Roads and Maritime

Pacific Motorway Widening - Tuggerah to Doyalson

Traffic and Transport Report

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PARSONS BRINCKERHOFF

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Contents

Contents (Continued)

Page number

List of tables

List of figures

List of appendices

1. Introduction

Roads and Maritime proposes to widen the Pacific Motorway to six lanes between Wyong Road, Tuggerah and Doyalson Link Road, Doyalson. Parsons Brinckerhoff was commissioned by Roads and Maritime to undertake a traffic and transport impact assessment of the project options. Paramics microsimulation software was used to assess the traffic impacts. The modelling provides detailed input into the design and environmental assessment process to help quantify the benefits of the proposed upgrade options.

1.1 Background

The Pacific Motorway M1 (formally the F3) has recently undergone extensive upgrading so that there are currently six lanes between Wahroonga and Kariong. Roads and Maritime proposes to continue the road widening to include the section from Tuggerah to Doyalson.

There are a number of drivers for the Pacific Motorway widening project at both a strategic and local level. Whilst there is strong traffic growth predicted for this area, Roads and Maritime has indicated that a key driver for advancing the widening of this section of the Pacific Motorway is the current failure of the concrete pavement. As part of the pavement replacement program, Roads and Maritime has proposed to widen the road with a proposed opening year for modelling purposes of 2019. Traffic modelling has been conducted to inform Roads and Maritime of the performance of the various scenarios, the results of which are used to determine impacts and guide the design process.

Recent state-wide infrastructure improvements such as the expansion of the Pacific Motorway to six lanes to the south between Wahroonga and Kariong and the opening of the Hunter Expressway towards the north will continue to increase traffic levels on the Pacific Motorway. In addition strong population and employment growth within the Central Coast, as outlined in the *Central Coast Regional Strategy 2006–2031* and the *North Wyong Shire Structure Plan (NWSP)* will increase demand on the Pacific Motorway and at its interchanges with Wyong Road, Sparks Road and Doyalson Link Road. It is forecast that the population of the Central Coast could grow by 100,000 by 2031. If left unchecked the resulting congestion could affect the ability of the network to efficiently move traffic to, from and within the Central Coast.

Strategically, the growth of road-based freight is continuing to put pressure on the national network, with national truck traffic expected to grow by approximately 50% between 2010 and 2030 (*National Land Freight Strategy, Infrastructure Australia, 2011).* As a national freight link, the Pacific Motorway is likely to bear the full force of this increase, and therefore the upgrade is also important to serve the needs of freight on a national level.

1.2 Purpose and scope

The purpose of the assessment is to determine the traffic and transport impact and performance for two key design scenarios involving the widening of the Pacific Motorway. The final scenarios tested are as follows:

- Base case models – do nothing scenario
- Design 17E - Pacific Motorway widening to six lanes without north facing ramps at Doyalson Link Road
- Design 17F - Pacific Motorway widening to six lanes with north facing ramps at Doyalson Link Road.

The design scenarios were tested using the low growth scenario for the AM and PM peaks for the future years 2019, 2029, 2039, 2049.

1.2.1 Design development and assessment

During the project lifecycle the design has been iteratively updated following input from the traffic modelling conducted as part of this study. Therefore the originally assessed design differs from the scenarios outlined above. The original brief requested analysis of the following scenarios:

1. Base case models – do nothing scenario
2. Original design - Pacific Motorway widening to six lanes
3. Managed motorway – as per Original design with managed motorway components.

During the traffic modelling process it was identified that assessment of the managed motorway scenario would not be required as it does not provide a benefit to the motorway (refer to section 5.3.1). Therefore no further analysis of this option was conducted.

The original design scenario was tested for both high and low traffic growth in the AM and PM peaks for the future years 2019 (opening year), 2029, 2039 and 2049 with the base case also tested for 2013. This resulted in the creation of 34 traffic models.

The original design mentioned above was based on the Sparks Road Interchange which included a dual right turn arrangement for access to the northbound motorway. This arrangement resulted in severe congestion along Sparks Road and at the interchange. In consultation with Roads and Maritime, design solutions for this area (amongst others) were developed to address the identified issues. Therefore subsequent design options all included a northbound entry loop (g-loop) ramp design, which facilitated a more free-flowing entry from Sparks Road to the motorway travelling northbound.

1.2.2 Study area

The total length of the project is 12.3 km, with 11.3 km of motorway widening required. The study area includes the Pacific Motorway from 250 metres south of Tuggerah Interchange (Wyong Road) to 250 metres north of the Doyalson Link Road Interchange. Figure 1.1 shows the extent of the study area for the traffic modelling along the M1 corridor as well as the local area considered for future development.

The study area includes the following road sections:

- Pacific Motorway from 250 metres south of Tuggerah Interchange to 250 metres north of the Doyalson Link Road Interchange
- Sparks Road between Hue Hue Road and Burnet Road
- Service station access ramps on the east and west side of the Pacific Motorway (near St Johns Road bridge)
- Wyong Road between Tonkiss Street and Cobbs Road.

The study area includes the following general intersections:

- Wyong Road/Tonkiss Street/Woodbury Park Drive
- Sparks Road/Hue Hue Road
- Sparks Road/Burnet Road
- Sparks Road/Precinct 14 access road (proposed to be constructed by 2019 by others).

The study area includes the following motorway interchanges:

- Tuggerah Interchange (at Wyong Road)

- Freeway Service Centre Interchange (near St Johns Road bridge)
- Sparks Road Interchange
- Doyalson Link Road Interchange.

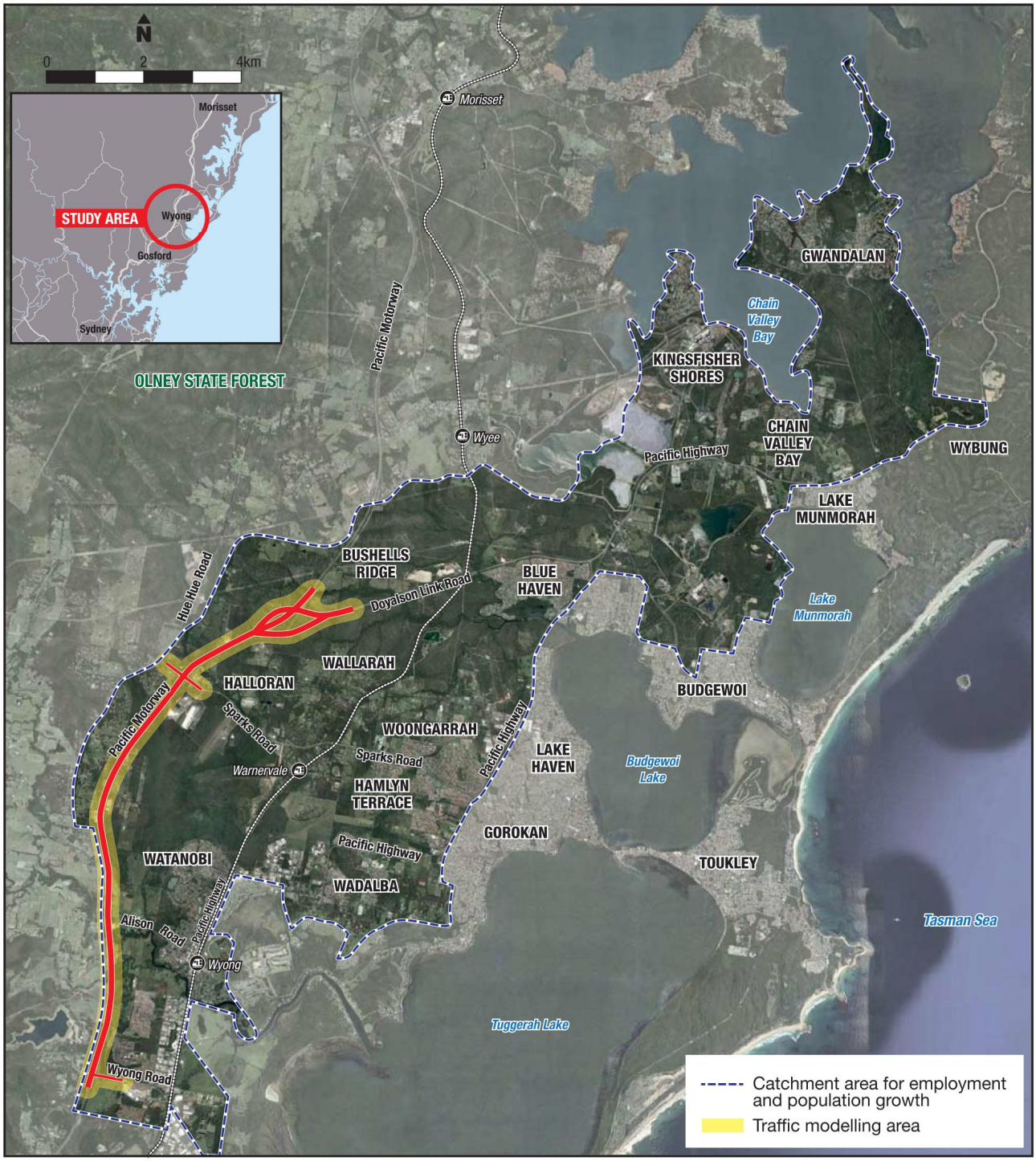


Figure 1.1 Study area

1.3 Report structure

The contents of this report are presented in the following sections:

- Section 2 describes the existing traffic and transport environment in the study area including the performance of the network
- Section 3 describes the base case model development and the validation and calibration process
- Section 4 outlines the traffic forecasting assumptions
- Section 5 describes the future year model development process including the tested motorway upgrade proposals
- Section 6 provides the results of the motorway modelling assessment
- Section 7 explains the crash analysis process and results
- Section 8 provides a summary of the impact of the proposal on traffic and transport within the study area.

1.4 Reviewed documents

Land use and traffic generation data used within the traffic modelling was gained from the following documents:

- Central Coast Regional Strategy 2006-2031, NSW Department of Planning, 2008
- North Wyong Shire Structure Plan, NSW Department of Planning and Infrastructure, October 2012
- Draft Wyong Local Environmental Plan (LEP) 2012, Wyong Shire Council
- Wyong Employment Zone Information Sheet, Wyong Shire Council, May 2010
- Concept Plan Warner Industrial Park and Adjoining Lands, Terrace Tower Group, October 2007
- Warner Industrial Park Preferred Project Report Concept Plan and Project Application - Precinct 14, Appendix 14, Traffic Assessment, Terrace Tower Group, May 2009.

To a lesser extent the following documents were also reviewed:

- Employment Land Development Program 2010, Central Coast Subregion, NSW Department of Planning and Infrastructure, May 2011
- M1 Wyong Interchange Modelling Report, Halcrow, November 2010
- Sparks Road/M1 Interchange – Paramics Modelling, SKM, April 2010.

No existing traffic models were provided.

2. Existing transport environment

2.1 Road network and performance

2.1.1 Road hierarchy

The existing road network within the vicinity of the study area consists of the Pacific Motorway, Wyong Road, Sparks Road, Doyalson Link Road, Burnet Road, Hue Hue Road and Service Station access roads which are further described below. Figure 2.1 shows a map of the surrounding road network.

Figure 2.1 Road network hierarchy

Pacific Motorway

The proposed upgrade of the Pacific Motorway is located between the Tuggerah Interchange and the Doyalson Link Road Interchange which provides a vital connection from Sydney to the Central Coast, Newcastle and Hunter regions of New South Wales. It also links with the New England and Pacific highways connecting northern NSW regional centres and Queensland.

It is classified as a national freeway as part of the AusLink National Network and under the development and maintenance responsibility of NSW Roads and Maritime. The existing Pacific Motorway within the study area provides a high standard alignment with a four lane divided road configuration and high speed driving conditions with a posted speed limit of 110 km/h. Access onto the motorway in the study area is via three interchanges at Wyong Road, Sparks Road and Doyalson Link Road. There are also on and off ramps from the twin service stations near St Johns Road Bridge, with access available to the northbound and southbound travel direction from the service station on the western and eastern side of the motorway respectively.

As a motorway, this road is designated as a B-double route and allows vehicles with a maximum vertical height clearance of 4.6 metres to operate without a permit. Vehicles above 4.6 metres can operate under permit issued by Roads and Maritime, with the bridges at Wyong Road, Sparks Road and Alison Road all capable of accommodating a 5.3 metre high vehicles.

Wyong Road

Wyong Road is classified as a State Road (SR 335) and a gazetted B-double route, linking the Pacific Motorway to the west and the township of Tuggerah to the east. It is a four-lane divided road with a posted speed limit of 70 km/h.

The Wyong Road Interchange (referred as Tuggerah Interchange in this report) has been recently upgraded. The southbound entry/exit ramps of the Pacific Motorway form a roundabout intersection with Wyong Road. A signalised T-junction and a new loop ramp have been provided for the northbound entry/exit ramps.

Sparks Road

Sparks Road runs generally in the east-west direction, linking Hue Hue Road to the west and the Pacific Highway to the east. It is a generally two-lane, two-way undivided road with a posted speed limit of 70 km/h. It forms a signalised intersection with the northbound entry/exit ramps of the Pacific Motorway and a priority controlled intersection at the southbound entry/exit ramps.

Sparks Road is a State Road (SR 509) between the western motorway ramps and the Pacific Highway and a regional road, under the care and control of Wyong Shire Council between the western ramps and Hue Hue Road. The road is gazetted for B-double operations between the western motorway ramps and Burnet Road.

Doyalson Link Road

Doyalson Link Road is classified as a State Road (SR 675) and a gazetted B-double route. The road provides a connection between the Pacific Motorway and the northern region of the Central Coast. It is generally, a two-lane, two-way undivided road with the exception of the interchange sections to/from the Pacific Motorway, where two travel lanes are provided for in each direction.

The Doyalson Link Road Interchange only provides a northbound exit ramp and southbound entry ramp to the Pacific Motorway. This road has a posted speed limit of 100 km/h between the motorway interchange and Blue Haven, where it reduces to 80 km/h.

Hue Hue Road

Hue Hue Road is a regional road which runs in a north-south direction, parallel to the western side of the Pacific Motorway in the study area. It is a two-lane, two-way undivided road with a posted speed limit of 80 km/h. Hue Hue Road forms a priority controlled T-junction with Sparks Road, west of the Sparks Road Interchange.

Burnet Road

Burnet Road is a local road which provides access to an industrial area containing major developments such as a Woolworths distribution centre and Pacific Beverages Brewery. It is a two-lane, two-way undivided road with a posted speed limit of 50 km/h. The intersection with Sparks road is a priority controlled T-junction with seagull layout for eastbound egressing traffic from Burnet Road.

Tonkiss Street

Tonkiss Street is a local road which provides access to the Tuggerah Westfield shopping centre and connects the Pacific Highway and Wyong Road via a residential area located to the south of Westfield. In the modelled area it is a four lane, two-way divided road with a posted speed limit of 60 km/h. The intersection with Wyong Road is a priority controlled dual lane roundabout, with Woodbury Park Drive providing the fourth (northern) leg.

Woodbury Park Drive

Woodbury Park Drive is a local road which provides access to the residential areas of Mardi located to the north of Wyong Road. It is a two lane, two-way undivided road which becomes four lane divided road on approach to Wyong Road. The road has a posted speed limit of 50 km/h. The intersection with Wyong Road is a priority controlled dual lane roundabout, with Tonkiss Street providing the fourth (southern) leg.

2.1.2 Traffic volumes

Existing traffic volumes in the area were collated from Roads and Maritime permanent and temporary counting stations as well as traffic counts conducted for this study. Traffic counts for this study were conducted in April and May 2013. The existing traffic volumes are provided in diagrammatic format in Appendix A.

Table 2.1 summarises the historical traffic data and the annual average traffic growth between 1992 and 2010.

Table 2.1 Historical AADT traffic volumes

Station No.	Location	AADT[1]										% Growth p.a.	
		1992	1995	1998	2001	2004	2007	2008	2010[1]	2012	2013	3 years 2007 to 2010	6 years 2004 to 2010
05.007	Pacific Motorway at Alison Road overpass, Alison	32746	39698	46413	52284	60093	61993	61754	65007	66500	69600	1.62%	1.36%
05.049	Wyong Road, east of Pacific Highway, Tuggerah	13547	26284	30223		35266		33706	37917			-	1.25%
05.161	Wyong Road, east of Pacific Motorway, Tuggerah	13466	19127	27848	31600	32973			25637			-	-3.71%
05.302	Doyalson Link Road west of Pacific Highway, Blue Haven	11678	10615	12240	14283	16130	16745	16502	17089			0.68%	0.99%

Source: Data extracted from the Roads and Maritime Traffic Volume Data, Hunter Region

(1) Average Daily Traffic (ADT) data was used for year 2010 as AADT data was not available

The data for the Pacific Motorway at Alison road points to a high level of growth in the early years between 1992 and 2004 with an average annual growth rate of 7.0%. This growth slows after 2004, with an average annual growth rate between 2004 and 2013 of 1.76%.

Table 2.1 indicates that:

- Traffic volume on the Pacific Motorway has increased at a per annum rate of 1.36% during the 6 years prior to 2010. Over the 3 years prior to 2010 the Pacific Motorway experienced a growth of 1.62% per annum.
- Over the 6 years prior to 2010, Wyong Road has seen traffic growth with an increase of 1.25% east of the Pacific Highway but traffic volume closer to the Pacific Motorway has decreased over the same period. This decrease in traffic volumes is most likely because of traffic redistribution in this area due to network upgrades (such as the Tuggerah Straight Pacific Highway Upgrade and the completion of the Tonkiss Street connection south of Tuggerah Westfield).
- Traffic volume on Doyalson Link Road has increased at a per annum rate of approximately 1% between 2004 and 2010.

2.1.3 Travel patterns

Referring to the existing traffic volumes in Appendix A, it can be seen that generally the traffic flows in the region are greatest between the Pacific Motorway and the developed areas towards the east. To the west of the motorway the traffic volumes are relatively small.

Overall the primary movements can be summarised as follows:

- On the Pacific Motorway the greatest volumes are seen at the southern end of the study area
- Generally the flows on the Pacific Motorway are greatest in the southbound direction in the AM and in the northbound direction in the PM. However south of the Tuggerah Interchange the southbound direction is still the most prominent in the PM.
- At Sparks Road the general traffic patterns show that the primary traffic flow is westbound along Sparks Road and then southbound onto the Pacific Motorway in the AM. In the PM the reverse of this is the primary movement. This would indicate that Sparks Road is currently used for access by the adjoining residential areas, with traffic volumes flowing out of the area in the AM and returning in the PM.
- At the Tuggerah Interchange general traffic patterns show that the primary traffic flow is southbound along the Pacific Motorway onto Wyong Road eastbound in the AM. In the PM the reverse of this is the primary movement. This would indicate that Wyong Road is currently used to access the adjoining commercial and industrial areas, with traffic volumes flowing into the area in the AM and leaving in the PM.
- Doyalson Link Road shows major movements southbound in the AM and northbound in the PM which shows that this road may be utilised by local residents traveling to workplaces located towards the south.

2.1.4 Travel speeds

Travel times for the Pacific Motorway section were provided by Roads and Maritime for the year 2012. The results are provided in Table 2.2 and show that existing travel speeds on the Pacific Motorway are approximately 12% below the posted speed limit of 110 km/h.

Table 2.2 Existing Pacific Motorway travel speeds

Time period	Direction	Average speed (km/h)
AM (6.00–10.00 am)	Northbound	96
AM (6.00–10.00 am)	Southbound	97
PM (3.00–7.00 pm)	Northbound	96
PM (3.00–7.00 pm)	Southbound	97

Source: Roads and Maritime

2.1.5 Intersection performance

The level of service of the existing intersections was calculated from the Paramics base model. The performance criteria used are outlined in Appendix B. The AM peak results are provided in Table 2.3 and the PM peak results are provided in Table 2.4.

For road links, level of service (LoS) is a qualitative measure describing operational conditions within a traffic stream, and the perception of motorists and/or passengers. It considers factors such as speed and travel

time, freedom to manoeuvre, traffic interruptions, comfort and convenience, and safety. There are six levels of service, designated from A to F, with LoS A representing the best operating condition and LoS F the worst.

According to the Roads and Maritime guidelines the overall intersection LoS is reported for the worst movement at unsignalised intersections Table 2.3 and Table 2.4 show the overall LoS as an average for the intersection approaches at signalised intersections and as the worst approach for unsignalised intersections. Further detail on the performance of each intersection approach is provided in Appendix G.

Overall it can be seen that most intersections in the study area provide a good level of service with a LoS of B for both AM and PM peak periods. Amongst the signalised intersections, only the Pacific Motorway/Sparks Road West Interchange operates at a LoS C during the PM peak. There are some intersection approaches that are beginning to show limitations in terms of performance, these are as follows:

- the Woodbury Park Road (northern) approach to the Wyong Road roundabout reaches LoS D in the AM peak. This is due to the significant traffic volumes travelling eastbound along Wyong Road, which limits the opportunity for traffic from the north to enter the roundabout
- the Pacific Motorway/Sparks Road West Interchange reaches LoS D at the southern approach for the AM and PM peaks
- the Pacific Motorway/Sparks Road East Interchange reaches LoS D at the northern approach for the AM and PM peaks.

Table 2.3 Existing intersection performance – AM peak

Intersection	LoS	Average delay (sec)
Woodbury Park Drive/Wyong Road/Tonkiss Street	D*	45
Pacific Motorway/Wyong Road East Interchange	C*	34
Pacific Motorway/Wyong Road West Interchange	B	17
Hue Hue Road/Sparks Road	B*	21
Pacific Motorway/Sparks Road West Interchange	B	28
Pacific Motorway/Sparks Road East Interchange	D*	48
Burnet Road/Sparks Road	D*	43

* LoS for these priority controlled intersections is determined based on the worst approach/movement

Table 2.4 Existing intersection performance – PM peak

Intersection	LoS	Average delay (sec)
Woodbury Park Drive/Wyong Road/Tonkiss Street	B*	22
Pacific Motorway/Wyong Road East Interchange	C*	30
Pacific Motorway/Wyong Road West Interchange	B	17
Hue Hue Road/Sparks Road	B*	18
Pacific Motorway/Sparks Road West Interchange	C	30
Pacific Motorway/Sparks Road East Interchange	D*	51
Burnet Road/Sparks Road	B*	21

* LoS for these priority controlled intersections is determined based on the worst approach/movement

2.1.6 Motorway performance

The level of service thresholds for a basic freeway segment and the performance criteria used to determine the level of service (LoS) are summarised in Appendix B.

The level of service of the Pacific Motorway was calculated using the link speed and traffic volume outputs from the Paramics base model and is provided in Table 2.5 for the AM peak and Table 2.6 for the PM peak. It can be seen that the Pacific Motorway predominantly operates between LoS B and C. The level of service results indicate that the motorway within the study area currently has adequate spare capacity, though this would change as traffic along the motorway continues to grow.

Table 2.5 Existing Pacific Motorway Level of Service – AM peak

Section	Time period	Direction	Link speed (km/h)	Link volume (pcu)	LOS
Pacific Motorway at Service Station	7.00–8.00	NB	103	1949	B
		SB	95	2907	C
	8.00–9.00	NB	107	1956	B
		SB	96	2992	C
Pacific Motorway at Sparks Road	7.00–8.00	NB	93	1547	B
		SB	101	2058	B
	8.00–9.00	NB	99	1542	B
		SB	102	2120	B

Table 2.6 Existing Pacific Motorway Level of Service – PM peak

Section	Time period	Direction	Link speed (km/h)	Link volume (pcu)	LOS
Pacific Motorway at Service Station	15.00–16.00	NB	101	2844	C
		SB	103	2382	C
	16.00–17.00	NB	104	2801	C
		SB	99	2345	C
Pacific Motorway at Sparks Road	15.00–16.00	NB	95	2023	B
		SB	104	1862	B
	16.00–17.00	NB	101	2048	B
		SB	102	1866	B

2.2 Land use

The Pacific Motorway in the study area passes from west of Wyong to north of Wallarah within the Wyong local government area. Some of the existing land uses in proximity to the Pacific Motorway include:

- the area surrounding the Pacific Motorway is predominately zoned environmental conservation and environmental management
- the existing land use in the Wyong/Tuggerah CBD area is a combination of residential, light industrial and a small amount of commercial and community facilities, which include the Tuggerah Westfield shopping centre
- low density residential is located on the western side of the Pacific Motorway between Alison Road and Sparks Road
- some industrial development exists within the future Wyong Employment Zone (WEZ) accessed via Warren Road and Burnet Road including the Woolworths distribution centre, located on the south-eastern corner of the Sparks Road Interchange.

Figure 2.2 shows the existing land use within the study area.

