AECOM

Shepparton Bypass Strategic Model Update
Greater Shepparton City Council
30-Aug-2016

Shepparton Bypass Strategic Model Update

Demand Forecast and Economic Evaluation

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Client: Greater Shepparton City Council

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Prepared by

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Quality Information

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Prepared by Julie Vinas and Henry Le

Reviewed by Adrian Koon

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
A	19-Aug-2016	Draft Report	Henry Le Associate Director	
B	25-Aug-2016	Draft Report	Henry Le Associate Director	
C	30-Aug-2016	Report	Henry Le Associate Director	

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Executive Summary

In 2012 VicRoads engaged AECOM to develop a strategic transport model for the Greater Shepparton area, to assess the traffic and economic impacts associated with a number of bypass configuration options. The study was completed and documented in the report *Development of the Shepparton Bypass Strategic Transport Model* (September 2012). A total of seven options for the Shepparton Bypass were modelled including Option 1, 2, 3, 4, 5, 5A and 5B. Option 5A (also known as the Northern Bypass) involves a standard freeway with one lane in each direction and at grade intersections connecting Midland Highway in the south and Goulburn Valley Highway and Wanganui Road intersection in the north.

In May 2016, the Greater Shepparton City Council commissioned AECOM to update the model and use the updated model to study the travel demand and economic performance for variations of Option 5A, which are known as Options 1A, 1B and 1A&B (Option and Stage are used interchangeably in this report).

This study has updated the strategic transport model for Greater Shepparton in the following areas.

- The demographic data for the base and all future years were updated with the Victoria In Future (VIF) 2014.
- The traffic growth rates at the external cordon of the model were updated to be in line with the population and employment growth rates.
- The special traffic generators in the model were reviewed and left unchanged, except that the Goulburn Valley Freight Logistics Centre was assumed to be opened in 2031 rather than 2021, as advised by Council.
- The road networks were updated with three options of the bypass. In addition, it was also assumed that Ford Road would be upgraded to be aligned with the proposed bypass at this location, and the cost of Ford Road upgrade was also included in the economic evaluation process.

The traffic analysis indicated that Option 1B in isolation would attract very low traffic volumes because it represents an option without connections to Goulburn Valley Highway and Ford Road upgrade. Option 1A&B would attract the highest traffic volume and therefore relieve more traffic on the Midland Highway and Goulburn Valley Highway and within the city centre than the other options.

The report has also updated all economic evaluation parameters to 2015 prices, and provided an economic evaluation for three options. Sensitivity analysis was also conducted by varying some economic parameters.

The economic evaluation indicates that all three options have a benefit cost ratio (BCR) less than 1. Option 1A provides the highest BCR, while Option 1B has the lowest BCR.

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1.0 Introduction

1.1 Study Background

In 2012 VicRoads engaged AECOM to develop a strategic transport model for the Greater Shepparton area, to assess the traffic and economic impacts associated with a number of bypass configuration options. The study was completed and documented in the report *Development of the Shepparton Bypass Strategic Transport Model* (September 2012). There are a total of seven options for the Shepparton Bypass including Option 1, 2, 3, 4, 5, 5A and 5B. Option 5A (also known as the Northern Bypass) involves a standard freeway with one lane in each direction with at grade intersections connecting Midland Highway in the south and Goulburn Valley Highway and Wanganui Road intersection in the north.

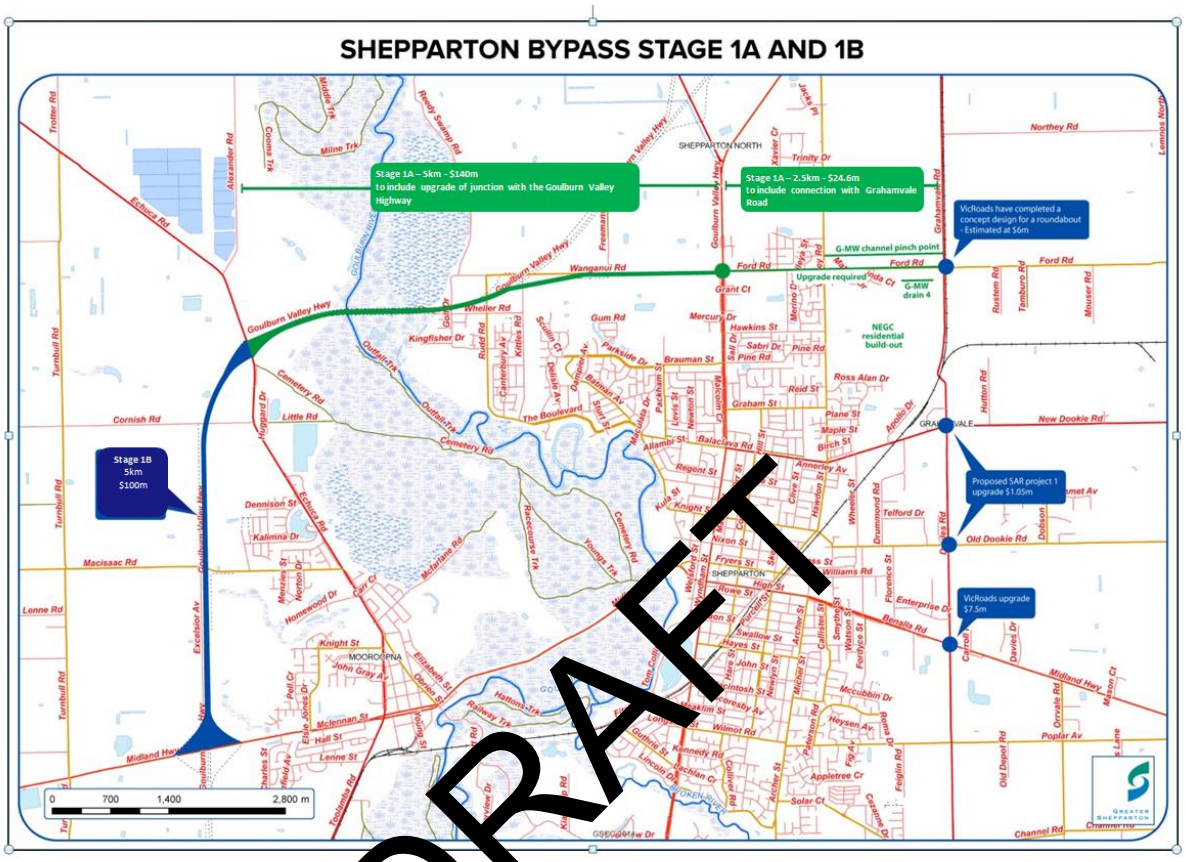
In May 2016, the Greater Shepparton City Council commissioned AECOM to update the model and use the updated model to study the travel demand and economic performance for variations of Option 5A, which are known as Options 1A, 1B and 1A&B (Option and Stage are used interchangeably in this report).

1.2 Study Scope

The main scope of this study includes:

- Update the Shepparton Strategic Transport Model to ensure that the model reflects the most current traffic and demographic data available
- Model the impact of Stages 1A and 1B as indicated in Figure 1 both separately and cumulatively (Stage 1AB). Stage 1A involves linking Echuca – Mooroopna Road to Grahamvale Road and Stage 1B connects Echuca – Mooroopna Road to Midland Highway. Both stages would include the update of Ford Road.
- Provide a cost benefit analysis for the three options

Figure 1: Shepparton Bypass Options



Source: Shepparton City Council

1.3 Structure of the report

The purpose of this report is to describe model updates, and present a forecast of travel demand and economic evaluation results for each bypass option.

- **Section 2** summarises key updates to the model
- **Section 3** presents the modelling results for three staging options
- **Section 4** presents the economic assessment results
- **Section 5** provides some concluding remarks

2.0 Model Updates

2.1 Methodology

The methodology for updating the Shepparton Bypass Strategic Model (the Shepparton Model) is as follows:

- Use the Shepparton Model developed by AECOM for VicRoads in 2012 as a starting point for this study
- Update the demographic data for 2011, 2016, 2021, 2031 and 2041 for the study area using the demographic data from the Victorian Integrated Transport Model (VITM) provided by the Department of Economic Development, Jobs, Transport and Resources (DEDJTR) in June 2015, based on VIF 2014. The VITM input data was developed originally by SGS Economics and Planning for 70 zones across the study area, and was disaggregated into 198 zones for the Shepparton Model
- Review the traffic growth rates for light and heavy vehicles at the external cordon
- Code the project network for three scenarios: Stage 1A Bypass, Stage 1B Bypass, and combined Stage 1A&B Bypass. The base cases were the same as those used in the 2012 study.
- Prepare and conduct model runs for 3 options for 5 planning years
- Update the economic parameters wherever possible and produce the economic evaluation results for three options

The following sections will discuss the model inputs to be updated.

2.2 Demographic data

Demographic data is a key input into the Shepparton Model as it will drive travel demand in the future. This study updates the demographic data input to the Shepparton Model based on the most recent data source: VIF 2014 provided by DEDJTR. Table 1 below shows a broad comparison of total population, total jobs and employment for the study area between VIF2011 (used for the previous 2012 study) and VIF2014 for this study. The data shows no significant changes in population and employment in 2011 and 2021, but growth is stronger in 2031 and 2041. This results in a 5% and 11% increase in population and employment in VIF2014 than VIF2011 in 2031 and 2041. The enrolments provided by VIF2014 are also much higher than as shown in VIF2011.

Table 1: Comparison of demographic data between VIF 2011 and VIF2014

Parameters	Data source	2011	2016	2021	2031	2041
Total Population	VIF 2011	51,098	54,089	56,956	62,154	66,244
	VIF 2014	50,181	53,104	57,103	65,302	73,786
	Percentage change	-2%	-2%	0%	5%	11%
Total Jobs	VIF 2011	31,342	32,617	34,085	36,831	39,940
	VIF 2014	30,386	32,126	34,635	38,825	44,484
	Percentage change	-3%	-2%	2%	5%	11%
Enrolments	VIF 2011	14,413	15,879	17,105	18,212	19,097
	VIF 2014	24,345	25,208	26,143	26,785	28,868
	Percentage change	69%	59%	53%	47%	51%

Appendix B provides more details of the distribution of demographic data for Shepparton in VIF 2014 by small area.

2.3 Traffic Growth rates applied to external-external trips

Table 2 below shows the growth rates of external-external trips, for each external transport zone, by light and heavy vehicles separately, which have been reviewed by VicRoads and adopted for this study.

Table 2: Traffic Growth rates applied to external-external trips

External Zone	Road Name	Location	Light & Heavy vehicles		
			2011-16	2016-31	2031-41
301	Katamatite-Shepparton Road	North east of Lemnos North Road	1.1%	1.3%	1.2%
302	Goulburn Valley Highway	North east of Trewins Road	1.1%	1.3%	1.2%
303	Barmah-Shepparton Road	North west of Zeerust Road	1.1%	1.3%	1.2%
304	Echuca-Mooroopna Road	North west of Dougan Road	1.1%	1.3%	1.2%
305	Merrigum-Ardmona Road	West of Ardmona Road	1.1%	1.3%	1.2%
306	Midland Highway	West of Ardmona Road	1.1%	1.3%	1.2%
307	Ferguson Road	West of Downer Road	1.1%	1.3%	1.2%
308	Toolamba-Rushworth Road	West of Downer Road	1.1%	1.3%	1.2%
309	Mooroopna-Murchison Road	South of Bitcon Road	1.5%	1.5%	1.2%
310	Goulburn Valley Highway	South of Ross Road	1.5%	1.5%	1.2%
311	Euroa-Shepparton Road	South of Union Road	1.5%	1.5%	1.2%
312	Shepparton-Eurora Road	South of Mitchell Road	1.1%	1.3%	1.2%
313	Midland Highway	East of Boundary Road	1.1%	1.3%	1.2%
314	New Dookie Road	East of Boundary Road	1.1%	1.3%	1.2%
315	Lemnos-Cosgrove Road	East of Boundary Road	1.1%	1.3%	1.2%
316	Congupna East Road	East of Boundary Road	1.1%	1.3%	1.2%
317	Jubilee Road	East of Boundary road	1.1%	1.3%	1.2%

With the exception of zones 309-311 (located to the south of the study area), the growth rate for light and heavy vehicles has generally kept in line with forecast population growth for the study area. Zones 309-311 have higher growth rates as the analysis of permanent count station data revealed that the Goulburn Valley Highway to the south of the study area has experienced higher traffic growth than the other permanent count stations surrounding the study area.

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Table 3: Forecast population and employment growth for the study area[1] (VIF2014)

Year	Population	Employment
2011	50,181	30,386
2016	53,104	32,126
2021	57,103	34,635
2031	65,302	38,825
2041	73,786	44,484
Growth rate p.a.		
2011-16	1.1%	1.1%
2016-21	1.5%	1.5%
2021-31	1.4%	1.1%
2031-41	1.2%	1.4%

[1] *Study area is smaller than the entire Greater Shepparton area*

2.4 Treatment of Special Generators

Additional trips associated with a number of special generators in the study area (that cannot be adequately represented by the trip attraction equations alone) were incorporated into the model. The special generators that were identified, along with the additional trip types, included:

- Shepparton railway station – park/kiss and ride trips
- Mooroopna railway station – park/kiss and ride trips
- Greater Shepparton City Council (Welsford Street offices) – visitor trips
- Shepparton Regional Hospital – patient and visitor trips
- Shepparton Private Hospital – patient and visitor trips
- Goulburn Valley Freight Logistics Centre – truck trips.

Table 4 shows the additional trips estimated for each of the special generators. The vehicle trips generated by these special generators are reasonable and do not require additional review, with the exception of the Goulburn Valley Freight Logistics Centre (GVFLC). In the 2012 study, it was assumed that the GVFLC would be operated in 2021. However, in the Inception meeting, Council indicated that the GVFLC would be likely to be opened in 2031, therefore the timing for the GVFLC was revised to start in 2031 as shown in Table 4. The remaining special generators were assumed unchanged.

Table 4: Additional daily trips associated with special generators in the study area

Special Generator	Transport Zone	Additional Daily (24-hour) Light Vehicle Trips					Additional Daily (24-hour) Heavy Vehicle Trips				
		2011	2016	2021	2031	2041	2011	2016	2021	2031	2041
Shepparton Railway Station	27	281	298	314	342	365	-	-	-	-	-
Mooroopna Railway Station	47	27	28	30	32	34	-	-	-	-	-
Greater Shepparton City Council (Welsford Street offices)	11	260	275	290	316	337	-	-	-	-	-
Shepparton Regional Hospital	109	666	705	743	811	864	-	-	-	-	-
Shepparton Private Hospital	110	150	159	167	182	194	-	-	-	-	-
Goulburn Valley Freight Logistics Centre	62	-	-	-	-	-	-	-	-	2,813	3,039

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2.5 Assumptions on the road network

1. The base cases

Assumed to be the same as those in the 2012 study

2. Stage 1A Bypass

This option was known as part of Option 5A of the 2012 study. It involves a bypass from the Echuca Road to the intersection of Goulburn Valley Highway and Wanganui Road in the north. This option has the following characteristics:

- Highway standard road with a speed limit of 100 km/hr
- One lane in each direction
- At-grade intersections at Echuca Road and Goulburn Valley Highway.
- Strathmerton Deviation is not included (located further north of the study area). Actually, the Strathmerton Deviation would have no significant impact to all three options, because traffic from that direction, with deviation or not, would merge to Goulburn Valley Highway to turn to Wanganui Road to access the bypass and vice versa.
- Upgrade Wanganui Road between the Bypass and Goulburn Valley Hwy

In addition, this option includes improvements on Ford Road between Goulburn Valley Hwy and Grahamvale Road resulting in the adoption of a 1 lane arterial in each direction (80 km/hr).

3. Stage 1B Bypass

This option involves a bypass between Midland Hwy and Echuca Road and has similar characteristicsto Option 1A above. It also includes improvements at Ford Road between Goulburn Valley Hwy and Grahamvale Road.

4. Stage 1A & 1B combined

This option involves a bypass between Midland Hwy and Goulburn Valley Highway with similar characteristics Option 1A. It also includes improvements at Ford Road between Goulburn Valley Hwy and Grahamvale Road.

3.0 Modelling results

3.1 Base Case

The 2011 and future base year road network were assumed to be the same as those in the 2012 study.

Figure 2 and Figure 3 illustrate the magnitude of daily (24-hour) traffic volumes across the road network in 2011 and 2041 respectively. As can be seen, Goulburn Valley Highway and Midland Highway within the inner area of Shepparton tend to experience higher traffic volumes than other roads. Figure 4 shows the difference in daily traffic volumes between 2041 and 2011 base cases. By 2041, traffic volumes are expected to increase as a result of forecast population and employment growth in the study area.

Figure 5 to Figure 7 illustrate the same set of information for heavy vehicles only. The figures show Goulburn Valley Highway, Shepparton Alternative Route and Midland Highway currently carry relatively high volumes of heavy vehicles, which will continue to increase into the future. Heavy vehicle traffic on Mooroopna-Murchison Road (immediately south of the Midland Highway) is also expected to increase into the future due to the additional truck traffic generated from the proposed Goulburn Valley Freight Logistics Centre, which was assumed to open in 2031.

Table 5 details existing (2011) and forecast traffic volumes (2016, 2021, 2031, 2041) along key roads in the study area. By 2041, Midland Highway would carry around 39,100 vehicles per day along the causeway, and Goulburn Valley Highway between Wanganui Road and Shepparton-Barmah Road would carry 17,100 vehicles per day. Relatively large heavy vehicle volumes of about 6100 vehicles per day are also expected along the causeway of the Midland Highway.

