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Transport Modelling and Economic Analysis for the Kilmore-Wallan Bypass Planning Study

Final Report

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Prepared for

VicRoads

Prepared by

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Executive Summary

In 2007, VicRoads investigated several bypass options for Kilmore and Wallan. As part of this work, a strategic transport model was developed for the study area which included a total of 71 transport zones (including 15 external zones) and a road network that was sufficiently detailed to examine the impact that each bypass option would have on the surrounding road network. Given the commitment by the Victorian Government in 2010 to construct a bypass of Kilmore by 2017, VicRoads engaged AECOM to update the strategic transport model for Kilmore and Wallan to investigate the traffic and transport economic impacts of five bypass options for the study area.

The transport model that was developed in 2007 was updated and extended further to cover Broadford Township and the recent changes to the Melbourne Growth Corridor to the south of Wallan. The model included two components - light vehicles and heavy vehicles. The development of the light vehicle component followed a traditional four step model, while the heavy vehicle component was based on an existing pattern of an origin-destination matrix. The total traffic was the result of a multi-class assignment of light and heavy vehicle matrices.

The zoning system was further disaggregated, comprising 110 internal zones and 18 external zones. The road network adopted included all freeways, highways and arterials in the study area. A selection of collector roads was also included in order to allow traffic to be appropriately distributed to and from each zone. The Hume Freeway and Northern Highway were the main north-south routes in the study area, with other arterials and collectors mainly providing an east-west function. In order to take into account the effect of future development (including residential, commercial and industrial development) in the study area, appropriate modifications to the 2021, 2031, 2041 road networks were undertaken.

For trip productions, the demographic data compiled for each zone in the study area covered total population, population employed and the number of children in school. For trip attractions, the data included the number of school enrolments, wholesale/retail jobs and other jobs. The data was compiled for 2011 and projected for the years of 2021, 2031 and 2041, in close consultation with Shire of Mitchell, Growth Areas Authority, Department of Transport, Department of Planning and Community Development, and VicRoads. As a result of the analysis, total population in the study area was forecast to grow from approximately 23,300 people in 2011 to 80,000 people in 2041. The total number of jobs was forecast to grow also, from approximately 5,400 jobs in 2011 to 20,600 jobs in 2041.

For the trip generation component of the model, two main trip purposes, Home Based (HB) and Non Home Based (NHB), were adopted since their trip rates and distributions were different. Trip generation rates from a number of studies were reviewed and adopted where appropriate. For the trip distribution component of the model, internal trips and internal-external trips (and external-internal trips) were distributed based on the gravity model. The distribution of external-external trips was based on an origin destination survey undertaken in 2011.

The light and heavy vehicle origin destination matrices were assigned to the network using a multi-class equilibrium trip assignment with capacity restraint to estimate the link flows as well as travel time through the network. The traffic assignment for the 2011 base year was based on both travel time and vehicle operating costs for light vehicles, and travel time only for heavy vehicles. For future years, the traffic assignment was based on travel time only for both light and heavy vehicles in future years.

Several model validation checks on the 2011 Base model were undertaken as per VicRoads' requirements. All checks and criteria were satisfied for all vehicles and heavy vehicles separately. The model validation criteria were also satisfied if the traffic assignment was based on solely travel time for both light and heavy vehicles.

For future years, the internal-internal trips were determined by applying the trip production and attraction process to the future demographic data and distributing the trip ends using the gravity model. For internal-external and external-internal trips, the growth in trip productions at external zones was considered to be the same as the employment growth rate for the study area. Similarly, the growth in trip attractions at external zones was considered to be the same as the population growth rate for the study area. Growth for external-external trips was determined by using the historical traffic growth rates at external zones recorded over the past ten years.

There are a number of additional roads planned in the southern part of study area in 2031 and 2041 that need to be represented by external zones in the model. As the distribution of traffic demand at these external zones could not be estimated from this Kilmore-Wallan model, the Victorian Integrated Transport Model (VITM) developed by the Growth Areas Authority for the northern growth area of Melbourne was used to estimate the proportion expected to use each of the additional roads, as well as the existing Hume Freeway.

The impact on freight as a result of the proposed relocation of the wholesale fruit market to Epping and the operation of the intermodal terminal facility at Somerton was reviewed. The assessment was based on origin-destination goods tonnage data for Victoria. Heavy vehicle traffic volumes were derived from the tonnage data and assigned to the network with reference to existing route preference criteria. As a result of the analysis, it was estimated that there would be insignificant heavy vehicles shifting to the Northern Highway from other roads as a result of the relocation of the wholesale fruit market to Epping and the operation of the intermodal terminal facility at Somerton. Nevertheless, these additional heavy vehicle trips were then added to the external-external heavy vehicle trip matrix used for the 2021, 2031 and 2041 traffic forecasts.

A total of 5 bypass options: Quinns Road, Western option, O'Gradys Road, Dry Creek and Sunday Creek Road, plus the Base Case were modelled for 2021, 2031 and 2041.

In terms of traffic performance, Quinns Road option is expected to carry the highest volume of traffic across all bypass options, with around 15,400 vehicles per day in 2041. This is followed by Western option (12,400 vehicles per day), Dry Creek (11,200 vehicles per day), O'Gradys Road (10,700 vehicles per day) and Sunday Creek Road (5,900 vehicles per day).

Quinns Road option is also expected to have the greatest impact on reducing traffic along the Northern Highway, with reductions of up to 33% (all vehicles) on Sydney Road (Kilmore) and 18% (all vehicles) on High Street (Wallan). This is followed by Dry Creek option, O'Gradys Road option, Western Option and Sunday Creek Road option.

Since Quinns Road option was the most effective option in relieving traffic on Northern Highway, the 2041 scenario with Quinns Road option was used as a base for conducting sensitivity tests. Sensitivity Test 1 with the traffic assignment based on both travel time and distance shows that traffic would use the bypass less when compared to the base with the traffic assignment based on travel time only. Sensitivity Test 2 with the traffic growth rates doubled for through traffic between the Northern Highway north and Hume Freeway south shows that the traffic using the bypass would increase by 5%. Sensitivity Tests 3 shows that if the population for the study area grows by 20%, the traffic using the bypass would increase by 10%, while traffic on Northern Hwy would increase by 16-21%. Similarly Sensitivity Test 4 shows a reverse pattern. Sensitivity Test 5 shows that if the public transport (PT) patronage increases by 25% (or an increase in the PT mode share from 5.8% to 7.3% and a corresponding decrease in the car driver mode share), the bypass traffic is expected to decrease by 2%. The sensitivity tests indicated that the model behaved logically in responding to the changes of input data.

An analysis of the overall network performance also shows that Quinns Road option would provide the highest travel time saving over the future years. This is followed by Western, O'Gradys Road, Dry Creek, and Sunday Creek Road options for 2031 and 2041. In 2021, O'Gradys Road and Dry Creek options perform better than Western option.

An overall assessment of both traffic and economic outcomes, to determine the best performing option will be completed when the option costs are confirmed.

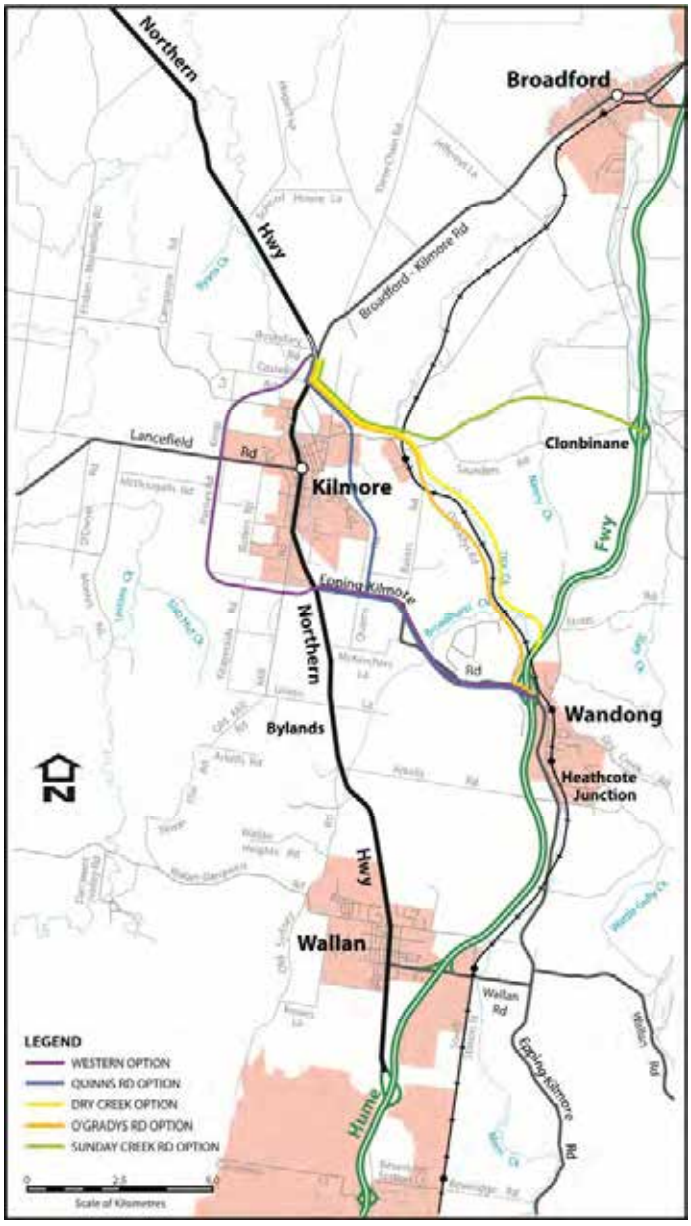
1.0 Introduction

1.1 Background

In 2007, VicRoads investigated several bypass options for Kilmore and Wallan. As part of this work, a strategic transport model was developed for the study area which included a total of 71 transport zones (including 15 external zones) and a road network that was sufficiently detailed to examine the impact that each bypass option would have on the surrounding road network.

Given the commitment by the Victorian Government in 2010 to construct a bypass of Kilmore by 2017, VicRoads is investigating five bypass options for the area, as illustrated in Figure 1 below. It is therefore timely to update the modelling undertaken in 2007 and develop this further to current conditions, particularly in light of significant population growth in the study area, especially in Wallan.

Figure 1: Bypass options



Source: VicRoads

1.2 Key objectives

VicRoads has engaged AECOM to update the strategic transport model for Kilmore and Wallan to test the impact of the new set of bypass options for the study area. Key objectives of the study are to:

- Review the existing model that was developed for the Kilmore-Wallan area and use this as a basis for the development of a new model for the study area
- Assess five (5) bypass concept alignments and their impact on the surrounding road network
- Provide current and forecast traffic volumes and traffic conditions for an average weekday in 2011 (base year), 2021, 2031 and 2041 for each concept bypass alignment
- Undertake an economic assessment of each concept bypass alignment.

1.3 Purpose and structure of this report

As part of this study, the following reports have been prepared:

- Inception Report
- Zonal Demographic Documentation
- Model Calibration and Validation Report.

The purpose of this Final Report is to summarise the methodology used to develop the 2011 base and future year transport models and present the results associated with using the future year model to test several bypass options for the study area. For detailed information on how the zonal demographic data was compiled and how the model was calibrated and validated, reference should be made to the above reports.

This report is structured as follows:

- **Section 2** describes the model structure
- **Section 3** describes how the road network and zoning system was developed
- **Section 4** explains how the demographic data was compiled and projected for the study area
- **Section 5** describes the development of the 2011 base year model
- **Section 6** presents the results of the traffic forecasts and modelling of bypass options
- **Section 7** presents the results of the economic assessment
- **Section 8** provides some concluding remarks.

2.0 Model Structure

2.1 Model platform

Cube Voyager software was used for developing the transport model for the 2007 study, and was therefore adopted for this study.

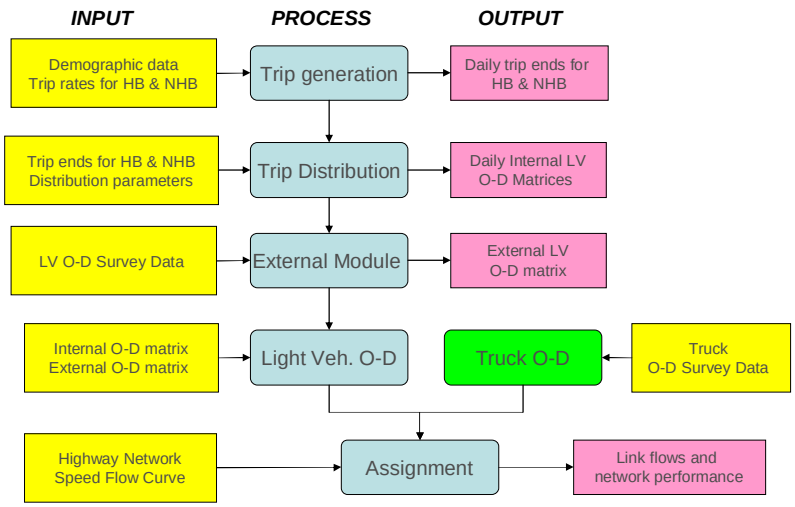
2.2 Study area

The study area is similar to that of the 2007 study, but expanded to include the Broadford Township and recent changes to the Melbourne Growth Corridor to the south of Wallan. The full study area is shown in Section 3.0 of this report.

2.3 Model structure

The model structure is similar to that used in the 2007 study. It has two components: light vehicles and heavy vehicles. The development of the light vehicle component follows a traditional four step model, while the heavy vehicle component is based on an existing pattern of an origin-destination matrix. The total traffic is the result of a multi-class assignment of light and heavy vehicle matrices. The model structure is shown in Figure 2.

Figure 2: Proposed Model Structure



For the purposes of modelling light and heavy vehicles and comparing these to actual surveyed traffic volumes, the following definitions are provided:

- Light vehicles are classified as either a car or light commercial vehicle
- Heavy vehicles are classified as a two-axle truck or bus and above.

2.4 Base year

A transport model is usually developed and validated for a base year before being used to confidently forecast future travel demand. In view of the availability of demographic data and traffic count data for the year of 2011 (which is used to develop and validate the model), the base year adopted for the model was 2011.

3.0 Development of the Zoning System and Road Network

3.1 Zoning system

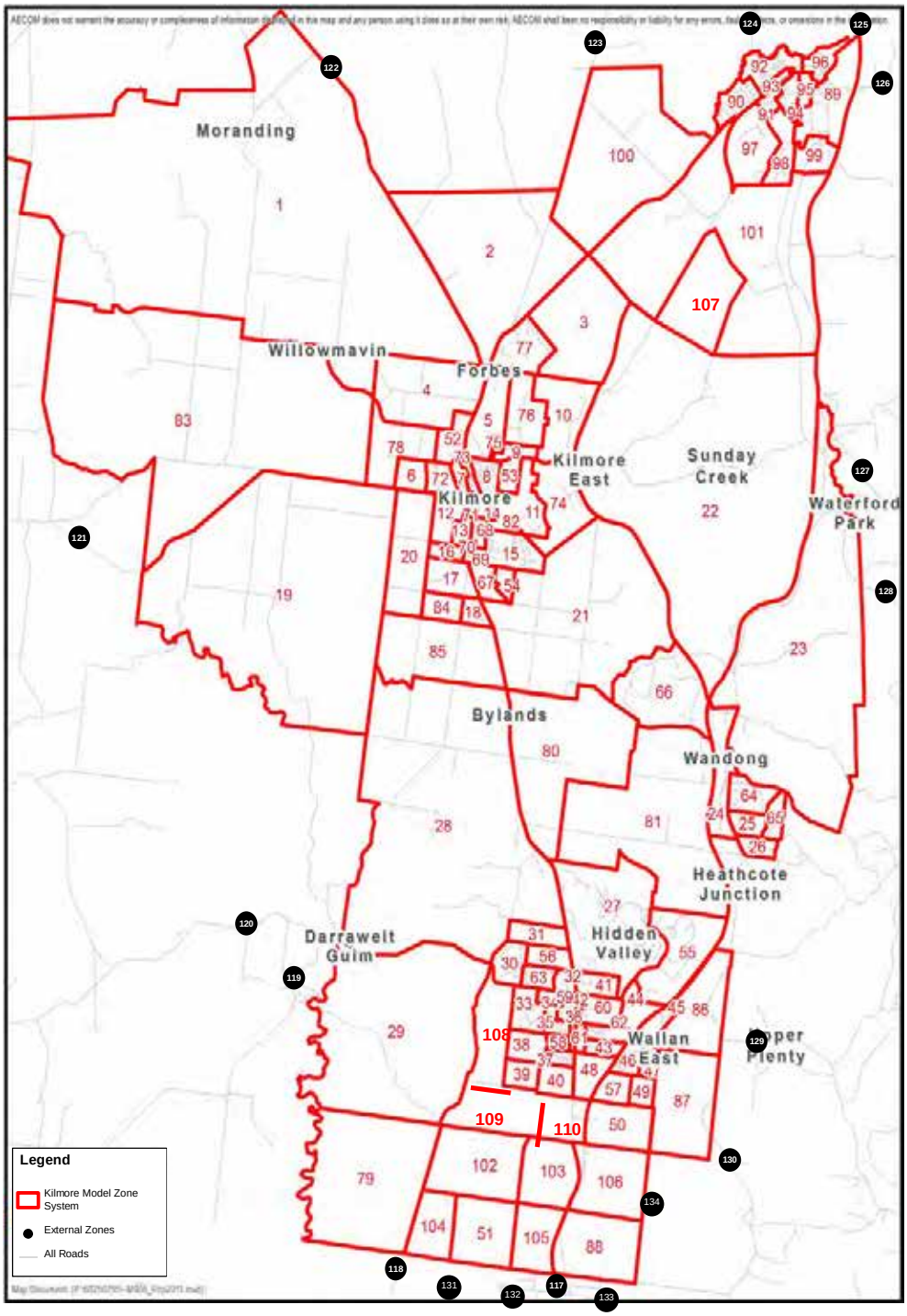
The zoning system from the transport model developed by AECOM in 2007 was initially reviewed. This zoning system comprised of 71 zones (including 15 external zones), which were generally smaller than the Census Collector Districts (CCDs) in the region, but aligned with the CCD boundaries where possible.

A similar zoning system was applied to this study with refinements made to ensure that the zones:

- Extended out northeast to include Broadford within the study area (i.e. zones 90-101)
- Sufficiently encompassed the bypass options
- Contained homogenous land uses (e.g. residential, commercial, industrial)
- Followed natural boundaries (e.g. rivers, railways, major roads) where possible
- Aligned with the zone system prepared by SGS (since demographic data was available from SGS)
- Could sufficiently reflect the distribution of traffic
- Allowed for future residential and commercial/industrial development in the area (including sites such as the Hidden Valley residential estate, Beveridge at the northern extent of the Urban Growth Boundary, Wallara Waters and Spring Ridge estates in Wallan, and the Kilmore industrial estate).

The final zoning system that was developed for this study is shown in Figure 3. This zoning system comprised of 110 internal zones and 18 external zones (zones 117 to 134). External zones 131-134 were created to represent the future road network developed for the growth area linking Beveridge to Wallan.

Figure 3: Internal and external zoning system



3.2 Road network

Figure 4 shows the 2011 base year road network adopted by AECOM which includes all freeways, highways and arterial roads in the study area. A series of carefully selected collector roads are also included to allow traffic to be appropriately distributed to and from each zone. The Hume Freeway and Northern Highway are the main north-south routes in the study area, with arterials[1] and collectors mainly providing an east-west function.

[1] Arterial roads shown in Figure 4 are those classified for the purposes of transport modelling and are not necessarily arterial roads in terms of the Road Management Act.

Figure 4: 2011 classified road network

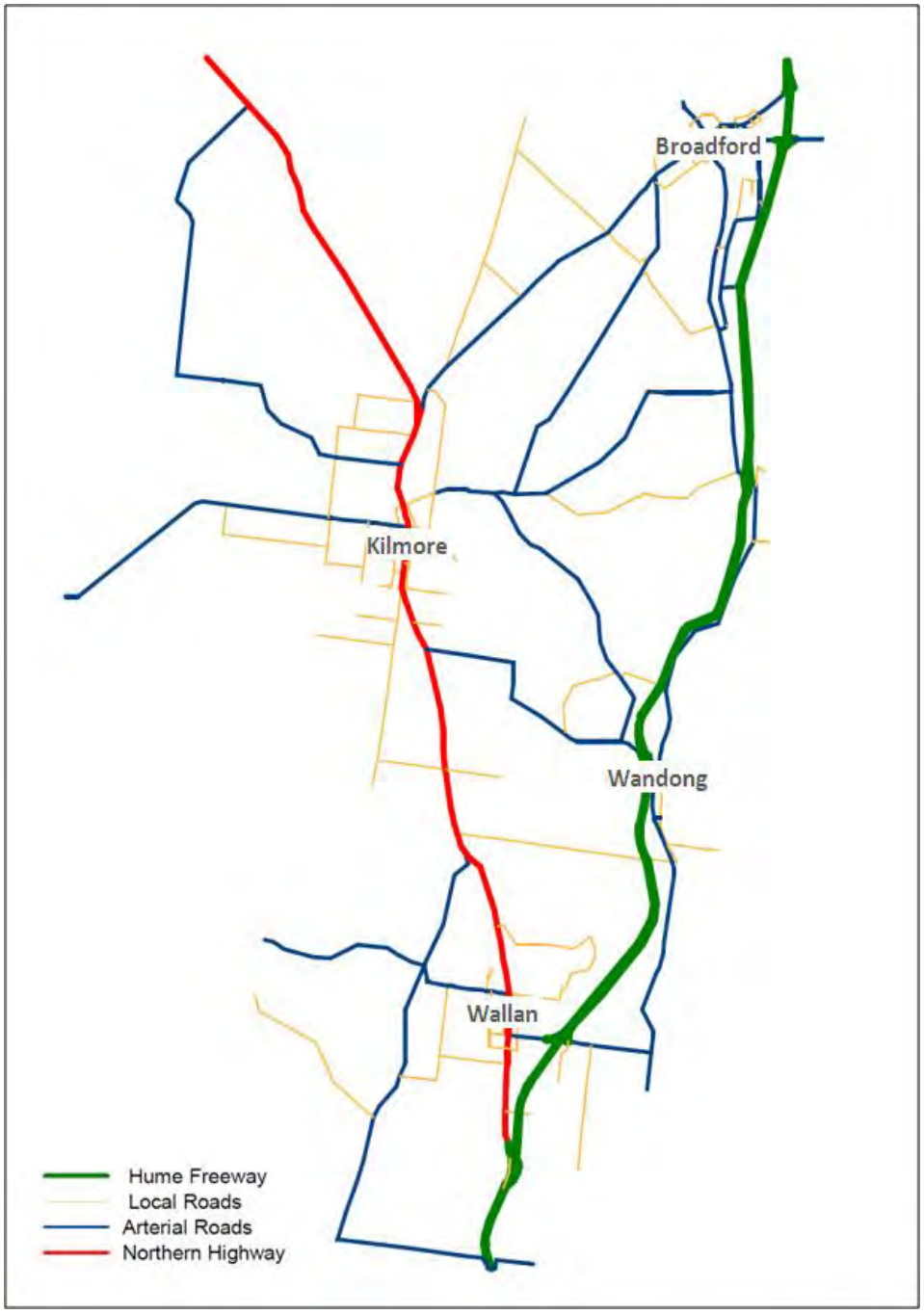
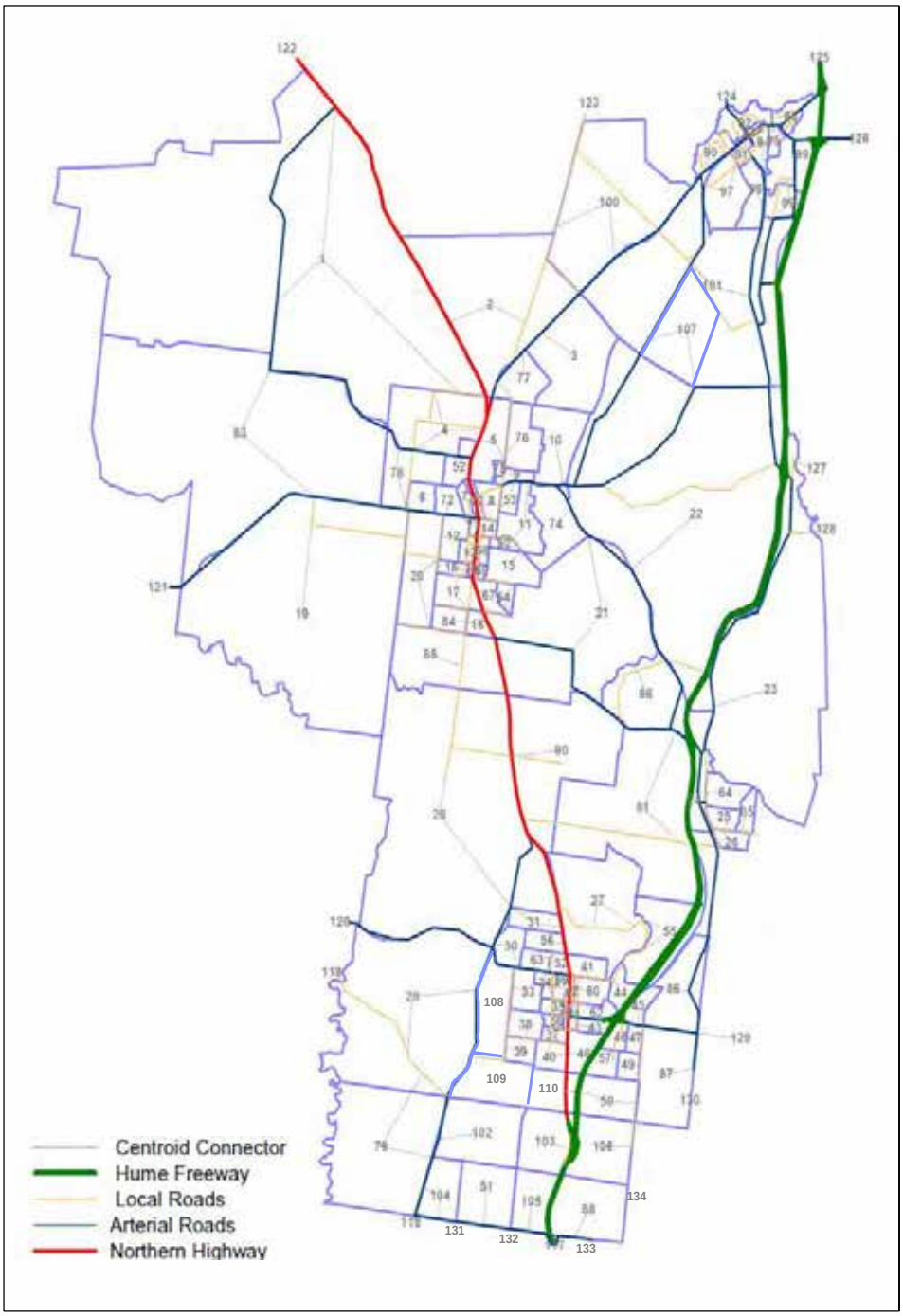


Figure 5 shows the same road network, but includes the zoning system adopted for the study.

Figure 5: 2011 classified road network and zoning system



Details of the characteristics of roads in the 2011 network are provided in Appendix A.

Table 1 below describes the hourly and daily capacities for each of the link types in the network. The hourly directional capacities were converted to daily capacities by using a peak hour to daily factor of 15, derived from observed traffic counts (see the Model Calibration and Validation Report for further details). As such, the assignment carried out by the model approximates a peak hour assignment, and the travel time produced by the model closely represents travel during the peak period for the peak direction.

It is important to note that the capacities in Table 1 are those used for modelling purposes only. They represent the road capacity or the service flow at level of service E, where above this level traffic would experience a breakdown of service. In addition, as traffic flow approaches level of service E, the traffic speed would be substantially reduced, and motorists would reconsider their choice of route. Table 1 also indicates the Akcelik curve parameter (J) and posted speed factor adopted for each of the link types.

Table 1: Link types and capacities

Link description	Link type	Hourly directional capacity per lane	24-hour directional capacity per lane	Akcelik curve parameter (J)	Posted speed factor
Centroid connector	1	10,000	150,000	0.0	1.0
Freeway divided	2	2,000	30,000	0.1	1.0
Freeway on/off ramp	3	900	13,500	0.3	0.8
Highway rural divided	4	1,900	28,500	0.3	0.95
Highway rural undivided	5	1,800	27,000	0.3	0.9
Highway urban divided	6	1,200	18,000	0.6	0.85
Highway urban undivided	7	1,100	16,500	0.6	0.8
Arterial rural unsealed	8	1,400	21,000	250	0.7
Arterial rural sealed	9	1,700	25,500	0.5	0.85
Arterial urban unsealed	10	700	10,500	250	0.7
Arterial urban sealed	11	900	13,500	0.8	0.75
Collector rural unsealed	12	600	9,000	250	0.7
Collector rural sealed	13	800	12,000	1.4	0.8
Collector urban unsealed	14	500	7,500	250	0.7
Collector urban sealed	15	700	10,500	1.6	0.7

As can be seen from Table 1, the J_a parameter for unsealed roads has been set to 250. This is recommended by VicRoads as it results in substantially reduced travel speeds following the addition of a relatively small number of vehicles on the link, thereby better representing traffic flow conditions on unsealed roads.

4.0 Development of Zonal Demographic Data

4.1 Compilation of existing demographic data sources

The compilation of demographic data gave consideration to the information required for the trip production component and trip attraction component of the model.

Demographic data required for the **trip production** component of the model included:

- Total population
- Employed persons
- Persons attending educational institutions.

Demographic data required for the **trip attraction** component of the model included:

- Educational enrolments
- Jobs at wholesale and retail employment sites
- Jobs at other employment sites.

The demographic data for the base year was developed by using the data compiled by the SGS Economics and Planning during 2011-12 for 53 zones across the study area. This data was provided by the Department of Transport's Policy and Communications Division, who are responsible for managing the development and application of the Victorian Integrated Transport Model (VITM). The demographic data developed by SGS Economics and Planning was then disaggregated by AECOM into the 110 transport zones developed for the model. The disaggregation process was undertaken by carefully applying specific proportions to each of the 53 SGS zones to compile demographic data for each of the 110 transport zones for the model. Comparisons were also made to the population estimates prepared by .id Pty Ltd for Mitchell Shire Council in June 2012.

For future years, the development of demographic data was based on a consultation process with relevant government agencies including the Department of Transport (DOT), Department of Planning and Community Development (DPCD), Growth Areas Authority (GAA) and Mitchell Shire Council.

As it is necessary to represent employment and educational enrolments at precise locations where future development is likely to occur, employment (jobs) and educational enrolments in Wallan, Kilmore and Broadford were redistributed to zones which are more likely to experience growth in employment and educational enrolments. The growth in households, population and employed persons were redistributed to areas where residential development is anticipated (e.g. Wallara Waters estate in Wallan). Following the redistribution of demographic data to the appropriate areas, the total number of jobs and enrolments for future year scenarios were adjusted directly in accordance with the ratios between the total number of jobs to employed persons, and the number of educational enrolments to persons in education from the 2011 base year data.

The demographic data for future years was further refined using following data sources:

- The population for Kilmore, Wandong, Pyalong (and the surrounding rural area), Broadford and Wallan for 2021, 2031 and 2041 was based on the .id population forecast for 2031 (prepared in June 2012) with the same growth rates extended to 2041.
- The development pattern for Wallan and the logical inclusions area was based on a meeting between GAA, Mitchell Shire Council and VicRoads on 29 June 2012 and subsequent discussions between Mitchell Shire Council and VicRoads on the staging of developments in Wallan in future years (2021, 2031 and 2041).
- The development pattern for the Beveridge area was provided by GAA (the 2046 VITM model input) on 31 July 2012. The population for Beveridge was determined as the remainder of the total population forecast for Mitchell Shire by DPCD (VIF12 or SGS) minus the estimated population of the other towns. For 2041, the total population for Shire of Mitchell was based on the SGS forecast as the VIF12 population forecast only extends to 2031.

Table 2 below shows a summary of estimated population by area for the study area for 2011, 2021, 2031 and 2041, and the corresponding growth rates.

Table 2: Summary of estimated population by area for the study area

Area	Population				Growth Rate		
	2011	2021	2031	2041	2011-2021	2021-2031	2031-2041
Kilmore	7,140	9,140	11,700	14,976	2.5%	2.5%	2.5%
Wandong	2,708	2,762	2,818	2,875	0.2%	0.2%	0.2%
Pyalong	1,050	1,071	1,092	1,114	0.2%	0.2%	0.2%
Broadford	4,434	4,995	5,628	6,341	1.2%	1.2%	1.2%
Wallan	7,849	17,680	28,773	38,669	8.5%	5%	3.0%
Beveridge North	91	3,908	11,995	16,063	45.6%	11.9%	3.0%
Total Study Area	**23,271**	**39,556**	**62,006**	**80,039**	**5.5%**	**4.6%**	**2.6%**
Rural North	12,495	12,747	13,004	13,267	0.2%	0.2%	0.2%
Beveridge South	-	6,598	20,250	27,117	-	11.9%	3.0%
Total Mitchell Shire	**35,766**	**58,901**	**95,260**	**120,423**	**5.1%**	**4.9%**	**2.4%**

An overall summary of the estimated demographic data developed for the study area is shown in Table 3. By 2041 the adjusted data in Table 3 shows that there will be around 15,600 educational enrolments and around 20,600 jobs in the study area.

Table 3: Summary of estimated demographic data for the study area[2]

Year	Total Population	Households	Employed Persons	Persons in Education	Educational Enrolments	Wholesale & Retail Jobs	Other Jobs
2011	23,271	7,864	12,324	5,818	5,011	980	4,429
2021	39,556	14,043	21,331	9,703	8,537	1,814	7,618
2031	62,006	22,473	34,231	15,163	13,339	3,088	12,457
2041	80,039	29,552	46,022	17,829	15,596	4,144	16,462
Growth rate p.a.							
2011-21	5.4%	6.0%	5.6%	5.2%	5.5%	6.4%	5.6%
2021-31	4.6%	4.8%	4.8%	4.6%	4.6%	5.5%	5.0%
2031-41	2.6%	2.8%	3.0%	1.6%	1.6%	3.0%	2.8%

[2] Study area is smaller than the entire Mitchell Shire area

Table 4 (on the following page) provides a summary of job and enrolment ratios. As can be seen, the ratios of jobs per employed person and enrolments per person in education are consistent over the years. However, the ratio of enrolments per household reduces slightly in future years. This is due to the future growth of households being more than that of population, which reflects an expected trend of smaller household size for the study area in the future.

Table 4: Summary of job and enrolment ratios

Year	Employed Persons per Household	Jobs per Household	Jobs per Employed Person	Persons in Education per Household	Enrolments per Household	Enrolments per Person in Education
2011	1.57	0.69	0.44	0.74	0.64	0.86
2021	1.52	0.67	0.44	0.69	0.61	0.88
2031	1.52	0.69	0.45	0.67	0.59	0.88
2041	1.56	0.70	0.45	0.60	0.53	0.87

Full detail of the process undertaken is contained in a separate AECOM report titled *Zonal Demographic Documentation*.

In order to represent the demographic data in a spatial form, Figure 6 to Figure 11 show how the total population, total employment and educational enrolments are distributed across the study area in 2011, and how they are expected to increase by 2041.

The full set of adjusted demographic data for each transport zone in the study area is provided for each model year (2011, 2021, 2031 and 2041) in Appendix B.

Figure 6: Distribution of total population in the study area in 2011

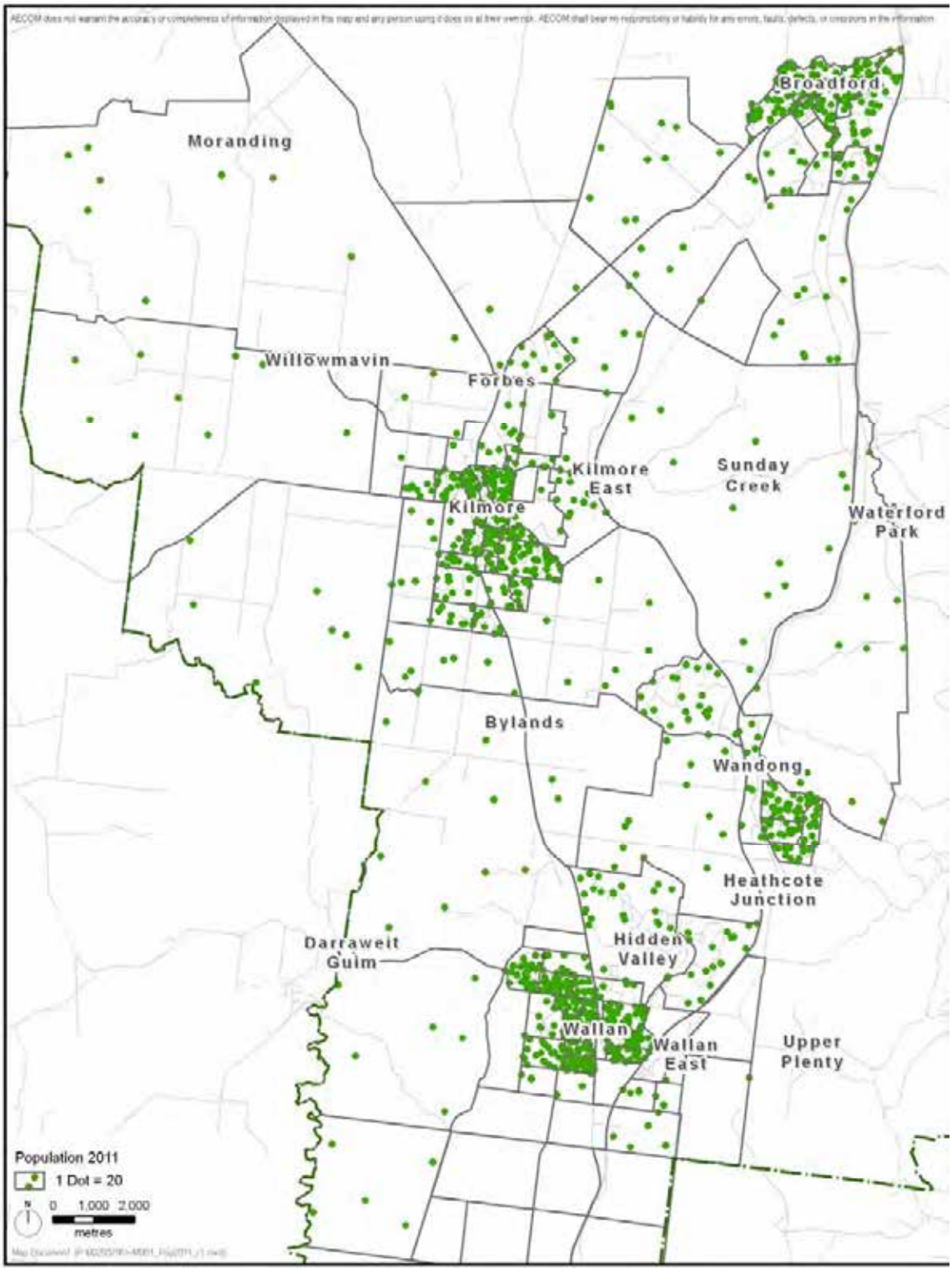


Figure 7: Growth in total population in the study area between 2011 and 2041

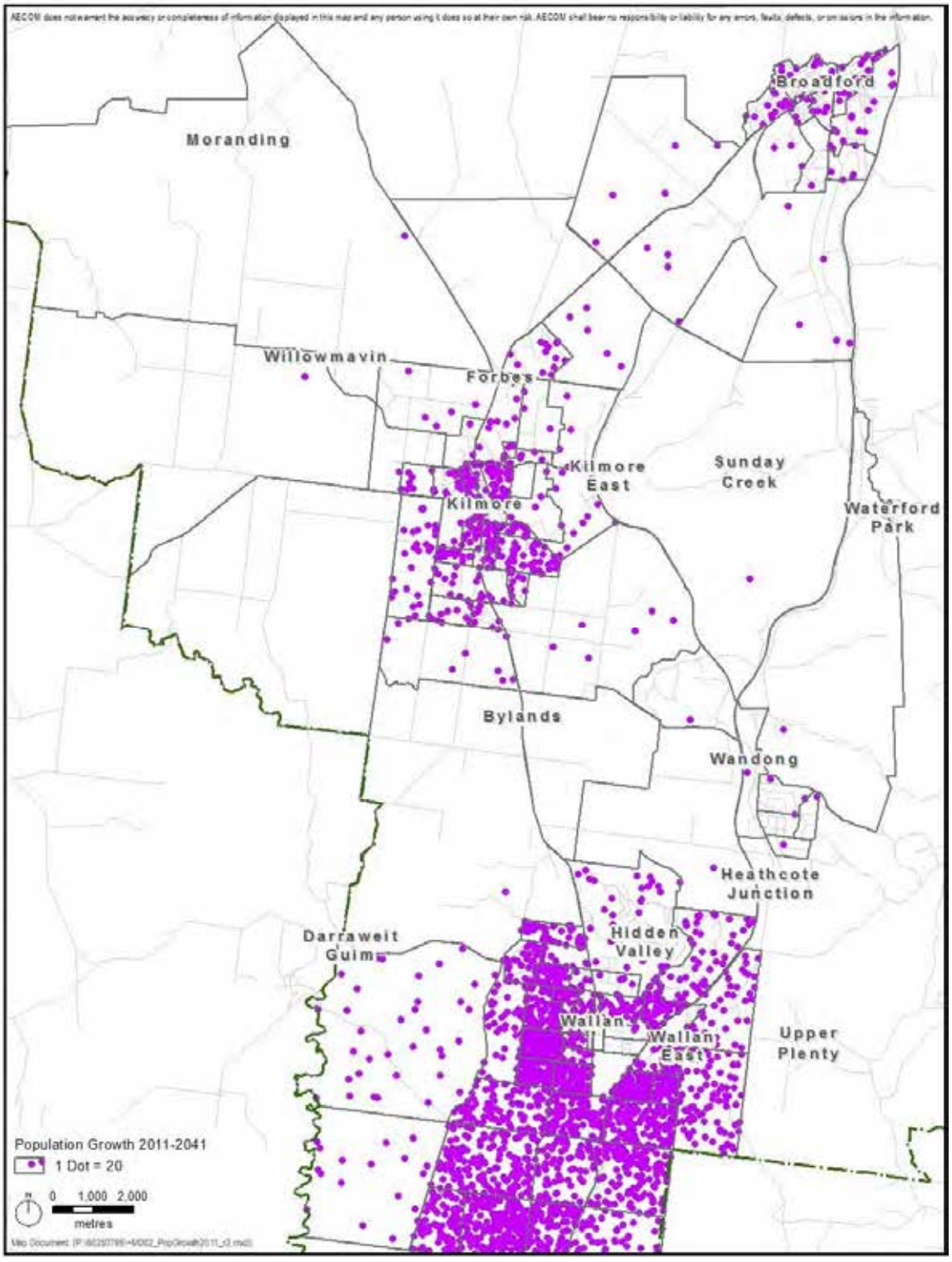


Figure 8: Distribution of total employment (jobs) in study area in 2011

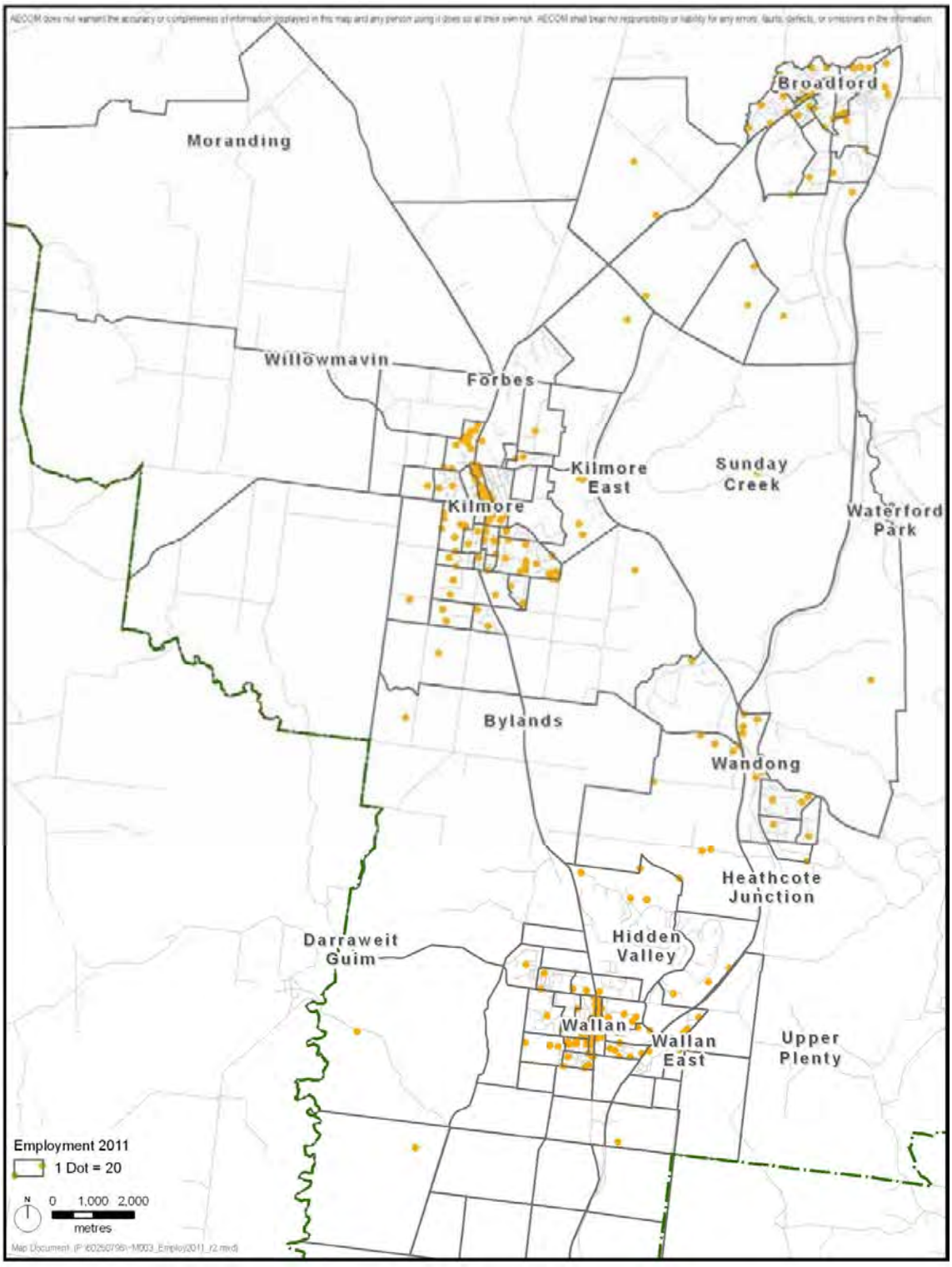


Figure 9: Growth in total employment (jobs) in the study area between 2011 and 2041