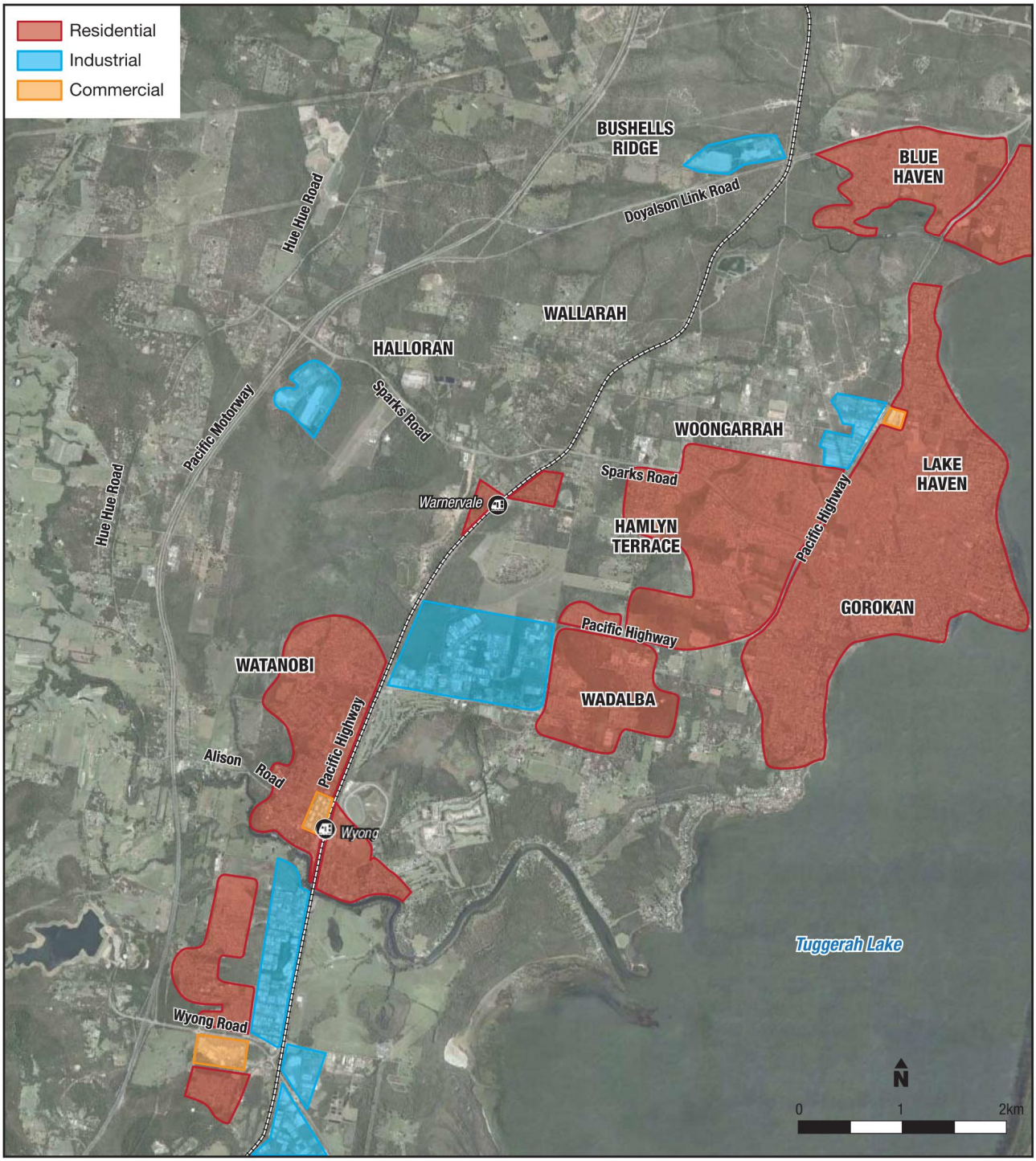


Figure 2.2 Existing land use

2.3 Mode share

A review of the 2011 Journey to Work (JTW) data available from the NSW Bureau of Transport Statistics (BTS) Transport Data Centre has been completed for the Wyong LGA to gain an understanding of existing resident commutes. This data has been summarised in Table 2.7 and indicates that 87.7% of resident trips to work are made by car, 4.4% by train, 2.0% by truck, 1.9% by walking, 1.5% by bus and the remaining 2.5% a combination of other modes. It is evident that car is the transport mode of choice in the region and is likely to remain so for the foreseeable future.

Table 2.7 Journey to work data for the Wyong LGA

Mode used to travel to work									Total
Car driver	Car passenger	Bus	Train	Motor bike	Bicycle	Walk	Truck	Other*	
39,832	3,441	625	1,117	276	142	934	984	866	48,217
80.7%	7.0%	1.5%	4.4%	0.6%	0.3%	1.9%	2.0%	1.8%	100%

* Other includes a combination of ferry, tram, taxi and other modes

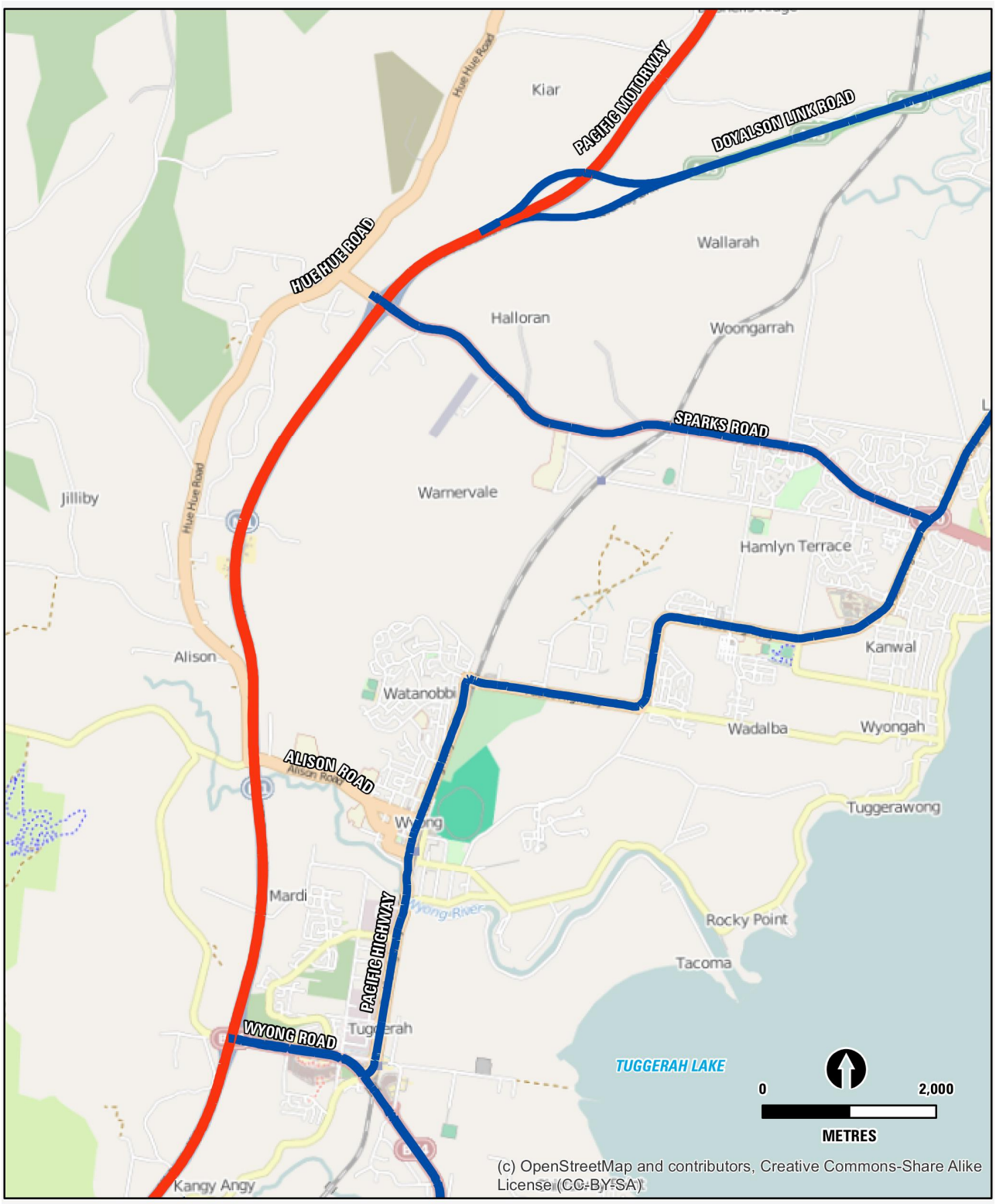
Source: BTS Transport Data Centre

2.4 Freight

Transport for NSW has defined the following road sections as freight routes located within the study area:

- Pacific Motorway – Primary freight route which serves the needs of freight for access interstate and to strategically important ports, airports, industrial areas, freight terminals and hubs within the Sydney, Newcastle and Wollongong area. This route typically carries high volumes of heavy freight vehicles (>4000 heavy vehicle AADT) and concentrations of road freight including high concentrations of live-haul, long distance and high capacity tucks.
- Wyong Road, Sparks Road, Pacific Highway and Doyalson Link Road – Tertiary freight routes which provide connection from the state road system to the primary freight routes. These routes serve the numerous major businesses and freight origins and destinations within a subregion and carry less than 2,000 heavy vehicles per day.

Figure 2.3 shows the existing freight network within the study area.



Source: Transport for NSW, Metropolitan Road Freight Hierarchy on the State Road Network Practise Note

Figure 2.3 Existing freight network

The existing percentage of heavy vehicles on the Pacific Motorway, Wyong Road, Sparks Road and Doyalson Link Road has been estimated during the peak hours based on the traffic survey data provided by Roads and Maritime (Refer to section 3.2). This data has been summarised in Table 2.8 and indicates the following:

- The percentage of heavy vehicles on the Pacific Motorway is currently between 7.7% in the PM peak and 13.6% in the AM peak, showing that the Pacific Motorway carries a higher percentage of heavy vehicles than other roads within the study area.
- Generally heavy vehicles enter the Pacific Motorway from Wyong Road in the AM peak hours and exit the Pacific Motorway to Wyong Road in the PM peak hours.
- The percentage of heavy vehicles on Sparks Road is between 5.5% in the AM peak and 8.8% in the PM peak. Generally, Sparks Road carries a greater percentage of heavy vehicles than Wyong Road as industrial developments are located adjacent to the Sparks Road Interchange. It is also noted that heavy vehicles perform U-turns at the Sparks Road Interchange to travel between the Hunter Region and Doyalson. This is because there are no north-facing ramps at the Doyalson Link Road Interchange.
- Generally heavy vehicles exit the Pacific Motorway to Doyalson Link Road in the AM peak hours and enter the Pacific Motorway from Doyalson Link Road in the PM peak hours.

Table 2.8 Current percentage of heavy vehicles

Roads	Section	Direction	% of Heavy vehicles	
			AM	PM
Pacific Motorway	North of Doyalson Link Road Interchange	Northbound	11.9%	11.6%
		Southbound	13.6%	10.8%
	At service station	Northbound	10.6%	7.8%
		Southbound	7.8%	8.6%
	South of Wyong Road Interchange	Northbound	10.2%	8.2%
		Southbound	9.9%	7.7%
Wyong Road	East of Wyong Road Interchange	Eastbound	5.4%	6.4%
		Westbound	8.2%	2.8%
Sparks Road	East of Sparks Road Interchange	Eastbound	8.8%	5.9%
		Westbound	7.3%	5.5%
	West of Sparks Road Interchange	Eastbound	8.7%	5.5%
		Westbound	7.9%	6.8%
Doyalson Link Road	West of Doyalson Link Road Interchange	Eastbound	11.3%	1.7%
		Westbound	5.2%	7.8%

2.5 Public transport

2.5.1 Rail

The main northern rail line, which runs between Sydney and Brisbane, lies just to the east of the study area. There are three stations adjacent the study area, Warnervale Station, Wyong Station and Tuggerah Station.

Warnervale is served every half hour in the AM and PM peaks and every hour in the off-peak, with services towards Newcastle and Gosford or Sydney.

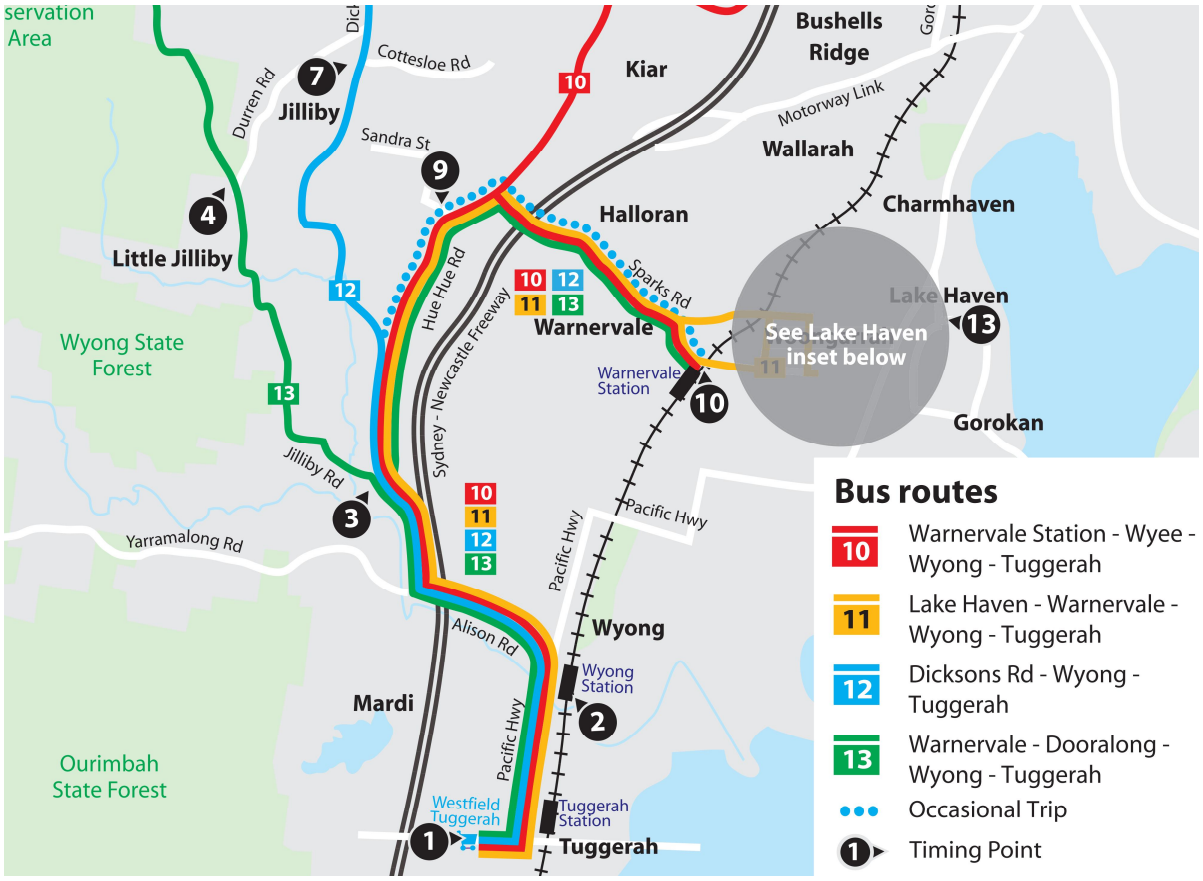
Wyong and Tuggerah Stations are serviced more frequently with services every 10–20 minutes in the AM and PM peaks and every half hour in the off-peak. These services operate towards Newcastle and Gosford or Sydney.

2.5.2 Bus

There are no bus routes that use the Pacific Motorway, however there are a number of services that utilise the adjacent road network in the study area, including several route services that cross (over or under) the motorway.

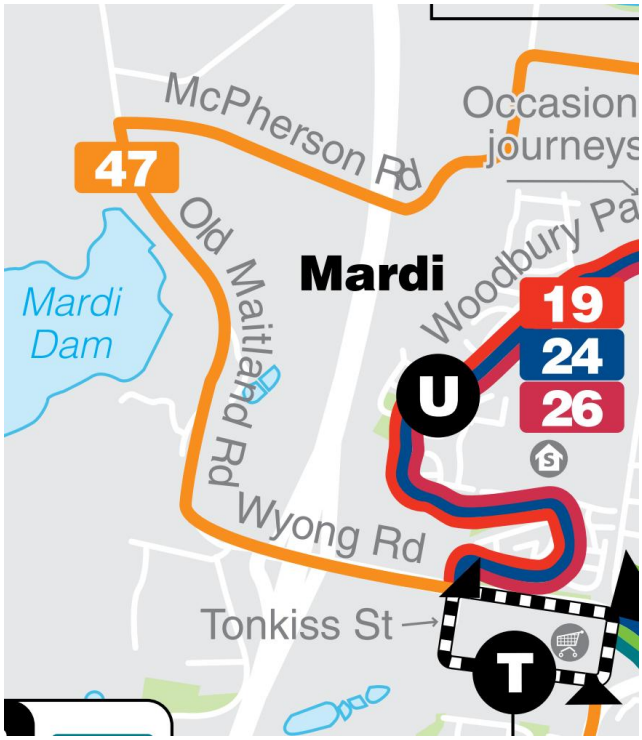
The following services use Wyong Road near the Pacific Motorway. These routes are operated by Red Bus Services and Coastal Liner:

- Routes 10, 11, 12, 13 all travel from the Westfield Tuggerah Interchange north along the Pacific Highway, Alison Road, Hue Hue Road and Sparks Road to Warnervale Rail Station. These routes are operated by Coastal Liner. Routes 10 and 11 each operate approximately four to five services per day in each direction. Routes 12 and 13 operate approximately six services per day in total.
- Route 47, operated by Red Bus travels along Old Maitland Road and Wyong Road to the Westfield Tuggerah Interchange. This route operates three to four services per day in each direction.
- Routes 19, 24, 26 operated by Coast Liner all cross Wyong Road at the Tonkiss Street/Woodbury Park Drive intersection to access the Westfield Tuggerah Interchange. Route 19 operates hourly in each direction throughout weekdays and the weekend. Route 24 operates sporadically in the AM and PM peak periods only. Route 26 operates half hourly in the AM and PM peaks and hourly throughout the rest of the day.



Source: Coastal Liner Services

Figure 2.4 Existing bus routes (Coastal Liner Services)



Source: Red Bus Services

Figure 2.5 Existing bus routes (Red Bus Services)

2.6 Pedestrian network

There is a minimal pedestrian network provided within the study area adjacent to the Pacific Motorway. This is due to a lack of adjacent development. There are currently no pedestrian crossings in the modelled area. The only pedestrian specific facilities are footpaths located on the northern side of the Sparks Road and Wyong Road overbridges. There are no footpaths connecting to these links however. Pedestrians would be required to use the road verges.

2.7 Cycle network

There is currently no designated cycle network or shared paths within the modelled study area. The cycle network in the study area consists primarily of the roadside shoulders with some marked cycle lanes provided on Sparks Road at the motorway interchange. Cyclists are permitted to use the shoulders of the Pacific Motorway. Cyclists can also use the shoulder facilities provided along Wyong Road, Sparks Road and Doyalson Link Road.

3. Base case model development

3.1 Modelling approach

The modelling tool Paramics microsimulation software (Version 6.9.3) has been used to deliver the required tasks for this project. Azalient plugin software (Version 6.9.0) was also incorporated into the modelling process.

Throughout the microsimulation modelling, Roads and Maritime Traffic *Modelling Guideline, Version 1, February 2013* was applied. This guideline is the most recent Roads and Maritime modelling guideline at the time of this report. However where the latest guideline does not address an area of the traffic modelling, the *RTA Paramics Microsimulation Modelling Manual* and *Design Manual for Roads and Bridges Volume 12 – Traffic Appraisal of Road Schemes (DMRB12)* are applied (e.g. Vehicle types, categories, configurations) has been used. The use of guidelines are discussed in the appropriate sections of this report.

3.1.1 Modelling time period

As agreed with Roads and Maritime, the traffic models were developed for the AM peak and PM peak for an average weekday condition. Paramics models were developed for the following time periods:

- AM peak: 07.00–09.00
- PM peak: 15.15–17.15.

Each model was also built with a 30 minute warm up period to ensure a good representation of traffic conditions at the beginning of the modelling period. In addition, a 30 minute cool down period was included to replicate the ‘clear out’ after the peak period.

3.1.2 Model network and zoning system

The study area includes the Pacific Motorway from 250 metres south of Tuggerah Interchange (Wyong Road) to 250 metres north of the Doyalson Link Road Interchange. Figure 3.1 shows the extent of the study area.

The study area includes the following intersections and motorway interchanges:

1. Wyong Road – Pacific Motorway (Tuggerah) Interchange
2. Service Station access road – Pacific Motorway (near St Johns Road bridge)
3. Sparks Road – Pacific Motorway Interchange
4. Wyong Road – Tonkiss Street
5. Hue Hue Road – Sparks Road
6. Sparks Road – Burnet Road.

The study area also includes the following road sections:

- Pacific Motorway from Tuggerah Interchange to Doyalson Link Road Interchange
- Sparks Road between Hue Hue Road an Burnet Road
- Service station access roads on the east and west side of the Pacific Motorway (near St Johns Road bridge)
- Wyong Road between Tonkiss Street and Cobbs Road.

Paramics models were developed based on the aerial photography provided by Roads and Maritime. As the provided aerial photos did not include the recent upgrades at the Wyong Road Interchange, Roads and Maritime provided the concept design layout for this section. The provided road layouts, coupled with Parsons Brinckerhoff site inspection provided adequate traffic network geometry details to finalise network coding.

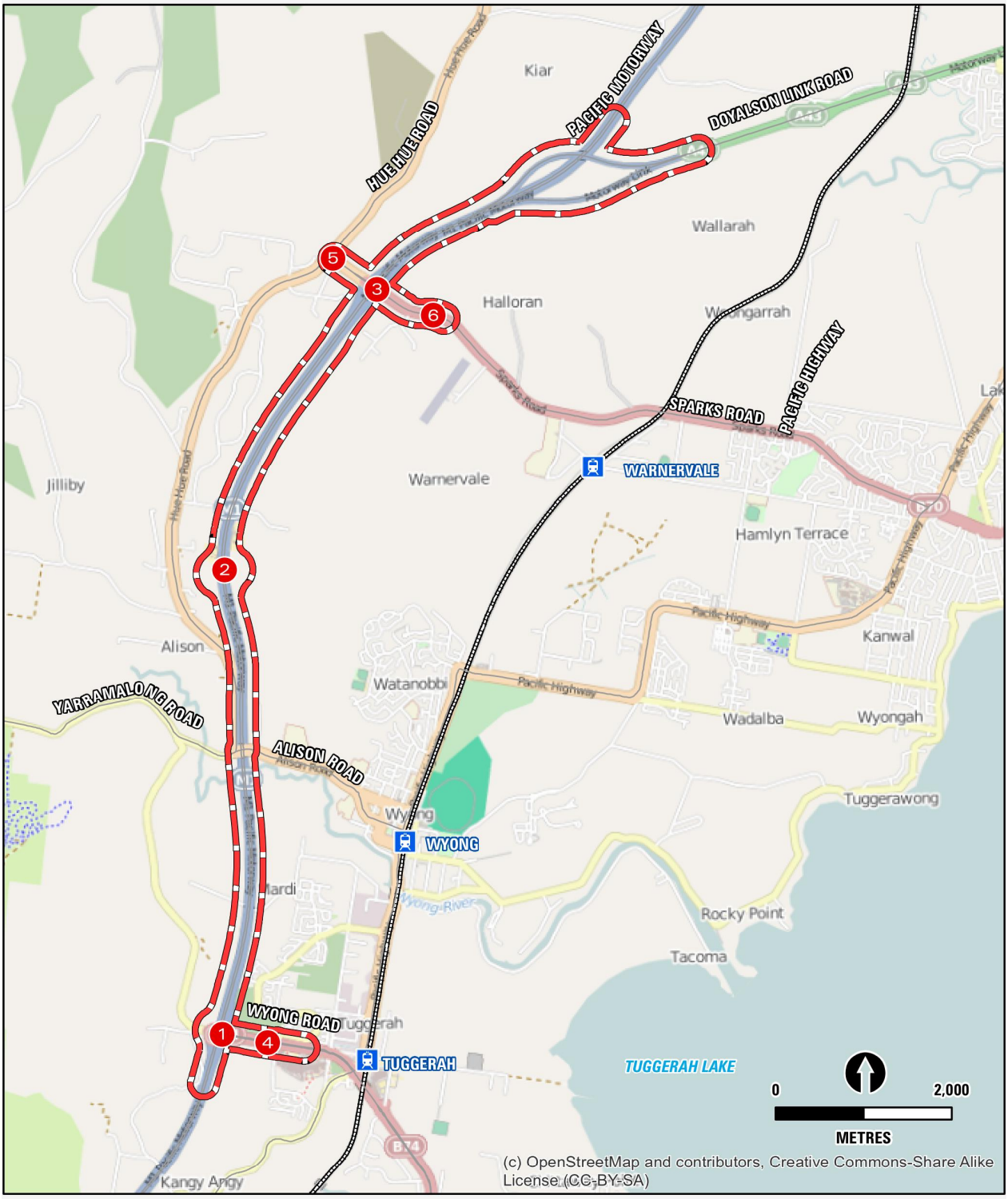


Figure 3.1 Traffic model area

3.2 Data source and data collection

3.2.1 Data sources

Roads and Maritime provided the following data in order to develop, calibrate and validate the traffic models.

3.2.1.1 Classified intersection turn counts

Classified turn counts were provided for Tuesday 9 April 2013. The survey period included the AM peak between 5.00 to 10.00 and PM peak between 15.00 to 19.00. The traffic surveys consist of 15 minute count intervals and include light vehicles, heavy vehicles, bus, and cyclists. The turn count data was provided for the following intersections/interchanges:

- Wyong Road – Pacific Motorway (Tuggerah) Interchange
- Sparks Road – Pacific Motorway Interchange
- Wyong Road – Tonkiss Street
- Hue Hue Road – Sparks Road
- Sparks Road – Burnet Road.