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Figure 2: 2011 Base Case one way traffic volumes ('000s) – All vehicles – Daily

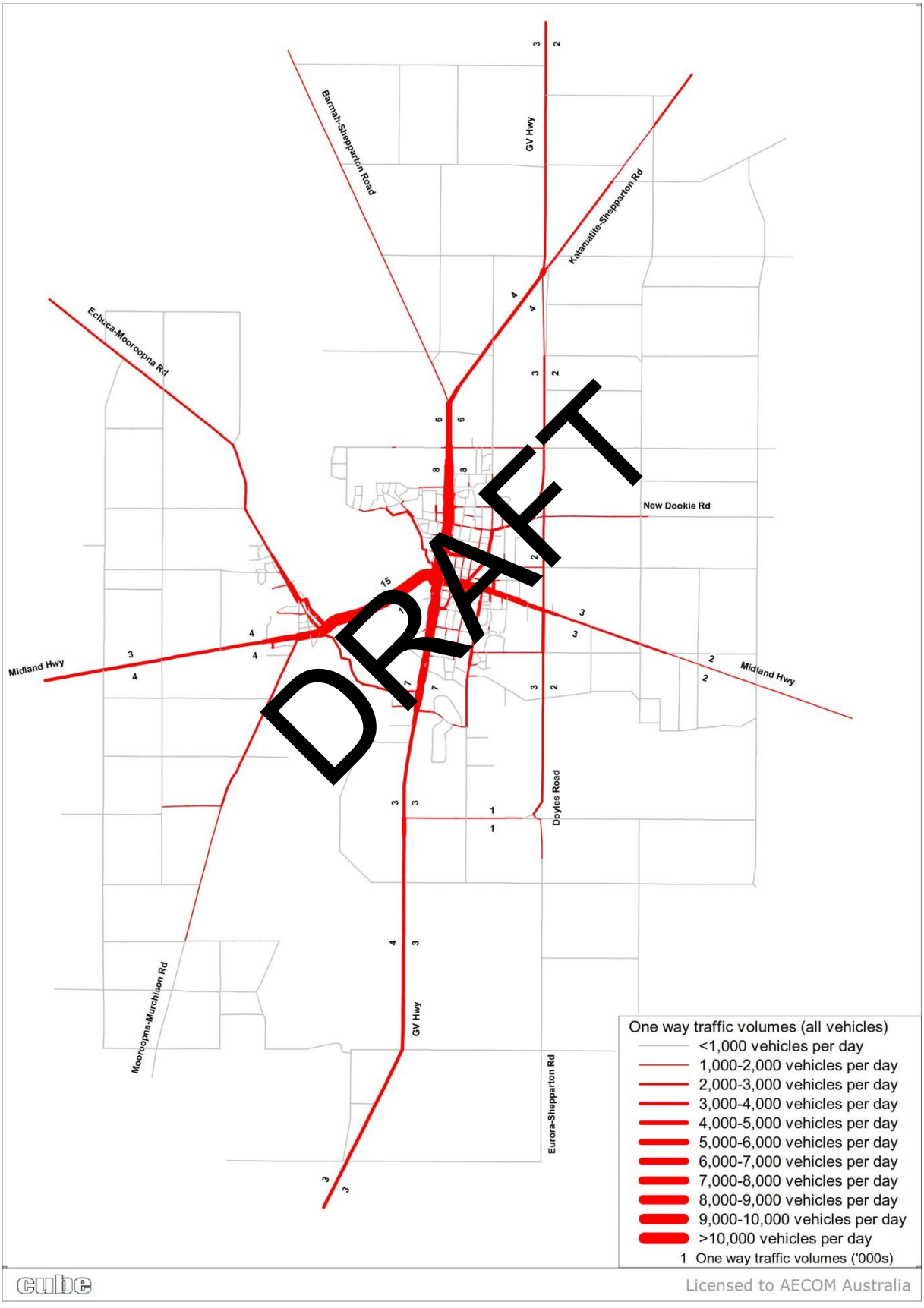

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Figure 3: 2041 Base Case one way traffic volumes ('000s) – All vehicles – Daily

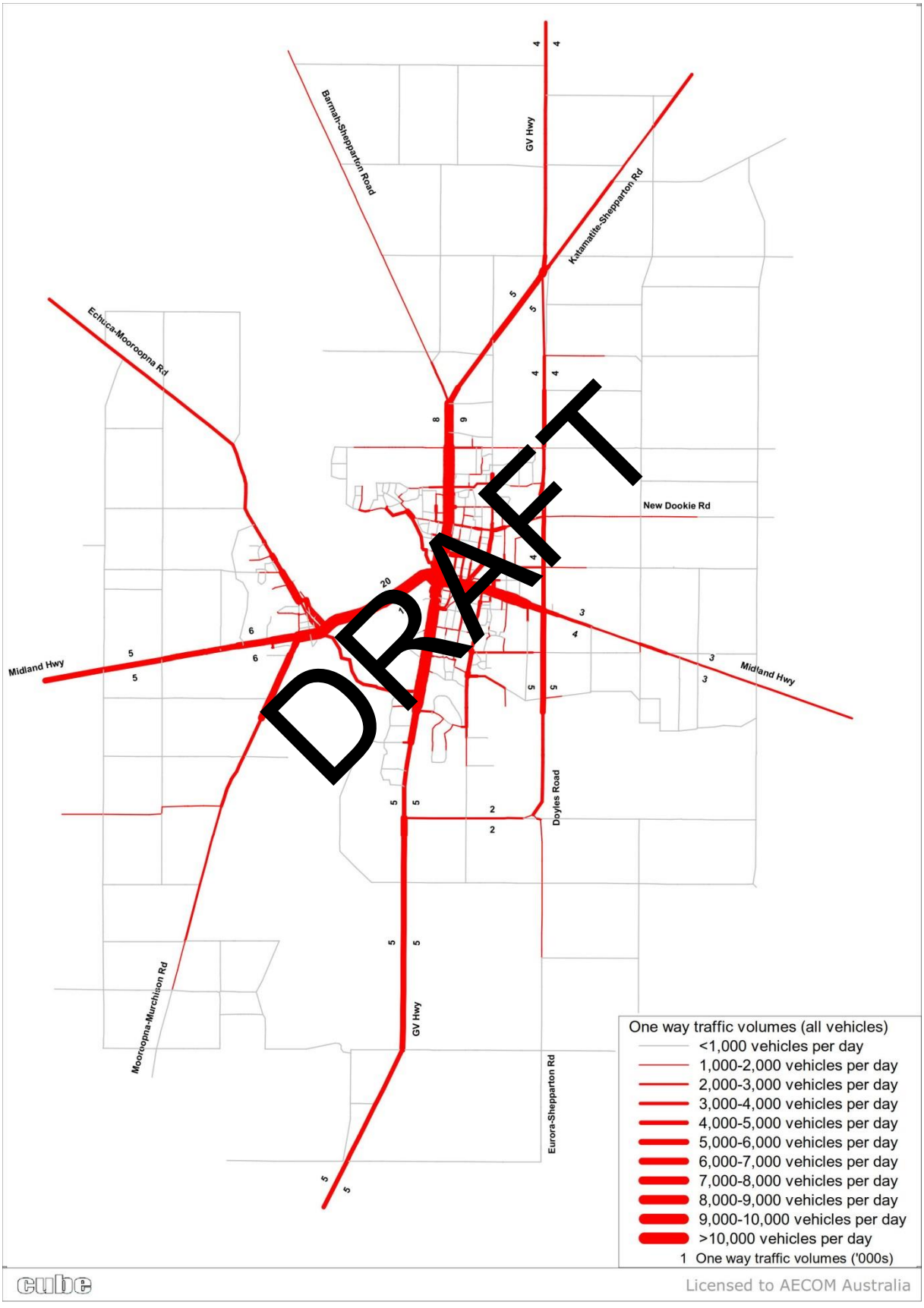

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Figure 4: Difference in daily (24-hour) traffic volumes between 2041 Base Case and 2011 Base Case – all vehicles

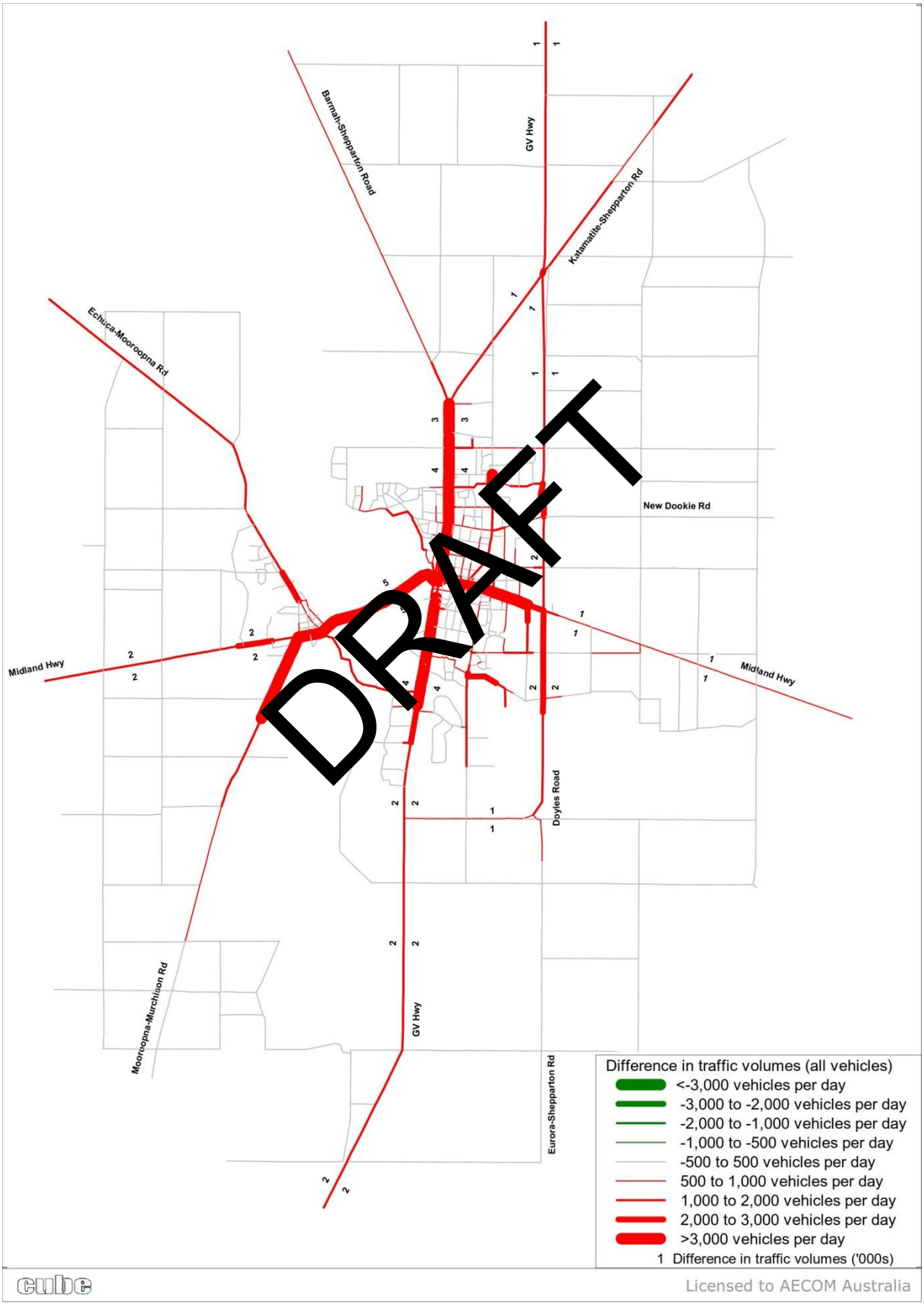

Figure 5: 2011 Base Case one way traffic volumes ('000s) – Heavy vehicles – Daily

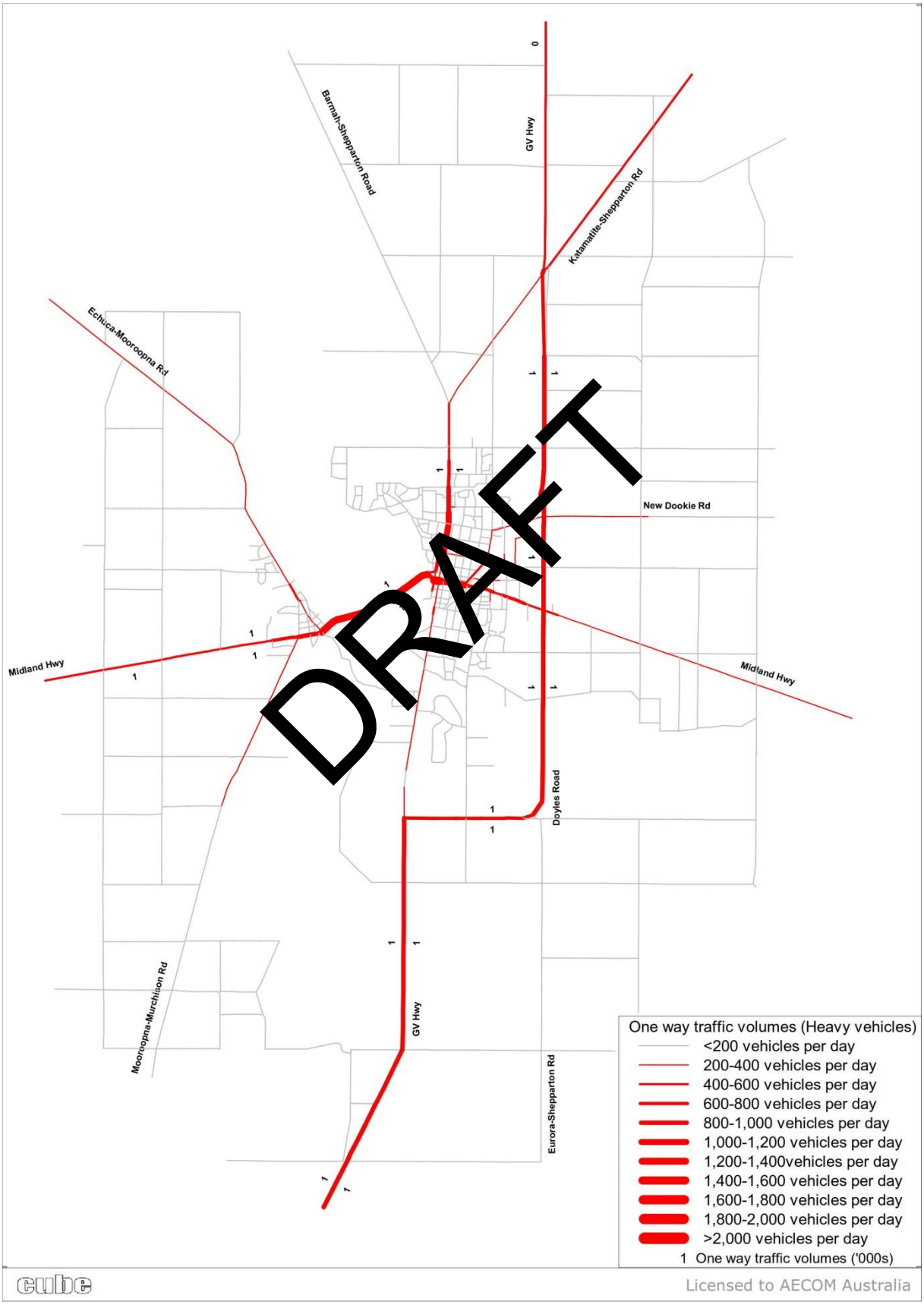

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Figure 6: 2041 Base Case one way traffic volumes ('000s) – Heavy vehicles – Daily