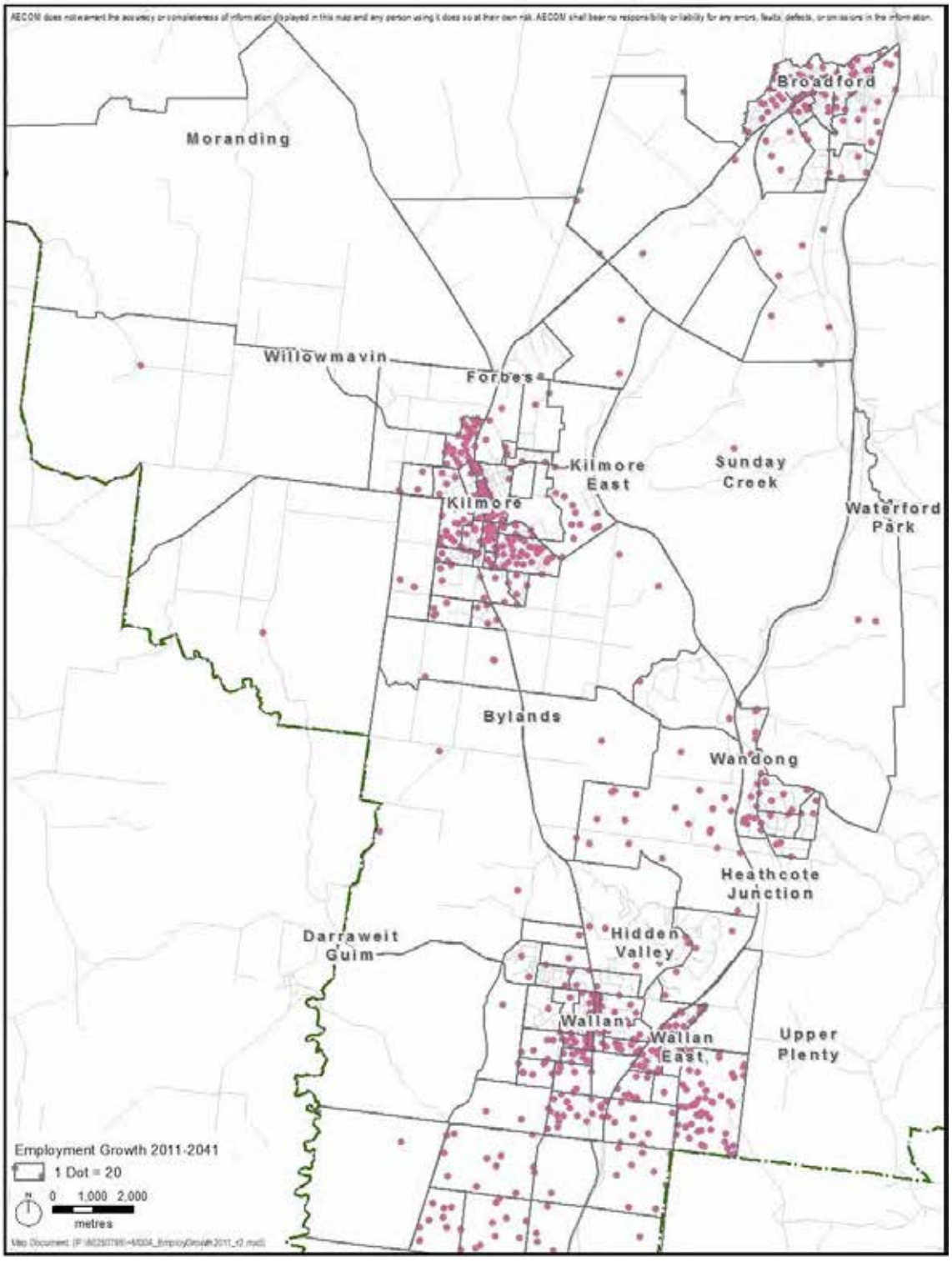


Figure 10: Distribution of educational enrolments in the study area in 2011

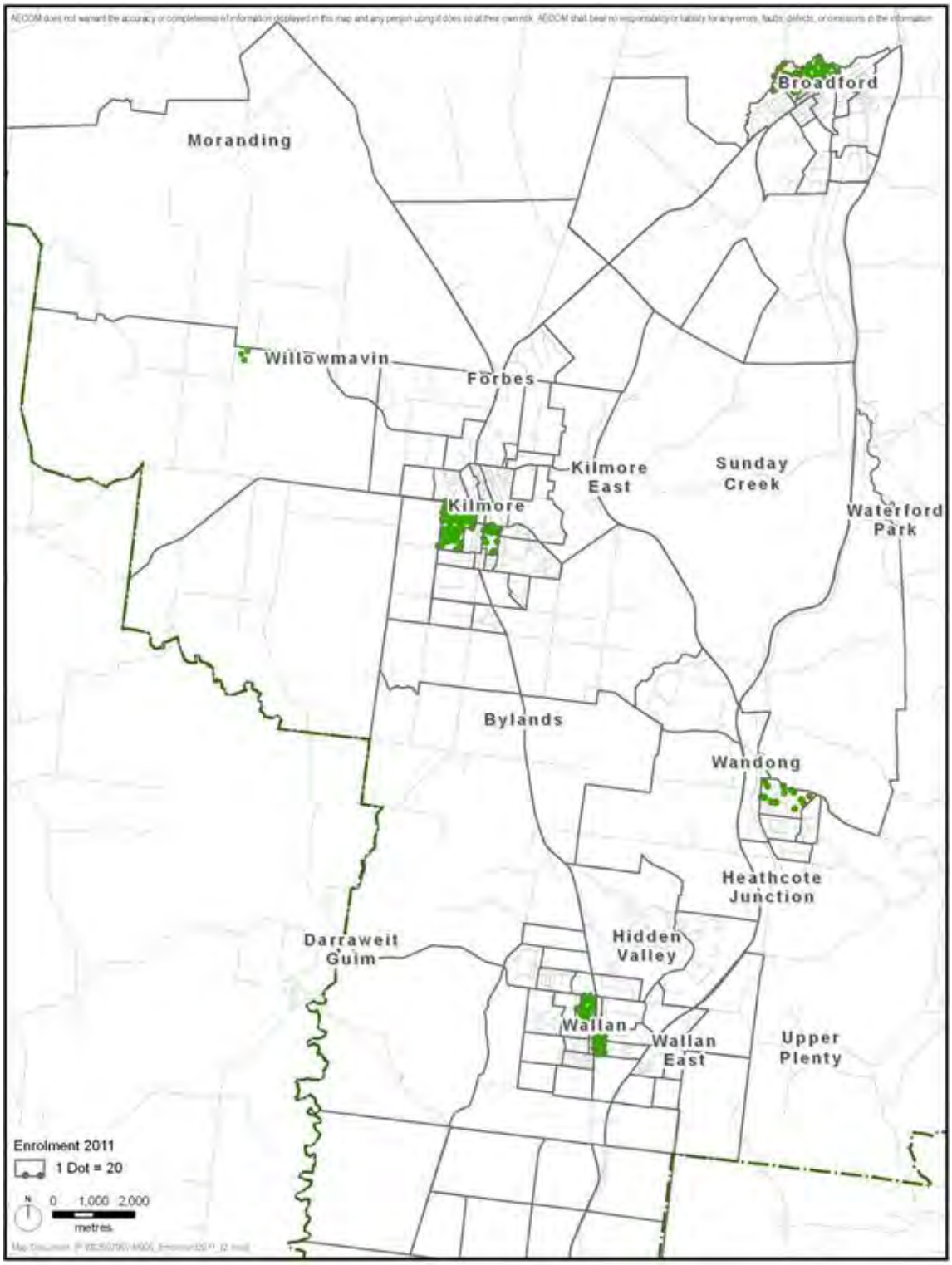
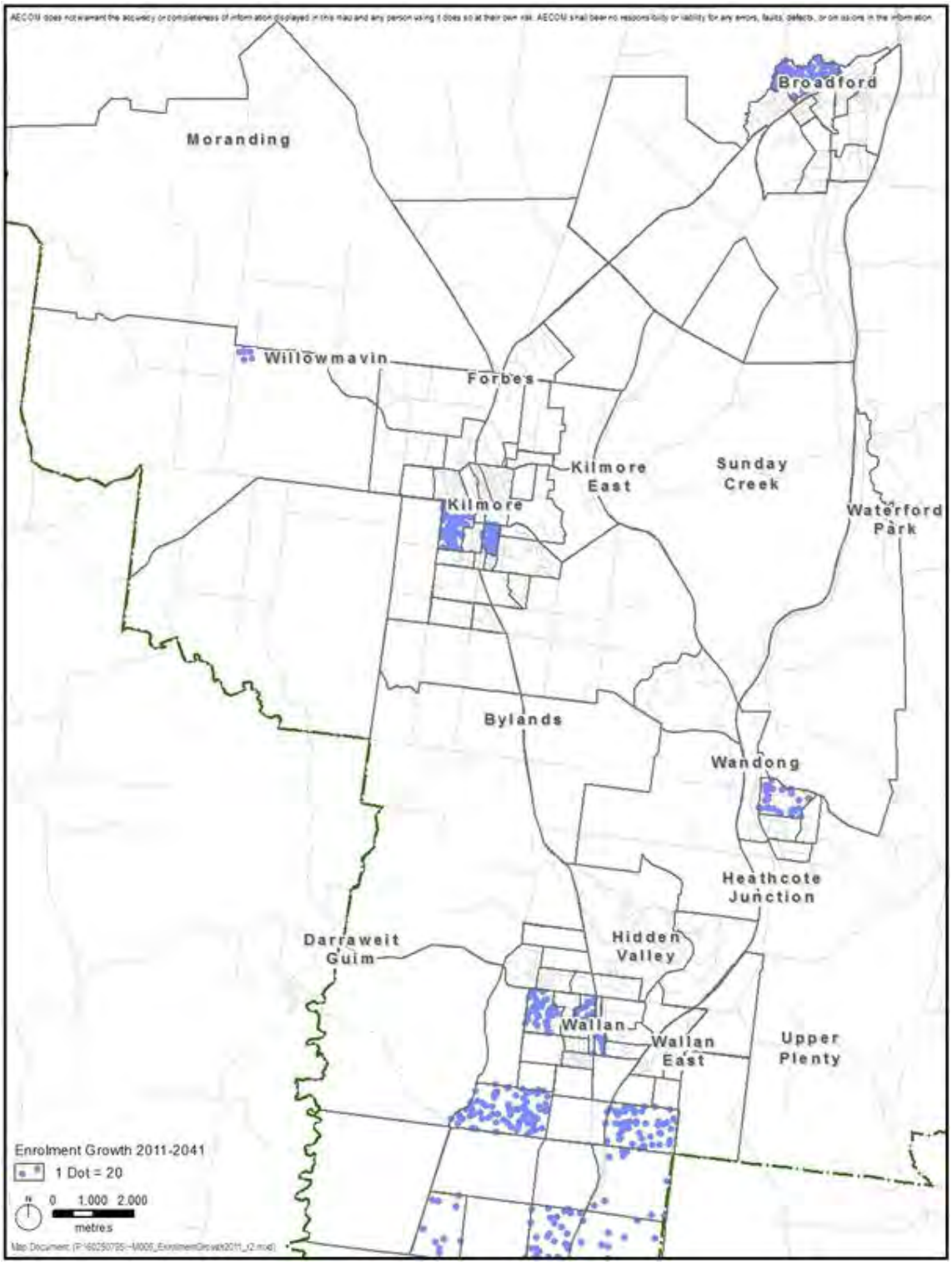


Figure 11: Growth in educational enrolments in the study area between 2011 and 2041



5.0 2011 Base Year Model Development

The development of the 2011 base year model involved the following steps:

- Trip generation
- Trip distribution
- Trip assignment
- Model convergence
- Model validation.

Further detail on the process that was undertaken to develop the 2011 base year model is provided in a separate AECOM report titled *Model Calibration & Validation Report* (Revision D), dated September 2012.

5.1 Trip generation

Two trip purposes were adopted for the trip generation component of the model, Home Based (HB) trips and Non Home Based (NHB) trips, since their trip rates and distributions are different. The HB trips were further segmented into:

- Home Based Work (HBW)
- Home Based Education (HBE)
- Home Based Shop and Other (HBSO).

For trip productions, the independent variables for HBW, HBE and HBSO are resident workers, resident school age children, and population respectively. For trip attractions, the independent variables for HBW, HBE and HBSO are jobs, school enrolments, and jobs and population respectively.

Trip generation rates were adopted from the 2007 study which were derived from three studies: the Bendigo 2020 Transportation Study (BTS) (BTS Steering Committee, 1993), Ballarat Strategic Transport Model (BSTM) (VicRoads, 2006) and the 2003/04 South East Queensland Travel Survey (SEQTS) (Queensland Transport, 2006).

For trip productions and trip attractions, the independent variables and associated trip rates for the various Home Based trip purposes are shown in Table 5 below.

Table 5: Vehicle trip production rates by purpose

Trip purpose	Trip Productions		Trip Attractions	
	Variable	Trip rate	Variable	Trip rate
HBW	Resident workers	**1.01**	Total Jobs	**1.06**
HBE	Children 5 to 18	**0.74**	School Enrolments	**0.76**
HBSO	Population	**0.79**	Population Retail & Wholesale Jobs	**0.26** **4.5**
NHB	Population	**0.63**	Population Retail & Wholesale Jobs Other Jobs School Enrolments	**0.16** **1.61** **0.61** **0.29**
Total	***Population***	***2.08***		

Source: 2007 Traffic Modelling for the Northern Highway, Kilmore Bypass Study Area – Model Validation Report

Table 6 below shows the vehicle trip production rates for Victorian regional centres (Bendigo Ballarat, Shepparton, Geelong and Latrobe), and the Melbourne Statistical Division (MSD), derived from the VISTA 07 data.

Table 6: Vehicle trip production rates by purpose derived from VISTA 07

Trip Purpose	Vehicle Trip Production Rate			Independent variable
	Regional Centres	MSD	All	
HBW	**1.07**	0.89	0.91	Resident workers
HBE	**0.65**	0.75	0.73	Children 5 to 17
HBSO	**0.93**	0.75	0.77	Population
NHB	**0.61**	0.47	0.48	Population
Total	***2.13***	***1.77***	***1.81***	***Population***

It can be seen that the daily vehicle trip production rates adopted for the Kilmore-Wallan model (Table 5) are comparable to those for regional centres (Table 6). The vehicle trip production rates for the MSD are generally lower because Melbourne has a greater level of public transport coverage and usage.

Since the vehicle trip production for the Kilmore study was derived from the Bendigo Transportation Study (1996) and SEQTS (2004) is consistent with the later vehicle trip production derived from VISTA 2007, it can reasoned that the trip production rates are consistent over the years.

Since the trip production is consistent over the years, the trip attraction rates should also be the same because they are from the same source. With the design and expansion of any household interview survey being usually based on households (trip productions) rather than employment (trip attractions), the trip production rates were deemed to be more reliable than the trip attraction rates, and the general modelling practice is to factor the trip attractions to the trip productions. Consequently if there is any variation in the trip attraction rates, it would not change the travel demand and significantly alter travel patterns in the study area. A comparison of the person trip attraction rates against those from the Victorian Integrated Transport Model (VITM) showed that they were in the same order of magnitude. Therefore, the above vehicle trip attraction rates have been adopted for this study.

The trip attractions of HB trip purposes were thus factored to the trip productions during the modelling process.

For NHB trips, both the trip productions and trip attractions were generated from employment or other attractions, thus the NHB trip productions were then set the same as NHB trip attractions at the zonal level. However, since the NHB attraction rates were more likely to be underestimated, the total NHB trips for the study area was controlled by the product of the study area population and the NHB production rate (Table 5).

The study area also contains a number of 'special generators' that cannot be explained satisfactorily by the independent variables. The special generators include four railway stations, which attract light vehicle trips.

Table 7 (on the following page) shows the estimated number of daily trip attractions for each of the five railway stations within the study area. The vehicle trip attractions to these railway stations were estimated by using the observed number of vehicles parked at the stations. It is observed that there would be some passengers dropped off by car (kiss and ride), therefore the vehicles attracted to the station would be more than the number of vehicles parked. However, there is no available data to derive a ratio between total arrived cars and total parked cars, which would vary according to the level of car ownership and parking availability for the area, and is expected to range from 1.1 to 1.5. Given there is ample parking capacity at these stations and a high level of car ownership for the regional area, a ratio of 1.2 was assumed to apply to the parked vehicles to provide an estimate of attractions to stations. The trip attractions to the four railway stations were then added to the HB trip attractions of the corresponding zones.

Table 7: Estimated trip attractions for railway stations

Railway station	Road	Zone	Total parked vehicles	Estimated two way trip attractions
Kilmore East	O'Gradys Road	22	129	155
Wandong	Rail Street	24	30	36
Heathcote	Rail Street	25	16	19
Wallan	Station Street	45	217	260
Broadford	High Street	93	50	60

The proportion of trip productions and attractions at an external cordon point was estimated by observing the directional traffic split for all light vehicles at the cordon during the AM period (i.e. between 6am and 10am), with the trip productions estimated by multiplying the proportion of traffic entering the study area by the remainder of two-way traffic counts, minus the through traffic.

Trip productions and attractions for each internal and external zone in the study area are provided in Appendix C.

5.2 Trip distribution

Trip distribution was carried out separately for light vehicles and heavy vehicles and is summarised in the following sub-sections.

5.2.1 Light vehicles

The trip distribution model for each purpose, Home Based (HB) and Non-Home Based (NHB), was based on the Gravity Model in which the number of trips (Tij) between zones i and j is proportional to the total trip productions at i (Pi) , attractions at j (Aj), and a cost deterrence function between i and j (f(Cij)). The model is expressed as follows:

$$Tij = k. Pi .Aj . f(Cij)$$

A Gamma deterrence function was used in the form of:

$$f(Cij) = Cij\ \alpha . \exp(\beta Cij)$$

Generally, the average trip length and duration for the HB trips are 10.8 km and 9.1 minutes respectively, which is similar to 11.1 km and 9.5 minutes from the 2007 study. For NHB trips, the average trip length and duration are 5.4 km and 5.5 minutes respectively, which is also similar to 4.7 km and 5 minutes from the 2007 study.

The production-attraction matrices from the trip distribution were transposed to represent the reverse pattern, attraction to production. The production to attraction and its transposed matrices were then averaged to derive the 24 hour O-D light vehicle internal matrix.

The external-external trips (through traffic) were determined from an origin destination survey for the Kilmore, Wallan and Wandong areas. The 2011 origin destination survey was carried out at eight external stations and five internal stations. The purpose of the internal stations was to provide a check of the routes taken by vehicles to and from external stations. They were not used for deriving external-external trips.

The 9x9 matrix (8 external and 1 internal) was expanded to a 15x15 (14 external and 1 internal) matrix. This initial matrix was then grown and balanced to the 24 hour directional counts by using the Cube Voyager Fratar method.

5.2.2 Heavy vehicles

The development of the heavy vehicle matrix was carried out in a similar way to the light vehicle matrix, with heavy vehicles defined as a two-axle truck or bus and above.

The external-external trips were derived from the origin destination survey and expanded to a 14x14 matrix using traffic count data. The external-internal trips were estimated by distributing the trips by internal zone attractions.

The internal-external trips were distributed based on internal zone productions. In addition, there are approximately 110 internal two-way heavy vehicle trips per day between Kilmore and Wallan, and 50 between Kilmore and Wandong estimated from the previous origin destination survey and traffic counts, which were distributed by using the light vehicle traffic pattern.

A special generator was created using zone 107 to represent 192 daily heavy vehicles generated by the Hanson and Galli quarry (based on an interview of the Quarry Manager on 31 May 2012). The distribution of this special generator to and from the external cordon was also estimated using the light vehicle traffic pattern. The other internal heavy vehicle trips were considered to be negligible and therefore not included in the modelling process.

5.3 Trip assignment

The light and heavy vehicle origin destination matrices were assigned to the base network using a multi-class equilibrium trip assignment with capacity restraint to estimate the link flows as well as travel time through the network.

A volume-delay function was used by the model to calculate travel times on links with respect to traffic volumes within an assignment. The Akcelik volume-delay functions used by the Victorian Integrated Transport Model (VITM) and Shepparton model were adopted. The original form of the equation is:

$$t = t_0 + 0.25T\left((x-1) + \sqrt{(x-1)^2 + \left(8\frac{J_A}{QT}\right)x}\right)$$

Where:

t = average travel time per unit distance (hrs/km)

t_0 = free flow travel time per unit distance (kph)

T = the flow period (hours)

x = the degree of saturation (vol/cap)

Q = capacity (veh/hr)

J_A = the delay parameter

The assignment was carried out using generalised cost with the value of time (VOT) and vehicle operating cost (VOC) for cars based on the Victorian Integrated Transport Model (VITM) and Shepparton Model for 2011. The assignment for trucks (heavy or commercial vehicles) was based on time only as it is observed that truck drivers are usually concerned with minimising travel time in selecting their route as the cost of travel would usually be paid by the employer. The minimising travel time behaviour of trucks is also evident through the toll rates set for trucks which are usually two or three times those for cars since truck drivers (or their company) would be willing to pay for tolls to save their travel time.

Table 8: VOT and VOC for light and heavy vehicles

Vehicle type	VOT (cents/min)	VOC (cents/km)
Light vehicles (car)	30.16	14.4
Heavy vehicles	63.76	N/A

The convergence “stopping” criteria in the assignment process was based on the standard Voyager procedure with the relative gap set at 0.005, which resulted in convergence after 8 iterations. However, to ensure the model outputs were suitable for economic assessment purposes, the assignment process was forced to run through 50 iterations.

5.4 Model convergence

The full model was set through a feedback loop with the generalised cost derived from the assignment stage fed back to the trip distribution stage in the next iteration. The model was run through several iterations to achieve convergence.

In order to determine if the model run has converged, a percentage change of the average generalised cost, which is equal to the total generalised cost divided by number of trips, between successive iterations is calculated, and if it is less than 0.5% the model is set to be converged.

For the 2011 base model, the full model converged after 2 iterations. However, the full model was set to run for 4 iterations for the base and future years to ensure that the results are all consistent and comparable.

5.5 Model validation

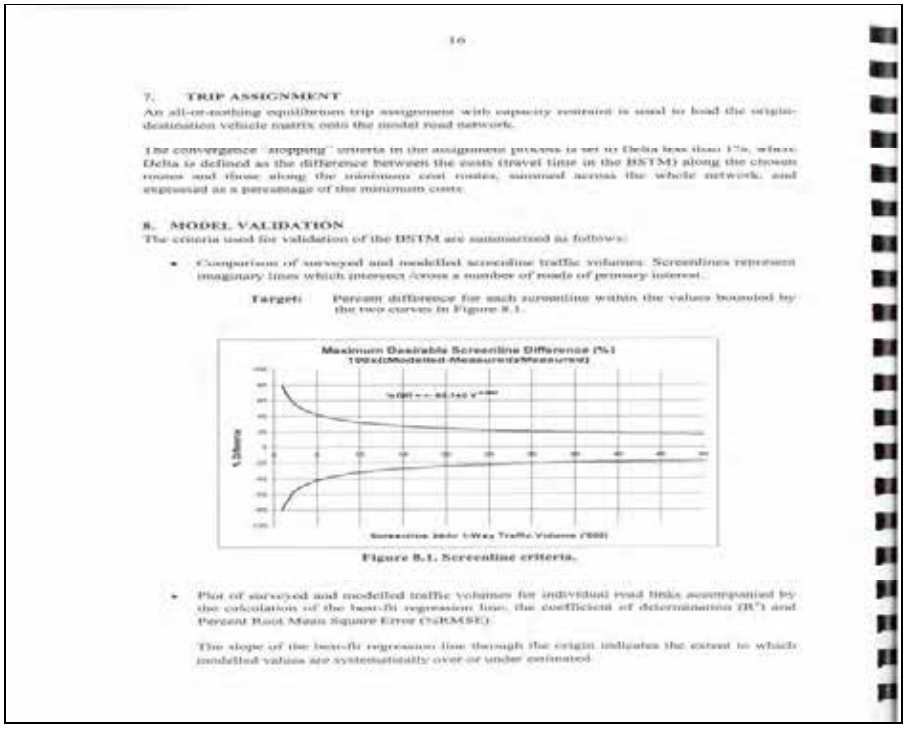
The following sub-sections outline the model validation checks performed to ensure the model was accurately representing 2011 traffic volumes to an acceptable level. The checks included a comparison of:

- Surveyed and modelled screenline traffic volumes
- Surveyed and modelled traffic volumes for individual road links
- Surveyed and modelled traffic volumes on key roads
- Travel time along the Northern Highway.

5.5.1 Comparison of surveyed and modelled screenline traffic volumes

The percentage difference between the surveyed and modelled screenline traffic volumes needs to be within the values bounded by the two curves shown in Figure 12 below.

Figure 12: Screenline criteria



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7. TRIP ASSIGNMENT

An all-or-nothing equilibrium trip assignment with capacity restraint is used to load the origin-destination vehicle matrix onto the model road network.

The convergence "stopping" criteria in the assignment process is set to Delta less than 1%, where Delta is defined as the difference between the costs (travel time in the BSTM) along the chosen routes and those along the minimum cost routes, summed across the whole network, and expressed as a percentage of the minimum costs.

8. MODEL VALIDATION

The criteria used for validation of the BSTM are summarised as follows:

- Comparison of surveyed and modelled screenline traffic volumes. Screenlines represent imaginary lines which intersect /cross a number of roads of primary interest.

  Target: Percent difference for each screenline within the values bounded by the two curves in Figure 8.1.

Figure 8.1. Screenline criteria.

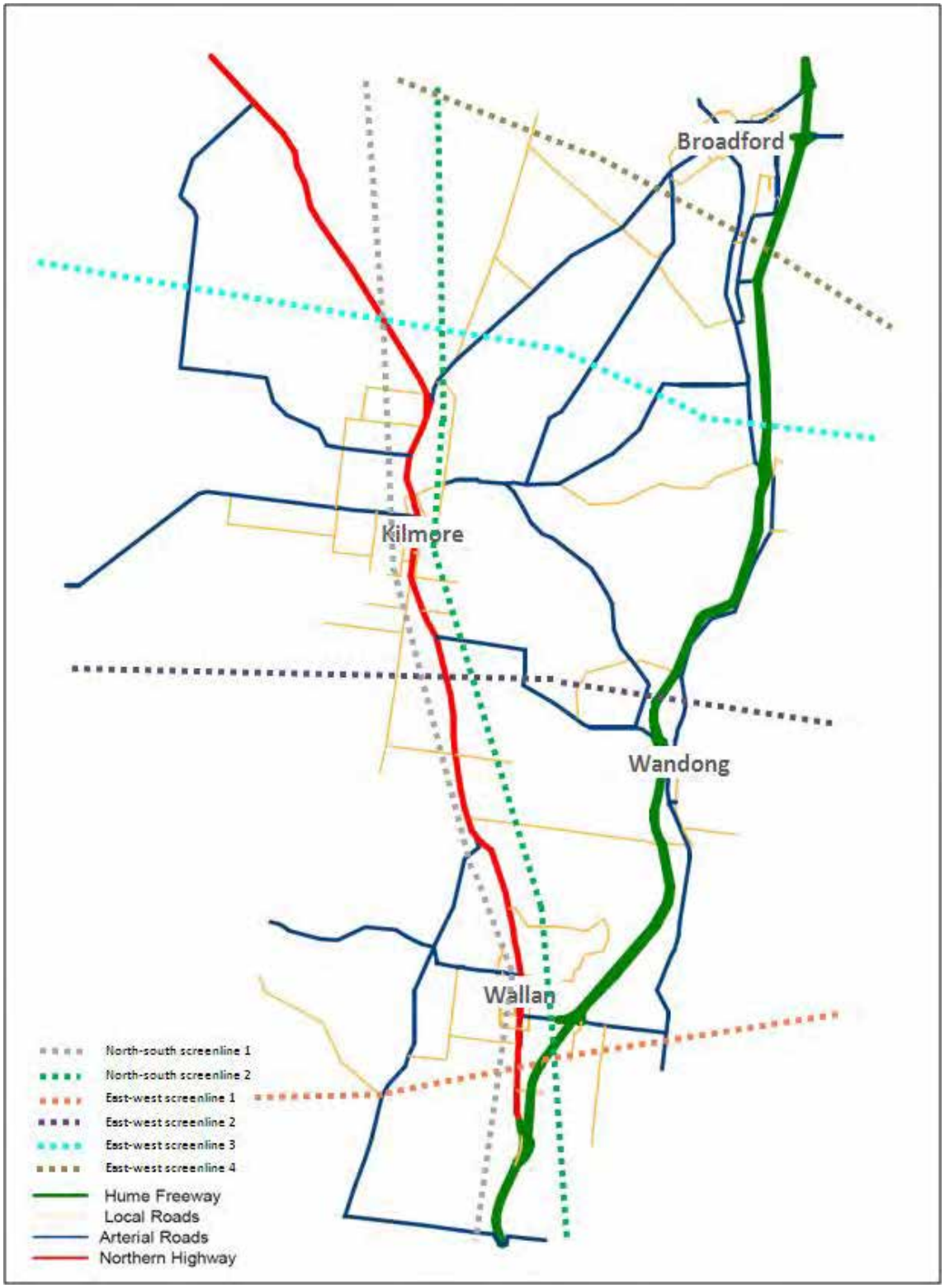
- Plot of surveyed and modelled traffic volumes for individual road links accompanied by the calculation of the best-fit regression line, the coefficient of determination (R^2) and Percent Root Mean Square Error (%RMSE).

  The slope of the best-fit regression line through the origin indicates the extent to which modelled values are systematically over or under estimated.

Source: Transport Modelling Guidelines, Volume 2: Strategic Modelling, VicRoads, Dec 2011

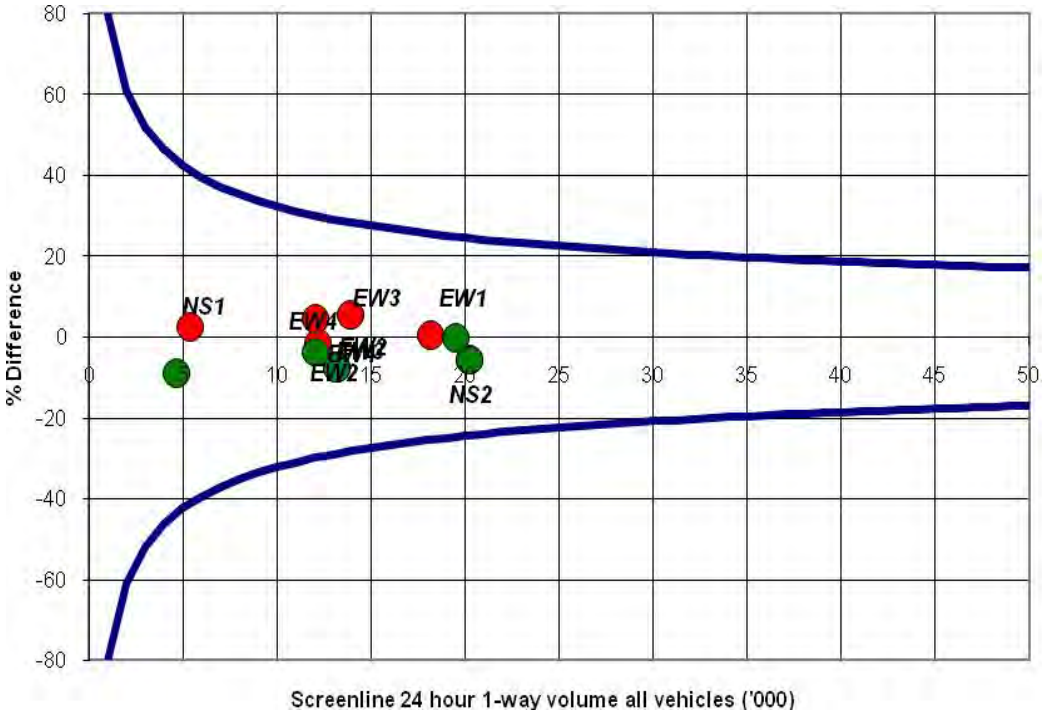
Screenlines represent imaginary lines which cross a number of roads in a traffic corridor. Two north-south screenlines and four east-west screenlines were adopted for this study, as shown in Figure 13 below.

Figure 13: Screenline locations



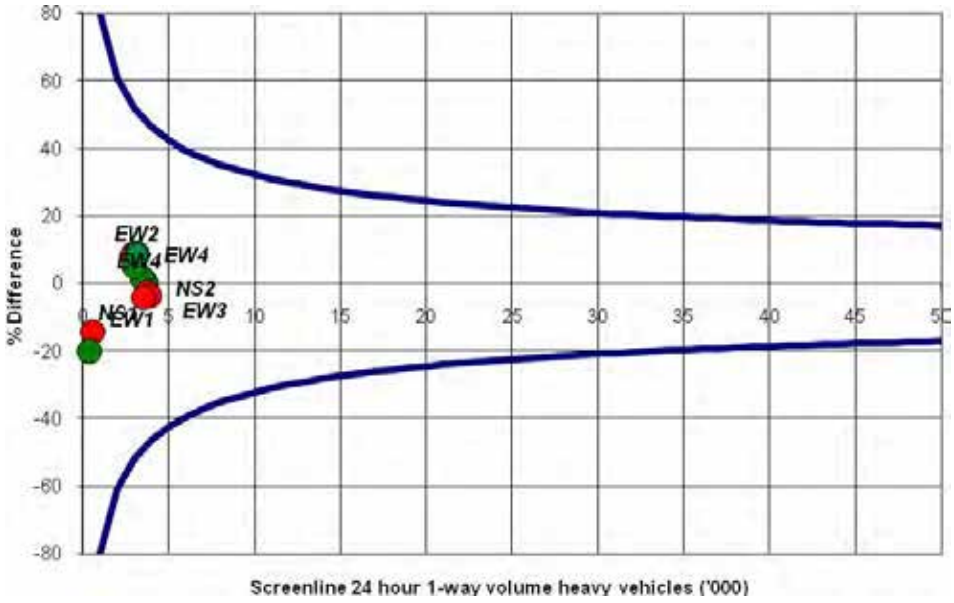
The level of agreement between the surveyed and modelled screenline traffic volumes is shown in Figure 14 below, each of which satisfies the VicRoads criterion (see Figure 12).

Figure 14: Comparison of surveyed and modelled screenline traffic volumes (all vehicles)



An assessment of the difference between surveyed and modelled screenline traffic volumes for heavy vehicles only was also undertaken. The results are presented in Figure 15, each of which satisfies the VicRoads criterion.

Figure 15: Comparison of surveyed and modelled screenline traffic volumes (heavy vehicles only)



5.5.2 Comparison of surveyed and modelled volumes for individual road links

A scatter plot of the measured and modelled traffic volumes for individual road links need to have a line of best fit with a slope of between 0.9 and 1.1. Furthermore, the statistical correlation between the measured and modelled traffic volumes (R^2) should be greater than or equal to 0.90. Finally, the percentage difference between the measured and modelled traffic volumes (%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;
Σ = summation of count / modelled link pair 1 to N;
M = modelled 24 hour 1-way link volume; and
C = average weekday traffic counts (24 hour 1-way).

Figure 16 below shows a scatter plot of the measured and modelled traffic volumes for individual road links, where survey data was available. The slope of the line of best fit is 1.00 (which is between 0.9 and 1.1) and the correlation (R^2) is 0.99 (which is greater than 0.90), which therefore satisfies the criteria.

Figure 16: Scatter plot of surveyed and modelled 24-hour traffic volumes (all vehicles)

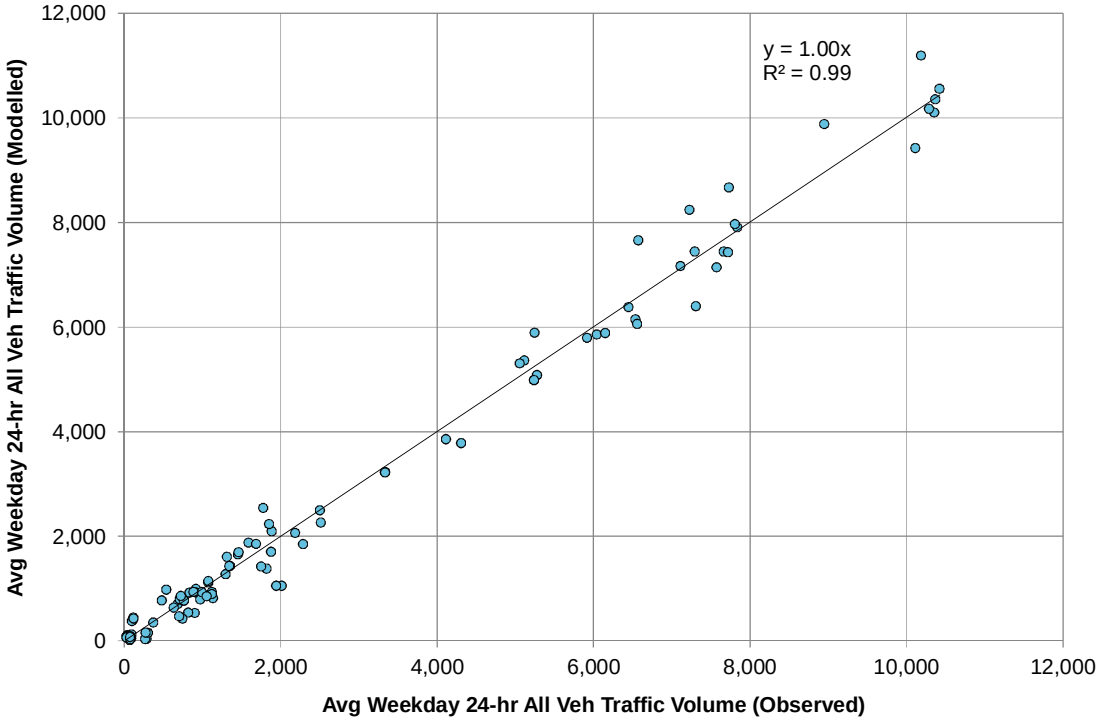


Table 9 shows that the overall %RMSE for all traffic volumes where survey data was available is 12.8 percent, which therefore satisfies the criteria. This is based upon 2011 traffic count data provided by VicRoads as well as other traffic count data provided by Mitchell Shire Council.

Table 9: Results of the %RMSE for survey locations (all vehicles)

24-hr 1-way all vehicle traffic volume	Number of sites	Sum of observed volumes	Sum of (modelled - observed volumes)^2	%RMSE
<500	32	3,160	631,606	144.5%
500-1,000	17	13,463	642,665	25.3%
1,000-2,000	21	30,959	2,440,140	23.7%
2,000-5,000	9	26,583	1,549,445	14.9%
>5,000	31	226,600	8,022,726	7.1%
Total	**110**	**300,765**	**13,286,582**	**12.8%**

A comparison of surveyed and modelled traffic volumes for individual road links was also undertaken separately for heavy vehicles. Figure 17 below shows a scatter plot of the measured and modelled heavy vehicle traffic volumes for individual road links, where survey data was available. The slope of the line of best fit is 1.02 (which is between 0.9 and 1.1) and the correlation (R^2) is 0.98 (which is greater than 0.90), which therefore satisfies the criteria.

Figure 17: Scatter plot of surveyed and modelled 24-hour traffic volumes (heavy vehicles only)

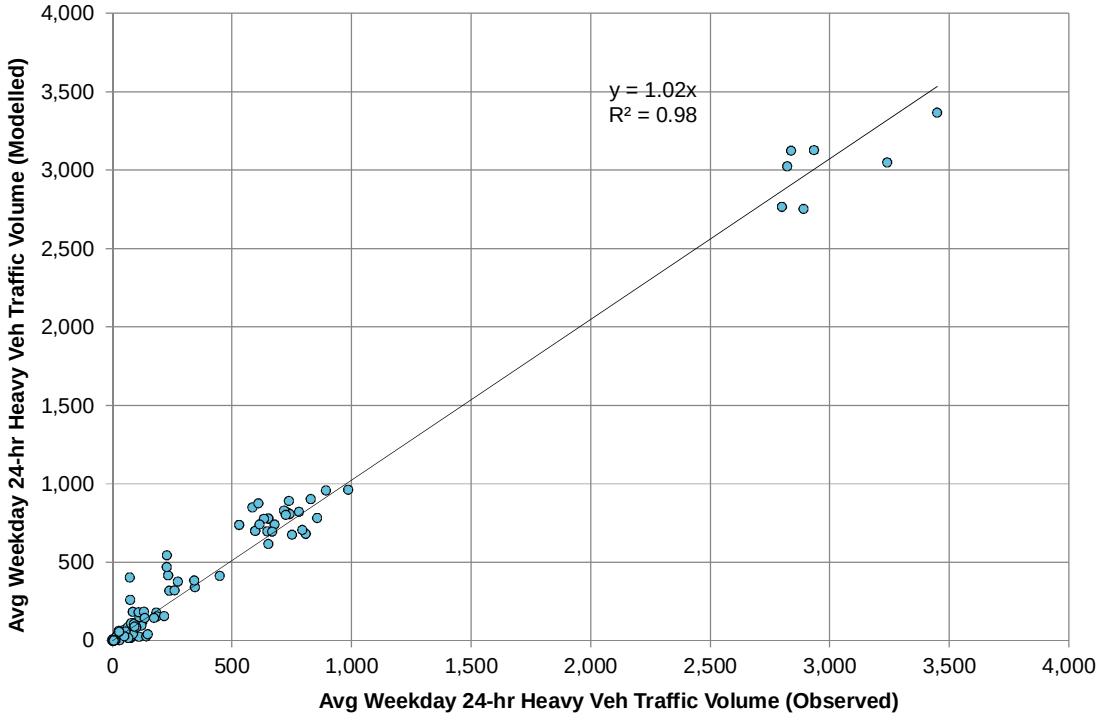


Table 10 below shows that the overall %RMSE for all heavy vehicle traffic volumes where survey data was available is 23.6 percent, which therefore satisfies the criteria.

Table 10: Results of the %RMSE for survey locations (heavy vehicles only)

24-hr 1-way heavy vehicle traffic volume	Number of sites	Sum of observed volumes	Sum of (modelled - observed volumes)^2	%RMSE
<500	77	6,664	437,936	87.7%
500-1,000	26	18,471	381,805	17.4%
>1,000	7	20,973	223,730	6.4%
Total	**110**	**46,108**	**1,043,471**	**23.3%**

5.5.3 Comparison of surveyed and modelled traffic volumes for key roads

Since the Northern Highway is the key road going through the study area and proposed to be bypassed, it is important for the model to represent the traffic volumes reasonably well for various sections of this route. Table 11 below shows the difference between surveyed and modelled traffic volumes for the Northern Highway.

Table 11: Comparison of surveyed and modelled traffic volumes along Northern Highway (all vehicles)

All Vehicles Between	Direction	24-hour traffic volume	
		Surveyed	Modelled
South of Broadford - Kilmore Road and School House Lane	Northbound	1,884	2,098
South of Broadford - Kilmore Road and School House Lane	Southbound	1,728	1,938
Foote Street and Bourke Street	Northbound	7,307	6,399
Foote Street and Bourke Street	Southbound	6,446	6,381
Rutledge and Piper Street	Northbound	6,149	5,886
Rutledge and Piper Street	Southbound	5,244	5,893
Union Lane and Arkells Road	Northbound	5,276	5,084
Union Lane and Arkells Road	Southbound	5,239	4,986
William Street and Hidden Valley Boulevard	Northbound	5,113	5,363
William Street and Hidden Valley Boulevard	Southbound	5,056	5,308
Watson Street and Queen Street	Northbound	7,226	8,245
Watson Street and Queen Street	Southbound	7,728	8,671
Macsfield Lane and Taylors Lane	Northbound	7,838	7,909
Macsfield Lane and Taylors Lane	Southbound	7,806	7,968
Average		**5,717**	**5,866**
Average absolute difference		**389**	
Average absolute % difference		**7.23%**	

The surveyed traffic volumes on the Northern Highway between Foote Street and Bourke Street are higher than the modelled traffic volumes. This is due to circulation of traffic within the Kilmore shopping area which cannot be represented in the strategic modelling process. It is recognised that circulation of traffic in busy shopping and retail precincts can add in the order of 20-25 percent to modelled traffic volumes. Overall, the modelled results for the Northern Highway are generally in good agreement with the surveyed volumes.

The results for heavy vehicles only are presented in Table 12 (on the following page). Again, the modelled results are generally in good agreement with the surveyed volumes.

Table 12: Comparison of surveyed and modelled traffic volumes along Northern Highway (heavy vehicles only)

Heavy Vehicles Between	Direction	24-hour traffic volume	
		Surveyed	Modelled
South of Broadford - Kilmore Road and School House Lane	Northbound	345	341
South of Broadford - Kilmore Road and School House Lane	Southbound	343	362
Foote Street and Bourke Street	Northbound	809	682
Foote Street and Bourke Street	Southbound	794	705
Rutledge and Piper Street	Northbound	751	675
Rutledge and Piper Street	Southbound	668	696
Union Lane and Arkells Road	Northbound	652	779
Union Lane and Arkells Road	Southbound	598	700
William Street and Hidden Valley Boulevard	Northbound	634	777
William Street and Hidden Valley Boulevard	Southbound	615	741
Watson Street and Queen Street	Northbound	893	957
Watson Street and Queen Street	Southbound	986	963
Macsfield Lane and Taylors Lane	Northbound	730	818
Macsfield Lane and Taylors Lane	Southbound	741	807
Average		**683**	**715**
Average absolute difference		**77**	
Average absolute % difference		**11.29%**	

Another key road passing through the study area is the Hume Freeway. Table 13 below compares the surveyed and modelled traffic volumes for this route, where traffic count data was available. Again, the modelled results are generally in good agreement with the surveyed volumes.

Table 13: Comparison of surveyed and modelled traffic volumes along Hume Freeway (all vehicles)

All Vehicles Between	Direction	24-hour traffic volume	
		Surveyed	Modelled
Northern Highway and Wallan East Interchange	Northbound	10,369	10,357
Northern Highway and Wallan East Interchange	Southbound	10,355	10,104
Wandong Interchange and Broadford - Wandong Road	Northbound	10,423	10,557
Wandong Interchange and Broadford - Wandong Road	Southbound	10,288	10,174
North of Broad-Kilmore Road Interchange	Northbound	10,185	11,193
North of Broad-Kilmore Road Interchange	Southbound	10,332	11,030
South of Strath Creek Road Interchange	Northbound	8,949	9,883
South of Strath Creek Road Interchange	Southbound	10,112	9,424
Average		**10,127**	**10,340**
Average absolute difference		**480**	
Average absolute % difference		**4.85%**	

The results for heavy vehicles only are presented in Table 14 below. Again, the modelled results are generally in good agreement with the surveyed volumes.

Table 14: Comparison of surveyed and modelled traffic volumes along Hume Freeway (heavy vehicles only)

Heavy Vehicles Between	Direction	24-hour traffic volume	
		Surveyed	Modelled
Northern Highway and Wallan East Interchange	Northbound	2,800	2,765
Northern Highway and Wallan East Interchange	Southbound	2,890	2,752
Wandong Interchange and Broadford - Wandong Road	Northbound	2,838	3,123
Wandong Interchange and Broadford - Wandong Road	Southbound	2,934	3,127
North of Broad-Kilmore Road Interchange	Northbound	3,449	3,366
North of Broad-Kilmore Road Interchange	Southbound	3,459	3,388
South of Strath Creek Road Interchange	Northbound	3,240	3,048
South of Strath Creek Road Interchange	Southbound	2,822	3,025
Average		**3,054**	**3,074**
Average absolute difference		**150**	
Average absolute % difference		**5.03%**	

Table 15 below compares the surveyed and modelled traffic volumes for other key roads where traffic count data was available. Again, the modelled results are generally in good agreement with the surveyed volumes.

Table 15: Comparison of surveyed and modelled traffic volumes along other key roads (all vehicles)

All Vehicles Between	Direction	24-hour traffic volume	
		Surveyed	Modelled
Broadford - Kilmore Rd (Between Northern Highway and Three chain Rd	Northbound	2,513	2,261
Broadford - Kilmore Rd (Between Northern Highway and Three chain Rd	Southbound	2,500	2,496
Broadford - Kilmore Road (South of Dry Creek Road)	Eastbound	2,285	1,851
Broadford - Kilmore Road (South of Dry Creek Road)	Westbound	2,184	2,065
Epping - Kilmore Road (Between Quinns Road and Bakers Road)	Eastbound	906	932
Epping - Kilmore Road (Between Quinns Road and Bakers Road)	Westbound	989	934
Epping - Kilmore Road (Between Wallan and Beveridge Road)	Northbound	1,305	1,341
Epping - Kilmore Road (Between Wallan and Beveridge Road)	Southbound	1,296	1,273
Wallan - Whittlesea Road (Between Hume Freeway and McCarthy Court)	Eastbound	3,335	3,227
Wallan - Whittlesea Road (Between Hume Freeway and McCarthy Court)	Westbound	3,333	3,222
Wallan - Whittlesea Rd (Between Epping Kilmore Road and Clarke Rd)	Eastbound	1,352	1,434
Wallan - Whittlesea Rd (Between Epping Kilmore Road and Clarke Rd)	Westbound	1,527	1,445
Kilmore - Lancefield Road (Between Kings Lane and High Park Road)	Eastbound	1,354	1,475
Kilmore - Lancefield Road (Between Kings Lane and High Park Road)	Westbound	1,341	1,429
Kilmore - Epping Rd (Between Caladenia Ct and Wandong Broadford Rd)	Northbound	1,456	1,616
Kilmore - Epping Rd (Between Caladenia Ct and Wandong Broadford Rd)	Southbound	1,546	1,429
Strath Creek Road - East of Hume Freeway	Eastbound	632	637
Strath Creek Road - East of Hume Freeway	Westbound	613	608
Strath Creek Road - West of Hume Freeway	Eastbound	1,120	897
Strath Creek Road - West of Hume Freeway	Westbound	1,054	854
Kilmore East Road (Between O'Gradys Road and Nothern Highway)	Eastbound	1,119	936
Kilmore East Road (Between O'Gradys Road and Nothern Highway)	Westbound	1,134	817
O'Gradys Road (Between Bakers Road and Epping-Kilmore Road)	Northbound	900	533
O'Gradys Road (Between Bakers Road and Epping-Kilmore Road)	Southbound	817	541
Broadford - Sugarloaf Creek Road (South of Dry Creek)	Northbound	370	352
Broadford - Sugarloaf Creek Road (South of Dry Creek)	Southbound	378	400
Average		**1,437**	**1,346**
Average absolute difference		**132**	
Average absolute % difference		**10.37%**	

The results for heavy vehicles only are presented in Table 16 (on the following page). Again, the modelled results are generally in good agreement with the surveyed volumes.

Table 16: Comparison of surveyed and modelled traffic volumes along other key roads (heavy vehicles only)

Heavy Vehicles Between	Direction	24-hour traffic volume	
		Surveyed	Modelled
Broadford - Kilmore Rd (Between Northern Highway and Three chain Rd	Northbound	238	318
Broadford - Kilmore Rd (Between Northern Highway and Three chain Rd	Southbound	233	417
Broadford - Kilmore Road (South of Dry Creek Road)	Eastbound	260	320
Broadford - Kilmore Road (South of Dry Creek Road)	Westbound	274	377
Epping - Kilmore Road (Between Quinns Road and Bakers Road)	Eastbound	61	58
Epping - Kilmore Road (Between Quinns Road and Bakers Road)	Westbound	55	53
Epping - Kilmore Road (Between Wallan and Beveridge Road)	Northbound	131	135
Epping - Kilmore Road (Between Wallan and Beveridge Road)	Southbound	126	122
Wallan - Whittlesea Road (Between Hume Freeway and McCarthy Court)	Eastbound	449	413
Wallan - Whittlesea Road (Between Hume Freeway and McCarthy Court)	Westbound	342	384
Wallan - Whittlesea Road (Between Epping Kilmore Road and Clarke Rd)	Eastbound	183	179
Wallan - Whittlesea Road (Between Epping Kilmore Road and Clarke Rd)	Westbound	104	106
Kilmore - Lancefield Road (Between Kings Lane and High Park Road)	Eastbound	176	156
Kilmore - Lancefield Road (Between Kings Lane and High Park Road)	Westbound	186	154
Kilmore - Epping Rd (Between Caladenia Ct and Wandong Broadford Rd)	Northbound	129	168
Kilmore - Epping Rd (Between Caladenia Ct and Wandong Broadford Rd)	Southbound	124	77
Strath Creek Road - East of Hume Freeway	Eastbound	92	90
Strath Creek Road - East of Hume Freeway	Westbound	79	80
Strath Creek Road - West of Hume Freeway	Eastbound	132	185
Strath Creek Road - West of Hume Freeway	Westbound	135	145
Kilmore East Road (Between O'Gradys Road and Nothern Highway)	Eastbound	76	18
Kilmore East Road (Between O'Gradys Road and Nothern Highway)	Westbound	111	25
O'Gradys Road (Between Bakers Road and Epping-Kilmore Road)	Northbound	70	37
O'Gradys Road (Between Bakers Road and Epping-Kilmore Road)	Southbound	86	43
Broadford - Sugarloaf Creek Road (South of Dry Creek)	Northbound	55	58
Broadford - Sugarloaf Creek Road (South of Dry Creek)	Southbound	58	53
Average		**153**	**160**
Average absolute difference		**37**	
Average absolute % difference		**23.98%**	

5.5.4 Comparison of travel time along Northern Highway

During a site inspection, the travel time was recorded from the southern part of the study area (interchange of the Hume Freeway and Northern Highway) to the northern part of the study area (School House Lane and Northern Highway) on a weekday at approximately 9am. The average measured travel time of 19.5 minutes compared well with the travel time predicted by the model of 20 minutes. It was assumed that the measured travel time is reasonably representative of an average day due to the minimal level of congestion in the area and the presence of only five sets of traffic signals along the route (three in Wallan and two in Kilmore).

