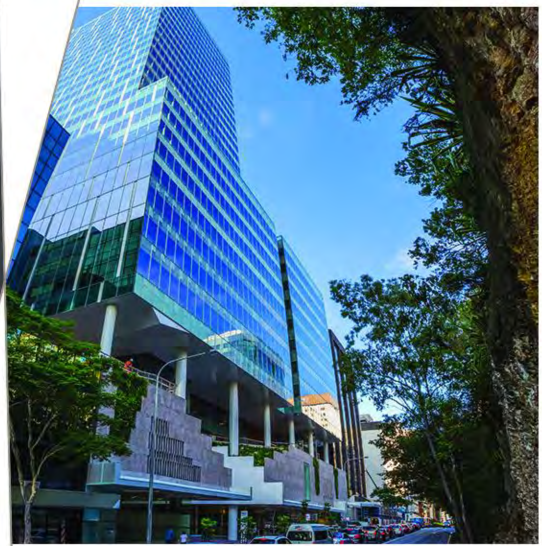
Future Modelling Report

Inner West Sydney Suburbs including Parramatta Road Corridor Urban Transformation Strategy

80018116



Prepared for Department of Planning, Industry and Environment in collaboration with Inner West Council

10 March 2022

Cardno®

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Glossary

Abbreviation	Description
Aimsun	Traffic modelling software used for the hybrid mesoscopic/microscopic traffic model
CBD	Central Business District
DPIE	Department of Planning, Industry and Environment
DUE	Dynamic user equilibrium
HV	Heavy vehicle
IWC	Inner West Council
LCV	Light commercial vehicle
LOS	Level of service
LV	Light vehicle
M4	M4 Motorway
M5	M5 Motorway
M8	M8 Motorway
NSW	New South Wales
OD	Origin-destination pair
PPM	Parking Precinct Module
PRCUTS	Parramatta Road Corridor Urban Transformation Study
PTPM	Public Transport Project Model
PwC	Pricewaterhouse Coopers
SGS	SGS Economics & Planning
SRC	Stochastic route choice
STFM	Sydney Traffic Forecasting Model
VHT	Vehicle hours travelled
VKT	Vehicle kilometres travelled
WCX	WestConnex

1 Introduction

1.1 Project background

Cardno was engaged by Department of Planning, Industry and Environment (DPIE) in close collaboration with Inner West Council (IWC) to investigate the traffic network along the Parramatta Road corridor within the IWC local government area. The study involves the development of a hybrid (microscopic/mesoscopic) traffic simulation model using Aimsun. The purpose of the study is to better inform future traffic and safety works, and ensure that future development in the corridor can be sustained with existing and proposed infrastructure upgrades.

Figure 1-1 shows the regional context of the study area. The study area is located in the Inner West suburbs of Sydney, approximately five kilometres south-west of the CBD. Parramatta Road is a key arterial road corridor connecting the Sydney CBD to the metropolitan centre of Parramatta, as well as other major destinations in the Inner West. The boundary of the Parramatta Road corridor traffic model, the software platform and the model inputs have been endorsed by IWC, DPIE and Transport for NSW.

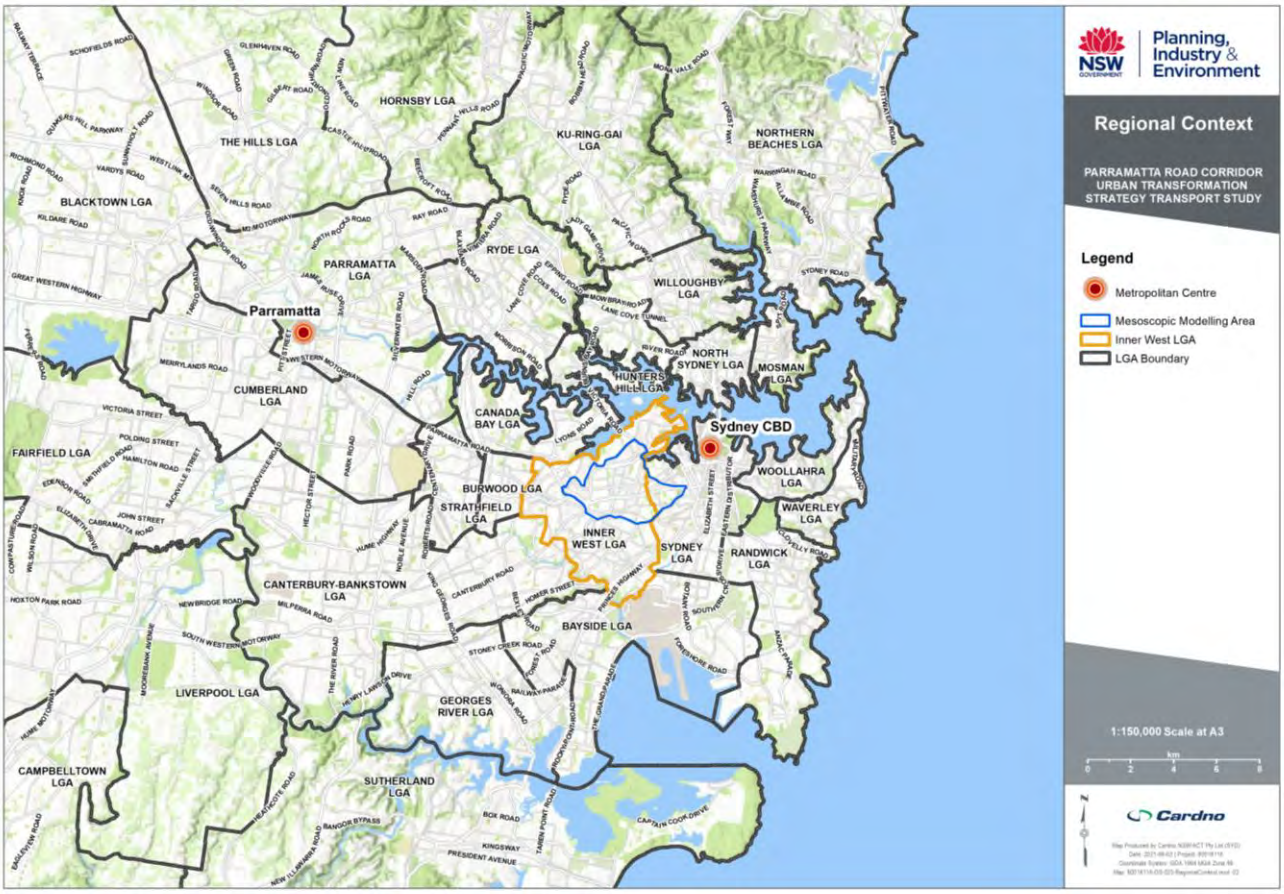


Figure 1-1 Regional context

1.2 Project objectives

The traffic modelling objectives of the Parramatta Road Corridor Urban Transformation Study (PRCUTS) are:

> Evaluate the impacts of future infrastructure upgrades and trip reassignment in the PRCUTS study area and other corridors within the inner western suburbs

> Assess the maximum network capacity and recommend public transport shift

> Analyse the impact of projected employment and population growth on the transport network

> Test and refine relevant items in the PRCUTS Infrastructure List.

1.3 Scope of works

The scope of works for the traffic modelling component of the study is:

> Review existing relevant works, previous traffic studies and development patterns along the Parramatta Road corridor
> Conduct traffic surveys and undertake analysis of the historical trends and existing traffic conditions
> Use existing strategic models to estimate current and future demands
> Develop, calibrate and validate a Base Model to capture existing conditions on a typical weekday to establish a reliable and robust platform for future-year testing, in accordance with the following guidelines:
  - *Traffic Modelling Guidelines* (Roads and Maritime Services, 2013)
  - *Technical Direction TTD 2018/002: Traffic signals in microsimulation modelling* (Roads and Maritime Services, 2018)
  - *Technical Direction TTD 2017/001: Operational modelling reporting structure* (Roads and Maritime Services, 2017)
> Develop scenarios to assess the future operation of Parramatta Road.

1.3.1 Previous reporting

Model Scoping Report (Cardno, 18 April 2018)

This document introduced the project and outlined the methodology for the traffic modelling, including:

> Defining the study area
> Outlining the survey data, strategic traffic demand sources and signal data
> Modelling methodology and assumptions
> Inception Meeting outcomes.

The modelling methodology was endorsed by all parties.

Base Model Development Report (Cardno, 29 October 2020)

This documented the development, calibration and validation of the Aimsun Base Model in accordance with the relevant guidelines including:

> *Traffic Modelling Guidelines* (Roads and Maritime Services, 2017)
> *Operational Modelling Reporting Structure* (Roads and Maritime Services, 2017)
> *Traffic Signals in Microsimulation Modelling* (Roads and Maritime Services, 2018).

The report included:

> Description and summary of the traffic data inputs including classified intersection counts
> Analysis of existing conditions and congestion hotspot locations
> Explanation of the study methodology and assumptions
> Statistical analysis of the stability of the Base Model
> Summary of the Base Model calibration and validation results
> Discussion of limitations and conclusions.

The *Base Model Development Report* (Cardno, October 2020) is attached to this report as **Appendix A**.

The Base Model was reviewed by Arup on behalf of DPIE and Transport for NSW and the findings are summarised in *Base Model Peer Review* (Arup, March 2020) which is attached to this report as **Appendix B**. The model and report were refined based on Arup's comments and resubmitted to Arup for independent review. The model was subsequently endorsed as fit for purpose by Arup.

For the future modelling stage, PwC were commissioned by DPIE to apply the PTPM growth to the STFM using a methodology designed in consultation with DPIE. The corresponding traffic growth was subsequently applied to the operational model in Aimsun.

1.3.2 This report

This report documents the Future Model development process, including modelling assumptions and demand estimation, and includes an operational performance assessment of the Base Model and Future Models. It is intended to be read in conjunction with previous reporting for the study.

1.4 Study area

The study area encompasses the precincts of Taverners Hill, Leichhardt and Camperdown which are all within the IWC local government area (except part of Camperdown precinct which is in the City of Sydney). **Figure 1-2** shows these precincts along Parramatta Road. The study is reviewing the traffic generation from the suburbs of inner west Sydney and includes the uplift proposed in these suburbs as well as that proposed by PRCUTS.

The study area includes the key links discussed below.

> Parramatta Road (Great Western Highway) between Haberfield and Ultimo including key intersections with Liverpool Road (Hume Highway), Pyrmont Bridge Road and City Road (Princes Highway). Parramatta Road is a major east-west route connecting the Sydney CBD to the Inner West, Strathfield, Lidcombe and Parramatta. At the western extent of the study area, Parramatta Road connects to the M4 East, twin tunnels between Haberfield and Homebush. On the calibration date (17 October 2018), the M4 East was under construction. It was subsequently opened on 13 July 2019.

> City-West Link Road between the Anzac Bridge in Rozelle and Dobroyd Point. This road forms part of the Western Distributor, a key link connecting North Sydney (via the Harbour Bridge) to Western Sydney. To the west of the study area, City-West Link Road connects to Parramatta Road and the M4 East.

> Victoria Road between City-West Link Road and Parramatta River. Victoria Road is a major north-south arterial road that connects the Western Distributor to Balmain, Rozelle, Drummoyne, Lane Cove and Ryde.

> Stanmore Road runs east-west along the southern edge of the study area. Stanmore Road connects to Enmore Road and King Street (Princes Highway) to the east of the study area and links Inner West suburbs Newtown, Petersham, Lewisham and Dulwich Hill to Old Canterbury Road.

The study area includes key trip generators (origins) and trip attractors (destinations) within the Inner West including three railway stations, seven light rail stops, commercial centres Leichhardt, Rozelle and Camperdown, the University of Sydney, Princes Alfred Hospital, numerous schools, parks, sports fields and light industries. Residential areas are generally low to medium density across the study area, with some high-density apartment complexes in Glebe, Lewisham and around the University of Sydney.

Figure 1-2 shows the study area.

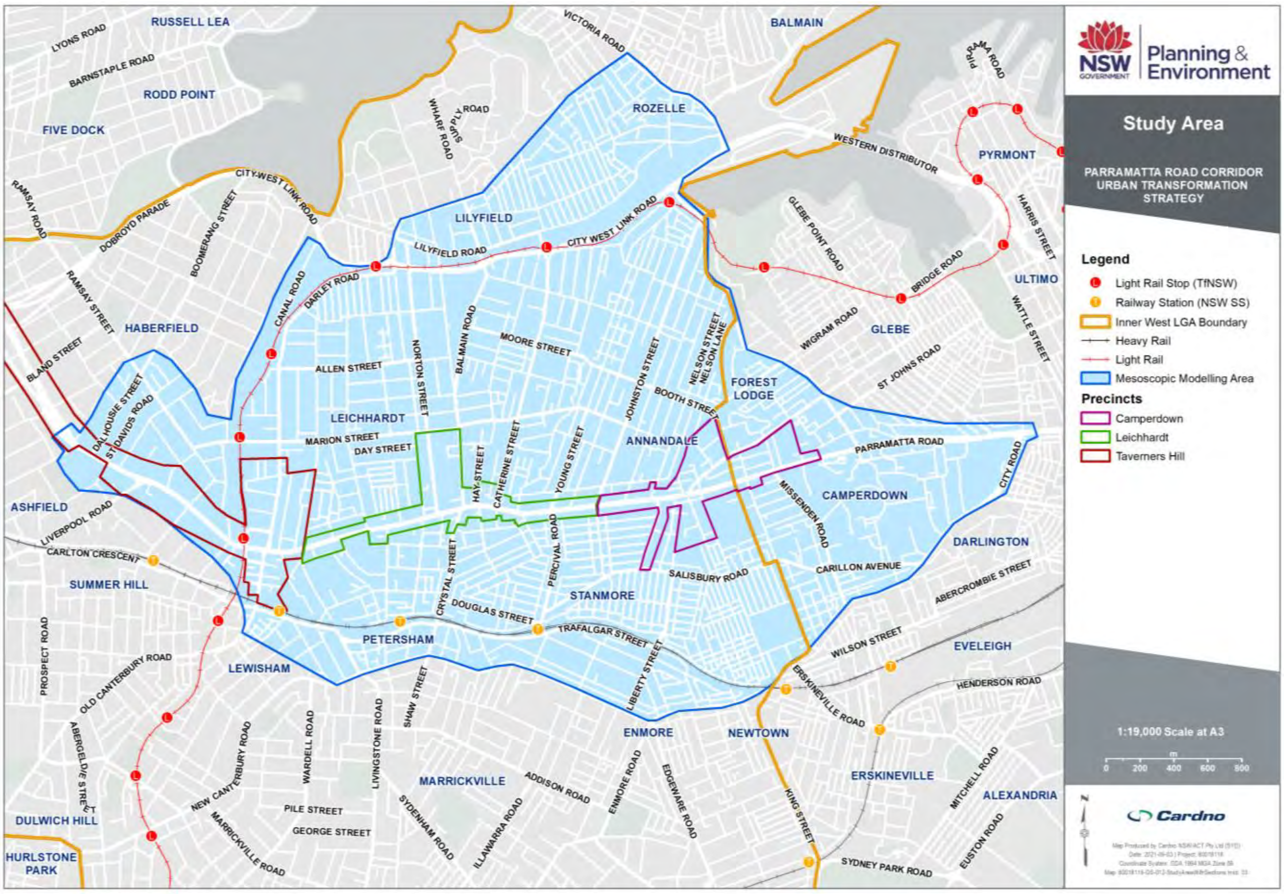


Figure 1-2 Study area

1.5 Stakeholders

The key stakeholders for this project are:

> Department of Planning, Industry and Environment (DPIE)[1]

> Inner West Council (IWC)

> Transport for NSW[2].

1.6 Report outline

This report follows the *Operational Modelling Reporting Structure* (Roads and Maritime Services, 2017). The structure of this report is outlined below:

> **Section 1 – Introduction**: Summarises the project objectives and reporting structure

> **Section 2 – Options testing**: Outlines the future years and scenarios assessed in the study

> **Section 3 – Assumptions**: Discusses the assumptions underlying the future models

> **Section 4 – Future demand development**: Outlines the methodology used to develop the future-year demands

> **Section 5** – **Base Model operational results**: Summarises the network and intersection performance results for the Base Model

> **Section 6** – **Do Minimum operational results**: Summarises the network and intersection performance results for the Do Minimum scenario

> **Section 7** – **With Upgrades operational results**: Summarises the network and intersection performance results for the With Upgrades scenario.

> **Section 8** – **Conclusions**.

[1] Formerly Department of Planning and Environment until 1 July 2018.
[2] Roads and Maritime Services existed as a separate agency until it was dissolved and functions transferred to Transport for NSW on 1 December 2018.

2 Options 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

DPIE provided a schedule of 10 infrastructure improvements in the area for consideration in the modelling. Cardno assessed each upgrade and determined that five upgrades would be included in the models. The remaining upgrades did not alter the road network (eg Sydney Metro West) or were outside the study area. The list of upgrades is included in **Appendix C**.

The future modelling included two infrastructure scenarios:

> **Do Minimum**: Includes all upgrades implemented between 2018 (the Base Model calibration year) and 2021, as well as the WestConnex Rozelle Interchange

> **With Upgrades**: Includes all upgrades from the Future Base, as well as localised intersection upgrades along Parramatta Road and at key intersections in the study area. More detailed investigations and consultation would need be carried out prior to any designs being prepared. The quantum of lost car parking spaces depends on road design requirements which would be determined during concept or detailed design stages.

The infrastructure upgrades included in each scenario are described in the following sections.

2.1.1 Do Minimum

Based on consultation with IWC, DPIE and Transport for NSW, five future upgrades were considered in the Do Minimum scenario. Four of these have already been implemented (as of July 2021) since the Base Model.

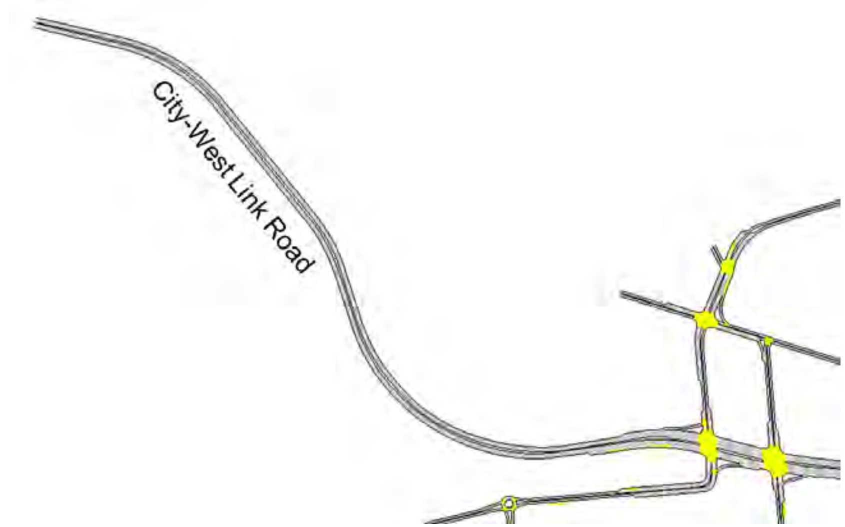
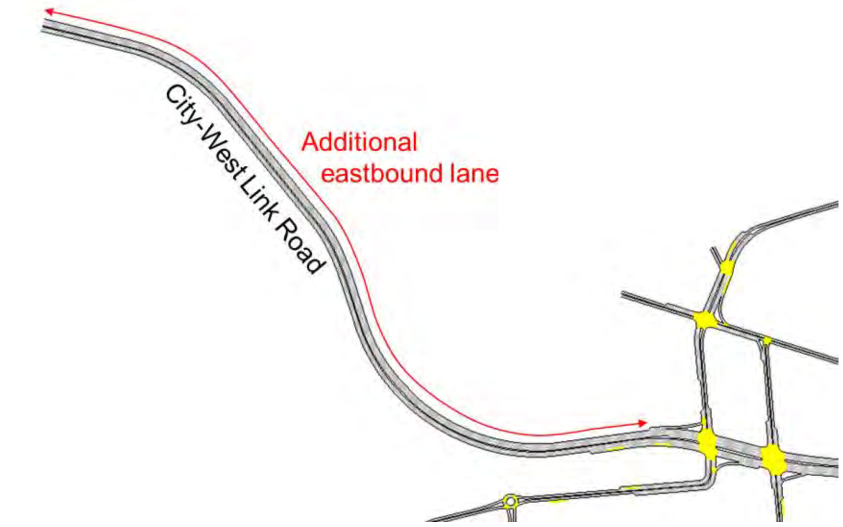
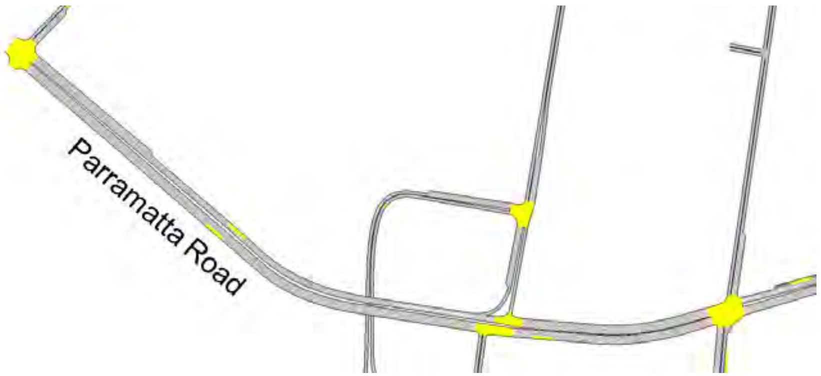
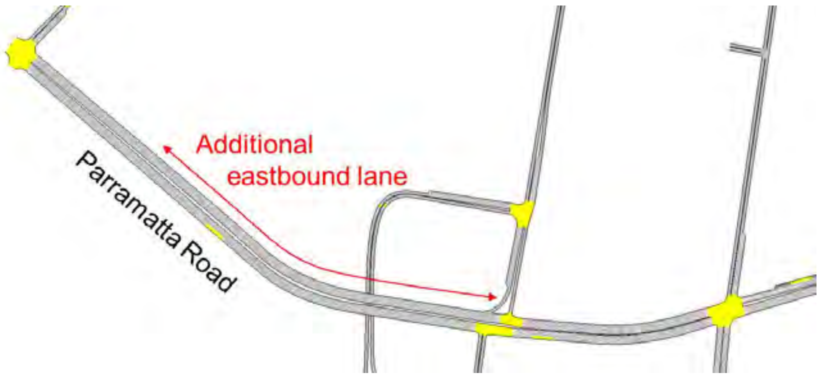
Table 2-1 describes the upgrades that were included in the Do Minimum scenario.

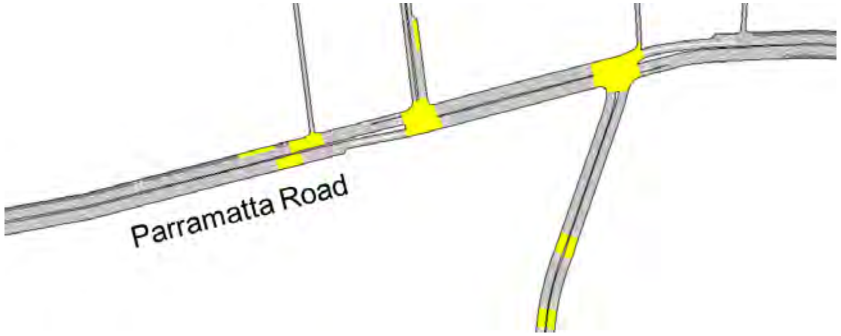
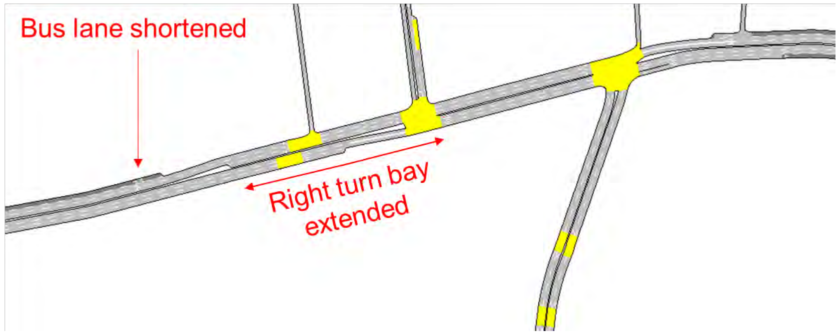
Table 2-1 List of upgrades

#	Upgrade location	Description of upgrade	Year implemented
1	City-West Link Road	Addition of third eastbound lane between Waratah Street and James Street	Late 2018
2	Parramatta Road / West Street	Extension of right turn bay and third lane on Parramatta Road eastbound from Tebbutt Street to 7/Eleven Haberfield	2018
3	Missenden Road	Reduction of speed limit from 50 to 40 kilometres per hour	2018
4	Parramatta Road / Crystal Street	Extension of right turn bay on Parramatta Road eastbound from Norton Street to west of Railway Street	2020
5	WestConnex Rozelle Interchange	Underground interchange between M4 Motorway, M8 Motorway, Victoria Road, City-West Link Road and Western Harbour Tunnel	Expected to open in 2023

Table 2-2 shows the layout for each upgrade outlined above.

Table 2-2 Do Minimum infrastructure layouts

Upgrade	Base layout	Future layout
1		
2		

Upgrade	Base layout	Future layout
3		
4		

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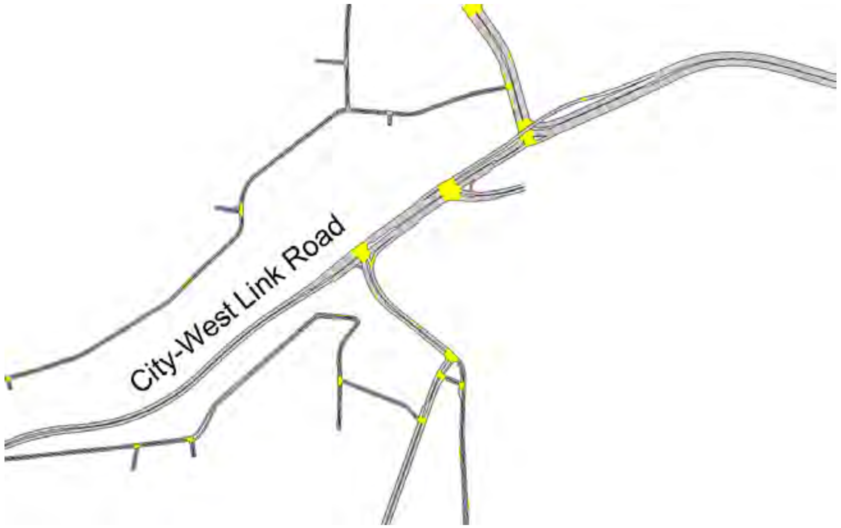
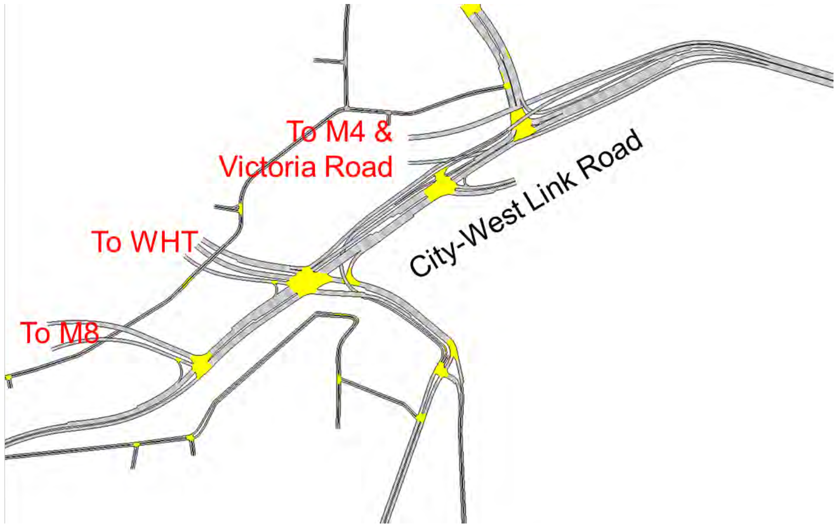
5		

2.1.2 With Upgrades

The With Upgrades scenario included localised upgrades proposed along Parramatta Road and at key locations across the study area. These suggestions were put forward by Cardno based on model results and observations and aim to improve traffic network performance. These upgrades have not been endorsed by Council, DPIE, Transport for NSW or any other stakeholders. Further traffic modelling is suggested during the Concept and Detailed Design stages to assess the viability of these upgrades in more detail as well as potential impact to other modes and place function.

The purpose of the upgrades was to alleviate queueing and congestion, and reduce the network average delay time. To avoid proposing unrealistic upgrades, the suggested improvements were chosen so that, if possible, they would:

> Fit within the existing road corridor

> Not require significant changes to bus stops or bus lanes

> Not require changes to approved heavy vehicle routes

> Retain the existing road hierarchy

> Require limited signal plan changes (such as introducing a right turn phase or split phase)

> Minimise the loss of on-street parking

> Not require tidal flow or contraflow lanes (excluding existing configuration on Victoria Road)

> Retain signalised pedestrian crossings at all current locations including midblock crossings, and no changes to pedestrian green times or late starts at intersections.

Consideration of vehicle swept paths has not been included.

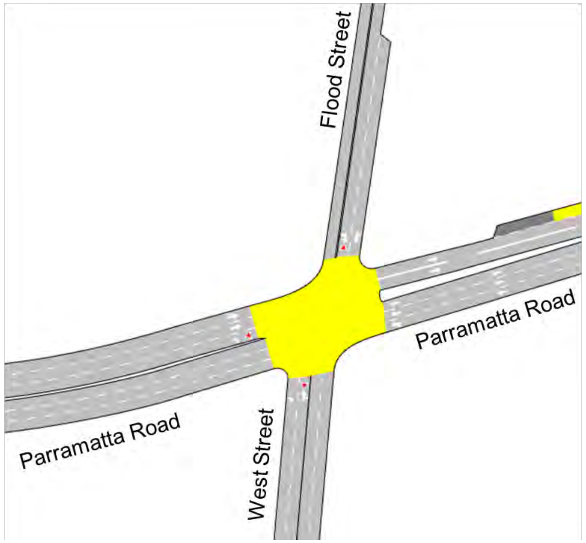
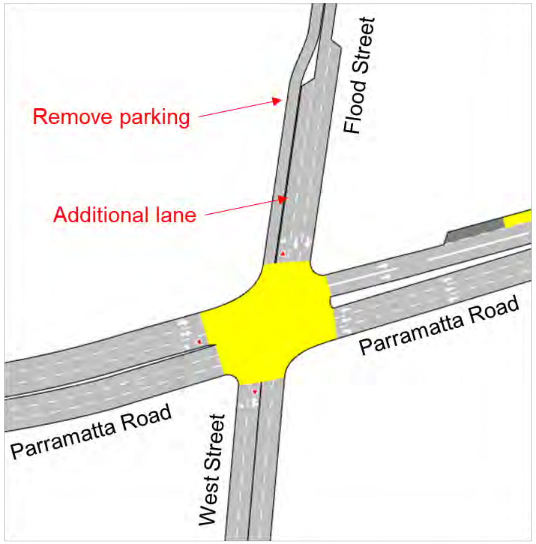
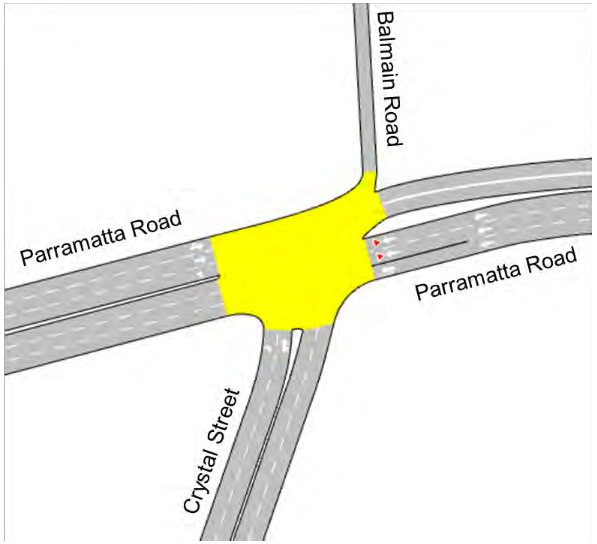
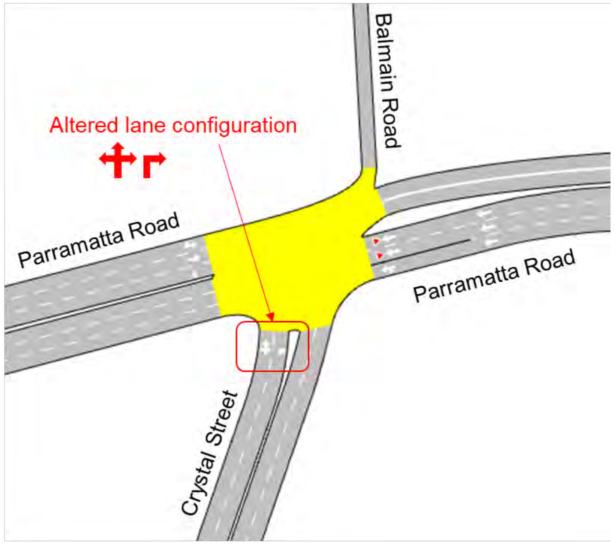
Table 2-3 describes the upgrades that were included in the With Upgrades models.

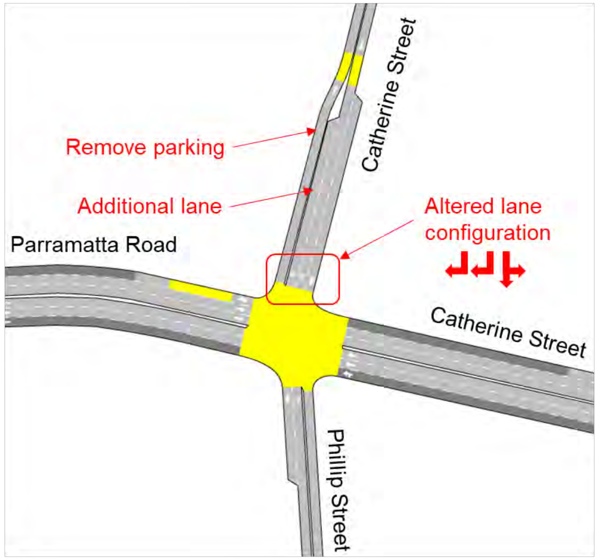
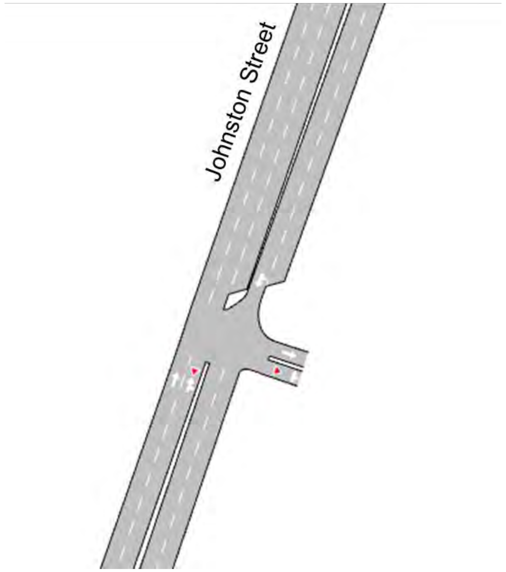
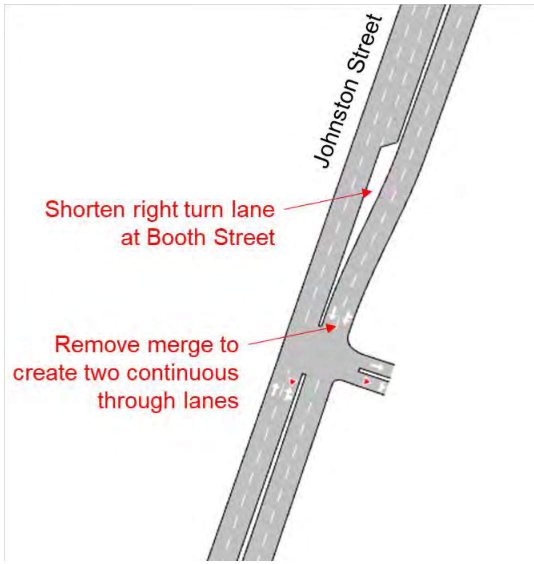
Table 2-3 List of upgrades

#	Upgrade location	Description of upgrade
6	Parramatta Road / West Street	Flood Street – removal of parking/kerbside lane in northbound direction to provide space for dedicated right turn lane in southbound direction
7	Parramatta Road / Crystal Street	Crystal Street – altered lane configuration to provide dedicated right turn lane and combined left/through/right lane
8	Parramatta Road / Catherine Street	Catherine Street (north) – removal of parking/kerbside lane in northbound direction to provide space for additional right turn lane in southbound direction Catherine Street (north) – altered lane configuration to provide dual right turn lanes and combined left/through lane
9	Johnston Street	Shorten right turn lane on Johnston Street (northbound) at Booth Street to provide space to remove the southbound merge on Johnston Street and allow two continuous through lanes
10	Parramatta Road / Johnston Street	Johnston Street (north) – removal of parking/kerbside lane in northbound direction to provide space for additional right turn lane in southbound direction Johnston Street (north) – altered lane configuration to provide dedicated right turn lane, combined through/right and dual left turn lanes Johnston Street (south) – removal of parking/kerbside lane in southbound direction to provide space for dedicated right turn lane in northbound direction
11	Parramatta Road / Bridge Road	Parramatta Road (west) – extend right turn bay using available space Bridge Road – altered lane configuration to provide dual right turn lanes and dedicated left turn lane
12	Parramatta Road / Ross Street	Ross Street – removal of parking/kerbside lane in northbound direction to provide space for dedicated left turn lane in southbound direction
13	Salisbury Road	Salisbury Road – removal of westbound kerbside lane between Kingston Road and Cardigan Street Salisbury Road – provide right turn bays at Cardigan Street and Kingston Road Salisbury Road – extend left turn lane leading to Kingston Road
14	Liberty Street / Trafalgar Street	Liberty Street (north) – ban right turn into Trafalgar Street
15	Stanmore Road	Stanmore Road – remove parking between Liberty Street and Wemyss Street to provide two continuous westbound lanes
16	Railway Terrace / West Street	Railway Terrace (west) – provide left turn bay
17	Pyrmont Bridge Road / Mallett Street / Booth Street	Booth Street - removal of parking/kerbside lane in northbound direction to provide space for additional right turn lane in southbound direction Booth Street – altered lane configuration to provide dedicated right turn lane, through lane and combined left/through lane Mallett Street – remove timed parking on Mallett Street southbound Mallett Street – Altered lane configuration to provide dedicated right turn lane and combined left/through lane

Table 2-4 shows the layout for each upgrade outlined above.

Table 2-4 With Upgrades infrastructure layouts

Upgrade	Base layout	Future layout
6		
7		

Upgrade	Base layout	Future layout
8		
9		

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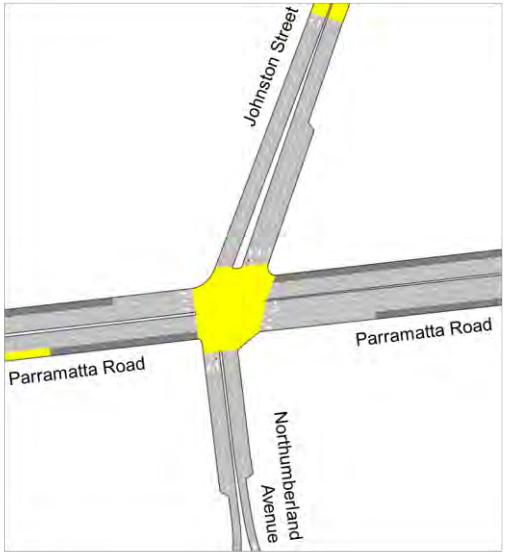

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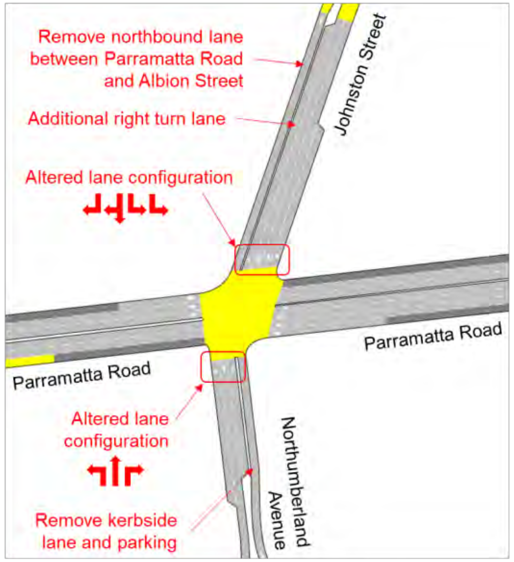

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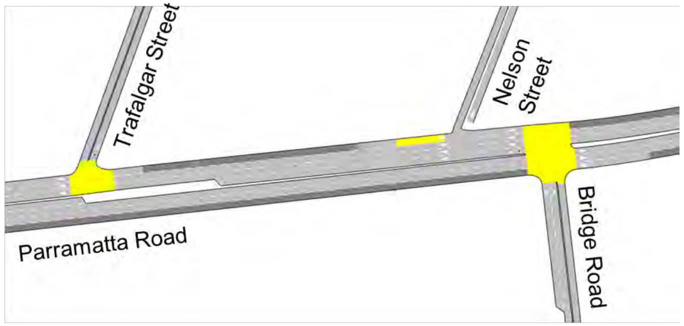

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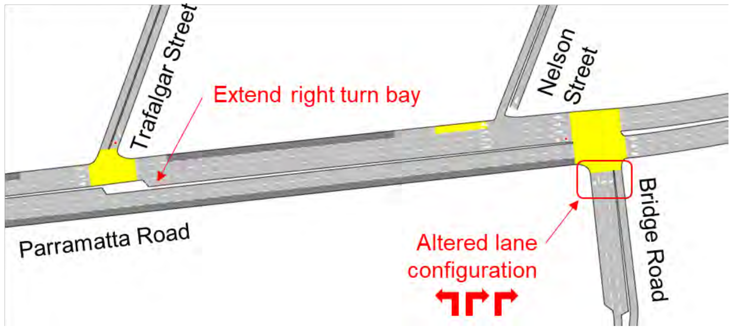

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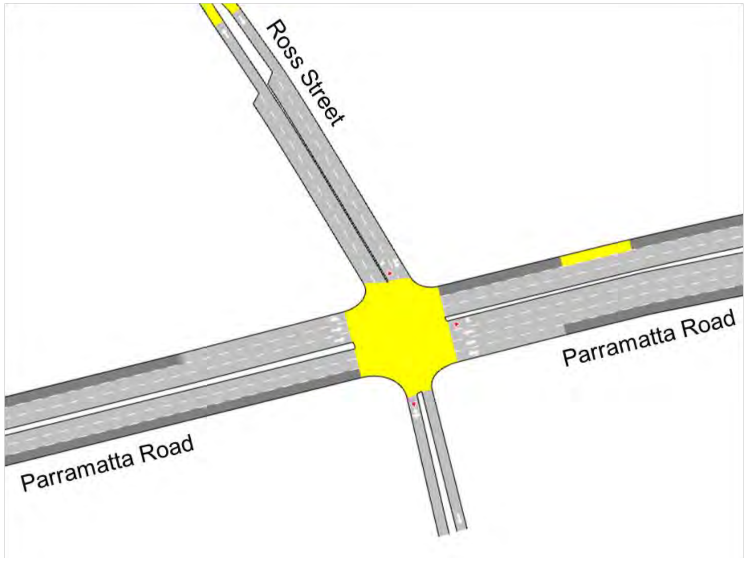
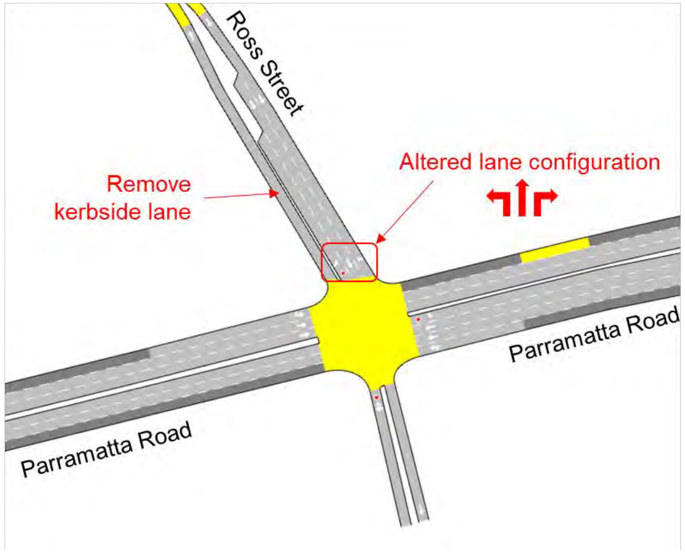
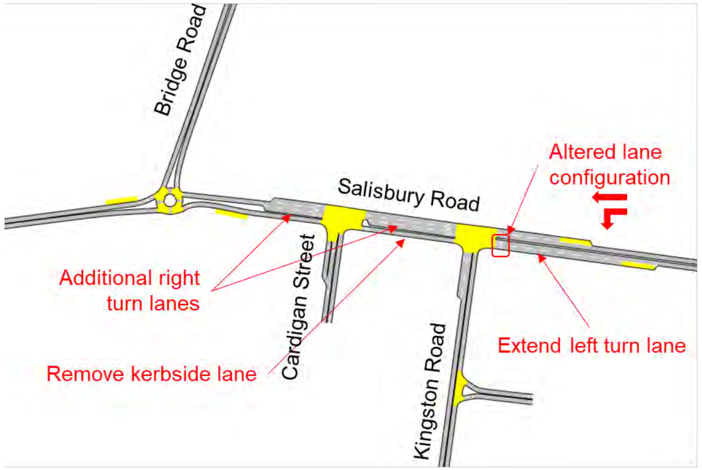
12		
13		

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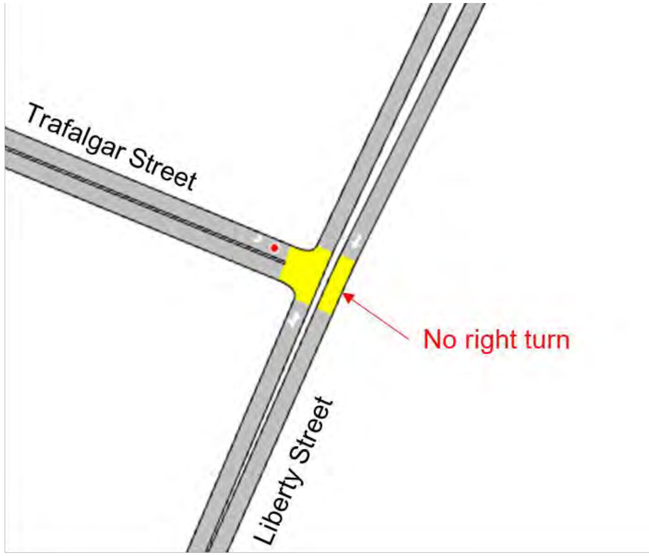
14		
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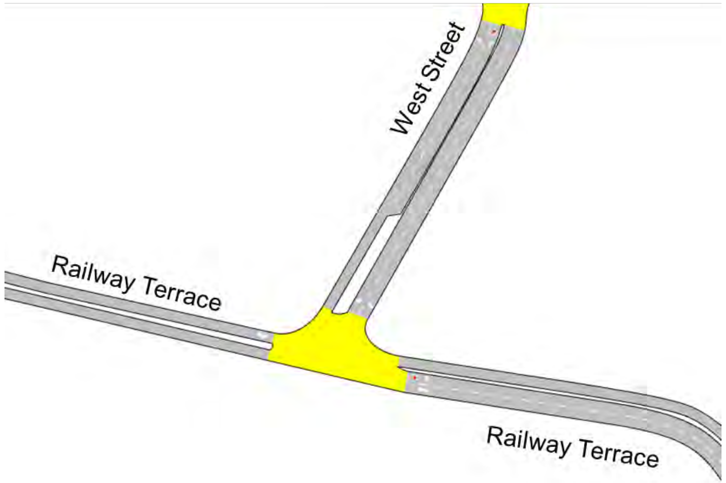
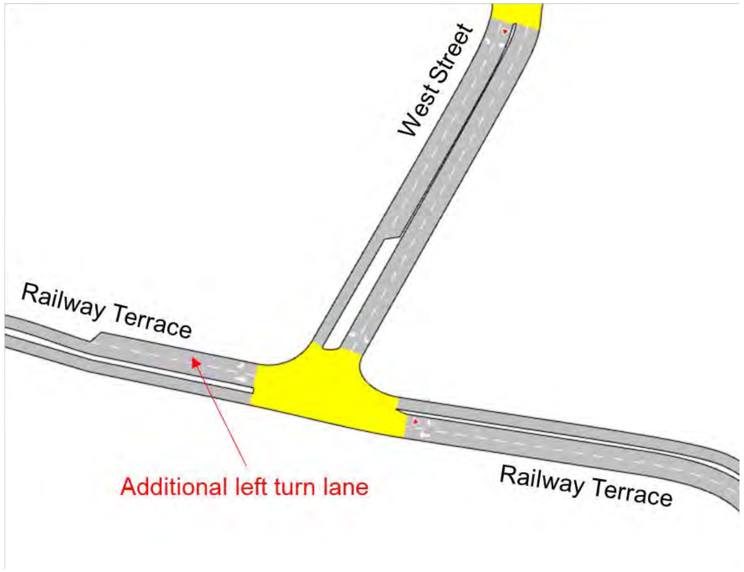
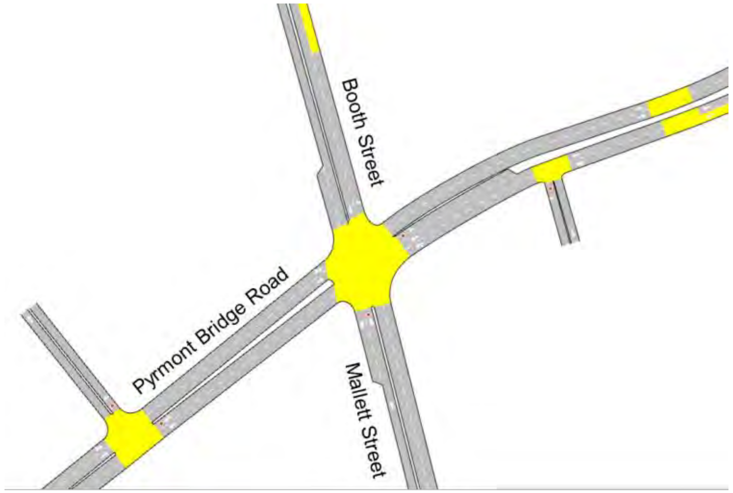
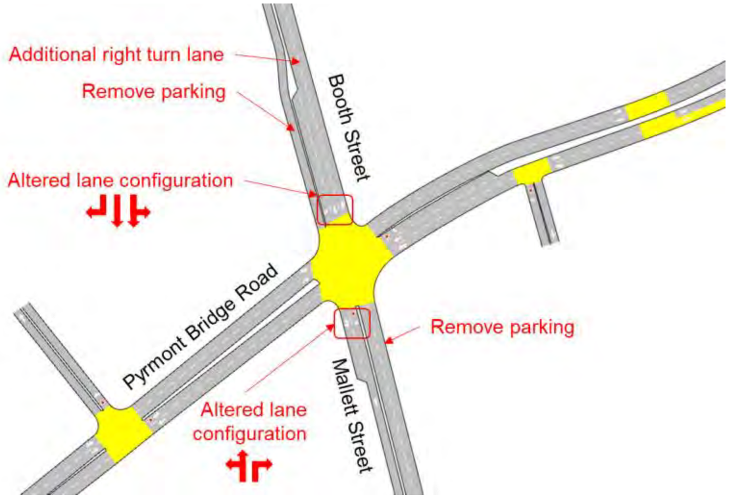
Upgrade	Base layout	Future layout
16		
17		

2.2 Assessment scenarios

Cardno assessed the following scenarios:

- Base Model
- Network Capacity Model
- Do Minimum
- With Upgrades.

Each of these scenarios is described below.

2.2.1 Base Model

The Base Model was previously developed, calibrated and validated for the study area. This was documented in *Base Model Development Report* (Cardno, 2020), attached to this report as **Appendix A**. The Base Model network and intersection performance results are contained within this report.

A Future Base ("Do Nothing") scenario was not assessed for future years given that some of the infrastructure upgrades have already been implemented, are under construction or are committed.

2.2.2 Network Capacity Model

The Network Capacity Model was used to determine the maximum capacity of the network in 2036 by applying incremental proportions of the traffic growth from the PTPM. The purpose of the Network Capacity Model was to determine the necessary penalty for private vehicle mode to ensure adequate capacity within the network up to 2036. This scenario was only used in the future demand development procedure and does not represent an actual projected future year scenario, so no results other than VKT for comparison to the PTPM scenarios have been included in this report.

The Network Capacity Model included the Do Minimum infrastructure.

2.2.3 Do Minimum

The Do Minimum scenario uses traffic growth from the STFM to predict the future network state and identify network deficiencies in 2026 and 2036 assuming a private vehicle mode penalty to shift some users to other modes. The Do Minimum scenario includes all upgrades implemented since the Base Model calibration date (2018), and the WestConnex Rozelle Interchange.

2.2.4 With Upgrades

The With Upgrades scenario included localised upgrades along Parramatta Road and at key locations across the study area. The purpose of the upgrades was to alleviate queueing and congestion, and reduce the network average delay time. The With Upgrades scenario includes the Do Minimum infrastructure upgrades and the additional upgrades listed in **Table 2-3**.

2.3 Assessment years and time periods

Table 2-5 summarises the scenarios and years assessed. Each scenario was assessed for two peaks consistent with the Base Model:

- 7:15AM – 9:15AM
- 4:30PM – 6:30PM.

Table 2-5 Scenarios assessed

Scenario	2018		2026		2036	
	AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak
Do Nothing (Base)	✓	✓	-	-	-	-
Network Capacity Model	-	-	-	-	✓	✓
Do Minimum	-	-	✓	✓	✓	✓
With Upgrades	-	-	✓	✓	✓	✓

3 Assumptions

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

3.1 Future Model assumptions

This section outlines the assumptions adopted in the development of the Future Models:

> All bus routes and timetables were assumed to remain the same as in the Base Model.

> The peak hours were assumed to remain consistent with the Base Model for each peak.

> The traffic profile for each future peak was assumed to remain consistent with the Base Models.

> Adjustments were made to some signal phase times to balance flows caused by future growth and traffic reassignment. Cycle times were assumed to remain consistent with the Base Model.

> Pedestrian phases at signalised intersections were assumed to remain consistent with the Base Model as no future pedestrian modelling was available.

> Assessment of intersections that were not calibrated in the Base Model is not recommended.

> Assessment of travel time on routes that were not calibrated in the Base Model is not recommended.

> The model only considers road vehicles (cars, trucks and buses), so does not include any improvements to public transport, walking or cycling infrastructure.

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 3-1** provides a summary of the network performance statistics reported for this study.

Table 3-1 Network performance metrics

Metric	Unit	Description
Total traffic demand	veh	> The total number of trips that enter the network during the modelled hour
Total vehicles arrived	veh	> The total number of vehicles that arrive at their destination during the modelled peak hour > The total vehicles arrived includes vehicles generated during the warm-up period that arrive during the simulated period, so may be higher than the total traffic demand
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 across the network > 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, summed across all vehicles in the network
Average vehicle kilometres travelled	km	> Average number of kilometres travelled by vehicles all vehicles in the network
Average time travelled in network	sec	> 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 > Equivalent to VKT divided by VHT
Average delay	sec	> Average delay time for all vehicles in the network > Delay time is the difference between the experienced travel time on a route, and the travel time on that route under free-flow conditions > Useful for assessing the impacts of each scenario on road users
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
Deleted vehicles	veh	> The microscopic/mesoscopic network checker removes vehicles that are stationary in the model for too long > This is designed to prevent unrealistic gridlocks, such as at roundabouts, where vehicles in the real world are capable of manoeuvring to avoid each other

DPIE requested Cardno to provide key network performance statistics per person. **Table 3-2** shows the assumed vehicle occupancies for each vehicle type. The following network statistics were provided by person in the study area:

> Total persons arrived
> Total person-kilometres travelled
> Total person-travel time
> Average speed
> Average delay.

Table 3-2 Assumed vehicle occupancies

	Vehicle type		
	Light vehicles	Heavy vehicles	Buses
Assumed occupancy (persons)	1.11	1.00	30.00

3.2.2 Travel time

Travel time data was used to validate the Base Model. It provides an indication of congestion hotspots along a particular route within a network and can be used to compare the future network performance. Travel times along five key routes were compared between scenarios. Average speed along each route is also provided. Cardno has adopted a colour code based on the speed ratio along the length of the route. Speed ratio is simulated speed divided by the posted speed limit. **Table 3-3** shows the colour code used throughout this report.

Table 3-3 Speed ratio colour code

Speed ratio					
0.00 – 0.30	0.30 – 0.40	0.40 – 0.50	0.50 – 0.67	0.67 – 0.80	> 0.80

Cardno also extracted travel times on Parramatta Road between the PRCUTS precincts.

3.2.3 Intersection performance metrics

The following performance metrics were used in the analysis of intersections:

> **Delay time**: Average delay experienced by all vehicles at the intersection
> **Level of service** (LOS): An intersection performance measure that is based on delay per vehicle
> **Queue length**[3]: Maximum queue length by approach.

Table 3-4 shows the level of service categories for intersections in NSW from *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 intersections and roundabouts), level of service is based on the maximum delay of all approaches.

Intersections operating at LOS C or better are 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.

[3] Intersections in the PRCUTS precincts only.

Table 3-4 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)*

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.

3.2.4 Network plots

DPIE requested the following network plots:

> **Traffic density**: Simulated vehicles per lane per kilometre over the modelled period

> **Speed ratio**: Simulated average speed over the modelled period for each section divided by the posted speed limit for that section

> **Heavy vehicle proportions** on each link.

4 Future demand development

This section provides an overview of the process used for deriving the future traffic demand. The methodology is outlined below. The numbered steps were completed by Cardno.

The Public Transport Project Model (PTPM) was run by TfNSW with the latest land-use and travel demand assumptions from STM. The specifics of these assumptions were documented in *Strategic Transport Modelling Interface Methodology* (VIAE Consulting, October 2020). This report is provided in **Appendix D**. The PTPM was run with the Precinct Parking Module (PPM) which applies additional travel costs to the private vehicle mode to reduce its utility and reflect capacity constraints not otherwise accounted for. The PTPM matrices with PPM penalties were provided to Cardno to complete Steps 1 to 3.

Steps 1 to 3 are based on the methodology outlined in *Strategic Transport Modelling Interface Methodology* (VIAE Consulting, October 2020).

1. Estimation of future growth using the PTPM 2018 and 2036 demand matrices (refer to **Section 4.1**).
2. Incremental application of the future growth to the Base Model demand to determine the point at which the network capacity is reached (refer to **Section 4.2**).
3. Comparison of the network-wide vehicle kilometres travelled (VKT) between the Network Capacity Model (Step 2) and the future demand scenarios from PTPM using the PPM penalties (refer to **Section 4.3**).

SGS Economics & Planning (SGS) were commissioned by DPIE to review and update the land-use projections within the study area. The updated land-use was supplied to Transport for NSW to run the STM, PTPM and PPM. PwC were commissioned by DPIE to apply the PTPM growth to the STFM using a modified methodology designed to account for negative growth in the PTPM. The methodology for this assessment was outlined in *PRCUTS Transport Model Update Recommendations Action Plan, updated based on comments from TfNSW* (PwC, June 2021). This report has been provided in **Appendix E**. The STFM matrices from the PwC update were provided to Cardno to complete Step 4.

4. Estimation of the future traffic demand using the outputs from the STFM (refer to **Section 4.4**).

This methodology has been endorsed by Transport for NSW and DPIE for use in this project. The assumptions and limitations of the methodology are explained in **Appendix D** and have been acknowledged by both agencies.

The following sections describe the methodology, assumptions and results of each stage.

4.1 PTPM growth estimation

This section outlines the methodology used to extract the future growth from the PTPM and summarises the results. The PTPM only includes the AM Peak.

The PTPM demands for the 2018 base-year scenario and 2036 high-growth scenario were extracted. The PTPM cordon provided included 119 centroids, consisting of:

- 65 external gates representing origins/destinations outside the study area
- 15 additional gates representing the approaches to the future WestConnex (WCX) Rozelle Interchange (not present in the 2018 base-year scenario cordon)
- 27 internal zones representing origins/destinations inside the study area
- Three zones representing train stations
- Seven zones representing light rail stops
- Two zones representing other destinations (Glebe Island Container Terminal and Glebe Point Ferry).

Appendix F shows the PTPM cordon and zoning for 2018 and 2036.

Only the entrance and exit points to the WestConnex Rozelle Interchange on City-West Link Road were included in the model. Consequently, any trips between the following centroids do not enter the modelled road network at any point:

- New M4 Motorway
- M8 Motorway
- Western Harbour Tunnel
- Victoria Road.

The demands between these centroids were removed from the matrix. Note that the demands between the centroids listed above and all other centroids in the study area remain in the matrix as these vehicles will enter the modelled network.

The PTPM includes four road-user vehicle types:

- Cars
- Light commercial vehicles (LCV)
- Rigid heavy vehicles
- Articulated heavy vehicles.

The Aimsun model only differentiates between light vehicles and heavy vehicles. The PTPM matrix was aggregated to produce two separate matrices representing light and heavy vehicles.

Growth across the study area was determined separately for each OD pair in the strategic model. The growth was calculated based on a subtraction of the 2018 PTPM matrix from the 2036 PTPM matrix. Zones that only exist in the 2036 PTPM matrix (i.e. those representing the WestConnex Rozelle Interchange) were assigned zero demand in 2018.

The strategic model growth was disaggregated to match the zoning structure already established in the Aimsun model. As was the case with the Base Model, the vehicle demand for train stations and light rail stops in the study area was low. These were not included as separate centroids in the Base Model, with the demand for these locations incorporated into the surrounding zone/s. The growth at these locations was similarly incorporated into the surrounding zones in the Aimsun model.

4.2 Incremental growth application

The traffic demand was incrementally applied to the Base Model to determine the network capacity. The following methodology was used:

1. Add a fixed proportion of the PTPM growth to the Base Model demand.
2. Apply this demand to the Aimsun model.
3. Run the model and extract the model input count (the number of vehicles that are able to enter the model during the simulation period).
4. Graph the proportion of growth applied versus the model input count for each scenario to determine the maximum network capacity.

The network capacity was assumed to occur at the proportion of the PTPM growth applied where the number of vehicles able to enter the model during the simulation period is at a maximum.

Figure 4-1 shows the demand applied and number of vehicles arrived in the network by the end of the simulation period for the proportions of the PTPM demand applied. The application of 40 per cent, to the nearest five percent, of the PTPM growth to the Base Network resulted in a peak in the number of vehicles able to enter the model during the simulation period.

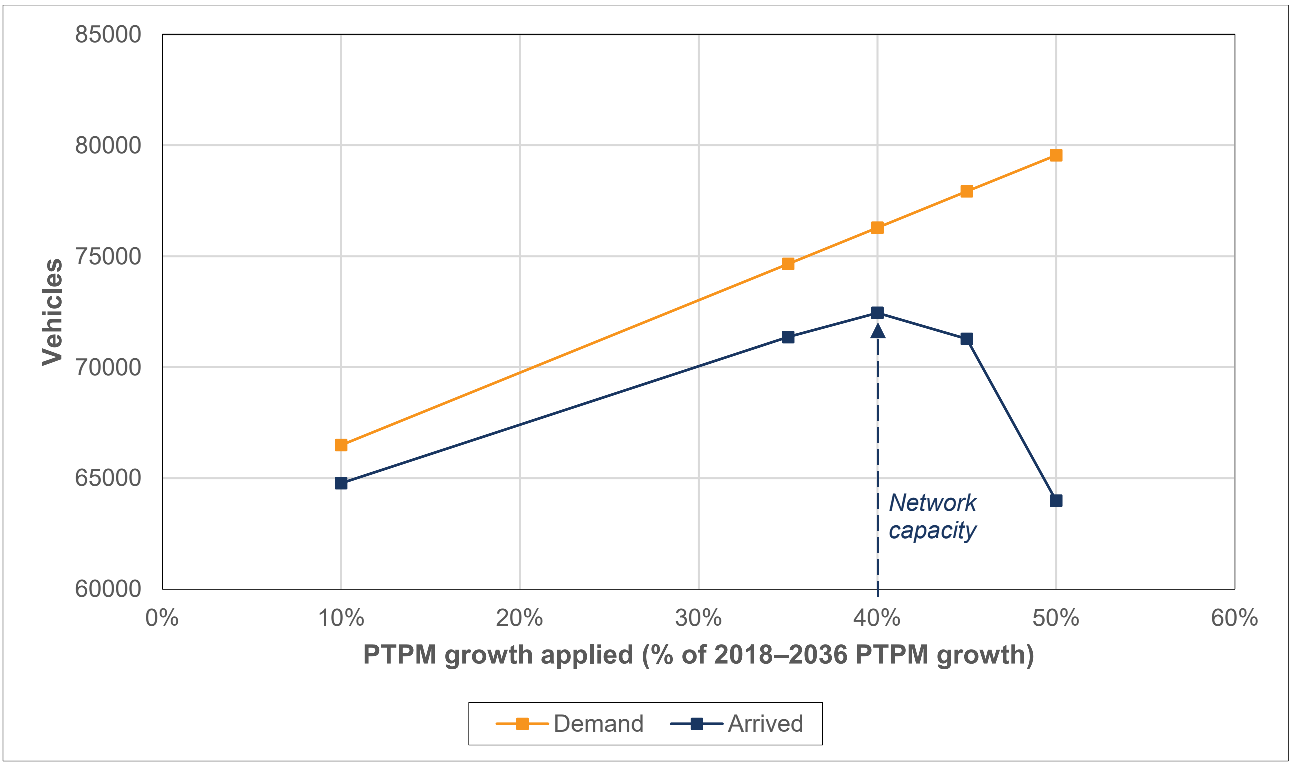


Figure 4-1 Incremental growth application results

4.3 Comparison of network capacity VKT to PPM penalty scenarios

The following procedure was used to determine the PTPM scenario with PPM penalty that most closely corresponds to the Network Capacity Model:

1. Calculate the change in vehicle kilometres travelled (VKT) between the Aimsun Network Capacity Model and Base Model as a percentage of the Base Model VKT
2. For each PPM penalty scenario, determine the change in VKT between the PTPM future scenario and PTPM base scenario as a percentage of the base VKT
3. Compare the Aimsun VKT change to the PTPM VKT change and identify which PPM penalty scenario has a VKT closest to that of the Aimsun model.

Figure 4-2 shows the change in VKT from the PTPM base scenario (2018) with each PPM penalty scenario applied. PPM0 resulted in an increase in VKT of 10.1 per cent while PPM60 resulted in a decrease of 11.0 per cent. The Network Capacity Model (2036 40% Growth) exhibited a decrease in VKT of 3.9 per cent compared to the Aimsun base scenario (2018). A decrease of 3.9 per cent corresponds to between PPM30 and PPM45 in the PTPM.

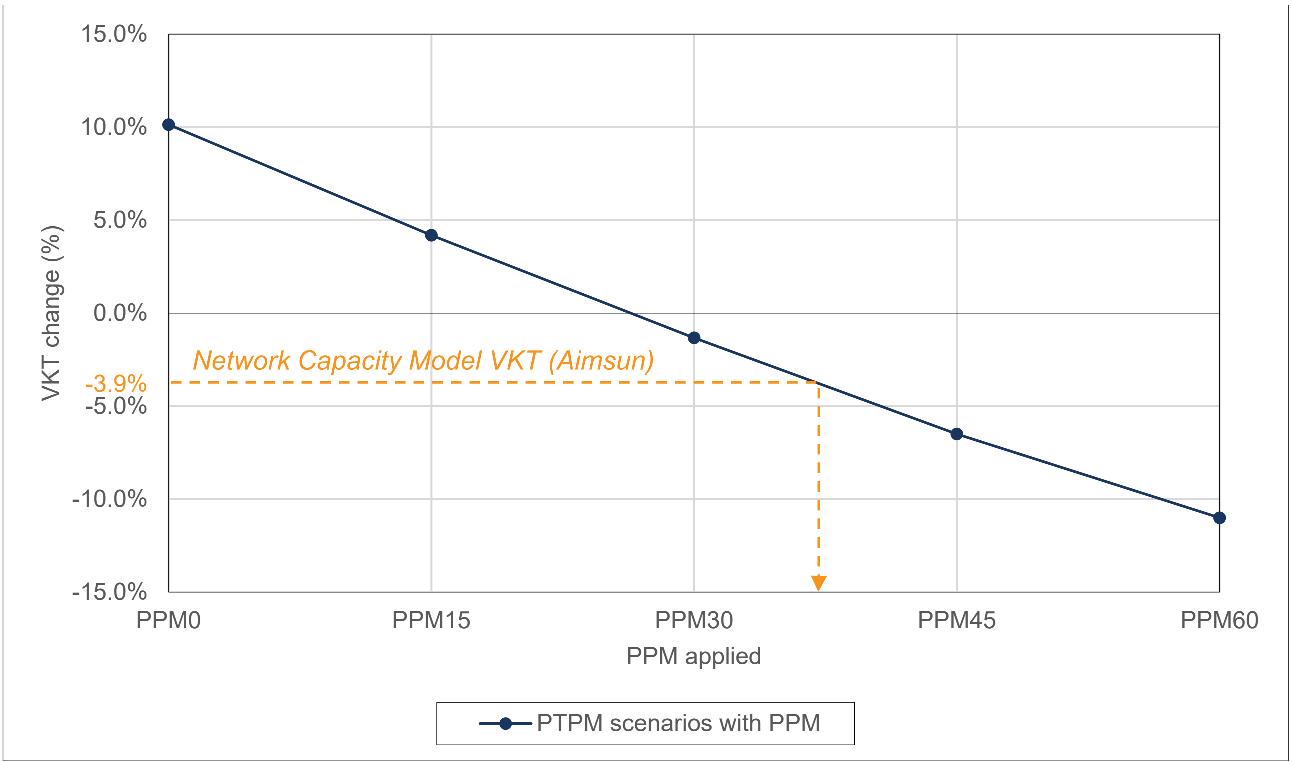


Figure 4-2 Comparison of Aimsun and PTPM VKT changes between scenarios

Cardno was advised by Transport for NSW and DPIE that to maintain consistency with other precincts along the corridor, PPM15 would be applied to all subsequent modelling.

4.4 STFM demand estimation

SGS Economics & Planning (SGS) were commissioned by DPIE to review and update the land-use within the study area. The updated land-use was supplied to Transport for NSW to run the STM, PTPM and PPM. PwC were commissioned by DPIE to apply the PTPM growth to the STFM using a modified methodology designed to account for negative growth in the PTPM. The methodology for this assessment was outlined in *PRCUTS Transport Model Update Recommendations Action Plan, updated based on comments from TfNSW* (PwC, June 2021). The STFM matrices from the PwC update for the study area were provided to Cardno.

The STFM was run with two scenarios:

> No Development

> With Development.

Cardno was instructed by DPIE to use the With Development scenario in the Aimsun model. All future references to the STFM demand in this report refer to the With Development scenario demand.

This section outlines the methodology for developing the future traffic demands using the STFM matrices. The steps are briefly outlined below:

1. Growth in the STFM for each origin-destination (OD) pair was calculated by subtraction of the base year matrix (2018) from the future year matrix (2026 or 2036)
2. The STFM growth was disaggregated to match the Aimsun zoning structure.
3. The growth was applied to the base matrices.
4. The future matrices were profiled using the same profile as the base matrices.

The following sections summarise the STFM and Aimsun demands.

4.4.1 STFM demand summary

This section provides a summary of the STFM demand

4.4.1.1 WestConnex demands

The STFM demands include trips that only use the WestConnex tunnels and do not interact with the surface network at all. **Figure 4-3** shows the number of trips in each year and peak that only use the WestConnex network within the study area. Only the entry and exit portals to WestConnex are part of the model, so vehicles that do not use the surface network at all are not included in the Aimsun models. This demand was removed from the STFM demands prior to calculating the STFM growth in the study area.

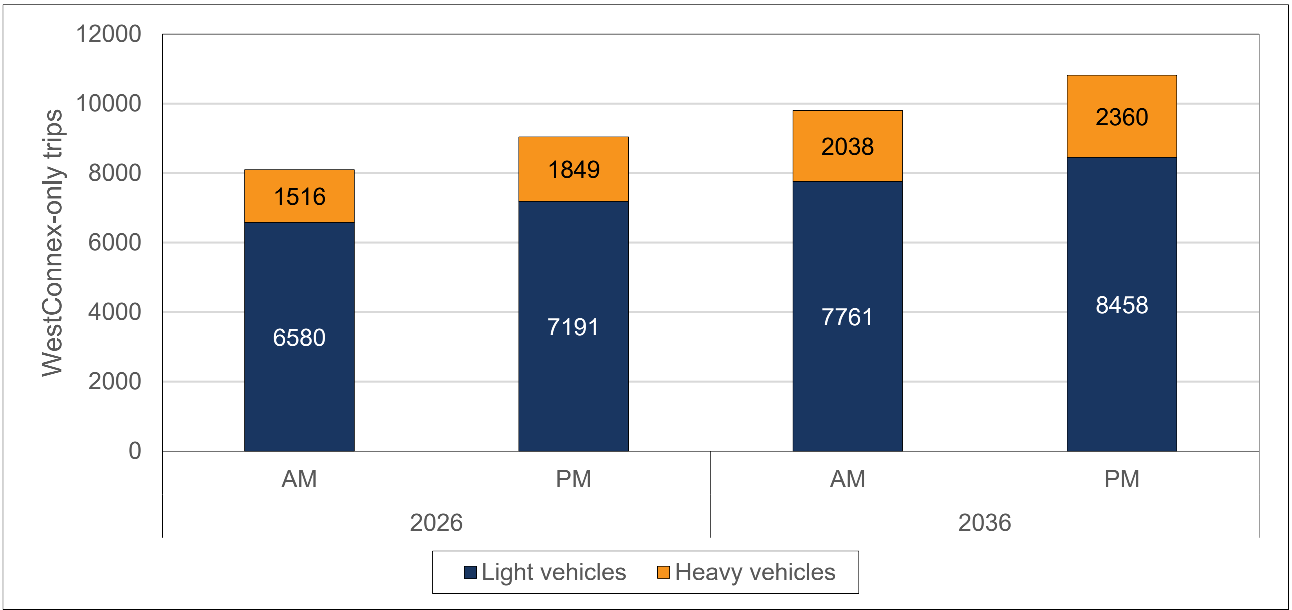


Figure 4-3 STFM WestConnex-only trips

4.4.1.2 STFM trip distribution

Trips were classified based on their origin and destination:

> **External-external** (through trips): Trips with both origin and destination outside the study area, but that transit through the study area

> **Internal-external**: Trips with an origin inside the study area but destination outside the study area

> **External-internal**: Trips with an origin outside the study area but destination inside the study area

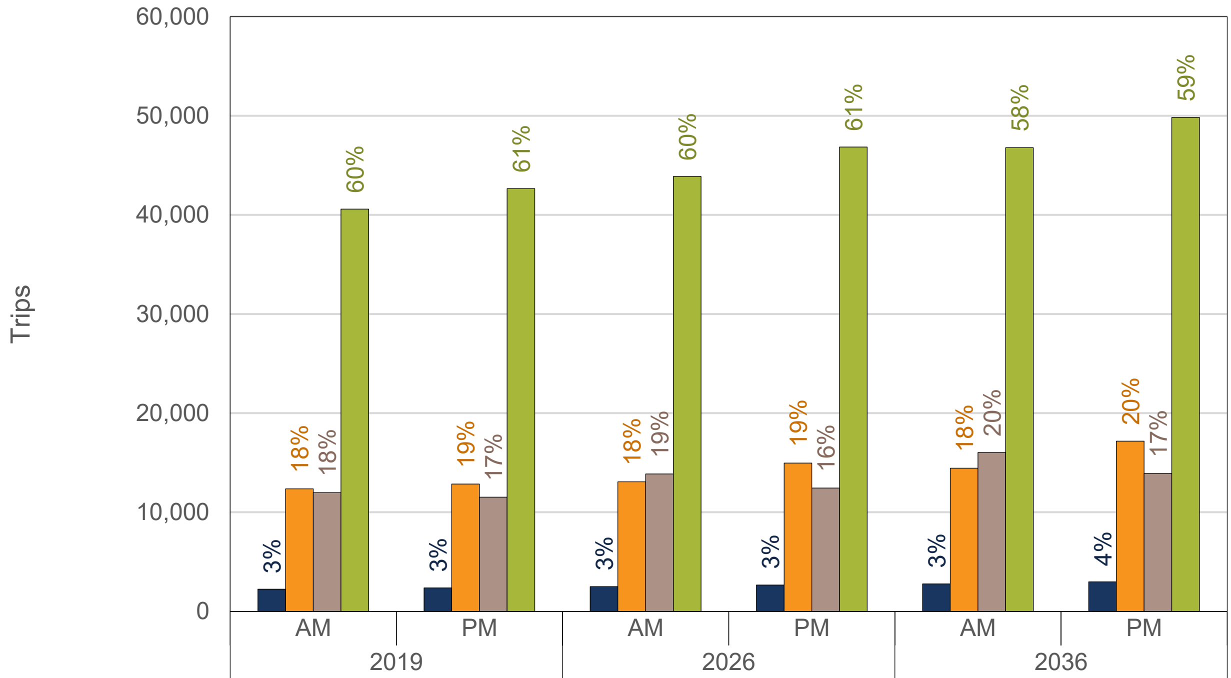
> **Internal-internal**: Trips with both origin and destination inside the study area.

Figure 4-4 shows the distribution of trips in the study area. The main observations are listed below.

> Trips entirely within the study area only represent a small proportion of the total demand in each peak.

> Trips with either an origin or destination in the study area, but not both, make up between 35 and 38 per cent of the total demand in each peak. Trips from the study area to external destinations are typically higher in the AM Peak, while trips from external destinations to the study area are higher in the PM Peak.

> Through trips (external-external) make up about 60 per cent of the total demand in each year.



	2019 AM	2019 PM	2026 AM	2026 PM	2036 AM	2036 PM
Internal-internal	2236	2361	2495	2665	2775	2974
Internal-external	12364	12849	13079	14963	14447	17167
External-internal	11970	11526	13860	12443	16020	13918
External-external	40586	42657	43879	46847	46788	49836

Internal-internal ■ Internal-external ■ External-internal ■ External-external

Figure 4-4 STFM trip distribution

4.4.1.3 STFM demand summary

Figure 4-5 shows the STFM demand in each future year. These values exclude the WestConnex-only trips identified in **Section 4.4.1.1**.

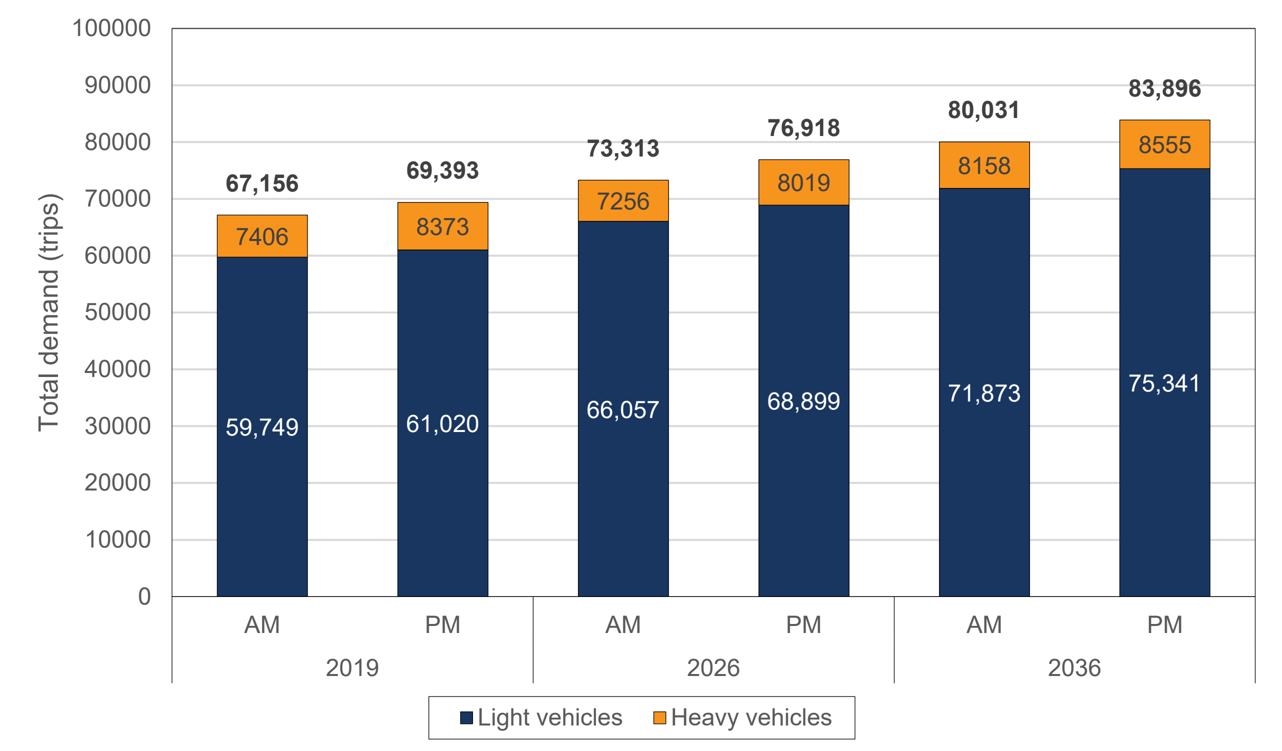


Figure 4-5 STFM demand in each future year

Table 4-1 provides a summary of the STFM demand and growth between 2019 and the two future years for each vehicle type. The main findings are discussed below.

> Between 2019 and 2026, the overall traffic demand increases by 11 per cent in the AM Peak and 13 per cent in the PM Peak. This corresponds to an additional 6308 and 7879 trips respectively.

> There is a decrease in the total heavy vehicle demand between 2019 and 2026 of two per cent in the AM Peak and four per cent in the PM Peak. The reduction is cause by diverting through traffic truck trips to WestConnex.

