Veitch Lister Consulting Pty Ltd

Prepared for

Australian Government
Infrastructure Australia

Transport Planning for the Australian Infrastructure Audit

Transport Modelling Report for Melbourne

June 2019

Transport Planning for the Australian Infrastructure Audit

FINAL

Transport Modelling Report for Melbourne

Project No. 18-025

LIMITATION: This report is confidential and has been prepared on behalf of and for the exclusive use of VLC's Client, and is subject to and issued in connection with the provisions of the agreement between VLC and its Client.

The purpose of the work remains as per the current contractual arrangement with the Client and is not varied by any statement contained herein.

The quality of the information contained in this report is on a best efforts basis and subject to the constraints of scope, budgets and the time allowed by the Client.

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The output of the models used within this report are based upon reasonable assumptions and inputs agreed with the Client. They are not predictions or promises for the future but based on mathematical likelihoods and probabilities based on the data available at the time. As with any modelling effort unforeseen variables will affect the accuracy of the eventual outcomes.

By issuing this report VLC is not recommending any course of action or investment undertaking.

Date	Revision	Prepared By	Checked By	Approved By	Description
22/10/2018	A	H Smithers	L Walker	D Veryard	Draft Report
22/11/2018	B	H Smithers	L Walker	D Veryard	Draft Report
10/12/2018	C	L Walker	L Walker	D Veryard	Final Report
15/02/2019	D	N Ng	D Veryard	D Veryard	Final Draft Report
20/03/2019	E	N Ng	D Veryard	D Veryard	Final Report
03/06/2019	F	A Mak	D Veryard	D Veryard	Final Report (revised train crowding)

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1. Introduction

1.1 Background

The first Infrastructure Audit, undertaken over 2014-15, for the first time provided evidence developed on a consistent basis to support the identification of current and emerging infrastructure problems. This helped IA to identify the most nationally significant problems that were not necessarily being identified or addressed by bottom-up state, territory and private sector proposals. Combining bottom-up submissions with top-down evidence developed through the Infrastructure Audit allows a more comprehensive and independent picture of national priorities.

Veitch Lister Consulting (VLC) supported the first Audit by modelling travel demands in six major mainland cities under base year (2011) and future year (2031) conditions using our multi-modal Zenith model. In the intervening four years, the landscape of Australian cities has changed considerably. New major transport projects have received significant political and financial commitment, while certain projects included in the original Audit have been cancelled or scaled down. Similarly, population growth has run ahead of projections in some urban areas but has slowed in other parts of the country.

It is important to note Infrastructure Australia does not view this modelling as a single version of the future. The modelling necessarily uses a set of assumptions about future projects, transport costs and technology. The chosen assumptions reflect a business as usual future, where there is minimal change to current conditions. However, in reality there is significant uncertainty about how these important inputs will change over time. The results in this modelling are therefore indicative and one of many potential futures.

1.2 Scope of this report

In response to these changed circumstances IA is updating their evidence base and VLC is assisting in this update by revising the travel modelling. Specific changes include:

- Updated future population and employment assumptions
- Revised transport system assumptions, including both networks and cost parameters
- Modelling with capacity-constrained public transport networks, and
- A wider range of transport-related indicators of success and challenges, including access to opportunities for employment, education, health and recreation, as well as the economic costs of crowding and road congestion.

This report summarises the results of this updated modelling for Melbourne. Specifically, it evaluates the performance of Greater Melbourne's transport network in 2031 based on an evaluation framework that includes transport, economic, environmental and social indicators.

VLC is also assisting IA to test an alternative road-user charging regime. The results of this alternative policy scenario will be documented in a separate report.

***A note on tables and figures in this report**:*

All tables and figures which quote numbers have been rounded to reflect that these forecasts are subject to considerable uncertainty. Where a numerical or percentage change has been quoted, it has been calculated using the unrounded data.

2. Melbourne in the future

Understanding how Melbourne's transport network might perform in the future requires a detailed vision of what the region may look like at specific future planning horizons. The scale and distribution of population and job opportunities, upgrades to the transport network, as well as the cost of parking, public transport fares and fuel all require consideration in order to produce robust travel demand forecasts. This section of the report provides an overview of the assumptions underpinning the Zenith model of Greater Melbourne. More detailed assumptions can be found in the appendices.

2.1 People and jobs

The number of people residing in Melbourne as well as the locations in which they live and work are the key drivers of the nature and scale of the transport task in the city. In 2016, the Melbourne Greater Capital City Statistical Area (GCCSA) had a population of around 4.6 million people, while the neighbouring Geelong SA4 had 192,000 residents.

Melbourne City and surrounding inner areas have the highest population densities, however in terms of the overall share of Melbourne's population, the number of people living in densely populated areas is relatively small. Around 10 per cent of Melbourne's population lived within the 'inner' areas (Melbourne City, Port Phillip, Yarra and Stonnington West) in 2016. Population density generally decreases as distance from the CBD increases, with the lowest population densities observed on the urban fringe (Figure 2-1). Melbourne's population is skewed towards the south east, with the south eastern suburbs extending much further than the western and northern suburbs.

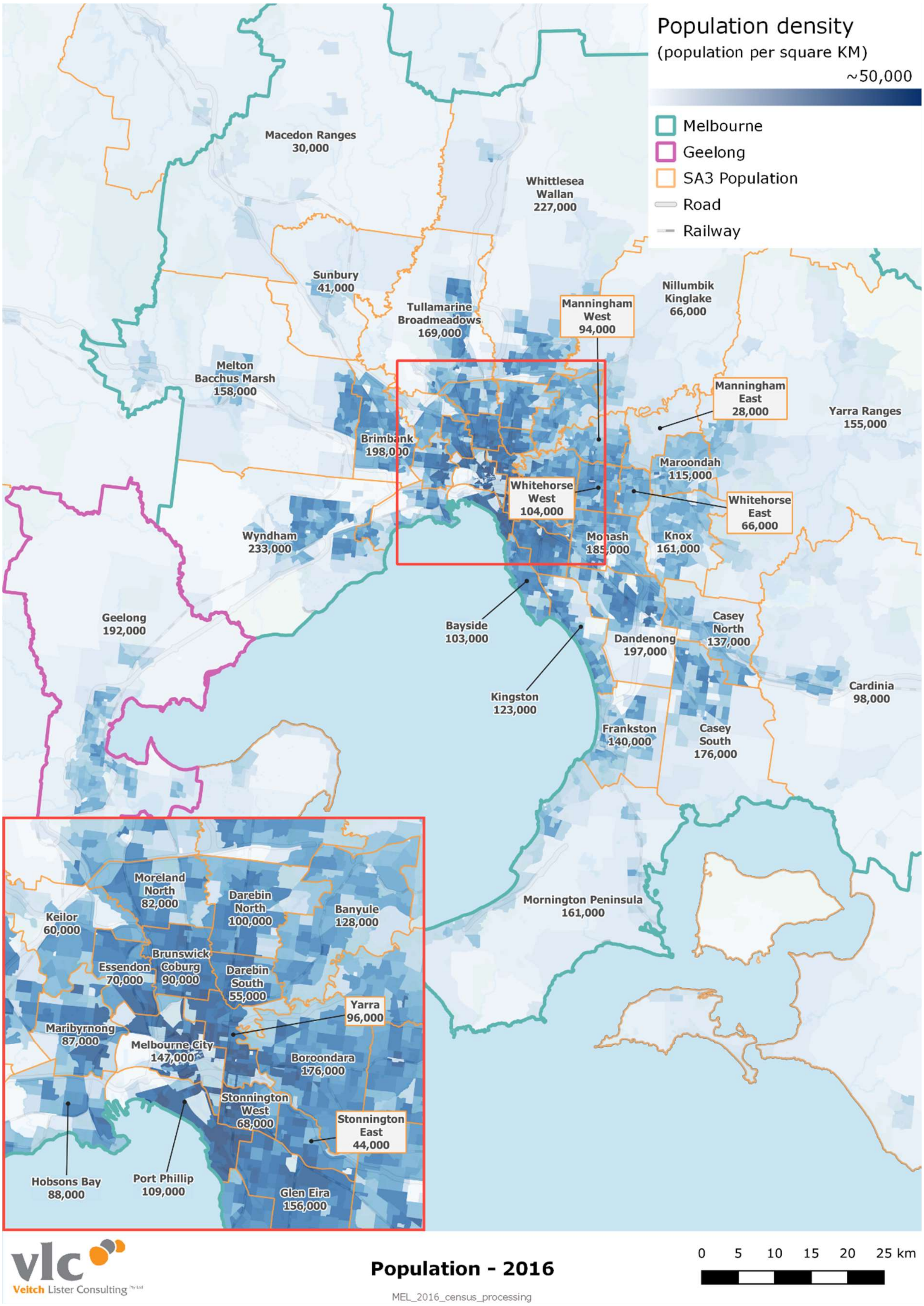
The Victorian Government projects that Melbourne's population will grow to just over 6 million people by 2031. The addition of around 1.3 million extra residents means the city's population will grow by almost 30 per cent, with a net increase of 90,000 people each year on average. By 2031, Melbourne's population is projected to have grown both through densification in established areas but also through greenfield development (Figure 2-2). The strongest densification is forecast for Melbourne City, Port Phillip and Maribyrnong (Figure 2-3). Slower population growth is forecast for the middle ring suburbs, particularly in the east.

Population in Melbourne's outer areas is forecast to grow strongly. In the west, Melton-Bacchus Marsh and Wyndham will house approximately 260,000 extra residents, accommodating almost 20 per cent of Melbourne's total growth. Also in the west, the Geelong SA3 is projected to grow by 48,000 residents to reach a population of 240,000 by 2031. This represents a growth of 25 per cent from 2016.

High levels of population growth are also expected in the north, with Whittlesea-Wallan's population forecast to increase by around 161,000 people. Projections also indicate that Cardinia and Casey South will experience substantial population growth.

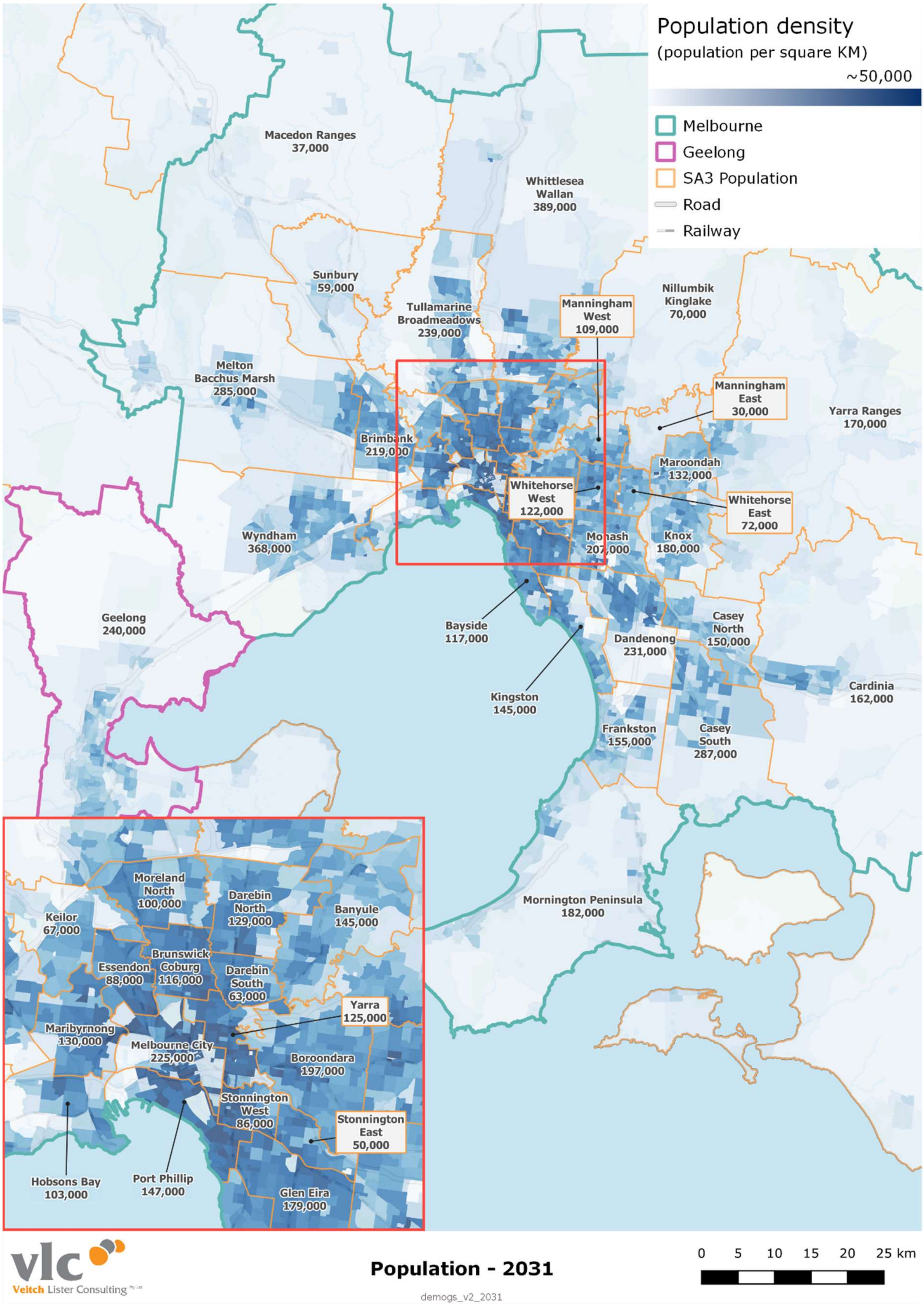
In light of the nature and location of the forecast growth, by 2031 more people will live at Melbourne's periphery. This will increase the pressure on the transport infrastructure in these growth areas, as well as the corridors which link them to major activity centres.

Figure 2-1 – Melbourne GCCSA and Geelong population density and SA3 totals in 2016



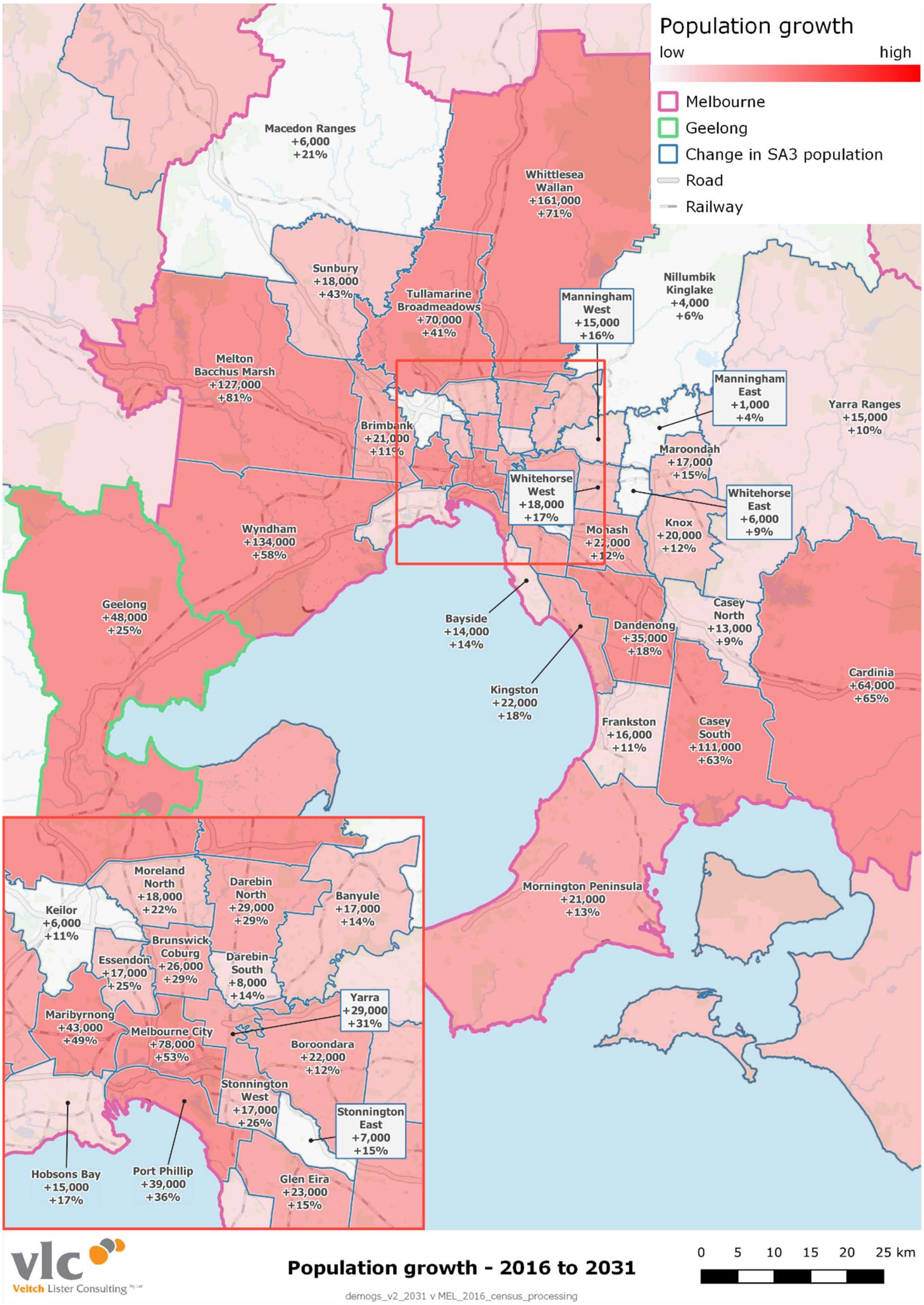
Source: ABS 2016 Census, disaggregated to Zenith travel zones

Figure 2-2 – Melbourne GCCSA and Geelong population density and SA3 totals in 2031



Source: The modelling uses demographic projections from Transport for Victoria (TfV), as well as projections previously prepared by SGS Economics and Planning for areas of the model where TfV projections were not provided. These are disaggregated to Zenith travel zones.

Figure 2-3 – Melbourne GCCSA and Geelong population growth by SA3 2016 to 2031 forecast



Source: ABS 2016 Census, TfV and SGS Economics and Planning

In 2016, Melbourne's GCCSA contained around 2.3 million jobs, with jobs concentrated in central areas (Figure 2-4). The CBD and its immediate surrounds had the highest job density, with Melbourne City containing around a fifth of Melbourne GCCSA's employment (around 486,000 jobs). The adjacent areas of Port Phillip, Yarra and Stonnington West also had high employment densities. Considered together, these 'inner' areas contained around 30 per cent of Melbourne's total employment, indicating that Melbourne's employment was relatively centralised in 2016. Outside the inner city, Melbourne's employment was generally evenly dispersed across the middle and outer suburbs. However, Dandenong and Monash represent significant employment clusters, each with around 120,000 jobs.

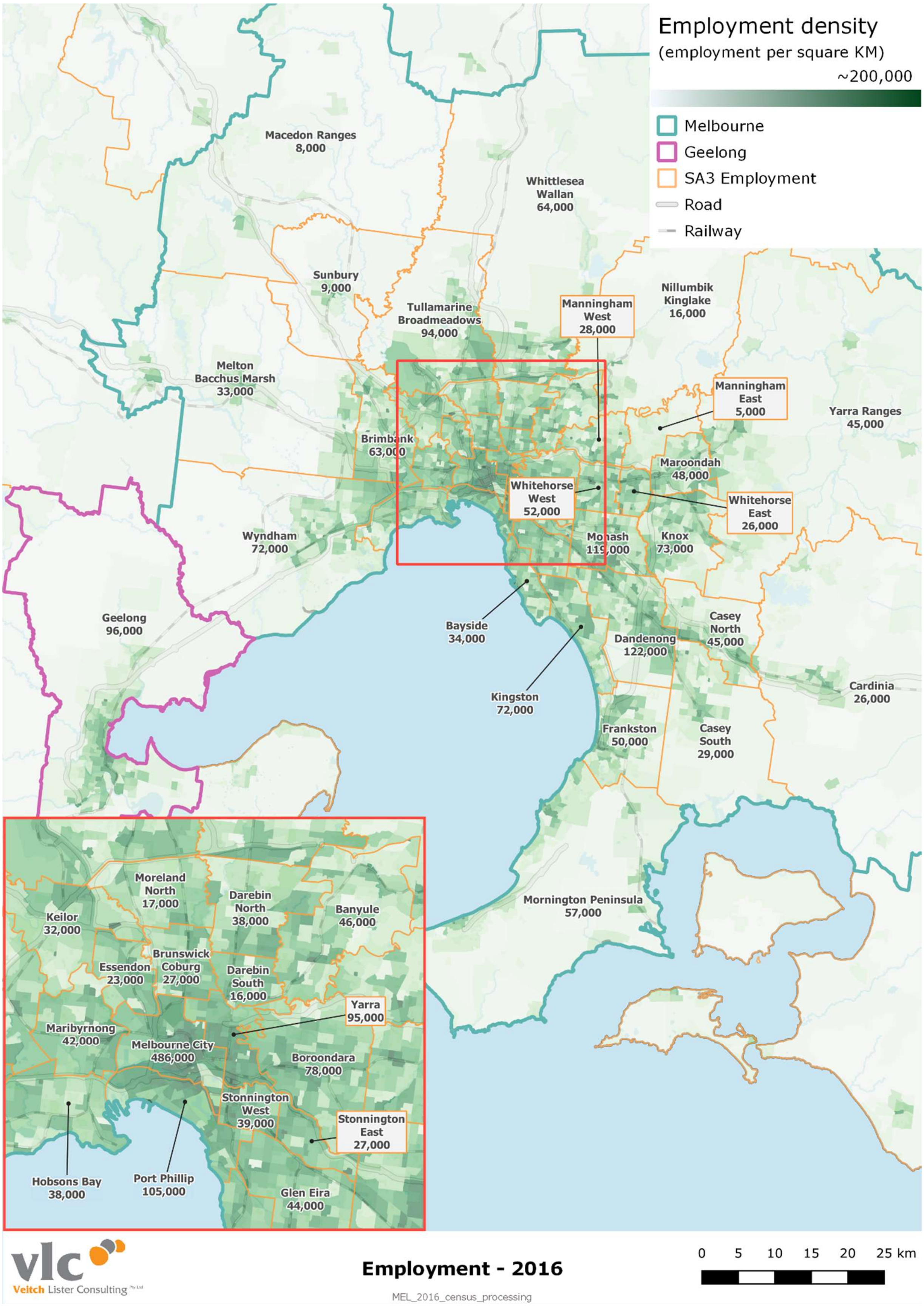
The Victorian Government projects strong employment growth for Melbourne with the number of jobs expected to grow by 859,000 to 3.2 million (a growth of 37%). Employment is expected to remain centralised, with increased employment agglomeration in Melbourne City (Figure 2-5). Port Phillip and Yarra are also expected to accumulate around 51,000 and 42,000 extra jobs respectively (Figure 2-6). Of the middle ring suburbs, Boroondara is expected to have the largest net increase in jobs, adding approximately 30,000 by 2031. Employment in Essendon is expected to almost double, with a net increase of around 20,000 jobs.

Melbourne's outer suburbs are expected to experience the fastest employment growth rates. In the south east, the expansion of the metropolitan area results in strong increases in employment in Casey South and Cardinia. Similar growth is expected in Melbourne's north and west, where new development in Melton-Bacchus Marsh, Wyndham and Whittlesea-Wallan result in substantial employment growth. The number of people moving to live in these areas will far outstrip the number of new jobs projected there. As such, demand for travel is likely to put pressure both on the local transport links and the corridors that facilitate access to the inner and middle areas.

In the Geelong SA3, jobs are projected to increase from 96,000 in 2016 to 135,000 in 2031. This represents an increase of 40 per cent, which is larger than the expected 25 per cent increase in residents.

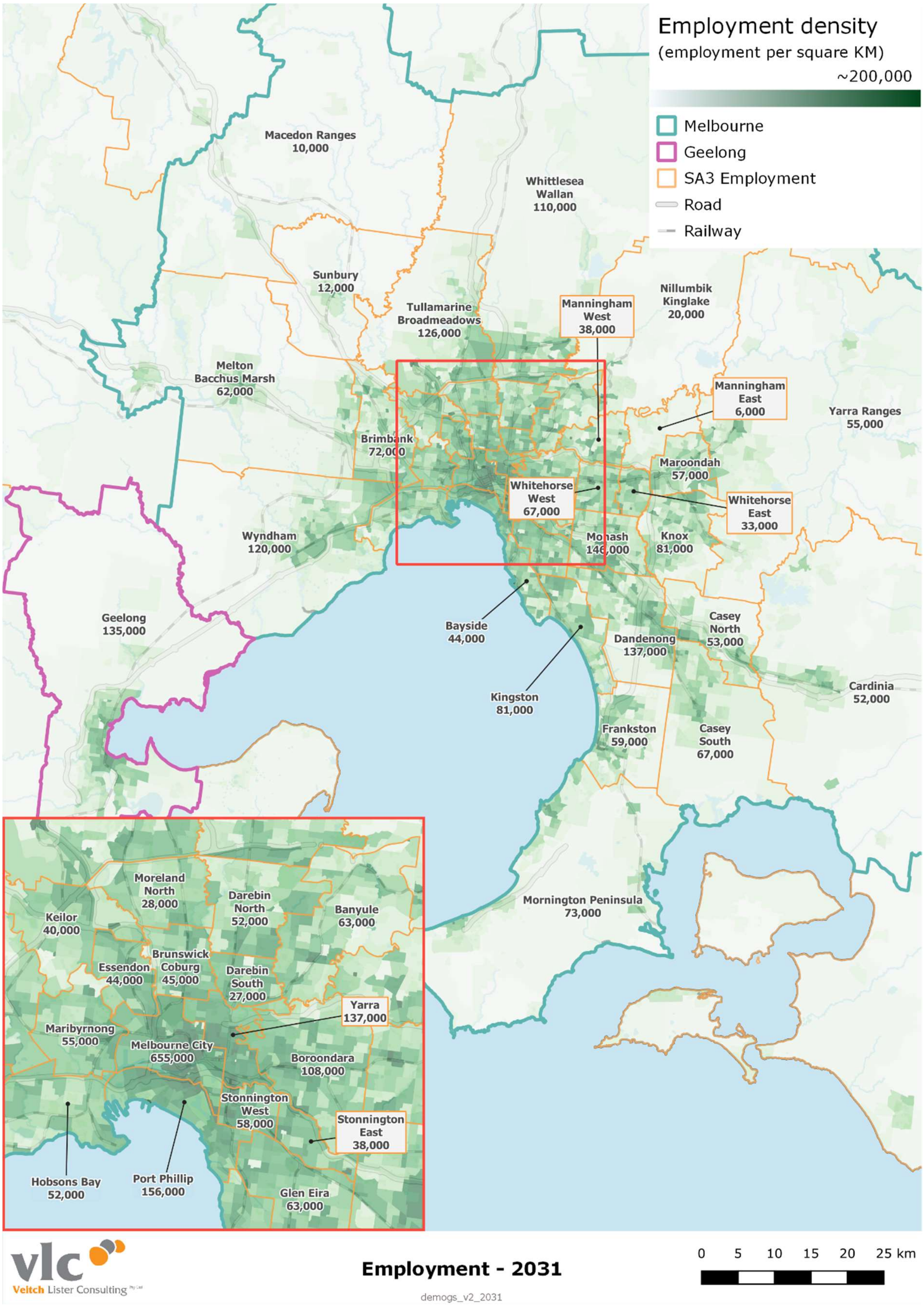
Melbourne is expected to grow both up (increased densities) and out (urban expansion). Melbourne's urban core is forecast to house both more people and a greater number of jobs. This intensification of activity will increase travel demand, putting increased pressure on inner Melbourne's already congested road and rail corridors. As Melbourne grows, employment is expected to remain strongly centralised, population is forecast to be remain less so. In fact, much of Melbourne's population growth is expected to be housed at the city's edge. The increasing disconnect between where people live and where they work is likely to considerably increase travel demand and put pressure on the transport links throughout the city.

Figure 2-4 – Melbourne GCCSA and Geelong employment density and SA3 totals in 2016



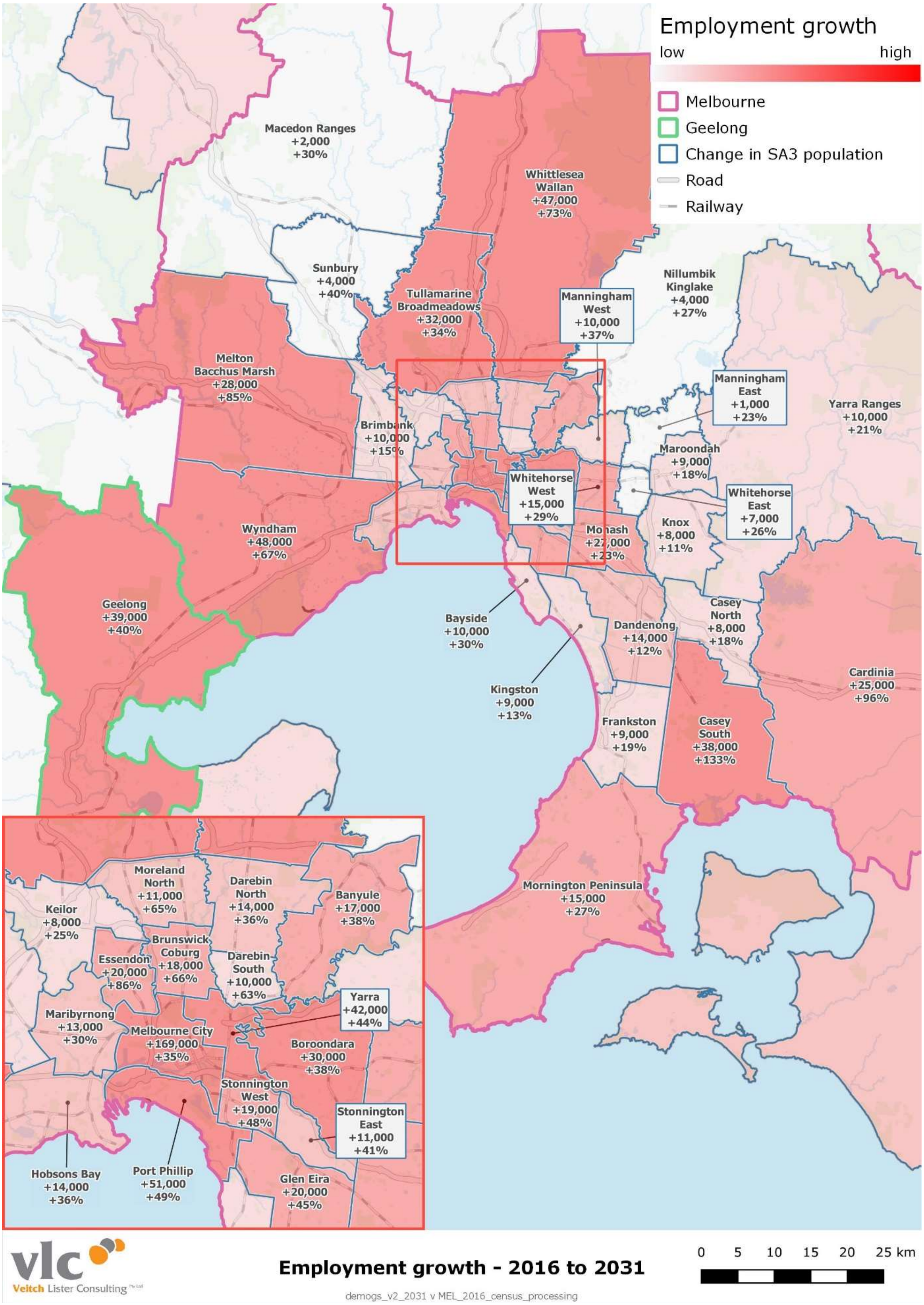
Source: ABS 2016 Place of Work, disaggregated to Zenith travel zones

Figure 2-5 – Melbourne GCCSA and Geelong employment density and SA3 totals in 2031



Source: ABS 2016 Census, TfV and SGS Economics and Planning

Figure 2-6 – Melbourne GCCSA and Geelong employment growth by SA3 2016 to 2031 forecast



Source: ABS 2016 Census, TfV and SGS Economics and Planning

2.2 Transport networks

The transport network assumed in transport modelling determines how (and how easily) people will get between their homes, jobs, schools, shops and other activity areas. The 2031 transport network for Greater Melbourne has been developed using a minimal-intervention approach. Included projects were (at the time of modelling in August 2018) either under construction, under procurement, or had a public commitment to fund construction from all relevant governments. It is important to note that some projects fall outside of government's budget forward estimates, so some modelled projects may not be fully funded. Finally, some bus routes have also been expanded to support the development of new suburbs. Some of the most significant projects are described in more detail below and can be referenced in Figure 2-7. A full list of network assumptions can be found in Appendix A:.

North East Link is a new freeway connecting the M80 Ring Road to the Eastern Freeway, linking growth areas in the city's north and south-east. The project has funding from both Victorian and Australian governments. The package of works includes additional lanes on the Eastern Freeway between Springvale Road and Chandler Highway and dedicated busways between Doncaster Park and Ride and Hoddle Street. The **M80 Upgrade** is a related project which involves widening various sections of the freeway between the Princes Freeway and the Greensborough Highway.

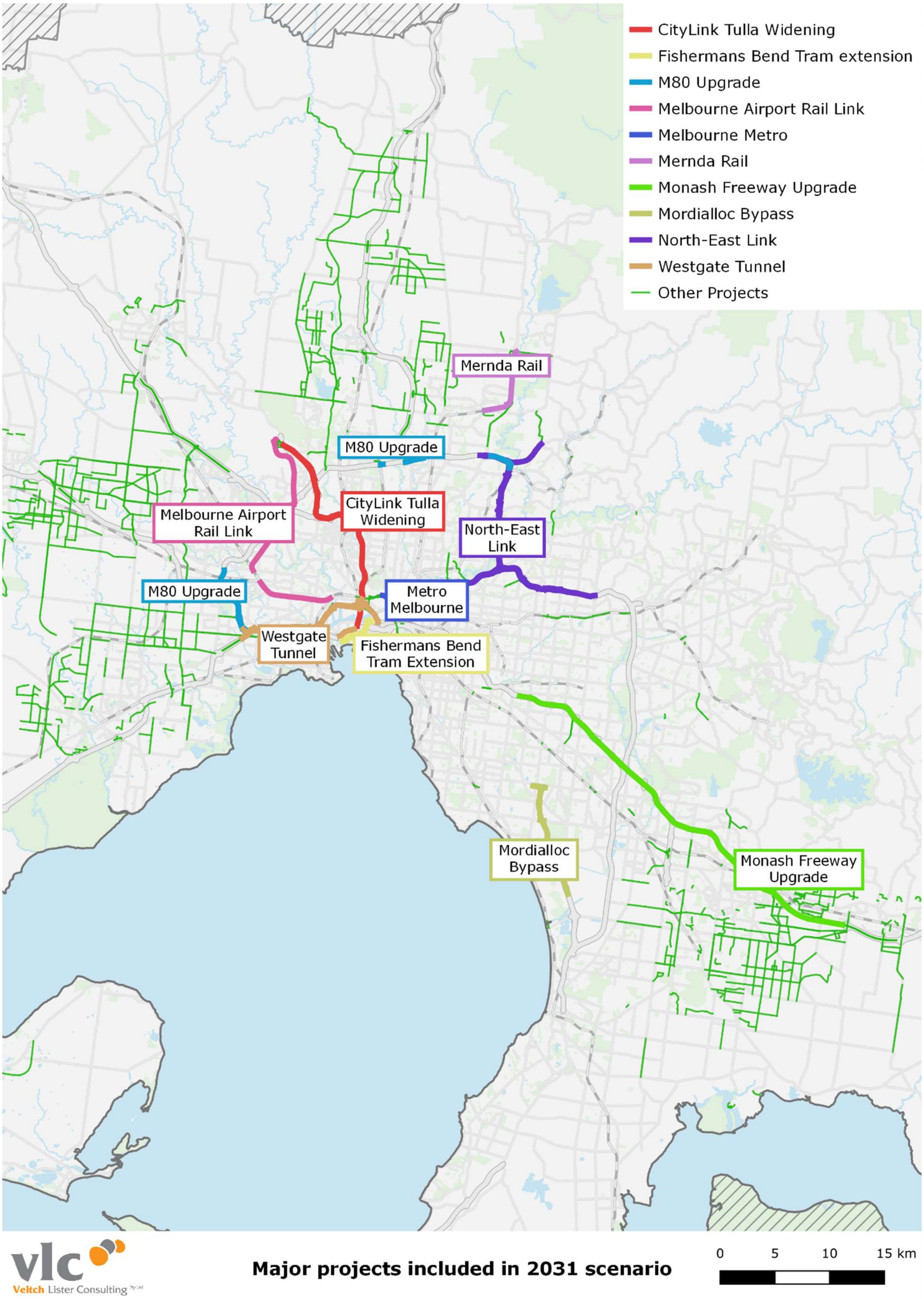
Melbourne Metro involves the construction of new rail tunnels through Melbourne's CBD. The project will link the Dandenong and Sunbury rail lines and will include five new stations in the inner city. Melbourne Metro will enable services to travel through the City Loop and CBD, allowing higher service frequencies across multiple rail lines. Higher capacity rolling stock will also operate on along the new Dandenong – Sunbury corridor.

An additional road crossing of the Maribyrnong River will be provided through the construction of the **West Gate Tunnel**. The project links the West Gate Freeway to Footscray Road via new tunnel and bridge infrastructure and widens the existing West Gate Freeway. Connected with this project is the **Monash Freeway Upgrade**, which widens the freeway between Warrigal Road and Clyde Road and upgrades the Princes Freeway to include managed motorways.

Other public transport network upgrades include the **Mernda Rail extension** (completed in 2018), the **Fishermans Bend Tram Link** and the **Melbourne Airport Rail Link**.

Several other upgrades are planned for Melbourne's freeway network after 2016. These include the **CityLinkTulla Widening**, providing additional capacity between the city and Melbourne Airport, and the **Mordialloc Bypass**, linking the Mornington Peninsula Freeway with the Dingley Bypass.

Figure 2-7 – Melbourne GCCSA major projects in 2031 forecast



By 2031 the provision of public transport is expected to increase substantially in Melbourne (Table 2-1). Both suburban and regional rail services are assumed to be expanded significantly, with Victorian Government planning documents indicating that service provision will grow fastest in the Off-peak (6PM-7AM). The introduction of Melbourne Metro, the Melbourne Airport Rail Link and the extension to Mernda increase the length of the urban rail network. The extra capacity provided by Melbourne Metro enable additional services to run on key corridors, as such the increase in service kilometres assumed in the modelling is a function of both the extended network and the higher frequencies across the network. The Victorian Government's Regional Rail Revival will allow more services to run on the regional rail network, driving an increase in service kilometres.

A conservative approach has been adopted to modelling Melbourne's 2031 bus network, with new routes and route extensions to service growth areas. As a result, bus service kilometres grow more slowly – growing by 33 per cent across the day. Nevertheless, buses on the Eastern Freeway benefit from the busway on the Eastern Freeway.

These metrics have also been included for the Geelong SA4 in Appendix Table F-1.

Table 2-1 – Melbourne GCCSA weekday public transport service kilometres[1]

Metric	Time period	2016	2031	Change	% change
Suburban rail	AM peak (7-9AM)	12,000	17,000	+5,000	+42%
	Inter-peak (9AM-4PM)	25,000	36,000	+11,000	+47%
	PM peak (4-6PM)	10,000	17,000	+6,000	+60%
	Off-peak (6PM-7AM)	24,000	58,000	+34,000	+144%
	Daily total	**70,000**	**127,000**	**+57,000**	**+81%**
Tram	AM peak (7-9AM)	9,000	14,000	+4,000	+47%
	Inter-peak (9AM-4PM)	30,000	31,000	+1,000	+2%
	PM peak (4-6PM)	10,000	14,000	+4,000	+36%
	Off-peak (6PM-7AM)	22,000	57,000	+35,000	+161%
	Daily total	**71,000**	**115,000**	**+44,000**	**+61%**
Bus	AM peak (7-9AM)	48,000	62,000	+14,000	+30%
	Inter-peak (9AM-4PM)	143,000	177,000	+34,000	+24%
	PM peak (4-6PM)	49,000	63,000	+15,000	+30%
	Off-peak (6PM-7AM)	95,000	141,000	+46,000	+49%
	Daily total	**334,000**	**443,000**	**+109,000**	**+33%**
Regional rail	AM peak (7-9AM)	5,000	8,000	+3,000	+47%
	Inter-peak (9AM-4PM)	12,000	19,000	+7,000	+54%
	PM peak (4-6PM)	5,000	8,000	+3,000	+71%
	Off-peak (6PM-7AM)	10,000	29,000	+18,000	+175%
	Daily total	**33,000**	**64,000**	**+31,000**	**+94%**
Total	AM peak (7-9AM)	75,000	101,000	+26,000	+35%
	Inter-peak (9AM-4PM)	210,000	263,000	+53,000	+25%
	PM peak (4-6PM)	74,000	101,000	+28,000	+38%
	Off-peak (6PM-7AM)	150,000	284,000	+133,000	+89%
	Daily total	**509,000**	**749,000**	**+241,000**	**+47%**

[1] Service kilometres include all public transport lines servicing the Melbourne GCCSA (and not exclusively kilometres operating within the Melbourne GCCSA).

3. Travel demands

The rapid population growth projected for Melbourne is likely to increase the transport task by 2031. This part of the report includes the Zenith model's estimates and forecasts for travel in the 2016 base and the 2031 forecast. Individual metrics are reported on under the following themes:

- Growth in person travel,
- Growth in road network demand, and
- Growth in public transport demand.

3.1 Growth in person travel

The number of trips made in Melbourne by 2031 are expected to increase to nearly 18 million on the average weekday (representing a 25% increase) (Table 3-1). The majority of extra trips are made by car, with a net increase of just over 2.6 million car trips by 2031 (Figure 3-2). In 2031, car travel is forecast to remain the most popular mode with a 77 per cent share of average weekday travel – this represents a slight decrease from 2016. Public transport use is expected to increase to nearly 13 per cent of trips. This outcome is a function the of greater time and monetary costs of driving (increased congestion and a real increase in parking charges), as well as the major investments planned for the public transport system (for more detailed model assumptions see Appendix D:).

Table 3-1– Melbourne GCCSA person trips by mode

Mode	Time period	2016	2031	Change	% change
Car	AM peak (7-9AM)	1,794,000	2,236,000	+442,000	+25%
	Inter-peak (9AM-4PM)	5,035,000	6,225,000	+1,191,000	+24%
	PM peak (4-6PM)	1,721,000	2,124,000	+404,000	+23%
	Off-peak (6PM-7AM)	2,529,000	3,136,000	+607,000	+24%
	Daily total	**11,079,000**	**13,722,000**	**+2,644,000**	**+24%**
Public transport	AM peak (7-9AM)	373,000	574,000	+201,000	+54%
	Inter-peak (9AM-4PM)	616,000	879,000	+262,000	+43%
	PM peak (4-6PM)	262,000	409,000	+147,000	+56%
	Off-peak (6PM-7AM)	247,000	422,000	+175,000	+71%
	Daily total	**1,499,000**	**2,284,000**	**+785,000**	**+52%**
Walk and cycle	AM peak (7-9AM)	225,000	264,000	+39,000	+17%
	Inter-peak (9AM-4PM)	813,000	872,000	+59,000	+7%
	PM peak (4-6PM)	233,000	267,000	+34,000	+15%
	Off-peak (6PM-7AM)	388,000	437,000	+49,000	+13%
	Daily total	**1,659,000**	**1,840,000**	**+182,000**	**+11%**
Total	AM peak (7-9AM)	2,393,000	3,075,000	+682,000	+29%
	Inter-peak (9AM-4PM)	6,464,000	7,977,000	+1,512,000	+23%
	PM peak (4-6PM)	2,216,000	2,800,000	+584,000	+26%
	Off-peak (6PM-7AM)	3,163,000	3,995,000	+832,000	+26%
	Daily total	**14,236,000**	**17,847,000**	**+3,611,000**	**+25%**

Figure 3-1 – Melbourne GCCSA mode share of daily trips - 2016 and 2031

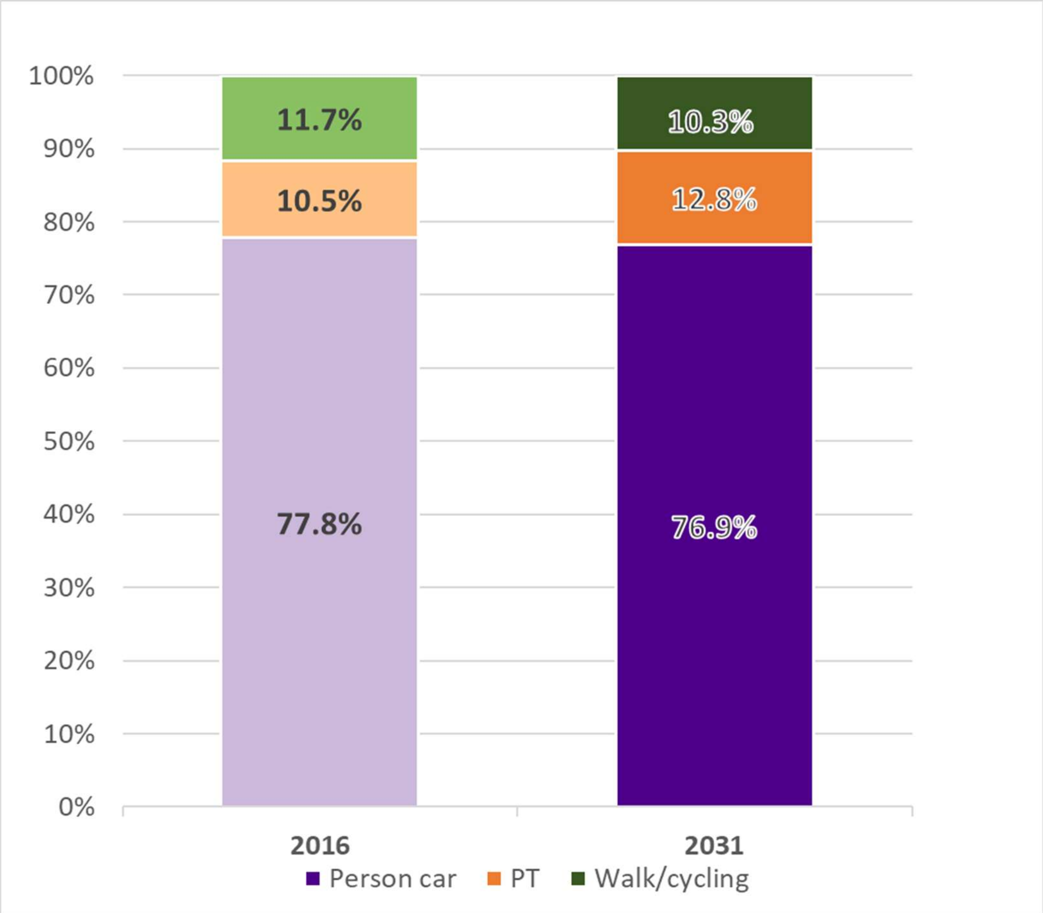
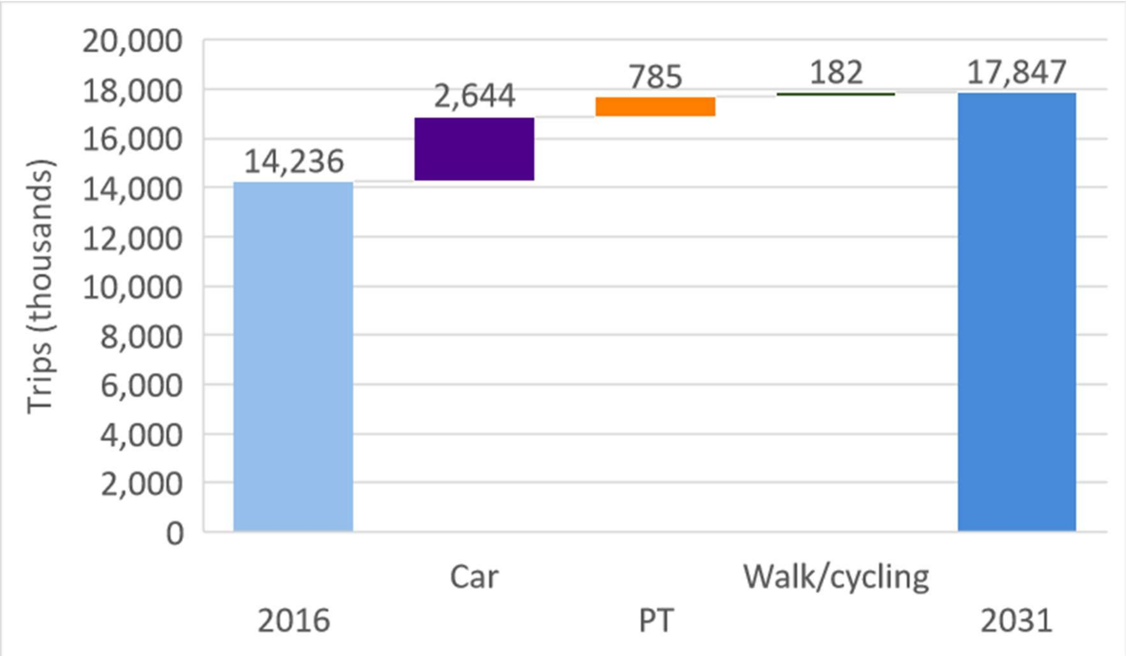


Figure 3-2 – Melbourne GCCSA growth in weekday person trips, 2016 to 2031



These travel demand metrics have also been reported for the Geelong SA4 in Appendix Table F-2.

