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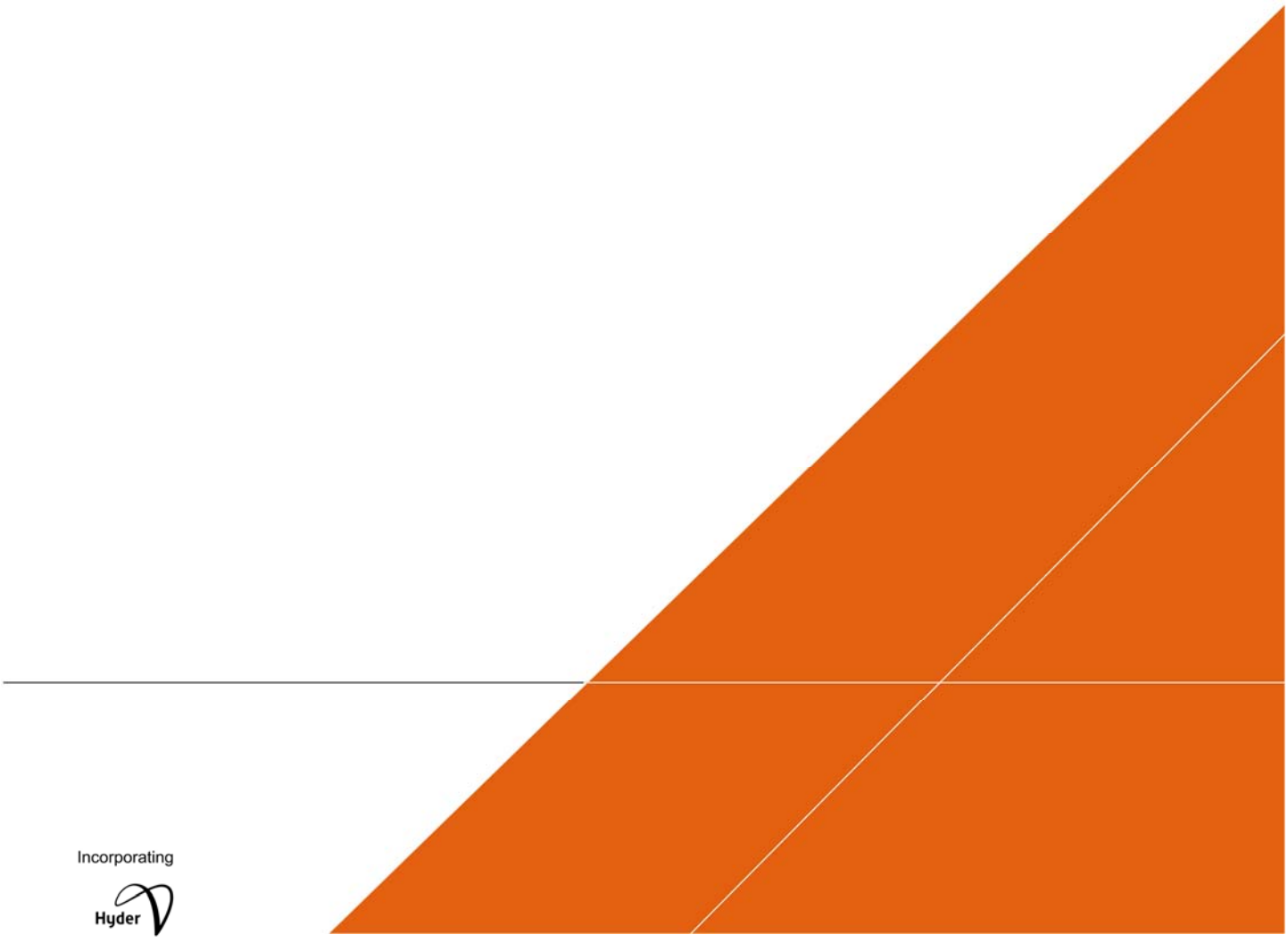
MULGOA ROAD/CASTLEREAGH ROAD CORRIDOR UPGRADE BETWEEN GLENMORE PARKWAY AND ANDREWS ROAD

VOLUME 1 – Traffic and Transport Assessment Study



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ROADS AND MARITIME
MULGOA ROAD / CASTLEREAGH ROAD CORRIDOR UPGRADE BETWEEN GLENMORE PARKWAY AND ANDREWS ROAD

Traffic and Transport Assessment Study

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REVISIONS

Revision	Date	Description	Prepared by	Approved by
A	Oct/Nov 2015	Draft Report for internal review	MW, MR, SI	
B/C	20Nov 2015	Draft Report submitted to client for comments	MR, MW	MR
D	4 May 2016	Draft Final	SI,MR,MW	MR
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CONTENTS

EXECUTIVE SUMMARY

Overview

Roads and Maritime is investigating an upgrade to Mulgoa Road / Castlereagh Road over a distance of about 6.1 kilometres between Glenmore Parkway (southern extent) and Andrews Road (northern extent). The proposed upgrade includes widening of the Mulgoa Road / Castlereagh Road from existing four lanes divided carriageway to six lanes divided carriageway including upgrading all intersections and staging them to meet the future traffic demand. The proposed upgrade would improve travel speed for through and local traffic, improve the reliability of journeys and provide more consistent driving conditions. The proposed upgrade would improve local amenity, access to Penrith Central Business District and improve road safety by reducing the crash rate.

Mulgoa Road and Castlereagh Road is an important commuter, freight and bus route and provides access to Penrith, Glenmore Park, and Jamisontown. The road provides a north-south connection between Glenmore Parkway and Andrews Road. It is located in the suburb of Penrith within the Penrith Local Government Area (LGA). Mulgoa Road and Castlereagh Road is currently a four-lane two-way road. Other key roads in the study include M4 Western Motorway and Great Western Highway.

Purpose of this Report

This report details the traffic and transport assessment of the upgrade. In the course of preparing this traffic and transport report relevant documents associated with the project have been reviewed, and potential traffic impacts on the road network have been assessed. The assessment identified upgrade works required for the project to maximise the performance of the road network for traffic. Future traffic growth data was sourced from Roads and Maritime's Strategic Highway Network Model (EMME). A road based traffic model was built for the study area using VISSIM micro simulation modelling software. The VISSIM model for the study area was calibrated and validated for 2015 traffic conditions for both morning and afternoon weekday peak periods. The EMME model provided forecast traffic volumes within the project study area for existing and future model years (2016, 2026 and 2036).

This traffic and transport assessment report has been prepared to support the strategic concept design for the proposed upgrade to Mulgoa Road / Castlereagh Road between Glenmore Parkway and Andrews Road.

Existing Road Network Operation

The traffic volumes on Mulgoa Road / Castlereagh Road corridor is steadily increasing with a high proportion of through vehicles carrying out trips within Penrith LGA. The corridor between Glenmore Parkway and Andrews Road has 17 sets of traffic signals[1] and three roundabouts. The large number of traffic signals along the corridor exacerbates stop-start traffic conditions causing delay and congestion. A substantial portion of the peak hour traffic travelling on the corridor is through traffic, conflicting with CBD local trips. The traffic congestion on the corridor is predicted to intensify as a result of continuing population and employment growth due to developments in Penrith CBD, Penrith Panthers and Penrith Lakes Development. During the morning and afternoon

[1] A new traffic signal at Masters Development is currently under construction. The 17 sets of signals also include two signals within the Jane Street / Mulgoa Road Infrastructure project.

peak periods, the Mulgoa Road and Castlereagh Road and its intersections experience considerable level of traffic congestion.

In 2015, Mulgoa Road / Castlereagh Road carried between 30,000 and 44,000 vehicles per day in a typical weekday condition, depending on sections. During weekends, traffic on Mulgoa Road / Castlereagh Road was found to be nine per cent to 22 per cent lower than the weekday traffic. In 2015, about 2,000 to 5,500 heavy vehicles were counted, equating to seven per cent to 15 per cent of daily traffic on the Mulgoa Road / Castlereagh Road.

Traffic volume has increased consistently on Mulgoa Road / Castlereagh Road between 1993 and 2015, with an average growth rate of 1.2 per cent per annum over the 22 year period.

The existing Mulgoa Road / Castlereagh Road experiences traffic congestion and delays during weekday peak traffic periods. During both morning and afternoon peak hours a substantial amount of turning traffic contributes to capacity problems at critical intersections, particularly on the section of Mulgoa Road / Castlereagh Road between the M4 Western Motorway and Andrews Road (refer to Figure E-1 below).

Figure E-1-1 Existing Traffic Congested Areas

Travel speed on Mulgoa Road / Castlereagh Road during the weekday peak period reduces substantially below the posted speed of 60 kilometres per hour. The 2015 survey indicates that motorists travel about 10 to 35 kilometres per hour from Museum Drive to M4 Western Motorway, and about 35 to 40 kilometres per hour from Andrews Road to Museum Drive and from M4 Western Motorway to Glenmore Parkway. The average travel speed for the entire corridor from Glenmore Parkway to Andrews Road was about 20 to 30 kilometres per hour.

There were 322 crashes recorded between 2009 and 2013 on the Mulgoa Road / Castlereagh from Andrews Road to Glenmore Parkway. About 37 per cent of crashes involved injury and 63 per cent were non-casualty crashes. The five year crash data showed that about 155 people were injured. It is likely that safety would deteriorate along Mulgoa Road / Castlereagh Road and associated intersections in their current

configuration for all road users as traffic levels and congestion increase, which is of on-going and substantial concern to Roads and Maritime and the local community.

Traffic Implications of Doing Nothing

The traffic congestion on the Mulgoa Road / Castlereagh is predicted to intensify as a result of continuing population and employment growth in the Penrith LGA, with developments being planned at Penrith Panthers, Penrith Lakes, Thornton, Masters, Bulky Goods and High Street. It is estimated that these would increase traffic growth to 2.0 per cent when fully developed by 2036. The future condition traffic analysis has found that if no action is taken to improve the traffic flow on the Mulgoa Road / Castlereagh from Glenmore Parkway to Andrews Road, the following is likely to occur:

- Major congestion at a number of key intersections during peak periods in the next five (2020) to ten years (2026) extending throughout a large part of the day. Of the 16 key intersections analysed, 10 intersections showed poor level of service F in 2020 either in morning or afternoon peak periods
- The Mulgoa Road / Castlereagh Road would be highly congested and there would be increased delays and queuing along the corridor
- Local amenity and access to the Penrith CBD would continue to decline due to increased traffic, as would other road related impacts such as noise and localised air quality
- The efficiency of public transport and freight would decline with reduced travel speed.

Proposed Upgrade

The proposed upgrade for the Mulgoa Road / Castlereagh Road from Glenmore Parkway to Andrews Road involves widening the road from existing four lanes to six lanes including staged upgrades to all intersections to meet the traffic demand. The Mulgoa Road / Castlereagh Road upgrades excludes the Jane Street and Mulgoa Road Infrastructure Upgrade which is being delivered by Roads and Maritime as a separate project. It is expected that the future upgrade of Mulgoa Road / Castlereagh Road would be an extension of the Jane Street and Mulgoa Road Infrastructure Upgrade project.

The proposed upgrade would improve reliability of journey times, including for buses, particularly during peak travel periods for the entire corridor from Glenmore Parkway to Andrews Road. The six lanes widening would increase road capacity of the Mulgoa Road / Castlereagh Road corridor which would support population and employment growth associated with developments in Penrith CBD, Penrith Panthers and Penrith Lakes Development.

Traffic modelling carried out for the six lanes upgrade indicated that key intersections within the corridor would provide a level of service E or better in 2036. An assessment of the current and future traffic volumes travelling on the existing road network has found that the Mulgoa Road / Castlereagh Road project is needed to improve the efficiency of the road network.

Staging Assessment

The proposed six lanes upgrade for the Mulgoa Road / Castlereagh Road can be progressively delivered in stages to cater for the forecast increase in traffic volumes between 2015 and 2036. The traffic model tested three future development scenarios (or growth models), referred to as the 'short term', 'medium term' and 'long term' development scenarios as follows:

- Short term: The short term development scenario is anticipated to be realised sometime between 2016 and 2020. For the short term, the modelling year of 2020 was assessed
- Medium term: The medium term development scenario is anticipated to be realised sometime between 2020 and 2026. For medium term, the modelling year of 2026 was assessed
- Long term: The long term development scenario is anticipated to be realised sometime between 2026 and 2036. For long term, the modelling year of 2036 has been assessed

The proposed improvements recommended for short term, medium term and longer term are outlined below and shown in Figures from E-2 to E-4.

Short term – 2020

1. Convert Andrews Road roundabout to traffic signal
2. Castlereagh Road upgrade (6 lanes) between Coreen Avenue and Union Road
3. Intersection upgrades at i) Coreen Avenue, ii) Peachtree Road
4. Jane Street and Mulgoa Road Infrastructure Upgrade (separate project)
5. Proposed upgrade at M4 Smart Motorway Ramps (separate project)
6. Mulgoa Road upgrade (6 lanes) between Blaikie Street and Glenmore Parkway
7. Convert Glenmore Parkway roundabout to traffic signal

Intersection	2020 Do Nothing		2020 Short Term Upgrade	
	AM	PM	AM	PM
Andrews Road	F	F	C	C
Jack William Drive	D	E	A	B
Coreen Avenue	F	F	C	C
Peachtree Road	D	F	B	C
Museum Drive	C	F	A	A
Jane Street	D	F	B	B
High Street	E	F	C	D
Union Road	D	F	A	A
Ransley Street	B	E	B	B
Panther Place	A	C	A	A
Jamison Road	D	E	C	C
Batt Street	B	E	B	C
Blaikie Street	A	F	B	B
Wolseley Drive (Retaining Mouse Hole Tunnel) [1]	B	B	A	A
M4 ramps	F	C	C	B
Glenmore Parkway	E	C	B	B

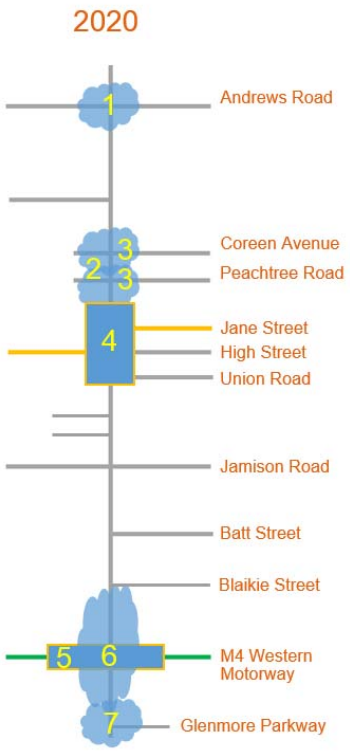


Figure E-1-2 Proposed Short Term Upgrade

Medium term – 2026

1. Intersection upgrade at i) Jamison Road, ii) Panther Place and iii) Ransley Street

2. Mulgoa Road upgrade (6 lanes) between Union Road and Blaikie Road

Intersection	2026 Do Nothing		2026 Medium Term Upgrade	
	AM	PM	AM	PM
Andrews Road	F	F	C	C
Jack William Drive	E	E	B	B
Coreen Avenue	F	F	D	C
Peachtree Road	D	F	C	C
Museum Drive	C	F	A	A
Jane Street	D	F	B	C
High Street	F	F	C	D
Union Road	E	F	A	A
Ransley Street	D	F	B	B
Panther Place	B	F	A	A
Jamison Road	F	F	C	C
Batt Street	B	F	A	B
Blaikie Street	A	F	A	B
Wolseley Drive (Retaining Mouse Hole Tunnel) [1]	B	E	A	A
M4 ramps	F	F	C	C
Glenmore Parkway	F	F	B	B

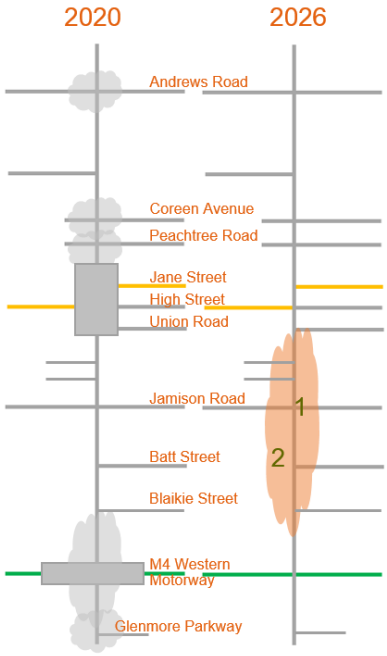


Figure E-1-3 Proposed Medium Term Upgrade

Long term – 2036

1. Mulgoa Road upgrade (6 lanes) between Andrews Road and Coreen Avenue

2. Intersection upgrades at i) Lugard Street, ii) Jack William Drive

Intersection	2036 Do Nothing		Ultimate Strategic Concept	
	AM	PM	AM	PM
Andrews Road	F	F	C	C
Jack William Drive	F	F	B	B
Coreen Avenue	F	F	D	C
Peachtree Road	D	F	C	C
Museum Drive	B	F	B	B
Jane Street	C	F	C	D
High Street	F	F	D	D
Union Road	F	F	A	A
Ransley Street	E	F	B	B
Panther Place	B	F	A	A
Jamison Road	F	F	D	C
Batt Street	D	F	B	C
Blaikie Street	A	F	A	D
Wolseley Drive (Retaining Mouse Hole Tunnel) [1]	B	F	A	A
M4 ramps	F	F	C	C
Glenmore Parkway	F	F	B	C

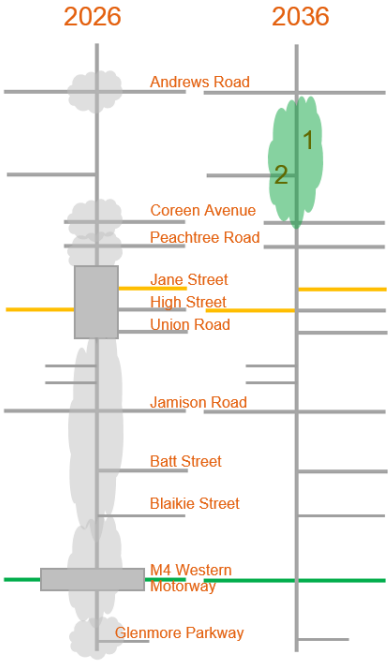


Figure E-1-4 Proposed Long Term Upgrade

The improvements identified for short term (2020), medium term (2026) and long term (2036) would substantially improve the level of service for the Mulgoa Road / Castlereagh Road from Glenmore Parkway to Andrews Road. If proposed improvements identified in short, medium and longer term are implemented, traffic modelling predicts level of service between A and E for key analysed intersections in 2036.

1 INTRODUCTION

1.1 Background

Roads and Maritime Services (Roads and Maritime) is investigating an upgrade to Mulgoa Road and Castlereagh Road over a distance of about 6.1 kilometres between Glenmore Parkway (southern extent) and Andrews Road (northern extent). This section of Mulgoa Road generally has a four lane configuration (two travel lanes in each direction) divided by a central median. The Mulgoa Road and Castlereagh Road connects the Penrith Central Business District (CBD) with other parts of Greater Sydney by providing a key link to the M4 Western Motorway.

Investigations for the section of Mulgoa Road between Museum Drive and Union Road are more advanced than for the other stages. A Preferred Option Report was completed for the Jane Street and Mulgoa Road Infrastructure Upgrade (Roads and Maritime Services, 2014). The Jane Street and Mulgoa Road Infrastructure Upgrade Preferred Option Report identified Option 12 as the best performing option for the section of Mulgoa Road between Museum Drive and Union Road.

In February 2015 the NSW Government indicated that it would commit $5 million to planning for a broader upgrade of Mulgoa Road and Castlereagh Road between Andrews Road and Glenmore Park Drive, which would include road widening, intersection improvements and turning lane upgrades (the Project). The Project objectives include:

- Improve traffic efficiency which will address specific traffic congestion issues and achieve a level of service of E or better in 2036
- Support residential growth
- Support employment growth
- Improve freight productivity
- Improve road safety
- Support public transport use
- Encourage active transport use
- Improved amenity

It is expected that the future upgrade of Mulgoa Road and Castlereagh Road would be an extension of the Jane Street and Mulgoa Road Infrastructure Upgrade project. It is also expected to be integrated with other road network and transport infrastructure upgrades planned and committed for the area, in particular the potential widening of The Northern Road, which runs parallel to Mulgoa Road.

Figure 1-1 below shows this section of Mulgoa Road and Castlereagh Road in its regional context.

Figure 1-2 below shows the project to increase its' capacity to six lanes in stages as follows:

- Jane Street and Mulgoa Road Infrastructure Project. This separate project involves upgrading of Mulgoa Road / Castlereagh Road between Union Road & Museum Drive and the intersections at Jane Street, High Street, Mulgoa Road, and the Great Western Highway
- Mulgoa Road Castlereagh Road Corridor Upgrade:
  - Mulgoa Road widening from the M4 Western Motorway to Union Road
  - Castlereagh Road widening from Museum Drive to Andrews Road,
  - Mulgoa Road widening from Glenmore Parkway to the M4 Western Motorway.

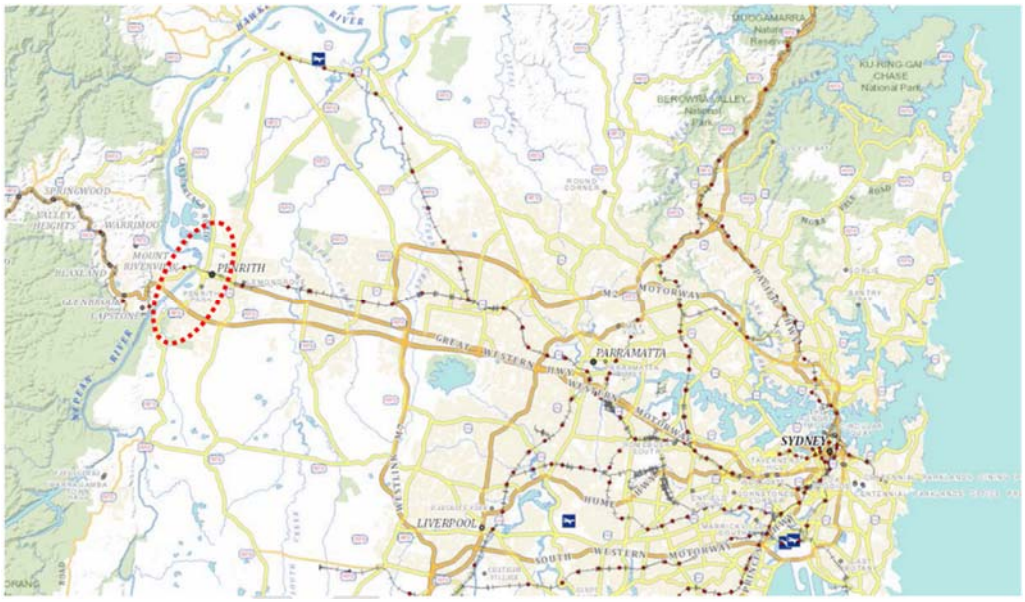


Figure 1-1 Locality Map (Source: Six Maps October 2015)

Figure 1-2 Corridor Upgrade Extent (Source: Community Upgrade August 2015)

1.2 Report Purpose

The following document is a Traffic and Transport Assessment (hereafter referred to as 'the study') of the strategic concept design of Mulgoa Road / Castlereagh Road from Glenmore Parkway to Andrews Road at Penrith ('the study area'). During the morning and afternoon peak periods, the Mulgoa Road and Castlereagh Road and its intersections experience considerable level of traffic congestion.

Roads and Maritime commissioned Arcadis Australia Pacific (Arcadis) to prepare a road based traffic model to identify network capacity issues that affect the performance of Mulgoa Road and Castlereagh Road between Glenmore Parkway and Andrews Road. The purpose of Arcadis' study was to assess the strategic concept design of the proposed upgrade from traffic point of view.

In the course of preparing this report relevant documents associated with the Project have been reviewed, and potential traffic impacts on the road network have been assessed. The study provides recommendations to Roads and Maritime on potential upgrading works at key intersections required to maximise the performance of the upgrade.

The study has been prepared in consultation with Roads and Maritime, including presentation of traffic modelling outcomes, a value management workshop, and participation in design meetings. Feedback from Roads and Maritime staff was incorporated in the study development and outcomes at various stages of Arcadis' investigation.

This Traffic and Transport Assessment Report has been prepared to support the strategic concept design of the proposed upgrade for Mulgoa Road / Castlereagh Road from Glenmore Parkway to Andrews Road.

1.3 Study Area

Mulgoa Road and Castlereagh Road are strategic routes which provide access to the M4 Western Motorway, Great Western Highway, Richmond, Penrith, Mulgoa and Wallacia. The Mulgoa Road and Castlereagh Road corridor provides a north-south link between Glenmore Parkway and Andrews Road. The corridor is located in the suburb of Penrith within the Penrith local government area (LGA). Mulgoa Road and Castlereagh Road is currently a four-lane, two way road.

Figure 1-3 below shows the study area for the purpose of traffic modelling.

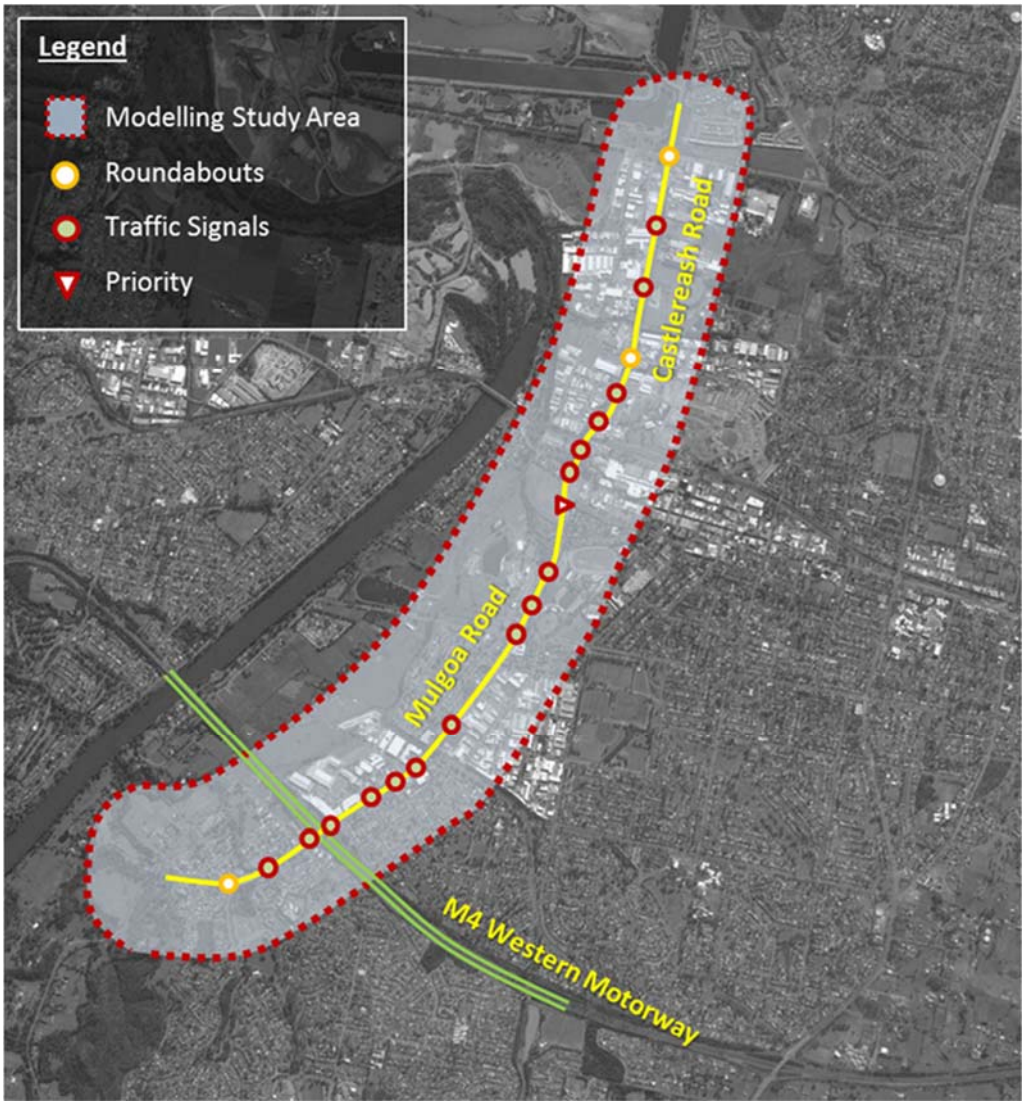


Figure 1-3 Castlereagh Road to Mulgoa Road Corridor – Traffic Modelling Study Area

Table 1-1 below shows study specifications and key intersections along the corridor.

Table 1-1 Study Area and Key Intersections

Mulgoa Road / Castlereagh Road Study Area	Specifications
Corridor Length	6.1 km in total 3.9 km Mulgoa Road 2.3 km Castlereagh Road
Number of Lanes	4 lanes (2 lanes each way)
Speed Limit	60 km/h
Key Intersections along Mulgoa Road / Castlereagh Road corridor	
1 Motorway Interchange	M4 Western Motorway / Mulgoa Road Interchange
3 roundabout intersections	Andrews Road / Castlereagh Road Coreen Avenue / Mullins Road / Castlereagh Road Glenmore Parkway / Mulgoa Road
14 signalised intersections	Lugard Street / Castlereagh Road Jack Williams Drive / Castlereagh Road Peachtree Road / Thornton Drive / Castlereagh Road Museum Drive / Castlereagh Road Jane Street / Castlereagh Road Great Western Highway / High Street / Mulgoa Road Ransley Street / Mulgoa Road Panther Place / Mulgoa Road Jamison Road / Mulgoa Road Batt Street / Mulgoa Road Blaikie Road / Mulgoa Road Glenbrook Street / Mulgoa Road Wolseley Street / Mulgoa Road Spencer Street / School House Road / Mulgoa Road
4 un-signalised intersections	Union Road / Mulgoa Road Rodley Avenue / Mulgoa Road Willoring Crescent / Mulgoa Road Factory Road / Jeanette Street / Mulgoa Road

1.4 Study Scopes

The scope of the study is to assess the traffic performance of proposed Mulgoa Road / Castlereagh Road upgrades. Traffic modelling results were used to assess the upgrades proposed in the strategic concept design.

A road based micro-simulation traffic model was developed for the study area using VISSIM software. Key objectives of the traffic modelling assessment were to:

- Determine the ultimate intersection footprint and level of service of the proposed upgrades taking into account expected traffic growth until 2036
- Identify options for improvements to traffic flow on Mulgoa Road / Castlereagh Road and associated intersections. This included an assessment of at-grade solutions based on traffic modelling outcomes
- Identify the timing of the upgrades required at Mulgoa Road / Castlereagh Road from traffic point of view
- Prepare a Traffic and Transport Assessment Report to support the strategic concept design of the proposed upgrade.

1.5 Strategic Concept Design

Roads and Maritime prepared the strategic concept design for the Mulgoa Road / Castlereagh Road upgrade and includes the following key features:

- Widening of the Mulgoa Road and Castlereagh Road from existing four lanes divided carriageway to six lanes divided carriageway and staging them to meet the future traffic demand
- Design speed 70 km/hr
- Provision of shared pathways and pedestrian / cyclist facilities
- Provision of bus priority treatments at signalised intersections
- Proposed smart motorway improvement at the M4 Western Motorway \ Mulgoa Road interchange. Roads and Maritime is carrying out investigation work for the proposed M4 Smart Motorway. The strategic concept design of the proposed Mulgoa Road /Castlereagh Road upgrade has considered the proposed upgrade at Mulgoa Road interchange with M4 Western Motorway (Figure 1-4)
- Jane Street and Mulgoa Road Infrastructure Upgrade. Roads and Maritime is carrying out investigation work for the proposed upgrade on Jane Street and Mulgoa Road. The Mulgoa Road and Castlereagh Road upgrade between Andrews Road and Glenmore Park has considered Jane Street and Mulgoa Road Infrastructure Upgrade project (Figure 1-5).

Jane Street and Mulgoa Road Infrastructure Upgrade project consist of the following proposed upgrade:

- Widening od Mulgoa Road / Castlereagh Road between Museum Drive and Union Road
- Intersection upgrade at High Street / Mulgoa Road
- Intersection upgrade at Jane Street / Castlereagh Road
- Lengthening of rail bridge to allow for widening of Castlereagh Road

Figure 1-4 M4 Smart Motorway Project

Figure 1-5 Jane Street and Mulgoa Road Infrastructure Upgrade Project

1.6 Study Approach

Key steps in the study approach included the following:

1. **Traffic surveys** - A new traffic survey was conducted in May 2015. This provided key input to base case model development, calibration and validation. Four types of data were collected including intersection turning movement counts, midblock traffic counts, queue length, and travel time survey
2. **Data analysis and results presentation -** The traffic survey data was analysed to provide existing traffic volumes on the road network
3. **VISSIM model development for the study area** - The existing base case VISSIM model was developed using the May 2015 counts.
4. **Base VISSIM model calibration / validation (AM peak)** - The base model calibration and validation was carried out as per the Roads and Maritime's Traffic Modelling Guidelines, Version 1.0 (February 2013) for the AM peak
5. **Base VISSIM model calibration / validation (PM peak) -** The base model calibration and validation was carried out as per the Roads and Maritime's Traffic Modelling Guidelines, Version 1.0 (February 2013) for the PM peak
6. **Development of the Future base case models -** Future year demand trip tables used in the VISSIM models were based on Roads and Maritime's Strategic Highway Network Model (EMME).
7. **Modelling strategic concept design of proposed upgrade options** – Assess six lanes proposed upgrade for Mulgoa Road / Castlereagh Road from Glenmore Parkway to Andrews Road
8. **Traffic and Transport Analysis Report –** Prepare a standalone traffic report supporting the proposed upgrades for Mulgoa Road / Castlereagh Road from Glenmore Parkway to Andrews Road.

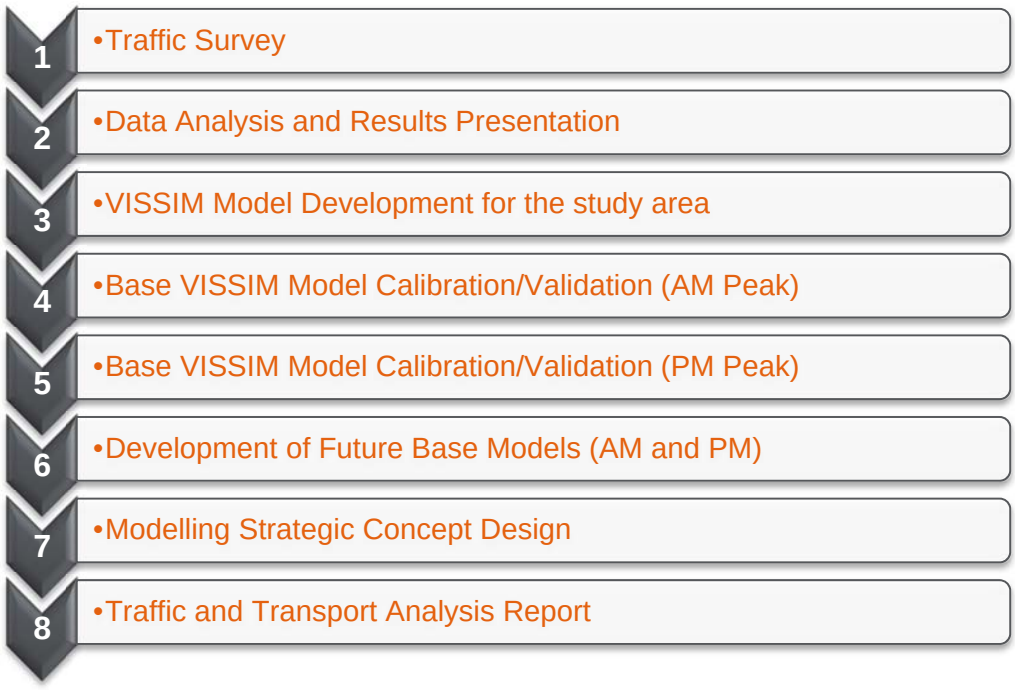


Figure 1-6 Overview of Arcadis' Modelling Approach

The study has been prepared in consultation with Roads and Maritime and key stakeholders. Stakeholder workshops were carried out over the course of this study. The stakeholder group was made up of representatives from the following organisations:

- Roads and Maritime
- Transport for NSW
- Penrith City Council.

Feedback from Roads and Maritime staff was incorporated into the traffic and transport study findings at various stages of Arcadis' investigation.

1.7 Reference Traffic Study, Data and Modelling

For the purpose of the study, future traffic growth and modelling data was sourced from Roads and Maritime's Strategic Highway Network Model (EMME). Arcadis used appropriate traffic growth data from EMME model relevant to the study area. In consultation with Roads and Maritime, a new traffic survey was carried out to satisfy the need and purpose of the traffic modelling. This included intersection classified turning movement counts (car and heavy vehicle), midblock traffic counts, queue length and travel time survey. The new traffic survey was carried out by Skyhigh in May 2015.

For the purpose of traffic modelling VISSIM micro simulation modelling software was used.

A traffic report was prepared by Roads and Maritime for the Mulgoa Road and The Northern Road corridor titled "Mulgoa Road–The Northern Road Upgrade from Great Western Highway to M4 Motorway (Roads and Maritime, March 2015). The purpose of the report was to investigate strategic options to upgrade Mulgoa Road and The Northern Road between the Great Western Highway and M4 Western Motorway. The future traffic growth and modelling data in Mulgoa Road–The Northern Road Upgrade study was used from Strategic Highway Network Model (EMME). Arcadis has carried out a brief technical review of future traffic volumes (EMME) used for this study particularly on the justification to upgrade both Mulgoa Road and The Northern Road corridors.

Arcadis review concurs the following modelling outcomes and recommendations made by RMS within that report including:

- Road capacity analysis undertaken for The Northern Road and Mulgoa Road corridors appear to be reasonable and in line with the industry practice. The mid-block road capacity and performance analysis used appropriate traffic data from EMME
- The section of Mulgoa Road between Great Western Highway and M4 Western Motorway particularly the section between the M4 Western Motorway and Jamison Road has almost reached its capacity
- Widening of either of the above sections of Mulgoa Road or The Northern Road to six lanes will only attract a small number of vehicles from one corridor to another without any major changes to the current and the planned road network system in the area
- There will be a need to upgrade the both Mulgoa Road and The Northern Road between the Great Western Highway and M4 Western Motorway to meet future traffic growth along these corridors.

1.8 Report Structure

The Mulgoa Road / Castlereagh Road Corridor Upgrade between Glenmore Parkway and Andrews Road Study Report is produced in two volumes. This report forms Volume 1.

VOLUME 1- EXECUTIVE SUMMARY AND REPORT

The Traffic and Transport Assessment Report – Volume 1 contains the following six chapters providing an assessment of the proposed upgrades on the Mulgoa Road /Castlereagh Road between Glenmore Parkway and Andrews Road:

- Chapter 1 Introduction – Provides an overview of the project, report purpose and study approach
- Chapter 2 Existing Traffic and Transport Conditions – Provides an overview of the regional / local context, key intersections, road network / hierarchy, historical traffic growth, current transport mode share, existing land use, crash data, public transport and cycling / walking connectivity
- Chapter 3 Existing Road Network Performance – Provides an overview of the traffic survey and congestion observed along the corridor
- Chapter 4 VISSIM Model Development – Provides an overview of the model development and model demand and calibration / validation
- Chapter 5 Future Traffic Conditions – Provides land use assumptions and future traffic volumes on the corridor
- Chapter 6 Traffic Assessment on Strategic Concept Design – Provides traffic assessment of options modelled. This section also documents staging of the proposed six lane upgrades

VOLUME 2 - APPENDICES

Detailed VISSIM model development, calibration and validation, existing and future traffic volumes are included in Volume 2 as appendices to Volume 1. The appendices are as follows:

- Appendix A Existing and Future Traffic Volumes
- Appendix B VISSIM Model Development, Calibration and Validation
- Appendix C Ultimate 80% Strategic Concept Design (RD0001 - RD0012)

The economic evaluation of the proposed upgrades have been documented separately in a standalone report prepared by Arcadis.

2 EXISTING TRAFFIC AND TRANSPORT CONDITIONS

The existing traffic and transport conditions in the study area are described within this chapter. It provides the regional and local transport context within which the assessment has been carried out.

2.1 Regional Context

The regional context of the Mulgoa Road /Castlereagh Road between Glenmore Parkway and Andrews Road project area is presented in Figure 2-1. The project study area is located in the west of Greater Sydney, NSW and falls within the Penrith LGA adjacent to the Penrith CBD. Penrith CBD is generally bounded by the Western / Blue Mountains Rail Line in the north, Castlereagh Road / Mulgoa Road in the west, Evan Street in the east, and Union Road and Lethbridge Street in the south. Penrith is about 30 kilometres west of Parramatta, and 50 kilometres west of Sydney, and is known as the Gateway to the Blue Mountains. It is about 10 kilometres south of the North West Growth Centre and about 10 kilometres north of the Broader Western Sydney Employment Area.

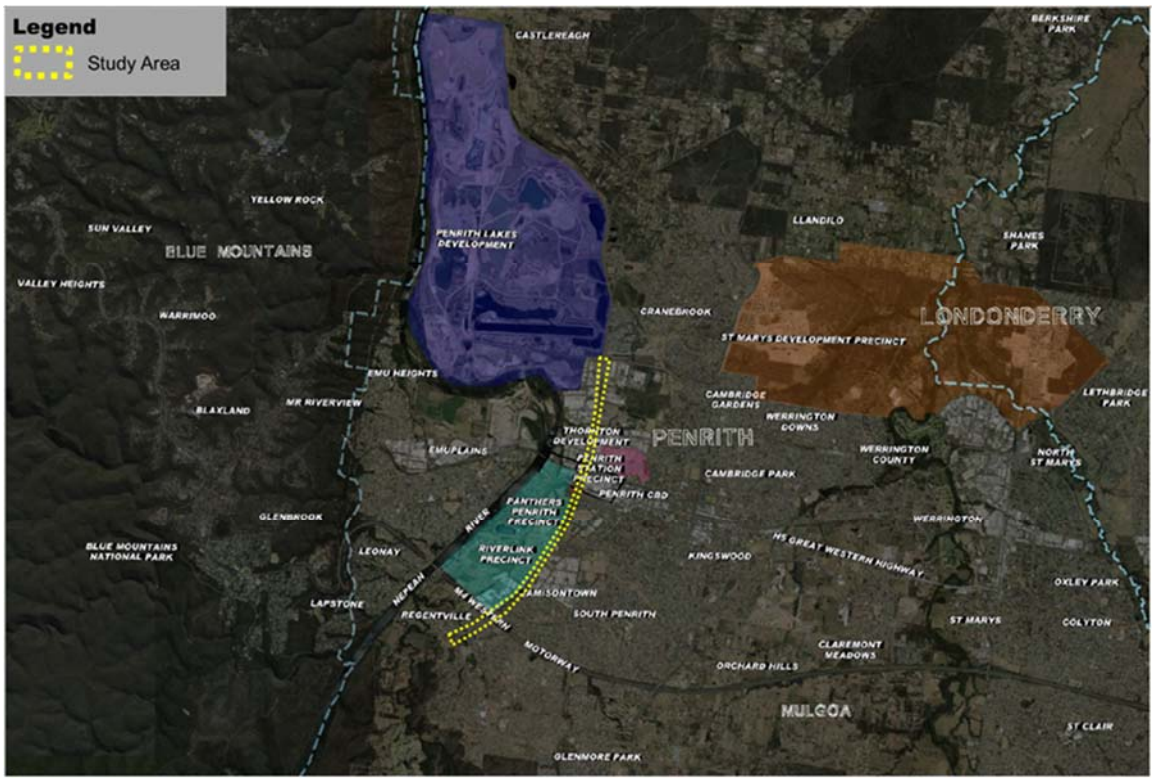


Figure 2-1 Regional Context of Mulgoa Road/Castlereagh Road between Glenmore Parkway and Andrews Road

2.2 Local context

Mulgoa Road and Castlereagh Road is a key strategic route and provides access to Penrith, Glenmore Park, and Jamisontown. The road provides a north-south connection between Andrews Road and Glenmore Parkway. It is located in the suburb of Penrith within The Penrith LGA. Mulgoa Road and Castlereagh Road is currently a four-lane two-way road. Other key local roads in the study include M4 Western Motorway and Great Western Highway.

The posted speed limit on Mulgoa Road and Castlereagh Road is currently 60 kilometres per hour between Andrews Road and Glenmore Parkway, 60 kilometres per hour on Great Western Highway, 50 kilometres per hour on Jane Street, and 110 kilometres per hour on M4 Western Motorway. Posted speed limits in the vicinity of the study area are shown in Figure 2-2.

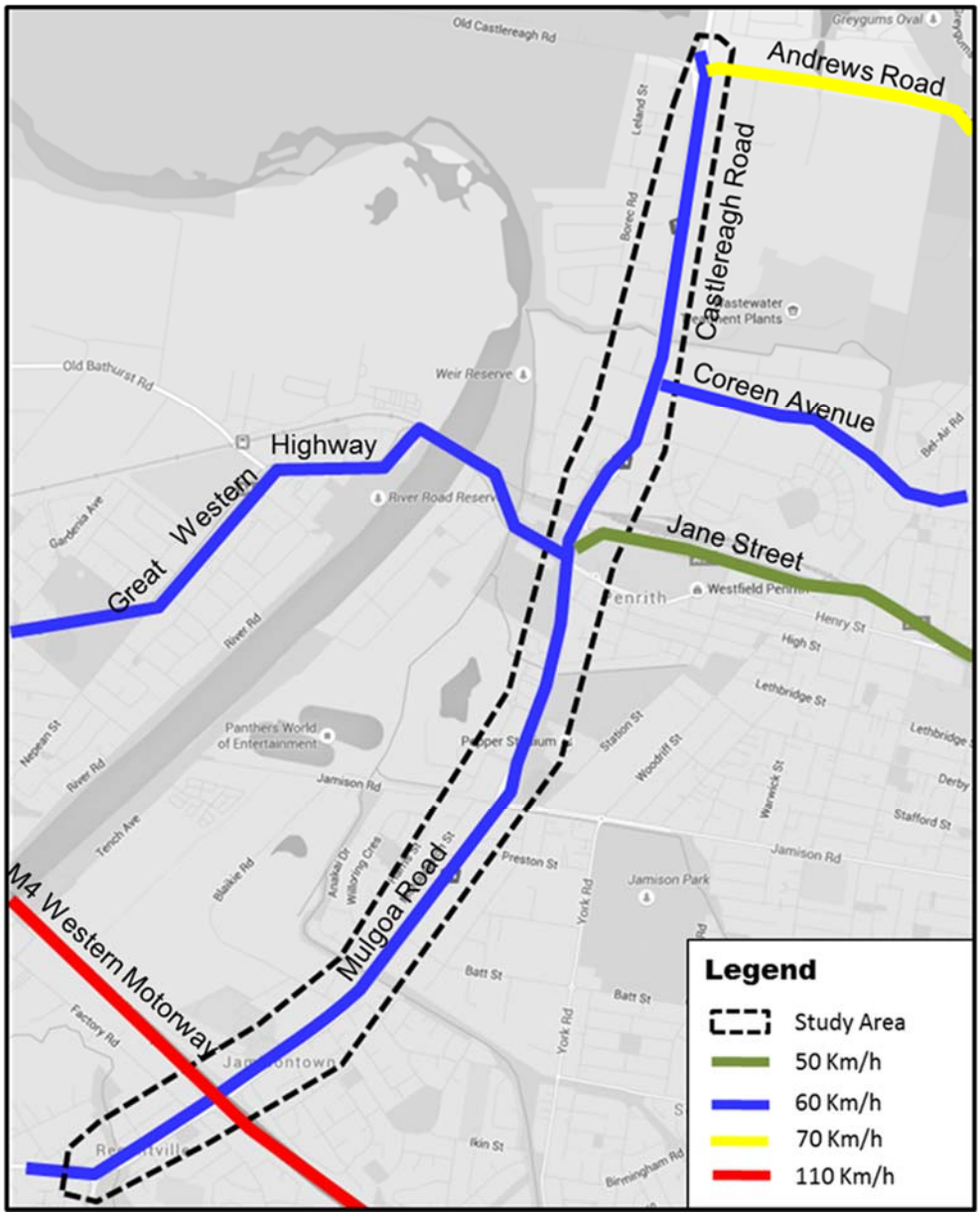


Figure 2-2 Posted Speed Limits in the Study Area

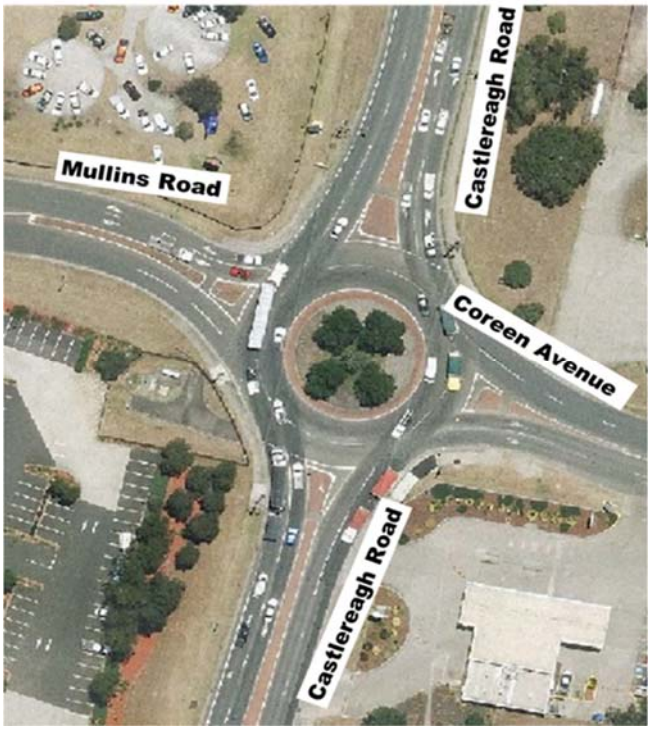
2.3 Road Network and Key Intersections

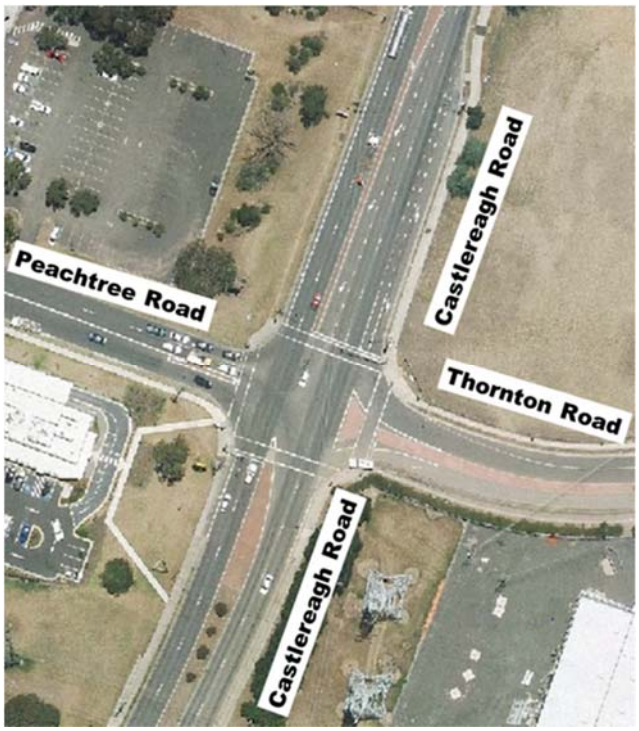
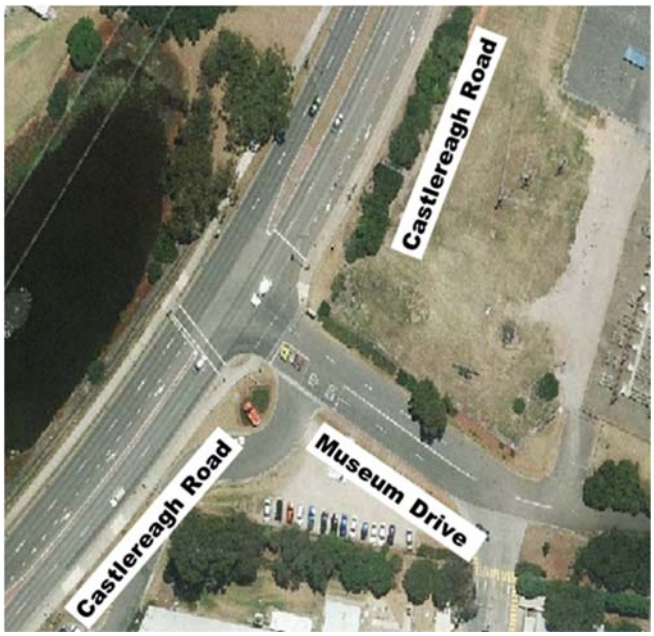
Mulgoa Road and Castlereagh Road is a north south transport corridor linking Richmond to Wallacia. Mulgoa Road and Castlereagh Road is an important stretch of road in the far west. The corridor also connects to the Great Western Highway via Castlereagh Road and M4 Motorway via Mulgoa Road.

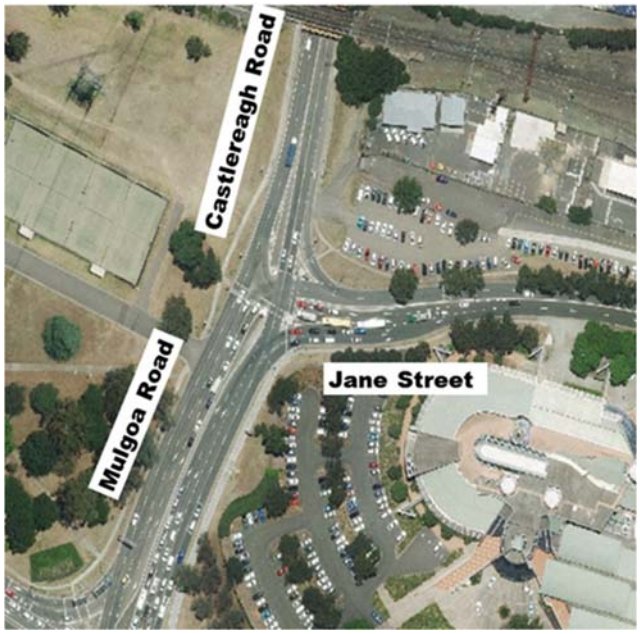
The traffic volumes on the Mulgoa Road and Castlereagh Road corridor is steadily increasing with a high proportion of through vehicles undertaking trips within Penrith LGA. The Mulgoa Road and Castlereagh Road corridor has 16 sets of traffic signals, three roundabouts and one priority intersection. Due to the amount of traffic signals on the corridor, they exacerbate stop-start traffic conditions causing delay and congestion. A substantial portion of the peak hour traffic travelling on the existing corridor is through traffic, conflicting with local trips. The traffic congestion on the highway is predicted to intensify as a result of continuing population growth due to the development of the Penrith CBD and the Riverlink Precinct / Panthers Penrith. The existing lane configurations at key intersections within the study area are shown in Table 2-1.

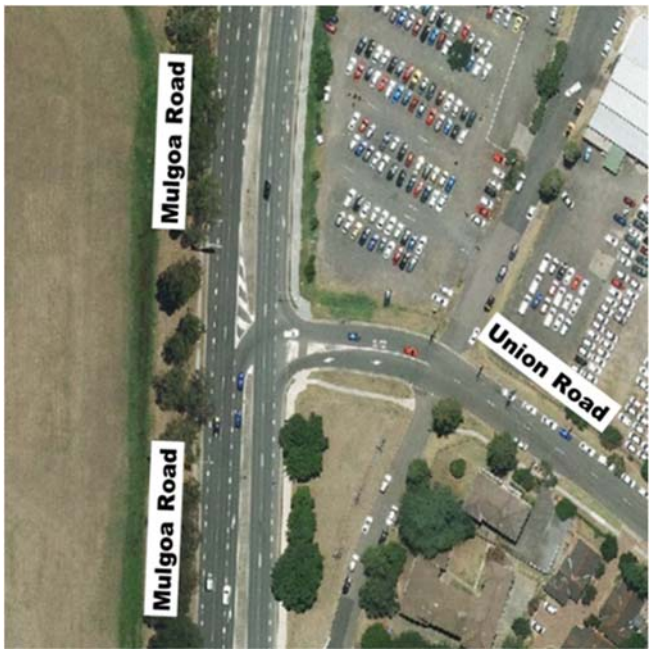
Table 2-1 Existing Lane Configurations at Key Intersections

Intersection	Configuration
Castlereagh Road / Old Castlereagh Road /Andrews Road	Two lane roundabout on the northern extent of the study area. Andrews Road is an important link to the east, providing access to The Northern Road corridor further to the east. 

Intersection	Configuration
Castlereagh Road / Jack Williams Drive	Three leg signalised intersection with left-turn slip lanes and a southbound right-turn bay. Jack Williams Drive provides access into the industrial lands to the west. 
Castlereagh Road / Mullins Road / Coreen Avenue	Two lane roundabout servicing as a major link to the east and industrial lands to the west. 