> Both light and heavy vehicle volumes increase between 2026 and 2036. The total traffic increase from 2019 is 19 per cent in the AM Peak and 21 per cent in the PM Peak.

Table 4-1 STFM growth summary

Year	AM Peak			PM Peak		
	Light vehicles	Heavy vehicles	All vehicles	Light vehicles	Heavy vehicles	All vehicles
2019	59,749	7406	67,156	61,020	8373	69,393
2026	66,057	7256	73,313	68,899	8019	76,918
2019 – 2026 growth	6308 (+11%)	-150 (-2%)	6157 (+9%)	7879 (+13%)	-354 (-4%)	7525 (11%)
2036	71,873	8158	80,031	75,341	8555	83,896
2019 – 2036 growth	12124 (+20%)	752 (+10%)	12876 (+19%)	14321 (+23%)	182 (+2%)	14503 (+21%)

4.4.2 Aimsun traffic demand

The STFM growth was disaggregated to match the Aimsun zoning structure.

Figure 4-5 shows the STFM demand in each future year. The values indicated exclude the WestConnex-only trips identified in **Section 4.4.1.1**.

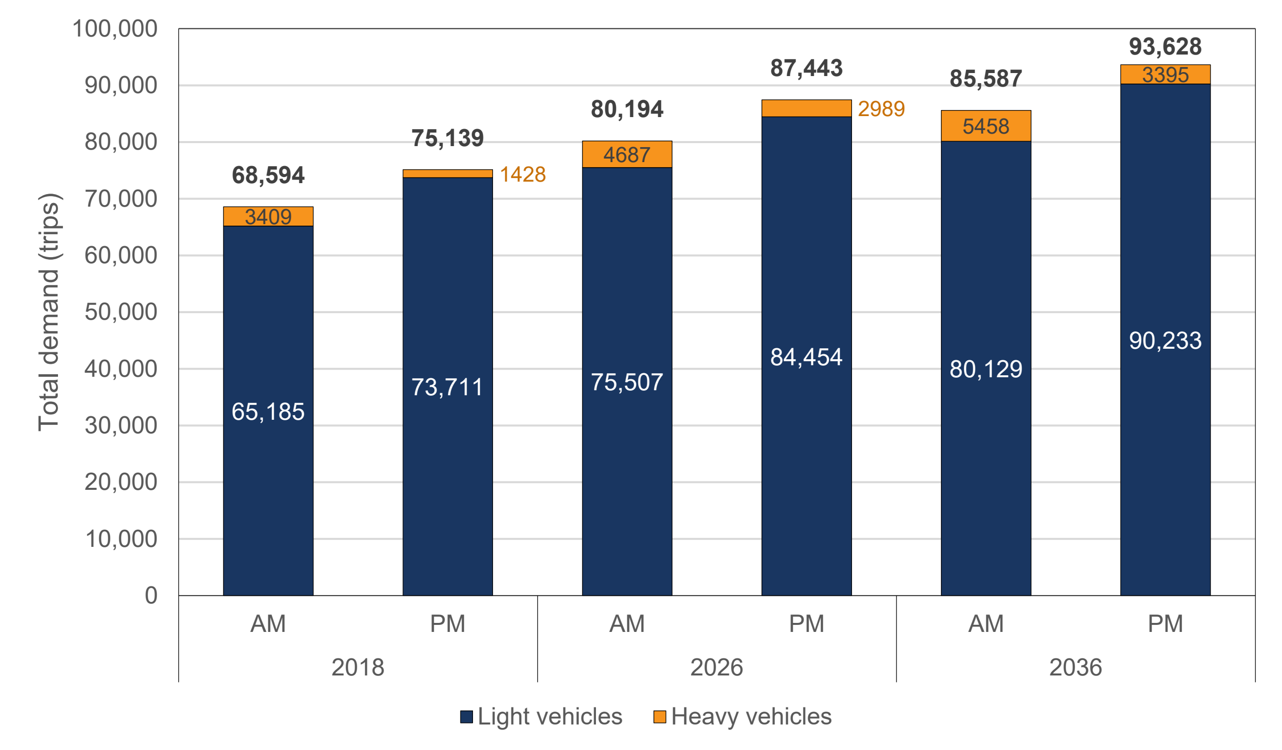


Table 4-3 summarises the future demand for the Aimsun model. The key observations are highlighted below.

> The STFM heavy vehicle demand for the base year is much higher than the Aimsun model demand. The Aimsun demand was validated using traffic surveys for more than 80 intersections across the study area.

> Application of the heavy vehicle growth from STFM (including negative growth) results in a number of ODs with negative heavy vehicle trips in the Aimsun matrix. **Table 4-2** shows that the STFM growth results in about 10 to 14 per cent of ODs having a negative heavy vehicle volume. These ODs were set to zero trips in the Aimsun matrix, which is a conservative assumption as it increases the number of vehicles in the model.

Table 4-2 ODs with negative trips in the Aimsun traffic demand

Year	Number of ODs with negative HV trips		Total number of negative HV trips	
	AM Peak	PM Peak	AM Peak	PM Peak
2026	3085 (13%)	3347 (14%)	1498 (30%)	2015 (64%)
2036	2432 (10%)	2640 (11%)	1366 (21%)	1901 (46%)

> The Aimsun growth is higher than the STFM growth because:

- The Aimsun growth includes an additional year of growth (2018-2019) as the Aimsun base year is 2018 while the STFM base year is 2019.
- ODs where the demand became negative when the STFM growth was applied were set to nil which introduces more trips into the matrix.

Table 4-3 Aimsun traffic demand

Year	AM Peak			PM Peak		
	Light vehicles	Heavy vehicles	All vehicles	Light vehicles	Heavy vehicles	All vehicles
2019	65,185	3409	68,594	73,711	1428	75139
2026	75,507	4687	80194	84,454	2989	87443
2019 – 2026 growth	10,322 (+16%)	1278 (+37%)	11,600 (17%)	10,743 (15%)	1,561 (109%)	12,304 (16%)
2036	80,129	5458	85587	90,233	3395	93628
2019 – 2036 growth	14,944 (23%)	2,049 (60%)	16,993 (25%)	16,522 (22%)	1,967 (138%)	18,489 (25%)

5 Base Model operational results

This section outlines the Base Model operational results. The development, calibration and validation of the Base Models was previously outlined in *Base Model Development Report* (Cardno, 28 October 2020). The results in this section establish the base reference case for comparative assessment with future scenarios.

5.1 Data inputs

The Base Models were developed using the following inputs:

> Cordon matrices from the STFM

> Intersection counts

> Travel time data from TomTom

> Traffic signal data, including historical phase times, cycle times and offsets

> Public transport operations from the GTFS feed.

5.2 Model specifications and assumptions

The traffic model was developed to replicate the road network conditions observed at the time of development. The settings and parameters of note from the Base Model are:

> Aimsun version 8.4.3[4] was used to develop the Base Models

> 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 fixed using historical timings from SCATS data in 15-minute intervals (microsimulation area) or one-hour intervals (mesoscopic simulation area)

> The peak periods were identified using traffic counts across all surveyed intersections:

- AM Peak: 7:15AM – 9:15AM
- PM Peak: 4:30PM – 6:30PM.

> The Base Model was developed in accordance with *Traffic Modelling Guidelines* (Roads and Maritime Services, 2013). The calibration and validation results showed that the Base Model provides an acceptable representation of existing conditions, including:

- High network-wide calibration with over 89 per cent of turns having a GEH less than five in the AM Peak and over 90 per cent in the PM Peak
- High statistical correlation between modelled and observed turning volumes
- Modelled travel time on key routes fits well with the observed data.

The *Base Model Development Report* (Cardno, October 2020) is attached to this report as **Appendix A**.

The Base Model was reviewed by Arup on behalf of DPIE and Transport for NSW and the findings summarised in *Base Model Peer Review* (Arup, March 2020) which is attached to this report as **Appendix B**. The model and report were refined based on Arup's comments and resubmitted to Arup for independent review. The model was subsequently endorsed as fit for purpose by Arup.

[4] 2020-06-03 (b46ec77181 x64 Python 2)

5.3 Existing network performance

5.3.1 Network performance summary

Table 5-1 summarises the Base Model network performance results for all peaks. Traffic demand is highest in the PM Peak, and this corresponds to a higher VKT and VHT. However, network performance is generally worse in the AM Peak with a lower mean speed and increased average delay. Unreleased demand is very low in both peaks.

Table 5-1 Network performance results – Base Model

Network performance metric	Unit	2018 Base Model results	
		AM Peak	PM Peak
All vehicles			
Total traffic demand	veh	68,595	75,142
Total vehicles arrived	veh	68,933	74,849
Total kilometres travelled (VKT)	km	168,922	188,415
Vehicle hours travelled (VHT)	hr	6718	6988
Average per vehicle			
Average kilometres travelled	km	2.5	2.5
Average time travelled in network	s	147	138
Average speed	km/hr	27.6	29.0
Average delay	s	78	71
Unreleased demand			
Unreleased demand (% of total demand)	veh (%)	4 (0.0%)	3 (0.0%)

5.3.2 Person statistics

Table 5-2 shows key network statistics per person based on the assumed vehicle occupancies outlined in **Section 3.2.1**.

Table 5-2 Network statistics by person – Base Model

Network performance metric	Unit	2018 Base Model results			
		AM Peak		PM Peak	
		LV	HV	LV	HV
Network statistics by vehicle type					
Total vehicles arrived	veh	65,210	3361	73,284	1486
Total kilometres travelled (VKT)	km	158,156	9785	183,672	4531
Vehicle hours travelled (VHT)	hr	6254	401	6800	176
Average speed	km/hr	27.7	27.0	29.0	28.6
Average delay	s	78	78	71	69
Network statistics by person					
Total persons arrived	person	72,698	3361	81,699	1486
Total person-kilometres travelled	km	176,316	9785	204,762	4531
Total person-hours travelled	hr	6973	401	7581	176
Average speed per person	km/hr	27.7	27.0	29.0	28.6
Average delay per person	s	87	78	79	69

5.4 Existing travel times

This section provides an overview of the travel times on key routes and through the PRCUTS precincts in the 2018 Base Model.

5.4.1 Travel times on key routes

Travel times on key routes were validated in the development of the Base Model. **Table 5-3** lists the modelled 2018 travel times on each route. The average speed along each route is also included. The colour code shown was presented in **Section 3.2.2** and excludes any temporary speed reductions such as school zones.

Note that the travel times shown in this table are for vehicles that traverse the full length of the route only.

Table 5-3 Travel times on key routes – Base Model

Route	Dir.	Travel time (s)		Average speed (km/hr)	
		AM Peak	PM Peak	AM Peak	PM Peak
Balmain Road	NB	332	250	15.5	20.6
	SB	188	169	18.3	20.4
Crystal Street	NB	176	195	17.6	15.9
	SB	273	224	11.4	13.9
Johnston Street	NB	312	284	20.2	22.2
	SB	254	302	24.7	20.8
Marion Street	EB	320	219	17.5	25.6
	WB	209	205	26.8	27.3
Parramatta Road	EB	1165	881	19.1	25.2
	WB	820	927	27.0	23.9

5.4.2 Travel times through precincts

Table 5-4 shows the modelled travel time through each precinct in each direction. Overleaf, **Figure 5-1** and **Figure 5-2** show travel times through each precinct along Parramatta Road for the eastbound and westbound directions respectively.

Table 5-4 Precinct travel times – Base Model

Direction	Travel time through precinct (s)		
	Taverners Hill	Leichhardt	Camperdown
AM Peak			
Eastbound	407	390	223
Westbound	197	284	115
PM Peak			
Eastbound	278	332	126
Westbound	215	292	179

Note that the travel times shown in these graphs are the cumulative sum of the travel times of each section along the route, so include vehicles that only traverse part of the route.

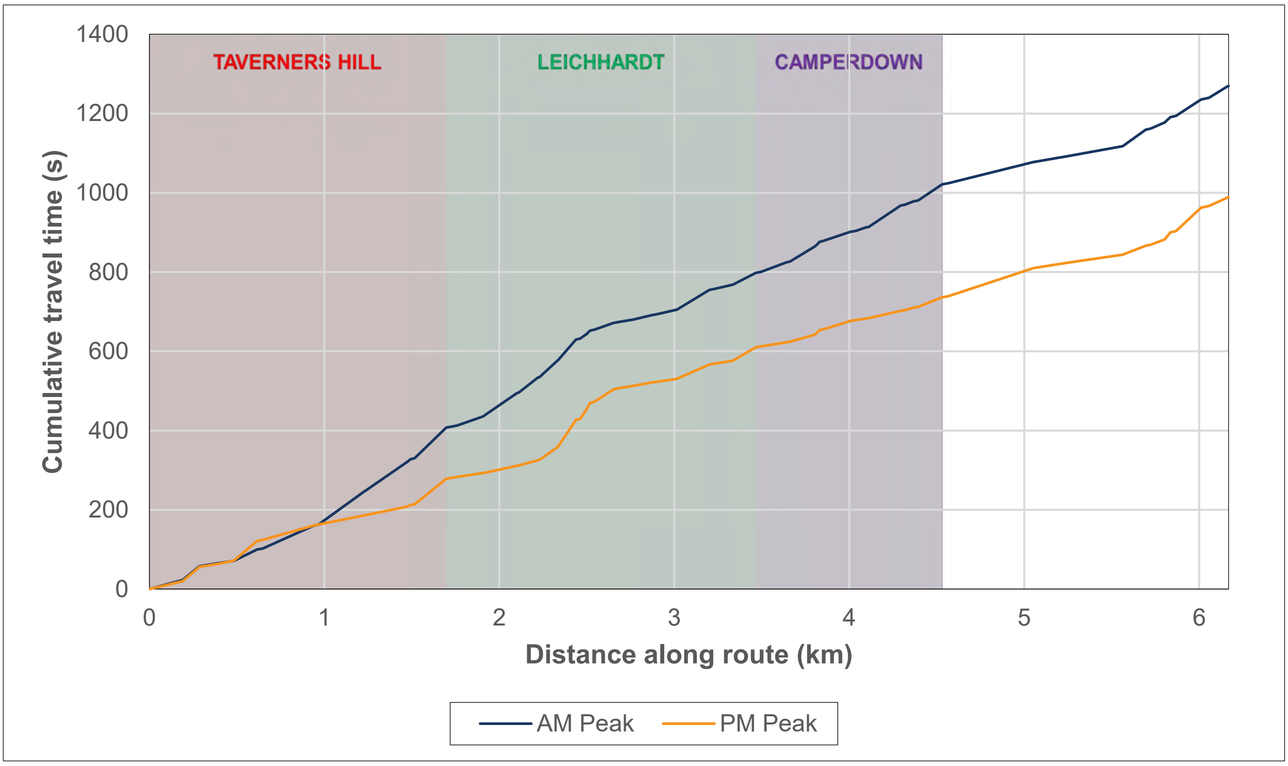


Figure 5-1 Travel times between precincts (eastbound) –Base Model

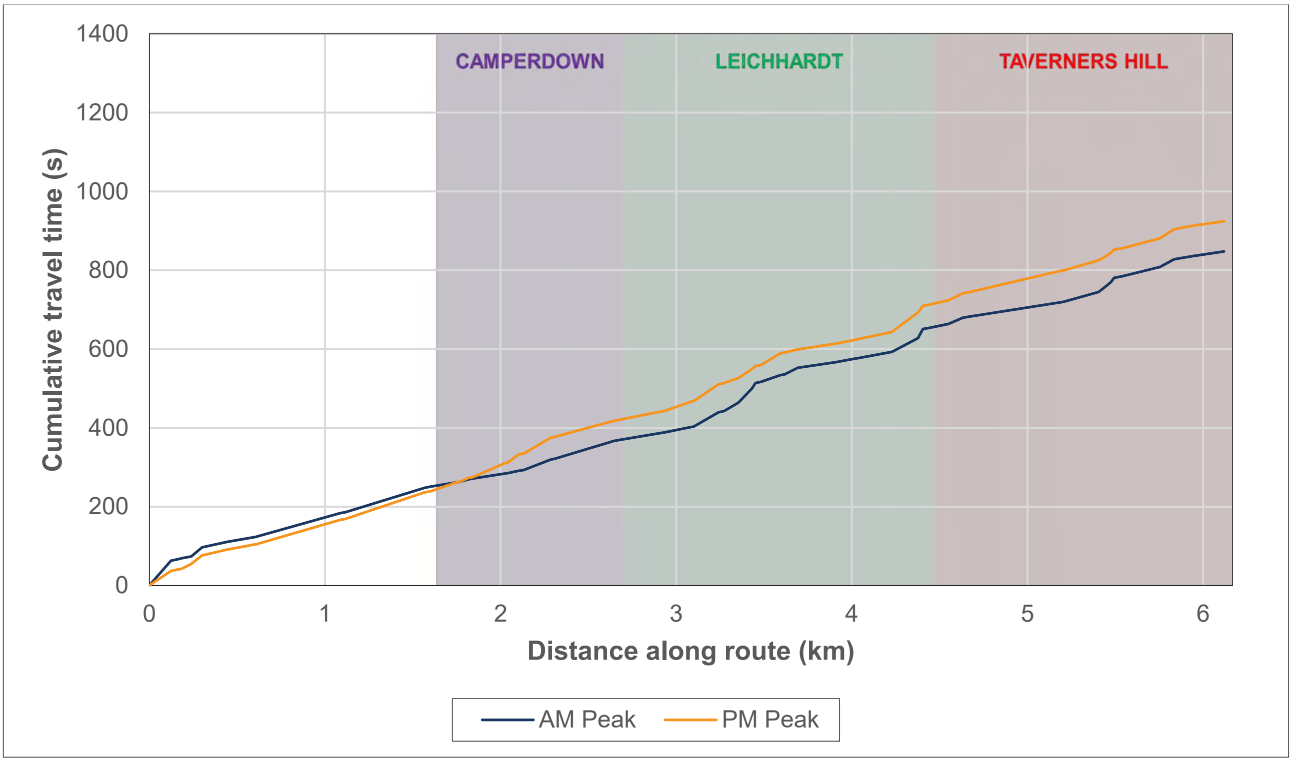


Figure 5-2 Travel times between precincts (westbound) –Base Model

5.5 Existing intersection performance

This section provides an overview of intersection performance in the study area. The results shown are for intersections in the PRCUTS precincts only. Detailed performance results for all intersections assessed are provided in **Appendix H**.

5.5.1 Intersection operation

Table 5-5 and **Table 5-6** show the intersection performance results for the AM and PM peaks respectively. These intersections were among those calibrated using survey data as documented in *Base Model Development Report* (Cardno, 2020). It is not recommended to assess the performance of intersections that were not calibrated.

The following sections provide a brief summary of the turns, movements and intersections that are at or over capacity in each peak. In general, most intersections along the corridor show acceptable performance for through traffic on Parramatta Road, however there is in most cases insufficient capacity on the side roads and some right turns from Parramatta Road.

Intersection performance at signalised intersections is based on the weighted average delay. Given that the through traffic movements on Parramatta Road are considerably higher than other movements at these intersections, overall intersection performance may be acceptable while there remain significant delays on the side road approaches.

AM Peak

- At Marion Street / Leichhardt Street / Balmain Road, the average delay on Balmain Road in both directions exceeds 70 seconds which corresponds to LOS F. The worst approach is Balmain Road (S). All movements on these approaches are LOS F across both hours.
- While the overall performance of Pyrmont Bridge Road / Booth Street / Mallett Street is LOS D, delays on Booth Street correspond to LOS E or F in both hours, and the right turn from Pyrmont Bridge Road is also LOS E in both hours.
- Parramatta Road / Liverpool Road is LOS C overall, but performance of the right turns from Liverpool Road and Parramatta Road is LOS E with an average delay of more than 60 seconds in the second hour.
- While the Parramatta Road movements at Sloane Street all have average delays of less than 38 seconds, most movements from Sloane Street in both directions are LOS E in both hours.
- Parramatta Road / Old Canterbury Road / Tebbutt Street performs at LOS F due queue spillback from the West Street intersection.
- The left and right turns out of Norton Street at Parramatta Road perform at LOS F in the first hour of the AM Peak. Performance improves to LOS C on the left turn and LOS E on the right turn in the second hour.
- The right turn from Parramatta Road into West Street experiences delays of over 140 seconds in both hours. At this intersection, some movements on Flood Street also perform at LOS F.
- The through and right turn movements from Crystal Street at Parramatta Road experience delays exceeding 80 seconds in both hours, corresponding to LOS F. This intersection in particular is a bottleneck in the AM Peak with the average delay eastbound on Parramatta Road also exceeding 80 seconds by the second hour.
- At Parramatta Road / Catherine Street / Phillip Street, most movements on the side roads perform at LOS E or worse in both hours. The highest delay is on the right turn movements. By the second hour, the average delay on Catherine Street exceeds 200 seconds.
- On Percival Road approaching Parramatta Road, average delay exceeds 70 seconds for all movements by the second hour.
- Average delays on Johnston Street and Northumberland Avenue were at least 52 seconds for all movements, with some turns experiencing delays of up to 89 seconds. The right turn from Parramatta Road also experienced heavy delays of up to 107 seconds.
- The right turn from Bridge Road is LOS F in the first hour and LOS E in the second hour.
- Average delay on Pyrmont Bridge Road is equivalent to LOS E in both peaks.

- At Parramatta Road / Mallett Street, delays increase throughout the AM Peak, with all movements on the southern approach exceeding 70 seconds average delay by the second hour.
- The side road movements at Parramatta Road / Missenden Avenue / Lyons Road experience delays of up to 106 seconds. The worst-performing movements are on Lyons Road. The right turn from Parramatta Road also has an average delay of 85 seconds in the first hour and 110 seconds in the second hour.

PM Peak

- At Marion Street / Leichhardt Street / Balmain Road, average delay on Balmain Road in both directions corresponds to LOS F. Delays on the southern approach are highest and were up to 89 seconds.
- At Liverpool Road, the right turn from Parramatta Road is LOS F in both peaks with delays up to 159 seconds. The right turn from Liverpool Road is also LOS E in the first hour but improves to LOS D in the second.
- The northern approach to Parramatta Road / Sloane Street is over capacity in both hours with delays exceeding 62 seconds on all approaches. Most movements on the southern approach are also LOS E in both hours.
- At Parramatta Road / Norton Street, the right turn from Norton Street performs at LOS E in both peaks, but all other movements have average delays less than 56 seconds (LOS D or better).
- Overall intersection performance at Parramatta Road / Flood Street / West Street is LOS E in both hours of the PM Peak. Average delays on at least one movement on all approaches except West Street corresponds to LOS F in one or both hours. The worst performing movements are the through and right turn from Flood Street, all movements on Parramatta Road in the westbound direction and the right turn from Parramatta Road (W) into West Street.
- All movements on Crystal Street at Parramatta Road experience delays corresponding to LOS F in one or both hours. In particular, the through and right turn movements experience protracted delays of up to 153 seconds. The right turn from Parramatta Road into Crystal Street also has an average delay corresponding to LOS E in both hours.
- The left turn from Phillip Street onto Parramatta Road has an average delay corresponding to LOS F in both hours. This is caused by downstream queueing which prevents vehicles from turning into Parramatta Road.
- The through and right turn movements on Johnston Street have average delays of up to 107 seconds. The right turn from Parramatta Road into Johnston Street also experiences delays up to 82 seconds (LOS F).
- The right turn from Parramatta Road at Bridge Road is LOS E in the first hour and LOS F in the second hour. The right turn from Bridge Road is also LOS E in the second hour.
- Pyrmont Bridge Road experiences long delays in both hours that correspond to LOS F. The maximum delay is 116 seconds. In the second hour, queueing on Parramatta Road in the westbound direction also results in delays of up to 70 seconds.
- Mallett Street performs poorly in both directions. The average delay on the left and through movements is LOS E in most instances, and the right turns are LOS F with average delays of up to 185 seconds.
- The right turn out of Dalhousie Street has an average delay of up to 94 seconds and is LOS F in both hours.
- At Missenden Road, most movements on Missenden Road are LOS E in both peaks.

Table 5-5 Intersection performance results – Base Model (AM Peak)

Intersection		Type	7:15AM – 8:15AM			8:15AM – 9:15AM		
			Vol. (veh)	Delay (s)	LOS	Vol. (veh)	Delay (s)	LOS
19	Marion Street / Norton Street	S	1753	28.0	B	1718	27.5	B
20	Marion Street / Leichhardt Street / Balmain Road	S	1611	41.5	C	1545	41.1	C
30	Pyrmont Bridge Road / Booth Street / Mallett Street	S	1783	51.0	D	1690	39.0	C
39	Parramatta Road / Liverpool Road	S	4055	38.0	C	4048	35.6	C
42	Tebbutt Street / Lords Road	S	1449	12.4	A	1498	15.6	B
44	Tebbutt Street / Hathern Street	S	1425	19.7	B	1508	20.0	B
45	Parramatta Road / Sloane Street	S	3975	18.3	B	3893	27.4	B
47	Parramatta Road / Old Canterbury Road / Tebbutt Street	S	3727	73.5	F	3763	80.7	F
50	Parramatta Road / Norton Street	S	3285	24.6	B	3321	14.7	B
51	Parramatta Road / Flood Street / West Street	S	3648	56.4	D	3672	56.4	D
52	Parramatta Road / Crystal Street / Balmain Road	S	3813	33.1	C	3731	42.7	D
53	Parramatta Road / Catherine Street / Phillip Street	S	3305	14.9	B	3292	38.4	C
67	Parramatta Road / Young Street / Percival Road	S	3433	26.6	B	3448	32.0	C
68	Parramatta Road /Northumberland Avenue / Johnston Street	S	4059	29.1	C	4050	32.9	C
69	Parramatta Road / Bridge Road	S	3964	38.2	C	3931	44.0	D
70	Parramatta Road /Pyrmont Bridge Road / Denison Street	S	3960	12.9	A	3980	12.5	A
71	Parramatta Road / Mallett Street	S	3850	33.2	C	3933	39.3	C
81	Parramatta Road / Dalhousie Street	S	3114	34.3	C	3169	37.0	C
83	Parramatta Road / Missenden Avenue / Lyons Road	S	3455	39.7	C	3676	49.0	D

Table 5-6 Intersection performance results – Base Model (PM Peak)

Intersection		Type	4:30PM – 5:30PM			5:30PM – 6:30PM		
			Vol. (veh)	Delay (s)	LOS	Vol. (veh)	Delay (s)	LOS
19	Marion Street / Norton Street	S	1575	24.5	B	1596	28.3	B
20	Marion Street / Leichhardt Street / Balmain Road	S	1456	40.5	C	1441	41.7	C
30	Pyrmont Bridge Road / Booth Street / Mallett Street	S	1689	23.8	B	1864	25.2	B
39	Parramatta Road / Liverpool Road	S	4584	33.5	C	4671	43.1	D
42	Tebbutt Street / Lords Road	S	1656	16.0	B	1657	16.1	B
44	Tebbutt Street / Hathern Street	S	1774	25.4	B	1763	30.3	C
45	Parramatta Road / Sloane Street	S	4484	22.3	B	4589	28.3	B
47	Parramatta Road / Old Canterbury Road / Tebbutt Street	S	4065	17.7	B	4217	17.1	B
50	Parramatta Road / Norton Street	S	3595	32.0	C	3808	30.7	C
51	Parramatta Road / Flood Street / West Street	S	4048	59.1	E	4339	59.4	E
52	Parramatta Road / Crystal Street / Balmain Road	S	3971	38.4	C	4167	32.2	C
53	Parramatta Road / Catherine Street / Phillip Street	S	3407	24.3	B	3542	27.5	B
67	Parramatta Road / Young Street / Percival Road	S	3468	16.7	B	3603	17.1	B
68	Parramatta Road /Northumberland Avenue / Johnston Street	S	4287	28.3	B	4470	33.8	C
69	Parramatta Road / Bridge Road	S	3876	26.2	B	4037	31.9	C
70	Parramatta Road /Pyrmont Bridge Road / Denison Street	S	3818	32.8	C	3991	49.7	D
71	Parramatta Road / Mallett Street	S	3494	19.1	B	3594	19.3	B
81	Parramatta Road / Dalhousie Street	S	3551	35.4	C	3707	37.2	C
83	Parramatta Road / Missenden Avenue / Lyons Road	S	3431	46.0	D	3564	37.0	C

Figure 5-3 and **Figure 5-4** show the intersection performance results on a map of the study area.

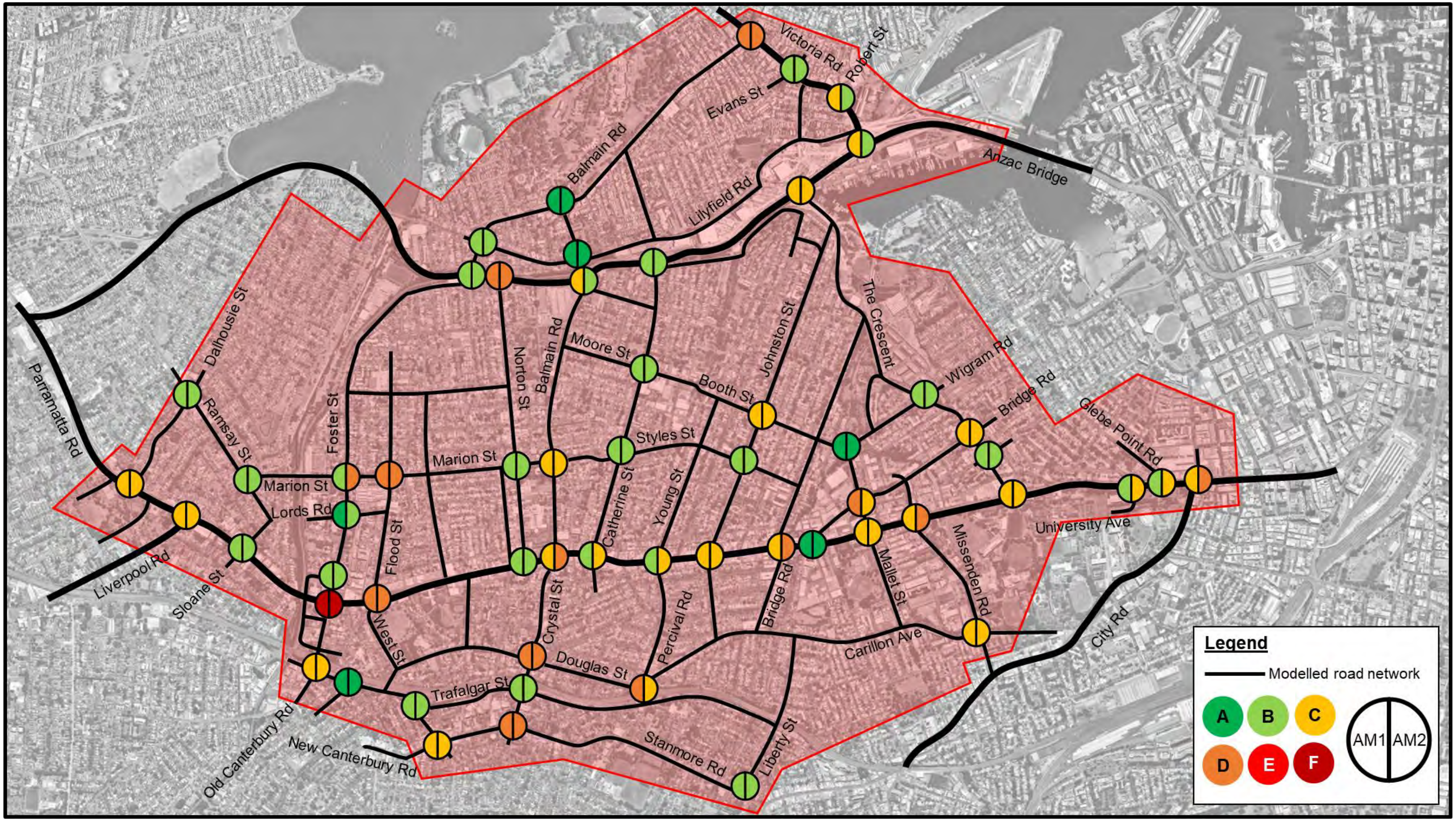


Figure 5-3 Intersection level of service – Base Model (AM Peak)

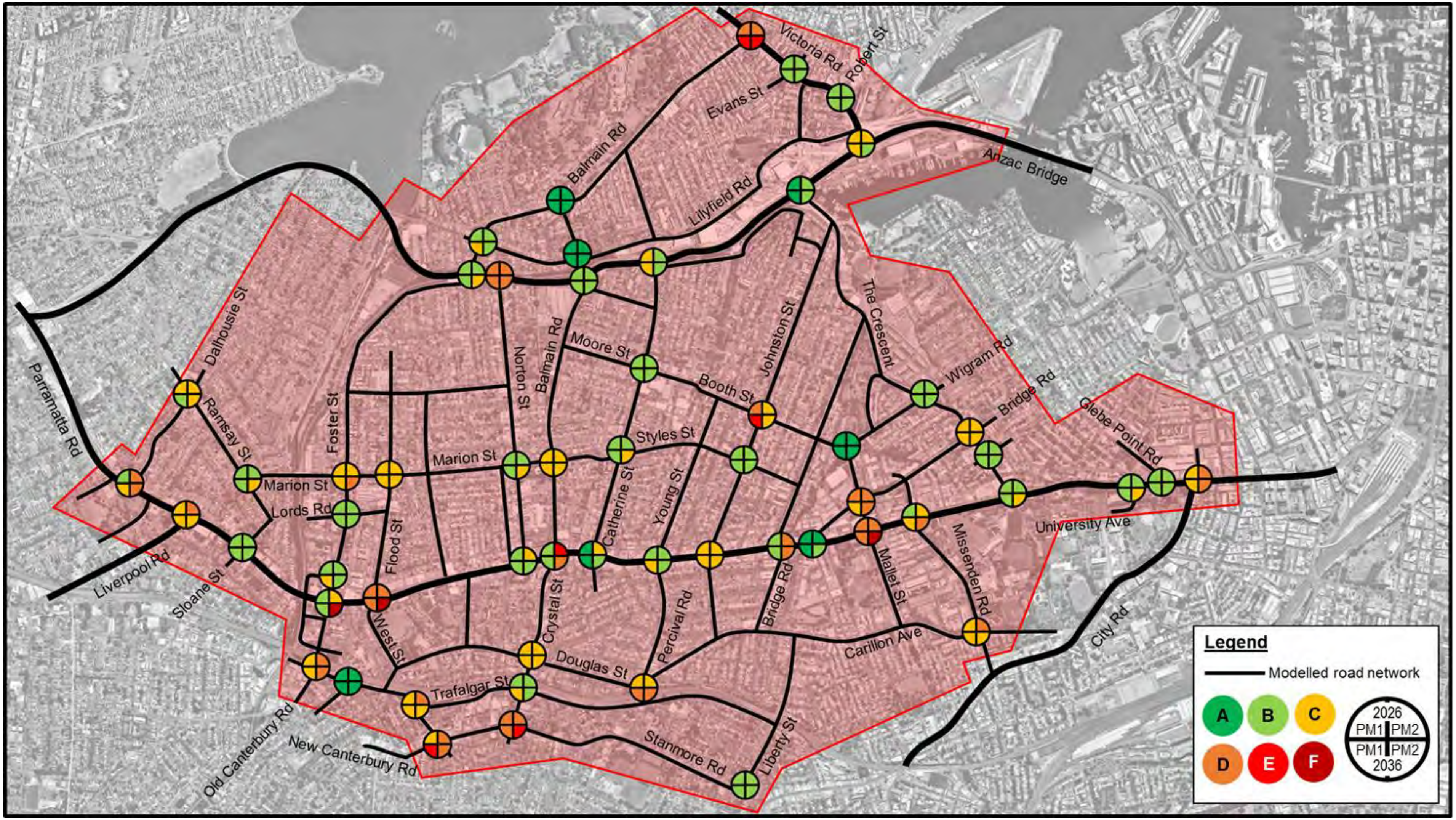


Figure 5-4 Intersection level of service – 2018 Base Model (PM Peak)

5.5.2 Queue lengths at major intersections

Table 5-7 shows the maximum queue length at major intersections along Parramatta Road in the PRCUTS precincts. On side roads, only queueing within the microsimulation area is included.

Table 5-7 Maximum queue length at major intersections in the PRCUTS precincts – Base Model

Intersection	Approach		Maximum queue length (m)	
			AM Peak	PM Peak
Parramatta Road / Dalhousie Street	N	Dalhousie Street	87	114
	E	Parramatta Road	91	86
	W	Parramatta Road	301	294
Parramatta Highway / Hume Highway	E	Parramatta Road	32	32
	S	Hume Highway	28	29
	W	Parramatta Road	116	136
Parramatta Road / Sloane Street	N	Sloane Street	45	50
	E	Parramatta Road	291	328
	S	Sloane Street	298	300
	W	Parramatta Road	306	147
Parramatta Road / Flood Street / West Street	N	Flood Street	134	231
	E	Parramatta Road	476	487
	S	West Street	66	68
	W	Parramatta Road	193	184
Parramatta Road / Norton Street	N	Norton Street	72	71
	E	Parramatta Road	117	121
	W	Parramatta Road	35	37
Parramatta Road / Crystal Street / Balmain Road	E	Parramatta Road	36	37
	S	Crystal Street	160	162
	W	Parramatta Road	115	116
Parramatta Road / Catherine Street	N	Catherine Street	176	68
	E	Parramatta Road	223	223
	S	Catherine Street	98	105
	W	Parramatta Road	51	48
Parramatta Road / Young Street / Percival Road	N	Young Street	104	100
	E	Parramatta Road	66	58
	S	Percival Road	82	65
	W	Parramatta Road	244	41
Parramatta Road / Johnston Street / Northumberland Avenue	N	Johnston Street	56	54
	E	Parramatta Road	83	81
	S	Northumberland Avenue	45	44
	W	Parramatta Road	146	140
Parramatta Road / Bridge Road	E	Parramatta Road	45	45
	S	Bridge Road	87	88
	W	Parramatta Road	34	26

Intersection	Approach		Maximum queue length (m)	
			AM Peak	PM Peak
Parramatta Road / Pyrmont Bridge Road / Denison Street	N	Pyrmont Bridge Road	73	164
	E	Parramatta Road	194	268
	W	Parramatta Road	40	39
Parramatta Road / Mallett Street	N	Mallett Street	72	71
	E	Parramatta Road	36	39
	S	Mallett Street	238	140
	W	Parramatta Road	265	37
Parramatta Road / Lyons Road / Missenden Road	N	Lyons Road	97	78
	E	Parramatta Road	198	353
	S	Missenden Road	62	103

5.6 Existing network plots

5.6.1 Traffic density

Figure 5-5 and **Figure 5-6** show the simulated traffic density for the AM and PM peaks respectively. In both peaks, traffic density is highest along Parramatta Road, with significant queueing approaching the Parramatta Road / West Street / Flood Street intersection in the AM Peak. Other areas with high traffic density include Crystal Street and the approaches to Victoria Road.

5.6.2 Speed ratio

Figure 5-7 and **Figure 5-8** show the simulated speed ratio for the AM and PM peaks respectively. Speed ratio is the average section speed as a proportion of the posted speed limit. The simulated speed ratio is low along Parramatta Road, particularly eastbound in the AM Peak and westbound in the PM Peak. Speed ratio is low on most approaches to signalised intersections along Parramatta Road, Victoria Road and City-West Link Road. Simulated speeds on Crystal Street and Stanmore Road, and their approaches, were low in both peaks also.

5.6.3 Heavy vehicle proportions

Figure 5-9 and **Figure 5-10** show the proportion of the total traffic volume on each link that is heavy vehicles. The proportion of heavy vehicles is significantly higher in the AM Peak than in the PM Peak on most roads. In the AM Peak, the heavy vehicle proportion on Parramatta Road westbound and City-West Link Road westbound is more than eight per cent. There is also high heavy vehicle traffic on Norton Street, Livingstone Road and Glebe Point Road.

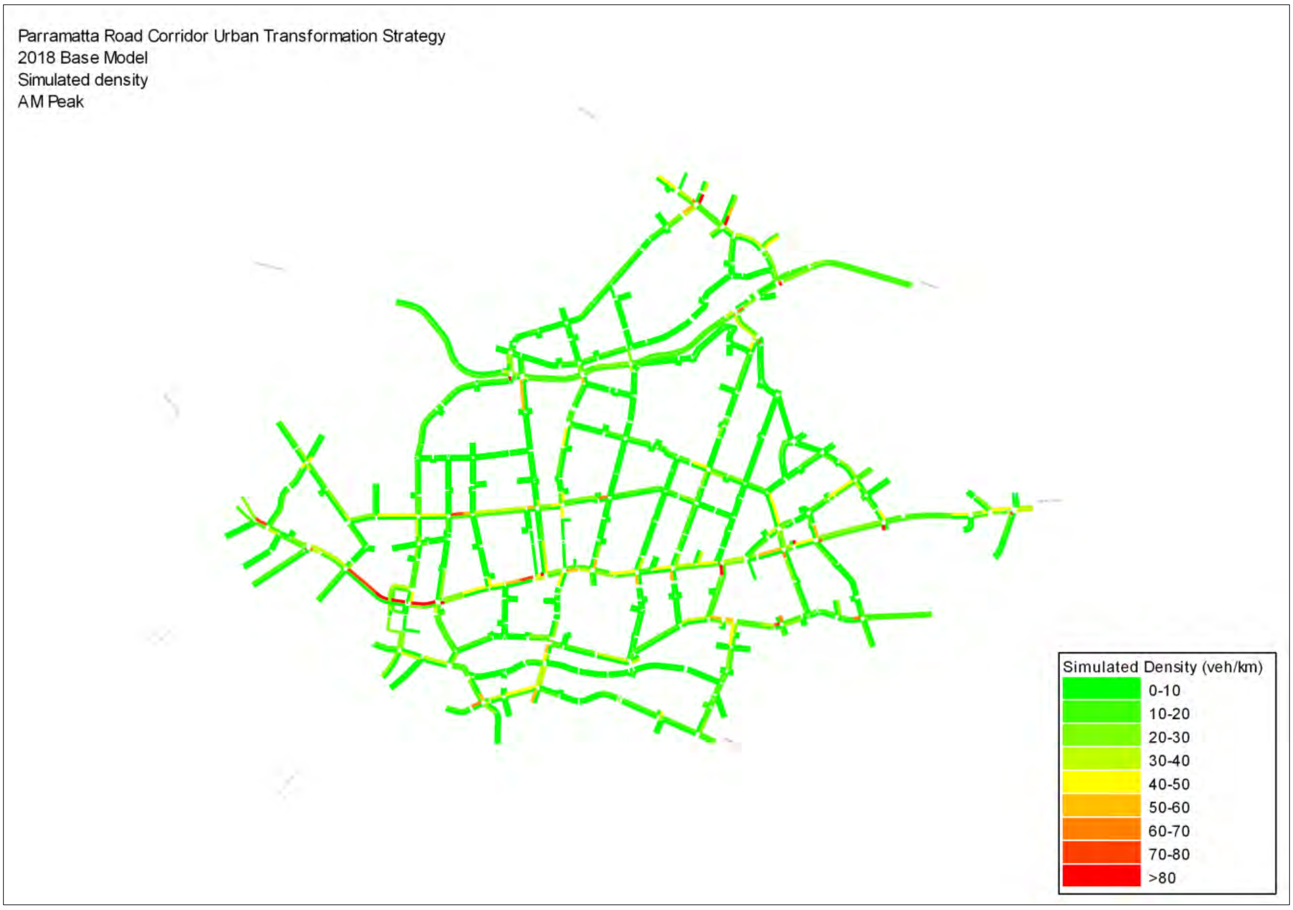


Figure 5-5 Simulated density – Base Model (AM Peak)

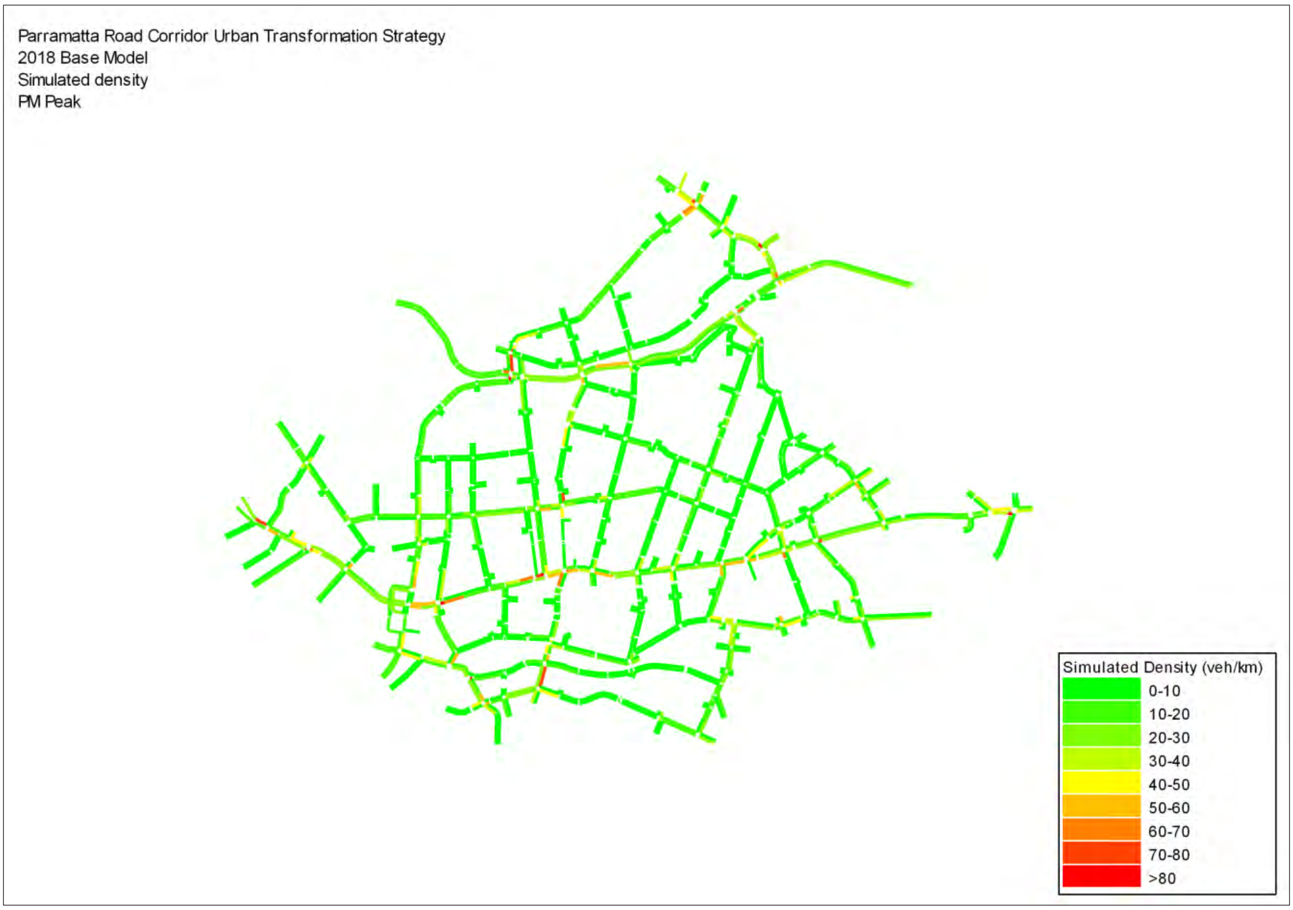


Figure 5-6 Simulated density – Base Model (PM Peak)

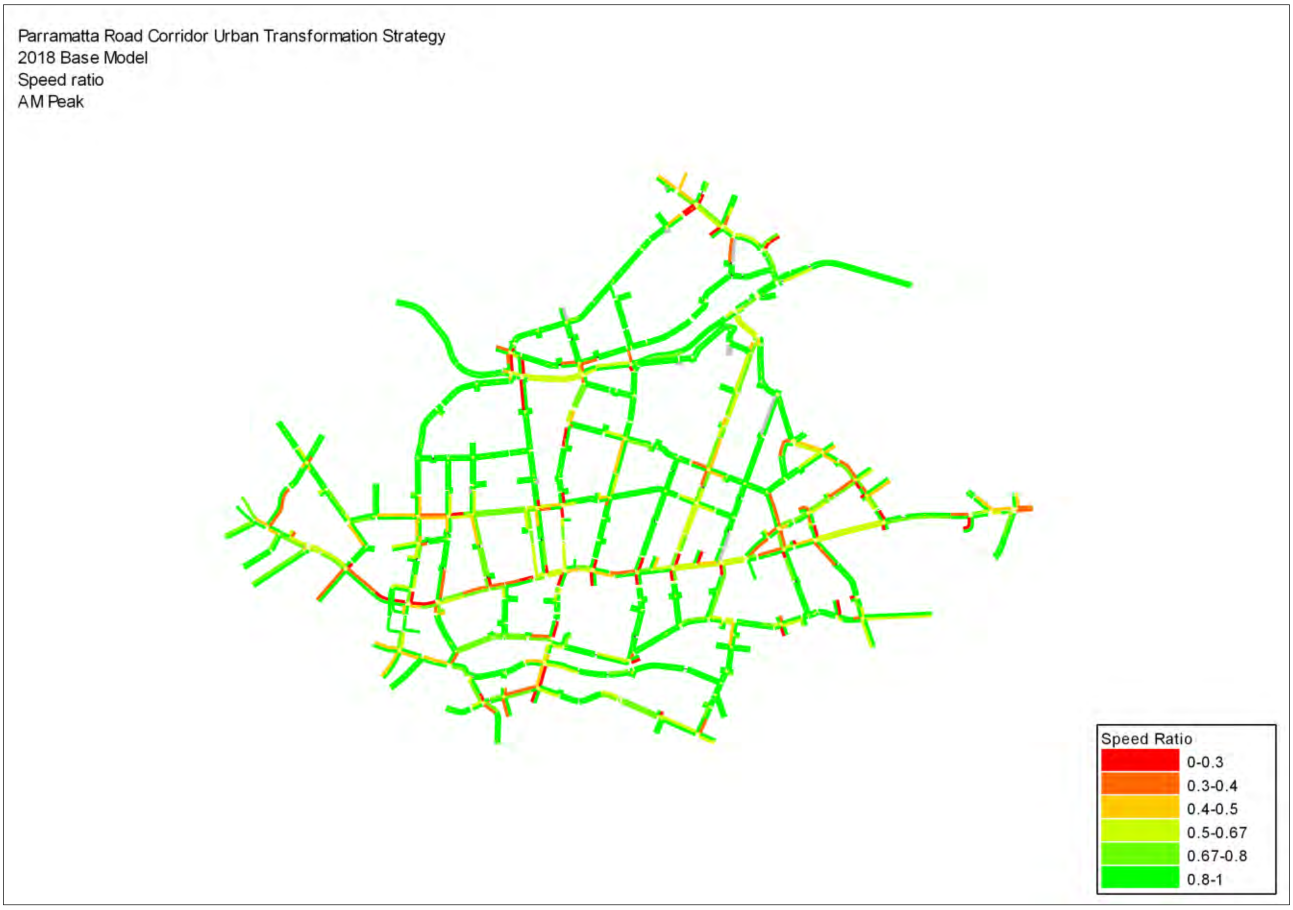


Figure 5-7 Speed ratio – Base Model (AM Peak)

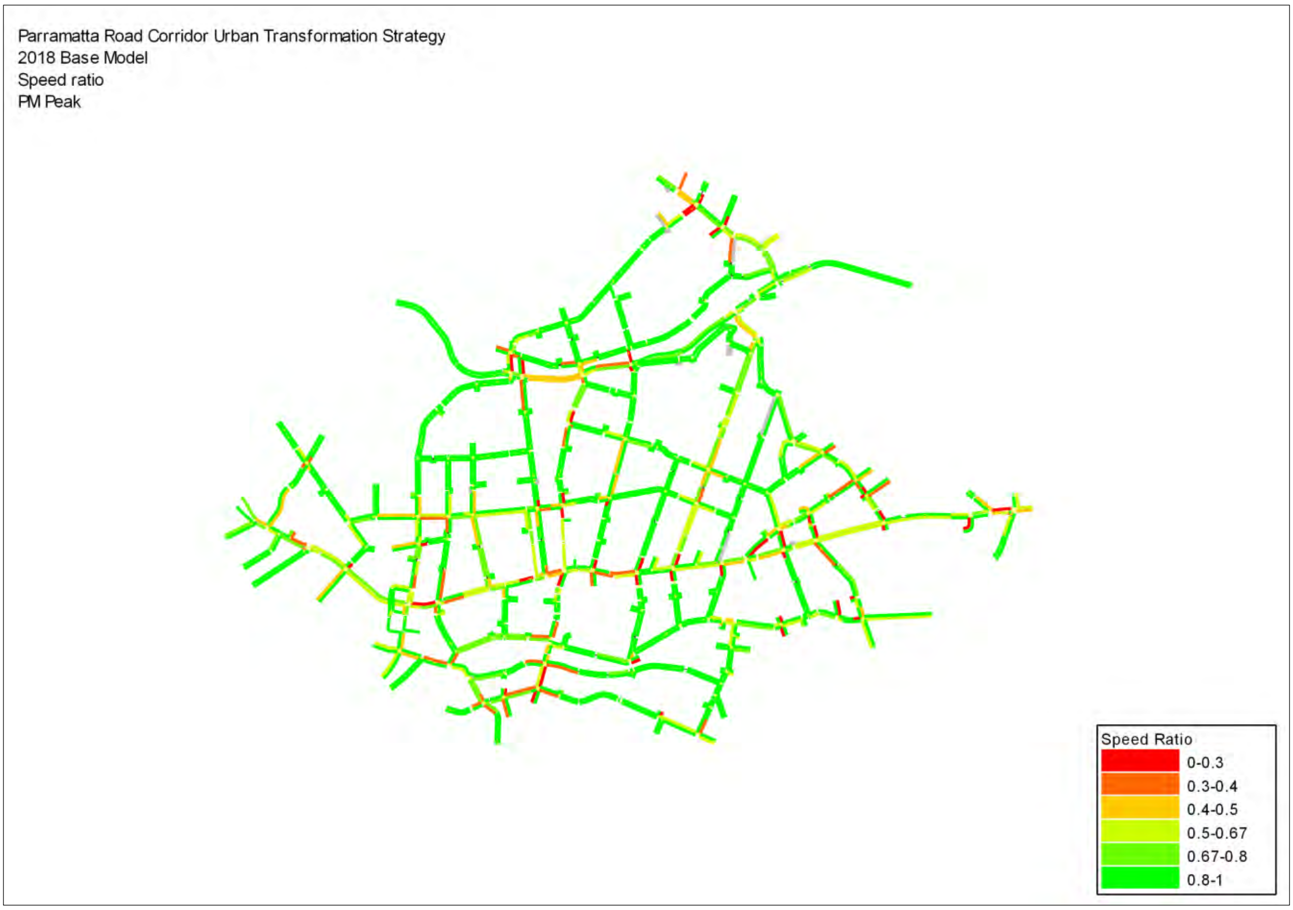


Figure 5-8 Speed ratio – Base Model (PM Peak)

Figure 5-9 Heavy vehicle proportions – Base Model (AM Peak)

Figure 5-10 Heavy vehicle proportions – Base Model (PM Peak)

6 Do Minimum operational results

The Do Minimum model was used to identify network deficiencies in the future network performance. It included the following infrastructure upgrades:

> City-West Link road additional eastbound lane between Waratah Street and James Street

> Parramatta Road / West Street right turn lane extension

> Missenden Road speed limit reduction

> Parramatta Road / Crystal Street right turn lane extension

> WestConnex Rozelle Interchange including Iron Cove Tunnel from Victoria Road to Anzac Bridge.

The above upgrades were outlined in greater detail in **Section 2.1**. These models identify deficiencies in the future road network absent any upgrades beyond those already implemented or under construction.

6.1 Do Minimum network performance

6.1.1 Network performance summary

Table 6-1 shows the network performance results for the Do Minimum scenario. The key findings are summarised below.

> Between 2018 and 2026, the total traffic demand increases by 11,598 trips in the AM Peak and 12,301 trips in the PM Peak. There are an additional 5394 trips in the AM Peak and 6185 trips in the PM Peak in 2036 compared to 2026.

> In 2026, the total distance travelled by all vehicles in the simulation (VKT) increases by 13.3 per cent in the AM Peak and by 7.8 per cent in the PM Peak. In 2036, these increases are 13.5 per cent and 8.3 per cent. These are less than the proportional increase in demand in each peak which results in a lower average kilometres travelled per vehicle.

  This reduction is primarily caused by the WestConnex tunnels. VKT is only measured while vehicles are on the modelled road network, which excludes the tunnels. Vehicles that use the tunnels for part of their journey have a lower distance travelled in the network, which increases the proportion of shorter trips within the study area.

> Vehicle hours travelled (VHT) generally increases more than the increase in demand, which indicates greater congestion in the network.

> In the AM Peak, average speed increases by 2.4 kilometres per hour between 2018 and 2026. The increase is 1.1 kilometres per hour up to 2036. In the PM Peak, the increase is 2.0 and 0.2 kilometres per hour. Network improvements including WestConnex, upgrades to Parramatta Road eastbound and upgrades to City-West Link Road eastbound have improved travel times on these roads. Some key congestion hotspots from 2018 such as Victoria Road and Parramatta Road have lower traffic volumes due to WestConnex.

  Average speed is also higher because vehicles using the WestConnex tunnels no longer have to traverse the surface network. The tunnels, such as the Iron Cove Tunnel, bypass some of the most congested parts of the network, which improves the overall vehicle average speed.

> Average delay time increases in all years and peaks, with the greatest increase in the PM Peak in both years.

> In 2026, the total of unreleased and deleted vehicles is 706 vehicles in the AM Peak and 740 vehicles in the PM Peak. These represent 0.9 per cent of the total demand. In 2036, the number of vehicles unreleased and deleted is 2110 in the AM Peak and 2738 in the PM Peak. Unreleased demand is discussed in the next section.

6.1.2 Person statistics

Table 6-2 shows key network statistics per person for the Do Minimum scenario based on the assumed vehicle occupancies outlined in **Section 3.2.1**.

Table 6-1 Network performance results – Do Minimum

Network performance metric	Unit	2026				2036			
		Do Minimum results		Compared to Base		Do Minimum results		Compared to Base	
		AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak
All vehicles									
Total traffic demand	veh	80,193	87,443	+11,598 (+16.9%)	+12,301 (+16.4%)	85,587	93,628	+16,992 (+22.6%)	+18,486 (+24.6%)
Total vehicles arrived	veh	78,904	85,173	+9971 (+14.5%)	+10,324 (+13.8%)	80,962	86,585	+12,029 (+16.1%)	+11,736 (+15.7%)
Total kilometres travelled (VKT)	km	191,466	203,096	+22,544 (+13.3%)	+14,681 (+7.8%)	194,433	204,051	+25,511 (+13.5%)	+15,636 (+8.3%)
Vehicle hours travelled (VHT)	hr	7671	8589	+953 (+14.2%)	+1601 (+22.9%)	8542	9898	1824 (+26.1%)	+2910 (+41.6%)
Average per vehicle									
Average kilometres travelled	km	2.4	2.4	-0.0 (-1.0%)	-0.1 (-5.3%)	2.4	2.4	-0.0 (-1.9%)	-0.2 (-6.4%)
Average time travelled in network	s	146	153	-1 (-0.4%)	+15 (+10.9%)	158	181	+11 (+8.3%)	+43 (+31.5%)
Average speed	km/hr	30.0	31.0	+2.4 (+8.6%)	+2.0 (+7.0%)	28.7	29.2	+1.1 (+3.6%)	+0.2 (+0.8%)
Average delay	s	79	87	+1 (+1.1%)	+16 (+23.0%)	91	115	+13 (+18.4%)	+45 (+63.6%)
Unreleased demand									
Unreleased demand (% of total demand)	veh (%)	73 (0.1%)	417 (0.5%)	+69	+414	916 (1.1%)	1839 (2.0%)	+912	+1836
Deleted vehicles (% of total demand)	veh (%)	633 (0.8%)	323 (0.4%)	+633	+323	1194 (1.4%)	899 (1.0%)	+1194	+899
Total unreleased and deleted (% of total demand)	veh (%)	706 (0.9%)	740 (0.8%)	+702	+737	2110 (2.5%)	2738 (2.9%)	+2106	+2735

Table 6-2 Network statistics by person – Do Minimum

Network performance metric	Unit	2026				2036			
		AM Peak		PM Peak		AM Peak		PM Peak	
		LV	HV	LV	HV	LV	HV	LV	HV
Network statistics by vehicle type									
Total vehicles arrived	veh	73,916	4517	82,113	2890	75,395	5094	83,200	3219
Total kilometres travelled (VKT)	km	178,438	11,681	195,520	7111	179,825	13,255	195,592	8015
Vehicle hours travelled (VHT)	hr	7108	478	8262	298	7861	593	9492	376
Average speed	km/hr	30.0	31.4	30.8	38.6	28.6	30.2	29.0	36.3
Average delay	s	79	74	88	62	92	83	117	79
Network statistics by person									
Total persons arrived	person	82,403	4517	91,541	2890	84,052	5094	92,753	3219
Total person-kilometres travelled	km	198,927	11,681	217,970	7111	200,473	13,255	218,050	8015
Total person-hours travelled	hr	7924	478	9210	298	8763	593	10,582	376
Average speed per person	km/hr	30.0	31.4	30.8	38.6	28.6	30.2	29.0	36.3
Average delay per person	s	88	74	98	62	102	83	130	79

6.1.3 Unreleased demand

Unreleased demand refers to vehicles that are unable to enter the study are by the end of the simulation period. This is caused by queueing on their arrival link that extends back to the edge of the study area. High unreleased demand is an indication of significant network congestion.

The following sections outline the total unreleased demand and locations of unreleased demand in the AM and PM peaks for the Do Minimum scenario.

AM Peak

The unreleased demand in the AM Peak is 73 vehicles in 2026 and 916 vehicles in 2036. **Figure 6-1** and **Figure 6-3** show the locations of unreleased demand in 2026 and 2036 respectively. The main locations with unreleased demand are discussed below.

> Unreleased demand on Shaw Street is caused by the nearby Crystal Street / Shaw Street / Stanmore Road / New Canterbury Road intersection. This totals 31 vehicles in 2026 and 143 vehicles in 2036.

> While there is no unreleased demand on Old Canterbury Road in 2026, in 2036, 180 vehicles are unreleased due to queueing from the Old Canterbury Road / Railway Terrace intersection.

> Queueing on West Street causes unreleased demand on Station Street up to 269 vehicles in 2036.

> Unreleased demand on Darling Street and Robert Street is caused by queueing on Victoria Road.

PM Peak

The unreleased demand in the PM Peak is 417 vehicles in 2026 and 1839 vehicles in 2036. **Figure 6-2** and **Figure 6-4** show the locations of unreleased demand in 2026 and 2036 respectively. The main locations with unreleased demand are discussed below.

> Unreleased demand on Bridge Road is 210 vehicles in 2026 and 297 vehicles in 2036. This is cause by queueing from the Bridge Road / Ross Street intersection.

> Queueing on Old Canterbury Road approaching Railway Terrace causes 76 vehicles to be unreleased in 2026 and 212 vehicles in 2036.

> Queueing on West Street causes unreleased demand on Station Street up to 162 vehicles in 2036.

Glebe Point Road experiences queueing in 2036 that results in 137 vehicles being unreleased.

Figure 6-1 Unreleased demand – 2026 Do Minimum (AM Peak)

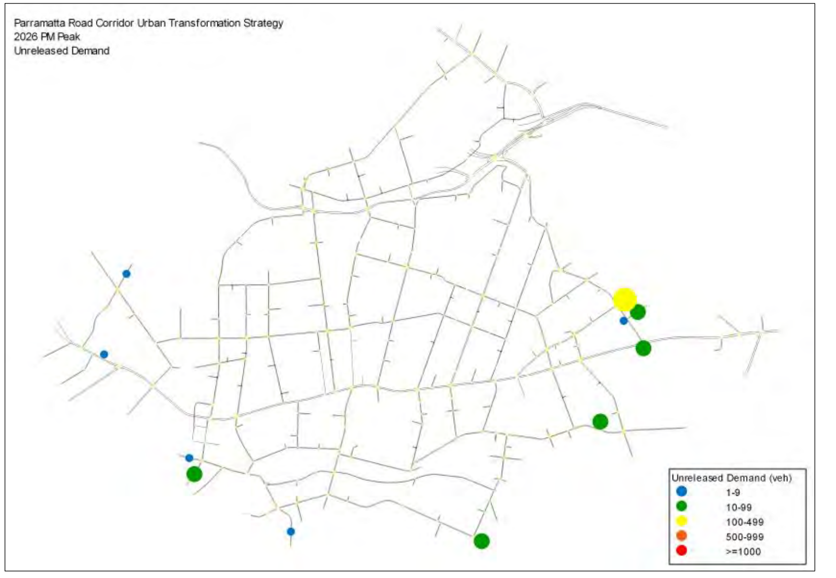


Figure 6-2 Unreleased demand – 2026 Do Minimum (PM Peak)

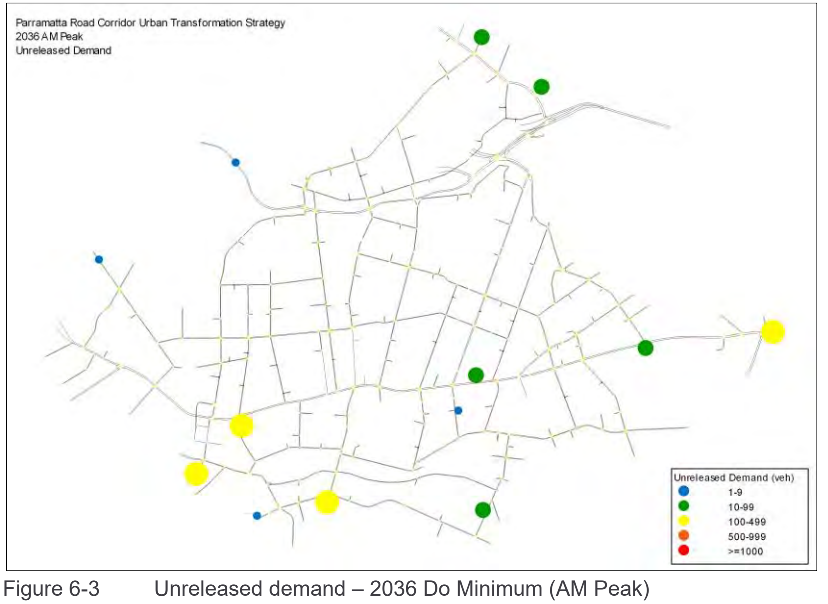


Figure 6-3 Unreleased demand – 2036 Do Minimum (AM Peak)

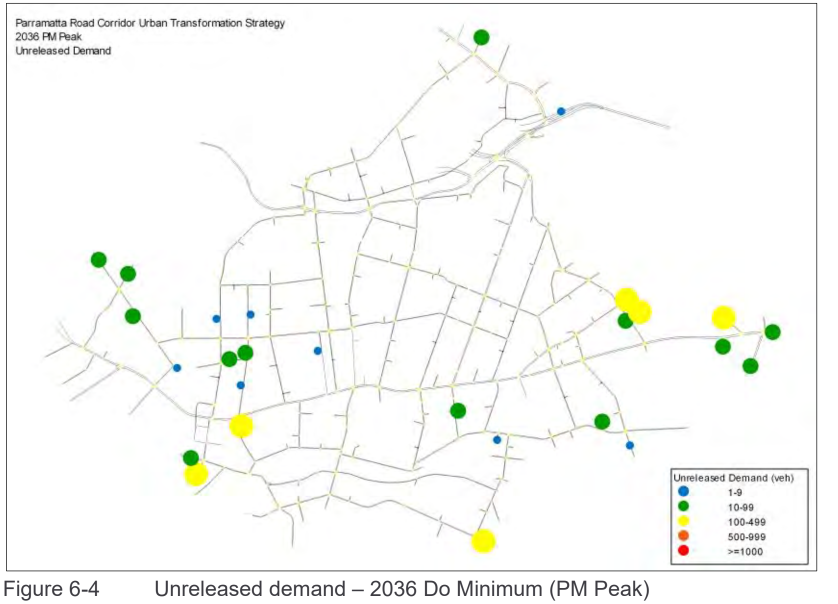


Figure 6-4 Unreleased demand – 2036 Do Minimum (PM Peak)

6.2 Do Minimum travel times

This section provides an overview of travel times on key routes and through the PRCUTS precincts in the 2026 and 2036 Do Minimum scenarios.

6.2.1 Travel times on key routes

Table 6-3 lists the modelled travel times on each route in the 2026 and 2036 Do Minimum scenarios. The key findings are discussed below.

- Travel times on Balmain Road in both directions decreased. Traffic volumes on Balmain Road significantly decreased with WestConnex. In 2018, the northbound volume was 354 vehicles, and in the southbound direction the volume was 160 vehicles. In 2026, these are reduced to 218 and 122 vehicles respectively.
- Travel times on Crystal Street increase in both directions, however the greatest increase is approaching Parramatta Road. In the AM Peak, travel times in that direction increased by 23 seconds in 2026 and by 24 seconds in 2036.
- Travel times generally increased on Johnston Street. In the PM Peak, the southbound travel time increased by 125 seconds in 2026 and 91 seconds in 2036. The traffic volume was lower in 2036 due to congestion elsewhere in the network, unreleased vehicles and deleted vehicles which resulted in an apparent improvement in performance.
- In 2026, travel times on Marion Street in the eastbound direction decreased in the AM Peak. Due to a combination of WestConnex and improvements in the eastbound direction along Parramatta Road, Marion Street becomes a less attractive rat-run, resulting in improved performance. However, travel times in the westbound direction increased by 56 seconds. In 2036, travel times in both peaks increased, with the greatest increase being in the PM Peak (up to 202 seconds).
- The number of vehicles using Parramatta road decreases due to WestConnex. Furthermore, network improvements such as an additional eastbound travel lane between Sloane Street and West Street, extended right turn bays at West Street and Crystal Street, and signal optimisation improve eastbound travel times. In the 2026 AM Peak, the resulting decrease represents a travel time saving of 261 seconds in the eastbound direction. In the 2026 PM Peak, the decrease is 32 seconds. However, the higher traffic volume by 2036 means that the eastbound travel time is 70 seconds longer in the AM Peak and 30 seconds longer in the PM Peak than the 2018 values.

  Travel times in the westbound direction increase by 165 seconds in the 2026 AM Peak and 217 seconds in the 2026 PM Peak. This is caused by additional congestion at key intersections including at West Street and Crystal Street. The increases are 302 and 223 seconds respectively in 2036.

Note that the travel times shown in this table are for vehicles that traverse the full length of the route only.

Table 6-3 Travel times on key routes – Do Minimum

Route	Dir.	Do Minimum results				Compared to 2018 Base			
		Travel times (s)		Average speed (km/hr)		Travel times (s)		Average speed (km/hr)	
		AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak
2026									
Balmain Road	NB	288	254	17.9	20.3	-44	+4	+2.4	-0.3
	SB	169	140	20.4	24.5	-19	-29	+2.1	+4.2
Crystal Street	NB	199	186	15.5	16.7	+23	-9	-2.1	+0.8
	SB	238	249	13.0	12.4	-35	+25	+1.7	-1.4
Johnston Street	NB	288	282	21.9	22.3	-24	-2	+1.7	+0.1
	SB	264	427	23.8	14.7	+10	+125	-0.9	-6.1
Marion Street	EB	243	214	23.0	26.2	-77	-5	+5.5	+0.6
	WB	261	202	21.5	27.8	+52	-3	-5.3	+0.5
Parramatta Road	EB	904	849	24.6	26.2	-261	-32	+5.5	+1.0
	WB	985	1144	22.5	19.4	+165	+217	-4.5	-4.5
2036									
Balmain Road	NB	324	390	15.9	13.2	-8	+140	+0.4	-7.4
	SB	186	149	18.6	23.1	-2	-20	+0.2	+2.7
Crystal Street	NB	200	203	15.5	15.3	+24	+8	-2.1	-0.6
	SB	253	477	12.3	6.5	-20	+253	+0.9	-7.3
Johnston Street	NB	297	289	21.2	21.8	-15	+5	+1.0	-0.4
	SB	278	393	22.6	16.0	+24	+91	-2.1	-4.8
Marion Street	EB	335	421	16.7	13.3	+15	+202	-0.8	-12.3
	WB	279	313	20.1	17.9	+70	+108	-6.7	-9.4
Parramatta Road	EB	1235	911	18.0	24.4	+70	+30	-1.1	-0.8
	WB	1122	1150	19.7	19.3	+302	+223	-7.3	-4.6

6.2.2 Travel times through precincts

Table 6-4 shows the modelled travel time through each precinct in each direction. Overleaf, **Figure 6-5** and **Figure 6-6** show travel times through each precinct along Parramatta Road for the eastbound and westbound directions respectively.

AM Peak

> Eastbound travel time through Taverners Hill is reduced from the Base Model in both 2026 and 2036. The reduction is caused by an additional lane provided between Sloane Street and West Street.

> Eastbound travel time through Leichhardt is also lower in 2026 than in 2018 due to upgrades around Crystal Street, however by 2036 the travel time through Leichhardt is higher than in the Base Model.

> In the westbound direction, travel time increased from 2018 to 2026 and 2036 in Taverners Hill and Leichhardt, and remained about the same through Camperdown.

PM Peak

> Intersection upgrades improve the eastbound travel time through Leichhardt in the PM Peak.

> Eastbound travel time through Taverners Hill is about the same in 2026 as in 2018, but increases by over 90 seconds in 2036.

> Eastbound travel times through Camperdown increase by 20 seconds from 2018 to 2026 and by an additional 27 seconds from 2026 to 2036.

> In the westbound direction, travel times through Taverners Hill remain about the same, while those through Leichhardt and Camperdown increase in both future years. The increase through Leichhardt is 39 seconds in 2026 and 57 seconds in 2036, while in Camperdown, this amounts to 30 additional seconds in 2026 and 50 seconds in 2036.

Table 6-4 Precinct travel times – Do Minimum

Direction	Travel time through precinct (s)					
	2026			2036		
	Taverners Hill	Leichhardt	Camperdown	Taverners Hill	Leichhardt	Camperdown
AM Peak						
Eastbound	307	259	188	291	446	231
Westbound	227	359	110	244	430	113
PM Peak						
Eastbound	276	313	146	363	312	173
Westbound	203	331	209	218	349	229

Note that the travel times shown in these graphs are the cumulative sum of the travel times of each section along the route, so include vehicles that only traverse part of the route.

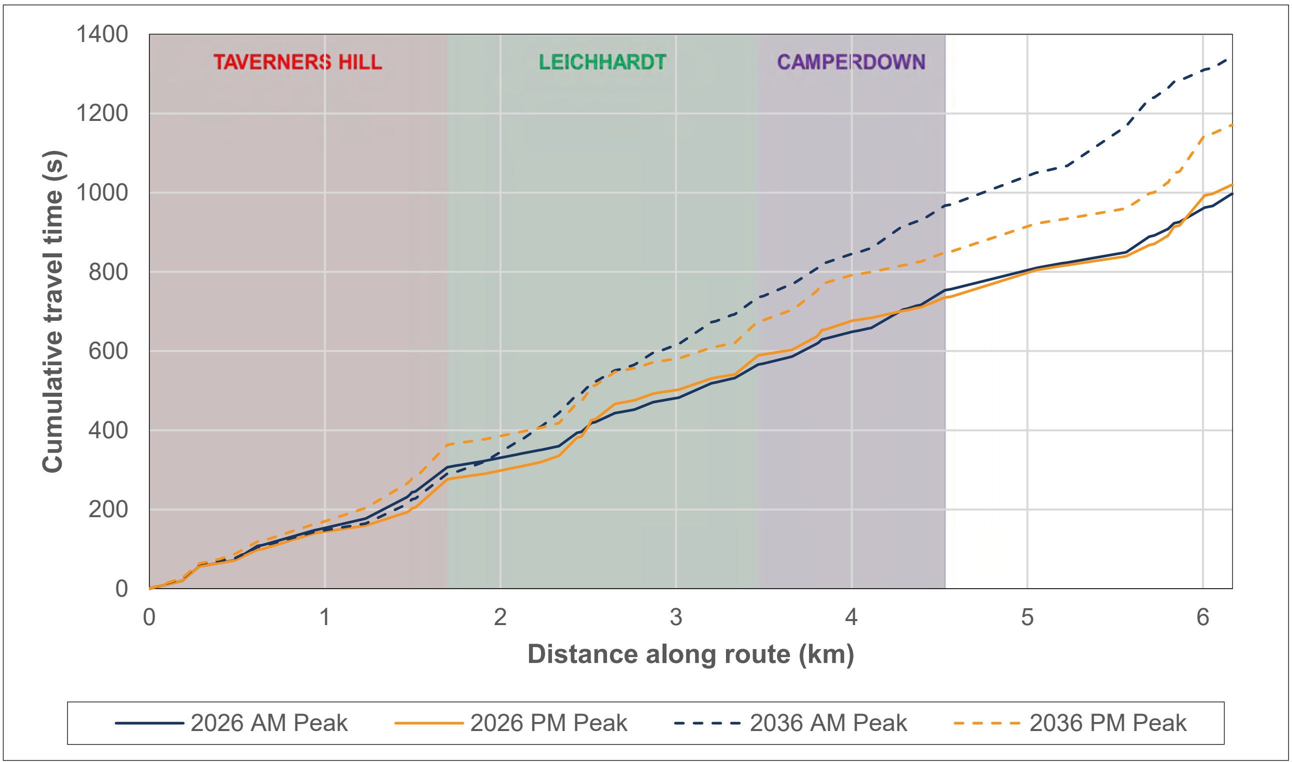


Figure 6-5 Travel times between precincts (eastbound) – Do Minimum

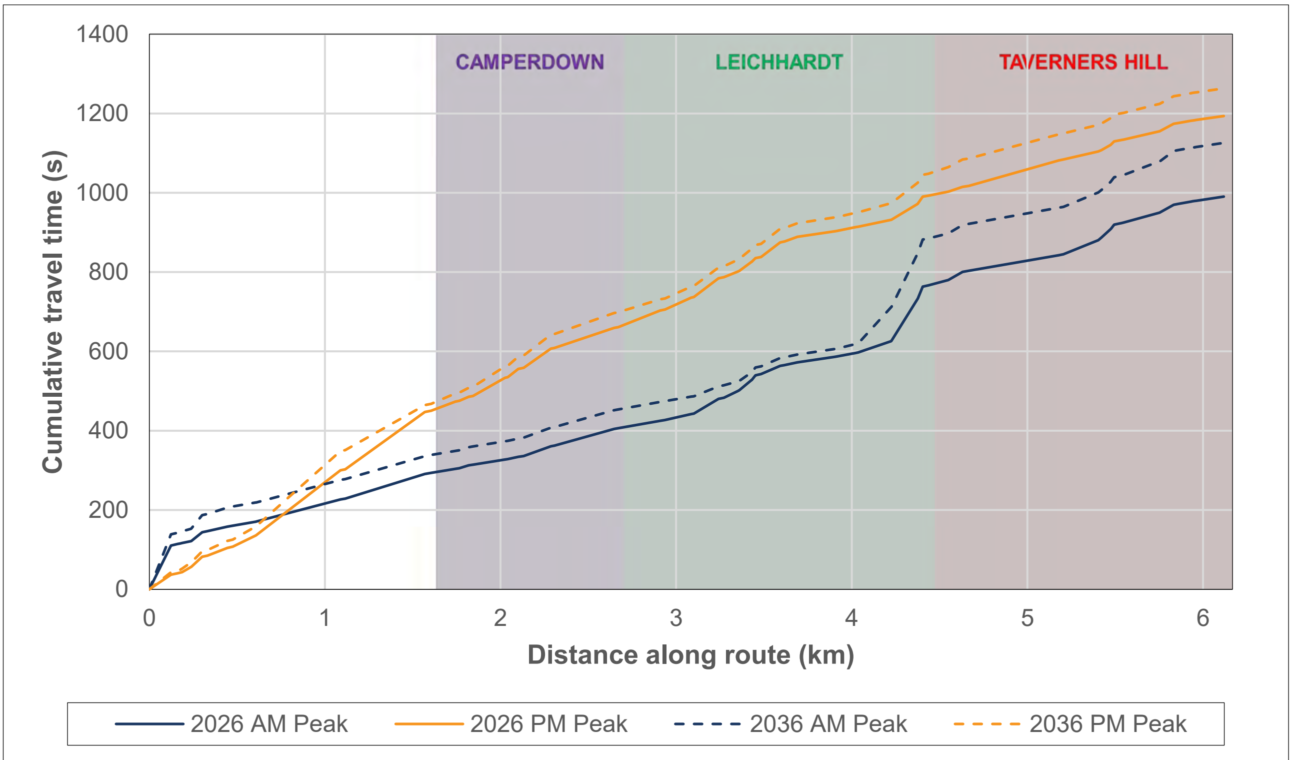


Figure 6-6 Travel times between precincts (westbound) – Do Minimum

6.3 Do Minimum intersection performance

This section provides an overview of intersection performance in the study area in the Do Minimum scenario. The results shown are for intersections in the PRCUTS precincts. Detailed performance results for all intersections assessed are provided in **Appendix H**.

6.3.1 Intersection operation

Table 6-5 and **Table 6-6** show the intersection performance results for the AM and PM peaks respectively. These intersections were among those calibrated using survey data as documented in *Base Model Development Report* (Cardno, 2020). It is not recommended to assess the performance of intersections that were not calibrated.

The following sections provide a brief summary of the key turns, movements and intersections that are at or over capacity in each peak. In general, the performance of side roads already noted as over capacity in the Base Model deteriorated, with most approaches to Parramatta Road performing at LOS E or F by 2036. Some other side roads that were not over capacity in 2018 are over capacity by 2026 or 2036. Some right turns from Parramatta Road also exhibited protracted delays in 2026 and/or 2036.

Intersection performance at signalised intersections is based on the weighted average delay. Given that the through traffic movements on Parramatta Road are considerably higher than other movements at these intersections, overall intersection performance may be acceptable while still recording significant delays on the side road approaches.

The performance of some movements or intersections may appear to improve as the proportion of the demand that arrives at the intersection by the end of the simulation period is reduced by the high levels of congestion in the model in this year.

AM Peak

> While the Marion Street and Leichhardt Street approaches to Marion Street / Leichhardt Street / Balmain Road continue to perform acceptably (LOS C or better), all movements on Balmain Road have average delays exceeding 72 seconds (LOS F). Overall intersection remains LOS C in 2026 and LOS C/D[5] in 2036.

> In 2026, both movements from Booth Street at Pyrmont Bridge Road / Booth Street / Mallett Street have delays of over 67 seconds. In 2036, average delays on this approach exceed 74 seconds, corresponding to LOS F. The right turn from Pyrmont Bridge Road continues to perform at LOS E up to 2036.

