Traffic Modelling and Intersection Analysis

Wollert Precinct Structure Plan

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Client: City of Whittlesea

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04-Sep-2014

Job No.: 60313908

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Quality Information

Document Traffic Modelling and Intersection Analysis

Ref 60313908

Date 04-Sep-2014

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Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
A	25-Jul-2014	Draft	Geoff Ford Principal Transport Analyst	
B	27-Aug-2014	Final Draft incorporating client comments	Paris Brunton Principal Transport Analyst	
0	03-Sep-2014	Final Report	Paris Brunton Principal Transport Analyst	
1	04-Sep-2014	Final Report - Incorporates additional comments	Paris Brunton Principal Transport Analyst	

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Executive Summary

AECOM Australia Pty Ltd (AECOM) was engaged by the City of Whittlesea's to undertake detailed strategic transport and SIDRA modelling for PSP 1070 (Wollert).

A review of the VITM model was produced to determine whether it was a suitable base to provide strategic modelling for the various scenarios for Wollert PSP. Eight different scenarios (including reference case) were modelled which included:

- Reference case
- Scenario 1 – Summerhill Road E6 connection
- Scenario 2 – Boundary Road E6 connection
- Scenario 3 – Craigieburn Road E6 connection
- Scenario 4 – Craigieburn Road and Boundary Road E6 connections
- Scenario 5 – Koukoura Drive, Summerhill Road four lanes
- Scenario 6 – Koukoura Drive, Summerhill Road, Craigieburn Road four lanes
- Scenario 7 – No rail to Wollert

Scenarios 1 to 4 were under the first theme of: East-West Connections to the E6 Corridor. The conclusion from this theme is that it is the least effective interchange in terms of marginal impact when removed is the Summerhill Road interchange; Boundary Road interchange is the most effective and has the greatest impact if not provided. The Craigieburn Road interchange assists in encouraging traffic to more directly access Craigieburn and the employment lands on Craigieburn Road.

Scenarios 5 and 6 were under the second theme of Arterial Road Design Widths. The conclusion from this theme is that a three-lane cross section does not appear to be warranted on general vehicle traffic demand and network performance grounds. Other factors that could be considered in determining the ultimate cross-section for planning include:

- Whether road safety for all users would be improved with a particular cross-section
- Public transport priority needs, in particular whether strategic allocation of space is required to secure on-road priority in the light of modelled congestion locations.
- Appropriate provision for overall network resilience in the event of disruptions on other trunk routes

Scenario 7 was under the third theme of The Role of Rail. The no rail scenario has a small negative impact on the amount of car travel, but does not affect the modelled performance of the road network

For the intersection modelling, there were three scenarios that were modelled:

- Interim Scenario (for the year 2026),
- Ultimate Scenario – Using the Reference Case volumes (for the year 2046)
- Ultimate Scenario – Using Scenario 6 volumes.

Both the AM and PM peaks were modelled. All the required intersections were modelled in the AM Peak (which is considered the highest peak) and selected intersections in the PM Peak. Using the strategic modelling data, a factor of 55% was used to convert the strategic model data into one hourly peak data to be input into SIDRA.

The aim for the intersection performance is to maintain DOS not more than 0.85 and a cycle not more than 120 seconds. All intersections except intersection number 1 (in the evening peak period) meet these criteria for both the Reference and Scenario 6 Ultimate year. The DOS is still under 1.0 which indicates that the intersection is likely to cope with the traffic under either Reference or Scenario 6. This shows that the intersections can operate efficiently with Koukoura Drive, Summerhill Road, Craigieburn Road being four lanes (Scenario 6).

There are a number of turning movements that have a LOS of E. The best outcome has been provided for each of these intersections and the LOS given is due to the delay, not the queues. Given none of the delays are greater than the cycle time; the majority are around 60 seconds and none greater than 72 seconds, this is deemed acceptable.

1.0 Introduction

1.1 Background

AECOM Australia Pty Ltd (AECOM) was engaged by the City of Whittlesea's to undertake detailed strategic transport and SIDRA modelling for PSP 1070 (Wollert).

The purpose of the modelling is to provide outputs to inform the scope of infrastructure required to be constructed to such as the size and number of intersections and the cross-section of roads within the precinct and also be inputs into the Infrastructure and Development Contributions Plans for the area.

The modelling work has been undertaken in close liaison with Metropolitan Planning Authority (MPA), City of Whittlesea and VicRoads to confirm the assumptions, inputs and modelling processes.

1.2 Objectives

Key objectives of this study are:

- Review of the existing VITM, particularly focusing on the Wollert PSP and surrounding area for at least 1.6 kilometres
- Consider the proposed road network in the model, including the proposed bus network
- Consider the model zones and zone centroid links
- Review the Wollert draft urban structure plan, land use and proposed road network
- Consider the future development of Outer Metropolitan Ring Road and its impact on the road network at construction
- Recommend adjustments/refinements to the Corridor model to better reflect the current proposed PSP structure and ensure the surrounding road network reflects actual and proposed conditions as far as possible
- Prepare the necessary input data and run the model for ultimate scenario (2046) and interim scenarios (2026)
- Produce appropriate outputs of the model such as trips to/from the Wollert Precinct by mode, select link analysis, VKT measures and public transport mode share
- Produce appropriate intersection analysis for the selected intersections for the interim and ultimate scenarios.

1.3 Methodology

In order to achieve these objectives, the study scope of work comprised of three key parts, which this report documents in the following sections. The key tasks undertaken were:

- A review and enhancement of VITM including examination and updating of road networks, public transport services and zone structure. The objective of this work was to create a strategic transport model that could be used to estimate traffic demand, including turning movements, for the road network in the Wollert PSP. This work is documented in section 2.0 of this report
- Running the enhanced strategic transport model to test future year network and land use scenarios. The objectives of this work were to develop an understanding of the transport infrastructure needs and performance and also to provide detailed traffic inputs for detailed intersection modelling. This work is documented in section 3.0 of this report
- Undertake SIDRA modelling of key intersections to determine the lane configuration and therefore road space requirements. This work is documented in section 4.0 of this report.

2.0 Review of VITM

2.1 VITM northern growth areas model

The standard Melbourne metropolitan version of VITM consists of 2959 zones, of which 2893 are internal to the modelled area and the remainder external. In recent years the Metropolitan Planning Authority (MPA) has managed the enhancement of standard VITM for the South Eastern, Western and Northern growth areas. A version of the northern growth areas model developed for Quarry Hills by SKM was used as the starting point for this study. This model had already undergone some enhancements around the Whittlesea growth areas increasing the total number of zones in VITM to 3316.

2.2 Zones

The review of the existing VITM considered the level of zone disaggregation within and around the Wollert PSP area. The zoning system had to be constructed in a way that distributes trips onto the local network in a reasonable manner and takes into account particular land uses. It was desirable to construct zones that have homogenous land use internally. For example, a town centre will be given its own zone to separate it from residential zones. The structure plan for Wollert was the guiding document for designing the new zone system. A simplified representation of the structure plan is shown in Figure 1.

Figure 2 shows the zone boundaries from the standard VITM, which has six zones covering the entire Wollert PSP area. However, this standard metropolitan version of VITM had already been enhanced in the Wollert region as part of the development of the Northern Growth Corridors model (NGC) by disaggregating zones.

Figure 3 shows the zones in Wollert from the NGC model, which increased the number of zones in Wollert from six to twenty six.

Figure 1 Wollert Structure Plan

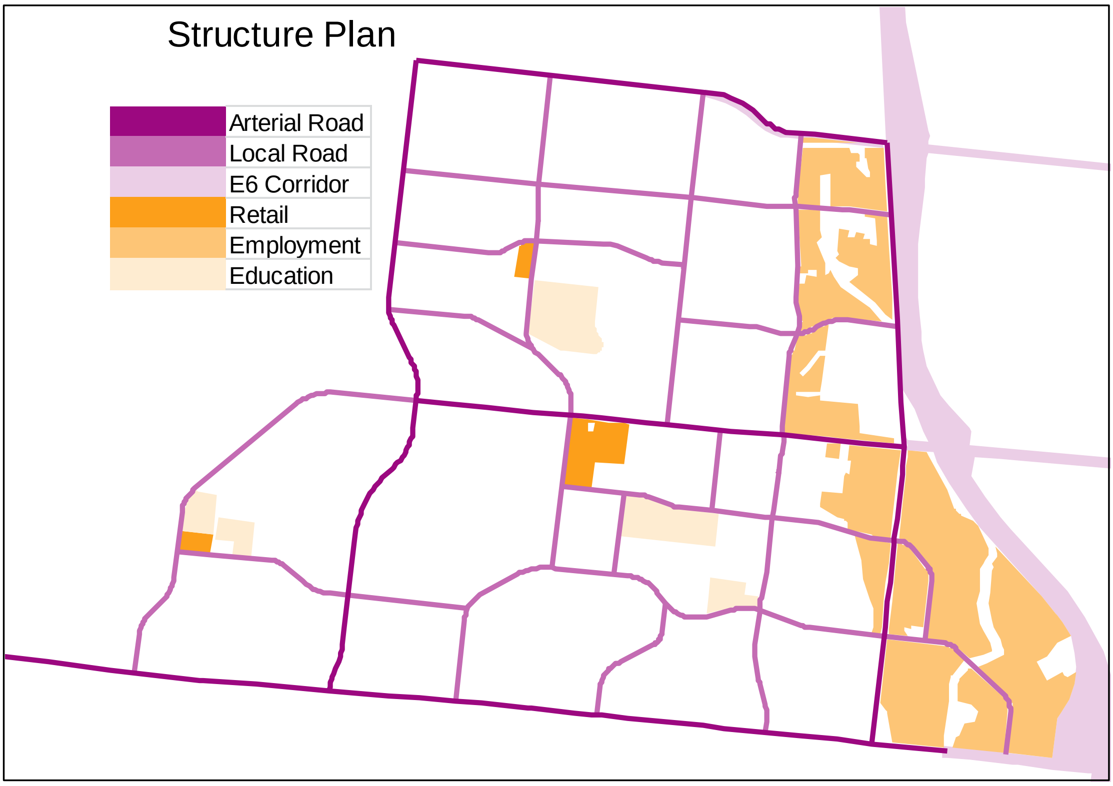


Figure 2 Original VITM Zones

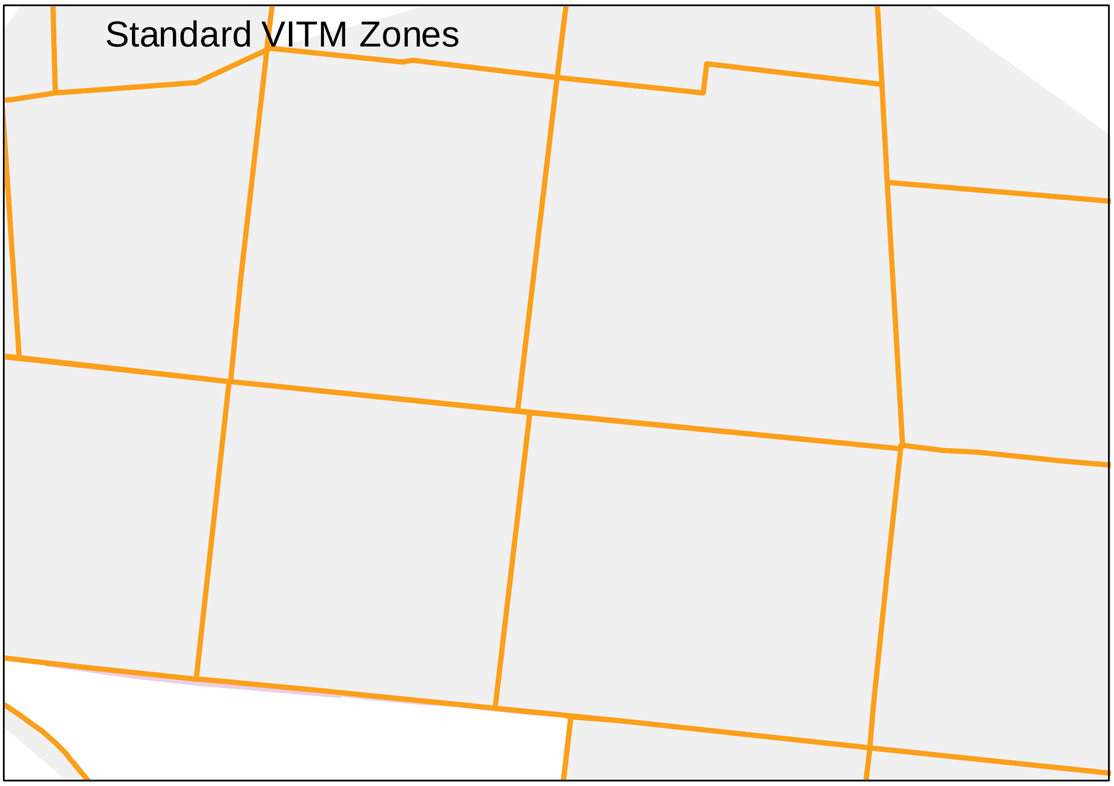
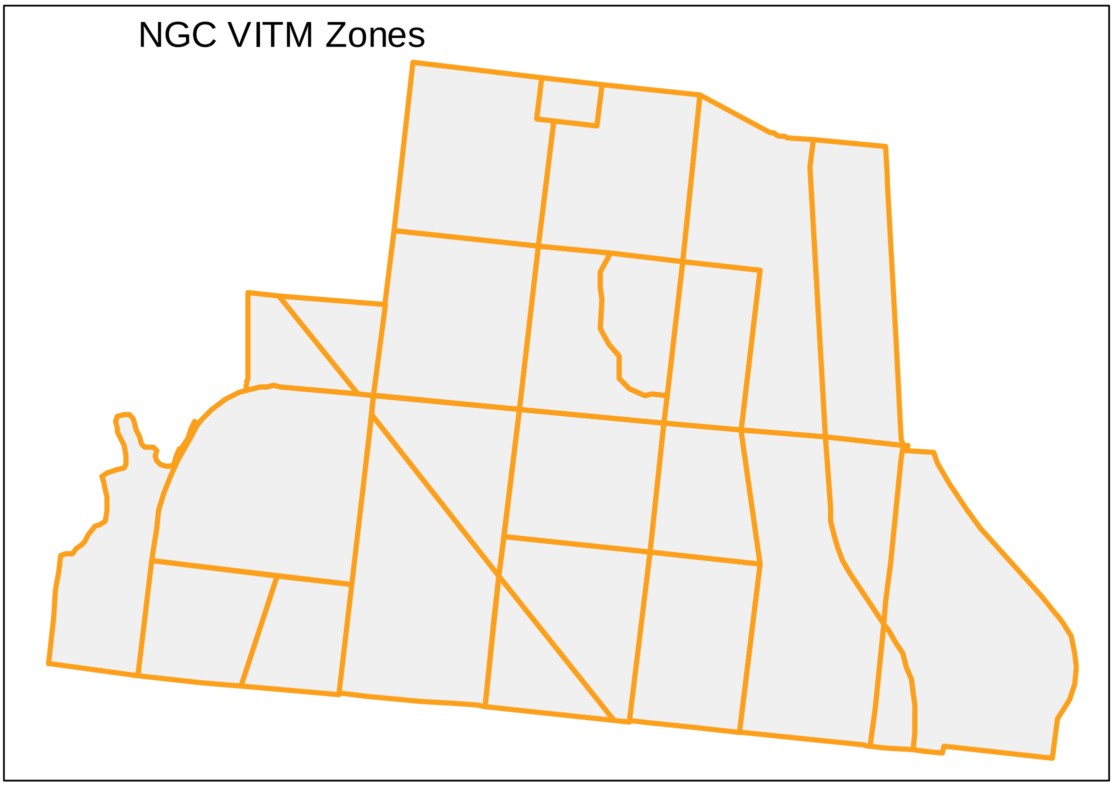
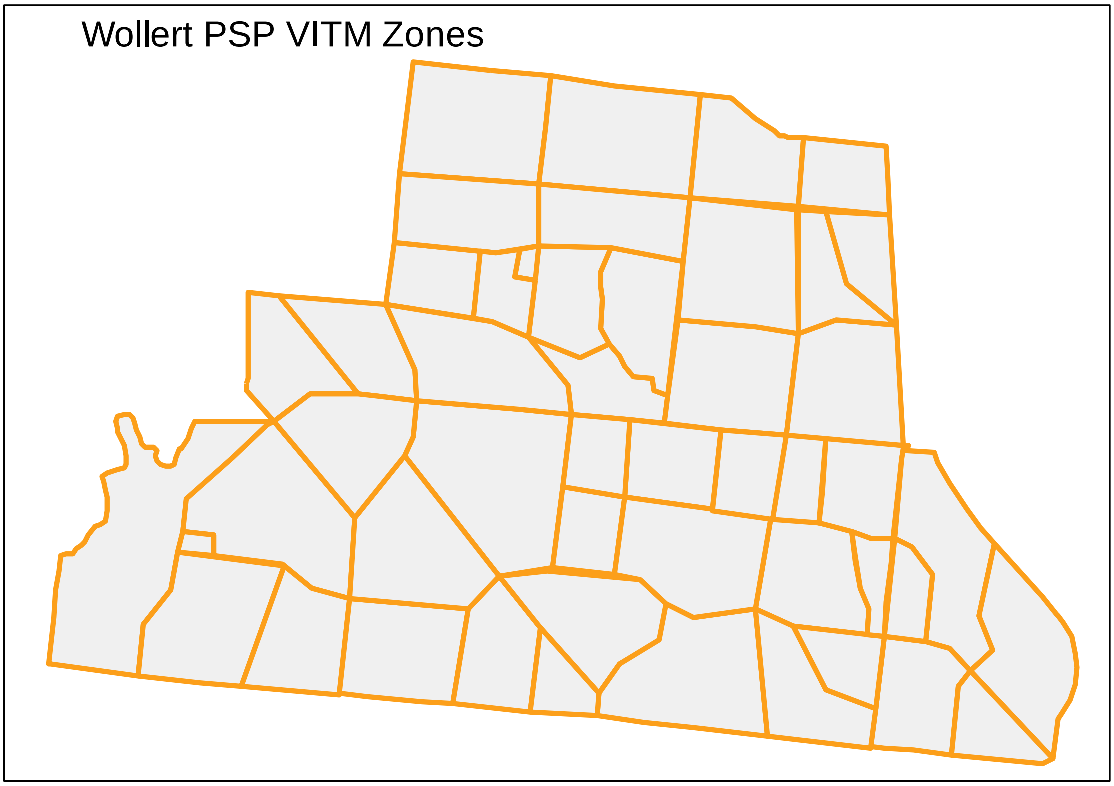


Figure 3 NGC VITM Zones



The zone system within Wollert was further refined after reviewing the structure plan for Wollert. Zones were disaggregated and moved to better reflect the locations of roads and the distribution of land use. Figure 4 shows the disaggregated zones for the Wollert PSP. The number of zones increased from twenty six in the NGC model to forty nine.

Figure 4 **New VITM Zones**



Disaggregating the zones in Wollert increased the total number of zones in the model from 3316 to 3335. This further extended the run time. Depending on the specifications of the computer, this could take over two days to complete a scenario. Therefore, in order to reduce the model run time, zones located far away from the study area were aggregated to reduce the number of model calculations required and cut down the run time. Figure 5 shows the regions where zones were disaggregated, retained or aggregated. This shows that the NGC zones were retained around the Wollert study area and down south past the Melbourne CBD. Major roads such as the Eastern Freeway, the Westgate Freeway and the M80 are included in the NGC zone area. This ensures that the major route choices involving trips that might influence travel behaviour in Wollert are modelled using either NGC zones or finer. The total number of zones after aggregation totalled 1708.