5.5.5 Summary of model validation

In summary, the validation criteria and checks detailed in sections 5.5.1 to 5.5.4 have all been satisfied. The model therefore represents base 2011 traffic volumes to an acceptable level. Furthermore, all criteria and checks were satisfied without the use of matrix estimation.

6.0 Forecasts of Future Traffic and Modelling of Bypass Options

This section describes how traffic volumes in the network were forecasted to the years of 2021, 2031 and 2041. It also describes the results from modelling the various bypass options. The following is specifically covered:

- Development of future base networks
- Development of future year trip matrices
- Traffic distribution adjustment in the southern part of the study area
- Impact on heavy vehicle traffic volumes as a result of the relocation of the Fruit and Vegetable Market to Epping and the operation of the intermodal terminal facility in Somerton
- Modelling of five (5) bypass options, in addition to the base case for the years 2021, 2031 and 2041
- Sensitivity testing and related results
- Overall network performance.

6.1 Development of future base networks

The 2011 base year road network was updated to reflect anticipated changes in future years, based on information provided by VicRoads and Mitchell Shire Council. All road network changes in future years were coded into a master network. Links in the master network could then be simply turned on or off depending on the year being modelled.

The changes made to the future year road networks are not necessarily part of any planned or proposed implementation. They were incorporated only for modelling purposes in response to anticipated traffic growth and capacity requirements within the study area.

A list of the anticipated road network changes within the study area is provided in Table 17 below.

Table 17: Anticipated road network changes in the study area

Year	Type	Location
2021	Upgrade	Increase capacity of Northern Hwy from Hidden Valley Blvd to Hume Freeway
2021	New road	New 2 lane collector at 50km/hr north of Darraweit Road and Northern Highway
2021	New road	New 2 lane collector from Dudley Street to Rowes Lane
2021	New road	New Hume Fwy southern ramps at Watson Street interchange
2021	New road	New 2 lane collector between Watson Street and William Street
2021	Upgrade	Increase capacity of Watson Street
2021	New road	New Hadfields Road 2 lane arterial at 80km/hr
2021	New road	New 2 lane collectors south of Watson Street near airfield site
2021	Removal	Remove existing Beveridge Interchange ramps
2021	New road	New John Street and Clarke Street arterial at 60km/hr near Kilmore
2021	New road	New Highgate 2 lane collector in Kilmore
2021	Speed limit	Speed limit at 60km/hr on Kilmore Lancefield Road west of Northern Hwy
2021	New road	Butler Road north-south 2 lane connector at 60km/hr

Year	Type	Location
2021	Speed limit	Northern Hwy speed limit at 80km/hr north of Wandong Road
2021	New road	New 2 lane collector at 60km/hr from Tootle Street to Cemetery Drive
2031	Upgrade	Taylors Lane and Rowes Lane upgrade to a 4 lane divided arterial at 80km/hr
2031	Upgrade	Rowes lane upgraded to 4 lane divided arterial at 80km/hr (E14)
2031	New road	New Hadfields Road 2 lane arterial at 80km/hr between Old Sydney Road and Northern Highway
2031	Upgrade	Upgrade Camerons Lane to a 2 lane arterial at 80km/hr
2031	Speed limit	Northern Hwy speed limit at 80km/hr north of Kilmore between Willowmavin Road and Broadford-Kilmore Road
2031	Speed limit	Northern Hwy speed limit at 50km/hr north of Union Street
2031	Speed limit	Northern Hwy speed limit at 50km/hr between Kilmore-Lancefield Road and Tootle Street
2031	Speed limit	Northern Hwy speed limit at 80km/hr between Hume Fwy and Taylors Lane
2031	New road	New McIvor Road 2 lane collector east of Northern Hwy
2041	Upgrade	Upgrade Darraweit Road to a 4 lane undivided arterial at 60km/hr between Rowes lane and Northern Hwy
2041	Upgrade	Upgrade Rowes Lane to a 4 lane undivided arterial to Taylors Lane
2041	Upgrade	Upgrade Taylors Lane to a 2 lane arterial at 60km/hr
2041	New road	New 2 lane arterials at 60km/hr south of Taylors Lane
2041	Upgrade	Upgrade E14 to a 6 lane divided arterial at 80km/hr
2041	Upgrade	Upgrade Hadfield Road to a 4 lane divided arterial 80km/hr for the whole length
2041	Upgrade	Upgrade Old Sydney Road to a 4 lane dvided arterial at 80km/hr south of Hadfields Road
2041	New road	New Hadfield Road interchange Northern ramps to Hume Fwy
2041	New road	New 2 lane arterials at 60km/hr between Camerons Lane and Hadfield Road
2041	Upgrade	Upgrade Stewart Street south of Hadfield Road to a 4 lane divided arterial at 80km/hr
2041	New road	New 2 lane arterials at 60km/hr south of Hadfields Road
2041	Upgrade	Upgrade Watson Street East of Railway line to a 4 lane divided arterial at 80km/hr
2041	Upgrade	Upgrade Epping Kilmore Road South of Waston Street to a 4 lane divided arterial at 80km/hr
2041	New road	New 4 lane north-south arterial east of Railway line between Watson Street

6.2 Development of future year trip matrices

Using the same method of determining internal-internal trips for 2011, the internal-internal trips for 2021, 2031 and 2041 were determined by applying the trip production and attraction process to the 2021, 2031 and 2041 demographic data and distributing the trip ends using the gravity model.

For internal-external and external-internal trips, the growth in trip productions at external zones was considered to be the same as the employment growth rate for the study area. Similarly, the growth in trip attractions at external zones was considered to be the same as the population growth rate for the study area. This is based on the rationale that employment growth in the study area would attract more trips into the study area, while population growth would increase trips going out of the study area.

Table 18 shows the employment and population growth rates per annum for the study area, which were derived from the demographic data.

Table 18: Population and employment growth rates for the study area

Year	Total population	Total employment (jobs)
2011	23,271	5,409
2021	39,556	9,432
2031	62,006	15,545
2041	80,039	20,606
Growth rate p.a.		
2011-21	5.4%	5.7%
2021-31	4.6%	5.1%
2031-41	2.6%	2.9%

The growth rates in Table 18 were applied to the 2011 internal-external and external-internal trip ends to derive these for 2021, 2031 and 2041 for all external zones except:

- Northern Highway north (zone 122)
- Three Chain Road (zone 123)
- Spur Road (zone 127)
- Clonbinane Road (zone 128).

The internal-external traffic growth rates for zones 122, 123, 127 and 128 were based on the historical traffic growth at these locations which experienced much slower rates when compared to the rest of the external zones.

The external-external or through trips for 2021, 2031 and 2041 were determined by using historical traffic growth rates at external zones.

Table 19 (on the following page) shows the historical traffic counts and growth rates for light and heavy vehicles for the Northern Highway south of Pyalong between 1997 and 2011, where data was available. It is shown that the traffic growth rate is less than 1% for both light and heavy vehicles.

Table 19: Traffic growth rates p.a. for Northern Highway south of Pyalong

Year	All Vehicles	Light Vehicles	Heavy Vehicles
1997	3,418	2,722	696
1998	3,392	2,678	714
1999	3,469	2,740	729
2000	3,416	2,708	708
2001	3,369	2,673	696
2002	3,345	2,661	684
2003	3,290	2,642	648
2004	3,334	2,651	683
2005	3,356	2,693	663
2006	3,432	2,728	704
2011	3,612	2,924	688
Growth rate p.a. (between 1997 & 2011)	**0.4%**	**0.5%**	**-0.1%**

Table 20 shows the historical traffic counts and growth rates for the Hume Freeway south of Broadford with 1.0% growth rate for light vehicles and 3.5% growth rate for heavy vehicles (between 1997 and 2011).

Table 20: Traffic growth rates p.a. for Hume Freeway south of Broadford

Year	All Vehicles	Light Vehicles	Heavy Vehicles
1997	15,064	11,335	3,729
1998	15,142	11,341	3,801
1999	15,838	11,835	4,003
2000	15,856	11,847	4,009
2001	16,053	11,969	4,084
2002	16,838	12,559	4,279
2003	17,231	12,915	4,316
2004	17,485	12,952	4,533
2005	17,574	13,017	4,557
2006	17,816	13,068	4,748
2011	19,061	12,999	6,062
Growth rate p.a. (between 1997 & 2011)	**1.7%**	**1.0%**	**3.5%**

Table 21 shows the historical traffic counts and derived growth rates for the Hume Freeway south of Beveridge. The growth rate for light vehicles (4.6%) and heavy vehicles (1.7%) would be driven by growth in population in Kilmore and Wallan.

Table 21: Traffic growth rates p.a. for Hume Freeway south of Beveridge

Year	All Vehicles	Light vehicles	Heavy Vehicles
1998	22,118	16,366	5,752
1999	24,043	19,080	4,963
2000	24,577	19,581	4,996
2001	25,170	20,106	5,064
2002	26,289	20,986	5,303
2003	26,962	21,740	5,222
2004	27,782	22,302	5,480
2005	28,761	23,202	5,559
2006	30,371	24,570	5,801
2011	36,368	29,207	7,161
Growth rate p.a. (between 1998 & 2011)	**3.9%**	**4.6%**	**1.7%**

Table 22 (on the following page) shows other roads in the study area for which historical traffic count data was available. Where the historical data did not contain figures separately for light and heavy vehicles, the growth rates for all vehicles was determined and considered to be the same for both light and heavy vehicles. As can be seen, traffic growth rates are highly variable between different roads.

The historical traffic growth rates show the trend over the past, and the expectation for the future. However, in the long term, traffic would grow in line with population and employment growth (and probably economic growth). Since the growth rate of population for the study area (and the state in general) is about 1-2%, it is expected that traffic growth rates higher than 3% may not be sustainable. The traffic growth rates adopted for the Northern Highway, Hume Freeway and other roads were based on the following principle:

For the traffic growth rates between 2011 and 2021, the following growth rates are adopted:

- 0.5% when the historical growth rate is negative
- 2.5% and 2% maximum growth rate for heavy and light vehicles respectively as a growth rate of more than 3% is most likely due to local developments rather than through traffic
- 1% when there is no historical traffic data.

For traffic growth rates between 2021 and 2041, a maximum traffic growth rate of 1.2% was adopted for both light and heavy vehicles based on the long term population growth which would drive the growth of employment and economic activity.

The final set of adopted traffic growth rates for external-external (through) trips are presented in Table 23.

Table 22: Traffic growth rates p.a. for other roads

Road Name	Between	Year	2-way 24-hour traffic volume			Growth rate p.a.	
			All veh	Light veh	Heavy veh	Light veh	Heavy veh
Wallan-Whittlesea Road	Epping-Kilmore Road and Clarkes Road	1997	2,072	1,964	108	2.0%	7.2%
		2000	1,951				
		2005	2,232	1,947	285		
		2006	2,140	1,982	158		
		2011	2,879	2,592	287		
Broadford-Kilmore Road	Northern Highway and Three Chain Road	1993	2,051	1,823	228	5.2%	4.1%
		2000	3,365				
		2006	4,514	4,033	481		
		2011	5,013	4,542	471		
Kilmore-Lancefield Road	Kings Lane and High Park Road	1999	1,633	1,470	163	3.6%	5.3%
		2000	1,969				
		2006	2,295	2,069	226		
		2011	2,562	2,260	302		
Epping-Kilmore Road	Hume Freeway and O'Gradys Road	2000	2,171			3.8%	3.8%
		2005	2,629	2,363	266		
		2011	3,272	3,037	235		
Old Sydney Road	Between Rowes Lane and Beveridge Darraweit Road	2002	129			-4.3%	-4.3%
		2005	98				
		2010	91				
Beveridge-Darraweit Road	Shire boundary and Old Sydney Road	1993	103			-0.6%	-0.6%
		2005	102				
		2010	93				
Wallan-Darraweit Road	Old Sydney Road and Simon Hill Road	1993 1999 2002 2011	539 755 1,039 1,355			5.3%	5.3%
Three Chain Road	Broadford Kilmore Road and Longs Lane	1996	105			1.7%	1.7%
		2001	114				

Table 23: Adopted traffic growth rates p.a. to 2041 for external-external trips

Zone	Roads	Growth Rate 2011-2021		Growth Rate 2021-2041	
		Light veh	Heavy veh	Light veh	Heavy veh
117	Hume Freeway South	2.0%	2.0%	1.2%	1.2%
118	Old Sydney Road	0.5%	0.5%	0.5%	0.5%
119	Beveridge-Darraweit Road	0.5%	0.5%	0.5%	0.5%
120	Wallan-Darraweit Road	2.0%	2.0%	1.2%	1.2%
121	Kilmore-Lancefield Road	1.5%	2.5%	1.2%	1.2%
122	Northern Highway (North)	0.5%	0.5%	0.5%	0.5%
123	Three Chain Road	1.5%	1.5%	1.2%	1.2%
124	Sugar Loaf Creek Road	1.0%	1.0%	1.0%	1.0%
125	Hume Freeway North Broadford	1.0%	2.0%	1.0%	1.2%
126	Broadford Flowerdale Road	1.0%	1.0%	1.0%	1.0%
127	Spur Road	1.0%	1.0%	1.0%	1.0%
128	Clonbinane Road	1.0%	1.0%	1.0%	1.0%
129	Wallan-Whittlesea Road	2.0%	2.5%	1.2%	1.2%
130	Epping-Kilmore Road	2.0%	0.5%	1.2%	0.5%

6.3 Traffic distribution adjustment in southern part of study area

There are a number of additional roads planned in the southern part of study area in 2031 and 2041 that need to be represented by external zones in the model. As traffic demand at these external zones could not be estimated from this Kilmore-Wallan model, information was used from the Victorian Integrated Transport Model (VITM) developed by the Growth Areas Authority for the northern growth area of Melbourne.

Of the total demand forecast in the south of the study area by the VITM, the proportion expected to use each of the additional roads, as well as the existing Hume Freeway, was applied to the total demand estimated by the Kilmore-Wallan model at the Hume Freeway South external zone (no. 117). This involved distributing some of the traffic from the Hume Freeway to the new roads. The proportions that were applied are detailed in Table 24 and Table 25 for light vehicles and heavy vehicles respectively. As can be seen, the majority of traffic is still expected to use the Hume Freeway, particularly in the case of heavy vehicles.

Table 24: Distribution of total light vehicle demand in the south of the study area to existing and new roads

External zone	2031	2041
117 (existing Hume Freeway in the south)	82.7%	70.4%
131 (new road in south, expected by 2031)	10.2%	8.2%
132 (new road in south, expected by 2031)	7.1%	6.1%
133 (new road in south, expected by 2041)	-	9.2%
134 (new road in south, expected by 2041)	-	6.1%
Total	**100.0%**	**100.0%**

Table 25: Distribution of total heavy vehicle demand in the south of the study area to existing and new roads

External zone	2031	2041
117 (existing Hume Freeway in the south)	98.0%	86.1%
131 (new road in south, expected by 2031)	1.0%	1.1%
132 (new road in south, expected by 2031)	1.0%	1.1%
133 (new road in south, expected by 2041)	-	1.1%
134 (new road in south, expected by 2041)	-	10.6%
Total	**100.0%**	**100.0%**

6.4 Impact of relocation of the market and intermodal terminal facility

The relocation of the Fruit and Vegetable Market from Footscray to Epping and further development of the Somerton Intermodal Terminal Facility is expected to have an impact on the number of heavy vehicles using the Northern Highway through Kilmore and Wallan. A detailed assessment of this impact is provided in Appendix D. The assessment was also supported by a series of telephone interviews with a number of freight operators who currently deliver to the existing Fruit and Vegetable Market in Footscray including Nolans Interstate Transport, Pickering Transport Group, Lindsay Transport and Minatour Transport.

Overall, the relocation of the Fruit and Vegetable Market from Footscray to Epping and further development of the Somerton Intermodal Terminal Facility is not expected to result in any significant change to heavy vehicles using the Northern Highway through Kilmore and Wallan.

Table 26 below provides a summary of the estimated impact showing an increase of only 2-3 trucks per day, in addition to the predicted truck traffic growth as shown in Table 23.

Table 26: Estimated increase in heavy vehicles using the Northern Highway through Kilmore and Wallan as a result of the relocation of the market and development of the intermodal terminal facility

Year	Additional heavy vehicles per day
2021	2
2031	3
2041	3

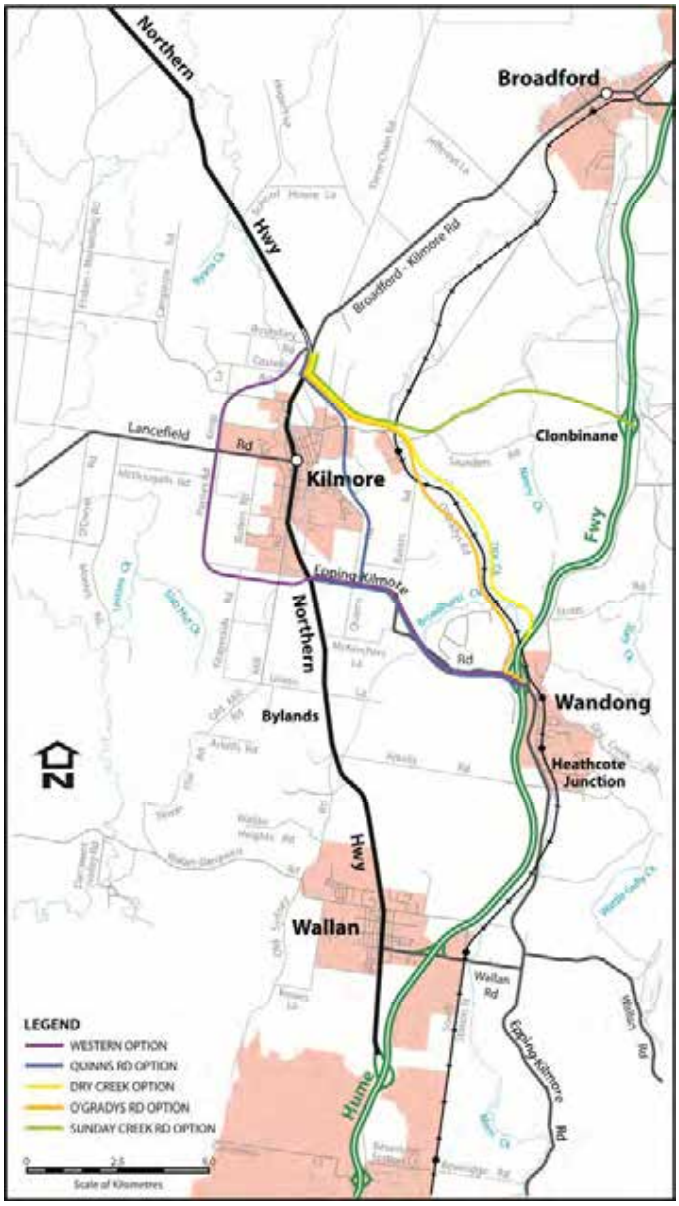
6.5 Modelling of options

In addition to the base case, five (5) bypass options were modelled. Each bypass option was modelled as a two-lane, two-way, undivided highway. Access to the bypass options was permitted at locations indicated on the Study Area Mark Up provided to AECOM on 20 June 2012 by VicRoads.

While the 2011 base year model calibration and validation process based the traffic assignment on both travel time and distance, the modelling of future years (for the base case and options) based the traffic assignment on travel time only. During the 2007 study, this was shown to be more acceptable to the community. A test was still undertaken on the 2011 base year model with the traffic assignment based on travel time only. This showed that the model validation results were still well within the acceptable standards.

Figure 18 shows the alignment of each bypass option that has been modelled. This is followed by a description of each bypass option.

Figure 18: Bypass options



6.5.1 Quinns Road option

Quinns Road option involves a bypass to the east of Kilmore between the Hume Freeway (interchange of Epping-Kilmore Road) and the Northern Highway (intersection of Costello Road). The bypass uses Epping-Kilmore Road and Quinns Road for most of its route, thereby requiring upgrades to these roads. The bypass is largely located in a rural environment and the speed limit is along the bypass is 100km/hr.

6.5.2 Western option

Western option involves a bypass west of Kilmore between the Hume Freeway (interchange of Epping-Kilmore Road) and Northern Highway (intersection of Broadford-Kilmore Road). The bypass uses Epping-Kilmore Road, Paynes Road and Kings Road, therefore requiring upgrades to these roads and is mainly located in a rural environment. The speed limit along the bypass is 100km/hr.

6.5.3 O'Gradys Road option

O'Gradys Road option involves a bypass east of Kilmore between the Hume Freeway (interchange of Epping-Kilmore Road) and Northern Highway (intersection of Costello Road). The bypass uses Epping-Kilmore Road and

O'Gradys Road, thereby requiring upgrades to these roads. Option 3 is mainly located in a rural environment and the speed limit along the bypass is 100km/hr.

6.5.4 Dry Creek option

Dry Creek option involves a bypass east of Kilmore between the Hume Freeway (north of the Epping-Kilmore Road interchange) and Northern Highway (intersection of Costello Road). The bypass uses a similar alignment to O'Gradys Road on the east side of the railway line and may require upgrades to O'Gradys Road. The bypass is largely located in a rural environment and the speed limit along the bypass is 100km/hr.

6.5.5 Sunday Creek Road option

Sunday Creek Road option involves an east-west bypass link between the Hume Freeway (interchange of Broadford-Wandong Road) and the Northern Highway (intersection of Costello Road). The bypass uses Broadford-Wandong Road and Sunday Creek Road, thereby requiring upgrades to these roads. It is mainly located in a rural environment and the speed limit along the bypass is 100km/hr.

6.6 Modelling results

The modelling results for the five options are presented separately for all vehicles and heavy vehicles in Table 27 to Table 32 for each future year (2021, 2031 and 2041).

For 2041, as can be seen, Quinns Road option is expected to carry the highest volume of traffic across all bypass options, with around 15,400 vehicles per day. This is followed by Western option (12,400 vehicles per day), Dry Creek option (11,200 vehicles per day), O'Gradys Road option (10,700 vehicles per day) and Sunday Creek Road option (5,900 vehicles per day).

Quinns Road option is also expected to have the greatest impact on reducing traffic along the Northern Highway, with reductions of up to 33% (all vehicles) expected north of Foote Street, and 18% (all vehicles) north of Watson Street. This is followed by Dry Creek option, O'Gradys Road option, Western Option and Sunday Creek Road option.

Table 27: 2021 daily two-way traffic volumes for the Base Case and each option – all vehicles

Road name	Daily two-way traffic volume (all vehicles '000s)					
	Base Case	Quinns Road	Western	O'Gradys Road	Dry Creek	Sunday Creek
Bypass (maximum volume)	-	9.6	4.8	6.4	6.9	4.2
Northern Hwy north of Foote St	15.3	8.8	14.7	10.7	10.8	12.1
Northern Hwy north of Arkells Rd	16.2	11.4	15.2	12.1	12.5	13.3
Northern Hwy north of Watson St	22.1	16.8	21	18.1	18.5	19.2
Hume Fwy north of Wandong interchange	28.4	28.5	28.6	28.3	28.2	28.2
Hume Fwy north of Watson St interchange	30.9	35.3	31.5	34.8	34.6	33.6
Percentage difference from the Base Case						
Northern Hwy north of Foote St	-	-42%	-4%	-30%	-29%	-21%
Northern Hwy north of Arkells Rd	-	-30%	-6%	-25%	-23%	-18%
Northern Hwy north of Watson St	-	-24%	-5%	-18%	-16%	-13%
Hume Fwy north of Wandong interchange	-	0%	1%	0%	-1%	-1%
Hume Fwy north of Watson St interchange	-	14%	2%	13%	12%	9%

Table 28: 2021 daily two-way traffic volumes for the Base Case and each option – heavy vehicles

Road name	Daily two-way traffic volume (heavy vehicles '000s)					
	Base Case	Quinns Road	Western	O'Gradys Road	Dry Creek	Sunday Creek
Bypass (maximum volume)	-	1.3	0.4	1	1	0.8
Northern Hwy north of Foote St	1.4	0.5	1.4	0.6	0.6	0.8
Northern Hwy north of Arkells Rd	1.9	0.9	1.8	1	1.1	1.2
Northern Hwy north of Watson St	2.4	1.4	2.3	1.6	1.6	1.7
Hume Fwy north of Wandong interchange	8.3	8.5	8.4	8.3	8.3	8.3
Hume Fwy north of Watson St interchange	8.1	9	8.2	8.9	9	8.9
Percentage difference from the Base Case						
Northern Hwy north of Foote St	-	-64%	0%	-57%	-57%	-43%
Northern Hwy north of Arkells Rd	-	-53%	-5%	-47%	-42%	-37%
Northern Hwy north of Watson St	-	-42%	-4%	-33%	-33%	-29%
Hume Fwy north of Wandong interchange	-	2%	1%	0%	0%	0%
Hume Fwy north of Watson St interchange	-	11%	1%	10%	11%	10%

Table 29: 2031 daily two-way traffic volumes for the Base Case and each option – all vehicles

Road name	Daily two-way traffic volume (all vehicles '000s)					
	Base Case	Quinns Road	Western	O'Gradys Road	Dry Creek	Sunday Creek
Bypass (maximum volume)	-	11.9	10.2	7.9	8.4	4.7
Northern Hwy north of Foote St	18.4	10.9	14	13.3	13.5	15.8
Northern Hwy north of Arkells Rd	21.2	15.9	19.9	16.2	16.8	18.2
Northern Hwy north of Watson St	28.7	22.5	27.1	23.9	24.5	25.5
Hume Fwy north of Wandong interchange	34.5	34.4	34.5	34.3	34.2	34
Hume Fwy north of Watson St interchange	37.1	41.7	37.8	41.7	41.4	40
Percentage difference from the Base Case						
Northern Hwy north of Foote St	-	-41%	-24%	-28%	-27%	-14%
Northern Hwy north of Arkells Rd	-	-25%	-6%	-24%	-21%	-14%
Northern Hwy north of Watson St	-	-22%	-6%	-17%	-15%	-11%
Hume Fwy north of Wandong interchange	-	0%	0%	-1%	-1%	-1%
Hume Fwy north of Watson St interchange	-	12%	2%	12%	12%	8%

Table 30: 2031 daily two-way traffic volumes for the Base Case and each option – heavy vehicles

Road name	Daily two-way traffic volume (heavy vehicles '000s)					
	Base Case	Quinns Road	Western	O'Gradys Road	Dry Creek	Sunday Creek
Bypass (maximum volume)	-	1.7	1.4	1.1	1.2	0.9
Northern Hwy north of Foote St	1.7	0.6	0.8	0.7	0.8	1.1
Northern Hwy north of Arkells Rd	2.4	1.3	2.2	1.4	1.5	1.6
Northern Hwy north of Watson St	3	2	2.9	2.1	2.2	2.3
Hume Fwy north of Wandong interchange	10.2	10.3	10.2	10.2	10.2	10.1
Hume Fwy north of Watson St interchange	9.9	10.9	10	10.8	10.8	10.6
Percentage difference from the Base Case						
Northern Hwy north of Foote St	-	-65%	-53%	-59%	-53%	-35%
Northern Hwy north of Arkells Rd	-	-46%	-8%	-42%	-38%	-33%
Northern Hwy north of Watson St	-	-33%	-3%	-30%	-27%	-23%
Hume Fwy north of Wandong interchange	-	1%	0%	0%	0%	-1%
Hume Fwy north of Watson St interchange	-	10%	1%	9%	9%	7%

Table 31: 2041 daily two-way traffic volumes for the Base Case and each option – all vehicles

Road name	Daily two-way traffic volume (all vehicles '000s)					
	Base Case	Quinns Road	Western	O'Gradys Road	Dry Creek	Sunday Creek
Bypass (maximum volume)	-	15.4	12.4	10.7	11.2	5.9
Northern Hwy north of Foote St	21.1	14.1	18.3	17.3	16.5	19.7
Northern Hwy north of Arkells Rd	25.5	20.6	26	22	21.6	23.5
Northern Hwy north of Watson St	34.6	28.3	34.2	31.1	30.6	32.3
Hume Fwy north of Wandong interchange	42.3	42.2	42.3	41.9	41.9	41.6
Hume Fwy north of Watson St interchange	48.6	53.2	47.8	52.4	52.9	50.8
Percentage difference from the Base Case						
Northern Hwy north of Foote St	-	-33%	-13%	-18%	-22%	-7%
Northern Hwy north of Arkells Rd	-	-19%	2%	-14%	-15%	-8%
Northern Hwy north of Watson St	-	-18%	-1%	-10%	-12%	-7%
Hume Fwy north of Wandong interchange	-	0%	0%	-1%	-1%	-2%
Hume Fwy north of Watson St interchange	-	9%	-2%	8%	9%	5%

Table 32: 2041 daily two-way traffic volumes for the Base Case and each option – heavy vehicles

Road name	Daily two-way traffic volume (heavy vehicles '000s)					
	Base Case	Quinns Road	Western	O'Gradys Road	Dry Creek	Sunday Creek
Bypass (maximum volume)	-	2.0	1.6	1.4	1.5	1.2
Northern Hwy north of Foote St	1.7	0.7	1.1	0.9	0.8	1.4
Northern Hwy north of Arkells Rd	2.6	1.6	2.7	1.8	1.7	2.0
Northern Hwy north of Watson St	3.2	2.2	3.3	2.5	2.4	2.7
Hume Fwy north of Wandong interchange	12.3	12.5	12.5	12.4	12.4	12.3
Hume Fwy north of Watson St interchange	12.3	13.2	12.1	13.0	13.2	12.9
Percentage difference from the Base Case						
Northern Hwy north of Foote St	-	-59%	-35%	-47%	-53%	-18%
Northern Hwy north of Arkells Rd	-	-38%	4%	-31%	-35%	-23%
Northern Hwy north of Watson St	-	-31%	3%	-22%	-25%	-16%
Hume Fwy north of Wandong interchange	-	2%	2%	1%	1%	0%
Hume Fwy north of Watson St interchange	-	7%	-2%	6%	7%	5%

6.7 Sensitivity testing

A number of sensitivity tests were also undertaken to assess the impact of changing various model inputs and assumptions. Since Quinns Road option was the most effective option in relieving traffic on Northern Highway, it was used as the base for conducting sensitivity tests. The tests were undertaken for the year 2041 only and included:

- **Sensitivity Test 1:** traffic assignment based on both travel time and distance for light and heavy vehicles
- **Sensitivity Test 2:** increase in the traffic growth rate for Hume Freeway (South) from 1.2% to 2.4% p.a. and increase in the traffic growth rate for Northern Highway (North) from 0.5% to 1.0% p.a.
- **Sensitivity Test 3:** increase in forecast population of 20% across the study area
- **Sensitivity Test 4:** decrease in forecast population of 20% across the study area
- **Sensitivity Test 5:** increase in public transport patronage of 25% across the study area.

For Sensitivity Test 5, the public transport (PT) mode share for the study area was increased by 25 percent, from 5.8 percent (the 2011 average PT mode share for Kilmore, Broadford, Wandong and Wallan, sourced from the 2011 Census) to 7.3 percent, with the car mode share being correspondingly decreased from 73.3 percent (sourced from 2011 Census) to 71.8 percent. The decrease in car mode share was incorporated by applying the appropriate reduction to the vehicle trip production rates for the internal-internal trip components and also to the internal-external (and external-internal) components. The additional trips to railway stations in the study area were increased correspondingly in response to the increased public transport mode share. Heavy vehicle trips were left unaffected.

A summary of the results of the sensitivity tests are provided in Table 33.

Table 33: 2041 daily two-way traffic volumes for option 1 and the sensitivity tests – all vehicles

Road name	Daily two-way traffic volume (all vehicles '000s)					
	Quinns Road	ST1	ST2	ST3	ST4	ST5
Bypass (maximum volume)	15.4	9.7	16.1	16.9	13.9	15.1
Northern Hwy north of Foote St	14.1	16	14.1	17	11.3	13.8
Northern Hwy north of Arkells Rd	20.6	20.8	21.1	24.4	16.9	20.2
Northern Hwy north of Watson St	28.3	30.8	28.7	32.7	24.2	27.7
Hume Fwy north of Wandong interchange	42.2	37.7	44.9	43.7	40.7	41.9
Hume Fwy north of Watson St interchange	53.2	43.4	57.3	56.6	49.9	52.7
Percentage difference from Quinns Road Option						
Bypass (maximum volume)	-	-37%	5%	10%	-10%	-2%
Northern Hwy north of Foote St	-	13%	0%	21%	-20%	-2%
Northern Hwy north of Arkells Rd	-	1%	2%	18%	-18%	-2%
Northern Hwy north of Watson St	-	9%	1%	16%	-14%	-2%
Hume Fwy north of Wandong interchange	-	-11%	6%	4%	-4%	-1%
Hume Fwy north of Watson St interchange	-	-18%	8%	6%	-6%	-1%

Sensitivity Test 1 shows that with the traffic assignment using both travel time and distance, the traffic would continue using Northern Highway rather than the bypass and Hume Freeway despite the traffic congestion on Northern Highway because Northern Highway offers a shorter route.

Sensitivity Test 2 shows that with the annual traffic growth rates doubled for through traffic from the Northern Highway north and Hume Freeway south, the maximum traffic on the bypass would increase by 5%. Traffic on Northern Highway would increase by 1-2%.

Sensitivity Test 3 shows that if the population for the study area grows by 20%, the maximum traffic on the bypass would increase by 10%, while traffic on Northern Highway would increase by 16%-21%. Similarly Sensitivity Test 4 shows a reverse pattern.

Sensitivity Test 5 shows that if the public transport patronage increases by 25% for the study area, the traffic using the bypass and Northern Hwy would reduce by 2% or about 300-400 vehicles per day.

6.8 Overall network performance

The overall performance of the network in terms of total daily Vehicle Hours Travelled (VHT), total daily Vehicle Kilometres Travelled (VKT) and average travel speed is described in Table 34 for each bypass option and year.

As can be seen, each option provides a network wide saving in total VHT, but also results in a network wide increase in total VKT. Quinns Road option results in the largest saving in total daily VHT, but also results in the largest increase in total daily VKT. The reason is that motorists are generally willing to travel longer distance to achieve time saving.

The overall network performance also shows consistently that Quinns Road option performs the best in providing the travel time saving over the future years. This is followed by Western option, O'Gradys Road option, Dry Creek option, and Sunday Creek Road option for 2031 and 2041. In 2021, O'Gradys Road and Dry Creek options perform better than Western option.

Table 34: Overall network performance (daily 24-hr)

Scenario	Daily (24-hr) network performance indicator			Difference from Base Case		
	Vehicle Hours Travelled (VHT)	Vehicle Kilometres Travelled (VKT)	Average Travel Speed (km/hr)	Vehicle Hours Travelled (VHT)	Vehicle Kilometres Travelled (VKT)	Average Travel Speed (km/hr)
2021						
Base Case	25,901	1,998,407	77.2			
Quinns Road	25,412	2,020,667	79.5	- 489	22,260	2.4
Western	25,593	2,002,298	78.2	- 309	3,892	1.1
O'Gradys Road	25,531	2,011,978	78.8	- 370	13,571	1.6
Dry Creek	25,582	2,015,158	78.8	- 319	16,752	1.6
Sunday Creek	25,758	2,015,121	78.2	- 143	16,714	1.1
2031						
Base Case	32,646	2,522,222	77.3			
Quinns Road	31,865	2,550,140	80	- 780	27,918	2.8
Western	32,014	2,546,548	79.5	- 631	24,326	2.3
O'Gradys Road	32,073	2,541,867	79.3	- 573	19,645	2
Dry Creek	32,138	2,544,321	79.2	- 507	22,100	1.9
Sunday Creek	32,348	2,543,556	79	- 298	21,334	1.4
2041						
Base Case	44,411	3,262,852	73.5			
Quinns Road	42,965	3,297,386	76.7	- 1,446	34,534	3.3
Western	43,139	3,287,822	76.2	- 1,272	24,970	2.7
O'Gradys Road	43,292	3,284,642	75.9	- 1,120	21,790	2.4
Dry Creek	43,369	3,292,241	75.9	- 1,042	29,389	2.4
Sunday Creek	43,754	3,285,679	75.1	- 657	22,827	1.6

7.0 Economic Assessment

An economic assessment will be undertaken to assess the financial viability of each bypass option. The methodology will be undertaken in accordance with VicRoads' requirements with the appropriate sensitivity tests performed.

VicRoads has advised that the total estimated are currently being finalised in consideration of mitigation measures proposed by the individual specialist's studies. Accordingly, the full economic assessment will be undertaken on final costs estimates.

8.0 Conclusion

This report has presented the structure, methodology and development process for the Kilmore-Wallan Bypass Transport model. The 2011 base year model was developed using a range of available data sources, household interview data, classified traffic counts, and origin destination survey, and the existing demographic data from Department of Transport and Shire of Mitchell. The study area was expanded to cover Broadford township. The 2011 base model was validated when comparing the modelled traffic volumes against observed traffic counts at three levels: screenlines, RMSE and scatter plots of all traffic count sites. The validation was satisfactory at all levels of criteria for both total and heavy vehicles.

After the validation of the 2011 base model, the models for future year, 2021, 2031 and 2041 were established with the future networks and demographic data developed in close consultation with Shire of Mitchell, GAA, DOT, DPCD, VicRoads and in line with the Victorian in Future 2012 forecast of population.

A total of 5 bypass options: Quinns Road, Western option, O'Gradys Road, Dry Creek and Sunday Creek Road, plus the Base Case were modelled for 2021, 2031 and 2041.

In terms of traffic performance, Quinns Road option is expected to carry the highest volume of traffic across all bypass options, with around 15,400 vehicles per day in 2041. This is followed by Western option (12,400 vehicles per day), Dry Creek (11,200 vehicles per day), O'Gradys Road (10,700 vehicles per day) and Sunday Creek Road (5,900 vehicles per day).

Quinns Road option is expected to have the greatest impact on reducing traffic along the Northern Highway, with reductions of up to 33% (all vehicles) on Sydney Road (Kilmore) and 18% (all vehicles) on High Street (Wallan). This is followed by Dry Creek option, O'Gradys Road option, Western Option and Sunday Creek Road option.

In terms of the overall network performance, Quinns Road option would provide the largest travel time saving when compared to the corresponding base over the future years. This is followed by Western option, O'Gradys Road option, Dry Creek option, and Sunday Creek Road option for 2031 and 2041. But O'Gradys Road and Dry Creek options perform better than Western option in 2021.

An overall assessment of both traffic and economic outcomes, to determine the best performing option will be completed when the option costs are confirmed.

9.0 Bibliography

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Appendix A

2011 Road Network Attributes

Road Name	Road classification	Environment	Divided status	Sealed status	Number of lanes	Speed limit (km/hr)
Hume Freeway	Freeway	Rural	Divided	Sealed	4	110
Hume Freeway on/off ramps	Freeway	Rural	Undivided	Sealed	1	60/80
Northern Highway	Highway	Urban/ Rural	Divided/ Undivided	Sealed	2/4	50/60/80/ 100
Broadford-Kilmore Road	Arterial	Rural/ Urban	Undivided	Sealed	2	60/80/100
Broadford-Wandong Road*	Arterial	Rural	Undivided	Sealed	2	60/100
Darraweit-Wallan Road*	Arterial	Urban/ Rural	Undivided	Sealed	2	100
Dry Creek Road	Arterial	Rural	Undivided	Sealed/ Unsealed	2	100
Epping-Kilmore Road	Arterial	Urban/ Rural	Undivided	Sealed	2	60/80/100
Forbes-Moranding Road	Arterial	Rural	Undivided	Sealed	2	80
Kilmore East Road	Arterial	Urban	Undivided	Sealed	2	80
Kilmore East-Sunday Creek Road	Arterial	Rural	Undivided	Sealed	2	100
Kilmore-Lancefield Road	Arterial	Urban/ Rural	Undivided	Sealed	2	60/80/100
O'Grady's Road	Arterial	Urban/ Rural	Undivided	Sealed	2	50/80/100
Old Sydney Road	Arterial	Rural	Undivided	Unsealed	2	100
Wallan-Whittlesea Road	Arterial	Urban/ Rural	Undivided	Sealed	2	60/80/100
Willowmavin Road	Arterial	Urban/ Rural	Undivided	Sealed/ Unsealed	2	80/100
Sunday Creek Road	Arterial	Rural	Undivided	Sealed	2	100
McDonalds Road	Arterial	Rural	Undivided	Sealed	2	60
High Street	Arterial	Urban	Undivided	Sealed	2	60
Broadford-Sugarloaf Creek Road	Arterial	Urban	Undivided	Sealed	2	60/80
Short Street	Arterial	Urban	Undivided	Sealed	2	60
Broadford-Flowerdale Road	Arterial	Rural	Undivided	Sealed	2	100
Allen Street	Collector	Urban	Undivided	Sealed	2	50
Anderson Road	Collector	Urban	Undivided	Sealed	2	60
Arkells Road	Collector	Rural	Undivided	Unsealed	1	100
Bentinck Street	Collector	Urban	Undivided	Sealed	2	50
Beveridge-Darraweit Road	Collector	Rural	Undivided	Unsealed	2	100
Boundary Road	Collector	Rural	Undivided	Unsealed	2	100
Butlers Road	Collector	Urban	Undivided	Unsealed	2	50
Church Street	Collector	Urban	Undivided	Sealed	2	60
Clonbinane Road	Collector	Rural	Undivided	Sealed	2	100
Costellos Road	Collector	Rural	Undivided	Unsealed	2	100
Curry Road	Collector	Urban	Undivided	Unsealed	2	100
Dudley Street	Collector	Urban	Undivided	Sealed	2	50
Duke Street	Collector	Urban	Undivided	Sealed	2	50
East Street	Collector	Urban	Undivided	Sealed	2	50

Road Name	Road classification	Environment	Divided status	Sealed status	Number of lanes	Speed limit (km/hr)
Flahertys Road	Collector	Rural	Undivided	Unsealed	2	100
Foote Street	Collector	Urban	Undivided	Sealed	2	50
Gehrey's Lane	Collector	Urban	Undivided	Sealed	2	80
Green Street	Collector	Urban	Undivided	Sealed	2	50
Harrington Drive	Collector	Urban	Undivided	Sealed	2	50
Hidden Valley Boulevard	Collector	Urban	Undivided	Sealed	2	50
Highpark Road	Collector	Rural	Undivided	Sealed	2	100
Kelly's Lane	Collector	Urban	Undivided	Sealed/ Unsealed	2	60
King Street	Collector	Urban	Undivided	Sealed	2	50
Kings Lane	Collector	Rural	Undivided	Unsealed	2	100
Lumsden Street	Collector	Urban	Undivided	Sealed	2	50
Mathiesons Road	Collector	Rural	Undivided	Sealed	2	80
McDougalls Road	Collector	Rural	Undivided	Unsealed	2	100
McIvors Road	Collector	Urban	Undivided	Unsealed	2	60
Mill Road (between Union Lane and Gehreys Lane)	Collector	Rural	Undivided	Unsealed	2	100
Mill Road (between Gehreys Lane and Northern Hwy)	Collector	Rural	Undivided	Sealed	2	80
O'Donohue's Road	Collector	Urban	Undivided	Unsealed	2	50
Paynes Road	Collector	Rural	Undivided	Unsealed	2	100
Pretty Sally Drive	Collector	Urban	Undivided	Sealed	2	60
Queen Street	Collector	Urban	Undivided	Sealed	2	50
Quinns Road	Collector	Urban	Undivided	Unsealed	2	60
Rail Street	Collector	Urban	Undivided	Sealed	2	60
Rowes Lane	Collector	Urban/ Rural	Undivided	Unsealed	2	60
Rutledge Street	Collector	Urban	Undivided	Sealed	2	50
Saunders Road	Collector	Rural	Undivided	Unsealed	2	100
Spur Road	Collector	Rural	Undivided	Sealed	2	100
Sutherland Street	Collector	Urban	Undivided	Sealed/ Unsealed	2	50
Taylors Lane	Collector	Urban	Undivided	Sealed/ Unsealed	2	60
The Dene	Collector	Rural	Undivided	Sealed	2	80
Three Chain Road	Collector	Rural	Undivided	Unsealed	2	100
Tootle Street	Collector	Urban	Undivided	Sealed	2	60
Union Street	Collector	Urban	Undivided	Sealed	2	60
Valley Drive	Collector	Urban	Undivided	Sealed/ Unsealed	2	50
Victoria Parade	Collector	Urban	Undivided	Sealed	2	50
Watson Street	Collector	Urban	Undivided	Sealed	2	50
Wellington Street	Collector	Urban	Undivided	Sealed	2	50
White Street	Collector	Urban	Undivided	Sealed/ Unsealed	2	50
William Street	Collector	Urban	Undivided	Sealed	2	60

Road Name	Road classification	Environment	Divided status	Sealed status	Number of lanes	Speed limit (km/hr)
Windham Street	Collector	Urban	Undivided	Sealed	2	50
Longs Lane	Collector	Rural	Undivided	Unsealed	2	100
Jeffreys Lane	Collector	Rural	Undivided	Unsealed	2	100
Smiths Lane	Collector	Rural	Undivided	Unsealed	2	100
Burges Lane	Collector	Rural	Undivided	Unsealed	2	100
Roditis Avenue	Collector	Rural	Undivided	Sealed	2	60
Derek Drive	Collector	Rural	Undivided	Sealed	2	60
Govett Street	Collector	Urban	Undivided	Sealed	2	60
First Street	Collector	Urban	Undivided	Sealed	2	50
Ferguson Street	Collector	Urban	Undivided	Sealed	2	50
Davidson Street	Collector	Urban	Undivided	Sealed	2	50
Pinniger Street	Collector	Urban	Undivided	Sealed	2	50/60
Hamilton Street	Collector	Urban	Undivided	Sealed	2	50/60
High Street	Collector	Urban	Undivided	Sealed	2	50
Mollison Street	Collector	Urban	Undivided	Sealed	2	50
Murchison Street	Collector	Urban	Undivided	Sealed	2	50
Donaldson Drive	Collector	Urban	Undivided	Sealed	2	50
Casey Crescent	Collector	Urban	Undivided	Sealed	2	50
Powlett Street	Collector	Urban	Undivided	Sealed	2	50
The Parade	Collector	Urban	Undivided	Sealed	2	50
Jamieson Street	Collector	Urban	Undivided	Sealed	2	50
Sutherland Street	Collector	Urban	Undivided	Sealed	2	50
Last Street	Collector	Urban	Undivided	Sealed	2	50

Appendix B

Zonal Demographic Data

Zone	2011 Demographics							
	Total Pop	HH	Emp Persons	Persons in Educ	Educ Enrol	Whole & Ret Jobs	Other Jobs	Total Jobs/HH
1	186	62	105	38	0	0	0	0.00
2	62	21	35	13	0	0	0	0.00
3	105	38	59	29	0	1	15	0.42
4	93	31	52	19	0	0	0	0.00
5	201	79	110	46	0	0	32	0.41
6	142	56	71	43	0	6	23	0.52
7	486	185	250	122	0	10	10	0.11
8	846	348	383	157	0	0	0	0.00
9	105	37	49	27	0	3	15	0.47
10	57	20	32	16	0	0	8	0.42
11	53	22	24	10	0	0	0	0.00
12	124	42	60	34	2,097	0	160	3.78
13	249	84	119	72	0	11	26	0.44
14	79	33	36	15	0	114	106	6.74
15	849	214	370	284	0	12	267	1.30
16	270	91	129	78	0	11	29	0.44
17	251	89	135	70	0	7	36	0.48
18	188	67	101	53	0	5	27	0.48
19	150	48	85	33	0	2	3	0.10
20	102	26	50	37	0	6	11	0.64
21	130	45	72	33	0	1	16	0.36
22	260	91	144	66	0	1	16	0.18
23	260	91	144	66	0	1	16	0.18
24	190	65	111	54	0	36	94	2.01
25	304	91	187	79	0	1	24	0.29
26	262	78	161	68	0	1	21	0.29
27	628	221	366	145	0	21	89	0.50
28	177	59	105	39	0	1	24	0.42
29	97	32	58	21	0	1	13	0.42
30	472	142	257	145	0	3	27	0.21
31	0	0	0	0	0	0	0	N/A
32	232	75	135	51	0	1	30	0.41
33	160	48	86	44	0	2	20	0.44
34	481	158	254	108	0	2	0	0.01
35	255	85	129	54	0	0	112	1.32
36	22	7	12	6	0	145	247	57.10
37	856	280	449	220	0	1	113	0.41
38	374	113	201	103	0	4	46	0.44
39	44	15	26	10	0	0	6	0.42
40	44	15	26	10	0	0	6	0.42
41	85	26	49	21	0	0	11	0.42
42	14	5	8	4	0	97	157	55.46
43	518	164	283	151	0	1	120	0.74
44	3	1	2	1	0	0	0	0.00
45	0	0	0	0	0	6	118	N/A
46	9	3	5	2	0	24	0	8.74
47	35	11	20	10	0	0	0	0.00
48	3	1	2	1	0	0	0	0.00
49	46	15	26	13	0	0	0	0.00
50	101	32	58	28	0	0	13	0.41
51	0	0	0	0	0	0	0	0.40
52	31	10	17	6	0	8	227	22.61
53	0	0	0	0	0	0	0	N/A
54	195	77	94	42	0	3	31	0.45
55	340	122	198	76	0	11	49	0.50
56	180	54	101	43	0	0	9	0.17