3.2 Growth in vehicle travel

Traffic on the road network is split between car (94%) and commercial vehicles (6%). Significant growth is forecast for both types of vehicles (24% for cars and 21% for commercial vehicles) (Table 3-2 and Table 3-3). See section Appendix D: for VLC's commercial vehicle definitions.

Table 3-2 – Melbourne GCCSA weekday car traffic statistics

Mode	Time period	2016	2031	Change	% change
Trips	AM peak (7-9AM)	1,345,000	1,676,000	+331,000	+25%
	Inter-peak (9AM-4PM)	3,726,000	4,622,000	+896,000	+24%
	PM peak (4-6PM)	1,345,000	1,663,000	+318,000	+24%
	Off-peak (6PM-7AM)	1,880,000	2,331,000	+451,000	+24%
	Daily total	**8,295,000**	**10,291,000**	**+1,996,000**	**+24%**
Kilometres	AM peak (7-9AM)	18,455,000	24,664,000	+6,208,000	+34%
	Inter-peak (9AM-4PM)	45,801,000	61,655,000	+15,854,000	+35%
	PM peak (4-6PM)	18,192,000	24,313,000	+6,121,000	+34%
	Off-peak (6PM-7AM)	26,908,000	36,367,000	+9,459,000	+35%
	Daily total	**109,357,000**	**146,999,000**	**+37,642,000**	**+34%**
Hours	AM peak (7-9AM)	537,000	826,000	+289,000	+54%
	Inter-peak (9AM-4PM)	934,000	1,281,000	+347,000	+37%
	PM peak (4-6PM)	470,000	705,000	+235,000	+50%
	Off-peak (6PM-7AM)	488,000	642,000	+153,000	+31%
	Daily total	**2,429,000**	**3,454,000**	**+1,025,000**	**+42%**
Average assigned speed (kph)	AM peak (7-9AM)	34	30	-5	-13%
	Inter-peak (9AM-4PM)	49	48	-1	-2%
	PM peak (4-6PM)	39	35	-4	-11%
	Off-peak (6PM-7AM)	55	57	+2	+3%
	Daily total	**45**	**43**	**-2**	**-5%**

Table 3-3 – Melbourne GCCSA weekday commercial vehicle traffic statistics

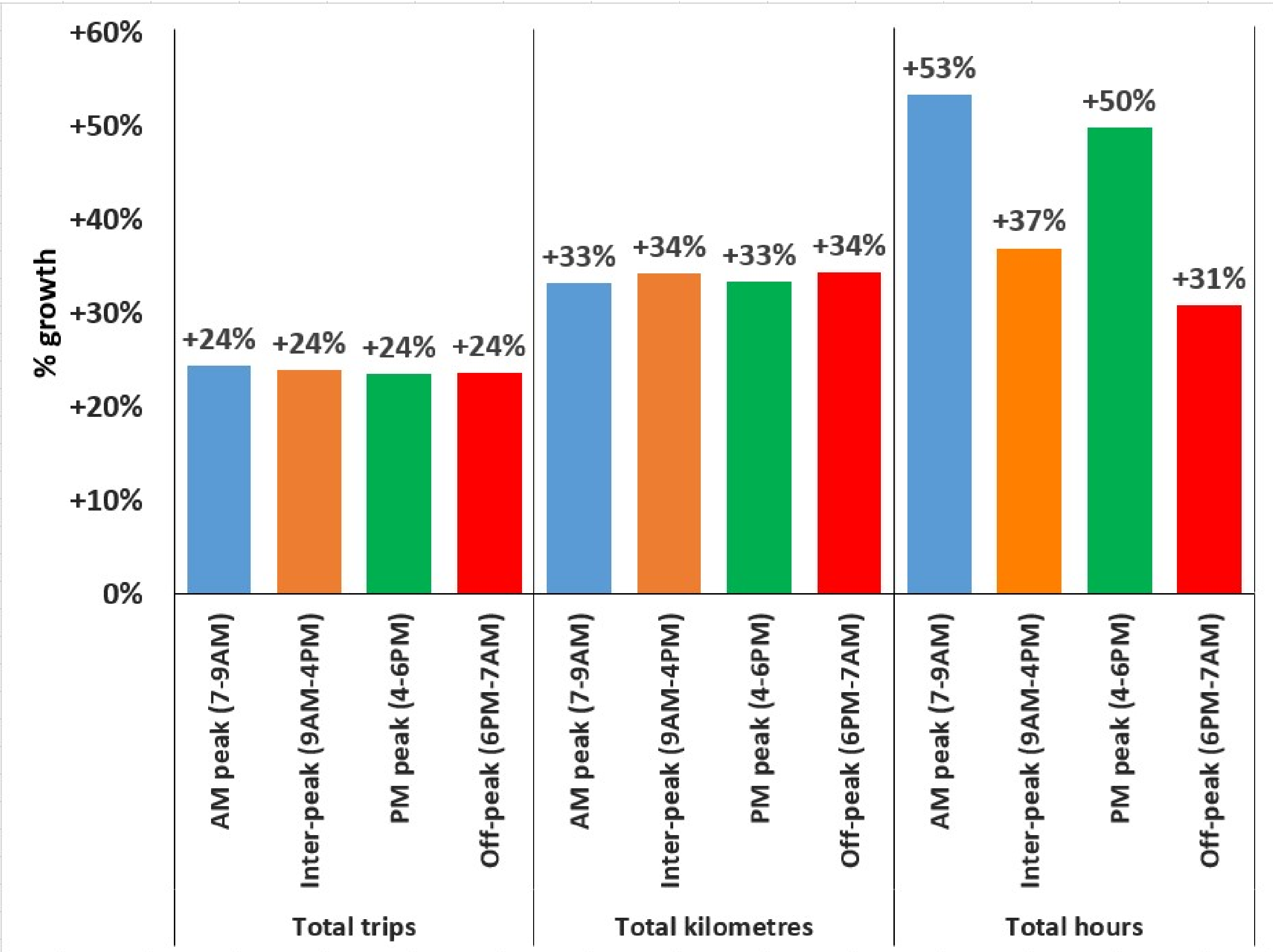
Metric	Time period	2016	2031	Change	% change
Trips	AM peak (7-9AM)	77,000	94,000	+16,000	+21%
	Inter-peak (9AM-4PM)	254,000	309,000	+55,000	+22%
	PM peak (4-6PM)	90,000	109,000	+19,000	+22%
	Off-peak (6PM-7AM)	126,000	148,000	+23,000	+18%
	Daily total	**547,000**	**660,000**	**+113,000**	**+21%**
Kilometres	AM peak (7-9AM)	1,215,000	1,539,000	+324,000	+27%
	Inter-peak (9AM-4PM)	3,912,000	5,043,000	+1,132,000	+29%
	PM peak (4-6PM)	1,390,000	1,800,000	+411,000	+30%
	Off-peak (6PM-7AM)	2,332,000	2,911,000	+579,000	+25%
	Daily total	**8,848,000**	**11,293,000**	**+2,445,000**	**+28%**
Hours	AM peak (7-9AM)	31,000	45,000	+14,000	+45%
	Inter-peak (9AM-4PM)	73,000	98,000	+25,000	+34%
	PM peak (4-6PM)	33,000	47,000	+15,000	+45%
	Off-peak (6PM-7AM)	38,000	47,000	+9,000	+23%
	Daily total	**176,000**	**238,000**	**+62,000**	**+36%**

In 2031 Melburnians are likely to drive further than in 2016, a trend reflected by total vehicle kilometres growing faster than the number of trips (Figure 3-3). This is likely a function of high levels of population growth in outer areas (section 2.1).

As well as travelling further, Melbourne's road users can mostly expect slower trips. This outcome is a function of increased road congestion, with Figure 3-3 illustrating that substantial increases in vehicle hours are expected in the AM and PM peaks. Inter-peak travel is also expected to be slower, but will deteriorate less than peak period travel. This is a result of the underlying dynamics of traffic flow (when additional traffic is added to an already congested road, the resultant delay is disproportionately higher than in less congested conditions).

These metrics have also been included for the Geelong SA4 in Appendix Table F-3 and Appendix Table F-4.

Figure 3-3 – Melbourne GCCSA weekday total vehicle metrics - growth between 2016 and 2031



3.3 Growth in public transport ridership

By 2031 the demand placed on Melbourne's public transport network is expected to increase substantially. This is reflected in the key public transport metrics, with public transport boardings, in-vehicle passenger kilometres and in-vehicle passenger hours predicted to grow substantially.
The increased popularity of public transport is primarily driven by service expansions and infrastructure improvements, most notably Melbourne Metro and the Melbourne Airport Rail Link. In addition, the road network congestion identified above also encourages a shift towards public transport. Table 3-6 illustrates considerable growth in:

- Boardings
- In-vehicle passenger kilometres
- In-vehicle passenger hours.

In-vehicle passenger kilometres *(or passenger kilometres) are a measure of movement of passengers for a particular mode or the public transport network as a whole. In-vehicle passenger kilometres are calculated through the network wide summation of the distances travelled by users onboard vehicles. This excludes the distance travelled (by car, walk or bike) accessing the service.*

In-vehicle passenger hours *(or passenger hours) are an analogous metric which is calculated through the network wide summation of the time spent by users onboard vehicles.*

A ***boarding*** *counts a person entering any public transport vehicle, irrespective of whether this is the first vehicle they have boarded for their trip, or whether they have transferred from another vehicle. One trip may include multiple boardings.*

Table 3-4 – Melbourne GCCSA weekday public transport metrics

Metric	Time period	2016	2031	Change	% change
Boardings	AM peak (7-9AM)	547,000	893,000	+346,000	+63%
	Inter-peak (9AM-4PM)	885,000	1,333,000	+448,000	+51%
	PM peak (4-6PM)	396,000	671,000	+275,000	+69%
	Off-peak (6PM-7AM)	332,000	631,000	+299,000	+90%
	Daily total	**2,160,000**	**3,528,000**	**+1,368,000**	**+63%**
In-vehicle passenger kilometres	AM peak (7-9AM)	6,267,000	11,833,000	+5,566,000	+89%
	Inter-peak (9AM-4PM)	8,003,000	15,226,000	+7,223,000	+90%
	PM peak (4-6PM)	4,584,000	8,658,000	+4,074,000	+89%
	Off-peak (6PM-7AM)	3,558,000	8,095,000	+4,537,000	+127%
	Daily total	**22,412,000**	**43,812,000**	**+21,400,000**	**+95%**
In-vehicle passenger hours	AM peak (7-9AM)	173,000	308,000	+135,000	+78%
	Inter-peak (9AM-4PM)	236,000	393,000	+156,000	+66%
	PM peak (4-6PM)	125,000	222,000	+97,000	+78%
	Off-peak (6PM-7AM)	101,000	204,000	+103,000	+102%
	Daily total	**635,000**	**1,127,000**	**+491,000**	**+77%**

Melbourne's suburban rail network (currently operated by Metro) consists of an electrified mixed grade network which serves the city's suburbs and inner areas. Some areas on Melbourne's fringe are served by regional rail (currently operated by V/Line, which also provides intercity travel between

Melbourne and Victoria's regional cities). Suburban rail boardings grow strongly, with infrastructure improvements (Melbourne Metro, Mernda extension and Melbourne Airport Rail Link) strengthening its primary function of providing access to central areas. Across the day patronage grows by 78 per cent, this is mainly driven by:

- New infrastructure and increased service frequencies
- Increased employment centralisation
- Population growth in outer areas
- Increased road congestion.

Boardings on regional rail grow the fastest, almost tripling across the day (note these boardings may occur outside the Melbourne GGCSA if the service they board enters it) (Table 3-5). This trend is largely driven by:

- Population growth on Melbourne's peri-urban fringe (which regional trains service)
- Strong employment growth in Melbourne GCCSA (attracting trips from outside Melbourne).

The uplift in bus and tram patronage is lower than for heavy rail, but is still forecast to be greater than population growth. One factor in this is the more modest expansions assumed for the 2031 bus and tram networks. Another is decreased travel speeds due to traffic congestion – large sections of Melbourne's bus and tram networks mix with traffic.

Appendix Table F-5 to Appendix Table F-8 details these metrics for the Geelong SA4.

Table 3-5 – Melbourne GCCSA weekday public transport boardings

Mode	Time period	2016	2031	Change	% change
Suburban rail	AM peak (7-9AM)	288,000	488,000	+201,000	+70%
	Inter-peak (9AM-4PM)	384,000	650,000	+267,000	+69%
	PM peak (4-6PM)	199,000	356,000	+156,000	+79%
	Off-peak (6PM-7AM)	159,000	334,000	+175,000	+110%
	Daily total	**1,030,000**	**1,828,000**	**+799,000**	**+78%**
Tram	AM peak (7-9AM)	124,000	176,000	+52,000	+42%
	Inter-peak (9AM-4PM)	279,000	348,000	+69,000	+25%
	PM peak (4-6PM)	115,000	174,000	+58,000	+51%
	Off-peak (6PM-7AM)	115,000	197,000	+82,000	+71%
	Daily total	**633,000**	**895,000**	**+262,000**	**+41%**
Bus	AM peak (7-9AM)	117,000	182,000	+64,000	+55%
	Inter-peak (9AM-4PM)	206,000	282,000	+76,000	+37%
	PM peak (4-6PM)	68,000	105,000	+37,000	+55%
	Off-peak (6PM-7AM)	50,000	70,000	+20,000	+40%
	Daily total	**441,000**	**639,000**	**+197,000**	**+45%**
Regional rail	AM peak (7-9AM)	18,000	47,000	+29,000	+165%
	Inter-peak (9AM-4PM)	17,000	53,000	+36,000	+217%
	PM peak (4-6PM)	14,000	37,000	+23,000	+168%
	Off-peak (6PM-7AM)	8,000	30,000	+22,000	+277%
	Daily total	**56,000**	**166,000**	**+110,000**	**+197%**

The distance travelled on Melbourne's rail network is expected to increase substantially by 2031 (Table 3-6). On the suburban rail weekday network, passenger kilometres increase by around 88 per cent between 2016 and 2031 (Table 3-6). Regional rail passenger kilometres are forecast to triple, a function of the factors identified above.

Tram and bus trips are generally shorter and thus make up a smaller share of the passenger kilometres. In this analysis Melbourne's bus network is extended to serve population growth on Melbourne's fringe. In contrast, the tram network serves the slower growing established suburbs. As a result, bus passenger kilometres are forecast to grow more quickly than tram passenger kilometres.

Table 3-6 – Melbourne GCCSA weekday in-vehicle passenger kilometres

Mode	Time period	2016	2031	Change	% change
Suburban rail	AM peak (7-9AM)	3,991,000	7,184,000	+3,193,000	+80%
	Inter-peak (9AM-4PM)	4,632,000	8,523,000	+3,891,000	+84%
	PM peak (4-6PM)	2,920,000	5,240,000	+2,319,000	+79%
	Off-peak (6PM-7AM)	2,130,000	4,820,000	+2,690,000	+126%
	Daily total	**13,673,000**	**25,767,000**	**+12,094,000**	**+88%**
Tram	AM peak (7-9AM)	517,000	692,000	+175,000	+34%
	Inter-peak (9AM-4PM)	1,013,000	1,158,000	+145,000	+14%
	PM peak (4-6PM)	412,000	558,000	+145,000	+35%
	Off-peak (6PM-7AM)	495,000	725,000	+230,000	+47%
	Daily total	**2,437,000**	**3,133,000**	**+696,000**	**+29%**
Bus	AM peak (7-9AM)	773,000	1,281,000	+508,000	+66%
	Inter-peak (9AM-4PM)	1,510,000	2,096,000	+586,000	+39%
	PM peak (4-6PM)	487,000	775,000	+288,000	+59%
	Off-peak (6PM-7AM)	464,000	616,000	+152,000	+33%
	Daily total	**3,234,000**	**4,768,000**	**+1,534,000**	**+47%**
Regional rail	AM peak (7-9AM)	986,000	2,676,000	+1,690,000	+171%
	Inter-peak (9AM-4PM)	847,000	3,448,000	+2,601,000	+307%
	PM peak (4-6PM)	764,000	2,085,000	+1,322,000	+173%
	Off-peak (6PM-7AM)	471,000	1,935,000	+1,464,000	+311%
	Daily total	**3,067,000**	**10,144,000**	**+7,076,000**	**+231%**

Similar trends are identified for passenger hours (Table 3-7). Though in peak periods, passenger hours grow at a faster rate than passenger kilometres, due to increased road congestion.

Table 3-7 – Melbourne GCCSA weekday in-vehicle passenger hours

Mode	Time period	2016	2031	Change	% change
Suburban rail	AM peak (7-9AM)	94,000	168,000	+75,000	+79%
	Inter-peak (9AM-4PM)	112,000	204,000	+92,000	+82%
	PM peak (4-6PM)	69,000	124,000	+55,000	+79%
	Off-peak (6PM-7AM)	51,000	117,000	+65,000	+127%
	Daily total	**326,000**	**613,000**	**+287,000**	**+88%**
Tram	AM peak (7-9AM)	33,000	47,000	+14,000	+44%
	Inter-peak (9AM-4PM)	58,000	71,000	+12,000	+21%
	PM peak (4-6PM)	26,000	37,000	+12,000	+45%
	Off-peak (6PM-7AM)	28,000	43,000	+15,000	+54%
	Daily total	**145,000**	**198,000**	**+54,000**	**+37%**
Bus	AM peak (7-9AM)	34,000	59,000	+26,000	+77%
	Inter-peak (9AM-4PM)	55,000	76,000	+21,000	+38%
	PM peak (4-6PM)	20,000	34,000	+14,000	+71%
	Off-peak (6PM-7AM)	15,000	20,000	+5,000	+31%
	Daily total	**124,000**	**190,000**	**+66,000**	**+53%**
Regional rail	AM peak (7-9AM)	13,000	33,000	+20,000	+160%
	Inter-peak (9AM-4PM)	11,000	42,000	+31,000	+282%
	PM peak (4-6PM)	10,000	26,000	+16,000	+163%
	Off-peak (6PM-7AM)	6,000	24,000	+18,000	+295%
	Daily total	**40,000**	**125,000**	**+85,000**	**+215%**

4. Road network performance

The previous section demonstrated that travel demand across Melbourne is expected to increase significantly by 2031. This section analyses the likely impacts of increased demand on the performance of the road network using the following metrics:

- Volume capacity (V/C) ratio. The V/C ratio for a section of road is a useful metric to gauge its level of congestion during a period of the day. As the demand placed on the link approaches capacity, the travel speed deteriorates, causing congestion. In strategic modelling it is possible for the V/C ratio to exceed 1.0. When this occurs, travel speed on this link deteriorates further.
- Average speed. Average speed reflects the amount of delay on the road network as a whole, it is the total distance travelled on a network divided by the time taken to do so. Average speed can be calculated either for an entire day or for a particular time period.

Melbourne's rapid growth is forecast to substantially increase average weekday traffic volumes throughout the city by 2031 (Figure 4-1). The modelling indicates increased traffic on Melbourne's key radial freeways, with traffic volumes on the Monash Freeway expected to grow by around 18,000 vehicles a day (20%) in both directions. Similarly, an increase of approximately 13,000 vehicles is expected both north and south bound on CityLink (Western Link) (growing by around 15%). Traffic also increases on the Princes Freeway and the Eastern Freeway, both of which serve radial movements to the inner city.

The largest daily traffic increases and fastest growth between 2016 and 2031 is expected on motorways in outer areas with:

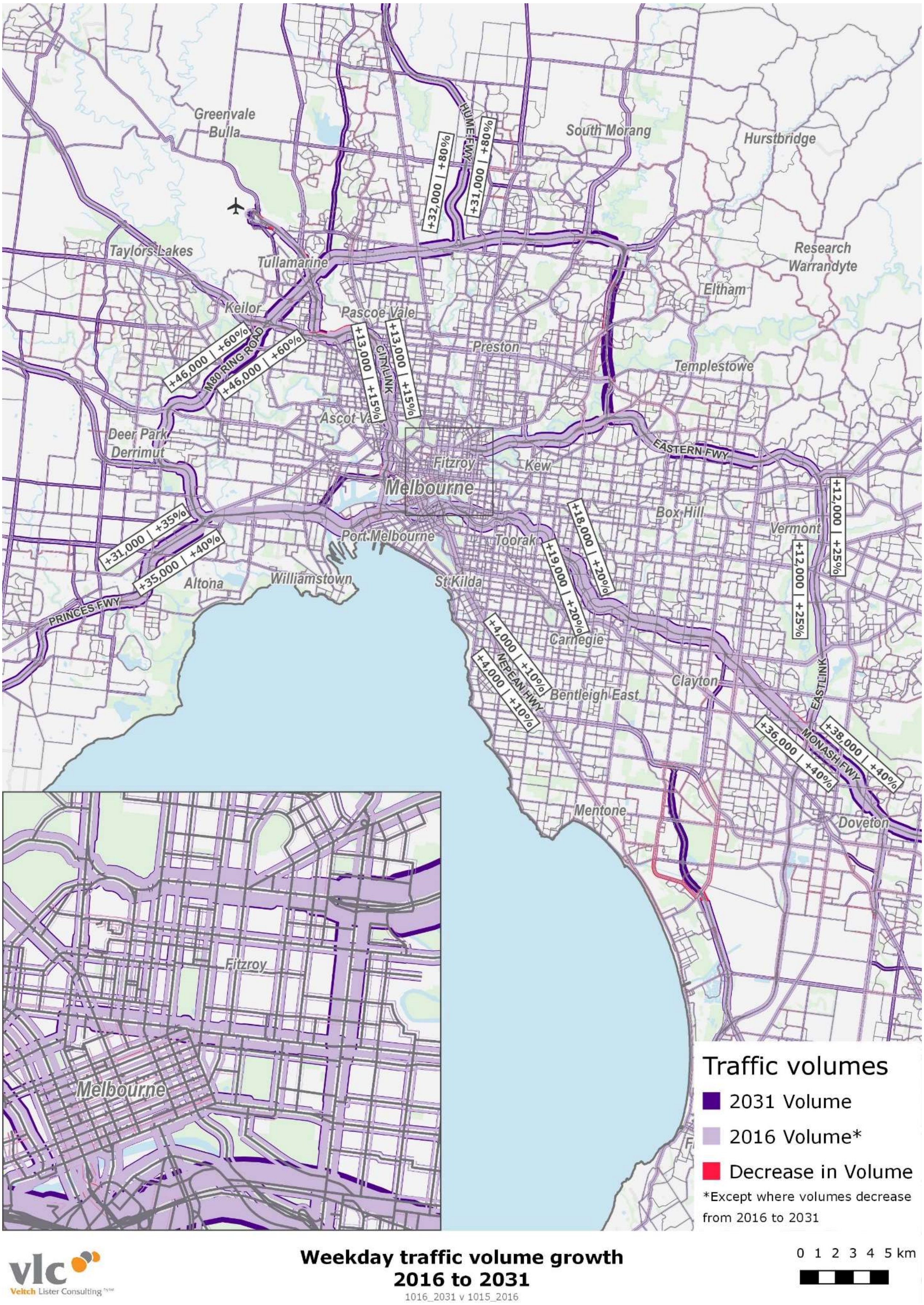
- Princes Freeway volumes growing by over 35 per cent (in both directions) west of the M80 Ring Road
- An increase of around 46,000 vehicles (in both directions) on the M80 Ring Road, representing a 60 per cent increase in traffic
- An 80 per cent increase in traffic (both north and southbound) on the Hume Freeway, with approximately 31,000 extra vehicles
- Approximately 36,000 extra vehicles (a 40% increase) on the Monash Freeway (east of EastLink).

The substantial growth expected on these roads is primarily driven by population growth in the outer areas (section 2.1) as well as upgrades to the motorway system (section 2.2).

In terms of new roads, the Mordialloc Bypass east of Mentone draws traffic from the parallel arterials. The North East Link connects the M80 Ring Road to the Eastern Freeway, bolstering capacity for orbital movements. The West Gate Tunnel provides access to the Port of Melbourne and offers an alternative to the West Gate Bridge. However, traffic volumes on the West Gate are still expected to grow.

High rates of traffic growth are expected on the local and arterial roads that serve Melbourne's fast-growing outer suburbs. This is particularly apparent in the west and north.

Figure 4-1 – Melbourne GCCSA weekday average traffic volume growth - 2016 to 2031



The following images illustrate the modelled levels of congestion in Melbourne in both 2016 and 2031 (Figure 4-3 to Figure 4-6). The V/C ratios are shown as the worst hour in the 2-hour peak. This peak one hour is assumed to be 56 per cent of the AM peak, and 52 per cent in the PM peak, an assumption developed based on observed travel data from various Australian cities. The colour of the bandwidth indicates the level of congestion, and the width is proportional to the volume of traffic using this link. (Minor roads have been excluded for clarity, as these links generally carry low volumes of traffic and are relatively uncongested).

In 2016, heavy congestion occurred on Melbourne's major motorways, notably the Princes and Monash Freeways. On the Princes Freeway demand for travel into central Melbourne was strongest in the morning with congestion impacting on travel from east of Altona into the CBD, with the equivalent congestion westbound in the evening. A similar outcome was observed on the Monash Freeway, with motorists travelling west from Doveton likely to experience heavy traffic on their morning commutes. The congestion on the Princes/Monash Freeway corridor reflects its importance to the network. These motorways provide both access to the city but also cater for east-west cross-town movements (the only complete motorway corridor to do so).

Congestion on the Western Link section of CityLink impacted on journeys from the north and west, with the junction of the Tullamarine Freeway and the Calder Highway a particularly problematic section. The key drivers of demand for travel on this corridor are demand for: landside access to Tullamarine Airport, access to the central areas and access to the Monash Freeway (and south-eastern suburbs).

The western end of the Eastern Freeway (just north east of Fitzroy) was also a congestion hotspot in peak periods in 2016. Here congestion is the result of demand for city access and cross-town travel.

Arterial roads were most congested in 2016 in growth areas and at river crossings. The Yarra River crossings (seen between Fitzroy and Templestowe) were particularly heavily congested. In growth areas, the new suburbs have put the road network under pressure, with the roads to the south of Derrimut an example of this.

Figure 4-2 shows how congestion in the model impacts travel speeds on the network. For arterials, increasing V/C ratios result in a gradual decline in travel speeds to about 0.6 (where speeds reduce to 85% of free flow), with a steeper decline between ratios of 0.6 and 1.0 (50% of free flow). Travel speeds on motorways are less affected by congestion up to a V/C ratio of 0.6 but experience a much steeper reduction in travel speeds thereafter. Managed motorways can accommodate far more vehicles relative to capacity before travel speeds are materially.

Figure 4-2 – Speed flow to volume / capacity ratio relationship

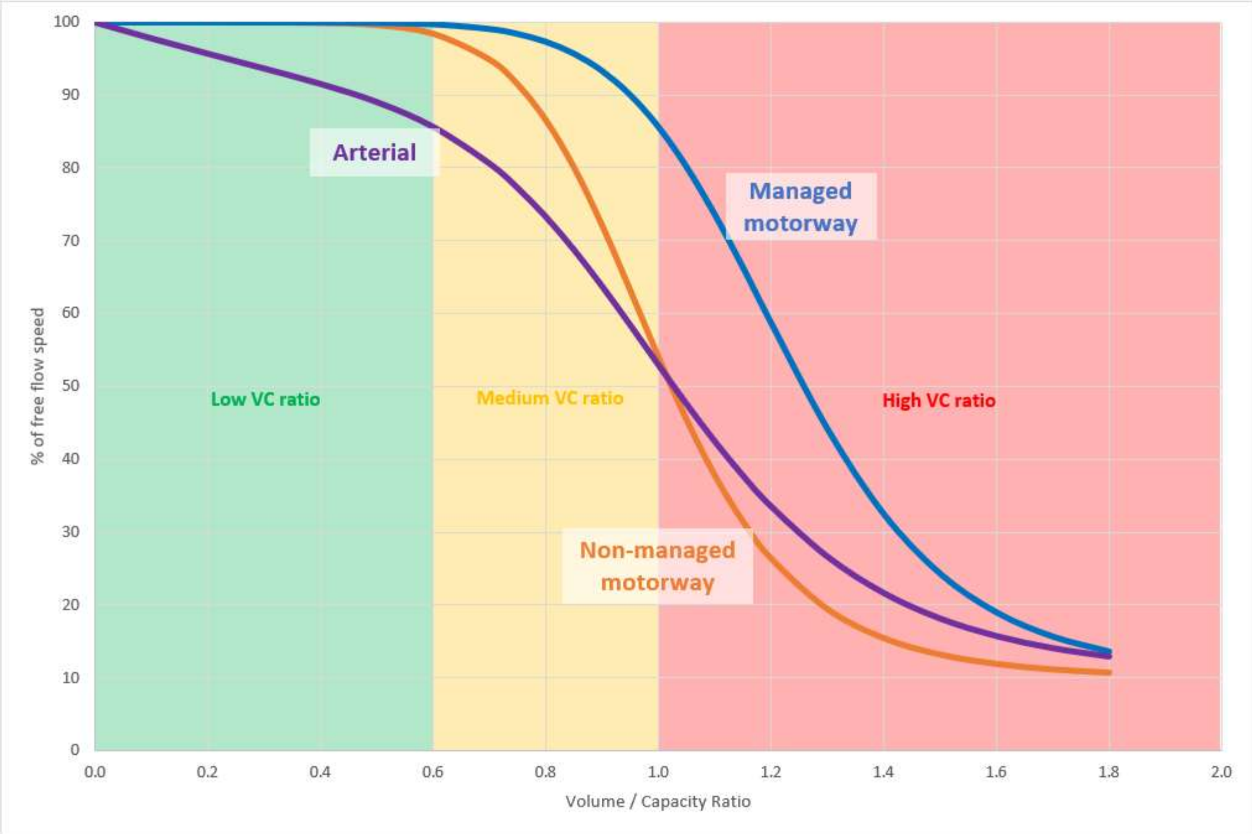


Figure 4-3 – Melbourne GCCSA weekday traffic volume / road capacity - 2016 1-hour AM peak

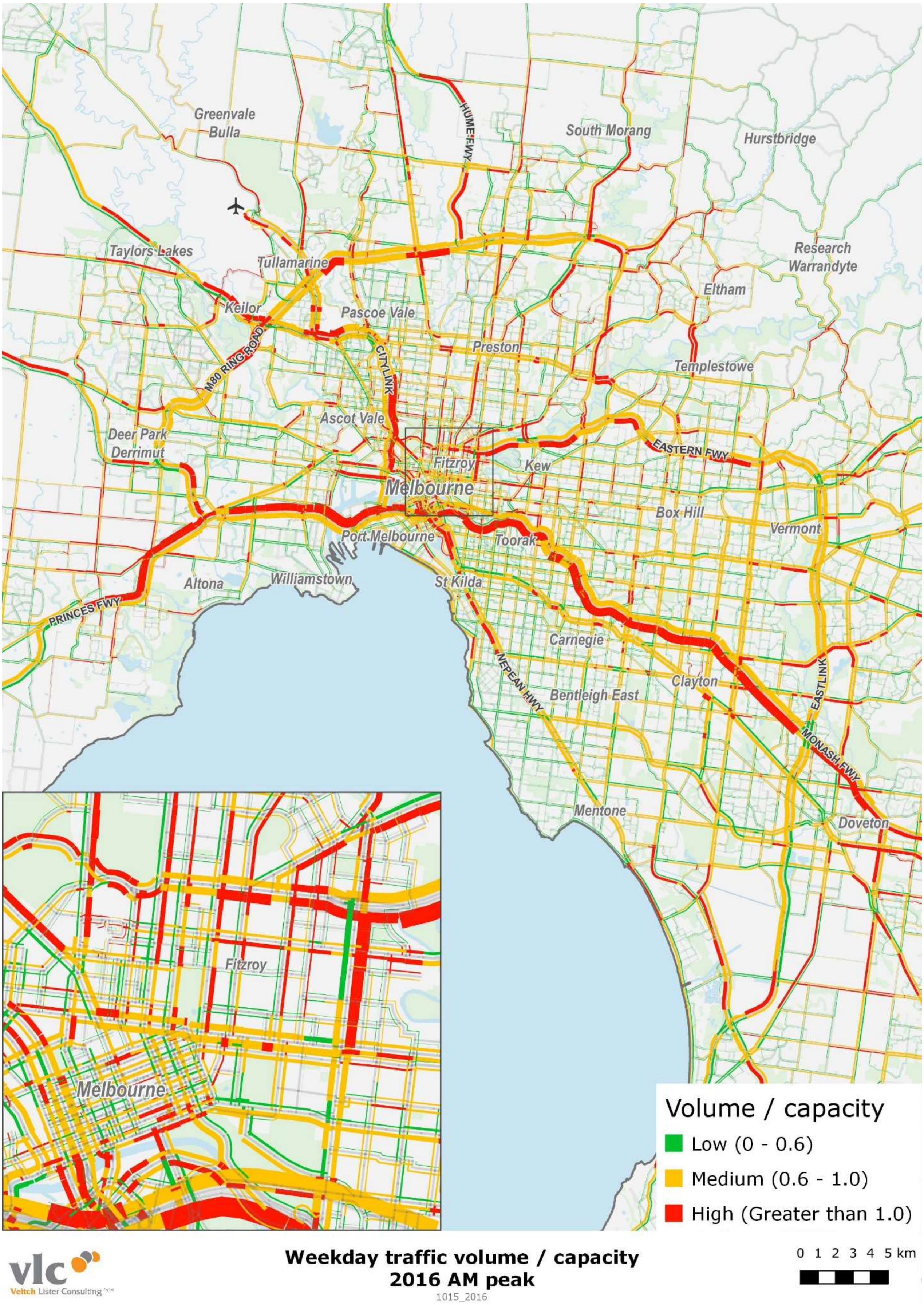
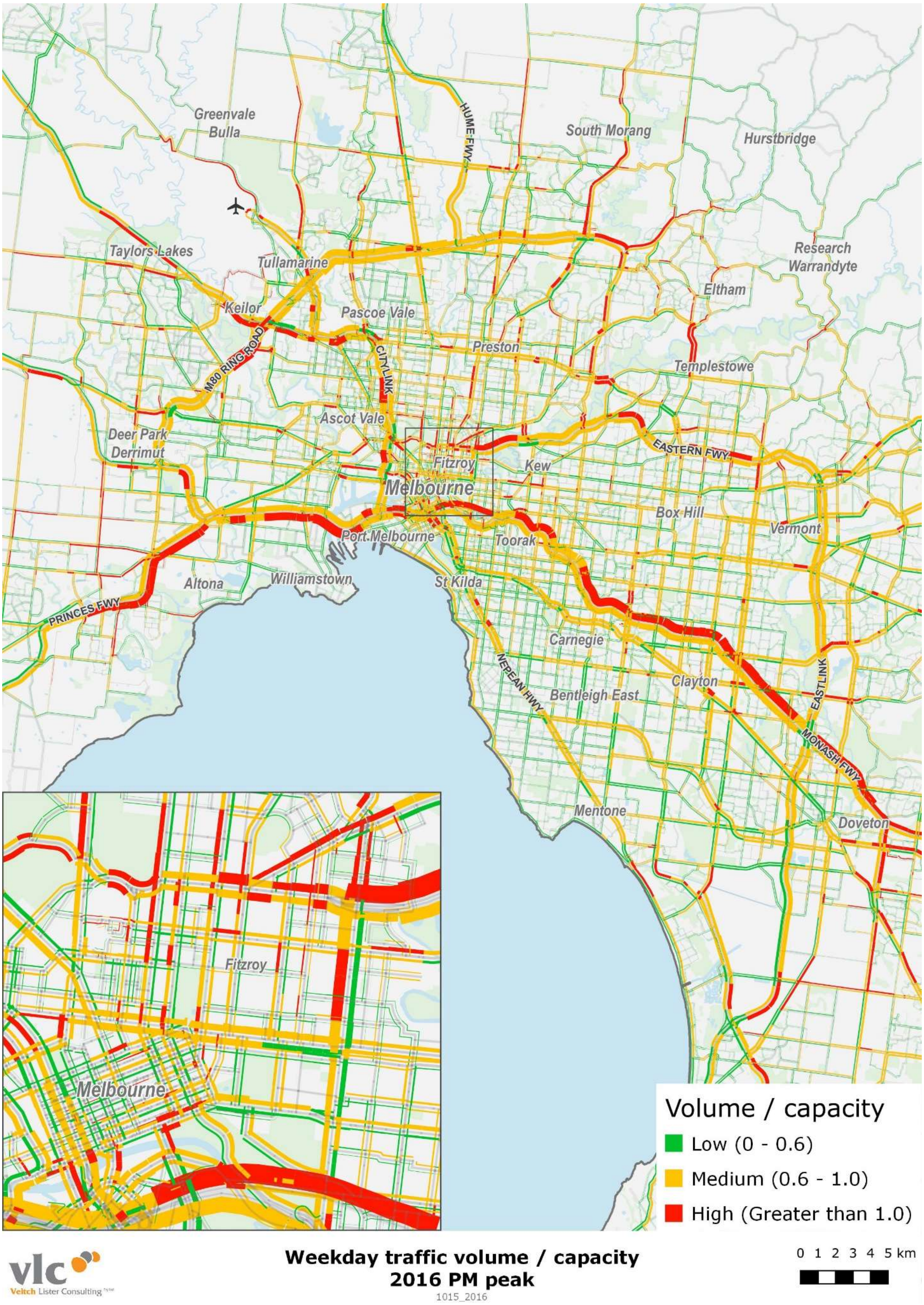


Figure 4-4 – Melbourne GCCSA weekday traffic volume / road capacity - 2016 1-hour PM peak



By 2031 the congestion observed in 2016 is expected to worsen and spread. By 2031 the major freeways are expected to play an even more important role in the city's function, though the levels of congestion will compromise the network's ability to play this role effectively. Congestion on the strategic Princes and Monash Freeways is forecast to worsen and affect the counter peak direction. A similar outcome is expected on the Eastern Freeway and CityLink (Western Link), where the peak period congestion is forecast to worsen. The North East Link is set to be heavily utilised in the peak direction while heavy congestion is expected in both directions on the M80 Ring Road. Traffic congestion on the M80 Ring Road is likely to be a result of strong population growth, and similar outcomes are expected on the Hume Freeway, Calder Freeway and Western Freeway.

Strong population growth in Melbourne's outer suburbs (section 2.1) is forecast to drive increased congestion on the freeways, but also the arterial roads which serve the fastest growing areas. High levels of congestion are forecast on the arterial roads in:

- the outer western suburbs (around Derrimut, Taylors Lakes and Bulla)
- the northern arterials that run parallel to the Hume Freeway (north of the M80 Ring Road)
- the arterials in the outer south east (south of Doveton).

Particularly high levels of congestion are expected on the growth area roads feeding the motorways in peak periods. While strong population growth is a key driver of this congestion, it also reflects:

- A number of roads are assumed to have relatively low capacities, as road network plans are not yet fully developed and funded
- Minimal assumed public transport services in growth areas
- Low density urban development, which is less suited to public and active transport trips
- Fewer jobs than residents, increasing the need to travel long distances.

High levels of congestion in growth areas are problematic as delays fall on people making relatively long trips, restricting their access jobs and services in the rest of the city.

Figure 4-5 – Melbourne GCCSA weekday traffic volume / road capacity - 2031 1-hour AM peak

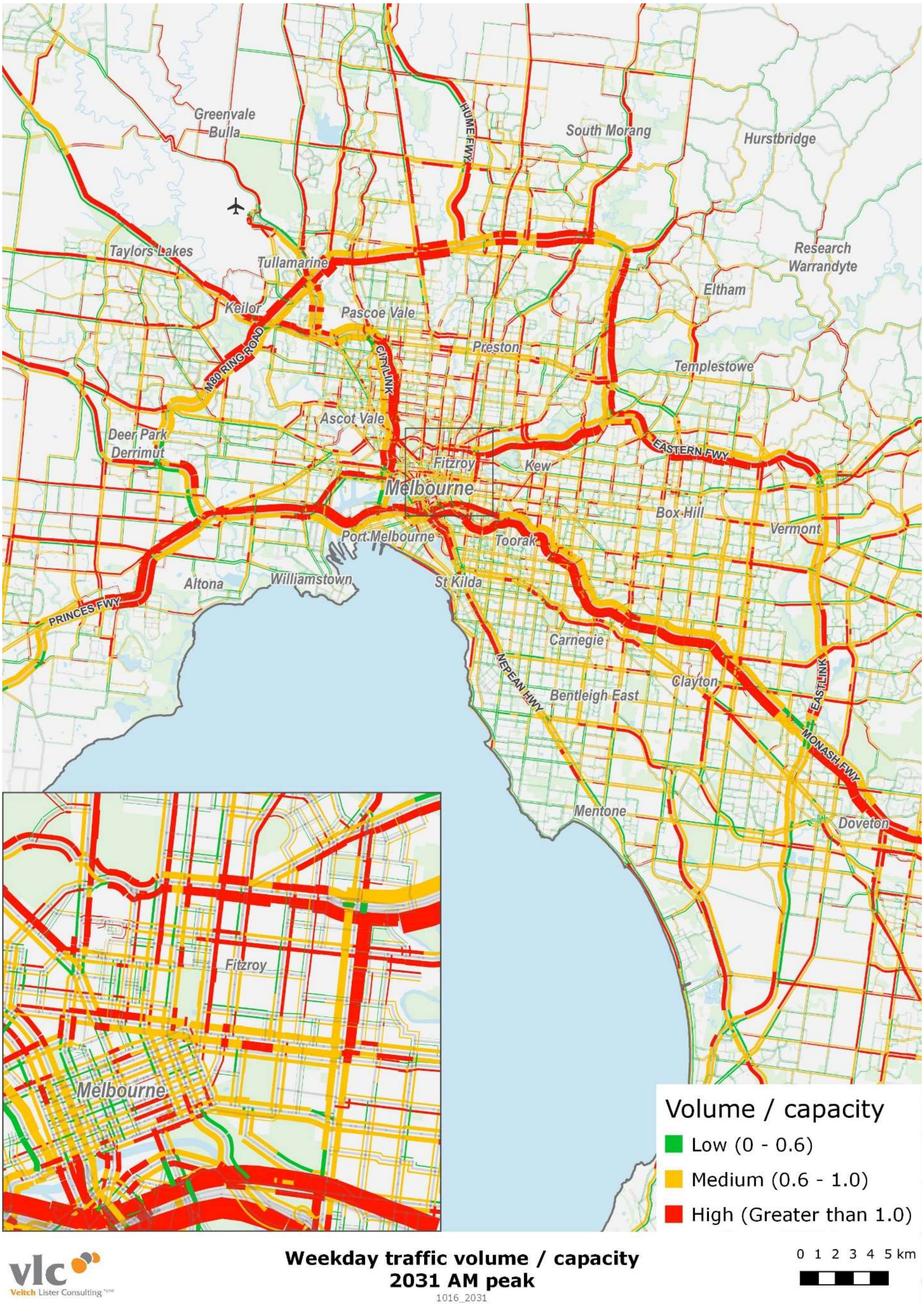
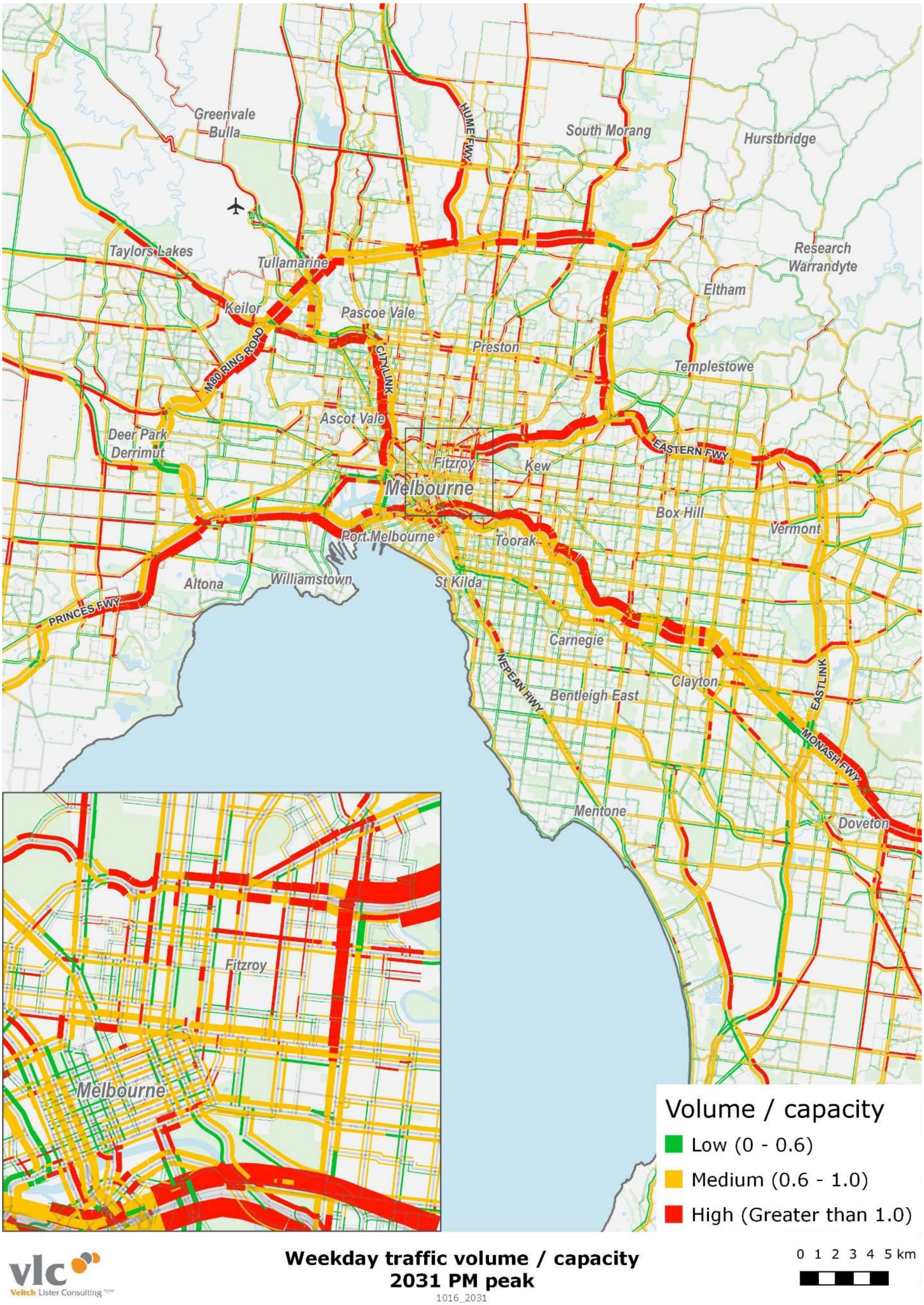
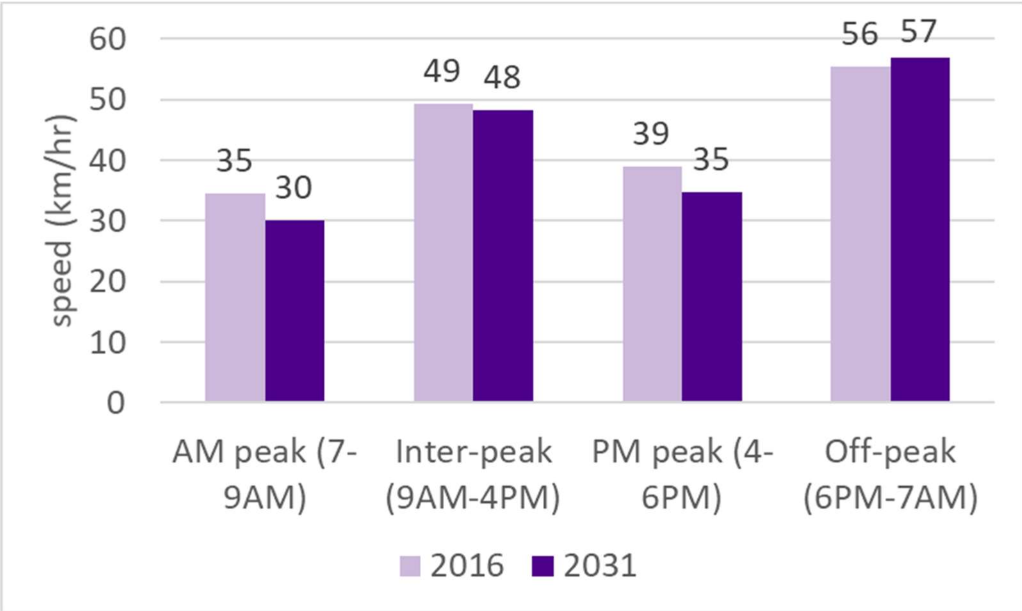


Figure 4-6 – Melbourne GCCSA weekday traffic volume / road capacity - 2031 1-hour PM peak



Average vehicle speeds on the road network are expected to decline by at approximately 4 kilometres per hour in the AM and PM peak periods. In the middle of day, average speed is forecast to decline slightly (about 1km/hr), reflecting the worsening congestion occurring on the network. Off peak speeds are stable, reflecting the average travel speed on a relatively uncongested network; the slight increase reflects the impact of the small expansion of high-speed freeway network kilometres in the overall network.

Figure 4-7 – Melbourne GCCSA average speeds on the road network



Road network delay hours are expected to increase significantly by 2031. As was illustrated above, congestion in the peak periods means vehicle delay is most intense during the peak periods. In Melbourne GCCSA delay hours in the peak periods are forecast to almost double, with growth in inter-peak congestion also growing strongly. Although off-peak delay also increases, much less delay is expected. Delay hours on roads in the Geelong SA4 increase at a high rate (around 142% across the day), however the magnitude of delay is much smaller.

