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South East Growth Corridor - VITM project

Final Report

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Prepared for

Growth Areas Authority

Prepared by

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C	20-Jan-2012	Draft Final Report	Paris Brunton	

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1.0   Introduction

This report describes AECOM's calibration and validation of the South East growth area strategic transport model. It also presents the results of a "full build" 2046 scenario and gives directions for further analysis and use of the model.

1.1   Background

AECOM was awarded the brief by the Growth Areas Authority (GAA) to undertake the calibration and refinement of the Victorian Integrated Transport Model (VITM) for the South East Growth Corridor of Melbourne. The brief stipulated that the model included a calibrated 2011 base year and a 2046 future year scenario. This report describes the calibration and validation of the 2011 base year and describes the development and results of a 2046 future year model scenario.

The purpose of this project is to provide a strategic model of the South East growth corridor. Whilst this project was commissioned by the GAA, the intention of GAA is that this South East growth corridor model will become the common starting position for the strategic modelling needs of GAA, Casey City Council, Cardinia Shire Council, and VicRoads for projects, such as Precinct Structure Plans (PSPs), within the corridor.

To achieve the aims of this project, AECOM has

-    Received the latest (September 2011) version of the VITM

-    Audited the VITM network in the south-east growth region.

-    Added collector roads and other local area roads within the study area not currently in the VITM

-    Reviewed the placement of transport zone centroid connectors.

-    Disaggregated the VITM zone system with the South East growth area.

-    Collated traffic count data from VicRoads, Casey City Council and Cardinia Shire Council

-    Incorporated the updated VITM speed flow curves to better reflect the speed flow relationship on unsealed roads.

-    Where data was available, validation was undertaken for a typical weekday AM peak, PM peak and 24hr period.

Matrix Estimation was not included as part of the calibration and validation process. Therefore all of the changes that were made to the VITM were within the existing model framework.

1.2   Victorian Integrated Transport Model (VITM)

The Victorian Integrated Transport Model (VITM) is the name given to the Department of Transport's four-step strategic traffic model. VITM and its predecessor Melbourne Integrated Transport Model (MITM) have both been used extensively by the Department of Transport and VicRoads for the strategic modelling of transport projects located in metropolitan Melbourne.

Features of the VITM include:

-    Four times periods (AM, Inter-peak, PM, and Off Peak)

-    Road and public transport modes

-    Three vehicle types (Car, Rigid Trucks and Articulated Trucks)

-    Three public transport modes (Train (Metro and VLine), Trams and Buses.)

-    Uses outputs from the Freight Movement Model to forecast truck volumes

Details of these features are discussed over the following page.

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1.2.1   Zones

The VITM covers the Melbourne Statistical Division (MSD) as defined by the Australian Bureau of Statistics (ABS) and consists of 2976 transport zones of which 2893 are internal to the MSD with the remainder being either external connectors or regional rail stations. The zones are generally more detailed in the inner and middle suburbs, and along major transport corridors.

1.2.2   Public Transport

All public transport routes are coded with details of service frequencies and stopping patterns by time of day. The public transport network includes:

- Stopping and express services for all metropolitan passenger train lines (including V/Line)

- Services for all tram routes

- Services for all bus routes

- Zonal public transport fare modelling

- Rail lines

- Park and ride facilities for rail

- Links to reflect walk access, including interchanges.

1.2.3   Road Network

The modelled highway transport network includes all freeways, highways, arterials, and a selection of collector roads. The network includes:

- Geographic and connectivity information;

- Clearways and transit lanes;

- Parking charges and tolls; and

- Links to reflect walk access.

Each link in the road network contains attributes relating to the road characteristics such as:

- The number of lanes;

- The posted speed;

- The geographic location; and

- An index relating to the link classification.

A map of showing the extent of the VITM 2011 network and the location of the South East Growth area is shown in Figure 1.

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Figure 1 VITM 2011 network
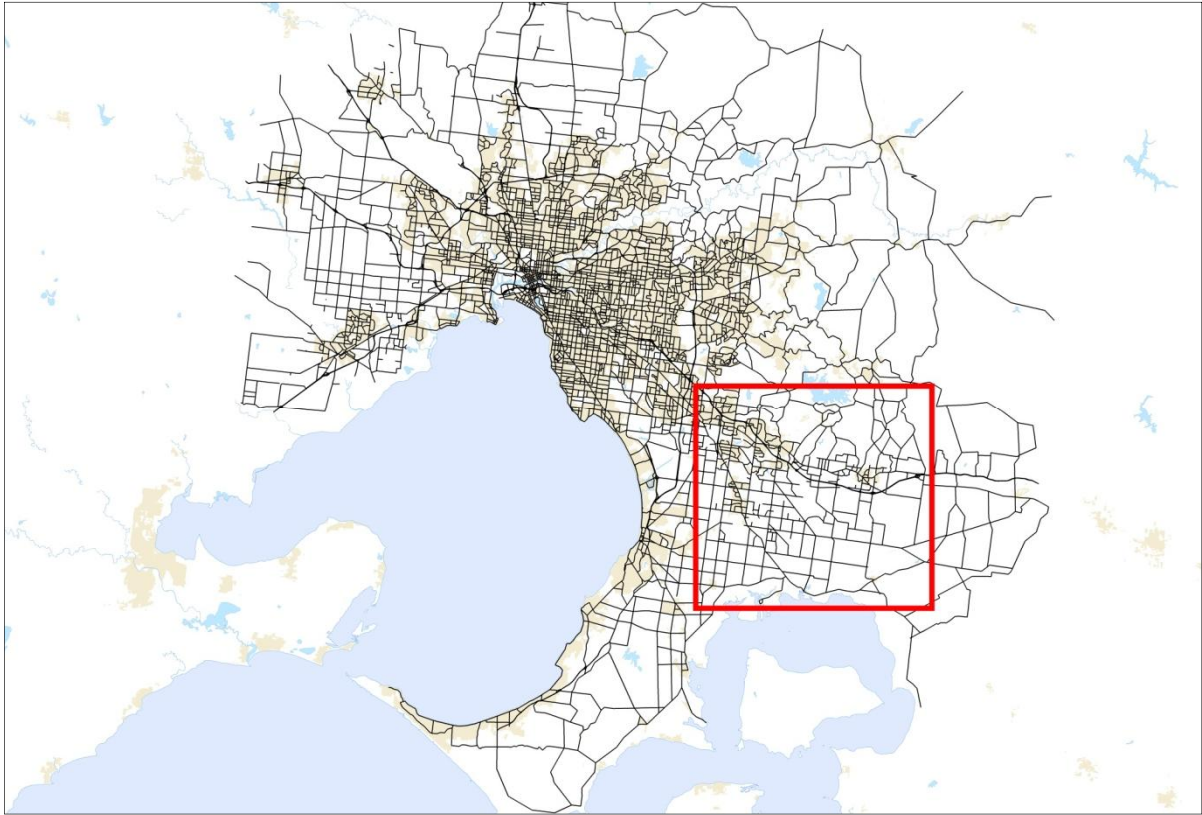
1.3   Study Area

The South East growth corridor model does not involve a sub area extraction process. In all cases, the model includes the full extent of the VITM; however, for the purposes of the model calibration this project was limited to the south east growth corridor as shown in Figure 2 on the following page.

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Figure 2 Study Area

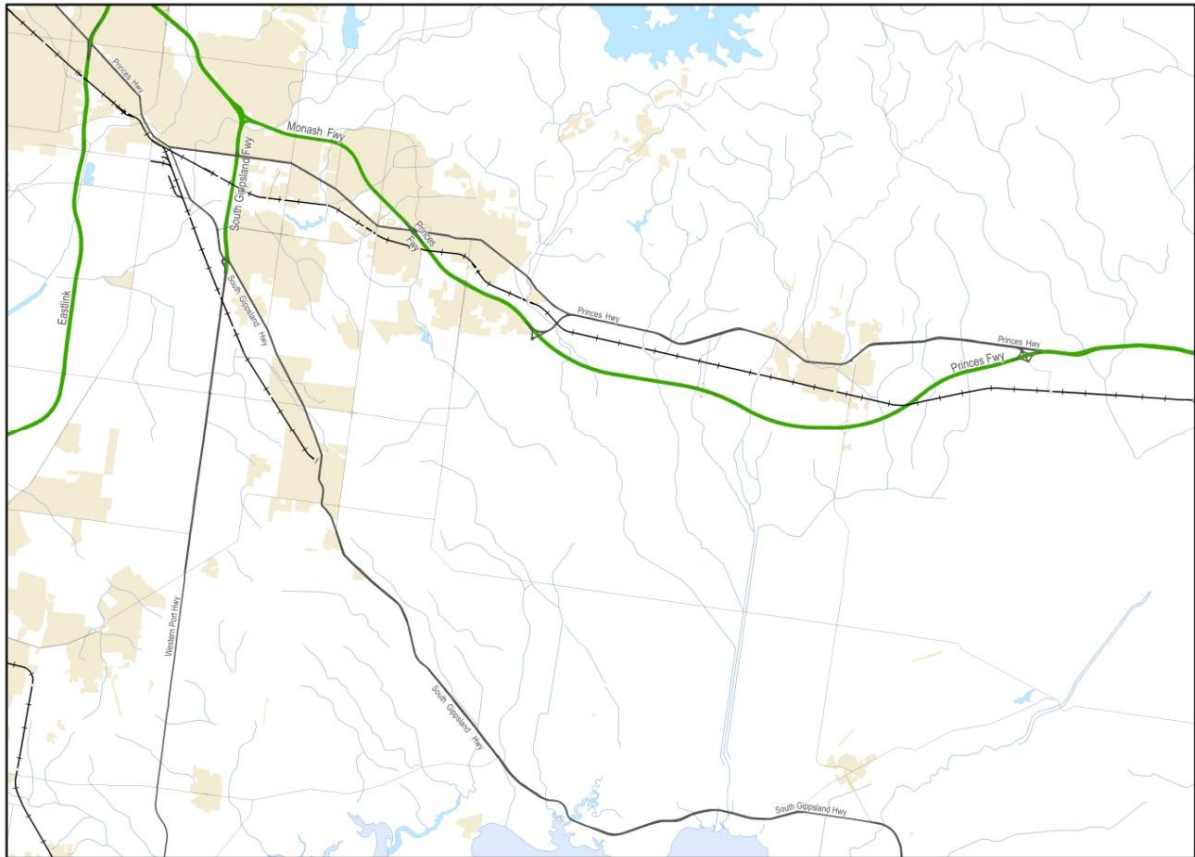# D R A F T

2.0   Model Refinement

The VITM was refined with the purpose of improving the calibration and scale of the model in the South East growth area region. This primarily consisted of adding transport zones, adding network links, reviewing the network as well as small changes to some input parameters of VITM. These refinements are discussed in this section.

2.1   Transport Zones

The South East Growth area includes the suburbs of Cranbourne, Pakenham and Officer. To cater for the mostly green field development that is forecast to occur in these suburbs, AECOM has disaggregated approximately 30 zones to produce approximately 100 additional zones. The addition of these new zones is not applicable for the base year as they have specifically been made for future developments, however, for completeness they are shown in Figure 3 below.

Figure 3 South East growth corridor transport zones
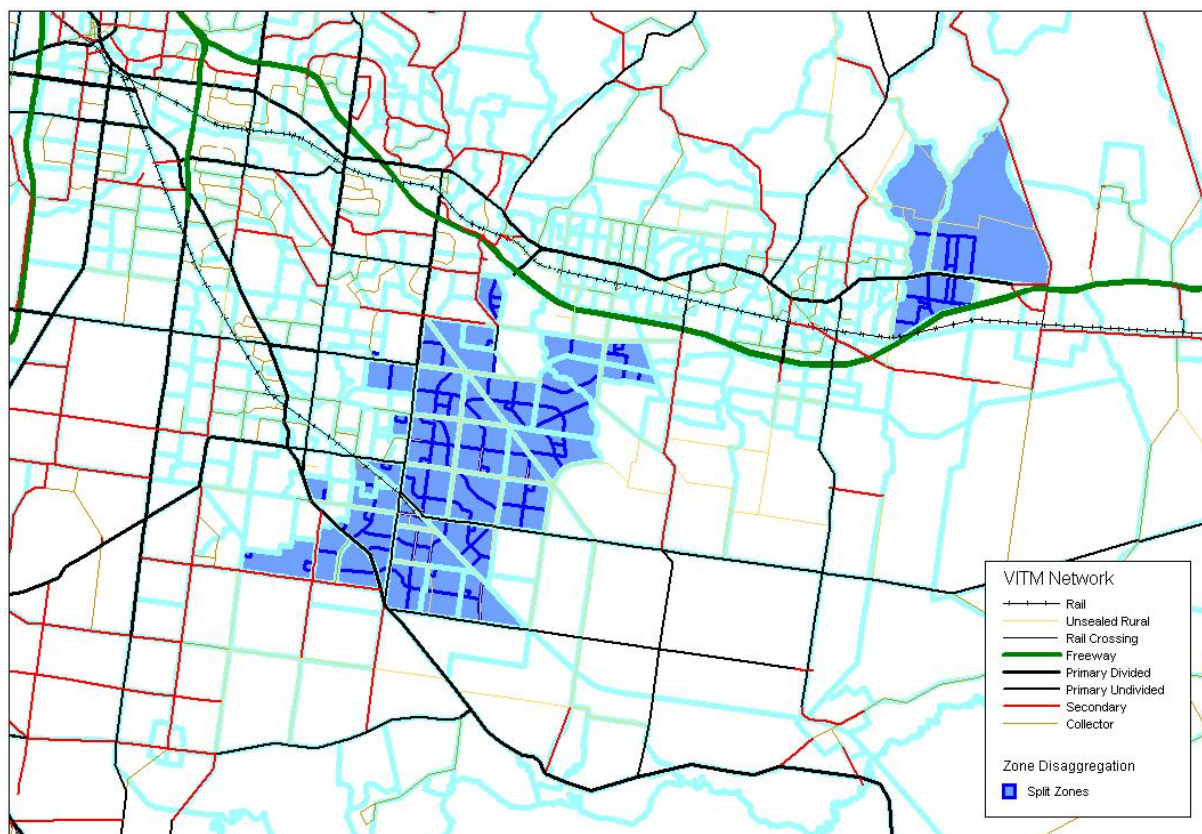
2.2   Network

The South East region has been one of the fastest growing regions of Melbourne in recent years. Accompanying the growth in population, households, employment and recreation, the road network within the study region has also undergone continuous and significant improvements. Major roads projects have included:

-    The Pakenham bypass

-    Westernport Highway duplication

-    M1 upgrade

-    Thompsons Road duplication

-    Cranbourne Frankston Road duplication

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There have also been numerous small roads projects in the region, including the construction of local roads for new housing estates and the sealing of unsealed roads.

