City of Cockburn

2018 District Traffic Study

Final | 29 November 2018

Job number 259590-00

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Document Verification

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Job title		2018 District Traffic Study			**Job number** 259590-00
Document title					**File reference**
Document ref					
Revision	**Date**	**Filename**	Draft City of Cockburn District Traffic Study Report.docx		
Draft 1	30 Jan 2018	**Description**	First draft		
			Prepared by	Checked by	Approved by
		Name	Stephen Loughnan	Joanna Karasiewicz	Darryl Patterson
		Signature			
Draft 2	8 Aug 2018	**Filename**	Draft City of Cockburn District Traffic Study Report_02.docx		
		Description			
			Prepared by	Checked by	Approved by
		Name	Stephen Loughnan & Joanna Karasiewicz	Joanna Karasiewicz	Darryl Patterson
		Signature			
Draft 3	13 Nov 2018	**Filename**	Draft City of Cockburn District Traffic Study Report_02a.docx		
		Description			
			Prepared by	Checked by	Approved by
		Name	Stephen Loughnan & Joanna Karasiewicz	Joanna Karasiewicz	
		Signature			
Draft 4	26 Nov 2018	**Filename**	Draft City of Cockburn District Traffic Study Report_04.docx		
		Description			
			Prepared by	Checked by	Approved by
		Name	Stephen Loughnan & Joanna Karasiewicz	Joanna Karasiewicz	Darryl Patterson
		Signature			
				Issue Document Verification with Document	✓

Document Verification

Job title		2018 District Traffic Study			**Job number** 259590-00
Document title		Click here to enter text.			**File reference**
Document ref					
Revision	**Date**	**Filename**			
Final	29 Nov 2018	**Description**	City of Cockburn District Traffic Study Report Final		
			Prepared by	Checked by	Approved by
		Name	Stephen Loughnan & Joanna Karasiewicz	Joanna Karasiewicz	Darryl Patterson
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
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		Signature			
				Issue Document Verification with Document	✓

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1 Introduction

Arup was engaged by the City of Cockburn to undertake an update of the 2013 District Traffic Study (DTS). The study involves updating the forecast traffic volumes throughout the City to assist decision making for future road network improvements and management of the local government controlled road network. This report summarises the process of updating and enhancing the Cockburn District Traffic Model (CDTM) and provides the main outputs from the model.

Our analysis covers three forecast year scenarios; base year (2016), medium term (2021) and long term (2031). The outputs from this study will inform the preparation of a road network work program by outlining short, medium and long-term upgrades and actions.

1.1 Background and scope

In 2006 the City undertook a District Traffic Study aimed at developing traffic forecasts for the years 2016 and 2031. This District Traffic Study was then updated in 2013 to consider future transport conditions in years 2020 and 2031 based on anticipated growth in land use, employment and population but additionally through traffic trips as forecast by the Main Roads Regional Operations Model (ROM). The CDTM took into account forecasted trips from significant development including Cockburn Central area, Murdoch Activity Centre, Jandakot Airport Development, Latitude 32, Australian Marine Complex and Cockburn Coast development. The CDTM was used to test future possible road network upgrades such as the North Lake Road Bridge across Kwinana Freeway, Bartram Road overpass of Kwinana Freeway and Roe Highway Stage 8 extension.

The 2013 CDTM uses the CUBE Voyager which is the same platform as the current Main Roads Regional Operations Model (ROM). Since this time, ROM has been upgraded to include peak period modelling and produces these outputs. This updated version of ROM is known as ROM24.

The 2018 CDTM uses the Aimsun software which gives more flexibility in order to transition from strategic model to microsimulation model if more detailed analysis might be required in the future.

The specific scope of this current commission is as follows:

- Update CDTM completed in 2013 to facilitate the Council's current major road planning identified in the City of Cockburn Regional and Major Roadworks Plan using Aimsun software.
- Prepare traffic forecasts for 2021 and 2031 including the development plans for all areas
- Adjust traffic generation and attractions due to review of demographic data

- Include scenarios with / without road network upgrades such as:
    - Stock Road Widening
    - Cockburn Road Widening

1.2 Glossary

The following terms and abbreviations have been used throughout this document:

Cockburn District Traffic Model	CDTM
Traffic Modelling Software	Aimsun
District Traffic Study	DTS
Integrated Transport Strategy	ITS
Main Roads Western Australia	Main Roads
Metropolitan Region Scheme	MRS
Passenger Car Units	PCU
Regional Operations Model (Main Roads Traffic Model)	ROM24 (current) ROM (previous version)
Town Planning Scheme	TPS
Volume Capacity Ratio	VCR
Assigned Volumes	AV
Roads and Martie Services	RMS

2 Modelling methodology and enhancements

Cockburn District Traffic Model has been built as a strategic model in order to capture the vast area of City of Cockburn. In order to build a feasible strategic model a subarea network and matrices have been extracted from the ROM24 model owned by Main Roads. Both network and matrices were utilised and updated in the Aimsun software. Aimsun is a modelling tool capable of modelling a single intersection to the whole transport network of large cities. The software allows to build both static and dynamic simulations of the environment. It also has a capability to transfer from strategic model into a microsimulation model for more detailed analysis if required in the future. The Cockburn District Traffic model has been modelled using the static assignment method and is considered a strategic model due to the size of the modelled area.

2.1 Modelled area and zoning system

A map showing the modelled area and zoning system used in CDTM is provided in Figure 1. This zoning system is adapted from the zoning system used for the Main Roads Western Australia's ROM24 as shown in Figure 2. The zoning structure from the current ROM24 was refined with some zones split to better reflect land use based on current land use data and future land use changes as reflected in the approved structure plans, Main Roads WA Infrastructure Delivery Plan and City of Cockburn Regional and Major Roadworks Plan and the City Town Planning Scheme. Final zone system used for City of Cockburn District Study has been shown on Figure 3.

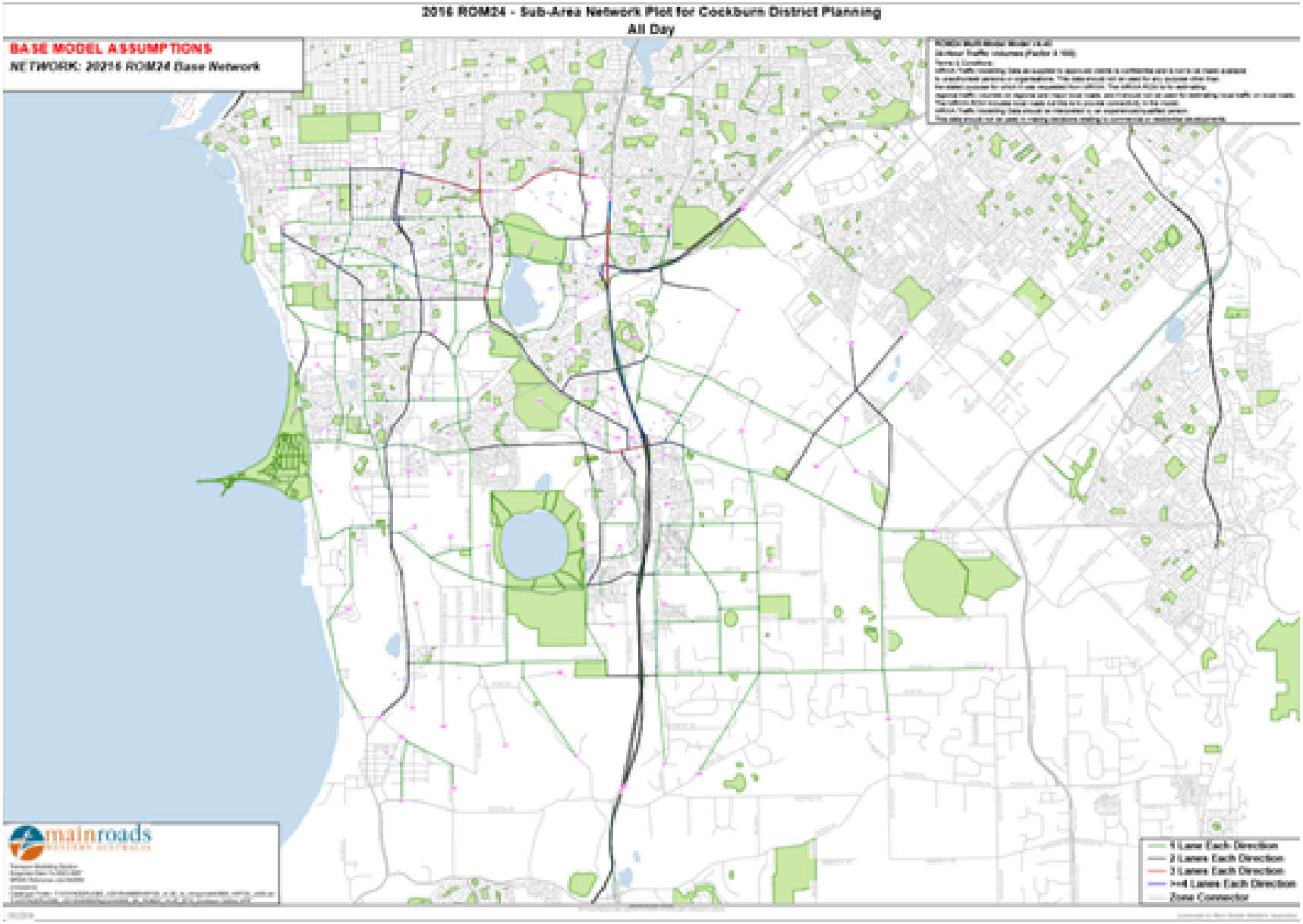


Figure 1 - Cockburn ROM24 Sub-Area Zone System

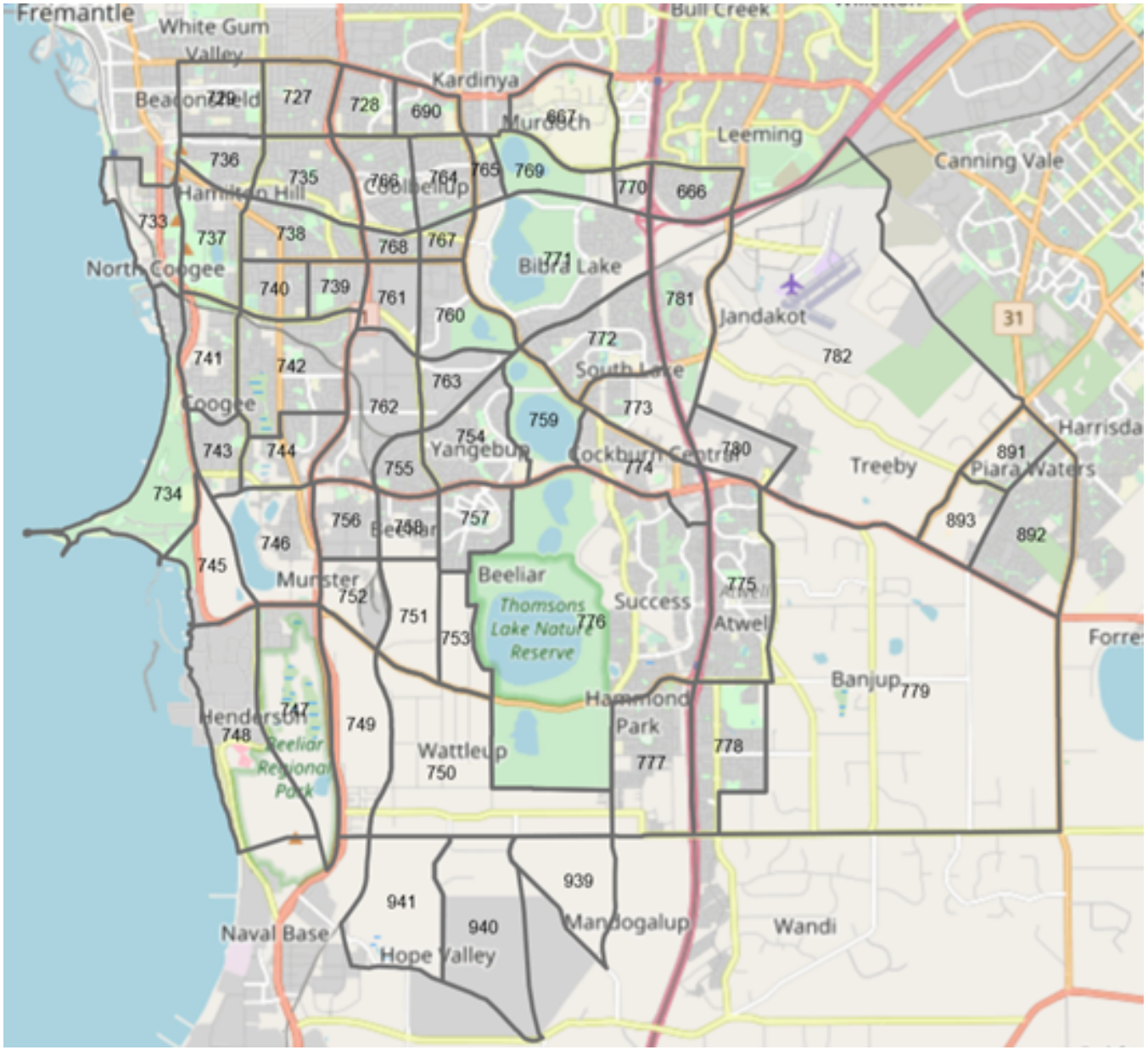


Figure 2 – ROM24 zones for demographic data

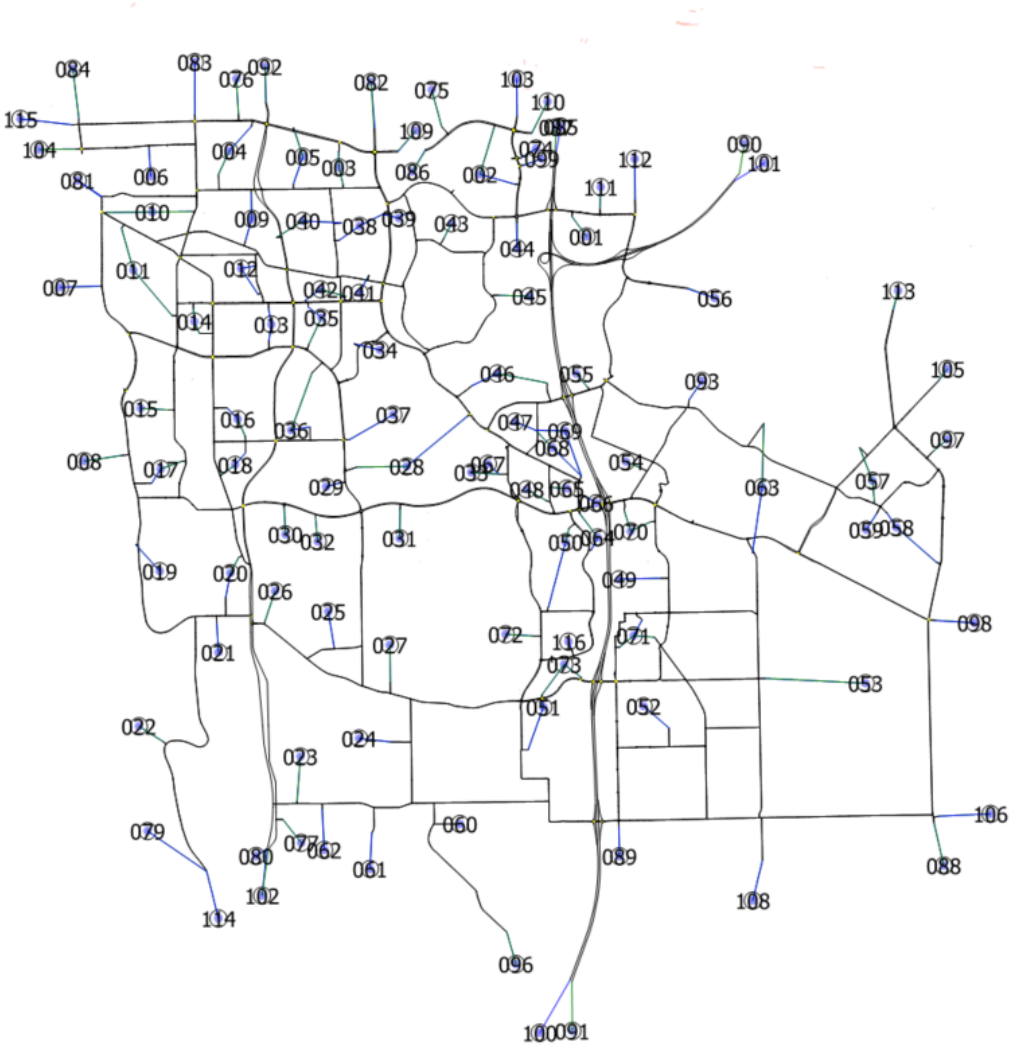


Figure 3 – Modelled Aimsun zone layout

The relationship between the original supplied ROM24 data and the updated data is summarised in Table 1.

Table 1 - Zone breakdown between ROM24 and CDTM

Zone Set	2011	2016	2020	2021	2031
Previous CDTM Internal Zones	77		77		77
Previous CDTM External Zones	23		25		27
Previous CDTM Dummy Zones for Growth	13		13		13

Zone Set	2011	2016	2020	2021	2031
Previous CDTM Total Zones	113		115		117
ROM24 Internal Zones		59		59	59
ROM24 External Zones		48		50	52
ROM24 Total Zones		107		109	111
CDTM Internal Zones		60		60	60
CDTM External Zones		48		50	52
CDTM Total Zones		108		110	112

The final CDTM has one more zone representing the City of Cockburn area than the ROM24. This slight increase has been made to enhance the accuracy of the forecast around the Wentworth Parade area. The increase in CDTM external zones between 2016, 2021 and 2031 are as a result of additional links from the external network as new corridors in and out of the City of Cockburn area are constructed. The zone system is different to the previous study completed as the zones were reflective of the years 2011, 2020 and 2031.

2.2 Demand matrix

The traffic demand matrix was derived using a sub-matrix from ROM24, with similar parameters to what was used for the existing Cockburn District Traffic Model such as demographics and trip generation confirmed with the city. Table 2 indicates the matrix totals used in the 2016, 2021 and 2031 models.

Table 2 - Demand Matrix Totals

Vehicle	2016		2021		2031	
	AM	PM	AM	PM	AM	PM
Cars	113,632	131,721	135,410	164,271	170,974	201,322
Trucks	12,369	12,835	15,011	18,178	18,959	22,292
Total	126,001	144,556	150,421	182,449	189,933	223,614

2.3 Review of Main Roads zoning, network and key developments

The review of the number of zones was undertaken to understand the detailed development areas along with a review of centroid connectors to better reflect access locations. Zones internal to the Cockburn sub-model were reviewed. This method ensures that road improvements such as roads identified or planned in Structure Plans, the City's future major road works and Main Roads WA planning for the projects such as Armadale Road, North LakeRoad Bridge, southern connection road to the Murdoch Activity Centre, Kwinana Freeway Widening, Karel Avenue Projects and other improvements within the State road network are taken into consideration.

The development of the model demographics, based on those supplied by Main Roads as part of the ROM24 model, was guided by the City of Cockburn officers. Figure 4 shows the major development areas as outlined by the City of Cockburn Regional and Major Roadworks diagram, version 9, dated March 2017.

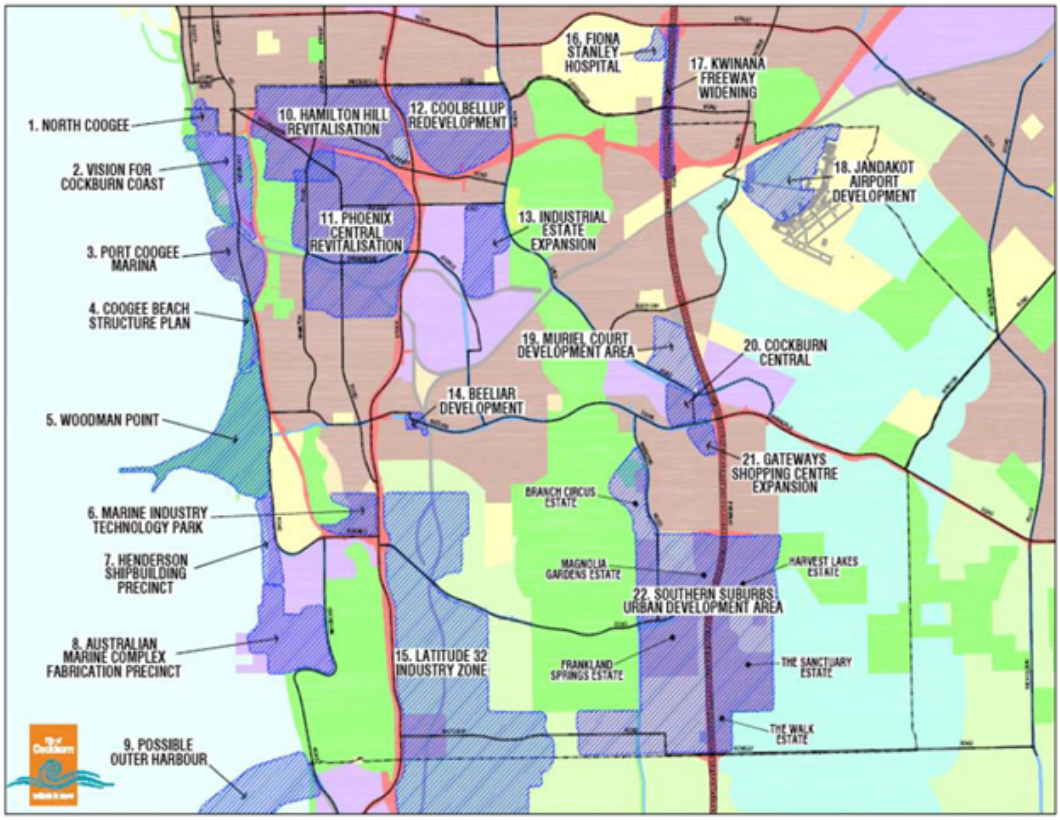


Figure 4 - Major development areas

Source: A Plan for the District 2010 - 2020, City of Cockburn

2.4 Demographic data review

Demographic data was obtained from the City of Cockburn, the Department of Planning, Lands and Heritage, and the Department of Education to review the ROM matrix outputs for the year 2016 for suitability. The three key demographic attributes used to validate the matrices were dwellings, employment and education as they were deemed to be significant factors impacting trip generation.

Total dwellings by zone was sourced from the City of Cockburn 2016 census data, and was adjusted to match the ROM24 zones to directly compare the total dwelling count from both data sets. Appendix D displays the ROM24 numbers and the City of Cockburn census numbers, and the final revised dwelling numbers.

Total local workers by zone was sourced from the City of Cockburn 2016 census data, and was adjusted to match the ROM24 zones to directly compare the total employment numbers from both data sets. These data sets were then compared against survey data retrieved from the Department of Planning, Lands and Heritage which identify the key “complexes” within the City of Cockburn and the levels of employment they generate accordingly. The survey is of all commercial, industrial, public purpose and recreation/open space land uses, with key data including how many people work at each activity centre.

As they are survey results, they were used to validate findings rather than in calibrating the initial ROM24 and City of Cockburn datasets. Once the 2016 employment rates were determined, the 2021 and 2031 predicted employment levels were determined using the growth rates determined from the ROM24 land use data. Appendix D displays the ROM24 input employment numbers, the City of Cockburn census data and the final revised employment numbers.

The total amount of students by zone was validated using student enrolment numbers sourced from the Department of Education, for schools within the City of Cockburn. Once the 2016 employment levels were validated, the ROM growth factors were used to determine 2021 and 2031 education levels. This is also shown in Appendix D.

Table 3 - Key development area yield assumptions in the supplied ROM24 land use files (source: Main Roads)

Development Area	ROM Zone Nos	ROM Demographic Zones (2016)	Dwellings			Employment			Education		
			2016	2021	2031	2016	2021	2031	2016	2021	2031
Cockburn Central	774	48	123	414	352	300	1181	836	0	0	0
Fiona Stanley Precinct	External to model 667	2	287	270	385	2703	10904	19257	12876	14039	16504
Jandakot Airport Development	782	56	143	196	198	1605	1705	1741	29	14	0
Latitude 32	749, 750, 751, 752, 753, 939, 940 & 941	23, 24, 25, 26, 27, 60, 61 & 62	416	432	468	686	5139	16820	138	135	135
Australian Marine Complex	748	22	7	7	6	3953	4054	4315	457	487	513
Cockburn Coast Development	733	47	255	2510	4849	364	1642	2791	0	250	500

Table 4 - Key development area yield assumptions in the revised CDTM

Development Area	ROM Zone Nos	ROM Demographic Zones (2016)	Dwellings			Employment			Education		
			2016	2021	2031	2016	2021	2031	2016	2021	2031
Cockburn Central	774	48	144	476	634	3305	13008	9205	0	0	0
Fiona Stanley Precinct	External to model 667	2	287	270	385	2703	10904	19257	12876	14039	16504
Jandakot Airport Development	782	56	151	1593	2743	5112	5431	5544	29	14	0
Latitude 32	749, 750, 751, 752, 753, 939, 940 & 941	23, 24, 25, 26, 27, 60, 61 & 62	343	990	1612	614	3936	13744	138	135	135
Australian Marine Complex	748	22	5	6	7	5439	5578	5937	457	487	513
Cockburn Coast Development	733	47	269	1250	3751	516	2328	3958	0	200	500

Table 3 summarises demographic data from ROM 24 in key development areas within City of Cockburn and Table 4 shows demographic data after review. Both demographic data assumes similar growth in a number of the key development areas as shown in Table 3 and 4. In terms of employment growth, Fiona Stanley Precinct, Latitude 32 area and Cockburn Coast Development show the most significant growth compared

to 2016 employment levels. The Jandakot Airport Development area and Cockburn Coast Development show the most significant dwelling growth from 2016 dwelling levels.

From the demographic review process, no employment forecasts for 2021 and 2031 were provided within the city of Cockburn, so the 2016 values were determined for each zone and factored up using the ROM24 forecasted increases.

Latitude 32 is identified as an industrial development area which reflects the significant job growth, however due to the nature of the ROM24 zoning boundaries, some of the surrounding residential areas to the north were captured within this area. This accounts for the dwelling growth identified in Latitude 32 the area.

2.5 Trip generation

Revised trip generation equations were applied to match previous work (City of Cockburn District Traffic Study, 2013) and latest available trip generation information. Research into trip generation trends was also undertaken to review how these may change into the future. The updated 'internal to internal' trip matrices were combined with the 'external to internal'; 'internal to external'; and 'external to external' trip matrices from the ROM24 to produce overall demand matrices for light and heavy vehicles for 2021 and 2031. Interpolation was used for years that do not align with ROM24 forecast years.

Trip generation rates are applied to the yields for each zone in order to establish the quantum of traffic generated by each zone. Trip generation rates were determined for both households and for employment based on a review of first principles data and similar transport model parameters. The trip generation rates for employment were based on a review of modelling practice in Western Australia and within Australia. Employment was divided into three categories:

- Retail
- Commercial
- Industry

Some adjustments were made based on the more detailed breakdown of these categories to adjust the trip rates so they were more relevant to the modelled area. Despite the adjustment residential trip generation rates are conservative and consistent with rates that are traditionally accepted by the Western Australian Planning Commission when assessing new development applications and structure plans.

The trip rates are vehicular trips and are as follows:

- 7 trips per household
- 1 trip per school student
- 9.3 trips per retail employee
- 3.0 trips per commercial employee
- 2.6 trips per industrial employee.

Additionally, trip generation rates were calibrated against total vehicle trips generated in the ROM24 on a zone by zone basis.

2.6 Time period

In a difference to the 2013 DTS, the model was updated to reflect that ROM24 can now provide a breakdown of matrices into peak periods (not available in 2013). This means that the time period splits were undertaken in ROM24 rather than the CDTM. As a result, two time periods have been modelled, morning peak (between 07:00-09:00) and evening peak (between 16:00-18:00). Modelling results are presented for 2 hour peaks throughout the report.

2.7 Mode split

Matrices have been developed based on ROM24 to reflect the mode split to allow for assessment of car/light and heavy vehicle impacts on the network. These rates have been validated against the traffic counts collected from the Main Roads traffic counts mapping tool and traffic counts provided by the City of Cockburn.

It is envisaged that some sensitivity testing on modal share factors may need to be undertaken by the City to mimic greater non-car mode share if a more detailed traffic assessment is required; currently outside of this scope.

2.8 Trip assignment

A key advantage of the Aimsun platform is its ability to undertake the assignment of matrix demand to the road network in a simple robust manner.

A multiclass volume static origin-destination matrix adjustment assignment was undertaken with car/light and heavy vehicles. This approach provided the following:

- Better modelling of the impact of heavy vehicles on road capacity given the mix of freight and non-freight routes in the study area
- Ability to better model the mix of heavy vehicle types and their impact on road capacity
- Volume averaging approach consistent with future upgrade of explicit modelling of intersection operations
- Converges to a stable and consistent result more readily than other assignment techniques

Model network and initial matrices have been extracted from ROM24 and therefore major parameters have been brought from ROM24 into Aimsun. That allowed DTS model consistency with Main Roads strategic modelling.

3 Cockburn district traffic model

The CDTM is a macroscopic Aimsun model derived from ROM24 demand matrices and validated against available count data. Mode share is divided into car/light and heavy vehicles based off the ROM24 matrices and 'furnessed' to count data to accurately represent existing situation. According to Main Roads Operational Modelling Guidelines furnessing is defined as follow:

"The Furness method of matrix updating is an iterative process to derive matrices that result in the best match to trip end count data. Trip end totals for each zone should be formed from external link survey data, internal link survey data and other filler zones with the values based on surveys, surrounding land use or the number of individual households. Within this, individual OD pairs should be fixed to known survey values or established during the calibration process."

The public transport data has not been included at this stage of the modelling. Figure 5 and Figure 6 depict the process of the base model development and future model development.

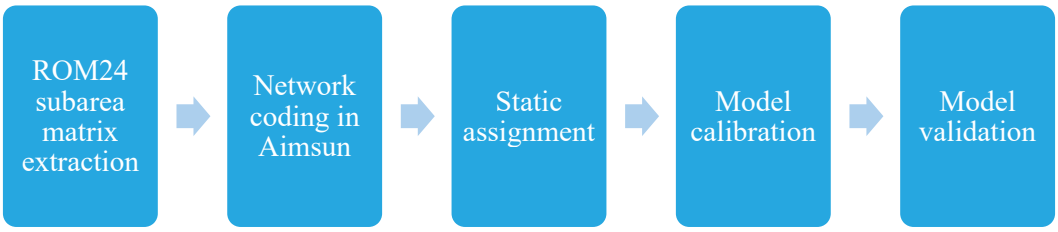


Figure 5 - Base model development

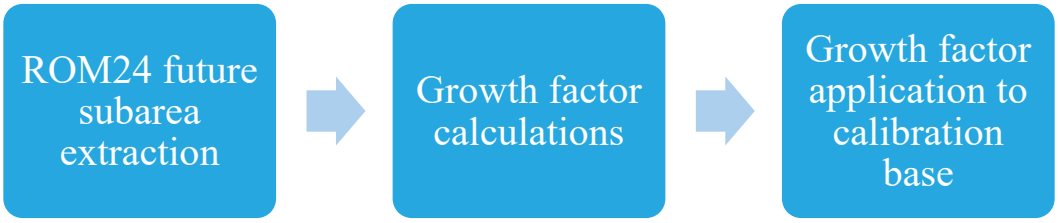


Figure 6 - Future model development

3.1 2016 base year

A 2016 base year model was developed and calibrated with parameters using existing traffic count information to confirm that the model is fit for purpose. Once calibrated and validated the model was used to forecast future changes to traffic volumes associated with changes to land use.

Based on the traffic data available for the study and correlation with the ROM24 data to observed daily traffic counts within the City of Cockburn, the CDTM calibrates to well within industry accepted standards at a daily level and satisfactory for peak periods.

The desirable industry standards extracted from NSW Road and Maritime Services Traffic Modelling Guidelines version 1 and Main Roads OMeGA guidelines are contained in Table 5.

Table 5 - Link Validation Measures

Link Calibration Measure	Desirable Value
GEH < 5	85%
Link Validation Measure	**Desirable Value**
Coefficient of Determination (R^2)	>0.90

Source: "Traffic Modelling Guidelines" Version 1, NSW Road and Marine Services

Additional measures such as GEH have been included as these are required for the Aimsun strategic modelling based on the local Main Roads modelling guidelines.

3.1.1 Base model calibration – GEH statistic

The criteria from Roads and Martie Services (RMS) guidelines for model calibration are based on statistics formula called GEH. As RMS states:

"the formula is a form of Chi-square statistic that is designed to be tolerant of largest errors in low flows. The reason for introducing such a statistic is the inability of either the absolute difference or the relative difference to cope over a wide range of flows."

The GEH equation is as follows:

$$GEH = \sqrt{\frac{(V_o - V_m)^2}{0.5\,(V_o + V_m)}}$$

Where:

V_o is the observed flow in vehicles per hour

V_m is the modelled flow in vehicles per hour

According to RMS, turn volumes calibration is achieved when" 85 per cent of individual turn volumes to have a GEH ≤ 5.0".

3.1.2 Base model calibration results

The calibration has shown a very good model performance against observed flows. All time periods were calibrated above the required 85% margin as shown in Table 6.

Table 6 - GEH results

GEH Results	GEH Range	Car	Heavy Vehicles
AM Peak Hour	=<5	86%	93%
	5 to 10	10%	7%
	>10	4%	0%
PM Peak Hour	=<5	85%	94%
	5 to 10	14%	6%
	>10	1%	0%

3.1.3 Validation plots – peak periods

The scatter plot validates well against 2016 average peak period traffic volumes with parameters meeting the industry acceptable standard. To demonstrate the model validation scatter plots of 240 traffic count locations versus 2016 CDTM volumes are shown in Figure 7 and Figure 8 for AM peak and PM peak time periods respectively.

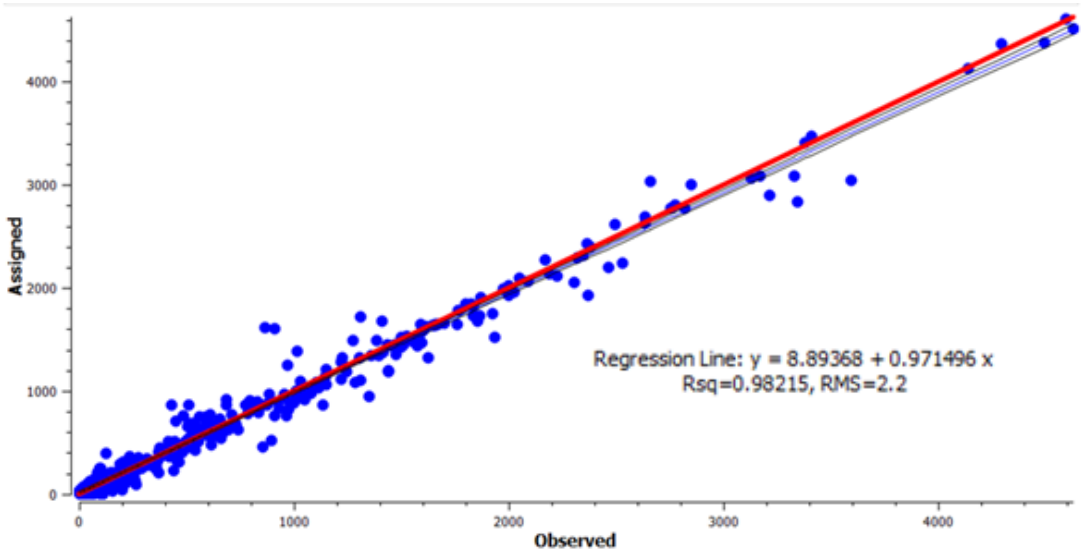


Figure 7 – AM Peak period validation plot

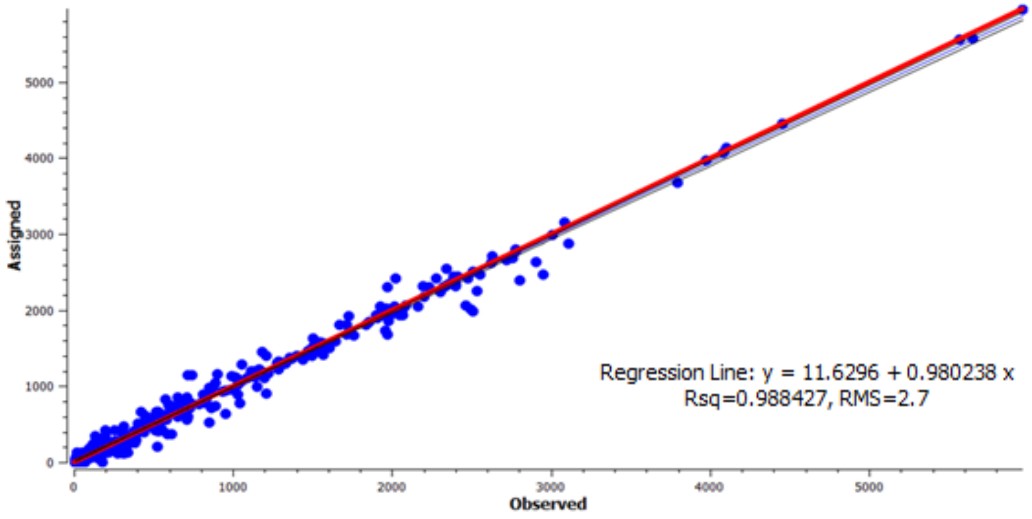


Figure 8 – PM Peak period validation plot

The AM and PM peak periods validate very well to the guideline standards which shows a very good model robustness and fit for purpose. As a result, both modelled peak periods provide a useful guide in understanding peak period traffic, operation including directional bias and traffic growth under congested conditions.