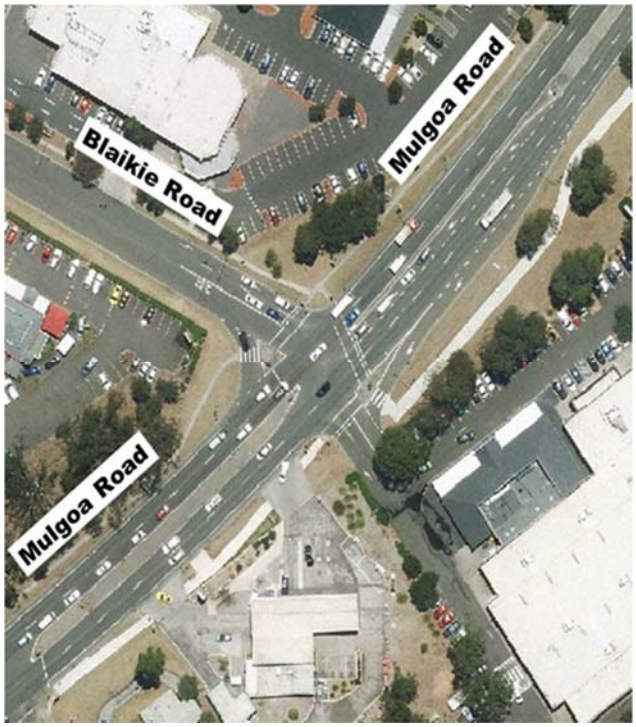
Intersection	Configuration
Castlereagh Road / Peachtree Road / Thornton Drive	Four leg signalised intersection with protected northbound and southbound right-turn bays. Thornton Drive provides access to the new Thornton development on the eastern side and Peachtree Road provides access to the industrial land on the western side. 
Castlereagh Road / Museum Drive	Three leg signalised intersection with a northbound right-turn bay. Museum Drive provides access into the Lions Dairy site and the Museum Of Fire. 

Intersection	Configuration
Castlereagh Road / Jane Street	Three leg signalised intersection with a left-turn slip lanes and a northbound dual lane right-turn bay. Jane Street servicing as a major link to the Penrith CBD in the east. 
Mulgoa Road / High Street	Four leg signalised intersection with left-turn slip lanes, dual southbound right-turn bays, single northbound right turn bay and right turn bays on High Street (eastbound and westbound). Great Western Highway servicing as a major link to Emu Plains in the west. High Street provides alternate access to Penrith CBD in the east. 

Intersection	Configuration
Mulgoa Road / Union Road	Un-signalised intersection with a northbound right turn bay and left only from Union Road. Currently allowing left in, left out and right in traffic movements. 
Mulgoa Road / Rodley Avenue	Un-signalised intersection which only left in traffic movement is allowed. 

Intersection	Configuration
Mulgoa Road / Ransley Street	Four leg signalised intersection with protected northbound and southbound right-turn bays. Ransley Street provides access to the Penrith Panthers site on the west and to private open space on the east of Mulgoa Road corridor. 
Mulgoa Road / Panther Place	Three leg signalised intersection with left-turn slip lanes and a southbound right-turn bay. Panther Place provides access to the Penrith Panthers site. 

Intersection	Configuration
Mulgoa Road / Jamison Road	Four leg signalised intersection with right-turn bays on all legs. This intersection is one of the busiest intersection along the corridor. The intersection caters for traffic movements into and out of Jamison Road eastbound and westbound. This intersection is the main point south of the Penrith CBD, where buses enter and exit Mulgoa Road. The final 2 kilometres to the Penrith Bus Interchange is travelled by buses along Jamison Road and Station Street. 

Intersection	Configuration
Mulgoa Road / Batt Street Mulgoa Road / Willoring Crescent	Three leg signalised intersection with a northbound right-turn bay and a southbound left-turn slip. Batt Street provides access into the industrial lands on the eastern side of Mulgoa Road. Willoring Crescent on the southern side on the intersection provides access for the local residential lands on the western side of Mulgoa Road. 
Mulgoa Road / Blaikie Road	Four leg signalised intersection with a southbound left slip lane and southbound right turn bay. This intersection servicing the commercial lands on the east and west of the Mulgoa Road corridor. 

Intersection	Configuration
Mulgoa Road / Wolseley Street	Three leg signalised intersection with a grade separated tunnel for the southbound right-turn to Wolseley Street. The intersection also includes a northbound left turn slip lane on Mulgoa Road into Wolseley Street. 
Mulgoa Road / M4 Motorway Interchange	Full grade separated diamond interchange comprises two signalised intersections. The south intersection provides access from the M4 Westbound to Mulgoa Road and access from Mulgoa Road to the M4 Westbound. The north intersection providing access from the M4 Eastbound to Mulgoa Road and access from Mulgoa Road onto the M4 Eastbound. 

Intersection	Configuration
Mulgoa Road / Glenmore Parkway	Three leg two lane roundabout. The predominant movement through the roundabout is Glenmore Parkway to Mulgoa Road (North). 

2.4 Road Hierarchy

Roads and Maritime, in co-operation with local councils, defines the functional road hierarchy in an urban area to establish a consistent basis for traffic management. The key road categories and their functions are stated as below:

- State Roads- Freeways / Motorways and Primary Arterials
- Regional Roads- Secondary or Sub Arterials
- Local Roads- Collector and Local access roads.

The road hierarchy for the study area is shown in Figure 2-3. The classification criteria are sourced from NSW Road classification Review Panel- reclassified 2009 and the associated maps sourced from the Roads and Maritime website.

Figure 2-3 Road Hierarchy within the Study Area

Note: Local roads are not shown in the map
Sources: Classification road maps, Greater Sydney area, RMS 2011

2.5 Heavy Vehicles

Currently heavy vehicles use three key routes within the study area including Mulgoa Road / Castlereagh Road, M4 Western Motorway and Great Western Highway / Jane Street.

2.5.1 High Vehicle Routes (4.6 Metres)

Figure 2-4 below shows approved routes for the 4.6 metres high vehicles within study area. The 4.6 metres high vehicles can travel along the Mulgoa Road until Jane Street, where they need to detour via Jane Street to The Northern Road to travel further north. The 4.6 metres high vehicles do not travel on Castlereagh Road north of Jane Street mainly due to the height clearance at the railway bridge, which is 4.4 metres.

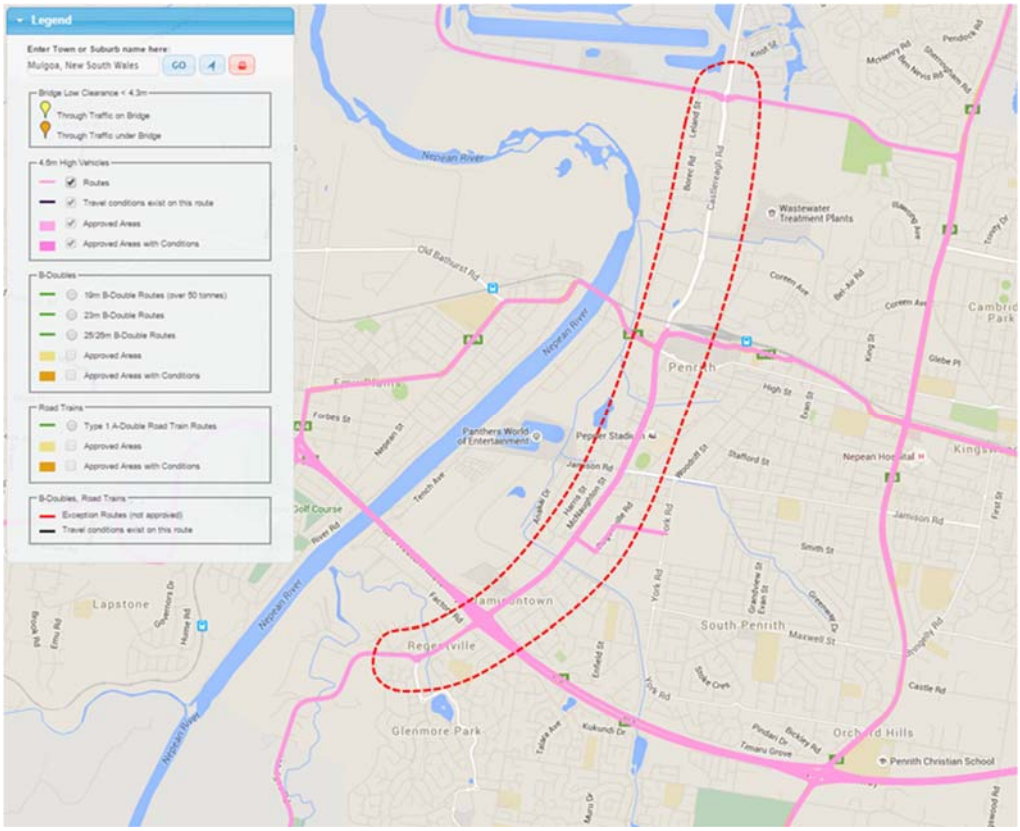


Figure 2-4 Designated 4.6 Metres High Vehicles Routes in the Study Area

Source: RMS Restricted Access Vehicle Map NSW (map as of 2 November 2015)

2.5.2 B-Double Routes

The B-Double routes for 25/26 metres vehicles are shown in Figure 2-5. The primary B-Doubles routes are Mulgoa Road / Castlereagh Road, Great Western Highway, Jane Street. Andrews Road, Coreen Avenue and Jamison Road.

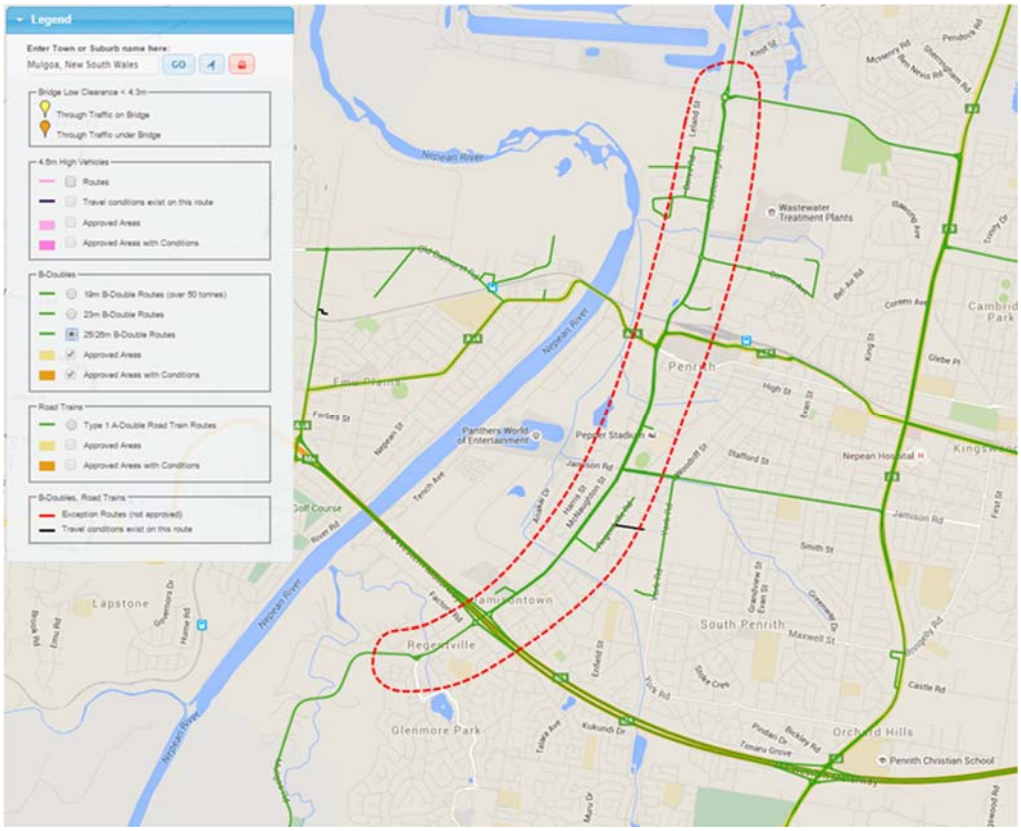


Figure 2-5 Designated B-Double Routes in the Study Area

Source: RMS Restricted Access Vehicle Map NSW (map as of 2 November 2015)

2.5.3 A-Double Road Train Routes

Currently there are no A-Double routes within the study area.

2.5.4 Heavy Vehicle Volumes

Table 2-2 below summarises the 2015 counted heavy vehicles on study area network. Currently Mulgoa Road / Castlereagh from Glenmore Parkway to Andrews Road carries about 2,000 to 5,600 heavy vehicles on an average weekday depending on sections. The section between M4 Western Motorway and Museum Drive carried about 3,800 to 5,600 heavy vehicles per day. The section between Glenmore Parkway and M4 Western Motorway carried about 2,000 heavy vehicles per day. The heavy vehicles proportion was recorded between 7 per cent (near Glenmore Parkway) to 15 per cent (near Jane Street).

Table 2-2 Daily Heavy Vehicles on Various Sections of Mulgoa Road

Site ID	Road Sections	Average Weekday		
		All Vehicles	Heavy Vehicles	% Heavy Vehicles
M-1	Castlereagh Road- 200m north of Jack Williams Drive	31,823	3491	11%
M-2	Castlereagh Road- between Museum Drive and Jane Street	36,025	5523	15%
M-3	Mulgoa Road- between Rodley Avenue and Ransley Street	34,684	3854	11%
M-4	Mulgoa Road- at Surveyors Creek Bridge	40,439	5598	14%
M-5	Mulgoa Road- between Spencer Street and Glenmore Parkway	28,888	2054	7%

Source: ATC survey-May 2015

2.5.5 Freight Services

The number of heavy vehicles moving freight along the Mulgoa Road /Castlereagh Road is substantial and will continue to grow in the foreseeable future. This will place pressure on these road corridors to support expected future growth as part of the overall traffic demand. Therefore, it is critical that the road capacity is improved to handle the future freight movements along these sections of Mulgoa Road /castle Road which are approved MHL B-Double routes.

2.6 Commuter Mode Share

The Bureau of Transport Statistics (BTS) provides journey to work data for the Sydney Greater Metropolitan Area which comprises of a comprehensive sample of commuter travel, collected during the 2011 Census. Work trip origin and destinations are coded to the 2011 travel zones and showed in Figure 2-6. Table 2-3 summarises the work trips by mode of travel reported for the study area.

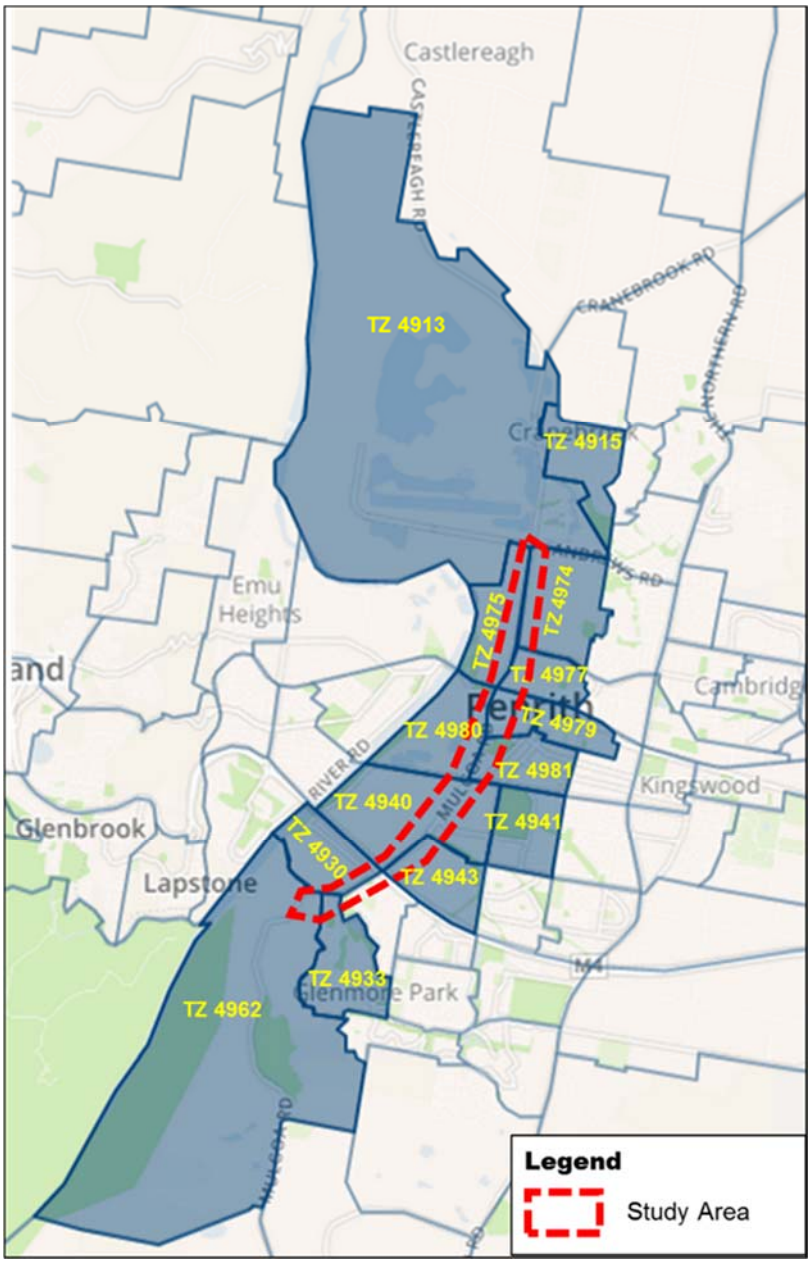


Figure 2-6 Travel Zones in the Study Area

Table 2-3 Daily Work Trips Modal Distribution in the Study Area

Travel Modes	Study Area as Home (Outbound trips)	% Trips as Home	Study Area as Workplace (Inbound trips)	% Trips as Workplace
Car Driver	6,218	67%	15,667	69%
Car Passenger	465	5%	1,549	7%
Train	964	10%	1,004	4%
Bus	90	1%	426	2%
Walked only	223	3%	394	2%
Other (ferry, tram Mode not stated)	216	2%	593	2%
Worked from home	1,152	12%	3,085	14%
Total	**9,338**	**100%**	**22,717**	**100%**

Source: F:\AA008188\D-Calculations\JTW-mode%20share\JTW-mode%20share.xlsx

In 2011, about 9,338 residents travelled from the study area to work. About 12 per cent of people did not travel to work or worked from home on the census day. The Census data showed that around 67 per cent of work trips from the study area were made by motorists in a private vehicle, with five per cent of those as car passengers. About 11 per cent of workers travelled by public transport, and three per cent walked. Of the 11 per cent public transport users, only one per cent trips were made by bus, with the remaining 10 per cent trips made by train.

In 2011 about 22,717 employees travelled to the study area to work. From the inbound trip statistics, it can be seen that private vehicles are still the dominant mode of transport to work, accounting for about 76 per cent. About six per cent of employees travelled by public transport and two per cent walked. The percentage of people who did not go to work or worked from home increased to 14 per cent when compared to outbound trips.

2.7 Work Trips Distribution

The JTW data was further analysed to understand the distribution of work trips to and from study area. Outbound work trip distribution made by private car (both as driver and as passenger) from the study area are summarised in Table 2-4. Inbound work trip distribution made by private car (both as driver and as passenger) to the study area are summarised in Table 2-5.

The results indicate the following work trip patterns:

- Inbound work trip distribution shows that substantial trips are made within the Penrith LGA (52 per cent). In addition to this 13 per cent of inbound trips travelled from Blue Mountains, 6 per cent from St Marys and 9 per cent from Mount Druitt/Richmond-Windsor. About 12 per cent of trips travelled from West Central Sydney (Auburn, Hills Shire, Bankstown, Blacktown) and 10 per cent of trips travelled from the South West Sydney (Campbelltown, Fairfield, Liverpool).
- Outbound work trip distribution shows that substantial trips are made within the Penrith LGA (40 per cent). In addition to this 8 per cent of outbound trips travelled to Mount Druitt, 5 per cent to St Marys and 10 per cent towards Blacktown/Parramatta. About 12 per cent of trips travelled towards West Central Sydney (Auburn, Hills Shire, Bankstown) and 10 per cent of trips travelled to the South West Sydney (Campbelltown, Fairfield, Liverpool).

Table 2-4 Daily Car Work Trips from the Study Area (Outbound Direction)

Geographic Area	Number of car trips from study area (outbound)	% outbound trips from study area
Penrith	2,691	40%
Mount Druitt	504	8%
Parramatta	349	5%
St Marys	348	5%
Blacktown	303	5%
West Central[1]	790	12%
South West[2]	695	10%
Central[3]	294	4%
West[4]	167	3%
North[5]	156	2%
South[6]	31	0.5%
Lower Hunter[7]	13	0.2%
Central Coast[8]	10	0.1%
Illawarra[9]	9	0.1%
Other[10]	324	5%
Total	**6,684**	**100%**

Source: F:\AA008188\D-Calculations\JTW-mode%20share\JTW-mode%20share.xlsx

Table 2-5 Daily Car Work Trips to the Study Area (Inbound Direction)

Geographic Area	Number of car trips to study area (Inbound)	% inbound trips to study area
Penrith	8,944	52%
Mount Druitt	2,175	13%
Parramatta	1,117	6%
St Marys	805	5%
Blacktown	619	4%
West Central[1]	1,522	9%
South West[2]	1,040	6%
Central[3]	327	2%
West[4]	183	1%
North[5]	174	1%
South[6]	102	1%
Lower Hunter[7]	57	0.3%
Central Coast[8]	45	0.3%
Illawarra[9]	18	0.1%
Other[10]	88	1%
Total	**17,216**	**100%**

Source: F:\AA008188\D-Calculations\JTW-mode%20share\JTW-mode%20share.xlsx

Note:

1. West Central – Auburn, Bankstown, Blacktown, Holroyd, Parramatta, The Hills Shire
2. South West-Camden, Campbelltown, Fairfield, Liverpool, Wollondilly
3. Central- Ashfield, Botany Bay, Burwood, Canada Bay, Leichhardt, Marrickville, Randwick, Strathfield, Sydney, Waverley, Woollahra
4. West – Blue Mountains, Hawkesbury, Penrith
5. North- Hornsby, Hunters Hill, Ku-ring-gai, Lane Cove, Manly, Mosman, North Sydney, Pittwater, Ryde, Warringah, Willoughby
6. South – Canterbury, Hurstville, Kogarah, Rockdale, Sutherland Shire
7. Lower Hunter – Cessnock, Lake Macquarie, Maitland, Newcastle, Port Stephens
8. Central Coast – Gosford, Wyong
9. Illawarra- Kiama, Shellharbour, Shoalhaven, Wollongong

2.8 Historical Traffic Growth

Historical traffic data between 1993 and 2015 on Mulgoa Road and Castlereagh Road was obtained from Roads and Maritime.

Table 2-6 below shows daily traffic volumes on Mulgoa Road / Castlereagh Road for 22 years period between 1993 and 2015. The historical traffic data shows that:

- In the last 22 years (between 1993 and 2015), traffic volumes on the Castlereagh Road north of Great Western Highway (86.027) have increased from 29,000 vehicles per day in 1993 to 41,000 vehicles per day in 2015
- Similar traffic increases were observed on the Mulgoa Road south of Preston Street (86.166). Traffic increased from 30,000 vehicles per day (1993) to 40,000 vehicles per day (2015).

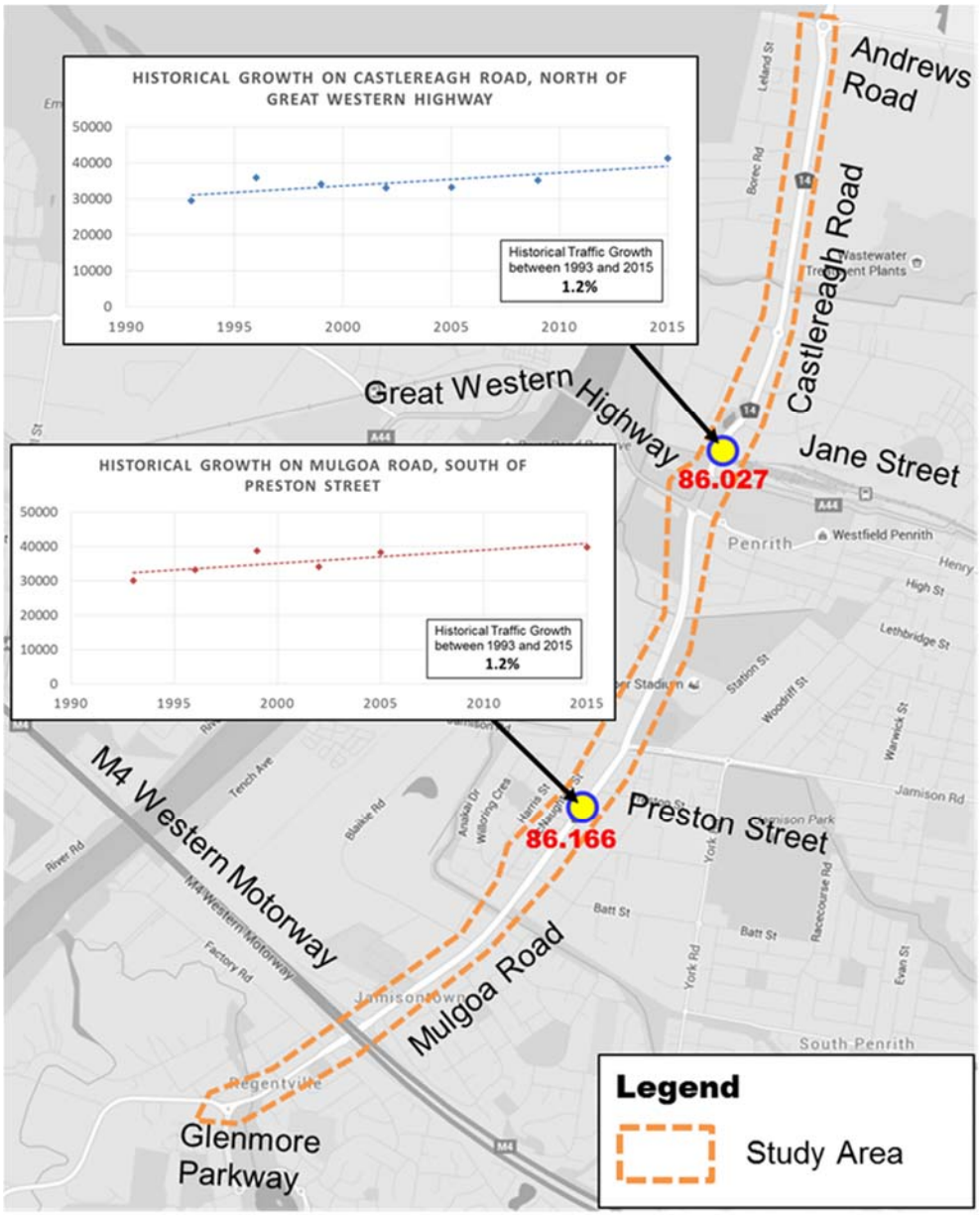


Figure 2-7 shows historical traffic growth trend observed on Mulgoa Road / Castlereagh Road. Traffic on the Castlereagh Road north of Great Western Highway has grown by 1.2 per cent per annum between 1993 and 2015. Similar traffic growth of 1.2 per cent was also observed on the Mulgoa Road south of Preston Street.

Table 2-6 Historical Traffic Growth along the Corridor between 1993 and 2015

Stations	Roads	Daily Traffic Volumes (AADT/ADT)						
		1993	1996	1999	2002	2005	2009	2015
86.027	Castlereagh Road, north of Great Western Highway	29401	35819	34011	33081	33196	35,160	41200
86.166	Mulgoa Road, south of Preston Street	29992	33243	38698	34015	38226		39800

Source: Roads and Maritime and traffic counts. The traffic counts between 1993 and 2005 represent annual average daily traffic (AADT). The 2009 and 2015 data represents average daily traffic for one week period (ADT).

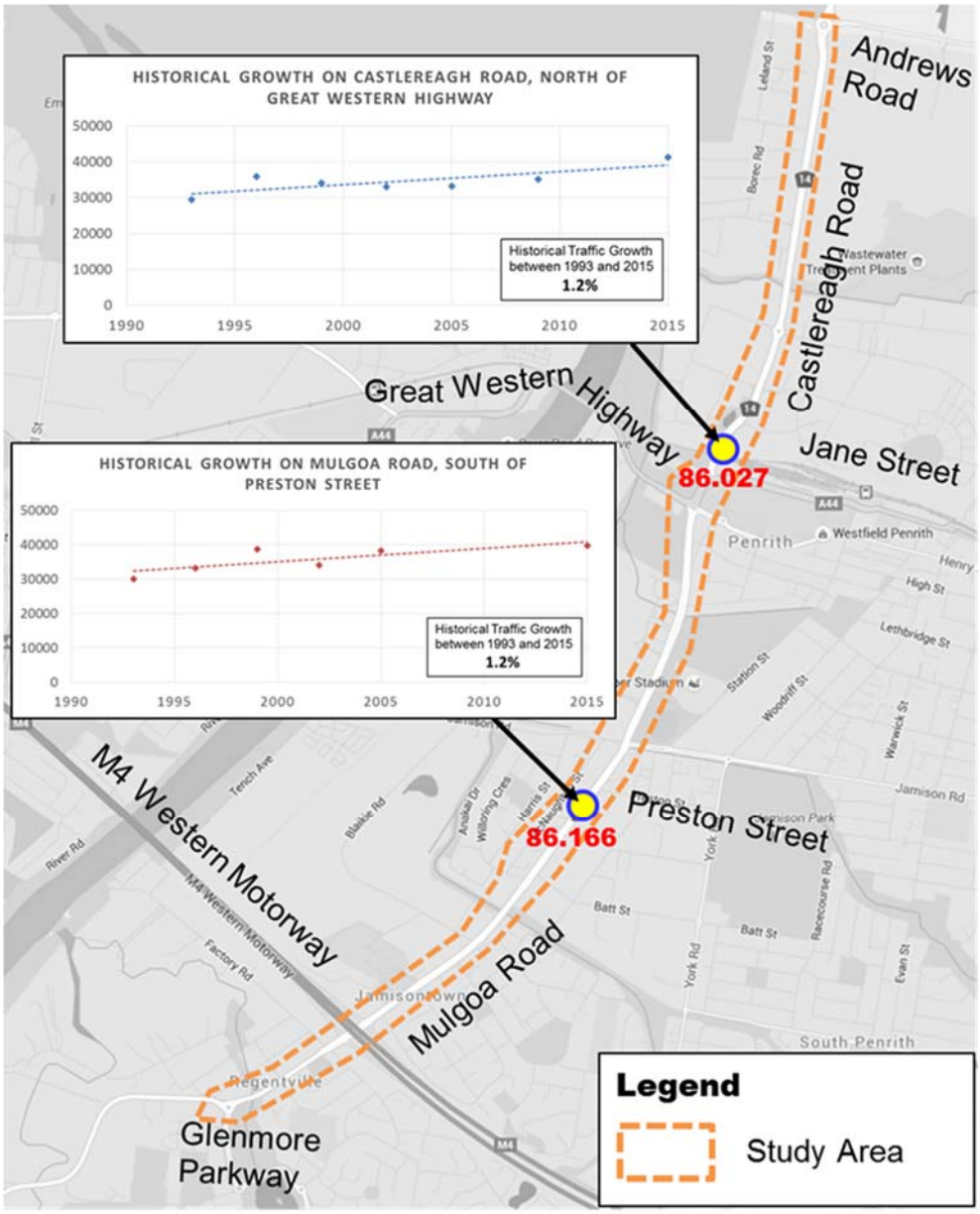


Figure 2-7 Historical Traffic Growth along the Corridor between 1993 and 2015

Source: Roads and Maritime AADT, 2015 AADT was estimated from 2015 traffic survey (ADT).

2.9 Existing Land Use

Land use in the surrounding locality has a predominantly urban character. The northern section of the study area includes vehicle dealerships, equipment hire centres, industrial areas, services stations, bulky goods retailers and infrastructure including roads, rail and wastewater recycling / treatment facilities. The central part of the study area includes sporting facilities (paceway and sports stadium), the Panthers entertainment complex, the Penrith City Council administration centre and more prevalent residential uses. South of Jamison Road residential uses become the dominant, although commercial / industrial uses are still prevalent on the western side of Mulgoa Road and the M4 Western Motorway interchange is a major feature. Figure 2-8 shows existing land use in the study area.

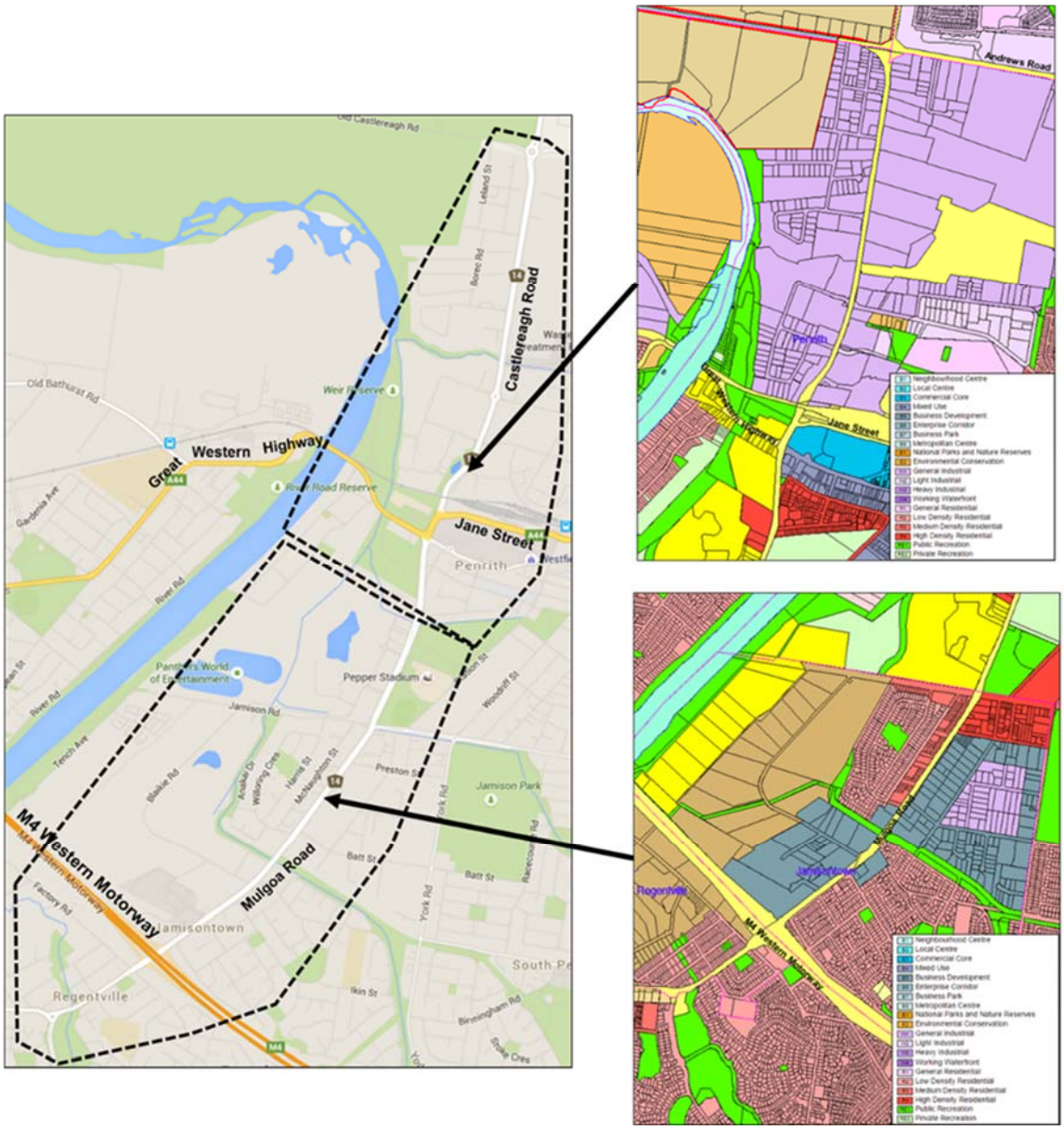


Figure 2-8 Existing Land Use in the Study Area

Source: Penrith City Council Planning Information Map

2.10 Public Transport

2.10.1 Buses Services

A number of bus routes operate in the study area. A large number of buses stop on the southern side of the Penrith Railway Station and Transport Interchange on Belmore Street. The Interchange is used by three bus services (Busways, NightRide and Blue Mountains Bus Company).

Buses operating along Mulgoa Road / Castlereagh Road are mainly Busways services consisting of bus routes 673, 783, 784 which operate north of Jane Street, and bus routes 781, 795, 797, 799 which operate south of Jamison Road.

- Buses operating north of Jane Street has a combined frequency of 16 services within the 3-hour peak period, with a half hourly service
- Buses operating south of Jamison Road has a combined frequency of 29 services within the 3-hour peak period, with a half hourly service

Other bus services within the study area are from Blue Mountains Bus Company. The service routes consist of bus routes 688, 689, 690P, 691 and 1688. Route 688, 689 and 1688 travel from Great Western Highway to High Street into the Transport Interchange, then a loop back to Great Western Highway via Ransley Street, Jamison Road and Mulgoa Road. Route 690P and 691 travel from Great Western Highway to High Street into the Transport Interchange, then onto M4 Western Motorway via Ransley Street and Mulgoa Road.

- Buses operating as a loop via Penrith CBD has a combined frequency of maximum 11 services within the 3-hour peak, with a half hourly service

A summary of the service details for bus services in the study area is provided in Table 2-7 and Figure 2-9.

There are about 24 bus stops along the Mulgoa Road / Castlereagh Road corridor, sixteen of them are located on Mulgoa Road between Glenmore Parkway and Jamison Road. These stop mainly serve the bus routes 781, 795, 797, 799 and 691. Seven bus stops located on Castlereagh Road between Jane Street and Andrews Road which serve the bus routes 673, 783 and 784. Only one bus stop is located on Mulgoa Road between Jamison Road and Jane Street. This bus stop serve the bus loop service 688, 689, 690P, 691 and 1688.

Table 2-7 Existing Bus Services on Mulgoa Road / Castlereagh Road

Section	Route	Route Description	AM services (6-hour)	AM Peak services (3-hour)	PM services (8-hour)	PM Peak services (3-hour)
North of Jane Street	673	Between Penrith and Windsor (via Cranebrook and Llandilo)	7	6 (every 30-60 mins)	5	3 (every 90 mins)
	783	Jordan Springs to Penrith Loop	10	6 (every 30 mins)	13	6 (every 30 mins)

Section	Route	Route Description	AM services (6-hour)	AM Peak services (3-hour)	PM services (8-hour)	PM Peak services (3-hour)
	784	Cranebrook to Penrith Loop	4	4 (every 30 mins)	4	4 (every 30 mins)
South of Jamison Road	781	Between Penrith and St Marys (via Claremont Meadows and Glenmore Park)	3	3 (every 60 mins)	1	1
	795	Warragamba to Penrith Loop (via Wallacia & Jamisontown)	10	7 (every 30-60 mins)	10	7 (every 30-60 mins)
	797	Glenmore Park to Penrith Loop	14	8 (every 30 mins)	16	7 (every 30 mins)
	799	Between Penrith and Blue Hills (via Glenmore Park)	18	11 (every 30 mins)	22	11 (every 30 mins)
Loop via Mulgoa Road (between Jamison and High Street)	688	Emu Heights to Penrith Loop	6	2 (every 30 mins)	14	7 (every 60 mins)
	689	Leonay to Penrith Loop	8	5 (every 30 mins)	9	4 (every 30-60 mins)
	1688	Leonay to Penrith Loop (via Emu Heights)	No service	No service	2	2 (every 60 mins)
GWH - Mulgoa Road - M4	690P	Between Penrith and Springwood (via Glenbrook, Blaxland, Warrimoo and Valley Heights)	7	No service	9	3 (every 60 mins)
	691	Between Blaxland and Penrith	6	3 (every 30 mins)	3	1

Source: http://www.transportnsw.info/

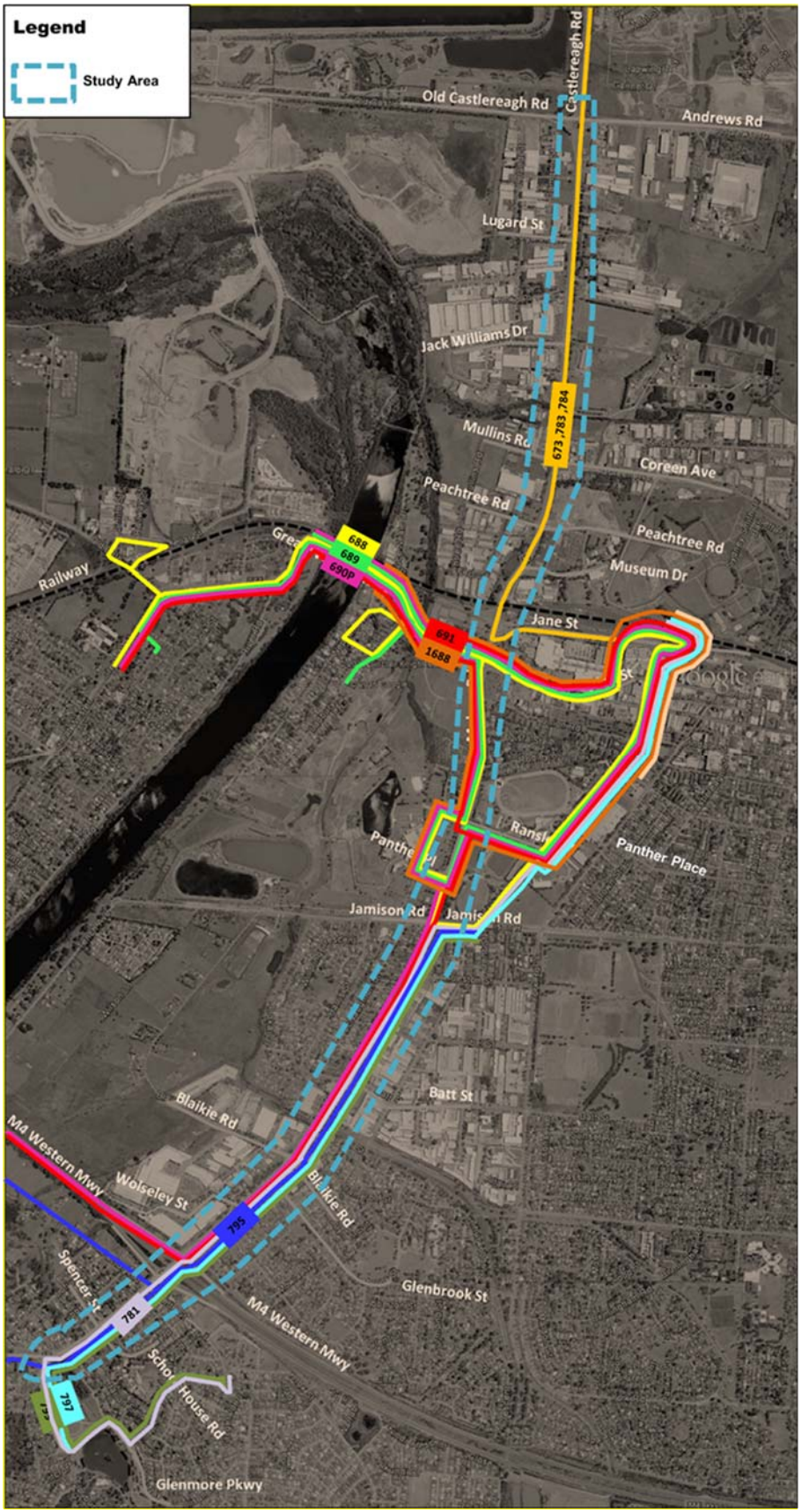


Figure 2-9 Existing Bus Routes on Mulgoa Road / Castlereagh Road

Source: http://www.transportnsw.info/

Figure 2-10 highlight bus services that travel on Mulgoa Road between Jane Street and Jamison Road. These are bus services from Blue Mountains Bus Company which consist of bus routes 688, 689, 690P, 691 and 1688.

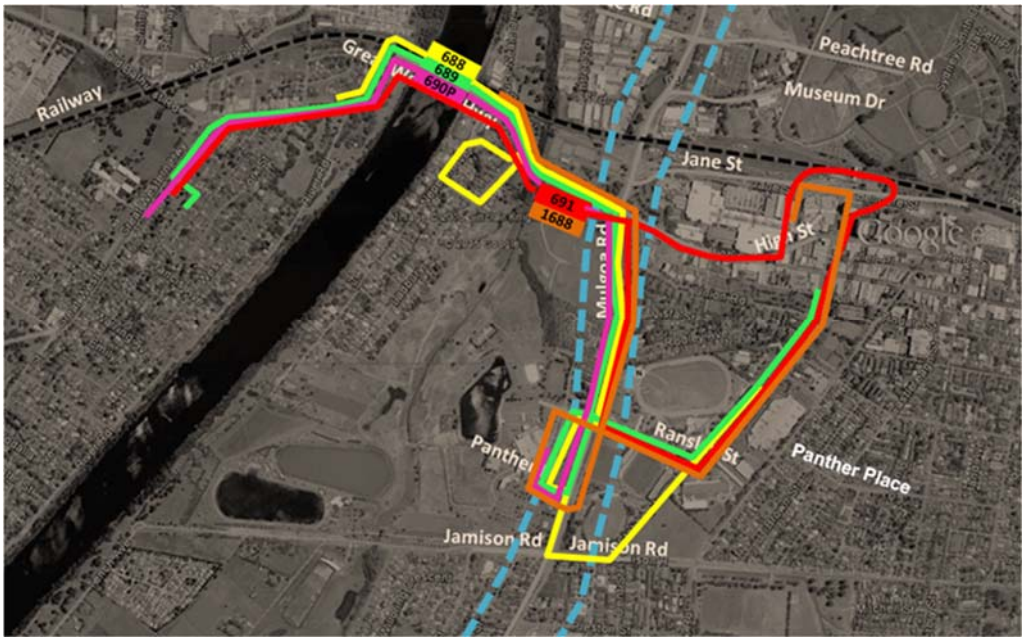


Figure 2-10 Existing Bus Routes on Mulgoa Road between Jane Street and Jamison Road

Source: http://www.transportnsw.info/

2.10.2 Train Services

Penrith City Centre is a strategic transport mode on the Sydney Transport network that connects the western subregion with Sydney CBD, Parramatta and Blacktown to the east and Blue Mountains to the West. Penrith Station is located on Jane Street and is located 800 metres from the Jane Street / Mulgoa Road Intersection. Penrith Station is serviced by two train lines, namely the T1 Western Line which connects Penrith to the West (Blacktown, Parramatta) and towards the Sydney CBD and the Blue Mountains line which provided services between suburbs west of Penrith up to Blue Mountains while providing an express service between Penrith and the Sydney CBD. Table 2-8 shows the frequency of trains to the Penrith Station, indicating a high frequency of services. The high rail service frequency highlights the importance of Penrith as a transport hub. The train station is accessible for commuters and includes the provision of the following services:

- Stairs and Lifts
- Station Car Parking and Bike rack and lockers
- Kiss and ride zones and Taxi ranks close by
- Hearing Loop, Tactile tiles
- Wheelchair accessible toilets; and
- Wheelchair accessible car spaces for the less able commuters.

A summary of rail services is showed in Table 2-8 and Figure 2-11.

Table 2-8 Existing Train Services in Penrith

Route description	Significant destinations on route	Service frequency
Suburban Service		
T1-Western Line	Penrith, Richmond, Blacktown, Parramatta, Granville, Strathfield, Redfern, Central, Town Hall, North Sydney, Chatswood	4-11 mins (peak) 15 mins (off-peak)
Intercity Service		
Blue Mountains Line	Bathurst, Katoomba, Glenbrook, Emu Plains, Penrith, Blacktown, Parramatta, Strathfield, Redfern, Central	15 mins (morning peak) 30 mins (evening peak) 1 Hour (off-peak)

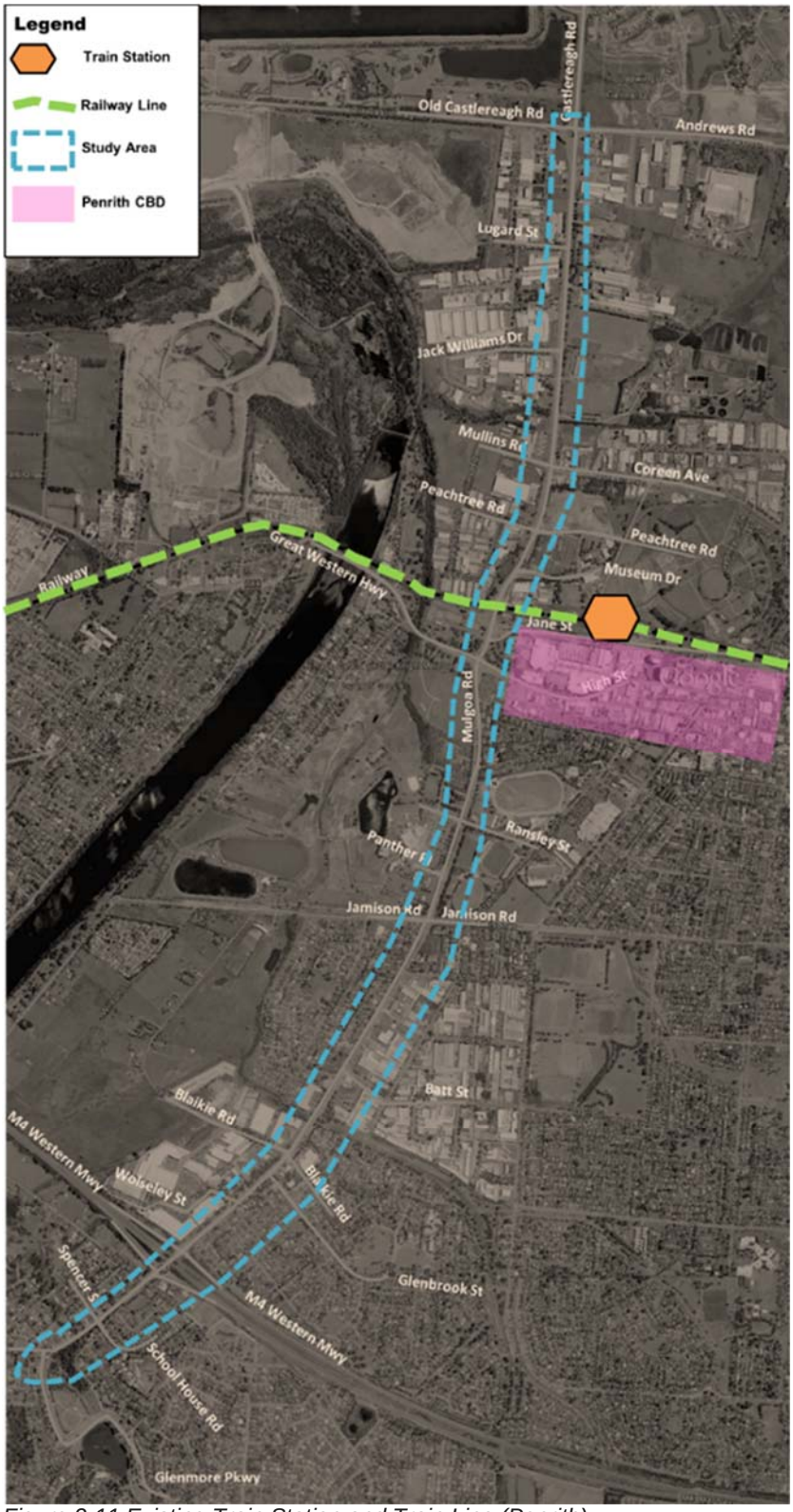


Figure 2-11 Existing Train Station and Train Line (Penrith)

Source: http://www.transportnsw.info/

2.11 Active Transport

Mulgoa Road /Castlereagh Road services a range of land uses including residential, office, recreational parks and retail. Walking and cycling are important as they reduce the amounts of vehicles on the road and decrease congestion. Provision of safe and effective pedestrian and cycling infrastructure along Mulgoa Road and Castlereagh Road is therefore important. About 2.5 metres sealed pathways are provided on the entire eastern side of Mulgoa Road / Castlereagh Road corridor. On the western side of the corridor, pedestrian pathways are provided from Glenmore Parkway to Peachtree Road. Pedestrian accessibility is further enhanced as most traffic signals in the study area have pedestrian facilities that allow pedestrians to cross safely.

The roads on and around Castlereagh Road / Mulgoa Road contain a few dedicated off road cycling lanes as well as cycle friendly roads. The southbound direction has off road paths which are dedicated to cyclists and pedestrians and stretch along the Mulgoa Road and Castlereagh Road corridor. Off road paths traverse the northbound section, from the Great Western Highway and Peachtree Road. Sections of the corridor contain on-road cycling paths, including:

- From Peachtree Road to Andrews Road (High difficulty) travelling northbound
- From Glenbrook Street to the signal approaching M4 Western Motorway (Low difficulty).

Adjoining roads such as Jamison Road and Coreen Avenue have on road and off road cycling accessibility. Jamison Road west of the corridor has low difficulty on road cycle paths as well as off road shared paths east of the corridor. Also Coreen Avenue has moderate difficulty on road cycle paths from the Coreen Avenue and Castlereagh intersection.

These leads to more cycle friendly conditions and encourages walking and cyclist activities. The availability of bike racks at the station also allow commuters to cycle to the station and use other transport modes (buses and trains) to reach their intended destination. The cycleway routes are shown in Figure 2-12.

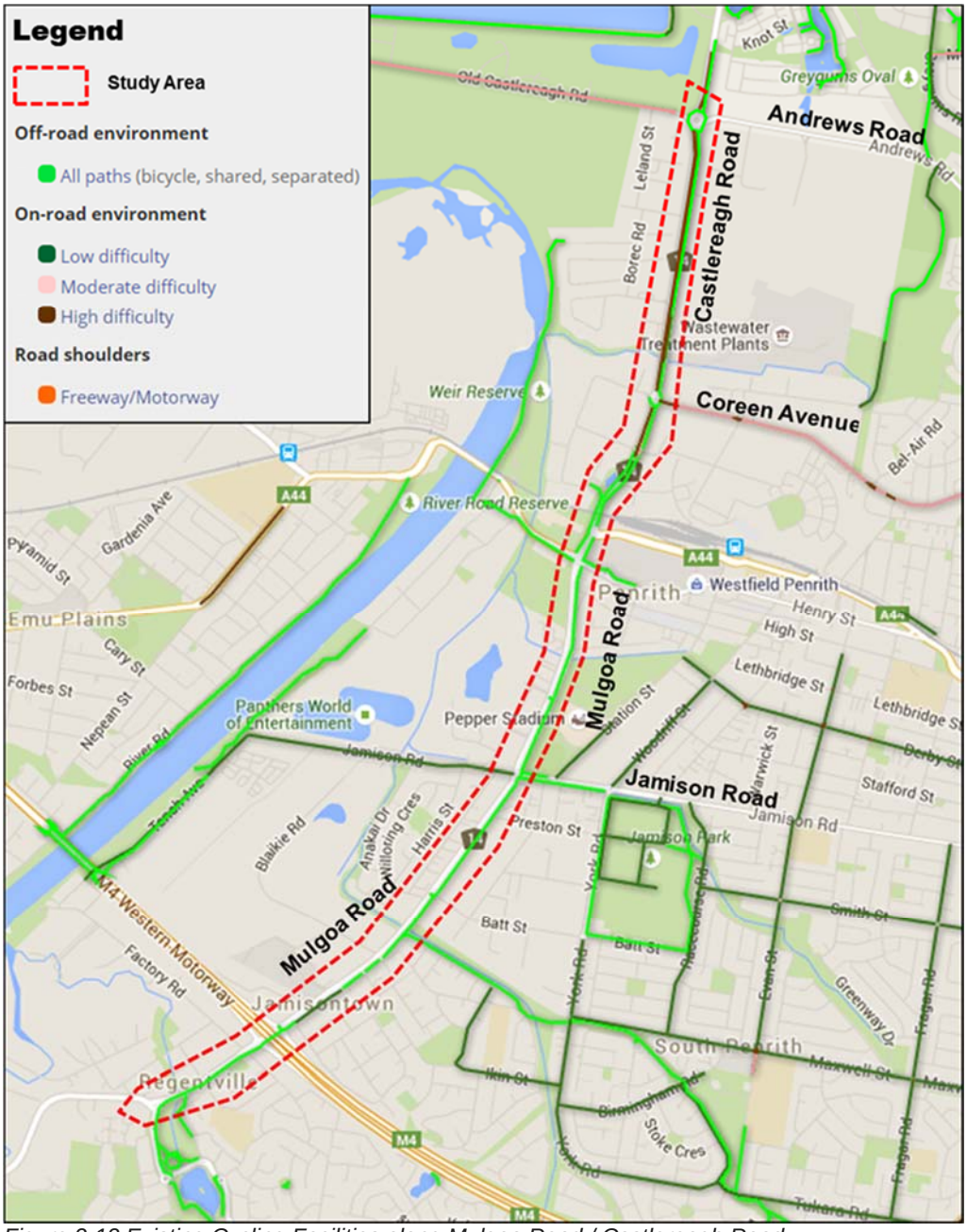


Figure 2-12 Existing Cycling Facilities along Mulgoa Road / Castlereagh Road

Source: (1) RMS Cycleway Finder V2

2.12 Crash Data

This assessment is based on the recent crash data supplied by Roads and Maritime for a five-year period from January 2011 to December 2015. The crash data includes fatal, injury or vehicle damage accidents. The crash analysis has been undertaken for Castlereagh Road and Mulgoa Road from Andrews Road to Glenmore Parkway.

Table 2-9 summarises crash statistics, classified by severity (fatal, injury and non-casualty). There were 262 crashes recorded between 2011 and 2015 on Castlereagh Road and Mulgoa Road from Andrews Road to Glenmore Parkway. Of that no fatal crash was reported, 38 per cent of crashes involved injury and 62 per cent were non-casualty crashes. The five year crash data showed that about 133 people were injured.