3.2.1.2 Mid-block road section counts

24 hour mid-block counts with 15 minute intervals were provided for the following road sections and dates:

- Pacific Motorway at Wyong Road - Tuesday 9 April 2013
- Pacific Motorway at Doyalson Link Road - Tuesday 9 April 2013.

Roads and Maritime also provided 24 hour mid-block counts with 1 hour intervals for the following road sections and dates:

- Pacific Motorway between service station access roads - Friday 5 April 2013.

3.2.1.3 Intersection approach queue length

Intersection approach queue length data was provided for the survey carried out on Tuesday 9 April 2013. The survey period included the AM peak between 5.00 to 9.00 and the PM peak between 15.00 to 19.00. The traffic surveys consist of 5 minute count intervals. The approach queue length data was provided for the following intersections/interchanges:

- Wyong Road – Pacific Motorway (Tuggerah) Interchange
- Sparks Road – Pacific Motorway Interchange
- Wyong Road – Tonkiss Street
- Hue Hue Road – Sparks Road
- Sparks Road – Burnet Road.

3.2.1.4 Travel time

Roads and Maritime provided travel time data for the Pacific Motorway section between Doyalson Link Road Interchange and Wyong Road Interchange. The data was collected based on the spot speed method from the fleet of vehicles (Minorplanet) with GPS for a whole calendar year of 2012, excluding public holidays and only during weekdays. The travel time data includes AM peak between 6.00 to 10.00 and PM peak between 15.00–19.00.

3.2.1.5 Gradient data

The road design model for the Pacific Motorway and its interchanges was provided by Roads and Maritime to assist in incorporating gradients into the model.

3.2.1.6 Traffic signal data

Roads and Maritime provided Parsons Brinckerhoff with SCATS Intersection Diagnostic Monitor (IDM) traffic signal data and Intersection Traffic Control Signal (TCS) plans for the following signalised intersections:

- Sparks Road – Pacific Motorway interchange west
- Wyong Road – Pacific Motorway interchange west.

The IDM data was provided for the morning peak between 6.00 to 10.00 and afternoon peak between 15.00 to 19.00.

3.2.2 Site inspection

Site inspections were undertaken by Parsons Brinckerhoff to observe current traffic conditions in the study area during the AM and PM peaks. The site inspections were carried out on 14 May 2013 between 6.30 to 9.30 and 15 of May between 15.00 to 18.30. During the site visit specific notes were made of the following:

- turn restrictions
- on-street parking
- lane configuration
- driver behaviour
- lane usage
- public transport
- pedestrian movements.

Parsons Brinckerhoff also captured comprehensive video footage for intersection approach queue length and driver behaviour at intersection approaches.

3.3 Model parameters

An all-or-nothing assignment method has been adopted for this model. Due to the size of the model and the associated road layout, there is no route choice within the model.

Azalient Plugin software was used in the development of the base models. The following plugins have been utilised:

- Network Evaluation
- Validator
- Level of Service
- Lane Choice.

Since the Roads and Maritime *Traffic Modelling Guideline* (February 2013) does not provide any specific recommendations in regards to the core Paramics standard files, Parsons Brinckerhoff used the standard Paramics input files recommended in *RTA Paramics Microsimulation Modelling Manual Version 1.0*. These parameters include: configuration, behaviour, categories, acceleration profiles and vehicles.

Parsons Brinckerhoff also made the following changes to the standard files to reflect the local traffic network conditions:

- The model start time and duration were changed to reflect the actual model periods. Also, throughout the traffic modelling a time step value of 5 was adopted and speed memory and mean reaction times were adjusted to reflect the adjusted time step. The mean driver reactions were adjusted in order to control any shockwave phenomenon associated with traffic flow and ensure drivers' late reaction is not causing an overreaction (e.g. on ramp merge section of the motorway). These parameters were adjusted as part of the model calibration process to reflect the observed traffic conditions. While a time step value of 2 is the default value, the guidelines state that this value can be changed and may provide some benefit in larger models.
- Information on light and heavy vehicle proportions on the study area was determined through the classified counts. The proportions used for the models are shown in Table 3.1.

Table 3.1 Vehicle classification summary

	Vehicle type	Split matrix
Light vehicle matrix	Type 1: Small Car	28.85
	Type 2: Medium Car	39.21
	Type 3: Large Car	22.94
	Type 4: Taxi	1.39
	Type 5: LGV	7.61
Fixed route	Type 6: STA Mini Bus	Fixed Route Vehicles- Volume determined by Service Frequency
	Type 7: Non STA Mini Bus	
	Type 8: STA Bus	
	Type 9: Non STA Bus	

	Vehicle type	Split matrix
Heavy vehicle matrix	Type 10: OD Bus	1.56
	Type 11: Rigid (Light)	9.36
	Type 12: Rigid (Medium)	65.05
	Type 13: Rigid (Heavy)	9.36
	Type 14: Semi (Light)	2.03
	Type 15: Semi (Medium)	10.61
	Type 16: Semi (Heavy)	2.03
B-Double matrix	Type 17: B-Double (Light)	16.67
	Type 18: B-Double (Medium)	66.67
	Type 19: B-Double (Heavy)	16.67

3.3.1 Traffic signal coding

The traffic signals were coded as per the average cycle time provided in the IDM data. The IDM data was also used to obtain average cycle time and phase splits.

In general the signal operations were coded via fixed signal timing methods. However the review of the signal operation at Wyong Road Interchange indicated that phase B (Figure 3.2) is introduced only where there is a right turn demand on Wyong Road eastbound towards the motorway on-ramp.

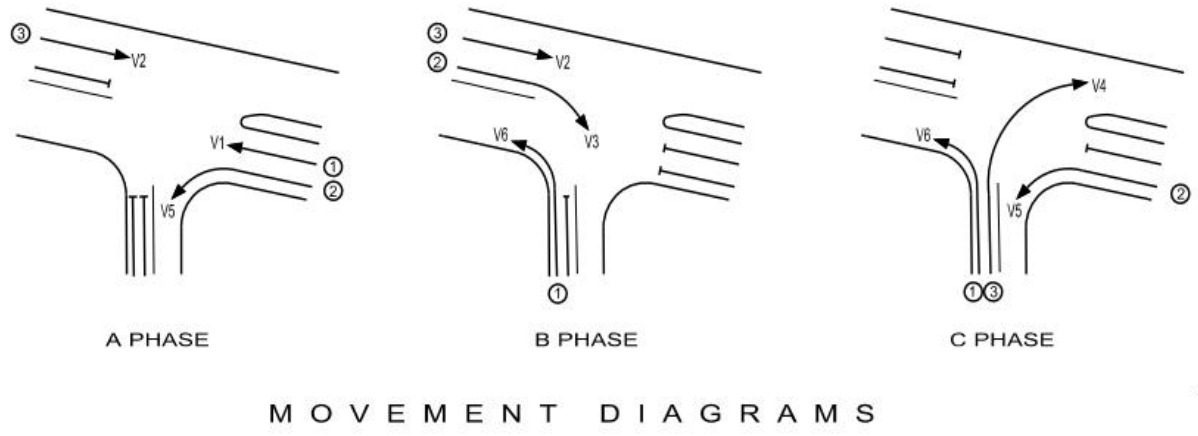


Figure 3.2 Wyong Road Interchange – Signal diagram

In order to model the operation of the traffic signals at Wyong Road Interchange, Vehicle Actuated (VA) signal coding was adopted. VA operation was coded in order to skip phase B unless the right turn detector identifies right turn demand. Phase B would then run in the next cycle to ensure the demand is cleared.

3.4 Demand development

In the absence of detailed origin and destination information, matrix estimation has been undertaken based on the intersection turning movement counts.

The basic process for the manual estimation is outlined below.

3.4.1 Collate traffic data

All traffic data available for the model was collated into a Microsoft excel spreadsheet. A model schematic was developed in excel and populated with the turning movement volumes and the traffic flow diagram of the collected data was developed.

3.4.2 Create light and heavy vehicle hourly diagrams

Individual traffic flow diagrams of the study area were developed for both light and heavy vehicle movements. Therefore for each modelled hour there was a separate light vehicle and heavy vehicle flow diagram. This allows the development of different demand matrices for light and heavy vehicles.

The summary of the intersection turn diagram can be seen in Appendix A.

3.4.2.1 Flow balancing

Since the data provided by Roads and Maritime was collected over different periods, flow balancing was applied to the traffic flow diagrams of the recorded traffic flows in order to ensure robust demand estimation.

3.4.2.2 Matrix estimation

Based on the balanced traffic flow diagrams, demand matrices were estimated. Parsons Brinckerhoff used a matrix estimation engine provided by LinSig 3.2.6 modelling software to obtain the initial matrix estimation. The estimated matrices were further carefully examined and refined to calibrate turn/link flows.

3.4.3 Demand profile

Demand profiles were developed for each of the peak period models. These profiles specify the timing of proportional release of vehicles into the models. The profiles were developed from the 15 minute interval turning/link movement counts. The demand profiles were developed for three major zone to zone movements in the study area as follows:

- Pacific Motorway northbound through flow
- Pacific Motorway southbound through flow
- all other link/road flow.

Figure 3.3 and Figure 3.4 show the summary of the demand profile for the AM and PM peak periods.

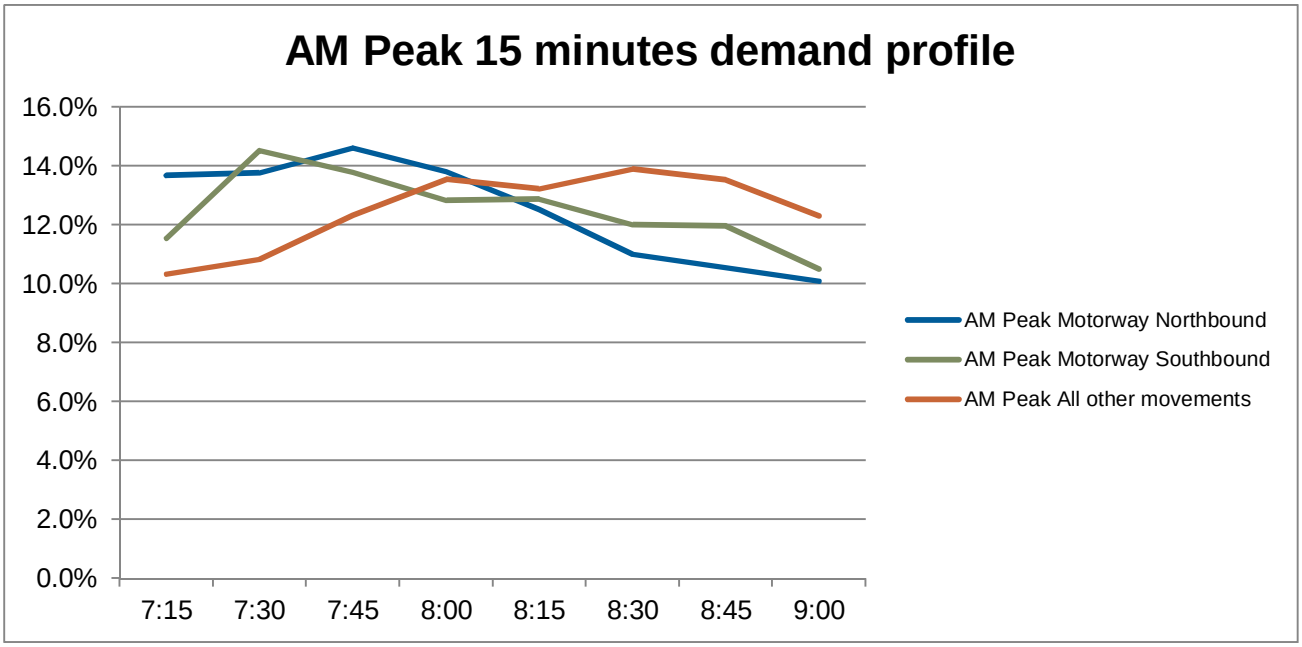


Figure 3.3 AM peak 15 minutes demand profile

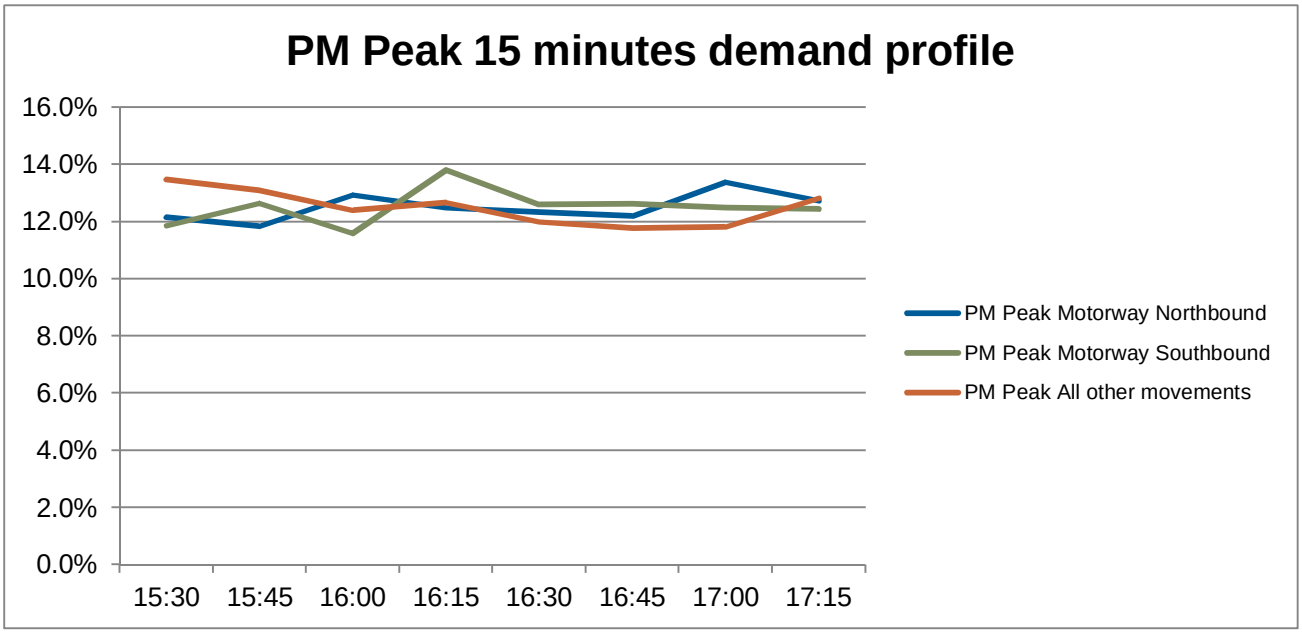


Figure 3.4 PM peak 15 minutes demand profile

4. Traffic forecasting

4.1 Traffic forecasting approach

The key inputs for development of forecast traffic volumes for future years involved the Roads and Maritime strategic traffic forecasting model and current NSW Government planning documents. These key inputs are summarised below:

- Roads and Maritime maintains a strategic traffic forecasting model using software known as EMME (Equilibrium Model/Multimodal Equilibrium). EMME is a travel demand model used for urban, regional and national transportation forecasting. This model is used state wide for forecasting of road schemes with wide-reaching network impacts, and to examine the effects of significant new residential or employment land releases.
- The two key documents which specify future development levels in the study area are the Central Coast Regional Strategy 2006–2031, NSW Department of Planning (2008), and the North Wyong Shire Structure Plan, Department of Planning and Infrastructure (Oct 2012). The former document was used to determine development levels in Tuggerah and Wyong Town Centre. The latter document contains all the information for all other developments in the study area as shown in Figure 4.2.

The Roads and Maritime EMME model was used for this project to determine the future traffic volumes that would result from the implementation of expected development levels and future road upgrades. This model was only available for the year 2031. EMME model outputs were provided to allow determination of background growth levels as well as growth levels with all proposed development incorporated. The data sets were provided as follows:

- 2011 and 2031 link volumes excluding all development areas within the study area (background traffic)
- 2011 and 2031 link volumes including all development areas within the study area
- 2031 select link analysis to determine traffic volumes and distribution from each development area.

These data sets allowed determination of background traffic growth for each road link resulting from all development outside of the study area. The above data was provided for the year 2031 assuming two network scenarios, one with north facing ramps at Doyalson Link Road and one without. The select link analysis allowed further adjustment to be made to the traffic volumes for input to the Paramics model. Adjustments were made as follows:

- The EMME model was based on the Draft North Wyong Structure Plan; however the final document is now available and differs slightly to the draft. Therefore some of the development area sizes and resultant traffic volumes were adjusted for input to the Paramics model.
- The Precinct 14 area of the Wyong Employment Zone currently has approval for subdivision and development. This area is located to the north west of the intersection of Sparks Road and the Pacific Motorway and will have a new access provided directly to Sparks Road. These traffic volumes were added to the network.
- Part of the Precinct 11/13 area of the Wyong Employment Zone would be accessible from the northern leg of the Sparks Road/Burnet Road intersection. The portion of Precinct 11/13 development accessible from this leg was calculated as a proportion of the total precinct land area. Trips were therefore added to this intersection leg as a proportion of trips generated for the total precinct.

4.2 Strategic model network assumptions

The assumed future road projects which were included within the EMME model for the year 2031 are shown in Figure 4.1 and are described below:

- widening of the Pacific Motorway to six lanes north of Tuggerah Interchange
- duplication of the Pacific Highway to four lanes between Johnson Road, Tuggerah and Doyalson Link Road, Doyalson
- widening Sparks Road to four lanes between the Pacific Highway and Hue Hue Road
- construction of a new two lane Warnervale Link Road between the intersection of Pacific Highway and Britannia Road, Watanobbi and the intersection of Sparks Road and Albert Warner Drive, Warnervale and on to the new Warnervale Town Centre
- additional access roads to North Warnervale development areas.

In addition to the above network changes a strategic model was also run to include north facing ramps at Doyalson Link Road. This data was used in the scenario analysis.

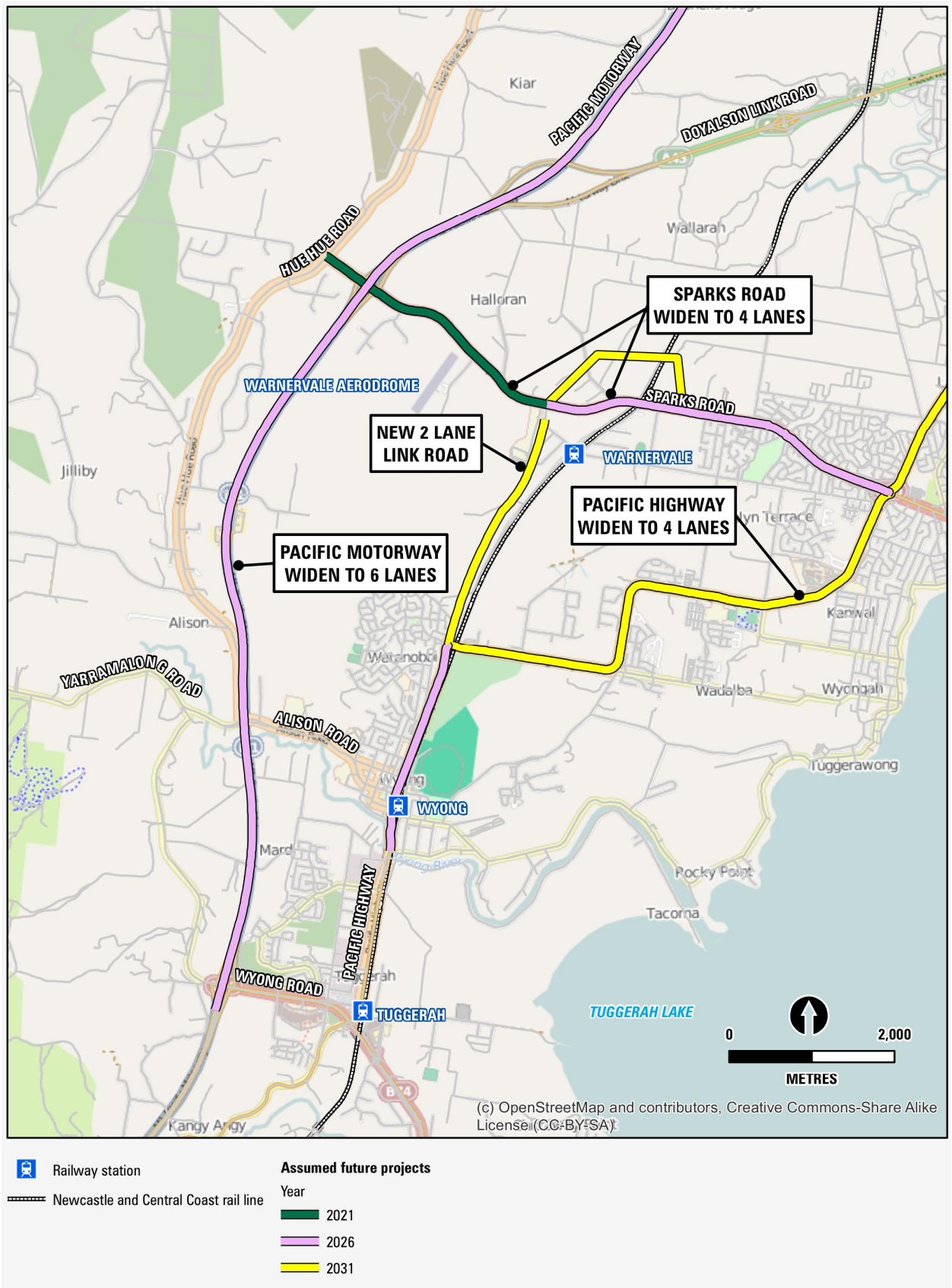


Figure 4.1 Strategic model assumed future projects

4.3 Strategic model development assumptions

A large amount of development is proposed along the eastern side of the study area leading up to the year 2031. This will lead to a significant increase in residents and employees in the area from Tuggerah up to the southern end of Lake Macquarie. The development assumptions within the model are as outlined below:

- Incorporation of proposed development areas as outlined in the Draft North Wyong Shire Structure Plan, NSW Department of Planning, November 2010. Note that the Paramics model was run to include the updates provided in the final North Wyong Shire Structure Plan, Department of Planning and Infrastructure, October 2012. This document proposes growth in these areas of 16,680 dwellings and between 12,150 and 17,100 jobs.
- Incorporation of proposed development within Wyong Town Centre and Tuggerah as per the Central Coast Regional Strategy 2006–2031, NSW Department of Planning, 2008 which proposes growth in these areas of 4,000 dwellings and 5,500 jobs between 2006–2031.

Accordingly the addition of development outlined in the North Wyong Shire Structure Plan and the Central Coast Regional Strategy 2006–2031, results in a total 20,680 dwellings and up to 22,600 jobs within the study area.

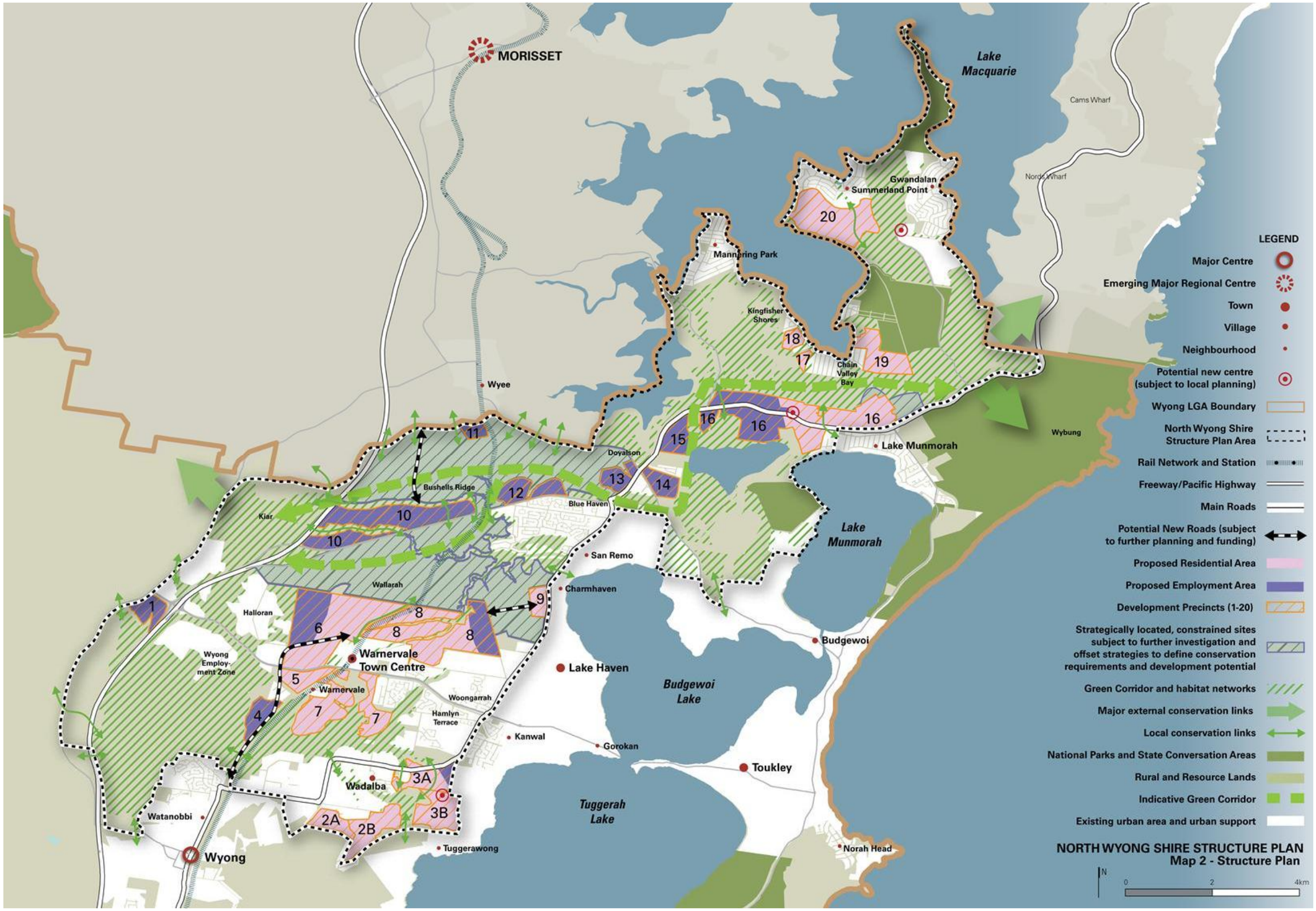
The key development precincts adjacent the study area can be listed as follows:

- Warnervale Town Centre
- Wyong Employment Zone (WEZ)
- Tuggerah – Wyong Major Centre and employment lands
- Wadalba development area
- Bushells Ridge
- Doyalson and Lake Munmorah corridor.

