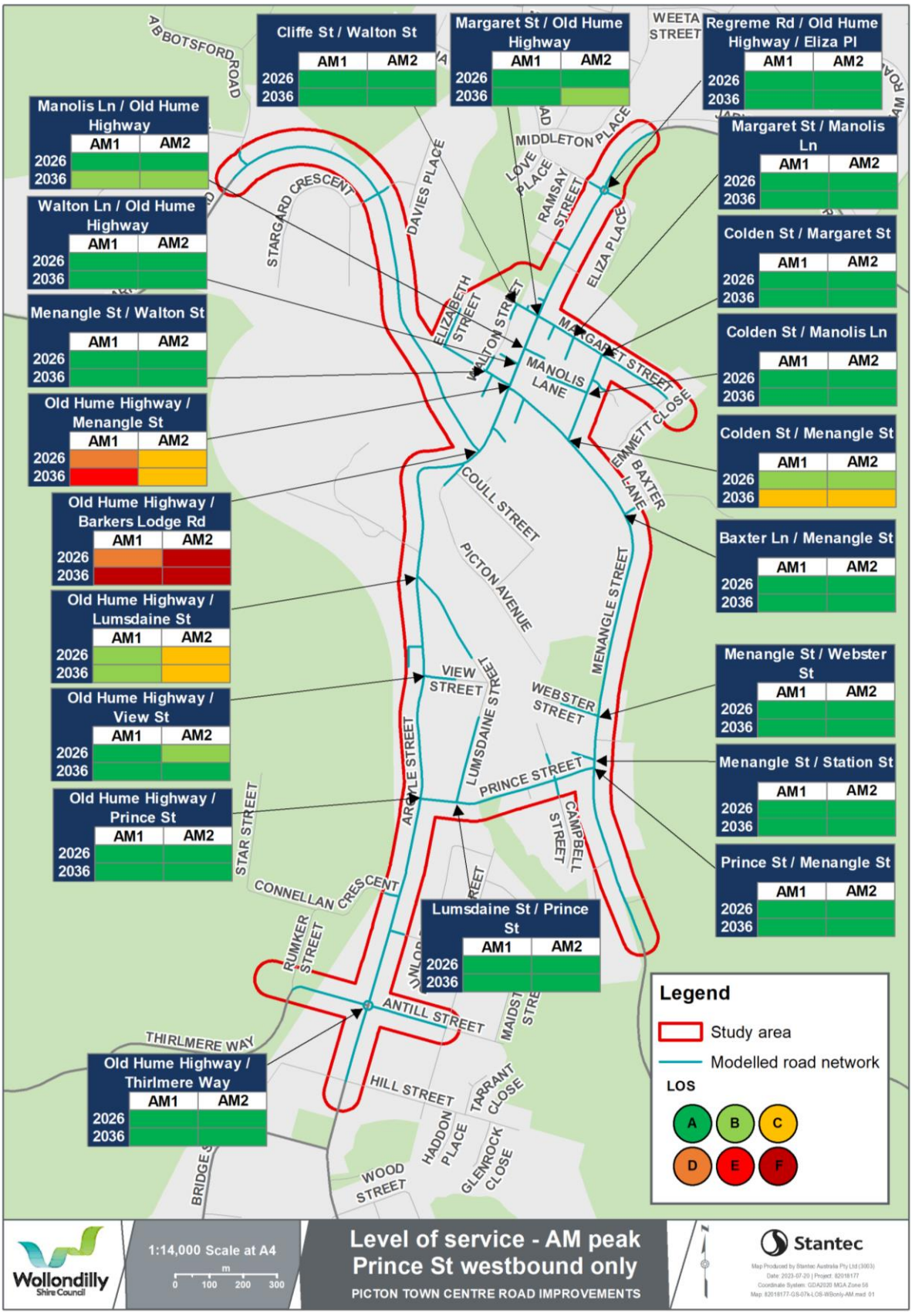


Figure 17: Prince Street westbound only AM peak intersection level of service

Option operational results

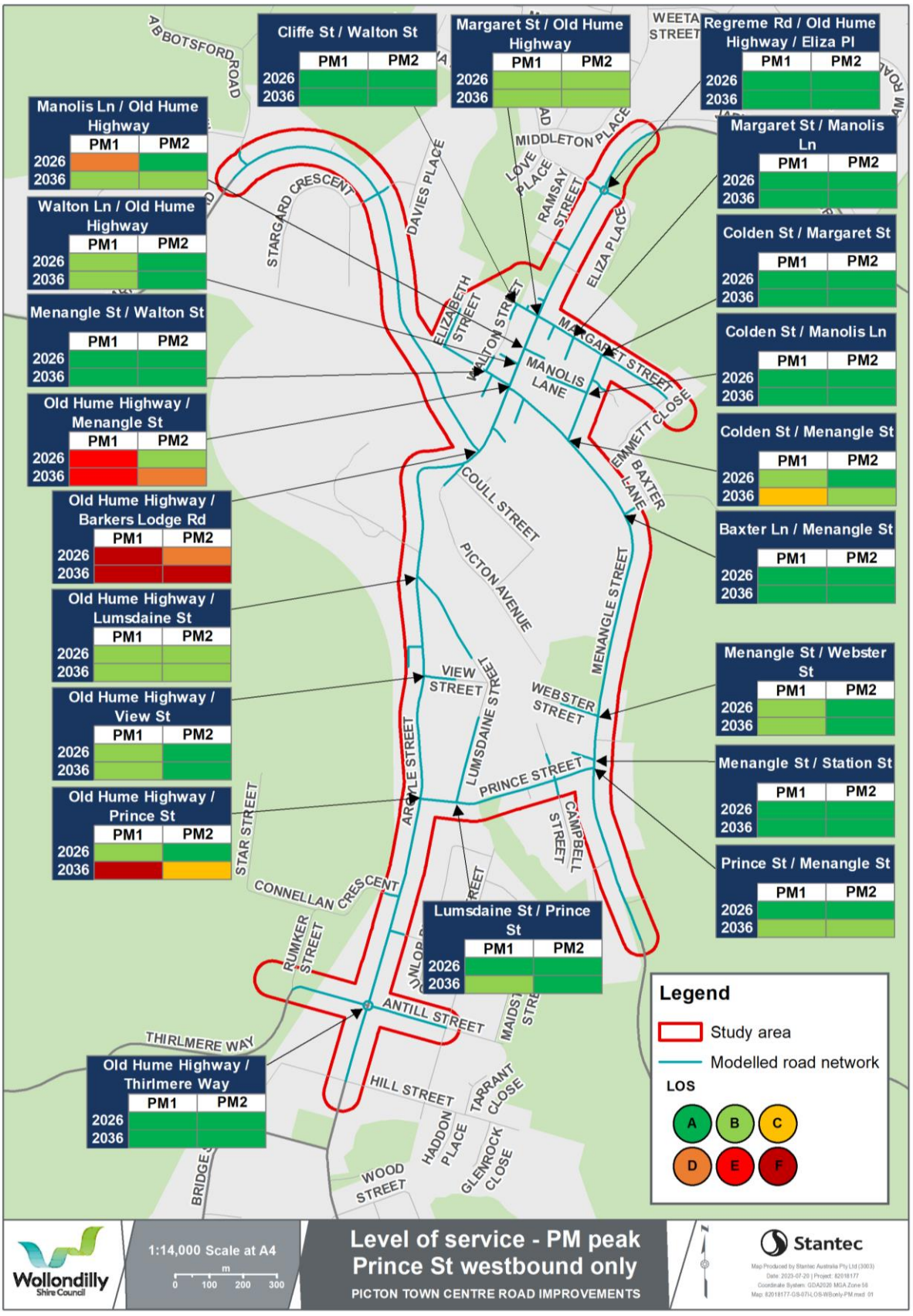


Figure 18: Prince Street westbound only PM peak intersection level of service

7.3.3 Prince Street westbound only travel times

Table 36 to **Table 39** show the Prince Street westbound only travel times and average speeds for each two-hour peak for the travel time routes presented in **Section 3.2.3**. The main findings are:

- Average travel times and speeds on Argyle Street southbound remain similar between the Do Nothing and Prince Street westbound only scenarios in all modelled peaks and years.
- Travel times on Argyle Street northbound increase by 41 seconds in the first hour of the 2036 PM peak. Increases of 21 seconds are also observed in the second hour of the 2036 AM peak.
  - Travel times between Lumsdaine Street and Menangle Street increase due to the rerouting caused by the Prince Street eastbound movement ban, and the subsequent delays at Argyle Street / Menangle Street.
- Average travel times on Prince Street westbound decrease by between 20 and 43 seconds in the 2026 and 2036 AM peaks. Travel times decrease by between 3 and 31 seconds in the 2026 and 2036 PM peaks.
  - As eastbound movements on Prince Street are banned, delays at Victoria Bridge due to opposing traffic are eliminated, reducing travel times in the westbound direction in these peaks.
  - In the AM peaks, queues along the eastbound carriageway originating from Prince Street / Menangle Street intersection extended to Victoria Bridge and blocked westbound traffic in the Do Nothing scenarios. This obstruction is eliminated in the Prince Street westbound only scenario.
- Travel times on Menangle Street southbound increase by 14 seconds in the first hour of the 2036 PM peak.
  - The reduction in delay along Prince Street attracts road users seeking to travel westbound in the study area. As a result, volumes on the right turn from Menangle Street southbound into Prince Street increase, resulting in an increase in queuing and delay on Menangle Street.
- Travel times on Menangle Street northbound and southbound are otherwise similar between the Do Nothing and Prince Street westbound only scenarios in all modelled peaks and years.

Option operational results

Table 36: 2026 Prince Street westbound only AM peak travel times and average speeds

Route	Dir.	2026 Prince Street westbound only AM peak					
		Travel time (mm:ss)		Compared to Do Nothing		Average speed (km/hr)	
		7:15am-8:15am	8:15am-9:15am	7:15am-8:15am	8:15am-9:15am	7:15am-8:15am	8:15am-9:15am
Argyle Street	NB	3:33	3:56	+00:04	+00:07	42	38
	SB	3:21	3:37	+00:00	-00:00	45	41
Menangle Street	NB	1:53	1:55	+00:01	-00:01	39	38
	SB	1:45	1:50	+00:01	+00:02	42	40
Prince Street	EB	-	-	-	-	-	-
	WB	0:44	0:49	-00:21	-00:20	41	38

Table 37: 2026 Prince Street westbound only PM peak travel times and average speeds

Route	Dir.	2026 Prince Street westbound only PM peak					
		Travel time (mm:ss)		Compared to Do Nothing		Average speed (km/hr)	
		3:15pm-4:15pm	4:15pm-5:15pm	3:15pm-4:15pm	4:15pm-5:15pm	3:15pm-4:15pm	4:15pm-5:15pm
Argyle Street	NB	3:57	3:35	+00:16	+00:02	38	42
	SB	3:38	3:29	-00:02	-00:04	41	43
Menangle Street	NB	2:17	2:02	+00:05	+00:02	32	36
	SB	1:47	1:43	-00:01	+00:00	41	42
Prince Street	EB	-	-	-	-	-	-
	WB	0:55	0:48	-00:21	-00:31	33	38

Table 38: 2036 Prince Street westbound only AM peak travel times and average speeds

Route	Dir.	2036 Prince Street westbound only AM peak					
		Travel time (mm:ss)		Compared to Do Nothing		Average speed (km/hr)	
		7:15am-8:15am	8:15am-9:15am	7:15am-8:15am	8:15am-9:15am	7:15am-8:15am	8:15am-9:15am
Argyle Street	NB	3:56	4:18	+00:18	+00:21	38	35
	SB	3:26	3:41	+00:05	-00:00	43	40
Menangle Street	NB	2:01	2:06	+00:05	+00:03	36	35
	SB	1:47	1:52	+00:02	+00:02	41	39
Prince Street	EB	-	-	-	-	-	-
	WB	0:48	0:53	-00:43	-00:25	38	34

Option operational results

Table 39: 2036 Prince Street westbound only PM peak travel times and average speeds

Route	Dir.	2036 Prince Street westbound only PM peak					
		Travel time (mm:ss)		Compared to Do Nothing		Average speed (km/hr)	
		3:15pm-4:15pm	4:15pm-5:15pm	3:15pm-4:15pm	4:15pm-5:15pm	3:15pm-4:15pm	4:15pm-5:15pm
Argyle Street	NB	4:37	3:52	+00:41	+00:15	32	39
	SB	3:41	3:34	+00:03	+00:01	40	42
Menangle Street	NB	3:02	2:08	+00:09	+00:03	24	34
	SB	2:01	1:49	+00:14	+00:02	36	40
Prince Street	EB	-	-	-	-	-	-
	WB	2:08	1:20	-00:03	-00:09	14	23

7.4 MENANGLE STREET / PRINCE STREET / STATION STREET ELLIPTICAL ROUNDABOUT

As outlined in **Section 2.0**, the elliptical roundabout scenario includes the following infrastructure upgrade from the Do Nothing scenario:

- Menangle Street / Prince Street / Station Street elliptical roundabout

The traffic demand for the scenario is the same as the Do Nothing scenario and is described in **Section 4.0**.

7.4.1 Elliptical roundabout network performance

Table 40 summarises the elliptical roundabout network performance results for the AM peak and PM peak in 2026 and 2036. The results indicate that:

- Trip demand remains the same in each peak between the Do Nothing and Elliptical roundabout scenarios.
- VHT decreases by a larger magnitude than VKT in all modelled peaks and years, indicating road users experience a reduction in delay in the network.
- Average travel times and number of stops decrease, and average speeds increase across all modelled peaks and years.
- There are no unreleased vehicles in each of the peak periods.

Option operational results

Table 40: Elliptical roundabout network performance

Network performance		Elliptical roundabout results				Compared to Do Nothing			
		2026 AM	2026 PM	2036 AM	2036 PM	2026 AM	2026 PM	2036 AM	2036 PM
All vehicles									
Total demand	veh	6149	7049	7212	8038	0 (+0%)	0 (+0%)	0 (+0%)	0 (+0%)
Completed trips	veh	6114	7056	7167	8036	+7 (+0.1%)	+8 (+0.1%)	-48 (-0.7%)	-51 (-0.6%)
Vehicle kilometres travelled	km	12751	14807	15180	17079	+30 (+0.2%)	+73 (+0.5%)	-273 (-1.8%)	-440 (-2.5%)
Vehicle hours travelled	hr	325	385	401	464	-5 (-1.4%)	-3 (-0.8%)	-39 (-8.8%)	-26 (-5.3%)
Total number of stops	stop	7115	9425	10073	11992	-486 (-6.4%)	-309 (-3.2%)	-797 (-7.3%)	-699 (-5.5%)
Averages per vehicle									
Average trip length	km	2.09	2.10	2.12	2.13	0 (+0.1%)	+0.01 (+0.4%)	-0.02 (-1.1%)	-0.04 (-1.9%)
Average travel time in network	sec	192	196	202	208	-3 (-1.5%)	-2 (-0.9%)	-18 (-8.1%)	-10 (-4.7%)
Average number of stops	stop	1.16	1.34	1.41	1.49	-0.08 (-6.5%)	-0.05 (-3.3%)	-0.1 (-6.7%)	-0.08 (-4.9%)
Average speed	km/h	39.2	38.5	37.8	36.8	+0.6 (+1.7%)	+0.5 (+1.3%)	+2.7 (+7.7%)	+1.1 (+3%)
Unreleased demand									
Unreleased vehicles	veh	0	0	0	0	+0	+0	+0	+0
Proportion of demand unreleased	%	0%	0%	0%	0%				

7.4.2 Elliptical roundabout intersection performance

Table 41 and **Table 42** show the elliptical roundabout intersection performance results for the AM and PM peaks for the future years of 2026 and 2036 respectively. **Figure 19** and **Figure 20** show the Elliptical roundabout intersection LOS results for the AM peak and PM peak, respectively. The intersection performance results indicate that:

- All intersections in 2026 perform satisfactorily at LOS C or better in all modelled hours of the AM and PM peaks.
- Argyle Street / Barkers Lodge Road operates at LOS D in the second hour of the 2036 AM peak, and LOS E in both hours of the 2036 PM peak.
  - Road users experience average delays of approximately 60 seconds on the right turn movement from Barkers Lodge Road to Argyle Street, due to high opposing traffic volumes along Argyle Street.
- In 2036, Argyle Street / Prince Street performs at LOS E in the first hour of the PM peak.

  - High volumes along Argyle Street reduce opportunities to turn out of Prince Street, resulting in average delays of 63 seconds.
- Argyle Street / Menangle Street performs at LOS D in the first hour of the 2036 PM peak, as a combination of high opposing traffic volumes along Argyle Street and parking activity in the town centre increase delay for the left turn from Menangle Street to Argyle Street.
- All other intersections in 2036 perform satisfactorily at LOS C or better in all modelled hours of the AM and PM peaks.

Option operational results

Table 41: 2026 Elliptical roundabout scenario intersection performance

Intersection	2026 Elliptical roundabout AM peak								2026 Elliptical roundabout PM peak							
	7:15am-8:15am				8:15am-9:15am				3:15pm-4:15pm				4:15pm-5:15pm			
	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)
Regreme Rd / Argyle Street	1043	6.3	A	2	1004	7.2	A	3	1249	2.4	A	4	1263	3.1	A	5
Margaret St / Argyle Street	1144	11.6	A	13	1137	14.5	B	13	1400	19.8	B	18	1396	21.7	B	13
Manolis Ln / Argyle Street	1045	4.5	A	3	977	4.5	A	6	1316	12.2	A	11	1271	18.7	B	10
Walton Ln / Argyle Street	1036	5.9	A	3	950	2.0	A	5	1289	11.5	A	10	1235	2.0	A	6
Argyle Street / Menangle St	1336	20.7	B	15	1439	16.8	B	27	1661	31.7	C	23	1548	19.9	B	12
Menangle St / Walton St	62	1.9	A	1	119	2.7	A	1	72	1.7	A	1	69	1.7	A	1
Cliffe St / Walton St	73	2.0	A	1	153	2.5	A	0	136	2.2	A	1	168	2.2	A	2
Colden St / Menangle St	576	5.1	A	6	749	13.3	A	8	790	7.5	A	9	758	5.8	A	7
Colden St / Manolis Ln	264	2.4	A	1	442	5.0	A	2	523	4.2	A	2	511	4.8	A	3
Colden St / Margaret St	185	1.8	A	1	294	1.9	A	2	346	2.0	A	2	304	2.1	A	2
Margaret St / Manolis Ln	217	2.7	A	2	304	2.6	A	2	414	3.2	A	3	370	3.7	A	2
Argyle Street / Barkers Lodge Rd	1210	21.6	B	14	1321	38.1	C	17	1607	39.8	C	26	1478	34.9	C	19
Argyle Street / Lumsdaine St	1037	13.7	A	2	1130	21.3	B	2	1332	17.3	B	2	1195	13.7	A	2
Argyle Street / View St	1045	10.7	A	1	1165	8.3	A	3	1358	12.6	A	2	1214	14.9	B	1
Lumsdaine St / Prince St	640	19.0	B	6	609	18.3	B	8	707	22.7	B	9	662	17.0	B	9
Argyle Street / Prince St	1590	9.5	A	9	1664	9.9	A	10	1943	29.1	C	20	1788	17.0	B	10
Prince St / Menangle St / Station St	1153	10.0	A	11	1211	9.9	A	9	1336	5.9	A	8	1281	6.5	A	11
Menangle St / Webster St	252	1.9	A	3	420	16.2	B	2	407	9.9	A	5	401	5.7	A	4
Argyle Street / Thirlmere Way	1555	8.2	A	0	1673	11.3	A	0	1955	11.3	A	0	1757	9.6	A	0
Baxter Ln / Menangle St	1132	4.0	A	0	1234	3.9	A	0	1475	7.1	A	0	1322	7.6	A	0

Option operational results

Table 42: 2036 Elliptical roundabout scenario intersection performance

Intersection	2036 Elliptical roundabout AM peak								2036 Elliptical roundabout PM peak							
	7:15am-8:15am				8:15am-9:15am				3:15pm-4:15pm				4:15pm-5:15pm			
	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)
Regreme Rd / Argyle Street	1240	3.6	A	4	1175	12.6	A	3	1359	2.3	A	5	1339	13.9	A	4
Margaret St / Argyle Street	1327	15.0	B	17	1309	16.5	B	13	1533	22.0	B	18	1495	21.3	B	16
Manolis Ln / Argyle Street	1203	13.2	A	3	1109	6.0	A	8	1415	11.0	A	12	1365	15.6	B	11
Walton Ln / Argyle Street	1188	8.3	A	4	1085	2.3	A	7	1384	16.4	B	6	1328	3.6	A	8
Argyle Street / Menangle St	1566	22.1	B	17	1629	29.0	C	26	1903	44.1	D	29	1767	26.4	B	11
Menangle St / Walton St	101	1.7	A	1	149	1.7	A	1	126	1.6	A	1	102	1.9	A	0
Cliffe St / Walton St	76	2.1	A	1	153	2.7	A	0	144	2.1	A	1	154	2.1	A	1
Colden St / Menangle St	851	8.9	A	11	1016	20.4	B	11	1034	14.4	B	13	959	9.4	A	9
Colden St / Manolis Ln	370	4.1	A	2	536	4.1	A	2	596	4.8	A	3	548	3.9	A	2
Colden St / Margaret St	250	2.0	A	2	357	2.2	A	3	422	2.3	A	2	350	2.2	A	1
Margaret St / Manolis Ln	255	2.7	A	1	344	5.0	A	2	462	4.5	A	4	411	2.8	A	2
Argyle Street / Barkers Lodge Rd	1383	31.2	C	15	1474	43.8	D	21	1799	63.6	E	21	1649	59.6	E	18
Argyle Street / Lumsdaine St	1140	13.5	A	2	1224	23.6	B	3	1429	21.1	B	2	1316	15.5	B	2
Argyle Street / View St	1166	29.3	C	2	1271	15.2	B	2	1465	13.1	A	2	1338	2.6	A	1
Lumsdaine St / Prince St	738	21.3	B	9	764	21.2	B	7	801	21.9	B	18	744	20.2	B	13
Argyle Street / Prince St	1781	12.0	A	18	1878	17.0	B	10	2131	63.7	E	27	1990	37.0	C	15
Prince St / Menangle St / Station St	1512	7.9	A	12	1602	8.8	A	11	1715	8.3	A	12	1609	9.6	A	11
Menangle St / Webster St	395	1.5	A	4	562	11.7	A	6	539	1.1	A	7	502	1.5	A	4
Argyle Street / Thirlmere Way	1701	11.7	A	0	1848	11.1	A	0	2115	13.0	A	0	1945	7.3	A	0
Baxter Ln / Menangle St	1210	3.5	A	0	1314	4.6	A	0	1622	9.0	A	0	1471	6.5	A	0

Option operational results

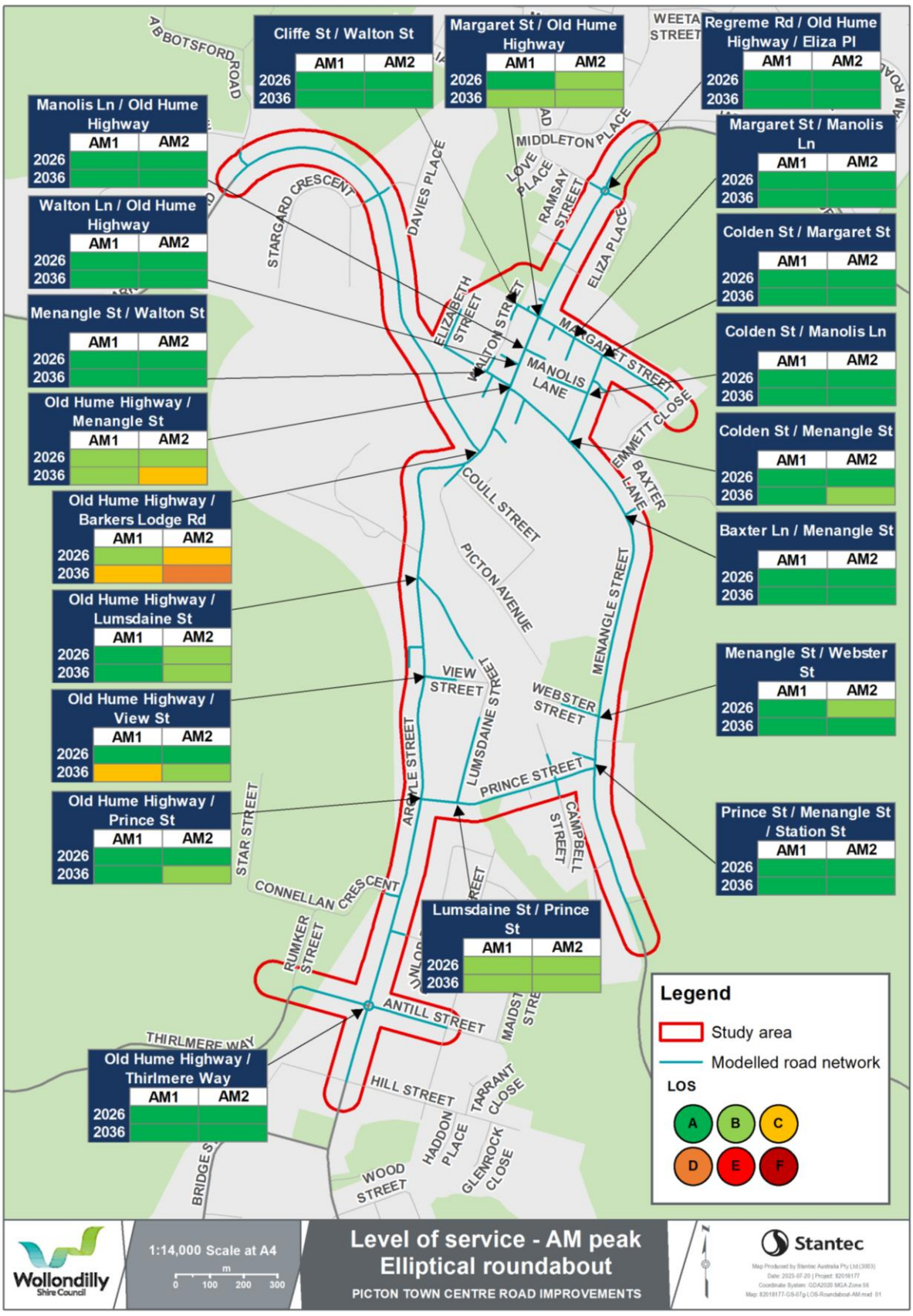


Figure 19: Elliptical roundabout AM peak intersection level of service

Option operational results

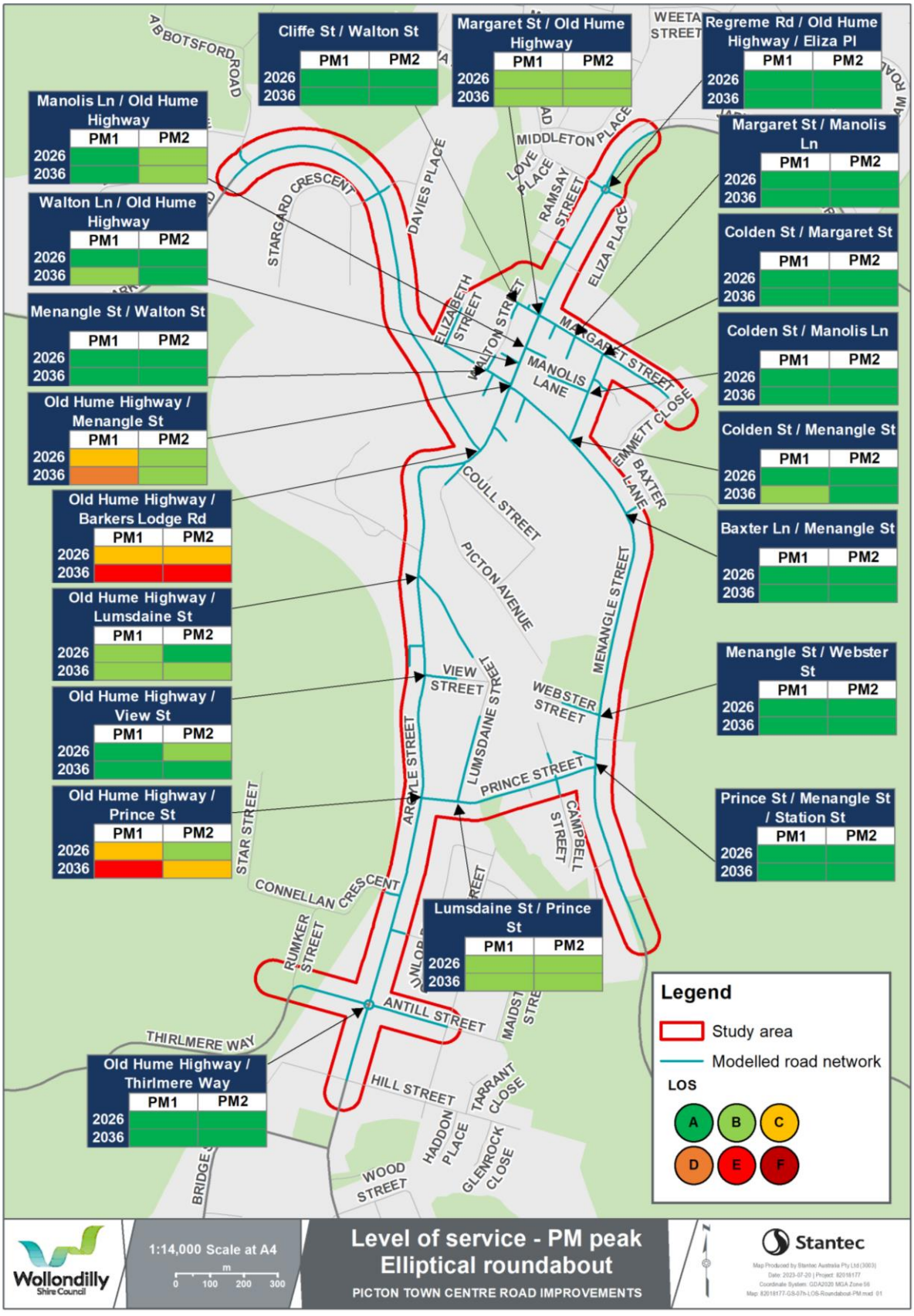


Figure 20: Elliptical roundabout PM peak intersection level of service

7.4.3 Elliptical roundabout travel times

Table 29 to **Table 32** show the elliptical roundabout travel times and average speeds for each two-hour peak for the travel time routes presented in **Section 3.2.3**. The main findings are:

- Average travel times and speeds on Argyle Street remain similar between the Do Nothing and elliptical roundabout scenarios in both the 2026 and 2036 AM and PM peaks.
- Travel times on Prince Street eastbound reduce by between 22 and 29 seconds across the 2026 AM and PM peaks, and reduce by between 34 seconds and three minutes in the 2036 AM and PM peaks.
  - The elliptical roundabout upgrade reduces queuing and delay at the intersection of Prince Street and Menangle Street, reducing travel times.
- Travel times on Prince Street westbound reduce by 20 seconds in the first hour of the 2036 AM peak.
  - In the Do Nothing AM peak, queues from Prince Street / Menangle Street extended onto Victoria Bridge, blocking westbound movements. The elliptical roundabout upgrade reduces queuing on this approach, reducing westbound travel times.
- Average travel times and speeds on Menangle Street remain similar between the Base and Elliptical roundabout scenarios in the 2026 AM, 2026 PM and 2036 AM peaks.
- Travel times on Menangle Street northbound decrease by 25 seconds in the first hour of the 2036 PM peak.
  - The elliptical roundabout drives rerouting for vehicles travelling to the south-eastern exits of the study area, being Argyle Street, Thirlmere Way and Antill Street. Fewer vehicles route through the town centre by turning left from Menangle Street to access Argyle Street southbound, using Prince Street instead. This results in a decrease in travel time on Menangle Street from Colden Street to Argyle Street.

Option operational results

Table 43: 2026 Elliptical roundabout AM peak travel times and average speeds

Route	Dir.	2026 Elliptical roundabout AM peak					
		Travel time (mm:ss)		Compared to Do Nothing		Average speed (km/hr)	
		7:15am-8:15am	8:15am-9:15am	7:15am-8:15am	8:15am-9:15am	7:15am-8:15am	8:15am-9:15am
Argyle Street	NB	3:29	3:48	-00:01	-00:01	43	39
	SB	3:21	3:38	+00:00	+00:01	45	41
Menangle Street	NB	1:55	1:57	+00:04	+00:01	38	38
	SB	1:47	1:50	+00:04	+00:03	41	40
Prince Street	EB	1:02	1:01	-00:27	-00:29	29	29
	WB	1:04	1:05	-00:01	-00:03	28	27

Table 44: 2026 Elliptical roundabout PM peak travel times and average speeds

Route	Dir.	2026 Elliptical roundabout PM peak					
		Travel time (mm:ss)		Compared to Do Nothing		Average speed (km/hr)	
		3:15pm-4:15pm	4:15pm-5:15pm	3:15pm-4:15pm	4:15pm-5:15pm	3:15pm-4:15pm	4:15pm-5:15pm
Argyle Street	NB	3:39	3:33	-00:01	+00:01	41	42
	SB	3:37	3:31	-00:02	-00:02	41	42
Menangle Street	NB	2:13	2:01	+00:01	+00:01	33	37
	SB	1:46	1:45	-00:02	+00:02	42	42
Prince Street	EB	1:03	1:02	-00:30	-00:22	28	28
	WB	1:20	1:14	+00:04	-00:05	22	24

Table 45: 2036 Elliptical roundabout AM peak travel times and average speeds

Route	Dir.	2036 Elliptical roundabout AM peak					
		Travel time (mm:ss)		Compared to Do Nothing		Average speed (km/hr)	
		7:15am-8:15am	8:15am-9:15am	7:15am-8:15am	8:15am-9:15am	7:15am-8:15am	8:15am-9:15am
Argyle Street	NB	3:35	3:53	-00:03	-00:04	42	39
	SB	3:25	3:45	+00:04	+00:03	44	40
Menangle Street	NB	1:56	2:03	+00:00	-00:00	38	36
	SB	1:49	1:56	+00:04	+00:05	40	38
Prince Street	EB	1:04	1:06	-03:08	-01:09	28	27
	WB	1:11	1:17	-00:20	-00:01	25	23

Table 46: 2036 Elliptical roundabout PM peak travel times and average speeds

Route	Dir.	2036 Elliptical roundabout PM peak					
		Travel time (mm:ss)		Compared to Do Nothing		Average speed (km/hr)	
		3:15pm-4:15pm	4:15pm-5:15pm	3:15pm-4:15pm	4:15pm-5:15pm	3:15pm-4:15pm	4:15pm-5:15pm
Argyle Street	NB	3:44	3:32	-00:13	-00:05	40	42
	SB	3:40	3:33	+00:02	-00:00	41	42
Menangle Street	NB	2:28	2:08	-00:25	+00:03	30	35
	SB	1:49	1:46	+00:02	-00:01	40	41
Prince Street	EB	1:06	1:06	-00:49	-00:34	27	27
	WB	2:05	1:33	-00:06	+00:03	14	19

7.5 MENANGLE STREET / PRINCE STREET / STATION STREET SIGNALISED INTERSECTION

As outlined in **Section 2.0**, the Signalised Intersection scenario includes the following infrastructure upgrade from the Do Nothing scenario:

- Menangle Street / Prince Street / Station Street signalised intersection

The traffic demand for the scenario is the same as the Do Nothing scenario and is described in **Section 4.0**.

7.5.1 Signalised intersection network performance

- Trip demand remains the same in each peak between the Do Nothing and Signalised Intersection scenarios.
- In the 2026 AM and PM peaks, VKT and average trip lengths increase by between 0.3 per cent and 0.8 per cent.
  - The signalisation of Menangle Street / Prince Street does not improve Prince Street eastbound travel times under 2026 traffic volumes. Some vehicles detour away from using Prince Street eastbound, increasing average trip lengths and subsequently VKT.
- VHT and average travel times increase in the 2026 AM and PM peaks, as delay for through traffic on Menangle Street increases due to the Menangle Street / Prince Street signals.
- In the 2036 AM and PM peaks, VKT and average trip lengths decrease.
  - The Menangle Street / Prince Street signals reduce delay on Prince Street eastbound under 2036 traffic volumes. More vehicles use Prince Street as an alternative east-west travel route to routing through the town centre, reducing trip lengths and subsequently VKT.
- VHT and average travel times decrease in the 2036 AM peak, as the rerouting benefits to travel times outweigh the delays for Menangle Street through traffic.
- The average number of stops increases across all modelled scenarios and peaks, as the Menangle Street / Prince Street signals interrupt through traffic flow on Menangle Street.

Option operational results

Table 47: Signalised intersection network performance

Network performance		Signalised Intersection results				Compared to Do Nothing			
		2026 AM	2026 PM	2036 AM	2036 PM	2026 AM	2026 PM	2036 AM	2036 PM
All vehicles									
Total demand	veh	6149	7049	7212	8038	0 (+0%)	0 (+0%)	0 (+0%)	0 (+0%)
Completed trips	veh	6110	7063	7188	8027	+3 (+0%)	+15 (+0.2%)	-27 (-0.4%)	-60 (-0.7%)
Vehicle kilometres travelled	km	12766	14857	15272	17111	+44 (+0.3%)	+123 (+0.8%)	-181 (-1.2%)	-408 (-2.3%)
Vehicle hours travelled	hr	341	399	424	488	+11 (+3.3%)	+11 (+2.9%)	-16 (-3.7%)	-2 (-0.4%)
Total number of stops	stop	8326	10384	11538	13512	+725 (+9.5%)	+650 (+6.7%)	+668 (+6.1%)	+821 (+6.5%)
Averages per vehicle									
Average trip length	km	2.09	2.10	2.12	2.13	+0.01 (+0.3%)	+0.01 (+0.6%)	-0.02 (-0.8%)	-0.03 (-1.6%)
Average travel time in network	sec	201	203	212	219	+6 (+3.2%)	+5 (+2.7%)	-7 (-3.3%)	+1 (+0.3%)
Average number of stops	stop	1.36	1.47	1.61	1.68	+0.12 (+9.5%)	+0.09 (+6.5%)	+0.1 (+6.5%)	+0.11 (+7.3%)
Average speed	km/h	37.5	37.2	36.1	35.0	-1.1 (-2.8%)	-0.8 (-2%)	+0.9 (+2.6%)	-0.7 (-1.9%)
Unreleased demand									
Unreleased vehicles	veh	0	0	0	0	+0	+0	+0	+0
Proportion of demand unreleased	%	0%	0%	0%	0%				

7.5.2 Signalised Intersection scenario intersection performance

Table 23 and **Table 24** show the Signalised Intersection scenario intersection performance results for the AM and PM peaks for the future years of 2026 and 2036 respectively. **Figure 14** and **Figure 15** show the Signalised Intersection scenario intersection LOS results for the AM peak and PM peak, respectively. The intersection performance results indicate that:

- Argyle Street / Barkers Lodge Road operates at LOS E in the second hour of the 2026 AM peak and first hour of the 2026 PM peak, as vehicles experience average delays of 59 seconds when turning right from Barkers Lodge Road.
- Manolis Lane / Argyle Street performs at LOS F in the first hour of the 2026 PM peak. A small number of vehicles experience delays turning right out of Manolis Lane.
- All other intersections in 2026 perform satisfactorily at LOS C or better in all modelled hours of the AM and PM peaks.

Option operational results

- In 2036, the Argyle Street / Barkers Lodge Road intersection performs at LOS D or worse in the second hour of the AM peak and both hours of the PM peak.
  - Road users experience average delays of over 80 seconds on the Barkers Lodge Road approach, as high volumes along Argyle Street reduce opportunities to turn out of Barkers Lodge Road.
- Argyle Street / Prince St performs at LOS E in the first hour of the PM peak.
  - High volumes along Argyle Street reduce opportunities to turn out of Prince Street, resulting in average delays of 58 seconds.
- All other intersections in 2036 perform satisfactorily at LOS C or better in all modelled hours of the AM and PM peaks.

Option operational results

Table 48: 2026 Signalised intersection scenario intersection performance

Intersection	2026 Signalised intersection AM peak								2026 Signalised intersection PM peak							
	7:15am-8:15am				8:15am-9:15am				3:15pm-4:15pm				4:15pm-5:15pm			
	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)
Regreme Rd / Argyle Street	1042	6.3	A	3	1000	2.8	A	4	1229	4.4	A	4	1262	2.6	A	4
Margaret St / Argyle Street	1147	11.0	A	13	1143	14.2	B	12	1390	21.7	B	15	1395	19.7	B	14
Manolis Ln / Argyle Street	1057	4.6	A	3	997	4.4	A	6	1310	71.3	F	14	1277	21.5	B	9
Walton Ln / Argyle Street	1049	5.9	A	4	969	2.0	A	4	1285	28.7	C	8	1234	1.9	A	7
Argyle Street / Menangle St	1366	26.4	B	17	1459	19.5	B	30	1697	39.3	C	22	1581	25.9	B	11
Menangle St / Walton St	60	1.9	A	1	118	2.7	A	1	85	1.6	A	0	70	1.8	A	1
Cliffe St / Walton St	74	2.0	A	1	152	2.5	A	1	139	2.3	A	1	161	2.3	A	0
Colden St / Menangle St	577	4.5	A	8	735	10.8	A	9	821	7.9	A	9	754	7.4	A	8
Colden St / Manolis Ln	255	2.4	A	1	423	4.5	A	1	520	3.8	A	4	481	3.2	A	3
Colden St / Margaret St	176	1.8	A	2	279	2.1	A	2	339	2.2	A	2	291	2.2	A	2
Margaret St / Manolis Ln	210	2.9	A	3	295	3.4	A	2	402	3.0	A	4	368	3.6	A	4
Argyle Street / Barkers Lodge Rd	1234	23.0	B	11	1356	36.9	C	17	1642	59.1	E	22	1535	39.5	C	10
Argyle Street / Lumsdaine St	1055	16.1	B	3	1174	20.0	B	2	1353	18.0	B	2	1240	20.1	B	2
Argyle Street / View St	1060	5.9	A	2	1204	11.8	A	2	1373	11.1	A	1	1261	10.6	A	1
Lumsdaine St / Prince St	640	21.1	B	5	627	34.7	C	14	695	19.3	B	9	650	27.6	B	8
Argyle Street / Prince St	1603	11.7	A	8	1692	11.6	A	9	1946	23.9	B	16	1816	17.5	B	11
Prince St / Menangle St / Station St	1144	23.9	B	14	1196	22.8	B	13	1328	21.9	B	14	1214	17.1	B	10
Menangle St / Webster St	531	1.6	A	4	650	8.3	A	3	757	6.0	A	6	631	1.8	A	3
Argyle Street / Thirlmere Way	1558	7.8	A	0	1667	8.0	A	0	1939	10.3	A	0	1774	7.7	A	0
Baxter Ln / Menangle St	1136	2.6	A	0	1228	3.8	A	0	1467	8.0	A	0	1322	6.4	A	0

Option operational results

Table 49: 2036 Signalised intersection scenario intersection performance

Intersection	2036 Signalised intersection AM peak								2036 Signalised intersection PM peak							
	7:15am-8:15am				8:15am-9:15am				3:15pm-4:15pm				4:15pm-5:15pm			
	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)	Vol. (veh)	Del. (s)	LOS	QL (veh)
Regreme Rd / Argyle Street	1191	3.3	A	4	1155	6.7	A	3	1357	3.0	A	3	1338	18.3	B	3
Margaret St / Argyle Street	1286	11.8	A	13	1297	15.6	B	15	1525	21.4	B	17	1506	21.5	B	16
Manolis Ln / Argyle Street	1200	17.9	B	8	1149	4.3	A	6	1417	9.6	A	11	1374	24.8	B	10
Walton Ln / Argyle Street	1184	4.2	A	5	1120	4.8	A	7	1385	16.5	B	7	1338	3.6	A	7
Argyle Street / Menangle St	1596	26.6	B	22	1722	25.3	B	29	1927	74.2	F	29	1792	26.7	B	15
Menangle St / Walton St	96	1.9	A	1	163	1.7	A	2	124	1.6	A	1	102	1.9	A	1
Cliffe St / Walton St	77	2.1	A	0	139	2.4	A	1	142	2.1	A	1	153	2.1	A	1
Colden St / Menangle St	845	16.1	B	9	1017	19.5	B	12	1046	10.6	A	14	977	8.5	A	9
Colden St / Manolis Ln	354	3.7	A	1	516	4.0	A	2	592	3.8	A	2	553	5.3	A	2
Colden St / Margaret St	245	3.0	A	2	333	2.1	A	1	410	3.0	A	2	355	2.2	A	1
Margaret St / Manolis Ln	233	3.7	A	3	331	4.2	A	2	453	3.5	A	3	416	3.6	A	2
Argyle Street / Barkers Lodge Rd	1428	35.4	C	14	1574	75.1	F	24	1827	82.8	F	27	1685	49.2	D	18
Argyle Street / Lumsdaine St	1164	14.3	B	2	1304	24.7	B	2	1466	16.1	B	2	1353	18.2	B	2
Argyle Street / View St	1184	6.8	A	1	1341	42.5	D	2	1503	16.3	B	2	1367	3.7	A	1
Lumsdaine St / Prince St	733	30.1	C	8	730	20.6	B	8	800	19.8	B	17	740	24.4	B	10
Argyle Street / Prince St	1794	13.6	A	23	1911	20.8	B	16	2137	58.8	E	20	2006	57.7	E	12
Prince St / Menangle St / Station St	1496	23.7	B	27	1565	24.0	B	16	1685	25.5	B	21	1584	17.6	B	12
Menangle St / Webster St	786	8.6	A	4	915	9.1	A	7	983	13.7	A	7	884	3.2	A	4
Argyle Street / Thirlmere Way	1716	10.7	A	0	1860	11.1	A	0	2110	12.4	A	0	1937	12.8	A	0
Baxter Ln / Menangle St	1211	5.2	A	0	1330	6.1	A	0	1619	8.9	A	0	1467	10.9	A	0

Option operational results

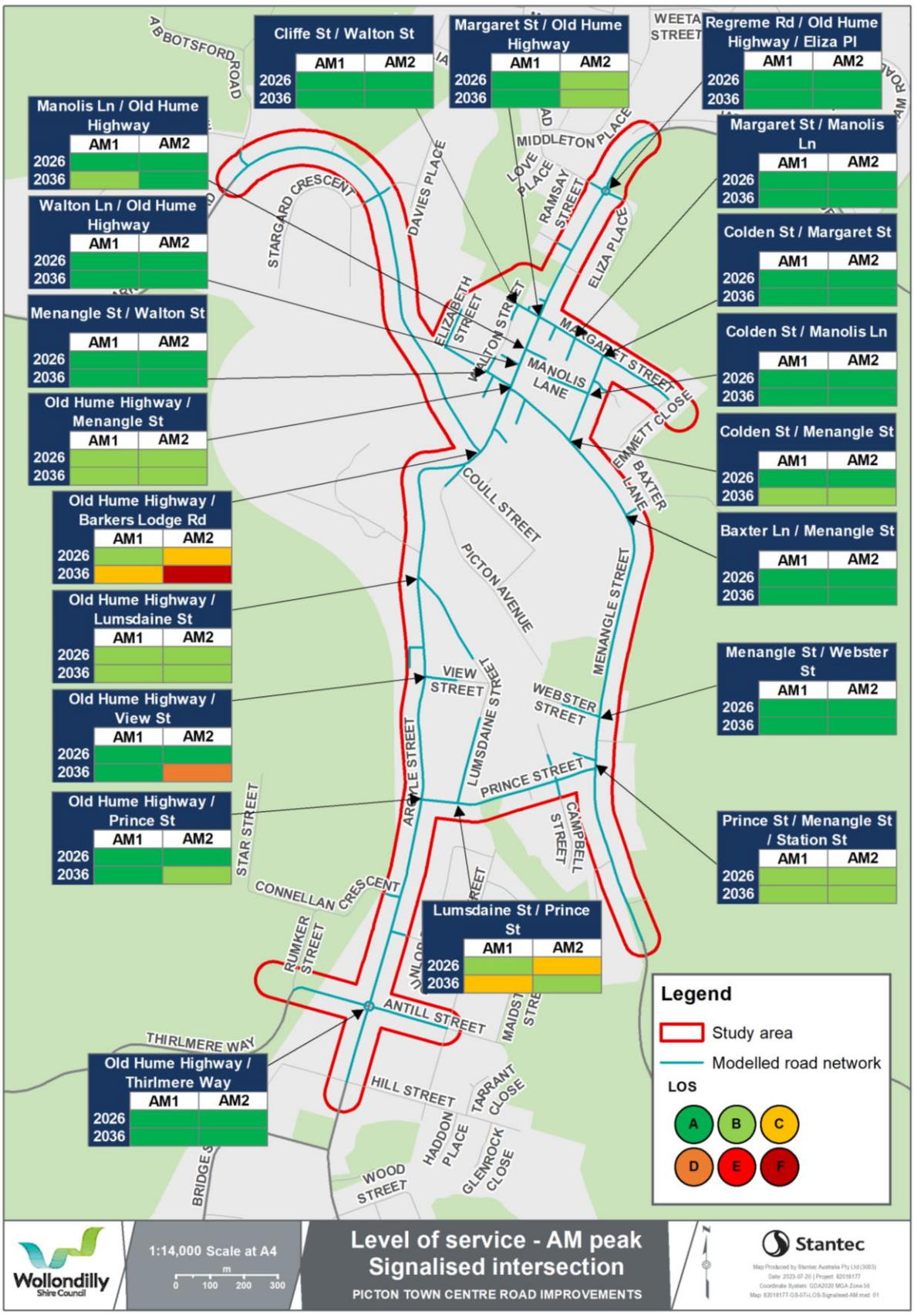


Figure 21: Signalised intersection AM peak intersection level of service

Option operational results

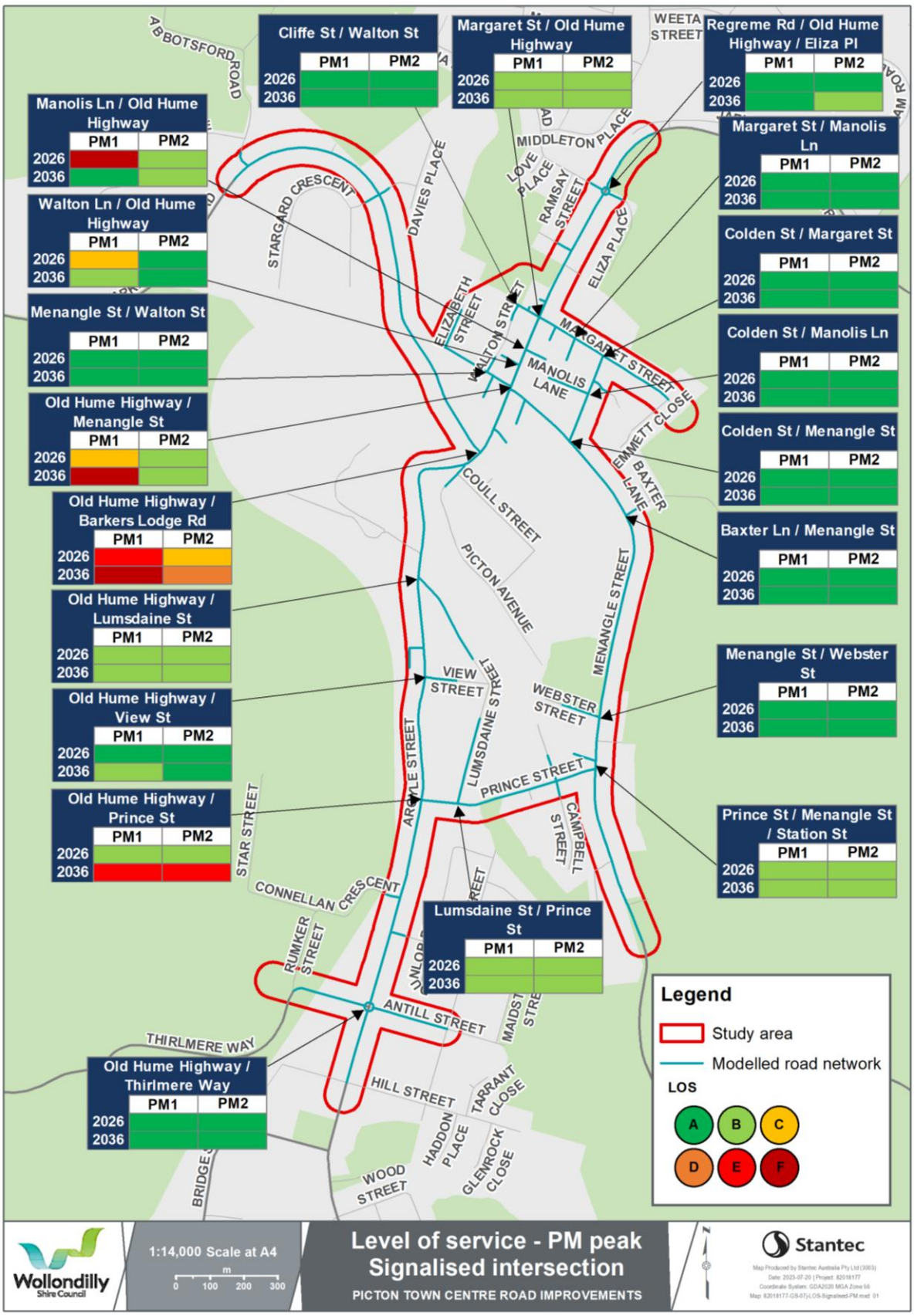


Figure 22: Signalised intersection PM peak intersection level of service

7.5.3 Signalised intersection travel times

Table 29 to **Table 32** show the Signalised Intersection travel times and average speeds for each two-hour peak for the travel time routes presented in **Section 3.2.3**. The main findings are:

- Average travel times and speeds on Argyle Street remain similar between the Do Nothing and Signalised Intersection scenarios in both the 2026 and 2036 AM and PM peaks.
- Average travel times on Menangle Street southbound increase by between five and 16 seconds, and increase by between three and ten seconds across the 2026 and 2036 AM and PM peaks
  - The Menangle Street / Prince Street signalisation interrupts through traffic flow along Menangle Street.
- In the 2026 AM and PM peaks, travel times on Prince Street eastbound increase by between seven and 12 seconds.
  - Under 2026 traffic volumes, the Menangle Street / Prince Street signalisation does not provide benefits to travel times on Prince Street.
- In 2036, Prince Street eastbound travel times decrease by over two minutes in the first hour of the AM peak, 28 seconds in the second hour of the AM peak, and 14 seconds in the first hour of the PM peak.
  - The Menangle Street / Prince Street signals provide opportunities for vehicles to exit Prince Street onto Menangle Street, decreasing queuing and delay on the route.
- Average travel times on Prince Street westbound decrease by 15 seconds in the first hour of the 2036 AM peak.
  - In the Do Nothing AM peak, queues from Prince Street / Menangle Street extended onto Victoria Bridge, blocking westbound movements. The Menangle Street / Prince Street signalisation reduces queuing on this approach, reducing westbound travel times.
- In the 2036 PM peak, average travel times on Prince Street westbound decrease by 12 seconds in the first hour and increase by 30 seconds in the second hour.
  - The change in arrival patterns as a result of the Menangle Street / Prince Street signalisation, combined with the high volumes on Prince Street westbound result in a higher level of variability in the service and queuing behaviour along the route.