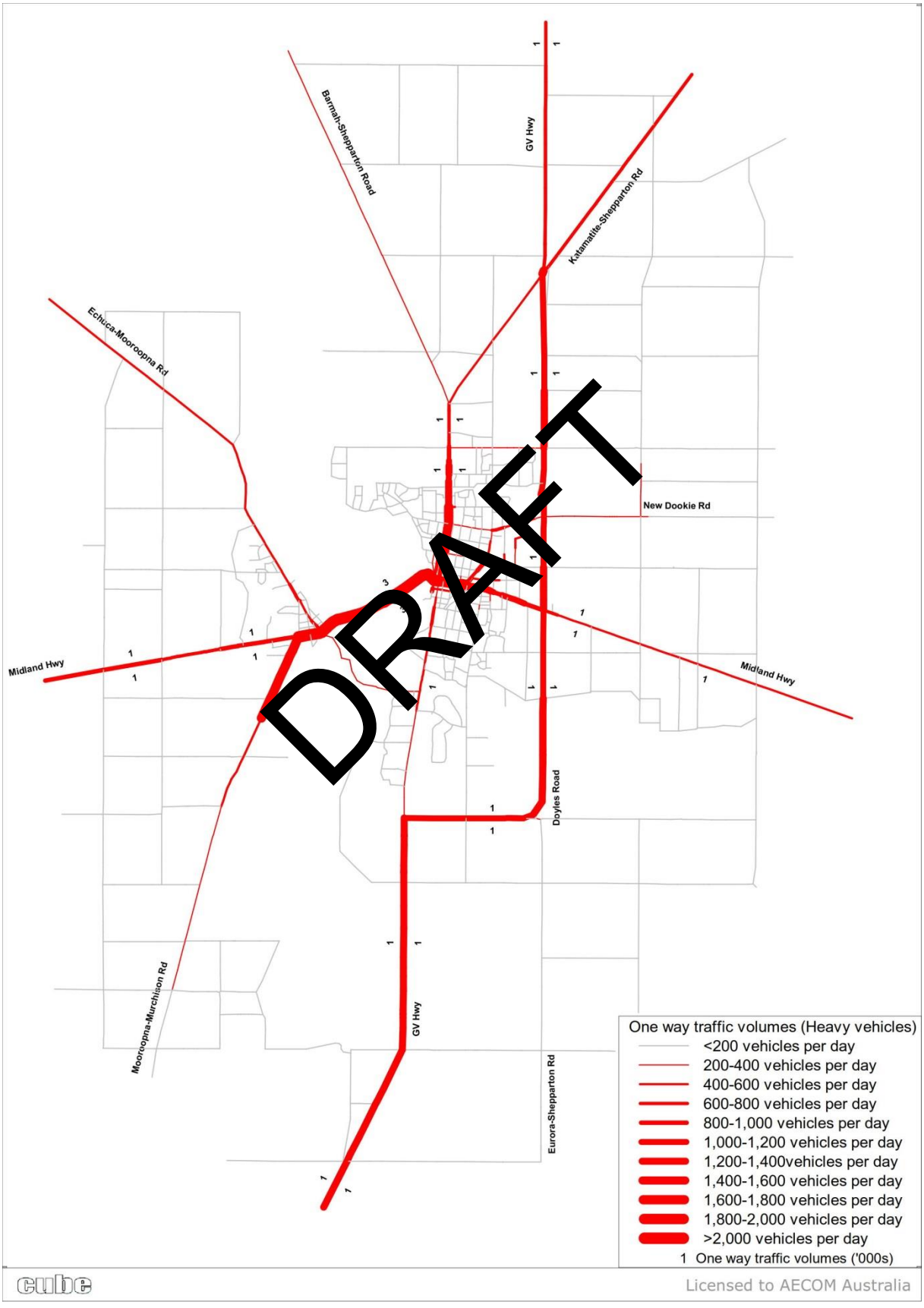

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Figure 7: Difference in daily (24-hour) traffic volumes between 2041 Base Case and 2011 Base Case – Heavy vehicles

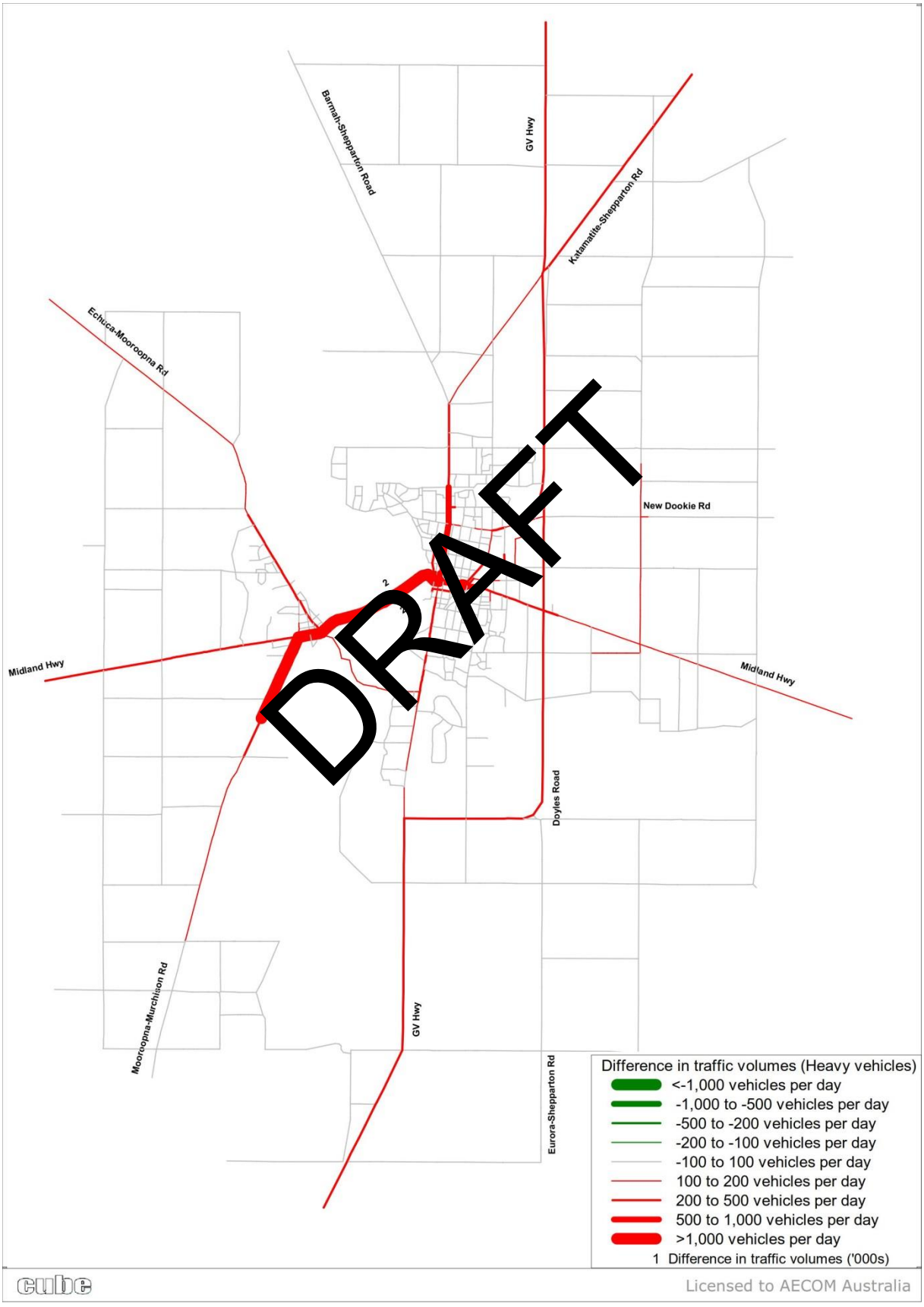

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Table 5: Base Case traffic volumes

Road name	Two-Way Daily (24-hour) All Vehicles					Two-Way Daily (24-hour) Heavy Vehicles				
	2011	2016	2021	2031	2041	2011	2016	2021	2031	2041
Shepparton Bypass										
Between Gribben Road and Bridge Road	0	0	0	0	0	0	0	0	0	0
Between Bridge Road and Mooroopna-Murchison Road	0	0	0	0	0	0	0	0	0	0
Between Mooroopna-Murchison Road and Midland Highway	0	0	0	0	0	0	0	0	0	0
Between Midland Highway and Echuca-Mooroopna Road	0	0	0	0	0	0	0	0	0	0
Between Echuca-Mooroopna Road and Wanganui Road	0	0	0	0	0	0	0	0	0	0
Between Wanganui Road and Shepparton-Barmah Road	0	0	0	0	0	0	0	0	0	0
Between Shepparton-Barmah Road and Goulburn Valley Highway	0	0	0	0	0	0	0	0	0	0
Goulburn Valley Highway										
Between Doyles Road and Karramomus Road	6,500	7,000	7,500	8,700	9,800	1,600	1,800	1,900	2,200	2,500
Between Union Road and Mitchell Road	7,000	7,600	8,100	9,300	10,500	1,700	1,800	1,900	2,300	2,600
Between River Road and Rafferty Road	6,200	6,400	6,600	8,700	9,300	400	400	400	500	600
Between Midland Highway and Fryers Street	10,200	10,800	11,300	13,800	15,400	600	700	700	1,100	1,600
Between Wanganui Road and Shepparton-Barmah Road	11,100	11,800	12,900	15,500	17,100	900	900	900	1,200	1,300
Between Shepparton-Barmah Road and Shepparton Alt. Route	7,200	7,600	7,900	9,400	10,100	500	600	600	700	800
Between Zeerust Road and Trewins Road	5,200	5,500	5,900	6,800	7,700	800	900	1,000	1,100	1,300
Midland Highway										

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Road name	Two-Way Daily (24-hour) All Vehicles					Two-Way Daily (24-hour) Heavy Vehicles				
	2011	2016	2021	2031	2041	2011	2016	2021	2031	2041
Between Downer Road and Turnbull Road	7,000	7,400	8,000	9,200	10,500	1,000	1,100	1,100	1,400	1,500
Near Kidstown Adventure Playground (on causeway)	29,200	29,900	31,300	35,900	39,100	2,700	2,900	3,000	5,500	6,100
Between Goulburn Valley Highway and Maude Street	16,200	16,600	17,200	19,100	20,100	2,500	2,500	2,500	3,600	4,000
Between Doyles Road and Orrvale Road	5,300	5,500	5,700	6,400	7,000	800	800	800	1,000	1,100
Shepparton Alternative Route										
Between Archer Road and Central Kialla Road	2,700	2,900	3,300	3,700	4,400	1,400	1,500	1,600	1,800	2,000
Between Poplar Avenue and Midland Highway	6,200	7,600	7,900	8,200	11,500	1,700	1,800	1,900	2,000	2,200
Between New Dookie Road and Ford Road	5,000	5,300	5,400	6,800	7,100	1,600	1,700	1,700	1,800	2,000
Between Knights Road and Goulburn Valley Highway	3,300	3,500	4,200	4,400	5,600	1,300	1,400	1,500	1,600	1,800
Other Links										
Wanganui Road between Shepparton Bypass and GVH	2,000	2,200	2,400	2,600	2,900	100	100	100	100	100
Ford Road between GVH and Shepparton Alternative Route	2,600	3,000	3,400	4,100	5,100	400	400	300	400	500
Ford Road between Verney and Grahamvale Road	2,200	2,300	2,400	2,800	3,500	300	300	300	400	500
Katamatite-Shepparton Road at Congupna	4,500	4,800	5,100	5,800	6,600	900	1,000	1,100	1,200	1,400
Shepparton-Barmah Road North West of Shepparton Bypass	2,300	2,500	2,700	3,200	3,600	300	300	300	400	400
Echuca-Mooroopna Road North West of Shepparton Bypass	4,200	4,500	4,900	5,500	6,300	600	600	600	800	900
Mooroopna-Murchison Road South West of Shepparton Bypass	4,700	4,900	5,300	6,000	6,700	500	500	600	700	800
Shepparton Bypass (applies to options 6-8 only)										
Between Goulburn Valley Highway and River Road	0	0	0	0	0	0	0	0	0	0

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3.2 Stage 1A

Figure 8 and Figure 9 illustrate the magnitude of forecast daily traffic volumes in 2041 across the road network under Option 1A, as well as the difference in one way traffic volumes when compared to the 2041 base case. Figure 10 and Figure 11 illustrate a similar picture for heavy vehicle volumes. Table 6 provides further detail on these, with a summary of existing and forecast two way daily traffic volumes along key roads in the study area, including the bypass.

Using the above information, the following inferences can be made:

- Shepparton Bypass between Wanganui Road west of Goulburn Valley Highway, under Option 1A, is expected to carry up to 10,000 vehicles (two ways) including around 1,200 trucks per day by 2041.
- The greatest reductions in traffic on the existing road network with Option 1A in place (when compared to the 2041 base case) are expected along the Midland Highway causeway (reduction of around 8,600 vehicles per day)
- The greatest reductions in heavy vehicle traffic on the existing road network with Option 1A in place (when compared to the 2041 base case) are also expected along the Midland Highway causeway (reduction of around 900 trucks per day by 2041).

Figure 8: 2041 Stage 1A one way traffic volumes ('000s) – All vehicles – Daily

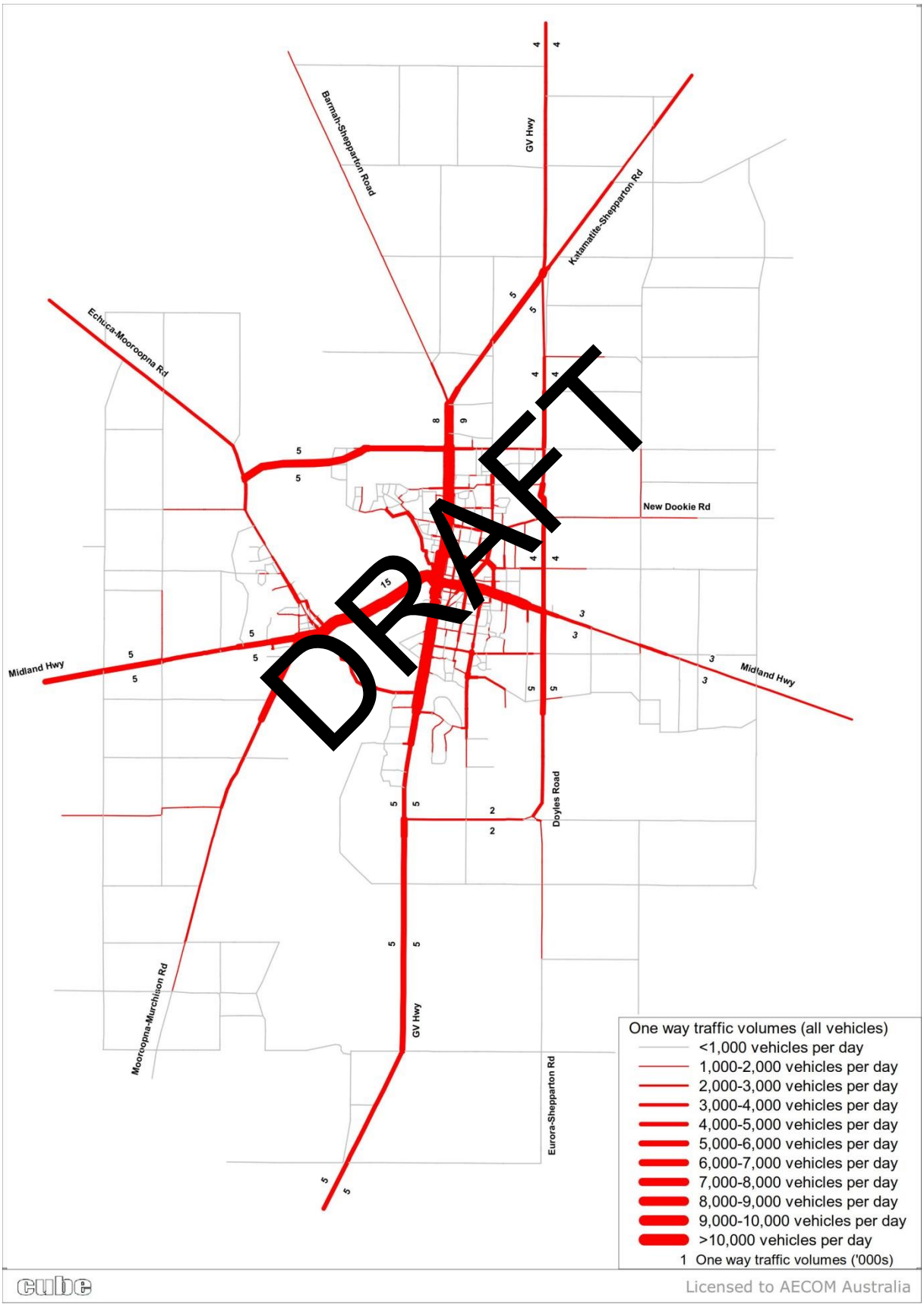

Figure 9: Difference in daily (24-hour) traffic volumes between 2041 Stage 1A and 2041 Base Case – all vehicles