In order to align with the demographic data used within VITM, the base year network was determined to be correct as of August 2011.

The process of reviewing and updating the VITM network involved using local knowledge, Google maps, Google Street view, as well as inputs from Casey City Council, Cardinia Shire Council and the Growth Areas Authority.

The review process led to additional roads being added to the network as well as a number of changes being made to the network. These updates included changes to:

- Posted speed limits

- Number of vehicle lanes

- Link class (i.e. collector / secondary / primary road)
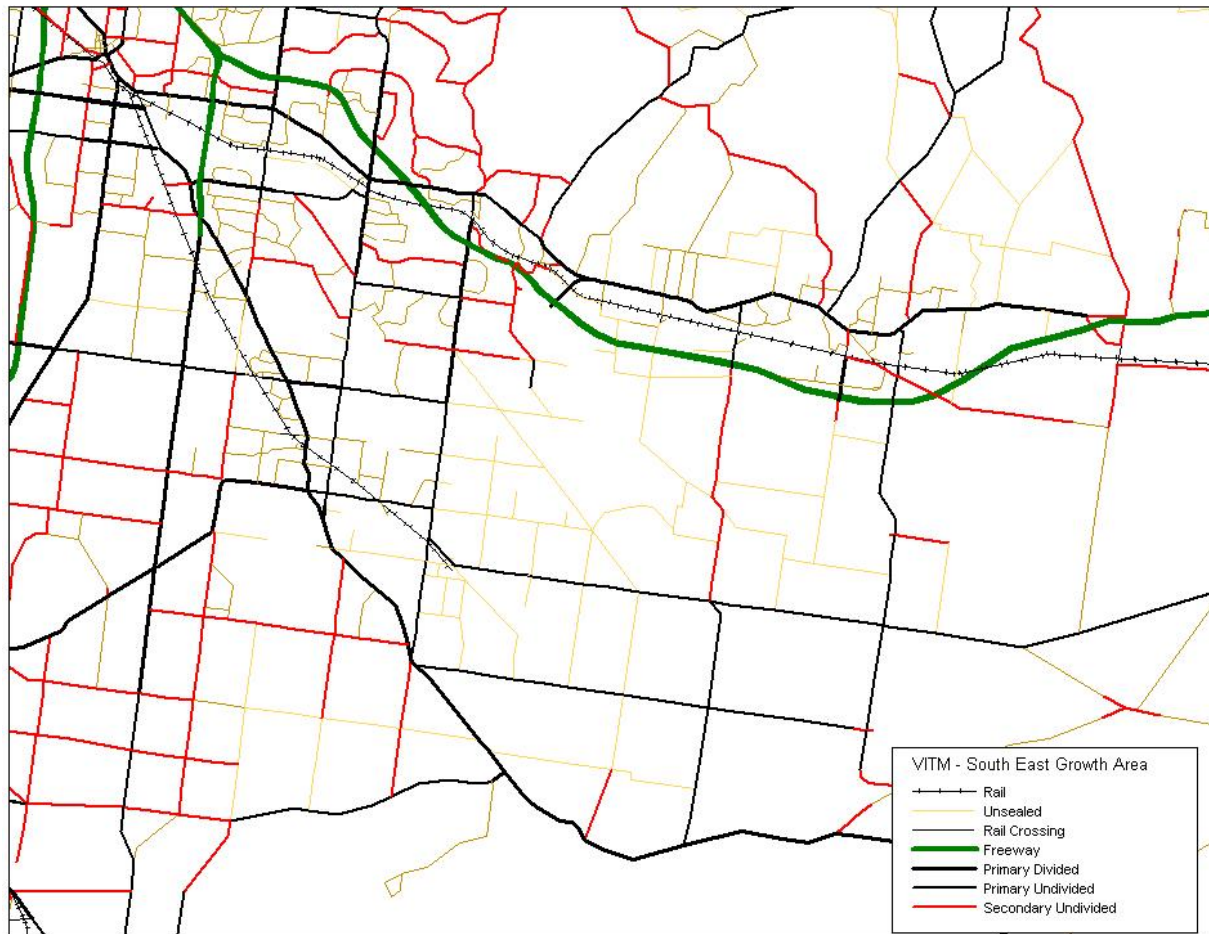
- Divided or Undivided status

- Road closures

To illustrate the changes made to the network within the study area, Figure 4 shows the initial VITM network configuration, whilst Figure 5 shows the refined VITM network.

Figure 4 Initial 2011 VITM network configuration
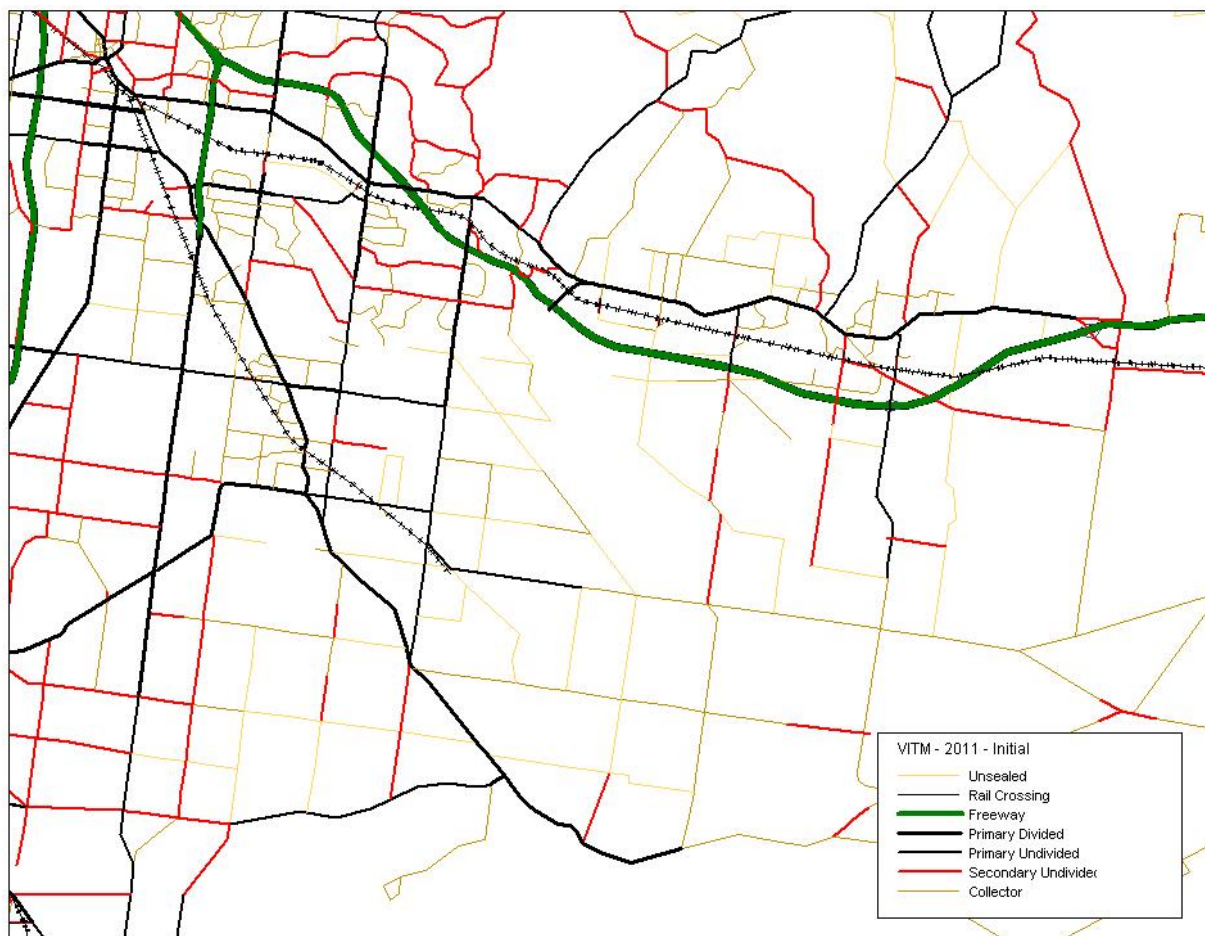
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Figure 5 Refined 2011 VITM network configuration for South East Growth Area model

2.3   VITM model inputs

In addition to the network refinements described above, other minor changes were made to the VITM speed flow curves.

2.3.1   Speed flow curve for unsealed roads

As is evident from Figure 5 above, the eastern half of the study area contains many unsealed roads. In order to improve the modelling of traffic on these roads, the incorporation of the new speed flow curve for unsealed roads was made following advice from VicRoads. The updated version allows for vehicles to travel at the posted speed, commonly up to 100km/hr, under low traffic volumes but the modelled vehicle speed is rapidly reduced with increasing volumes of traffic.

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3.0   2011 Base Year Model Validation

This section of the report describes the model validation results which are used to assess whether the model can satisfactorily represent existing traffic patterns in 2011. The criteria and checks adopted have been based on those recommended in the VicRoads guidelines titled *Guidelines on the Validation Process and Criteria for Strategic Transport Modelling (March 2010).*

The model validation checks that were undertaken included comparisons of surveyed and modelled:

- Screenline traffic volumes;
- Traffic volumes for individual road links; and
- Travel times.

3.1   Validation Data

For the purposes of validation and calibration of the model, historic traffic count data was obtained from VicRoads, Casey City Council and Cardinia Shire Council. Travel time data on several major routes was also obtained from VicRoads.

The traffic count data consists of an extensive set of counts taken on most of the key roads in the study region. The data sourced from VicRoads consisted of classified hourly counts by direction, while the data sourced from the councils consisted of 24 hour counts.

Whilst a preference was given to counts taken during 2011, in order to obtain a wide coverage of the study area as well as to allow for the construction of screenlines, traffic counts taken from between February 2009 and August 2011 have been used.

It is a usual model validation practice to 'standardise' counts by using growth factors and/or seasonal factors to scale the set of traffic counts to the model validation month and year. Importantly, this has not been undertaken for this project. It was determined that due to the dynamic growth of the South East growth region; it would not be possible to scale the traffic counts to an appropriate level of accuracy. For example, for many roads within the study area, recent local area activities such as housing developments, road works and other construction may have either a positive or negative impact to the level of traffic.

In total, 321 count locations were used for the validation process. The location of these counts and the source of the data are shown in Figure 6 on the following page.
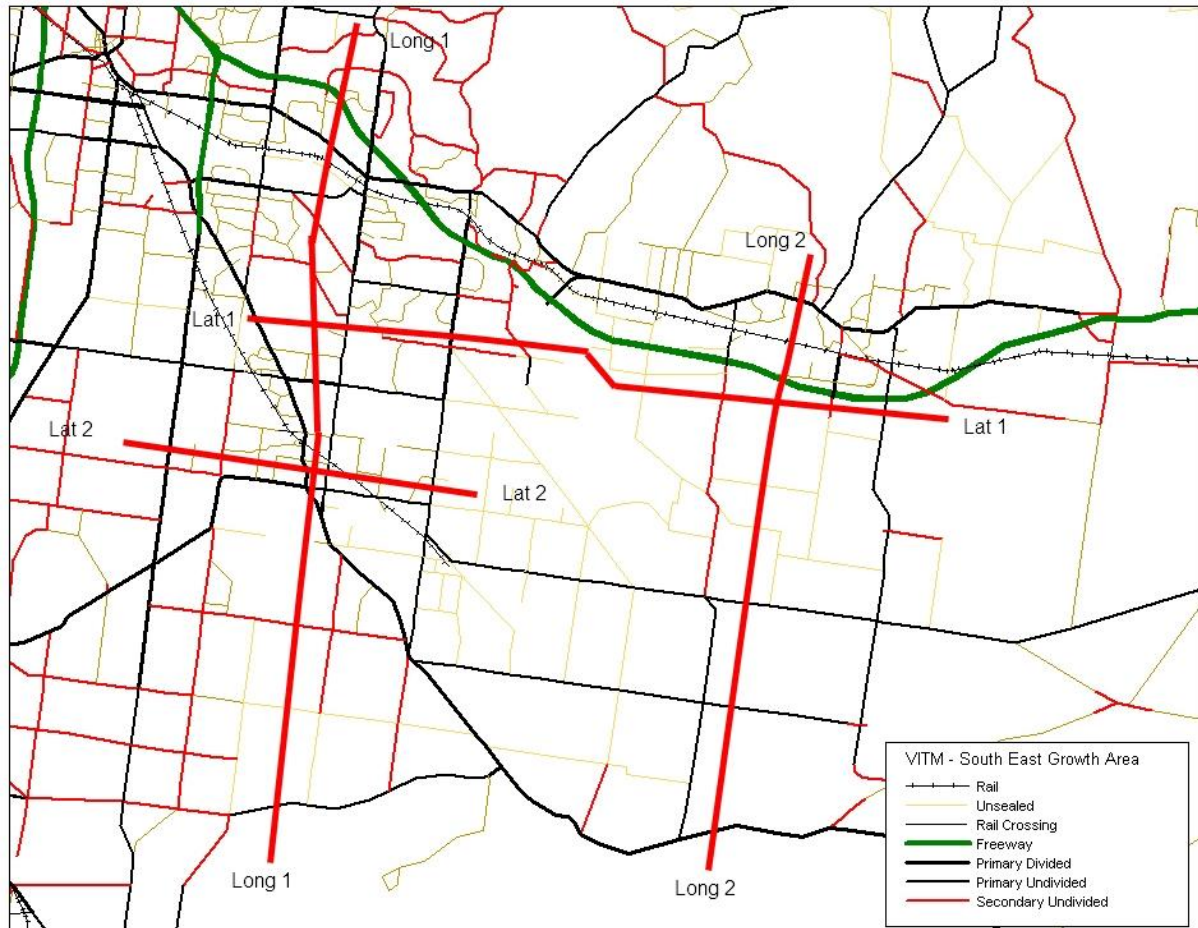
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Figure 6 Traffic count locations
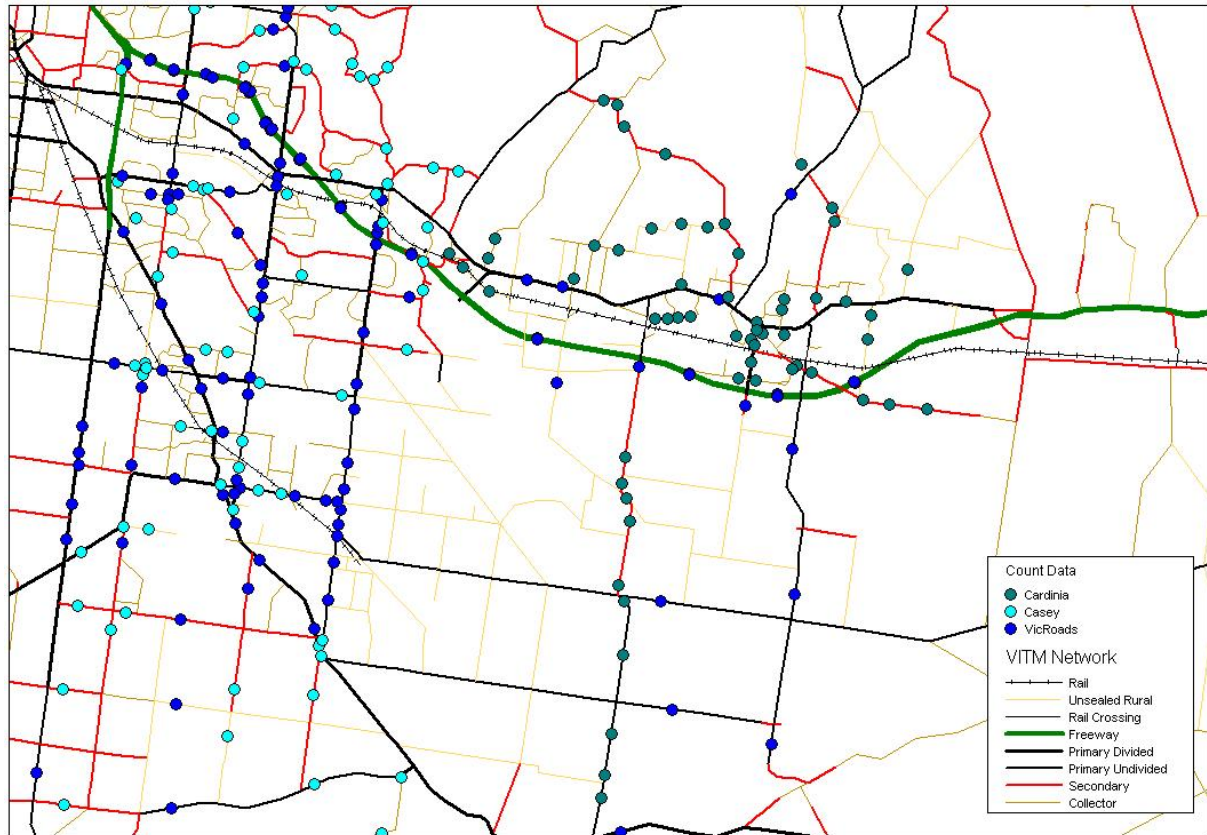
To assist in the validation, four screenlines were created from the hourly VicRoads counts. These screenlines cover all the major movements within the study area and their locations are shown in Figure 7.