Option operational results

Table 50: 2026 Signalised intersection AM peak travel times and average speeds

Route	Dir.	2026 Signalised intersection AM peak					
		Travel time (mm:ss)		Compared to Do Nothing		Average speed (km/hr)	
		7:15am-8:15am	8:15am-9:15am	7:15am-8:15am	8:15am-9:15am	7:15am-8:15am	8:15am-9:15am
Argyle Street	NB	3:29	3:49	-00:01	+00:00	43	39
	SB	3:20	3:38	-00:01	+00:01	45	41
Menangle Street	NB	1:55	2:01	+00:03	+00:06	38	36
	SB	2:00	2:02	+00:16	+00:14	37	36
Prince Street	EB	1:39	1:42	+00:10	+00:12	19	18
	WB	1:10	1:11	+00:04	+00:02	26	26

Table 51: 2026 Signalised intersection PM peak travel times and average speeds

Route	Dir.	2026 Signalised intersection PM peak					
		Travel time (mm:ss)		Compared to Do Nothing		Average speed (km/hr)	
		3:15pm-4:15pm	4:15pm-5:15pm	3:15pm-4:15pm	4:15pm-5:15pm	3:15pm-4:15pm	4:15pm-5:15pm
Argyle Street	NB	3:41	3:31	+00:01	-00:01	41	43
	SB	3:37	3:29	-00:03	-00:04	41	43
Menangle Street	NB	2:21	2:07	+00:10	+00:07	31	35
	SB	1:55	1:49	+00:07	+00:06	38	40
Prince Street	EB	1:40	1:33	+00:07	+00:09	18	20
	WB	1:17	1:17	+00:02	-00:02	24	24

Table 52: 2036 Signalised intersection AM peak travel times and average speeds

Route	Dir.	2036 Signalised intersection AM peak					
		Travel time (mm:ss)		Compared to Do Nothing		Average speed (km/hr)	
		7:15am-8:15am	8:15am-9:15am	7:15am-8:15am	8:15am-9:15am	7:15am-8:15am	8:15am-9:15am
Argyle Street	NB	3:36	3:55	-00:02	-00:02	42	38
	SB	3:21	3:42	-00:00	+00:00	44	40
Menangle Street	NB	2:02	2:06	+00:05	+00:03	36	35
	SB	2:01	2:06	+00:16	+00:16	36	35
Prince Street	EB	1:44	1:47	-02:28	-00:28	18	17
	WB	1:16	1:20	-00:15	+00:02	24	23

Option operational results

Table 53: 2036 Signalised intersection PM peak travel times and average speeds

Route	Dir.	2036 Signalised intersection PM peak					
		Travel time (mm:ss)		Compared to Do Nothing		Average speed (km/hr)	
		3:15pm-4:15pm	4:15pm-5:15pm	3:15pm-4:15pm	4:15pm-5:15pm	3:15pm-4:15pm	4:15pm-5:15pm
Argyle Street	NB	3:45	3:33	-00:12	-00:05	40	42
	SB	3:40	3:32	+00:01	-00:01	41	42
Menangle Street	NB	3:03	2:09	+00:10	+00:05	24	34
	SB	2:03	1:52	+00:15	+00:05	36	39
Prince Street	EB	1:41	1:40	-00:14	+00:00	18	18
	WB	1:59	1:59	-00:12	+00:30	15	15

8.0 OPERATIONAL ASSESSMENT COMPARISON

This section provides a comparison of the key metrics across all scenarios tested.

8.1 NETWORK PERFORMANCE COMPARISON

The following sections summarise key network performance comparisons between the scenarios.

8.1.1 Vehicle kilometres travelled

Vehicle kilometres travelled (VKT) is a metric that represents the total distance travelled by vehicles in the network. A higher VKT may indicate that vehicles are taking longer routes to complete their journey, or that more vehicles are able to complete their trips. VKT can provide an indication of the amount of congestion within a model.

Figure 23 and **Figure 24** show the VKT for each scenario in 2026 and 2036, respectively.

In 2026:

- VKT is similar between the Do Nothing, Do Nothing with Seagull Intersection, elliptical roundabout and signalised intersection scenarios in both peaks, indicating vehicles are taking similar routes in these scenarios.
- VKT in the Prince Street westbound only scenario is higher than the Do Nothing scenario in both peaks, as road users must reroute through the town centre to travel eastbound.

In 2036,

- The Do Nothing with Seagull Intersection, elliptical roundabout and signalised intersection scenarios record lower VKT than the Do Nothing scenario in both peaks. The upgrades allow more vehicles to use Prince Street as an east-west travel route to routing through the town centre, reducing trip lengths and subsequently VKT.
- VKT in the Prince Street westbound only scenario continues to be higher than the Do Nothing scenario in both peaks.
- The 2036 Do Nothing with Picton Bypass scenario records the lowest VKT out of all future scenarios. The Picton Bypass diverts traffic away from the Picton town centre, resulting in the lowest traffic demand and therefore VKT in this scenario.

Operational assessment comparison

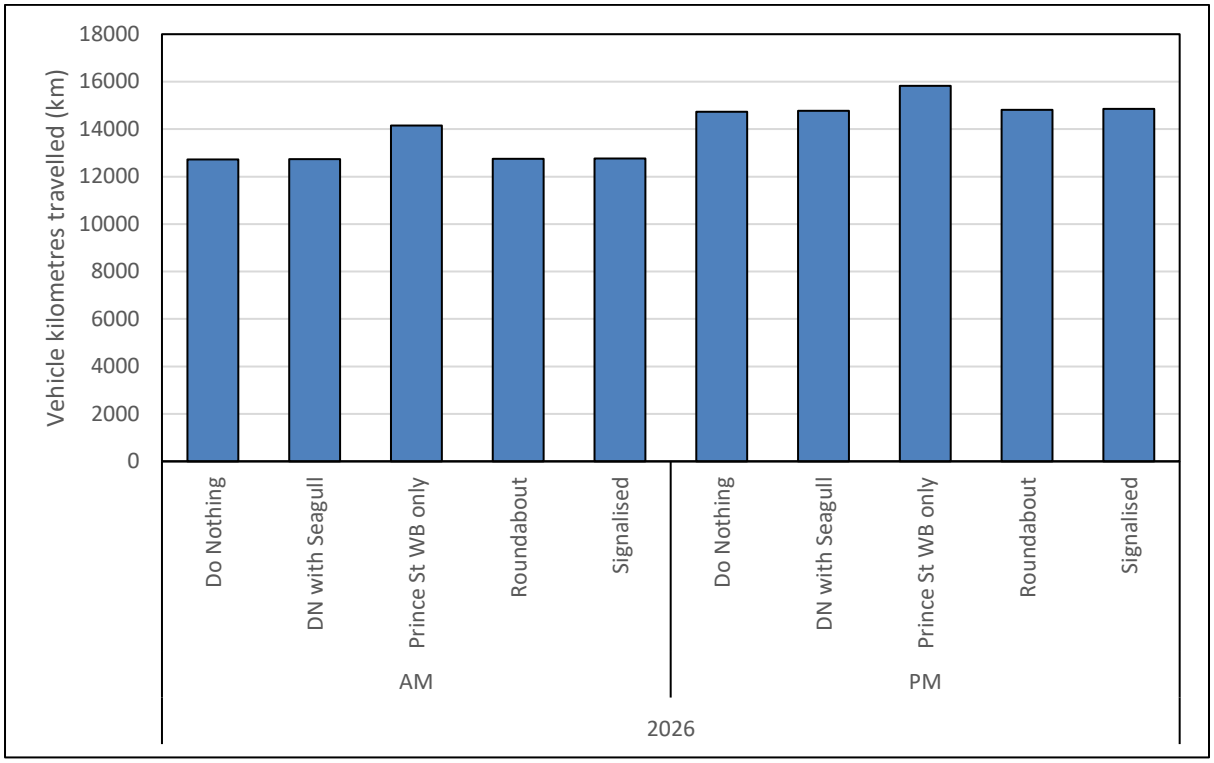


Figure 23: VKT comparison between scenarios – 2026

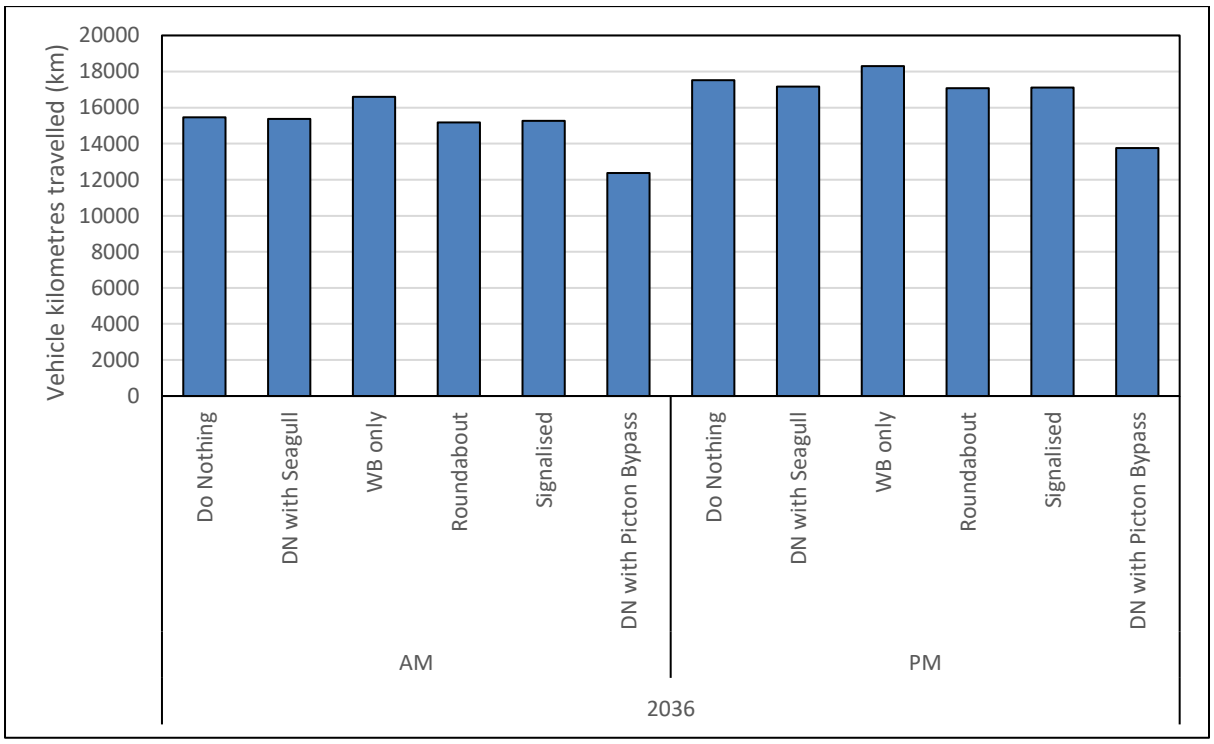


Figure 24: VKT comparison between scenarios – 2036

8.1.2 Vehicle hours travelled

Vehicle hours travelled (VHT) is a metric that represents the time spent by all vehicles in the network. A higher VHT indicates that vehicles are taking longer to complete their journeys, either because of congestion or using longer routes. VHT can provide an indication of the amount of congestion within a model.

Figure 25 and **Figure 26** show the VHT for each scenario in 2026 and 2036, respectively.

In 2026,

- VHT is similar between the Do Nothing, Do Nothing with Seagull Intersection and elliptical roundabout scenarios in both peaks, indicating that journey travel times are similar in these scenarios.
- VHT increases by approximately three per cent from the Do Nothing to the signalised intersection scenarios in both peaks, as the scenario does not provide routing or Prince Street travel time benefits that outweigh the delays for Menangle Street through traffic under 2026 traffic volumes.
- The Prince Street westbound only scenario records the highest VHT across all scenarios in both peaks. Road users reroute through the town centre to travel eastbound, resulting in the longest journey travel times out of all scenarios.

In 2036,

- The Prince Street westbound only scenario continues to record the highest VHT across all scenarios in both peaks.
- VHT in the Do Nothing with Seagull Intersection scenario is similar to the Do Nothing scenario in the AM peak and lower in the PM peak. The scenario provides the most journey time benefits in the PM peak, where westbound traffic volumes on Prince Street are highest.
- VHT in the signalised intersection scenario is lower than the Do Nothing scenario in the AM peak and similar in the PM peak. The scenario provides the most journey time benefits in the AM peak, where eastbound traffic volumes on Prince Street are highest.
- The elliptical roundabout scenario records the second-lowest VHT out of all scenarios in both peaks.
- VHT is lowest in the Do Nothing with Picton Bypass scenario. The scenario has the lowest traffic demand out of all future scenarios, which results in the lowest network congestion.

Operational assessment comparison

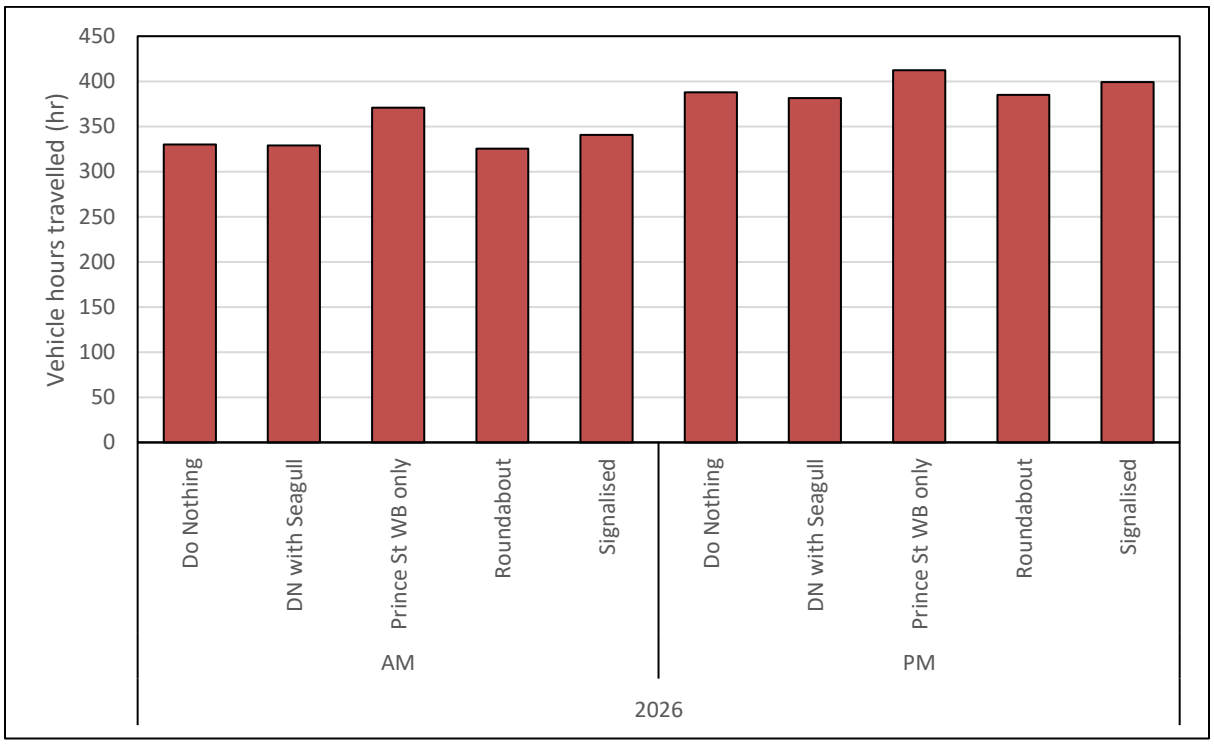


Figure 25: VHT comparison between scenarios – 2026

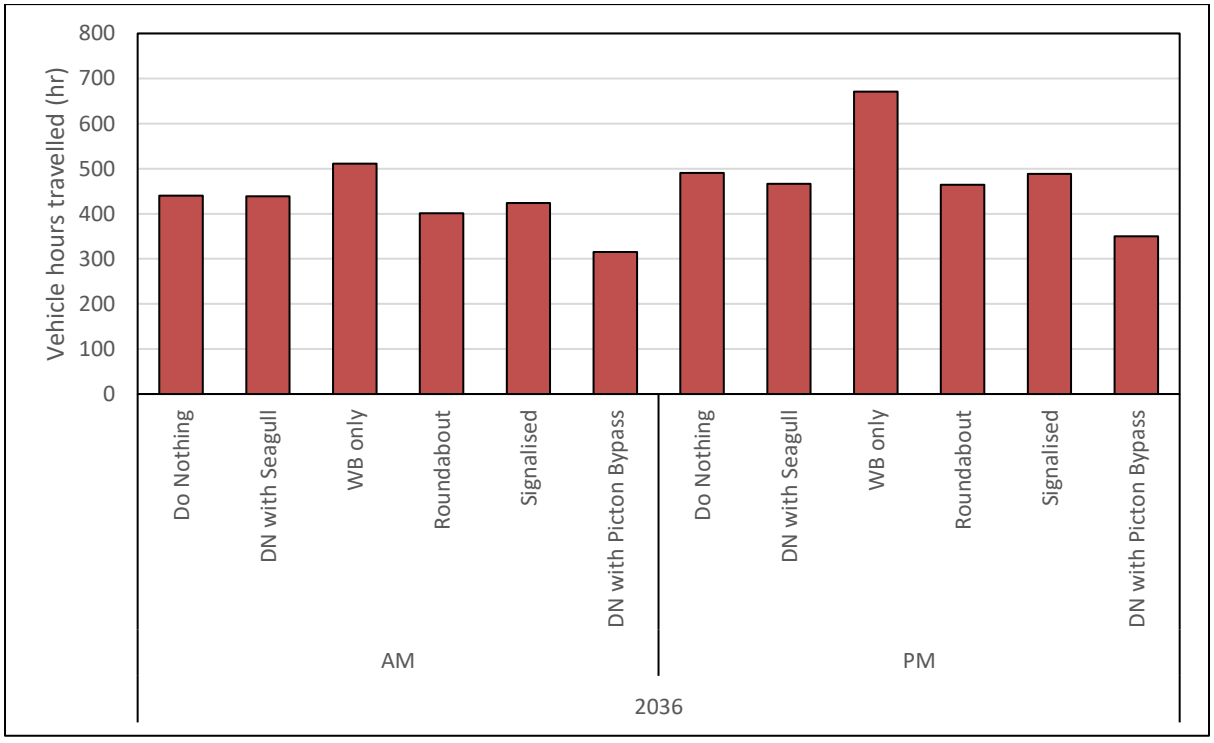


Figure 26: VHT comparison between scenarios – 2036

8.1.3 Network average speed

Network average speed is the average speed of all vehicles in the simulation over their entire journey. It provides an indication of the amount of congestion in the network. Network average speed does not include vehicles that are unable to enter the simulation.

Figure 27 and **Figure 28** show the network average speed for each scenario in 2026 and 2036, respectively.

In 2026,

- Average speeds are similar across all scenarios in both peaks, indicating that congestion levels are not significantly affected by the infrastructure changes under 2026 traffic volumes.

In 2036,

- The Prince Street westbound only scenario records the lowest average speed out of all scenarios in both peaks, as the eastbound movement ban results in the most congestion in the Picton town centre.
- Average speed in the signalised intersection scenario is similar to the Do Nothing scenario in both peaks.
- Average speeds in the Do Nothing with Seagull Intersection scenario are similar to the Do Nothing scenario in the AM peak and higher in the PM peak. The scenario provides the most benefits in the PM peak, where westbound traffic volumes on Prince Street are highest.
- The elliptical roundabout scenario records the second highest average speed out of all scenarios in both peaks.
- Average speed is highest in the Do Nothing with Picton Bypass scenario, as the scenario has the lowest traffic demand and congestion.

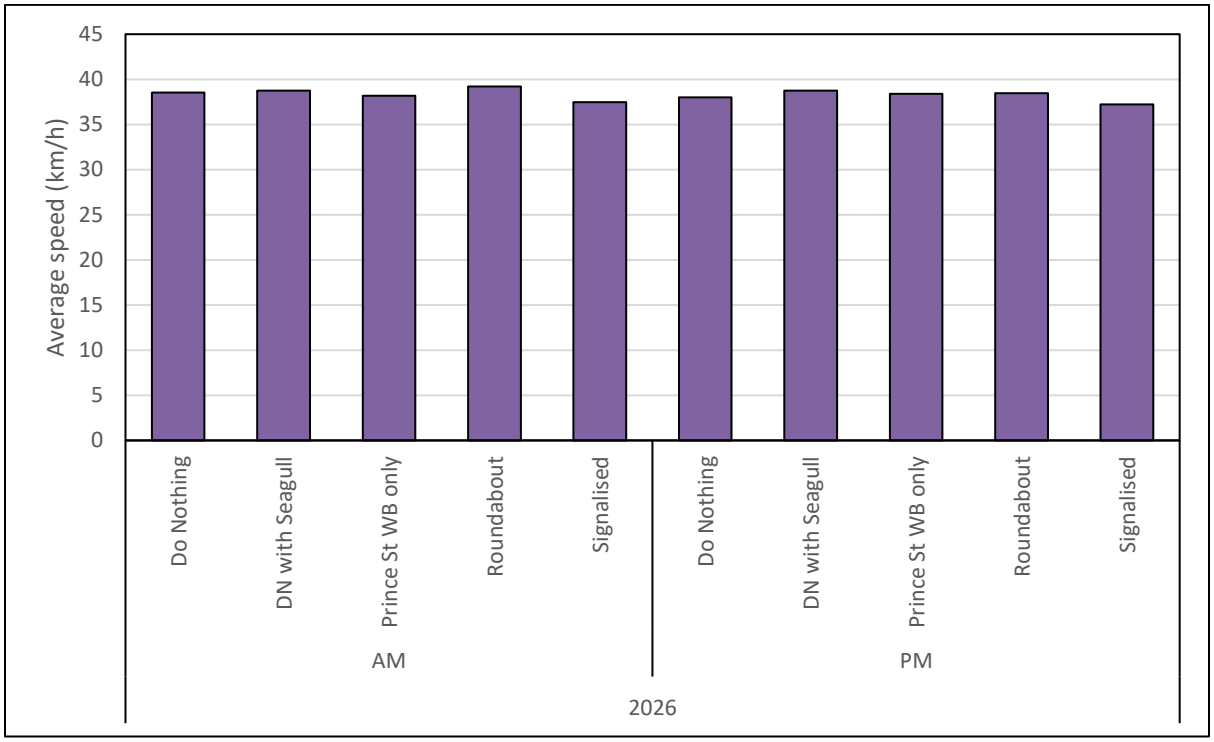


Figure 27: Average speed comparison between scenarios – 2026

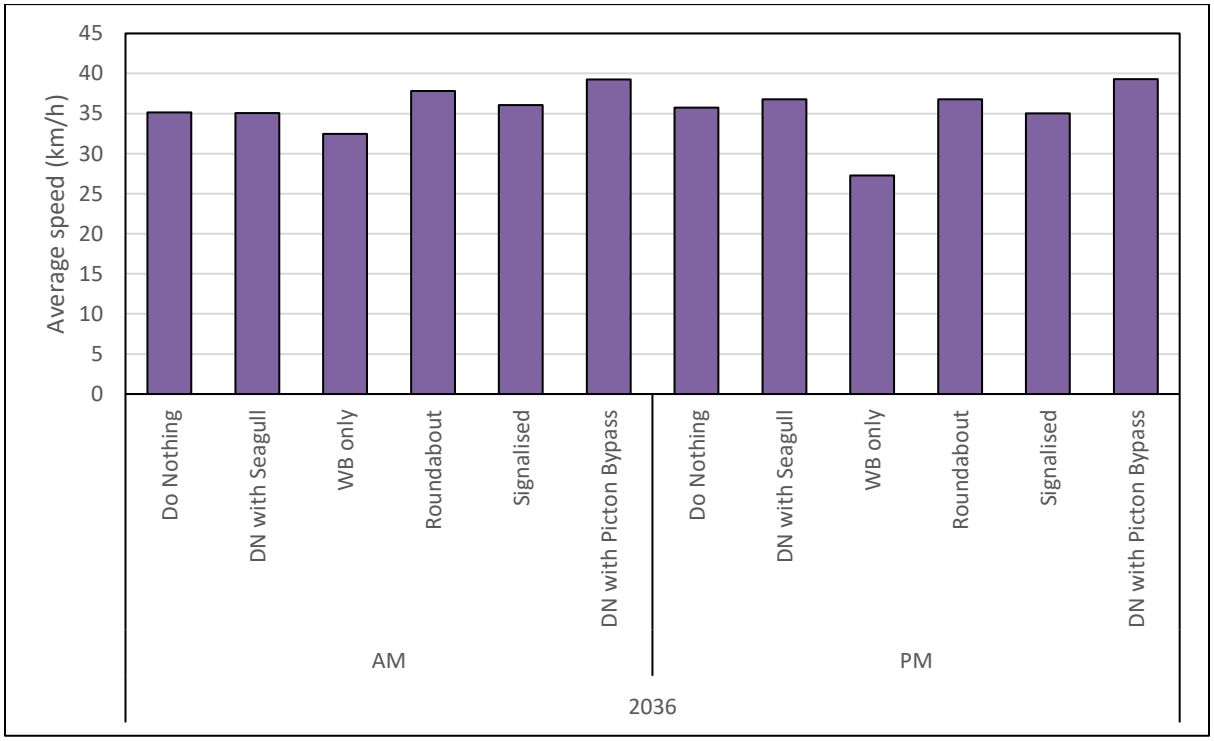


Figure 28: Average speed comparison between scenarios – 2036

8.1.4 Unreleased demand

Unreleased demand is the number of vehicles that are unable to enter the simulation during the modelled period due to queueing on their arrival link.

There is no unreleased demand for each scenario.

8.2 INTERSECTION PERFORMANCE COMPARISON

Table 54 to **Table 57** provide a summary of the intersection LOS for each scenario in the AM peak and PM peak, respectively.

Argyle Street / Menangle Street

- In the 2026 AM, 2026 PM and 2036 AM peaks, Argyle Street / Menangle Street performs satisfactorily in all scenarios, peaks and hours except under the Prince Street westbound only scenario.
- The intersection performs at LOS E or worse in the first hour of the 2036 PM peak in all scenarios except for the Do Nothing with Picton Bypass scenario. With the Bypass operational, the intersection operates at LOS B due to lower traffic volumes.

Argyle Street / Barkers Lodge Road

- Across the Do Nothing, Do Nothing with Seagull Intersection, Prince Street westbound only and signalised intersection scenarios, Argyle Street / Barkers Lodge Road performs at LOS F in the second hour of the 2036 AM peak and first hour of the 2036 PM peak, as high traffic volumes reduce turning opportunities out of Barkers Lodge Road.
- Under the elliptical roundabout scenario, intersection performance improves to LOS D in the second hour of the AM peak and LOS E in the first hour of the PM peak.
- The introduction of the Picton Bypass in 2036 improves performance to LOS D in both peaks, due to lowered traffic volumes along Argyle Street.

Argyle Street / Prince Street

- Under the Do Nothing, Prince Street westbound only, elliptical roundabout and signalised intersection scenarios, the Argyle Street / Prince Street intersection performs at LOS E or worse in the first hour of the 2036 PM peak, as high traffic volumes reduce turning opportunities out of Prince Street.
- The Argyle Street / Prince Street seagull intersection upgrade improves performance to LOS B in the same time period.
- The intersection performs at LOS A in the 2036 Do Nothing with Picton Bypass scenario.

Prince Street / Menangle Street

- The Prince Street / Menangle Street intersection performs satisfactorily in all modelled scenarios, peaks and hours in 2026.
- In both the 2036 Do Nothing and 2036 Do Nothing with Seagull Intersection scenarios, the intersection performs at LOS F in both hours of the AM peak, as there is insufficient capacity for right-turning vehicles from Prince Street to Menangle Street.
- In the 2036 Do Nothing and 2036 Do Nothing with Seagull Intersection scenarios, the intersection performs at LOS D in the first hour of the PM peak.
- The intersection performs satisfactorily, at LOS B or better under the Prince Street westbound only, elliptical roundabout, signalised intersection or Picton Bypass scenarios.

Operational assessment comparison

Table 54: Intersection LOS comparison between scenarios – 2026 AM peak

Intersection	2026 7:15am-8:15am					2026 8:15am-9:15am				
	DN	DN with Seagull	WB only	Round-about	Signals	DN	DN with Seagull	WB only	Round-about	Signals
Regreme Rd / Argyle Street	A	A	A	A	A	A	A	A	A	A
Margaret St / Argyle Street	A	A	A	A	A	B	B	A	B	B
Manolis Ln / Argyle Street	A	A	A	A	A	A	A	A	A	A
Walton Ln / Argyle Street	A	A	A	A	A	A	A	A	A	A
Argyle Street / Menangle St	B	B	D	B	B	B	B	C	B	B
Menangle St / Walton St	A	A	A	A	A	A	A	A	A	A
Cliffe St / Walton St	A	A	A	A	A	A	A	A	A	A
Colden St / Menangle St	A	A	B	A	A	A	A	B	A	A
Colden St / Manolis Ln	A	A	A	A	A	A	A	A	A	A
Colden St / Margaret St	A	A	A	A	A	A	A	A	A	A
Margaret St / Manolis Ln	A	A	A	A	A	A	A	A	A	A
Argyle Street / Barkers Lodge Rd	B	B	D	B	B	C	C	F	C	C
Argyle Street / Lumsdaine St	A	A	B	A	B	B	B	C	B	B
Argyle Street / View St	A	A	A	A	A	C	C	B	A	A
Lumsdaine St / Prince St	B	B	A	B	B	B	B	A	B	C
Argyle Street / Prince St	A	A	A	A	A	A	A	A	A	A
Prince St / Menangle St	C	C	A	A	B	C	C	A	A	B
Menangle St / Station St	A	A	A			A	A	A		
Menangle St / Webster St	A	A	A	A	A	A	A	A	B	A
Argyle Street / Thirlmere Way	A	A	A	A	A	A	A	A	A	A
Baxter Ln / Menangle St	A	A	A	A	A	A	A	A	A	A

Operational assessment comparison

Table 55: Intersection LOS comparison between scenarios – 2026 PM peak

Intersection	2026 3:15pm-4:15pm					2026 4:15pm-5:15pm				
	DN	DN with Seagull	WB only	Round-about	Signals	DN	DN with Seagull	WB only	Round-about	Signals
Regreme Rd / Argyle Street	A	A	A	A	A	A	A	A	A	A
Margaret St / Argyle Street	B	B	B	B	B	B	B	B	B	B
Manolis Ln / Argyle Street	A	A	D	A	F	B	B	A	B	B
Walton Ln / Argyle Street	A	A	B	A	C	A	A	A	A	A
Argyle Street / Menangle St	C	C	E	C	C	B	B	B	B	B
Menangle St / Walton St	A	A	A	A	A	A	A	A	A	A
Cliffe St / Walton St	A	A	A	A	A	A	A	A	A	A
Colden St / Menangle St	A	A	B	A	A	A	A	A	A	A
Colden St / Manolis Ln	A	A	A	A	A	A	A	A	A	A
Colden St / Margaret St	A	A	A	A	A	A	A	A	A	A
Margaret St / Manolis Ln	A	A	A	A	A	A	A	A	A	A
Argyle Street / Barkers Lodge Rd	D	C	F	C	E	C	C	D	C	C
Argyle Street / Lumsdaine St	B	B	B	B	B	A	A	B	A	B
Argyle Street / View St	A	A	B	A	A	A	A	A	B	A
Lumsdaine St / Prince St	C	B	A	B	B	C	B	A	B	B
Argyle Street / Prince St	B	B	B	C	B	B	A	A	B	B
Prince St / Menangle St	C	C	A	A	B	B	B	A	A	B
Menangle St / Station St	A	A	A			A	A	A		
Menangle St / Webster St	A	A	B	A	A	A	B	A	A	A
Argyle Street / Thirlmere Way	A	A	A	A	A	A	A	A	A	A
Baxter Ln / Menangle St	A	A	A	A	A	A	A	A	A	A

Operational assessment comparison

Table 56: Intersection LOS comparison between scenarios – 2036 AM peak

Intersection	2036 7:15am-8:15am						2036 8:15am-9:15am					
	DN	DN with Seagull	WB only	Round-about	Signals	Picton Bypass	DN	DN with Seagull	WB only	Round-about	Signals	Picton Bypass
Regreme Rd / Argyle Street	A	A	A	A	A	A	A	A	A	A	A	A
Margaret St / Argyle Street	A	A	A	B	A	A	B	B	B	B	B	B
Manolis Ln / Argyle Street	A	B	B	A	B	A	A	A	B	A	A	A
Walton Ln / Argyle Street	A	A	A	A	A	A	A	A	A	A	A	A
Argyle Street / Menangle St	C	C	E	B	B	B	B	B	C	C	B	B
Menangle St / Walton St	A	A	A	A	A	A	A	A	A	A	A	A
Cliffe St / Walton St	A	A	A	A	A	A	A	A	A	A	A	A
Colden St / Menangle St	A	B	C	A	B	B	B	A	C	B	B	B
Colden St / Manolis Ln	A	A	A	A	A	A	A	A	A	A	A	A
Colden St / Margaret St	A	A	A	A	A	A	A	A	A	A	A	A
Margaret St / Manolis Ln	A	A	A	A	A	A	A	A	A	A	A	A
Argyle Street / Barkers Lodge Rd	C	C	F	C	C	C	F	F	F	D	F	D
Argyle Street / Lumsdaine St	A	A	B	A	B	A	B	C	C	B	B	B
Argyle Street / View St	A	A	A	C	A	A	B	C	A	B	D	A
Lumsdaine St / Prince St	C	C	A	B	C	B	B	C	A	B	B	B
Argyle Street / Prince St	B	A	A	A	A	A	B	A	A	B	B	A
Prince St / Menangle St	F	F	A	A	B	B	F	F	A	A	B	B
Menangle St / Station St	A	A	A			A	A	A	A			A
Menangle St / Webster St	A	A	A	A	A	A	B	A	A	A	A	A
Argyle Street / Thirlmere Way	A	A	A	A	A	A	A	A	A	A	A	A
Baxter Ln / Menangle St	A	A	A	A	A	A	A	A	A	A	A	A

Operational assessment comparison

Table 57: Intersection LOS comparison between scenarios – 2036 PM peak

Intersection	2036 3:15pm-4:15pm						2036 4:15pm-5:15pm					
	DN	DN with Seagull	WB only	Round-about	Signals	Picton Bypass	DN	DN with Seagull	WB only	Round-about	Signals	Picton Bypass
Regreme Rd / Argyle Street	A	A	A	A	A	A	A	A	A	A	B	A
Margaret St / Argyle Street	B	B	B	B	B	B	B	B	B	B	B	B
Manolis Ln / Argyle Street	A	B	B	A	A	A	A	A	B	B	B	B
Walton Ln / Argyle Street	B	B	B	B	B	A	A	A	A	A	A	A
Argyle Street / Menangle St	E	D	E	D	F	B	C	B	D	B	B	B
Menangle St / Walton St	A	A	A	A	A	A	A	A	A	A	A	A
Cliffe St / Walton St	A	A	A	A	A	A	A	A	A	A	A	A
Colden St / Menangle St	B	B	C	B	A	A	A	A	B	A	A	A
Colden St / Manolis Ln	A	A	A	A	A	A	A	A	A	A	A	A
Colden St / Margaret St	A	A	A	A	A	A	A	A	A	A	A	A
Margaret St / Manolis Ln	A	A	A	A	A	A	A	A	A	A	A	A
Argyle Street / Barkers Lodge Rd	F	F	F	E	F	D	E	D	F	E	D	D
Argyle Street / Lumsdaine St	B	B	B	B	B	B	B	B	B	B	B	A
Argyle Street / View St	A	A	B	A	B	B	A	A	A	A	A	A
Lumsdaine St / Prince St	C	B	B	B	B	B	B	B	A	B	B	B
Argyle Street / Prince St	E	B	F	E	E	A	C	B	C	C	E	A
Prince St / Menangle St	D	D	B	A	B	A	C	E	B	A	B	A
Menangle St / Station St	A	A	A			A	A	A	A			A
Menangle St / Webster St	B	A	B	A	A	A	B	A	A	A	A	A
Argyle Street / Thirlmere Way	A	A	A	A	A	A	A	B	A	A	A	A
Baxter Ln / Menangle St	A	A	A	A	A	A	A	A	A	A	A	A

8.3 TRAVEL TIME COMPARISON

This section compares the travel times on the routes presented in **Section 3.2.3**.

8.3.1 Argyle Street

Figure 29 to **Figure 32** show the travel times recorded for each scenario for the Argyle Street northbound and Argyle Street southbound routes in 2026 and 2036, respectively.

- In the northbound direction, the Prince Street westbound only scenario records the highest travel time across all modelled hours and years, as the eastbound travel ban on Prince Street increases delay on this route.
- Travel times on Argyle Street southbound are similar across all modelled hours and years.
- In 2036, the Do Nothing with Picton Bypass scenario records the lowest travel times across both directions, peaks and hours, due to the reduced volume of traffic.

Operational assessment comparison

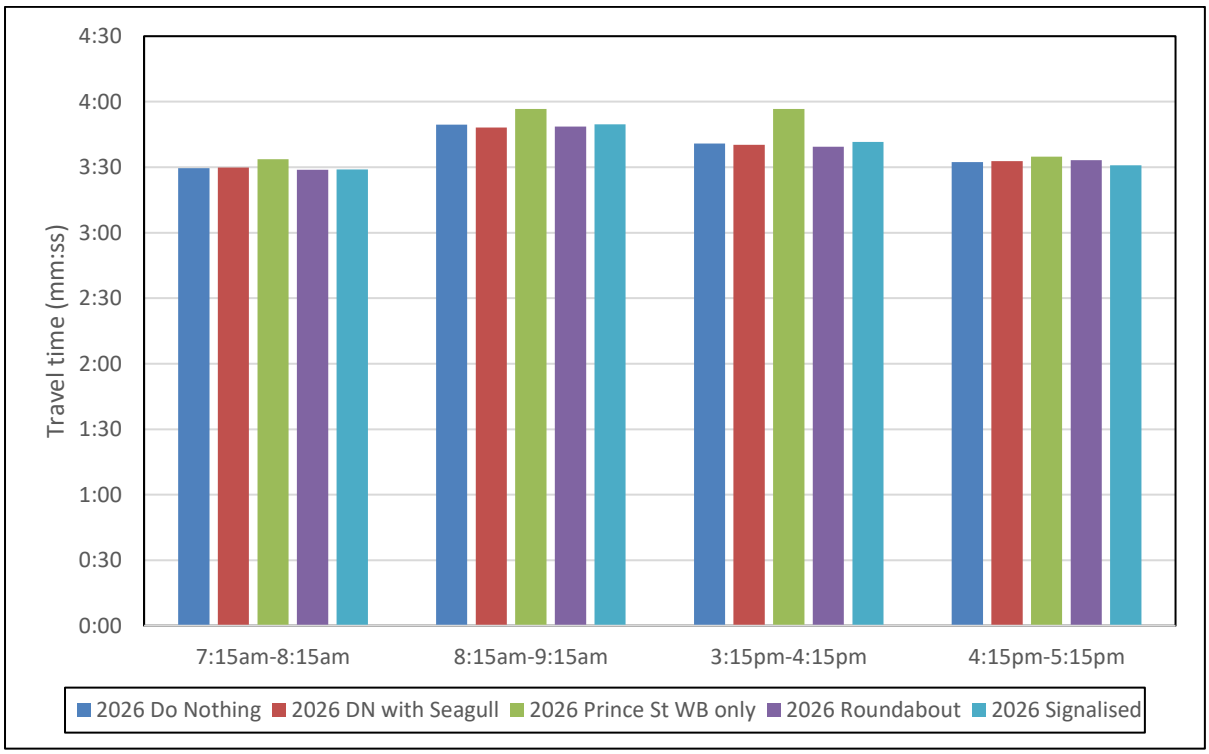


Figure 29: Argyle Street northbound travel time comparison – 2026

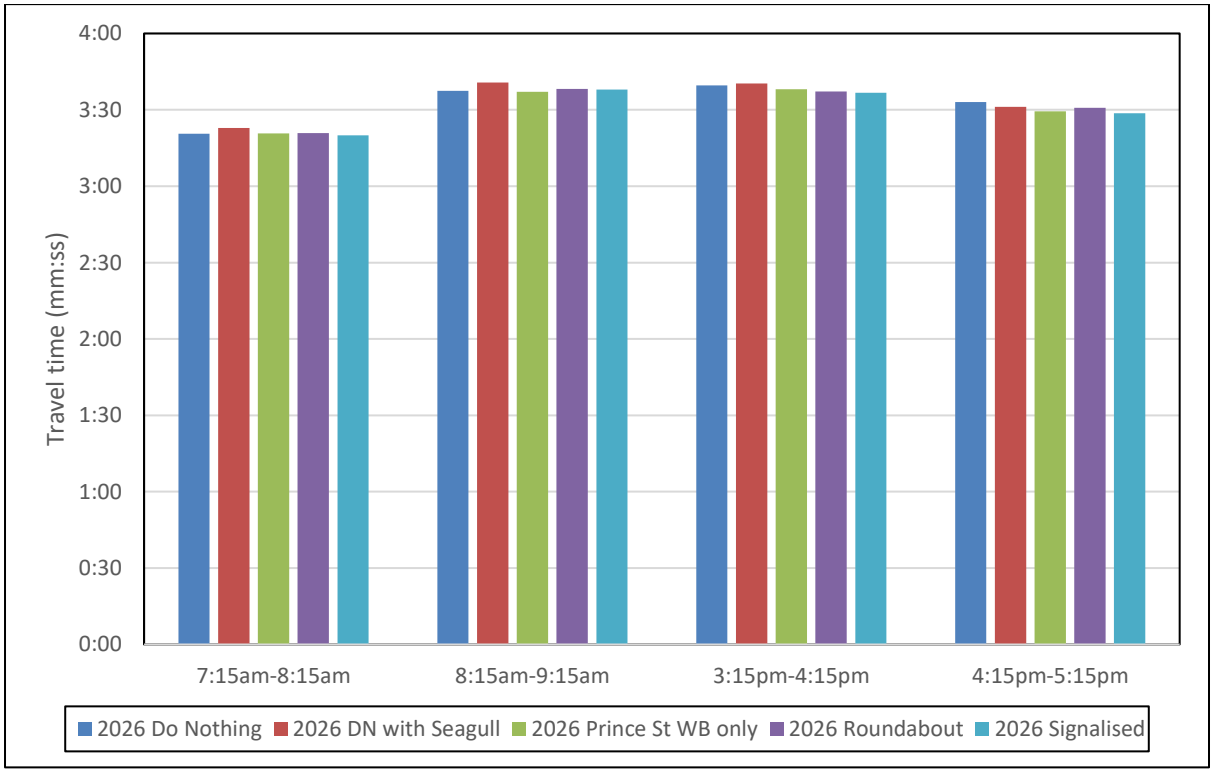


Figure 30: Argyle Street southbound travel time comparison – 2026

Operational assessment comparison

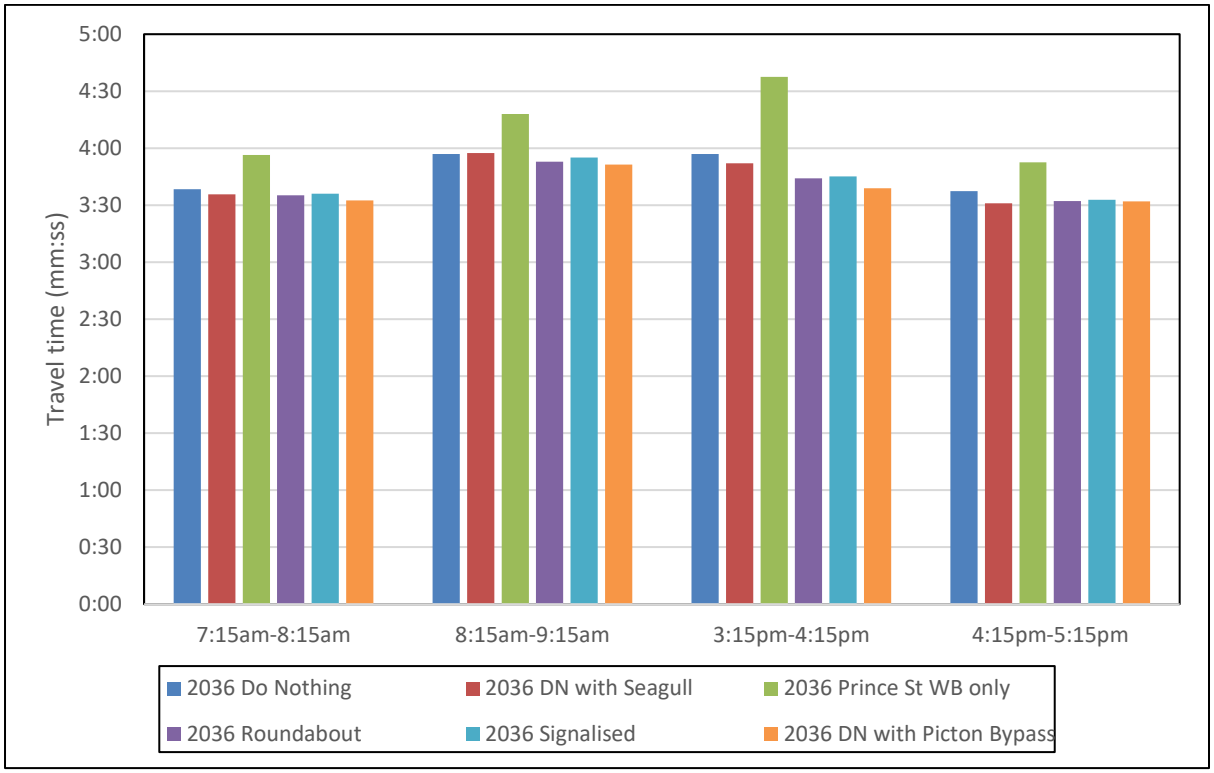


Figure 31: Argyle Street northbound travel time comparison – 2036

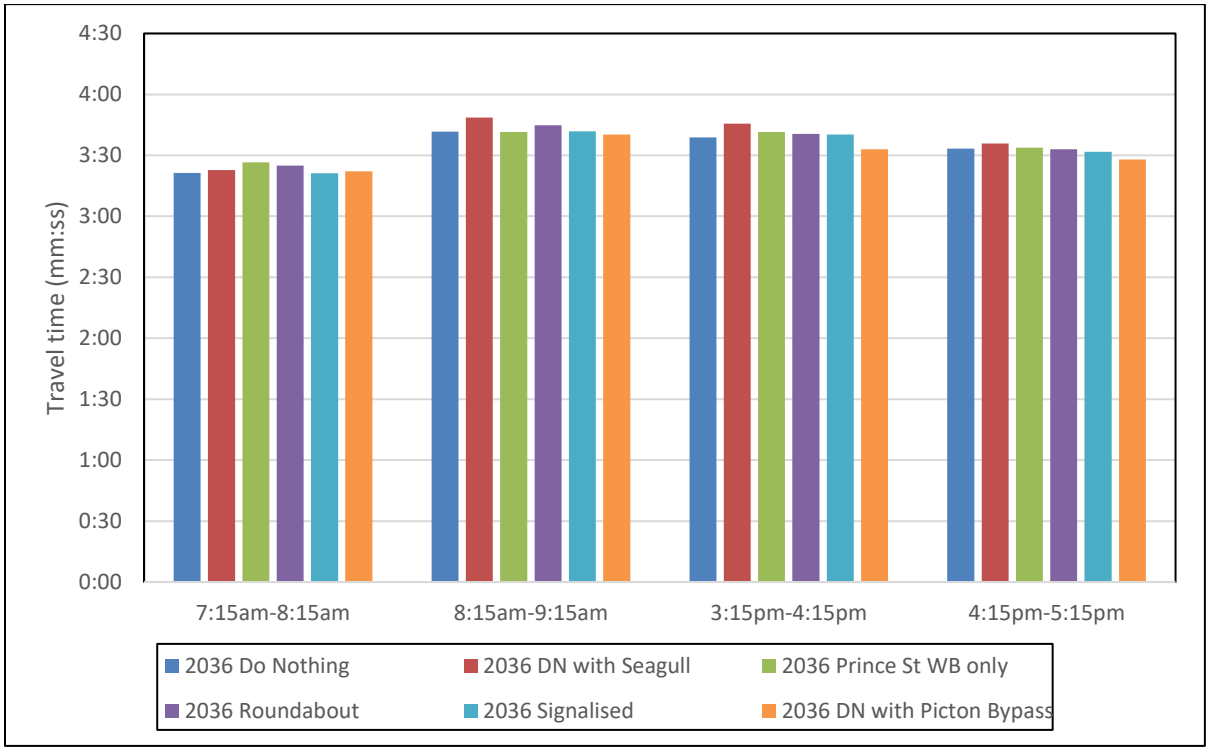


Figure 32: Argyle Street southbound travel time comparison – 2036

8.3.2 Menangle Street

Figure 33 to **Figure 36** show the travel times recorded for each scenario for the Menangle Street northbound and Menangle Street southbound routes in 2026 and 2036, respectively.

- Travel times on Menangle Street northbound vary by less than ten seconds across all modelled scenarios and peaks in 2026.
- In the first hour of the 2036 PM peak, travel times on Menangle Street northbound decrease by between 17 and 25 seconds under the Do Nothing with Seagull Intersection and elliptical roundabout scenarios, as the infrastructure changes result in rerouting away from the Menangle Street northbound route.
- Across all years and peaks, travel times on Menangle Street southbound are highest under the signalised intersection scenario, as the Menangle Street / Prince Street signalisation interrupts through traffic flow along Menangle Street.
- In the first hour of the 2036 PM peak, travel times on Menangle Street southbound under the Prince Street westbound only scenario increase, as more vehicles queue for the right turn into Prince Street.
- Travel times on Menangle Street southbound are otherwise similar across the modelled scenarios and peaks.
- In 2036, the Do Nothing with Picton Bypass scenario records the lowest travel times across both directions, peaks and hours, due to the reduced volume of traffic.