> Liverpool Road experiences average delays of up to 249 seconds by 2036, and delays increase over the simulation period as queues build up on Parramatta Road. Overall intersection performance deteriorates from LOS C in 2018 to LOS F in the second hour in 2036.

> Parramatta Road / Norton Street continues to perform at LOS B up to 2036. The right turn movement out of Norton Street is LOS E in both hours. Additionally, the right turn from Parramatta Road performs at LOS F in the first hour in 2036, up from LOS D in 2018.

> The performance of Parramatta Road / Flood Street / West Street deteriorates from LOS D in 2018 to LOS F by 2026. Almost all movements at this intersection perform at LOS F with delays exceeding 100 seconds on Parramatta Road (E), West Street and the right turns from Parramatta Road (W) and Flood Street.

> The through and right turn movements out of Crystal Street remain LOS F, but the maximum delay increases from 91 seconds to 149 second by 2026.

> Queueing on Young Street and Percival Road increase throughout the peak period, with delays on these side roads exceeding 100 seconds in the second hour by 2036. Overall intersection performance deteriorates from LOS B/C to LOS C/D by 2036.

> All movements on Northumberland Drive perform at LOS F by 2026, and on Johnston Street by 2036. Overall performance in the second hour is worse as queues build up over the simulation period. Level of service goes from LOS C in 2018 to LOS E by 2036.

[5] LOS C in the first hour and LOS D in the second hour.

> All movements on Bridge Road continue to fail in 2026 and 2036. By 2036, the eastbound Parramatta Road movement at this location is also LOS F.

> Queueing on Missenden Road and Lyons Road build up over the simulation period such that these approaches perform at LOS F by the second hour of the AM Peak by 2026. The right turn from Parramatta Road remains LOS F in both future years.

PM Peak

> As was the case in the Base Model, Balmain Road (S) at Marion Street / Leichhardt Street / Balmain Road is over capacity with delays corresponding to LOS F in both hours. However, due to WestConnex, the volume on Balmain Road (N) is reduced, and LOS improves from LOS F in 2018 to LOS D in 2036.

> While all movements at Pyrmont Bridge Road / Booth Street / Mallett Street were acceptable in 2018, performance in the second hour particularly deteriorates by 2036 with all movements on Booth Street and Mallett street experiencing average delays corresponding to LOS E or F.

> Delay on the right turn from Liverpool Road increases from LOS E/D in 2018 to LOS F/F in 2026. By 2036, the left turn is also over capacity at LOS E/F. Overall intersection performance is LOS E in 2036.

> Tebbutt Street / Lords Road and Tebbutt street / Hathern Street perform at LOS E in the second hour in 2036. This is caused by queue spillback from Parramatta Road along Tebbutt Street.

> All southbound movements on Sloane Street remain over capacity in both future years with LOS E or F recorded. Overall intersection performance is LOS D in the second hour by 2036.

> Norton Street is severely over capacity by 2036 with average delays of over 200 seconds observed. The right turn from Parramatta Road also experiences delays corresponding to LOS E. Overall intersection performance is LOS E in 2026 and 2036.

> Parramatta Road / Flood Street / West Street performed at LOS E in 2018. By 2026, all movements except those on Parramatta Road (W) perform at LOS E or worse and the overall intersection delay is 73 seconds. By 2036, overall intersection delay is 104 seconds.

> Parramatta Road / Crystal Street performs similarly to the Base Model, with the main delays being all movements on Crystal Street. Average delay increases from 38 seconds in 2018 to 47 seconds in 2036.

> All movements on Catherine Street are LOS F in both hours. Additionally, Parramatta Road westbound is LOS F in the second hour with delays exceeding 75 seconds.

> At Parramatta Road / Northumberland Avenue / Johnston Street, the side road movements remain over capacity up to 2036. Traffic volume on the right turn from Parramatta Road is reduced with WestConnex, and performance of this movement improves from LOS F in 2018 to LOS E by 2036.

> All movements on Bridge Road at Parramatta Road are LOS F by 2036. Additionally, the right turn from Parramatta Road at this location is also LOS F, with delays of up to 287 seconds experienced.

> Pyrmont Bridge Road performs at LOS F in both hours. By the second hour, queueing on Parramatta Road in the westbound direction at this location also results in LOS F for these movements. Overall intersection performance remains LOS D up to 2036.

> All movements except the left and through movements on Parramatta Road (W) at Parramatta Road / Missenden Road / Lyons Road are LOS E or F in 2026 and 2036. Overall intersection performance corresponds to LOS F also.

Table 6-5 Intersection performance results – Do Minimum (AM Peak)

Intersection		Type	2026						2036					
			7:15AM – 8:15AM			8:15AM – 9:15AM			7:15AM – 8:15AM			8:15AM – 9:15AM		
			Vol. (veh)	Delay (s)	LOS	Vol. (veh)	Delay (s)	LOS	Vol. (veh)	Delay (s)	LOS	Vol. (veh)	Delay (s)	LOS
19	Marion Street / Norton Street	S	1879	28.6	C	1650	23.4	B	1956	29.5	C	1908	54.0	D
20	Marion Street / Leichhardt Street / Balmain Road	S	1628	33.1	C	1423	32.3	C	1670	36.0	C	1626	47.3	D
30	Pyrmont Bridge Road / Booth Street / Mallett Street	S	2149	53.2	D	2132	68.5	E	2126	54.3	D	2068	63.4	E
39	Parramatta Road / Liverpool Road	S	4279	48.0	D	4388	64.9	E	4341	42.2	C	4328	94.5	F
42	Tebbutt Street / Lords Road	S	2000	27.3	B	1827	18.0	B	1970	19.6	B	1996	20.1	B
44	Tebbutt Street / Hathern Street	S	1936	23.6	B	1780	27.7	B	1780	24.4	B	1893	24.7	B
45	Parramatta Road / Sloane Street	S	4495	20.6	B	4446	18.0	B	4589	22.4	B	4546	20.8	B
47	Parramatta Road / Old Canterbury Road / Tebbutt Street	S	4076	50.4	D	4450	33.9	C	4145	43.7	D	4156	27.9	B
50	Parramatta Road / Norton Street	S	3463	21.9	B	3624	18.0	B	3488	22.8	B	3374	22.3	B
51	Parramatta Road / Flood Street / West Street	S	4278	76.6	F	4730	89.3	F	4459	66.9	E	4324	144.3	F
52	Parramatta Road / Crystal Street / Balmain Road	S	4018	48.2	D	4245	33.8	C	4072	38.5	C	4012	38.4	C
53	Parramatta Road / Catherine Street / Phillip Street	S	3480	37.6	C	3751	45.3	D	3483	24.8	B	3554	35.5	C
67	Parramatta Road / Young Street / Percival Road	S	3571	25.3	B	3717	23.9	B	3557	34.7	C	3587	49.0	D
68	Parramatta Road /Northumberland Avenue / Johnston Street	S	4275	36.6	C	4332	35.7	C	4094	40.0	C	4171	58.0	E
69	Parramatta Road / Bridge Road	S	4060	38.5	C	4223	43.5	D	4012	53.1	D	4176	61.0	E
70	Parramatta Road /Pyrmont Bridge Road / Denison Street	S	4117	10.4	A	4245	9.2	A	4048	15.1	B	4249	11.1	A
71	Parramatta Road / Mallett Street	S	4225	54.9	D	4164	50.2	D	4120	53.7	D	4229	39.6	C
81	Parramatta Road / Dalhousie Street	S	3322	38.9	C	3350	32.5	C	3402	47.5	D	3274	47.8	D
83	Parramatta Road / Missenden Avenue / Lyons Road	S	3859	41.4	C	3900	55.6	D	3895	44.8	D	3874	46.7	D

Table 6-6 Intersection performance results – Do Minimum (PM Peak)

Intersection		Type	2026						2036					
			4:30PM – 5:30PM			5:30PM – 6:30PM			4:30PM – 5:30PM			5:30PM – 6:30PM		
			Vol. (veh)	Delay (s)	LOS	Vol. (veh)	Delay (s)	LOS	Vol. (veh)	Delay (s)	LOS	Vol. (veh)	Delay (s)	LOS
19	Marion Street / Norton Street	S	1650	22.7	B	1701	30.5	C	1736	103.8	F	1654	40.6	C
20	Marion Street / Leichhardt Street / Balmain Road	S	1245	29.8	C	1361	33.5	C	1290	37.9	C	1523	47.0	D
30	Pyrmont Bridge Road / Booth Street / Mallett Street	S	1921	41.4	C	1771	44.8	D	1996	31.4	C	1738	65.8	E
39	Parramatta Road / Liverpool Road	S	4637	29.0	C	4928	31.2	C	4821	44.0	D	4642	59.6	E
42	Tebbutt Street / Lords Road	S	1880	22.6	B	1894	19.8	B	1987	25.0	B	1744	70.3	E
44	Tebbutt Street / Hathern Street	S	2008	24.5	B	2091	25.1	B	2029	25.2	B	1982	67.2	E
45	Parramatta Road / Sloane Street	S	4654	33.0	C	4999	39.9	C	4854	30.1	C	4712	50.1	D
47	Parramatta Road / Old Canterbury Road / Tebbutt Street	S	3958	22.8	B	4239	13.4	A	4149	16.6	B	3802	76.3	F
50	Parramatta Road / Norton Street	S	3399	32.6	C	3561	56.9	E	3564	61.1	E	3613	51.1	D
51	Parramatta Road / Flood Street / West Street	S	4278	73.2	F	4529	64.9	E	4347	81.5	F	4041	106.4	F
52	Parramatta Road / Crystal Street / Balmain Road	S	3771	30.9	C	3957	53.0	D	3988	43.6	D	3691	46.8	D
53	Parramatta Road / Catherine Street / Phillip Street	S	3199	36.9	C	3318	78.1	F	3427	39.7	C	3177	57.0	E
67	Parramatta Road / Young Street / Percival Road	S	3041	14.5	A	3303	39.7	C	3289	17.7	B	3075	35.1	C
68	Parramatta Road /Northumberland Avenue / Johnston Street	S	3877	42.3	C	4255	82.9	F	4203	44.7	D	4096	78.7	F
69	Parramatta Road / Bridge Road	S	3533	50.9	D	3740	47.4	D	3741	47.6	D	3413	84.3	F
70	Parramatta Road /Pyrmont Bridge Road / Denison Street	S	3502	35.4	C	3817	43.2	D	3708	49.2	D	3477	44.4	D
71	Parramatta Road / Mallett Street	S	3682	32.3	C	4067	32.3	C	3823	36.3	C	3743	36.6	C
81	Parramatta Road / Dalhousie Street	S	3735	44.9	D	3957	101.5	F	3772	84.4	F	3807	86.8	F
83	Parramatta Road / Missenden Avenue / Lyons Road	S	3492	71.2	F	3875	114.9	F	3754	63.3	E	3731	109.5	F

Figure 6-7 and **Figure 6-8** show the intersection performance results on a map of the study area.

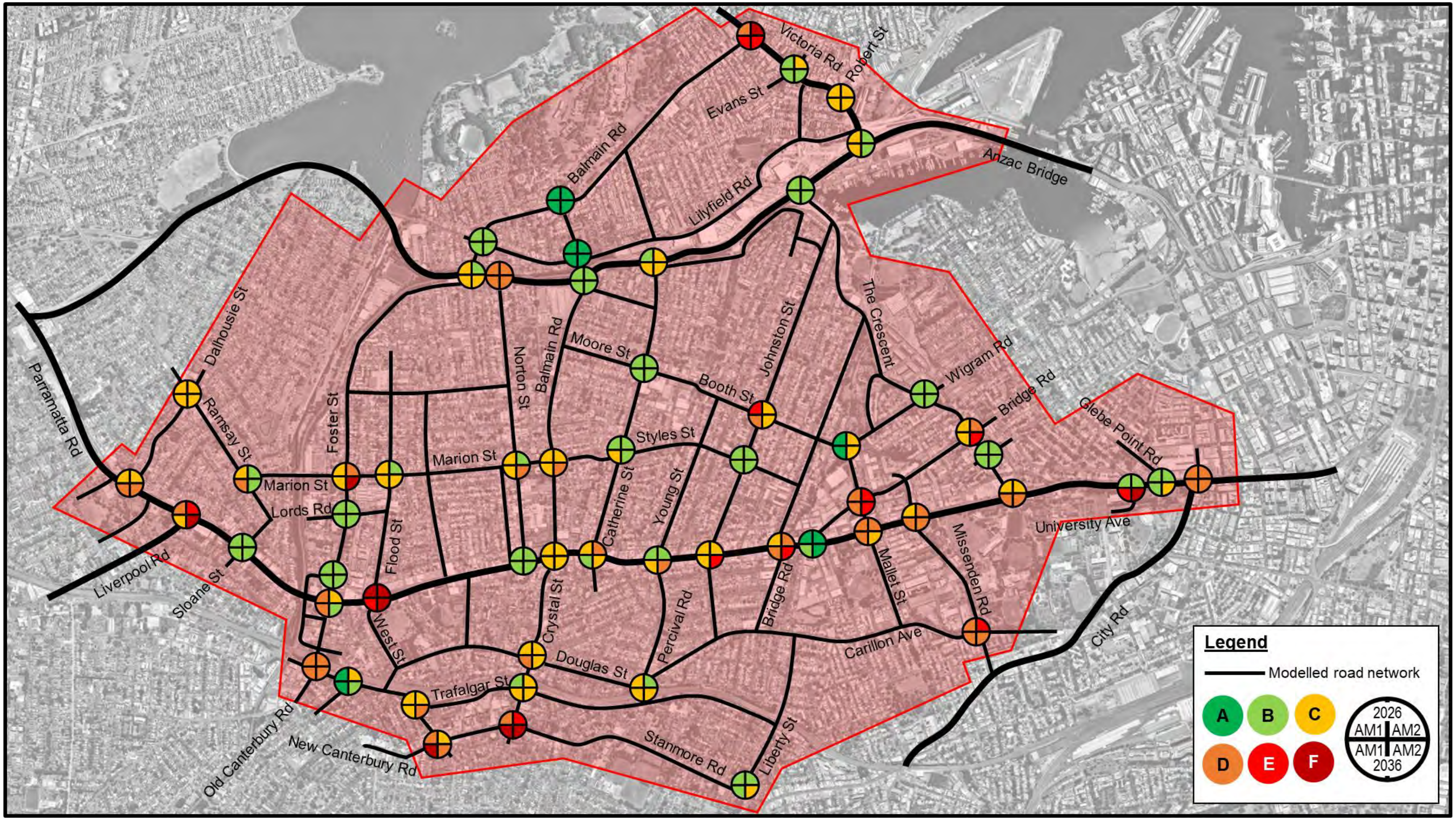


Figure 6-7 Intersection level of service – Do Minimum (AM Peak)

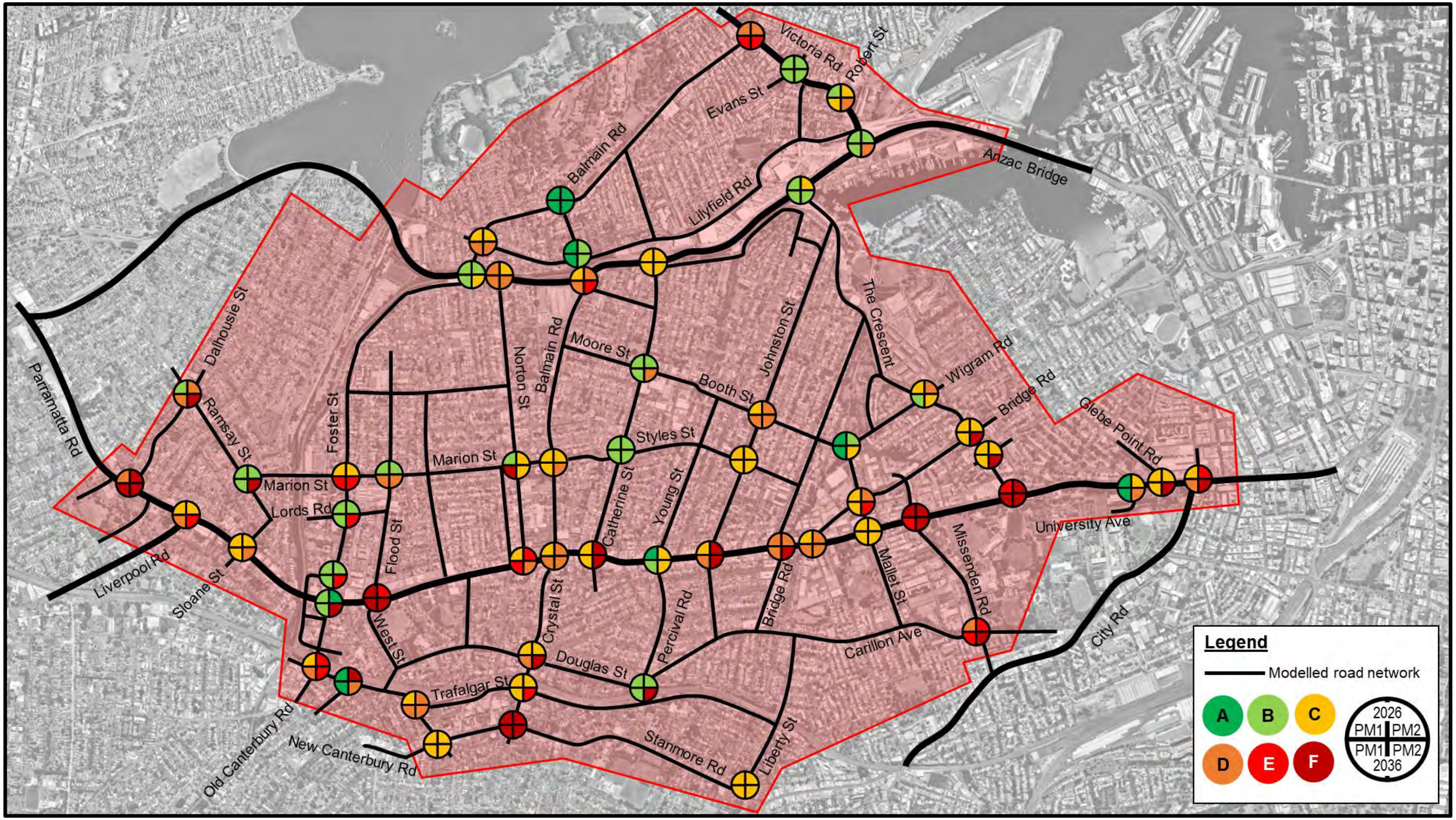


Figure 6-8 Intersection level of service – Do Minimum (PM Peak)

6.3.2 Queue lengths at major intersections

Table 6-7 shows the maximum queue length at major intersections along Parramatta Road in the PRCUTS precincts. On side roads, only queueing within the microsimulation area is included.

Table 6-7 Maximum queue length at major intersections in the PRCUTS precincts – Do Minimum

Intersection	Approach		Maximum queue length (m)			
			2026		2036	
			AM Peak	PM Peak	AM Peak	PM Peak
Parramatta Road / Dalhousie Street	N	Dalhousie Street	157	325	209	331
	E	Parramatta Road	91	88	93	90
	W	Parramatta Road	301	295	300	297
Parramatta Highway / Hume Highway	E	Parramatta Road	31	32	32	33
	S	Hume Highway	29	28	27	28
	W	Parramatta Road	139	136	99	136
Parramatta Road / Sloane Street	N	Sloane Street	44	54	49	60
	E	Parramatta Road	299	376	329	319
	S	Sloane Street	299	299	299	297
	W	Parramatta Road	302	144	302	174
Parramatta Road / Flood Street / West Street	N	Flood Street	231	239	205	240
	E	Parramatta Road	473	480	492	494
	S	West Street	74	69	73	74
	W	Parramatta Road	194	190	194	192
Parramatta Road / Norton Street	N	Norton Street	72	71	73	70
	E	Parramatta Road	119	118	113	114
	W	Parramatta Road	65	62	65	65
Parramatta Road / Crystal Street / Balmain Road	E	Parramatta Road	37	37	34	36
	S	Crystal Street	168	161	170	161
	W	Parramatta Road	116	125	121	123
Parramatta Road / Catherine Street	N	Catherine Street	185	186	176	183
	E	Parramatta Road	223	225	189	225
	S	Catherine Street	100	103	103	101
	W	Parramatta Road	52	50	52	43
Parramatta Road / Young Street / Percival Road	N	Young Street	105	105	107	113
	E	Parramatta Road	66	67	60	61
	S	Percival Road	84	62	91	73
	W	Parramatta Road	244	40	244	41
Parramatta Road / Johnston Street / Northumberland Avenue	N	Johnston Street	56	57	56	55
	E	Parramatta Road	82	82	93	84
	S	Northumberland Avenue	44	42	45	44
	W	Parramatta Road	200	251	243	251
Parramatta Road / Bridge Road	E	Parramatta Road	44	44	41	44
	S	Bridge Road	91	90	95	94
	W	Parramatta Road	34	31	33	34

Intersection	Approach		Maximum queue length (m)			
			2026		2036	
			AM Peak	PM Peak	AM Peak	PM Peak
Parramatta Road / Pyrmont Bridge Road / Denison Street	N	Pyrmont Bridge Road	73	157	81	187
	E	Parramatta Road	200	270	199	265
	W	Parramatta Road	37	40	40	35
Parramatta Road / Mallett Street	N	Mallett Street	81	80	80	81
	E	Parramatta Road	34	42	33	41
	S	Mallett Street	241	233	242	233
	W	Parramatta Road	264	33	262	39
Parramatta Road / Lyons Road / Missenden Road	N	Lyons Road	95	96	96	99
	E	Parramatta Road	181	489	211	494
	S	Missenden Road	226	224	187	229

6.4 Do Minimum network plots

6.4.1 Traffic density

Figure 6-9 to **Figure 6-12** show the simulated traffic density for the Do Minimum scenario. Traffic density is generally highest along Parramatta Road, and at major side road approaches to the corridor including Crystal Street, Catherine Street, Johnston Street and Mallett Street. In 2036, traffic density is also high on roads below the corridor such as Stanmore Road and Salisbury Road.

6.4.2 Speed ratio

Figure 6-13 to **Figure 6-16** show the simulated speed ratio for the Do Minimum scenario. Speed ratio is the average section speed as a proportion of the posted speed limit. The simulated speed ratio is low along Parramatta Road, particularly eastbound in the AM Peak and westbound in the PM Peak. Speed ratio is low on most approaches to signalised intersections along Parramatta Road, Victoria Road and City-West Link Road. In 2036, the speed ratio is reduced on parallel routes to Parramatta Road including Marion Street and Salisbury Road as vehicles reroute to avoid congestion along the main corridor.

6.4.3 Heavy vehicle proportions

Figure 6-17 to **Figure 6-20** show the proportion of the total traffic volume on each link that is heavy vehicles for the Do Minimum scenario. The proportion of heavy vehicles is significantly higher in the AM Peak than in the PM Peak on most roads.

In the AM Peak, the heavy vehicle percentage is highest on WestConnex, Victoria Road and Anzac Bridge. The heavy vehicle proportion on Parramatta is also between eight and 10 per cent. The main north-south routes used by heavy vehicles are Johnston Street, Balmain Road and Norton Street.

In the PM Peak, heavy vehicle proportions remain highest on WestConnex. The heavy vehicle proportion on Parramatta Road is between four and eight per cent at most locations. The main north-south route used by heavy vehicles is Balmain Road.

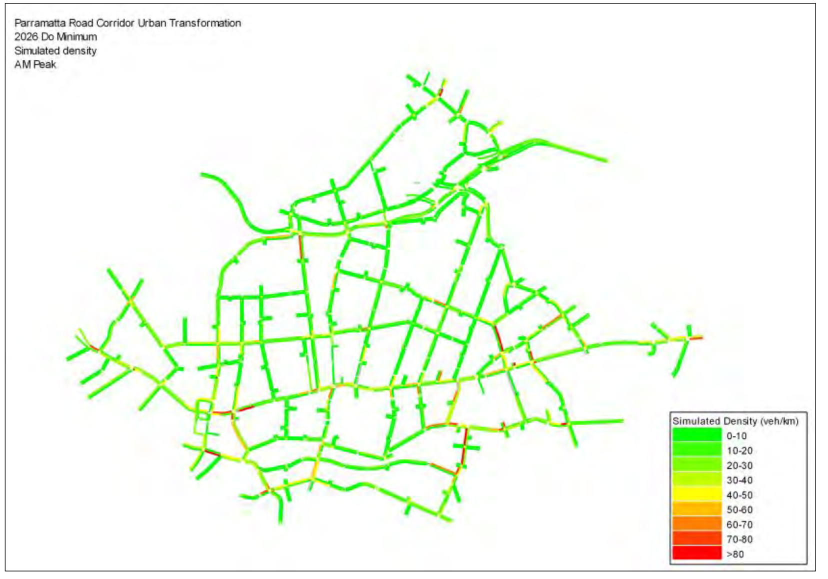


Figure 6-9 Simulated density – 2026 Do Minimum (AM Peak)

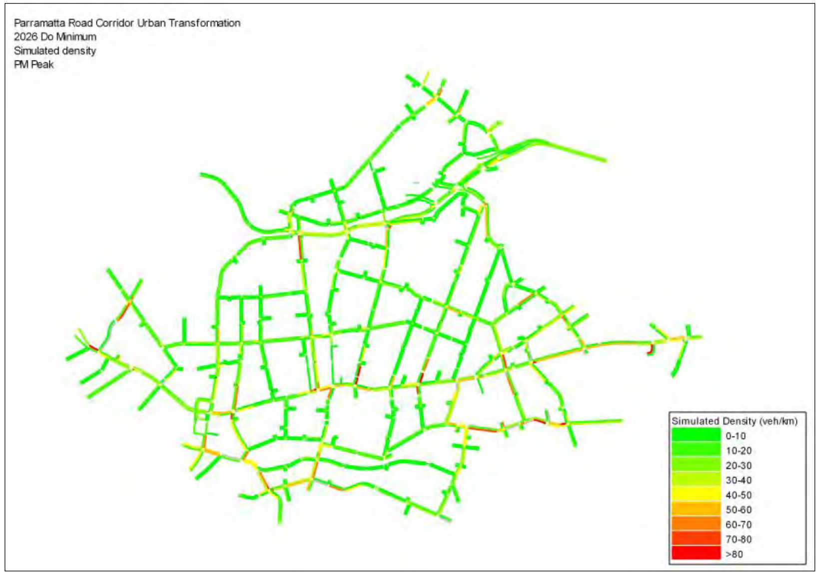


Figure 6-10 Simulated density – 2026 Do Minimum (PM Peak)

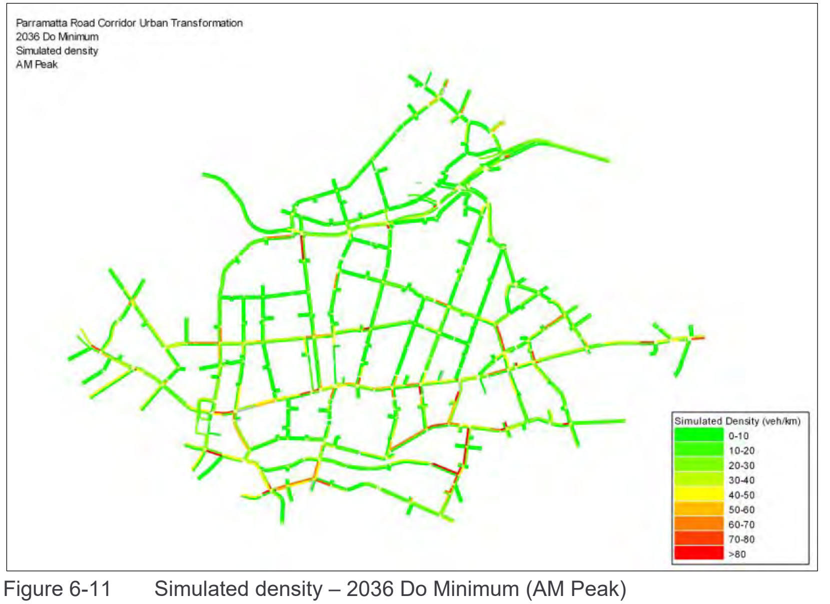


Figure 6-11 Simulated density – 2036 Do Minimum (AM Peak)

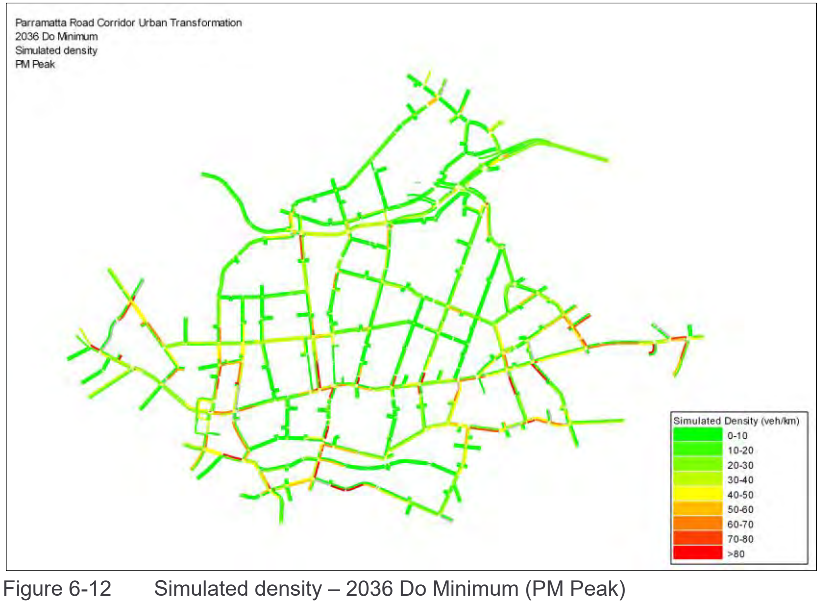


Figure 6-12 Simulated density – 2036 Do Minimum (PM Peak)

Figure 6-13 Speed ratio – 2026 Do Minimum (AM Peak)

Figure 6-14 Speed ratio – 2026 Do Minimum (PM Peak)

Figure 6-15 Speed ratio – 2036 Do Minimum (AM Peak)

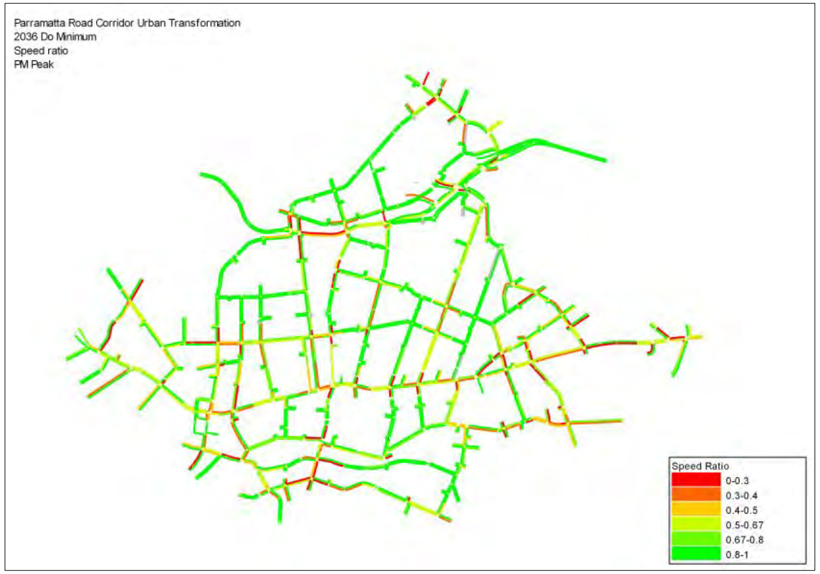


Figure 6-16 Speed ratio – 2036 Do Minimum (PM Peak)

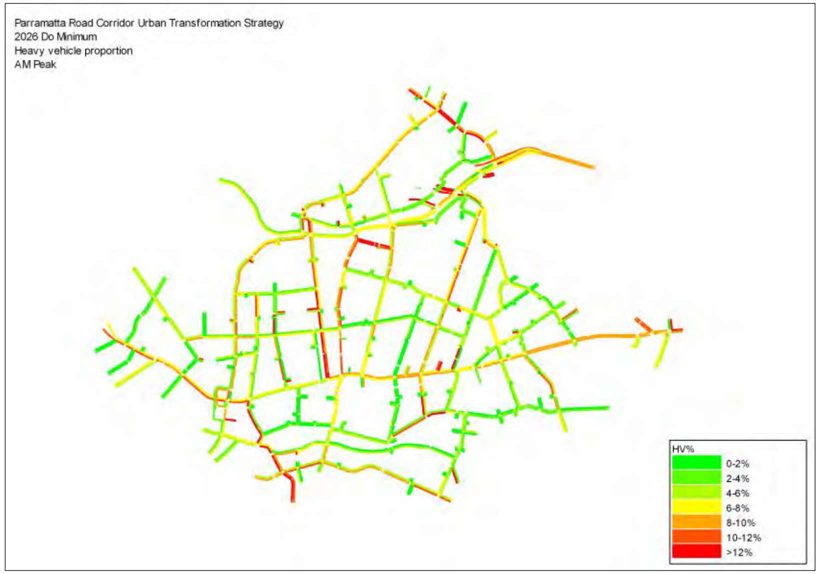


Figure 6-17 Heavy vehicle proportions – 2026 Do Minimum (AM Peak)

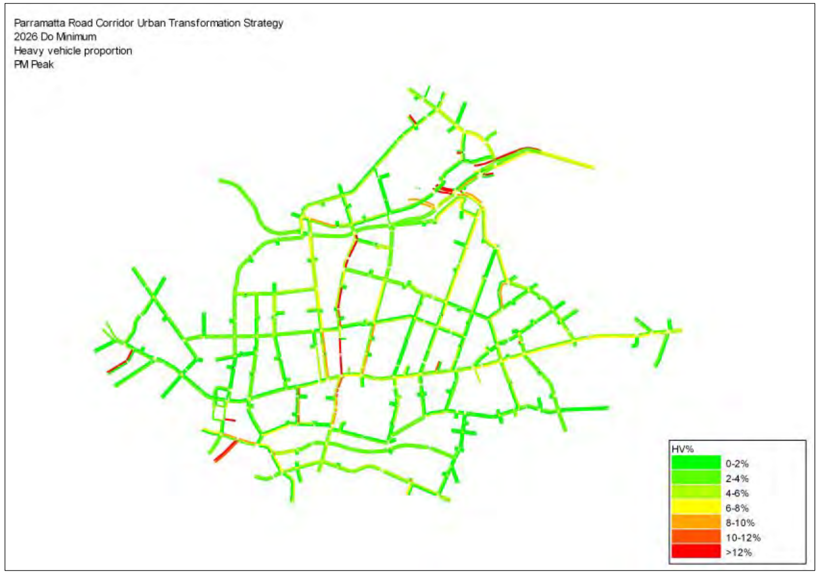


Figure 6-18 Heavy vehicle proportions – 2026 Do Minimum (PM Peak)

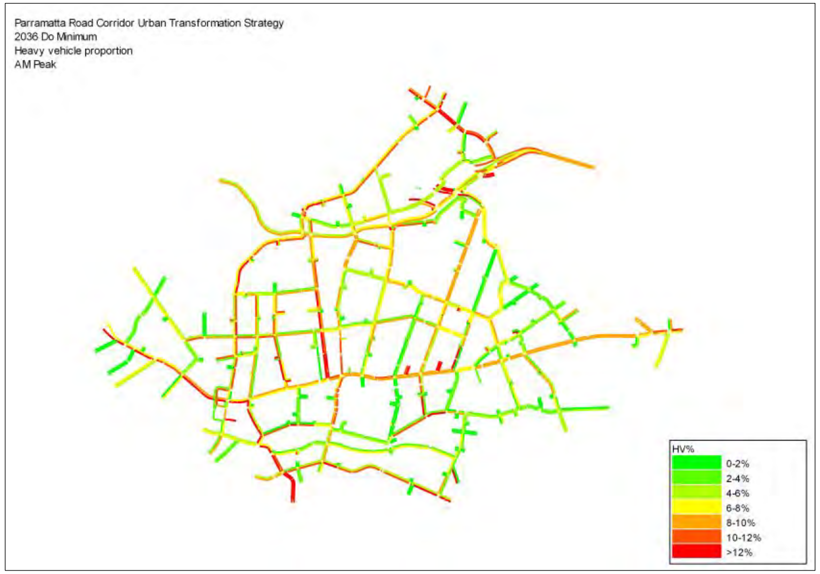


Figure 6-19 Heavy vehicle proportions – 2036 Do Minimum (AM Peak)

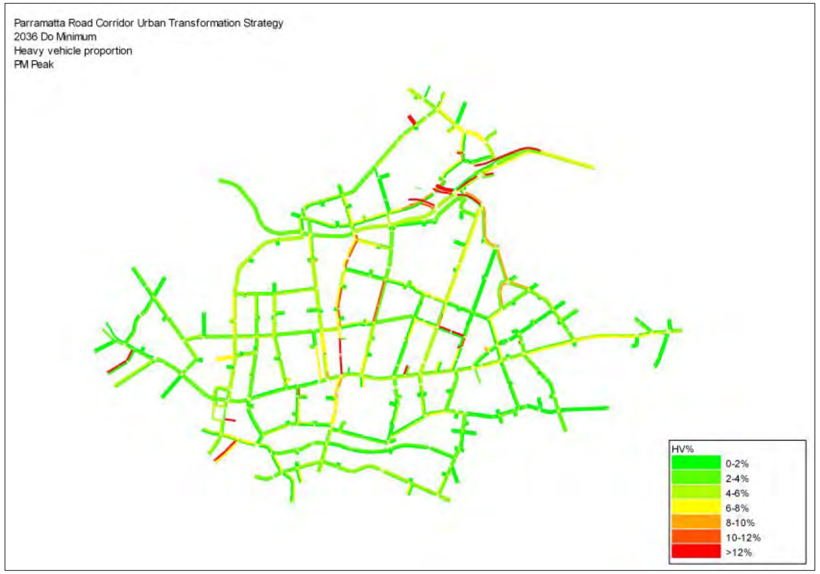


Figure 6-20 Heavy vehicle proportions – 2036 Do Minimum (PM Peak)

7 With Upgrades operational results

The With Upgrades model was used to optimise network performance by introducing localised infrastructure upgrades across the study area. The upgrades included were discussed in **Section 2.1.2**. As discussed in that section, the localised upgrades were Cardno's suggestions for how the traffic performance of the network could be improved, and are not endorsed by Council, DPIE, Transport for NSW or any other stakeholders. Further traffic modelling is suggested during the Concept and Detailed Design stages to assess the viability of these upgrades.

7.1 With Upgrades network performance

7.1.1 Network performance summary

Table 7-1 shows the network performance results for the With Upgrades scenario. The key findings are summarised below.

> The total traffic demand remains the same as the Do Minimum scenario.

> The number of vehicles arrived increases in all peaks. The increase is greatest in the PM Peak in each future year. In 2036, an additional 2554 vehicles arrive at their destination by the end of the simulation period. This is a result of reduced congestion throughout the network, fewer unreleased vehicles and fewer deleted vehicles.

> In 2026, the total distance travelled by all vehicles in the simulation (VKT) increase by 0.8 per cent in the AM Peak and 1.8 per cent in the PM Peak. In 2036, these increases are 1.8 per cent and 3.8 per cent respectively. This is also a result of reduced congestion throughout the network as more vehicles are able to complete their trips (ie travel further) in the simulation period.

> Vehicle hours travelled (VHT) reduces in both peaks. In 2026, the reduction is up to 4.6 per cent and in 2036 the reduction is up to 3.5 per cent. This is a result of lower congestion in the model which increases average speeds and decreases delay time.

> Average speed increases by 0.6 kilometres per hour in the 2026 AM Peak and by 0.3 kilometres per hour in the 2026 PM Peak. In 2036, these values are 0.4 and 0.3 respectively.

> Average delay decreases by five to 10 seconds in 2026 and by up to 18 seconds in 2036.

> The total of deleted and unreleased demand is reduced by 829 vehicles in the AM Peak and 993 vehicles in the PM Peak. Unreleased demand is discussed in the next section.

7.1.2 Person statistics

Table 7-2 shows key network statistics per person for the With Upgrades scenario based on the assumed vehicle occupancies outlined in **Section 3.2.1**.

Table 7-1 Network performance results – With Upgrades

Network performance metric	Unit	2026				2036			
		With Upgrades results		Compared to Base		With Upgrades results		Compared to Base	
		AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak
All vehicles									
Total traffic demand	veh	80,193	87,443	0 (+0.0%)	0 (+0.0%)	85,587	93,628	0 (0.0%)	0 (0.0%)
Total vehicles arrived	veh	79,425	86,386	+521 (+0.7%)	+1213 (+1.4%)	82,289	89,139	+1050 (+1.3%)	+2554 (+3.1%)
Total kilometres travelled (VKT)	km	193,032	206,804	+1566 (+0.8%)	+3708 (+1.8%)	200,098	211,719	+4049 (+2.1%)	+7668 (+3.8%)
Vehicle hours travelled (VHT)	hr	7320	8251	-351 (-4.6%)	-338 (-3.9%)	8302	9597	-163 (-1.9%)	-301 (-3.5%)
Average per vehicle									
Average kilometres travelled	km	2.4	2.4	+0.0 (+0.2%)	+0.0 (+0.4%)	2.4	2.4	0 (+0.8%)	0 (+0.8%)
Average time travelled in network	s	141	143	-5 (-3.4%)	-10 (-6.4%)	153	164	-4 (-2.4%)	-18 (-10.6%)
Average speed	km/hr	30.6	31.3	+0.6 (+2.1%)	+0.3 (+0.9%)	29.2	29.6	+0.4 (+1.2%)	+0.3 (+1.2%)
Average delay	s	74	77	-5 (-6.3%)	-10 (-11.3%)	86	97	-4 (-4.3%)	-18 (-20.9%)
Unreleased demand									
Unreleased demand (% of total demand)	veh (%)	31 (0.0%)	107 (0.1%)	-42	-310	715 (0.8%)	472 (0.5%)	-40	-1367
Deleted vehicles (% of total demand)	veh (%)	147 (0.2%)	232 (0.3%)	-486	-91	343 (0.4%)	1273 (1.4%)	-789	374
Total unreleased and deleted (% of total demand)	veh (%)	178 (0.2%)	339 (0.4%)	-528	-401	1058 (1.2%)	1745 (1.9%)	-829	-993

Table 7-2 Network statistics by person – With Upgrades

Network performance metric	Unit	2026				2036			
		AM Peak		PM Peak		AM Peak		PM Peak	
		LV	HV	LV	HV	LV	HV	LV	HV
Network statistics by vehicle type									
Total vehicles arrived	veh	74,407	4547	83,272	2941	76,621	5196	85,652	3315
Total kilometres travelled (VKT)	km	179,861	11,824	199,010	7316	184,947	13,802	202,828	8414
Vehicle hours travelled (VHT)	hr	6779	459	7935	287	7619	597	9187	381
Average speed	km/hr	30.6	31.9	31.1	38.8	29.2	30.3	29.3	36.1
Average delay	s	74	69	78	55	86	81	98	72
Average per vehicle									
Total persons arrived	person	82,951	4547	92,833	2941	85,419	5196	95,487	3315
Total person-kilometres travelled	km	200,513	11,824	221,860	7316	206,183	13,802	226,117	8414
Total person-hours travelled	hr	7557	459	8846	287	8494	597	10,241	381
Average speed per person	km/hr	30.6	31.9	31.1	38.8	29.2	30.3	29.3	36.1
Average delay per person	s	83	69	87	55	96	81	110	72

7.1.3 Unreleased demand

Unreleased demand refers to vehicles that are unable to enter the study are by the end of the simulation period. This is caused by queueing on their arrival link that extends back to the edge of the study area. High unreleased demand is an indication of significant network congestion.

The following sections outline the total unreleased demand and locations of unreleased demand in the AM and PM peaks for the With Upgrades scenario.

AM Peak

- Unreleased demand in 2026 is 31 vehicles which represents a reduction of 42 vehicles compared to the Do Minimum. In 2036, the unreleased demand is 715 vehicles which is a reduction of 472 vehicles compared to the Do Minimum.
- In 2026, there was significant unreleased demand on Darling Street approaching Victoria Road, as well as on Western Avenue near Parramatta Road. Unreleased demand as these locations have been removed/reduced by localised intersection upgrades.
- Localised intersection upgrades in 2036 resulted in a reduction of unreleased demand on Shaw Street and Station Street. Unreleased demand on Old Canterbury Road and Parramatta Road was also significantly reduced.

PM Peak

- Unreleased demand in 2026 is 107 vehicles which represents a reduction of 310 vehicles compared to the Do Minimum. In 2036, the unreleased demand is 472 vehicles which is a reduction of 1367 vehicles compared to the Do Minimum.
- Localised intersection improvements around Ross Street remove significant unreleased demand on Bridge Road, St Johns Road and Western Avenue in 2026.
- In 2036, reduced congestion along Parramatta Road and its approaches leads to the removal/reduction of unreleased demand on Dalhousie Street, Tebbutt Street, Station Street, along Salisbury Road, around Bridge Rod and St Johns Road and Glebe Point Road. Some unreleased demand remains on Old Canterbury Road, Parramatta Road and Victoria Road.

Figure 7-1 Unreleased demand – 2026 With Upgrades (AM Peak)

Figure 7-2 Unreleased demand – 2026 With Upgrades (PM Peak)

Figure 7-3 Unreleased demand – 2036 With Upgrades (AM Peak)

Figure 7-4 Unreleased demand – 2036 With Upgrades (PM Peak)

7.2 With Upgrades travel times

This section provides an overview of travel times on key routes and through the PRCUTS precincts in the 2026 and 2036 Do Minimum scenarios.

7.2.1 Travel times on key routes

Table 7-3 lists the modelled travel times on each route in the 2026 and 2036 Do Minimum scenarios. In general, the intersection upgrades improve the performance of Parramatta Road and reduce queueing on side road approaches. This reduces travel time on most routes compared to the Do Minimum scenario.

> The With Upgrades scenario provides improvements to travel times along Balmain Road in both peaks and future years. In 2026, travel times in the northbound direction are up to 15 seconds shorter than in the Do Minimum scenario, while those in the southbound direction are up to 16 seconds shorter. In 2036, the travel time savings are more extreme. In the 2036 PM Peak, travel times in the northbound direction are more than two minutes faster, while those in the southbound direction are 28 seconds shorter in the 2036 AM Peak.

> Travel times on Crystal Street generally improve in 2026, however travel times were longer in 2036 than in the Do Minimum scenario. This is one of the most congested areas of the model in both scenarios.

> Intersection improvements at Johnston Street reduce the southbound travel time by 109 seconds in 2026 and by 26 seconds in 2036. There are also improvements to travel times in the northbound direction in the AM Peak in both years.

> Travel times along Marion Street remain similar in 2026, but significantly improve in 2036, particularly in the PM Peak. Intersection improvements along Parramatta Road make Marion Street a less attractive rat-run which improves its performance. It is also less affected by queue spillback from Parramatta Road in the second hour of the peak.

> Travel times along Parramatta Road improve in both peaks and future years. Intersection improvements significantly reduced travel times in the westbound direction on Parramatta Road. In the 2026 AM Peak, travel times are reduced by 236 seconds, corresponding to an increase in average speed of 7.1 kilometres per hour. In the 2026 PM Peak, the reduction is 176 seconds. In 2036, 341 seconds are saved in the AM Peak in the westbound direction, corresponding to an average speed increase of 8.6 kilometres per hour compared to the Do Minimum scenario.

Note that the travel times shown in this table are for vehicles that traverse the full length of the route only.

Table 7-3 Travel times on key routes – With Upgrades

Route	Dir.	Do Minimum results				Compared to 2018 Base			
		Travel times (s)		Average speed (km/hr)		Travel times (s)		Average speed (km/hr)	
		AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak
2026									
Balmain Road	NB	281	239	18.4	21.6	-7	-15	0.4	1.3
	SB	153	131	22.6	26.3	-16	-9	2.2	1.7
Crystal Street	NB	195	268	15.9	11.6	-4	82	0.3	-5.1
	SB	235	225	13.2	13.8	-3	-24	0.2	1.3
Johnston Street	NB	268	287	23.5	22.0	-19	4	1.6	-0.3
	SB	273	317	23.0	19.8	9	-109	-0.8	5.1
Marion Street	EB	245	219	22.8	25.6	2	5	-0.2	-0.7
	WB	284	199	19.7	28.1	23	-3	-1.8	0.4
Parramatta Road	EB	836	798	26.6	27.9	-67	-51	2.0	1.7
	WB	748	968	29.6	22.9	-236	-176	7.1	3.5
2036									
Balmain Road	NB	280	263	18.4	19.6	-44	-126	2.5	6.4
	SB	158	138	21.9	24.9	-28	-11	3.3	1.8
Crystal Street	NB	283	470	10.9	6.6	84	267	-4.6	-8.7
	SB	257	499	12.1	6.2	4	22	-0.2	-0.3
Johnston Street	NB	272	281	23.2	22.4	-26	-8	2.0	0.6
	SB	264	367	23.8	17.1	-14	-26	1.2	1.1
Marion Street	EB	311	252	18.0	22.2	-24	-169	1.3	8.9
	WB	286	222	19.6	25.3	7	-92	-0.5	7.4
Parramatta Road	EB	1058	837	21.0	26.5	-176	-74	3.0	2.2
	WB	781	1136	28.3	19.5	-341	-14	8.6	0.2

7.2.2 Travel times through precincts

Table 7-4 shows the modelled travel time through each precinct in each direction. Overleaf, **Figure 7-5** and **Figure 7-6** show travel times through each precinct along Parramatta Road for the eastbound and westbound directions respectively.

AM Peak

> Eastbound travel time through Taverners Hill is reduced from the Do Minimum scenario in both 2026 and 2036. In 2026, the reduction is 50 seconds and 27 seconds in 2036.

> Eastbound travel time through Leichhardt is also reduced, with the most significant reductions occurring in the AM Peak. In 2026, the reduction is 34 seconds and in 2036 it is 43 seconds.

> The most significant reduction in the precinct travel time is through Leichhardt in the westbound direction. In the Do Minimum scenario, the travel time in 2026 was 359 seconds and in 2036 it was 430 seconds. With upgrades, these are reduced to 217 seconds and 242 seconds, a saving of over three minutes by 2036.

PM Peak

> Travel times through Taverners Hill are reduced in the eastbound direction by up to 51 seconds. Travel times are slightly increased in the westbound direction which is caused by intersection and signal optimisation to reduce queueing on side roads.

> Travel times also slightly increase in the westbound direction through Leichhardt in both future years.

> Through Camperdown, travel times decreased in both future years, with the greatest decrease occurring in the westbound direction in 2026.

Table 7-4 Precinct travel times – With Upgrades

Direction	Travel time through precinct (s)					
	2026			2036		
	Taverners Hill	Leichhardt	Camperdown	Taverners Hill	Leichhardt	Camperdown
AM Peak						
Eastbound	257	293	157	264	489	190
Westbound	244	217	99	261	242	104
PM Peak						
Eastbound	261	304	150	312	332	147
Westbound	224	342	177	227	420	233

Note that the travel times shown in these graphs are the cumulative sum of the travel times of each section along the route, so include vehicles that only traverse part of the route.

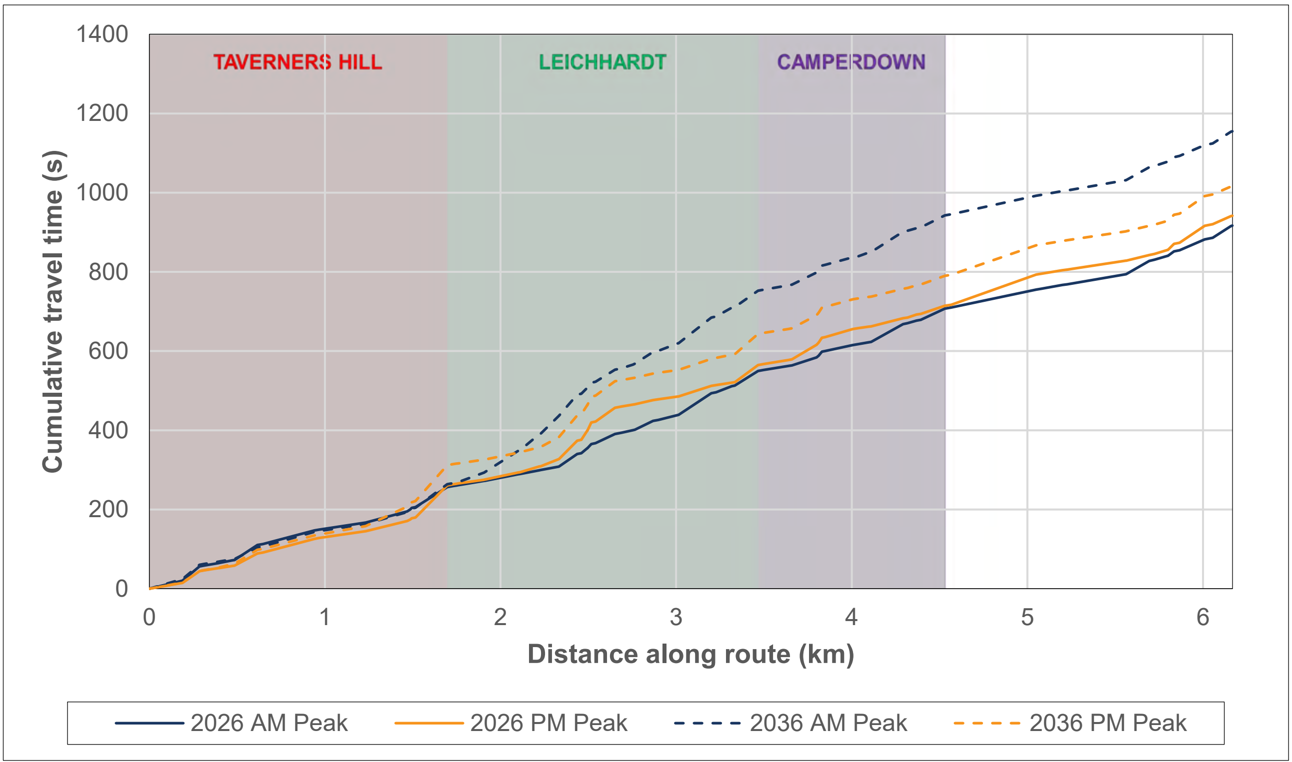


Figure 7-5 Travel times between precincts (eastbound) –With Upgrades

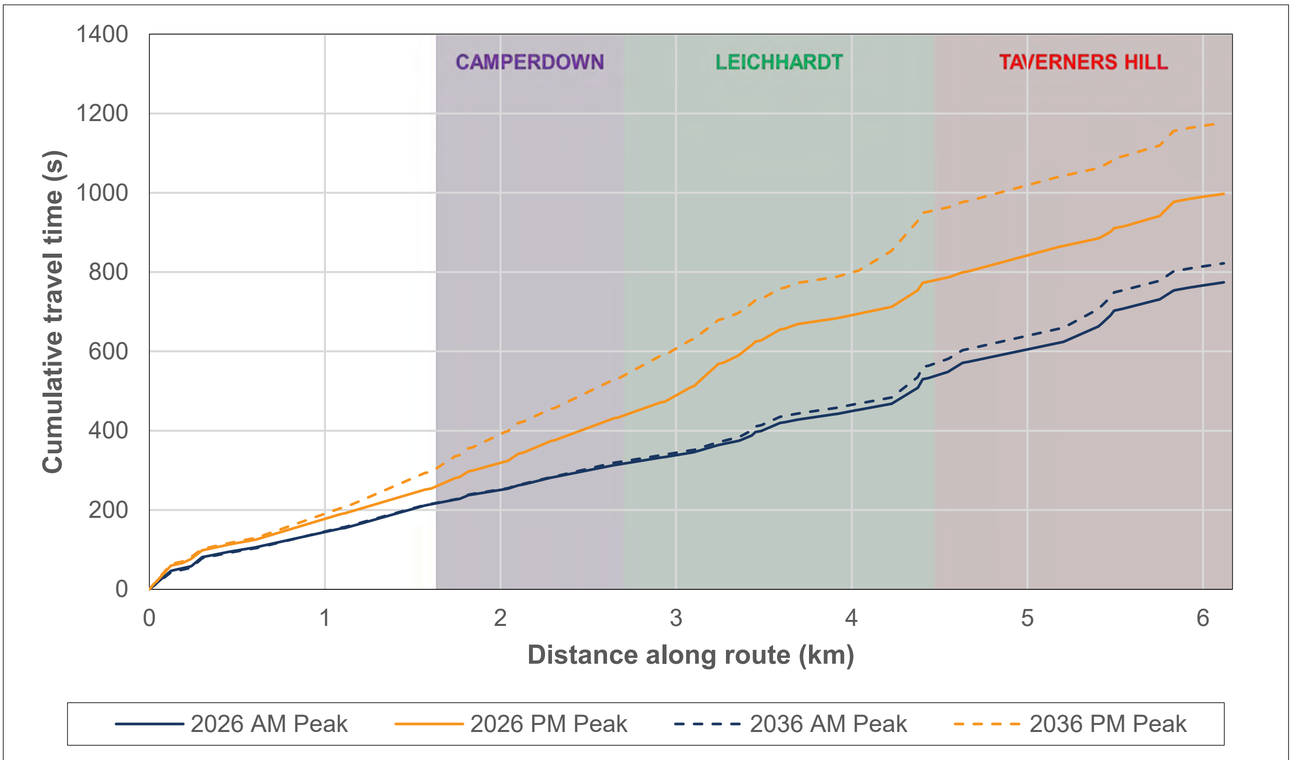


Figure 7-6 Travel times between precincts (westbound) – With Upgrades

7.3 With Upgrades intersection performance

This section provides an overview of intersection performance in the study area in the With Upgrades scenario. The results shown are for intersections in the PRCUTS precincts. Detailed performance results for all intersections assessed are provided in **Appendix H**.

7.3.1 Intersection operation

Table 7-5 and **Table 7-6** show the intersection performance results for the AM and PM peaks respectively.

The following sections provide a brief summary of the turns, movements and intersections where there is a notable improvement in performance between the Do Minimum scenario and corresponding With Upgrades scenario. In general, the modelled upgrades provide additional capacity for the side road approaches to Parramatta Road. This reduces the average delay on these approaches. In some cases, the green time for side roads could be reduced due to additional turn lanes (ie higher capacity), which provides benefits for traffic on Parramatta Road.

AM Peak

Table 7-5 shows the intersection performance for key intersections in the study area. **Figure 7-7** shows the performance of these intersections on a map of the study area.

> Upgrades at Booth Street improve the overall intersection performance from LOS D/E in the 2036 Do Minimum scenario to LOS C/C in the 2036 With Upgrades scenario. All movements on Booth Street have acceptable delays (LOS C or better), in comparison to the Do Minimum scenario where they were LOS F.

> While Parramatta Road / Flood Street / West Street remains over capacity in 2036, with upgrades, the average delay is reduced from 144 seconds (LOS F) to 62 seconds (LOS E) in the second hour of the AM Peak. Average delay is also reduced on the West Street and Flood Street approaches, although these remain LOS F.

> At Percival Road and Young Street, average delays on the side roads are reduced by intersection upgrades, but overall intersection performance remains LOS D.

> The overall performance of Parramatta Road / Northumberland Avenue / Johnston Street is improved, with the average delay in the second hour decreased from 58 seconds (LOS E) to 46 seconds (LOS D).

> Performance of Parramatta Road / Bridge Road improves as the average delay decreases from 61 seconds (LOS E) to 33 seconds (LOS C).

> Performance of Parramatta Road / Missenden Road / Lyons Road is improved from LOS D to LOS C in 2036.All movements on Missenden Road except the right turn experience average delays less than 52 seconds (corresponding to LOS D), while in the Do Minimum scenario, these movements were all LOS E or F.

PM Peak

Table 7-6 shows the intersection performance for key intersections in the study area. **Figure 7-8** shows the performance of these intersections on a map of the study area.

> Intersection improvements at Pyrmont Bridge Road / Booth Street / Mallett Street improve the overall intersection performance. In 2036, overall delay in the second hour is reduced from 66 seconds (LOS E) to 50 seconds (LOS D), and delays on Booth street and Mallett Street are reduced with upgrades.

> Queue spillback on Parramatta Road affecting Tebbutt Street is greatly reduced with the upgrades, which improves the performance of Tebbutt Street / Lords Road and Tebbutt Street / Hathern Road. Both intersections perform acceptably in 2036 with upgrades.

> Although the performance of Parramatta Road / Flood Street / West Street remains LOS F in 2036, upgrades to the side road approaches reduce their average delays. Flood street in the PM Peak experiences up to 845 seconds delay in 2036 Do Minimum, but with upgrades, this is reduced to 295.

> Maximum delay on Young Street decreases from 141 seconds to 92 seconds with upgrades.

> While remaining over capacity, overall delay at Parramatta Road / Northumberland Avenue / Johnston Street is reduced from 79 seconds (LOS F) to 62 seconds (LOS E) in the second hour.

> The performance of Parramatta Road / Bridge Road improves from LOS D/F to LOS C/D in 2036.

> Parramatta Road / Missenden Road / Lyons Road remains over capacity, however the average delay is decreased from 110 seconds to 85 seconds. Improvements on Lyons Road and Missenden Road reduce the average delays associated with these approaches, but they remain LOS F.

Table 7-5 Intersection performance results – With Upgrades (AM Peak)

	Intersection	Type	2026						2036					
			7:15AM – 8:15AM			8:15AM – 9:15AM			7:15AM – 8:15AM			8:15AM – 9:15AM		
			Vol. (veh)	Delay (s)	LOS	Vol. (veh)	Delay (s)	LOS	Vol. (veh)	Delay (s)	LOS	Vol. (veh)	Delay (s)	LOS
19	Marion Street / Norton Street	S	1705	35.6	C	2008	39.8	C	1705	35.6	C	2008	39.8	C
20	Marion Street / Leichhardt Street / Balmain Road	S	1364	30.5	C	1604	51.8	D	1364	30.5	C	1604	51.8	D
30	Pyrmont Bridge Road / Booth Street / Mallett Street	S	1845	39.4	C	1964	50.4	D	1845	39.4	C	1964	50.4	D
39	Parramatta Road / Liverpool Road	S	4640	39.4	C	4933	48.0	D	4640	39.4	C	4933	48.0	D
42	Tebbutt Street / Lords Road	S	1979	23.4	B	2028	22.2	B	1979	23.4	B	2028	22.2	B
44	Tebbutt Street / Hathern Street	S	1960	18.7	B	2159	33.6	C	1960	18.7	B	2159	33.6	C
45	Parramatta Road / Sloane Street	S	4682	26.5	B	5039	39.5	C	4682	26.5	B	5039	39.5	C
47	Parramatta Road / Old Canterbury Road / Tebbutt Street	S	4038	13.9	A	4290	41.7	C	4038	13.9	A	4290	41.7	C
50	Parramatta Road / Norton Street	S	3384	53.2	D	3533	32.3	C	3384	53.2	D	3533	32.3	C
51	Parramatta Road / Flood Street / West Street	S	4357	74.6	F	4438	153.0	F	4357	74.6	F	4438	153.0	F
52	Parramatta Road / Crystal Street / Balmain Road	S	4006	54.0	D	3847	71.5	F	4006	54.0	D	3847	71.5	F
53	Parramatta Road / Catherine Street / Phillip Street	S	3614	52.7	D	3516	40.8	C	3614	52.7	D	3516	40.8	C
67	Parramatta Road / Young Street / Percival Road	S	3488	40.8	C	3362	27.6	B	3488	40.8	C	3362	27.6	B
68	Parramatta Road /Northumberland Avenue / Johnston Street	S	4116	62.3	E	4155	62.4	E	4116	62.3	E	4155	62.4	E
69	Parramatta Road / Bridge Road	S	4028	38.7	C	4027	51.0	D	4028	38.7	C	4027	51.0	D
70	Parramatta Road /Pyrmont Bridge Road / Denison Street	S	4087	40.2	C	4152	44.8	D	4087	40.2	C	4152	44.8	D
71	Parramatta Road / Mallett Street	S	3769	36.1	C	3747	30.8	C	3769	36.1	C	3747	30.8	C
81	Parramatta Road / Dalhousie Street	S	3788	67.2	E	4007	87.0	F	3788	67.2	E	4007	87.0	F
83	Parramatta Road / Missenden Avenue / Lyons Road	S	3812	44.0	D	3794	85.4	F	3812	44.0	D	3794	85.4	F

Table 7-6 Intersection performance results – With Upgrades (PM Peak)

Intersection		Type	2026						2036					
			4:30PM – 5:30PM			5:30PM – 6:30PM			4:30PM – 5:30PM			5:30PM – 6:30PM		
			Vol. (veh)	Delay (s)	LOS	Vol. (veh)	Delay (s)	LOS	Vol. (veh)	Delay (s)	LOS	Vol. (veh)	Delay (s)	LOS
19	Marion Street / Norton Street	S	1714	23.0	B	1791	29.3	C	1705	35.6	C	2008	39.8	C
20	Marion Street / Leichhardt Street / Balmain Road	S	1322	28.7	C	1399	33.9	C	1364	30.5	C	1604	51.8	D
30	Pyrmont Bridge Road / Booth Street / Mallett Street	S	1878	44.2	D	1987	47.6	D	1845	39.4	C	1964	50.4	D
39	Parramatta Road / Liverpool Road	S	4572	29.2	C	4969	33.4	C	4640	39.4	C	4933	48.0	D
42	Tebbutt Street / Lords Road	S	1819	20.7	B	1796	17.9	B	1979	23.4	B	2028	22.2	B
44	Tebbutt Street / Hathern Street	S	1852	17.9	B	1959	18.5	B	1960	18.7	B	2159	33.6	C
45	Parramatta Road / Sloane Street	S	4654	28.3	B	5080	31.6	C	4682	26.5	B	5039	39.5	C
47	Parramatta Road / Old Canterbury Road / Tebbutt Street	S	4042	17.9	B	4345	11.2	A	4038	13.9	A	4290	41.7	C
50	Parramatta Road / Norton Street	S	3360	30.3	C	3489	33.8	C	3384	53.2	D	3533	32.3	C
51	Parramatta Road / Flood Street / West Street	S	4472	83.1	F	4753	71.0	F	4357	74.6	F	4438	153.0	F
52	Parramatta Road / Crystal Street / Balmain Road	S	3805	44.9	D	3918	51.2	D	4006	54.0	D	3847	71.5	F
53	Parramatta Road / Catherine Street / Phillip Street	S	3472	53.2	D	3501	57.3	E	3614	52.7	D	3516	40.8	C
67	Parramatta Road / Young Street / Percival Road	S	3338	13.4	A	3338	30.3	C	3488	40.8	C	3362	27.6	B
68	Parramatta Road /Northumberland Avenue / Johnston Street	S	3963	35.5	C	4188	51.6	D	4116	62.3	E	4155	62.4	E
69	Parramatta Road / Bridge Road	S	4093	37.9	C	4228	35.1	C	4028	38.7	C	4027	51.0	D
70	Parramatta Road /Pyrmont Bridge Road / Denison Street	S	4080	25.0	B	4317	34.9	C	4087	40.2	C	4152	44.8	D
71	Parramatta Road / Mallett Street	S	3737	27.6	B	3942	28.9	C	3769	36.1	C	3747	30.8	C
81	Parramatta Road / Dalhousie Street	S	3708	45.9	D	4036	61.3	E	3788	67.2	E	4007	87.0	F
83	Parramatta Road / Missenden Avenue / Lyons Road	S	3603	36.7	C	3899	41.3	C	3812	44.0	D	3794	85.4	F

Figure 7-7 and **Figure 7-8** show the intersection performance results on a map of the study area.

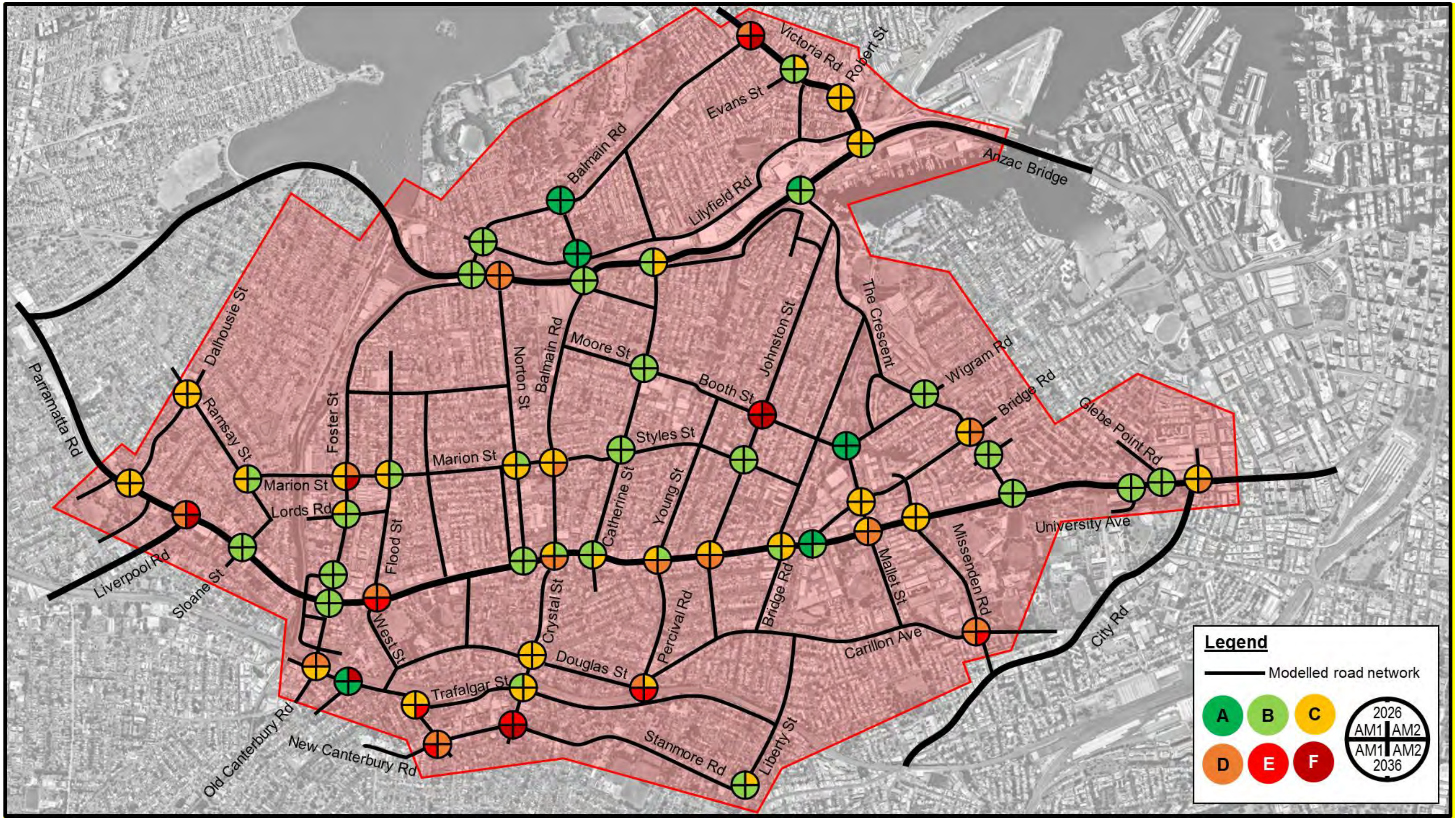


Figure 7-7 Intersection level of service – With Upgrades (AM Peak)

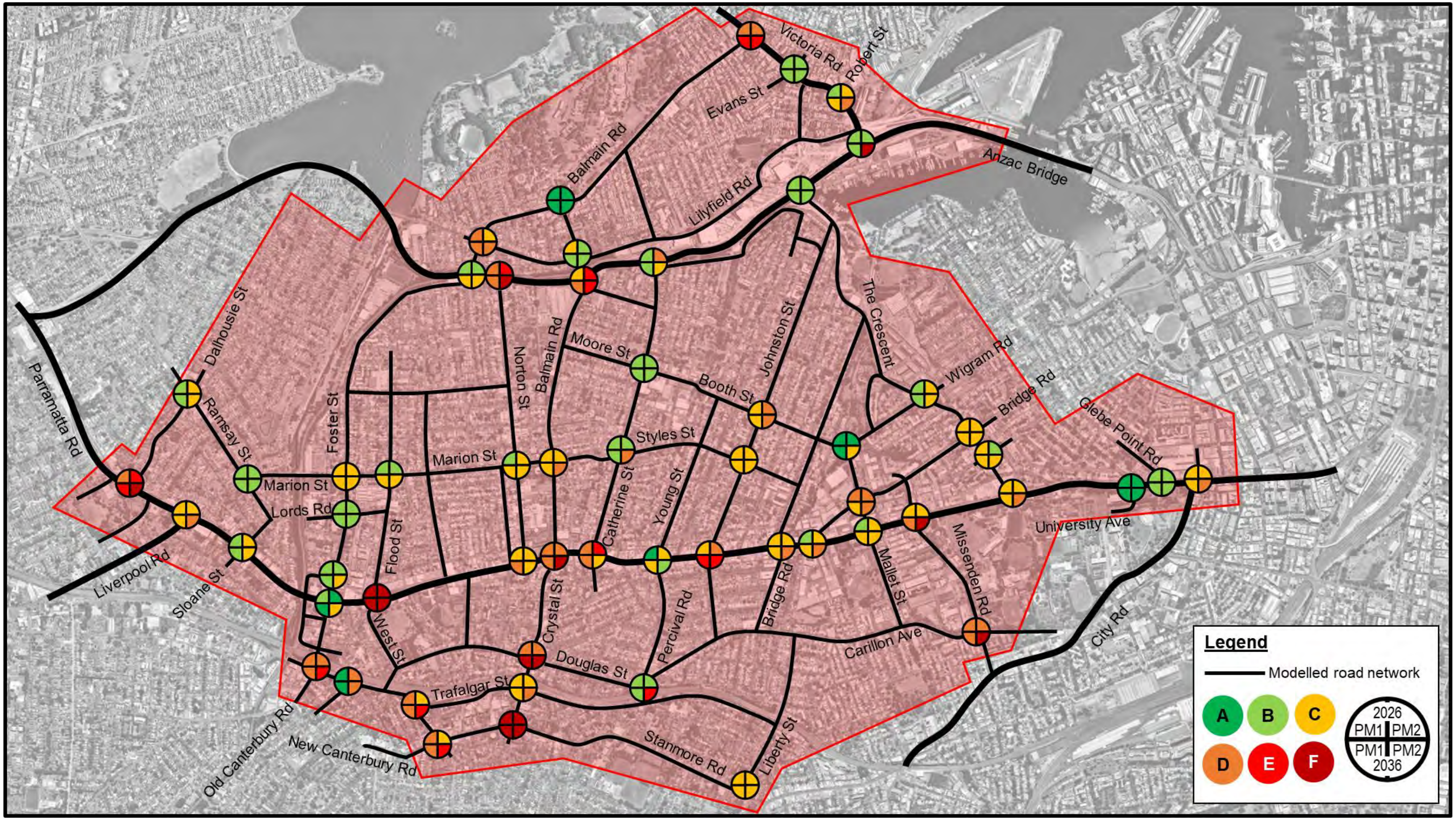


Figure 7-8 Intersection level of service – With Upgrades (PM Peak)

7.3.2 Queue lengths at major intersections

Table 7-7 shows the maximum queue length at major intersections along Parramatta Road in the PRCUTS precincts. On side roads, only queueing within the microsimulation area is included.

Table 7-7 Maximum queue length at major intersections in the PRCUTS precincts – With Upgrades

Intersection	Approach		Maximum queue length (m)			
			2026		2036	
			AM Peak	PM Peak	AM Peak	PM Peak
Parramatta Road / Dalhousie Street	N	Dalhousie Street	129	322	169	329
	E	Parramatta Road	94	91	95	93
	W	Parramatta Road	301	291	301	295
Parramatta Highway / Hume Highway	E	Parramatta Road	31	29	31	32
	S	Hume Highway	30	24	30	28
	W	Parramatta Road	140	133	110	137
Parramatta Road / Sloane Street	N	Sloane Street	41	50	51	54
	E	Parramatta Road	345	379	312	334
	S	Sloane Street	299	299	299	297
	W	Parramatta Road	304	153	306	143
Parramatta Road / Flood Street / West Street	N	Flood Street	232	238	221	240
	E	Parramatta Road	491	484	481	496
	S	West Street	70	70	69	66
	W	Parramatta Road	193	193	189	193
Parramatta Road / Norton Street	N	Norton Street	74	72	75	76
	E	Parramatta Road	111	113	116	113
	W	Parramatta Road	69	62	67	65
Parramatta Road / Crystal Street / Balmain Road	E	Parramatta Road	36	35	36	35
	S	Crystal Street	169	168	171	172
	W	Parramatta Road	115	122	119	116
Parramatta Road / Catherine Street	N	Catherine Street	148	186	127	149
	E	Parramatta Road	42	226	45	225
	S	Catherine Street	100	104	103	105
	W	Parramatta Road	52	52	52	48
Parramatta Road / Young Street / Percival Road	N	Young Street	104	88	105	105
	E	Parramatta Road	57	68	57	68
	S	Percival Road	82	49	83	83
	W	Parramatta Road	243	34	244	41
Parramatta Road / Johnston Street / Northumberland Avenue	N	Johnston Street	50	56	56	56
	E	Parramatta Road	87	83	93	91
	S	Northumberland Avenue	45	37	43	43
	W	Parramatta Road	78	245	59	256
Parramatta Road / Bridge Road	E	Parramatta Road	80	84	79	85
	S	Bridge Road	95	89	97	89
	W	Parramatta Road	34	33	34	33

Intersection	Approach		Maximum queue length (m)			
			2026		2036	
			AM Peak	PM Peak	AM Peak	PM Peak
Parramatta Road / Pyrmont Bridge Road / Denison Street	N	Pyrmont Bridge Road	111	192	116	205
	E	Parramatta Road	201	263	202	266
	W	Parramatta Road	39	33	39	38
Parramatta Road / Mallett Street	N	Mallett Street	129	84	131	112
	E	Parramatta Road	41	41	39	41
	S	Mallett Street	242	243	243	239
	W	Parramatta Road	259	42	269	43
Parramatta Road / Lyons Road / Missenden Road	N	Lyons Road	96	96	98	93
	E	Parramatta Road	168	210	164	488
	S	Missenden Road	88	132	67	226

7.4 With Upgrades network plots

7.4.1 Traffic density

Figure 7-9 to **Figure 7-12** show the simulated traffic density for With Upgrades scenario. The density results are similar across the network to the Do Minimum scenario, however the impact of localised upgrades can be seen in reduced densities on side roads to Parramatta Road, on Booth Street, along Salisbury Road and on Liberty Street.

7.4.2 Speed ratio

Figure 7-13 to **Figure 7-16** show the simulated speed ratio for the With Upgrades scenario. Speed ratio is the average section speed as a proportion of the posted speed limit. The With Upgrades scenario shows improvements to the speed ratio, particularly on side roads with intersection upgrades including Liverpool Road, Booth Street and Missenden Road.

7.4.3 Heavy vehicle proportions

Figure 7-17 to **Figure 7-20** show the proportion of the total traffic volume on each link that is heavy vehicles. The proportion of heavy vehicles is significantly higher in the AM Peak than in the PM Peak on most roads. There is no significant change to the heavy vehicle distribution with upgrades.