Table 4-1 – Road network total delay hours

	Time period	2016	2031	Change	% change
Melbourne GCCSA	AM peak (7-9AM)	207,000	399,000	+191,000	+92%
	Inter-peak (9AM-4PM)	129,000	235,000	+106,000	+83%
	PM peak (4-6PM)	148,000	289,000	+141,000	+95%
	Off-peak (6PM-7AM)	28,000	44,000	+16,000	+58%
	Daily total	**512,000**	**966,000**	**+454,000**	**+89%**
Geelong SA4	AM peak (7-9AM)	4,000	11,000	+7,000	+161%
	Inter-peak (9AM-4PM)	4,000	8,000	+4,000	+117%
	PM peak (4-6PM)	3,000	8,000	+5,000	+168%
	Off-peak (6PM-7AM)	1,000	2,000	+1,000	+79%
	Daily total	**12,000**	**29,000**	**+17,000**	**+142%**

5. Public transport system performance

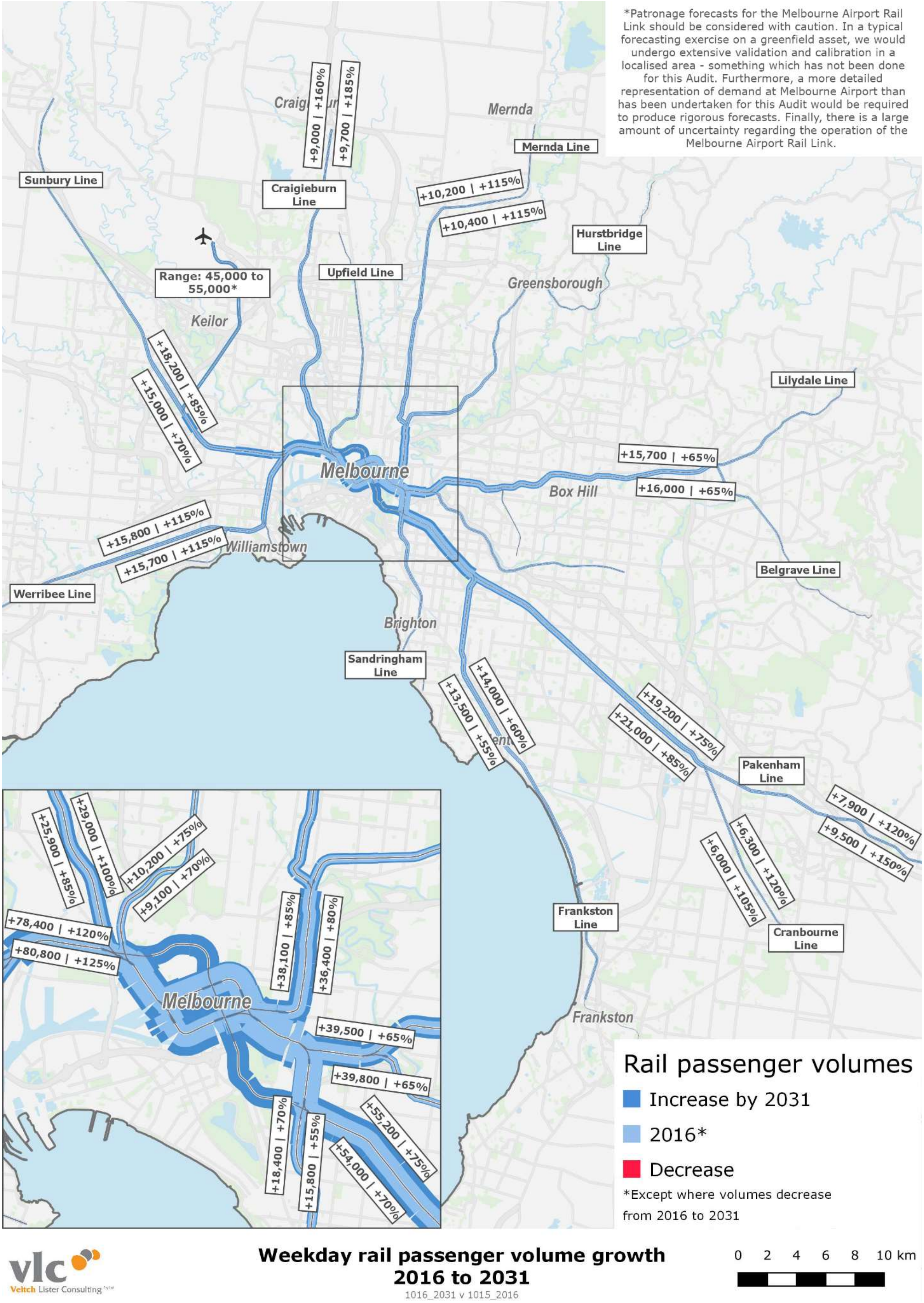
This section focuses on the performance of Melbourne's public transport network.

Melbourne's suburban rail network provides access to the CBD from the outer, middle and inner suburbs. Demand on the system is highly directional with heavy passenger loadings on citybound trains in the morning peak and the opposite occurring in the PM peak. The addition of Melbourne Metro as well as the Mernda extension will increase passenger loadings on the network on an average weekday (Figure 5-1).

Melbourne Metro allows more services and passengers to travel through the inner city (see inset in Figure 5-1). The largest increase can be seen on the lines serving the western and south eastern suburbs with approximately 80,000 and 55,000 extra passengers in each direction respectively. Nevertheless, in percentage terms strong increases in patronage are expected on all rail lines. The uplift in passenger volumes into the city is primarily driven by increased employment in central Melbourne.

As well the 'pull' of highly concentrated employment, patronage increases on the suburban rail network are also a function of population growth. Population growth in the outer suburbs drives higher passenger volumes on the outer section many rail lines, these include the: Sunbury, Werribee, Craigieburn, Mernda, Pakenham and Cranbourne Lines. For example, compared to 2016, almost 10,000 extra daily passengers are forecast to board at Craigieburn Station. The high number of boardings on the outer sections of the lines means they make up a substantial portion of overall patronage on these lines, this is likely to increase crowding levels as trains approach the city. The additional outer ring passenger growth is likely to mean that passengers in middle ring suburbs will find it more challenging to obtain a seat for their journeys in 2031 than in 2016.

Figure 5-1 – Melbourne GCCSA weekday rail passenger volume growth - 2016 to 2031

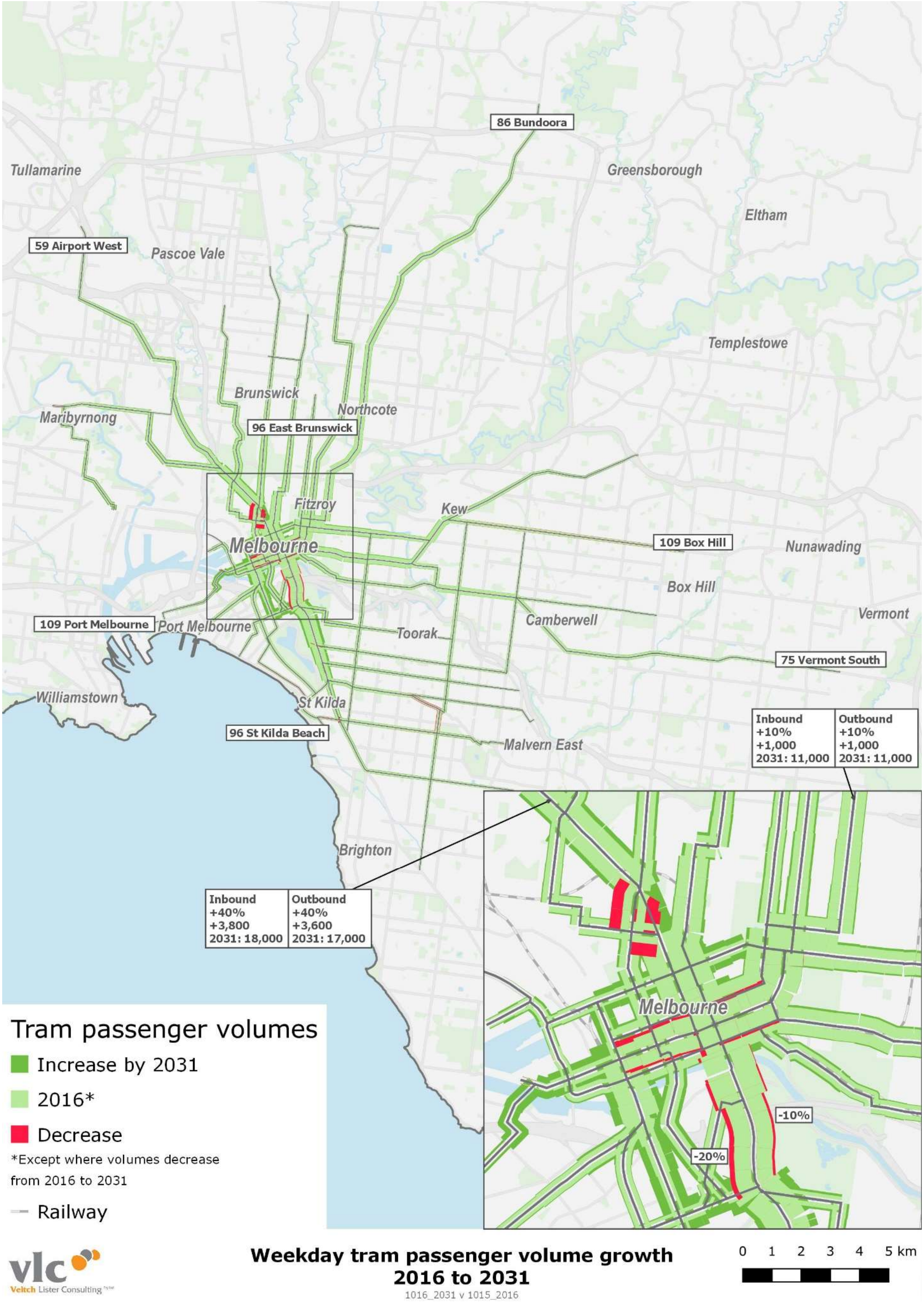


Melbourne’s tram network largely serves Melbourne’s inner areas with some routes running further into the suburbs (such as the 86 to Bundoora). In general, the tram lines run along the major roads that make up inner Melbourne’s established suburbs. In this way the trams facilitate not only city bound travel but also provide a public transport option for travel along these neighbourhood corridors and enable access to other modes (such as the rail system).

Growth on Melbourne’s tram network on an average weekday is expected to be more moderate than on the rail network (Figure 5-2). This is likely to be function of slower population growth in the established areas as well as the increased service level of the rail system. For instance, Melbourne Metro will compete for CBD-bound travellers on the St Kilda Road corridor, leading to a 10 to 20 per cent drop in tram patronage there. Furthermore, most of Melbourne’s tram network mixes with general traffic meaning that in the modelling (as in real life) future tram speeds are affected by traffic congestion, reducing its appeal to travellers relative to other modes.

On most routes tram patronage growth to 2031 is expected to be between 10 and 50 per cent, with daily passenger loadings (in one direction) expected to be between 5,000 and 15,000 passengers. Particularly high growth is forecast for the north-south corridor on the CBD’s western edge, along Spencer and Clarendon Streets, as well as the central section of the Fishermans Bend tram link (inset Figure 5-2). The decrease seen just north of the CBD is a result of a slight route change.

Figure 5-2 – Melbourne GCCSA weekday tram passenger volume growth - 2016 to 2031



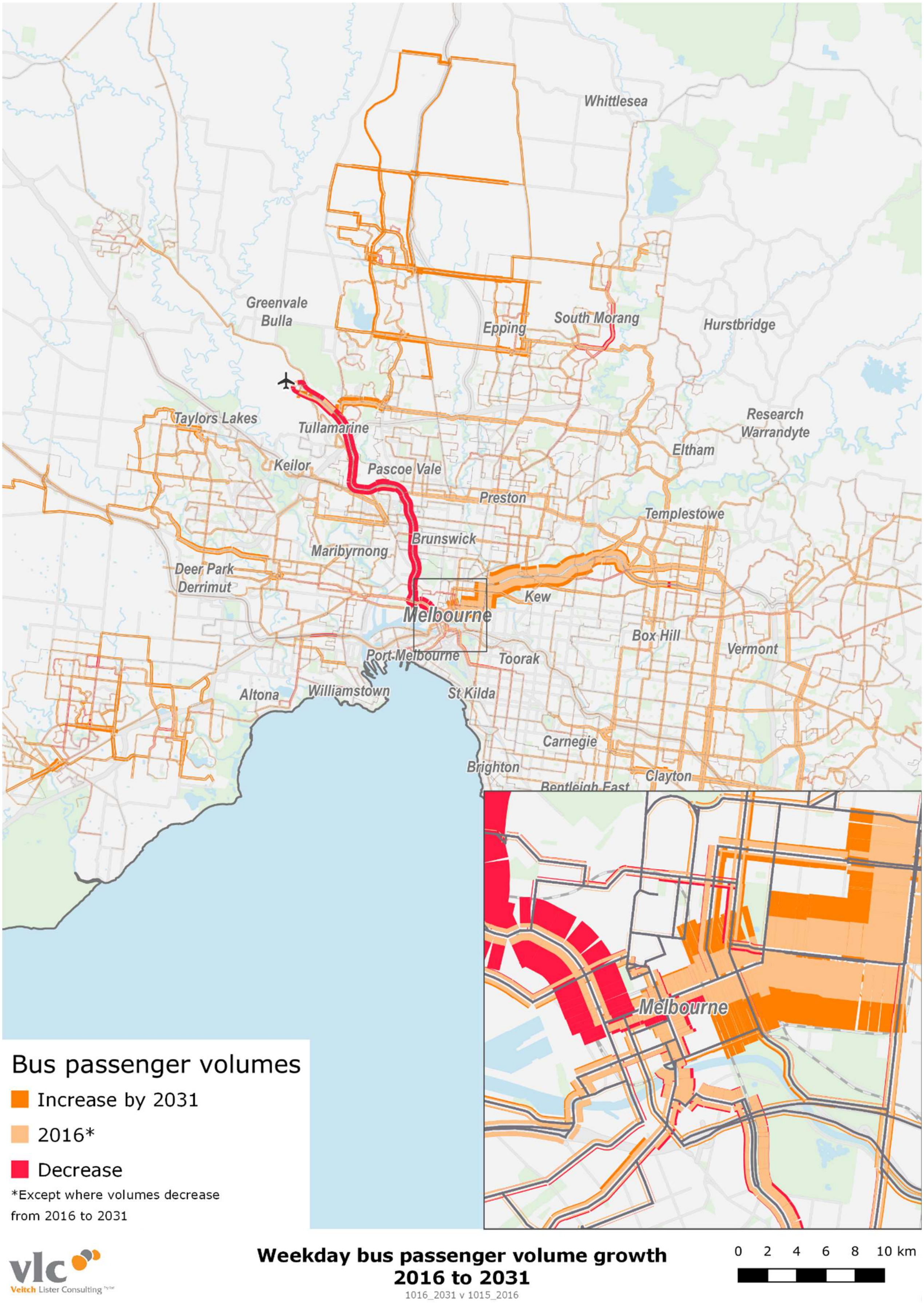
Melbourne’s bus network plays a multifaceted role in the city’s public transport network. The SmartBus routes run at high frequencies and service major roads. Buses also serve the Doncaster area with rapid services to the city running express along the Eastern Freeway. At a local level buses perform a coverage role. While these local services provide the majority of urban residences with access to a reasonably local bus stop, they generally run at lower frequencies and have less direct routes.

Bus patronage is expected to increase by 2031 (Figure 5-3). Strong growth is expected on the Doncaster rapid bus corridor, with around 6,000 extra passengers (a 70% increase) inbound on the average weekday and almost 5,000 outbound (a 60%) increase. As part of the North East Link, this bus corridor is upgraded, fully separating buses from traffic. It is likely that the increased utility of this upgrade is a major factor in the uplift expected on this corridor. Centralised employment against dispersed population growth also plays a role.

The increase in patronage in the established suburbs is expected to be relatively moderate, reflecting the slower population growth and alternative modes of public transport. In growth areas, new bus routes and services have been added to the 2031 network. These routes are expected to be well patronised, as they are often the only form of local public transport assumed in the modelling. Existing bus routes in growth areas are also expected to have strong increases in passenger demand, particularly where they provide access to railway stations.

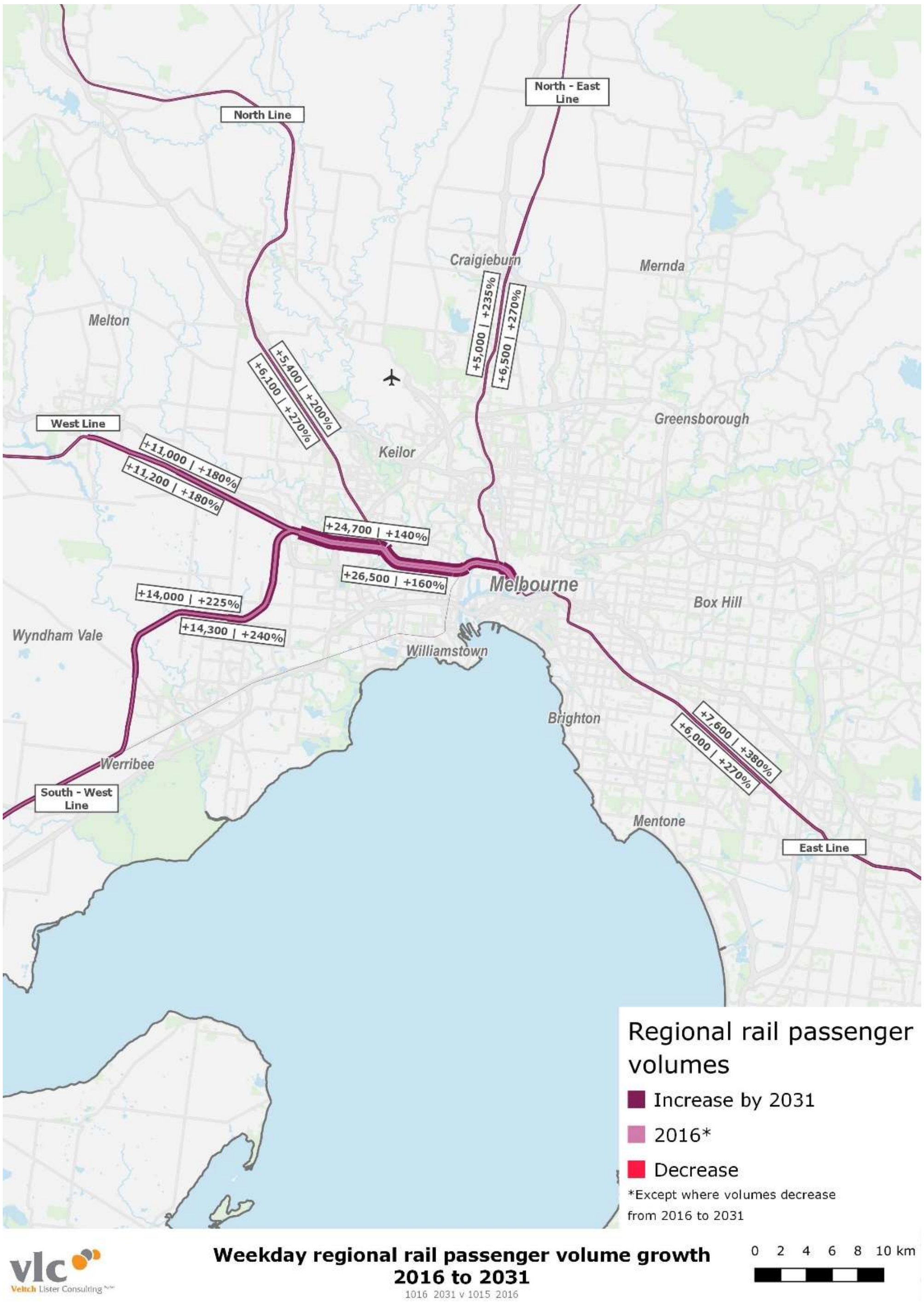
The bus routes that experience the largest reduction in passengers between 2016 and 2031 are services withdrawn due to the introduction of heavy rail. Specifically, Melbourne Airport Rail Link replaces the SkyBus to the airport and the Mernda Rail extension replaces the local bus feeder in this corridor.

Figure 5-3 – Melbourne GCCSA weekday bus passenger volume growth – 2016 to 2031



Victoria's regional rail network links regional centres (such as Ballarat) to Melbourne. In addition, regional rail also services Melbourne's outer growth areas. By 2031 the task performed by the regional rail network is expected to increase. Patronage on the South-West Line and West Line is expected to grow particularly strongly (Figure 5-4). On the South-West Line an increase of around 16,000 passengers in each direction is expected on an average weekday. This growth is driven by additional travel demand from Geelong and population growth in Melbourne's western growth areas. Strong demand from Melbourne's outer west is expected, with station usage forecast to triple in Melton-Bacchus Marsh and double in the Brimbank and Wyndham SA3s. A similar outcome is predicted for the northern growth areas located in Whittlesea-Wallan.

Figure 5-4 – Melbourne GCCSA weekday regional rail passenger volume growth – 2016 to 2031



The rest of this chapter focuses on crowding on Melbourne's public transport network. This has been measured by using a V/C ratio, where the number of passengers on each service on a line is divided by the crush capacity of the rail rolling stock allocated to that service during the worst hour in the peak period. The worst hour in the 2-hour peak is assumed to be 55 per cent of that period, an assumption developed based on observed travel data from various Australian cities.

In 2016, suburban rail crowding levels in the AM and PM peaks were relatively light, with the highest levels of crowding observed on the western lines (Figure 5-5 and Figure 5-6).

By 2031, the increased patronage highlighted above is forecast to worsen crowding on several lines (Figure 5-7 and Figure 5-8). In general crowding is worse on the sections closer to the city. The high numbers of boardings on the outer part of the Pakenham and Cranbourne lines means that passenger loadings approach crush capacity along the majority of this corridor. Similar outcomes are expected on the Mernda and Craigieburn lines, both of which serve growth areas. Nevertheless, significant crowding is also expected on the Belgrave and Lilydale lines – which mainly serves established areas.

Crush V/C ratios above 0.6 in the maps indicate that seated capacity is already exceeded by more than 50 per cent, suggesting all areas coloured yellow have a significant proportion of standing passengers during the peak hour (see Appendix D4 for capacity assumptions). By 2031, the modelling indicates that crowding will affect a greater portion of the network and that passengers are likely to experience more highly crowded trains and stand for longer periods.

Rail crowding is particularly acute in the AM peak period and directions, when commuting demand is more concentrated, compared to the PM peak where travellers tend to depart the city at more diverse times.

Limitations of crowding measures:

While the model provides a sophisticated representation of the impacts of passenger crowding on the public transport network, there are two primary limitations to the crowding metric used in this report:

Firstly, the model represents 'timetabled' public transport operating conditions. When severe crowding occurs, it is often a result of service delays, cancellations or incidents. This is not captured in the modelling.

Secondly, the V/C ratios represent a weighted average of all services on each corridor. This means that the measure does not reflect the complexity of the crowding on each individual service. For example, there may be uneven demand across services on the same line e.g. more passengers on an express service compared with an all-stopper or higher loadings at 8 a.m. compared with 7.15 a.m.), or within a single service (e.g. one carriage is at capacity while another is much less crowded).

Figure 5-5 – Melbourne GCCSA weekday rail passenger volume / crush capacity - 2016 1-hour AM peak

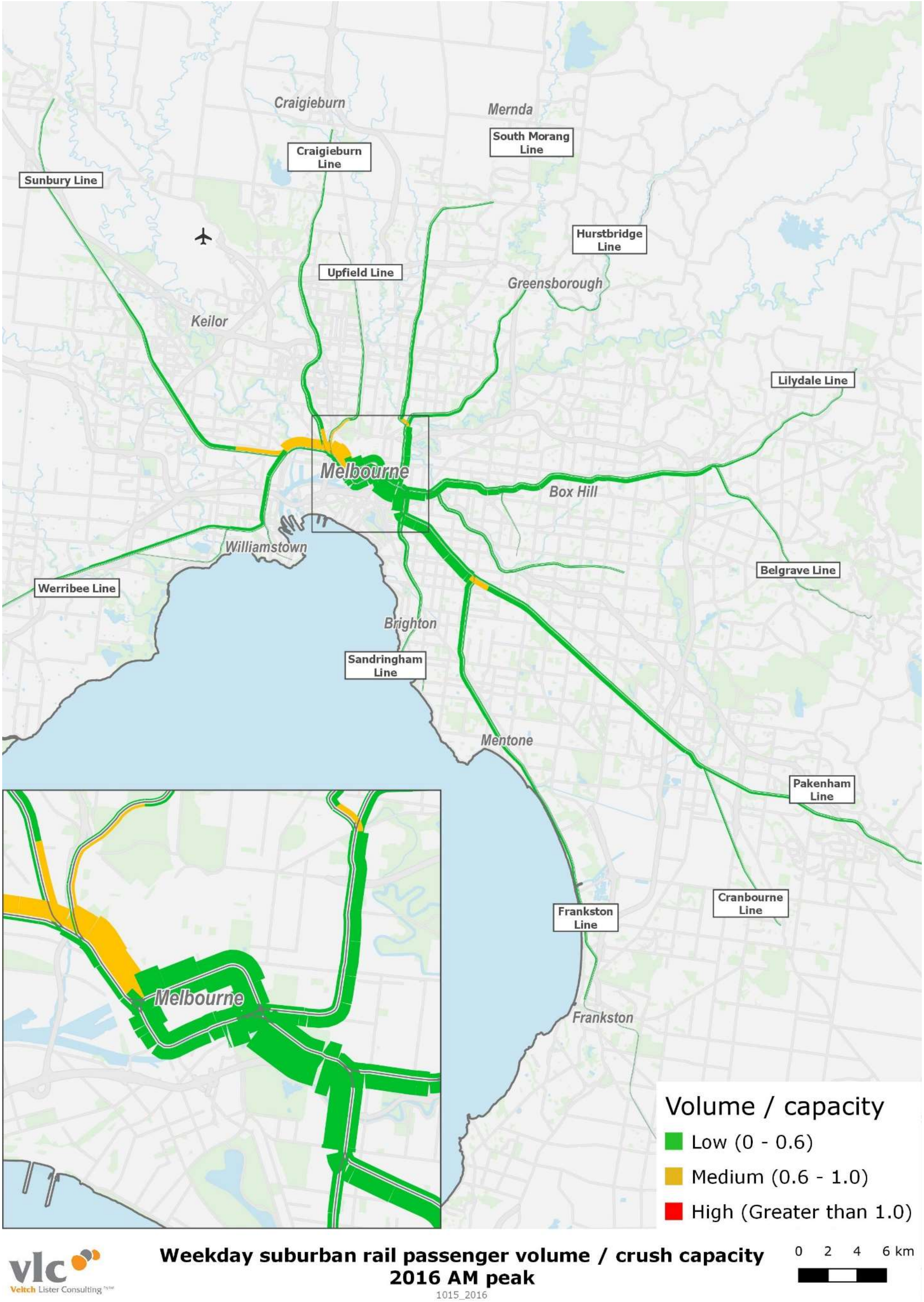


Figure 5-6 – Melbourne GCCSA weekday rail passenger volume / crush capacity - 2016 1-hour PM peak

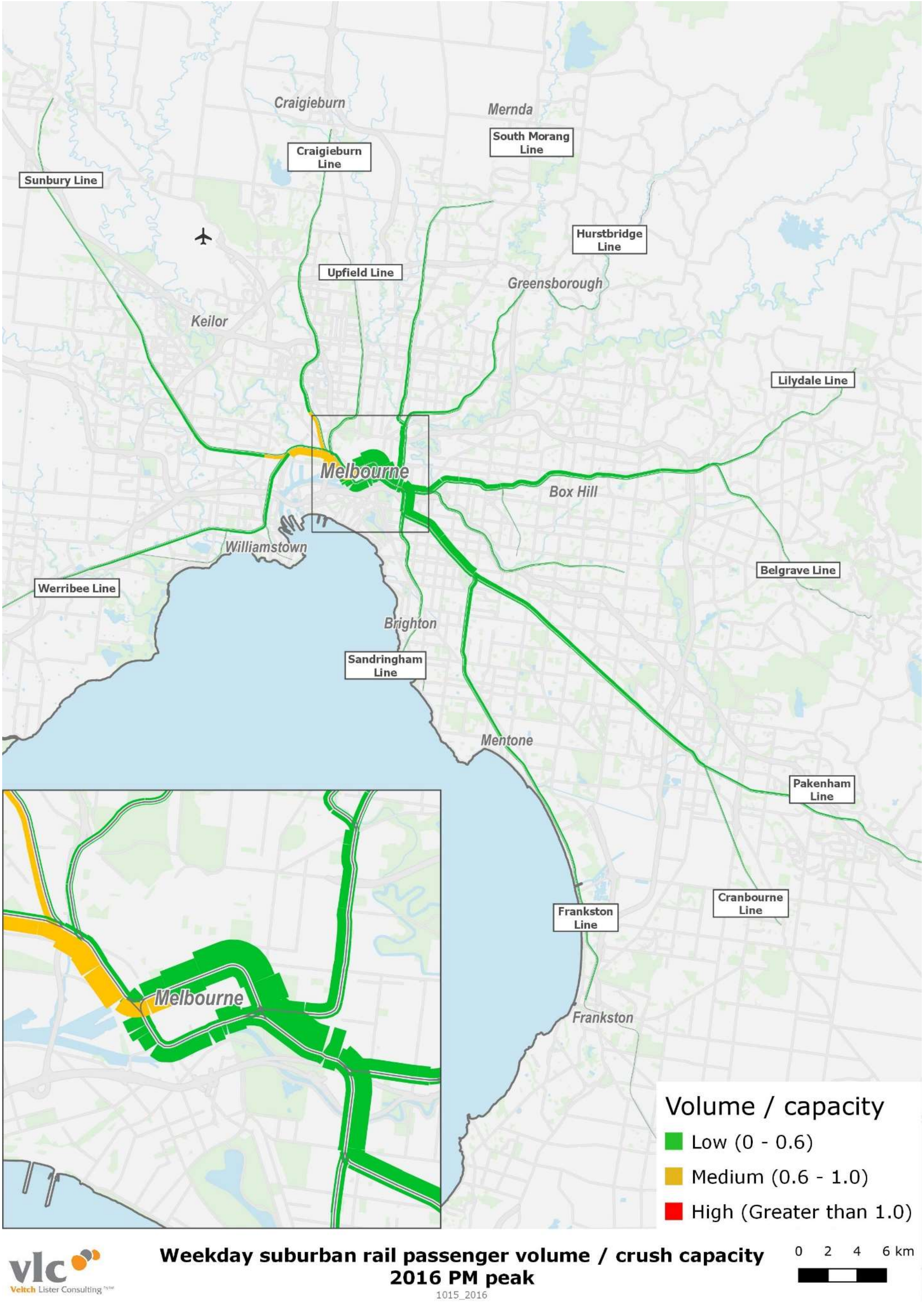


Figure 5-7 – Melbourne GCCSA weekday rail passenger volume / crush capacity - 2031 1-hour AM peak

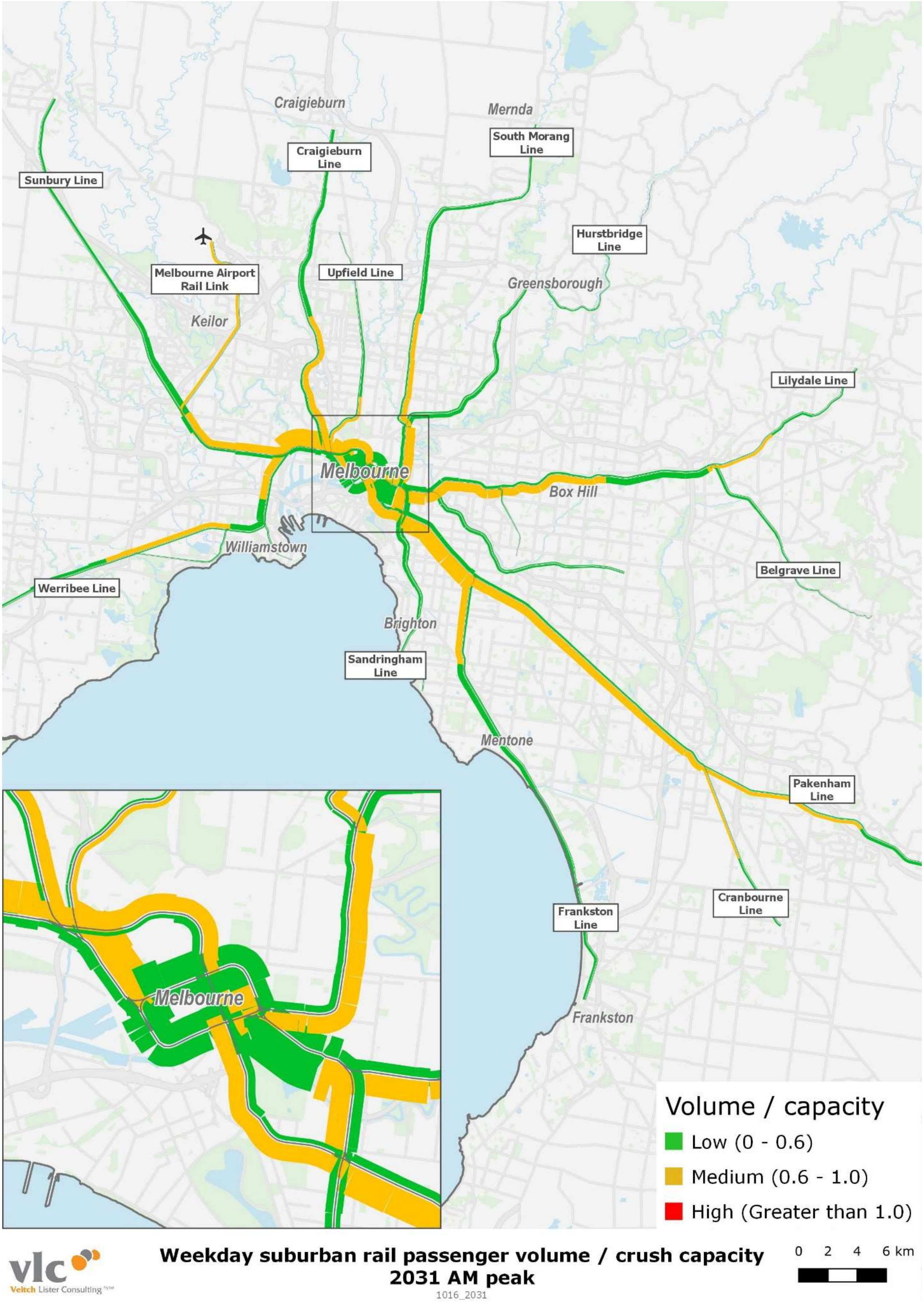
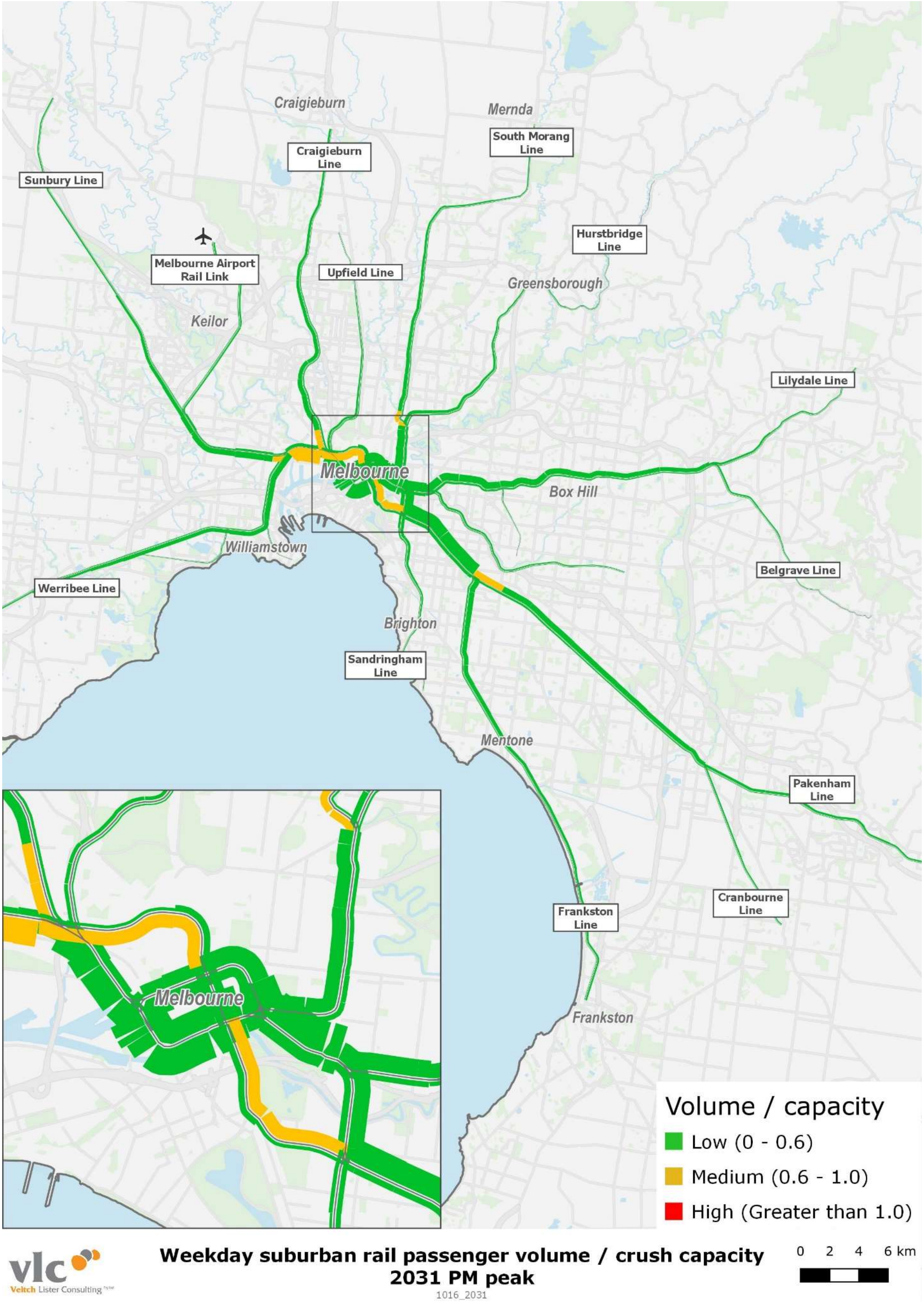


Figure 5-8 – Melbourne GCCSA weekday rail passenger volume / crush capacity - 2031 1-hour PM peak



The crowding observed on Melbourne's tram network in 2016 was relatively contained (Figure 5-9 and Figure 5-10). However, trams have relatively few seats, meaning that even if the volume / capacity ratio is in the 'Low' range (0 to 0.6), some passengers may be forced to stand.[2] In peak periods, passenger loads approach crush capacity on the 86 Bundoora tram. This route is one of the longest in the network and serves LaTrobe and RMIT universities in Bundoora.

By 2031, crowding on the tram network is expected to increase and spread (Figure 5-11 and Figure 5-12). The crowding on observed on the 86 tram in 2016 is forecast to worsen, and by 2031 passengers can expect high levels of crowding from Preston inbound in the morning and to Northcote outbound in the evening. The 86 serves an area outside the immediate catchments of the Mernda / South Morang Line, connecting the city to major universities. Its route is relatively direct and is partially separated from traffic. Thus, the increase in crowding is likely a function the utility of this route coupled with population growth in areas such as Darebin North.

Crowding is also expected on the routes which serve the inner west, this is likely to be driven by strong population growth in Maribyrnong and access to the rail system. In some sections on the 82 tram line (Footscray to Moonee Ponds) crush capacity is exceeded, suggesting that assumed 2031 service levels are insufficient to cater for future demand growth.

[2] If all the seats on a tram are occupied the vehicle will still be at less than a third of its crush capacity. Different classes of tram operate on the network, each has slightly different seating configurations. The maximum seat to crush capacity ratio is around 0.3 and the minimum is around 0.2.

Figure 5-9 – Melbourne GCCSA weekday tram passenger volume / crush capacity - 2016 1-hour AM peak

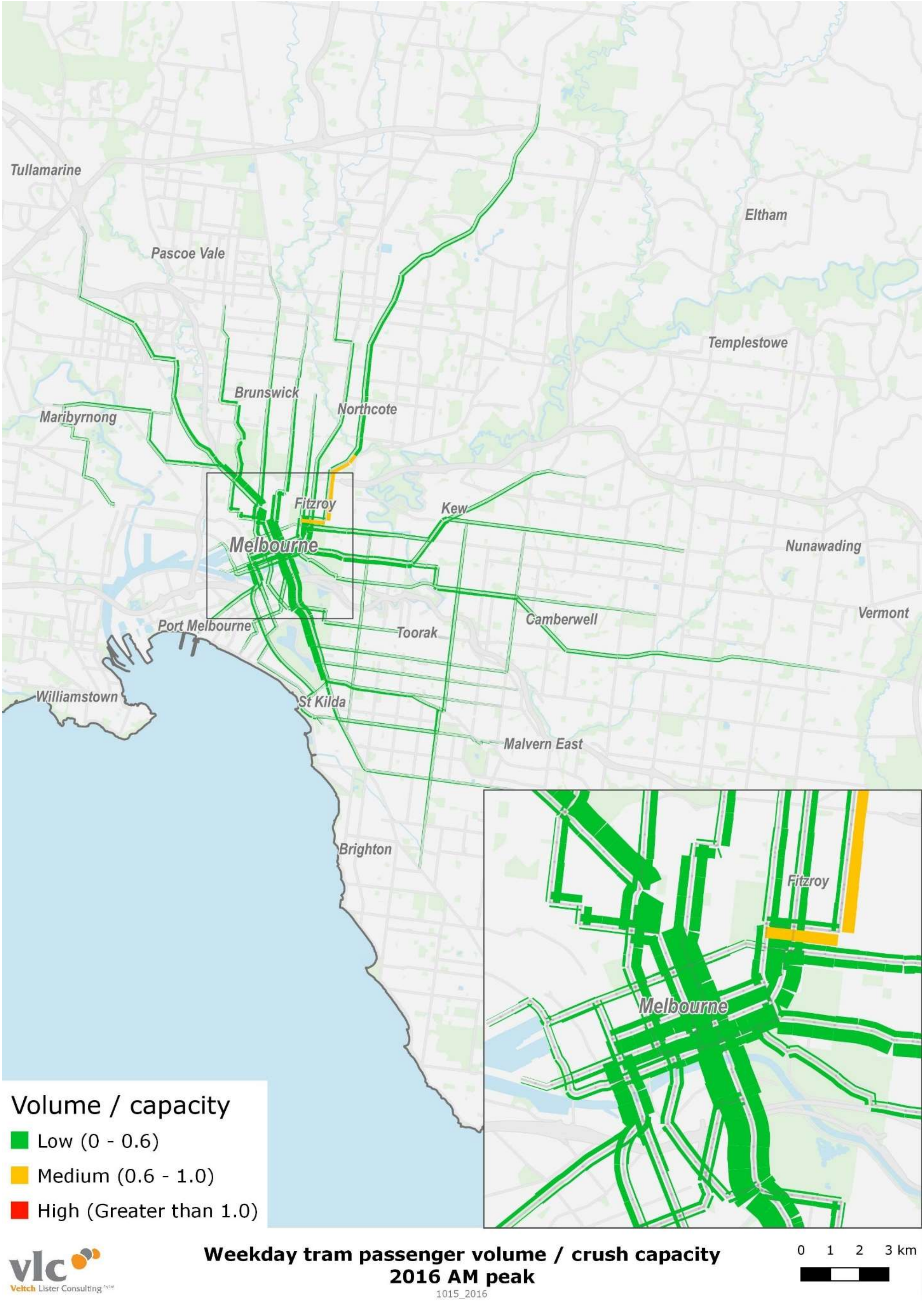


Figure 5-10 – Melbourne GCCSA weekday tram passenger volume / crush capacity - 2016 1-hour PM peak

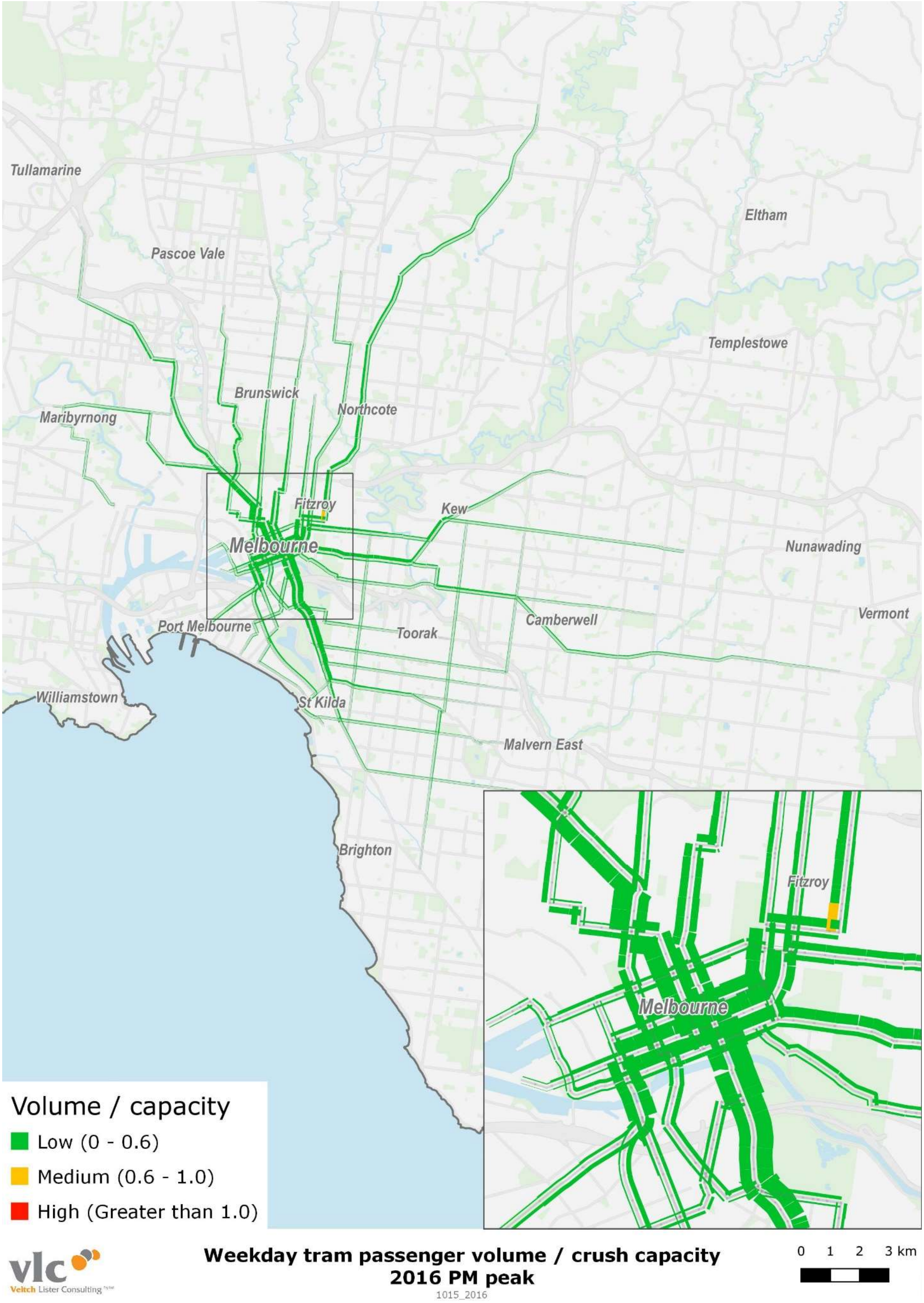


Figure 5-11 – Melbourne GCCSA weekday tram passenger volume / crush capacity - 2031 1-hour AM peak

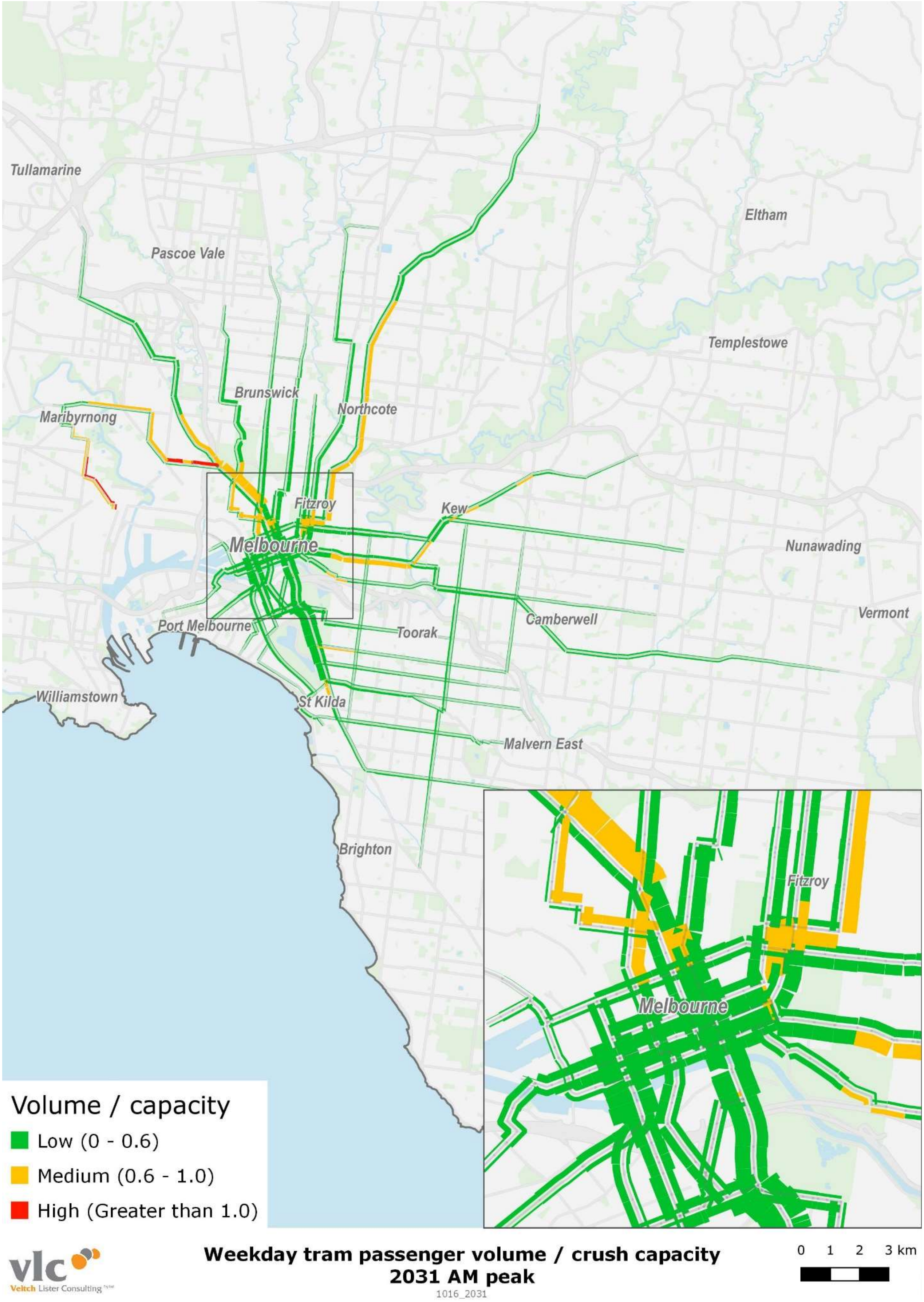
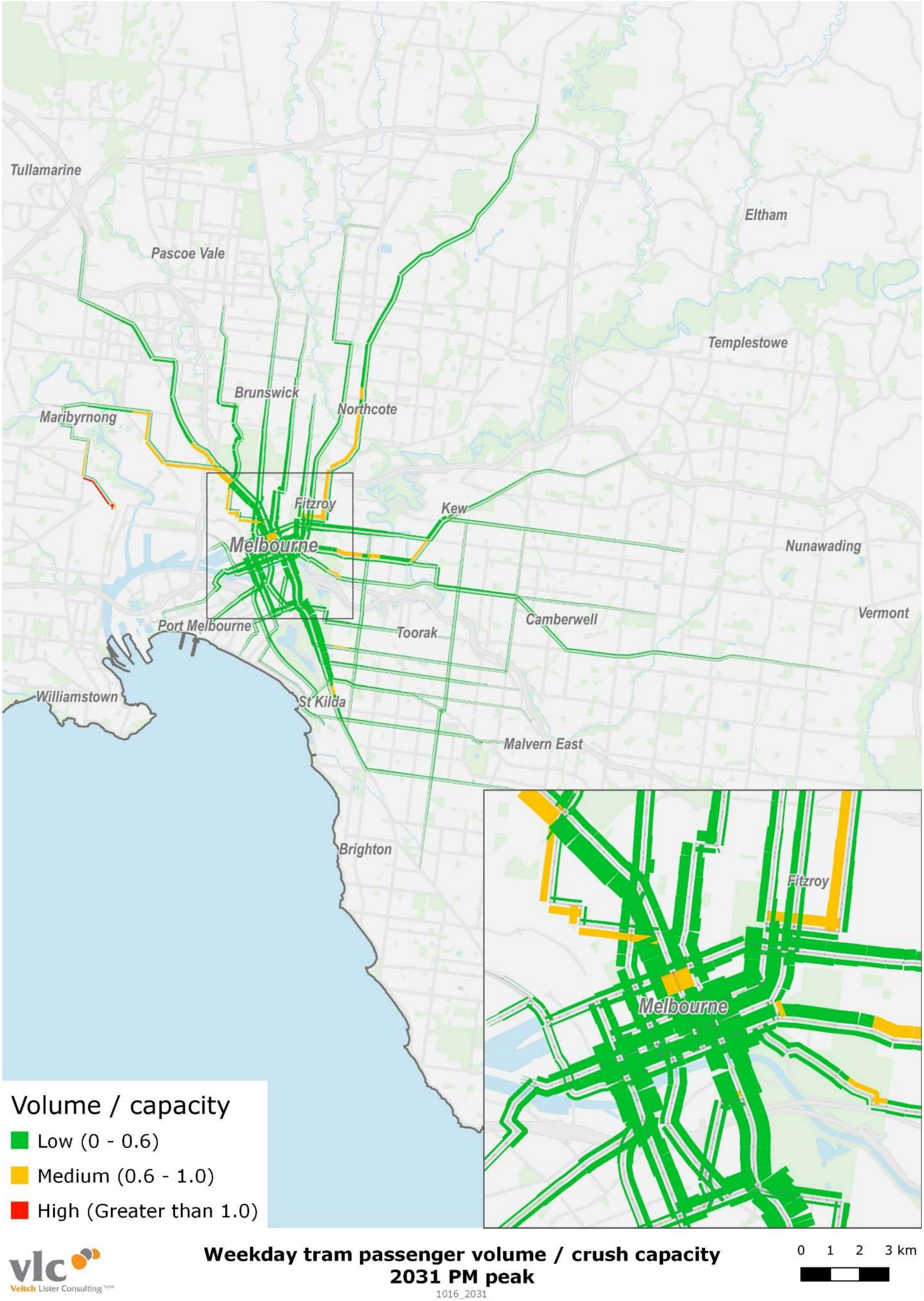


Figure 5-12 – Melbourne GCCSA weekday tram passenger volume / crush capacity - 2031 1-hour PM peak



In general, low levels of crowding were observed on the bus network in 2016. The SkyBus, which serves Melbourne Airport, was highlighted as being highly utilised in peak periods (Figure 5-13 and Figure 5-14). In addition the buses serving the key activity centres of Monash and Dandenong in the south eastern suburbs also had moderate levels of crowding in the peak periods.