3.1.4 Model convergence

The 2016 base model was run with 50 iterations to ensure it converged appropriately. The AM peak had a relative gap of 3.37% and the PM peak had a relative gap of 2.05%. Model is considered converged when relative gap is lower than 5%, therefore results of both model calibrations show very good model convergence.

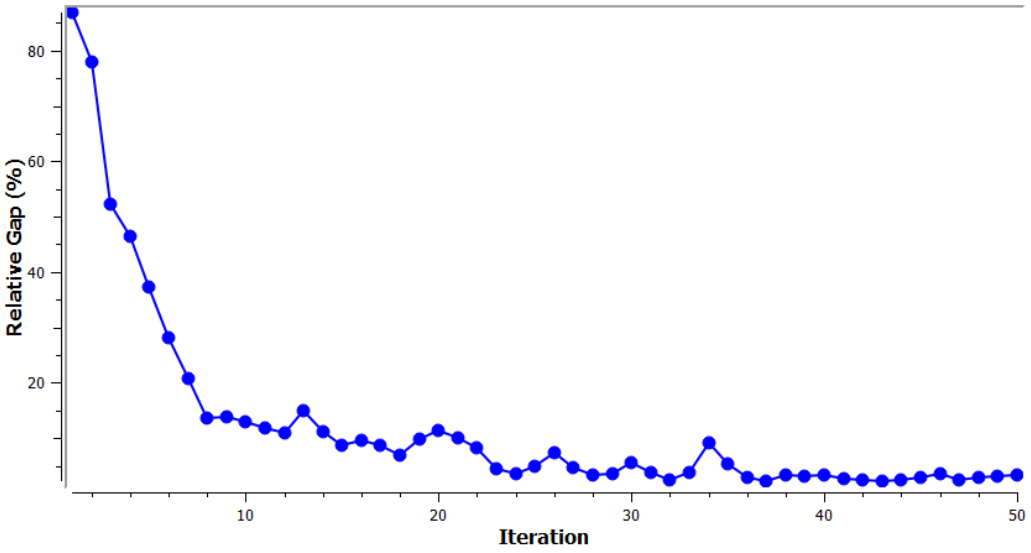


Figure 9 – AM Peak period convergence plot

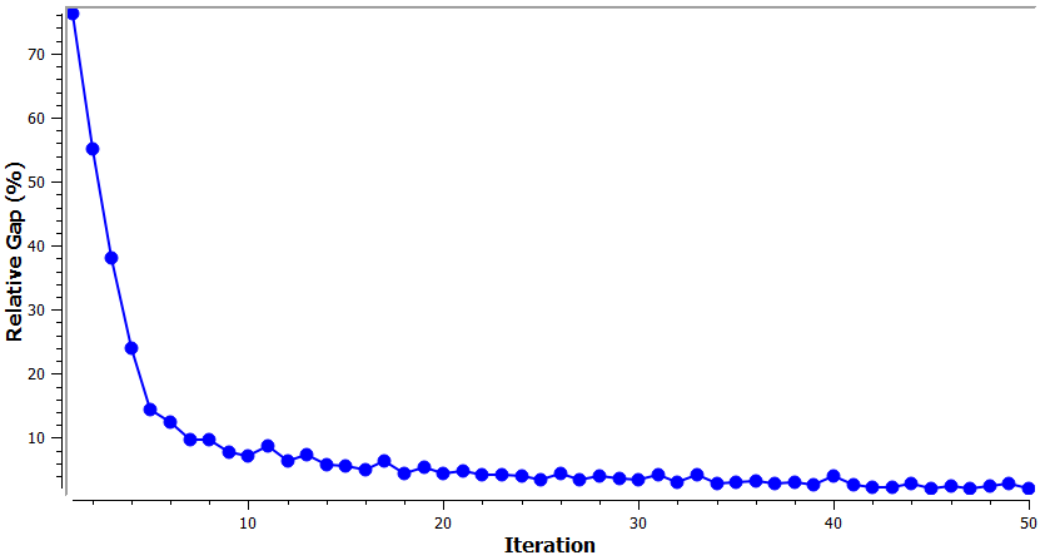


Figure 10 – PM Peak period convergence plot

3.1.5 Validation summary

Overall, the CDTM provides a sound basis for the future modelling of the transport network in and the City of Cockburn area. From a review of the 2016 peak traffic volumes supplied from the Main Roads and City of Cockburn, the CDTM validates very well against requires industry standards. Both coefficient of determination (r-square) are over required 0.95%. The R-Square (R2) is a

statistical measure of the correlation between the entire count data set and the predicted model volumes. Unlike the GEH statistic (which applies to individual flows and screenlines), the R-Square (R2) applies to the entire comparison data set and is expressed as a single value.

As with any transport model, the CDTM will be enhanced through project application in the future to improve performance at a detailed level. As it currently stands, the CDTM would appear to provide the best available tool to understand strategic transport flows on the majority of roads within the City of Cockburn area. A summary of the level of validation for each time period is shown in Table 7.

Table 7 - Validation summary

Link Validation Measure	Desirable Value	AM Peak	PM Peak
Coefficient of Determination (R^2)	>0.90	0.98	0.98

3.2 Use of CDTM

The use of the CDTM output should be treated in a similar manner as other strategic models. Whilst suitable as a strategic network analysis tool, it is recommended that forecast traffic volumes used for design be verified against actual count data collected specifically to each project.

In general, the process for determining forecast traffic volumes should be as follows:

1. Obtain 2016 and forecast year traffic flows from CDTM
2. Calculate growth rate to the required design year based on the CDTM link growth data.
3. Apply traffic growth from the CDTM to existing traffic counts
4. Review the forecast volumes to ensure reasonable in the context of surrounding development and traffic growth

Where new links and intersections are under construction, unmodified CDTM output will require additional scrutiny to ensure reasonable for design purposes such as analysis at intersections.

4 Base modelling results

4.1 Volume capacity ratio

Link capacities are often referred to as the mid-block capacity and when calculated take into account the characteristics of a link between two points, usually intersections. Different methods for calculating road capacities are used for different road environments and flow characteristics.

According to AustRoads document "*Level of Service Metrics (for Network Operations Planning)* ", capacity is defined as the maximum hourly rate at which vehicles can reasonably be expected to traverse a point or uniform section of a lane or roadway during a given time period under the prevailing roadway, traffic and control conditions.

In order to determine the point at which more capacity is required to allow more traffic to pass through a road or intersection, the volume to capacity ratio is used.

The levels of service are calculated based on the assigned volumes produced by strategic model and mid-bloc capacity coded in the network.

The volume to capacity ratios range from A to F and are defined by qualitative measures describing operational conditions within a traffic stream and their perception by motorists and/ or passengers.

The level of service range and corresponding volume to capacity ratios used in the DTS model are indicated in Table 8.

Table 8 - Volume to capacity ratios governing midblock level of service

Volume Capacity Ratio	**Level of Service**					
	A	**B**	**C**	**D**	**E**	**F**
100km/h	32%	50%	72%	92%	100%	>100%
90km/h	30%	47%	68%	89%	100%	>100%
80km/h	28%	44%	64%	85%	100%	>100%
70km/h	26%	41%	59%	81%	100%	>100%

Source: AustRoads 2009

In order to reflect modelling results a unified LOS range has been determined for better visualisation, as shown in Table 9, and used in the peak hour volume plots for the AM and PM peak for the base year 2016, as shown in Figure 11 and Figure 12.

Table 9 – Volume to capacity ratios used in model to govern level of service

Volume Capacity Ratio	Level of Service					
	A	B	C	D	E	F
Unified Speed Range	29%	46%	60%	80%	100%	>100%

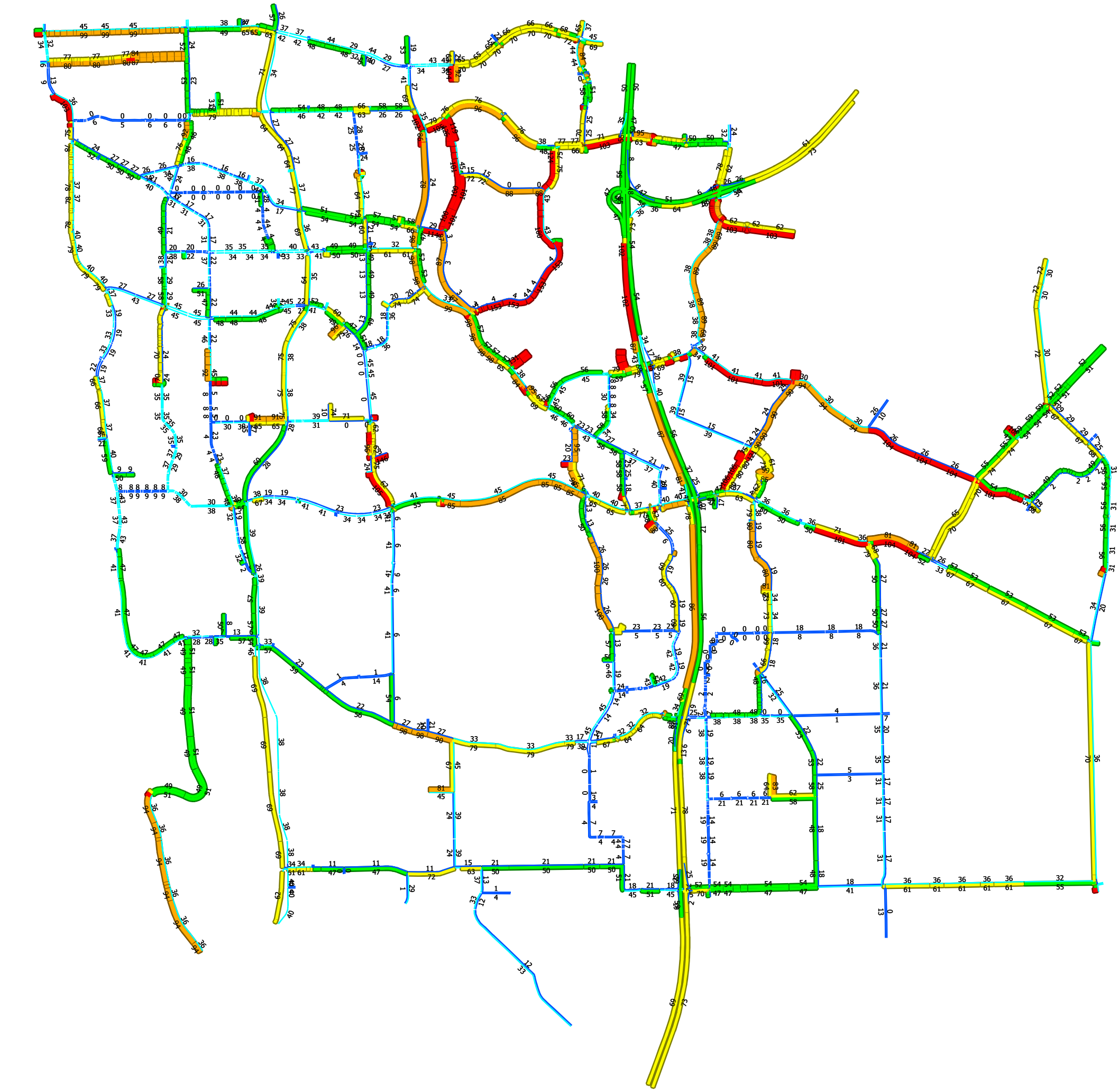


Figure 11 - Volume Capacity Ratio - AM Peak, year 2016

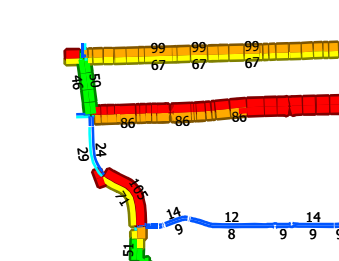


Figure 12 - Volume Capacity Ratio - PM Peak, year 2016

The 2016 model run confirms known congestion hotspots in the City where the modelled volume capacity is over 100%. Most notably sections of the following roads as displayed in Table 10 and Figure 13.

Table 10 - Roads with a volume capacity ratio exceeding 100% in both peak periods.

Reference Number	Road Type	Road Name
1	Primary Distributor	Kwinana Freeway
2	Primary Distributor	Armadale Road
3	Primary Distributor	Farrington Road
4	Regional Distributor	Jandakot Road
5	Regional Distributor	Russell Road
6	Distributor A	Cockburn Road
7	Distributor A	Spearwood Avenue
8	Distributor A	Beeliar Drive
9	Distributor A	Berrigan Drive
10	Distributor A	Karel Avenue
11	Distributor B	Bibra Drive
12	Distributor B	Hammond Road
13	Local Distributor	Tapper Road

Figure 13 depicts the corridor hotspots on the Cockburn network for 2016.

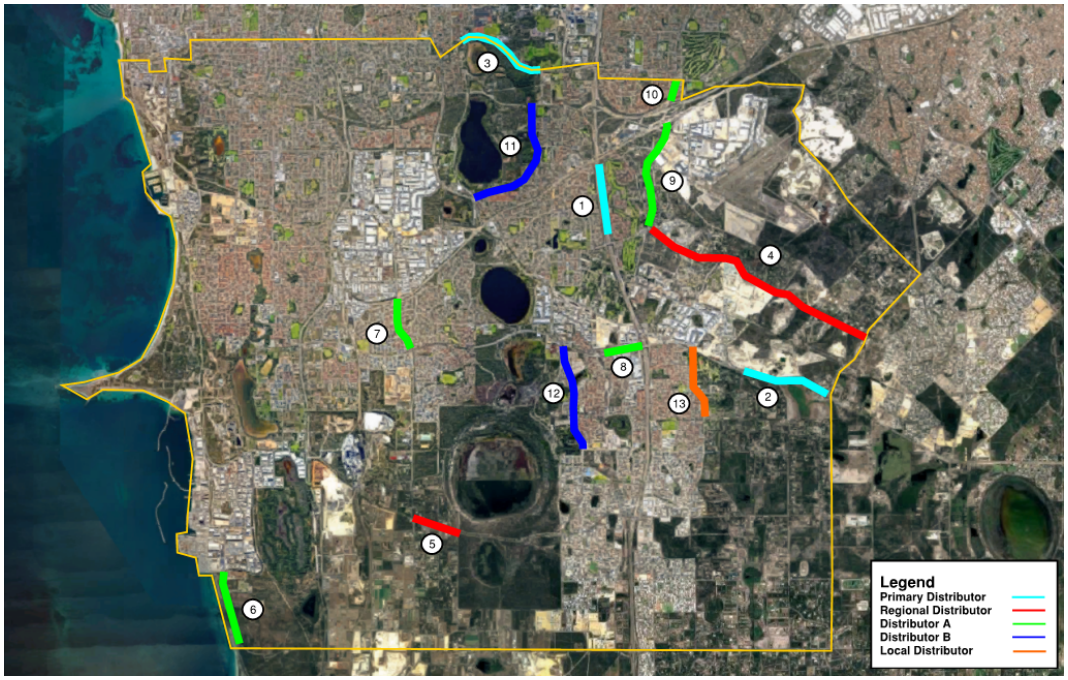


Figure 13 – 2016 corridor hotspots

Some features (eg wetlands/lakes, Jandakot Airport) restrict the permeability of the road network in locations which results in short sections of roads operating close to capacity including Farrington Rd (north of Bibra Lake) and Berrigan Drive (Jandakot Airport).

4.2 Assigned volumes

As part of the strategic modelling exercise model outputs assigned volumes plots. As mentioned in section 4.1 assigned volumes are an output from strategic model, often used for calculation of level of service. Figure 14 shows AM Peak plot and Figure 15 shows PM peak plots. Appendix A shows all remaining assigned volumes plots for all modelled scenarios.

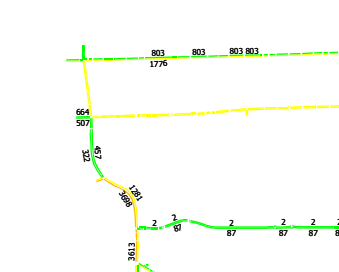


Figure 14 - Assigned Volumes - AM Peak, year 2016

Figure 15 - Assigned Volumes - PM Peak, year 2016

4.3 Base traffic conditions in Cockburn

Given its location in the south-western suburbs of Perth, the City of Cockburn experiences pronounced peak traffic conditions during weekday commuter peaks and in the lead up to long weekends as people travel south along the Kwinana Freeway to the south west. Combined with this demand, is the east west heavy vehicle flows between the industrial areas in the west e.g. Henderson and Fremantle and industrial areas near Perth Airport/ Forrestfield/ Kewdale. Given the level of forecast development, it may be difficult and unsustainable to provide road infrastructure upgrades to accommodate unconstrained peak hour vehicle demand in the future. However, network planning needs to be cognisant of these peak conditions and make some allowances for appropriate traffic management measures to manage peak demand scenarios.

The assessment assumes average weekday peak conditions (i.e. model output); however, it is recommended that capacity targets are kept relatively optimistic (e.g. LoS D) so at least some capacity is kept in reserve for future growth (beyond the forecast horizon of 2031) or if funding constraints result in particular projects being delayed. This desirable level of service will be more applicable to trunk routes such as Rockingham Road; a reduced LoS should generally be considered in the activity centres, where traffic management measures may be better applied and the needs of non-car modes should take greater precedence improving average speeds for motorists.

4.4 Impact of network capacity on non-car modes

It is noted that the adoption of target LoS (Volume Capacity Ratio) can have impacts on non-car modes of transport. Along trunk routes, increased capacity, traffic flows (e.g. added lanes) and higher speed limits generally diminish the attractiveness and safety of the route for walking and cycling trips. Pedestrian crossing movements away from controlled locations (e.g. under/ overpasses or traffic/ pedestrian signals) also become less safe and attractive. In addition, public transport services may be detrimentally affected by route upgrades when opportunities to perform turning movements and manoeuvre in and out of stops are diminished with increased traffic flows. It is important the LoS is chosen with respect to all the modes using road corridors. Further detailed analysis might be required when planning road improvements on individual locations.

Where segregated facilities for walking and cycling trips exist such as along Kwinana Freeway and selected arterial roads in the City, the level of service of the road network has less impact on the experience and safety of pedestrian and cycle movements.

Roads with a low classification within the functional road hierarchy that service activity centres, should afford a high priority to alternative modes to the car, reducing the focus of road network planning on level of service. For example, within Cockburn Central, it is recommended that a lower LoS is accepted to increase opportunities for pedestrians and cyclists to undertake trips safely and with higher amenity. This may be facilitated through:

- Appropriate signal phasing

- Limiting road capacity to one lane in each direction rather than duplication
- Avoiding installation of turning pockets slip lanes at intersections where there are high crossing demands
- Adopting posted speed limits of 50kph or less subject to Main Roads approval

It is recommended to adopt a sliding LoS scale in the first instance, based on the status of each modelled link and its location within the sub-region. The target LoS would be subject to change based on the future land use and network scenarios that are tested.

5 Forecast scenarios

Two future year scenarios – 2021 and 2031 have been analysed. The year 2031 is the standard horizon adopted for road network planning in Western Australia and consistent with the Main Roads strategic model, ROM24. For each year, two road network scenarios have been modelled:

- Do nothing – the road network is as per year 2016
- Do minimum – current network plus Main Roads committed road improvements
- Do Something 01 - City of Cockburn Preferred Network – Main Roads committed road improvements plus network upgrades as identified in current City of Cockburn planning
- Do Something 02 – additional widening scenarios requested to be investigated by City of Cockburn, such as Stock Road and Cockburn Road. These scenarios have been modelled as additional assessment.

The ‘do nothing’ scenario helps to support a case for road network upgrades and identify priority investment locations. This scenario needs to be considered given some of the proposed upgrade projects are unfunded and therefore there is no firm commitment to proceed with the upgrades.

Forecasting for the 2021 and 2031 scenarios was undertaken based on “furnessing” the base 2016 matrix with growth in the trip ends based on the internal zone trip generation rates.

For this commission, Arup undertook modelling of three network scenarios summarised in Table 11.

Table 11 - Scenario Matrix

Scenario	Existing (2016)	Short Term (2021)	Long Term (2031)
Do Nothing - Existing Network	Existing Network	No improvements	No improvements
Do Minimum		ROM24 road improvements	ROM24 road improvements
Do Something		City of Cockburn identified road improvements	City of Cockburn identified road improvements
Stock Road Widening			City of Cockburn identified road improvements with Stock Road widened
Cockburn Road Widening			City of Cockburn identified road improvements with Cockburn Road widened

5.1 Mode share assumptions

The City of Cockburn DTS model has been based on the Main Roads mode share in order to keep consistency with Main Roads strategic model. The adopted mode share is assumed to remain constant at 2016 levels over the modelled future years. This is a conservative approach in light of increased road network congestion.

5.2 Network assumptions

Arup conducted a policy review to understand the potential timings for road network upgrades within the City of Cockburn. The road network upgrades adopted in the modelling are detailed in Figure 16 and Table 12. City of Cockburn structure plans, Table 13, Main Roads projects (Table 14) were also taken into consideration to update the road network and zoning. These timings are as per the Main Roads ROM24, a review of the 2013 City of Cockburn District Traffic Study and final confirmation from the City of Cockburn. As discussed earlier, the inclusion of these projects does not infer a funding commitment to the listed upgrades.

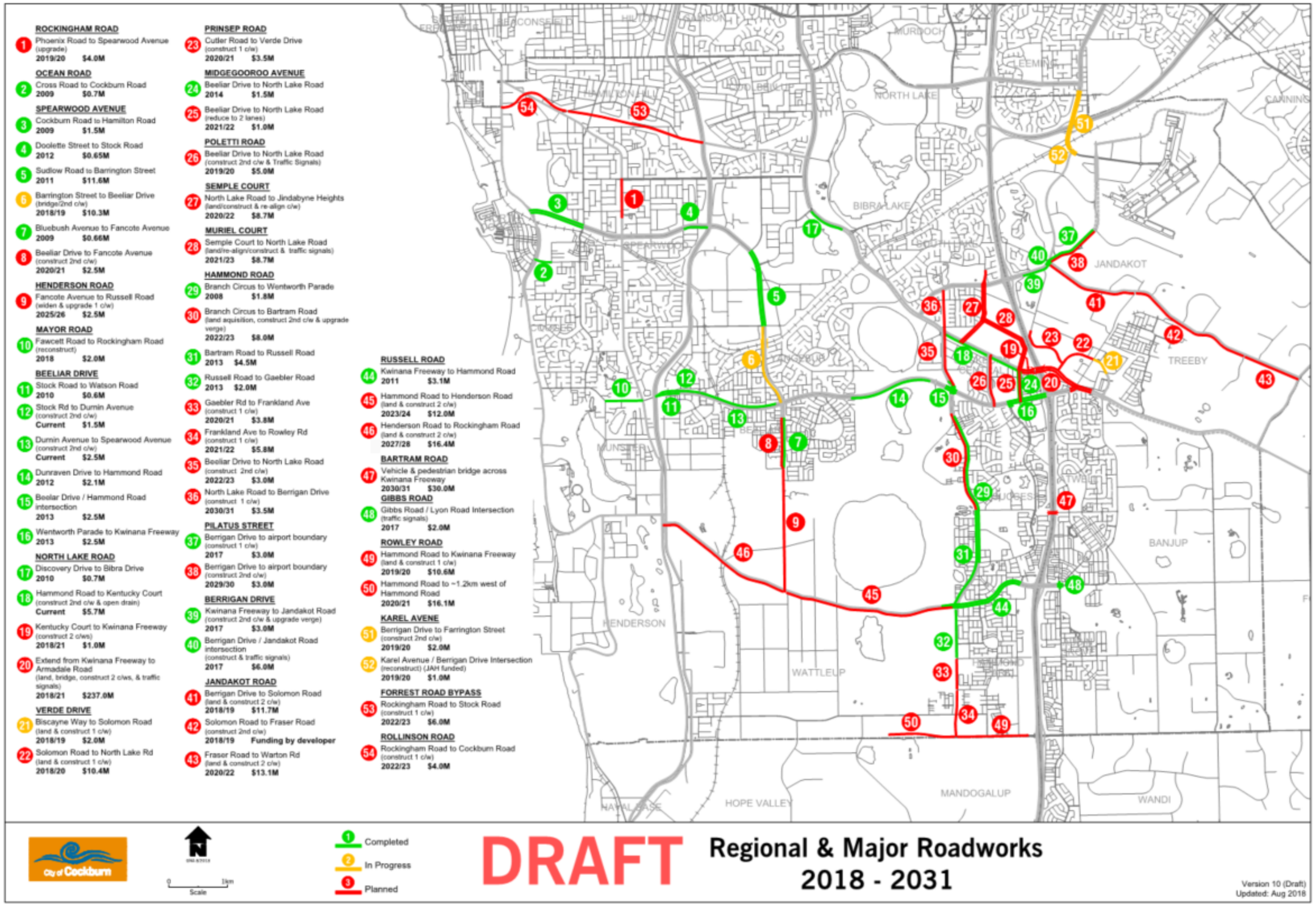


Figure 16 – City of Cockburn Regional and Major Roadworks diagram, version 10, August 2018

Table 12 - City of Cockburn Road Network Upgrades

Road Network Upgrade	2021	2031	Comment regarding assumption basis
Rockingham Road – Phoenix Road to Spearwood Avenue reconstruction (to 1 lane each way)		✓	Not reflected in ROM model
Spearwood Avenue - Barrington Street to Beeliar Drive (bridge / 2nd c/w)	✓	✓	Not reflected in ROM model
Spearwood Avenue – Beeliar Drive to Fancote Avenue (construct 2nd c/w)	✓	✓	Not reflected in ROM model
Henderson Road – Fancote Avenue to Russell Road (widen and upgrade 1 c/w)		✓	Not applicable for strategic modelling
Beeliar Drive – Fawcett Road to Stock Road (reconstruction)	✓	✓	Not applicable for strategic modelling
North Lake Road / Discovery Drive intersection (traffic signals)	✓	✓	Not applicable for strategic modelling
North Lake Road – Kentucky Court to Kwinana Freeway (construct 2 c/ws)		✓	In ROM 2021 & 2031
North Lake Road – Extend from Kwinana Freeway to Armadale Road (land, bridge, construct 2 c/ws, & traffic signals)		✓	In ROM 2021 & 2031
Verde Drive – Biscayne Way to Solomon Road (land & construct 1 c/w)	✓	✓	In ROM 2021 & 2031
Verve Drive – Solomon Road to North Lake Road (land & construct 1 c/w)	✓	✓	In ROM 2021 & 2031
Prinsep Road – Cutler Road to Verde Drive (construct 1 c/w)	✓	✓	Not reflected in ROM model
Midgegooroo Avenue – Beeliar Drive to North Lake Road (reduce to 2 lanes)		✓	
Poletti Road – Beeliar Drive to North Lake Road (construct 2nd c/w & traffic signals)	✓	✓	Not reflected in ROM model
Semple Court – North Lake Road to Jindabyne Heights (land / construct & re-align c/w)		✓	No impact on network layout
Muriel Court – Semple Court to North Lake Road (land / re-align / construct & traffic signals)		✓	No impact on network layout
Hammond Road – Branch Circus to Bartram Road (construct 2nd c/w & upgrade verge)		✓	Not reflected in ROM model
Hammond Road – Gaebler Road to Frankland Avenue (construct 1 c/w)	✓	✓	Existing
Hammond Road – Frankland Avenue to Rowley Road (construct 1 c/w)	✓	✓	Not reflected in ROM model
Hammond Road – Beeliar Drive to North Lake Road (construct second c/w)	✓	✓	Not in ROM 2021 & in ROM 2031
Hammond Road – North Lake Road to Berrigan Drive (construct 1 c/w)	✓	✓	Not reflected in ROM model
Pilatus Street – Berrigan Drive to airport boundary (construct 2nd c/w)		✓	In ROM 2021 & 2031

Road Network Upgrade	2021	2031	Comment
Jandakot Road – Berrigan Drive to Solomon Road (land & construct 2 c/w)	✓	✓	In ROM 2021 & 2031
Jandakot Road – Solomon Road to Fraser Road (construct 2nd c/w)	✓	✓	In ROM 2021 & 2031
Jandakot Road – Fraser Road to Warton Road (land & construct 2 c/w)		✓	In ROM 2021 & 2031
Russell Road - Hammond Road to Henderson Road (land & construct 2 c/w)		✓	Not reflected in ROM model
Russell Road – Henderson Road to Rockingham Road (land & construct 2 c/w)		✓	Not reflected in ROM model
Bartram Road – Vehicle & pedestrian bridge across Kwinana Freeway		✓	Not in ROM 2021 & not in ROM 2031, potentially in 2041
Rowley Road – Hammond Road to Kwinana Freeway (land & construct 1 c/w)	✓	✓	Not in ROM 2021 & in ROM 2031
Rowley Road – Hammond Road to ~1.2km west of Hammond Road	✓	✓	Not in ROM 2021 & in ROM 2031
Karel Avenue – Berrigan Drive to Farrington Street (construct 2nd c/w)		✓	In ROM 2021 & 2031
Forrest Road Bypass – Rockingham Road to Stock Road (construct 1 c/w)	✓	✓	Not Modelled
Rollinson Road – Rockingham Road to Cockburn Road (construct 1 c/w)		✓	Not Modelled

Source: City of Cockburn Regional and Major Roadworks diagram, version 10, August 2018

Approved City of Cockburn District Structure Plans are included in Table 13.

Table 13 - Approved City of Cockburn District Structure Plans

Approved District Structure Plans	2021	2031
Southern Suburbs Stage 3 – Hammond Park west of the Freeway and south of Gaebler Road	✓	✓
Packham North	✓	✓
Branch Circus	✓	✓
Cockburn Coast	✓	✓
Treeby (released December 2017)	✓	✓

Source: Approved Structure Plans on the City of Cockburn website

Main Roads Western Australia (Main Roads) future major works in the Main Roads Infrastructure Delivery Plan 2016-2019 are included in Table 14.

Table 14 - Main Roads WA Infrastructure Delivery Plan Projects

Infrastructure Delivery Plan Projects	2021	2031
Armadale Road – Dual Carriageway – North Lake Road to Tapper Road (Commenced)	✓	✓
Murdoch Drive Connection to Kwinana Freeway and Roe Highway (extension of Murdoch Drive which joins onto Farrington Road) (Commenced)	✓	✓
Kwinana Freeway Northbound Widening – Russell Road to Roe Highway (Commenced)	✓	✓
Stock Road / Beeliar Drive Intersection Upgrade (Development)	✓	✓
Karel Avenue upgrades (Procurement)	✓	✓

Source: Main Roads WA Infrastructure Delivery Plan last updated 22 November 2017

6 Future modelling results

The traffic volumes for the forecast years for key routes are represented in the network plots in Appendix A. Figure 21 to Figure 24 illustrate the volume to capacity ratio of the Do Nothing, for 2021 and 2031 network upgrades for the AM and PM peak periods.

The results of the future scenario modelling are discussed below.

6.1 Network statistics

The summary network statistic for each development year for the ‘do nothing’ and the upgraded network scenarios (as per Table 12) are shown in Table 15. Those statistics allow identify impact of upgrades on overall travel time and travel distance.

Table 15 - Forecast scenario assignment summary statistics

Network Variable	Base	Do Nothing		Do Something	
	2016	2021	2031	2021	2031
Vehicle Hours (AM Peak)	96,917	2,126,083	2,521,283	1,876,583	1,028,405
Vehicle Kilometres (AM Peak)	763,311	911,291	1,220,820	912,039	1,244,320
Vehicle Hours (PM Peak)	113,826	1,758,417	2,204,200	1,677,867	1,492,047
Vehicle Kilometres (PM Peak)	860,180	1,089,200	1,363,730	1,149,940	1,474,940

The summary of network statistics has also been shown on the Figure 17 and Figure 18.

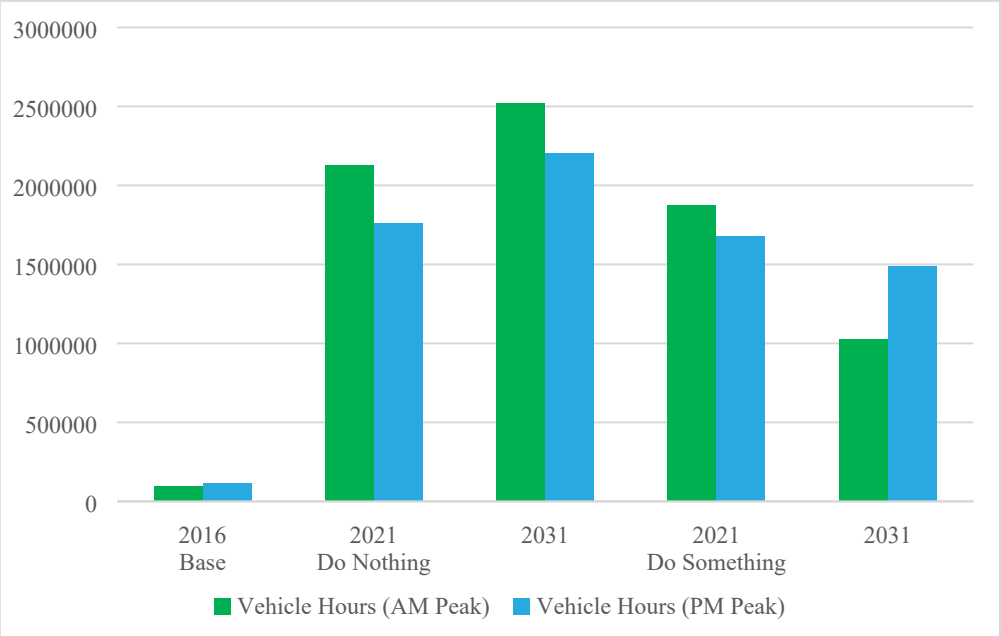


Figure 17 - Vehicle hours travelled across Cockburn road network

Figure 17 indicates significant increase in vehicle hours travelled due to decrease of accessibility to local roads which are result of increased congestion. This is a network wide statistic which includes all the roads modelled within the network. Future models show higher travel times which are result of some minor roads not performing as well. Additionally, results show significant growth in travel time if no network upgrades materialise (i.e. do nothing). However, it also shows a significant decrease in vehicle hours compared to 2021 if planned road improvements are implemented by year 2031.

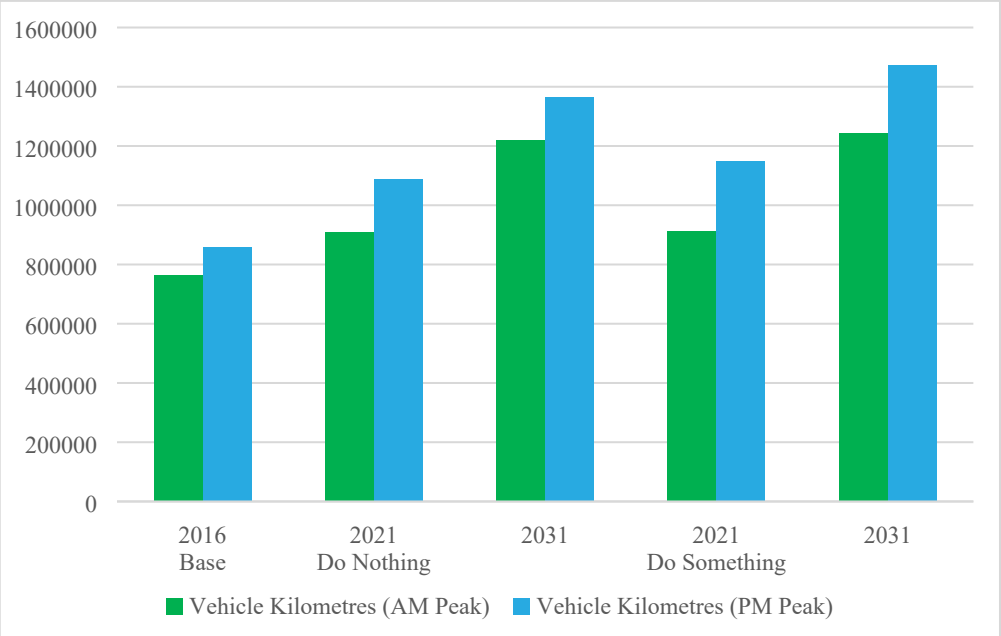


Figure 18 – Vehicle kilometres travelled across Cockburn road network

Vehicle distance travelled in kilometres further confirms need for road improvements but also shows similar pattern of growth between 2021 and 2031.

6.2 Road capacity results – year 2021

Without any changes to the road network, the model shows widespread congestion with many north-south and east-west links operating at a capacity of 95% or higher. The levels of congestion are expected to be similar during both the AM and PM peak periods.