Figure 7-9 Simulated density – 2026 With Upgrades (AM Peak)

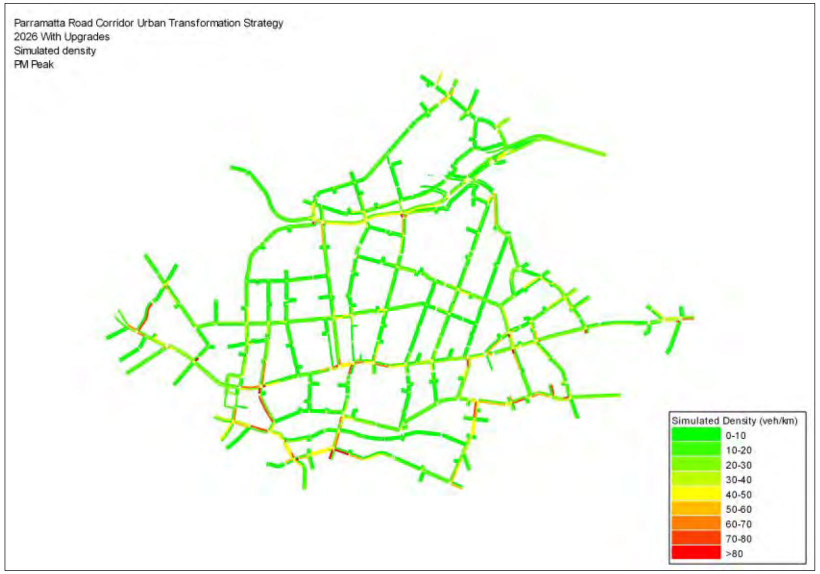


Figure 7-10 Simulated density – 2026 With Upgrades (PM Peak)

Figure 7-11 Simulated density – 2036 With Upgrades (AM Peak)

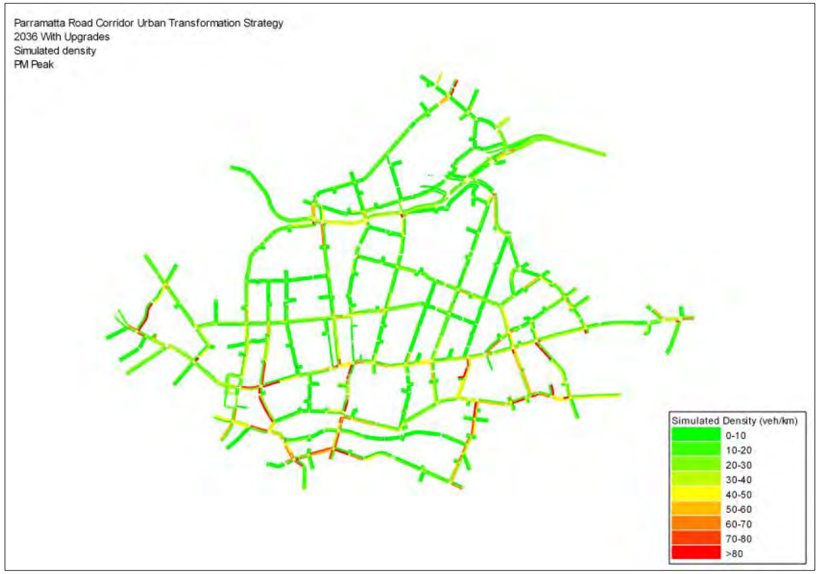


Figure 7-12 Simulated density – 2036 With Upgrades (PM Peak)

Figure 7-13 Speed ratio – 2026 With Upgrades (AM Peak)

Figure 7-14 Speed ratio – 2026 With Upgrades (PM Peak)

Figure 7-15 Speed ratio – 2036 With Upgrades (AM Peak)

Figure 7-16 Speed ratio – 2036 With Upgrades (PM Peak)

Figure 7-17 Heavy vehicle proportions – 2026 With Upgrades (AM Peak)

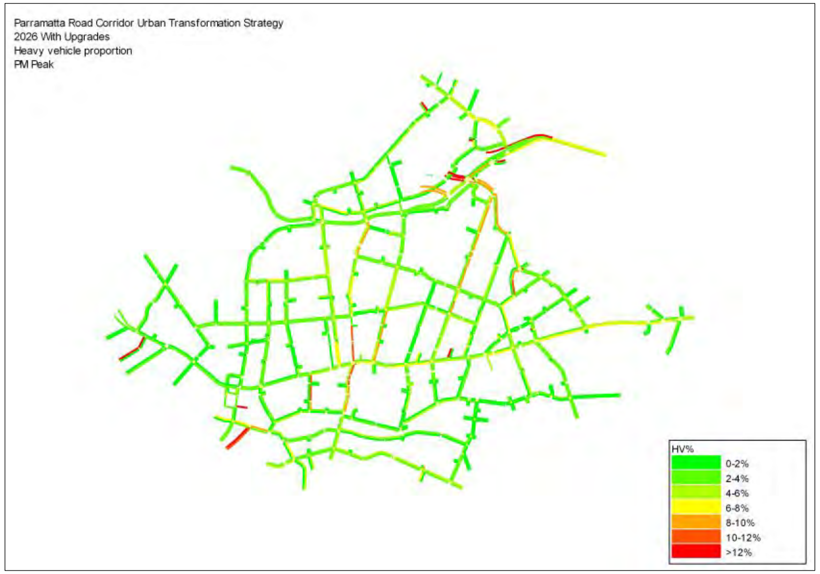


Figure 7-18 Heavy vehicle proportions – 2026 With Upgrades (PM Peak)

Figure 7-19 Heavy vehicle proportions – 2036 With Upgrades (AM Peak)

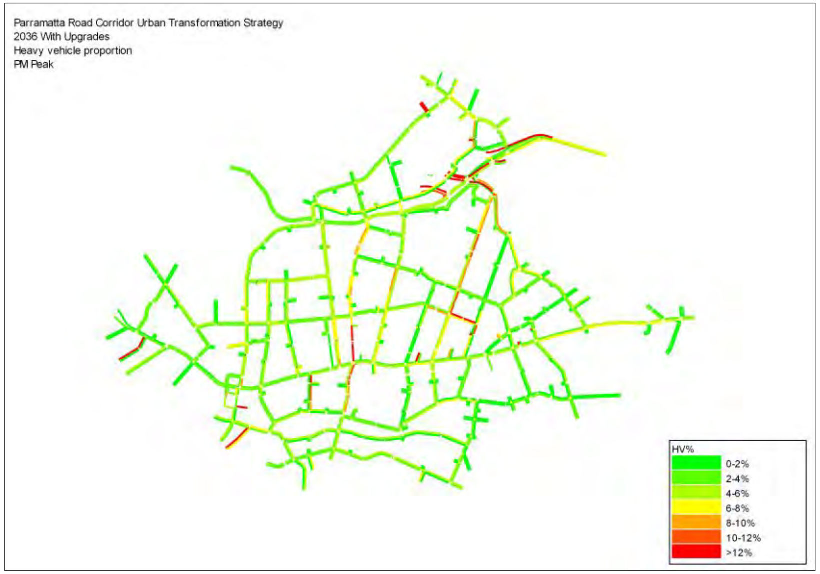


Figure 7-20 Heavy vehicle proportions – 2036 With Upgrades (PM Peak)

8 Conclusion

This report documents the development and results of the hybrid mesoscopic / microscopic model of the Parramatta Road corridor through Taverners Hill, Leichhardt and Camperdown, and the surrounding road network. The purpose of the study was to assess the impact of traffic demands on the operation of the corridor after the opening of the WestConnex interchange. The model will be used to develop strategies to cater for that demand. The following scenarios were modelled in detail:

> Base / Do Nothing

> Do Minimum.

Two peaks were modelled to capture typical weekday operation:

> 7:15AM – 9:15AM

> 4:30PM – 6:30PM.

A summary of the main findings is presented below.

> The traffic demand increased by 11,598 trips in the AM Peak and 12,301 trips in the PM Peak between 2018 and 2026. The increase between 2026 and 2036 was 5394 and 6185 trips respectively.

> The key findings of the Do Minimum scenario are:

- The total distance travelled by all vehicles in the simulation increases in both future years, but by proportionally less than the demand increase which results in a lower average kilometres travelled per vehicle
- Vehicle hours travelled also increases in both future years, but network improvements including WestConnex result in an increase in average speed between 2018 and 2026
- Average delay increases in each future year, with the greatest increase in the PM Peak in both years
- Up to three per cent of the total demand is either unreleased or deleted due to congestion across the network
- Travel times on most routes increase, although there is a short-term decrease in travel times on Parramatta Road due to upgrades at West Street and Crystal Street
- Many side road approaches to Parramatta Road are over capacity by 2026 and/or 2036 which results in long queues and significant approach delays.

> The localised upgrades were Cardno's suggestions for how the traffic performance of the network could be improved, and are not endorsed by Council, DPIE, Transport for NSW or any other stakeholders. Further traffic modelling is suggested during the Concept and Detailed Design stages to assess the viability of these upgrades.

> The key findings of the With Upgrades scenario are:

- The upgrades resulted in an increased number of vehicles arrived within the simulation period, fewer unreleased vehicles and fewer deleted vehicles across all peaks
- Vehicle kilometres travelled increased as more vehicles were able to complete their trips
- Vehicle hours travelled decreased in all peaks as a result of less congestion within the study area
- Average speed across the network increased with the upgrades and average delay time decreased by up to 18 seconds in 2036
- Less than 0.4 per cent of the total demand was unreleased or deleted in 2026, and less than two per cent in 2036
- The upgrades provided travel time improvements to key routes across the study area including Parramatta Road in both directions
- Intersection performance was improved at most key locations, particularly for side road movements, by providing additional capacity such as dedicated turning lanes and/or dual turning lanes.

APPENDIX

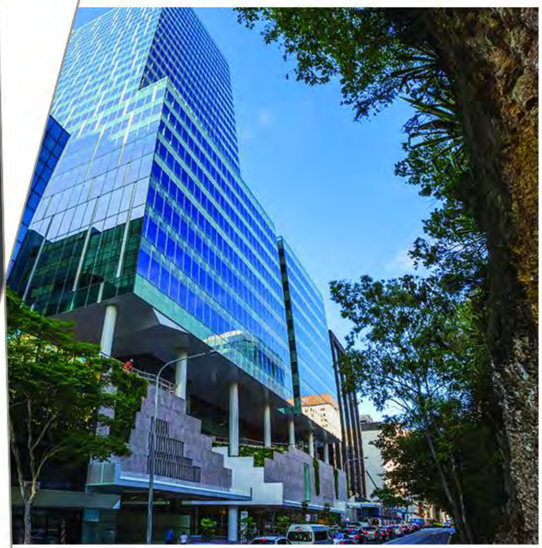
A

BASE MODEL DEVELOPMENT REPORT

Base Model Development Report

Parramatta Road Corridor Urban Transformation Strategy

80018116



Prepared for

Department of Planning, Industry and Environment

28 October 2020

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1	12/04/2019	Draft	Kevin Wu Stephen Payne	Ghaith Farfour
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1 Introduction

1.1 Project background

Cardno was engaged by Department of Planning, Industry and Environment (DPIE) to investigate the traffic network along the Parramatta Road corridor within the Inner West Council (IWC) local government area. The study involves the development of a hybrid (microscopic/mesoscopic) traffic simulation model using Aimsun, and the analysis of key sites on Parramatta Road using SIDRA Intersection. The purpose of the study is to better inform future minor traffic and safety works.

Figure 1-1 shows the regional context of the study area. The study area is located in the Inner West suburbs of Sydney approximately five kilometres south west of the CBD. The Parramatta Road is a key arterial road corridor connecting the Sydney CBD to the metropolitan centre of Parramatta, as well as other major destinations in inner western Sydney.

The boundary of the Parramatta Road corridor traffic model, the software platform and the locations and types of traffic surveys for input into the model development have been previously endorsed Inner West Council (IWC), Department of Planning, Industry and Environment (DPIE) and Transport for NSW (TfNSW) and used as the basis for developing the base mode.

This report documents the development, calibration and validation of the hybrid Aimsun model. A separate report was previously submitted detailing the SIDRA Intersection analysis (*SIDRA Base Model Development Report*, Cardno, April 2019).

1.2 Project objectives

The objectives of the Parramatta Road Corridor Urban Transformation Study (PRCUTS) are to:

> Evaluate the impacts of future infrastructure upgrades and trip reassignment in the study area on Parramatta Road and other major corridors

> Investigate future developments and land use changes in the study area

> Asses the maximum network capacity and recommended public transport mode shift

> Investigate optimal configuration of intersection improvements at key locations.

1.3 Scope of works

The traffic modelling scope of work for this traffic study is as follows:

> Review existing relevant works, previous traffic studies and development patterns in the Parramatta Road study area

> Conduct traffic surveys and undertake analysis of the historical trends and existing traffic conditions within the study area

> Use existing strategic models to estimate current and future demands across the study area

> Develop, calibrate and validate a Base Model to capture existing conditions on a typical weekday in the study area to establish a reliable and robust platform for future year testing, in accordance with the following guidelines:

- *Traffic Modelling Guidelines* (Roads and Maritime Services, 2017)
- *Technical Direction TTD 2018/002: Traffic signals in microsimulation modelling* (Roads and Maritime Services, 2018)
- *Technical Direction TTD 2017/001: Operational modelling reporting structure* (Roads and Maritime Services, 2018).

Develop future year scenarios to assess the operation of Parramatta Road and the surrounding network in the future

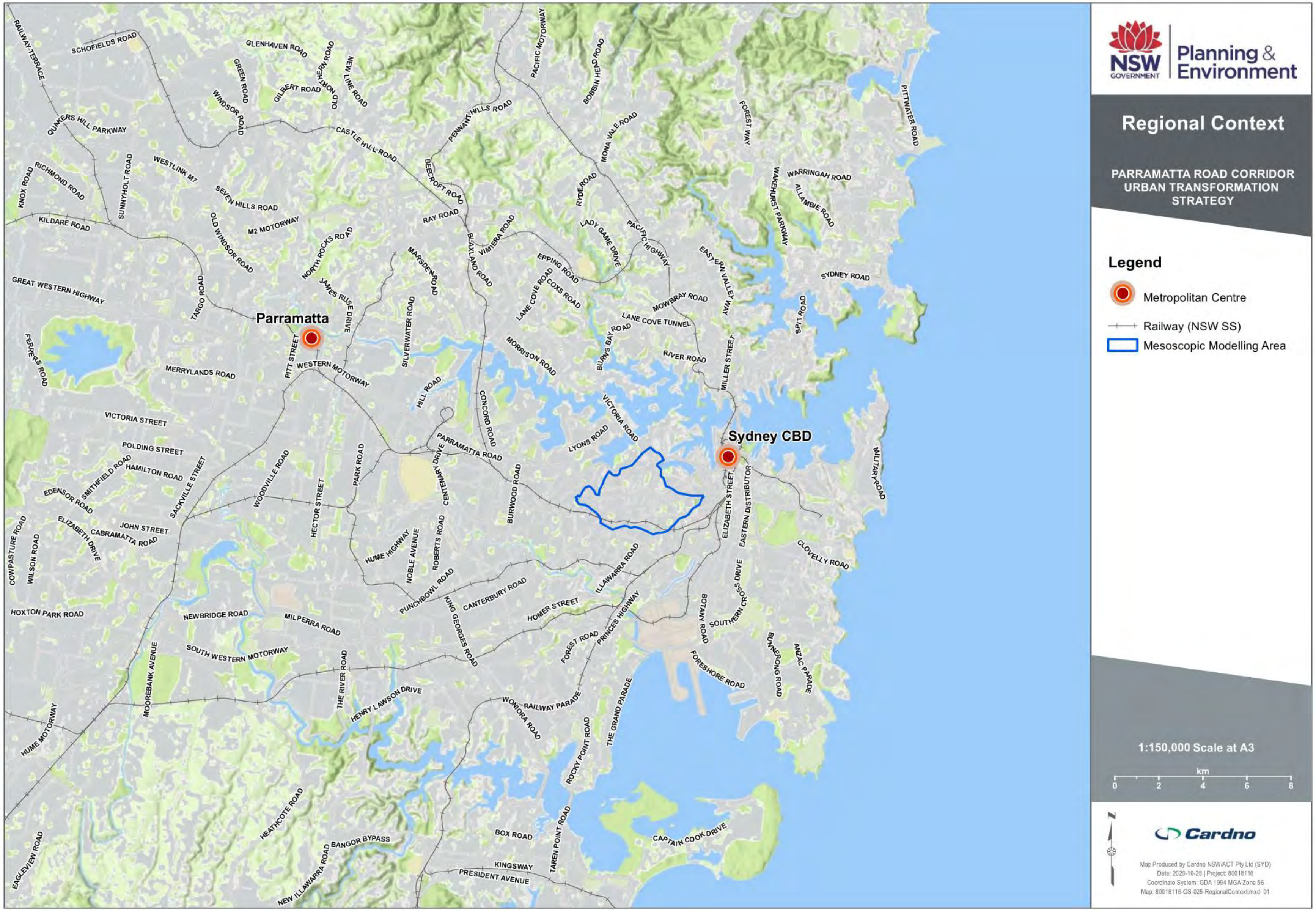


Figure 1-1 Regional context

1.4 Stakeholders

The key stakeholders for this project are:

> Department of Planning, Industry and Environment (DPIE)[1]
> Inner West Council (IWC)
> Transport for NSW (TfNSW)[2].

1.5 Report outline

This report documents the Base Model development process, including discussion of the modelling assumptions, stability, calibration and validation process, limitations and conclusions. It follows the *Operational Modelling Reporting Structure* (Roads and Maritime Services, 2017) and is intended to be read in isolation from previous reporting.

The structure of this report is outlined below:

> **Section 1 – Introduction**
> **Section 2 – Existing conditions**: discussion of the study area, explanation of the data inputs used in the study including classified intersection counts, travel time data and signal timings, and existing congestion locations
> **Section 3 – Model assumptions**: explanation of the study methodology and discussion of the assumptions underlying the development of the Base Model
> **Section 4 – Model stability**: statistical analysis of the stability of the Base Model
> **Section 5 – Model calibration and validation**: summary of the Base Model calibration and validation results
> **Section 6 – Limitations**: discussion of the limitations of the Base Model that could affect future modelling, and suggestions for accounting for these limitations in future year model outputs
> **Section 7 – Conclusions**.

[1] Formerly Department of Planning and Environment until 1 July 2019
[2] Roads and Maritime Services existed as a separate agency until it was dissolved and functions transferred to Transport for NSW on 1 December 2019

2 Existing conditions

2.1 Study area

The study area encompasses the precincts of Taverners Hill, Leichhardt and Camperdown which are all within the IWC local government area. **Figure 2-1** shows these precincts along Parramatta Road.

The study area includes the following key links:

> Parramatta Road (Great Western Highway) between Haberfield and Ultimo including key intersections with Liverpool Road (Hume Highway), Pyrmont Bridge Road and City Road (Princes Highway). Parramatta Road is a major east-west route connecting the Sydney CBD to the Inner West, Strathfield, Lidcombe and Parramatta. At the western extent of the study area, Parramatta Road connects to the M4 East, twin tunnels between Haberfield and Homebush. On the calibration date (17 October 2018), the M4 East was under construction. It was subsequently opened on 13 July 2019

> City-West Link Road between the Anzac Bridge in Rozelle and Dobroyd Point. This road forms part of the Western Distributor, a key link connecting North Sydney (via the Harbour Bridge) to Western Sydney. To the west of the study area, City-West Link Road connects to Parramatta Road and the M4 East

> Victoria Road between City-West Link Road and Parramatta River. Victoria Road is a major north-south arterial road that connects the Western Distributor to Balmain, Rozelle, Drummoyne, Lane Cove and Ryde

> Stanmore Road runs east-west along the southern edge of the study area. Stanmore Road connects to Enmore Road and King Street (Princes Highway) to the east of the study area and links Inner West suburbs Newtown, Petersham, Lewisham and Dulwich Hill to Old Canterbury Road.

The study area includes key trip generators (origins) and trip attractors (destinations) within the Inner West including three railway stations, seven light rail stops, commercial centres Leichhardt, Rozelle and Camperdown, the University of Sydney, Princes Alfred Hospital, numerous schools, parks, sports fields and light industries. Residential areas are generally low to medium density across the study area, with some high-density apartment complexes in Glebe, Lewisham and around the University of Sydney.

Figure 2-2 shows the study area.

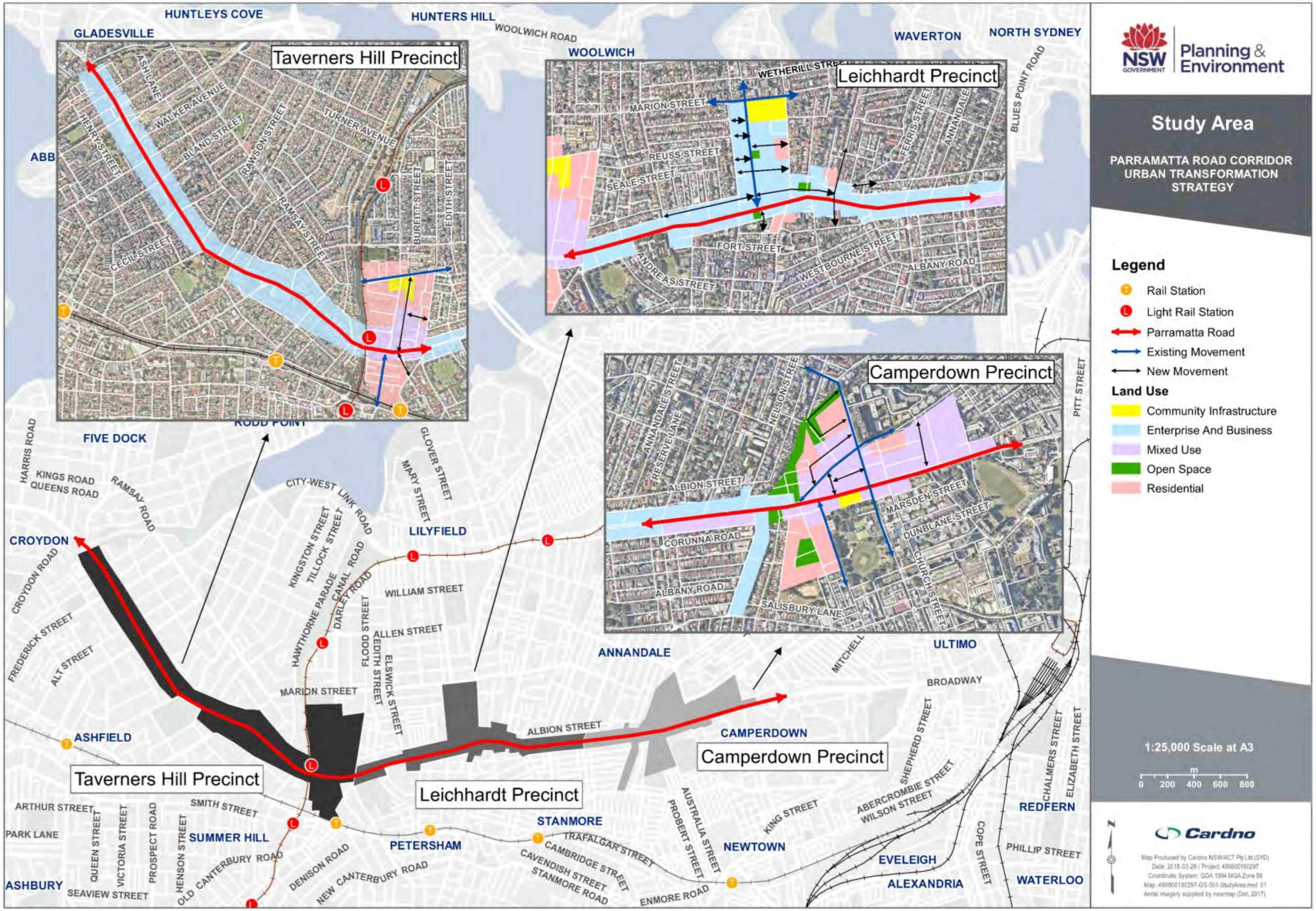


Figure 2-1 IWC precincts along Parramatta Road

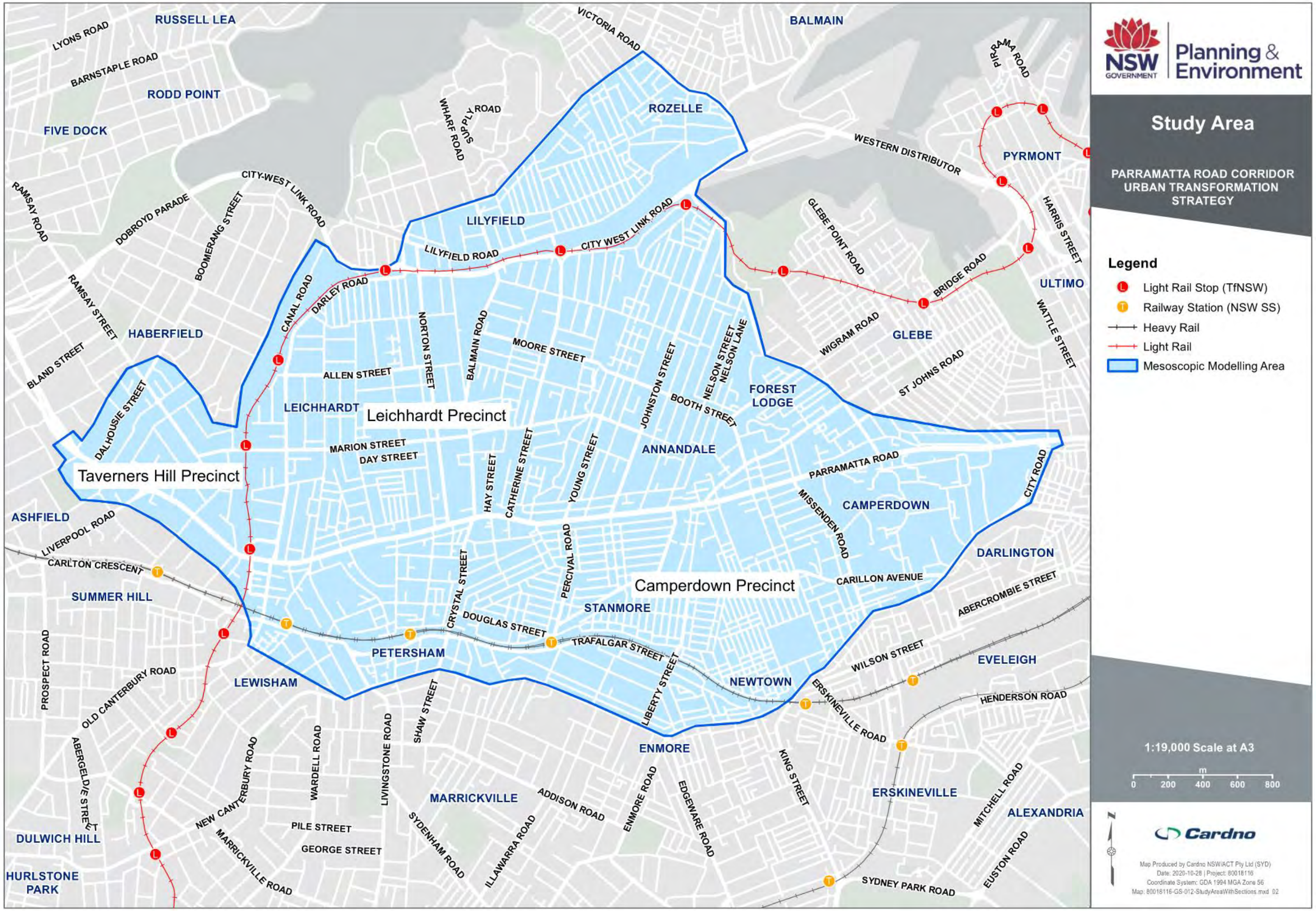


Figure 2-2 Study area

2.2 Data inputs

Traffic models rely on a range of survey inputs to capture existing conditions including vehicle routing, driver behaviour and congestion hotspots. The more data that is used in the development of a model, the better the model can replicate existing conditions to provide a more reliable and robust basis for future year assessments.

The data set for the microsimulation model was compiled from the following sources:

> Cordon matrices from the Sydney Transport Forecast Model (STFM) provided by TfNSW
> Classified intersection counts undertaken at 88 locations in 2018
> Travel time data from TomTom
> Average speed data from TomTom
> Traffic signal data obtained from TfNSW.

The data collected for each of the above categories is outlined in the following sections.

2.2.1 Cordon matrices

TfNSW provided traffic matrices from the STFM for 2016.The cordon matrices consisted of 96 centroids made up of:

> 51 internal travel zones wholly or partially within the study area
> 31 external gates
> Three railway station centroids
> Nine light rail stop centroids
> One ferry wharf centroid
> One container terminal centroid.

The locations and STFM zoning structure is discussed in **Section 3.6**.

2.2.2 Classified intersection counts

Classified intersection counts 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 counts were undertaken for 88 intersections on Wednesday 17 October 2018. The counts were classified into the following classes:

> Light vehicles (cars)
> Heavy vehicles (trucks)
> Pedestrians.

The classified intersection counts were undertaken for the following four-hour periods in each peak:

> 6:00AM – 10:00AM
> 3:00PM – 7:00PM.

Table 2-1 lists the survey locations for classified intersection counts. Following the table, **Figure 2-3** shows these locations on a map of the study area.

Table 2-1 Classified intersection count survey locations

Survey ID	Intersection	Type[3]
1	Victoria Road / Darling Street	S
2	Victoria Road / Evans Street	S
3	Victoria Road / Robert Street	S
4	Balmain Road / Cecily Street / Park Drive	S
5	Balmain Road / Lilyfield Road	S
6	The Crescent / Victoria Road	S
7	Balmain Road / Perry Street / Wharf Road	S
8	City-West Link Road / The Crescent	S
9	City-West Link Road / Norton Street	S
10	City-West Link Road / Brenan Street / Balmain Road	S
11	City-West Link Road / Brenan Street / Catherine Street	S
12	Catherine Street / Piper Street	P
13	Catherine Street / Moore Street	S
14	Styles Street / Catherine Street	S
15	Balmain Road / Moore Street	S
16	Grove Street and O'Neill Lane	P
17	Salisbury Road / Carillon Avenue / Church Street	S
18	Norton Street / Allen Street	S
19	Marion Street / Norton Street	S
20	Marion Street / Leichhardt Street / Balmain Road	S
21	Young Street / Collins Street	R
22	Johnston Street / Collins Street	S
23	Johnston Street / Booth Street	S
24	Lilyfield Road / Lamb Street	P
25	Johnston Street / Rose Street	P
26	The Crescent / Nelson Street	R
27	Booth Street / Wigram Road	R
28	Minogue Crescent / Wigram Road	S
29	Ross Street / Bridge Road	S
30	Pyrmont Bridge Road / Booth Street / Mallett Street	S
31	Allen Street / Elswick Street	R
32	Allen Street / Flood Street	R
33	Allen Street / Foster Street / Darley Road	R

Survey ID	Intersection	Type[3]
34	Marion Street / Foster Street	S
35	Marion Street / Flood Street	S
36	Marion Street / Ramsay Street	S
39	Parramatta Road / Liverpool Road (Hume Highway)	S
41	City-West Link Road / James Street	S
42	Tebbutt Street / Lords Road	S
43	Lilyfield Road / James Street	S
44	Tebbutt Street / Hathern Street	S
45	Parramatta Road / Sloane Street	P
46	Cook Street / Old Canterbury Road	P
47	Parramatta Road / Old Canterbury Road / Tebbutt Street	P
48	Old Canterbury Road / Barker Street	P
49	Old Canterbury Road / Railway Terrace / Longport Street	S
50	Parramatta Road / Norton Street	S
51	Parramatta Road / Flood Street / West Street	S
52	Parramatta Road / Crystal Street / Balmain Road	S
53	Parramatta Road / Catherine Street / Phillip Street	S
54	Parramatta Road / Elswick Street	P
55	Crystal Street / Fort Street / Robert Street	P
56	Crystal Street / Douglas Street / Brighton Street	S
57	Crystal Street / Trafalgar Street	S
58	New Canterbury Road / Stanmore Road / Crystal Street / Shaw Street	S
59	Gordon Street / Trafalgar Street	S
60	New Canterbury Road / Gordon Street / Livingstone Road	S
61	Stanmore Road / Wemyss Street / Merchant Street	S
62	Ramsay Road / Dalhousie Street	S
64	Stanmore Road / Merton Street	P
65	Stanmore Road / Liberty Street	S
66	Ross Street / St Johns Road	S

[3] S = signalised, R = roundabout, P = priority

Survey ID	Intersection	Type[3]
67	Parramatta Road / Young Street / Percival Road	S
68	Parramatta Road /Northumberland Avenue / Johnston Street	S
69	Parramatta Road / Bridge Road	S
70	Parramatta Road /Pyrmont Bridge Road / Denison Street	S
71	Parramatta Road / Mallett Street	S
72	Parramatta Road / Ross Street / Western Avenue	S
73	Great Western Highway / Glebe Point Road	S
74	Broadway / City Road (Princes Highway) / Bay Street	S
75	University Avenue / Parramatta Road / Derwent Street / Arundel Street	S
76	Gordon Street / Lilyfield Road / Burt Street	P

Survey ID	Intersection	Type[3]
77	Salisbury Road / Northumberland Ave	R
78	Liberty Street / Trafalgar Street	P
79	Douglas Street / Percival Road	S
80	Railway Terrace / Victoria Street	P
81	Parramatta Road / Dalhousie Street	S
82	Carillon Avenue / Missenden Road	S
83	Parramatta Road / Missenden Avenue / Lyons Road	S
84	Parramatta Road / Rofe Street	S
85	Dot Lane / Balmain Road	P
86	Parramatta Road / Renwick Street / Railway Street	P
87	Crystal Street / Queen Street	S
88	Parramatta Road / Petersham Street	P

Figure 2-3 Classified intersection count locations

2.2.3 Travel time routes

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.

Travel time and speed data for vehicles travelled along six key routes in the study area was extracted from TomTom. The data was aggregated over a four-week period including the survey date (Wednesday 17 October 2018) for Tuesdays, Wednesdays and Thursdays only. The data was separately aggregated for each hour of each peak.

Table 2-2 lists the travel time routes. Each route is bi-directional. **Figure 2-4** shows the locations of these routes in the study area.

Table 2-2 Travel time routes

Route #	Description
1	Parramatta Road between Princes Highway (City Road) and Orpington Street
2	Crystal Street between Trafalgar Street and Parramatta Road
3	Balmain Road between Parramatta Road and City-West Link Road[4]
4	Brighton Street between West Street and Crystal Street, then Douglas Street between Crystal Street and Salisbury Road, then Salisbury Road between Douglas Street and Australia Street
5	Marion Street between Ramsay Street and Balmain Road
6	Johnston Street between Parramatta Road and The Crescent

2.2.4 Average speed data

Average speed data was extracted from TomTom for all major roads in the study area for the AM Peak and PM Peak to identify congestion locations and compare to the modelled outputs (refer to **Section 5.3.3**).

[4] In the southbound direction, Route 3 ends at Marion Street at Balmain Road is one-way in the opposite direction between Parramatta Road and Marion Street.

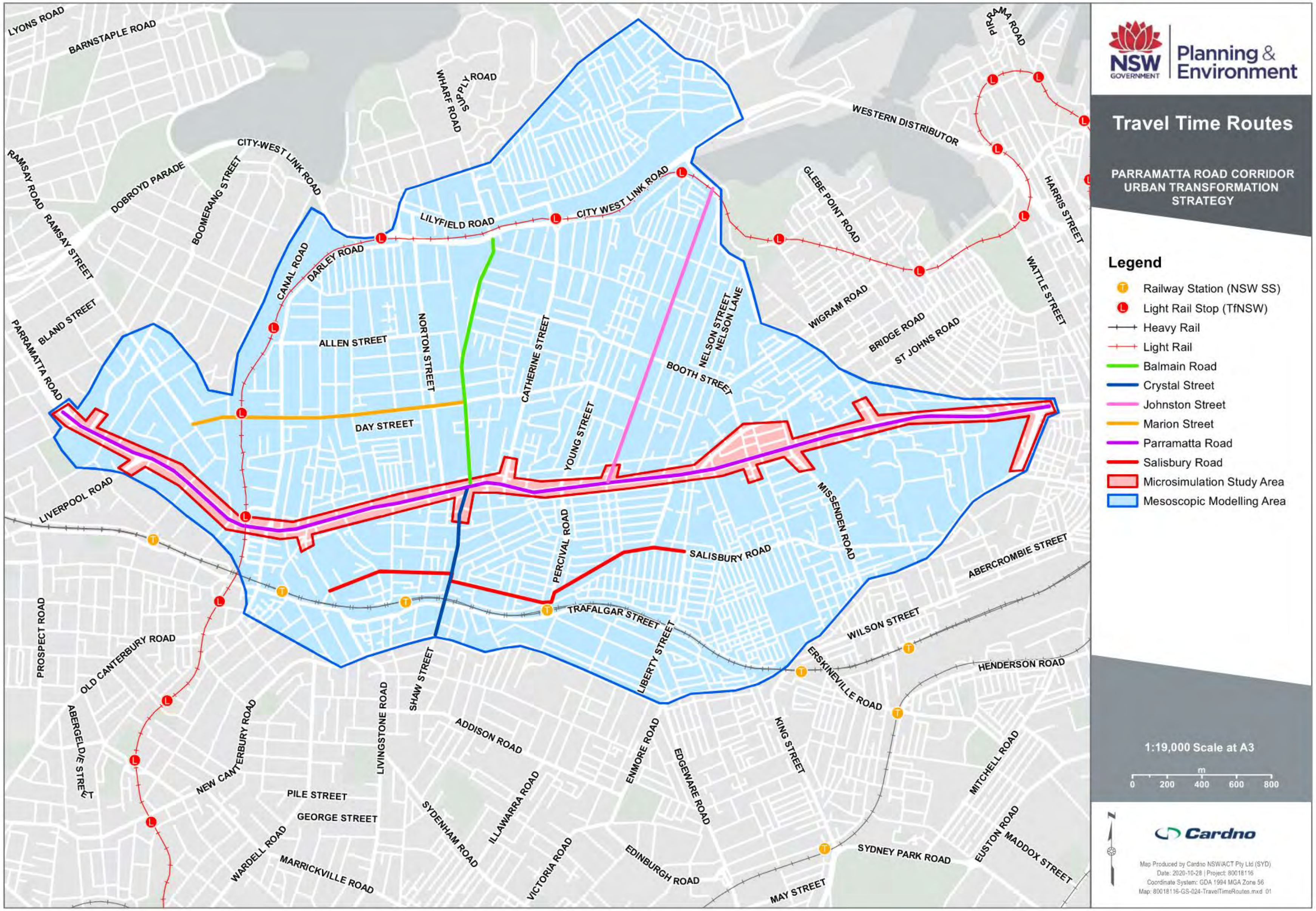


Figure 2-4 Travel time routes

2.2.5 SCATS traffic signal data

The following SCATS traffic signal information was obtained from TfNSW for the signalised intersections within the study area:

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

Table 2-3 shows the TCS number for all signalised intersections in the study area and the subsystems to which they belong.

Table 2-3 TCS number and subsystem for signalised intersections

TCS	SS	Intersection
2	ROZ 24	Parramatta Road / Pyrmont Bridge Road / Denison Street
4	ROZ 25	Pyrmont Bridge Road / Booth Street
13	NEW 11	Salisbury Road / Australia Street
16	LEW 27	Parramatta Road / Flood Street
17	LEW 43	Old Canterbury Road / Longport Street / Railway Terrace
18	LEW 22	Parramatta Road / Sloane Street
19	LEW 22	Salisbury Road / Cardigan Street
21	LEW 50	Parramatta Road / Bridge Road
33	LEW 30	Parramatta Road / Percival Road / Young Street
62	LEW 50	Ross Street / Bridge Road
63	ROZ 36	Marion Street / Foster Street
70	LEW 22	Parramatta Road / Liverpool Road
87	ROZ 8	Balmain Road / Lilyfield Road
91	ROZ 37	Norton Street / Marion Street
92	LEW 92	Parramatta Road / Johnston Street / Northumberland Avenue
93	LEW 28	Parramatta Road / Balmain Road / Crystal Street
97	LEW 44	Railway Terrace / Cardigan Street
100	LEW 7	Crystal Street / New Canterbury Road / Shaw Street / Stanmore Road
101	LEW 10	Crystal Street / Trafalgar Street
102	LEW 13	New Canterbury Road / Gordon Street / Livingstone Road
132	LEW 32	Parramatta Road / Missenden Road
140	LEW 49	Parramatta Road / Dalhousie Street
143	LEW 45	Parramatta Road / Norton Street

TCS	SS	Intersection
176	LEW 0	Percival Road / Douglas Street
179	ROZ 27	Catherine Street / Styles Street
215	ROZ 13	Johnston Street / Booth Street
327	LEW 57	Dalhousie Street / Ramsay Street
373	LEW 28	Parramatta Road / Catherine Street / Philip Street
384	LEW 32	Parramatta Road / Mallett Street
385	LEW 32	Parramatta Road / Layton Street
411	ULT 4	Parramatta Road / Broadway / Derwent Street / University Avenue
412	ULT 4	Broadway / Glebe Point Road
413	ULT 4	Broadway / Princes Highway
414	ULT 25	Broadway / Mountain Street
434	LEW 33	Parramatta Road / Ross Street / Western Avenue
438	LEW 16	Crystal Street / Douglas Street
546	ROZ 8	City West Link Road / Brenan Street / Balmain Road
651	ROZ 2	Victoria Road / The Crescent
652	ROZ 6	Victoria Road / Roberts Street
653	ROZ 35	Victoria Road / Gordon Street
654	ROZ 35	Victoria Road / Evans Street
655	-	Victoria Road / Darling Street
656	ROZ 1	Victoria Road / Wellington Street
661	NEW 5	City Road / Princes Highway / Carillon Avenue
664	NEW 1	King Street / Missenden Road
667	NEW 2	King Street / Mary Street / Erskineville Road
721	FIDO1 0	Catherine Street / Moore Street
747	LEW 13	New Canterbury Road / Audley Street

TCS	SS	Intersection
821	LEW 14	New Canterbury Road / Wardell Road
861	ROZ 36	Marion Street / Flood Street
862	ROZ 11	City West Link Road / Brenan Street / Catherine Street
884	NEW 23	Stanmore Road / Liberty Street
902	LEW 52	New Canterbury Road / Constitution Road / Beach Road
1081	ROZ 92	Lilyfield Road / Mary Street / James Street
1143	ROZ 25	Pyrmont Bridge Road / Alexandria Drive / Lyons Road
1208	ROZ 12	City West Link Road / The Crescent
1209	ROZ 26	Wigram Road / Minogue Crescent
1406	ROZ 36	Foster Street / Tebutt Street / Lords Road
1407	ROZ 13	Collins Street / Johnston Street
1502	ROZ 33	City West Link Road / Norton Street
1527	ROZ 34	City West Link Road / James Street / Darley Street
1540	ROZ 32	The Crescent / Johnston Street
1585	NEW 23	Stanmore Road / Merchant Street / Wemyss Street
1864	ROZ 27	Balmain Road / Marion Street
1865	LEW 45	Pedestrian crossing: Parramatta Road near Railway Street

TCS	SS	Intersection
1873	FIDO2 29	Balmain Road / Perry Street / Wharf Road
1879	ROZ 24	Ross Street / St Johns Road
1881	LEW 21	Railway Terrace / Trafalgar Street / Gordon Street
1913	NEW 0	Pedestrian crossing: Trafalgar Street outside Stanmore Station
1939	FIDO1 0	Balmain Road / Cecily Street / Park Drive
2004	NEW 23	Pedestrian crossing: Stanmore Road outside Newington College
2020	ROZ 13	Pedestrian crossing: Johnston Street outside Annandale North Public School
2087	ROZ 25	Pedestrian crossing: Pyrmont Bridge Road near Layton Street
2124	LEW 27	Pedestrian crossing: Parramatta Road opposite Tebbutt Street
2405	NEW 11	Salisbury Road / Kingston Road
2673	ROZ 53	Balmain Road / Moore Street
2753	ROZ 36	Marion Street / Elswick Street
3495	NEW 48	Missenden Road / Carillon Avenue
3547	ROZ 38	Marion Street / Ramsay Street
4207	ROZ 1	Darling Street / Waterloo Road / Belmore Street
4221	ROZ 53	Balmain Road / Alfred Street
4441	ROZ 45	Minogue Crescent / The Crescent / Scotsman Street
4559	ROZ 15	Tebbutt Street / Hathern Street

2.3 Congestion locations

Cardno extracted speed data from TomTom for five Wednesdays in October 2018 to assist with identifying congestion hotspots across the study area. **Figure 2-5** and **Figure 2-6** show the median speed data graphically across the study area. Only roads with a sufficient sample size are shown. Note the following limitations of the TomTom output:

> The median speed on local roads is the average of both directions

> On major roads such as Parramatta Road, the median speed is reported in each direction but in the output one direction is often obscured by the other

> Anomalous speed data appears to have been recorded on Trafalgar Street and Railway Terrace. Both these roads have speed limits of 50 kilometres per hour, however the median speed data recorded speeds of up to 90 kilometres per hour. This is likely due to the close proximity of this road to the railway line. As TomTom data is also captured from mobile phones, it is likely that some of the data collected for this road is actually sourced from mobile phones on the train line. These roads will not be considered in the hotspot validation.

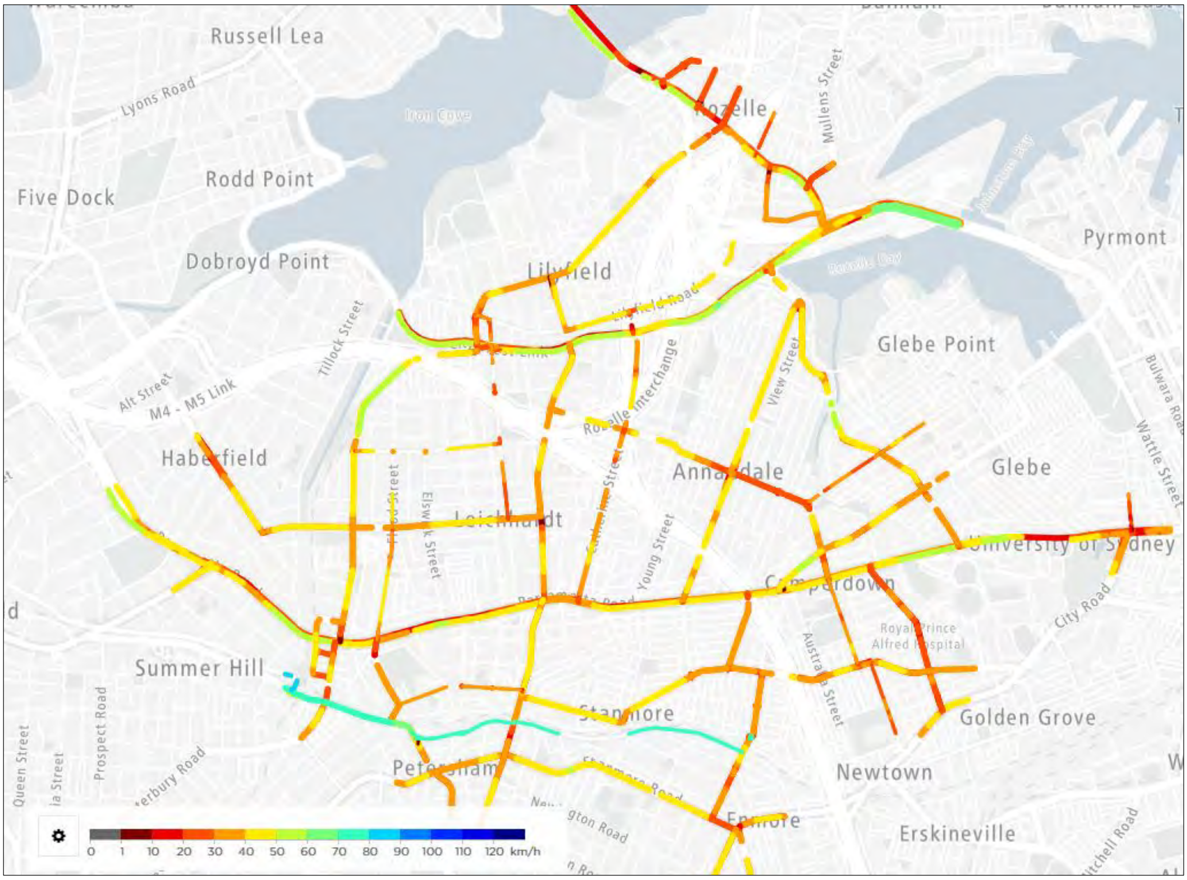


Figure 2-5 TomTom median speed (AM Peak)

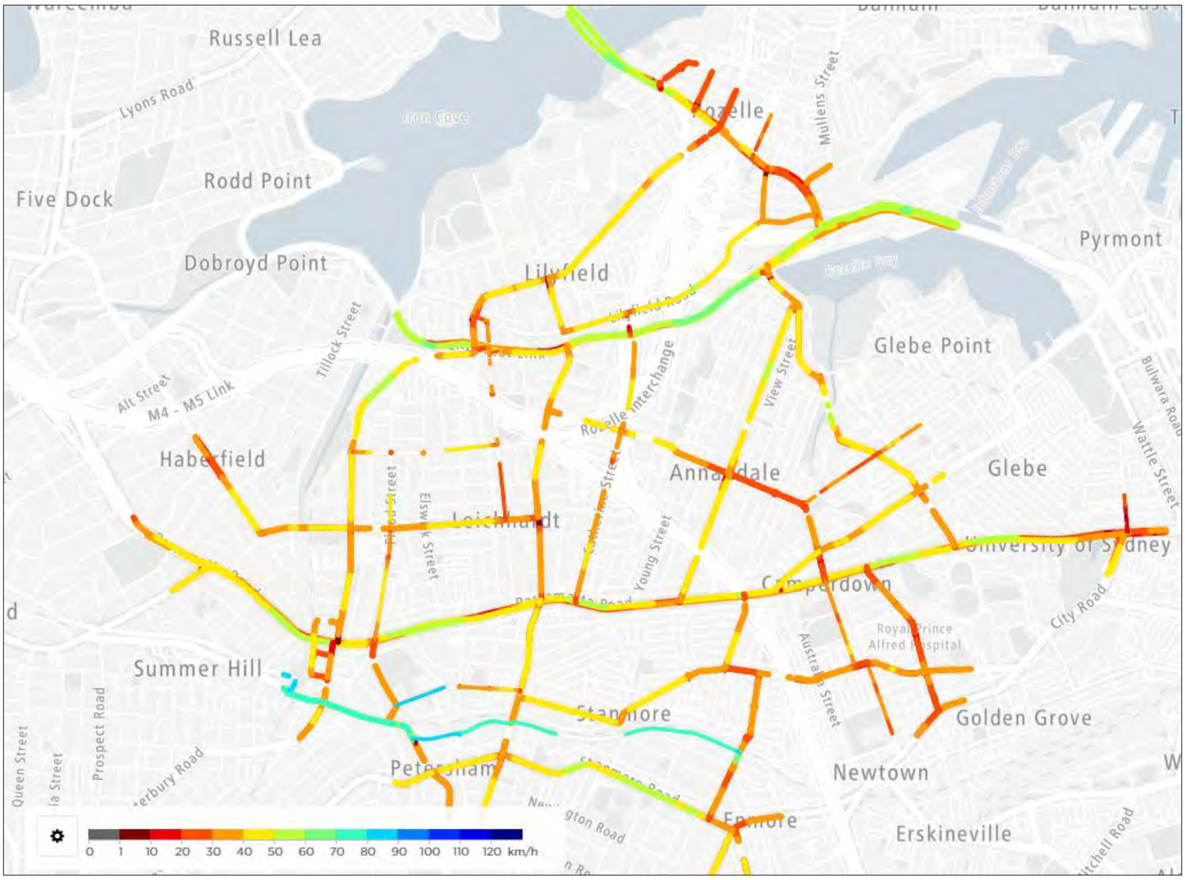


Figure 2-6 TomTom median speed (PM Peak)

In the AM Peak, the following key congestion locations were observed from the site visit and TomTom data:

> Parramatta Road eastbound generally exhibited very low average speeds, in particular at the following locations:
  - Between Liverpool Road and West Street the average speed on Parramatta Road was observed to be less than 25 kilometres per hour. Some segments, in particular around the merge from three lanes to two lanes, had an average speed of less than 10 kilometres per hour over the two-hour AM Peak
  - Approaching Balmain Road, the average speed on Parramatta Road is approximately 15 kilometres per hour across the AM Peak with queues regularly extending back to West Street
  - Between Balmain Road and Johnston Street, the average speed is less than 20 kilometres per hour
  - East of Pyrmont Bridge Road, traffic was generally observed to be less congested on Parramatta Road with the average speed approximately 30 kilometres per hour
  - Congestion was observed approaching City Road and Broadway on Parramatta Road with the average speed across the AM Peak being approximately 25 kilometres per hour.

> Long queues and slow-moving traffic were observed in both directions on Crystal Street in the AM Peak

> Long queueing was observed approaching Parramatta Road on Missenden Road

> Long queues and slow-moving traffic were observed on Booth Street approaching the Wigram Road roundabout. This was mainly caused by queue propagation from the Pyrmont Bridge Road / Bridge Road / Mallett Street / Booth Street intersection

> Average speeds on City-West Link Road in the eastbound direction were generally less than 40 kilometres per hour west of Balmain Road. Traffic was more free-flowing between Balmain Road and Victoria Road where more lanes are provided with an average speed approaching 60 kilometres per hour. However, the average speed over the Anzac Bridge was approximately 35 kilometres per hour

> Congestion and slow-moving traffic was observed on Victoria Road in the southbound direction. The average speed between Terry Street and City-West Link Road was approximately 25 kilometres per hour. Significant queueing was also observed on all side roads leading to Victoria Road from Rozelle (to the north)

> In the non-peak direction (westbound), traffic was generally more free-flowing with the average speed on Parramatta Road approximately 40 kilometres per hour and on City-West Link Road approximately 55 kilometres per hour.

In the PM Peak, the following key congestion locations were observed from the site visit and TomTom data:

> Parramatta Road westbound generally exhibited low average speeds, in particular at the following locations:
  - West of Johnston Street, traffic was generally slow-moving with average speeds varying between 30 and 40 kilometres per hour with the highest average speeds observed in longer sections and away from traffic signals
  - Average speed on the section of Parramatta Road approaching Catherine Street was approximately 25 kilometres per hour in the PM Peak
  - Congestion and queueing were also observed on Booth Street where the average speed in the PM Peak was less than 30 kilometres per hour approaching Wigram Road
  - Long queueing was also observed on Perry Street approaching City-West Link Road
  - Victoria Road was slow-moving in the northbound direction with the average speed between City-West Link Road and Darling Street being about 25 kilometres per hour
  - Average speed on the Anzac Bridge in the westbound direction was 30 kilometres per hour
  - Significant queueing and slow-moving traffic was observed on Carillon Avenue and Liberty Street, and on Missenden Road and Mallett Street approaching Parramatta Road
  - In the non-peak direction (eastbound), traffic was generally more free-flowing with the average speed on Parramatta Road approximately 30-40 kilometres per hour and on City-West Link Road approximately 60 kilometres per hour.

3 Model assumptions

This section outlines the assumptions behind the Base Model development.

3.1 Modelling platform

The PRCUTS model was developed using Aimsun version 8.4.3[5]. Aimsun was considered an appropriate tool for this study as it seamlessly integrates microscopic and mesoscopic simulation into the one model (hybrid simulation). It is capable of modelling baseline conditions and incorporating future infrastructure changes, and quantifying the performance of the traffic network.

Mesoscopic models bridge the gap between strategic planning models (macroscopic models) and detailed operational models (microscopic models). Mesoscopic modelling utilises the dynamic traffic simulation framework similar to microscopic models but at a lower level of detail. The level of detail in mesoscopic models is sufficient to determine the performance of the road network under proposed future land use scenarios and provide guidance on the need for further road infrastructure requirements. Additionally, mesoscopic simulation allows for true dynamic equilibrium assignment where vehicles can select their optimum/preferred travel routes based on their perceived cost. This provides a confidence that the modelled pattern of traffic represents a realistic response to the delays and capacity constraints that would be experience by users on a daily basis.

The microscopic simulation (microsimulation) section of the hybrid model provides a higher level of detail beneficial to this study. Microsimulation allows for detailed interaction between vehicles and/or pedestrians at intersections to be modelled and visualised which results in accurate queueing behaviour only achievable with this type of modelling. Microsimulation also more accurately replicates travel times due to detailed friction, acceleration and deceleration factors and it provides a visualisation of the simulation to verify driver behaviour.

3.2 Modelled network

3.2.1 BSORT / PRRP model

Following discussions with DPIE, IWC and TfNSW, Cardno obtained the previously-developed Burwood to Sydney On-street Rapid Transit Model (BSORT) which was used as the basis for the model development. This included the Parramatta Road Reconfiguration Program (PRRP) models (September 2018), however these were not considered fit for the purpose of this project following an internal review as the calibration and validation targets from *Traffic Modelling Guidelines* (Roads and Maritime Services, 2013) were not met. The PRRP model was only used to import the network geometry to develop the hybrid model.

3.2.2 PRCUTS model network

The PRCUTS model extent covers an area of approximately 15 square kilometres including the Taverners Hill, Leichhardt and Camperdown precincts in the IWC local area. Geometry and coding from the PRRP model were checked against aerial photography from *Nearmap*[6]. Network infrastructure and road geometry for the Base Model was based on that which existed on the calibration date (17 October 2018).

Figure 3-1 shows the modelled road network including the extent of the microsimulation area.

[5] 2020-06-03 (b46ec77181 x64 Python 2)
[6] Aerial photography from Tuesday 23 October 2018

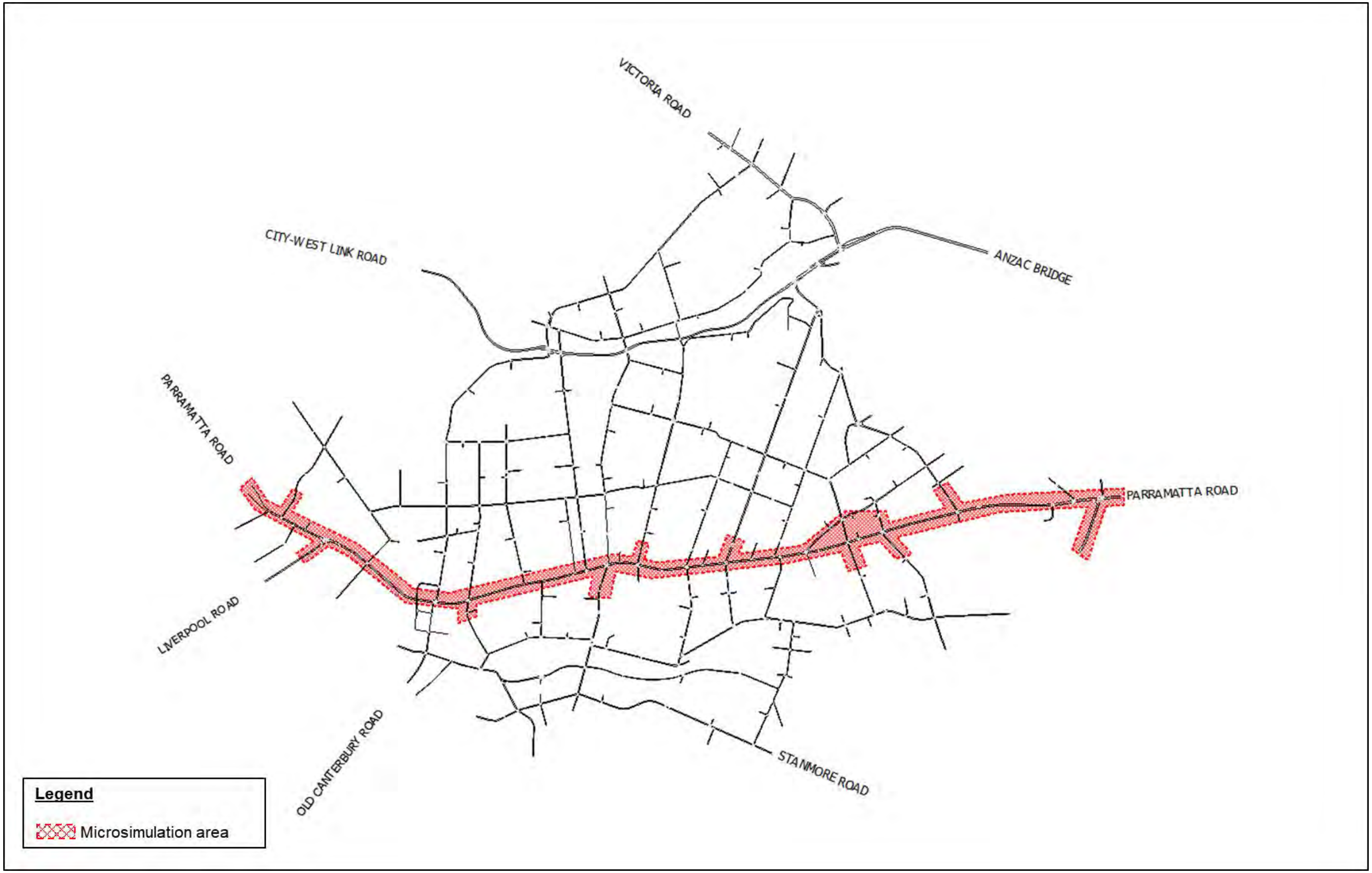


Figure 3-1 Modelled road network

3.3 Time period

The traffic peak periods were determined from the classified intersection counts. The busiest two-hour period in each peak was identified as the period during which the greatest number of turn movements were recorded across all intersections. The model provides an indication of the performance of the network during the worst two-hour period in each peak.

The peak periods were identified as:

> 7:15AM – 9:15AM

> 4:30PM – 6:30PM.

Figure 3-2 and **Figure 3-3** show the traffic profiles for the AM Peak and PM Peak respectively.

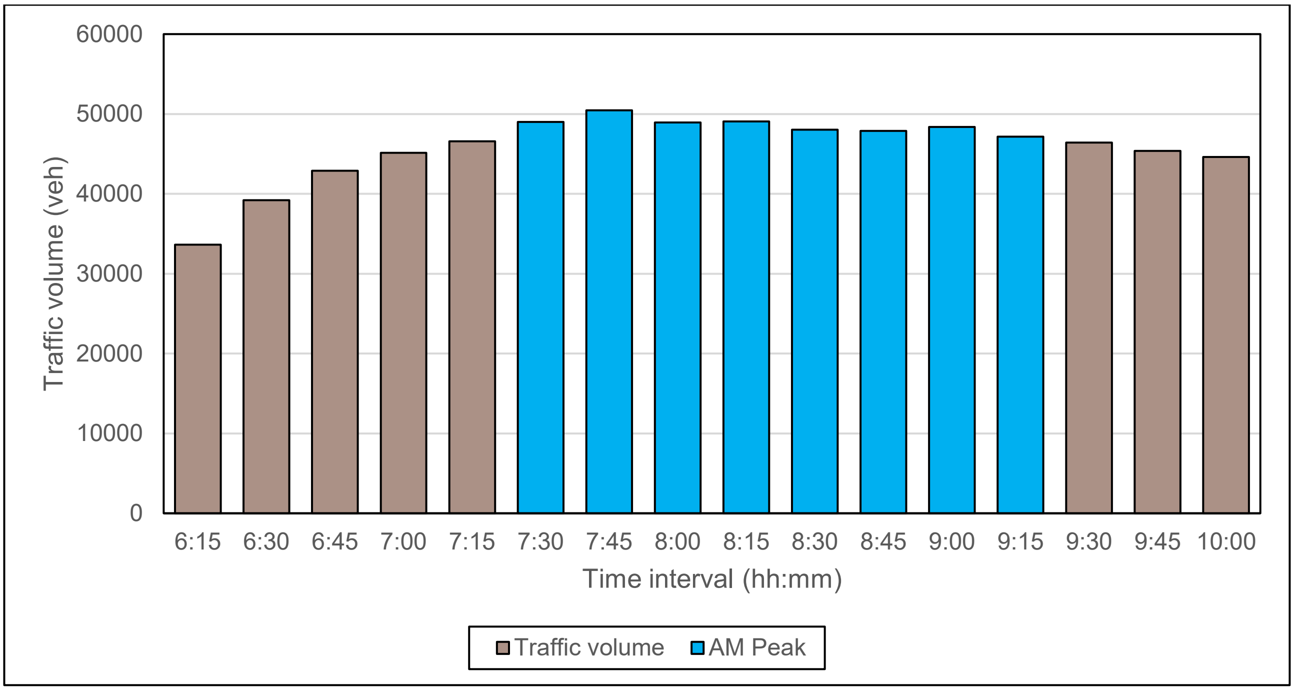


Figure 3-2 Traffic profile (AM Peak)

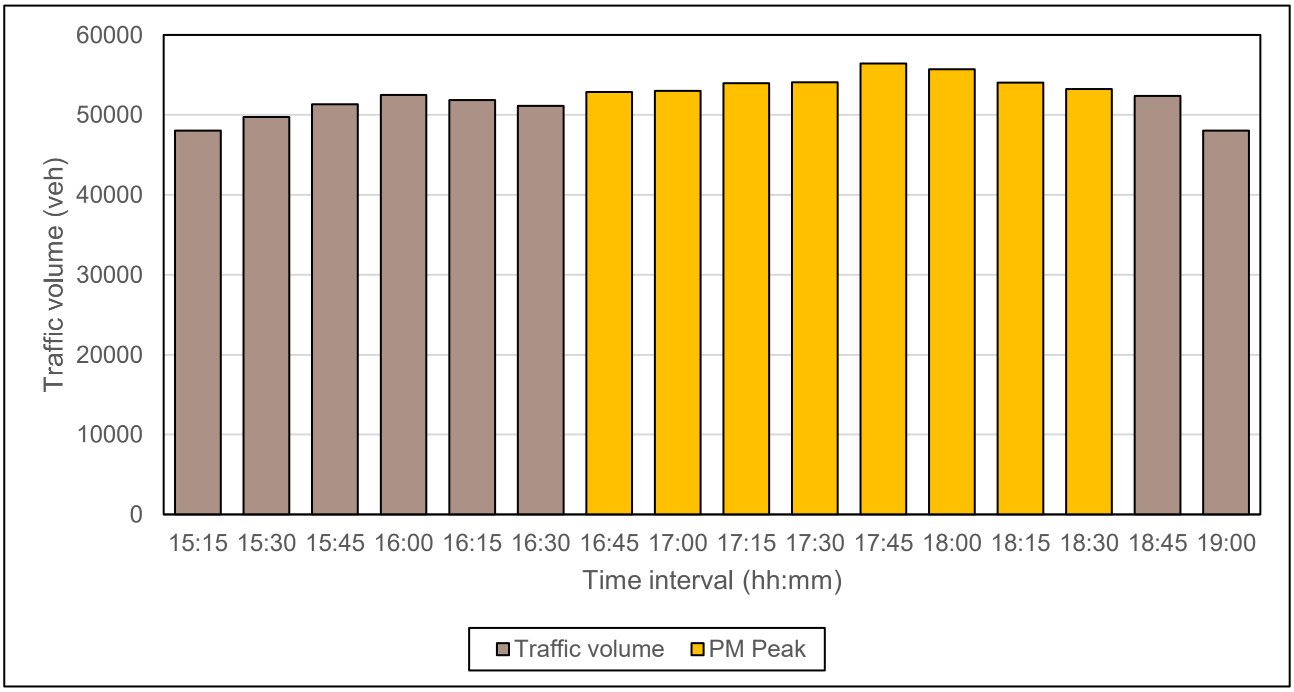


Figure 3-3 Traffic profile (PM Peak)

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 multiplied by the travel time on that link (given by the link performance function), summed for all links in the network. At equilibrium, all paths that are used between a given origin and destination will have the same generalised cost.

3.4.2 Dynamic user equilibrium

To assess options that impact vehicle route choice, dynamic user equilibrium (DUE) assignment was used. Dynamic assignment 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 model 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 (Ran and Boyce's dynamic version of Wardrop's equilibrium).

3.4.3 Stochastic route choice assignment

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 area available. This model uses the probability of choosing alternative paths from the available paths as a function of their disutility, typically travel time or travel cost.

3.5 Vehicle types

The following vehicle types were used in the models:

- Light vehicles (cars)
- Heavy vehicles (trucks)
- Buses.

Cardno adopted the definition of light vehicle from Austroads (1994). A light vehicle is any vehicle with only two axles that does not have dual tyres on the rear axle, and is up to 5.5 metres in length. This can include cars, SUVs, small vans and motorcycles. The default Aimsun maximum car length was increased from 4.5 metres to 5.5 metres to align with the Austroads classification.

A heavy vehicle is any vehicle with more than two axles, or with dual tyres on the rear axle. This includes rigid vehicles, trucks and heavy articulated vehicles but excludes buses. Buses were included as a separate vehicle type. The demand for buses was adopted using fixed routes and timetables (refer to **Section 3.11**).

Aimsun defaults were generally adopted for all parameters. Cardno notes that the PRRP model inherited for this project contained substantial adjustment to many of the vehicle parameters. In some cases, these were restored to Aimsun defaults as the adjusted values were found to be unrealistic. **Figure 3-4** presents the values for key vehicle attributes adopted in the models.

Figure 3-4 Key vehicle attributes

Attribute	Vehicle type	Mean	Deviation	Minimum	Maximum
Length	Car	4.50 m	1.00 m	3.50 m	5.50 m
	Truck	12.00 m	4.00 m	8.00 m	16.00 m
	Bus	13.00 m	1.00 m	12.00 m	14.50 m
Speed acceptance	Car	1.00	0.10	0.90	1.10
	Truck	0.90	0.10	0.80	1.00
	Bus	0.90	0.10	0.80	1.00
Clearance	Car	1.00 m	0.50 m	0.50 m	1.50 m
	Truck	2.00 m	0.50 m	1.50 m	2.50 m
	Bus	2.00 m	0.50 m	1.50 m	2.50 m

3.6 Traffic zones/input

Traffic demands were informed by the STFM. The demand development procedure is discussed in **Section 3.12**. The STFM cordon included 96 centroids made up of:

- 51 internal travel zones wholly or partially within the study area
- 31 external gates
- Three railway station centroids
- Nine light rail stop centroids
- One ferry wharf centroid
- One container terminal centroid.

Figure 3-5 shows the location and numbering of the STFM centroids within the study area.

Zones for railway stations, light rail stops, ferry wharves and the container terminal were aggregated into the surrounding zone as their demands were low (refer to **Section 3.11**). The 51 internal travel zones were disaggregated into 114 zones in the Aimsun model. Proportions were based on land use assumptions and traffic survey counts (where available). **Figure 3-6** shows the Aimsun zone numbering system indicating how the STFM centroids were disaggregated and incorporated into the hybrid model.

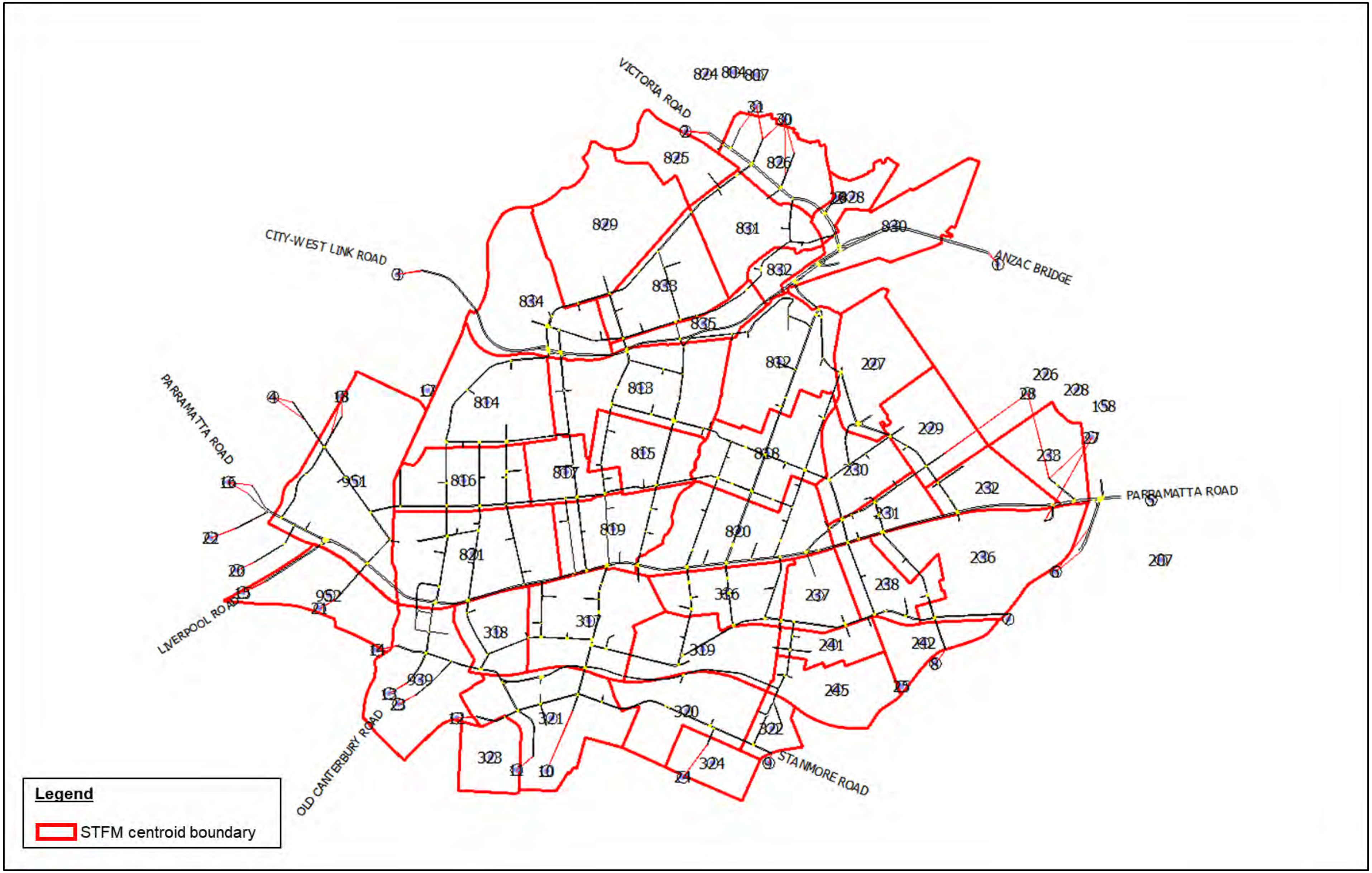


Figure 3-5 STFM centroid numbering and zone boundaries

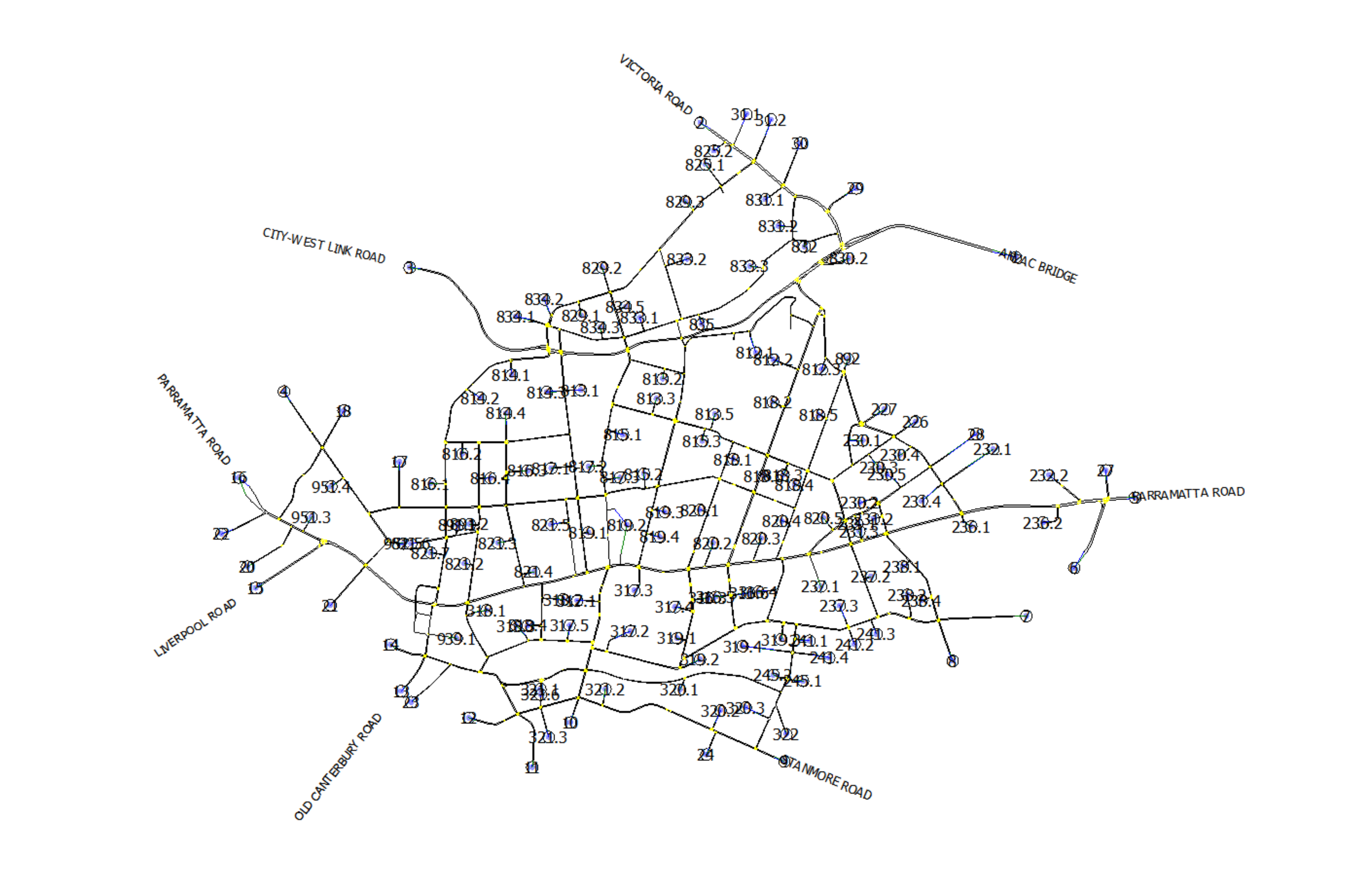


Figure 3-6 Aimsun centroid disaggregation and numbering

3.7 Road types

3.7.1 Modelled road types

Road types were inherited from the previous PRRP model, however upon review Cardno found inconsistencies in the capacities and speed limits of some sections from that model. Section capacities and road types were updated to provide consistency across the PRCUTS model and create more realistic vehicle assignment. **Table 2-3** shows the road types and section capacities adopted in the model.

Table 3-1 Road types and section capacities

Description	Road type	Capacity (PCU/ln/hr)
Local	Sydney 01. LOCAL	700
Sub-arterial	Sydney 02. Sub-ART (non-commercial)	800
Arterial (undivided)	Sydney 04. ART (Undivided)	900
Arterial (divided)	Sydney 05. ART (Divided)	1100
State highway (undivided)	Sydney 06. SH(UD)	1200
State highway (divided)	Sydney 07. SH(D)	1200
Expressway ramp	Sydney 08. EXP RAMP	900
Expressway	Sydney 09. EXP	1800
Expressway bridge	Sydney 14. HARBOUR BRIDGES	1500

The capacities of individual sections were adjusted during the calibration stage based on observed conditions. Examples of factors that influenced the capacity adjustments included:

> On street parking, clearways or lane closures (such as bus lanes)

> Speed humps and other traffic calming

> Driveways and access points, particular yin commercial/residential areas.

Figure 3-7 shows the modelled road types used in the model.

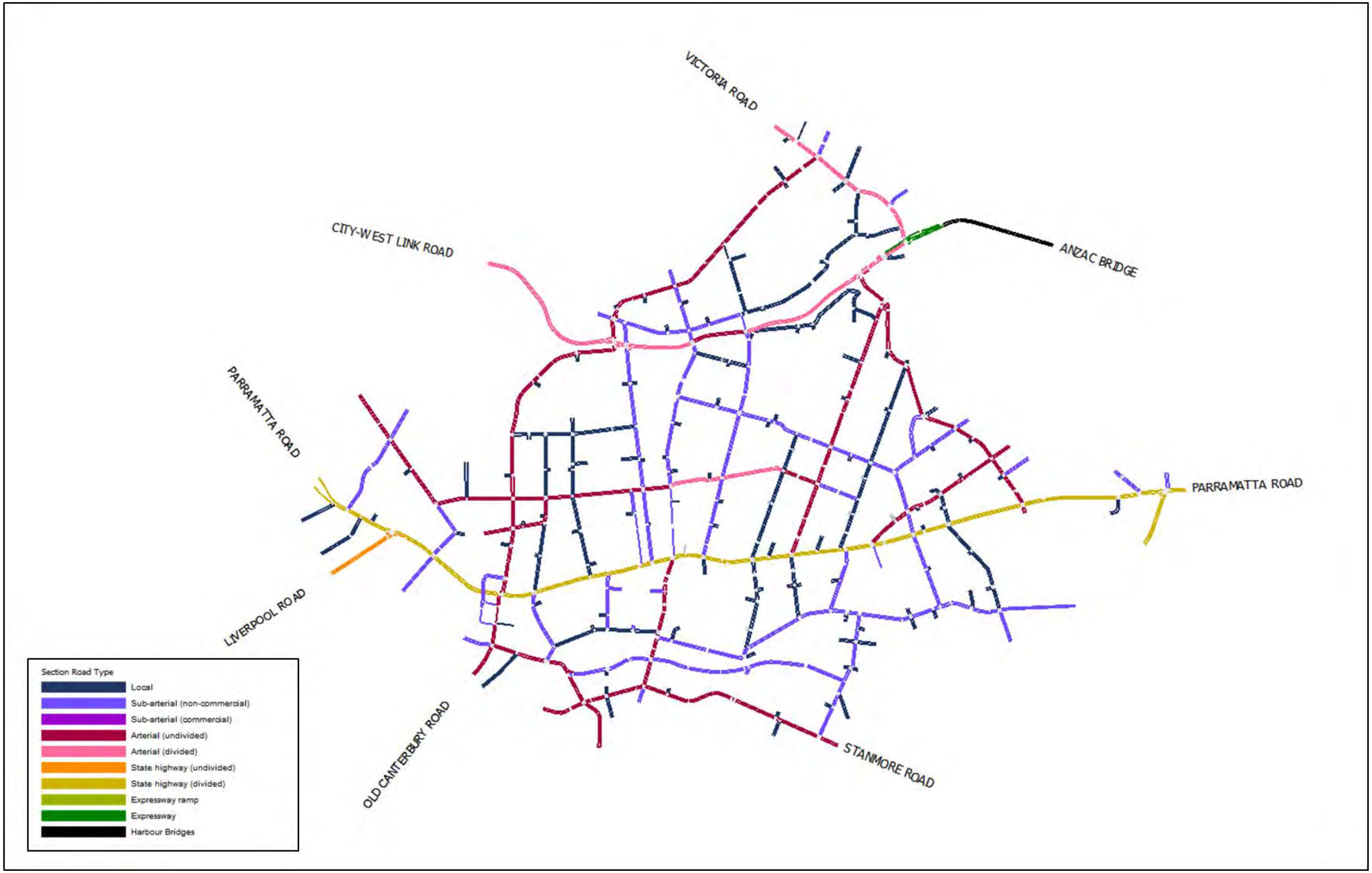


Figure 3-7 Modelled road types

3.7.2 Lane cooperation

Lane cooperation was maintained as default (50 per cent) for all sections except the following locations:

> Parramatta Road (EB) approaching Tebbutt Street. Queues were observed to often spill back from the right turn into West Street and obstruct one of the through lanes on Parramatta Road. The cooperation was increased to 80 per cent so that vehicles were more likely to merge out of the partially-obstructed through lane into the kerbside lane. This was necessary to match observed queueing and travel times on this section

> City-West Link Road and Victoria Road approaching Robert Street. The right turn bay from Victoria Road into Robert Street is only accessible from the right lane of Victoria Road. Due to the high demand for this turn, queues in the model were observed to build up disproportionately in the right lane, whereas observed data suggested an even queueing pattern across all lanes. The cooperation was increased to 60-70 per cent to increase the number of vehicles using other lanes to turn right from City-West Link Road and then merging on the section of Victoria Road between City-West Link Road and Robert Street.

3.7.3 Acceleration factor

Acceleration factors were applied locally on side roads at some signalised intersections. The queue discharge rate at each location was able to be determined using the historical SCATS phase times and turn volumes from classified intersection counts. In some locations it was observed that default Aimsun queue dissipation resulted in a much lower intersection throughput than was recorded from the survey volumes. In such locations, the acceleration factor of the section was increased to account for the observed rate of queue dissipation.

Acceleration factors were used at the extremities of Parramatta Road to increase delay associated with congestion outside the modelled area. Acceleration factors were also used on Parramatta Road around Balmain Road / Catherine Street. Due to curves in the road, queues often extended further than the visibility of the traffic lights. Acceleration factors were used to account for the impacts of reduced visibility, parking manoeuvres, queue jumps at Crystal Street and Norton Street, and buses merging in and out of bus lanes.

3.8 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 class within the model proportionally to the slope of the road at any given point. Higher penalties are imposed on heavier vehicles such as those belonging to the truck and bus classes.

Slope data was obtained from a five-metre resolution digital terrain model available from Department of Finance, Services and Innovation Spatial Services. The slope was calculated using the Slope Tool in ArcGIS (v10.6) from the digital terrain model. The slope 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 of the slope map. The start and end altitude points were set for each section of the Aimsun model.