In the 2031 forecast, passenger loadings on the Eastern Freeway busway from Doncaster are expected to increase, causing moderate levels of crowding. Buses in growth areas are forecast to experience more significant crowding by 2031, particularly feeder services to the rail network at the northern and western fringes. The growth area bus networks assumed in this study are simplistic in nature and may be insufficient to cater for additional demands resulting from the significant population increases. In reality, it is likely that growth area bus services would be improved to better match demand, and as such the level of crowding predicted here is likely to be overstated. This will have a flow on effect on the cost of crowding calculated in section 7.3.

Figure 5-13 – Melbourne GCCSA weekday bus passenger volume / crush capacity - 2016 1-hour AM peak

Figure 5-14 – Melbourne GCCSA weekday bus passenger volume / crush capacity - 2016 1-hour PM peak

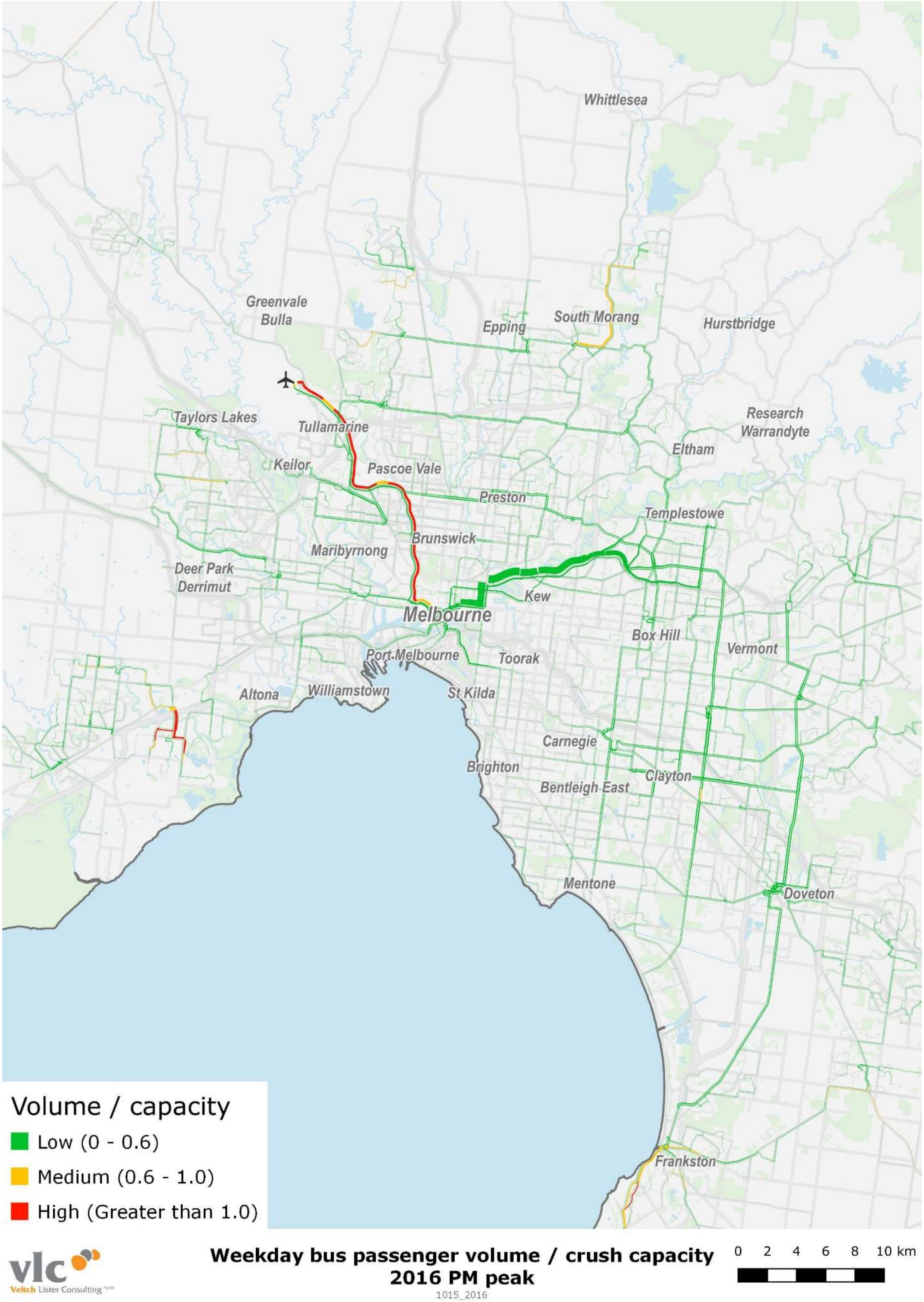


Figure 5-15 – Melbourne GCCSA weekday bus passenger volume / crush capacity - 2031 1-hour AM peak

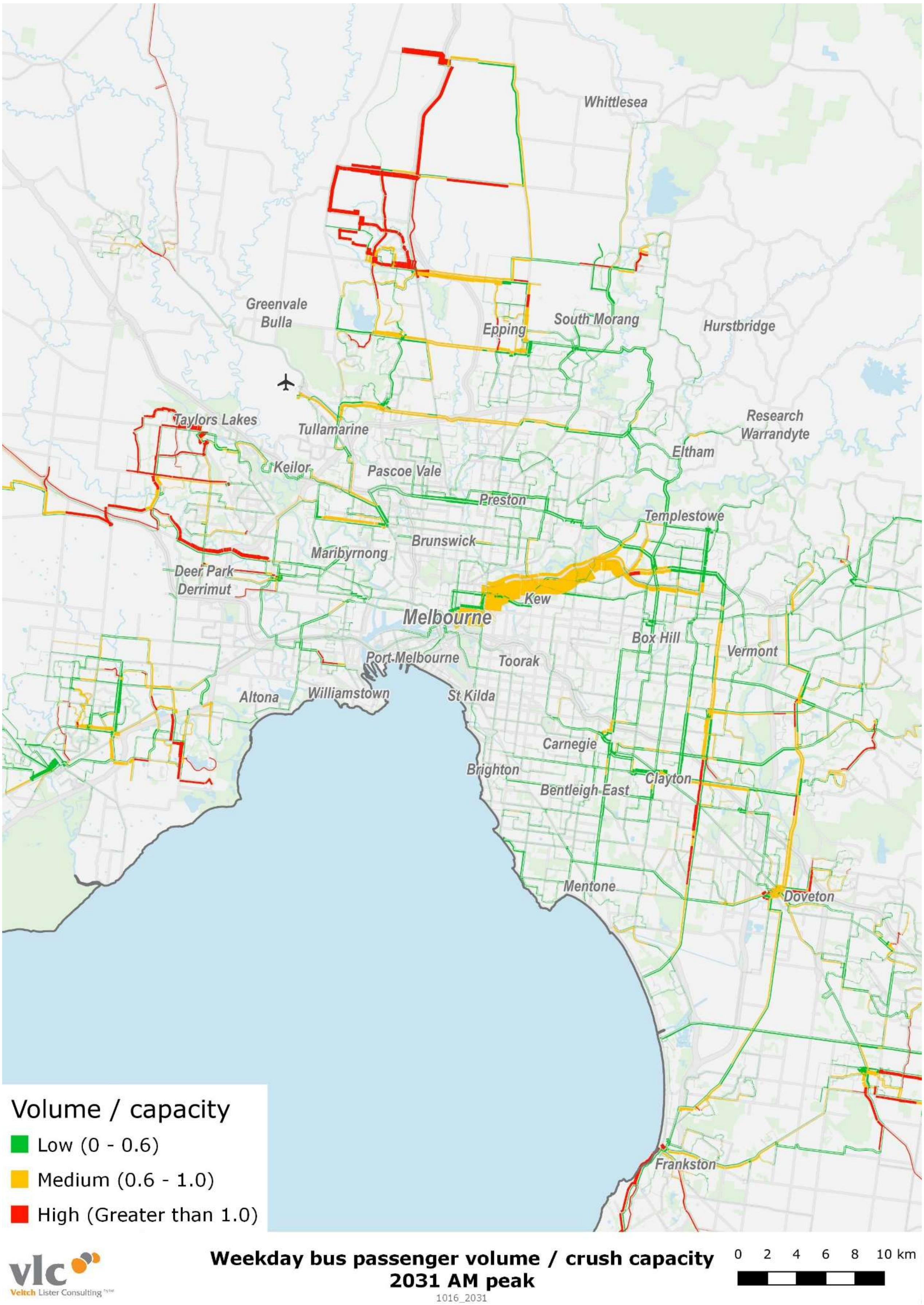
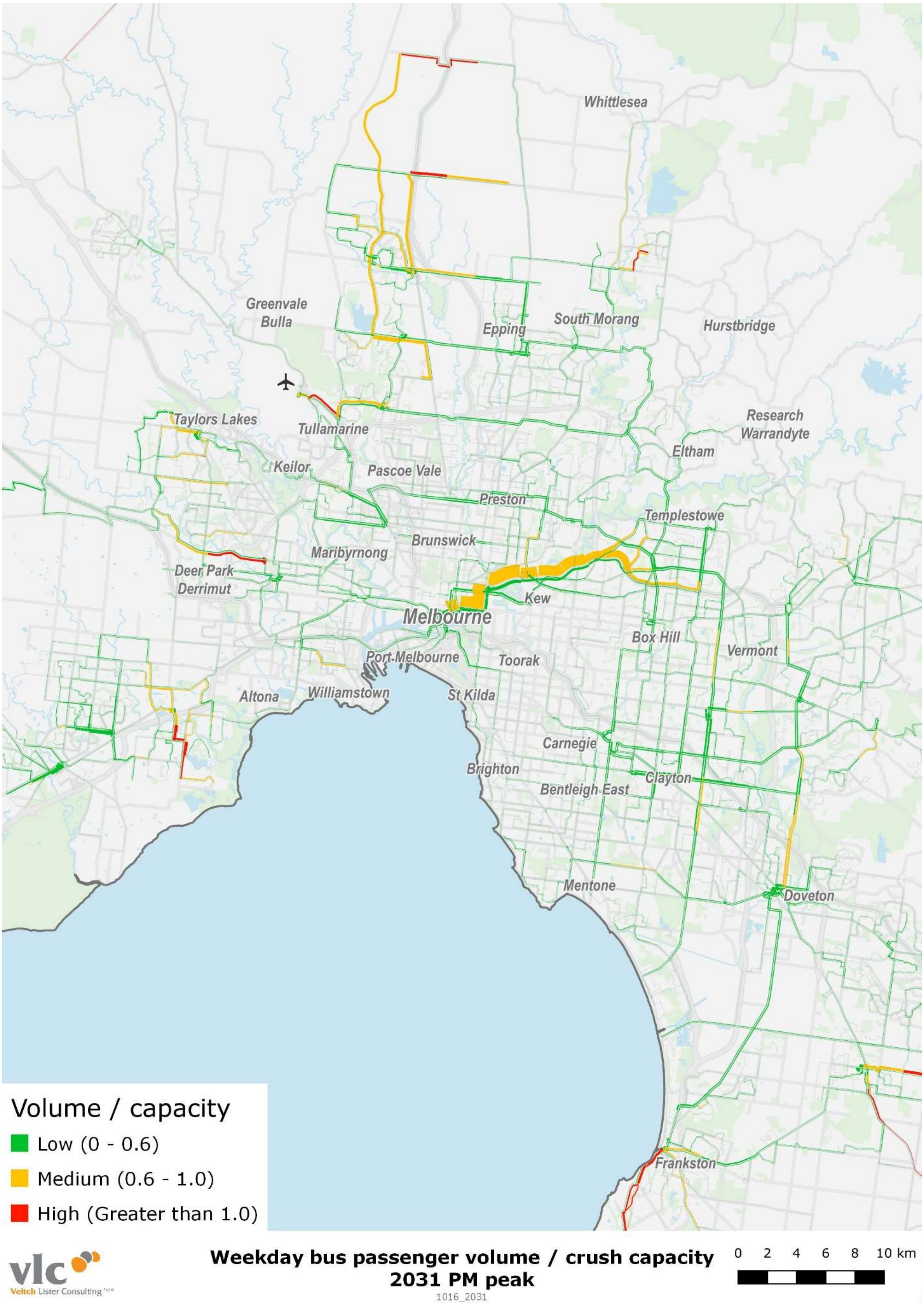
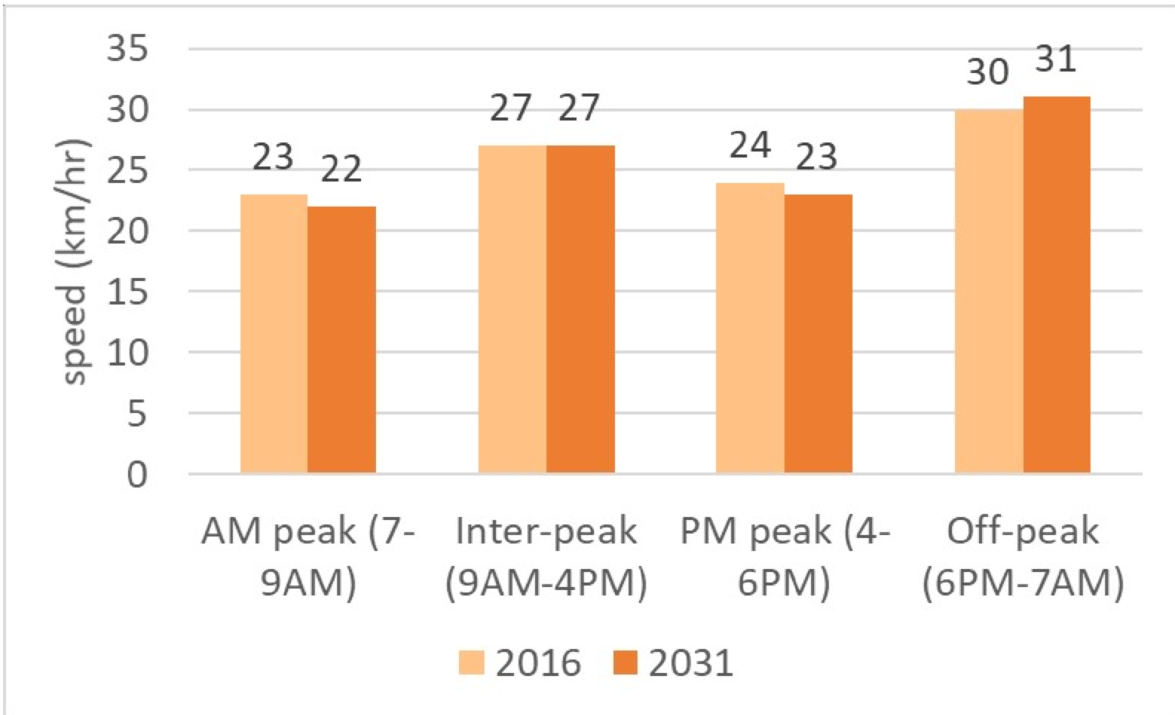


Figure 5-16 – Melbourne GCCSA weekday bus passenger volume / crush capacity - 2031 1-hour PM peak



A further indicator of the performance of the bus network is average speed (Figure 5-17). Average speeds are expected to decline slightly between 2016 and 2031 – by approximately one kilometre per hour in the peak periods. This is compared with decreases of around five kilometres per hour for traffic (refer to Figure 4-7), suggesting that bus priority lanes are helping to mitigate the extent to which services are impacted by delays resulting from congestion. Bus speeds will remain stable in the inter-peak, while performance will marginally improve in the off-peak. This is consistent with the changes in traffic speeds, indicating that investments in the road network infrastructure will benefit bus users as well.

Figure 5-17 – Melbourne GCCSA average bus speeds



Passengers using the regional rail network will experience some crowding in the AM and PM peaks in 2016, particularly on the West and South-West lines (Figure 5-18 and Figure 5-19). Patronage growth on the regional rail network (see Figure 5-4) significantly increases crowding to 2031. In the AM peak, most lines are predicted to exceed capacity on the approach to the city (Figure 5-20), with slightly better outcomes in the PM peak (Figure 5-21). Population growth on Melbourne's fringe is a key driver of this crowding, however the levels of crowding are subject to significant uncertainty. This uncertainty is a function of:

- Lower levels of precision in growth area transport networks making modelled users highly dependent on the regional rail system (due to lack of detailed information about future roads and other public transport alternatives).
- Lower levels of certainty about the future operations of the regional rail system (for example, service frequencies).

Additional supporting infrastructure and increased service frequencies would alleviate the high levels of crowding predicted. The high level of crowding identified here drives very high crowding costs on the regional rail network in section 7.3.

Figure 5-18 – Melbourne GCCSA weekday regional rail passenger volume / crush capacity - 2016 1-hour AM peak

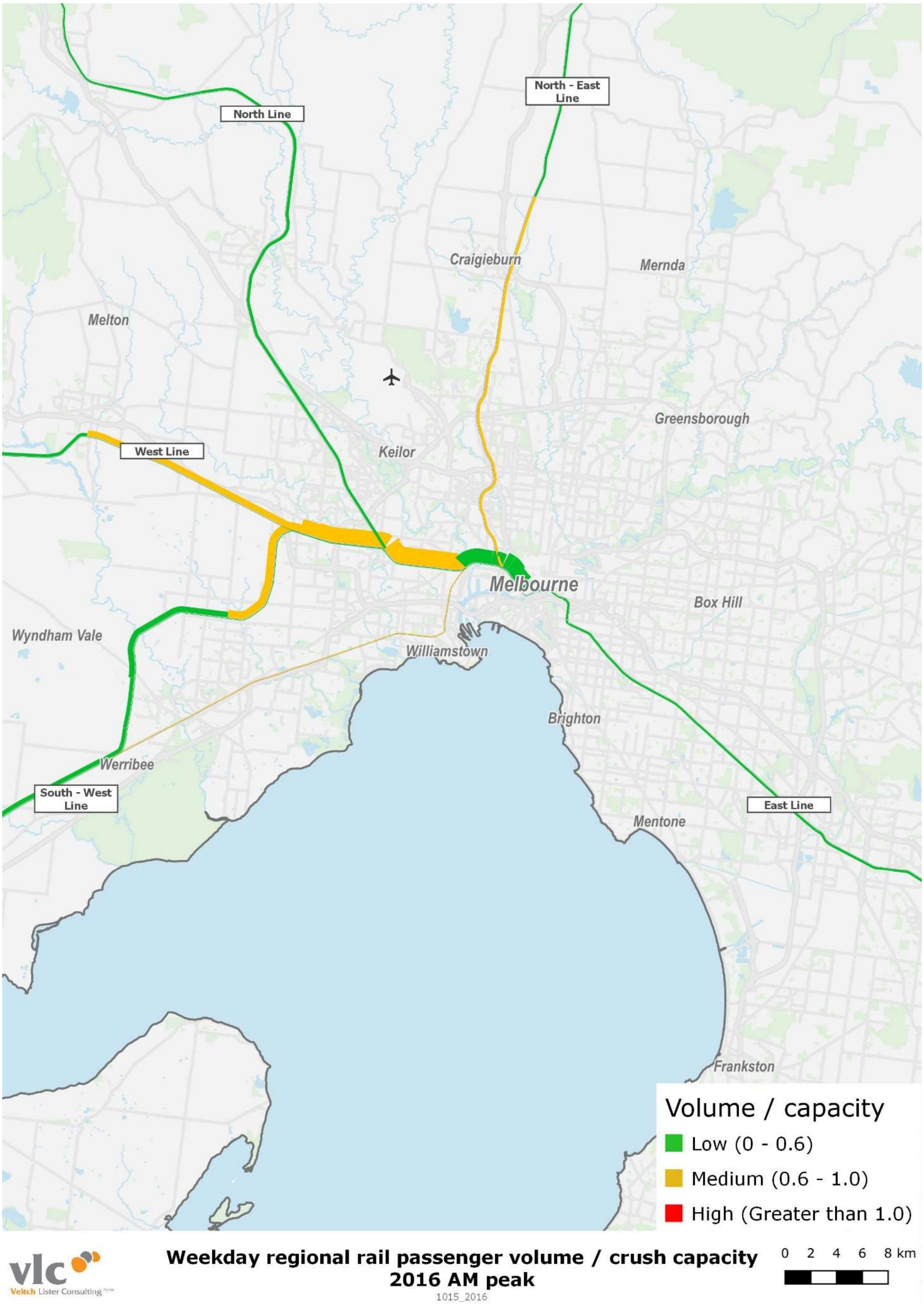


Figure 5-19 – Melbourne GCCSA weekday regional rail passenger volume / crush capacity - 2016 1-hour PM peak

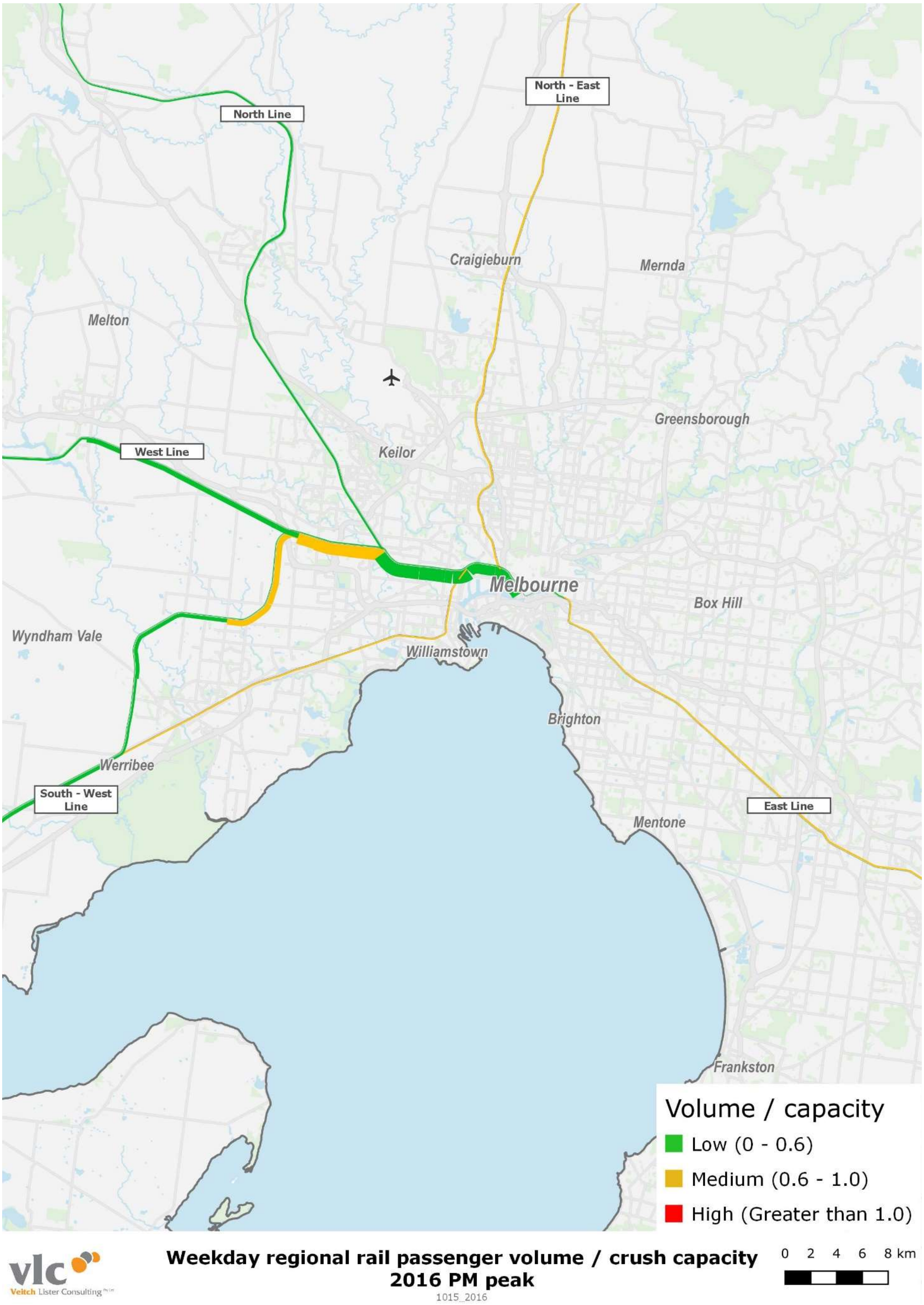
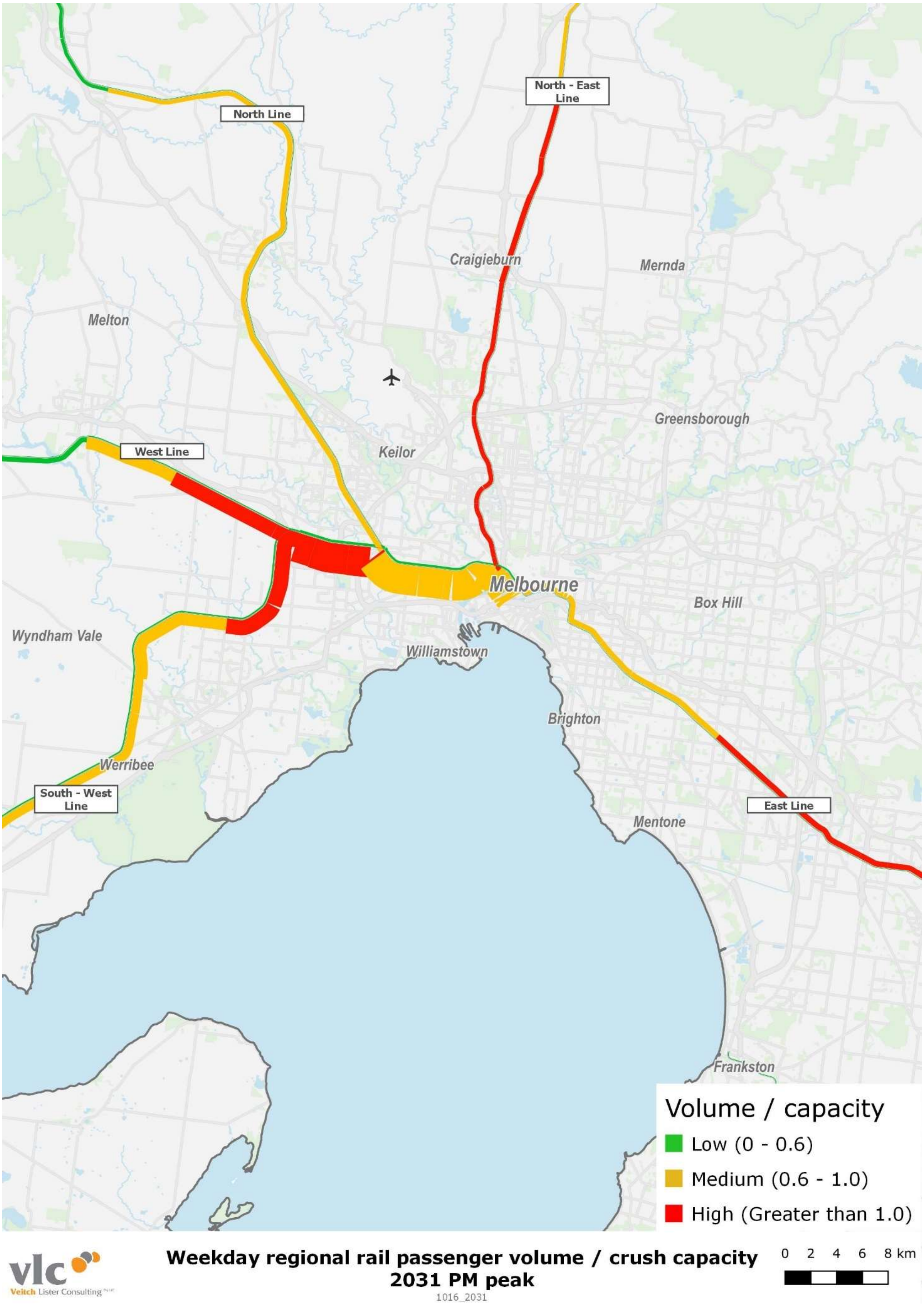


Figure 5-20 – Melbourne GCCSA weekday regional rail passenger volume / crush capacity - 2031 1-hour AM peak

Figure 5-21 – Melbourne GCCSA weekday regional rail passenger volume / crush capacity - 2031 1-hour PM peak



6. Accessibility and social inclusion

The ability to participate in society is greatly affected by access to services and opportunities. Hospitals, schools, child care services and green space are all vital types of social infrastructure that can enhance the wellbeing of individuals and the community generally. Conversely, poor transport connections and lack of access to these kinds of services can lead to social isolation and exclusion.

This section of the report examines the extent to which areas across Greater Melbourne have adequate access to key services and opportunities both now and in the future. Services have been considered at two levels of geography – local and regional (Table 6-1). Shorter travel times would be expected for services in the former group, while longer travel times are more acceptable for regional social infrastructure.

Two factors affect a person's accessibility to services. The first is the travel times across the transport network. For example, increased congestion on the road network causes longer travel times, resulting in lower accessibility. New road connections, on the other hand, may reduce travel times, resulting in higher accessibility. Accessibility is measured by both car and public transport travel times.

The second factor is the spatial distribution of services. The addition of more jobs, a new hospital, or a new park would result in an improvement to accessibility for adjacent areas, even without apparent changes to travel times. The locations of child care services, hospitals, schools and green space are assumed to remain static between 2016 and 2031. In reality this is unlikely to be the case, and new services will almost certainly be developed over the coming years. While to some extent this is a limitation of these measures, it also provides an opportunity to highlight where new social infrastructure development should be focused if it is not already in planning.

Limitations of strategic accessibility modelling:

All travel times represent journeys between travel zones – one zone is at the home end of the trip and the other at the destination. Demand produced from each travel zone is fed onto the transport network from a single point (the 'centroid') via a notional link known as a 'centroid connector'. The precision of modelled travel times is therefore highly dependent on the granularity of travel zones at either end of the journey. Geographically larger travel zones (generally at the fringes of the urban area) have a greater imprecision associated with the location of the centroid versus the actual locations of households. Larger zones also have longer centroid connectors, so the travel time on these connectors to reach the realistic transport network becomes a proportionally longer component of the overall trip. The model is not able to estimate travel times for trips made by public transport entirely within a travel zone – 'intrazonal trips'. Travel times for these trips are therefore based on walk times. Finally, the model does not consider all factors that can affect end-to-end car travel time, such as locating a car park.

To aid interpretation, two adjustments are made to the maps of PT accessibility: large and low population density zones are not mapped, and remaining zones containing the relevant social infrastructure are capped at 30 minute access time.

Table 6-1 – Social infrastructure services

Service	Metric	Rationale	Source
		Local	
Child care services	Average travel time to the nearest five child care centres	The availability of child care services is an important driver for participation in social activities for parents and children alike. Having a choice of more than one service increases the likelihood that parents and children will find a centre to meet their specific needs, for example in terms of opening hours or style of care.	Approved education and care services in 2018 form the Australian Children's Education & Care Quality Authority.
Public schools (primary/ secondary)	Travel time to the nearest school	School is generally the most significant social activity for school age children and teenagers. This metric has been limited to public schools to ensure that the service is usable by all residents.	Schools in 2016 from the Australian Curriculum, Assessment and Reporting Authority
Green space	% of the residential population in an SA3 within a 10-minute walk of green space	Green space is a vital component of liveable cities and provides an opportunity for recreation and socialising for residents.	Parkland classified meshblocks in the 2016 Census. This includes nature reserves, conserved/protected areas, and public open space. It may also include sporting facilities not open to the public. Minor alterations have been made based on satellite data.
		Regional	
Jobs	Number of jobs that can be reached within 30 minutes by car and public transport	Access to jobs is a critical indicator of social inclusion. The more employment opportunities within a reasonable travel time from a person's home, the higher the likelihood of that person finding a job that appropriately matches their skills and experience.	2016 and 2031 employment data from Zenith, which is adapted from the 2016 ABS Census and 2031 Victorian Government projections
Hospitals (public/ emergency)	Travel time to the nearest public/emergency hospital	Limited access to healthcare can negatively impact health outcomes and overall quality of life. This metric has been limited to public hospitals and/or hospitals with an emergency department to ensure that the service is usable by all residents.	Hospitals in 2018 from the MyHospital database (Australian Institute of Health and Welfare)

6.1 Accessibility in 2016 and 2031

Local infrastructure should be accessible within short travel times. Ideally, residents should also have options to choose motorised or active modes of transport for these journeys.

The average resident of Melbourne with access to a car can reach child care and public primary schools within a four-minute trip in 2016, extending to a five-minute trip in 2031 (Table 6-2). Travel times to public secondary schools is slightly longer – 5.4 minutes in 2016 and 6.6 minutes in 2031. Residents who depend on public or active transport modes for their daily travel will face much longer travel times - around 20 minutes for child care services and primary schools in 2016, with public secondary schools averaging 28 minutes. The modelling suggests that public transport travel times will increase somewhat to 2031.

Table 6-2 – Melbourne GCCSA population-weighted average travel times to child care and public schools - AM peak (7-9AM)

Service	Car (mins)		PT (mins)	
	2016	*2031*	*2016*	*2031*
Child care services	4.0	4.9	21.7	25.9
Public primary school	3.5	4.4	18.7	23.2
Public secondary school	5.4	6.6	28.5	32.6

Figure 6-1 highlights average travel times to the nearest five child care centres by car in more spatial detail for 2031. Consistent with the city-wide average travel time of four minutes, many areas of Melbourne can reach a range of child care centres within a five-minute drive from home in 2031, providing they have access to a car. The main exceptions are SA3s at the urban fringe, including Wyndham, Melton-Bacchus Marsh, Cardinia and Whittlesea-Wallan. Whittlesea-Wallan is also expected to experience among the largest increases in average travel times by car to 2031 (Table 6-3). This estimated reduction in accessibility is a function of significant population growth projections coupled with the limited existing supply of both transport and social infrastructure in designated growth areas.

Public transport offers a realistic alternative to car for accessing educational infrastructure for residents across many parts of Melbourne. Travel times to access childcare (Figure 6-2) and public primary schools (Figure 6-4) in the 2031 AM peak using public transport are likely to take up to 20 minutes from most parts of the city, while secondary school students are projected to have slightly longer travel times (Figure 6-6). In areas on the urban fringe, travel times in excess of 30 minutes will be required. This is largely a function of the way in which the public transport network serves the CBD and, to a lesser extent, large activity centres (see Section 3). The public transport system is not as effective at catering for local travel needs as it is at transporting large numbers of people into the city.

Figure 6-1 – Melbourne GCCSA and Geelong average time to nearest five child care centres by Car - 2031 AM peak (7-9AM)

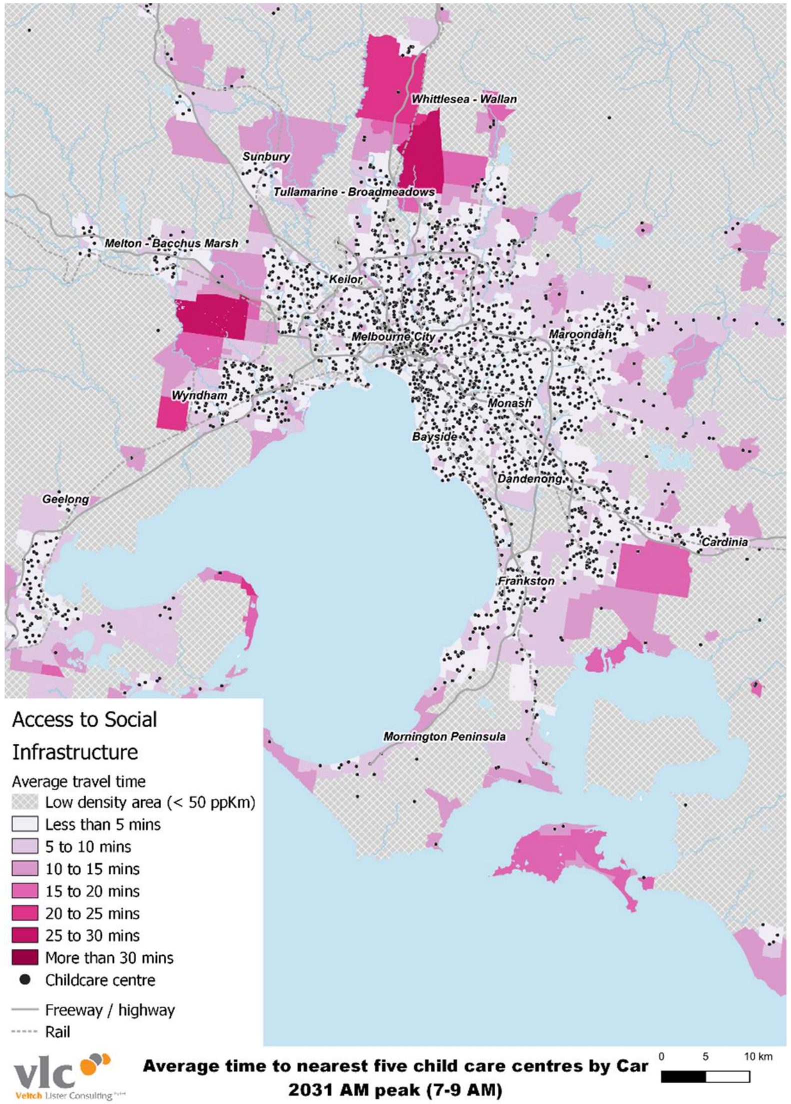


Figure 6-2 – Melbourne GCCSA and Geelong average time to nearest five child care centres by PT - 2031 AM peak (7-9AM)

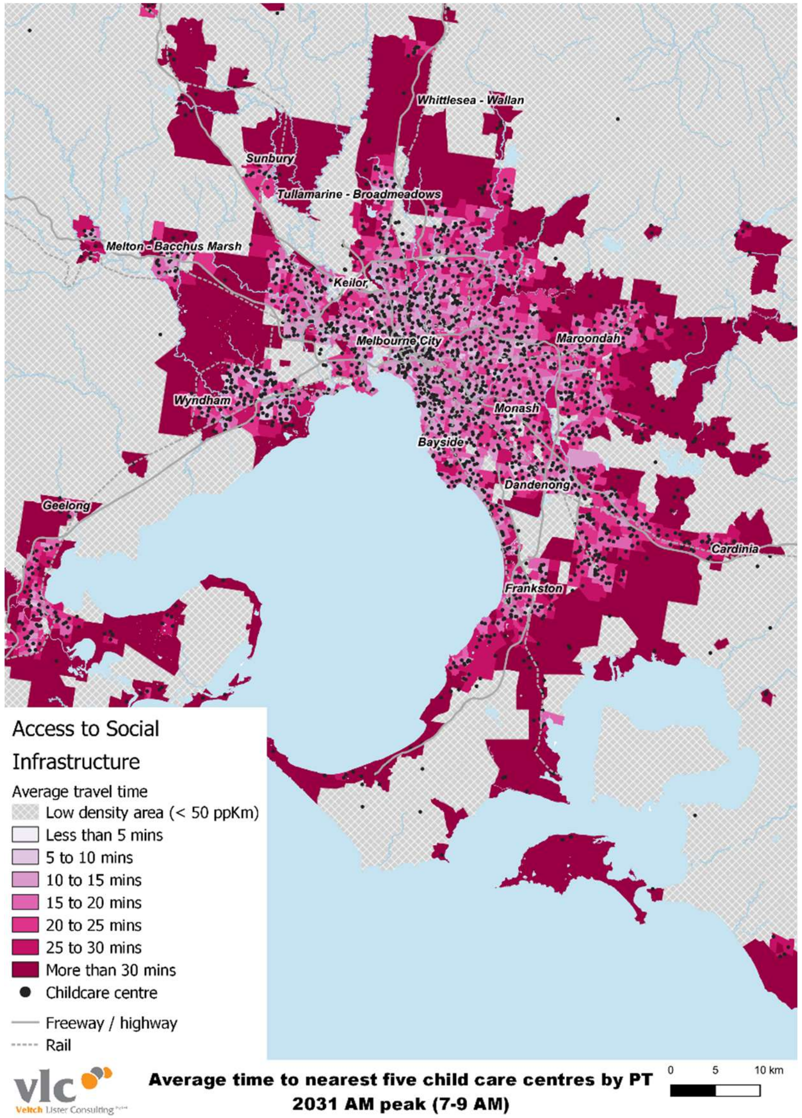


Figure 6-3 – Melbourne GCCSA and Geelong average time to nearest public primary school by Car - 2031 AM peak (7-9AM)

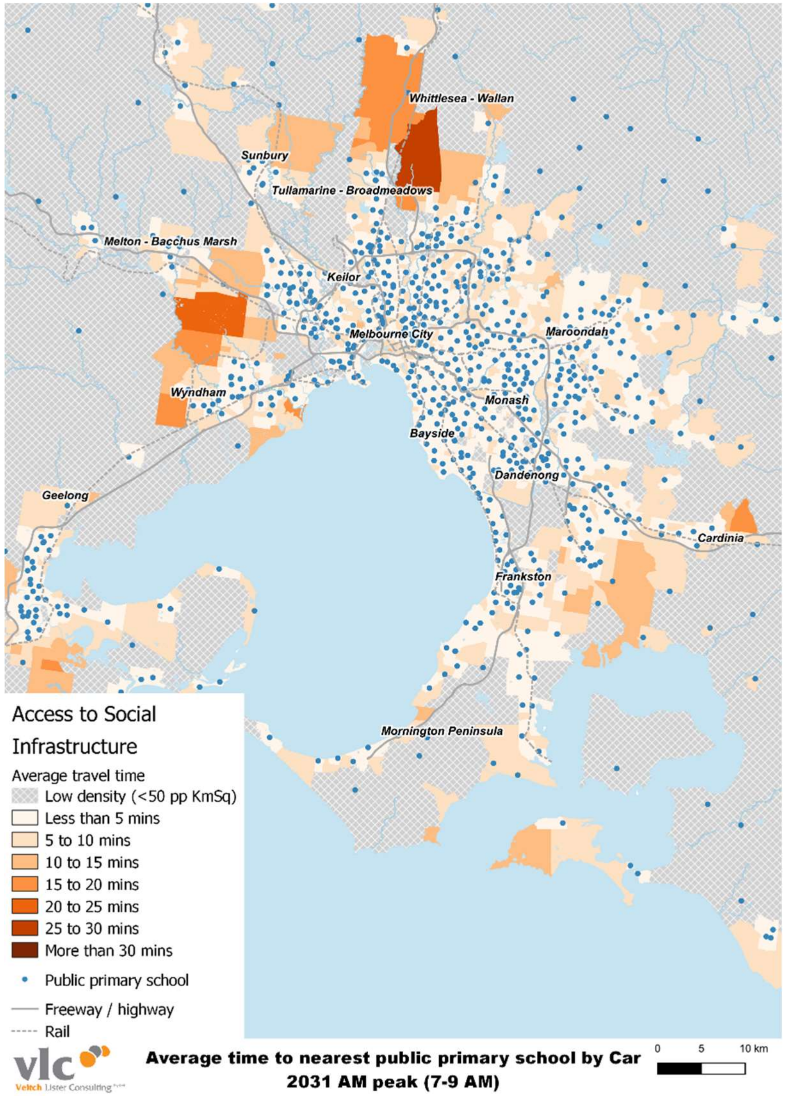


Figure 6-4 – Melbourne GCCSA and Geelong average time to nearest public primary school by PT - 2031 AM peak (7-9AM)