Zone	2011 Demographics							
	Total Pop	HH	Emp Persons	Persons in Educ	Educ Enrol	Whole & Ret Jobs	Other Jobs	Total Jobs/HH
57	72	23	41	20	0	0	0	0.00
58	255	85	129	54	0	0	112	1.32
59	431	138	251	94	581	1	56	0.41
60	763	236	437	189	0	4	95	0.42
61	0	0	0	0	648	0	45	N/A
62	551	174	302	146	0	1	70	0.41
63	721	215	403	172	0	1	35	0.17
64	736	216	455	185	308	3	59	0.28
65	279	83	171	73	0	1	22	0.29
66	390	136	216	99	0	1	16	0.12
67	107	38	52	22	0	10	16	0.67
68	448	152	204	110	387	22	104	0.83
69	71	26	34	15	0	7	10	0.67
70	9	3	4	1	0	17	1	5.35
71	187	64	90	51	0	7	10	0.26
72	311	106	150	84	0	0	30	0.28
73	79	33	36	15	0	171	158	10.10
74	260	91	144	66	0	6	93	1.09
75	92	32	43	24	0	2	13	0.47
76	66	23	31	17	0	2	9	0.47
77	247	83	139	51	0	0	0	0.00
78	10	3	6	2	0	0	0	0.10
79	91	32	59	16	0	0	13	0.41
80	44	15	26	10	0	0	6	0.42
81	285	98	167	81	0	55	142	2.01
82	346	111	151	94	0	2	45	0.42
83	170	54	96	37	59	2	4	0.10
84	188	67	101	53	0	5	27	0.48
85	159	41	79	57	0	10	17	0.64
86	9	3	5	2	0	0	0	0.00
87	12	4	7	3	0	0	0	0.00
88	0	0	0	0	0	0	0	0.40
89	618	217	305	152	0	5	88	0.43
90	629	228	322	163	0	3	92	0.42
91	221	82	108	40	0	1	33	0.42
92	601	231	301	145	932	2	100	0.44
93	119	47	60	15	0	50	100	3.20
94	391	146	190	71	0	2	59	0.42
95	238	89	116	43	0	1	36	0.42
96	561	209	269	124	0	2	85	0.41
97	135	51	67	43	0	8	21	0.56
98	58	22	29	18	0	3	9	0.56
99	213	82	101	60	0	3	33	0.44
100	219	79	123	60	0	1	32	0.42
101	430	155	242	118	0	2	62	0.42
102	0	0	0	0	0	0	0	0.40
103	0	0	0	0	0	0	0	0.40
104	0	0	0	0	0	0	0	0.40
105	0	0	0	0	0	0	0	0.40
106	0	0	0	0	0	0	0	0.40
107	0	0	0	0	0	0	46	N/A
108	13	4	8	3	0	0	2	N/A
109	14	5	8	3	0	0	2	N/A
110	8	3	5	2	0	0	1	N/A
Total	**23,270**	**7,864**	**12,324**	**5,818**	**5,011**	**980**	**4,429**	**0.69**

Zone	2021 Demographics							
	Total Pop	HH	Emp Persons	Persons in Educ	Educ Enrol	Whole & Ret Jobs	Other Jobs	Total Jobs/HH
1	189	66	109	39	0	0	4	0.06
2	63	22	36	13	0	0	1	0.06
3	135	50	68	34	0	1	25	0.53
4	119	44	59	30	0	0	3	0.06
5	257	96	129	65	0	0	53	0.56
6	182	68	91	46	0	11	38	0.72
7	622	231	311	158	0	17	14	0.13
8	1083	403	542	275	0	0	24	0.06
9	135	50	68	34	0	5	25	0.59
10	73	27	36	18	0	1	14	0.53
11	68	25	34	17	0	0	2	0.06
12	159	59	80	40	2200	0	266	4.50
13	319	119	160	81	0	18	44	0.52
14	102	38	51	26	0	198	176	9.89
15	1087	404	544	276	0	21	444	1.15
16	346	128	173	88	0	20	48	0.52
17	322	119	161	82	0	12	60	0.60
18	241	90	121	61	0	9	45	0.60
19	153	54	89	32	0	3	5	0.15
20	130	48	65	33	0	11	18	0.59
21	167	62	83	42	0	2	26	0.45
22	266	93	153	55	0	2	26	0.30
23	266	85	162	69	0	2	26	0.33
24	194	62	118	50	0	63	157	3.55
25	311	99	190	81	0	3	41	0.44
26	267	85	163	69	0	2	35	0.44
27	945	330	525	233	0	27	126	0.46
28	180	63	104	38	0	2	40	0.66
29	75	4	42	18	0	0	5	1.28
30	854	209	474	211	0	4	38	0.20
31	376	131	209	93	0	0	7	0.06
32	298	104	165	73	0	1	42	0.42
33	1089	380	604	269	640	2	28	0.08
34	851	297	472	210	0	2	12	0.05
35	425	148	236	105	0	1	157	1.06
36	22	0	12	5	0	189	349	0.00
37	851	297	472	210	0	1	160	0.54
38	2501	887	1389	617	0	6	134	0.16
39	0	0	0	0	0	0	8	0.00
40	0	0	0	0	0	0	8	0.00
41	136	48	76	34	0	1	15	0.33
42	14	0	8	3	0	126	222	0.00
43	378	132	210	93	0	2	169	1.30
44	567	198	315	140	0	0	30	0.15
45	0	0	0	0	0	8	300	0.00
46	116	44	65	29	0	191	83	6.29
47	465	174	258	115	0	0	10	0.06
48	3	0	2	1	0	0	0	0.00
49	620	232	344	153	0	0	14	0.06
50	1357	508	753	335	730	0	71	0.14
51	1112	528	618	274	0	34	40	0.14
52	40	15	20	10	0	15	378	26.65
53	0	0	0	0	0	0	0	0.00
54	249	93	125	63	0	6	51	0.62
55	945	330	525	233	0	15	70	0.26
56	229	80	127	56	0	0	12	0.16

Zone	2021 Demographics							
	Total Pop	HH	Emp Persons	Persons in Educ	Educ Enrol	Whole & Ret Jobs	Other Jobs	Total Jobs/HH
57	969	363	538	239	0	0	71	0.20
58	425	148	236	105	0	1	157	1.06
59	553	193	307	136	627	1	79	0.42
60	612	428	340	151	0	6	134	0.33
61	0	0	0	0	1100	0	63	0.00
62	473	165	262	117	0	2	99	0.61
63	1306	319	725	322	0	2	50	0.16
64	751	240	458	195	535	4	98	0.43
65	285	91	174	74	0	2	37	0.44
66	398	127	243	103	0	2	26	0.22
67	137	51	68	35	0	18	26	0.85
68	573	213	287	145	671	38	173	0.99
69	91	34	46	23	0	12	17	0.85
70	11	4	6	3	0	29	2	7.61
71	239	89	120	61	0	11	17	0.32
72	398	148	199	101	0	0	50	0.34
73	102	38	51	26	0	296	263	14.83
74	333	124	167	85	0	11	155	1.34
75	118	44	59	30	0	4	22	0.59
76	84	31	42	21	0	3	16	0.59
77	317	118	158	80	0	0	7	0.06
78	13	5	6	3	0	0	0	0.12
79	357	119	198	88	0	0	21	0.18
80	45	16	26	9	0	0	10	0.66
81	291	93	178	75	0	95	235	3.55
82	443	165	222	112	0	3	75	0.47
83	174	61	100	36	102	3	6	0.15
84	241	90	121	61	0	9	45	0.60
85	204	76	102	52	0	17	28	0.59
86	0	0	0	0	0	0	0	0.00
87	0	0	0	0	0	0	0	0.00
88	0	81	0	0	0	0	0	0.00
89	696	269	344	156	0	9	146	0.58
90	709	274	350	159	0	5	153	0.58
91	249	96	123	56	0	2	55	0.59
92	677	262	335	152	1617	3	166	0.65
93	134	52	66	30	0	87	166	4.88
94	440	170	218	99	0	3	98	0.59
95	268	104	132	60	0	2	60	0.59
96	632	244	312	142	0	3	141	0.59
97	153	59	75	34	0	14	34	0.82
98	65	25	32	15	0	6	15	0.82
99	240	93	119	54	0	5	55	0.65
100	247	95	122	55	0	2	53	0.58
101	484	187	239	109	0	4	104	0.58
102	872	99	484	215	0	34	31	0.66
103	398	53	221	98	0	0	14	0.27
104	503	251	279	124	71	31	23	0.21
105	666	93	370	164	244	0	39	0.42
106	0	76	0	0	0	0	0	0.00
107	0	0	0	0	0	0	46	0.00
108	225	12	125	55	0	0	8	0.64
109	0	0	0	0	0	1	15	0.00
110	0	0	0	0	0	1	15	0.00
Total	**39556**	**14043**	**21331**	**9703**	**8537**	**1814**	**7618**	**0.67**

Zone	2031 Demographics							
	Total Pop	HH	Emp Persons	Persons in Educ	Educ Enrol	Whole & Ret Jobs	Other Jobs	Total Jobs/HH
1	193	70	114	40	0	0	6	0.09
2	64	23	38	13	0	0	2	0.09
3	168	65	86	42	0	2	40	0.64
4	148	57	75	37	0	0	4	0.07
5	320	124	163	80	0	1	84	0.68
6	227	88	116	57	0	18	59	0.88
7	773	299	394	194	0	28	22	0.17
8	1347	520	687	339	0	0	38	0.07
9	168	65	86	42	0	7	39	0.72
10	90	35	46	23	0	1	22	0.64
11	84	33	43	21	0	0	2	0.07
12	198	76	101	50	3438	0	419	5.48
13	397	153	202	100	0	29	69	0.64
14	126	49	64	32	0	317	277	12.17
15	1351	522	689	340	0	33	700	1.40
16	430	166	219	108	0	32	75	0.64
17	400	154	204	100	0	19	94	0.74
18	300	116	153	75	0	15	71	0.74
19	156	57	92	32	0	5	8	0.23
20	500	193	255	126	0	17	28	0.23
21	207	80	106	52	0	3	41	0.54
22	271	99	159	56	0	3	41	0.44
23	271	89	168	70	0	3	41	0.49
24	198	65	123	51	0	101	247	5.36
25	317	104	197	82	0	4	64	0.66
26	273	90	169	70	0	4	55	0.66
27	1178	421	665	290	0	49	196	0.58
28	184	67	108	38	0	3	62	0.98
29	235	84	133	58	0	0	12	0.15
30	1065	380	602	262	0	7	59	0.17
31	670	239	378	165	0	0	11	0.05
32	371	133	210	91	0	1	66	0.51
33	1697	606	958	417	800	4	43	0.08
34	1060	379	599	261	0	4	18	0.06
35	530	189	299	130	0	1	245	1.30
36	22	0	12	5	0	336	543	0.00
37	1060	379	599	261	0	2	249	0.66
38	3920	1414	2214	963	0	10	168	0.13
39	586	209	331	144	0	1	20	0.10
40	586	209	331	144	0	1	20	0.10
41	170	61	96	42	0	1	23	0.40
42	14	0	8	3	0	224	346	0.00
43	471	168	266	116	0	3	264	1.58
44	990	353	559	243	0	0	7	0.02
45	0	0	0	0	0	14	420	0.00
46	194	69	110	48	0	255	104	5.18
47	777	277	439	191	0	0	16	0.06
48	3	0	2	1	0	0	1	0.00
49	1036	370	585	255	0	0	21	0.06
50	2266	809	1280	557	1303	0	173	0.21
51	3564	1647	2013	876	0	110	128	0.14
52	49	19	25	12	0	24	595	32.52
53	0	0	0	0	0	0	0	0.00
54	310	120	158	78	0	10	81	0.76
55	1178	421	665	290	0	26	109	0.32
56	407	145	230	100	0	1	19	0.14

Zone	2031 Demographics							
	Total Pop	HH	Emp Persons	Persons in Educ	Educ Enrol	Whole & Ret Jobs	Other Jobs	Total Jobs/HH
57	1618	578	914	398	0	0	130	0.22
58	530	189	299	130	0	1	245	1.30
59	689	246	389	169	1120	3	123	0.51
60	1527	545	862	375	0	10	209	0.40
61	0	0	0	0	1248	0	99	0.00
62	589	210	333	145	0	3	154	0.75
63	1629	582	920	400	0	3	77	0.14
64	766	252	475	197	835	7	155	0.64
65	290	95	180	75	0	4	59	0.66
66	406	134	252	105	0	3	41	0.33
67	170	66	87	43	0	28	41	1.05
68	713	275	364	179	1049	61	273	1.21
69	113	44	58	29	0	19	27	1.05
70	14	5	7	4	0	47	4	9.44
71	297	115	152	75	0	18	26	0.39
72	495	191	253	124	0	0	79	0.41
73	126	49	64	32	0	476	415	18.26
74	414	160	211	104	0	18	244	1.63
75	147	57	75	37	0	6	34	0.72
76	105	41	53	26	0	5	25	0.72
77	394	152	201	99	0	0	11	0.07
78	16	6	8	4	0	0	1	0.14
79	616	211	348	151	0	1	33	0.16
80	46	17	27	10	0	1	16	0.98
81	297	98	184	76	0	152	371	5.36
82	551	213	281	138	0	4	117	0.57
83	177	64	104	37	160	5	9	0.23
84	300	116	153	75	0	15	71	0.74
85	254	98	129	64	0	27	44	0.72
86	0	0	0	0	0	0	4	0.00
87	471	168	266	116	0	0	300	1.78
88	0	295	0	0	0	0	0	0.00
89	784	312	397	174	0	14	230	0.78
90	799	318	404	178	0	9	241	0.79
91	280	112	142	62	0	3	87	0.81
92	763	304	386	170	2527	5	262	0.88
93	151	60	76	34	0	139	262	6.66
94	496	198	251	110	0	5	154	0.81
95	302	120	153	67	0	3	94	0.81
96	712	283	360	158	0	4	222	0.80
97	172	68	87	38	0	22	54	1.12
98	74	29	37	16	0	10	23	1.12
99	271	108	137	60	0	9	87	0.89
100	278	111	141	62	0	3	83	0.78
101	546	217	276	121	0	7	164	0.78
102	2794	363	1578	687	0	110	101	0.58
103	1276	192	721	314	0	0	46	0.24
104	1611	783	910	396	90	98	73	0.22
105	2134	341	1205	524	310	0	126	0.37
106	0	279	0	0	0	0	0	0.00
107	0	0	0	0	0	0	46	0.00
108	177	63	100	43	0	1	18	0.30
109	528	188	298	130	460	1	37	0.20
110	528	188	298	130	0	1	37	0.20
Total	**62006**	**22473**	**34231**	**15163**	**13339**	**3088**	**12457**	**0.69**

Zone	2041 Demographics							
	Total Pop	HH	Emp Persons	Persons in Educ	Educ Enrol	Whole & Ret Jobs	Other Jobs	Total Jobs/HH
1	197	73	119	37	0	0	8	0.11
2	66	24	40	12	0	0	3	0.11
3	215	85	113	49	0	2	53	0.65
4	189	75	100	43	0	0	5	0.07
5	410	162	216	93	0	1	110	0.68
6	290	114	153	66	0	24	78	0.89
7	989	390	521	226	0	37	29	0.17
8	1724	680	909	394	0	0	50	0.07
9	215	85	113	49	0	10	52	0.73
10	116	46	61	26	0	1	28	0.65
11	108	43	57	25	0	0	3	0.07
12	253	100	134	58	3780	0	552	5.52
13	508	200	268	116	0	39	91	0.65
14	162	64	85	37	0	426	364	12.40
15	1730	682	912	395	0	45	921	1.42
16	550	217	290	126	0	43	99	0.65
17	512	202	270	117	0	26	124	0.75
18	384	151	202	88	0	20	93	0.75
19	160	59	96	30	0	6	11	0.29
20	640	253	337	146	0	23	37	0.24
21	265	105	140	61	0	4	53	0.55
22	276	103	167	52	0	4	53	0.56
23	276	93	178	65	0	4	53	0.62
24	202	68	130	48	0	136	326	6.81
25	323	109	208	76	0	6	84	0.83
26	278	93	180	66	0	5	73	0.83
27	1209	440	714	271	0	52	211	0.60
28	188	70	113	35	0	4	82	1.24
29	843	307	498	189	0	0	14	0.05
30	1093	397	645	245	0	7	64	0.18
31	687	250	406	154	0	0	12	0.05
32	381	139	225	85	0	1	71	0.52
33	1741	633	1028	390	800	5	46	0.08
34	1088	396	642	244	0	4	20	0.06
35	544	198	321	122	0	1	264	1.34
36	22	0	13	5	0	358	585	0.00
37	1088	396	642	244	0	3	268	0.68
38	4007	1477	2365	897	0	11	168	0.12
39	2097	766	1238	469	0	1	142	0.19
40	2097	766	1238	469	0	1	142	0.19
41	174	63	103	39	0	1	25	0.41
42	14	0	8	3	0	238	372	0.00
43	518	176	306	116	0	3	284	1.63
44	1451	528	856	325	0	0	8	0.02
45	0	0	0	0	0	15	600	0.00
46	199	72	118	45	0	259	104	5.01
47	797	290	471	178	0	0	17	0.06
48	3	0	2	1	0	0	1	0.00
49	1063	387	627	238	0	0	23	0.06
50	2325	846	1373	520	1064	0	186	0.22
51	3772	1672	2227	844	0	117	133	0.15
52	63	25	33	14	0	32	783	32.77
53	0	0	0	0	0	0	0	0.00
54	397	157	209	91	0	13	107	0.76
55	1209	440	714	271	0	28	117	0.33
56	418	152	247	94	0	1	21	0.14

Zone	2041 Demographics							
	Total Pop	HH	Emp Persons	Persons in Educ	Educ Enrol	Whole & Ret Jobs	Other Jobs	Total Jobs/HH
57	1661	604	980	372	0	0	140	0.23
58	544	198	321	122	0	1	264	1.34
59	707	257	418	158	914	3	132	0.52
60	1567	570	925	351	0	11	225	0.41
61	0	0	0	0	1018	0	106	0.00
62	605	220	357	135	0	3	166	0.77
63	1671	608	986	374	0	3	83	0.14
64	781	262	504	184	918	10	203	0.81
65	296	99	191	70	0	5	77	0.83
66	415	139	267	98	0	4	53	0.41
67	218	86	115	50	0	38	54	1.07
68	912	360	481	208	1153	82	359	1.22
69	145	57	77	33	0	25	36	1.07
70	18	7	9	4	0	63	5	9.70
71	380	150	200	87	0	25	34	0.39
72	634	250	334	145	0	0	103	0.41
73	162	64	85	37	0	640	546	18.60
74	530	209	280	121	0	24	321	1.65
75	188	74	99	43	0	9	45	0.73
76	134	53	71	31	0	6	32	0.73
77	504	199	266	115	0	0	15	0.07
78	20	8	11	5	0	0	1	0.14
79	436	153	257	98	0	1	44	0.29
80	47	17	28	9	0	1	21	1.24
81	303	102	195	71	0	204	488	6.81
82	705	278	372	161	0	6	155	0.58
83	181	67	109	34	176	7	12	0.29
84	384	151	202	88	0	20	93	0.75
85	325	128	171	74	0	37	57	0.73
86	725	264	428	162	0	0	4	0.02
87	1693	616	999	379	0	0	1050	1.71
88	1130	603	667	253	300	0	59	0.10
89	884	359	459	177	0	19	303	0.89
90	900	366	467	181	0	12	317	0.90
91	316	128	164	63	0	4	115	0.92
92	860	349	446	173	2778	7	345	1.01
93	170	69	89	34	0	187	345	7.67
94	559	227	290	112	0	7	203	0.92
95	340	138	177	68	0	4	124	0.92
96	802	326	416	161	0	6	292	0.91
97	194	79	101	39	0	30	71	1.29
98	83	34	43	17	0	13	31	1.29
99	305	124	158	61	0	12	115	1.02
100	313	127	163	63	0	5	110	0.90
101	615	250	319	123	0	9	215	0.90
102	2958	742	1746	662	0	117	104	0.30
103	1351	393	797	302	0	0	48	0.12
104	1705	795	1006	382	204	104	76	0.23
105	2259	696	1333	506	703	0	130	0.19
106	2452	571	1448	549	180	85	101	0.33
107	0	0	0	0	0	0	46	0.00
108	635	231	375	142	0	1	20	0.09
109	1895	689	1119	424	1610	1	41	0.06
110	1895	689	1119	424	0	281	100	0.55
Total	**80039**	**29552**	**46022**	**17829**	**15596**	**4144**	**16462**	**0.70**

Appendix C

Zonal Trip Productions and Attractions

Zones	Home Based (HB Trip Productions)				Home Based (HB Trip Attractions)			
	2011	2021	2031	2041	2011	2021	2031	2041
Internal Zones								
1	281	289	297	303	70	75	77	80
2	94	96	99	101	23	25	26	27
3	164	200	250	320	71	95	128	165
4	140	176	220	282	35	157	221	251
5	304	382	477	611	125	176	235	302
6	216	270	338	433	138	208	295	385
7	727	922	1152	1475	280	383	509	659
8	1171	1607	2008	2571	320	432	525	667
9	152	200	250	320	87	122	169	220
10	89	108	135	172	34	51	69	89
11	74	100	126	161	20	27	33	42
12	184	236	295	378	2621	2813	4195	4701
13	370	473	592	757	223	325	457	596
14	110	151	188	241	1117	1315	2812	3725
15	1255	1612	2015	2580	830	1222	1721	2230
16	401	513	641	820	236	352	495	646
17	386	477	596	763	207	301	420	546
18	290	358	447	572	153	226	315	409
19	229	234	241	246	78	87	103	118
20	158	193	746	955	104	159	345	446
21	200	247	309	395	82	114	153	197
22	400	406	416	425	131	150	175	200
23	400	424	435	447	131	150	175	200
24	302	310	318	326	561	849	1229	1586
25	487	496	509	522	188	221	260	299
26	420	427	439	450	140	167	201	234
27	973	1449	1817	1876	545	746	1055	1099
28	275	275	283	289	112	140	176	211
29	151	18	362	1309	65	13	102	314
30	740	1310	1643	1696	244	398	507	521
31	0	576	1033	1066	0	148	250	255
32	357	456	572	591	142	178	235	243
33	246	1669	2617	2702	108	1144	1508	1514
34	716	1304	1635	1689	198	344	424	432
35	372	652	818	844	269	395	544	569

Zones	Home Based (HB Trip Productions)				Home Based (HB Trip Attractions)			
	2011	2021	2031	2041	2011	2021	2031	2041
36	34	0	0	0	1564	1994	3287	3472
37	1293	1304	1635	1689	506	559	744	773
38	575	3895	6106	6305	245	1173	1701	1723
39	68	0	904	3268	26	15	239	933
40	68	0	904	3268	26	15	239	933
41	132	209	262	270	49	77	101	104
42	22	0	0	0	1033	1314	2168	2290
43	807	580	727	751	389	403	562	590
44	5	869	1526	2252	1	252	356	513
45	0	0	0	0	609	1331	1985	2659
46	14	191	300	309	198	1663	2128	2134
47	55	764	1198	1237	13	197	294	300
48	5	0	0	0	1	0	2	2
49	72	1019	1598	1650	17	263	392	400
50	159	2229	3495	3608	58	1420	2376	2146
51	0	1705	5496	5854	0	735	2254	2354
52	46	59	73	94	427	692	1042	1360
53	0	0	0	0	0	0	0	0
54	280	370	462	592	146	215	297	384
55	525	1449	1817	1876	293	563	761	788
56	276	351	628	648	82	105	176	180
57	113	1592	2496	2577	27	485	751	771
58	372	652	818	844	269	395	544	569
59	664	848	1063	1098	902	1003	1584	1379
60	1184	939	2355	2432	468	468	907	939
61	0	0	0	0	789	1273	1421	1183
62	848	725	909	938	325	334	449	467
63	1104	2003	2512	2593	335	565	703	720
64	1178	1200	1231	1263	736	1029	1400	1561
65	447	455	467	479	148	178	214	249
66	600	637	653	670	180	198	222	248
67	153	203	254	325	146	226	330	433
68	641	850	1063	1361	938	1356	2171	2599
69	102	135	169	217	99	151	220	289
70	12	17	21	27	143	238	363	483
71	276	354	443	567	143	202	279	363

Zones	Home Based (HB Trip Productions)				Home Based (HB Trip Attractions)			
	2011	2021	2031	2041	2011	2021	2031	2041
72	459	590	738	945	164	220	285	365
73	110	151	188	241	1658	3403	4197	5559
74	400	494	618	791	516	717	967	1245
75	134	175	219	280	71	107	148	192
76	96	125	156	200	55	76	106	137
77	373	470	587	752	93	126	154	195
78	15	19	24	30	4	7	9	11
79	143	548	950	677	54	165	268	219
80	68	69	71	72	26	35	44	53
81	454	465	477	489	772	1196	1768	2303
82	495	657	821	1051	217	295	394	506
83	259	265	273	278	152	99	116	134
84	290	358	447	572	153	226	315	409
85	248	303	378	484	167	248	354	464
86	14	0	0	1126	3	0	6	257
87	19	0	727	2627	5	0	593	2067
88	0	0	0	1754	0	0	0	778
89	909	1013	1149	1293	410	540	707	872
90	943	1032	1171	1317	404	529	688	845
91	313	362	411	462	143	187	244	300
92	886	985	1118	1258	1432	2254	3273	3655
93	166	195	222	249	691	1068	1569	2042
94	553	641	727	818	255	332	432	531
95	337	390	443	498	154	202	263	323
96	807	919	1043	1173	360	461	596	730
97	206	222	252	283	148	216	306	391
98	88	95	108	121	60	93	131	168
99	315	350	397	446	156	212	284	354
100	342	359	407	458	140	185	241	297
101	671	705	799	900	275	364	474	582
102	0	1337	4310	4590	0	634	1945	2032
103	0	611	1969	2097	0	167	512	534
104	0	771	2484	2645	0	533	1636	1672
105	0	1021	3291	3505	0	563	1728	1677
106	0	0	0	3806	0	0	0	1802
107	0	0	0	0	71	69	66	65

Zones	Home Based (HB Trip Productions)				Home Based (HB Trip Attractions)			
	2011	2021	2031	2041	2011	2021	2031	2041
108	21	54	273	985	8	27	92	253
109	21	0	814	2941	8	28	717	2355
110	13	0	814	2941	5	28	245	2874
111	0	0	0	0	0	0	0	0
112	0	0	0	0	0	0	0	0
113	0	0	0	0	0	0	0	0
114	0	0	0	0	0	0	0	0
115	0	0	0	0	0	0	0	0
116	0	0	0	0	0	0	0	0
External Zones								
117	5179	8803	11214	12331	10693	18444	24169	27658
118	17	29	277	357	107	185	597	802
119	38	65	101	131	29	50	80	108
120	540	918	1439	1857	201	347	555	746
121	1158	1968	3085	3983	518	893	1431	1923
122	720	757	796	836	490	515	541	569
123	164	190	214	242	155	180	203	228
124	229	389	610	788	175	302	483	650
125	1509	2565	4021	5190	2296	3960	6343	8522
126	166	282	442	571	104	179	287	386
127	107	118	131	144	82	91	100	111
128	153	169	187	206	118	130	144	159
129	1064	1809	2835	3659	770	1328	2127	2858
130	575	977	1532	1978	1160	2001	3205	4305
131	0	0	1384	1430	0	0	2984	3207
132	0	0	969	1072	0	0	2089	2405
133	0	0	0	1608	0	0	0	3608
134	0	0	0	1072	0	0	0	2405

Zones	Non Home Based (NHB) Trip Productions				Non Home Based (NHB) Trip Attractions			
	2011	2021	2031	2041	2011	2021	2031	2041
Internal Zones								
1	45	49	50	53	45	49	50	53
2	15	16	17	18	15	16	17	18
3	42	59	79	103	42	59	79	103
4	23	77	107	126	23	77	107	126
5	80	112	151	197	80	112	151	197
6	72	106	148	195	72	106	148	195
7	153	205	265	347	153	205	265	347
8	207	282	346	447	207	282	346	447
9	48	67	92	121	48	67	92	121
10	22	32	43	56	22	32	43	56
11	13	18	22	28	13	18	22	28
12	1144	1276	1920	2215	1144	1276	1920	2215
13	113	163	225	296	113	163	225	296
14	408	489	1038	1395	408	489	1038	1395
15	492	727	1025	1349	492	727	1025	1349
16	121	176	243	321	121	176	243	321
17	113	163	224	295	113	163	224	295
18	84	122	168	221	84	122	168	221
19	45	49	55	63	45	49	55	63
20	51	75	182	239	51	75	182	239
21	50	69	92	120	50	69	92	120
22	81	92	107	123	81	92	107	123
23	81	92	107	123	81	92	107	123
24	227	349	511	670	227	349	511	670
25	100	119	141	166	100	119	141	166
26	87	102	122	143	87	102	122	143
27	291	411	566	598	291	411	566	598
28	69	85	106	128	69	85	106	128
29	39	8	66	210	39	8	66	210
30	149	250	316	330	149	250	316	330
31	0	97	165	171	0	97	165	171
32	88	113	149	157	88	113	149	157
33	63	580	790	809	63	580	790	809
34	122	220	271	281	122	220	271	281
35	169	251	347	370	169	251	347	370

Zones	Non Home Based (NHB) Trip Productions				Non Home Based (NHB) Trip Attractions			
	2011	2021	2031	2041	2011	2021	2031	2041
36	607	793	1294	1393	607	793	1294	1393
37	319	356	476	504	319	356	476	504
38	145	748	1093	1126	145	748	1093	1126
39	16	9	156	621	16	9	156	621
40	16	9	156	621	16	9	156	621
41	31	48	63	66	31	48	63	66
42	398	519	848	913	398	519	848	913
43	243	253	354	378	243	253	354	378
44	1	164	236	345	1	164	236	345
45	128	300	413	581	128	300	413	581
46	63	580	750	765	63	580	750	765
47	9	129	194	201	9	129	194	201
48	1	0	1	1	1	0	1	1
49	11	172	259	268	11	172	259	268
50	37	743	1248	1177	37	743	1248	1177
51	0	389	1205	1280	0	389	1205	1280
52	244	399	605	803	244	399	605	803
53	0	0	0	0	0	0	0	0
54	85	123	168	221	85	123	168	221
55	157	328	433	455	157	328	433	455
56	53	67	114	118	53	67	114	118
57	18	315	492	514	18	315	492	514
58	169	251	347	370	169	251	347	370
59	428	492	764	692	428	492	764	692
60	287	286	567	596	287	286	567	596
61	340	554	632	542	340	554	632	542
62	204	210	283	300	204	210	283	300
63	212	364	454	473	212	364	454	473
64	385	523	698	792	385	523	698	792
65	92	109	129	152	92	109	129	152
66	113	124	138	155	113	124	138	155
67	67	101	144	191	67	101	144	191
68	441	638	1013	1241	441	638	1013	1241
69	45	67	96	127	45	67	96	127
70	46	78	119	161	46	78	119	161
71	73	101	136	179	73	101	136	179

Zones	Non Home Based (NHB) Trip Productions				Non Home Based (NHB) Trip Attractions			
	2011	2021	2031	2041	2011	2021	2031	2041
72	105	142	186	242	105	142	186	242
73	601	1249	1542	2074	601	1249	1542	2074
74	167	252	359	473	167	252	359	473
75	40	59	80	106	40	59	80	106
76	30	42	57	75	30	42	57	75
77	60	82	101	131	60	82	101	131
78	2	4	5	6	2	4	5	6
79	35	106	174	144	35	106	174	144
80	16	21	27	32	16	21	27	32
81	344	524	767	1006	344	524	767	1006
82	132	183	244	319	132	183	244	319
83	77	56	63	71	77	56	63	71
84	84	122	168	221	84	122	168	221
85	80	117	163	216	80	117	163	216
86	2	0	4	173	2	0	4	173
87	3	0	380	1350	3	0	380	1350
88	0	0	0	448	0	0	0	448
89	247	325	423	527	247	325	423	527
90	249	326	424	526	249	326	424	526
91	88	116	151	187	88	116	151	187
92	674	1053	1525	1747	674	1053	1525	1747
93	250	402	604	803	250	402	604	803
94	157	205	267	332	157	205	267	332
95	95	125	162	202	95	125	162	202
96	223	289	375	466	223	289	375	466
97	73	103	143	183	73	103	143	183
98	30	44	61	78	30	44	61	78
99	91	123	162	203	91	123	162	203
100	86	114	148	184	86	114	148	184
101	169	223	290	361	169	223	290	361
102	0	323	1001	1065	0	323	1001	1065
103	0	109	337	358	0	109	337	358
104	0	249	773	806	0	249	773	806
105	0	306	948	952	0	306	948	952
106	0	0	0	947	0	0	0	947
107	44	43	42	42	44	43	42	42

Zones	Non Home Based (NHB) Trip Productions				Non Home Based (NHB) Trip Attractions			
	2011	2021	2031	2041	2011	2021	2031	2041
108	5	16	59	168	5	16	59	168
109	5	16	358	1186	5	16	358	1186
110	3	16	158	1209	3	16	158	1209
111	0	0	0	0	0	0	0	0
112	0	0	0	0	0	0	0	0
113	0	0	0	0	0	0	0	0
114	0	0	0	0	0	0	0	0
115	0	0	0	0	0	0	0	0
116	0	0	0	0	0	0	0	0
External Zones								
117	0	0	0	0	0	0	0	0
118	0	0	0	0	0	0	0	0
119	0	0	0	0	0	0	0	0
120	0	0	0	0	0	0	0	0
121	0	0	0	0	0	0	0	0
122	0	0	0	0	0	0	0	0
123	0	0	0	0	0	0	0	0
124	0	0	0	0	0	0	0	0
125	0	0	0	0	0	0	0	0
126	0	0	0	0	0	0	0	0
127	0	0	0	0	0	0	0	0
128	0	0	0	0	0	0	0	0
129	0	0	0	0	0	0	0	0
130	0	0	0	0	0	0	0	0
131	0	0	0	0	0	0	0	0
132	0	0	0	0	0	0	0	0
133	0	0	0	0	0	0	0	0
134	0	0	0	0	0	0	0	0

Appendix D

Impact of Fruit Market Relocation and Intermodal Terminal Facility

Introduction

This report assesses the impact on truck numbers using the Northern Highway through Kilmore and Wallan as a result of any routing choice changes expected to flow from:

- Relocation of the Fruit and Vegetable Markets from Footscray to Epping
- Further development of the Somerton (AusTrak) intermodal terminal as an inland port.

The outputs of this report will be used as an input to the strategic traffic model which has been developed as part of the Kilmore-Wallan Bypass Planning Study. This study examines B-Double and semi-trailers only, anything smaller than this vehicle class has not been considered. Smaller trucks are not generally considered for interregional movement of produce and instead are used for local movement to and from market.

Truck movement study area

Figure 19 shows the study area for this assessment which broadly forms a triangle with Bendigo, Shepparton and north Melbourne forming the three corners.

Road Hierarchy and Factors that Affect Route Choice

The study area contains roads that vary in classification and usage. The principal north-south corridors are the Goulburn Valley/Hume Highway and the Calder Highway which all connect directly or indirectly to the Western Ring Road. For much of their length, these roads have high quality surfacing, multiple lanes and have been designed to provide a high speed connection between Melbourne and the areas to the north of the State. The strategic role of these roads and their importance as corridors for movement means that they are the focus of Government capital expenditure on the road network.

The Northern Highway and McIvor Highway also provide a north-south connection between Melbourne and the northern areas of the State along the central Murray area including the Echuca region. However, these routes service a more restricted hinterland and have not been developed to the same extent as the other northern routes. They are not as attractive for vehicles making longer distance strategic movements as they are slower, primarily single carriageway roads that pass through busy towns. The relatively poorer quality of the surfacing on some sections of local roads is a further factor which discourages their use by trucks (given that operators are sensitive to the costs associated with wear and tear on their vehicles).

Although the Northern and McIvor Highways can sometimes provide the most direct route between a given origin and a destination, the Goulburn Valley, Hume and Calder Highways are generally the preferred route choice as a result of ongoing improvements offering lower journey times and/or increased journey time reliability. Figure 20 shows travel times between various northern Victorian locations and the interchange of the Western Ring Road and Hume Freeway.

Figure 19: Truck assessment study area

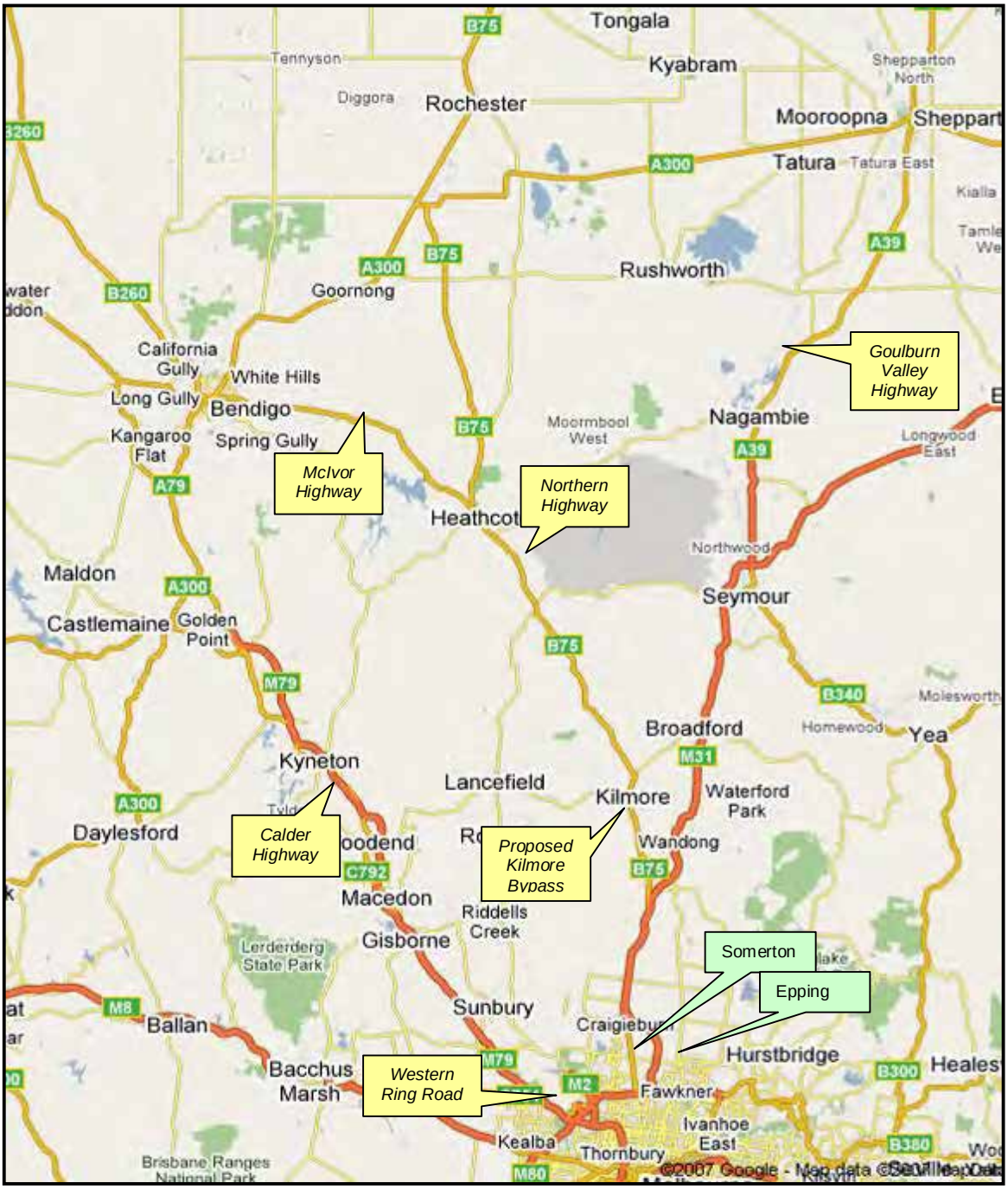
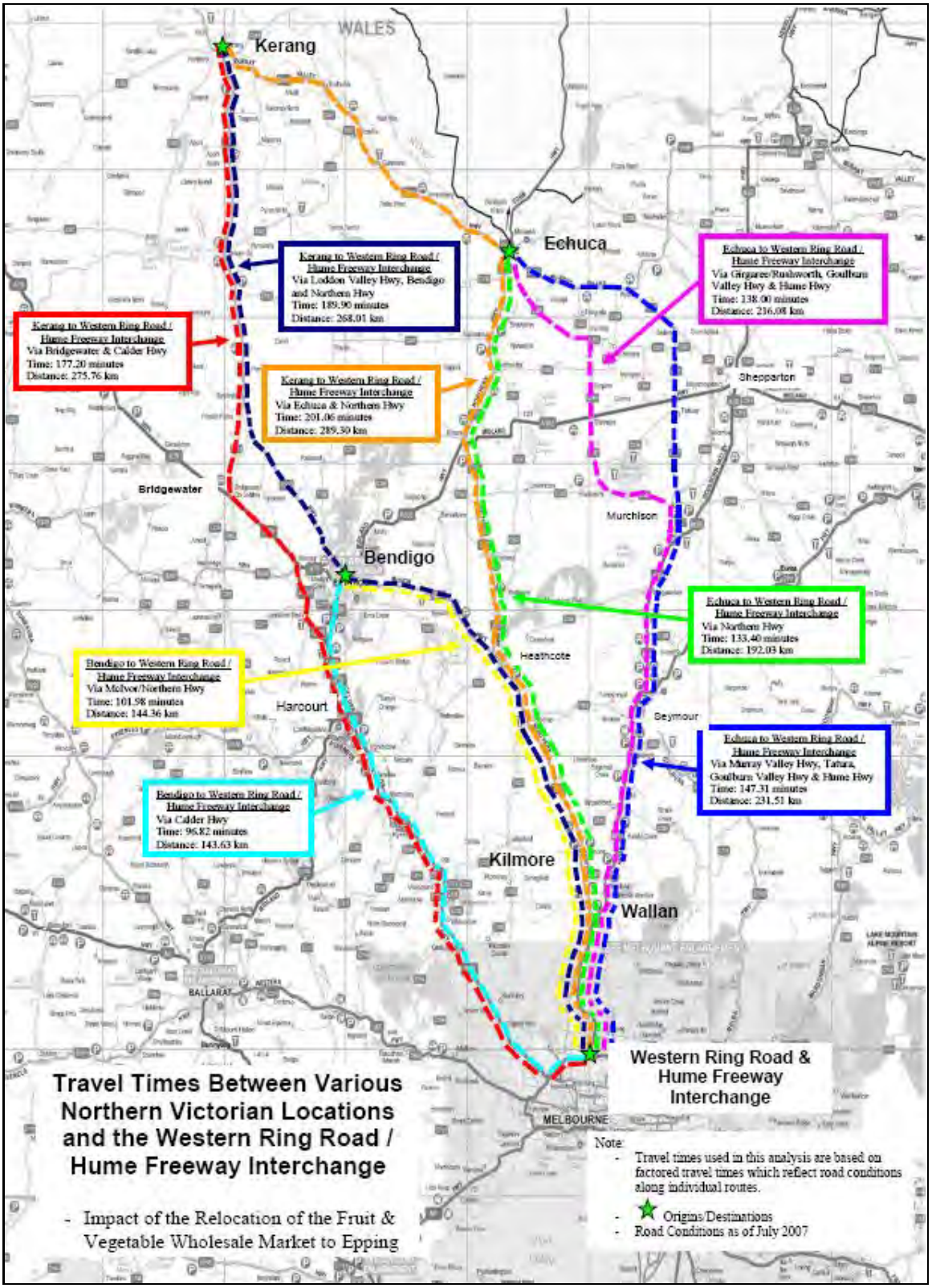


Figure 20: Travel times between various northern Victoria locations and the Western Ring Road/Hume Freeway



Issues for Consideration

This study considers the potential changes to truck volumes as a result of the introduction of the Kilmore-Wallan Bypass given proposed changes to the location of the Fruit and Vegetable Markets, and the growing importance of the Somerton intermodal terminal. These changes are described in the following sections.

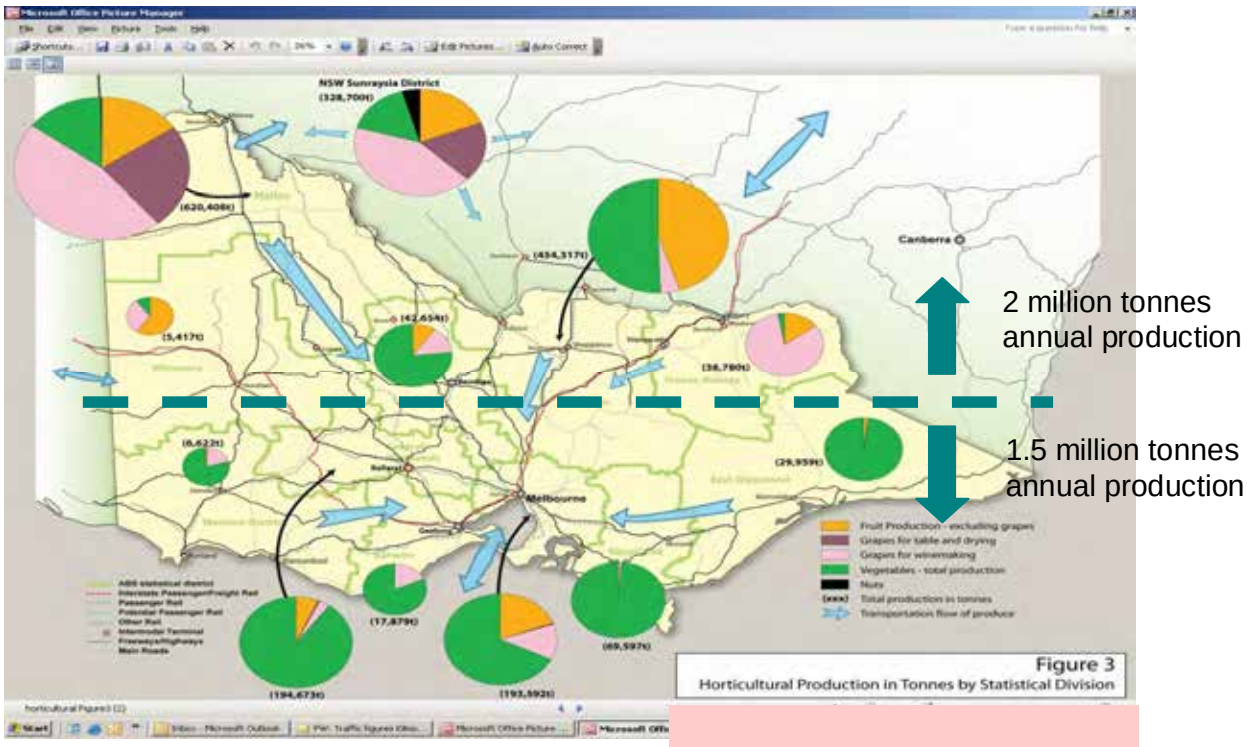
Melbourne Wholesale Market

The Melbourne Wholesale Markets are located only three kilometres from the centre of the city of Melbourne at 542 Footscray Road, West Melbourne. They have been at this site since October 1969, having formerly been located at the Queen Victoria Market site and prior to this at the Eastern Market and at the Western Market.

The Market is used by more than 4,000 grower, wholesaler and retail businesses with more than 7,000 individuals having access to the site for daily trading. The Wholesale Fruit and Vegetable Market houses over 600 grower/wholesaler stands and 140 wholesaler trading units.

Produce is delivered fresh from farms throughout Victoria, particularly from the 'Food Bowl Region' in the north, in the Murray and Goulburn Valleys. Trucks from these areas use the Goulburn Valley, Northern and Calder Highways to access the Markets. Figure 21 illustrates the relative tonnages of fresh produce from the various areas of the state and indicates the broad corridors used to access market. Significant quantities of produce are also consigned from other parts of Australia.

Figure 21: Truck assessment study area



Tropical produce arrives from New South Wales, Queensland and the Northern Territory and from abroad but trucks carrying this produce do not have a need to travel through Kilmore on the Northern Highway.

The Melbourne Market Relocation report states that approximately 40,000 vehicles, of which 34,000 are semi-tailors and 6,000 B-Doubles deliver to the Market annually. The Market operates 360 days per year this represents an average of 111 vehicles per day with an estimated 75% of total deliveries made from the northern regions of Victoria.

The Market serves the wholesale industry 4.30am to 11:00am. All deliveries are made between 5.00pm and 3.00am with buyers conducting business between 4.00am and 8.00am. Buyer associated vehicles are overwhelmingly smaller than those that deliver to the Market and generally comprise a mix of larger and smaller rigid refrigerated and non-refrigerated vehicles.

The proposed site for the relocation of the Wholesale Market is situated off Cooper Street in Epping and will be of a similar throughput capacity as the existing market.

Somerton Intermodal Terminal

The intermodal terminal at Somerton will provide an outer metropolitan hub where containers can be moved from road on to rail and then into the Port of Melbourne via a direct rail link. This facility has been provided because there is a growing constraint on capacity in and around the Port of Melbourne to expand storage and road capacity. It is anticipated that outer metropolitan intermodal terminals such as the one at Somerton will ease the demands on the Port.

The intermodal terminal which is located in the AusTrak Business Park is expected to remove 160 container movements to Melbourne Port each day. This gives some indication of the total amount of freight that may be directed towards the Somerton site, but of this, only a very small proportion is expected to result in road movements from the northern regions of the State.