3.9 Speed profiles

All roads were coded with speed limit as it was posted in October 2018. **Figure 3-8** shows the posted speed limits in the model. Speed profiles for each vehicle type are given in **Section 3.5**.

3.9.1 Local roads

Local roads do not always have a speed limit posted. The speed limit on all local roads is 50 kilometres per hour unless otherwise indicated. Some local roads in Leichhardt, Annandale, Rozelle and Glebe have posted speed limits of 40 kilometres per hour.

3.9.2 School zones

School zones surround all schools in NSW. When in operation, the speed limit on signposted roads is reduced to 40 kilometres per hour. Generally, this is during 8:00AM – 9:30AM and 2:30PM – 4:00PM. **Figure 3-9** shows the locations of school zones within the study area.

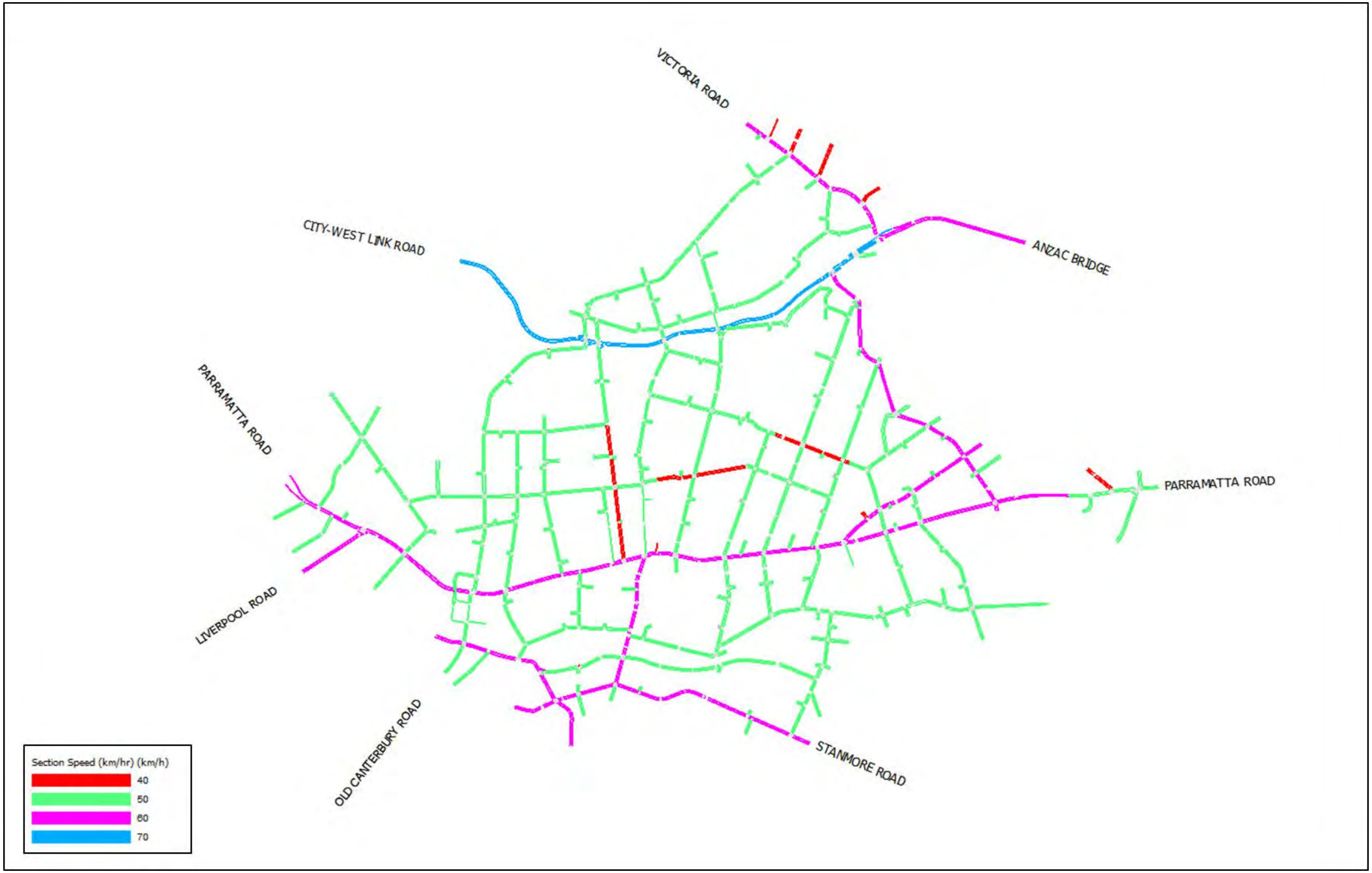


Figure 3-8 Posted speed limits

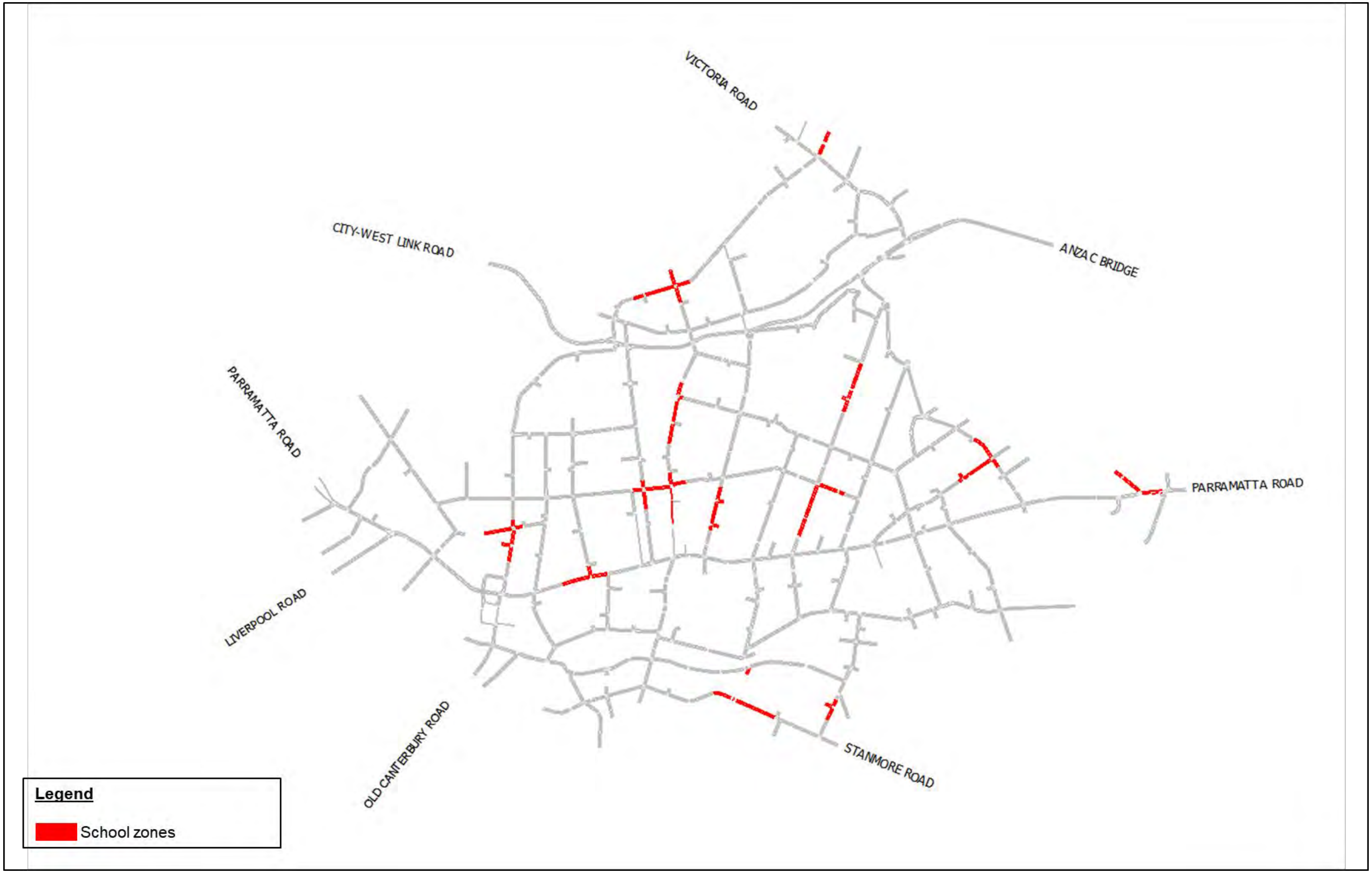


Figure 3-9 School zones

3.9.3 Local speed reductions

Aimsun supports detailed section speeds where the maximum speed on part of a section may be reduced, such as due to a speed hump, traffic calming, parking or other delays. However, as detailed speeds are not supported in mesoscopic simulations due to software limitations, to capture these delays, Cardno applied a reduction to the maximum desired speed on some key links in the mesoscopic portion of the model during the validation stage. **Table 3-2** lists the links on which a localised maximum desired speed reduction was applied. Generally, this reduction was only applied to sections where travel time data was available, so that the realism of the speed reduction could be verified.

Table 3-2 Local speed reductions

Road	Location	Posted speed limit (km/hr)	Maximum desired speed (km/hr)	Justification
Balmain Road	Parramatta Road – Marion Street	50	30	Balmain Road is a narrow one-way road with parking on both sides and traffic calming. The posted speed limit on the parallel Norton Street is 40 kilometres per hour. The maximum desired speed on Balmain Road was reduced to 30 kilometres per hour to capture the impacts of parking and traffic calming, and to reduce the attractiveness of Balmain Road as an alternative to Norton Street.
Brighton Street	West Street – Crystal Street	50	40	Brighton Street is a narrow local road with parking on both sides and a posted speed limit of 50 kilometres per hour. It has four wombat humps and two roundabouts along a stretch of approximately 500 metres. The maximum desired speed on Brighton Street was reduced to 40 kilometres per hour to capture delays associated with parking and traffic calming.
Elswick Street	Parramatta Road – Marion Street	50	40	Elswick Street is a narrow local road with a posted speed limit of 50 kilometres per hour. It has a wombat hump at either end and parking on both sides. Parking on one or both sides of the road is angle parking. No angle parking lines are marked and the angle of vehicles relative to the kerb was observed to vary from site visit observations and *Google Streetview*, which impacts the parking space length. Longer vehicles were observed to occasionally partially obstruct the traffic lanes so that through traffic would have to cross the centre line. Elswick Street was observed to be less utilised than the parallel Norton Street and Foster Street. The maximum desired speed on Elswick Street was reduced to 40 kilometres per hour to capture delays associated with parking and traffic calming, and to reduce the attractiveness of Elswick Street as an alternative to Norton Street or Foster Street.
Johnston Street	Parramatta Road – The Crescent	50	40	Johnston Street is a mostly-two-lane local road with a posted speed limit of 50 kilometres per hour. Parking on one or both sides of the road is angle parking. As noted for Elswick Street above, parked vehicles were often observed to partially obstruct through traffic lanes and it was observed that vehicles tended to use the centre lane in preference to the outside lane, likely due to parked cars. The maximum desired speed on Johnston Street was reduced to 40 kilometres per hour to capture delays associated with parking.

3.10 Traffic signals

Due to the complexity of the network, all signalised intersections were modelled as fixed-time based on intersection diagnostic monitor (IDM) data provided by TfNSW for the modelled date (17 October 2018). Average phase and cycle times for each intersection were calculated from the SCATS data and coded using:

> Fixed-time signals in 15-minute intervals inside the microsimulation area

> Fixed-time signals in 1-hour intervals outside the microsimulation area (mesoscopic simulation area).

Signal coordination offsets were extracted from the SCATS LX files. The signal offsets coordinate adjacent intersections to more realistically model the traffic flow. The signal offsets were calculated based on the average phase times in each 15-minute interval.

Intersections 721, 1873 and 1939 had no SCATS historical data for the survey date. Phase times were estimated based on modelled flows and SCATS phasing to achieve satisfactory calibration and validation results.

Figure 3-10 shows the locations of signalised intersections and pedestrian crossings in the study area.

Figure 3-11 shows the relationships between intersections and subsystems. These relationships were used to code the signal offsets to accurately model coordination between adjacent signalised intersections.

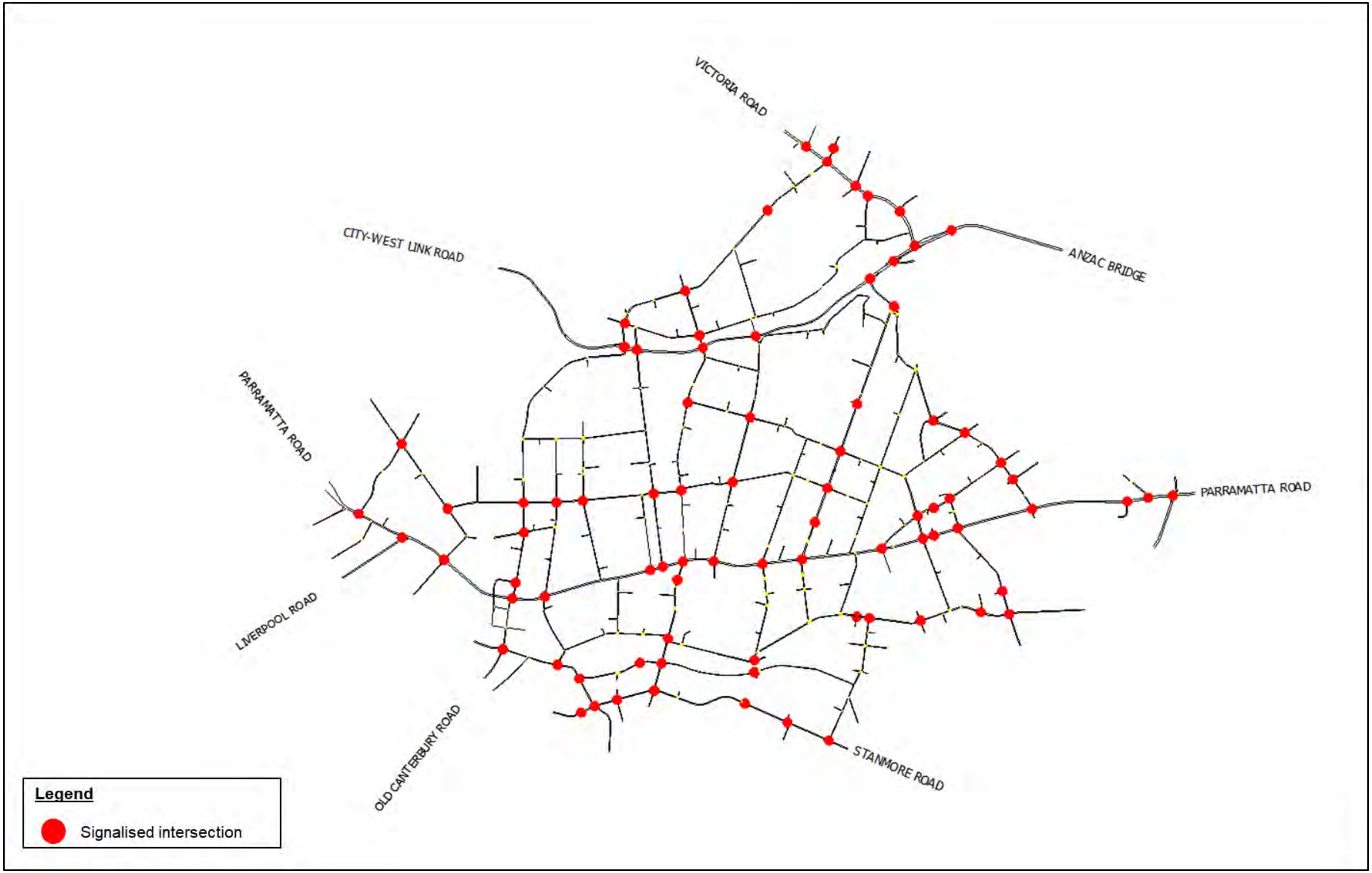


Figure 3-10 Signalised intersection locations

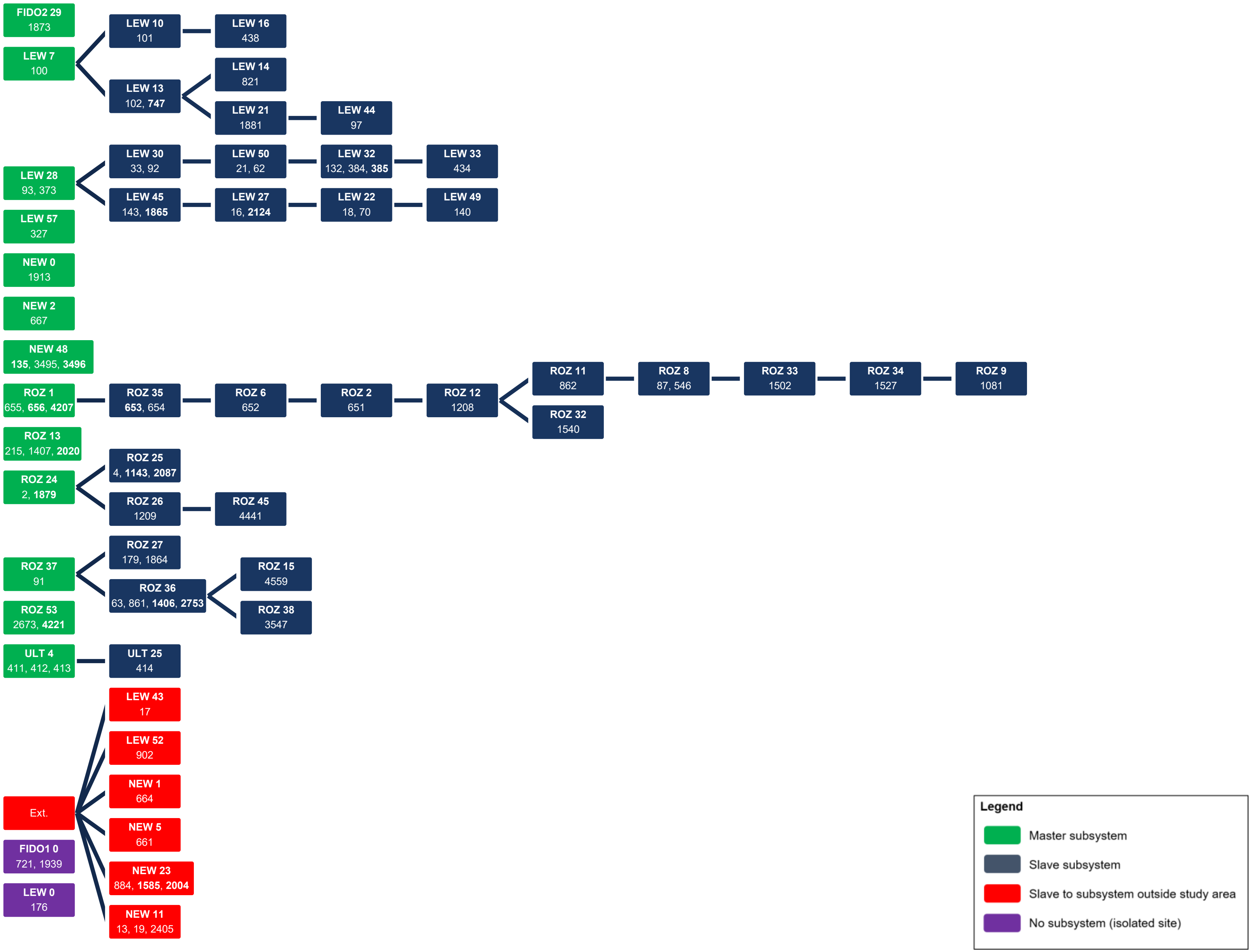


Figure 3-11 SCATS subsystem hierarchy

3.11 Public transport services

3.11.1 Train services

The Main Western Railway Line runs through the study area with stations at Stanmore, Petersham and Lewisham within the model boundary. The Main Western Railway Line is a six-track mainline that services the western, south-western and north-western areas of Sydney. The line has six tracks but only local trains stop at stations within the study area. Stanmore, Petersham and Lewisham are serviced by the Sydney Trains T2 Inner West Line which operates from the City Circle to Parramatta, Homebush and Leppington. Trains stop approximately every 15 minutes during off-peak periods and on weekends, with additional trains during peak hours.

All road-rail crossings in the study area are grade-separated, so there is no interaction between the trains and road vehicles.

Station barrier counts provide an indication of the number of trips made to and from a station by train on a typical weekday. **Table 3-3** shows the average number of station entries and exits during the modelled peak hours and across the entire day, calculated based on Opal data available from 21-25 November 2017.

Table 3-3 Station barrier counts (November 2017)

Station	AM Peak (7:15AM – 9:15AM)			PM Peak (4:30PM – 6:30PM)			Daily average		
	In	Out	Total	In	Out	Total	In	Out	Total
Stanmore Station	1770	315	2085	389	1216	1605	3834	3339	7173
Petersham Station	1183	528	1712	387	856	1244	3292	3152	6444
Lewisham Station	1164	278	1442	308	719	1027	2446	2090	4536

Table 3-4 indicates trip demand for the railway stations within the STM. The strategic model includes the railway stations are centroids separate from the surrounding zones.

Table 3-4 Vehicle trips to train stations from STM data (2016)

Station	Total trips (7:15AM – 9:15AM)		Total trips (4:30PM – 6:30PM)	
	To	From	To	From
Stanmore Station	74	2	5	65
Petersham Station	69	2	4	72
Lewisham Station	85	2	4	82

None of the three stations have commuter car park facilities and there is limited on-street parking in close proximity. The minimal number of trips in the STM demand suggests that the majority of train users take public transport (such as bus or light rail) or walk to the station. Consequently, due to their low demand, the railway stations were not included as separate centroids within the model and their trips were incorporated into the surrounding zone.

3.11.2 Bus services

The study area is in Region 6 of the Sydney bus network. Local bus services are primarily operated by Transit Systems. Some bus routes only operate at certain times such as peak hours or late at night. The bus routes that are wholly or partially within the study area are listed below:

- L23 Kingsgrove to City Martin Place (Limited Stops)
- L28 Canterbury to City Martin Place (Limited Stops)
- L37 Haberfield to City Town Hall (Limited Stops)
- L38 Abbotsford to City Martin Place (Limited Stops)
- L39 Mortlake to City Martin Place (Limited Stops)
- M10 Maroubra Junction to Leichhardt via City
- M30 Sydenham to Taronga Zoo
- M50 Coogee to Drummoyne
- M52` Parramatta to City Circular Quay
- N50 Liverpool to City Town Hall (NightRide)
- N60 Fairfield to City Town Hall (NightRide)
- N61 Carlingford to City Town Hall (NightRide)
- N80 Hornsby to City Town Hall via Strathfield (NightRide)
- N81 Parramatta to City Town Hall via Sydney Olympic Park (NightRide)
- X00 City to Ryde (Express Service)
- X04 City Domain to Chiswick (Express Service)
- X06 City Domain to East Ryde (Express Service)
- X15 City Town Hall to Eastwood (Express Service)
- X18 City Town Hall to Denistone East (Express Service)
- 412 Campsie to City Martin Place via Earlwood
- 413 Campsie to City Martin Place
- 422 Kogarah to City via Newtown
- 423 Kingsgrove to City Martin Place
- 426 Dulwich Hill to City Martin Place
- 428 Canterbury to City Martin Place
- 431 Glebe Point to City Martin Place
- 433 Balmain Gladstone Park to Central Pitt Street
- 436 Rodd Point and Chiswick to Central Pitt Street
- 438 Abbotsford to Martin Place
- 439 Mortlake to City Martin Place
- 440 Bondi Junction to Rozelle
- 441 City Art Gallery to Birchgrove via QVB (Loop Service)
- 442 City QVB to Balmain East Wharf (Loop Service)
- 445 Campsie to Balmain via Leichhardt Marketplace
- 447 Lilyfield to Leichhardt Marketplace (Loop Service)
- 461 Burwood to City Domain
- 470 Lilyfield to City Martin Place
- 480 Strathfield to Central Pitt Street via Homebush Road
- 483 Strathfield to Central Pitt Street via South Strathfield
- 500 Ryde to City Circular Quay
- 501 West Ryde to Central Pitt Street via Pyrmont and Ultimo
- 502 Five Dock to City Town Hall
- 504 Chiswick to City Domain
- 505 Woolwich to City Town Hall
- 506 Macquarie University to City Domain via East Ryde
- 507 Macquarie University to City Circular Quay via Putney
- 508 Drummoyne to City Town Hall
- 510 Ryde to City Town Hall
- 515 Eastwood to City Circular Quay
- 518 Macquarie University to City Circular Quay
- 520 Parramatta to City Circular Quay via West Ryde.

The major roads supporting the bus network within the model are Parramatta Road, Victoria Road, Norton Street, Marion Street and Balmain Road.

Bus routes and timetables were imported into the model using GTFS data. The purpose of the GTFS bus timetable feed is to publish in advance the schedule and route information of bus services operated under the Sydney Metropolitan and Outer Sydney Olympic Park Major Events Bus Contracts. GTFS data is typically used for TfNSW Transport Info, real-time transport apps and online map services such as Google Maps and Apple Maps. GTFS data is provided in the following nine data files:

> agency.txt – defines one or more transit agencies (operators) that provide the data in this feed
> calendar.txt – defines dates for service IDs using a weekly schedule; provides the start and end dates as well as the days of the week when the service is available
> calendar_dates.txt – defines exceptions for the service IDs defined in the calendar.txt file
> routes.txt – defines transit routes
> shapes.txt – defines rules for drawing lines on a map to represent a transit agency's routes
> stop_times.txt – provides the times that a vehicle arrives at or departs from individual stops for each trip including dwell times
> stops.txt – provides individual locations where vehicles pick up or drop off passengers
> trips.txt – provides the trips for each route (a trip is a sequence of two or more stops that occurs at a specific time)
> notes.txt – this file is an extension of the GTFS file set standard; it contains a list of notes references from trips.txt and stop_times.txt.

To utilise this data, Aimsun includes a GTFS importing function. GTFS data from November 2018 was sourced from the NSW Government Open Data Portal and used for the base model development for the AM and PM peak periods. Cardno undertook sanity-checks of the public transport routes to ensure that the import process did not produce incomplete routing. In cases where public transport lines were not properly imported or where links were not present in the model, manual adjustments were made to the routes.

3.11.3 Light rail

The L1 Dulwich Hill Line runs through the study area. The following seven light rail stops are present within the model boundary:

> Rozelle Bay
> Lilyfield
> Leichhardt North
> Hawthorne
> Marion
> Taverners Hill
> Lewisham West.

The line operates between Central and Dulwich Hill Station. Although services do not run from the L1 Line onto the L2 Randwick and L3 Juniors Kingsford lines[7], a new maintenance facility has been constructed at Lilyfield within the study area for the maintenance of vehicles used on these routes.

All road-light rail crossings in the study area are grade separated so there is no interaction between the light rail vehicles and road vehicles. Pedestrian crossings are present at most light rail stops and between some stops.

There are no carparks provided at any of the stops within the study area and limited on-street parking is available in close proximity. The minimal number of trips in the STM demand suggests that the majority of light rail users take public transport or walk to the stop. Consequently, due to the low demand, the light rail stops were not included as separate centroids within the model and their trips were incorporated into the surrounding zone.

[7] Under construction during the modelled periods (October 2018) but subsequently opened in 2019 and 2020 respectively.

3.12 Demand assumptions and adjustment

3.12.1 Demand estimation procedure overview

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

1. The prior matrix for each scenario was extracted from the STFM
2. The prior matrix was disaggregated based on estimated vehicle splits based on observed land uses and classified intersection counts
3. The prior 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 the trips are under- or over-estimated by the strategic model
4. The prior matrix was manually adjusted based on observed counts. Generally, the strategic model was observed to underestimate the trips generated by residential areas. Trips were generally adjusted proportionally to all centroids, except in instances where an exact number of trips could be derived (such as between two centroids with only one turn in between)
5. The static model was calibrated to eliminate unrealistic route choice. As the static model does not fully consider delays associated with intersections, traffic calming, parking, local streets or congestion, user-defined costs were introduced in some locations to simulate these delays and improve the static assignment
6. The Aimsun Static OD Adjustment tool was used to refine the matrix using the observed counts for each scenario. The matrix elasticity and trip distribution elasticity were constrained to ensure that the final matrix did not significantly deviate from the strategic demand. A one-hour warm-up was included to ensure that a realistic number of vehicles were pre-loaded in the network at the beginning of the first modelled interval
7. Some minor manual adjustments were made to the matrix to account for areas where the Static OD Adjustment process was found to have unrealistically increased or decreased the demand significantly
8. The profiled matrix was used in dynamic experiments
9. The final traffic demand and assignment from the stochastic route choice experiment were used in the calibration and validation process to ensure that the models accurately represent existing conditions.

The demand estimation procedure is iterative and involves continual refinement of the model parameters and demand matrix. **Figure 3-12** provides a diagrammatic representation of the demand estimation, calibration and validation process.

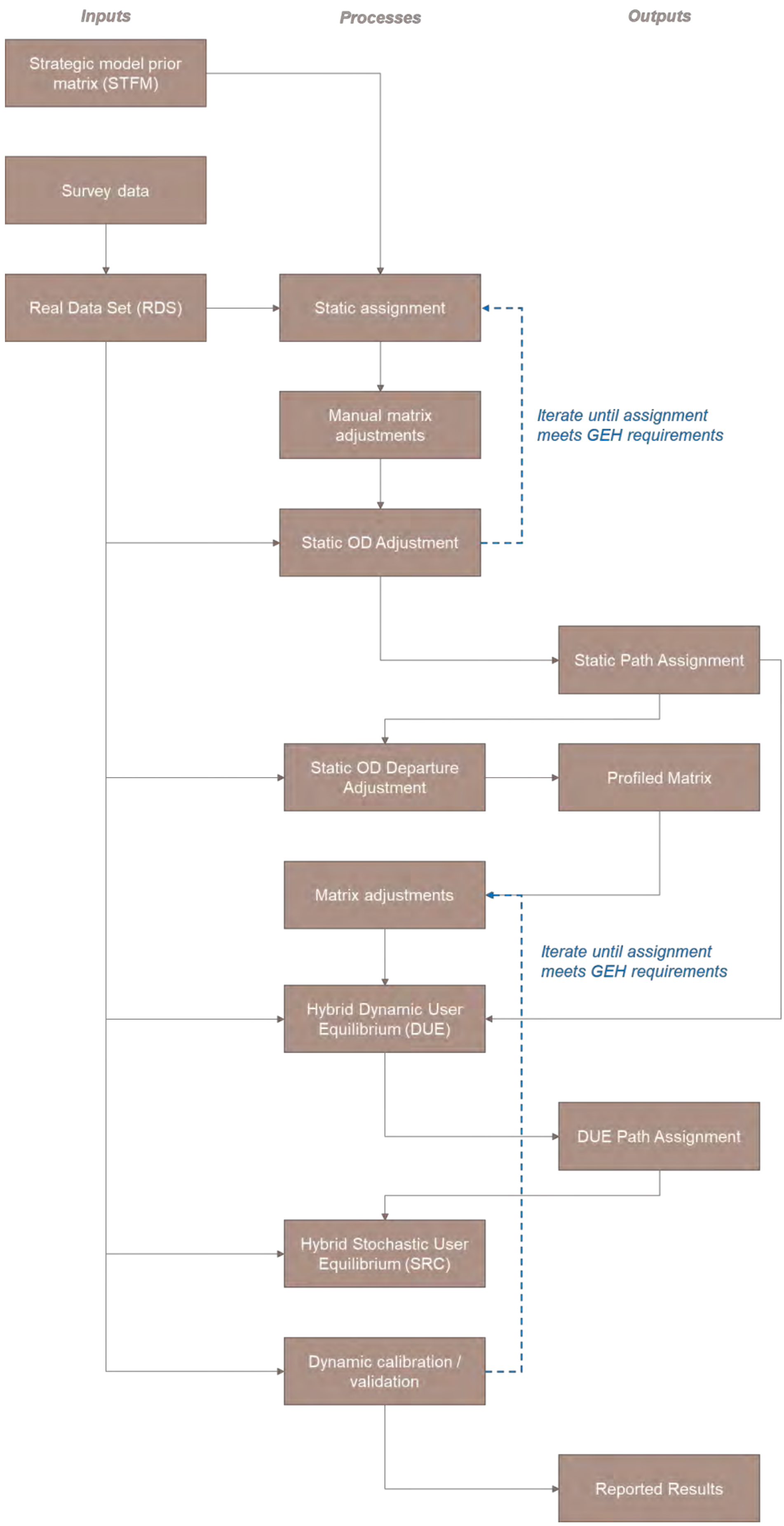


Figure 3-12 Multi-level modelling framework process

3.12.2 Demand adjustment

The following adjustments were made to the STFM demand:

- The initial STFM matrix was disaggregated and adjusted to account for unrealistic demands such as trips with the same origin and destination and trips between adjacent gates where there is a more direct route outside the modelled area
- The AM STFM matrix was also found to be substantially lower than suggested by traffic survey volumes so was scaled up by 27.8 per cent
- This matrix was run through the Aimsun Static OD Adjustment process which adjusts the demand to match survey counts at intersections. The process was restricted using the matrix and trip length elasticity constraints in Aimsun
- The adjusted demand was profiled using the Aimsun Static OD Departure Adjustment to match the surveyed traffic profile. Some manual adjustments were also made to the profiled demand to account for unrealistic inflation or deflation of demand during the Static OD Adjustment process.

Figure 3-13 provides a comparison of the total number of trips for each of the above steps in the demand estimation procedure.

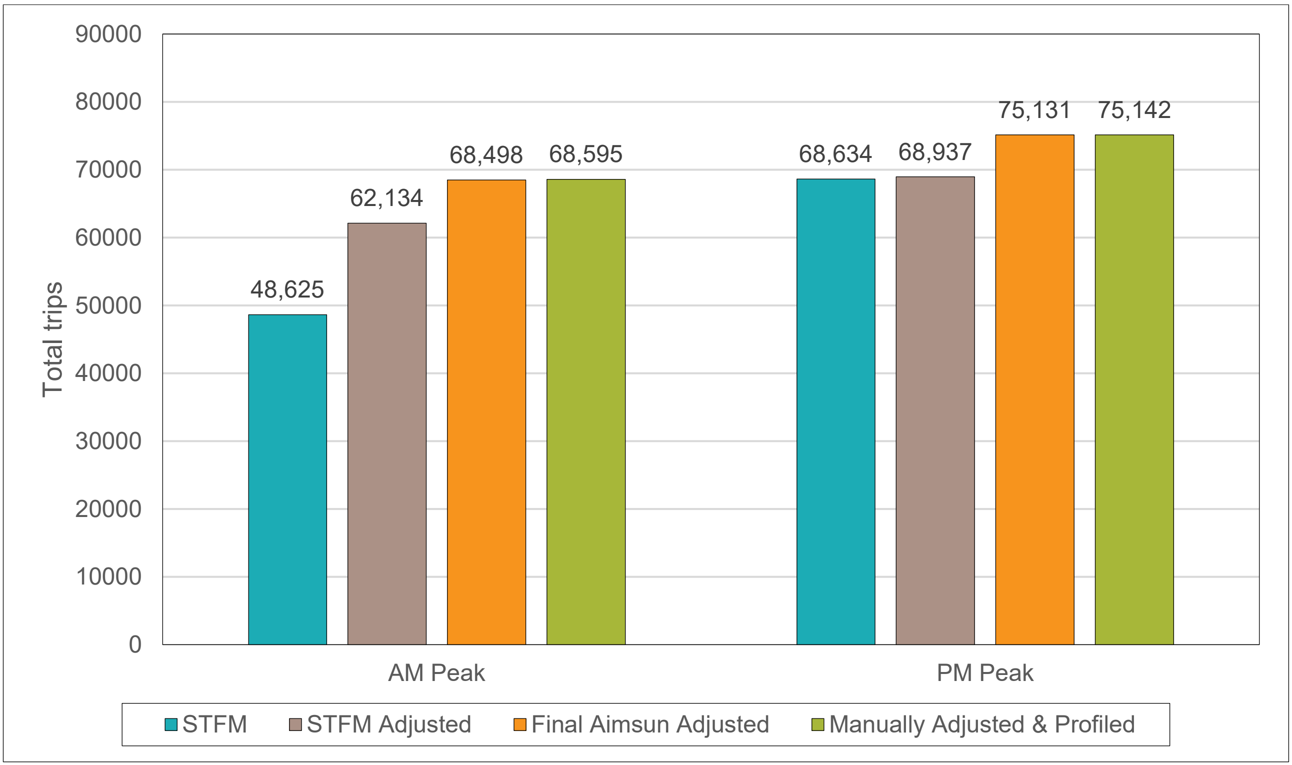


Figure 3-13 Total trips

3.12.3 OD adjustment and trip length distribution

Figure 3-14 and **Figure 3-15** show the trip length distribution outputs for all vehicles following the final Static OD Adjustment experiment for the AM Peak and PM Peaks respectively. There are no significant changes to the shape of the profile following the final adjustment.

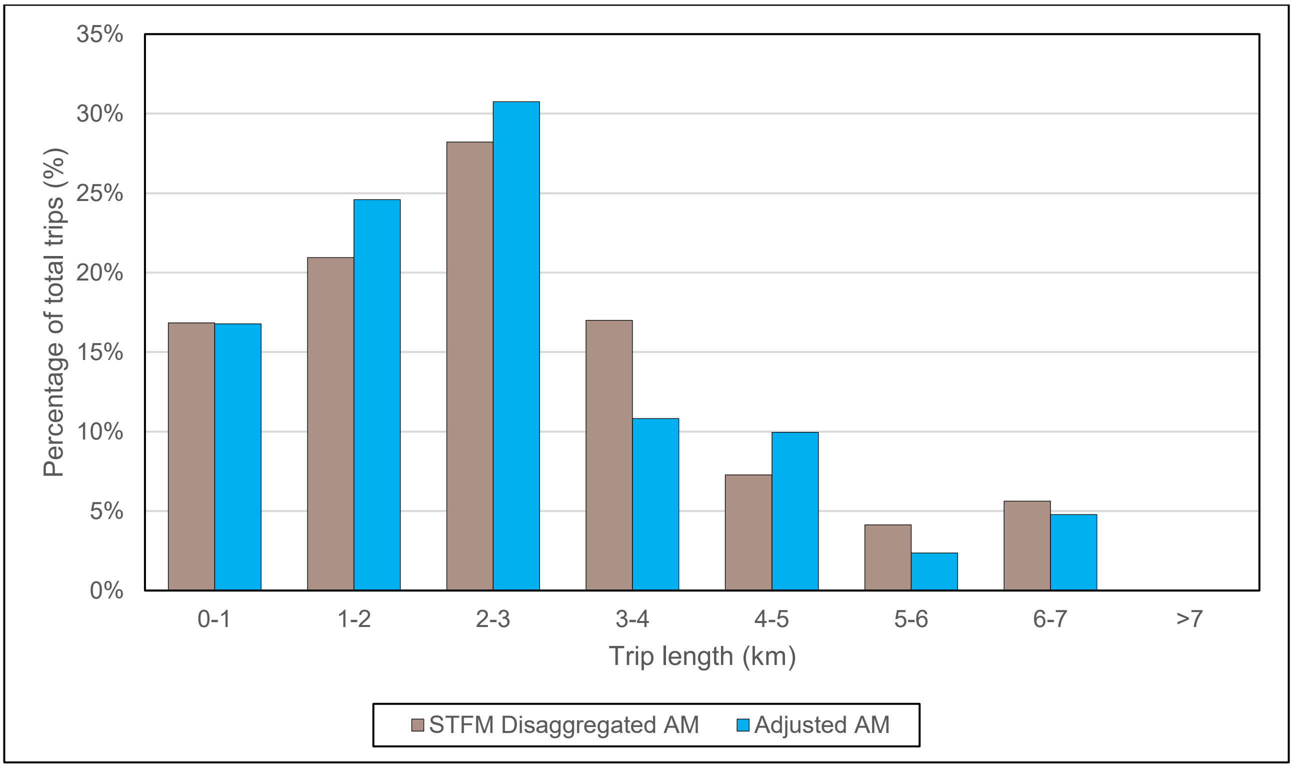


Figure 3-14 AM Peak trip length distribution

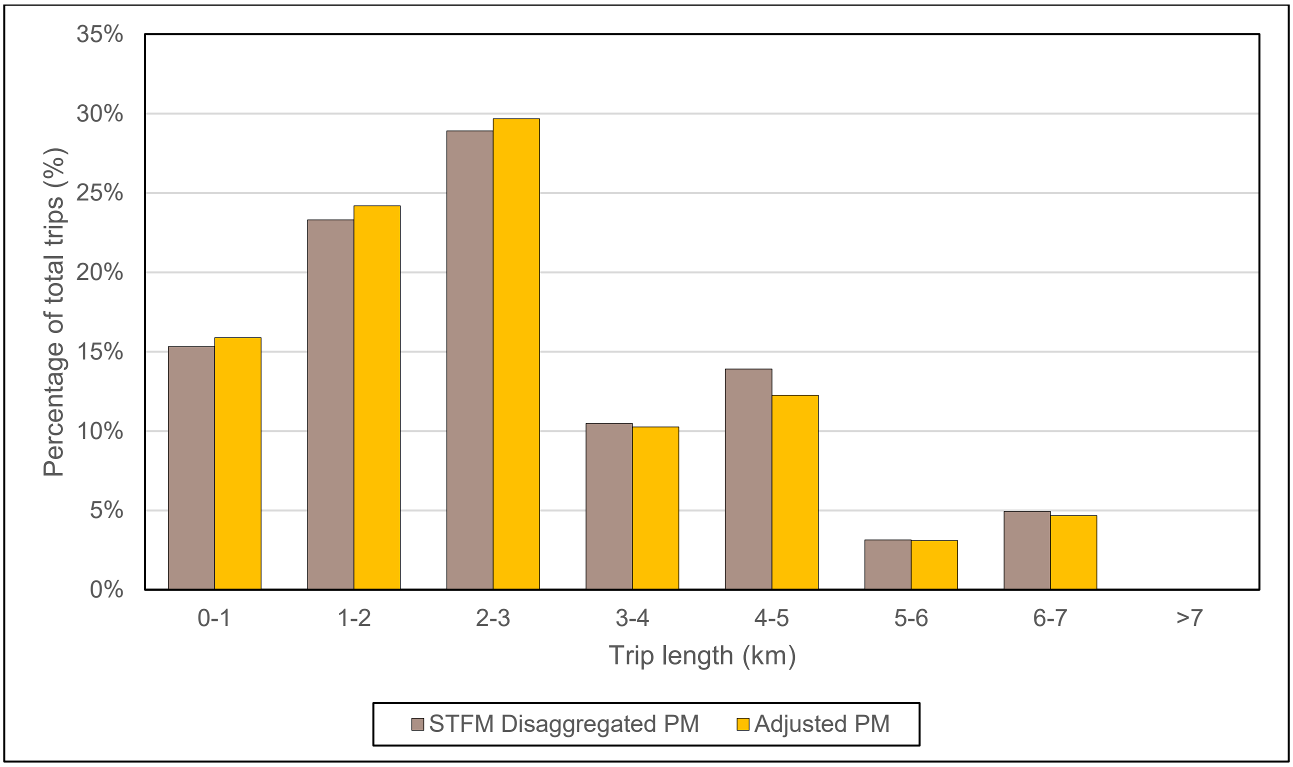


Figure 3-15 PM Peak trip length distribution

3.12.4 Departure adjustment

The two-hourly traffic demand was profiled using the Aimsun Static OD Departure Adjustment based on the profile of the RDS (refer to **Section 2.2.2**). This process was used to generate a profiled demand in 15-minute intervals.

Figure 3-16 and **Figure 3-17** show a comparison between the profile of the RDS and the profiled demand for the AM Peak and PM Peak respectively. All values are within 0.4 per cent of the total demand and there are no significant changes to the shape of the profile.

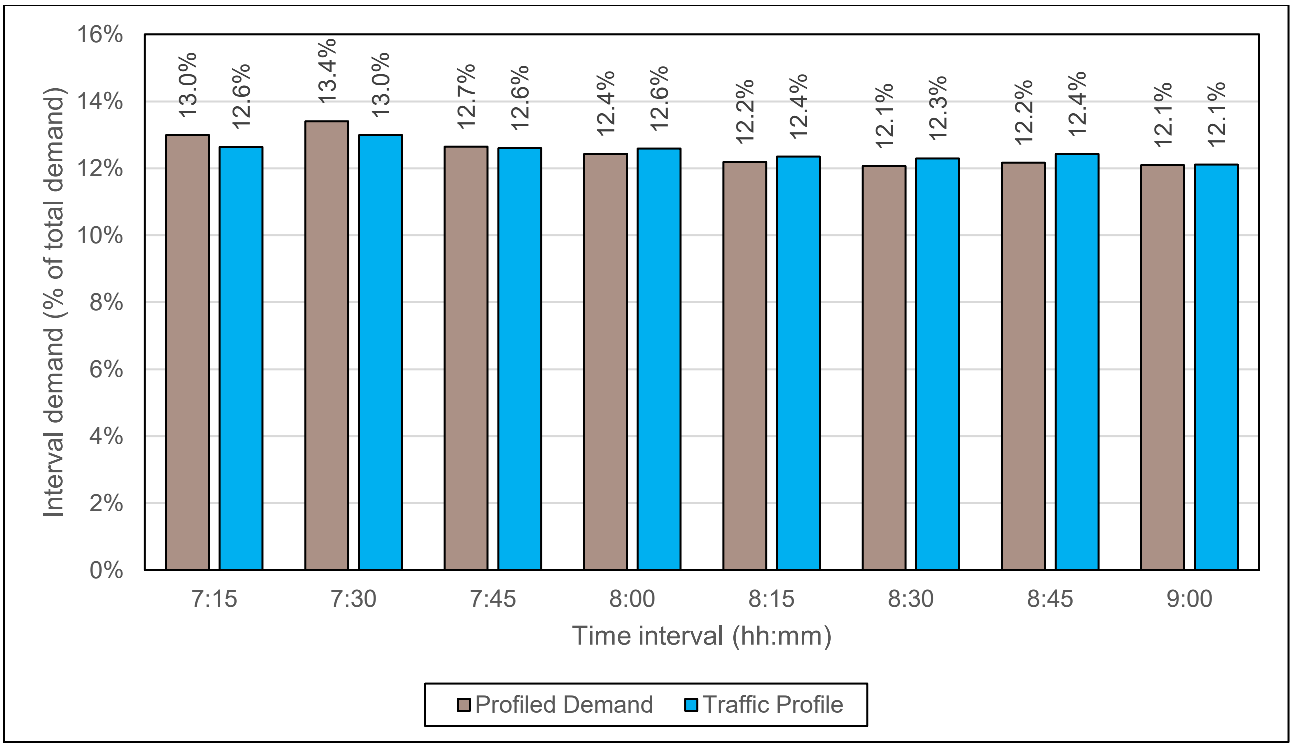


Figure 3-16 Profiled demand comparison (AM Peak)

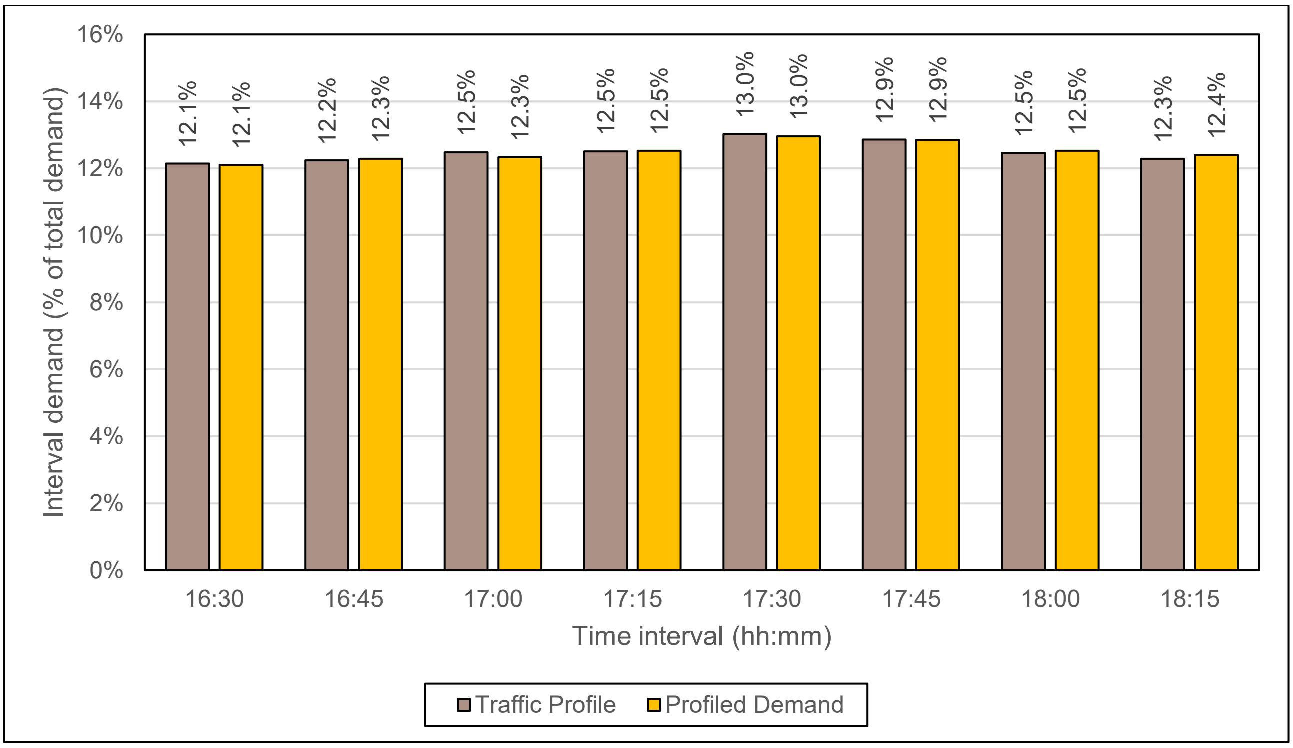


Figure 3-17 Profiled demand comparison (PM Peak)

3.12.5 Traffic demand composition

The traffic demands differentiated between light and heavy vehicles (refer to **Section 3.5**). **Table 3-5** summarises the traffic composition of the demand for each peak. Note that buses are part of the heavy vehicle class but are not included in the demand as they follow fixed routes and run to a fixed timetable.

Table 3-5 Profile demand traffic composition

Peak	Light vehicles		Heavy vehicles		All vehicles
	Demand (veh)	% of total demand	Demand (veh)	% of total demand	Total demand (veh)
AM Peak	65,185	95.0%	3409	5.0%	68,595
PM Peak	73,713	98.1%	1428	1.9%	75142

3.13 Pedestrians and cyclists

Consideration for pedestrian movements in the model was mainly at the intersection level due to the lack of information on mid-block pedestrian paths and walking destinations.

Cyclist volumes were not considered in the model.

3.14 Behaviour parameters

Aimsun defaults were generally adopted for all parameters. Cardno notes that the PRRP model inherited for this project contained substantial adjustment to many of the vehicle behavioural parameters. In some cases, these were restored to Aimsun defaults as the adjusted values were found to be unrealistic. **Figure 3-18** lists the key behavioural parameters that were adjusted based on observations during the calibration and validation process. Note that higher reaction times were utilised in the mesoscopic simulation area. In mesoscopic simulation, vehicles are assumed to accelerate and decelerate instantaneously. Increasing the reaction time factor in mesoscopic simulations is accepted best-practice to account for vehicle acceleration and deceleration time.

Figure 3-18 Key behavioural parameters

Vehicle type	Reaction time	Reaction time at stop	Reaction time for front vehicle at traffic lights	Probability
Microsimulation area				
Car	0.9	1.1	1.3	1
Truck	0.8	1.2	1.5	1
Bus	0.8	1.2	1.5	1
Mesoscopic simulation area				
Car	1.3	-	1.7	1
Truck	1.3	-	1.7	1
Bus	1.3	-	1.7	1

3.15 End constraints at model boundary

To correctly represent queue spillback into the model area as a means of reflecting broader network congestion in the microsimulation model area, dummy signals were included on Parramatta Road in the eastbound direction (east of City Road). The green time on the dummy signals was adjusted to ensure a good match with travel time data and generate variable queue on the edge of the model.

Note that although the signals are located at the Broadway / Mountain Street intersection, they are not intended to represent queue spillback from this intersection but rather queues propagating back along Broadway in the eastbound travel direction caused by congestion on Broadway and George Street that was observed during the site visit and from *Google Traffic* data.

3.16 Calibration criteria

The Base Model was calibrated in accordance with the criteria outlined in *Traffic Modelling Guidelines* (Roads and Maritime Series, 2013) to ensure that the existing traffic conditions are replicated to a statistically high level 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 from 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**:

$$GEH = \sqrt{\frac{(V_o - V_m)^2}{0.5(V_o + V_m)}}$$ 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. *Traffic Modelling Guidelines* (Roads and Maritime Services, 2013) recommends the following criteria for model calibration:

> 85 per cent of turn and link flow comparisons to have a GEH less than five

> 100 per cent of turn and link flow comparisons to have a GEH less than 10

> The R-square (R^2) statistic to be greater than 0.95 for a flow plot of observed versus modelled turn volumes (where R^2 = 1.0 indicates a perfect correlation).

Due to the size of the model and time constraints during the calibration stage, a reduced GEH criteria was agreed with DPIE for the mesoscopic area. The relaxed criteria was 80 per cent of turns to have a GEH less than five and 95 per cent of turns to have a GEH less than 10.

3.17 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. The Base Model was validated in accordance with the criteria outlined in *Traffic Modelling Guidelines* (Roads and Maritime Services, 2013) to ensure accurate replication of driver behaviour and road conditions. Two validation criteria were used for the Base Model:

> Travel time validation

> Signal validation

> Congestion hotspot validation.

These are outlined below.

3.17.1 Travel time validation

The validation of travel time on key routes confirms that the model is accurately replicating observed congestion and driver behaviour. *Traffic Modelling Guidelines* (Roads and Maritime Services, 2013) recommends the following criteria for travel time validation:

> Average modelled journey time to be within 15 per cent or one minute (whichever is greater) of the average observed journey time for the full length of the route
> Average modelled time for each section to be within 15 per cent of the observed journey time for that section.

The travel time routes are shown in **Section 2.2.3**.

3.17.2 Signal validation

Traffic Modelling Guidelines (Roads and Maritime Services, 2013) recommends the following criteria for signal timing validation:

> 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
> Total of green time over each one-hour period to be within 10 per cent of the observed equivalent for each phase
> Call frequency of demand-dependent phases (including pedestrian call phases) to be compared with observed data to ensure phase activation occurs to a similar level over each hour period.

3.17.3 Congestion hotspot validation

Modelled average speed by section was plotted for each peak and compared to the average speed data extracted from TomTom (refer to **Section 2.3**). This provided an additional layer of verification that the average speeds in the model were reflective of those in reality.

4 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 4-1 and **Figure 4-2** show the variation in VHT per 15-minute interval for the AM Peak and PM Peak respectively. The results show that the model performs similarly across the five seeds run.

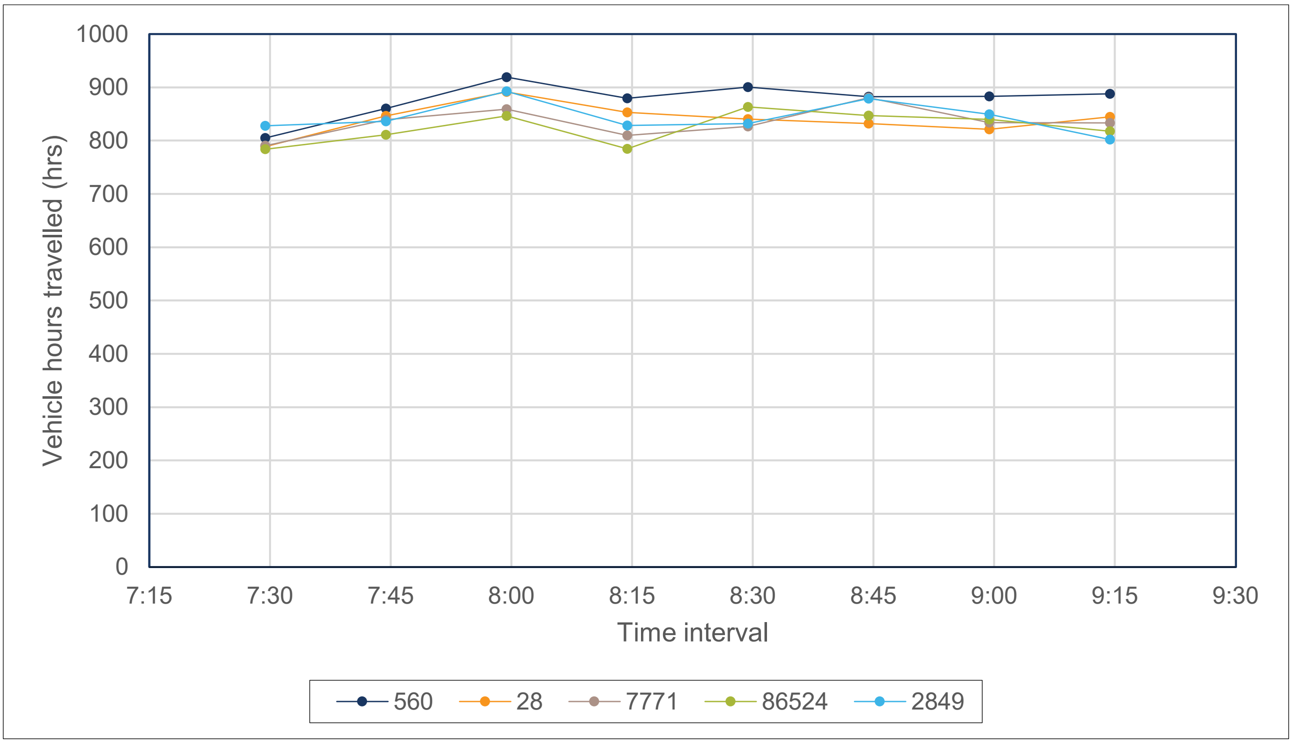


Figure 4-1 Vehicle hours travelled (VHT) across all seeds (AM Peak)

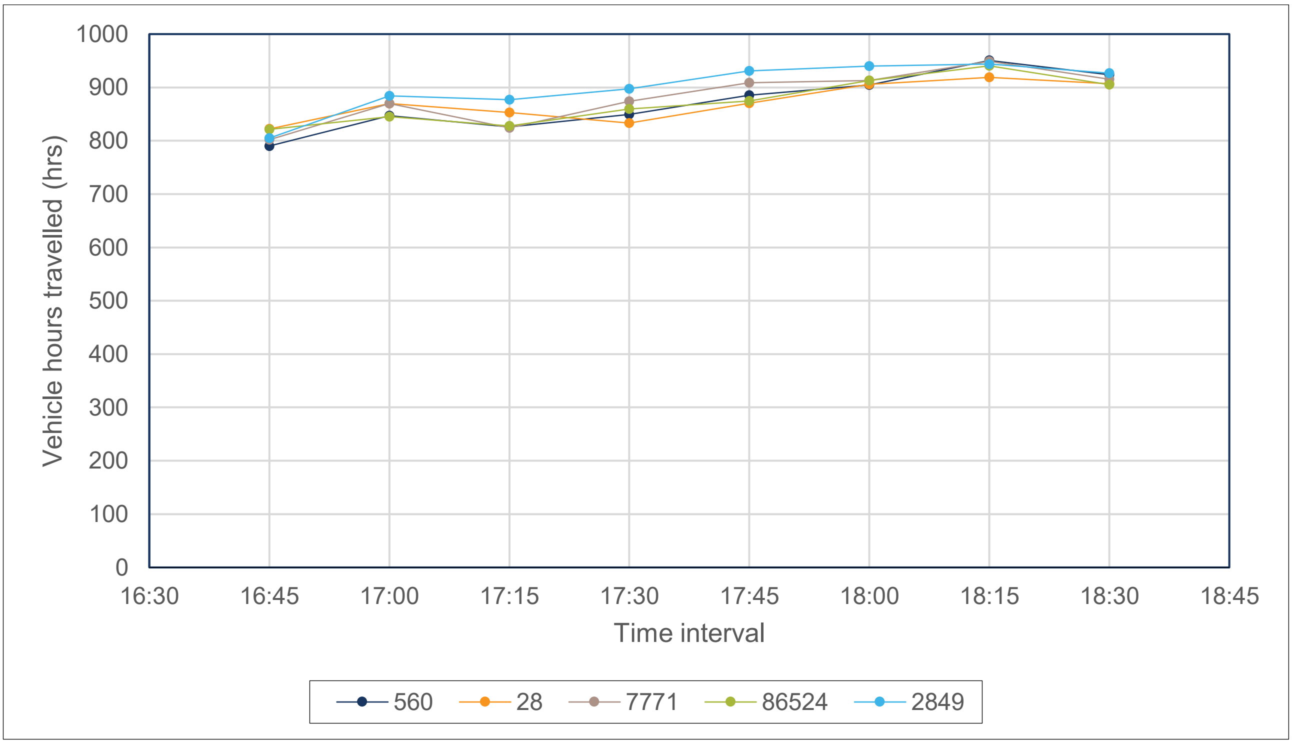


Figure 4-2 Vehicle hours travelled (VHT) across all seeds (PM Peak)

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

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

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 4-1**.

Table 4-1 Number of simulation runs required

Parameter	AM peak	PM peak
t	2.776	2.776
σ	160.3	97.4
$\bar{x}$	6750	7041
Δ	337.51	352.04
N	1.74	0.59

The number of simulation runs required (N) is less than the initial five seeds used in both peaks, therefore it is sufficient to retain the initial five seeds for a confidence interval of 95 per cent. **Table 4-2** shows the VHT bounds and the median seed for each peak.

Table 4-2 Median seed values

Peak	All seeds			Median seed	
	VHT lower bound	Mean VHT	VHT upper bound	VHT	Seed value
AM Peak	6594	6750	7012	6718	28
PM Peak	6976	7041	7205	6988	86524

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 4-2**.

5 Model calibration and validation

5.1 Convergence

As outlined in Section 3.4.2, 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 1.0 per cent was adopted.

Figure 5-1 and **Figure 5-2** show the DUE convergence for the AM Peak and PM Peak respectively. Both peaks converge within four iterations.

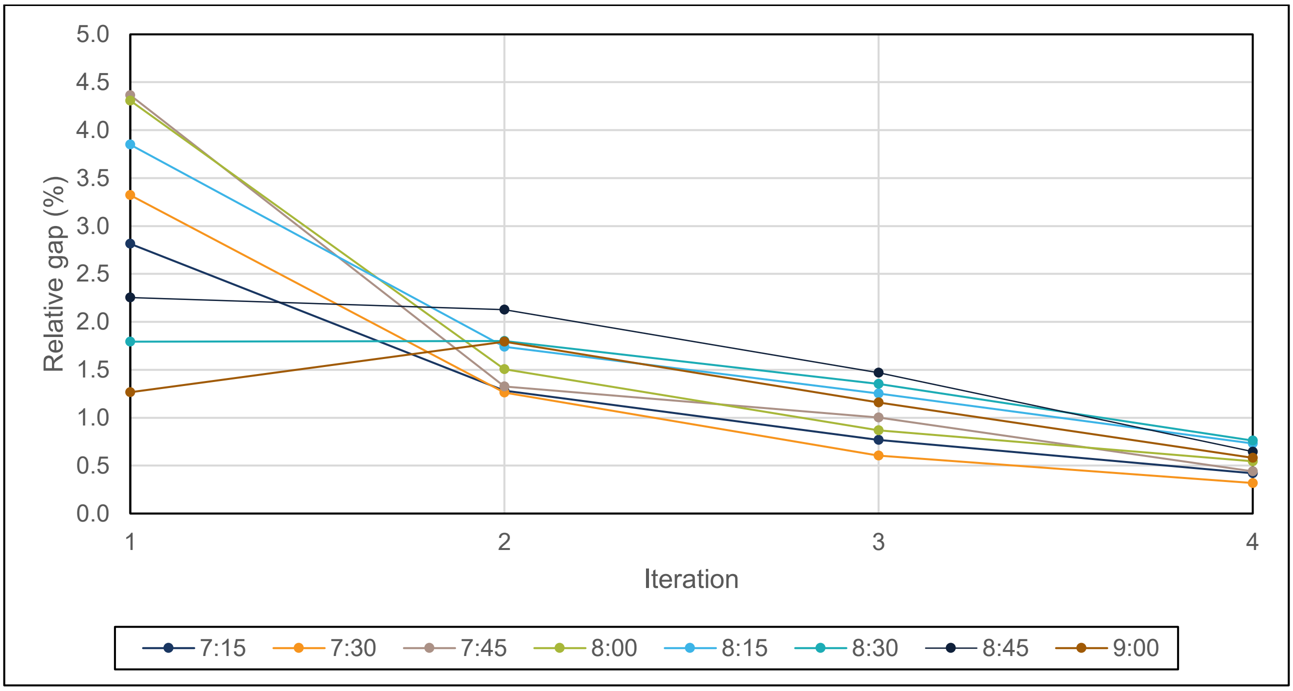


Figure 5-1 AM Peak DUE convergence

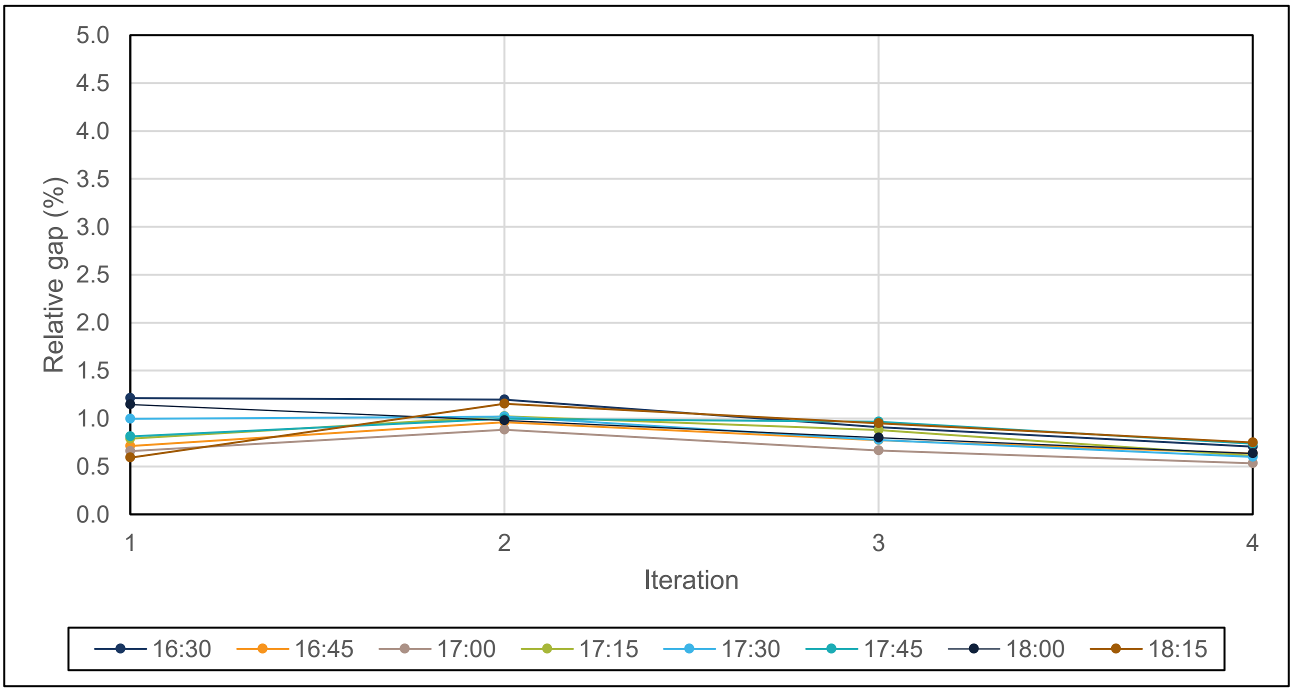


Figure 5-2 PM Peak DUE convergence

5.2 Calibration results

This section outlines the calibration results. **Table 5-1** provides a summary of the GEH criteria and for turning counts and the number of compliant counts for each hour of each peak.

Table 5-1 Summary of GEH statistics for each modelled hour

Model area	Criteria	AM Peak		PM Peak	
		7:15AM – 8:15AM	8:15AM – 9:15AM	4:30PM – 5:30PM	5:30PM – 6:30PM
Light vehicles					
Micro	Turns with GEH < 5	133 / 142 93.7%	131 / 142 92.3%	129 / 142 90.8%	127 / 142 89.4%
	Turns with GEH < 10	142 / 142 100.0%	142 / 142 100.0%	142 / 142 100.0%	142 / 142 100.0%
	Calibration achieved?	✓	✓	✓	✓
Meso	Turns with GEH < 5	412 / 462 89.2%	410 / 462 88.7%	424 / 462 91.8%	417 / 462 90.3%
	Turns with GEH < 10	459 / 462 99.4%	461 / 462 99.8%	456 / 462 98.7%	458 / 462 99.1%
	Calibration achieved?	✓	✓	✓	✓
All	Turns with GEH < 5	545 / 604 90.2%	541 / 604 89.6%	553 / 604 91.6%	544 / 604 90.1%
	Turns with GEH < 10	601 / 604 99.5%	603 / 604 99.8%	598 / 604 99.0%	600 / 604 99.3%
	Calibration achieved?	✓	✓	✓	✓
Heavy vehicles					
Micro	Turns with GEH < 5	142 / 142 100.0%	140 / 142 98.6%	140 / 142 98.6%	140 / 142 98.6%
	Turns with GEH < 10	142 / 142 100.0%	142 / 142 100.0%	142 / 142 100.0%	142 / 142 100.0%
	Calibration achieved?	✓	✓	✓	✓
Meso	Turns with GEH < 5	458 / 462 99.1%	452 / 462 97.8%	457 / 462 98.9%	450 / 462 97.4%
	Turns with GEH < 10	462 / 462 100.0%	462 / 462 100.0%	462 / 462 100.0%	462 / 462 100.0%
	Calibration achieved?	✓	✓	✓	✓
All	Turns with GEH < 5	600 / 604 99.3%	592 / 604 98.0%	597 / 604 98.8%	590 / 604 97.7%
	Turns with GEH < 10	604 / 604 100.0%	604 / 604 100.0%	604 / 604 100.0%	604 / 604 100.0%
	Calibration achieved?	✓	✓	✓	✓

Across the four modelled hours, a total 11 different turns have a GEH greater than 10. **Table 5-2** lists the locations of these turns and the modelled hours for which the GEH exceeds 10. All such turns are in the mesoscopic area of the model so only indirectly impact the calibration of the Parramatta Road corridor. Nevertheless, a short explanation of each turn and the reason/s that the GEH exceeds 10 in the given modelled hours is provided in the table.

In most cases the GEH did not significantly exceed 10. The average GEH of turns with a GEH above 10 was 11.25 and the maximum value across all modelled hours was 13.83. Furthermore, the total number of turns with GEH exceeding 10 was not more than six in any modelled hour, which represents less than one per cent of the total number of comparisons. Due to the low number of turns with GEH exceeding 10 and their location outside the Parramatta Road corridor (the key focus of the model), the impact of this on the calibration of the model is considered to be negligible. Most of the turns with GEH greater than 10 were concentrated in two areas for the following reasons:

> Near Lilyfield Road and City-West Link Road due to a large number of local roads that were not modelled and scarcity of survey data in this area to understand OD patterns and vehicle routing behaviour

> Moore Street / Booth Street caused by limited survey data along Moore Street and Booth Street and a lack of local roads that may be used as shortcuts.

Table 5-2 Turns with GEH greater than 10

Turn ID	Description	GEH	Model area	Modelled hours with GEH > 10	Notes
3NR	Right turn from Catherine Street to City-West Link Road	10.70	Meso	4:30PM – 5:30PM	Underrepresented in the model with 58 vehicles (surveyed volume was 173 vehicles). This is likely caused by the high density of local roads in this area of the model that have not been modelled and the scarcity of survey data in this area to identify routes to a high degree of accuracy. The GEH for this turn is also not substantially above 10.
5ER	Right turn from Moore Street to Catherine Street	13.83 13.40	Meso	4:30PM – 5:30PM 5:30PM – 6:30PM	Underrepresented in the model due to a lack of vehicles on Moore Street and Booth Street. Only limited survey data was available on Moore Street and Booth Street so vehicle routing and OD patterns could not be modelled to a high level of accuracy.
7SR	Right turn from Balmain Road to Moore Street	12.74	Meso	8:15AM – 9:15AM	
15NL	Left turn from Johnston Street to Collins Street	11.93	Meso	7:15AM – 8:15AM	Overrepresented in the model. This is likely due to an overestimation of the demand for destinations in this area as this route does not provide a shortcut to any other key destinations in the model.
16WR	Right turn from Booth Street to Johnston Street	10.04	Meso	7:15AM – 8:15AM	Overrepresented in the model due to uncertainty surrounding vehicle routing and OD patterns on Booth Street / Moore Street due to scarcity of survey data in this vicinity. The GEH for this turn is also not substantially above 10.
16SL	Left turn from Johnston Street to Booth Street	11.30 12.09	Meso	4:30PM – 5:30PM 5:30PM – 6:30PM	Underrepresented in the model due to uncertainty surrounding vehicle routing and OD patterns on Booth Street / Moore Street due to scarcity of survey data in this vicinity.

Turn ID	Description	GEH	Model area	Modelled hours with GEH > 10	Notes
33NT	Through movement from James Street to Darley Road	10.79	Meso	5:30PM – 6:30PM	Overrepresented in the model. It was observed that vehicles tended to use Darley Street rather than Catherine Street or Norton Street as major north-to-south connectors. Subsequently traffic volumes on Darley Road were higher than observed while those on Catherine Street and Norton Street were lower. This is likely caused by the high density of local roads in the area that have not been modelled and the scarcity of survey data to accurately identify routes and OD patterns. The GEH for this turn is also not substantially above 10.
35EL	Left turn from Lilyfield Road to James Street	10.03	Meso	4:30PM – 5:30PM	Underrepresented in the model due to uncertainty surrounding traffic volumes on Lilyfield Road (see above). The GEH for this turn is also not substantially above 10.
41NL	Left turn from Tebbutt Street to Railway Terrace	10.10 10.20	Meso	4:30PM – 5:30PM 5:30PM – 6:30PM	Underrepresented in the model due to the zoning system. The GEH for this turn is also not substantially above 10.
42ET	Through movement on Lilyfield Road at Balmain Road	10.09	Meso	4:30PM – 5:30PM	Underrepresented in the model due to uncertainty surrounding traffic volumes on Lilyfield Road (see above). The GEH for this turn is also not substantially above 10.
56NL	Left turn from Dalhousie Street to Ramsay Street	10.28	Meso	7:15AM – 8:15AM	Overrepresented in the model with more vehicles tending to turn left onto Ramsay Street rather than going through then turning left at Parramatta Road. The GEH for this turn is also not substantially above 10.

Figure 5-3 and **Figure 5-4** show the results of a regression analysis of the results for the AM Peak. **Figure 5-5** and **Figure 5-6** show the results of a regression analysis of the results for the PM Peak.

Table 5-3 provides a summary of the regression analysis results. For each modelled hour, the results indicate a strong correlation between the modelled and observed flows. The coefficient of determination (R^2) exceeds the required value of 0.95 for all hours.

Table 5-3 Regression analysis summary

Modelled hour	Slope	Coefficient of determination (R^2)	Calibration achieved?
7:15AM – 8:15AM	1.0155	0.9922	✓
8:15AM – 9:15AM	0.9708	0.9894	✓
4:30PM – 5:30PM	0.9965	0.9946	✓
5:30PM – 6:30PM	0.9849	0.9940	✓

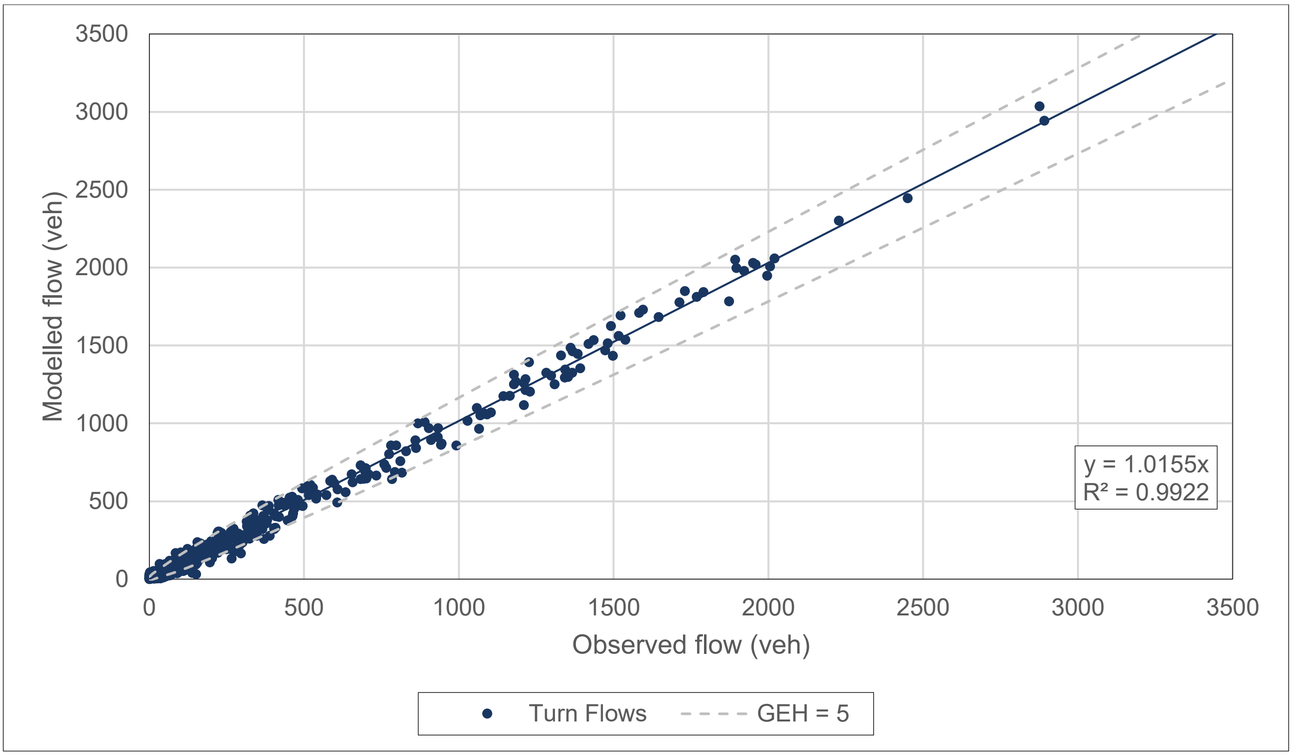


Figure 5-3 AM Peak (7:15AM – 8:15AM) regression plot

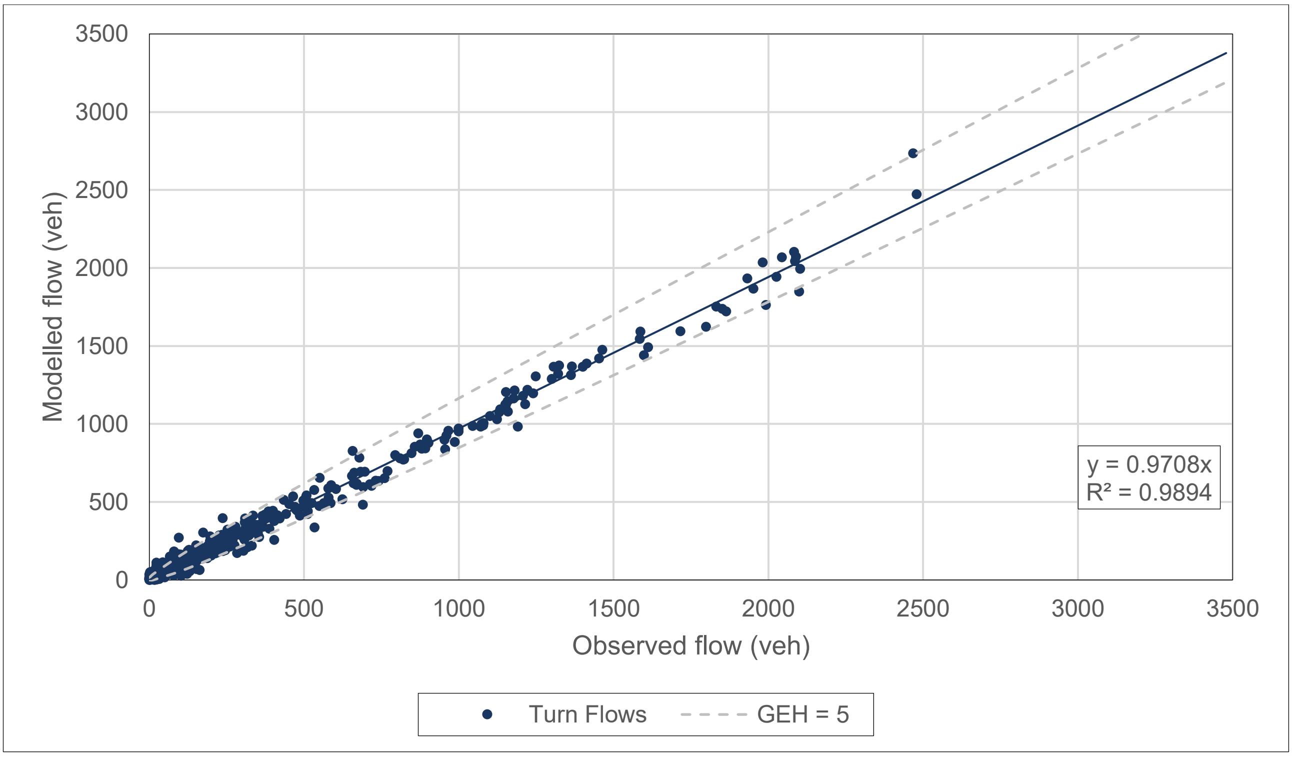


Figure 5-4 AM Peak (8:15AM – 9:15AM) regression plot

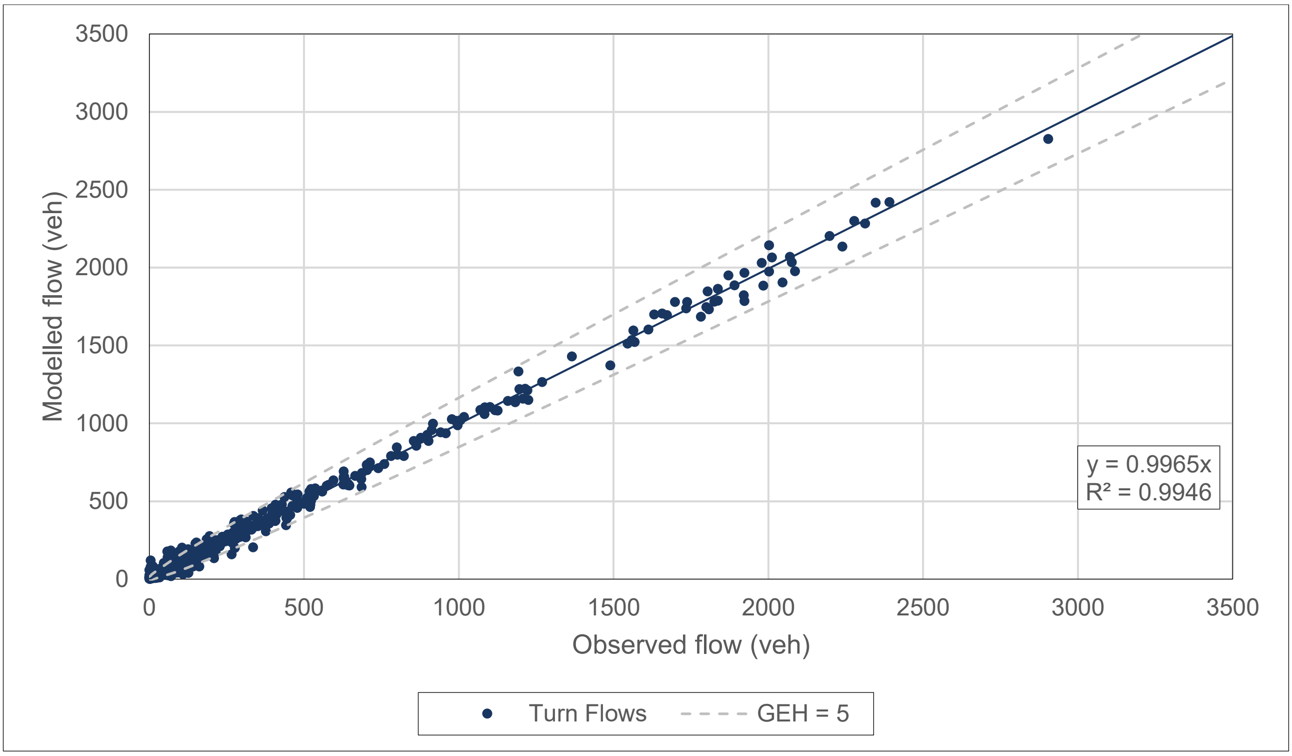


Figure 5-5 PM Peak (4:30PM – 5:30PM) regression plot

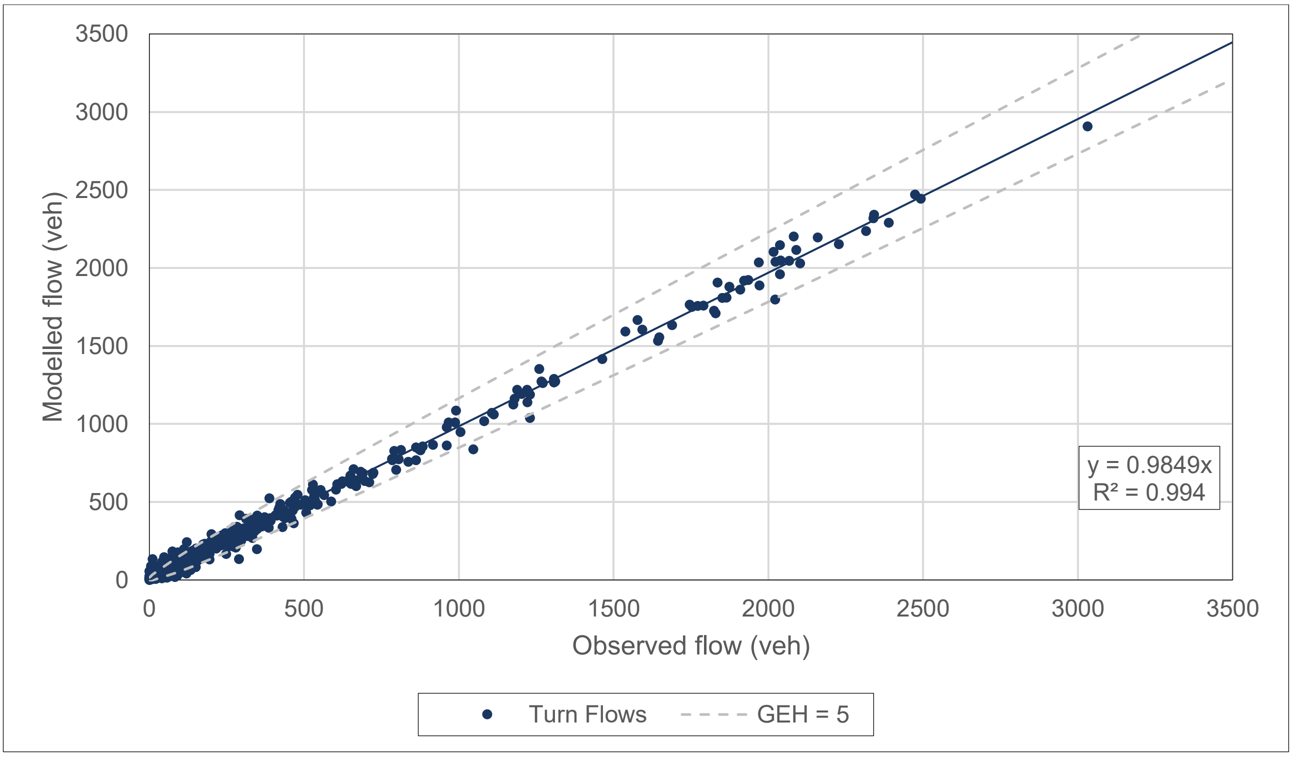


Figure 5-6 PM Peak (5:30PM – 6:30PM) regression plot

5.3 Validation results

5.3.1 Travel time validation

This section outlines the travel time validation results. Six bi-directional routes were used for travel time validation as discussed in **Section 2.2.3**. **Table 5-4** shows the travel time validation results for each route for each modelled hour. All routes are within 60 seconds or 15 per cent of the observed value as required by *Traffic Modelling Guidelines* (Roads and Maritime Services, 2013).