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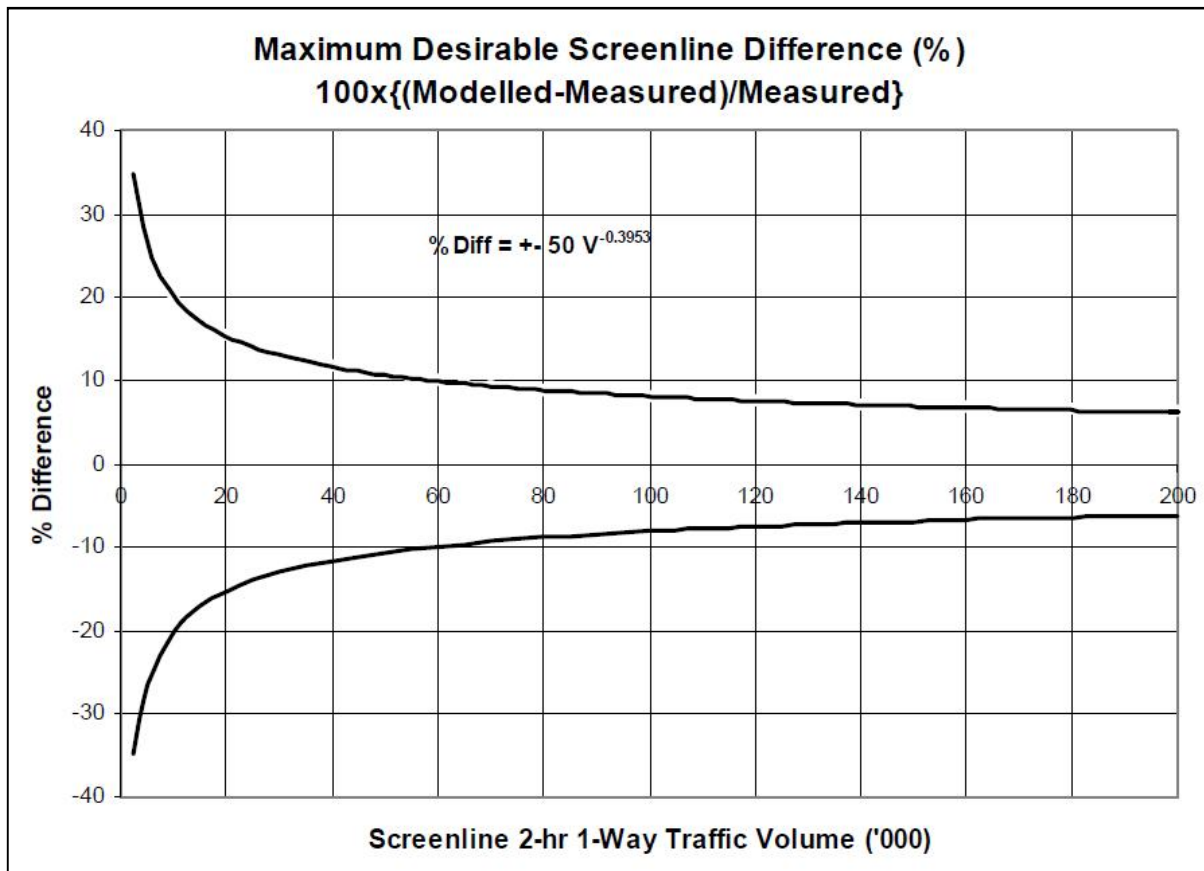**Figure 7 Screenline location map**

3.2   Comparison of Observed and Modelled Screenline Traffic Volumes

To meet the requirements of the VicRoads screenline criteria, the percentage difference between the observed and modelled screenline traffic volumes needs to be within the values bounded by the two curves shown in Figure 8.

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Figure 8: Validation criteria for 2-hour 1-way screenline traffic volumes

The four screenlines shown in Figure 7 were used to test the model against the VicRoads criteria. The results showing the percentage difference between the modelled and observed volumes for each of the screenlines by direction are shown for the AM peak period in Figure 9 and for the PM peak in Figure 10. It can be seen that for both time periods, each of the screenlines are within the VicRoads screenline criteria.

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Figure 9: Comparison of observed and modelled screenline traffic volumes (all vehicles) for the AM peak period

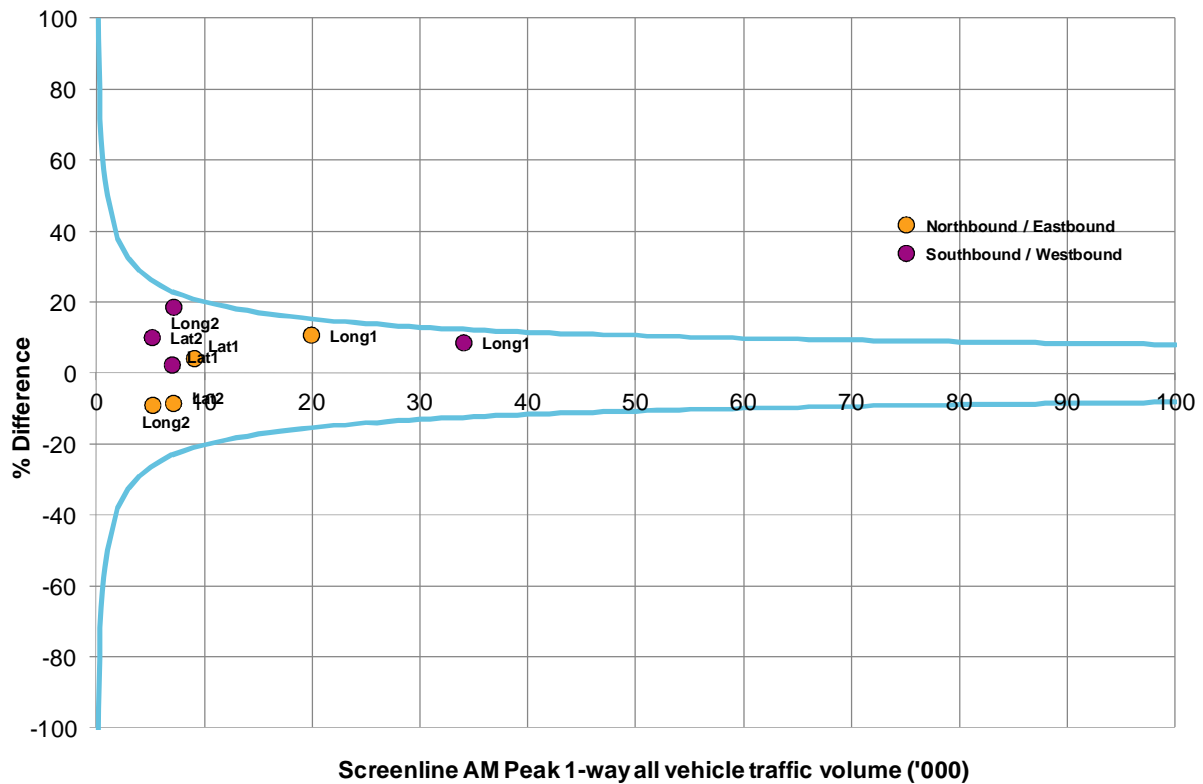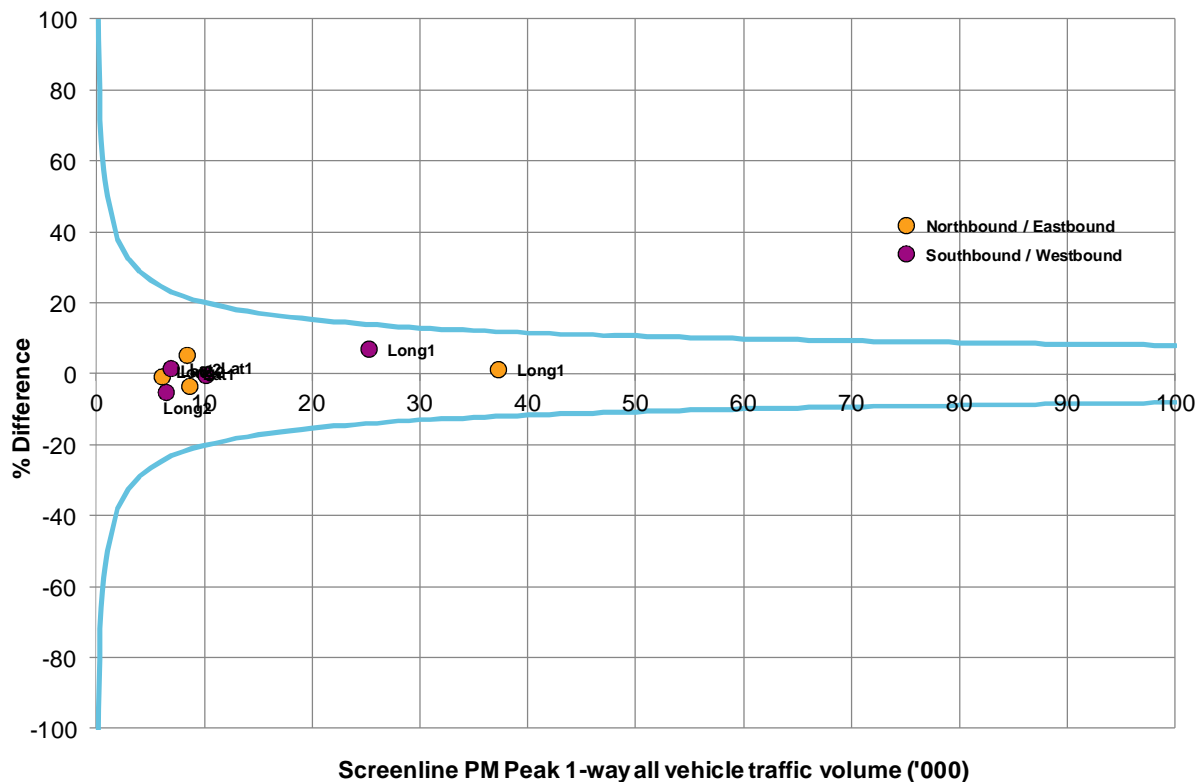

Screenline AM Peak 1-way all vehicle traffic volume ('000)

Figure 10: Comparison of observed and modelled screenline traffic volumes (all vehicles) for the PM peak period

Screenline PM Peak 1-way all vehicle traffic volume ('000)

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3.3 Comparison of Observed and Modelled Traffic Volumes for Individual Road Links

To meet the requirements of the VicRoads criteria for individual road links, a scatter plot of the observed and modelled traffic volumes for individual road links needs to have a line of best fit with a slope of between 0.9 and 1.1, and a statistical correlation (R^2) greater than or equal to 0.90.