Consultation

The strategic transport model developed by AECOM for the Kilmore-Wallan Bypass Planning Study contains an existing year scenario and future year scenarios incorporating 2021, 2031 and 2041. Over this time it is anticipated that the number of trucks on the highway network will increase as a result of economic growth and projected population rises. This anticipation is based on factors that are known at the present time.

Any redistribution of truck traffic that may occur as a result of the market relocation and activity at the Somerton intermodal terminal will be added to the baseline.

To establish existing truck flows across the network, key origins and destinations for freight and generate anticipated truck movements associated with major uses, AECOM contacted the following organisations:

- The Melbourne Market Authority
- AusTrak
- The Department of Infrastructure, Freight Logistics and Marine Division
- The Victorian Freight and Logistics Council.

The level of activity associated with certain activities was not forthcoming from the consultation because it was either not in existence or was commercially sensitive and the companies declined to release the information. In order to establish baseline truck flows for the study area it has been necessary to generate an estimate of demand based on the following sources:

- Assessment of the Victorian Freight Task (dated January 2002). This report was produced by Maunsell and was commissioned by the Department of Infrastructure. It is a comprehensive examination of all aspects of freight demand throughout Victoria and it contains a thorough analysis of road freight tonnage levels by route and by material and is an appropriate source for deriving truck numbers throughout the defined study area for the Kilmore-Wallan Bypass Planning Study

- Melbourne Market Relocation (dated January 2005) has also been referenced which was produced by Maunsell and commissioned by the City of Whittlesea. This is a policy based document that does not discuss truck origins and tonnage levels in detail. However the report does contain some broad tonnage throughput figures which have been used to determine the fruit and vegetable related truck flow assumptions within this study
- In 2012 we contacted several carriers to discuss some of the higher activity operators who run through Kilmore on a daily basis to ascertain the impact that a Kilmore-Wallan bypass would have on their operations. The output of these investigations was that Kilmore-Wallan bypass and the relocation of the intermodal terminal and fruit market will not result in a significant change in truck movements on the main arterial network.

Methodology and Growth Predictions

This section of the report will set out the methodology and growth predictions used to assess truck movements throughout the study area under the various scenarios determined for the Kilmore-Wallan Bypass Options Examination.

Years of Assessment

Truck flows across the network have been generated for the years 2012, 2021, 2031 2041. The future year scenarios have been run through the strategic transport model to assess the traffic impact of the proposed bypass.

Truck Movement Growth Rates

The following types of goods are transported by truck within the study area:

- Fruit and Vegetables
- Meat
- Grain
- Wood
- Steel and Building
- Motor Vehicles
- Dairy
- Minerals
- Other Manufactured
- Beverages
- Livestock.

It is anticipated that the number of trucks on the highway network will increase over the coming years due to economic growth factors and increases in population. Traffic counts completed within the study area since the early to mid-1990s show that the number of recorded truck movements on the major highways within the study area has generally increased. The recorded level of growth varies from corridor to corridor.

Traffic counts completed over the last 15 years within the study area on the major highways show an annual truck flow growth rate which varies from 0.5% to 6% per annum. It should be noted that the annual historical growth rates for truck movements on the Northern Highway north of Kilmore over the nine years prior to 2007 are lower at around 0.5% growth per year. From these historical truck count surveys it has been assumed that there will be an

average 3.5% increase in truck movements per annum. This growth factor has been applied to the truck flows associated with the transportation of all goods except fruit and vegetables.

It is not anticipated that the number of trucks transporting fruit and vegetables will increase significantly between 2012 and 2031 as there is a practical limit to the amount of produce that can be grown within a given area due to restrictions on water and soil fertility. In consideration of this it has been assumed that the number of daily truck movements associated with the transport of fruit and vegetables will increase by only 1% per annum as a result of efficiency/yield gains.

Deriving Network Truck Flows

Baseline truck flows for the study area have been derived from the Victorian Freight Task Report which contains product specific annual truck related flows for roads throughout Victoria.

Truck carrying capacities for each type of good vary depending on the shape and weight of goods being transported. The assumed tonnage carried per truck has been collected by AECOM for numerous port related transport studies and are represented in the table below.

Table 35: Truck capacity allocation by commodity

Goods	Tonnage Per Truck
Fruit and veg	10
Meat	15
Grain	30
Wood	20
Steal and building	30
Motor vehicles	20
Dairy	25
Minerals	25
Other manufactured	20
Beverages	25
Livestock	20

Obtaining Daily Truck Flows From Annual Data

Daily baseline truck flows for the study have been obtained by dividing the annual truck flow tonnage data into 360 trading days for operation of the Fruit and Vegetable Market.

Baseline Network Flows

The set of diagrams provided at the end of this report show baseline Melbourne bound truck movements (B double and semi-trailers only) throughout the study area in 2012, 2021 and 2031. These baseline flows are based on existing truck movements which have been increased for future year scenarios using the per annum growth rates outlined earlier.

The Hume Highway has the largest number of daily truck movements which is as expected given that this is a principal interstate route. The Midland Highway, Calder Freeway, Northern Highway (to the north of the Midland

Highway) and the Goulburn Valley Highway also have a large number of trucks movements compared to the flows on the McIvor Highway, and the southern section of the Northern Highway.

The current daily Melbourne bound **baseline** truck flows for truck traffic to the Market and Somerton Intermodal Terminal on the Northern Highway through Kilmore, without relocation of the Market and/or the full development of the Somerton Intermodal Terminal are shown in Table 36.

Table 36: Daily Melbourne bound baseline truck flows destined to the existing Market and Somerton Intermodal Terminal using the Northern Highway via Kilmore

Assessment year	Number of trucks
2012	14
2021	18
2031	26
2041	36

It should be noted that the above truck flows consist entirely of the larger truck varieties including semi-trailers and B-Doubles and represent long distance freight movements. Smaller truck types such as rigid trucks, flatbed trucks, transit vans and other bespoke vehicles capable of carrying goods such as tractors, and local truck movements, are not included in these figures.

Anticipated Changes to Truck Journey Patterns

The relocation of the market will only affect those trucks that are transporting fruit and vegetables. The increased level of container related activity that is anticipated at Somerton will only affect those trucks currently carrying export related goods. Trucks carrying fruit and vegetables and export related goods are therefore the focus of analysis regarding the potential for altered journey patterns on the Northern Highway.

Impact of the Market Relocation on Truck Journey Patterns

The relocation of the market will have some effect on the distribution of (B double and semi-trailer) truck movements throughout the study area however the relocation will only alter truck journey patterns from a small number of origins. It should be noted that fruit and vegetable related trucks that are travelling to the existing Market only make up a small proportion of total truck movements on the highway network. This is illustrated as part of the set of diagrams at the end of this report which show fruit and vegetable related truck flow and total truck flow.

Fruit and vegetable related trucks associated broadly with areas to the northwest of Bendigo make their way to the existing market via the Calder Highway and the Loddon Valley Highway before using the Calder Freeway to the south of Bendigo.

Once the market has relocated to Cooper Street in Epping, the Northern Highway provides a marginally more direct route (approximately 1 km) based on distance compared to the Calder Highway for trucks to and from the centre of Bendigo. Use of the McIvor Highway for trucks originating from north of Bendigo would require trucks to travel through the built up area of Bendigo which is not attractive option. It should also be noted that the McIvor and Northern Highways are not of the same standard as the Calder Highway; it is single carriageway width road with a low design speed that passes through six towns between Bendigo and Melbourne. Other than any yet to be confirmed improvements in the Wallan and Kilmore area, there are no proposed changes to the McIvor and Northern Highways that are likely to improve travel times on this route. Continued improvements to Calder Highway have resulted in freeway standards south of Bendigo

In summary, the total journey distance to the relocated market site from Bendigo is much the same when taking the McIvor/Northern Highway route or the Calder Freeway route, but journey times will be greater via Kilmore and

truck maintenance will increase due to the lower road standards and more variable terrain. Consequently, fruit and vegetable trucks from north of Bendigo are expected to continue to travel down the Calder Highway and access Cooper Street via the Western Ring Road which is principal route with multiple lanes and a high design speed. It should be noted that market related trucks generally travel during off peak times (late at night/very early in the morning) so are not affected by traffic congestion such as that which can occur on the Western Ring Road.

Fruit and vegetable related tucks associated broadly with the Shepparton area travel to the existing market via the Goulburn Valley and Hume Highways which are generally multi-lane principal corridors with a high design speed links. There will be a gradual further improvement in the Goulburn Valley Highway including bypasses off Nagambie, Shepparton and Strathmerton. Once the market has been relocated to Cooper Street It is anticipated that these trucks will continue to use the Goulburn Valley/Hume Freeway route.

Fruit and vegetable related trucks associated with the Echuca area travel to the existing market via the Midland Highway and the Calder Freeway. Once the Goulburn Valley Highway improvements are completed it is anticipated that these trucks will change their route preference and will primarily travel down the Goulburn Valley Highway. It is predicted that a small number of trucks will travel down the Northern Highway via Heathcote. When assessing the impact of the market relocation on Kilmore it has been predicted that 70% of trucks from the Echuca area will switch routes and travel down the Goulburn Valley Highway with the remaining 30% will continue to travel on the Northern Highway via Kilmore.

This prediction is based on advice to VicRoads from the freight transport forums that a considerable amount of these trucks may be diverted to the Goulburn Valley Highway once duplication of this route is completed and the Shepparton Bypass has been established. The route from Echuca via the Goulburn Valley Highway/Hume Freeway is marginally longer (approximately 14 km) but the route is significantly flatter and will be gradually upgraded freeway conditions for most of the route with only one small town to pass through and therefore likely to be increasingly attractive.

Origin-destination data with the Victorian Freight Task Report indicates that 1 truck per day carrying fruit and vegetables is currently travelling along Northern Highway through Kilmore. This vehicle has an origin in the local area and is expected to continue to use local roads when the market is relocated.

The diagrams provided at the end of this report show the base fruit and vegetable related truck flows and changes to truck flow as a result of the market relocation for 2012 (base case only), 2021, 2031, and 2041. These figures have been generated using the route preference principles as set out above. The figures show that the majority of fruit and vegetable related trucks travel to the existing market location via the Calder Freeway and the Hume Highway. With reference to these figures the fruit and vegetable flows via Kilmore under the various scenarios are summarized in Table 37 below.

Table 37: Fruit and vegetable related truck flows via the Kilmore area (B Doubles and semi-trailers only)

2012	2021			2031			2041		
Base Case	Base Case	Change due to relocation	Proposed total F&V truck flow	Base Case	Change	Proposed	Base Case	Change	Proposed
0	0	1	1	0	1	1	0	1	1

In conclusion once the market has relocated it is predicted that there will be a slight uplift in truck numbers due to an increase in the number of trucks travelling via Heathcote from the Northern Highway. However it is predicted that the majority of trucks from the Echuca – Southern NSW area will re-route via the Goulburn Valley Highway once the market is relocated.

Impact of Somerton Intermodal Terminal on Truck Journey Patterns

It is anticipated that the intermodal terminal at Somerton will intercept some Melbourne Port related truck trips from origins to the north of the city. Export related trucks have the same route preference characteristics as trucks associated with the transportation of fruit and vegetables and for travel from Northern Victoria primarily use the Calder Freeway, Goulburn Valley Highway/Hume Freeway and Western Ring Road.

Within this assessment it has been predicted that 70% of all B-Double and Semi-trailer trucks (except those carrying fruit and vegetables) are associated with the export market and are travelling to Melbourne Port. Assessment has been made on the basis that 30% of this 70% will use the Somerton inter modal terminal in the future instead of Melbourne Port. It is expected that the terminal will attract 160 truck movements per day (as stated within a Victoria press release dated May 18, 2005). Within the flow diagrams the assumed 2021 truck flow to Somerton is 371 trucks per day.

It is not anticipated that the Somerton intermodal operations will change truck route preferences for the vast majority of trucks that currently use the Calder Freeway and Hume Highway to get to Melbourne port for the same reasons that fruit and vegetable related trucks will continue to use the same principal routes when the market relocates.

The Victorian Freight Task Report indicates that in 2007, 32 trucks per day are carrying export goods and are on the Northern Highway at Kilmore. These trucks are most likely to be from Echuca and for the basis of the report it is considered they will continue to use the Northern Highway in future scenarios and that trucks from further east and west of the Northern Highway would be inclined to use the Calder, Goulburn Valley and Hume Highway routes to Somerton.

The diagrams at the end of this report have been generated with reference to the Victorian Freight Task Report. These diagrams show total export related truck flows, Somerton related truck flows and changes to truck flow as a result of new trips to the Somerton intermodal terminal for 2007 (total export only), 2021, 2031 and 2041. These diagrams have been generated using the route preference principles as set out previously in this report.

With reference to these diagrams the total export and modal interchange related truck flows via Kilmore under the various scenarios are summarised Table 38 below.

Table 38: Daily Melbourne bound export and intermodal terminal related truck flows via the Kilmore area (B Doubles and semi-trailers only)

	2012	2021	2031	2041
Total export related truck flow via Kilmore	9	13	18	25
Total Somerton related truck flow via Kilmore	-	4	5	8
Number of additional vehicles that will re-route to Somerton via Kilmore	-	2	2	8

In 2021 the baseline number of export related trucks travelling via Kilmore is 13 trucks this will increase to 18 trucks by 2031 as a result of the growth rate identified earlier. In 2021, 4 of the 13 trucks that are already using the Northern Highway will travel to Somerton instead of Melbourne Port with the remaining trucks continuing to travel to Melbourne Port. In the context of these vehicles the inter modal terminal will result in reduced truck flows on the Western Ring Road but truck flows on the Northern Highway local to Kilmore will not change as these trucks are already on the network. In 2021 there will be 2 additional truck movements per day via Kilmore as a result of the intermodal terminal. This vehicle will have come from the Echuca area and will have travelled via Heathcote on the Northern Highway rather than using the Goulburn Valley Highway to the intermodal terminal as per the prediction for the majority of Echuca trucks.

The net effect of the intermodal terminal will be 2 additional truck movements per day over the baseline figure derived for 2021. It should be noted that this figure is premised on the terminal flows of 371 trucks per day with the Government predicting that the facility will attract 160 trucks per day.

Conclusion

This report has established that market relocation and the intermodal facility will have some impact on truck journey patterns throughout the study area. However, it should be noted that these developments will only be relevant to a small proportion of trucks on the network.

The McIvor and Northern Highways are secondary order roads that are used primarily by local traffic and some longer distance movements from the Echuca area to Melbourne. Longer distance traffic from other parts of the northern areas of the State prefers to use the " A " Road network including the Calder, Goulburn Valley and Hume Highways. The McIvor and Northern Highways will largely remain lower speed single carriageway sections with delays caused by the need to transit through intermediate towns along the route. Although traffic speeds will be increased on the Kilmore-Wallan section should a bypass be built it will still be quicker and easier for the vast majority of trucks that already use the "A' Roads or the highway network to continue to do so.

It is predicted that the relocation of the Market to Epping and increased truck related activity at Somerton will marginally increase the number of trucks expected to travel through Kilmore.

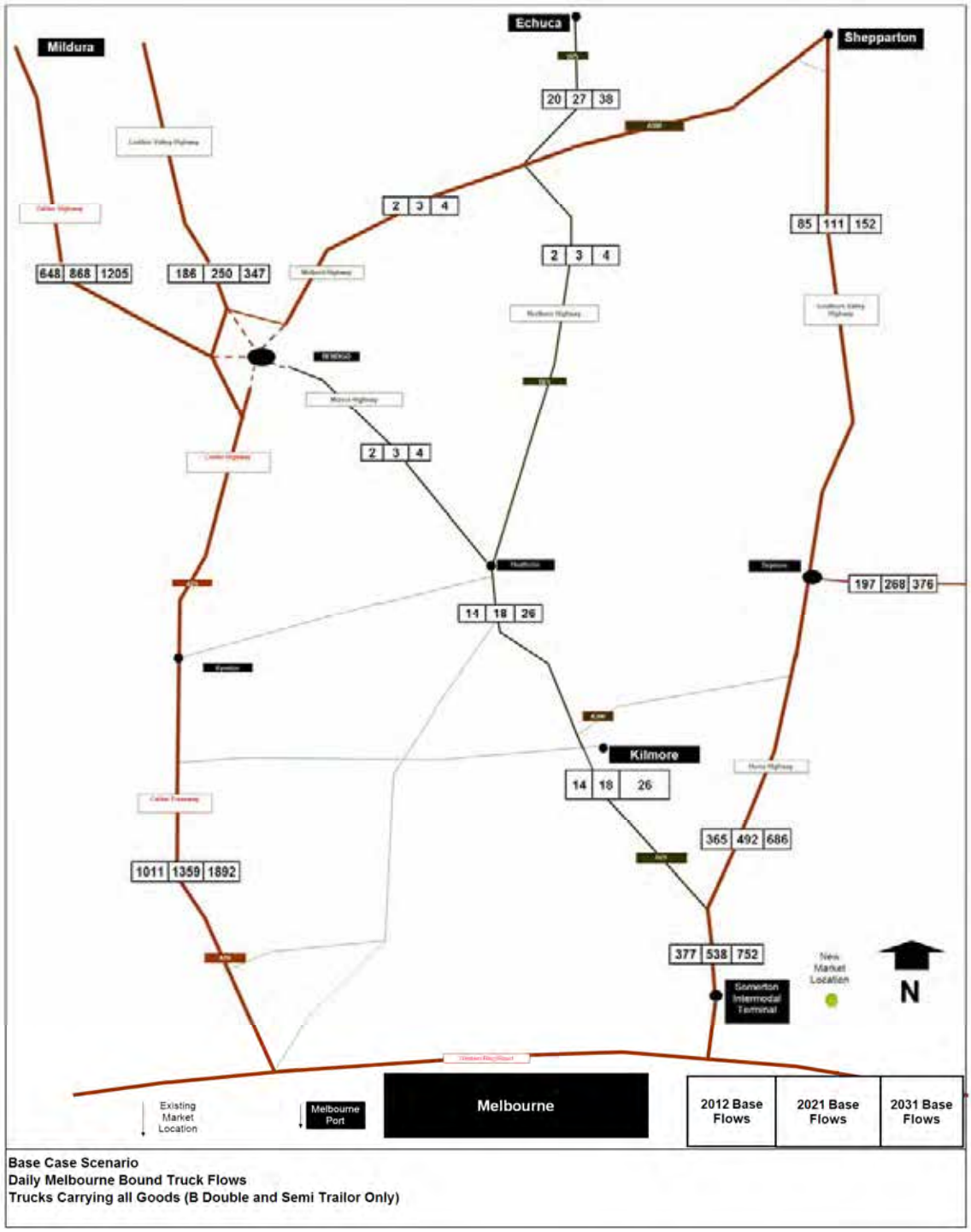
The diagrams provided at the end of this report shows total predicted truck flows within the study area in the base case and proposed scenario for 2021, 2031 and 2041. With reference to these diagrams truck flows via Kilmore under the various scenarios are summarised in Table 39 below.

Table 39: Summary of increases in truck movements as a result of the Market relocation and growth of Somerton Intermodal terminal

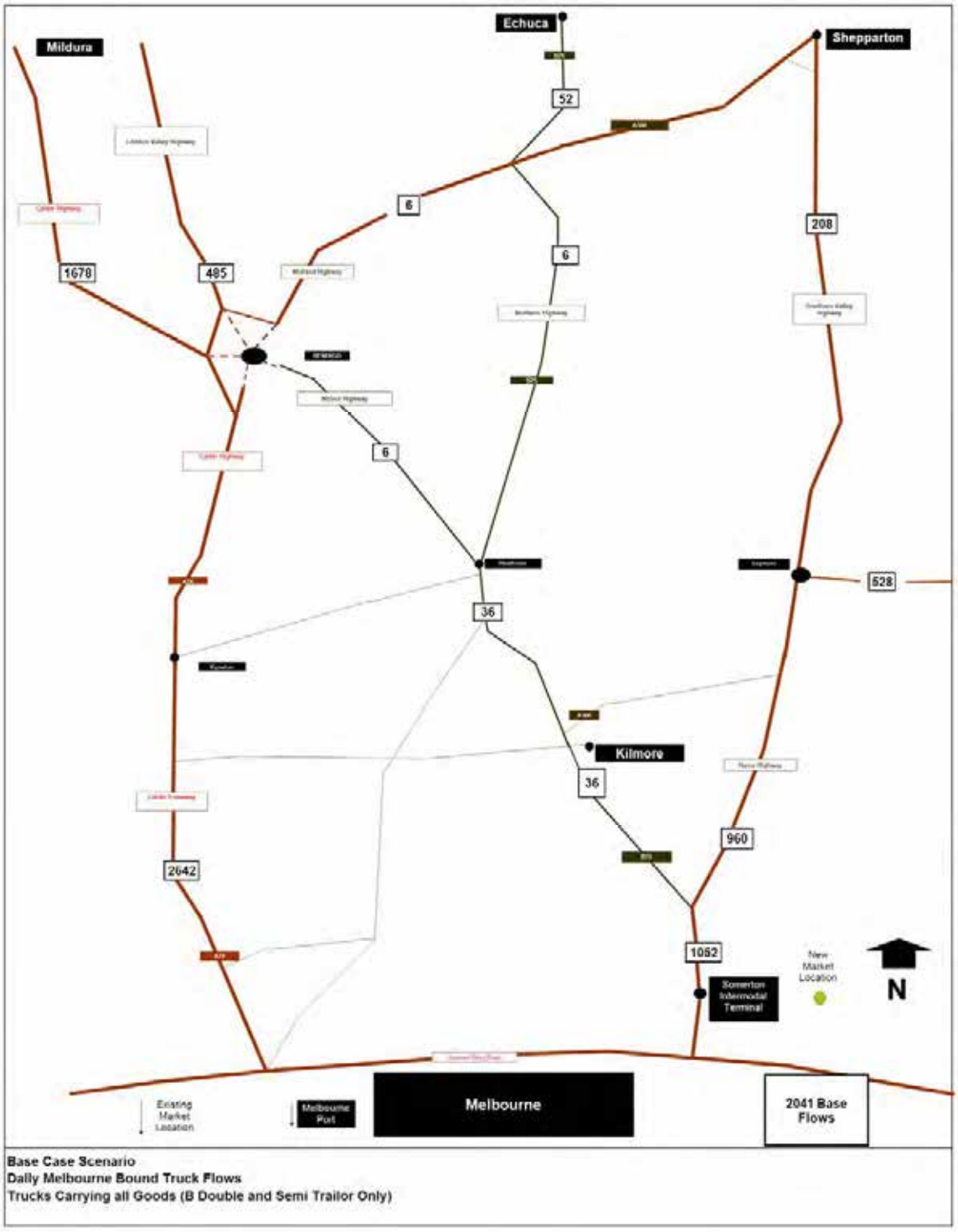
	2021			2031			2041		
	Base flow	Change in flow	Forecast flow	Base flow	Change in flow	Forecast flow	Base flow	Change in flow	Forecast flow
Daily total truck flows on the Northern Highway via Kilmore	18	2	21	26	3	29	36	3	39

In conclusion, it is predicted that the total truck vehicle flow (in terms of articulated B-double and semi-trailers) will not rise significantly as a result of the Market, the intermodal terminal and a bypass of Kilmore-Wallan.

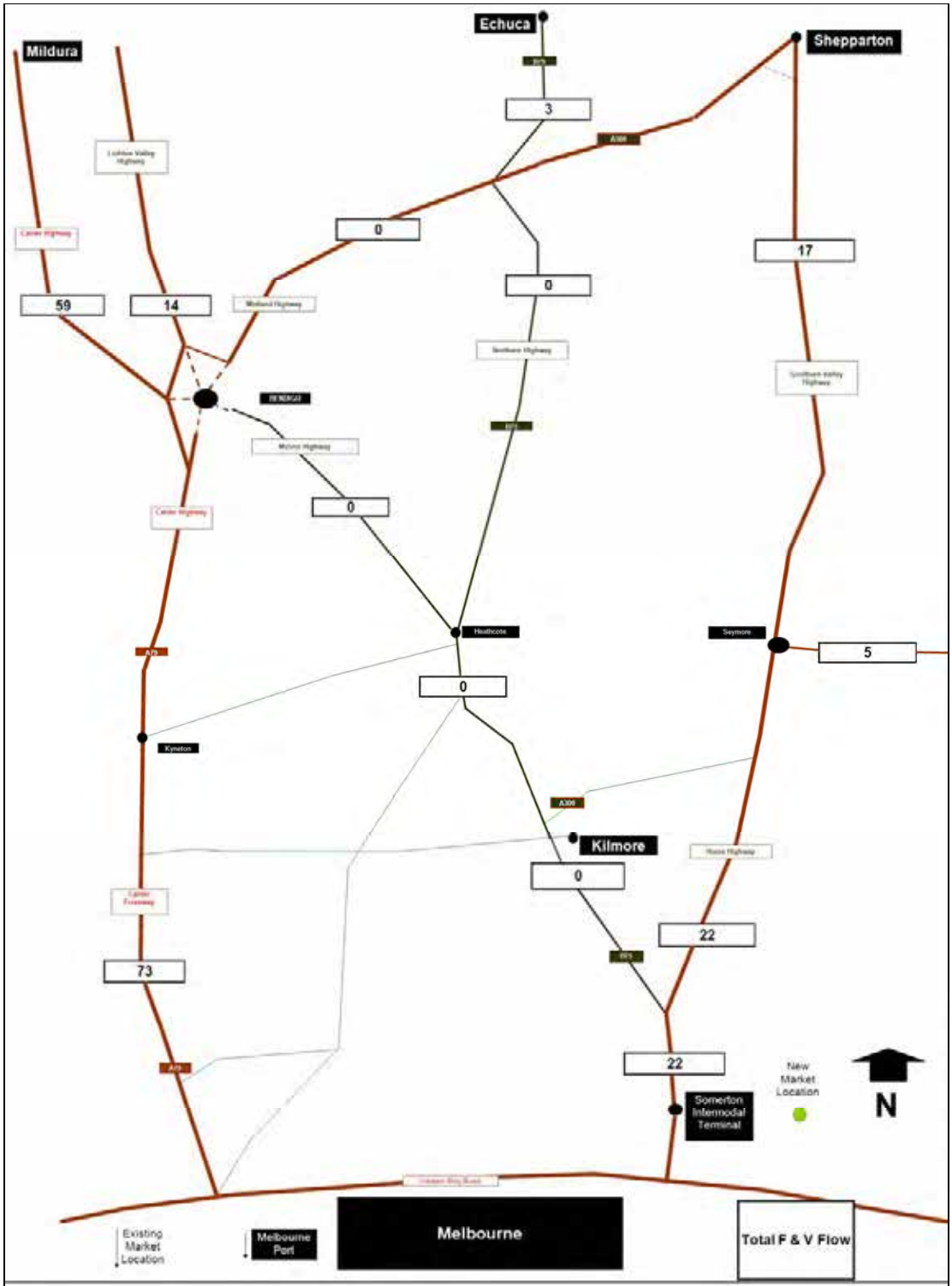
Baseline Truck Movements



Base Case Scenario
Daily Melbourne Bound Truck Flows
Trucks Carrying all Goods (B Double and Semi Trailor Only)

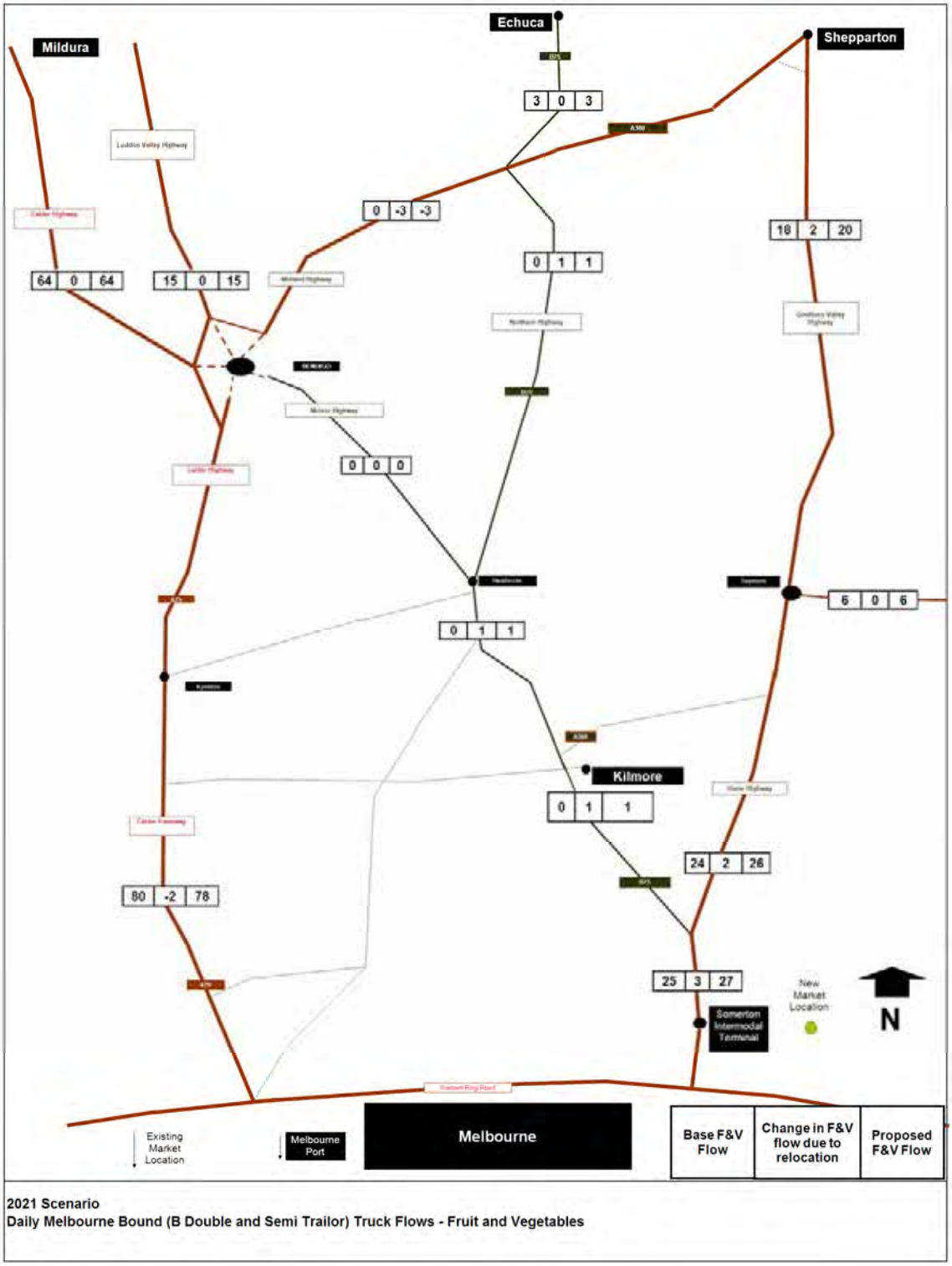

Mildura
Echuca
Shepparton
52
6
208
6
1678
485
6
36
528
Kilmore
36
960
2642
1082
Somerton Intermodal Terminal
New Market Location
N
Existing Market Location
Melbourne Port
Melbourne
2041 Base Flows
Base Case Scenario
Daily Melbourne Bound Truck Flows
Trucks Carrying all Goods (B Double and Semi Trailor Only)

Fruit and Vegetable Truck Flows

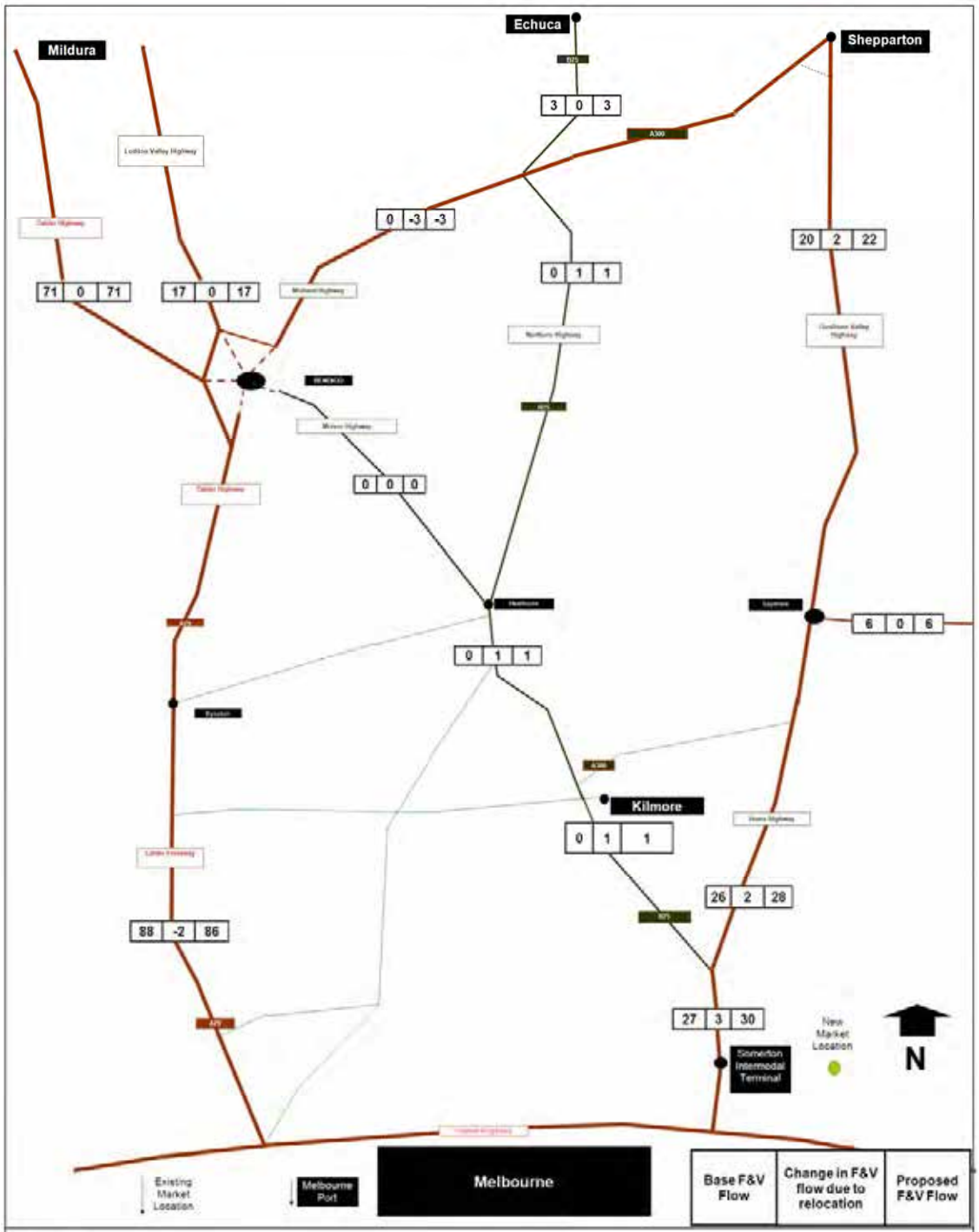


2012 Existing Scenario
Daily Melbourne Bound (B Double and Semi Trailor) Truck Flows - Fruit and Vegetables

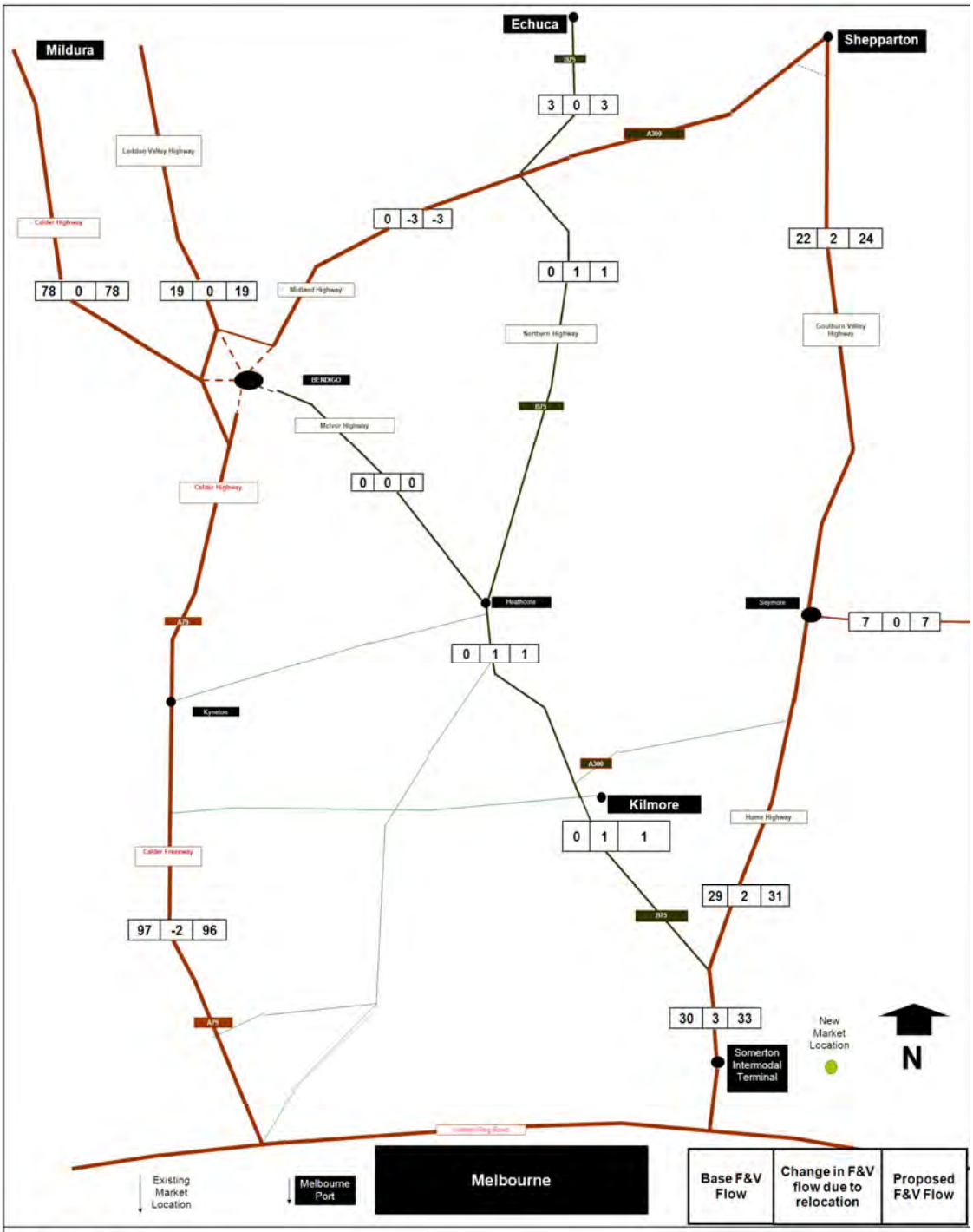
Relocated Market Truck Flows



2021 Scenario
Daily Melbourne Bound (B Double and Semi Trailor) Truck Flows - Fruit and Vegetables

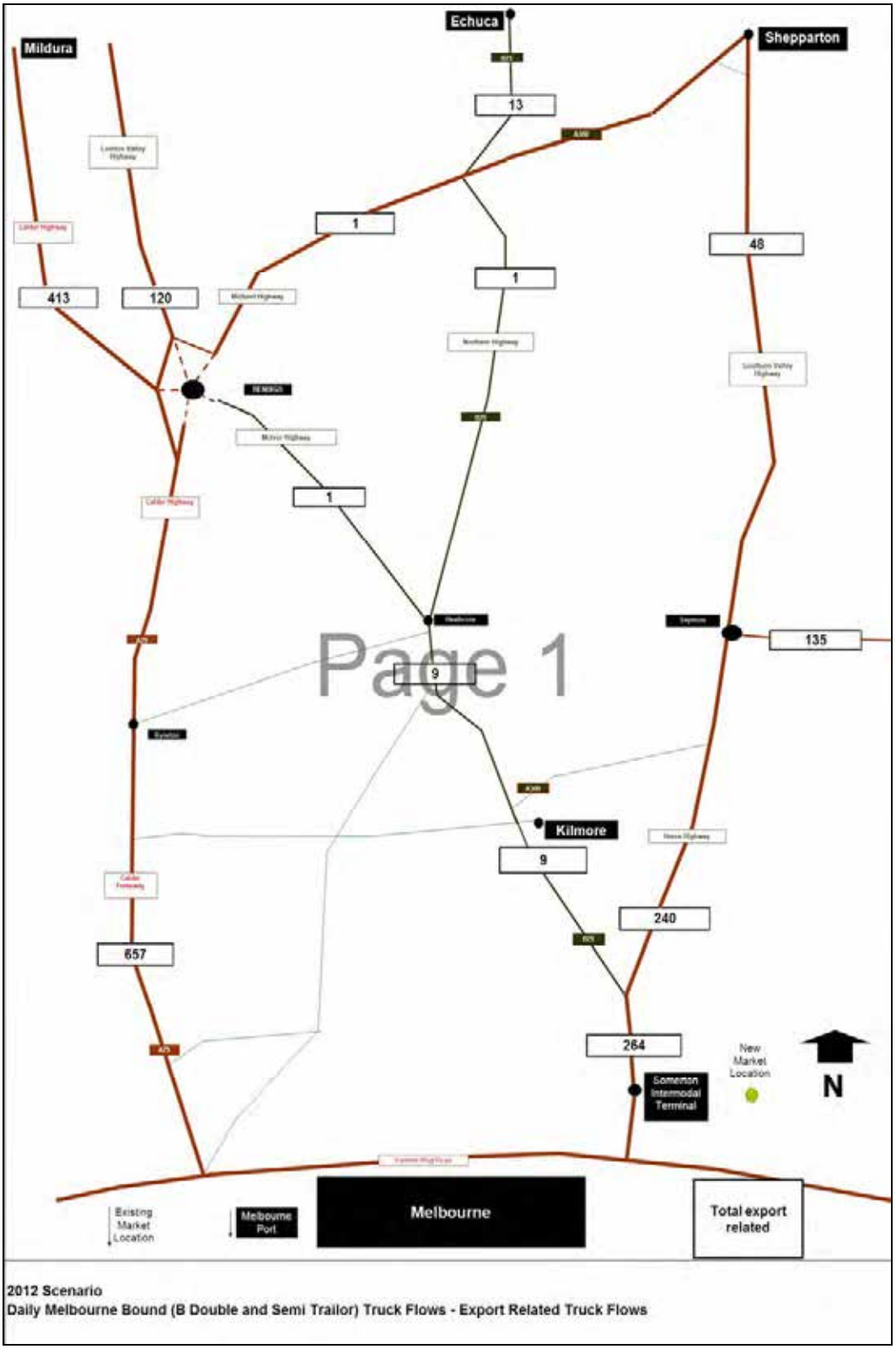


2031 Scenario
Daily Melbourne Bound (B Double and Semi Trailor) Truck Flows - Fruit and Vegetables

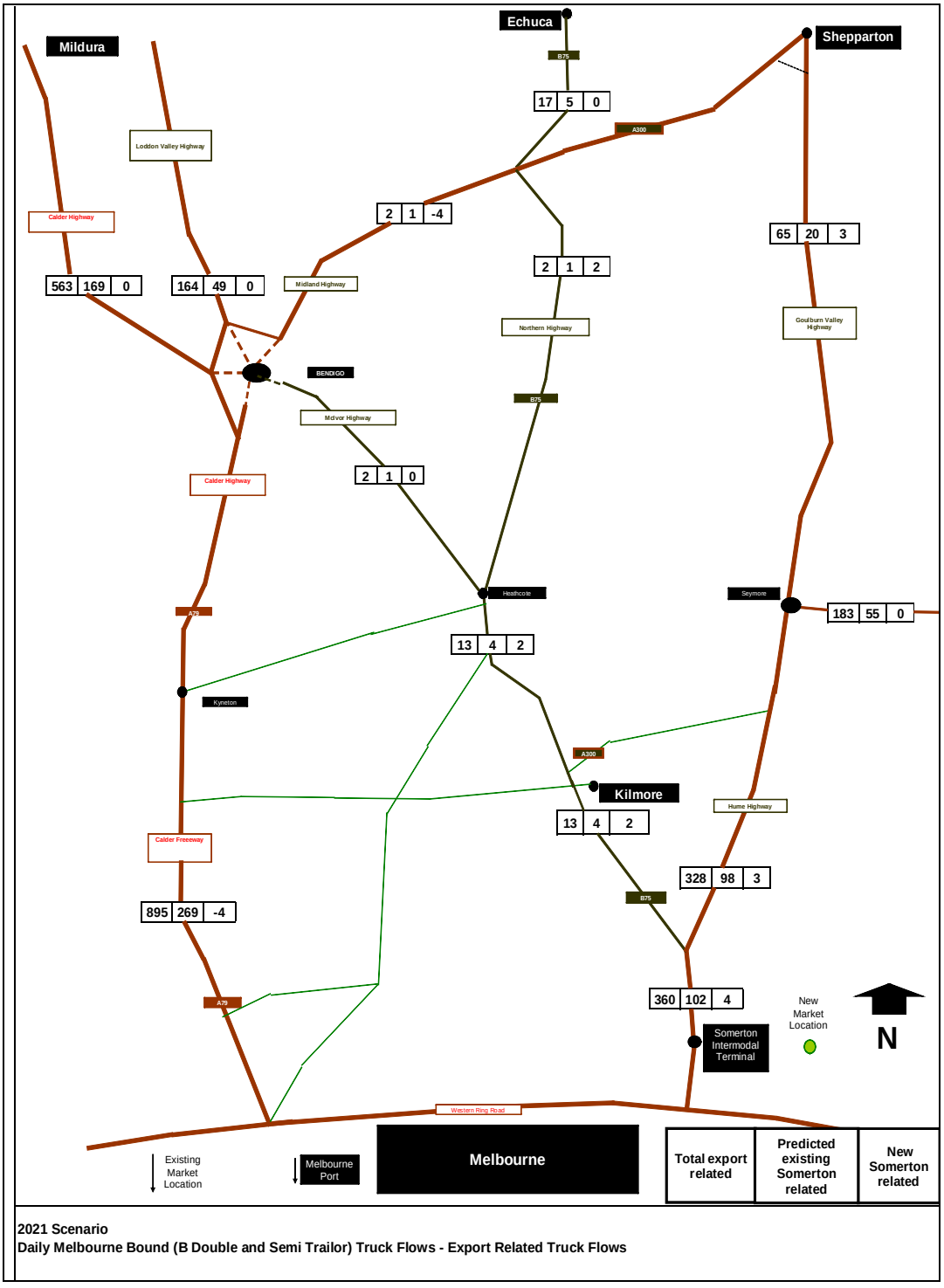


2041 Scenario
Daily Melbourne Bound (B Double and Semi Trailor) Truck Flows - Fruit and Vegetables

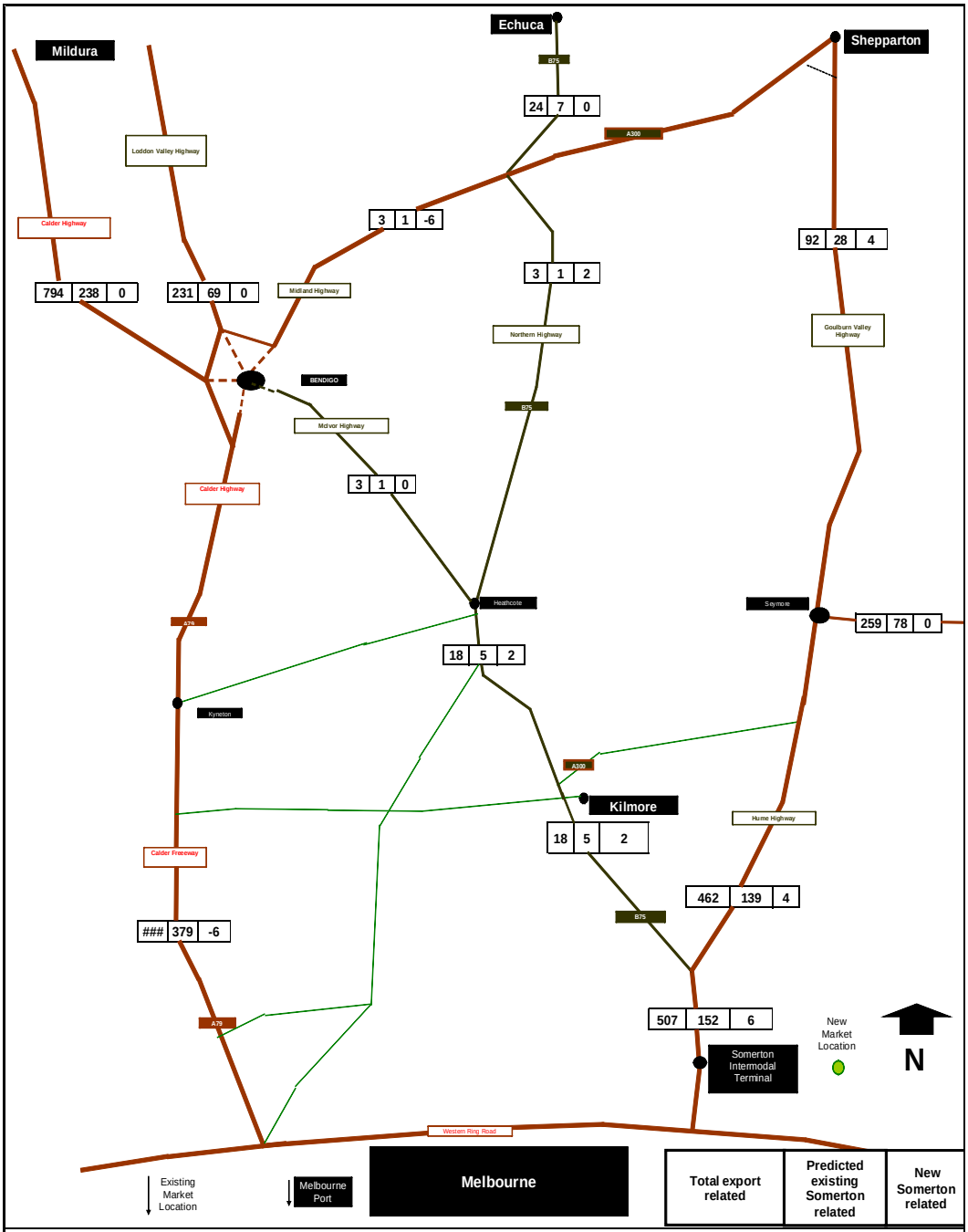
Intermodal Truck Flows



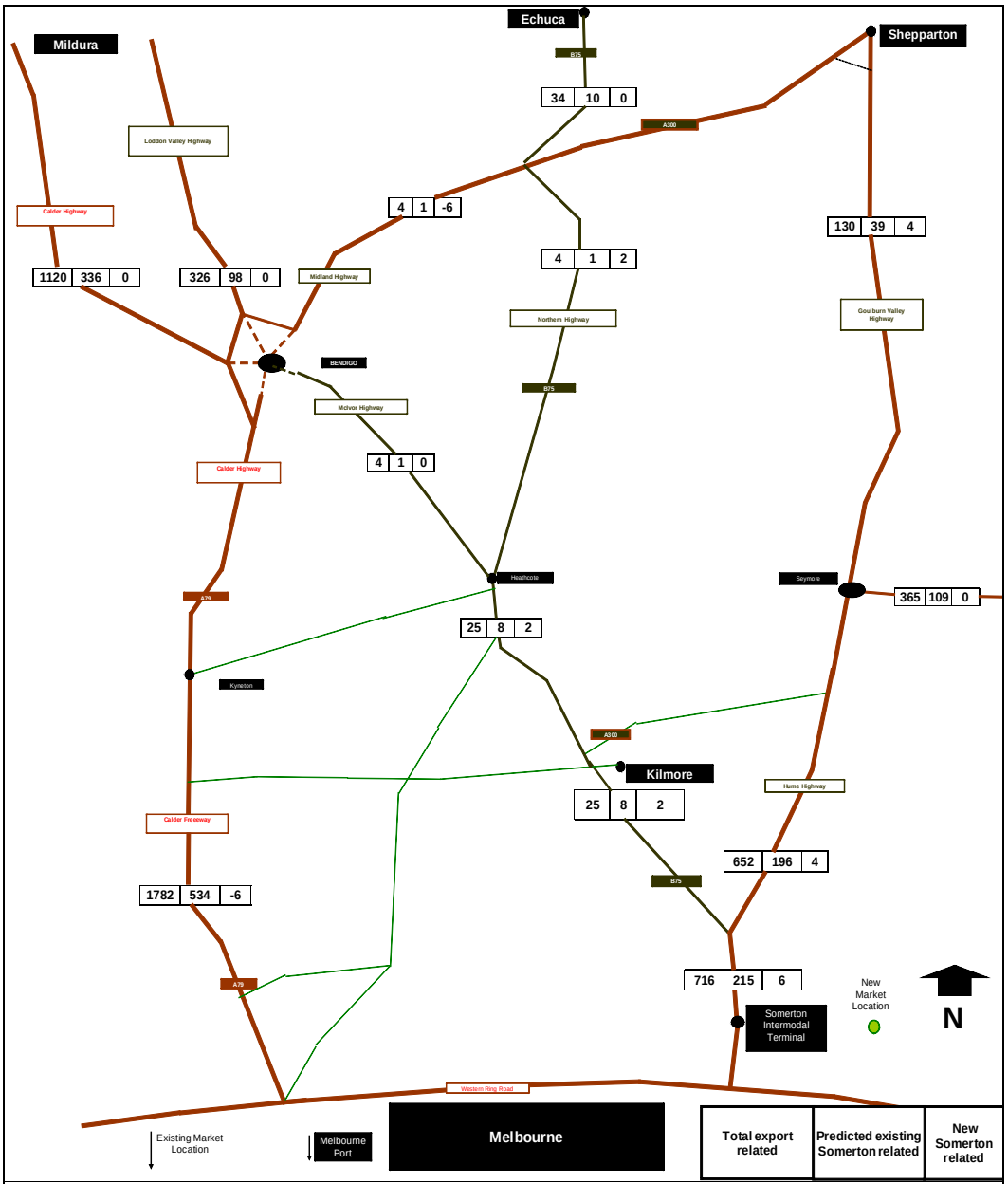
2012 Scenario
Daily Melbourne Bound (B Double and Semi Trailor) Truck Flows - Export Related Truck Flows