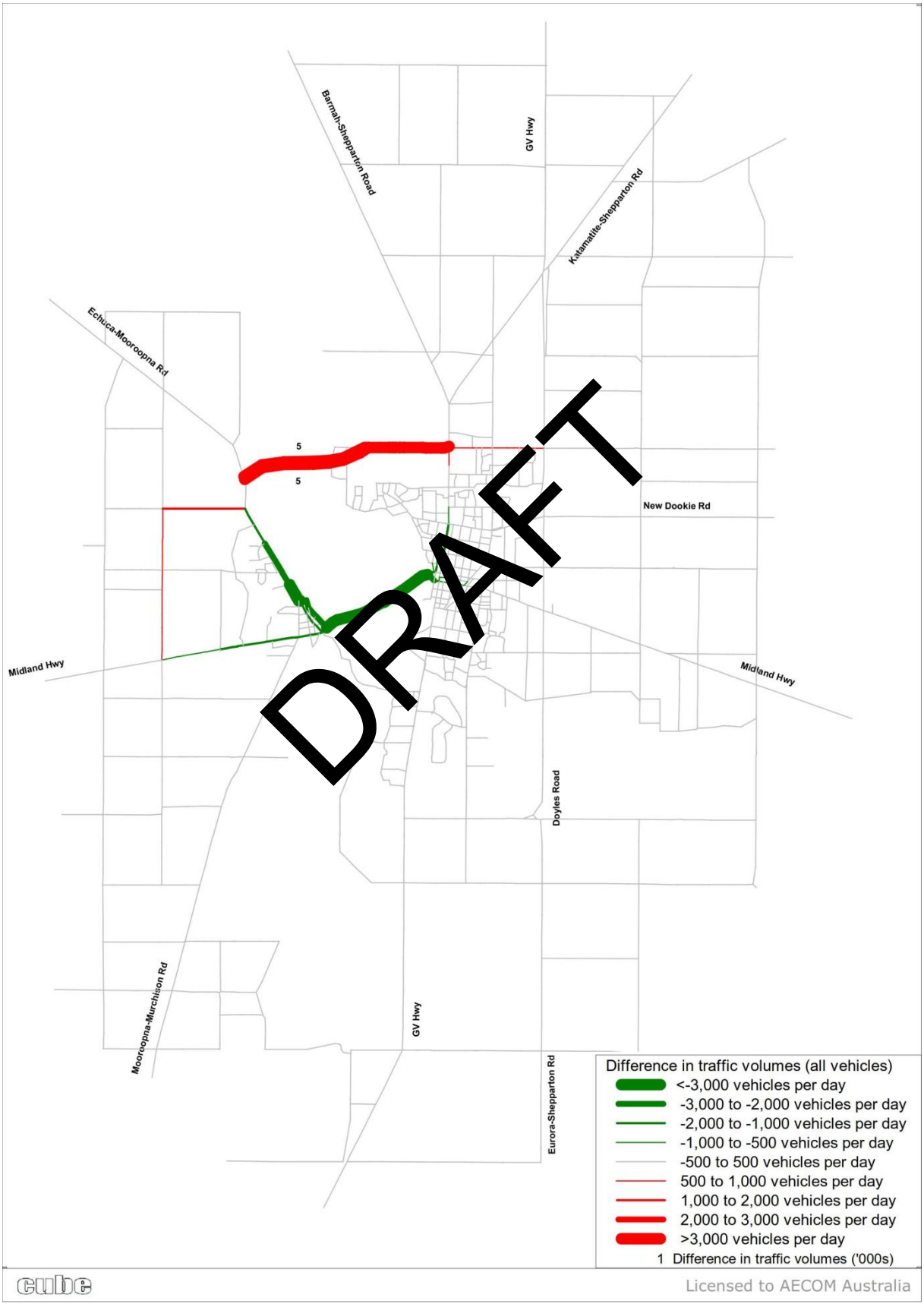

Figure 10: 2041 Stage 1A one way traffic volumes ('000s) – Heavy vehicles – Daily

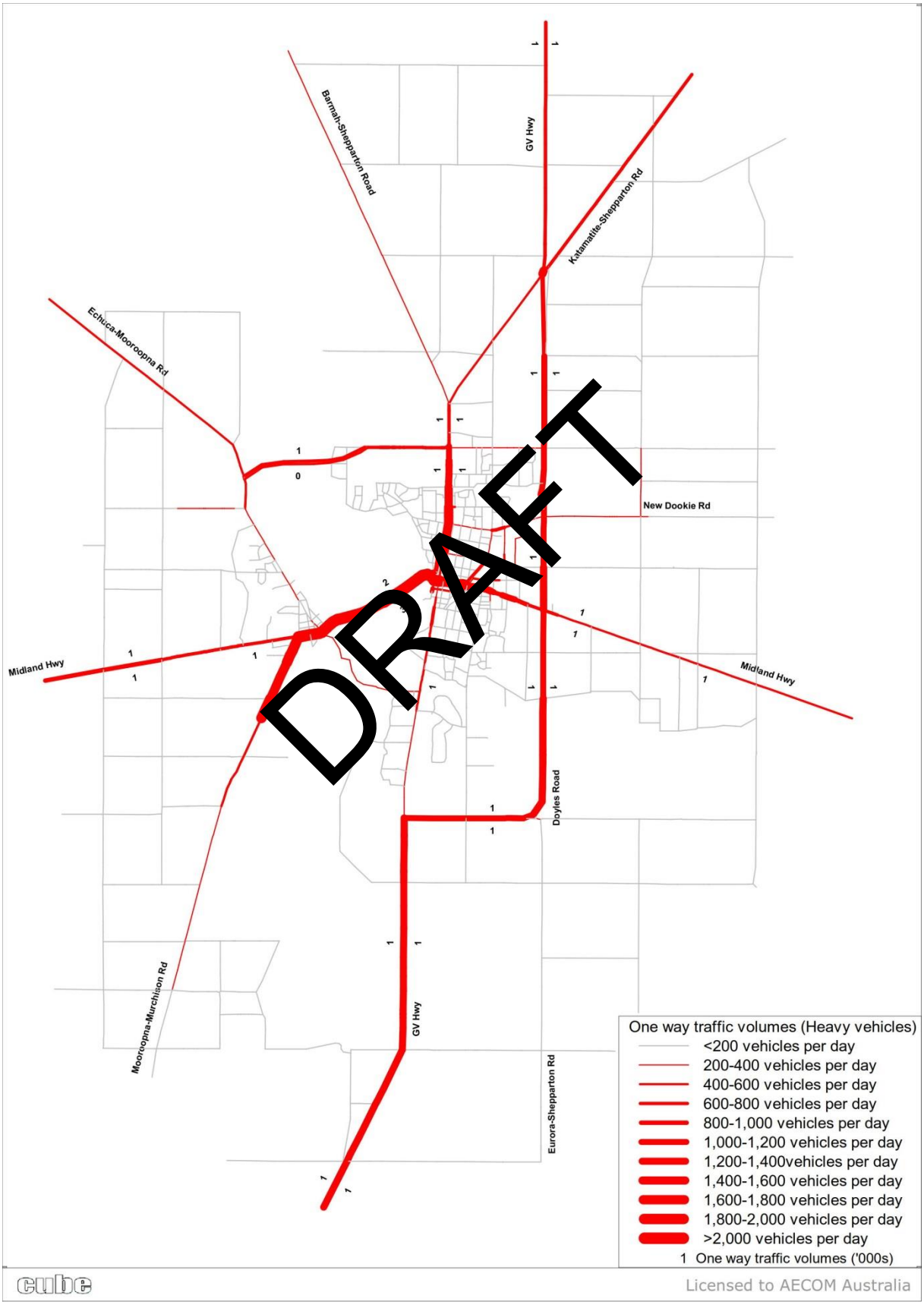

Figure 11: Difference in daily (24-hour) traffic volumes between 2041 Stage 1A and 2041 Base Case – Heavy vehicles

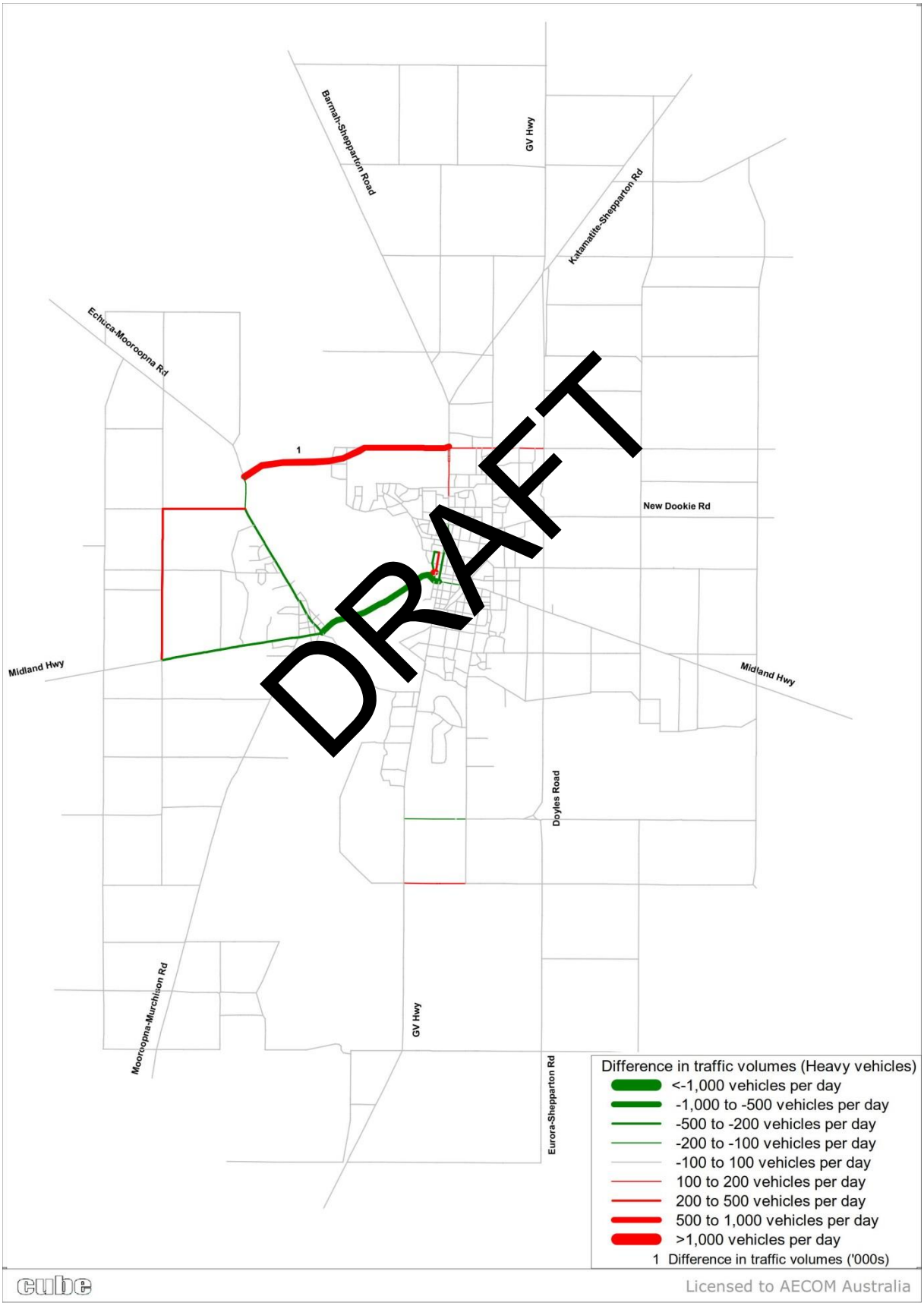

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Table 6: Stage 1A traffic volumes

Road name	Two-Way Daily (24-hour) All Vehicles					Two-Way Daily (24-hour) Heavy Vehicles				
	2011	2016	2021	2031	2041	2011	2016	2021	2031	2041
Shepparton Bypass										
Between Gribben Road and Bridge Road	0	0	0	0	0	0	0	0	0	0
Between Bridge Road and Mooroopna-Murchison Road	0	0	0	0	0	0	0	0	0	0
Between Mooroopna-Murchison Road and Midland Highway	0	0	0	0	0	0	0	0	0	0
Between Midland Highway and Echuca-Mooroopna Road	0	0	0	0	0	0	0	0	0	0
Between Echuca-Mooroopna Road and Wanganui Road	0	0	[illegible]800	[illegible]00	10,000	0	0	900	1,000	1,200
Between Wanganui Road and Shepparton-Barmah Road	0	0	0	0	0	0	0	0	0	0
Between Shepparton-Barmah Road and Goulburn Valley Highway	0	0	0	0	0	0	0	0	0	0
Goulburn Valley Highway										
Between Doyles Road and Karramomus Road	6,5[illegible]	[illegible]000	7,500	8,700	9,800	1,600	1,800	1,900	2,200	2,500
Between Union Road and Mitchell Road	[illegible]100	7,600	8,100	9,300	10,500	1,700	1,800	2,000	2,300	2,600
Between River Road and Rafferty Road	6,200	6,100	6,500	8,600	9,200	400	400	400	500	600
Between Midland Highway and Fryers Street	[illegible]0,2[illegible]	10,800	11,500	13,600	15,100	600	700	700	800	900
Between Wanganui Road and Shepparton-Barmah Road	11,100	11,800	12,900	15,400	17,000	900	900	900	1,200	1,300
Between Shepparton-Barmah Road and Shepparton Alt. Route	7,200	7,600	7,800	9,300	10,100	500	600	600	700	800
Between Zeerust Road and Trewins Road	5,200	5,500	5,700	6,600	7,400	800	900	900	1,100	1,300
Midland Highway										
Between Downer Road and Turnbull Road	7,000	7,400	8,000	9,200	10,500	1,000	1,100	1,100	1,300	1,500
Near Kidstown Adventure Playground (on causeway)	29,200	29,900	24,300	28,200	30,500	2,700	2,900	2,200	4,600	5,100

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Road name	Two-Way Daily (24-hour) All Vehicles					Two-Way Daily (24-hour) Heavy Vehicles				
	2011	2016	2021	2031	2041	2011	2016	2021	2031	2041
Between Goulburn Valley Highway and Maude Street	16,200	16,600	15,600	17,400	18,800	2,500	2,500	2,500	3,500	3,700
Between Doyles Road and Orrvale Road	5,300	5,500	5,600	6,300	6,900	800	800	800	1,000	1,100
Shepparton Alternative Route										
Between Archer Road and Central Kialla Road	2,700	2,900	3,300	3,700	4,400	1,400	1,500	1,600	1,800	2,000
Between Poplar Avenue and Midland Highway	6,200	7,600	8,100	8,300	11,700	1,700	1,800	2,000	2,000	2,200
Between New Dookie Road and Ford Road	5,000	5,300	5,700	6,200	7,500	1,600	1,700	1,700	1,900	2,100
Between Knights Road and Goulburn Valley Highway	3,300	3,500	3,900	4,300	5,500	1,300	1,400	1,400	1,600	1,800
Other Links										
Wanganui Road between Shepparton Bypass and GVH	2,000	2,200	8,900	10,000	11,400	100	100	1,000	1,100	1,300
Ford Road between GVH and Shepparton Alternative Route	2,600	3,000	4,300	5,200	6,700	400	400	500	600	700
Ford Road between Verney and Grahamvale Road	2,200	2,600	3,100	3,700	4,600	300	300	500	600	700
Katamatite-Shepparton Road at Congupna	4,300	4,800	5,100	5,800	6,600	900	1,000	1,100	1,200	1,400
Shepparton-Barmah Road North West of Shepparton Bypass	2,300	2,500	2,700	3,200	3,600	300	300	300	400	400
Echuca-Mooroopna Road North West of Shepparton Bypass	4,200	4,500	4,900	5,600	6,400	600	600	600	800	900
Mooroopna-Murchison Road South West of Shepparton Bypass	4,700	4,900	5,400	6,000	6,700	500	500	600	700	800
Shepparton Bypass (applies to options 6-8 only)										
Between Goulburn Valley Highway and River Road	0	0	0	0	0	0	0	0	0	0

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3.3 Stage 1B

Figure 12 and Figure 13 illustrate the magnitude of forecast daily traffic volumes in 2041 across the road network under Option 1B, as well as the difference in one way traffic volumes when compared to the 2041 base case. Figure 14 and Figure 15 illustrate a similar picture for heavy vehicle volumes. Table 7 provides further detail on these, with a summary of existing and forecast two way daily traffic volumes along key roads in the study area, including the bypass.

The figures show that Option 1B carries very light traffic volumes of around 300 vehicles per day by 2041, and therefore does not produce any impact to the overall road network. This is due to an insignificant traffic demand between Echuca-Mooroopna Road and Midland Highway west.