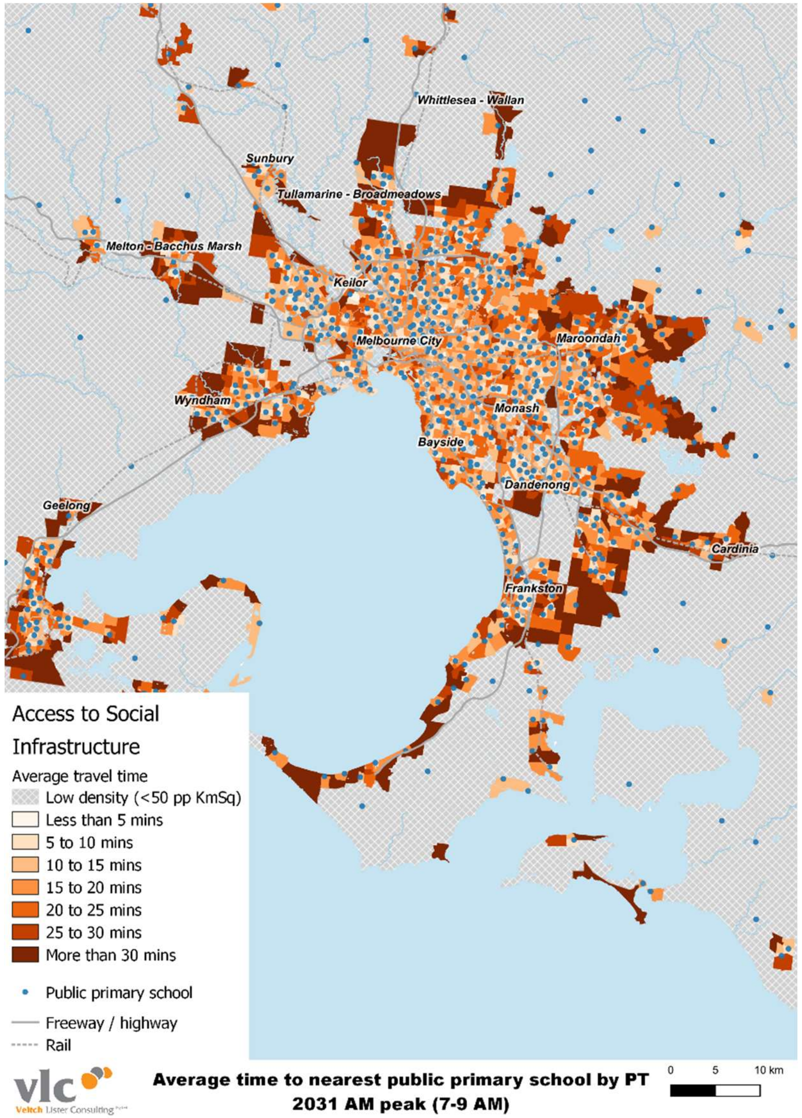


Figure 6-5 – Melbourne GCCSA and Geelong average time to nearest public secondary school by Car - 2031 AM peak (7-9AM)

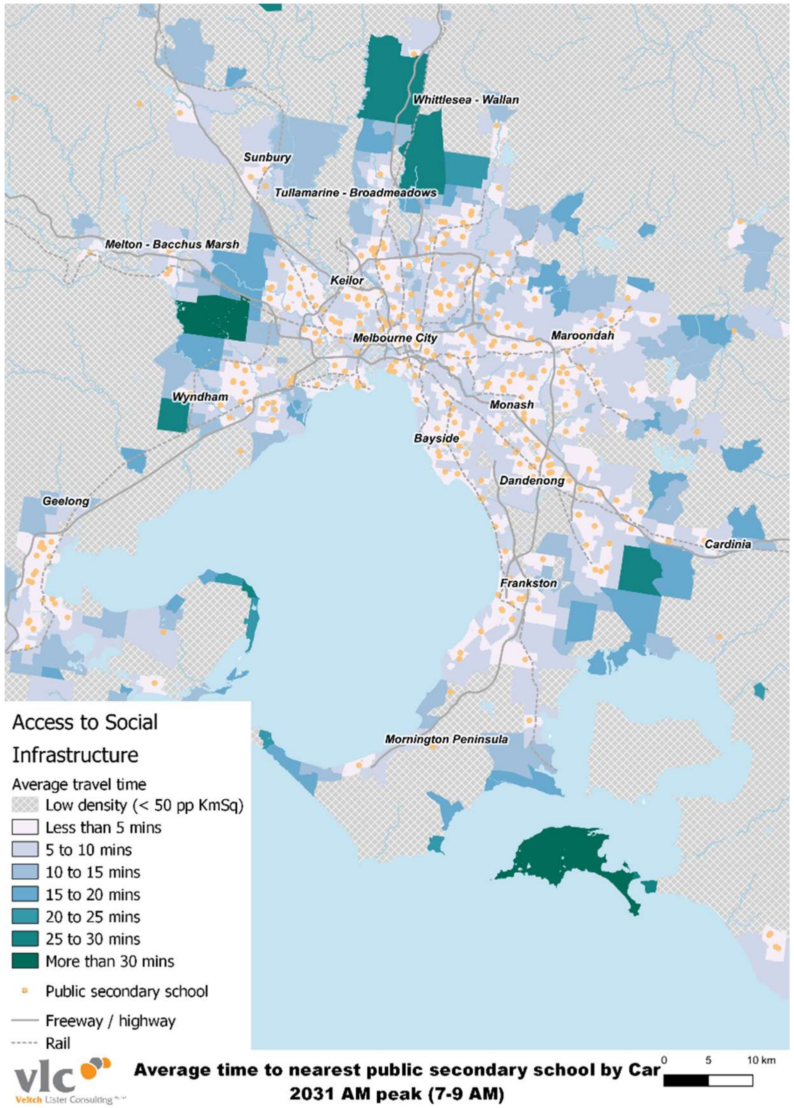


Figure 6-6 – Melbourne GCCSA and Geelong average time to nearest public secondary school by PT - 2031 AM peak (7-9AM)

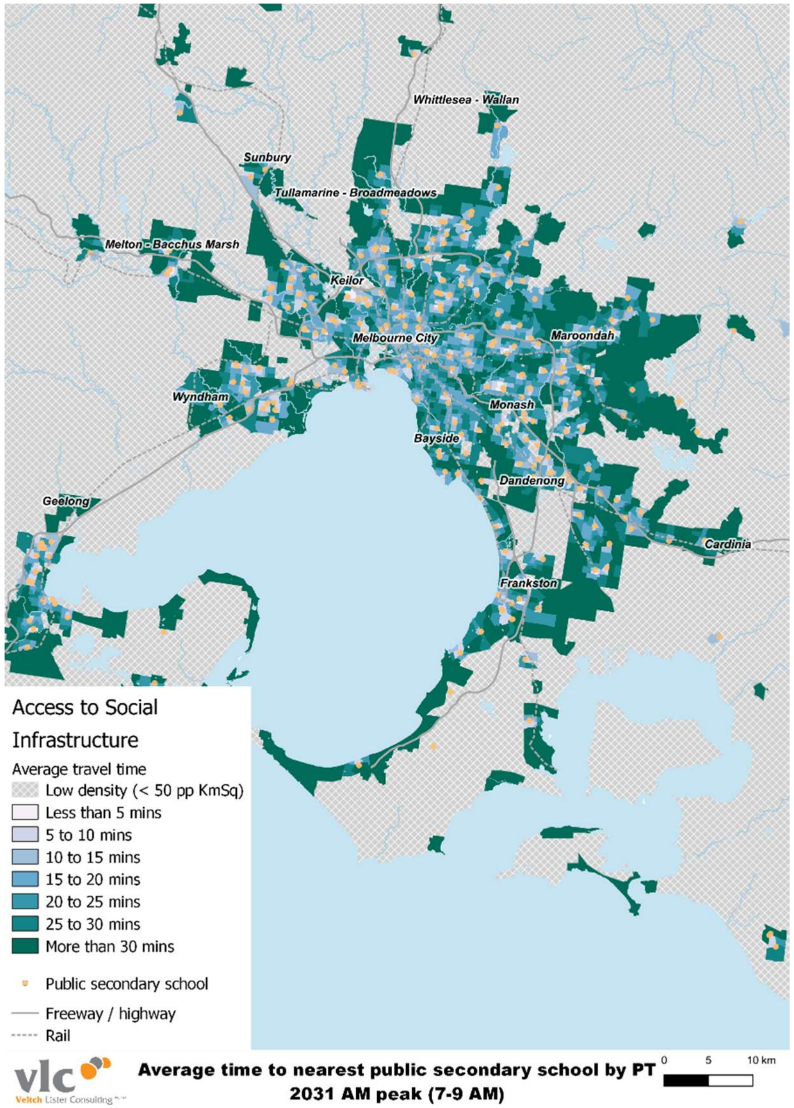


Table 6-3 – Melbourne GCCSA and Geelong population-weighted average travel times* to child care and public schools by SA3 - AM peak (7-9AM)

SA3	Child care (nearest five, mins)						Nearest public primary school (mins)						Nearest public secondary school (mins)					
	Car			PT			Car			PT			Car			PT		
	2016	2031	Diff	2016	2031	Diff	2016	2031	Diff	2016	2031	Diff	2016	2031	Diff	2016	2031	Diff
Banyule	4.3	4.3	+0.0	17.8	17.4	-0.4	3.4	3.5	+0.0	14.2	14.1	-0.1	5.6	5.8	+0.1	23.3	22.8	-0.5
Bayside	3.0	3.1	+0.1	16.8	16.9	+0.1	2.9	3.0	+0.1	16.3	16.2	-0.1	4.5	4.6	+0.1	25.9	25.6	-0.3
Boroondara	3.4	3.6	+0.2	15.8	15.5	-0.3	3.1	3.3	+0.2	14.7	14.5	-0.2	4.7	5.1	+0.4	21.6	21.0	-0.6
Brimbank	3.1	3.2	+0.1	18.1	18.3	+0.2	2.5	2.6	+0.1	14.7	14.8	+0.1	3.7	3.9	+0.2	21.6	21.7	+0.1
Brunswick - Coburg	3.0	3.4	+0.4	13.3	13.0	-0.2	3.1	3.4	+0.4	13.5	13.4	-0.1	4.2	4.8	+0.6	18.8	18.4	-0.4
Cardinia	7.0	7.1	+0.1	45.5	42.1	-3.4	5.6	5.9	+0.3	36.9	37.6	+0.7	9.3	9.3	+0.1	58.0	52.8	-5.1
Casey - North	3.6	3.9	+0.3	20.8	21.2	+0.4	3.2	3.5	+0.3	17.9	18.9	+1.0	4.6	4.9	+0.3	25.9	26.0	+0.1
Casey - South	4.5	7.8	+3.3	27.9	31.8	+4.0	4.2	6.4	+2.3	25.5	27.8	+2.3	6.4	11.5	+5.1	38.7	41.1	+2.5
Dandenong	3.3	3.3	+0.0	17.6	17.3	-0.3	2.7	2.7	+0.0	14.1	14.1	+0.1	4.4	4.5	+0.1	23.6	23.1	-0.5
Darebin - North	3.7	4.2	+0.5	16.7	16.4	-0.3	3.2	3.4	+0.2	13.9	13.8	-0.2	5.5	6.0	+0.5	24.1	24.1	-0.0
Darebin - South	3.5	3.7	+0.2	14.3	13.9	-0.3	2.7	2.9	+0.2	11.3	11.2	-0.2	5.3	5.7	+0.4	21.6	20.6	-1.0
Essendon	2.6	2.8	+0.2	13.9	13.8	-0.1	2.3	2.5	+0.2	11.6	11.8	+0.2	4.1	4.5	+0.4	19.6	19.5	-0.0
Frankston	4.2	4.3	+0.1	24.8	24.8	-0.0	3.6	3.7	+0.1	20.6	20.7	+0.1	4.9	5.0	+0.1	29.0	28.8	-0.2
Glen Eira	2.8	3.0	+0.1	14.5	14.3	-0.2	2.7	2.8	+0.1	14.0	13.8	-0.2	4.7	4.9	+0.2	22.0	21.3	-0.6
Hobsons Bay	3.4	3.5	+0.0	20.1	19.9	-0.2	2.5	2.5	-0.0	14.1	13.8	-0.3	5.7	5.7	+0.0	27.7	27.4	-0.3
Keilor	4.1	4.3	+0.3	20.4	20.4	-0.0	3.5	3.6	+0.1	17.3	17.1	-0.2	4.4	4.7	+0.3	23.1	22.6	-0.6
Kingston	3.2	3.3	+0.1	17.3	17.2	-0.1	2.8	2.9	+0.1	14.6	14.7	+0.0	5.3	5.4	+0.1	27.5	26.9	-0.6
Knox	3.7	3.8	+0.1	20.2	20.2	-0.0	3.1	3.2	+0.1	16.2	16.2	+0.0	4.8	4.9	+0.1	25.4	25.6	+0.2
Macedon Ranges	9.2	11.2	+1.9	69.0	74.7	+5.7	5.6	6.8	+1.2	40.7	47.0	+6.3	14.7	17.1	+2.4	89.7	98.7	+9.0
Manningham - East	5.7	5.9	+0.2	26.2	26.2	-0.0	4.6	4.9	+0.2	23.8	23.8	-0.0	7.7	8.0	+0.2	32.1	32.2	+0.1
Manningham - West	3.7	3.7	-0.0	16.8	16.6	-0.2	3.9	3.9	+0.0	17.6	17.9	+0.3	5.7	5.7	-0.1	25.3	25.0	-0.4
Maribyrnong	2.9	3.4	+0.5	14.1	13.6	-0.5	3.3	4.0	+0.8	15.5	16.4	+0.9	4.9	5.0	+0.2	21.5	20.2	-1.3
Maroondah	3.5	3.6	+0.1	19.7	19.5	-0.2	3.2	3.3	+0.1	17.9	18.1	+0.2	4.7	4.9	+0.1	25.4	25.2	-0.2
Melbourne City	2.8	3.0	+0.2	10.1	10.1	+0.0	4.4	5.1	+0.7	16.5	16.4	-0.2	4.2	4.9	+0.6	17.1	16.5	-0.5
Melton - Bacchus Marsh	4.4	7.2	+2.9	26.3	36.5	+10.2	3.9	6.8	+2.9	22.0	32.5	+10.4	6.1	9.7	+3.6	35.1	42.0	+6.9
Monash	3.5	3.6	+0.1	18.3	18.4	+0.2	3.0	3.2	+0.1	15.7	15.9	+0.2	4.5	4.6	+0.1	22.6	22.8	+0.2
Moreland - North	3.6	4.0	+0.4	17.5	17.6	+0.0	3.1	3.3	+0.2	14.9	14.9	+0.0	4.5	5.0	+0.5	22.4	22.6	+0.2
Mornington Peninsula	6.6	6.7	+0.1	45.1	44.9	-0.2	4.9	4.9	+0.1	32.7	32.8	+0.1	7.9	8.0	+0.1	54.9	54.3	-0.6
Nillumbik - Kinglake	7.7	8.4	+0.7	45.4	51.0	+5.6	5.8	6.0	+0.2	31.6	33.5	+1.9	10.4	11.4	+1.0	56.0	61.6	+5.7
Port Phillip	2.5	2.8	+0.3	12.2	12.5	+0.4	2.9	3.5	+0.6	14.1	15.2	+1.1	4.0	4.6	+0.6	19.4	21.1	+1.7
Stonnington - East	3.0	3.2	+0.2	15.8	15.7	-0.0	2.8	2.9	+0.2	14.7	14.6	-0.1	5.3	5.8	+0.5	24.8	23.6	-1.2
Stonnington - West	2.5	2.6	+0.1	12.6	12.4	-0.2	2.8	3.0	+0.2	14.5	14.3	-0.1	5.3	5.4	+0.1	20.4	18.1	-2.2
Sunbury	5.0	6.3	+1.3	33.1	39.6	+6.5	3.8	4.7	+0.9	26.5	33.2	+6.8	6.5	7.6	+1.1	43.4	49.3	+5.9

SA3	Child care (nearest five, mins)						Nearest public primary school (mins)						Nearest public secondary school (mins)					
	Car			PT			Car			PT			Car			PT		
	2016	*2031*	*Diff*	*2016*	*2031*	*Diff*	*2016*	*2031*	*Diff*	*2016*	*2031*	*Diff*	*2016*	*2031*	*Diff*	*2016*	*2031*	*Diff*
Tullamarine - Broadmeadows	3.9	5.9	*+2.0*	23.0	77.5	*+54.5*	3.6	5.6	*+2.0*	21.2	77.9	*+56.8*	5.8	8.0	*+2.2*	31.9	86.0	*+54.1*
Upper Goulburn Valley	15.4	16.7	*+1.2*	108.9	116.5	*+7.6*	9.7	10.2	*+0.5*	74.2	77.3	*+3.1*	15.4	16.9	*+1.5*	120.8	135.8	*+14.9*
Whitehorse - East	3.2	3.3	*+0.2*	17.2	17.3	*+0.0*	2.4	2.5	*+0.1*	12.8	12.9	*+0.1*	4.3	4.6	*+0.3*	24.1	24.2	*+0.1*
Whitehorse - West	2.9	3.0	*+0.1*	15.0	14.6	*-0.4*	2.9	3.1	*+0.2*	15.1	15.2	*+0.2*	4.4	4.6	*+0.2*	23.2	22.4	*-0.8*
Whittlesea – Wallan	5.5	10.4	*+4.9*	29.4	42.7	*+13.3*	4.7	8.9	*+4.2*	25.2	35.0	*+9.8*	6.1	11.8	*+5.7*	33.7	50.8	*+17.1*
Wyndham	3.7	5.5	*+1.9*	18.9	26.1	*+7.2*	4.0	5.9	*+1.9*	20.4	28.1	*+7.7*	4.8	7.0	*+2.2*	24.4	31.2	*+6.8*
Yarra	2.8	3.1	*+0.3*	10.9	10.8	*-0.1*	2.6	3.0	*+0.3*	10.0	10.0	*+0.0*	3.8	4.6	*+0.7*	15.2	15.1	*-0.1*
Yarra Ranges	6.8	6.8	*-0.1*	41.5	40.1	*-1.4*	4.6	4.6	*-0.0*	28.7	27.9	*-0.7*	7.8	7.8	*+0.0*	46.3	45.0	*-1.3*
Melbourne GCCSA	**4.0**	**4.9**	***+1.0***	**21.7**	**25.9**	***+4.2***	**3.5**	**4.4**	***+0.9***	**18.7**	**23.2**	***+4.5***	**5.4**	**6.6**	***+1.2***	**28.5**	**32.6**	***+4.1***
Barwon - West	18.1	19.7	*+1.6*	153.5	170.0	*+16.5*	10.4	11.7	*+1.3*	90.4	101.4	*+10.9*	28.0	31.9	*+3.9*	195.6	218.2	*+22.6*
Geelong	4.3	5.2	*+0.9*	27.7	32.3	*+4.6*	3.6	4.6	*+1.0*	22.2	27.9	*+5.7*	4.9	6.1	*+1.2*	30.0	36.5	*+6.5*
Surf Coast - Bellarine Peninsula	9.1	11.0	*+1.8*	58.5	69.6	*+11.1*	6.1	7.4	*+1.3*	41.7	50.6	*+8.9*	12.6	12.8	*+0.2*	76.3	84.3	*+8.0*
Geelong SA4	**6.4**	**7.5**	***+1.1***	**44.3**	**49.8**	***+5.5***	**4.7**	**5.7**	***+1.0***	**31.5**	**37.3**	***+5.9***	**8.4**	**9.3**	***+0.9***	**53.9**	**59.9**	***+6.0***

*The travel times reflect all modelled zones and so does not reflect adjustments made in Figures 6-2, 6-4 and 6-6 (see ‘Limitations of strategic accessibility modelling’ box above).

Melbourne residents generally have good access to green space. In 2016, 86 per cent of the population was within a 10-minute walk of green space, decreasing to 83 per cent in 2031. This measure excludes population in large travel zones (mostly on the urban fringe or rural areas). Applying a similar filter at an SA3 level constrains the analysis largely to established areas. The inner city, such as the Melbourne CBD, has very good access to green space, as it is highly walkable and is surrounded by a ring of substantial gardens and parks (Figure 6-7). SA3s along significant corridors of parkland also have good accessibility to green space, including Whitehorse – East, where there is a string of major parks that follow the alignment of EastLink, and Banyule, where there is parkland around the Yarra River through to Rosanna and extended towards Eltham. Some SA3s in outer areas, such as Brunswick – Coburg and Glen Eira, have below average access to green space.[3]

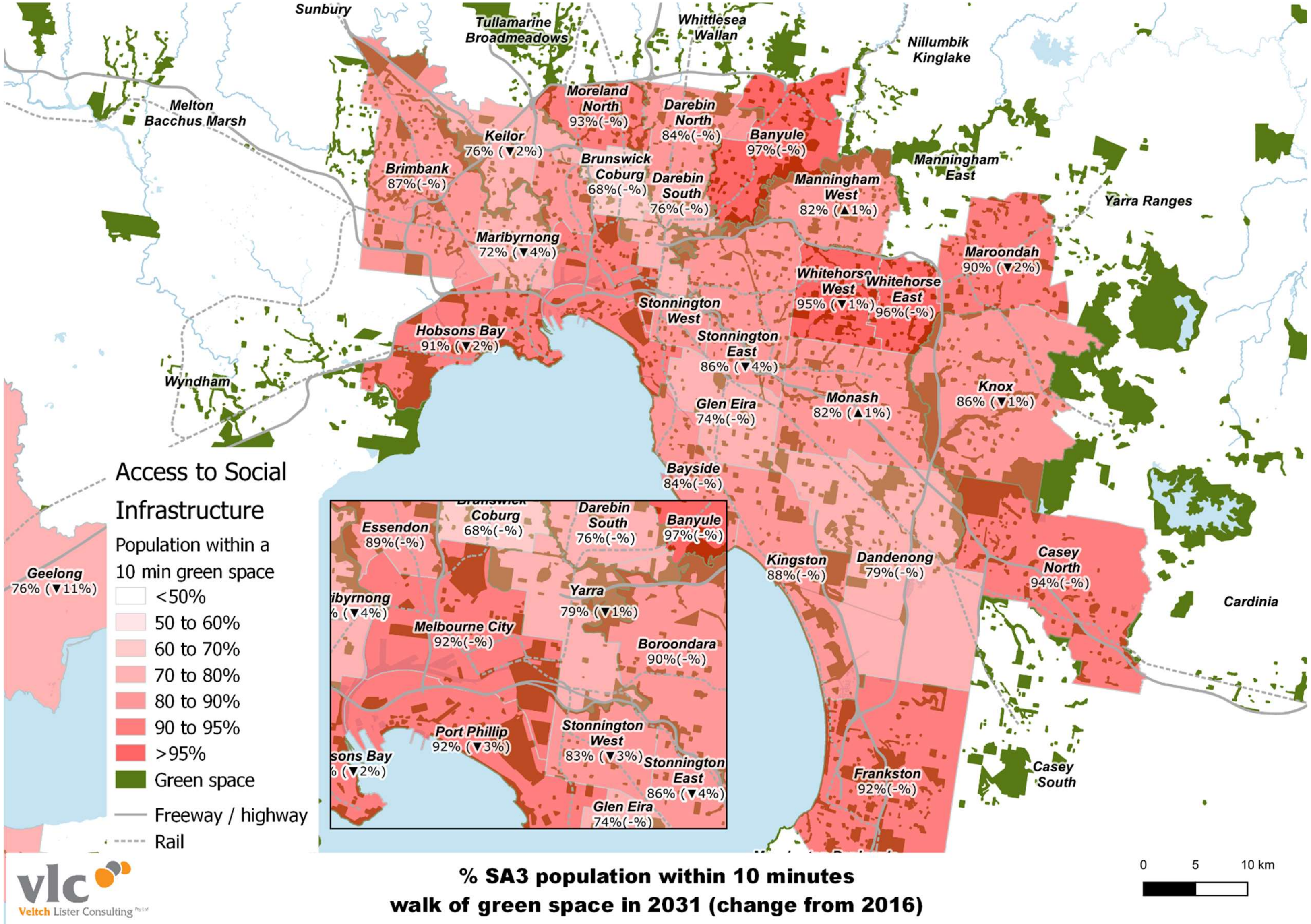
Limitations to measuring green space access:

Green areas defined in Figure 6-7 overleaf are used to estimate the green space accessibility metric. This interpretation of green space is quite broad, and does not account for the quality or quantity of the area. All residents in a travel zone are measured as having the same access to green space in one of two ways. The first is if the travel zone itself includes green space, it is assumed that walking time for everyone is 10 minutes or less. The second is if the walking time to nearby travel zones with green space is 10 minutes or less.

Both of these cases for estimation of metrics have issues on the urban fringe where travel zones are large. To overcome these issues, large and low-population-density travel zones have been excluded from the SA3 metrics mapped in Figure 6-7. Similarly, SA3s with more than 80 per cent of its population in large travel zones are not mapped.

[3] While not mapped, growth areas such as Melton-Bacchus Marsh, are assessed to experience declining green space accessibility to 2031. This is likely due to a combination of the spatial distribution of projected population growth in these areas and a lack of resolution in modelling of the future land uses on the urban fringe (travel zones, pedestrian and local road infrastructure, as well as future parklands themselves). Plans for these areas are at an early stage for the growth area which limits the level of detail that can be input to the model.

Figure 6-7 – Melbourne GCCSA and Geelong percentage of population within a 10-minute walk of green space in 2031



Employment accessibility is measured here as the percentage of total jobs that can be reached within 30 minutes by car (Figure 6-8 and Figure 6-9), and by public transport (Figure 6-10 and Figure 6-11). As jobs represent a ‘regional’ level category of social infrastructure, travel times are generally expected to be longer than for child care, schools and green space.

Access to employment opportunities varies considerably across Melbourne depending on where a person lives and what mode of travel they take. This accessibility also changes significantly between 2016 and 2031.

A large proportion of Greater Melbourne’s employment opportunities are in the CBD and adjacent suburbs, meaning that ease of access to these areas in the primary driver of job accessibility, irrespective of mode. In 2016, residents of Melbourne City had access to 44.6 per cent of the city’s job market by car, shifting only slightly to 40.2 per cent by 2031. SA3s close to the city, such as Port Phillip, Yarra and Stonnington-West also have good job accessibility by car (36.6%, 35.3% and 35.6% of jobs in 2031 respectively).

There is a clear east-west divide in access to jobs. In Melbourne’s east, there are several job clusters in middle-ring suburbs (e.g. Monash and Dandenong) that are well-serviced by Melbourne’s freeway network. In 2016 Monash had very good levels of job accessibility (23% of jobs) – though this declines slightly to 2031 due to congestion (to 17.9% of jobs). By contrast, SA3s to the west of Melbourne at a comparable distance to the CBD have more limited local employment, and more limited transport infrastructure provision. This results in much lower job accessibility by car in both 2016 and 2031 than the comparable eastern areas (Figure 6-8 and Figure 6-9). For example, residents of Brimbank can reach just 5.8 per cent of the region’s jobs by car in 2031.

While job accessibility by public transport is relatively stable between 2016 and 2031, most residents are unable to reach many jobs within a 30-minute commute. With a high concentration of Melbourne’s jobs and a role as the centre of the region’s public transport network, Melbourne City has the best job accessibility by public transport. Residents are able to reach 16 percent of jobs in 2016, growing to 17 percent in 2031. Outside of the inner suburbs, most SA3s can access an extremely small proportion of the city’s jobs within 30 minutes – typically less than one percent.

Access to critical healthcare is measured by the travel time to the nearest public hospital, or hospital with an emergency department, by car and public transport (Figure 6-12 and Figure 6-13). For residents with access to a car, accessibility to hospitals is generally good, with an average travel time of 13 minutes in 2031. By public transport, however, most residents of Greater Melbourne will need to travel for more than 30 minutes to reach their nearest public hospital (Table 6-4).

Figure 6-8 – Melbourne GCCSA and Geelong access to jobs by Car - 2016 AM peak (7-9AM)

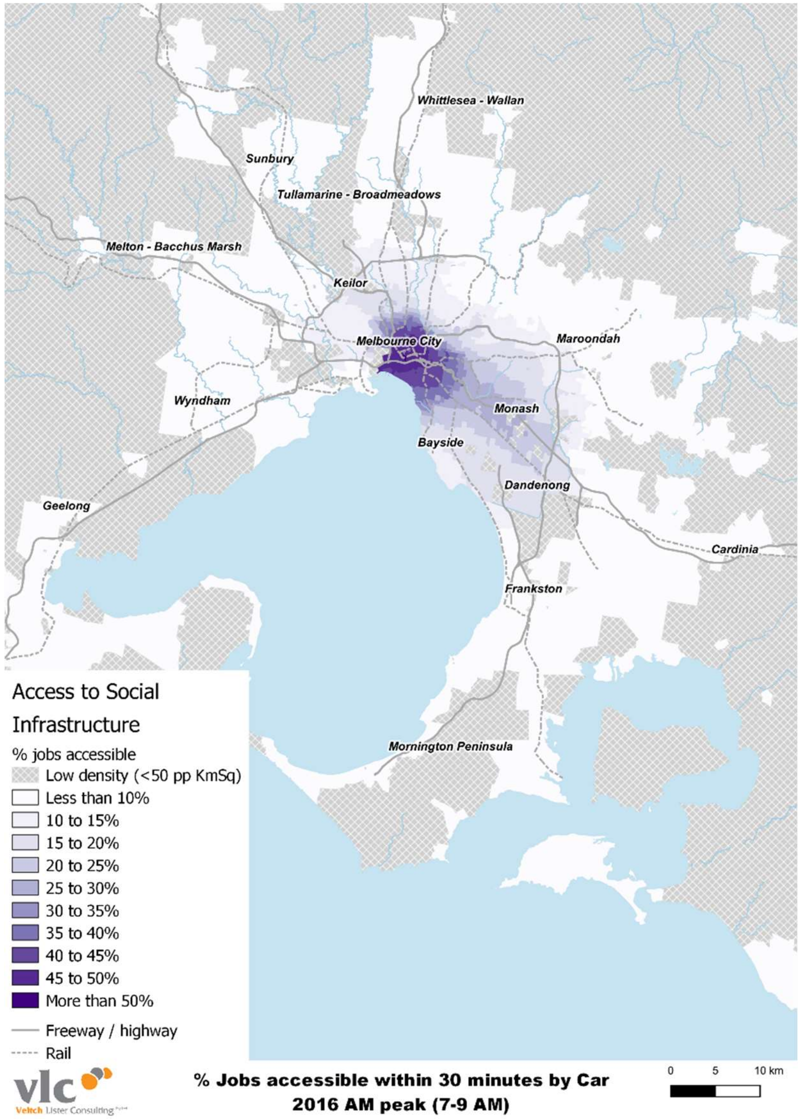


Figure 6-9 – Melbourne GCCSA and Geelong access to jobs by Car - 2031 AM peak (7-9AM)

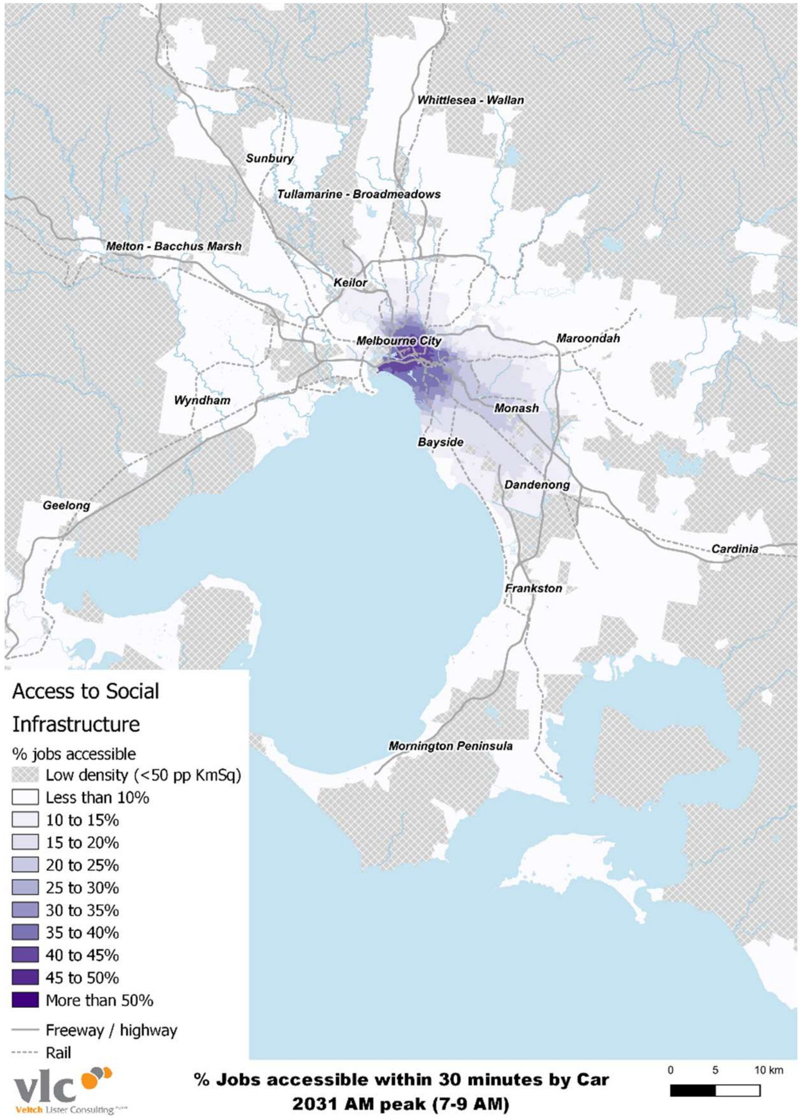


Figure 6-10 – Melbourne GCCSA and Geelong access to jobs by PT - 2016 AM peak (7-9AM)

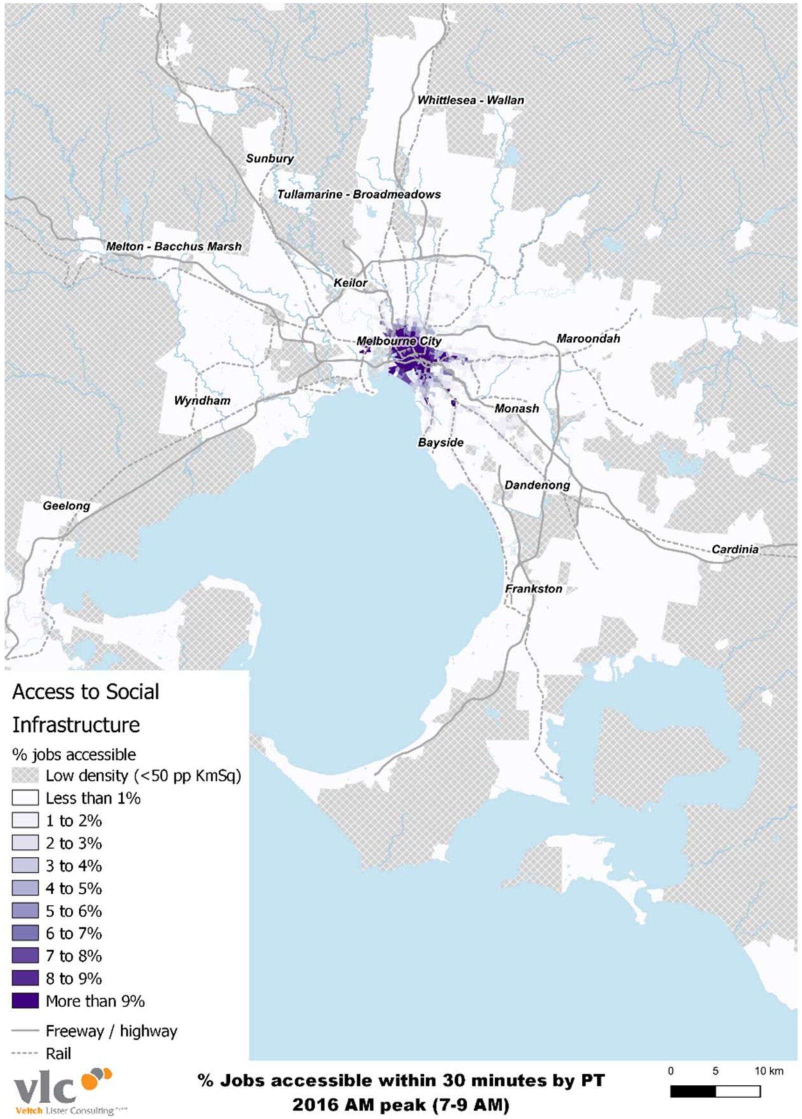


Figure 6-11 – Melbourne GCCSA and Geelong access to jobs by PT - 2031 AM peak (7-9AM)

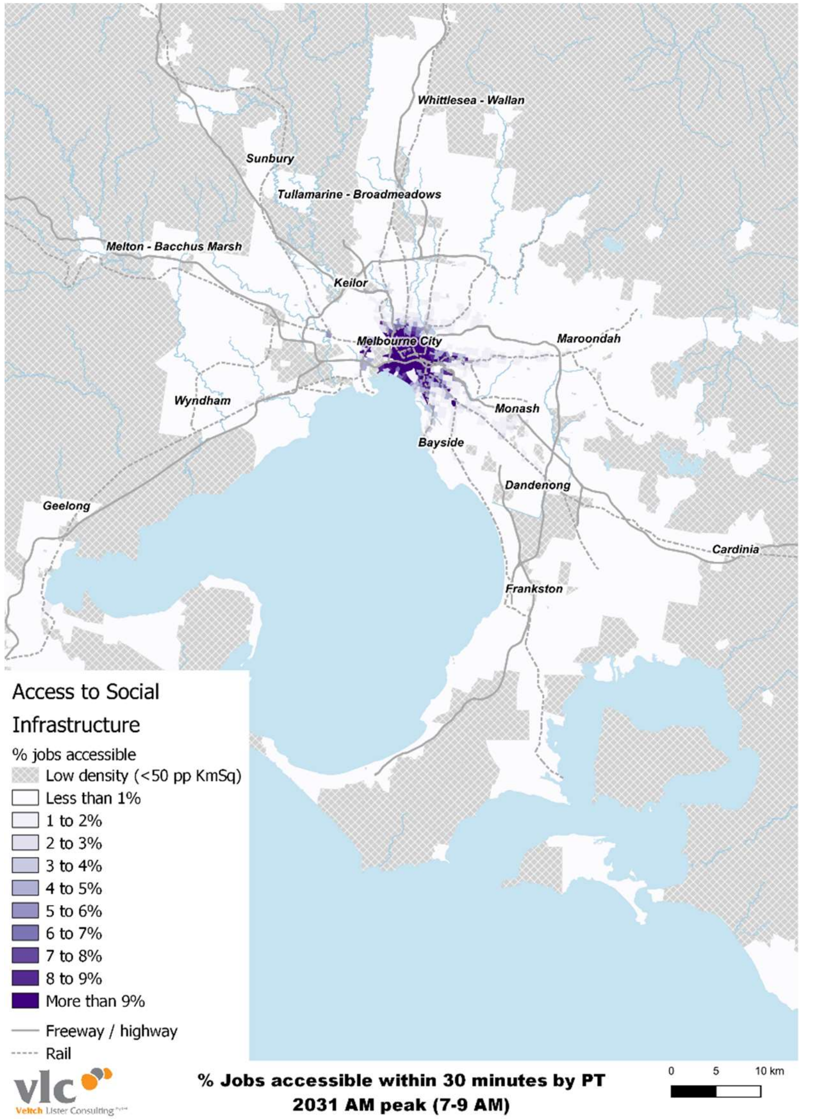


Table 6-4 – Melbourne GCCSA and Geelong population-weighted average travel time to the nearest public hospital by SA3 - AM peak (7-9AM)*

SA3	Car			PT		
	2016	2031	*Change*	2016	2031	*Change*
Banyule	12.5	12.8	*+0.3*	34.9	33.1	*-1.8*
Bayside	6.1	6.4	*+0.3*	33.0	32.7	*-0.3*
Boroondara	7.7	8.4	*+0.7*	29.5	29.1	*-0.3*
Brimbank	10.1	11.4	*+1.3*	41.8	41.6	*-0.2*
Brunswick - Coburg	14.3	17.2	*+2.9*	29.4	29.5	*+0.1*
Cardinia	20.7	20.9	*+0.2*	76.3	67.8	*-8.5*
Casey - North	10.1	10.8	*+0.8*	50.1	48.4	*-1.7*
Casey - South	10.8	15.5	*+4.7*	55.8	54.6	*-1.2*
Dandenong	6.6	6.6	*+0.0*	34.3	33.3	*-1.0*
Darebin - North	10.6	11.5	*+0.9*	38.7	37.5	*-1.2*
Darebin - South	8.0	8.8	*+0.7*	33.7	33.5	*-0.2*
Essendon	12.8	15.0	*+2.2*	37.6	36.8	*-0.9*
Frankston	9.5	10.2	*+0.8*	48.4	48.0	*-0.4*
Glen Eira	5.4	5.7	*+0.3*	25.9	25.2	*-0.7*
Hobsons Bay	10.4	11.4	*+1.1*	47.2	44.7	*-2.4*
Keilor	13.0	14.3	*+1.3*	57.6	56.3	*-1.3*
Kingston	11.1	11.3	*+0.1*	40.0	38.9	*-1.1*
Knox	10.2	10.7	*+0.5*	49.1	48.8	*-0.4*
Macedon Ranges	21.6	24.6	*+3.0*	119.9	112.0	*-7.9*
Manningham - East	17.5	18.8	*+1.3*	60.5	61.9	*+1.4*
Manningham - West	16.6	19.1	*+2.5*	43.5	44.3	*+0.8*
Maribyrnong	5.5	6.4	*+0.9*	25.9	25.1	*-0.8*
Maroondah	9.0	9.6	*+0.6*	44.1	43.0	*-1.1*
Melbourne City	4.7	5.2	*+0.5*	17.1	16.8	*-0.3*
Melton - Bacchus Marsh	13.1	14.8	*+1.7*	53.6	63.0	*+9.5*
Monash	9.5	10.0	*+0.5*	40.7	40.9	*+0.2*
Moreland - North	11.3	12.8	*+1.4*	41.7	40.9	*-0.8*
Mornington Peninsula	12.7	12.9	*+0.2*	73.7	73.0	*-0.7*
Nillumbik - Kinglake	34.0	37.3	*+3.3*	87.9	91.1	*+3.1*
Port Phillip	7.3	8.2	*+0.9*	30.7	29.1	*-1.6*
Stonnington - East	10.6	11.3	*+0.7*	37.2	34.8	*-2.4*
Stonnington - West	6.0	6.2	*+0.2*	25.0	23.7	*-1.3*
Sunbury	6.4	7.8	*+1.4*	45.2	50.3	*+5.1*
Tullamarine - Broadmeadows	8.7	12.4	*+3.7*	43.9	94.8	*+51.0*
Upper Goulburn Valley	16.0	17.4	*+1.4*	116.5	123.8	*+7.3*
Whitehorse - East	8.1	8.6	*+0.5*	33.3	33.4	*+0.0*
Whitehorse - West	6.4	6.9	*+0.5*	29.6	28.1	*-1.5*
Whittlesea - Wallan	17.7	24.9	*+7.2*	62.3	71.5	*+9.2*
Wyndham	13.1	18.7	*+5.6*	61.5	59.0	*-2.6*
Yarra	6.9	7.6	*+0.7*	21.6	21.3	*-0.4*
Yarra Ranges	14.5	14.7	*+0.2*	64.5	62.6	*-2.0*
Melbourne GCCSA	**10.9**	**12.9**	***+2.0***	**44.9**	**47.5**	***+2.6***
Barwon - West	24.8	28.4	*+3.5*	189.4	214.7	*+25.3*
Geelong	10.9	14.9	*+4.0*	49.3	57.2	*+7.9*
Surf Coast - Bellarine	30.8	37.0	*+6.2*	108.6	122.5	*+13.9*
Geelong SA4	**16.3**	**20.8**	***+4.5***	**73.7**	**83.2**	***+9.5***

*The travel times reflect all modelled zones and so does not reflect adjustments made in Figure 6-13 (see 'Limitations of strategic accessibility modelling' box above).

Figure 6-12 – Melbourne GCCSA and Geelong average time to nearest public/emergency hospital by Car - 2031 AM peak (7-9AM)

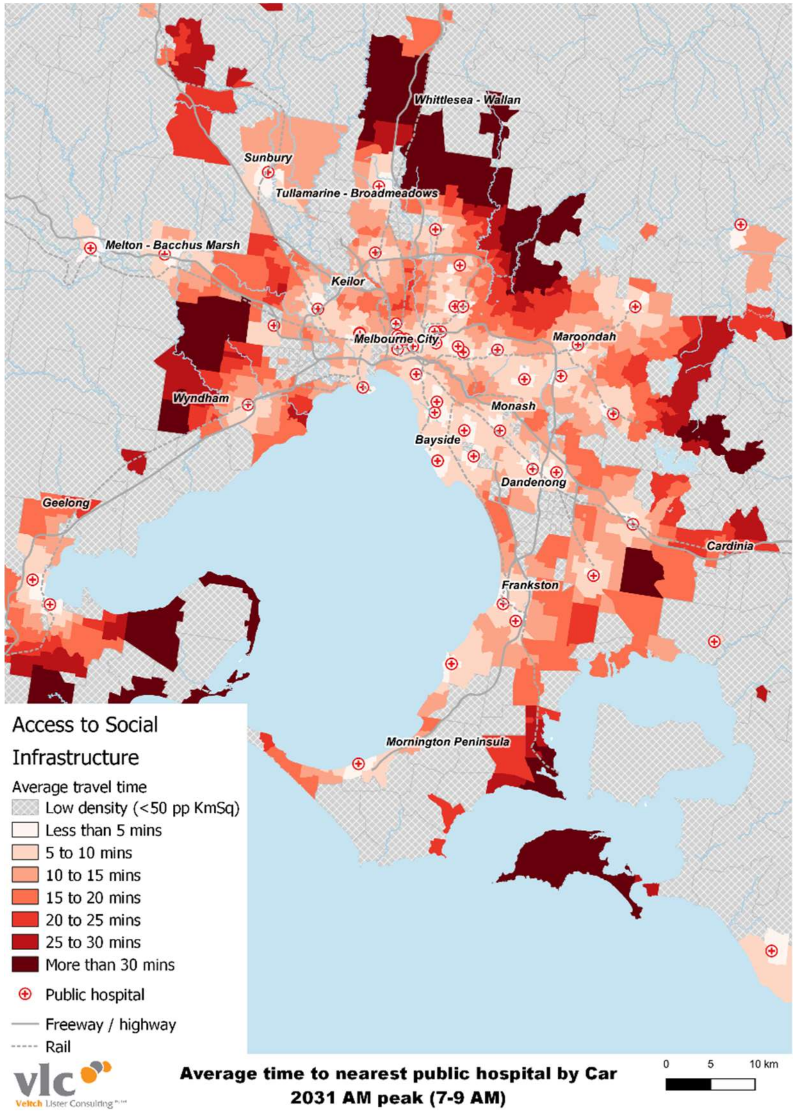
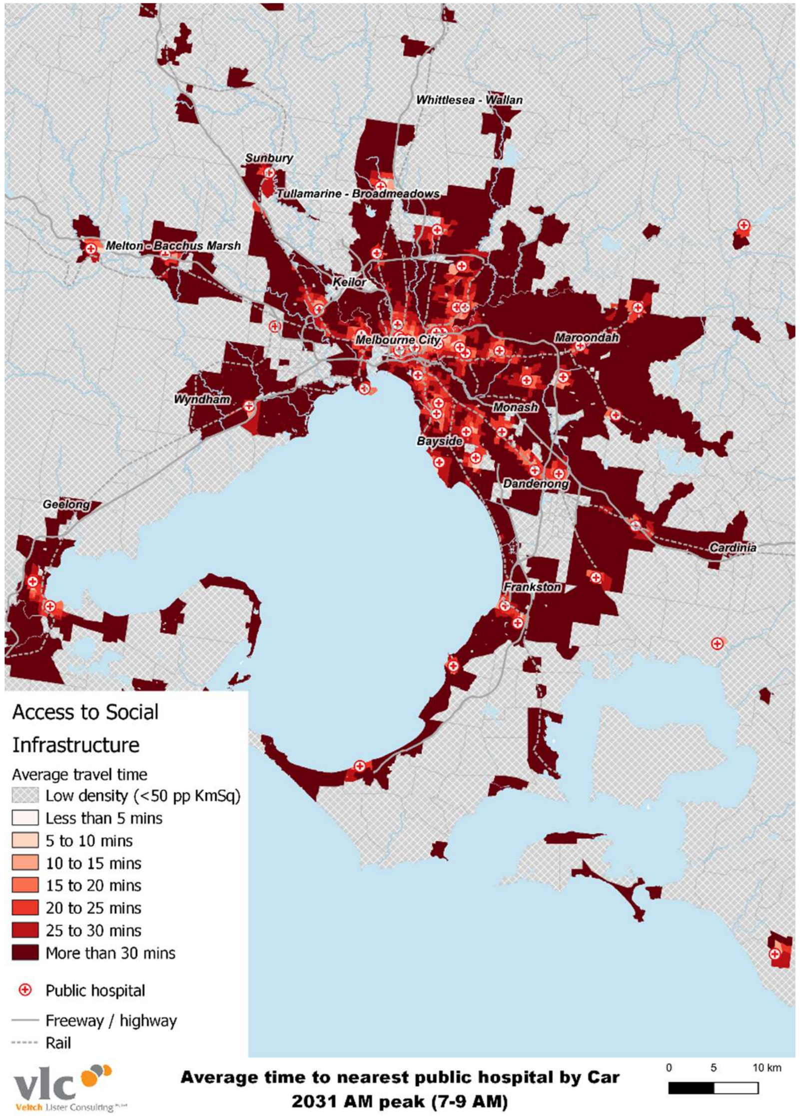


Figure 6-13 – Melbourne GCCSA and Geelong average time to nearest public/emergency hospital by PT - 2031 AM peak (7-9AM)



7. Assessment

This section draws together the analysis of the preceding chapters and assesses transport network performance along two dimensions: corridors and regions.