Table 2-9 Severity of Crashes in the Study Area between 2011 and 2015

Crash Severity	Number of Crashes	Percentage	Number of people casualties
Fatal	0	0%	0 killed
Injury	99	37.8%	133 injured
Non-casualty	163	62.2%	n/a
Total	**262**	**100.0%**	**133**

Source: Roads and Maritime, The crash statistics included 2015 provisional data, at the time of updating crash analysis.

Table 2-10 summarises crash statistics, classified by severity and road sections. Figure 2-14 shows the location of all crash on the Mulgoa Road and Castlereagh corridor.

Table 2-10 Summary of Crashes by Location and Severity in the Study Area

Section	Location	Crash Data
1	Castlereagh Road / Museum Drive	A total of 51 crashes, including 25 injury crash and 26 non casualty crash.
2	Museum Dive / Union Road	A total of 26 crashes, including 8 injury crash and 18 non casualty crash.
3	Union Road to Jamison Road	A total of 43 crashes, including 18 injury crash and 25 non casualty crash.
4	Jamison Road to M4 Western Motorway	A total of 107 crashes, including 40 injury crash and 67 non casualty crash.
5	M4 Western Motorway to Glenmore Parkway	A total of 35 crashes, including 8 injury crash and 27 non casualty crash.

Figure 2-13 shows the crash statistics for this period by type. The highest crash type recorded was rear end crashes, accounting for 111 crashes (42 per cent). 66 (25 per cent) crashes occurred when vehicles carrying out turning manoeuvres were hit by another vehicle. It is likely that safety will deteriorate along Mulgoa Road and Castlereagh Road and associated intersections in their current configuration for all road

users as traffic levels and congestion increase, which is of on-going and substantial concern to Roads and Maritime and the local community.

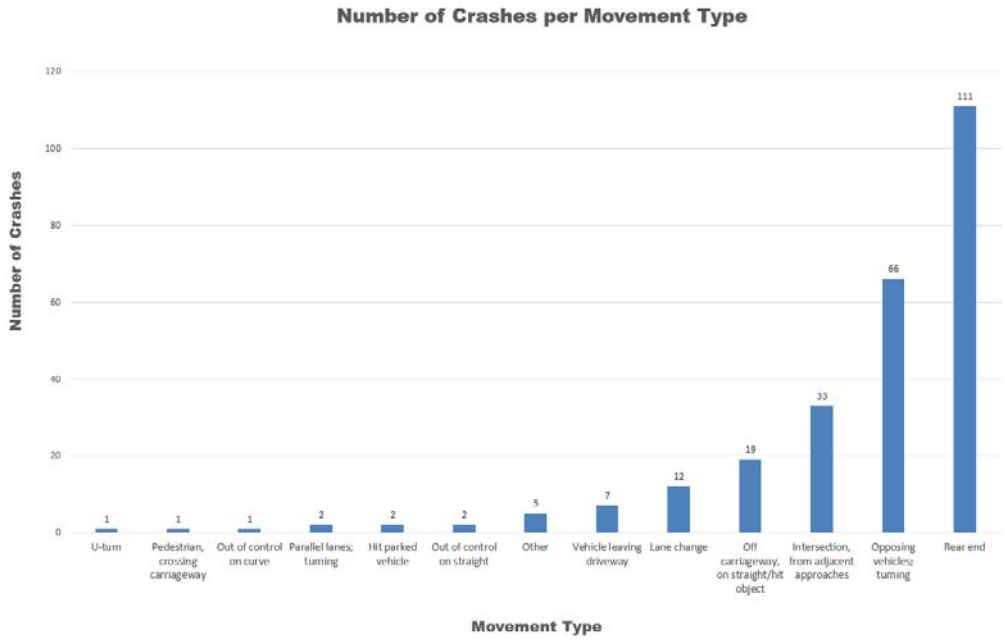


Figure 2-13 Number of Crashes per Movement Type

Source: RMS, Arcadis analysis

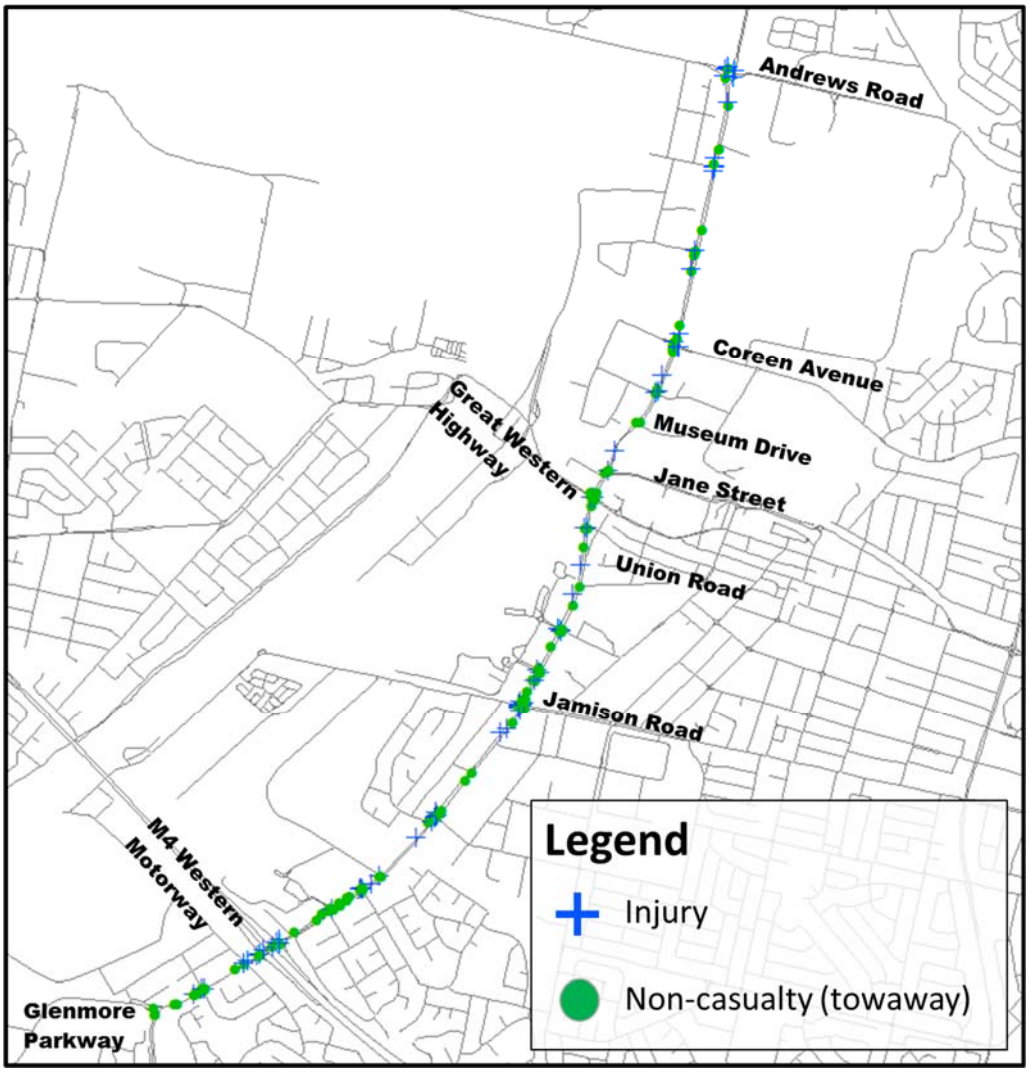


Figure 2-14 Crashes by Location and Severity in the Study Area

Source: RMS, Arcadis analysis

2.13 Road Safety Performance

The road safety performance for various sections of the Castlereagh Road and Mulgoa Road from Andrews Road to Glenmore Parkway were assessed using crash rates and casualty rates per 100 million-vehicle kilometres travelled (MVKT). The parameter vehicle-kilometre travelled (VKT) is an industry-accepted measure of crash exposure. In general, the more traffic that uses a road (traffic volume), and longer the trip length (kilometres travelled), the greater the exposure to crashes.

By normalising crash frequency by VKT (or MVKT), this also makes sections of the corridor more comparable. Without normalising the rates in this manner, the longer section and section with higher traffic volumes would tend to perform much worse than shorter, less trafficked section.

The three data inputs required for crash data analysis by MVKT are:

- Number of crashes
- Traffic volumes

- Segment lengths

Crash rates mapping are prepared based on the above mentioned inputs. Casualty crash rates were categorised by bandwidths of 10 casualty crashes per 100MVKT. These were then mapped using a colour code. Crash rates were also categorised by bandwidths of 20 crashes per 100MVKT and were mapped using a similar colour code.

The crash rates maps are the primary outputs for road safety performance, and they are as shown in Figure 2-15 and Figure 2-16 below.

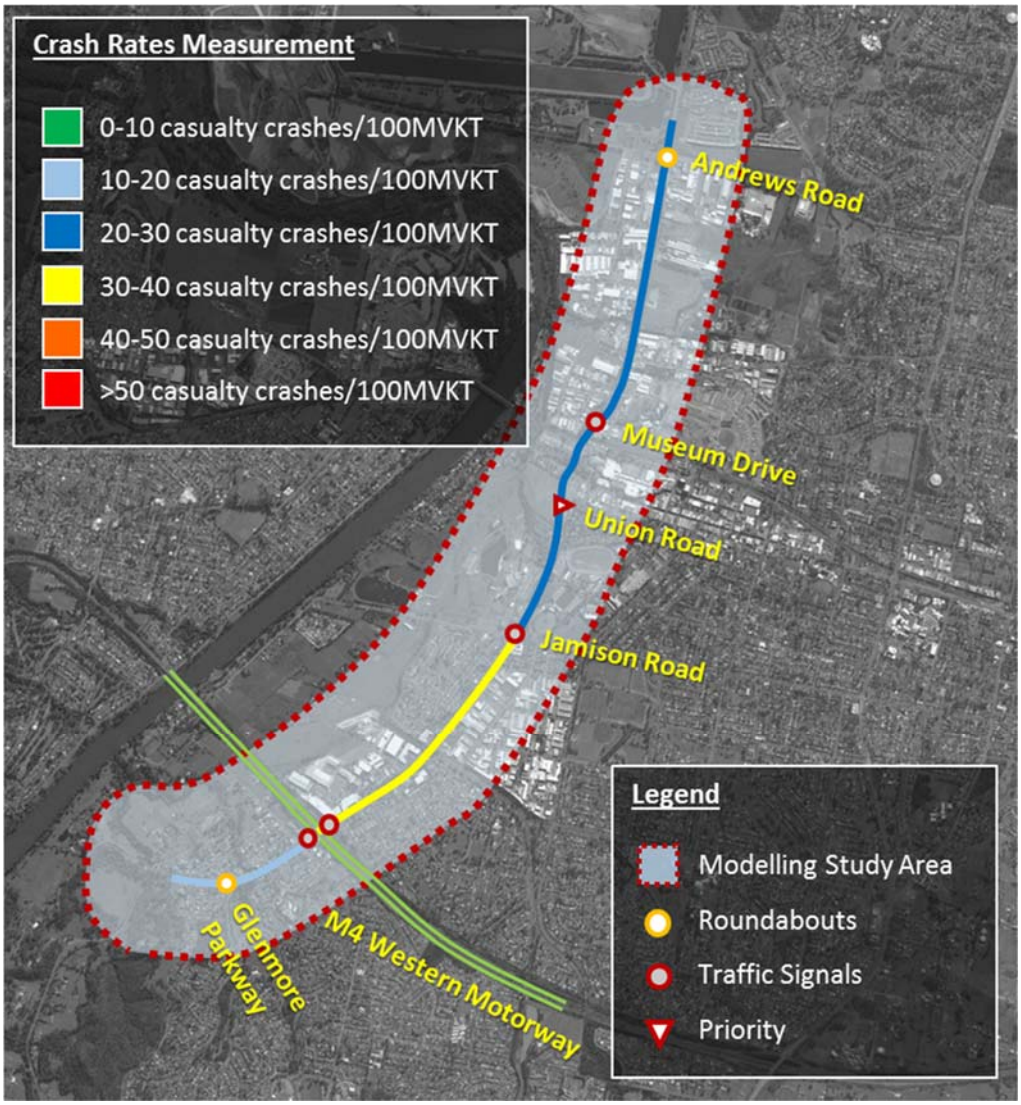


Figure 2-15 Crash Rate Map for Casualty Crashes in the Study Area

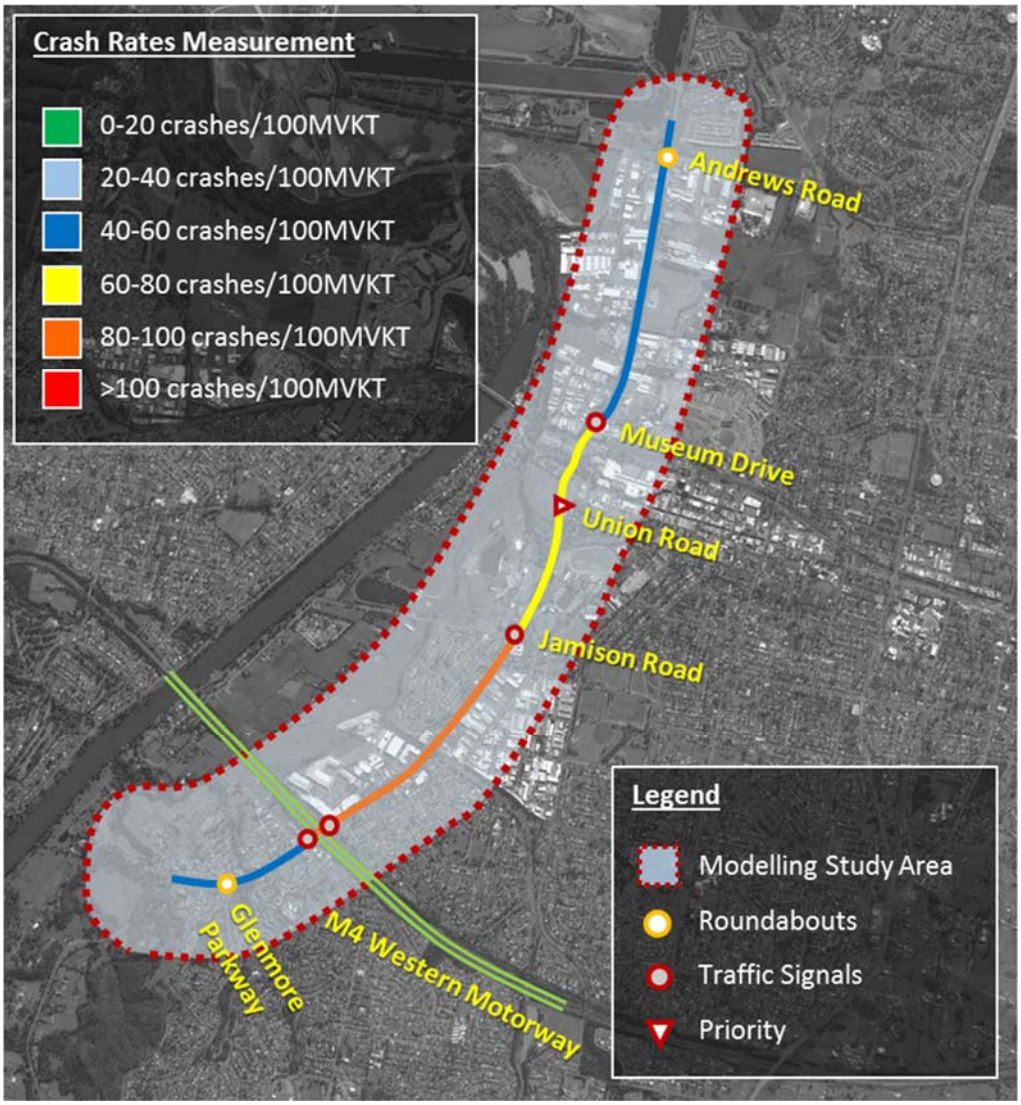


Figure 2-16 Crash Rate Map for All Crashes in the Study Area

The crash data analysis was only intended to be high level, to identify which section of the corridor are performing well and which are performing poorly. The graduated colour code enables to determine relative priorities between segments with red coloured segments being those that have performed poorly, and green coloured segments being those that have performed comparatively better.

There was no sections that were identified as poor performing section with more than 40 casualty crashes per 100MVKT:

When considering all crashes (casualty and non-casualty crashes), the following segments were identified as poor performing segments with more than 80 crashes per 100MVKT:

- Mulgoa Road, between Jamison Road and M4 Western Motorway.

2.14 Access

The following roads provide access to key areas surrounding the study area:

- Jack Williams Drive provides access to Nepean Motor Group and Penrith Indoor Sports and Recreation
- Jane Street and High Street provide access to the heart of Penrith CBD and some keys area of access are Westfield Penrith and Penrith Station via Station Street
- Jamison Road provides access to Penrith Park and Howell Oval which are used extensively by local residents
- Willoring Crescent provides access for the local residential lands on the western side of Mulgoa Road.
- Wolseley Street provides access to many stores such as Harvey Norman, Bunnings and Bing Lee
- Glenmore Parkway provides access to many parks and recreation areas for local residents.

There are also some low density residential properties along Mulgoa Road within the project area, they exist in the following locations along the corridor:

- On the western side between Willoring Crescent and Jamison Road
- On the western side between Spencer Street and Factory Road

2.15 Pedestrian and Cyclist Movements

Figure 2-17 below shows locations of pedestrian and cyclist counts undertaken by Matrix. The pedestrian movements were counted on 19th March (Saturday) and 20th March (Sunday) due to NRL game at Peppers Stadium. The pedestrian movements were counted for eleven hours from 10 am to 9 pm. The pedestrian movements were counted at four intersections including:

- Mulgoa Road and Jamison Road intersection
- Mulgoa Road and Panther Place intersection
- Mulgoa Road and Ransley Street intersection
- Mulgoa Road and High Street intersection

The cyclist movement survey was undertaken from 18th February 2016 (Thursday) to 24th February 2016 (Wednesday) for a period of one week. The cyclist movements were counted for 24 hours for one week period. The cyclist movements were counted at three locations including:

- Mulgoa Road at Surveyors Creek Bridge
- Mulgoa Road south High Street
- Castlereagh Road north of High Street

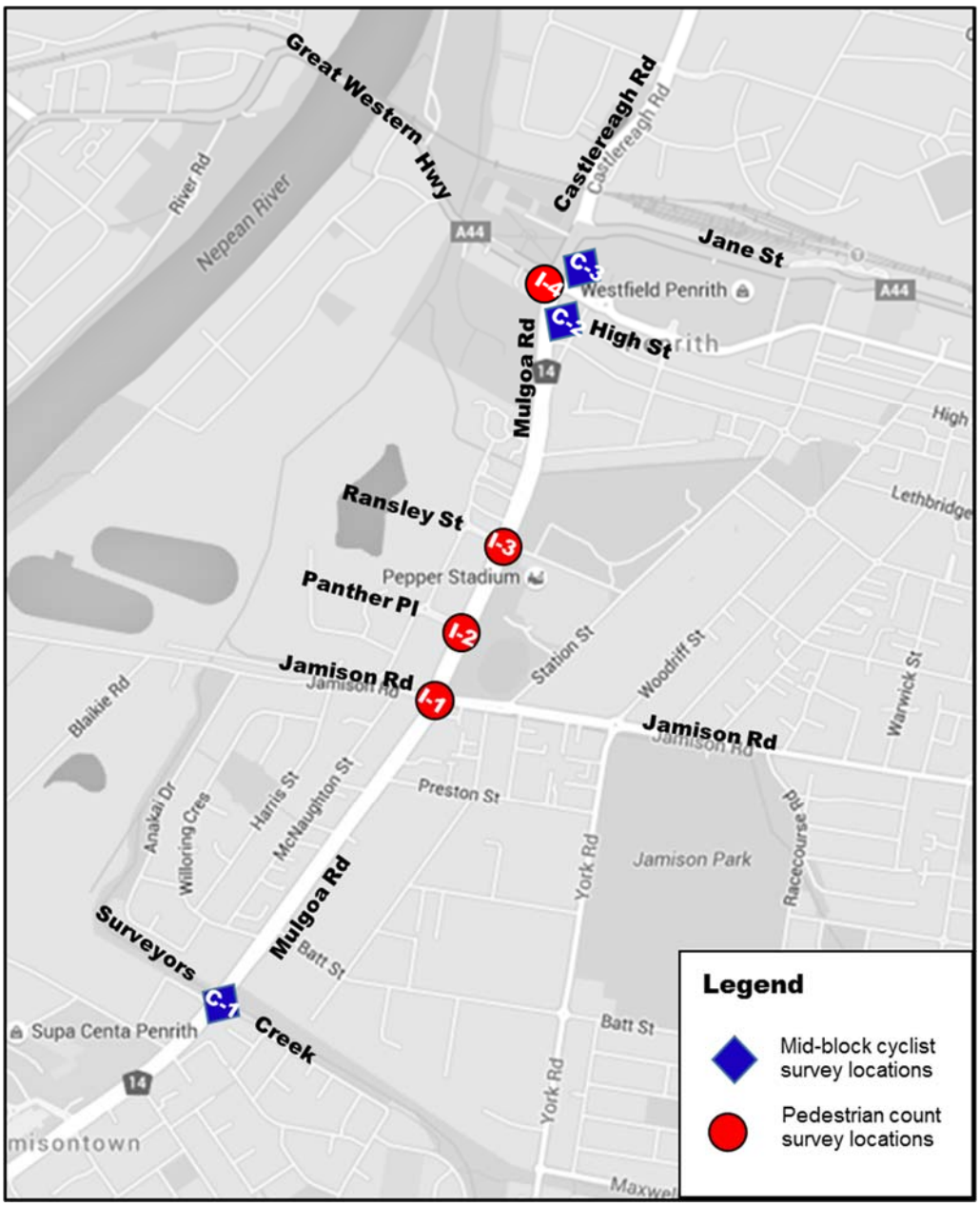


Figure 2-17 Pedestrian Counts and Cyclist Midblock Survey Locations

2.15.1 Pedestrian Movements

This section presents the existing pedestrian flows at surveyed four intersections. The pedestrian flows are based on survey undertaken in March 2016..

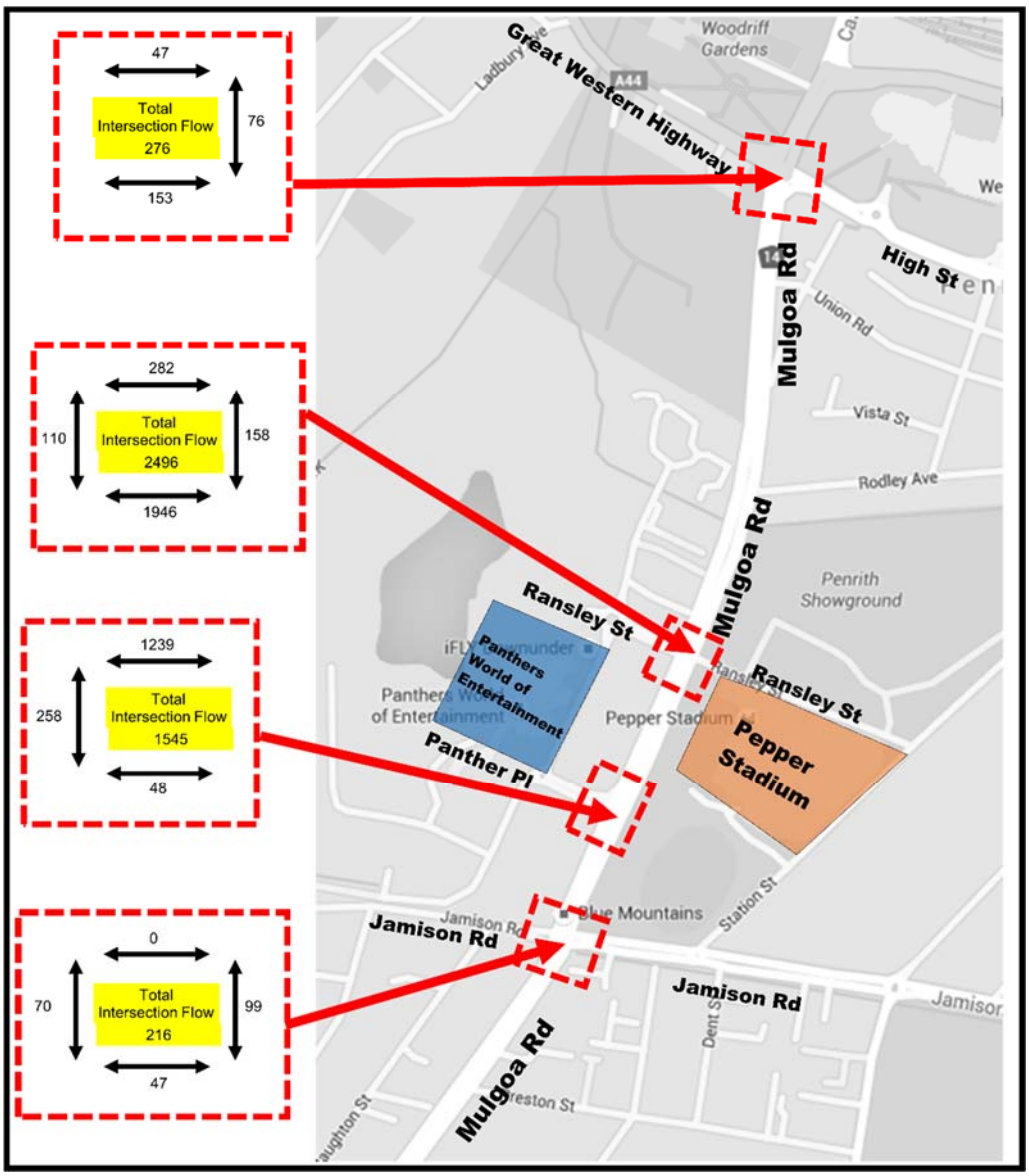
Source: Intersection count survey-March 2016

Figure 2-18 and Source: Intersection count survey-March 2016

Note: Mulgoa Road/Ransley St intersection pedestrian data for Sunday includes 4 hours period (10am-2pm)

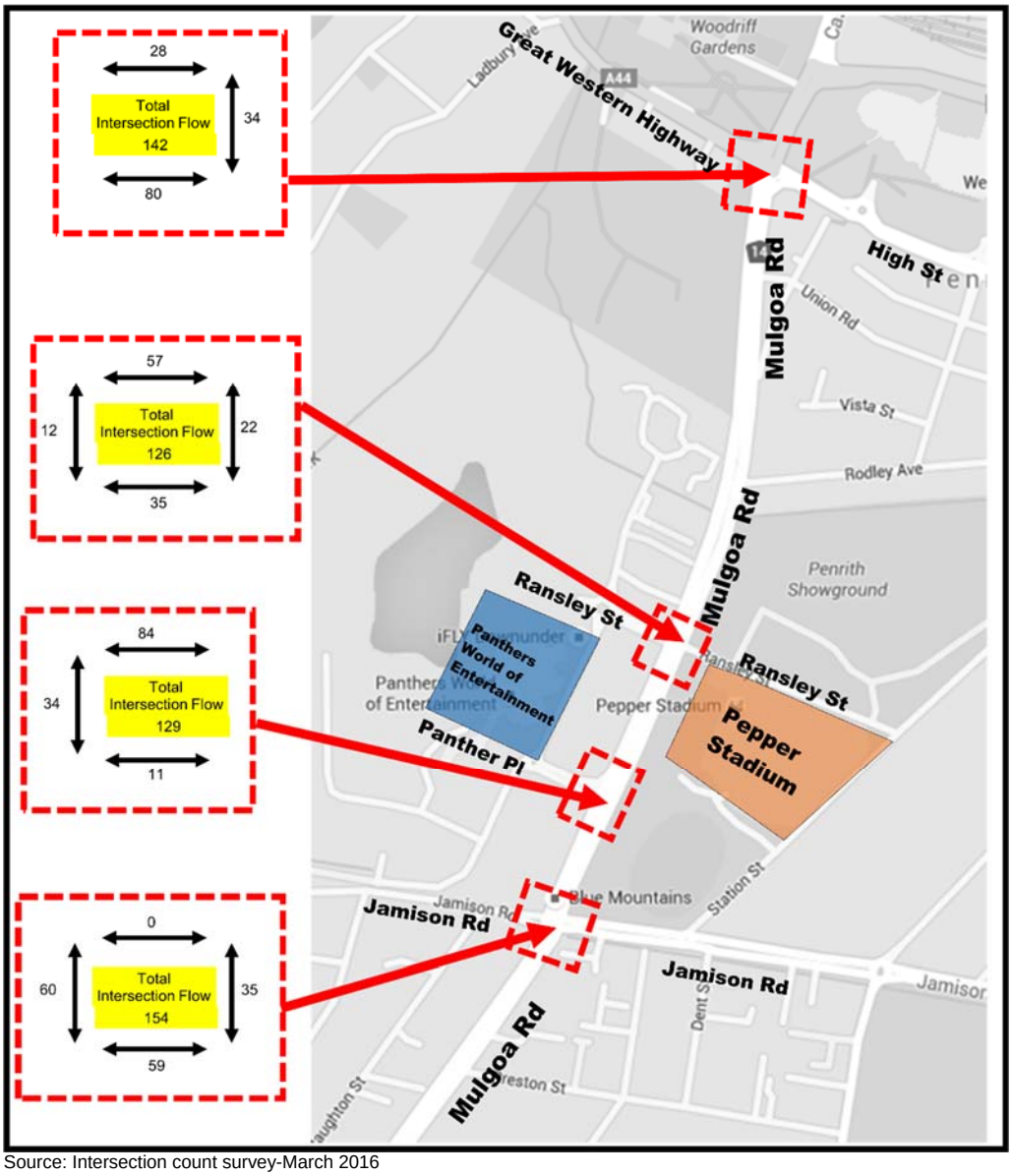
Figure 2-19 shows total pedestrian flows recorded at four intersections along the Mulgoa Road for eleven hour period from 10 AM to 9 PM on Saturday 19 March 2016 and Sunday 20 March 2016 respectively. The results for total eleven hours pedestrian survey indicated the following patterns:

- The pedestrian movements on Saturday was found to be significantly higher than Sunday. The higher pedestrian movements on Saturday was contributed by events at the Peppers Stadium.
- On Saturday, about 216 pedestrians crossed at Mulgoa Road / Jamison Road intersection. The highest pedestrian movement was recorded across the Jamison Road eastern approach (99 pedestrians) followed by the western approach (70 pedestrians). About 47 pedestrian crossed the Mulgoa Road southern approach.
- On Saturday, about 1545 pedestrians crossed at the Mulgoa Road / Panther Place intersection. The highest pedestrian movement was recorded across the Mulgoa Road northern approach (1239 pedestrians) followed by the Panther Place western approach (258 pedestrians). About 48 pedestrian crossed the Mulgoa Road southern approach
- On Saturday, about 2496 pedestrians crossed at the Mulgoa Road / Ransley Street intersection. The highest pedestrian movement was recorded across the Mulgoa Road southern approach (1946 pedestrians) followed by the northern approach (282 pedestrians). About 158 pedestrian crossed the Ransley St eastern approach and 110 pedestrian crossed the western approach.
- On Saturday, about 276 pedestrians crossed at the Mulgoa Road / High Street intersection. The highest pedestrian movement was recorded across the Mulgoa Road southern approach (153 pedestrians) followed by the High Street eastern approach (76 pedestrians). About 47 pedestrian crossed the Mulgoa Road northern approach
- The pedestrian movements at Mulgoa Road/Jamison Road intersection and Mulgoa Road/High Street intersection were found to be slightly higher on Saturday 19 March compared to Sunday 20 March.



Source: Intersection count survey-March 2016

Figure 2-18 *Intersection Pedestrian Flows – 19 March 2016 (Saturday) 10 AM to 9 PM (11 Hours Volumes)*



Source: Intersection count survey-March 2016

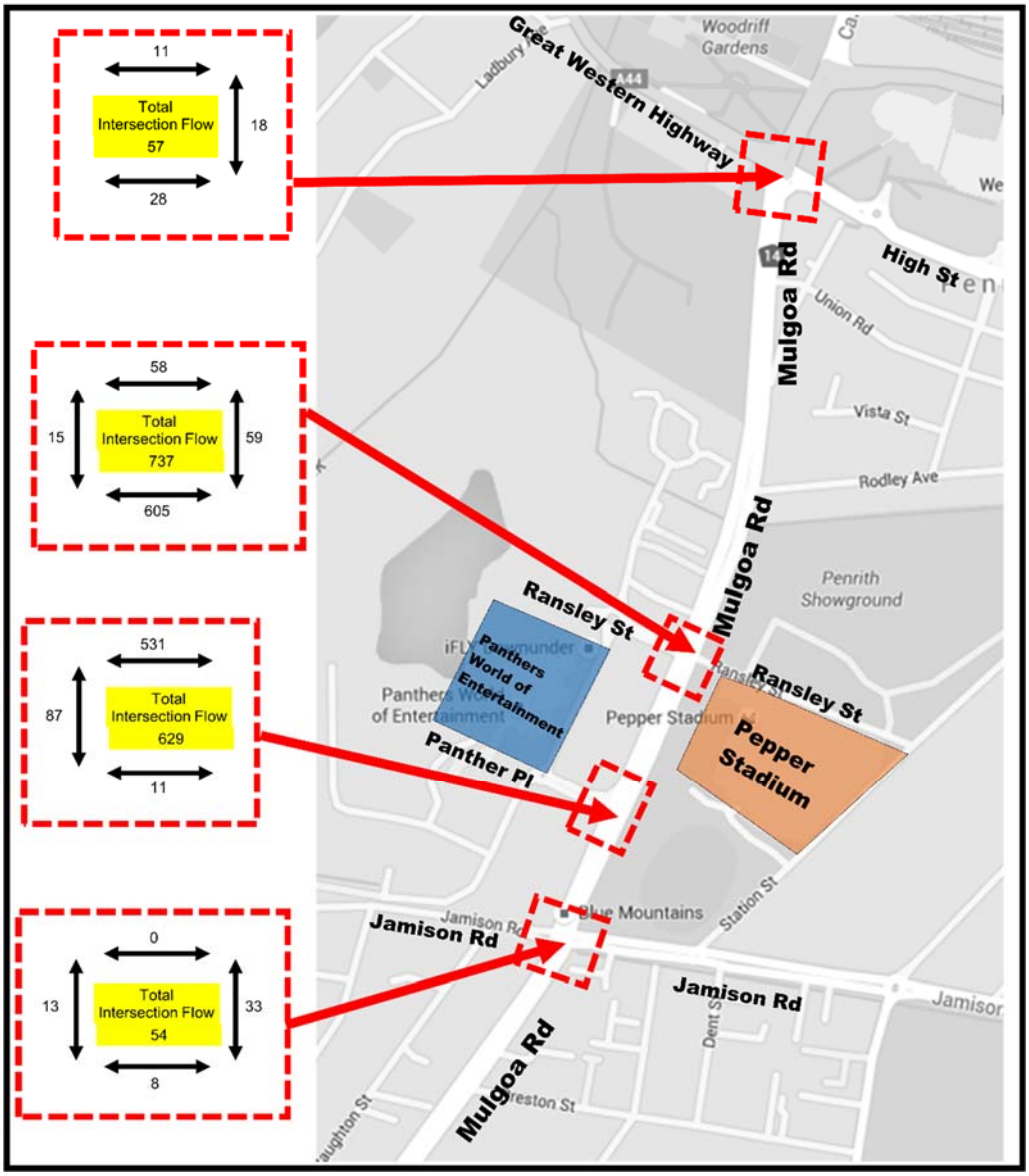
Note: Mulgoa Road/Ransley St intersection pedestrian data for Sunday includes 4 hours period (10am-2pm)

Figure 2-19 Intersection Pedestrian Flows – 20 March 2016 (Sunday) 10 AM to 9 PM (11 Hours Volumes)

Source: Intersection count survey-March 2016

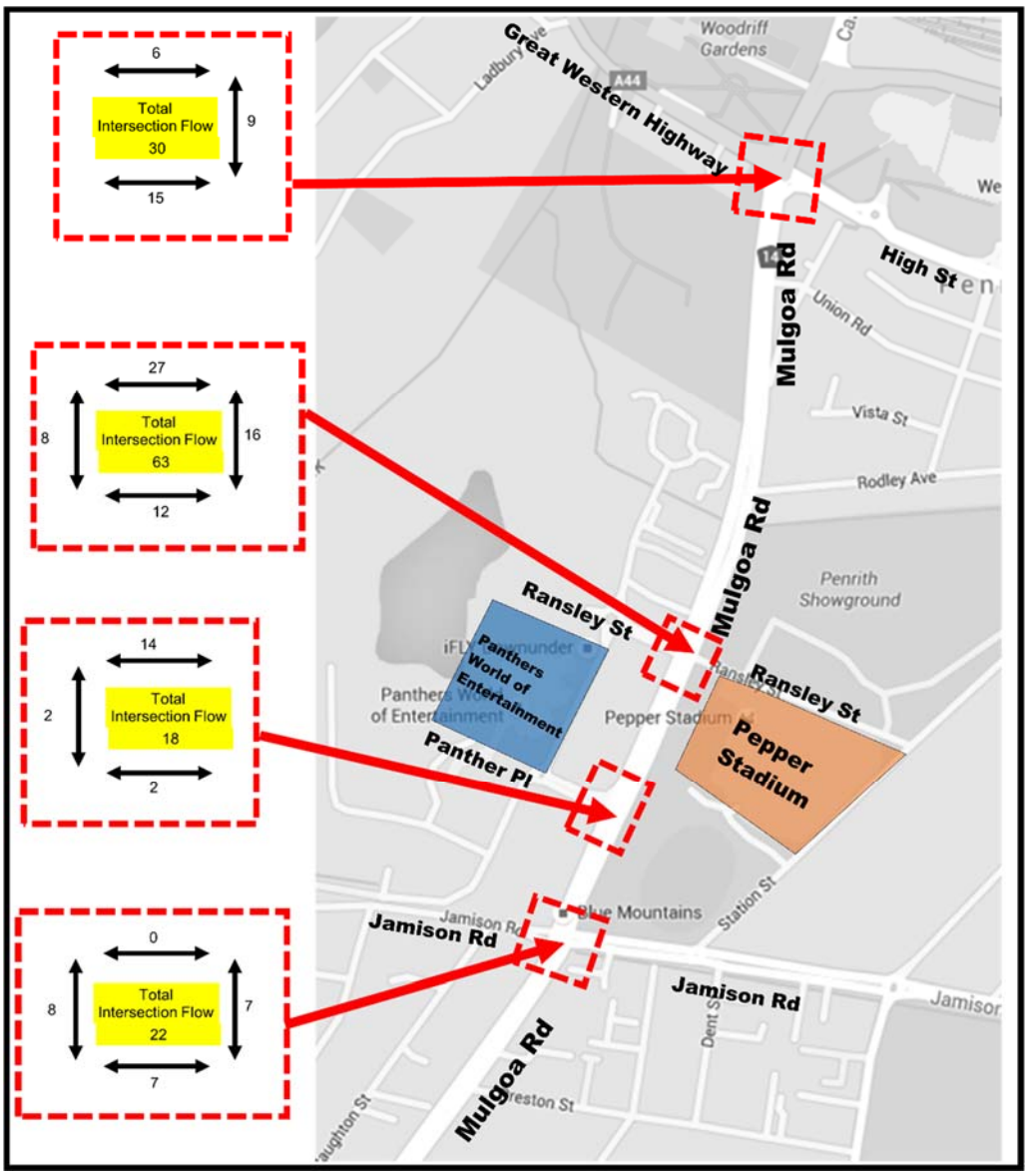
Figure 2-20 and Figure 2-21 shows one highest peak hour pedestrian flows at four intersections along the Mulgoa Road on Saturday and Sunday respectively. The Saturday pedestrian flows was found to be the highest and peak one hour results indicated the following patterns:

- About 54 pedestrians crossed at the Mulgoa Road / Jamison Road intersection. The highest pedestrian movement was recorded across the Jamison Road eastern approach (33 pedestrians) followed by the western approach (13 pedestrians). About 8 pedestrian crossed the Mulgoa Road southern approach
- About 629 pedestrians crossed at the Mulgoa Road / Panther Place intersection. The highest pedestrian movement was recorded across the Mulgoa Road northern approach (531 pedestrians) followed by the Panther Place western approach (87 pedestrians). About 11 pedestrian crossed the Mulgoa Road southern approach
- About 737 pedestrians crossed at the Mulgoa Road / Ransley Street intersection. The highest pedestrian movement was recorded across the Mulgoa Road southern approach (605 pedestrians) followed by the northern approach (58 pedestrians). About 59 pedestrian crossed the Ransley St eastern approach and 15 pedestrian crossed the western approach.
- About 57 pedestrians crossed at the Mulgoa Road / High Street intersection. The highest pedestrian movement was recorded across the Mulgoa Road southern approach (28 pedestrians) followed by the High Street eastern approach (18 pedestrians). About 11 pedestrian crossed the Mulgoa Road northern approach



Source: Intersection count survey-March 2016

Figure 2-20 Highest Peak Hour Intersection Pedestrian Flows – 19 March 2016 (Saturday)



Source: Intersection count survey-March 2016

Figure 2-21 Highest Peak Hour Intersection Pedestrian Flows – 20 March 2016 (Sunday)

2.15.2 Cyclist Movements

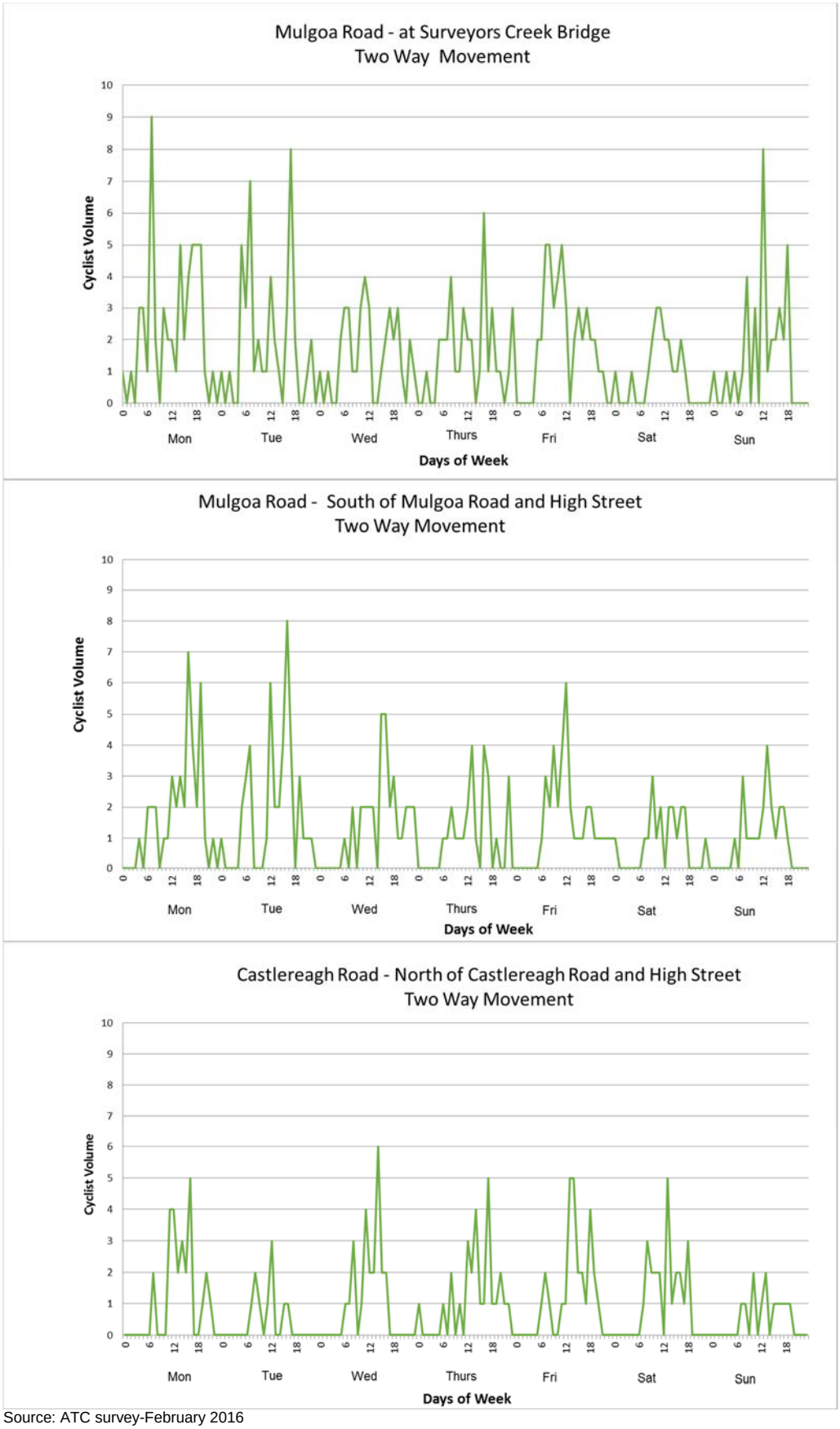
Source: ATC survey-February 2016

Figure 2-22 below shows existing cyclist movements recorded at three sites including:

- Mulgoa Road at Surveyors Creek Bridge
- Mulgoa Road south of High Street
- Castlereagh Road north High Street

The existing cyclist movement data at three locations indicated the following pattern:

- About 44 cyclist crossed the Mulgoa Road at Surveys Creek Bridge on a typical weekday (24 hours). The number of cyclist movements on a typical weekend decreased to 27 cyclists. On Monday in one peak hour about 9 cyclists crossed the bridge. On Sunday in one peak hour about 8 cyclists crossed the bridge.
- About 36 cyclist crossed the Mulgoa Road, south of High Street intersection on a typical weekday (24 hours). The number of cyclist movements on a typical weekend decreased to 21 cyclists. On Tuesday in one peak hour about 8 cyclists crossed the cyclist path. On Sunday in one peak hour about 4 cyclists crossed the cyclist path.
- About 23 cyclist crossed the Castlereagh Road, north of High Street intersection on a typical weekday (24 hours). The number of cyclist movements on a typical weekend decreased to 18 cyclists. On Wednesday in one peak hour about 6 cyclists crossed the cyclist path. On Saturday in one peak hour about 5 cyclists crossed the cyclist path.



Source: ATC survey-February 2016

Figure 2-22 Existing Cyclist Movements in the Study Area

Based on the existing survey on pedestrian and cyclist movements, the data suggests that active transport demand is low in the study area, generally reflecting the level and type of land use that occurs in the study area. It is expected that active transport demand will grow over time. The proposed intersections upgrades as part of the Mulgoa Road / Castlereagh Road corridor would not change the existing provisions for walking and cycling. The upgrades would accommodate active transport future demand.

3 EXISTING ROAD NETWORK PERFORMANCE

3.1 Traffic Survey

Four types of surveys were carried out by Tracsis (previously known as Skyhigh) to satisfy the needs and purpose of the project. They were:

- Intersection turning movement counts for critical peak periods
- Daily automatic traffic counts on midblock locations for a one week period
- Queue length surveys at critical intersections
- Travel speed survey.

Surveys were carried out between 11 May and 20 May 2015 as follows:

- Automatic Tube Counts (Midblock) were carried out between 11 May and 20 May 2015
- Intersection counts, were carried out on 19 May 2015 (Tuesday) at key locations in the study area
- Queue Length surveys were carried out on 19 May 2015 (Tuesday) at key locations in the study area
- Travel time surveys were carried out on 19 May 2015 (Tuesday) and 11th June 2015 (Thursday)

Table 3-1 below shows traffic survey locations.

Table 3-1 Traffic Survey Locations

Survey Type	Survey Summary
ATC – Automatic Tube Counts (Midblocks)	• ATC of one week for 7 locations • Locations are: – Castlereagh Road -200m north of Jack Williams Drive – Castlereagh Road - between Museum Drive & Jane Street – Mulgoa Road - between Rodley Avenue & Ransley Street – Mulgoa Road - at Suveyors Creek bridge – Mulgoa Road - between Spencer Street & Glenmore Parkway – Belmore Street - 100m east of Station Street – Great Western Highway - 50m east of Ladbury Avenue • Figure 3-2 shows all Midblock locations
Intersection counts, Queue Length Surveys	• Intersection Turning counts during the morning and afternoon peak periods for 15 intersections including: – Castlereagh Road and Andrews Road – Castlereagh Road and Jack Williams Drive – Castlereagh Road and Coreen Avenue – Castlereagh Road & Mulgoa Road & Jane Street – Great Westwen Highway & Mulgoa Road & High Street

Survey Type	Survey Summary
	– Mulgoa Road and Ransley Road – Mulgoa Road and Panther Place – Mulgoa Road and Jamison Road – Mulgoa Road and Batt Street – Mulgoa Road and Blaikie Road – Mulgoa Road and Wolseley Street – Mulgoa Road / M4 Western Motorway on/off ramps (south of Wolseley Street) – Mulgoa Road / M4 Western Motorway on/off ramps (north of Factory Road) – Mulgoa Road and Glenmore Parkway – Mulgoa Road and Union Road • Queue Length are done on all 15 locations listed above • Figure 3-1 shows all locations for Intersection counts and Queue Lengths.
Travel time	• Travel time survey was carried out on Mulgoa Road and Castlereagh Road between Andrews Road and Glenmore Parkway in both northbound and southbound directions • Figure 3-3 shows travel time survey routes

The intersection turning movements counts were carried out for three hours in both AM Peaks (6am-9am) and PM peaks (3pm-6pm). The Queue length surveys were carried out for four hours in both AM peaks (6am-10am) and PM peaks (3pm-7pm)

The daily automatic traffic counts (ATC) were conducted as per 12 Ausroads standard vehicle classes.

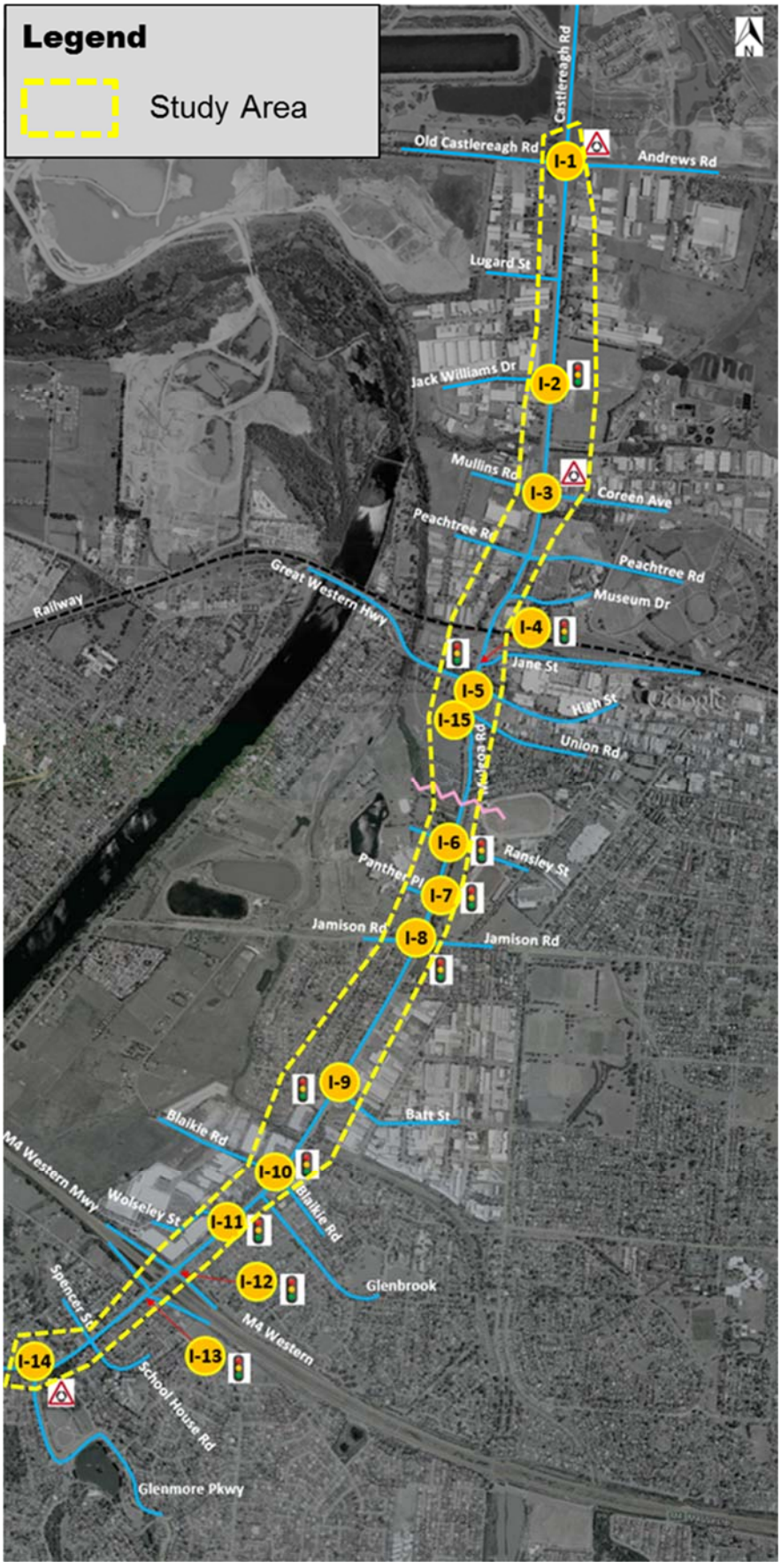


Figure 3-1 Intersection Counts and Queue Lengths Survey Locations

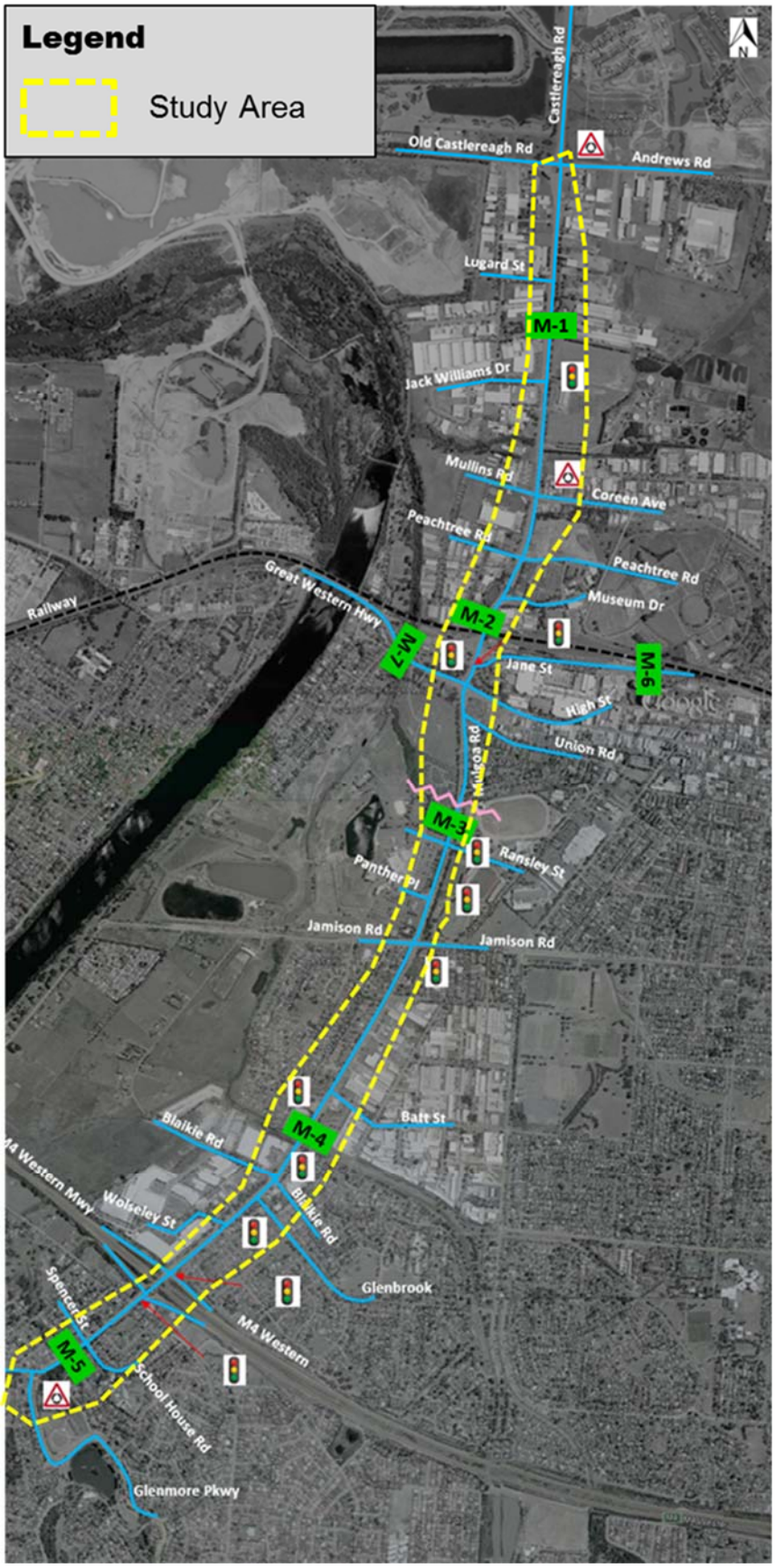


Figure 3-2 ATC Survey Locations

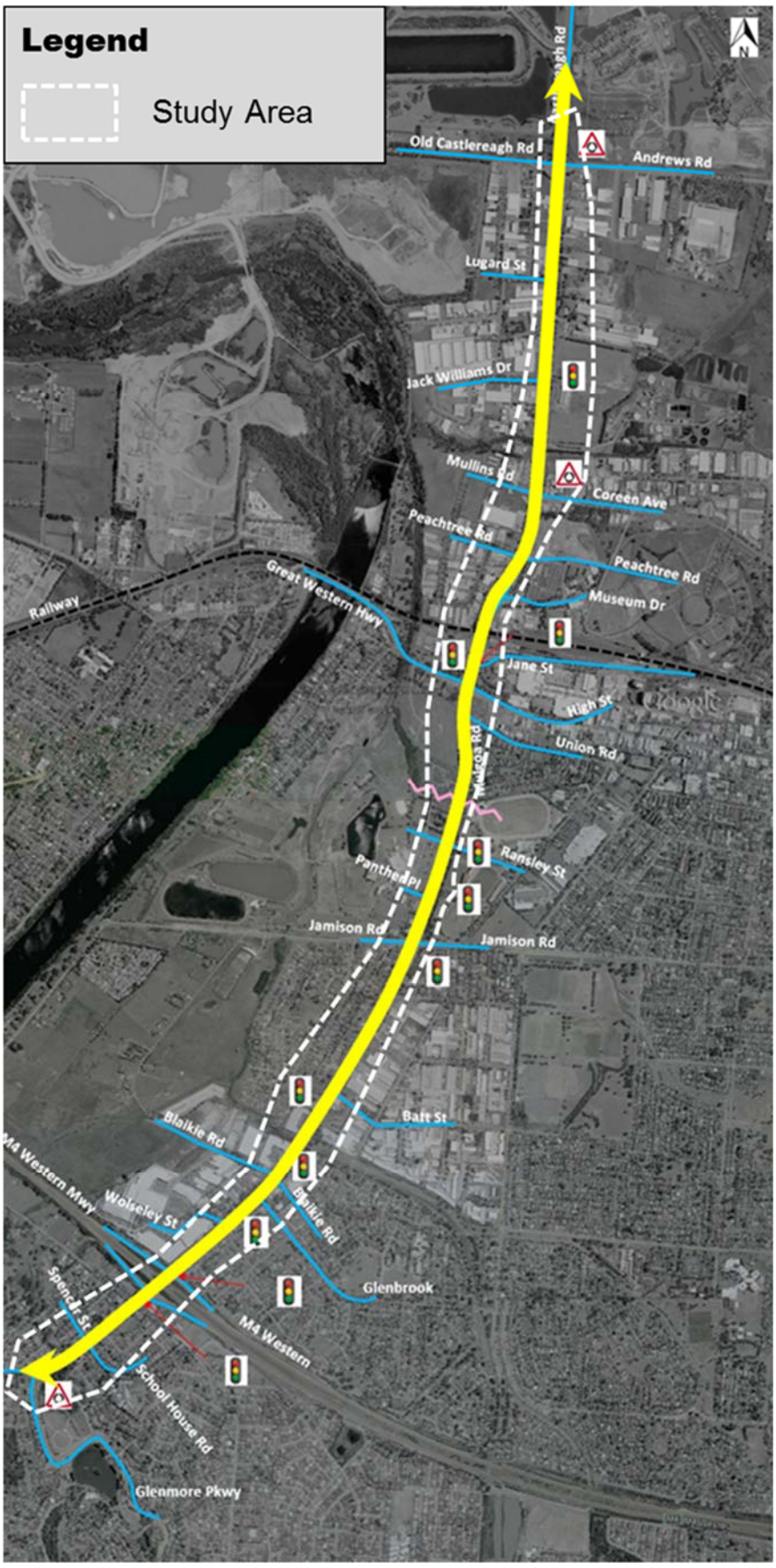


Figure 3-3 Travel Time Survey Route

3.2 Traffic Results

This section quantifies the daily and peak hour traffic flows on key roads and intersections within the study area. The results are based on survey data recorded from key roads and intersections in 2015. Supplementary traffic survey was undertaken at Mulgoa Road at Surveyors Creek Bridge on 18 February to 24 February 2016 for one week period.