2021 Scenario
Daily Melbourne Bound (B Double and Semi Trailor) Truck Flows - Export Related Truck Flows

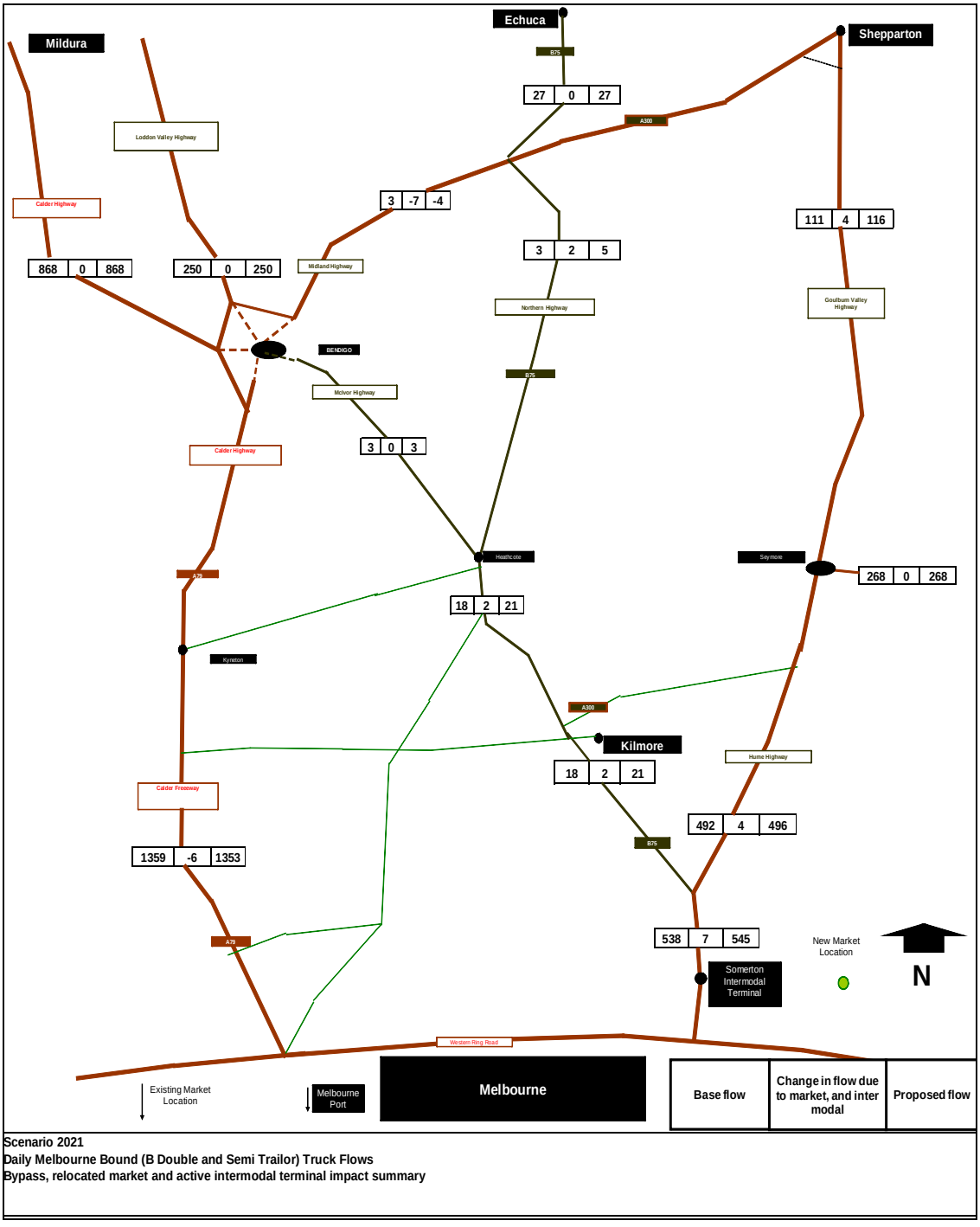


2031 Scenario
Daily Melbourne Bound (B Double and Semi Trailor) Truck Flows - Export Related Truck Flows

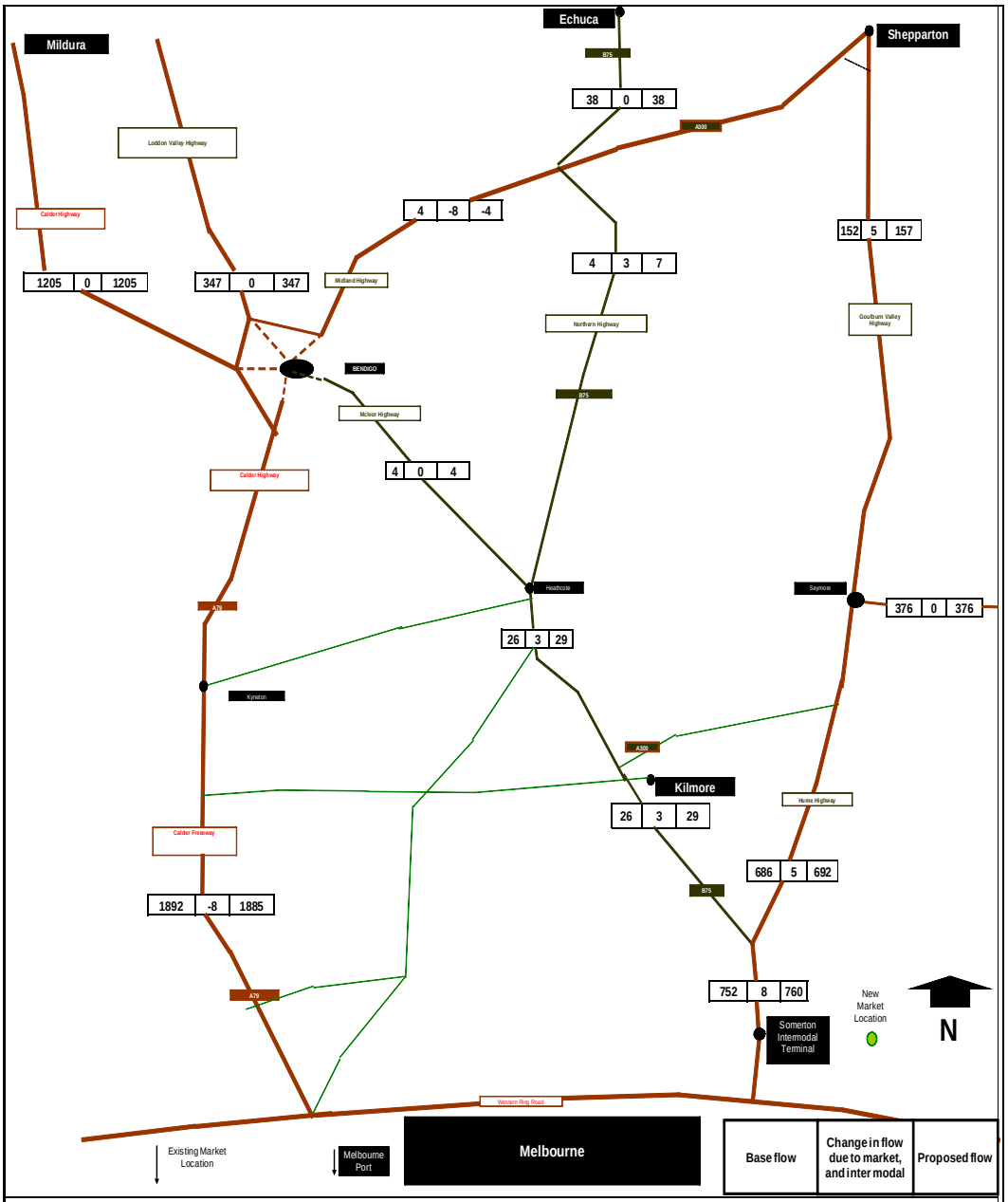


2041 Scenario
Daily Melbourne Bound (B Double and Semi Trailor) Truck Flows - Export Related Truck Flows

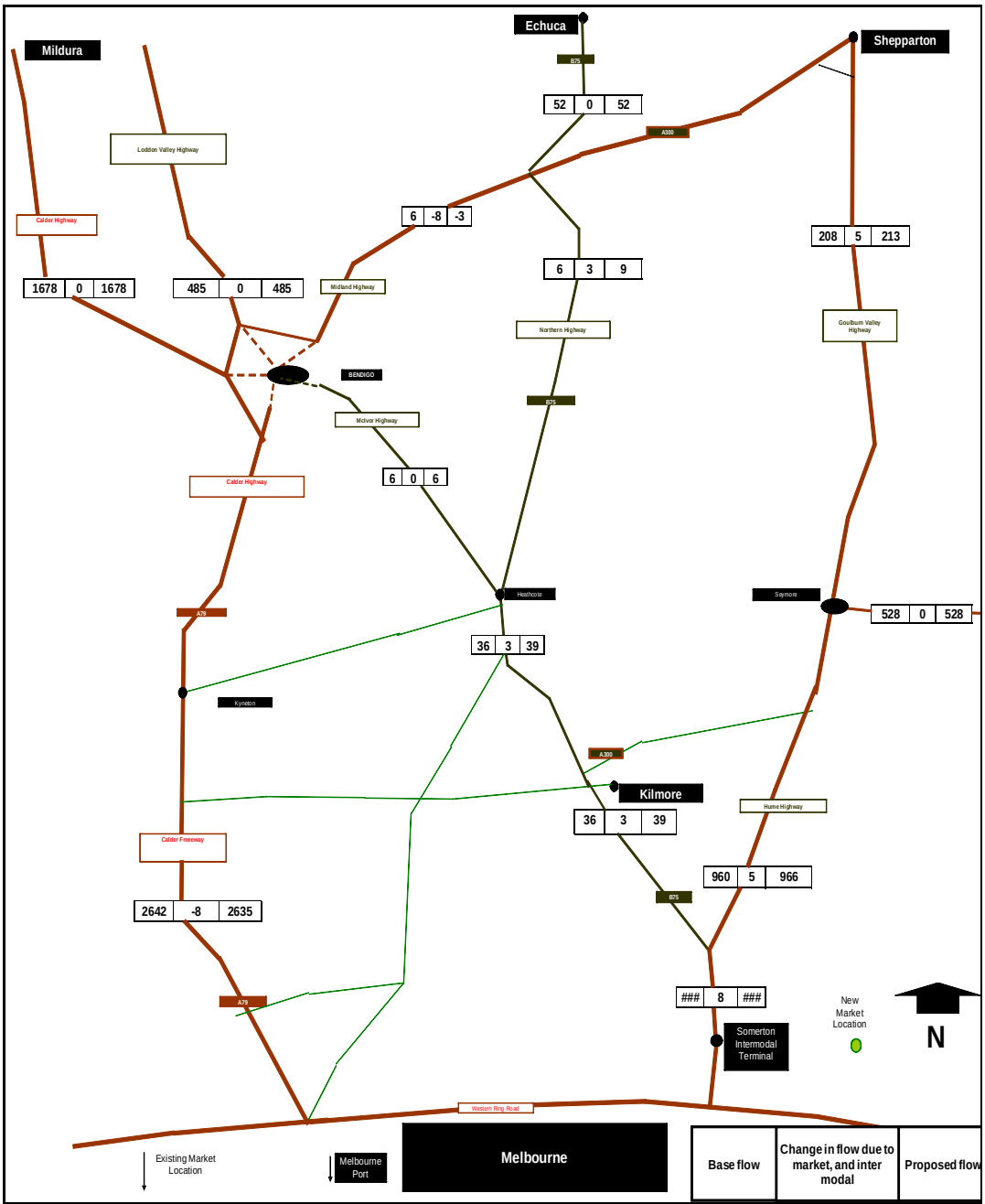
Forecast Combined Truck Flows



Scenario 2021
Daily Melbourne Bound (B Double and Semi Trailor) Truck Flows
Bypass, relocated market and active intermodal terminal impact summary



Scenario 2031
Daily Melbourne Bound (B Double and Semi Trailor) Truck Flows
Bypass, relocated market and active intermodal terminal impact summary



Scenario 2041
Daily Melbourne Bound (B Double and Semi Trailor) Truck Flows
Bypass, relocated market and active intermodal terminal impact summary

Appendix E

Traffic Volume Plots

Figure 22: Two-way vehicle traffic volumes in year 2011

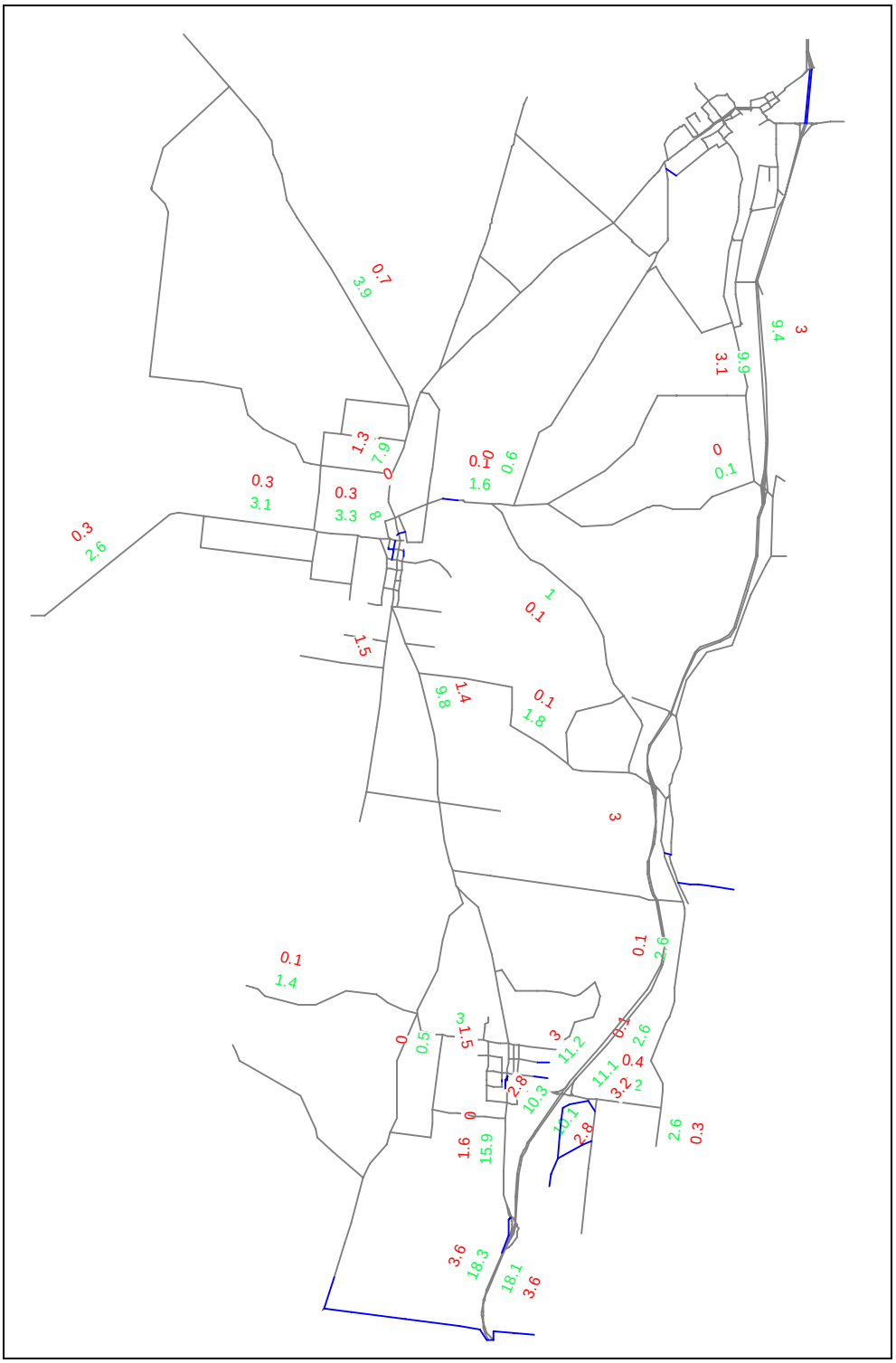


Figure 23: Kilmore township two-way vehicle traffic volumes in year 2011

Figure 24: Wallan township two-way vehicle traffic volumes in 2011

Figure 25: Two-way vehicle traffic volumes in year 2021 (Base case)

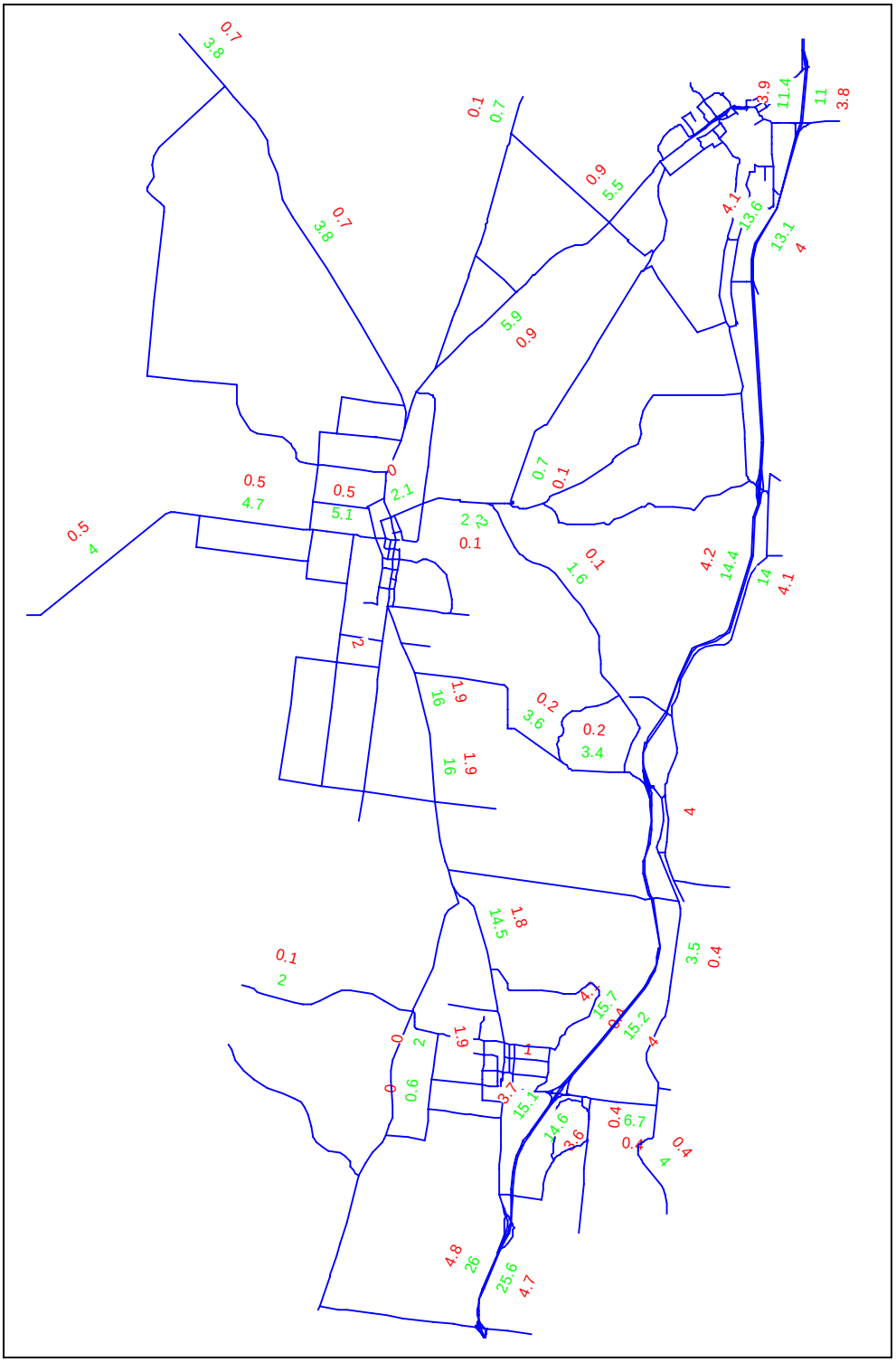


Figure 27: Kilmore township two-way vehicle traffic volumes in 2021 (Base case)

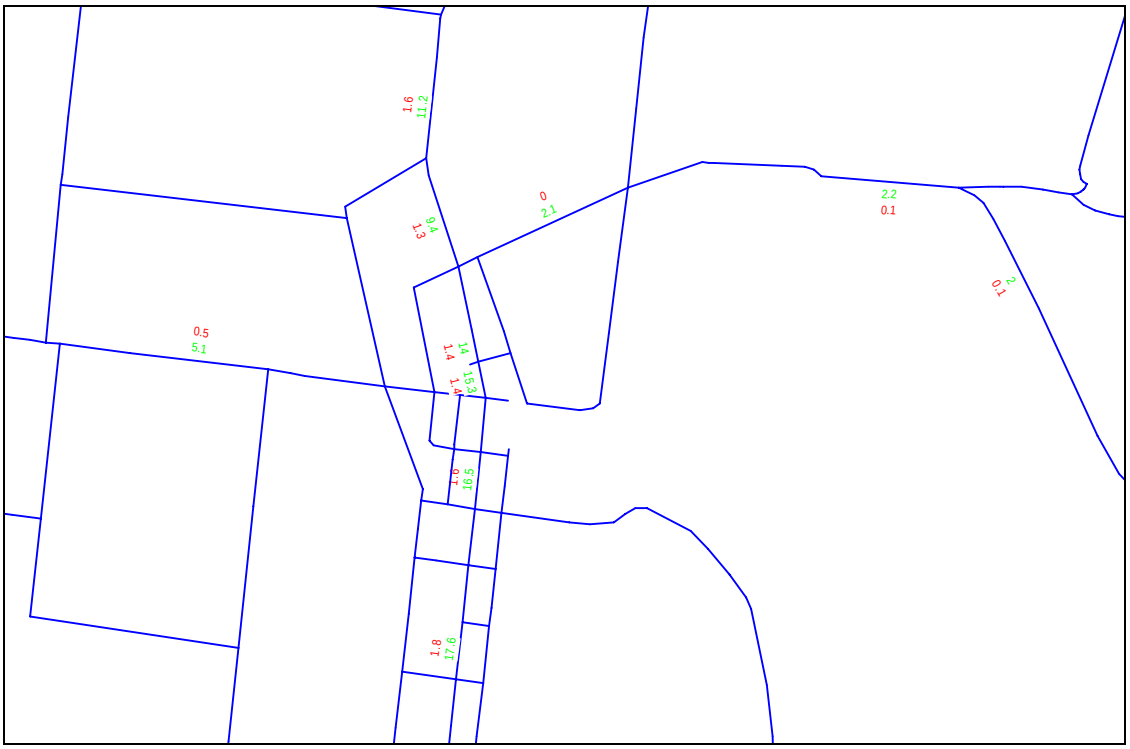


Figure 26: Wallan township two-way vehicle traffic volumes in 2021 (Base case)

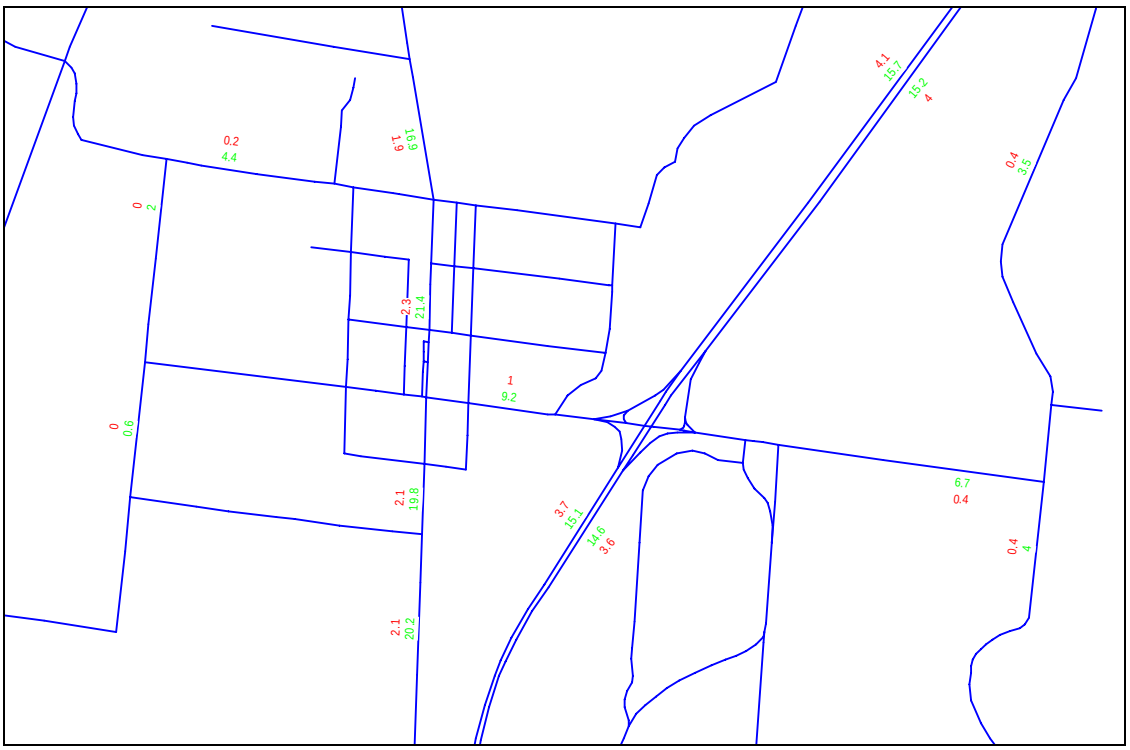


Figure 28: Two-way vehicle traffic volumes in 2031 (Base case)

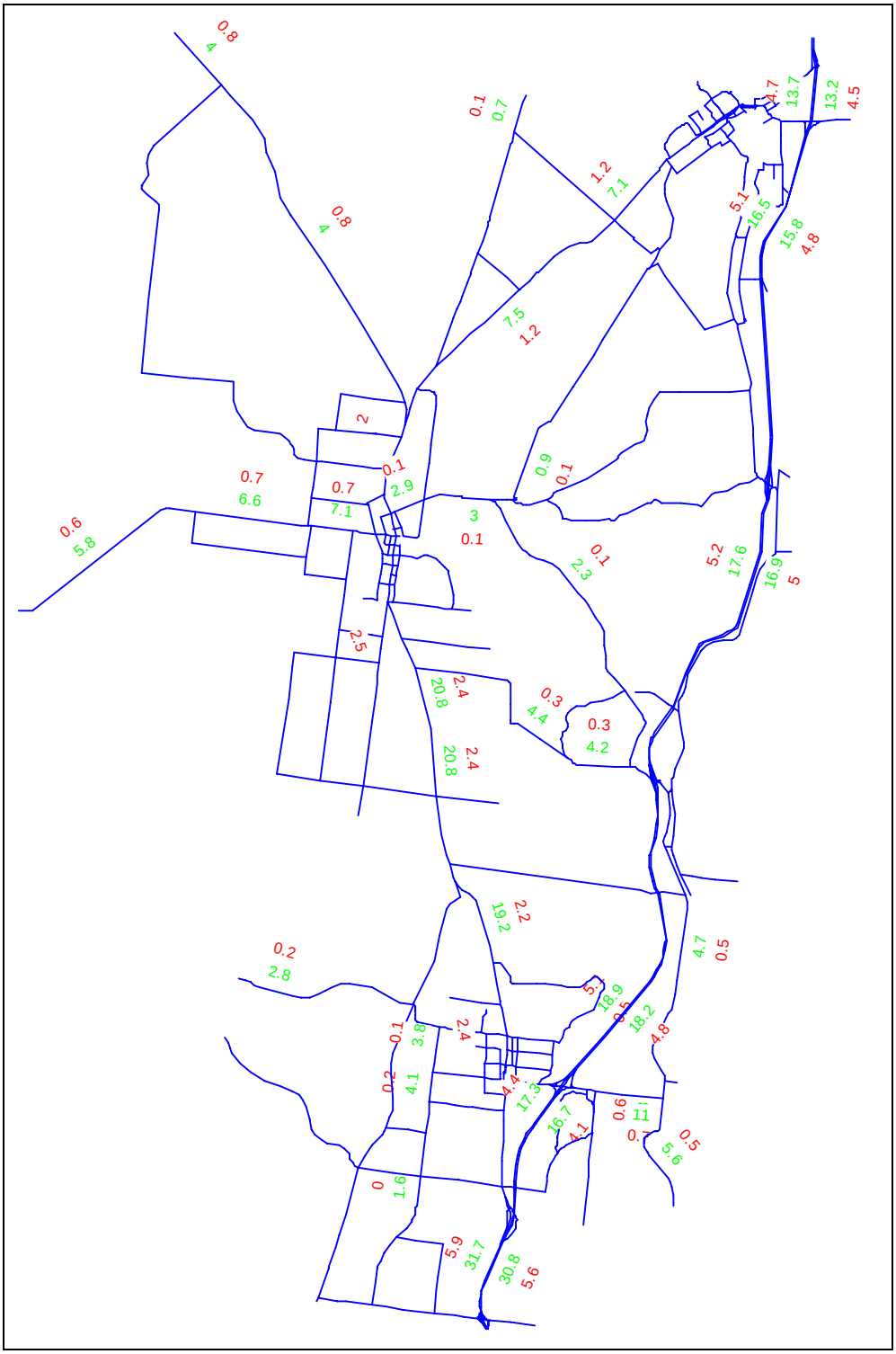


Figure 30: Kilmore township two-way vehicle traffic volumes in 2031 (Base case)

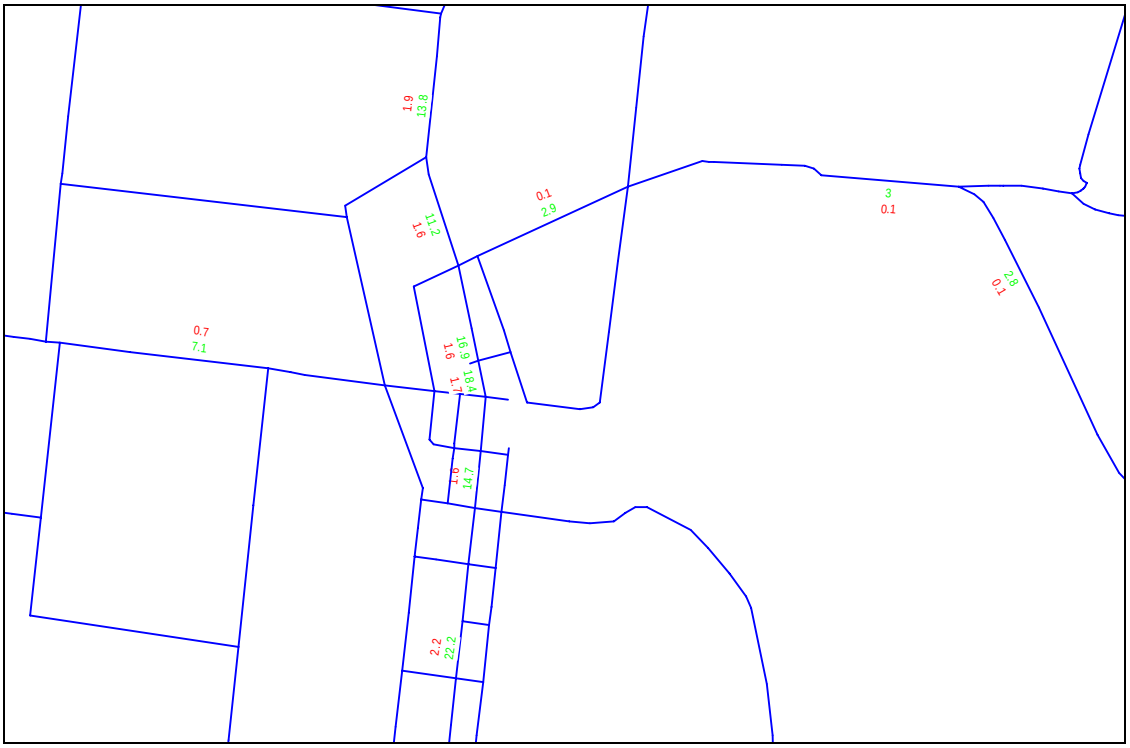


Figure 29: Wallan township two-way vehicle traffic volumes in 2031 (Base case)

Figure 31: Two-way vehicle traffic volumes in 2041 (Base case)

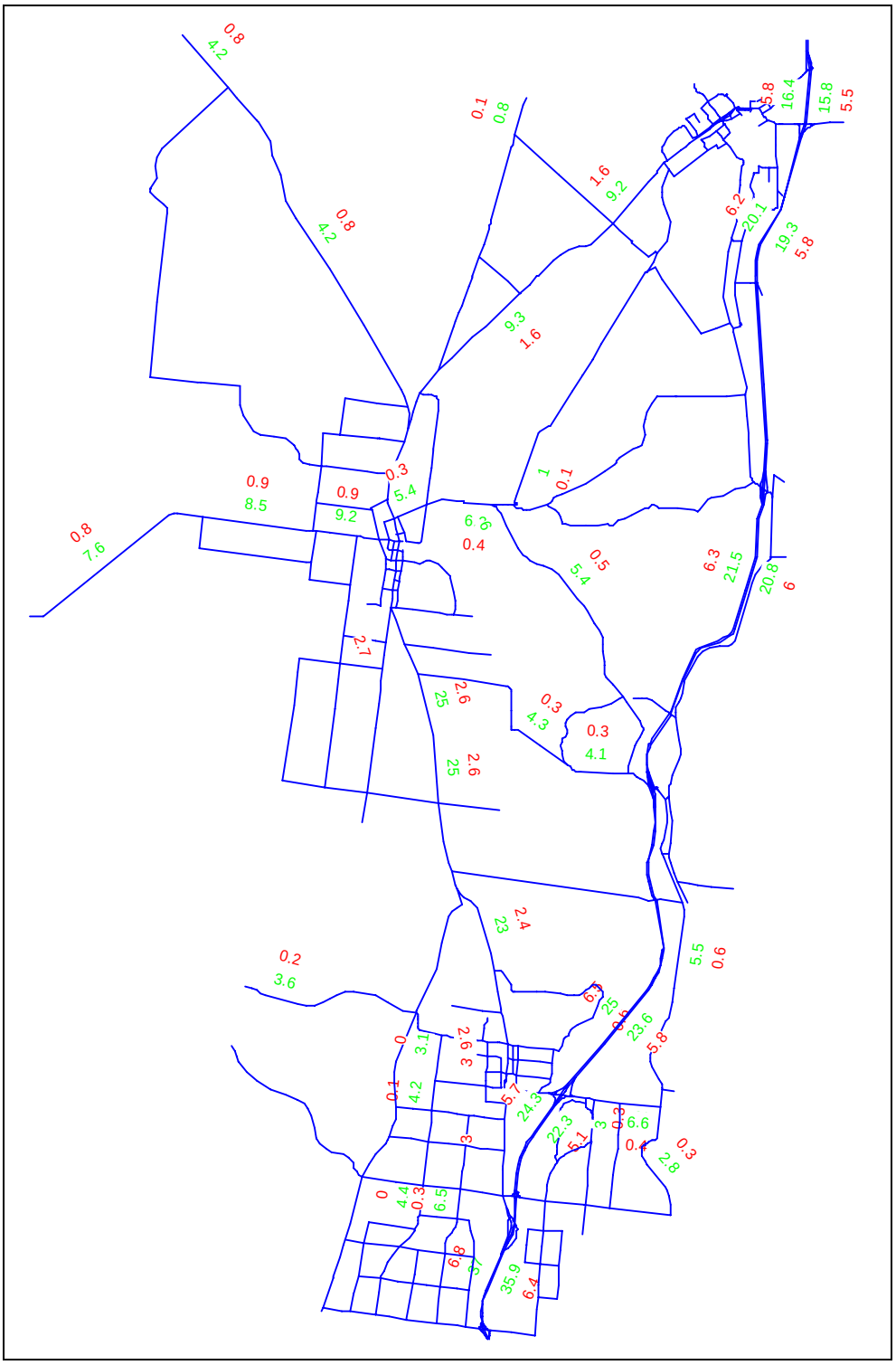


Figure 32: Kilmore township two-way vehicle traffic volumes in 2041 (Base case)

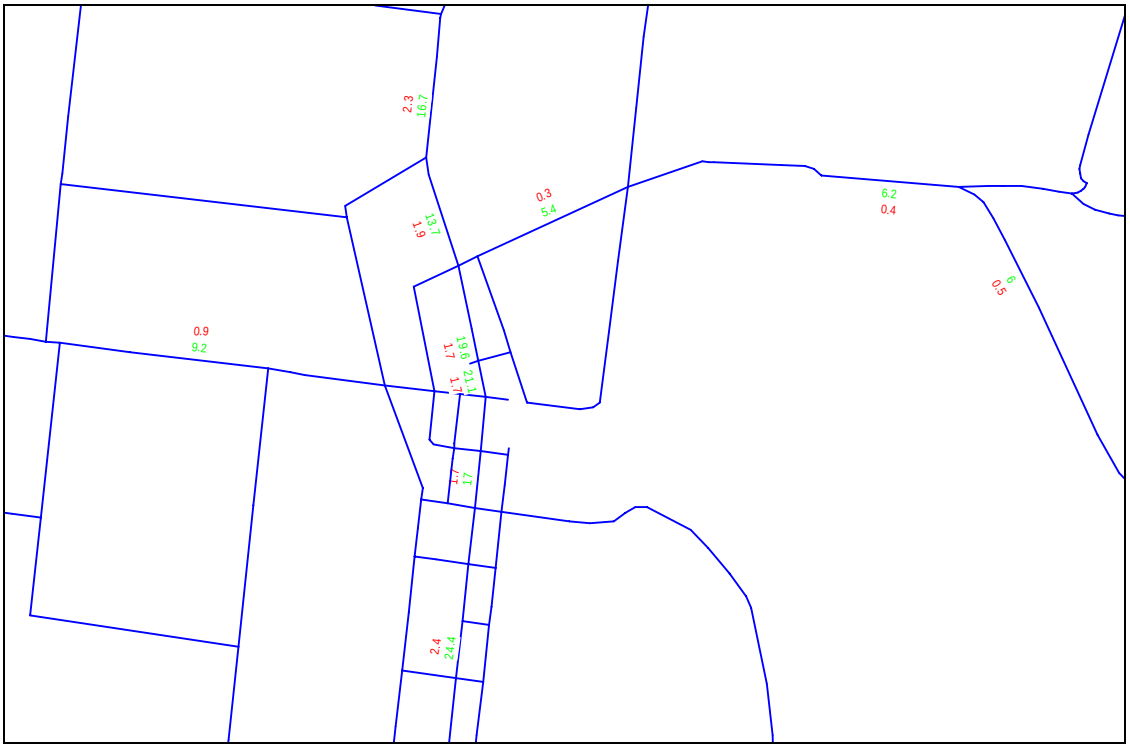


Figure 33: Wallan township two-way vehicle traffic volumes in 2041 (Base case)

Figure 34: Two-way vehicle traffic volumes in 2021 (Quinns Road Option)

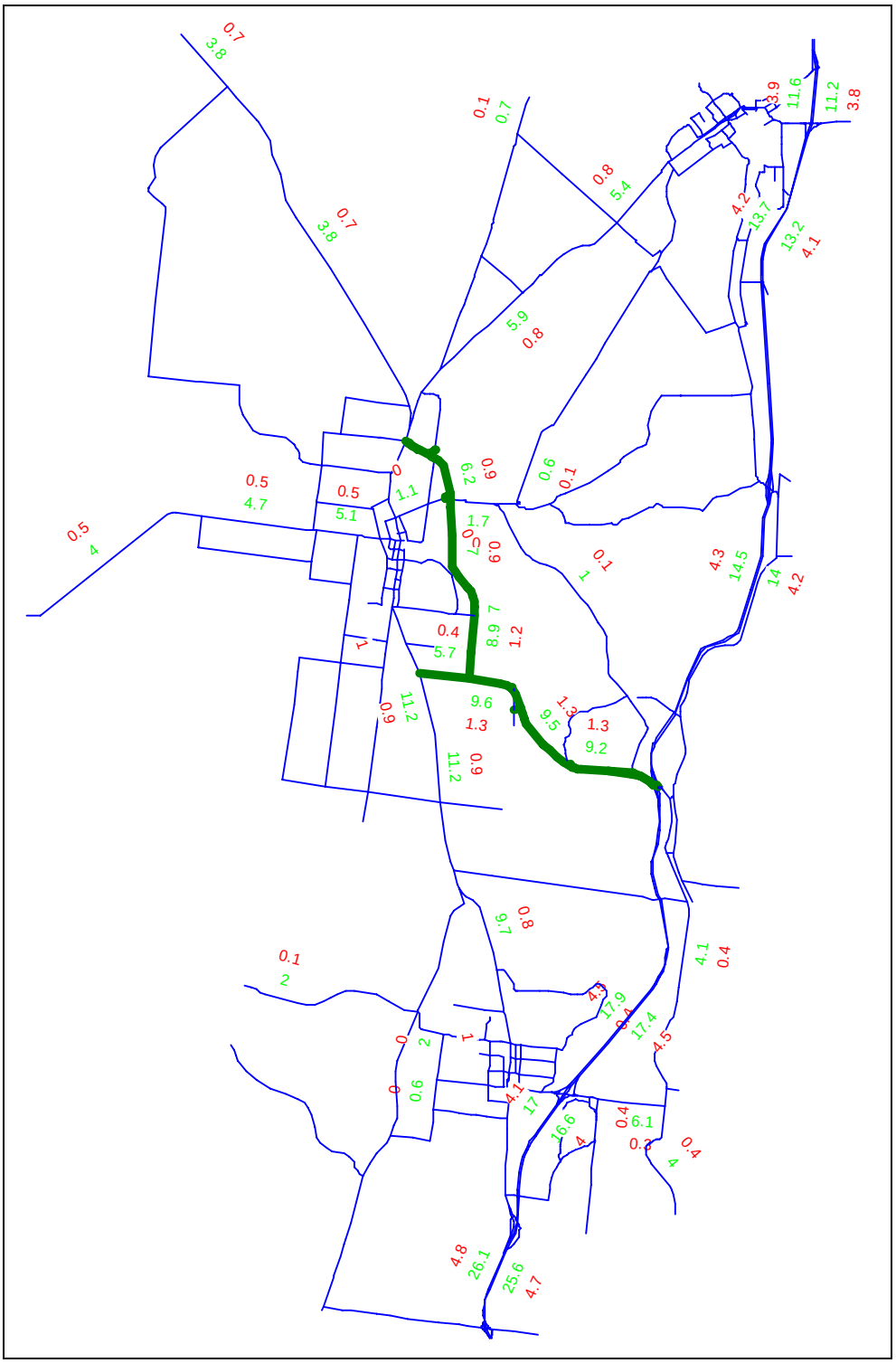


Figure 35: Kilmore township two-way vehicle traffic volumes in 2021 (Quinns Road Option)

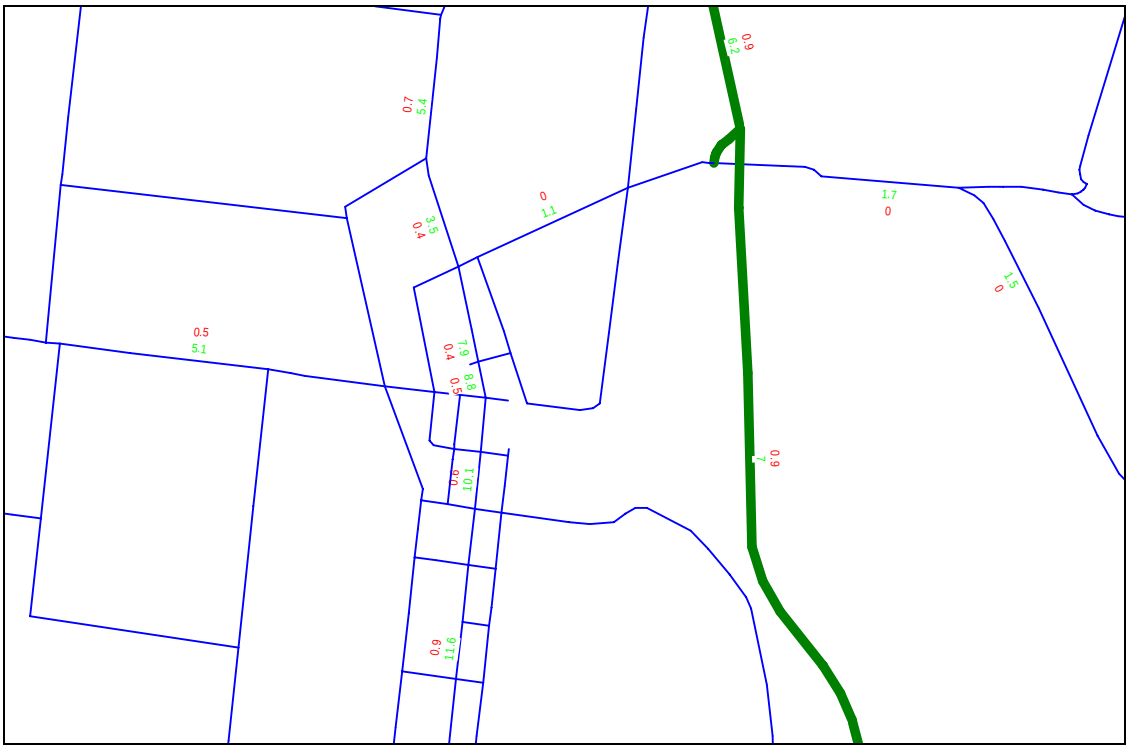


Figure 36: Wallan township two-way vehicle traffic volumes in 2021 (Quinns Road Option)