Operational assessment comparison

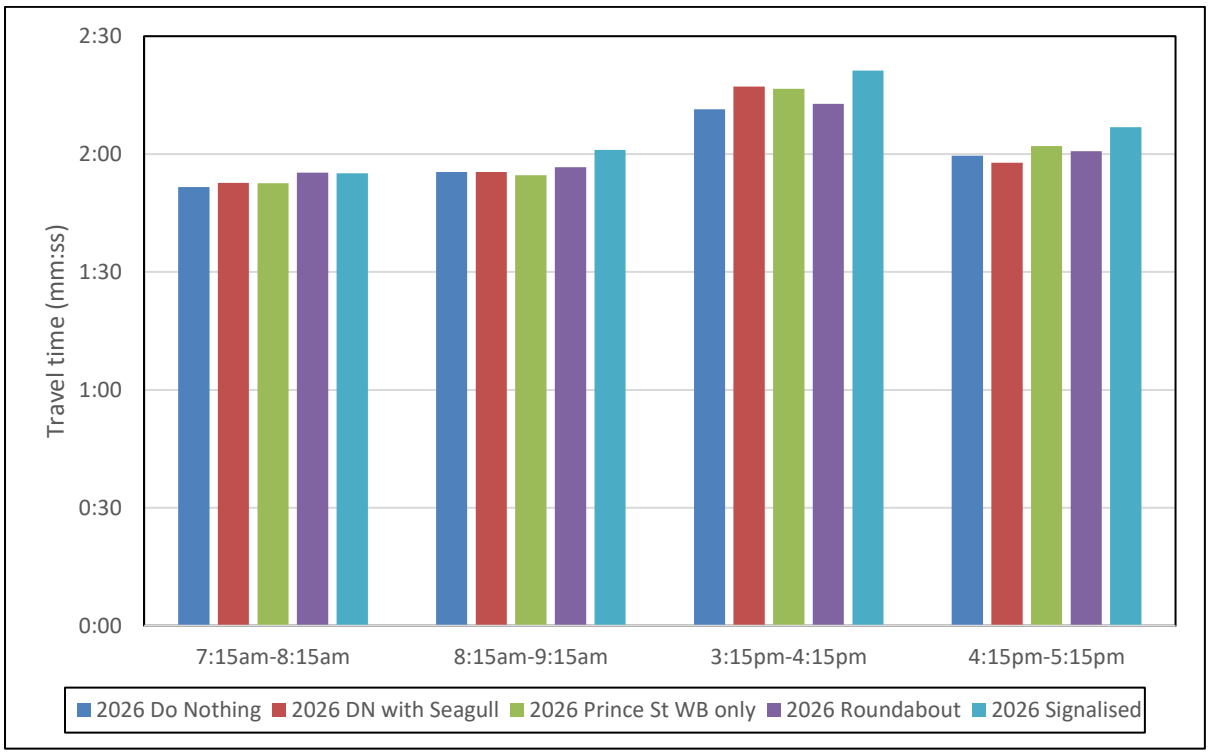


Figure 33: Menangle Street northbound travel time comparison – 2026

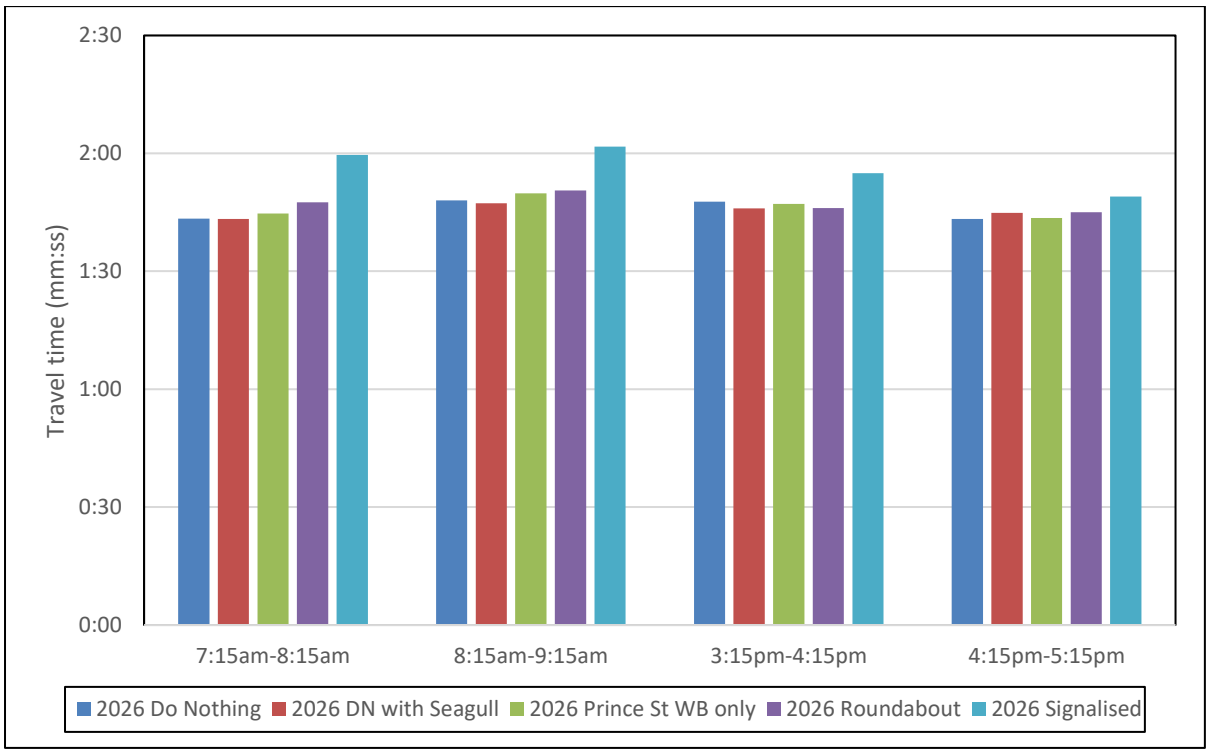


Figure 34: Menangle Street southbound travel time comparison – 2026

Operational assessment comparison

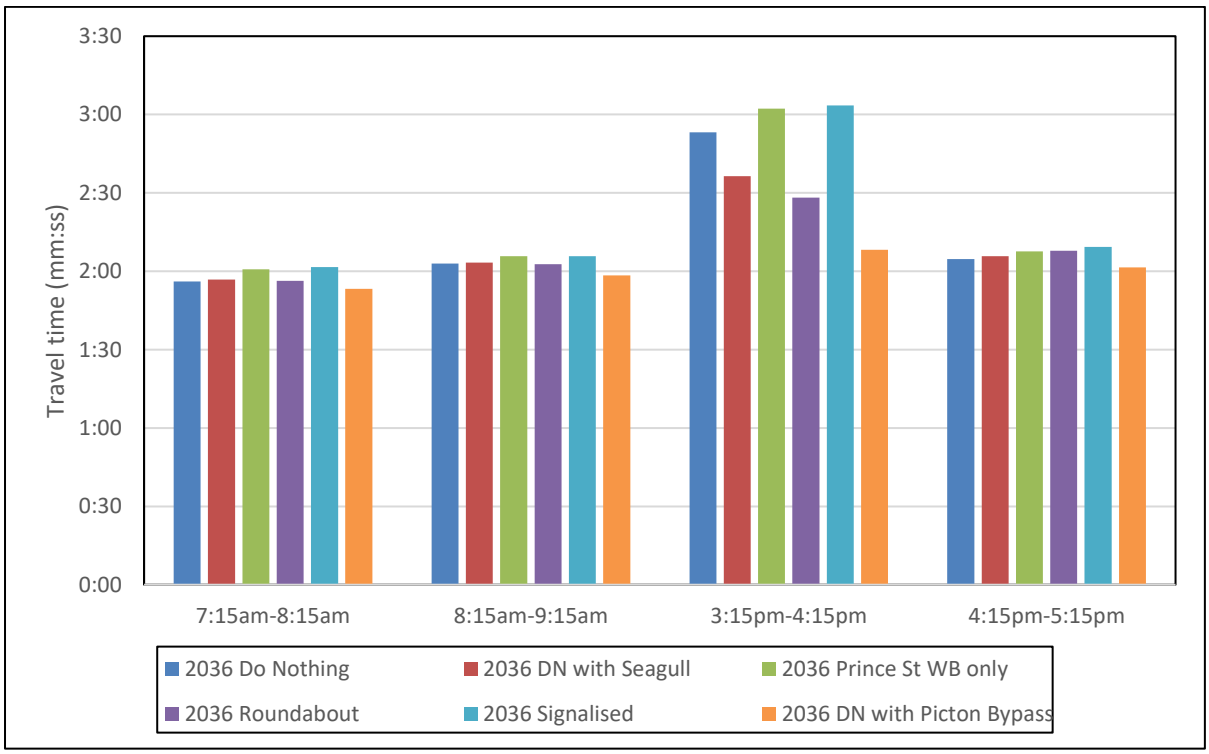


Figure 35: Menangle Street northbound travel time comparison – 2036

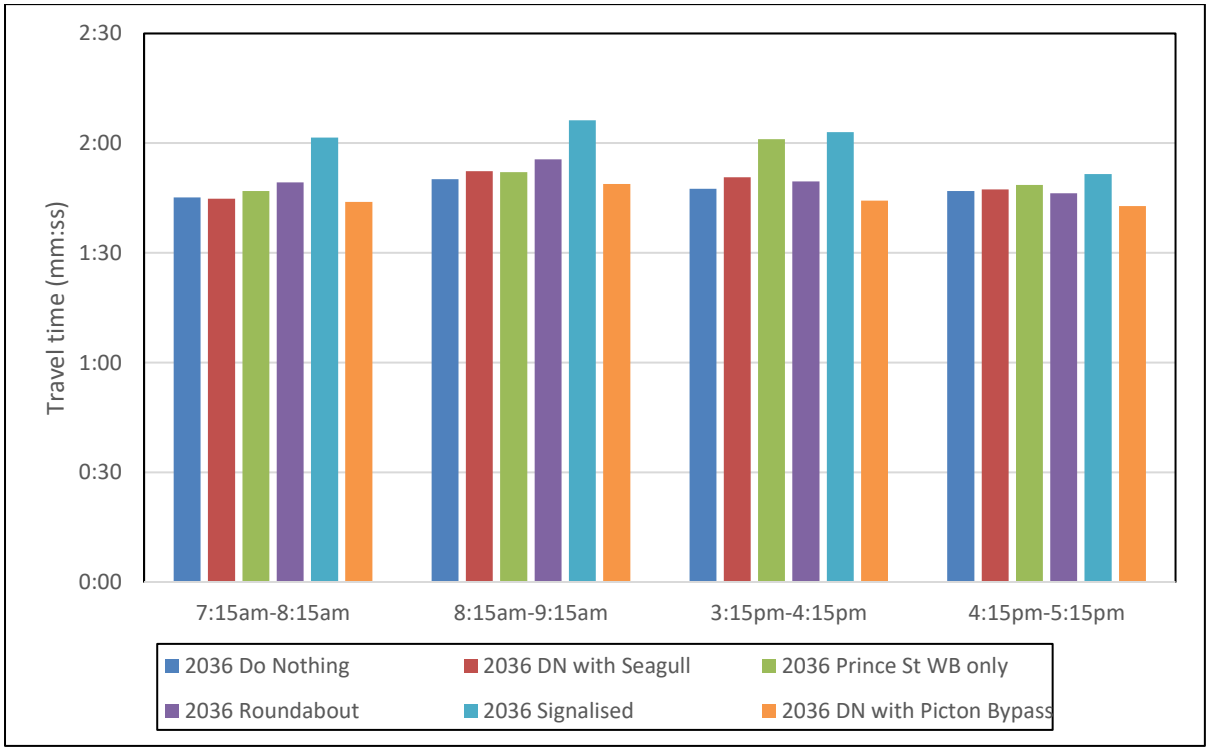


Figure 36: Menangle Street southbound travel time comparison – 2036

8.3.3 Prince Street

Figure 37 and **Figure 40** show the travel times recorded for each scenario for the Prince Street eastbound and Prince Street westbound routes in 2026 and 2036, respectively.

2026

- In 2026, Prince Street eastbound travel times are similar between the Do Nothing and Do Nothing with Seagull Intersection scenarios across the modelled peaks and hours.
- The signalised intersection scenario records the highest eastbound travel times in 2026, as the signalisation does not provide benefits to travel times under 2026 traffic volumes in this direction.
- The elliptical roundabout scenario records the lowest eastbound travel times in 2026.
- In 2026, Prince Street westbound travel times are lowest under the Prince Street westbound only scenario, which eliminates delays at Victoria Bridge due to queuing and opposing traffic.
- The Do Nothing with Seagull Intersection scenario provides the second lowest Prince Street westbound travel times in 2026, with the most benefit under PM traffic patterns.
- The Do Nothing, elliptical roundabout and signalised intersection scenarios record similar Prince Street westbound travel times in 2026.

2036

- In 2036, Prince Street eastbound travel times are similar between the Do Nothing and Do Nothing with Seagull Intersection scenarios across the modelled peaks and hours.
- The signalised intersection scenario records eastbound travel time improvements of over two minutes in 2036 when compared to the Do Nothing scenario.
- The elliptical roundabout and Do Nothing with Picton Bypass scenarios record the lowest eastbound travel times in 2036.
- In the 2036 AM peak, Prince Street westbound travel times are lowest under the Prince Street westbound only scenario, which eliminates delays at Victoria Bridge due to queuing and opposing traffic.
- The Do Nothing with Seagull Intersection and Do Nothing with Picton Bypass scenarios also provide travel time benefits in the westbound direction in the 2036 AM peak.
- The Do Nothing with Seagull Intersection and Do Nothing with Picton Bypass scenarios record the lowest westbound travel times in the 2036 PM peak.

Operational assessment comparison

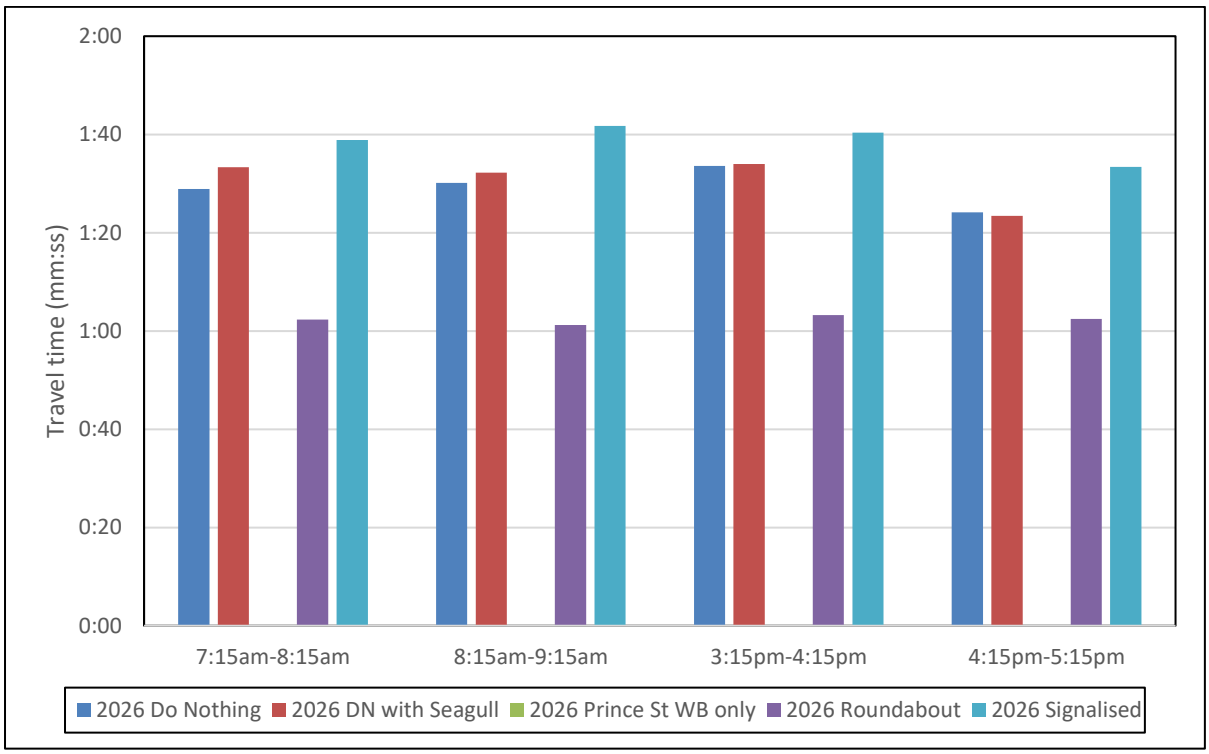


Figure 37: Prince Street eastbound travel time comparison – 2026

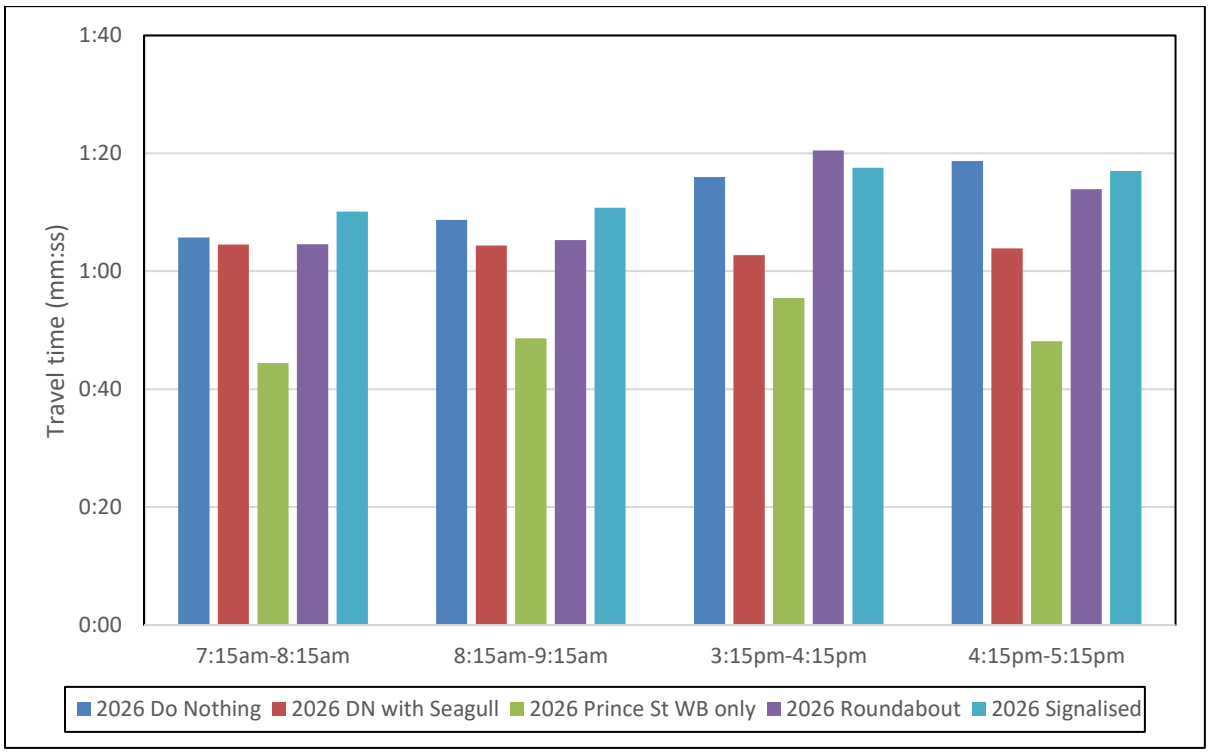


Figure 38: Prince Street westbound travel time comparison – 2026

Operational assessment comparison

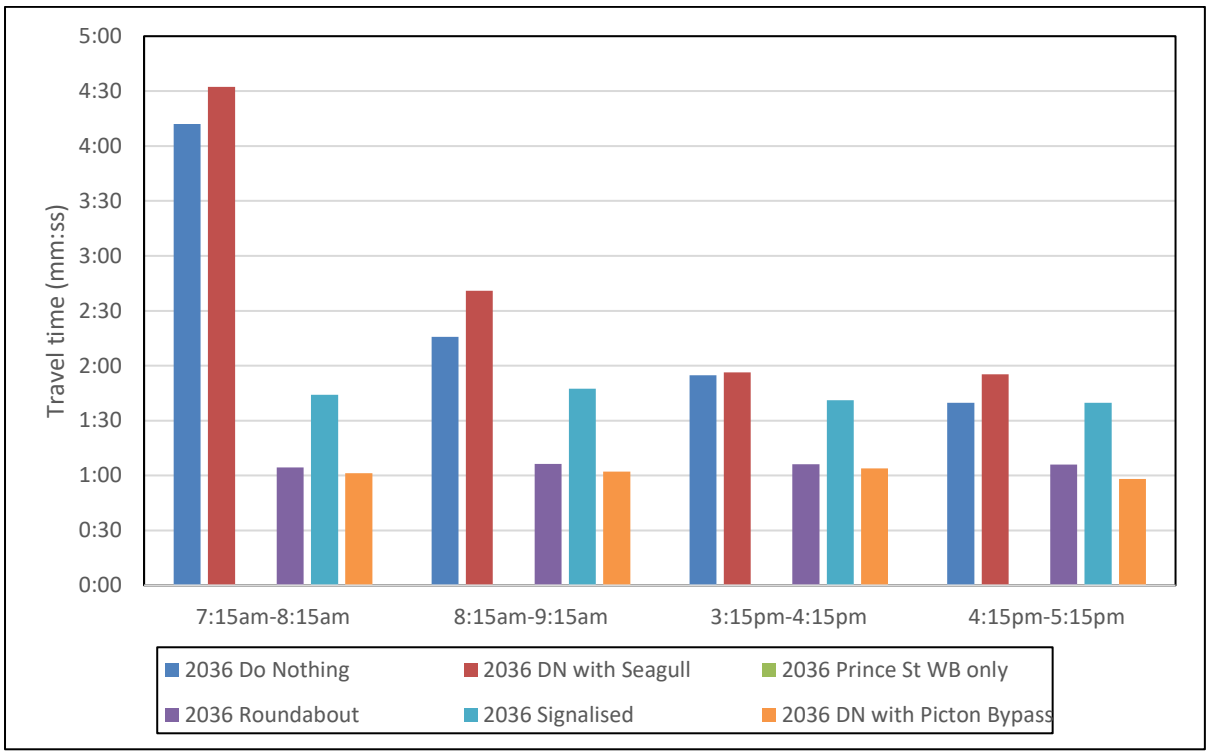


Figure 39: Prince Street eastbound travel time comparison – 2036

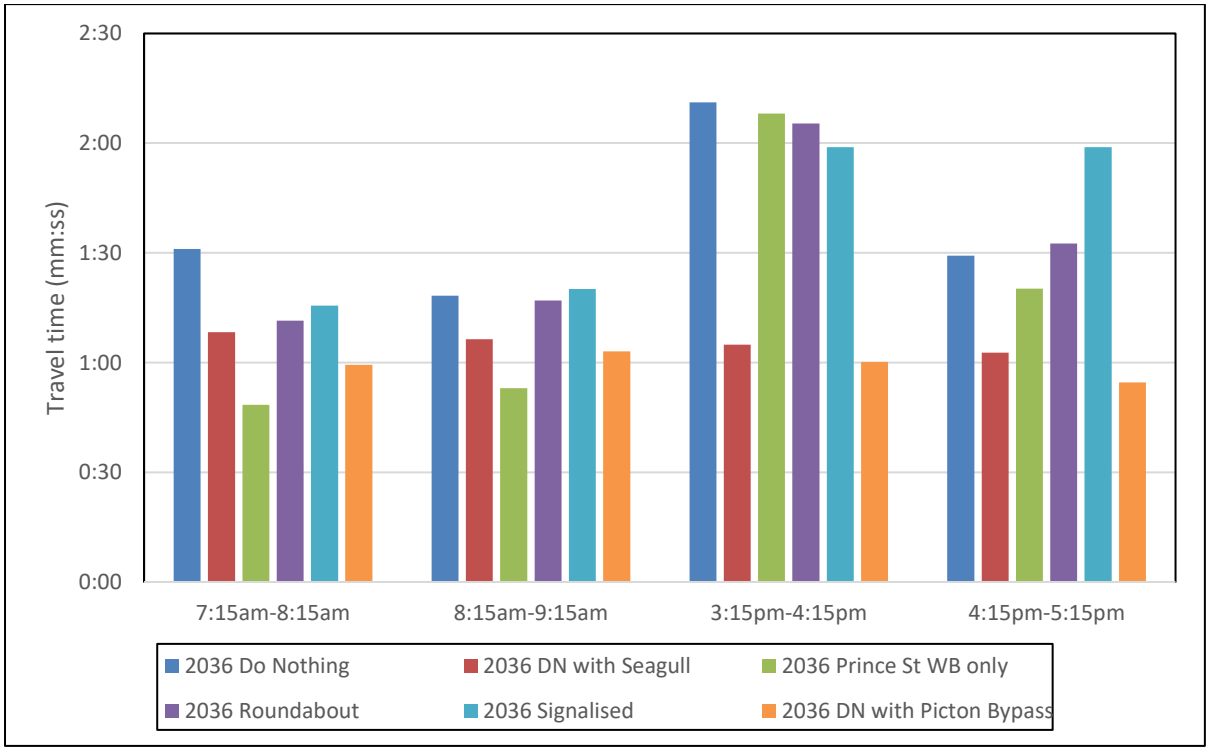


Figure 40: Prince Street westbound travel time comparison – 2036

9.0 CONCLUSION

This report has documented the development and results of the microsimulation model of the Picton town centre. The purpose of this study was to develop new traffic models of the town centre to obtain a current view of existing traffic operations and draw on updated land use development assumptions to understand future traffic network performance, with a particular focus on the Menangle Street / Prince Street intersection. The Do Nothing and four upgrade scenarios were modelled for 2026 and 2036, and the Do Nothing with Picton Bypass scenario was modelled for 2036.

For all scenarios, two peaks were modelled to capture typical weekday operation:

- AM peak: 7:15am - 9:15am
- PM peak: 3:15pm - 5:15pm.

The Do Nothing scenarios indicate that:

- In 2026, all assessed intersections in the study area will operate satisfactorily in all modelled peaks and hours, with the exception of Argyle Street / Barkers Lodge Road.
- In 2036, several intersections within the town centre operate unsatisfactorily in one or more peak hours, including Argyle Street / Prince Street and Menangle Street / Prince Street, and significant increases in travel time are observed on Prince Street in both directions.

The Do Nothing with Picton Bypass scenario assesses the operation of the Picton town centre road network with the proposed Picton Bypass operational. The model outputs of the scenario indicate that in 2036:

- The scenario provides the highest network average speeds out of all future scenarios.
- All assessed intersections in the study area will operate satisfactorily in all modelled peaks and hours, with the exception of Argyle Street / Barkers Lodge Road.
- The scenario generally provides the most benefits to travel time, including on the Prince Street eastbound and westbound routes, when compared with the other modelled scenarios.

The results of the Picton Town Centre Road Improvements study suggest that the Menangle Street / Prince Street intersection will operate satisfactorily with no action in 2026. With the proposed Picton Bypass operational, the Menangle Street / Prince Street intersection will operate satisfactorily with no action in 2036. However, if the Picton Bypass is not implemented, additional measures will be required to allow the Menangle Street / Prince Street intersection to maintain satisfactory performance in 2036.

The assessment of the four upgrade scenarios indicate that in 2036, the Menangle Street / Prince Street / Station Street elliptical roundabout upgrade generally provides the second-best network, intersection and travel time performance, behind the Do Nothing with Picton Bypass scenario. The scenario:

- Achieves the second-best network trip length and congestion benefits
- Records the best performance at Menangle Street / Prince Street, and second-best intersection performance across the network
- Provides the second-best Prince Street eastbound travel times.

Conclusion

In 2036, the Menangle Street / Prince Street / Station Street signalised intersection scenario:

- Provides satisfactory intersection performance at Menangle Street / Prince Street
- Records significant improvements in Prince Street eastbound travel times
- Provides benefits to network performance and trip lengths, especially in the AM peak.

In 2036, the Do Nothing with Seagull Intersection scenario:

- Records the best intersection performance at Argyle Street / Prince Street out of the non-Bypass scenarios
- Provides improvements to network trip length and congestion levels in the PM peak, and performs similarly to the Do Nothing scenario in the AM peak
- The scenario provides the most benefits to travel times on Prince Street westbound out of the non-Bypass scenarios.

The Prince Street westbound only scenario was found to:

- Provide disbenefits to network trip lengths, travel times and congestion levels
- Increase traffic volumes in the Picton town centre and increase delay at intersections including Argyle Street / Menangle Street.

Appendix A

Base Model Development Report

Picton Town Centre Road Improvements

Base Model Development Report

02/02/2023

Prepared for:
Wollondilly Shire Council

Prepared by:
Cardno now Stantec

Project Number:
82018177 / 304100681

Revision	Description	Author		Quality Check		Independent Review	
1	Draft	Jackie Liang Edward Wu	21/10/2022	Siavash Shahsavaripour	21/10/2022	Siavash Shahsavaripour	21/10/2022
2	Final – Addressing Council Comments	Jackie Liang Edward Wu	14/11/2022	Siavash Shahsavaripour	14/11/2022	Siavash Shahsavaripour	14/11/2022
3	Final – Addressing TfNSW Review Comments	Jackie Liang	2/02/2023	Siavash Shahsavaripour	2/02/2023	Siavash Shahsavripour	2/02/2023

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1.0 INTRODUCTION

1.1 BACKGROUND

Picton is situated in the Wollondilly Shire local government area, within the Macarthur region of New South Wales. The town is located at the intersection of three major transport corridors, which include the Old Hume Highway, Menangle Street and Barkers Lodge Road, and therefore forms a major hub for traffic travelling between Sydney or Wollongong and surrounding regions in the Wollondilly Shire. **Figure 1** shows the regional context of Picton.

The Wollondilly Shire is expected to undergo significant land development and population growth in the near future. Combined with further development in the Greater Macarthur region and its location along major transport corridors, these factors place significant challenges on Picton's transport network, including traffic congestion and elevated heavy vehicle volumes through the Picton town centre. With these challenges in mind, Wollondilly Shire Council commissioned the Picton Town Centre Transport Master Plan in 2017. The Transport Master Plan recommended upgrades to several intersections and other road infrastructure in Picton.

Council identified that a number of items in the Picton Town Centre Transport Master Plan would require significant resources to implement and would be influenced by re-zoning and development in the region. Therefore, Council engaged Cardno in 2018 to develop the Picton Town Centre Transport Plan 2026, which proposed short-term, low-cost upgrades to provide sufficient network capacity until at least 2026. Upgrade options were proposed at six intersections in the town centre, including the signalisation of Menangle Street / Prince Street and the addition of turning lanes at Argyle Street / Prince Street.

Following the development of the Picton Town Centre Transport Plan 2026, community consultation was undertaken regarding the items identified in the Transport Plan 2026. Consultation on the Menangle Street / Prince Street intersection upgrade was conducted in 2019. After further community feedback was received that questioned the need to signalise the Menangle Street / Prince Street intersection, Council resolved to undertake additional community engagement in February 2022. The key outcomes from the first round of community engagement were summarised in the *Prince and Menangle Streets Intersection Community Workshop Outcomes Report – Interim* (WSP, July 2022). The outcomes included the provision for new traffic modelling of the upgrade options to be undertaken, incorporating new traffic survey data, updated development assumptions and the impact of the proposed Picton Bypass.

As a result of the interim community engagement outcomes, Wollondilly Shire Council has re-engaged Cardno, now Stantec (Cardno) to undertake an updated transport study of the Picton town centre. The study aims to develop new traffic models of the town centre to obtain a current view of existing traffic operations and draw on updated development assumptions to understand future traffic network performance, with a particular focus on the Menangle Street / Prince Street intersection.

1.2 MODELLING OBJECTIVES

The primary objectives of the traffic modelling for this project are to:

- Develop, calibrate and validate a microsimulation base model to replicate and provide an understanding of existing network performance in the Picton town centre
- Investigate and quantify existing traffic performance of the road network at key intersections and sections
- Utilise current land use projections and strategic modelling forecasts to model the impact of traffic growth on road network performance in the Picton town centre, including at Prince Street / Menangle Street
- Assess the need for network and intersection upgrades, including at Prince Street / Menangle Street and provide recommendations to improve traffic efficiency and maintain road safety under existing or predicted future network conditions.

1.3 SCOPE OF WORKS

Cardno's scope of works for the traffic modelling services includes the following steps:

- Develop a 2022 base model for AM and PM peak periods
- Calibrate and validate the base model in accordance with:
  - *Traffic Modelling Guidelines* (Roads and Maritime Services, 2013)
  - *Technical Direction 2018/002: Traffic Signals in Microsimulation* (Roads and Maritime Services, 2018)
- Prepare the Base Model Development Report (this report) in accordance with:
  - *Technical Direction 2017/001: Operational Modelling and Reporting Structure* (Roads and Maritime Services, 2017)
  - *Editorial Style Guide* (Roads and Maritime Services, 2014)
- Assess the existing traffic performance of the road network at key intersections and sections
- Develop future year 2026 and 2036 models for AM and PM peak periods to assess the impact of proposed network upgrades, identify network deficiencies and pinch points and provide modelling outputs which inform level of service and intersection performance
- Provide recommendations to improve traffic efficiency and maintain road safety under existing or predicted future network conditions.

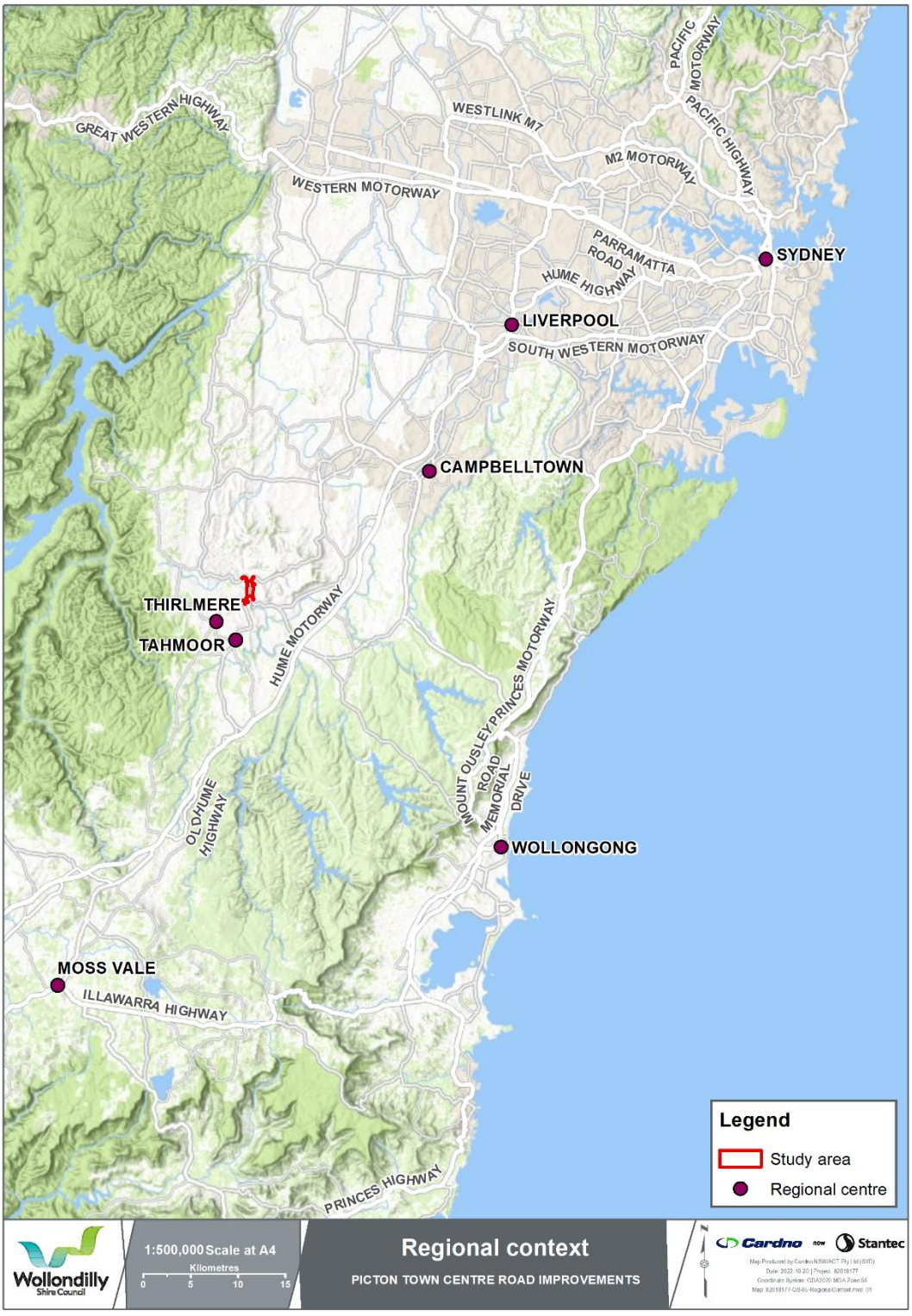


Figure 1: Regional context

1.4 STUDY AREA

The study area is centred on the Picton town centre. The Old Hume Highway runs in a north-south direction through the study area, forming the primary access route to and from the study area. Menangle Street, Thirlmere Way and Barkers Lodge Road are also major access links to the study area. Margaret Street and Colden Street border major retail and commercial destinations within the Picton town centre. The study area is shown in **Figure 2** below.

Five core areas have been defined in the model boundary. The core areas were selected to correspond with the focus areas of the study, being the Menangle Street / Prince Street intersection and the Picton town centre. The five core areas are:

1. Old Hume Highway / Margaret Street
2. Old Hume Highway / Menangle Street
3. Old Hume Highway / Barkers Lodge Road
4. Old Hume Highway / Prince Street
5. Menangle Street between Prince Street and Webster Street.

Figure 2 also shows the location of each of the core areas within the study area.

1.5 STAKEHOLDERS

Stakeholders for the project include:

- Wollondilly Shire Council
- Transport for NSW

1.6 REPORT OUTLINE

The structure of this report is outlined below:

- **Introduction**: Outline of background, project objective and study area
- **Existing conditions**: Discussion of the existing network operations and traffic data used for the model development and calibration/validation process
- **Model assumptions**: discussion of the assumptions underlying the development of the Base Model
- **Model stability**: Statistical analysis of the stability of the model
- **Model calibration and validation**: Summary of the Base Model calibration and validation
- **Model limitations**: Discussion of the limitations of the model that may affect the model outputs
- **Conclusion:** Summary of the main outcomes of the Base Model development.

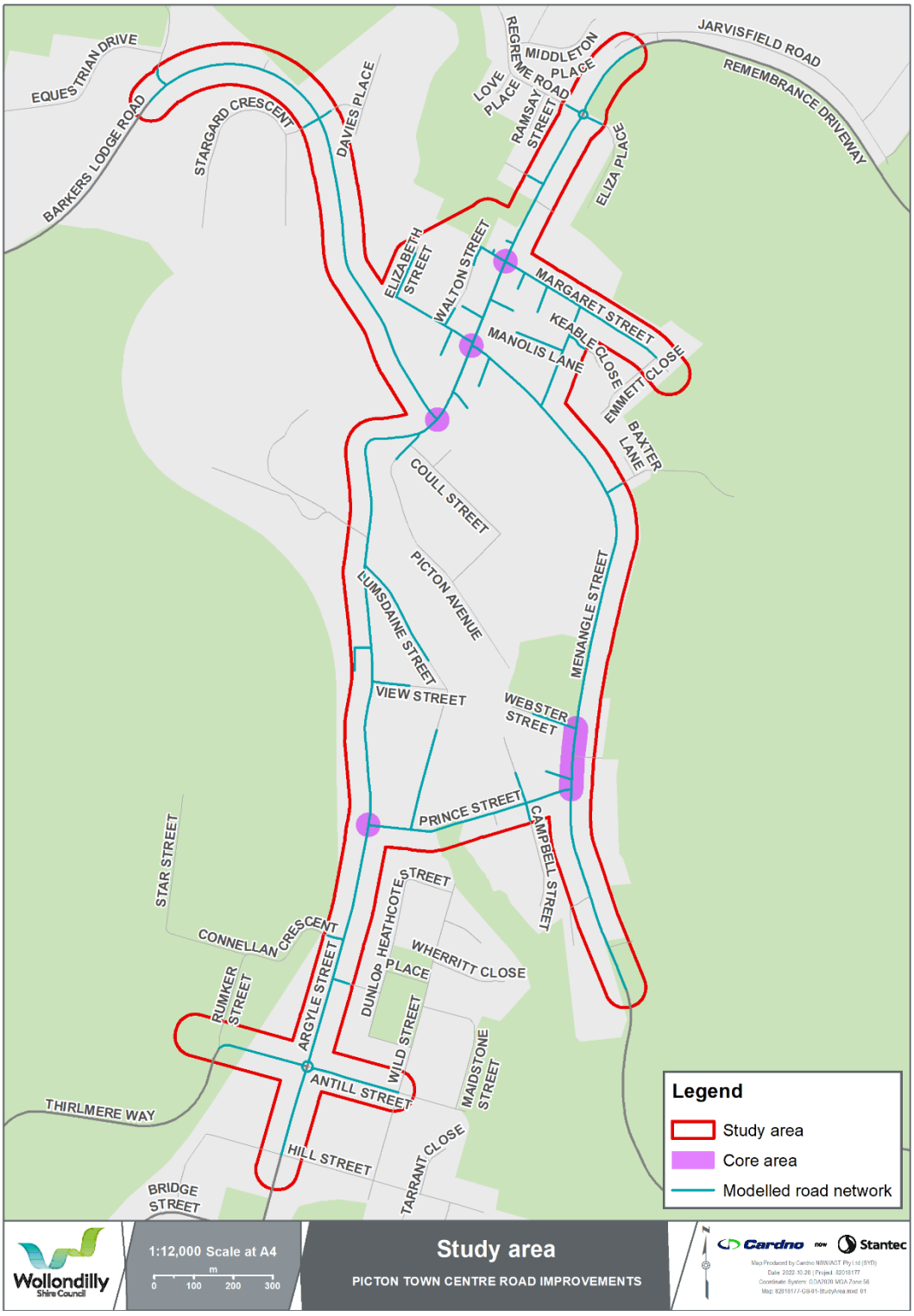


Figure 2: Study area

2.0 EXISTING CONDITIONS

This section provides an overview of the existing conditions in and around the study area, including a description of the survey data collected for the project and existing conditions analysis.

2.1 TRAFFIC DATA SOURCES

Traffic data used to develop the Aimsun model was compiled from a variety of sources, including:

- Classified intersection counts
- Queue length surveys
- Automated tube counts
- Travel time surveys and TomTom travel time data
- Strategic model outputs.

2.2 INTERSECTION COUNTS

Classified intersection counts (CIC) record vehicle movements for all approaches to an intersection. The number of vehicles making each turn are used in the development of the Base Model to ensure that the modelled volumes are reflective of those in reality.

Classified intersection count surveys were undertaken at 21 locations including 1 signalised and 20 priority and roundabout intersections. The intersections were surveyed on Wednesday 22 June 2022, Thursday 23 June 2022 and Friday 24 June 2022 for the following times:

- AM peak: 6:00am-10:00am
- PM peak: 3:00pm-7:00pm.

The data was recorded in 15-minute intervals and was classified into the following vehicle types:

- Light vehicles
- Heavy rigid vehicles
- Heavy articulated vehicles
- Cyclists
- Pedestrians.

Table 1 lists the intersections which were surveyed and the type of intersection. **Figure 3** shows these locations on a map of the study area.

Table 1: Classified intersection count survey locations

ID	Intersection	Type
1	Old Hume Highway / Regreme Road / Eliza Place	RB
2	Old Hume Highway / Cliffe Street / Margaret Street	S
3	Old Hume Highway / Manolis Lane	P
4	Old Hume Highway / Walton Lane	P
5	Old Hume Highway / Menangle Street	P
6	Menangle Street / Walton Street	P
7	Cliffe Street / Walton Street	P
8	Menangle Street / Colden Street	P
9	Colden Street / Monalis Lane	P
10	Colden Street / Margaret Street	P
11	Margaret Street / Manolis Lane (Carpark Access)	P
12	Old Hume Highway / Barkers Lodge Road	P
13	Old Hume Highway / Lumsdaine Street	P
14	Old Hume Highway / View Street	P
15	Lumsdaine Street / Prince Street	P
16	Old Hume Highway / Prince Street	P
17	Menangle Street / Prince Street	P
18	Menangle Street / Station Street	P
19	Menangle Street / Webster Street	P
20	Old Hume Highway / Antill Street / Thirlmere Way	RB
21	Menangle Street / Baxter Lane	P

P = priority, RB = roundabout, S = signalised

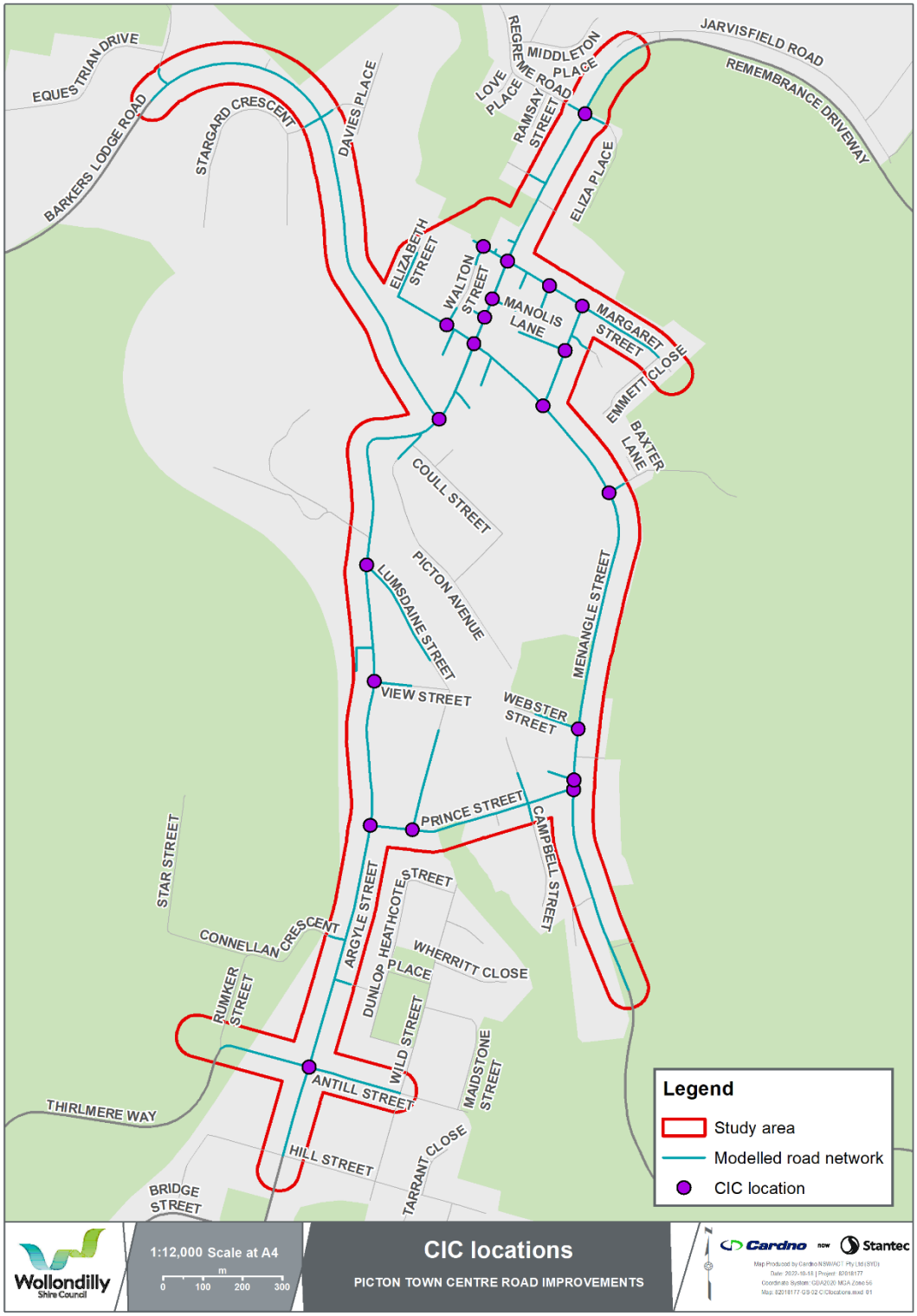


Figure 3: Classified intersection count locations

2.3 QUEUE LENGTH SURVEYS

Queue lengths are an indication of delays experienced at an intersection. Queue length surveys record the number of cars queued and/or the distance from the stop line to the back of queue. During the validation process, observed queue lengths are compared to modelled queues to ensure that the model is accurately replicating driver behaviours (such as aggressiveness and reaction time) and environmental factors (such as sight distance, and gradient).

Queue lengths were collected at the same time as the CICs for 12 out of the 21 intersections. **Table 2** lists the intersections which were surveyed and the type of survey. **Figure 4** shows these locations on a map of the study area.

Table 2: Queue length survey locations

ID	Intersection	Type
1	Old Hume Highway / Regreme Road / Eliza Place	RB
2	Old Hume Highway / Cliffe Street / Margaret Street	S
3	Old Hume Highway / Manolis Lane	P
4	Old Hume Highway / Walton Lane	P
5	Old Hume Highway / Menangle Street	P
8	Menangle Street / Colden Street	P
12	Old Hume Highway / Barkers Lodge Road	P
15	Lumsdaine Street / Prince Street	P
16	Old Hume Highway / Prince Street	P
17	Menangle Street / Prince Street	P
18	Menangle Street / Station Street	P
19	Menangle Street / Webster Street	P

P = priority, RB = roundabout, S = signalised

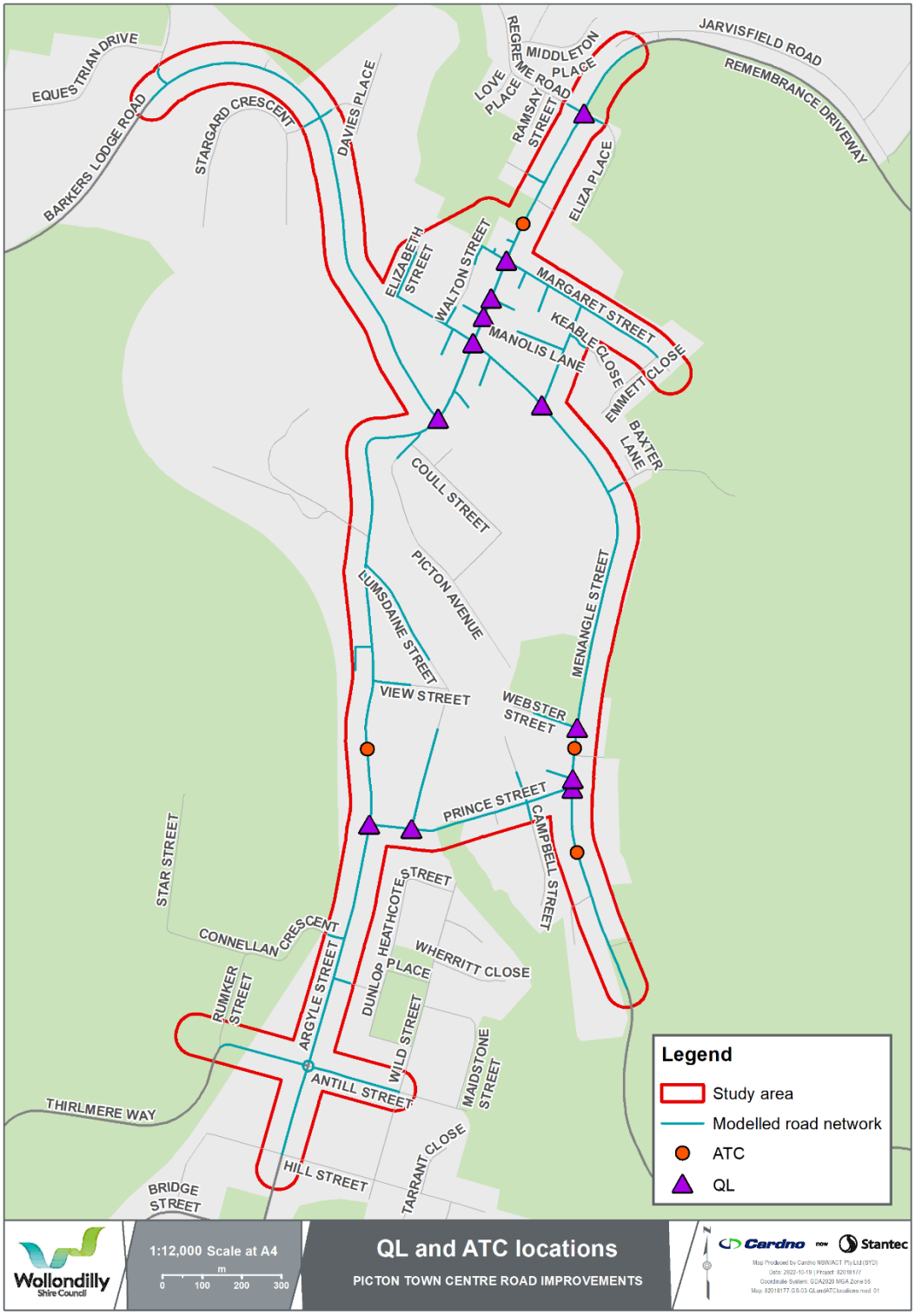


Figure 4: Queue length and automatic tube count locations

2.4 AUTOMATIC TUBE COUNTS

Automatic tube counts (ATC) use pneumatic tubes across the road that register vehicle movement. They are capable of measuring traffic volumes, vehicle types and speeds. ATCs are typically used to record data over an extended period of time, such as a week or month.