3.2.1 Daily Traffic Volumes

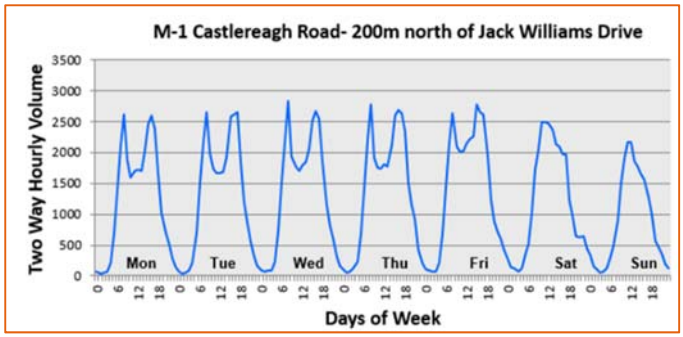
Table 3-2 shows the average daily traffic (ADT) volumes in the study area for weekdays and the weekend. Average weekly two-way traffic volume profiles are shown on Figure 3-4. The results indicate that:

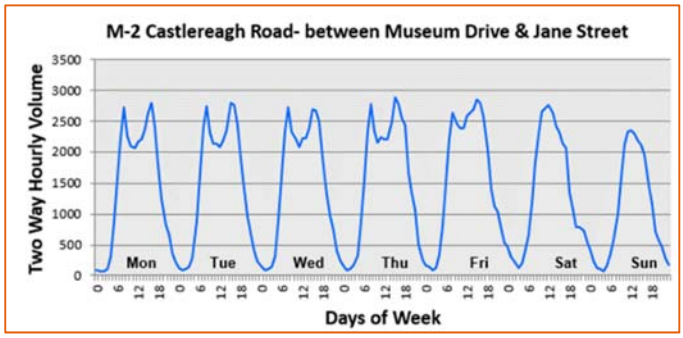
- Castlereagh Road carries between 34,000 to 38,000 vehicles per weekday
- Mulgoa Road carries between 30,000 to 44,000 vehicles per weekday
- Average weekend traffic on Castlereagh Road is 20 per cent to 22 per cent lower than weekday traffic
- Average weekend traffic on Mulgoa Road is nine to 13 per cent lower than weekday traffic.

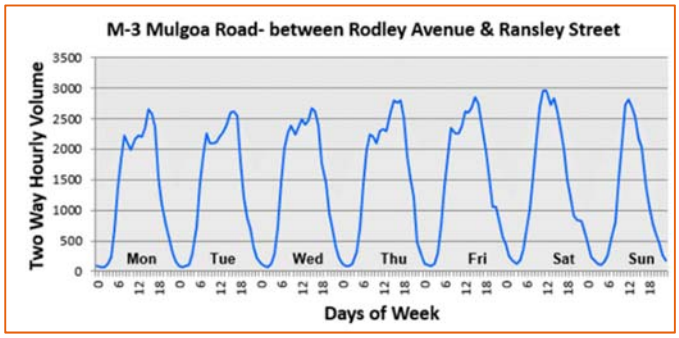
Table 3-2 Average Daily Weekday and Weekend Traffic Volumes in the Study Area

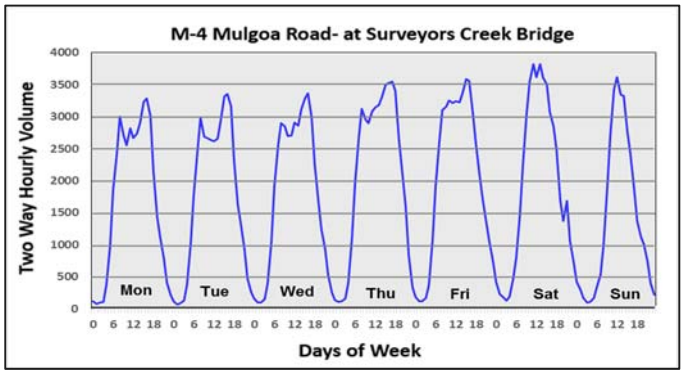
Site ID	Road Sections	Average 7-days	Average Weekday	Average Weekend	Critical day	%Traffic Change	
						Critical day vs Weekday	Weekend vs Weekday
M-1	Castlereagh Road-200m north of Jack Williams Drive	29,866	31,823	24,974	33,973	7%	-22%
M-2	Castlereagh Road-between Museum Drive and Jane Street	33,935	36,025	28,710	38,196	6%	-20%
M-3	Mulgoa Road-between Rodley Avenue and Ransley Street	33,376	34,684	30,105	37,198	7%	-13%
M-4	Mulgoa Road- at Surveyors Creek Bridge[1]	43,452	44,942	39,726	49,876	11%	12%
M-5	Mulgoa Road-between Spencer Street and Glenmore Parkway	28,125	28,888	26,219	30,408	5%	-9%

Source: ATC survey-May 2015
Note: 1. M-4: Mulgoa Road- at Surveyors Creek Bridge represents February 2016 traffic data.









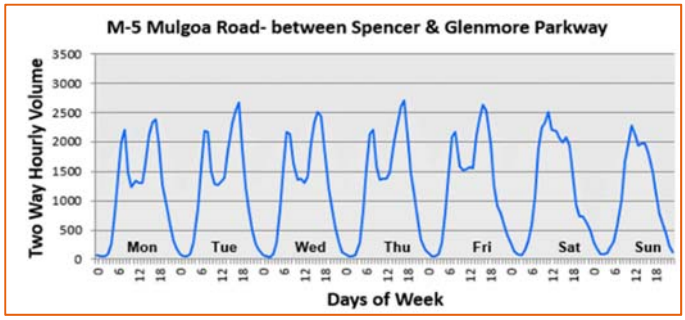
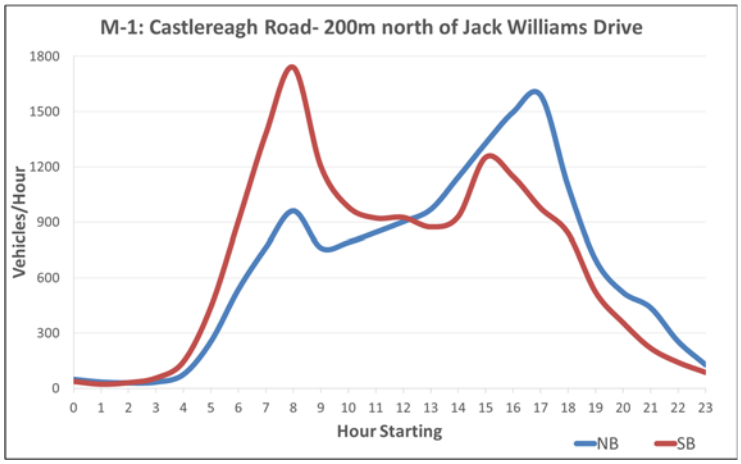


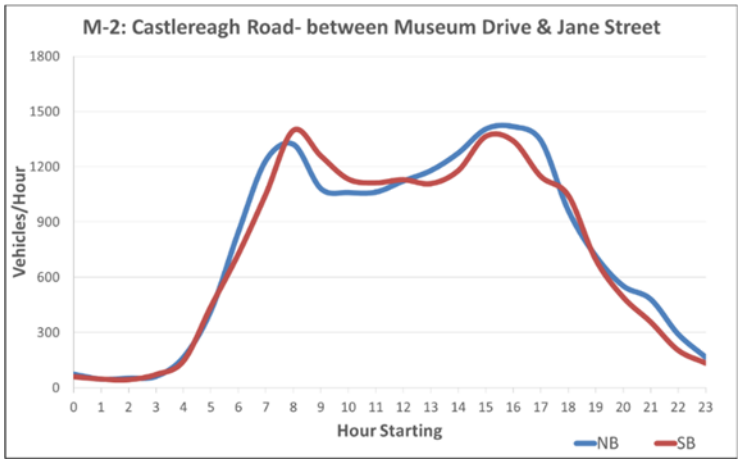
Figure 3-4 Average Weekly Two Way Traffic Volumes in the Study Area

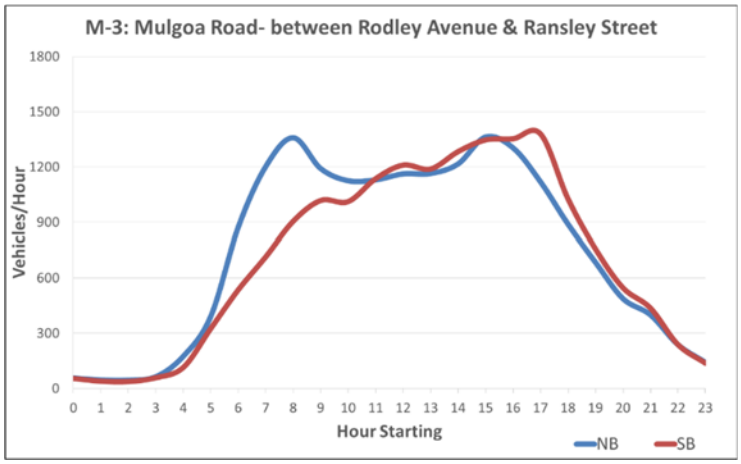
3.2.2 Daily Traffic Profiles

Daily traffic volume profiles for the five surveyed sites on the Mulgoa Road and Castlereagh Road corridor are shown on Figure 3-5. The traffic profiles suggest morning and afternoon peak hour durations as follows:

- Morning (AM) peak between 7:00 and 9:00 AM
- Afternoon (PM) peak between 4:00 and 6:00 PM.







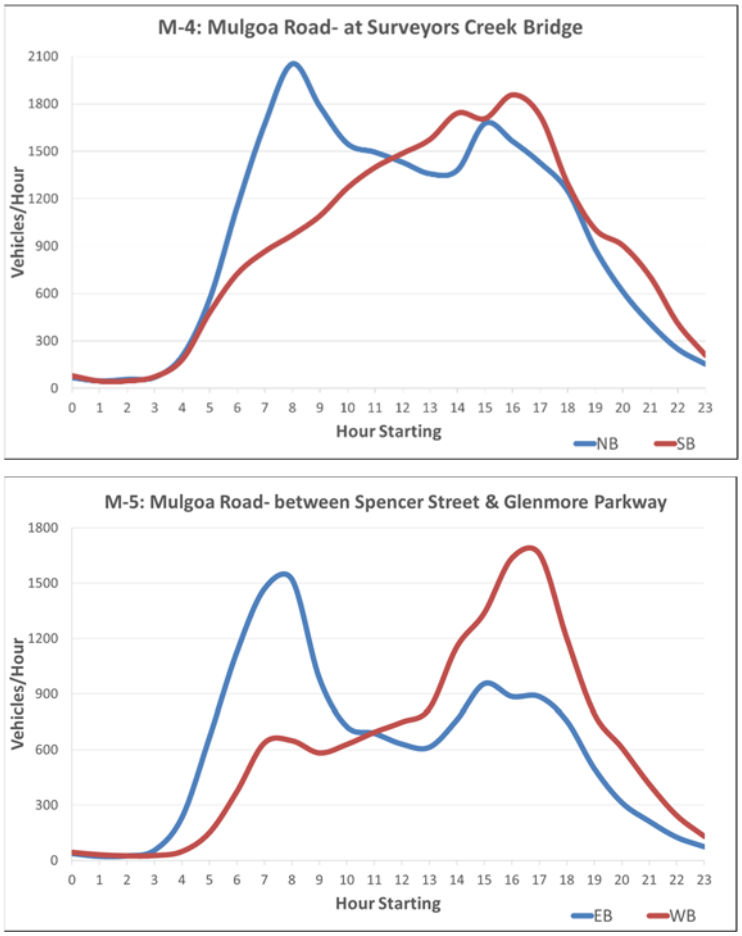


Figure 3-5 Daily Traffic Profiles in the Study Area

3.2.3 Peak Hour Volumes and Mid-Block Capacity

Appendix A included peak hour traffic volumes at surveyed intersections. They show graphically morning peak one hour (8 am to 9 am) and afternoon peak one hour (4 pm to 5 pm) traffic flows at key intersections within the study area.

Generally, there is a strong morning peak traffic flow in the southbound direction on Castlereagh Road from Andrews Road to Penrith CBD. However, a strong morning peak traffic flow is observed for the northbound direction on Mulgoa Road from M4 Western Motorway to Penrith CBD. The data also suggests a strong afternoon peak traffic flow in the northbound direction on Castlereagh Road (from Penrith CBD to Andrews Road) and in the southbound direction on Mulgoa Road (from Penrith CBD to M4 Western Motorway).

The morning and afternoon peak hour mid-block traffic capacity for Mulgoa Road / Castlereagh Road is showed in Table 3-3. In estimating volume capacity ratios for mid-block sections, the analysis assumed a notional capacity of 900-1000 vehicles per lane for Mulgoa Road / Castlereagh Road depending on the close proximity of adjacent intersections. Based on morning and afternoon peak traffic flows volume to capacity ratios (VCRs) have been estimated for various sections of Mulgoa Road / Castlereagh Road. The VCRs values can be interpreted as follows:

- No capacity problems (VCRs <0.60)
- Acceptable capacity (VCRs >0.60 but <0.85)
- Near capacity (VCRs >0.85 but <1.0)
- Over capacity (VCRs >1.0).

Currently in both morning and afternoon peak period part of the Mulgoa Road /Castlereagh Road corridor between Glenmore Parkway and Andrews Road is operating near or over its capacity, in particular the section between M4 Western Motorway and Jane Street, indicating a need for improving the operations of this section of Mulgoa Road /Castlereagh Road.

Table 3-3 Peak Hour Traffic Volumes in 2015

Sections	Road	AM Peak 1 Hour				PM Peak 1 Hour			
		Northbound		Southbound		Northbound		Southbound	
		Flow	VCR	Flow	VCR	Flow	VCR	Flow	VCR
Between Andrews Road and Museum Drive	Castlereagh Road [1]	1597	0.80	1755	0.88	1536	0.77	1493	0.75
Between Museum Drive and Union Road	Castlereagh Road [2]	1824	1.01	1523	0.85	1559	0.87	1589	0.88
Between Union Road and Jamison Road	Mulgoa Road [2]	1518	0.84	901	0.50	1146	0.64	1371	0.76
Between Jamison Road and M4	Mulgoa Road [1]	2454	1.23	1138	0.57	1683	0.84	2356	1.18
Between M4 and Glenmore Parkway	Mulgoa Road [1]	1656	0.83	797	0.40	886	0.44	1677	0.84

Note:
1. Road sections with notional capacity of 1000 vehicle/lane
2. Road sections with notional capacity of 900 vehicle/lane
3. Reported traffic volumes are highest within each section

3.3 Traffic Congestion

The traffic volumes on Mulgoa Road / Castlereagh Road corridor is steadily increasing with a high proportion of through vehicles carrying out trips within Penrith LGA. The corridor between Glenmore Parkway and Andrews Road has 17 sets of traffic signalsi and three roundabouts. The large number of traffic signals along the corridor exacerbates stop-start traffic conditions causing delay and congestion. A substantial portion of the peak hour traffic travelling on the corridor is through traffic, conflicting with CBD local trips. The traffic congestion on the corridor is predicted to intensify as a result of continuing population and employment growth due to developments in Penrith CBD, Penrith Panthers and Penrith Lakes Development. During the morning and afternoon peak periods, the Mulgoa Road and Castlereagh Road and its intersections experience considerable level of traffic congestion.

The existing Mulgoa Road / Castlereagh Road experiences traffic congestion and delays during weekday peak traffic periods. During both morning and afternoon peak hours a substantial amount of turning traffic contributes to capacity problems at critical intersections, particularly on the section of Mulgoa Road / Castlereagh Road between the M4 Western Motorway and Andrews Road (refer to Figure 3-6 below).

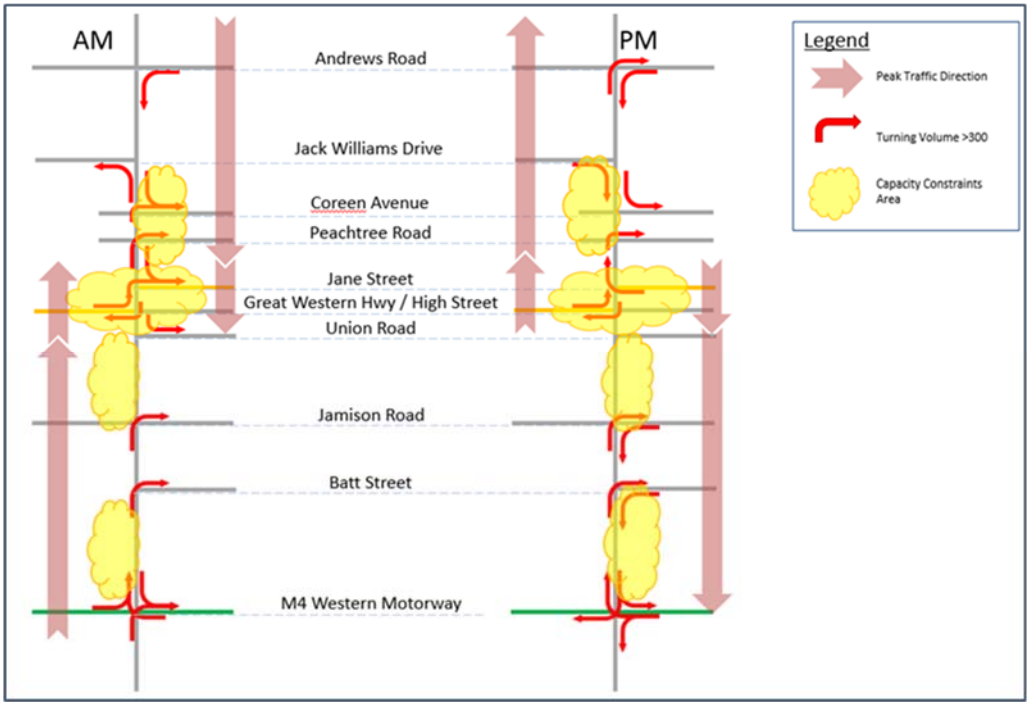


Figure 3-6 Observed Traffic Congested Areas in 2015

Travel speed on Mulgoa Road / Castlereagh Road during the weekday peak period reduces substantially below the posted speed of 60 kilometres per hour. The 2015 survey indicates that motorists travel about 10 to 35 kilometres per hour from Museum Drive to M4 Western Motorway, and about 35 to 40 kilometres per hour from Andrews Road to Museum Drive and from M4 Western Motorway to Glenmore Parkway. The average travel speed for the entire corridor from Glenmore Parkway to Andrews Road was about 20 to 30 kilometres per hour. Table 3-4 shows 2015 surveyed travel speed on Mulgoa Road / Castlereagh Road.

A new traffic signal at Masters Development is currently under construction. The 17 sets of signals also include two signals within the Jane Street / Mulgoa Road Infrastructure project.

Table 3-4 Existing Travel Speeds in the Study Area for 2015

Section	Description	Travel Speed (km/h)			
		AM Peak		PM Peak	
		NB	SB	NB	SB
1	Andrews Road to Museum Drive	40	39	38	31
2	Museum Drive to Union Road	15	13	16	13
3	Union Road to Jamison Road	35	43	36	48
4	Jamison Road to M4	31	26	30	23
5	M4 to Glenmore Parkway	27	39	31	43

Source: Skyhigh Traffic surevy
F:\AA008188\Traffic Modelling\VISSIM Models\2015 Base Models\2015 Base Statistic

4 VISSIM MODEL DEVELOPMENT

4.1 Overview

VISSIM models were used to facilitate a more in depth analysis of the operational performance key intersections within the study area. Figure 4-1 shows the VISSIM network developed for this study. VISSIM models were calibrated and validated according to the Roads and Maritime's Traffic Modelling Guidelines, Version 1.0 (February 2013). The models represented 2015 traffic conditions for both morning (AM) peak and afternoon (PM) peak periods being:

- The AM peak period between 7:00 AM and 9:00 AM
- The PM peak period between 4:00 PM and 6:00 PM.

The model specifically represents traffic for an average weekday by modelling the AM and PM peak periods.

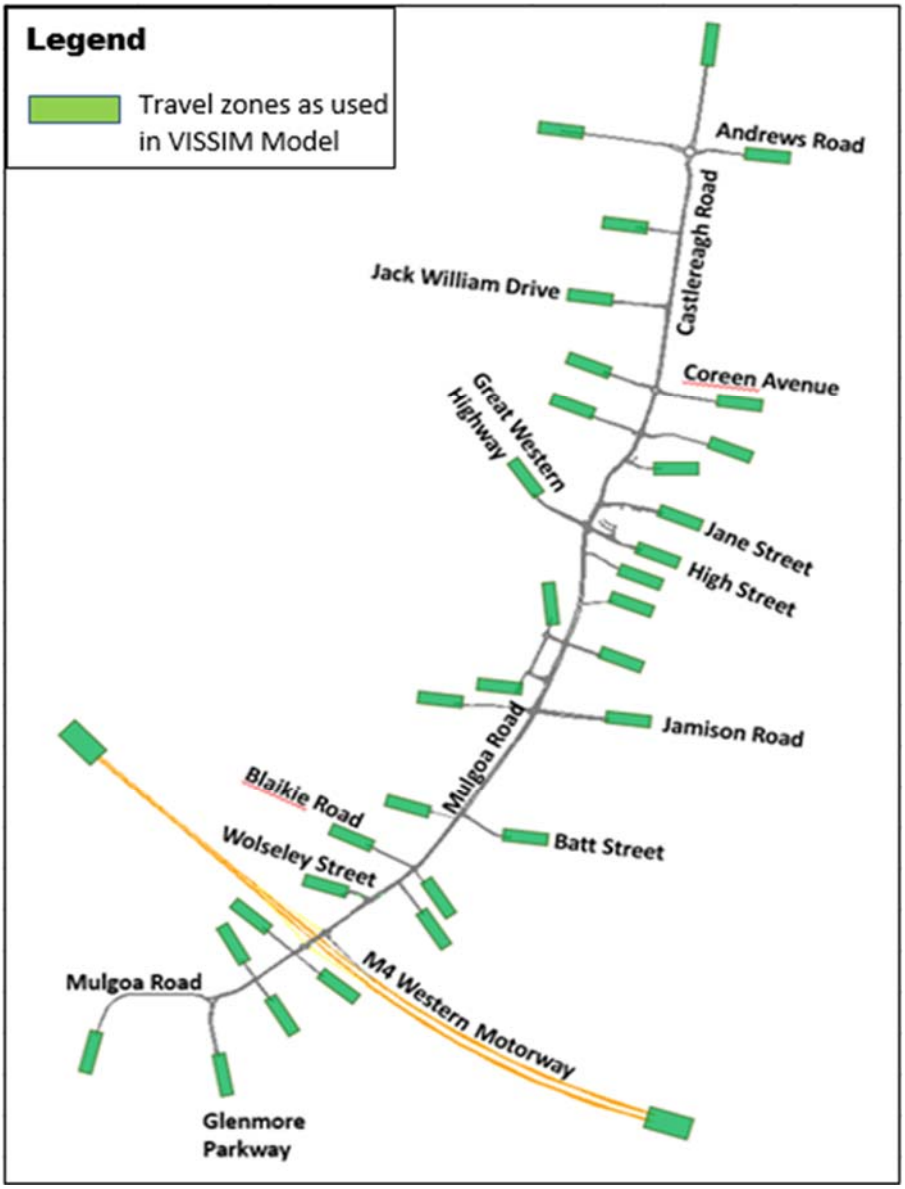


Figure 4-1 VISSIM Model Road Network and Travel Zone System

4.2 Traffic Demand

The demand matrix was estimated using surveyed intersection turning movement counts. The proportion of heavy vehicles and vehicle types were taken directly from available classified traffic data. The demand profiles are developed based on the traffic survey data.

4.3 Model Calibration and Validation

The VISSIM modelling was calibrated and validated as per Roads and Maritime's guideline. A technical note was prepared and submitted to Roads and Maritime documenting model calibration and validation results. Roads and Maritime staff commented on model calibration and validation results and found to be fit for the study purpose.

A copy of VISSIM model calibration and validation technical note is included in Appendix B.

5 FUTURE TRAFFIC CONDITIONS

5.1 Land use Assumptions

The future traffic growth data on the Mulgoa Road / Castlereagh Road from Glenmore Parkway to Andrews Road was sourced from Roads and Maritime's Strategic Highway Network Model (EMME). The EMME model used land use data (households, employment) from Bureau of Transport Statistics (BTS). The BTS data contained planned residential and employment growth within Penrith CBD and Penrith LGA including Penrith Panthers, Penrith Lakes and Thornton.

Two growth scenarios have been assessed from EMME by varying development potentials identified for Penrith Panthers, Penrith Lakes and Thornton developments.

- Growth scenario 1 (BTS)
- Growth scenario 2 (Accelerated Growth)

The land use assumptions for scenario 1 is shown in Table 5-1.

Table 5-1 Land Use Assumption for Growth Scenario 1 (BTS)

Area	Household			Employment		
	2016	2026	2036	2016	2026	2036
Penrith Lakes	802	1500	2288	246	249	263
Thornton	398	1177	1673	828	895	973
Panthers	361	404	499	2385	2496	2665
Entire Corridor	10519	13229	15937	30647	33521	36533

1. Growth scenario 1: This is based on BTS growth projection and includes developments in Penrith Lakes, Thornton and Penrith Panthers. The scenario 1 assumes that by 2036:

- Penrith Lakes will have 2288 households
- Thornton Development will have 1673 households
- Penrith Panthers will have 499 households and 2665 employments

The land use assumptions for scenario 2 is shown in Table 5-2.

Table 5-2 Land Use Assumption for Growth Scenario 2 (Accelerated Growth)

Area	Household			Employment		
	2016	2026	2036	2016	2026	2036
Penrith Lakes	802	2427	4577	246	249	263
Thornton	398	1177	1673	828	1170	1555
Panthers	361	948	1548	2385	3186	4086
Entire Corridor	10519	14700	19275	30647	34543	38566

2. Growth scenario 2: Scenario 2 is built on scenarios 1 plus accelerated growth within Penrith Lakes, Thornton and Panthers. The scenario 2 assumes that by 2036:

- Penrith Lakes will have 4577 households
- Thornton Development will have 1555 employments
- Penrith Panthers will have 1548 households and 4086 employments

5.2 Corridor Sections

For reporting purpose the Mulgoa Road / Castlereagh Road from Glenmore Parkway to Andrews Road is divided into five sections as follows:

- **Section 1:** From Andrews Road to Museum Road
- **Section 2:** From Museum Road to Union Road
- **Section 3:** From Union Road to Jamison Road
- **Section 4:** From Jamison Road to M4 Western Motorway
- **Section 5:** From M4 Western Motorway to Glenmore Parkway

Figure 5-1 below shows five sections of Mulgoa Road / Castlereagh Road corridor.

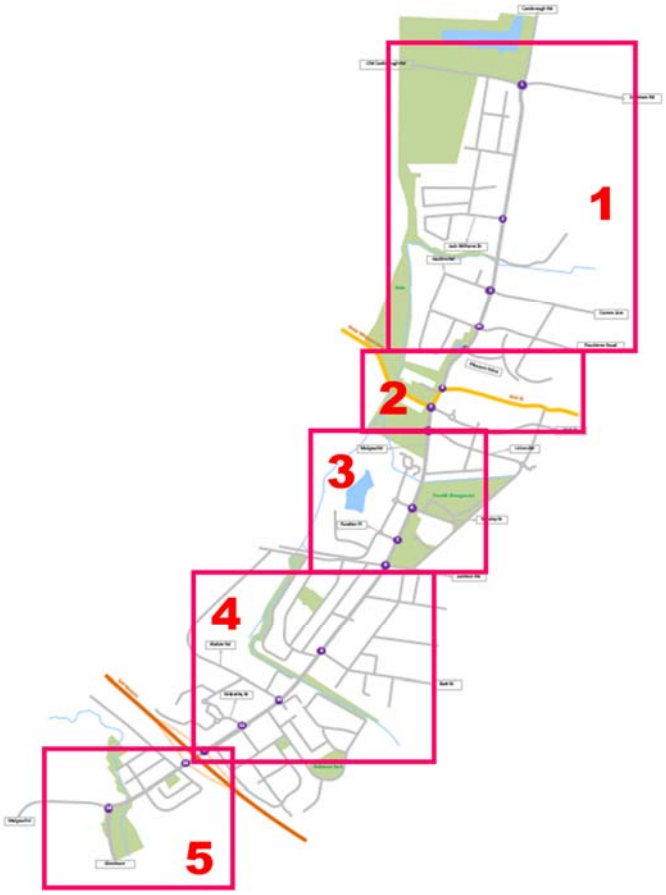


Figure 5-1 Corridor Sections for Mulgoa Road / Castlereagh Road

5.3 Future Traffic Volumes on Mulgoa Road / Castlereagh Road

The future traffic growth on the Mulgoa Road / Castlereagh Road from Glenmore Parkway to Andrews Road within the modelling study area were determined using EMME model. Based on the land use assumptions documented for scenario 1 and scenario 2, traffic growth between 2015 and 2036 are estimated for the entire corridor. Under scenario 1 (BTS), EMME model predicted about 1.3 per cent growth per annum for the entire corridor in the next 21 years (to 2036). The scenario 1 (BTS) growth of 1.3 per cent is in line with the historical growth (1.2 per cent) observed on the Mulgoa Road / Castlereagh Road.

Under scenario 2 (Accelerated growth), EMME model predicted about 2.0 per cent growth per annum for the entire corridor in the next 21 years (to 2036). The scenario 2 (Accelerated growth) growth of 2.0 per cent is higher than the historical growth (1.2 per cent) observed on the Mulgoa Road / Castlereagh Road.

Table 5-3 shows daily traffic volumes for 2015, 2026, 2036 at five sections on the Mulgoa Road / Castlereagh Road corridor for scenario 1 (BTS).

Table 5-3 Future Traffic Volume and Growth along the Corridor for Scenario 1 (BTS)

Section	Daily Volumes			Growth rate (per annum)		
	2015	2026	2036	2015-2026	2026-2036	2015-2036
Andrews Road to Museum Drive[1]	36700	53000	60000	4.0%	1.3%	3.0%
Museum Drive to Union Road[2]	43700	61000	70000	3.6%	1.5%	2.9%
Union Road to Jamison Road[3]	34500	46000	56000	3.0%	2.2%	3.0%
Jamison Road to M4 Western Motorway[4]	48400	58000	69000	1.8%	1.9%	2.0%
M4 Western Motorway to Glenmore Parkway[5]	31300	35000	38000	1.1%	0.9%	1.0%
Entire corridor growth between Glenmore Parkway and Andrews Road				**1.6%**	**1.0%**	**1.3%**

Note
1: Traffic volume is reported on Castlereagh Road, north of Coreen Avenue
2: Traffic volume is reported on Castlereagh Road, south of Museum Drive
3: Traffic volume is reported on Mulgoa Road, north of Ransley Street
4: Traffic volume is reported on Mulgoa Road, north of Blaikie Road
5: Traffic volume is reported on Mulgoa Road, south of M4 Western Motorway

Under scenario 1 (BTS), daily traffic volumes on the Mulgoa Road / Castlereagh Road corridor is forecast to grow from current 31,000 to 48,000 vehicles to 38,000 to 70,000 vehicles in 2036 depending on sections. Future traffic volumes from Table 5-3 indicates that:

- Traffic volumes on section 1 between Andrews Road and Museum Drive is forecast to grow from 37,000 vehicle per day in 2015 to 60,000 vehicle per day in 2036
- Traffic volumes on section 2 between Museum Drive and Union Road (Jane Street / Mulgoa Road Infrastructure Upgrade project) is forecast to grow from 44,000 vehicle per day in 2015 to 70,000 vehicle per day in 2036
- Traffic volumes on section 3 between Union Road and Jamison Road is forecast to grow from 35,000 vehicle per day in 2015 to 56,000 vehicle per day in 2036
- Traffic volumes on section 4 between Jamison Road and M4 is forecast to grow from 48,000 vehicle per day in 2015 to 69,000 vehicle per day in 2036
- Traffic volumes on section 5 between the M4 and Glenmore Parkway is forecast to grow from 31,000 vehicle per day in 2015 to 38,000 vehicle per day in 2036

Table 5-4 shows daily traffic volumes for 2015, 2026, 2036 at five sections on the Mulgoa Road / Castlereagh Road corridor for scenario 2 (Accelerated growth).

Table 5-4 Future Traffic Volume and Growth along the Corridor for Scenario 2 (Accelerated Growth)

Section	Daily Volumes			Growth rate (per annum)		
	2015	2026	2036	2015-2026	2026-2036	2015-2036
Andrews Road to Museum Drive[1]	36700	55000	65000	4.5%	1.8%	3.7%
Museum Drive to Union Road[2]	43700	63000	76000	4.0%	2.1%	3.5%
Union Road to Jamison Road[3]	34500	50000	62000	4.1%	2.4%	3.8%
Jamison Road to M4 Western Motorway[4]	48400	59000	71000	2.0%	2.0%	2.2%
M4 Western Motorway to Glenmore Parkway[5]	31300	35000	40000	1.1%	1.4%	1.3%
Entire corridor growth between Glenmore Parkway and Andrews Road				**2.2%**	**1.4%**	**2.0%**

Note
1: Traffic volume is reported on Castlereagh Road, north of Coreen Avenue
2: Traffic volume is reported on Castlereagh Road, south of Museum Drive
3: Traffic volume is reported on Mulgoa Road, north of Ransley Street
4: Traffic volume is reported on Mulgoa Road, north of Blaikie Road
5: Traffic volume is reported on Mulgoa Road, south of M4 Western Motorway

Under scenario 2 (Accelerated growth), daily traffic volumes on the Mulgoa Road / Castlereagh Road corridor is forecast to grow from current 31,000 to 48,000 vehicles to 40,000 to 76,000 vehicles in 2036 depending on sections. Future traffic volumes from Table 5-4 indicates that:

- Traffic volumes on section 1 between Andrews Road and Museum Drive is forecast to grow from 37,000 vehicle per day in 2015 to 65,000 vehicle per day in 2036
- Traffic volumes on section 2 between Museum Drive and Union Road (Jane Street / Mulgoa Road Infrastructure Upgrade project) is forecast to grow from 44,000 vehicle per day in 2015 to 76,000 vehicle per day in 2036
- Traffic volumes on section 3 between Union Road and Jamison Road is forecast to grow from 35,000 vehicle per day in 2015 to 62,000 vehicle per day in 2036
- Traffic volumes on section 4 between Jamison Road and M4 is forecast to grow from 48,000 vehicle per day in 2015 to 71,000 vehicle per day in 2036
- Traffic volumes on section 5 between the M4 and Glenmore Parkway is forecast to grow from 31,000 vehicle per day in 2015 to 40,000 vehicle per day in 2036

Detailed peak hour traffic volumes for both scenarios 1 and 2 are included in Appendix A.

5.4 Future Level of Service at Key Intersections

The future level of service was estimated for key intersections along the Mulgoa Road /Castlereagh Road corridor between Glenmore Parkway and Andrews Road. Level of service (LoS) is reported in accordance with the Roads and Maritime's Guideline (Guide to Traffic Generating Developments, Issue 2.2, Roads and Maritime, October 2002). For priority intersections such as a roundabout and sign controlled intersections, the LoS value is determined by the critical movement with the highest delay whereas for a signalised intersection, LoS criteria are related to the average intersection delay measured in seconds per vehicle. The performance of an intersection is measured by the intersection average delay per vehicle which in turns leads to a "level of service" measure for the intersection. These measures are:

- Level of Service A – average delay per vehicle is less than 14 seconds. Good operation
- Level of Service B – average delay per vehicle is between 14 and 28 seconds. Good operation with acceptable delays and spare capacity
- Level of Service C – average delay per vehicle is between 28 and 42 seconds. Satisfactory operation
- Level of Service D – average delay per vehicle is between 42 and 55 seconds. Operating near capacity
- Level of Service E – average delay per vehicle is between 55 and 70 seconds. Operating at capacity
- Level of Service F – average delay per vehicle is more than 70 seconds. Extra capacity required.

Table 5-5 below shows level of service results for key analysed 16 intersections for 2020, 2026 and 2036 for base case (Do nothing) traffic condition.

The future level of service analysis has found that if no action is taken to improve the traffic flow on the Mulgoa Road / Castlereagh from Glenmore Parkway to Andrews Road, the following is likely to occur:

- Major congestion at a number of key intersections during peak periods in the next five (2020) to ten years (2026) extending throughout a large part of the day
- Of the 16 key intersections analysed, 10 intersections showed poor level of service F in 2020 either in morning or afternoon peak periods
- In 2026, about 14 intersections showed poor level of service F either in morning or afternoon peak periods
- In 2036, all 16 analysed intersections showed poor level of service F either in morning or afternoon peak periods
- The Mulgoa Road / Castlereagh Road would be highly congested and there would be increased delays and queuing along the corridor
- Local amenity and access to the Penrith CBD would continue to decline due to increased traffic, as would other road related impacts such as noise and localised air quality
- The efficiency of public transport and freight would decline with reduced travel speed.

Table 5-5 Level of Service for Intersections in 2020, 2026 and 2036 Base Case (Do Nothing)

Intersection	Control Type	Do Nothing 2020		Do Nothing 2026		Do Nothing 2036	
		AM	PM	AM	PM	AM	PM
Andrews Road / Castlereagh Road	Roundabout	229 (F)	459 (F)	270 (F)	>600 (F)	293 (F)	>600 (F)
Jack William Drive / Castlereagh Road	Signal	52 (D)	65 (E)	70 (E)	70 (E)	95 (F)	94 (F)
Coreen Avenue / Castlereagh Road	Roundabout	171 (F)	559 (F)	415 (F)	>600 (F)	>600 (F)	>600 (F)
Peachtree Road / Castlereagh Road	Signal	52 (D)	159 (F)	52 (D)	159 (F)	52 (D)	145 (F)
Museum Drive / Castlereagh Road	Signal	31 (C)	84 (F)	26 (C)	173 (F)	21 (C)	251 (F)
Jane Street / Castlereagh Road	Signal	48 (D)	91 (F)	45 (D)	87 (F)	41 (D)	82 (F)
High Street / GWH / Mulgoa Road	Signal	57 (E)	79 (F)	75 (F)	103 (F)	88 (F)	115 (F)
Union Road / Mulgoa Road	Priority (sign)	47 (D)	410 (F)	69 (E)	507 (F)	75 (F)	576 (F)
Ransley Street / Mulgoa Road	Signal	17 (B)	65 (E)	54 (D)	137 (F)	70 (E)	180 (F)
Panther Place / Mulgoa Road	Signal	10 (A)	37 (C)	15 (B)	77 (F)	15 (B)	117 (F)
Jamison Road / Mulgoa Road	Signal	52 (D)	67 (E)	82 (F)	229 (F)	103 (F)	355 (F)
Batt Street / Mulgoa Road	Signal	17 (B)	64 (E)	28 (B)	157 (F)	47 (D)	221 (F)
Blaikie Street / Mulgoa Road	Signal	13 (A)	79 (F)	13 (A)	126 (F)	13 (A)	149 (F)
Wolseley Street / Mulgoa Road	Signal	23 (B)	24 (B)	23 (B)	60 (E)	22 (B)	76 (F)
M4 ramps / Mulgoa Road	Signal	90 (F)	35 (C)	135 (F)	154 (F)	161 (F)	258 (F)
Glenmore Parkway / Mulgoa Road	Roundabout	56 (E)	34 (C)	157 (F)	292 (F)	232 (F)	542 (F)

6 TRAFFIC ASSESSMENT ON THE STRATEGIC CONCEPT DESIGN

6.1 Scenarios Testing

The proposed upgrade for the Mulgoa Road / Castlereagh Road from Glenmore Parkway to Andrews Road involves widening the road from existing four lanes to six lanes including staged upgrades to all intersections to meet the traffic demand. The Mulgoa Road / Castlereagh Road upgrades excludes the Jane Street and Mulgoa Road Infrastructure Upgrade which is being delivered by Roads and Maritime as a separate project. It is expected that the future upgrade of Mulgoa Road / Castlereagh Road would be an extension of the Jane Street and Mulgoa Road Infrastructure Upgrade project. Road and Maritime has developed the strategic concept design for six lanes ultimate upgrade. The six lanes ultimate upgrade is referred to as the Reference Design.

The purpose of scenarios testing is to optimise the reference design and provide adequate traffic capacity to intersections within the Mulgoa Road / Castlereagh Road between Andrews Road and Glenmore Parkway. The reference design has been optimised achieving a target level of service E for the entire intersection for 2036 traffic conditions. The BTS land use forecast (scenario 1) have been used for testing various modelling options.

Traffic modelling scenarios investigated the following options:

- Option 1 – New signalised intersection at Union Road connecting Carpenter Site
- Option 2 – Left in left out at Union Road
- Option 2A – Partial signalised intersection at Union Road
- Option 3 – Two-lane northbound exit lane at Glenmore Parkway / Mulgoa Road intersection
- Option 4 – Two-lane southbound through lane from Wolseley Street to M4
- Option 4A – Four-lane southbound underneath the M4 (2 short lane north of M4)
- Option 4B – Four-lane southbound underneath the M4 (1 short lane north of M4, 3 southbound through lane underneath M4)
- Option 4C – Four-lane southbound underneath the M4 (1 short lane north of M4, 2 southbound through lane underneath M4)
- Option 6 – Two right turn lane into Jamison Road (1 for general traffic, 1 for buses)
- Option 7 – Four-lane northbound underneath the M4
- Option 8 – Two right turn lane from Castlereagh Road to Coreen Avenue
- Option 9 – Mouse hole grade separated tunnel is removed (at-grade right turn is provided into Wolseley Street)
- Option 9A – Mouse hole grade separated tunnel is removed(banned the right-turn into Wolseley Street)

The above mentioned options are tested independently from traffic grounds. Appendix C includes a copy of the 80% strategic concept design (RD0001-RD0012) provided by Roads and Maritime.

6.1.1 Option 1

The reference design assumed that High Street / Mulgoa Road intersection would be upgraded as part of the Jane Street / Mulgoa Road Infrastructure Upgrade Project. Currently Mulgoa Road/Union Road intersection is un-signalised with left in, left out and right in movements are permitted.

Option 1 proposes a new four-leg signalised intersection at Union Road connecting the Carpenter site. Option 1 assumes a new traffic signal on the Great Western Highway connecting the Carpenter site. Future traffic volumes for the Carpenter site is sourced from Penrith City Council.

Option 1 – New signalised intersection at Union Road connecting Carpenter Site

The following modifications are proposed:

1. New connection to the proposed site at the corner of High Street and Mulgoa Road
2. New traffic signal at Union Road, the fourth leg would form the Carpenter site access
3. New traffic signal on Great Western Highway at Carpenter site

Traffic Implications

Table 6-1 and Table 6-2 show traffic performance of Option 1 and reference design for 2036 morning and afternoon peak periods respectively.

Table 6-1 Forecast Levels of Service at Union Road / Mulgoa Road Intersection in AM Peak

Time Period	Approach	Reference Design		Option 1	
		Average Delay (sec)	LOS	Average Delay (sec)	LOS
AM	Mulgoa Road (N)	5	A	32 ▲	C
	Union Road (E)	2	A	22 ▲	B

Time Period	Approach	Reference Design		Option 1	
		Average Delay (sec)	LOS	Average Delay (sec)	LOS
	Mulgoa Road (S-Right Turn)	35	C	106 ▲	F
	Mulgoa Road (S-Through)	Free Flow		58 ▲	E
	Mulgoa Road (S-Left Turn)	N/A		31 ▲	C
	Carpenter Site (W)	N/A		40 ▲	C
	Overall [1]	35	C	50 ▲	D

Note: 1. Overall intersection delay and level of service for priority junction was the adopted from the worst movement

Table 6-2 Forecast Levels of Service at Union Road / Mulgoa Road Intersection in PM Peak

Time Period	Approach	Reference Design		Option 1	
		Average Delay (sec)	LOS	Average Delay (sec)	LOS
PM	Mulgoa Road (N)	2	A	32 ▲	C
	Union Road (E)	6	A	24 ▲	B
	Mulgoa Road (S-Right Turn)	21	B	81 ▲	F
	Mulgoa Road (S-Through)	Free Flow		118 ▲	F
	Mulgoa Road (S-Left Turn)	N/A		74 ▲	F
	Carpenter Site (W)	N/A		49 ▲	D
	Overall [1]	21	B	65 ▲	E

Note: 1. Overall intersection delay and level of service for priority junction was the adopted from the worst movement

When Option 1 was compared with reference design, modelling result indicated adverse impact to Mulgoa Road/High Street intersection level of service. Option 1 proposes two sets of new traffic signals which will adversely impact to adjacent Mulgoa Road /High Street intersection. Model has predicted level of service F at Mulgoa Road /High Street intersection for Option 1 compared to reference design (level of service D).

Key Findings

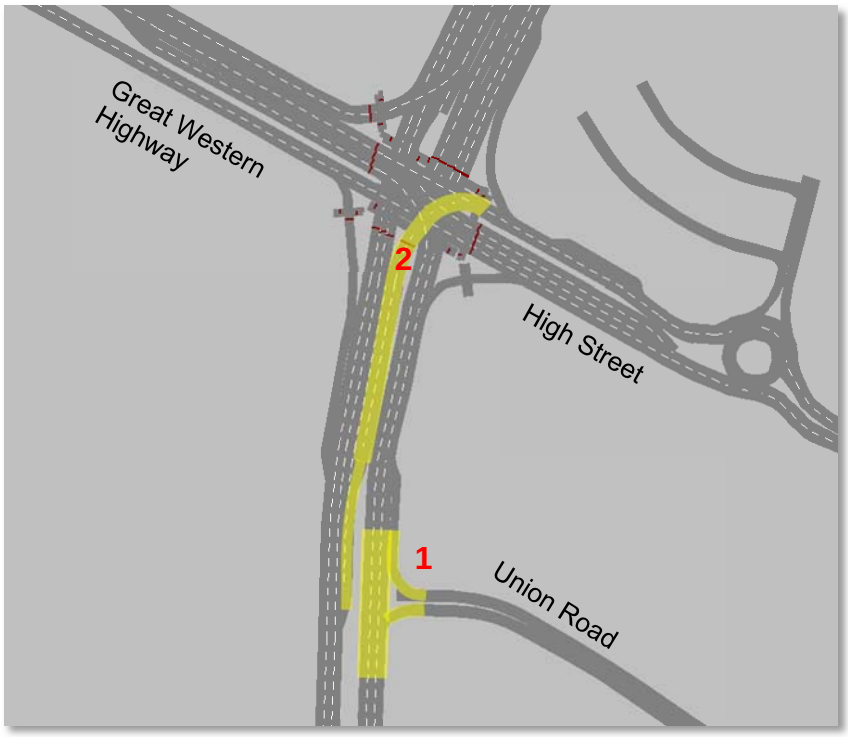
Option 1 proposes two sets of new traffic signals which will adversely impact to adjacent Mulgoa Road /High Street intersection.

6.1.2 Option 2

The reference design assumed that High Street / Mulgoa Road intersection would be upgraded as part of the Jane Street / Mulgoa Road Infrastructure Upgrade Project. Currently Mulgoa Road/Union Road intersection is un-signalised with left in, left out and right in movements are permitted.

Option 2 proposes left in /left out only at Union Road. It is assumed that right turn traffic currently use Union Road will use the High Street intersection instead. Option 2 proposes double right turn at High Street / Mulgoa Road intersection to accommodate the additional traffic.

Option 2 – Left in left out at Union Road



The following modifications are proposed:

1. Left in left out only at Union Road, right turn in from Mulgoa Road is banned
2. Additional right turn lane from Mulgoa Road to High Street.

Traffic Implications

Table 6-3 and Table 6-4 show traffic performance of Option 2 and reference design for 2036 morning and afternoon peak periods respectively.

Option 2 improves traffic performance at Union Road, however adversely impacts High Street intersection. The level of service for the southern approach will be adversely impacted (LoS F) due to additional right turn volumes.

Table 6-3 Forecast Levels of Service at High Street / Mulgoa Road Intersection in AM Peak

Time Period	Approach	Reference Design		Option 1	
		Average Delay (sec)	LOS	Average Delay (sec)	LOS
AM	Castlereagh Road (N)	33	C	34	C
	High Street (E)	49	D	53 ▲	D
	Mulgoa Road (S)	48	D	75 ▲	F
	GWH (W)	63	E	86 ▲	F
	Overall	46	D	61 ▲	E

Table 6-4 Forecast Levels of Service at High Street / Mulgoa Road Intersection in PM Peak

Time Period	Approach	Reference Design		Option 1	
		Average Delay (sec)	LOS	Average Delay (sec)	LOS
PM	Castlereagh Road (N)	39	C	42 ▲	C
	High Street (E)	63	E	64	E
	Mulgoa Road (S)	44	D	43	D
	GWH (W)	58	E	62 ▲	E
	Overall	48	D	49	D

Key Findings

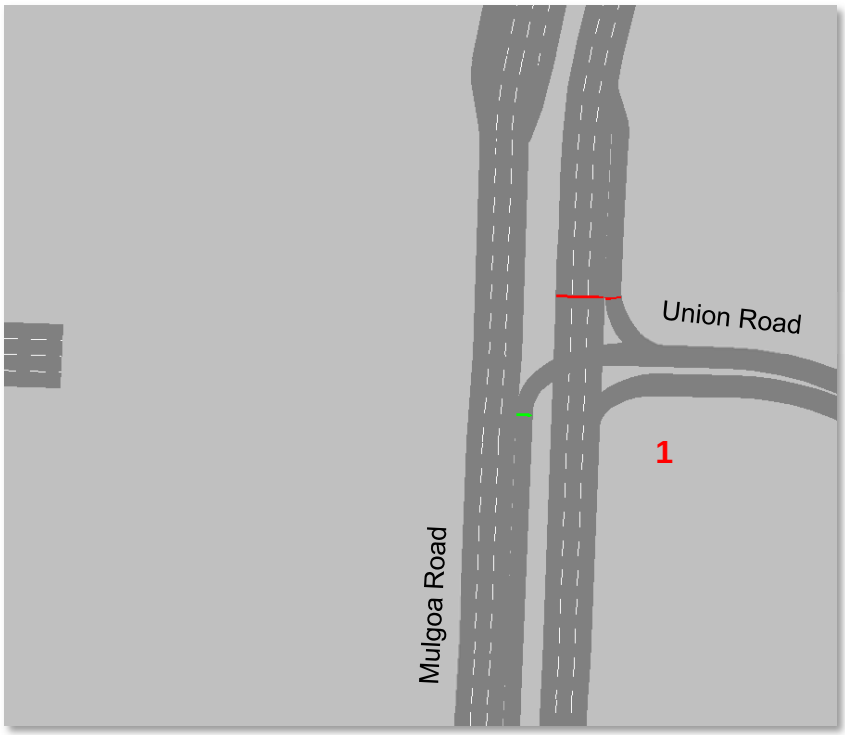
Option 2 improves traffic performance at Union Road, however adversely impacts High Street intersection. Option 2 changes are not recommended to the reference design from traffic grounds.

6.1.3 Option 2A

The reference design assumed that High Street / Mulgoa Road intersection would be upgraded as part of the Jane Street / Mulgoa Road Infrastructure Upgrade Project. Currently Mulgoa Road/Union Road intersection is un-signalised with left in, left out and right in movements are permitted.

Option 2A proposes partial signalisation at Union Road intersection. The southbound traffic on Mulgoa Road and northbound right turn traffic to Union Road will be impacted from partial signals. The northbound through traffic will be free flow.

Option 2A – Partially signalised intersection at Union Road



The following modifications are proposed:

1. Partial signals at Union Road intersection

Traffic Implications

Table 6-5 and Table 6-6 show traffic performance of Option 2A and reference design for 2036 morning and afternoon peak periods respectively.

Option 2A (partial signalisation) improves traffic performance at Union Road intersection. The right turn from Mulgoa Road to Union Road experiences more delay due to traffic signal with level of service C and D.

Table 6-5 Forecast Levels of Service at Union Road / Mulgoa Road Intersection in AM Peak

Time Period	Approach	Reference Design		Option 2A	
		Average Delay (sec)	LOS	Average Delay (sec)	LOS
AM	Mulgoa Road (N)	4	A	9 ▲	A
	Union Road (E)	2	A	3	A
	Mulgoa Road (S-Right Turn)	16	B	42 ▲	C
	Overall [1]	16	B	16	B

Note: 1. Overall intersection delay and level of service for priority junction was the adopted from the worst movement

Table 6-6 Forecast Levels of Service at Union Road / Mulgoa Road Intersection in PM Peak

Time Period	Approach	Reference Design		Option 2A	
		Average Delay (sec)	LOS	Average Delay (sec)	LOS
PM	Mulgoa Road (N)	2	A	5 ▲	A
	Union Road (E)	7	A	6	A
	Mulgoa Road (S-Right Turn)	22	B	45 ▲	D
	Overall [1]	22	B	8 ▼	A

Note: 1. Overall intersection delay and level of service for priority junction was the adopted from the worst movement

Key Findings

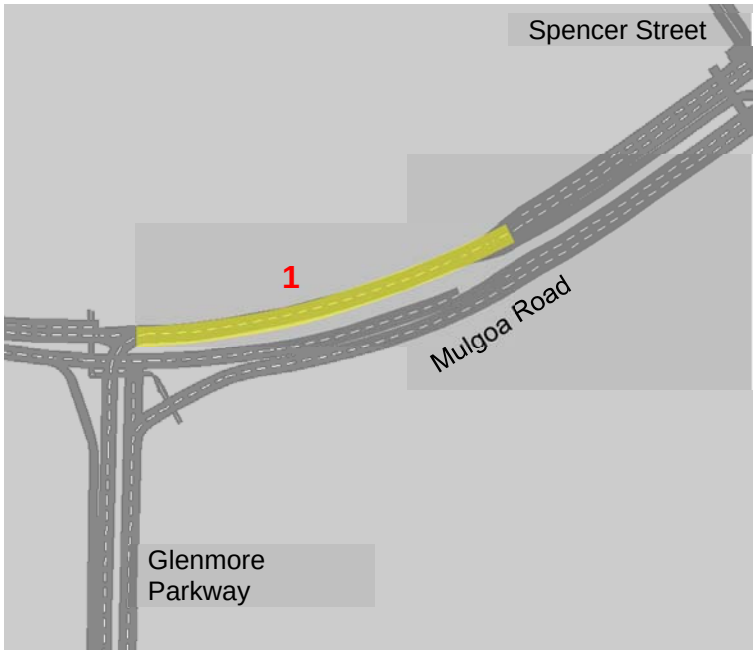
Option 2A improves traffic performance at Union Road. Option 2A changes would improve the safety performance of right turn traffic into Union Road. Option 2A changes are recommended to the reference design from traffic grounds.