Figure 4.2 shows the North Wyong Shire Structure Plan development locations with the inclusion of already zoned areas, Warnervale Town Centre and WEZ.

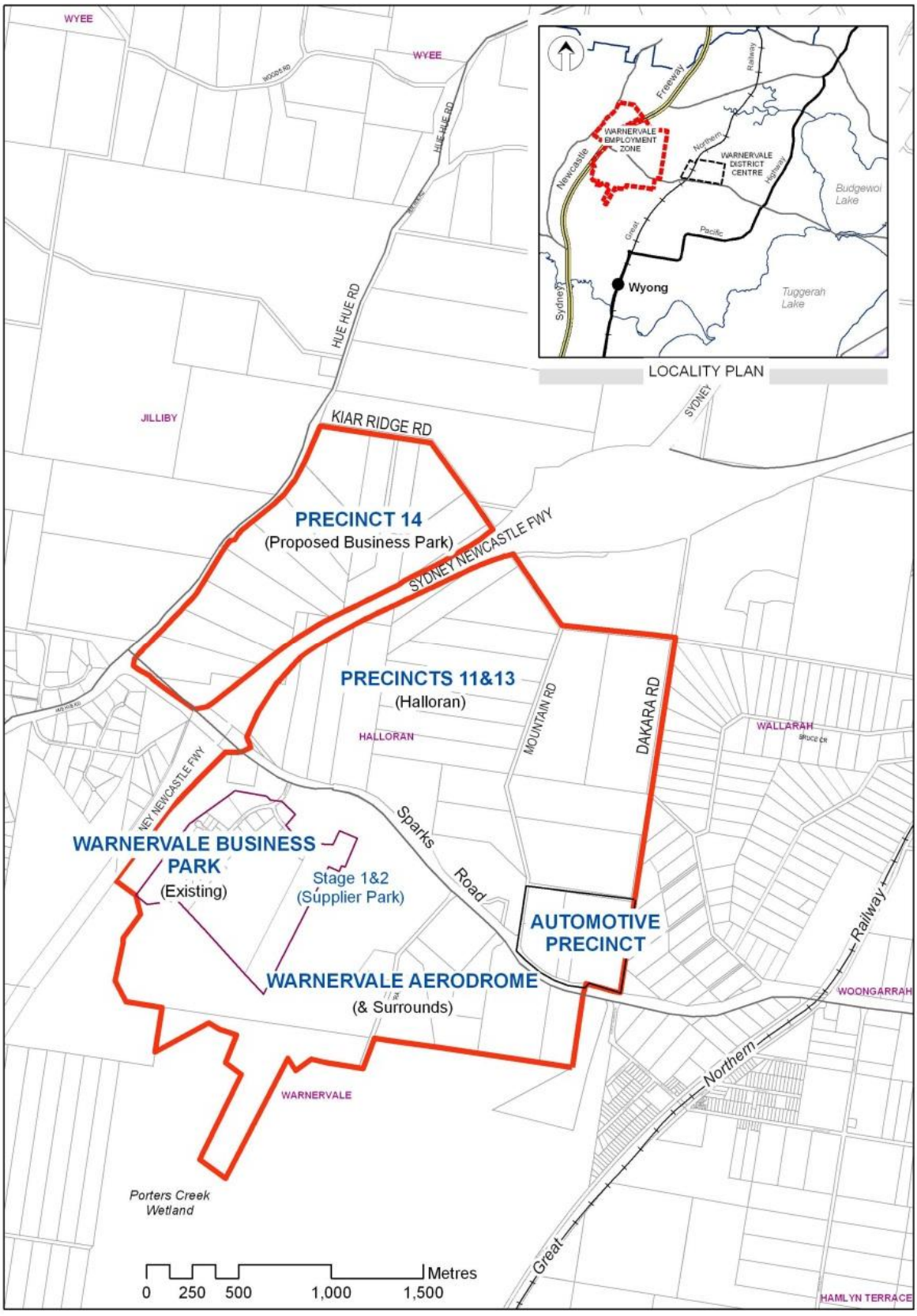
The WEZ is proposed to be located adjacent to the Pacific Motorway. The development precincts for the WEZ are shown in Figure 4.3.

The Tuggerah – Wyong Major Centre is identified in the Central Coast Regional Strategy 2006–2031. It is just to the south of the North Wyong area, adjacent the Wyong Interchange.



Source: North Wyong Shire Structure Plan, NSW Department of Planning and Infrastructure, 2012

Figure 4.2 North Wyong Shire Structure Plan development areas



Source: Wyong Employment Zone, Wyong Shire Council, May 2010

Figure 4.3 Wyong Employment Zone

The proposed development yield for each of the numbered precincts shown in Figure 4.2 is provided in Figure 4.4. Also included in the table are the WEZ, Warnervale Town Centre and 'Other existing zoned areas'. The *North Wyong Shire Structure Plan* proposes growth in these areas of 16,680 dwellings and between 12,150 and 17,100 jobs. However the North Wyong Shire Structure Plan does not include the development in the Wyong–Tuggerah Major Centre. *The Central Coast Regional Strategy 2006–2031* proposes growth in this area of 4,000 dwellings and 5,500 jobs between 2006–2031. Therefore the total development yield within the study area is 20,680 dwellings and up to 22,600 jobs.

Precinct No.	Area name	Land Use	Gross Area	Estimated Net Developable Area (ha)**	Dwellings	Jobs	
					15 /ha	10 /ha	20 /ha
1	Hue Hue Road	Employment	36	25	-	252	504
2A	Wadalba South	Residential	32	22	336	-	-
2B	Wadalba South	Residential	67	47	704	-	-
3A	Wadalba East	Residential	57	40	551	32	63
3B	Wadalba East	Residential	69	48	725	-	-
4	Warnervale South West	Employment	39	27	-	273	546
5	Warnervale South West	Residential	36	25	378	-	-
6	Warnervale North West	Residential & Employment	254	178	1,764	602	1,204
7	Warnervale South East	Residential	140	98	1,470	-	-
8	Warnervale North East	Residential & Employment	221	155	1,764	371	742
9	Charmhaven West	Residential	26	18	273	-	-
10	Bushells Ridge South	Employment	180	126	-	1,260	2,520
11	Bushells Ridge North East	Employment	16	11	-	112	224
12	Doyalson South West	Employment	52	36	-	364	728
13	Doyalson West	Employment	34	24		238	476
14	Doyalson East	Employment	34	24	-	238	476
15	Doyalson North East	Employment	37	26	-	259	518
16	Lake Munmorah	Residential & Employment	293	205	1,670	945	1,890
17	Chain Valley Bay West	Residential	8	6	84	-	-
18	Chain Valley Bay North West	Residential	16	11	168	-	-
19	Chain Valley Bay East	Residential	68	48	714	-	-
20	Summerland Point South	Residential	142	99	1,491	-	-
	*Wyong Employment Zone****	*Employment*				*6,000*	*6,000*
	*Warnervale Town Centre*****	*Residential, Retail and Commercial*			*1,650*	*1,200*	*1,200*
	*Other existing zoned areas******	*Residential*			*2,940*		
ESTIMATED TOTAL DEVELOPMENT YIELD			*1,857*	*1,299*	*16,682*	*12,146*	*17,091*

Source: North Wyong Shire Structure Plan, NSW Department of Planning and Infrastructure, 2012

Figure 4.4 North Wyong Shire Structure Plan, proposed development yield

4.4 Background growth

EMME model outputs were provided to allow determination of background growth levels as well as total growth levels (with all proposed development incorporated). The data sets were provided as follows:

- 2011 and 2031 link volumes excluding all development areas within the study area
- 2011 and 2031 link volumes including all development areas within the study area.

These data sets allowed determination of background traffic growth for each road link resulting from all development outside of the study area.

Utilising the EMME model assumptions for development growth, the analysis of the background growth in the area for 2011–2031 shows the following:

- In the AM peak, growth on the Pacific Motorway ranges between 0.8–1.8% p.a.
- In the PM peak, growth on the Pacific Motorway ranges between approximately 0.3–1.4% p.a.
- Generally the higher background growth occurs at the northern end of the Pacific Motorway.
- The largest levels of background growth are felt to the west of the Pacific Motorway on Hue Hue Road and Old Maitland Road, with growth levels up to 3.3% p.a. on Hue Hue Road and 5.5% p.a. on Old Maitland Road. These are however from a low volume base.
- Wyong Road background growth generally decreases, presumably due to adjacent improvements to the Pacific Highway and the inclusion of the Warnervale Link Road as shown in Figure 4.1 (which would divert traffic to these improved links).

4.5 Growth scenarios

A high and low growth scenario was developed for the initial modelling assessment. The development of the low and high growth scenarios was closely linked to the residential and employment development levels proposed for the greater study area. The key difference between the low and high growth scenarios is the timing of the implementation of the proposed developments.

The *North Wyong Shire Structure Plan* provides a high-level overview of the development area staging. The vision for the long-term development areas is described as 'land that will not be zoned before 15 years, the timing of which will be impacted by future coal extraction potential, future use of the power station sites and access to services and employment opportunities'. This would suggest that whilst the EMME model assumes that all development would be complete by 2031, there is in fact broad flexibility in the proposed rate of development. In the past, the rate of development on the Central Coast has typically come in far below expectations. Therefore the following approach was adopted to develop the low and high growth scenarios:

- The low growth scenario provides a background traffic growth level of 0.5% p.a. up to the year 2023. From the year 2023 it is assumed that the proposed development areas will begin to be populated. Rather than assuming the proposed development is complete by 2031, the low growth scenario applies the proposed development growth from 2023 to 2069.
- The high growth scenario assumes that the proposed development begins immediately and will be complete by 2049.

The extension to the period of time for development in both growth scenarios is justified by similar circumstances in the planning history of the Central Coast. In the past it is clear that development has progressed much more slowly than expected. The timeframes set out above were discussed and agreed with Roads and Maritime based on local operational knowledge.

The approach described above results in the AADT and growth rates as shown in Table 4.1. The location for this AADT is on the Pacific Motorway at the Alison Road overpass (Roads and Maritime count station V05.007). This information is also presented in Figure 4.5 which shows previous years to provide a perspective of proposed growth rates.

It should be noted that distribution of the development areas results in differing growth rates in different areas of the network. To demonstrate the proposed growth rates on each road the yearly compound growth rates for the low growth scenario is shown in Appendix D for the year 2023 to 2069. Prior to 2023 a 0.5% growth rate is used.

The final modelling scenarios were tested using the low growth scenario only as the high growth scenario was agreed to represent an unrealistic situation. The total forecast traffic volumes used for the low growth scenario in each future year is provided in Appendix E.

Table 4.1 Growth scenario AADT (Pacific Motorway at Alison Road overpass)

		2013*	2019*	2029*	2039*	2049*
High Growth	AADT	69,600	77,900	85,300	94,300	103,200
	Compound Growth	-	1.9%	0.9%	1.0%	0.9%
Low Growth	AADT	69,600	71,600	76,300	82,000	88,100
	Compound Growth	-	0.5%	0.7%	0.7%	0.7%

* factored daily traffic counts

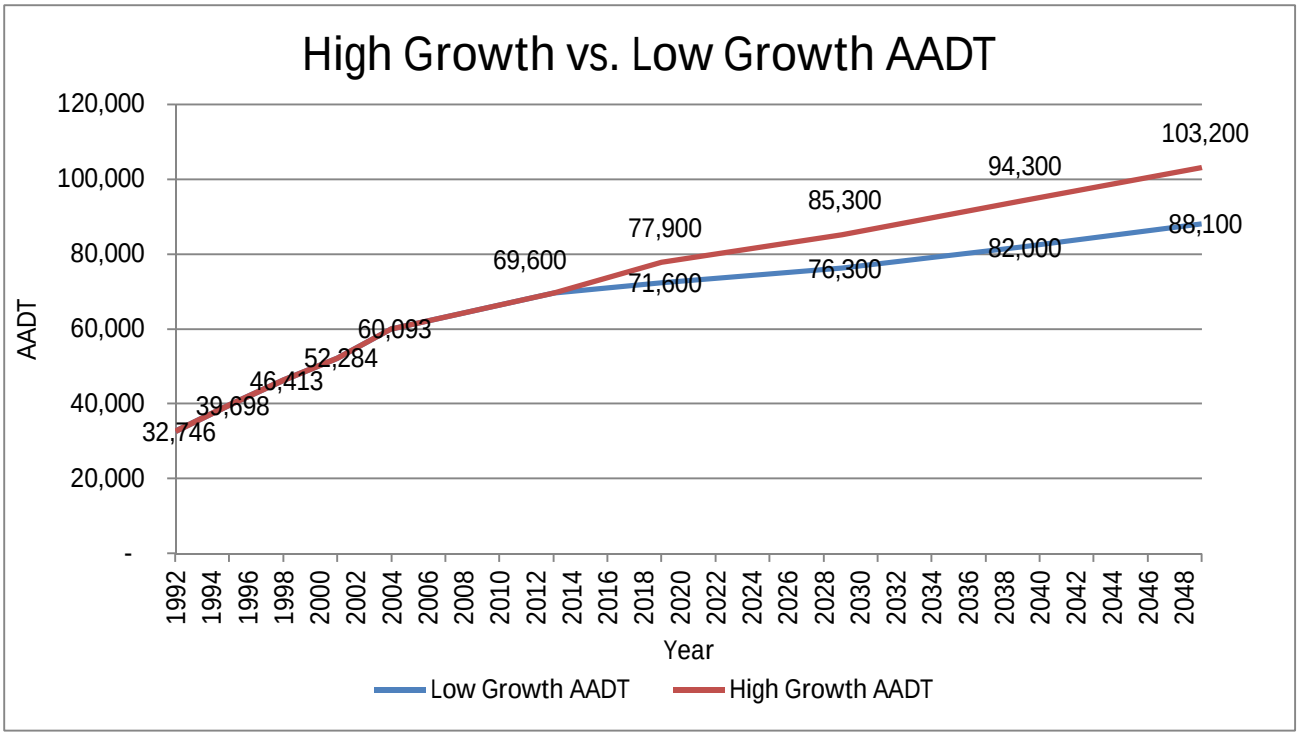


Figure 4.5 Growth scenario AADT (Pacific Motorway at Alison Road overpass)

4.6 Freight projections

The Pacific Motorway is considered to be one of the nation's busiest interstate freight routes and as such supports the majority of interstate road freight movements along the NSW coastal route. The amount of freight to be transported along this corridor is predicted to increase significantly between 2011 and 2031.

According to the NSW Long Term Transport Master Plan (Transport for NSW, December 2012, p281) in 2011 there were 'around 320,000 trips on an average weekday for heavy vehicles and over 1.2 million trips for light commercial vehicles within Sydney and between the Greater Metropolitan Area and the rest of NSW and other states'. By 2031 it is anticipated that growth in freight 'will result in nearly 500,000 trips on an average weekday for heavy vehicles and over 1.5 million light commercial vehicle trips per day within Sydney and between the Greater Metropolitan Area and the rest of NSW and other states'.

This indicates that the freight task in NSW is set to increase by approximately 56% between the years 2011–2031. For modelling purposes it was agreed with Roads and Maritime to maintain the current proportion of heavy vehicles within the model. This results in the following growth for heavy vehicles (2013–2031):

- 29% for AM peak low growth scenario
- 36% for PM peak low growth scenario
- 51% for AM peak high growth scenario
- 67% for PM peak high growth scenario.

Therefore the low growth scenario allows for a lower growth in heavy vehicles than that forecast by the *NSW Long Term Transport Master Plan* and the high growth scenario allows for a higher growth in heavy vehicles.

5. Future year model development

The future year model development includes development of the traffic demand models, which provide the traffic volumes for different growth rate assumptions in future years, and development of the future network, which relies on the design undertaken by Roads and Maritime.

A summary of the overall design development and traffic assessment for the project is outlined in Table 5.1. The table shows how four different design options were assessed as the design was progressively updated throughout the project phase. The table also shows which traffic demand scenarios were used to test each design.

Table 5.1 Design options assessment summary

Design option	Description	Traffic assessment scope	Assessment outcomes
Original design	Sparks Road Interchange - dual right turn arrangement to the northbound on-ramp	high and low growth scenarios AM and PM peak 2019, 2029, 2039, 2049	Severe congestion at Sparks Road Interchange and related intersections.
Managed motorway	Original design with managed motorway components	none	Based on the original design assessment, this option was deemed not required due to capacity constraints in accessing the motorway.
Option 17E	Sparks Road Interchange - northbound entry loop ramp and Doyalson Road exit tunnel	low growth scenario AM and PM peak 2019, 2029, 2039, 2049	As reported in section 6.
Option 17F	Selected design with north facing ramps at Doyalson Link Road	low growth scenario AM and PM peak 2019, 2029, 2039, 2049	As reported in section 6.

An explanation of the designs, design development process and traffic demand model development is provided below.

5.1 Model development

In order to assess the impact of the Pacific Motorway Widening project, a set of Paramics microsimulation models and LinSig intersection models were developed. The original design scenario was tested for both high and low background traffic growth in the AM and PM peaks for the future years 2019 (opening year), 2029, 2039 and 2049 with the base case also tested for 2013. As the design developed, it was realised that the high growth scenario may present an unrealistic situation and therefore the preferred designs were tested for the low growth scenarios only. The total forecast traffic volumes used for the low growth scenario for each year is provided in Appendix E.

Appendix E shows the 2-hour peak total vehicle volumes for a scenario with north facing ramps at Doyalson Link Road. It can be seen that only small volumes of traffic use these ramps. Generally for the scenario without these ramps this traffic diverts to U-turn at the Sparks Road Interchange.

Average weekday AM and PM peak Paramics models were developed for both high and low growth scenarios for the future years. The development of the growth scenarios and their justification is described in section 4.5. The microsimulation models were developed based on the calibrated/validated base year models, the development of which is described in section 3.

Table 5.2 summarises the number of developed traffic models. Detailed discussions regarding the traffic forecasting methodology are provided in section 4 of this report.

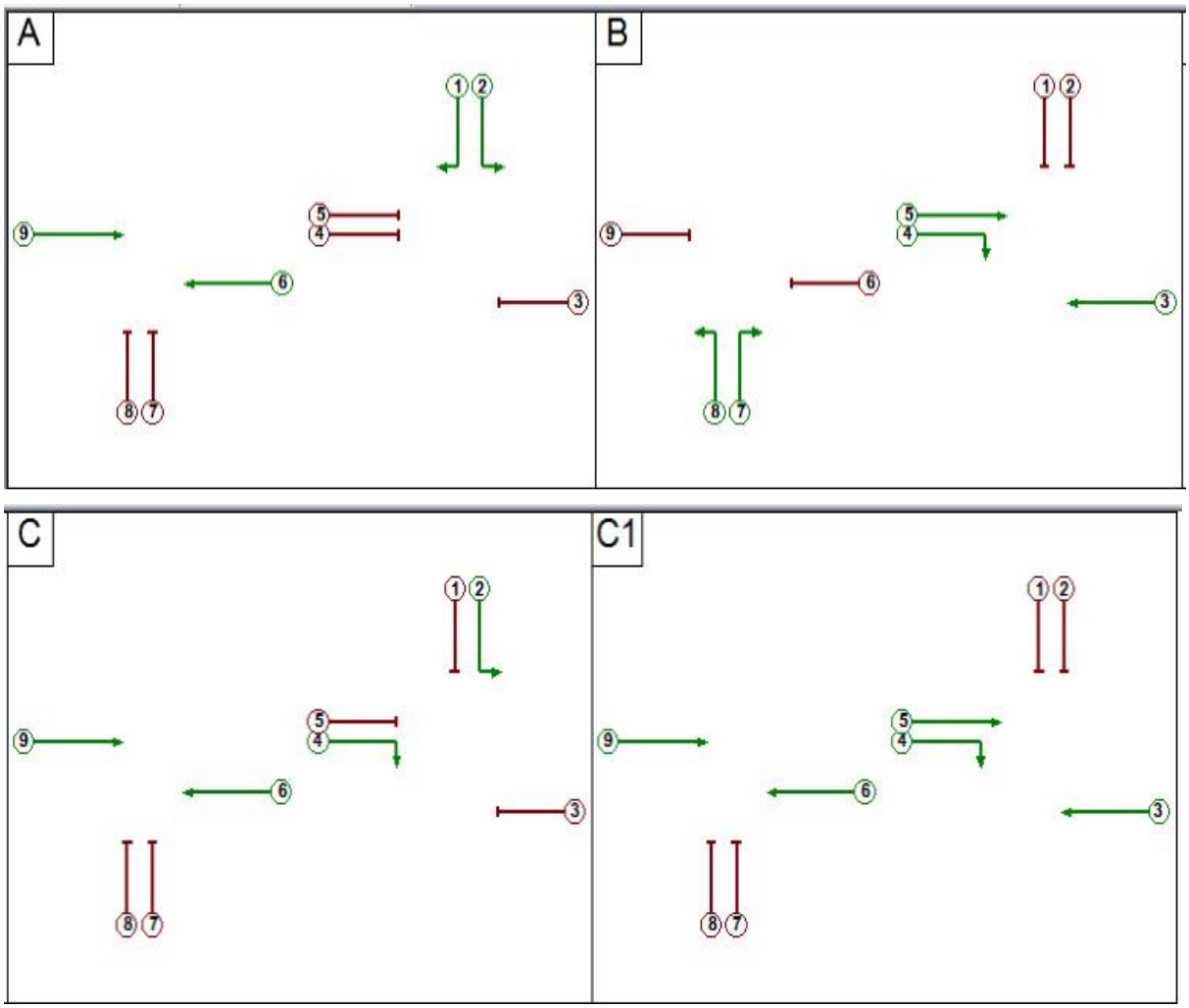
Table 5.2 Number of traffic demand models

Modelling year	Low growth rate		High growth rate	
	AM	PM	AM	PM
2013	1	2	--	--
2019	3	4	5*	6*
2029	7	8	9*	10*
2039	11*	12*	13*	14*
2049	15*	16*	17*	18*

* LinSig models were developed for these scenarios

A set of LinSig models were developed for the Sparks Road Interchange, which included both of the interchange intersections and the intersection with Burnet Road. This model was used to determine optimum signal phasing arrangements, timings and offsets for input into the Paramics model for each scenario. The number of LinSig traffic models developed is shown in Table 5.2 above.

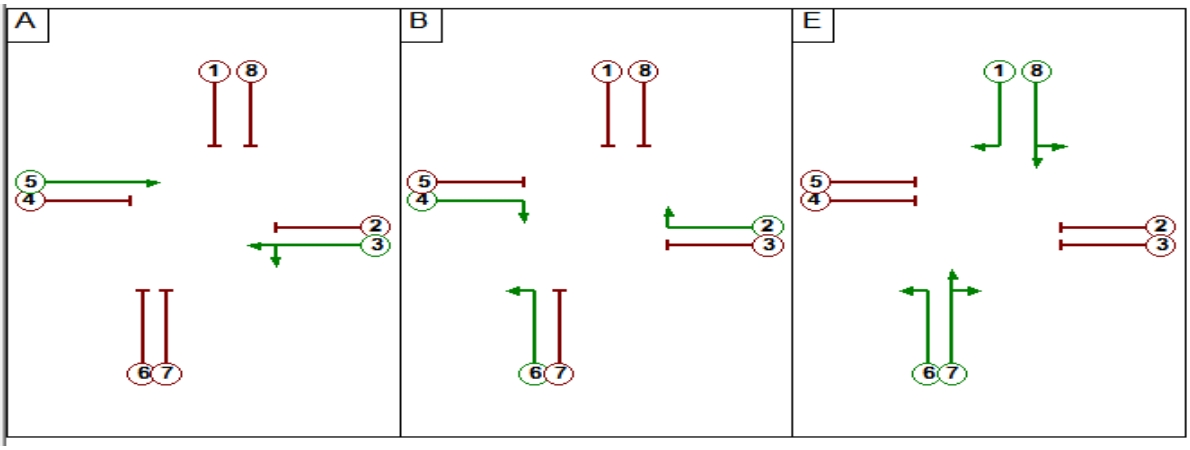
Figure 5.1 and Figure 5.2 show the LinSig model signal phasing assumptions at Sparks Road Interchange and the Sparks Road intersection with Burnet Road.