The model shows that many of these congestion issues would be overcome with the introduction of the planned improvements as shown on Figure 21 to Figure 24. With these improvements, Kwinana Freeway is expected to continue to experience congestion with the road operating at over 95% capacity during both peaks. This is despite the planned upgrade to three lanes in each direction north of Russell Road. Table 16 and Figure 19 shows other roads on the network that are expected to operate at over 95% capacity.

Additionally, based on the Do Nothing results of roads with VCR over 85% for roads which are expected to be upgraded (see Table 18) it was indicated that all improvements planned to be implemented before year 2021 are required.

This is a large suite of upgrade options, most of which are understood to be unfunded and there is therefore no guarantee that all upgrades will be implemented within the year 2021 timeframe. Additionally, the analysis also highlights that some of the options planned post year 2021, are warranted at an earlier stage.

Table 16 - 2021 Do nothing roads with a volume capacity exceeding 100% in both peak periods.

Reference Number	Road Type	Road Name
1	Primary Distributor	Kwinana Freeway
2	Primary Distributor	Cockburn Road
3	Primary Distributor	Armadale Road
4	Primary Distributor	Farrington Road
5	Regional Distributor	Jandakot Road
6	Regional Distributor	Rowley Road
7	Distributor A	Cockburn Road
8	Distributor A	Russell Road
9	Distributor A	Beeliar Drive
10	Distributor A	Karel Avenue
11	Distributor A	Spearwood Avenue
12	Distributor A	Berrigan Drive
13	Distributor B	Hammond Road
14	Distributor B	Midgegooroo Avenue
15	Local Distributor	Gibbs Road
16	Local Distributor	Lyon Road
17	Local Distributor	Liddelow Road
18	Local Distributor	Wentworth Parade
19	Local Distributor	Tapper Road

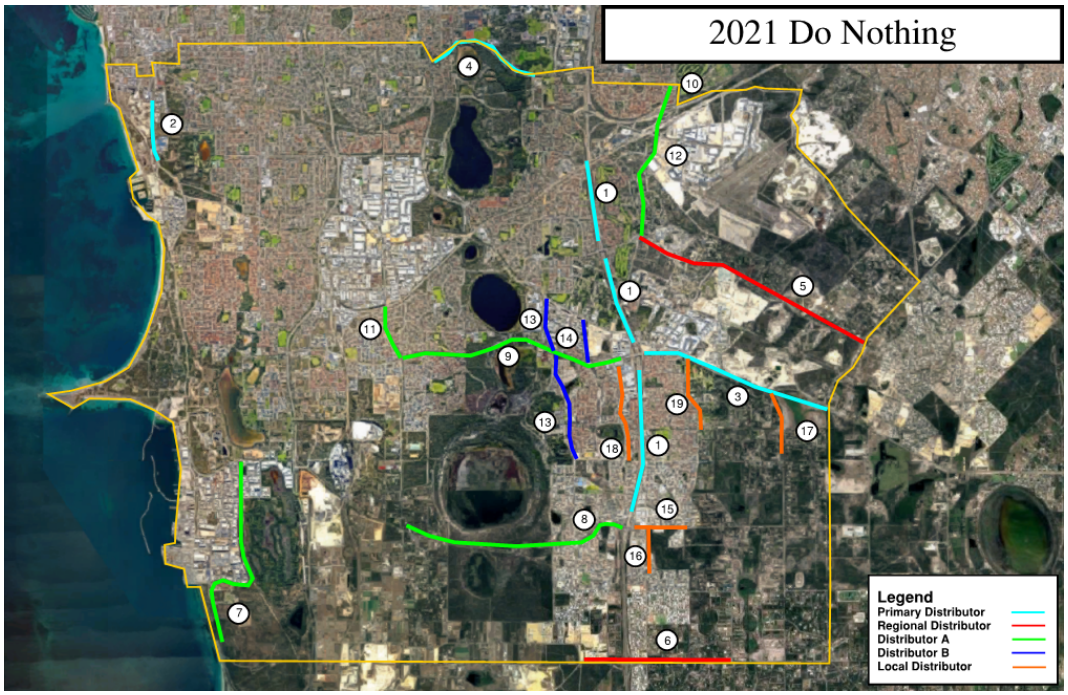


Figure 19 - Heat map of 2031 do nothing scenario of major roads with volume capacity ratios exceeding 100%

Table 17 - 2021 Do something roads with a volume capacity exceeding 100% in both peak periods.

Reference Number	Road Type	Road Name
1	Primary Distributor	Kwinana Freeway
2	Primary Distributor	Cockburn Road
3	Primary Distributor	Farrington Road
4	Regional Distributor	Rowley Road
5	Distributor A	Cockburn Road
6	Distributor A	Russell Road
7	Distributor A	Beeliar Drive
8	Distributor B	Hammond Road
9	Distributor B	Midgegooroo Avenue
10	Local Distributor	Lyon Road
11	Local Distributor	Liddelow Road
12	Local Distributor	Wentworth Parade
13	Local Distributor	Tapper Road

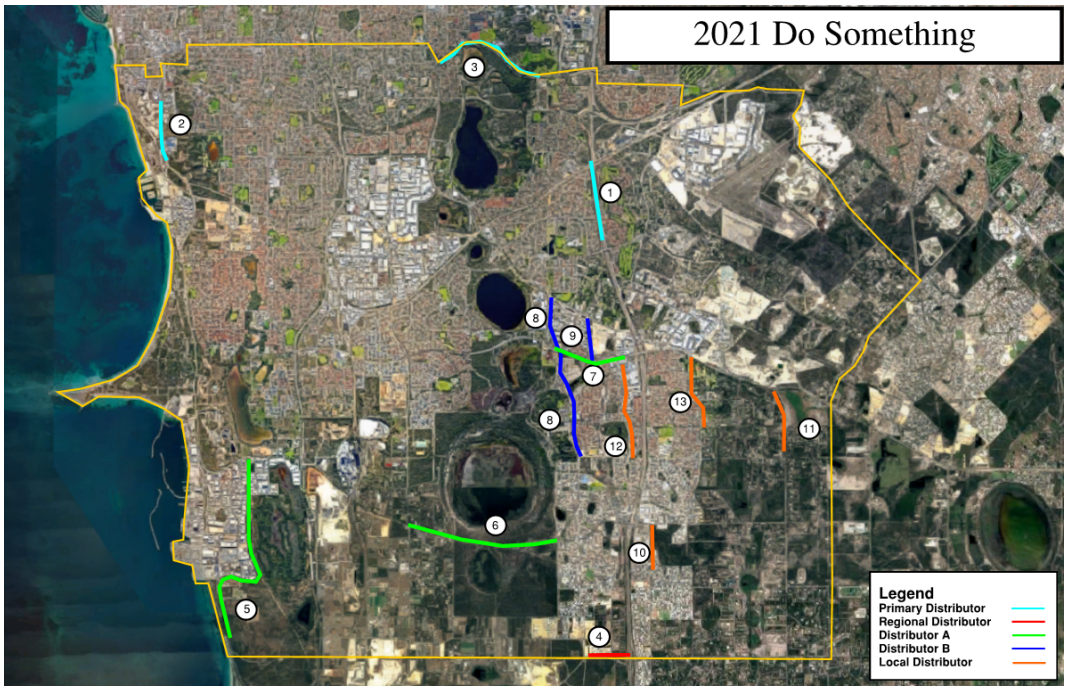


Figure 20 - 2021 Do something roads with a volume capacity exceeding 100%

Table 18 - Roads with Volume Capacity Ratio above 85% in Do Nothing (Year 2021) in both peak periods.

Implementation Plan	Planned Upgrade				Sections	Direction	Planned Upgrades Based on Modelling Results by 2021
	City of Cockburn		Main Roads				
Road Network Upgrade	2021	2031	2021	2031			
Spearwood Avenue - Barrington Street to Beeliar Drive (bridge / 2nd c/w)	✓	✓			Beeliar Drive to Mainsail Terrace	Northbound	upgrade
						Southbound	upgrade
					Mainsail Terrace to Yangebup Road	Northbound	upgrade
						Southbound	upgrade
					Yangebup Road to Barrington Street	Northbound	upgrade
						Southbound	upgrade
Henderson Road – Fancote Avenue to Russell Road (widen and upgrade 1 c/w)		✓			Russell Road to Holmes Road	Northbound	upgrade
						Southbound	not required
Midgegooroo Avenue – Beeliar Drive to North Lake Road (reduce to 2 lanes)		✓			Beeliar Drive to Signal Terrace	Northbound	upgrade
						Southbound	not required
					Signal Terrace to North Lake Road	Northbound	upgrade
						Southbound	not required
Poletti Road – Beeliar Drive to North Lake Road (construct 2nd c/w & traffic signals)	✓	✓			Beeliar Drive to Cooper Road	Northbound	not required
						Southbound	upgrade
					Cooper Road to Davison Road	Northbound	upgrade
						Southbound	upgrade
					Davison Road to North Lake Road	Northbound	upgrade
						Southbound	upgrade
Semple Court – North Lake Road to Jindabyne Heights (land / construct & re-align c/w)		✓			North Lake Road to Muriel Court	Northbound	upgrade
						Southbound	upgrade
Hammond Road – Branch Circus to Bartram Road (construct 2nd c/w & upgrade verge)	✓	✓			Bartram Road to Branch Circus	Northbound	upgrade
						Southbound	upgrade
Hammond Road – Frankland Avenue to Rowley Road (construct 1 c/w)	✓	✓			Rowley Road to Wattleup Road	Northbound	upgrade
						Southbound	upgrade
Hammond Road – Beeliar Drive to North Lake Road (construct second c/w)	✓	✓		✓	Beeliar Drive to Blackly Row	Northbound	upgrade
						Southbound	upgrade
					Blackly Row to North Lake Road	Northbound	upgrade
						Southbound	upgrade
Jandakot Road – Berrigan Drive to Solomon Road (land & construct 2 c/w)	✓	✓	✓	✓	Solomon Road to Berrigan Drive	Eastbound	upgrade
						Westbound	upgrade
Jandakot Road – Solomon Road to Fraser Road (construct 2nd c/w)	✓	✓	✓	✓	Fraser Road to Solomon Road	Eastbound	upgrade
						Westbound	upgrade
Jandakot Road – Fraser Road to Warton Road (land & construct 2 c/w)		✓	✓	✓	Warton Road to Fraser Road	Eastbound	upgrade
						Westbound	upgrade
Russell Road - Hammond Road to Henderson Road (land & construct 2 c/w)		✓			Henderson Road to Pearse Road	Eastbound	upgrade
						Westbound	upgrade
					Pearse Road to Hammond Road	Eastbound	upgrade
						Westbound	upgrade
Rowley Road – Hammond Road to Kwinana Freeway (land & construct 1 c/w)	✓	✓		✓	Hammond Road to Kwinana Freeway	Eastbound	upgrade
						Westbound	upgrade
Karel Avenue – Berrigan Drive to Farrington Street (construct 2nd c/w)		✓	✓	✓	Berrigan Drive to Roe Highway	Northbound	upgrade
						Southbound	upgrade
					Roe Highway Bridge	Northbound	upgrade
						Southbound	upgrade
					Roe Highway to Farrington Street	Northbound	upgrade
						Southbound	upgrade
Cockburn Road - Rockingham Road South to Rockingham Road North	✓	✓			Rockingham Road South to Nautical Drive	Northbound	upgrade
						Southbound	upgrade
	✓	✓			Nautical Drive to Russell Road	Northbound	upgrade
						Southbound	upgrade
	✓	✓			Mayor Road to Spearwood Avenue	Northbound	not required
						Southbound	upgrade
	✓	✓			Spearwood Avenue to Rockingham Road North	Northbound	upgrade
						Southbound	upgrade
Stock Road - Rockingham Road to Garling Street	✓	✓			Rockingham Road to Beeliar Drive	Northbound	not required
						Southbound	upgrade
	✓	✓			Barrington Street to Spearwood Avenue	Northbound	upgrade
						Southbound	upgrade
	✓	✓			Spearwood Avenue to Phoenix Road	Northbound	not required
						Southbound	upgrade

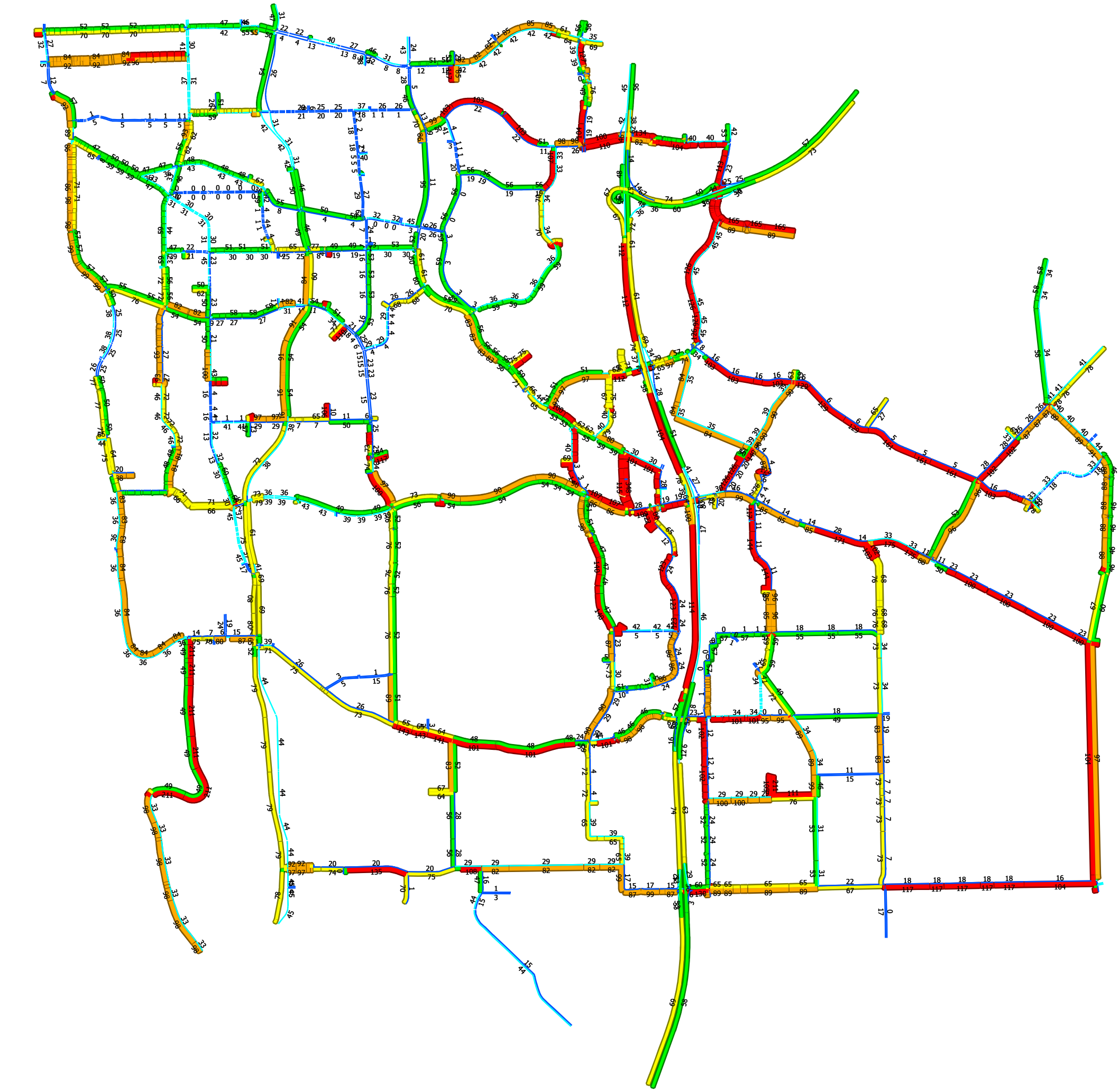


Figure 21 - Do Nothing - Volume Capacity Ratio – AM Peak, year 2021

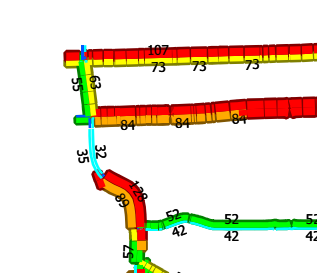


Figure 22 - Do Nothing - Volume Capacity Ratio – PM Peak, year 2021

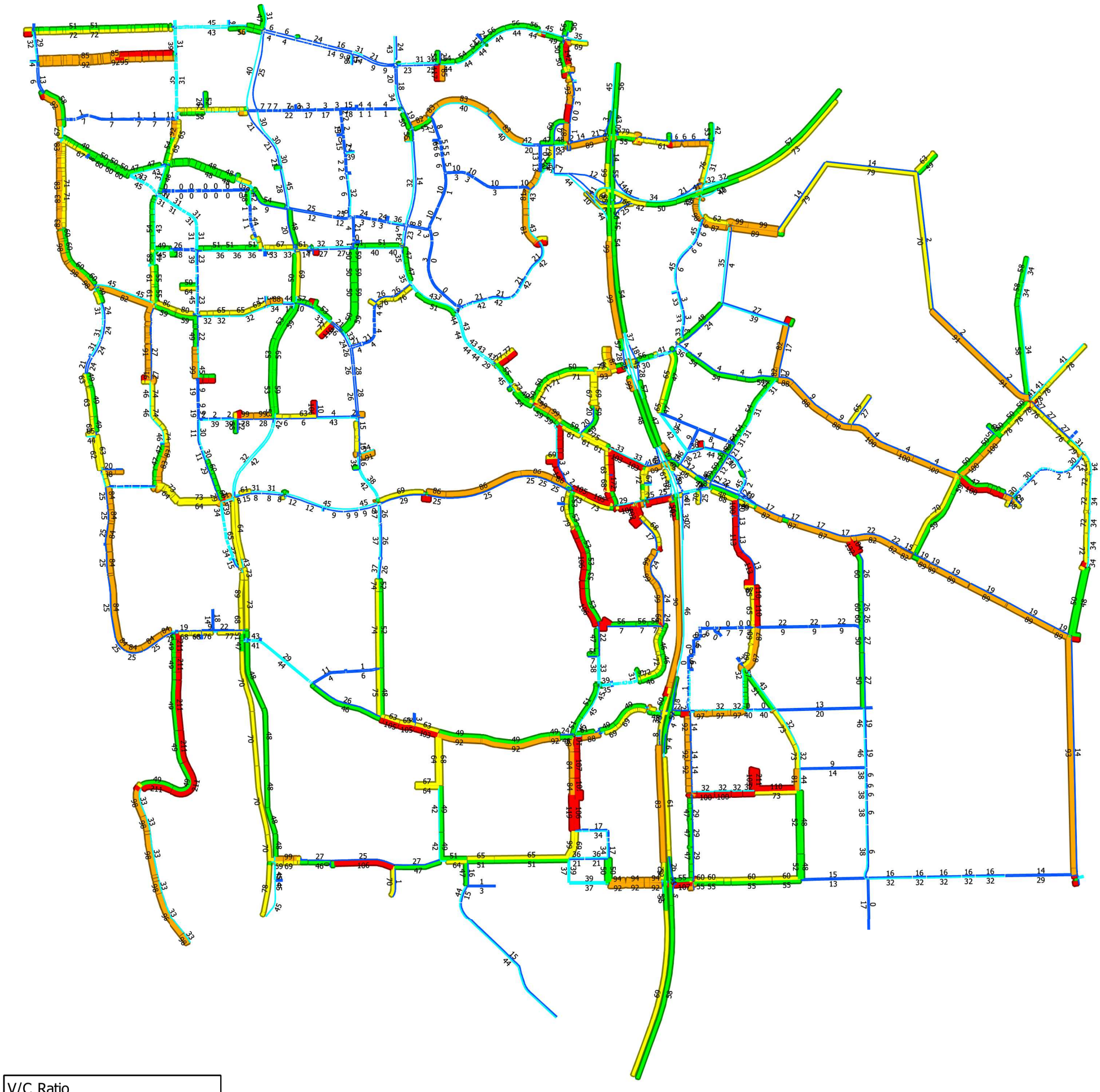


Figure 23 - Do Something - Volume Capacity Ratio – AM Peak, year 2021

Figure 24 - Do Something - Volume Capacity Ratio – PM Peak, year 2021

A comparison of 2016 results and 2021 results (assuming upgrades are in place as per the Road Improvements Plan), shows that some locations will experience capacity issues well into the future.

6.3 Road capacity results – year 2031

A 'do nothing' scenario for 2031 year has shown widespread growth with more links expected to operate within 95% to 100% of their capacity in the PM peak compared to the AM peak as shown in Table 19 and Figure 25.

No further upgrades have been assumed for Kwinana Freeway between 2021 and 2031 and consequently, it remains a congestion issue at several locations throughout City of Cockburn. Approaches to the freeway at Farrington Road, Roe Highway, and Beeliar Drive are also expected to operate close to capacity.

Table 19 - 2031 Do nothing roads with a volume capacity exceeding 100% in both peak periods.

Reference Number	Road Type	Road Name
1	Primary Distributor	Kwinana Freeway
2	Primary Distributor	Cockburn Road
3	Primary Distributor	Rockingham Road
4	Primary Distributor	Armadale Road
5	Primary Distributor	Stock Road
6	Primary Distributor	Farrington Road
7	Regional Distributor	Jandakot Road
8	Regional Distributor	Rowley Road
9	Regional Distributor	Wattleup Road
10	Distributor A	Cockburn Road
11	Distributor A	Russell Road
12	Distributor A	Beeliar Drive
13	Distributor A	Hope Road
14	Distributor A	Karel Avenue
15	Distributor A	Spearwood Avenue
16	Distributor A	Berrigan Drive
17	Distributor B	Spearwood Avenue
18	Distributor B	Hamilton Road
19	Distributor B	Hammond Road
20	Distributor B	Midgegooroo Avenue
21	Local Distributor	Henderson Road
22	Local Distributor	Gibbs Road
23	Local Distributor	Lyon Road
24	Local Distributor	Liddelow Road
25	Local Distributor	Wentworth Parade
26	Local Distributor	Tapper Road
27	Local Distributor	Prinsep Road

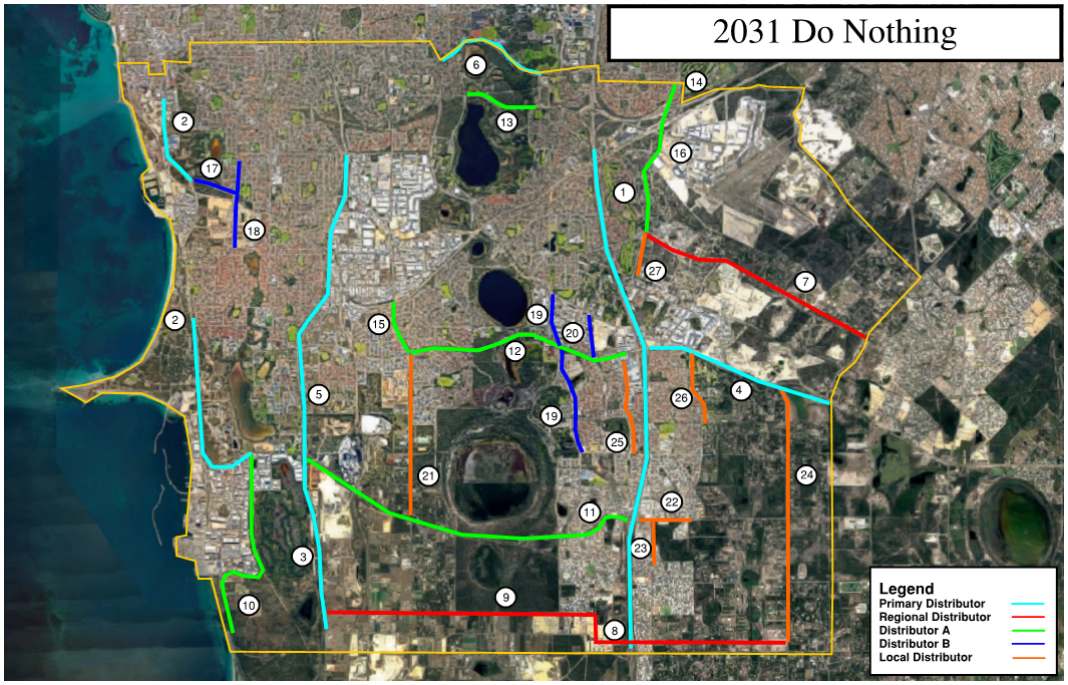


Figure 25 – Heat map of 2031 do nothing scenario of major roads with volume capacity ratios exceeding 100%

Modelling results with planned upgrades has indicated reduction in congestion in several locations. It can be seen in Table 20 and Figure 25 that the degree of congestion has reduced to smaller sections of each road identified in "do nothing" scenario as congestion issue. It was determined that all necessary upgrades listed in Table 21 are recommended to be implemented by 2031.

Table 20 - 2031 Do something major roads with volume capacity exceeding 100% in both peak periods.

Reference Number	Road Type	Road Name
1	Primary Distributor	Kwinana Freeway
2	Primary Distributor	Cockburn Road
3	Primary Distributor	Rockingham Road
4	Primary Distributor	Armadale Road
5	Primary Distributor	Stock Road
6	Primary Distributor	Farrington Road
7	Regional Distributor	Jandakot Road
8	Regional Distributor	Rowley Road
9	Distributor A	Cockburn Road
10	Distributor A	Russell Road
11	Distributor A	Beeliar Drive
12	Distributor A	Hope Road
13	Distributor A	Karel Avenue
14	Distributor B	Spearwood Avenue
15	Distributor B	Hamilton Road
16	Distributor B	Hammond Road
17	Distributor B	Midgegooroo Avenue
18	Local Distributor	Henderson Road

19	Local Distributor	Gibbs Road
20	Local Distributor	Lyon Road
21	Local Distributor	Liddelow Road
22	Local Distributor	Wentworth Parade
23	Local Distributor	Tapper Road
24	Local Distributor	Prinsep Road

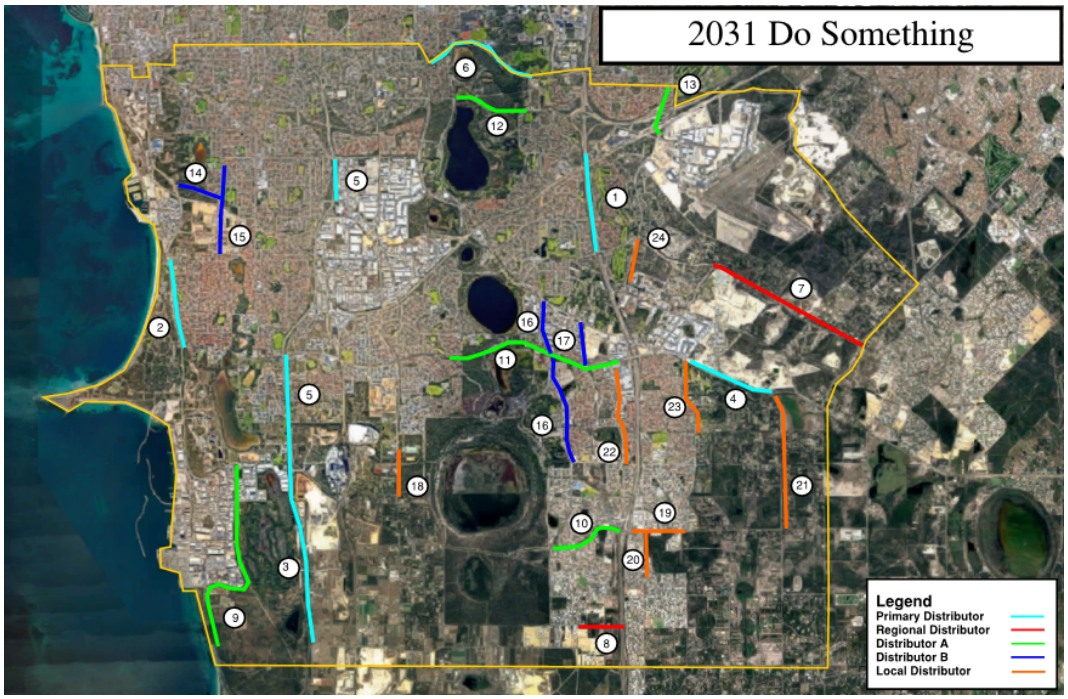


Figure 26 - Heat map of 2031 do something scenario of major roads with volume capacity ratios exceeding 100%

Other locations which were identified to have congestion issues in 2021, where no subsequent road network upgrades are planned, clearly continue to operate at close or over the capacity as shown in Figure 27 to Figure 30.

Table 21 - Implications of planned road network upgrades (Year 2031) in both peak periods.

Implementation Plan	Planned Upgrade				Sections	Direction	Planned Upgrades Based on Modelling Results by 2031
	City of Cockburn		Main Roads				
Road Network Upgrade	**2021**	**2031**	**2021**	**2031**			
Rockingham Road – Phoenix Road to Spearwood Avenue reduction (1 lane each way)	✓	✓	✓	✓	Phoenix Road to Spearwood Ave	Northbound	not required
						Southbound	upgrade
Spearwood Avenue - Barrington Street to Beeliar Drive (bridge / 2nd c/w)	✓	✓			Beeliar Drive to Mainsail Terrace	Northbound	upgrade
						Southbound	upgrade
					Mainsail Terrace to Yangebup Road	Northbound	upgrade
						Southbound	upgrade
					Yangebup Road to Barrington Street	Northbound	upgrade
						Southbound	upgrade
Spearwood Avenue – Beeliar Drive to Fancote Avenue (construct 2nd c/w)	✓	✓			Beeliar Drive to Fancote Avenue	Northbound	upgrade
						Southbound	upgrade
Henderson Road – Fancote Avenue to Russell Road (widen and upgrade 1 c/w)		✓			Russell Road to Holmes Road	Northbound	upgrade
						Southbound	upgrade
					Holmes Road to Fancote Avenue	Northbound	upgrade
						Southbound	upgrade
Beeliar Drive – Fawcett Road to Stock Road (reconstruction)	✓	✓			Fawcett Road to Rockingham Road	Eastbound	upgrade
						Westbound	upgrade
					Rockingham Road to Stock Road	Eastbound	upgrade
						Westbound	upgrade
Midgegooroo Avenue – Beeliar Drive to North Lake Road (reduce to 2 lanes)		✓			Beeliar Drive to Signal Terrace	Northbound	upgrade
						Southbound	not required
					Signal Terrace to North Lake Road	Northbound	upgrade
						Southbound	not required
Poletti Road – Beeliar Drive to North Lake Road (construct 2nd c/w & traffic signals)	✓	✓			Beeliar Drive to Cooper Road	Northbound	not required
						Southbound	upgrade
					Cooper Road to Davison Road	Northbound	upgrade
						Southbound	upgrade
					Davison Road to North Lake Road	Northbound	upgrade
						Southbound	upgrade
Semple Court – North Lake Road to Jindabyne Heights (land / construct & re-align c/w)		✓			North Lake Road to Muriel Court	Northbound	upgrade
						Southbound	upgrade
					Muriel Court to Berrigan Drive	Northbound	upgrade
						Southbound	not required
Hammond Road – Branch Circus to Bartram Road (construct 2nd c/w & upgrade verge)	✓	✓			Bartram Road to Branch Circus	Northbound	upgrade
						Southbound	upgrade
Hammond Road – Gaebler Road to Frankland Avenue (construct 1 c/w)	✓	✓	✓	✓	Frankland Avenue to Gaebler Road	Northbound	not required
						Southbound	upgrade
Hammond Road – Frankland Avenue to Rowley Road (construct 1 c/w)	✓	✓			Rowley Road to Wattleup Road	Northbound	upgrade
						Southbound	upgrade
					Wattelup Road to Frankland Avenue	Northbound	not required
						Southbound	upgrade
Hammond Road – Beeliar Drive to North Lake Road (construct second c/w)	✓	✓		✓	Beeliar Drive to Blackly Row	Northbound	upgrade
						Southbound	upgrade
					Blackly Row to North Lake Road	Northbound	upgrade
						Southbound	upgrade
Jandakot Road – Berrigan Drive to Solomon Road (land & construct 2 c/w)	✓	✓	✓	✓	Solomon Road to Berrigan Drive	Eastbound	upgrade
						Westbound	upgrade
Jandakot Road – Solomon Road to Fraser Road (construct 2nd c/w)	✓	✓	✓	✓	Fraser Road to Solomon Road	Eastbound	upgrade
						Westbound	upgrade
Jandakot Road – Fraser Road to Warton Road (land & construct 2 c/w)		✓	✓	✓	Warton Road to Fraser Road	Eastbound	upgrade
						Westbound	upgrade
Russell Road - Hammond Road to Henderson Road (land & construct 2 c/w)		✓			Henderson Road to Pearse Road	Eastbound	upgrade
						Westbound	upgrade
					Pearse Road to Hammond Road	Eastbound	upgrade
						Westbound	upgrade

Implementation Plan	Planned Upgrade				Sections	Direction	Planned Upgrades Based on Modelling Results by 2031
	City of Cockburn		Main Roads				
Road Network Upgrade	**2021**	**2031**	**2021**	**2031**			
Russell Road – Henderson Road to Rockingham Road (land & construct 2 c/w)		✓			Rockingham Road to Holmes Road	Eastbound	not required
						Westbound	upgrade
					Holmes Road to Henderson Road	Eastbound	not required
						Westbound	upgrade
Rowley Road – Hammond Road to Kwinana Freeway (land & construct 1 c/w)	✓	✓		✓	Hammond Road to Kwinana Freeway	Eastbound	upgrade
						Westbound	upgrade
Karel Avenue – Berrigan Drive to Farrington Street (construct 2nd c/w)		✓	✓	✓	Berrigan Drive to Roe Highway	Northbound	upgrade
						Southbound	upgrade
					Roe Highway Bridge	Northbound	upgrade
						Southbound	upgrade
					Roe Highway to Farrington Street	Northbound	upgrade
						Southbound	upgrade
Cockburn Road - Rockingham Road South to Rockingham Road North	✓	✓			Rockingham Road South to Nautical Drive	Northbound	upgrade
						Southbound	upgrade
	✓	✓			Nautical Drive to Russell Road	Northbound	upgrade
						Southbound	upgrade
	✓	✓			Russell Road to Mayor Road	Northbound	upgrade
						Southbound	upgrade
	✓	✓			Mayor Road to Spearwood Avenue	Northbound	upgrade
						Southbound	upgrade
	✓	✓			Spearwood Avenue to Rockingham Road North	Northbound	upgrade
						Southbound	upgrade
Stock Road - Rockingham Road to Garling Street	✓	✓			Rockingham Road to Beeliar Drive	Northbound	upgrade
						Southbound	upgrade
	✓	✓			Beeliar Drive to Barrington Street	Northbound	upgrade
						Southbound	upgrade
	✓	✓			Barrington Street to Spearwood Avenue	Northbound	upgrade
						Southbound	upgrade
	✓	✓			Spearwood Avenue to Phoenix Road	Northbound	upgrade
						Southbound	upgrade
	✓	✓			Phoenix Road to Forrest Road	Northbound	not required
						Southbound	upgrade
	✓	✓			Forrest Road to Winterfold Road	Northbound	upgrade
						Southbound	upgrade
	✓	✓			Winterfold Road to South Street	Northbound	not required
						Southbound	upgrade