Table 5-4 Travel time validation results by route

Modelled hour	Modelled (s)	Observed (s)	Difference (s)	Difference (%)	Validation
Parramatta Road (eastbound)					
7:15AM – 8:15AM	1113	1261	-148	-11.7%	✓
8:15AM – 9:15AM	1249	1385	-136	-9.8%	✓
4:30PM – 5:30PM	887	970	-83	-8.5%	✓
5:30PM – 6:30PM	950	1086	-136	-12.5%	✓
Parramatta Road (westbound)					
7:15AM – 8:15AM	836	866	-30	-3.5%	✓
8:15AM – 9:15AM	833	967	-134	-13.9%	✓
4:30PM – 5:30PM	916	908	+8	+0.9%	✓
5:30PM – 6:30PM	933	1006	-72	-7.2%	✓
Crystal Street (northbound)					
7:15AM – 8:15AM	173	147	+26	+17.5%	✓
8:15AM – 9:15AM	185	152	+33	+21.9%	✓
4:30PM – 5:30PM	216	209	+7	+3.3%	✓
5:30PM – 6:30PM	179	218	-39	-17.8%	✓
Crystal Street (southbound)					
7:15AM – 8:15AM	257	304	-47	-15.5%	✓
8:15AM – 9:15AM	293	339	-46	-13.7%	✓
4:30PM – 5:30PM	207	264	-56	-21.4%	✓
5:30PM – 6:30PM	233	289	-56	-19.4%	✓
Balmain Road (northbound)					
7:15AM – 8:15AM	337	363	-25	-6.9%	✓
8:15AM – 9:15AM	314	344	-30	-8.9%	✓
4:30PM – 5:30PM	301	321	-20	-6.3%	✓
5:30PM – 6:30PM	283	303	-20	-6.7%	✓
Balmain Road (southbound)					
7:15AM – 8:15AM	173	218	-45	-20.8%	✓
8:15AM – 9:15AM	179	221	-42	-18.8%	✓
4:30PM – 5:30PM	178	174	+4	+2.4%	✓
5:30PM – 6:30PM	154	176	-22	-12.4%	✓

Modelled hour	Modelled (s)	Observed (s)	Difference (s)	Difference (%)	Validation
Brighton Street – Douglas Street – Salisbury Road (eastbound)					
7:15AM – 8:15AM	458	457	+1	+0.3%	✓
8:15AM – 9:15AM	444	497	-53	-10.6%	✓
4:30PM – 5:30PM	371	371	0	0.0%	✓
5:30PM – 6:30PM	368	381	-13	-3.4%	✓
Salisbury Road – Douglas Street – Brighton Street (westbound)					
7:15AM – 8:15AM	311	277	+35	+12.5%	✓
8:15AM – 9:15AM	300	278	+23	+8.2%	✓
4:30PM – 5:30PM	321	280	+41	+14.5%	✓
5:30PM – 6:30PM	312	295	+17	+5.8%	✓
Marion Street (eastbound)					
7:15AM – 8:15AM	310	308	+2	+0.6%	✓
8:15AM – 9:15AM	317	333	-16	-4.7%	✓
4:30PM – 5:30PM	223	278	-55	-19.8%	✓
5:30PM – 6:30PM	212	181	+31	+17.0%	✓
Marion Street (westbound)					
7:15AM – 8:15AM	211	199	24	12.5%	✓
8:15AM – 9:15AM	218	213	+5	+2.3%	✓
4:30PM – 5:30PM	206	203	+3	+1.7%	✓
5:30PM – 6:30PM	220	207	+13	+6.1%	✓
Johnston Street (northbound)					
7:15AM – 8:15AM	321	297	+26	+8.7%	✓
8:15AM – 9:15AM	276	299	-23	-7.7%	✓
4:30PM – 5:30PM	261	290	-29	-9.9%	✓
5:30PM – 6:30PM	286	290	-3	-1.2%	✓
Johnston Street (southbound)					
7:15AM – 8:15AM	246	270	-24	-8.9%	✓
8:15AM – 9:15AM	256	303	-47	-15.5%	✓
4:30PM – 5:30PM	313	312	+1	+0.2%	✓
5:30PM – 6:30PM	275	319	-44	-13.8%	✓

Table 5-5 compares the observed and modelled travel time for each segment of each route for each modelled hour. Following the table, **Figure 5-7** to **Figure 5-18** provide a comparison between the modelled and observed travel time for each segment of each route. The results show an acceptable replication of the travel time along each route. Consequently, the Base Models are considered to accurately replicate traffic and congestion patterns along key routes in the study area.

Table 5-5 Modelled versus observed travel time by segment

Segment	AM Peak						PM Peak					
	7:15AM – 8:15AM			8:15AM – 9:15AM			4:30PM – 5:30PM			5:30PM – 6:30PM		
	Modelled (s)	Observed (s)	Difference (s)	Modelled (s)	Observed (s)	Difference (s)	Modelled (s)	Observed (s)	Difference (s)	Modelled (s)	Observed (s)	Difference (s)
Parramatta Road (eastbound)												
1	365	410	-46	400	410	-10	251	239	12	277	299	-22
2	267	264	3	250	286	-36	199	196	3	242	225	17
3	200	238	-38	242	241	1	143	190	-48	165	189	-24
4	283	349	-67	357	448	-91	295	345	-50	266	373	-108
Parramatta Road (westbound)												
1	298	323	-26	294	365	-71	371	370	1	319	388	-69
2	203	202	1	223	248	-26	186	196	-10	237	234	3
3	125	128	-3	129	155	-26	160	149	11	143	142	1
4	210	212	-2	187	199	-12	200	193	7	234	241	-7
Crystal Street (northbound)												
1	71	54	17	88	57	31	70	44	26	60	44	16
2	102	94	8	97	94	2	145	165	-19	119	173	-54
Crystal Street (southbound)												
1	144	174	-29	169	212	-43	100	158	-58	94	167	-73
2	112	130	-18	124	128	-3	107	106	2	139	122	17
Balmain Road (northbound)												
1	123	126	-2	149	164	-15	108	127	-19	114	129	-15
2	91	95	-5	81	92	-11	100	92	9	61	79	-18
3	123	141	-18	84	89	-5	93	102	-9	108	96	12
Balmain Road (southbound)												
1	54	81	-27	55	69	-13	66	78	-12	65	74	-9
2	119	137	-18	124	152	-28	112	96	16	90	103	-13

Segment	AM Peak						PM Peak					
	7:15AM – 8:15AM			8:15AM – 9:15AM			4:30PM – 5:30PM			5:30PM – 6:30PM		
	Modelled (s)	Observed (s)	Difference (s)	Modelled (s)	Observed (s)	Difference (s)	Modelled (s)	Observed (s)	Difference (s)	Modelled (s)	Observed (s)	Difference (s)
Brighton Street – Douglas Street – Salisbury Road (westbound)												
1	218	146	72	196	147	49	176	149	27	168	137	30
2	72	82	-11	63	82	-19	55	67	-12	56	73	-17
3	116	163	-46	137	185	-48	103	111	-9	107	124	-17
4	52	66	-14	47	82	-35	38	45	-7	37	47	-10
Salisbury Road – Douglas Street – Brighton Street (eastbound)												
1	31	31	-1	30	33	-2	40	33	7	42	36	6
2	113	103	10	109	100	8	99	98	1	103	106	-3
3	101	61	41	96	62	34	113	65	48	95	69	26
4	33	38	-5	33	39	-6	33	38	-5	33	38	-5
5	33	43	-10	33	44	-11	35	46	-11	39	46	-7
Marion Street (eastbound)												
1	149	167	-18	141	169	-28	112	120	-8	98	92	6
2	160	141	19	177	164	13	111	158	-47	114	90	25
Marion Street (westbound)												
1	121	96	26	121	114	8	114	116	-2	132	113	19
2	90	92	-2	96	99	-3	92	87	5	88	95	-6
Johnston Street (northbound)												
1	71	83	-12	68	88	-21	69	85	-16	73	78	-5
2	47	44	4	49	55	-5	34	54	-19	59	49	10
3	203	169	34	159	156	3	158	151	7	154	163	-8
Johnston Street (southbound)												
1	128	142	-14	134	165	-31	139	152	-13	141	143	-1
2	30	33	-3	28	34	-6	60	32	28	36	33	3
3	88	95	-7	95	105	-10	114	128	-14	98	143	-45

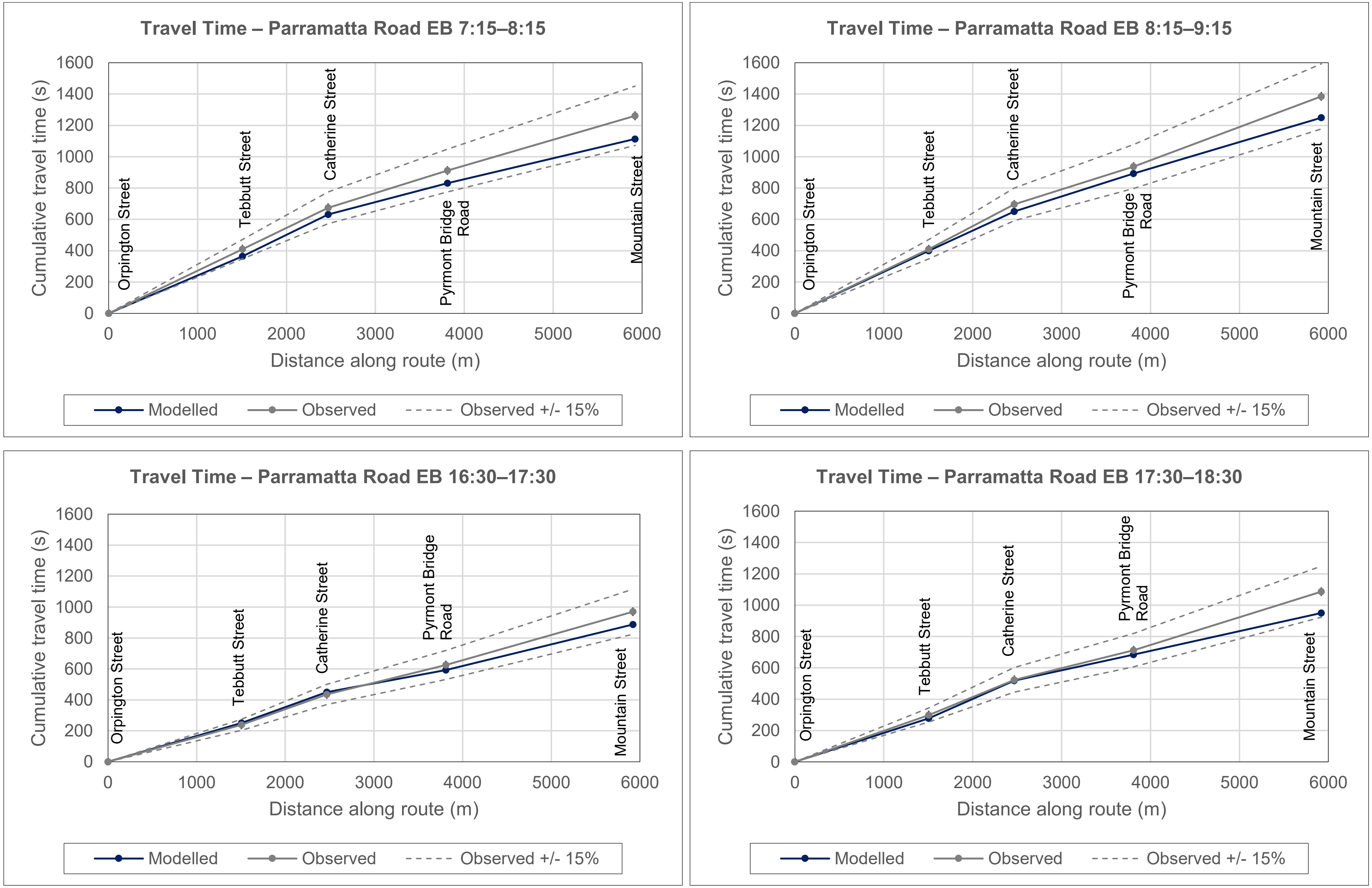


Figure 5-7 Travel times on Parramatta Road (eastbound)

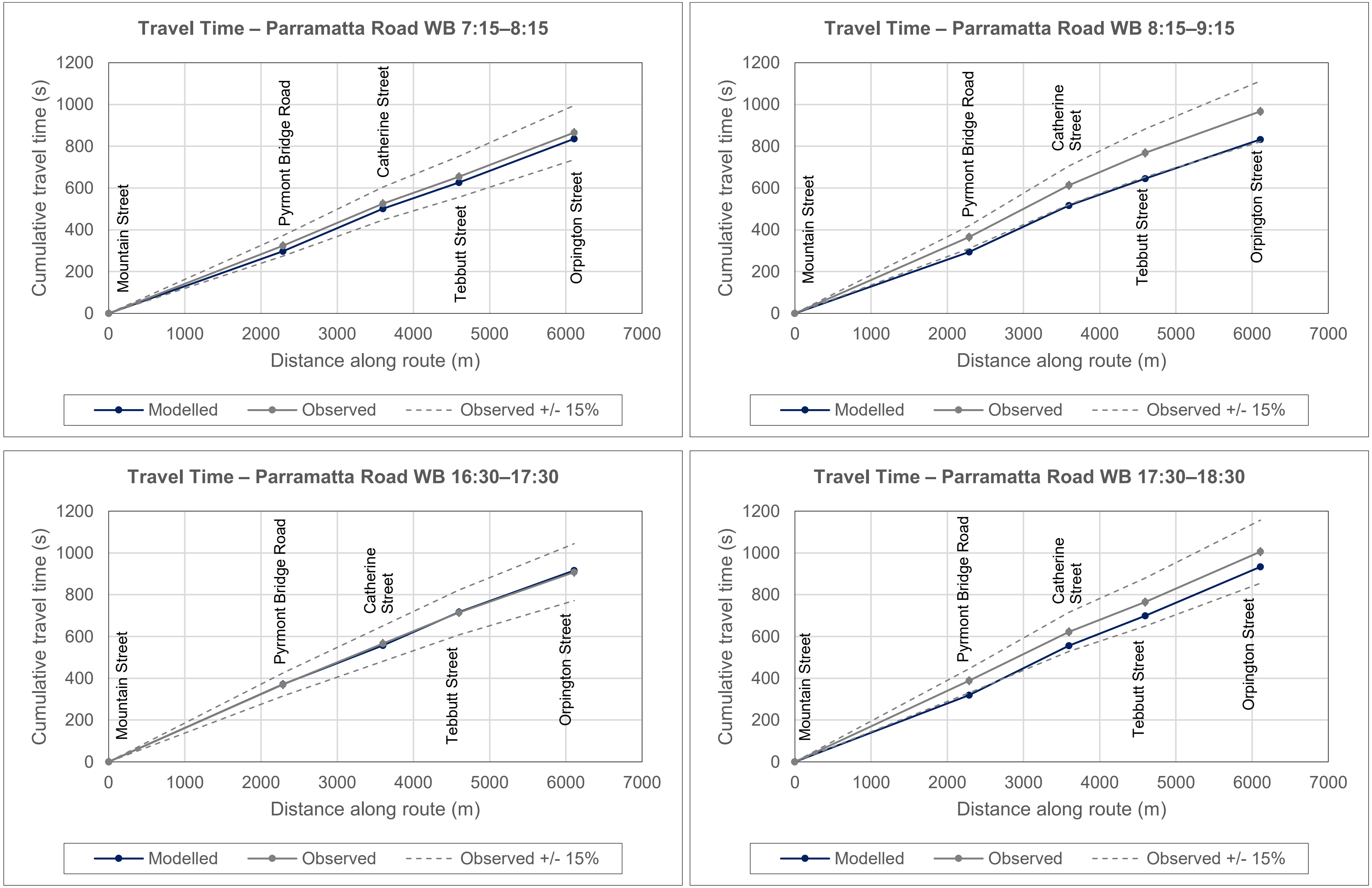


Figure 5-8 Travel times on Parramatta Road (westbound)

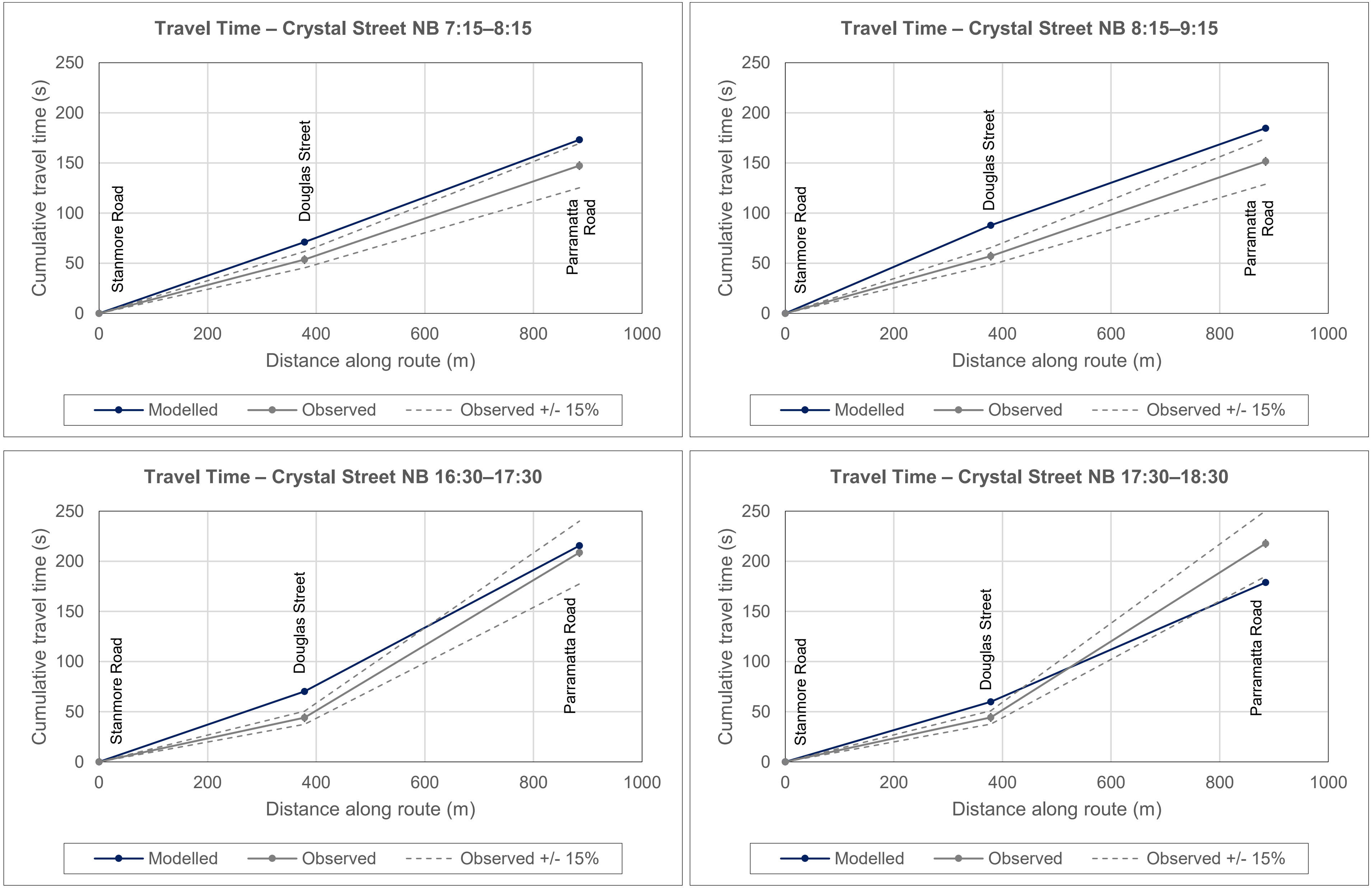


Figure 5-9 Travel times on Crystal Street (northbound)

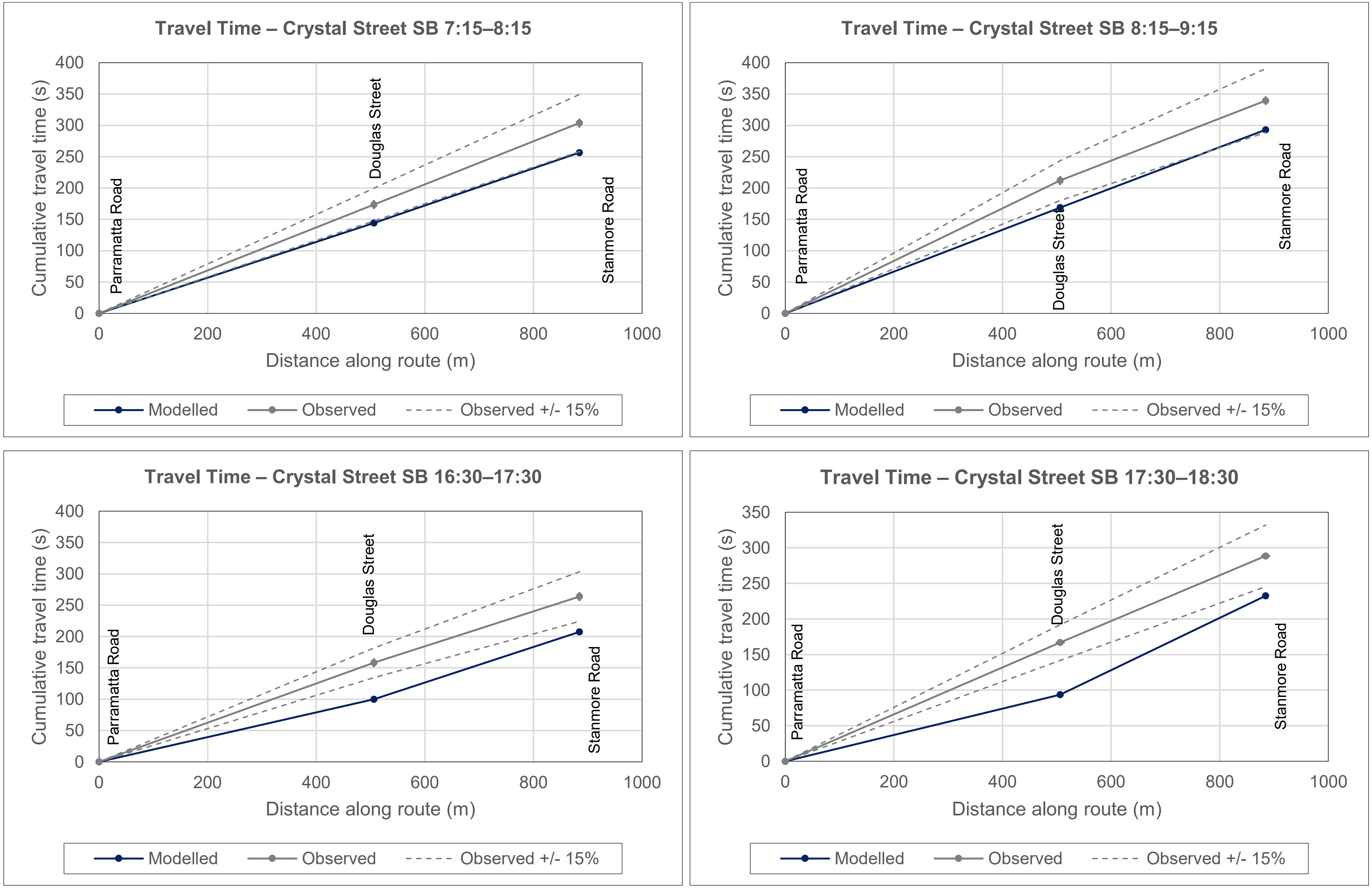


Figure 5-10 Travel times on Crystal Street (southbound)

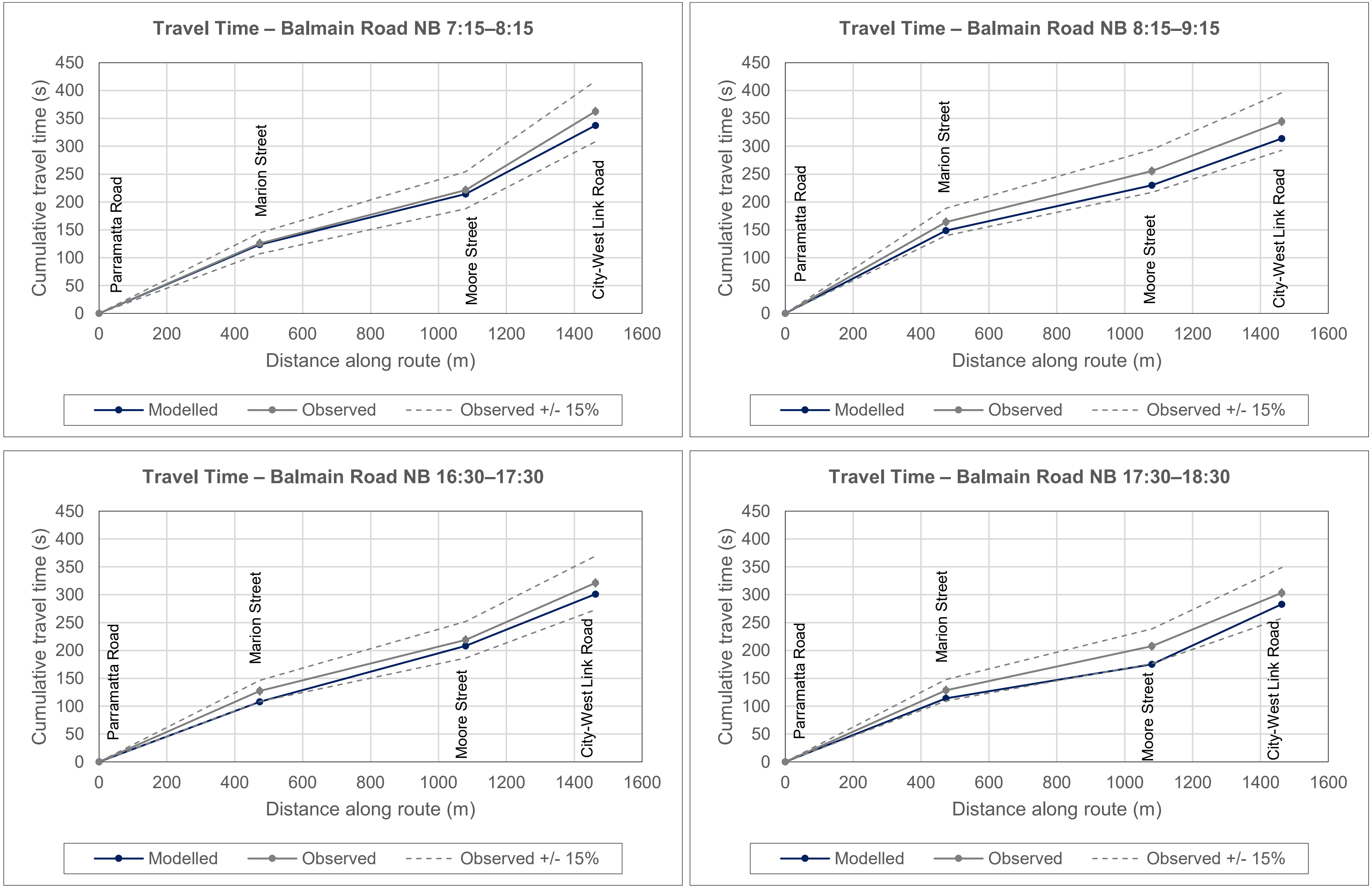


Figure 5-11 Travel times on Balmain Road (northbound)

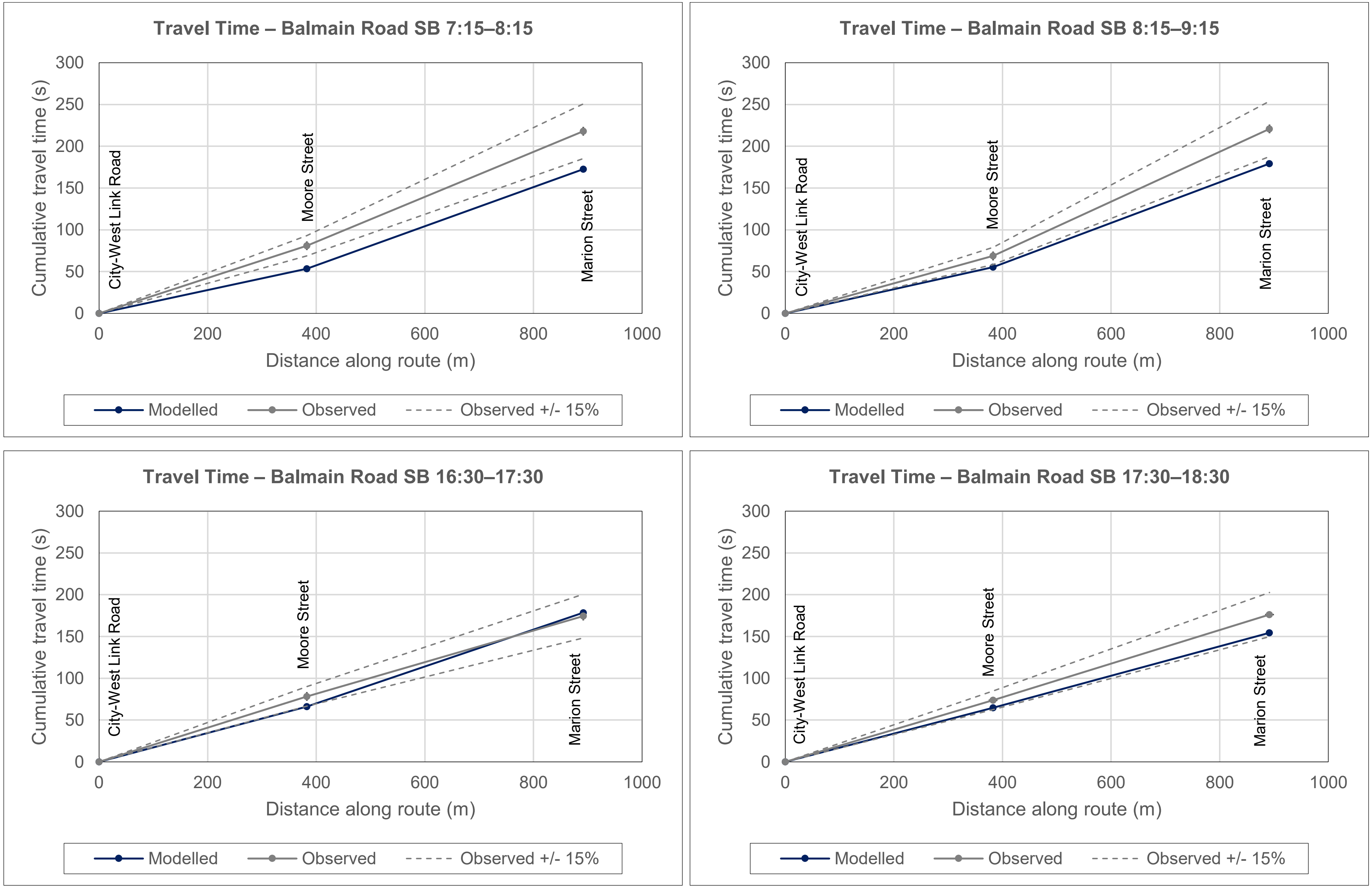


Figure 5-12 Travel times on Balmain Road (southbound)

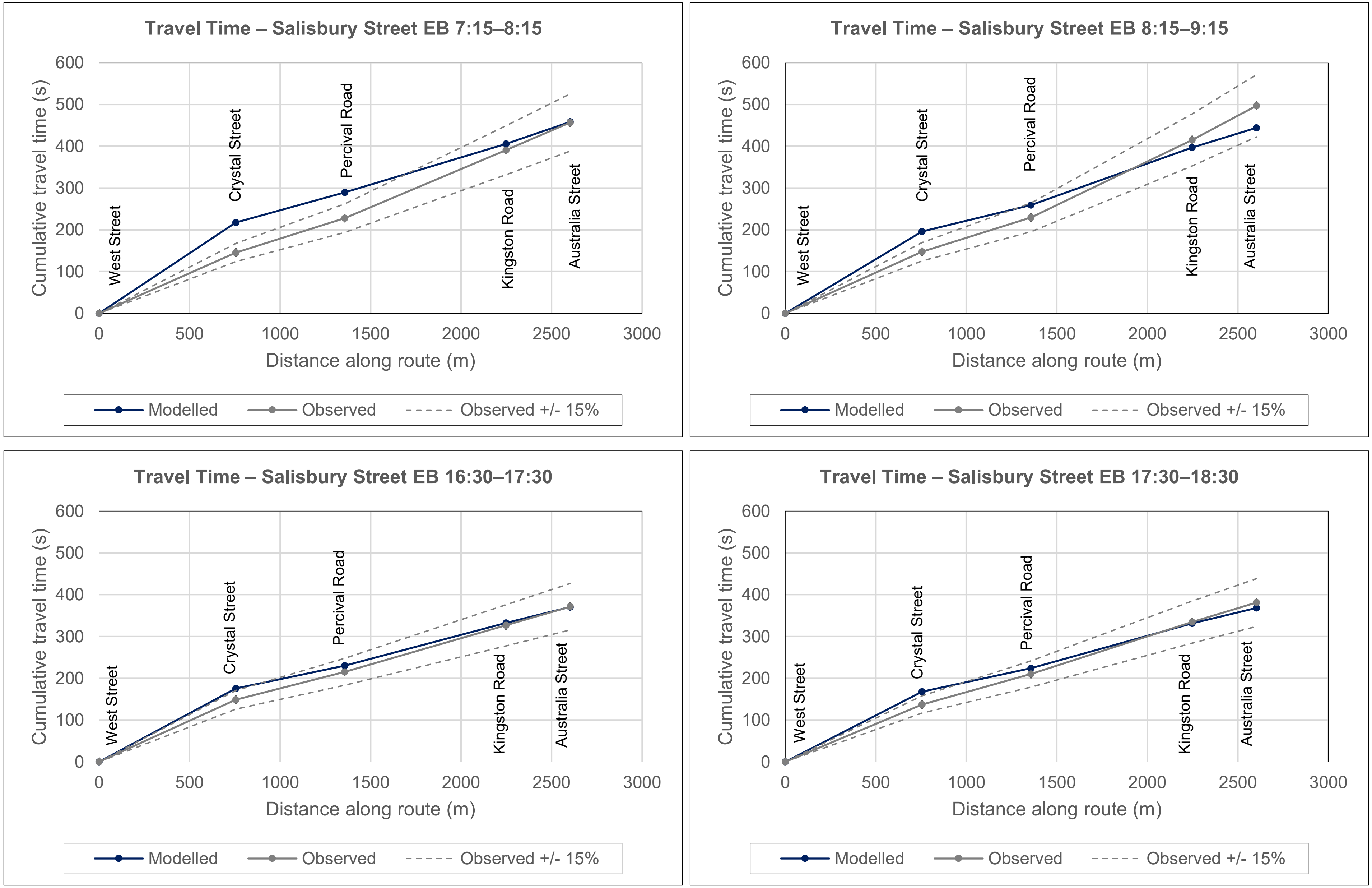


Figure 5-13 Travel times on Salisbury Street (eastbound)

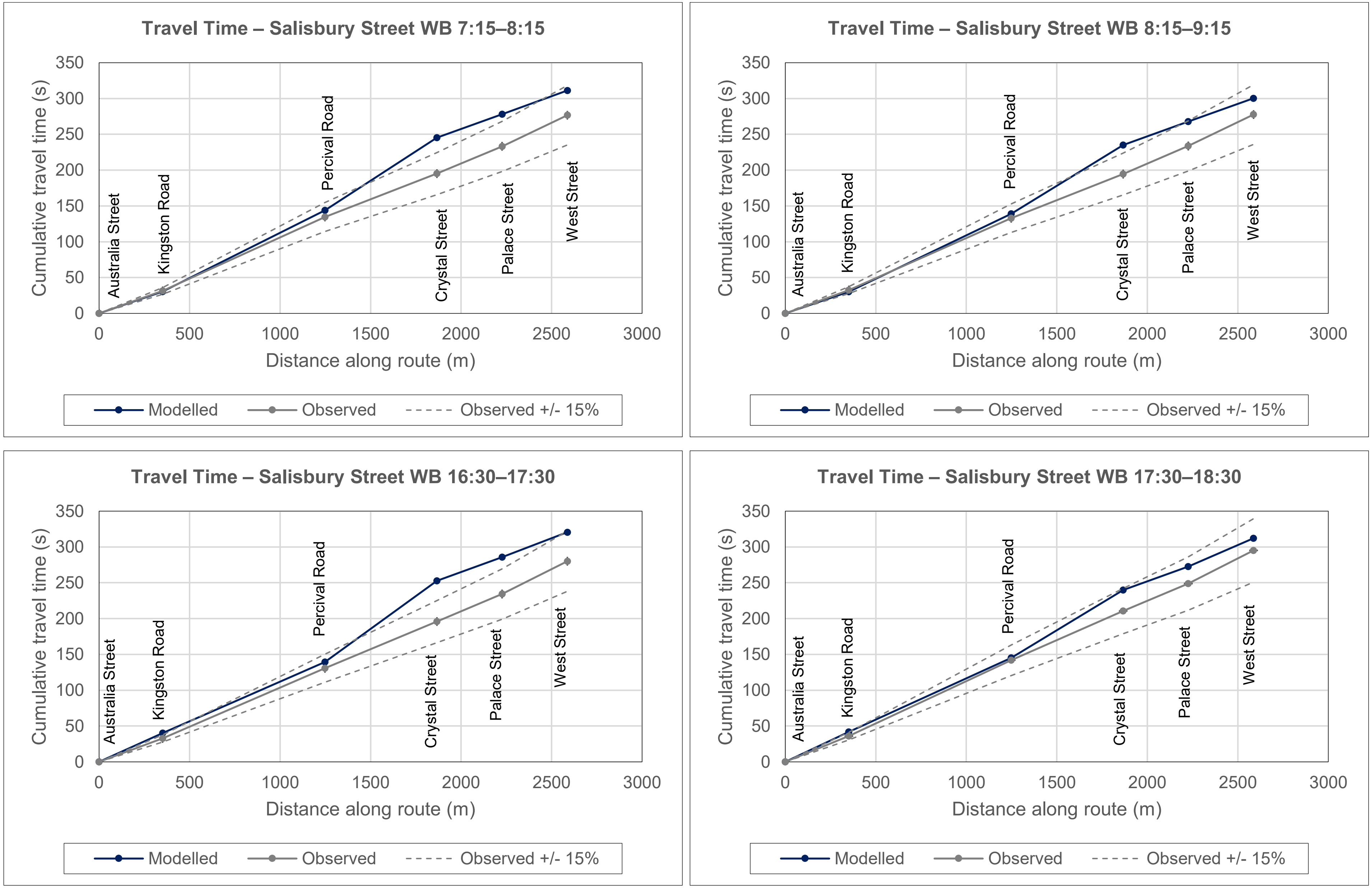


Figure 5-14 Travel times on Salisbury Street (westbound)

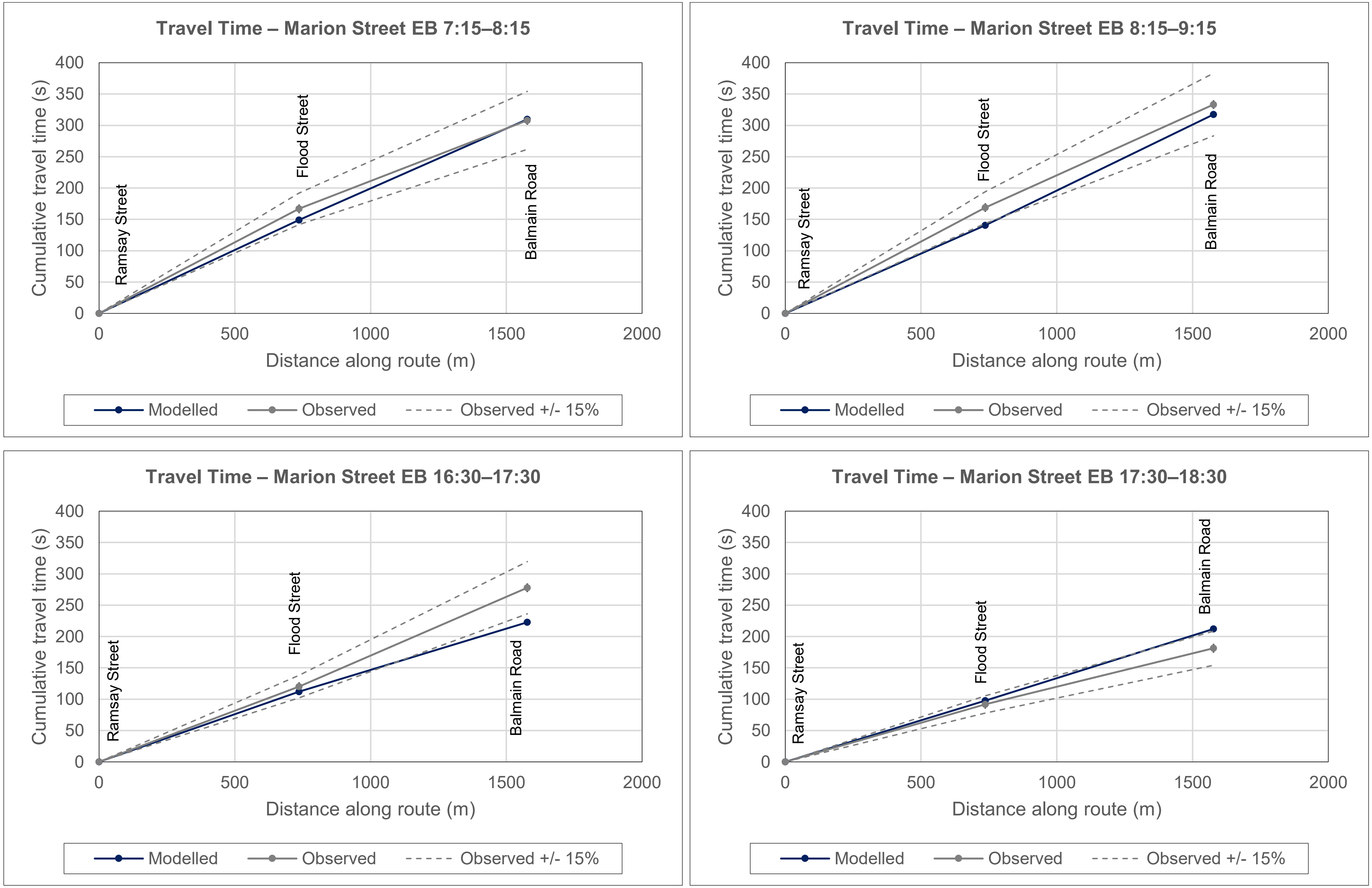


Figure 5-15 Travel times on Marion Street (eastbound)

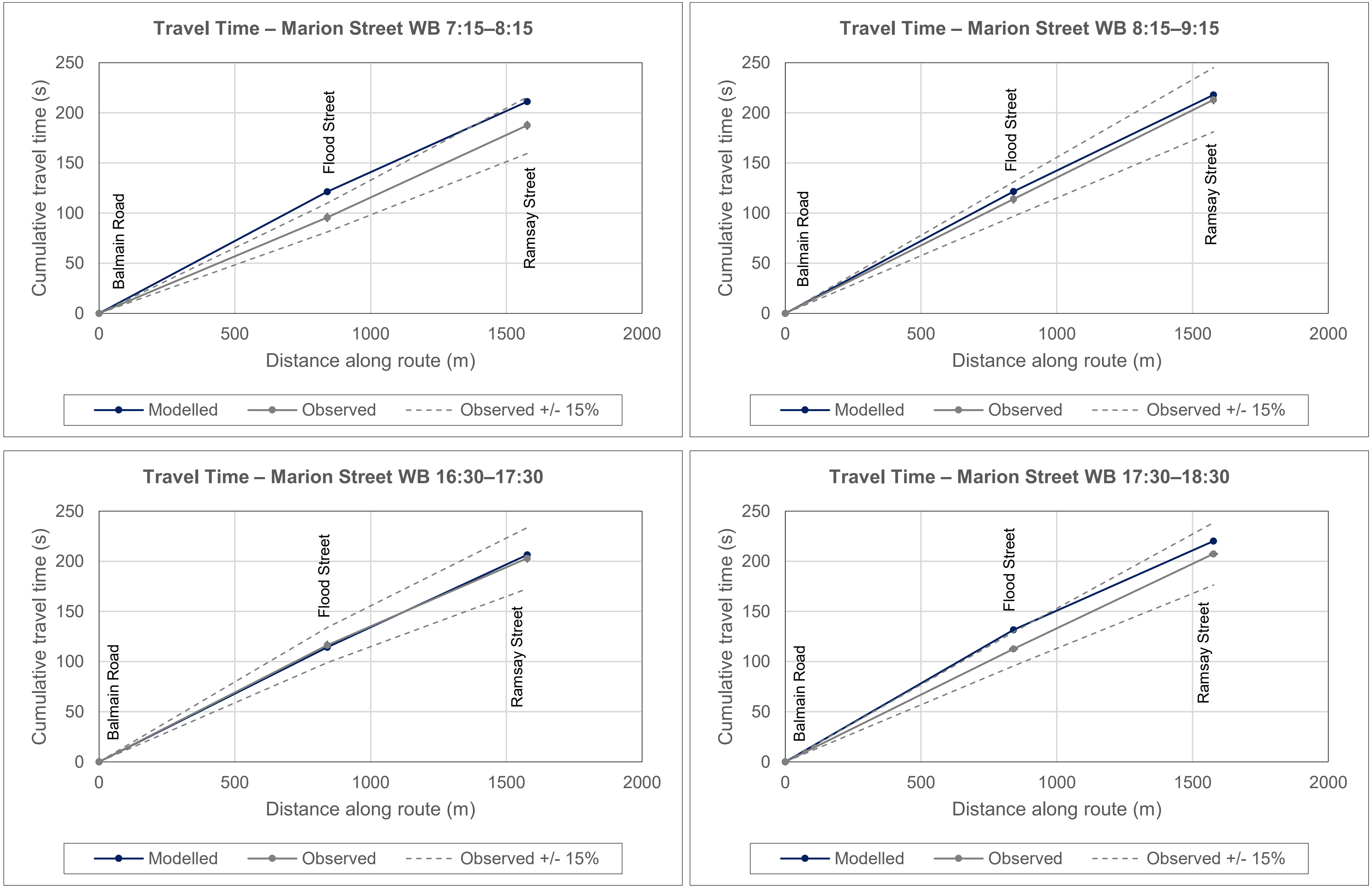


Figure 5-16 Travel times on Marion Street (westbound)

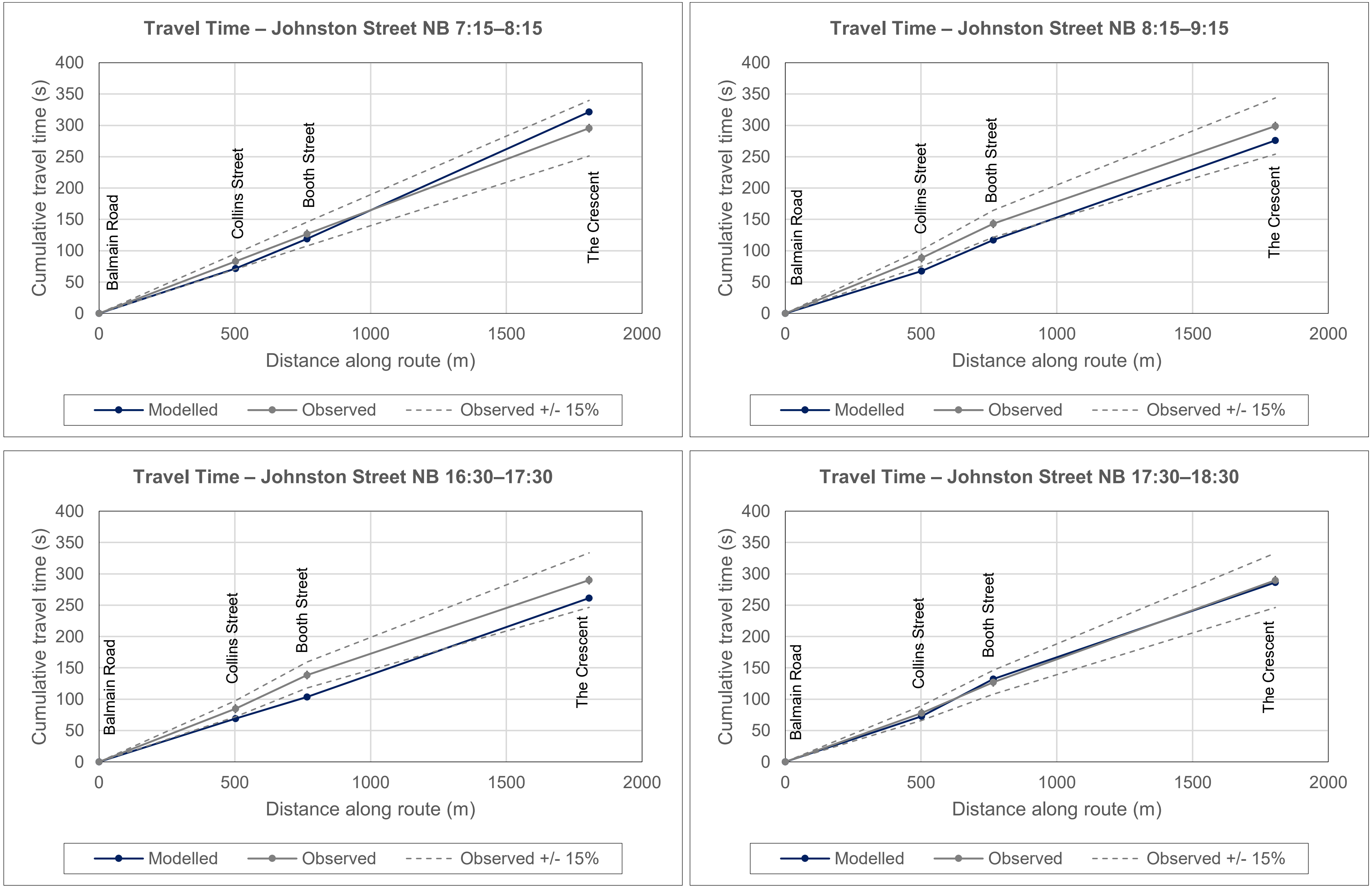


Figure 5-17 Travel times on Johnston Street (northbound)

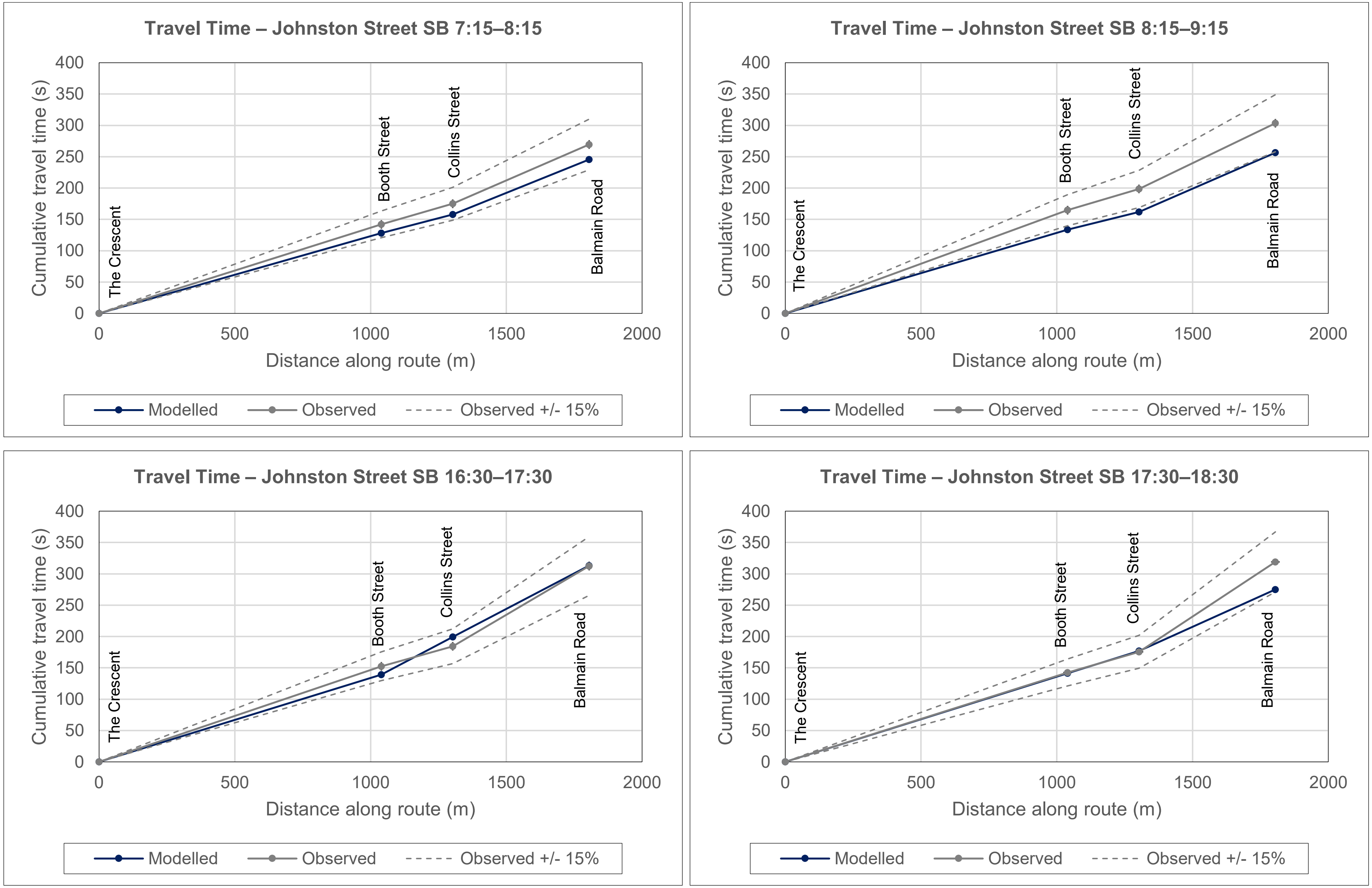


Figure 5-18 Travel times on Johnston Street (southbound)

Table 5-6 shows segments where the modelled travel time was significantly outside the recommended 15 per cent tolerance and provides an explanation for each instance.

Table 5-6 Segments with travel times exceeding 15 per cent of the observed value

Route	Segment	Applicable modelled hours	Notes
Crystal Street (southbound)	1	5:30PM – 6:30PM	Travel time is underrepresented on Crystal Street in the southbound direction in the second hour of the PM Peak. This is attributable to frictional effects of parking and driveways that are not considered in the model. On-street parking is permitted on Crystal Street after 6:00PM.
Salisbury Road (westbound)	2	7:15AM – 8:15AM 8:15AM – 9:15AM 4:30PM – 5:30PM	Travel times were generally overestimated on this segment of Salisbury Road in the westbound direction. In the model this is likely caused by queueing on Crystal Street in the southbound direction that was necessary to meet observed travel times in both the AM and PM peaks.

5.3.2 Travel time variability

Figure 5-19, **Figure 5-20**, **Figure 5-21** and **Figure 5-22** show a comparison between the modelled and observed travel times on each route. The bars show the 10th and 90th percentile for both the modelled (calculated based on the standard deviation assuming a normal distribution of travel times) and observed (extracted from TomTom travel time data).

Traffic Modelling Guidelines (Roads and Maritime Services, 2013) recommends the use of the 5th/95th percentile for this comparison. Cardno has used the 10th/90th percentile due to a small number of significant outliers in the TomTom data that are likely caused by parking manoeuvres, stopped vehicles and pedestrians.

The graphs indicate that all modelled travel times fit within the 10th and 90th percentile of the observed data for all routes. For all routes the modelled percentiles were within the observed percentiles. This is because the TomTom data captures vehicles circulating for on-street parking, parking manoeuvres and vehicles that are stopped for short periods of time.

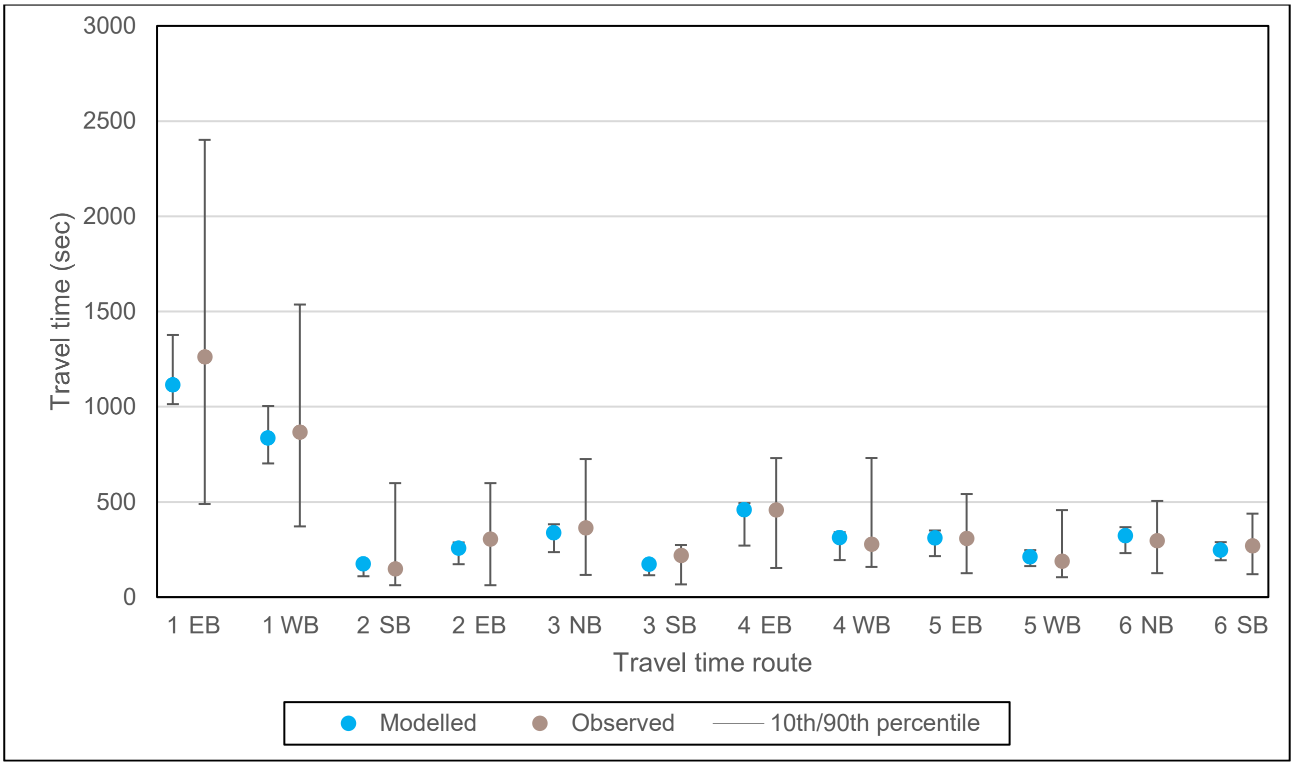


Figure 5-19 Travel time variability (7:15AM – 8:15AM)

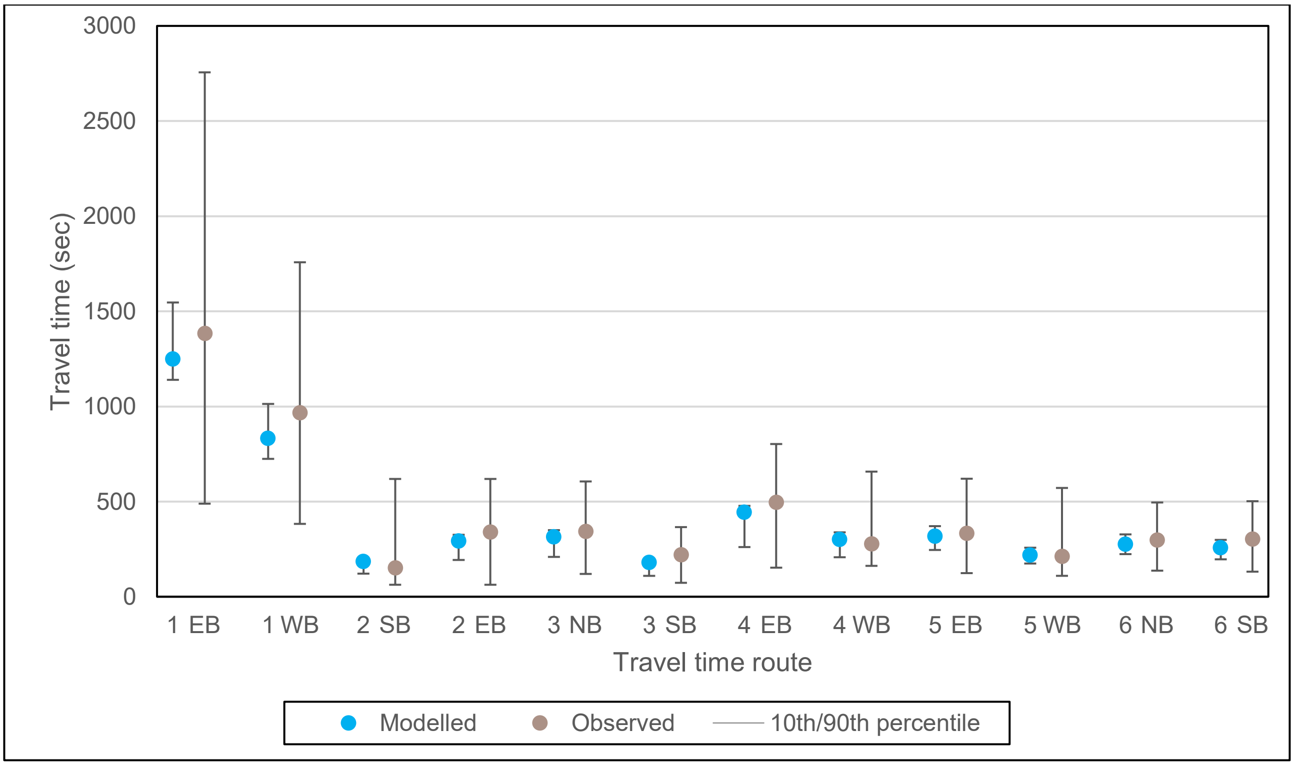


Figure 5-20 Travel time variability (8:15AM – 9:15AM)

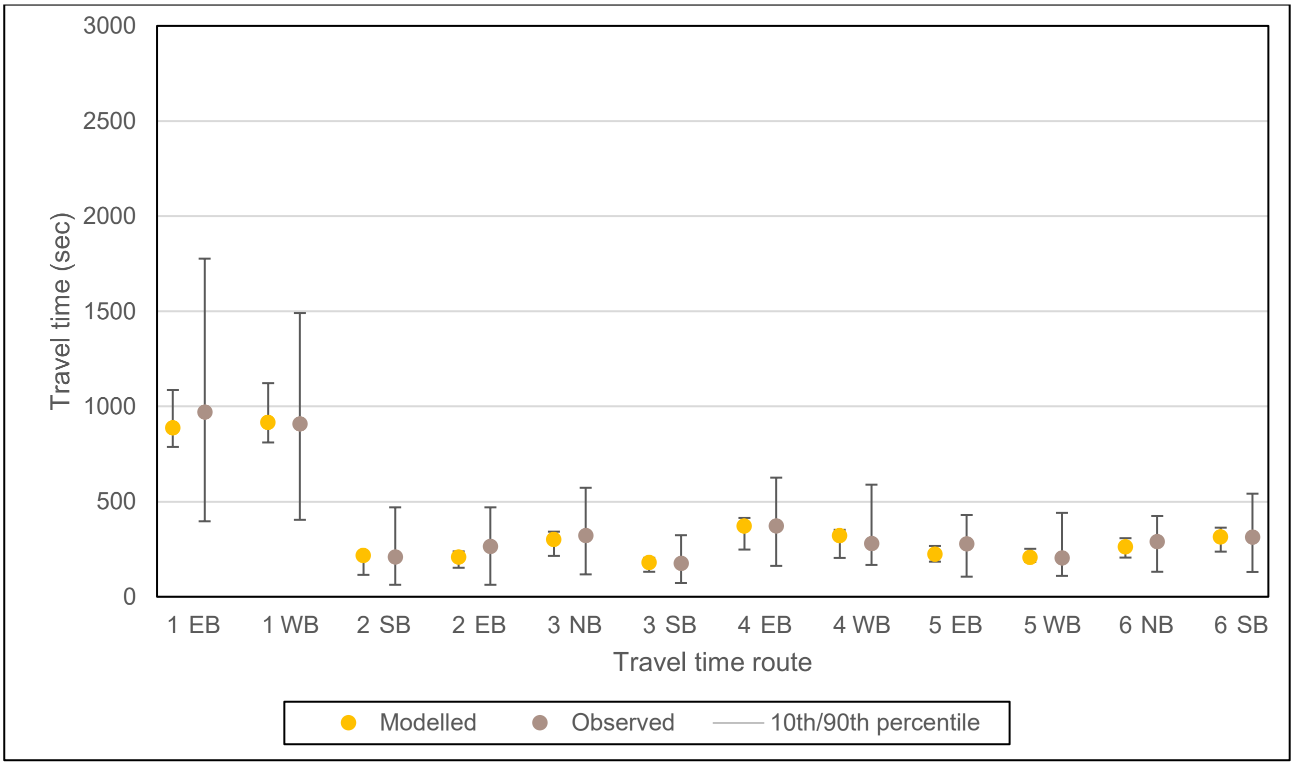


Figure 5-21 Travel time variability (4:30PM – 5:30PM)

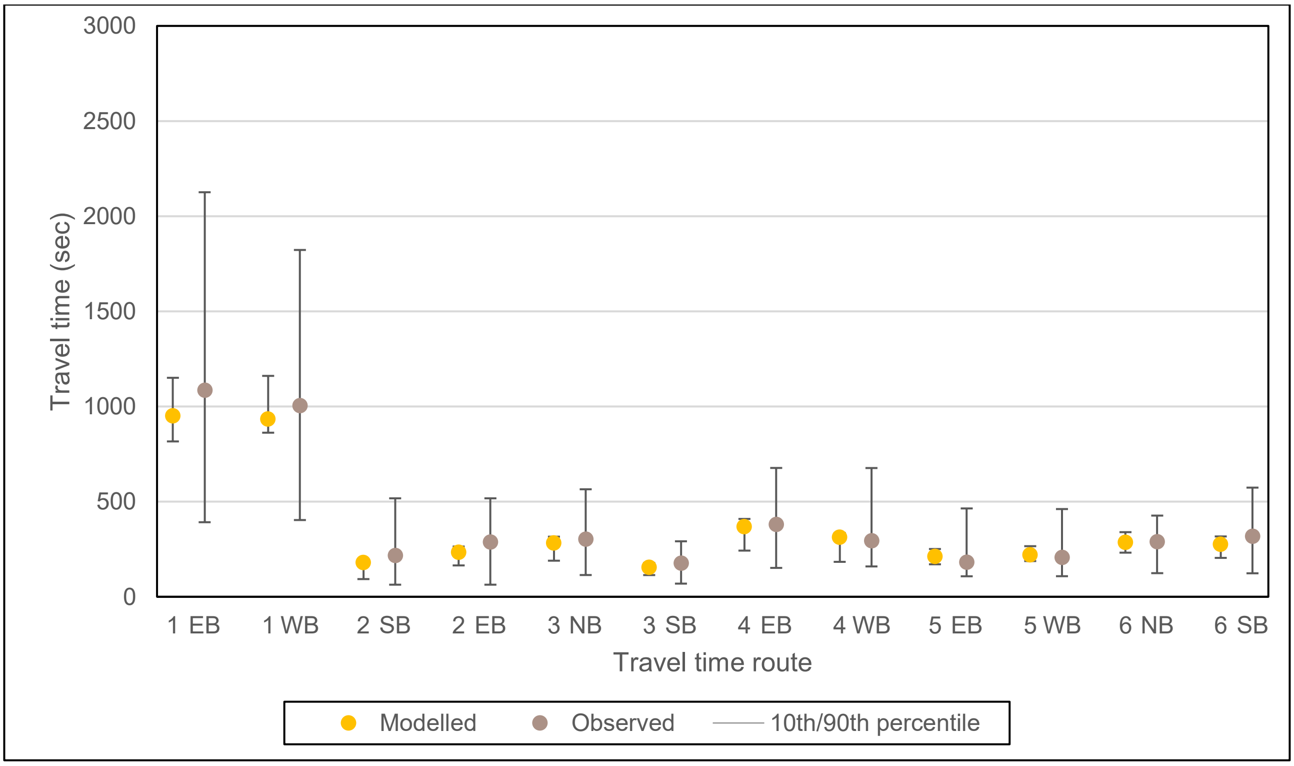


Figure 5-22 Travel time variability (5:30PM – 6:30PM)

5.3.3 Signal timing validation

Cycle times were coded in the model based on historical cycle times from SCATS data. Phase times were based on historical phase times scaled proportionally to account for reduced call frequency of some phases. All signals were coded as fixed so all phases were called in each cycle. Offsets were calculated based on the signal LX files and were applied to the model to ensure realistic coordination between adjacent intersections.

5.3.4 Congestion hotspot validation

Figure 5-23 and **Figure 5-24** show a comparison between the observed and modelled average speed on key links. The model generally shows an adequate replication of observed speeds on key routes.

In the AM Peak:

> There is good correlation between the modelled and observed speeds on Parramatta Road in the eastbound (peak) direction. The most congested sections in the model are approaching West Street and Catherine Street. The model also replicates slow-moving vehicles at the Parramatta Road / City Road intersection on the eastern extent of the study area

> In the opposite direction, the model generally replicates observed average speeds along Parramatta Road with the modelled speed typically between 40 and 50 kilometres per hour which is consistent with the data from TomTom

> Slow-moving vehicles on Victoria Road and on the approaches to Victoria Road from the north (Rozelle) are well-replicated in the model with both modelled and observed average speeds being about 20-30 kilometres per hour

> The model also mostly replicates congestion on City-West Link Road approaching the Anzac Bridge and there is good correlation between average speeds on James Street approaching City-West Link Road

> Most congestion is well-replicated on north-south routes between Parramatta Road and City-West Link Road including on Johnston Street, Catherine Street and Balmain Road

> Slow-moving vehicles on Booth Street approaching Wigram Street and Pyrmont Bridge Road are also replicated in the model

> The model appears to over-estimate the number of slow-moving vehicles on Crystal Street with apparently more queueing approaching Stanmore Road than was observed. However, as the TomTom data is the aggregate of vehicles in both directions, and this route was validated using directional travel time data, it is considered to be an accurate representation of average speeds on Crystal Street

In the PM Peak:

> There is good correlation between the modelled and observed speeds on Parramatta Road in the westbound (peak) direction. The model replicates slow-moving vehicles around City Road as well as congestion on Parramatta Road approaching Johnston Street and Catherine Street

> In the opposite direction, there is good correlation between the modelled and observed speeds with congestion replicated in key locations including approaching West Street, Catherine Street and City Road

> Queueing on Victoria Road and on the approaches to Victoria Road from the north (Rozelle) is captured in the model with observed and modelled speeds being between 20 and 40 kilometres per hour

> The model also mostly replicates congestion on City-West Link Road with queueing approaching Victoria Road in the westbound direction and approaching James Street, but mostly free-flowing traffic between these intersections

> Congestion is mostly well-replicated on north-south routes between Parramatta Road and City-West Link Road including on Johnston Street, Catherine Street and Balmain Road

> Slow-moving vehicles on Booth Street approaching Wigram Street and Pyrmont Bridge Road are also replicated in the model.

As noted in **Section 2.3**, for minor roads the TomTom data is the aggregate of both directions, so in some locations the average speed may appear higher in the observed plot than the modelled outputs. Notwithstanding, the model appears to replicate the observed average speeds on key links including Parramatta Road, City-West Link Road and Victoria Road.