In addition, the percentage difference between the measured and modelled traffic volumes (defined by the Percent Root Mean Square Error, %RMSE) should be less than 30 percent. %RMSE is defined as follows:

$$\%RMSE = 100N\frac{\sqrt{\sum(M-C)^2/(N-1)}}{\sum C}$$

Where:
N = number of count/modelled link pairs;
$\sum$ = summation of count/modelled link pair 1 to N;
M = modelled one-way link volume (AM/PM Peak); and
C = surveyed one-way traffic volume (AM/PM Peak).

Scatter plots showing the difference between modelled and observed volumes were constructed for the AM peak, PM peak and Daily time periods. The peak periods plots used the hourly VicRoads count data (195 locations), while the Daily plot used the VicRoads data as well as the traffic count data supplied from Casey and Cardinia councils (321 locations in total). The lines of best fit of these scatter plots all meet the VicRoads criteria. Importantly, the scatter plots also show that despite using a large extent of traffic counts that have been taken over three years, there are no large outliers being produced by the model. This result, as well as the fact that the model meets the slope and correlation criteria of VicRoads, gives confidence that the model is robust.

The slopes and the R^2 for the lines of best fit are summarized in Table 1, while the actual scatter plots are shown in Figure 11 to Figure 13.

Table 1 Summary of scatter plot lines of best fit

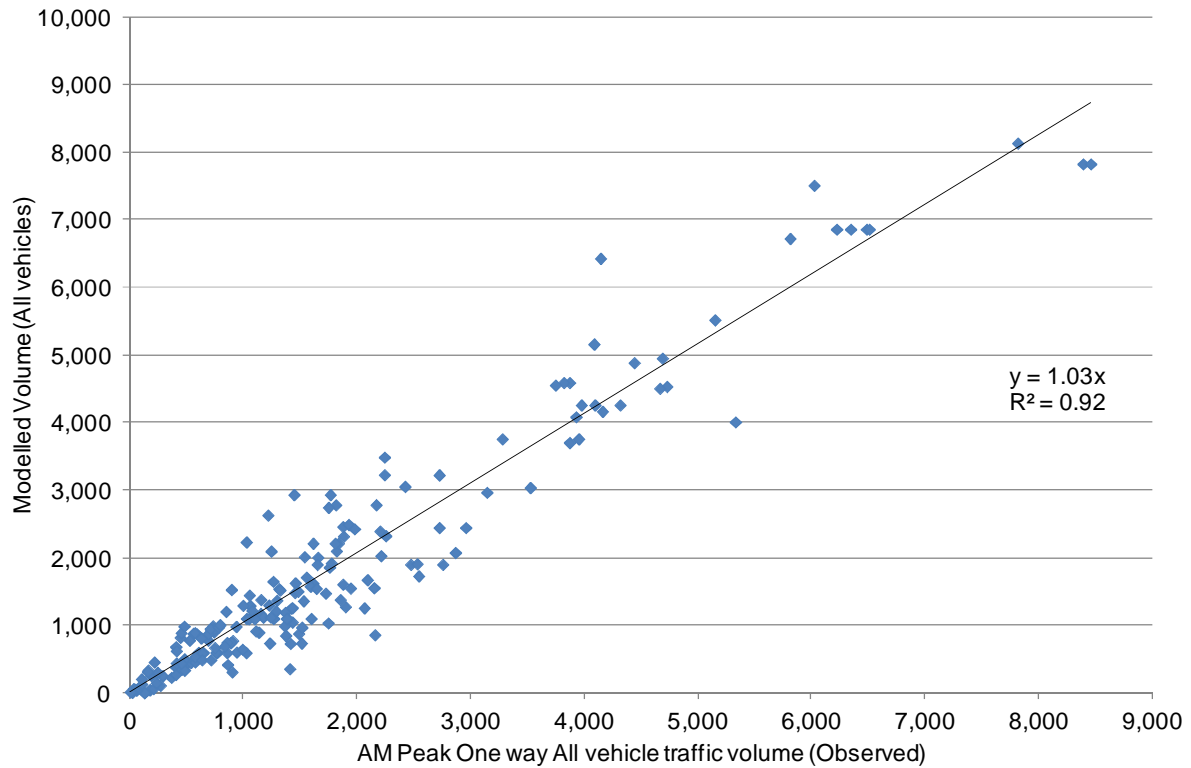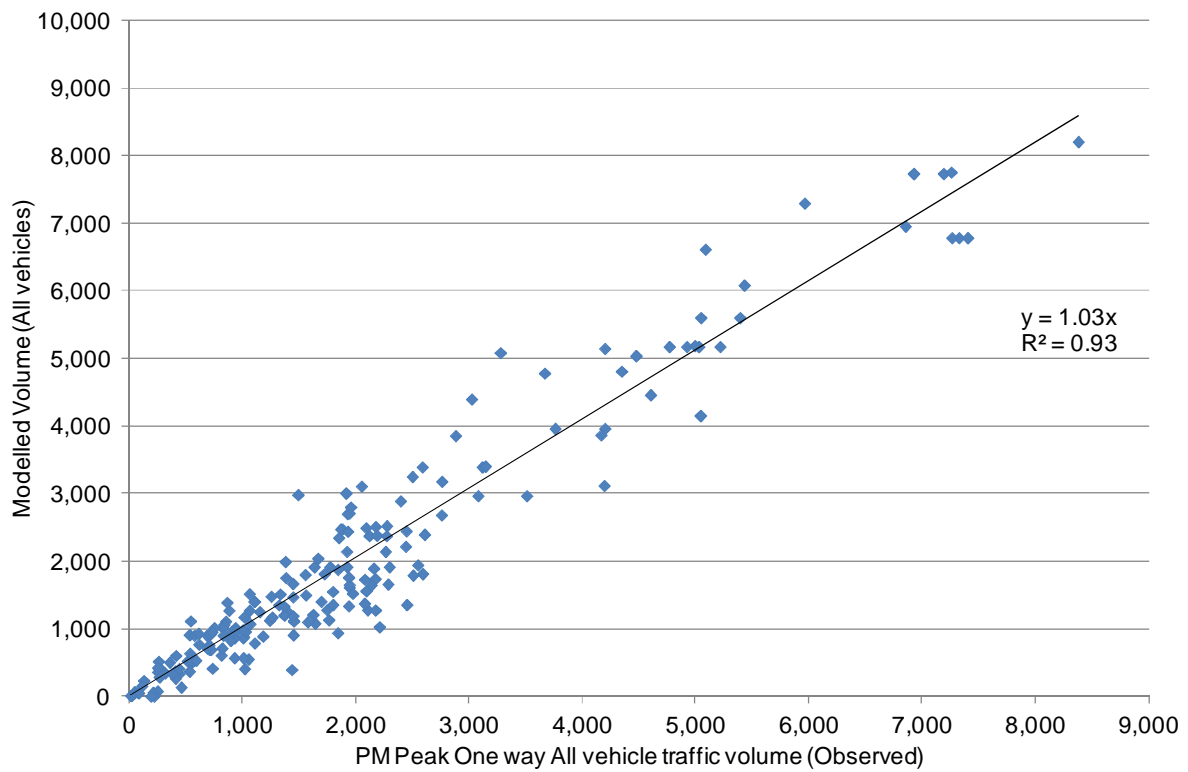| Time Period	Number of counts	Slope of the line of best fit	R^2	Pass/Fail
AM peak	195	1.03	0.92	Pass
PM peak	195	1.03	0.93	Pass
Daily	321	1.02	0.92	Pass

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Figure 11 Observed and modelled traffic volumes – all vehicles – AM Peak – VicRoads count data

Figure 12 Observed and modelled traffic volumes – all vehicles – PM Peak – VicRoads count data

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Figure 13 Observed and modelled traffic volumes – all vehicles – Average Weekday – VicRoads and council count data
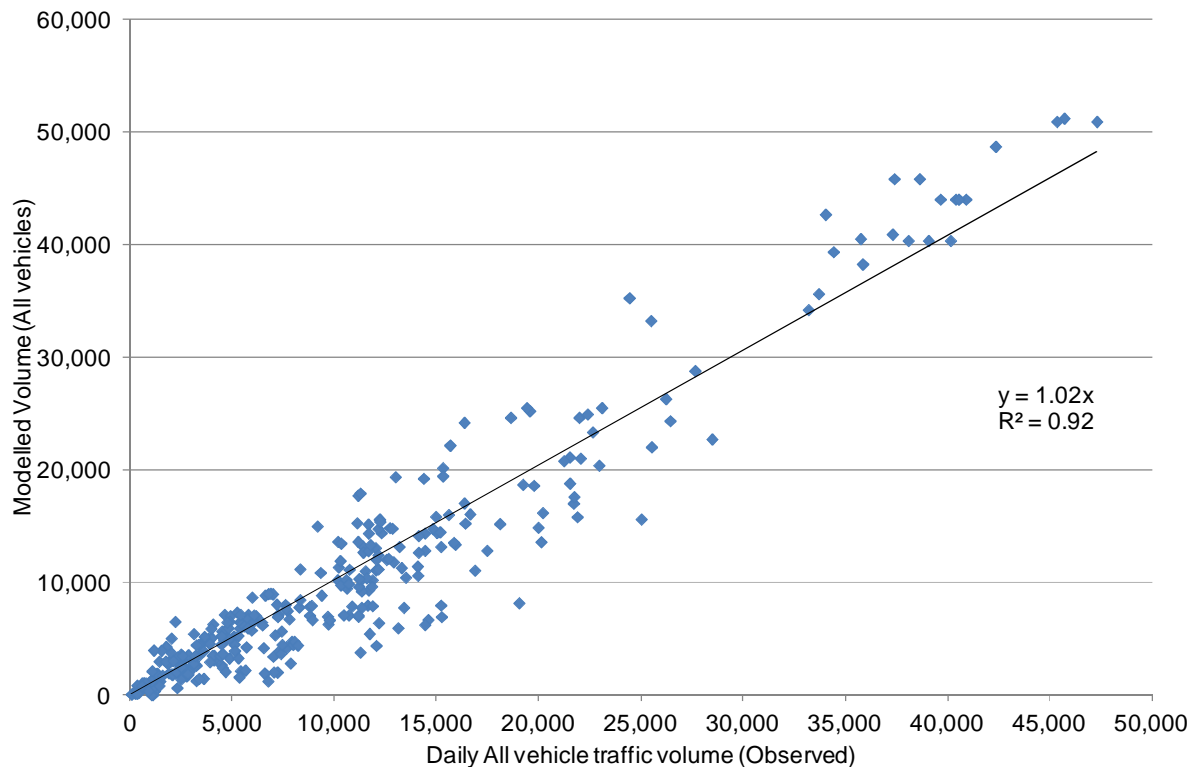
The Root Mean Square Error (RMSE) provides a way to compare errors between the model and observed traffic volumes while allowing for the relative size of the observed traffic count. That is, a large percentage difference is more important, in terms of model validation, on a high volume road than it is on a low volume road.

The VicRoads guidelines recommend applying the RMSE criteria to two hour directional traffic volumes, however, for completeness, the RMSE was calculated for the Daily time period as well as the AM and PM peaks. The results are shown in Table 2 to Table 4 below. It can be seen from the tables that when considering the RMSE for all of the count locations, the model meets the VicRoads (RMSE <30%) criteria for the AM peak, PM peak and Daily time periods. It can also be seen that for both the peak periods as well as the daily period the model performs better for roads with higher traffic volumes. This result is in part to be expected due to the scale of the network and zones within the strategic model. At the local road level, factors such as the size of transport zones and the placement of centroid connectors can significantly affect the modelled volume. Furthermore, the variability in the actual traffic on local roads often increases as the volume decreases.

Table 2 %RMSE statistic for all vehicles (AM Peak)

AM Peak 1-way all vehicle traffic volume	Number of directional sites	Sum of (modelled – surveyed traffic volumes)²	Sum of surveyed traffic volumes	%RMSE
<1,000	76	3,525,737	39,928	41.3%
1,000 – 2,000	70	18,404,130	102,518	35.3%
2,000 – 5,000	38	18,717,418	122,235	22.1%
5,000 – 10,000	11	6,662,941	72,547	12.4%
>10,000	0			
Total	**195**	**47,310,226**	**337,228**	**28.6%**

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Table 3 %RMSE statistic for all vehicles (PM Peak)

AM Peak 1-way all vehicle traffic volume	Number of directional sites	Sum of (modelled – surveyed traffic volumes)^2	Sum of surveyed traffic volumes	%RMSE
<1,000	64	2,413,224	33,813	37.0%
1,000 – 2,000	65	14,093,847	131,799	23.1%
2,000 – 5,000	50	21,679,993	277,955	12.0%
5,000 – 10,000	16	7,846,784	378,764	3.1%
>10,000	0			
Total	**195**	**46,033,848**	**378,764**	**25.1%**

Table 4 %RMSE statistic for all vehicles (Daily)

Daily all vehicle traffic volume	Number of directional sites	Sum of (modelled – surveyed traffic volumes)^2	Sum of surveyed traffic volumes	%RMSE
<5,000	116	162,394,789	302,266	45.6%
5,000 – 10,000	66	420,453,572	463,567	36.2%
10,000 – 15,000	72	849,376,383	869,173	28.7%
15,000 – 20,000	25	599,289,616	423,258	29.5%
>20,000	42	928,713,027	1,293,659	15.5%
Total	**321**	**2,960,227,387**	**3,351,924**	**29.1%**

3.4   Key Routes

In addition to comparing the model against screenlines and individual links, the model was also compared against observed traffic and travel times along key routes in the study area. This section shows how the model compares against observed traffic on the major inbound routes during the AM Peak period, this being the most important movement in terms of traffic volume.

The traffic counts were sourced from the years 2009 to 2011, while the travel time data was obtained from VicRoads surveys conducted in 2009.

The routes include:

- Princes Freeway Westbound

- Westernport Highway Northbound

- South Gippsland Highway Northbound

- Princes Highway Westbound

3.4.1   Princes Freeway Westbound

A chart of the modelled traffic volume versus distance travelled on the Princes Freeway westbound between Bunyip and Doveton is shown in Figure 14. Observed traffic volumes are shown by circles, with the size indicating the year of the traffic count. The larger circles represent traffic counts taken in 2011, while the smaller circles represent counts taken in 2010 and 2009. The blue line represents the modelled traffic volume along the route.