Shepparton Bypass Strategic Model Update

Figure 12: 2041 Stage 1B one way traffic volumes ('000s) – All vehicles – Daily

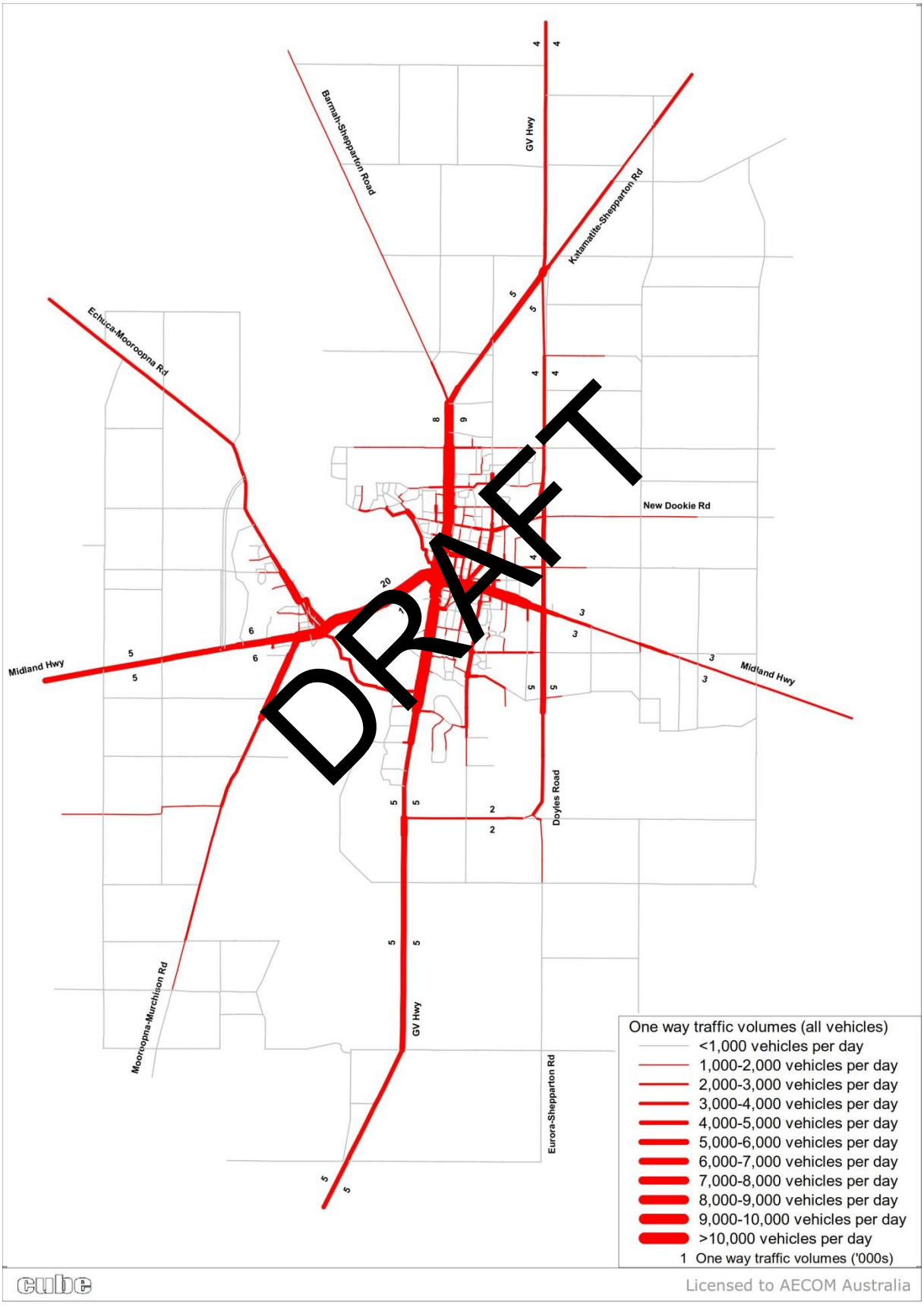

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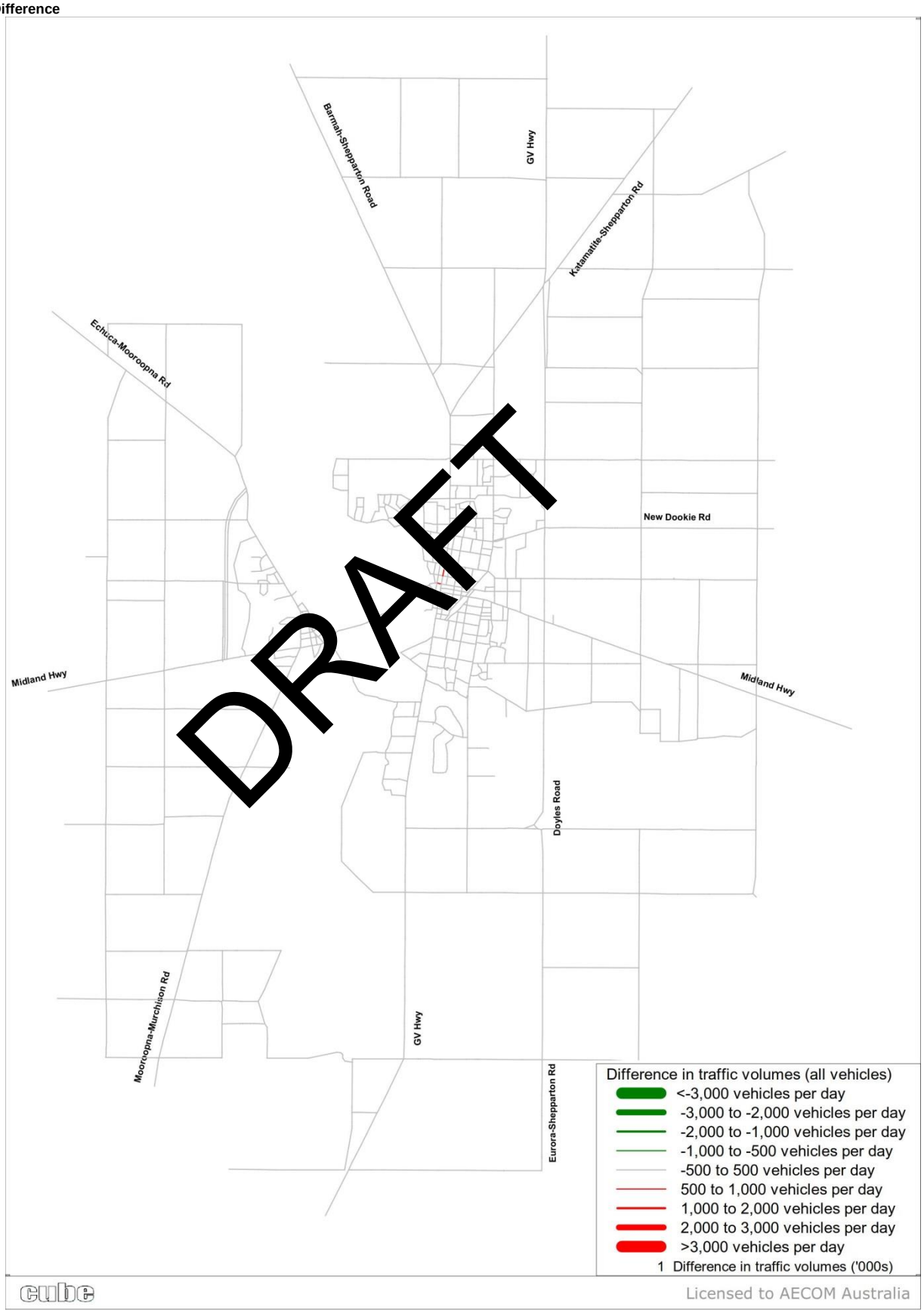
Figure 13: Difference



2041 Stage 1B and 2041 Base Case – all vehicles

Figure 14: 2041 Stage 1B one way traffic volumes ('000s) – Heavy vehicles – Daily

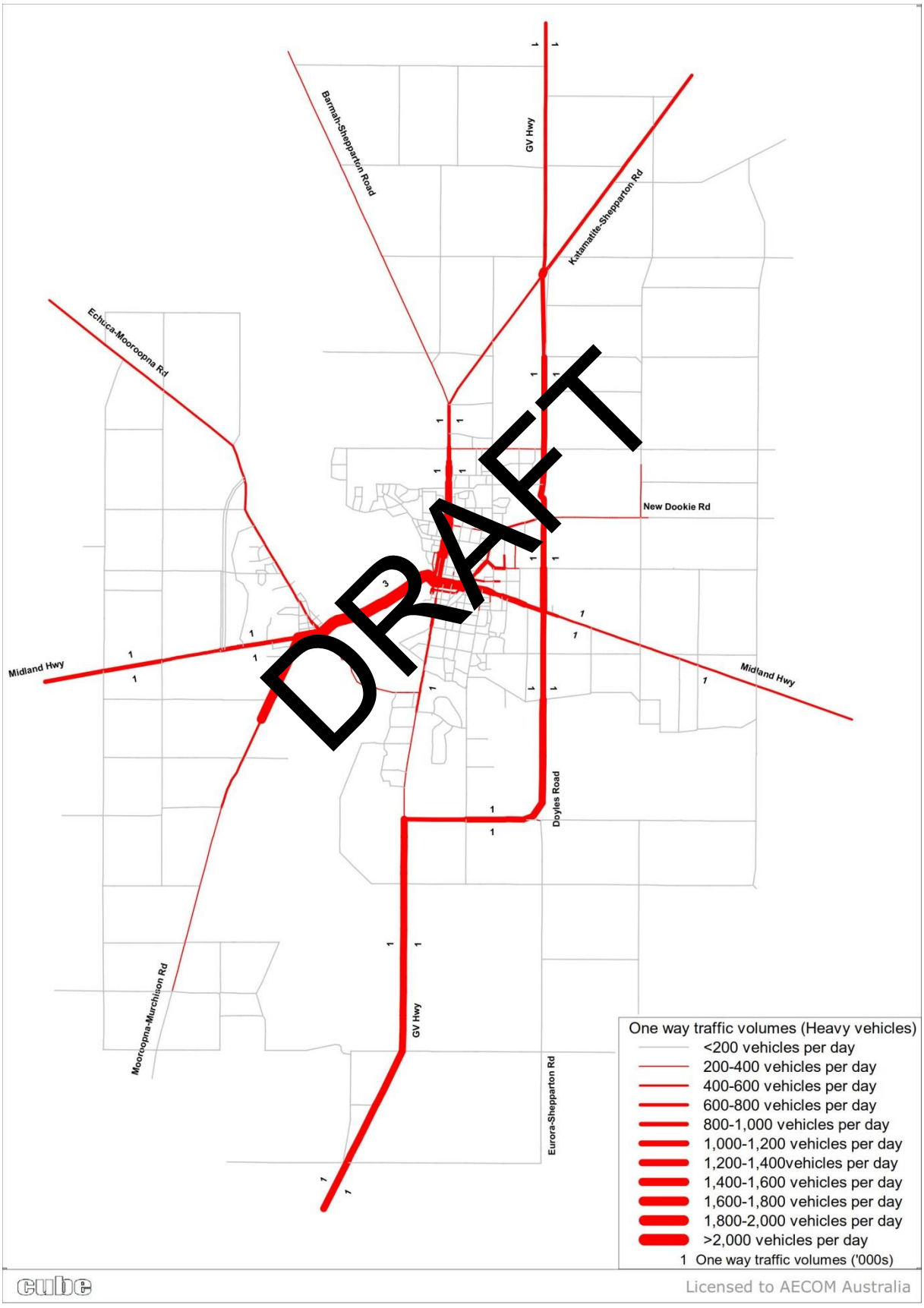


Figure 15: Difference in daily (24-hour) traffic volumes between 2041 Stage 1B and 2041 Base Case – Heavy vehicles

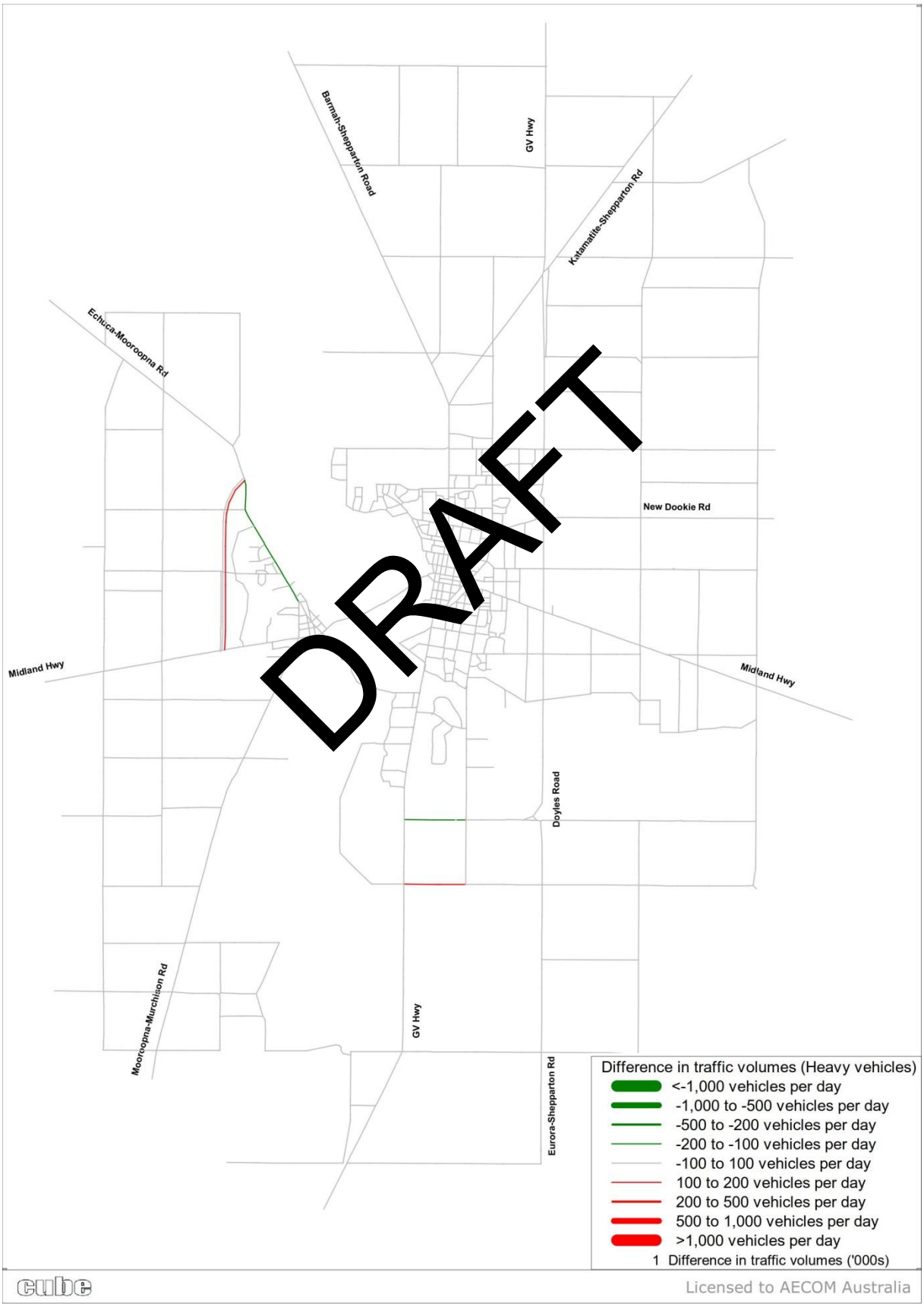


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Table 7: Stage 1B traffic volumes

Road name	Two-Way Daily (24-hour) All Vehicles					Two-Way Daily (24-hour) Heavy Vehicles				
	2011	2016	2021	2031	2041	2011	2016	2021	2031	2041
Shepparton Bypass										
Between Gribben Road and Bridge Road	0	0	0	0	0	0	0	0	0	0
Between Bridge Road and Mooroopna-Murchison Road	0	0	0	0	0	0	0	0	0	0
Between Mooroopna-Murchison Road and Midland Highway	0	0	0	0	0	0	0	0	0	0
Between Midland Highway and Echuca-Mooroopna Road	0	100	100	300	300	0	0	0	200	200
Between Echuca-Mooroopna Road and Wanganui Road	0	0	0	0	0	0	0	0	0	0
Between Wanganui Road and Shepparton-Barmah Road	0	0	0	0	0	0	0	0	0	0
Between Shepparton-Barmah Road and Goulburn Valley Highway	0	0	0	0	0	0	0	0	0	0
Goulburn Valley Highway										
Between Doyles Road and Karramomus Road	6,500	7,500	7,500	8,700	9,800	1,600	1,900	1,900	2,200	2,500
Between Union Road and Mitchell Road	7,100	8,100	8,100	9,300	10,500	1,700	1,900	1,900	2,300	2,600
Between River Road and Rafferty Road	6,200	6,600	6,600	8,700	9,300	400	400	400	500	600
Between Midland Highway and Fryers Street	10,200	11,400	11,400	13,800	14,900	600	800	800	1,100	1,700
Between Wanganui Road and Shepparton-Barmah Road	11,100	12,900	12,900	15,500	17,100	900	900	900	1,200	1,300
Between Shepparton-Barmah Road and Shepparton Alt. Route	7,200	7,800	7,800	9,400	10,100	500	600	600	700	800
Between Zeerust Road and Trewins Road	5,200	5,700	5,700	6,600	7,400	800	900	900	1,100	1,300
Midland Highway										
Between Downer Road and Turnbull Road	7,000	8,000	8,000	9,200	10,500	1,000	1,100	1,100	1,400	1,500
Near Kidstown Adventure Playground (on causeway)	29,200	31,300	31,300	35,900	39,100	2,700	3,000	3,000	5,500	6,100

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Road name	Two-Way Daily (24-hour) All Vehicles					Two-Way Daily (24-hour) Heavy Vehicles				
	2011	2016	2021	2031	2041	2011	2016	2021	2031	2041
Between Goulburn Valley Highway and Maude Street	16,200	17,300	17,300	19,300	20,100	2,500	2,500	2,500	3,600	3,900
Between Doyles Road and Orrvale Road	5,300	5,600	5,600	6,300	6,900	800	800	800	1,000	1,100
Shepparton Alternative Route										
Between Archer Road and Central Kialla Road	2,700	3,300	3,300	3,700	4,400	1,400	1,600	1,600	1,800	2,000
Between Poplar Avenue and Midland Highway	6,200	8,000	8,000	8,200	11,400	1,700	1,900	1,900	2,000	2,200
Between New Dookie Road and Ford Road	5,000	5,400	5,400	5,800	7,000	1,600	1,700	1,700	1,800	2,000
Between Knights Road and Goulburn Valley Highway	3,300	3,900	3,900	4,200	5,400	1,300	1,400	1,400	1,600	1,800
Other Links										
Wanganui Road between Shepparton Bypass and GVH	2,000	2,400	2,400	2,600	2,900	100	100	100	100	100
Ford Road between GVH and Shepparton Alternative Route	2,600	3,400	3,400	4,100	5,200	400	300	300	400	500
Ford Road between Verney and Grahamvale Road	2,200	2,400	2,400	2,800	3,500	300	300	300	400	500
Katamatite-Shepparton Road at Congupna	4,800	5,100	5,100	5,800	6,600	900	1,100	1,100	1,200	1,400
Shepparton-Barmah Road North West of Shepparton Bypass	2,300	2,700	2,700	3,200	3,600	300	300	300	400	400
Echuca-Mooroopna Road North West of Shepparton Bypass	4,600	4,900	4,900	5,500	6,300	600	600	600	800	900
Mooroopna-Murchison Road South West of Shepparton Bypass	4,700	5,300	5,300	6,000	6,700	500	600	600	700	800
Shepparton Bypass (applies to options 6-8 only)										
Between Goulburn Valley Highway and River Road	0	0	0	0	0	0	0	0	0	0

Shepparton Bypass Strategic Model Update

3.4 Stage 1A&B

Figure 16 and Figure 17 illustrate the magnitude of forecast daily traffic volumes in 2041 across the road network under Option 1A&B, as well as the difference in one way traffic volumes when compared to the 2041 base case. Figure 18 and Figure 19 illustrate a similar picture for heavy vehicle volumes. Table 8 provides further detail on these, with a summary of existing and forecast two way daily traffic volumes along key roads in the study area, including the bypass.