Figure 5 Aggregation of Zones

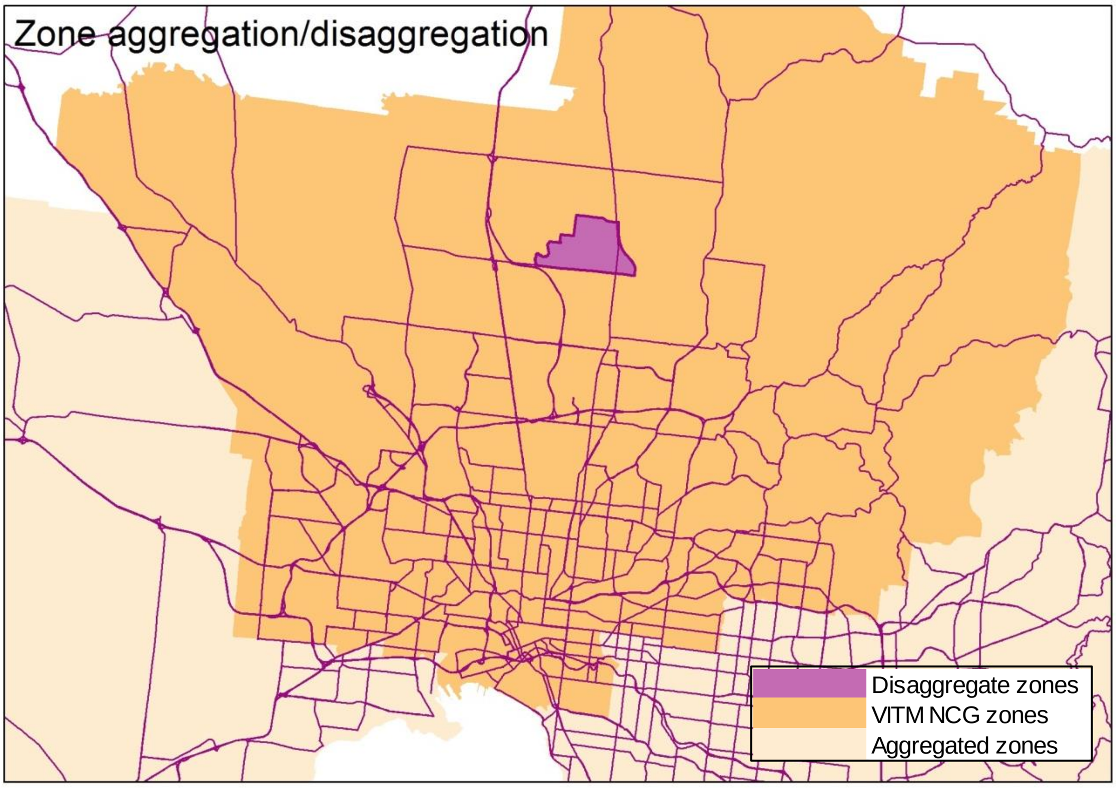


Table 1 shows the number of transport zones by the region of Melbourne and how these change from the standard VITM to the NGC VITM and then the disaggregation and aggregation processes for the Wollert model.

Table 1 Number of zones by region of Melbourne

Region of Melbourne	Standard VITM	NGC VITM	Disaggregated Wollert Zones	Aggregated remote Zones
Wollert	6	26	49	49
Whittlesea North of Wollert	74	104	100	100
Whittlesea South of Wollert	39	83	83	83
Central suburbs	195	195	195	195
Other northern suburbs	675	927	927	927
Rest of Melbourne	1905	1916	1916	289
External	65	65	65	65
Total	2959	3316	3335	1708

2.3 Networks

The study area comprises a grid of arterial and collector roads shown in Figure 6. In the reference case, Koukoura Drive, Summerhill Road, and Craigieburn Road are all six-lane roads with an 80 kph speed limit. Epping Road is a two-lane north-south road north of Craigieburn Road with a 60kph speed limit. Boundary Road, located between

Summerhill and Craigieburn Roads, is a two-lane east-west road with a 60 kph speed limit. Summerhill Road, Boundary Road and Craigieburn Road each have a full-movement interchange with the E6. Lanes and speed limits are shown in Figure 7 and Figure 8 respectively.

Figure 6 Key roads in Wollert

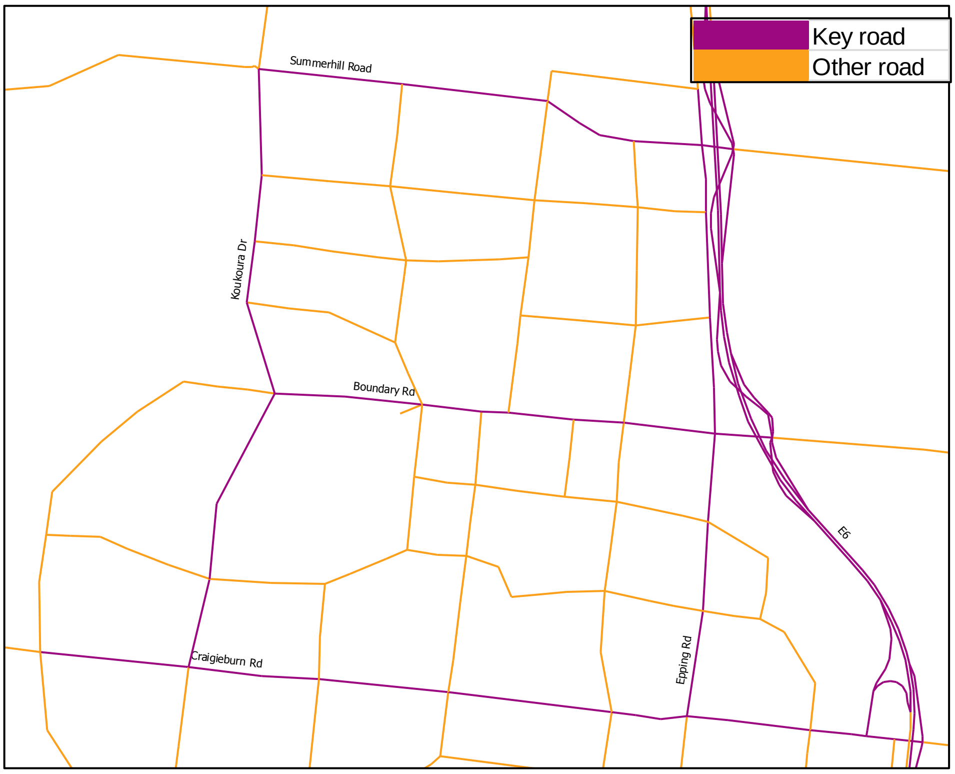
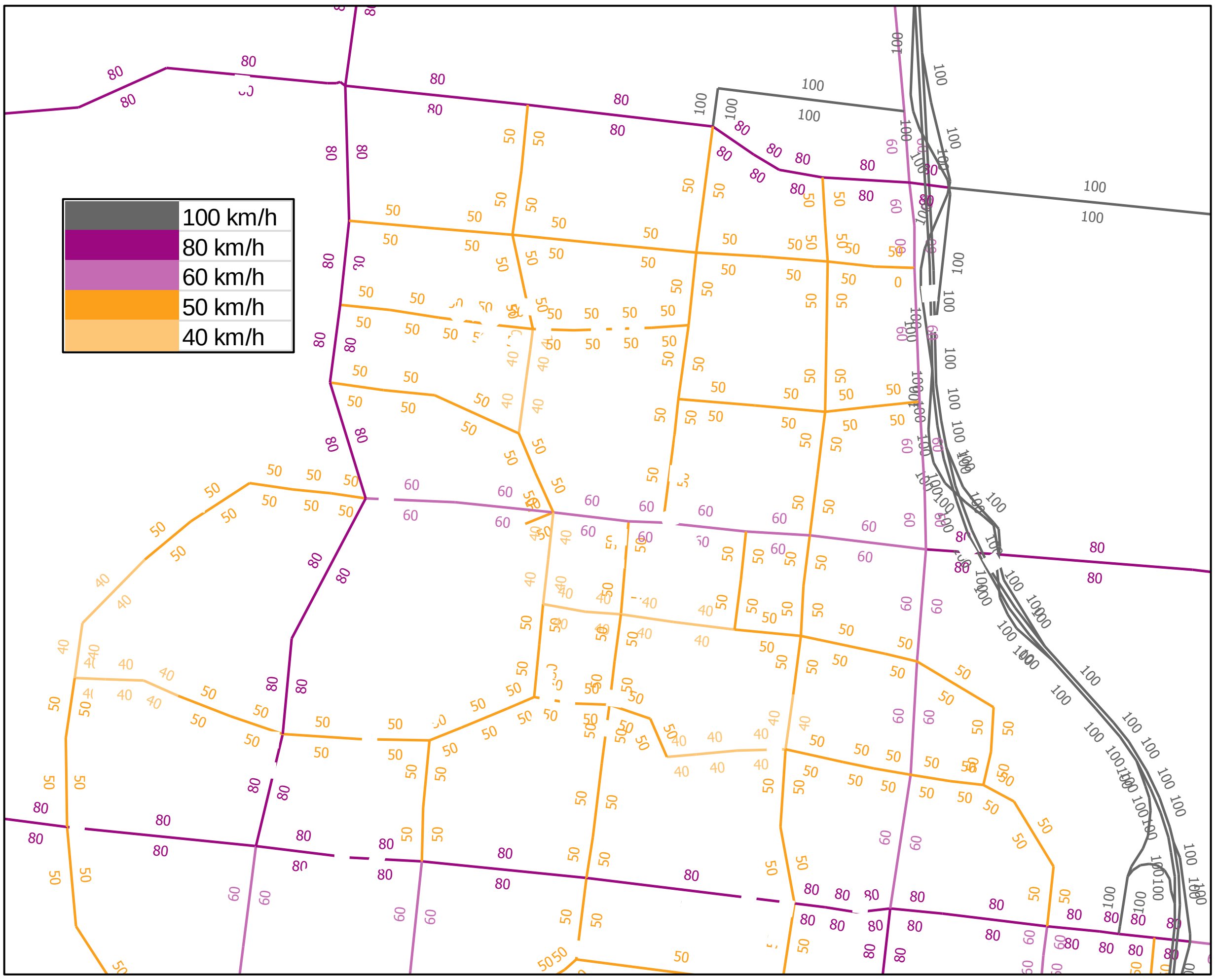


Figure 7 Number of lanes, Ultimate network

Figure 8 Posted speed, Ultimate network



2.4 Public transport services

The public transport network specified in the model comprises:

- a suburban rail service from Wollert to the City Loop (direct service) in central Melbourne, assuming stations at:
  - west side of Wollert Town Centre south of Boundary Rd
  - North of Harvest Home Road
  - North of O'Herns Rd
  - South of Cooper Street
  - The headways of the service were 10 minutes in the peak hour in the peak direction (city bound in the AM, Wollert bound in the PM), and 20 mins all other times.
- a network of bus services based on Wollert Railway Station. The bus network includes services that extend outside the study area, providing east-west connectivity. The network used in the VITM modelling is shown in Figure 9 with the colours of the routes indicating the AM peak headways for the services. For clarity, the bus routes are also shown, in a map prepared by Public Transport Victoria, in Figure 10. Note that this is a more recent iteration than the network modelled. For example, the service from the east on Boundary Road now runs more directly to the Wollert town centre. Nevertheless, the modelled network is generally representative of the proposed coverage, connectivity and frequency of bus services.

Figure 9 Public transport services by AM peak headway

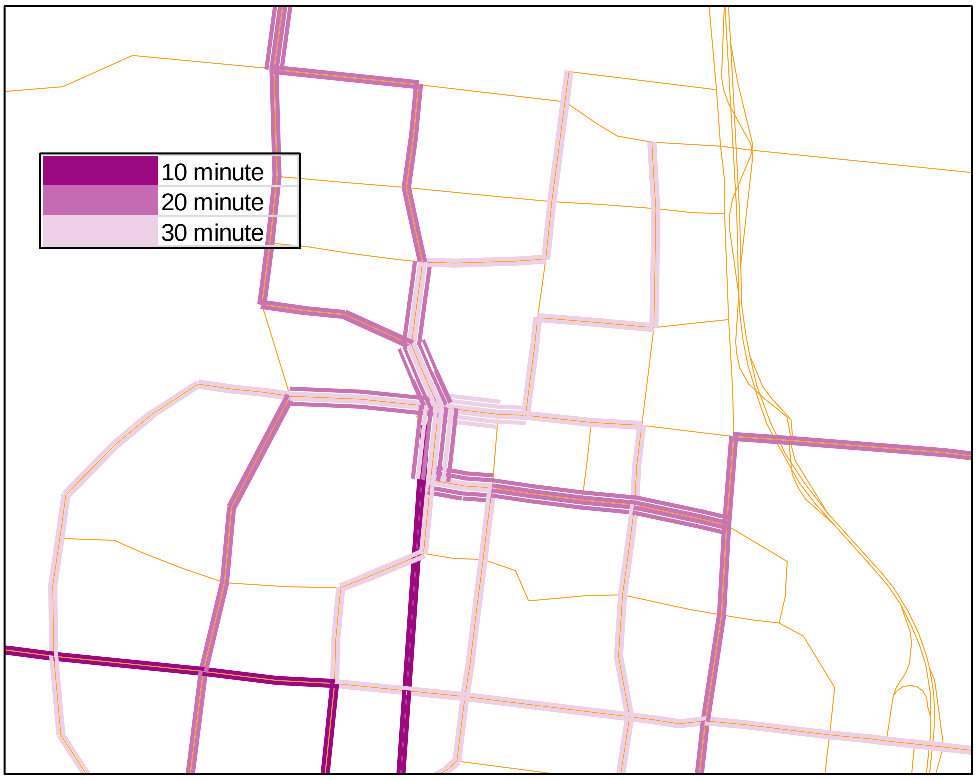
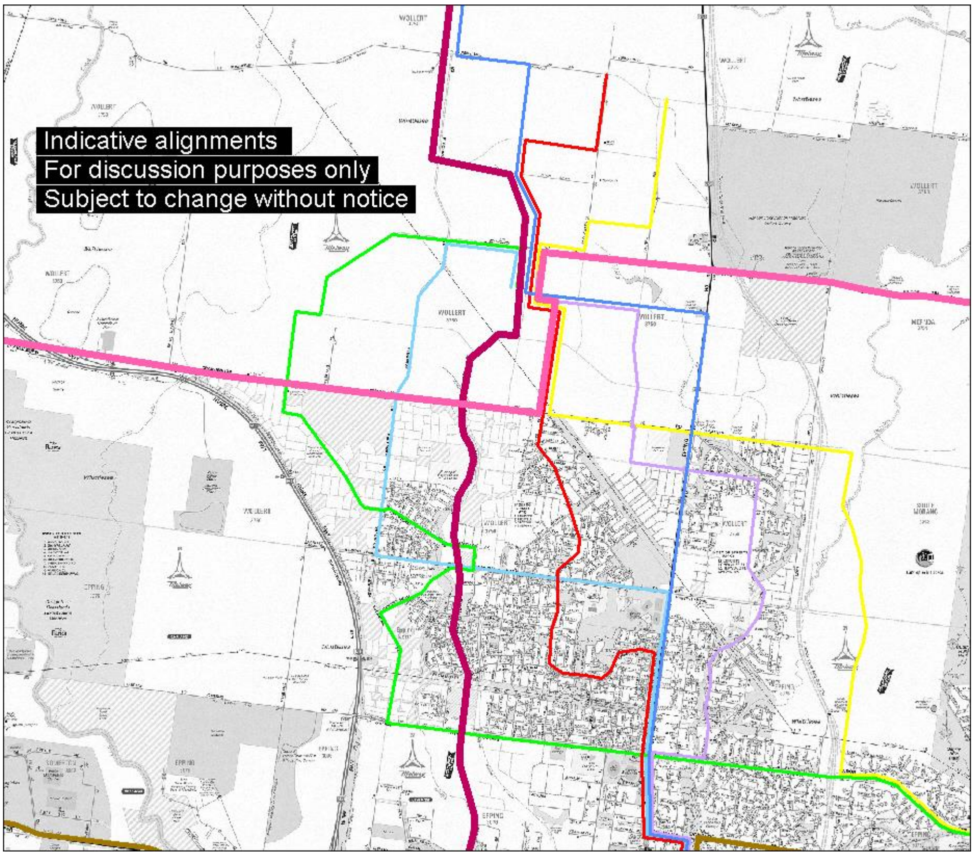


Figure 10 PTV supplied bus network for strategic modelling



2.5 Land Use

Table 2 summarises the relevant population and employment projects that are incorporated in the model. Figure 11 and Figure 12 show the spatial distribution of population and employment for 2026 (Interim) and 2046 (Ultimate) respectively.

Table 2 Forecast population and employment by region

	Population 2026 (Interim)	Population 2046 (Ultimate)	Employment 2026 (Interim)	Employment 2046 (Ultimate)
Wollert	25,700	33,000	3,600	6,800
Whittlesea North of Wollert	92,500	135,900	12,600	36,200
Whittlesea South of Wollert	162,600	200,700	52,900	76,000
Central suburbs	319,200	440,800	811,200	1,034,100
Other northern suburbs	1,526,700	2,031,400	620,000	823,200
Rest of Melbourne	3,037,400	3,665,000	1,282,600	1,593,900
All regions	5,164,100	6,506,800	2,783,000	3,570,100

Figure 11 Ultimate population and employment within Wollert

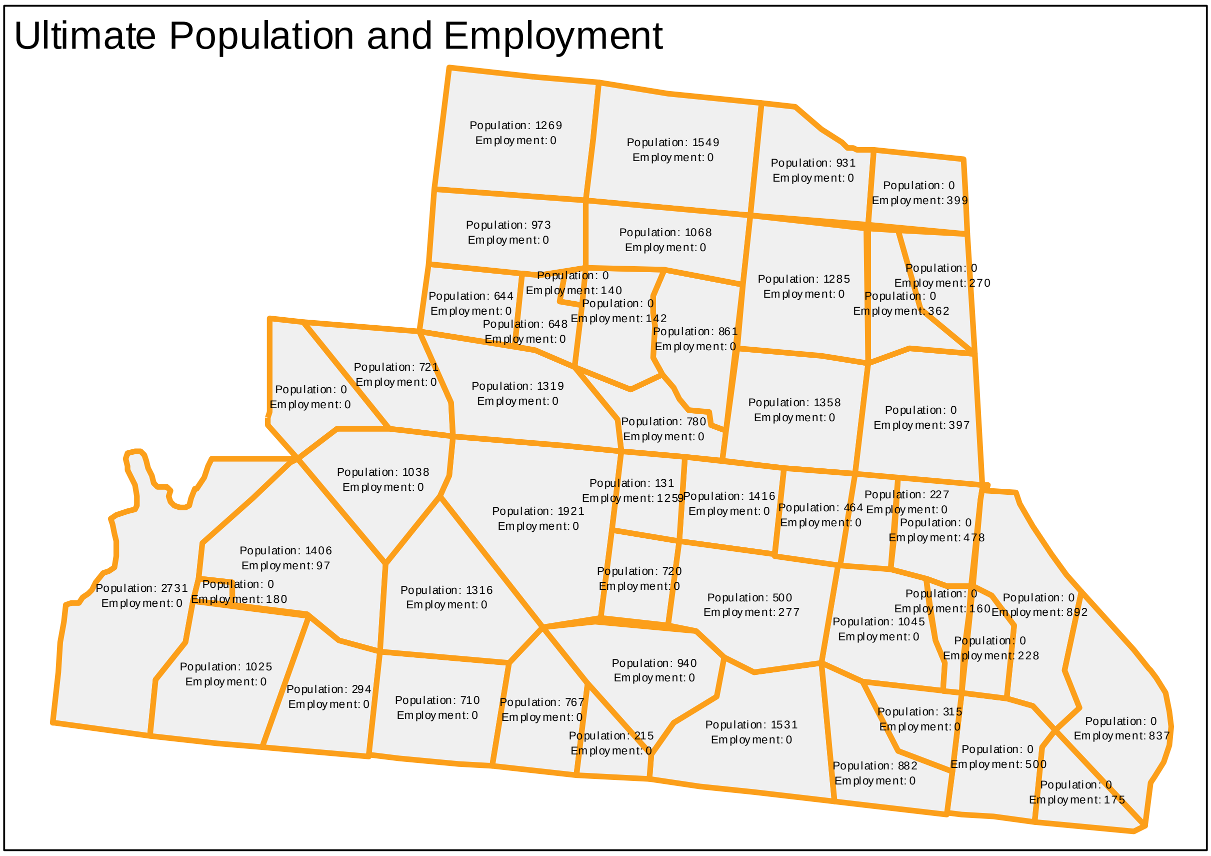
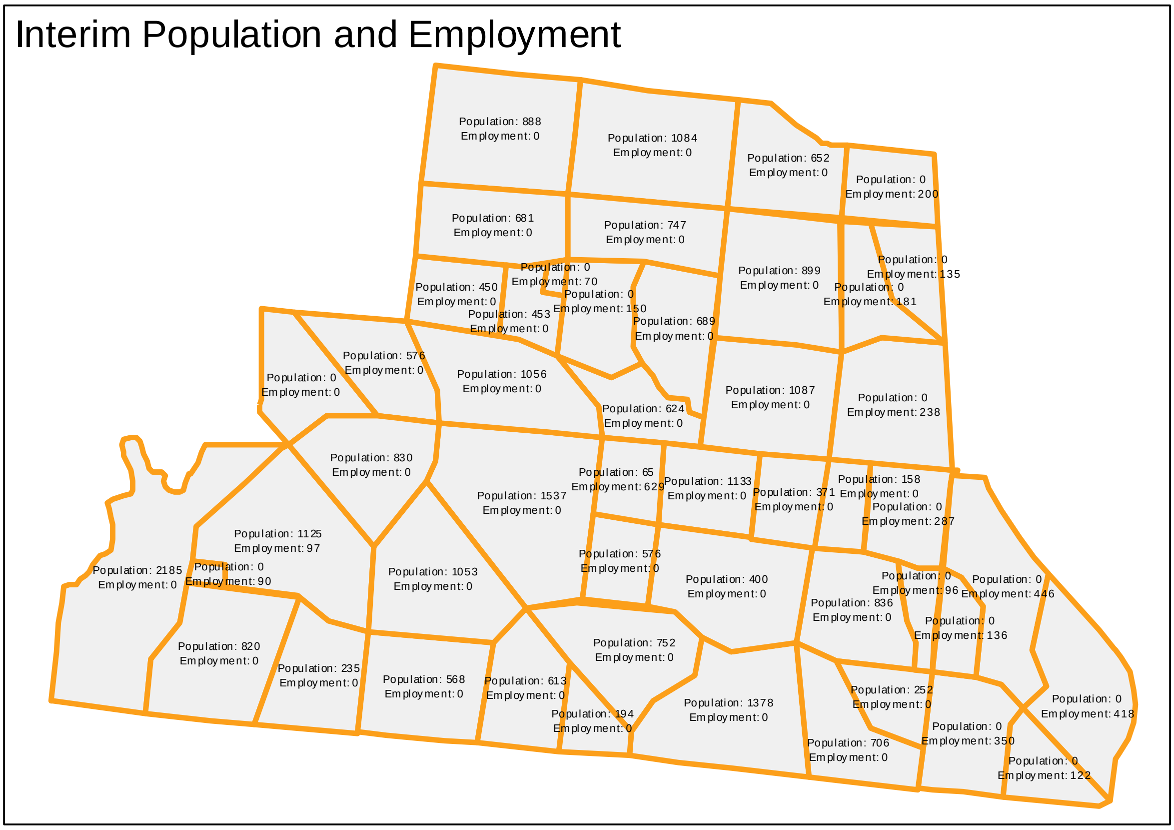


Figure 12 Interim population and employment within Wollert



3.0 Transport modelling for future scenarios

3.1 Introduction

A reference case and seven scenarios were modelled. The reference case represents the agreed base model as specified above, and the seven scenarios were designed to investigate the effects of changes to specific links in the transport network. The scenarios address three strategic themes for Wollert's development.