It can be seen in Figure 14 that the model is producing a reasonably good fit to observed AM traffic along the length of the Princes Freeway in the westbound direction.

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A comparison of modelled versus observed travel time on the Princes Freeway between Nar Nar Goon and Doveton is shown in Figure 15. This too is showing a reasonably good fit.

Figure 14 Princes Freeway Westbound – AM Model all vehicle volume versus Observed - from Bunyip to Doveton
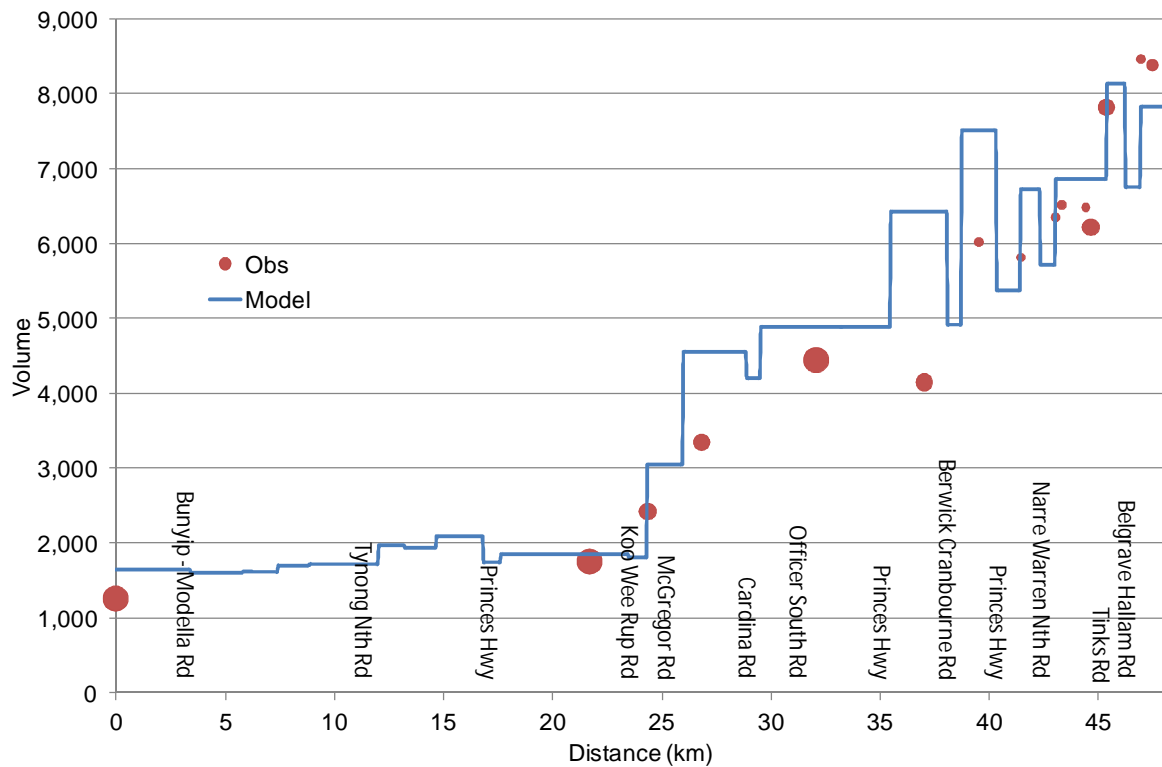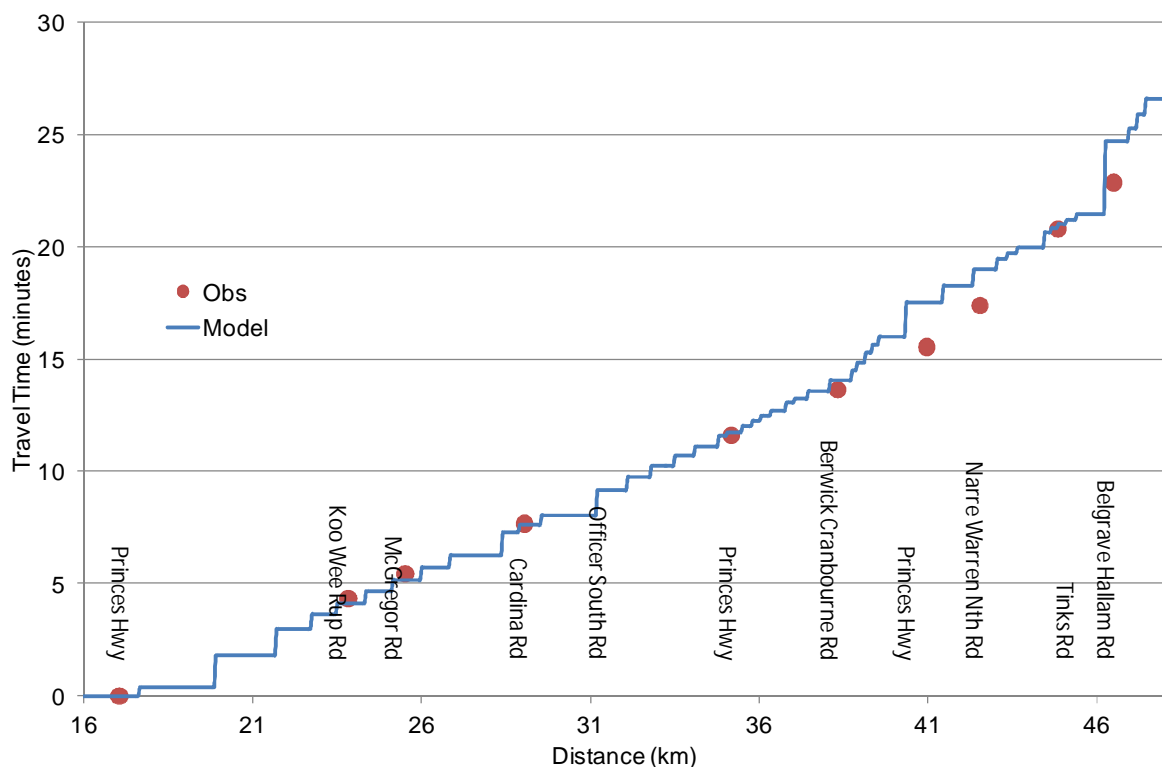

Figure 15 Princes Freeway Westbound – AM Model travel time versus Observed - from Nar Nar Goon to Doveton
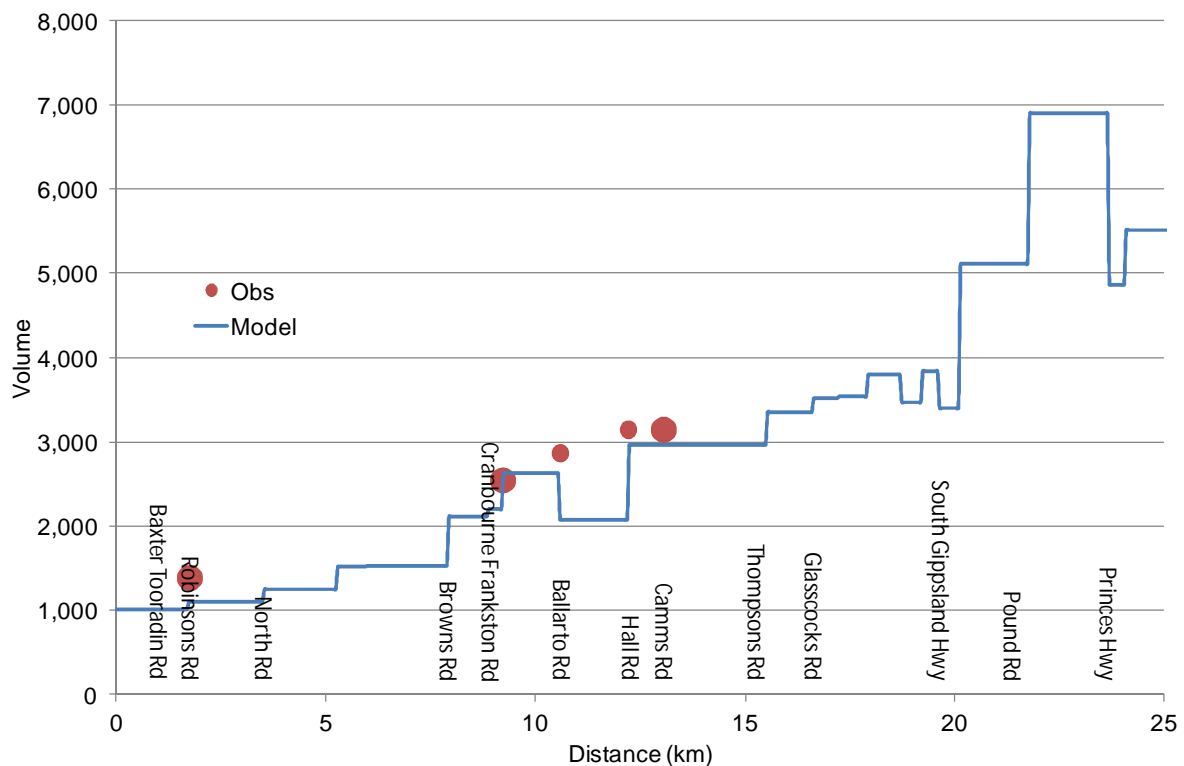
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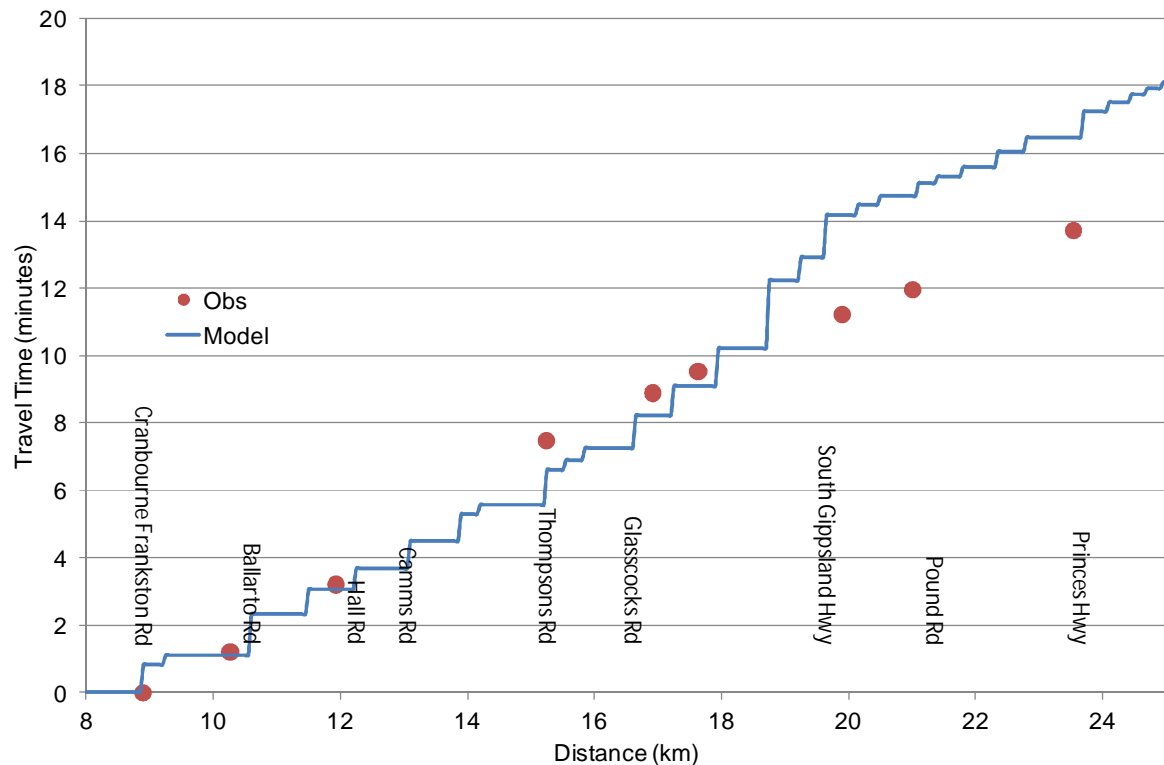### 3.4.2   Westernport Hwy Northbound

Similar to the chart for the Princes Freeway, Figure 16 shows the modelled traffic volume versus distance travelled on the Westernport Highway between Pearcedale and Doveton, while Figure 17 shows the comparison between modelled and observed travel times between Skye and Doveton. In this case, the modelled volumes are providing a reasonable match to observed traffic and travel times with the exception of the section north of the South Gippsland Highway. Here, the model is showing slower travel times than what was observed during the 2009 travel time surveys. It is likely that some of this difference can be explained by changes that have occurred within the network since the survey date. For example the effects of the M1 upgrade and the increase in households within the Lyndhurst / Lynbrook area.

Figure 16 Westernport Hwy Northbound – AM Model all vehicle volume versus Observed - from Pearcedale to Doveton

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Figure 17 Westernport Hwy Northbound– AM Model travel time versus Observed - from Skye to Doveton

3.4.3   South Gippsland Hwy Northbound

The pattern between the modelled and observed traffic volume and travel time for the South Gippsland Highway is comparable to that for the Westernport Highway. Figure 18 and Figure 19 show the modelled versus observed for traffic volume and travel time respectively, both of which show a reasonable fit between the modelled and observed traffic data.   Similar to the comparison for Westernport Highway, the model is producing slower travels times than the 2009 observed travel times for the section of highway north of the Lyndhurst/Lynbrook area.