Using the above information, the following inferences can be made:

- Shepparton Bypass between Echuca-Mooroopna Road and Wanganui Road is expected to carry up to 11,200 vehicles (two ways) including around 1,400 trucks per day by 2041.
- The greatest reductions in traffic on the existing road network with Option 1A&B in place (when compared to the 2041 base case) are expected along the Midland Highway causeway (reduction of around 9,700 vehicles per day)
- The greatest reductions in heavy vehicle traffic on the existing road network with Option 1A&B in place (when compared to the 2041 base case) are also expected along the Midland Highway causeway (reduction of around 1,200 trucks per day by 2041).

Figure 16: 2041 Stage 1AB one way traffic volumes ('000s) – All vehicles – Daily

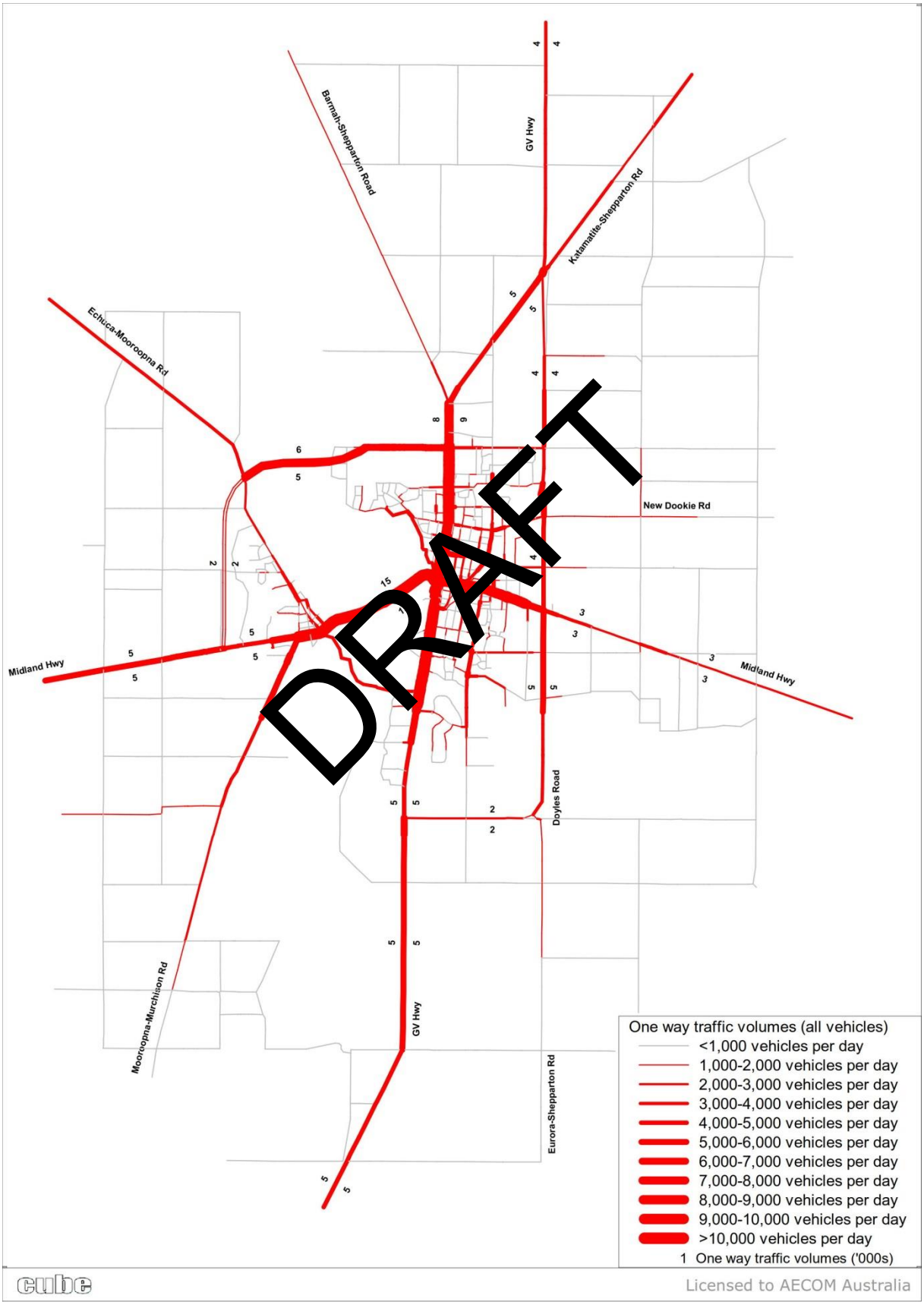

Figure 17: Difference in daily (24-hour) traffic volumes between 2041 Stage 1AB and 2041 Base Case – all vehicles

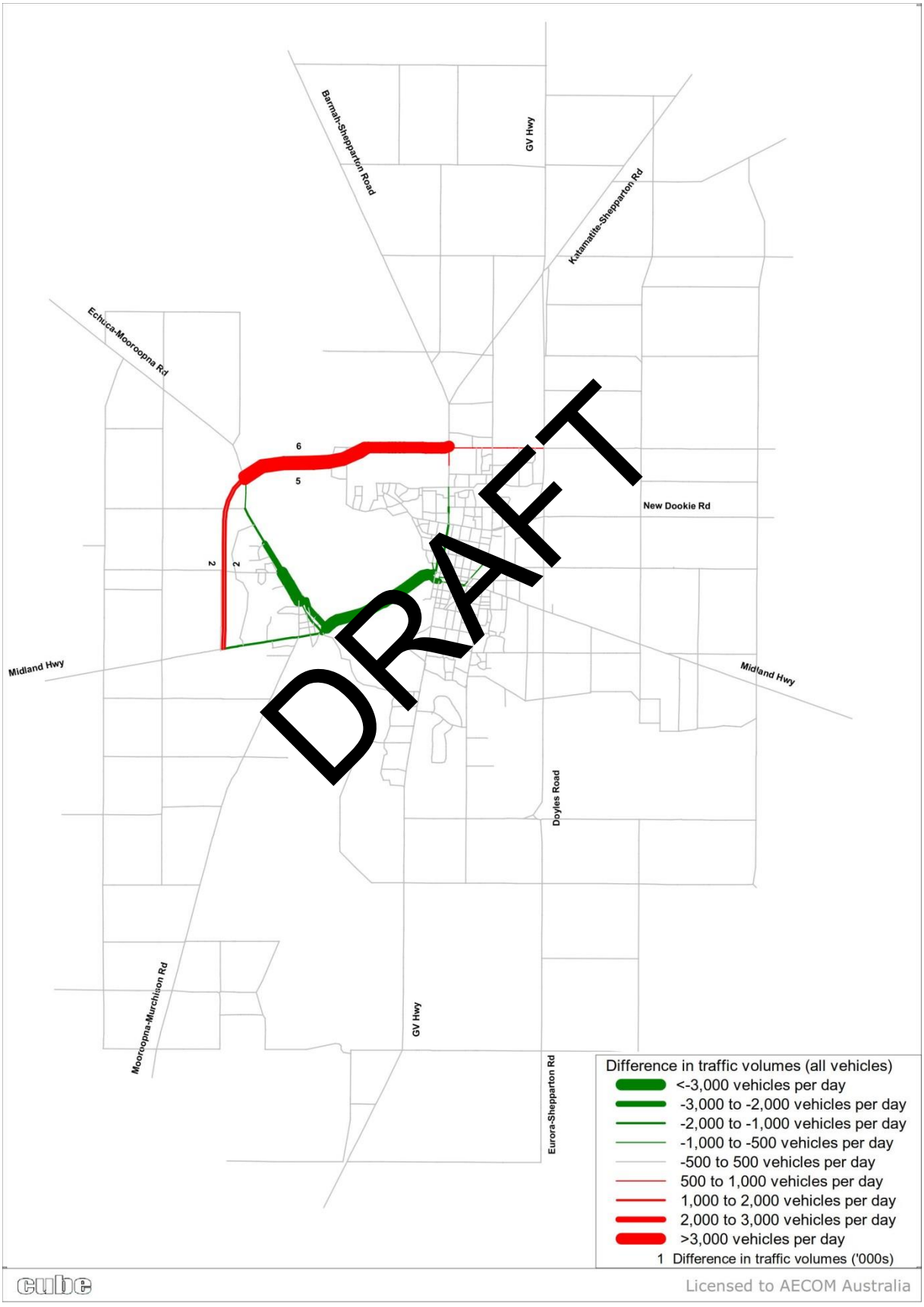

Figure 18: 2041Stage 1AB one way traffic volumes ('000s) – Heavy vehicles – Daily

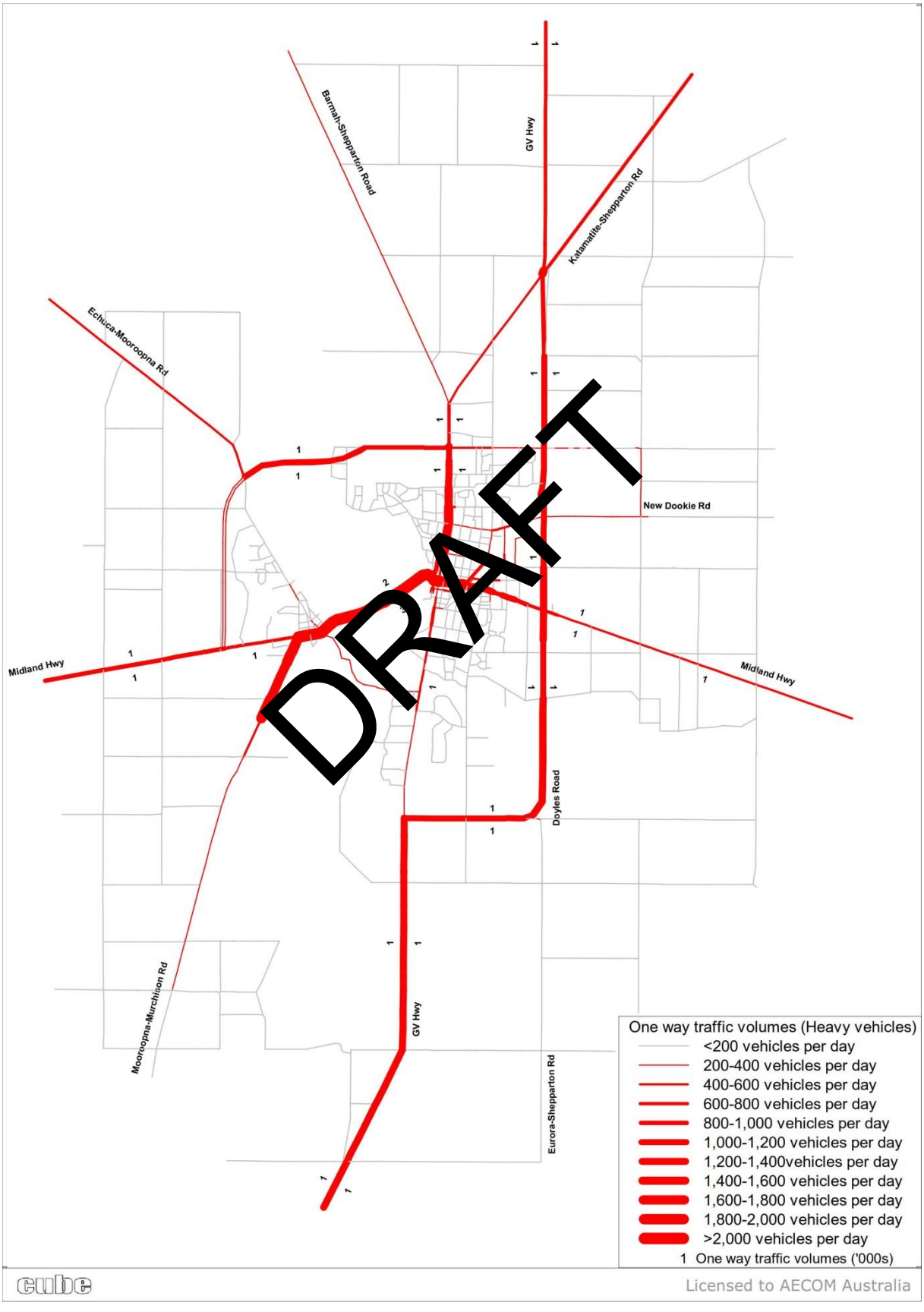

Figure 19: Difference in daily (24-hour) traffic volumes between 2041 Stage 1AB and 2041 Base Case – Heavy vehicles

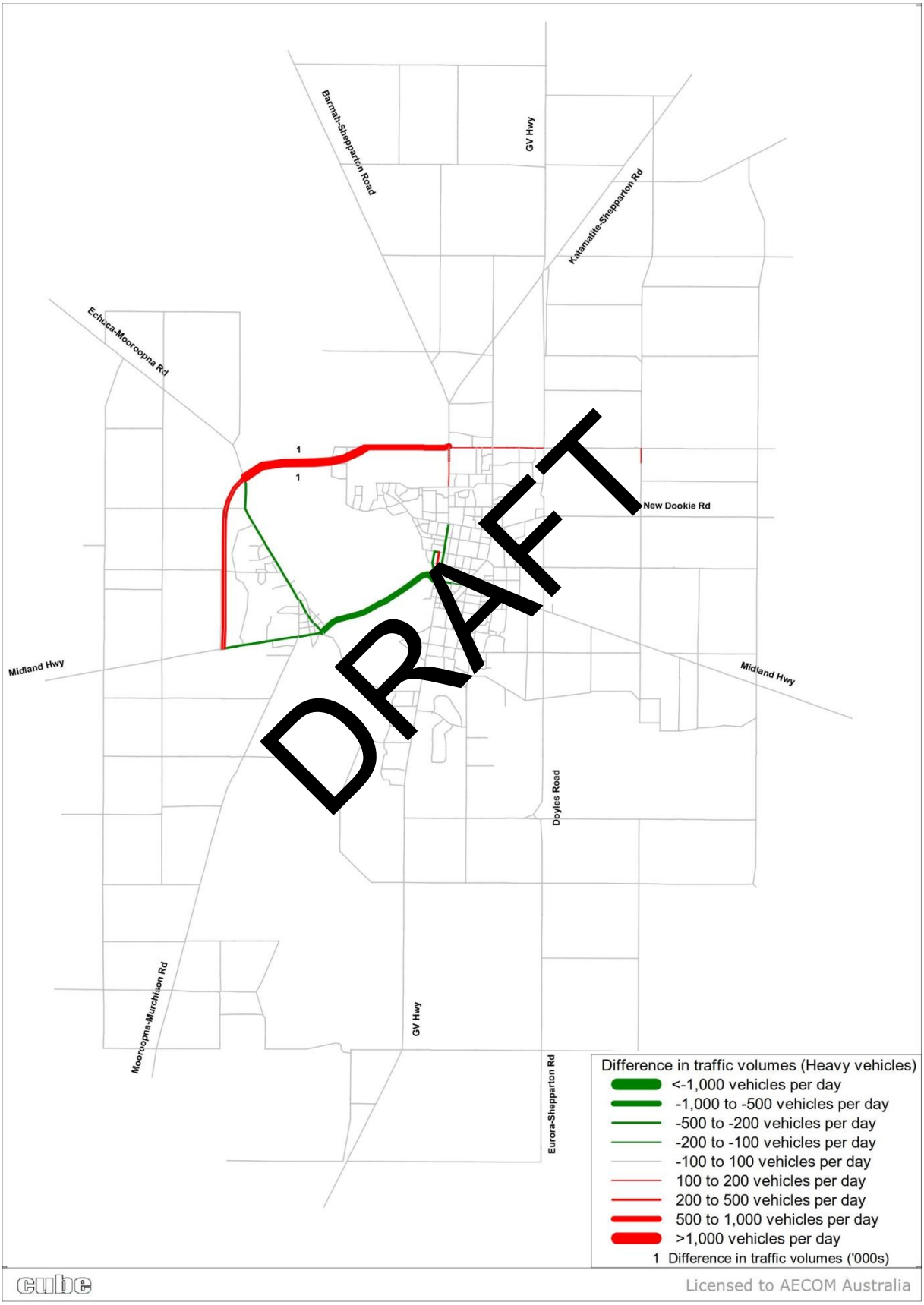
Barmah-Shepparton Road
GV Hwy
Katamatite-Shepparton Rd
Echuca-Mooroopna Rd
1
1
New Dookie Rd
Midland Hwy
Midland Hwy
Doyles Road
Moorooopna-Murchison Rd
GV Hwy
Eurora-Shepparton Rd
DRAFT
Difference in traffic volumes (Heavy vehicles)
<-1,000 vehicles per day
-1,000 to -500 vehicles per day
-500 to -200 vehicles per day
-200 to -100 vehicles per day
-100 to 100 vehicles per day
100 to 200 vehicles per day
200 to 500 vehicles per day
500 to 1,000 vehicles per day
>1,000 vehicles per day
1 Difference in traffic volumes ('000s)
cube
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Table 8: Stage 1AB traffic volumes