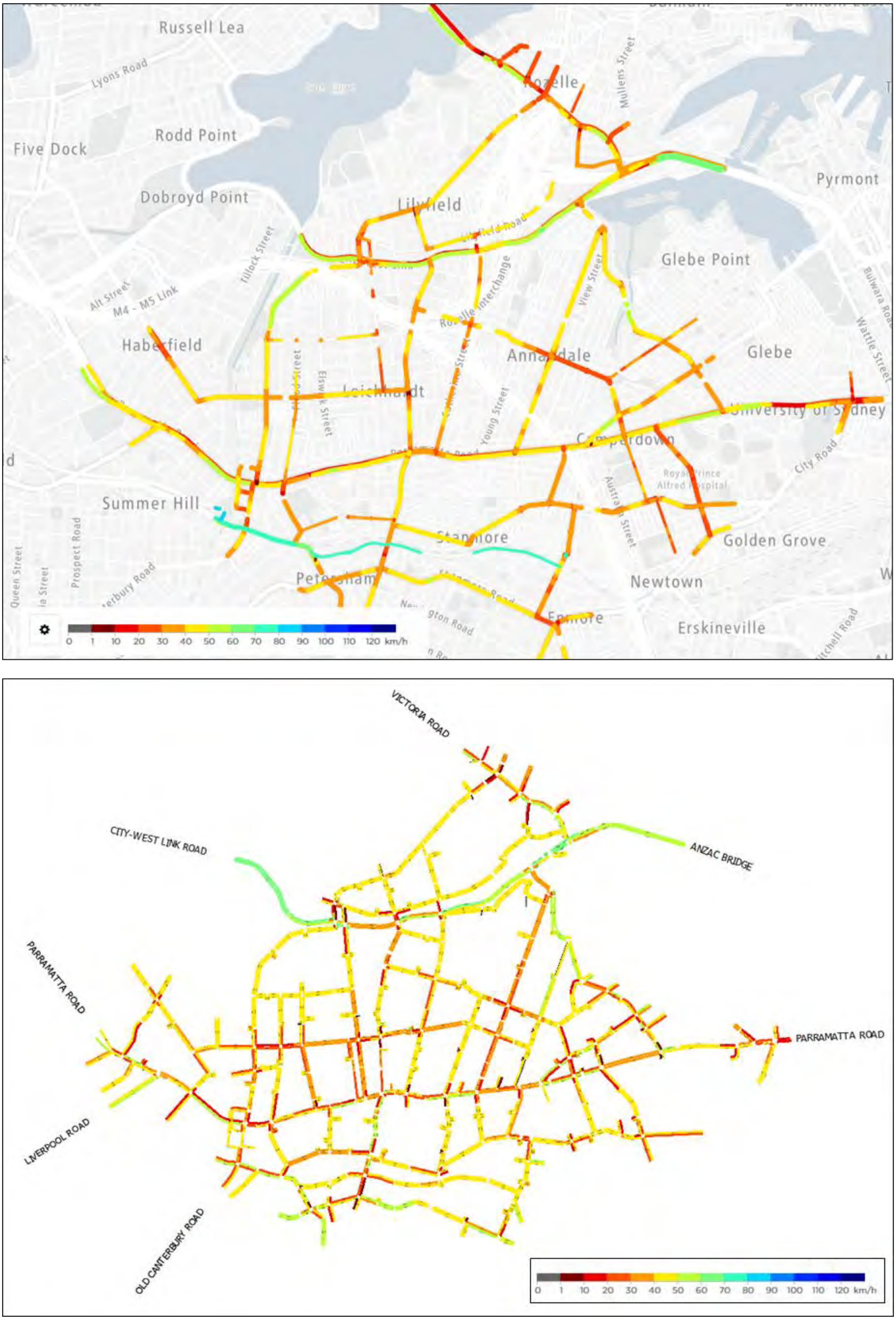
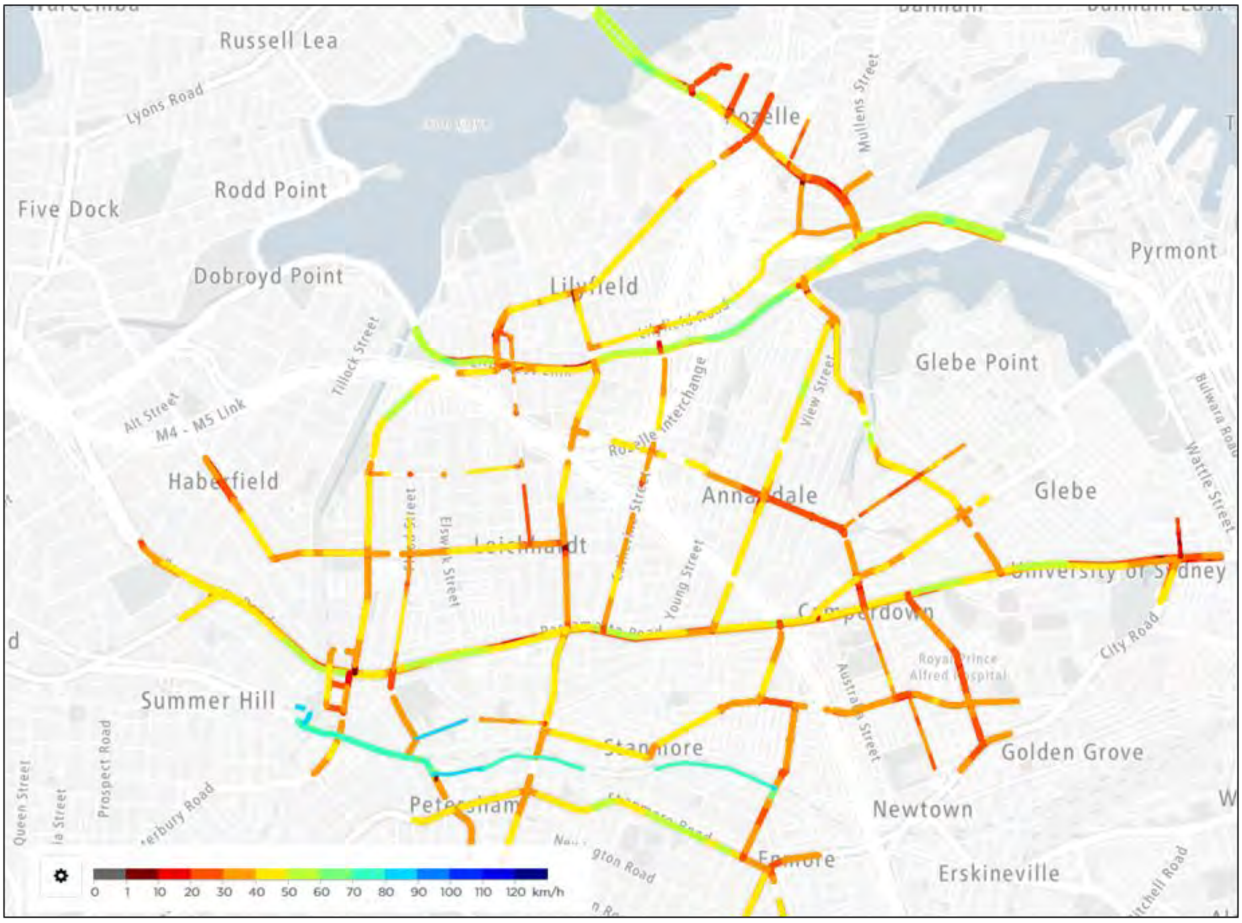


Figure 5-23 Observed (top) and modelled (bottom) average speed plots (AM Peak)



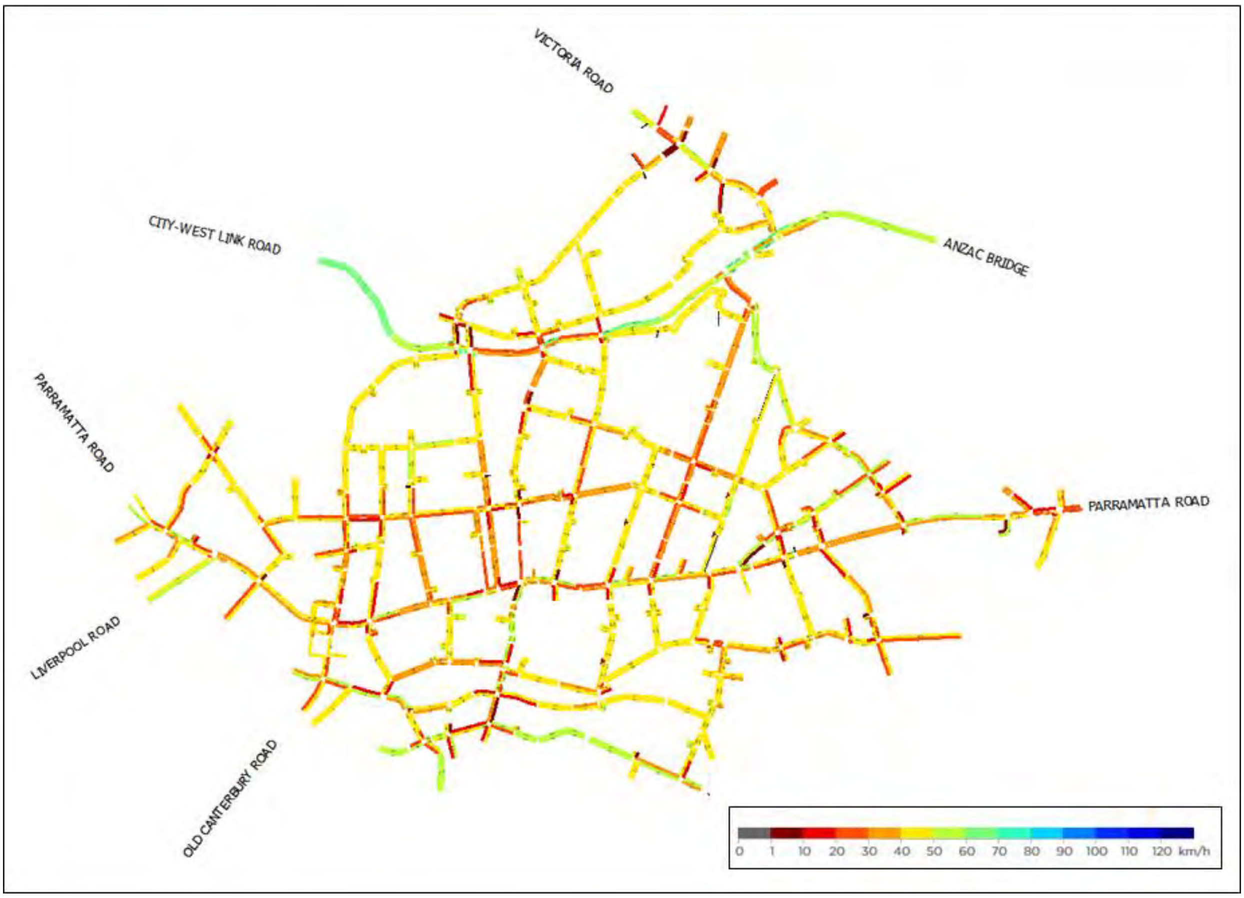


Figure 5-24 Observed (top) and modelled (bottom) average speed plots (PM Peak)

6 Model limitations

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

- Fixed signal timings were used in the Base Models due to the size and complexity of the network. Control plans were coded in 15-minute intervals in the microsimulation area and one-hour intervals in the mesoscopic simulation area
- Signal timings were adjusted to meet minimum green time requirements and include pedestrian walk times at major intersections
- Empty running buses were not included in the model as the GTFS data used to code public transport does not include these vehicles
- The modelled road network does not include all the roads and intersections within 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
- The model should not be used to assess intersections that were not calibrated to the survey data
- Consideration for pedestrians was limited to an intersection level. Pedestrian walk times were included at signalised intersections
- Cyclist volumes and infrastructure were not considered in the model
- The impact of congestion on Broadway in the eastbound direction outside the study area (represented by dummy signals in the Base Model) should be considered in future options
- The models do not consider the impact of on-street parking.

7 Conclusions

This report documents the development of the hybrid microscopic-mesoscopic model for the Parramatta Road Corridor Urban Transformation Study (PRCUTS) project.

The existing traffic conditions were analysed from traffic data collected in October 2018, SCATS historical timings and TomTom travel time data. Strategic demands were extracted from the Sydney Traffic Forecasting Model (STFM) and used as the starting point for demand estimation for the Base Models. These were adjusted manually and using the matrix adjustment procedures available in Aimsun to match the observed traffic counts.

The Base Models were calibrated to represent two peaks:

> Wednesday 17 October 2018, 7:15AM – 9:15AM

> Wednesday 17 October 2018, 4:30PM – 6:30PM.

The Base Models were developed in accordance with the relevant traffic modelling guidelines for NSW. 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:

> Acceptable calibration of the microsimulation area with greater than 89 per cent of turns having a GEH less than five in the AM Peak and greater than 90 per cent in the PM Peak

> Twelve turns had a GEH greater than 10 across the four modelled hours, representing less than one per cent of the total number of count locations for each peak. All turns with GEH greater than 10 were outside the microsimulation area

> High statistical correlation between modelled and observed turning volumes with $R^2 > 0.98$ across all modelled hours

> Modelled travel time on key routes fits well with the observed data.

The Base Models are 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.

These models are designed to assist DPIE, TfNSW, IWC and other relevant stakeholders in understanding the current operation of the Parramatta Road corridor, and future planning to support land use changes along the corridor in the future.

APPENDIX

A

GEH SUMMARY

Turn Name	Aimsun ID	Area	AM Peak															
			715-815								815-915							
			LV				HV				LV				HV			
			Modelled	Observed	Difference	GEH	Modelled	Observed	Difference	GEH	Modelled	Observed	Difference	GEH	Modelled	Observed	Difference	GEH
30ST	61436	Meso	101	61	40	4.44	1	0	1	1.41	102	63	39	4.29	0	3	-3	2.45
30ER	61437	Meso	254	246	8	0.51	17	12	5	1.31	203	212	-9	0.62	14	18	-4	1.00
30NT	61438	Meso	61	64	-3	0.38	1	0	1	1.41	68	87	-19	2.16	0	0	0	0.00
30EL	61439	Meso	29	29	0	0.00	1	1	0	0.00	24	38	-14	2.51	0	0	0	0.00
30NL	61440	Meso	867	854	13	0.44	43	38	5	0.79	838	843	-5	0.17	64	34	30	4.29
30SR	61441	Meso	190	190	0	0.00	2	4	-2	1.15	216	176	40	2.86	4	1	3	1.90
29WT	61459	Meso	907	876	31	1.04	25	34	-9	1.66	862	821	41	1.41	30	21	9	1.78
29NL	61460	Meso	13	12	1	0.28	0	0	0	0.00	15	9	6	1.73	0	1	-1	1.41
29SR	61461	Meso	226	181	45	3.15	4	12	-8	2.83	166	191	-25	1.87	8	6	2	0.76
29WL	61462	Meso	39	45	-6	0.93	0	0	0	0.00	29	24	5	0.97	1	0	1	1.41
29ER	61463	Meso	10	9	1	0.32	1	1	0	0.00	9	1	8	3.58	0	0	0	0.00
29ST	61464	Meso	75	95	-20	2.17	2	0	2	2.00	100	88	12	1.24	15	2	13	4.46
29WR	61465	Meso	84	42	42	5.29	0	0	0	0.00	65	55	10	1.29	6	0	6	3.46
29EL	61466	Meso	143	91	52	4.81	7	1	6	3.00	146	163	-17	1.37	3	1	2	1.41
29NT	61467	Meso	96	90	6	0.62	5	0	5	3.16	72	138	-66	6.44	2	3	-1	0.63
31WR	69795	Micro	248	184	64	4.35	8	13	-5	1.54	254	247	7	0.44	16	21	-5	1.16
31SR	69796	Micro	741	644	97	3.69	52	42	10	1.46	618	448	170	7.36	72	34	38	5.22
31WT	69797	Micro	1215	1296	-81	2.29	115	138	-23	2.04	1341	1351	-10	0.27	123	123	0	0.00
76ET	69812	Micro	1133	1130	3	0.09	82	82	0	0.00	1053	979	74	2.32	77	96	-19	2.04
76NR	69813	Micro	110	113	-3	0.28	13	11	2	0.58	105	112	-7	0.67	8	5	3	1.18
76WT	69814	Micro	1418	1388	30	0.80	120	148	-28	2.42	1449	1457	-8	0.21	138	134	4	0.34
76NL	69815	Micro	62	116	-54	5.72	3	1	2	1.41	122	153	-31	2.64	1	7	-6	3.00
76WL	69816	Micro	81	62	19	2.25	11	5	6	2.12	94	59	35	4.00	22	3	19	5.37
76ER	69817	Micro	265	265	0	0.00	11	12	-1	0.29	254	290	-36	2.18	9	6	3	1.10
56WT	70256	Meso	464	441	23	1.08	32	28	4	0.73	501	318	183	9.04	33	18	15	2.97
56NL	70257	Meso	265	122	143	10.28	1	10	-9	3.84	169	147	22	1.75	0	5	-5	3.16
56SR	70258	Meso	75	112	-37	3.83	10	2	8	3.27	79	108	-29	3.00	26	3	23	6.04
56ET	70259	Meso	237	260	-23	1.46	14	9	5	1.47	204	234	-30	2.03	12	17	-5	1.31
56NR	70260	Meso	24	27	-3	0.59	0	1	-1	1.41	20	28	-8	1.63	0	0	0	0.00
56SL	70261	Meso	72	42	30	3.97	0	2	-2	2.00	68	48	20	2.63	0	1	-1	1.41
56ER	70262	Meso	25	19	6	1.28	0	3	-3	2.45	21	29	-8	1.60	0	5	-5	3.16
56WL	70263	Meso	14	12	2	0.55	0	1	-1	1.41	20	19	1	0.23	0	0	0	0.00
56ST	70264	Meso	199	178	21	1.53	11	8	3	0.97	199	193	6	0.43	6	3	3	1.41
56EL	70265	Meso	94	69	25	2.77	5	1	4	2.31	83	73	10	1.13	2	0	2	2.00
56WR	70266	Meso	0	15	-15	5.48	3	1	2	1.41	0	16	-16	5.66	1	2	-1	0.82
56NT	70267	Meso	77	160	-83	7.62	8	7	1	0.37	148	151	-3	0.25	6	6	0	0.00
28NL	71068	Meso	11	12	-1	0.29	1	1	0	0.00	7	17	-10	2.89	0	0	0	0.00
28SR	71069	Meso	110	89	21	2.11	1	5	-4	2.31	88	104	-16	1.63	2	1	1	0.82
28WT	71070	Meso	910	945	-35	1.15	23	23	0	0.00	845	821	24	0.83	35	20	15	2.86
28ST	71071	Meso	370	457	-87	4.28	16	11	5	1.36	452	434	18	0.86	22	18	4	0.89
28WL	71072	Meso	276	207	69	4.44	13	5	8	2.67	288	250	38	2.32	19	8	11	2.99
28EL	71073	Meso	56	60	-4	0.53	0	8	-8	4.00	63	59	4	0.51	0	5	-5	3.16
28NT	71074	Meso	204	283	-79	5.06	16	12	4	1.07	165	291	-126	8.34	9	12	-3	0.93
28WR	71075	Meso	225	272	-47	2.98	10	9	1	0.32	247	266	-19	1.19	14	7	7	2.16
28ET	71076	Meso	245	261	-16	1.01	14	10	4	1.15	203	244	-41	2.74	11	16	-5	1.36
28NR	71077	Meso	40	40	0	0.00	1	2	-1	0.82	42	42	0	0.00	4	3	1	0.53
28SL	71078	Meso	81	62	19	2.25	3	1	2	1.41	94	74	20	2.18	0	2	-2	2.00
39WT	71093	Micro	1654	1666	-12	0.29	136	176	-40	3.20	1781	1727	54	1.29	171	140	31	2.49
39NL	71094	Micro	169	176	-7	0.53	0	10	-10	4.47	192	202	-10	0.71	1	7	-6	3.00
39ET	71095	Micro	1318	1420	-102	2.76	101	88	13	1.34	1260	1197	63	1.80	102	116	-14	1.34
39EL	71097	Micro	209	202	7	0.49	8	10	-2	0.67	210	208	2	0.14	5	4	1	0.47
41ET	71099	Meso	464	492	-28	1.28	16	15	1	0.25	503	464	39	1.77	22	29	-7	1.39
41SL	71100	Meso	47	66	-19	2.53	0	1	-1	1.41	55	47	8	1.12	3	2	1	0.63
41WT	71101	Meso	342	383	-41	2.15	26	21	5	1.03	366	391	-25	1.29	21	23	-2	0.43
41NL	71102	Meso	81	71	10	1.15	33	18	15	2.97	136	60	76	7.68	27	4	23	5.84
41EL	71104	Meso	26	26	0	0.00	1	2	-1	0.82	21	23	-2	0.43	0	3	-3	2.45
41NT	71105	Meso	567	606	-39	1.61	17	22	-5	1.13	497	525	-28	1.24	11	16	-5	1.36
41WL	71106	Meso	58	58	0	0.00	4	2	2	1.15	68	69	-1	0.12	4	4	0	0.00
41ST	71108	Meso	884	948	-64	2.11	19	20	-1	0.23	943	932	11	0.36	23	24	-1	0.21
1NT	73126	Meso	227	209	18	1.22	14	17	-3	0.76	214	263	-49	3.17	16	19	-3	0.72
1EL	73127	Meso	48	59	-11	1.50	9	5	4	1.51	51	67	-16	2.08	13	6	7	2.27
1SL	73128	Meso	250	180	70	4.77	10	15	-5	1.41	232	192	40	2.75	11	11	0	0.00
1ET	73129	Meso	1155	1135	20	0.59	75	67	8	0.95	909	859	50	1.68	90	92	-2	0.21
1ST	73130	Meso	214	234	-20	1.34	7	20	-13	3.54	190	261	-71	4.73	7	17	-10	2.89
1ER	73132	Meso	125	101	24	2.26	18	13	5	1.27	120	129	-9	0.81	8	9	-1	0.34
1NL	73134	Meso	210	156	54	3.99	11	13	-2	0.58	182	148	34	2.65	14	12	2	0.55
23EL	73152	Meso	646	695	-49	1.89	37	34	3	0.50	636	745	-109	4.15	43	39	4	0.62
23NT	73153	Meso	2756	2800	-44	0.83	136	142	-6	0.51	2356	2345	11	0.23	123	127	-4	0.36
23SR	73154	Meso	571	541	30	1.27	37	35	2	0.33	517	617	-100	4.20	33	38	-5	0.84
23NL	73155	Meso	20	44	-24	4.24	0	3	-3	2.45	18	40	-22	4.09	0	1	-1	1.41
23ST	73156	Meso	1249	1212	37	1.05	93	81	12	1.29	1045	1015	30	0.93	105	108	-3	0.29
3NL	73175	Meso	193	198	-5	0.36	11	9	2	0.63	187	202	-15	1.08	3	7	-4	1.79
3WT	73176	Meso	1482	1580	-98	2.50	100	129	-29	2.71	1024	1004	20	0.63	110	89	21	2.11
3NR	73177	Meso	99	86	13	1.35	0	0	0	0.00	110	93	17	1.69	4	7	-3	1.28
3ET	73178	Meso	1264	1238	26	0.74	128	114	14	1.27	1191	1155	36	1.05	109	133	-24	2.18
3SL	73179	Meso	128	176	-48	3.89	26	11	15	3.49	81	150	-69	6.42	22	11	11	2.71
3NT	73180	Meso	256	194	62	4.13	26	17	9	1.94	256	275	-19	1.17	24	23	1	0.21
42ET	73195	Meso	57	54	3	0.40	1	2	-1	0.82	46	49	-3	0.44	1	2	-1	0.82
42SL	73196	Meso	39	34	5	0.83	2	2	0	0.00	40	54	-14	2.04	1	0	1	1.41
42WL	73197	Meso	3	18	-15	4.63	0	0	0	0.00	13	16	-3	0.79	0	0	0	0.00
42ER	73198	Meso	1	14	-13	4.75	3	0	3	2.45	3	7	-4	1.79	4	0	4	2.83
42ST	73199	Meso	329	295	34	1.92	11	8	3	0.97	271	327	-56	3.24	7	13	-6	1.90
42WT	73200	Meso	218	209	9	0.62	9	2	7	2.98	228	250	-22	1.42	4	11	-7	2.56
42NL	73201	Meso	65	50	15	1.98	6	1	5	2.67	59	66	-7	0.89	1	1	0	0.00
42SR	73202	Meso	383	298	85	4.61	25	30	-5	0.95	334	367	-33	1.76	34	16	18	3.60
42WR	73203	Meso	9	35	-26	5.54	0	0	0	0.00	10	39	-29	5.86	5	0	5	3.16
42NT	73204	Meso	183	217	-34	2.40	11	5	6	2.12	158	195	-37	2.79	2	7	-5	2.36
42EL	73205	Meso	6	23	-17	4.46	4	0	4	2.83	10	38	-28	5.72	4	1	3	1.90
63EL	73214	Meso	185	192	-7	0.51	13	5	8	2.67	186	171	15	1.12	2	7	-5	2.36
63WR	73215	Meso	72	51	21	2.68	3	2	1	0.63	57	63	-6	0.77	1	2	-1	0.82
63SR	73216	Meso	246	252	-6	0.38	7	9	-2	0.71	206	253	-47	3.10	4	12	-8	2.83
63WT	73217	Meso	318	381	-63	3.37	8	26	-18	4.37	342	386	-44	2.31	23	23	0	0.00
63SL	73218	Meso	49	46	3	0.44	4	0	4	2.83	55	87	-32	3.80	5	0	5	3.16
63ET	73219	Meso	200	217	-17	1.18	14	23	-9	2.09	248	238	10	0.64	21	19	2	0.45
35SR	73221	Meso	75	82	-7	0.79	9	2	7	2.98	84	99	-15	1.57	3	0	3	2.45
35EL	73223	Meso	3	31	-28	6.79	0	1	-1	1.41	6	23	-17	4.46	1	0	1	1.41
35NT	73224	Meso	138	139	-1	0.08	11	12	-1	0.29	179	153	26	2.02	18	6	12	3.46
35ER	73225	Meso	71	98	-27	2.94	6	16	-10	3.02	83	113	-30	3.03	4	15	-11	3.57
35ST	73226	Meso	258	274	-16	0.98	10	12	-2	0.60	306	307	-1	0.06	21	9	12	3.10
11ET	73238	Meso	282	211	71	4.52	11	8	3	0.97	257	253	4	0.25	7	11	-4	1.33
11SL	73239	Meso	23	39	-16	2.87	7	7	0	0.00	34	65	-31	4.41	4	12	-8	2.83
11NR	73240	Meso	42	32	10	1.64	1	3	-2	1.41	37	51	-14	2.11	1	1	0	0.00
11WT	73241	Meso	849	822	27	0.93	13	19	-6	1.50	807	760	47	1.68	16	13	3	0.79
11SR	73242	Meso	7	33	-26	5.81	1	0	1	1.41	5	24	-19	4.99	6	1	5	2.67
11NL	73243	Meso	105	52	53	5.98	1	0	1	1.41	148	69	79	7.58	4	0	4	2.83
11WR	73244	Meso	145	166	-21	1.68	0	19	-19	6.16	152	164	-12	0.95	5	14	-9	2.92
11EL	73245	Meso	92	123	-31	2.99	0	3	-3	2.45	94	163	-69	6.09	0	1	-1	1.41
11NT	73246	Meso	162	181	-19	1.45	18	21	-3	0.68	165	185	-20	1.51	17	20	-3	0.70
11WL	73247	Meso	71	62	9	1.10	5	7	-2	0.82	57	69	-12	1.51	3	3	0	0.00

11ER	73248	Meso	0	36	-36	8.49	3	0	3	2.45	3	40	-37	7.98	1	1	0	0.00
11ST	73249	Meso	83	97	-14	1.48	10	20	-10	2.58	86	84	2	0.22	8	23	-15	3.81
13ET	73258	Meso	224	206	18	1.23	7	3	4	1.79	205	227	-22	1.50	6	6	0	0.00
13SL	73259	Meso	20	43	-23	4.10	1	1	0	0.00	18	67	-49	7.52	1	1	0	0.00
13NR	73260	Meso	138	157	-19	1.56	5	5	0	0.00	127	187	-60	4.79	1	5	-4	2.31
13WT	73261	Meso	702	665	37	1.42	7	6	1	0.39	721	627	94	3.62	20	6	14	3.88
13SR	73262	Meso	42	24	18	3.13	0	0	0	0.00	43	39	4	0.62	0	0	0	0.00
13NL	73263	Meso	30	18	12	2.45	0	0	0	0.00	30	42	-12	2.00	0	0	0	0.00
13WL	73264	Meso	256	250	6	0.38	8	15	-7	2.06	242	210	32	2.13	6	6	0	0.00
13ER	73265	Meso	23	21	2	0.43	1	1	0	0.00	23	22	1	0.21	0	0	0	0.00
13ST	73266	Meso	207	184	23	1.64	0	5	-5	3.16	176	199	-23	1.68	0	2	-2	2.00
7NL	73268	Meso	49	77	-28	3.53	1	13	-12	4.54	49	67	-18	2.36	1	3	-2	1.41
7SR	73269	Meso	122	182	-60	4.87	1	11	-10	4.08	93	263	-170	12.74	2	7	-5	2.36
7ER	73270	Meso	111	102	9	0.87	9	11	-2	0.63	126	148	-22	1.88	12	13	-1	0.28
7ST	73271	Meso	383	432	-49	2.43	0	9	-9	4.24	334	348	-14	0.76	3	7	-4	1.79
7EL	73272	Meso	115	79	36	3.66	1	6	-5	2.67	108	150	-42	3.70	1	5	-4	2.31
7NT	73273	Meso	100	111	-11	1.07	0	3	-3	2.45	84	122	-38	3.74	0	4	-4	2.83
5SL	73275	Meso	40	25	15	2.63	3	3	0	0.00	56	37	19	2.79	1	4	-3	1.90
5NR	73276	Meso	0	23	-23	6.78	0	2	-2	2.00	0	34	-34	8.25	0	1	-1	1.41
5ET	73277	Meso	166	143	23	1.85	4	14	-10	3.33	181	236	-55	3.81	15	11	4	1.11
5NT	73279	Meso	104	107	-3	0.29	10	2	8	3.27	118	113	5	0.47	4	10	-6	2.27
5EL	73280	Meso	47	25	22	3.67	0	1	-1	1.41	33	37	-4	0.68	2	2	0	0.00
5WL	73281	Meso	49	30	19	3.02	4	4	0	0.00	55	45	10	1.41	5	1	4	2.31
5ST	73282	Meso	65	87	-22	2.52	6	4	2	0.89	66	87	-21	2.40	8	3	5	2.13
5ER	73283	Meso	100	89	11	1.13	10	8	2	0.67	65	75	-10	1.20	13	8	5	1.54
5WT	73284	Meso	280	245	35	2.16	4	21	-17	4.81	256	290	-34	2.06	12	10	2	0.60
5SR	73285	Meso	33	87	-54	6.97	5	3	2	1.00	50	79	-29	3.61	3	1	2	1.41
16NT	73288	Meso	226	265	-39	2.49	10	10	0	0.00	222	247	-25	1.63	6	7	-1	0.39
16EL	73289	Meso	86	77	9	1.00	1	2	-1	0.82	77	75	2	0.23	0	2	-2	2.00
16WR	73290	Meso	130	38	92	10.04	9	1	8	3.58	105	48	57	6.52	9	2	7	2.98
16ST	73291	Meso	536	507	29	1.27	3	9	-6	2.45	483	403	80	3.80	3	9	-6	2.45
16ER	73292	Meso	91	69	22	2.46	0	2	-2	2.00	64	87	-23	2.65	3	1	2	1.41
16WL	73293	Meso	76	69	7	0.82	1	3	-2	1.41	63	97	-34	3.80	1	2	-1	0.82
16SR	73294	Meso	285	192	93	6.02	1	3	-2	1.41	308	207	101	6.29	10	4	6	2.27
16NL	73295	Meso	49	67	-18	2.36	6	11	-5	1.71	60	57	3	0.39	2	8	-6	2.68
16WT	73296	Meso	366	331	35	1.87	7	24	-17	4.32	397	394	3	0.15	17	20	-3	0.70
16SL	73297	Meso	1	40	-39	8.61	1	3	-2	1.41	1	47	-46	9.39	1	2	-1	0.82
16NR	73298	Meso	63	51	12	1.59	4	2	2	1.15	89	88	1	0.11	5	7	-2	0.82
16ET	73299	Meso	235	216	19	1.27	10	12	-2	0.60	229	306	-77	4.71	24	15	9	2.04
15WL	73301	Meso	369	255	114	6.45	1	2	-1	0.82	394	253	141	7.84	10	4	6	2.27
15ST	73302	Meso	454	469	-15	0.70	4	14	-10	3.33	410	388	22	1.10	4	10	-6	2.27
15NR	73303	Meso	68	71	-3	0.36	2	2	0	0.00	64	72	-8	0.97	1	0	1	1.41
15SL	73304	Meso	82	55	27	3.26	7	2	5	2.36	83	73	10	1.13	1	4	-3	1.90
15NT	73305	Meso	225	285	-60	3.76	8	11	-3	0.97	230	279	-49	3.07	6	10	-4	1.41
15WR	73306	Meso	186	221	-35	2.45	1	0	1	1.41	185	216	-31	2.19	4	4	0	0.00
6NR	73315	Meso	42	26	16	2.74	0	1	-1	1.41	24	36	-12	2.19	2	2	0	0.00
6SL	73316	Meso	66	48	18	2.38	0	0	0	0.00	61	81	-20	2.37	1	0	1	1.41
6ET	73317	Meso	145	116	29	2.54	7	6	1	0.39	140	164	-24	1.95	4	2	2	1.15
6WL	73318	Meso	82	42	40	5.08	5	3	2	1.00	109	39	70	8.14	9	1	8	3.58
6ST	73319	Meso	54	73	-19	2.38	8	2	6	2.68	63	92	-29	3.29	3	2	1	0.63
6ER	73320	Meso	2	2	0	0.00	0	0	0	0.00	0	5	-5	3.16	0	0	0	0.00
6WR	73321	Meso	26	4	22	5.68	1	0	1	1.41	18	5	13	3.83	0	0	0	0.00
6NT	73322	Meso	97	134	-37	3.44	9	8	1	0.34	109	112	-3	0.29	4	6	-2	0.89
6EL	73323	Meso	11	8	3	0.97	2	0	2	2.00	14	10	4	1.15	1	1	0	0.00
6WT	73324	Meso	689	712	-23	0.87	2	4	-2	1.15	685	689	-4	0.15	11	5	6	2.12
6NL	73325	Meso	15	3	12	4.00	1	0	1	1.41	17	8	9	2.55	0	0	0	0.00
6SR	73326	Meso	15	11	4	1.11	0	1	-1	1.41	23	10	13	3.20	2	0	2	2.00
18ST	73344	Meso	650	661	-11	0.43	4	11	-7	2.56	572	575	-3	0.13	6	12	-6	2.00
18WL	73345	Meso	62	48	14	1.89	4	1	3	1.90	52	64	-12	1.58	1	5	-4	2.31
18NT	73346	Meso	324	355	-31	1.68	19	24	-5	1.08	341	334	7	0.38	16	21	-5	1.16
18WR	73347	Meso	2	12	-10	3.78	0	2	-2	2.00	4	23	-19	5.17	0	0	0	0.00
18NR	73348	Meso	37	38	-1	0.16	0	2	-2	2.00	47	35	12	1.87	0	2	-2	2.00
18SL	73349	Meso	53	33	20	3.05	0	3	-3	2.45	35	93	-58	7.25	0	1	-1	1.41
75SL	73351	Meso	71	78	-7	0.81	0	0	0	0.00	67	56	11	1.40	0	1	-1	1.41
75ET	73352	Meso	422	452	-30	1.44	17	19	-2	0.47	456	415	41	1.96	21	29	-8	1.60
75EL	73354	Meso	7	12	-5	1.62	0	2	-2	2.00	10	16	-6	1.66	3	2	1	0.63
75WT	73355	Meso	425	445	-20	0.96	60	42	18	2.52	502	443	59	2.71	47	30	17	2.74
75SR	73356	Meso	16	5	11	3.39	0	0	0	0.00	11	6	5	1.71	3	0	3	2.45
22ET	73381	Meso	408	380	28	1.41	11	19	-8	2.07	396	393	3	0.15	15	13	2	0.53
22SL	73382	Meso	141	91	50	4.64	3	7	-4	1.79	98	122	-24	2.29	2	6	-4	2.00
22WT	73383	Meso	810	795	15	0.53	20	24	-4	0.85	831	791	40	1.40	16	22	-6	1.38
22NL	73384	Meso	68	69	-1	0.12	2	3	-1	0.63	73	73	0	0.00	0	1	-1	1.41
22NT	73385	Meso	331	356	-25	1.35	5	10	-5	1.83	387	431	-44	2.18	12	11	1	0.29
22WL	73386	Meso	36	32	4	0.69	3	4	-1	0.53	31	44	-13	2.12	4	2	2	1.15
22ER	73387	Meso	43	29	14	2.33	0	0	0	0.00	27	46	-19	3.14	1	4	-3	1.90
22ST	73388	Meso	139	115	24	2.13	4	3	1	0.53	137	171	-34	2.74	4	5	-1	0.47
67NR	73421	Micro	73	44	29	3.79	0	5	-5	3.16	61	68	-7	0.87	0	5	-5	3.16
67ET	73422	Micro	992	957	35	1.12	93	103	-10	1.01	987	949	38	1.22	114	101	13	1.25
67WL	73423	Micro	33	39	-6	1.00	0	1	-1	1.41	28	39	-11	1.90	0	2	-2	2.00
67ER	73424	Micro	194	160	34	2.56	31	19	12	2.40	206	234	-28	1.89	21	31	-10	1.96
67WT	73425	Micro	1855	1783	72	1.69	141	163	-22	1.78	1892	1909	-17	0.39	152	158	-6	0.48
67NL	73426	Micro	273	239	34	2.13	39	35	4	0.66	304	316	-12	0.68	39	37	2	0.32
66WT	73434	Micro	1740	1619	121	2.95	133	163	-30	2.47	1844	1639	205	4.91	148	122	26	2.24
66NL	73435	Micro	129	88	41	3.94	7	5	2	0.82	113	104	9	0.86	10	6	4	1.41
66ET	73436	Micro	862	783	79	2.75	82	86	-4	0.44	862	836	26	0.89	98	88	10	1.04
66NR	73437	Micro	110	161	-51	4.38	0	4	-4	2.83	147	152	-5	0.41	4	3	1	0.53
66ER	73438	Micro	106	113	-7	0.67	5	5	0	0.00	85	131	-46	4.43	6	8	-2	0.76
66WL	73439	Micro	196	238	-42	2.85	4	4	0	0.00	237	387	-150	8.49	0	8	-8	4.00
78NL	73441	Meso	60	53	7	0.93	0	0	0	0.00	56	93	-37	4.29	5	2	3	1.60
78SR	73442	Meso	61	58	3	0.39	6	7	-1	0.39	87	76	11	1.22	1	8	-7	3.30
78WT	73443	Meso	1795	1815	-20	0.47	127	163	-36	2.99	1945	1919	26	0.59	141	124	17	1.48
78ST	73444	Meso	95	113	-18	1.77	5	3	2	1.00	98	100	-2	0.20	7	4	3	1.28
78WL	73445	Meso	29	14	15	3.23	2	0	2	2.00	27	13	14	3.13	4	1	3	1.90
78EL	73446	Meso	111	127	-16	1.47	0	10	-10	4.47	142	120	22	1.92	2	11	-9	3.53
78NT	73447	Meso	187	192	-5	0.36	6	4	2	0.89	176	164	12	0.92	5	8	-3	1.18
78WR	73448	Meso	150	184	-34	2.63	2	12	-10	3.78	144	214	-70	5.23	7	8	-1	0.37
78ET	73449	Meso	859	776	83	2.90	83	86	-3	0.33	888	800	88	3.03	99	83	16	1.68
78NR	73450	Meso	13	5	8	2.67	4	0	4	2.83	12	10	2	0.60	4	1	3	1.90
78SL	73451	Meso	84	113	-29	2.92	4	9	-5	1.96	81	86	-5	0.55	0	4	-4	2.83
24WL	73460	Meso	63	55	8	1.04	11	2	9	3.53	67	60	7	0.88	7	5	2	0.82
24ER	73461	Meso	128	130	-2	0.18	7	11	-4	1.33	124	147	-23	1.98	22	12	10	2.43
24ST	73462	Meso	187	104	83	6.88	9	2	7	2.98	124	121	3	0.27	8	2	6	2.68
24ET	73463	Meso	234	227	7	0.46	13	9	4	1.21	216	225	-9	0.61	10	15	-5	1.41
24SL	73464	Meso	23	16	7	1.59	2	2	0	0.00	13	14	-1	0.27	0	0	0	0.00
24NL	73465	Meso	289	229	60	3.73	21	27	-6	1.22	300	204	96	6.05	31	16	15	3.09
24WT	73466	Meso	444	508	-64	2.93	17	20	-3	0.70	438	468	-30	1.41	14	18	-4	1.00
24SR	73467	Meso	90	99	-9	0.93	0	0	0	0.00	116	74	42	4.31	1	1	0	0.00
24NT	73468	Meso	378	274	104	5.76	11	3	8	3.02	337	264	73	4.21	18	11	7	1.84
24EL	73469	Meso	29	59	-30	4.52	0	0	0	0.00	38	56	-18	2.63	3	2	1	0.63
64WL	73471	Micro	483	572	-89	3.88	29	23	6	1.18	480	503	-23	1.04	26	25	1	0.20
64NL	73472	Micro	0	17	-17	5.83	0	1	-1	1.41	4	18	-14	4.22	0	1	-1	1.41
64WT	73473	Micro	1871	1843	28	0.65	134	163	-29	2.38	1948	1944	4	0.09	141	128	13	1.12
64NR	73474	Micro	224	226	-2	0.13	11	11	0	0.00	226	233	-7	0.46	5	15	-10	3.16

64ET	73475	Micro	998	961	37	1.18	93	96	-3	0.31	978	906	72	2.35	96	92	4	0.41
61NL	73477	Micro	241	205	36	2.41	7	3	4	1.79	225	206	19	1.29	6	7	-1	0.39
61WT	73478	Micro	1740	1804	-64	1.52	157	191	-34	2.58	1790	1783	7	0.17	142	150	-8	0.66
61SR	73479	Micro	60	34	26	3.79	1	0	1	1.41	60	78	-18	2.17	0	1	-1	1.41
61ER	73480	Micro	121	113	8	0.74	7	12	-5	1.62	113	129	-16	1.45	3	3	0	0.00
61WL	73481	Micro	63	36	27	3.84	2	4	-2	1.15	57	31	26	3.92	2	4	-2	1.15
61ST	73482	Micro	341	337	4	0.22	2	4	-2	1.15	328	297	31	1.75	1	3	-2	1.41
61ET	73483	Micro	988	963	25	0.80	82	87	-5	0.54	987	891	96	3.13	92	99	-7	0.72
61SL	73484	Micro	12	21	-9	2.22	0	0	0	0.00	10	14	-4	1.15	0	1	-1	1.41
61EL	73485	Micro	12	18	-6	1.55	0	0	0	0.00	20	27	-7	1.44	0	0	0	0.00
61NT	73486	Micro	224	298	-74	4.58	2	6	-4	2.00	236	256	-20	1.28	3	7	-4	1.79
46WL	73488	Micro	51	40	11	1.63	8	1	7	3.30	63	90	-27	3.09	5	5	0	0.00
46NR	73489	Micro	105	102	3	0.29	1	1	0	0.00	95	101	-6	0.61	4	5	-1	0.47
46ET	73490	Micro	1095	1166	-71	2.11	89	100	-11	1.13	1085	1055	30	0.92	92	107	-15	1.50
46NL	73491	Micro	35	27	8	1.44	1	1	0	0.00	25	19	6	1.28	0	3	-3	2.45
46WT	73492	Micro	1586	1664	-78	1.93	144	184	-40	3.12	1708	1592	116	2.86	143	145	-2	0.17
45WL	73494	Micro	6	30	-24	5.66	0	2	-2	2.00	5	50	-45	8.58	0	1	-1	1.41
45ST	73495	Micro	206	165	41	3.01	1	5	-4	2.31	187	189	-2	0.15	0	4	-4	2.83
45WT	73496	Micro	1515	1516	-1	0.03	131	165	-34	2.79	1663	1481	182	4.59	136	141	-5	0.42
45SR	73497	Micro	145	171	-26	2.07	23	14	9	2.09	156	161	-5	0.40	11	15	-4	1.11
45SL	73499	Micro	166	177	-11	0.84	12	20	-8	2.00	172	160	12	0.93	9	18	-9	2.45
45WR	73501	Micro	208	289	-81	5.14	14	15	-1	0.26	215	213	2	0.14	7	20	-13	3.54
47ET	73503	Micro	1130	1024	106	3.23	80	92	-12	1.29	1103	888	215	6.81	87	94	-7	0.74
47WT	73504	Micro	1328	1404	-76	2.06	108	130	-22	2.02	1474	1423	51	1.34	110	121	-11	1.02
44SL	73506	Micro	321	256	65	3.83	27	21	6	1.22	294	176	118	7.70	23	33	-10	1.89
44ET	73507	Micro	1100	1232	-132	3.87	78	80	-2	0.23	1097	1130	-33	0.99	83	85	-2	0.22
44NR	73508	Micro	106	50	56	6.34	4	1	3	1.90	80	42	38	4.87	1	1	0	0.00
44WR	73509	Micro	442	393	49	2.40	22	28	-6	1.20	426	511	-85	3.93	39	24	15	2.67
44EL	73510	Micro	3	17	-14	4.43	3	2	1	0.63	11	23	-12	2.91	0	3	-3	2.45
44NT	73511	Micro	147	151	-4	0.33	8	1	7	3.30	130	130	0	0.00	14	3	11	3.77
44WT	73512	Micro	1258	1350	-92	2.55	103	133	-30	2.76	1487	1311	176	4.71	111	128	-17	1.56
44NL	73513	Micro	21	23	-2	0.43	0	1	-1	1.41	15	24	-9	2.04	0	0	0	0.00
44WL	73514	Micro	65	54	11	1.43	8	2	6	2.68	74	78	-4	0.46	17	3	14	4.43
44ST	73515	Micro	229	181	48	3.35	4	6	-2	0.89	205	181	24	1.73	13	3	10	3.54
34ST	73517	Meso	503	588	-85	3.64	17	16	1	0.25	581	563	18	0.75	22	19	3	0.66
34NT	73518	Meso	343	454	-111	5.56	22	18	4	0.89	318	394	-76	4.03	17	18	-1	0.24
52NT	73533	Meso	332	345	-13	0.71	77	57	20	2.44	367	385	-18	0.93	75	38	37	4.92
43ER	73536	Micro	188	189	-1	0.07	24	27	-3	0.59	195	191	4	0.29	13	35	-22	4.49
43WL	73537	Micro	4	16	-12	3.79	0	3	-3	2.45	36	51	-15	2.27	0	2	-2	2.00
43NL	73538	Micro	238	271	-33	2.07	25	31	-6	1.13	296	252	44	2.66	26	32	-6	1.11
43NR	73540	Micro	51	85	-34	4.12	1	11	-10	4.08	64	90	-26	2.96	4	6	-2	0.89
43ET	73541	Micro	1099	1166	-67	1.99	79	84	-5	0.55	1052	1008	44	1.37	87	84	3	0.32
50ST	73543	Meso	1320	1279	41	1.14	46	44	2	0.30	1338	1328	10	0.27	27	40	-13	2.25
50WL	73544	Meso	183	192	-9	0.66	9	16	-7	1.98	206	158	48	3.56	7	12	-5	1.62
50NT	73546	Meso	437	504	-67	3.09	16	18	-2	0.49	426	479	-53	2.49	8	33	-25	5.52
50EL	73547	Meso	11	11	0	0.00	0	0	0	0.00	15	9	6	1.73	0	0	0	0.00
50NR	73548	Meso	84	82	2	0.22	6	11	-5	1.71	86	70	16	1.81	9	9	0	0.00
50SL	73549	Meso	25	4	21	5.51	2	1	1	0.82	24	22	2	0.42	5	1	4	2.31
50ET	73550	Meso	143	129	14	1.20	1	2	-1	0.82	161	140	21	1.71	3	3	0	0.00
50NL	73551	Meso	36	77	-41	5.45	1	3	-2	1.41	56	71	-15	1.88	3	2	1	0.63
50WT	73553	Meso	178	187	-9	0.67	6	2	4	2.00	203	190	13	0.93	15	4	11	3.57
49EL	73555	Meso	159	217	-58	4.23	2	4	-2	1.15	194	209	-15	1.06	8	8	0	0.00
49NTR	73556	Meso	396	479	-83	3.97	21	28	-7	1.41	373	403	-30	1.52	12	36	-24	4.90
49SR	73557	Meso	678	630	48	1.88	15	14	1	0.26	718	625	93	3.59	13	10	3	0.88
49NL	73558	Meso	143	120	23	2.01	0	4	-4	2.83	130	180	-50	4.02	1	3	-2	1.41
49STL	73559	Meso	822	846	-24	0.83	38	44	-6	0.94	846	894	-48	1.63	23	46	-23	3.92
49ETR	73560	Meso	91	85	6	0.64	4	2	2	1.15	82	106	-24	2.48	0	3	-3	2.45
73NR	73648	Meso	149	173	-24	1.89	3	4	-1	0.53	169	179	-10	0.76	10	10	0	0.00
73ET	73649	Meso	84	80	4	0.44	0	1	-1	1.41	103	94	9	0.91	0	1	-1	1.41
73WL	73650	Meso	795	669	126	4.66	21	14	7	1.67	744	640	104	3.95	16	12	4	1.07
73ER	73651	Meso	138	121	17	1.49	0	1	-1	1.41	109	147	-38	3.36	4	3	1	0.53
73WT	73652	Meso	102	100	2	0.20	0	0	0	0.00	120	127	-7	0.63	0	0	0	0.00
73NL	73653	Meso	56	62	-6	0.78	3	0	3	2.45	47	43	4	0.60	1	1	0	0.00
58WT	73665	Meso	833	945	-112	3.76	35	53	-18	2.71	807	806	1	0.04	51	48	3	0.43
58NL	73666	Meso	299	297	2	0.12	25	13	12	2.75	304	303	1	0.06	15	16	-1	0.25
58ET	73667	Meso	452	537	-85	3.82	41	44	-3	0.46	474	398	76	3.64	38	43	-5	0.79
58NR	73668	Meso	128	103	25	2.33	6	3	3	1.41	122	101	21	1.99	3	2	1	0.63
58ER	73669	Meso	354	308	46	2.53	11	13	-2	0.58	313	347	-34	1.87	10	10	0	0.00
58WL	73670	Meso	105	136	-31	2.82	4	1	3	1.90	78	178	-100	8.84	2	4	-2	1.15
55EL	73684	Meso	41	40	1	0.16	2	0	2	2.00	45	56	-11	1.55	2	0	2	2.00
55ET	73686	Meso	546	592	-46	1.93	45	45	0	0.00	547	444	103	4.63	38	47	-9	1.38
55SL	73687	Meso	114	133	-19	1.71	0	1	-1	1.41	113	136	-23	2.06	3	2	1	0.63
51ST	73689	Meso	475	463	12	0.55	9	9	0	0.00	470	460	10	0.46	1	7	-6	3.00
51WL	73690	Meso	663	623	40	1.58	20	18	2	0.46	667	672	-5	0.19	16	22	-6	1.38
51ER	73691	Meso	210	187	23	1.63	20	17	3	0.70	224	189	35	2.44	14	14	0	0.00
51NT	73692	Meso	249	216	33	2.16	2	3	-1	0.63	217	233	-16	1.07	2	5	-3	1.60
51EL	73693	Meso	34	3	31	7.21	2	0	2	2.00	27	8	19	4.54	1	0	1	1.41
51NR	73694	Meso	99	120	-21	2.01	7	7	0	0.00	101	121	-20	1.90	4	11	-7	2.56
51SL	73695	Meso	2	0	2	2.00	0	0	0	0.00	2	0	2	2.00	0	0	0	0.00
51ET	73696	Meso	354	338	16	0.86	25	19	6	1.28	361	296	65	3.59	27	32	-5	0.92
51NL	73697	Meso	102	125	-23	2.16	6	8	-2	0.76	122	100	22	2.09	2	18	-16	5.06
51WT	73699	Meso	767	812	-45	1.60	30	44	-14	2.30	742	771	-29	1.05	52	29	23	3.61
54SL	73701	Meso	17	25	-8	1.75	4	3	1	0.53	16	17	-1	0.25	3	8	-5	2.13
54ET	73702	Meso	302	295	7	0.41	25	18	7	1.51	291	303	-12	0.70	19	27	-8	1.67
54NT	73703	Meso	244	288	-44	2.70	72	51	21	2.68	277	312	-35	2.04	76	31	45	6.15
54EL	73704	Meso	18	13	5	1.27	2	1	1	0.82	12	24	-12	2.83	1	4	-3	1.90
54WL	73705	Meso	34	39	-5	0.83	2	0	2	2.00	46	45	1	0.15	0	4	-4	2.83
54ST	73706	Meso	373	388	-15	0.77	31	33	-2	0.35	313	310	3	0.17	33	33	0	0.00
54ER	73707	Meso	152	158	-6	0.48	6	9	-3	1.10	172	123	49	4.03	15	17	-2	0.50
54WT	73708	Meso	1299	1292	7	0.19	45	52	-7	1.01	1263	1324	-61	1.70	61	50	11	1.48
54NL	73709	Meso	111	64	47	5.02	6	8	-2	0.76	97	78	19	2.03	6	9	-3	1.10
32WT	79337	Meso	514	549	-35	1.52	15	36	-21	4.16	506	545	-39	1.70	27	31	-4	0.74
32ET	79339	Meso	394	448	-54	2.63	24	24	0	0.00	447	437	10	0.48	23	30	-7	1.36
12NL	79573	Meso	296	163	133	8.78	0	0	0	0.00	284	171	113	7.49	0	1	-1	1.41
12EL	79575	Meso	10	8	2	0.67	0	0	0	0.00	8	15	-7	2.06	0	1	-1	1.41
12NT	79576	Meso	124	99	25	2.37	0	3	-3	2.45	108	125	-17	1.58	0	1	-1	1.41
12ST	79577	Meso	110	105	5	0.48	3	0	3	2.45	115	133	-18	1.62	0	3	-3	2.45
84ST	80097	Meso	181	149	32	2.49	7	16	-9	2.65	196	184	12	0.87	10	19	-9	2.36
84WL	80098	Meso	0	17	-17	5.83	0	0	0	0.00	0	35	-35	8.37	0	0	0	0.00
84ER	80099	Meso	18	14	4	1.00	1	2	-1	0.82	30	25	5	0.95	0	2	-2	2.00
84NT	80100	Meso	87	86	1	0.11	12	10	2	0.60	97	134	-37	3.44	10	13	-3	0.88
84WR	80101	Meso	105	87	18	1.84	4	1	3	1.90	107	98	9	0.89	1	4	-3	1.90
84SL	80103	Meso	43	23	20	3.48	13	17	-4	1.03	44	64	-20	2.72	8	3	5	2.13
84ET	80104	Meso	1358	1398	-40	1.08	123	115	8	0.73	1288	1245	43	1.21	112	120	-8	0.74
84NL	80105	Meso	5	12	-7	2.40	4	0	4	2.83	3	3	0	0.00	0	0	0	0.00
84SR	80106	Meso	140	158	-18	1.47	5	4	1	0.47	104	99	5	0.50	6	3	3	1.41
84WT	80107	Meso	1422	1434	-12	0.32	94	127	-33	3.14	1007	941	66	2.11	116	89	27	2.67
59ER	80121	Meso	101	62	39	4.32	2	3	-1	0.63	81	104	-23	2.39	0	6	-6	3.46
59ST	80122	Meso	161	134	27	2.22	5	6	-1	0.43	118	180	-62	5.08	6	4	2	0.89
59NL	80123	Meso	104	98	6	0.60	10	21	-11	2.79	111	152	-41	3.58	16	18	-2	0.49
59SR	80124	Meso	115	57	58	6.25	2	0	2	2.00	134	122	12	1.06	1	0	1	1.41
59NT	80125	Meso	269	312	-43	2.52	3	11	-8	3.02	294	353	-59	3.28	14	15	-1	0.26
59EL	80126	Meso	20	48	-28	4.80	2	1	1	0.82	37	70	-33	4.51	0	2	-2	2.00

62WT	80256	Micro	1749	1873	-124	2.91	144	177	-33	2.60	1837	1897	-60	1.39	145	137	8	0.67
62SR	80257	Micro	614	551	63	2.61	20	6	14	3.88	570	595	-25	1.04	18	11	7	1.84
62ET	80258	Micro	1075	1076	-1	0.03	90	99	-9	0.93	1063	984	79	2.47	95	95	0	0.00
62SL	80259	Micro	56	49	7	0.97	0	5	-5	3.16	65	60	5	0.63	0	5	-5	3.16
62EL	80260	Micro	145	148	-3	0.25	13	4	9	3.09	145	189	-44	3.40	7	10	-3	1.03
62WR	80261	Micro	210	194	16	1.13	12	8	4	1.26	182	183	-1	0.07	5	13	-8	2.67
33NR	80647	Meso	77	113	-36	3.69	11	8	3	0.97	106	121	-15	1.41	17	7	10	2.89
33ET	80648	Meso	1157	1200	-43	1.25	126	123	3	0.27	1093	1069	24	0.73	114	110	4	0.38
33SL	80649	Meso	6	19	-13	3.68	7	0	7	3.74	4	8	-4	1.63	1	0	1	1.41
33ST	80651	Meso	168	186	-18	1.35	10	2	8	3.27	195	218	-23	1.60	8	4	4	1.63
33WT	80652	Meso	1202	1191	11	0.32	96	114	-18	1.76	767	788	-21	0.75	108	80	28	2.89
33NL	80653	Meso	8	3	5	2.13	0	0	0	0.00	11	10	1	0.31	0	0	0	0.00
33SR	80654	Meso	312	355	-43	2.35	3	13	-10	3.54	340	289	51	2.88	11	13	-2	0.58
33NT	80655	Meso	87	70	17	1.92	1	2	-1	0.82	92	87	5	0.53	4	2	2	1.15
2WL	80661	Meso	292	222	70	4.37	9	11	-2	0.63	276	273	3	0.18	23	10	13	3.20
2ER	80662	Meso	108	79	29	3.00	22	10	12	3.00	69	82	-13	1.50	10	11	-1	0.31
2ST	80663	Meso	351	309	42	2.31	7	19	-12	3.33	300	385	-85	4.59	9	9	0	0.00
2NR	80664	Meso	22	94	-72	9.45	11	2	9	3.53	20	91	-71	9.53	3	3	0	0.00
2ET	80665	Meso	1340	1355	-15	0.41	133	112	21	1.90	1289	1251	38	1.07	124	135	-11	0.97
2SL	80666	Meso	79	71	8	0.92	0	9	-9	4.24	92	65	27	3.05	2	4	-2	1.15
2NL	80667	Meso	57	29	28	4.27	3	0	3	2.45	41	34	7	1.14	7	1	6	3.00
2WT	80668	Meso	1276	1340	-64	1.77	91	122	-31	3.00	851	815	36	1.25	103	84	19	1.96
2SR	80669	Meso	149	226	-77	5.62	6	10	-4	1.41	152	157	-5	0.40	5	5	0	0.00
2NT	80670	Meso	116	139	-23	2.04	1	4	-3	1.90	116	141	-25	2.21	1	4	-3	1.90
2EL	80671	Meso	41	66	-25	3.42	0	2	-2	2.00	27	69	-42	6.06	0	1	-1	1.41
60WT	80701	Micro	1629	1631	-2	0.05	140	180	-40	3.16	1724	1571	153	3.77	140	150	-10	0.83
60NL	80702	Micro	32	38	-6	1.01	0	0	0	0.00	24	68	-44	6.49	0	0	0	0.00
60SR	80703	Micro	107	63	44	4.77	0	0	0	0.00	103	52	51	5.79	0	1	-1	1.41
60ET	80704	Micro	976	1002	-26	0.83	82	95	-13	1.38	988	902	86	2.80	92	102	-10	1.02
60NR	80705	Micro	91	59	32	3.70	1	2	-1	0.82	80	71	9	1.04	0	1	-1	1.41
60SL	80706	Micro	29	21	8	1.60	6	0	6	3.46	26	12	14	3.21	0	0	0	0.00
60WL	80707	Micro	6	13	-7	2.27	0	2	-2	2.00	2	20	-18	5.43	3	1	2	1.41
60ST	80708	Micro	144	149	-5	0.41	0	2	-2	2.00	126	130	-4	0.35	0	2	-2	2.00
60EL	80709	Micro	7	12	-5	1.62	0	0	0	0.00	8	17	-9	2.55	0	0	0	0.00
60NT	80710	Micro	196	177	19	1.39	0	0	0	0.00	168	136	32	2.60	3	0	3	2.45
74SR	80747	Meso	1076	1045	31	0.95	28	24	4	0.78	967	938	29	0.94	32	32	0	0.00
74WT	80748	Meso	1600	1640	-40	0.99	113	136	-23	2.06	1130	1106	24	0.72	110	90	20	2.00
74WR	80750	Meso	69	56	13	1.64	0	8	-8	4.00	86	81	5	0.55	2	3	-1	0.63
74ET	80751	Meso	1195	1145	50	1.46	114	104	10	0.96	1117	1088	29	0.87	105	130	-25	2.31
21EL	82727	Meso	11	12	-1	0.29	2	1	1	0.82	17	17	0	0.00	0	0	0	0.00
21WR	82728	Meso	0	5	-5	3.16	0	0	0	0.00	0	17	-17	5.83	0	0	0	0.00
21NT	82729	Meso	338	318	20	1.10	4	10	-6	2.27	409	383	26	1.31	12	10	2	0.60
21SL	82733	Meso	11	18	-7	1.84	1	0	1	1.41	6	33	-27	6.11	5	0	5	3.16
21ET	82734	Meso	132	82	50	4.83	0	0	0	0.00	93	129	-36	3.42	0	2	-2	2.00
21NR	82735	Meso	6	1	5	2.67	0	0	0	0.00	1	1	0	0.00	0	0	0	0.00
21ST	82736	Meso	162	134	28	2.30	6	6	0	0.00	143	164	-21	1.69	4	10	-6	2.27
21ER	82737	Meso	35	78	-43	5.72	0	13	-13	5.10	23	100	-77	9.82	0	11	-11	4.69
21WL	82738	Meso	22	7	15	3.94	0	0	0	0.00	21	1	20	6.03	1	0	1	1.41
69WT	82740	Micro	1881	1888	-7	0.16	139	170	-31	2.49	1949	1855	94	2.16	154	139	15	1.24
69ET	82742	Micro	977	883	94	3.08	88	80	8	0.87	963	875	88	2.90	108	108	0	0.00
65ST	82760	Micro	261	193	68	4.51	5	2	3	1.60	231	183	48	3.34	6	2	4	2.00
65WL	82761	Micro	39	30	9	1.53	6	2	4	2.00	23	32	-9	1.72	3	1	2	1.41
65NT	82762	Micro	215	201	14	0.97	7	2	5	2.36	237	185	52	3.58	8	6	2	0.76
65EL	82763	Micro	32	33	-1	0.18	1	0	1	1.41	40	53	-13	1.91	7	0	7	3.74
65NR	82764	Micro	61	31	30	4.42	1	0	1	1.41	31	22	9	1.75	1	3	-2	1.41
65SL	82765	Micro	19	33	-14	2.75	2	1	1	0.82	23	24	-1	0.21	2	1	1	0.82
65ET	82766	Micro	936	920	16	0.53	92	95	-3	0.31	949	891	58	1.91	96	96	0	0.00
65NL	82767	Micro	127	60	67	6.93	3	1	2	1.41	114	64	50	5.30	12	4	8	2.83
65SR	82768	Micro	72	49	23	2.96	2	3	-1	0.63	81	59	22	2.63	1	0	1	1.41
65WT	82769	Micro	1826	1867	-41	0.95	125	162	-37	3.09	1945	1974	-29	0.66	138	128	10	0.87
77ST	82771	Meso	167	199	-32	2.37	11	13	-2	0.58	181	180	1	0.07	7	13	-6	1.90
77ER	82772	Meso	60	68	-8	1.00	0	3	-3	2.45	60	73	-13	1.59	1	2	-1	0.82
77WL	82773	Meso	58	62	-4	0.52	3	5	-2	1.00	62	69	-7	0.86	2	6	-4	2.00
77NT	82774	Meso	153	153	0	0.00	6	19	-13	3.68	153	148	5	0.41	10	14	-4	1.15
77EL	82775	Meso	16	17	-1	0.25	0	2	-2	2.00	34	27	7	1.27	0	0	0	0.00
77WR	82776	Meso	13	48	-35	6.34	1	2	-1	0.82	14	51	-37	6.49	4	1	3	1.90
77NL	82777	Meso	83	124	-41	4.03	2	9	-7	2.98	78	143	-65	6.18	3	8	-5	2.13
77SR	82778	Meso	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00	0	1	-1	1.41
77WT	82779	Meso	438	372	66	3.28	9	3	6	2.45	397	372	25	1.27	6	6	0	0.00
77NR	82780	Meso	33	46	-13	2.07	1	4	-3	1.90	47	66	-19	2.53	0	3	-3	2.45
77SL	82781	Meso	189	127	62	4.93	5	2	3	1.60	145	115	30	2.63	6	2	4	2.00
77ET	82782	Meso	213	215	-2	0.14	0	0	0	0.00	206	199	7	0.49	5	5	0	0.00
37ET	84210	Micro	1419	1593	-174	4.48	103	99	4	0.40	1351	1302	49	1.35	102	117	-15	1.43
37SL	84211	Micro	47	28	19	3.10	0	2	-2	2.00	38	46	-8	1.23	0	3	-3	2.45
37NR	84212	Micro	29	28	1	0.19	1	1	0	0.00	26	41	-15	2.59	0	1	-1	1.41
37WT	84213	Micro	1801	1845	-44	1.03	158	173	-15	1.17	1902	1693	209	4.93	198	156	42	3.16
37NL	84214	Micro	0	29	-29	7.62	0	2	-2	2.00	13	42	-29	5.53	0	2	-2	2.00
37EL	84215	Micro	9	28	-19	4.42	0	0	0	0.00	10	29	-19	4.30	4	0	4	2.83
37NT	84216	Micro	80	93	-13	1.40	1	0	1	1.41	84	79	5	0.55	0	0	0	0.00
37WL	84217	Micro	97	108	-11	1.09	5	3	2	1.00	107	106	1	0.10	2	2	0	0.00
37ST	84218	Micro	165	226	-61	4.36	1	2	-1	0.82	156	184	-28	2.15	0	3	-3	2.45
72WL	84220	Meso	150	141	9	0.75	6	1	5	2.67	176	184	-8	0.60	19	3	16	4.82
72ST	84221	Meso	750	700	50	1.86	15	13	2	0.53	645	810	-165	6.12	12	17	-5	1.31
72SL	84223	Meso	34	15	19	3.84	0	0	0	0.00	33	9	24	5.24	0	1	-1	1.41
72NT	84224	Meso	778	741	37	1.34	33	16	17	3.43	788	756	32	1.15	22	23	-1	0.21
36NT	88660	Meso	69	21	48	7.16	0	3	-3	2.45	78	30	48	6.53	0	2	-2	2.00
36WR	88661	Meso	102	165	-63	5.45	0	5	-5	3.16	124	181	-57	4.62	1	5	-4	2.31
36ST	88662	Meso	7	28	-21	5.02	0	4	-4	2.83	44	55	-11	1.56	0	3	-3	2.45
36WL	88663	Meso	754	788	-34	1.22	21	14	7	1.67	794	753	41	1.47	26	19	7	1.48
36SL	88664	Meso	66	51	15	1.96	19	18	1	0.23	108	52	56	6.26	22	3	19	5.37
36NR	88665	Meso	404	473	-69	3.30	29	16	13	2.74	355	402	-47	2.42	19	16	3	0.72
38WR	88667	Meso	467	521	-54	2.43	49	32	17	2.67	460	451	9	0.42	37	19	18	3.40
38NT	88668	Meso	209	204	5	0.35	8	9	-1	0.34	210	204	6	0.42	5	6	-1	0.43
40NT	88670	Meso	649	671	-22	0.86	50	40	10	1.49	631	585	46	1.87	38	23	15	2.72
40NL	88676	Meso	28	26	2	0.38	7	1	6	3.00	37	46	-9	1.40	4	0	4	2.83
68ET	92156	Micro	492	460	32	1.47	80	78	2	0.23	584	531	53	2.24	86	86	0	0.00
68WT	92158	Micro	1026	1025	1	0.03	118	148	-30	2.60	1122	1181	-59	1.74	126	124	2	0.18
68SR	92159	Micro	732	807	-75	2.70	49	49	0	0.00	603	562	41	1.70	57	57	0	0.00
68NL	92160	Micro	24	19	5	1.08	1	2	-1	0.82	28	24	4	0.78	1	4	-3	1.90
68WR	92161	Micro	930	783	147	5.02	62	74	-12	1.46	894	778	116	4.01	62	59	3	0.39
68EL	92162	Micro	342	343	-1	0.05	39	35	4	0.66	340	362	-22	1.17	35	30	5	0.88
68WL	92163	Micro	164	124	40	3.33	2	7	-5	2.36	174	159	15	1.16	2	6	-4	2.00
68ST	92164	Micro	180	165	15	1.14	7	3	4	1.79	180	161	19	1.46	8	7	1	0.37
81WT	104064	Micro	1372	1466	-94	2.50	119	157	-38	3.23	1497	1363	134	3.54	114	129	-15	1.36
81ET	104065	Micro	1136	1197	-61	1.79	79	86	-7	0.77	1124	1039	85	2.58	90	86	4	0.43
10WL	104081	Meso	146	149	-3	0.25	2	3	-1	0.63	138	127	11	0.96	7	5	2	0.82
10ST	104082	Meso	104	105	-1	0.10	15	25	-10	2.24	97	123	-26	2.48	13	22	-9	2.15
10NR	104083	Meso	79	49	30	3.75	14	5	9	2.92	65	49	16	2.12	16	0	16	5.66
10SL	104084	Meso	21	36	-15	2.81	0	1	-1	1.41	22	33	-11	2.10	1	1	0	0.00
10NT	104085	Meso	209	228	-19	1.29	18	23	-5	1.10	216	258	-42	2.73	17	28	-11	2.32
10WR	104086	Meso	92	116	-24	2.35	0	1	-1	1.41	127	126	1	0.09	8	1	7	3.30
48NT	117031	Meso	319	398	-79	4.17	17	23	-6	1.34	310	325	-15	0.84	9	32	-23	5.08
48ST	117032	Meso	479	501	-22	0.99	36	38	-2	0.33	478	469	9	0.41	20	40	-20	3.65

4SL	117169	Meso	73	38	35	4.70	0	1	-1	1.41	62	41	21	2.93	3	0	3	2.45
4NR	117170	Meso	0	12	-12	4.90	0	0	0	0.00	0	12	-12	4.90	0	1	-1	1.41
4WR	117171	Meso	26	24	2	0.40	2	0	2	2.00	28	6	22	5.34	4	0	4	2.83
4NT	117172	Meso	229	196	33	2.26	24	15	9	2.04	243	236	7	0.45	23	22	1	0.21
4WL	117173	Meso	35	14	21	4.24	1	0	1	1.41	21	6	15	4.08	1	1	0	0.00
4ST	117174	Meso	140	142	-2	0.17	20	11	9	2.29	125	140	-15	1.30	22	11	11	2.71
52EL	13089151	Meso	20	1	19	5.86	1	3	-2	1.41	13	3	10	3.54	8	4	4	1.63
52SR	13089152	Meso	0	2	-2	2.00	0	5	-5	3.16	0	0	0	0.00	0	4	-4	2.83
31EL	13089157	Micro	351	341	10	0.54	19	21	-2	0.45	343	318	25	1.38	24	22	2	0.42
31SL	13089166	Micro	79	61	18	2.15	11	8	3	0.97	88	90	-2	0.21	9	4	5	1.96
39SL	13089176	Micro	89	64	25	2.86	1	8	-7	3.30	102	74	28	2.98	3	5	-2	1.00
38WL	13089177	Meso	88	68	20	2.26	1	6	-5	2.67	102	67	35	3.81	3	5	-2	1.00
47WL	13089187	Micro	25	17	8	1.75	2	1	1	0.82	32	20	12	2.35	1	1	0	0.00
47NL	13089188	Micro	35	48	-13	2.02	3	2	1	0.63	39	40	-1	0.16	3	1	2	1.41
34WL	13089197	Meso	17	18	-1	0.24	3	1	2	1.41	24	15	9	2.04	1	2	-1	0.82
34WT	13089198	Meso	55	26	29	4.56	1	1	0	0.00	52	33	19	2.91	4	0	4	2.83
34WR	13089199	Meso	24	8	16	4.00	0	0	0	0.00	25	3	22	5.88	1	1	0	0.00
34ER	13089200	Meso	34	20	14	2.69	0	0	0	0.00	28	43	-15	2.52	0	1	-1	1.41
34ET	13089201	Meso	38	24	14	2.51	1	0	1	1.41	50	66	-16	2.10	0	2	-2	2.00
34EL	13089202	Meso	69	61	8	0.99	7	3	4	1.79	77	67	10	1.18	0	1	-1	1.41
34SR	13089203	Meso	242	222	20	1.31	5	4	1	0.47	237	270	-33	2.07	4	3	1	0.53
34SL	13089204	Meso	25	10	15	3.59	0	0	0	0.00	21	15	6	1.41	0	0	0	0.00
34NL	13089206	Meso	145	155	-10	0.82	4	12	-8	2.83	161	200	-39	2.90	6	7	-1	0.39
46SL	13089483	Micro	24	6	18	4.65	0	0	0	0.00	31	11	20	4.36	0	0	0	0.00
46ST	13089484	Micro	74	80	-6	0.68	0	0	0	0.00	60	100	-40	4.47	0	0	0	0.00
46SR	13089485	Micro	19	18	1	0.23	0	0	0	0.00	25	12	13	3.02	1	0	1	1.41
46EL	13089486	Micro	2	9	-7	2.98	0	0	0	0.00	1	12	-11	4.31	0	0	0	0.00
46NT	13089487	Micro	39	31	8	1.35	7	0	7	3.74	37	42	-5	0.80	0	1	-1	1.41
48WL	13089503	Meso	36	23	13	2.39	0	2	-2	2.00	35	32	3	0.52	0	1	-1	1.41
48WR	13089504	Meso	9	11	-2	0.63	1	5	-4	2.31	8	12	-4	1.26	0	4	-4	2.83
48NR	13089505	Meso	4	6	-2	0.89	0	0	0	0.00	4	11	-7	2.56	0	0	0	0.00
48SL	13089506	Meso	40	20	20	3.65	3	0	3	2.45	43	29	14	2.33	1	0	1	1.41
81NL	13089549	Micro	116	109	7	0.66	1	3	-2	1.41	128	147	-19	1.62	1	0	1	1.41
22WR	13089736	Meso	0	0	0	0.00	0	18	-18	6.00	0	0	0	0.00	0	17	-17	5.83
53ER	13089812	Meso	1386	1331	55	1.49	112	102	10	0.97	1186	1205	-19	0.55	135	116	19	1.70
53WL	13089814	Meso	578	466	112	4.90	29	25	4	0.77	545	463	82	3.65	19	28	-9	1.86
33EL	13089842	Meso	244	235	9	0.58	9	10	-1	0.32	241	243	-2	0.13	7	14	-7	2.16
35NL	13089853	Meso	99	95	4	0.41	8	11	-3	0.97	106	115	-9	0.86	7	13	-6	1.90
35WL	13089854	Meso	8	37	-29	6.11	0	1	-1	1.41	8	26	-18	4.37	0	0	0	0.00
35WT	13089855	Meso	95	67	28	3.11	2	0	2	2.00	94	68	26	2.89	3	6	-3	1.41
35WR	13089856	Meso	29	22	7	1.39	1	0	1	1.41	22	26	-4	0.82	2	2	0	0.00
35ET	13089857	Meso	56	36	20	2.95	0	4	-4	2.83	42	47	-5	0.75	1	4	-3	1.90
35NR	13089858	Meso	8	23	-15	3.81	0	0	0	0.00	13	15	-2	0.53	1	1	0	0.00
35SL	13089859	Meso	24	18	6	1.31	1	1	0	0.00	29	19	10	2.04	0	1	-1	1.41
23ER	13090099	Meso	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
59ET	13090152	Meso	10	19	-9	2.36	0	1	-1	1.41	9	12	-3	0.93	0	0	0	0.00
59WT	13090153	Meso	28	23	5	0.99	0	0	0	0.00	17	22	-5	1.13	0	1	-1	1.41
59WL	13090154	Meso	14	15	-1	0.26	0	1	-1	1.41	26	14	12	2.68	0	1	-1	1.41
59WR	13090155	Meso	2	9	-7	2.98	1	0	1	1.41	0	8	-8	4.00	2	1	1	0.82
59SL	13090156	Meso	79	56	23	2.80	0	0	0	0.00	102	26	76	9.50	1	0	1	1.41
59NR	13090157	Meso	16	2	14	4.67	0	0	0	0.00	17	0	17	5.83	0	0	0	0.00
68SL	13090179	Micro	689	609	80	3.14	44	54	-10	1.43	613	639	-26	1.04	49	47	2	0.29
66SL	13090338	Micro	10	26	-16	3.77	0	3	-3	2.45	13	30	-17	3.67	0	2	-2	2.00
66ST	13090339	Micro	50	32	18	2.81	0	1	-1	1.41	33	53	-20	3.05	0	1	-1	1.41
66SR	13090340	Micro	27	13	14	3.13	2	0	2	2.00	32	11	21	4.53	2	1	1	0.82
66EL	13090341	Micro	15	16	-1	0.25	0	2	-2	2.00	21	28	-7	1.41	5	0	5	3.16
66NT	13090342	Micro	54	65	-11	1.43	0	2	-2	2.00	67	90	-23	2.60	0	4	-4	2.83
69SL	13090343	Micro	15	1	14	4.95	0	2	-2	2.00	6	10	-4	1.41	0	0	0	0.00
69SR	13090345	Micro	6	13	-7	2.27	3	0	3	2.45	11	15	-4	1.11	0	2	-2	2.00
69EL	13090346	Micro	90	40	50	6.20	5	4	1	0.47	83	69	14	1.61	6	2	4	2.00
55NR	13119550	Meso	48	52	-4	0.57	0	4	-4	2.83	52	62	-10	1.32	0	2	-2	2.00
55WL	13119551	Meso	74	83	-9	1.02	0	0	0	0.00	80	77	3	0.34	0	2	-2	2.00
15NL	13119942	Meso	140	30	110	11.93	11	0	11	4.69	114	37	77	8.86	8	1	7	3.30
15EL	13119943	Meso	60	36	24	3.46	0	0	0	0.00	45	62	-17	2.32	0	0	0	0.00
63NR	13120448	Meso	0	1	-1	1.41	0	0	0	0.00	0	1	-1	1.41	0	4	-4	2.83
63NL	13120449	Meso	0	3	-3	2.45	0	0	0	0.00	0	6	-6	3.46	0	0	0	0.00
63ER	13120450	Meso	7	15	-8	2.41	0	0	0	0.00	16	17	-1	0.25	2	1	1	0.82
63WL	13120451	Meso	15	9	6	1.73	0	0	0	0.00	15	21	-6	1.41	0	0	0	0.00
63ST	13120452	Meso	22	28	-6	1.20	3	0	3	2.45	21	35	-14	2.65	2	1	1	0.82
63NT	13120458	Meso	0	10	-10	4.47	0	0	0	0.00	0	6	-6	3.46	0	0	0	0.00
64EL	13168443	Micro	32	19	13	2.57	2	2	0	0.00	25	30	-5	0.95	2	1	1	0.82
64NT	13168444	Micro	26	36	-10	1.80	2	2	0	0.00	22	37	-15	2.76	1	1	0	0.00
31ET	13405771	Micro	1146	1310	-164	4.68	81	82	-1	0.11	1075	1102	-27	0.82	77	102	-25	2.64
40NR	13405912	Meso	0	6	-6	3.46	0	0	0	0.00	0	8	-8	4.00	0	0	0	0.00
52ST	13405918	Meso	559	577	-18	0.76	39	38	1	0.16	531	477	54	2.41	48	50	-2	0.29
52ER	13405919	Meso	225	224	1	0.07	4	5	-1	0.47	265	215	50	3.23	10	7	3	1.03
55WT	13406071	Meso	854	956	-102	3.39	36	52	-16	2.41	843	852	-9	0.31	54	48	6	0.84
55NL	13406072	Meso	72	39	33	4.43	3	2	1	0.63	56	56	0	0.00	0	5	-5	3.16
71WT	13406099	Meso	771	627	144	5.45	13	13	0	0.00	702	603	99	3.88	11	11	0	0.00
71WL	13406100	Meso	121	87	34	3.33	3	2	1	0.63	111	111	0	0.00	6	2	4	2.00
71ETR	13406104	Meso	106	142	-36	3.23	5	3	2	1.00	95	129	-34	3.21	10	9	1	0.32
71NR	13406109	Meso	75	85	-10	1.12	0	1	-1	1.41	87	65	22	2.52	1	3	-2	1.41
71NL	13406110	Meso	229	246	-17	1.10	2	5	-3	1.60	254	237	17	1.08	10	7	3	1.03
72NR	13406231	Meso	66	54	12	1.55	1	2	-1	0.82	84	51	33	4.02	3	0	3	2.45
9ET	13406258	Meso	399	312	87	4.61	4	9	-5	1.96	351	345	6	0.32	11	12	-1	0.29
9WT	13406262	Meso	686	671	15	0.58	12	16	-4	1.07	697	587	110	4.34	21	15	6	1.41
22EL	13406293	Meso	57	41	16	2.29	8	4	4	1.63	40	69	-29	3.93	18	5	13	3.83
20WT	13406439	Meso	442	421	21	1.01	26	26	0	0.00	468	398	70	3.36	43	24	19	3.28
20WL	13406440	Meso	226	195	31	2.14	2	12	-10	3.78	225	278	-53	3.34	1	6	-5	2.67
20ETR	13406443	Meso	376	315	61	3.28	27	11	16	3.67	316	334	-18	1.00	37	17	20	3.85
20NL	13406448	Meso	198	132	66	5.14	5	1	4	2.31	134	131	3	0.26	5	2	3	1.60
20NR	13406449	Meso	86	96	-10	1.05	3	5	-2	1.00	70	150	-80	7.63	9	7	2	0.71
21NL	13406675	Meso	68	87	-19	2.16	1	18	-17	5.52	64	131	-67	6.79	2	18	-16	5.06
74EL	13406690	Meso	725	694	31	1.16	34	41	-7	1.14	737	658	79	2.99	33	39	-6	1.00
53ET	13406693	Meso	1253	1310	-57	1.59	131	135	-4	0.35	1179	1223	-44	1.27	127	142	-15	1.29
53NL.AM	13406696	Meso	2730	2898	-168	3.17	146	137	9	0.76	2324	2599	-275	5.54	144	135	9	0.76
53NR.AM	13406697	Meso	676	618	58	2.28	25	28	-3	0.58	666	569	97	3.90	25	26	-1	0.20
12ET	13406725	Meso	1257	1213	44	1.25	96	83	13	1.37	1044	1016	28	0.87	108	105	3	0.29
12NR	13406726	Meso	54	43	11	1.58	1	1	0	0.00	43	45	-2	0.30	1	3	-2	1.41
12SL	13406727	Meso	4	35	-31	7.02	4	0	4	2.83	8	24	-16	4.00	2	0	2	2.00
12WL	13406731	Meso	0	18	-18	6.00	0	1	-1	1.41	2	8	-6	2.68	0	0	0	0.00
12WT	13406732	Meso	2322	2310	12	0.25	128	134	-6	0.52	1909	1821	88	2.04	117	121	-4	0.37
33WL	13406803	Meso	192	193	-1	0.07	9	13	-4	1.21	221	224	-3	0.20	16	6	10	3.02
5NL	13406817	Meso	147	114	33	2.89	16	11	5	1.36	156	132	24	2.00	22	12	10	2.43
14STR	13406825	Meso	94	98	-4	0.41	0	4	-4	2.83	105	92	13	1.31	0	2	-2	2.00
14SL	13406826	Meso	35	45	-10	1.58	0	1	-1	1.41	36	33	3	0.51	1	0	1	1.41
14WTR	13406829	Meso	654	618	36	1.43	3	2	1	0.63	642	657	-15	0.59	13	9	4	1.21
14EL	13406831	Meso	32	27	5	0.92	1	1	0	0.00	34	24	10	1.86	0	0	0	0.00
14ETR	13406832	Meso	118	121	-3	0.27	8	3	5	2.13	113	133	-20	1.80	2	3	-1	0.63
29SL	13406949	Meso	27	43	-16	2.70	2	1	1	0.82	35	32	3	0.52	1	3	-2	1.41
29ET	13406950	Meso	232	229	3	0.20	12	17	-5	1.31	198	236	-38	2.58	10	21	-11	2.79
29NR	13406951	Meso	41	37	4	0.64	0	1	-1	1.41	37	24	13	2.35	1	0	1	1.41
27NT	13406968	Meso	279	281	-2	0.12	9	11	-2	0.63	275	294	-19	1.13	13	13	0	0.00