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Figure 18 South Gippsland Hwy Northbound– AM Model all vehicle volume versus Observed - from Koo Wee Rup to Lynbrook
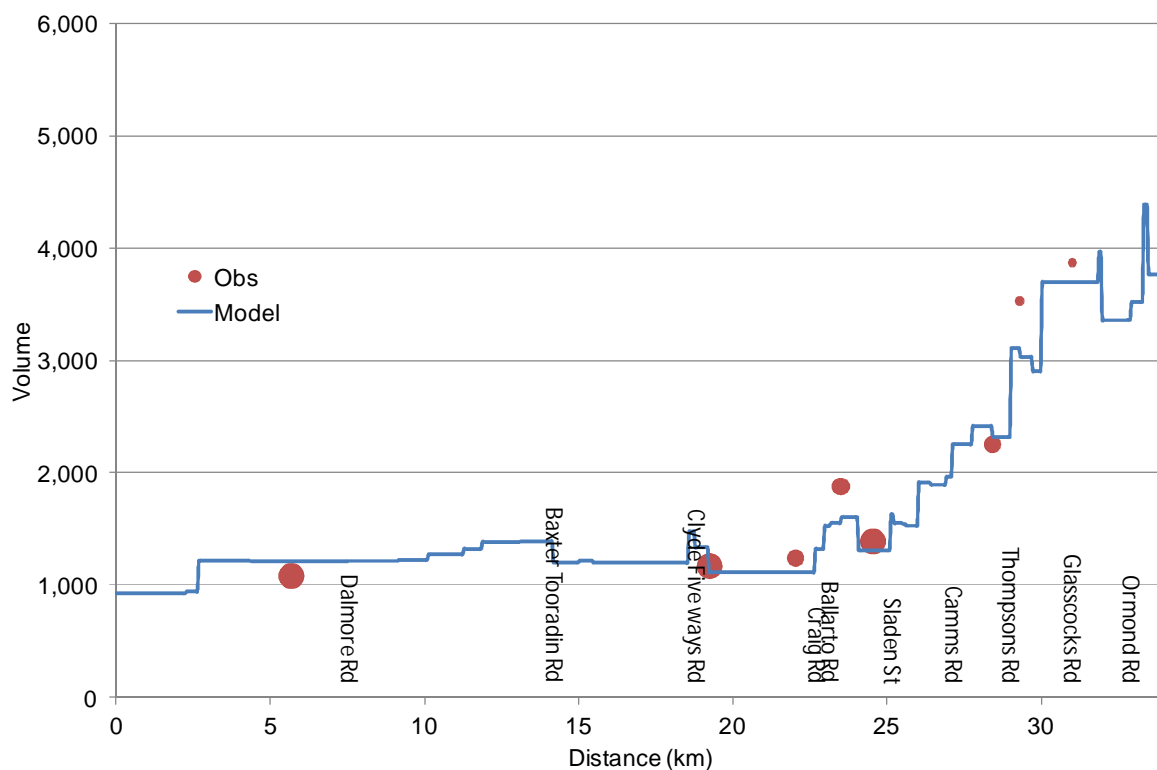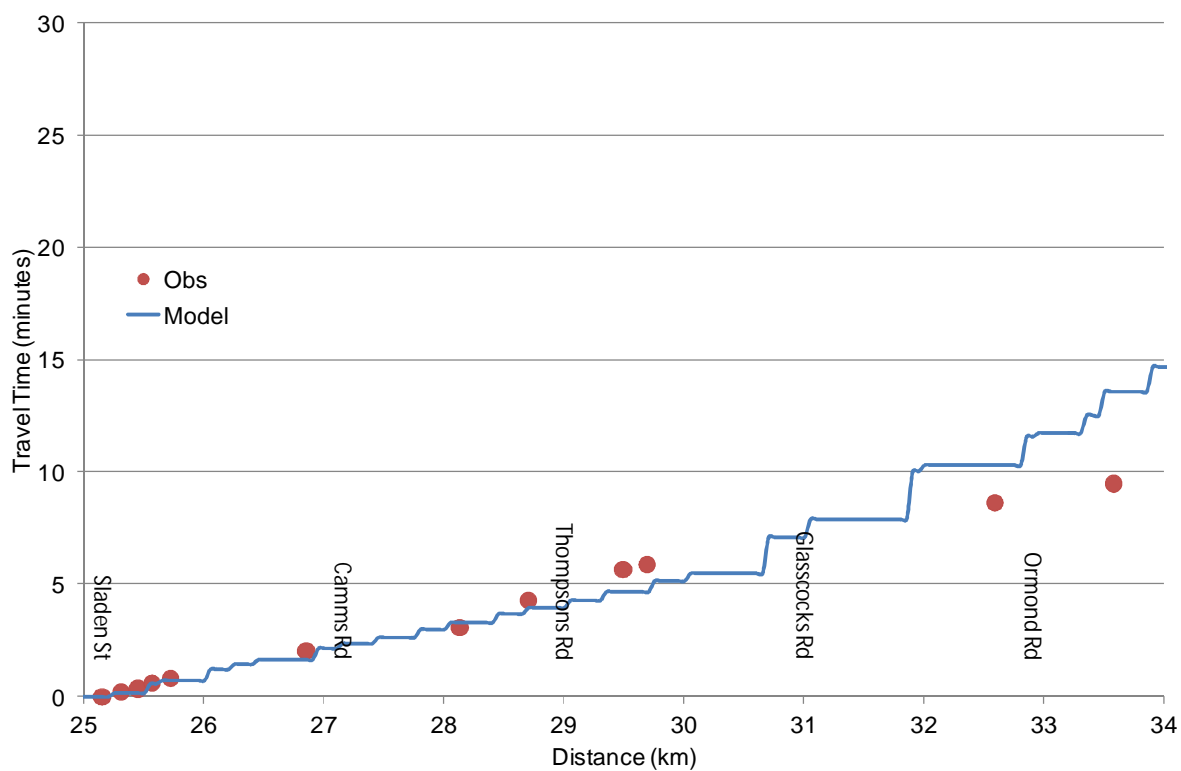

Figure 19 South Gippsland Hwy Northbound -AM Model travel time versus Observed - from Cranbourne to Lynbrook
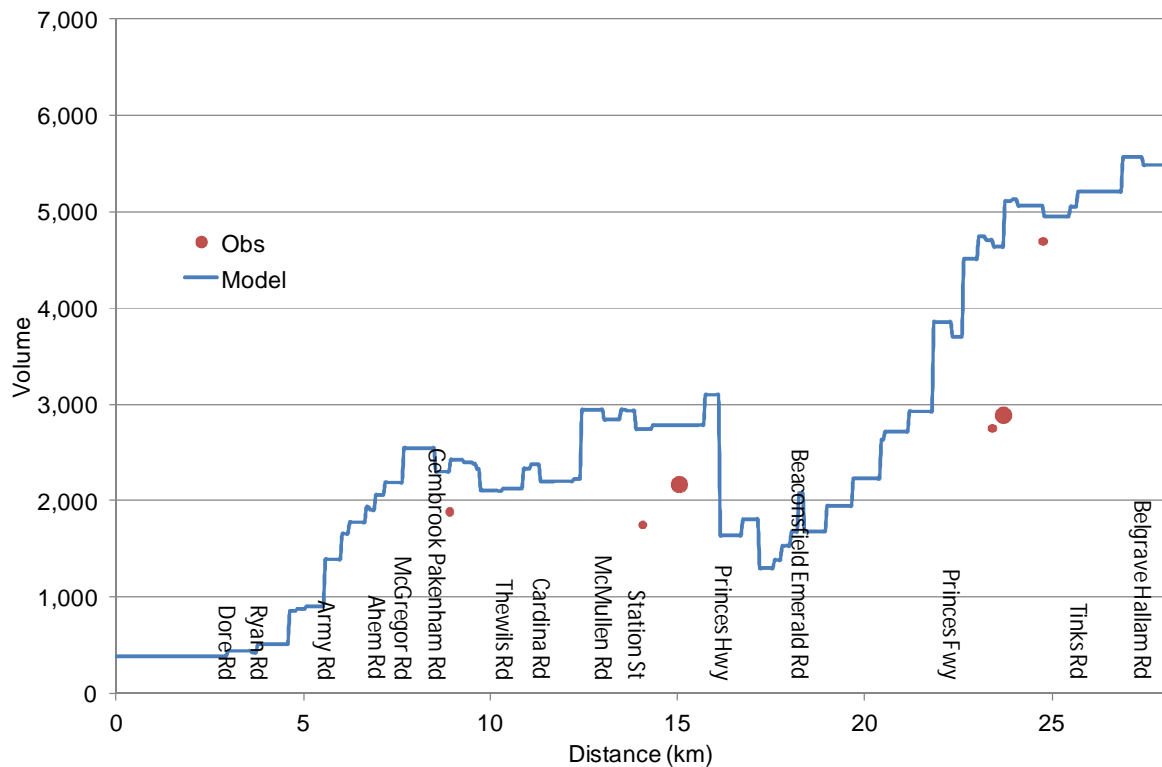
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3.4.4   Princes Hwy Westbound

The comparison between the model and observed traffic volumes along the Princes Highway between Nar Nar Goon and Doveton is shown in Figure 20. While the fit between the model and observed traffic on the Princes Highway is not as good as the other three routes, the most recent traffic count shown in the chart was taken during May 2010.   It is likely that more up to date traffic counts would show that there has been growth on the road during the past couple of years.

Interestingly, the model provides a reasonable fit to the traffic count south of Tinks road. This suggests that growth in traffic on the Princes Hwy during the AM peak may be occurring due to local trips rather than longer distance commuter trips.

The comparison between model and observed travel times between Nar Nar Goon and Doveton show that the model is consistently slower than the 2009 observed travel times for the section west of Pakenham. This result is not considered unreasonable given that traffic volumes are likely to have increased since the survey date.

Figure 20 Princes Hwy Westbound– AM Model all vehicle volume versus Observed - from Nar Nar Goon to Doveton

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Figure 21 Princes Hwy Westbound– AM Model travel time versus Observed - from Nar Nar Goon to Doveton
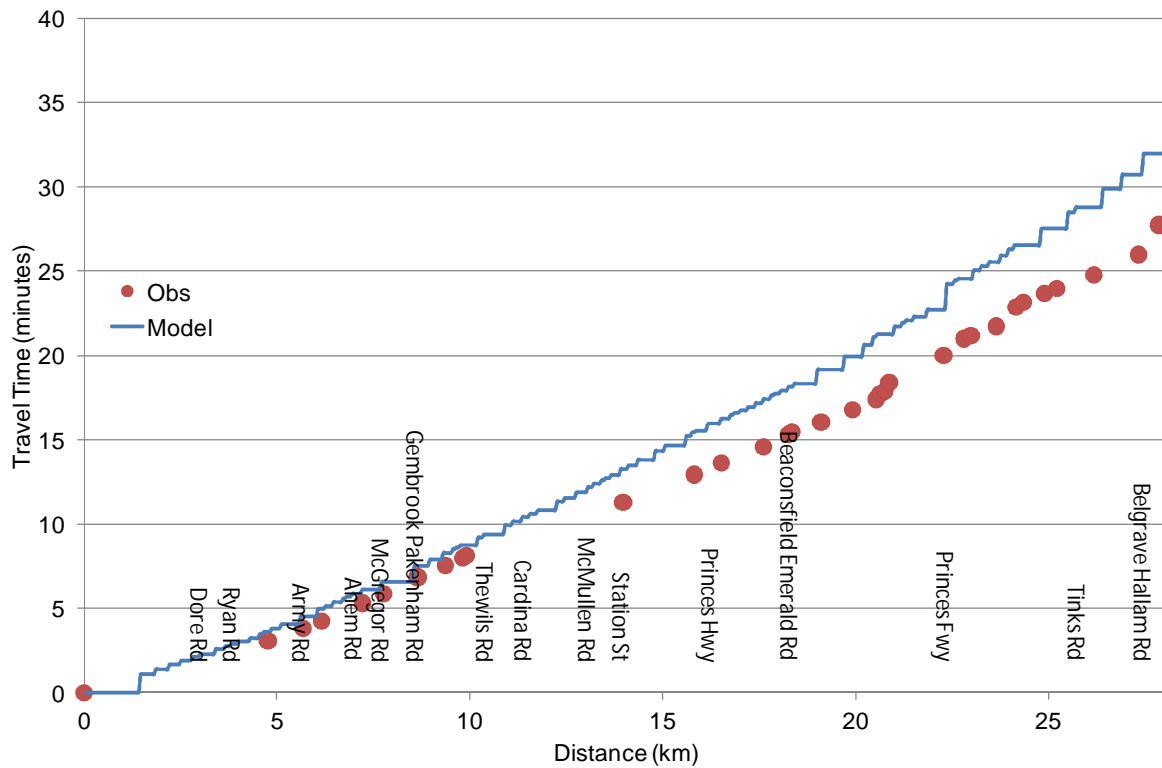
3.5 Model Validation Conclusions

The model has been validated against screenline flows, link flows, corridor flows and corridor travel times. When compared against VicRoads validation criteria the model satisfies the criteria at both the screenline level and when considering all of the link flows. The model performs well along key corridors when comparing flow profiles and also travels times.

4.0   Forecast Year 2046 Modelling

The validated South East growth area model was used to run to a 2046 future year scenario. The assumptions and the results of this 2046 run are described in this section.

4.1   Assumptions

The 2046 model scenario differs from the validated base year model in terms of the following assumptions:

- Road network

- Land use

- Public transport services

- Other VITM cost inputs (Tolls, parking costs etc.)

The 2046 assumptions for public transport and other VITM inputs are consistent with the Department of Transports 2046 reference case model and are not described here. The assumptions for the 2046 road network and land use have been refined for the South East growth area and are described below.