* Movement 4 operates as a filter turn

**North is up the page

Figure 5.1 Signal phasing assumption at Sparks Road Interchange



* Movements 1 and 7 operate as filter turns

**North is up the page

Figure 5.2 Signal phasing assumption at Sparks Road/Burnet Road intersection

On completion of the LinSig traffic modelling, the optimum signal timings and signal offset times were applied to the Paramics microsimulation models.

5.2 Selected design proposals

The concept designs for the motorway widening proposal were provided by Roads and Maritime and are shown in Appendix F. The proposals show widening of the motorway from four lanes to six between the Tuggerah Interchange (Wyong Road) and the Doyalson Link Road Interchange. Two designs were provided for testing, as follows:

- Option 17E - Pacific Motorway widening to six lanes without north facing ramps at Doyalson Link Road
- Option 17F - Pacific Motorway widening to six lanes with north facing ramps at Doyalson Link Road.

The only difference between the two options is the inclusion of the north facing ramps at Doyalson Link Road.

The Tuggerah Interchange (Wyong Road) was recently upgraded with a new northbound loop entry ramp and a new roundabout at the Wyong Road/southbound ramps intersection. Therefore this arrangement was included within the base model and maintained for all future models.

The proposal includes upgrades to the Sparks Road Interchange to incorporate widening of the Sparks Road overbridge and the provision of a new northbound entry loop ramp. The northbound exit ramp is upgraded to a dual lane exit and widened to three lanes at the intersection, with a dual right turn. The southbound ramps intersection with Sparks Road is signalised which incorporates two left turn and two right turn lanes from the exit ramp on to Sparks Road. The southbound entry ramp becomes an added lane to the motorway.

The Doyalson Link Road Interchange was updated with a new northbound exit ramp location which is a single lane (compared to two lanes on the existing ramp). This ramp broadens to two lanes prior to the existing overpass bridge. Due to the short distance between the Sparks Road Interchange and Doyalson Link Road Interchange, the northbound entry ramp from Sparks Road remains on a service road until it crosses over the Doyalson Link Road exit to then merge with the motorway.

For design option 17F, north facing ramps are provided at Doyalson Link Road with the entry ramp consisting of a loop ramp adjacent the existing Doyalson Link Road motorway overpass. The exit ramp is a standard ramp arrangement merging into Doyalson Link Road eastbound.

All other ramps were updated with the extended merge and diverge lengths as proposed within the design.

5.2.1 Other proposed road upgrades

There were a number of additional road upgrade/changes proposed which were not included within the Roads and Maritime concept designs. To improve the accuracy of the modelling results these additional road upgrade/changes were included in all of the motorway upgrade scenarios within the Paramics modelled network. The road network upgrade/changes are as follows:

- Sparks Road was upgraded from two lanes to four to the east of the intersection with Burnet Road.
- The intersection of Sparks Road and Hue Hue Road was upgraded to a fully channelised intersection with slip lanes and acceleration lanes. The speed limit on Hue Hue Road was dropped from 80 km/h to 70 km/h. On the westbound approach two lanes are provided along Sparks Road.
- The intersection of Sparks Road and Burnet Road was upgraded with traffic signals, slip lanes and a new northern approach leg to serve the property there. On the westbound approach to the intersection, three lanes are provided for a distance of approximately 450 m.

- A new roundabout intersection is provided from ‘Precinct 14’ to Sparks Road to the west of the motorway.

5.3 Design development

During the project lifecycle the design has been iteratively updated following input from the traffic modelling conducted as part of this study. Therefore the originally assessed design differs from the scenarios outlined above (design options 17E and 17F). The original brief requested analysis of the following design scenarios:

- Original design - Pacific Motorway widening to six lanes
- Managed motorway – as per Original design with managed motorway components.

During the traffic modelling process it was identified that assessment of the managed motorway scenario would not be required as it does not provide a benefit to the motorway. Therefore no further analysis of this option was conducted. This is explained further below.

5.3.1 Managed motorway option

During the modelling process it was evident that a managed motorway scenario would provide little benefit to the operation of the motorway. For the longer-term scenarios congestion occurs at the access points to and from the motorway, mainly at Sparks Road and Wyong Road. These constraints limit the ability of traffic to access the motorway.

Ramp metering is typically used at motorway locations which are operating beyond capacity and therefore exhibit flow breakdown. The ramp metering system is used to restrict motorway access to allow free-flow conditions on the motorway. As flow breakdown on the motorway was not evident in the modelling of the standard upgrade scenario, it was agreed with Roads and Maritime to remove the managed motorway option from the modelling analysis.

5.3.2 Sparks Road Interchange

The original design mentioned above was based on a Sparks Road Interchange which included a dual right turn arrangement for access to the northbound motorway. This arrangement is shown in Figure 5.3. This arrangement resulted in severe congestion along Sparks Road and at the interchange. In consultation with Roads and Maritime, design solutions for this area (amongst others) were developed to address the identified issues. Therefore subsequent design options all included a northbound entry loop ramp design similar to that shown in Figure 5.4.

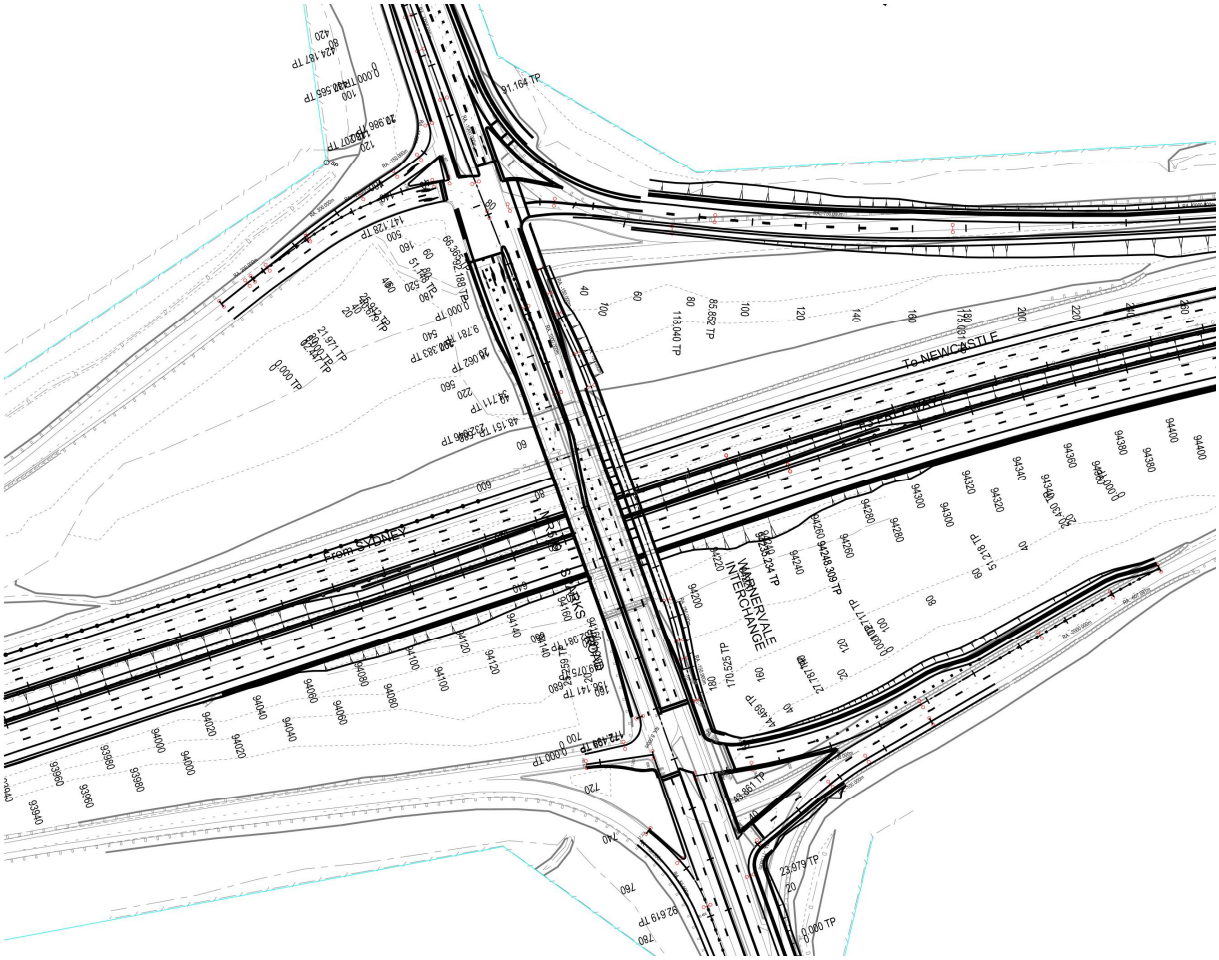


Figure 5.3 Sparks Road Interchange – discarded original design option

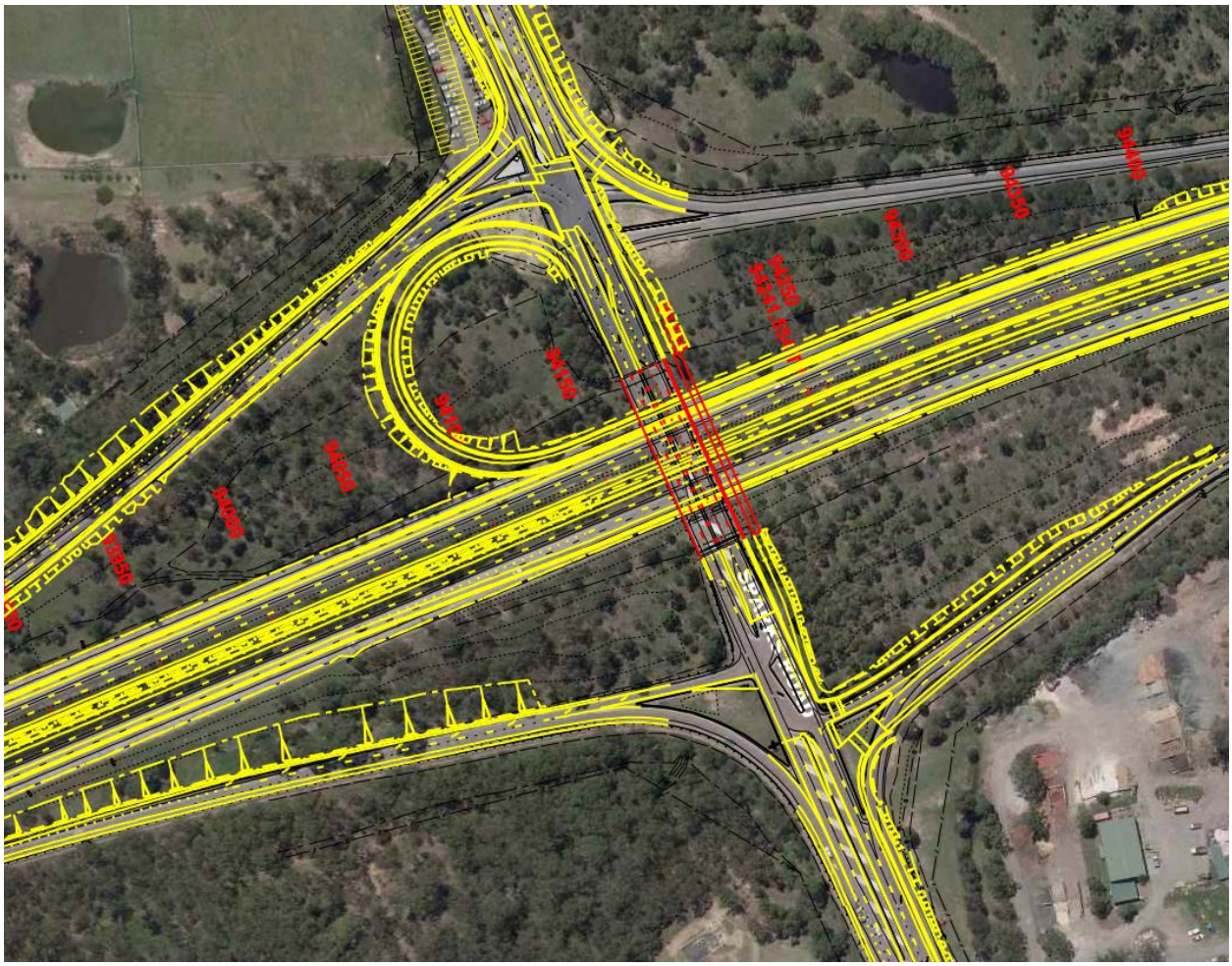


Figure 5.4 Sparks Road Interchange – preferred option 17E, 17F (loop ramp)

5.3.3 Doyalson Link Road Interchange

The first round of project modelling uncovered problems in the northbound section of motorway between Sparks Road and Doyalson Link Road. The original design included a standard northbound merge and diverge arrangement between these interchanges, as per the existing arrangement. Due to the increase in traffic volumes and the small distance between the interchanges, congestion occurred in this area due to the merge and diverge weaving movements. To solve this problem Roads and Maritime began exploring options to introduce some form of grade separation between the Doyalson Link Road northbound off-load manoeuvre and the Sparks Road northbound on-ramp manoeuvre.

Roads and Maritime considered that if an efficient option could be developed which provided this grade separation, then two key benefits would accrue. Firstly, the elimination of the weaving would enhance the safe operation of the motorway. Secondly, the elimination of the weave and subsequent jockeying for position between onloading and offloading vehicles would improve the operation of the motorway. This resulted in development of the preferred options 17E and 17F (the Sparks Road Interchange arrangement is shown in Figure 5.4).

Options 17E and 17F provide three lanes northbound between the Sparks Road Interchange and Doyalson Link Road. The northbound ramps from Sparks Road remain separated from the Motorway mainline until the Doyalson Link Road Interchange where they travel over the Doyalson Link Road exit to merge with the Motorway at that point. This arrangement is shown in Figure 5.5.

Figure 5.5 Doyalson Link Road Interchange – preferred option (17E, 17F)

It has been identified that a small volume of traffic accessing Doyalson Link Road to and from the M1 Motorway north utilise the Sparks Road Interchange to U-turn. B-Doubles in particular were identified performing this manoeuvre during site visits. Roads and Maritime requested that Option 17F, which includes north facing ramps at Doyalson Link Road, be included in the final stage of modelling. The arrangement of these ramps is shown in blue in Figure 5.6.

Figure 5.6 Doyalson Link Road Interchange – north facing ramps, Option 17F

6. Modelling results

This section outlines the results of the modelling conducted for the base case and the upgraded motorway scenario. For a description of the network assumed for each of the scenarios, refer to section 5.2. All results are based on the low growth scenario. The total forecast traffic volumes for each year are provided in Appendix E. A description of the assessment criteria used is provided in Appendix B.

6.1 Opening year 2019

Traffic model results for the 2019 AM and PM periods are shown below.

6.1.1 Intersection level of service

Table 6.1 shows the main intersection LoS for the year 2019. Detailed intersection approach delay and LoS are shown in Appendix G.

Table 6.1 Intersection level of service 2019

Intersection	BASE		Option 17E		Option 17F	
	LoS (AM/PM)	Delay (AM/PM)	LoS (AM/PM)	Delay (AM/PM)	LoS (AM/PM)	Delay (AM/PM)
Woodbury Park Drive - Wyong Road - Tonkiss Street	F/C*	>110/31	F/B*	>110/26	F/C*	>110/30
M1- Wyong Road Interchange East	E/D*	70/56	F/D*	77/55	F/D*	73/53
M1- Wyong Road Interchange West	B/B	25/25	B/B	24/24	B/B	24/24
Hue Hue Road – Sparks Road	B/B*	21/17	B/B*	25/25	B/B*	25/25
M1 -Sparks Road Interchange West	C/C	34/31	C/B	30/28	C/B	30/28
M1 -Sparks Road Interchange East	D/D*	56/51	B/B	23/22	B/B	22/23
Burnet Road - Sparks Road	C/B*	41/24	B/A	19/14	B/A	20/14

* LoS for these priority controlled intersections is determined based on the worst approach/movement

By 2019 both Option 17E and 17F, show improved performance at Sparks Road Interchange where Sparks Road – East interchange shows over 25 seconds reduction in overall delay. Both options do not improve the Wyong Road performance at Tonkiss Road and M1 interchange as there is no change to the network on Wyong Road.

6.1.2 Motorway travel times and travel speed

Table 6.2 shows average motorway travel time for vehicles travelling between Doyalson Link Road and Wyong Road in both directions.

Table 6.2 Travel time 2019

Motorway Direction	BASE		Option 17E		Option 17F	
	Average travel time (AM/PM)	Average travel speed (AM/PM)	Average travel time (AM/PM)	Average travel speed (AM/PM)	Average travel time (AM/PM)	Average travel speed (AM/PM)
Northbound	390/405	95/92	380/390	98/95	380/390	98/95
Southbound	440/395	83/92	365/345	100/105	360/345	101/105

Traffic modelling results for the base network, by the year 2019, during the AM peak indicate no major impact will be observed for northbound traffic whilst the traffic speed in the southbound direction will operate with an average speed under 83 km/h in the AM peak, which represents congested conditions.

Traffic modelling results for the base network, by the year 2019, during the PM peak indicate no major impact will be observed on the motorway travel speed.

The upgrade option shows that the average travel time and travel speed for vehicles traveling between Doyalson Link Road and Wyong Road are significantly improved along the motorway. The observed travel speed along the motorway section is close to those of the posted speed limit for the southbound direction. The northbound direction also shows minor improvement along the upgraded section.

6.1.3 Motorway mainline level of service

Table 6.3 show the Pacific Motorway mainline LoS at the service station and at Sparks Road.

Table 6.3 Motorway mainline level of service 2019

Section	Peak time period	Direction	BASE			Option 17E			Option 17F		
			Link speed (km/h)	Link volume (pcu)	LOS	Link speed (km/h)	Link volume (pcu)	LOS	Link speed (km/h)	Link volume (pcu)	LOS
Pacific Motorway at Service Station	7.00–8.00	NB	108	2036	B	102	2026	A	104	2017	A
		SB	92	2815	C	97	2787	B	99	2792	B
	8.00–9.00	NB	106	2067	B	104	2072	A	105	2055	A
		SB	85	3142	D	101	3124	B	100	3135	B
Pacific Motorway at Sparks Road	7.00–8.00	NB	99	1568	B	104	1558	A	101	1578	A
		SB	103	2004	B	102	2001	A	103	2025	A
	8.00–9.00	NB	95	1619	B	100	1609	A	101	1613	A
		SB	102	2170	B	105	2151	A	105	2147	A

Section	Peak time period	Direction	BASE			Option 17E			Option 17F		
			Link speed (km/h)	Link volume (pcu)	LOS	Link speed (km/h)	Link volume (pcu)	LOS	Link speed (km/h)	Link volume (pcu)	LOS
Pacific Motorway at Service Station	15.00–16.00	NB	101	2950	C	101	2937	B	102	2945	B
		SB	97	2445	C	102	2405	B	99	2428	B
	16.00–17.00	NB	102	2920	C	101	2938	B	102	2935	B
		SB	99	2360	C	99	2378	B	101	2375	B
Pacific Motorway at Sparks Road	15.00–16.00	NB	94	2116	B	99	2110	A	102	2116	A
		SB	103	1937	B	105	1921	A	104	1918	A
	16.00–17.00	NB	96	2184	B	100	2166	A	98	2168	A
		SB	102	1902	B	103	1900	A	103	1918	A

The traffic modelling results indicate that for the base case, by the year 2019, no major impact will be observed in the motorway performance with only a minor reduction in spot speeds.

Both Option 17E and Option 17F, show minor improved motorway spot speed at the Sparks Road Interchange and near the service stations in both directions. As a result both options show improvements in Level of service in both directions.

6.1.4 Motorway merge section performance

Table 6.4 shows the speeds at the Pacific Motorway merges at the motorway interchanges. The time period for this data is 8.00–9.00 am and 16.00–17.00 pm.

Table 6.4 Motorway merge section performance 2019

Section	Direction	Average speed (km/h)		
		BASE (AM/PM)	Option 17E (AM/PM)	Option 17F (AM/PM)
Doyalson Link Road Ramp	SB	100/100	104/108	105/107
Sparks Road Ramp	NB	86/82	97/103	99/101
Sparks Road Ramp	SB	101/107	107/110	107/110
Wyong Road Ramp	NB	111/111	118/118	119/119
Wyong Road Ramp	SB	104/103	105/107	106/108

The base case traffic modelling results indicate that the Sparks Road northbound ramp operates at a low level of service. Traffic modelling results indicates both Option 17E and 17F significantly improve these results.

6.1.5 General network statistics and unreleased demand

Table 6.5 shows the general network statistics and overall network release percentage.

Table 6.5 Network statistics and release rate 2019

Network	AM peak				PM peak			
	Network speed (km/h)	VKT	VHT	Overall demand release	Network speed (km/h)	VKT	VHT	Overall demand release
BASE	80	190,201	2,385	100%	84	200,273	2,395	100%
Option 17E	84	190,214	2,264	100%	87	200,277	2,314	100%
Option 17F	85	189,219	2,234	100%	86	200,045	2,313	100%

The traffic modelling results indicate the traffic network will operate at an overall network speed of 80 to 84 km/h during the base case. The traffic models indicate no unmet traffic demand during both AM and PM peak.

For the upgrade options the general network performance indicators show some minor improvements in the overall network speed. The network average speed shows up to a 5 km/h increase compared to the base case.

6.2 Year 2029

Traffic model results for the base case network and the upgrade network for 2029 AM and PM periods are shown below.

6.2.1 Intersection level of service

Table 6.6 shows the main intersection LoS for the year 2029. Detailed intersection approach delay and LoS are shown in Appendix G.

Table 6.6 Intersection level of service 2029

Intersection	BASE		Option 17E		Option 17F	
	LoS (AM/PM)	Delay (AM/PM)	LoS (AM/PM)	Delay	LoS	Delay
Woodbury Park Drive - Wyong Road - Tonkiss Street	F/B*	467/28	F/C*	254/30	F/C*	250/34
M1- Wyong Road Interchange East	E/E*	66/69	F/E*	82/67	F/E*	87/69
M1- Wyong Road Interchange West	B/B	24/25	B/B	24/26	B/B	24/25
Hue Hue Road – Sparks Road	B/B*	22/18	B/B*	25/25	B/B*	25/25
M1 -Sparks Road Interchange West	D/E	48/63	C/C	30/29	C/B	30/28

Intersection	BASE		Option 17E		Option 17F	
	LoS (AM/PM)	Delay (AM/PM)	LoS (AM/PM)	Delay	LoS	Delay
M1 -Sparks Road Interchange East	F/F*	263/156	B/B	26/25	B/B	22/23
Burnet Road - Sparks Road	F/B*	90/23	B/B	21/15	B/B	21/15

* LoS for these priority controlled intersections is determined based on the worst approach/movement

During the base case scenario, the results of the traffic modelling indicate that the M1 interchanges at Sparks Road and Wyong Road will operate at over capacity conditions. This condition is most noticeable at the Sparks Road intersections with M1 and Burnet Road.

By the year 2029 under both upgrade options, overall intersection LoS shows a significant performance improvement at Sparks Road intersections with M1 and Burnet Road. However limited improvement is observed at Wyong Road intersections with M1 and Tonkiss Street.

6.2.2 Motorway travel times and travel speed

Table 6.7 shows the average motorway travel time for vehicles travelling between Doyalson Link Road and Wyong Road in both directions.

Table 6.7 Travel time 2029

Motorway Direction	BASE		Option 17E		Option 17F	
	Average travel time (AM/PM)	Average travel speed (AM/PM)	Average travel time (AM/PM)	Average travel speed (AM/PM)	Average travel time (AM/PM)	Average travel speed (AM/PM)
Northbound	395/410	94/91	380/395	98/94	380/395	98/94
Southbound	470/395	77/92	370/355	98/103	375/350	97/104

The results of the base case traffic modelling show a significant travel speed reduction along the motorway southbound direction in the AM peak.

For the upgrade option the average travel time and travel speed for vehicles traveling between Doyalson Link Road and Wyong Road show a large degree of improvement along the motorway section. The traffic modelling shows average travel speeds of over 94 km/h in both directions of the motorway under both upgrade options. The traffic modelling results also indicate significant improvements in the southbound direction during AM peak is achieved for both upgrade scenarios with over 20 km/h increase in the travel speed.

6.2.3 Motorway mainline level of service

Table 6.8 shows the Pacific Motorway main line level of service at the service station and Sparks Road.