6.1.4 Option 3

The reference design proposes new traffic signals replacing the roundabout at Glenmore Parkway intersection. The reference design assumes three exit lanes on the eastern approach and continues up to Spencer Street / Mulgoa Road intersection.

Option 3 proposes two exit lanes on the eastern approach reducing one lane in the northbound direction. Two lanes will be widened to three lanes at Spencer Street / Mulgoa Road intersection approach.

Option 3 – Northbound exit lane at Glenmore Parkway / Mulgoa Road intersection



The following modifications are proposed:

1. Two-lane northbound exit lane at Glenmore Parkway / Mulgoa Road intersection (about 130m long)

Traffic Implications

and Table 6-8 show traffic performance of option 3 and reference design for 2036 morning and afternoon peak periods respectively. Option 3 does not impact substantially to intersection level of service.

Table 6-7 Forecast Levels of Service at Glenmore Parkway / Mulgoa Road Intersection in AM Peak

Time Period	Approach	Reference Design		Option 3	
		Average Delay (sec)	LOS	Average Delay (sec)	LOS
AM	Mulgoa Road (N)	19	B	19	B
	Glenmore Parkway (S)	22	B	23	B
	Mulgoa Road (W)	42	C	42	C
	Overall	27	B	27	B

Table 6-8 Forecast Levels of Service at Glenmore Parkway / Mulgoa Road Intersection in PM Peak

Time Period	Approach	Reference Design		Option 3	
		Average Delay (sec)	LOS	Average Delay (sec)	LOS
PM	Mulgoa Road (N)	19	B	19	B
	Glenmore Parkway (S)	20	B	20	B
	Mulgoa Road (W)	34	C	34	C
	Overall	20	B	20	B

Key Findings

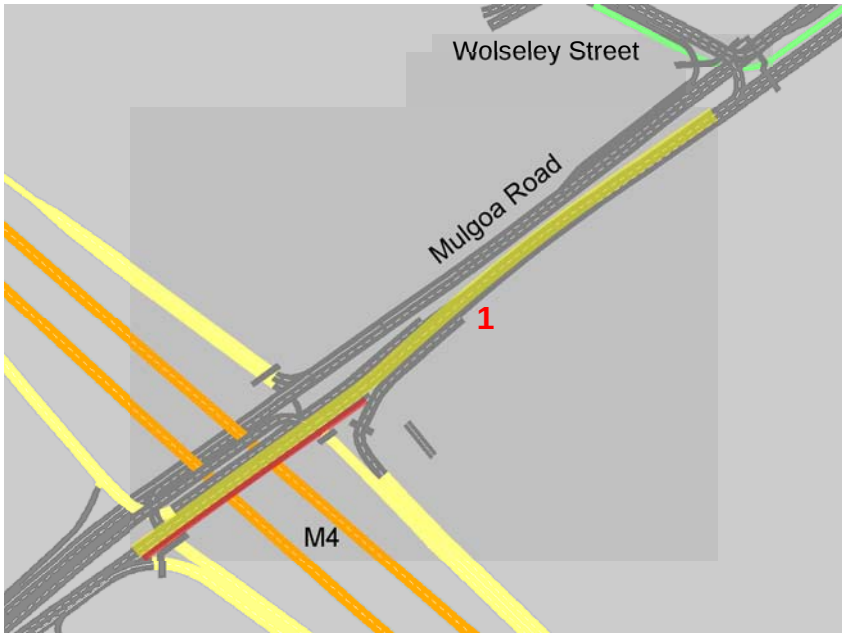
Option 3 does not impact traffic performance at Glenmore Parkway intersection. Option 3 changes are recommended to the reference design from traffic grounds.

6.1.5 Option 4

The reference design proposes three southbound through lanes underneath the M4 Bridge.

Option 4 proposes to reduce to two southbound through lanes underneath the M4 Bridge.

Option 4 – Two-lane southbound through lane from Wolseley Street to M4



The following modifications are proposed:

1. Two-lane southbound through lane from Wolseley Street to M4

Traffic ImplicationsTable 6-11 shows travel speed on Mulgoa Road for reference design and Option 4.

Table 6-9 and Table 6-10 show traffic performance of Option 4 and reference design for 2036 morning and afternoon peak periods respectively. The results are shown for the northern approach at M4 eastbound ramps traffic signal.

Option 4 adversely impacts traffic capacity on the Mulgoa Road in the southbound direction. Model shows extended queues for the southbound traffic beyond Wolseley Street intersection. The south bound trave speed on Mulgoa Road between Jamison Road and M4 in PM peak reduces substantially to 11 km/h for Option 4 compared to reference design (24 km/h). Table 6-11 shows travel speed on Mulgoa Road for reference design and Option 4.

Table 6-9 Forecast Levels of Service at Northern Traffic Signal of M4 Ramps in AM Peak

Time Period	Approach	Reference Design	Option 4
		Average Delay (sec)	Average Delay (sec)
AM	Mulgoa Road (N)	30 (C)	41 (C) ▲

Note: 1. VISSIM measure queues from the signal stop line up to the next intersection only.

Table 6-10 Forecast Levels of Service at Northern Traffic Signal of M4 Ramps in PM Peak

Time Period	Approach	Reference Design	Option 4
		Average Delay (sec)	Average Delay (sec)
PM	Mulgoa Road (N)	40 (C)	64 (E) ▲

Note: 1. VISSIM measure queues from the signal stop line up to the next intersection only.

Table 6-11 Forecast Southbound Average Speed for Section between Jamison Road and M4

Section	Time Period	Reference Design	Option 4
		Southbound	Southbound
Between Jamison Road and M4	AM	35	32 ▼
	PM	24	11 ▼

Key Findings

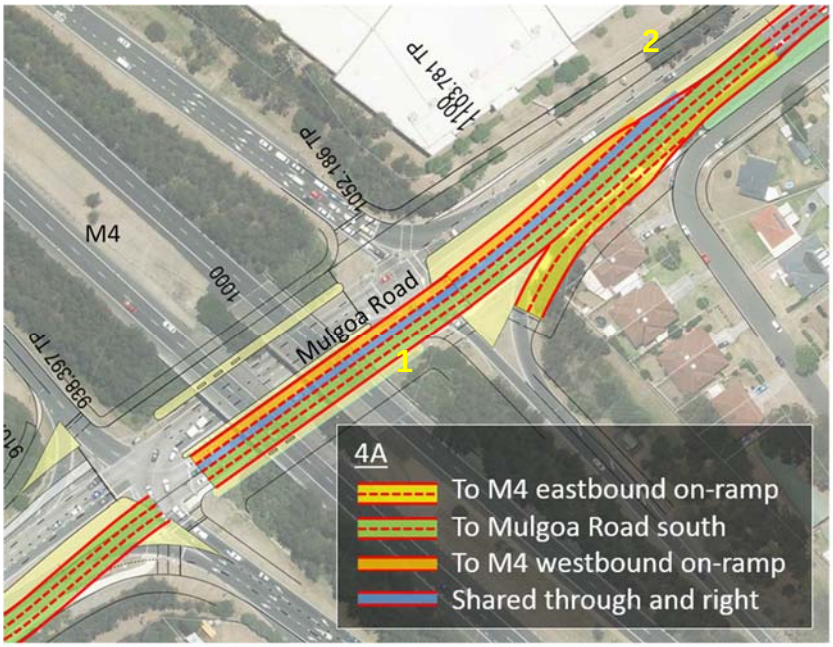
Option 4 adversely impacts traffic performance on the Mulgoa Road for southbound traffic. Option 4 changes are not recommended to the reference design from traffic grounds.

Three additional sub-options 4A, 4B and 4C of Option 4 are assessed varying southbound lanes configuration. They are described in the following section.

6.1.6 Option 4A

Option 4A is a variation to Option 4 which proposes two dedicated southbound through lanes, one shared through and right turn lane, and one dedicated right turn lane underneath the M4 Bridge.

Option 4A – Four-lane southbound underneath M4



The following modifications are proposed:

1. Four-lane southbound underneath M4 (2 through, 1 shared through and right, 1 dedicated right)
2. Length of shared lane is 190m

Traffic Implications

Table 6-12 and

Table 6-13 show traffic performance of Option 4A and reference design for 2036 morning and afternoon peak periods respectively. The results are shown for the northern approach at M4 eastbound ramps traffic signal.

Option 4A marginally improves traffic performance on the Mulgoa Road in the southbound direction than Option 4. However model shows extended queues for the southbound traffic beyond Wolseley Street intersection.

Table 6-12 Forecast Levels of Service at Northern Traffic Signal of M4 Ramps in AM Peak

Time Period	Approach	Reference Design	Option 4A
		Average Delay (sec)	Average Delay (sec)
AM	Mulgoa Road (N)	30 (C)	36 (C) ▲

Note: 1. VISSIM measure queues from the signal stop line up to the next intersection only.

Table 6-13 Forecast Levels of Service at Northern Traffic Signal of M4 Ramps in PM Peak

Time Period	Approach	Reference Design	Option 4A
		Average Delay (sec)	Average Delay (sec)
PM	Mulgoa Road (N)	40 (C)	52 (D) ▲

Note: 1. VISSIM measure queues from the signal stop line up to the next intersection only.

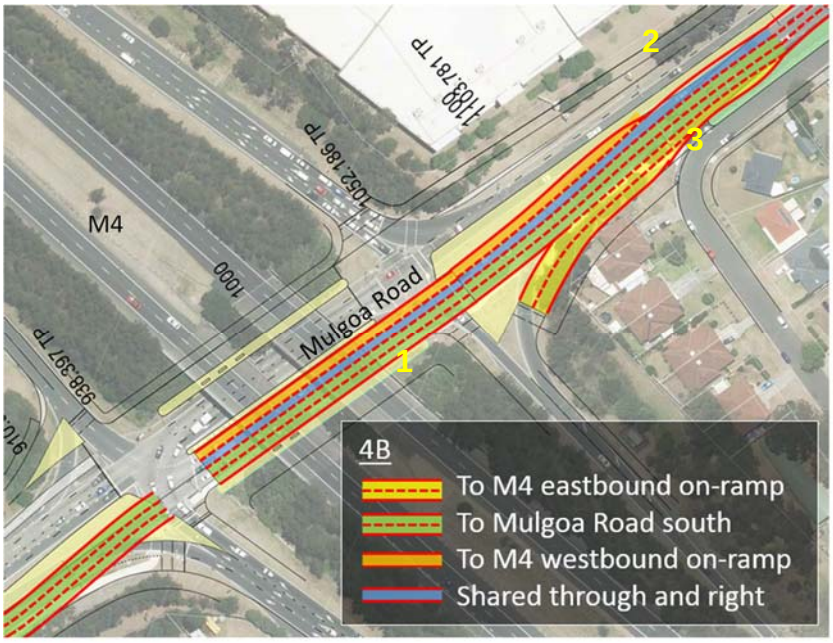
Key Findings

Similar to Option 4, Option 4A does not improve traffic performance on the Mulgoa Road for southbound traffic. Option 4A changes are not recommended to the reference design from traffic grounds.

6.1.7 Option 4B

Option 4B is a variation to Option 4 which proposes two dedicated southbound through lanes, one shared through and right turn lane, and one dedicated right turn lane underneath M4 Bridge. The length of the shared lane is approximately 400 metres extended up to Wolseley Street.

Option 4B – Four-lane southbound underneath M4



The following modifications are proposed:

1. Four-lane southbound underneath M4 (2 through, 1 shared through and right, 1 dedicated right)
2. Shared lane continue through to Wolseley Street
3. Length of left turn slip lane to M4 eastbound on-ramp reduced

Traffic Implications

Table 6-14 and Table 6-15 show traffic performance of Option 4B and reference design for 2036 morning and afternoon peak periods respectively. The results are shown for the northern approach at M4 eastbound ramps traffic signal.

Option 4B improves traffic performance on Mulgoa Road in the southbound direction than previous Options 4 and 4A.

Table 6-14 Forecast Levels of Service at Northern Traffic Signal of M4 Ramps in AM Peak

Time Period	Approach	Reference Design	Option 4B
		Average Delay (sec)	Average Delay (sec)
AM	Mulgoa Road (N)	30 (C)	32 (C)

Note: 1. VISSIM measure queues from the signal stop line up to the next intersection only.

Table 6-15 Forecast Levels of Service at Northern Traffic Signal of M4 Ramps in PM Peak

Time Period	Approach	Reference Design	Option 4B
		Average Delay (sec)	Average Delay (sec)
PM	Mulgoa Road (N)	40 (C)	47 (D)

Note: 1. VISSIM measure queues from the signal stop line up to the next intersection only.

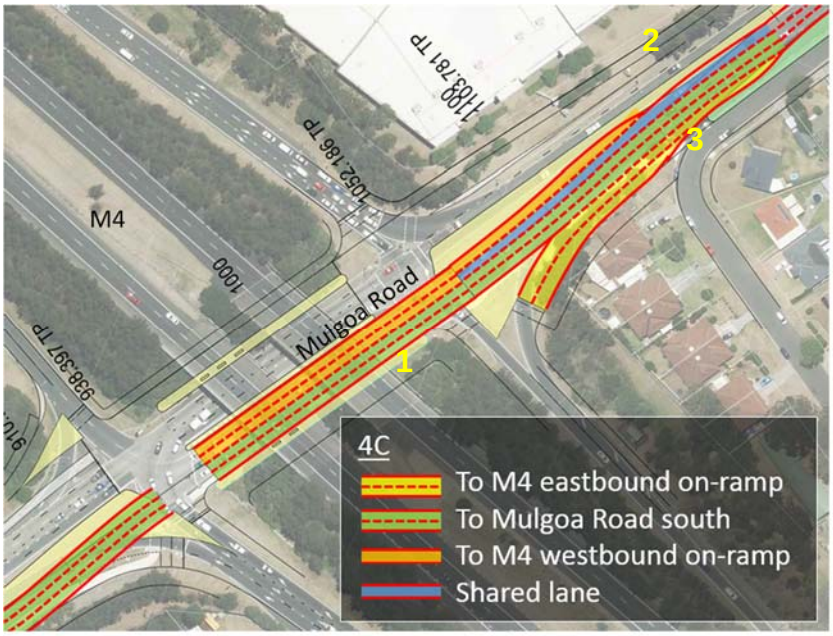
Key Findings

Option 4B improves traffic performance on Mulgoa Road in the southbound direction than previous Options 4 and 4A. Of the three sub options tested (Option 4, 4A and 4C) Option 4B performs the best. Option 4B changes are recommended to the reference design from traffic grounds.

6.1.8 Option 4C

Option 4C is a variation to Option 4 which proposes two dedicated southbound through lanes and two dedicated right turn lane underneath M4 Bridge. This Option 4C is similar to Option 4.

Option 4C – Four-lane southbound underneath M4



The following modifications are proposed:

1. Four-lane southbound underneath M4 (2 through, 2 dedicated right)
2. Shared lane continue through to Wolseley Street
3. Length of left turn slip lane to M4 eastbound on-ramp reduced

Traffic Implications

Table 6-16 and Table 6-17 show traffic performance of Option 4C and reference design for 2036 morning and afternoon peak periods respectively. The results are shown for the northern approach at M4 eastbound ramps traffic signal.

Similar to Option 4, Option 4C does not improve traffic performance on the Mulgoa Road in the southbound direction. Model shows extended queues for the southbound traffic beyond Wolseley Street intersection.

Table 6-16 Forecast Levels of Service at Northern Traffic Signal of M4 Ramps in AM Peak

Time Period	Approach	Reference Design	Option 4C
		Average Delay (sec)	Average Delay (sec)
AM	Mulgoa Road (N)	30 (C)	40 (C) ▲

Note: 1. VISSIM measure queues from the signal stop line up to the next intersection only.

Table 6-17 Forecast Levels of Service at Northern Traffic Signal of M4 Ramps in PM Peak

Time Period	Approach	Reference Design	Option 4C
		Average Delay (sec)	Average Delay (sec)
PM	Mulgoa Road (N)	40 (C)	61 (E) ▲

Note: 1. VISSIM measure queues from the signal stop line up to the next intersection only.

Key Findings

Similar to Option 4, Option 4C does not improve traffic performance on the Mulgoa Road for southbound traffic. Option 4C changes are not recommended to the reference design from traffic grounds.

6.1.9 Option 6

The reference design proposes two northbound right turn lanes from Mulgoa Road to Jamison Road.

Option 6 proposes one right turn lane for general traffic and one right turn lane for buses. Option 6 assumes that in 2036 bus service frequency will be double than currently being used at this intersection.

Option 6 – Right turn lane to Jamison Road

The following modifications are proposed:

1. One right-turn lane for general traffic from Mulgoa Road to Jamison Road
2. One right-turn lane for buses from Mulgoa Road to Jamison Road

Traffic Implications

Table 6-18 and Table 6-19 show traffic performance of Option 6 and reference design for 2036 morning and afternoon peak periods respectively.

Option 6 does not improve traffic performance at Mulgoa Road /Jamison Road intersection. Option 6 adversely impacts to the level of service of Mulgoa Road /Jamison Road intersection due to reduced capacity provided to the general traffic. Option 6 modelling predicted level of service F at Mulgoa Road /Jamison Road intersection for morning and afternoon peak.

Table 6-18 Forecast Levels of Service at Jamison Road / Mulgoa Road in AM Peak

Time Period	Approach	Reference Design	Option 6
		Average Delay (sec)	Average Delay (sec)
AM	Mulgoa Road (S)	64 (E)	244 (F) ▲

Table 6-19 Forecast Levels of Service at Jamison Road / Mulgoa Road in PM Peak

Time Period	Approach	Reference Design	Option 6
		Average Delay (sec)	Average Delay (sec)
PM	Mulgoa Road (S)	60 (E)	269 (F) ▲

Key Findings

Option 6 does not improve traffic performance at Mulgoa Road /Jamison Road intersection. Option 6 changes are not recommended to the reference design from traffic grounds.

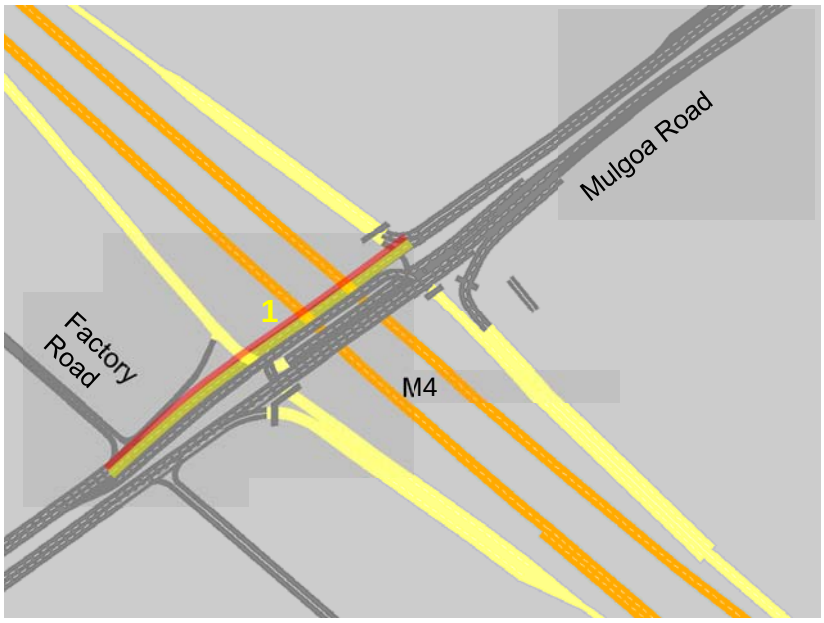
6.1.10 Option 7

The reference design proposes three northbound through lanes underneath the M4 Bridge.

Option 7 proposes to reduce to two northbound through lanes underneath the M4 Bridge.

Option 7 is similar to previous Option 4 tested. Option 7 proposes modifications in the northbound direction, where previous Option 4 proposes modifications in the southbound direction.

Option 7 – Two -lane northbound underneath M4



The following modifications are proposed:

1. Two through lanes northbound underneath the M4

Traffic Implications

Table 6-20 and Table 6-21 show traffic performance of Option 7 and reference design for 2036 morning and afternoon peak periods respectively.

Option 7 adversely impacts traffic capacity on the Mulgoa Road in the northbound direction. Model shows extended queues for the northbound traffic beyond Glenmore Parkway intersection. The north bound trave speed on Mulgoa Road between Glenmore Parkway and M4 in PM peak reduces substantially to 5 km/h for Option 7 compared to reference design (35 km/h). Table 6-22 shows travel speed on Mulgoa Road for reference design and Option 7.

Table 6-20 Forecast Levels of Service at Northern Traffic Signal of M4 Ramps in AM Peak

Time Period	Approach	Reference Design	Option 7
		Average Delay (sec)	Average Delay (sec)
AM	Mulgoa Road (S)	22 (B)	93 (F) ▲

Table 6-21 Forecast Levels of Service at Northern Traffic Signal of M4 Ramps in PM Peak

Time Period	Approach	Reference Design	Option 7
		Average Delay (sec)	Average Delay (sec)
PM	Mulgoa Road (S)	71 (F)	360 (F) ▲

Table 6-22 Forecast Northbound Average Speed for Section between Glenmore Parkway and M4

Section	Time Period	Reference Design	Option 7
		Northbound	Northbound
Between Glenmore Parkway and M4	AM	25	17 ▼
	PM	35	5 ▼

Key Findings

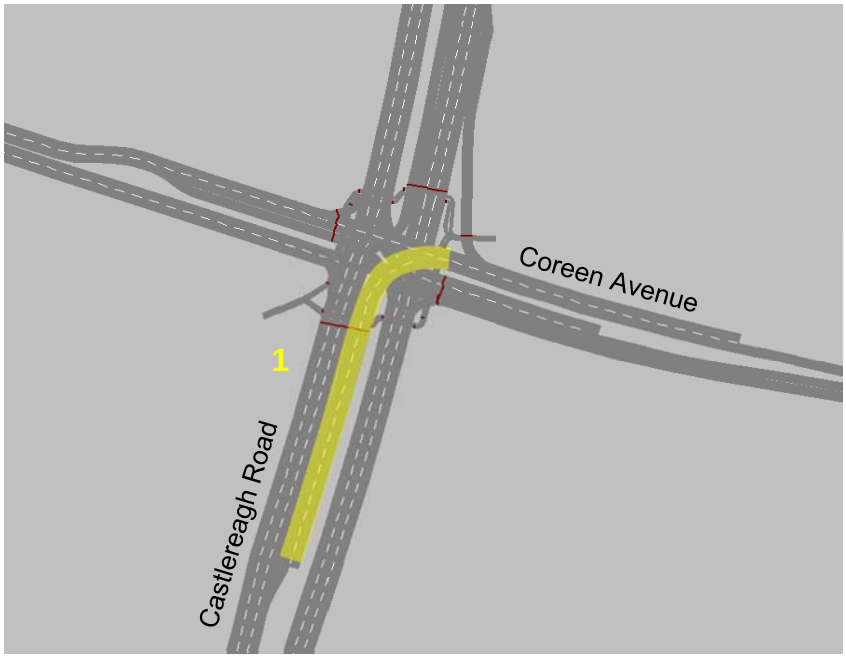
Option 7 adversely impacts traffic performance on the Mulgoa Road for northbound traffic. Option 7 changes are not recommended to the reference design from traffic grounds.

6.1.11 Option 8

The reference design proposes one northbound right turn lane from Castlereagh Road to Coreen Avenue signalised intersection.

Option 8 proposes two northbound right turn lanes from Castlereagh Road to Coreen Avenue. This modification is proposed to provide adequate capacity for right turn traffic and associated intersection level of service improvement.

Option 8 – Right turn lane to Coreen Avenue



The following modifications are proposed:

1. Two-right-turn lane from Castlereagh Road to Coreen Avenue

Traffic Implications

Table 6-23 and Table 6-24 show traffic performance of Option 8 and reference design for 2036 morning and afternoon peak periods respectively.

Option 8 improves traffic performance substantially at Castlereagh Road/Coreen Avenue intersection. Model predicted level of service C for Option 8.

Table 6-23 Forecast Levels of Service at Coreen Avenue / Mulgoa Road Intersection in AM Peak

Time Period	Approach	Reference Design		Option 8	
		Average Delay (sec)	LOS	Average Delay (sec)	LOS
AM	Castlereagh Road (N)	100	F	45 ▼	D
	Coreen Avenue (E)	104	F	62 ▼	E
	Castlereagh Road (S)	25	B	22 ▼	B
	Mullins Road (W)	60	E	72 ▲	F
	Overall	74	F	40 ▼	C

Table 6-24 Forecast Levels of Service at Coreen Avenue / Mulgoa Road Intersection in PM Peak

Time Period	Approach	Reference Design		Option 8	
		Average Delay (sec)	LOS	Average Delay (sec)	LOS
PM	Castlereagh Road (N)	62	E	33 ▼	C
	Coreen Avenue (E)	69	E	63 ▼	E
	Castlereagh Road (S)	40	C	25 ▼	B
	Mullins Road (W)	63	E	71 ▲	F
	Overall	53	D	35 ▼	C

Key Findings

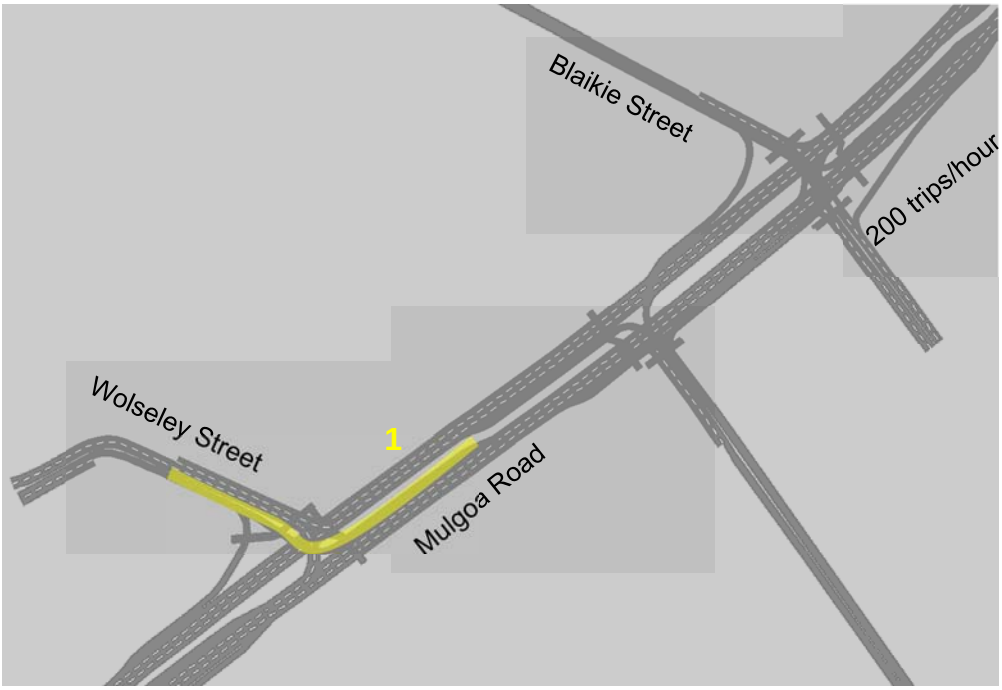
Option 8 improves traffic performance at Castlereagh Road/Coreen Avenue intersection. Option 8 changes are recommended to the reference design from traffic grounds.

6.1.12 Option 9

The reference design proposes to retain existing Mouse Hole grade separated tunnel accessing to Wolseley Street and the shopping precinct. The tunnel provides southbound right turn movement from Mulgoa Road to Wolseley Street.

Option 9 proposes that Mouse Hole grade separated tunnel is removed and southbound right turn movement is permitted via at-grade signalised intersection.

Option 9 – Mouse Hole tunnel is removed and right turn is provided via at grade intersection



The following modifications are proposed:

1. "Mouse hole" tunnel is removed and at-grade right-turn lane is provided at Mulgoa Road/Wolseley Street signalised intersection

Traffic Implications

Table 6-25 show traffic performance of Option 9 and reference design for 2036 morning and afternoon peak periods respectively. The results are showed separately for Mouse hole right turn movement and entire intersection with Wolseley Street. A further sensitivity test was undertaken increasing right turn demand by 20 per cent and results from sensitivity test is also showed in Table 6-25.

Under the reference design (retaining grade separated tunnel), no delay occurs to right turn movement and level of service is A. In Option 9 at-grade signalised right turn incurs delays between 58 seconds and 71 seconds resulting level of service between E and F for this right turn movement. Model indicates that queues for right turn exceeds the right turning lane capacity and impacts southbound through lanes traffic. On this basis, Option 9 (removing Mouse Hole tunnel) performs adversely than reference design (retaining Mouse Hole tunnel).

When level of service results for the entire signalised intersection is considered, Option 9 (removing Mouse Hole tunnel) does not indicate substantial adverse impact to the entire intersection performance. This is due to substantial improvement provided to six lanes through traffic. Option 9 predicted level of service B for the entire intersection.

Table 6-25 Forecast Levels of Service at Wolseley Street / Mulgoa Road Intersection

Time Period	Approach	Reference Design		Option 9		Option 9 Sensitivity +20%	
		Average Delay (sec)	LOS	Average Delay (sec)	LOS	Average Delay (sec)	LOS
AM	Mouse Hole / Right Turn	Free Flow	A	58 ▲	E	58 ▲	E
	Intersection	12	A	18 ▲	B	20 ▲	B
PM	Mouse Hole / Right Turn	Free Flow	A	71 ▲	F	88 ▲	F
	Intersection	18	B	21 ▲	B	24 ▲	B

Key Findings

Under the reference design (retaining grade separated tunnel), no delay occurs to right turn movement and level of service is A. In Option 9 (the at-grade signalised) right turn movement incurs delays and level of service is found to be between E and F. Model indicates that for Option 9 (removing Mouse Hole tunnel) queues for the right turn movement (at-grade) exceeds the right turning lane capacity and impacts southbound through lanes traffic. On this basis, Option 9 (removing Mouse Hole tunnel) performs adversely than reference design (retaining Mouse Hole tunnel).

When level of service results for the entire signalised intersection is considered, Option 9 (removing Mouse Hole tunnel) does not indicate substantial adverse impact to the entire intersection performance. This is due to substantial improvement provided to six lanes through traffic at this intersection. Model predicted level of service B for Option 9 for the entire intersection.

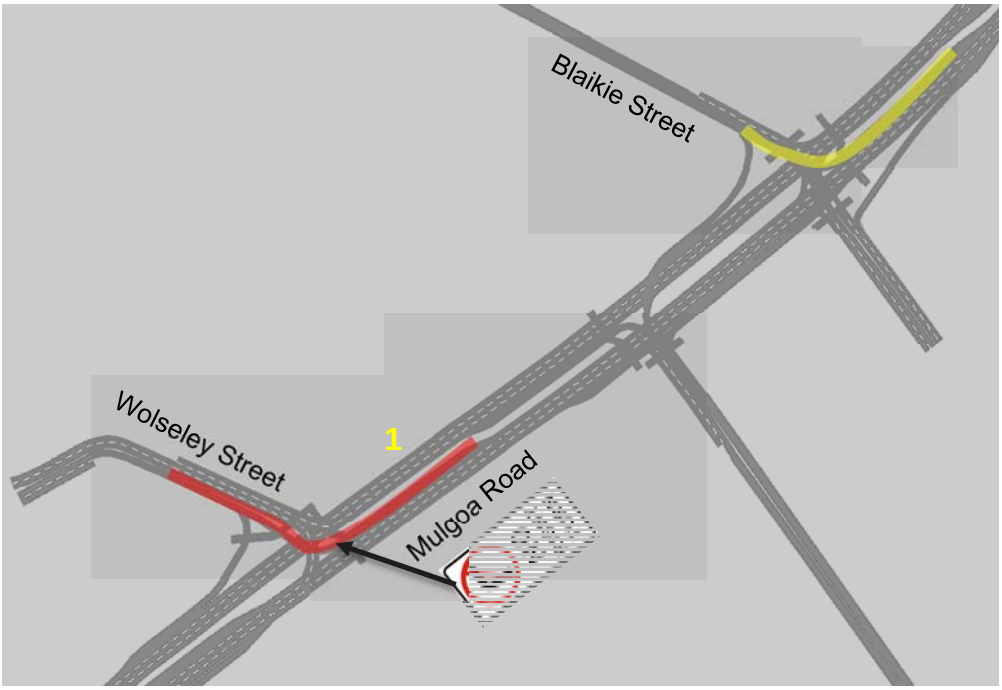
The traffic modelling outcome is considered to be neutral on “whether the existing Mouse hole grade separated tunnel should be removed or retained”. Further justification on Option 9 (removing Mouse Hole tunnel) is required from social, community and business point of view.

6.1.13 Option 9A

The reference design proposes to retain existing Mouse Hole grade separated tunnel accessing to Wolseley Street and the shopping precinct. The tunnel provides southbound right turn movement from Mulgoa Road to Wolseley Street.

Option 9A is a variation to Option 9. Option 9A proposes that Mouse Hole grade separated tunnel is removed and southbound right turn movement is banned. It is assumed Mouse Hole traffic would use Blaikie Street instead.

Option 9A – Mouse Hole tunnel is removed and right turn is banned.



The following modifications are proposed:

1. "Mouse Hole" tunnel is removed, at-grade right-turn lane is banned at Wolseley Street; traffic need to use right turn at Blaikie Street instead

Traffic Implications

Table 6-26 show traffic performance of Option 9A and reference design for 2036 morning and afternoon peak periods respectively. The results are showed separately for right turn movement and entire intersection with Blaikie Street. A further sensitivity test was undertaken increasing right turn demand by 20 per cent and results from sensitivity test is also showed in Table 6-26.

Option 9A performs adversely than reference design. In Option 9A, the single right turn (about 85 metres) incurs delays between 64 seconds and 117 seconds resulting level of service between E and F for this right turn movement. Model indicates that queues for right turn exceeds the right turning lane capacity and impacts southbound through lanes traffic. On this basis, Option 9A performs adversely than reference design.

When level of service results for the entire signalised intersection is considered, Option 9A does not indicate substantial adverse impact to the entire intersection performance. This is due to substantial improvement provided to six lanes through traffic at this intersection. Model predicted level of service B for Option 9A.

Table 6-26 Forecast Levels of Service at Blaikie Street / Mulgoa Road Intersection

Time Period	Approach	Reference Design		Option 9A		Option 9A Sensitivity +20%	
		Average Delay (sec)	LOS	Average Delay (sec)	LOS	Average Delay (sec)	LOS
AM	Right Turn from Mulgoa Road to Blaikie Street	62	E	63 ▲	E	64 ▲	E
	Intersection	18	B	18	B	20 ▲	B
PM	Right Turn from Mulgoa Road to Blaikie Street	60	E	66 ▲	E	117 ▲	F
	Intersection	25	B	25	B	28 ▲	B

Key Findings

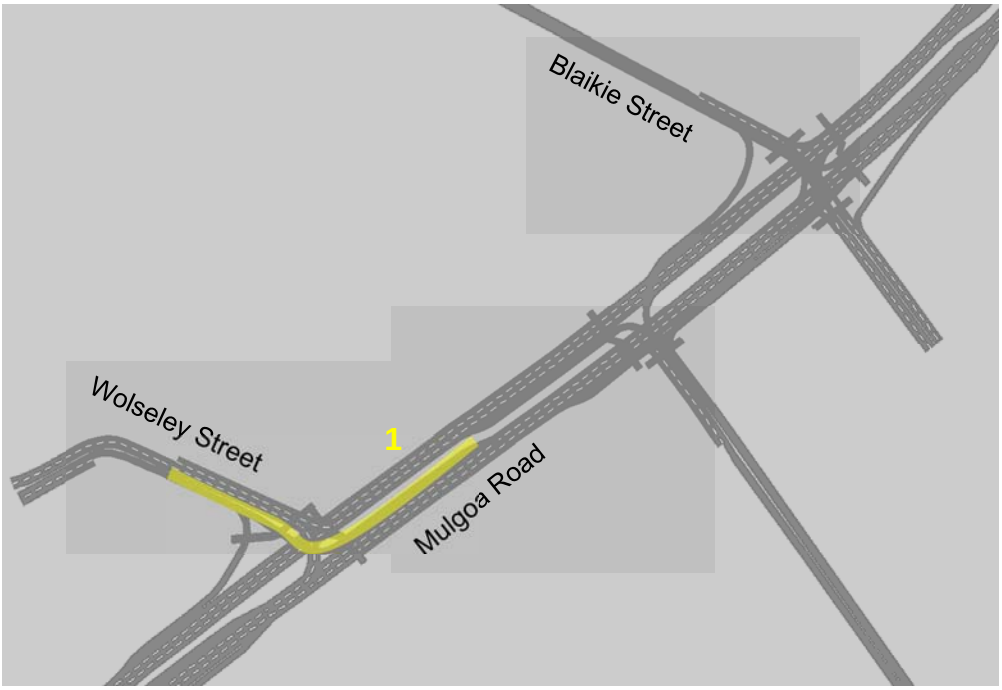
Option 9A adversely impacts the operational performance of right turning lane at Blaikie Street intersection. Option 9A changes are not recommended to the reference design from traffic grounds.

6.1.14 Option 9B

The reference design proposes to retain existing Mouse Hole grade separated tunnel accessing to Wolseley Street and the shopping precinct. The tunnel provides southbound right turn movement from Mulgoa Road to Wolseley Street.

Option 9B is a variation to Option 9. Option 9B proposes that Mouse Hole grade separated tunnel is removed and southbound right turn movement is permitted via at-grade signalised intersection with double right turn lane.

Option 9B – Mouse Hole tunnel is removed and double right turn is provided via at grade intersection



The following modifications are proposed:

1. "Mouse hole" tunnel is removed and at-grade double right-turn lane is provided at Mulgoa Road/Wolseley Street signalised intersection

Traffic Implications

Table 6-27 show traffic performance of Option 9B and reference design for 2036 morning and afternoon peak periods respectively. The results are showed separately for Mouse hole right turn movement and entire intersection with Wolseley Street. A further sensitivity test was undertaken increasing right turn demand by 20 per cent and results from sensitivity test is also showed in Table 6-27.

Under the reference design (retaining grade separated tunnel), no delay occurs to right turn movement and level of service is A. In Option 9B at-grade signalised double right turn incurs delays between 47 seconds and 51 seconds resulting level of service D for this right turn movement. Model indicates that queues for right turn are accommodated within the right turning lane capacity and therefore would not impacts southbound through lanes traffic.

When level of service results for the entire signalised intersection is considered, Option 9B (removing Mouse Hole tunnel) does not indicate substantial adverse impact to the entire intersection performance. This is due to substantial improvement provided to six lanes through traffic. Option 9B predicted level of service B for the entire intersection.

Table 6-27 Forecast Levels of Service at Wolseley Street / Mulgoa Road Intersection

Time Period	Approach	Reference Design		Option 9B		Option 9B Sensitivity +20%	
		Average Delay (sec)	LOS	Average Delay (sec)	LOS	Average Delay (sec)	LOS
AM	Mouse Hole / Right Turn	Free Flow	A	47 ▲	D	51 ▲	D
	Intersection	12	A	16 ▲	B	17 ▲	B
PM	Mouse Hole / Right Turn	Free Flow	A	47 ▲	D	48 ▲	D
	Intersection	18	B	20 ▲	B	20 ▲	B

Key Findings

Under the reference design (retaining grade separated tunnel), no delay occurs to right turn movement and level of service is A. In Option 9B (the at-grade signalised) double right turn movement incurs delays and level of service is found to be D. On this basis, Option 9B (removing Mouse Hole tunnel) performs adversely than reference design (retaining Mouse Hole tunnel).

Model indicates that for Option 9B (removing Mouse Hole tunnel) queues for the right turn movement (at-grade) contained within the right turning lane capacity and does not impacts southbound through lanes traffic.

When level of service results for the entire signalised intersection is considered, Option 9B (removing Mouse Hole tunnel) does not indicate substantial adverse impact to the entire intersection performance. This is due to substantial improvement provided to six lanes through traffic at this intersection. Model predicted level of service B for Option 9B for the entire intersection.

The traffic modelling outcome is considered to be neutral on “whether the existing Mouse hole grade separated tunnel should be removed or retained”. Further justification on Option 9B (removing Mouse Hole tunnel) is required from social, community and business point of view.

6.2 Staging Assessment

The proposed six lanes upgrade for the Mulgoa Road / Castlereagh Road can be progressively delivered in stages to cater for the forecast increase in traffic volumes between 2015 and 2036. The traffic model tested three future development scenarios (or growth models), referred to as the 'short term', 'medium term' and 'long term' development scenarios as follows:

- Short term: The short term development scenario is anticipated to be realised sometime between 2016 and 2020. For the short term, the modelling year of 2020 was assessed
- Medium term: The medium term development scenario is anticipated to be realised sometime between 2020 and 2026. For medium term, the modelling year of 2026 was assessed
- Long term: The long term development scenario is anticipated to be realised sometime between 2026 and 2036. For long term, the modelling year of 2036 has been assessed

The proposed improvements recommended for short term, medium term and longer term are outlined below and shown in Table 6-28 to Table 6-30

The improvements identified for short term (2020), medium term (2026) and long term (2036) would substantially improve the level of service for the Mulgoa Road / Castlereagh Road from Glenmore Parkway to Andrews Road.

If proposed improvements identified in short, medium and longer term are implemented, traffic modelling predicts level of service between A and E for key analysed intersections in 2036.

Table 6-31 show level of service for short term, medium term and long term after the proposed upgrades in place

Table 6-28 Proposed Short Term Upgrade

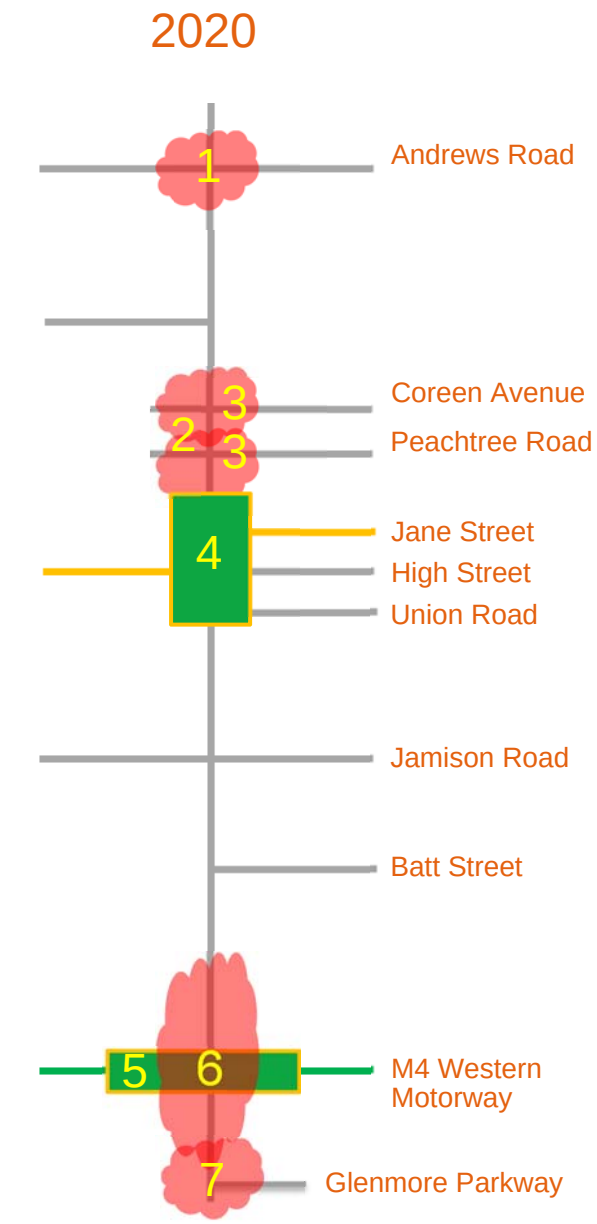
Proposed short term upgrade (2020)	Upgrade description
	1. Convert Andrews Road roundabout to traffic signal 2. Castlereagh Road upgrade (6 lanes) between Coreen Avenue and Union Road 3. Intersection upgrades at i) Coreen Avenue, ii) Peachtree Road 4. Jane Street and Mulgoa Road Infrastructure Upgrade (separate project) 5. Proposed upgrade at M4 Smart Motorway Ramps (separate project) 6. Mulgoa Road upgrade (6 lanes) between Blaikie Road and Glenmore Parkway 7. Convert Glenmore Parkway roundabout to traffic signal

Table 6-29 Proposed Medium Term Upgrade

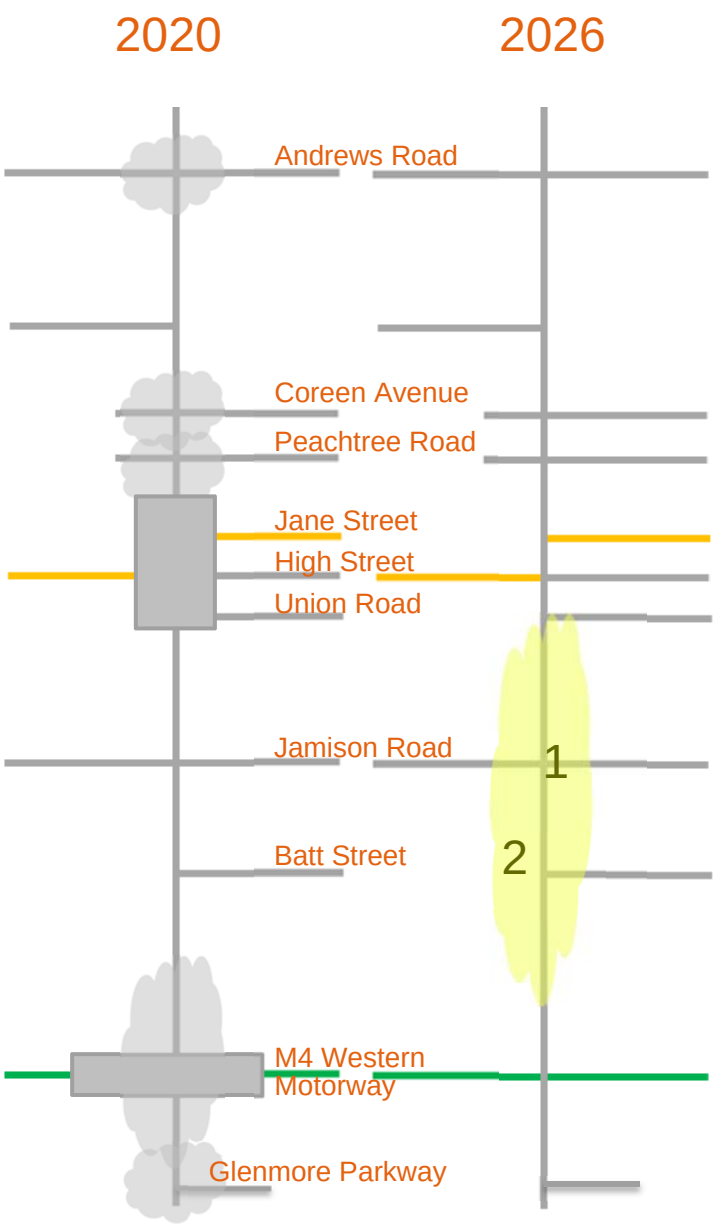
Proposed medium term upgrade (2026)	Upgrade description
	1. Intersection upgrade at i) Jamison Road, ii) Panther Place and iii) Ransley Street 2. Mulgoa Road upgrade (6 lanes) between Union Road and Blaikie Road

Table 6-30 Proposed Long Term Upgrade

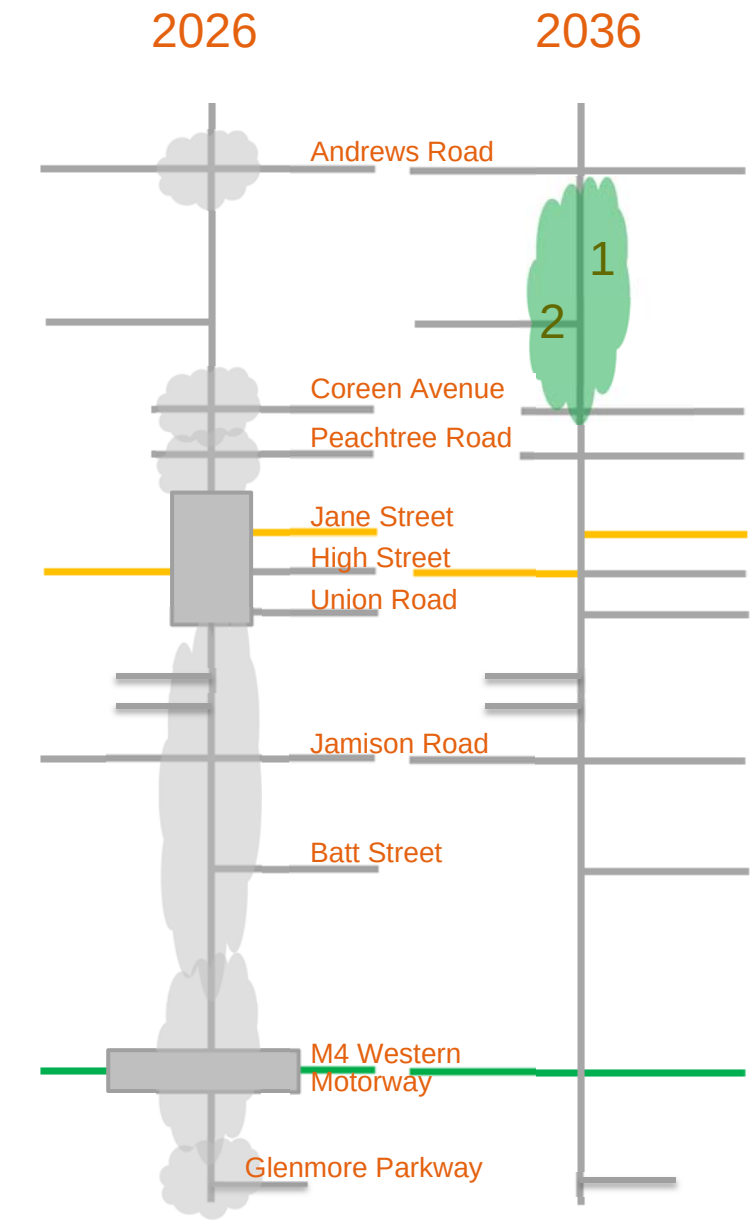
Proposed long term upgrade (2036)	Upgrade description
	1. Mulgoa Road upgrade (6 lanes) between Andrews Road and Coreen Avenue 2. Intersection upgrades at i) Lugard Street, ii) Jack William Drive

Table 6-31 Intersection Level of Service for Improvement Case in 2020, 2026 and 2036

Intersection	Control Type	Short Term Improvement 2020		Medium Term Improvement 2026		Ultimate Strategic Concept 2036	
		AM	PM	AM	PM	AM	PM
Andrews Road / Castlereagh Road	Roundabout	33 (C)	34 (C)	37 (C)	39 (C)	38 (C)	41 (C)
Jack William Drive / Castlereagh Road	Signal	13 (A)	16 (B)	26 (B)	19 (B)	20 (B)	17 (B)
Coreen Avenue / Castlereagh Road	Roundabout	37 (C)	33 (C)	43 (D)	36 (C)	52 (D)	35 (C)
Peachtree Road / Castlereagh Road	Signal	25 (B)	30 (C)	31 (C)	32 (C)	41 (C)	31 (C)
Museum Drive / Castlereagh Road	Signal	3 (A)	4 (A)	8 (A)	7 (A)	17 (B)	15 (B)
Jane Street / Castlereagh Road	Signal	23 (B)	27 (B)	24 (B)	29 (C)	32 (C)	49 (D)
High Street / GWH / Mulgoa Road	Signal	42 (C)	50 (D)	41 (C)	51 (D)	49 (D)	47 (D)
Union Road / Mulgoa Road	Priority (sign)	6 (A)	7 (A)	9 (A)	5 (A)	12 (A)	6 (A)
Ransley Street / Mulgoa Road	Signal	20 (B)	28 (B)	20 (B)	25 (B)	21 (B)	28 (B)
Panther Place / Mulgoa Road	Signal	8 (A)	9 (A)	6 (A)	8 (A)	8 (A)	9 (A)
Jamison Road / Mulgoa Road	Signal	39 (C)	37 (C)	34 (C)	32 (C)	44 (D)	33 (C)
Batt Street / Mulgoa Road	Signal	21 (B)	41 (C)	13 (A)	26 (B)	17 (B)	35 (C)
Blaikie Street / Mulgoa Road	Signal	15 (B)	18 (B)	10 (A)	20 (B)	11 (A)	44 (D)
Wolseley Street / Mulgoa Road	Signal	10 (A)	11 (A)	11 (A)	11 (A)	13 (A)	10 (A)
M4 ramps / Mulgoa Road	Signal	33 (C)	28 (B)	35 (C)	30 (C)	39 (C)	39 (C)
Glenmore Parkway / Mulgoa Road	Roundabout	25 (B)	23 (B)	25 (B)	27 (B)	28 (B)	40 (C)

6.3 Impact on Other Travel Modes

6.3.1 Bus services

With the Mulgoa Road /Castlereagh Road corridor upgrade in place, there will be no impact to current bus routes and services. All the existing bus services along the Mulgoa Road/Castlereagh Road would be retained. The 80% strategic concept design (refer to Appendix C) proposed bus priority measures at the following traffic signals:

- Glenmore Parkway northbound
- Mulgoa Road northbound at Wolseley Street intersection
- Mulgoa Road southbound at Glenbrook Street intersection
- Mulgoa Road both northbound and southbound at Blaikie Road intersection
- Mulgoa Road southbound at Batt Street intersection
- Mulgoa Road both northbound and southbound at Jamison Road intersection
- Mulgoa Road both northbound and southbound at Ransley Street intersection
- Castlereagh Road southbound at Museum Drive intersection
- Castlereagh Road both northbound and southbound at Peachtree Road intersection
- Castlereagh Road both northbound and southbound at Coreen Avenue intersection
- Castlereagh Road northbound at Jack William Drive intersection
- Castlereagh Road northbound at Lugard Street intersection
- Castlereagh Road both northbound and southbound at Andrews Road intersection;

In conjunction with bus priority lane at intersections, indented bus bays are also proposed at the following locations:

- Mulgoa Road northbound near Batt Street
- Jamison Road eastbound near Howell Oval
- Castlereagh Road southbound near Jack William Drive intersection
- Castlereagh Road southbound near Lugard Street intersection

Bus priority lanes (i.e. queue-jump lanes) will be provided to allow buses a head start along the Mulgoa Road / Castlereagh Road. This will provide more efficient operation to bus services. Figure 6-1 shows an example of bus priority lanes proposed at Jamison Road/Mulgoa Road intersection.

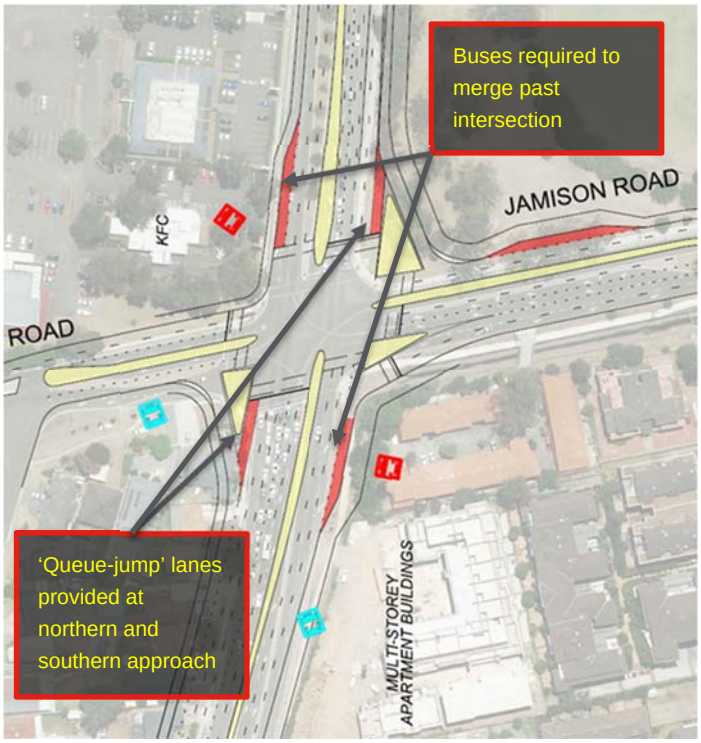


Figure 6-1 Bus Priority Lanes Provided at Jamison Road / Mulgoa Road Intersection

6.3.2 Pedestrians and Cyclist

The ultimate strategic concept design would provide separated pathway 4 metres wide on the eastern side and 1.5 metres wide footpath on the western side of Mulgoa Road / Castlereagh Road corridor. All current pedestrian crossing at signalised intersections will be retained. New pedestrian crossings will be provided to new signalised intersections proposed at Glenmore Parkway, Coreen Avenue and Andrews Road. Figure 6-2 shows the example of pedestrian/cyclist access along Mulgoa Road corridor.