7.1 Corridor deficiencies

By 2031 demand on Melbourne's key transport corridors is expected to compromise their performance. This will cause delay for motorists, on-road trams and buses. Increasing demand can also increase crowding on public transport services if service frequencies do not keep pace. In this section we measure network performance for road, rail and bus corridors in 2016 and 2031 using 31 key multi-modal corridors that were identified with Infrastructure Australia.

Each of the major roads in each corridor was then divided up into subsections, based on variations in the road's characteristics - such as the number of traffic lanes, posted speed and likely changes in traffic demand. A summary of the transport corridors included in the analysis is included in Figure 7-1.

Performance on each road corridor is analysed in terms of delay hours (an aggregate measure) and percentage of journey time accounted for by congestion (a measure of individual road user experience).

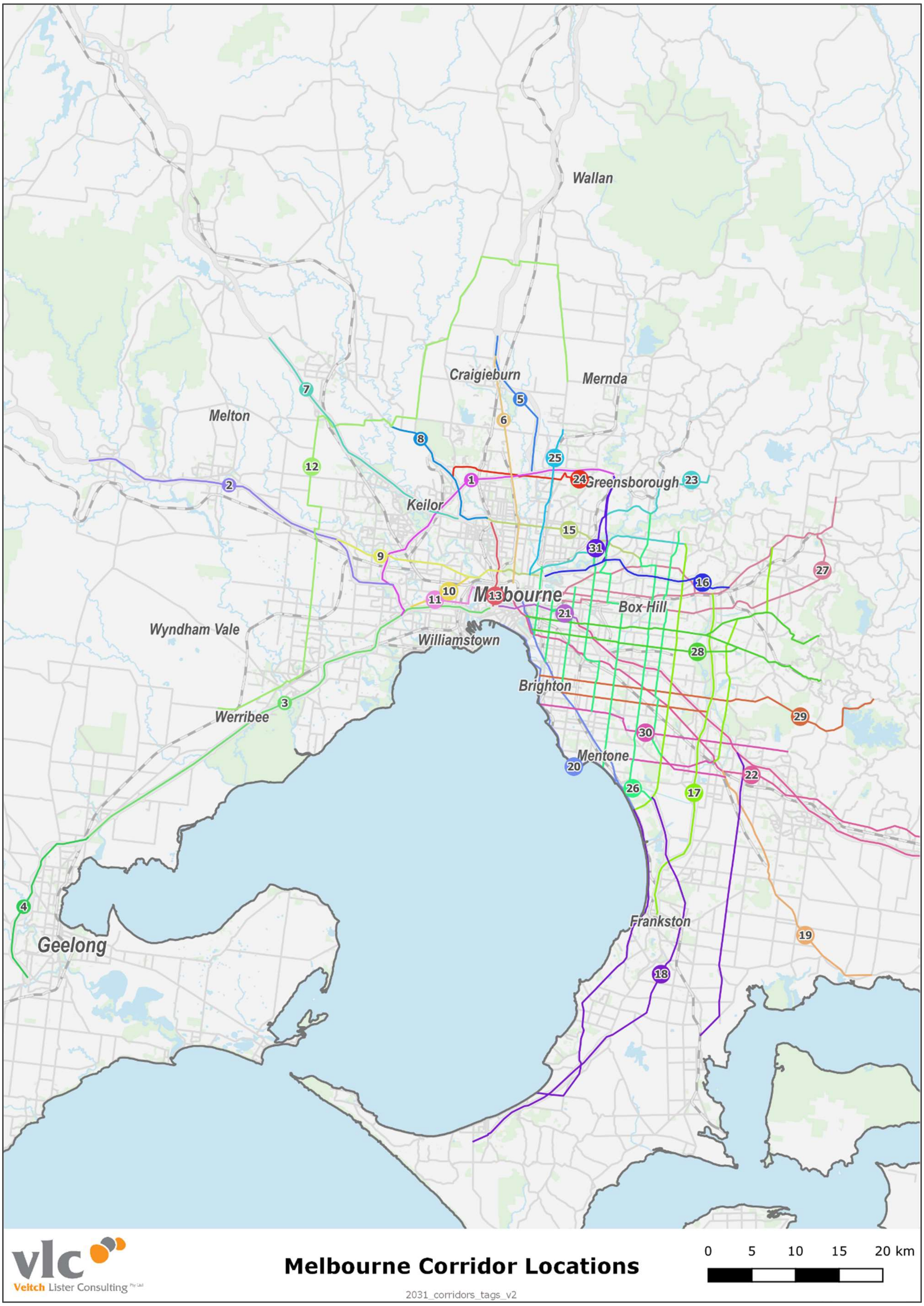
In 2016 Melbourne's most delayed corridors were the West Gate/Princes Freeway Corridor and the Monash/Princes Fwy Corridor (Monash/Princes Fwy) (Table 7-1). The aggregate delay incurred on these corridors was significantly larger than the other high-ranking corridors. Together these corridors form the only complete east to west motorway link.

Melbourne's other motorways also ranked among the major contributors to delay with the Calder Freeway Corridor and the Eastern Freeway resulting in more than 3,000 hours of delay on the average weekday AM peak (7-9AM). Western/Metropolitan Ring Road appears twice on the list with both north and south bound directions among the Melbourne's most delayed corridors.

The Princes Highway subsection of the Monash/Princes Freeway Corridor is the worst performing arterial. Delays on the Nepean Highway, Maroondah Highway and Canterbury Road are also highlighted as major contributors to aggregate delay hours.

By 2031 aggregate delay on Melbourne's key corridors has increased significantly. The West Gate/Princes Freeway Corridor and the Monash/Princes Fwy Corridor remain the largest contributors to delay. Each of these corridors is forecast to cause over 15,000 hours of delay each morning (AM peak 7-9AM).

Figure 7-1 – Melbourne GCCSA and Geelong transport corridors



The strong population growth projected for Melbourne's outer northern and western suburbs is reflected in in Table 7-2 with key corridors to the north and west ranking higher on the 2031 list. In particular, the aggregate delay incurred on the Western/Metropolitan Ring Road is expected to almost double southbound and more than double northbound.

Growth in Melbourne's northern suburbs is reflected in the increase in delay hours expected on the Hume Freeway and Sydney Rd Corridors, both forecast to result in over 4,000 hours of aggregate delay in the AM peak (7-9AM).

Table 7-1 – Melbourne GCCSA 2016 ten most delayed road corridors

	Corridor name	Number	Direction	Delay Hours
	AM peak (7-9AM)			
1	West Gate/Princes Freeway Corridor	3	EB	10,800
2	Monash/Princes Fwy Corridor (Monash/Princes Fwy)	22	WB	8,500
3	Monash/Princes Freeway Corridor (Princes Hwy)	22	WB	5,300
4	M80 Ring Road	1	SB	4,400
5	Calder Freeway Corridor	7	EB	3,600
6	Eastern Fwy Corridor to Ringwood	16	WB	3,300
7	Inner Beach Suburbs Corridor (Nepean Highway)	20	NB	2,900
8	Western/Metropolitan Ring Road	1	NB	2,700
9	East-West Arterials - Eastern Suburbs (Maroondah Hwy)	27	WB	2,600
10	East-West Arterials - Eastern Suburbs (Canterbury Rd)	27	WB	2,400
	PM peak (4-6PM)			
1	West Gate/Princes Freeway Corridor	3	WB	7,100
2	Monash/Princes Fwy Corridor (Monash/Princes Fwy)	22	EB	6,200
3	Monash/Princes Fwy Corridor (Princes Hwy)	22	EB	3,800
4	Western/Metropolitan Ring Road	1	NB	3,100
5	Calder Freeway Corridor	7	WB	2,400
6	Eastern Fwy Corridor to Ringwood	16	EB	2,400
7	Western/Metropolitan Ring Road	1	SB	2,200
8	Inner Beach Suburbs Corridor (Nepean Highway)	20	SB	1,900
9	East-West Arterials - Eastern Suburbs (Maroondah Hwy)	27	EB	1,700
10	East-West Arterials - Eastern Suburbs (Canterbury Rd)	27	EB	1,600

Table 7-2 – Melbourne GCCSA 2031 top ten most delayed road corridors

	Corridor name	Number	Direction	Delay Hours
	AM peak (7-9AM)			
1	West Gate/Princes Freeway Corridor	3	EB	16,800
2	Monash/Princes Fwy Corridor (Monash/Princes Fwy)	22	WB	15,900
3	Western/Metropolitan Ring Road	1	SB	8,500
4	Calder Freeway Corridor	7	EB	8,200
5	Monash/Princes Freeway Corridor (Princes Hwy)	22	WB	7,500
6	Western/Metropolitan Ring Road	1	NB	7,000
7	Western Freeway Corridor	2	EB	5,700
8	Hume Freeway Corridor	5	SB	5,700
9	Outer Metropolitan Ring Corridor	12	NB	5,100
10	Sydney Rd Corridor	6	SB	4,500
	PM peak (4-6PM)			
1	West Gate/Princes Freeway Corridor	3	WB	12,300
2	Monash/Princes Fwy Corridor (Monash/Princes Fwy)	22	EB	11,200
3	Western/Metropolitan Ring Road	1	SB	6,200
4	Calder Freeway Corridor	7	WB	6,200
5	Western/Metropolitan Ring Road	1	NB	6,100
6	Monash/Princes Fwy Corridor (Princes Hwy)	22	EB	5,200
7	Hume Freeway Corridor	5	NB	4,600
8	Western Freeway Corridor	2	WB	4,300
9	Outer Metropolitan Ring Corridor	12	SB	4,100
10	Outer Metropolitan Ring Corridor	12	NB	3,300

Table 7-3 and Table 7-4 consider traffic delays using a user-focused approach for 2016 and 2031 respectively. Using the user focused metric highlights the corridors which cause the most travel time delay to each motorist.

The Tullamarine Freeway (Airport) Corridor and CityLink Western Link Corridor make up the motorway connection between the CBD and the airport. In 2016, morning airport arrivals heading to the city were likely to spend a substantial portion of their journey stuck in traffic.

In the 2016 AM peak (7-9AM), travel between CityLink and the Eastern Freeway was likely to take around 16 minutes (in both directions), approximately 10 minutes slower than free flow travel. In Melbourne's north-east, approximately 60 percent of the peak period travel time for journeys between Greensborough and the Eastern Freeway – through some of the city's worst traffic – could be attributed to congestion.

In 2016 the worst four corridors had approximately 60 per cent of journey time caused by congestion, by 2031 this is forecast to increase to over 70 per cent. In addition the geography of the worst performing corridors is expected to shift, with the roads and motorways which serve the fast growing north and western suburbs forecast to perform poorly. In particular, the traffic generated by the fast growing Melton Bacchus Marsh and Wyndham areas result in substantial user delay on the Calder Freeway and Western Freeways. Motorists who travel the length of the Calder Freeway corridor in the AM peak, can expect travel times of over 70 minutes, with approximately 50 minutes stuck in traffic. A similar outcome is expected in the north, where the Hume Freeway is likely to become Melbourne's worst performing corridor, motorists travelling between Donnybrook and the M80 Ring Road can expect to spend over 70 per cent of their journey time in congested conditions, with the 11 minute journey in ideal conditions, predicted to take around 50 minutes southbound in the morning and 42 minutes northbound in the evening. Furthermore, the parallel arterials (St Georges Rd/High St and Sydney Road corridors) both have user delay ratios of over 60 per cent.

On the Tullamarine Freeway – the worst performing corridor in 2016 – southbound travel in the AM peak increases from approximately 36 minutes in 2016 to 45 minutes in 2031.[4] Despite this, the Tullamarine Airport corridor falls to number 3 in 2031 (Table 7-4). Other corridors in the 2016 top ten no longer rank in the top 10 in 2031, though this does not necessarily mean that these corridors are less congested, rather they have been overtaken by large increases in delay on other corridors.

Corridors which serve growth areas are generally expected to be the worst performing in 2031. However the CityLink-Eastern Fwy connection across Melbourne's inner north is predicted to remain one of the worst performers in 2031.

[4] The Tullamarine Freeway Corridor includes the section of Sunbury Road north of Melbourne Airport

Table 7-3 – Melbourne GCCSA 2016 top ten most delayed road corridors (ranked by user delay)

	Corridor name	Number	Direction	Corridor length (km)	% of journey time accounted for by congestion	Delay per vehicle (mins)	Congested travel time for corridor (mins)
			AM peak (7-9AM)				
1	Tullamarine Freeway (Airport) Corridor	8	SB	17	67%	24	36
2	Greensborough Rd / Rosanna Rd	31	SB	11	63%	21	33
3	CityLink Western Link	13	SB	10	61%	10	16
4	CityLink-Eastern Fwy connection north of CBD	15	WB	5	60%	10	17
5	North-South Arterial - Northern Suburbs (St Georges Rd/High St)	25	SB	17	59%	31	52
6	Docklands Hwy Corridor	11	EB	10	59%	18	31
7	Calder Freeway Corridor	7	EB	31	59%	29	49
8	Eastern Fwy Corridor to Ringwood	16	WB	23	59%	22	38
9	CityLink-Eastern Fwy connection north of CBD	15	EB	5	58%	9	16
10	Monash/Princes Fwy Corridor (Monash/Princes Fwy)	22	WB	57	57%	49	86
			PM peak (4-6PM)				
1	Greensborough Rd / Rosanna Rd	31	NB	11	57%	17	29
2	Tullamarine Freeway (Airport) Corridor	8	NB	18	56%	16	29
3	CityLink-Eastern Fwy connection north of CBD	15	EB	5	52%	7	14
4	CityLink Western Link	13	NB	10	52%	7	13
5	CityLink-Eastern Fwy connection north of CBD	15	WB	5	51%	7	14
6	Monash/Princes Fwy Corridor (Monash/Princes Fwy)	22	EB	58	50%	36	73
7	Eastern Fwy Corridor to Ringwood	16	EB	23	50%	15	30
8	North-South Arterial - Northern Suburbs (St Georges Rd/High St)	25	NB	17	49%	21	42
9	Calder Freeway Corridor	7	WB	32	46%	19	40
10	South Gippsland Highway Corridor	19	SB	32	45%	22	50

Table 7-4 – Melbourne GCCSA 2031 top ten most delayed road corridors (ranked by user delay)

	Corridor name	Number	Direction	Corridor length (km)	% of journey time accounted for by congestion	Delay per vehicle (mins)	Congested travel time for corridor (mins)
			AM peak (7-9AM)				
1	Hume Freeway Corridor	5	SB	18	77%	39	50
2	Calder Freeway Corridor	7	EB	31	72%	51	71
3	Tullamarine Freeway (Airport) Corridor	8	SB	17	71%	32	45
4	CityLink-Eastern Fwy connection north of CBD	15	WB	5	70%	16	23
5	CityLink-Eastern Fwy connection north of CBD	15	EB	5	68%	14	21
6	North-South Arterial - Northern Suburbs (St Georges Rd/High St)	25	SB	17	66%	42	64
7	West Gate/Princes Freeway Corridor	3	EB	57	65%	69	105
8	Monash/Princes Fwy Corridor (Monash/Princes Fwy)	22	WB	57	64%	67	104
9	Sydney Rd Corridor	6	SB	27	64%	63	98
10	Western Freeway Corridor	2	EB	41	64%	46	73
			PM peak (4-6PM)				
1	Hume Freeway Corridor	5	NB	18	73%	31	42
2	Tullamarine Freeway (Airport) Corridor	8	NB	18	66%	26	39
3	Calder Freeway Corridor	7	WB	32	63%	37	59
4	CityLink-Eastern Fwy connection north of CBD	15	EB	5	62%	11	18
5	CityLink-Eastern Fwy connection north of CBD	15	WB	5	61%	11	18
6	West Gate/Princes Freeway Corridor	3	WB	56	59%	51	86
7	North-South Arterial - Northern Suburbs (St Georges Rd/High St)	25	NB	17	57%	28	50
8	Western Freeway Corridor	2	WB	41	57%	34	60
9	Monash/Princes Fwy Corridor (Monash/Princes Fwy)	22	EB	58	56%	47	84
10	Sydney Rd Corridor	6	NB	26	55%	43	78

By 2031, the level of demand placed on Melbourne's public transport system is expected to increase. In this study, high levels of crowding are taken as an indicator of poor network performance. In reality, other adverse network performance outcomes not modelled by VLC are likely to result from high loadings of services, such as increased dwell times at stations, reduced reliability and passengers being unable to board their preferred service.

Despite a substantial increase in patronage, crowding levels on Melbourne's suburban rail network are expected to remain relatively stable (Table 7-5 and Table 7-6). This is a largely a result on the increased capacity brought into the network with the implementation of Melbourne Metro. The Metro is expected to be the most crowded part of the network in 2031, with the section north of ANZAC station nearing crush capacity in the AM peak (7-9am). Crowding levels on other rail corridors are also expected to increase incrementally.

Table 7-5 – Melbourne GCCSA crowding on 2016 public transport corridors

Corridor	Direction	Indicative volume / crush capacity	Indicative volume / seated capacity
AM peak (7-9AM)			
Craigieburn line south of Kensington Station	SB	0.7	1.6
Sunbury, Werribee and Williamstown lines west of South Kensington Station	EB	0.7	1.5
PM peak (4-6PM)			
Craigieburn line south of Kensington Station	NB	0.7	1.6
Sunbury, Werribee and Williamstown lines west of South Kensington Station	WB	0.7	1.5

Table 7-6 – Melbourne GCCSA crowding on 2031 suburban rail corridors

Corridor	Direction	Indicative volume / crush capacity	Indicative volume / seated capacity
AM peak (7-9AM)			
Sunbury, Werribee and Williamstown lines west of South Kensington Station	EB	1.0	2.0
Craigieburn line south of Kensington Station	SB	0.9	1.9
Alamein, Belgrave Glen Waverly and Lilydale lines east of Richmond station	WB	0.9	2.0
Hurstbridge and Mernda lines east of Jolimont Station	SB	0.8	1.6
Cranbourne, Frankston and Pakenham lines east of South Yarra station	NB	0.7	1.7
Melbourne Metro north of ANZAC station	NB	0.6	2.2
PM peak (4-6PM)			
Sunbury, Werribee and Williamstown lines west of South Kensington Station	WB	0.7	1.5
Craigieburn line south of Kensington Station	NB	0.6	1.6
Alamein, Belgrave Glen Waverly and Lilydale lines east of Richmond station	WB	0.6	1.5
Hurstbridge and Mernda lines east of Jolimont Station	SB	0.6	1.0
Cranbourne, Frankston and Pakenham lines east of South Yarra station	NB	0.6	1.4
Melbourne Metro north of ANZAC station	NB	0.5	1.6

In 2016 moderate levels of crowding were observed on the regional rail network on an average weekday (Table 7-7). By 2031 strong demand growth and a lack of alternative options in the model mean crowding levels are predicted to be much higher (Table 7-8). However, some of the ratios in Table 7-8 overrepresent the likely levels of crowding. The crowding level calculated on the North - East Line is unrealistically high, this outcome reflects a situation in which modelled users have only one viable public transport option for their trip – which occurs in the coarsest parts of the modelled network (outer and regional areas).

Table 7-7 – Melbourne GCCSA crowding on 2016 regional rail corridors

Corridor	Direction	Indicative volume / crush capacity	Indicative volume / seated capacity
AM peak (7-9AM)			
West and South - West Lines west of Sunshine Station	EB	0.7	1.1
PM peak (4-6PM)			
West and South - West Lines west of Sunshine Station	WB	0.7	1.1

Table 7-8 – Melbourne GCCSA crowding on 2031 regional rail corridors

Corridor	Direction	Indicative volume / crush capacity	Indicative volume / seated capacity
AM peak (7-9AM)			
West and South - West Lines west of Sunshine Station	EB	1.5	1.8
North - East Line south of Kensington Station	SB	1.0	2.0
East Line south of Richmond Station	WB	0.7	1.6
PM peak (4-6PM)			
West and South - West Lines west of Sunshine Station	WB	1.4	1.7
North - East Line south of Kensington Station	NB	0.7	1.6
East Line south of Richmond Station	EB	0.6	1.3

In 2016 moderate levels of crowding were observed on Melbourne's tram network (Table 7-9). By 2031 the levels of crowding are forecast to worsen, particularly in the inner west (Table 7-10). Nevertheless, overall crowding levels are not expected to be excessive on the average weekday.

Table 7-9 – Melbourne GCCSA crowding on 2016 tram corridors

Corridor	Direction	Indicative volume / crush capacity	Indicative volume / seated capacity
AM peak (7-9AM)			
Route 86 to Bundoora through Fitzroy	SB	0.7	2.9
PM peak (4-6PM)			
Route 86 to Bundoora through Fitzroy	NB	0.6	2.5

Table 7-10 – Melbourne GCCSA crowding on 2031 tram corridors

Corridor	Direction	Indicative volume / crush capacity	Indicative volume / seated capacity
AM peak (7-9AM)			
Route 86 to Bundoora through Fitzroy	SB	1.0	4.9
Western tram routes through Flemington	EB	0.9	3.6
PM peak (4-6PM)			
Route 86 to Bundoora through Fitzroy	NB	0.7	3.6
Western tram routes through Flemington	WB	0.7	3.0

By 2031 the levels of crowding on Melbourne's bus network are likely to worsen (Table 7-11 and Table 7-12). The upgraded Doncaster busway is forecast to have moderate levels of crowding while higher levels of crowding are expected on key bus corridors in the south east.

Table 7-11 – Melbourne GCCSA crowding on 2016 bus corridors

Corridor	Direction	Indicative volume / crush capacity	Indicative volume / seated capacity
AM peak (7-9AM)			
SkyBus	NB	1.0	1.5
Doncaster Busway	EB	0.6	0.9
PM peak (4-6PM)			
SkyBus	SB	1.0	1.5
Doncaster Busway	WB	0.5	0.8

Table 7-12 – Melbourne GCCSA crowding on 2031 bus corridors

Corridor	Direction	Indicative volume / crush capacity	Indicative volume / seated capacity
AM peak (7-9AM)			
Springvale Rd in Monash	NB	1.1	1.7
Stud Rd Dandenong	SB	1.0	1.4
Doncaster busway	EB	0.9	1.4
PM peak (4-6PM)			
Doncaster busway	WB	0.9	1.2
Stud Rd Dandenong	SB	0.7	1.1
Springvale Rd in Monash	SB	0.6	0.9

7.2 Regional deficiencies

Growing congestion will impact on the level of access that residents of Greater Melbourne have to local social infrastructure. Residents with access to a car, or who live in established inner-city areas, will be less affected by this congestion. The average resident in Greater Melbourne will be able to reach the nearest five child care centres, public primary school and public secondary school within a ten-minute drive in the morning peak. In growth areas at the urban fringe, travel times closer to 30 minutes will be required. This is a result of modelled growth in congestion around these SA3, that partly reflects limitations in the knowledge of the future networks (section 6.1). However, the modelling highlights the importance of ensuring that investment in infrastructure keeps pace with projected increase in population.

Residents on the urban fringe have even poorer accessibility if they do not have regular car access. In areas such as Whittlesea-Wallan, Tullamarine-Broadmeadows and Cardinia, residents can expect to spend 30 minutes to over an hour to accompany their young child to care or primary school. High school students in these areas would also expect to travel close to an hour or more. This reflects the limited ability of Melbourne’s public transport system to cater for local travel, as well as the lower walkability of suburbs at the peri-urban fringe.

7.3 Economic impacts

Congestion, traffic delays and poor travel time reliability result in widespread negative impacts on the community and economy. Delays (particularly where they are unexpected) can result in missed appointments, wasted time and frustration for users of the transport system.

VLC has estimated the dollar value of the cost of congestion in Melbourne GCCSA and Geelong SA4 in 2016 and 2031 based on the way people are prepared to trade off money for reductions in the time spent travelling (see Appendix D for a detailed calculation methodology). The daily cost of congestion is estimated nearly double, from $15.9 million in 2016 to $30.1 million in 2031 (Figure 7-2). This is consistent with the deteriorating network performance described in the preceding chapters.

Each modelled time-period contributes a different amount to the total daily congestion cost. The highest costs are accrued in the AM peak (39.6% in 2016, growing to 40.3% in 2031, followed by the PM peak (growing from 28.6% in 2016 to 29.5% in 2031). In terms of hourly cost incurred, AM peak is highest in both years ($3.1 million in 2016 and $6.1 million in 2031). While the inter-peak has a much lower hourly cost incurred, it is expected to nearly double into the future (Figure 7-4).

The total cost of congestion by time period and region is provided in Table 7-13, while the estimated annual cost of congestion is described in Table 7-14.

Figure 7-2 – Melbourne GCCSA and Geelong SA4 average weekday cost of congestion, 2016 and 2031

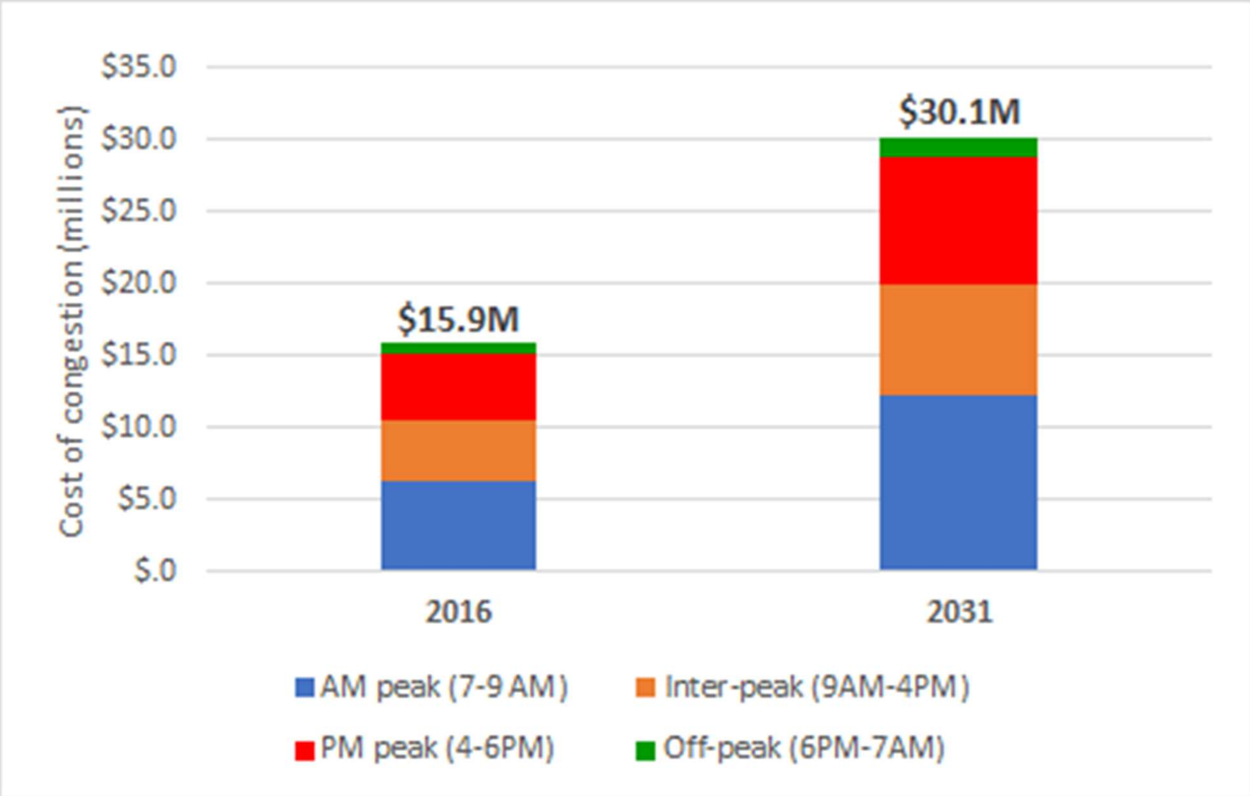


Figure 7-3 Melbourne GCCSA and Geelong SA4 average weekday cost of congestion by region, 2016 and 2031

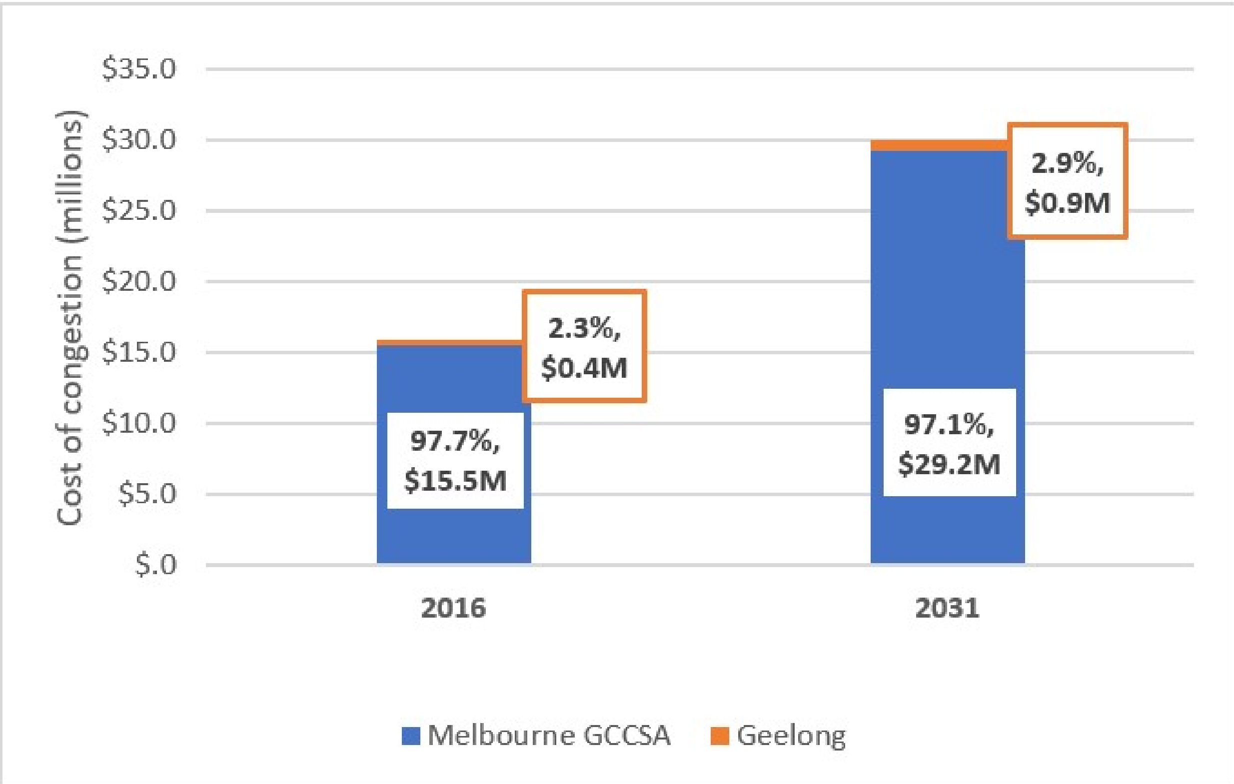


Figure 7-4 – Melbourne GCCSA and Geelong SA4 average weekday hourly cost of congestion by time-period, 2016 and 2031

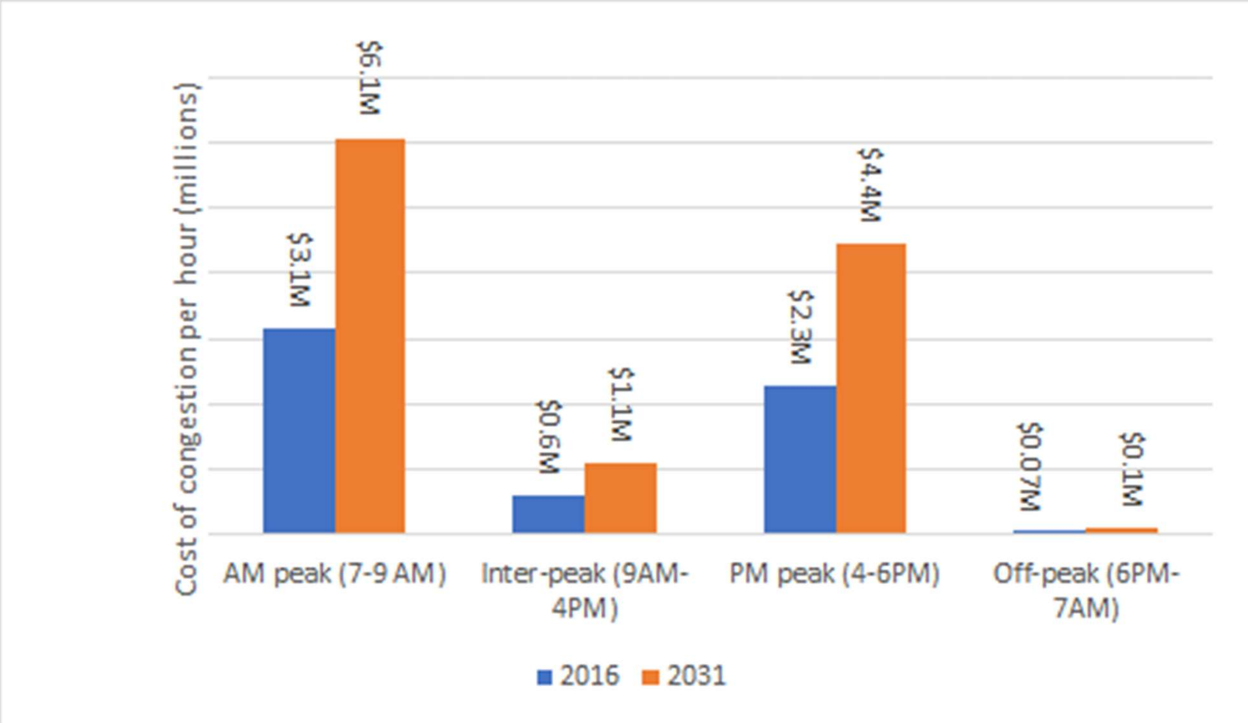


Table 7-13 – Melbourne GCCSA and Geelong SA4 average weekday cost of congestion by time period

	Time period	2016	2031
Melbourne GCCSA	AM peak (7-9AM)	$6,168,000	$11,824,000
	Inter-peak (9AM-4PM)	$4,077,000	$7,457,000
	PM peak (4-6PM)	$4,449,000	$8,627,000
	Off-peak (6PM-7AM)	$840,000	$1,316,000
	Daily total	**$15,534,000**	**$29,224,000**
Geelong SA4	AM peak (7-9AM)	$121,000	$307,000
	Inter-peak (9AM-4PM)	$117,000	$241,000
	PM peak (4-6PM)	$94,000	$252,000
	Off-peak (6PM-7AM)	$35,000	$61,000
	Daily total	**$367,000**	**$861,000**

Table 7-14 – Melbourne GCCSA and Geelong SA4 estimated annual cost of congestion by region

Region	2016 (millions)	2031 (millions)
Melbourne GCCSA	$5,359	$10,082
Geelong SA4	$127	$297
Total region	$5,485	$10,379

An economic cost can also be estimated for the crowding experienced by passengers on the public transport network reflecting the dislike people have when they have to stand during their ride, and particularly where vehicles are very full (again, see Appendix D.4 for a detailed calculation methodology). Crowding costs are based on the average crowding of services in each two-hour peak period (similar to chapter 5). As such, the cost of crowding would underestimate costs where there is high variability in crowding levels across services within this peak period.

During the peak periods, crowding costs are forecast to grow substantially for users across all public transport modes operating in Melbourne GCCSA and the Geelong SA4 to 2031 (Table 7-15). AM peak crowding costs on tram and metropolitan rail are expected to more than double, indicating passenger kilometres are likely to outpace increases in in-service kilometres. Annually, the estimated cost of crowding in Melbourne GCCSA and the Geelong SA4 is $74.8 million in 2016, growing to $352 million in 2031.

The estimated cost of crowding on buses grows by a factor of six (Table 7-15). Though the extreme levels of crowding forecast on some growth area bus routes are unlikely to eventuate (section 5), the growth in the cost of bus crowding is expected to be substantial there and in other parts of the network under a minimal public transport service expansion scenario. Similarly, the high level and costs of crowding on the regional rail system are subject to considerable uncertainty. Rather than yielding precise estimates, this high-level modelling exercise demonstrates the potential for rapidly expanded public transport needs in greenfield development areas.

Table 7-15 – Melbourne GCCSA and Geelong SA4 average weekday cost of public transport crowding, 2016 and 2031

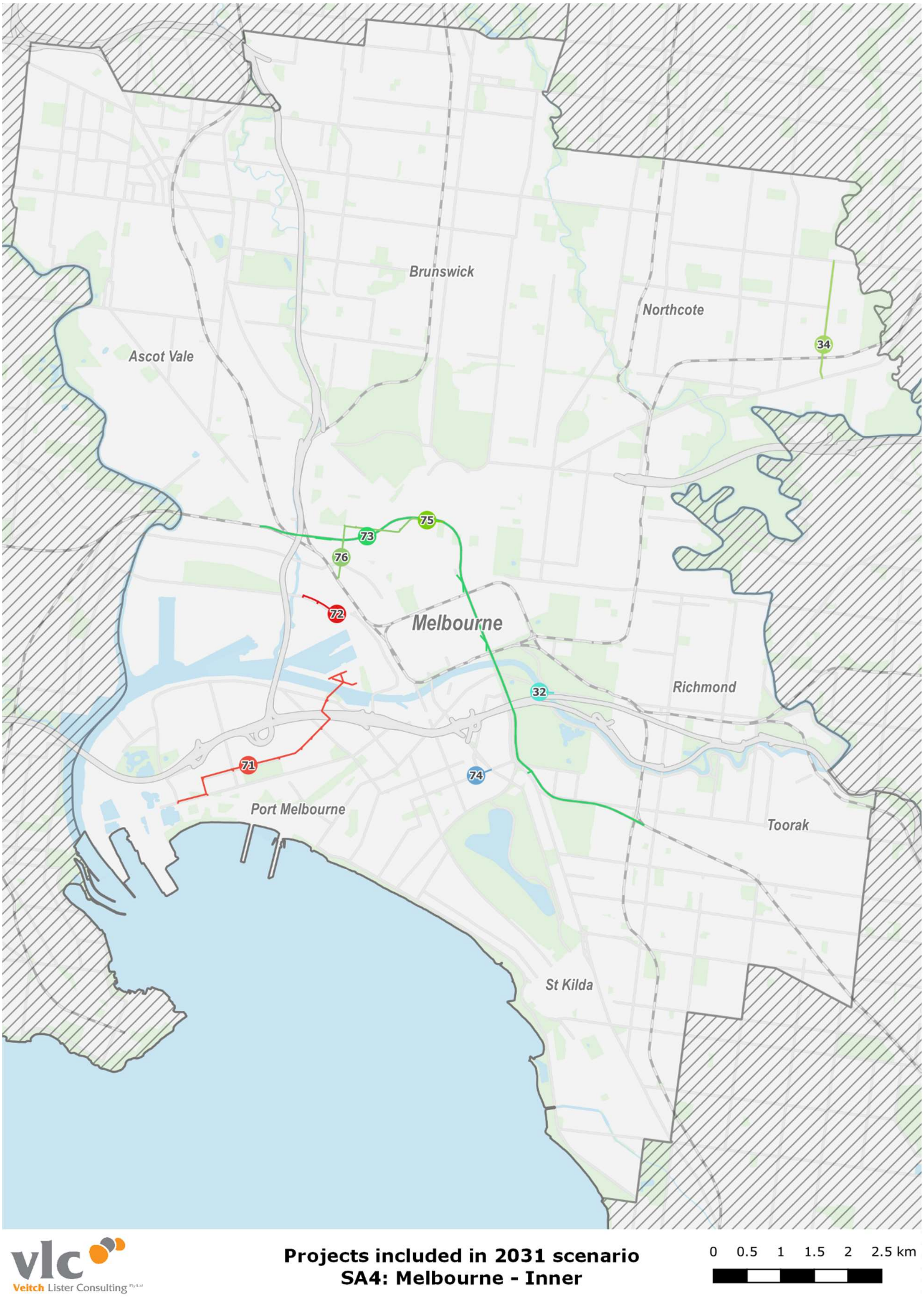
Mode	Time period	2016	2031	Change	% change
Melbourne GCCSA					
Suburban rail	AM peak (7-9AM)	$87,200	$250,700	$163,500	188%
	PM peak (4-6PM)	$59,900	$115,400	$55,500	93%
Tram	AM peak (7-9AM)	$28,600	$64,600	$36,000	126%
	PM peak (4-6PM)	$17,100	$39,400	$22,300	130%
Bus	AM peak (7-9AM)	$44,200	$336,100	$291,900	660%
	PM peak (4-6PM)	$5,500	$37,200	$31,700	576%
Regional rail	AM peak (7-9AM)	$8,200	$264,200	$256,000	3122%
	PM peak (4-6PM)	$7,500	$91,600	$84,100	1121%
Geelong SA4					
Suburban rail	AM peak (7-9AM)	$0	$0	$0	-
	PM peak (4-6PM)	$0	$0	$0	-
Tram	AM peak (7-9AM)	$0	$0	$0	-
	PM peak (4-6PM)	$0	$0	$0	-
Regional Bus	AM peak (7-9AM)	$3,200	$27,500	$24,300	759%
	PM peak (4-6PM)	$0	$1,400	$1,400	-
Regional rail	AM peak (7-9AM)	$200	$2,100	$1,900	950%
	PM peak (4-6PM)	$200	$1,300	$1,100	550%
Total Region					
Suburban rail	AM peak (7-9AM)	$87,200	$250,700	$163,500	188%
	PM peak (4-6PM)	$59,900	$115,400	$55,500	93%
Tram	AM peak (7-9AM)	$28,600	$64,600	$36,000	126%
	PM peak (4-6PM)	$17,100	$39,400	$22,300	130%
Bus	AM peak (7-9AM)	$47,400	$363,600	$316,200	667%
	PM peak (4-6PM)	$5,500	$38,600	$33,100	602%
Regional rail	AM peak (7-9AM)	$8,400	$266,300	$257,900	3070%
	PM peak (4-6PM)	$7,700	$92,900	$85,200	1106%

Appendix A: Projects included in modelling

This section details the projects included in the modelling. A map for each SA4 has been included (Appendix Figure A-1 gives an overview of the relevant SA4s). The numbers referenced in maps are linked to project names in Appendix Figure A-1.