Table 6.8 Motorway mainline level of service 2029

Section	Peak time period	Direction	BASE			Option 17E			Option 17F		
			Link speed (km/h)	Link volume (pcu)	LOS	Link speed (km/h)	Link volume (pcu)	LOS	Link speed (km/h)	Link volume (pcu)	LOS
Pacific Motorway at Service Station	7.00–8.00	NB	103	2190	B	104	2171	A	102	2164	A
		SB	89	3119	D	95	3118	B	94	3133	B
	8.00–9.00	NB	103	2205	B	103	2120	A	104	2136	A
		SB	81	3420	D	98	3395	C	98	3408	C
Pacific Motorway at Sparks Road	7.00–8.00	NB	92	1733	B	100	1735	A	100	1728	A
		SB	103	2151	B	104	2133	A	102	2153	A
	8.00–9.00	NB	93	1664	B	103	1671	A	102	1686	A
		SB	103	2193	B	105	2180	A	105	2170	A
Pacific Motorway at Service Station	15.00–16.00	NB	99	3079	C	102	3084	B	102	3102	B
		SB	98	2402	C	103	2406	B	101	2427	B
	16.00–17.00	NB	98	3030	C	101	3036	B	100	3030	B
		SB	97	2452	C	102	2476	B	97	2414	B
Pacific Motorway at Sparks Road	15.00–16.00	NB	95	2053	B	103	2095	A	101	2119	A
		SB	105	1835	B	106	1844	A	106	1843	A
	16.00–17.00	NB	89	2190	C	100	2145	A	99	2146	A
		SB	103	1924	B	104	1926	A	104	1909	A

The traffic modelling results indicate that for the base case, by the year 2029, minor impacts will be observed on the motorway spot speed. A few of the locations begin to register as LoS D in the AM peak southbound.

Both Option 17E and Option 17F, show improved motorway spot speed and level of service at the Sparks Road Interchange and the service stations in both directions.

6.2.4 Motorway merge section performance

Table 6.9Table 6.9 shows the speeds at the Pacific Motorway merges at the motorway interchanges. The time period for this data is 8.00–9.00 am and 16.00–17.00 pm.

Table 6.9 Motorway merge section performance 2029

Section	Direction	Average speed (km/h)		
		BASE (AM/PM)	Option 17E (AM/PM)	Option 17F (AM/PM)
Doyalson Link Road Ramp	SB	90/95	101/104	105/106
Sparks Road Ramp	NB	86/70	94/103	97/101
Sparks Road Ramp	SB	99/107	107/110	107/110
Wyong Road Ramp	NB	110/108	117/115	117/116
Wyong Road Ramp	SB	103/100	101/106	99/106

For the base case, the model results of the merge section performance show adverse impacts at the southbound Doyalson Link Road ramp and the northbound Sparks Road ramp. The southbound Doyalson Link Road ramp drops 10km/h in the AM peak compared to 2019.

For the upgrade option the traffic modelling results indicate motorway merge sections will continue to operate at good level of service in the year 2029 under both design options.

6.2.5 General network statistics and unreleased demand

Table 6.10 shows the general network statistics and overall network release percentage.

Table 6.10 Network statistics and release rate 2029

Network	AM peak				PM peak			
	Network speed (km/h)	VKT	VHT	Overall demand release	Network speed (km/h)	VKT	VHT	Overall demand release
BASE	76	206,311	2,732	100%	81	212,577	2,639	100%
Option 17E	82	206,429	2,508	100%	84	212,639	2,534	100%
Option 17F	82	203,313	2,467	100%	85	210,544	2,488	100%

For the base case the general network statistics show a network speed reduction during the AM peak.

For the upgrade options the general network performance indicators show major improvements in the overall network speed during the AM peak. The network average speed shows up to a 7 km/h increase under both design options. PM peak models also indicate minor improvement in the overall network speed up to 5 km/h.

6.3 Year 2039

Traffic model results for the base case network and the upgrade network for 2039 AM and PM periods are shown below.

6.3.1 Intersection level of service

Table 6.11 shows the main intersection LoS for the year 2039. Detailed intersection approach delay and LoS are shown in Appendix G.

Table 6.11 Intersection level of service 2039

Intersection	BASE		Option 17E		Option 17F	
	LoS (AM/PM)	Delay (AM/PM)	LoS (AM/PM)	Delay (AM/PM)	LoS (AM/PM)	Delay (AM/PM)
Woodbury Park Drive - Wyong Road - Tonkiss Street	F/C*	235/38	F/C*	159/35	F/C*	174/31
M1- Wyong Road Interchange East	N/A*	N/A	N/A*	N/A	N/A*	N/A
M1- Wyong Road Interchange West	B/B	26/26	B/B	27/28	B/B	27/27
Hue Hue Road – Sparks Road	C/B*	29/23	B/B*	26/25	B/B*	26/25
M1 -Sparks Road Interchange West	F/E	76/65	C/C	29/30	C/C	29/29
M1 -Sparks Road Interchange East	F/F*	492/737	B/B	25/26	B/B	23/24
Burnet Road - Sparks Road	F/C*	88/36	B/B	21/16	B/B	22/16

* LoS for these priority controlled intersections is determined based on the worst approach/movement

For the base case scenario the results of the traffic modelling indicate that most of the major intersections in the traffic network will be over capacity for both the AM and PM peaks. This condition is more noticeable at the Sparks Road intersections.

The Wyong Road intersections show low intersection delay due to heavy congestion in the network. This causes limited vehicle arrival at the Wyong Road Interchange which results in improved intersection operation, which is a false reading (hence ‘Not Applicable’ or N/A).

By the year 2039 for the upgrade option the overall intersection LoS shows a significant performance improvement compared to the base case scenario. It is evident that the proposed improvements at the Sparks Road Interchange have improved the overall intersection operation by the year 2039 for both upgrade options.

6.3.2 Motorway travel times and travel speed

Table 6.12 show the average motorway travel time for vehicles travelling between Doyalson Link Road and Wyong Road in both directions.

Table 6.12 Travel time 2039

Motorway direction	BASE		Option 17E		Option 17F	
	Average travel time (AM/PM)	Average travel speed (AM/PM)	Average travel time (AM/PM)	Average travel speed (AM/PM)	Average travel time (AM/PM)	Average travel speed (AM/PM)
Northbound	400/440	93/84	380/405	98/92	380/400	98/93
Southbound	480/465	76/78	375/350	97/104	370/355	98/103

For the base case scenario the results of the traffic modelling show significant travel speed reduction along the motorway southbound.

For the upgrade option the average travel time and travel speed for vehicles traveling between Doyalson Link Road and Wyong Road show a large degree of improvement along the Motorway. The traffic modelling shows an average travel speed of over 92 km/h for the northbound direction and over 97 km/h for the southbound direction for both upgrade options.

6.3.3 Motorway mainline level of service

Table 6.13 show the Pacific Motorway main line level of service at the service station and Sparks Road.

Table 6.13 Motorway mainline level of service 2039

Section	Peak time period	Direction	BASE			Option 17E			Option 17F		
			Link speed (km/h)	Link volume (pcu)	LOS	Link speed (km/h)	Link volume (pcu)	LOS	Link speed (km/h)	Link volume (pcu)	LOS
Pacific Motorway at Service Station	7.00–8.00	NB	106	2286	B	101	2321	B	102	2302	B
		SB	91	3198	D	97	3232	B	94	3210	B
	8.00–9.00	NB	99	2283	C	102	2253	A	98	2267	B
		SB	84	3558	D	92	3703	C	92	3715	C
Pacific Motorway at Sparks Road	7.00–8.00	NB	89	1833	B	101	1822	A	104	1797	A
		SB	103	2195	B	102	2197	A	101	2191	A
	8.00–9.00	NB	90	1726	B	102	1715	A	97	1720	A
		SB	97	2382	C	103	2364	B	102	2370	B

Section	Peak time period	Direction	BASE			Option 17E			Option 17F		
			Link speed (km/h)	Link volume (pcu)	LOS	Link speed (km/h)	Link volume (pcu)	LOS	Link speed (km/h)	Link volume (pcu)	LOS
Pacific Motorway at Service Station	15:00-16:00	NB	92	3371	D	100	3374	B	100	3368	B
		SB	98	2482	C	98	2615	B	99	2606	B
	16:00-17:00	NB	92	3338	D	100	3343	B	97	3318	B
		SB	98	2132	B	102	2656	B	102	2646	B
Pacific Motorway at Sparks Road	15:00-16:00	NB	97	2225	B	99	2285	B	102	2244	A
		SB	103	1853	B	105	2001	A	104	2016	A
	16:00-17:00	NB	97	2251	C	102	2257	A	97	2302	B
		SB	98	1512	B	104	2043	A	104	2034	A

For the base case the spot travel speed results indicate speed drops and flow constraints at various locations along the motorway. In particular the motorway exhibits flow breakdown southbound in the vicinity of Sparks Road in both the AM and PM peaks. It can be seen that these areas handle lower traffic volumes, which means that upstream congestion is limiting the traffic flow to the motorway. Overall the motorway is operating in significantly congested conditions for the base case.

For the upgrade option the results at the above locations indicate significant travel speed and link level of service improvements on the Pacific Motorway. Overall the analysis indicates acceptable motorway performance with all level of service generally around A and B and spot speeds greater than 92km/h.

6.3.4 Motorway merge section performance

Table 6.14 shows the speeds at the Pacific Motorway merges at the motorway interchanges. The time period for this data is 8.00–9.00 am and 16.00–17.00 pm.

Table 6.14 Motorway merge section performance 2039

Section	Direction	Average speed (km/h)		
		BASE (AM/PM)	Option 17E (AM/PM)	Option 17F (AM/PM)
Doyalson Link Road Ramp	SB	67/15	102/101	104/105
Sparks Road Ramp	NB	81/77	93/102	97/101
Sparks Road Ramp	SB	93/110	105/110	104/110
Wyong Road Ramp	NB	109/108	116/116	117/116
Wyong Road Ramp	SB	98/104	101/104	97/107

For the base case the model results of the merge section performance show significant adverse impact on the merge section performance at the southbound Doyalson Link Road ramp and the northbound Sparks Road ramp, with minor impacts in other areas. Areas that show reasonable performance should be read in conjunction with the overall motorway performance, which is operating under heavily congested conditions which results in lower volumes of vehicles arriving at the merge section of the freeway.

For the upgrade scenario the traffic modelling results indicate that the motorway merge sections will continue to operate at a good level of service by the year 2039.

6.3.5 General network statistics and unreleased demand

Table 6.15 shows the general network statistics and overall network release percentage.

Table 6.15 Network statistics and release rate 2039

Network	AM peak				PM peak			
	Network speed (km/h)	VKT	VHT	Overall demand release	Network speed (km/h)	VKT	VHT	Overall demand release
BASE	54	217,070	4,047	96%	59	232,807	3,964	99%
Option 17E	82	217,255	2,636	100%	84	232,890	2,773	100%
Option 17F	83	214,517	2,595	100%	84	230,495	2,732	100%

For the base case the general network statistics show a significant network speed reduction during both peak periods. This indicates extended congestion in the road networks which lead to an extended peak period as a result of network grid lock.

For the upgrade options the general network performance indicators show major improvements to the overall network speed and release rate. The network average speed shows significant improvement compared to the base case scenario. The improvement of the overall network performance is more noticeable during the PM peak, where a demand release percentage of over 100% is achieved and the overall network speed is improved by 26 km/h.

6.4 Year 2049

Traffic model results for the base case network and the upgrade network for 2049 AM and PM periods are shown below.

6.4.1 Intersection level of service

Table 6.16 shows the main intersection LoS for the year 2049. Detailed intersection approach delay and LoS are shown in Appendix G.

Table 6.16 Intersection level of service 2049

Intersection	BASE		Option 17E		Option 17F	
	LoS (AM/PM)	Delay (AM/PM)	LoS (AM/PM)	Delay (AM/PM)	LoS (AM/PM)	Delay (AM/PM)
Woodbury Park Drive - Wyong Road - Tonkiss Street	C/C*	29/38	E/C*	57/34	E/C*	70/35
M1- Wyong Road Interchange East	N/A*	N/A	F/F*	195/229	F/F*	190/232
M1- Wyong Road Interchange West	C/B	37/26	C/C	34/33	C/C	37/33
Hue Hue Road – Sparks Road	F/B*	796/23	B/B*	25/26	B/B*	25/26
M1 -Sparks Road Interchange West	F/E	187/65	C/C	31/34	C/C	30/33
M1 -Sparks Road Interchange East	F/F*	993/737	B/C	30/30	B/B	27/27
Burnet Road - Sparks Road	F/C*	195/36	C/B	42/18	D/B	43/18

* LoS for these priority controlled intersections is determined based on the worst approach/movement

For the base case the results of the traffic modelling indicate that most of the major intersections in the traffic network will be over capacity for both the AM and PM peaks. The Wyong Road intersections show low intersection delay due to heavy congestion in the network. This causes limited vehicle arrival at the Wyong Road Interchange which results in improved intersection operation, which is a false reading (hence N/A).

By the year 2049 under the upgrade option the overall intersection LoS shows a degree of performance improvement compared to the base case scenario. It is evident that the proposed road upgrades have improved the overall intersection operation at the Sparks Road Interchange. Both options also indicate heavy congestion at Wyong Road intersection with M1 and Tonkiss Street.

6.4.2 Motorway travel times and travel speed

Table 6.17 shows the average motorway travel time for vehicles travelling between Doyalson Link Road and Wyong Road in both directions.

Table 6.17 Travel time 2049

Motorway Direction	BASE		Option 17E		Option 17F	
	Average travel time (AM/PM)	Average travel speed (AM/PM)	Average travel time (AM/PM)	Average travel speed (AM/PM)	Average travel time (AM/PM)	Average travel speed (AM/PM)
Northbound	405/510	92/73	380/410	98/91	380/405	98/92
Southbound	545/690	67/53	660/775	55/47	685/835	53/44

For the base case the results of the traffic modelling show significant travel speed reductions along the motorway in both directions.

For the upgrade option and for the northbound direction, the average travel time and travel speed for vehicles traveling between Doyalson Link Road and Wyong Road show a large degree of improvement along the Motorway.

However all traffic models indicate significant congestion in the southbound direction. This is due to the operation of the southbound off ramp at Wyong Road Interchange. This approach shows extended queues from the Wyong road Interchange which severely impacts the mainline traffic for all models.

6.4.3 Motorway mainline level of service

Table 6.18 shows the Pacific Motorway main line level of service at the service station and Sparks Road.

Table 6.18 Motorway mainline level of service 2049

Section	Peak time period	Direction	BASE			Option 17E			Option 17F		
			Link speed (km/h)	Link volume (pcu)	LOS	Link speed (km/h)	Link volume (pcu)	LOS	Link speed (km/h)	Link volume (pcu)	LOS
Pacific Motorway at Service Station	7.00–8.00	NB	96	2445	C	101	2379	B	101	2384	B
		SB	95	3105	C	93	3462	C	94	3471	C
	8.00–9.00	NB	102	2367	C	98	2330	B	99	2308	B
		SB	96	2494	C	51	3650	E	38	3503	F
Pacific Motorway at Sparks Road	7.00–8.00	NB	86	1820	B	97	1827	A	100	1824	A
		SB	101	2155	B	106	2224	A	105	2225	A
	8.00–9.00	NB	93	1791	B	102	1761	A	104	1745	A
		SB	99	1224	A	104	2441	B	102	2452	B

Section	Peak time period	Direction	BASE			Option 17E			Option 17F		
			Link speed (km/h)	Link volume (pcu)	LOS	Link speed (km/h)	Link volume (pcu)	LOS	Link speed (km/h)	Link volume (pcu)	LOS
Pacific Motorway at Service Station	15.00–16.00	NB	81	3512	D	98	3558	C	98	3518	C
		SB	102	2351	C	100	2904	B	92	2943	B
	16.00–17.00	NB	26	3580	F	102	3592	C	98	3608	C
		SB	99	2223	B	99	2831	B	100	2819	B
Pacific Motorway at Sparks Road	15.00–16.00	NB	96	2118	B	102	2259	A	101	2222	A
		SB	103	1531	A	104	2194	A	103	2210	A
	16.00–17.00	NB	92	2353	C	103	2349	B	99	2343	B
		SB	101	1412	A	106	2173	A	106	2133	A

For the base case the link volume results indicate significant flow breakdown at various locations along the motorway. It can be seen that at most locations the base case caters for much lower traffic volumes, which means that upstream congestion is limiting the traffic flow on the motorway. Overall the motorway is operating in significantly congested conditions for the base case. This can provide deceiving results at some locations. For example in the AM peak at the service station southbound the base case carries approximately 1200 pcu's less than the upgrade options. This results in a LoS C compared to LoS E and F for the upgrade options. This is due to complete flow break down in the base case scenario. In general this is worse in the southbound direction than it is in the northbound direction.

The results at the above locations indicate that a greater throughput of traffic is possible for the upgraded options. Most links cater to much higher traffic volumes than the base case due to the release of upstream capacity constraints. Overall the 2049 analysis shows that the upgrade options begin to fail at certain locations, such as southbound at the service station in the AM peak. The results show a significant speed drop along the motorway AM peak in the southbound direction. This is due to queuing from the Wyong Road Interchange ramp.

6.4.4 Motorway merge section performance

Table 6.19 shows the speeds at the Pacific Motorway merges at the motorway interchanges. The time period for this data is 8.00–9.00 am and 16.00–17.00 pm.

Table 6.19 Motorway merge section performance 2049

Section	Direction	Average speed (km/h)		
		BASE (AM/PM)	Option 17E (AM/PM)	Option 17F (AM/PM)
Doyalson Link Road Ramp	SB	13/14	96/92	101/103
Sparks Road Ramp	NB	83/79	88/102	92/100
Sparks Road Ramp	SB	110/112	91/109	79/110
Wyong Road Ramp	NB	110/102	115/114	116/111
Wyong Road Ramp	SB	106/105	102/110	103/107

Except at the southbound Doyalson Link Road ramp and the Sparks Road northbound ramp, the base case model results of the merge section performance do not show any adverse impacts. However this set of results should be read in conjunction with the overall motorway performance, which is operating under heavily congested conditions, which lowers the volumes of vehicles arriving at the merge section of the freeway. This provides a false result.

The upgrade options generally indicate improved performance at the merge areas, in particular at the Doyalson Link Road ramp. These options also cater for much higher traffic volumes as upstream traffic constraints are released due to increased network capacity.

6.4.5 General network statistics and unreleased demand

Table 6.20 shows the general network statistics and overall network release percentage.

Table 6.20 Network statistics and release rate 2049

Network	AM peak				PM peak			
	Network speed (km/h)	VKT	VHT	Overall demand release	Network speed (km/h)	VKT	VHT	Overall demand release
BASE	30	236,712	7,889	66%	37	249,646	6,713	85%
Option 17E	54	236,653	4,414	100%	53	252,494	4,768	100%
Option 17F	54	233,608	4,334	100%	51	249,969	4,870	100%

For the base case the general network statistics show a significant network speed reduction during both peak periods. The base models also show a significant amount of unmet demand which leads to an extended peak period. All traffic models show a significant drop in overall network speed.

For both upgrade options the general network performance indicators show major improvements in the overall network speed and release rate. The network average speed shows up to a 16 km/h increase compared to the base case scenario. The improvement of the overall network performance is more noticeable when referring to the network release rate where a 100% release rate is achieved.

7. Crash analysis

This section presents a crash data analysis of the Pacific Motorway over a five year period and identifies the impacts on road safety based on the concept design of the proposed Pacific Motorway widening. The north facing ramps at Doyalson Link Road were not considered in the crash analysis.

7.1 Crash history

The latest crash data was obtained from Roads and Maritime for the five year period between 1 July 2007 and 30 June 2012 to estimate the recent accident patterns in the study area. The data was collated for the following road sections:

- Pacific Motorway from 250 m south of the Tuggerah Interchange to 250 m north of the Doyalson Link Road Interchange
- Wyong Road between Tonkiss Street and Cobbs Road
- Sparks Road between Hue Hue Road and Burnet Road
- Doyalson Link Road between the on/off ramps to the Pacific Motorway and the western end of the four-lane, two-way section (approximately 1.7 km west of Tooheys Road Interchange).

Refer to Appendix H for the raw Roads and Maritime crash data.

A review of the crash data indicates that 282 reported crashes have been recorded on the assessed road sections. These include two fatal crashes, 108 injury crashes and 172 non-casualty crashes. The crashes are classified as shown in Table 7.1.

Table 7.1 Summary of crash data (July 2007 to June 2012)

Total number of crashes	Crashes			Total number of casualties	Casualties	
	Fatal	Injury	Non-Casualty		Killed	Injured
282	2 (0.7%)	108 (38.3%)	172 (61.0%)	161	2 (1.2%)	159 (98.8%)

Analysis of the location of recorded crashes indicated that:

- 209 out of 282 crashes (74.1%) occurred on the Pacific Motorway including:
  - 71 casualty crashes - two fatal crashes and 69 injury crashes
  - 138 non-casualty crashes
- 73 out of 282 crashes (25.9%) occurring on other sections of road include:
  - 39 casualty crashes
  - 34 non-casualty crashes.

7.2 Predominant crash types

Analysis of the type of crashes on the Pacific Motorway indicates:

- over the five year period, the most common crash type was off-road on-straight then hit object. 80 out of 282 crashes (28.4%) occurred along the Pacific Motorway. Also on the Pacific Motorway there were 25 off-road on-curve then hit object crashes (8.9%) and 23 off-road on straight crashes (8.2%)
- rear-end crashes were the second most common crash type. 65 out of 282 (23.0%) were reported as rear-end type crashes
- a total of 26 (9.2%) lane change collisions occurred.

Figure 7.1shows the number of crashes per crash movement within the study area for the period July 2007 to June 2012.

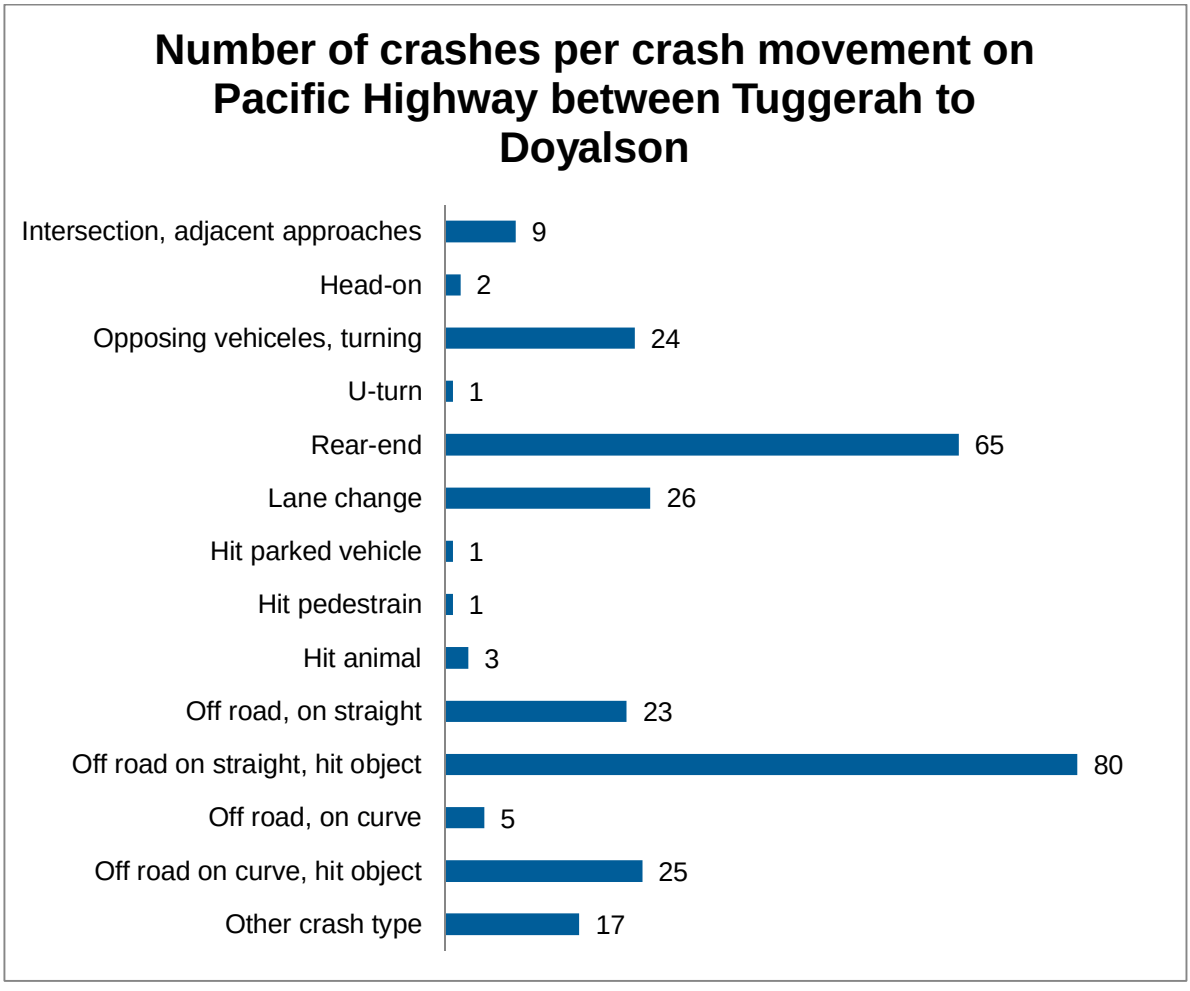


Figure 7.1 Pacific Motorway crash movements

7.3 Comparison with a similar section of Motorway

Existing crash rates have been determined for the crashes that were reported on the Pacific Motorway between Wyong Road Interchange and Doyalson Link Road Interchange during the crash data period. Existing crash rates are also determined for a nearby section of the Pacific Motorway between Mandalong Road Interchange and Palmers Road Interchange which also has a dual carriageway configuration with two travel lanes in each direction.

Note that this analysis excluded crashes that occurred on Wyong Road, Sparks Road and Doyalson Link Road in order to compare the existing crash rate on the Pacific Motorway mainline.

Table 7.2 shows the assumptions used in determining the existing crash rates.