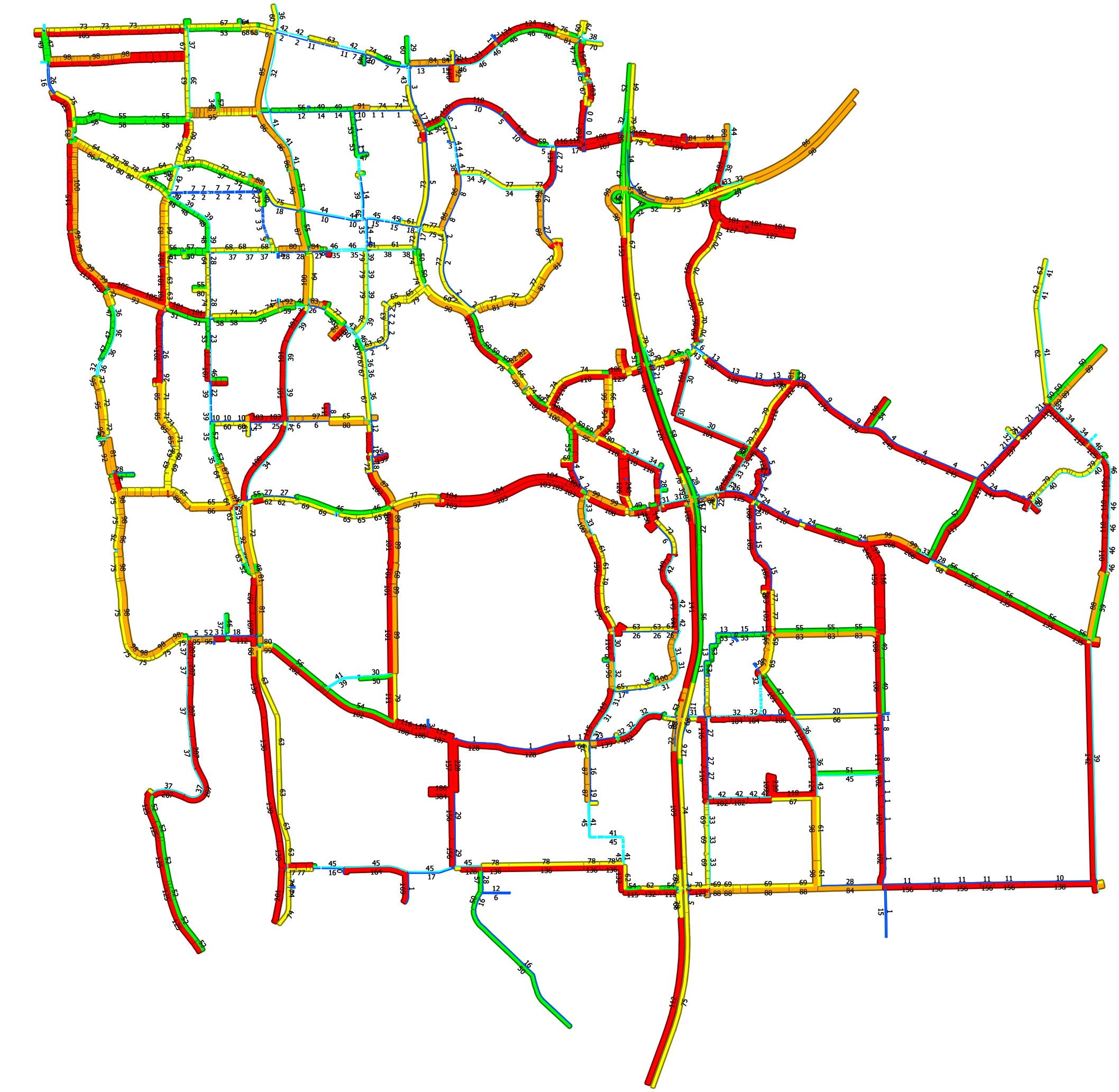


Figure 27 - Do Nothing - Volume Capacity Ratio – AM Peak, year 2031

V/C Ratio
0 to 29
29 to 46
46 to 60
60 to 80
80 to 100
100 to 800

Figure 28 - Do Nothing - Volume Capacity Ratio – PM Peak, year 2031

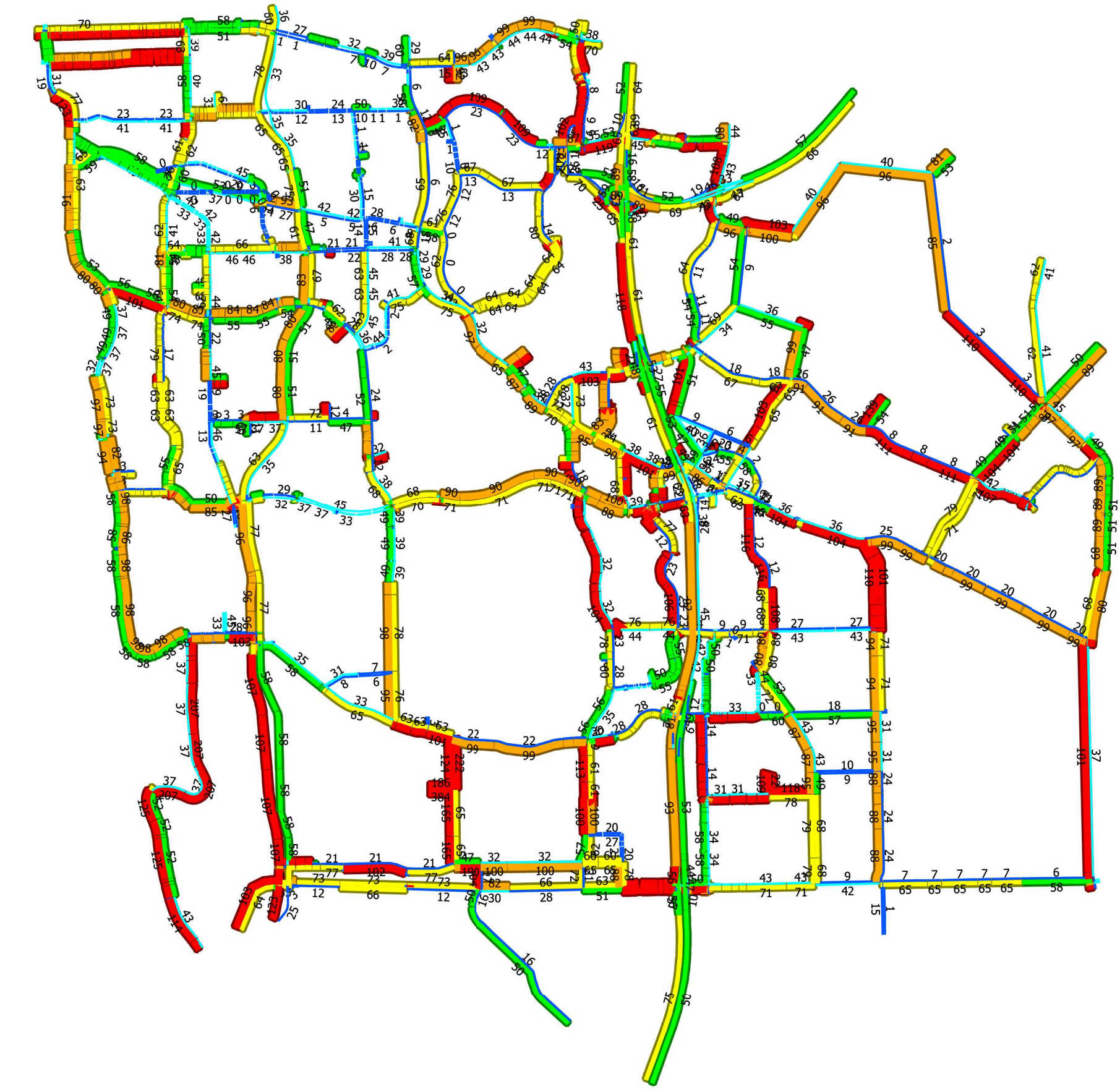


Figure 29 - Do Something - Volume Capacity Ratio – AM Peak, year 2031

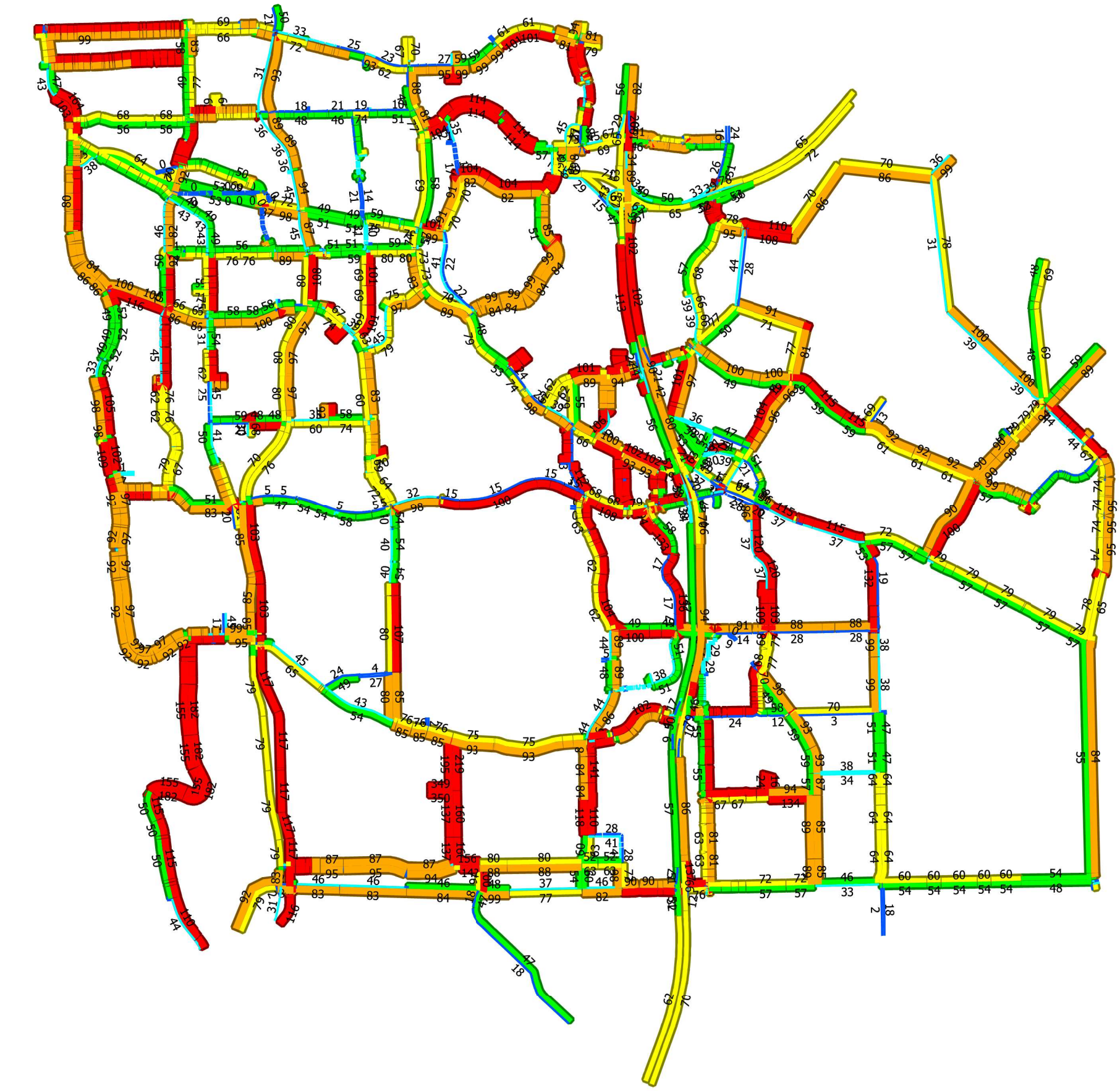


Figure 30 - Do Something - Volume Capacity Ratio – PM Peak, year 2031

6.4 Average daily traffic

Average daily traffic has been calculated using AM and PM volumes. The peak hour analysis has been more meaningful in order to assess the impacts of the proposed road improvements. However, average daily traffic has been calculated for all corridors where significant improvements are planned in order to see the daily magnitude of traffic as shown in Table 22. The average daily traffic results have been shown for all modelled years and following scenarios:

1. Do Nothing scenario – network without any road upgrades, and
2. Do Something scenarios – network with planned upgrades.

Table 22 shows general increase in average daily traffic on several sections were upgrades are planned. However, roads such as Polletti Road shows much higher traffic volumes in the future, which are due to future demographic growth within that area.

Table 22 – Average 5-day daily traffic comparison between various scenarios between year 2016 and 2031

	Sections	Direction	AWDT				
			Do Nothing Average	Do Nothing Average	Do Nothing Average	Do Something Average	Do Something Average
Road Network Upgrade			2016	2021	2031	2021	2031
Rockingham Road – Phoenix Road to Spearwood Avenue reduction (1 lane each way)	Phoenix Road to Spearwood Ave	Northbound	10,300	11,900	16,900	10,700	9,400
		Southbound	9,300	12,100	18,600	11,300	9,800
Spearwood Avenue - Barrington Street to Beeliar Drive (bridge / 2nd c/w)	Beeliar Drive to Mainsail Terrace	Northbound	9,400	10,800	10,900	11,200	14,500
		Southbound	12,400	11,700	10,600	10,500	11,700
	Mainsail Terrace to Yangebup Road	Northbound	6,000	8,800	9,100	10,200	12,900
		Southbound	8,400	8,200	7,300	8,300	8,700
	Yangebup Road to Barrington Street	Northbound	12,800	12,200	15,000	13,200	16,900
		Southbound	14,000	9,100	7,200	9,600	10,400
Spearwood Avenue – Beeliar Drive to Fancote Avenue (construct 2nd c/w)	Beeliar Drive to Fancote Avenue	Northbound	2,400	6,300	8,700	6,300	8,300
		Southbound	2,100	6,300	11,700	6,900	9,400
Henderson Road – Fancote Avenue to Russell Road (widen and upgrade 1 c/w)	Russell Road to Holmes Road	Northbound	2,700	7,200	8,500	6,500	8,100
		Southbound	2,600	6,400	9,900	6,500	8,300
	Holmes Road to Fancote Avenue	Northbound	2,400	6,300	8,700	6,300	8,300
		Southbound	2,100	6,300	11,700	6,900	9,400
Beeliar Drive – Fawcett Road to Stock Road (reconstruction)	Fawcett Road to Rockingham Road	Eastbound	4,100	6,400	10,200	6,600	5,800
		Westbound	4,500	7,700	11,700	7,700	9,400
	Rockingham Road to Stock Road	Eastbound	6,200	6,200	7,200	6,300	7,600
		Westbound	6,500	5,600	7,600	6,700	11,100
North Lake Road – Kentucky Court to Kwinana Freeway (construct 2 c/ws)	Kentucky Court to Kwinana Freeway	Eastbound	Not in Model	Not in Model	Not in Model	14,500	15,400
		Westbound	Not in Model	Not in Model	Not in Model	20,700	22,700
North Lake Road – Extend from Kwinana Freeway to Armadale Road (land, bridge, construct 2 c/ws, & traffic signals)	Kwinana Freeway to Armadale Road	Eastbound	Not in Model	Not in Model	Not in Model	13,400	16,900
		Westbound	Not in Model	Not in Model	Not in Model	12,200	14,700
Verde Drive – Biscayne Way to Solomon Road (land & construct 1 c/w)	Biscayne Way to Solomon Road	Northbound	Not in Model	Not in Model	Not in Model	8,300	11,900
		Southbound	Not in Model	Not in Model	Not in Model	6,400	7,900
Verve Drive – Solomon Road to North Lake Road (land & construct 1 c/w)	Solomon Road to North Lake Road	Northbound	Not in Model	Not in Model	Not in Model	13,700	16,400
		Southbound	Not in Model	Not in Model	Not in Model	7,900	11,200

Road Network Upgrade	Sections	Direction	AWDT				
			Do Nothing Average	Do Nothing Average	Do Nothing Average	Do Something Average	Do Something Average
			2016	2021	2031	2021	2031
Prinsep Road – Cutler Road to Verde Drive (construct 1 c/w)	Cutler Road to Verde Drive	Northbound	Not in Model	Not in Model	Not in Model	6,100	6,700
		Southbound	Not in Model	Not in Model	Not in Model	5,000	5,400
Midgegooroo Avenue – Beeliar Drive to North Lake Road (reduce to 2 lanes)	Beeliar Drive to Signal Terrace	Northbound	10,000	26,600	28,700	21,000	14,700
		Southbound	8,000	14,900	15,100	16,800	11,700
	Signal Terrace to North Lake Road	Northbound	8,900	22,700	24,800	19,100	12,800
		Southbound	7,600	13,100	13,000	17,000	12,100
Poletti Road – Beeliar Drive to North Lake Road (construct 2nd c/w & traffic signals)	Beeliar Drive to Cooper Road	Northbound	7,400	6,600	8,300	2,500	4,200
		Southbound	3,500	25,200	17,000	23,700	14,300
	Cooper Road to Davison Road	Northbound	4,200	19,300	15,000	20,500	17,600
		Southbound	2,800	41,200	29,300	41,300	30,900
	Davison Road to North Lake Road	Northbound	4,200	19,300	15,000	20,500	17,600
		Southbound	2,800	41,200	29,300	41,700	31,300
Semple Court – North Lake Road to Jindabyne Heights (land / construct & re-align c/w)	North Lake Road to Muriel Court	Northbound	3,800	6,900	10,400	5,000	8,300
		Southbound	3,600	6,600	8,300	5,200	5,600
	Muriel Court to Berrigan Drive	Northbound	4,800	5,200	8,400	4,800	8,000
		Southbound	1,100	4,500	5,500	4,800	5,000
Hammond Road – Branch Circus to Bartram Road (construct 2nd c/w & upgrade verge)	Bartram Road to Branch Circus	Northbound	6,000	10,300	12,100	9,200	13,500
		Southbound	4,800	6,500	9,000	7,300	11,100
Hammond Road – Gaebler Road to Frankland Avenue (construct 1 c/w)	Frankland Avenue to Gaebler Road	Northbound	1,500	4,700	3,000	11,000	9,000
		Southbound	700	4,100	4,500	2,300	2,100
Hammond Road – Frankland Avenue to Rowley Road (construct 1 c/w)	Rowley Road to Wattleup Road	Northbound	2,700	8,200	9,600	5,300	8,700
		Southbound	2,800	4,300	9,900	5,700	8,400
	Wattelup Road to Frankland Avenue	Northbound	1,500	4,700	3,000	3,800	2,900
		Southbound	700	4,100	4,500	2,300	2,100
Hammond Road – Beeliar Drive to North Lake Road (construct second c/w)	Beeliar Drive to Blackly Row	Northbound	5,600	3,600	4,500	4,000	5,900
		Southbound	6,300	4,900	5,300	6,000	9,400
	Blackly Row to North Lake Road	Northbound	7,200	9,800	12,000	12,900	19,300
		Southbound	7,600	8,700	8,900	11,100	16,300
Hammond Road – North Lake Road to Berrigan Drive (construct 1 c/w)	North Lake Road to Berrigan Drive	Northbound	Not in Model	Not in Model	Not in Model	Not in Model	6,300
		Southbound	Not in Model	Not in Model	Not in Model	Not in Model	7,500
Pilatus Street – Berrigan Drive to airport boundary (construct 2nd c/w)	Berrigan Drive to Airport Boundary	Northbound	Not in Model	Not in Model	Not in Model	13,700	17,700
		Southbound	Not in Model	Not in Model	Not in Model	7,200	9,400
Jandakot Road – Berrigan Drive to Solomon Road (land & construct 2 c/w)	Solomon Road to Berrigan Drive	Eastbound	8,100	6,700	14,000	6,500	10,400
		Westbound	9,300	11,400	14,800	9,500	11,800
Jandakot Road – Solomon Road to Fraser Road (construct 2nd c/w)	Fraser Road to Solomon Road	Eastbound	6,200	6,200	9,700	8,600	12,800
		Westbound	6,800	9,100	12,100	12,400	15,000
Jandakot Road – Fraser Road to Warton Road (land & construct 2 c/w)	Warton Road to Fraser Road	Eastbound	6,500	5,300	6,300	6,700	8,000
		Westbound	6,300	8,000	10,400	13,000	16,500
Russell Road - Hammond Road to Henderson Road (land & construct 2 c/w)	Henderson Road to Pearse Road	Eastbound	7,900	14,000	22,000	12,000	21,900
		Westbound	9,200	20,400	26,400	17,600	32,800

Road Network Upgrade	Sections	Direction	AWDT				
			Do Nothing Average	Do Nothing Average	Do Nothing Average	Do Something Average	Do Something Average
			2016	2021	2031	2021	2031
	Pearse Road to Hammond Road	Eastbound	6,500	10,900	8,300	9,500	12,000
		Westbound	9,200	18,200	22,700	18,200	34,800
Russell Road – Henderson Road to Rockingham Road (land & construct 2 c/w)	Rockingham Road to Holmes Road	Eastbound	5,600	7,000	11,200	4,800	12,300
		Westbound	6,000	10,900	17,700	8,100	23,500
	Holmes Road to Henderson Road	Eastbound	5,500	6,900	10,000	4,700	11,900
		Westbound	5,900	10,200	14,900	7,900	20,900
Rowley Road – Hammond Road to Kwinana Freeway (land & construct 1 c/w)	Hammond Road to Kwinana Freeway	Eastbound	2,800	4,400	10,000	10,700	23,000
		Westbound	3,200	9,700	11,400	11,300	28,000
Rowley Road – Hammond Road to ~1.2km west of Hammond Road	Hammond Road to Rockingham Road	Eastbound	Not in Model	Not in Model	Not in Model	4,900	14,600
		Westbound	Not in Model	Not in Model	Not in Model	4,900	15,200
Karel Avenue – Berrigan Drive to Farrington Street (construct 2nd c/w)	Berrigan Drive to Roe Highway	Northbound	14,700	13,900	17,600	21,500	27,400
		Southbound	6,400	19,100	20,700	14,100	17,800
	Roe Highway Bridge	Northbound	12,300	17,200	25,200	19,900	24,300
		Southbound	7,100	18,300	21,000	12,100	14,100
	Roe Highway to Farrington Street	Northbound	9,900	10,800	16,100	12,100	15,100
		Southbound	9,900	9,600	10,000	7,900	11,700
Cockburn Road - Rockingham Road South to Rockingham Road North	Rockingham Road South to Nautical Drive	Northbound	5,900	6,200	8,100	6,200	8,100
		Southbound	7,400	6,900	8,500	6,800	8,300
	Nautical Drive to Russell Road	Northbound	4,700	9,500	14,200	9,600	9,200
		Southbound	5,400	19,500	24,800	19,500	19,300
	Russell Road to Mayor Road	Northbound	6,000	7,800	12,900	7,400	10,600
		Southbound	5,700	10,900	15,600	11,100	14,500
	Mayor Road to Spearwood Avenue	Northbound	8,500	10,700	12,800	9,000	13,800
		Southbound	7,500	10,600	13,100	9,900	13,300
	Spearwood Avenue to Rockingham Road North	Northbound	9,700	12,500	16,500	11,600	24,000
		Southbound	9,300	13,100	18,600	12,800	24,800
Stock Road - Rockingham Road to Garling Street	Rockingham Road to Beeliar Drive	Northbound	13,400	20,200	24,700	19,000	25,400
		Southbound	13,800	23,400	32,900	23,000	27,100
	Beeliar Drive to Barrington Street	Northbound	14,000	22,700	23,300	13,500	19,000
		Southbound	11,900	19,100	22,300	15,800	15,800
	Barrington Street to Spearwood Avenue	Northbound	16,900	24,400	23,000	17,900	22,700
		Southbound	14,900	22,700	23,800	21,600	21,300
	Spearwood Avenue to Phoenix Road	Northbound	16,300	22,300	24,000	16,700	23,000
		Southbound	14,800	26,500	29,900	24,500	25,700
	Phoenix Road to Forrest Road	Northbound	17,000	15,300	19,000	8,800	14,700
		Southbound	14,900	21,600	25,200	18,300	19,300
	Forrest Road to Winterfold Road	Northbound	16,300	13,100	19,200	7,700	13,700
		Southbound	13,200	18,900	23,600	14,400	17,300

Road Network Upgrade	Sections	Direction	AWDT				
			Do Nothing Average	Do Nothing Average	Do Nothing Average	Do Something Average	Do Something Average
			2016	2021	2031	2021	2031
	Winterfold Road to South Street	Northbound	16,500	11,900	15,700	9,300	14,300
		Southbound	14,300	17,100	19,700	13,800	17,300
	South Street to Garling Street	Northbound	9,800	9,000	10,700	8,900	10,500
		Southbound	8,900	10,500	12,100	11,200	12,800

7 Implementation plan

The resulting implementation plan from the analysis combines the initial road network assumptions advice supplied by the City of Cockburn, outcomes of the modelling analysis and further work required to better understand the transport system. This chapter shows detailed analysis for each planned road improvement for all scenarios. The outcomes of the analysis have already been detailed in Section 6.2 and 6.3.

Table 23 - Road network action plan as a result of modelling

Implementation Plan	Planned Upgrade				Sections		Planned Upgrades Based on Modelling Results		Do Nothing AM		Do Nothing PM		Do Nothing AM		Do Nothing PM		Do Nothing AM		Do Nothing PM		Do Something AM		Do Something PM		Do Something AM		Do Something PM	
	City of Cockburn		Main Roads				by 2021	by 2031	2016		2016		2021		2021		2031		2031		2021		2021		2031		2031	
Road Network Upgrade	2021	2031	2021	2031		Direction			Volume	VCR	Volume	VCR	Volume	VCR	Volume	VCR	Volume	VCR	Volume	VCR	Volume	VCR	Volume	VCR	Volume	VCR [%]	Volume	VCR
Rockingham Road – Phoenix Road to Spearwood Avenue reduction (1 lane each way)	✓	✓	✓	✓	Phoenix Road to Spearwood Ave	Northbound	x	x	1,701	47	1,268	35	1,796	50	1,700	47	2,659	74	1,980	55	1,611	45	1,555	43	1,421	79	1,351	75
						Southbound	x	upgrade	800	22	1,642	46	818	23	2,524	70	1,000	28	3,690	103	843	23	2,261	63	798	44	1,827	102
Spearwood Avenue - Barrington Street to Beeliar Drive (bridge / 2nd c/w)	✓	✓			Beeliar Drive to Mainsail Terrace	Northbound	upgrade	upgrade	1,680	105	1,180	74	1,606	100	1,684	105	1,633	102	1,682	105	1,351	42	2,227	70	2,182	68	2,291	72
						Southbound	upgrade	upgrade	992	62	1,880	117	1,554	97	1,363	85	1,393	87	1,662	104	1,219	38	1,682	53	1,215	38	2,051	64
					Mainsail Terrace to Yangebup Road	Northbound	upgrade	upgrade	385	24	1,359	85	1,183	74	1,408	88	1,157	72	1,413	88	1,246	39	2,006	63	1,963	61	1,994	62
						Southbound	upgrade	upgrade	1,201	75	553	35	542	34	1,498	94	290	18	1,832	114	524	16	1,872	58	369	12	2,193	69
					Yangebup Road to Barrington Street	Northbound	upgrade	upgrade	2,295	143	1,305	82	1,760	110	1,752	110	2,557	160	1,785	112	2,013	63	2,058	64	2,955	92	2,089	65
						Southbound	upgrade	upgrade	1,115	62	2,226	124	450	25	1,881	105	208	12	2,301	128	494	15	2,296	72	327	10	2,755	86
Spearwood Avenue – Beeliar Drive to Fancote Avenue (construct 2nd c/w)	✓	✓			Beeliar Drive to Fancote Avenue	Northbound	x	upgrade	574	41	203	15	1,064	76	740	53	1,410	101	934	67	1,042	37	874	31	1,379	49	1,118	40
						Southbound	upgrade	upgrade	81	6	432	31	722	52	1,190	85	1,249	89	1,654	118	727	26	1,188	42	1,098	39	1,500	54
Henderson Road – Fancote Avenue to Russell Road (widen and upgrade 1 c/w)		✓			Russell Road to Holmes Road	Northbound	upgrade	upgrade	763	54	204	15	1,243	89	817	58	1,549	111	992	71	1,050	75	916	65	1,326	95	1,121	80
						Southbound	x	upgrade	88	6	632	45	716	51	1,183	85	1,111	79	1,398	100	669	48	1,153	82	1,061	76	1,187	85
					Holmes Road to Fancote Avenue	Northbound	x	upgrade	574	41	203	15	1,064	76	740	53	1,410	101	934	67	1,042	74	874	62	1,379	98	1,118	80
						Southbound	upgrade	upgrade	81	6	432	31	722	52	1,190	85	1,249	89	1,654	118	727	52	1,188	85	1,098	78	1,500	107
Beeliar Drive – Fawcett Road to Stock Road (reconstruction)	✓	✓			Fawcett Road to Rockingham Road	Eastbound	x	x	474	30	593	37	1,130	71	763	48	1,043	65	1,153	72	1,166	73	668	42	801	50	815	51
						Westbound	x	upgrade	611	38	657	41	1,055	66	1,205	75	1,376	86	1,617	101	1,023	64	1,193	75	1,360	85	1,330	83
					Rockingham Road to Stock Road	Eastbound	x	x	778	49	894	56	1,200	75	640	40	1,051	66	707	44	1,301	81	437	27	1,599	100	506	32
						Westbound	x	upgrade	863	54	804	50	428	27	1,263	79	464	29	1,504	94	687	43	1,281	80	1,280	80	1,956	122
North Lake Road – Kentucky Court to Kwinana Freeway (construct 2 c/ws)		✓	✓	✓	Kentucky Court to Kwinana Freeway	Eastbound	x	x													577	16	4,151	115	1,002	28	3,760	104
						Westbound	x	x													3,211	89	2,626	73	3,579	99	2,838	79
North Lake Road – Extend from Kwinana Freeway to Armadale Road (land, bridge, construct 2 c/ws, & traffic signals)		✓	✓	✓	Kwinana Freeway to Armadale Road	Eastbound	x	x													584	16	3,762	104	1,192	33	3,962	110
						Westbound	x	x													1,885	52	1,543	43	2,192	61	1,923	53
Verde Drive – Biscayne Way to Solomon Road (land & construct 1 c/w)	✓	✓	✓	✓	Biscayne Way to Solomon Road	Northbound	x	x													1,445	40	539	15	2,089	58	747	21
						Southbound	x	x													48	1	1,492	41	78	2	1,846	51
Verve Drive – Solomon Road to North Lake Road (land & construct 1 c/w)	✓	✓	✓	✓	Solomon Road to North Lake Road	Northbound	x	x													1,651	46	2,093	58	2,137	59	2,266	63
						Southbound	x	x													991	28	1,175	33	1,287	36	1,752	49
Prinsep Road – Cutler Road to Verde Drive (construct 1 c/w)	✓	✓			Cutler Road to Verde Drive	Northbound	x	x													761	42	900	50	850	47	954	53
						Southbound	x	x													625	35	734	41	595	33	859	48
Midgegooroo Avenue – Beeliar Drive to North Lake Road (reduce to 2 lanes)		✓			Beeliar Drive to Signal Terrace	Northbound	upgrade	upgrade	1,543	43	1,559	43	3,922	109	4,242	118	4,588	127	4,406	122	2,628	73	3,798	106	1,847	103	2,636	146
						Southbound	x	x	859	24	1,158	32	1,407	39	2,391	66	1,562	43	1,893	53	2,723	76	1,006	28	1,804	100	912	51
					Signal Terrace to North Lake Road	Northbound	upgrade	upgrade	1,458	40	1,322	37	3,780	105	3,094	86	4,359	121	3,264	91	2,579	72	3,284	91	1,792	100	2,152	120
						Southbound	x	x	719	20	1,388	39	1,006	28	2,469	69	1,014	28	2,124	59	2,416	67	1,718	48	1,430	79	1,801	100
Poletti Road – Beeliar Drive to North Lake Road (construct 2nd c/w & traffic signals)	✓	✓			Beeliar Drive to Cooper Road	Northbound	x	x	1,417	51	672	24	2	0	451	16	112	4	1,058	38	10	0	617	22	169	6	981	35
						Southbound	upgrade	upgrade	255	18	594	42	1,708	122	5,515	394	878	63	4,043	289	1,534	55	5,369	192	818	29	3,508	125
					Cooper Road to Davison Road	Northbound	upgrade	upgrade	808	58	655	47	1,605	115	4,043	289	1,767	126	2,927	209	1,907	68	4,189	150	1,918	69	3,466	124
						Southbound	upgrade	upgrade	248	18	350	25	4,866	348	3,590	256	3,366	240	2,681	191	4,829	172	3,751	134	3,535	126	2,999	107
					Davison Road to North Lake Road	Northbound	upgrade	upgrade	808	58	655	47	1,605	115	4,043	289	1,767	126	2,927	209	1,907	68	4,189	150	1,918	69	3,466	124
						Southbound	upgrade	upgrade	348	25	350	25	4,935	353	3,590	256	3,440	246	2,681	191	4,898	175	3,751	134	3,609	129	2,999	107
Semple Court – North Lake Road to Jindabyne Heights (land / construct & re-align c/w)		✓			North Lake Road to Muriel Court	Northbound	upgrade	upgrade	808	58	557	40	560	40	1,595	114	1,319	94	1,857	133	276	20	1,329	95	1,165	83	1,487	106
						Southbound	x	upgrade	470	34	836	60	1,108	79	799	57	1,551	111	801	57	824	59	776	55	1,150	82	540	39
					Muriel Court to Berrigan Drive	Northbound	x	upgrade	417	30	734	52	944	67	837	60	1,384	99	1,334	95	941	67	592	42	1,168	83	1,383	99
						Southbound	x	x	109	8	258	18	1,044	75	498	36	927	66	995	71	968	69	492	35	376	27	1,244	89
Hammond Road – Branch Circus to Bartram Road (construct 2nd c/w & upgrade verge)	✓	✓			Bartram Road to Branch Circus	Northbound	upgrade	upgrade	1,597	100	721	45	2,246	140	1,374	86	3,130	196	1,696	106	1,692	106	1,596	100	3,323	104	1,985	62
						Southbound	upgrade	upgrade	413	26	1,369	86	756	47	1,856	116	983	61	2,438	152	855	53	1,665	104	1,018	32	3,320	208
Hammond Road – Gaebler Road to Frankland Avenue (construct 1 c/w)	✓	✓	✓	✓	Frankland Avenue to Gaebler Road	Northbound	x	x	52	4	350	29	781	65	853	71	542	45	585	49	1,660	139	2,053	147	1,404	100	1,649	118
						Southbound	x	upgrade	81	7	84	7	465	39	710	59	490	41	1,122	94	241	17	630	45	286	20	397	28
Hammond Road – Frankland Avenue to Rowley Road (construct 1 c/w)	✓	✓			Rowley Road to Wattleup Road	Northbound	upgrade	upgrade	714	51	472	34	1,385	99	1,491	106	1,846	132	1,616	115	801	50	998	62	1,403	88	1,575	98
						Southbound	upgrade	upgrade	292	21	703	50	234	17	1,375	98	868	62	1,698	121	803	50	950	59	1,243	78	1,225	77
					Wattelup Road to Frankland Avenue	Northbound	x	x	52	4	350	29	781	65	853	71	542	45	585	49	479	34	737	53	372	27	574	41
						Southbound	x	upgrade	81	7	84	7	465	39	710	59	490	41	1,122	94	241	17	630	45	286	20	397	28
Hammond Road – Beeliar Drive to North Lake Road (construct second c/w)	✓	✓		✓	Beeliar Drive to Blackly Row	Northbound	upgrade	upgrade	1,590	99	601	38	2,295	143	74	5	2,688	168	100	6	2,255	141	42	3	3,242	101	103	3
						Southbound	upgrade	upgrade	1,139	71	1,399	87	48	3	3,205	200	68	4	3,650	228	51	3	3,161	198	569	18	3,589	112
					Blackly Row to North Lake Road	Northbound	upgrade	upgrade	324	20	1,591	99	645	40	2,903	181	876	55	3,424	214	647	40	2,958	185	1,678	52	4,121	129
						Southbound	upgrade	upgrade	1,526	95	514	32	2,111	132	211	13	2,274	142	92	6	2,156	135	253	16	3,024	95	725	23
Hammond Road – North Lake Road to Berrigan Drive (construct 1 c/w)		✓			North Lake Road to Berrigan Drive	Northbound	x	x																	582	32	1,425	79
						Southbound	x	x																	1,307	73	993	55
Pilatus Street – Berrigan Drive to airport boundary (construct 2nd c/w)		✓	✓	✓	Berrigan Drive to Airport Boundary	Northbound	x	x													1,726	48	2,247	62	2,480	69	2,767	77
						Southbound	x	x													847	24	1,463	41	1,209	34	1,806	50
Jandakot Road – Berrigan Drive to Solomon Road (land & construct 2 c/w)	✓	✓	✓	✓	Solomon Road to Berrigan Drive	Eastbound	upgrade	upgrade	652	41	1,683	105	251	16	1,723	108	204	13	2,123	133	137	4	2,582	81	582	18	3,185	100
						Westbound	upgrade	upgrade	1,615	101	1,122	70	1,643	103	1,603	100	2,047	128	1,790	112	1,733	54	1,261	39	2,131	67	1,559	49
Jandakot Road – Solomon Road to Fraser Road (construct 2nd c/w)	✓	✓	✓	✓	Fraser Road to Solomon Road	Eastbound	upgrade	upgrade	472	30	1,639	102	102	6	2,188	137	151	9	2,737	171	287	9	3,154	99	818	26	3,681	115
						Westbound	upgrade	upgrade	1,499	94	693	43	2,066	129	775	48	2,823	176	1,016	64	2,823	88	1,422	44	2,927	91	1,903	59
Jandakot Road – Fraser Road to Warton Road (land & construct 2 c/w)		✓	✓	✓	Warton Road to Fraser Road	Eastbound	upgrade	upgrade	415	26	1,480	92	76	5	1,732	108	68	4	1,906	119	124	4	2,691	84	258	8	2,958	92
						Westbound	upgrade	upgrade	1,672	104	688	43	2,571	161	755	47	3,927	245	962	60	3,190	100	1,395	44	3,554	111	1,957	61
Russell Road - Hammond Road to Henderson Road (land & construct 2 c/w)		✓			Henderson Road to Pearse Road	Eastbound	upgrade	upgrade	491	27	1,706	95	1,176	65	1,952	108	2,088	116	2,727	152	1,141	63	1,764	98	2,266	63	2,752	76
						Westbound	upgrade	upgrade	1,772	98	740	41	2,566	143	1,797	100	3,382	188	2,329	129	1,884	105	1,675	93	3,672	102	3,078	85
					Pearse Road to Hammond Road	Eastbound	x	upgrade	600	33	1,279	71	871	48	1,454	81	19	1	2,048	114	873	49	1,459	81	784	22	2,686	75
						Westbound	upgrade	upgrade	1,414	79	842	47	1,812	101	1,746	97	2,299	128	2,097	117	1,661	92	1,806	100	3,569	99	3,354	93
Russell Road – Henderson Road to Rockingham Road (land & construct 2 c/w)		✓			Rockingham Road to Holmes Road	Eastbound	x	x	416	23	1,108	62	466	26	744	41	1,007	56	1,420	79	526	29	543	30	1,256	35	1,609	45
						Westbound	x	upgrade	1,071	60	544	30	1,356	75	1,055	59	1,844	102	1,780	99	797	44	784	44	2,085	58	2,355	65
					Holmes Road to Henderson Road	Eastbound	x	x	402	22	1,074	60	460	26	769	43	977	54	1,330	74	472	26	612	34	1,205	33	1,565	43
						Westbound	x	upgrade	1,010	56	537	30	1,323	73	980	54	1,833	102	1,338	74	834	46	759	42	2,346	65	1,957	54
Rowley Road – Hammond Road to Kwinana Freeway (land & construct 1 c/w)	✓	✓		✓	Hammond Road to Kwinana Freeway	Eastbound	upgrade	upgrade	292	21	703	50	234	17	1,375	98	868	62	1,698	121	1,510	94	1,670	104	3,510	110	2,872	90
						Westbound	upgrade	upgrade	714	51	472	34	1,385	99	1,491	106	1,846	132	1,616	115	1,467	92	1,759	110	3,225	101	4,541	142
Rowley Road – Hammond Road to ~1.2km west of Hammond Road	✓	✓		✓	Hammond Road to Rockingham Road	Eastbound	x	x													707	39	721	40	2,277	63	1,649	46
						Westbound	x	x													666	37	762	42	995	28	2,774	77
Karel Avenue – Berrigan Drive to Farrington Street (construct 2nd c/w)		✓	✓	✓	Berrigan Drive to Roe Highway	Northbound	upgrade	upgrade	1,942	108	1,928	107	2,046	114	2,974	165	2,806	156	3,515	195	3,515	98	3,654	102	4,828	134	4,270	119
						Southbound	upgrade	upgrade	1,555	86	672	37	3,006	167	2,829	157	3,084	171	3,672	204	1,305	36	2,970	83	1,419	39	4,092	114
					Roe Highway Bridge	Northbound	upgrade	upgrade	2,159	120	2,150	119	2,599	144	2,774	154	4,262	237	3,260	181	3,583	100	3,019	84	4,706	131	3,306	92
						Southbound	upgrade	upgrade	1,031	57	698	39	2,423	135	2,385	132	2,618	145	3,199	178	1,497	42	2,034	57	1,786	50	2,303	64
					Roe Highway to Farrington Street	Northbound	upgrade	upgrade	1,406	78	1,703	95	2,038	113	1,309	73	3,254	181	1,216	68	2,747	76	1,179	33	3,877	108	951	26
						Southbound	upgrade	upgrade	1,113	62	1,541	86	419	23	1,779	99	679	38	2,311	128	1,117	31	1,135	32	1,548	43	1,831	51
Cockburn Road - Rockingham Road South to Rockingham Road North	✓	✓			Rockingham Road South to Nauticle Drive	Northbound	upgrade	upgrade	1,498	94	543	34	1,570	98	580	36	1,993	125	805	50	1,570	98	580	36	1,993	125	805	50
						Southbound	upgrade	upgrade	569	36	1,814	113	531	33	1,645	103	837	52	1,840	115	531	33	1,645	103	837	52	1,840	115
	✓	✓			Nauticle Drive to Russell Road	Northbound	upgrade	upgrade	786	49	816	51	780	49	2,426	152	595	37	2,484	155	780	49	2,426	152	595	37	2,484	155
						Southbound	upgrade	upgrade	823	51	811	51	3,370	211	2,914	182	3,309	207	2,916	182	3,370	211	2,914	182	3,309	207	2,916	182
	✓	✓			Russell Road to Mayor Road	Northbound	x	upgrade	992	41	1,130	47	876	36	1,958	82	1,810	75	2,194	91	604	25	1,873	78	1,388	58	2,202	92
						Southbound	x	upgrade	1,127	47	843	35	2,006	84	1,608	67	2,358	98	2,483	103	2,016	84	1,567	65	2,361	98	2,318	97
	✓	✓			Mayor Road to Spearwood Avenue	Northbound	x	upgrade	1,580	66	1,249	52	1,848	77	1,786	74	2,268	95	2,039	85	1,504	63	1,565	65	2,335	97	2,362	98
						Southbound	upgrade	upgrade	899	37	1,474	61	1,202	50	2,182	91	1,727	72	2,371	99	1,166	49	2,005	84	1,762	73	2,516	105
	✓	✓			Spearwood Avenue to Rockingham Road North	Northbound	upgrade	upgrade	1,884	78	1,422	59	2,052	86	2,092	87	2,768	115	2,832	118	1,987	83	1,967	82	4,351	91	3,845	80
						Southbound	upgrade	upgrade	891	37	2,025	84	1,699	71	2,433	101	2,389	100	3,347	139	1,713	71	2,404	100	3,032	63	4,945	103
Stock Road - Rockingham Road to Garling Street	✓	✓			Rockingham Road to Beeliar Drive	Northbound	x	upgrade	2,794	58	2,035	42	3,623	75	3,290	69	4,408	92	3,438	72	3,132	65	3,273	68	4,593	96	4,082	85
						Southbound	upgrade	upgrade	1,879	39	2,705	56	2,926	61	4,176	87	3,440	72	5,591	116	3,094	64	4,267	89	3,691	77	4,947	103
	✓	✓			Beeliar Drive to Barrington Street	Northbound	x	upgrade	2,868	60	1,838	38	3,435	72	4,027	84	4,807	100	4,135	86	1,560	33	2,772	58	3,039	63	3,341	70
						Southbound	x	upgrade	1,345	28	2,728	57	1,825	38	3,803	79	1,613	34	4,925	103	2,008	42	3,114	65	1,678	35	3,654	76
	✓	✓			Barrington Street to Spearwood Avenue	Northbound	upgrade	upgrade	3,596	75	2,379	50	4,353	91	4,175	87	4,872	102	3,933	82	2,558	53	3,351	70	3,846	80	3,837	80
						Southbound	upgrade	upgrade	1,822	38	3,200	67	2,602	54	4,696	98	1,869	39	5,158	107	2,811	59	4,157	87	2,432	51	4,678	97
	✓	✓			Spearwood Avenue to Phoenix Road	Northbound	x	upgrade	3,082	64	2,336	49	4,051	84	3,885	81	4,787	100	4,025	84	2,420	50	3,102	65	3,981	83	3,838	80
						Southbound	upgrade	upgrade	1,672	35	2,972	62	2,881	60	4,728	99	3,089	64	5,437	113	3,304	69	4,536	95	3,207	67	5,194	108
	✓	✓			Phoenix Road to Forrest Road	Northbound	x	upgrade	3,327	69	2,563	53	2,350	49	2,616	54	4,166	87	2,746	57	981	20	1,842	38	2,924	61	2,178	45
						Southbound	x	upgrade	1,731	36	2,995	62	2,213	46	3,979	83	2,631	55	4,794	100	2,319	48	3,649	76	2,238	47	4,178	87
	✓	✓			Forrest Road to Winterfold Road	Northbound	x	upgrade	3,086	64	2,365	49	2,016	42	2,190	46	4,151	86	2,439	51	985	21	1,509	31	3,138	65	1,749	36
						Southbound	x	upgrade	1,290	27	2,976	62	1,495	31	3,742	78	1,946	41	4,689	98	1,418	30	3,538	74	1,685	35	4,289	89
	✓	✓			Winterfold Road to South Street	Northbound	x	upgrade	3,410	71	2,248	47	2,606	54	1,584	33	4,103	85	1,534	32	1,941	40	1,306	27	3,766	78	1,475	31
						Southbound	x	upgrade	1,630	34	2,855	59	1,239	26	3,851	80	1,555	32	4,694	98	1,180	25	3,664	76	1,573	33	4,460	93
	✓	✓			South Street to Garling Street	Northbound	x	x	2,720	57	909	19	2,275	47	963	20	2,893	60	1,015	21	2,275	47	963	20	2,893	60	1,015	21
						Southbound	x	x	1,225	26	1,810	38	1,508	31	2,070	43	1,719	36	2,393	50	1,508	31	2,070	43	1,719	36	2,393	50
						Number of locations with VCR>85%			13		14		30		46		49		61		17		29		31		47	
									92		92		92		92		92		92		106		106		108		108	