4.1.1   Network

The 2046 South East growth area network is essentially the '2046 plus' VITM network that has been refined within the South East growth area. This means that outside of the South East growth area, the network includes '2046 plus' projects such as North East link and the East West link road. Importantly, the '2046 plus' network should be considered as a full build, or unconstrained network rather than a most likely network scenario. Within the South East growth area, the network was refined using inputs from the:

- South East Growth Corridor plan

- VicRoads south east metro region

- Casey City Council

- Cardinia Shire Council

- Growth Areas Authority

- Growth Areas logical inclusions review

The 2046 network assumptions relating to road type, number of lanes and posted speed for the South East growth area are shown in the following three figures.
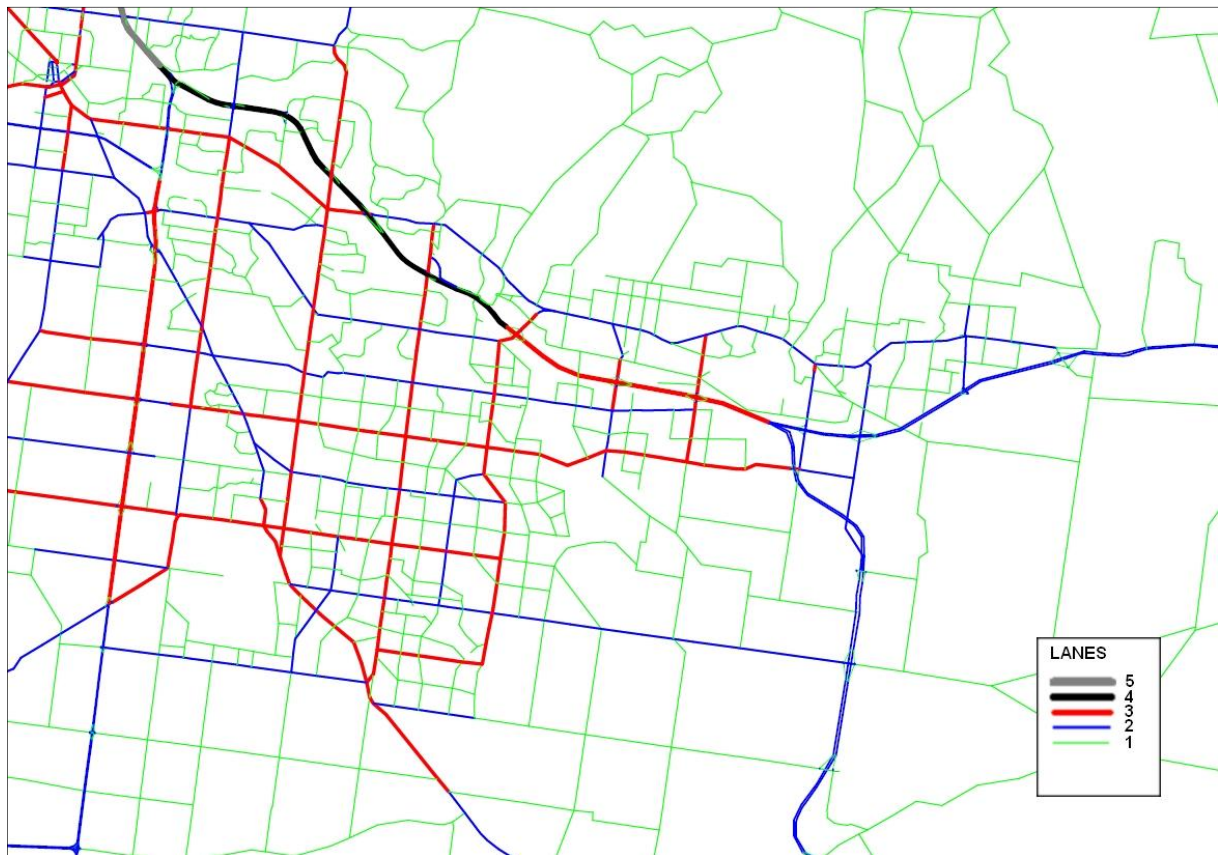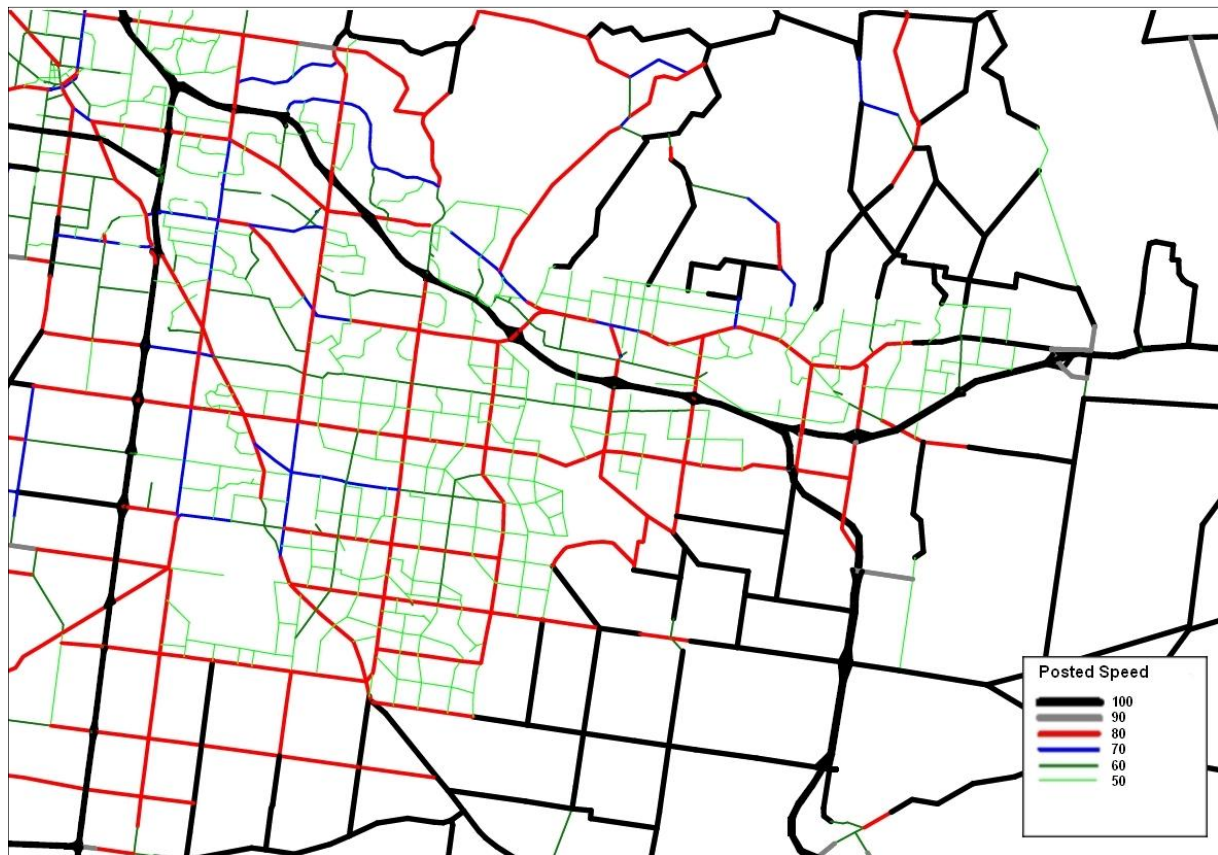
Figure 22 Network 2046 Assumption – Road Type
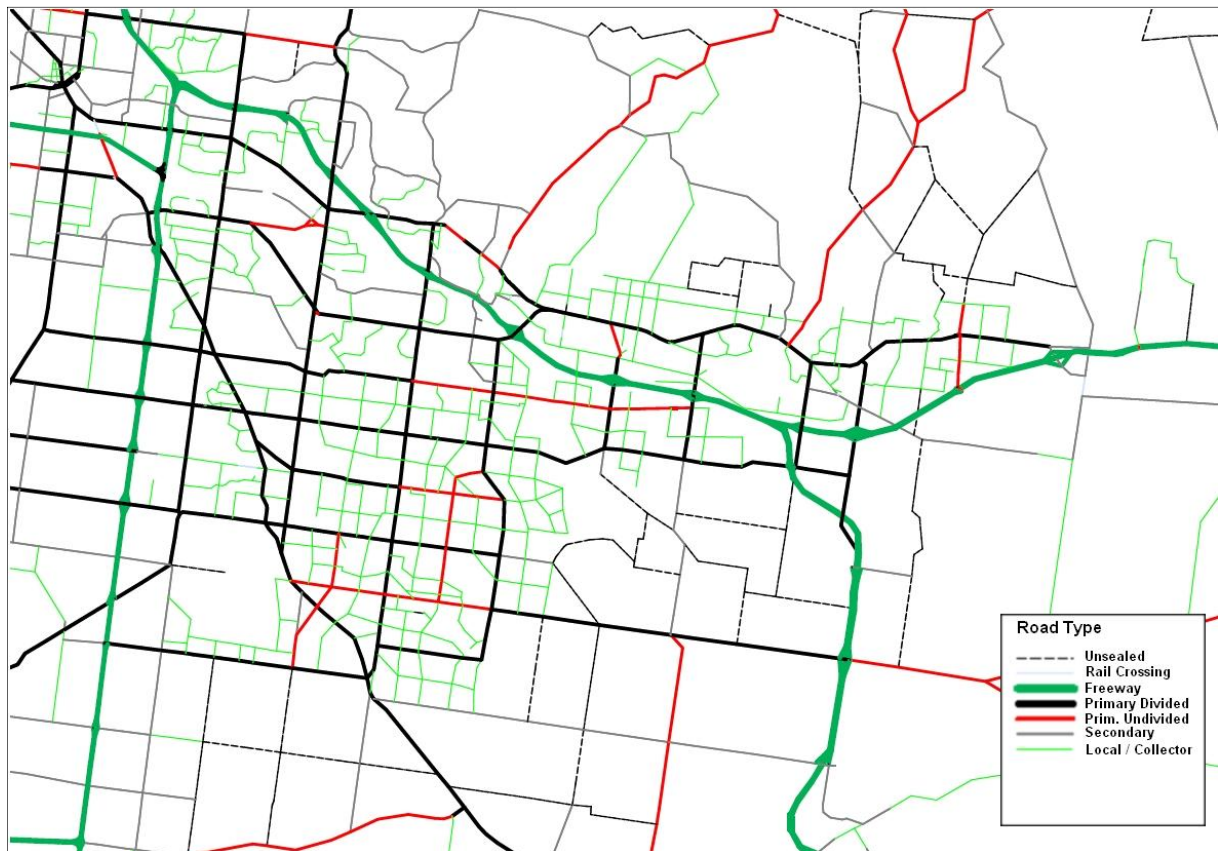
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Figure 23 Network 2046 Assumption – Number of lanes

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Figure 24 Network 2046 Assumption – Posted Speed


4.1.2   Land use

The 2046 land use assumptions were, in a similar manner to the network assumptions, made using a combination of VITM 2046 reference case land use for metropolitan Melbourne and a refined land use for the South East growth area.

The VITM 2046 reference case includes a container port at the Port of Hastings.

Land use assumptions for 2046 on the number of households, employment and population were provided by GAA for each of the disaggregated zones in the South East Growth area. Density plots of the 2046 population and employment forecasts for the study area are shown in Figure 25 and Figure 26 respectively.
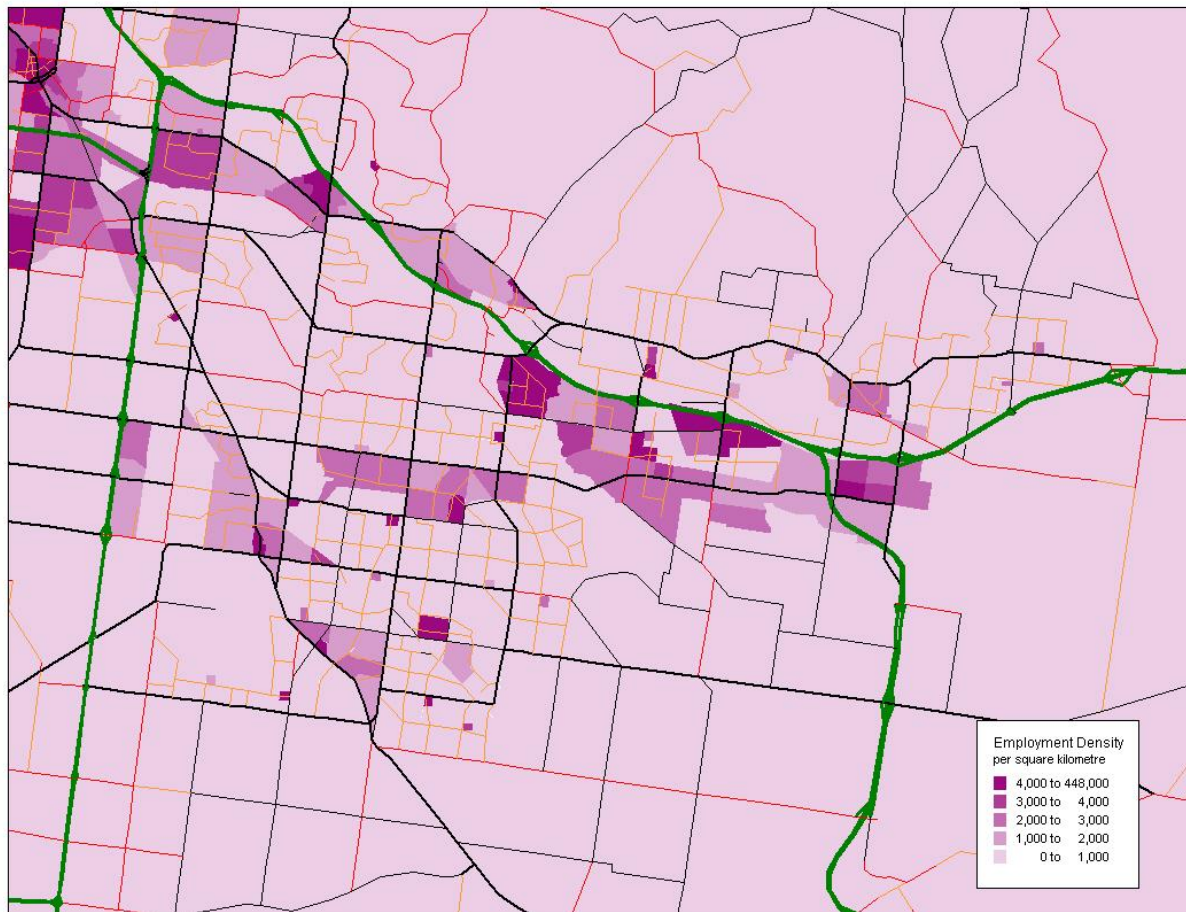
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Figure 25 2046 Land use – South East Growth area population
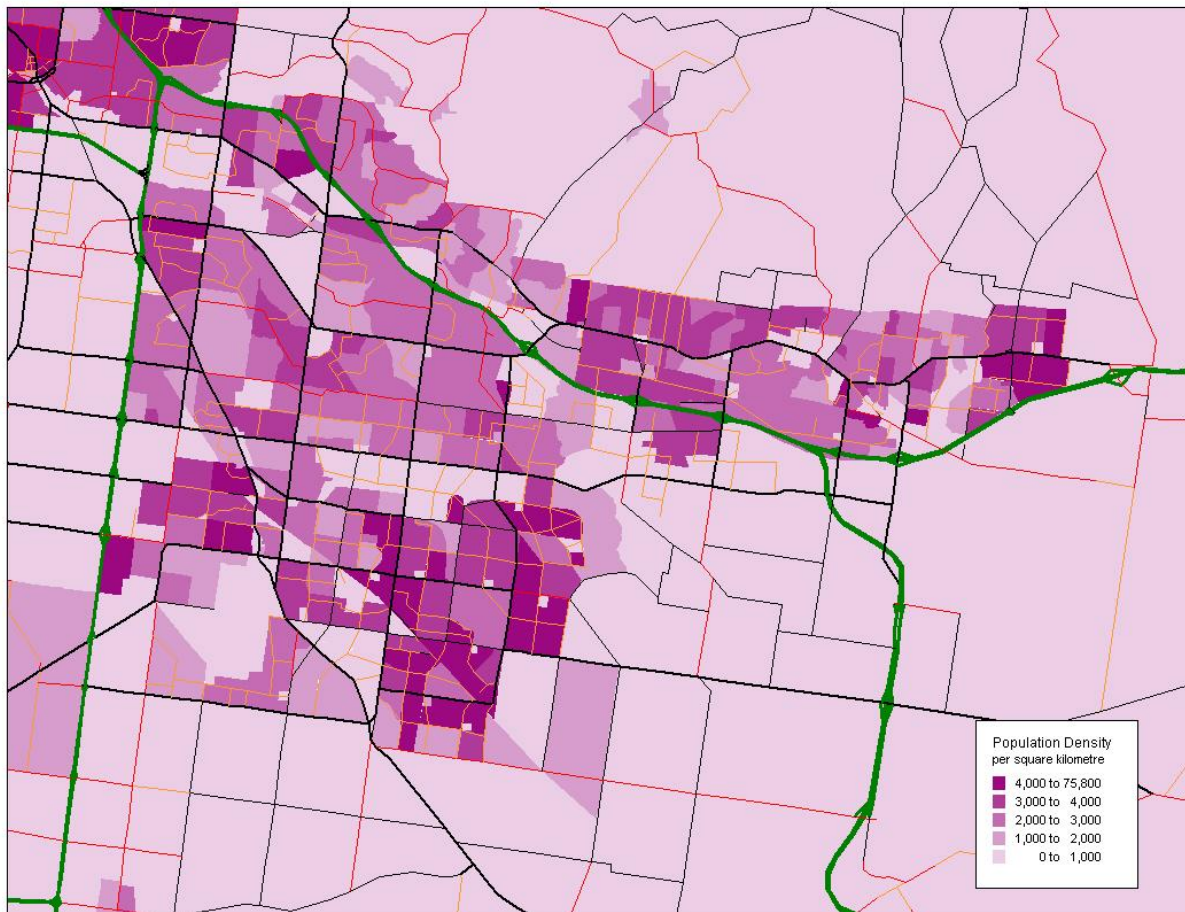
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Figure 26 2046 Land use – South East Growth area employment