ATCs were collected at nine locations in the study area. The data was collected for a one-week period from Monday 20 June 2022 to Sunday 27 June 2022. **Table 3** lists the locations where ATC surveys were conducted, and **Figure 4** shows the ATC locations.

Table 3: Automatic tube count locations

ID	Location
1	Old Hume Highway between Prince Street and View Street
2	Old Hume Highway between Downing St and Margaret St
3	Menangle St between Basin Rd and Prince St
4	Menangle St between Prince St and Webster St

2.5 TRAVEL TIME DATA

Travel time data was used to determine the delays incurred at intersections, merges, or pinch points. Data was collected from travel time surveys and TomTom travel time data.

Travel time surveys were conducted using the 'floating vehicle' method and travel times were recorded using GPS units set to record the vehicle's position in one second increments. Floating car surveys were undertaken at the same time as the CIC and QL surveys.

TomTom captures 3.5 million kilometres of floating car data (FCD) every day in Australia. The data is collected from a combination of TomTom devices (fleet and consumer), third-party auto original-equipment manufacturers (OEMs) and mobile devices. FCD provides a new method for measuring speeds, travel times and road performance. Probe devices in vehicles, which may be cellular phones or Global Positioning System (GPS) devices, provide average travel time data in large sample sizes per route segment. This method of data collection is advantageous to the traditional floating car method and less susceptible to being skewed by anomalous data points.

Table 4 lists the travel time routes and **Figure 5** shows the location of these routes.

Table 4: Travel time survey routes

ID	Route name	Segment	Description
1	Old Hume Highway	1	Eliza Pl to Downing St
		2	Downing St to Margaret St
		3	Margaret St to Cliffe Street
		4	Margaret St to Menangle St
		5	Menangle St to Barkers Lodge Rd
		6	Barkers Lodge Rd to Lumsdaine St
		7	Lumsdaine St to View St
		8	View St to Prince St
		9	Prince St to Antill St
2	Menangle Street	1	Prince St to Webster St
		2	Webster St to Baxter Ln
		3	Baxter Ln to Colden St
		4	Colden St to Old Hume Highway
3	Prince Street	1	Old Hume Highway to Menangle Street

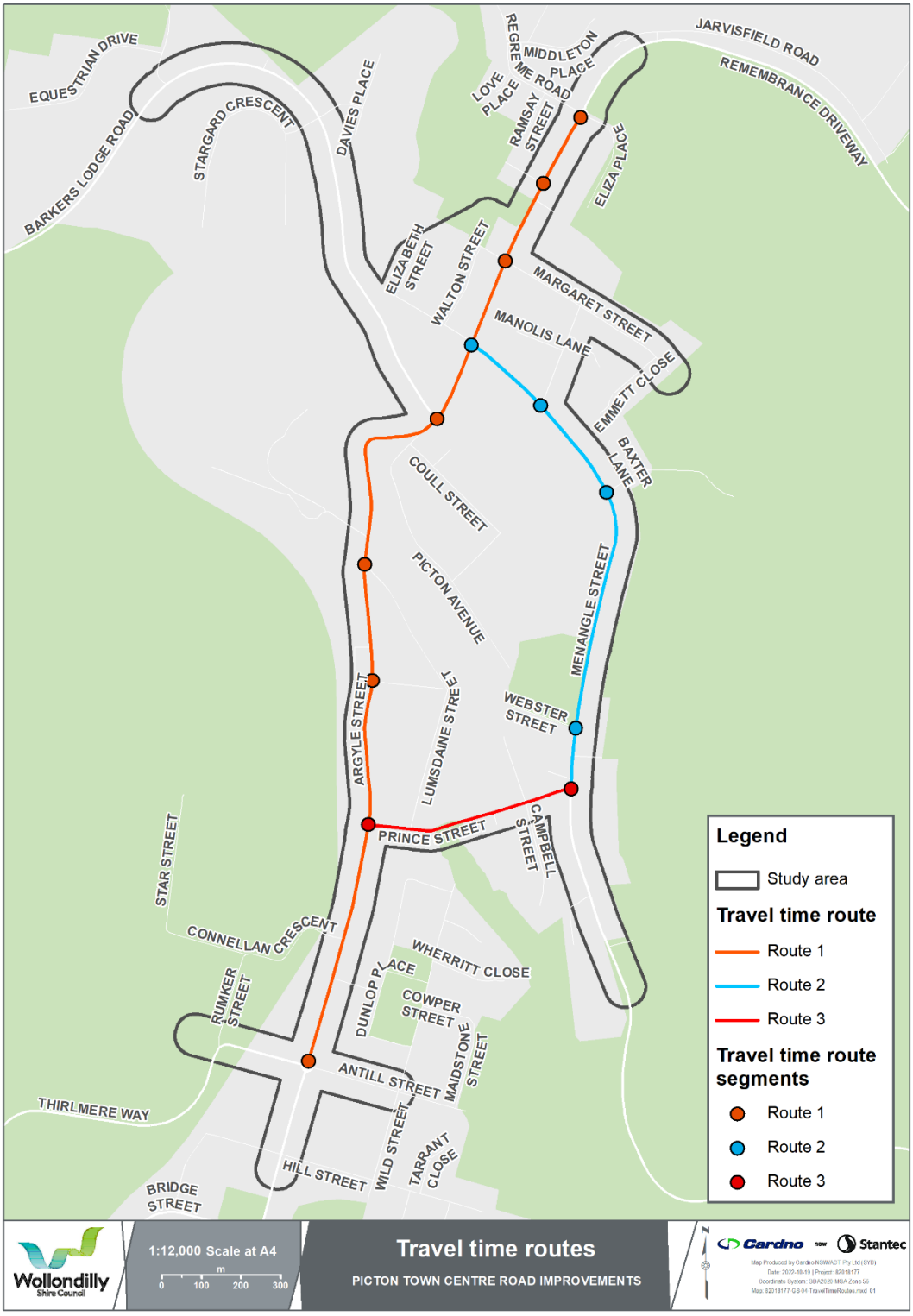


Figure 5: Travel time routes

2.6 SCATS TRAFFIC SIGNAL DATA

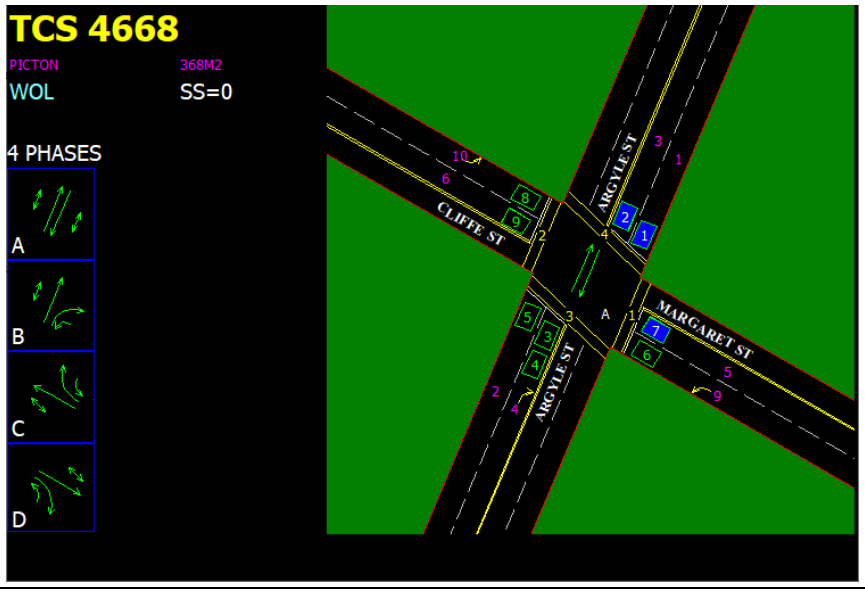
The following SCATS traffic signal information was obtained from Transport for NSW for the signalised intersection within the study area:

- SCATS history file
- TCS graphic plots
- SCATS Region LX files
- TCS plans.

Historical data for the CIC survey dates was extracted. Historical phase times were provided separately for each 15-minute interval of each survey day.

One signalised intersection is present within the study area. **Table 5** provides the TCS number and SCATS graphic plot for the signalised intersection.

Table 5: Signalised intersections

TCS #	Intersection	SCATS graphic plot
4668	Old Hume Highway / Cliffe Street / Margaret Street	

2.7 STRATEGIC MODEL OUTPUT

Cordon matrices were extracted from the TRACKS strategic model. The cordon matrices included 45 zones, of which 8 were external (representing all destinations outside the study area along major roads) and 37 were internal (representing destinations inside the study area). **Figure 6** shows the cordoned TRACKS network.

Figure 6: TRACKS cordon network

Table 6 lists the TRACKS zones within the study area.

Table 6: TRACKS zones within the study area

TRACKS zone ID	Zone type	Description
1	Internal	Picton Bowling Club, restaurants and shops
2	Internal	Residential along Old Hume Highway
3	Internal	Residential and commercial along Margaret Street
4	Internal	St. Vincent De Paul Family Centre and residential along Colden Street
5	Internal	Margaret Street
6	Internal	Picton Mall Shopping Centre
7	Internal	Picton Mall Shopping Centre
8	Internal	Wollondilly Library Picton Branch
9	Internal	Wollondilly Shire Council and Wollondilly School Holiday Care
10	Internal	St. Anthony's Catholic Parish Primary School
11	Internal	Picton Mall Shopping Centre
12	Internal	Picton Rural Fire Brigade and Picton Masonic Centre
13	Internal	Emmett Close
14	Internal	Residential along Menangle Street
15	Internal	Baxter Lane
16	Internal	Picton Town Square
17	Internal	Davidson Lane
18	Internal	Crankanthorp Lane
19	Internal	Commercial along Old Hume Highway
20	Internal	Elizabeth Street
21	Internal	Menangle Street W
22	Internal	Walton Lane
23	Internal	Elizabeth Street
24	Internal	Walton Street
25	Internal	Commercial along Old Hume Highway
26	Internal	Picton Bowling Club and McDonald's
27	Internal	Walton Street
28	Internal	Council Works Depot
29	Internal	Picton Service Centre
30	Internal	Commercial along Old Hume Highway
31	Internal	Webster Street
32	Internal	Lumsdaine Street

TRACKS zone ID	Zone type	Description
33	Internal	Downing Street
34	Internal	Cornnellan Crescent
35	Internal	Ramsay Street
36	Internal	Love Place
37	External	Picton Botanic Gardens
38	External	Menangle Street
39	Internal	Cowper Street
40	External	Antill Street
41	External	Old Hume Highway
42	External	Thirlmere Way
43	External	Barkers Lodge Road
44	External	Regreme Road
45	External	Old Hume Highway

3.0 MODEL ASSUMPTIONS

3.1 MODELLING PLATFORM

The Base Model was developed using Aimsun Next 20.0.3. A microsimulation model was considered the most appropriate tool for modelling the baseline conditions as well as future infrastructure changes involving general traffic, pedestrians and public transport. Microsimulation models are capable of explicitly modelling each of these elements and quantifying the network impacts of infrastructure changes.

3.2 NETWORK CODING

The network was coded based on aerial imagery from NearMap in June 2022 and supplemented by site visit observations. The extent of the modelled network is shown in **Figure 8**.

3.3 TIME PERIOD

3.3.1 Peak day

As classified intersection count surveys were conducted on three weekdays, Cardno first determined which of the dates surveyed had the highest traffic volumes. **Figure 7** shows the total traffic volume recorded on each survey day. The maximum traffic volume was recorded on Thursday 23 June 2022.

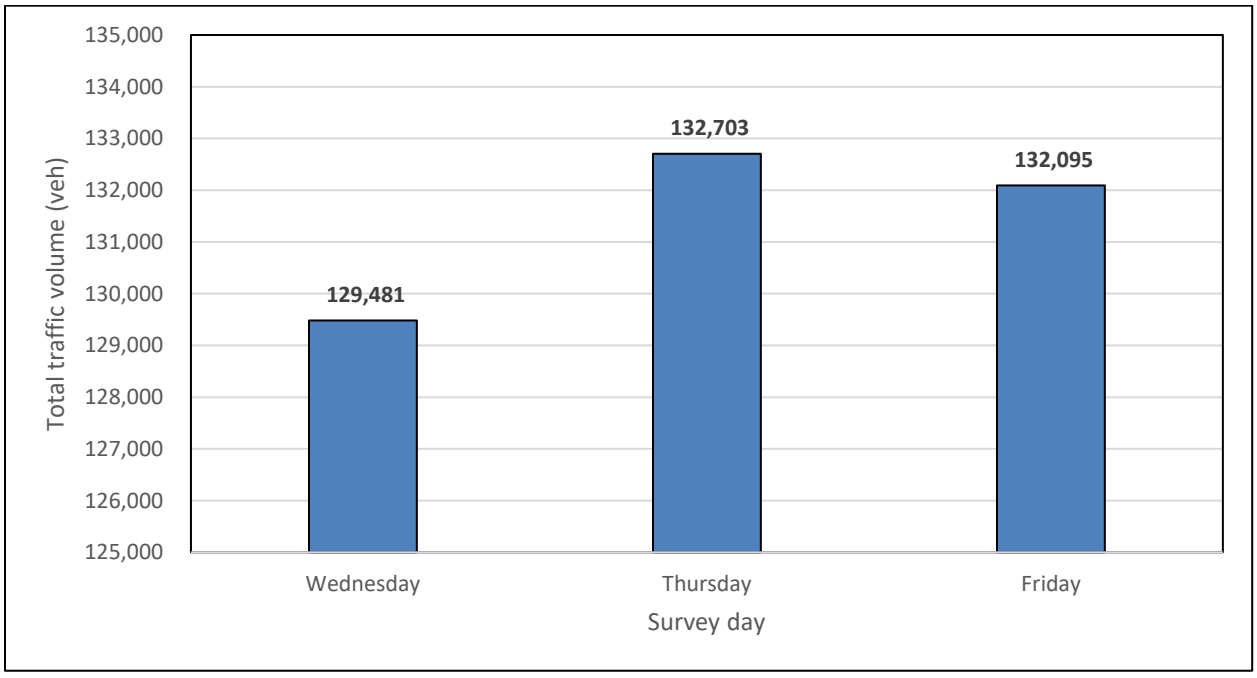


Figure 7: Total traffic volume per survey day

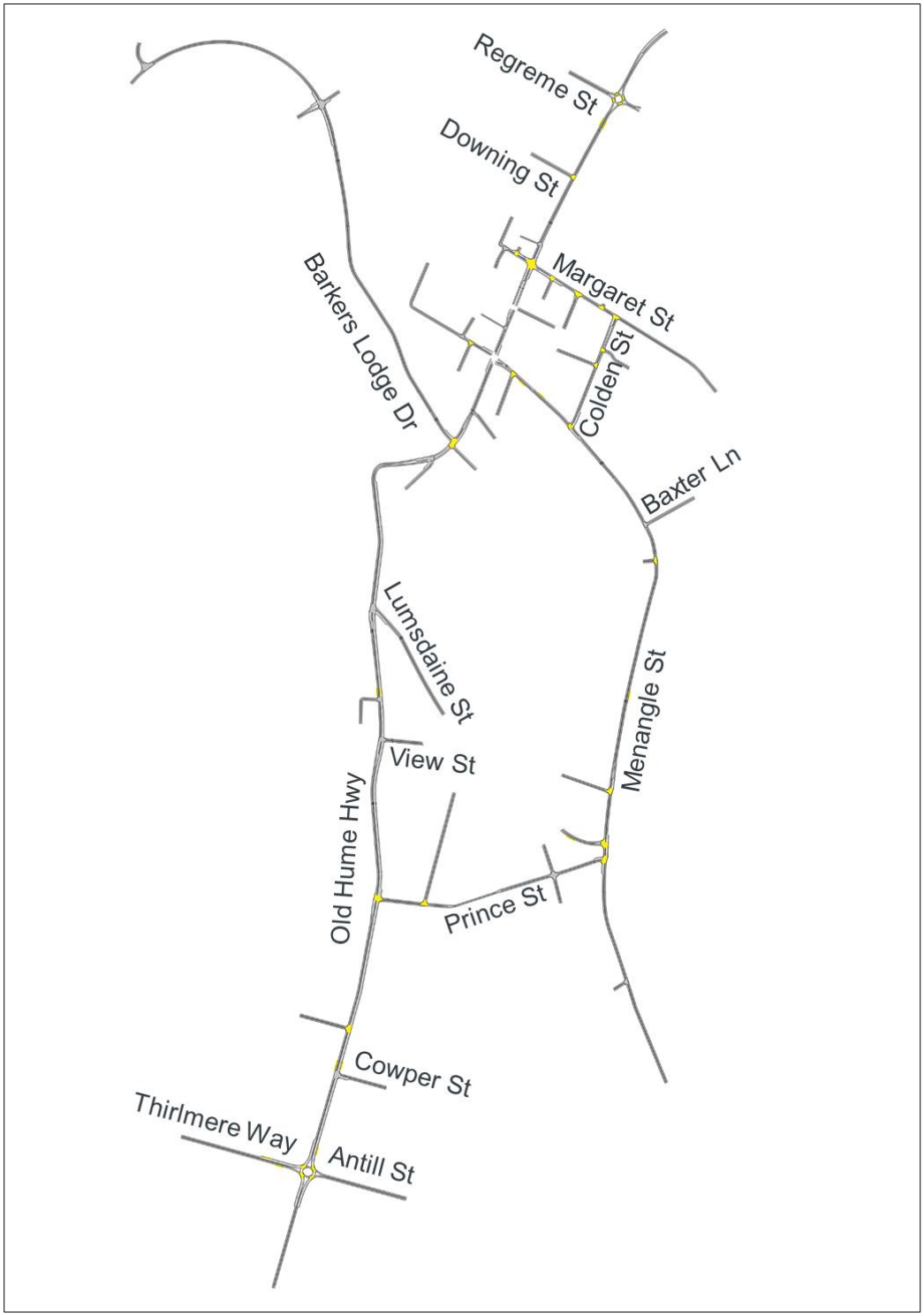


Figure 8: Modelled network

3.3.2 Seasonality analysis

Cardno conducted a traffic volume seasonality analysis to determine how the traffic volume on the peak survey date compared with traffic volumes on other days of the year.

Transport for NSW provided SCATS detector data for the signalised intersection in the study area listed in **Table 5**. Data was provided for the one-year period prior to and including the traffic survey dates. Cardno calculated the number of vehicles detected at each detector between Friday 25 June 2021 and Friday 24 June 2022. The total daily volume recorded by the detectors for each day is shown in **Figure 9**, ranked from lowest to highest.

The analysis indicates that the peak survey date of Thursday 23 June 2022 is the 47th busiest day observed in the year leading up to the traffic survey dates.

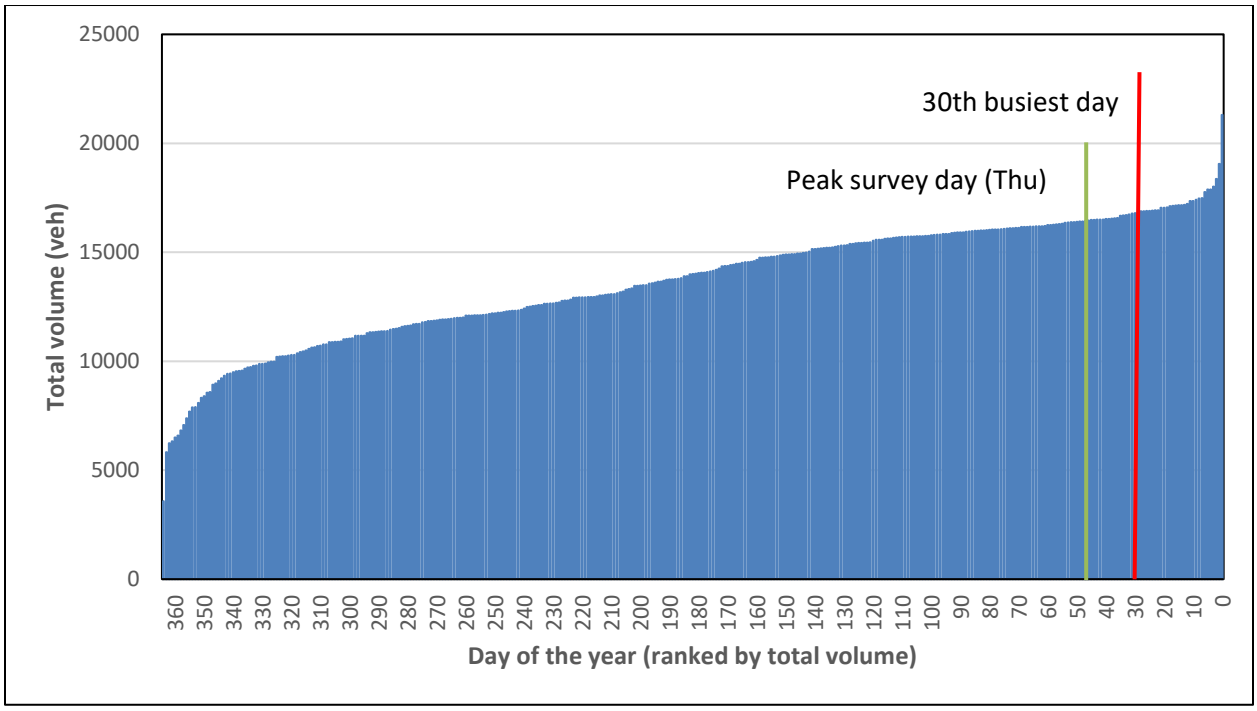


Figure 9: SCATS detector count seasonality analysis

3.3.3 Traffic profile

The traffic profile was determined from the classified intersection counts and automatic tube counts. It was assumed that the peak period was the two-hour period with the highest traffic volume recorded across all intersections in the network. The model provides an indication of the performance of the network during this period in each peak.

Figure 10 shows the traffic profile recorded by the automatic tube counts between 5:00am and 12:00pm on the peak day, and **Figure 11** shows the traffic profile recorded by the classified intersection counts between 6:00am and 10:00am. The profiles are recorded in 15-minute intervals with the two-hour AM peak period highlighted in each case.

Figure 12 shows the traffic profile recorded by the automatic tube counts between 12:00pm and 7:00pm on the peak day, and **Figure 13** shows the traffic profile recorded by the classified intersection counts between 3:00pm and 7:00pm. The profiles are recorded in 15-minute intervals with the two-hour PM peak period highlighted in each case.

3.3.4 Modelled time period

Two hours were modelled for each peak in the microsimulation model. A half-hour warm-up period was included in each model to build-up the traffic density in the model to accurately reflect the starting traffic conditions of each peak. **Table 7** shows the warm-up and modelled period for each peak for the microsimulation model.

Table 7: Modelled time periods

Peak	Warm-up	Peak period
AM peak	6:45am-7:15am	7:15am-9:15am
PM peak	2:45pm-3:15pm	3:15pm-5:15pm

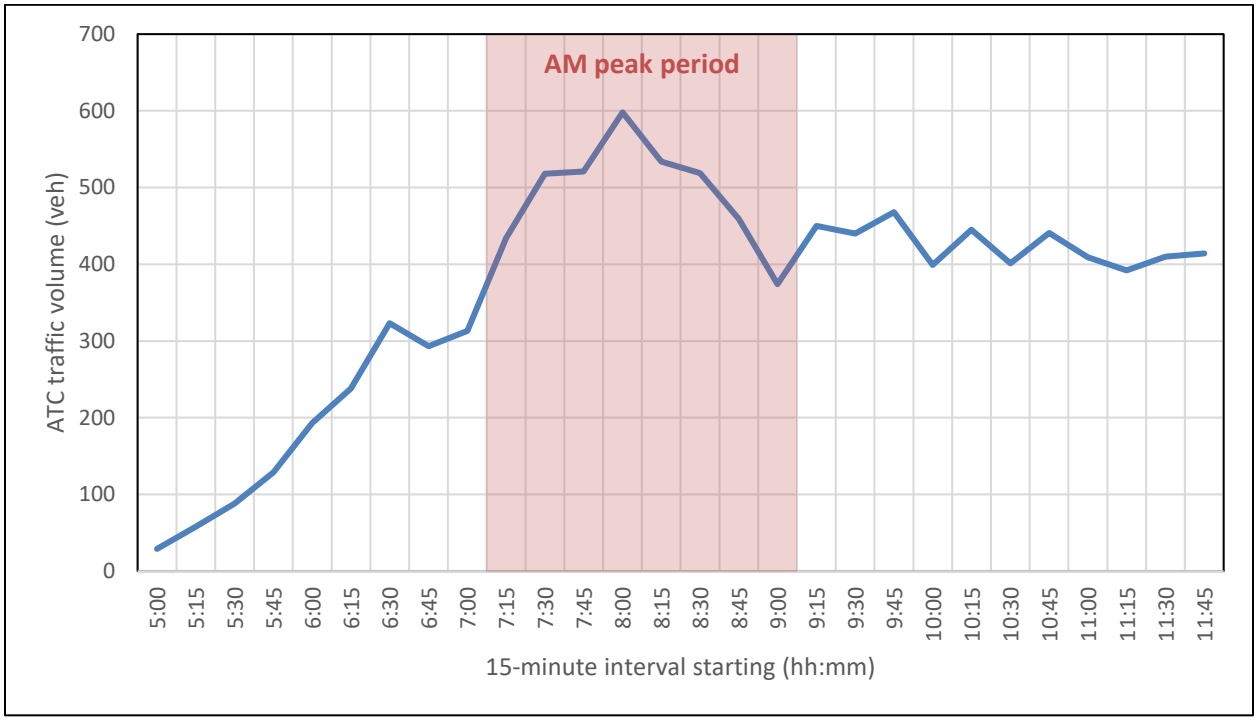


Figure 10: ATC surveyed traffic volume – AM peak

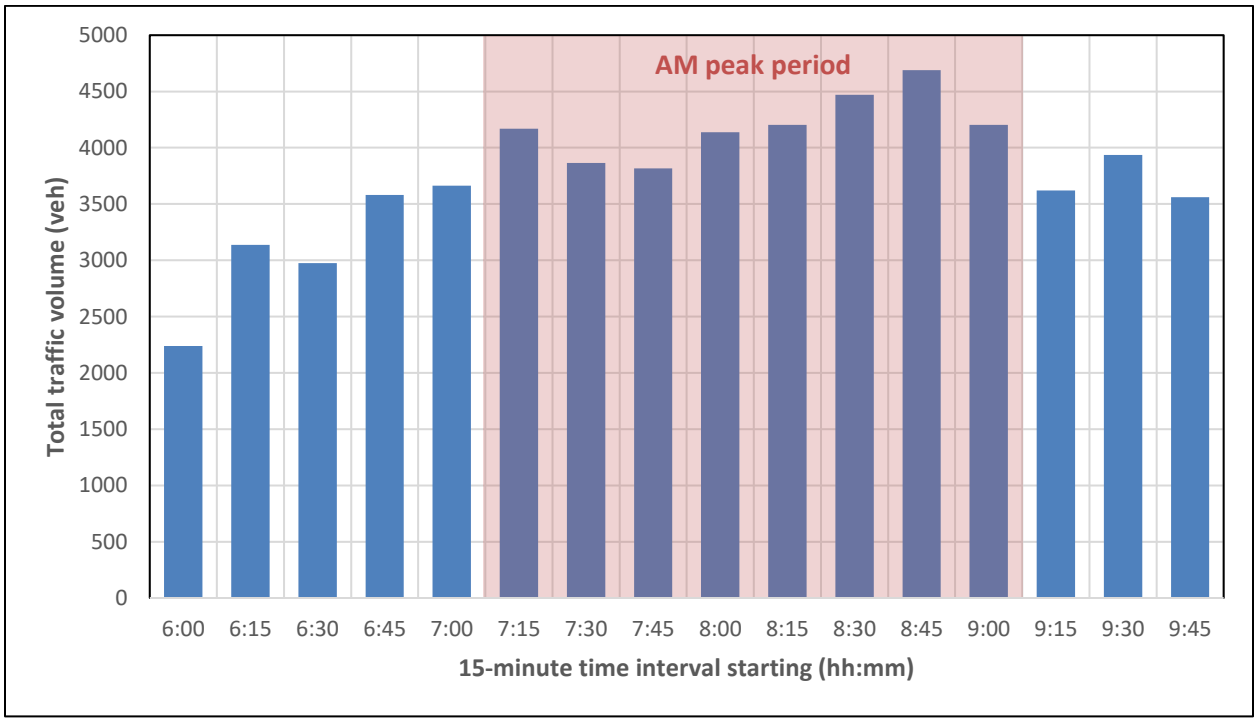


Figure 11: CIC surveyed traffic profile – AM peak

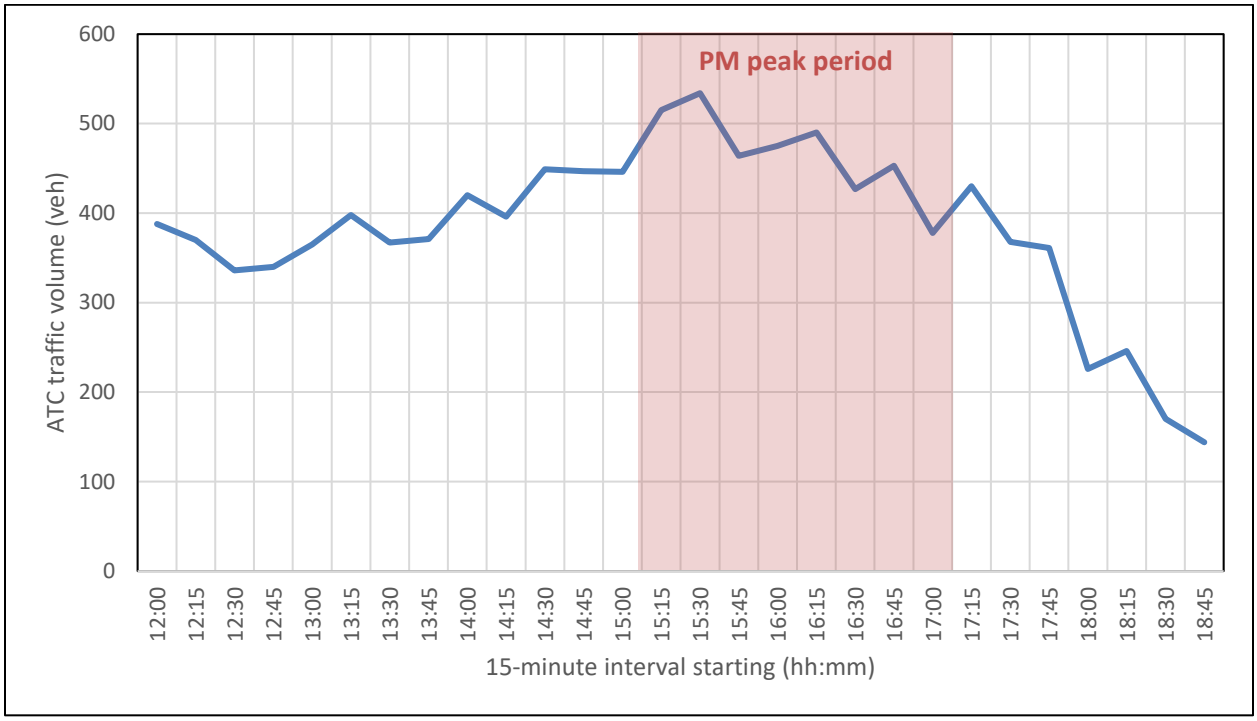


Figure 12: ATC surveyed traffic volume – PM peak

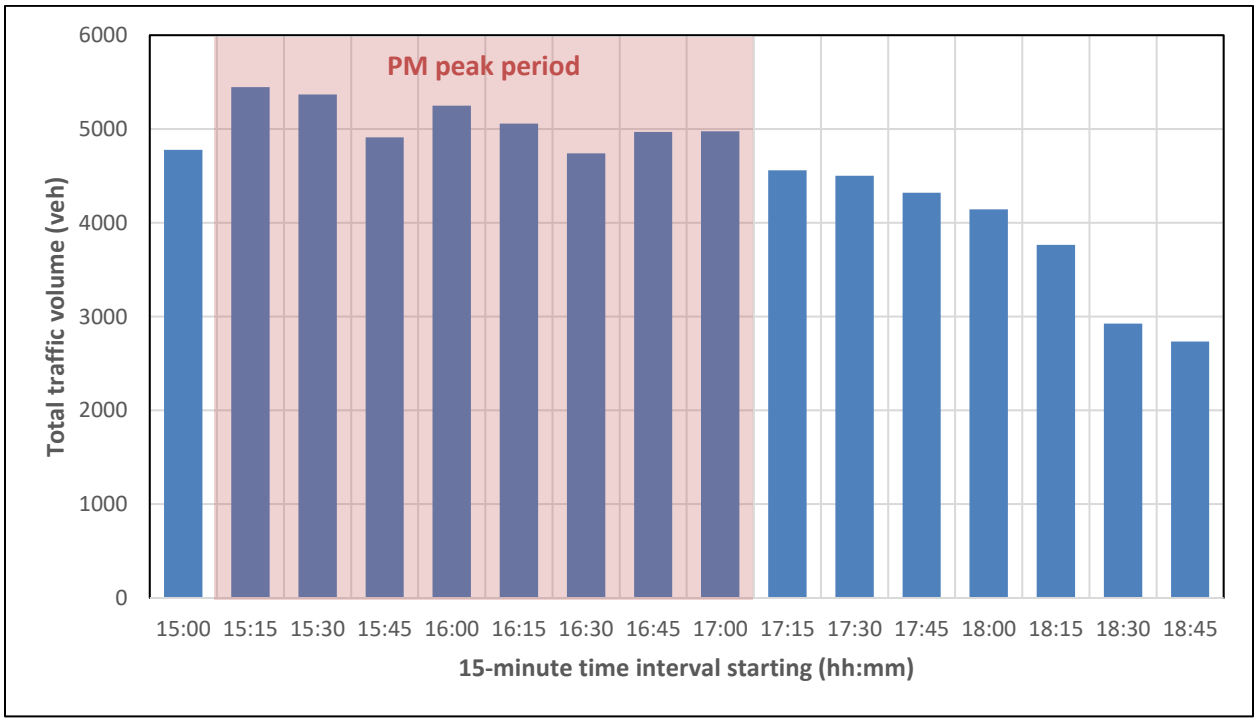


Figure 13: CIC surveyed traffic profile – PM peak

3.4 ASSIGNMENT TYPE

This section outlines the assignment types used in the model. **Section 3.12** provides greater detail of the demand estimation and assignment process.

3.4.1 Static assignment

Static assignment uses deterministic algorithms to assign traffic volumes to links in the network. Individual vehicles are not modelled and the performance of each section is determined by the link performance function. Typically link performance functions are based on the number of vehicles assigned to a section and the section capacity, although other attributes may also be considered. The aim of static assignment is to minimise the total generalised cost (usually a function of travel time) across the network. The total travel time for the network is calculated by the product of the volume on each link and the travel time on that link (given by the link performance function), summed for all links in the network.

3.4.2 Dynamic user equilibrium

To assess options that impact vehicle route choice, dynamic user equilibrium (DUE) assignment was used. DUE is based on an iterative simulation process where drivers choose their routes through the network based on the travel cost they experienced in the previous iteration. The simulation continues until a stable environment is reached where travel times and volumes do not change significantly between iterations. The principle of this assignment is that users will try to minimise their individual travel times by travelling on a route which they perceive to be the shortest path given the traffic conditions. To achieve a dynamic equilibrium state, the travel times of each OD pair for vehicles departing at the same time must be equal across all used routes, and less than that of a single user on any of the unused routes.

3.4.3 Stochastic route choice

The stochastic route choice (SRC) assignment is based on discrete route choice models or on a user-defined assignment. Discrete route choice models are based on discrete choice theory and emulate the decisions of users selecting paths from those that are available. This model uses the probability of choosing alternative paths from the available paths as a function of their disutility, typically influenced by travel time and/or travel cost

3.5 VEHICLE TYPES

The model includes five vehicle types:

- Light vehicles (cars and light vans)
- Rigid heavy vehicles (Austroads Classes 3-5)
- Articulated heavy vehicles (Austroads Classes 6-9)
- B-Doubles (Austroads Classes 10)
- Buses.

The following sections outline the assumptions behind the vehicle parameters that were varied from the default values in the modelling. The ATC data was collected based on the Austroads (1994) vehicle classification scheme shown in **Figure 14**.

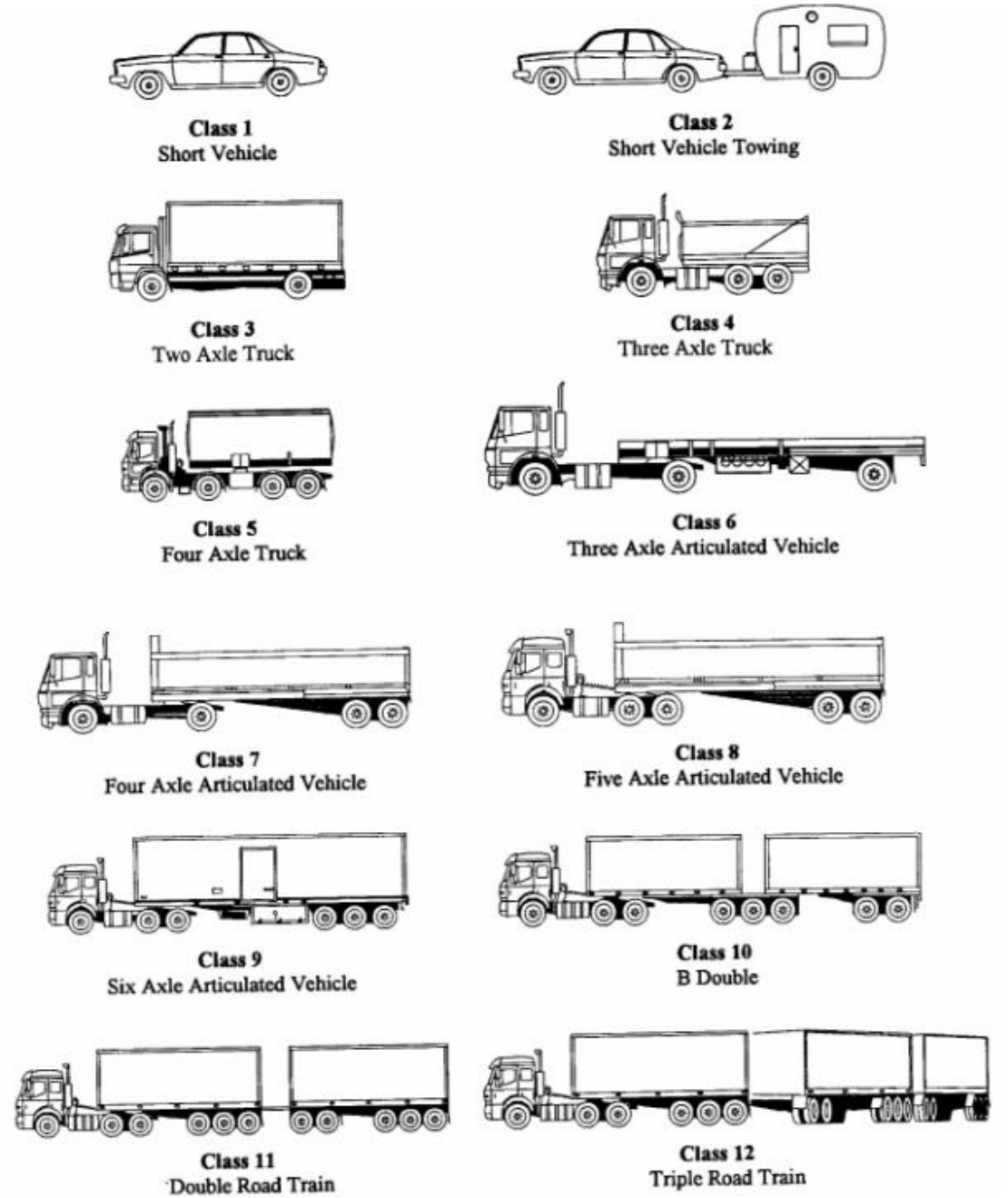


Figure 14: Austroads vehicle classification

Figure 15 and **Table 8** show the traffic composition for the typical weekday in the study area.

- Light vehicles (Classes 1-2) make up about 86 per cent of total weekday traffic
- Two-axle trucks (Class 3) make up about 7 per cent of total weekday traffic.

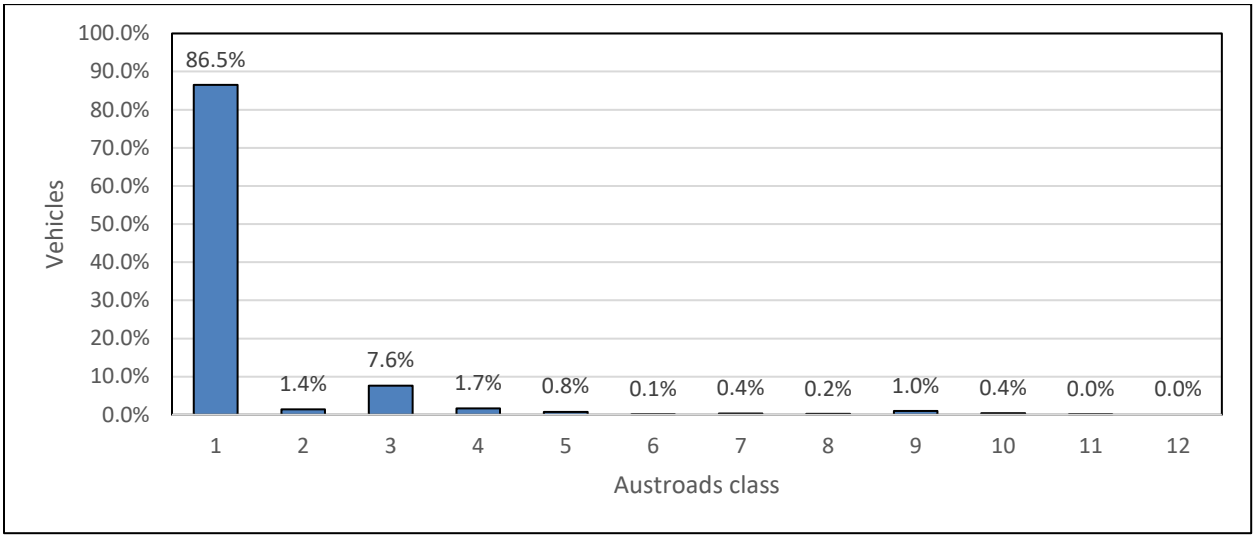


Figure 15: Typical weekday traffic composition

Table 8: Typical weekday traffic composition

Austroads (1994) class	Typical weekday vehicle type proportion (%)
Light vehicles (Class 1-2)	
Class 1: Short vehicle	86.5%
Class 2: Short vehicle towing	1.4%
Rigid heavy vehicles (Class 3-5)	
Class 3: Two-axle truck	7.6%
Class 4: Three-axle truck	1.7%
Class 5: Four-axle truck	0.8%
Articulated heavy vehicles (Class 6-12)	
Class 6: Three-axle articulated truck	0.1%
Class 7: Four-axle articulated truck	0.4%
Class 8: Five-axle articulated truck	0.2%
Class 9: Six-axle articulated truck	1.0%
Class 10: B-double	0.4%
Class 11: Double Road Train	0.0%
Class 12: Triple Road Train	0.0%

3.5.1 B-Double Routes

B-double routes were determined using the following data:

- Automatic tube count data
- TfNSW NSW Combined Higher Mass Limits (HML) and Restricted Access Vehicle (RAV) Map

Based on the above data, B-doubles use the following roads within the model:

- Old Hume Highway
- Menangle Street
- Barkers Lodge Road

3.6 ROAD TYPES

Table 9 summarises the modelled road types and **Figure 16** shows them visually in the network. The capacities shown were used as starting points and locally adjusted based on surveyed traffic volumes and observed road function.

Table 9: Modelled road types

Road type	Description	Capacity (pcu/ln/hr)
Sydney 01. LOCAL	Local roads	800
Sydney 02. Sub-ART	Sub-arterial roads	1600
Sydney 04. ART (undivided)	Arterial roads (undivided)	1800

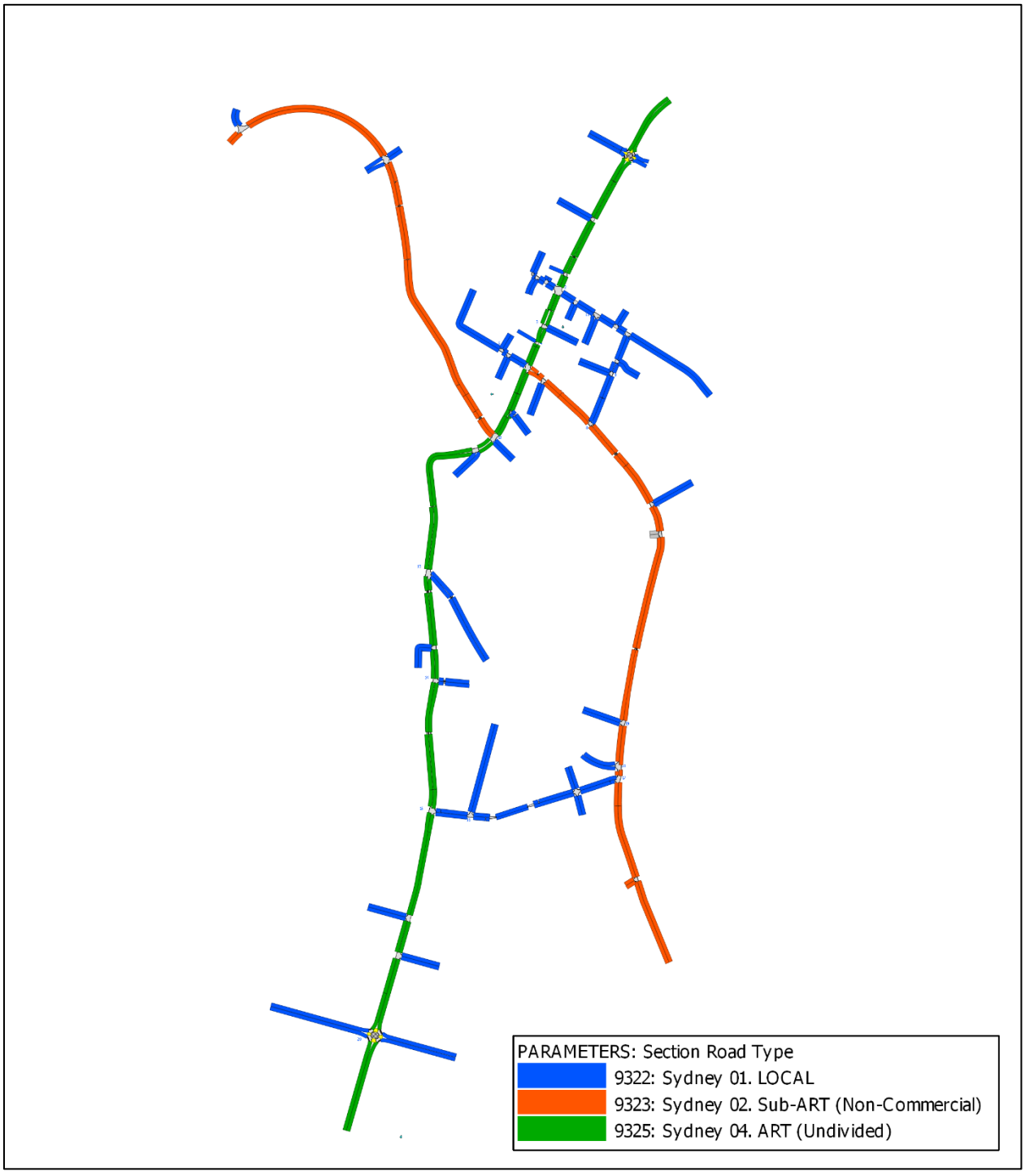


Figure 16: Modelled road types

3.7 SPEED PROFILES

Posted speed limits were determined from the Transport for NSW Speed Zones data set and verified using aerial photography and site visit observations. **Figure 18** shows the posted speed limits that were used in the models.

3.7.1 Turn speeds

Aimsun default turn speeds were adopted for most minor intersections. These speeds are typically overestimated by Aimsun, so turn speeds were manually adjusted at major intersections including all signalised intersections and roundabouts to more accurately reflect vehicle behaviour.

3.7.2 Speed acceptance

Speed acceptance refers to an individual vehicle's acceptance of the speed limit. A speed acceptance of 1.0 indicates that the vehicle will drive at the speed limit where possible, whereas a speed acceptance of 1.1 indicates that the vehicle will drive up to 10 per cent faster than the speed limit where possible. In urban environments, typically some vehicles will exceed the speed limit.

Table 10 shows the speed acceptance parameters used in the modelling.

Table 10: Speed acceptance parameters

Vehicle type	Minimum speed limit acceptance	Maximum speed limit acceptance	Average speed limit acceptance	Standard deviation speed limit acceptance
Light vehicles	0.80	1.10	0.90	0.10
Rigid heavy vehicles	0.80	1.00	0.90	0.10
Articulated heavy vehicles	0.80	1.00	0.90	0.10
Buses	0.90	1.10	1.00	0.10

3.7.3 Detailed speeds

Detailed speeds were implemented to reflect driver behaviour within the study area. These were added for the following reasons:

- Reduced driving speeds due to driver awareness on approach to pedestrian crossings and minimising emergency braking when there is a conflict with pedestrians
- Advisory speed limits for turns around bends

Figure 17 shows the locations where detailed speeds were implemented

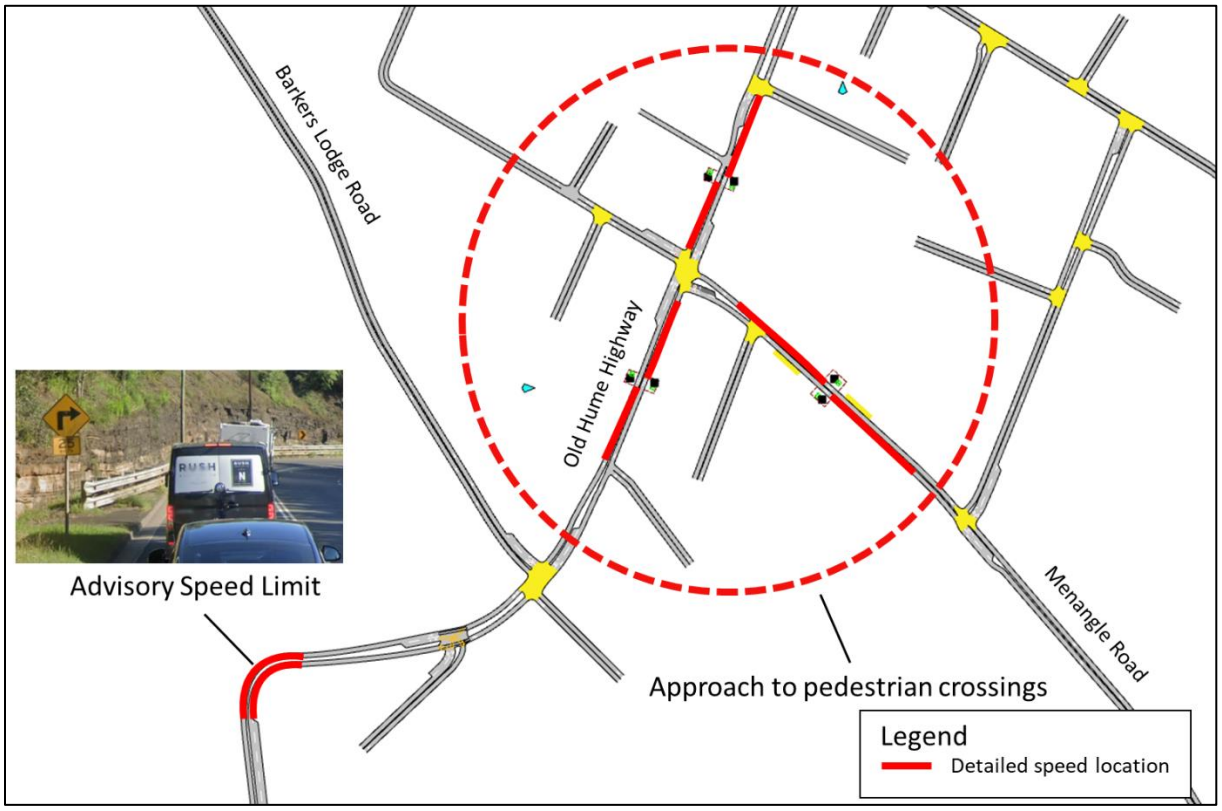


Figure 17: Locations of detailed speeds

Figure 18: Posted speed limits

3.8 TRAFFIC ZONES

The study area and modelled network was set to capture all major route choices in the local area and any vehicle reassignment. The model comprises a total of 43 zones within the study area. **Figure 19** shows the locations of these zones in the model. The relationship between Aimsun and TRACKS zones is summarised in **Table 11** below.