Figure 37: Two-way vehicle traffic volumes in 2031 (Quinns Road Option)

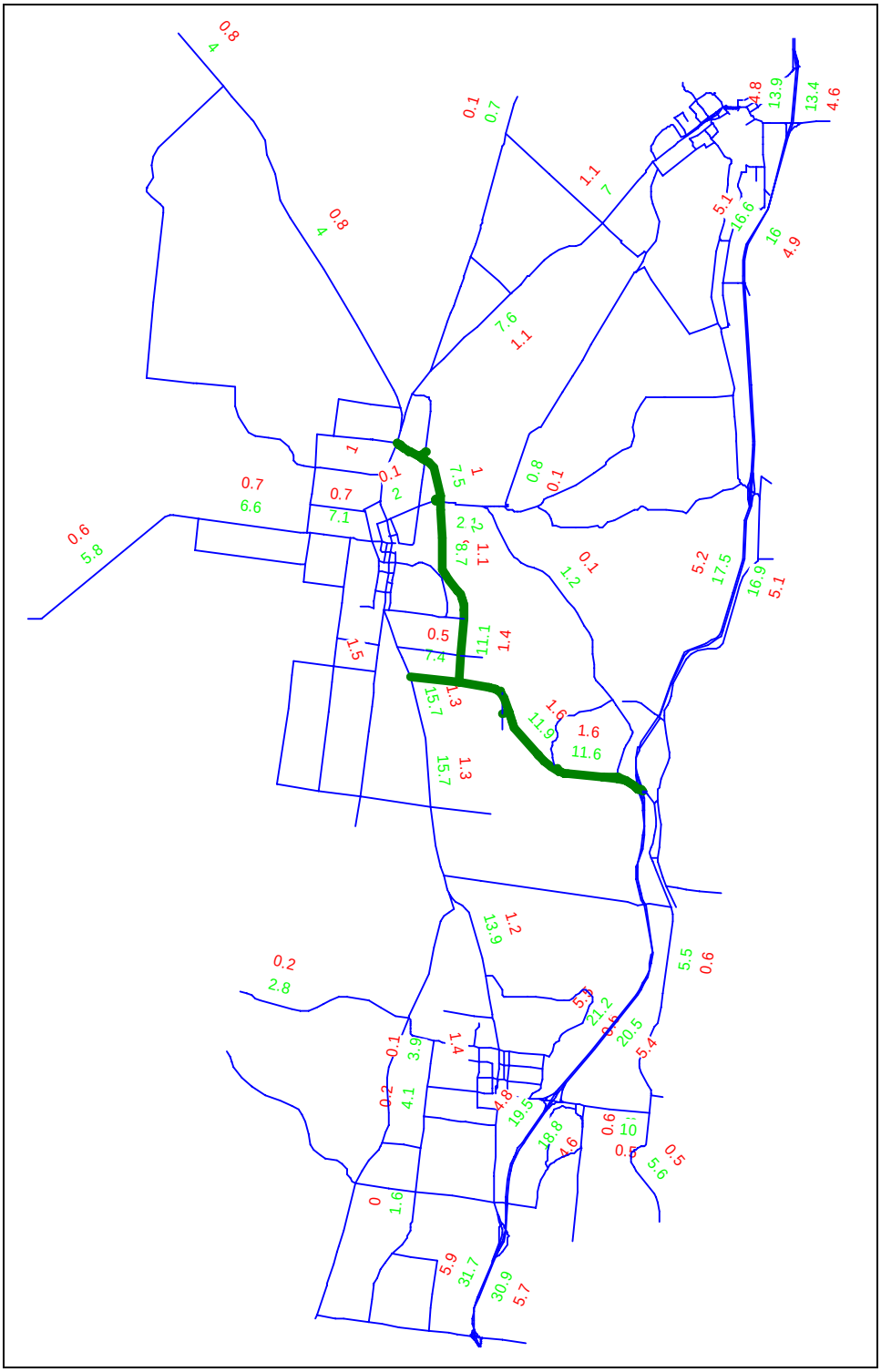


Figure 38: Kilmore township two-way vehicle traffic volumes in 2031 (Quinns Road Option)

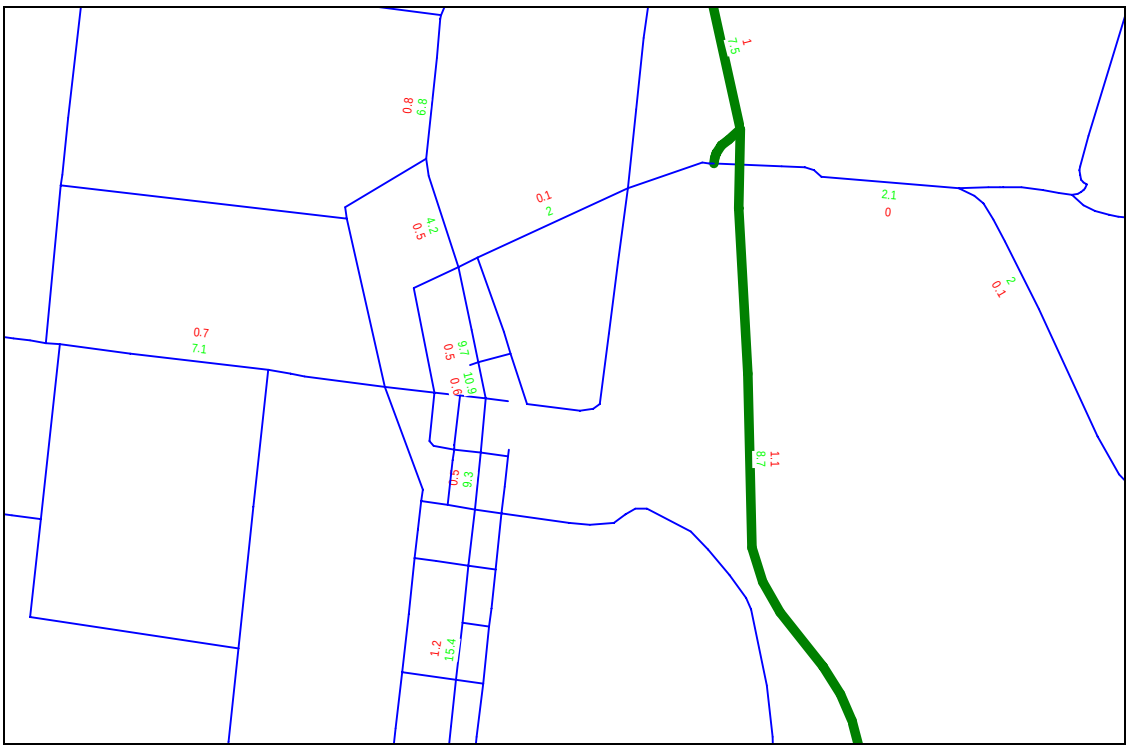


Figure 39: Wallan township two-way vehicle traffic volumes in 2031 (Quinns Road Option)

Figure 40: Two-way vehicle traffic volumes in 2041 (Quinns Road Option)

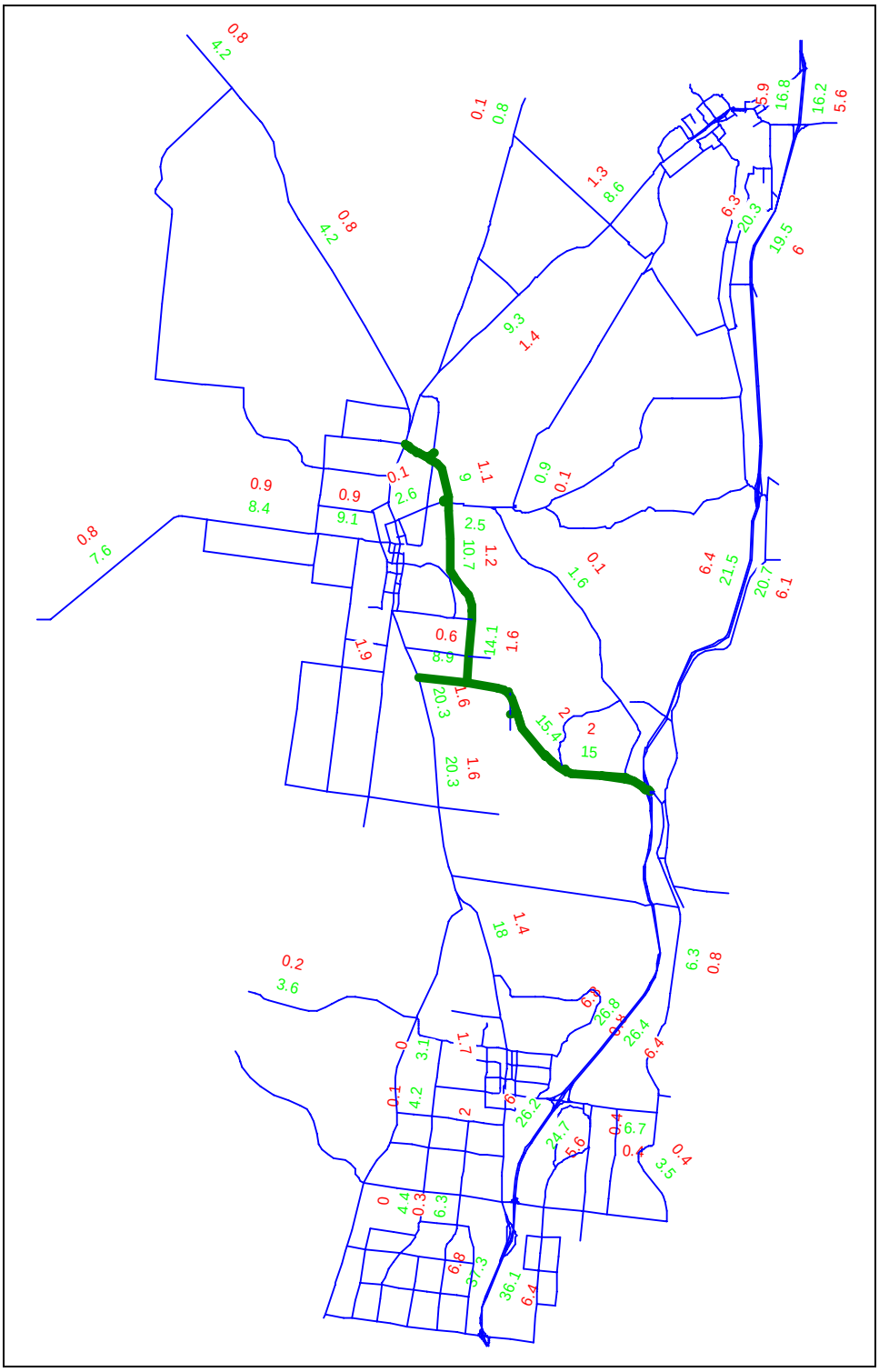


Figure 41: Kilmore township two-way vehicle traffic volumes in 2041 (Quinns Road Option)

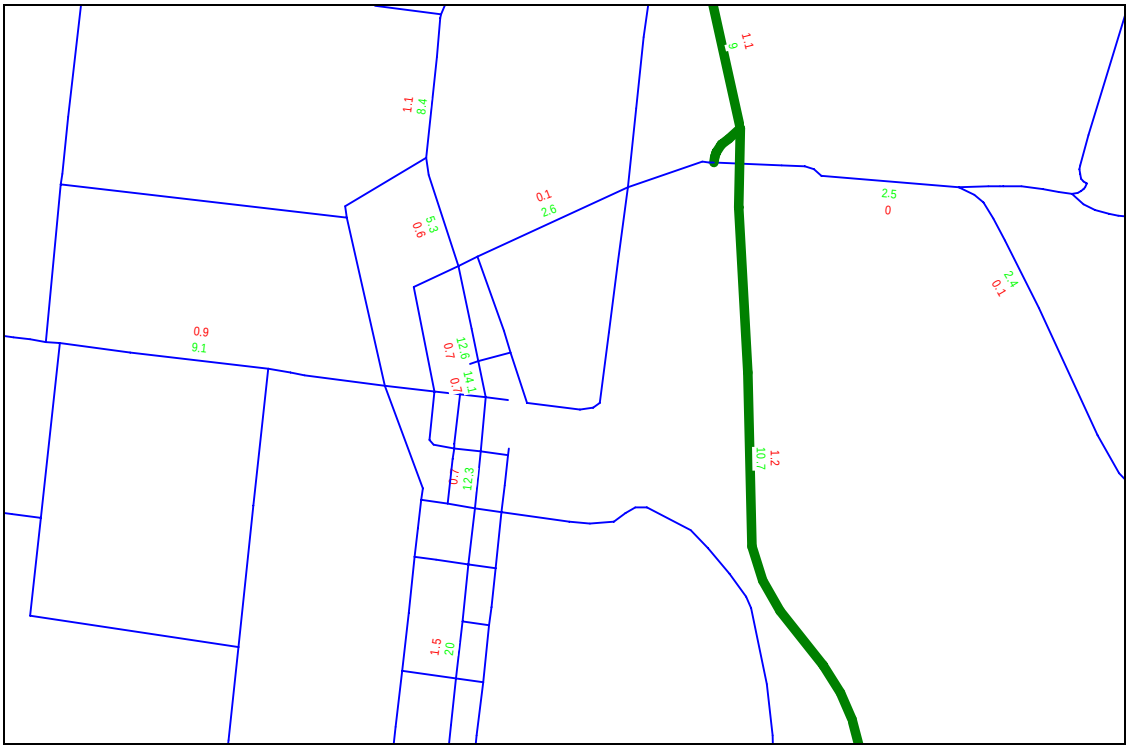


Figure 42: Wallan township two-way traffic volumes in 2041 (Quinns Road Option)

Figure 43: Two-way vehicle traffic volumes in 2021 (Western Option)

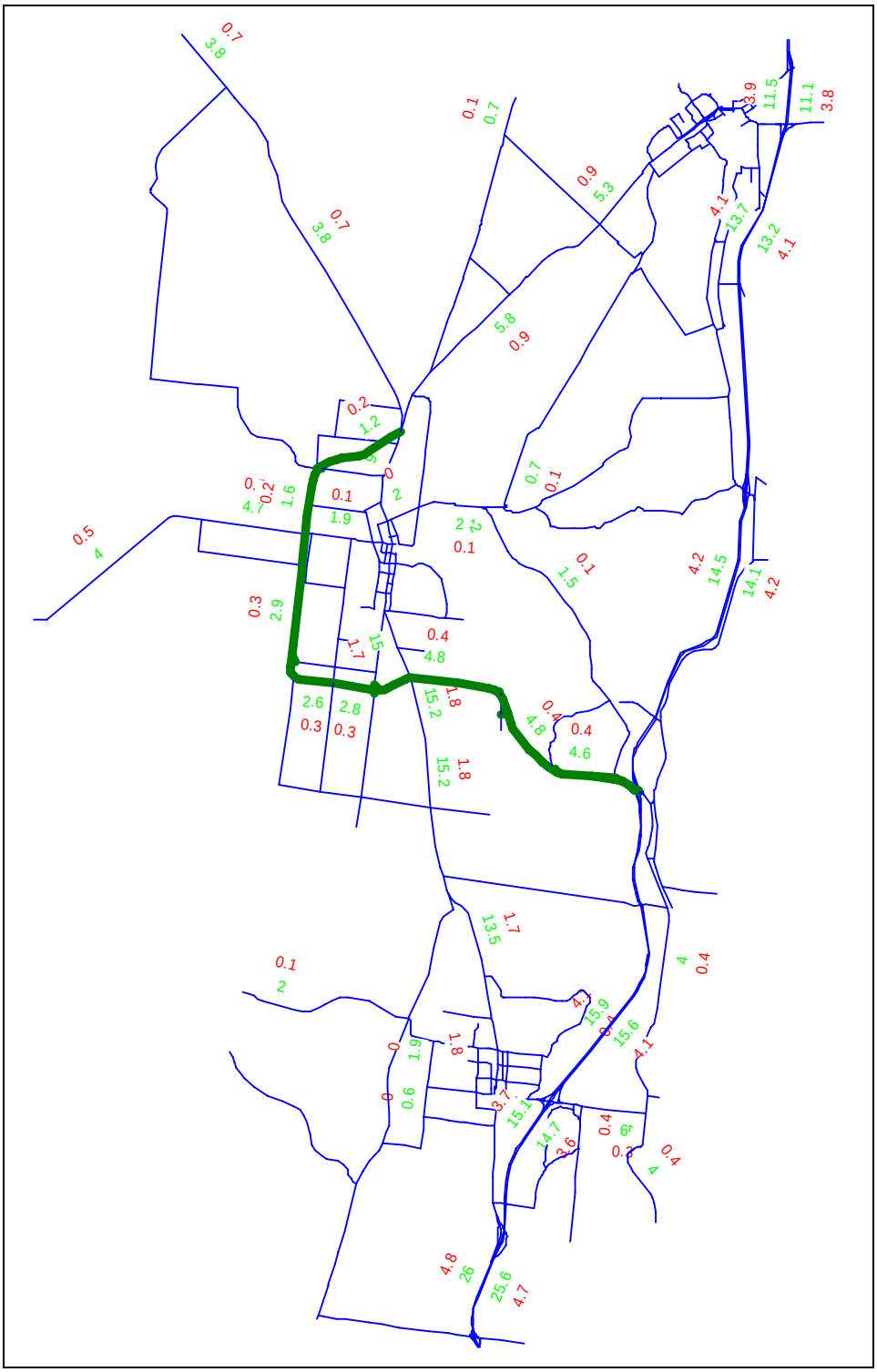


Figure 45: Kilmore township two-way vehicle traffic volumes in 2021 (Western Option)

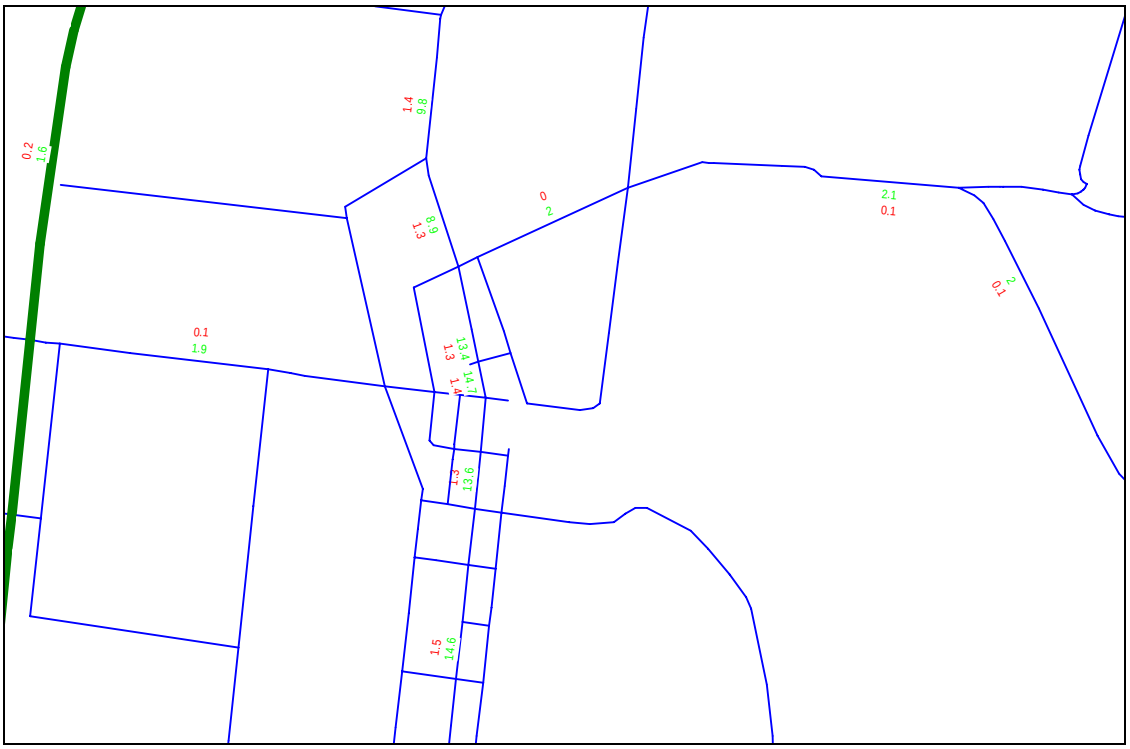


Figure 44: Wallan township two-way vehicle traffic volumes in 2021 (Western Option)

Figure 46: Two-way vehicle traffic volumes in 2031 (Western Option)

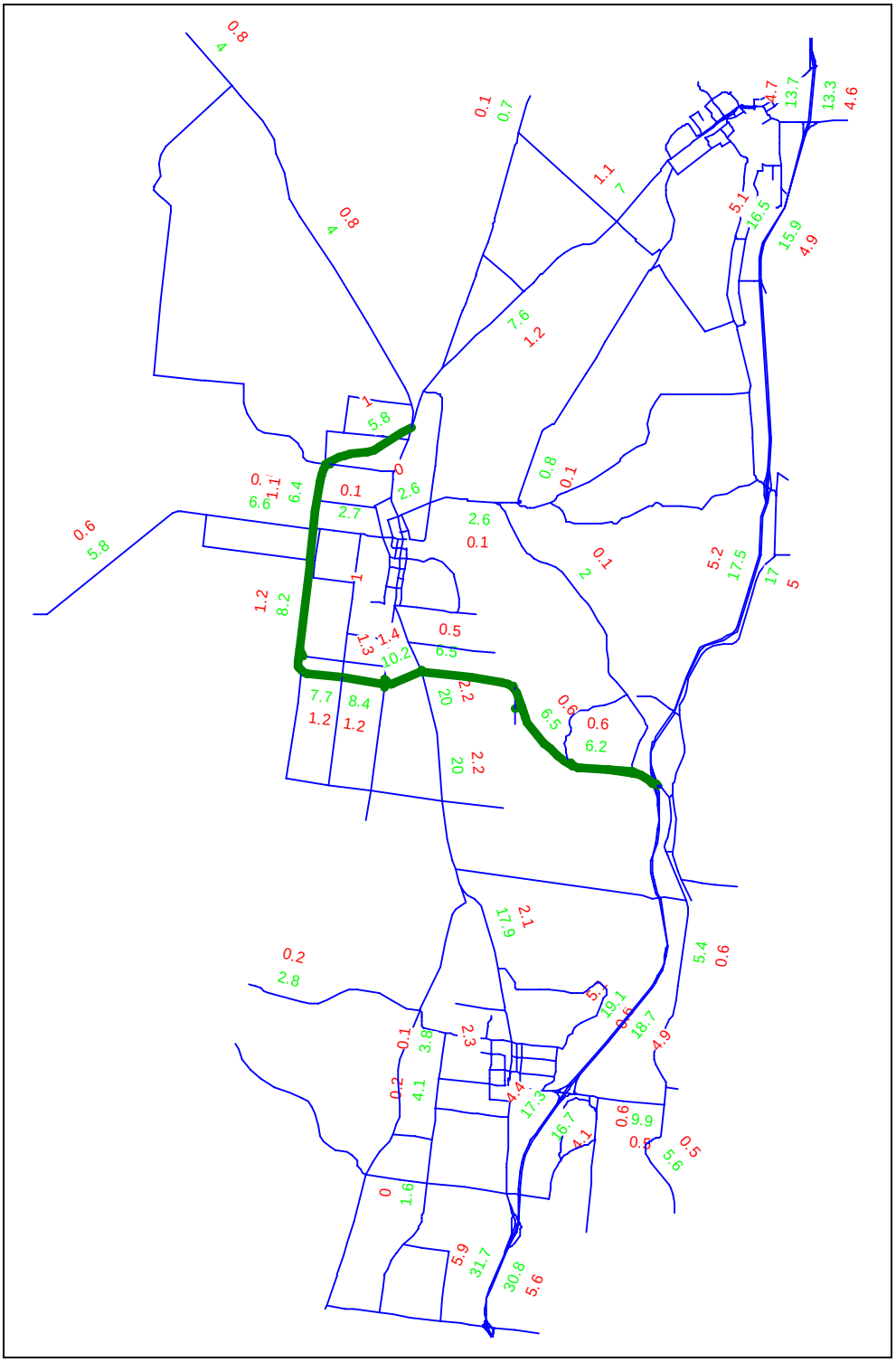


Figure 47: Kilmore township two-way vehicle traffic volumes in 2031 (Western Option)

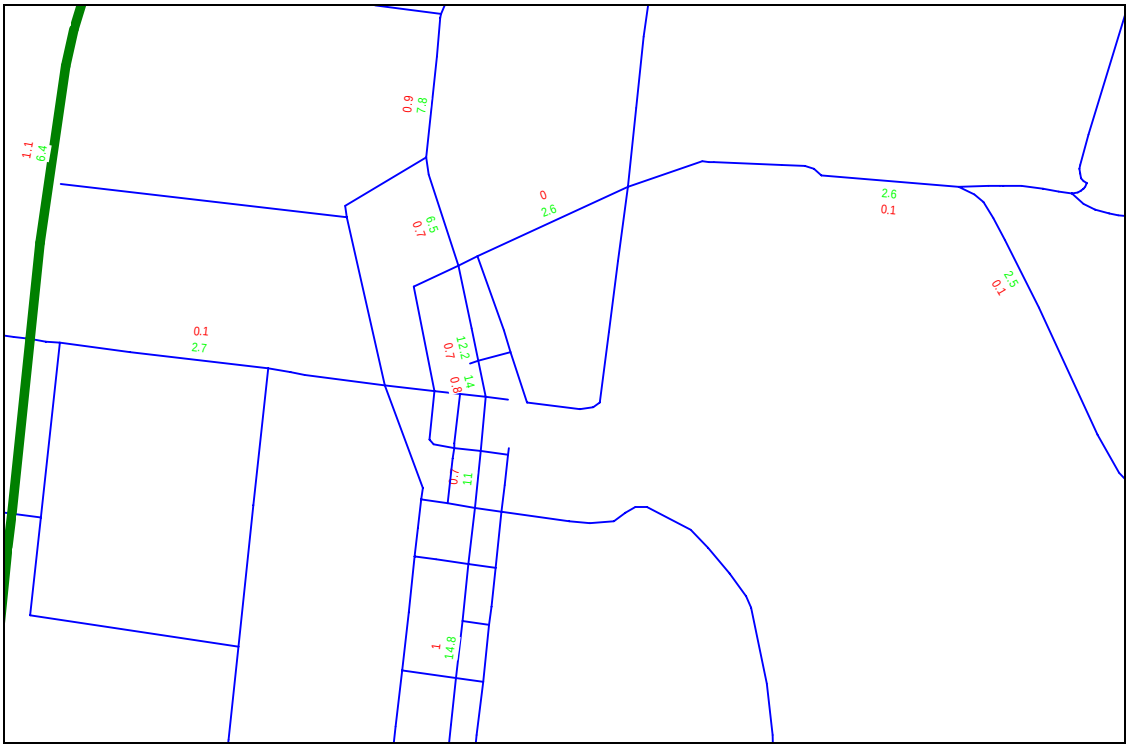


Figure 48: Wallan township two-way vehicle traffic volumes in 2031 (Western Option)

Figure 49: Two-way vehicle traffic volumes in 2041 (Western Option)

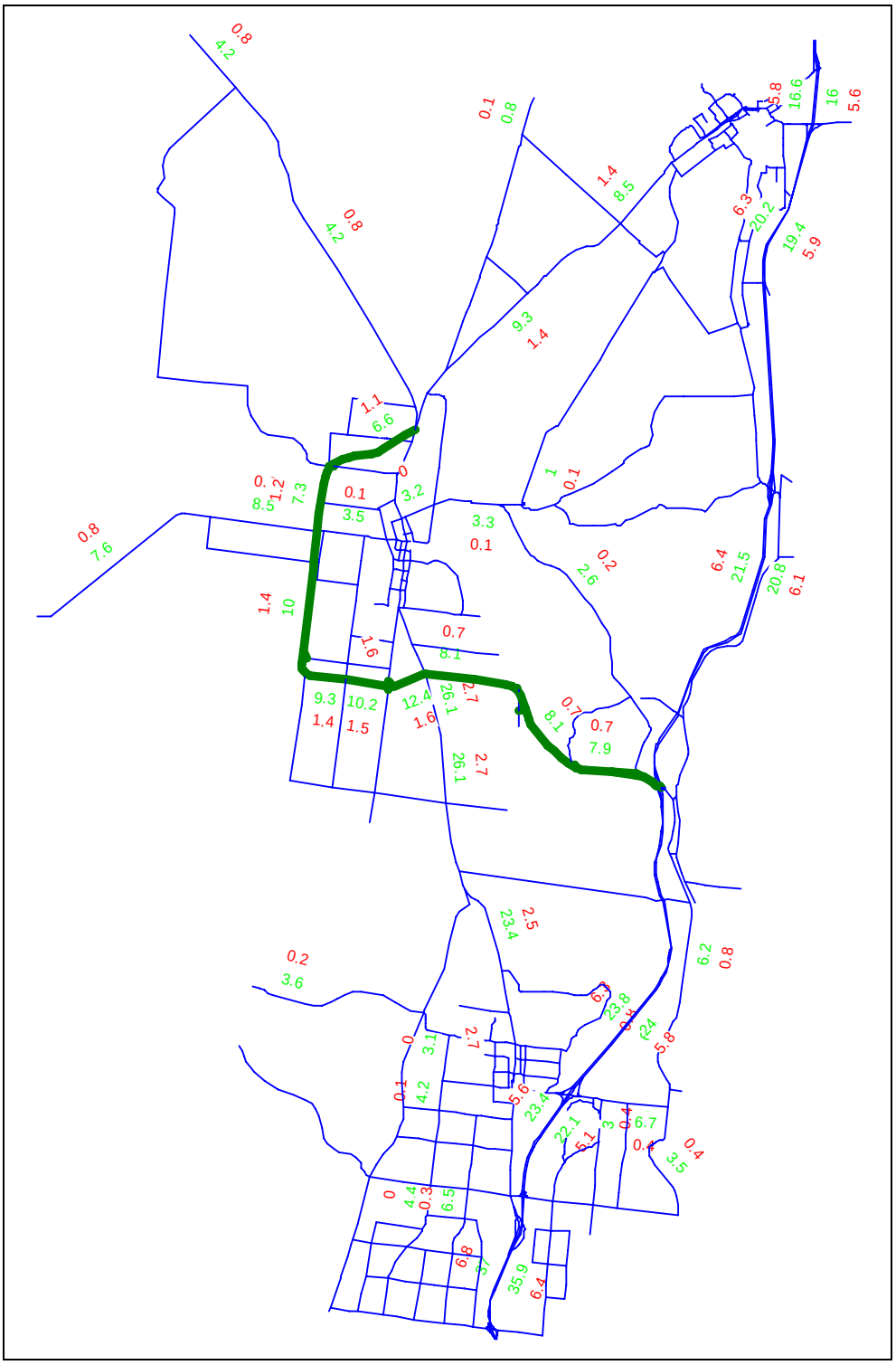


Figure 50: Kilmore township two-way vehicle traffic volumes in 2041 (Western Option)

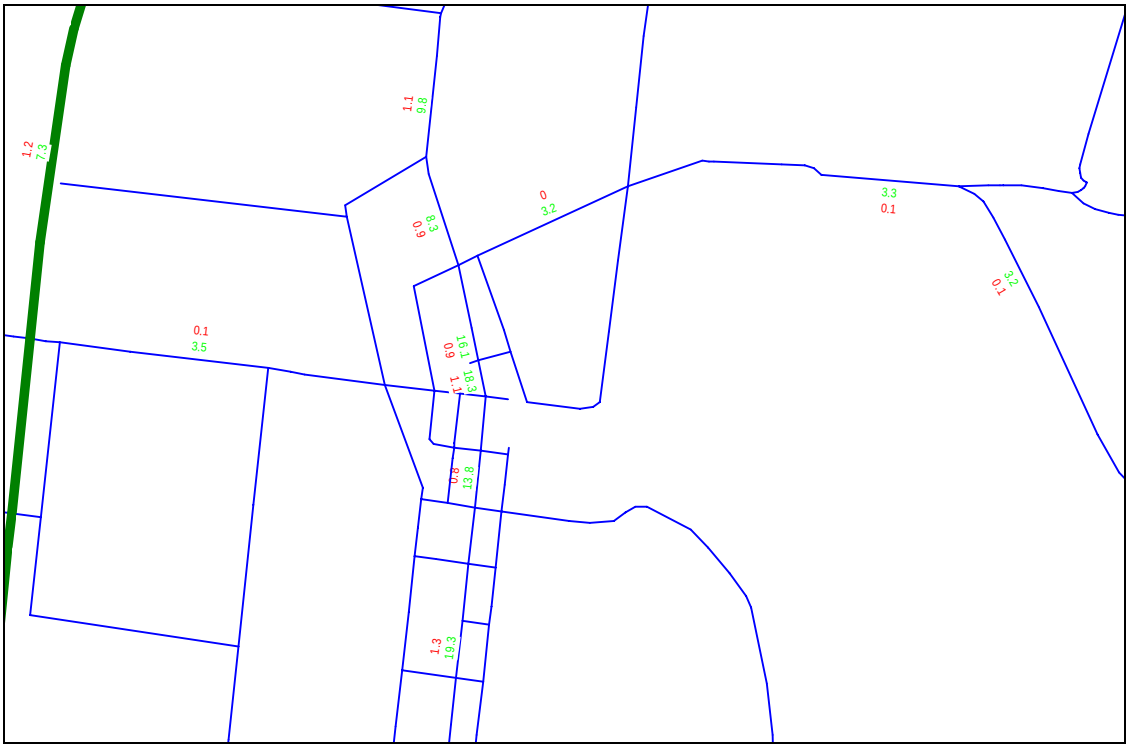


Figure 51: Wallan township two-way vehicle traffic volumes in 2041 (Western Option)

Figure 52: Two-way vehicle traffic volumes in 2021 (O'Gradys Road Option)

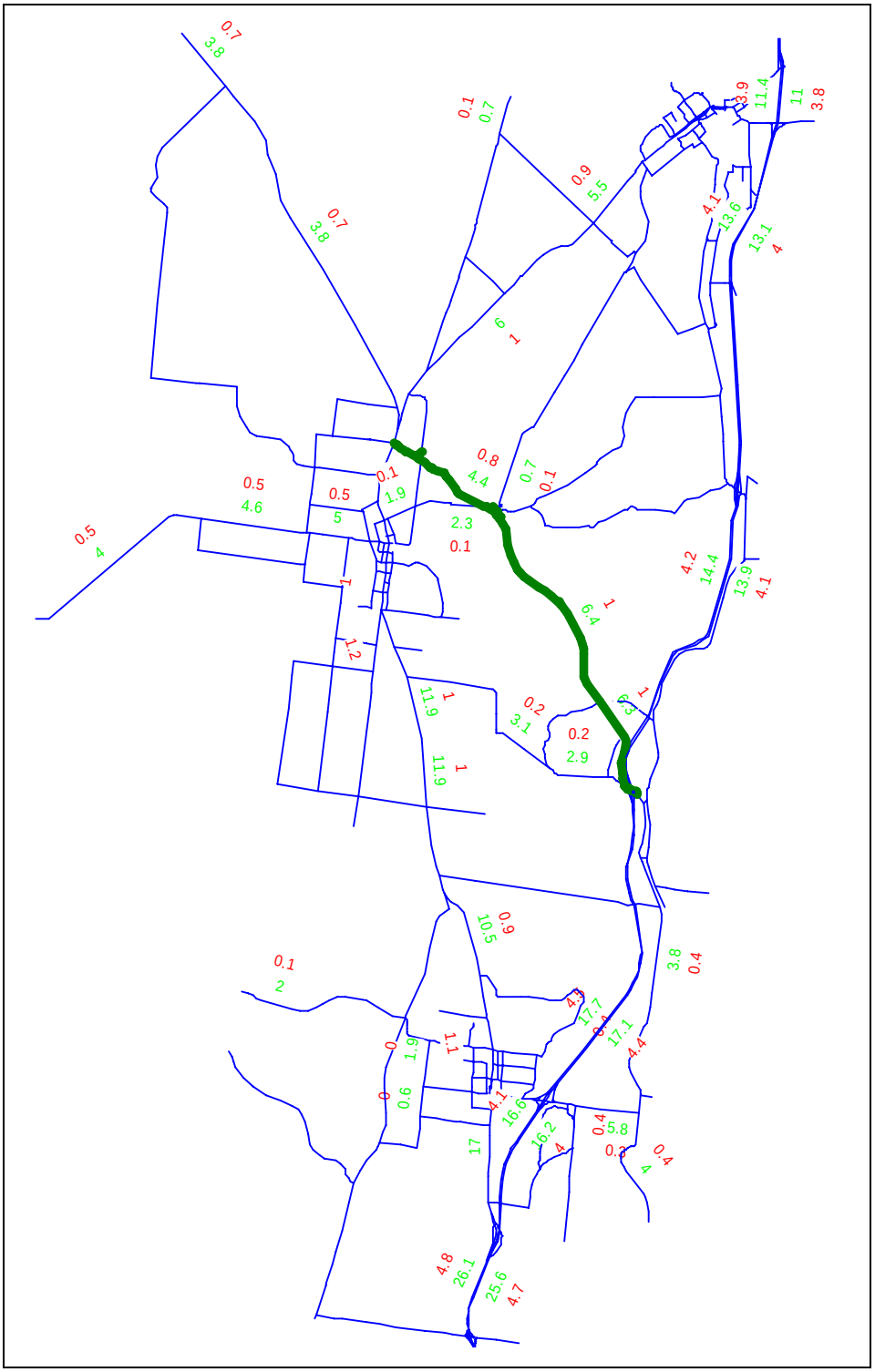


Figure 53: Kilmore township two-way vehicle traffic volumes in 2021 (O'Gradys Road Option)

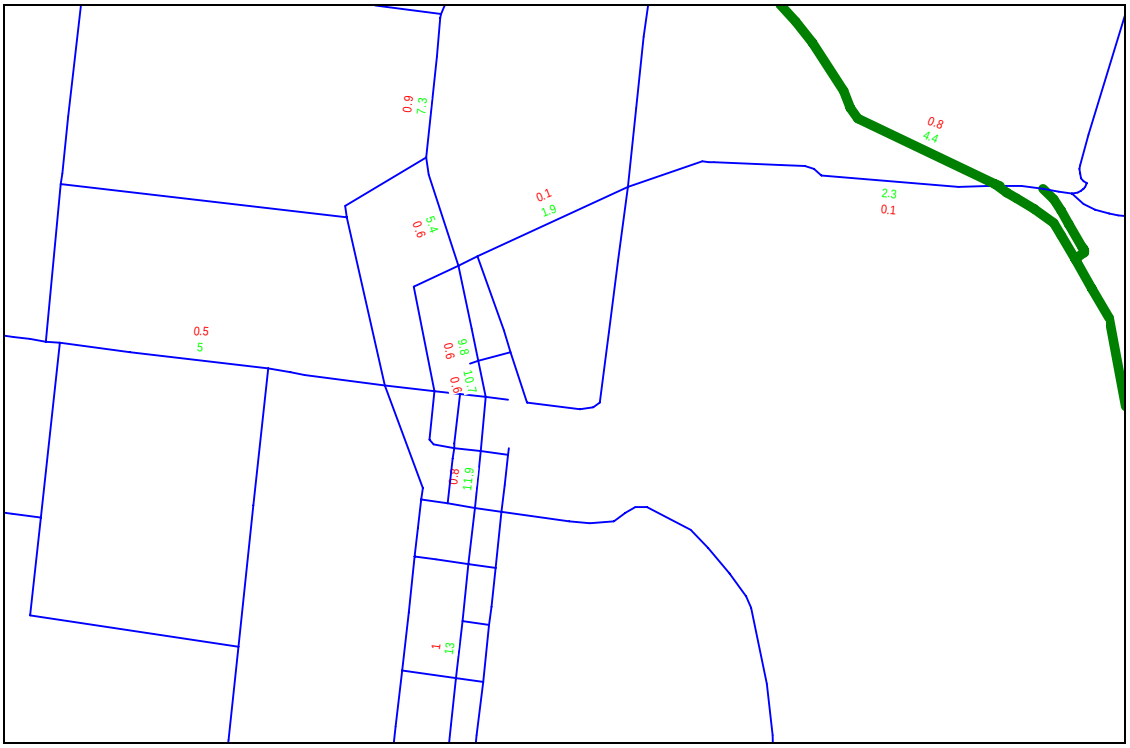


Figure 54: Wallan township two-way vehicle traffic volumes in 2021 (O'Gradys Road Option)

Figure 55: Two-way vehicle traffic volumes in 2031 (O'Gradys Road Option)

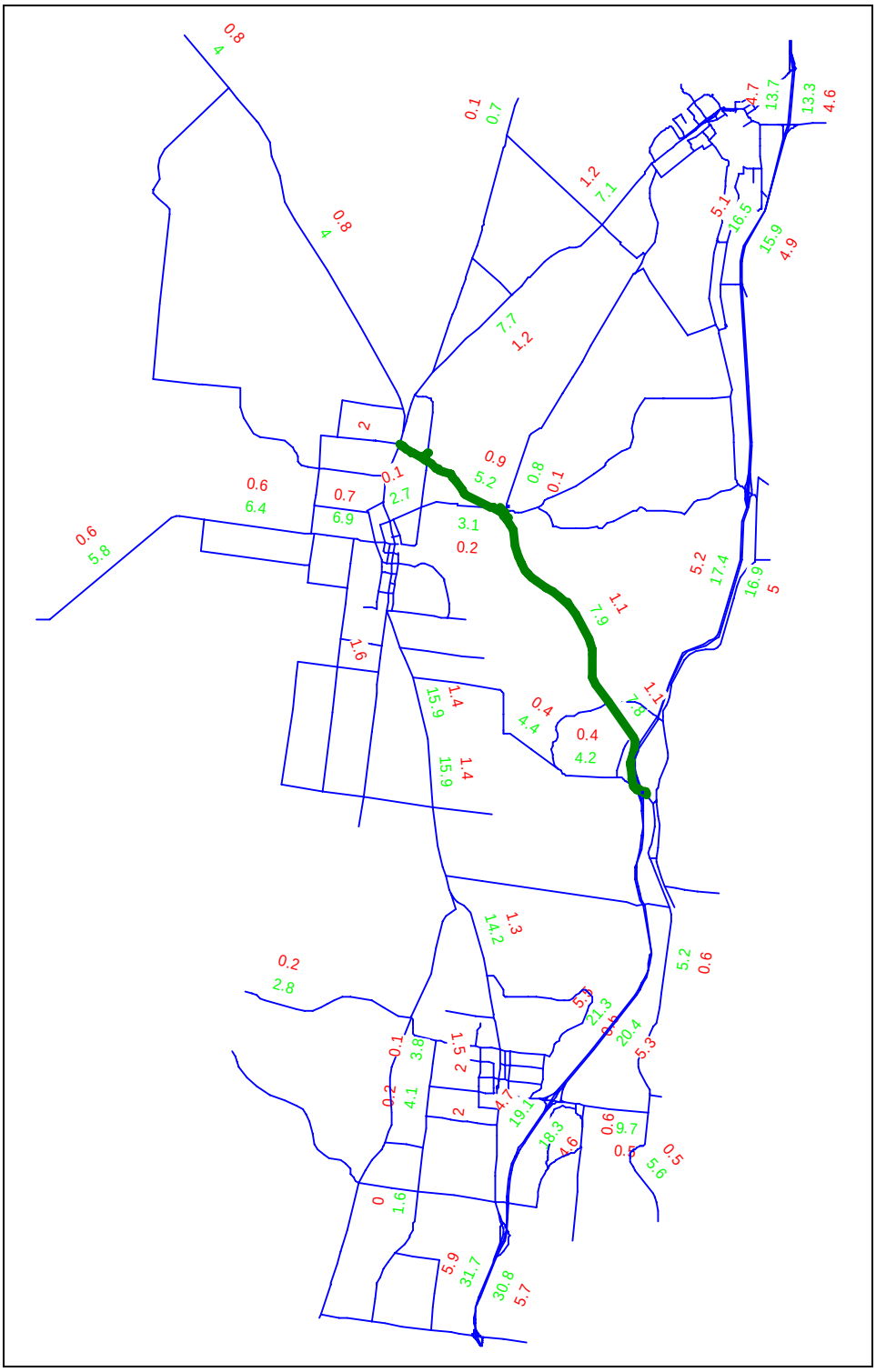


Figure 56: Kilmore township two-way vehicle traffic volumes in 2031 (O'Gradys Road Option)

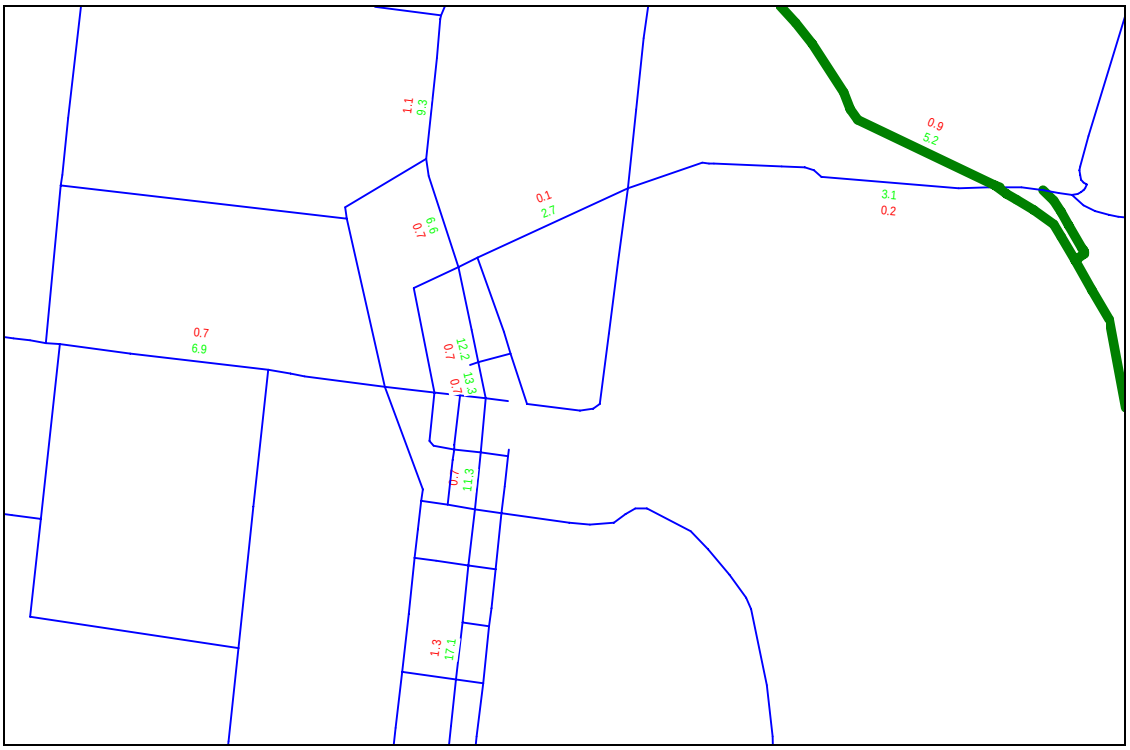


Figure 57: Wallan township two-way vehicle traffic volumes in 2031 (O'Gradys Road Option)

Figure 58: Two-way vehicle traffic volumes in 2041 (O'Gradys Road Option)

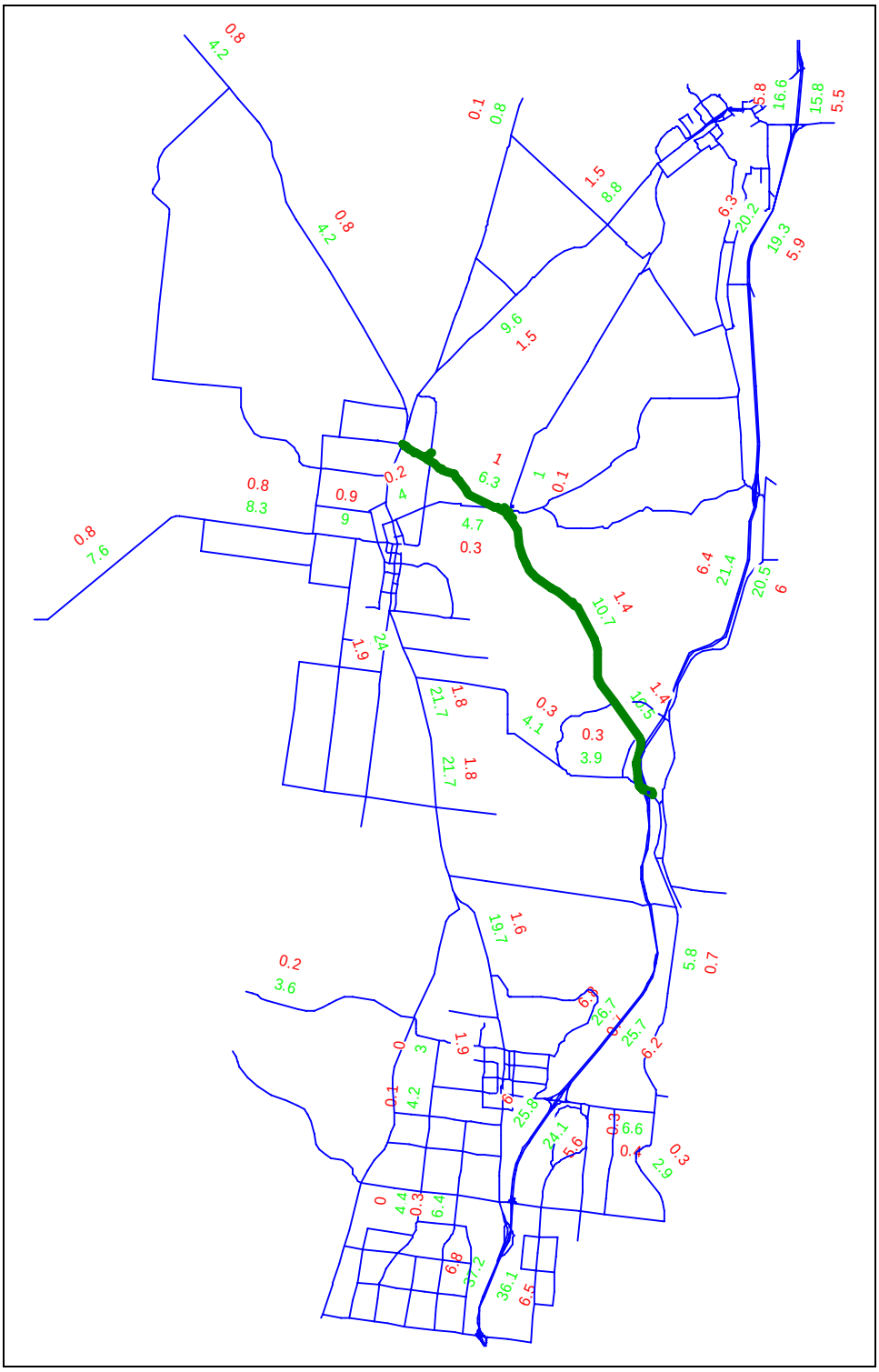


Figure 59: Kilmore township two-way vehicle traffic volumes in 2041 (O'Gradys Road Option)