4.1.3   Public Transport

The South East Growth area model uses the same public transport as the VITM 2046 reference case. This includes detailed coding of trains, trams and buses. The train services include both metropolitan and regional rail lines.

Where it was necessary, bus routes within the South East growth area were realigned to match changes in the network.

4.2   Results

The results from the 2046 model show a reasonable level of road traffic performance within the South East growth area.

A bandwidth plot of the daily Passenger Car Unit (PCU) volumes is shown in Figure 27. Passenger Car Unit Volumes are a convenient measure of traffic volumes in which truck volumes are converted to car volumes by multiplication factors. VITM uses factors of 1.3 and 2.3 for rigid trucks and articulated trucks respectively. This plot shows how traffic is concentrated on the freeways and larger arterials within the network. In respect to the arterials, it can be seen that Thompsons Road has particular importance amongst the east-west routes in the South East growth area. Further to the south, the east-west Halls Road / Cranbourne-Frankston Road route is also carrying high volumes of traffic. Of the north-south arterials, traffic is highest on the Narre Warren – Cranbourne Road, Clyde Road and Soldiers Road.

Volume-Capacity plots of the peak periods are found in section 4.2.1, while plots of the Daily, AM and PM traffic volumes are found in section 4.2.2

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Figure 27 2046 Daily PCU Volumes
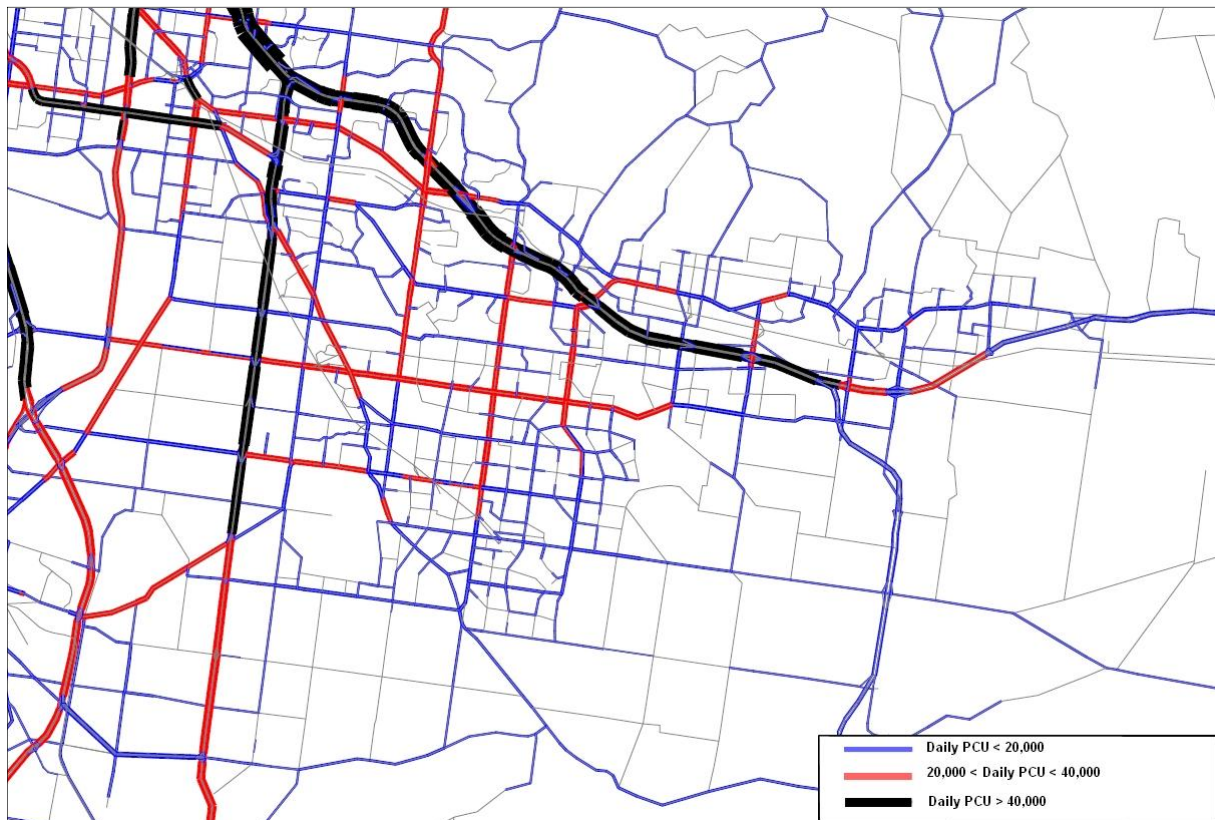
4.2.1   Volume Capacity Ratio

The Volume Capacity Ratio is a useful measure of the performance of a road network. In general terms, a road with a volume capacity ratio less than 0.8 indicates that it is in uncongested conditions while a ratio greater than 0.8 indicates congested conditions. When the volume capacity ratio exceeds 1, the road can be thought of as being above capacity, and very slow congested conditions are expected.

Plots of the volume capacity ratio for the 2046 AM and PM peak periods are shown in Figure 28 and Figure 29 respectively.

It can be seen in these plots that for the most part, the arterial roads of the South East growth area are operating below capacity in the peak periods. However, sections of the Monash Freeway, Wester Port Highway and the Princes Freeway experience above capacity conditions.

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Figure 28 2046 AM Volume Capacity Ratio

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Figure 29 2046 PM Volume Capacity Ratio

4.2.2   Traffic Volume plots

Traffic volume plots are useful for checking the vehicle demand on each road in the study area. However, unlike Volume Capacity plots, they do not for highlight areas of congestion within the network.

Daily, AM peak and PM peak traffic volume plots, expressed in PCU volumes, are shown in Figure 30, Figure 31 and Figure 32 respectively. The volumes in each of the plots have been rounded to the nearest 50; hence volumes shown as '0' infer a volume less than 25.
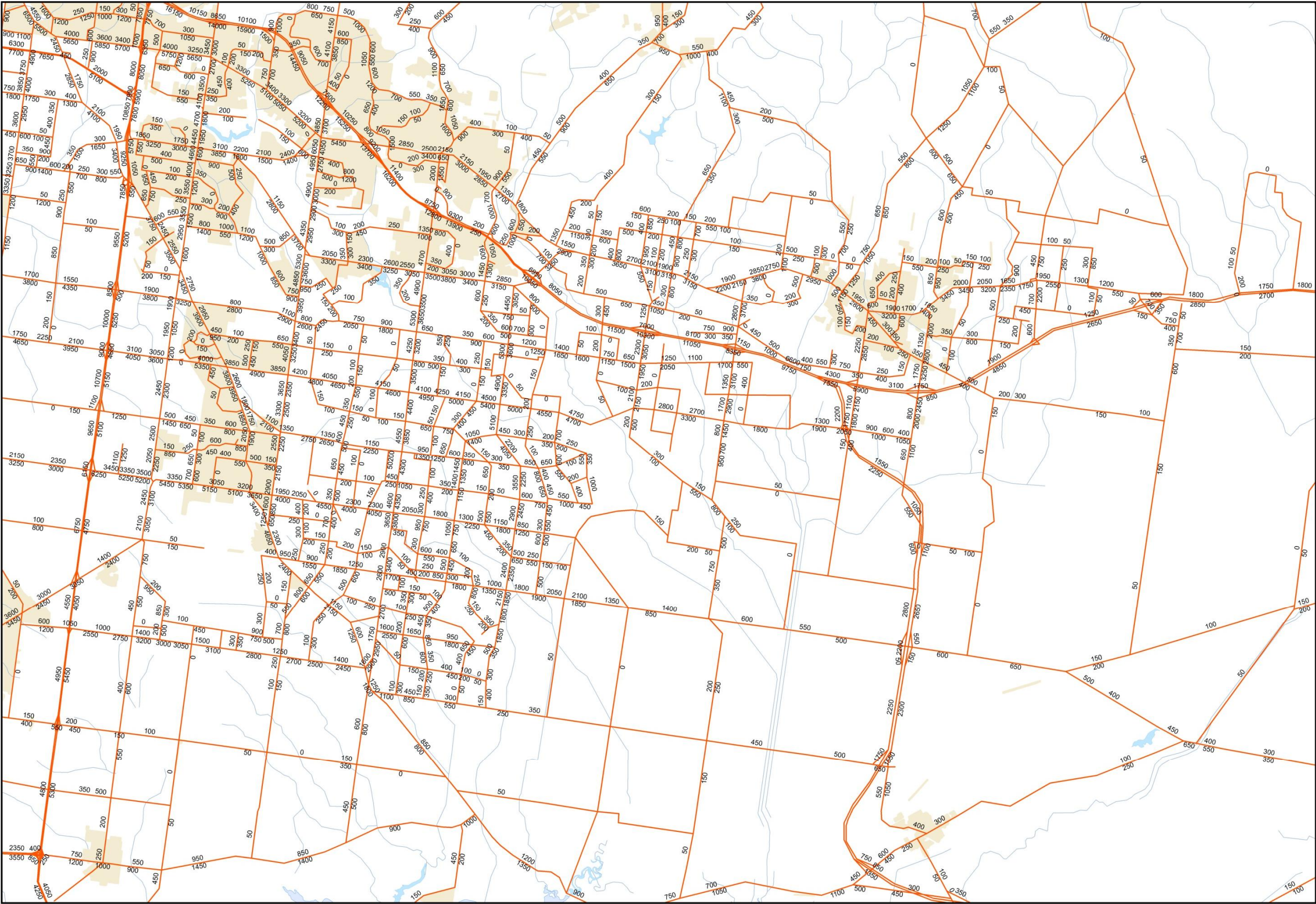
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Figure 30 2046 Daily PCU Volumes

D R A F T

Figure 31 2046 AM PCU Volumes

D R A F T

Figure 32 2046 PM PCU Volumes

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5.0   Future Use of the SE Growth Area Model

5.1   Networks

To help ensure the networks were accurate for future modelling work, both the 2011 network and the 2046 network were reviewed by VicRoads, Casey City Council and Cardinia Shire Council. This review was conducted after the completion of the modelling work presented in this report. The changes recommend by the review have been incorporated into the networks that will be used for future modelling work.

The changes to the 2011 network include the following roads (all involve changes to the posted speed link attribute):

- Ballarto Road east of Twyford Road

- Dalmore Road south of Ballarto Road

- Ryan Road South of Princes Hwy

- Starling Road north of Princes Hwy

- Brunt Road south of Princes Hwy

- Arena Parade west of Cardinia Road

The changes to the 2046 network include the following road sections (the network change and the affected distance are shown in brackets):

- Thompsons Road between Westernport Hwy and Evens Road (lanes, 900m)

- Officer South Road south of Rix Road (lanes and link class,10m)

- Officer South Road north of Rix Road (lanes and link class, 20m)

- McGregor's Road north of Main Street (lanes and link class, 20m)

5.2   South East Growth Area Model

The South East Growth Area model, being a refined version of the VITM, will be retained by the Department of Transport. Where appropriate, the Department of Transport may make changes to the model to maintain consistency with the master version of the VITM.

The 'model' delivered by AECOM to the Department of Transport includes:

- The validated 2011 model and results as documented in this report

- The 2046 model and results as documented in this report

- An updated Master Network to include the changes recommended following the presentation of the modelling results.