Theme 1: East-west connections to the E6 corridor, addressed by

- Scenario 1 – Summerhill Road E6 connection
- Scenario 2 – Boundary Road E6 connection
- Scenario 3 – Craigieburn Road E6 connection
- Scenario 4 – Craigieburn Road and Boundary Road E6 connections

Theme 2: Arterial road design widths, addressed by

- Scenario 5 – Koukoura Drive, Summerhill Road four lanes
- Scenario 6 – Koukoura Drive, Summerhill Road, Craigieburn Road four lanes

Theme 3: The role of rail, addressed by

3.2 Theme 3: The role of rail

- Scenario 7 – No rail to Wollert

3.3 Reference case

3.3.1 Overview results

Table 3 presents a summary of the AM peak trips to and from Wollert by their mode and origin / destination and Table 4 presents percentages. Features to note include:

- 28 percent of trips are into Wollert from outside; 48 percent of trips are leaving Wollert; and 24 percent of trips are internal to Wollert. In broad terms, travel is localised, with a majority of the inbound trips coming from within Whittlesea; only in the outbound AM peak trips does the central city play an important role as a destination.
- The wide swathe of the northern suburbs accounts for ten to 20 percent of Wollert-related AM peak trips by direction. This indicates a significant amount of dispersed travel given the large area covered by the northern suburbs.
- Car dominates local travel, and internal trips are the largest single proportion of car trips. Cars are also a favoured mode for the dispersed travel to the northern suburbs.
- Public transport dominates the small market for travel to and from the central suburbs.
- Overall mode share to public transport varies between 3 percent for internal trips, 14 percent for outwards trips, to 85 percent for AM peak trips to the central city.

Table 3 Ultimate scenario AM peak trips to and from Wollert by mode and origin/destination region

Location	All trips		Car		Public Transport	
	To	From	To	From	To	From
Wollert (internal trip)	7,200		7,000		200	
Whittlesea Nth of Wollert	2,400	1,700	2,300	1,600	200	100
Whittlesea Sth of Wollert	2,700	4,400	2,500	4,100	200	200
Central suburbs	100	1,900	0	300	100	1,600
Other northern suburbs	3,000	5,700	2,900	5,100	100	600
Rest of Melbourne	200	600	200	300	0	300
All regions	15,600	21,400	14,800	18,400	800	3,100

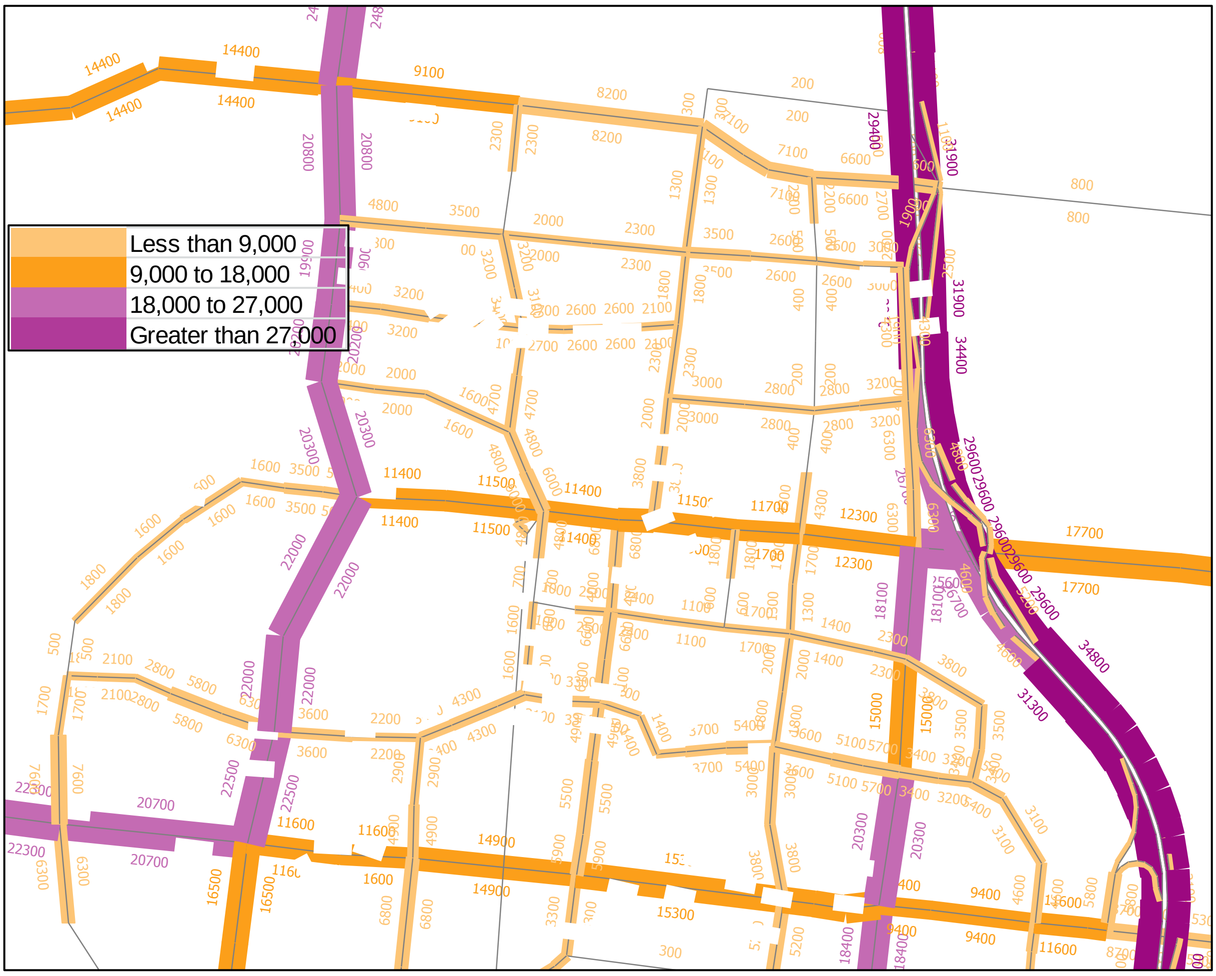
Table 4 Ultimate scenario AM peak trips to and from Wollert by mode and origin/destination region by percentage

Location	All trips		Car		Public Transport		Mode Share	
	To	From	To	From	To	From	To	From
Wollert (internal trip)	24%		47%	38%	30%	8%	3%	
Whittlesea Nth of Wollert	8%	6%	15%	9%	20%	2%	7%	3%
Whittlesea Sth of Wollert	9%	15%	17%	22%	22%	8%	7%	5%
Central suburbs	0%	6%	0%	2%	11%	54%	67%	85%
Other northern suburbs	10%	19%	19%	28%	14%	20%	4%	11%
Rest of Melbourne	1%	2%	1%	2%	4%	9%	19%	47%
All regions	100%		100%	100%	100%	100%	5%	14%

The volumes[1] of traffic forecast on the network are shown in Figure 13. Koukoura Drive is expected to be the principal north-south route in the precinct with volumes of up to 22,500 vehicles a day, with marginally lower volumes on Epping Road. Craigieburn Road is the principal east-west road, with incrementally lower volumes on each east-west route option to the north.

[1] Note that all volume plots in this report show two way figures for all roads except the E6, which show volumes by direction.

Figure 13 Daily estimated vehicle volumes, ultimate network



This arterial network is forecast to generally perform well in the AM peak, with volume-capacity ratios below 0.6 except on Epping Road southbound and on Koukoura Drive entering and exiting the study area southbound, including the three-lane arterial roads. However, the E6 is forecast to be congested with a volume-capacity ratio between 0.8 and 0.9, and Boundary Road east of the E6 is also congested. These results are shown in Figure 14.

Figure 14 AM peak volume capacity ratios, ultimate network

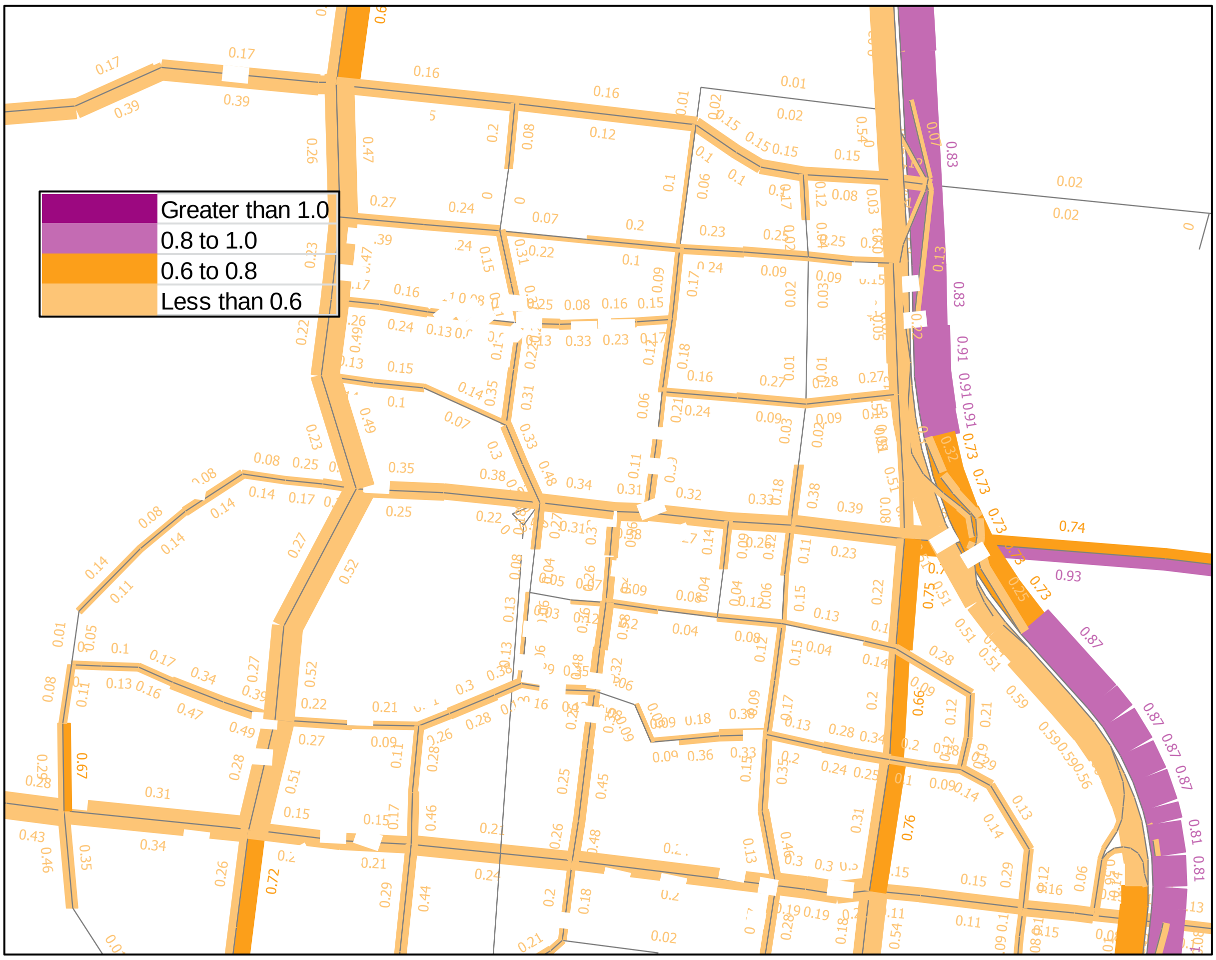


Figure 15 shows the daily public transport line loads. These loadings are *by direction*, as can be observed by the differential loading on the magenta rail corridor. Each bus line is modelled to carry 100 to 200 passengers per direction per day. The railway is modelled to have approximately 4,400 boardings a day. Figure 16 compares Wollert's future forecast patronage with present day stations that performed a similar role as terminus stations in growth areas in 2011/12.[2] If Wollert were open today with that patronage it would be ranked around the 30th busiest station in Melbourne.

[2] "Station Patronage Research - June 2013" available online at http://ptv.vic.gov.au/about-ptv/ptv-data-and-reports/research-and-statistics/#bulletins, last accessed 17 July 2014

Figure 15 Daily public transport line loads

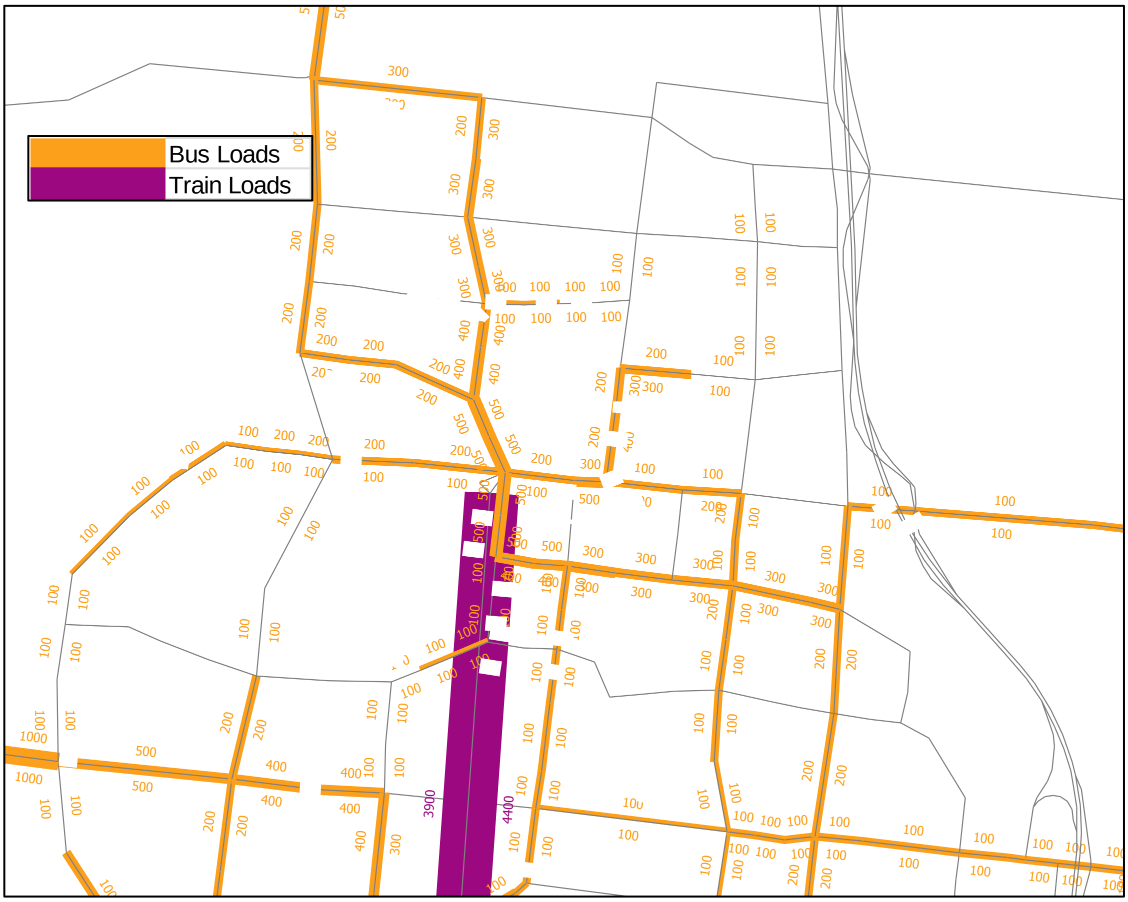
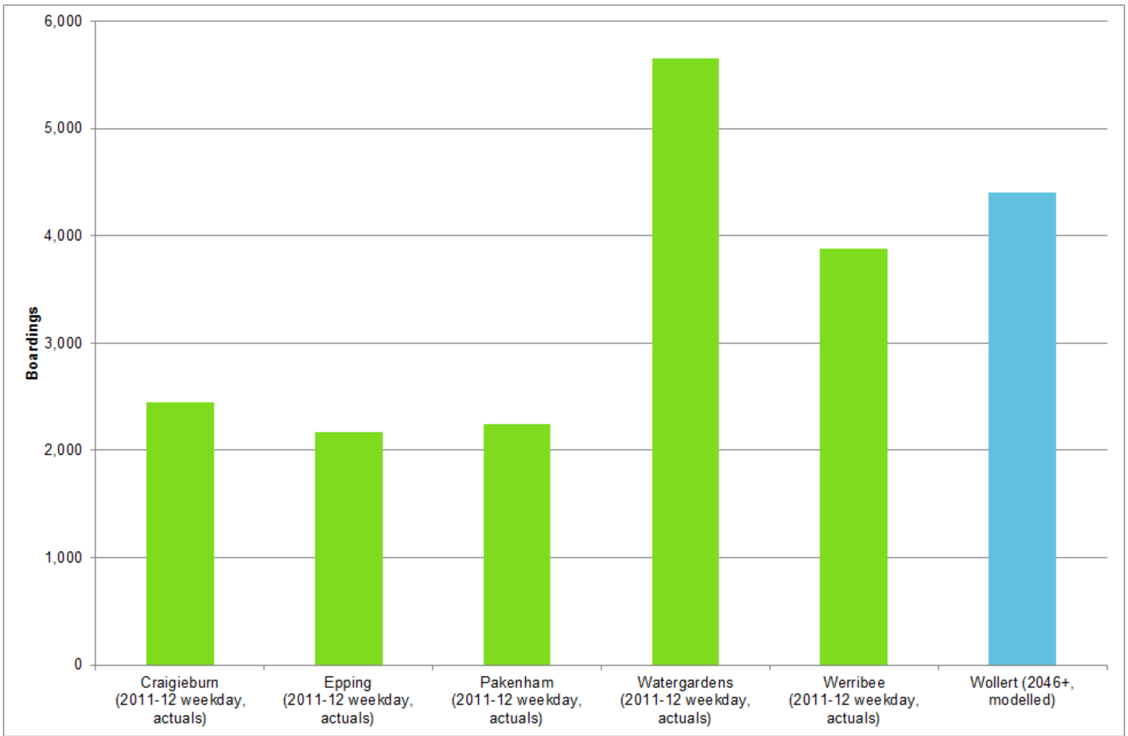


Figure 16 Comparison of recent actual and Wollert modelled station boardings for peer stations



3.3.2 Overview observations on demand and design relationship

Figure 13 and Figure 14 show that almost all of the secondary roads are forecast to have daily demand volumes in the order of 2000 to 5000 vehicles *per day* in total.