Table 11: Aimsun and TRACKS zone summary

TRACKS Zone ID	Zone type	Description	Aimsun zones
1	Internal	Picton Bowling Club, restaurants and shops	9283, 9285
2	Internal	Residential along Old Hume Highway	4200
3	Internal	Residential and commercial along Margaret Street	9041
4	Internal	St. Vincent De Paul Family Centre and residential along Colden Street	9302
5	Internal	Margaret Street	2711
6	Internal	Picton Mall Shopping Centre	8627
7	Internal	Picton Mall Shopping Centre	8628
8	Internal	Wollondilly Library Picton Branch	8674
9	Internal	Wollondilly Shire Council and Wollondilly School Holiday Care	8628
10	Internal	St. Anthony's Catholic Parish Primary School	8674
11	Internal	Picton Mall Shopping Centre	8628
12	Internal	Picton Rural Fire Brigade and Picton Masonic Centre	8628
13	Internal	Emmett Close	2711
14	Internal	Residential along Menangle Street	10387
15	Internal	Baxter Lane	2699
16	Internal	Picton Town Square	8677
17	Internal	Davidson Lane	2703
18	Internal	Crankanthorp Lane	2702, 8680
19	Internal	Commercial along Old Hume Highway	2702
20	Internal	Elizabeth Street	8637
21	Internal	Menangle Street W	8637
22	Internal	Walton Lane	2705, 8626, 8699
23	Internal	Elizabeth Street	8637

TRACKS Zone ID	Zone type	Description	Aimsun zones
24	Internal	Walton Street	8626
25	Internal	Commercial along Old Hume Highway	2705, 8626, 8699
26	Internal	Picton Bowling Club and McDonald's	2706
27	Internal	Walton Street	2705
28	Internal	Council Works Depot	9095
29	Internal	Picton Service Centre	8627
30	Internal	Commercial along Old Hume Highway	8629
31	Internal	Webster Street	2701, 8664, 8671, 8661
32	Internal	Lumsdaine Street	8667, 8692, 9344, 9347
33	Internal	Downing Street	8623
34	Internal	Connellan Crescent	8654
35	Internal	Ramsay Street	2713
36	Internal	Love Place	2713
37	External	Picton Botanic Gardens	2713
38	External	Menangle Street	2697
39	Internal	Cowper Street	8657
40	External	Antill Street	8648
41	External	Old Hume Highway	2698
42	External	Thirlmere Way	8651, 8654
43	External	Barkers Lodge Road	2696, 2712, 8640, 8643
44	External	Regreme Road	2713
45	External	Old Hume Highway	2710

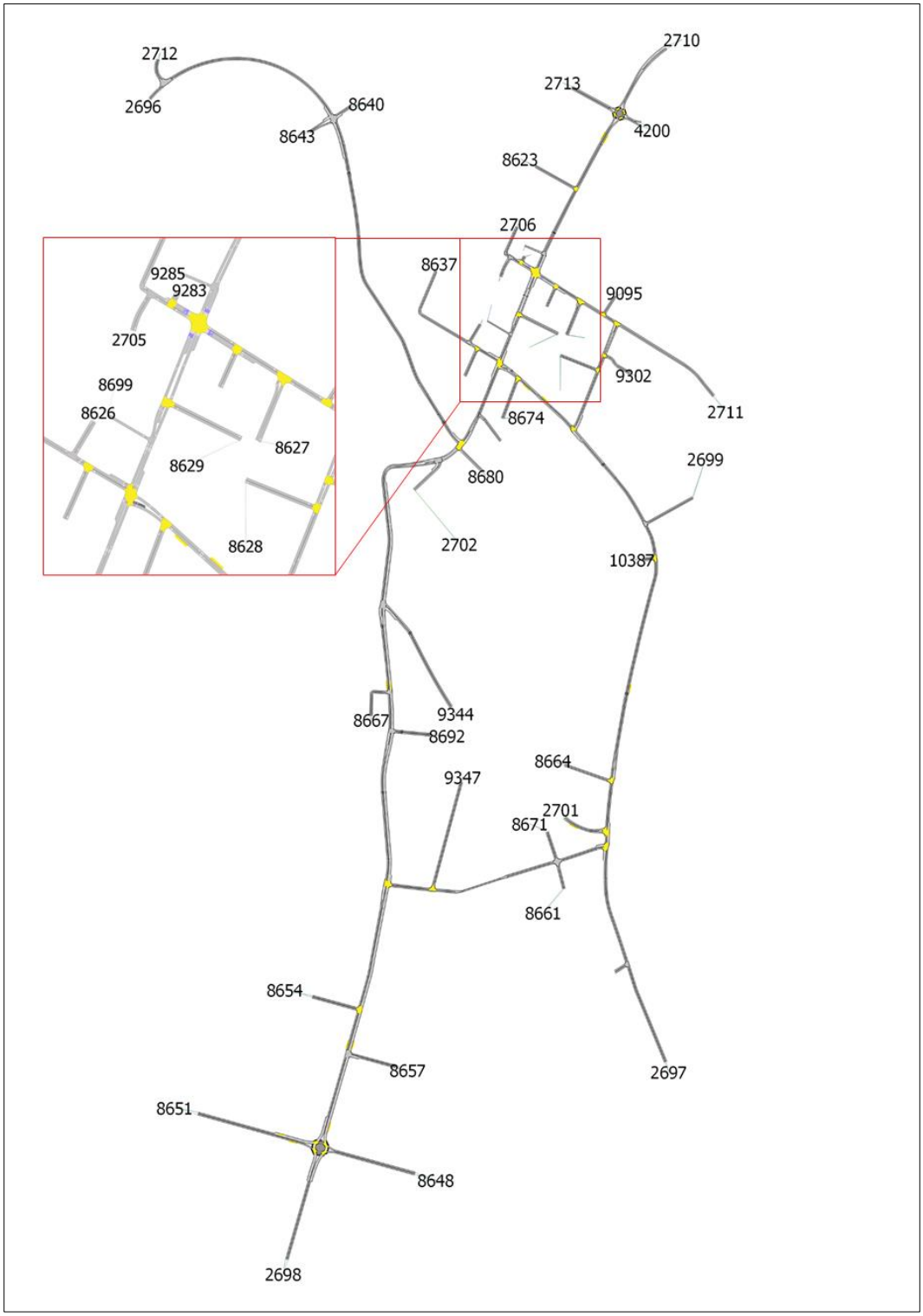


Figure 19: Aimsun zoning structure

3.9 SCHOOL ZONES

The roads surrounding schools have a speed limit of 40 kilometres per hour from 8:00am to 9:30am and from 2:30pm to 4:00pm. **Figure 20** shows the location of the school zones in the study area

- The modelled AM peak is 7:15am-9:15am, so this speed limit reduction was applied to the last one and 15 minutes of the AM peak model.
- The modelled PM peak is 3:15pm-5:15pm, so this speed limit reduction was applied to the first 45 minutes of the PM peak model.

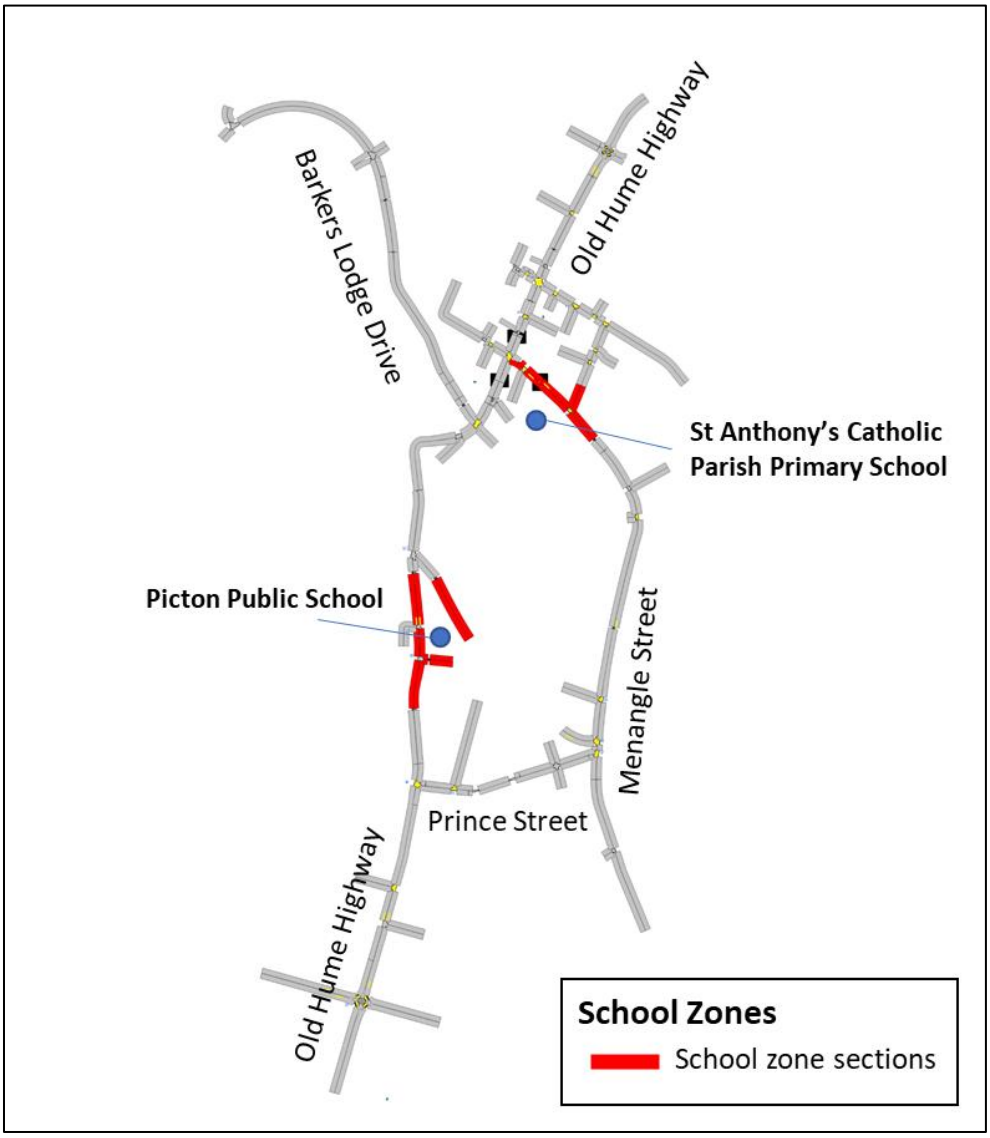


Figure 20: School zones

3.10 PUBLIC TRANSPORT

Five regular bus routes operate through the study area. **Table 12** describes the bus routes which service the study area. **Figure 21** shows the route of each bus service. The local bus routes provide connections to and from the study area and the surrounding regions, including Bowral, Campbelltown, Bargo, Yanderra and Buxton.

Table 12: Bus routes

ID	Bus route	Route description
1	828	Bowral to Picton
2	900	Campbelltown to Picton
3	911	Bargo to Picton
4	912	Yanderra to Picton
5	914	Buxton to Picton

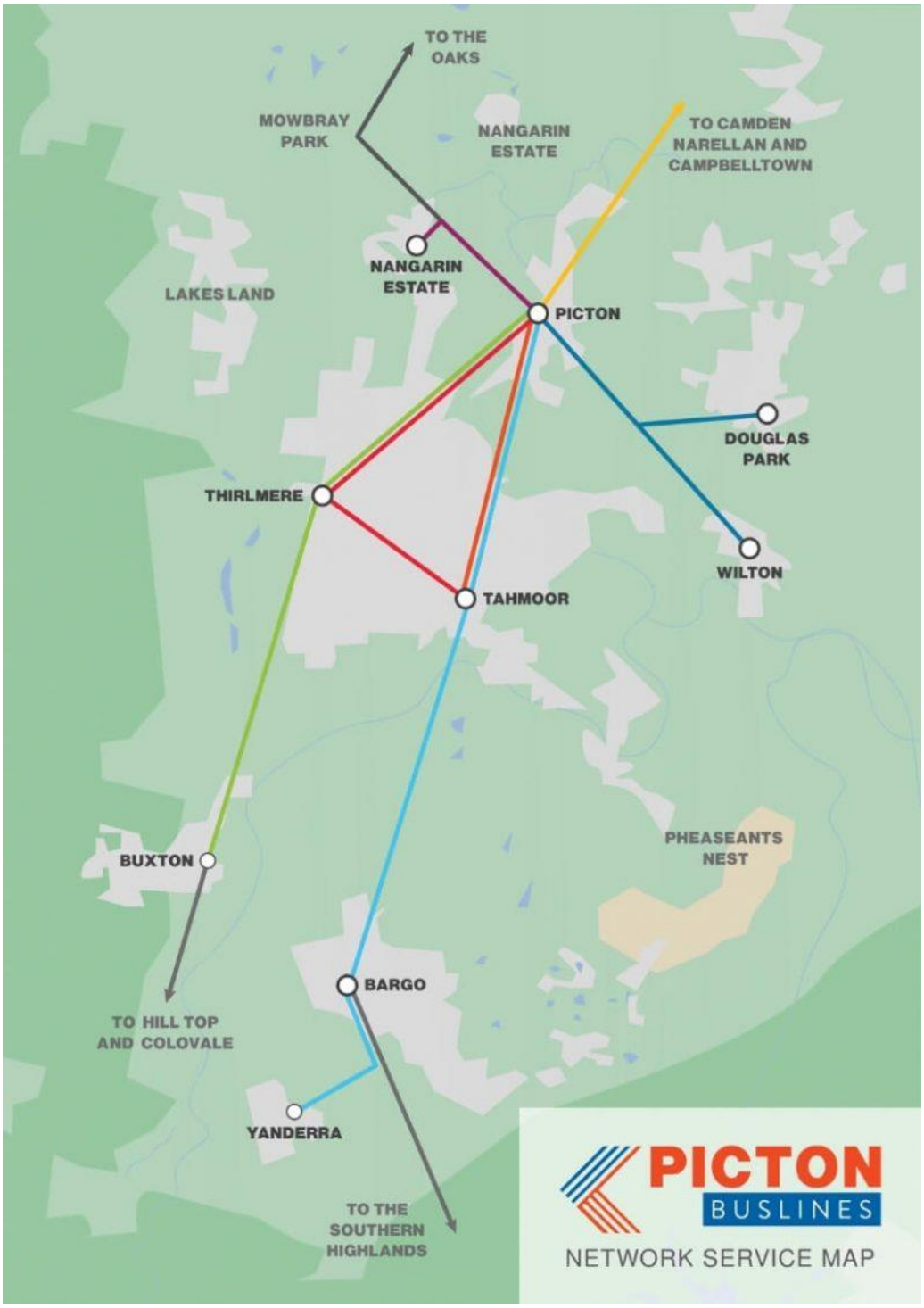


Figure 21: Bus routes

3.11 DEMAND DEVELOPMENT

This section outlines the demand development procedure.

3.11.1 Demand estimation procedure overview

The methodology to develop the Base Model demand is outlined below.

1. The prior matrix for the AM peak and PM peak scenarios were extracted from the TRACKS.
2. The prior matrix was disaggregated based on survey counts and/or observed land uses.
3. An estimate of the total traffic volume (in and out) of each centroid was determined by:
    - Survey data of the intersection leading to the centroid (if available)
    - Survey data from nearby intersections by calculating the increase or decrease in traffic volume between two intersections with a centroid in between
    - Estimates from observed land uses.
4. The disaggregated prior matrix was refined by furnessing based on the estimated total traffic volume for each centroid.
5. The furnessed matrix was imported into Aimsun and run through a static assignment experiment. This experiment loads the demand into the network and allows for identification of areas where trips are under- or overestimated in the demand.
6. Known trips (such as where the only feasible route between an OD pair is a single turn which was surveyed) were added to the matrices.
7. The prior matrices were manually adjusted based on observed counts in the model. The static model was calibrated to eliminate unrealistic route choice. As the static model does not consider the delays associated with intersections or traffic signals, volume-delay functions and some user-defined costs were introduced to simulate delays and improve the static assignment. Manual adjustments were mostly undertaken proportionally to maintain the trip distribution pattern from the TRACKS.
8. The Aimsun Static OD Adjustment tool was used to refine the matrices based on observed counts for each scenario.
9. The matrices were profiled based on the traffic surveys information.
10. The profiled matrix was used in dynamic experiments. Additional manual adjustments were made to the profiled matrix to attain a higher level of calibration and validation.

The demand estimation procedure is iterative and involves continual refinement of the model parameters and demand matrix. **Figure 22** provides a diagrammatic representation of the demand estimation, calibration and validation process.

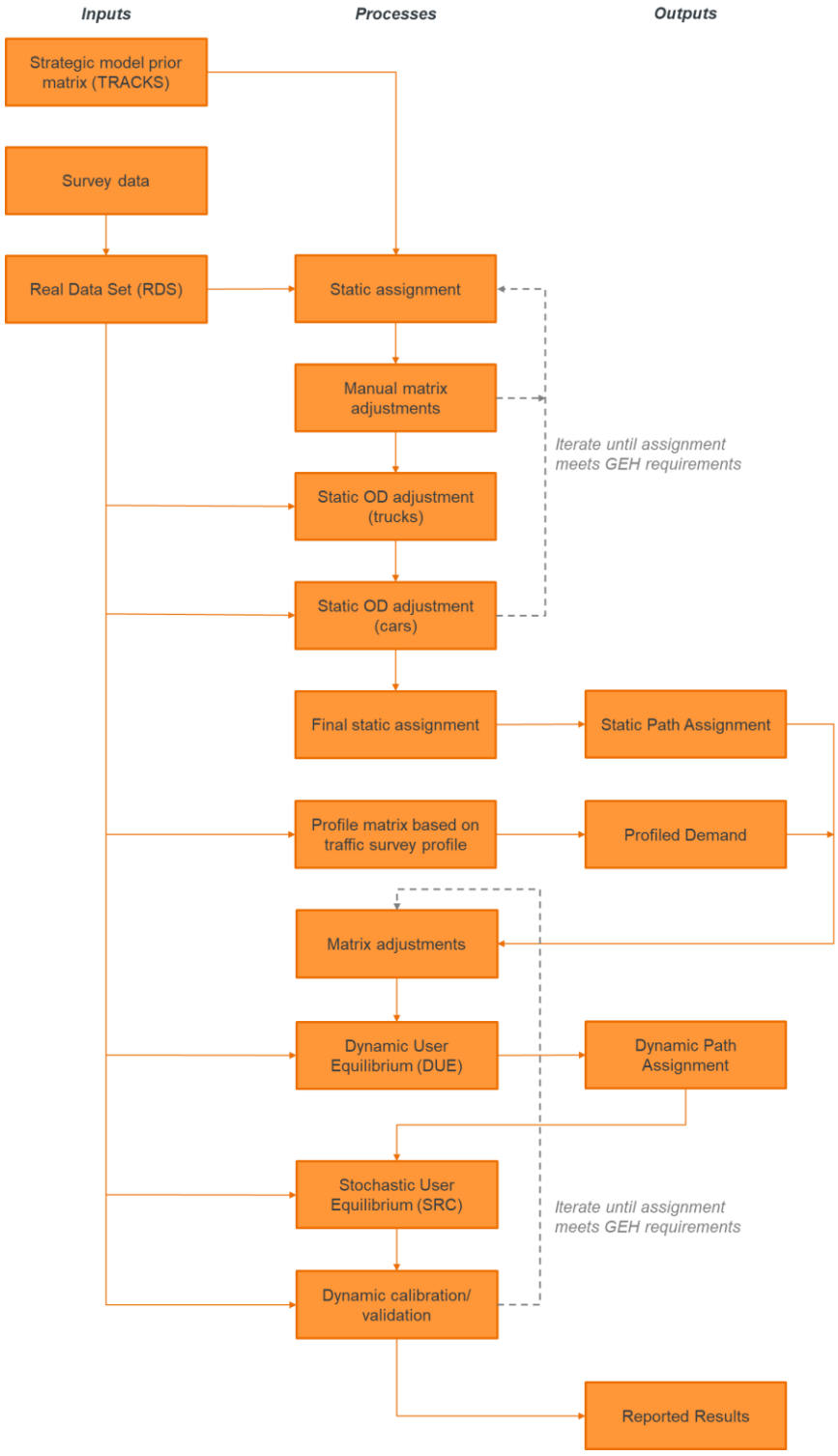


Figure 22: Demand estimation procedure

3.11.2 Total traffic demand

Figure 23 provides a comparison of the light vehicle and heavy vehicle traffic demand in the 2022 TRACKS model and the final profiled demand in the microsimulation model (Aimsun). The TRACKS volumes have been adjusted from one to two hours. The results indicate that there is a good correlation between the two matrices for light vehicles in the AM peak and for both light and heavy vehicles in the PM peak. The light vehicle TRACKS demand is lower in the PM peak by 497 trips.

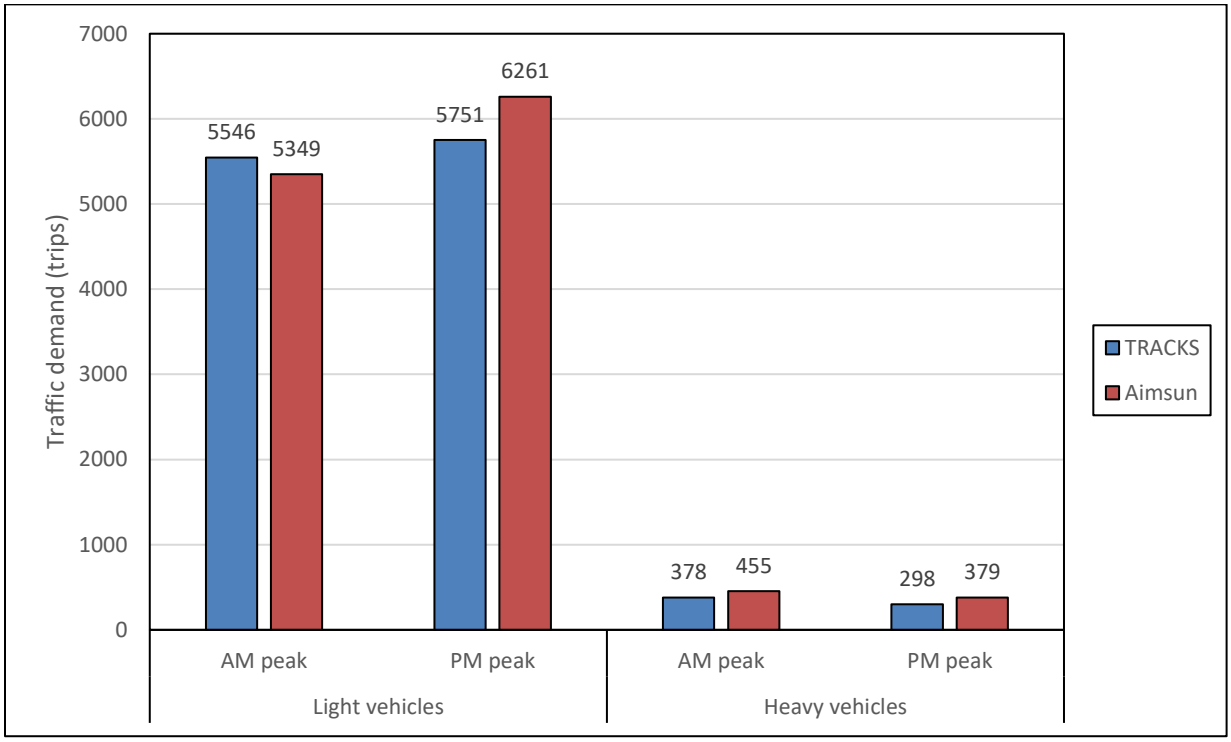


Figure 23: Comparison of traffic demand in TRACKS and Aimsun

3.11.3 Traffic demand composition

The traffic demand differentiated between light vehicles, rigid heavy vehicles and articulated heavy vehicles (refer to **Section 3.5**). **Table 13** summarises the traffic demand composition for each peak. Note that buses are not included in the demand as they follow fixed routes and run to a fixed timetable.

Table 13: Traffic demand composition

Peak	Light vehicles		Rigid heavy vehicles		Articulated heavy vehicles		B-Doubles		All vehicles
	Demand (veh)	% of total demand	Demand (veh)	% of total demand	Demand (veh)	% of total demand	Demand (veh)	% of total demand	Total demand (veh)
AM peak	5349	92.2%	374	6.4%	59	1.0%	21	0.4%	5803
PM peak	6261	94.5%	312	4.7%	56	0.8%	11	0.2%	6629

3.11.4 Trip length distribution

Figure 24 and **Figure 25** show a comparison of the trip length distribution between the TRACKS model outputs and the final profiled Aimsun Base Model demand for all vehicles. Generally, there is a good correlation between the TRACKS demand and the final model demand with the maximum change for any trip length less than five per cent of the total demand.

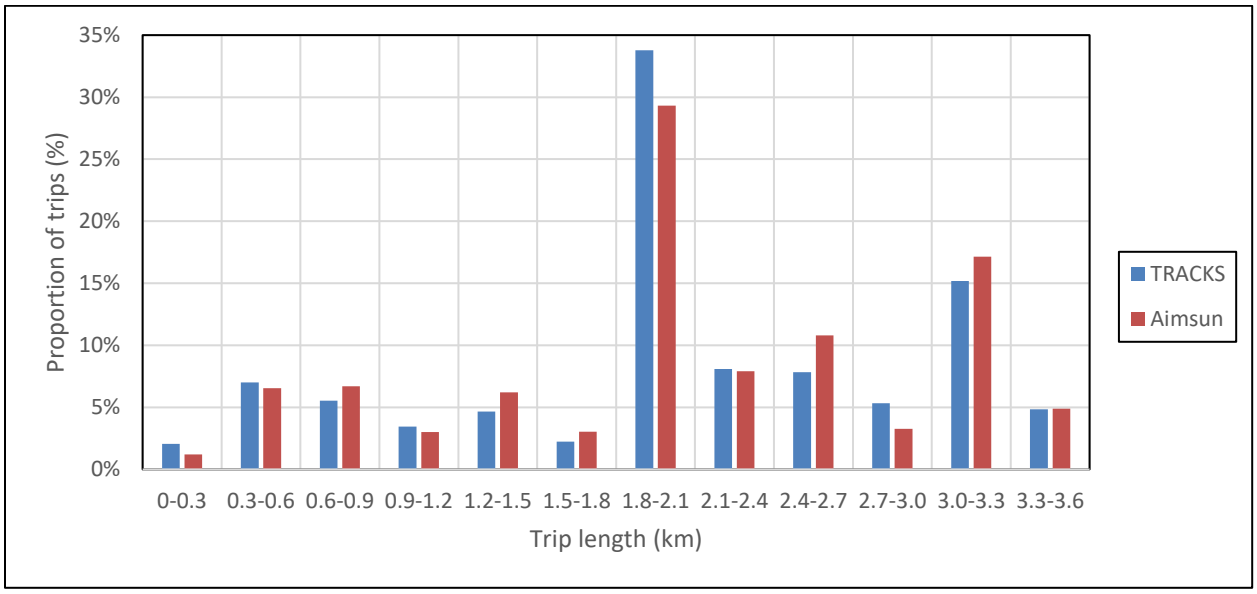


Figure 24: AM peak trip length distribution comparison

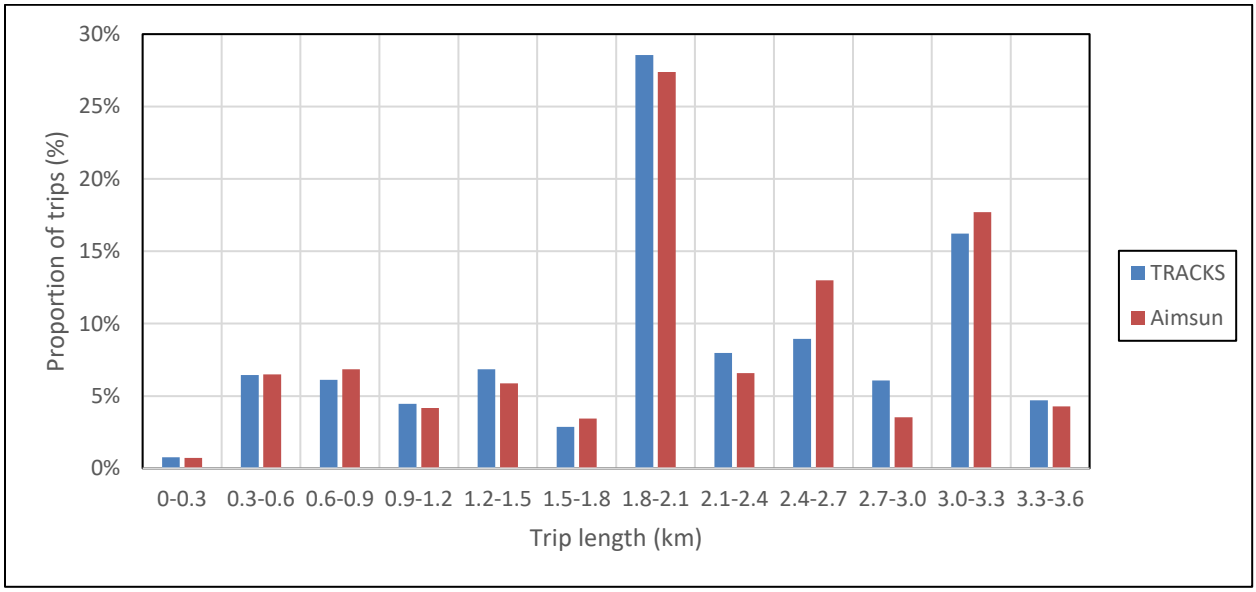


Figure 25: PM peak trip length distribution comparison

3.11.5 Demand profiling

The traffic profiles were modelled at 15-minute intervals in Aimsun and a global factor was obtained from the CIC surveys undertaken on 23 June 2022. This global factor was applied across the entire modelled network. **Figure 26** and **Figure 27** compare the overall surveyed traffic profile to the modelled traffic profile for each peak period. The difference in any 15-minute interval does not exceed 0.3 per cent. The reasons for the discrepancies are:

- The modelled survey profile is based on the time vehicles enter the network (measured at their origin), while the overall survey profile counts vehicles at multiple locations along their journey
- Vehicles can take up to 15-minutes to traverse the full corridor, and the surveys count vehicles at each location along their trip. This means a vehicle released in the first 15-minute interval can contribute to the profile observed in the second 15-minute interval. The modelled profile is based only on the profile of the vehicle entry point.

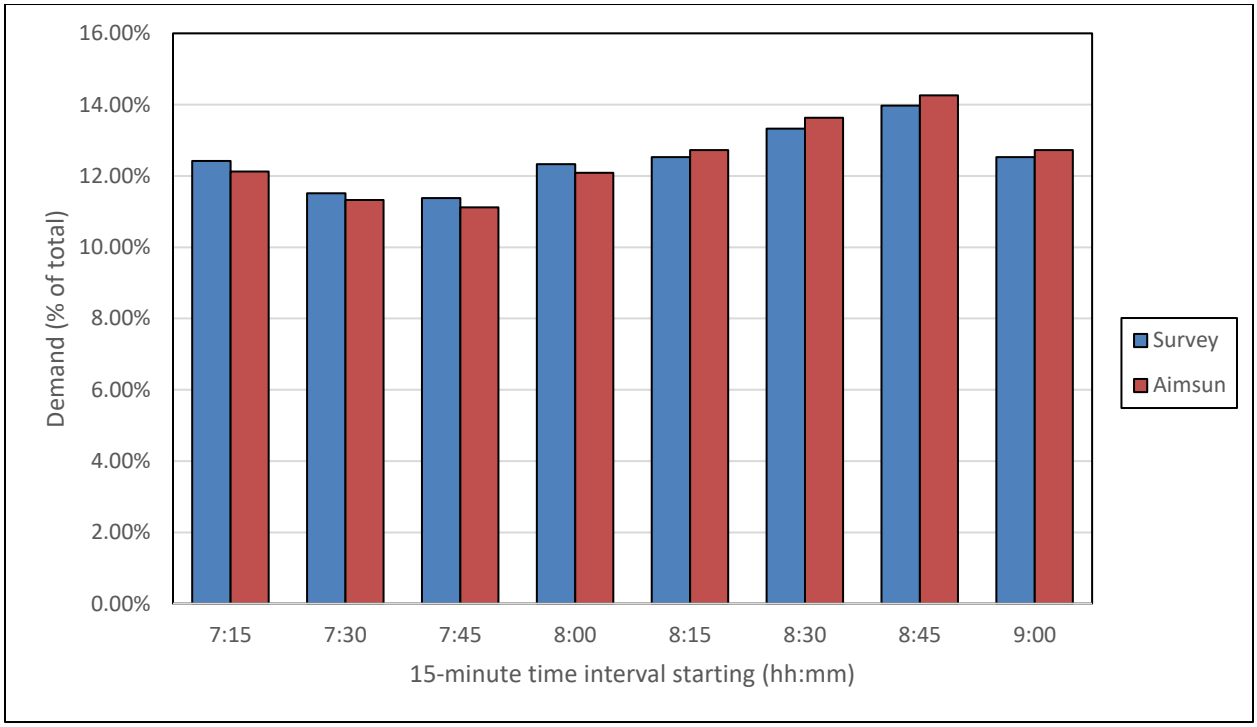


Figure 26: AM peak modelled traffic profile

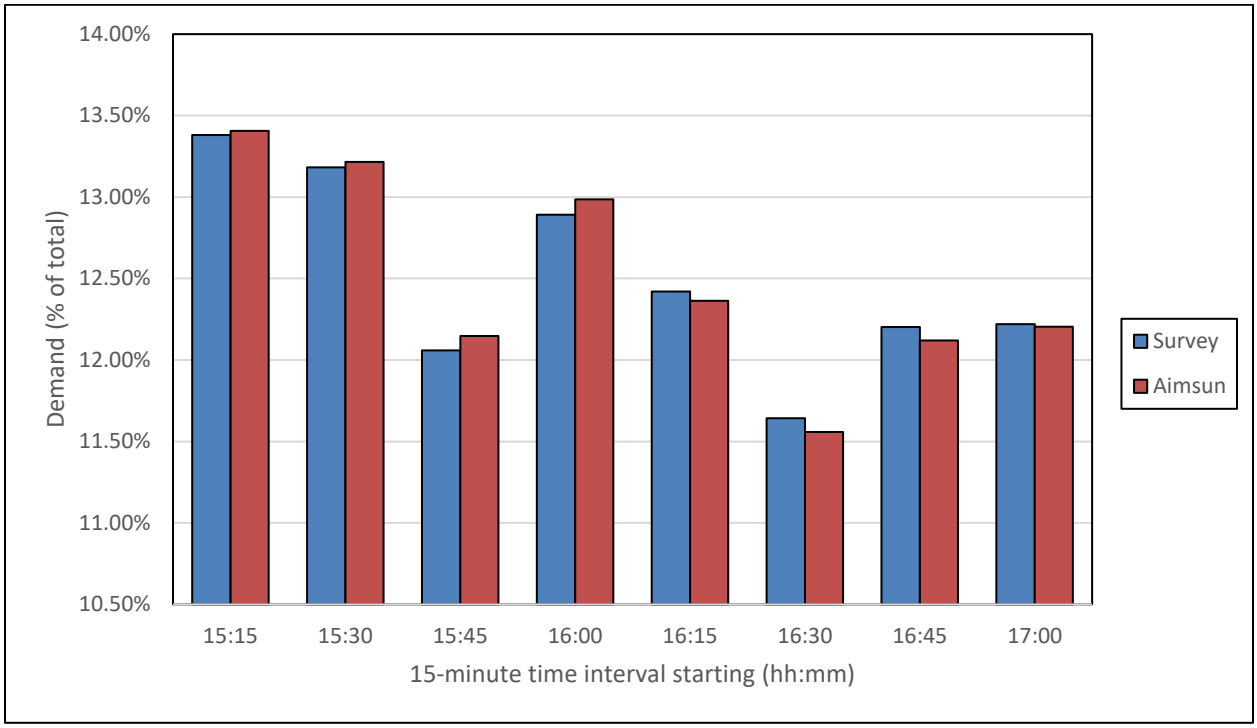


Figure 27: PM peak modelled traffic profile

3.12 ELEVATION AND SLOPE PROFILE

Slopes have an impact on traffic behaviour, queue dispersion and travel times. A slope model was developed to factor the acceleration of each vehicle type within the model proportionally to the slope of the road at any given point.

Slope data was obtained from a five-metre resolution digital terrain model available from the Department of Finance, Services and Innovation Spatial Services. The slope was calculated using the Slope Tool in ArcGIS from the digital terrain model. The altitude was queried at the start and end points of the sections in the Aimsun model based on whether the point fell in a particular grid square on the slope map. The start and end altitude points were set for each section of the model which allowed for the generation of a slope profile of the study area.

3.13 PEDESTRIANS AND CYCLISTS

Signalised and unsignalised pedestrian crossings were included in the model.

Pedestrian volumes at the Old Hume Highway / Cliffe Street / Margaret Street signalised intersection were determined from the classified intersection counts. As Aimsun currently does not natively support pedestrian-actuated signals, delays associated with pedestrian crossings were included as a late start for vehicle movements that conflict with the crossing. The duration of the late start was adjusted based on the number of pedestrians and frequency of the pedestrian phase activations.

Unsignalised pedestrian zebra crossings are located at:

- Menangle Street between Old Hume Highway and Colden Street
- Old Hume Highway south of Menangle Street, and
- Old Hume Highway near Walton Lane.

Pedestrian volumes at the zebra crossings were determined from the pedestrian surveys. **Figure 28** and **Figure 29** show the pedestrian zebra crossing profiles for the AM peak and PM peak, respectively. The profile is recorded in 15-minute intervals with the two-hour modelled peak highlighted in each case. The data indicates that the modelled period captures the 15-minute period with the highest pedestrian volume in each peak.

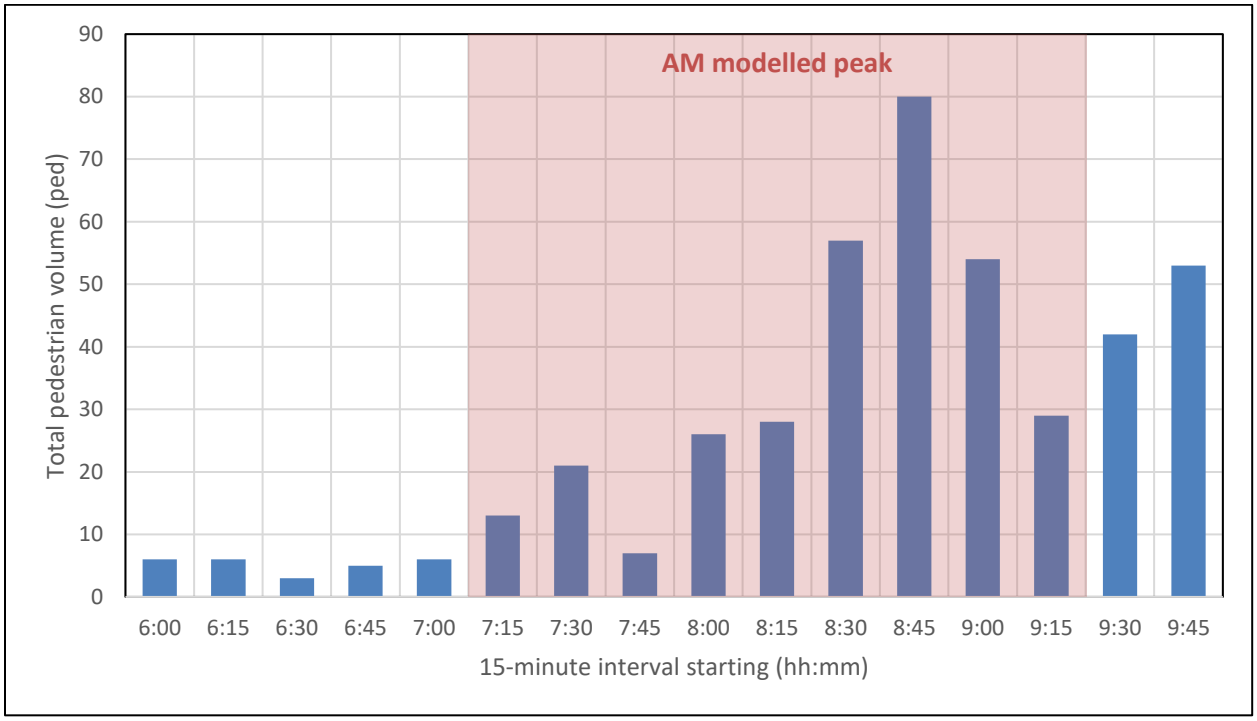


Figure 28: Pedestrian zebra crossing AM peak profile

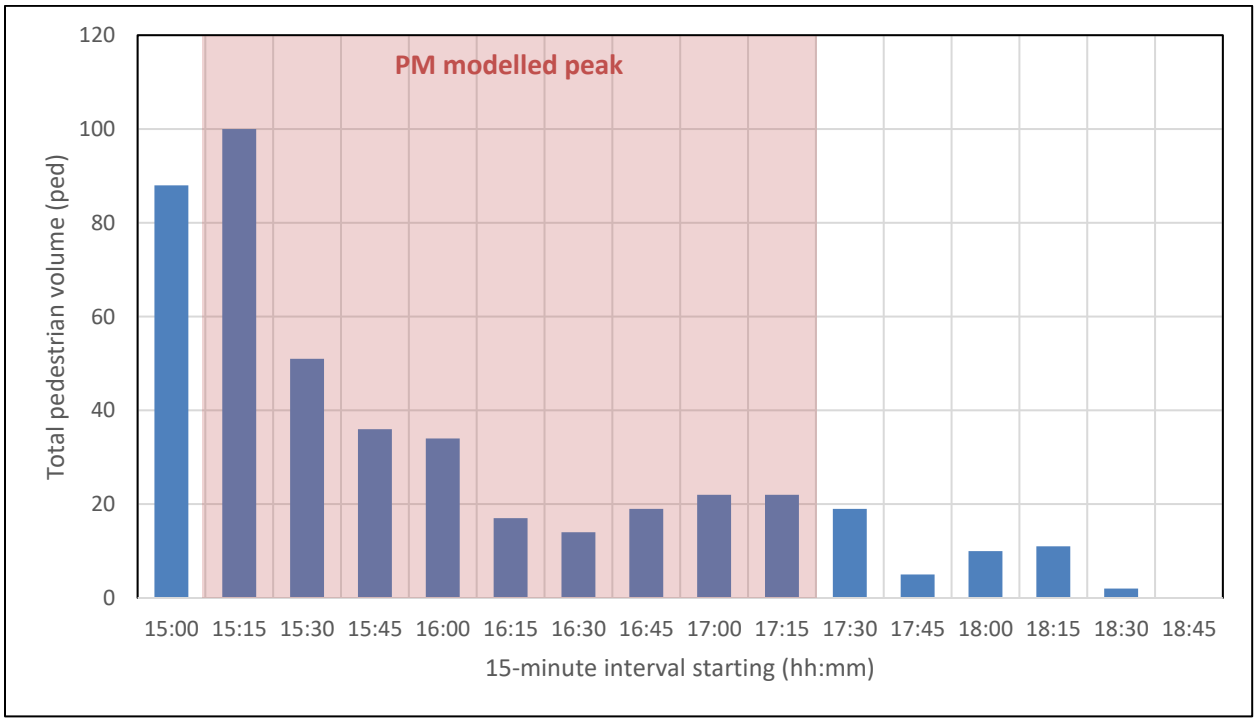


Figure 29: Pedestrian zebra crossing PM peak profile

3.14 CALIBRATION CRITERIA

3.14.1 Network calibration

The Base Model was calibrated in accordance with the criteria outlined in *Traffic Modelling Guidelines* (Roads and Maritime Services, 2013) to ensure that existing traffic conditions are replicated to a statistically high degree of accuracy.

The recommended method of calibration is the modified Chi-Square empirical formula developed by Geoffrey E. Harves in the 1970s, known as the GEH-statistic. The GEH-statistic measures the degree of divergence of the modelled value form the observed value while accounting for the relative scale of each movement, that is, movements with higher volumes are more important to match than those with lower volumes.

The GEH-statistic is given by **Equation 1**:

$$GEH = \sqrt{\frac{(V_o - V_m)^2}{0.5(V_o + V_m)}} \qquad \text{Equation 1}$$

where:

V_o = the observed traffic flow
V_m = the modelled traffic flow.

The GEH-statistic is used for individual flows and the R-squared (R^2) statistical measure is used for correlation of the entire data set.

A GEH less than five is considered a good match between the modelled and observed traffic flows while a GEH value of greater than 10 requires further explanation. **Table 14** provides the criteria recommended in *Traffic Modelling Guidelines* (Roads and Maritime Services, 2013) for model calibration.

Table 14: Network-wide calibration criteria

Criteria	Requirement
Turn and link flow comparisons with GEH ≤ 5	At least 85% of all surveyed turns and links
Turn and link flow comparisons with GEH ≤ 10	100% of all surveyed turns and links
Turn and link flow comparisons with GEH > 10	Requires explanation in the Base Model Development Report
Coefficient of determination (R^2)	Greater than 0.9 for a plot of observed versus modelled flows

3.14.2 Core area calibration

The core area calibration criteria are based on definitive limits for all turning movements within the core area. *Traffic Modelling Guidelines* (Roads and Maritime Services, 2013) recommends the following criteria for core area calibration:

- All modelled flows should be within the limits shown in **Table 15**.

Table 15: Core area calibration criteria

Criteria	Requirement			
	≤ 99 veh	100–999 veh	1000–1999 veh	≥ 2000 veh
Comparison of observed and modelled flows	Within 10 vehicles	Within 10 per cent	Within 100 vehicles	Within 5 per cent
Coefficient of determination (R^2)	Greater than 0.95 for a plot of observed versus modelled flows			

3.15 VALIDATION CRITERIA

Validation ensures that factors that influence traffic (other than traffic volumes) such as road capacity, driver behaviour and responsiveness are adequately captured in the model. Two validation criteria were used for the Base Model:

- Travel time validation
- Signal timing validation.

These are each outlined below.

3.15.1 Travel time validation

The validation of travel times on key routes confirms that the model is accurately replicating observed congestion and driver behaviour. **Table 16** shows the travel time validation criteria recommended in *Traffic Modelling Guidelines* (Roads and Maritime Services, 2013).

Table 16: Travel time validation criteria

Criteria	Requirement
Journey time average	Average modelled journey time to be within 15 per cent or one minute of average observed journey time for the full length of the route
Section time average	Average modelled journey time to be within 15 per cent of the observed journey time for individual sections

The travel time routes are shown in **Section 2.5**.

3.15.2 Signal timing validation

Table 17 shows the signal timing validation criteria recommended in *Traffic Modelling Guidelines* (Roads and Maritime Services, 2013).

Table 17: Signal validation criteria

Criteria	Requirement
Cycle time	Average modelled cycle time for each one-hour period to be within 10 per cent of the observed average cycle time for the same one-hour period
Green time	Total of green time over each one-hour period to be within 10 per cent of the observed equivalent for each phase

4.0 MODEL STABILITY

The stochasticity of a microsimulation model can cause instability. This can undermine the reliability of the model to forecast future traffic conditions. It is important that the Base Model is stable and has an appropriate degree of accuracy for future options assessment. To determine the stability of a model, a total of five seed values and the default time-step value in Aimsun are initially used to iteratively determine the number of runs, as recommended by *Traffic Modelling Guidelines* (Roads and Maritime Services, 2013).

Vehicle hours travelled (VHT) was the statistic chosen to determine the model stability. The VHT results are a single-figure summary that provide an indication of whole-network performance by identifying whether the model has unrealistic gridlocks and/or excessive delays. VHT is calculated by summing the individual travel time for each vehicle across the whole network. In Aimsun, VHT is only calculated using vehicles which complete a trip from their origin to their destination; any vehicles remaining in the network at the conclusion of the simulation period are excluded from the VHT.

4.1 SEEDS RUN

To analyse the model stability, each peak period model was assessed using the five seed values recommended in *Traffic Modelling Guidelines* (Roads and Maritime Services, 2013). The different seeds introduce slight variations to the number of vehicles in the network for regular intervals throughout the simulation. The seed values used were:

- 560
- 28
- 7771
- 86524
- 2849.

4.2 STABILITY ASSESSMENT

Figure 30 and **Figure 31** show the variation in VHT per 15-minute interval for the AM peak and PM peak respectively. The results show that the model results are consistently similar across the seeds run.