8 Additional modelling results

City of Cockburn has requested additional option testing to determine optimal Major Roadworks Plan. Initially, it was determined that two options need to be tested as part of first round of modelling, which are as follows:

1. Cockburn Road widening
2. Stock Road widening

Cockburn Road and Stock Road widening has been tested in order to investigate what potential impacts it may have on the City of Cockburn network. However, those two roads are under Main Road jurisdiction and therefore, this analysis has been done for information only. The results of the additional analysis have been explained in Appendix B.

Results of the first round of modelling was presented to Councillors at briefing meeting in August 2018.

As the result of the presentation, Councillors requested additional option testing which are as follows:

1. Network with/without Roe 9 link and Hammond Road extension
2. Network with/without Rockingham Road duplication
3. Network with/without Farrington Road duplication
4. Network with/without Roe 9 only
5. Network with/without Russell Road duplication
6. Network with Armadale Road widening by 2020
7. Bartram Road link analysis

The outcomes of this analysis have been explained and shown in Appendix C. A further briefing of those results was presented to Councillors in October 2018.

9 Conclusion

The 2018 City of Cockburn District Traffic Study has undertaken a comprehensive review of the traffic demand, current and forecast, in the City of Cockburn local government area. As part of the study the following key outcomes have been achieved:

- Development of AM and PM peak traffic models in Aimsun software for the City of Cockburn Local Government Area consistent with Main Roads ROM24 daily output for external movements. This will provide a valuable tool for future transport and land use planning in the City of Cockburn.
- Demographic data review undertaken to refine AM and PM peak models to provide more accurate forecasting for the local area.
- Validation of link-based traffic volumes to very good levels for peak periods within the City of Cockburn area. This offers the ability for modelling accurate traffic forecasts.
- Forecasts for 2021 (do nothing and City of Cockburn aligned upgrades) and 2031 (City of Cockburn aligned upgrades) forecast years.

The analysis has shown significant increases in traffic demand and travel times without any road network upgrades. Even with the proposed upgrades there are sections which are forecast to operate over the available road network capacity as identified in Section 6. However, despite the increase in demand there will insufficient capacity in upgrading the road network to fully solve congestion due to already constrained network.

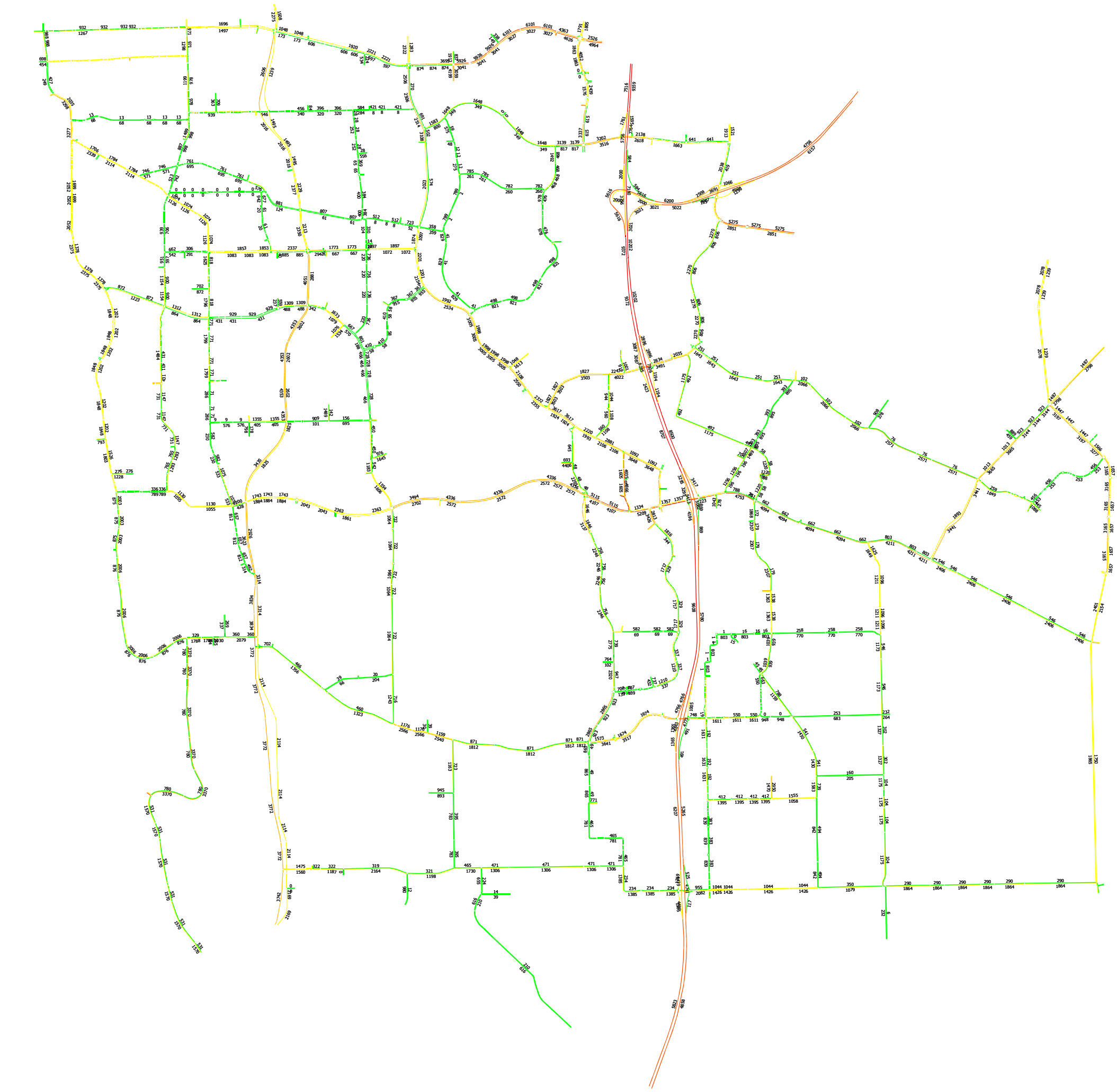
This indicates that additional road network demand management measures will be required beyond road network upgrades similar to what has been identified in the previous Integrated Transport Strategy for the city. These could include but not be limited to the following:

- Public transport improvements to rail and bus routes and infrastructure
- Further encouraging pedestrian and cycle transport modes
- Examining the impact of peak spreading on road infrastructure requirements
- Examining the timing and sequencing of development
- Increasing implementation of Intelligent Transport Systems