Road name	Two-Way Daily (24-hour) All Vehicles					Two-Way Daily (24-hour) Heavy Vehicles				
	2011	2016	2021	2031	2041	2011	2016	2021	2031	2041
Shepparton Bypass										
Between Gribben Road and Bridge Road	0	0	0	0	0	0	0	0	0	0
Between Bridge Road and Mooroopna-Murchison Road	0	0	0	0	0	0	0	0	0	0
Between Mooroopna-Murchison Road and Midland Highway	0	0	0	0	0	0	0	0	0	0
Between Midland Highway and Echuca-Mooroopna Road	0	2,300	2,400	2,700	3,400	0	400	400	500	600
Between Echuca-Mooroopna Road and Wanganui Road	0	8,000	8,500	9,600	11,200	0	1,000	1,000	1,200	1,400
Between Wanganui Road and Shepparton-Barmah Road	0	0	[illegible]	0	0	0	0	0	0	0
Between Shepparton-Barmah Road and Goulburn Valley Highway	0	0	0	0	0	0	0	0	0	0
Goulburn Valley Highway										
Between Doyles Road and Karramomus Road	6,500	7,000	[illegible]	8,700	9,800	1,600	1,800	1,900	2,200	2,500
Between Union Road and Mitchell Road	7,100	7,[illegible]	8,[illegible]	9,300	10,500	1,700	1,800	2,000	2,300	2,600
Between River Road and Rafferty Road	6,200	6,10[illegible]	[illegible]	8,700	9,300	400	400	400	500	600
Between Midland Highway and Fryers Street	10,200	[illegible],000	11,600	13,700	15,100	600	600	700	800	900
Between Wanganui Road and Shepparton-Barmah Road	11,1[illegible]	[illegible],900	12,900	15,400	17,100	900	900	900	1,200	1,300
Between Shepparton-Barmah Road and Shepparton Alt. Route	7,200	7,700	7,800	9,300	10,100	500	600	600	700	800
Between Zeerust Road and Trewins Road	5,2[illegible]	5,400	5,700	6,600	7,400	800	900	900	1,100	1,300
Midland Highway										
Between Downer Road and Turnbull Road	7,00[illegible]	7,400	8,100	9,200	10,500	1,000	1,100	1,100	1,300	1,500
Near Kidstown Adventure Playground (on causeway)	29,200	22,600	23,500	27,300	29,400	2,700	1,900	2,100	4,400	4,900
Between Goulburn Valley Highway and Maude Street	16,200	14,800	15,500	17,200	18,500	2,500	2,300	2,500	3,500	3,600
Between Doyles Road and Orrvale Road	5,300	5,500	5,600	6,300	6,900	800	800	800	1,000	1,100
Shepparton Alternative Route										
Between Archer Road and Central Kialla Road	2,700	2,800	3,300	3,700	4,400	1,400	1,500	1,600	1,800	2,000
Between Poplar Avenue and Midland Highway	6,200	7,700	8,000	8,300	11,700	1,700	1,800	2,000	2,000	2,200
Between New Dookie Road and Ford Road	5,000	5,500	5,700	6,200	7,500	1,600	1,700	1,700	1,900	2,100
Between Knights Road and Goulburn Valley Highway	3,300	3,300	3,900	4,300	5,400	1,300	1,300	1,400	1,600	1,800
Other Links										

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Road name	Two-Way Daily (24-hour) All Vehicles					Two-Way Daily (24-hour) Heavy Vehicles				
	2011	2016	2021	2031	2041	2011	2016	2021	2031	2041
Wanganui Road between Shepparton Bypass and GVH	2,000	8,900	9,600	10,800	12,500	100	1,100	1,100	1,300	1,500
Ford Road between GVH and Shepparton Alternative Route	2,600	4,100	4,500	5,400	7,100	400	600	500	700	800
Ford Road between Verney and Grahamvale Road	2,200	3,100	3,200	3,700	4,700	300	500	500	700	700
Katamatite-Shepparton Road at Congupna	4,500	4,800	5,100	5,800	6,600	900	1,000	1,100	1,200	1,400
Shepparton-Barmah Road North West of Shepparton Bypass	2,300	2,500	2,700	3,200	3,600	300	300	300	400	400
Echuca-Mooroopna Road North West of Shepparton Bypass	4,200	4,500	4,900	5,600	6,400	600	600	600	800	900
Mooroopna-Murchison Road South West of Shepparton Bypass	4,700	4,500	4,900	5,500	6,200	500	500	500	600	700
Shepparton Bypass (applies to options 6-8 only)										
Between Goulburn Valley Highway and River Road	0	0	0	0	0	0	0	0	0	0

4.0 Economic Assessment

The following section provides detail on the calculation and valuation of economic benefits, and the economic parameters used for the cost-benefit analysis. Details of all economic parameters used in this study are discussed in Appendix A.

4.1 Economic Parameters and Expansion Factors

A key parameter used to estimate travel time saving benefits is the value of travel time (VTT). The VTT for car and truck have been updated in this study based on the 2015 National Guidelines for Transport System Management. The Guidelines base the VTT on June 2013 values and these have been updated to the 2015 values by using the growth of average weekly earnings for a full time adult in Victoria.

The other economic parameters and expansion factors used in the analysis are shown in Table 9.

Table 9: Economic parameters and expansion factors

Parameter	Value	Comment
Discount rate	5.00%	New rate to be applied for all transport projects for funding in 2017/12 budget cycle
First year of construction	2016	
Last year of construction	2022	
Opening year	2023	Year in which traffic is expected to begin using the road
Appraisal period	30 years from opening year	
Base year for discounting	2016	Year in which first capital cost expenditure is incurred
Price base	2016	

Three time periods were modelled within the Shepparton Bypass Strategic Transport Model – the AM Peak, PM Peak and Off Peak. When added together these trips represent the whole 24 hour period. Therefore an expansion factor of one is used for each time period to calculate average weekday benefits. A different set of expansion factors has been derived from traffic count data for weekend (days) and public holidays. The factors used are shown in Table 10 and Table 11.

Table 10: Modelling period to daily expansion factors (car)

Modelling period	Weekday expansion factor	Weekend day/public holiday expansion factor
AM	1	0
PM	1	0
Off Peak	1	1.2

Source: AECOM calculation based on traffic counts

Table 11: Modelling period to daily expansion factors (heavy vehicles)

Modelling period	Weekday expansion factor	Weekend day/public holiday expansion factor
AM	1	0
PM	1	0
Off Peak	1	0.6

Source: AECOM calculation based on traffic counts

To calculate annual benefits, we have applied the factors shown in Table 12 to convert the average weekday and average weekend day totals to yearly totals.

Table 12: Daily to annual expansion factors

Day type	Daily to annual expansion factor
Weekday	252
Weekend and public holiday	112

Source: AECOM assumption, based upon 260 workdays less 8 public holidays

4.2 Economic Costs

4.2.1 Capital costs

The total construction costs of each stage were provided by Greater Shepparton City Council in Table 13 below.

Table 13: Construction costs

Options	Construction costs ($ millions)
Stage 1A	140
Stage 1B	100
Stage 1A and 1B	240
Ford Road Upgrade[1] (3 lane option)	24.6

[1] Ford Road Upgrade – Goulburn Valley Highway to Grahamvale Road

The cost of the Ford Road upgrade was added to Stage 1A, 1B and 1A and 1B together. Total capital costs are expected to be spread across seven years of construction as shown in Table 14 in a profile similar to the previous study. Note that these costs exclude 'real' construction cost escalation, so construction costs are assumed to increase in line with CPI.

Table 14: Capital cost expenditure profile (un-escalated), all values in $ millions

Financial year	Spending Profile	Option 1	Option 2	Option 3
2016	16%	$25.6	$19.4	$41.2
2017	18%	$29.0	$22.0	$46.6
2018	18%	$29.9	$22.7	$48.1
2019	17%	$28.4	$21.5	$45.7
2020	15%	$24.5	$18.5	$39.3
2021	11%	$18.0	$13.6	$29.0
2022	6%	$9.1	$6.9	$14.7
Total	**100%**	$164.6	$124.6	$264.6

4.2.2 Operating and maintenance costs

Operating and maintenance costs (including annual maintenance and periodic rehabilitation/asset renewal) for the roadway were derived from *Review of asset preservation costs* (ARRB Ltd 2009). This study collected maintenance and rehabilitation costs from VicRoads to calculate the annual road preservation costs. From this information, it was estimated an average operating and maintenance cost of $8,000 per lane and per km. Cost modifiers were assumed to be the same as that were used in the 2012 Shepparton study to take into account conditions that would lead to higher than average maintenance costs. For this assessment we have used the maximum cost modifier factor of 1.45 for rural roads to be conservative. The operating costs were then updated to December 2015 value by applying an appropriate CPI index, and the results are shown in Table 15.

Several options contain significant structural works such as bridges and overpasses which are not accounted for in the average preservation costs calculated by ARRB. The annual maintenance costs for these assets have been estimated using 1% of the capital costs of the structural assets.

Table 15: Operating and maintenance costs of roadway

Road Type	Operating and Maintenance Costs (2015)
Cost per lane km	$14,500 per lane km per year

4.3 Economic Benefits

The following benefits have been calculated:

- Road user benefits, including:
  - travel time savings
  - vehicle operating cost savings.
- Non-user benefits (or externality cost savings), including:
  - crash cost savings
  - greenhouse gas emission savings
  - other environmental externality savings (such as air and noise pollution).

Benefits have been calculated using the outputs from the transport model for the Base Case and Options over the AM Peak, PM Peak and Off Peak time periods.

4.4 Economic Results

The results of the economic assessment are shown in Table 16. Option 1A&B, with the inclusion of the Ford Road upgrade, provides the greatest benefits,

Option 1A has the highest Benefit Cost Ratio (BCR) as it generates significant travel time savings relative to its construction costs. Option 1B has the lowest benefits as it represents an isolated option without connection to Goulburn Valley Highway, and the Ford Road upgrade. Furthermore, this option does not provide an attractive alternative to parallel routes such as Echuca Rd or Turnbull Road. Option 1A&B has a BCR of 0.37, which is lower than Option 1A, as the combined benefits increase by only 12% while its costs increase by 58% under this option.

Table 16: Results of the economic assessment

Option	Option 1A	Option 1B	Option 1A&B
Present Value of Costs			
Capital costs ($m)	146.0	110.5	234.7
Operating and maintenance costs ($m)	9.6	2.5	11.3
Present Value of Benefits			
User Benefits			
Vehicle travel time savings ($m)	53.1	1.3	60.0
Vehicle operating cost savings ($m)	14.2	0.4	15.6
Externalities Savings			
Crash cost savings ($m)	-0.[illegible]	[illegible].0	-0.2
CO_2 savings ($m)	[illegible].9	0.0	2.0
Environmental externality savings ($m)	11.[illegible]	0.5	13.1
Overall			
Present value of total costs ($m)	1[illegible]5.6	113.0	246.0
Present value of total benefits ($m)	80.8	2.2	90.4
Net Present Value ($m)	-74.8	-110.8	-155.5
Benefit Cost Ratio	0.52	0.02	0.37

4.5 Sensitivity Tests

Table 17 shows the results of the sensitivity tests. A 20% increase in the value of time for both private and heavy vehicles improved the Net Present Value (NPV) and Benefit Cost Ratio (BCR) of all options due to the increase in travel time savings. The lower discount rate of 4% improved the results more than any other sensitivity test; however, due to the large difference between costs and benefits for all options, the sensitivity tests did not change the overall results significantly.

Table 17: Results of sensitivity tests

Sensitivity Test	Option 1A	Option 1B	Option 1A&B
Standard Results			
Net Present Value ($m)	-74.8	-110.8	-155.5
Benefit Cost Ratio	0.52	0.02	0.37
Discount Rate of 4%			
Net Present Value ($m)	-63.6	-113.3	-144.7
Benefit Cost Ratio	0.60	0.02	0.43
Discount Rate of 6%			
Net Present Value ($m)	-83.3	-108.4	-163.3
Benefit Cost Ratio	0.45	0.02	0.32
Value of time + 20%			
Net Present Value ($m)	-65.2	-110.6	-144.6
Benefit Cost Ratio	0.58	0.02	0.41
Value of time -20%			
Net Present Value ($m)	-84.5	-111.0	-166.4
Benefit Cost Ratio	0.46	0.02	0.32

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5.0 Conclusions

This report presents an updated Strategic Transport Model for Greater Shepparton and the applies the Model to assess the traffic and economic impacts of three Goulburn Valley Highway bypass options.

This study has updated the strategic transport model for Greater Shepparton in the following areas.

- The demographic data for the base and all future years were updated with the VIF2014.
- The traffic growth rates at the external cordon of the model were updated in line with the population and employment growth rates.
- The special traffic generators in the model were reviewed and unchanged, except that the Goulburn Valley Freight Logistics Centre was assumed to be opened in 2031 rather than 2021 as advised by Council.
- The road networks were updated with the three options for the Bypass. It was also assumed that Ford Road would be upgraded to be aligned with the proposed bypass at this location, and this was included in the economic evaluation process.

The traffic analysis indicated that Option 1B in isolation would attract very low traffic volumes because it represents an option without connections to Goulburn Valley Highway and Ford Road upgrade. Option 1A&B would attract the highest traffic volume and therefore relieve more traffic on the Midland Highway and Goulburn Valley Highway and within the city centre than the other two options.

The report provides an economic evaluation for all three options, using economic evaluation parameters updated to 2015 prices. A sensitivity analysis was conducted by varying some economic parameters.

The economic evaluation indicates that all three options have a benefit cost ratio (BCR) less than 1, with Option 1A providing the highest BCR and Option 1B providing the lowest.

Shepparton Bypass Strategic Model Update

Appendix A

Economic Parameters

Appendix A Economic Parameters

Travel Time Savings

Light Vehicles

Travel time savings were assessed on a person-trip level using vehicle occupancies specified within the Model for each time period.

Using the Model outputs, the cost of travel time between each origin and destination pair was calculated in the Base and Project Case in each time period, as well as the consumer surplus resulting from the change in travel time. These travel times were calculated separately for two trip purposes: in-work trips (i.e. undertaken on employers' business) and other light vehicle trips (including commuting, shopping and leisure trips).

The value of in-work travel time is significantly higher than that for non-work travel time, since these represent a cost to the economy rather than an individual's 'willingness to pay'. The values of time per person (sourced from (Transport and Infrastructure Council, 2015) are shown in Table 18.

Table 18: Values of travel time per person

Trip type	Value of travel time per person (per hour)	
	(June 2015)	(Nov 2015)
Non-work trips (commuting and other)	$14.99	$15.84
In-work trips	$48.63	$51.37

Source: (Transport and Infrastructure Council, 2015)

Values have been pro-rated to Nov 2015 using the change in average weekly earnings (ABS, 2016)

Heavy Vehicles

The Shepparton Model doesn't disaggregate heavy vehicles into rigid and articulated trucks, which is required due to the different values of travel time. This has therefore been undertaken using the Vehicle Kilometres Travelled (VKT) for rigid and articulated trucks in Victoria (ABS Survey of Motor Vehicle Users, 2010). This breakdown is shown in Table 19.

Table 19: Proportion of rigid and articulated heavy vehicles

Vehicle Type	Proportion of heavy vehicles
Rigid Heavy Vehicles	52.5%
Articulated Heavy Vehicles	47.5%

The value of travel time for heavy vehicles is estimated using a combination of the driver's value of time and the value of time of the freight, as shown in Table 20. As large articulated heavy vehicles carry larger payloads than rigid heavy vehicles the proportion of travel time value attributed to freight time is also significantly higher.

Using these parameters and the Model outputs, the cost of travel time between each origin and destination pair was calculated for rigid and articulated vehicles separately in the Base and Project Case. These costs were then used to calculate the consumer surplus using the methodology.

Table 20: Value of travel time (VTT) for heavy vehicles

Vehicle Type	Driver VTT (Per Hour)	Payload VTT (Per Hour)	Total VTT (Per Hour)
Rigid Heavy Vehicles	$27.17	$4.41	$31.58
Articulated Heavy Vehicles	$28.32	$41.42	$69.75

Source: (Transport and Infrastructure Council, 2015) Driver time values have been pro-rated to Nov 2015 using the change in average weekly earnings (ABS, 2016). Payload time values have been pro-rated to Nov 2016 using CPI (ABS, 2016).

Vehicle Operating Costs

Operating costs of vehicles, such as fuel and maintenance, are related to the speeds travelled on the network and differ by vehicle type. For each origin-destination pair in the network, the average travel speed (km/h) was determined from the model using the distance and travel time. The non-fuel vehicle operating cost (cents/km) and fuel usage (l/100km) for each origin-destination pair could then be determined through the use of the following equation:

$$c = A + \frac{B}{V} + CV + DV^2$$

where:

c = non-fuel vehicle operating cost (cents/km) parameter, fuel usage (l/100km) parameter
A, B, C, D = model coefficients
V = average speed (km/hr)

The values of the model coefficients are shown in Table 21 and Table 22. As can be seen, the model coefficients differ by vehicle type. Fuel usage was converted to monetary value using the current resource cost of fuel.