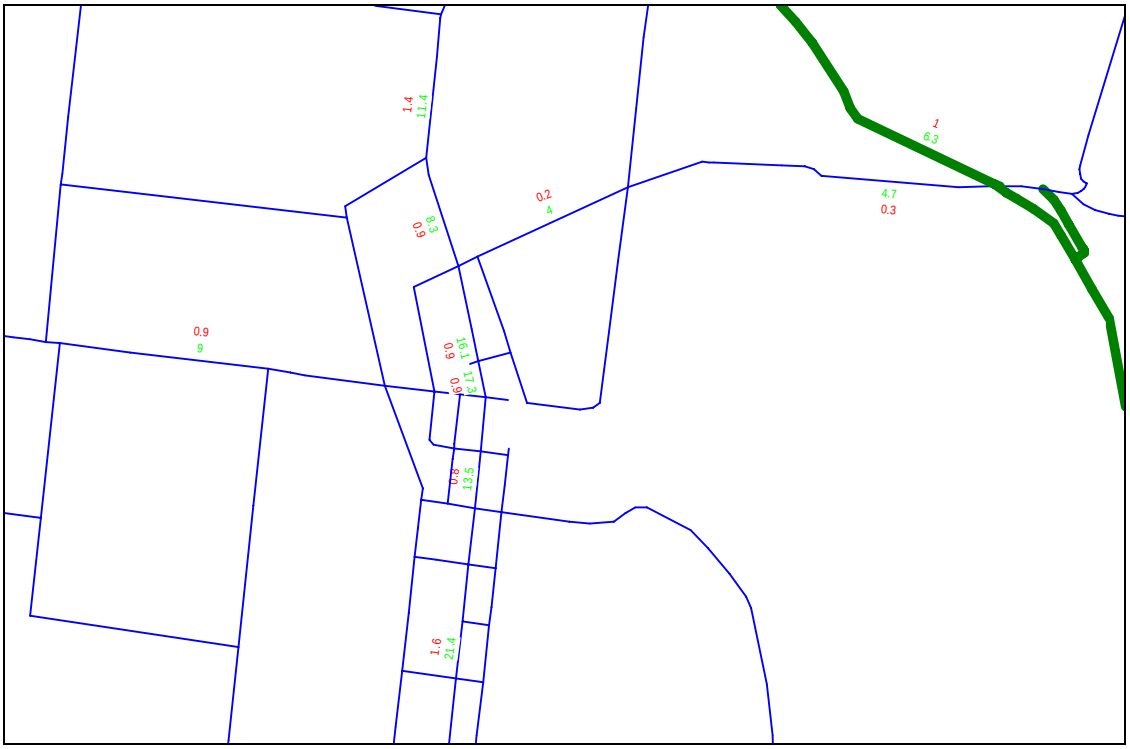


Figure 60: Wallan township two-way vehicle traffic volumes in 2041 (O'Gradys Road Option)

Figure 61: Two-way vehicle traffic volumes in 2021 (Dry Creek Option)

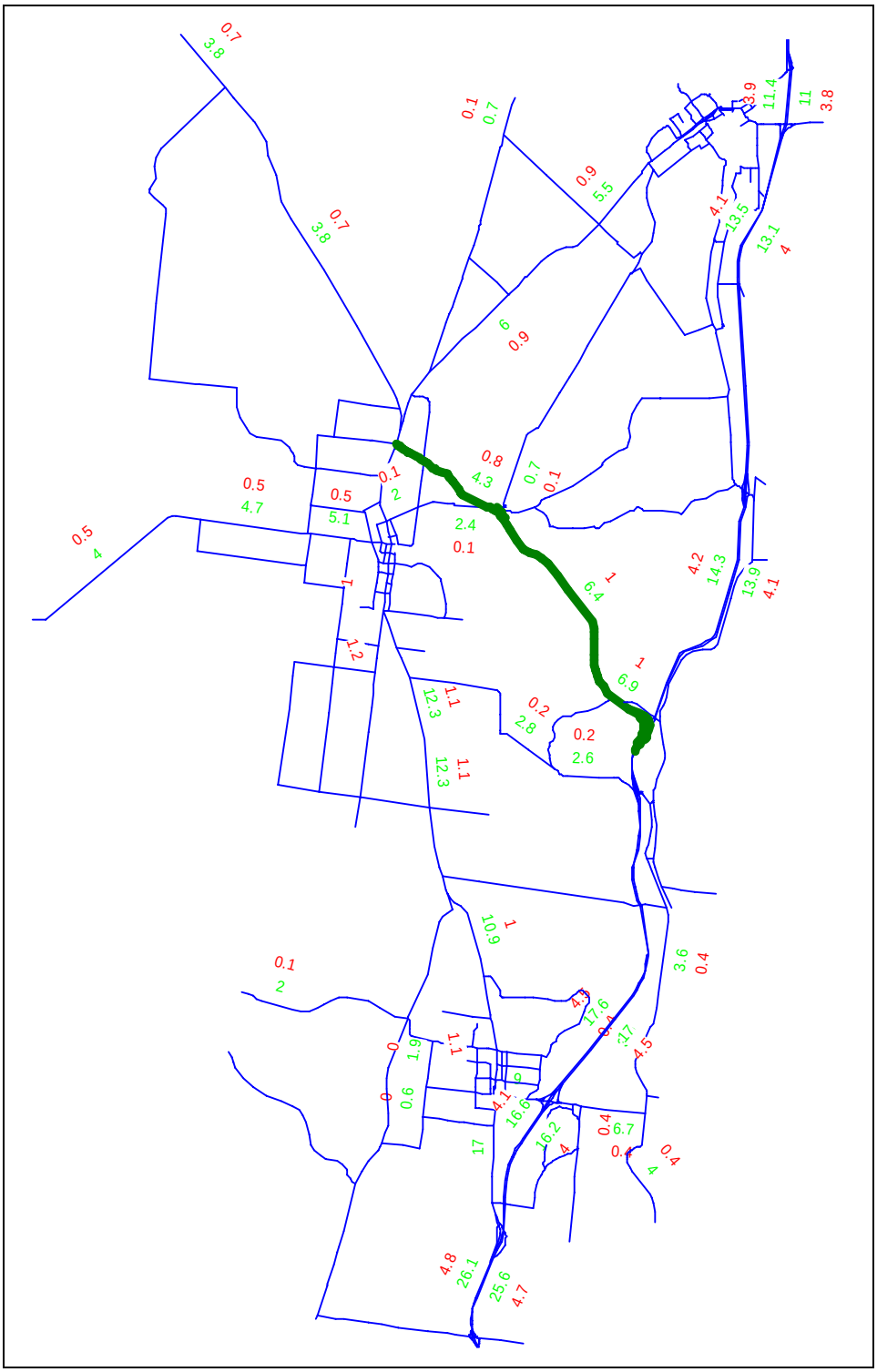


Figure 62: Kilmore township two-way vehicle traffic volumes in 2021 (Dry Creek Option)

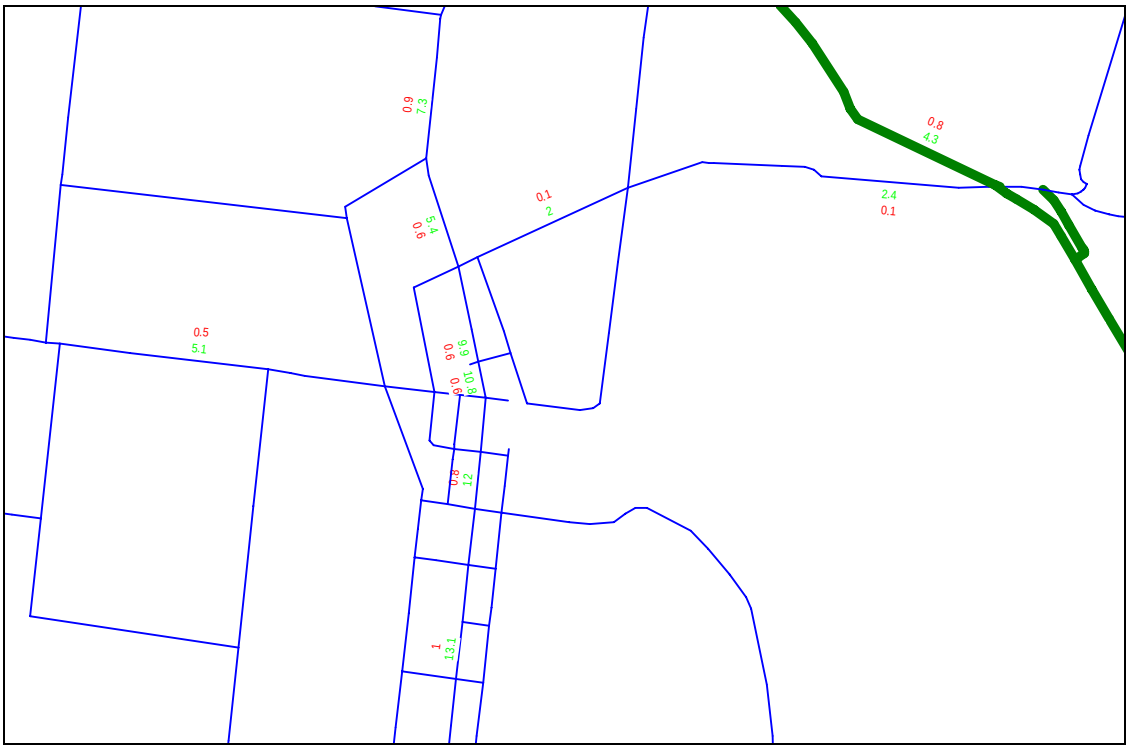


Figure 63: Wallan township two-way vehicle traffic volumes in 2021 (Dry Creek Option)

Figure 64: Two-way vehicle traffic volumes in 2031 (Dry Creek Option)

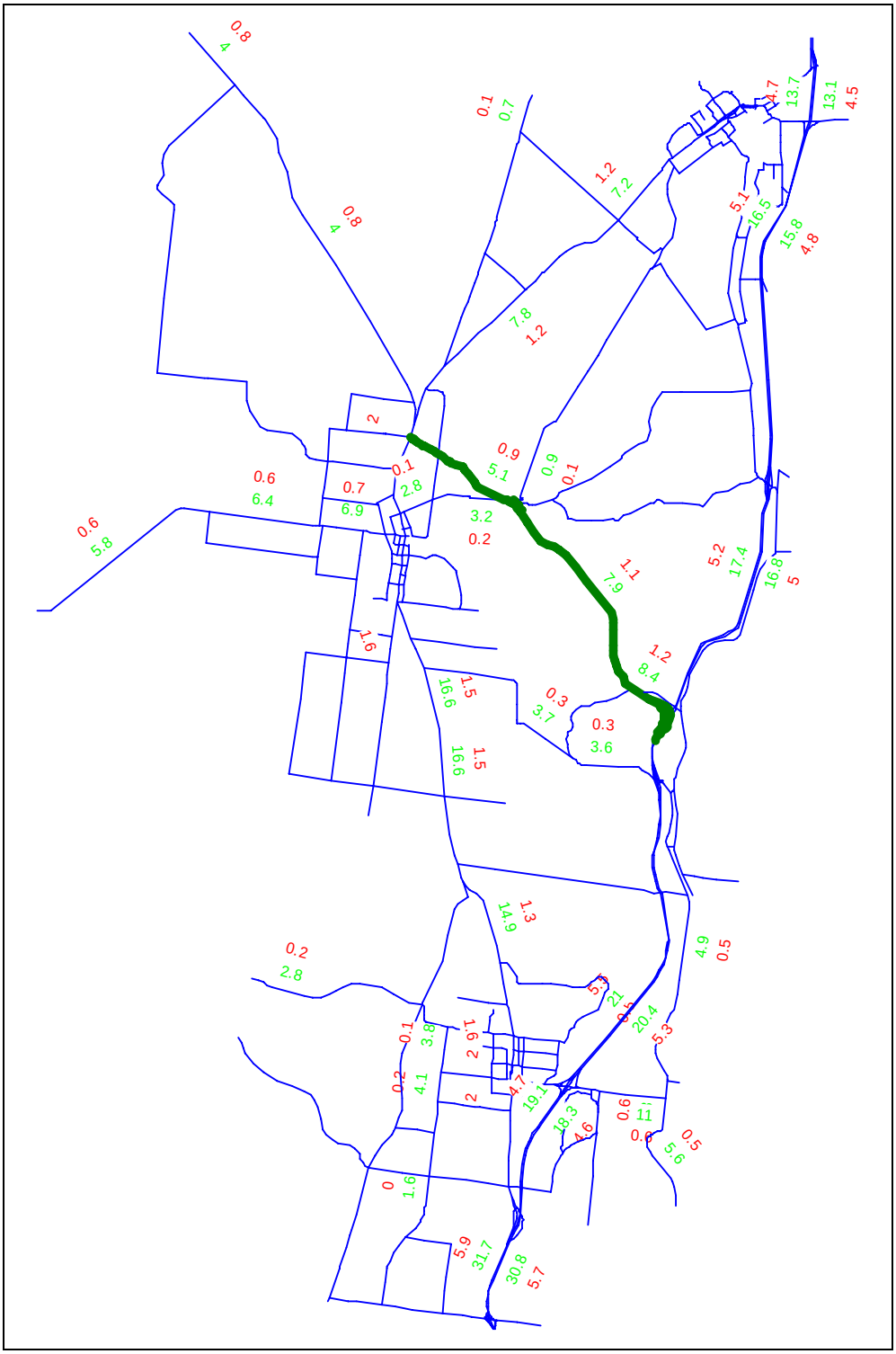


Figure 65: Kilmore township two-way vehicle traffic volumes in 2031 (Dry Creek Option)

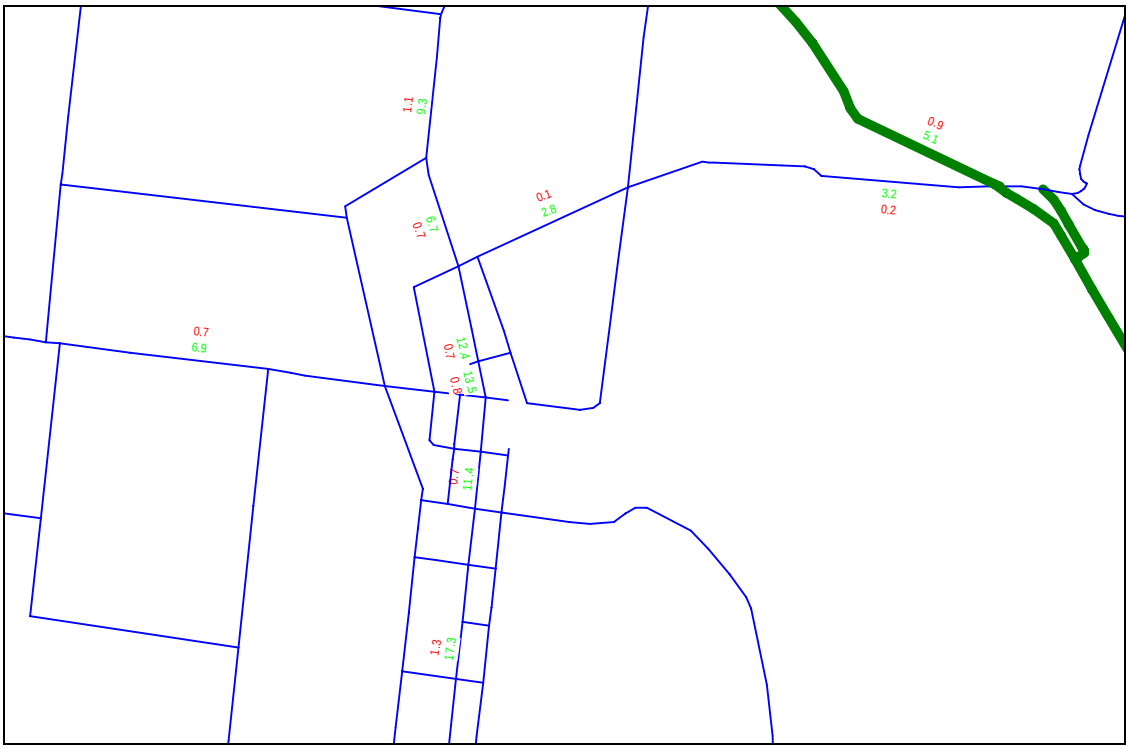


Figure 66: Wallan township two-way vehicle traffic volumes in 2031 (Dry Creek Option)

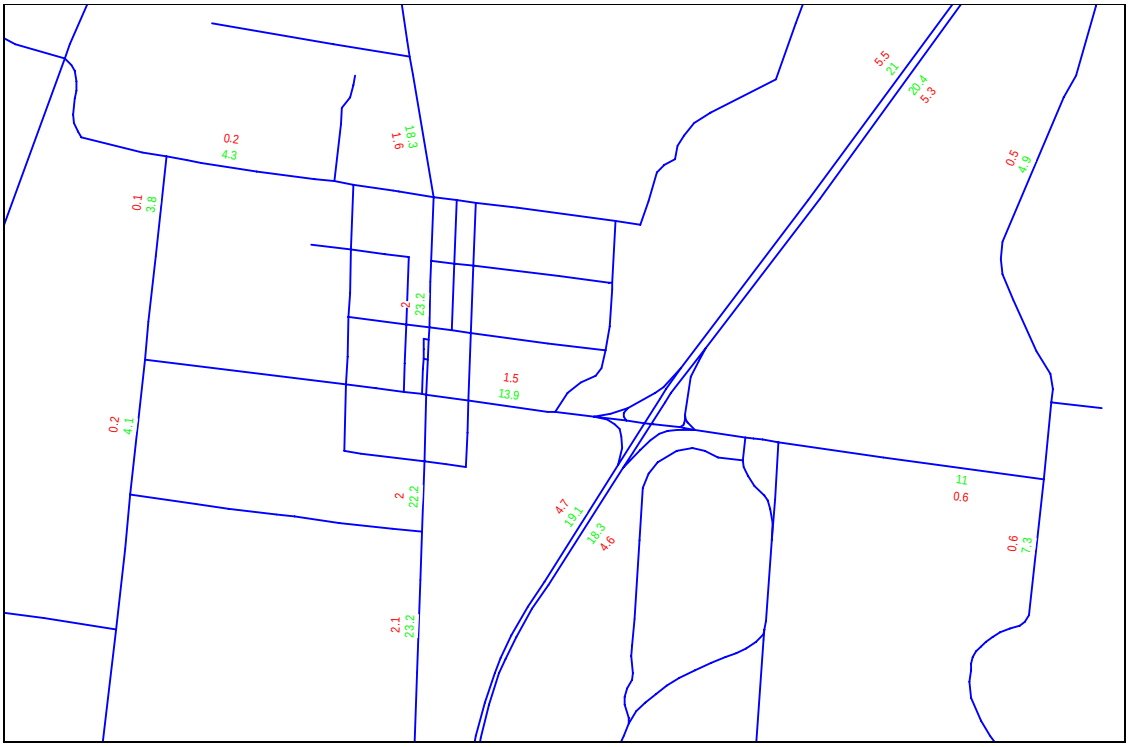


Figure 67: Two-way vehicle traffic volumes in 2041 (Dry Creek Option)

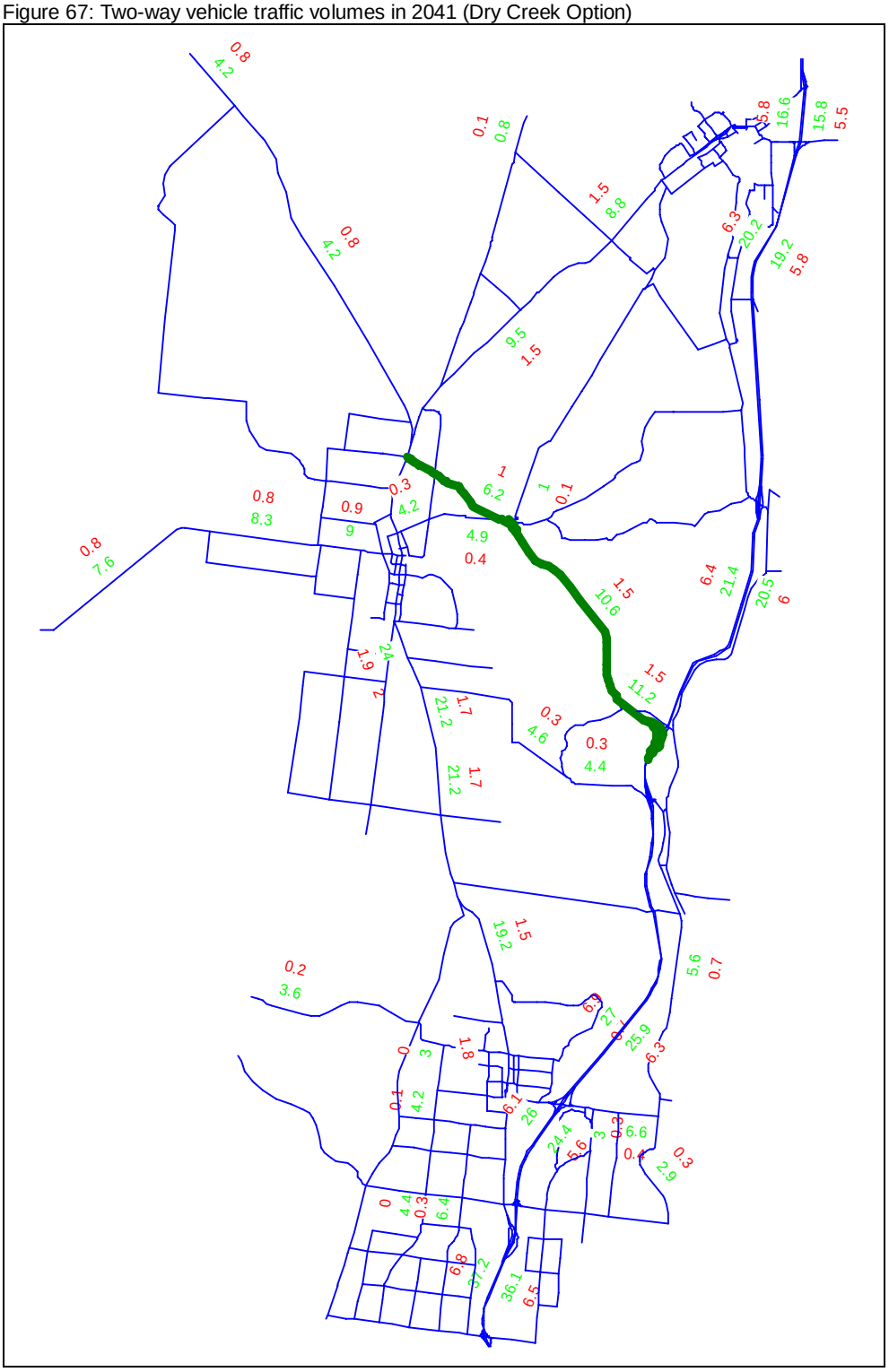


Figure 68: Kilmore township two-way vehicle traffic volumes in 2041 (Dry Creek Option)

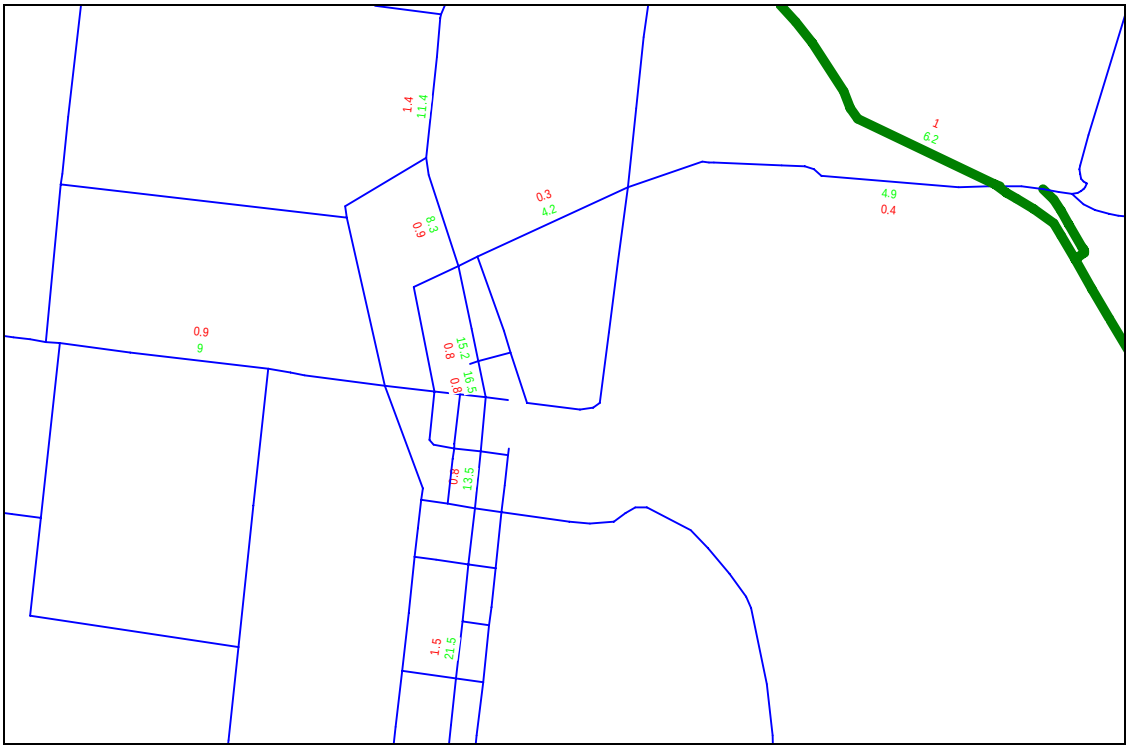


Figure 69: Wallan township two-way vehicle traffic volumes in 2041 (Dry Creek Option)

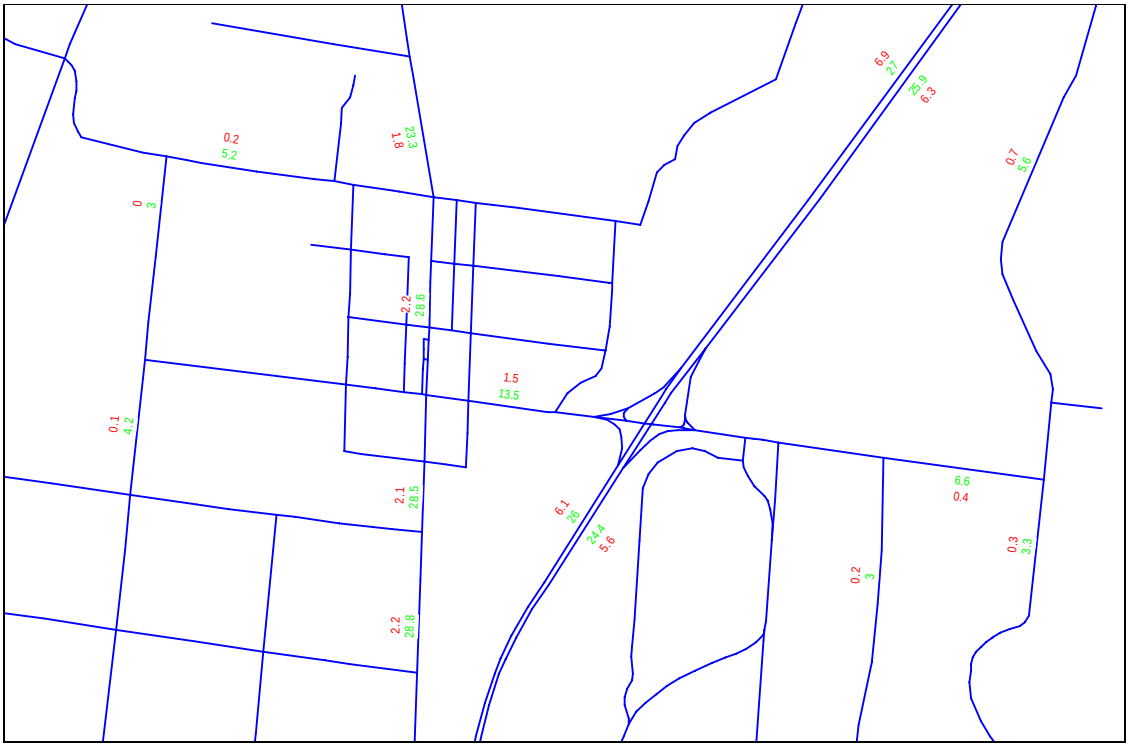


Figure 70: Two-way vehicle traffic volumes in 2021 (Sunday Creek Option)

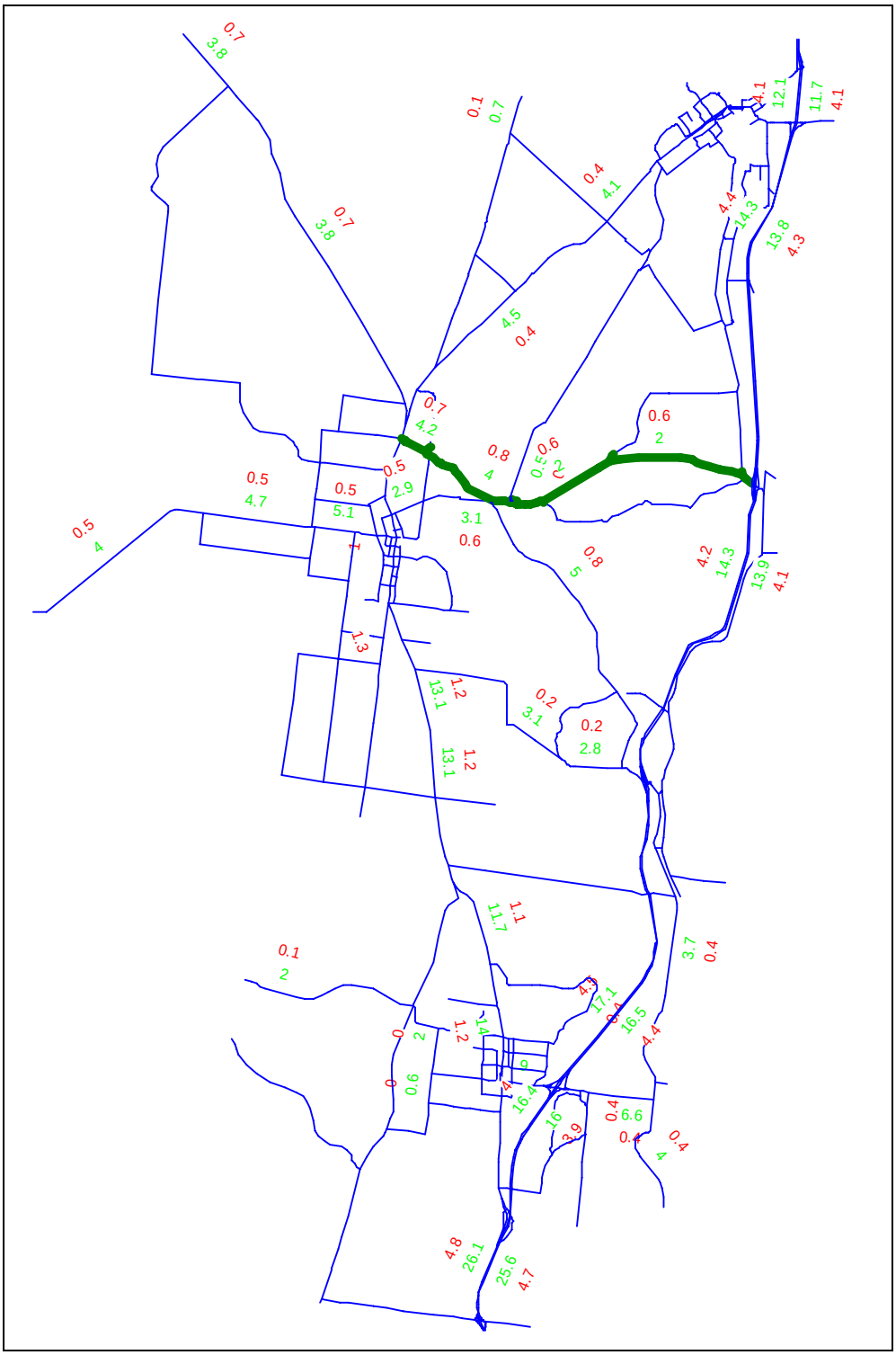


Figure 71: Kilmore township two-way vehicle traffic volumes in 2021 (Sunday Creek Option)

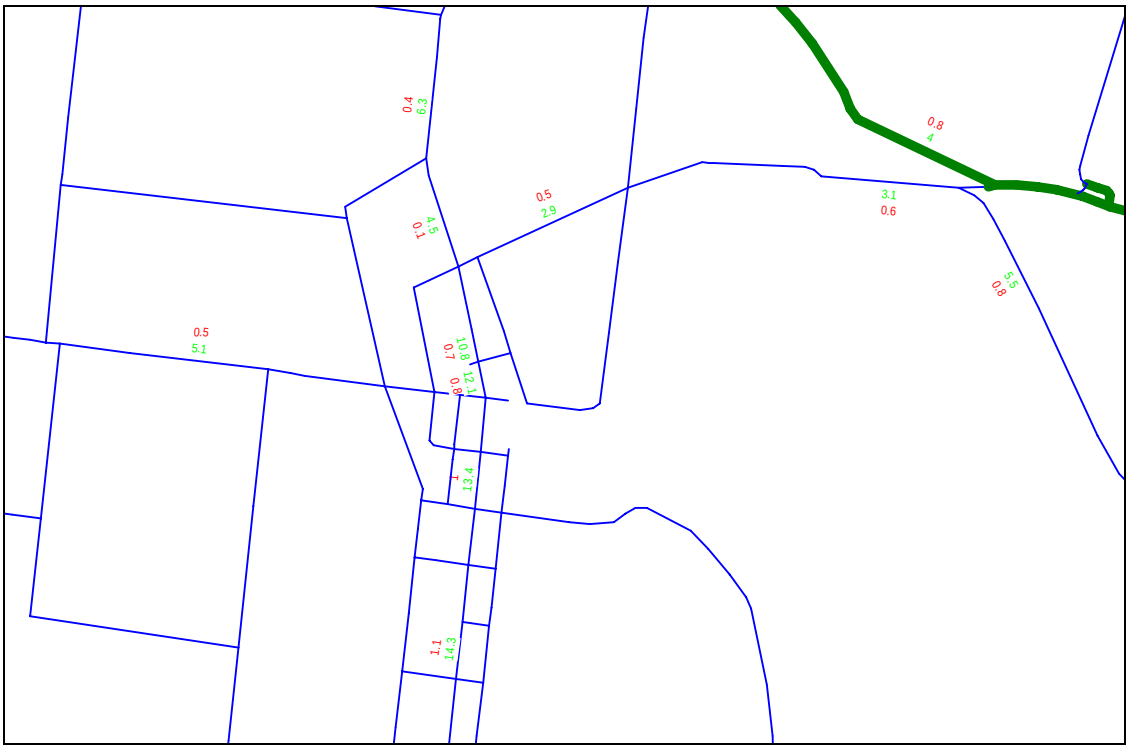


Figure 72: Wallan township two-way vehicle traffic volumes in 2021 (Sunday Creek Option)

Figure 73: Two-way vehicle traffic volumes in 2031 (Sunday Creek Option)

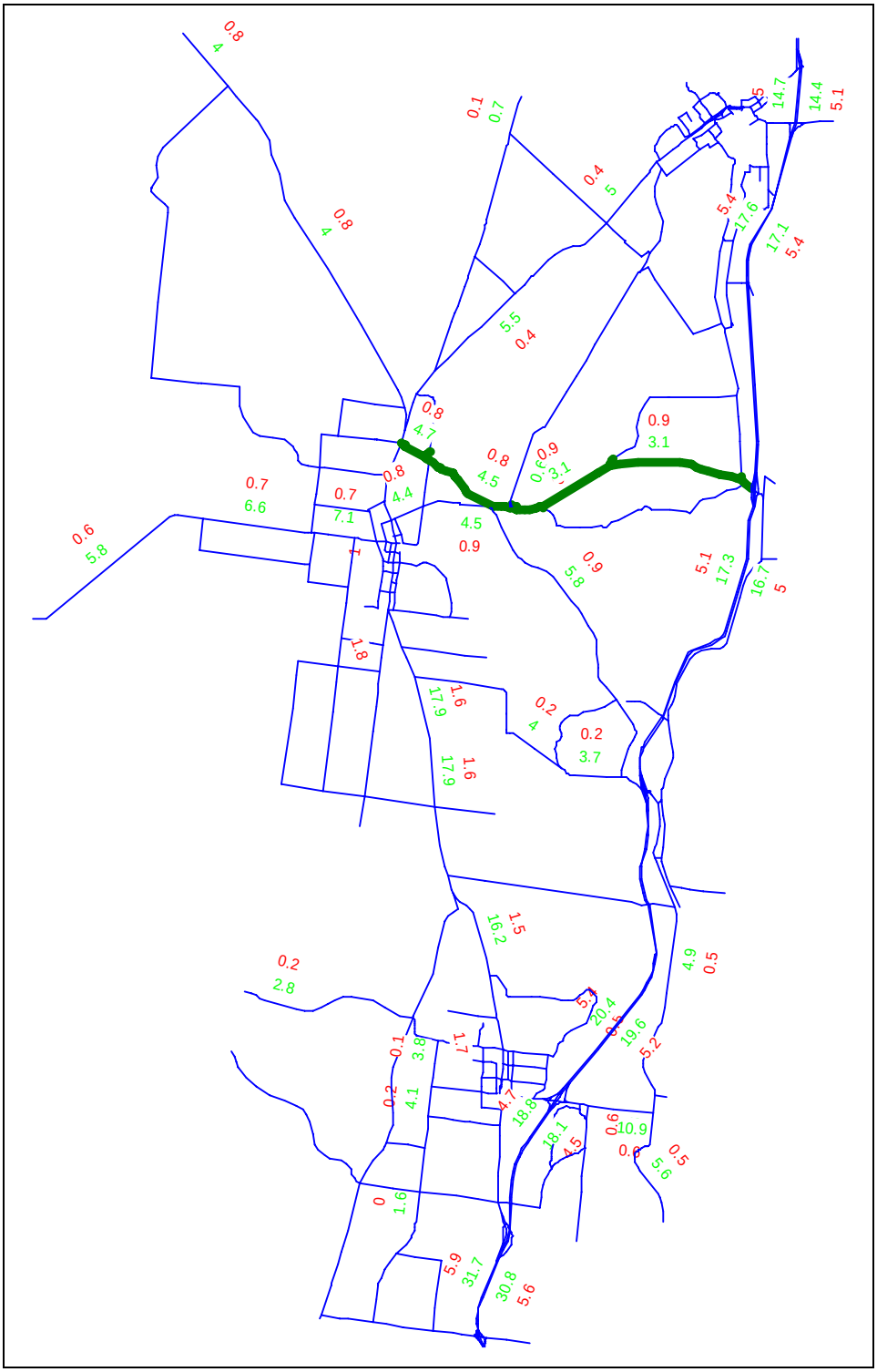


Figure 74: Kilmore township two-way vehicle traffic volumes in 2031 (Sunday CreekOption)

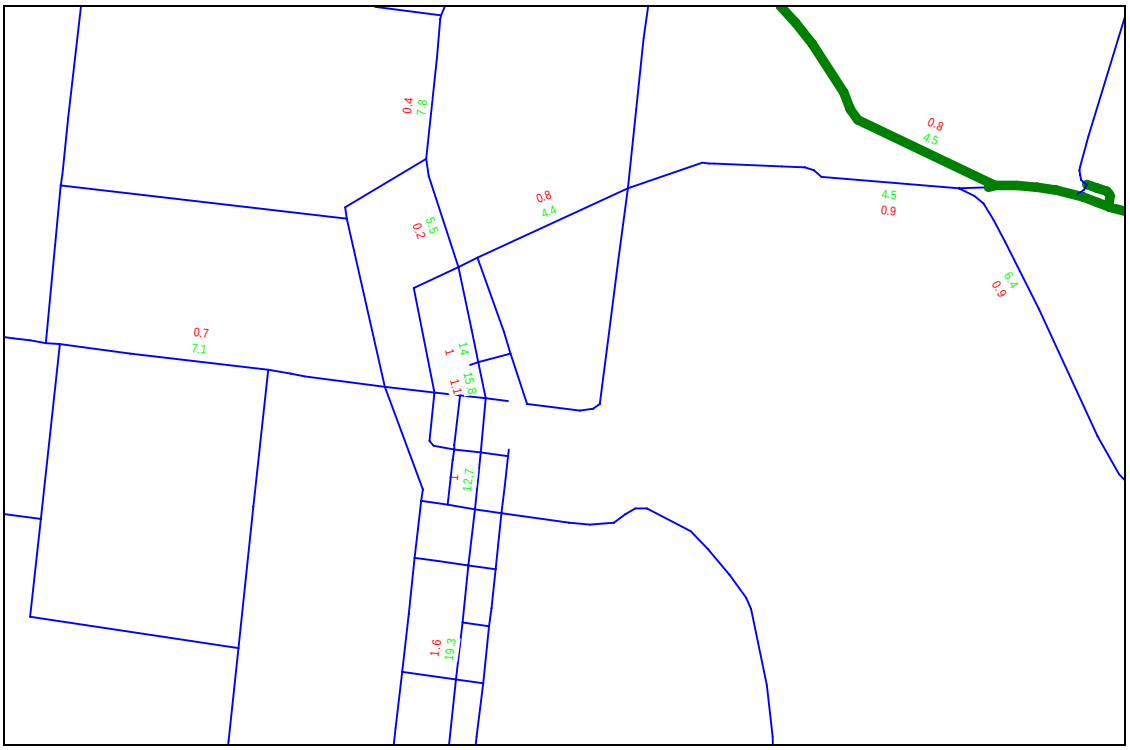


Figure 75: Wallan township two-way vehicle traffic volumes in 2031 (Sunday Creek Option)

Figure 76: Two-way vehicle traffic volumes in 2041 (Sunday Creek Option)

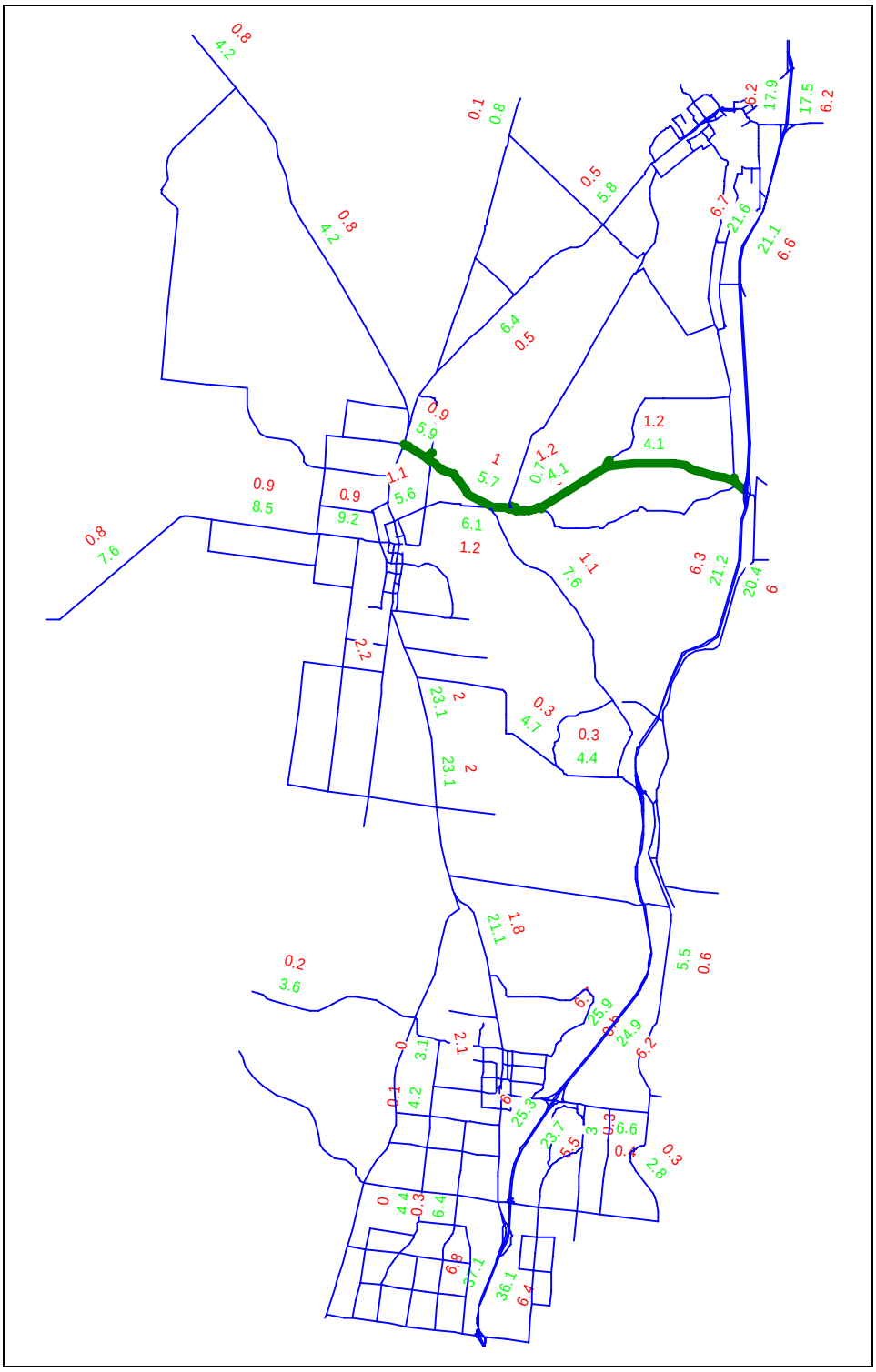


Figure 77: Kilmore township two-way vehicle traffic volumes in 2041 (Sunday Creek Option)

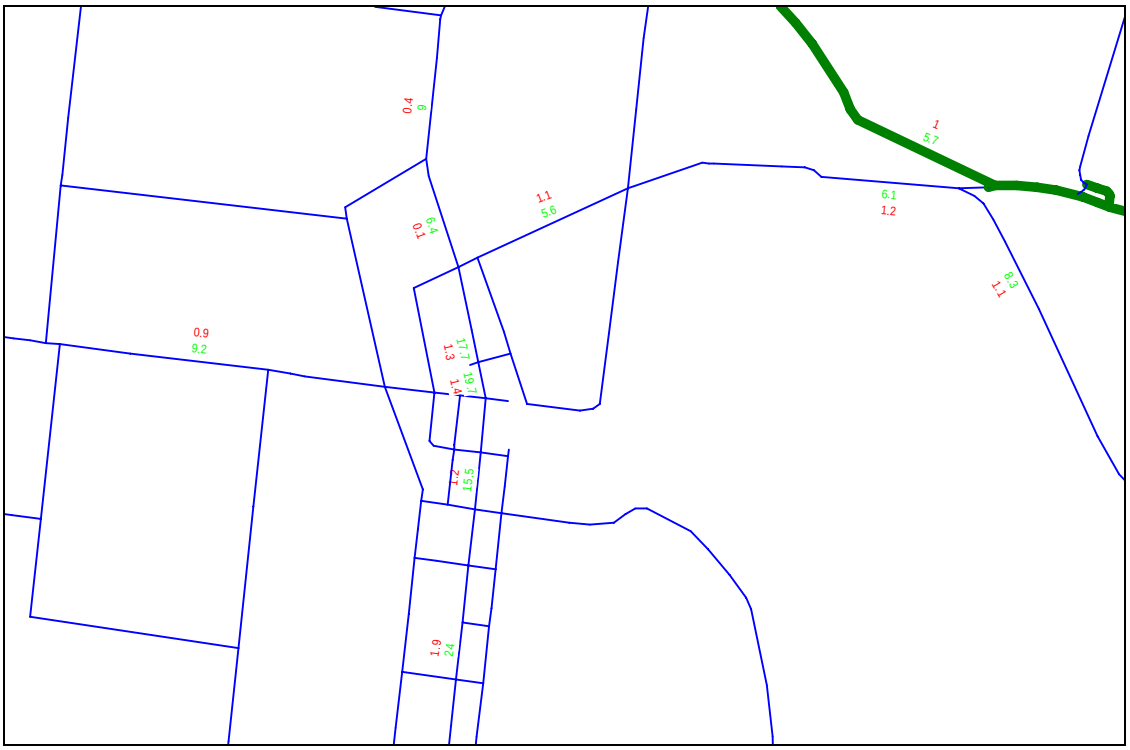


Figure 78: Wallan township two-way vehicle traffic volumes in 2041 (Sunday Creek Option)

Appendix F

Economic Assessment Details

Appendix F Economic Assessment Details

TO BE COMPLETED