The Austroads *Guide to Traffic Management Part 3: Traffic Studies* Table 5.1 outlines the typical mid-block capacities for local collector roads, accounting for parking, roundabouts and other features that result in interrupted flow for vehicles. Figures relevant to planning two-lane roads are summarised in Table 5. Note that these capacities are *per hour*.

Under the assumption that the peak planning period is 10 percent of the daily flow, it is clear that the modelled number of lanes (one clear flow lane each way, as shown in Figure 7) is well within the design standards indicated by AustRoads.

Further commentary on the design widths of the main arterial roads is discussed in Section 3.5.

Table 5 Typical mid-block capacities for urban roads with interrupted flow

Type of lane	One-way mid-block capacity (passenger cars per hour)
Median or inner lane	
Divided road	1000
Undivided road	900
Kerb lane	
Adjacent to parking lane [i.e. three lane cross-section, dedicated parking]	900
Occasional parked vehicles	600
Clearway conditions	900

3.3.3 AM Peak period travel patterns on specific links

Select link analysis shows the origin and destination patterns associated with traffic modelled on a specific link in the transport network. Figure 17 shows that the section of Boundary Road west of the E6 serves an important role as a collector / distributor road providing access to the E6, Epping Road and Boundary Road East. Almost 15 percent of the traffic travels from west of Wollert before travelling on the selected link.

Figure 17 Select link analysis: Boundary Road west of Epping Road

Figure 18 shows the patterns of use of Koukoura Drive north of Craigieburn Road. Nearly half the traffic heading southbound here comes from north of Wollert, and nearly three-quarters of the traffic continues south.

Figure 19 shows a link further north at the entrance to Wollert. It shows that over half the traffic entering Wollert from the north leaves Wollert to the south or west.

At both locations the balance of traffic reaches Koukoura Drive by local connector roads, generated from the nearby land uses.

These results indicate that Koukoura Drive is performing a substantial network role as a through traffic route across the Wollert PSP area.

Figure 18 **Select link analysis: Koukoura Drive north of Craigieburn Road**

Figure 19 **Select link analysis: Koukoura Drive north of Summerhill Road**

3.4 Theme 1: East-west connections to the E6 corridor

3.4.1 Scenario 1 – Summerhill Road E6 connection

Scenario 1 differs from the Reference Case in that Summerhill Road provides the only connection to the E6.

Table 6 and Table 7 shows there is no significant difference in overall travel behaviour compared to the reference case, with negligible shifts in mode or destination.

Table 6 Scenario 1 AM peak trips to and from Wollert by mode and origin/destination region

Location	Ultimate scenario (All trips)		Scenario 1 (All trips)		Car		Public Transport	
	To	To From	To	From	To	From	To	From
Wollert (internal trip)	7,200		7,300		7,100		300	
Whittlesea Nth of Wollert	2,400	2,400	2,400	1,700	2,300	1,600	200	100
Whittlesea Sth of Wollert	2,700	2,700	2,600	4,300	2,400	4,100	200	200
Central suburbs	100	100	100	2,000	0	300	100	1,700
Other northern suburbs	3,000	3,000	3,000	5,700	2,800	5,000	100	600
Rest of Melbourne	200	200	200	600	200	300	0	300
All regions	15,600	15,600	15,600	21,500	14,800	18,400	800	3,100

Table 7 Scenario 1 AM peak trips to and from Wollert by mode and origin/destination region by percentages

Location	All trips		Car		Public Transport		Mode Share	
	To	From	To	From	To	From	To	From
Wollert (internal trip)	25%		48%	38%	30%	8%	3%	
Whittlesea Nth of Wollert	8%	6%	15%	9%	20%	2%	7%	3%
Whittlesea Sth of Wollert	9%	14%	16%	22%	21%	8%	7%	6%
Central suburbs	0%	7%	0%	2%	11%	54%	67%	85%
Other northern suburbs	10%	19%	19%	27%	14%	20%	4%	11%
Rest of Melbourne	1%	2%	1%	2%	4%	9%	20%	48%
All regions	100%		100%	100%	100%	100%	5%	14%

Figure 20 shows how traffic redistributes when Summerhill Road is the only E6 access location. There is a large increase in traffic on Epping Road north of Boundary Road and south of Craigieburn Road, and increases on Summerhill Road and other routes leading to the interchange. There is a small increase in traffic on Koukoura Drive. There is a reduction in traffic on the E6.

Figure 21 indicates that the increase in traffic on Epping Road results in congestion on that route.

These results suggest that Summerhill Road is an inconvenient location for a single interchange, with traffic using Epping Road as the alternative north and south rather than backtracking to Summerhill Road interchange and using the congested E6.

Figure 20 Scenario 1 difference plot to Reference Case

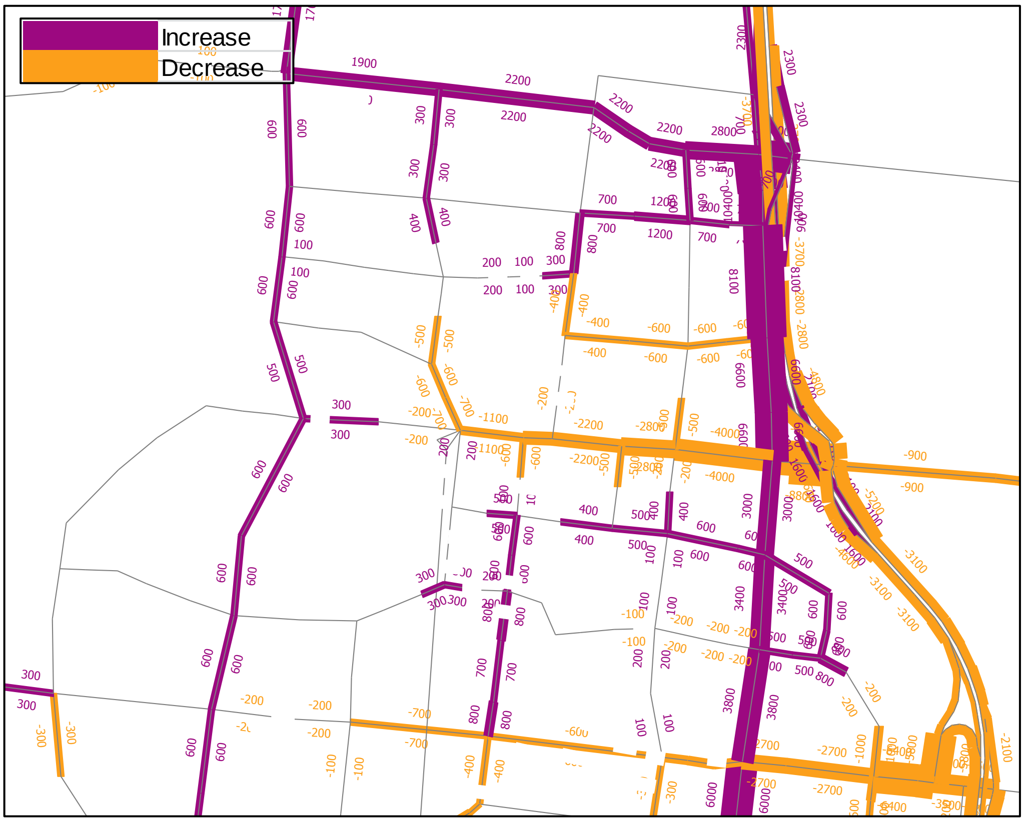
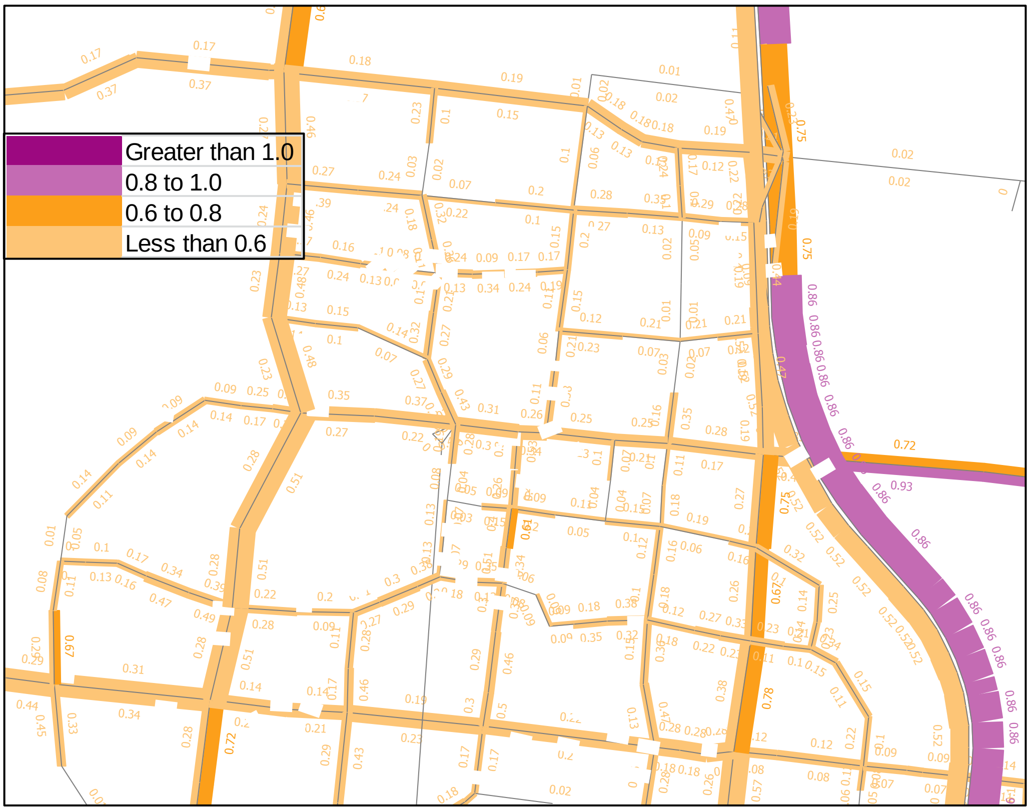


Figure 21 AM peak volume capacity ratios, Scenario 1 network



3.4.2 Scenario 2 – Boundary Road E6 connection

Scenario 2 differs from the Reference Case in that Boundary Road provides the only connection to the E6.

Table 8 and Table 9 show there is no significant difference in overall travel behaviour compared to the reference case, with negligible shifts in mode or destination.

Table 8 Scenario 2 AM peak trips to and from Wollert by mode and origin/destination region

Location	Ultimate scenario (All trips)		Scenario 2 (All trips)		Car		Public Transport	
	To	From	To	From	To	From	To	From
Wollert (internal trip)	7,200		7,300		7,000		300	
Whittlesea Nth of Wollert	2,400	2,400	2,400	1,700	2,300	1,600	200	100
Whittlesea Sth of Wollert	2,700	2,700	2,600	4,400	2,500	4,100	200	200
Central suburbs	100	100	100	1,900	0	300	100	1,600
Other northern suburbs	3,000	3,000	3,000	5,700	2,900	5,100	100	600
Rest of Melbourne	200	200	200	600	200	300	0	300
All regions	15,600	15,600	15,600	21,500	14,800	18,400	800	3,100

Table 9 Scenario 2 AM peak trips to and from Wollert by mode and origin/destination region by percentages

Location	All trips		Car		Public Transport		Mode Share	
	To	From	To	From	To	From	To	From
Wollert (internal trip)	24%		47%	38%	30%	8%	3%	
Whittlesea Nth of Wollert	8%	6%	15%	9%	20%	2%	7%	3%
Whittlesea Sth of Wollert	9%	15%	17%	22%	22%	8%	7%	6%
Central suburbs	0%	6%	0%	2%	11%	54%	67%	85%
Other northern suburbs	10%	19%	19%	28%	14%	20%	4%	11%
Rest of Melbourne	1%	2%	1%	2%	4%	9%	19%	47%
All regions	100%		100%	100%	100%	100%	5%	14%

Figure 22 shows that placing the only interchange at Boundary Road results in increases in traffic on Epping Road along its length, and approximately an additional 1000 vehicles along Boundary Road. Figure 23 identifies areas of potential congestion on Epping Road southbound of Boundary Road, in the Wollert Town Centre, on the northern and southern boundaries of Wollert PSP on Koukoura Drive; and along Boundary Road east of the precinct.

Figure 22 Scenario 2 difference plot to Reference Case

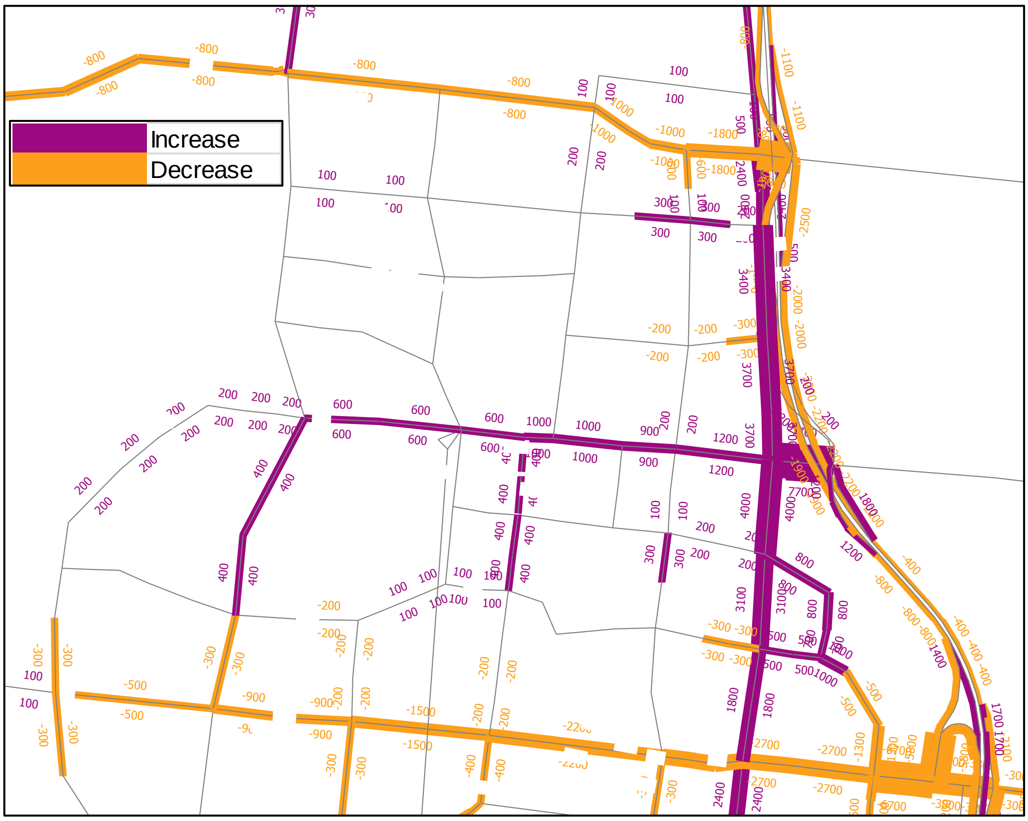


Figure 23 AM peak volume capacity ratios, Scenario 2 network

3.4.3 Scenario 3 – Craigieburn Road E6 connection

Scenario 3 differs from the Reference Case in that Craigieburn Road provides the only connection to the E6.

Table 10 and Table 11 shows there is no significant difference in overall travel behaviour compared to the reference case, with negligible shifts in mode or destination.

Table 10 Scenario 3 AM peak trips to and from Wollert by mode and origin/destination region

Location	Ultimate scenario (All trips)		Scenario 3 (All trips)		Car		Public Transport	
	To	From	To	From	To	From	To	From
Wollert (internal trip)	7,200		7,300		7,000		300	
Whittlesea Nth of Wollert	2,400	2,400	2,400	1,700	2,300	1,600	200	100
Whittlesea Sth of Wollert	2,700	2,700	2,600	4,300	2,400	4,100	200	200
Central suburbs	100	100	100	1,900	0	300	100	1,700
Other northern suburbs	3,000	3,000	3,000	5,700	2,800	5,100	100	600
Rest of Melbourne	200	200	200	600	200	300	0	300
All regions	15,600	15,600	15,600	21,500	14,800	18,400	800	3,100

Table 11 Scenario 3 AM peak trips to and from Wollert by mode and origin/destination region by percentages

Location	All trips		Car		Public Transport		Mode Share	
	To	From	To	From	To	From	To	From
Wollert (internal trip)	24%		48%	38%	30%	8%	3%	
Whittlesea Nth of Wollert	8%	6%	15%	9%	20%	2%	7%	3%
Whittlesea Sth of Wollert	9%	14%	17%	22%	21%	8%	7%	6%
Central suburbs	0%	7%	0%	2%	11%	54%	67%	85%
Other northern suburbs	10%	19%	19%	27%	14%	20%	4%	11%
Rest of Melbourne	1%	2%	1%	2%	4%	9%	19%	47%
All regions	100%		100%	100%	100%	100%	5%	14%

Figure 24 shows that placing the only interchange at Craigieburn Road results in increases in traffic on Epping Road along its length, but between 1600 and 3000 fewer vehicles routed along Boundary Road. Traffic filters on local roads south to Craigieburn Road to access the interchange, with volumes on Craigieburn Road increasing by up to 1700 vehicles west of Epping Road. The section east of Epping Road, which becomes a major access route, has 9100 additional vehicles.

Figure 25 identifies areas of potential congestion on Epping Road southbound of Boundary Road, in the Wollert Town Centre, on the northern and southern boundaries of Wollert PSP on Koukoura Drive; and along Boundary Road east of the precinct. This is a very similar pattern to that observed in Scenario 1 and Scenario 2.

Figure 24 Scenario 3 difference plot to Reference Case

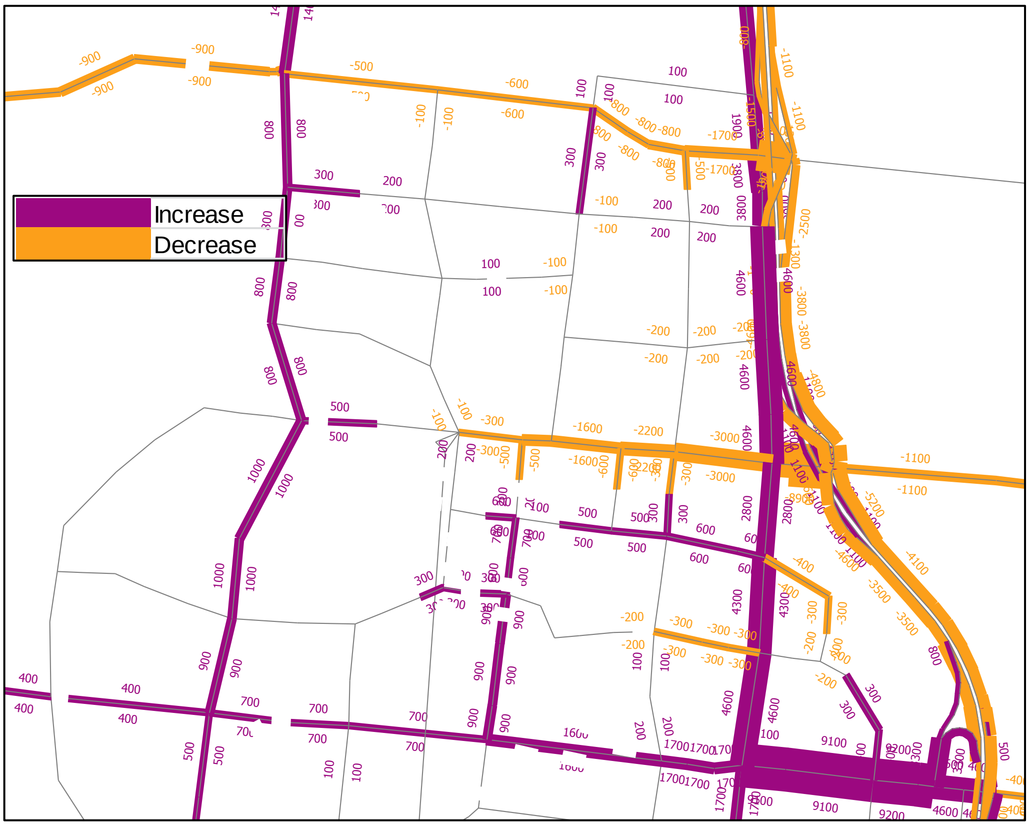


Figure 25 AM peak volume capacity ratios, Scenario 3 network

3.4.4 Scenario 4 – Craigieburn Road and Boundary Road E6 connections

Scenario 4 differs from the Reference Case in that both Craigieburn Road and Boundary Road provide connections to the E6. Summerhill Road does not.