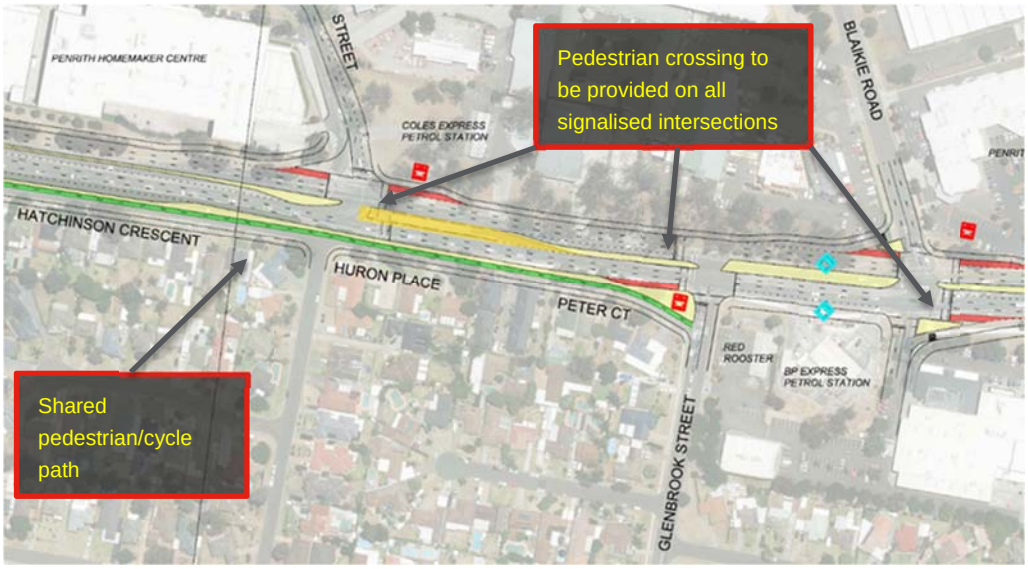


Figure 6-2 Pedestrian/Cycle Access Provided along Mulgoa Road between M4 and Blaikie Road

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MULGOA ROAD/CASTLEREAGH ROAD CORRIDOR UPGRADE BETWEEN GLENMORE PARKWAY AND ANDREWS ROAD

VOLUME 2 - APPENDICES

May 2016

Incorporating Hyder

APPENDICES

- **Appendix A Existing and Future Traffic Volumes**
- **Appendix B VISSIM Model Development, Calibration and Validation**
- **Appendix C 80% Strategic Concept Design (RD0001-RD0012)**

APPENDIX A

EXISTING AND FUTURE TRAFFIC VOLUMES

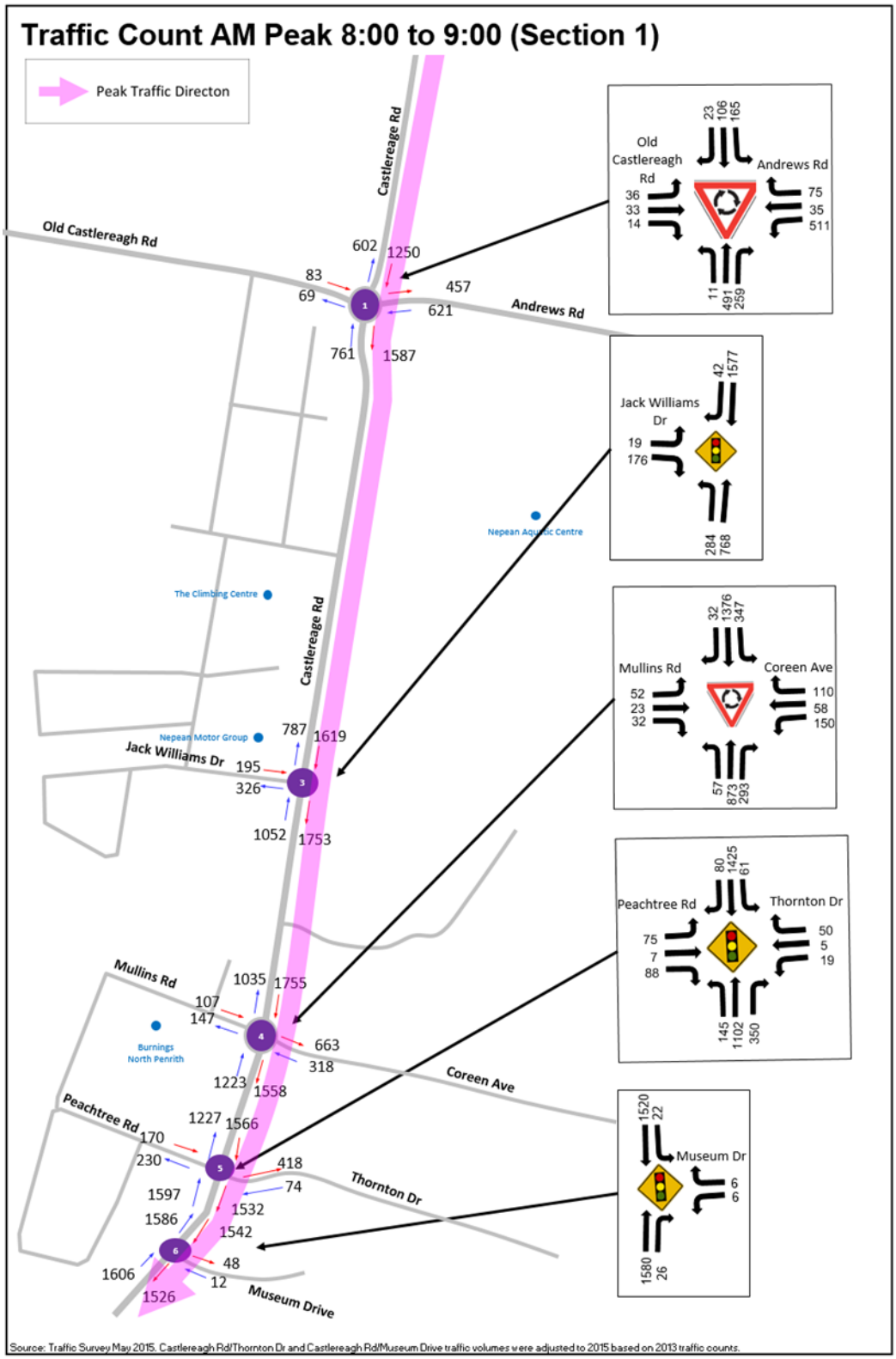


Figure A-1 Intersections Turn Flows and Traffic Flows on Castlereagh Road (Section 1) in 2015 AM Peak

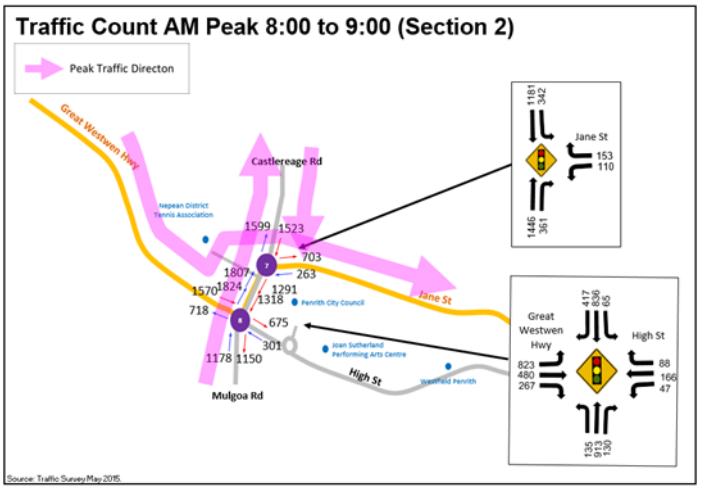


Figure A-2 Intersections Turn Flows and Traffic Flows on Castlereagh Road (Section 2) in 2015 AM Peak

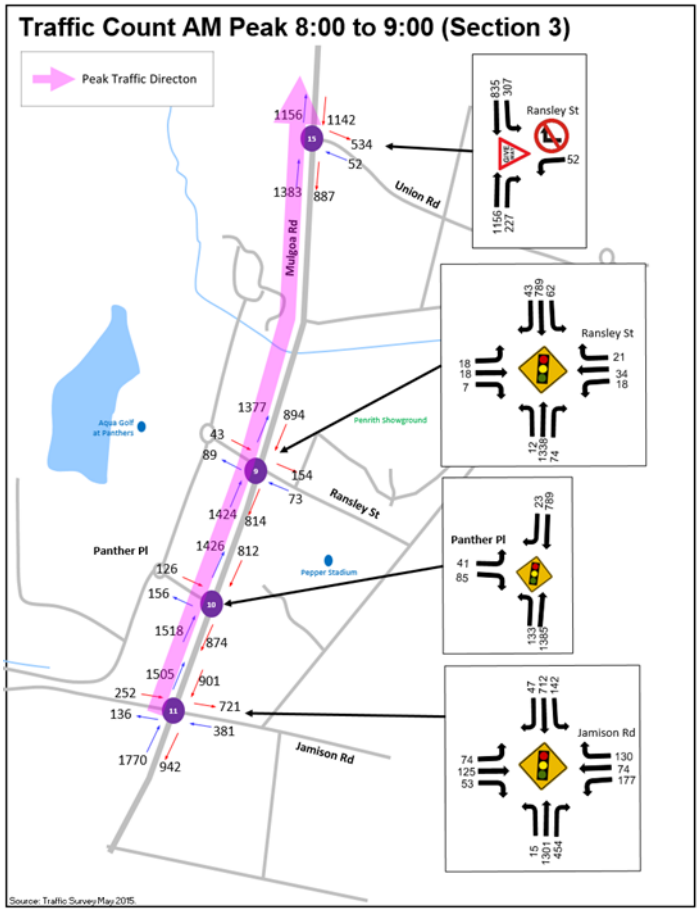


Figure A-3 Intersections Turn Flows and Traffic Flows on Mulgoa Road (Section 3) in 2015 AM Peak

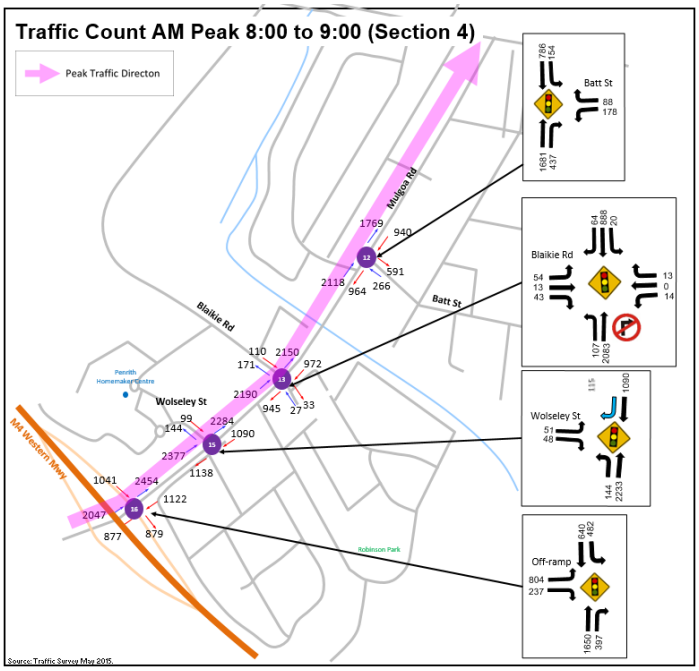


Figure A-4 Intersections Turn Flows and Traffic Flows on Mulgoa Road (Section 4) in 2015 AM Peak

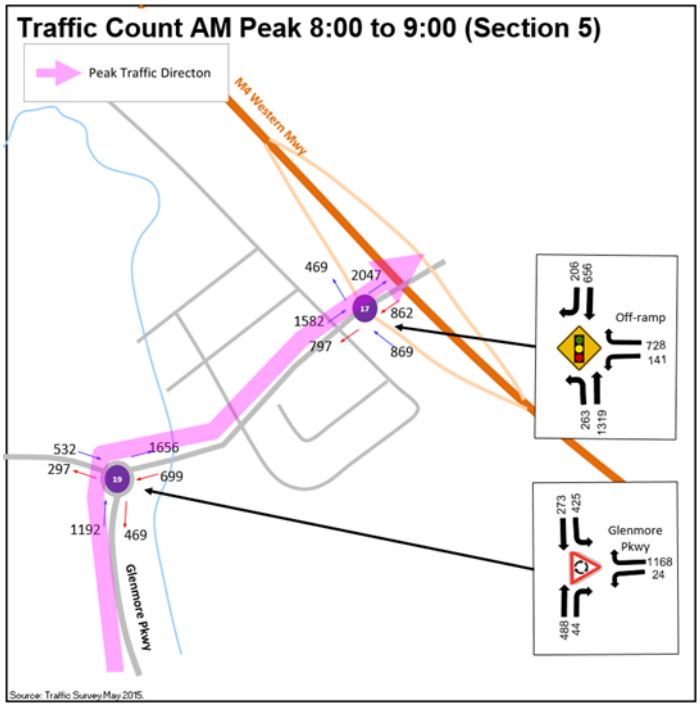


Figure A-5 Intersections Turn Flows and Traffic Flows on Mulgoa Road (Section 5) in 2015 AM Peak

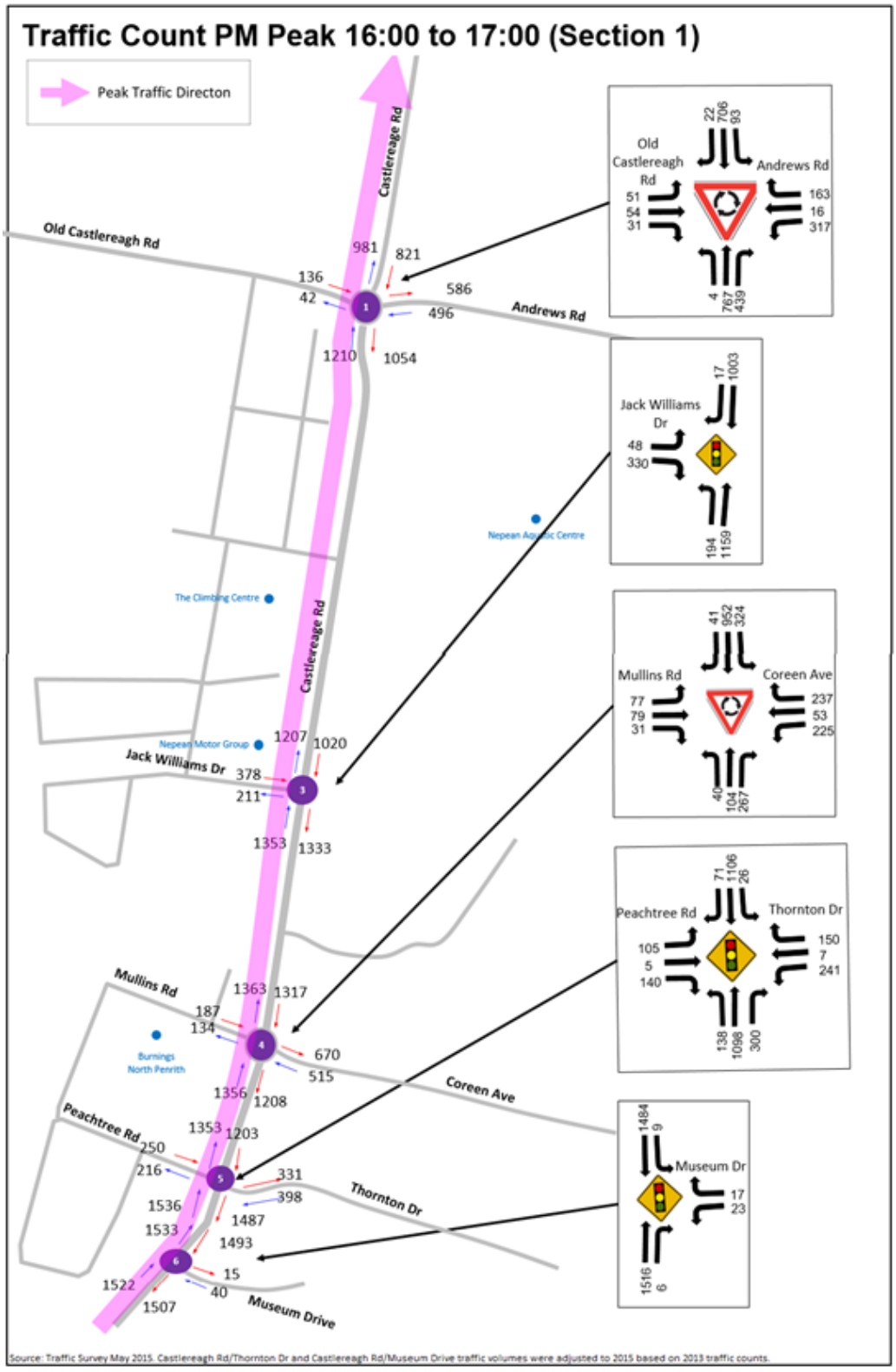


Figure A-6 Intersections Turn Flows and Traffic Flows on Castlereagh Road (Section 1) in 2015 PM Peak

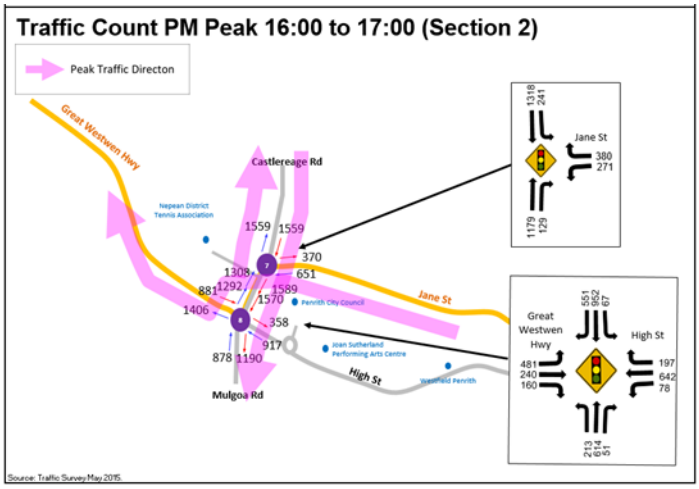


Figure A-7 Intersections Turn Flows and Traffic Flows on Castlereagh Road (Section 2) in 2015 PM Peak

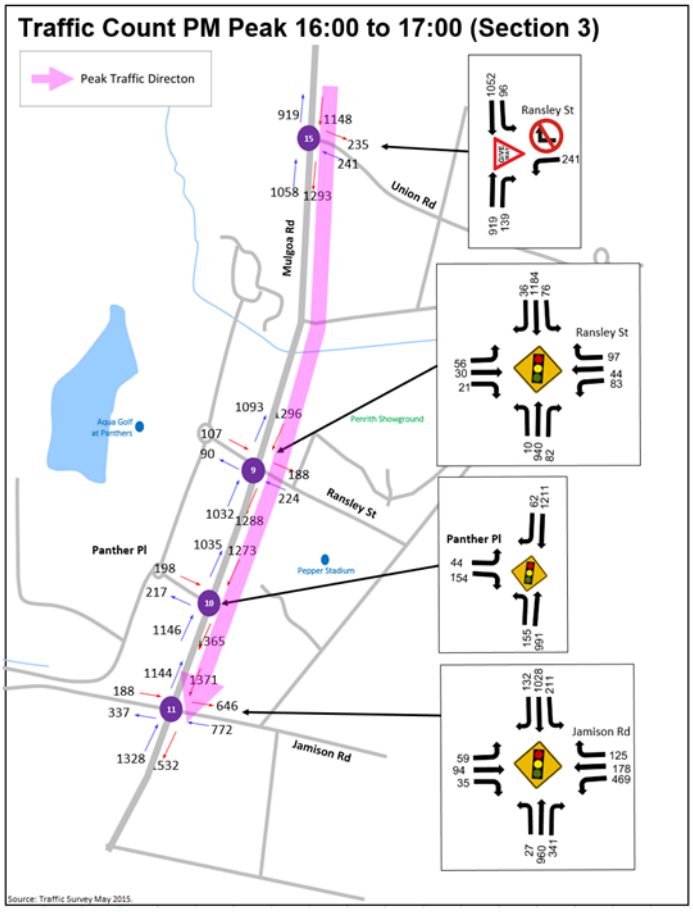


Figure A-8 Intersections Turn Flows and Traffic Flows on Mulgoa Road (Section 3) in 2015 PM Peak

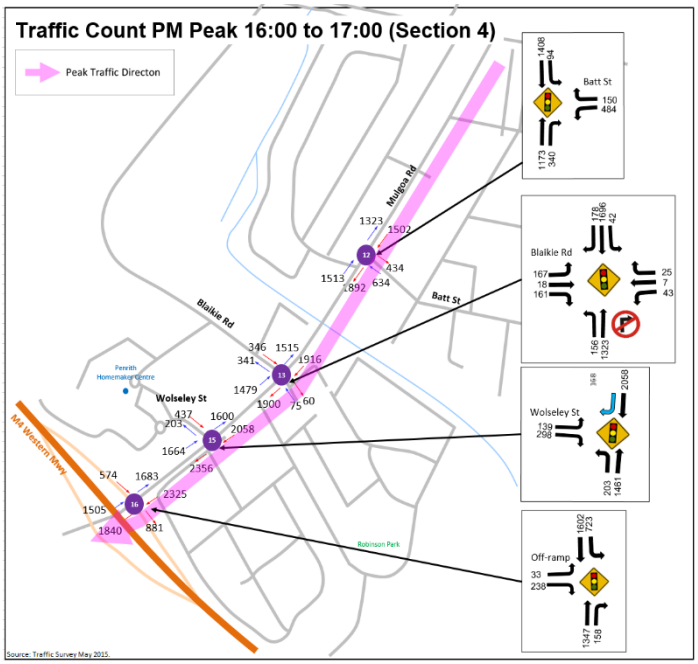


Figure A-9 Intersections Turn Flows and Traffic Flows on Mulgoa Road (Section 4) in 2015 PM Peak

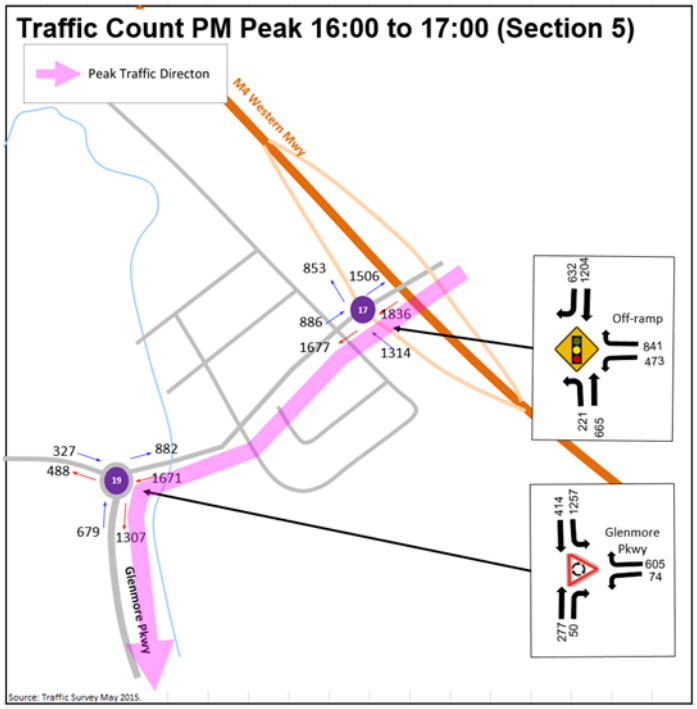


Figure A-10 Intersections Turn Flows and Traffic Flows on Mulgoa Road (Section 5) in 2015 PM Peak

Growth Scenario 1: BTS

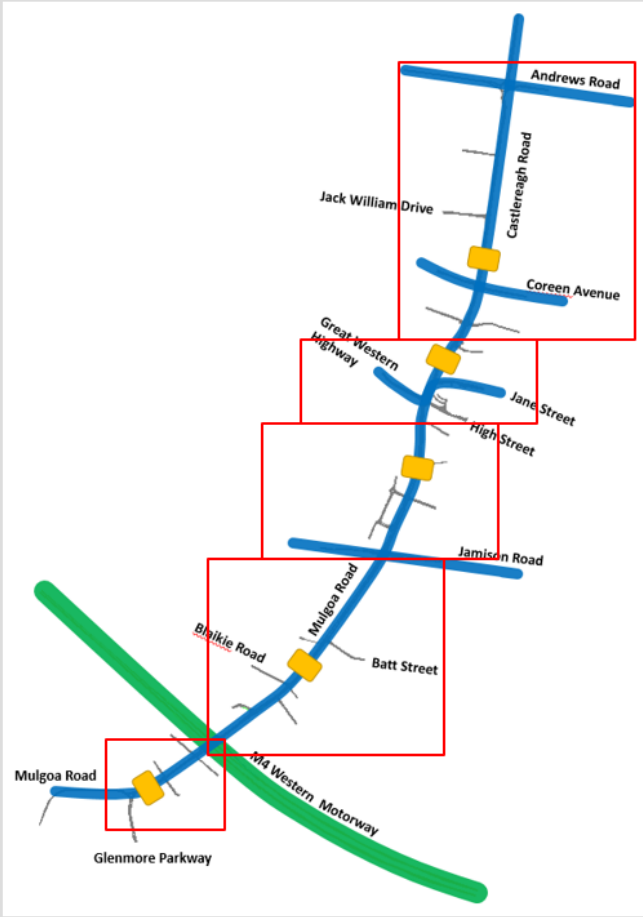
Section	VISSIM Network	Daily Traffic Volume (Growth Scenario 1: BTS)		
		2015	2026	2036
1 Andrews Road to Museum Drive		36700 (AM Peak: 2790 vph PM Peak: 2760 vph)	53000 (AM Peak: 3940 vph PM Peak: 3930 vph)	60000 (AM Peak: 4550 vph PM Peak: 4500 vph)
2 Museum Drive to Union Road		43700 (AM Peak: 3132 vph PM Peak: 3149 vph)	61000 (AM Peak: 4370 vph PM Peak: 4320 vph)	70000 (AM Peak: 5030 vph PM Peak: 5020 vph)
3 Union Road to Jamison Road		34500 (AM Peak: 2271 vph PM Peak: 2439 vph)	46000 (AM Peak: 3010 vph PM Peak: 3180 vph)	56000 (AM Peak: 3700 vph PM Peak: 3880 vph)
4 Jamison Road to M4 Western Motorway		48400 (AM Peak: 3122 vph PM Peak: 3491 vph)	58000 (AM Peak: 3790 vph PM Peak: 4040 vph)	69000 (AM Peak: 4540 vph PM Peak: 4820 vph)
5 M4 Western Motorway to Glenmore Parkway		31300 (AM Peak: 2379 vph PM Peak: 2563 vph)	35000 (AM Peak: 2690 vph PM Peak: 2740 vph)	38000 (AM Peak: 3000 vph PM Peak: 3000 vph)

Figure A-11 Peak Hour Traffic Volumes for Growth Scenario 1

Growth Scenario 2: BTS (Accelerated Growth)

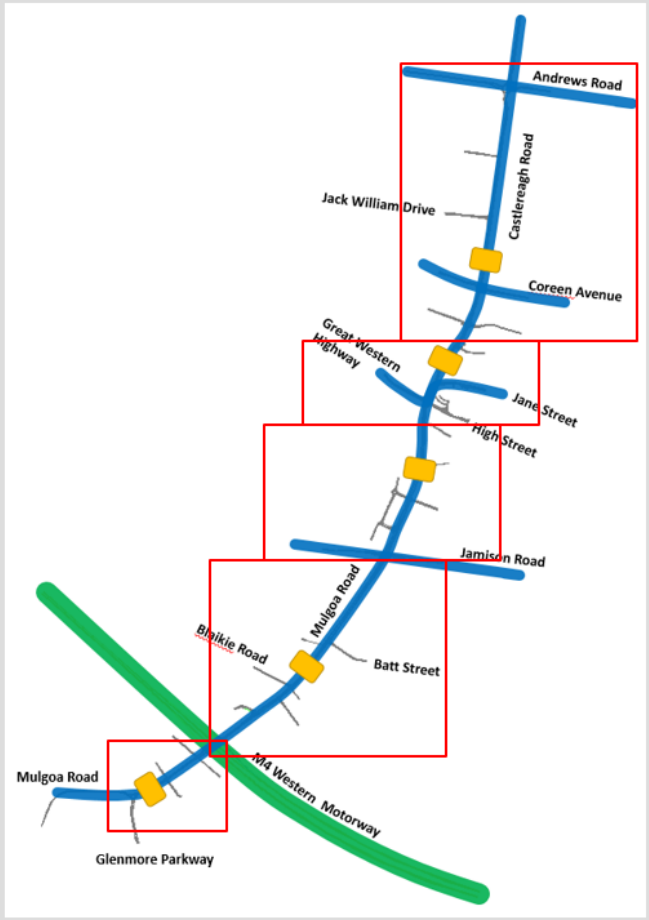
Section	VISSIM Network	Daily Traffic Volume (Growth Scenario 2: BTS with Accelerated Growth)		
		2015	2026	2036
1 Andrews Road to Museum Drive		36700 (AM Peak: 2790 vph PM Peak: 2760 vph)	55000 (AM Peak: 4100 vph PM Peak: 4150 vph)	65000 (AM Peak: 4880 vph PM Peak: 4920 vph)
2 Museum Drive to Union Road		43700 (AM Peak: 3132 vph PM Peak: 3149 vph)	63000 (AM Peak: 4500 vph PM Peak: 4540 vph)	76000 (AM Peak: 5340 vph PM Peak: 5460 vph)
3 Union Road to Jamison Road		34500 (AM Peak: 2271 vph PM Peak: 2439 vph)	50000 (AM Peak: 3280 vph PM Peak: 3450 vph)	62000 (AM Peak: 4140 vph PM Peak: 4320 vph)
4 Jamison Road to M4 Western Motorway		48400 (AM Peak: 3122 vph PM Peak: 3491 vph)	59000 (AM Peak: 3850 vph PM Peak: 4190 vph)	71000 (AM Peak: 4640 vph PM Peak: 5060 vph)
5 M4 Western Motorway to Glenmore Parkway		31300 (AM Peak: 2379 vph PM Peak: 2563 vph)	35000 (AM Peak: 2740 vph PM Peak: 2760 vph)	40000 (AM Peak: 3080 vph PM Peak: 3080 vph)

Figure A-12 Peak Hour Traffic Volumes for Growth Scenario 2

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APPENDIX B

VISSIM MODEL DEVELOPMENT, CALIBRATION AND VALIDATION

Mulgoa Road & Castlereagh Road Corridor Calibration and Validation Report

1 Introduction

This Technical Note has been prepared to report model calibration and validation results for the Mulgoa Road and Castlereagh Road corridor between Glenmore Parkway and Andrews Road using micro-simulation software VISSIM. The report documents development of the Base case VISSIM model, calibration and validation results for 2015 existing traffic conditions. The VISSIM model has been calibrated and validated for morning (AM) and afternoon (PM) traffic conditions.

2 VISSIM Model Development

The VISSIM model has been developed, calibrated and validated as per the latest RMS modelling guideline *Traffic Modelling Guidelines, V.1.0, RMS, February 2013*.

The Base case model represents the existing 2015 traffic conditions for:

- AM Peak period (two-hours) between 7:00-9:00; and
- PM Peak period (two-hours) between 16:00-18:00.

In addition, a pre loading “warm-up” period for 60 minutes and post peak “cool down” period for 60 minutes were applied to AM and PM peak periods.

The above mentioned time periods for both AM and PM peak period modelling have been agreed with RMS staff during the inception meeting.

2.1 Data Sources

The following data sources were used in the VISSIM model development, calibration and validation purposes:

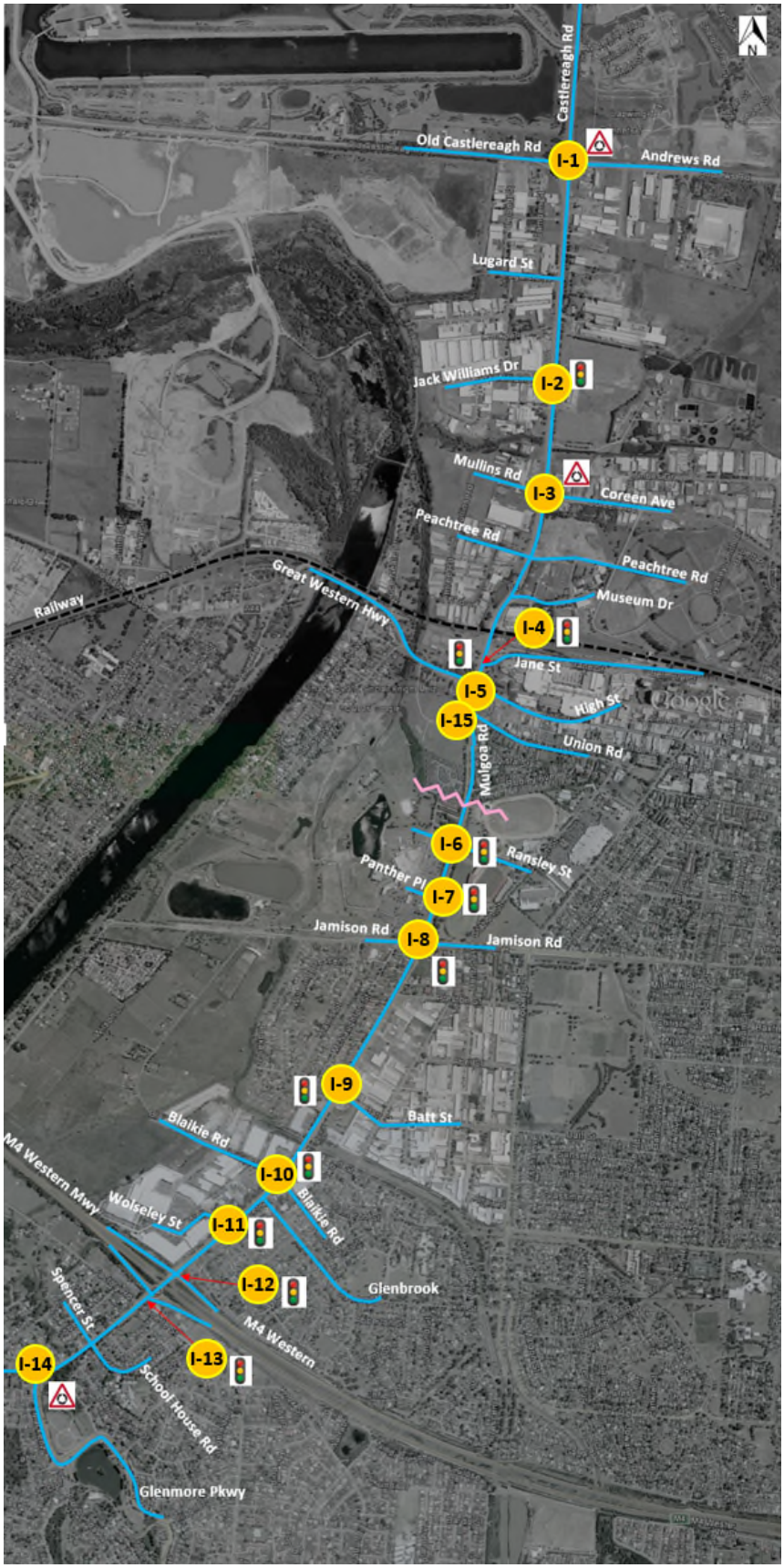
- New traffic survey data including intersection movement counts, intersection queue length survey, one week midblock ATC counts, intersection delays and travel time surveys in the study area (Table 2-1). New traffic survey was undertaken by Skyhigh between 11 May 2015 and 20 May 2015.
- Aerial photography;
- SCATS Intersection Diagnostic Monitor (IDM) data and Traffic Control Signal plans provided by RMS.
- Public transport data from Transport for New South Wales (TfNSW) and Busways

2.2 Traffic Survey

The following data sources were used in the VISSIM model development, calibration and validation purposes:

Table 2-1 Traffic Survey

Data Type	Location ID	Location	Year
Intersection counts and queue length survey	I-1	Castlereagh Road / Andrews Road	May 2015
	I-2	Castlereagh Road / Jack Williams Drive	
	I-3	Castlereagh Road / Coreen Avenue	
	I-4	Mulgoa Road / Jane Street	
	I-5	Mulgoa Road / High Street / Great Western Highway	
	I-6	Mulgoa Road / Ransley Street	
	I-7	Mulgoa Road / Panther Place	
	I-8	Mulgoa Road / Jamison Road	
	I-9	Mulgoa Road / Batt Street	
	I-10	Mulgoa Road / Blaikie Road	
	I-11	Mulgoa Road / Wolseley Street	
	I-12	Mulgoa Road / M4 Eastbound On-Off ramps	
	I-13	Mulgoa Road / M4 Westbound On-Off ramps	
	I-14	Mulgoa Road / Glenmore Parkway	
	I-15	Mulgoa Road / Union Road	
24hr/7 days ATC Midblock	M-1	Castlereagh Road, north of Jack Williams Drive	May 2015
	M-2	Castlereagh Road, north of Jane Street	
	M-3	Mulgoa Road, north of Ransley Street	
	M-4	Mulgoa Road, at Surveyors Creek bridge	
	M-5	Mulgoa Road, east of Glenmore Parkway	
	M-6	Belmore Street, east of Station Street	
	M-7	Great Western Highway, east of Ladbury Avenue	
Travel Time Survey		Castlereagh Road / Mulgoa Road (between Andrews Road and Glenmore Parkway)	19/May/2015 & 11/June/2015



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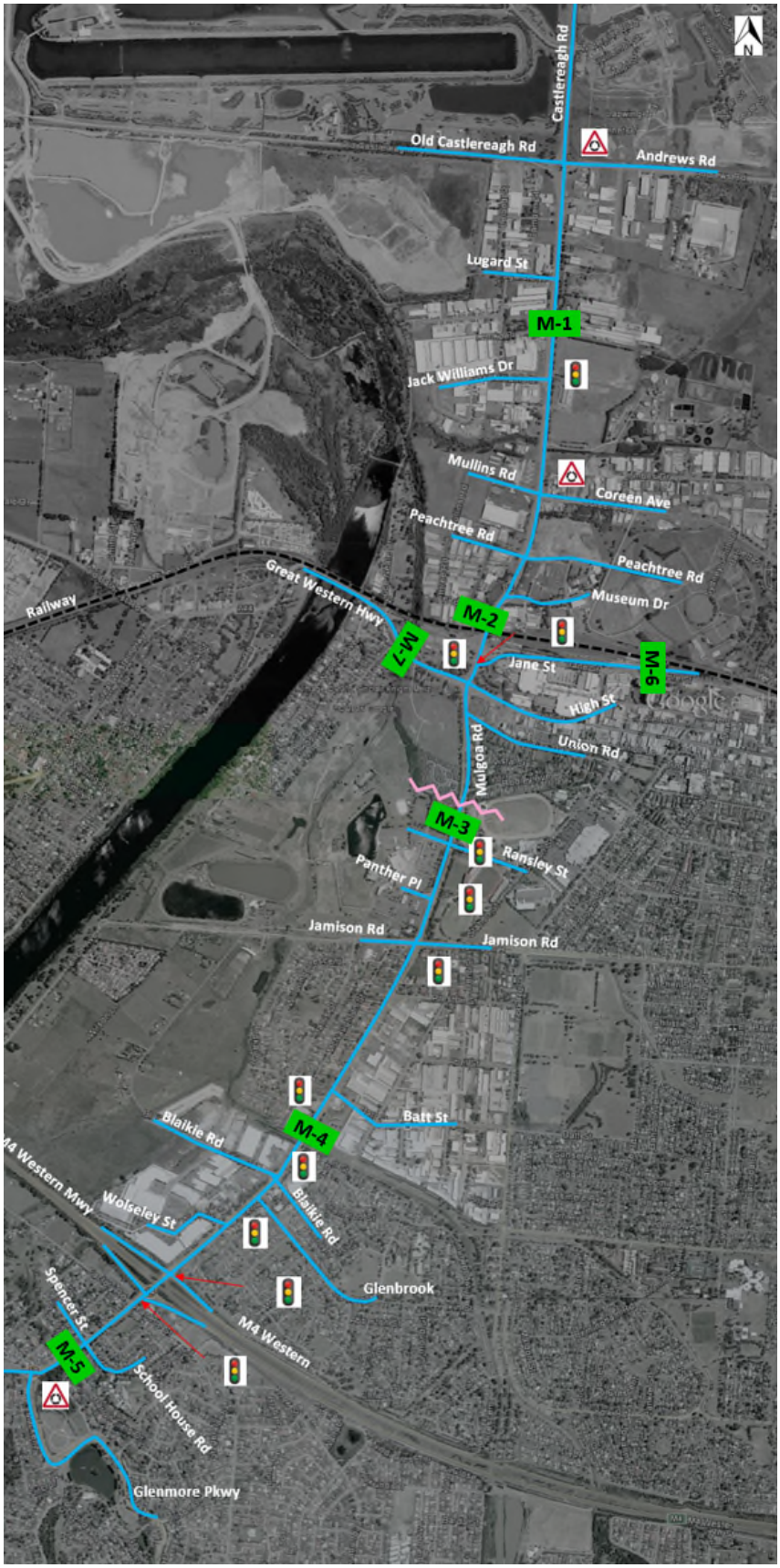
intersection survey.png

Figure 2-1 Intersection Counts and Queue Length Survey Sites



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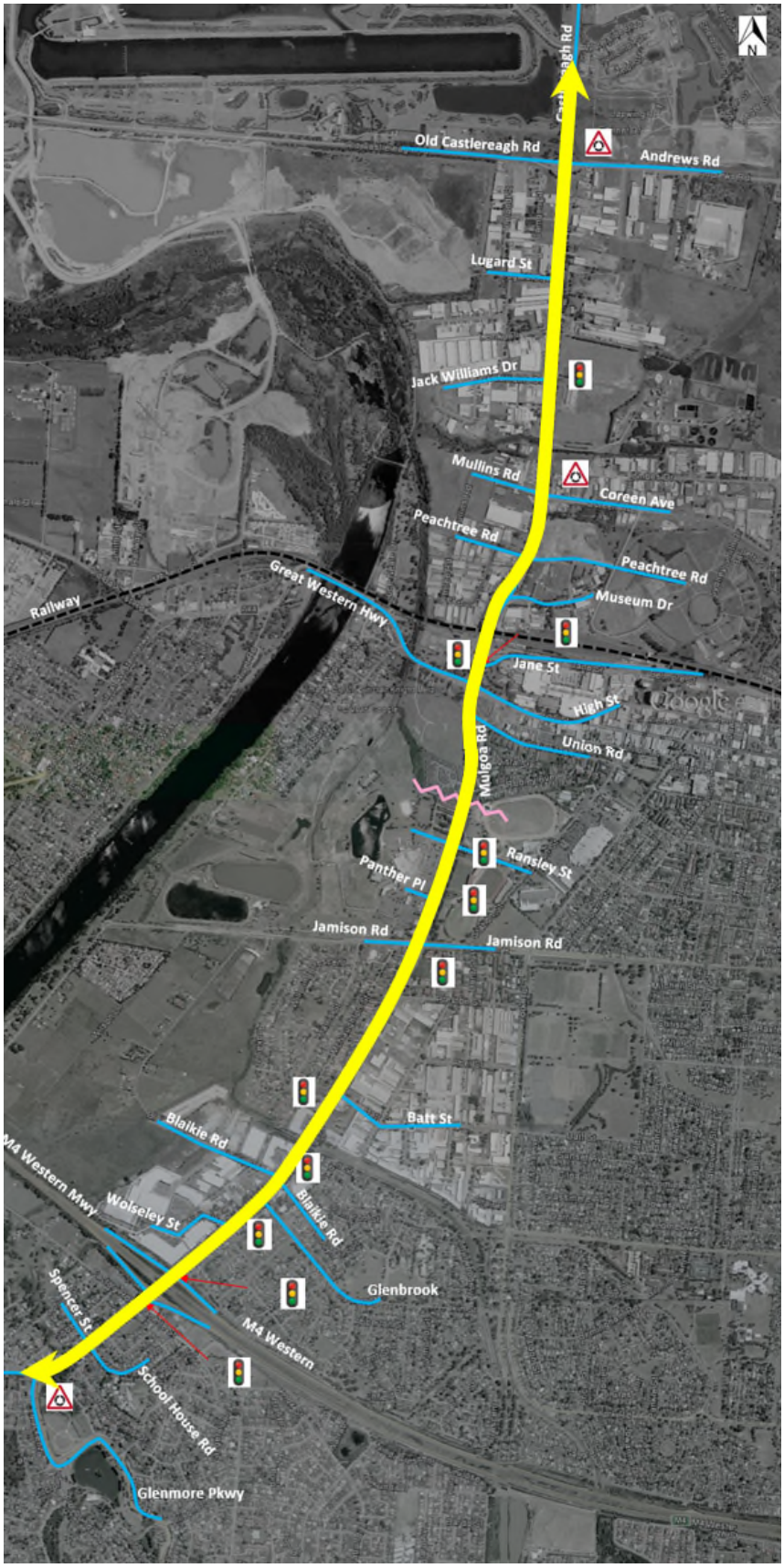
ATC survey.png

Figure 2-2 One Week Midblock Count Sites



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travel time survey.png

Figure 2-3 Travel Time Survey Route

2.3 Road Network Coding

Hyder utilised aerial photo images to code the road network for the existing condition. The aerial photography provided adequate information for network coding including road length, lane width, number of lanes, lane discipline and intersection configurations. Figure 2-4 shows the VISSIM model network study area and travel zones. In consultation and agreement with the RMS staff, Hyder developed the study area network and travel zones in VISSIM modelling.

All link-types and categories used in the VISSIM model are in line with RMS guidelines.

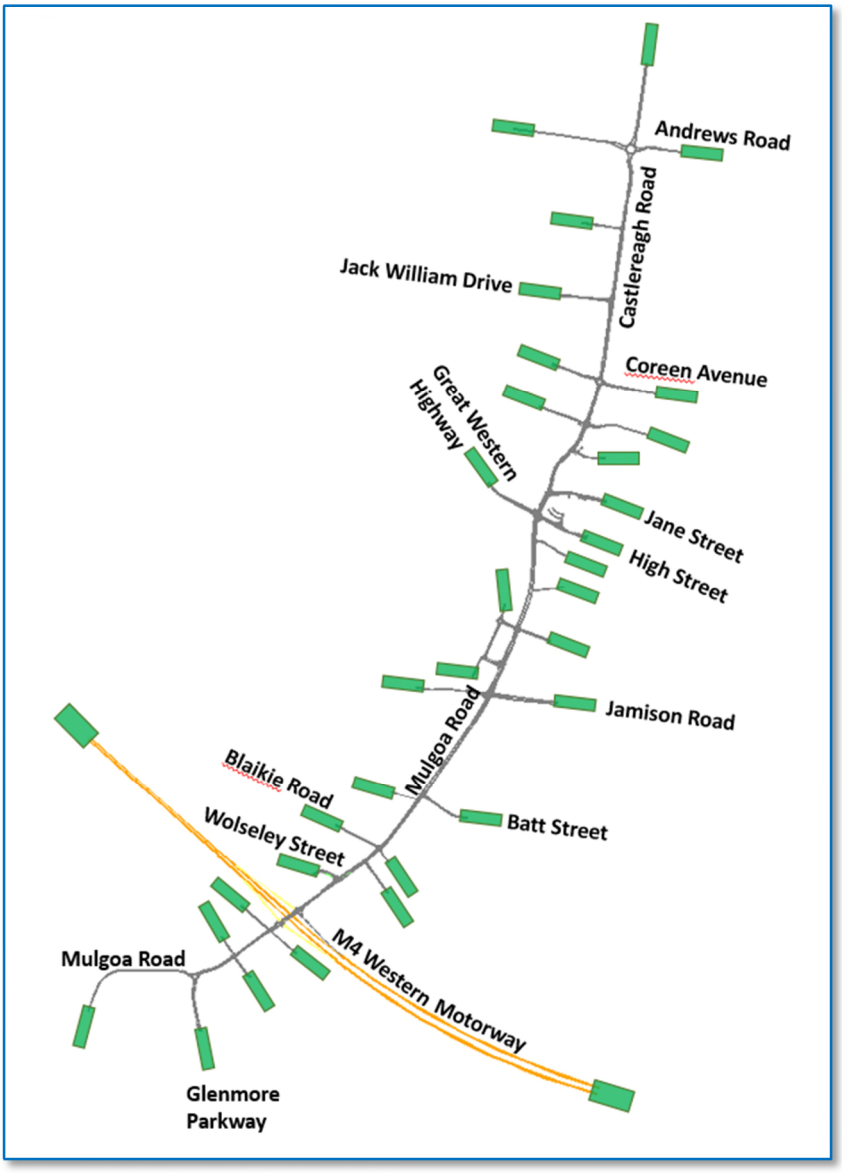

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Figure 2-4 VISSIM Model Network and Travel Zones

2.4 Traffic Controls & VAP

The study area VISSIM network contains three roundabouts, thirteen signalised intersections and one sign control (priority) intersection. The key intersections coded within the VISSIM network have been consulted and agreed with the RMS staff. The VAPs have been coded in the VISSIM model for thirteen signalised intersections to emulate SCATS operation within the study area network.

2.5 Demand Matrix

2.5.1 Demand Data

The demand matrix was estimated using surveyed intersection turning movement counts. The proportion of heavy vehicles and vehicle types was taken directly from available classified traffic data. The demand profiles are developed based on the traffic survey data.

2.5.2 Travel Zones

The VISSIM model network contains 34 travel zones within the study area.

2.5.3 Public Transport

The public transport services within the study area have been coded and included in the model. Bus frequencies and recent time tables for each bus route have been sourced form Transport for NSW and Busways web sites. Table 2-2 summarises current bus routes and frequencies coded in the AM and PM peak periods models.

Table 2-2 Public Transport (Bus) Services Coded

Bus Route ID	Route description	Bus Frequency (two-way)	
		AM Peak 7:00-9:00	PM Peak 4:00-6:00
673	Penrith to Windsor via Cranebrook & Llandilo	6	2
688	Emu Heights to Penrith Loop	1	1
689	Penrith to Leonay Loop	4	1
690P	Penrith to Springwood via Glenbrook, Blaxland, Warrimoo and Valley Heights	0	3
691	Blaxland to Penrith	3	1
781	Penrith to St Marys via Glenmore Park & Claremont Meadows	3	1
783	Penrith & Jordan Springs Loop	4	4
784	Penrith to Cranebrook Loop	3	2
795	Penrith to Warragamba via Wallacia	5	4
797	Penrith to Glenmore Park Loop	4	4
799	Blue Hills to Penrith via Glenmore Park	7	7
1688	Leonay to Penrith Loop via Emu Heights	0	0

Source: www.transportnsw.info

3 Model Calibration

Model calibration is the process that develops and adjusts model parameters to adequately reflect the observed traffic behaviour. The model calibration criteria were based on Traffic Modelling Guidelines, RMS, Version 1.0, February 2013.

The model validation provides an independent check of the calibrated model to assess its accuracy and confirm its 'fit for the project purpose'. For this study, model was validated against surveyed travel time data and observed queue lengths. The following sections provide a summary of calibration results.

3.1 Calibration Criteria

Seventeen intersections in the study area were included in the Base case model calibration. The 2015 observed intersection turning volumes were compared with the modelled intersection turning volumes for AM and PM peak periods. Comparison assessment is undertaken based on the core area modelling criteria as per RMS Guide and detailed in Table.

Table 3-1 Micro-simulation turn target calibration criteria (core area)

Topic	Calibration Criteria	Target
Turn	Difference in turn flow within 10 for flows <99 vph	100%
	Difference in turn flow within 10% for flows 100-999 vph	100%
	Difference in turn flow within 100 for flows 1,000-1,999 vph	100%
	Difference in turn flow within 5% for flows >2,000 vph	100%
	10 per cent of observations to be within tolerance limits (GEH Statistic less than 5 of all individual modelled flow)	100%
	R^2 value to be included with plots of observed vs modelled hourly flows required	>0.95

Table 3-2 and Figure below show the list and location of key intersections included in the model calibration.

Table 3-2 Key intersections included in model calibration

ID	Intersection	Control Type
I-1	Castlereagh Road / Andrews Road	Roundabout
I-2	Castlereagh Road / Jack Williams Drive	Signal
I-3	Castlereagh Road / Coreen Avenue	Roundabout
I-4	Mulgoa Road / Jane Street	Signal
I-5	Mulgoa Road / High Street / Great Western Highway	Signal
I-6	Mulgoa Road / Ransley Street	Signal
I-7	Mulgoa Road / Panther Place	Signal
I-8	Mulgoa Road / Jamison Road	Signal
I-9	Mulgoa Road / Batt Street	Signal

ID	Intersection	Control Type
I-10	Mulgoa Road / Blaikie Road	Signal
I-11	Mulgoa Road / Wolseley Street	Signal
I-12	Mulgoa Road / M4 Eastbound On-Off ramps	Signal
I-13	Mulgoa Road / M4 Westbound On-Off ramps	Signal
I-14	Mulgoa Road / Glenmore Parkway	Roundabout
I-15	Mulgoa Road / Union Road	Priority
I-16	Castlereagh Road / Museum Drive	Signal
I-17	Castlereagh Road / Peachtree Road / Thornton Drive	Signal

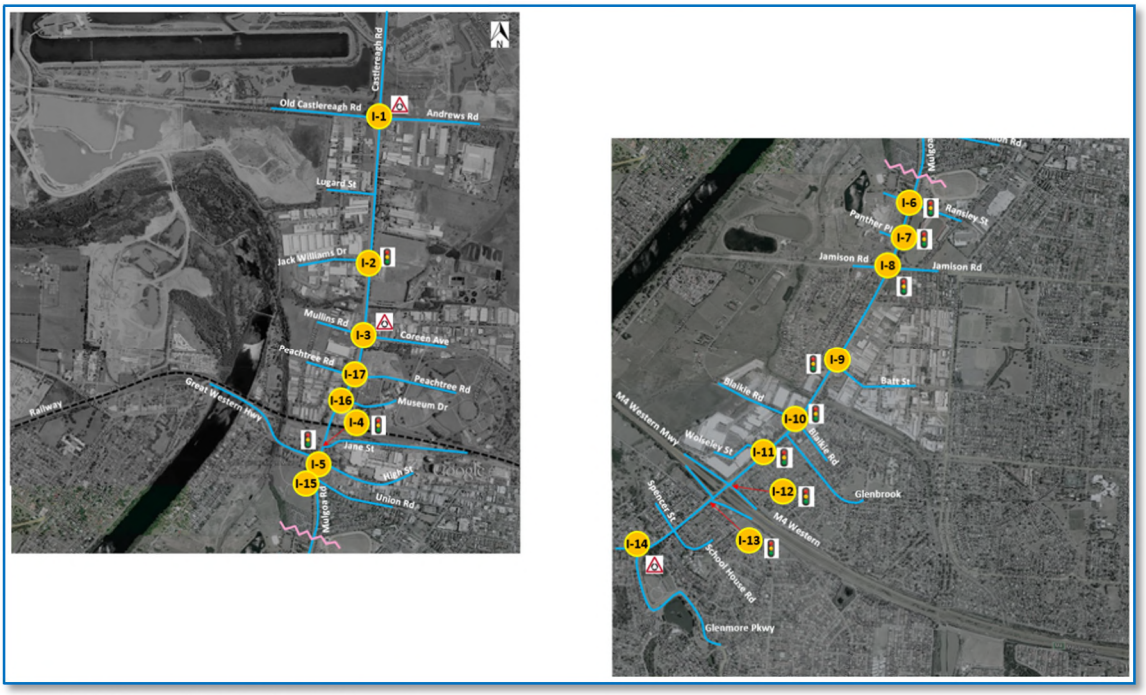

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Figure 3-1 Key Intersections included in Model Calibration

3.2 Calibration Results for the AM Peak

Intersection turning volumes have been assessed based on the calibration criteria. Approximately 142 turning movements at 17 intersections were included in model calibration.

Table 3-3 below summarises the calibration results for the AM Peak model. Figure 3-2 shows comparison of observed versus model flows for AM peak graphically. A high standard of calibration was achieved for AM peak model with R^2 value was found to be 0.99.

Table 3-3 2015 AM Peak Model Calibration Summary

Model Calibration, Intersection Turning Movements			
Total number of turn flows:	142 (17 intersections)		
Number of flows less than 99 vph	*62*		
Number of flows between 100 and 999 vph	*60*		
Number of flows between 1,000 and 1,999 vph	*18*		
Number of flows more than 2,000 vph	*2*		
Meet the assessment criteria:	**Target**	**Achieved**	**Status**
Difference in link flow within 10 for flows <99 vph	100%	100%	Pass
Difference in link flow within 10% for flows 100-999 vph	100%	100%	Pass
Difference in link flow within 100 for flows 1,000-1,999 vph	100%	100%	Pass
Difference in link flow within 5% for flows >2,000 vph	100%	100%	Pass
100 per cent of observations to be within tolerance limits (GEH Statistic less than 5 of all individual modelled flow)	100%	100%	Pass
R^2 value	>0.95	0.99	Pass

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Node Evaluation Results_0800_0900_v04.xls
Model: F:\AA008188\Traffic Modelling\VISSIM Models\2015 Base Models\Mulgoa Road_2015_AM_Base_TZ034_V4

Detailed turn counts calibration spreadsheet is included in Appendix A.