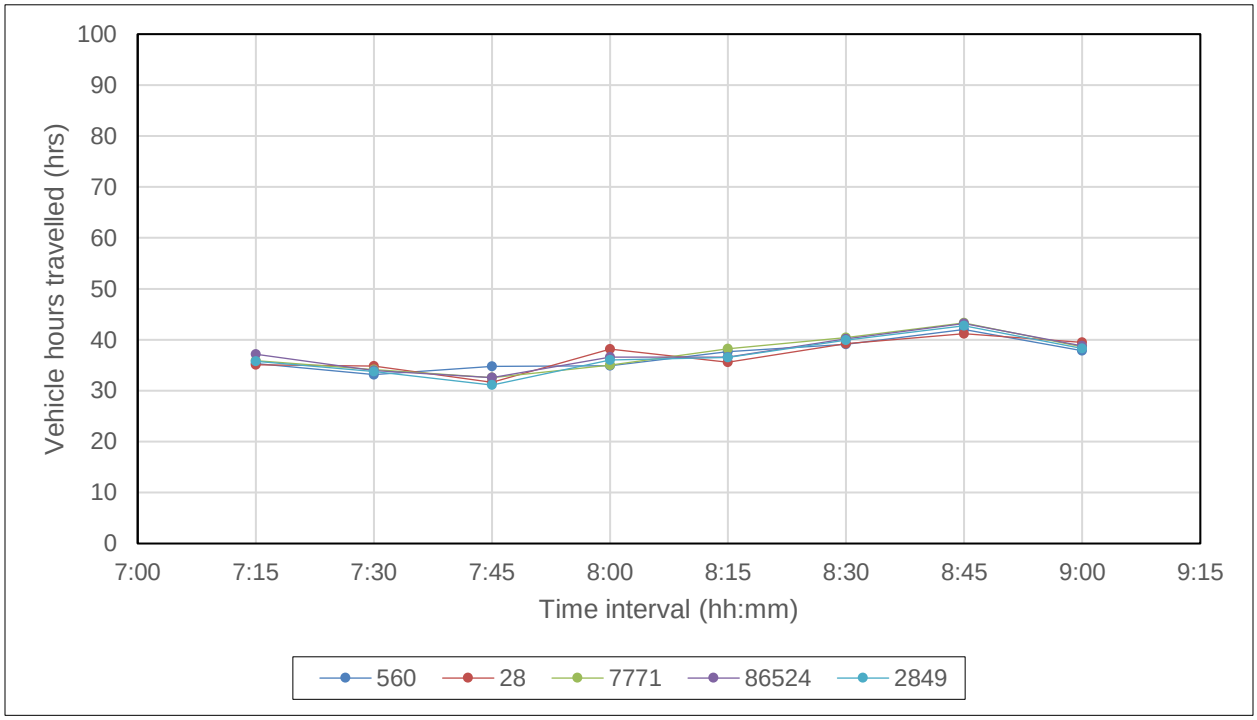


Figure 30: Vehicle hours travelled (VHT) per seed – AM peak

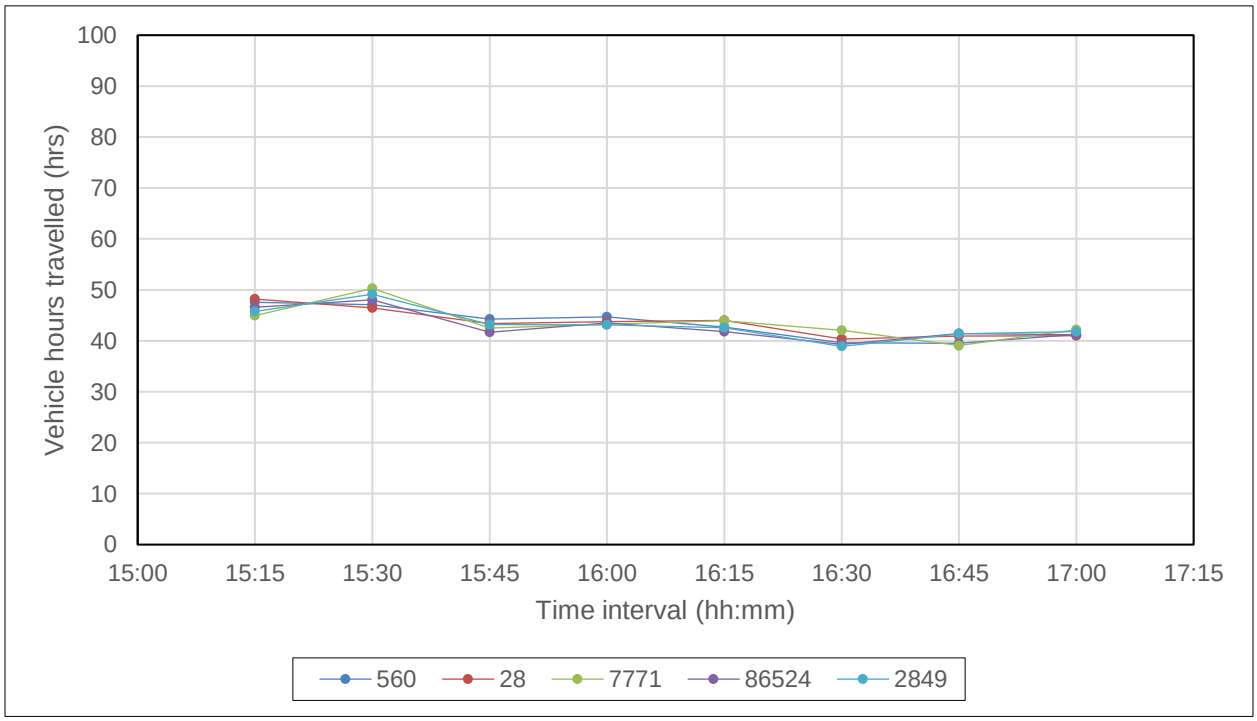


Figure 31: Vehicle hours travelled (VHT) per seed – PM peak

The number of seed runs required to determine the stability of the model is calculated iteratively using **Equation 2**:

$$N = \left(\frac{t\sigma}{\Delta}\right)^2$$ Equation 2

where:

- N = number of runs required
- t = two-tailed inverse of Student's t-distribution
- σ = standard deviation
- Δ = acceptable error (produce of precision and sample mean).

The t-value required for a confidence interval of 95 per cent given five initial seeds is 2.776. The number of runs required for each peak period are shown in **Table 18**.

Table 18: Number of simulation runs required

Parameter	AM Peak	PM Peak
t	2.776	2.776
σ	2.2	1.9
$\bar{x}$	296	346
Δ	14.82	17.32
N	0.17	0.09

The number of simulation runs required (N) is less than the initial number of seeds used in all peaks, therefore it is sufficient to retain the five seeds for a confidence interval of 95 per cent. **Table 19** shows the VHT bounds and the median seed for each peak.

Table 19: Median seed values

Peak	All seeds			Median seed	
	VHT lower bound	Mean VHT	VHT upper bound	VHT	Seed value
AM peak	294	296	298	296	28
PM peak	343	346	348	348	560

The results reported in the remainder of this report for calibration and validation are based on the median seed values for each peak shown in **Table 19**.

5.0 MODEL CALIBRATION AND VALIDATION

5.1 CONVERGENCE

As outlined in **Section 3.4**, DUE is an iterative procedure that involves shifting users to the shortest path given the travel times on each path in the previous iteration. The relative gap (RGap) is a measure of the difference between the modelled travel times and the travel times if all vehicles were using the shortest path. It provides an indication of whether the DUE assignment has converged to the optimal solution. Due to the size of the model and required run time for DUE convergence, a stopping RGap of 0.5 per cent was adopted.

Figure 32 and **Figure 33** show the DUE convergence for the AM peak and PM peak respectively. All peaks converge within 11 iterations.

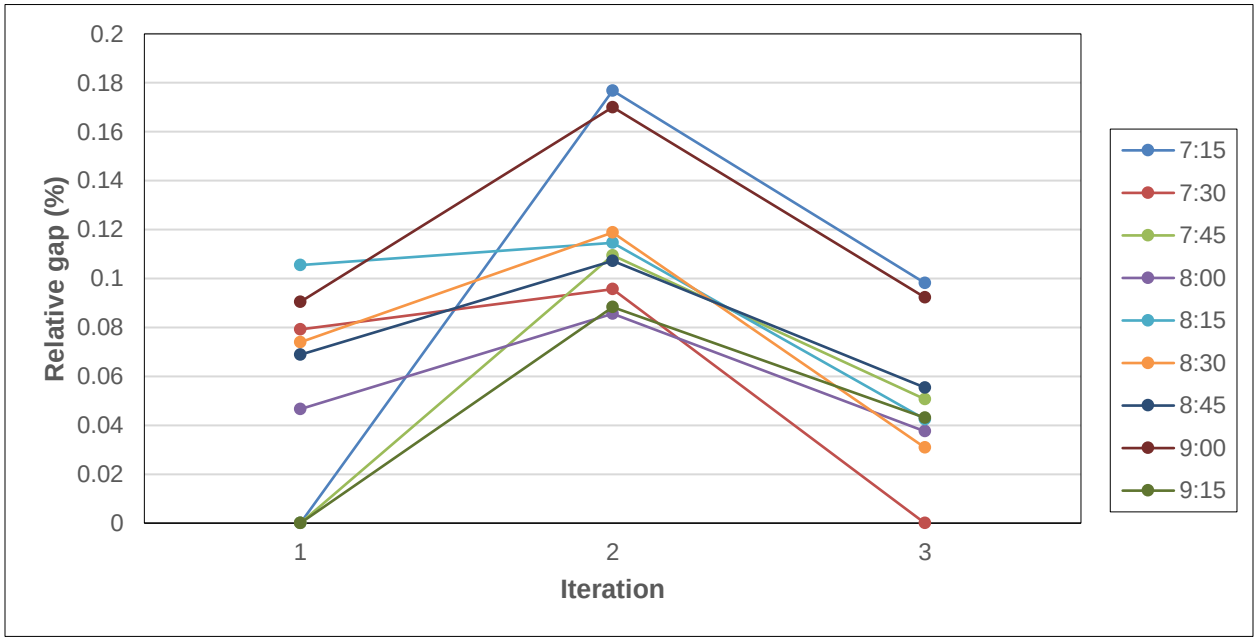


Figure 32: AM peak DUE convergence

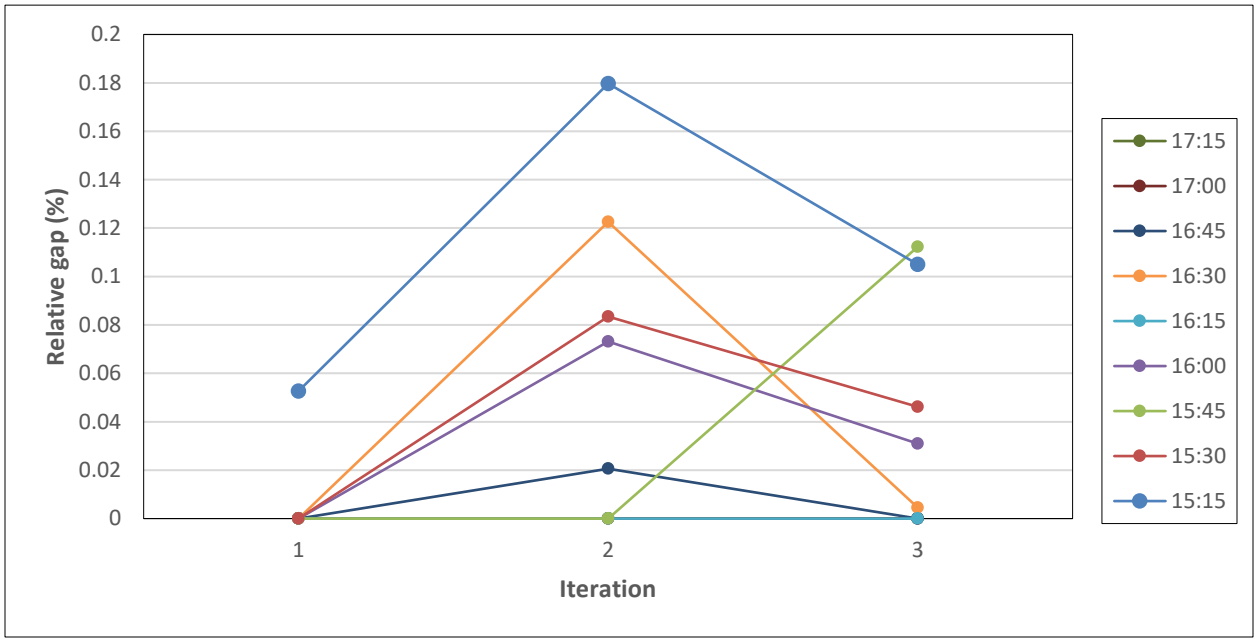


Figure 33: PM peak DUE convergence

5.2 CALIBRATION

This section outlines the calibration results. **Table 20** provides a summary of the network-wide GEH criteria for turning counts and the number of compliant counts within each peak. **Appendix A** provides the calibration results in detail. The results indicate that:

- There is a good correlation between the observed and modelled turn volumes for light and heavy vehicles with 100 per cent of locations having a GEH less than five across all peaks
- The co-efficient of determination (R^2) exceeds 0.99 in all modelled hours.
- No turns had a GEH exceeding 10.

Table 20: Summary of network-wide calibration statistics

Criteria	AM peak		PM peak	
	7:15am – 8:15am	8:15am – 9:15am	3:15pm – 4:15pm	4:15pm – 5:15pm
Light vehicles				
Turns with GEH ≤ 5.0	100.0%	100.0%	100.0%	100.0%
Turns with GEH ≤ 10.0	100.0%	100.0%	100.0%	100.0%
Heavy vehicles				
Turns with GEH ≤ 5.0	100.0%	100.0%	100.0%	100.0%
Turns with GEH ≤ 10.0	100.0%	100.0%	100.0%	100.0%
All vehicles				
Turns with GEH ≤ 5.0	100.0%	100.0%	100.0%	100.0%
Turns with GEH ≤ 10.0	100.0%	100.0%	100.0%	100.0%
Slope	0.9967	1.0043	0.9961	1.0293
Coefficient of determination	0.9967	0.9983	0.9986	0.9981
Calibration target achieved?	✓	✓	✓	✓

Table 21 outlines the calibration statistics for the core area. The results indicate that:

- All core calibration targets were met in each hour of both peak periods and for all vehicle types.

Table 21: Summary of core area calibration statistics

Flow (veh)	Criteria	AM peak		PM peak	
		07:15 - 08:15	08:15 - 09:15	15:15 - 16:15	16:15 - 17:15
Light vehicles					
≤ 99	Within 10 vehicles of the observed value	35/35	39/39	35/35	36/36
100-999	Within 10 per cent of the observed value	24/24	20/20	24/24	23/23
1000-1999	Within 100 vehicles of the observed value	0/0	0/0	0/0	0/0
≥ 2000	Within 5 per cent of the observed value	0/0	0/0	0/0	0/0
All	Within the tolerance levels set out above	59/59	59/59	59/59	59/59
Heavy vehicles					
≤ 99	Within 10 vehicles of the observed value	59/59	59/59	59/59	59/59
100-999	Within 10 per cent of the observed value	0/0	0/0	0/0	0/0
1000-1999	Within 100 vehicles of the observed value	0/0	0/0	0/0	0/0
≥ 2000	Within 5 per cent of the observed value	0/0	0/0	0/0	0/0
All	Within the tolerance levels set out above	59/59	59/59	59/59	59/59

Figure 34 to **Figure 37** show the regression analysis for all vehicles for each peak. The coefficient of determination (R^2) value for the linear trendline in each instance is shown on the chart. The boundaries for GEH = 5.0 are also shown.

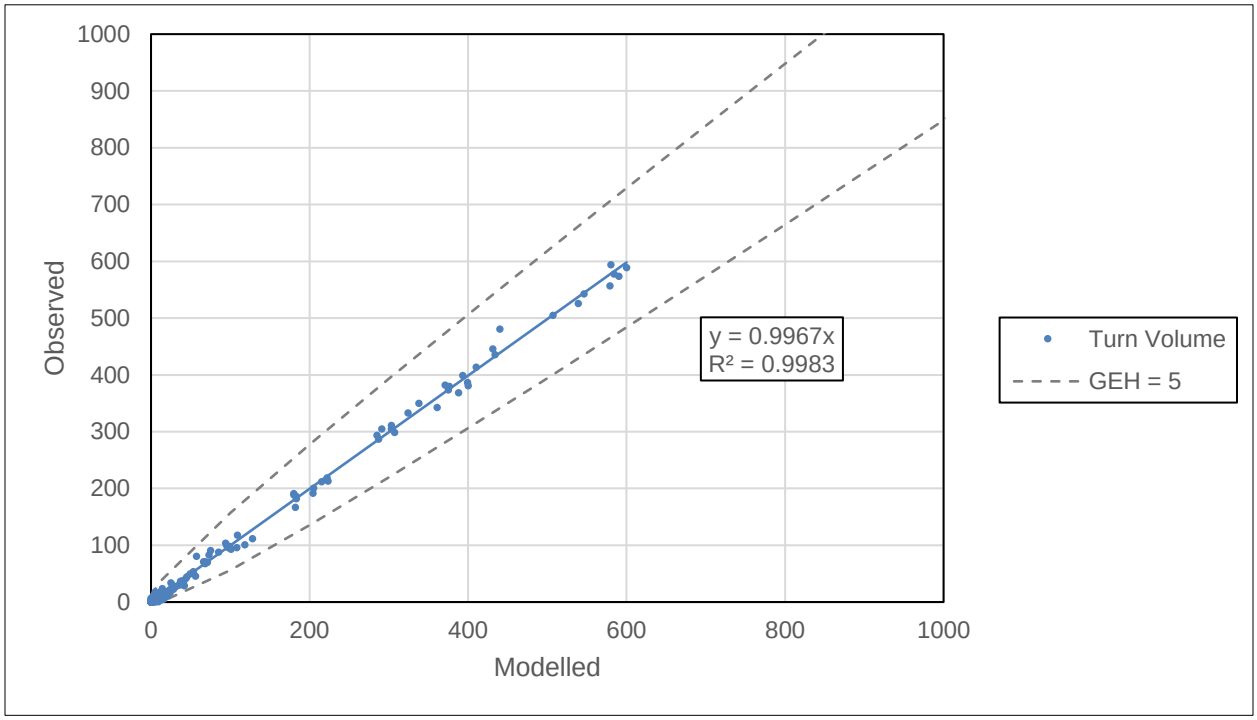


Figure 34: 7:15am – 8:15am turn count regression plot

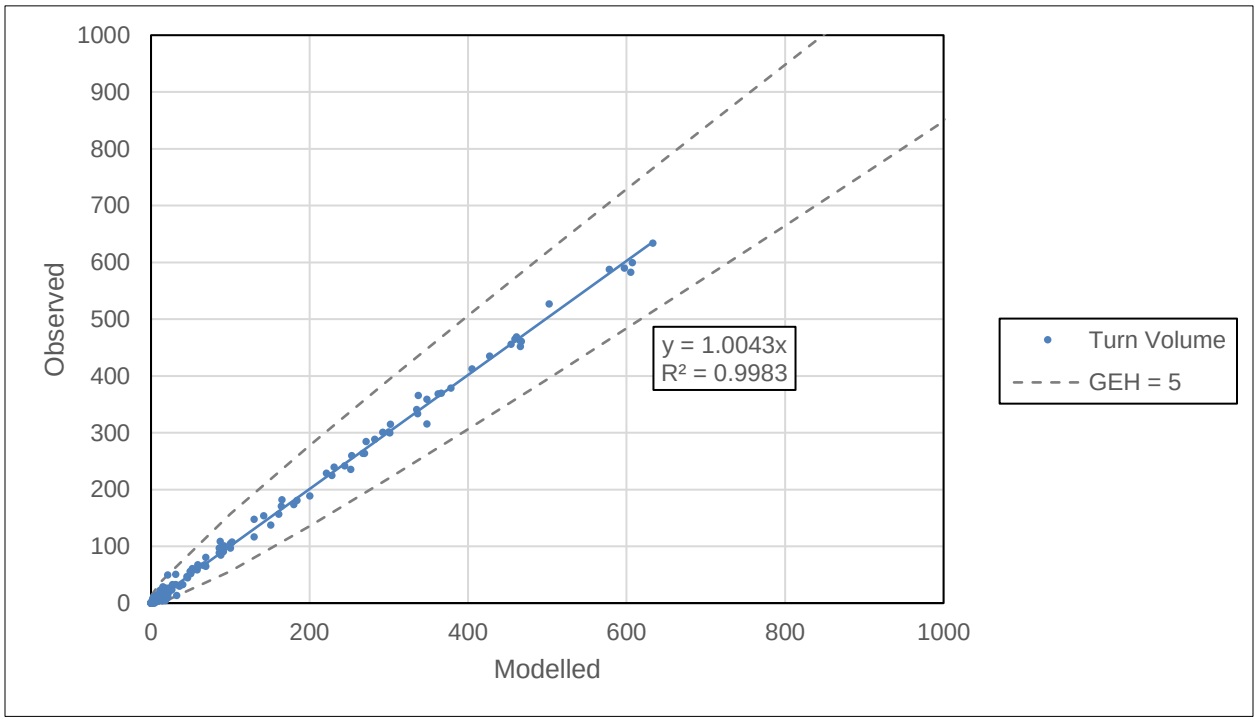


Figure 35: 8:15am – 9:15am turn count regression plot

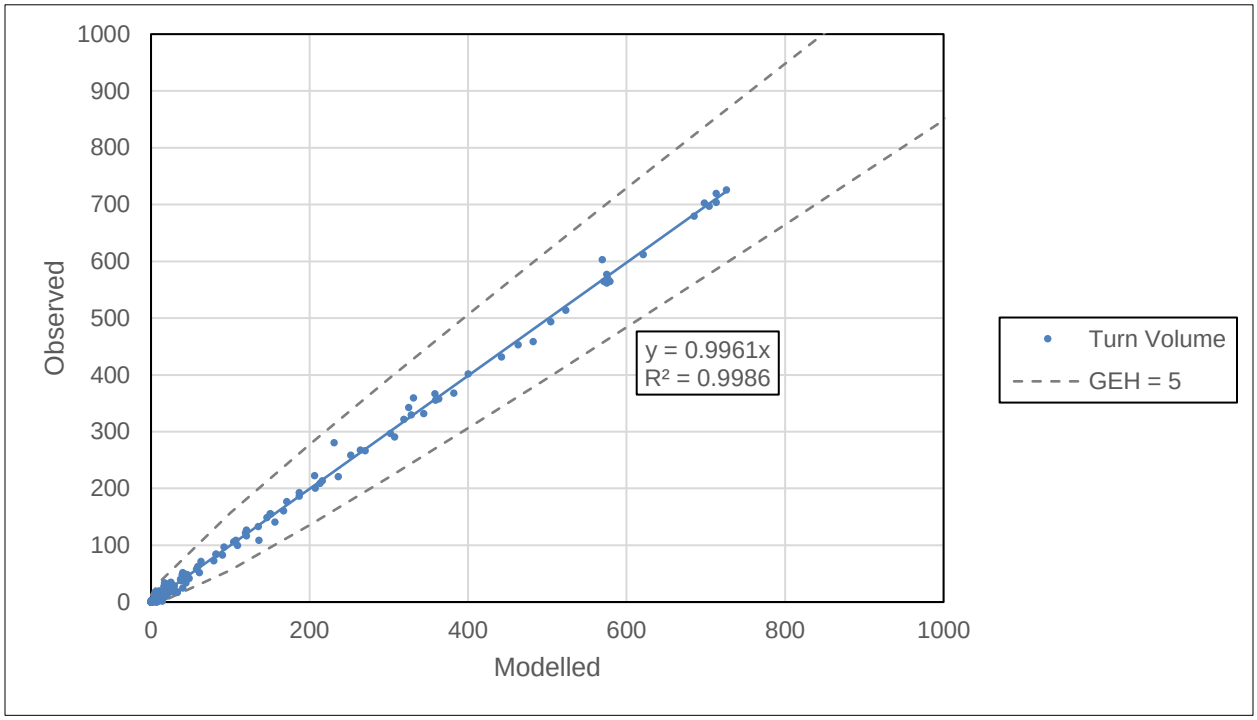


Figure 36: 3:15pm – 4:15pm turn count regression plot

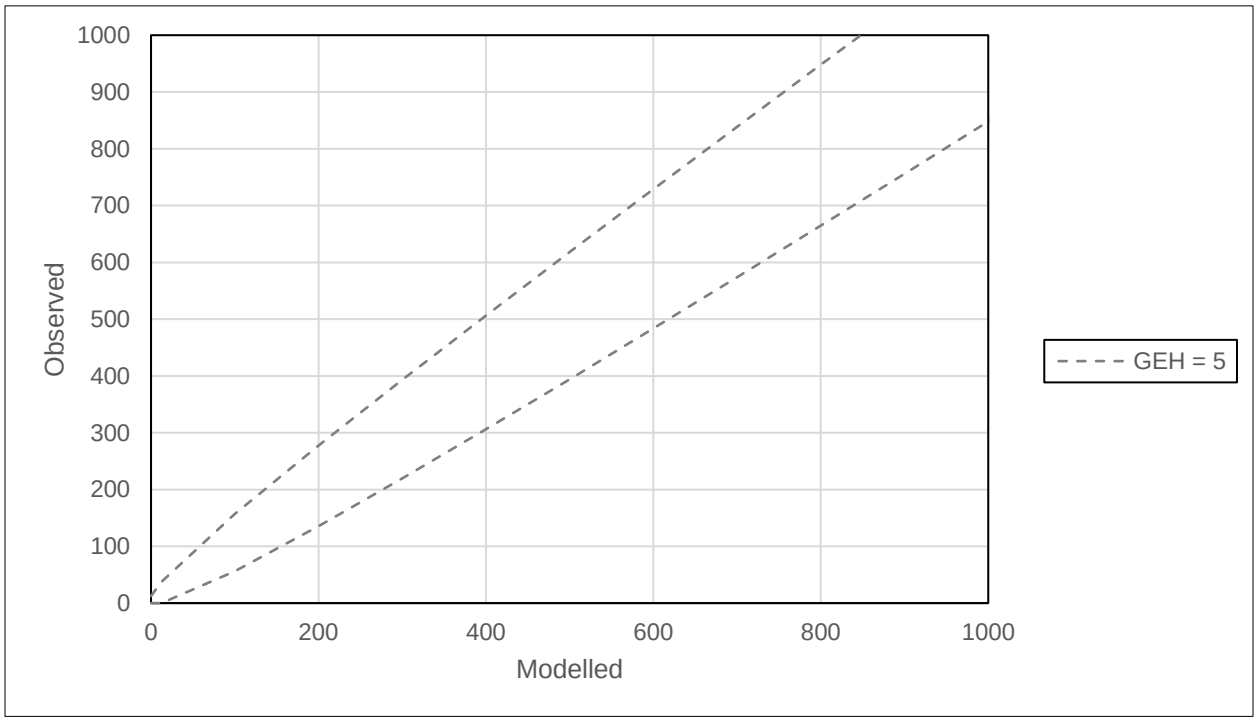


Figure 37: 4:15pm – 5:15pm turn count regression plot

5.3 VALIDATION

5.3.1 Travel time validation results

This section outlines the travel time validation results. As explained in **Section 2.5**, travel time surveys and TomTom travel time data were collected. A comparison of the two travel time data sources showed each travel time segment extracted from TomTom had over 40 samples in each modelled hour, and the travel time surveys provided two samples in each modelled hour. The TomTom travel time data was assessed as the more robust data source, and therefore Cardno adopted the TomTom travel time data for the travel time validation.

Table 22 and **Table 23** show the observed and modelled cumulative travel time along each route for the AM peak and PM peak, respectively. Detailed travel time plots are provided in **Appendix B**.

- All three routes meet the cumulative journey travel time validation criteria, with each route validated to within 15 per cent or 60 seconds of the observed travel time in both directions
- The modelled travel time on all segments on Old Hume Highway was within 15 per cent of the observed travel time in all peak periods, except for:
  - between Barkers Lodge Road and Menangle Street in the second hour of the AM peak for both northbound and southbound directions, and
  - from Downing Street to Margaret Street in the second hour of the PM peak.

  The travel time for these locations exceeded the 15 per cent margin by up to two seconds. This is a result of differences in arrival patterns which vary the degree of blockage at conflicts such as vehicles waiting for turns, changes in kerbside parking utilisation in the town centre and/or pedestrian movements.
- The modelled travel time on all segments on Menangle Street was within 15 per cent of the observed travel time in all peak periods.
- The modelled travel time on the Prince Street segment was within the 15 per cent of the observed travel time in both directions in all peak periods, with the exception of the eastbound direction in the second hour of the PM peak, where the travel time exceeded the 15 per cent margin by four seconds.

Table 22: Travel time validation results – AM peak

Segment	7:15am-8:15am					8:15am-9:15am				
	Modelled (s)	**Observed** (s)	**Observed +/-15%** (s)	**Difference**		**Modelled** (s)	**Observed** (s)	**Observed +/-15%** (s)	**Difference**	
Old Hume Highway (northbound)										
1	44	45	38-52	-2%	✓	43	46	39-53	-3%	✓
2	69	68	58-78	+1%	✓	71	76	65-87	-6%	✓
3	90	89	76-102	+1%	✓	99	103	88-118	-4%	✓
4	133	129	110-148	+3%	✓	142	153	130-176	-7%	✓
5	151	158	134-182	-4%	✓	166	198	168-228	-16%	×
6	178	184	156-212	-3%	✓	196	226	192-260	-13%	✓
7	194	201	171-231	-4%	✓	212	244	207-281	-13%	✓
8	210	216	184-248	-3%	✓	228	260	221-299	-12%	✓
Old Hume Highway (southbound)										
1	15	16	14-18	-6%	✓	15	15	13-17	0%	✓
2	37	37	31-43	0%	✓	40	38	32-44	+6%	✓
3	57	65	55-75	-12%	✓	61	69	59-79	-11%	✓
4	76	88	75-101	-14%	✓	80	97	82-112	-17%	×
5	113	126	107-145	-10%	✓	119	137	116-158	-13%	✓
6	133	146	124-168	-9%	✓	144	163	139-187	-12%	✓
7	157	168	143-193	-7%	✓	172	188	160-216	-9%	✓
8	200	210	179-242	-5%	✓	215	231	196-266	-7%	✓
Menangle Street (northbound)										
1	9	10	9-12	-7%	✓	9	10	9-12	-5%	✓
2	49	50	43-58	-1%	✓	50	49	42-56	+2%	✓
3	70	71	60-82	-2%	✓	71	72	61-83	-1%	✓
4	100	99	84-114	+1%	✓	104	107	91-123	-3%	✓
Menangle Street (southbound)										
1	21	23	20-26	-11%	✓	24	27	23-31	-11%	✓
2	41	42	36-48	-2%	✓	46	48	41-55	-4%	✓
3	81	80	68-92	+2%	✓	86	87	74-100	-1%	✓
4	91	90	77-104	+1%	✓	97	97	82-112	0%	✓
Prince Street (eastbound)										
1	83	89	76-102	-7%	✓	81	70	60-81	+15%	✓
Prince Street (westbound)										
1	64	61	52-70	+4%	✓	65	64	54-74	+2%	✓

Table 23: Travel time validation results – PM peak

Segment	3:15pm-4:15pm					4:15pm-5:15pm				
	Modelled (s)	**Observed** (s)	**Observed +/-15%** (s)	**Difference**		**Modelled** (s)	**Observed** (s)	**Observed +/-15%** (s)	**Difference**	
Old Hume Highway (northbound)										
1	46	45	38-52	+1%	✓	44	44	37-51	0%	✓
2	69	71	60-82	-3%	✓	67	66	56-76	+2%	✓
3	88	97	82-112	-9%	✓	87	86	73-99	+1%	✓
4	131	140	119-161	-6%	✓	129	124	105-143	+4%	✓
5	153	174	148-200	-12%	✓	149	149	127-171	0%	✓
6	185	205	174-236	-10%	✓	182	177	150-204	+3%	✓
7	201	222	189-255	-10%	✓	198	194	165-223	+2%	✓
8	217	238	202-274	-9%	✓	214	210	179-242	+2%	✓
Old Hume Highway (southbound)										
1	15	16	14-18	-6%	✓	15	15	13-17	+2%	✓
2	47	42	36-48	+11%	✓	46	38	32-44	+20%	×
3	70	78	66-90	-10%	✓	68	69	59-79	-2%	✓
4	91	105	89-121	-14%	✓	86	91	77-105	-6%	✓
5	130	143	122-164	-9%	✓	124	127	108-146	-3%	✓
6	148	168	143-193	-12%	✓	142	145	123-167	-2%	✓
7	172	191	162-220	-10%	✓	165	165	140-190	0%	✓
8	216	233	198-268	-7%	✓	208	205	174-236	+2%	✓
Menangle Street (northbound)										
1	10	10	9-12	-4%	✓	9	10	9-12	-6%	✓
2	50	49	42-56	+2%	✓	50	50	43-58	0%	✓
3	70	72	61-83	-3%	✓	70	70	60-81	0%	✓
4	117	107	91-123	+9%	✓	105	100	85-115	+5%	✓
Menangle Street (southbound)										
1	21	24	20-28	-13%	✓	20	21	18-24	-7%	✓
2	41	44	37-51	-6%	✓	40	40	34-46	-1%	✓
3	82	82	70-94	0%	✓	80	78	66-90	+2%	✓
4	95	92	78-106	+3%	✓	92	87	74-100	+5%	✓
Prince Street (eastbound)										
1	86	83	71-95	-3%	✓	78	64	54-74	+22%	×
Prince Street (westbound)										
1	72	65	55-75	+11%	✓	70	65	55-75	+8%	✓

5.3.2 Signal timing validation results

Operation of traffic signals is sufficiently represented in the model. Modelled phase timings were varied from actual phase timings were for the following reasons:

- The frequency of B phase was observed to be low in both peak periods. Therefore, the average times were below the minimum required green and interphase times. In order to meet the minimum phase time requirements, the PM peak took time from the A phase (stretch phase) as time would be returned to the stretch phase should B phase not be called. However, the B phase was not operated in the AM peak due to the lower cycle time of 60 / 70 seconds. By implementing the B phase in the model, the minimum green and interphase times for other phases would be impacted.
- Each pedestrian crossing was activated two times or less in the first hour of the AM peak. Pedestrian protection was not implemented in the first hour of the AM peak due to the low number of calls.

Table 24 shows the signal timing validation results.

Table 24: Signal timing validation results

Intersection	Phase	Actual	Actual +/-10%	Modelled	Difference	Validation
Old Hume Highway / Margaret Street / Cliffe Street	**7:15am-8:15am**					
	A	36	32-40	35	-1	✓
	B	4	4-4	0	-4	×
	C	13	12-14	13	0	✓
	D	7	6-8	12	+5	×
	Cycle	60	54-66	60	0	✓
	8:15am-9:15am					
	A	37	33-41	37	0	✓
	B	6	5-7	0	-6	×
	C	17	15-19	17	0	✓
	D	10	9-11	16	+6	×
	Cycle	70	63-77	71	+1	✓
	3:15pm-4:15pm					
	A	46	41-51	40	-6	×
	B	7	6-8	12	+5	×
	C	22	20-24	22	0	✓
	D	16	14-18	16	0	✓
	Cycle	90	81-99	90	0	✓
	4:15pm-5:15pm					
	A	47	42-52	40	-7	×
	B	6	5-7	12	+6	×
	C	22	20-24	22	0	✓
	D	15	14-17	16	+1	✓
	Cycle	100	90-110	90	-10	✓

6.0 MODEL LIMITATIONS

The Base Model has been developed in accordance with *Traffic Modelling Guidelines* (Roads and Maritime Services, 2013) and *Technical Direction 2018/002: Traffic Signals in Microsimulation* (Roads and Maritime Services, 2018). Notwithstanding, the main assumptions and limitations of the modelling are outlined below:

- Signal timings were adjusted to meet minimum green time requirements and include pedestrian walk times at major intersections
- The modelled road network does not include all the roads and intersections in the study area. The internal road network reduction was assumed to minimise path allocation and route choice to roads that could not be verified using survey counts
- It is not recommended to use the model to assess intersections that were not calibrated using survey data, or to assess routes that were not calibrated using travel time data
- The latest bus timetables were used to code bus routes.
- U-turn movements were not calibrated at any intersections, including roundabouts.
- The impacts of on-street parking have been considered only at a high-level on key corridors. Circulating vehicles looking for parking, or vehicles using the kiss-and-ride zones may not have been fully captured in the model.

7.0 CONCLUSION

This report documents the development of a microsimulation Base Model of the Picton town centre. The existing traffic conditions in the study area were analysed from various data sources including classified intersection counts, video footage, travel time data, queue length surveys and site observations.

Strategic demands were extracted from the TRACKS strategic model and used as the starting point for demand estimation for the Base Models. These were adjusted manually and using the matrix adjustment functions available in Aimsun to match observed traffic counts.

The Base Model was calibrated to represent conditions during two typical weekday peaks:

- AM peak: 7:15am-9:15am
- PM peak: 3:15pm-5:15pm.

The Base Models were developed in accordance with *Traffic Modelling Guidelines* (Roads and Maritime Services, 2013) and *Traffic Signals in Microsimulation Modelling* (Roads and Maritime Services, 2018). A statistical analysis of stability indicated that the models are stable with less than five seeds required to ensure a confident statistical result. The calibration and validation results indicate that the Base Models have:

- High network-wide calibration with 100 per cent of turning movements having a GEH of less than five, and no turning movements having a GEH greater than 10 across all peaks
- Adherence to the core calibration criteria in all hours for light and heavy vehicle types
- High statistical correlation between modelled and observed turning volumes with $R^2 > 0.99$ across all modelled peaks
- Modelled travel times on key routes fit well with observed data
- Sufficient representation of signal timing at signalised intersections.

The Base Models meet the calibration and validation targets set out in *Traffic Modelling Guidelines* (Roads and Maritime Services, 2013) and are therefore considered fit-for-purpose for assessing existing and future network performance. They are considered to provide a realistic replication of existing traffic conditions across the study area and provide a robust foundation on which to base the future-year assessment.

APPENDIX A

GEH results

Turn	Aimsun ID	Area	AM Peak																			
			07:15 - 08:15										08:15 - 09:15									
			Light vehicles					Heavy vehicles					Light vehicles					Heavy vehicles				
			Model	Obs	Diff	GEH	Core	Model	Obs	Diff	GEH	Core	Model	Obs	Diff	GEH	Core	Model	Obs	Diff	GEH	Core
1EL	9128	Network	0	2	-2	2.00		0	0	0	0.00		1	1	0	0.00		0	1	-1	1.41	
1ER	9130	Network	0	2	-2	2.00		0	0	0	0.00		0	1	-1	1.41		0	0	0	0.00	
1ET	9129	Network	0	0	0	0.00		0	0	0	0.00		0	0	0	0.00		0	0	0	0.00	
1NL	9123	Network	0	2	-2	2.00		0	1	-1	1.41		2	1	1	0.82		0	0	0	0.00	
1NR	9125	Network	6	5	1	0.43		0	1	-1	1.41		9	8	1	0.34		1	1	0	0.00	
1NT	9124	Network	281	273	8	0.48		26	26	0	0.00		314	284	30	1.73		33	32	1	0.18	
1SL	9133	Network	43	37	6	0.95		1	8	-7	3.30		43	45	-2	0.30		2	2	0	0.00	
1SR	9131	Network	0	0	0	0.00		0	0	0	0.00		0	0	0	0.00		0	0	0	0.00	
1ST	9134	Network	413	461	-48	2.30		27	20	7	1.44		307	335	-28	1.56		30	31	-1	0.18	
1WL	9138	Network	48	47	1	0.15		1	3	-2	1.41		30	30	0	0.00		1	3	-2	1.41	
1WR	9136	Network	117	99	18	1.73		1	2	-1	0.82		130	114	16	1.45		0	3	-3	2.45	
1WT	9135	Network	0	0	0	0.00		0	0	0	0.00		0	0	0	0.00		0	0	0	0.00	
2EL	10844	Core	34	28	6	1.08	PASS	3	9	-6	2.45	PASS	24	29	-5	0.97	PASS	3	2	1	0.63	PASS
2ER	10907	Core	68	65	3	0.37	PASS	3	5	-2	1.00	PASS	66	64	2	0.25	PASS	2	4	-2	1.15	PASS
2ET	10906	Core	26	23	3	0.61	PASS	0	0	0	0.00	PASS	52	60	-8	1.07	PASS	0	1	-1	1.41	PASS
2NL	3873	Core	66	69	-3	0.37	PASS	0	2	-2	2.00	PASS	90	98	-8	0.83	PASS	2	3	-1	0.63	PASS
2NR	3870	Core	27	30	-3	0.56	PASS	0	0	0	0.00	PASS	50	51	-1	0.14	PASS	0	1	-1	1.41	PASS
2NT	3874	Core	312	324	-12	0.67	PASS	26	26	0	0.00	PASS	303	309	-6	0.34	PASS	31	32	-1	0.18	PASS
2SL	3871	Core	66	65	1	0.12	PASS	2	3	-1	0.63	PASS	54	58	-4	0.53	PASS	2	2	0	0.00	PASS
2SR	3869	Core	36	28	8	1.41	PASS	0	2	-2	2.00	PASS	36	36	0	0.00	PASS	10	9	1	0.32	PASS
2ST	3872	Core	382	392	-10	0.51	PASS	27	22	5	1.01	PASS	274	287	-13	0.78	PASS	28	28	0	0.00	PASS
2WL	8489	Core	6	8	-2	0.76	PASS	0	0	0	0.00	PASS	8	10	-2	0.67	PASS	0	1	-1	1.41	PASS
2WR	8491	Core	26	23	3	0.61	PASS	0	1	-1	1.41	PASS	34	29	5	0.89	PASS	1	2	-1	0.82	PASS
2WT	8490	Core	2	8	-6	2.68	PASS	0	1	-1	1.41	PASS	3	6	-3	1.41	PASS	1	1	0	0.00	PASS
3EL	966	Network	41	37	4	0.64		0	0	0	0.00		49	55	-6	0.83		0	1	-1	1.41	
3ER	6495	Network	6	6	0	0.00		0	0	0	0.00		5	7	-2	0.82		0	0	0	0.00	
3NL	6496	Network	9	12	-3	0.93		0	0	0	0.00		17	24	-7	1.55		0	0	0	0.00	
3NT	6494	Network	364	363	1	0.05		29	36	-7	1.23		342	343	-1	0.05		35	36	-1	0.17	
3SR	968	Network	39	38	1	0.16		1	0	1	1.41		58	59	-1	0.13		0	0	0	0.00	
3ST	6493	Network	477	478	-1	0.05		29	27	2	0.38		363	374	-11	0.57		42	39	3	0.47	
4NT	8454	Network	405	400	5	0.25		29	36	-7	1.23		391	398	-7	0.35		35	37	-2	0.33	
4ST	8444	Network	515	516	-1	0.04		30	27	3	0.56		419	431	-12	0.58		42	38	4	0.63	
4WL	8456	Network	1	0	1	1.41		0	0	0	0.00		3	2	1	0.63		0	1	-1	1.41	
4WR	8457	Network	1	1	0	0.00		1	0	1	1.41		0	0	0	0.00		0	0	0	0.00	
5EL	612	Core	72	69	3	0.36	PASS	35	27	8	1.44	PASS	104	94	10	1.01	PASS	46	44	2	0.30	PASS
5ER	9034	Core	0	3	-3	2.45	PASS	0	1	-1	1.41	PASS	0	1	-1	1.41	PASS	0	1	-1	1.41	PASS
5NL	605	Core	95	93	2	0.21	PASS	4	5	-1	0.47	PASS	63	67	-4	0.50	PASS	5	14	-9	2.92	PASS
5NR	607	Core	12	5	7	2.40	PASS	1	1	0	0.00	PASS	17	19	-2	0.47	PASS	5	1	4	2.31	PASS
5NT	606	Core	299	303	-4	0.23	PASS	25	30	-5	0.95	PASS	311	312	-1	0.06	PASS	25	22	3	0.62	PASS
5SL	616	Core	33	38	-5	0.84	PASS	11	4	7	2.56	PASS	80	87	-7	0.77	PASS	6	2	4	2.00	PASS
5SR	614	Core	151	145	6	0.49	PASS	31	37	-6	1.03	PASS	218	201	17	1.17	PASS	33	35	-2	0.34	PASS
5ST	615	Core	510	501	9	0.40	PASS	29	25	4	0.77	PASS	413	419	-6	0.29	PASS	41	37	4	0.64	PASS
5WL	608	Core	7	12	-5	1.62	PASS	1	1	0	0.00	PASS	2	11	-9	3.53	PASS	1	0	1	1.41	PASS
5WR	610	Core	3	5	-2	1.00	PASS	0	0	0	0.00	PASS	2	1	1	0.82	PASS	2	0	2	2.00	PASS
5WT	609	Core	9	4	5	1.96	PASS	2	1	1	0.82	PASS	7	3	4	1.79	PASS	2	1	1	0.82	PASS
6ER	8468	Network	31	24	7	1.33		11	5	6	2.12		58	65	-7	0.89		8	2	6	2.68	
6ET	5935	Network	0	0	0	0.00		0	0	0	0.00		7	3	4	1.79		0	0	0	0.00	
6NL	8465	Network	12	14	-2	0.55		4	2	2	1.15		11	26	-15	3.49		4	1	3	1.90	
6NR	8466	Network	0	0	0	0.00		0	0	0	0.00		3	2	1	0.63		0	0	0	0.00	
6WL	8467	Network	0	0	0	0.00		0	0	0	0.00		1	1	0	0.00		0	0	0	0.00	
6WT	5937	Network	0	0	0	0.00		0	0	0	0.00		0	0	0	0.00		0	0	0	0.00	
7EL	8483	Network	28	23	5	0.99		0	0	0	0.00		69	63	6	0.74		0	2	-2	2.00	
7ET	8484	Network	7	9	-2	0.71		2	2	0	0.00		24	21	3	0.63		2	3	-1	0.63	
7SL	8486	Network	3	3	0	0.00		0	0	0	0.00		13	16	-3	0.79		0	0	0	0.00	
7SR	8485	Network	14	24	-10	2.29		0	0	0	0.00		22	25	-3	0.62		0	2	-2	2.00	
7WR	8488	Network	0	0	0	0.00		0	0	0	0.00		2	1	1	0.82		0	0	0	0.00	
7WT	8487	Network	18	8	10	2.77		0	2	-2	2.00		19	10	9	2.36		2	2	0	0.00	
8ER	670	Network	89	95	-6	0.63		5	9	-4	1.51		162	177	-15	1.15		3	5	-2	1.00	
8ET	669	Network	90	86	4	0.43		36	26	10	1.80		155	149	6	0.49		44	40	4	0.62	
8NL	668	Network	83	84	-1	0.11		2	4	-2	1.15		89	89	0	0.00		2	2	0	0.00	
8NR	667	Network	12	10	2	0.60		0	2	-2	2.00		18	19	-1	0.23		0	8	-8	4.00	
8WL	665	Network	55	46	9	1.27		1	0	1	1.41		99	97	2	0.20		1	0	1	1.41	
8WT	666	Network	183	176	7	0.52		38	43	-5	0.79		130	123	7	0.62		48	51	-3	0.43	
9NR	5969	Network	4	5	-1	0.47		0	0	0	0.00		32	14	18	3.75		0	0	0	0.00	
9NT	5970	Network	71	78	-7	0.81		2	5	-3	1.60		84	87	-3	0.32		2	10	-8	3.27	
9SL	926	Network	51	53	-2	0.28		2	1	1	0.82		102	108	-6	0.59		0	0	0	0.00	
9ST	925	Network	93	88	5	0.53		4	8	-4	1.63		160	166	-6	0.47		4	5	-1	0.47	
9WL	923	Network	8	2	6	2.68		0	0	0	0.00		9	7	2	0.71		0	0	0	0.00	
9WR	5968	Network	24	16	8	1.79		0	1	-1	1.41		23	21	2	0.43		0	0	0	0.00	
10EL	5964	Network	4	2	2	1.15		0	0	0	0.00		9	4	5	1.96		0	0	0	0.00	
10ET	5965	Network	5	7	-2	0.82		0	0	0	0.00		5	5	0	0.00		0	0	0	0.00	
10SL	916	Network	97	85	12	1.26		4	8	-4	1.63		157	152	5	0.40		4	5	-1	0.47	
10SR	5963	Network	1	5	-4	2.31		0	0	0	0.00		3	5	-2	1.00		0	0	0	0.00	
10WR	5967	Network	55	76	-21	2.59		2	5	-3	1.60		98	95	3	0.31		2	10	-8	3.27	
10WT	5966	Network	6	6	0	0.00		0	0	0	0.00		7	3	4	1.79		0	0	0	0.00	
11EL	947	Network	16	6	10	3.02		0	0	0	0.00		21	10	11	2.79		0	0	0	0.00	
11ET	948	Network	90	86	4	0.43		5	14	-9	2.92		138	147	-9	0.75		4	7	-3	1.28	
11SL	946	Network	23	21	2	0.43		0	0	0	0.00		19	17	2	0.47		0	0	0	0.00	
11SR	5961	Network	1	0	1	1.41		0	0	0	0.00		18	5	13	3.83		0	0	0	0.00	
11WR	5960	Network	21	11	10	2.50		0	0	0	0.00		36	30	6	1.04		0	0	0	0.00	
11WT	5962	Network	75	86	-11	1.23		0	5	-5	3.16		85	96	-11	1.16		2	13	-11	4.02	
12EL	8281	Core	0	0	0	0.00	PASS	0	0	0	0.00	PASS	1	0	1	1.41	PASS	0	0	0	0.00	PASS
12ER	8283	Core	1	0	1	1.41	PASS	0	0	0	0.00	PASS	0	0	0	0.00	PASS	0	0	0	0.00	PASS
12ET	8282	Core	0	0	0	0.00	PASS	0	0	0	0.00	PASS	0	0	0	0.00	PASS	0	0	0	0.00	PASS
12NL	8280	Core	0	0	0	0.00	PASS	1	0	1	1.41	PASS	0	0	0	0.00	PASS	1	0	1	1.41	PASS