Table 12 and Table 13 show there is no significant difference in overall travel behaviour compared to the reference case, with negligible shifts in mode or destination.

Table 12 Scenario 4 AM peak trips to and from Wollert by mode and origin/destination region

Location	Ultimate scenario (All trips)		Scenario 4 (All trips)		Car		Public Transport	
	To	From	To	From	To	From	To	From
Wollert (internal trip)	7,200		7,200		7,000		200	
Whittlesea Nth of Wollert	2,400	2,400	2,400	1,700	2,300	1,600	200	100
Whittlesea Sth of Wollert	2,700	2,700	2,700	4,400	2,500	4,100	200	200
Central suburbs	100	100	100	1,900	0	300	100	1,600
Other northern suburbs	3,000	3,000	3,000	5,700	2,900	5,100	100	600
Rest of Melbourne	200	200	200	600	200	300	0	300
All regions	15,600	15,600	15,600	21,500	14,800	18,400	800	3,100

Table 13 Scenario 4 AM peak trips to and from Wollert by mode and origin/destination region by percentages

Location	All trips		Car		Public Transport		Mode Share	
	To	From	To	From	To	From	To	From
Wollert (internal trip)	24%		47%	38%	30%	8%	3%	
Whittlesea Nth of Wollert	8%	6%	15%	9%	20%	2%	7%	3%
Whittlesea Sth of Wollert	9%	15%	17%	22%	21%	8%	7%	6%
Central suburbs	0%	6%	0%	2%	11%	54%	67%	85%
Other northern suburbs	10%	19%	19%	28%	14%	20%	4%	11%
Rest of Melbourne	1%	2%	1%	2%	4%	9%	19%	47%
All regions	52%	72%	100%	100%	100%	100%	5%	14%

Figure 26 shows that this combination of interchanges increases traffic on Epping Road north of Boundary Road by around 3200 vehicles, but reduces traffic on Summerhill Road by between 900 and 1100 vehicles along most of its length, and more so on the section that connects to the interchange location. There are minor changes in flows on Craigieburn Road. Figure 27 identifies areas of potential congestion on Epping Road southbound of Boundary Road, on the northern and southern boundaries of Wollert PSP on Koukoura Drive; and along Boundary Road east of the precinct. The overall congestion pattern is similar to the reference case.

Figure 26 Scenario 4 difference plot to Reference Case

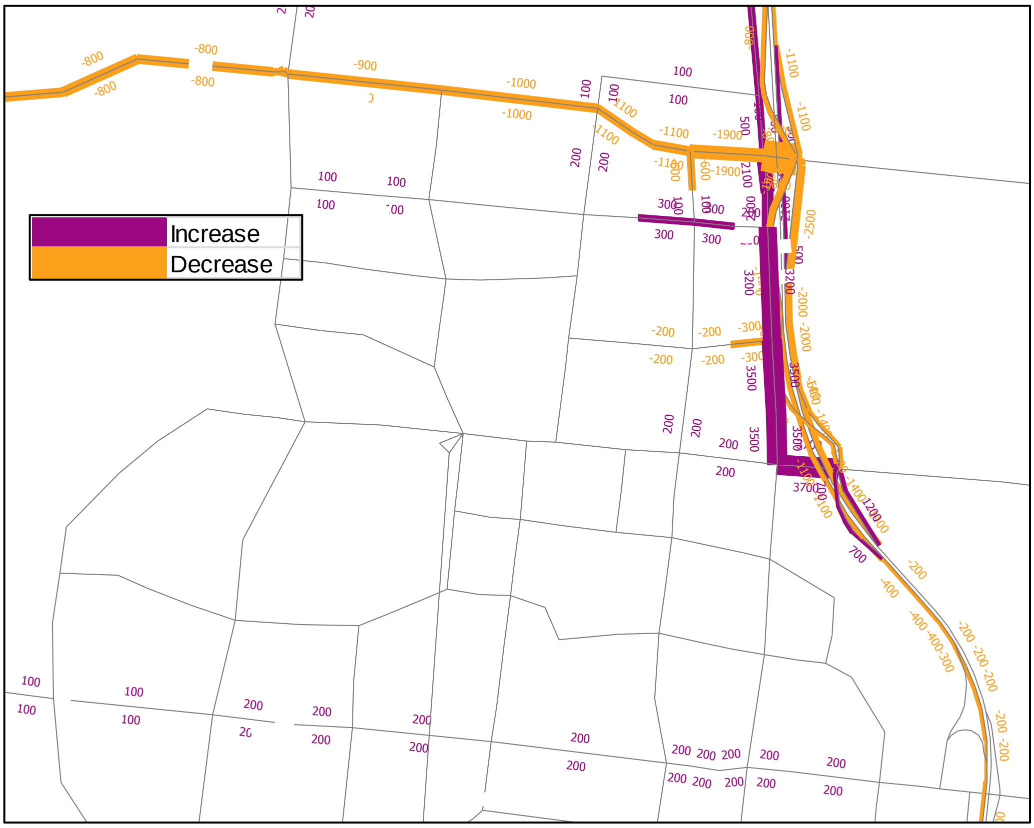


Figure 27 AM peak volume capacity ratios, Scenario 4 network

3.5 Theme Two: Arterial road design widths

3.5.1 Scenario 5 – Koukoura Drive, Summerhill Road four lanes

In Scenario 5, Koukoura Drive and Summerhill Road are assumed to be four lanes, whereas the reference case assumes them to be six lanes.

Table 14and Table 15 show there is no significant difference in overall travel behaviour compared to the reference case, with negligible shifts in mode or destination.

Table 14 Scenario 5 AM peak trips to and from Wollert by mode and origin/destination region

Location	Ultimate scenario (All trips)		Scenario 5 (All trips)		Car		Public Transport	
	To	From	To	From	To	From	To	From
Wollert (internal trip)	7,200		7,300		7,000		300	
Whittlesea Nth of Wollert	2,400	1,700	2,400	1,600	2,200	1,600	200	100
Whittlesea Sth of Wollert	2,700	4,400	2,700	4,400	2,500	4,100	200	200
Central suburbs	100	1,900	100	1,900	0	300	100	1,600
Other northern suburbs	3,000	5,700	3,000	5,600	2,800	5,000	100	600
Rest of Melbourne	200	600	200	600	200	300	0	300
All regions	15,600	21,400	15,600	21,400	14,800	18,400	800	3,100

Table 15 Scenario 5 AM peak trips to and from Wollert by mode and origin/destination region by percentages

Location	All trips		Car		Public Transport		Mode Share	
	To	From	To	From	To	From	To	From
Wollert (internal trip)	25%		48%	38%	30%	8%	3%	
Whittlesea Nth of Wollert	8%	6%	15%	9%	20%	2%	7%	3%
Whittlesea Sth of Wollert	9%	15%	17%	22%	22%	8%	7%	6%
Central suburbs	0%	6%	0%	2%	11%	54%	67%	85%
Other northern suburbs	10%	19%	19%	27%	14%	20%	4%	11%
Rest of Melbourne	1%	2%	1%	2%	4%	9%	19%	46%
All regions	100%		100%	100%	100%	100%	5%	14%

Figure 28 shows that with a four-lane Koukoura Drive and Summerhill Road, traffic crossing the northern study area boundary is redistributed. There are some 2,500 fewer trips per day on Koukoura Drive. Investigations of the model output showed that this traffic was redistributed widely across the regional network, including Epping Road and the E6 corridor in the model area, but also to other routes that have not been investigated in detail in this study.

Summerhill Road continues to have a good level of service under this scenario. Nevertheless, some traffic is redistributed from Summerhill Road to Boundary Road to access the freeway and Epping Road corridors.

Figure 29 shows that Koukoura Drive now has some areas of localised congestion between Summerhill Road and Boundary Road, and efficient use of planned capacity between Boundary Road and Craigieburn Road. Epping Road continues to perform broadly as per the reference case.

Figure 28 Scenario 5 difference plot to Reference Case

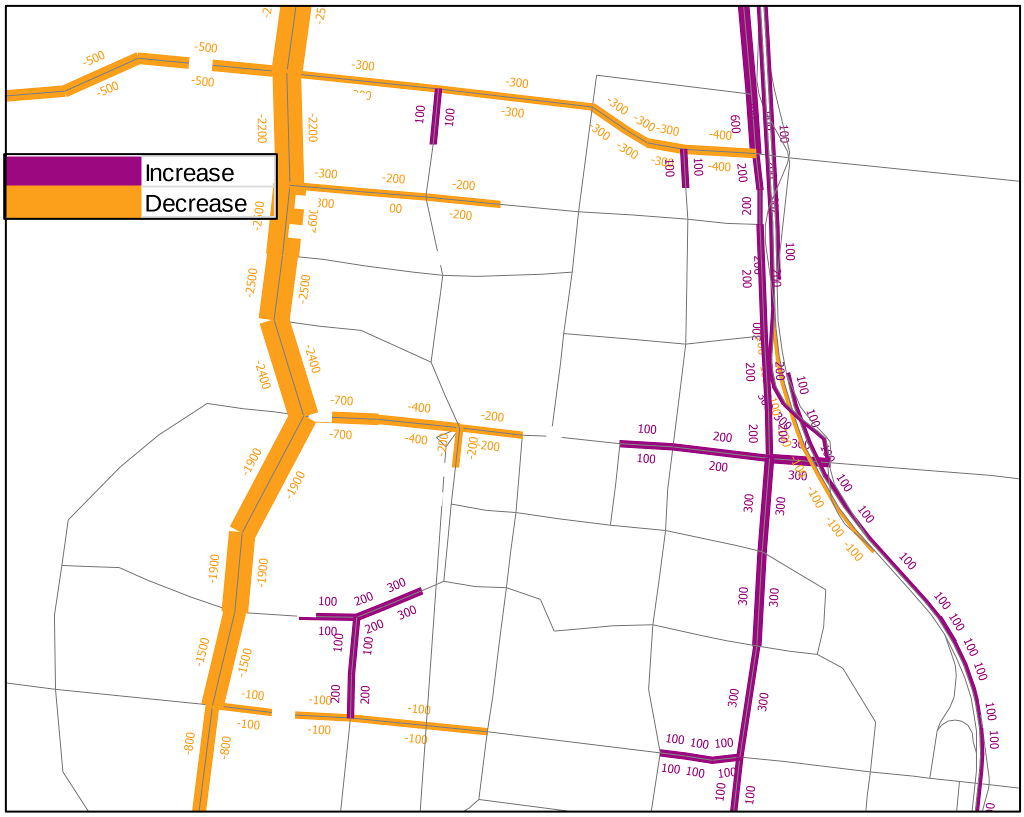
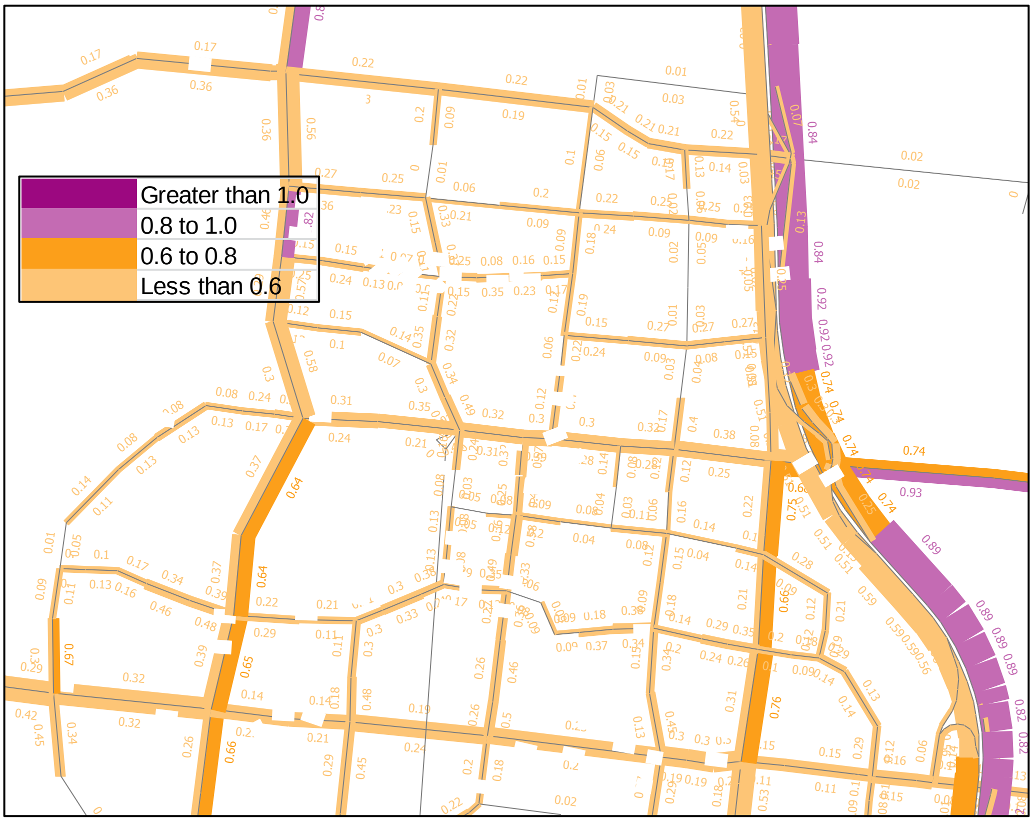


Figure 29 AM peak volume capacity ratios, Scenario 5 network



3.5.2 Scenario 6 – Koukoura Drive, Summerhill Road, Craigieburn Road four lanes

In Scenario 6, Koukoura Drive, Summerhill Road and Craigieburn Road are assumed to be four lanes, whereas the reference case assumes them to be six lanes.

Table 16 and Table 17 show there is no significant difference in overall travel behaviour compared to the reference case, with negligible shifts in mode or destination.

Table 16 Scenario 6 AM peak trips to and from Wollert by mode and origin/destination region

Location	Ultimate scenario (All trips)		Scenario 6 (All trips)		Car		Public Transport	
	To	From	To	From	To	From	To	From
Wollert (internal trip)	7,200		7,300		7,100		300	
Whittlesea Nth of Wollert	2,400	1,700	2,400	1,600	2,200	1,600	200	100
Whittlesea Sth of Wollert	2,700	4,400	2,700	4,400	2,500	4,100	200	200
Central suburbs	100	1,900	100	1,900	0	300	100	1,600
Other northern suburbs	3,000	5,700	3,000	5,600	2,800	5,000	100	600
Rest of Melbourne	200	600	200	600	200	300	0	300
All regions	15,600	21,400	15,600	21,500	14,800	18,400	800	3,100

Table 17 Scenario 6 AM peak trips to and from Wollert by mode and origin/destination region by percentages

Location	All trips		Car		Public Transport		Mode Share	
	To	From	To	From	To	From	To	From
Wollert (internal trip)	25%		48%	38%	30%	8%	3%	
Whittlesea Nth of Wollert	8%	6%	15%	9%	20%	2%	7%	3%
Whittlesea Sth of Wollert	9%	15%	17%	22%	22%	8%	7%	6%
Central suburbs	0%	6%	0%	2%	11%	54%	67%	85%
Other northern suburbs	10%	19%	19%	27%	14%	20%	4%	11%
Rest of Melbourne	1%	2%	1%	2%	4%	9%	19%	47%
All regions	100%		100%	100%	100%	100%	5%	14%

Figure 30 shows that the network effects of Scenario 6 are similar to Scenario 5, with the additional effect that Craigieburn Road becomes a relatively less attractive east-west option from Wollert, with Boundary Road experiencing a further small increase in forecast volumes of traffic travelling to and from the freeway corridor compared to Scenario 5.

Road network performance has a similar pattern as in Scenario 5, with localised congestion but otherwise efficient use of planned capacity in Koukoura Drive, and east-west volume-capacity ratios of less than 0.3.

Figure 30 Daily volume difference plot comparing Scenario 6 results to the reference case

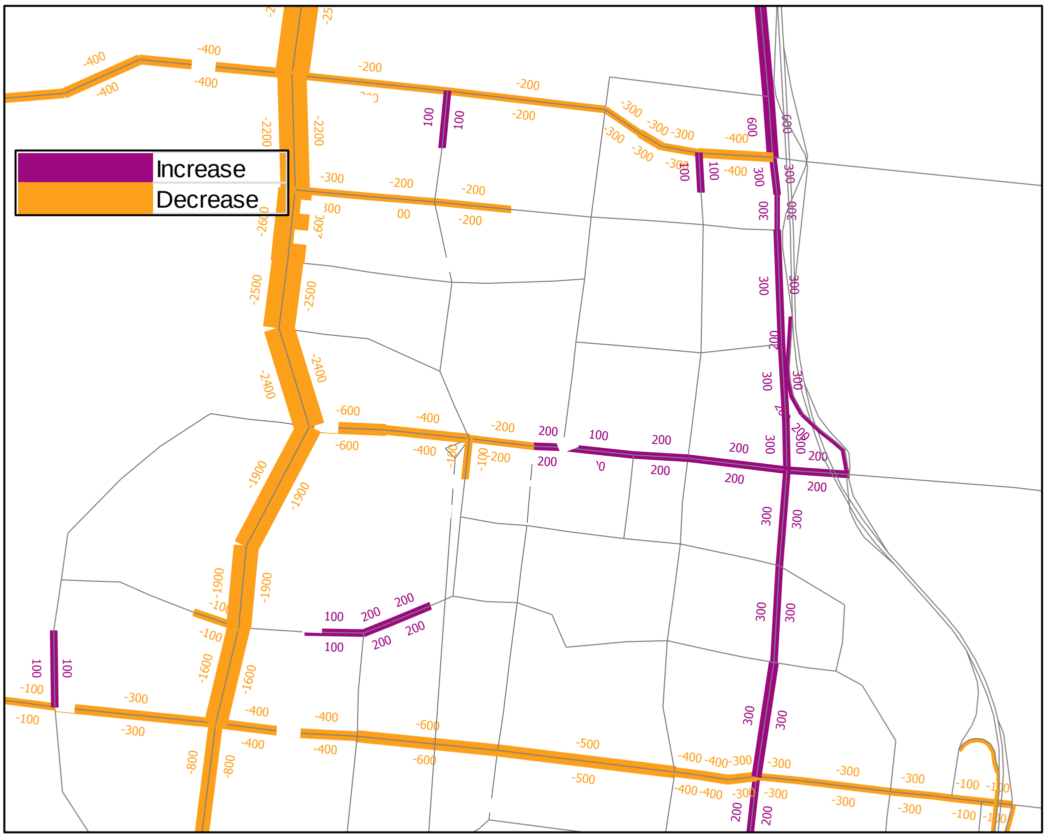
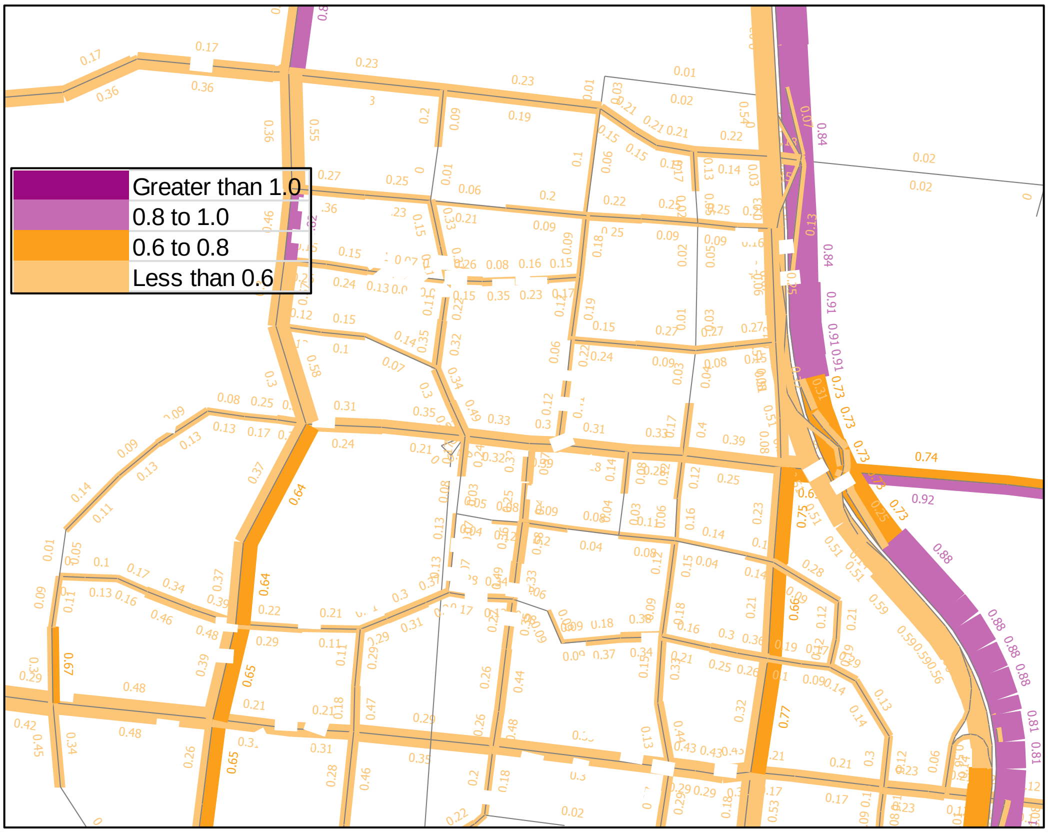


Figure 31 AM peak volume capacity ratios, scenario 6 network



3.5.3 Travel speeds and level of service

AustRoads guidance recommends the following interpretations of Level of Service based on the percentage of free flow speeds. In summary:

- LOS A describes primarily free-flow operation.
- LOS B describes reasonably unimpeded operation.
- LOS C describes stable operation.
- LOS D indicates a less stable condition in which small increases in flow may cause substantial increases in delay and decreases in travel speed.
- LOS E is characterised by unstable operation and significant delay.
- LOS F is characterised by flow at extremely low speed. Congestion is likely occurring at the boundary intersections, as indicated by high delay and extensive queuing. The travel speed is 30% or less of the base free-flow speed.