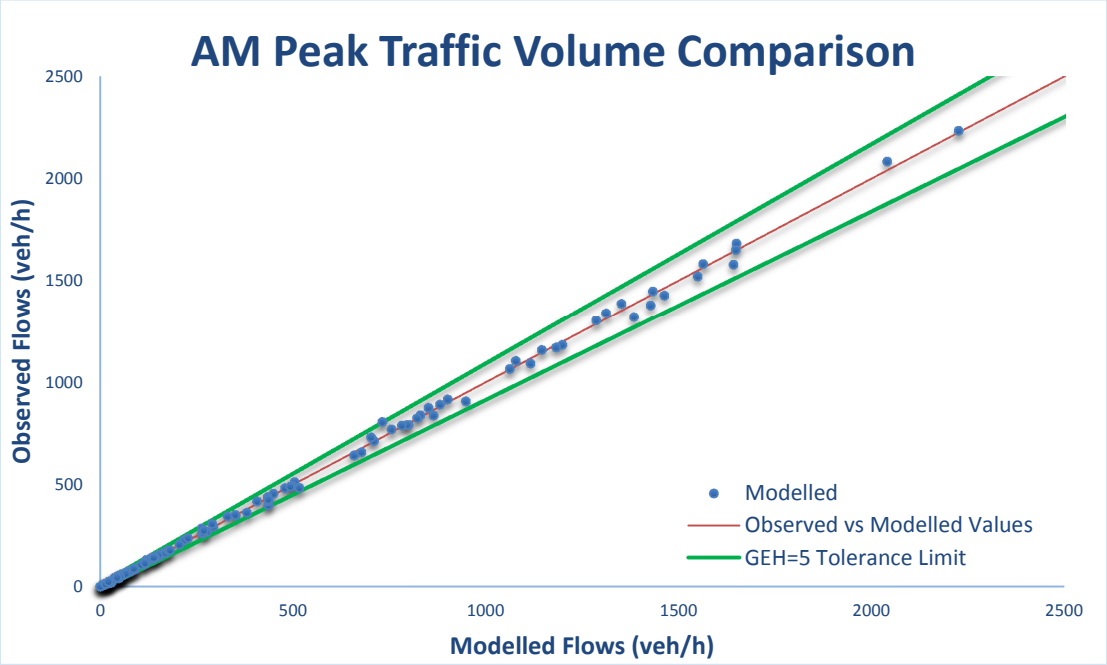

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Figure 3-2 Observed vs Modelled Intersection Turning Flows, Existing AM Peak

The results from above assessment confirmed that AM Peak model satisfied the Core Area calibration criteria.

3.3 Calibration Results for the PM Peak

Intersection turning volumes have been assessed based on the calibration criteria. Approximately 142 turning movements at 17 intersections were included in model calibration. Table 3-4 below summarises the calibration results for the PM Peak model. Figure 3-3 shows comparison of observed versus model flows for PM peak graphically. A high standard of calibration was achieved for PM peak model with R^2 value was found to be 0.99.

Table 3-4 2015 PM Peak Model Calibration Summary

Model Calibration **Intersection Turning Movements**			
Total number of turn flows:	142 (17 intersections)		
Number of flows less than 99 vph	*51*		
Number of flows between 100 and 999 vph	*67*		
Number of flows between 1,000 and 1,999 vph	*23*		
Number of flows more than 2,000 vph	*1*		
Meet the assessment criteria:	**Target**	**Achieved**	**Status**
Difference in link flow within 10 for flows <99 vph	100%	100%	Pass
Difference in link flow within 10% for flows 100-999 vph	100%	100%	Pass
Difference in link flow within 100 for flows 1,000-1,999 vph	100%	100%	Pass
Difference in link flow within 5% for flows >2,000 vph	100%	100%	Pass
100 per cent of observations to be within tolerance limits (GEH Statistic less than 5 of all individual modelled flow)	100%	100%	Pass
R^2 value	>0.95	0.99	Pass

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Model: F:\AA008188\Traffic Modelling\VISSIM Models\2015 Base Models\MulgoaRoad_2015_PM_Base_TZ034_V4.2

Detail turn count calibration spreadsheet is included in Appendix A.

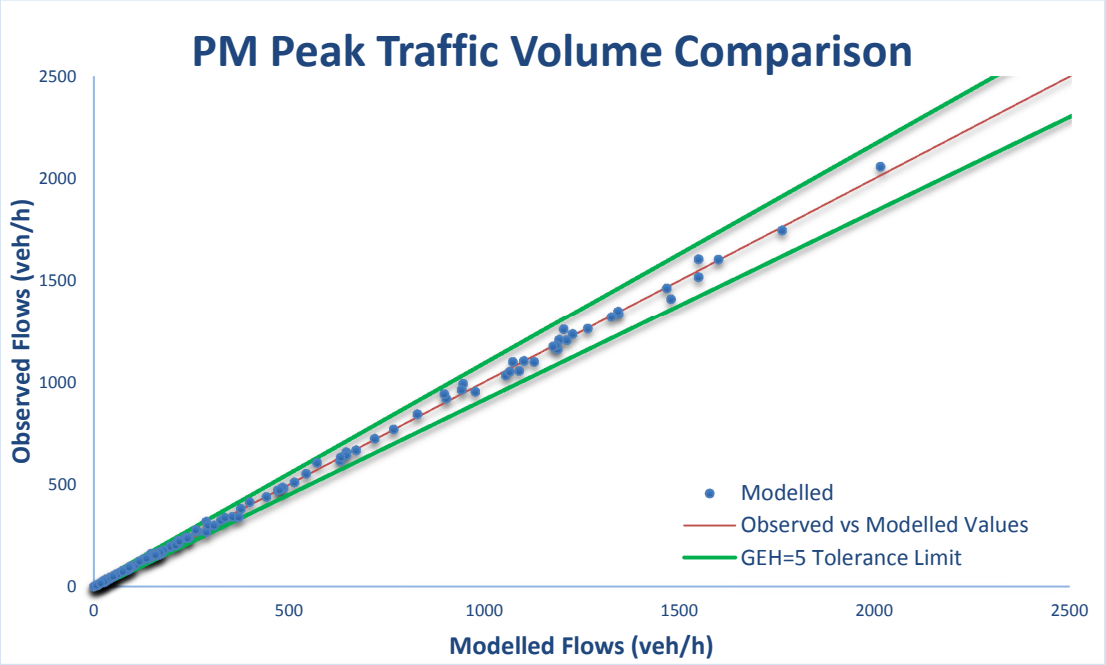

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Figure 3-3 Observed vs Modelled Intersection Turning Flows, Existing PM Peak

The results from above assessment confirmed that PM Peak model satisfied the Core Area calibration criteria.

4 Model Validation

Model validation has been undertaken as per RMS guideline. Both AM and PM Peak models have been validated for travel time and queue length data.

Figure shows travel time survey route along Mulgoa Road / Castlereagh Road corridor in northbound and southbound direction.

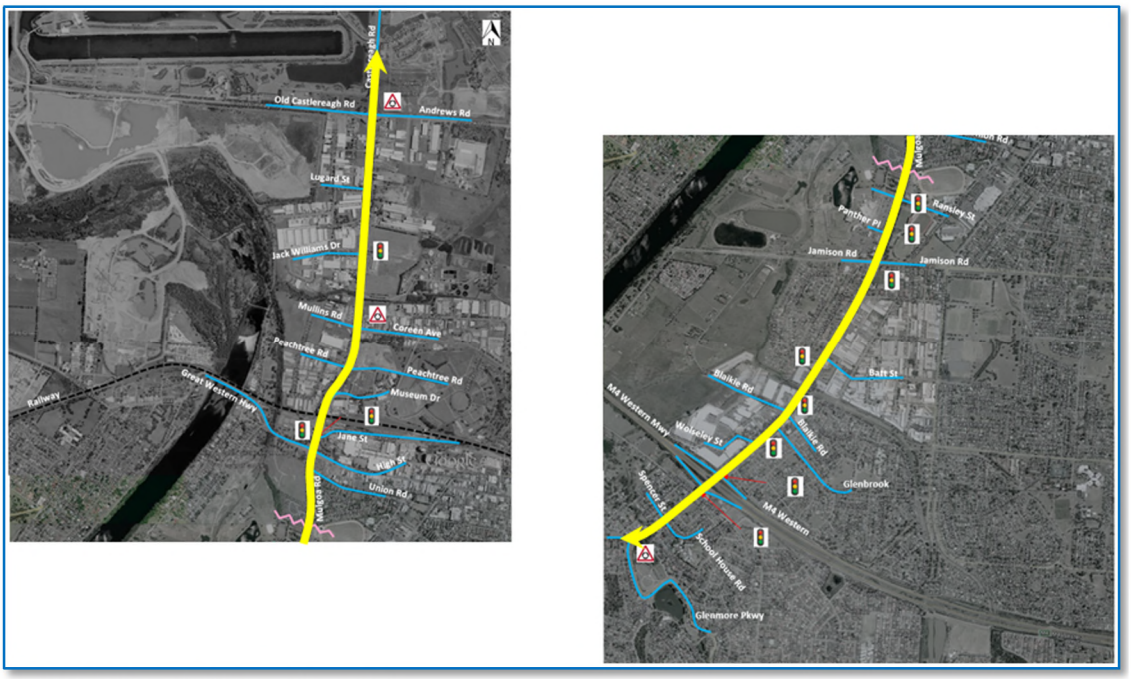

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Figure 4-1 Travel Time Survey Route along Mulgoa Road/Castlereagh Road corridor

4.1 Travel Time Validation

Observed and modelled travel times, as cumulative values, were compared in northbound and southbound direction along the Mulgoa Road / Castlereagh Road corridor between Glenmore Parkway and Andrews Road roundabouts (approximately 6.3 km).

Comparison assessment is undertaken based on RMS travel time validation criteria target that average modelled journey time needs to be within 15% of average observed journey time for individual sections along the route.

Figure 4-2 to Figure 4-5 below show cumulative time-distance graph of modelled and observed travel time data along the route for AM and PM peak periods.

The modelled travel time (red line) is within the upper (+15%) and lower (-15%) boundary of observed average travel time values and followed the same trend with the survey travel time data at each section.

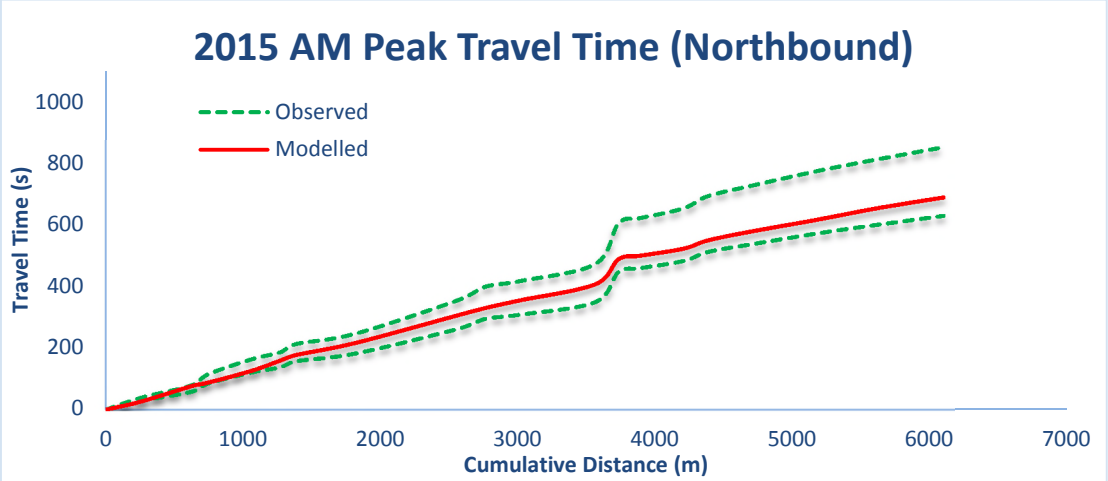

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Figure 4-2 Travel Time Comparison on the Mulgoa Road / Castlereagh Road corridor Northbound – AM Peak

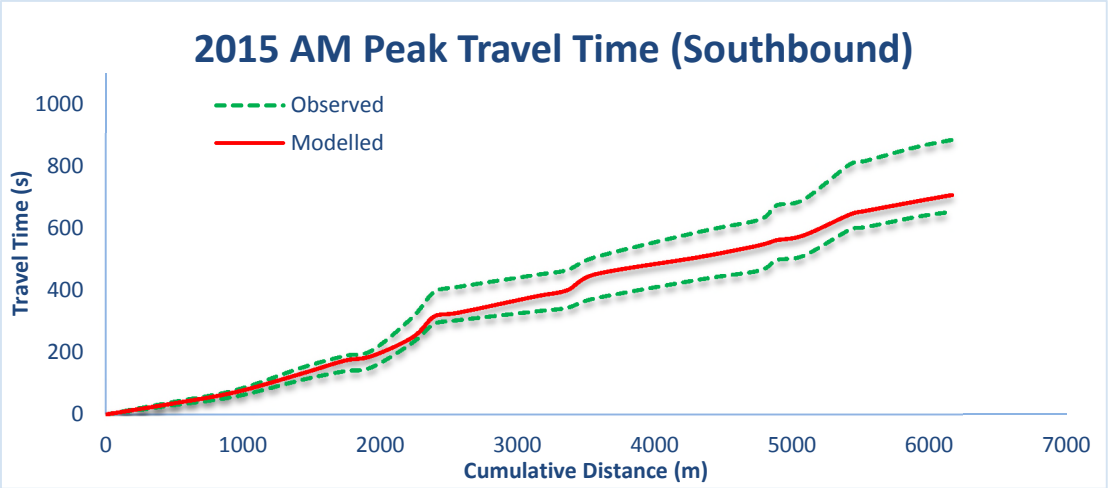

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Figure 4-3 Travel Time Comparison on the Mulgoa Road / Castlereagh Road corridor Southbound – AM Peak

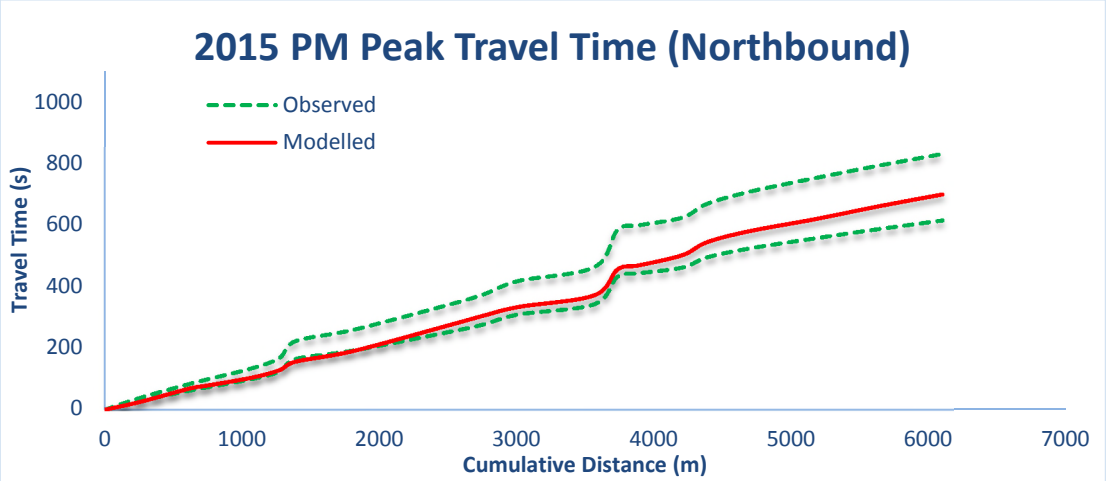

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Figure 4-4 Travel Time Comparison on the Mulgoa Road / Castlereagh Road corridor Northbound – PM Peak

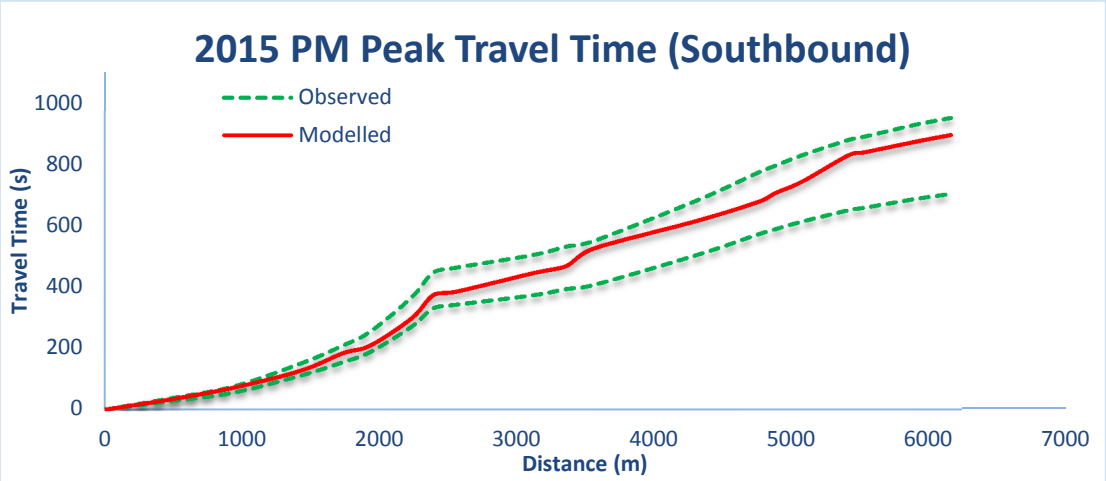

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Figure 4-5 Travel Time Comparison on the Mulgoa Road / Castlereagh Road corridor Southbound – PM Peak

4.2 Queue Length Validation

As stated in the RMS modelling guideline, counting or calculating queue length is a subjective exercise since queued vehicles will often still be moving slowly and it will not always be clear what criteria should be used to constitute a queue during surveys. For that reason RMS does not have mandatory statistical guideline criteria for queue length comparison. Nevertheless modelled queue length have been compared with observed survey data (for both AM and PM peak period models). The modelled queue length have been verified by our own site observation by Hyder's staff.

Appendix A includes the comparison between observed queues and modelled queues for AM and PM peak periods.

5 Key Findings

The AM and PM peak VISSIM models have been calibrated and validated as per RMS Guideline. The modelling results confirms that both AM and PM peak Base case VISSIM models have been adequately calibrated and validated for 2015 traffic conditions and model is “fit for the study purpose”.

Appendix A

Description		Direction	Movement	Links From	Links To	Volume Model	Volume Count	Volume Mod-Cn	Volume % Diff*	GEH	Accept
Andrews Road Roundabout	Castlereagh Rd (N) to Old Castlereagh Rd	NE-NW	SB --> R	510	506	23	23	0	0.0%	0.0	✓
	Castlereagh Rd (N) to Castlereagh Rd (S)	NE-S	SB ^ T	510	36	1062	1062	0	0.0%	0.0	✓
	Castlereagh Rd (N) to Andrews Rd	NE-E	SB <-- L	510	512	164	165	-1	-0.6%	0.1	✓
	Andrews Rd to Castlereagh Rd (N)	E-NE	WB --> R	515	511	73	75	-2	-2.7%	0.2	✓
	Andrews Rd to Old Castlereagh Rd	E-NW	WB ^ T	515	506	34	35	-1	-2.9%	0.2	✓
	Andrews Rd to Castlereagh Rd (S)	E-S	WB <-- L	515	36	504	511	-7	-1.4%	0.3	✓
	Castlereagh Rd (S) to Andrews Rd	S-E	NB --> R	517	512	264	259	5	1.9%	0.3	✓
	Castlereagh Rd (S) to Castlereagh Rd (N)	S-NE	NB ^ T	517	511	499	491	8	1.6%	0.4	✓
	Castlereagh Rd (S) to Old Castlereagh Rd	S-NW	NB <-- L	517	506	10	11	-1	-9.1%	0.3	✓
	Old Castlereagh Rd to Castlereagh Rd (S)	W-S	EB --> R	508	36	19	14	5	35.7%	1.2	✓
	Old Castlereagh Rd to Andrews Rd	W-E	EB ^ T	508	512	33	33	0	0.0%	0.0	✓
	Old Castlereagh Rd to Castlereagh Rd (N)	W-NE	EB <-- L	508	511	35	36	-1	-2.8%	0.2	✓
	ALL					**2721**	**2715**	**6**	**0.2%**	**0.1**	✓
Jack Williams Dr	Castlereagh Rd (N) to Jack Williams Dr	N-W	SB --> R	499	496	42	42	0	0.0%	0.0	✓
	Castlereagh Rd (N) to Castlereagh Rd (S)	N-S	SB ^ T	518	518	1642	1577	65	4.1%	1.6	✓
	Castlereagh Rd (S) to Castlereagh Rd (N)	S-N	NB ^ T	38	38	755	768	-13	-1.7%	0.5	✓
	Castlereagh Rd (S) to Jack Williams Dr	S-W	NB <-- L	497	496	263	284	-21	-7.4%	1.3	✓
	Jack Williams Dr to Castlereagh Rd (S)	W-S	EB --> R	491	518	175	176	-1	-0.6%	0.1	✓
	Jack Williams Dr to Castlereagh Rd (N)	W-N	EB <-- L	491	38	20	19	1	5.3%	0.2	✓
	ALL					**2898**	**2866**	**32**	**1.1%**	**0.6**	✓
Mullins Road / Coreen Avenue Roundat	Castlereagh Rd (N) to Mullins Rd	N-NW	SB --> R	518	240	31	32	-1	-3.1%	0.2	✓
	Castlereagh Rd (N) to Castlereagh Rd (S)	N-S	SB ^ T	518	35	1427	1376	51	3.7%	1.4	✓
	Castlereagh Rd (N) to Coreen Ave	N-SE	SB <-- L	518	238	351	347	4	1.2%	0.2	✓
	Coreen Ave to Castlereagh Rd (N)	SE-NE	WB --> R	239	38	110	110	0	0.0%	0.0	✓
	Coreen Ave to Mullins Rd	SE-NW	WB ^ T	239	240	58	58	0	0.0%	0.0	✓
	Coreen Ave to Castlereagh Rd (S)	SE-S	WB <-- L	239	35	153	150	3	2.0%	0.2	✓
	Castlereagh Rd (S) to Coreen Ave	S-SE	NB --> R	34	238	293	293	0	0.0%	0.0	✓
	Castlereagh Rd (S) to Castlereagh Rd (N)	S-NE	NB ^ T	34	38	851	873	-22	-2.5%	0.7	✓
	Castlereagh Rd (S) to Mullins Rd	S-NW	NB <-- L	34	240	59	57	2	3.5%	0.3	✓
	Mullins Rd to Castlereagh Rd (S)	NW-S	EB --> R	241	35	32	32	0	0.0%	0.0	✓
	Mullins Rd to Coreen Ave	NW-SE	EB ^ T	241	238	24	23	1	4.3%	0.2	✓
	Mullins Rd to Castlereagh Rd (N)	NW-NE	EB <-- L	241	38	54	52	2	3.8%	0.3	✓
	ALL					**3443**	**3403**	**40**	**1.2%**	**0.7**	✓
Castlereagh Rd/Peachtree Rd	Castlereagh Rd (N) to Peachtree Rd (W)	N-W	SB --> R	43	49	81	80	1	1.3%	0.1	✓
	Castlereagh Rd (N) to Castlereagh Rd (S)	N-S	SB ^ T	43	44	1463	1425	38	2.7%	1.0	✓
	Castlereagh Rd (N) to Peachtree Rd (E)	N-E	SB <-- L	43	53	58	61	-3	-4.9%	0.4	✓
	Peachtree Rd (E) to Castlereagh Rd (N)	E-N	SB <-- L	618	34	50	50	0	0.0%	0.0	✓
	Peachtree Rd (E) to Peachtree Rd (W)	E-W	SB <-- L	55	49	0	0	0	0.0%	0.0	✓
	Peachtree Rd (E) to Castlereagh Rd (S)	E-S	WB <-- L	55	44	29	19	10	52.6%	2.0	✓
	Castlereagh Rd (S) to Peachtree Rd (E)	S-E	WB <-- L	617	53	350	350	0	0.0%	0.0	✓
	Castlereagh Rd (S) to Castlereagh Rd (N)	S-N	NB ^ T	42	34	1078	1102	-24	-2.2%	0.7	✓
	Castlereagh Rd (S) to Peachtree Rd (W)	S-W	NB <-- L	42	49	146	145	1	0.7%	0.1	✓
	Peachtree Rd (W) to Castlereagh Rd (S)	W-S	EB --> R	48	44	90	88	2	2.3%	0.2	✓
	Peachtree Rd (W) to Peachtree Rd (E)	W-E	EB --> R	48	53	0	0	0	0.0%	0.0	✓
	Peachtree Rd (W) to Castlereagh Rd (N)	W-N	EB --> R	48	34	79	75	4	5.3%	0.5	✓
	ALL					**3424**	**3395**	**29**	**0.9%**	**0.5**	✓
Castlereagh Rd/Museum Drive	Castlereagh Rd (N) to Castlereagh Rd (S)	NE-SW	SB ^ T	37	39	1549	1520	29	1.9%	0.7	✓
	Castlereagh Rd (N) to Museum Dr	NE-SE	SB <-- L	37	65	22	22	0	0.0%	0.0	✓
	Museum Dr to Castlereagh Rd (N)	SE-NE	WB --> R	64	42	6	6	0	0.0%	0.0	✓
	Museum Dr to Castlereagh Rd (S)	SE-SW	WB <-- L	64	39	4	6	-2	-33.3%	0.9	✓
	Castlereagh Rd (S) to Museum Dr	SW-SE	NB --> R	41	65	23	26	-3	-11.5%	0.6	✓
	Castlereagh Rd (S) to Castlereagh Rd (N)	SW-NE	NB ^ T	41	42	1563	1580	-17	-1.1%	0.4	✓
	ALL					**3167**	**3160**	**7**	**0.2%**	**0.1**	✓
Castlereagh Rd/Jane St	Castlereagh Rd (N) to Castlereagh Rd (S)	N-SW	SB ^ T	74	80	1198	1181	17	1.4%	0.5	✓
	Castlereagh Rd (N) to Jane St	N-E	SB <-- L	107	78	330	342	-12	-3.5%	0.7	✓
	Jane St to Castlereagh Rd (N)	E-N	WB --> R	76	40	151	153	-2	-1.3%	0.2	✓
	Jane St to Castlereagh Rd (S)	E-SW	WB <-- L	77	80	114	110	4	3.6%	0.4	✓
	Castlereagh Rd (S) to Jane St	SW-E	NB --> R	7	78	380	361	19	5.3%	1.0	✓
	Castlereagh Rd (S) to Castlereagh Rd (N)	SW-N	NB ^ T	7	40	1433	1446	-13	-0.9%	0.3	✓
	ALL					**3606**	**3593**	**13**	**0.4%**	**0.2**	✓
GWH/Castlereagh Rd/Henry St/Mulgoa	Castlereagh Rd (N) to Great Western Hway	NE-NW	SB --> R	80	5	407	417	-10	-2.4%	0.5	✓
	Castlereagh Rd (N) to Mulgoa Rd (S)	NE-S	SB ^ T	80	85	830	836	-6	-0.7%	0.2	✓
	Castlereagh Rd (N) to High St	NE-SE	SB <-- L	80	23	64	65	-1	-1.5%	0.1	✓
	High St to Castlereagh Rd (N)	SE-NE	WB --> R	31	7	87	88	-1	-1.1%	0.1	✓
	High St to Great Western Hway	SE-NW	WB ^ T	31	5	169	166	3	1.8%	0.2	✓
	High St to Mulgoa Rd (S)	SE-S	WB <-- L	31	85	50	47	3	6.4%	0.4	✓
	Mulgoa Rd (S) to High St	S-SE	NB --> R	88	23	119	130	-11	-8.5%	1.0	✓
	Mulgoa Rd (S) to Castlereagh Rd (N)	S-NE	NB ^ T	89	7	901	913	-12	-1.3%	0.4	✓
	Mulgoa Rd (S) to Great Western Hway	S-NW	NB <-- L	104	5	138	135	3	2.2%	0.3	✓
	Great Western Hway to Mulgoa Rd (S)	NW-S	EB --> R	102	85	275	267	8	3.0%	0.5	✓
	Great Western Hway to High St	NW-SE	EB ^ T	82	23	479	480	-1	-0.2%	0.0	✓
	Great Western Hway to Castlereagh Rd (N)	NW-NE	EB <-- L	82	7	822	823	-1	-0.1%	0.0	✓
	ALL					**4341**	**4367**	**-26**	**-0.6%**	**0.4**	✓
Union Rd	Mulgoa Rd (N) to Mulgoa Rd (S)	N-S	SB ^ T	90	90	864	835	29	3.5%	1.0	✓
	Mulgoa Rd (N) to Union Rd	N-E	SB <-- L	90	95	290	307	-17	-5.5%	1.0	✓
	Union Rd to Mulgoa Rd (S)	E-S	WB <-- L	96	90	52	52	0	0.0%	0.0	✓
	Mulgoa Rd (S) to Union Rd	S-E	NB --> R	93	95	217	227	-10	-4.4%	0.7	✓
	Mulgoa Rd (S) to Mulgoa Rd (N)	S-N	NB ^ T	93	92	1145	1156	-11	-1.0%	0.3	✓
	ALL					**2568**	**2577**	**-9**	**-0.3%**	**0.2**	✓
Mulgoa Rd/Ransley St	Mulgoa Rd (N) to Ransley St (W)	N-NW	SB --> R	10	15	36	43	-7	-16.3%	1.1	✓
	Mulgoa Rd (N) to Mulgoa Rd (S)	N-S	SB ^ T	10	12	799	789	10	1.3%	0.4	✓
	Mulgoa Rd (N) to Ransley St (E)	N-E	SB <-- L	10	17	56	62	-6	-9.7%	0.8	✓
	Ransley St (E) to Mulgoa Rd (N)	E-N	WB --> R	16	8	23	21	2	9.5%	0.4	✓
	Ransley St (E) to Ransley St (W)	E-NW	WB ^ T	16	15	34	34	0	0.0%	0.0	✓
	Ransley St (E) to Mulgoa Rd (S)	E-S	WB <-- L	16	12	20	18	2	11.1%	0.5	✓
	Mulgoa Rd (S) to Ransley St (E)	S-E	NB --> R	11	17	71	74	-3	-4.1%	0.4	✓
	Mulgoa Rd (S) to Mulgoa Rd (N)	S-N	NB ^ T	11	8	1312	1338	-26	-1.9%	0.7	✓
	Mulgoa Rd (S) to Ransley St (W)	S-NW	NB <-- L	11	15	12	12	0	0.0%	0.0	✓
	Ransley St (W) to Mulgoa Rd (S)	NW-S	EB --> R	14	12	9	7	2	28.6%	0.7	✓
	Ransley St (W) to Ransley St (E)	NW-E	EB ^ T	14	17	18	18	0	0.0%	0.0	✓
	Ransley St (W) to Mulgoa Rd (N)	NW-N	EB <-- L	14	8	18	18	0	0.0%	0.0	✓
	ALL					**2407**	**2391**	**16**	**0.7%**	**0.3**	✓
Mulgoa Rd/Panther Pl	Mulgoa Rd (N) to Panther Pl	NE-NW	SB --> R	190	194	23	23	0	0.0%	0.0	✓
	Mulgoa Rd (N) to Mulgoa Rd (S)	NE-SW	SB ^ T	190	193	796	789	7	0.9%	0.2	✓
	Mulgoa Rd (S) to Mulgoa Rd (N)	SW-NE	NB ^ T	422	13	1352	1385	-33	-2.4%	0.9	✓
	Mulgoa Rd (S) to Panther Pl	SW-NW	NB <-- L	422	194	133	133	0	0.0%	0.0	✓
	Panther Pl to Mulgoa Rd (S)	NW-SW	EB --> R	195	193	90	85	5	5.9%	0.5	✓
	Panther Pl to Mulgoa Rd (N)	NW-NE	EB <-- L	195	13	49	41	8	19.5%	1.2	✓
	ALL					**2442**	**2456**	**-14**	**-0.6%**	**0.3**	✓
Jamison Rd	Mulgoa Rd (N) to Jamison Rd (W)	NE-W	SB --> R	418	419	47	47	0	0.0%	0.0	✓
	Mulgoa Rd (N) to Mulgoa Rd (S)	NE-SW	SB ^ T	193	614	710	712	-2	-0.3%	0.1	✓
	Mulgoa Rd (N) to Jamison Rd (E)	NE-E	SB <-- L	193	420	133	142	-9	-6.3%	0.8	✓
	Jamison Rd (E) to Mulgoa Rd (N)	E-NE	WB --> R	427	615	132	130	2	1.5%	0.2	✓
	Jamison Rd (E) to Jamison Rd (W)	E-W	WB ^ T	426	419	73	74	-1	-1.4%	0.1	✓
	Jamison Rd (E) to Mulgoa Rd (S)	E-SW	WB <-- L	426	614	176	177	-1	-0.6%	0.1	✓
	Mulgoa Rd (S) to Jamison Rd (E)	SW-E	NB --> R	423	420	449	454	-5	-1.1%	0.2	✓
	Mulgoa Rd (S) to Mulgoa Rd (N)	SW-NE	NB ^ T	192	615	1286	1301	-15	-1.2%	0.4	✓
	Mulgoa Rd (S) to Jamison Rd (W)	SW-W	NB <-- L	192	419	18	15	3	20.0%	0.7	✓
	Jamison Rd (W) to Mulgoa Rd (S)	W-SW	EB --> R	417	614	52	53	-1	-1.9%	0.1	✓
	Jamison Rd (W) to Jamison Rd (E)	W-E	EB ^ T	86	420	121	125	-4	-3.2%	0.4	✓
	Jamison Rd (W) to Mulgoa Rd (N)	W-NE	EB <-- L	86	615	74	74	0	0.0%	0.0	✓
	ALL					**3271**	**3304**	**-33**	**-1.0%**	**0.6**	✓
Batt St	Mulgoa Rd (N) to Mulgoa Rd (S)	NE-SW	SB ^ T	421	421	782	786	-4	-0.5%	0.1	✓
	Mulgoa Rd (N) to Batt St	NE-SE	SB <-- L	489	487	150	154	-4	-2.6%	0.3	✓
	Batt St to Mulgoa Rd (N)	SE-NE	WB --> R	488	465	87	88	-1	-1.1%	0.1	✓
	Batt St to Mulgoa Rd (S)	SE-SW	WB <-- L	488	421	181	178	3	1.7%	0.2	✓
	Mulgoa Rd (S) to Batt St	SW-SE	NB --> R	490	487	434	437	-3	-0.7%	0.1	✓
	Mulgoa Rd (S) to Mulgoa Rd (N)	SW-NE	NB ^ T	465	465	1650	1681	-31	-1.8%	0.8	✓
	ALL					**3284**	**3324**	**-40**	**-1.2%**	**0.7**	✓
Blaikie Rd	Mulgoa Rd (N) to Blaikie Rd (W)	NE-NW	SB --> R	431	430	66	64	2	3.1%	0.2	✓
	Mulgoa Rd (N) to Mulgoa Rd (S)	NE-SW	SB ^ T	421	421	881	888	-7	-0.8%	0.2	✓
	Mulgoa Rd (N) to Blaikie Rd (E)	NE-SE	SB <-- L	434	432	20	20	0	0.0%	0.0	✓
	Blaikie Rd (E) to Mulgoa Rd (N)	SE-NE	WB --> R	531	465	10	13	-3	-23.1%	0.9	✓
	Blaikie Rd (E) to Blaikie Rd (W)	SE-NW	WB ^ T	531	430	0	0	0	0.0%	0.0	✓
	Blaikie Rd (E) to Mulgoa Rd (S)	SE-SW	WB <-- L	531	421	13	14	-1	-7.1%	0.3	✓
	Mulgoa Rd (S) to Mulgoa Rd (N)	SW-NE	NB ^ T	465	465	2041	2083	-42	-2.0%	0.9	✓
	Mulgoa Rd (S) to Blaikie Rd (W)	SW-NW	NB <-- L	465	430	106	107	-1	-0.9%	0.1	✓
	Blaikie Rd (W) to Mulgoa Rd (S)	NW-SW	EB --> R	429	421	44	43	1	2.3%	0.2	✓
	Blaikie Rd (W) to Blaikie Rd (E)	NW-SE	EB ^ T	429	432	14	13	1	7.7%	0.3	✓
	Blaikie Rd (W) to Mulgoa Rd (N)	NW-NE	EB <-- L	429	465	46	54	-8	-14.8%	1.1	✓
	ALL					**3241**	**3299**	**-58**	**-1.8%**	**1.0**	✓
Wolseley St / Harvey Norman	Mulgoa Rd (N) - Mouase Hole to Wolseley St	NE-SW	SB --> R	443	446	116	115	1	0.9%	0.1	✓
	Mulgoa Rd (N) to Mulgoa Rd (S)	NE-SW	SB ^ T	421	421	1116	1090	26	2.4%	0.8	✓
	Mulgoa Rd (S) to Mulgoa Rd (N)	SW-NE	NB ^ T	465	465	2226	2233	-7	-0.3%	0.1	✓
	Mulgoa Rd (S) to Wolseley St	SW-SW	NB <-- L	442	446	142	144	-2	-1.4%	0.2	✓
	Wolseley St to Mulgoa Rd (S)	W-SW	EB --> R	439	421	51	48	3	6.3%	0.4	✓
	Wolseley St to Mulgoa Rd (N)	W-NE	EB <-- L	439	465	51	51	0	0.0%	0.0	✓
	ALL					**3702**	**3681**	**21**	**0.6%**	**0.3**	✓
Mulgoa Road / M4 EB Off Load Ramp	Mulgoa Rd (N) to Mulgoa Rd (S)	NE-SW	SB ^ T	421	532	658	640	18	2.8%	0.7	✓
	Mulgoa Rd (N) to M4 EB On Ramp	NE-SE	SB <-- L	463	466	516	482	34	7.1%	1.5	✓
	Mulgoa Rd (S) to M4 EB On Ramp	SW-SE	NB --> R	613	466	436	397	39	9.8%	1.9	✓
	Mulgoa Rd (S) to Mulgoa Rd (N)	SW-NE	NB ^ T	425	465	1648	1650	-2	-0.1%	0.0	✓
	M4 EB Off Ramp to Mulgoa Rd (S)	NW-SW	EB --> R	459	532	227	237	-10	-4.2%	0.7	✓
	M4 EB Off Ramp to Mulgoa Rd (N)	NW-NE	EB <-- L	458	465	731	804	-73	-9.1%	2.6	✓
	ALL					**4216**	**4210**	**6**	**0.1%**	**0.1**	✓
Mulgoa Road / M4 WB Off Load Ramp	Mulgoa Rd (N) to M4 WB On Ramp	NE-NW	SB --> R	611	451	205	206	-1	-0.5%	0.1	✓
	Mulgoa Rd (N) to Glenmore Pway	NE-SW	SB ^ T	532	533	677	656	21	3.2%	0.8	✓
	M4 WB Off Ramp to Mulgoa Rd (N)	SE-NE	WB --> R	471	425	702	728	-26	-3.6%	1.0	✓
	M4 WB Off Ramp to Glenmore Pway	SE-SW	WB <-- L	472	533	138	141	-3	-2.1%	0.3	✓
	Mulgoa Rd (S) to Mulgoa Rd (N)	SW-NE	NB ^ T	425	425	1384	1319	65	4.9%	1.8	✓
	Mulgoa Rd (S) to M4 WB On Ramp	SW-NW	NB <-- L	469	451	267	263	4	1.5%	0.2	✓
	ALL					**3373**	**3313**	**60**	**1.8%**	**1.0**	✓
Glenmore Pway	Mulgoa Rd (N) to Mulgoa Rd (S)	NE-NW	SB ^ T	533	481	269	273	-4	-1.6%	0.3	✓
	Mulgoa Rd (N) to Glenmore Pway	NE-S	SB <-- L	533	533	436	425	11	2.5%	0.5	✓
	Glenmore Pway to Mulgoa Rd (N)	S-E	WB --> R	478	468	1182	1168	14	1.2%	0.4	✓
	Glenmore Pway to Mulgoa Rd (S)	S-NW	WB <-- L	478	481	21	24	-3	-10.8%	0.5	✓
	Mulgoa Rd (S) to Glenmore Pway	NW-S	NB --> R	479	533	44	44	0	0.0%	0.0	✓
	Mulgoa Rd (S) to Mulgoa Rd (N)	NW-E	NB ^ T	479	468	493	488	5	1.0%	0.2	✓
	ALL					**2445**	**2422**	**23**	**0.9%**	**0.5**	✓

Appendix A-1 AM Peak Turn Count Calibration

Description		Direction	Movement	Links From	Links To	Volume Model	Volume Count	Volume Mod-Cn	Volume % Diff*	GEH	Accept
Andrews Road Roundabout	Castlereagh Rd (N) to Old Castlereagh Rd	NE-NW	SB --> R	510	506	23	22	1	4.5%	0.2	✓
	Castlereagh Rd (N) to Castlereagh Rd (S)	NE-S	SB ^ T	510	36	647	656	-9	-1.4%	0.4	✓
	Castlereagh Rd (N) to Andrews Rd	NE-E	SB <-- L	510	512	94	93	1	1.1%	0.1	✓
	Andrews Rd to Castlereagh Rd (N)	E-NE	WB --> R	515	511	163	163	0	0.0%	0.0	✓
	Andrews Rd to Old Castlereagh Rd	E-NW	WB ^ T	515	506	16	16	0	0.0%	0.0	✓
	Andrews Rd to Castlereagh Rd (S)	E-S	WB <-- L	515	36	288	317	-29	-9.1%	1.7	✓
	Castlereagh Rd (S) to Andrews Rd	S-E	NB --> R	517	512	442	439	3	0.7%	0.1	✓
	Castlereagh Rd (S) to Castlereagh Rd (N)	S-NE	NB ^ T	517	511	768	767	1	0.1%	0.0	✓
	Castlereagh Rd (S) to Old Castlereagh Rd	S-NW	NB <-- L	517	506	4	4	0	0.0%	0.0	✓
	Old Castlereagh Rd to Castlereagh Rd (S)	W-S	EB --> R	508	36	26	31	-5	-16.1%	0.9	✓
	Old Castlereagh Rd to Andrews Rd	W-E	EB ^ T	508	512	54	54	0	0.0%	0.0	✓
	Old Castlereagh Rd to Castlereagh Rd (N)	W-NE	EB <-- L	508	511	51	51	0	0.0%	0.0	✓
		ALL				**2576**	**2613**	**-37**	**-1.4%**	**0.7**	✓
Jack Williams Dr	Castlereagh Rd (N) to Jack Williams Dr	N-W	SB --> R	499	496	18	17	1	5.9%	0.2	✓
	Castlereagh Rd (N) to Castlereagh Rd (S)	N-S	SB ^ T	518	518	1090	1053	37	3.5%	1.1	✓
	Castlereagh Rd (S) to Castlereagh Rd (N)	S-N	NB ^ T	38	38	1188	1159	29	2.5%	0.8	✓
	Castlereagh Rd (S) to Jack Williams Dr	S-W	NB <-- L	497	496	196	194	2	1.0%	0.1	✓
	Jack Williams Dr to Castlereagh Rd (S)	W-S	EB --> R	491	518	331	330	1	0.3%	0.1	✓
	Jack Williams Dr to Castlereagh Rd (N)	W-N	EB <-- L	491	38	48	48	0	0.0%	0.0	✓
		ALL				**2870**	**2801**	**69**	**2.5%**	**1.3**	✓
Mullins Road / Coreen Avenue Roundat	Castlereagh Rd (N) to Mullins Rd	N-NW	SB --> R	518	240	42	41	1	2.4%	0.2	✓
	Castlereagh Rd (N) to Castlereagh Rd (S)	N-S	SB ^ T	518	35	1055	1032	23	2.2%	0.7	✓
	Castlereagh Rd (N) to Coreen Ave	N-SE	SB <-- L	518	238	326	324	2	0.6%	0.1	✓
	Coreen Ave to Castlereagh Rd (N)	SE-NE	WB --> R	239	38	236	237	-1	-0.4%	0.1	✓
	Coreen Ave to Mullins Rd	SE-NW	WB ^ T	239	240	53	53	0	0.0%	0.0	✓
	Coreen Ave to Castlereagh Rd (S)	SE-S	WB <-- L	239	35	217	225	-8	-3.6%	0.5	✓
	Castlereagh Rd (S) to Coreen Ave	S-SE	NB --> R	34	238	288	267	21	7.9%	1.3	✓
	Castlereagh Rd (S) to Castlereagh Rd (N)	S-NE	NB ^ T	34	38	1065	1049	16	1.5%	0.5	✓
	Castlereagh Rd (S) to Mullins Rd	S-NW	NB <-- L	34	240	42	40	2	5.0%	0.3	✓
	Mullins Rd to Castlereagh Rd (S)	NW-S	EB --> R	241	35	30	31	-1	-3.2%	0.2	✓
	Mullins Rd to Coreen Ave	NW-SE	EB ^ T	241	238	78	79	-1	-1.3%	0.1	✓
	Mullins Rd to Castlereagh Rd (N)	NW-NE	EB <-- L	241	38	77	77	0	0.0%	0.0	✓
		ALL				**3508**	**3455**	**53**	**1.5%**	**0.9**	✓
Castlereagh Rd/Peachtree Rd	Castlereagh Rd (N) to Peachtree Rd (W)	N-W	SB --> R	43	49	69	71	-2	-2.8%	0.2	✓
	Castlereagh Rd (N) to Castlereagh Rd (S)	N-S	SB ^ T	43	44	1192	1206	-14	-1.2%	0.4	✓
	Castlereagh Rd (N) to Peachtree Rd (E)	N-E	SB <-- L	43	53	25	26	-1	-3.8%	0.2	✓
	Peachtree Rd (E) to Castlereagh Rd (N)	E-N	SB <-- L	618	34	152	150	2	1.3%	0.2	✓
	Peachtree Rd (E) to Peachtree Rd (W)	E-W	SB <-- L	55	49	0	0	0	0.0%	0.0	✓
	Peachtree Rd (E) to Castlereagh Rd (S)	E-S	WB <-- L	55	44	235	241	-6	-2.5%	0.4	✓
	Castlereagh Rd (S) to Peachtree Rd (E)	S-E	WB <-- L	617	53	292	300	-8	-2.7%	0.5	✓
	Castlereagh Rd (S) to Castlereagh Rd (N)	S-N	NB ^ T	42	34	1128	1098	30	2.7%	0.9	✓
	Castlereagh Rd (S) to Peachtree Rd (W)	S-W	NB <-- L	42	49	140	138	2	1.4%	0.2	✓
	Peachtree Rd (W) to Castlereagh Rd (S)	W-S	EB --> R	48	44	140	140	0	0.0%	0.0	✓
	Peachtree Rd (W) to Peachtree Rd (E)	W-E	EB --> R	48	53	0	0	0	0.0%	0.0	✓
	Peachtree Rd (W) to Castlereagh Rd (N)	W-N	EB --> R	48	34	105	105	0	0.0%	0.0	✓
		ALL				**3477**	**3475**	**2**	**0.1%**	**0.0**	✓
Castlereagh Rd/Museum Drive	Castlereagh Rd (N) to Castlereagh Rd (S)	NE-SW	SB ^ T	37	39	1549	1604	-55	-3.4%	1.4	✓
	Castlereagh Rd (N) to Museum Dr	NE-SE	SB <-- L	37	65	11	9	2	22.2%	0.6	✓
	Museum Dr to Castlereagh Rd (N)	SE-NE	WB --> R	64	42	17	17	0	0.0%	0.0	✓
	Museum Dr to Castlereagh Rd (S)	SE-SW	WB <-- L	64	39	27	23	4	17.4%	0.8	✓
	Castlereagh Rd (S) to Museum Dr	SW-SE	NB --> R	41	65	7	6	1	16.7%	0.4	✓
	Castlereagh Rd (S) to Castlereagh Rd (N)	SW-NE	NB ^ T	41	42	1549	1516	33	2.2%	0.8	✓
		ALL				**3161**	**3175**	**-14**	**-0.4%**	**0.2**	✓
Castlereagh Rd/Jane St	Castlereagh Rd (N) to Castlereagh Rd (S)	N-SW	SB ^ T	74	80	1326	1318	8	0.6%	0.2	✓
	Castlereagh Rd (N) to Jane St	N-E	SB <-- L	107	78	243	241	2	0.8%	0.1	✓
	Jane St to Castlereagh Rd (N)	E-N	WB --> R	76	40	377	380	-3	-0.8%	0.2	✓
	Jane St to Castlereagh Rd (S)	E-SW	WB <-- L	77	80	265	271	-6	-2.2%	0.4	✓
	Castlereagh Rd (S) to Jane St	SW-E	NB --> R	7	78	126	129	-3	-2.3%	0.3	✓
	Castlereagh Rd (S) to Castlereagh Rd (N)	SW-N	NB ^ T	7	40	1186	1179	7	0.6%	0.2	✓
		ALL				**3523**	**3518**	**5**	**0.1%**	**0.1**	✓
GWH/Castlereagh Rd/Henry St/Mulgoa	Castlereagh Rd (N) to Great Western Hway	NE-NW	SB --> R	80	5	544	551	-7	-1.3%	0.3	✓
	Castlereagh Rd (N) to Mulgoa Rd (S)	NE-S	SB ^ T	80	85	977	952	25	2.6%	0.8	✓
	Castlereagh Rd (N) to High St	NE-SE	SB <-- L	80	23	64	67	-3	-4.5%	0.4	✓
	High St to Castlereagh Rd (N)	SE-NE	WB --> R	31	7	195	197	-2	-1.0%	0.1	✓
	High St to Great Western Hway	SE-NW	WB ^ T	31	5	647	642	5	0.8%	0.2	✓
	High St to Mulgoa Rd (S)	SE-S	WB <-- L	31	85	73	78	-5	-6.4%	0.6	✓
	Mulgoa Rd (S) to High St	S-SE	NB --> R	88	23	51	51	0	0.0%	0.0	✓
	Mulgoa Rd (S) to Castlereagh Rd (N)	S-NE	NB ^ T	89	7	631	614	17	2.8%	0.7	✓
	Mulgoa Rd (S) to Great Western Hway	S-NW	NB <-- L	104	5	211	213	-2	-0.9%	0.1	✓
	Great Western Hway to Mulgoa Rd (S)	NW-S	EB --> R	102	85	146	160	-14	-8.8%	1.1	✓
	Great Western Hway to High St	NW-SE	EB ^ T	82	23	244	240	4	1.7%	0.3	✓
	Great Western Hway to Castlereagh Rd (N)	NW-NE	EB <-- L	82	7	486	481	5	1.0%	0.2	✓
		ALL				**4269**	**4246**	**23**	**0.5%**	**0.4**	✓
Union Rd	Mulgoa Rd (N) to Mulgoa Rd (S)	N-S	SB ^ T	90	90	1102	1102	0	0.0%	0.0	✓
	Mulgoa Rd (N) to Union Rd	N-E	SB <-- L	90	95	95	96	-1	-1.0%	0.1	✓
	Union Rd to Mulgoa Rd (S)	E-S	WB <-- L	96	90	237	241	-4	-1.7%	0.3	✓
	Mulgoa Rd (S) to Union Rd	S-E	NB --> R	93	95	141	139	2	1.4%	0.2	✓
	Mulgoa Rd (S) to Mulgoa Rd (N)	S-N	NB ^ T	93	92	903	919	-16	-1.7%	0.5	✓
		ALL				**2478**	**2497**	**-19**	**-0.8%**	**0.4**	✓
Mulgoa Rd/Ransley St	Mulgoa Rd (N) to Ransley St (W)	N-NW	SB --> R	10	15	32	36	-4	-11.1%	0.7	✓
	Mulgoa Rd (N) to Mulgoa Rd (S)	N-S	SB ^ T	10	12	1227	1234	-7	-0.6%	0.2	✓
	Mulgoa Rd (N) to Ransley St (E)	N-E	SB <-- L	10	17	73	76	-3	-3.9%	0.3	✓
	Ransley St (E) to Mulgoa Rd (N)	E-N	WB --> R	16	8	92	97	-5	-5.2%	0.5	✓
	Ransley St (E) to Ransley St (W)	E-NW	WB ^ T	16	15	43	44	-1	-2.3%	0.2	✓
	Ransley St (E) to Mulgoa Rd (S)	E-S	WB <-- L	16	12	84	83	1	1.2%	0.1	✓
	Mulgoa Rd (S) to Ransley St (E)	S-E	NB --> R	11	17	88	82	6	7.3%	0.7	✓
	Mulgoa Rd (S) to Mulgoa Rd (N)	S-N	NB ^ T	11	8	898	940	-42	-4.5%	1.4	✓
	Mulgoa Rd (S) to Ransley St (W)	S-NW	NB <-- L	11	15	11	10	1	10.0%	0.3	✓
	Ransley St (W) to Mulgoa Rd (S)	NW-S	EB --> R	14	12	20	21	-1	-4.8%	0.2	✓
	Ransley St (W) to Ransley St (E)	NW-E	EB ^ T	14	17	29	30	-1	-3.3%	0.2	✓
	Ransley St (W) to Mulgoa Rd (N)	NW-N	EB <-- L	14	8	53	56	-3	-5.4%	0.4	✓
		ALL				**2651**	**2673**	**-22**	**-0.8%**	**0.4**	✓
Mulgoa Rd/Panther Pl	Mulgoa Rd (N) to Panther Pl	NE-NW	SB --> R	190	194	58	62	-4	-6.5%	0.5	✓
	Mulgoa Rd (N) to Mulgoa Rd (S)	NE-SW	SB ^ T	190	193	1265	1261	4	0.3%	0.1	✓
	Mulgoa Rd (S) to Mulgoa Rd (N)	SW-NE	NB ^ T	422	13	946	991	-45	-4.5%	1.4	✓
	Mulgoa Rd (S) to Panther Pl	SW-NW	NB <-- L	422	194	166	155	11	7.1%	0.9	✓
	Panther Pl to Mulgoa Rd (S)	NW-SW	EB --> R	195	193	148	154	-6	-3.9%	0.5	✓
	Panther Pl to Mulgoa Rd (N)	NW-NE	EB <-- L	195	13	41	44	-3	-6.8%	0.5	✓
		ALL				**2625**	**2667**	**-42**	**-1.6%**	**0.8**	✓
Jamison Rd	Mulgoa Rd (N) to Jamison Rd (W)	NE-W	SB --> R	418	419	126	132	-6	-4.5%	0.5	✓
	Mulgoa Rd (N) to Mulgoa Rd (S)	NE-SW	SB ^ T	193	614	1073	1098	-25	-2.3%	0.8	✓
	Mulgoa Rd (N) to Jamison Rd (E)	NE-E	SB <-- L	193	420	217	211	6	2.8%	0.4	✓
	Jamison Rd (E) to Mulgoa Rd (N)	E-NE	WB --> R	427	615	117	125	-8	-6.4%	0.7	✓
	Jamison Rd (E) to Jamison Rd (W)	E-W	WB ^ T	426	419	177	178	-1	-0.6%	0.1	✓
	Jamison Rd (E) to Mulgoa Rd (S)	E-SW	WB <-- L	426	614	471	469	2	0.4%	0.1	✓
	Mulgoa Rd (S) to Jamison Rd (E)	SW-E	NB --> R	423	420	355	341	14	4.1%	0.8	✓
	Mulgoa Rd (S) to Mulgoa Rd (N)	SW-NE	NB ^ T	192	615	942	960	-18	-1.9%	0.6	✓
	Mulgoa Rd (S) to Jamison Rd (W)	SW-W	NB <-- L	192	419	31	27	4	14.8%	0.7	✓
	Jamison Rd (W) to Mulgoa Rd (S)	W-SW	EB --> R	417	614	33	35	-2	-5.7%	0.3	✓
	Jamison Rd (W) to Jamison Rd (E)	W-E	EB ^ T	86	420	94	94	0	0.0%	0.0	✓
	Jamison Rd (W) to Mulgoa Rd (N)	W-NE	EB <-- L	86	615	59	59	0	0.0%	0.0	✓
		ALL				**3696**	**3729**	**-33**	**-0.9%**	**0.5**	✓
Batt St	Mulgoa Rd (N) to Mulgoa Rd (S)	NE-SW	SB ^ T	421	421	1479	1408	71	5.0%	1.9	✓
	Mulgoa Rd (N) to Batt St	NE-SE	SB <-- L	489	487	90	94	-4	-4.3%	0.4	✓
	Batt St to Mulgoa Rd (N)	SE-NE	WB --> R	488	465	142	150	-8	-5.3%	0.7	✓
	Batt St to Mulgoa Rd (S)	SE-SW	WB <-- L	488	421	483	484	-1	-0.2%	0.0	✓
	Mulgoa Rd (S) to Batt St	SW-SE	NB --> R	490	487	371	340	31	9.1%	1.6	✓
	Mulgoa Rd (S) to Mulgoa Rd (N)	SW-NE	NB ^ T	465	465	1177	1173	4	0.3%	0.1	✓
		ALL				**3743**	**3649**	**94**	**2.6%**	**1.5**	✓
Blaikie Rd	Mulgoa Rd (N) to Blaikie Rd (W)	NE-NW	SB --> R	431	430	180	178	2	1.1%	0.1	✓
	Mulgoa Rd (N) to Mulgoa Rd (S)	NE-SW	SB ^ T	421	421	1763	1746	17	1.0%	0.4	✓
	Mulgoa Rd (N) to Blaikie Rd (E)	NE-SE	SB <-- L	434	432	40	42	-2	-4.8%	0.3	✓
	Blaikie Rd (E) to Mulgoa Rd (N)	SE-NE	WB --> R	531	465	26	25	1	4.0%	0.2	✓
	Blaikie Rd (E) to Blaikie Rd (W)	SE-NW	WB ^ T	531	430	7	7	0	0.0%	0.0	✓
	Blaikie Rd (E) to Mulgoa Rd (S)	SE-SW	WB <-- L	531	421	44	43	1	2.3%	0.2	✓
	Mulgoa Rd (S) to Mulgoa Rd (N)	SW-NE	NB ^ T	465	465	1345	1333	12	0.9%	0.3	✓
	Mulgoa Rd (S) to Blaikie Rd (W)	SW-NW	NB <-- L	465	430	157	156	1	0.6%	0.1	✓
	Blaikie Rd (W) to Mulgoa Rd (S)	NW-SW	EB --> R	429	421	172	161	11	6.8%	0.9	✓
	Blaikie Rd (W) to Blaikie Rd (E)	NW-SE	EB ^ T	429	432	17	18	-1	-5.6%	0.2	✓
	Blaikie Rd (W) to Mulgoa Rd (N)	NW-NE	EB <-- L	429	465	163	167	-4	-2.4%	0.3	✓
		ALL				**3916**	**3876**	**40**	**1.0%**	**0.6**	✓
Wolseley St / Harvey Norman	Mulgoa Rd (N) - Mouase Hole to Wolseley St	NE-SW	SB --> R	443	446	169	168	1	0.6%	0.1	✓
	Mulgoa Rd (N) to Mulgoa Rd (S)	NE-SW	SB ^ T	421	421	2015	2058	-43	-2.1%	1.0	✓
	Mulgoa Rd (S) to Mulgoa Rd (N)	SW-NE	NB ^ T	465	465	1468	1461	7	0.5%	0.2	✓
	Mulgoa Rd (S) to Wolseley St	SW-SW	NB <-- L	442	446	209	203	6	3.0%	0.4	✓
	Wolseley St to Mulgoa Rd (S)	W-SW	EB --> R	439	421	308	298	10	3.4%	0.6	✓
	Wolseley St to Mulgoa Rd (N)	W-NE	EB <-- L	439	465	135	139	-4	-2.9%	0.3	✓
		ALL				**4303**	**4327**	**-24**	**-0.6%**	**0.4**	✓
Mulgoa Road / M4 EB Off Load Ramp	Mulgoa Rd (N) to Mulgoa Rd (S)	NE-SW	SB ^ T	421	532	1600	1602	-2	-0.1%	0.0	✓
	Mulgoa Rd (N) to M4 EB On Ramp	NE-SE	SB <-- L	463	466	720	723	-3	-0.4%	0.1	✓
	Mulgoa Rd (S) to M4 EB On Ramp	SW-SE	NB --> R	613	466	159	158	1	0.6%	0.1	✓
	Mulgoa Rd (S) to Mulgoa Rd (N)	SW-NE	NB ^ T	425	465	1343	1347	-4	-0.3%	0.1	✓
	M4 EB Off Ramp to Mulgoa Rd (S)	NW-SW	EB --> R	459	532	240	238	2	0.8%	0.1	✓
	M4 EB Off Ramp to Mulgoa Rd (N)	NW-NE	EB <-- L	458	465	336	336	0	0.0%	0.0	✓
		ALL				**4397**	**4404**	**-7**	**-0.2%**	**0.1**	✓
Mulgoa Road / M4 WB Off Load Ramp	Mulgoa Rd (N) to M4 WB On Ramp	NE-NW	SB --> R	611	451	633	632	1	0.2%	0.0	✓
	Mulgoa Rd (N) to Mulgoa Rd (S)	NE-SW	SB ^ T	532	533	1212	1204	8	0.7%	0.2	✓
	M4 WB Off Ramp to Mulgoa Rd (N)	SE-NE	WB --> R	471	425	829	841	-12	-1.4%	0.4	✓
	M4 WB Off Ramp to Mulgoa Rd (S)	SE-SW	WB <-- L	472	533	476	473	3	0.6%	0.1	✓
	Mulgoa Rd (S) to Mulgoa Rd (N)	SW-NE	NB ^ T	425	425	672	665	7	1.1%	0.3	✓
	Mulgoa Rd (S) to M4 WB On Ramp	SW-NW	NB <-- L	469	451	219	221	-2	-0.9%	0.1	✓
		ALL				**4040**	**4036**	**4**	**0.1%**	**0.1**	✓
Glenmore Pway	Mulgoa Rd (N) to Mulgoa Rd (S)	NE-NW	SB ^ T	533	481	399	414	-15	-3.6%	0.7	✓
	Mulgoa Rd (N) to Mulgoa Rd (S)	NE-S	SB <-- L	533	533	1204	1257	-53	-4.2%	1.5	✓
	Glenmore Pway to Mulgoa Rd (N)	S-E	WB --> R	478	468	572	605	-33	-5.5%	1.4	✓
	Glenmore Pway to Mulgoa Rd (S)	S-NW	WB <-- L	478	481	74	74	0	-0.2%	0.0	✓
	Mulgoa Rd (S) to Mulgoa Rd (S)	NW-S	NB --> R	479	533	49	50	-1	-2.0%	0.1	✓
	Mulgoa Rd (S) to Mulgoa Rd (N)	NW-E	NB ^ T	479	468	261	277	-16	-5.8%	1.0	✓
		ALL				**2560**	**2677**	**-117**	**-4.4%**	**2.3**	✓