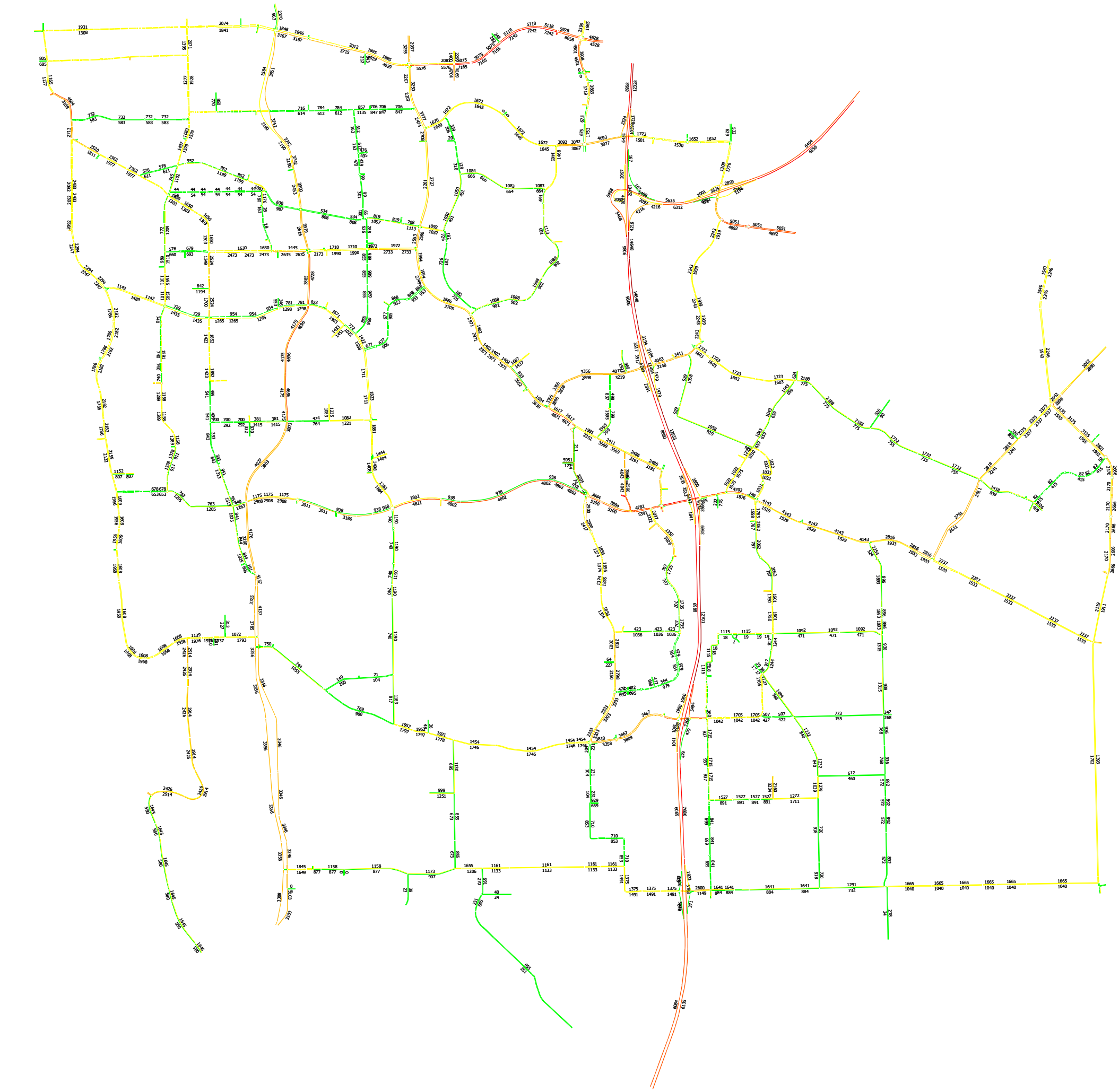
Appendix A

Assigned volumes

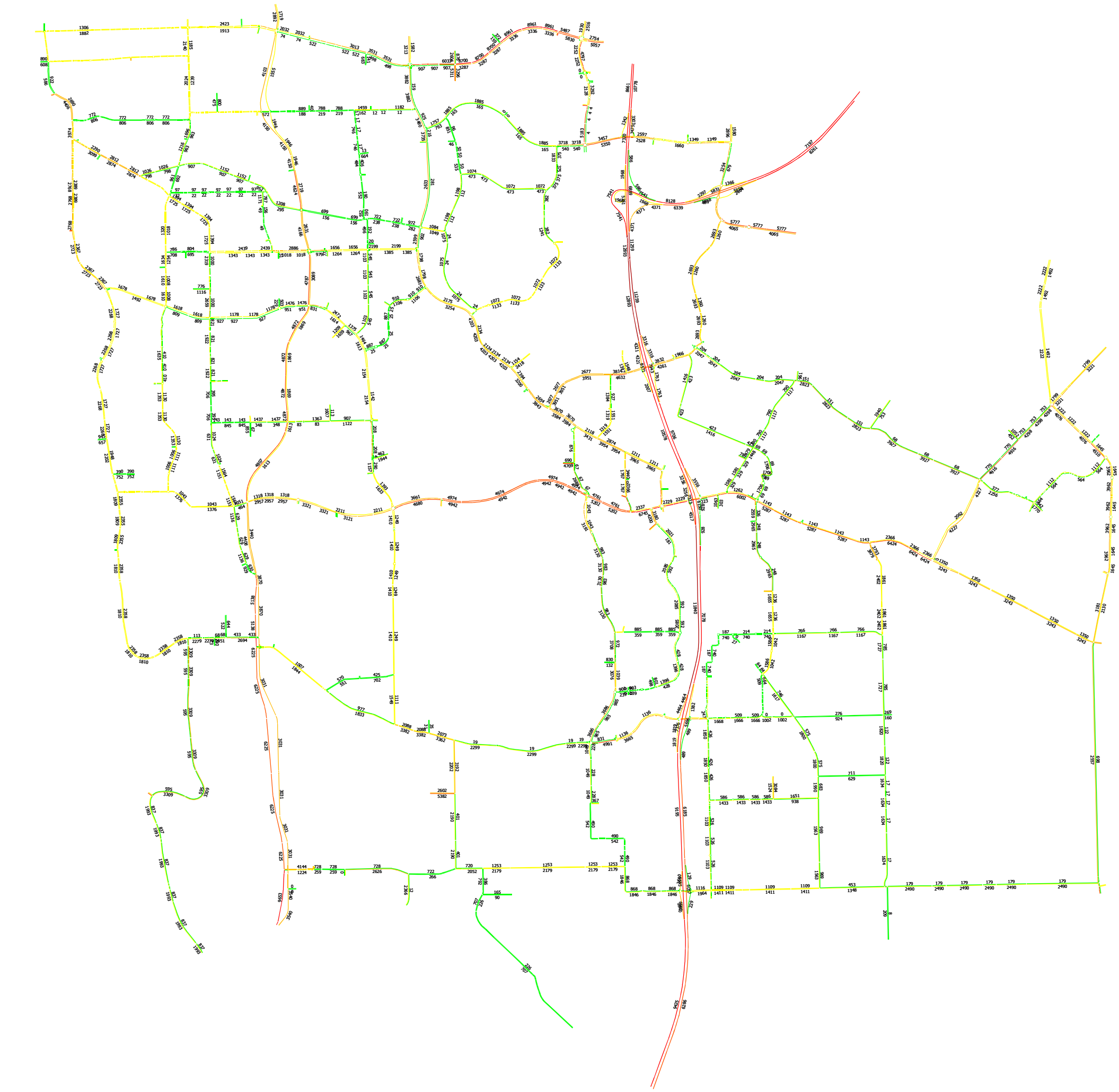
A1 2021 Do Nothing - AM Peak



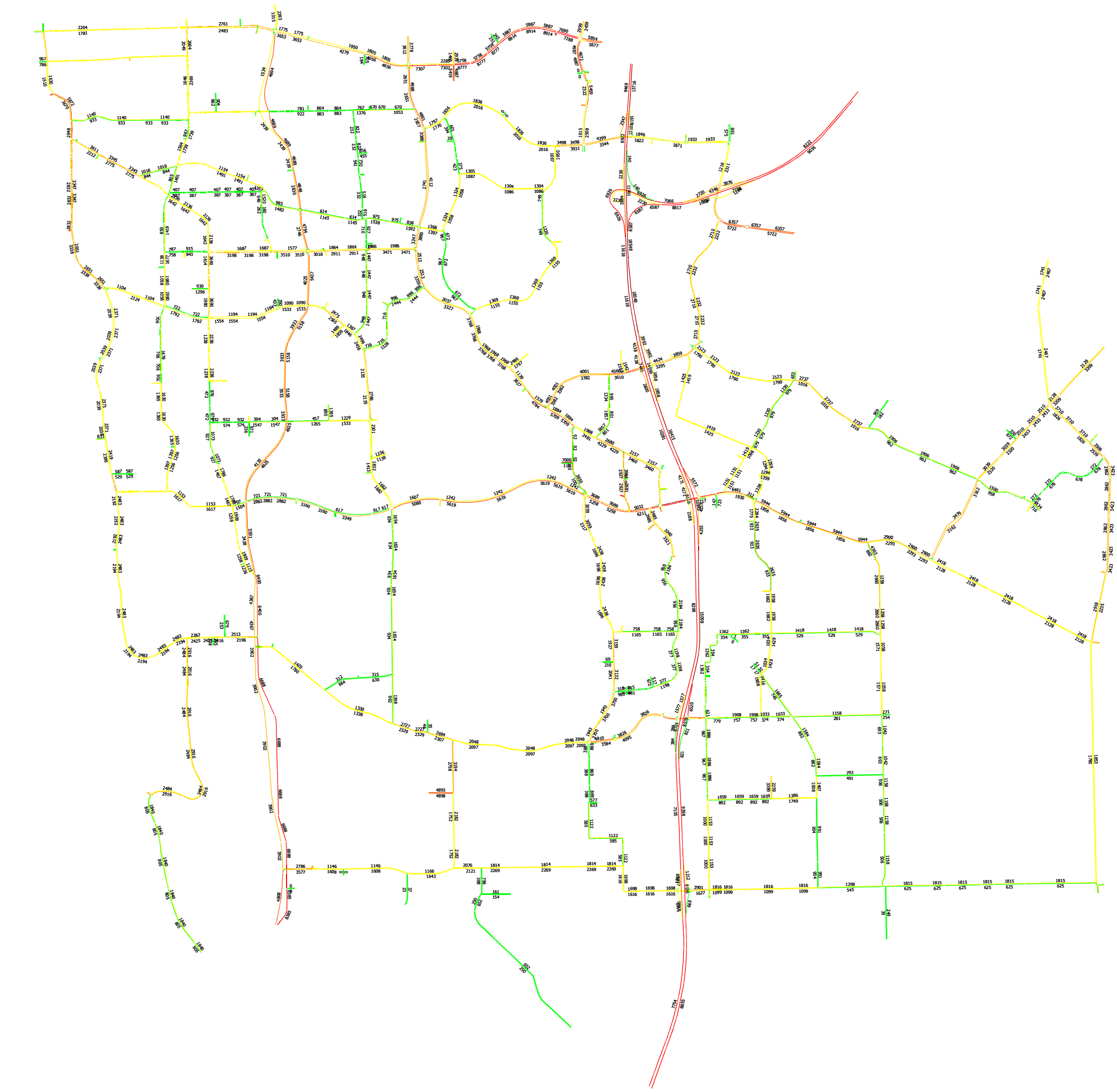
A2 2021 Do Nothing - PM Peak



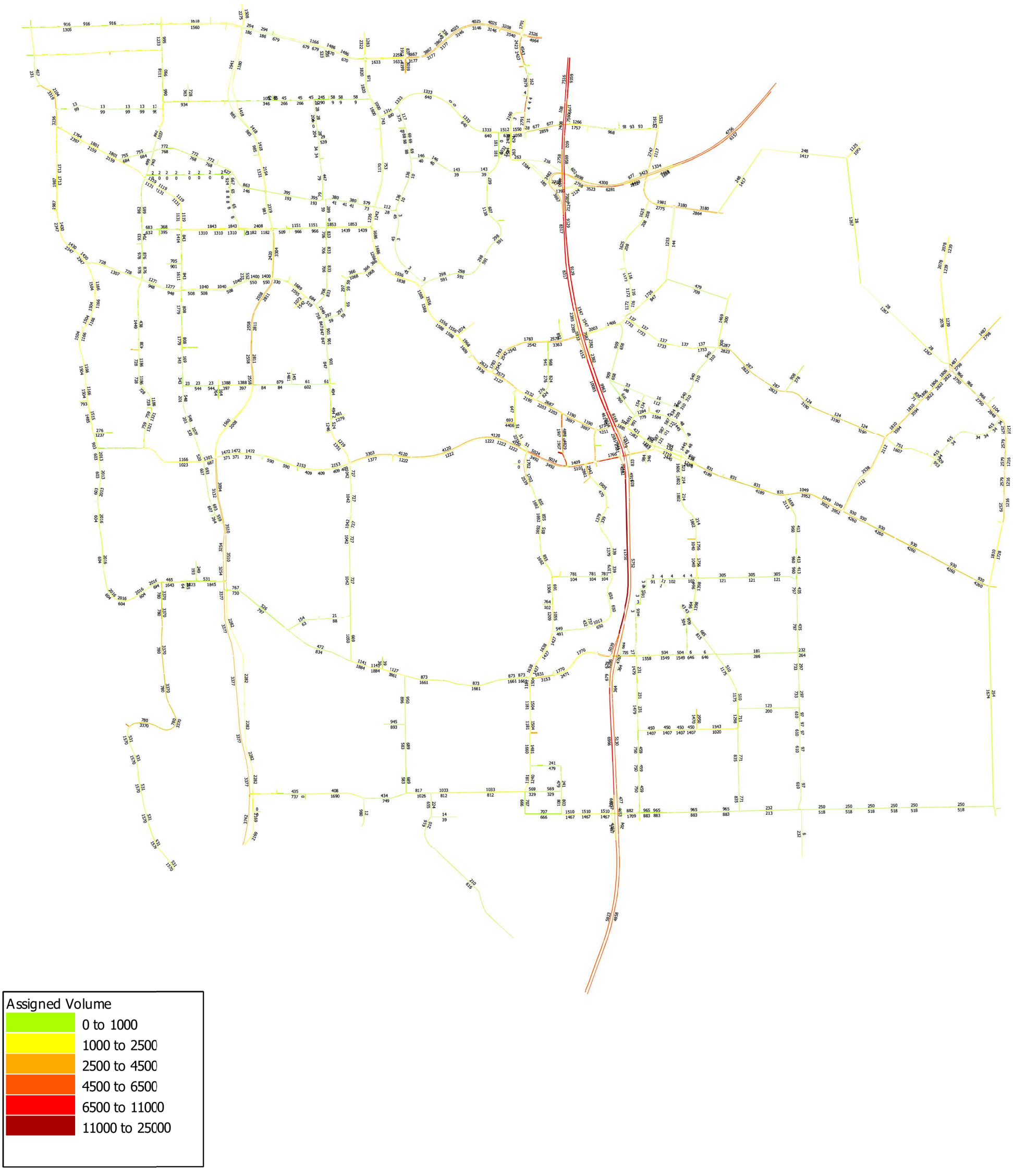
A3 2031 Do Nothing - AM Peak



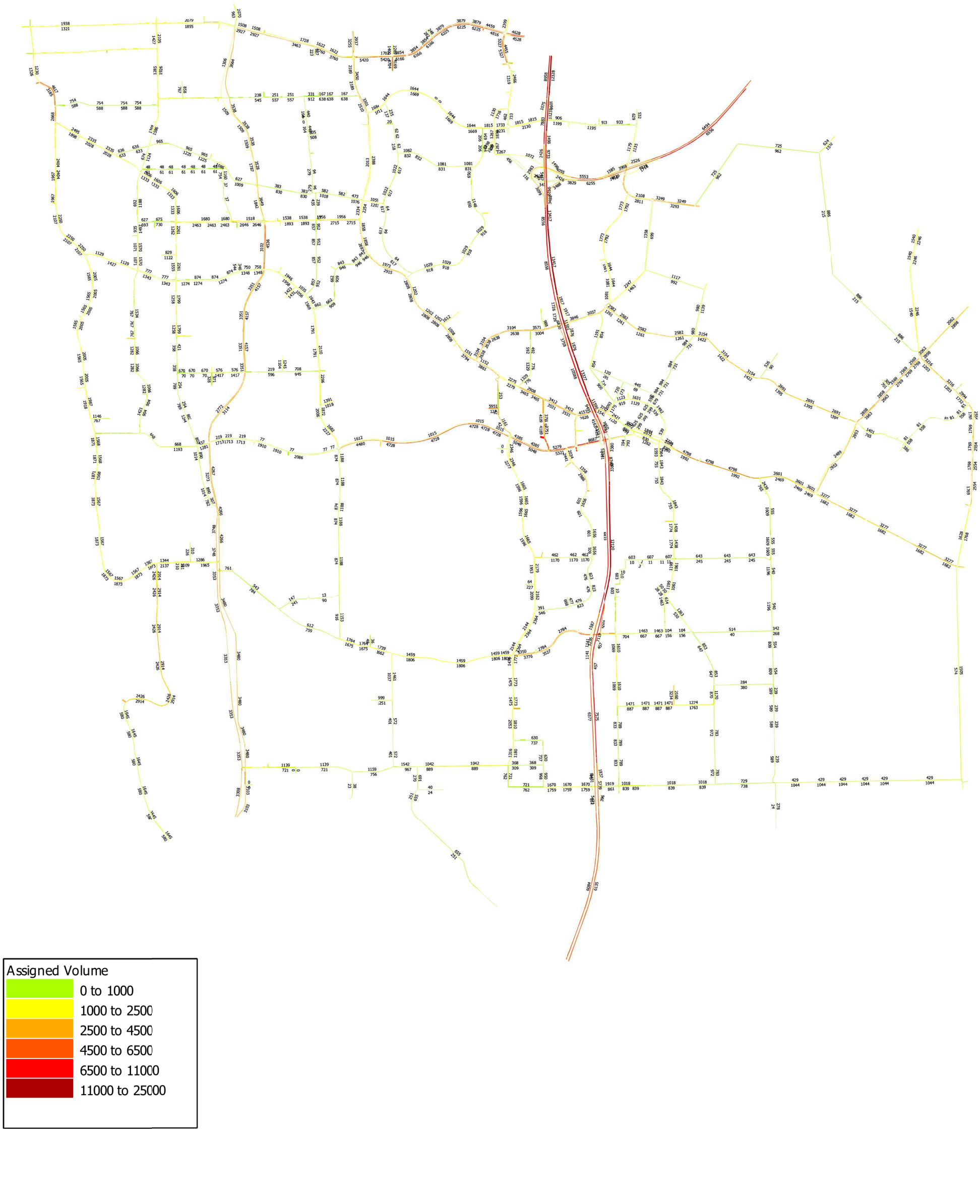
A4 2031 Do Nothing - PM Peak



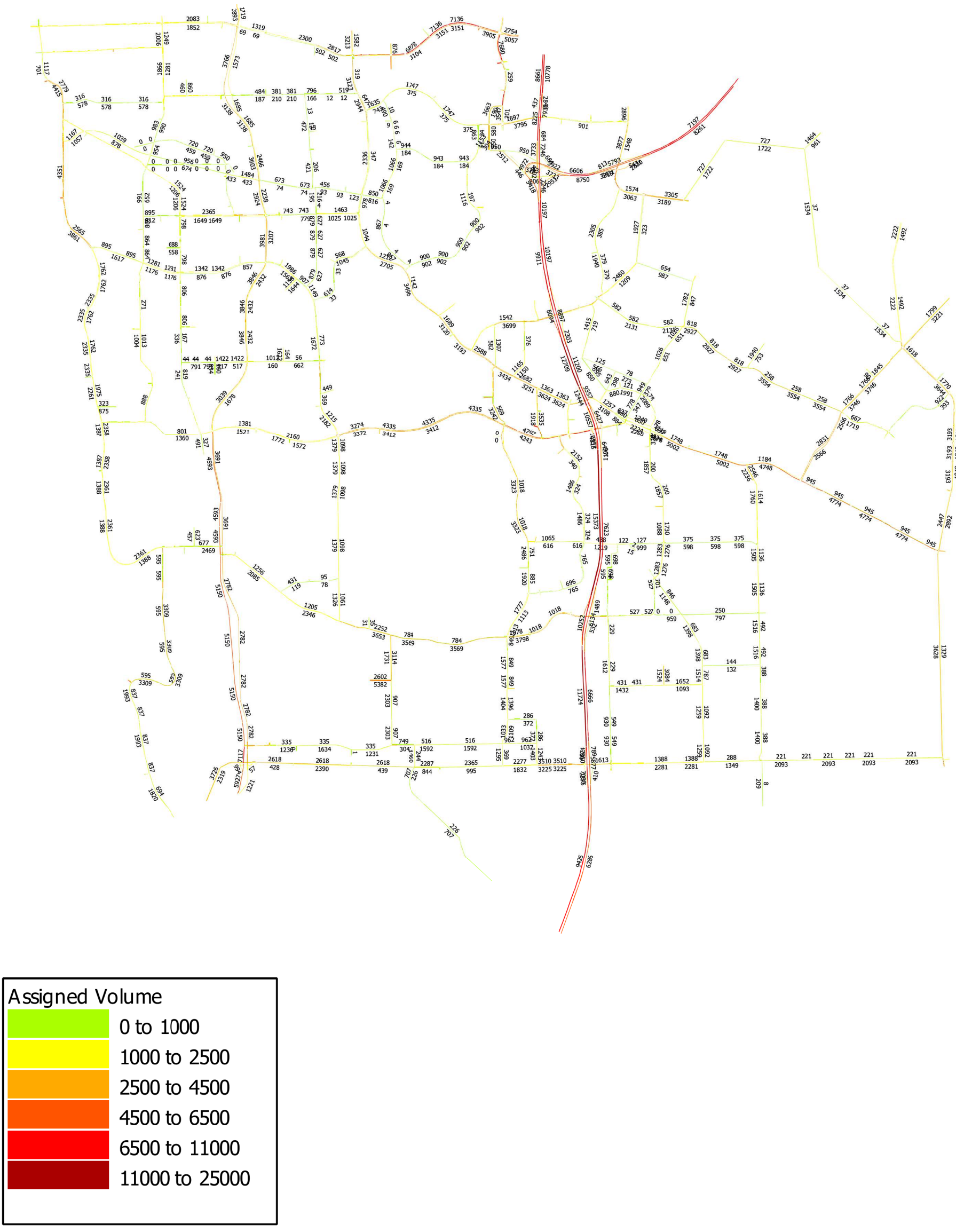
A5 2021 Do Something - AM Peak



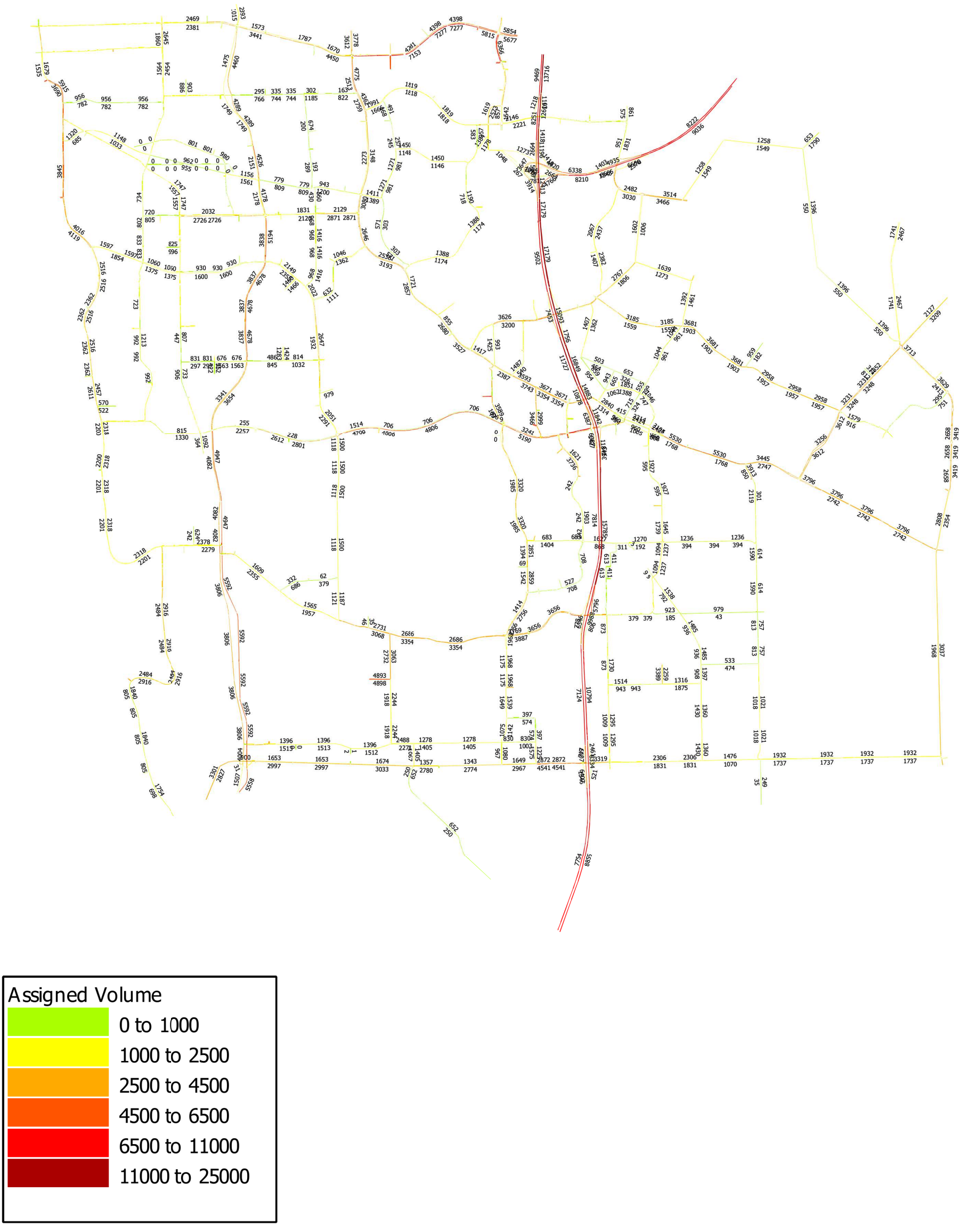
A6 2021 Do Something - PM Peak



A7 2031 Do Something - AM Peak



A8 2031 Do Something - PM Peak

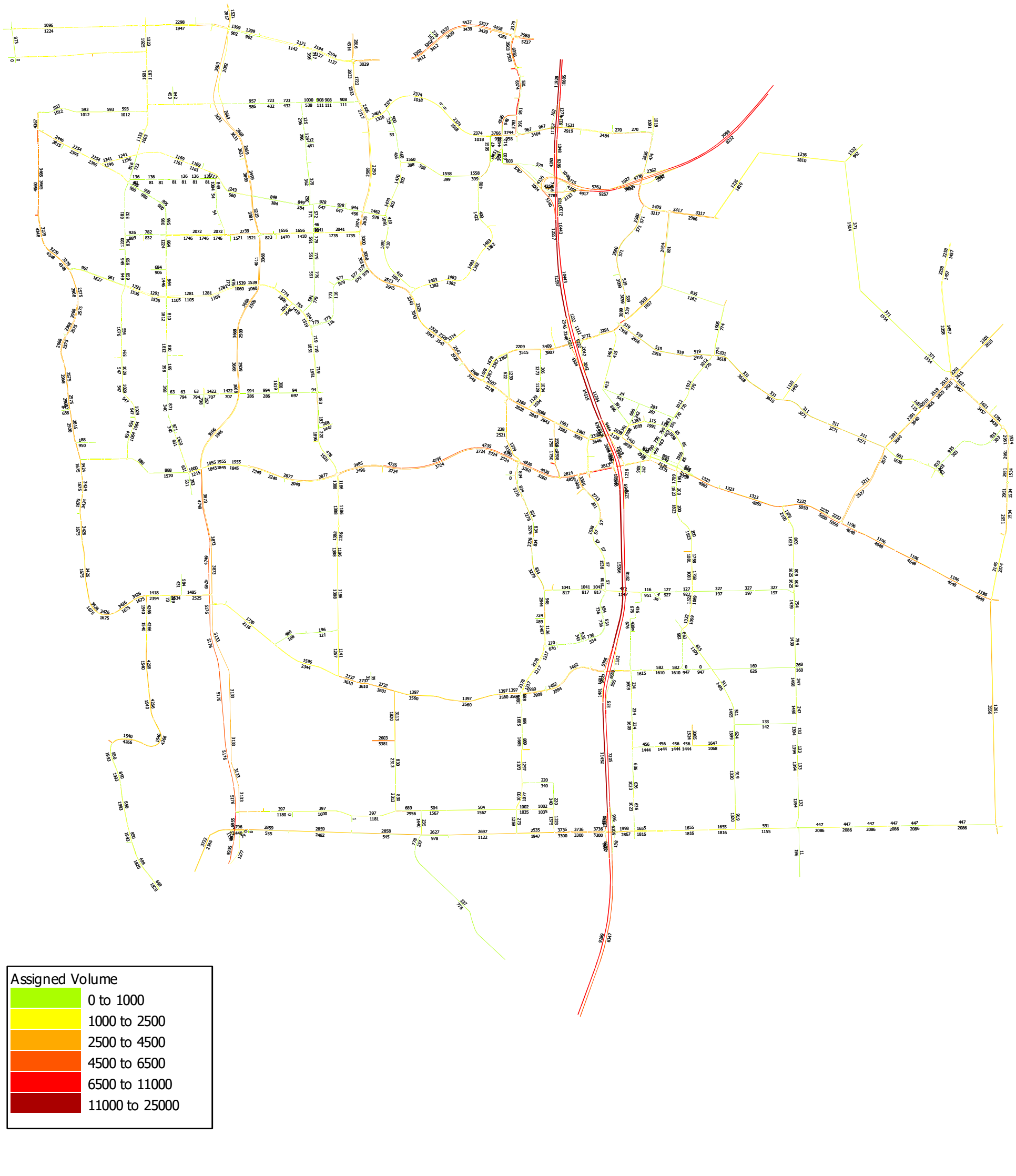


Appendix B

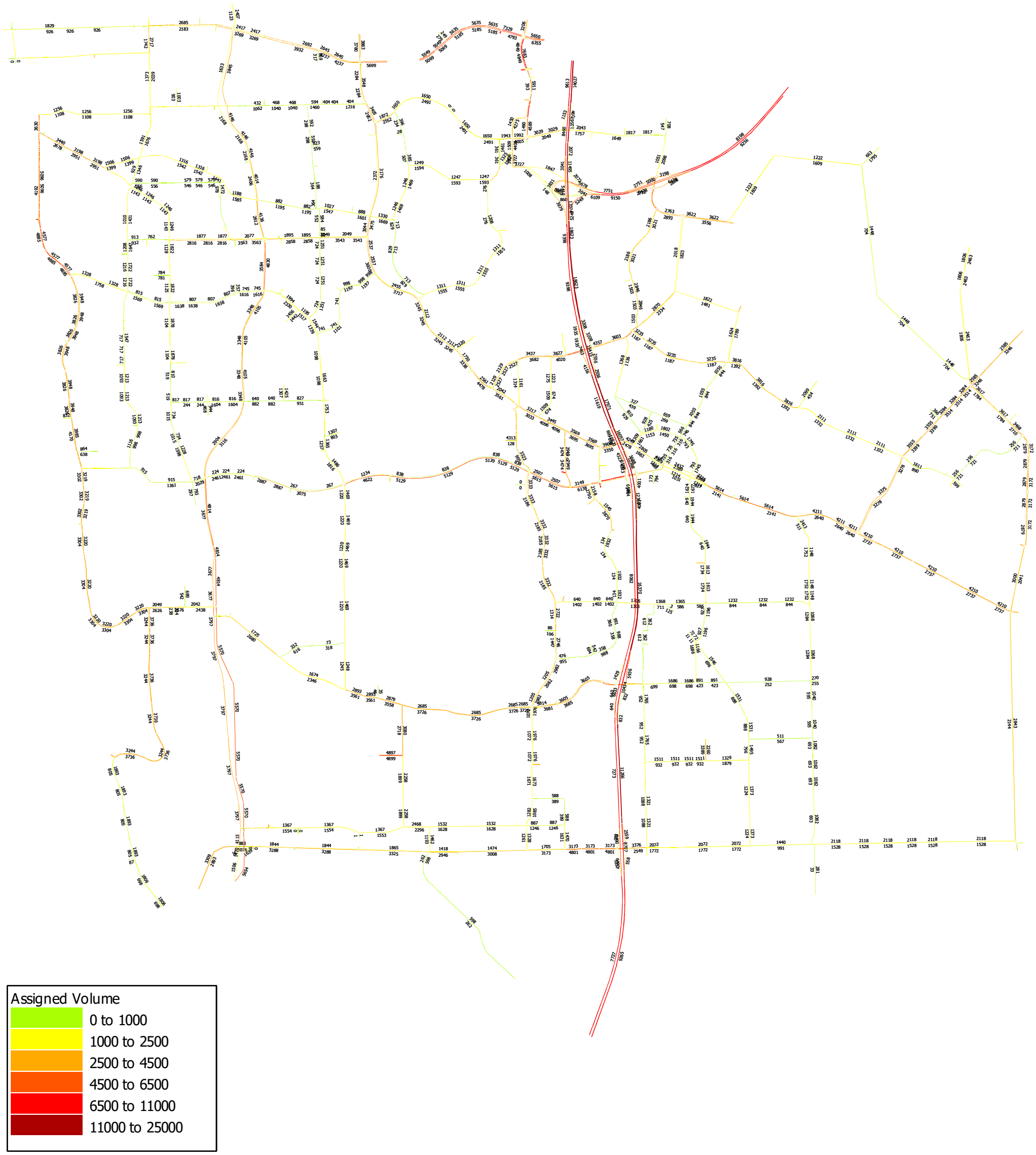
Stock Road and Cockburn Road Widening Scenarios

Two additional scenarios have been tested in order to investigate implication of Stock Road and Cockburn Road widening. Below are figures showing assigned volume and volume capacity ratio figures indicating isolated impact of those widening on the road network. As mentioned in section 8 this analysis has been produced for information only as both these roads are responsibility of the Main Roads WA.

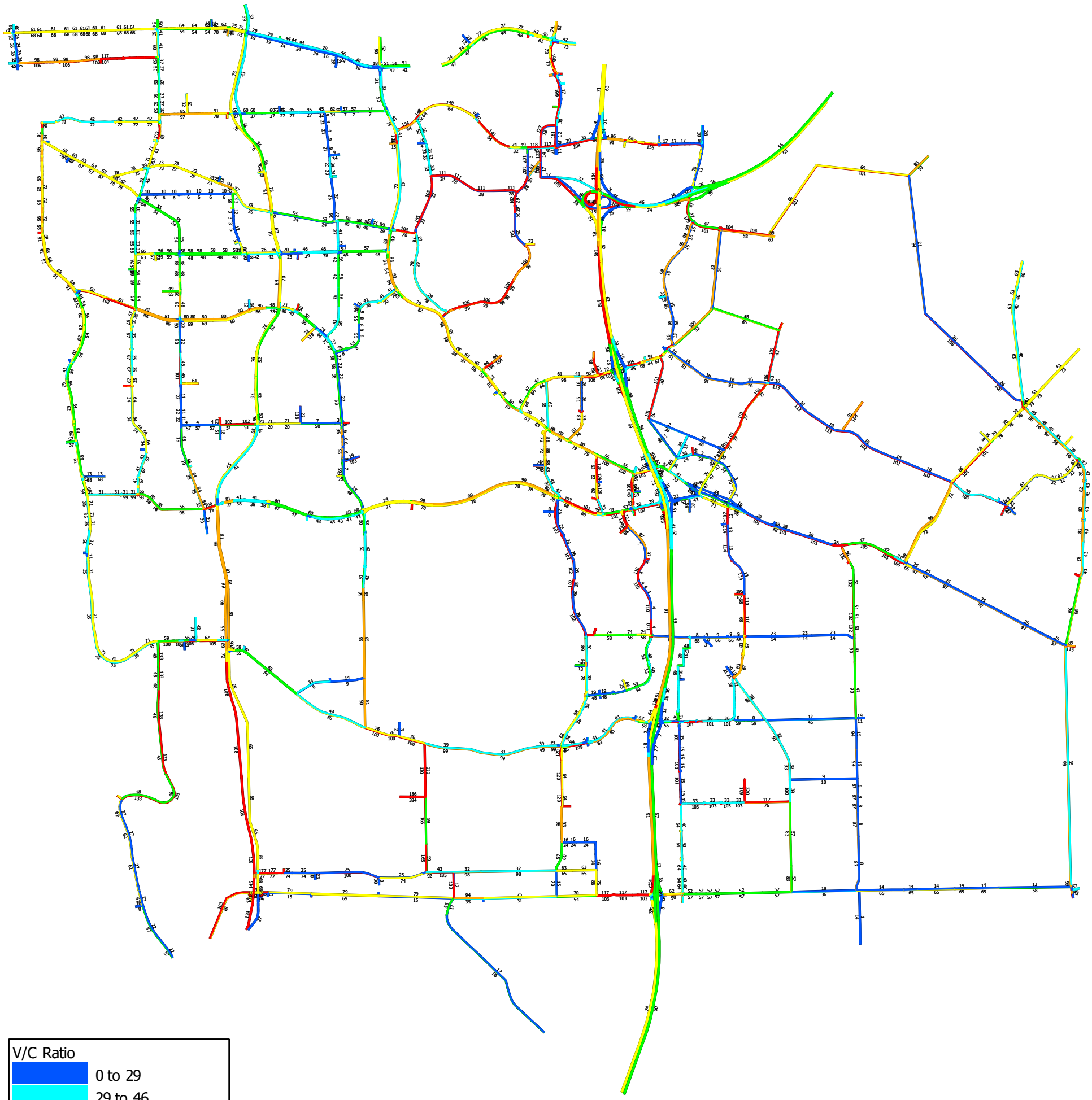
B1 2031 Do Something - Cockburn Road Widening - Assigned Volume - AM Peak



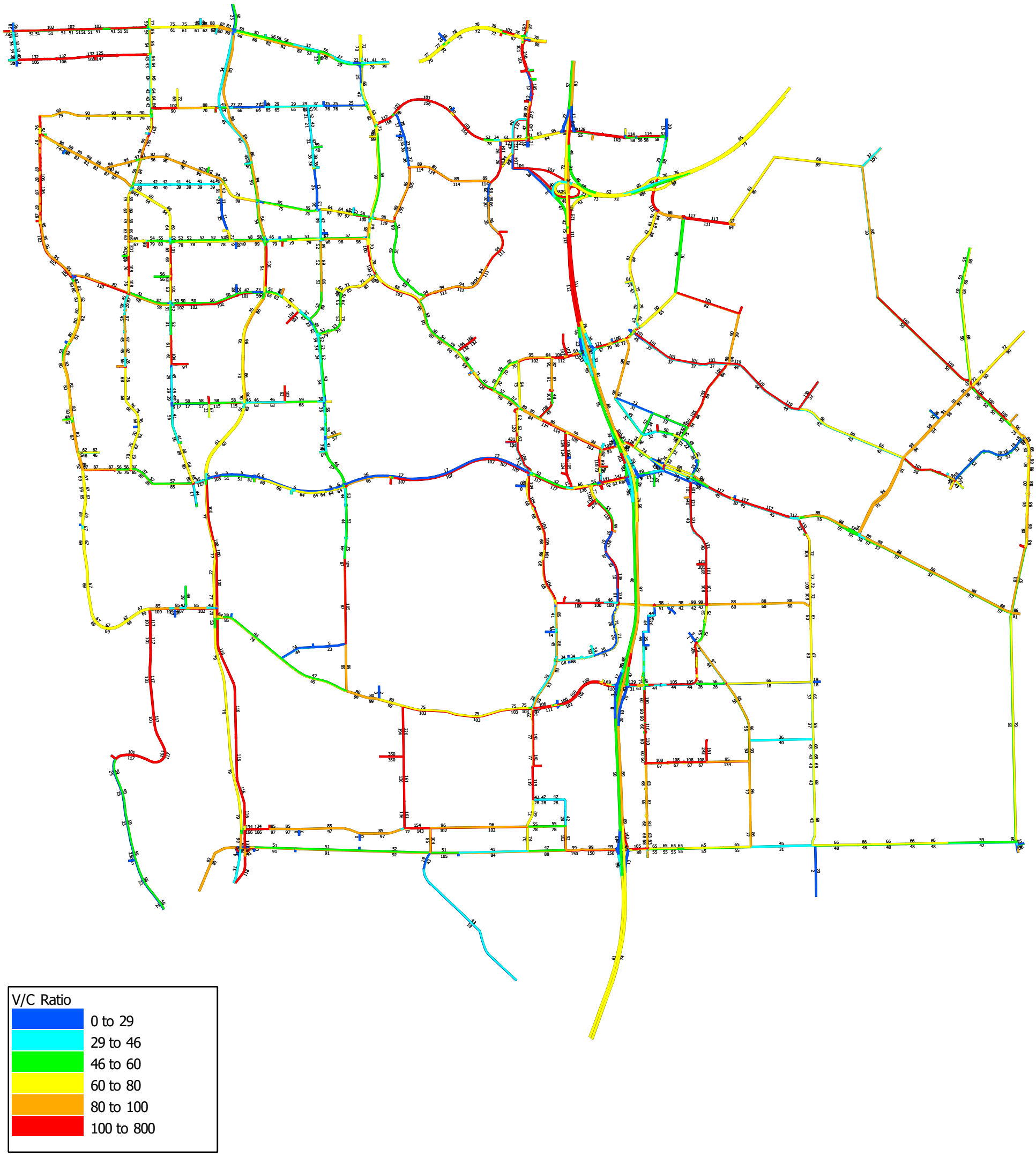
B2 2031 Do Something - Cockburn Road Widening - Assigned Volume - PM Peak



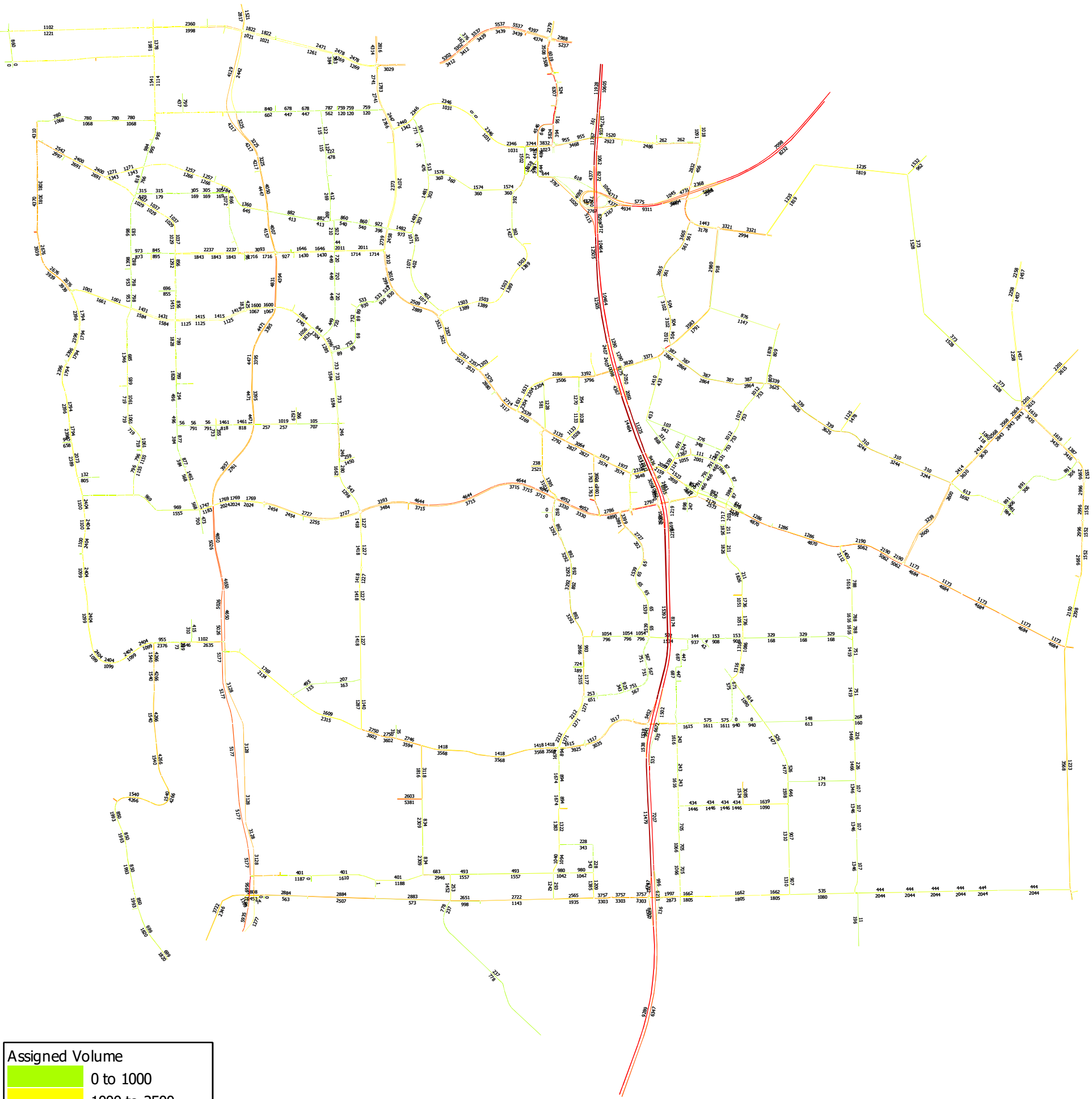
B3 2031 Do Something - Cockburn Road Widening - Volume Capacity - AM Peak



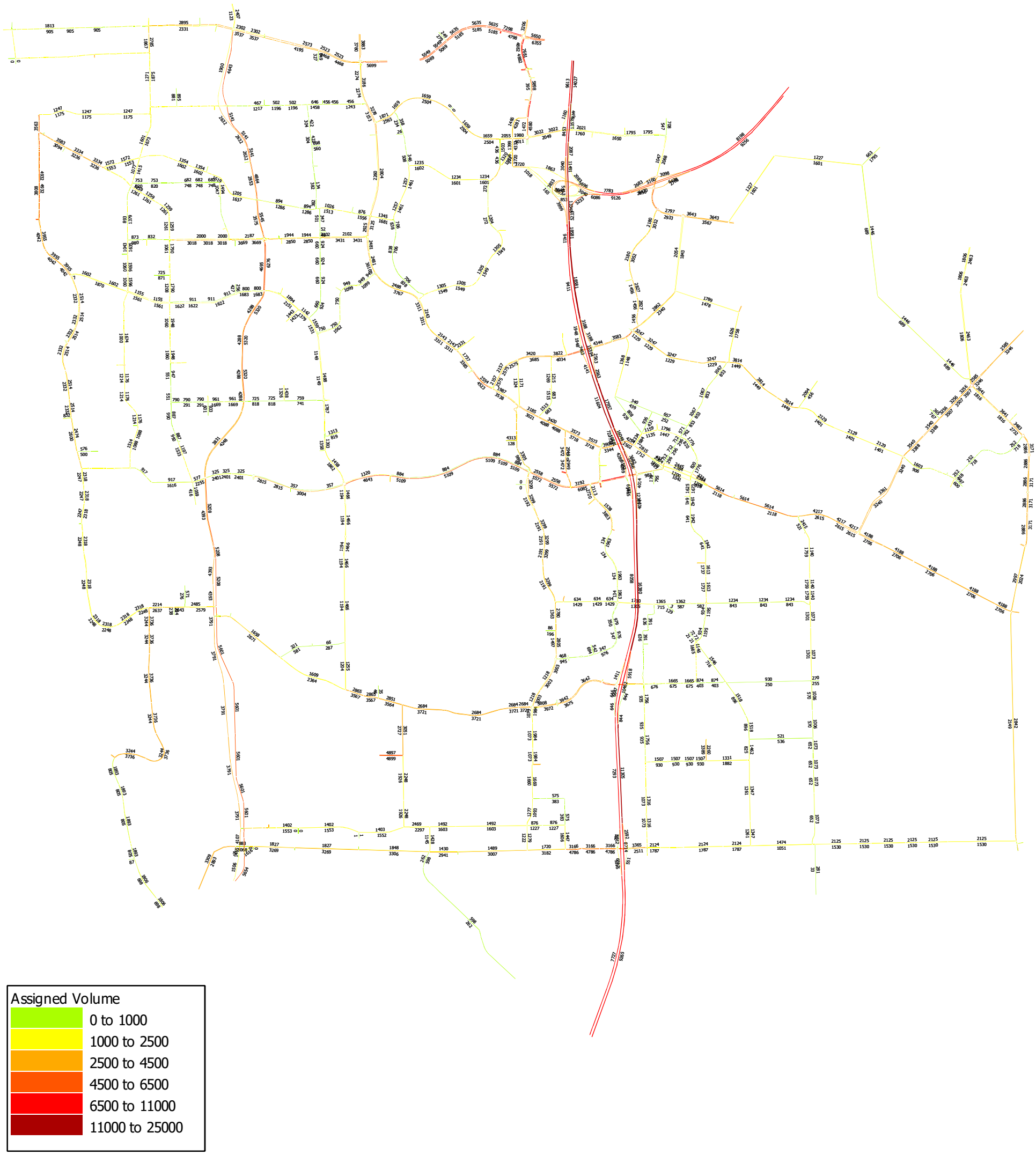
B4 2031 Do Something - Cockburn Road Widening - Volume Capacity - PM Peak



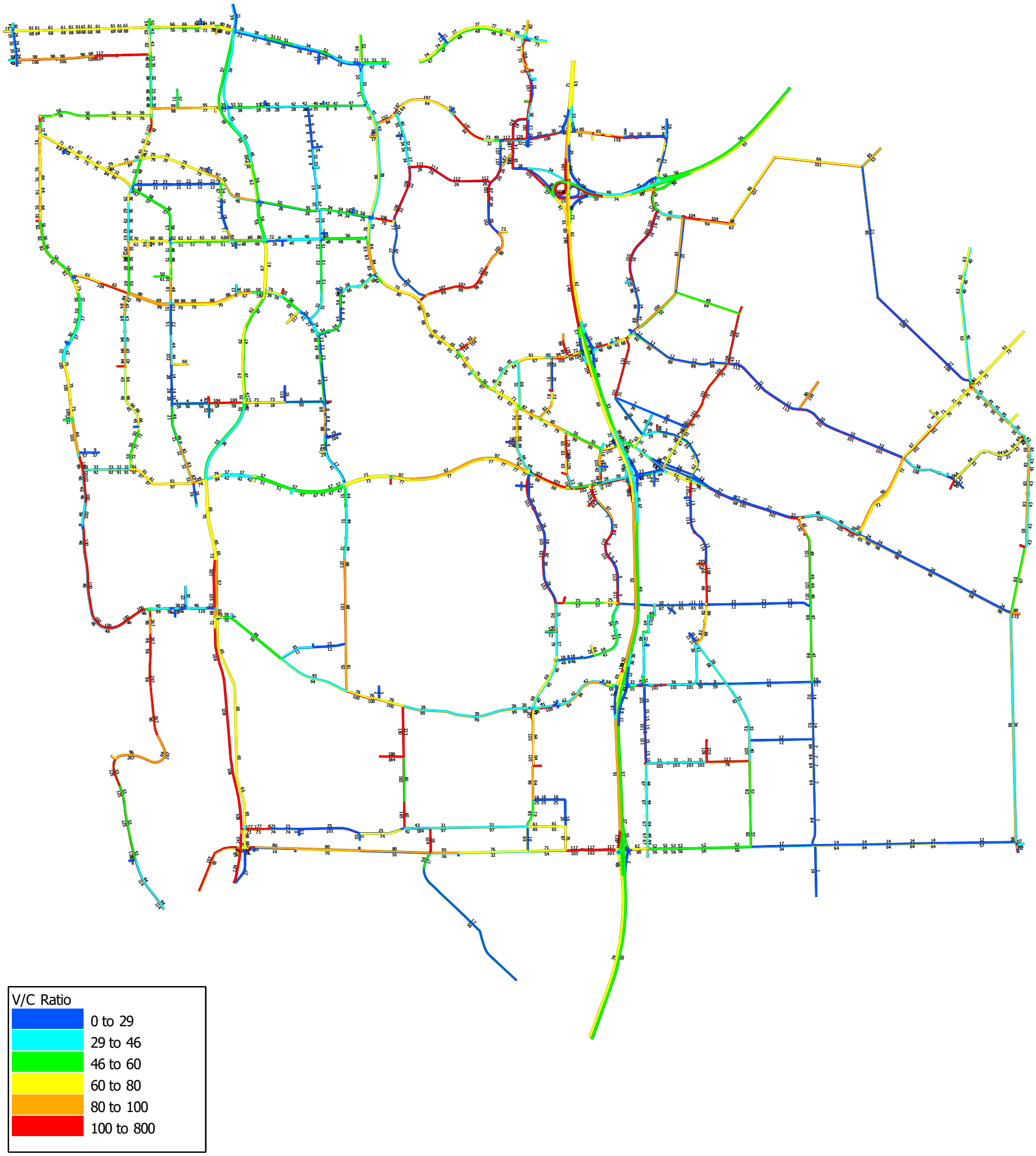
B5 2031 Do Something - Stock Road Widening - Assigned Volume - AM Peak



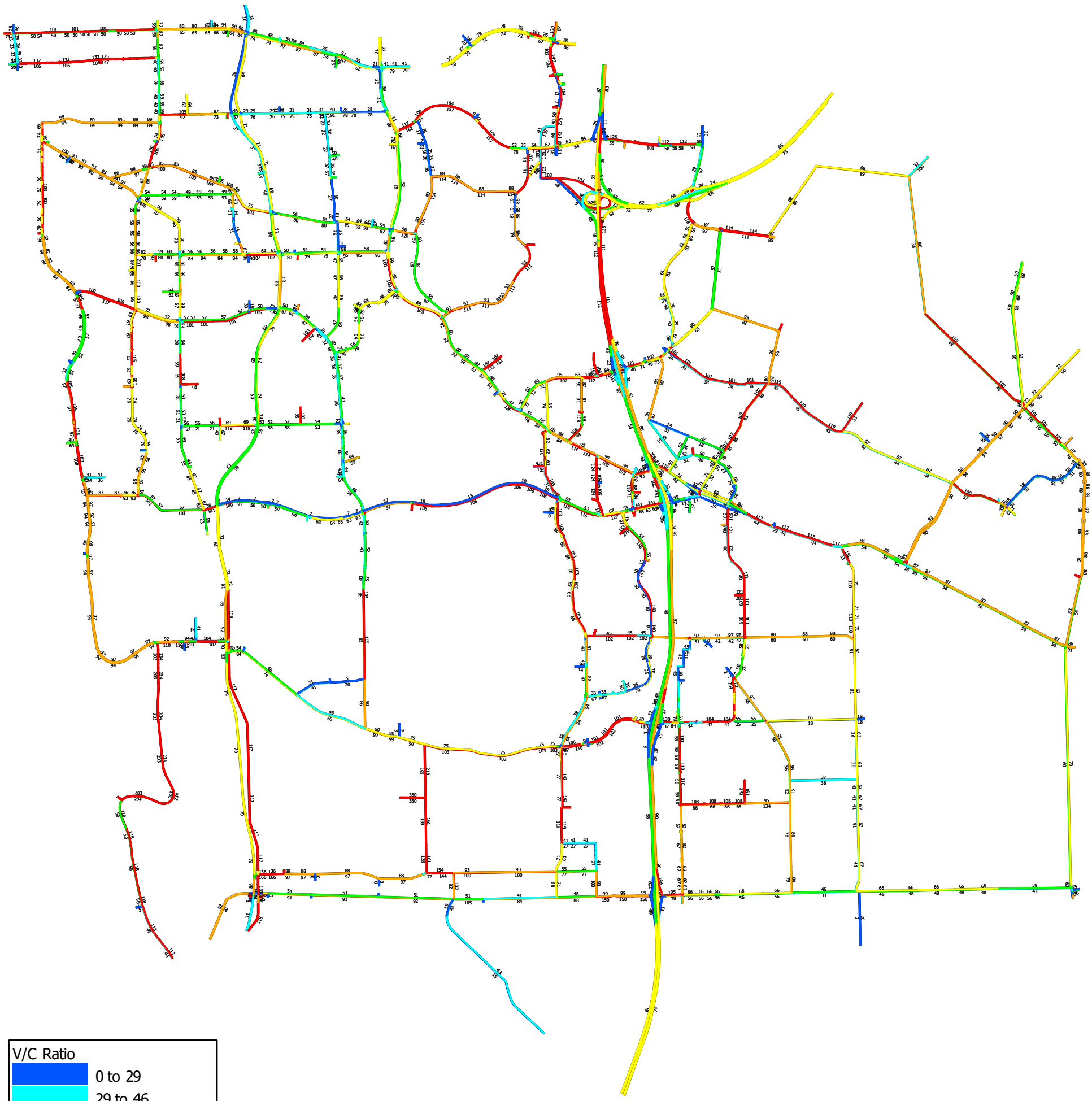
B6 2031 Do Something - Stock Road Widening - Assigned Volume - PM Peak



B7 2031 Do Something - Stock Road Widening - Volume Capacity - AM Peak



B8 2031 Do Something - Stock Road Widening - Volume Capacity - PM Peak



Appendix C

Additional Scenarios

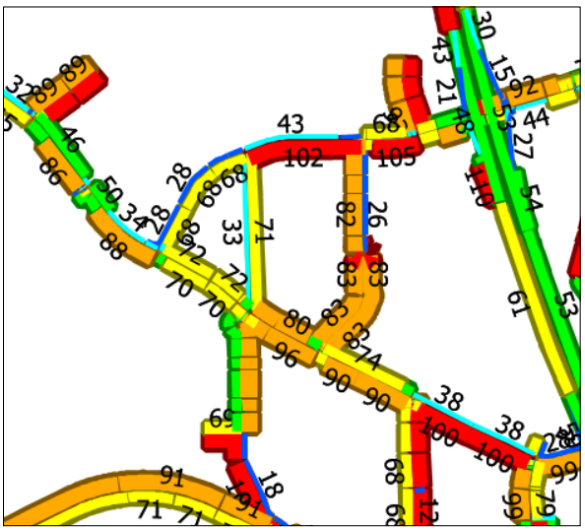
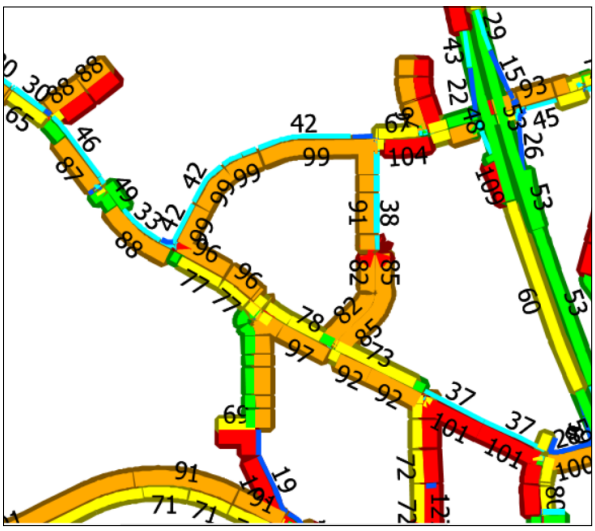
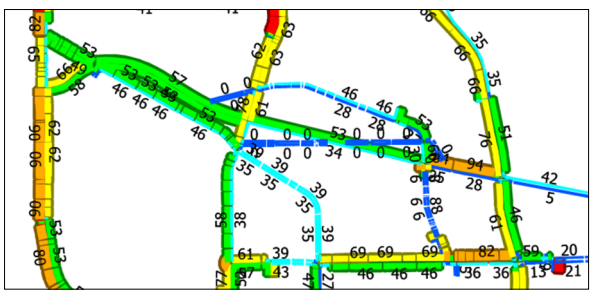
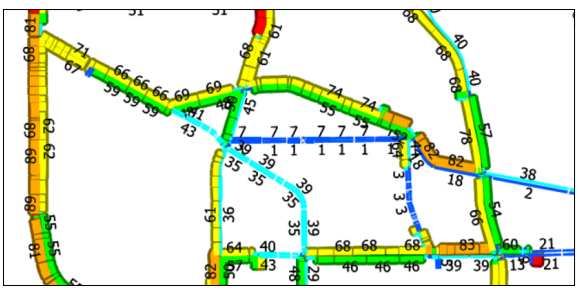
C1 Scenario 1 (year 2031) – network without items 36, 53 and 54