The relevant criteria are presented in Table 18.

Table 18 Level of Service Criteria for cars on urban streets

Travel speed as a percentage of base Free Flow Speed (%)	LOS by critical volume-to-capacity ratio	
	≤ 1.0	> 1.0
> 85	A	F
> 67–85	B	F
> 50–67	C	F
> 40–50	D	F
> 30–40	E	F
≤ 30	F	F

Table 19 summarises the relevant model inputs and outputs for the reference case and scenarios 5 and 6; Table 20 presents the associated Level of Service value. It shows a minor reduction in the Level of Service on Koukoura Road from A to B; however, the actual result is 84.4%, indicating it only narrowly falls below the LOS A criteria.

Table 19 AM Peak Average Speed (km/h) for reference case and Scenarios 5 and 6

Road	Modelled free flow speed (All networks)	Ref	SC5	SC6
		Ultimate	Koukoura, Summerhil 4 lanes	Koukoura, Summerhill, Craigieburn 4 lanes
Local roads	33	33	33	33
Summerhill Rd	64	63	62	62
Boundary Rd	43	43	43	43
Craigieburn Rd	64	62	62	61
Koukoura Dr	64	60	54	54
Epping Rd	48 (north of Craigieburn Road) 64 (south of Craigieburn Road)	44	44	44

Table 20 Indicated LOS based on criteria in Table 18

Road	Ref	SC5	SC6
	Ultimate	Koukoura, Summerhil 4 lanes	Koukoura, Summerhill, Craigieburn 4 lanes
Local roads	A	A	A
Summerhill Rd	A	A	A
Boundary Rd	A	A	A
Craigieburn Rd	A	A	A
Koukoura Dr	A	B	B
Epping Rd	A	A	A

3.6 Theme 3: The role of rail

3.6.1 Scenario 7 – No rail to Wollert

Scenario 7 differs from the Reference Case in that there is no rail service to Wollert.

Table 21 and Table 22 shows there is a significant difference in overall travel behaviour compared to the reference case. Public transport trips to and from the central suburbs fall significantly as a source of public transport patronage, and internal trips become relatively more important as a source of boardings. Mode share for trips to and from the central suburbs, other northern suburbs and the Rest of Melbourne zones falls significantly, although it is noted that public transport still dominates the share of trips to central Melbourne.

Table 21 Scenario 7 AM peak trips to and from Wollert by mode and origin/destination region

Location	Ultimate scenario (All trips)		Scenario 7 (All trips)		Car		Public Transport	
	To	From	To	From	To	From	To	From
Wollert (internal trip)	7,200		7,500		7,200		300	
Whittlesea Nth of Wollert	2,400	1,700	2,400	1,800	2,200	1,700	100	100
Whittlesea Sth of Wollert	2,700	4,400	2,700	4,500	2,500	4,300	100	200
Central suburbs	100	1,900	100	1,200	0	300	0	900
Other northern suburbs	3,000	5,700	2,900	5,800	2,900	5,400	100	400
Rest of Melbourne	200	600	200	500	200	300	0	100
All regions	15,600	21,400	15,700	21,200	15,000	19,200	700	2,000

Table 22 Scenario 7 AM peak trips to and from Wollert by mode and origin/destination region by percentages

Location	All trips		Car		Public Transport		Mode Share	
	To	From	To	From	To	From	To	From
Wollert	25%		48%	37%	42%	16%	4%	
Whittlesea Nth of Wollert	8%	6%	15%	9%	19%	3%	6%	4%
Whittlesea Sth of Wollert	9%	15%	17%	22%	20%	9%	5%	4%
Central suburbs	0%	4%	0%	2%	6%	44%	48%	73%
Other northern suburbs	10%	20%	19%	28%	11%	21%	3%	7%
Rest of Melbourne	1%	2%	1%	2%	2%	7%	10%	30%
All regions	100%		100%	100%	100%	100%	5%	9%

As a result of the lack of rail services, traffic levels increase across most of the network, except around the Wollert town centre, as shown in Figure 32. However, generally the increase on any individual link is small (200 vehicles or less). Figure 33 shows the pattern of congestion remains the same as in the Reference Case, as the shift in traffic is generally well within the capacity of the roads. Figure 34 shows the line loads for bus services when no trains are provided, and Figure 35 shows the difference to the Reference Case.

Although all bus routes play a role in replacing the rail service, a notable desire line from Wollert to Epping Road emerges as the preferred route towards the central city. Note also that buses feeding to the train station from Koukoura Road have a modelled increase in boardings despite the lack of a train station. This result can be interpreted as people who previously walked or drove to the station now using a feeder bus for the longer trip to the next nearest station.

Figure 32 Scenario 7 difference plot to Reference Case (highway)

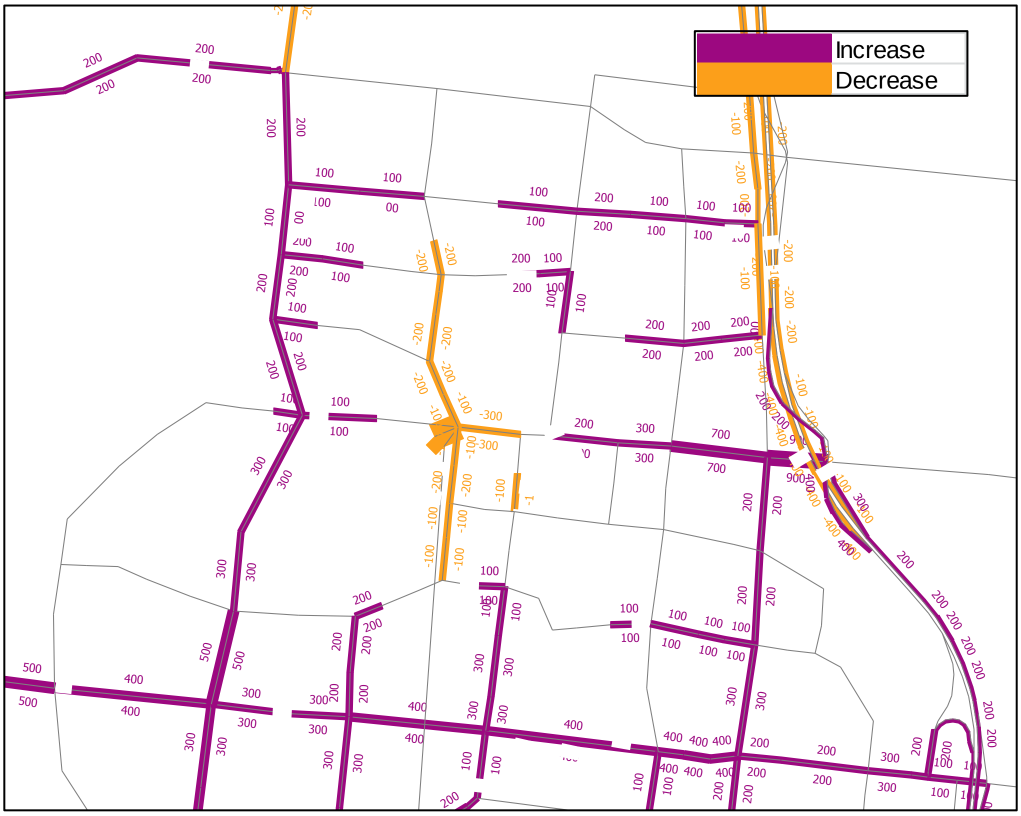


Figure 33 AM peak volume capacity ratios, Scenario 7 network

Figure 34 Scenario 7 daily public transport line loads

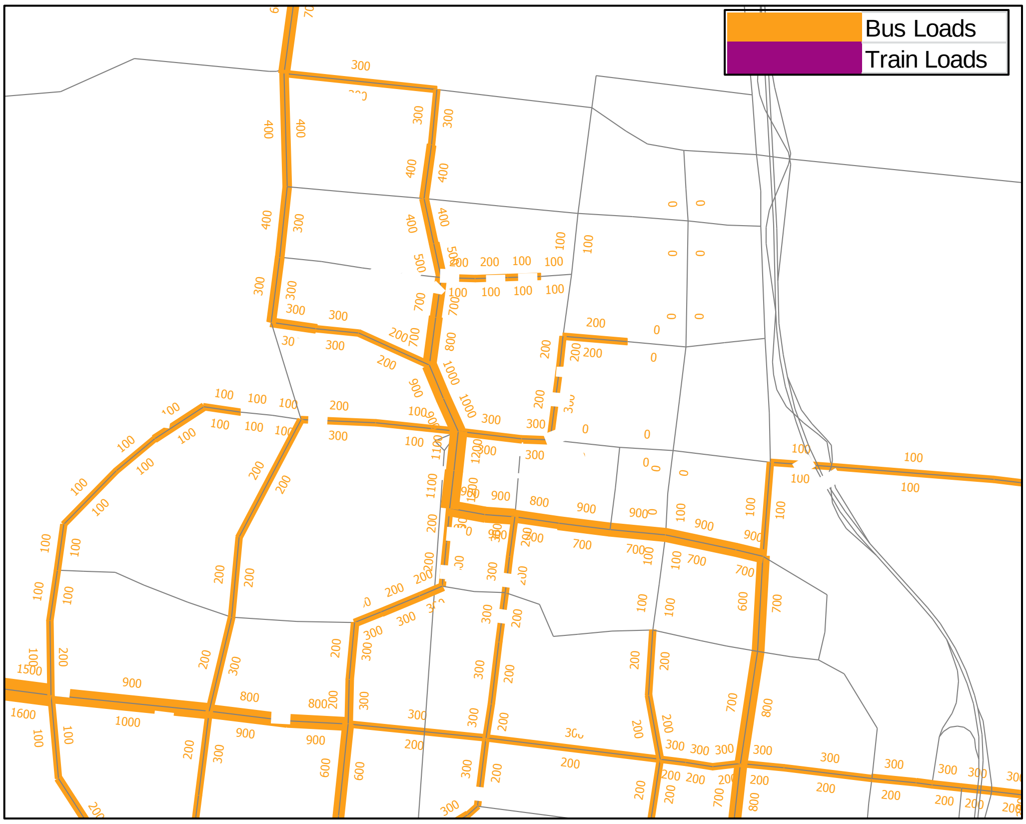
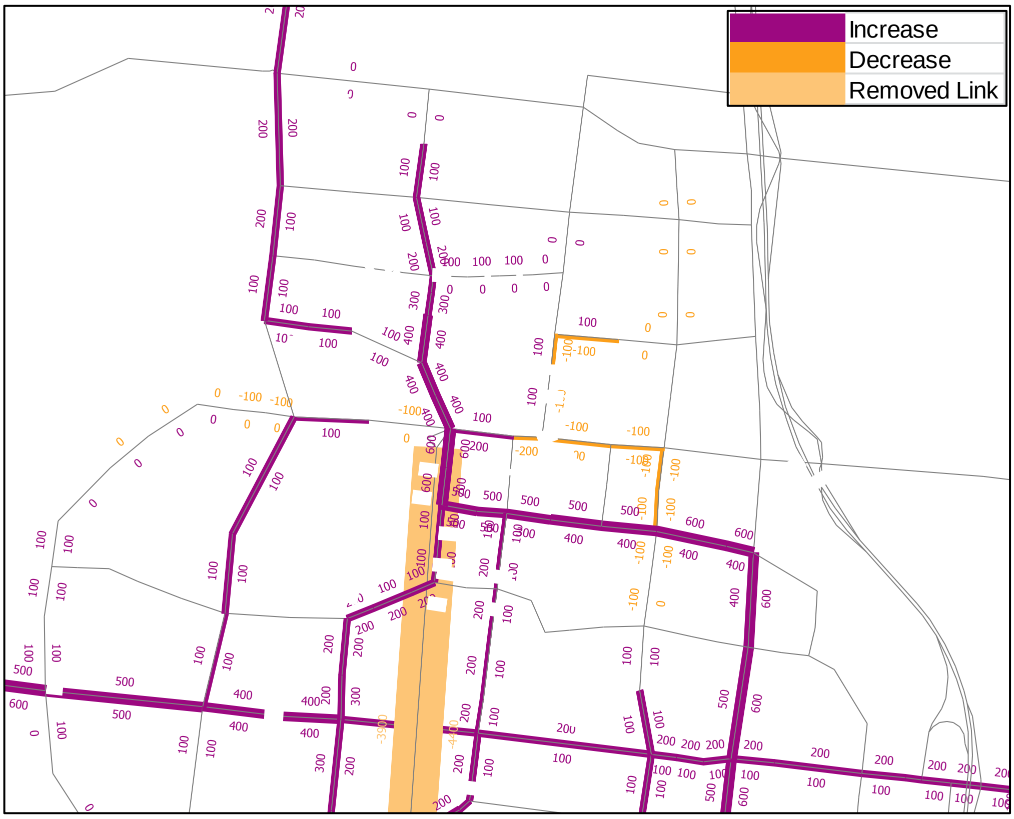


Figure 35 Scenario 7 difference plot to Reference Case (public transport)



3.7 Interim Scenarios

Table 23 and Table 24 show that at the interim stage of development:

- Travel patterns in Wollert are relatively more self-contained, with 30 percent of trips internal to the precinct. In the ultimate scenario, this is 24 percent.
- The area of Whittlesea north of Wollert is less significant for travel, probably because it has not yet been developed. As a result, the demand pattern is more southerly-oriented.
- Mode share to public transport is lower, and internal trips a relatively more significant source of boardings than longer distance trips.

Table 23 Interim AM peak trips to and from Wollert by mode and origin/destination region

Location	All trips		Car		Public Transport	
	To	From	To	From	To	From
Wollert (internal trip)	6,100		6,000		200	
Whittlesea Nth of Wollert	900	1,000	900	1,000	0	0
Whittlesea Sth of Wollert	2,300	3,300	2,200	3,100	100	100
Central suburbs	100	1,100	0	300	0	800
Other northern suburbs	1,300	4,200	1,300	3,700	0	500
Rest of Melbourne	100	400	100	200	0	200
All regions	10,800	16,100	10,500	14,300	300	1,800

Table 24 Interim scenario AM peak trips to and from Wollert by mode and origin/destination region by percentages

Location	All trips		Car		Public Transport		Mode Share	
	To	From	To	From	To	From	To	From
Wollert	30%		57%	42%	53%	9%	3%	
Whittlesea Nth of Wollert	4%	5%	8%	7%	5%	3%	3%	4%
Whittlesea Sth of Wollert	11%	16%	21%	22%	20%	7%	3%	4%
Central suburbs	0%	5%	0%	2%	12%	44%	52%	72%
Other northern suburbs	6%	20%	12%	26%	8%	28%	2%	12%
Rest of Melbourne	0%	2%	1%	2%	2%	9%	10%	44%
All regions	100%		100%	100%	100%	100%	3%	11%

The volumes of traffic forecast on the network are shown in Figure 36. Epping Road is clearly the principal north-south route in the precinct with volumes of up to 23,000 vehicles a day, whereas Koukoura Drive carries almost 16,000 vehicles a day. Craigieburn Road is the principal east-west road, with incrementally lower volumes on each east-west route option to the north.

Figure 37 shows how traffic is forecast to change between the ultimate and interim scenarios. The major difference is in the north-western quadrant of Wollert where Koukoura Drive and Summerhill Road become significant traffic routes, and along the Epping Road corridor where the E6 provides some relief for through traffic, although this varies from 2,700 vehicles to 8,100 vehicles depending on segment, showing that much of the traffic is local and accessing the interchanges using Epping Road. Elsewhere on the network increases of 1000 to 3000 vehicles a day are observed, with the higher volume changes on the main feeder links, Boundary Road and in the town centre.

In the interim scenario, Epping Road, Boundary Road , Koukoura Drive and Craigieburn Road west all experience congestion, including severe capacity concerns on the western exit of the precinct towards the Hume Freeway. These locations are shown in Figure 38. By contrast, much of the proposed collector and arterial road network is running well under capacity with low levels of demand compared to capacity on some links giving volume-capacity ratios of less than 0.1.

Figure 39 and Figure 40 together suggest that public transport patronage achieves its ultimate forecast loadings on some segments of the network at the interim stage of development. Buses north-west of the town centre have more patronage in the ultimate scenario than in the interim. Most other bus routes, however, show lower boardings when their role is largely replaced by rail in the reference case and the demand patterns become less southerly-oriented.