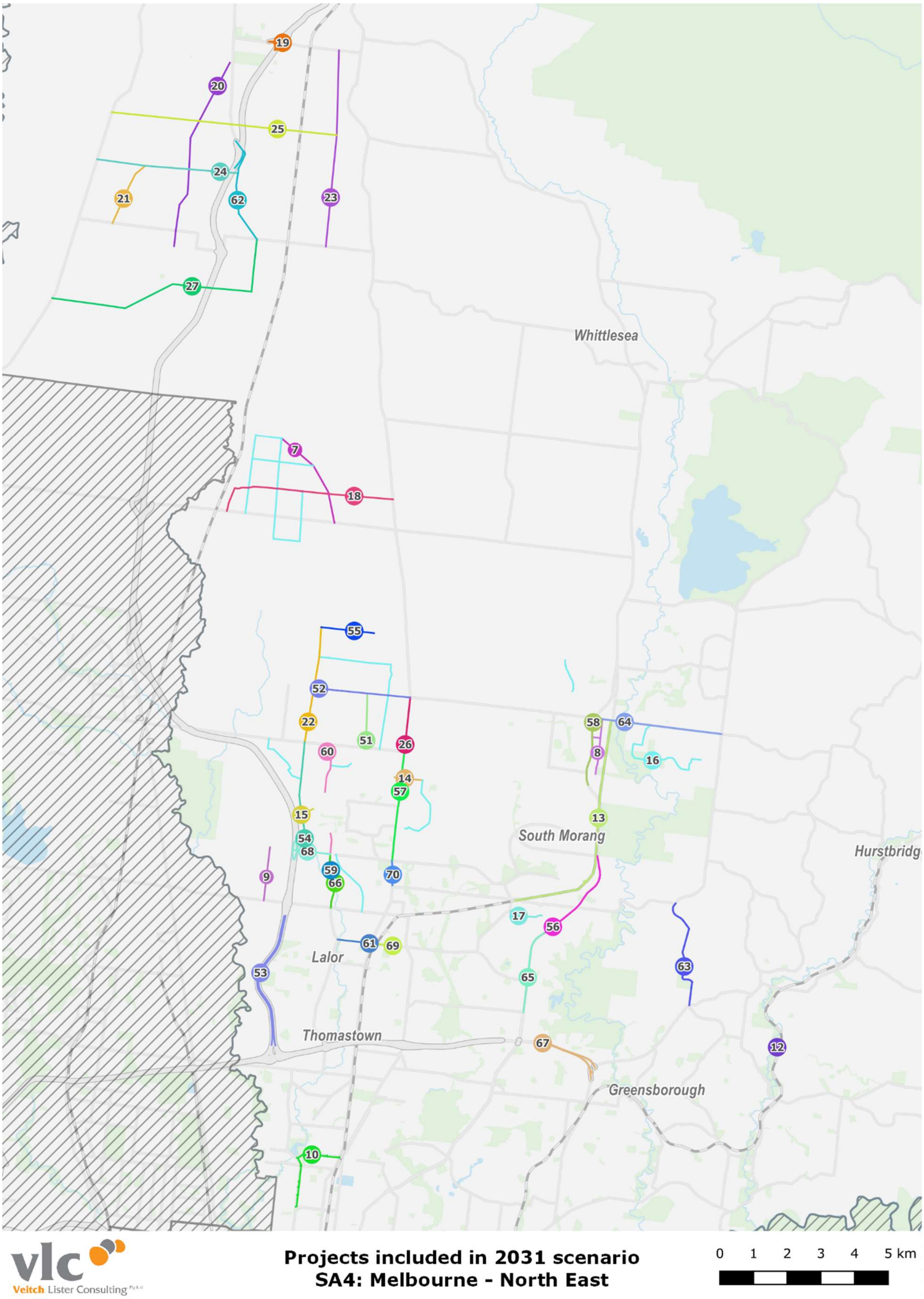
Appendix Figure A-1 – Greater Melbourne SA4 Overview

Appendix Figure A-2 – Projects included in the 2031 scenario SA4: Melbourne – Inner

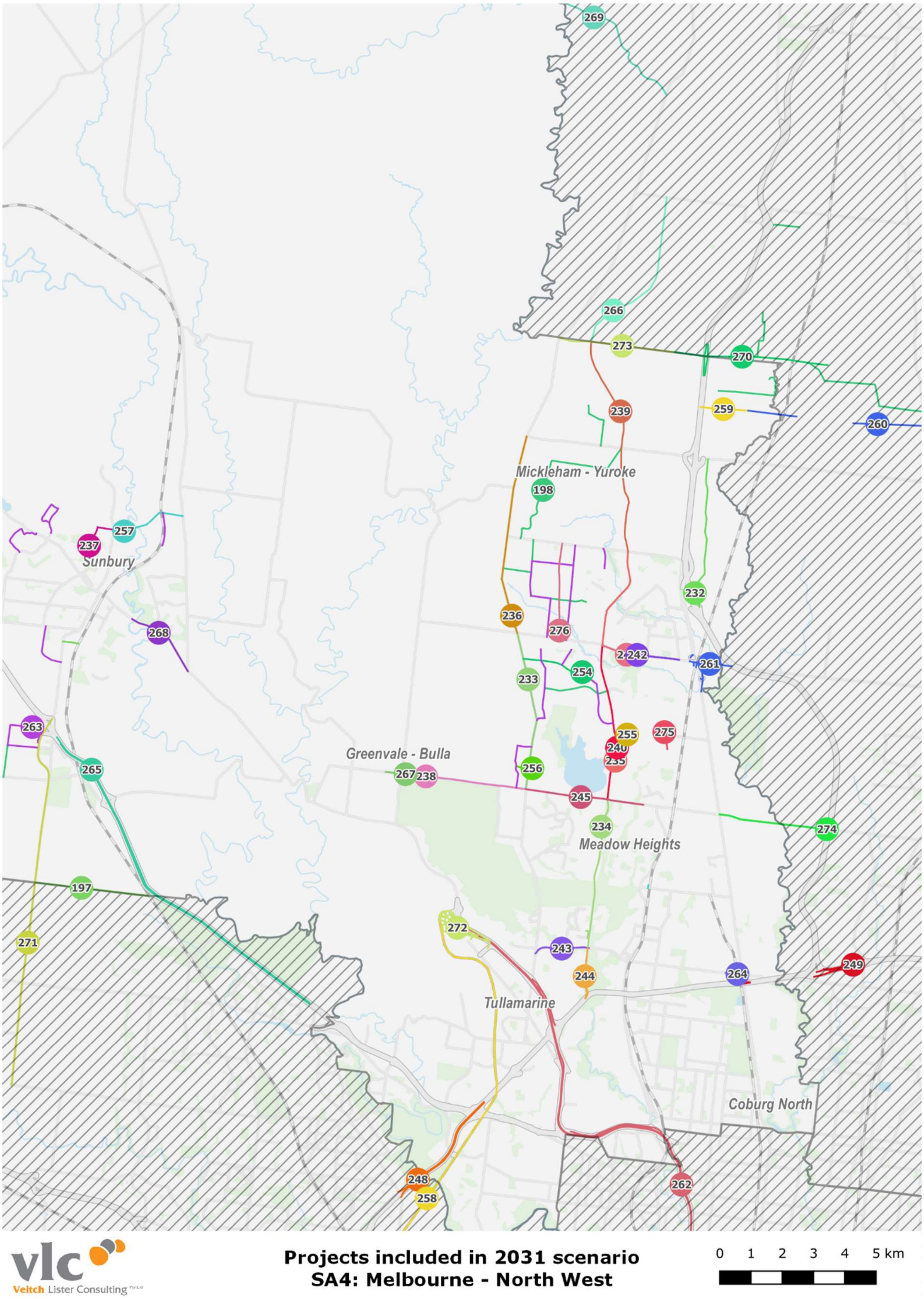


Appendix Figure A-3 – Projects included in the 2031 scenario SA4: Melbourne – Inner South

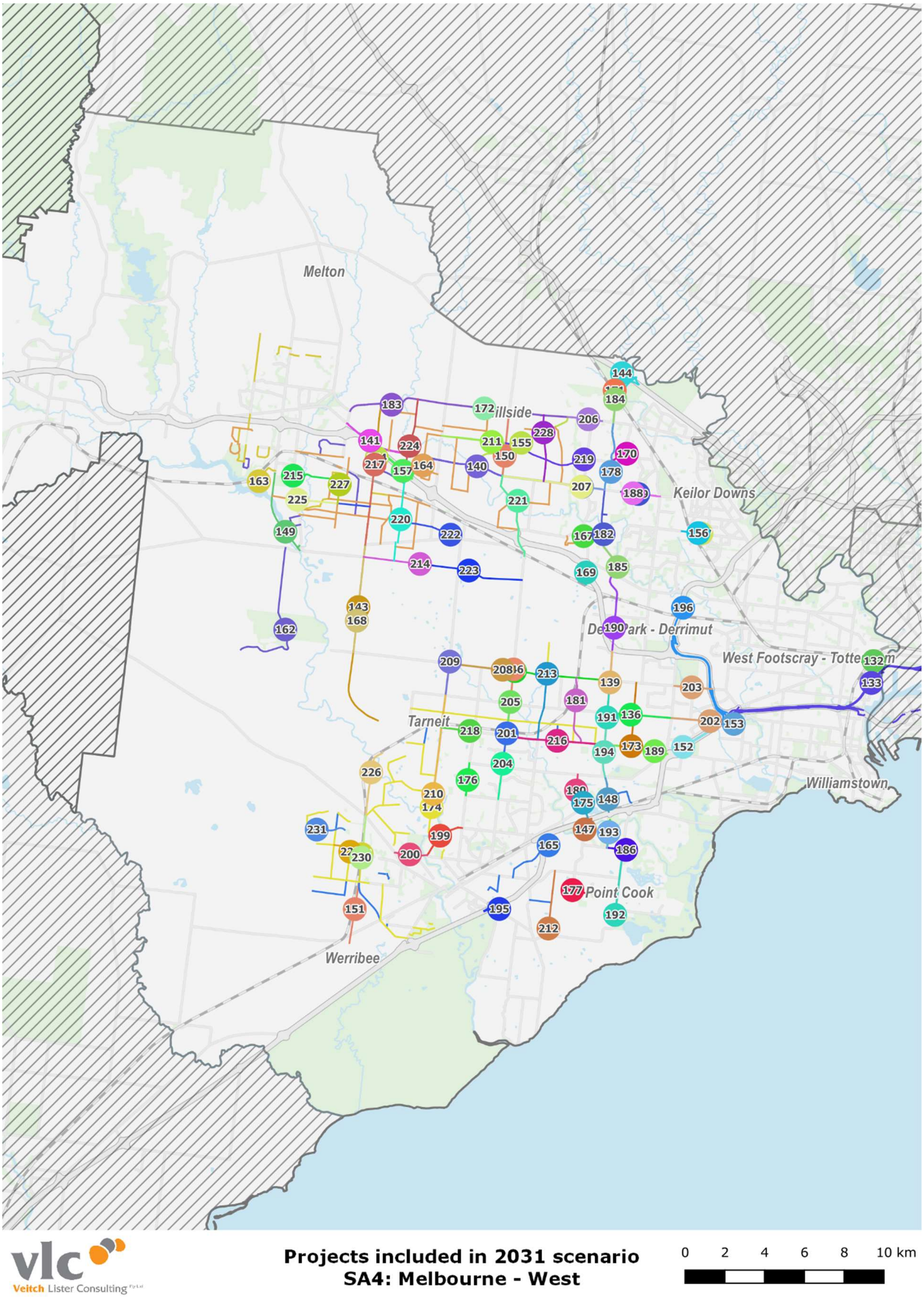
Appendix Figure A-4 – Projects included in the 2031 scenario SA4: Melbourne – North East



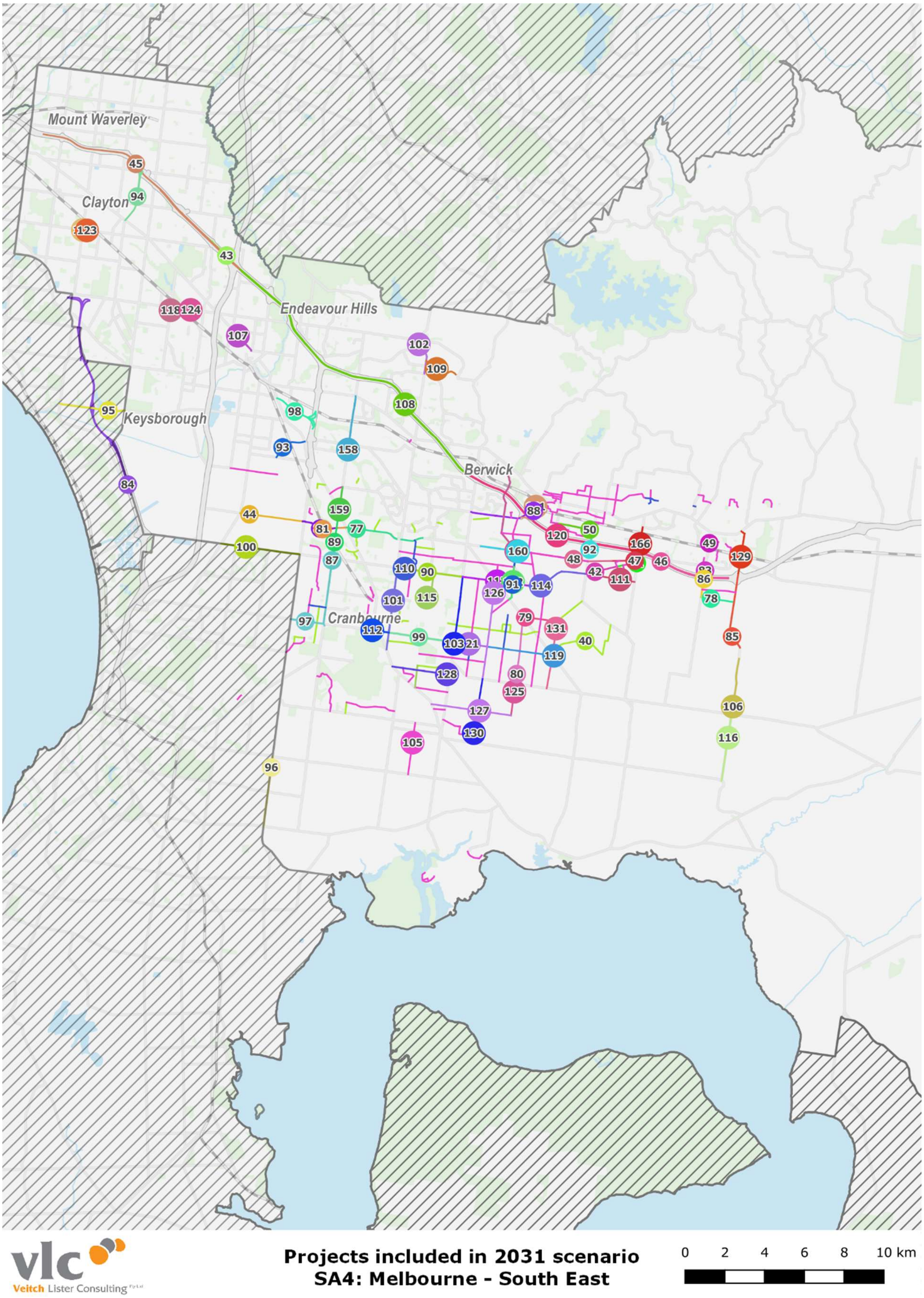
Appendix Figure A-5 – Projects included in the 2031 scenario SA4: Melbourne – North West



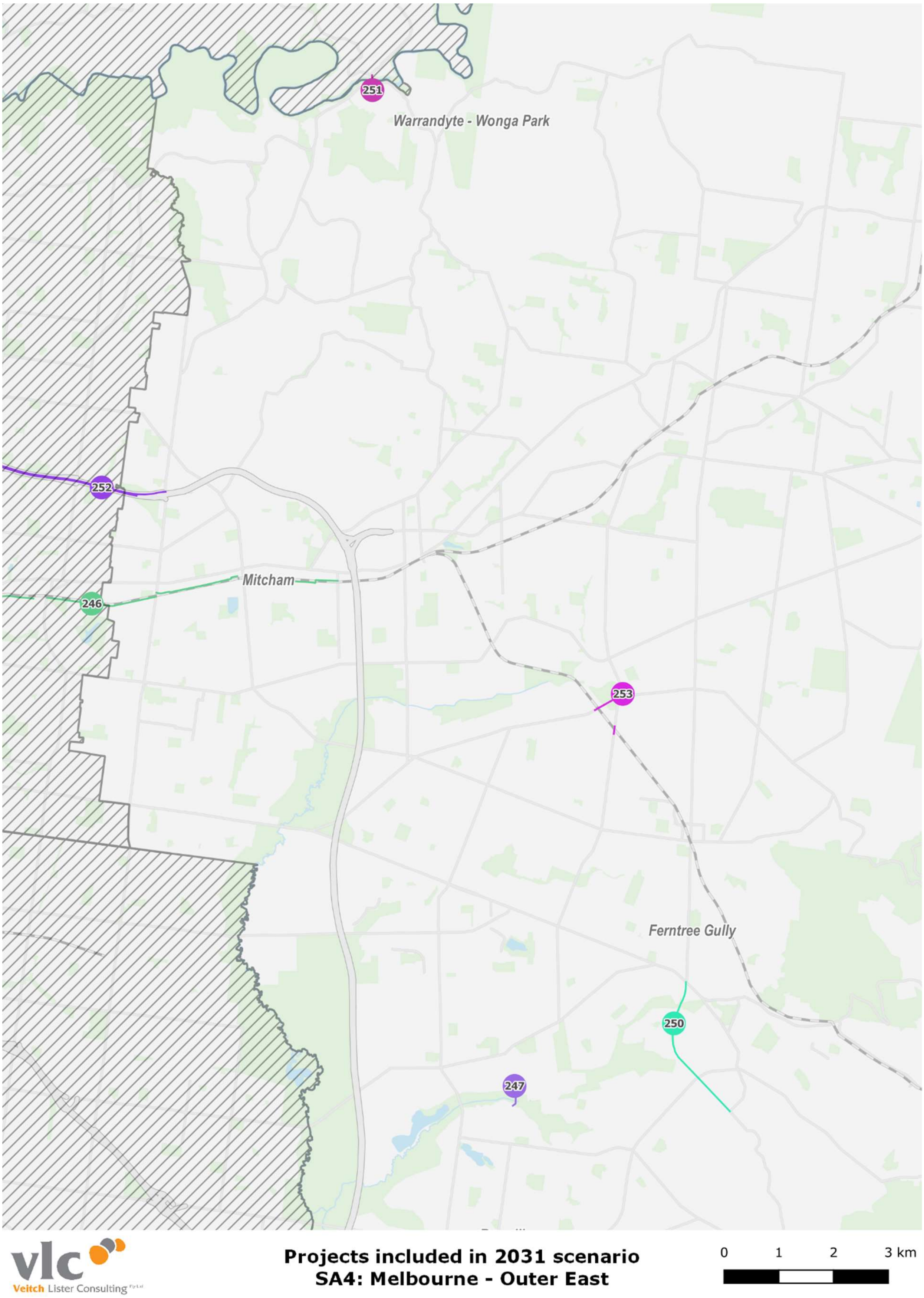
Appendix Figure A-6 – Projects included in the 2031 scenario SA4: Melbourne – West



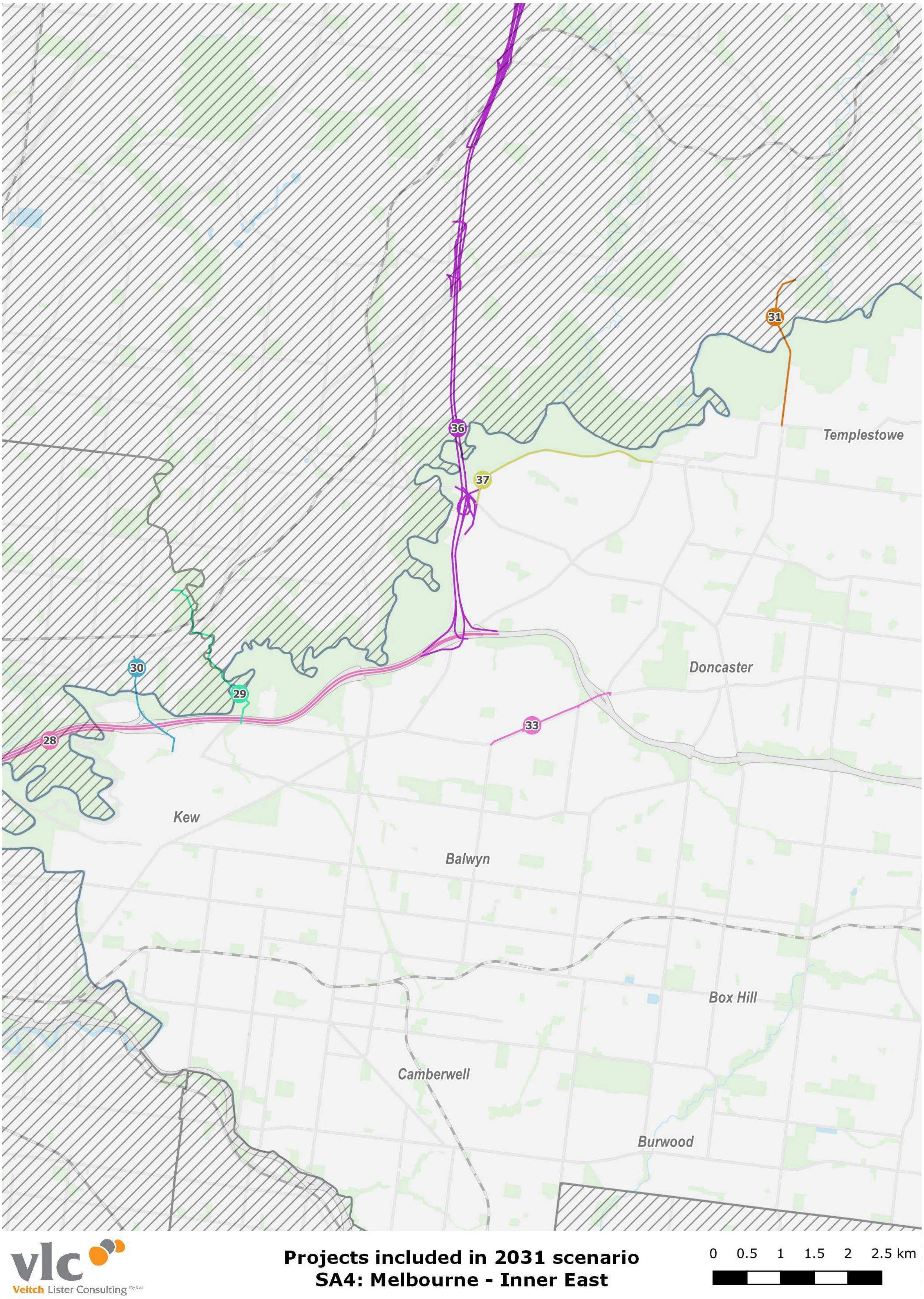
Appendix Figure A-7 – Projects included in the 2031 scenario SA4: Melbourne – South East



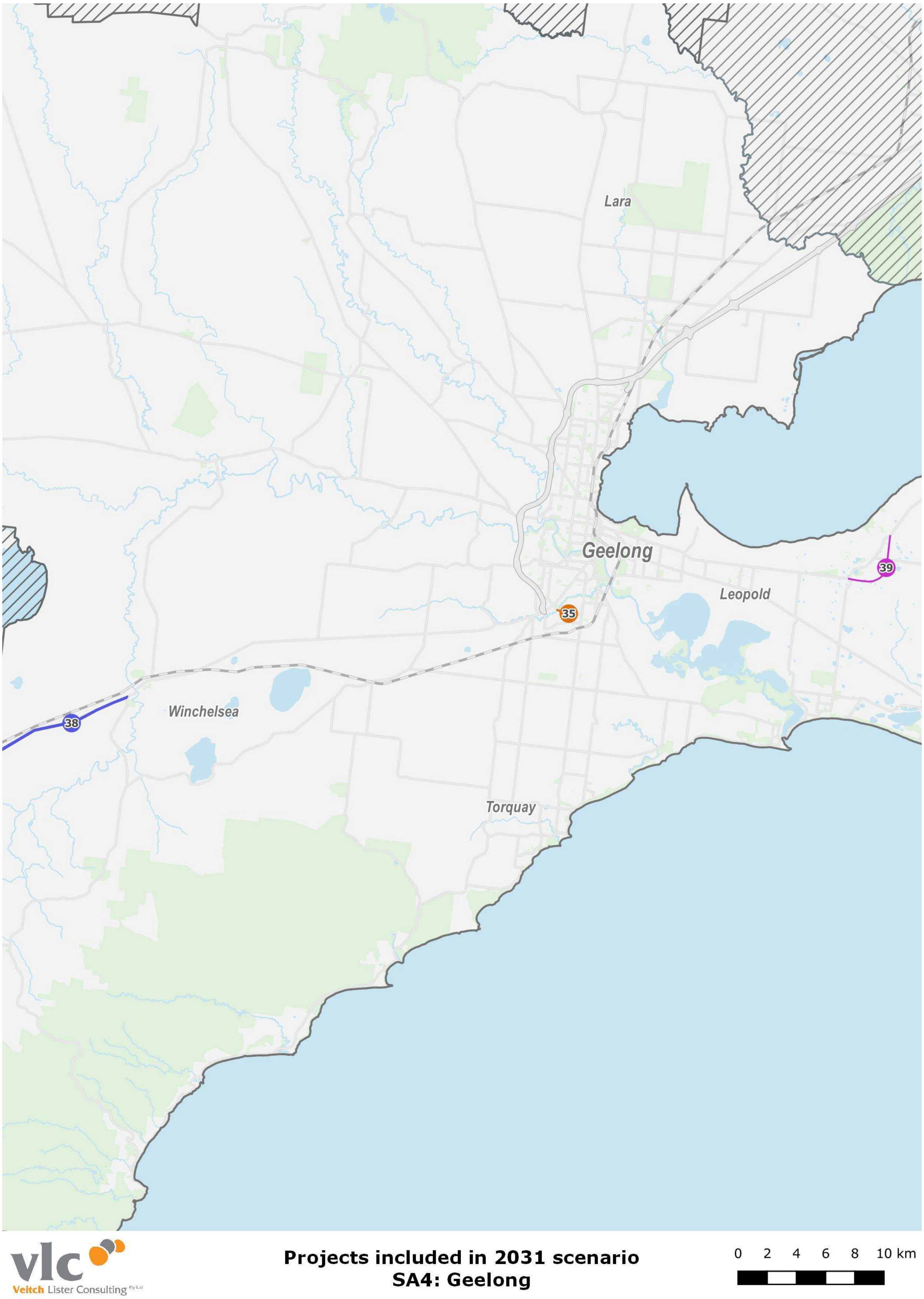
Appendix Figure A-8 – Projects included in the 2031 scenario SA4: Melbourne – Outer East



Appendix Figure A-9 – Projects included in the 2031 scenario SA4: Melbourne – Inner East



Appendix Figure A-10 – Projects included in the 2031 scenario SA4: Geelong



Appendix Table A-1 – Projects included in the 2031 forecast

Project Number	Name
1	McLeod Road Carrum extension - Between Nepean Hwy and Station St. Expected extension with grade separation.
2	New Stations to existing lines (Southland).
3	Poath Rd upgrade - Between Railway Pde and Willesden Rd.
4	Station Street, Carrum extension. Expected extension across Patterson River.
5 & 6	Additional planned tram infrastructure – route extension along Waverley Rd, Malvern East - Between East Malvern Terminus (Darling Rd) and Malvern Rd.
7	Kokoura Drive construction – New 2-lane road between Donnybrook Road and Gunns Gully Road.
8	Riversdale Blvd and Berry Lane construction – New 2-lane road between Berry lane and Bridge Inn Rd.
9	Vearings Road construction – New 2-lane road between Cooper St and O'Hearns Rd.
10	Additional planned tram infrastructure – route extension along Gilbert Rd, Reservoir between West Preston Terminus (Regent St) and Reservoir Station (Broadway).
11	Grange Rd upgrade - Between Princes Hwy and Moodie St
12	New Stations to existing lines (Allendale Rd).
13	Rail extension to Mernda - Between South Morang Railway Station and Mernda.
14	Growth Area Roads - Outer North road infrastructure planned for 2019 (South Morang/Epping).
15	Tesselaar Rd/Pythagoras St construction – New 2-lane road between Scanlon Dr and Harvest Home Rd.
16	Growth Area Roads - Outer North road infrastructure planned for 2021 (South Morang/Epping).
17	Civic Drive construction – New 2-lane road between Bush Bld and Morang Drive.
18	Hayes Hill Blvd construction – New 2-lane road between Donnybrook Road and Merriang Road.
19	Wallan-Whittlesea Rd (Watson St) - Hume Fwy Interchange southerly ramps and duplication of overpass to 4-lanes in 2026.
20	Patterson St construction – New 2-lane road between Beveridge and north of Beveridge.
21	E14 (Mandalay Rd) construction – New 2-lane road between Camerons Lane and north of boundary.
22	Scanlon Dr Extension – between Craigieburn Rd and Summerhill Rd.
23	Scanlon Dr Extension – between Beveridge Rd and Wallan.
24	New east-west arterial north of Camerons Lane - Between Old Sydney Rd and Stewart St.
25	Beveridge-Darraweit Rd Extension - Between Old Sydney Rd and Scanlon Dr Extension.
26	Epping Rd upgrade – 4-lanes between Bridge Inn Rd and Craigieburn Rd.
27	New east-west arterial south of Camerons Lane (Rankin St?) - Between Old Sydney Rd and Stewart St.
28	Eastern Fwy Widening - Between Hoddle St and North East Link.
29	Darebin Trail Link construction – Between Farm Road and Eastern Fwy (Darebin).
30	Chandler Hwy upgrade – 6-lanes between Princess St and Heidelberg Rd.
31	Fitzsimons La upgrade – 6-lanes between Main Rd and Porter St.
32	Swan St Bridge Widening – 5-lanes between Alexandra Ave and Batman Ave.

Project Number	Name
33	Additional planned tram infrastructure – route extension along Doncaster Rd, Balwyn North - Between North Balwyn Terminus (Balwyn Rd) and Doncaster Park & Ride (Eastern Fwy).
34	Grange Rd upgrade - Between Heidelberg Rd and Darebin Rd.
35	Pioneer Rd upgrade - Between Church St and Waurn Ponds Creek.
36	North-East Link – New motorway between Metropolitan Ring Rd and Eastern Fwy(Bulleen).
37	Templestowe Rd upgrade – Between Bridge St and Thompsons Rd.
38	Princes Hwy upgrade - Between Winchelsea and Colac.
39	Drysdale Bypass construction – new link between Jetty Road and north of Whitcombes Road.
40	Growth Area Bus Infrastructure - Outer SE (Cranbourne/Pakenham/Dandenong) – Addition of bus routes to support population growth
41 & 42 & 47	Western Arterial road extension – Between Cardinia Rd and Gum Scrum Creek.
43	Monash Freeway Upgrade - Between Jackson Rd and Eastlink.
44	Glasscocks Road duplication – 4-lanes between Dandenong Valley Hwy and Western Port Hwy.
45	Monash widening - Between Warrigal Rd and EastLink interchange.
46	Monash Freeway Widening - Between Cardinia Rd and Koo Wee Rup Rd.
48	Grices Rd construction - between Soldiers Rd and Gum Scrum Creek.
49	McGregors Rd duplication at Level Crossing.
50	Rix Rd duplication – Between Officer South Rd and Brunt Rd.
51	Bodycoats Rd construction - Between Craigieburn Rd and Summerhill Rd.
52	Boundary Rd construction - Between Scanlon Dr and Epping Rd.
53	Hume Fwy upgrade – 4-lanes Between Western Ring Rd and Cooper St.
54	Scanlon Dr upgrade – 4-lanes between O'Herns Rd and Craigieburn Rd.
55	Summerhill Rd/Masons Rd construction – Between Scanlon Dr and E6.
56	Plenty Rd upgrade – 6-lanes between Centenary Dr and Gordons Rd.
57	Epping Rd upgrade – 4-lanes between Findon Rd and Craigieburn Rd.
58	Plenty Rd – 4-lanes between Riverdale Bvd and Bridge Inn Rd.
59	Edgars Rd upgrade – 6-lanes between Cooper St and O'Herns Rd.
60	Edgars Rd upgrade – 2-lanes between O'Herns Rd and Craigieburn Rd East.
61	Childs Rd Extension (Deveney Rd) - Between High St and Edgars Rd.
62	Stewart St Extension - Between Beveridge and Northern Hwyat Hume Interchange.
63	Yan Yean Rd upgrade – 4-lanes between Kurrak Rd and Diamond Creek Rd.
64	Bridge Inn Rd upgrade – 4-lanes between Plenty Rd and Yan Yean Rd.
65	Plenty Rd upgrade – 6-lanes between McKimmies Rd and Centenary Dr.
66	Edgars Rd – 2-lanes between Cooper St and O'Herns Rd.
67	M80 upgrade – 6-lanes between Plenty Rd and Greensborough Hwy.
68	O'Herns Rd/Hume Fwy interchange upgrad – 4-lanes between Hume Fwy and Edgars Rd.
69	Childs Rd upgrade – 4-lanes between High St and Dalton Rd.
70	Epping Rd upgrade – 4-lanes between Memorial Av and Findon Rd.
71	Fishermans Bend tram link – extension of tram routes 11 and 48

Project Number	Name
72	Additional planned tram infrastructure – Route extension along Footscray Rd, Docklands - Between Waterfront City and Docklands Dr.
73	Melbourne Metro – new rail tunnel through the CBD including construction of 5 new rail stations
74	Tram Route 5 realignment.
75	Additional planned tram infrastructure - Grattan Street, Parkville - Between Royal Parade and University of Melbourne.
76	Additional planned tram infrastructure- Arden Street, Parkville - Between North Melbourne Station and Royal Parade.
77	Glasscocks Rd construction – 2-lanes between South Gippsland Hwy and Berwick-Cranbourne Rd.
78	Greenhills Rd upgrade – 2-lanes between McGregors Rd and Koo Wee Rup Rd.
79	Hardys Rd construction – 2-lanes between Pound Rd and Muddy Gates La.
80	Bells Rd construction – 2-lanes between Pound Rd and Ballarto Rd.
81	Glasscocks Rd construction – 2-lanes between Western Port Hwy and South Gippsland Hwy.
82	Glasscocks Rd construction – 4-lanes between Western Port Hwy and Evans Rd.
83	McGregor Rd upgrade – 4-lanes between South of Henty St and Pakenham Bypass.
84	Mornington Peninsula Fwy construction – 4-lanes between Springvale Rd and Dingley Fwy.
85	Koo Wee Rup Rd upgrade – 4-lanes between Pakenham Bypass and Hall Rd.
86	McGregor Rd extension – between Pakenham Bypass and Thompsons Rd
87	Evans Rd upgrade – 4-lanes between Thompsons Rd and Hall Rd.
88	O'Shea Rd upgrade – 4-lanes between Berwick-Cranbourne Rd and Princes Fwy.
89	Evans Rd upgrade – 4-lanes between South Gippsland Hwy and Thompsons Rd.
90	Thompsons Rd upgrade – 4-lanes between Narre Warren-Cranbourne Rd and Berwick-Cranbourne Rd.
91	Soldiers Rd upgrade – 4-lanes between Grices Rd and Pound Rd.
92	Officer South Rd upgrade – 2-lanes between Railway line and Pakenham Bypass.
93	Pound Rd West/Remington Dr Extension - Between South Gippsland Hwy and Abbotts Rd.
94	Westall Rd (Nothern Extension) - Between Princes Hwy East and Monash Fwy.
95	Governor Rd construction – 4-lanes between Boundary Rd and Springvale Rd.
96	Western Port Hwy upgrade – 4-lanes between North Rd and Baxter-Tooradin Rd.
97	Hall Rd upgrade – 4-lanes between Western Port Hwy and Sladen St.
98	Dingley Arterial construction – 6-lanes between South Gippsland Hwy and South Gippsland Fwy.
99	Berwick-Cranbourne Rd upgrade – 4-lanes between Pattersons Rd and Narre Warren-Cranbourne Rd.
100	Thompsons Rd upgrade – 4-lanes between Dandenong Valley Hwy and Western Port Hwy.
101	Narre Warren-Cranbourne Rd upgrade – 4-lanes between Thompsons Rd and South Gippsland Hwy.
102	Narre Warren North Rd upgrade – 4-lanes between Ernst Wanke Rd and Heatherton Rd.
103	Berwick-Cranbourne Rd - Between Thompsons Rd and Pattersons Rd. Expected upgrade in 2031. 4 Lanes.
104	C21 North South Blvd construction – 4-lanes between Princes Fwy and Grices Rd.

Project Number	Name
105	Growth Area Roads construction - Outer SE (Cranbourne/Pakenham). Expected growth areas in 2021.
106	KooWeeRup Rd duplication – 4-lanes between Hall Rd and Ballarto Rd.
107	Princes Highway upgrade – Between Henty Street and Robinson Street.
108	Monash widening Stage 1 – Between EastLink interchange and Clyde Rd.
109	Brundrett Rd (Narre Warren) construction – Between Narre Warren Rd and Crawley Rd. Expected new route in 2017. 2 Lanes.
110	Growth Area Roads – Outer SE (Cranbourne/Pakenham). Expected growth areas in 2019.
111	Thompsons Rd Extension – Between Officer South Rd and Cardinia Rd.
112	Sladen St upgrade – 4-lanes between Narre Warren-Cranbourne Rd and South Gippsland Hwy.
113	Thompsons Rd Extension - Between Berwick-Cranbourne Rd and Soldiers Rd.
114	Thompsons Rd Extension - Between Soldiers Rd and Officer South Rd.
115	Casey Fields Blvd 2 - Between Thompsons Rd to Linsell Blvd and AND Lineham Dr to South Gippsland Hwy.
116	KooWeeRup Rd duplication – 4-lanes between Ballarto Rd and Manks Rd.
117	Clayton Rd upgrade - Between Haughton Rd and Carinish Rd.
118	Corrigan Rd upgrade - Between Lightwood Rd and Crescent St.
119	Pattersons Rd construction – 2-lanes between Tuckers Rd and Pound Rd.
120	Monash Freeway upgrade – Between Clyde Rd and Cardinia Road.
121	Pattersons Rd construction – 2-lanes between Berwick-Cranbourne Rd and Tuckers Rd.
122	Soldiers Rd construction – 2-lanes between Grices Rd and Pound Rd.
123	Centre Rd/Clayton Rd upgrade
124	Heatherton Rd upgrade
125	Bells Rd/Yallambie Rd construction – Between Ballarto Rd and Manks Rd.
126	Tuckers Rd construction – Between Pound Rd and Ballarto Rd.
127	Moores Rd construction – Between South Gippsland Hwy and Bells Rd.
128	Ballarto Rd upgrade – Between South Gippsland Hwy and Clyde-Five Ways Rd.
129	Racecourse Rd upgrade – 4-lanes between Princes Hwy and Princes Fwy.
130	Tuckers Rd/Derricks Rd construction – 2-lanes between Ballarto Rd and Manks Rd.
131	Muddy Gates Lane construction – 2-lanes between Ballarto Rd and Hardys Rd.
132	Shepherd's Bridge widening - Between Off ramp to MacKenzie Rd and Whitehall St.
133	Western Distributor – New road between M1/M80 Interchange and CityLink.
134	Armstrong Rd construction – between Greens Road and Black Forest Rd.
135	Palmers Road, Point Cook - Between Dennings Rd and Princes Fwy. Expected upgrade in 2021. 4 Lanes.
136	Dohertys Rd widening – 4-lanes between Palmers Rd and Foundation Rd.
137	Main Road upgrade – between West Esplanade and Alfrieda Street.
138	Taylors Rd extension - Between Melton Hwy and Plumpton Rd.
139	Robinsons Rd upgrade – 4-lanes between Boundary Rd and Deer Park Bypass.
140	Taylors Rd Extension - Between Plumpton Rd and Paynes Rd.
141	Beattys Rd construction - Between Melton Hwy and Paynes Rd.
142	Leakes Rd upgrade – 4-lanes between Palmers Rd and Derrimut Rd.
143	Mt Cottrell Rd upgrade – Between Leakes Rd and Melton Hwy.

Project Number	Name
144	Calder Fwy/Calder Park Dr Interchange upgrade
145	Boundary Rd upgrade – Between Derrimut and Palmers Rd.
146	Derrimut Rd upgrade – Between Dohertys Rd and Boundary Rd.
147	Princes Fwy West upgrade
148	Palmers Rd upgrade – between Princes Fwy and Sayers Rd.
149	Coburns Rd construction – between Hume Av and Exford Rd.
150	Hopkins Rd Extension - Between Neale Rd and Melton Hwy.
151	Armstrong Rd construction – Between Westbrook Dr and Black Forest Rd.
152	Princes Fwy upgrade – 10-lanes between Kororoit Creek Rd and Dohertys Rd.
153	Dohertys Rd upgrade - Between Cherry La and Westgate Dr.
154	Mt Cottrell Rd/Western Fwy Interchange construction
155	Beattys Rd upgrade - Between Troups Rd and Melton Hwy(East side).
156	Main Rd (St Albans) upgrade.
157	Western Fwy upgrade
158	Hallam South Rd upgrade - Between Princes Hwy and Pound Rd.
159	Hallam South Rd upgrade - Between Ormond Rd and South Gippsland Hwy.
160	Grices Rd upgrade – Between Berwick-Cranbourne Rd and Soldiers Rd.
161	O'Shea Rd construction - Between Soldiers Rd and Princes Fwy, including South-East facing ramps.
162	Growth Area Bus Infrastructure- Outer West (Melton) - Expected growth areas in 2031.
163	Growth Area Bus Infrastructure- Outer West (Melton) - Expected growth areas in 2021.
164	Growth Area Bus Infrastructure- Outer West (Caroline Springs/Melton) - Expected growth areas in 2021.
165	Growth Area Bus Infrastructure- Outer SW (Werribee/Hoppers Crossing) - Expected growth areas in 2031.
166	Cardinia Rd upgrade - Between Shearwater Dr and Pakenham Bypass.
167	Rockbank Middle Road duplication – 4-lanes between Caroline Springs Blvd and Westwood Dr.
168	Mt Cottrell Rd - Between Greigs Rd and Boundary Road. Expected sealing 2 lanes.
169	Christies Rd duplication - Between Western Fwy and Caroline Springs Station.
170	Hume Drive duplication - Between Calder Park Drive and Overton Lea Bvd.
171	Calder Park Railway Station Access construction
172	Melton Hwy duplication - Between The Regency and Leakes Rd.
173	Foundation Rd construction - Between Leakes Rd and Boundary Rd
174	Growth Area Roads - Outer SW (Werribee/Hoppers Crossing). Expected growth areas in 2021.
175	Princes Freeway/Forsyth Road interchange upgrade, Hoppers Crossing - Between Old Geelong Rd and Princes Fwy.
176	Tarneit Rd duplication - Between Hogans Rd and Sayers Rd.
177	Growth Area Roads - Outer SW (Point Cook). Expected growth areas in 2021.
178	Calder Park Dr upgrade - Between Melton Hwy and Taylors Rd.
179	Taylors Rd upgrade - Between Kurung Dr (west) and west of Shire boundary (Watervale Bvd?).
180	Forsyth Rd upgrade - Between Old Geelong Rd and Sayers Rd.
181	Forsyth Rd/Christies Rd construction - Between Leakes Rd and Boundary Rd.
182	Westwood Dr construction - Between Rockbank Middle Rd and Taylors Rd.

Project Number	Name
183	Melton Hwy duplication - Between The Regency and Ryans Lane (Federation Dr).
184	Calder Park Dr upgrade - Between Calder Fwy and Melton Hwy.
185	Westwood Dr upgrade - Between Western Hwy and Rockbank Middle Rd.
186	Dunnings Rd upgrade - Between Pt Cook Rd and Palmers Rd.
187	Taylors Rd upgrade - Between Calder Park Dr and Gourlay Rd.
188	Taylors Rd upgrade - Between Kings Rd and Kurung Dr
189	Leakes Rd upgrade - Between Palmers Rd and Fitzgerald Rd.
190	Robinsons Rd/Westwood Dve upgrade - Between Deer Park Bypass and Western Hwy.
191	Palmers Rd upgrade - Between Dohertys Rd and Boundary Rd.
192	Point Cook Rd upgrade - Between Pt Cook Homestead Rd and Dunnings Rd.
193	Palmers Rd upgrade - Between Dunnings Rd and Princes Fwy
194	Palmers Rd upgrade - Between Sayers Rd and Dohertys Rd.
195	Princes Fwy West/Duncans Rd Interchange upgrade.
196	M80 upgrade – 6-lanes Between WestGate Fwy and Western Hwy.
197	Sunbury Electrification and Extension (Holden Rd, Jacksons HIll Stn) - Stage 2.
198	Growth Area Bus Infrastructure- Outer NW (Craigieburn/Sunbury/Kalkallo). Expected growth areas in 2031.
199	Heaths Rd upgrade - Between Shaws Rd and Tarneit Rd.
200	Heaths Rd/Bolton Rd upgrade - Between Ballan Rd and Shaws Rd.
201	Derrimut Rd upgrade – Between Sayers Rd and Leakes Rd.
202	Dohertys Rd upgrade - Between Fitzgerald Rd and Grieve Pde.
203	Boundary Rd upgrade - Between Fitzgerald Rd and Western Ring Rd.
204	Derrimut Rd upgrade - Between Hogans Rd and Sayers Rd.
205	Derrimut Rd upgrade - Between Leakes Rd and Dohertys Rd.
206	Melton Hwy upgrade - Between Banchory Av and The Regency.
207	Taylors Rd upgrade - Between Gourlay Rd and Plumpton Rd.
208	Boundary Rd upgrade - Between Davis Rd and Derrimut Rd.
209	Davis Rd construction - Between Dohertys Rd and Boundary Rd.
210	Davis Rd construction - Between Dohertys Rd and Hogans Rd.
211	Tarletons Rd construction - Between Leakes Rd and Plumpton Rd.
212	Hacketts Rd upgrade - Between Sneydes Rd and Aviation Rd.
213	Morris Rd construction - Between Leakes Rd and Boundary Rd.
214	Harrison Rd construction - Between Mount Cottrell Rd and Downing St.
215	Bridge Rd upgrade - Between Ferris Rd and Exford Rd.
216	Leakes Rd duplication - Between Derrimut Rd and Palmers Rd.
217	Mt Cottrell Rd upgrade - Between Greigs Rd and Western Fwy.
218	Leakes Rd upgrade - Between Davis Rd and Tarneit Rd. Expected sealing in 2021.
219	Hume Dr construction - Between Plumpton Rd and Gourlay Rd.
220	Paynes Rd construction - Between Western Fwy and Harrison Rd.
221	Hopkins Rd upgrade - Between Greigs Rd and Plumpton Rd.
222	Iramoo Rd construction - Between Ferris Rd and Greigs Rd.
223	Harrison Rd construction - Between Downing St and Hopkins Rd.
224	Paynes Rd construction - Between Melton Hwy and Western Fwy.
225	Iramoo Rd construction - Between Exford Rd and Ferris Rd.

Project Number	Name
226	Armstrong Rd construction - Between Ballan Rd and Sayers Rd.
227	Ferris Rd construction - Between Abey Rd and Iramoo Rd.
228	Saric Rd construction - Between Melton Hwy and Taylors Rd.
229	Greens Rd upgrade - Between Armstrong Rd and Ison Rd.
230	Armstrong Rd construction - Between Ballan Rd and Greens Road.
231	Manor Lakes Bvd Extension.
232	Amaroo Rd construction - Between Summerhill Rd and Donnybrook Rd.
233	Mickleham Rd upgrade – 4-lanes between Somerton Rd and Craigieburn Rd.
234	E14 (Aitken Bvd) construction - Between Broadmeadows Rd Deviation and Somerton Rd.
235	E14 upgrade - Between Somerton Rd and Mt Ridley Rd.
236	Mickleham Rd upgrade – 4-lanes between Craigieburn Rd and Donnybrook Rd.
237	Elizabeth Dr Extension (Sunbury) - Between from existing urban area northwards and line of future ring route (new link).
238	Somerton Rd upgrade - Between Mickleham Rd and Oaklands Rd.
239	E14 (Aitken Bvd) - Between Mt Ridley Rd and Gunns Gully Rd.
240	E14 (Aitken Bvd) construction - Between Somerton Rd and Craigieburn Rd.
241	Craigieburn Rd upgrade – 4-lanes between Dorchester St and Waterview Bvd.
242	Craigieburn Rd upgrade – 4-lanes between Hanson Rd and Dorchester St.
243	Broadmeadows Rd upgrade - Between Mickleham Rd and Ripplebrook Dr.
244	E14 (Aitken Bvd) construction - Between M80 and Broadmeadows Rd.
245	Somerton Rd upgrade – 4-lanes between Mickleham Rd and Roxburgh Park Dr.
246	Box Hill to Ringwood shared path - Between Station Street and Wantirna Road.
247	Henderson Rd Bridge (Rowville) construction.
248	M80 upgrade – 10-lanes between Sunshine Av and Calder Fwy.
249	M80 upgrade – 8-lanes between Sydney Rd and Edgars Rd.
250	Dorset Rd Extension - Between Burwood Hwy and Lysterfield Rd.
251	Kangaroo Ground-Warrandyte Rd upgrade - Between Research-Warrandyte Rd and Yarra St.
252	Eastern Fwy Widening - Between North East Link and Doncaster Rd.
253	Grade separation of rail crossing at Bayswater Station.
254	Elevation Blvd construction - Between Vantage Blvd and Mickleham Rd.
255	Arena Boulevard construction - Between James Mirriams Drive and Silvester Parade.
256	Hillview Rd – new growth area road
257	Growth Area Roads - Outer NW (Craigieburn/Sunbury). Expected growth areas in 2019.
258	Melbourne Airport Rail Link.
259	Cameron Street construction - Between Hume Fwy and east of Cloverton Boulevard.
260	Cameron Street construction - Between Sydney Melb railway overpass and Merriang Road.
261	Craigieburn Rd Overpass construction - Between Craigieburn Rd East and Craigieburn Rd West.
262	CTW (CityLink Tulla Widening). Expected upgrade in 2021.
263	Growth Area Roads - Outer NW (Craigieburn/Sunbury). Expected growth areas in 2021.
264	Camp Rd level crossing removal.
265	Calder Fwy upgrade - Between Vineyard Rd and Melton Hwy.

Project Number	Name
266	E14 (Mandalay Rd) construction - Between Gunns Gully Rd and Camerons Lane.
267	Somerton Rd upgrade - Between Tullamarine Fwy extension and Oaklands Rd.
268	Sunbury Rd upgrade - Between Melbourne-Lancefield Rd and Powlett St.
269	Beveridge-Darraweit Rd construction - Between Romsey Rd and Old Sydney Rd.
270	Gunns Gully Rd construction - Between Hume Fwy and Scanlon Dr Extension.
271	Plumpton Rd upgrade - Between Hopkins Rd Extension and Calder Fwy.
272	Elevated Airport Ring Rd construction - Between Melbourne Airport and Tullamarine Fwy.
273	Grants Rd Extension - Between Aitken Bvd and Hume Fwy.
274	Cooper St upgrade - Between Hume Hwy and Hume Fwy. Expected upgrade in 2031.
275	Donald Cameron Dr upgrade - Between Bridgewater Rd and Southern Cross Dr.
276	Vantage Blvd construction - Between Craigieburn Rd and Mt Ridley Rd.
Not shown on map	Hurstbridge rail line upgrade - Removal of level crossings at Grange Road in Alphington and Lower Plenty Road in Rosanna, duplication of tracks between Heidelberg and Rosanna to enable more frequent peak period services.
	Ballarat Line Upgrade - Duplication of tracks, new passing loops etc. to enable higher service frequencies, new pedestrian links at Rockbank, Bacchus Marsh and Ballan stations.
	Gippsland Rail Upgrade - Upgrade Gippsland line to increase frequency and reliability.

Appendix B: Public Transport Network Assumptions

This section provides a high level overview of the public transport networks used in the modelling.

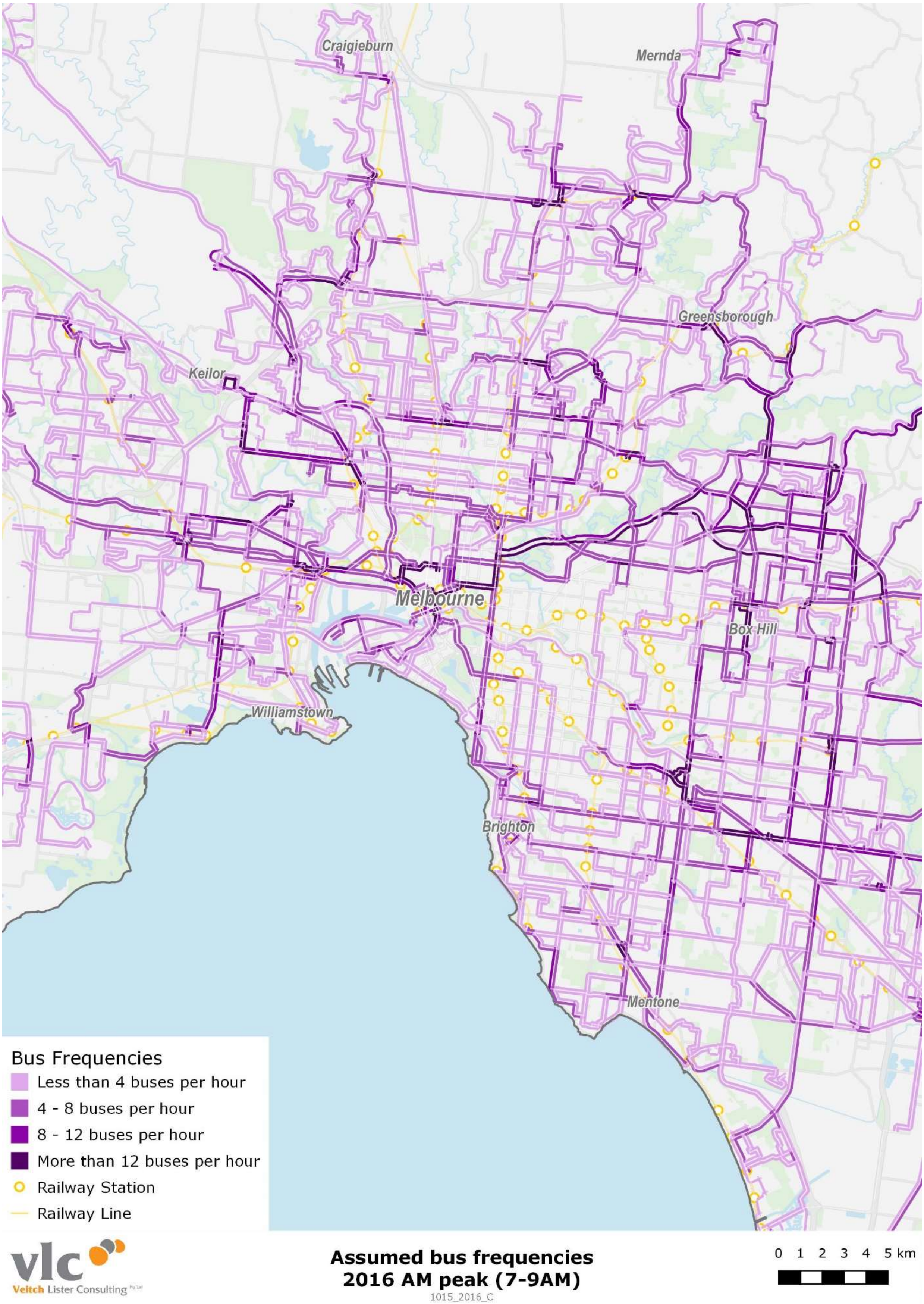
Appendix Figure B-1 through to Appendix Figure B-4 illustrate the frequencies assumed on Melbourne's bus network.

Appendix Figure B-5 through to Appendix Figure B-9 illustrate the frequencies assumed on Melbourne's rail network.

Appendix Figure B-13 through to Appendix Figure B-16 illustrate the frequencies assumed on Melbourne's tram network.