Table 7.2 Assumptions used in determining existing crash rates

	Project road section (between Wyong Road Interchange and Doyalson Link Road Interchange)	Nearby road section (between Mandalong Road Interchange and Palmers Road Interchange)
Number of fatal crashes per year	2	0
Number of casualty crashes per year	108	54
Number of overall crashes per year	209	166
ADT[1] (2010)	65007[2]	35930[3]
Length of road section (km)	11.4	16

Source: Roads and Maritime

(1) Average Daily Traffic (ADT) data was used for year 2010 as AADT data was not available
(2) As measured at counting station 05.007 on the Pacific Motorway at Alison Road overpass
(3) Average ADT data of two counting stations was adopted, measured at counting station 05.222 on the Pacific Motorway at Hue Hue Road overpass and counting station 05.098 on the Pacific Motorway at Palmers Road overpass.

Table 7.3 shows the existing crash rates of the two Pacific Motorway sections.

Table 7.3 Existing crash rates on the Pacific Motorway

	Project road section (between Wyong Road Interchange and Doyalson Link Road Interchange)		Nearby road section (between Mandalong Road Interchange and Palmers Road Interchange)	
	No. of crashes per 100 MVKT	No. of crashes per km/year	No. of crashes per 100 MVKT	No. of crashes per km/year
Fatal crashes	0.1	0.02	0.0	0.0
Casualty crashes	4.0	0.9	2.6	0.3
Overall crashes	7.7	1.8	7.9	1.0

(1) Notes: 100 MVKT stands for 100 million vehicle kilometres travelled

While two fatal crashes occurred in the project road section of the Pacific Motorway, there were no fatal crashes recorded on the nearby road section.

The crash rate in all crashes (7.7 crashes/100 MVKT) is slightly lower than that of the nearby road section (7.9 crashes/100 MVKT), but the number of overall crashes/km/year is higher in the study section of the Pacific Motorway. The crash rate in casualty crashes (4.0 crashes/100 MVKT or 0.9 crashes/km/year) is also higher than that of the nearby road section.

7.4 Crash savings

An impact on road safety would occur as a direct result of widening the Pacific Motorway, and upgrading the layout at Tuggerah, Sparks Road and Doyalson Link Road interchanges. Table 7.4 shows the impact on road safety associated with the concept design, based on the Roads and Maritime *Accident Reduction Guide Part 1: Accident Investigation and Prevention* (2004).

Table 7.4 Impact on road safety

Location	Concept design	No. of crashes occurred at this location by DCA type(between July 2007 and June 2012)	Percentage reduction in crashes by DCA type (based on Roads and Maritime guide)	Impact on road safety as a result of the proposed upgrade
Pacific Motorway between approximately 800 m north of the Tuggerah Interchange and Doyalson Link Road Interchange	Provision of an additional travel lane on the Pacific Motorway in each direction	■ DCA 201: one injury crash and one non-casualty crash ■ DCA 301-303: 15 injury crashes and 21 non-casualty crashes ■ DCA 305-307: seven injury crashes and 12 non-casualty crashes ■ DCA 701-702: nine injury crashes and six non-casualty crashes ■ DCA 703-704: two fatal crashes. 15 injury crashes and 40 non-casualty crashes ■ DCA 801-802: three non-casualty crashes ■ DCA 803-804: five injury crashes and 11 non-casualty crashes ■ Other DCA: seven injury crashes and six non-casualty crashes	■ 30% reduction in crashes involving off carriageway on straight section (DCA 701–702) and off carriageway on straight then hit object (DCA 703–704) ■ 20% reduction in crashes involving off carriageway on curve section (DCA 801–802) and off carriageway on curve then hit object (DCA 803–804).	Note that the Roads and Maritime accident reduction guide does not consider road widening as a crash reduction factor alone. Therefore it was proposed to assess the impact of 'overtake/climbing lanes' treatment to consider the road widening. Provision of an additional travel lane on the motorway is predicted to reduce off carriageway type crashes by 20 to 30% for single vehicle accidents.
	Provision of median safety barrier		■ 100% reduction in head-on crashes (DCA 201 & 501).	Provision of the safety barrier on the median of the Pacific Motorway is predicted to eliminate head-on crashes on the motorway.
	Provision of new pavement		■ 20% reduction in crashes involving off carriageway on straight section (DCA 701–702) and off carriageway on straight then hit object (DCA 703–704) ■ 30% reduction in crashes involving off carriageway on curve section (DCA 801–802) and off carriageway on curve then hit object (DCA 803–804).	Provision of new pavement on the motorway is predicted to reduce off carriage type crashes by 20 to 30% for single vehicle accidents.
Intersection of Wyong Road and the southbound on/off-ramps at the eastern side of Tuggerah Interchange	Provision of a roundabout for southbound on/off ramp traffic	■ DCA 101-109: one injury crash ■ DCA 202-206: two injury crashes and two non-casualty crashes ■ DCA 301-303: one injury crash and two non-casualty crashes ■ DCA 600: one non-casualty crash ■ DCA 701-702: one injury crash ■ DCA 801-802: one injury crash.	■ 70% reduction in crashes that occur at intersections involving vehicles from adjacent approaches (DCA 101–109) ■ 60% reduction in crashes involving opposite turning vehicles (DCA 202–206).	Provision of a new roundabout is predicted to reduce crashes between vehicles from adjacent approaches and turning vehicles at the intersection. This is because give-way rules at a roundabout intersection are clearer than at a priority controlled intersection.

Location	Concept design	No. of crashes occurred at this location by DCA type(between July 2007 and June 2012)	Percentage reduction in crashes by DCA type (based on Roads and Maritime guide)	Impact on road safety as a result of the proposed upgrade
Intersection of Wyong Road and the northbound on/off-ramps at the western side of Tuggerah Interchange	Provision of new traffic signals for northbound off ramp traffic and dedicated loop ramp for northbound on ramp traffic	▪ DCA 202-206: one injury crash ▪ DCA 301-303: two injury crashes and three non-casualty crashes ▪ DCA 703-704: one non-casualty crash.	▪ 90% reduction in crashes involving opposite turning vehicles (DCA 202–206) ▪ 40% increase in rear-end crashes (DCA 301–303).	Provision of new traffic signals is predicted to reduce angle-type crashes at the intersection as the traffic signals would separate the conflicting movements by time. The road improvement scheme may trade off an increase in rear-end crashes for a decrease in the angle-type crashes.
Intersection of Sparks Road and Burnet Road	Provision of a signalised intersection	▪ DCA 301-303: one injury crash ▪ DCA 707: one non-casualty crash ▪ DCA 800: one injury crash.	▪ 40% increase in rear-end crashes (DCA 301–303).	Provision of new traffic signals at the intersection is predicted to increase rear-end crashes.
Intersection of Sparks Road and the northbound on ramp at the western side of Sparks Road Interchange	Provision of dual right turn into the northbound on ramp and no filter turn allowed	▪ DCA 101-109: two injury crashes and four non-casualty crashes ▪ DCA 202-206: nine injury crashes and eight non-casualty crashes ▪ DCA 305-307: one non-casualty crash.	▪ 90% reduction in crashes involving opposite turning vehicles (DCA 202–206).	Provision of dual right turn lanes for the northbound on ramp traffic would almost eliminate the angle-type crashes at the intersection as the traffic signals would separate the conflicting movements by time and no filter turns would be allowed for the right turn movement. However, this upgrade may increase crashes that involve vehicles changing lanes where two northbound on ramp lanes merge into one lane.
Intersection of Sparks Road and the southbound on/off-ramps at the eastern side of Sparks Road Interchange	Provision of a signalised intersection	▪ DCA 101-109: two non-casualty crashes ▪ DCA 202-206: two injury crashes ▪ DCA 301-303: two non-casualty crashes ▪ DCA 601: one non-casualty crash ▪ DCA 703-704: one injury crash and one non-casualty crash.	▪ 60% reduction in crashes at intersections involving vehicles from adjacent approaches (DCA 101–109) ▪ 90% reduction in crashes involving opposite turning vehicles (DCA 202–206) ▪ 40% increase in rear-end crashes (DCA 301–303).	Provision of new traffic signals is predicted to reduce angle-type crashes at the intersection as the traffic signals would separate the conflicting movements by time. The road improvement scheme may trade off an increase in rear-end crashes for a decrease in the angle-type crashes.

Location	Concept design	No. of crashes occurred at this location by DCA type(between July 2007 and June 2012)	Percentage reduction in crashes by DCA type (based on Roads and Maritime guide)	Impact on road safety as a result of the proposed upgrade
Northbound off-ramp at Doyalson Link Road Interchange	Provision of a new northbound off ramp with reduced speed limit	▪ DCA 803-804: three injury crashes and one non-casualty crash (closing section of the northbound off-ramp).	▪ 60% reduction in off carriageway on curve into object type crashes ▪ Additional 15% reduction in off carriageway on curve into object type crashes.	The proposed northbound off ramp to Doyalson Link Road has higher radii than the existing off ramp. It is expected that lower exit speed would be introduced on the new off-ramp. Thus the number of off carriageway crashes would be decreased when motorists travel at a lower speed.

Source: Roads and Maritime's *Accident Reduction Guide Part 1: Accident Investigation and Prevention (2004)*

(1) DCA stands for Definition of Coding Accidents

7.5 Predicted crash rate

Table 7.5 shows the estimated number of crashes per year in 2019, 2029, 2039 and 2049 for the do-nothing case and the concept design along the section of the Pacific Motorway. These estimates are based on the historical crash data for the 5 year period between July 2007 and June 2012, and assume that the number of crashes would increase at the same rate as the traffic growth (low growth scenario) predicted to occur in the future assessment years. Crash reduction rates (refer to Table 7.4) are then applied to reflect the benefits of the concept design.

Table 7.5 Predicted crash rates on the Pacific Motorway

Year	Crash type	Do-nothing			Concept Design upgrade		
		No. of crashes per year	Crash rate (per 100 MVKT)	Crash rate (per km/year)	No. of crashes per year	Crash rate (per 100 MVKT)	Crash rate (per km/year)
2019	Overall crashes	62.0	10.4	2.7	47.8	8.0	2.1
	Injury crashes	23.8	4.0	1.0	17.4	2.9	0.8
	Fatal crashes	0.44	0.07	0.02	0.33	0.06	0.01
2029	Overall crashes	70.4	10.4	3.1	54.2	8.0	2.4
	Injury crashes	27.0	4.0	1.2	19.8	2.9	0.9
	Fatal crashes	0.50	0.07	0.02	0.37	0.06	0.02
2039	Overall crashes	75.8	10.4	3.3	58.4	8.0	2.6
	Injury crashes	29.0	4.0	1.3	21.3	2.9	0.9
	Fatal crashes	0.54	0.07	0.02	0.40	0.06	0.02
2049	Overall crashes	82.8	10.4	3.6	63.7	8.0	2.8
	Injury crashes	31.7	4.0	1.4	23.2	2.9	1.0
	Fatal crashes	0.59	0.07	0.03	0.44	0.06	0.02

By 2049, the predicted overall crash rates for the concept design upgrade (8.0 crashes/100 MVKT or 2.8 crashes/km/year) would be lower when compared with the do-nothing case (10.4 crashes/100 MVKT or 3.6 crashes/km/year).

8. Traffic and transport assessment summary

8.1 Overview

The traffic and transport impact of the proposal to widen the Pacific Motorway from four lanes to six lanes between Tuggerah and Doyalson has been assessed in this report. The assessment included the following key areas:

- Traffic modelling using the traffic micro-simulation software, Paramics. The traffic modelling was conducted for the years 2019, 2029, 2039 and 2049.
- A crash analysis assessment to determine the potential impact to crash rates as a result of the motorway upgrade.
- Potential impact to freight movements, public transport and pedestrian and cyclists.

The results and resultant impact for the assessment is summarised in the sections below.

8.2 Traffic impacts

The results showed the following traffic outcomes for the assessment of the project:

- Additional upgrades will be required in addition to the Roads and Maritime concept design to enable the local road network and motorway interchanges to function in the longer term. This is referred to as the upgrade option.
- The traffic modelling shows that the proposed widening of the Pacific Motorway would ensure that the motorway operates satisfactorily up to the year 2039 for all scenarios. In 2049 the motorway shows reduced travel speeds however this is primarily due to congestion overflowing from the interchanges. Work would be required on the approach roads and the connections to the motorway to alleviate this congestion.
- The results for the entire modelled network include the interchanges, which exhibit congestion issues for future years. The traffic modelling shows that in the do-nothing scenario, the modelled network area would become severely congested by 2039. The upgrade option would extend the effective operation of the network, with the modelled network area experiencing moderate congestion in 2039 and severe congestion by 2049.
- Ramp metering would not be warranted to maintain acceptable operation of the motorway post-upgrade. This is evidenced in the modelling which shows that the motorway operates satisfactorily for the upgrade option. The constraints in the model are at the interchanges, which effectively operate to limit traffic onto the motorway, thereby negating the need for ramp metering.
- The crash analysis shows that by 2049, the predicted overall crash rate for the concept design upgrade (8.0 crashes/100 MVKT or 2.8 crashes/km/year) would be lower when compared with the do-nothing case (10.4 crashes/100 MVKT or 3.6 crashes/km/year).
- The project will provide benefits to freight transport in the area through improvements to congestion levels on the national and local network. As freight is most heavily reliant on the Pacific Motorway link, freight will see a greater benefit than general traffic as the Pacific Motorway will maintain effective operation for longer than the overall network (the motorway interchanges reach capacity prior to the motorway).

- The project will provide benefits to bus transport in the area through improvements to congestion levels on the local network.
- The project would provide some safety benefits to pedestrians and cyclists travelling through the motorway interchange areas. This is due to the provision of additional footpath and shared path facilities which do not currently exist in these areas. These additional facilities will improve traffic performance by providing an option for cyclists to be separated from the road traffic network.
- The proposal would impact property accesses on the north eastern side of the motorway/Sparks Road interchange by restricting right turn access from the two properties located immediately north east of the interchange. Access options will be further explored with the property owners during detailed design.
- When comparing design options 17E and 17F, there is little difference in performance between the two options. The proposed north facing ramps at Doyalson Link Road are estimated to carry a very low volume of traffic and therefore, for the years assessed, cannot be justified purely on traffic performance criteria.

8.2.1 Travel patterns and growth rates

Recent state-wide infrastructure improvements such as the expansion of the Pacific Motorway to six lanes to the south between Wahroonga and Kariong and the opening of the Hunter Expressway towards the north will continue to increase traffic levels on the Pacific Motorway through induced traffic and, at a local level, encouraging drivers to utilise the motorway network rather than less-suited local connections.

Strong population and employment growth proposed for the Central Coast, as outlined in the *North Wyong Shire Structure Plan* and the *Central Coast Regional Strategy (2006–2031)*, will have a substantial impact on the local road network and would increase the local role of the Pacific Motorway. As the proposed development is geographically dispersed the result is differing growth rates on different parts of the network. The yearly compound growth rates used for the modelling in the low growth scenario between the year 2023 and 2069 is shown in Appendix D. Prior to 2023 a flat 0.5% growth rate is assumed.

In the future, as per the existing situation, the primary traffic flows in the region remain the greatest between the Pacific Motorway and the developed areas towards the east. To the west of the motorway the traffic volumes increase at a greater rate than those movements towards the east, however the volumes remain relatively minor.

To the east of the motorway, Wyong Road sees only a minor increase/decrease in traffic. This is attributed to Pacific Highway upgrades north of Wyong and a new road link between Sparks Road at Warnervale and the Pacific Highway at Watanobbi which would act to redistribute traffic in the local area. Sparks Road will come under increased pressure with the scenarios showing a growth rate for this road link of up to 2.6%p.a. for the AM peak westbound. Doyalson Link Road also sees a reasonably high level of growth of up to 1.9%p.a.

8.2.2 Network performance

A summary of the overall network travel speed for all scenarios is provided in Figure 8.1. This measure provides the average speed for all vehicles within the modelled network and is a good measure of the performance of the network as a whole.

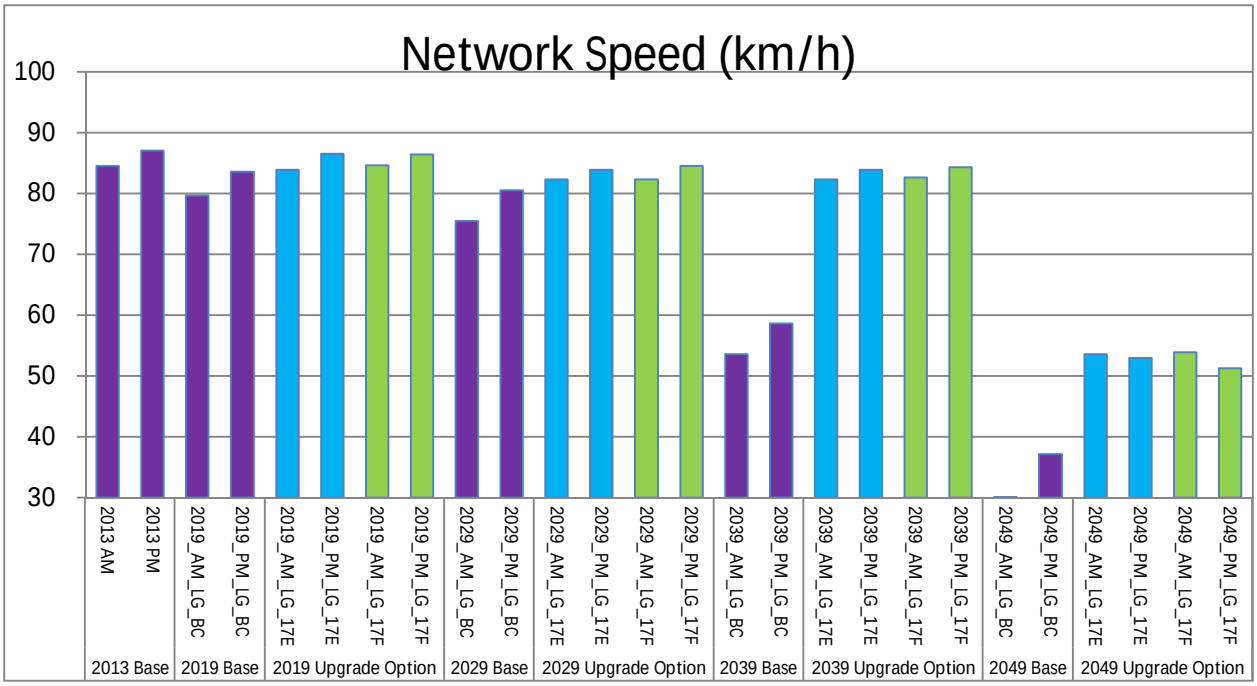


Figure 8.1 Network travel speed summary

The results show that for the base case scenario the network is not severely congested until 2039, with moderate to high congestion experienced in 2029.

The network speed analyses also indicate both Option 17E and 17F operate at very close level and provide significant improvement for the year 2039 and 2049.

8.2.3 Motorway performance

The network travel speed accounts for the delays which are evident at the motorway interchanges and is explained above. To summarise the performance of the motorway itself, motorway mainline travel speeds are provided in Figure 8.2 and Figure 8.3.

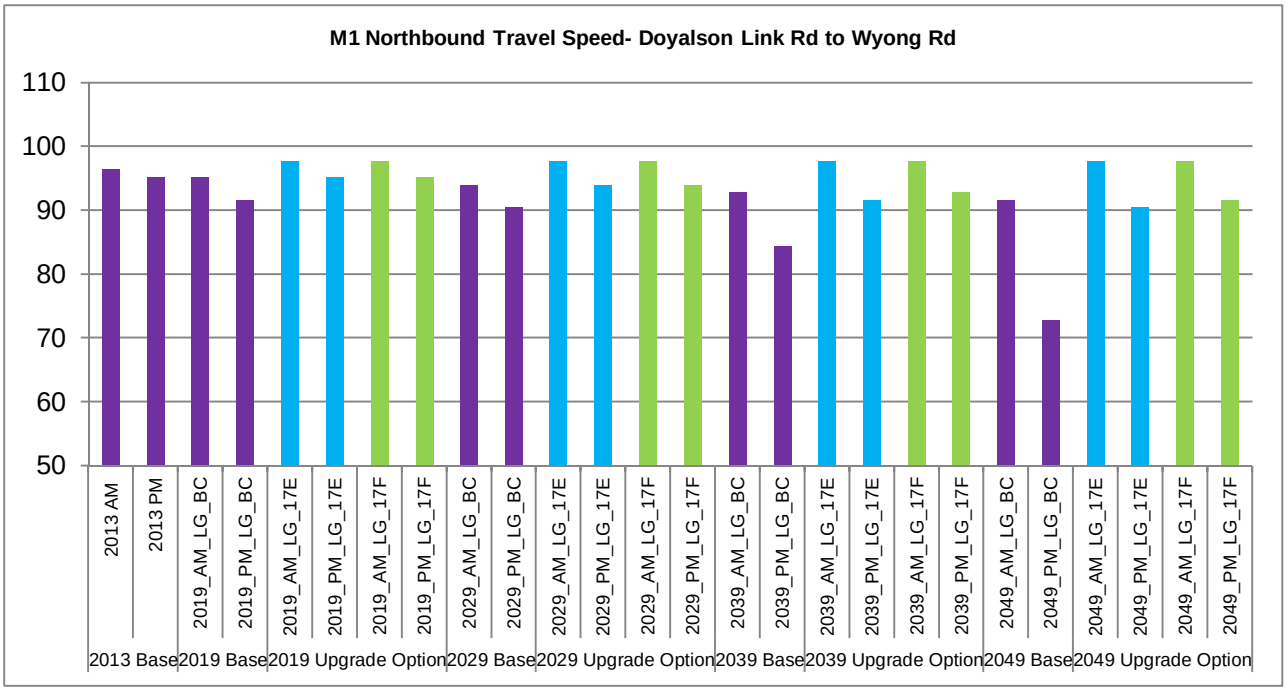


Figure 8.2 Motorway travel speed summary - northbound

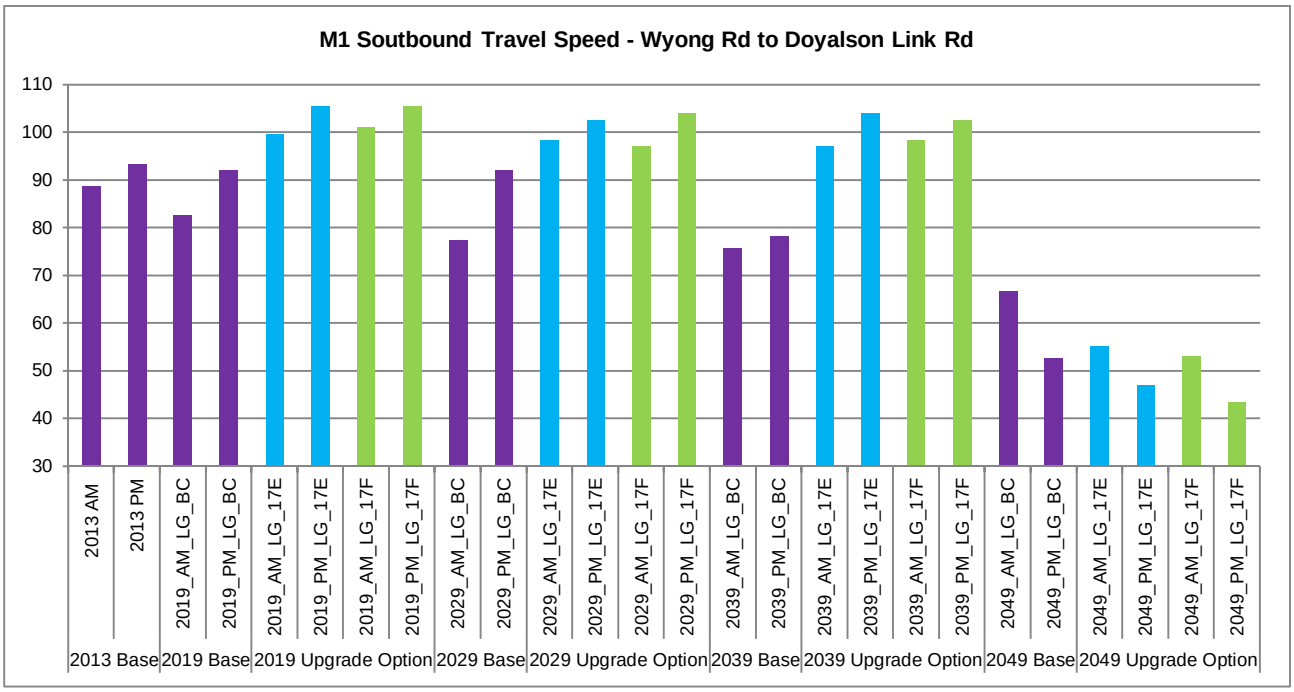


Figure 8.3 Motorway travel speed summary – southbound

It can be seen that the southbound section of the motorway is the most congested overall. The base case suffers negative effects from 2029, whilst the design options do not see issues until 2049, and then only in the southbound direction.

8.2.4 Level of service

A summary of the intersections LoS for each year for the AM peak and PM peak are provided in Table 8.1 and Table 8.2. Figures reported as N/A indicate that the network is so congested that inaccurate results are reported in the modelling. For example an intersection in grid-lock may report a more favourable LoS than a slightly congested intersection, as less vehicles are able to enter the network. Therefore LoS results in these situations are not relevant.