Figure 36 Average weekday two way flows – Interim reference case – cars only

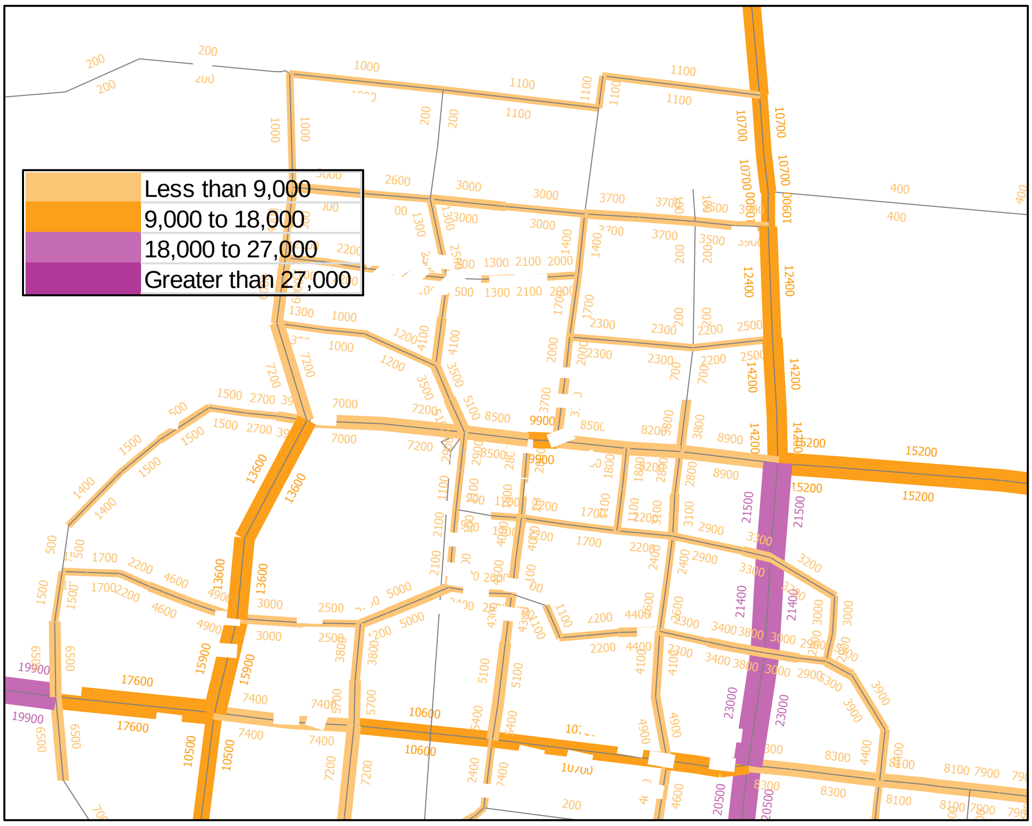


Figure 37 Change in weekday traffic Ultimate to Interim

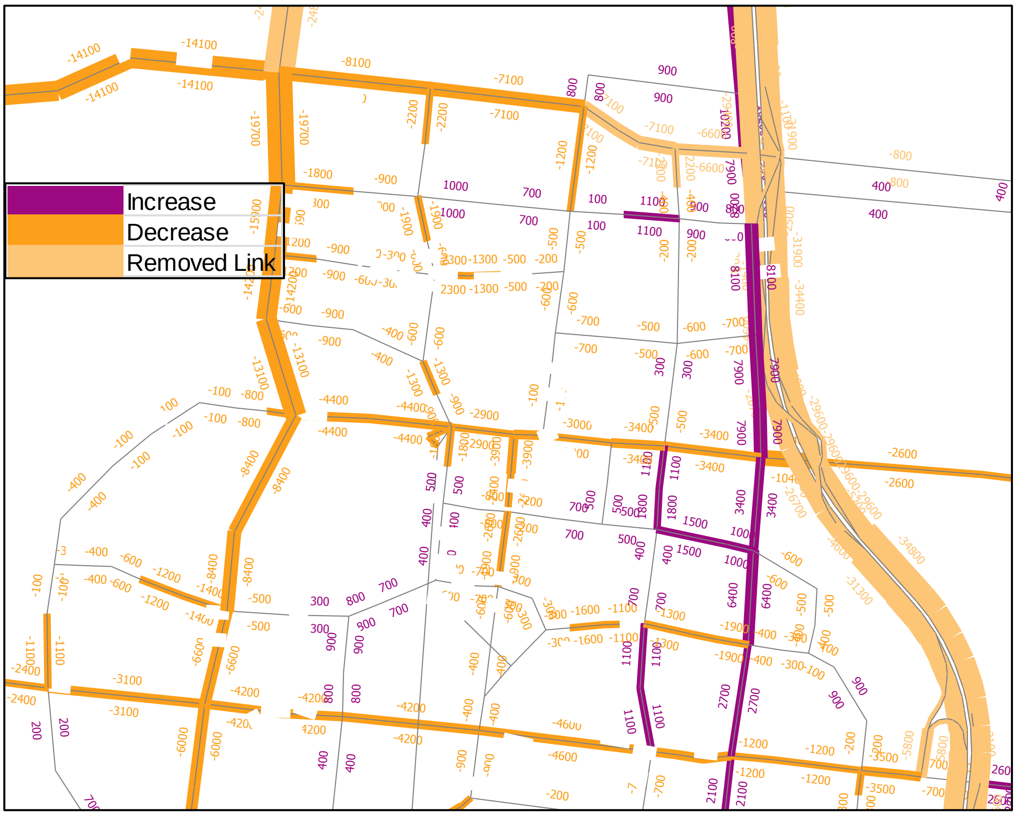


Figure 38 AM peak volume capacity ratios, Interim scenario network

Figure 39 Daily public transport line loads (interim scenario)

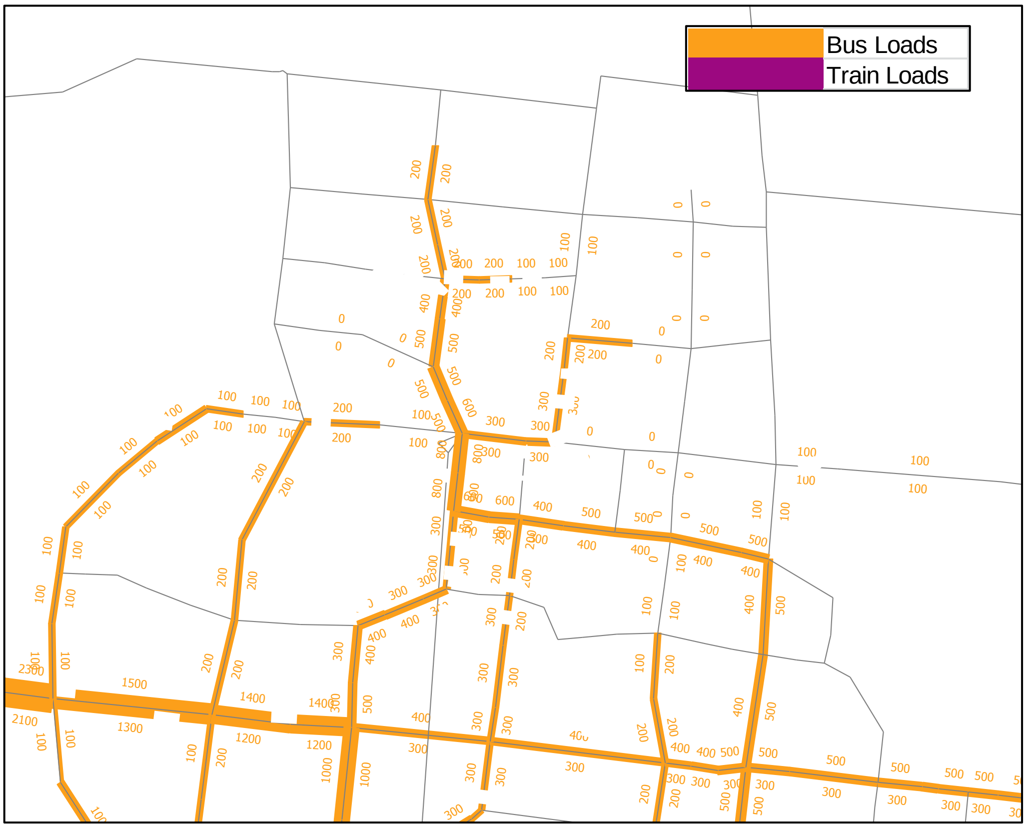


Figure 40 Ultimate compared to Interim scenario difference plot (public transport)

3.8 Network performance

Table 25 and Table 26 show the absolute AM peak vehicle kilometres and the change against the reference case respectively. The tables show that:

- Scenarios 5 and 6 result in less AM peak period travel overall within the study area as a result of the changed cross section. This does not necessarily mean that travel has been reduced – just that if it is occurring during the modelled time, it is no longer passing through the Wollert PSP area.
- Scenario 2 is neutral with respect to the reference case.
- Scenarios 1, 3, 4 and 7 all result in increased AM peak vehicle kilometres travelled, with Scenario 3 producing the most additional kilometres.
- The reference case best minimises traffic growth on Epping Road.

Table 25 AM Peak Vehicle Kilometres Travelled (VKT)

VKT	Ref	SC1	SC2	SC3	SC4	SC5	SC6	SC7
Road	Ultimate	Summerhill - E6	Boundary - E6	Craigieburn - E6	Boundary & Craigieburn – E6	Koukoura, Summerhil 4 lanes	Koukoura, Summerhill, Craigieburn 4 lanes	No Rail
Local roads	18,946	19,161	19,033	19,161	18,974	19,072	19,007	19,652
Summerhill Rd	3,987	4,870	3,438	3,112	3,263	3,666	3,697	4,032
Boundary Rd	5,876	4,828	6,526	5,054	6,043	5,756	5,792	6,175
Craigieburn Rd	11,985	11,123	10,584	14,298	12,187	11,914	11,742	12,487
Koukoura Dr	13,433	13,472	13,271	13,815	13,347	11,486	11,514	13,363
Epping Rd	6,519	8,931	8,074	8,362	7,270	6,880	6,783	6,622
Total	60,745	62,385	60,927	63,804	61,083	58,774	58,536	62,331

Table 26 AM Peak Vehicle Kilometres Travelled (VKT) – Change from reference case

VKT	Ref	SC1	SC2	SC3	SC4	SC5	SC6	SC7
Road	Ultimate	Summerhill - E6	Boundary - E6	Craigieburn - E6	Boundary & Craigieburn – E6	Koukoura, Summerhil 4 lanes	Koukoura, Summerhill, Craigieburn 4 lanes	No Rail
Local roads		215	86	215	28	126	61	706
Summerhill Rd		884	-549	-874	-724	-321	-289	45
Boundary Rd		-1,048	650	-822	167	-120	-84	299
Craigieburn Rd		-862	-1,401	2,313	202	-71	-243	502
Koukoura Dr		40	-161	383	-86	-1,946	-1,918	-69
Epping Rd		2,412	1,556	1,844	752	362	265	103
Total		1,640	181	3,059	338	-1,971	-2,210	1,586

Table 27 shows that:

- All interchange scenarios are more effective than the reference case at reducing congested vehicle kilometres on Epping Road.
- Scenarios 2 and 4 result in significantly worse congestion than the reference case on Boundary Road.
- The reduction of arterial road widths in Scenarios 5 and 6 does not cause wider network congestion, although it does increase the total amount of measured network congestion. Table 27 shows that compared to the reference case, the additional length of road with volume-capacity ratio greater than 0.6 is almost entirely attributable to Koukoura Drive – that is, the extra congestion is entirely on that link, not elsewhere in the network.
- The ‘no rail’ scenario does not substantially change the percentage of vehicle kilometres in congested conditions compared to the reference case.

Table 27 AM Peak Percentage of Vehicle Kilometres Travelled (VKT) with VCR greater than 0.6

VKT	Ref	SC1	SC2	SC3	SC4	SC5	SC6	SC7
Road	Ultimate	Summerhill - E6	Boundary - E6	Craigieburn - E6	Boundary & Craigieburn – E6	Koukoura, Summerhil 4 lanes	Koukoura, Summerhill, Craigieburn 4 lanes	No Rail
Local roads	4%	2%	2%	2%	4%	4%	4%	4%
Summerhill Rd	0%	0%	0%	0%	0%	0%	0%	0%
Boundary Rd	11%	0%	26%	0%	24%	12%	12%	11%
Craigieburn Rd	0%	0%	0%	0%	0%	0%	0%	0%
Koukoura Dr	0%	0%	0%	0%	0%	38%	38%	0%
Epping Rd	52%	42%	46%	47%	46%	52%	51%	54%
Total	8%	7%	9%	7%	9%	16%	16%	8%

Table 28 and Table 29 show the AM peak vehicle hours and the change compared to the reference case. There is little difference between the scenarios, falling in a range of 66 hours (5% of the maximum).

Note that despite the time lost in congestion shown in Table 27 for Scenarios 5 and 6, total time spent in travel on the Wollert network is expected to marginally fall, as shown in Table 29. This can be interpreted as the narrower cross-section encouraging traffic to avoid the area of the modelled network.

Table 28 AM Peak Vehicle Hours Travelled (VHT) – Change from reference case

VKT	Ref	SC1	SC2	SC3	SC4	SC5	SC6	SC7
Road	Ultimate	Summerhill - E6	Boundary - E6	Craigieburn - E6	Boundary & Craigieburn – E6	Koukoura, Summerhil 4 lanes	Koukoura, Summerhill, Craigieburn 4 lanes	No Rail
Local roads	578	587	582	586	579	582	580	600
Summerhill Rd	63	77	54	49	52	60	60	64
Boundary Rd	137	112	154	118	141	133	135	143
Craigieburn Rd	193	179	169	230	196	191	192	201
Koukoura Dr	223	223	220	230	221	214	215	222
Epping Rd	148	203	184	191	164	157	155	151
Total	1,342	1,381	1,364	1,403	1,353	1,338	1,337	1,381

Table 29 AM Peak Vehicle Hours Travelled (VHT) – Change from reference case

VKT	Ref	SC1	SC2	SC3	SC4	SC5	SC6	SC7
Road	Ultimate	Summerhill - E6	Boundary - E6	Craigieburn - E6	Boundary & Craigieburn – E6	Koukoura, Summerhil 4 lanes	Koukoura, Summerhill, Craigieburn 4 lanes	No Rail
Local roads		8	3	8	1	4	2	22
Summerhill Rd		14	-9	-14	-11	-4	-3	1
Boundary Rd		-24	17	-19	4	-3	-2	6
Craigieburn Rd		-14	-23	37	3	-1	-1	8
Koukoura Dr		0	-3	6	-2	-9	-8	-2
Epping Rd		55	36	43	16	9	7	3
Total		39	22	61	11	-4	-6	39

Table 30 shows the AM peak average speeds. There is little difference between the scenarios save that the change in road cross-section results in a ten percent reduction in average speed from 60 to 54 kph on Koukoura Drive. This is not expected to cause deterioration in travel speeds on other routes.

Table 30 AM Peak Average Speed (km/h)

VKT	Ref	SC1	SC2	SC3	SC4	SC5	SC6	SC7
Road	Ultimate	Summerhill - E6	Boundary - E6	Craigieburn - E6	Boundary & Craigieburn – E6	Koukoura, Summerhil 4 lanes	Koukoura, Summerhill, Craigieburn 4 lanes	No Rail
Local roads	33	33	33	33	33	33	33	33
Summerhill Rd	63	63	63	63	63	62	62	63
Boundary Rd	43	43	42	43	43	43	43	43
Craigieburn Rd	62	62	62	62	62	62	61	62
Koukoura Dr	60	60	60	60	60	54	54	60
Epping Rd	44	44	44	44	44	44	44	44
Total	45	45	45	45	45	44	44	45

4.0 Intersection Analysis

4.1 Assumptions and Inputs

The intersection analysis was based upon a number of assumptions and inputs. The key assumptions are discussed in the following sections.

4.1.1 Modelling Program

The intersection assessment was undertaken using SIDRA version 6.0.

It is acknowledged that results have been achieved at a micro-model level and each intersections performance is satisfactory. Assessing the precinct as a network, at a meso-model level, would display a more accurate depiction of the way intersection interact; linkage between cycle timing and of the affect individual intersection performances have on the surrounding network.

4.1.2 Intersections

The brief provided by Whittlesea City Council has included 32 intersections. However, in our proposal we have indicated that there are 30 intersections to be assessed in the AM peak (Intersection #25 has been removed) and 10 intersections in the PM peak under one interim and one reference design years. Scenario 6 has been requested by Council to be modelled under one ultimate design year, which will include assessment of 30 intersections in the AM peak (Intersection #25 has been removed) and 10 intersections in the PM peak.

Table 31 provides a summary of the intersections modelled in the interim and ultimate scenarios and have been modelled in the peak hours. Intersections modelled for Scenario 6 are identified as the same as those modelled in the ultimate scenario.

Intersections modelled in the PM peak hour have been discussed and selected by MPA and Whittlesea City Council before commencing modelling.

For the interim road network, the following assumptions have been made:

1) Craigieburn Road – secondary arterial road
2) Epping Road – primary arterial road
3) Koukoura Drive – Council collector road
4) Summerhill Road – local Council road
5) Boundary Road – local Council road

Under interim and ultimate design years, the five above mentioned roads will be classified as Arterial Roads.

Table 31 Intersections in the study area and intersections assessed for different scenarios and time periods

Int#	Major Road	Intersecting Road	Interim		Reference		Notes
			AM	PM	AM	PM	
1	Craigieburn Road / Lehmanns Road	Epping Road	✓	✓	✓	✓	
2	Craigieburn Road	Collector Road	✓	×	✓	×	
3	Craigieburn Road	Collector Road	✓	✓	✓	✓	
4	Craigieburn Road	Edgars Road	✓	✓	✓	✓	
5	Craigieburn Road	Koukoura Drive	✓	✓	✓	✓	
6	Craigieburn Road	Collector Road	✓	✓	✓	✓	
7	Collector Road	Epping Road	✓	×	✓	×	
8	Collector Road	Epping Road	✓	×	✓	×	
9	Boundary Road	Epping Road	✓	✓	✓	✓	
10	Collector Road	Epping Road	✓	×	✓	×	
11	Collector Road	Epping Road	✓	×	✓	×	
12	Summerhill Road	Epping Road	×	×	✓	✓	Does not exist in interim
13	Summerhill Road	Bodycoats Road	✓	×	✓	×	
14	Summerhill Road	Collector Road	✓	×	✓	×	
15	Summerhill Road	Koukoura Drive	✓	✓	✓	✓	
16	Collector Road	Andrew Road	×	×	✓	×	Does not exist in interim
17	Collector Road	Koukoura Drive	✓	×	✓	×	
18	Collector Road	Koukoura Drive	✓	×	✓	×	
19	Collector Road	Koukoura Drive	✓	×	✓	×	
20	Boundary Road	Koukoura Drive	✓	✓	✓	✓	
21	Collector Road	Koukoura Drive	✓	✓	✓	✓	
22	Boundary Road	Collector Road	✓	×	✓	×	
23	Boundary Road	Collector Road	✓	✓	✓	×	
24	Boundary Road	Collector Road	✓	×	✓	×	
25	Boundary Road	Collector Road	×	×	×	×	Does not exist
26	Boundary Road	Andrew Road	✓	×	✓	×	
27	Collector Road	Collector Road	✓	×	✓	×	
28	Collector Road	Collector Road	✓	×	✓	×	
29	Collector Road	Collector Road	✓	×	✓	×	
30	Collector Road	Collector Road	✓	×	✓	×	
31	Craigieburn Road	Collector Road	✓	×	✓	×	
32	Collector Road	Epping Road	✓	×	×	×	Does not exist in ultimate

4.1.3 Traffic Volumes

Whittlesea City Council has provided data and information for the anticipated land uses, employment and road hierarchy for future developments within Wollert Precinct Structure Plan. These data have been used to produce the future traffic estimation for interim, reference and ultimate design years.

The peak hourly flow for SIDRA has been determined by adopting 55% of two hour strategic modelling traffic volumes. As requested by MPA and Whittlesea City Council, only the traffic volume for light vehicles has been modelled. An agreed percentage of heavy vehicles have been applied to the road network such as follows:

- 10% of total light vehicles on Epping Road applied on all approaches
- 6% of total light vehicles on all other roads applied on all approaches.

The assumptions for the number of pedestrians per hour in all directions are based on our previous experience for East Werribee and Wyndham North PSP and similar projects, which has been agreed before commencing intersection modelling. The following assumptions have been adopted:

- **Within town centres and school areas (Intersection #1, 22, 23, 26, 28, 29 and 30):**
  - 50 pedestrians per peak hour in all directions (i.e. 200 pedestrians in total for a cross intersection)
- **Outside of town centres and school areas (i.e. intersections that are not mentioned above):**
  - 20 pedestrians per peak hour in all directions (i.e. 80 pedestrians in total for a cross intersection)

When the total traffic volumes at intersections showing low or no volumes for some turn movements, manual adjustments to the low or no turn movement volumes to the number of light vehicles (LV) will be undertaken:

- On an arterial road, a minimum *total* vehicle of 50 vehicles (total of LV and HV) be adopted. If the total volumes less than 50 vehicles, an additional LV of up to 50 will be added to the turn movement to meet the minimum total vehicles.
- On a collector road *or* on a collector road to an arterial road *or* an arterial road to a collector road, a minimum *total* vehicle of 20 vehicles (total of LV and HV) be adopted. If the total volumes less than 20 vehicles, an additional LV of up to 20 will be added to the turn movement to meet the minimum total vehicles.
- The number of heavy vehicles generally varies for different land uses and it is more challenging to identify suitable percentage of HV on the road without proper planning. Therefore, no additional traffic volumes have been made to the HV.

The following intersections have been manually adjusted:

a) AM Peak

- **A minimum total vehicle of 50 vehicles:**
  - Intersections #1, 5, 9, 12, 15 and 22
- **A minimum total vehicle of 20 vehicles:**
  - Intersections #4, 7, 8, 13, 22, 26, 27, 28, 29, 30 and 31.

a) PM Peak

- **A minimum total vehicle of 50 vehicles:**
  - Intersections #5, 9 and 15
- **A minimum total vehicle of 20 vehicles:**
  - Intersections #4 and 12

4.1.4 Cycle Times

A maximum cycle time of 120 seconds has been adopted. The cycle time for intersections has been adjusted to have an overall Degree of Saturation (DOS) not more than 0.85.