Modelling results of Scenario 1 with Hammond Road extension (between North Lake Road and Berrigan Drive) and Roe 9 link indicated several findings:

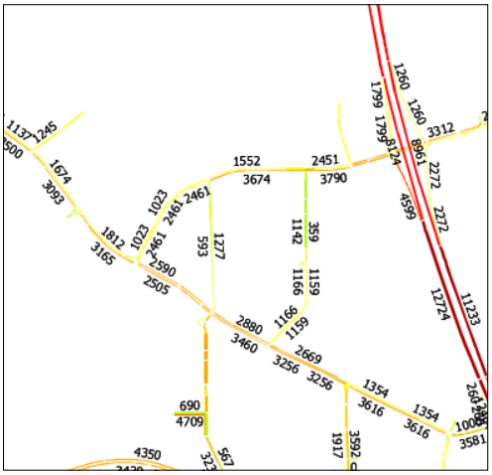
1. Hammond Road extension shows it contributes to higher congestion at surrounding intersections and therefore degrades the overall performance of the network in the area
2. Hammond Road extension relieve some congestion around small sections of Berrigan Drive and North Lake Road
3. Roe 9 link reliefs some sections of Forrest Road from congestion
4. Roe 9 link increases congestion around Cockburn Road

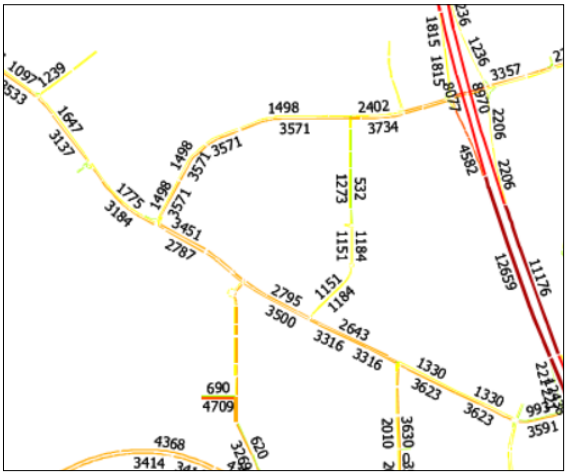
Modelling results of Scenario 1 without Hammond Road extension and Roe 9 link shows:

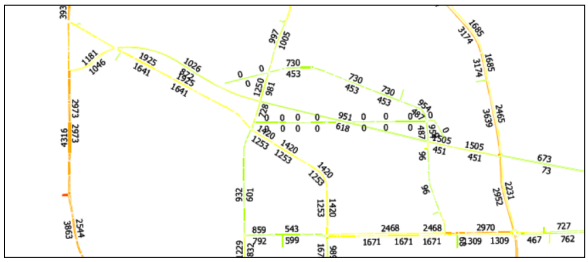
1. Network without Hammond Road extension still performs within acceptable limits
2. Without Roe 9 link network still operates at acceptable levels with many links still within capacity

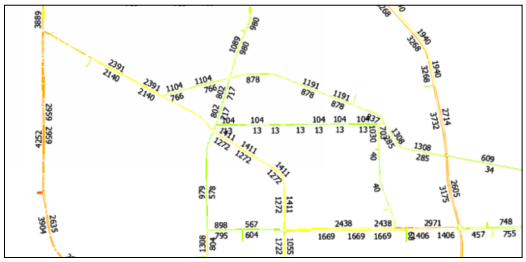
With Hammond Road extension and Roe 9 link	**Without Hammond Road extension and Roe 9 link**
2031 AM Volume Capacity	
	
	

2031 AM Assigned Volume

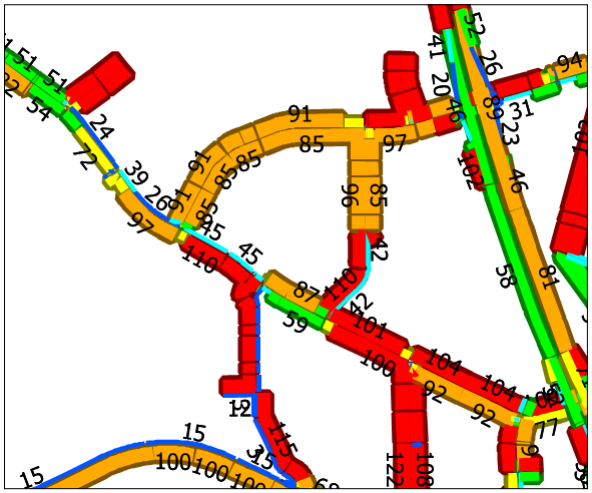


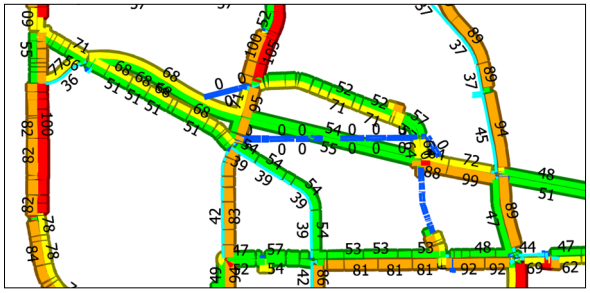


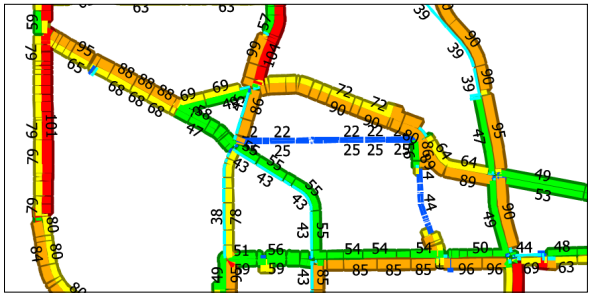




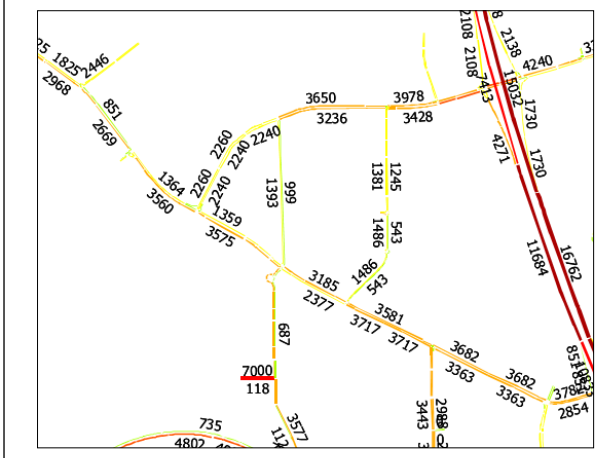
2031 PM Volume Capacity

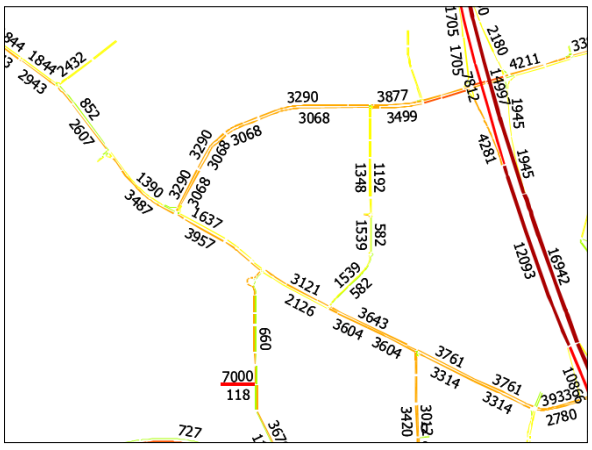


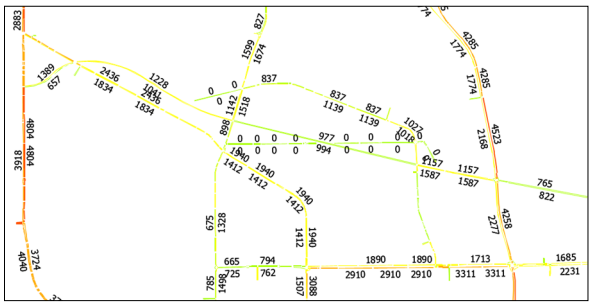


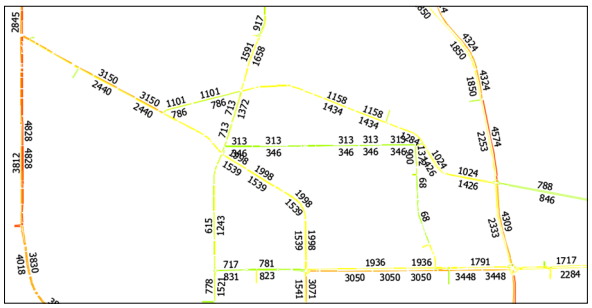


2031 PM Assigned Volume









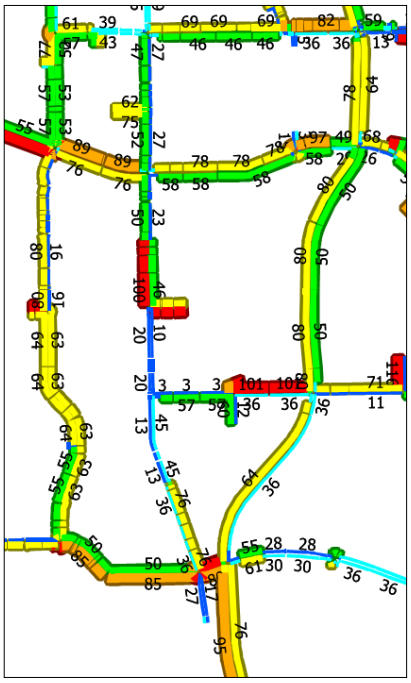
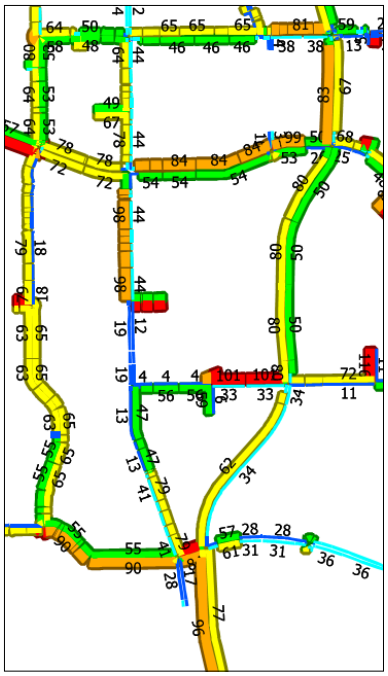
C2 Scenario 2 (year 2031) – network with Rockingham Road narrowed to 2 lanes

Modelling results of Scenario 2 with Rockingham Road as is with 4 lanes indicated several findings:

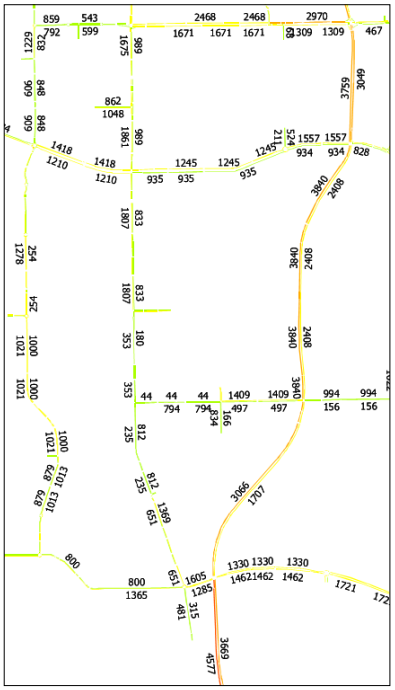
1. Rockingham Road with 4 lanes increases congestion around intersection between Spearwood Avenue and Rockingham Road,
2. Small sections of Stock Road between Spearwood Avenue and Phoenix Road reduces in congestion.
3. Small section of Spearwood Avenue performs marginally better

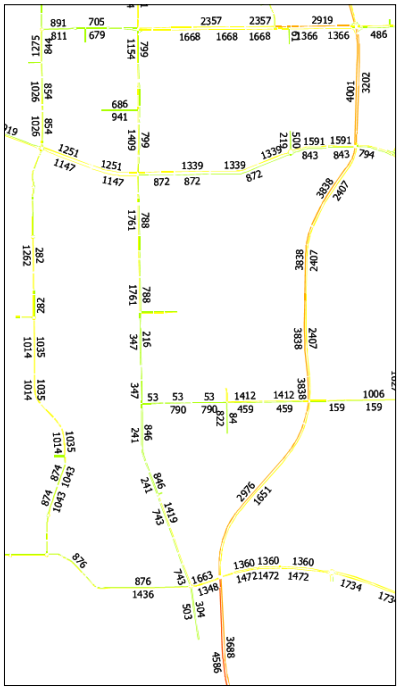
Modelling results of Scenario 2 with Rockingham Road narrowing to 2 lanes shows:

1. Spearwood Avenue still operates within capacity
2. Small section of Rockingham Road shows higher congestion
3. There is minor increase in congestion in surrounding network but generally volume capacity ration between scenarios very similar
4. Network still performs within road capacity

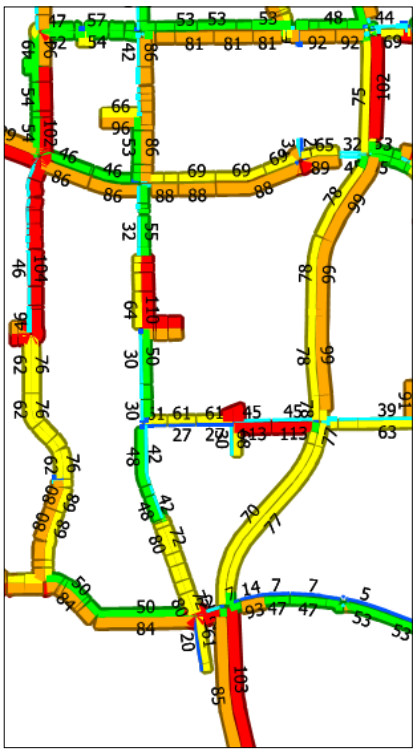
With Rockingham Road with 4 lanes	**With Rockingham Road Narrowing to 2 lanes**
2031 AM Volume Capacity	
	

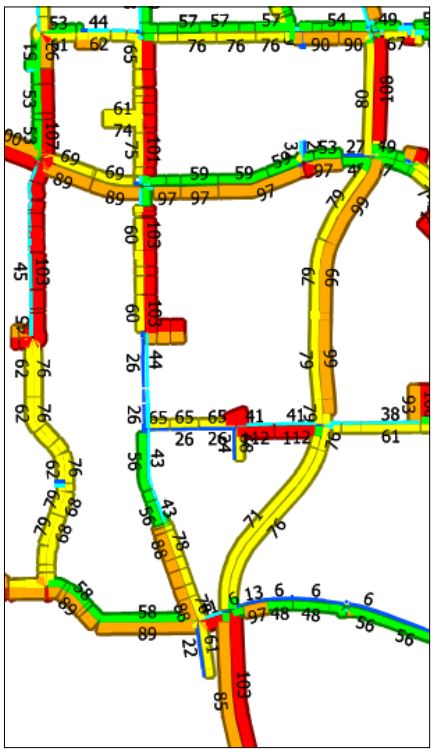
2031 AM Assigned Volume



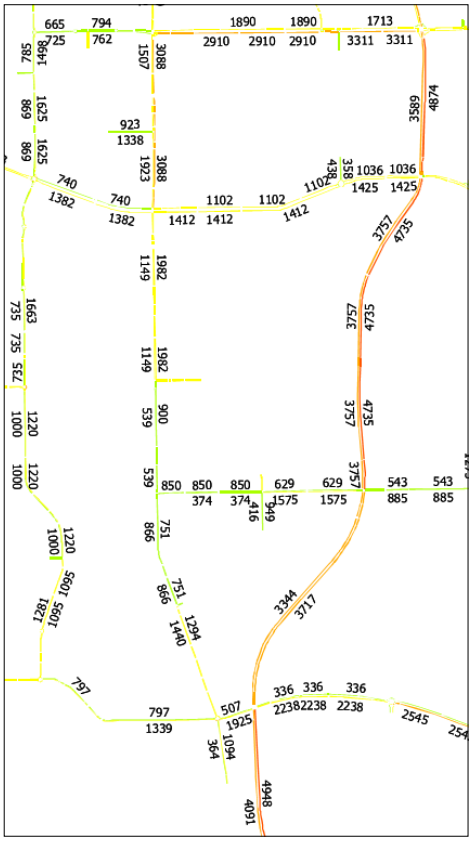


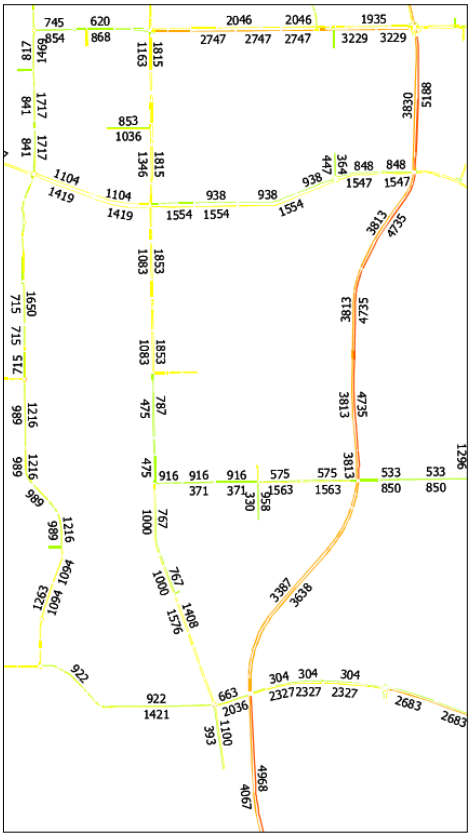
2031 PM Volume Capacity





2031 PM Assigned Volume





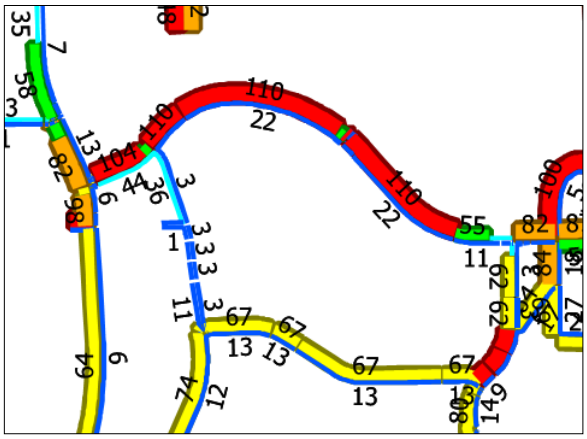
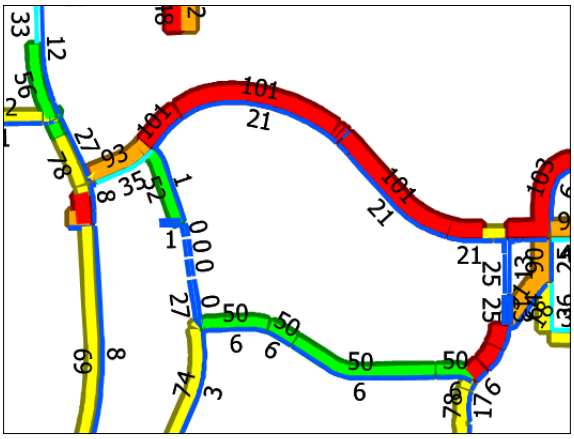
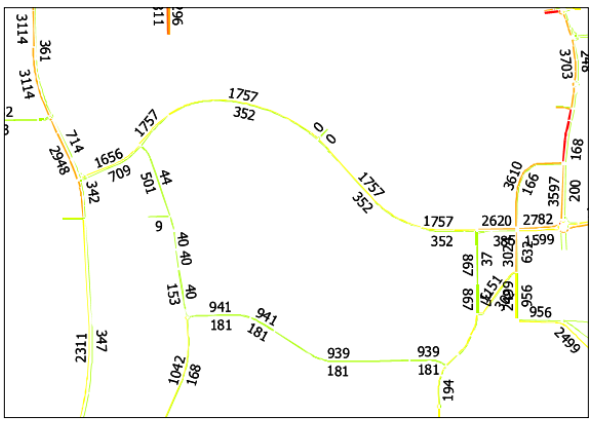
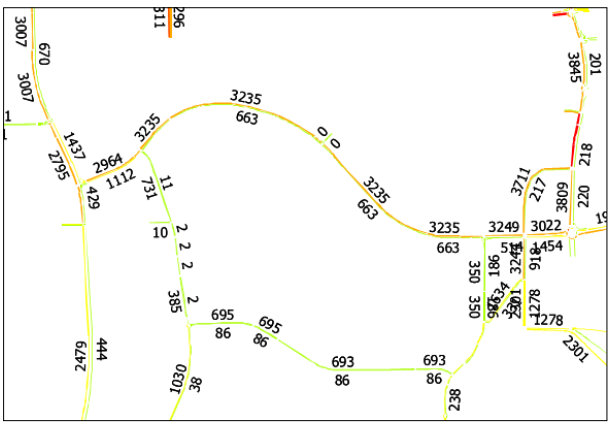
C3 Scenario 3 (year 2031) – network with Farrington Road duplication

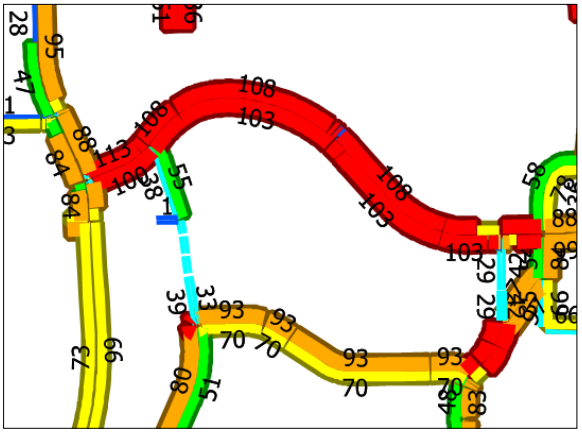
Modelling results of Scenario 3 With Farrington Road Duplication indicated several findings:

1. Farrington Road performance is still over capacity after duplication
2. Duplication attracts almost double volume to Farrington Road
3. North Lake Road and Farrington intersection, south arm is over capacity after duplication
4. Small reduction in congestion on Hope Road

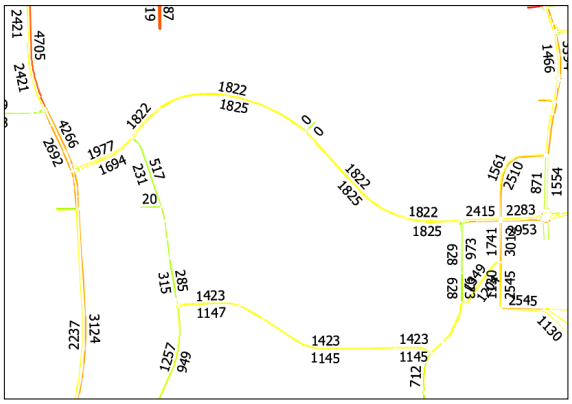
Modelling results of Scenario 3 Without Farrington Road Duplication shows:

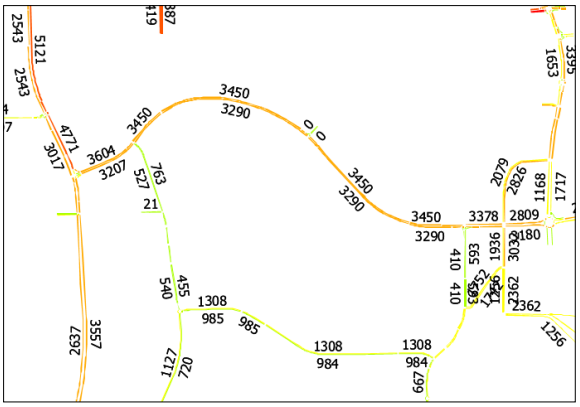
1. Farrington Road over capacity without duplication
2. Overall performance between two scenarios is very similar because Farrington road is already congested and with increase of capacity Farrington Road attracts significantly more traffic which causes it to reach capacity again. Therefore, there is minimal benefit in duplication.

Without Farrington Road Duplication	**With Farrington Road Duplication**
2031 AM Volume Capacity	
	
2031 AM Assigned Volume	
	
2031 PM Volume Capacity	



2031 PM Assigned Volume





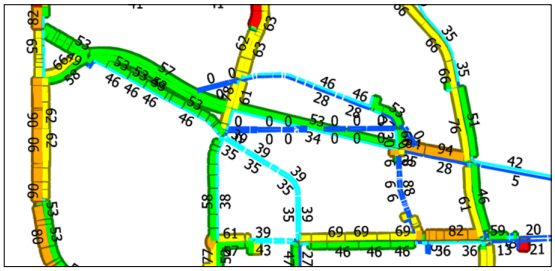
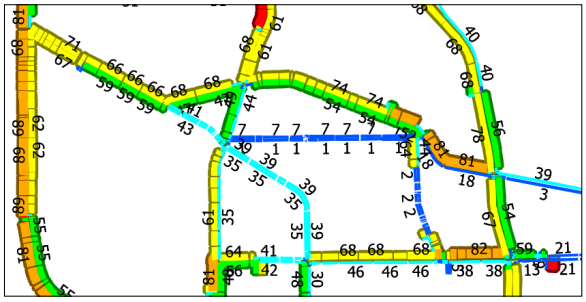
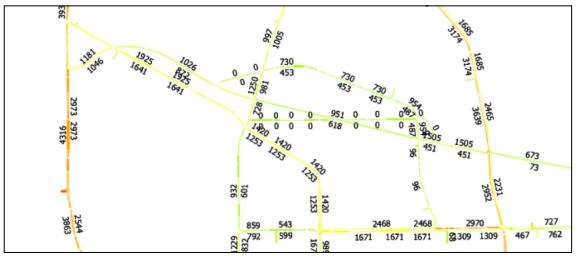
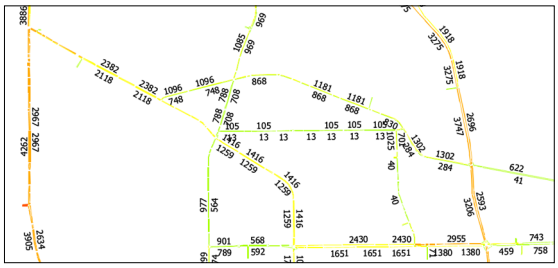
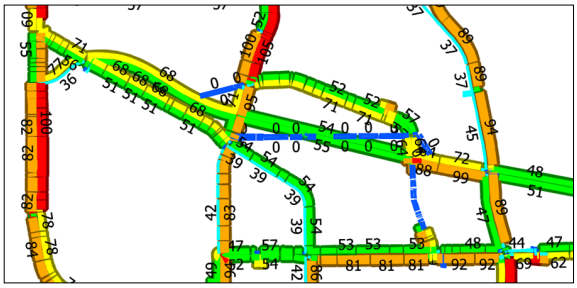
C4 Scenario 4 (year 2031) – network without Roe 9 link

Modelling results of Scenario 4 indicated several findings:

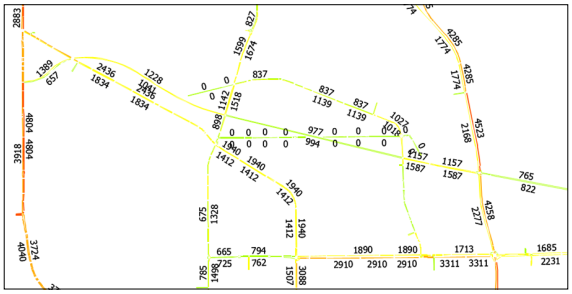
1. Roe 9 link relieves some sections of Forrest Road from congestion
2. Roe 9 link increases congestion around Cockburn Road

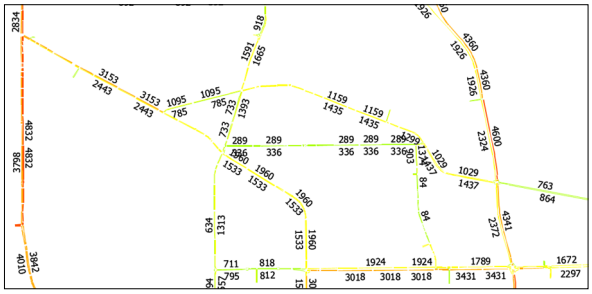
Modelling results of Scenario 4 Without Roe 9 only shows:

1. Without Roe 9 link network still operates at acceptable levels with many links still within capacity

With Roe 9 only	Without Roe 9 only
2031 AM Volume Capacity	
	
2031 AM Assigned Volume	
	
2031 PM Volume Capacity	
	

2031 PM Assigned Volume





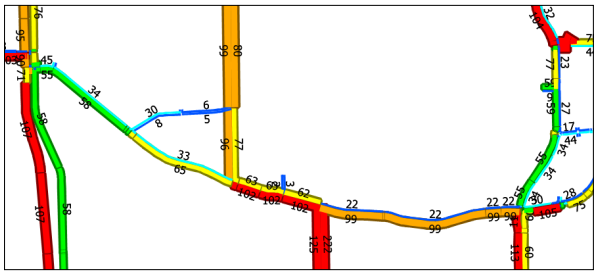
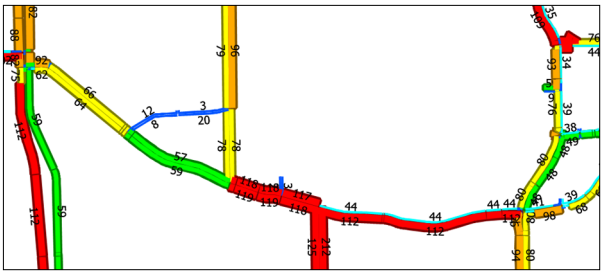
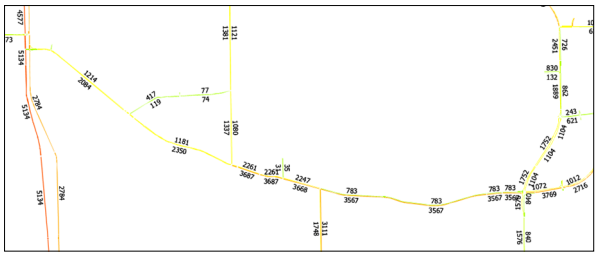
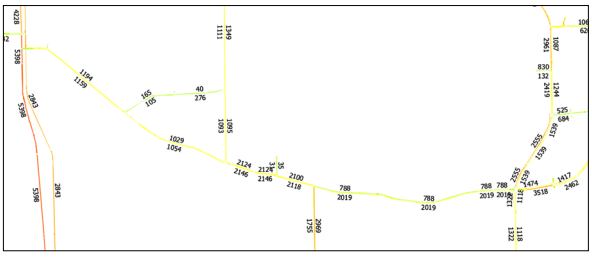
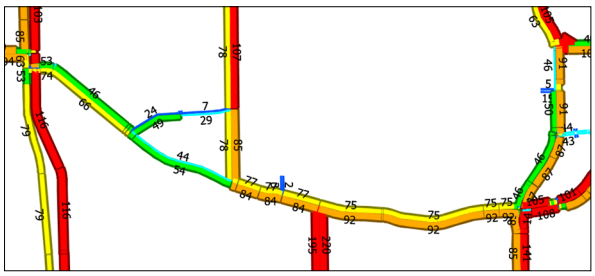
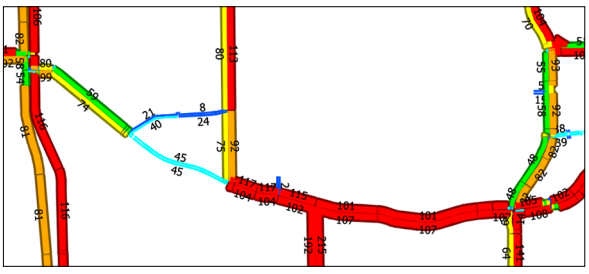
C5 Scenario 5 (year 2031) – network with Russell Road duplication

Modelling results of Scenario 5 With Rowley Road duplication & with Russell Road duplication indicated several findings:

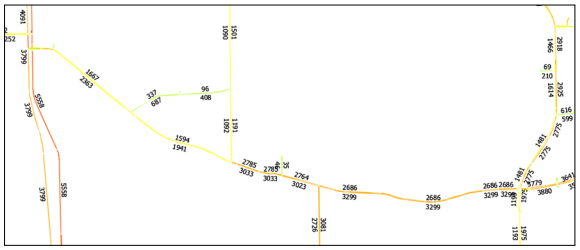
1. Major decrease in congestion on Russell Road between Henderson Road and Rockingham Road
2. Major decrease in congestion on Russell Road between Frankland Avenue and Kwinana Freeway
3. Some additional congestion on south arm of Frankland Road

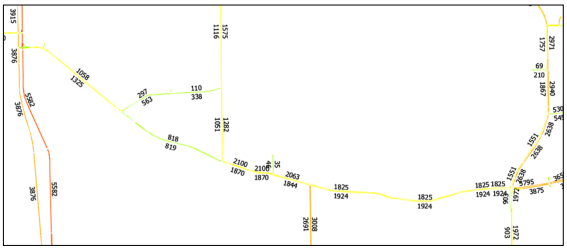
Modelling results of Scenario with Rowley Road duplication & Without Russell Road duplication shows:

1. Significant increase in congestion between Kwinana Freeway and Henderson Road
2. Frankland Road south arm is already over capacity

With Rowley Road duplication & with Russell Road duplication	**With Rowley Road duplication & without Russell Road duplication**
2031 AM Volume Capacity	
	
2031 AM Assigned Volume	
	
2031 PM Volume Capacity	
	

2031 PM Assigned Volume





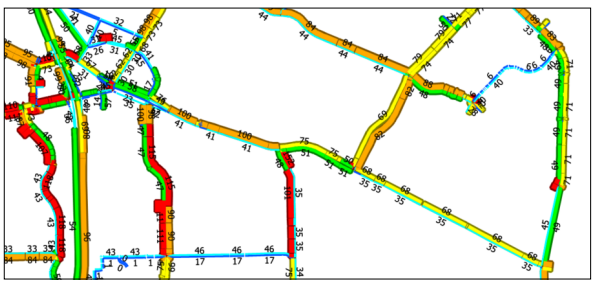
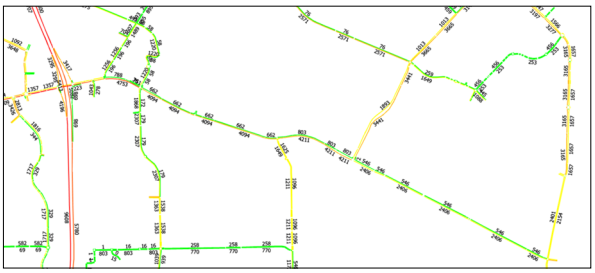
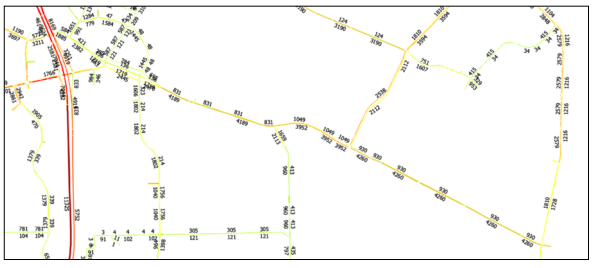
C6 Scenario 6 (year 2021) – network with Armadale Road duplication

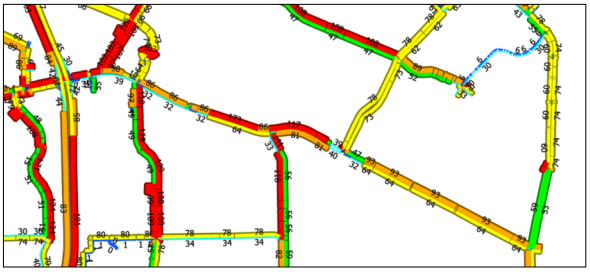
Modelling results of Scenario 6 with Armadale Road duplication of the entire length by 2021 indicated several findings:

1. Major decrease in congestion on Armadale Road
2. Some increase in congestion on Liddelow Road
3. Tapper Rodd northbound movement shows reduction in congestion
4. Tapper Road southbound remains congested
5. Significant reduction in congestion around Armadale Road and Kwinana Freeway interchange
6. Reduction in traffic volume on Bartram Road