Table 21: Model coefficients for non-fuel vehicle operating costs (c/km)

Vehicle Type	Coefficients			
	A	B	C	D
Light vehicle (in-work)	1.598	579.148	0.049680031	0.00011887
Light vehicle (non-work)	1.598	0	0	0
Rigid heavy vehicles	14.557	5082.718	0.616632478	-0.000667607
Articulated heavy vehicles	21.645	3466.603	0.525873662	-0.000852921

Source: AECOM analysis, based upon (Austroads, 2008). Coefficients have been adjusted to 2015 levels using CPI (ABS, 2016)

Table 22: Model coefficients for fuel usage (l/100km)

Vehicle Type	Coefficients			
	A	B	C	D
All light vehicle	0.863	542.92	0.01333	0.000585
Rigid heavy vehicles	-7.445	1893.84	0.12777	0.000974
Articulated heavy vehicles	-14.839	3579.6	0.22244	0.001167

Source: (Austroads, 2008)

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The 'A' parameter for non-fuel vehicle operating costs represents the costs of oil, tyres and mileage and maintenance related depreciation. The other parameters for non-fuel vehicle operating costs differ for in-work light vehicle travel and non-work light vehicle travel due to the time related effects of depreciation and lump sum payments of insurance and registration. As most work vehicles operate in fleets, if travel times decrease companies will be able to undertake the same task with a smaller number of fleet vehicles and therefore save on time-related depreciation, registration and insurance. Private motorists however, do not change the number of vehicles they own in response to changes in travel time and therefore do not have the ability to save on these time related costs. The exclusion of these components from non-work trip purposes is consistent with the methodology applied in the UK (Department for Transport (UK), 2011).

Crash Cost Savings

Crash cost savings were assessed from the change in vehicle-kilometres travelled (VKT) on each link in the model between the Base and Project Case. Crash cost savings vary by link class (road classification), since some road types have higher crash rates than others. The links used in the model are shown in Table 23.

Table 23: Link classes used in model

Link class	Link description	Hourly directional capacity per l	24-hour directional capacity per lane	Posted speed factor
1	Centroid connector	10,000	150,000	1.00
2	Collector urban unsealed	900	9,000	0.80
3	Collector urban sealed	7	10,500	0.70
4	Collector rural unsealed	700	10,500	0.90
5	Collector rural sealed	800	12,000	0.80
10	Arterial urban unsealed	700	10,500	0.80
11	Arterial urban sealed	900	13,500	0.70
12	Arterial rural unsealed	1,400	21,000	0.80
13	Arterial rural sealed	1,700	25,500	0.80
14	Highway urban undivided	1,100	16,500	0.75
15	Highway urban divided	1,200	18,000	0.80
16	Highway rural undivided	1,800	27,000	0.85
17	Highway rural divided	1,900	28,500	0.90
18	Highway rural divided (1 lane each way)	1,400	21,000	0.9
19	Freeway divided	2,000	30,000	1.00
20	Freeway on/off ramp	900	13,500	0.80

The crash costs and rates applied to each of these link classes are shown in Table 24 to Table 26.

Table 24: Crash costs by link class

Speed limit (km/h)	Average casualty cost (June 2007)	Average casualty cost (Dec 2015)	Corresponding link class
<50	168,000	$210,444	
50	163,000	$204,181	1,2,3,4
60	167,000	$209,192	10,11
70	197,000	$246,771	15
80	216,000	$270,571	4,5,12,14,16,20
90	324,000	$405,857	
100	319,000	$399,593	13,16,17,18
110	332,000	$415,878	19

Source: (Austroads, 2008) Values have been converted to Dec 2015 prices using CPI (ABS, 2016).

Table 25: Crash rates used – Urban Roads

Urban Road Type	Casualty crashes per million veh-km	Corresponding link class
Old Freeways (Inner City 4 lanes)	0.16	
South Eastern Art (Toorak to Warrigal)	0.14	
High Standard Freeways	0.09	
All Freeways	0.11	
Primary Arterials (Divided Trams)	0.40	
Primary Arterials (Undivided Trams)	0.52	
Primary Arterials (Divided No Trams)	0.26	15
Primary Arterials (Undivided No Trams)	0.32	14, 11
All Primary Arterials	0.30	
Secondary Arterials (Divided Trams)	0.66	
Secondary Arterials (Undivided Trams)	0.69	
Secondary Arterials (Divided No Trams)	0.37	
Secondary Arterials (Undivided No Trams)	0.44	3, 1
All Secondary Arterials	0.47	
Primary Arterial/Service Roads	0.23	
All Melbourne Arterials	0.36	

Source: (VicRoads, 1996)

Shepparton Bypass Strategic Model Update

Table 26: Crash rates used – Rural Roads

Rural Road Type	Sub-classification	Casualty crashes per million veh-km	Corresponding link class
Undivided roads (gravel)	MRS 1 Natural surface	0.30	
	MRS 2 Formed roads	0.30	
	MRS 3 Gravel <= 4.5 m	0.35	4, 2
	MRS 4 Gravel >= 4.5 m	0.35	12, 10
Undivided roads (sealed)	MRS 5 Sealed <= 4.5m	0.30	
	MRS 6 Sealed 4.51 – 5.2 m	0.39	
	MRS 7 Sealed 5.21 – 5.8 m	0.40	
	MRS 8 Sealed 5.81 – 6.4 m	0.33	5
	MRS 9 Sealed 6.41 – 7.0 m	0.25	
	MRS 10 Sealed 7.01 – 7.6 m	0.23	
	MRS 11 Sealed 7.61 – 8.2 m	0.21	
	MRS 12 Sealed 8.21 – 8.8m	0.20	13
	MRS 15 Sealed 10.01 – 11.[illegible] m	0.20	
	MRS 16 Sealed [illegible].61 – [illegible].7 m	0.19	
	MRS 17 Sealed > 13.7 m	0.21	16,18
Undivided roads	MRS 18 Seal[illegible] <= 7.6 m	0.20	
	MRS 19 Sealed 7.61 – 8.2 m	0.20	
	MRS 20 Sealed 8.21 – 8.8 m	0.20	
	MRS 21 Sealed 8.81 – 9.4 m	0.20	
	MRS 22 Sealed 9.41 – 11.6 m	0.20	
	MRS 23 Sealed > 11.6 m	0.20	17
Freeways	MRS 24 Sealed (4 lane) <= 9.4 m	0.06	18,19,20
	MRS 25 Sealed (6 lane) 9.41 – 11.6 m	0.06	
	MRS 26 Sealed (8 lane) >= 11.6 m	0.06	

Source: (VicRoads, 1996)

Greenhouse gas emission savings

For each link in the network, the average travel speed (km/hr) was determined from the model. The vehicle fuel consumption rate (litres/km) for each link could then be determined through the use of the following equation:

$$l = A + \frac{B}{V} + CV + DV^2$$

where:

l = fuel consumption rate (litres/km)

A, B, C, D = model coefficients

V = 24-hour average link speed (km/hr)

The values of the model coefficients are shown in Table 27 and Table 28. As can be seen, the model coefficients differ by whether traffic is subject to arterial stop start conditions or freeway conditions.

Table 27: Model coefficients for vehicle fuel consumption for light vehicles only

Light Vehicles	A	B	C	D
Arterial stop start conditions	0.863	542.92	0.01333	0.0005847
Freeway conditions	-18.433	1306.02	0.15477	0.0003203

Source: (Austroads, 2008)

Table 28: Model coefficients for vehicle fuel consumption for heavy vehicles only

Heavy Vehicles	A	B	C	D
Arterial stop start conditions	-7.445	1893.84	0.12777	0.0009736
Freeway conditions	-65.056	4156.75	0.49681	0.0006798

Source: (Austroads, 2008)

Once the fuel consumption rates (litres/km) were determined for each link in the network, the annual vehicle fuel consumption (litres) could then be derived for each link by applying the annual Vehicle Kilometres Travelled (VKT) from the model to each link (daily VKT was factored to annual VKT by applying the expansion factor). The annual vehicle fuel consumption for each link was then summed for the network.

The fuel use was converted into CO_2 - equivalent using the National Greenhouse Accounts Factors shown in Table 29. Annual greenhouse gas emission costs were then determined by applying a rate of $60.13/tonne (derived from a 2007 price of $48.00/tonne sourced from Austroads (2008), adjusted to 2015 dollars using CPI (ABS, 2016) to the total amount of annual greenhouse gas emissions.

Table 29: NGA emission factors

Vehicle	Energy content factor GJ/kL	Emission Factors		
		CO_2 kg CO2-e/GJ	CH_4 kg CO2-e/GJ	N_2O kg CO2-e/GJ
All light vehicle	34.2	66.7	0.6	2.3
Rigid heavy vehicles	38.6	69.2	0.2	0.5
Articulated heavy vehicles	34.2	66.7	0.6	2.3

Source: (Department of Climate Change and Energy Efficiency, 2011)

Other environmental externality costs

Other environmental externalities were calculated using the values given in Table 30 for light vehicles and Table 31 for heavy vehicles.

Table 30: Environmental externality parameters – light vehicles (cents/VKM)

Pollutant	June 2007 prices	December 2015 prices	June 2007 prices	December 2015 prices
	Urban	Urban	Rural	Rural
Air pollution (c/km)	2.5	3.18	0.03	0.04
Noise pollution (c/km)	0.82	1.03	0.00	0.00
Water pollution (c/km)	[illegible]	0.48	0.04	0.05
Nature & landscape (c/km)	0.05	0.06	0.47	0.59
Urban separation (c/km)	0.59	0.74	0.00	0.00
Upstream and downstream costs (c/km)	3.42	4.28	3.42	4.28
Total	**7.80**	**9.77**	**3.96**	**4.96**

Source: (Austroads, 2008). Values have been adjusted to 2015 levels using CPI (ABS, 2016)

Table 31: Environmental externality parameters – trucks ($ per 1000 tonne-km)

Pollutant	June 2007 prices	December 2051 prices	June 2007 prices	December 2051 prices
	Urban	Urban	Rural	Rural
Air pollution ($ per 1000 tonne-km)	21.19	26.54	0.21	0.26
Noise pollution ($ per 1000 tonne-km)	3.54	4.43	0.35	0.44
Water pollution ($ per 1000 tonne-km)	3.18	3.98	1.27	1.59
Nature & landscape ($ per 1000 tonne-km)	0.35	0.44	3.54	4.43
Urban separation ($ per 1000 tonne-km)	2.36	2.96	0.00	0.00
Upstream and downstream costs ($ per 1000 tonne-km)	18.86	23.62	18.86	23.62
Total	**49.48**	**61.98**	**24.23**	**30.35**

Source: (Austroads, 2008). Values have been adjusted to 2015 levels using CPI (ABS, 2016)

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Appendix B

Demographic data by VIF2014 by small areas

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Shepparton Bypass Strategic Model Update

Appendix B Demographic data by VIF2014 by small areas

Demographic data for trip productions

.id Small Area	Total Population				
	2011	2016	2021	2031	2041
Kialla-Shepparton Surrounds South	5,888	6,206	7,188	9,664	9,468
Mooroopna	7,855	7,800	7,933	8,189	8,349
Rural North East	715	616	671	797	883
Rural North West	325	329	324	318	311
Rural South	1,357	1,377	1,386	1,388	1,357
Shepparton Central	2,769	2,876	3,031	3,427	3,437
Shepparton North Central	6,502	6,740	7,087	8,274	8,136
Shepparton North East	2,974	3,099	3,251	3,688	6,287
Shepparton North West	5,938	6,107	7,128	8,024	8,148
Shepparton South	6,710	6,881	7,230	7,535	7,300
Shepparton South East	6,003	6,963	7,638	8,970	13,539
Shepparton Surrounds North	3,146	3,516	4,237	5,028	6,571
Total Shepparton	**50,18**	**53,104**	**57,103**	**65,302**	**73,786**

.id Small Area	Employed Persons				
	2011	2016	2021	2031	2041
Kialla-Shepparton Surrounds South	3,278	3,450	3,995	5,493	5,415
Mooroopna	4,052	4,017	4,067	4,324	4,409
Rural North East	424	368	401	489	547
Rural North West	174	177	176	181	180
Rural South	814	831	840	869	859
Shepparton Central	1,446	1,508	1,576	1,854	1,866
Shepparton North Central	3,493	3,607	3,758	4,448	4,365
Shepparton North East	1,577	1,638	1,708	1,957	3,534
Shepparton North West	2,834	3,309	3,510	4,043	4,152
Shepparton South	3,339	3,416	3,555	3,795	3,683
Shepparton South East	2,753	3,224	3,481	4,237	6,381
Shepparton Surrounds North	1,826	2,044	2,472	3,012	3,970
Total Shepparton	**26,012**	**27,589**	**29,538**	**34,702**	**39,361**

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.id Small Area	Persons in Primary & Secondary Education				
	2011	2016	2021	2031	2041
Kialla-Shepparton Surrounds South	968	991	1,017	1,066	1,117
Mooroopna	1,473	1,494	1,532	1,596	1,676
Rural North East	136	112	107	113	118
Rural North West	51	52	54	56	59
Rural South	323	336	350	375	395
Shepparton Central	366	364	375	392	416
Shepparton North Central	1,056	1,064	1,086	1,129	1,187
Shepparton North East	503	518	534	548	581
Shepparton North West	968	983	1,004	1,047	1,102
Shepparton South	1,197	1,214	1,240	1,285	1,341
Shepparton South East	1,085	1,101	1,146	1,205	1,270
Shepparton Surrounds North	781	817	850	906	951
Total Shepparton	**8,908**	**9,0**	**9,295**	**9,718**	**10,213**

.id Small Area	Persons in Further & Tertiary Education				
	11	2016	2021	2031	2041
Kialla-Shepparton Surrounds South	15	155	149	149	152
Mooroopna	365	371	359	356	364
Rural North East	30	27	25	25	26
Rural North West	24	24	24	24	25
Rural South	85	88	87	89	92
Shepparton Central	205	209	203	203	209
Shepparton North Central	364	368	355	352	361
Shepparton North East	157	162	159	156	162
Shepparton North West	283	289	280	279	286
Shepparton South	390	394	380	375	382
Shepparton South East	311	321	313	315	324
Shepparton Surrounds North	145	148	144	149	154
Total Shepparton	**2,509**	**2,557**	**2,479**	**2,473**	**2,538**

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Demographic data for trip attractions

.id Small Area	Total Jobs				
	2011	2016	2021	2031	2041
Kialla-Shepparton Surrounds South	1,321	1,320	1,406	1,577	1,803
Mooroopna	1,944	2,066	2,579	2,942	3,401
Rural North East	109	115	97	110	126
Rural North West	149	151	157	169	190
Rural South	469	503	548	634	732
Shepparton Central	10,987	11,603	12,297	13,695	15,646
Shepparton North Central	5,075	5,410	5,779	6,578	7,596
Shepparton North East	2,247	2,342	2,570	2,871	3,283
Shepparton North West	1,940	2,082	2,290	2,600	3,001
Shepparton South	1,167	1,261	1,350	1,554	1,807
Shepparton South East	2,563	2,80[illegible]	[illegible]172	3,506	3,989
Shepparton Surrounds North	2,416	[illegible]465	2,390	2,589	2,910
Total Shepparton	**30,386**	**32,[illegible]**	**34,635**	**38,825**	**44,484**

.id Small Area	Wholesale & Retail Jobs				
	[illegible]11	2016	2021	2031	2041
Kialla-Shepparton Surrounds South	32[illegible]	330	344	359	395
Mooroopna	[illegible]171	176	185	193	213
Rural North East	9	9	7	8	8
Rural North West	-	-	-	-	-
Rural South	37	38	12	13	14
Shepparton Central	2,860	2,928	3,058	3,189	3,509
Shepparton North Central	201	205	213	222	239
Shepparton North East	177	181	188	196	216
Shepparton North West	259	265	276	288	317
Shepparton South	-	-	-	-	-
Shepparton South East	1,074	1,101	1,150	1,199	1,320
Shepparton Surrounds North	299	304	315	327	359
Total Shepparton	**5,409**	**5,535**	**5,749**	**5,994**	**6,588**

.id Small Area	Primary & Secondary Enrolments				
	2011	2016	2021	2031	2041
Kialla-Shepparton Surrounds South	57	61	537	539	560
Mooroopna	1,325	2,632	2,660	2,796	2,985
Rural North East	93	94	96	102	110
Rural North West	43	46	48	52	57
Rural South	234	253	262	286	306
Shepparton Central	466	451	468	486	488
Shepparton North Central	3,255	3,219	3,334	3,557	3,592
Shepparton North East	257	271	279	301	307
Shepparton North West	1,249	1,203	1,269	1,326	1,326
Shepparton South	1,955	2,035	2,099	2,258	2,436
Shepparton South East	-	-	323	321	331
Shepparton Surrounds North	2,019	2,05[illegible]	117	2,224	2,340
Total Shepparton	**10,953**	**[illegible],322**	**13,493**	**14,248**	**14,838**

.id Small Area	Furtner & Tertiary Enrolments				
	201[illegible]	2016	2021	2031	2041
Kialla-Shepparton Surrounds South	-	-	-	-	-
Mooroopna	-	-	-	-	-
Rural North East	-	-	-	-	-
Rural North West	-	-	-	-	-
Rural South	-	-	-	-	-
Shepparton Central	7,076	6,811	6,684	6,620	7,410
Shepparton North Central	3,563	3,429	3,365	3,333	3,731
Shepparton North East	-	-	-	-	-
Shepparton North West	2,754	2,645	2,600	2,583	2,890
Shepparton South	-	-	-	-	-
Shepparton South East	-	-	-	-	-
Shepparton Surrounds North	-	-	-	-	-
Total Shepparton	**13,392**	**12,885**	**12,649**	**12,537**	**14,030**