4.1.5 Road and Intersection Layouts

All the intersections will be signalised intersections. The number of lanes for approach roads has been modelled as agreed and used in the strategic modelling.

An intersection layout assumption is as follows:

- Slip lanes are provided on:
  - At all arterial to arterial intersections
  - At arterial to connector intersections where there are more than 6 heavy vehicle (bus) turning movements per hour. Please refer to the attached plan which identifies PTV's current take on priority bus routes (10 minute services) to determine this. Slip lanes will be long enough to allow buses to overtake waiting through-traffic. A plan identifying PTV's planned bus network (see Figure 10), will now be Epping to Lockerbie running north-south, and Craigieburn to Mernda going east-west, rather than the route going north through Aurora and heading west to Craigieburn.
  - Arterial to industrial connector intersections (10, 11, 12, 8, 7 (to the east only as residential land uses to the west))
  - Note that slip lanes are not to be provided in the vicinity of town centres in order to provide for a more pedestrian-friendly environment and in order to provide for a better overall urban design outcome.
  - Intersection 32, at the existing alignment of Summerhill Road and Epping Road, to the north of the PSP boundary, is to be considered in the interim scenario, in place of Intersection 12, which will not be in the interim network.
- For T-intersections, pedestrian crossings are provided on all approaches.
- The length of the auxiliary lanes has been determined by the 95th percentile of queue lengths. A minimum length of 65m and a maximum length of 150m have been adopted.

4.1.6 Signal Phasing

Fully controlled right turn is desirable and has been modelled for all intersections. However, if the DOS shows more than 0.85, partial controlled right turn will be adopted. Intersections #1 is modelled with partial controlled right turn.

4.1.7 Additional Traffic Volumes from Public Transport Data

Traffic generated by park and ride stations is calculated during the public transport assignment stage of VITM. This traffic is loaded onto the highway network prior to assigning the traffic from the trip matrices, this ensures that park and ride traffic is included in the calculation of network performance during the highway assignment. However, as the park and ride traffic has been pre-loaded onto the network, we are unable to extract the turning movements generated by park and ride traffic directly from the traffic assignment. Rather, the turning movements generated by park and ride traffic needs to be added to the turning movements extracted from the highway assignment by undertaking a manual inspection of the road volumes and deducing the turning movements from the viewed volumes. This observation of park and ride volumes indicated that most of the additional park and ride volumes on Epping Road and Koukoura Drive are not related to the park and ride in Wollert. This issue has been identified during our review.

Tables below show the additional volumes to be added to the intersection models under interim and ultimate design years.

Table 32 AM Peak Additional Traffic Volumes from Public Transport Data

Int #	Approach	Movement	Existing			Add. PT Vols.	Proposed			Comment
			Total	LV	HV	Total	Total	LV	HV	
1	North	Through	1037	933	104	237	1273	1170	104	This station park and ride is not related to Wollert
2	West	Through	596	560	36	28	624	588	36	
3	West	Through	478	449	29	28	507	478	29	
4	West	Through	386	363	23	28	414	391	23	
5	North	Left Turn	123	117	6	28	129	123	6	
7	North	Through	1123	1011	112	226	1350	1237	112	This station park and ride is not related to Wollert
8	North	Through	1078	970	108	226	1304	1196	108	
9	East	Left Turn	766	689	77	220	986	909	77	
15	North	Right Turn	301	283	18	242	543	525	18	
18	North	Through	1319	1240	79	39	1358	1279	79	
19	North	Through	1410	1325	85	39	1449	1364	85	
20	North	Through	1170	1100	70	39	1209	1139	70	
	South	Right Turn	287	270	17	33	320	303	17	
22	North	Through	55	52	3	74	129	126	3	
	West	Right Turn	151	142	9	84	235	226	9	
23	East	Left turn	266	250	16	95	361	345	16	
	South	Right Turn	112	96	6	5	117	101	6	
29	North	Through	81	76	5	50	131	126	5	

Table 33 PM Peak Additional Traffic Volumes from Public Transport Data

Int #	Approach	Movement	Existing			Add. PT Vols.	Proposed		
			Total	LV	HV	Total	Total	LV	HV
15	West	Left Turn	465	437	28	44	509	481	28
22	South	Left Turn	231	217	14	55	286	272	28
		Through	94	88	6	55	149	143	6
23	South	Right Turn	0	0	0	66	94	94	0

4.2 Intersection Outputs and Operation

The analysis tested a number of different arrangements, including lane configurations and phasing options to provide the best intersection performance.

An overview of the road network showing the degree of saturation for individual traffic movements has been provided for each peak period (AM and PM peak).

The overview includes the following colour coding for degree of saturation:

- <0.85 – green
- 0.85-0.95 – yellow
- 0.95-1.00 – orange
- >1.00 - red

Where the Degree of Saturation for the worst movement of the intersection was above 1, therefore above capacity, alternate layout options were considered where practical.

In addition, AECOM has provided the following information for each individual site in:

- Intersection Layout Plan
- AM and PM peaks phasing summary
- AM and PM peaks movement and lane summary table
- Adjusted AM and PM peaks total traffic volumes (LV + HV) which summarises the volume input into SIDRA
- Original AM and PM peaks turning movement volumes for LV based on strategic modelling results
- Original AM and PM peaks turning movement volumes for HV based on strategic modelling results
- An overview Degree of Saturation (DOS) for the road network in the AM and PM peaks

The resultant performance of each movement for the tested intersections in the AM peak and PM peaks is summarised in the following figures.

Full outputs for each intersection for the Interim Scenario are in Appendix A and the summary shown in Table 34. For the Ultimate Scenario the full outputs for each intersection are shown in Appendix B and the summary shown in Table 34.

Table 34 Summary of Intersection Outputs: Interim and Ultimate Scenarios (Reference Case)

Int #	Interim Scenario	Ultimate Scenario – Reference Case
1	**AM:** Leading Right phasing (120sec); DOS 0.78; Short through lane provided for all approaches, slip lanes provided on all legs for arterial priority **PM:** Leading Right phasing (120sec); DOS 0.83; Short through lane applied for all approaches, slip lanes provided on all legs for arterial priority	**AM:** Variable phasing (110sec); DOS 0.75; Double right turn provided for north and west approaches, slip lanes provided on all legs for arterial priority **PM:** Variable phasing (120sec); **DOS 0.87**; Double right turn provided for north and west approaches, slip lanes provided on all legs for arterial priority
2	**AM:** Split phasing (80sec); DOS 0.81 **PM:** Not applicable	**AM:** Split phasing (90sec); DOS 0.50 **PM:** Not applicable
3	**AM:** Leading Right phasing (100sec); DOS 0.65; Slip lane added to west approach for bus priority **PM:** Leading Right phasing (100sec); DOS 0.85; Slip lane added to west approach for bus priority	**AM:** Leading Right phasing (90sec); DOS 0.62; Slip lane provided for west approach for bus priority **PM:** Leading Right phasing (90sec); DOS 0.78; Slip lane provided for west approach for bus priority
4	**AM:** Leading Right phasing (80sec); DOS 0.67 **PM:** Leading Right phasing (80sec); DOS 0.72	**AM:** Leading Right phasing (90sec); DOS 0.43 **PM:** Leading Right phasing (90sec); DOS 0.72
5	**AM:** Leading Right phasing (120sec); DOS 0.83; Short through lane provided for east and south bound **PM:** Leading Right phasing (120sec); DOS 0.74; Short through lane provided for east and south bound	**AM:** Split phasing (100sec); DOS 0.78; Slip lanes provided for all approaches for arterial priority **PM:** Split phasing (100sec); DOS 0.73; Slip lanes provided for all approaches for arterial priority
6	**AM:** Variable phasing (100sec); DOS 0.77; Short through lane provided for east and west bound **PM:** Variable phasing (100sec); DOS 0.84; Short through lane provided for east and west bound	**AM:** Variable phasing (100sec); DOS 0.82 **PM:** Variable phasing (110sec); DOS 0.78

Int #	Interim Scenario	Ultimate Scenario – Reference Case
7	**AM:** Leading Right phasing (100sec); DOS 0.83; Short through lane for north and south bound, slip lanes provided on north and east approaches for arterial road priority and industrial zone **PM:** Not applicable	**AM:** Leading Right phasing (110sec); DOS 0.83; **PM:** Not applicable
8	**AM:** Variable phasing (100sec); DOS 0.81; Short through lanes provided on north and south approaches, slip lanes provided on north and south approach for arterial priority **PM:** Not applicable	**AM:** Variable phasing (110sec); DOS 0.85; **PM:** Not applicable
9	**AM:** Variable phasing (100sec); DOS 0.66; Short through lane provided for north, south and west approach **PM:** Leading Right phasing (100sec); DOS 0.81; Short through lane provided for north, south and west approach	**AM:** Leading Right phasing (80sec); DOS 0.69; Slip lane provided to all approaches for arterial priority, double right turn provided for south approach, double left turn for east approach **PM:** Split phasing (100sec); DOS 0.83; Slip lane provided to all approaches for arterial priority, double right turn provided for south approach, double left turn for east approach
10	**AM:** Leading Right phasing (80sec); DOS 0.79 **PM:** Not applicable	**AM:** Leading Right phasing (80sec); DOS 0.51 **PM:** Not applicable
11	**AM:** Variable phasing (80sec); DOS 0.45 **PM:** Not applicable	**AM:** Variable phasing (80sec); DOS 0.37 **PM:** Not applicable
12	Not applicable	**AM:** Variable phasing (90sec); DOS 0.63; Slip lanes provided to all approaches for arterial priority **PM:** Variable phasing (90sec); DOS 0.37; Slip lanes provided to all approaches for arterial priority
13	**AM:** Variable phasing (70sec); DOS 0.20 **PM:** Not applicable	**AM:** Variable phasing (90sec); DOS 0.30 **PM:** Not applicable
14	**AM:** Variable phasing (70sec); DOS 0.10 **PM:** Not applicable	**AM:** Variable phasing (90sec); DOS 0.43 **PM:** Not applicable
15	**AM:** Leading Right phasing (70sec); DOS 0.27 **PM:** Leading Right phasing (70sec); DOS 0.38	**AM:** Split phasing (100sec); DOS 0.81; Slip lanes provided on all approaches for arterial priority **PM:** Split phasing (100sec); DOS 0.70; Slip lanes provided on all approaches for arterial priority
16	Not applicable	**AM:** Variable phasing (90sec); DOS 0.38 **PM:** Not applicable
17	**AM:** Variable phasing (70sec); DOS 0.17 **PM:** Not applicable	**AM:** Variable phasing (110sec); DOS 0.68 **PM:** Not applicable
18	**AM:** Variable phasing (70sec); DOS 0.36; Slip lane added to north approach for bus priority **PM:** Not applicable ed	**AM:** Variable phasing (100sec); DOS 0.82; Slip lane added to north approach for bus priority **PM:** Not applicable
19	**AM:** Variable phasing (70sec); DOS 0.65 **PM:** Not applicable	**AM:** Variable phasing (105sec); DOS 0.85 **PM:** Not applicable
20	**AM:** Split phasing (110sec); DOS 0.85 **PM:** Split phasing (110sec); DOS 0.82	**AM:** Split phasing (110sec); DOS 0.76 **PM:** Split phasing (100sec); DOS 0.72
21	**AM:** Variable phasing (110sec); DOS 0.75 **PM:** Variable phasing (110sec); DOS 0.83	**AM:** Variable phasing (110 sec); DOS 0.77 **PM:** Variable phasing (100 sec); DOS 0.79
22	**AM:** Variable phasing (70sec); DOS 0.81 **PM:** Not applicable	**AM:** Variable phasing (80sec); DOS 0.59 **PM:** Not applicable
23	**AM:** Variable phasing (70sec); DOS 0.81 **PM:** Variable phasing (80sec); DOS 0.60	**AM:** Variable phasing (80sec); DOS 0.56 **PM:** Not applicable

Int #	Interim Scenario	Ultimate Scenario – Reference Case
24	**AM:** Variable phasing (70sec); DOS 0.74 **PM:** Not applicable	**AM:** Variable phasing (80sec); DOS 0.61 **PM:** Not applicable
26	**AM:** Variable phasing (70sec); DOS 0.71 **PM:** Intersection model not required	**AM:** Variable phasing (80sec); DOS 0.58 **PM:** Not applicable
27	**AM:** Variable phasing (70sec); DOS 0.12 **PM:** Not applicable	**AM:** Variable phasing (70sec); DOS 0.06 **PM:** Not applicable
28	**AM:** Variable phasing (70sec); DOS 0.29 **PM:** Intersection model not required	**AM:** Variable phasing (70sec); DOS 0.58 **PM:** Not applicable
29	**AM:** Variable phasing (70sec); DOS 0.19; Slip lane added to south approach for bus priority **PM:** Not applicable	**AM:** Variable phasing (70sec): DOS 0.46; Slip lane provided on south approach for bus priority **PM:** Not applicable
30	**AM:** Variable phasing (70sec); DOS 0.11 **PM:** Not applicable	**AM:** Variable phasing (70sec); DOS 0.10 **PM:** Not applicable
31	**AM:** Variable phasing (70sec); DOS 0.76 **PM:** Not applicable	**AM:** Variable phasing (90sec); DOS 0.50 **PM:** Not applicable
32	**AM:** Leading Right phasing (70sec); DOS 0.79 **PM:** Not applicable	Not applicable

4.3 Scenario 6

Scenario 6 has been requested to be modelled in addition to the reference case. This is only applicable to the Ultimate Scenario as the Interim Scenario does not change. This includes an assessment of 31 intersections in the AM peak and 10 intersections in the PM peak.

The following intersections have been modelled in the peak hours under reference design year:

- **AM Peak Hour (under interim, reference and ultimate design years)**
  - 30 intersections (Intersections #1 to 31 except #25 which has been removed)
- **PM Peak Hour (under reference and ultimate design years)**
  - 10 intersections (Intersections #1, 3, 4, 5, 6, 9, 12, 15, 20 and 21)

Table 35 Summary of Intersection Outputs: Ultimate Scenario – Scenario 6

Int #	AM Peak	PM Peak
1	Variable phasing (110sec); DOS 0.76; Double right turn provided for north approach, slip lanes provided on all legs for arterial priority	Variable phasing (120sec); **DOS 0.92**; Double right turn provided for north approach, slip lanes provided on all legs for arterial priority
2	Split phasing (80sec); DOS 0.65	Not applicable
3	Leading Right phasing (80sec); DOS 0.82; Slip lane provided on west approach for bus priority	Leading Right phasing (100sec); DOS 0.73; Slip lane provided on west approach for bus priority
4	Leading Right phasing (80sec); DOS 0.59	Leading Right phasing (90sec); DOS 0.76
5	Split phasing (120sec); DOS 0.78; Slip lanes provided for all approaches for arterial priority	Split phasing (120sec); DOS 0.83; Slip lanes provided for all approaches for arterial priority
6	Variable phasing (100sec); DOS 0.76	Variable phasing (120sec); DOS 0.84
7	Leading Right phasing (120sec); DOS 0.81;	Not applicable
8	Variable phasing (120sec); DOS 0.80;	Not applicable
9	Leading Right phasing (80sec); DOS 0.72; Slip lane provided to all approaches for arterial priority, double right turn provided for south approach, double left turn provided on east	Leading Right phasing (94sec); DOS 0.84; Slip lane provided to all approaches for arterial priority, double right turn provided for south approach, double left turn provided on east approach

Int #	AM Peak	PM Peak
	approach	
10	Leading Right phasing (80sec); DOS 0.56	Not applicable
11	Variable phasing (80sec); DOS 0.41	Not applicable
12	Variable phasing (80sec); DOS 0.46; Slip lanes provided to all approaches for arterial priority	Variable phasing (80sec); DOS 0.46; Slip lanes provided to all approaches for arterial priority
13	Variable phasing (80sec); DOS 0.41	Not applicable
14	Variable phasing (80sec); DOS 0.47	Not applicable
15	Split phasing (100sec); DOS 0.71; Slip lanes provided on all approaches for arterial priority	Split phasing (90sec); DOS 0.78; Slip lanes provided on all approaches for arterial priority
16	Variable phasing (80sec); DOS 0.39	Not applicable
17	Variable phasing (100sec); DOS 0.71	Not applicable
18	Variable phasing (100sec); DOS 0.72; Slip lane provided on north approach for bus priority	Not applicable
19	Variable phasing (100sec); DOS 0.82	Not applicable
20	Split phasing (110sec); DOS 0.84	Split phasing (110sec); DOS 0.84
21	Variable phasing (110 sec); DOS 0.78	Variable phasing (120 sec); DOS 0.80
22	Variable phasing (90sec); DOS 0.59	Not applicable
23	Variable phasing (80sec); DOS 0.54	Not applicable
24	Variable phasing (80sec); DOS 0.60	Not applicable
26	Variable phasing (80sec); DOS 0.58	Not applicable
27	Variable phasing (70sec); DOS 0.07	Not applicable
28	Variable phasing (70sec); DOS 0.62	Not applicable
29	Variable phasing (70sec): DOS 0.52; Slip lane provided on south approach for bus priority	Not applicable
30	Variable phasing (70sec); DOS 0.12	Not applicable
31	Variable phasing (80sec); DOS 0.55	Not applicable

5.0 Summary and Conclusions

Theme 1: East-west connections to the E6 corridor

The modelling outputs show that compared to the reference case, all arrangements with fewer interchanges result in increased vehicle travel and time in the network. Scenario 2 and 4, which feature an interchange at Boundary Road, minimise this increase both in terms of time and distance.

Scenario 2 directs additional traffic along Boundary Road and results in some localised congestion. Scenario 4 does not have this concern as Epping Road provides the alternative access and the section with the additional traffic performs well.

Conclusion: the least effective interchange in terms of marginal impact when removed is the Summerhill Road interchange; Boundary Road interchange is the most effective and has the greatest impact if not provided. The Craigieburn Road interchange assists in encouraging traffic to more directly access Craigieburn and the employment lands on Craigieburn Road.

Theme 2: Arterial road design widths

The modelling results show that the Wollert PSP road transport network is not significantly adversely affected by a reduction in road cross-sections for east-west traffic and the impacts of a reduction in Koukoura Drive cross-section has primarily localised impacts on Koukoura Drive. These results can be primarily attributed to a reduced volume of traffic entering and leaving the Wollert PSP area from the north. Reducing the arterial road width reduces modelled travel by around 2,000 kilometres.

The results could be refined by considering whether the modelled speed limit would be affected by the changed cross section. However the speed results presented in section 3.5 suggest this would not significantly affect the findings.

Assessment of AustRoads Level of Service guidance (in section 3.5.3) indicates there is no significant change in Level of Service by reducing the cross section from three lanes to two, with Koukoura Drive only marginally falling into LOS B, which is reasonably unimpeded operation.

Conclusion: A three-lane cross section does not appear to be warranted on general vehicle traffic demand and network performance grounds.

Other factors that could be considered in determining the ultimate cross-section for planning include:

- Whether road safety for all users would be improved with a particular cross-section
- Public transport priority needs, in particular whether strategic allocation of space is required to secure on-road priority in the light of modelled congestion locations.
- Appropriate provision for overall network resilience in the event of disruptions on other trunk routes

Theme 3: No rail to Wollert

In the scenario where no rail is provided to Wollert, public transport's effectiveness in its strongest market of travel to the central city is significantly reduced. However, it still dominates mode share of the relatively small number of trips that are to the central city in the AM peak.

Removing rail increases the amount of travel on the local road network. Removing rail increases travel by 1,586 km. However, because the increases are spread across the local road network, rail has no measurable impact on kilometres travelled in congested conditions on the local network.

Conclusion: The no rail scenario has a small negative impact on the amount of car travel, but does not affect the modelled performance of the road network.

5.1 Summary of intersection analysis

The aim for the intersection performance is to maintain DOS not more than 0.85 and a cycle not more than 120 seconds. All intersections except intersection number 1 (in the evening peak period) meet these criteria for both the Reference and Scenario 6 Ultimate year. The DOS is still under 1.0 which indicates that the intersection is likely to cope with the traffic under either Reference or Scenario 6. This shows that the intersections can operate efficiently with Koukoura Drive, Summerhill Road, Craigieburn Road being four lanes (Scenario 6).

There are a number of turning movements that have a LOS of E. The best outcome has been provided for each of these intersections and the LOS given is due to the delay, not the queues. Given none of the delays are greater than the cycle time; the majority are around 60 seconds and none greater than 72 seconds, this is deemed acceptable.