27NL	13406969	Meso	36	13	23	4.65	1	1	0	0.00	44	17	27	4.89	2	1	1	0.82
27EL	13406973	Meso	77	38	39	5.14	4	1	3	1.90	76	28	48	6.66	3	1	2	1.41
27ER	13406974	Meso	9	13	-4	1.21	4	1	3	1.90	20	16	4	0.94	9	0	9	4.24
27STR	13406976	Meso	522	528	-6	0.26	20	15	5	1.20	598	501	97	4.14	26	16	10	2.18
26STR	13406990	Meso	0	23	-23	6.78	0	0	0	0.00	8	29	-21	4.88	7	0	7	3.74
26SL	13406991	Meso	10	20	-10	2.58	3	1	2	1.41	22	18	4	0.89	6	0	6	3.46
26WTR	13406996	Meso	266	173	93	6.28	7	1	6	3.00	292	181	111	7.22	12	6	6	2.00
26ET	13407001	Meso	56	46	10	1.40	9	1	8	3.58	69	42	27	3.62	6	0	6	3.46
26EL	13407002	Meso	86	36	50	6.40	4	1	3	1.90	56	45	11	1.55	5	1	4	2.31
25STR	13407011	Meso	43	39	4	0.62	2	1	1	0.82	33	30	3	0.53	1	0	1	1.41
25SL	13407012	Meso	6	12	-6	2.00	1	0	1	1.41	6	11	-5	1.71	3	0	3	2.45
25WTR	13407017	Meso	214	227	-13	0.88	5	1	4	2.31	243	203	40	2.68	17	9	8	2.22
25ETR	13407022	Meso	66	55	11	1.41	10	3	7	2.75	58	60	-2	0.26	8	1	7	3.30
25EL	13407023	Meso	35	16	19	3.76	4	2	2	1.15	28	34	-6	1.08	9	0	9	4.24
14WL	13603367	Meso	61	49	12	1.62	0	0	0	0.00	87	47	40	4.89	0	0	0	0.00
14NTR	13603369	Meso	153	100	53	4.71	1	2	-1	0.82	125	126	-1	0.09	4	2	2	1.15
14NL	13603370	Meso	3	9	-6	2.45	0	0	0	0.00	5	20	-15	4.24	3	1	2	1.41
19SL	13603378	Meso	4	3	1	0.53	0	0	0	0.00	0	11	-11	4.69	0	0	0	0.00
19STR	13603393	Meso	304	243	61	3.69	20	15	5	1.20	286	283	3	0.18	19	16	3	0.72
19NT	13603399	Meso	453	387	66	3.22	9	16	-7	1.98	481	481	0	0.00	24	17	7	1.55
19NL	13603400	Meso	57	35	22	3.24	4	8	-4	1.63	48	51	-3	0.43	6	6	0	0.00
19ER	13603404	Meso	36	27	9	1.60	12	8	4	1.26	28	37	-9	1.58	2	5	-3	1.60
19EL	13603405	Meso	63	20	43	6.67	0	3	-3	2.45	62	35	27	3.88	0	5	-5	3.16
21WT	13603995	Meso	284	203	81	5.19	0	4	-4	2.83	283	288	-5	0.30	0	1	-1	1.41
32WL	13604612	Meso	46	10	36	6.80	0	0	0	0.00	45	31	14	2.27	0	1	-1	1.41
32ER	13604614	Meso	22	19	3	0.66	0	0	0	0.00	28	25	3	0.58	4	1	3	1.90
32NL	13604615	Meso	53	15	38	6.52	0	1	-1	1.41	50	17	33	5.70	0	0	0	0.00
32NR	13604617	Meso	0	2	-2	2.00	0	1	-1	1.41	0	9	-9	4.24	0	1	-1	1.41
41SR	13606020	Meso	0	0	0	0.00	0	4	-4	2.83	0	0	0	0.00	0	4	-4	2.83
1WT.AM	13608779	Meso	2111	2181	-70	1.51	117	119	-2	0.18	1729	1654	75	1.82	103	98	5	0.50
1WR.AM	13608780	Meso	146	189	-43	3.32	6	7	-1	0.39	196	151	45	3.42	4	5	-1	0.47
1WR.PM	13608783	Meso																
1WT.PM	13608784	Meso																
1WL.AM	13608787	Meso	21	27	-6	1.22	0	4	-4	2.83	26	28	-2	0.38	0	0	0	0.00
1WL.PM	13608788	Meso																
53NL.PM	13608794	Meso																
53NR.PM	13608795	Meso																
70ET	13610952	Meso	123	99	24	2.28	13	8	5	1.54	129	127	2	0.18	15	4	11	3.57
70ER	13610953	Meso	39	25	14	2.47	7	0	7	3.74	39	18	21	3.93	2	1	1	0.82
70NL	13610954	Meso	0	1	-1	1.41	0	0	0	0.00	0	3	-3	2.45	0	0	0	0.00
70NR	13610955	Meso	44	28	16	2.67	1	0	1	1.41	53	25	28	4.48	0	2	-2	2.00
70WT	13610956	Meso	64	80	-16	1.89	2	5	-3	1.60	44	111	-67	7.61	0	1	-1	1.41
70WL	13610957	Meso	241	188	53	3.62	8	3	5	2.13	202	218	-16	1.10	7	5	2	0.82
21SR	13611251	Meso	28	34	-6	1.08	0	0	0	0.00	19	55	-36	5.92	0	0	0	0.00
45ET	13611806	Micro	1120	1166	-46	1.36	90	92	-2	0.21	1066	1040	26	0.80	91	104	-13	1.32
45EL	13612038	Micro	116	115	1	0.09	2	9	-7	2.98	93	151	-58	5.25	2	12	-10	3.78
43WT	13612111	Micro	1476	1573	-97	2.48	119	156	-37	3.16	1599	1467	132	3.37	117	126	-9	0.82
61NR	13613542	Micro	0	0	0	0.00	0	2	-2	2.00	0	1	-1	1.41	0	0	0	0.00

Turn Name	Aimsun ID	Area	PM Peak															
			1630-1730								1730-1830							
			LV				HV				LV				HV			
			Modelled	Observed	Difference	GEH	Modelled	Observed	Difference	GEH	Modelled	Observed	Difference	GEH	Modelled	Observed	Difference	GEH
30ST	61436	Meso	95	73	22	2.40	0	1	-1	1.41	87	70	17	1.92	1	0	1	1.41
30ER	61437	Meso	403	395	8	0.40	8	18	-10	2.77	398	398	0	0.00	10	17	-7	1.91
30NT	61438	Meso	81	100	-19	2.00	0	0	0	0.00	79	82	-3	0.33	1	0	1	1.41
30EL	61439	Meso	100	64	36	3.98	3	1	2	1.41	99	68	31	3.39	0	0	0	0.00
30NL	61440	Meso	370	295	75	4.11	7	10	-3	1.03	343	355	-12	0.64	13	10	3	0.88
30SR	61441	Meso	150	155	-5	0.40	0	0	0	0.00	136	88	48	4.54	1	0	1	1.41
29WT	61459	Meso	439	380	59	2.92	4	13	-9	3.09	467	459	8	0.37	6	12	-6	2.00
29NL	61460	Meso	27	25	2	0.39	0	0	0	0.00	23	27	-4	0.80	0	0	0	0.00
29SR	61461	Meso	172	188	-16	1.19	0	8	-8	4.00	133	165	-32	2.62	0	4	-4	2.83
29WL	61462	Meso	12	17	-5	1.31	0	0	0	0.00	14	23	-9	2.09	0	0	0	0.00
29ER	61463	Meso	24	14	10	2.29	0	0	0	0.00	23	27	-4	0.80	0	0	0	0.00
29ST	61464	Meso	108	154	-46	4.02	0	0	0	0.00	128	152	-24	2.03	0	2	-2	2.00
29WR	61465	Meso	34	65	-31	4.41	0	0	0	0.00	40	52	-12	1.77	0	0	0	0.00
29EL	61466	Meso	239	237	2	0.13	0	1	-1	1.41	276	205	71	4.58	3	1	2	1.41
29NT	61467	Meso	125	191	-66	5.25	0	0	0	0.00	133	136	-3	0.26	0	0	0	0.00
31WR	69795	Micro	397	416	-19	0.94	0	3	-3	2.45	392	378	14	0.71	0	2	-2	2.00
31SR	69796	Micro	427	432	-5	0.24	4	9	-5	1.96	448	429	19	0.91	9	3	6	2.45
31WT	69797	Micro	1225	1221	4	0.11	44	43	1	0.15	1266	1258	8	0.23	41	29	12	2.03
76ET	69812	Micro	1429	1313	116	3.13	60	58	2	0.26	1485	1554	-69	1.77	53	37	16	2.39
76NR	69813	Micro	115	147	-32	2.80	4	8	-4	1.63	121	121	0	0.00	6	2	4	2.00
76WT	69814	Micro	1514	1487	27	0.70	45	46	-1	0.15	1554	1570	-16	0.40	39	33	6	1.00
76NL	69815	Micro	142	138	4	0.34	1	1	0	0.00	145	132	13	1.10	1	0	1	1.41
76WL	69816	Micro	72	58	14	1.74	0	4	-4	2.83	79	68	11	1.28	0	0	0	0.00
76ER	69817	Micro	195	261	-66	4.37	0	3	-3	2.45	225	216	9	0.61	0	4	-4	2.83
56WT	70256	Meso	302	270	32	1.89	7	8	-1	0.37	335	317	18	1.00	14	8	6	1.81
56NL	70257	Meso	106	65	41	4.43	0	2	-2	2.00	75	70	5	0.59	0	1	-1	1.41
56SR	70258	Meso	46	54	-8	1.13	0	0	0	0.00	36	54	-18	2.68	0	0	0	0.00
56ET	70259	Meso	332	391	-59	3.10	4	14	-10	3.33	343	372	-29	1.53	3	15	-12	4.00
56NR	70260	Meso	61	58	3	0.39	0	0	0	0.00	60	48	12	1.63	0	0	0	0.00
56SL	70261	Meso	108	86	22	2.23	0	1	-1	1.41	128	84	44	4.27	0	1	-1	1.41
56ER	70262	Meso	85	41	44	5.54	0	3	-3	2.45	84	31	53	6.99	0	3	-3	2.45
56WL	70263	Meso	55	62	-7	0.92	0	0	0	0.00	66	70	-4	0.49	0	0	0	0.00
56ST	70264	Meso	114	152	-38	3.30	0	3	-3	2.45	140	119	21	1.85	0	2	-2	2.00
56EL	70265	Meso	70	76	-6	0.70	4	3	1	0.53	55	72	-17	2.13	8	0	8	4.00
56WR	70266	Meso	22	25	-3	0.62	1	0	1	1.41	41	35	6	0.97	1	0	1	1.41
56NT	70267	Meso	165	179	-14	1.07	0	5	-5	3.16	165	175	-10	0.77	0	2	-2	2.00
28NL	71068	Meso	30	17	13	2.68	0	1	-1	1.41	27	18	9	1.90	0	0	0	0.00
28SR	71069	Meso	69	75	-6	0.71	0	3	-3	2.45	86	98	-12	1.25	0	1	-1	1.41
28WT	71070	Meso	387	372	15	0.77	4	9	-5	1.96	407	400	7	0.35	6	11	-5	1.71
28ST	71071	Meso	431	425	6	0.29	3	9	-6	2.45	434	424	10	0.48	7	3	4	1.79
28WL	71072	Meso	156	142	14	1.15	3	1	2	1.41	121	141	-20	1.75	8	0	8	4.00
28EL	71073	Meso	119	108	11	1.03	3	7	-4	1.79	128	119	9	0.81	3	7	-4	1.79
28NT	71074	Meso	456	543	-87	3.89	2	11	-9	3.53	474	536	-62	2.76	5	9	-4	1.51
28WR	71075	Meso	184	154	30	2.31	0	1	-1	1.41	155	123	32	2.71	0	0	0	0.00
28ET	71076	Meso	417	458	-41	1.96	11	20	-9	2.29	449	484	-35	1.62	9	17	-8	2.22
28NR	71077	Meso	80	75	5	0.57	0	1	-1	1.41	66	61	5	0.63	1	1	0	0.00
28SL	71078	Meso	169	202	-33	2.42	0	1	-1	1.41	176	187	-11	0.82	0	0	0	0.00
39WT	71093	Micro	1319	1385	-66	1.79	46	43	3	0.45	1415	1388	27	0.72	48	28	20	3.24
39NL	71094	Micro	116	137	-21	1.87	5	2	3	1.60	116	94	22	2.15	0	2	-2	2.00
39ET	71095	Micro	2161	2048	113	2.46	78	86	-8	0.88	2236	2173	63	1.34	80	63	17	2.01
39EL	71097	Micro	219	243	-24	1.58	11	4	7	2.56	224	282	-58	3.65	10	3	7	2.75
41ET	71099	Meso	670	661	9	0.35	17	20	-3	0.70	691	613	78	3.05	20	13	7	1.72
41SL	71100	Meso	83	82	1	0.11	2	1	1	0.82	94	108	-14	1.39	0	2	-2	2.00
41WT	71101	Meso	481	495	-14	0.63	3	0	3	2.45	459	466	-7	0.33	10	4	6	2.27
41NL	71102	Meso	0	51	-51	10.10	0	7	-7	3.74	0	52	-52	10.20	0	4	-4	2.83
41EL	71104	Meso	17	54	-37	6.21	8	4	4	1.63	24	64	-40	6.03	4	3	1	0.53
41NT	71105	Meso	1210	1131	79	2.31	15	17	-2	0.50	1206	1125	81	2.37	16	13	3	0.79
41WL	71106	Meso	78	77	1	0.11	3	1	2	1.41	63	62	1	0.13	0	0	0	0.00
41ST	71108	Meso	626	631	-5	0.20	2	14	-12	4.24	601	611	-10	0.41	6	2	4	2.00
1NT	73126	Meso	195	264	-69	4.55	0	11	-11	4.69	201	280	-79	5.09	0	13	-13	5.10
1EL	73127	Meso	64	53	11	1.44	0	6	-6	3.46	64	74	-10	1.20	6	5	1	0.43
1SL	73128	Meso	283	262	21	1.27	3	3	0	0.00	293	270	23	1.37	4	3	1	0.53
1ET	73129	Meso	2189	2223	-34	0.72	88	76	12	1.33	2301	2211	90	1.89	88	78	10	1.10
1ST	73130	Meso	247	233	14	0.90	0	9	-9	4.24	272	205	67	4.34	0	7	-7	3.74
1ER	73132	Meso	116	128	-12	1.09	0	5	-5	3.16	122	136	-14	1.23	0	6	-6	3.46
1NL	73134	Meso	125	80	45	4.44	0	7	-7	3.74	138	99	39	3.58	0	3	-3	2.45
23EL	73152	Meso	614	576	38	1.56	32	24	8	1.51	611	612	-1	0.04	26	20	6	1.25
23NT	73153	Meso	2120	2120	0	0.00	78	82	-4	0.45	2271	2251	20	0.42	68	66	2	0.24
23SR	73154	Meso	898	932	-34	1.12	14	24	-10	2.29	957	985	-28	0.90	10	24	-14	3.40
23NL	73155	Meso	28	48	-20	3.24	0	2	-2	2.00	48	45	3	0.44	0	0	0	0.00
23ST	73156	Meso	2259	2328	-69	1.44	88	88	0	0.00	2383	2372	11	0.23	91	97	-6	0.62
3NL	73175	Meso	62	97	-35	3.93	2	6	-4	2.00	59	103	-44	4.89	3	3	0	0.00
3WT	73176	Meso	2022	1895	127	2.87	64	80	-16	1.89	2027	2058	-31	0.69	63	57	6	0.77
3NR	73177	Meso	58	173	-115	10.70	0	3	-3	2.45	62	129	-67	6.86	0	7	-7	3.74
3ET	73178	Meso	1866	1715	151	3.57	57	69	-12	1.51	2012	2000	12	0.27	55	46	9	1.27
3SL	73179	Meso	139	160	-21	1.72	4	11	-7	2.56	147	172	-25	1.98	0	14	-14	5.29
3NT	73180	Meso	298	269	29	1.72	0	7	-7	3.74	316	277	39	2.26	3	3	0	0.00
42ET	73195	Meso	69	182	-113	10.09	0	1	-1	1.41	75	182	-107	9.44	0	0	0	0.00
42SL	73196	Meso	71	63	8	0.98	0	0	0	0.00	66	49	17	2.24	0	0	0	0.00
42WL	73197	Meso	33	14	19	3.92	0	0	0	0.00	34	28	6	1.08	0	0	0	0.00
42ER	73198	Meso	10	19	-9	2.36	0	0	0	0.00	6	15	-9	2.78	0	0	0	0.00
42ST	73199	Meso	301	307	-6	0.34	1	3	-2	1.41	305	308	-3	0.17	0	3	-3	2.45
42WT	73200	Meso	47	102	-55	6.37	0	1	-1	1.41	48	144	-96	9.80	0	1	-1	1.41
42NL	73201	Meso	63	25	38	5.73	2	0	2	2.00	63	22	41	6.29	2	0	2	2.00
42SR	73202	Meso	236	248	-12	0.77	5	11	-6	2.12	231	222	9	0.60	5	13	-8	2.67
42WR	73203	Meso	66	21	45	6.82	1	0	1	1.41	56	14	42	7.10	1	1	0	0.00
42NT	73204	Meso	276	322	-46	2.66	4	4	0	0.00	273	322	-49	2.84	2	7	-5	2.36
42EL	73205	Meso	76	58	18	2.20	0	0	0	0.00	61	47	14	1.91	1	0	1	1.41
63EL	73214	Meso	247	254	-7	0.44	6	3	3	1.41	234	269	-35	2.21	4	7	-3	1.28
63WR	73215	Meso	24	55	-31	4.93	0	1	-1	1.41	24	34	-10	1.86	0	1	-1	1.41
63SR	73216	Meso	242	245	-3	0.19	1	4	-3	1.90	232	278	-46	2.88	0	2	-2	2.00
63WT	73217	Meso	300	294	6	0.35	2	11	-9	3.53	325	322	3	0.17	3	14	-11	3.77
63SL	73218	Meso	48	49	-1	0.14	0	0	0	0.00	60	55	5	0.66	0	0	0	0.00
63ET	73219	Meso	442	332	110	5.59	0	13	-13	5.10	458	348	110	5.48	9	15	-6	1.73
35SR	73221	Meso	42	35	7	1.13	0	0	0	0.00	31	29	2	0.37	0	0	0	0.00
35EL	73223	Meso	12	80	-68	10.03	0	1	-1	1.41	19	53	-34	5.67	0	0	0	0.00
35NT	73224	Meso	335	200	135	8.25	0	3	-3	2.45	341	193	148	9.06	7	3	4	1.79
35ER	73225	Meso	134	123	11	0.97	1	9	-8	3.58	140	173	-33	2.64	0	14	-14	5.29
35ST	73226	Meso	277	251	26	1.60	1	3	-2	1.41	283	322	-39	2.24	3	2	1	0.63
11ET	73238	Meso	516	488	28	1.25	6	13	-7	2.27	515	472	43	1.94	4	6	-2	0.89
11SL	73239	Meso	102	142	-40	3.62	4	14	-10	3.33	96	140	-44	4.05	3	16	-13	4.22
11NR	73240	Meso	39	50	-11	1.65	0	2	-2	2.00	74	43	31	4.05	0	2	-2	2.00
11WT	73241	Meso	477	445	32	1.49	1	10	-9	3.84	457	486	-29	1.34	0	7	-7	3.74
11SR	73242	Meso	43	57	-14	1.98	0	0	0	0.00	62	54	8	1.05	0	1	-1	1.41
11NL	73243	Meso	73	38	35	4.70	0	1	-1	1.41	65	50	15	1.98	0	0	0	0.00
11WR	73244	Meso	119	121	-2	0.18	6	10	-4	1.41	135	128	7	0.61	2	6	-4	2.00
11EL	73245	Meso	145	186	-41	3.19	8	4	4	1.63	163	166	-3	0.23	6	1	5	2.67
11NT	73246	Meso	172	169	3	0.23	7	17	-10	2.89	173	202	-29	2.12	15	15	0	0.00
11WL	73247	Meso	77	74	3	0.35	0	1	-1	1.41	67	92	-25	2.80	0	5	-5	3.16

11ER	73248	Meso	48	36	12	1.85	0	0	0	0.00	52	46	6	0.86	0	0	0	0.00
11ST	73249	Meso	143	157	-14	1.14	3	15	-12	4.00	142	171	-29	2.32	3	20	-17	5.01
13ET	73258	Meso	350	366	-16	0.85	2	4	-2	1.15	381	334	47	2.49	5	0	5	3.16
13SL	73259	Meso	58	106	-48	5.30	0	3	-3	2.45	67	79	-12	1.40	1	1	0	0.00
13NR	73260	Meso	300	259	41	2.45	11	8	3	0.97	293	248	45	2.74	4	5	-1	0.47
13WT	73261	Meso	386	387	-1	0.05	0	4	-4	2.83	383	383	0	0.00	0	1	-1	1.41
13SR	73262	Meso	51	65	-14	1.84	0	0	0	0.00	71	53	18	2.29	0	0	0	0.00
13NL	73263	Meso	62	25	37	5.61	0	0	0	0.00	49	36	13	1.99	0	0	0	0.00
13WL	73264	Meso	205	192	13	0.92	1	6	-5	2.67	199	194	5	0.36	0	7	-7	3.74
13ER	73265	Meso	40	36	4	0.65	0	0	0	0.00	26	31	-5	0.94	0	0	0	0.00
13ST	73266	Meso	146	203	-57	4.31	3	2	1	0.63	173	208	-35	2.54	2	1	1	0.82
7NL	73268	Meso	48	44	4	0.59	0	2	-2	2.00	48	48	0	0.00	2	1	1	0.82
7SR	73269	Meso	106	119	-13	1.23	0	7	-7	3.74	83	122	-39	3.85	0	4	-4	2.83
7ER	73270	Meso	182	184	-2	0.15	0	2	-2	2.00	183	191	-8	0.59	3	3	0	0.00
7ST	73271	Meso	371	346	25	1.32	7	3	4	1.79	385	393	-8	0.41	6	3	3	1.41
7EL	73272	Meso	155	161	-6	0.48	0	9	-9	4.24	167	158	9	0.71	0	6	-6	3.46
7NT	73273	Meso	266	198	68	4.46	10	1	9	3.84	256	216	40	2.60	0	0	0	0.00
5SL	73275	Meso	9	23	-14	3.50	0	0	0	0.00	11	31	-20	4.36	0	2	-2	2.00
5NR	73276	Meso	10	32	-22	4.80	0	0	0	0.00	7	34	-27	5.96	0	0	0	0.00
5ET	73277	Meso	325	310	15	0.84	0	12	-12	4.90	330	295	35	1.98	3	8	-5	2.13
5NT	73279	Meso	92	160	-68	6.06	0	0	0	0.00	95	128	-33	3.13	0	0	0	0.00
5EL	73280	Meso	71	42	29	3.86	0	1	-1	1.41	61	64	-3	0.38	0	0	0	0.00
5WL	73281	Meso	8	27	-19	4.54	0	0	0	0.00	10	33	-23	4.96	0	1	-1	1.41
5ST	73282	Meso	113	95	18	1.77	0	2	-2	2.00	87	62	25	2.90	0	0	0	0.00
5ER	73283	Meso	4	107	-103	13.83	0	11	-11	4.69	11	119	-108	13.40	0	13	-13	5.10
5WT	73284	Meso	146	139	7	0.59	0	11	-11	4.69	125	150	-25	2.13	2	4	-2	1.15
5SR	73285	Meso	24	29	-5	0.97	0	1	-1	1.41	27	40	-13	2.25	0	2	-2	2.00
16NT	73288	Meso	479	467	12	0.55	1	5	-4	2.31	467	463	4	0.19	1	0	1	1.41
16EL	73289	Meso	67	96	-29	3.21	0	1	-1	1.41	57	84	-27	3.22	1	0	1	1.41
16WR	73290	Meso	26	19	7	1.48	2	0	2	2.00	28	23	5	0.99	0	0	0	0.00
16ST	73291	Meso	403	367	36	1.83	4	4	0	0.00	454	389	65	3.17	5	2	3	1.60
16ER	73292	Meso	101	87	14	1.44	1	0	1	1.41	108	102	6	0.59	0	0	0	0.00
16WL	73293	Meso	65	61	4	0.50	1	1	0	0.00	70	91	-21	2.34	2	1	1	0.82
16SR	73294	Meso	156	178	-22	1.70	0	1	-1	1.41	155	184	-29	2.23	0	0	0	0.00
16NL	73295	Meso	91	89	2	0.21	0	1	-1	1.41	125	118	7	0.64	1	0	1	1.41
16WT	73296	Meso	149	223	-74	5.43	3	11	-8	3.02	115	232	-117	8.88	6	9	-3	1.10
16SL	73297	Meso	4	75	-71	11.30	0	2	-2	2.00	5	87	-82	12.09	0	0	0	0.00
16NR	73298	Meso	109	119	-10	0.94	0	3	-3	2.45	112	142	-30	2.66	0	1	-1	1.41
16ET	73299	Meso	297	361	-64	3.53	0	21	-21	6.48	289	395	-106	5.73	3	20	-17	5.01
15WL	73301	Meso	180	150	30	2.34	0	1	-1	1.41	179	160	19	1.46	0	0	0	0.00
15ST	73302	Meso	404	470	-66	3.16	4	6	-2	0.89	449	492	-43	1.98	5	2	3	1.60
15NR	73303	Meso	75	128	-53	5.26	0	1	-1	1.41	62	124	-62	6.43	1	0	1	1.41
15SL	73304	Meso	212	170	42	3.04	2	3	-1	0.63	242	164	78	5.47	6	1	5	2.67
15NT	73305	Meso	428	438	-10	0.48	2	5	-3	1.60	421	443	-22	1.06	0	0	0	0.00
15WR	73306	Meso	90	112	-22	2.19	0	1	-1	1.41	110	112	-2	0.19	0	0	0	0.00
6NR	73315	Meso	34	43	-9	1.45	0	1	-1	1.41	32	35	-3	0.52	0	0	0	0.00
6SL	73316	Meso	87	84	3	0.32	0	0	0	0.00	85	90	-5	0.53	0	0	0	0.00
6ET	73317	Meso	281	312	-31	1.80	2	1	1	0.82	312	282	30	1.74	4	3	1	0.53
6WL	73318	Meso	72	56	16	2.00	0	0	0	0.00	55	47	8	1.12	0	0	0	0.00
6ST	73319	Meso	75	70	5	0.59	0	0	0	0.00	66	81	-15	1.75	0	1	-1	1.41
6ER	73320	Meso	2	14	-12	4.24	0	0	0	0.00	3	7	-4	1.79	0	0	0	0.00
6WR	73321	Meso	19	5	14	4.04	0	0	0	0.00	34	21	13	2.48	0	0	0	0.00
6NT	73322	Meso	128	134	-6	0.52	0	1	-1	1.41	125	142	-17	1.47	0	2	-2	2.00
6EL	73323	Meso	25	19	6	1.28	0	0	0	0.00	30	33	-3	0.53	0	1	-1	1.41
6WT	73324	Meso	407	373	34	1.72	1	1	0	0.00	423	484	-61	2.86	0	2	-2	2.00
6NL	73325	Meso	0	10	-10	4.47	0	0	0	0.00	0	9	-9	4.24	0	0	0	0.00
6SR	73326	Meso	3	8	-5	2.13	0	0	0	0.00	9	12	-3	0.93	0	0	0	0.00
18ST	73344	Meso	514	475	39	1.75	6	2	4	2.00	522	522	0	0.00	10	2	8	3.27
18WL	73345	Meso	37	29	8	1.39	0	1	-1	1.41	45	24	21	3.58	0	1	-1	1.41
18NT	73346	Meso	642	603	39	1.56	0	8	-8	4.00	667	635	32	1.25	3	2	1	0.63
18WR	73347	Meso	21	13	8	1.94	0	0	0	0.00	19	18	1	0.23	0	0	0	0.00
18NR	73348	Meso	113	100	13	1.26	0	0	0	0.00	126	112	14	1.28	0	0	0	0.00
18SL	73349	Meso	54	52	2	0.27	0	2	-2	2.00	71	90	-19	2.12	0	1	-1	1.41
75SL	73351	Meso	5	10	-5	1.83	0	0	0	0.00	9	15	-6	1.73	0	0	0	0.00
75ET	73352	Meso	688	702	-14	0.53	25	20	5	1.05	700	670	30	1.15	24	17	7	1.55
75EL	73354	Meso	74	57	17	2.10	0	1	-1	1.41	51	50	1	0.14	0	0	0	0.00
75WT	73355	Meso	476	534	-58	2.58	3	8	-5	2.13	461	517	-56	2.53	10	10	0	0.00
75SR	73356	Meso	2	3	-1	0.63	7	0	7	3.74	3	4	-1	0.53	4	0	4	2.83
22ET	73381	Meso	701	723	-22	0.82	2	11	-9	3.53	771	764	7	0.25	13	11	2	0.58
22SL	73382	Meso	211	237	-26	1.74	6	12	-6	2.00	250	275	-25	1.54	9	20	-11	2.89
22WT	73383	Meso	458	530	-72	3.24	4	6	-2	0.89	501	429	72	3.34	6	2	4	2.00
22NL	73384	Meso	58	58	0	0.00	1	1	0	0.00	65	52	13	1.70	1	0	1	1.41
22NT	73385	Meso	306	292	14	0.81	4	4	0	0.00	318	294	24	1.37	7	3	4	1.79
22WL	73386	Meso	83	64	19	2.22	1	0	1	1.41	86	67	19	2.17	0	0	0	0.00
22ER	73387	Meso	105	108	-3	0.29	1	1	0	0.00	108	119	-11	1.03	0	0	0	0.00
22ST	73388	Meso	349	388	-39	2.03	4	2	2	1.15	411	417	-6	0.29	1	1	0	0.00
67NR	73421	Micro	158	183	-25	1.91	0	3	-3	2.45	145	166	-21	1.68	0	3	-3	2.45
67ET	73422	Micro	1566	1589	-23	0.58	91	114	-23	2.27	1648	1658	-10	0.25	98	105	-7	0.69
67WL	73423	Micro	37	45	-8	1.25	6	2	4	2.00	34	45	-11	1.75	3	0	3	2.45
67ER	73424	Micro	207	227	-20	1.36	9	22	-13	3.30	213	236	-23	1.54	4	23	-19	5.17
67WT	73425	Micro	1140	1268	-128	3.69	53	63	-10	1.31	1191	1293	-102	2.89	69	58	11	1.38
67NL	73426	Micro	293	360	-67	3.71	0	16	-16	5.66	317	370	-53	2.86	2	14	-12	4.24
66WT	73434	Micro	943	934	9	0.29	53	53	0	0.00	1023	971	52	1.65	59	46	13	1.79
66NL	73435	Micro	154	79	75	6.95	6	2	4	2.00	124	111	13	1.20	11	1	10	4.08
66ET	73436	Micro	1486	1443	43	1.12	82	79	3	0.33	1554	1450	104	2.68	89	83	6	0.65
66NR	73437	Micro	106	199	-93	7.53	0	3	-3	2.45	112	196	-84	6.77	0	1	-1	1.41
66ER	73438	Micro	204	202	2	0.14	10	0	10	4.47	235	240	-5	0.32	12	0	12	4.90
66WL	73439	Micro	95	133	-38	3.56	0	1	-1	1.41	100	132	-32	2.97	0	0	0	0.00
78NL	73441	Meso	19	36	-17	3.24	9	0	9	4.24	19	41	-22	4.02	7	0	7	3.74
78SR	73442	Meso	62	73	-11	1.34	0	9	-9	4.24	44	68	-24	3.21	1	7	-6	3.00
78WT	73443	Meso	973	992	-19	0.61	44	47	-3	0.44	1054	1028	26	0.81	53	42	11	1.60
78ST	73444	Meso	175	183	-8	0.60	3	0	3	2.45	194	165	29	2.16	0	1	-1	1.41
78WL	73445	Meso	23	29	-6	1.18	3	0	3	2.45	25	19	6	1.28	0	0	0	0.00
78EL	73446	Meso	122	138	-16	1.40	0	10	-10	4.47	124	160	-36	3.02	0	11	-11	4.69
78NT	73447	Meso	127	107	20	1.85	0	0	0	0.00	136	130	6	0.52	1	0	1	1.41
78WR	73448	Meso	194	146	48	3.68	5	5	0	0.00	149	165	-16	1.28	19	0	19	6.16
78ET	73449	Meso	1482	1512	-30	0.78	82	84	-2	0.22	1557	1482	75	1.92	91	72	19	2.10
78NR	73450	Meso	0	14	-14	5.29	0	0	0	0.00	0	8	-8	4.00	0	1	-1	1.41
78SL	73451	Meso	207	130	77	5.93	2	3	-1	0.63	192	129	63	4.97	3	2	1	0.63
24WL	73460	Meso	60	67	-7	0.88	1	2	-1	0.82	82	74	8	0.91	2	2	0	0.00
24ER	73461	Meso	261	260	1	0.06	2	11	-9	3.53	285	291	-6	0.35	2	14	-12	4.24
24ST	73462	Meso	146	143	3	0.25	1	1	0	0.00	159	169	-10	0.78	0	0	0	0.00
24ET	73463	Meso	515	489	26	1.16	3	10	-7	2.75	575	497	78	3.37	13	6	7	2.27
24SL	73464	Meso	27	15	12	2.62	0	1	-1	1.41	40	31	9	1.51	0	0	0	0.00
24NL	73465	Meso	175	135	40	3.21	0	5	-5	3.16	195	161	34	2.55	0	5	-5	3.16
24WT	73466	Meso	275	274	1	0.06	2	2	0	0.00	268	253	15	0.93	5	1	4	2.31
24SR	73467	Meso	43	71	-28	3.71	0	0	0	0.00	63	62	1	0.13	0	0	0	0.00
24NT	73468	Meso	225	227	-2	0.13	7	0	7	3.74	220	222	-2	0.13	13	0	13	5.10
24EL	73469	Meso	114	91	23	2.27	3	1	2	1.41	124	114	10	0.92	1	1	0	0.00
64WL	73471	Micro	310	298	12	0.69	2	4	-2	1.15	329	340	-11	0.60	5	4	1	0.47
64NL	73472	Micro	1	18	-17	5.52	0	0	0	0.00	0	17	-17	5.83	0	0	0	0.00
64WT	73473	Micro	1085	1033	52	1.60	40	49	-9	1.35	1161	1163	-2	0.06	56	41	15	2.15
64NR	73474	Micro	493	475	18	0.82	2	11	-9	3.53	533	475	58	2.58	11	8	3	0.97

64ET	73475	Micro	1740	1692	48	1.16	85	88	-3	0.32	1757	1731	26	0.62	94	76	18	1.95
61NL	73477	Micro	118	75	43	4.38	3	2	1	0.63	145	107	38	3.39	0	0	0	0.00
61WT	73478	Micro	1171	1166	5	0.15	43	54	-11	1.58	1248	1228	20	0.57	63	44	19	2.60
61SR	73479	Micro	21	10	11	2.79	2	0	2	2.00	25	14	11	2.49	3	0	3	2.45
61ER	73480	Micro	247	255	-8	0.50	2	5	-3	1.60	252	285	-33	2.01	6	2	4	2.00
61WL	73481	Micro	60	44	16	2.22	1	1	0	0.00	59	38	21	3.02	0	1	-1	1.41
61ST	73482	Micro	319	343	-24	1.32	3	3	0	0.00	351	343	8	0.43	5	1	4	2.31
61ET	73483	Micro	1700	1580	120	2.96	82	103	-21	2.18	1731	1645	86	2.09	93	79	14	1.51
61SL	73484	Micro	70	17	53	8.04	0	1	-1	1.41	83	18	65	9.15	0	1	-1	1.41
61EL	73485	Micro	88	69	19	2.14	1	1	0	0.00	103	51	52	5.93	0	1	-1	1.41
61NT	73486	Micro	331	330	1	0.06	0	3	-3	2.45	336	344	-8	0.43	0	1	-1	1.41
46WL	73488	Micro	36	54	-18	2.68	0	1	-1	1.41	37	42	-5	0.80	0	0	0	0.00
46NR	73489	Micro	135	115	20	1.79	0	0	0	0.00	139	116	23	2.04	0	0	0	0.00
46ET	73490	Micro	1842	1863	-21	0.49	81	102	-21	2.20	1932	1954	-22	0.50	91	84	7	0.75
46NL	73491	Micro	22	22	0	0.00	1	0	1	1.41	23	24	-1	0.21	1	0	1	1.41
46WT	73492	Micro	1145	1100	45	1.34	40	50	-10	1.49	1211	1230	-19	0.54	56	42	14	2.00
45WL	73494	Micro	39	44	-5	0.78	0	3	-3	2.45	26	48	-22	3.62	0	1	-1	1.41
45ST	73495	Micro	135	150	-15	1.26	3	1	2	1.41	156	162	-6	0.48	2	0	2	2.00
45WT	73496	Micro	1088	1032	56	1.72	29	51	-22	3.48	1170	1176	-6	0.18	50	43	7	1.03
45SR	73497	Micro	123	97	26	2.48	11	1	10	4.08	103	104	-1	0.10	8	1	7	3.30
45SL	73499	Micro	265	224	41	2.62	2	9	-7	2.98	253	270	-17	1.05	7	10	-3	1.03
45WR	73501	Micro	216	207	9	0.62	12	2	10	3.78	254	240	14	0.89	5	2	3	1.60
47ET	73503	Micro	1973	1830	143	3.28	73	74	-1	0.12	1948	1727	221	5.16	74	70	4	0.47
47WT	73504	Micro	977	982	-5	0.16	28	37	-9	1.58	1017	812	205	6.78	30	25	5	0.95
44SL	73506	Micro	334	328	6	0.33	17	11	6	1.60	414	331	83	4.30	16	8	8	2.31
44ET	73507	Micro	1940	1981	-41	0.93	72	83	-11	1.25	1944	2054	-110	2.46	73	48	25	3.21
44NR	73508	Micro	111	62	49	5.27	0	0	0	0.00	103	73	30	3.20	1	1	0	0.00
44WR	73509	Micro	270	323	-53	3.08	19	14	5	1.23	323	304	19	1.07	16	6	10	3.02
44EL	73510	Micro	8	18	-10	2.77	0	6	-6	3.46	11	21	-10	2.50	0	5	-5	3.16
44NT	73511	Micro	264	267	-3	0.18	0	0	0	0.00	284	277	7	0.42	0	2	-2	2.00
44WT	73512	Micro	1041	1054	-13	0.40	28	32	-4	0.73	1081	1041	40	1.23	32	19	13	2.57
44NL	73513	Micro	9	20	-11	2.89	0	0	0	0.00	11	10	1	0.31	0	0	0	0.00
44WL	73514	Micro	92	90	2	0.21	1	1	0	0.00	136	86	50	4.75	3	1	2	1.41
44ST	73515	Micro	225	243	-18	1.18	0	2	-2	2.00	263	252	11	0.69	0	2	-2	2.00
34ST	73517	Meso	530	517	13	0.57	2	14	-12	4.24	528	533	-5	0.22	5	4	1	0.47
34NT	73518	Meso	698	684	14	0.53	5	14	-9	2.92	714	667	47	1.79	8	11	-3	0.97
52NT	73533	Meso	573	612	-39	1.60	22	20	2	0.44	624	601	23	0.93	28	14	14	3.06
43ER	73536	Micro	264	321	-57	3.33	9	32	-23	5.08	309	357	-48	2.63	12	34	-22	4.59
43WL	73537	Micro	75	55	20	2.48	4	0	4	2.83	78	61	17	2.04	1	2	-1	0.82
43NL	73538	Micro	274	245	29	1.80	18	24	-6	1.31	310	248	62	3.71	23	20	3	0.65
43NR	73540	Micro	101	134	-33	3.04	8	5	3	1.18	102	138	-36	3.29	3	7	-4	1.79
43ET	73541	Micro	1741	1653	88	2.14	67	78	-11	1.29	1783	1757	26	0.62	82	52	30	3.67
50ST	73543	Meso	948	923	25	0.82	10	12	-2	0.60	949	970	-21	0.68	12	8	4	1.26
50WL	73544	Meso	153	127	26	2.20	7	8	-1	0.37	123	139	-16	1.40	5	7	-2	0.82
50NT	73546	Meso	925	933	-8	0.26	16	8	8	2.31	953	859	94	3.12	8	2	6	2.68
50EL	73547	Meso	37	22	15	2.76	0	0	0	0.00	42	23	19	3.33	2	0	2	2.00
50NR	73548	Meso	221	219	2	0.13	2	10	-8	3.27	193	197	-4	0.29	2	12	-10	3.78
50SL	73549	Meso	41	32	9	1.49	0	0	0	0.00	38	38	0	0.00	1	0	1	1.41
50ET	73550	Meso	159	159	0	0.00	0	0	0	0.00	176	149	27	2.12	0	0	0	0.00
50NL	73551	Meso	21	37	-16	2.97	0	0	0	0.00	23	45	-22	3.77	0	1	-1	1.41
50WT	73553	Meso	99	152	-53	4.73	0	0	0	0.00	92	176	-84	7.26	0	0	0	0.00
49EL	73555	Meso	555	559	-4	0.17	2	7	-5	2.36	541	476	65	2.88	2	6	-4	2.00
49NTR	73556	Meso	612	642	-30	1.20	16	12	4	1.07	642	658	-16	0.63	8	10	-2	0.67
49SR	73557	Meso	296	309	-13	0.75	1	7	-6	3.00	305	326	-21	1.18	0	3	-3	2.45
49NL	73558	Meso	62	72	-10	1.22	0	0	0	0.00	77	83	-6	0.67	0	0	0	0.00
49STL	73559	Meso	806	775	31	1.10	16	15	1	0.25	775	815	-40	1.42	16	12	4	1.07
49ETR	73560	Meso	85	102	-17	1.76	0	0	0	0.00	86	126	-40	3.89	0	1	-1	1.41
73NR	73648	Meso	529	545	-16	0.69	2	6	-4	2.00	502	505	-3	0.13	2	5	-3	1.60
73ET	73649	Meso	64	71	-7	0.85	0	0	0	0.00	76	82	-6	0.68	0	0	0	0.00
73WL	73650	Meso	273	287	-14	0.84	1	6	-5	2.67	284	337	-53	3.01	0	3	-3	2.45
73ER	73651	Meso	112	118	-6	0.56	1	1	0	0.00	116	133	-17	1.52	0	2	-2	2.00
73WT	73652	Meso	69	76	-7	0.82	0	1	-1	1.41	91	84	7	0.75	0	0	0	0.00
73NL	73653	Meso	70	38	32	4.35	0	0	0	0.00	73	46	27	3.50	0	0	0	0.00
58WT	73665	Meso	514	556	-42	1.82	3	5	-2	1.00	526	603	-77	3.24	3	7	-4	1.79
58NL	73666	Meso	336	326	10	0.55	0	4	-4	2.83	320	333	-13	0.72	0	1	-1	1.41
58ET	73667	Meso	829	861	-32	1.10	25	25	0	0.00	809	738	71	2.55	28	19	9	1.86
58NR	73668	Meso	207	249	-42	2.78	0	1	-1	1.41	216	251	-35	2.29	0	3	-3	2.45
58ER	73669	Meso	358	357	1	0.05	7	8	-1	0.37	357	375	-18	0.94	9	4	5	1.96
58WL	73670	Meso	123	74	49	4.94	1	0	1	1.41	148	85	63	5.84	0	0	0	0.00
55EL	73684	Meso	151	119	32	2.75	0	0	0	0.00	138	118	20	1.77	0	2	-2	2.00
55ET	73686	Meso	891	973	-82	2.69	25	24	1	0.20	888	842	46	1.56	28	23	5	0.99
55SL	73687	Meso	37	56	-19	2.79	0	0	0	0.00	42	74	-32	4.20	3	1	2	1.41
51ST	73689	Meso	358	374	-16	0.84	4	2	2	1.15	371	398	-27	1.38	1	3	-2	1.41
51WL	73690	Meso	293	284	9	0.53	1	3	-2	1.41	280	300	-20	1.17	4	1	3	1.90
51ER	73691	Meso	342	346	-4	0.22	5	7	-2	0.82	334	324	10	0.55	8	5	3	1.18
51NT	73692	Meso	468	481	-13	0.60	10	1	9	3.84	470	469	1	0.05	1	0	1	1.41
51EL	73693	Meso	15	15	0	0.00	0	0	0	0.00	26	17	9	1.94	0	0	0	0.00
51NR	73694	Meso	349	358	-9	0.48	2	6	-4	2.00	379	354	25	1.31	3	0	3	2.45
51SL	73695	Meso	20	9	11	2.89	2	0	2	2.00	19	25	-6	1.28	0	0	0	0.00
51ET	73696	Meso	682	713	-31	1.17	20	18	2	0.46	676	614	62	2.44	20	20	0	0.00
51NL	73697	Meso	137	78	59	5.69	4	1	3	1.90	144	80	64	6.05	6	2	4	2.00
51WT	73699	Meso	508	514	-6	0.27	1	5	-4	2.31	535	509	26	1.14	0	6	-6	3.46
54SL	73701	Meso	98	92	6	0.62	2	10	-8	3.27	102	102	0	0.00	0	6	-6	3.46
54ET	73702	Meso	861	881	-20	0.68	16	25	-9	1.99	858	815	43	1.49	18	16	2	0.49
54NT	73703	Meso	452	507	-55	2.51	23	21	2	0.43	500	494	6	0.27	28	19	9	1.86
54EL	73704	Meso	45	36	9	1.41	0	0	0	0.00	61	44	17	2.35	0	1	-1	1.41
54WL	73705	Meso	31	28	3	0.55	6	0	6	3.46	41	25	16	2.79	1	1	0	0.00
54ST	73706	Meso	535	537	-2	0.09	24	24	0	0.00	603	601	2	0.08	18	14	4	1.00
54ER	73707	Meso	200	211	-11	0.77	8	5	3	1.18	191	178	13	0.96	7	10	-3	1.03
54WT	73708	Meso	663	650	13	0.51	2	12	-10	3.78	679	687	-8	0.31	4	7	-3	1.28
54NL	73709	Meso	148	107	41	3.63	0	3	-3	2.45	136	126	10	0.87	0	2	-2	2.00
32WT	79337	Meso	519	562	-43	1.85	3	15	-12	4.00	550	561	-11	0.47	3	16	-13	4.22
32ET	79339	Meso	680	571	109	4.36	6	18	-12	3.46	677	661	16	0.62	13	22	-9	2.15
12NL	79573	Meso	72	50	22	2.82	2	0	2	2.00	64	43	21	2.87	0	0	0	0.00
12EL	79575	Meso	25	34	-9	1.66	4	0	4	2.83	35	36	-1	0.17	6	0	6	3.46
12NT	79576	Meso	121	128	-7	0.63	0	0	0	0.00	139	141	-2	0.17	0	0	0	0.00
12ST	79577	Meso	110	104	6	0.58	0	2	-2	2.00	107	122	-15	1.40	0	0	0	0.00
84ST	80097	Meso	159	126	33	2.76	1	10	-9	3.84	148	174	-26	2.05	0	13	-13	5.10
84WL	80098	Meso	0	24	-24	6.93	0	0	0	0.00	0	24	-24	6.93	0	0	0	0.00
84ER	80099	Meso	22	21	1	0.22	0	0	0	0.00	36	37	-1	0.17	0	1	-1	1.41
84NT	80100	Meso	188	213	-25	1.77	1	12	-11	4.31	188	196	-8	0.58	3	11	-8	3.02
84WR	80101	Meso	121	115	6	0.55	0	7	-7	3.74	133	133	0	0.00	3	14	-11	3.77
84SL	80103	Meso	69	81	-12	1.39	4	1	3	1.90	78	69	9	1.05	1	2	-1	0.82
84ET	80104	Meso	1952	2084	-132	2.94	50	58	-8	1.09	2029	2159	-130	2.84	53	41	12	1.75
84NL	80105	Meso	16	10	6	1.66	2	0	2	2.00	20	26	-6	1.25	1	0	1	1.41
84SR	80106	Meso	46	76	-30	3.84	0	2	-2	2.00	30	87	-57	7.45	1	3	-2	1.41
84WT	80107	Meso	1837	1841	-4	0.09	54	44	10	1.43	1882	1878	4	0.09	53	43	10	1.44
59ER	80121	Meso	224	232	-8	0.53	0	10	-10	4.47	291	272	19	1.13	0	17	-17	5.83
59ST	80122	Meso	265	363	-98	5.53	10	3	7	2.75	302	391	-89	4.78	10	1	9	3.84
59NL	80123	Meso	70	59	11	1.37	0	4	-4	2.83	78	63	15	1.79	0	5	-5	3.16
59SR	80124	Meso	97	49	48	5.62	0	0	0	0.00	96	45	51	6.07	2	0	2	2.00
59NT	80125	Meso	265	274	-9	0.55	6	3	3	1.41	264	269	-5	0.31	11	2	9	3.53
59EL	80126	Meso	67	91	-24	2.70	0	0	0	0.00	49	96	-47	5.52	0	0	0	0.00

62WT	80256	Micro	1141	1085	56	1.68	41	50	-9	1.33	1210	1219	-9	0.26	61	43	18	2.50
62SR	80257	Micro	235	266	-31	1.96	1	4	-3	1.90	282	266	16	0.97	0	1	-1	1.41
62ET	80258	Micro	1916	1873	43	0.99	86	101	-15	1.55	1936	1877	59	1.35	101	82	19	1.99
62SL	80259	Micro	139	116	23	2.04	0	4	-4	2.83	139	132	7	0.60	0	1	-1	1.41
62EL	80260	Micro	354	366	-12	0.63	1	5	-4	2.31	348	412	-64	3.28	1	1	0	0.00
62WR	80261	Micro	160	196	-36	2.70	1	1	0	0.00	201	195	6	0.43	0	3	-3	2.45
33NR	80647	Meso	128	162	-34	2.82	0	2	-2	2.00	131	172	-41	3.33	4	2	2	1.15
33ET	80648	Meso	1578	1645	-67	1.67	53	52	1	0.14	1719	1720	-1	0.02	53	36	17	2.55
33SL	80649	Meso	24	30	-6	1.15	0	1	-1	1.41	32	24	8	1.51	4	1	3	1.90
33ST	80651	Meso	198	152	46	3.48	1	2	-1	0.82	187	208	-21	1.49	3	1	2	1.41
33WT	80652	Meso	1619	1647	-28	0.69	53	46	7	0.99	1707	1696	11	0.27	46	54	-8	1.13
33NL	80653	Meso	0	10	-10	4.47	0	0	0	0.00	2	15	-13	4.46	0	0	0	0.00
33SR	80654	Meso	328	310	18	1.01	2	6	-4	2.00	313	335	-22	1.22	9	3	6	2.45
33NT	80655	Meso	266	154	112	7.73	0	4	-4	2.83	287	131	156	10.79	3	2	1	0.63
2WL	80661	Meso	138	181	-43	3.40	4	1	3	1.90	154	162	-8	0.64	2	3	-1	0.63
2ER	80662	Meso	85	81	4	0.44	0	9	-9	4.24	88	95	-7	0.73	0	10	-10	4.47
2ST	80663	Meso	385	351	34	1.77	2	4	-2	1.15	360	340	20	1.07	3	2	1	0.63
2NR	80664	Meso	96	175	-79	6.79	0	1	-1	1.41	80	161	-81	7.38	1	6	-5	2.67
2ET	80665	Meso	1818	1879	-61	1.42	53	69	-16	2.05	1983	2092	-109	2.41	54	54	0	0.00
2SL	80666	Meso	139	110	29	2.60	0	4	-4	2.83	129	116	13	1.17	3	2	1	0.63
2NL	80667	Meso	125	38	87	9.64	1	1	0	0.00	119	39	80	9.00	1	2	-1	0.82
2WT	80668	Meso	1750	1701	49	1.18	50	44	6	0.88	1781	1861	-80	1.87	55	44	11	1.56
2SR	80669	Meso	114	150	-36	3.13	10	35	-25	5.27	156	184	-28	2.15	8	11	-3	0.97
2NT	80670	Meso	198	195	3	0.21	4	1	3	1.90	193	176	17	1.25	2	0	2	2.00
2EL	80671	Meso	153	76	77	7.20	8	3	5	2.13	147	114	33	2.89	1	1	0	0.00
60WT	80701	Micro	1166	1106	60	1.78	41	52	-11	1.61	1249	1224	25	0.71	58	42	16	2.26
60NL	80702	Micro	0	14	-14	5.29	0	1	-1	1.41	0	16	-16	5.66	0	0	0	0.00
60SR	80703	Micro	55	31	24	3.66	1	0	1	1.41	59	34	25	3.67	1	0	1	1.41
60ET	80704	Micro	1757	1687	70	1.69	80	100	-20	2.11	1817	1779	38	0.90	92	81	11	1.18
60NR	80705	Micro	71	73	-2	0.24	0	1	-1	1.41	87	65	22	2.52	0	0	0	0.00
60SL	80706	Micro	29	26	3	0.57	0	0	0	0.00	31	25	6	1.13	0	0	0	0.00
60WL	80707	Micro	20	19	1	0.23	0	0	0	0.00	19	19	0	0.00	0	0	0	0.00
60ST	80708	Micro	93	147	-54	4.93	0	1	-1	1.41	77	150	-73	6.85	0	1	-1	1.41
60EL	80709	Micro	87	41	46	5.75	3	0	3	2.45	78	27	51	7.04	3	1	2	1.41
60NT	80710	Micro	193	234	-41	2.81	0	2	-2	2.00	216	201	15	1.04	0	0	0	0.00
74SR	80747	Meso	792	833	-41	1.44	8	11	-3	0.97	853	755	98	3.46	9	11	-2	0.63
74WT	80748	Meso	1917	1799	118	2.74	67	84	-17	1.96	1906	1969	-63	1.43	63	65	-2	0.25
74WR	80750	Meso	183	140	43	3.38	1	6	-5	2.67	181	156	25	1.93	1	4	-3	1.90
74ET	80751	Meso	1647	1713	-66	1.61	51	64	-13	1.71	1821	1836	-15	0.35	53	42	11	1.60
21EL	82727	Meso	2	11	-9	3.53	0	0	0	0.00	5	16	-11	3.39	0	0	0	0.00
21WR	82728	Meso	58	24	34	5.31	0	0	0	0.00	46	21	25	4.32	0	0	0	0.00
21NT	82729	Meso	215	241	-26	1.72	6	2	4	2.00	238	296	-58	3.55	7	4	3	1.28
21SL	82733	Meso	41	57	-16	2.29	3	0	3	2.45	50	49	1	0.14	0	0	0	0.00
21ET	82734	Meso	135	100	35	3.23	0	1	-1	1.41	117	114	3	0.28	0	0	0	0.00
21NR	82735	Meso	0	9	-9	4.24	0	0	0	0.00	0	12	-12	4.90	0	0	0	0.00
21ST	82736	Meso	312	364	-52	2.83	3	3	0	0.00	343	393	-50	2.61	1	2	-1	0.82
21ER	82737	Meso	93	128	-35	3.33	0	10	-10	4.47	87	96	-9	0.94	2	14	-12	4.24
21WL	82738	Meso	12	12	0	0.00	0	0	0	0.00	12	11	1	0.29	0	0	0	0.00
69WT	82740	Micro	1136	1140	-4	0.12	60	79	-19	2.28	1159	986	173	5.28	71	52	19	2.42
69ET	82742	Micro	1647	1669	-22	0.54	91	109	-18	1.80	1732	1628	104	2.54	98	81	17	1.80
65ST	82760	Micro	189	182	7	0.51	1	1	0	0.00	210	220	-10	0.68	0	0	0	0.00
65WL	82761	Micro	32	29	3	0.54	0	1	-1	1.41	40	54	-14	2.04	0	0	0	0.00
65NT	82762	Micro	215	220	-5	0.34	0	1	-1	1.41	223	214	9	0.61	0	1	-1	1.41
65EL	82763	Micro	50	104	-54	6.15	1	1	0	0.00	42	114	-72	8.15	0	2	-2	2.00
65NR	82764	Micro	34	22	12	2.27	0	0	0	0.00	43	33	10	1.62	0	0	0	0.00
65SL	82765	Micro	64	50	14	1.85	0	2	-2	2.00	60	29	31	4.65	3	0	3	2.45
65ET	82766	Micro	1650	1649	1	0.02	84	88	-4	0.43	1696	1683	13	0.32	94	74	20	2.18
65NL	82767	Micro	83	50	33	4.05	10	0	10	4.47	78	40	38	4.95	14	0	14	5.29
65SR	82768	Micro	37	40	-3	0.48	0	0	0	0.00	31	21	10	1.96	0	0	0	0.00
65WT	82769	Micro	1059	1055	4	0.12	41	49	-8	1.19	1124	1120	4	0.12	56	41	15	2.15
77ST	82771	Meso	182	186	-4	0.29	4	3	1	0.53	208	204	4	0.28	2	5	-3	1.60
77ER	82772	Meso	106	81	25	2.59	0	7	-7	3.74	101	97	4	0.40	0	2	-2	2.00
77WL	82773	Meso	45	60	-15	2.07	0	4	-4	2.83	55	54	1	0.14	1	2	-1	0.82
77NT	82774	Meso	166	176	-10	0.76	5	9	-4	1.51	156	223	-67	4.87	18	5	13	3.83
77EL	82775	Meso	36	42	-6	0.96	0	0	0	0.00	39	39	0	0.00	0	1	-1	1.41
77WR	82776	Meso	40	63	-23	3.20	0	0	0	0.00	41	63	-22	3.05	0	1	-1	1.41
77NL	82777	Meso	162	162	0	0.00	0	4	-4	2.83	150	199	-49	3.71	1	2	-1	0.82
77SR	82778	Meso	2	2	0	0.00	0	0	0	0.00	1	0	1	1.41	0	0	0	0.00
77WT	82779	Meso	254	278	-24	1.47	0	8	-8	4.00	323	343	-20	1.10	0	2	-2	2.00
77NR	82780	Meso	56	77	-21	2.58	0	4	-4	2.83	65	95	-30	3.35	0	4	-4	2.83
77SL	82781	Meso	122	115	7	0.64	1	1	0	0.00	122	132	-10	0.89	0	3	-3	2.45
77ET	82782	Meso	462	462	0	0.00	0	6	-6	3.46	437	417	20	0.97	0	2	-2	2.00
37ET	84210	Micro	2233	2191	42	0.89	80	91	-11	1.19	2263	2275	-12	0.25	79	66	13	1.53
37SL	84211	Micro	48	24	24	4.00	0	2	-2	2.00	52	30	22	3.44	0	0	0	0.00
37NR	84212	Micro	70	67	3	0.36	3	0	3	2.45	73	127	-54	5.40	0	0	0	0.00
37WT	84213	Micro	1566	1558	8	0.20	46	44	2	0.30	1639	1598	41	1.02	50	35	15	2.30
37NL	84214	Micro	27	18	9	1.90	0	0	0	0.00	22	26	-4	0.82	0	0	0	0.00
37EL	84215	Micro	32	48	-16	2.53	0	0	0	0.00	24	39	-15	2.67	2	0	2	2.00
37NT	84216	Micro	157	178	-21	1.62	0	0	0	0.00	156	176	-20	1.55	1	0	1	1.41
37WL	84217	Micro	72	113	-41	4.26	0	1	-1	1.41	78	93	-15	1.62	1	0	1	1.41
37ST	84218	Micro	150	145	5	0.41	0	1	-1	1.41	144	170	-26	2.08	0	1	-1	1.41
72WL	84220	Meso	112	79	33	3.38	0	1	-1	1.41	117	82	35	3.51	0	0	0	0.00
72ST	84221	Meso	633	594	39	1.57	8	7	1	0.37	653	704	-51	1.96	7	6	1	0.39
72SL	84223	Meso	20	24	-4	0.85	0	0	0	0.00	38	10	28	5.72	2	0	2	2.00
72NT	84224	Meso	977	1020	-43	1.36	0	6	-6	3.46	988	1002	-14	0.44	0	7	-7	3.74
36NT	88660	Meso	35	28	7	1.25	1	0	1	1.41	38	18	20	3.78	0	2	-2	2.00
36WR	88661	Meso	79	108	-29	3.00	4	1	3	1.90	78	82	-4	0.45	0	0	0	0.00
36ST	88662	Meso	63	62	1	0.13	0	2	-2	2.00	78	57	21	2.56	2	3	-1	0.63
36WL	88663	Meso	578	588	-10	0.41	1	15	-14	4.95	549	560	-11	0.47	5	2	3	1.60
36SL	88664	Meso	188	163	25	1.89	0	6	-6	3.46	184	144	40	3.12	0	4	-4	2.83
36NR	88665	Meso	857	840	17	0.58	6	14	-8	2.53	861	826	35	1.21	11	11	0	0.00
38WR	88667	Meso	986	997	-11	0.35	4	19	-15	4.42	998	933	65	2.09	7	14	-7	2.16
38NT	88668	Meso	219	238	-19	1.26	11	4	7	2.56	222	275	-53	3.36	10	3	7	2.75
40NT	88670	Meso	1206	1186	20	0.58	15	25	-10	2.24	1213	1172	41	1.19	17	16	1	0.25
40NL	88676	Meso	3	14	-11	3.77	0	0	0	0.00	4	12	-8	2.83	0	0	0	0.00
68ET	92156	Micro	1073	1047	26	0.80	85	95	-10	1.05	1088	1019	69	2.13	88	105	-17	1.73
68WT	92158	Micro	741	723	18	0.67	40	67	-27	3.69	759	717	42	1.55	47	57	-10	1.39
68SR	92159	Micro	497	549	-52	2.27	39	33	6	1.00	538	523	15	0.65	27	20	7	1.44
68NL	92160	Micro	45	45	0	0.00	0	0	0	0.00	48	37	11	1.69	0	0	0	0.00
68WR	92161	Micro	618	671	-53	2.09	10	20	-10	2.58	654	585	69	2.77	14	16	-2	0.52
68EL	92162	Micro	597	619	-22	0.89	33	36	-3	0.51	588	598	-10	0.41	36	33	3	0.51
68WL	92163	Micro	93	165	-72	6.34	4	0	4	2.83	88	143	-55	5.12	8	1	7	3.30
68ST	92164	Micro	182	195	-13	0.95	0	3	-3	2.45	181	207	-26	1.87	0	1	-1	1.41
81WT	104064	Micro	1055	1029	26	0.81	28	29	-1	0.19	1172	1162	10	0.29	31	29	2	0.37
81ET	104065	Micro	1846	1740	106	2.50	75	82	-7	0.79	1886	1832	54	1.25	85	55	30	3.59
10WL	104081	Meso	66	77	-11	1.30	0	3	-3	2.45	81	88	-7	0.76	0	1	-1	1.41
10ST	104082	Meso	211	197	14	0.98	1	18	-17	5.52	198	225	-27	1.86	1	21	-20	6.03
10NR	104083	Meso	132	133	-1	0.09	2	4	-2	1.15	116	142	-26	2.29	0	1	-1	1.41
10SL	104084	Meso	54	59	-5	0.67	1	0	1	1.41	51	79	-28	3.47	2	0	2	2.00
10NT	104085	Meso	303	311	-8	0.46	5	21	-16	4.44	355	329	26	1.41	14	17	-3	0.76
10WR	104086	Meso	8	50	-42	7.80	0	0	0	0.00	4	55	-51	9.39	0	0	0	0.00
48NT	117031	Meso	435	427	8	0.39	14	7	7	2.16	494	486	8	0.36	7	3	4	1.79
48ST	117032	Meso	503	451	52	2.38	16	11	5	1.36	475	470	5	0.23	14	12	2	0.55

4SL	117169	Meso	15	37	-22	4.31	0	0	0	0.00	13	41	-28	5.39	0	1	-1	1.41
4NR	117170	Meso	7	18	-11	3.11	0	1	-1	1.41	2	36	-34	7.80	0	0	0	0.00
4WR	117171	Meso	22	14	8	1.89	0	0	0	0.00	27	11	16	3.67	0	0	0	0.00
4NT	117172	Meso	185	249	-64	4.34	0	5	-5	3.16	188	215	-27	1.90	3	3	0	0.00
4WL	117173	Meso	15	10	5	1.41	0	0	0	0.00	7	9	-2	0.71	0	0	0	0.00
4ST	117174	Meso	110	161	-51	4.38	0	11	-11	4.69	95	150	-55	4.97	0	15	-15	5.48
52EL	13089151	Meso	24	6	18	4.65	1	7	-6	3.00	24	7	17	4.32	0	4	-4	2.83
52SR	13089152	Meso	0	0	0	0.00	0	5	-5	3.16	0	0	0	0.00	0	3	-3	2.45
31EL	13089157	Micro	878	853	25	0.85	24	32	-8	1.51	857	837	20	0.69	26	18	8	1.71
31SL	13089166	Micro	154	160	-6	0.48	0	3	-3	2.45	168	144	24	1.92	1	0	1	1.41
39SL	13089176	Micro	106	42	64	7.44	2	3	-1	0.63	90	69	21	2.36	5	2	3	1.60
38WL	13089177	Meso	107	43	64	7.39	2	3	-1	0.63	90	64	26	2.96	5	2	3	1.60
47WL	13089187	Micro	75	30	45	6.21	0	0	0	0.00	70	44	26	3.44	1	1	0	0.00
47NL	13089188	Micro	109	30	79	9.48	0	0	0	0.00	90	27	63	8.24	0	0	0	0.00
34WL	13089197	Meso	15	20	-5	1.20	1	0	1	1.41	6	45	-39	7.72	0	0	0	0.00
34WT	13089198	Meso	51	28	23	3.66	0	0	0	0.00	43	37	6	0.95	0	1	-1	1.41
34WR	13089199	Meso	30	10	20	4.47	3	0	3	2.45	33	19	14	2.75	2	0	2	2.00
34ER	13089200	Meso	127	180	-53	4.28	0	0	0	0.00	164	133	31	2.54	2	0	2	2.00
34ET	13089201	Meso	41	39	2	0.32	0	0	0	0.00	41	35	6	0.97	0	0	0	0.00
34EL	13089202	Meso	149	228	-79	5.75	0	0	0	0.00	158	183	-25	1.91	0	4	-4	2.83
34SR	13089203	Meso	103	126	-23	2.15	0	1	-1	1.41	106	85	21	2.15	0	0	0	0.00
34SL	13089204	Meso	20	16	4	0.94	0	1	-1	1.41	20	11	9	2.29	2	0	2	2.00
34NL	13089206	Meso	59	134	-75	7.63	0	6	-6	3.46	43	108	-65	7.48	0	7	-7	3.74
46SL	13089483	Micro	10	20	-10	2.58	0	2	-2	2.00	12	14	-2	0.55	0	0	0	0.00
46ST	13089484	Micro	63	67	-4	0.50	0	0	0	0.00	60	59	1	0.13	0	1	-1	1.41
46SR	13089485	Micro	26	8	18	4.37	0	0	0	0.00	10	6	4	1.41	0	0	0	0.00
46EL	13089486	Micro	7	18	-11	3.11	0	0	0	0.00	7	8	-1	0.37	0	0	0	0.00
46NT	13089487	Micro	28	42	-14	2.37	0	0	0	0.00	39	57	-18	2.60	0	0	0	0.00
48WL	13089503	Meso	41	34	7	1.14	0	1	-1	1.41	29	35	-6	1.06	2	0	2	2.00
48WR	13089504	Meso	29	16	13	2.74	1	3	-2	1.41	39	30	9	1.53	0	4	-4	2.83
48NR	13089505	Meso	9	12	-3	0.93	3	0	3	2.45	9	11	-2	0.63	1	0	1	1.41
48SL	13089506	Meso	71	47	24	3.12	0	2	-2	2.00	76	67	9	1.06	0	0	0	0.00
81NL	13089549	Micro	74	80	-6	0.68	0	0	0	0.00	64	76	-12	1.43	0	2	-2	2.00
22WR	13089736	Meso	0	2	-2	2.00	0	3	-3	2.45	0	0	0	0.00	0	4	-4	2.83
53ER	13089812	Meso	2803	2728	75	1.43	101	96	5	0.50	2932	2804	128	2.39	99	102	-3	0.30
53WL	13089814	Meso	732	693	39	1.46	8	17	-9	2.55	791	687	104	3.83	6	18	-12	3.46
33EL	13089842	Meso	436	517	-81	3.71	1	8	-7	3.30	388	516	-128	6.02	0	7	-7	3.74
35NL	13089853	Meso	136	112	24	2.16	3	12	-9	3.29	134	118	16	1.43	3	11	-8	3.02
35WL	13089854	Meso	32	44	-12	1.95	0	0	0	0.00	40	41	-1	0.16	0	1	-1	1.41
35WT	13089855	Meso	71	53	18	2.29	0	0	0	0.00	72	82	-10	1.14	0	1	-1	1.41
35WR	13089856	Meso	60	46	14	1.92	0	1	-1	1.41	56	71	-15	1.88	0	1	-1	1.41
35ET	13089857	Meso	65	51	14	1.84	0	0	0	0.00	84	94	-10	1.06	0	0	0	0.00
35NR	13089858	Meso	19	25	-6	1.28	0	0	0	0.00	17	30	-13	2.68	0	2	-2	2.00
35SL	13089859	Meso	57	35	22	3.24	0	0	0	0.00	56	76	-20	2.46	0	0	0	0.00
23ER	13090099	Meso	21	42	-21	3.74	0	0	0	0.00	15	45	-30	5.48	0	0	0	0.00
59ET	13090152	Meso	13	10	3	0.88	0	0	0	0.00	13	13	0	0.00	0	0	0	0.00
59WT	13090153	Meso	29	29	0	0.00	0	0	0	0.00	27	36	-9	1.60	0	0	0	0.00
59WL	13090154	Meso	70	40	30	4.05	0	0	0	0.00	72	53	19	2.40	0	0	0	0.00
59WR	13090155	Meso	6	18	-12	3.46	0	0	0	0.00	9	14	-5	1.47	0	0	0	0.00
59SL	13090156	Meso	1	10	-9	3.84	0	0	0	0.00	2	7	-5	2.36	0	0	0	0.00
59NR	13090157	Meso	0	1	-1	1.41	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
68SL	13090179	Micro	696	722	-26	0.98	17	25	-8	1.75	772	748	24	0.87	13	19	-6	1.50
66SL	13090338	Micro	4	36	-32	7.16	0	0	0	0.00	8	35	-27	5.82	0	0	0	0.00
66ST	13090339	Micro	63	64	-1	0.13	0	1	-1	1.41	74	57	17	2.10	0	1	-1	1.41
66SR	13090340	Micro	17	14	3	0.76	0	0	0	0.00	21	26	-5	1.03	2	2	0	0.00
66EL	13090341	Micro	8	11	-3	0.97	1	1	0	0.00	9	16	-7	1.98	0	1	-1	1.41
66NT	13090342	Micro	76	67	9	1.06	0	1	-1	1.41	88	59	29	3.38	0	1	-1	1.41
69SL	13090343	Micro	55	26	29	4.56	0	0	0	0.00	47	26	21	3.48	0	1	-1	1.41
69SR	13090345	Micro	48	47	1	0.15	0	2	-2	2.00	54	39	15	2.20	0	0	0	0.00
69EL	13090346	Micro	77	59	18	2.18	0	5	-5	3.16	58	63	-5	0.64	0	4	-4	2.83
55NR	13119550	Meso	38	64	-26	3.64	0	0	0	0.00	46	37	9	1.40	0	0	0	0.00
55WL	13119551	Meso	14	18	-4	1.00	0	0	0	0.00	13	16	-3	0.79	2	0	2	2.00
15NL	13119942	Meso	37	38	-1	0.16	2	0	2	2.00	47	24	23	3.86	1	0	1	1.41
15EL	13119943	Meso	13	39	-26	5.10	3	0	3	2.45	21	55	-34	5.52	0	0	0	0.00
63NR	13120448	Meso	5	19	-14	4.04	0	0	0	0.00	1	10	-9	3.84	0	0	0	0.00
63NL	13120449	Meso	10	19	-9	2.36	0	0	0	0.00	17	11	6	1.60	0	0	0	0.00
63ER	13120450	Meso	17	10	7	1.91	0	0	0	0.00	21	5	16	4.44	0	0	0	0.00
63WL	13120451	Meso	8	8	0	0.00	0	1	-1	1.41	9	10	-1	0.32	0	0	0	0.00
63ST	13120452	Meso	5	20	-15	4.24	0	0	0	0.00	11	14	-3	0.85	0	0	0	0.00
63NT	13120458	Meso	23	39	-16	2.87	0	0	0	0.00	30	28	2	0.37	0	0	0	0.00
64EL	13168443	Micro	16	28	-12	2.56	0	0	0	0.00	27	26	1	0.19	0	0	0	0.00
64NT	13168444	Micro	48	50	-2	0.29	0	1	-1	1.41	58	45	13	1.81	0	0	0	0.00
31ET	13405771	Micro	1485	1447	38	0.99	60	63	-3	0.38	1525	1624	-99	2.49	52	42	10	1.46
40NR	13405912	Meso	0	8	-8	4.00	0	0	0	0.00	1	9	-8	3.58	0	0	0	0.00
52ST	13405918	Meso	764	774	-10	0.36	38	23	15	2.72	836	827	9	0.31	26	22	4	0.82
52ER	13405919	Meso	340	347	-7	0.38	2	0	2	2.00	320	282	38	2.19	2	1	1	0.82
55WT	13406071	Meso	622	602	20	0.81	5	5	0	0.00	645	643	2	0.08	4	9	-5	1.96
55NL	13406072	Meso	21	23	-2	0.43	0	0	0	0.00	27	25	2	0.39	0	0	0	0.00
71WT	13406099	Meso	245	266	-21	1.31	2	5	-3	1.60	263	300	-37	2.21	0	3	-3	2.45
71WL	13406100	Meso	60	65	-5	0.63	0	0	0	0.00	67	72	-5	0.60	0	0	0	0.00
71ETR	13406104	Meso	471	474	-3	0.14	6	7	-1	0.39	454	438	16	0.76	9	6	3	1.10
71NR	13406109	Meso	83	105	-22	2.27	0	1	-1	1.41	72	113	-41	4.26	0	0	0	0.00
71NL	13406110	Meso	239	237	2	0.13	0	2	-2	2.00	225	229	-4	0.27	0	0	0	0.00
72NR	13406231	Meso	133	125	8	0.70	0	0	0	0.00	129	84	45	4.36	0	0	0	0.00
9ET	13406258	Meso	684	636	48	1.87	1	5	-4	2.31	650	635	15	0.59	3	6	-3	1.41
9WT	13406262	Meso	382	382	0	0.00	0	6	-6	3.46	439	392	47	2.31	0	4	-4	2.83
22EL	13406293	Meso	33	37	-4	0.68	2	0	2	2.00	21	37	-16	2.97	4	0	4	2.83
20WT	13406439	Meso	264	290	-26	1.56	6	7	-1	0.39	267	333	-66	3.81	7	5	2	0.82
20WL	13406440	Meso	143	132	11	0.94	0	8	-8	4.00	116	135	-19	1.70	0	4	-4	2.83
20ETR	13406443	Meso	473	495	-22	1.00	4	16	-12	3.79	522	559	-37	1.59	4	17	-13	4.01
20NL	13406448	Meso	114	134	-20	1.80	1	0	1	1.41	115	130	-15	1.36	5	0	5	3.16
20NR	13406449	Meso	140	154	-14	1.15	3	7	-4	1.79	127	172	-45	3.68	0	7	-7	3.74
21NL	13406675	Meso	105	84	21	2.16	0	14	-14	5.29	114	132	-18	1.62	0	9	-9	4.24
74EL	13406690	Meso	892	912	-20	0.67	6	13	-7	2.27	984	1078	-94	2.93	7	6	1	0.39
53ET	13406693	Meso	1754	1789	-35	0.83	50	57	-7	0.96	1987	2008	-21	0.47	53	39	14	2.06
53NL.AM	13406696	Meso																
53NR.AM	13406697	Meso																
12ET	13406725	Meso	2305	2333	-28	0.58	86	87	-1	0.11	2406	2351	55	1.13	86	93	-7	0.74
12NR	13406726	Meso	50	67	-17	2.22	1	1	0	0.00	52	79	-27	3.34	4	0	4	2.83
12SL	13406727	Meso	21	27	-6	1.22	0	0	0	0.00	35	17	18	3.53	4	0	4	2.83
12WL	13406731	Meso	20	36	-16	3.02	0	0	0	0.00	23	29	-6	1.18	0	0	0	0.00
12WT	13406732	Meso	2003	1950	53	1.19	73	82	-9	1.02	2160	2092	68	1.47	68	59	9	1.13
33WL	13406803	Meso	182	163	19	1.45	0	1	-1	1.41	179	230	-51	3.57	0	1	-1	1.41
5NL	13406817	Meso	102	96	6	0.60	0	5	-5	3.16	115	97	18	1.75	3	3	0	0.00
14STR	13406825	Meso	68	74	-6	0.71	0	0	0	0.00	67	82	-15	1.74	0	0	0	0.00
14SL	13406826	Meso	38	54	-16	2.36	0	0	0	0.00	36	45	-9	1.41	0	0	0	0.00
14WTR	13406829	Meso	366	364	2	0.10	0	2	-2	2.00	386	364	22	1.14	0	0	0	0.00
14EL	13406831	Meso	34	28	6	1.08	0	1	-1	1.41	31	21	10	1.96	3	0	3	2.45
14ETR	13406832	Meso	253	264	-11	0.68	2	3	-1	0.63	272	240	32	2.00	4	0	4	2.83
29SL	13406949	Meso	96	112	-16	1.57	0	1	-1	1.41	124	100	24	2.27	0	1	-1	1.41
29ET	13406950	Meso	400	417	-17	0.84	13	28	-15	3.31	408	448	-40	1.93	12	16	-4	1.07
29NR	13406951	Meso	40	27	13	2.25	1	0	1	1.41	48	20	28	4.80	0	0	0	0.00
27NT	13406968	Meso	572	587	-15	0.62	1	11	-10	4.08	598	569	29	1.20	5	9	-4	1.51

27NL	13406969	Meso	51	31	20	3.12	0	0	0	0.00	37	31	6	1.03	1	0	1	1.41
27EL	13406973	Meso	68	32	36	5.09	0	3	-3	2.45	51	37	14	2.11	0	1	-1	1.41
27ER	13406974	Meso	31	12	19	4.10	1	0	1	1.41	28	16	12	2.56	0	0	0	0.00
27STR	13406976	Meso	495	476	19	0.86	5	7	-2	0.82	457	483	-26	1.20	10	3	7	2.75
26STR	13406990	Meso	12	53	-41	7.19	0	1	-1	1.41	19	68	-49	7.43	0	0	0	0.00
26SL	13406991	Meso	35	25	10	1.83	0	0	0	0.00	35	34	1	0.17	0	1	-1	1.41
26WTR	13406996	Meso	101	57	44	4.95	0	2	-2	2.00	79	65	14	1.65	0	0	0	0.00
26ET	13407001	Meso	76	58	18	2.20	1	4	-3	1.90	50	51	-1	0.14	2	2	0	0.00
26EL	13407002	Meso	110	75	35	3.64	1	0	1	1.41	134	63	71	7.15	0	0	0	0.00
25STR	13407011	Meso	18	36	-18	3.46	0	0	0	0.00	15	35	-20	4.00	0	0	0	0.00
25SL	13407012	Meso	15	16	-1	0.25	0	0	0	0.00	6	14	-8	2.53	0	1	-1	1.41
25WTR	13407017	Meso	62	107	-45	4.90	0	2	-2	2.00	40	93	-53	6.50	0	1	-1	1.41
25ETR	13407022	Meso	138	124	14	1.22	3	4	-1	0.53	120	109	11	1.03	2	1	1	0.82
25EL	13407023	Meso	48	34	14	2.19	0	1	-1	1.41	47	37	10	1.54	0	0	0	0.00
14WL	13603367	Meso	46	26	20	3.33	1	2	-1	0.82	44	30	14	2.30	0	0	0	0.00
14NTR	13603369	Meso	83	124	-41	4.03	0	1	-1	1.41	103	162	-59	5.13	0	0	0	0.00
14NL	13603370	Meso	8	18	-10	2.77	0	1	-1	1.41	17	14	3	0.76	0	0	0	0.00
19SL	13603378	Meso	15	24	-9	2.04	0	0	0	0.00	15	51	-36	6.27	0	0	0	0.00
19STR	13603393	Meso	390	443	-53	2.60	5	10	-5	1.83	426	392	34	1.68	6	12	-6	2.00
19NT	13603399	Meso	449	398	51	2.48	6	12	-6	2.00	498	484	14	0.63	9	6	3	1.10
19NL	13603400	Meso	33	49	-16	2.50	0	1	-1	1.41	27	83	-56	7.55	0	0	0	0.00
19ER	13603404	Meso	50	55	-5	0.69	0	0	0	0.00	64	63	1	0.13	0	0	0	0.00
19EL	13603405	Meso	29	30	-1	0.18	0	1	-1	1.41	28	45	-17	2.81	0	1	-1	1.41
21WT	13603995	Meso	117	98	19	1.83	0	0	0	0.00	116	113	3	0.28	0	0	0	0.00
32WL	13604612	Meso	31	15	16	3.34	0	1	-1	1.41	21	11	10	2.50	0	0	0	0.00
32ER	13604614	Meso	16	19	-3	0.72	0	0	0	0.00	16	17	-1	0.25	0	0	0	0.00
32NL	13604615	Meso	17	50	-33	5.70	0	0	0	0.00	15	16	-1	0.25	0	0	0	0.00
32NR	13604617	Meso	16	30	-14	2.92	0	1	-1	1.41	22	18	4	0.89	0	1	-1	1.41
41SR	13606020	Meso	0	0	0	0.00	0	2	-2	2.00	0	1	-1	1.41	0	2	-2	2.00
1WT.AM	13608779	Meso																
1WR.AM	13608780	Meso																
1WR.PM	13608783	Meso	439	388	51	2.51	6	0	6	3.46	428	443	-15	0.72	7	3	4	1.79
1WT.PM	13608784	Meso	1905	1958	-53	1.21	73	70	3	0.35	2035	1977	58	1.29	68	51	17	2.20
1WL.AM	13608787	Meso																
1WL.PM	13608788	Meso	80	76	4	0.45	0	0	0	0.00	93	78	15	1.62	0	1	-1	1.41
53NL.PM	13608794	Meso	1983	1985	-2	0.04	87	83	4	0.43	2076	2123	-47	1.03	83	71	12	1.37
53NR.PM	13608795	Meso	739	719	20	0.74	20	19	1	0.23	800	820	-20	0.70	13	12	1	0.28
70ET	13610952	Meso	363	435	-72	3.60	3	5	-2	1.00	415	443	-28	1.35	2	3	-1	0.63
70ER	13610953	Meso	23	31	-8	1.54	1	0	1	1.41	27	24	3	0.59	3	0	3	2.45
70NL	13610954	Meso	2	0	2	2.00	0	0	0	0.00	0	1	-1	1.41	0	0	0	0.00
70NR	13610955	Meso	54	35	19	2.85	0	1	-1	1.41	72	35	37	5.06	0	0	0	0.00
70WT	13610956	Meso	22	41	-19	3.39	0	3	-3	2.45	27	32	-5	0.92	0	1	-1	1.41
70WL	13610957	Meso	84	69	15	1.71	4	0	4	2.83	92	73	19	2.09	3	0	3	2.45
21SR	13611251	Meso	63	85	-22	2.56	0	0	0	0.00	92	92	0	0.00	0	0	0	0.00
45ET	13611806	Micro	1762	1763	-1	0.02	75	99	-24	2.57	1835	1839	-4	0.09	87	78	9	0.99
45EL	13612038	Micro	225	246	-21	1.37	5	6	-1	0.43	250	258	-8	0.50	3	1	2	1.41
43WT	13612111	Micro	1063	1073	-10	0.31	21	29	-8	1.60	1155	1190	-35	1.02	33	28	5	0.91
61NR	13613542	Micro	81	54	27	3.29	3	0	3	2.45	80	63	17	2.01	0	0	0	0.00