Appendix A-2 PM Peak Turn Count Calibration

Table A-1 Queue Length Comparison between Observed and Modelled

Intersection	Control Type	Approach	AM (7.00-9.00)		PM (4.00-6.00)	
			Observed Queues	Modelled Queues	Survey Queues	Modelled Queues
Castlereagh Road / Andrews Road	Roundabout	N	0-10	1-3	2-8	3-5
		E	1-6	2-9	3-6	1
		S	0-9	0-1	2-15	1-2
		W	0-3	1	1-7	1
Castlereagh Road / Jack Williams Drive	Signal	N	0-8	0-3	0-6	1-2
		S	0-5	0-1	0-8	0-2
		W	0-5	0-1	0-8	0-3
Castlereagh Road / Coreen Avenue	Roundabout	N	2-19	3-17	2-15	1-4
		E	3-7	1-2	3-15	1-1
		S	4-12	1	6-13	3-4
		W	1-3	1	1-4	1-2
Mulgoa Road / Jane Street	Signal	N	2-30	5-28	0-30	0-30
		E	0-7	1-2	0-14	2-5
		S	0-19	4-5	0-9	2-3
Mulgoa Road / High Street / Great Western Highway	Signal	N	2-15	7-13	5-15	13-14
		E	0-4	0-3	0-13	0-7
		S	0-35	1-34	0-15	1-12
		W	0-11	3-6	0-12	2-3
Mulgoa Road / Union Road	Priority	E	0-2	1	2-10	1
		S	0-6	0-7	1-6	0-1
Mulgoa Road / Ransley Street	Signal	N	0-11	2-4	3-15	6-10
		E	0-5	1	0-14	2
		S	0-10	2-7	0-13	5-7
		W	0-2	0-2	0-4	2
Mulgoa Road / Panther Place	Signal	N	0-5	1	0-6	3-4
		S	0-4	0-14	0-4	0-6
		W	0-3	0-1	0-5	0-2
Mulgoa Road / Jamison Road	Signal	N	0-7	1-6	0-13	4-10
		E	0-6	2-3	0-12	2-7
		S	1-14	7-9	3-12	6-7
		W	0-4	2-3	0-4	1-2
Mulgoa Road / Batt Street	Signal	N	0-12	0-2	0-20	0-20
		E	0-6	4-5	0-11	5-10
		S	0-9	3-5	0-17	4-6
Mulgoa Road / Blaikie Road	Signal	N	0-10	1-3	0-16	0-11
		E	0-2	1	0-2	1
		S	0-10	0-7	0-15	5-8
		W	1-5	1	2-10	5-10
Mulgoa Road / Wolseley Street	Signal	N	0-9	1-1	2-14	4-9
		S	0-30	0-29	0-12	0-1
		W	0-2	2	1-12	4-5
Mulgoa Road / M4 Eastbound On-Off ramps	Signal	N	2-11	6-6	6-22	20-22
		E	-	-	-	-
		S	0-15	2-7	0-15	1
		W	0-25	3-24	0-17	2-6
Mulgoa Road / M4 Westbound On-Off ramps	Signal	N	0-7	1-3	0-6	1
		E	0-24	0-29	0-21	3-11
		S	1-40	10-38	0-10	2-3
		W	-	-	-	-
Mulgoa Road / Glenmore Parkway	Roundabout	NE	0-3	1	0-2	1
		S	3-21	16-17	2-11	0-1
		W	0-5	1	0-5	1

F:\AA008188\Traffic Modelling\VISSIM Models\2015 Base Models\Mulgoa Road_2015_AM_Base_TZ034_V4\Calibration\Compare Queue.xlsx

This analysis indicated that modelled queue lengths in AM and PM Peak are representative and adequately reflect existing traffic condition in the study area road network.

ARCADIS Design & Consultancy for natural and built assets

APPENDIX C

80% STRATEGIC CONCEPT DESIGN (RD0001-RD0012)

LEGEND

DESIGN	
PROPOSED BACK OF FOOTWAY	
CADASTRAL BOUNDARIES	
BRIDGE OR CULVERT	
PROPOSED CARRIAGEWAY	
PROPOSED MEDIAN	
PROPOSED BUS PRIORITY	
ALLUVIAL WOODLAND	
LOCAL AND STATE HERITAGE	
CONTAMINAITED SOIL	

ROAD UPGRADE

1. ONLY KEY UTILITIES AFFECTED ARE SHOWN ON PLAN. REFER UT4744 UTILITIES INVESTIGATION SURVEY INFORMATION ON MULGOA ROAD AND CASTEREAGH ROAD FOR MORE DETAILS.

2. DESIGN UPDATE SUBJECTS TO DESIGN CHANGE ON RELATIVE PROJECT (M4 SMART MOTORWAY AND JANE STREET PROJECT).

3. THE DESIGN ASSUMES ROAD DESIGN LEVEL TO BE RAISED ABOUT 0.5m AT ANDREWS ROAD INTERSECTION FOR FLOOD EVACUATION ROUTE AND NO CULVERTS OR OPEN DRAIN TO BE UPDATEED.

4. PROPERTY BOUNDARY ADDJUSTMENT MAY VARY WHILE BATTER IS CONSIDERED IN THE FOLLOWING CONCEPT DESIGN.

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SCALE 1:1000m

CO-ORDINATE SYSTEM: MGA ZONE 56
HEIGHT DATUM: AHD

DRAWINGS / DESIGN PREPARED BY
ROAD DESIGN ENGINEERING
Transport Roads & Maritime Services

PLOT DATE / TIME: 16/02/2016 3:08:57 PM
PLOT BY: SkatovA

TITLE	NAME	DATE
DRAWN	A. SKATOV	16/02/2016
DRG CHECK	A. SHAN	16/02/2016
DESIGN	A. SHAN	16/02/2016
DESIGN CHECK	B. CARTWRIGHT	16/02/2016
DESIGN MNGR	T. HUFTON	16/02/2016
PROJECT MNGR	M. D. ALLEN	16/02/2016

CLIENT
NSW GOVERNMENT Transport Roads & Maritime Services

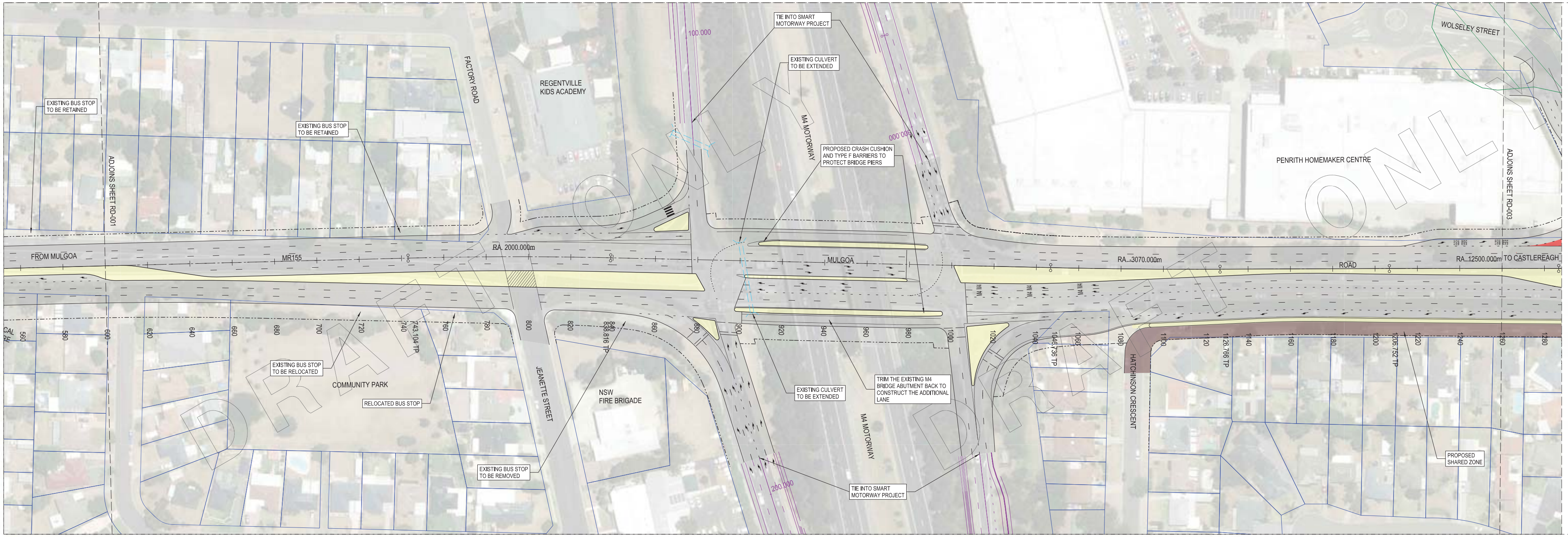
PREPARED FOR
INFRASTRUCTURE DEVELOPMENT
PROJECT DEVELOPMENT

PENRITH CITY COUNCIL
MR155 - MULGOA ROAD / MR630 - CASTLEREAGH ROAD
ROAD UPGRADE
BETWEEN GLENMORE PARKWAY AND ANDREWS ROAD
ROAD DESIGN PLAN
MR155 MULGOA ROAD - MC10 - 0m TO 600m

A4 x 4

RMS REGISTRATION No. DS2014 / 006410

ISSUE STATUS: STRATEGIC DESIGN
EDMS No.: SF2014/153104
SHEET No.: RD-0001



LEGEND	
DESIGN	
PROPOSED BACK OF FOOTWAY	
CADASTRAL BOUNDARIES	
BRIDGE OR CULVERT	
PROPOSED CARRIAGEWAY	
PROPOSED MEDIAN	
BUS PRIORITY	
PROPOSED SHARED ZONE	
ALLUVIAL WOODLAND	
LOCAL AND STATE HERITAGE	
CONTAMINAITED SOIL	

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SCALE 1:1000m

CO-ORDINATE SYSTEM: MGA ZONE 56
HEIGHT DATUM: AHD

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NSW GOVERNMENT Transport Roads & Maritime Services

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PLOT BY: SkatovA

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DRG CHECK	A. SHAN	16/02/2016
DESIGN	A. SHAN	16/02/2016
DESIGN CHECK	B. CARTWRIGHT	16/02/2016
DESIGN MNGR	T. HUFTON	16/02/2016
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CLIENT
NSW GOVERNMENT Transport Roads & Maritime Services

PREPARED FOR
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PROJECT DEVELOPMENT

PENRITH CITY COUNCIL
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ROAD UPGRADE
BETWEEN GLENMORE PARKWAY AND ANDREWS ROAD
ROAD DESIGN PLAN
MR155 MULGOA ROAD - MC10 - 600m TO 1260m

A4 x 4

RMS REGISTRATION No. DS2014 / 006410

ISSUE STATUS: STRATEGIC DESIGN
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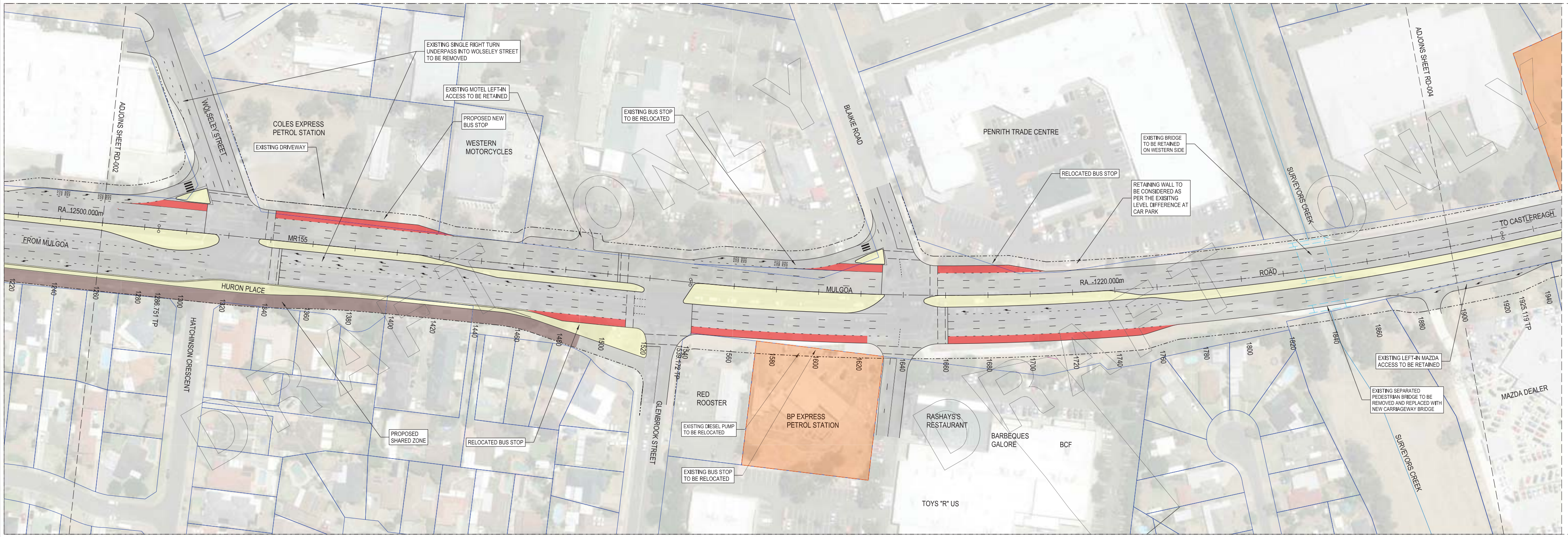

LEGEND

DESIGN	
PROPOSED BACK OF FOOTWAY	
CADASTRAL BOUNDARIES	
BRIDGE OR CULVERT	
PROPOSED CARRIAGEWAY	
PROPOSED MEDIAN	
BUS PRIORITY	
PROPOSED SHARED ZONE	
ALLUVIAL WOODLAND	
LOCAL AND STATE HERITAGE	
CONTAMINAITED SOIL	

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CO-ORDINATE SYSTEM: MGA ZONE 56 — HEIGHT DATUM: AHD

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DRG CHECK	A. SHAN	16/02/2016
DESIGN	A. SHAN	16/02/2016
DESIGN CHECK	B. CARTWRIGHT	16/02/2016
DESIGN MNGR	T. HUFTON	16/02/2016
PROJECT MNGR	M. D. ALLEN	16/02/2016

CLIENT: Transport Roads & Maritime Services, NSW Government

PREPARED FOR: INFRASTRUCTURE DEVELOPMENT PROJECT DEVELOPMENT

PENRITH CITY COUNCIL
MR155 - MULGOA ROAD / MR630 - CASTLEREAGH ROAD
ROAD UPGRADE
BETWEEN GLENMORE PARKWAY AND ANDREWS ROAD
ROAD DESIGN PLAN
MR155 MULGOA ROAD - MC10 - 1250m TO 1900m

A4 x 4

RMS REGISTRATION No. DS2014 / 006410

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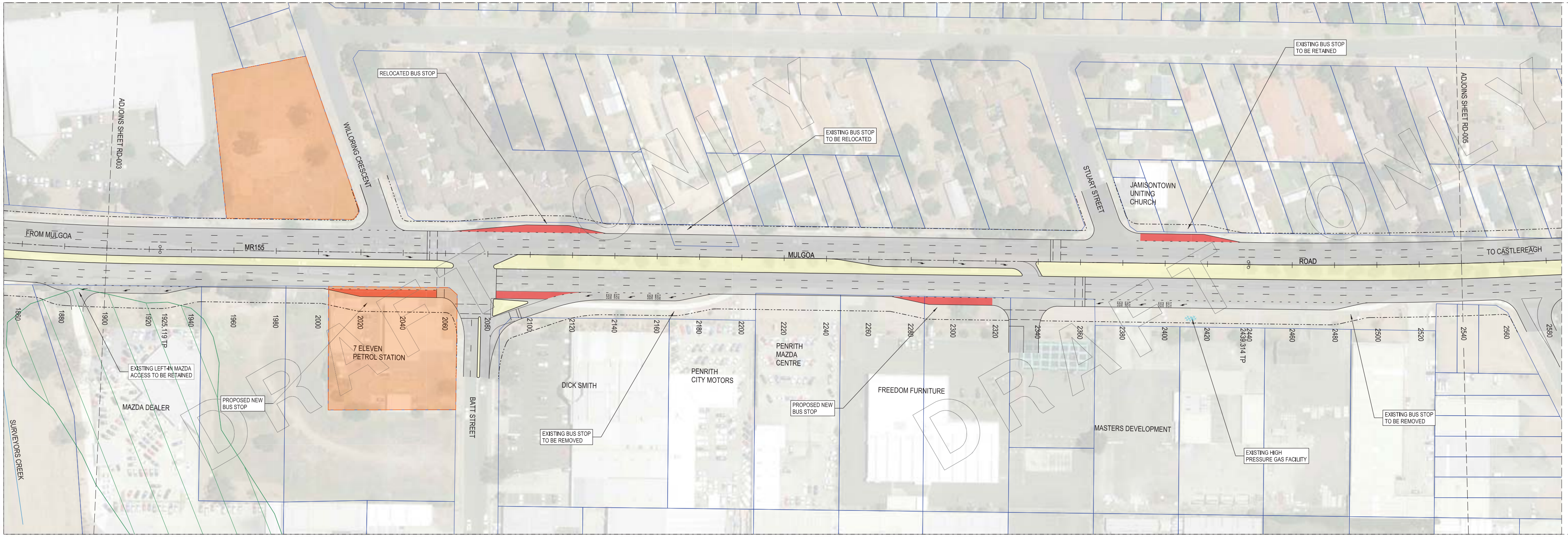

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LEGEND	
DESIGN	
PROPOSED BACK OF FOOTWAY	
CADASTRAL BOUNDARIES	
BRIDGE OR CULVERT	
PROPOSED CARRIAGEWAY	
PROPOSED MEDIAN	
PROPOSED BUS PRIORITY	
ALLUVIAL WOODLAND	
LOCAL AND STATE HERITAGE	
CONTAMINAITED SOIL	

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DRAWING FILE LOCATION / NAME
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EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	WVR No.	APPROVAL
XXXXXX	01	DD-MM-YY	ISSUED FOR XXXXX	XX	XXX

SCALES ON A4 x 4 SIZE DRAWING
0 10 20 30 40
SCALE 1:1000m

CO-ORDINATE SYSTEM: MGA ZONE 56
HEIGHT DATUM: AHD

DRAWINGS / DESIGN PREPARED BY: ROAD DESIGN ENGINEERING

PLOT DATE / TIME: 16/02/2016 3:09:31 PM
PLOT BY: SkatovA

TITLE	NAME	DATE
DRAWN	A. SKATOV	16/02/2016
DRG CHECK	A. SHAN	16/02/2016
DESIGN	A. SHAN	16/02/2016
DESIGN CHECK	B. CARTWRIGHT	16/02/2016
DESIGN MNGR	T. HUFTON	16/02/2016
PROJECT MNGR	M. D. ALLEN	16/02/2016

CLIENT: NSW GOVERNMENT Transport Roads & Maritime Services

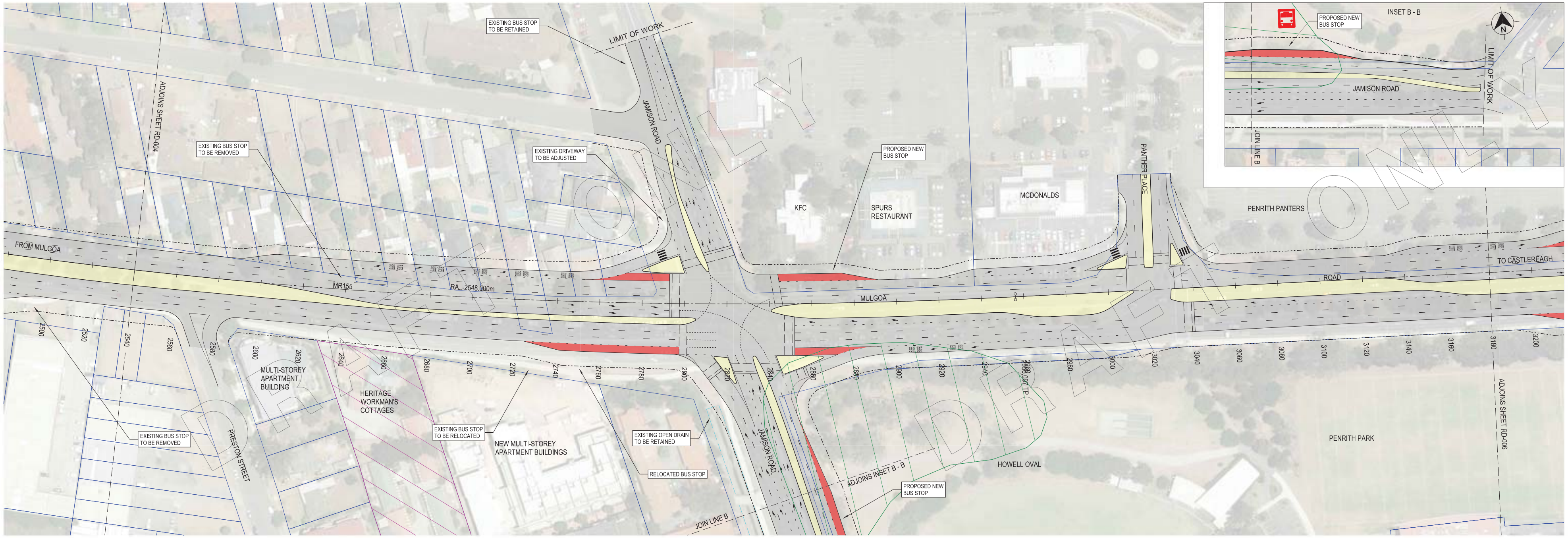
PREPARED FOR: INFRASTRUCTURE DEVELOPMENT PROJECT DEVELOPMENT

PENRITH CITY COUNCIL
MR155 - MULGOA ROAD / MR630 - CASTLEREAGH ROAD
ROAD UPGRADE
BETWEEN GLENMORE PARKWAY AND ANDREWS ROAD
ROAD DESIGN PLAN
MR155 MULGOA ROAD - MC10 - 1900m TO 2540m

A4 x 4

RMS REGISTRATION No. DS2014 / 006410

ISSUE STATUS: STRATEGIC DESIGN
EDMS No.: SF2014/153104
SHEET No.: RD-0004



LEGEND

DESIGN	
PROPOSED BACK OF FOOTWAY	
CADASTRAL BOUNDARIES	
BRIDGE OR CULVERT	
PROPOSED CARRIAGEWAY	
PROPOSED MEDIAN	
PROPOSED BUS PRIORITY	
ALLUVIAL WOODLAND	
LOCAL AND STATE HERITAGE	
CONTAMINAITED SOIL	

ROAD UPGRADE

1. ONLY KEY UTILITIES AFFECTED ARE SHOWN ON PLAN. REFER UT4744 UTILITIES INVESTIGATION SURVEY INFORMATION ON MULGOA ROAD AND CASTEREAGH ROAD FOR MORE DETAILS.

2. DESIGN UPDATE SUBJECTS TO DESIGN CHANGE ON RELATIVE PROJECT (M4 SMART MOTORWAY AND JANE STREET PROJECT).

3. THE DESIGN ASSUMES ROAD DESIGN LEVEL TO BE RAISED ABOUT 0.5m AT ANDREWS ROAD INTERSECTION FOR FLOOD EVACUATION ROUTE AND NO CULVERTS OR OPEN DRAIN TO BE UPDATEED.

4. PROPERTY BOUNDARY ADDJUSTMENT MAY VARY WHILE BATTER IS CONSIDERED IN THE FOLLOWING CONCEPT DESIGN.

NOT FOR CONSTRUCTION

ADVANCED COPY FOR 80% DESIGN REVIEW

TITLE	NAME	DATE
DRAWN	A. SKATOV	16/02/2016
DRG CHECK	A. SHAN	16/02/2016
DESIGN	A. SHAN	16/02/2016
DESIGN CHECK	B. CARTWRIGHT	16/02/2016
DESIGN MNGR	T. HUFTON	16/02/2016
PROJECT MNGR	M. D. ALLEN	16/02/2016

PLOT DATE / TIME 16/02/2016 3:09:40 PM — PLOT BY SkatovA

DRAWINGS / DESIGN PREPARED BY: ROAD DESIGN ENGINEERING

COORDINATE SYSTEM: MGA ZONE 56 — HEIGHT DATUM: AHD

CLIENT: Transport Roads & Maritime Services

PREPARED FOR: INFRASTRUCTURE DEVELOPMENT PROJECT DEVELOPMENT

PENRITH CITY COUNCIL
MR155 - MULGOA ROAD / MR630 - CASTLEREAGH ROAD
ROAD UPGRADE
BETWEEN GLENMORE PARKWAY AND ANDREWS ROAD
ROAD DESIGN PLAN
MR155 MULGOA ROAD - MC10 - 2540m TO 3180m

A4 x 4

RMS REGISTRATION No. DS2014 / 006410

ISSUE STATUS: STRATEGIC DESIGN — EDMS No. SF2014/153104 — SHEET No. RD-0005

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EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	ISSUE No.	APPROVAL
XXXXXX	01	DD-MM-YY	ISSUED FOR XXXXX	XX	XXX

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COORDINATE SYSTEM: MGA ZONE 56 | HEIGHT DATUM: AHD

DRAWINGS / DESIGN PREPARED BY: ROAD DESIGN ENGINEERING

Transport Roads & Maritime Services

PLOT DATE - TIME	PLOT BY
16/02/2016 3:05:55 PM	Skatov4

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TITLE		
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DES CHECK	A. SHAN	16/02/2016
DESIGN	A. SHAN	16/02/2016
DESIGN CHECK	B. CARTWRIGHT	16/02/2016
DESIGN MNGR	T. HUPTON	16/02/2016
PROJECT MNGR	M. O. ALLEN	16/02/2016

CLIENT: NSW GOVERNMENT Transport Roads & Maritime Services

PREPARED FOR: INFRASTRUCTURE DEVELOPMENT PROJECT DEVELOPMENT

PENRITH CITY COUNCIL
MR155 - MULGOA ROAD / MR630 - CASTLEREAGH ROAD
ROAD UPGRADE
BETWEEN GLENMORE PARKWAY AND ANDREWS ROAD
ROAD DESIGN PLAN
MR155 MULGOA ROAD - MC10 - 3180m TO 3860m

A4 x 4

RMS REGISTRATION No.: DS2014 / 006410

WBS CODE	SHEET No.
STRATEGIC DESIGN	RD-0006

DRAWING No.
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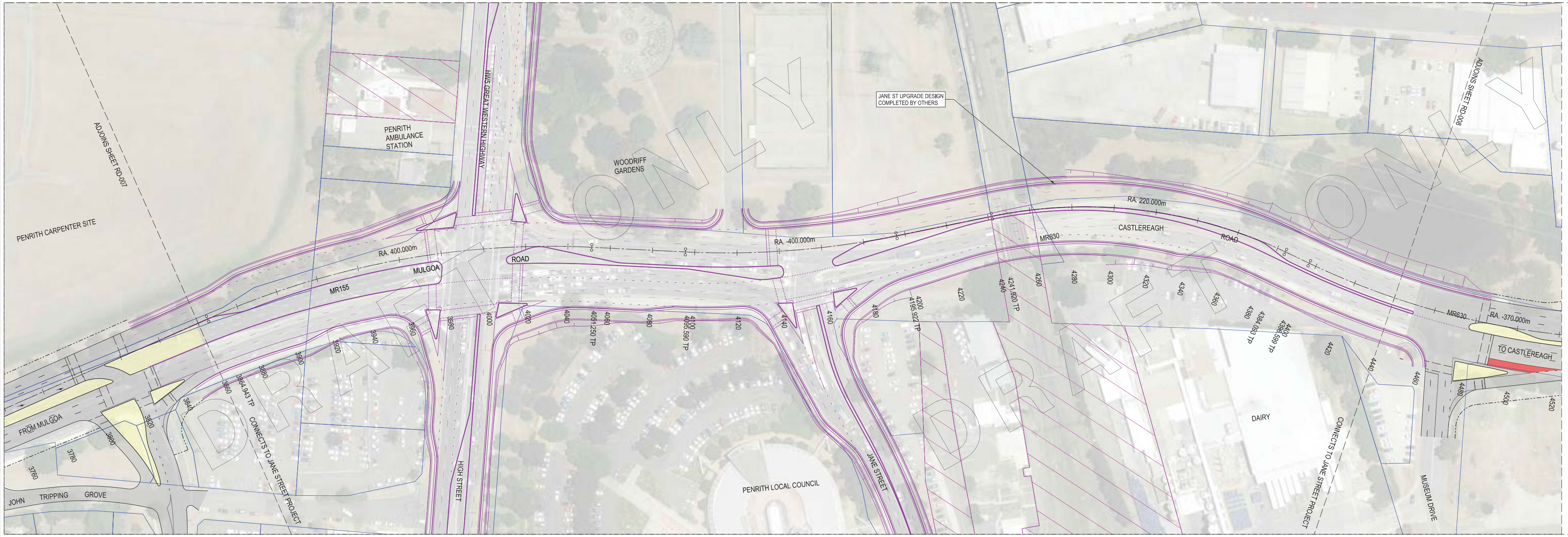

LEGEND

LEGEND
DESIGN
PROPOSED BACK OF FOOTWAY
CADASTRAL BOUNDARIES
BRIDGE OR CULVERT
PROPOSED CARRIAGEWAY
PROPOSED MEDIAN
BUS PRIORITY
JANE ST UPGRADE DESIGN
ALLUVIAL WOODLAND
LOCAL AND STATE HERITAGE
CONTAMINAITED SOIL

ROAD UPGRADE

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EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	WVR No.	APPROVAL
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SCALE 1:1000m
CO-ORDINATE SYSTEM: MGA ZONE 56
HEIGHT DATUM: AHD

DRAWINGS / DESIGN PREPARED BY
ROAD DESIGN ENGINEERING
NSW GOVERNMENT Transport Roads & Maritime Services

PLOT DATE / TIME: 16/02/2016 3:10:05 PM
PLOT BY: SkatovA

TITLE	NAME	DATE
DRAWN	A. SKATOV	16/02/2016
DRG CHECK	A. SHAN	16/02/2016
DESIGN	A. SHAN	16/02/2016
DESIGN CHECK	B. CARTWRIGHT	16/02/2016
DESIGN MNGR	T. HUFTON	16/02/2016
PROJECT MNGR	M. D. ALLEN	16/02/2016

CLIENT
NSW GOVERNMENT Transport Roads & Maritime Services

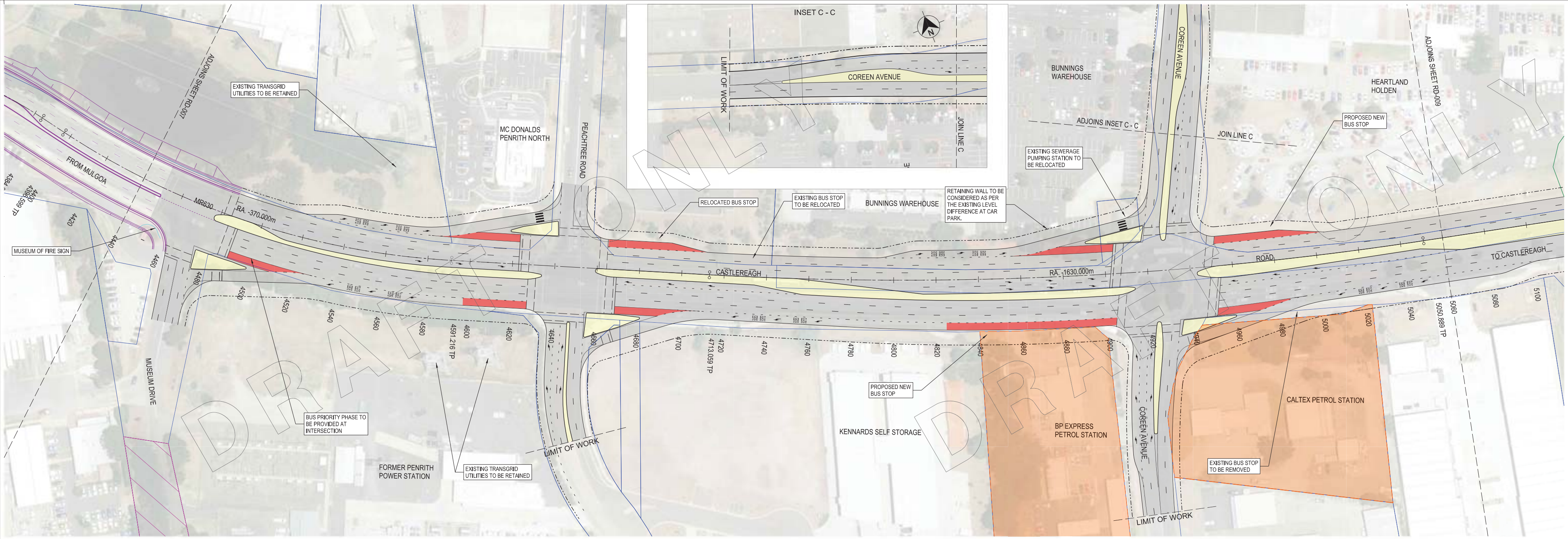
PREPARED FOR
INFRASTRUCTURE DEVELOPMENT
PROJECT DEVELOPMENT

PENRITH CITY COUNCIL
MR155 - MULGOA ROAD / MR630 - CASTLEREAGH ROAD
ROAD UPGRADE
BETWEEN GLENMORE PARKWAY AND ANDREWS ROAD
ROAD DESIGN PLAN
MR155 MULGOA ROAD - MC10 - 3860m TO 4440m

A4 x 4

RMS REGISTRATION No. DS2014 / 006410

ISSUE STATUS	EDMS No.	SHEET No.
STRATEGIC DESIGN	SF2014/153104	RD-0007



LEGEND

DESIGN	
PROPOSED BACK OF FOOTWAY	
CADASTRAL BOUNDARIES	
BRIDGE OR CULVERT	
PROPOSED CARRIAGEWAY	
PROPOSED MEDIAN	
BUS PRIORITY	
JANE ST UPGRADE DESIGN	
ALLUVIAL WOODLAND	
LOCAL AND STATE HERITAGE	
CONTAMINAITED SOIL	

ROAD UPGRADE

1. ONLY KEY UTILITIES AFFECTED ARE SHOWN ON PLAN. REFER UT4744 UTILITIES INVESTIGATION SURVEY INFORMATION ON MULGOA ROAD AND CASTEREAGH ROAD FOR MORE DETAILS.

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EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	WVR No.	APPROVAL
XXXXXX	01	DD-MM-YY	ISSUED FOR XXXXX	XX	XXX

SCALES ON A4 x 4 SIZE DRAWING
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SCALE 1:1000m

CO-ORDINATE SYSTEM: MGA ZONE 56
HEIGHT DATUM: AHD

DRAWINGS / DESIGN PREPARED BY: ROAD DESIGN ENGINEERING
NSW GOVERNMENT Transport Roads & Maritime Services

PLOT DATE / TIME: 16/02/2016 3:10:15 PM
PLOT BY: SkatovA

TITLE	NAME	DATE
DRAWN	A. SKATOV	16/02/2016
DRG CHECK	A. SHAN	16/02/2016
DESIGN	A. SHAN	16/02/2016
DESIGN CHECK	B. CARTWRIGHT	16/02/2016
DESIGN MNGR	T. HUFTON	16/02/2016
PROJECT MNGR	M. D. ALLEN	16/02/2016

CLIENT: NSW GOVERNMENT Transport Roads & Maritime Services

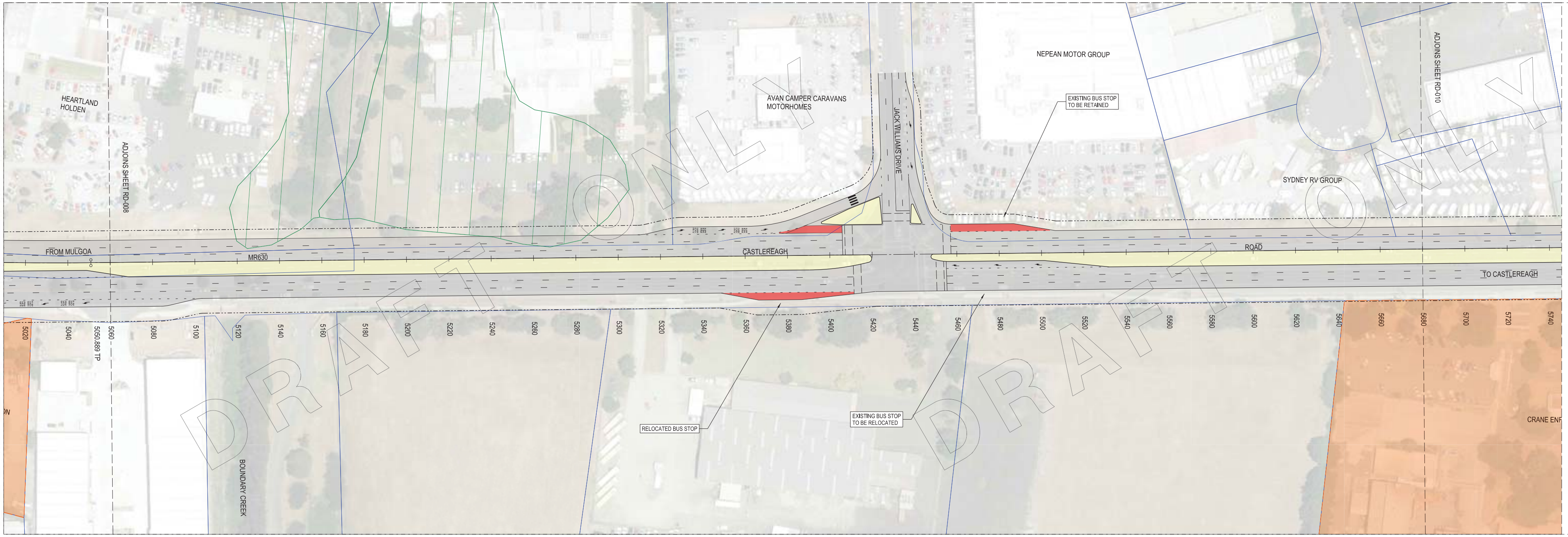
PREPARED FOR: INFRASTRUCTURE DEVELOPMENT PROJECT DEVELOPMENT

PENRITH CITY COUNCIL
MR155 - MULGOA ROAD / MR630 - CASTLEREAGH ROAD
ROAD UPGRADE
BETWEEN GLENMORE PARKWAY AND ANDREWS ROAD
ROAD DESIGN PLAN
MR155 MULGOA ROAD - MC10 - 4440m TO 5060m

A4 x 4

RMS REGISTRATION No. DS2014 / 006410

ISSUE STATUS	EDMS No.	SHEET No.
STRATEGIC DESIGN	SF2014/153104	RD-0008



LEGEND

DESIGN	
PROPOSED BACK OF FOOTWAY	
CADASTRAL BOUNDARIES	
BRIDGE OR CULVERT	
PROPOSED CARRIAGEWAY	
PROPOSED MEDIAN	
PROPOSED BUS PRIORITY	
ALLUVIAL WOODLAND	
LOCAL AND STATE HERITAGE	
CONTAMINAITED SOIL	

ROAD UPGRADE

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EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	WVR No.	APPROVAL
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SCALES ON A4 x 4 SIZE DRAWING: 0 10 20 30 40 SCALE 1:1000m

CO-ORDINATE SYSTEM: MGA ZONE 56 — HEIGHT DATUM: AHD

DRAWINGS / DESIGN PREPARED BY: ROAD DESIGN ENGINEERING — NSW GOVERNMENT Transport Roads & Maritime Services

PLOT DATE / TIME: 16/02/2016 3:10:30 PM — PLOT BY: SkatovA

TITLE	NAME	DATE
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DRG CHECK	A. SHAN	16/02/2016
DESIGN	A. SHAN	16/02/2016
DESIGN CHECK	B. CARTWRIGHT	16/02/2016
DESIGN MNGR	T. HUFTON	16/02/2016
PROJECT MNGR	M. D. ALLEN	16/02/2016

CLIENT: NSW GOVERNMENT Transport Roads & Maritime Services

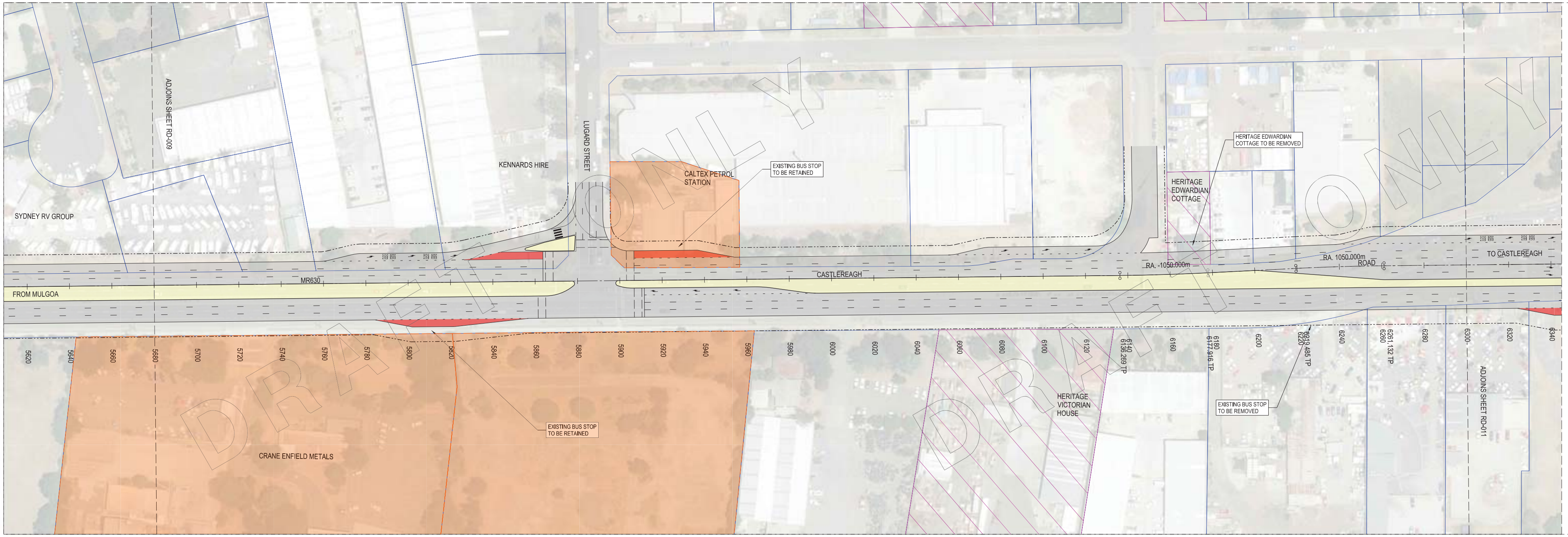
PREPARED FOR: INFRASTRUCTURE DEVELOPMENT PROJECT DEVELOPMENT

PENRITH CITY COUNCIL
MR155 - MULGOA ROAD / MR630 - CASTLEREAGH ROAD
ROAD UPGRADE
BETWEEN GLENMORE PARKWAY AND ANDREWS ROAD
ROAD DESIGN PLAN
MR155 MULGOA ROAD - MC10 - 5060m TO 5680m

A4 x 4

RMS REGISTRATION No. DS2014 / 006410

ISSUE STATUS: STRATEGIC DESIGN — EDMS No. SF2014/153104 — SHEET No. RD-0009



LEGEND

DESIGN	
PROPOSED BACK OF FOOTWAY	
CADASTRAL BOUNDARIES	
BRIDGE OR CULVERT	
PROPOSED CARRIAGEWAY	
PROPOSED MEDIAN	
PROPOSED BUS PRIORITY	
ALLUVIAL WOODLAND	
LOCAL AND STATE HERITAGE	
CONTAMINAITED SOIL	

ROAD UPGRADE

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DRAWING FILE LOCATION / NAME
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EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	WVR No.	APPROVAL
XXXXXX	01	DD-MM-YY	ISSUED FOR XXXXX	XX	XXX

SCALES ON A4 x 4 SIZE DRAWING
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SCALE 1:1000m

CO-ORDINATE SYSTEM: MGA ZONE 56
HEIGHT DATUM: AHD

DRAWINGS / DESIGN PREPARED BY: ROAD DESIGN ENGINEERING
NSW GOVERNMENT Transport Roads & Maritime Services

PLOT DATE / TIME: 16/02/2016 3:10:39 PM
PLOT BY: SkatovA

TITLE	NAME	DATE
DRAWN	A. SKATOV	16/02/2016
DRG CHECK	A. SHAN	16/02/2016
DESIGN	A. SHAN	16/02/2016
DESIGN CHECK	B. CARTWRIGHT	16/02/2016
DESIGN MNGR	T. HUFTON	16/02/2016
PROJECT MNGR	M. D. ALLEN	16/02/2016

CLIENT: NSW GOVERNMENT Transport Roads & Maritime Services

PREPARED FOR: INFRASTRUCTURE DEVELOPMENT PROJECT DEVELOPMENT

PENRITH CITY COUNCIL
MR155 - MULGOA ROAD / MR630 - CASTLEREAGH ROAD
ROAD UPGRADE
BETWEEN GLENMORE PARKWAY AND ANDREWS ROAD
ROAD DESIGN PLAN
MR155 MULGOA ROAD - MC10 - 5680m TO 6300m

A4 x 4

RMS REGISTRATION No. DS2014 / 006410

ISSUE STATUS: STRATEGIC DESIGN
EDMS No. SF2014/153104
SHEET No. RD-0010

LEGEND

DESIGN	
PROPOSED BACK OF FOOTWAY	
CADASTRAL BOUNDARIES	
BRIDGE OR CULVERT	
PROPOSED CARRIAGEWAY	
PROPOSED MEDIAN	
PROPOSED BUS PRIORITY	
ALLUVIAL WOODLAND	
LOCAL AND STATE HERITAGE	
CONTAMINAITED SOIL	

ROAD UPGRADE

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DRAWING FILE LOCATION / NAME
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EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	WVR No.	APPROVAL
XXXXXX	01	DD-MM-YY	ISSUED FOR XXXXX	XX	XXX

SCALES ON A4 x 4 SIZE DRAWING
0 10 20 30 40
SCALE 1:1000m

CO-ORDINATE SYSTEM: MGA ZONE 56
HEIGHT DATUM: AHD

DRAWINGS / DESIGN PREPARED BY
ROAD DESIGN ENGINEERING
Transport Roads & Maritime Services

PLOT DATE / TIME: 16/02/2016 3:10:47 PM
PLOT BY: SkatovA

TITLE	NAME	DATE
DRAWN	A. SKATOV	16/02/2016
DRG CHECK	A. SHAN	16/02/2016
DESIGN	A. SHAN	16/02/2016
DESIGN CHECK	B. CARTWRIGHT	16/02/2016
DESIGN MNGR	T. HUFTON	16/02/2016
PROJECT MNGR	M. D. ALLEN	16/02/2016

CLIENT
Transport Roads & Maritime Services

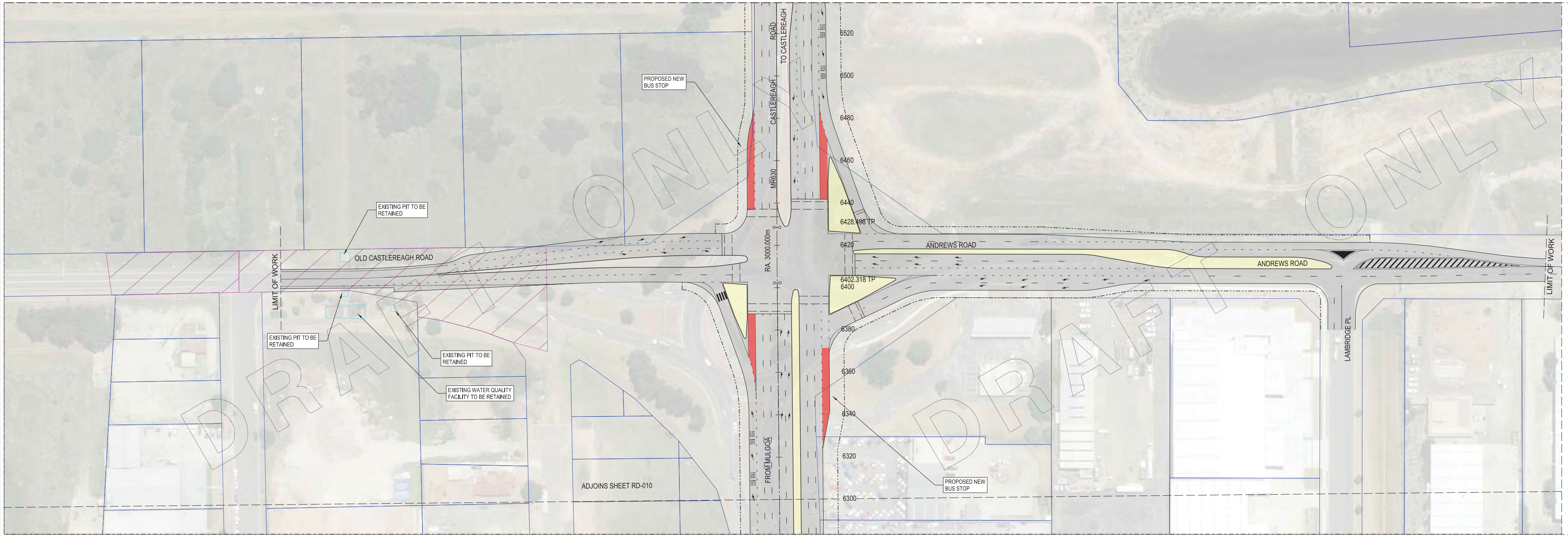
PREPARED FOR
INFRASTRUCTURE DEVELOPMENT
PROJECT DEVELOPMENT

PENRITH CITY COUNCIL
MR155 - MULGOA ROAD / MR630 - CASTLEREAGH ROAD
ROAD UPGRADE
BETWEEN GLENMORE PARKWAY AND ANDREWS ROAD
ROAD DESIGN PLAN
MR155 MULGOA ROAD - MC10 - 6300m TO 6820m

A4 x 4

RMS REGISTRATION No. DS2014 / 006410

ISSUE STATUS: STRATEGIC DESIGN
EDMS No.: SF2014/153104
SHEET No.: RD-0011



LEGEND

DESIGN	
PROPOSED BACK OF FOOTWAY	
CADASTRAL BOUNDARIES	
BRIDGE OR CULVERT	
PROPOSED CARRIAGEWAY	
PROPOSED MEDIAN	
PROPOSED BUS PRIORITY	
ALLUVIAL WOODLAND	
LOCAL AND STATE HERITAGE	
CONTAMINAITED SOIL	

ROAD UPGRADE

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EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	WVR No.	APPROVAL
XXXXXX	01	DD-MM-YY	ISSUED FOR XXXXX	XX	XXX

SCALES ON A4 x 4 SIZE DRAWING
0 10 20 30 40
SCALE 1:1000m

CO-ORDINATE SYSTEM: MGA ZONE 56
HEIGHT DATUM: AHD

DRAWINGS / DESIGN PREPARED BY
ROAD DESIGN ENGINEERING
NSW GOVERNMENT Transport Roads & Maritime Services

PLOT DATE / TIME: 16/02/2016 3:10:57 PM
PLOT BY: SkatovA

TITLE	NAME	DATE
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DRG CHECK	A. SHAN	16/02/2016
DESIGN	A. SHAN	16/02/2016
DESIGN CHECK	B. CARTWRIGHT	16/02/2016
DESIGN MNGR	T. HUFTON	16/02/2016
PROJECT MNGR	M. D. ALLEN	16/02/2016

CLIENT
NSW GOVERNMENT Transport Roads & Maritime Services

PREPARED FOR
INFRASTRUCTURE DEVELOPMENT
PROJECT DEVELOPMENT

PENRITH CITY COUNCIL
MR155 - MULGOA ROAD / MR630 - CASTLEREAGH ROAD
ROAD UPGRADE
BETWEEN GLENMORE PARKWAY AND ANDREWS ROAD
ROAD DESIGN PLAN
MR155 MULGOA ROAD - Andrews Rd Intersection

A4 x 4

RMS REGISTRATION No. DS2014 / 006410

ISSUE STATUS: STRATEGIC DESIGN
EDMS No.: SF2014/153104
SHEET No.: RD-0012