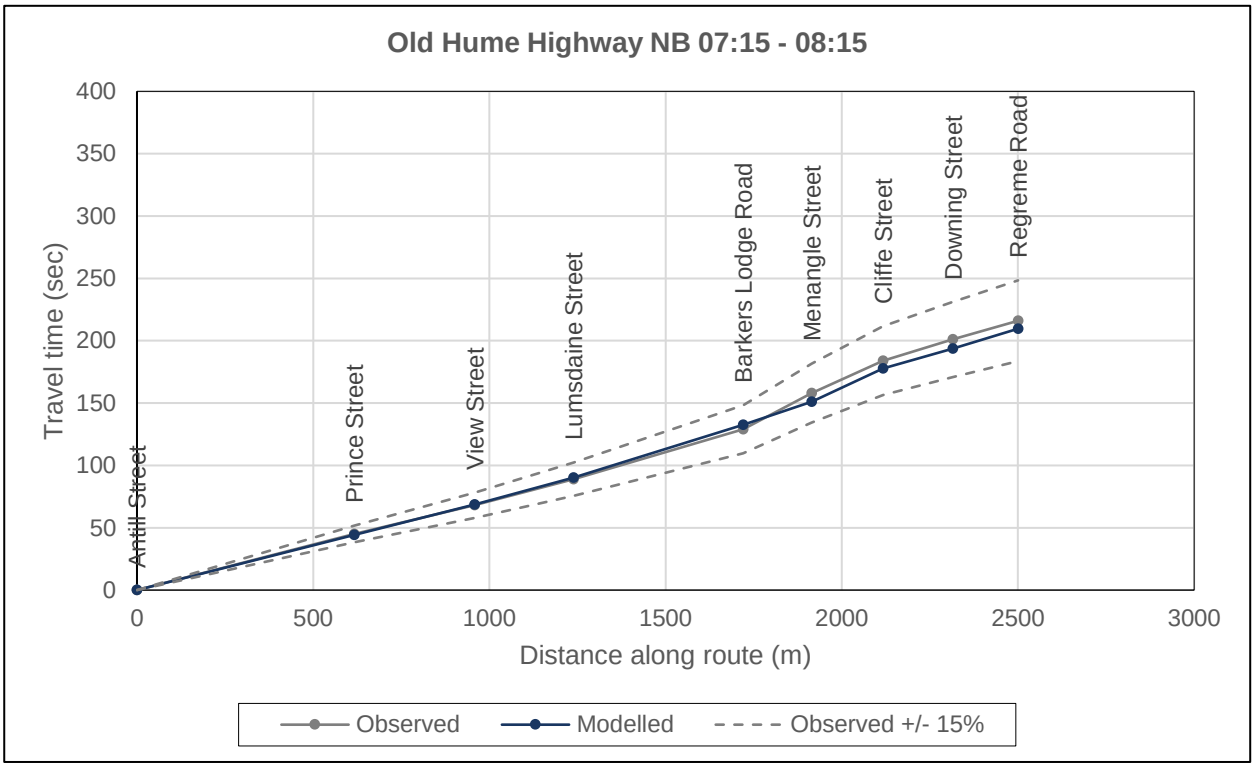
12NR	7349	Core	64	64	0	0.00	PASS	4	7	-3	1.28	PASS	77	72	5	0.58	PASS	11	13	-2	0.58	PASS
12NT	556	Core	321	320	1	0.06	PASS	53	54	-1	0.14	PASS	402	406	-4	0.20	PASS	64	55	9	1.17	PASS
12SL	7350	Core	19	15	4	0.97	PASS	1	3	-2	1.41	PASS	16	13	3	0.79	PASS	5	3	2	1.00	PASS
12SR	8278	Core	0	0	0	0.00	PASS	0	0	0	0.00	PASS	0	0	0	0.00	PASS	0	0	0	0.00	PASS
12ST	552	Core	526	521	5	0.22	PASS	57	57	0	0.00	PASS	544	540	4	0.17	PASS	62	60	2	0.26	PASS
12WL	554	Core	169	159	10	0.78	PASS	13	8	5	1.54	PASS	164	167	-3	0.23	PASS	20	14	6	1.46	PASS
12WR	553	Core	31	27	4	0.74	PASS	0	0	0	0.00	PASS	33	31	2	0.35	PASS	7	2	5	2.36	PASS
12WT	8279	Core	2	0	2	2.00	PASS	2	0	2	2.00	PASS	0	0	0	0.00	PASS	1	0	1	1.41	PASS
13EL	634	Network	9	9	0	0.00		0	1	-1	1.41		11	23	-12	2.91		0	0	0	0.00	
13ER	635	Network	24	21	3	0.63		0	1	-1	1.41		20	19	1	0.23		0	0	0	0.00	
13NL	633	Network	5	18	-13	3.83		0	0	0	0.00		15	29	-14	2.98		0	0	0	0.00	
13NT	632	Network	339	314	25	1.38		48	55	-7	0.98		399	392	7	0.35		66	60	6	0.76	
13SR	631	Network	9	1	8	3.58		0	0	0	0.00		7	5	2	0.82		0	0	0	0.00	
13ST	630	Network	523	498	25	1.11		55	59	-4	0.53		531	527	4	0.17		65	63	2	0.25	
14EL	645	Network	9	10	-1	0.32		0	0	0	0.00		8	10	-2	0.67		0	1	-1	1.41	
14ER	644	Network	0	0	0	0.00		0	0	0	0.00		1	2	-1	0.82		0	0	0	0.00	
14NL	643	Network	2	3	-1	0.63		0	2	-2	2.00		15	15	0	0.00		0	0	0	0.00	
14NT	642	Network	351	327	24	1.30		48	54	-6	0.84		400	402	-2	0.10		65	60	5	0.63	
14SR	641	Network	13	15	-2	0.53		0	1	-1	1.41		31	51	-20	3.12		0	0	0	0.00	
14ST	640	Network	533	515	18	0.79		56	59	-3	0.40		540	520	20	0.87		64	63	1	0.13	
15ER	846	Network	0	7	-7	3.74		0	0	0	0.00		2	8	-6	2.68		0	0	0	0.00	
15ET	845	Network	181	184	-3	0.22		2	2	0	0.00		223	223	0	0.00		5	2	3	1.60	
15NL	849	Network	2	7	-5	2.36		0	0	0	0.00		13	19	-6	1.50		0	0	0	0.00	
15NR	850	Network	5	6	-1	0.43		0	0	0	0.00		7	15	-8	2.41		0	0	0	0.00	
15WL	848	Network	8	6	2	0.76		0	0	0	0.00		18	20	-2	0.46		0	0	0	0.00	
15WT	847	Network	376	380	-4	0.21		0	0	0	0.00		281	289	-8	0.47		1	0	1	1.41	
16EL	651	Core	178	189	-11	0.81	PASS	2	2	0	0.00	PASS	226	238	-12	0.79	PASS	5	2	3	1.60	PASS
16ER	652	Core	6	1	5	2.67	PASS	0	0	0	0.00	PASS	4	0	4	2.83	PASS	0	0	0	0.00	PASS
16NL	649	Core	13	4	9	3.09	PASS	0	0	0	0.00	PASS	8	8	0	0.00	PASS	0	0	0	0.00	PASS
16NT	650	Core	350	333	17	0.92	PASS	48	54	-6	0.84	PASS	396	404	-8	0.40	PASS	62	61	1	0.13	PASS
16SR	653	Core	371	382	-11	0.57	PASS	0	0	0	0.00	PASS	291	301	-10	0.58	PASS	1	0	1	1.41	PASS
16ST	654	Core	543	529	14	0.60	PASS	56	60	-4	0.53	PASS	567	571	-4	0.17	PASS	65	63	2	0.25	PASS
17NR	6668	Core	13	13	0	0.00	PASS	1	0	1	1.41	PASS	22	24	-2	0.42	PASS	0	0	0	0.00	PASS
17NT	6667	Core	246	243	3	0.19	PASS	41	44	-3	0.46	PASS	190	188	2	0.15	PASS	54	54	0	0.00	PASS
17SL	6669	Core	179	187	-8	0.59	PASS	1	2	-1	0.82	PASS	216	226	-10	0.67	PASS	5	3	2	1.00	PASS
17ST	6670	Core	168	160	8	0.62	PASS	36	32	4	0.69	PASS	252	257	-5	0.31	PASS	49	43	6	0.88	PASS
17WL	708	Core	10	17	-7	1.91	PASS	0	0	0	0.00	PASS	59	67	-8	1.01	PASS	0	1	-1	1.41	PASS
17WR	6666	Core	361	343	18	0.96	PASS	0	0	0	0.00	PASS	299	301	-2	0.12	PASS	1	1	0	0.00	PASS
18NR	6663	Core	6	9	-3	1.10	PASS	0	3	-3	2.45	PASS	12	4	8	2.83	PASS	0	0	0	0.00	PASS
18NT	6664	Core	243	250	-7	0.45	PASS	42	44	-2	0.30	PASS	200	207	-7	0.49	PASS	53	53	0	0.00	PASS
18SL	697	Core	10	8	2	0.67	PASS	0	0	0	0.00	PASS	10	7	3	1.03	PASS	2	2	0	0.00	PASS
18ST	696	Core	168	169	-1	0.08	PASS	37	32	5	0.85	PASS	301	317	-16	0.91	PASS	47	42	5	0.75	PASS
18WL	698	Core	8	10	-2	0.67	PASS	0	3	-3	2.45	PASS	15	7	8	2.41	PASS	0	3	-3	2.45	PASS
18WR	6665	Core	16	6	10	3.02	PASS	0	0	0	0.00	PASS	10	5	5	1.83	PASS	1	1	0	0.00	PASS
19NR	738	Core	0	0	0	0.00	PASS	0	0	0	0.00	PASS	0	0	0	0.00	PASS	0	0	0	0.00	PASS
19NT	6661	Core	248	258	-10	0.63	PASS	42	47	-5	0.75	PASS	212	211	1	0.07	PASS	53	53	0	0.00	PASS
19SL	740	Core	1	2	-1	0.82	PASS	0	0	0	0.00	PASS	1	0	1	1.41	PASS	0	0	0	0.00	PASS
19ST	739	Core	176	177	-1	0.08	PASS	37	35	2	0.33	PASS	314	324	-10	0.56	PASS	47	45	2	0.29	PASS
19WL	741	Core	0	1	-1	1.41	PASS	0	0	0	0.00	PASS	0	1	-1	1.41	PASS	0	0	0	0.00	PASS
19WR	6662	Core	1	1	0	0.00	PASS	0	0	0	0.00	PASS	0	0	0	0.00	PASS	0	0	0	0.00	PASS
20EL	8881	Network	13	14	-1	0.27		0	0	0	0.00		24	23	1	0.21		0	0	0	0.00	
20ER	8883	Network	25	33	-8	1.49		0	1	-1	1.41		21	49	-28	4.73		0	1	-1	1.41	
20ET	8882	Network	1	1	0	0.00		0	0	0	0.00		8	7	1	0.37		0	0	0	0.00	
20NL	8896	Network	0	5	-5	3.16		0	1	-1	1.41		7	13	-6	1.90		0	0	0	0.00	
20NR	8894	Network	103	106	-3	0.29		5	12	-7	2.40		121	137	-16	1.41		9	11	-2	0.63	
20NT	8893	Network	390	403	-13	0.65		41	43	-2	0.31		447	474	-27	1.26		54	53	1	0.14	
20SL	8886	Network	4	6	-2	0.89		0	1	-1	1.41		13	13	0	0.00		0	1	-1	1.41	
20SR	8888	Network	6	6	0	0.00		0	0	0	0.00		21	21	0	0.00		0	0	0	0.00	
20ST	8887	Network	537	546	-9	0.39		43	48	-5	0.74		524	537	-13	0.56		54	51	3	0.41	
20WL	8891	Network	290	300	-10	0.58		12	11	1	0.29		264	274	-10	0.61		6	11	-5	1.71	
20WR	8889	Network	15	16	-1	0.25		0	2	-2	2.00		27	29	-2	0.38		0	4	-4	2.83	
20WT	8892	Network	2	3	-1	0.63		0	0	0	0.00		10	10	0	0.00		0	0	0	0.00	
21EL	1084	Network	0	0	0	0.00		0	0	0	0.00		0	0	0	0.00		0	0	0	0.00	
21ER	1083	Network	0	3	-3	2.45		0	0	0	0.00		1	1	0	0.00		0	0	0	0.00	
21NL	1080	Network	3	2	1	0.63		0	0	0	0.00		0	1	-1	1.41		0	0	0	0.00	
21NT	1079	Network	262	258	4	0.25		40	47	-7	1.06		217	211	6	0.41		50	53	-3	0.42	
21SR	1082	Network	0	0	0	0.00		0	0	0	0.00		0	0	0	0.00		0	0	0	0.00	
21ST	1081	Network	180	178	2	0.15		41	35	6	0.97		318	325	-7	0.39		47	45	2	0.29	

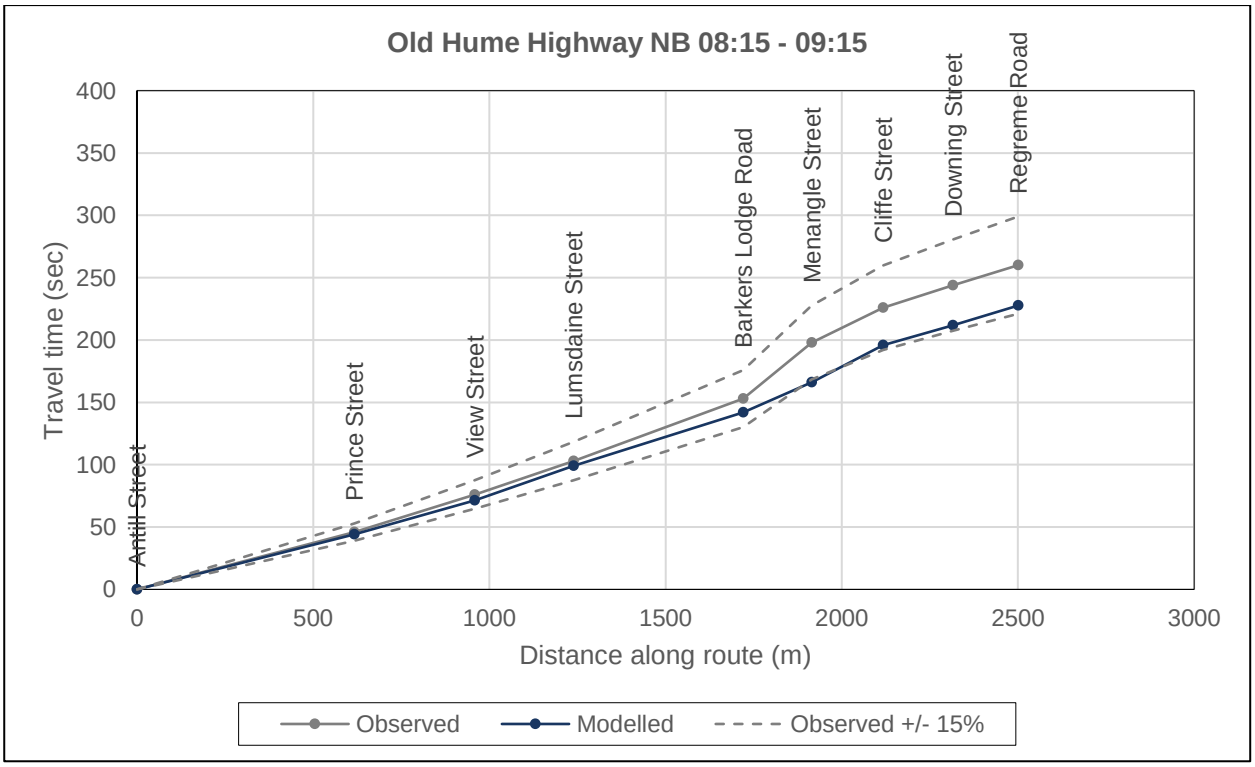
Turn	Aimsun ID	Area	PM Peak																			
			15:15 - 16:15										16:15 - 17:15									
			Light vehicles					Heavy vehicles					Light vehicles					Heavy vehicles				
			Model	Obs	Diff	GEH	Core	Model	Obs	Diff	GEH	Core	Model	Obs	Diff	GEH	Core	Model	Obs	Diff	GEH	Core
1EL	9128	Network	2	1	1	0.82		0	0	0	0.00		1	3	-2	1.41		0	0	0	0.00	
1ER	9130	Network	5	3	2	1.00		0	0	0	0.00		1	1	0	0.00		0	0	0	0.00	
1ET	9129	Network	0	0	0	0.00		0	1	-1	1.41		0	0	0	0.00		0	0	0	0.00	
1NL	9123	Network	0	0	0	0.00		0	0	0	0.00		1	2	-1	0.82		0	0	0	0.00	
1NR	9125	Network	36	39	-3	0.49		1	1	0	0.00		40	39	1	0.16		2	1	1	0.82	
1NT	9124	Network	444	428	16	0.77		38	31	7	1.19		508	491	17	0.76		29	31	-2	0.37	
1SL	9133	Network	119	123	-4	0.36		0	4	-4	2.83		96	108	-12	1.19		3	2	1	0.63	
1SR	9131	Network	0	3	-3	2.45		0	0	0	0.00		0	3	-3	2.45		0	0	0	0.00	
1ST	9134	Network	366	378	-12	0.62		34	24	10	1.86		331	343	-12	0.65		28	22	6	1.20	
1WL	9138	Network	16	16	0	0.00		2	1	1	0.82		23	22	1	0.21		0	0	0	0.00	
1WR	9136	Network	88	73	15	1.67		2	10	-8	3.27		77	70	7	0.82		0	0	0	0.00	
1WT	9135	Network	0	0	0	0.00		0	0	0	0.00		0	0	0	0.00		0	0	0	0.00	
2EL	10844	Core	92	96	-4	0.41	PASS	0	1	-1	1.41	PASS	69	77	-8	0.94	PASS	0	2	-2	2.00	PASS
2ER	10907	Core	142	144	-2	0.17	PASS	4	5	-1	0.47	PASS	130	133	-3	0.26	PASS	10	4	6	2.27	PASS
2ET	10906	Core	44	34	10	1.60	PASS	0	0	0	0.00	PASS	24	24	0	0.00	PASS	0	0	0	0.00	PASS
2NL	3873	Core	101	102	-1	0.10	PASS	6	7	-1	0.39	PASS	100	104	-4	0.40	PASS	2	1	1	0.82	PASS
2NR	3870	Core	19	23	-4	0.87	PASS	1	0	1	1.41	PASS	16	20	-4	0.94	PASS	0	2	-2	2.00	PASS
2NT	3874	Core	430	419	11	0.53	PASS	33	34	-1	0.17	PASS	483	485	-2	0.09	PASS	27	27	0	0.00	PASS
2SL	3871	Core	48	42	6	0.89	PASS	0	0	0	0.00	PASS	35	40	-5	0.82	PASS	0	0	0	0.00	PASS
2SR	3869	Core	35	33	2	0.34	PASS	3	6	-3	1.41	PASS	35	27	8	1.44	PASS	0	0	0	0.00	PASS
2ST	3872	Core	330	334	-4	0.22	PASS	28	22	6	1.20	PASS	277	294	-17	1.01	PASS	20	20	0	0.00	PASS
2WL	8489	Core	17	16	1	0.25	PASS	1	1	0	0.00	PASS	20	26	-6	1.25	PASS	0	0	0	0.00	PASS
2WR	8491	Core	44	48	-4	0.59	PASS	1	0	1	1.41	PASS	70	66	4	0.49	PASS	0	0	0	0.00	PASS
2WT	8490	Core	11	14	-3	0.85	PASS	0	0	0	0.00	PASS	14	22	-8	1.89	PASS	0	0	0	0.00	PASS
3EL	966	Network	134	132	2	0.17		1	1	0	0.00		103	115	-12	1.15		0	0	0	0.00	
3ER	6495	Network	2	5	-3	1.60		1	0	1	1.41		1	10	-9	3.84		0	0	0	0.00	
3NL	6496	Network	23	33	-10	1.89		0	0	0	0.00		40	28	12	2.06		0	0	0	0.00	
3NT	6494	Network	537	530	7	0.30		34	35	-1	0.17		587	600	-13	0.53		27	29	-2	0.38	
3SR	968	Network	80	85	-5	0.55		2	0	2	2.00		67	81	-14	1.63		0	0	0	0.00	
3ST	6493	Network	411	404	7	0.35		30	28	2	0.37		346	351	-5	0.27		21	20	1	0.22	
4NT	8454	Network	669	661	8	0.31		35	36	-1	0.17		692	715	-23	0.87		27	29	-2	0.38	
4ST	8444	Network	490	486	4	0.18		32	28	4	0.73		410	424	-14	0.69		21	20	1	0.22	
4WL	8456	Network	1	3	-2	1.41		0	0	0	0.00		5	8	-3	1.18		0	0	0	0.00	
4WR	8457	Network	4	2	2	1.15		0	0	0	0.00		0	0	0	0.00		0	0	0	0.00	
5EL	612	Core	151	145	6	0.49	PASS	55	56	-1	0.13	PASS	161	153	8	0.64	PASS	30	30	0	0.00	PASS
5ER	9034	Core	0	3	-3	2.45	PASS	0	1	-1	1.41	PASS	0	5	-5	3.16	PASS	0	1	-1	1.41	PASS
5NL	605	Core	57	60	-3	0.39	PASS	2	3	-1	0.63	PASS	54	46	8	1.13	PASS	0	3	-3	2.45	PASS
5NR	607	Core	23	24	-1	0.21	PASS	1	0	1	1.41	PASS	12	14	-2	0.55	PASS	1	0	1	1.41	PASS
5NT	606	Core	589	579	10	0.41	PASS	32	33	-1	0.18	PASS	627	655	-28	1.11	PASS	26	26	0	0.00	PASS
5SL	616	Core	46	48	-2	0.29	PASS	0	0	0	0.00	PASS	27	24	3	0.59	PASS	1	0	1	1.41	PASS
5SR	614	Core	113	117	-4	0.37	PASS	36	39	-3	0.49	PASS	92	101	-9	0.92	PASS	15	19	-4	0.97	PASS
5ST	615	Core	473	467	6	0.28	PASS	31	27	4	0.74	PASS	391	392	-1	0.05	PASS	21	19	2	0.45	PASS
5WL	608	Core	17	16	1	0.25	PASS	1	0	1	1.41	PASS	19	27	-8	1.67	PASS	0	0	0	0.00	PASS
5WR	610	Core	15	10	5	1.41	PASS	0	0	0	0.00	PASS	16	7	9	2.65	PASS	0	0	0	0.00	PASS
5WT	609	Core	8	6	2	0.76	PASS	0	0	0	0.00	PASS	5	6	-1	0.43	PASS	0	1	-1	1.41	PASS
6ER	8468	Network	40	52	-12	1.77		0	0	0	0.00		25	52	-27	4.35		1	0	1	1.41	
6ET	5935	Network	4	4	0	0.00		0	0	0	0.00		1	1	0	0.00		0	0	0	0.00	
6NL	8465	Network	13	12	1	0.28		1	0	1	1.41		15	15	0	0.00		0	1	-1	1.41	
6NR	8466	Network	0	0	0	0.00		0	0	0	0.00		1	1	0	0.00		0	0	0	0.00	
6WL	8467	Network	2	3	-1	0.63		0	0	0	0.00		2	2	0	0.00		0	0	0	0.00	
6WT	5937	Network	4	3	1	0.53		0	0	0	0.00		8	4	4	1.63		0	0	0	0.00	
7EL	8483	Network	40	25	15	2.63		0	0	0	0.00		28	23	5	0.99		0	2	-2	2.00	
7ET	8484	Network	32	18	14	2.80		1	0	1	1.41		27	14	13	2.87		0	0	0	0.00	
7SL	8486	Network	6	6	0	0.00		0	0	0	0.00		3	5	-2	1.00		0	0	0	0.00	
7SR	8485	Network	44	46	-2	0.30		0	0	0	0.00		77	82	-5	0.56		0	0	0	0.00	
7WR	8488	Network	0	0	0	0.00		0	0	0	0.00		0	0	0	0.00		0	0	0	0.00	
7WT	8487	Network	25	26	-1	0.20		2	1	1	0.82		20	25	-5	1.05		0	0	0	0.00	
8ER	670	Network	209	208	1	0.07		7	6	1	0.39		177	187	-10	0.74		4	4	0	0.00	
8ET	669	Network	99	107	-8	0.79		50	48	2	0.29		148	155	-7	0.57		29	31	-2	0.37	
8NL	668	Network	144	137	7	0.59		12	4	8	2.83		155	172	-17	1.33		0	1	-1	1.41	
8NR	667	Network	59	43	16	2.24		2	9	-7	2.98		48	42	6	0.89		2	0	2	2.00	
8WL	665	Network	77	72	5	0.58		2	1	1	0.82		47	42	5	0.75		1	2	-1	0.82	
8WT	666	Network	146	152	-6	0.49		40	41	-1	0.16		117	112	5	0.47		16	21	-5	1.16	
9NR	5969	Network	33	17	16	3.20		0	0	0	0.00		27	12	15	3.40		0	0	0	0.00	
9NT	5970	Network	123	96	27	2.58		13	13	0	0.00		80	104	-24	2.50		0	1	-1	1.41	
9SL	926	Network	105	99	6	0.59		4	1	3	1.90		69	71	-2	0.24		0	0	0	0.00	
9ST	925	Network	182	181	1	0.07		5	6	-1	0.43		154	158	-4	0.32		5	6	-1	0.43	
9WL	923	Network	37	38	-1	0.16		1	0	1	1.41		29	41	-12	2.03		2	0	2	2.00	
9WR	5968	Network	81	84	-3	0.33		1	0	1	1.41		123	110	13	1.20		2	0	2	2.00	
10EL	5964	Network	7	0	7	3.74		0	0	0	0.00		4	6	-2	0.89		0	0	0	0.00	
10ET	5965	Network	4	6	-2	0.89		0	0	0	0.00		5	6	-1	0.43		0	0	0	0.00	
10SL	916	Network	207	203	4	0.28		6	6	0	0.00		154	170	-16	1.26		7	6	1	0.39	
10SR	5963	Network	6	11	-5	1.71		0	0	0	0.00		10	8	2	0.67		0	0	0	0.00	
10WR	5967	Network	104	109	-5	0.48		15	13	2	0.53		82	109	-27	2.76		0	1	-1	1.41	
10WT	5966	Network	11	5	6	2.12		0	0	0	0.00		13	7	6	1.90		0	0	0	0.00	
11EL	947	Network	10	10	0	0.00		3	0	3	2.45		18	14	4	1.00		0	0	0	0.00	
11ET	948	Network	203	217	-14	0.97		3	6	-3	1.41		143	162	-19	1.54		8	6	2	0.76	
11SL	946	Network	43	49	-6	0.88		0	0	0	0.00		57	67	-10	1.27		1	0	1	1.41	
11SR	5961	Network	25	18	7	1.51		4	0	4	2.83		15	9	6	1.73		0	0	0	0.00	
11WR	5960	Network	33	48	-15	2.36		6	0	6	3.46		44	46	-2	0.30		0	0	0	0.00	
11WT	5962	Network	95	93	2	0.21		9	13	-4	1.21		82	109	-27	2.76		1	1	0	0.00	
12EL	8281	Core	2	0	2	2.00	PASS	0	0	0	0.00	PASS	0	0	0	0.00	PASS	0	0	0	0.00	PASS
12ER	8283	Core	0	0	0	0.00	PASS	0	0	0	0.00	PASS	0	0	0	0.00	PASS	0	0	0	0.00	PASS
12ET	8282	Core	0	0	0	0.00	PASS	0	0	0	0.00	PASS	0	0	0	0.00	PASS	0	0	0	0.00	PASS
12NL	8280	Core	0	0	0	0.00	PASS	0	0	0	0.00	PASS	1	0	1	1.41	PASS	0	0	0	0.00	PASS

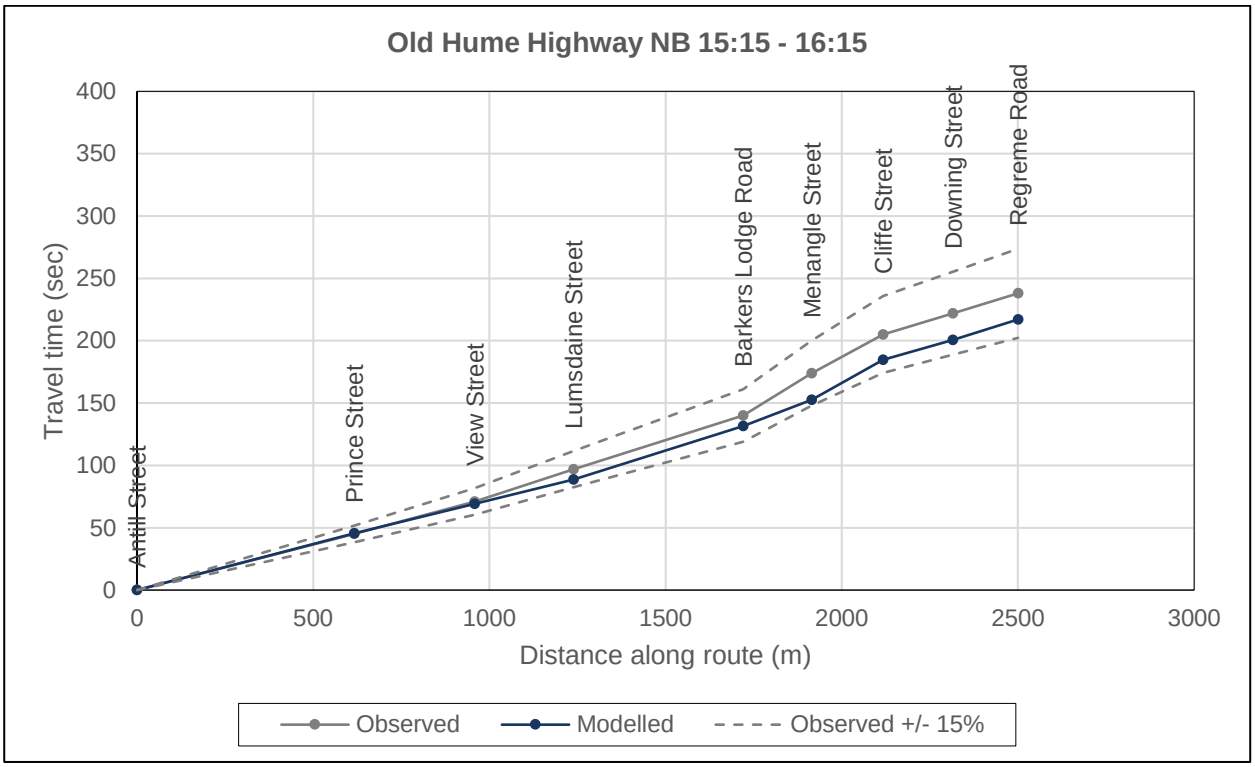
12NR	7349	Core	153	151	2	0.16	PASS	14	10	4	1.15	PASS	170	165	5	0.39	PASS	8	13	-5	1.54	PASS
12NT	556	Core	620	621	-1	0.04	PASS	77	82	-5	0.56	PASS	644	663	-19	0.74	PASS	43	47	-4	0.60	PASS
12SL	7350	Core	40	37	3	0.48	PASS	3	2	1	0.63	PASS	31	29	2	0.37	PASS	0	2	-2	2.00	PASS
12SR	8278	Core	0	0	0	0.00	PASS	0	0	0	0.00	PASS	0	0	0	0.00	PASS	0	0	0	0.00	PASS
12ST	552	Core	521	513	8	0.35	PASS	54	57	-3	0.40	PASS	422	428	-6	0.29	PASS	36	31	5	0.86	PASS
12WL	554	Core	109	108	1	0.10	PASS	11	9	2	0.63	PASS	85	89	-4	0.43	PASS	1	7	-6	3.00	PASS
12WR	553	Core	18	17	1	0.24	PASS	9	2	7	2.98	PASS	24	19	5	1.08	PASS	8	6	2	0.76	PASS
12WT	8279	Core	0	0	0	0.00	PASS	0	0	0	0.00	PASS	0	0	0	0.00	PASS	0	0	0	0.00	PASS
13EL	634	Network	16	28	-12	2.56		0	0	0	0.00		7	1	6	3.00		0	0	0	0.00	
13ER	635	Network	24	33	-9	1.69		1	2	-1	0.82		4	5	-1	0.47		0	0	0	0.00	
13NL	633	Network	10	20	-10	2.58		0	0	0	0.00		15	16	-1	0.25		0	1	-1	1.41	
13NT	632	Network	604	596	8	0.33		80	84	-4	0.44		649	655	-6	0.23		47	52	-5	0.71	
13SR	631	Network	5	3	2	1.00		0	0	0	0.00		4	3	1	0.53		0	0	0	0.00	
13ST	630	Network	524	508	16	0.70		54	57	-3	0.40		441	432	9	0.43		29	33	-4	0.72	
14EL	645	Network	24	31	-7	1.33		0	0	0	0.00		6	6	0	0.00		0	0	0	0.00	
14ER	644	Network	8	6	2	0.76		0	0	0	0.00		0	0	0	0.00		0	0	0	0.00	
14NL	643	Network	5	17	-12	3.62		0	1	-1	1.41		1	0	1	1.41		0	0	0	0.00	
14NT	642	Network	631	621	10	0.40		81	83	-2	0.22		651	654	-3	0.12		47	52	-5	0.71	
14SR	641	Network	6	14	-8	2.53		0	1	-1	1.41		4	3	1	0.53		0	0	0	0.00	
14ST	640	Network	520	505	15	0.66		54	57	-3	0.40		444	438	6	0.29		28	33	-5	0.91	
15ER	846	Network	6	5	1	0.43		0	0	0	0.00		5	8	-3	1.18		0	0	0	0.00	
15ET	845	Network	325	343	-18	0.98		0	0	0	0.00		345	377	-32	1.68		1	1	0	0.00	
15NL	849	Network	29	28	1	0.19		0	0	0	0.00		2	1	1	0.82		0	0	0	0.00	
15NR	850	Network	12	16	-4	1.07		0	1	-1	1.41		6	6	0	0.00		0	1	-1	1.41	
15WL	848	Network	9	6	3	1.10		0	0	0	0.00		8	4	4	1.63		0	0	0	0.00	
15WT	847	Network	262	266	-4	0.25		2	2	0	0.00		232	248	-16	1.03		1	0	1	1.41	
16EL	651	Core	331	359	-28	1.51	PASS	0	1	-1	1.41	PASS	351	381	-30	1.57	PASS	1	2	-1	0.82	PASS
16ER	652	Core	6	0	6	3.46	PASS	0	0	0	0.00	PASS	2	2	0	0.00	PASS	0	0	0	0.00	PASS
16NL	649	Core	21	15	6	1.41	PASS	0	0	0	0.00	PASS	14	4	10	3.33	PASS	0	0	0	0.00	PASS
16NT	650	Core	630	637	-7	0.28	PASS	82	83	-1	0.11	PASS	648	656	-8	0.31	PASS	48	52	-4	0.57	PASS
16SR	653	Core	250	257	-7	0.44	PASS	2	2	0	0.00	PASS	226	248	-22	1.43	PASS	1	0	1	1.41	PASS
16ST	654	Core	519	519	0	0.00	PASS	54	58	-4	0.53	PASS	448	439	9	0.43	PASS	28	33	-5	0.91	PASS
17NR	6668	Core	57	58	-1	0.13	PASS	0	0	0	0.00	PASS	59	60	-1	0.13	PASS	0	0	0	0.00	PASS
17NT	6667	Core	218	224	-6	0.40	PASS	52	43	9	1.31	PASS	219	215	4	0.27	PASS	18	20	-2	0.46	PASS
17SL	6669	Core	302	296	6	0.35	PASS	0	1	-1	1.41	PASS	352	343	9	0.48	PASS	1	1	0	0.00	PASS
17ST	6670	Core	253	239	14	0.89	PASS	54	52	2	0.27	PASS	267	271	-4	0.24	PASS	31	34	-3	0.53	PASS
17WL	708	Core	63	72	-9	1.10	PASS	0	0	0	0.00	PASS	58	68	-10	1.26	PASS	0	0	0	0.00	PASS
17WR	6666	Core	232	220	12	0.80	PASS	4	1	3	1.90	PASS	190	192	-2	0.14	PASS	1	1	0	0.00	PASS
18NR	6663	Core	10	8	2	0.67	PASS	0	1	-1	1.41	PASS	4	9	-5	1.96	PASS	0	2	-2	2.00	PASS
18NT	6664	Core	267	279	-12	0.73	PASS	52	43	9	1.31	PASS	276	274	2	0.12	PASS	18	20	-2	0.46	PASS
18SL	697	Core	7	5	2	0.82	PASS	0	0	0	0.00	PASS	7	3	4	1.79	PASS	0	0	0	0.00	PASS
18ST	696	Core	309	306	3	0.17	PASS	54	52	2	0.27	PASS	318	336	-18	1.00	PASS	31	34	-3	0.53	PASS
18WL	698	Core	15	8	7	2.06	PASS	1	2	-1	0.82	PASS	9	6	3	1.10	PASS	0	1	-1	1.41	PASS
18WR	6665	Core	9	2	7	2.98	PASS	0	0	0	0.00	PASS	2	2	0	0.00	PASS	0	0	0	0.00	PASS
19NR	738	Core	0	2	-2	2.00	PASS	0	0	0	0.00	PASS	0	1	-1	1.41	PASS	0	0	0	0.00	PASS
19NT	6661	Core	275	286	-11	0.66	PASS	52	44	8	1.15	PASS	279	282	-3	0.18	PASS	18	22	-4	0.89	PASS
19SL	740	Core	1	0	1	1.41	PASS	0	0	0	0.00	PASS	1	1	0	0.00	PASS	0	0	0	0.00	PASS
19ST	739	Core	325	314	11	0.62	PASS	55	54	1	0.14	PASS	326	341	-15	0.82	PASS	31	35	-4	0.70	PASS
19WL	741	Core	0	1	-1	1.41	PASS	0	0	0	0.00	PASS	0	1	-1	1.41	PASS	0	0	0	0.00	PASS
19WR	6662	Core	2	1	1	0.82	PASS	0	0	0	0.00	PASS	0	1	-1	1.41	PASS	0	0	0	0.00	PASS
20EL	8881	Network	21	20	1	0.22		0	0	0	0.00		9	10	-1	0.32		0	0	0	0.00	
20ER	8883	Network	40	40	0	0.00		0	1	-1	1.41		23	28	-5	0.99		0	0	0	0.00	
20ET	8882	Network	9	9	0	0.00		0	0	0	0.00		3	3	0	0.00		0	0	0	0.00	
20NL	8896	Network	17	33	-16	3.20		0	1	-1	1.41		6	21	-15	4.08		0	0	0	0.00	
20NR	8894	Network	224	265	-41	2.62		7	16	-9	2.65		246	292	-46	2.80		5	11	-6	2.12	
20NT	8893	Network	653	659	-6	0.23		72	67	5	0.60		664	705	-41	1.57		42	43	-1	0.15	
20SL	8886	Network	29	29	0	0.00		0	0	0	0.00		26	26	0	0.00		0	0	0	0.00	
20SR	8888	Network	16	19	-3	0.72		0	0	0	0.00		19	18	1	0.23		0	0	0	0.00	
20ST	8887	Network	527	562	-35	1.50		41	41	0	0.00		464	514	-50	2.26		20	30	-10	2.00	
20WL	8891	Network	160	159	1	0.08		10	18	-8	2.14		142	149	-7	0.58		4	3	1	0.53	
20WR	8889	Network	23	21	2	0.43		0	2	-2	2.00		11	11	0	0.00		0	2	-2	2.00	
20WT	8892	Network	5	5	0	0.00		0	0	0	0.00		6	6	0	0.00		0	0	0	0.00	
21EL	1084	Network	0	0	0	0.00		0	0	0	0.00		0	0	0	0.00		0	0	0	0.00	
21ER	1083	Network	6	2	4	2.00		0	0	0	0.00		7	2	5	2.36		0	0	0	0.00	
21NL	1080	Network	1	0	1	1.41		0	1	-1	1.41		2	1	1	0.82		0	0	0	0.00	
21NT	1079	Network	291	288	3	0.18		52	44	8	1.15		268	283	-15	0.90		17	22	-5	1.13	
21SR	1082	Network	13	2	11	4.02		1	0	1	1.41		6	2	4	2.00		0	0	0	0.00	
21ST	1081	Network	300	313	-13	0.74		56	54	2	0.27		320	340	-20	1.10		31	35	-4	0.70	

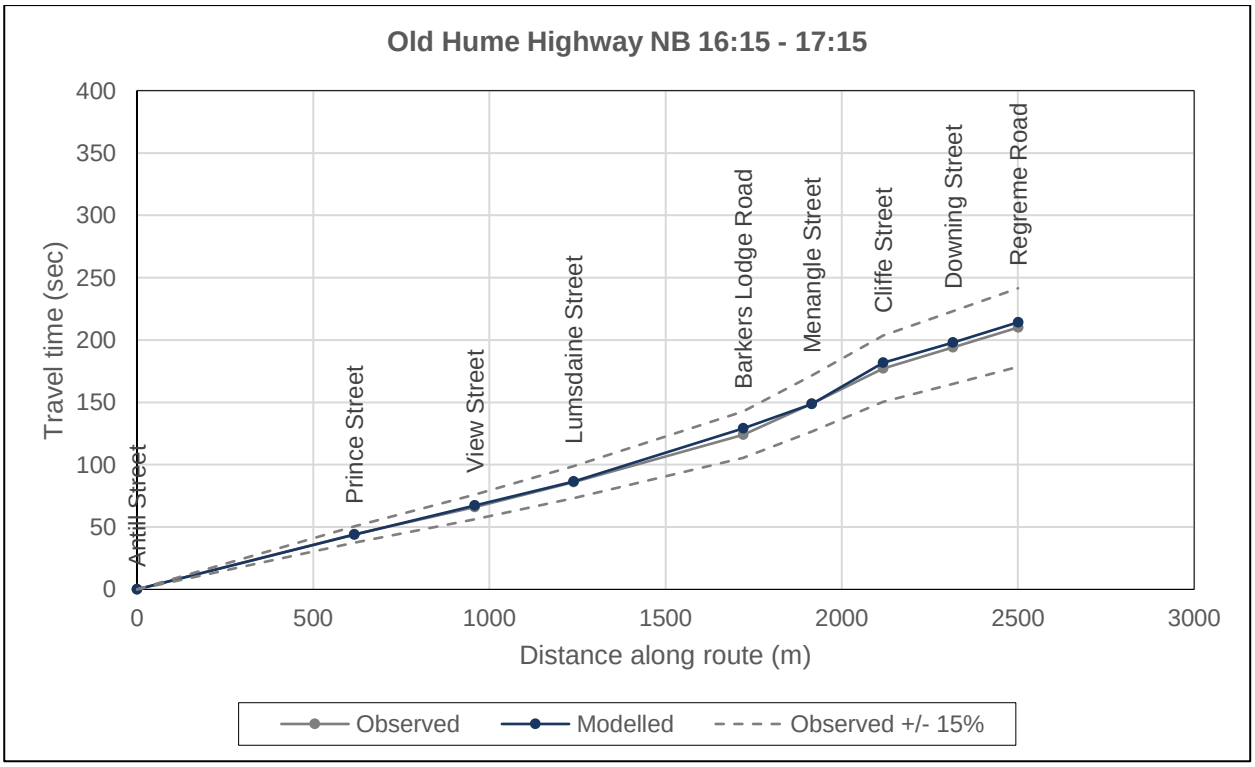
APPENDIX B

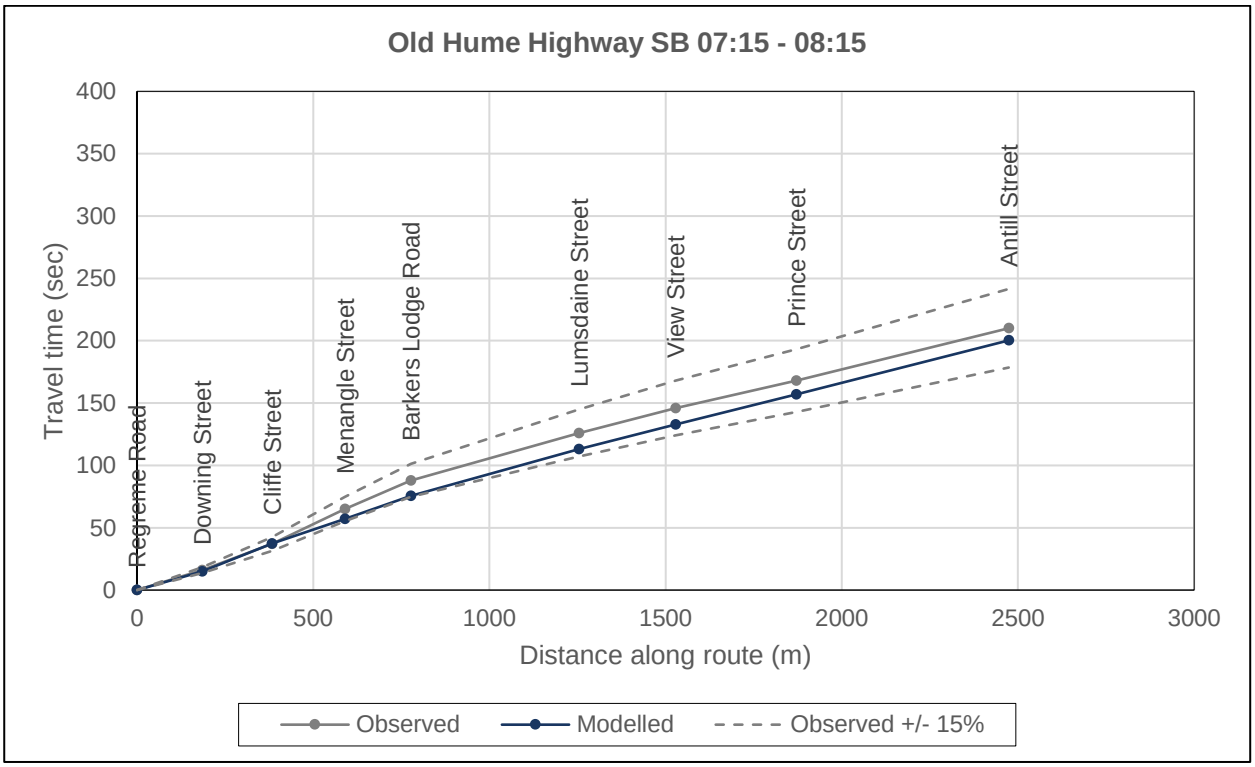
Travel time validation

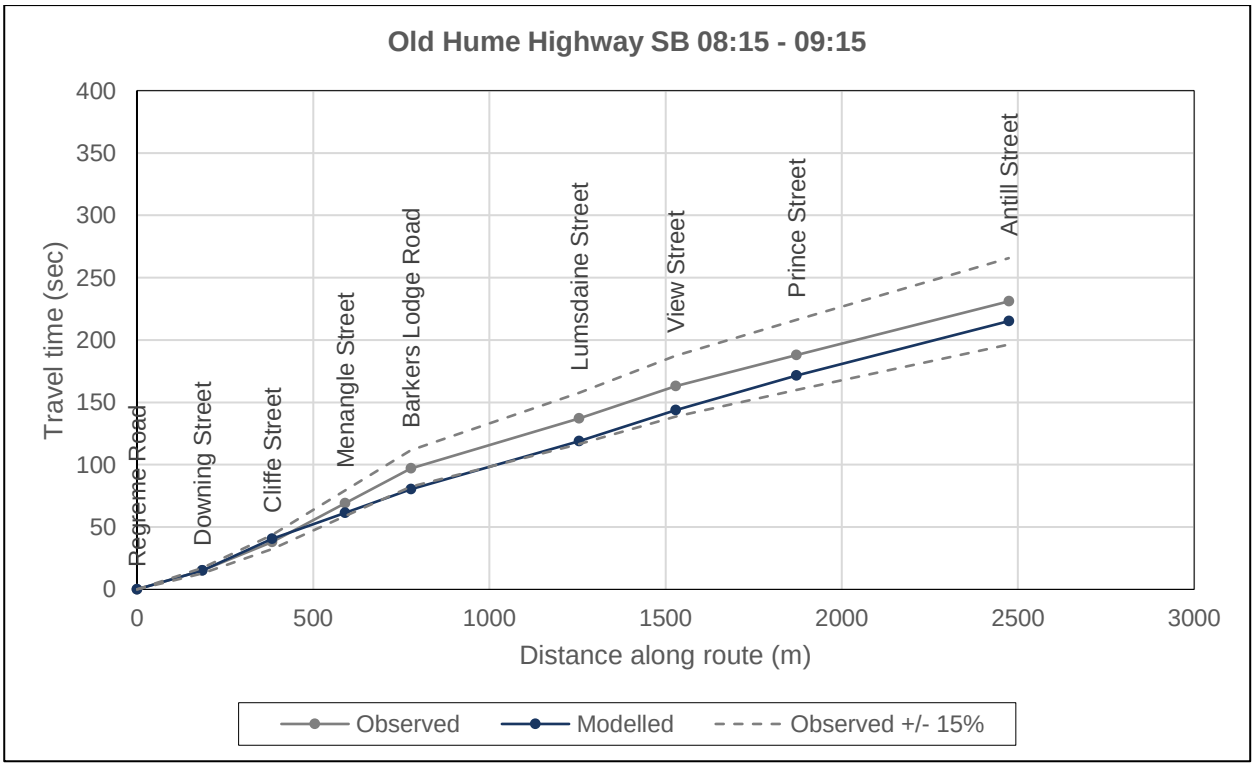

Old Hume Highway NB 07:15 - 08:15
Travel time (sec)
400
350
300
250
200
150
100
50
0
0
500
1000
1500
2000
2500
3000
Distance along route (m)
Antill Street
Prince Street
View Street
Lumsdaine Street
Barkers Lodge Road
Menangle Street
Cliffe Street
Downing Street
Regreme Road
Observed
Modelled
Observed +/- 15%

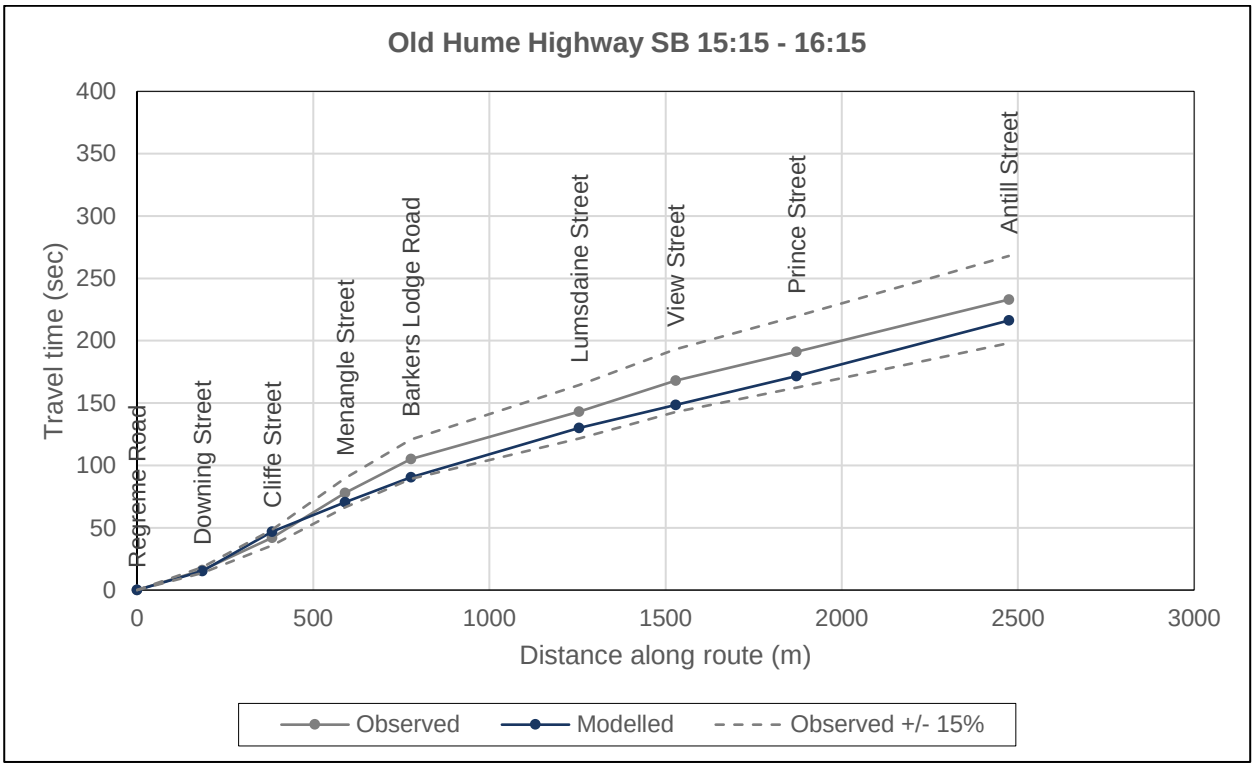

Old Hume Highway NB 08:15 - 09:15
Travel time (sec)
400
350
300
250
200
150
100
50
0
0
500
1000
1500
2000
2500
3000
Distance along route (m)
Antill Street
Prince Street
View Street
Lumsdaine Street
Barkers Lodge Road
Menangle Street
Cliffe Street
Downing Street
Regreme Road
Observed
Modelled
Observed +/- 15%

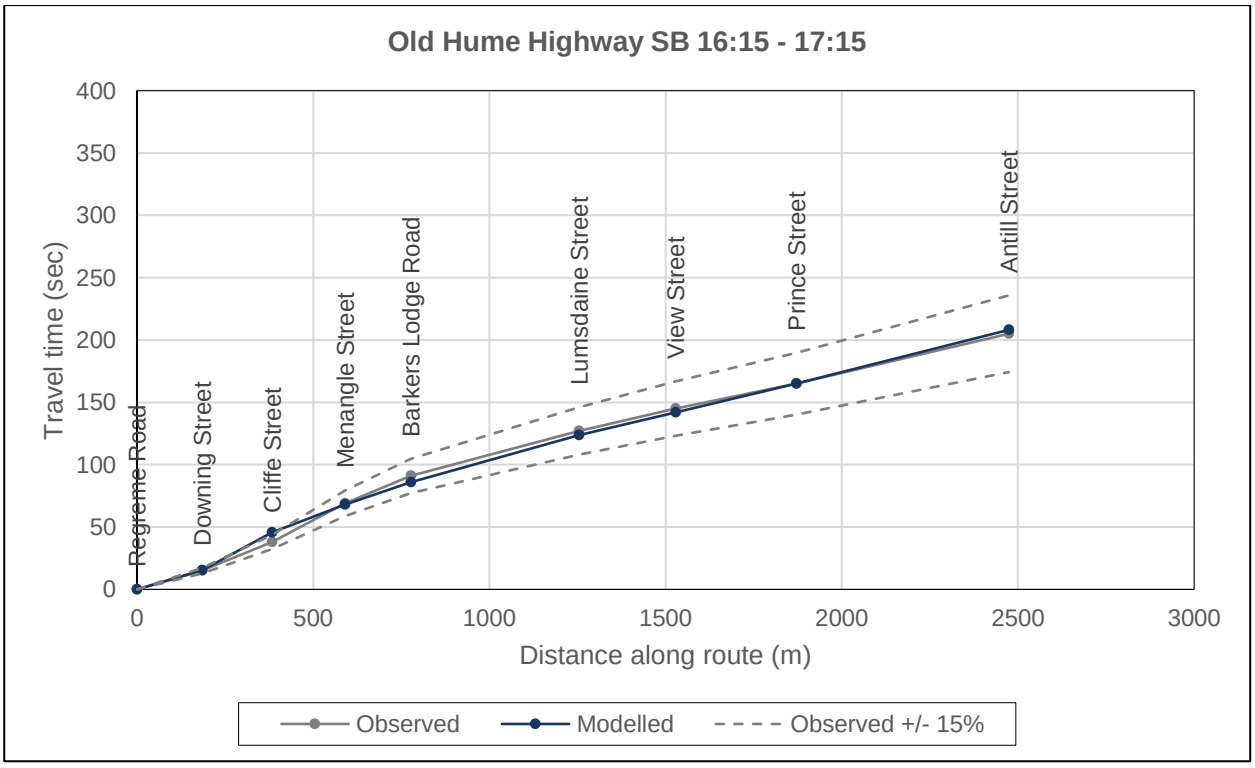

Old Hume Highway NB 15:15 - 16:15
Travel time (sec)
400
350
300
250
200
150
100
50
0
0
500
1000
1500
2000
2500
3000
Distance along route (m)
Antill Street
Prince Street
View Street
Lumsdaine Street
Barkers Lodge Road
Menangle Street
Cliffe Street
Downing Street
Regreme Road
Observed
Modelled
Observed +/- 15%