The tables show differing results for certain areas of the network. At Wyong Road (Tuggerah Interchange) capacity is reached early on in the 2029 AM peak. As the proposal provides no upgrades to this interchange the upgrade option shows limited improvement in this area and remains severely congested for all future options. At the Sparks Road Interchange the intersection LoS assessment shows that in the AM and PM peaks the base case situation has the intersections operating at LoS F by 2029. The proposed network upgrades significantly improve these results with all intersections operating satisfactorily through to 2049.

Table 8.1 AM peak intersection level of service summary

Scenario		Intersection						
Year	Network	Woodbury Park Drive/ Wyong Road/ Tonkiss Street	M1/Wyong Road/ Interchange East	M1/Wyong Road/ Interchange West	Hue Hue Road/ Sparks Road	M1/Sparks Road/ Interchange West	M1/Sparks Road/ Interchange East	Burnet Road/ Sparks Road
2013	Base	D	C	B	B	B	D	D
2019	Base	F	E	B	B	C	D	C
	17E	F	F	B	B	C	B	B
	17F	F	F	B	B	C	B	B
2029	Base	F	E	B	B	D	F	F
	17E	F	F	B	B	C	B	B
	17F	F	F	B	B	C	B	B
2039	Base	F	N/A	B	C	F	F	F
	17E	F	N/A	B	B	C	B	B
	17F	F	N/A	B	B	C	B	B
2049	Base	N/A	F	C	F	F	F	F
	17E	E	F	C	B	C	C	C
	17F	E	F	C	B	C	B	D

Table 8.2 PM peak intersection level of service summary

Scenario		Intersection						
Year	Network	Woodbury Park Drive/ Wyong Road/ Tonkiss Street	M1/Wyong Road/ Interchange East	M1/Wyong Road/ Interchange West	Hue Hue Road/ Sparks Road	M1/Sparks Road/ Interchange West	M1/Sparks Road/ Interchange East	Burnet Road/ Sparks Road
2013	Base	B	C	B	B	C	D	B
2019	Base	C	D	B	B	C	D	B
	17E	B	D	B	B	B	B	A
	17F	C	D	B	B	B	B	A
2029	Base	B	E	B	B	E	F	B
	17E	C	E	B	B	C	B	B
	17F	C	E	B	B	B	B	B
2039	Base	C	N/A	B	B	E	F	C
	17E	C	N/A	B	B	C	B	B
	17F	C	N/A	B	B	C	B	B
2049	Base	C	N/A	B	B	E	F	C
	17E	C	F	C	B	C	C	B
	17F	C	F	C	B	C	B	B

8.2.5 Key constraint areas

During the modelling a number of areas were identified as particular constraints in the network. Whilst these areas are obvious whilst viewing congestion in the model, they may be difficult to interpret from the reported results. Therefore this section provides an overview of the key constraint areas identified in both the base network and the design networks (17E and 17F). The 2039 model was used as the year for comparison of constraint areas in the network.

8.2.5.1 Base network

The base case model for the year 2039 clearly shows the failings in the existing network. These issues are shown numbered in Figure 8.4 for the AM peak and Figure 8.5 for the PM peak. The yellow areas in the figures indicate vehicles which are delayed. The constraint areas are identified as follows:

AM peak

1. significant speed drops along the motorway mainline in both directions
2. significant queues along the Sparks Road southbound exit ramp due to poor intersection performance
3. unreleased vehicles – vehicles are unable to enter the network at Sparks Road due to congestion

4. poor level of service at the southbound Doyalson Link Road on ramp merge
5. significant queues for vehicles exiting Woodbury Park Drive and turning right
6. significant queues along the Wyong Road southbound exit ramp due to poor intersection performance.

PM peak

1. significant speed drops along the motorway mainline in both directions
2. significant queues along the Sparks Road southbound exit ramp due to poor intersection performance
3. poor level of service at the northbound Sparks Road on ramp merge
4. poor level of service at the southbound Doyalson Link Road on ramp merge.

8.2.5.2 Design networks

An analysis of the models for the upgrade Options 17E and 17F show that the issues in the northern section of the modelled network, which were a result of the weave situation and exacerbated by traffic growth, have been resolved. The issues in the southern section remain as no upgrade is present to Wyong Road or its interchange with the Motorway. The issues are shown numbered in Figure 8.6 for the AM peak and Figure 8.7 for the PM peak. The yellow areas in the figures indicate vehicles which are delayed. The constraint areas are identified as follows:

AM peak

1. significant queues for vehicles exiting Woodbury Park Drive and turning right
2. queues form behind heavy vehicles travelling northbound in the single lane section between the Sparks Road and Doyalson Link Road interchanges
3. significant queues along the Wyong Road southbound exit ramp due to poor intersection performance.

PM peak

1. queues form behind heavy vehicles travelling northbound in the single lane section between the Sparks Road and Doyalson Link Road interchanges
2. significant queues along the Wyong Road southbound exit ramp due to poor intersection performance.

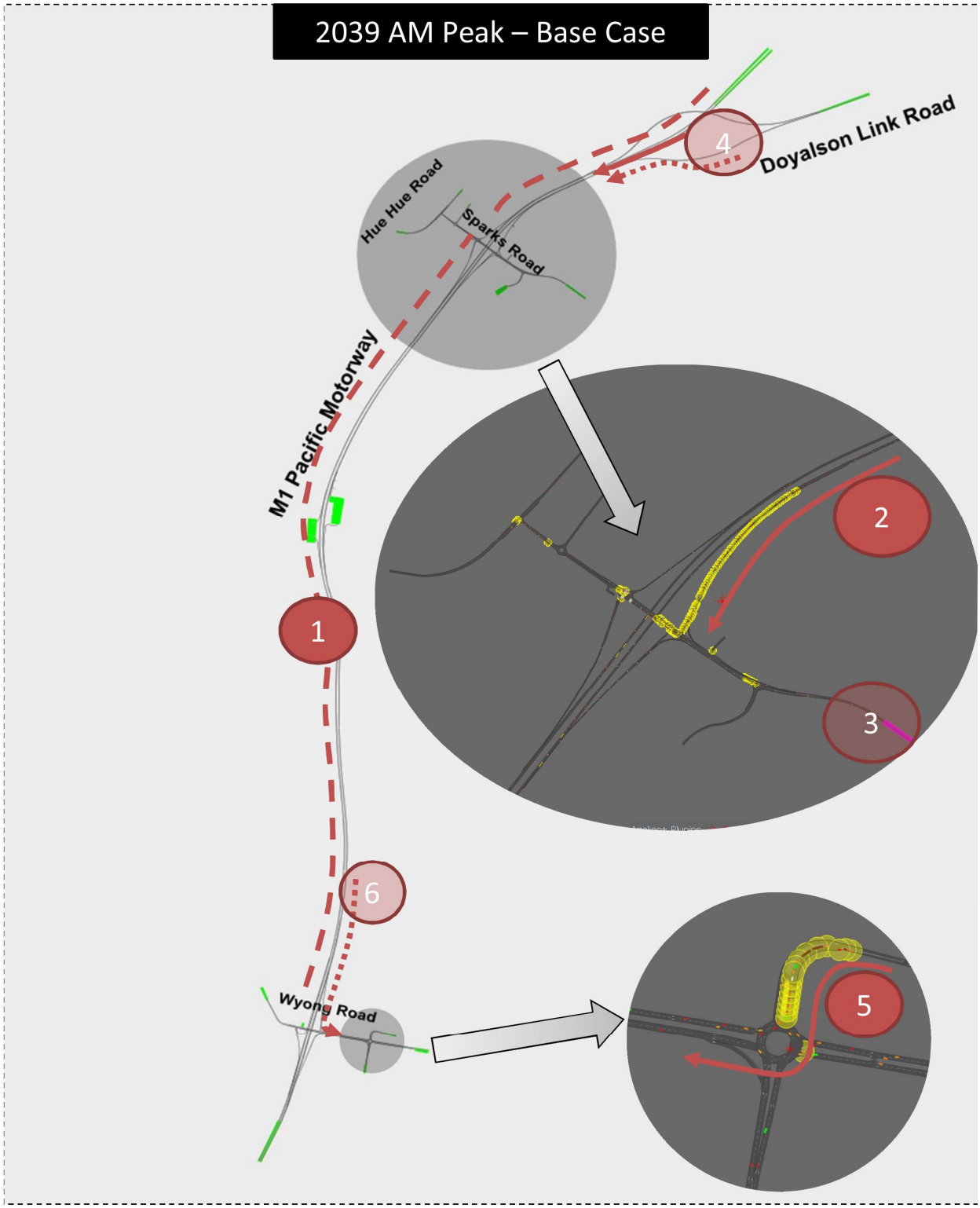


Figure 8.4 Base network constraint areas – AM peak 2039

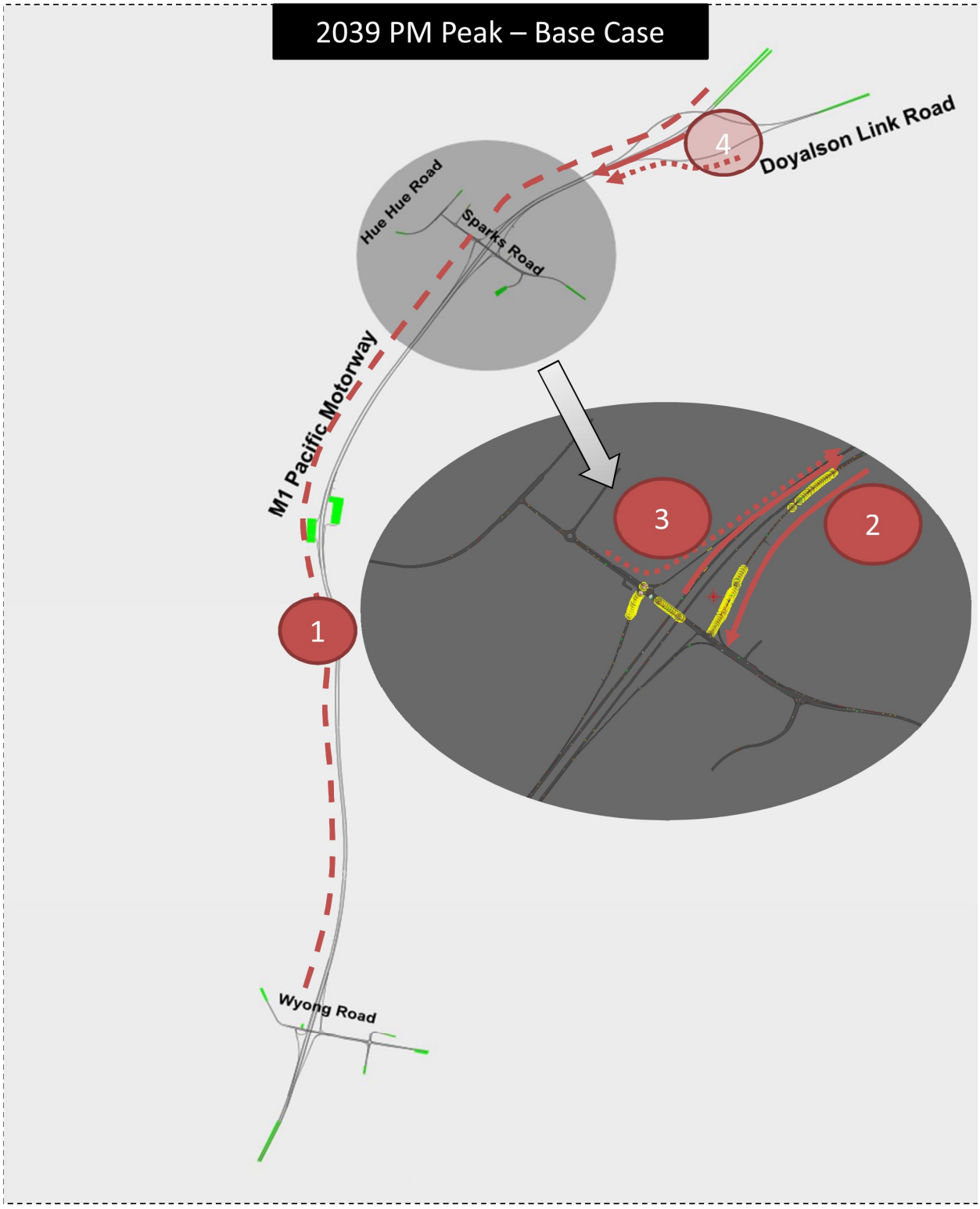


Figure 8.5 Base network constraint areas – PM peak 2039

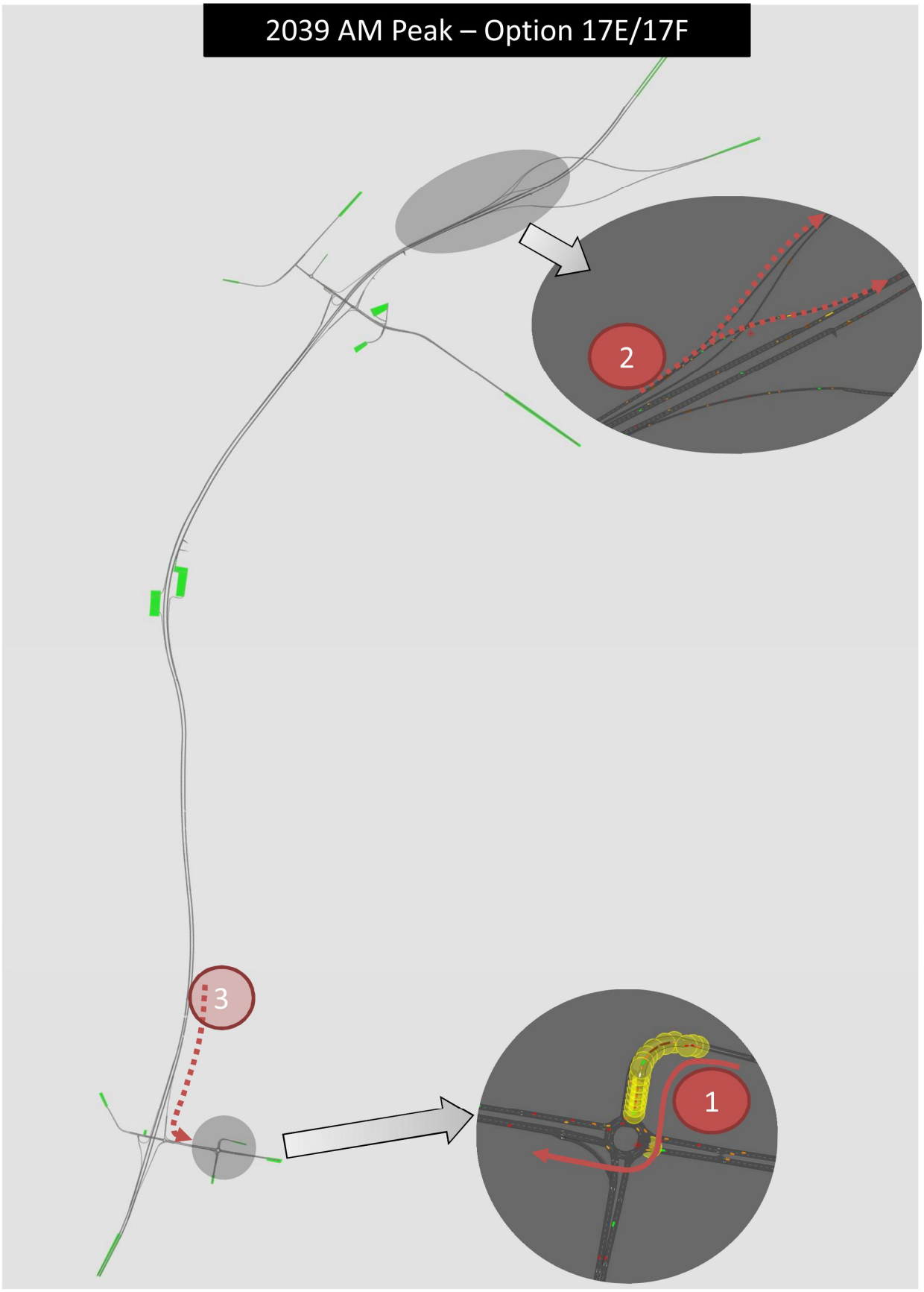


Figure 8.6 Options 17E/17F constraint areas – AM peak 2039

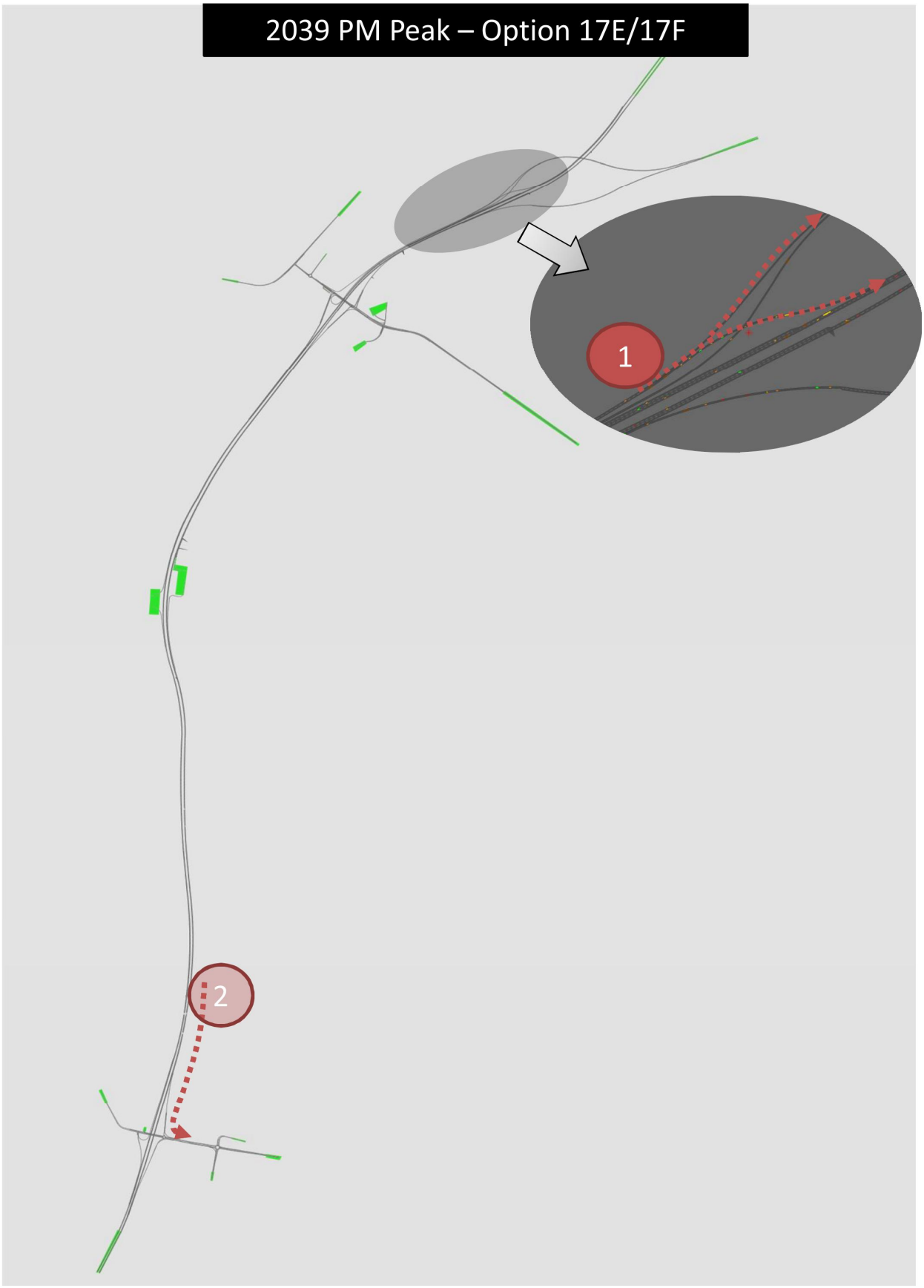


Figure 8.7 Options 17E/17F constraint areas – PM peak 2039

8.3 Freight impact

It can be seen that the project proposal will improve the level of service, travel speeds and network performance for all traffic when compared to the base case scenario. This benefit will also apply to freight traffic. In order to gain an overall understanding of the impact on freight travel within the modelled network Figure 8.8 is provided below. This chart shows the total number of stops for all heavy vehicles in the network for each modelled scenario.

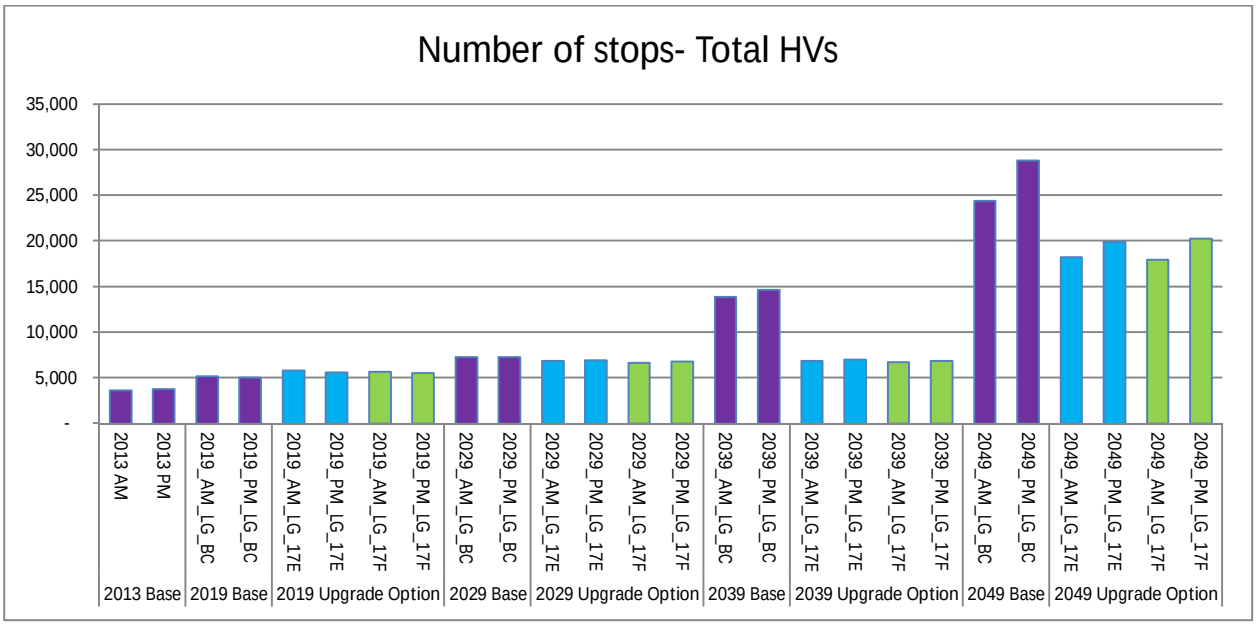


Figure 8.8 Heavy vehicle impact summary – total number of stops

The results show substantial benefits for freight with the upgrade option in place. This improvement is more defined as traffic volumes increase. For example the years beyond 2029 show that the upgrade option provides a significant benefit to heavy vehicles when compared to the base case, particularly in the PM peak. However, comparing between Option 17E and Option 17F does not show any significant differences.

8.4 Public transport impact

Rail will not be affected by the proposal.

The bus network and service frequencies are expected to grow from the current provision as development increases in the area. As no bus priority is currently proposed in these areas, bus routes using Sparks Road and Wyong Road will be affected by the proposal in the same manner as general traffic.

As local buses do not currently use the Pacific Motorway the benefits provided will depend on the route of the bus service. Whilst the upgrade will provide significant benefits for buses travelling through the Sparks Road Interchange, these benefits will not be as pronounced at the Tuggerah Interchange (Wyong Road). This is due to the fact that minimal additional infrastructure is provided at the Tuggerah Interchange for the upgrade option.

As delays on the network increase there may be a need for bus operators to adjust timetables and to account for additional travel time by increasing the size of bus fleets in order to maintain headways. The network benefits provided by the upgrade option would act to delay the need to make these changes by maintaining acceptable travel times and network performance for longer.

8.5 Pedestrian and cyclist impacts

The project will benefit pedestrians and cyclists at the Sparks Road Interchange where it is proposed to provide a separated shared path along the northern side of Sparks Road. Currently the Sparks Road Interchange has on-road bicycle lanes across the bridge and a footpath on the northern side of the existing bridge. There are no footpaths leading to or from the existing footpath on the bridge. In addition, there are a number of uncontrolled pedestrian movements in the vicinity of the interchange associated with commuter car-parking. The upgrade would provide a dedicated commuter car-park on the south-western corner of the interchange. Therefore the upgrade will provide an improvement to safety for pedestrians and cyclists, primarily around the M1/Sparks Road interchange compared to the current situation.

In other areas which see no change in cyclist facilities, cyclists using the existing shoulder areas (of the Pacific Motorway, Doyalson Link Road and Wyong Road) will, over time, be exposed to increased traffic volumes in the adjacent lanes which will mean a greater safety risk. This is likely to occur regardless of whether the project is constructed.

There are some locations of the Pacific Motorway, at bridge locations in particular, which will see a reduction in the existing shoulder width to 2.5 metres. This would present an increased safety the risk to cyclists using the motorway shoulder, however, the other improvements to the motorway provided by the additional lanes, improved surface and upgraded on-load ramps, especially from the service centres are considered to more than counteract the slight reduction of shoulder width over a limited length.