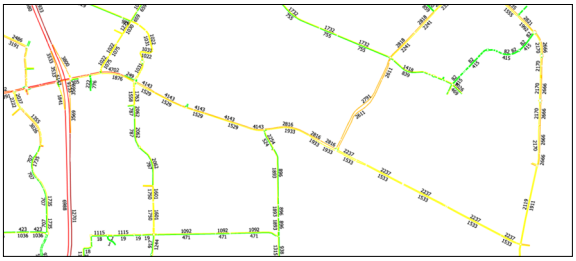
Modelling results of Scenario 6 without Armadale Road duplication by 2021 shows:

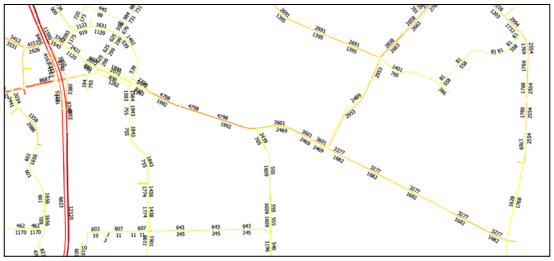
1. Significant congestion on the whole stretch of Armadale Road
2. Tapper Road over capacity
3. Liddelow Road over capacity
4. Significant congestion around Armadale Road and Kwinana Freeway interchange

Without Armadale Road duplication	**With Armadale Road duplication**
2021 AM Volume Capacity	
	
2021 AM Assigned Volume	
	
2021 PM Volume Capacity	



2021 PM Assigned Volume





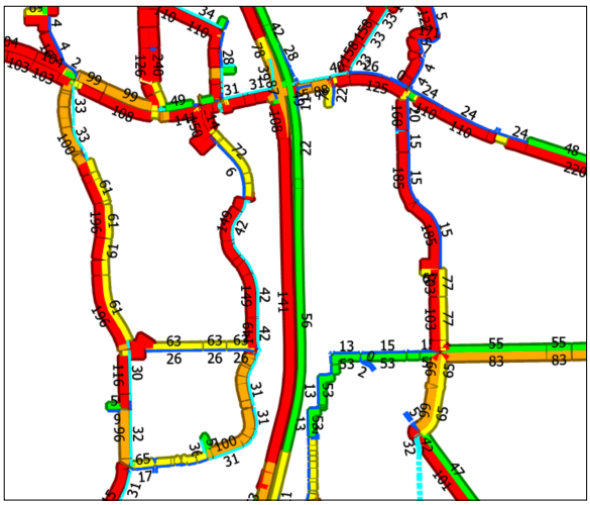
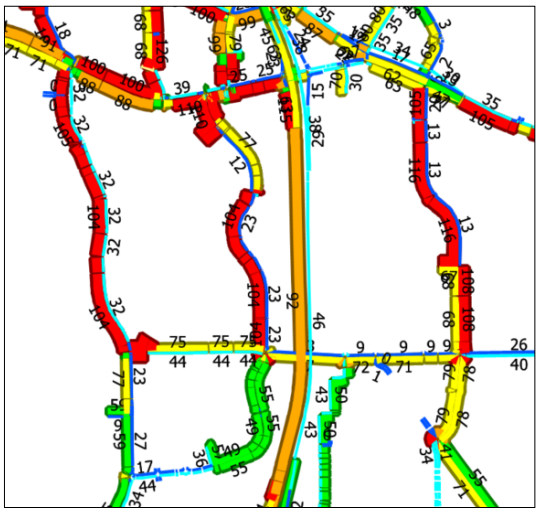
C7 Scenario 7 (year 2031) – network with Bartram Road Bridge crossing of the freeway

Modelling results of Scenario 7 with Bartram Road bridge crossing indicated several findings:

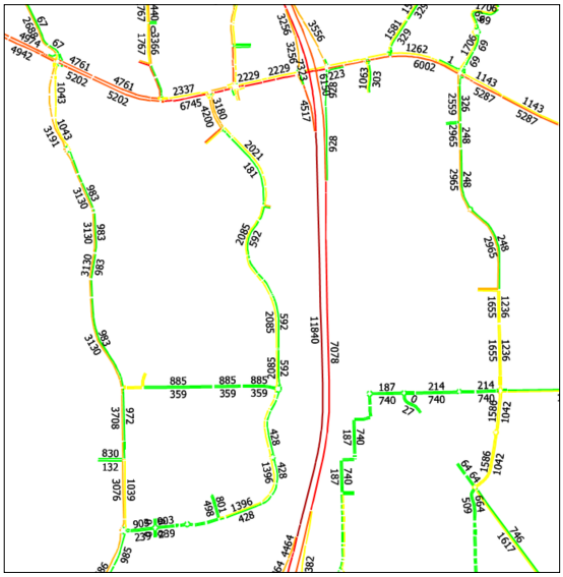
1. Major improvement on section of the Wentworth Parade between Bartram Road and Hammond Road
2. Reduction in congestion on Hammond Road
3. Reduction in congestion Tapper Road by around 10% but still just over capacity
4. Reduction in congestion on Wentworth Parade between Bartram Road and Beeliar Drive by around 40% but still just over capacity
5. Reduction in congestion on Hammond Road by around 90% but still just over capacity
6. Significant reduction in congestion on Kwinana Freeway

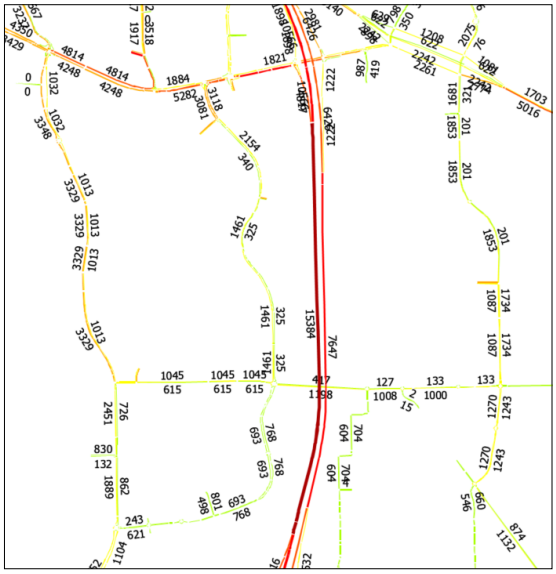
Modelling results of Scenario 7 without Bartram Road bridge crossing shows:

1. High congestion around whole Wentworth Parade, Hammond Road, Beeliar Drive, Tapper Road and Kwinana Freeway

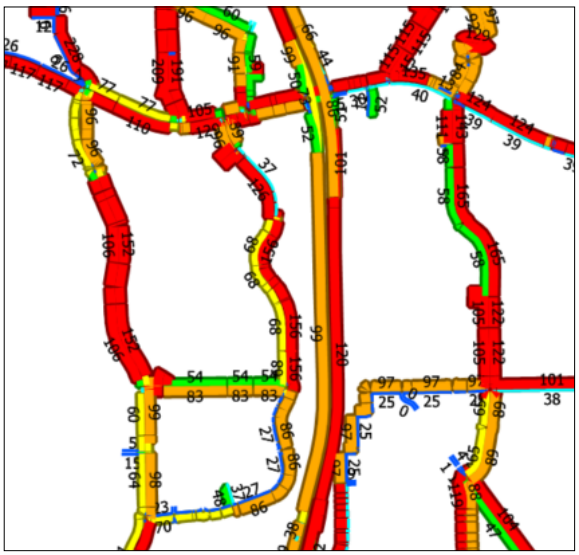
Without Bartram Road Bridge crossing	**With Bartram Road Bridge crossing**
2031 AM Volume Capacity	
	

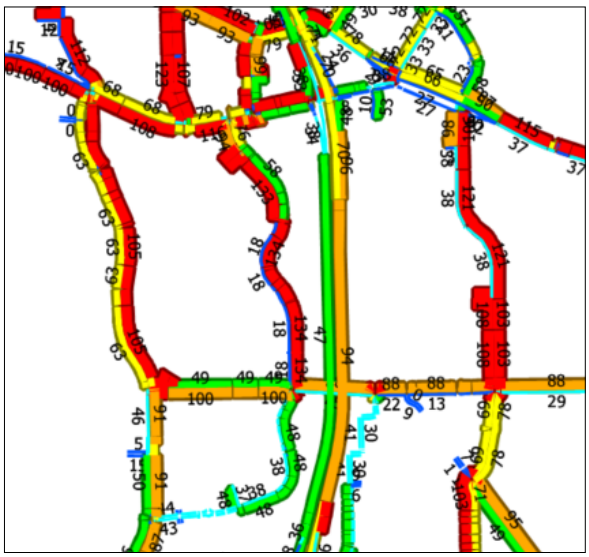
2031 AM Assigned Volume



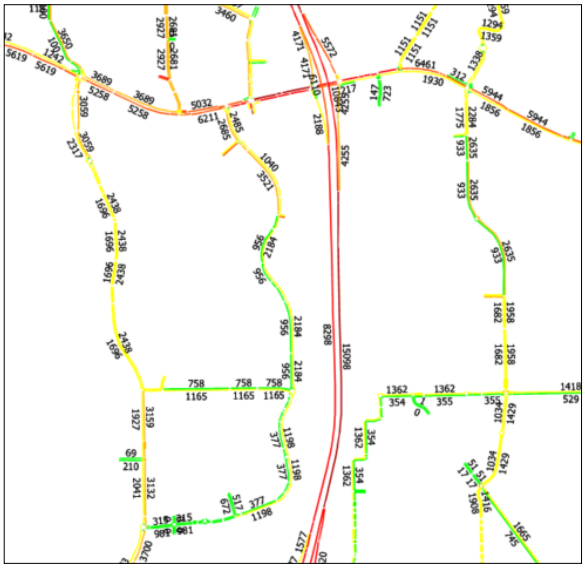


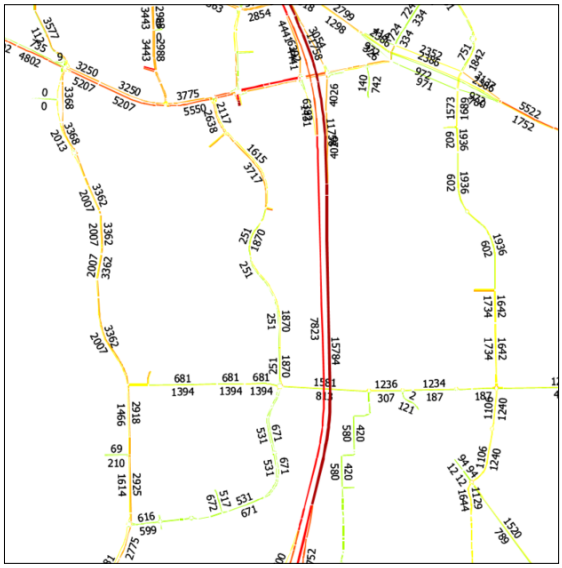
2031 PM Volume Capacity





2031 PM Assigned Volume





Appendix D

Demographic data

Zone	Population											
	2016		2021					2031				
	Main Roads	CoC Adjusted to Main Roads Zones	Main Roads Growth Rate 2016-2021	Main Roads	CoC Data Split into Main Roads Zones	Forecast based on the Adjusted 2016 Base with CoC data and factored up with Main Roads growth factors	CoC Further Refined from Feedback	Main Roads Growth Rate 2016-2031	Main Roads	CoC Data Split into Main Roads Zones	Forecast based on the Adjusted 2016 Base with CoC data and factored up with Main Roads growth factors	CoC Further Refined from Feedback
666	2,922	2,207	0.98	2,877	2,160	2,173	2,160	0.88	2,570	2,212	1,941	2,212
667	909	909	0.55	499	499	499	499	0.55	500	500	500	500
690	1,745	1,745	1.04	1,812	1,812	1,812	1,812	0.90	1,563	1,563	1,563	1,563
727	3,413	3,413	1.10	3,756	3,756	3,756	3,756	1.23	4,191	4,191	4,191	4,191
728	2,132	2,132	1.01	2,158	2,158	2,158	2,158	1.05	2,236	2,236	2,236	2,236
729	3,180	3,180	1.08	3,448	3,448	3,448	3,448	1.26	4,017	4,017	4,017	4,017
733	629	584	8.26	5,198	4,338	4,828	2,503	15.90	10,000	9,036	9,288	7,499
734	1,569	1,457	1.28	2,016	1,682	1,872	2,048	1.59	2,496	2,255	2,318	2,644
735	3,246	3,496	1.08	3,515	3,948	3,785	3,948	1.29	4,180	4,751	4,501	4,751
736	2,450	2,638	1.09	2,678	3,008	2,884	3,008	1.28	3,124	3,551	3,364	3,551
737	1,640	1,757	1.05	1,730	1,932	1,854	1,932	1.40	2,298	2,550	2,462	2,550
738	3,073	3,309	1.04	3,204	3,598	3,450	3,598	1.25	3,834	4,358	4,129	4,358
739	1,444	1,516	1.01	1,458	1,591	1,530	1,591	1.07	1,549	1,551	1,626	1,551
740	1,903	1,997	1.05	1,998	2,181	2,097	2,181	1.43	2,727	2,731	2,862	2,731
741	3,174	2,948	1.20	3,812	3,181	3,541	4,089	1.31	4,160	3,759	3,864	4,482
742	6,395	6,712	1.11	7,067	7,713	7,417	7,713	1.23	7,876	7,886	8,266	7,886
743	2,446	2,272	1.06	2,598	2,168	2,413	2,730	1.16	2,847	2,573	2,644	2,997
744	3,101	3,182	1.04	3,238	3,590	3,322	3,590	1.06	3,274	3,418	3,359	3,418
745	7	7	1.00	7	6	7	6	1.00	7	6	7	6
746	1,230	1,262	1.24	1,529	1,695	1,569	1,695	1.89	2,319	2,421	2,379	2,421
747	1	1	1.00	1	1	1	1	1.00	1	1	1	1
748	10	8	1.00	10	9	8	9	1.50	15	19	11	19
749	199	152	1.02	203	178	155	178	0.82	163	210	124	210
750	426	325	0.90	384	338	293	2,395	1.16	496	639	378	4,812
751	53	54	0.94	50	55	51	55	0.96	51	53	52	53
752	-	-		-	-	-	-		-	-	-	-
753	72	74	0.99	71	79	73	79	0.97	70	73	72	73
754	4,728	5,336	0.98	4,655	5,357	5,253	5,357	0.94	4,466	5,306	5,040	5,306
755	1,848	2,086	1.17	2,165	2,492	2,443	2,492	1.23	2,270	2,697	2,562	2,697
756	1,802	1,978	1.05	1,887	2,509	2,071	2,509	1.02	1,834	2,846	2,013	2,846
757	4,483	4,921	1.01	4,548	6,047	4,993	6,047	0.95	4,250	6,596	4,665	6,596
758	866	951	0.99	859	1,142	943	1,142	0.97	841	1,305	923	1,305
759	-	-		-	-	-	-		-	-	-	-
760	-	-		-	-	-	-		-	-	-	-
761	-	-		-	-	-	-		-	-	-	-
762	1,065	1,003	1.09	1,161	1,131	1,094	1,131	1.07	1,143	1,243	1,077	1,243

Zone	Population											
	2016		2021					2031				
	Main Roads	CoC Adjusted to Main Roads Zones	Main Roads Growth Rate 2016-2021	Main Roads	CoC Data Split into Main Roads Zones	Forecast based on the Adjusted 2016 Base with CoC data and factored up with Main Roads growth factors	CoC Further Refined from Feedback	Main Roads Growth Rate 2016-2031	Main Roads	CoC Data Split into Main Roads Zones	Forecast based on the Adjusted 2016 Base with CoC data and factored up with Main Roads growth factors	CoC Further Refined from Feedback
763	-	-		-	-	-	-		-	-	-	-
764	2,626	2,731	1.05	2,749	3,203	2,859	3,203	1.15	3,018	3,476	3,139	3,476
765	879	690	1.01	891	709	700	709	1.02	896	906	704	906
766	2,632	2,737	1.03	2,705	3,152	2,813	3,152	1.12	2,950	3,398	3,068	3,398
767	1,273	1,098	1.00	1,277	1,148	1,101	1,148	0.96	1,218	1,272	1,050	1,272
768	959	827	1.02	978	879	843	879	0.96	918	959	792	959
769	-	-		-	-	-	-		-	-	-	-
770	834	655	0.95	792	630	622	630	0.87	728	737	572	737
771	4,090	3,527	0.99	4,047	3,638	3,490	3,638	1.00	4,093	4,276	3,530	4,276
772	4,756	4,913	1.00	4,747	5,070	4,904	5,070	0.96	4,578	8,071	4,729	8,071
773	2,174	2,246	1.16	2,529	2,701	2,612	2,701	1.29	2,812	4,957	2,904	4,957
774	263	272	3.42	901	963	931	963	2.45	644	1,135	665	1,135
775	2,779	9,403	0.97	2,693	9,680	9,114	9,680	0.86	2,384	9,282	8,068	9,282
776	5,384	10,548	1.00	5,394	12,151	10,569	12,151	1.04	5,592	15,173	10,957	15,173
777	6,613	5,038	1.27	8,407	7,391	6,405	5,334	1.22	8,052	10,372	6,135	6,200
778	5,489	6,548	1.20	6,568	11,304	7,835	8,035	1.22	6,687	14,321	7,977	8,127
779	2,864	1,708	0.30	848	730	506	730	0.10	296	317	177	317
780	35	38	1.49	52	58	57	58	3.06	107	134	118	134
781	2,310	2,540	0.99	2,296	2,540	2,524	2,540	0.94	2,169	2,720	2,385	2,720
782	570	664	0.88	503	773	586	4,041	0.89	509	954	593	7,148
891	3,103	4,181	0.53	1,651	3,361	2,225	3,361	0.66	2,060	1,984	2,776	1,984
892	3,647	4,914	1.26	4,596	9,356	6,193	9,356	2.02	7,360	7,087	9,917	7,087
893	313	422	5.02	1,571	3,198	2,117	3,198	9.92	3,105	2,990	4,184	2,990
939	60	60	1.58	95	95	95	95	2.12	127	127	127	127
940	84	84	0.95	80	80	80	80	0.99	83	83	83	83
941	1	1	38.00	38	38	38	38	5.00	5	5	5	5
Total ROM Area	**115,899**	**129,456**		**127,000**	**156,649**	**141,010**	**156,649**		**141,759**	**181,292**	**157,089**	**181,292**
Cockburn only area	**97,312**	**108,415**		**107,296**	**128,848**	**118,590**	**128,848**		**116,512**	**156,510**	**127,490**	**156,510**
City of Cockburn forecast	108,770	108,770		129,308	129,308	129,308	129,308		157,018	157,018	157,018	157,018
Difference	(11,458)	(355)		(22,012)	(460)	(10,718)	(460)		(40,506)	(508)	(29,528)	(508)
External Zones Total	18,587	21,041		19,704	27,801	22,420	27,801		25,247	24,782	29,599	24,782

Zone	Dwellings											
	2016		2021					2031				
	Main Roads	CoC Adjusted to Main Roads Zones	Main Roads Growth Rate 2016-2021	Main Roads	CoC Data Split into Main Roads Zones	Forecast based on the Adjusted 2016 Base with CoC data and factored up with Main Roads growth factors	CoC Further Refined from Feedback	Main Roads Growth Rate 2016-2031	Main Roads	CoC Data Split into Main Roads Zones	Forecast based on the Adjusted 2016 Base with CoC data and factored up with Main Roads growth factors	CoC Further Refined from Feedback
666	947	749	1.01	952	754	753	754	1.02	970	770	767	770
667	287	287	0.94	270	270	270	270	1.34	385	385	385	385
690	710	710	1.02	721	721	721	721	1.02	726	726	726	726
727	1,525	1,525	1.11	1,688	1,688	1,688	1,688	1.24	1,895	1,895	1,895	1,895
728	781	781	1.02	795	795	795	795	1.07	837	837	837	837
729	1,485	1,485	1.10	1,639	1,639	1,639	1,639	1.31	1,947	1,947	1,947	1,947
733	255	269	9.84	2,510	2,717	2,650	1,250	19.02	4,849	4,121	5,119	3,751
734	447	472	1.42	636	688	671	1,000	1.86	831	706	877	815
735	1,543	1,669	1.07	1,653	1,848	1,788	1,848	1.24	1,917	2,208	2,074	2,208
736	1,145	1,239	1.09	1,244	1,391	1,346	1,391	1.25	1,426	1,643	1,542	1,643
737	774	838	1.05	816	911	884	911	1.31	1,013	1,141	1,097	1,141
738	1,416	1,532	1.04	1,474	1,648	1,594	1,648	1.20	1,695	1,953	1,833	1,953
739	644	701	1.01	648	721	706	721	1.09	701	719	764	719
740	898	978	1.04	931	1,036	1,014	1,036	1.27	1,137	1,166	1,238	1,166
741	1,292	1,364	1.22	1,580	1,710	1,668	2,370	1.40	1,804	1,533	1,904	1,726
742	2,553	2,781	1.12	2,861	3,183	3,116	3,183	1.29	3,296	3,380	3,590	3,380
743	934	986	1.12	1,043	1,129	1,101	1,624	1.31	1,225	1,041	1,293	1,111
744	1,148	1,161	1.09	1,249	1,333	1,263	1,333	1.22	1,403	1,364	1,419	1,364
745	4	4	1.00	4	4	4	4	1.00	4	3	4	3
746	527	533	1.26	665	710	673	710	1.79	944	918	955	918
747	-	-	1.00	-	-	-	-	1.00	-	-	-	-
748	7	5	1.00	7	6	5	6	0.86	6	7	5	7
749	141	107	0.99	140	112	106	112	0.96	136	150	103	150
750	166	126	1.00	166	133	126	749	1.14	189	208	143	1,321
751	21	21	1.00	21	22	21	22	1.00	21	20	21	20
752	-	-	1.00	-	-	-	-	1.00	-	-	-	-
753	30	30	1.00	30	32	30	32	1.00	30	29	30	29
754	1,827	2,010	1.00	1,831	1,979	2,015	1,979	1.01	1,840	1,992	2,025	1,992
755	748	823	1.22	910	983	1,001	983	1.30	975	1,056	1,073	1,056
756	624	685	1.11	692	838	759	838	1.18	739	936	811	936
757	1,652	1,813	1.07	1,762	2,135	1,934	2,135	1.10	1,820	2,306	1,997	2,306
758	350	384	1.07	373	452	409	452	1.10	386	489	424	489
759	-	-	1.00	-	-	-	-	1.00	-	-	-	-
760	-	-	1.00	-	-	-	-	1.00	-	-	-	-
761	-	-	1.00	-	-	-	-	1.00	-	-	-	-

Zone	Dwellings											
	2016		2021					2031				
	Main Roads	CoC Adjusted to Main Roads Zones	Main Roads Growth Rate 2016-2021	Main Roads	CoC Data Split into Main Roads Zones	Forecast based on the Adjusted 2016 Base with CoC data and factored up with Main Roads growth factors	CoC Further Refined from Feedback	Main Roads Growth Rate 2016-2031	Main Roads	CoC Data Split into Main Roads Zones	Forecast based on the Adjusted 2016 Base with CoC data and factored up with Main Roads growth factors	CoC Further Refined from Feedback
762	429	413	1.15	494	472	475	472	1.20	514	524	494	524
763	-	-	1.00	-	-	-	-	1.00	-	-	-	-
764	1,296	1,382	1.03	1,339	1,569	1,428	1,569	1.09	1,414	1,630	1,508	1,630
765	334	272	1.03	344	283	281	283	1.13	378	359	308	359
766	1,161	1,238	1.03	1,194	1,399	1,273	1,399	1.13	1,314	1,514	1,401	1,514
767	470	424	1.04	491	443	443	443	1.07	503	500	454	500
768	328	296	1.09	356	321	321	321	1.15	376	374	339	374
769	-	-	1.00	-	-	-	-	1.00	-	-	-	-
770	263	215	1.06	279	229	228	229	1.10	288	273	235	273
771	1,647	1,486	1.01	1,662	1,498	1,500	1,498	1.03	1,703	1,692	1,537	1,692
772	1,827	2,129	1.01	1,841	2,120	2,145	2,120	1.03	1,880	3,390	2,191	3,390
773	819	954	1.27	1,040	1,198	1,212	1,198	1.41	1,157	2,086	1,348	2,086
774	123	144	3.36	414	476	482	476	2.85	352	634	410	634
775	950	3,140	1.02	970	3,293	3,203	3,293	1.05	995	3,308	3,286	3,308
776	2,002	3,920	1.05	2,111	4,464	4,134	4,464	1.16	2,319	5,444	4,541	5,444
777	2,339	1,776	1.34	3,140	2,513	2,384	1,897	1.38	3,227	3,554	2,450	2,442
778	2,188	2,283	1.21	2,650	3,934	2,765	2,606	1.31	2,873	5,175	2,997	2,747
779	1,120	584	0.26	289	215	151	215	0.10	108	97	56	97
780	12	13	1.58	19	20	21	20	3.42	41	45	45	45
781	822	895	1.05	860	897	937	897	1.10	906	987	987	987
782	143	151	1.37	196	265	207	1,593	1.39	198	314	209	2,743
891	1,227	1,416	0.52	632	1,090	729	1,090	0.62	756	1,100	872	1,100
892	1,459	1,684	1.18	1,724	2,972	1,989	2,972	1.85	2,700	3,929	3,116	3,929
893	120	138	4.81	577	995	666	995	9.49	1,139	1,658	1,314	1,658
939	22	22	1.64	36	36	36	36	2.41	53	53	53	53
940	34	34	1.03	35	35	35	35	1.03	35	35	35	35
941	2	2	2.00	4	4	4	4	2.00	4	4	4	4
Total ROM Area	**46,018**	**51,080**		**52,007**	**62,327**	**57,801**	**62,327**		**60,378**	**74,330**	**67,090**	**74,330**
Cockburn only area	**38,366**	**42,996**		**43,886**	**52,082**	**49,228**	**52,082**		**49,901**	**61,761**	**55,906**	**61,761**
City of Cockburn forecast	43,333	43,333		50,949	50,949	50,950	50,951		62,098	62,098	62,099	62,100
Difference	(4,967)	(337)		(7,063)	1,133	(1,722)	1,131		(12,197)	(337)	(6,193)	(339)
External Zones Total	7,652	8,084		8,121	10,245	8,573	10,245		10,477	12,569	11,184	12,569

Zone	Employment							
	2016		Growth 2016-2021	2021		Growth 2016-2031	2031	
	Main Roads	Adjusted	Main Roads	Main Roads	Forecast based on the Adjusted 2016 Base with CoC data and factored up with Main Roads growth factors	Main Roads	Main Roads	Forecast based on the Adjusted 2016 Base with CoC data and factored up with Main Roads growth factors
666	180	1,165	1.03	186	1,204	0.77	138	893
667	2,703	2,703	4.03	10,904	10,904	7.12	19,257	19,257
690	124	124	1.00	124	124	1.10	136	136
727	362	362	1.05	379	379	1.16	421	421
728	224	224	1.08	242	242	1.25	279	279
729	1,327	1,327	1.07	1,423	1,423	1.22	1,617	1,617
733	364	516	4.51	1,642	2,328	7.67	2,791	3,958
734	274	261	1.95	533	509	1.64	448	428
735	600	677	1.06	633	714	1.18	705	795
736	180	203	1.11	200	226	1.26	227	256
737	211	358	1.01	213	362	1.15	242	411
738	236	548	1.04	246	571	1.14	269	625
739	31	24	1.10	34	26	1.23	38	29
740	1,916	1,457	1.05	2,017	1,534	1.18	2,255	1,715
741	392	322	0.90	353	290	0.93	366	301
742	1,245	789	1.01	1,252	794	1.08	1,341	850
743	118	107	1.02	120	108	1.19	140	126
744	196	177	1.07	209	189	1.20	235	212
745	358	-	0.91	324	-	0.92	328	-
746	368	332	1.07	393	355	1.42	521	470
747	198	272	1.08	214	294	1.22	242	333
748	3,953	5,439	1.03	4,054	5,578	1.09	4,315	5,937
749	276	243	5.41	1,494	1,318	16.09	4,440	3,916
750	133	117	6.18	822	725	48.29	6,423	5,665
751	13	11	23.38	304	268	41.40	538	475
752	245	216	2.19	536	473	3.57	874	771
753	15	22	1.00	15	22	1.07	16	24
754	290	376	1.05	305	396	1.17	339	440
755	111	144	1.05	116	151	1.15	128	166
756	99	171	1.12	111	192	1.10	109	189
757	427	739	1.08	462	800	1.21	515	891
758	113	196	1.04	118	204	1.10	124	215
759	9	12	0.78	7	9	0.78	7	9
760	772	1,126	1.28	989	1,443	1.44	1,111	1,621
761	2,442	3,563	1.03	2,521	3,678	1.14	2,794	4,077

Zone	Employment							
	2016		Growth 2016-2021	2021		Growth 2016-2031	2031	
	Main Roads	Adjusted	Main Roads	Main Roads	Forecast based on the Adjusted 2016 Base with CoC data and factored up with Main Roads growth factors	Main Roads	Main Roads	Forecast based on the Adjusted 2016 Base with CoC data and factored up with Main Roads growth factors
762	2,731	3,151	1.04	2,838	3,274	1.12	3,063	3,534
763	1,777	1,527	1.04	1,841	1,582	1.12	1,999	1,718
764	235	269	1.04	244	280	1.16	272	312
765	27	31	1.19	32	37	1.26	34	39
766	96	110	1.09	105	120	1.43	137	157
767	151	173	1.26	191	219	1.25	189	217
768	36	41	1.64	59	68	1.47	53	61
769	11	5	0.73	8	4	0.55	6	3
770	151	117	0.99	150	116	1.06	160	124
771	470	328	1.04	488	341	1.19	561	392
772	847	1,224	1.05	888	1,283	1.18	999	1,444
773	68	98	3.73	253	366	8.23	559	807
774	300	3,305	3.94	1,181	13,008	2.79	836	9,205
775	-	-	1.00	-	-	1.00	-	-
776	366	1,583	1.04	379	1,642	0.95	349	1,509
777	383	1,527	1.84	704	2,806	0.98	376	1,499
778	297	514	1.02	304	526	1.03	307	532
779	224	194	0.93	208	180	1.39	311	269
780	1,349	2,604	1.21	1,635	3,156	1.33	1,788	3,451
781	742	875	1.02	758	894	1.16	858	1,012
782	1,605	5,112	1.06	1,705	5,431	1.08	1,741	5,544
891	160	160	0.73	117	117	1.10	176	176
892	181	181	1.47	266	266	1.97	357	357
893	1	1	3.00	3	3	5.00	5	5
939	2	2	1.00	2	2	84.00	168	168
940	-	-	1.00	838	-	1.00	1,634	-
941	2	2	564.00	1,128	1,128	1,363.05	2,726	2,726
Total ROM Area	**32,716**	**47,460**		**49,821**	**74,681**		**73,392**	**92,766**
Cockburn only area	**27,630**	**42,374**		**34,395**	**60,093**		**46,616**	**67,624**
City of Cockburn forecast	54,575	54,575		54,577	54,578		54,580	54,581
Difference	(26,945)	(12,201)		(20,182)	5,515		(7,964)	13,043
External Zones Total	5,086	5,086		15,426	14,588		26,776	25,142

Zone	Education							
	2016		Growth 2016-2021	2021		Growth 2016-2031	2031	
	Main Roads	Adjusted	Main Roads	Main Roads	Forecast based on the Adjusted 2016 Base with Department of Education data and factored up with Main Roads growth factors	Main Roads	Main Roads	Forecast based on the Adjusted 2016 Base with Department of Education data and factored up with Main Roads growth factors
666	-	-	1.00	-	-	1.00	-	-
667	1,311	1,311	1.01	1,318	1,318	1.01	1,326	1,326
690	613	613	1.04	635	635	1.09	671	671
727	583	583	1.03	602	602	1.06	620	620
728	1,193	1,193	1.01	1,205	1,205	1.02	1,222	1,222
729	1,601	1,601	1.02	1,639	1,639	1.05	1,681	1,681
733	-	-	1.00	250	-	1.00	500	-
734	-	-	1.00	-	-	1.00	-	-
735	1,173	1,173	1.00	1,175	1,175	1.01	1,179	1,179
736	18	18	1.00	18	18	1.00	18	18
737	41	41	1.00	41	41	0.85	35	35
738	450	450	1.00	451	451	0.98	443	443
739	-	-	1.00	-	-	1.00	-	-
740	366	366	1.00	367	367	1.00	366	366
741	-	-	1.00	-	-	1.00	-	-
742	746	746	1.00	747	747	0.97	723	723
743	439	439	1.06	466	466	1.09	479	479
744	843	843	1.01	848	848	1.00	842	842
745	-	-	1.00	-	-	1.00	-	-
746	524	524	1.05	551	551	1.13	591	591
747	-	-	1.00	-	-	1.00	-	-
748	-	-	1.00	-	-	1.00	-	-
749	138	138	0.98	135	135	0.98	135	135
750	-	-	1.00	-	-	1.00	-	-
751	-	-	1.00	-	-	1.00	-	-
752	-	-	1.00	-	-	1.00	-	-
753	-	-	1.00	-	-	1.00	-	-
754	1,358	1,358	1.01	1,371	1,371	1.01	1,374	1,374
755	-	-	1.00	-	-	1.00	-	-
756	-	461	1.00	-	461	1.00	-	461
757	714	714	1.12	799	799	1.18	846	846
758	546	546	1.00	547	547	0.99	540	540
759	-	-	1.00	-	-	1.00	-	-
760	-	-	1.00	-	-	1.00	-	-
761	-	-	1.00	-	-	1.00	-	-

Zone	Education							
	2016		Growth 2016-2021	2021		Growth 2016-2031	2031	
	Main Roads	Adjusted	Main Roads	Main Roads	Forecast based on the Adjusted 2016 Base with Department of Education data and factored up with Main Roads growth factors	Main Roads	Main Roads	Forecast based on the Adjusted 2016 Base with Department of Education data and factored up with Main Roads growth factors
762	165	165	1.00	165	165	0.92	151	151
763	-	-	1.00	-	-	1.00	-	-
764	286	286	1.00	287	287	1.00	286	286
765	-	-	1.00	-	-	1.00	-	-
766	74	-	1.00	74	-	0.93	69	-
767	-	-	1.00	-	-	1.00	-	-
768	-	-	1.00	-	-	1.00	-	-
769	-	-	1.00	-	-	1.00	-	-
770	-	-	1.00	-	-	1.00	-	-
771	918	918	1.00	920	920	0.99	913	913
772	1,208	1,208	1.00	1,210	1,210	0.99	1,199	1,199
773	-	-	1.00	-	-	1.00	-	-
774	-	-	1.00	-	-	1.00	-	-
775	445	445	1.07	478	478	1.11	493	493
776	760	760	1.08	822	822	1.09	825	825
777	-	629	1.00	-	629	1.00	-	629
778	-	1,083	1.00	-	1,083	1.00	-	1,083
779	769	-	0.96	741	-	0.98	751	-
780	-	-	1.00	-	-	1.00	-	-
781	-	-	1.00	-	-	1.00	-	-
782	-	-	1.00	-	-	1.00	-	-
891	126	-	1.45	183	-	1.98	250	-
892	88	927	2.56	225	2,370	5.11	450	4,740
893	-	-	1.00	100	-	1.00	200	-
939	-	-	1.00	-	-	1.00	-	-
940	-	-	1.00	-	-	1.00	-	-
941	-	-	1.00	-	-	1.00	-	-
Total ROM Area	**17,496**	**19,539**		**18,370**	**21,340**		**19,178**	**23,871**
Cockburn only area	**11,981**	**13,311**		**12,463**	**13,571**		**12,758**	**13,611**
City of Cockburn forecast	54,582	54,583		54,585	54,586		54,588	54,589
Difference	(42,601)	(41,272)		(42,122)	(41,015)		(41,830)	(40,978)
External Zones Total	5,515	6,228		5,907	7,769		6,420	10,260

Zone Area	Population						Dwellings						Employment					
	2016		2021		2031		2016		2021		2031		2016		2021		2031	
	Main Roads	CoC Adjusted	Main Roads	CoC Adjusted	Main Roads	CoC Adjusted	Main Roads	CoC Adjusted	Main Roads	CoC Adjusted	Main Roads	CoC Adjusted	Main Roads	CoC Adjusted	Main Roads	CoC Adjusted	Main Roads	CoC Adjusted
Total ROM Area	115,899	129,456	127,000	156,649	141,759	181,292	46,018	51,080	52,007	62,327	60,378	74,330	32,716	47,460	49,821	74,681	73,392	92,766
Cockburn only area	97,312	108,415	107,296	128,848	116,512	156,510	38,366	42,996	43,886	52,082	49,901	61,761	27,630	42,374	34,395	60,093	46,616	67,624
City of Cockburn forecast	108,770	108,770	129,308	129,308	157,018	157,018	43,333	43,333	50,949	50,949	62,098	62,098	54,575	54,575	54,577	54,578	54,580	54,581
Difference	-11,458	-355	-22,012	-460	-40,506	-508	-4,967	-337	-7,063	1,133	-12,197	-337	-26,945	-12,201	-20,182	5,515	-7,964	13,043
External Zones Total	18,587	21,041	19,704	27,801	25,247	24,782	7,652	8,084	8,121	10,245	10,477	12,569	5,086	5,086	15,426	14,588	26,776	25,142