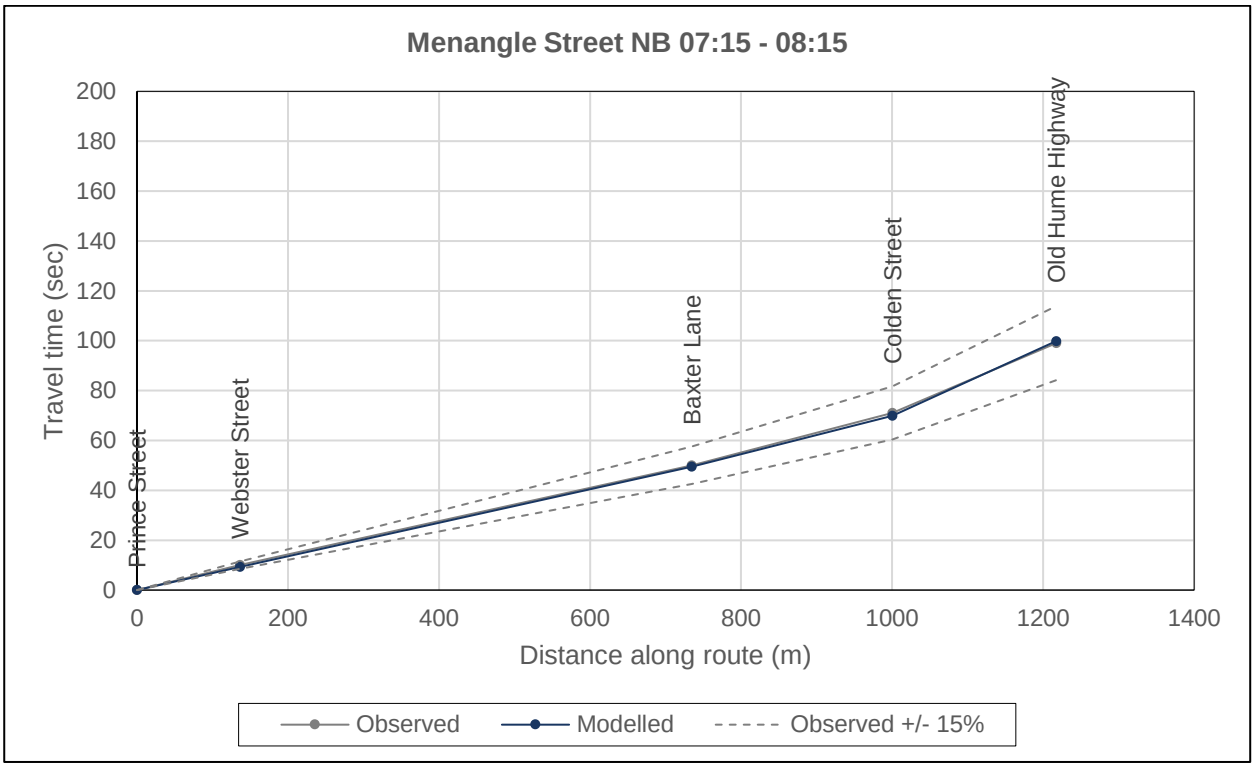

Old Hume Highway NB 16:15 - 17:15
Travel time (sec)
400
350
300
250
200
150
100
50
0
0
500
1000
1500
2000
2500
3000
Distance along route (m)
Antill Street
Prince Street
View Street
Lumsdaine Street
Barkers Lodge Road
Menangle Street
Cliffe Street
Downing Street
Regreme Road
Observed
Modelled
Observed +/- 15%

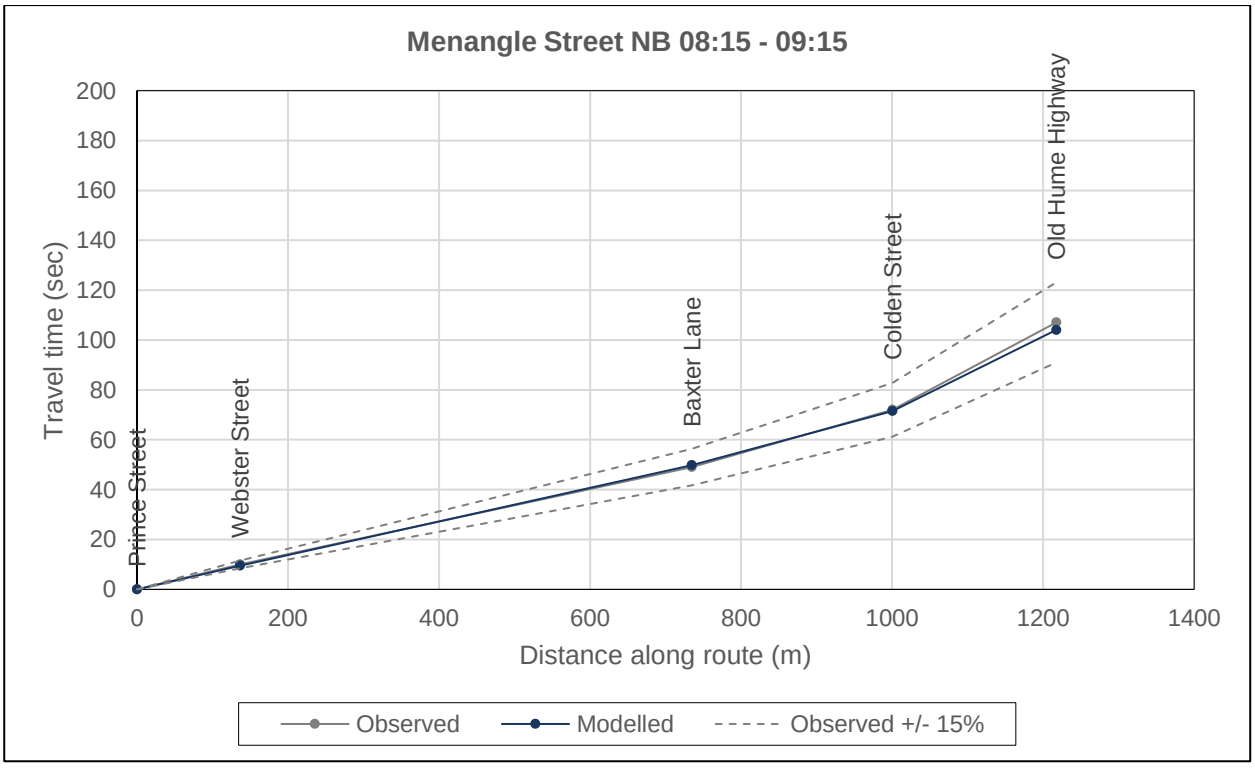

Old Hume Highway SB 07:15 - 08:15
Travel time (sec)
400
350
300
250
200
150
100
50
0
0
500
1000
1500
2000
2500
3000
Distance along route (m)
Regreme Road
Downing Street
Cliffe Street
Menangle Street
Barkers Lodge Road
Lumsdaine Street
View Street
Prince Street
Antill Street
Observed
Modelled
Observed +/- 15%

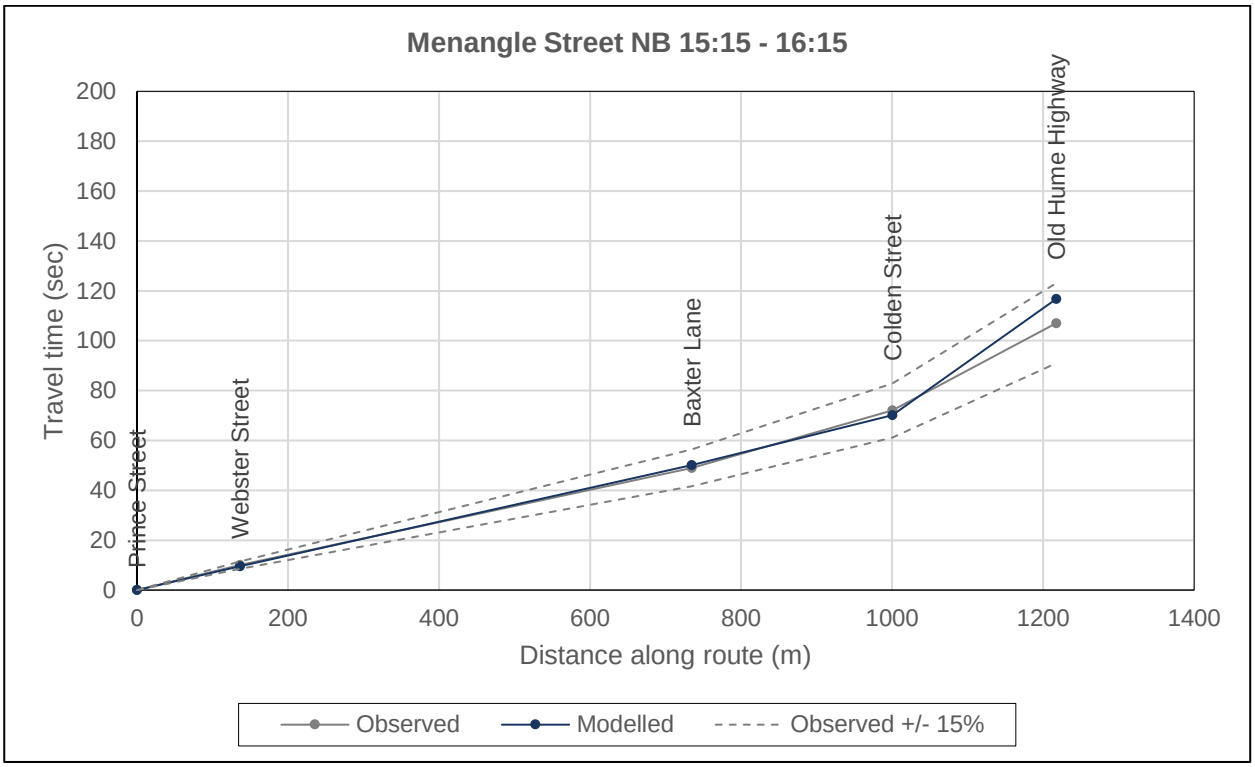

Old Hume Highway SB 08:15 - 09:15
Travel time (sec)
400
350
300
250
200
150
100
50
0
0
500
1000
1500
2000
2500
3000
Distance along route (m)
Regreme Road
Downing Street
Cliffe Street
Menangle Street
Barkers Lodge Road
Lumsdaine Street
View Street
Prince Street
Antill Street
Observed
Modelled
Observed +/- 15%

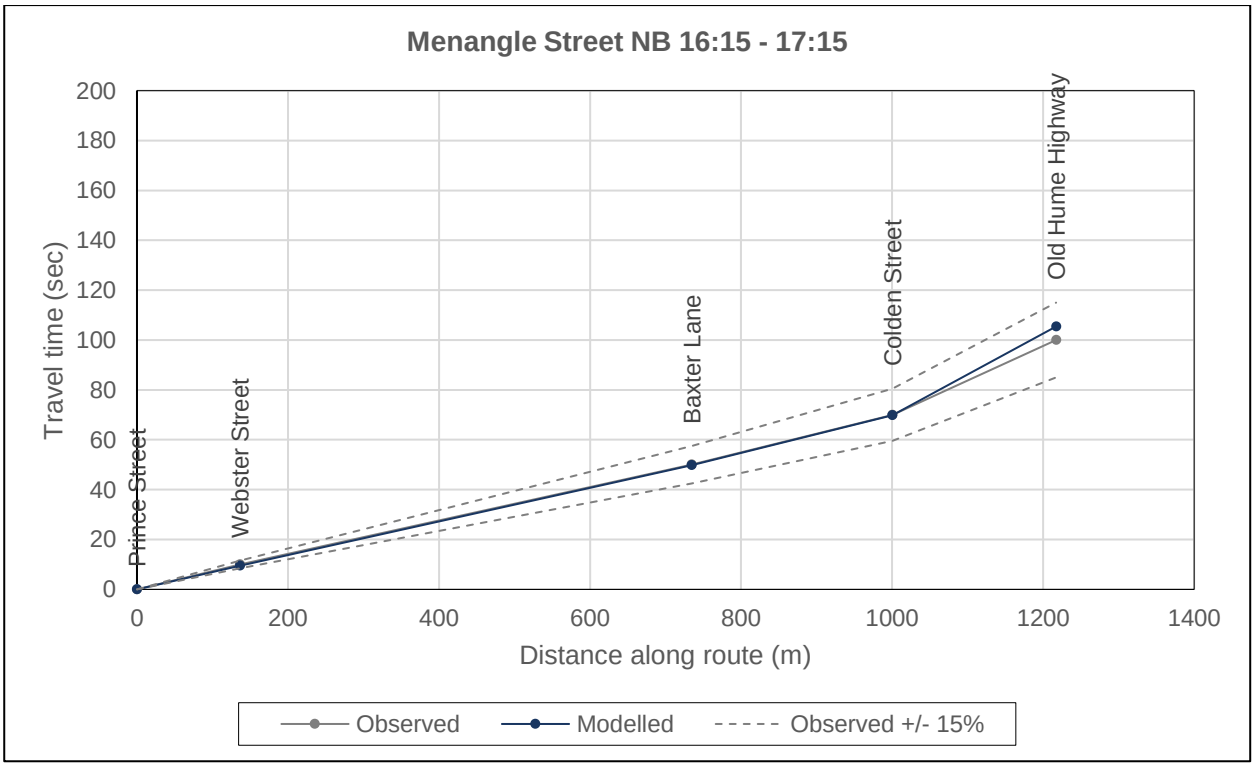

Old Hume Highway SB 15:15 - 16:15
Travel time (sec)
400
350
300
250
200
150
100
50
0
0
500
1000
1500
2000
2500
3000
Distance along route (m)
Regreme Road
Downing Street
Cliffe Street
Menangle Street
Barkers Lodge Road
Lumsdaine Street
View Street
Prince Street
Antill Street
Observed
Modelled
Observed +/- 15%

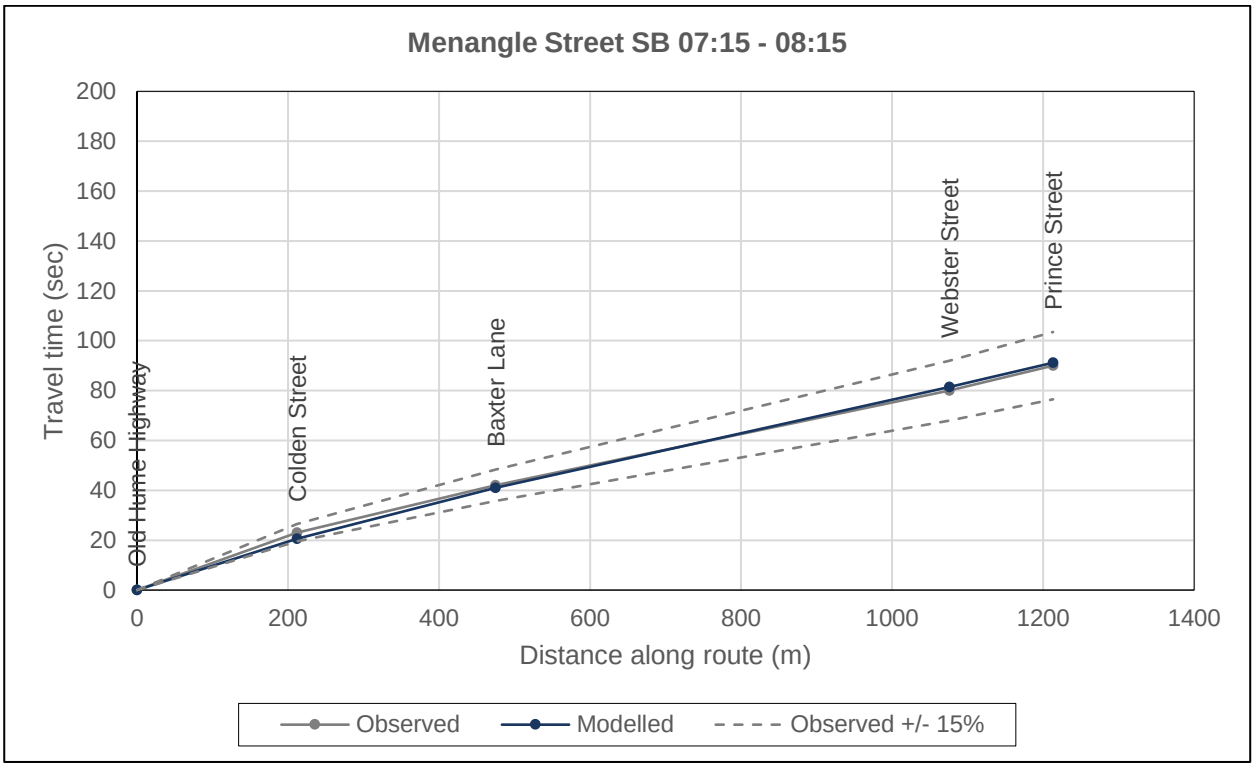

Old Hume Highway SB 16:15 - 17:15
Travel time (sec)
400
350
300
250
200
150
100
50
0
0
500
1000
1500
2000
2500
3000
Distance along route (m)
Regreme Road
Downing Street
Cliffe Street
Menangle Street
Barkers Lodge Road
Lumsdaine Street
View Street
Prince Street
Antill Street
Observed
Modelled
Observed +/- 15%


Menangle Street NB 07:15 - 08:15
Travel time (sec)
Distance along route (m)
Prince Street
Webster Street
Baxter Lane
Colden Street
Old Hume Highway
Observed
Modelled
Observed +/- 15%


Menangle Street NB 08:15 - 09:15
Travel time (sec)
Distance along route (m)
Prince Street
Webster Street
Baxter Lane
Colden Street
Old Hume Highway
Observed
Modelled
Observed +/- 15%


Menangle Street NB 15:15 - 16:15
Travel time (sec)
Distance along route (m)
Prince Street
Webster Street
Baxter Lane
Colden Street
Old Hume Highway
Observed
Modelled
Observed +/- 15%


Menangle Street NB 16:15 - 17:15
Travel time (sec)
Distance along route (m)
Prince Street
Webster Street
Baxter Lane
Colden Street
Old Hume Highway
Observed
Modelled
Observed +/- 15%


Menangle Street SB 07:15 - 08:15
Travel time (sec)
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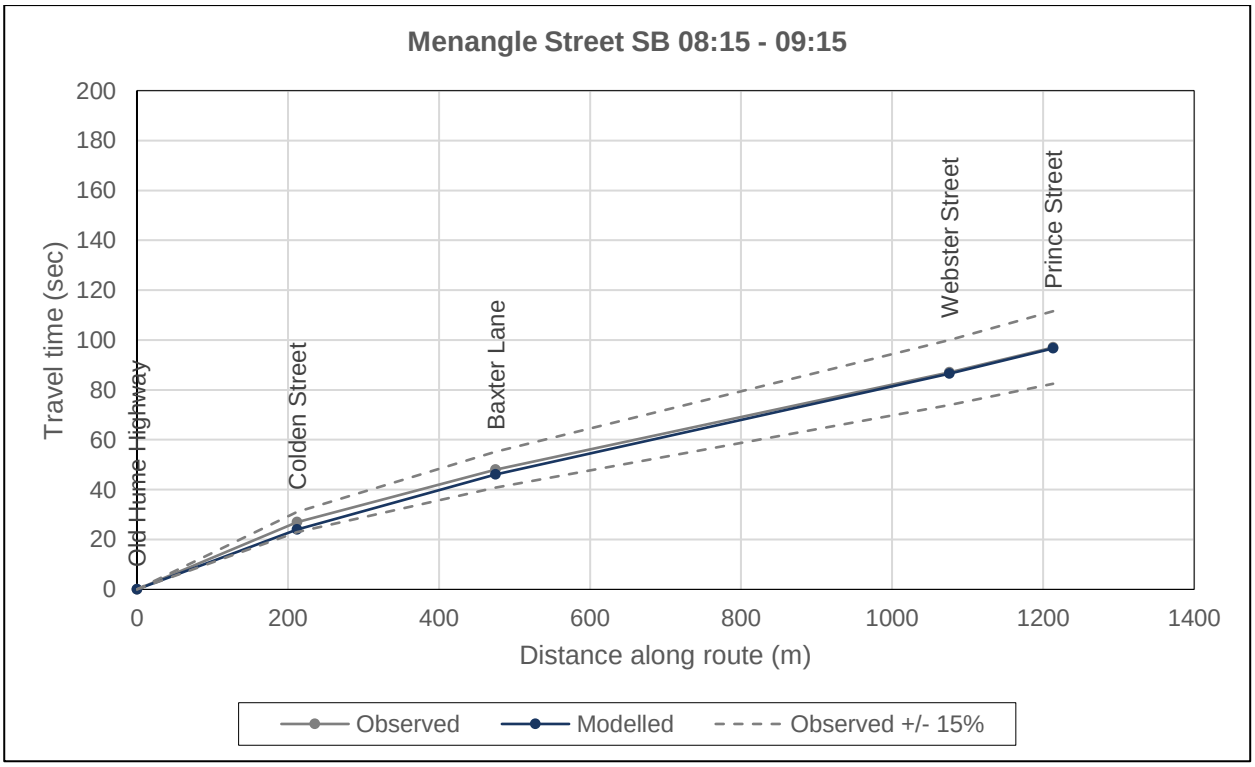
Distance along route (m)
Old Hume Highway
Colden Street
Baxter Lane
Webster Street
Prince Street
Observed
Modelled
Observed +/- 15%


Menangle Street SB 08:15 - 09:15
Travel time (sec)
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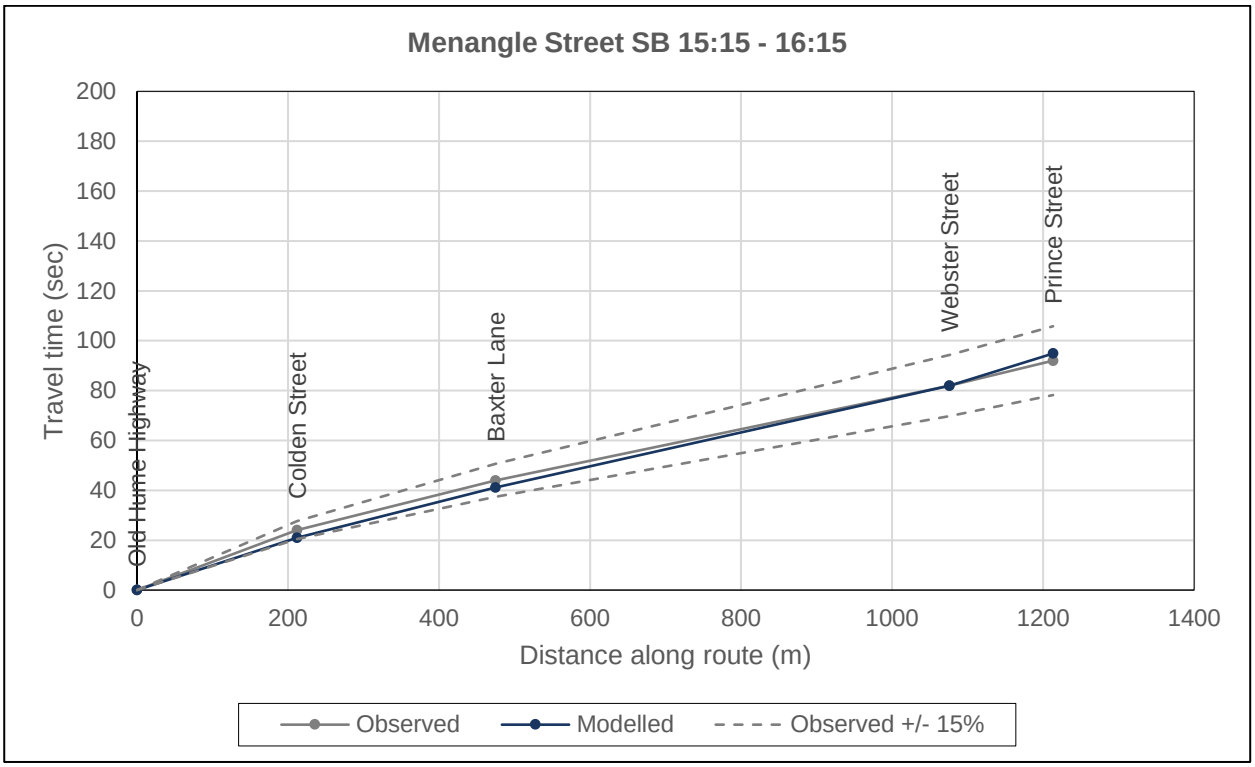
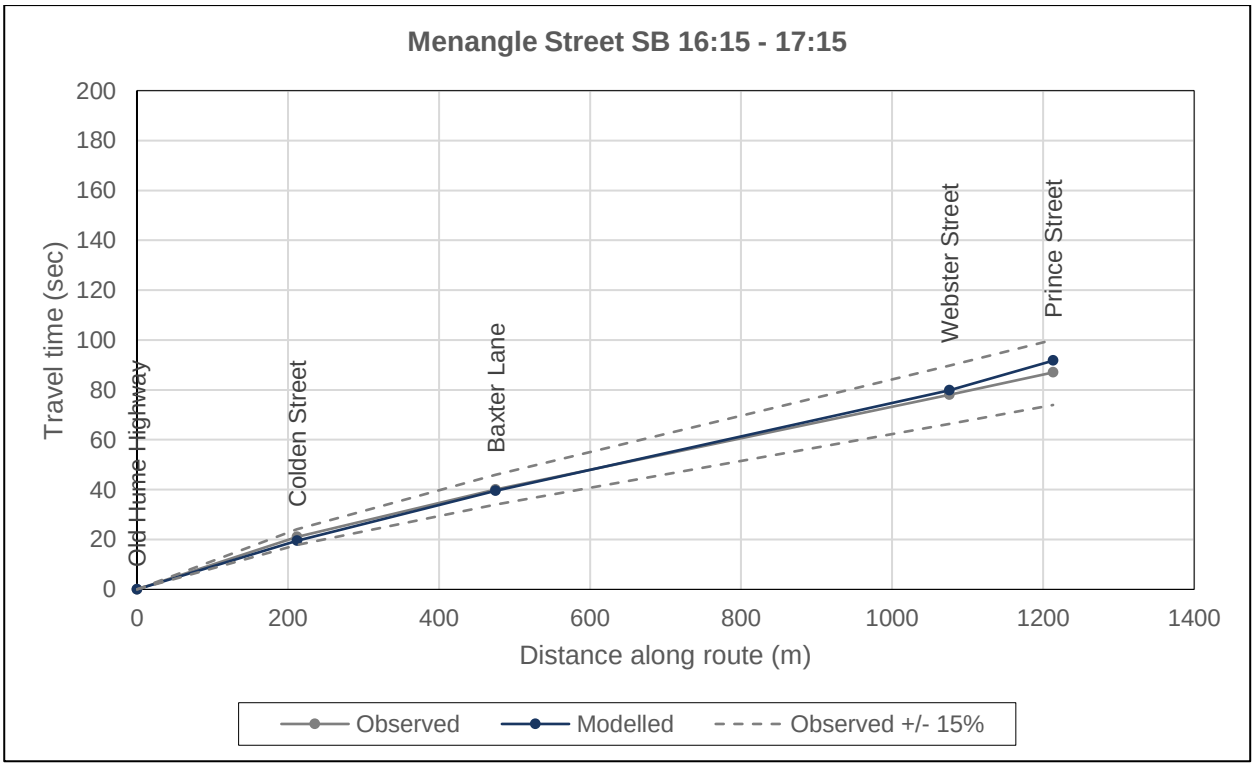
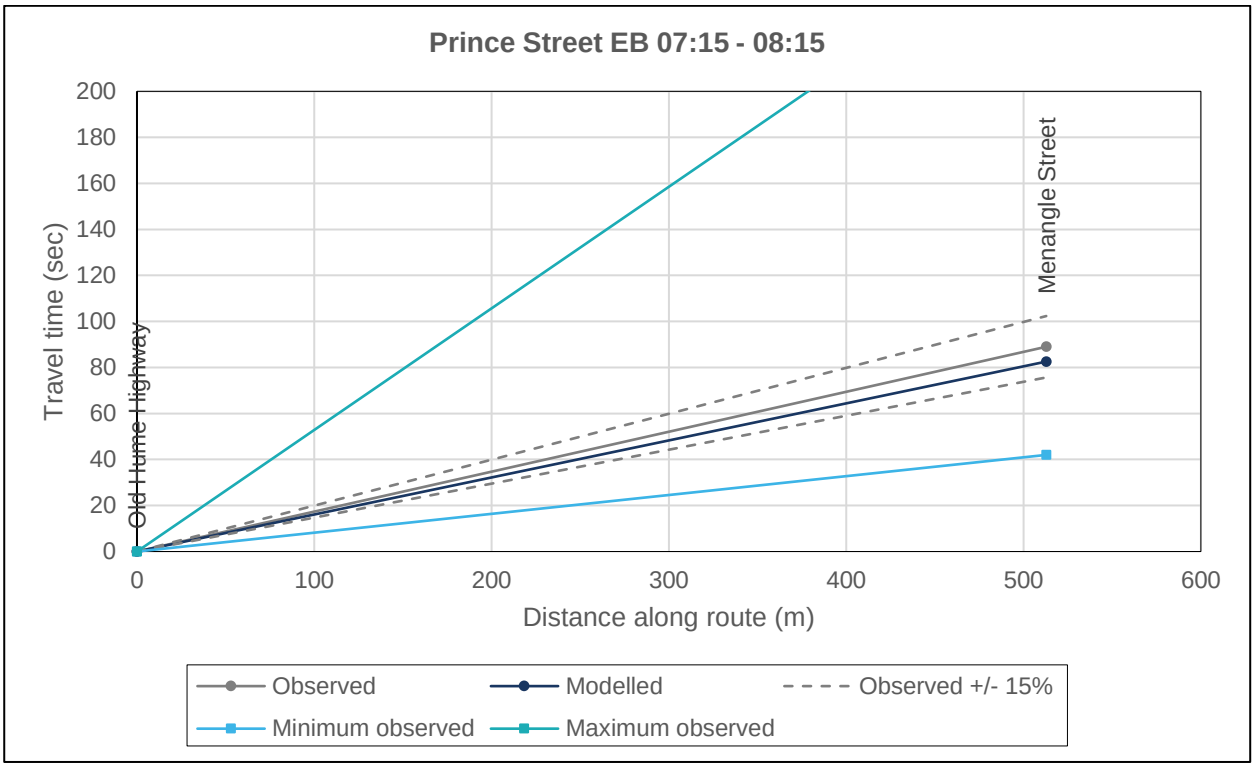
Distance along route (m)
Old Hume Highway
Colden Street
Baxter Lane
Webster Street
Prince Street
Observed
Modelled
Observed +/- 15%


Menangle Street SB 15:15 - 16:15
Travel time (sec)
Distance along route (m)
Old Hume Highway
Colden Street
Baxter Lane
Webster Street
Prince Street
Observed
Modelled
Observed +/- 15%


Menangle Street SB 16:15 - 17:15
Travel time (sec)
Distance along route (m)
Old Hume Highway
Colden Street
Baxter Lane
Webster Street
Prince Street
Observed
Modelled
Observed +/- 15%


Prince Street EB 07:15 - 08:15
Travel time (sec)
Distance along route (m)
Old Hume Highway
Menangle Street
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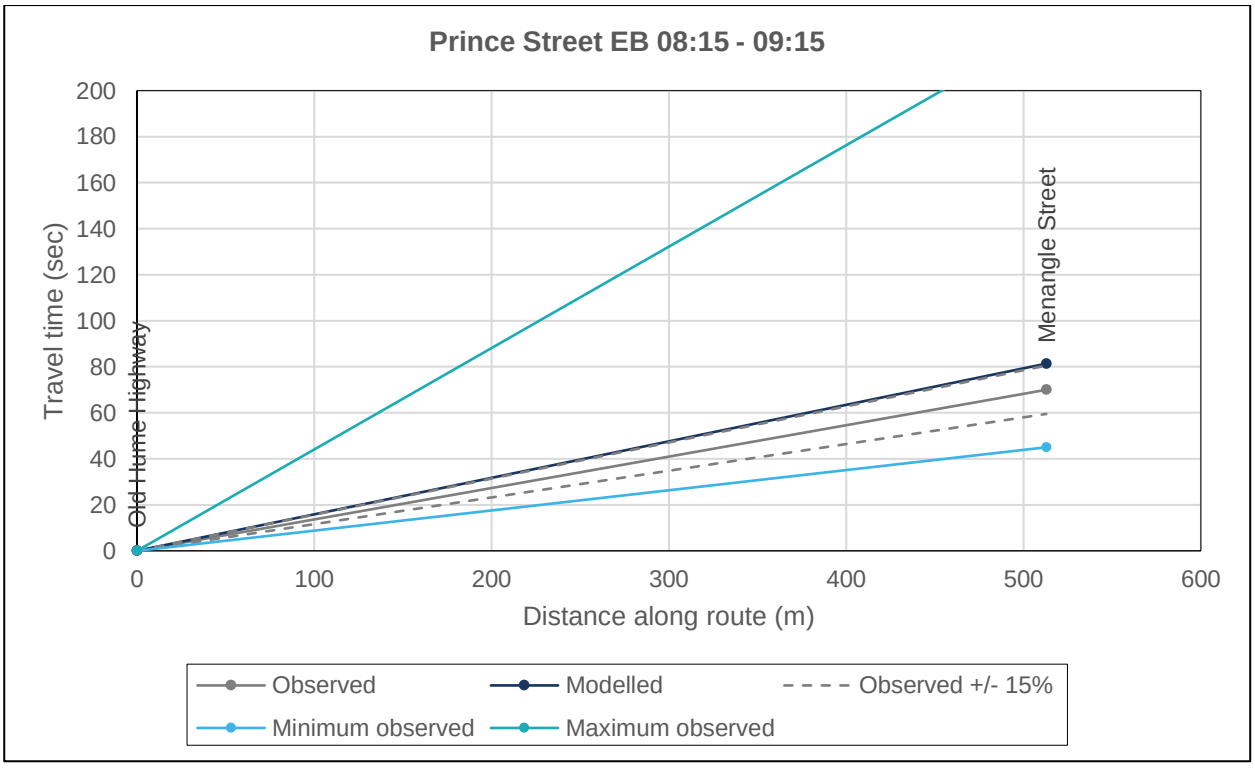
Observed
Modelled
Observed +/- 15%
Minimum observed
Maximum observed


Prince Street EB 08:15 - 09:15
Travel time (sec)
Distance along route (m)
Old Hume Highway
Menangle Street
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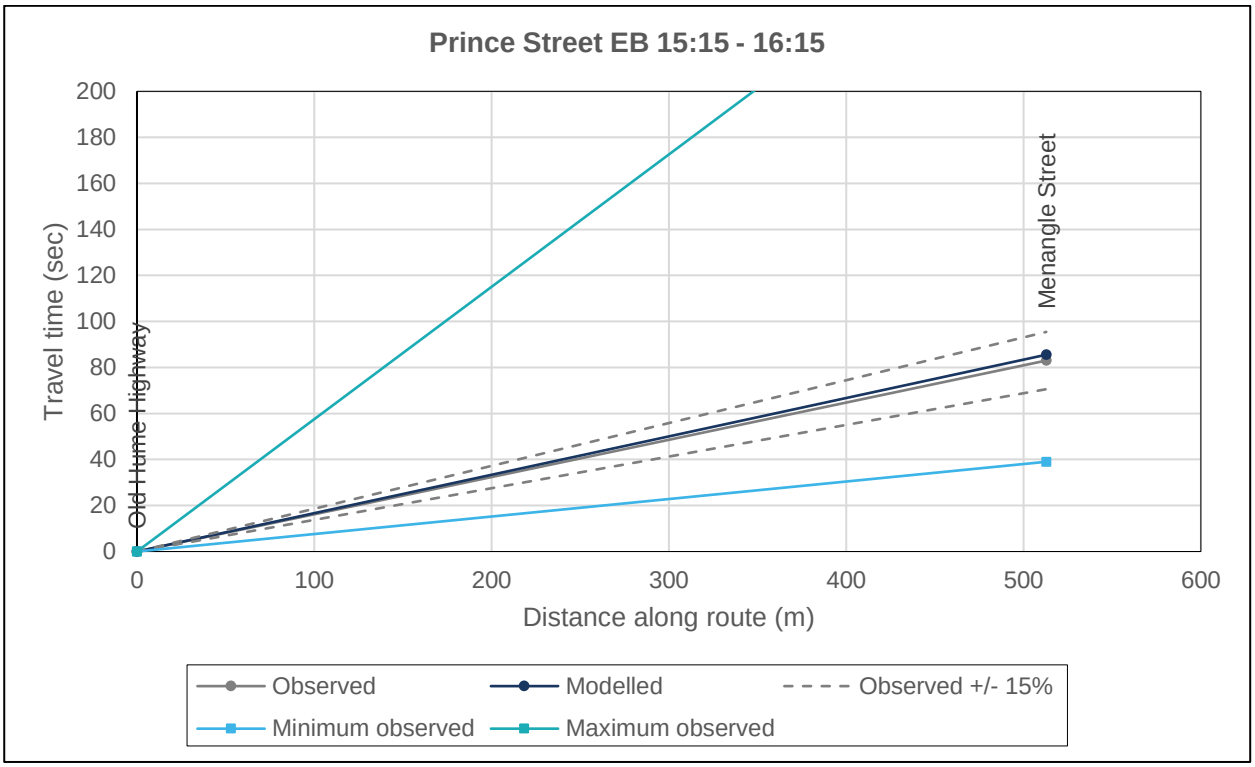
Observed
Modelled
Observed +/- 15%
Minimum observed
Maximum observed


Prince Street EB 15:15 - 16:15
Travel time (sec)
Distance along route (m)
Old Hume Highway
Menangle Street
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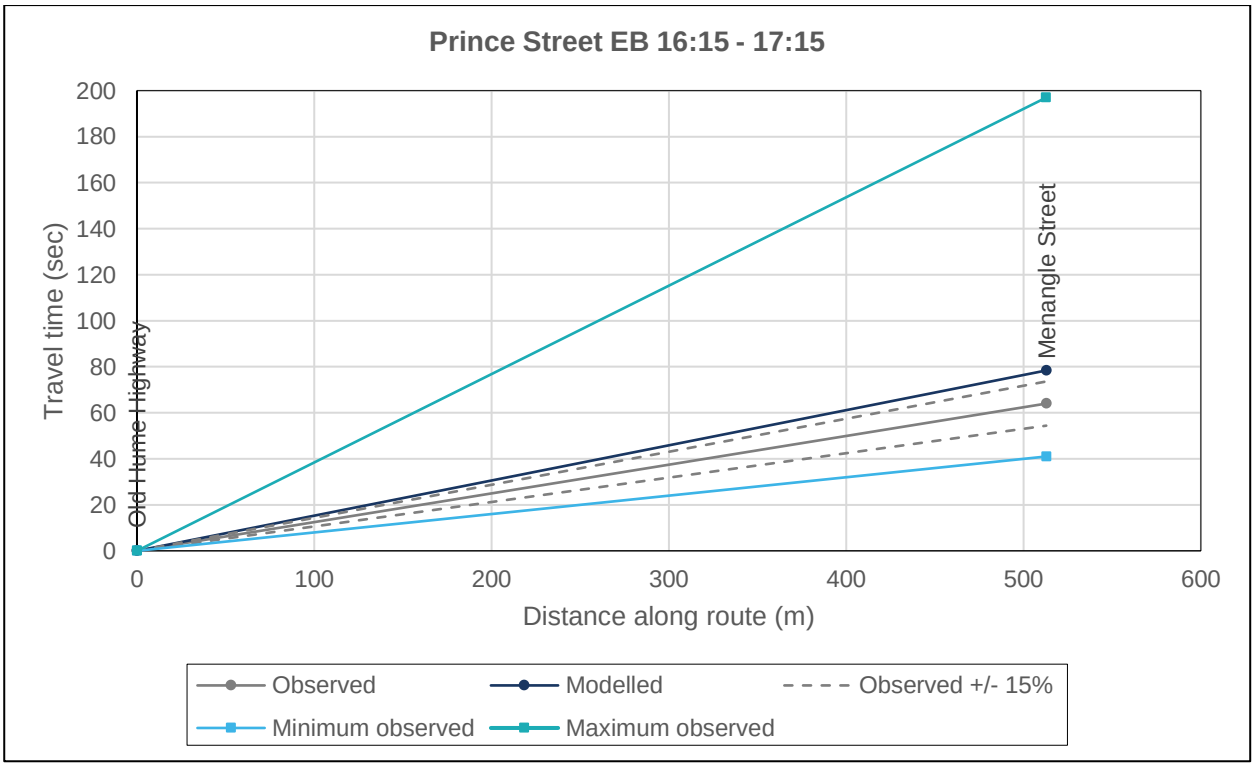
Observed
Modelled
Observed +/- 15%
Minimum observed
Maximum observed


Prince Street EB 16:15 - 17:15
Travel time (sec)
Distance along route (m)
Old Hume Highway
Menangle Street
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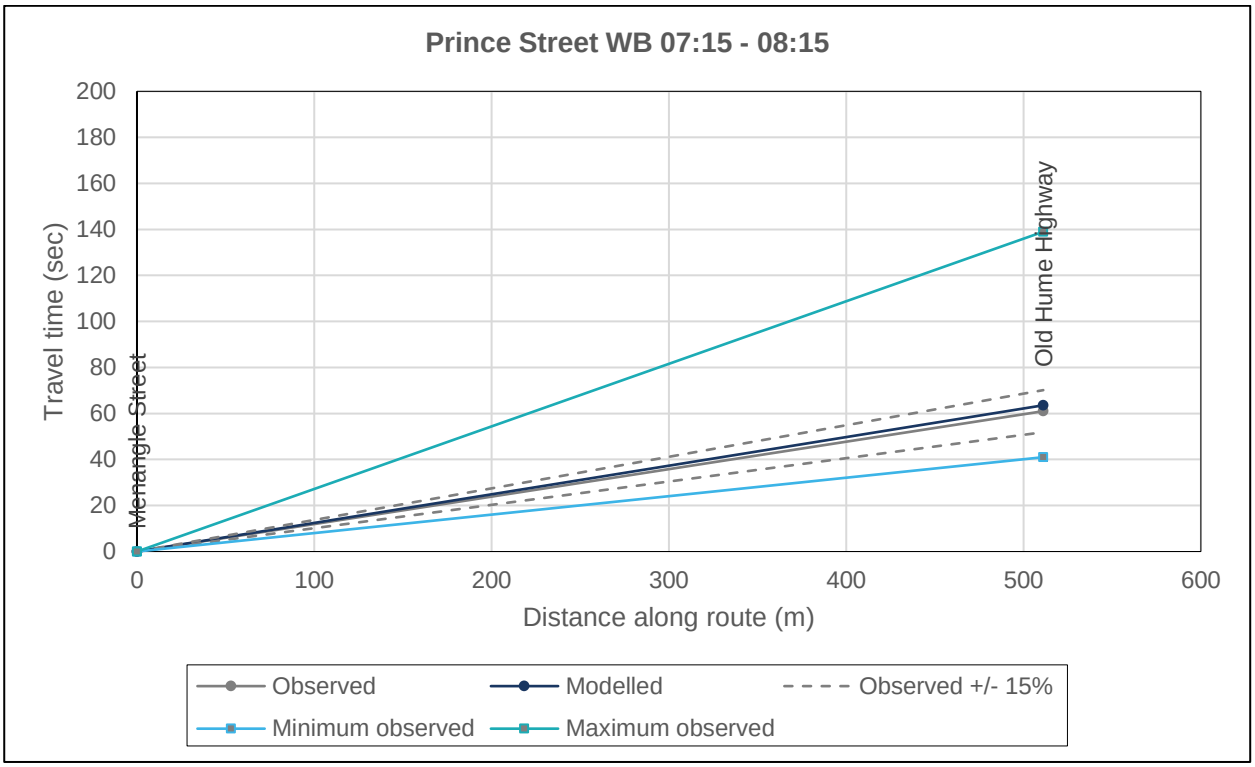
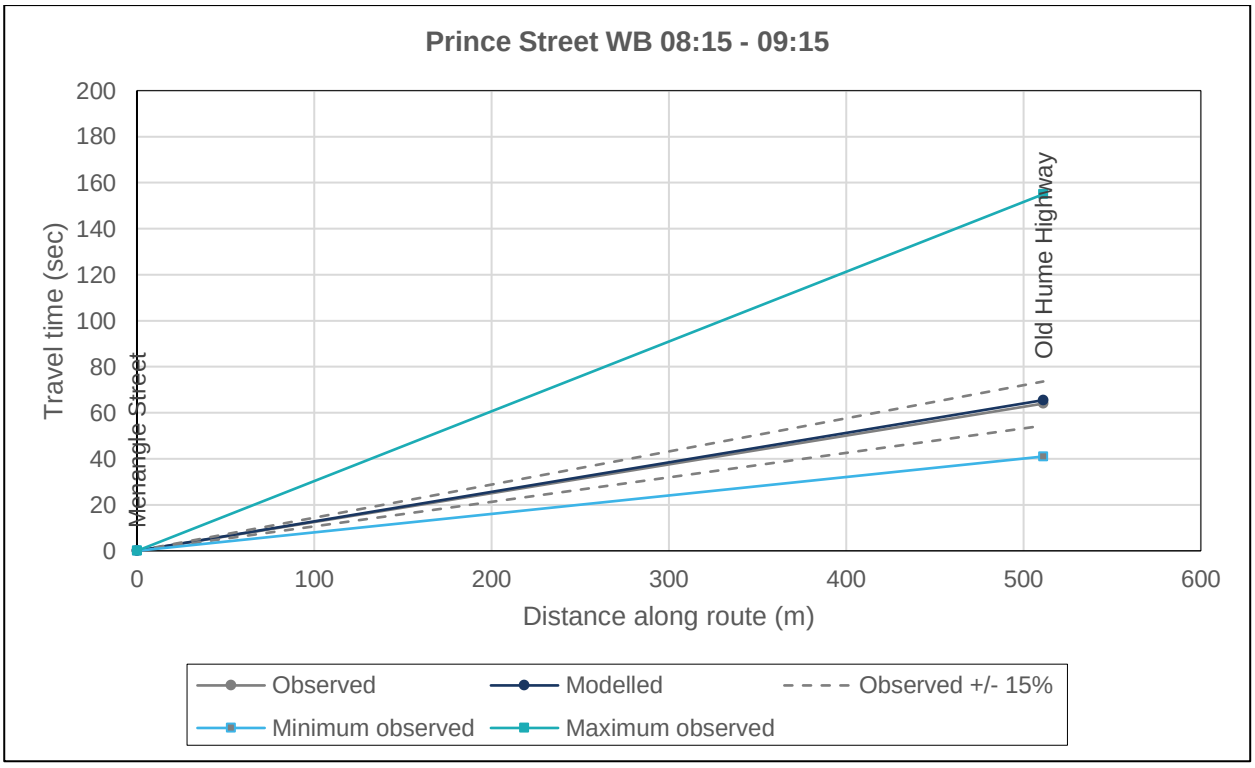
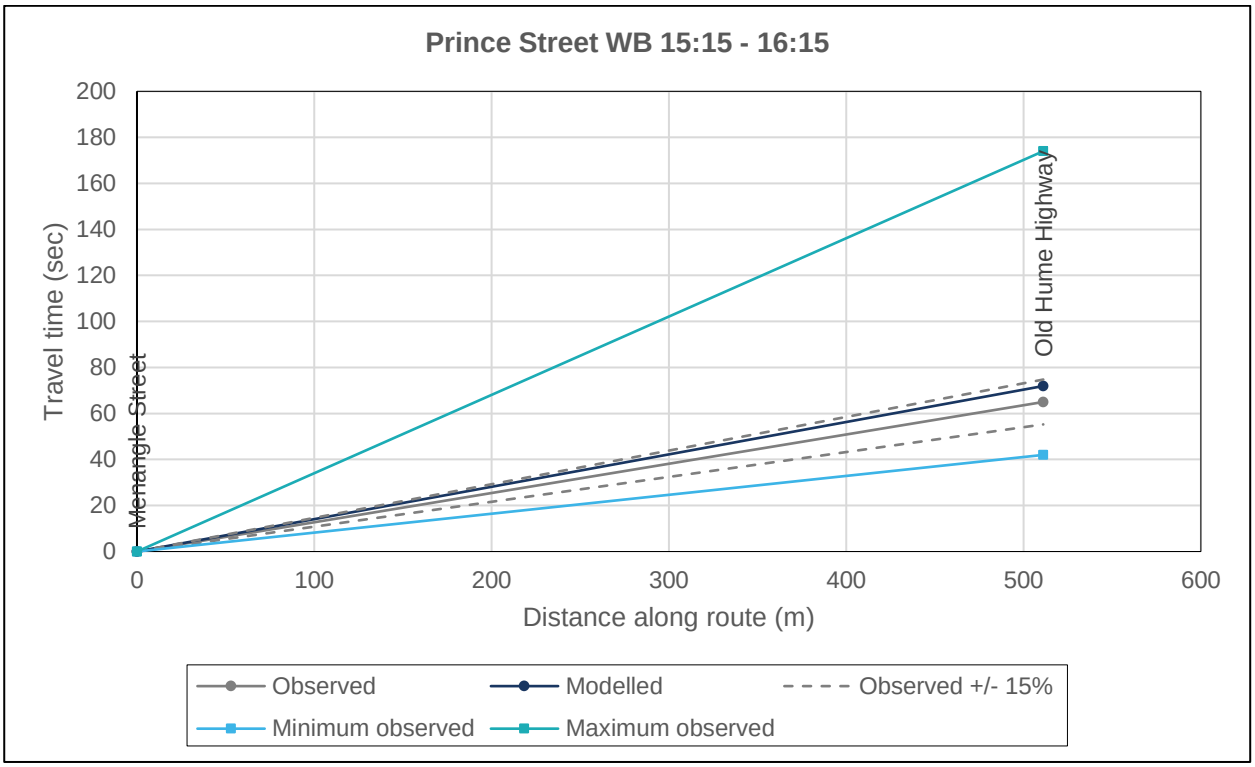
Observed
Modelled
Observed +/- 15%
Minimum observed
Maximum observed


Prince Street WB 07:15 - 08:15
Travel time (sec)
Distance along route (m)
Menangle Street
Old Hume Highway
Observed
Modelled
Observed +/- 15%
Minimum observed
Maximum observed


Prince Street WB 08:15 - 09:15
Travel time (sec)
Distance along route (m)
Menangle Street
Old Hume Highway
Observed
Modelled
Observed +/- 15%
Minimum observed
Maximum observed


Prince Street WB 15:15 - 16:15
Travel time (sec)
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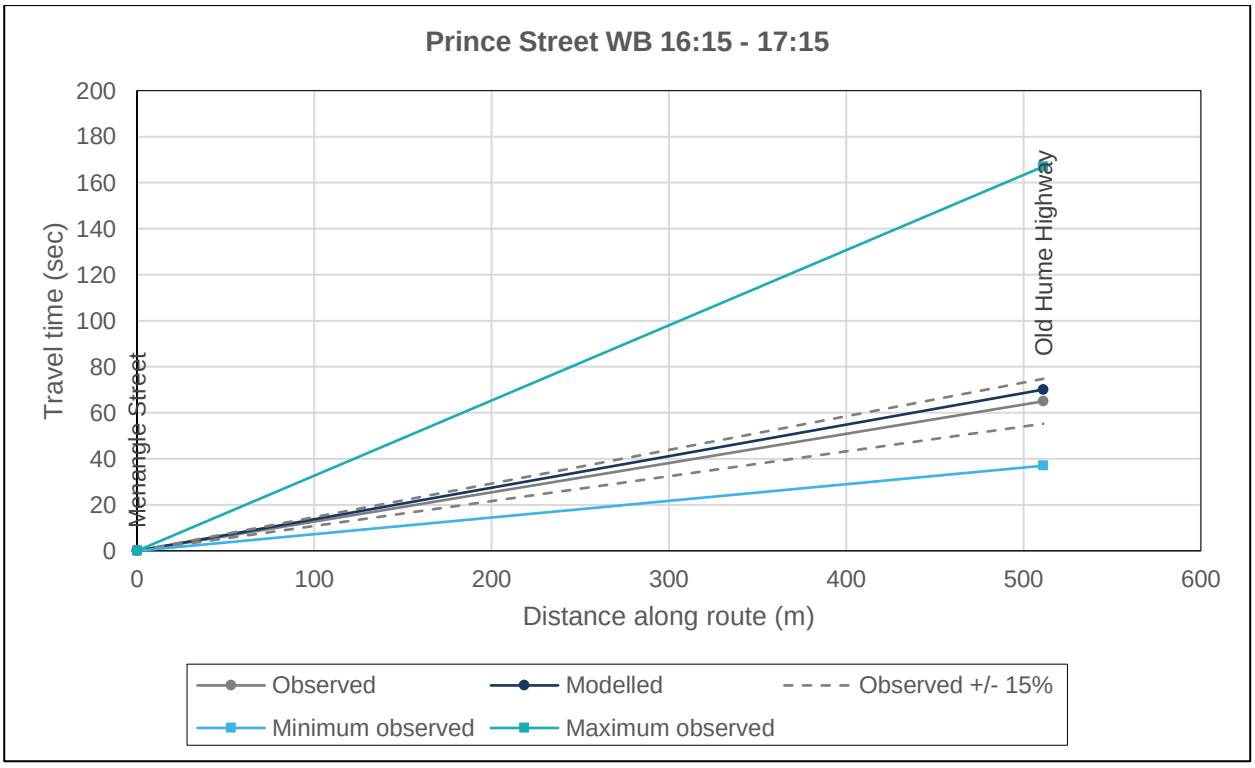
Distance along route (m)
Menangle Street
Old Hume Highway
Observed
Modelled
Observed +/- 15%
Minimum observed
Maximum observed


Prince Street WB 16:15 - 17:15
Travel time (sec)
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Distance along route (m)
Menangle Street
Old Hume Highway
Observed
Modelled
Observed +/- 15%
Minimum observed
Maximum observed