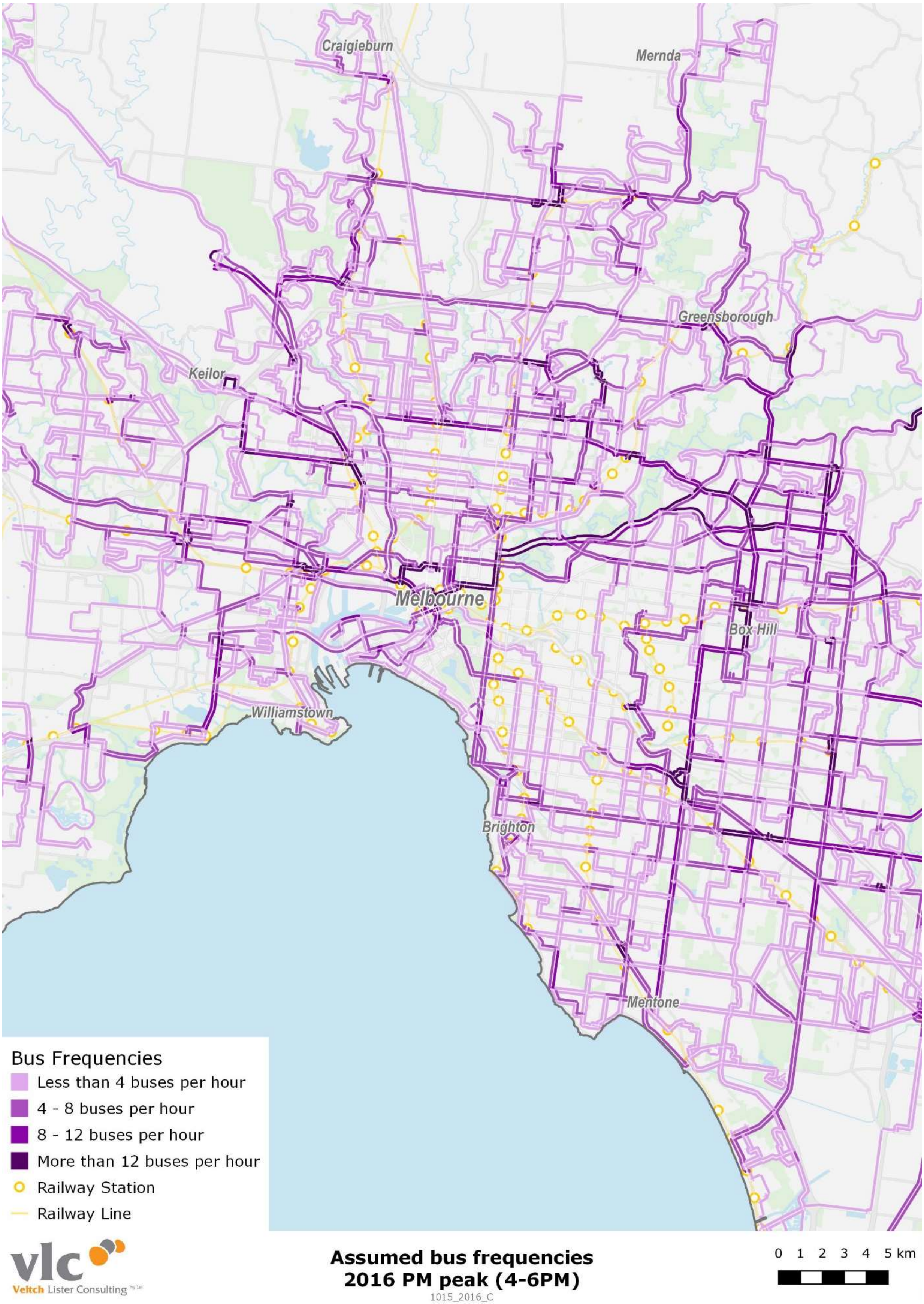
The 2016 routes and frequencies used in modelling were obtained from Public Transport Victoria. Details of how the 2031 network were developed can be found in Model Assumptions.

Appendix Figure B-1 – Melbourne GCCSA assumed bus frequencies - 2016 AM peak (7-9AM)



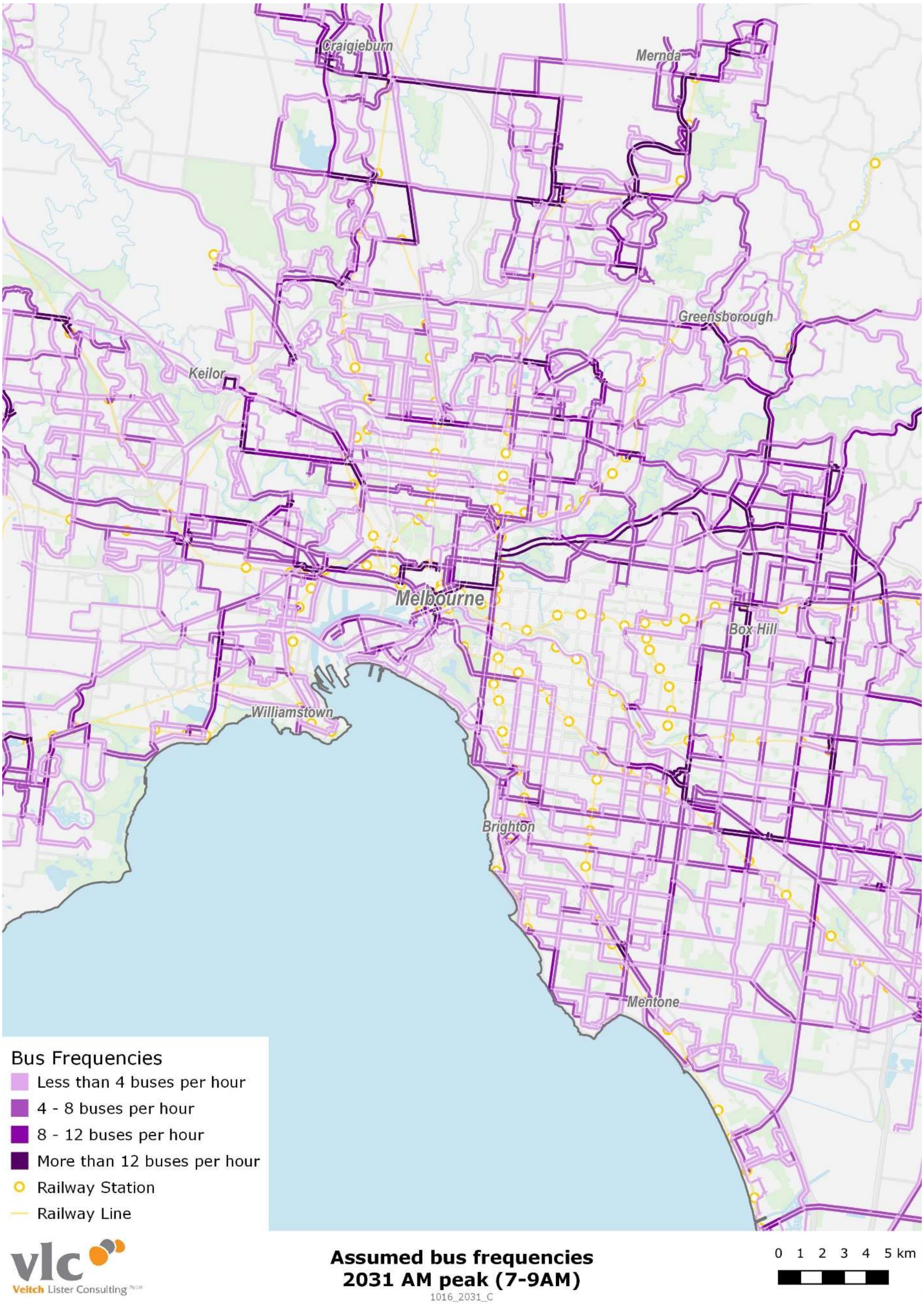
Source: Public Transport Victoria

Appendix Figure B-2 – Melbourne GCCSA assumed bus frequencies - 2016 PM peak (4-6PM)

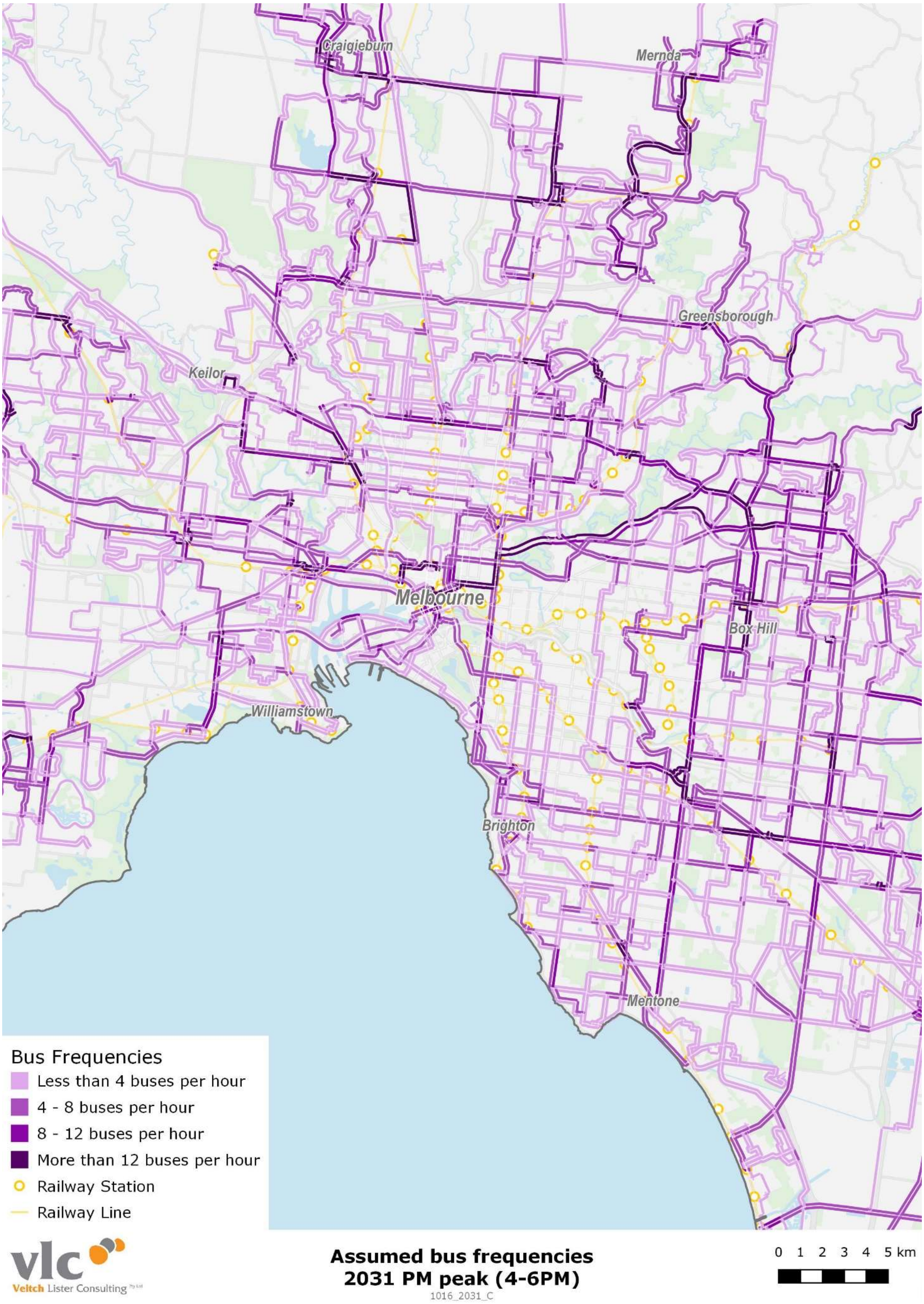


Source: Public Transport Victoria

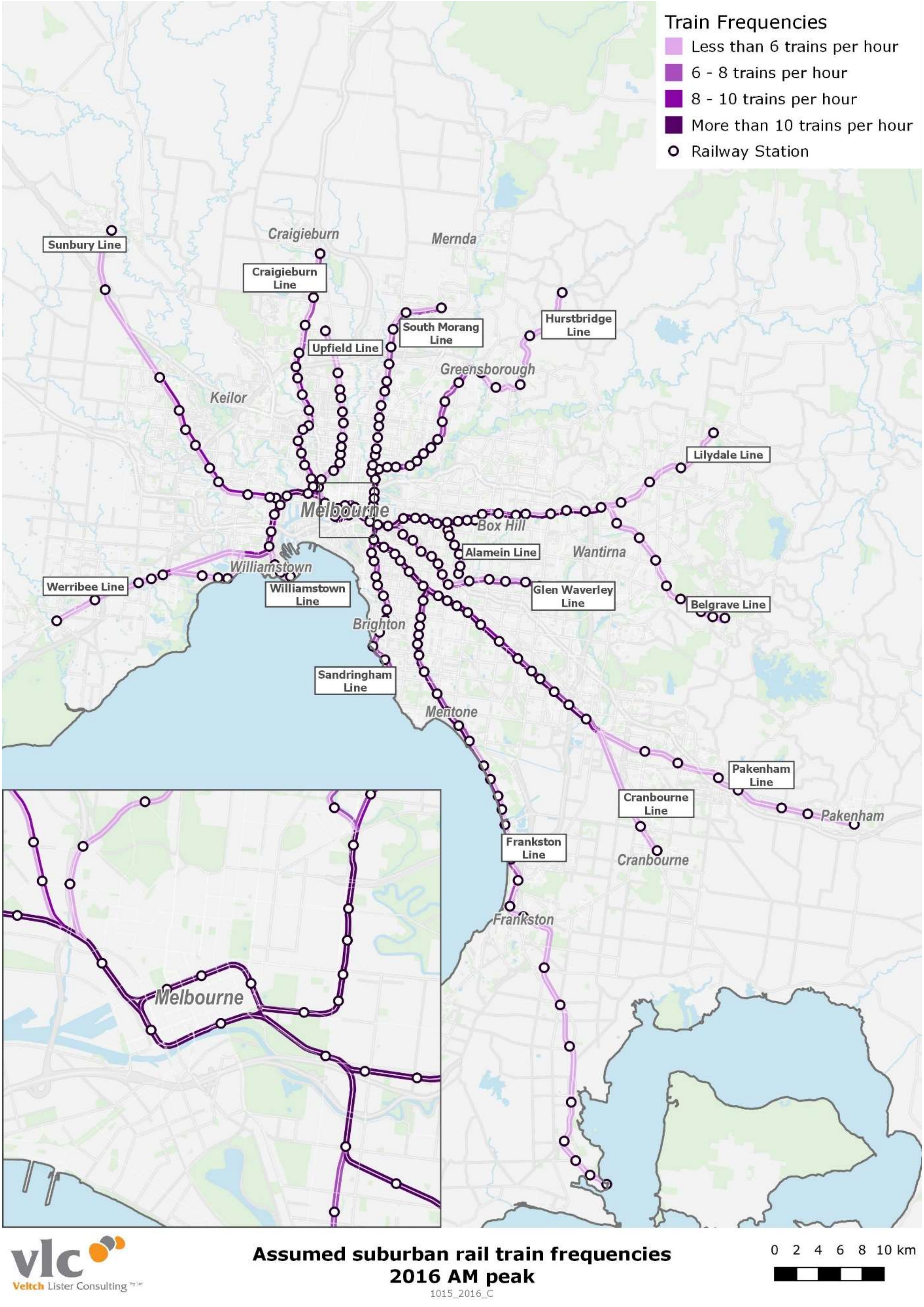
Appendix Figure B-3 – Melbourne GCCSA assumed bus frequencies - 2031 AM peak (7-9AM)



Appendix Figure B-4 – Melbourne GCCSA assumed bus frequencies - 2031 PM peak (4-6PM)

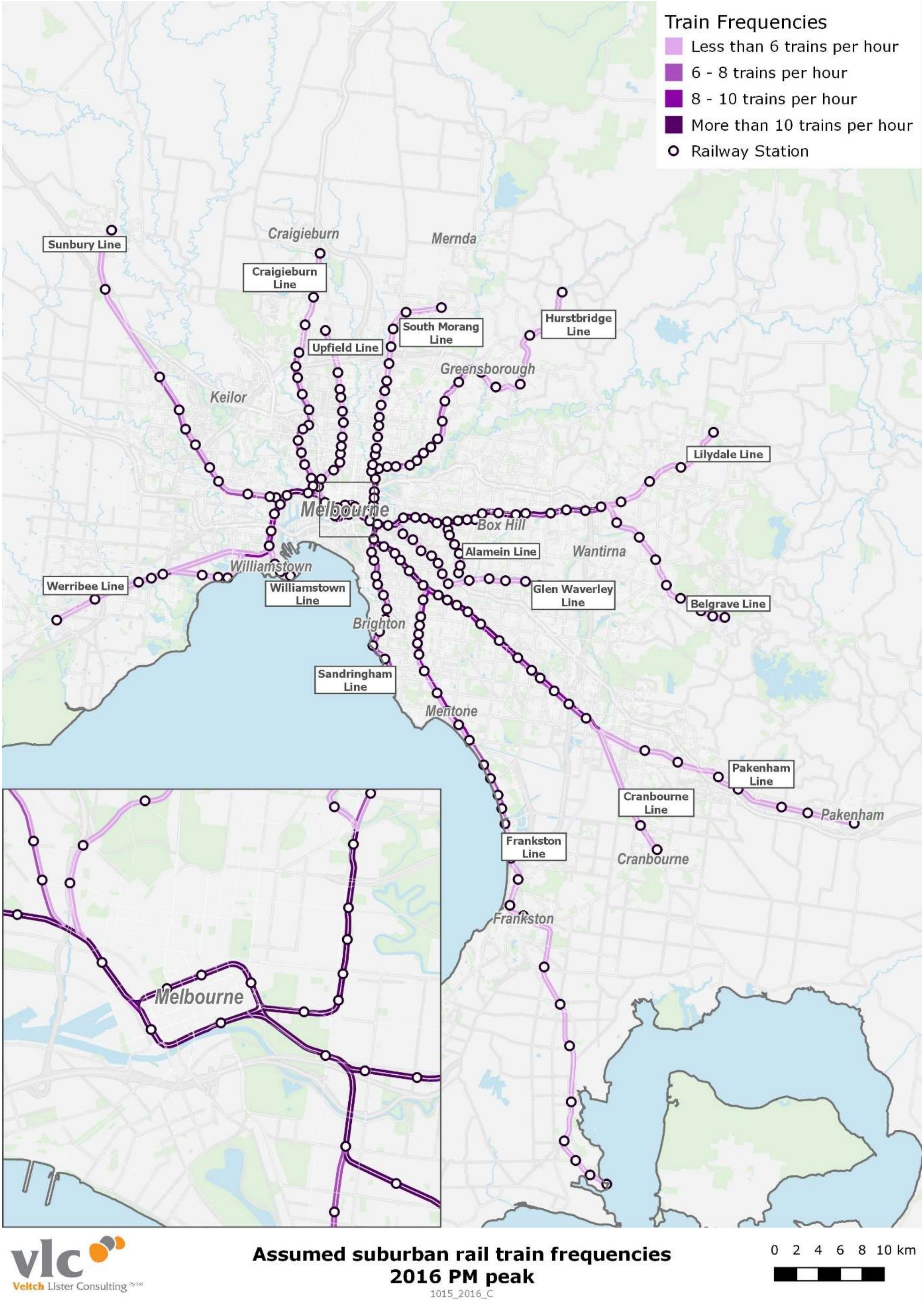


Appendix Figure B-5 – Melbourne GCCSA assumed metro rail frequencies - 2016 AM peak (7-9AM)



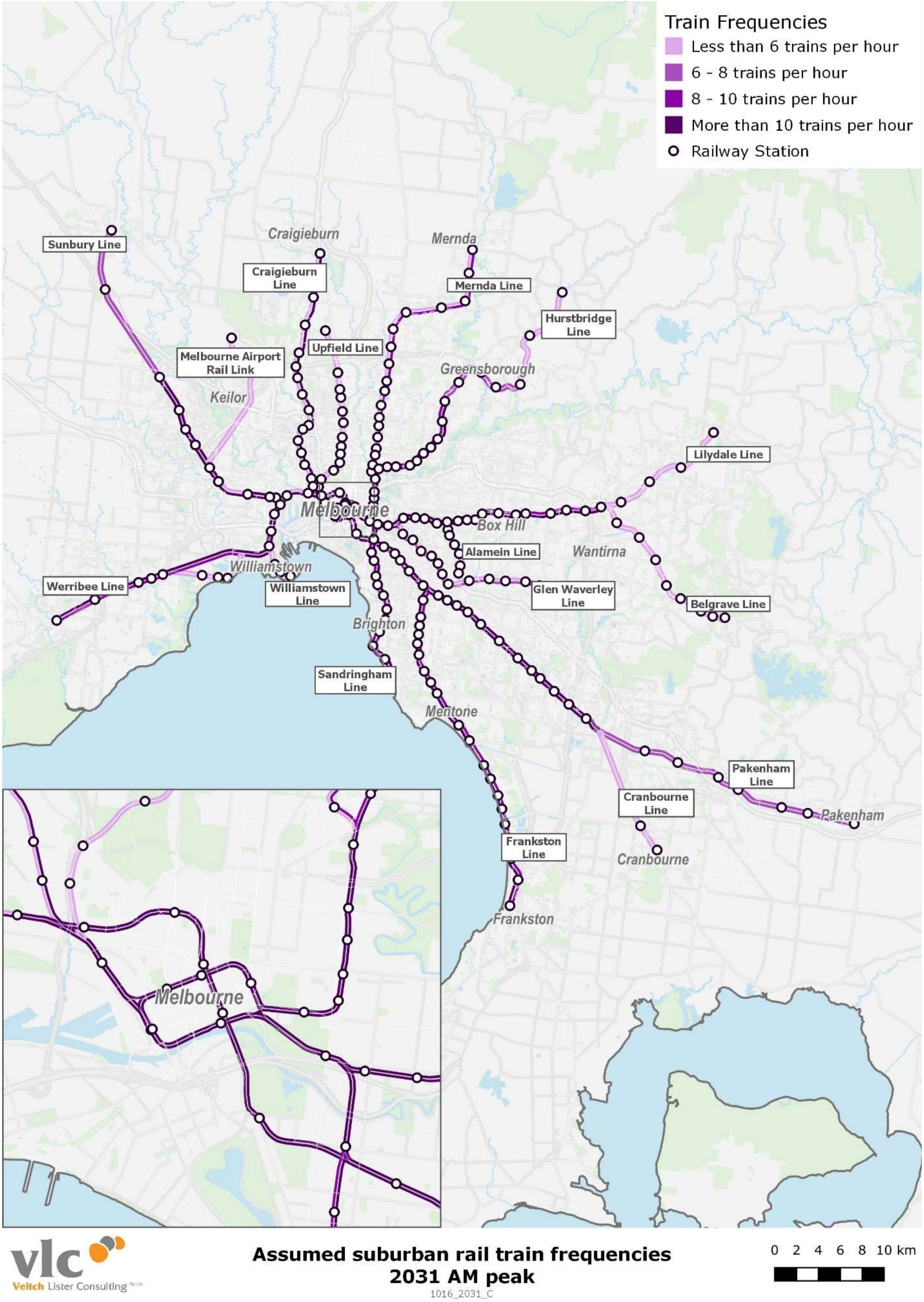
Source: Public Transport Victoria

Appendix Figure B-6 – Melbourne GCCSA assumed metro rail frequencies - 2016 PM peak (4-6PM)

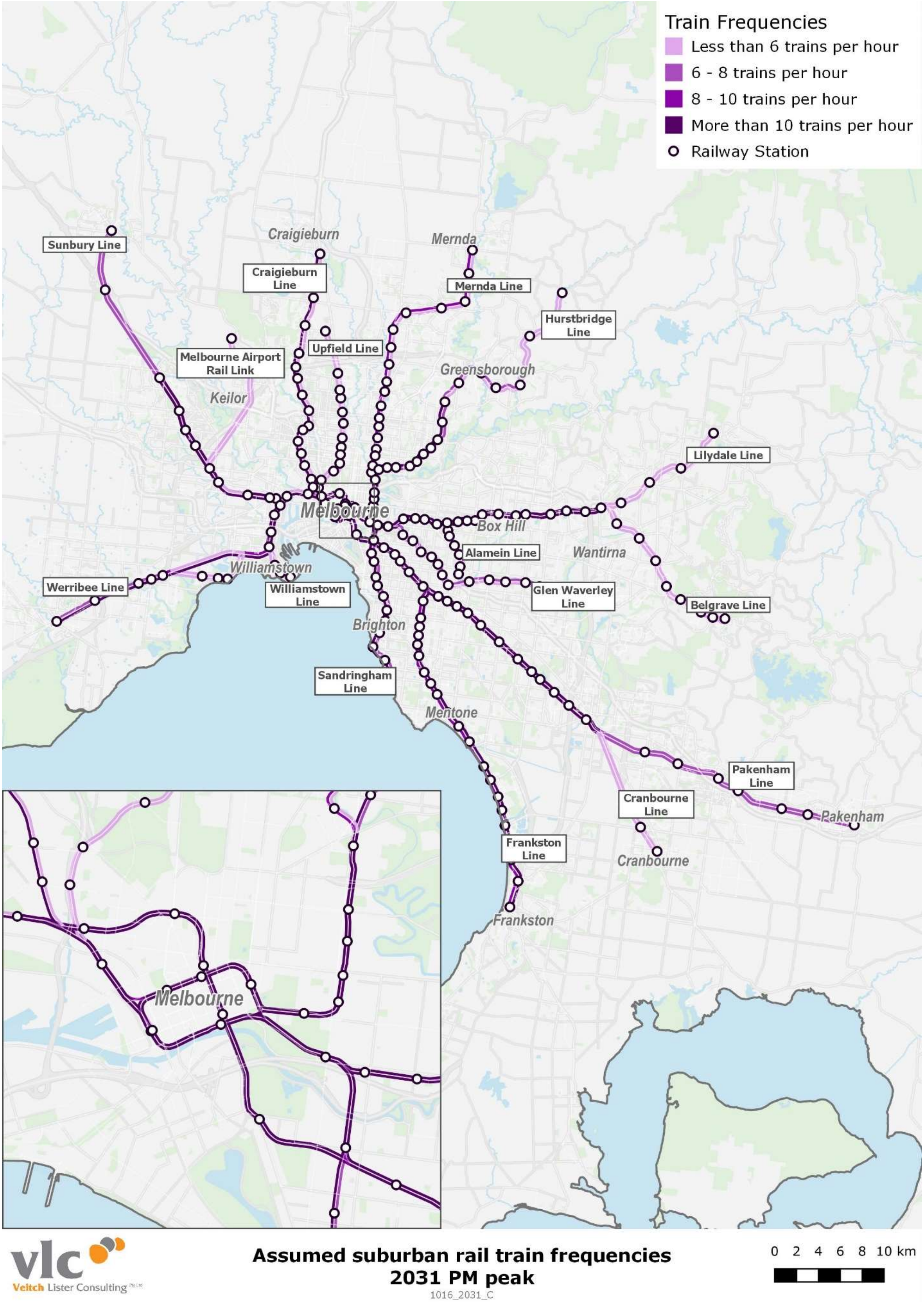


Source: Public Transport Victoria

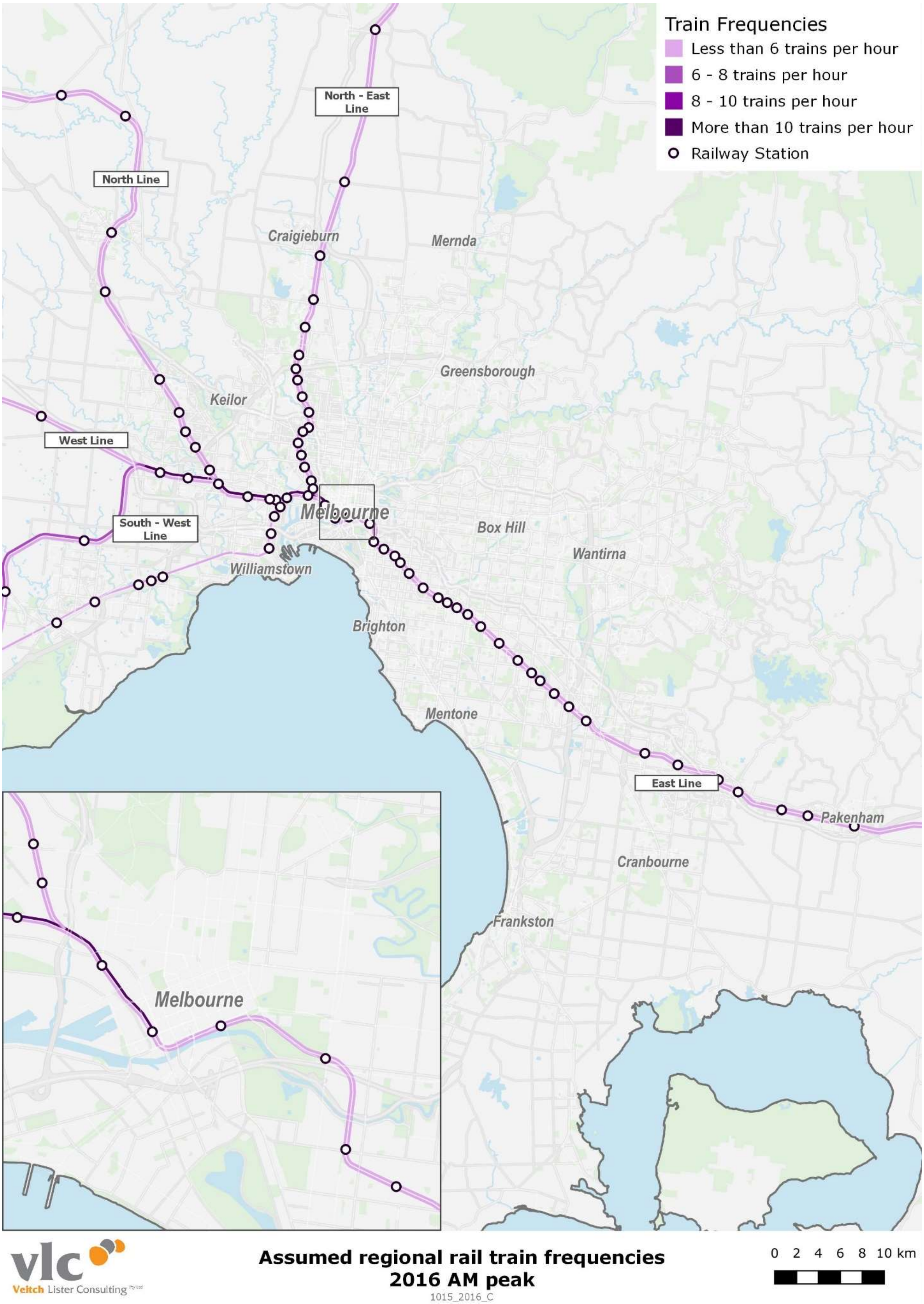
Appendix Figure B-7 – Melbourne GCCSA assumed metro rail frequencies - 2031 AM peak (7-9AM)



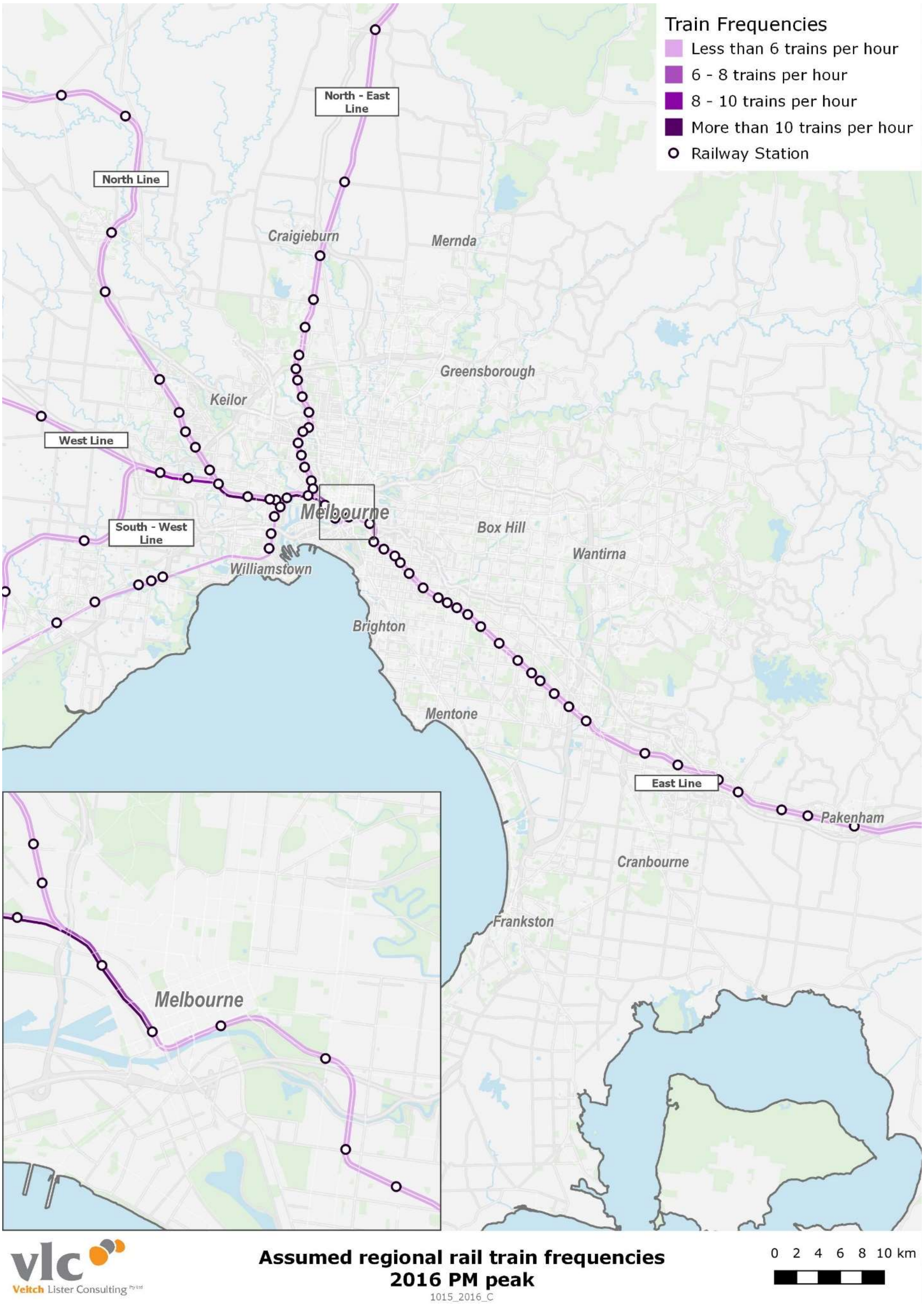
Appendix Figure B-8 – Melbourne GCCSA assumed metro rail frequencies - 2031 PM peak (4-6PM)



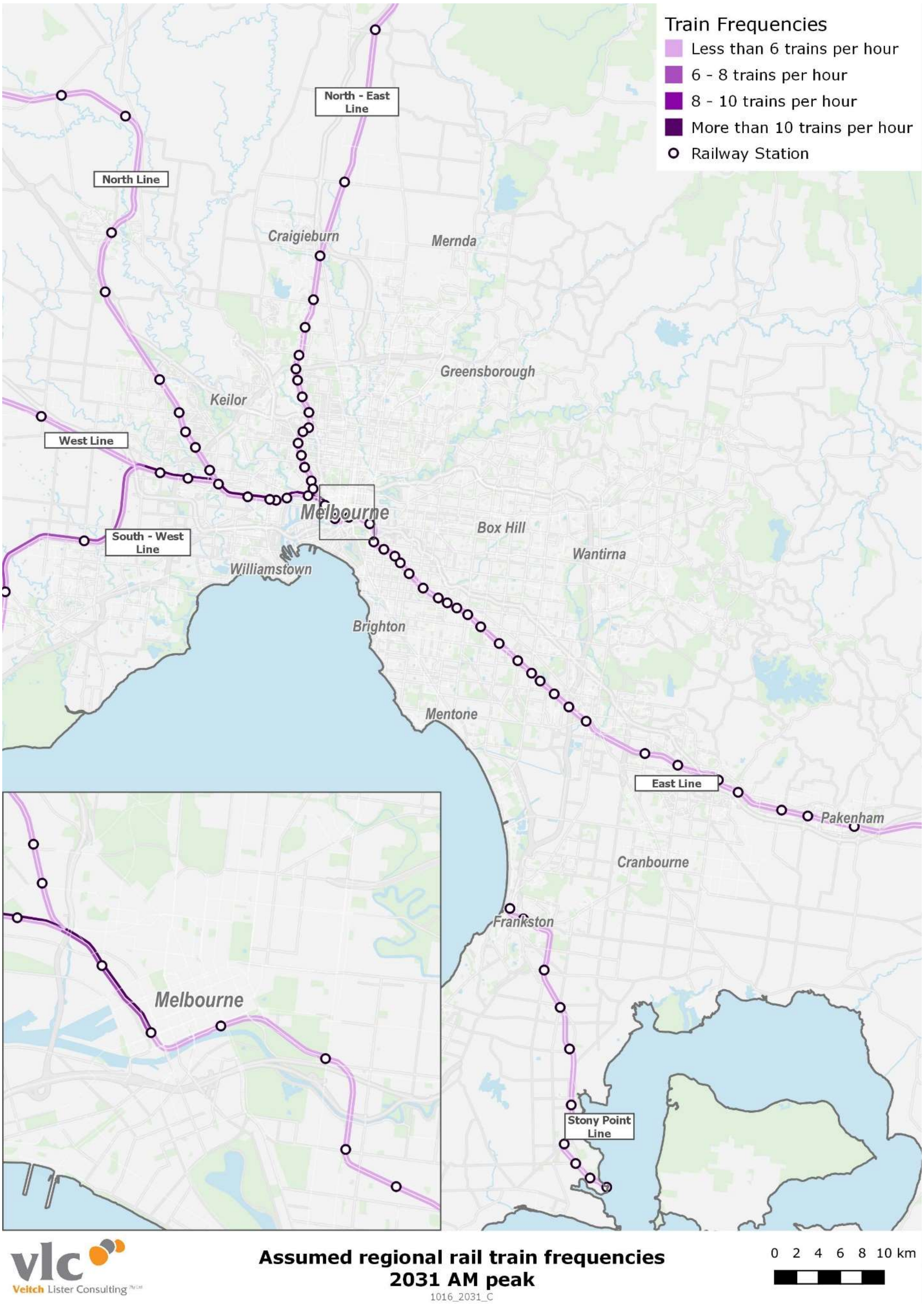
Appendix Figure B-9 – Melbourne GCCSA assumed regional rail frequencies - 2016 AM peak (7-9AM)



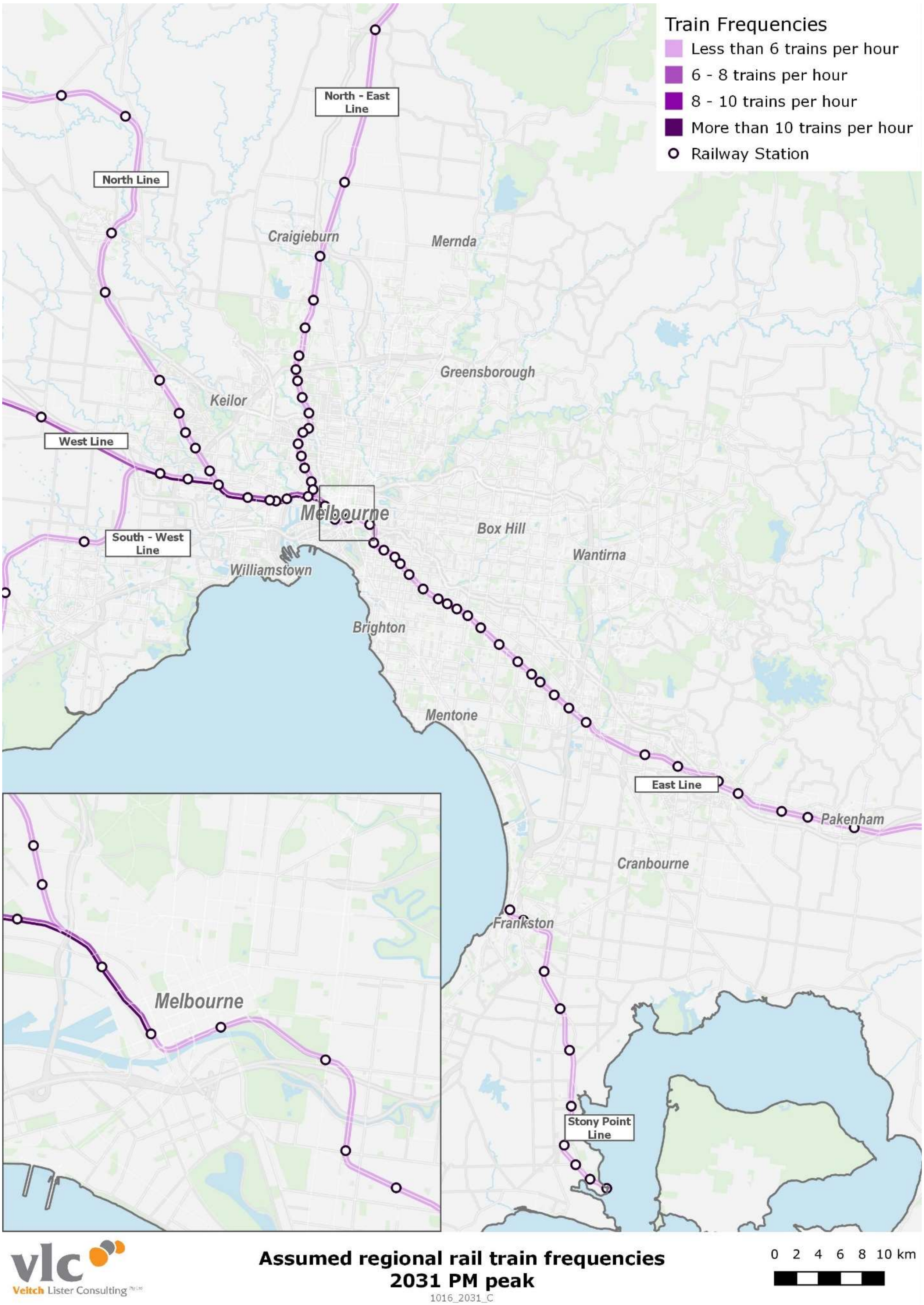
Appendix Figure B-10 – Melbourne GCCSA assumed regional rail frequencies - 2016 PM peak warnWodonga, Victoria (4-6PM)



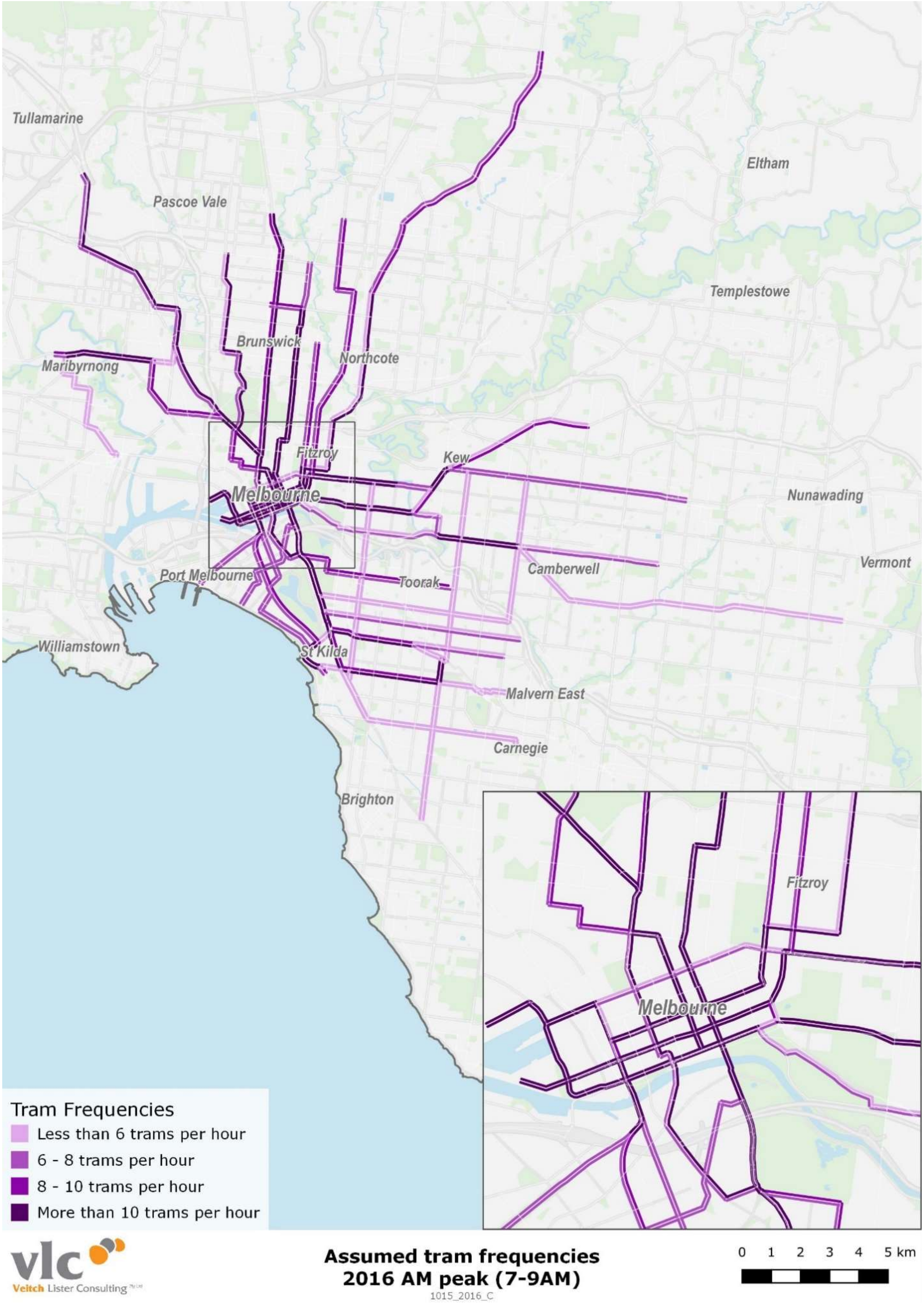
Appendix Figure B-11 – Melbourne GCCSA assumed regional rail frequencies - 2031 AM peak (7-9AM)



Appendix Figure B-12 – Melbourne GCCSA assumed regional rail frequencies - 2031 PM peak (4-6PM)

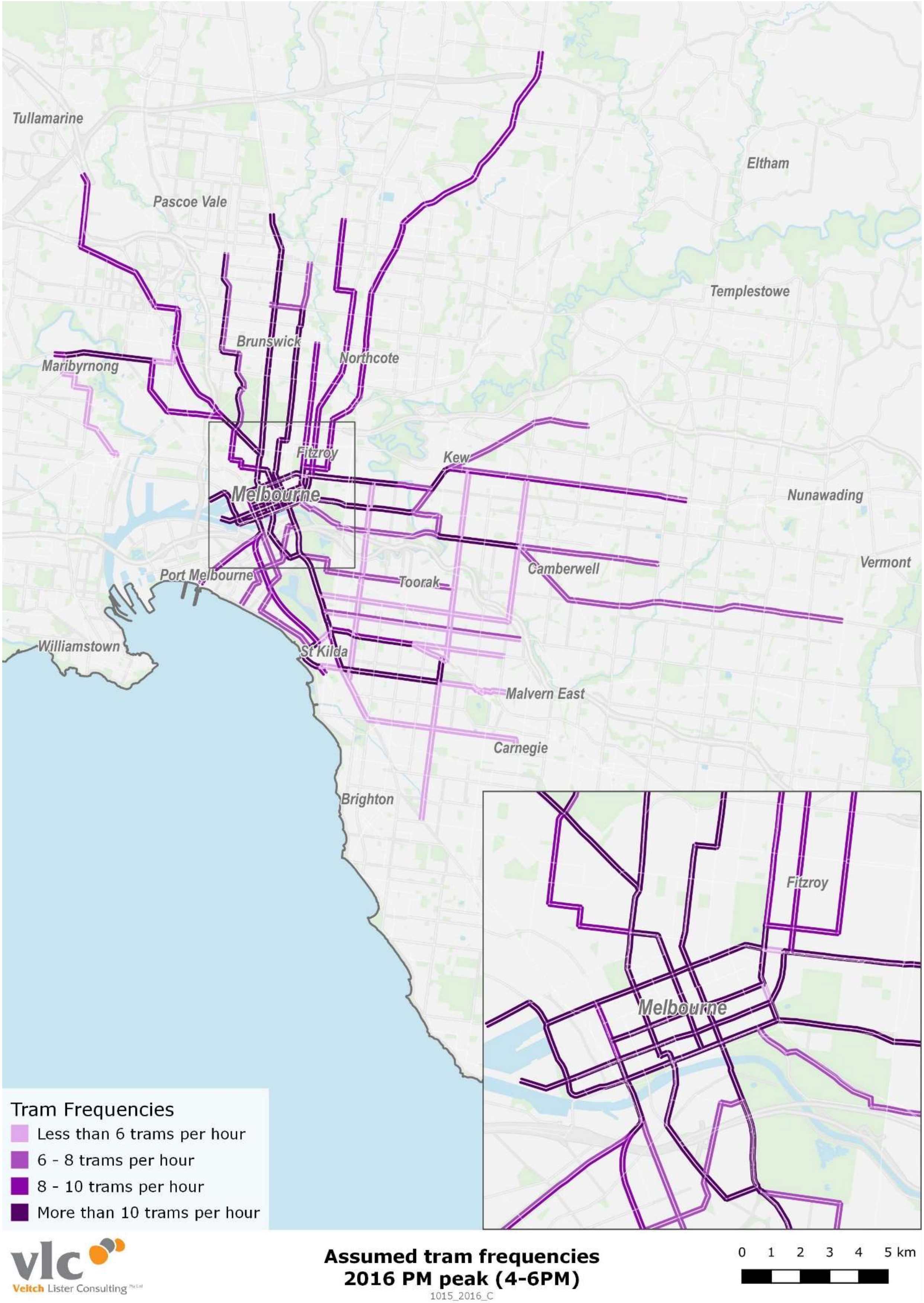


Appendix Figure B-13 – Melbourne GCCSA assumed tram frequencies - 2016 AM peak (7-9AM)



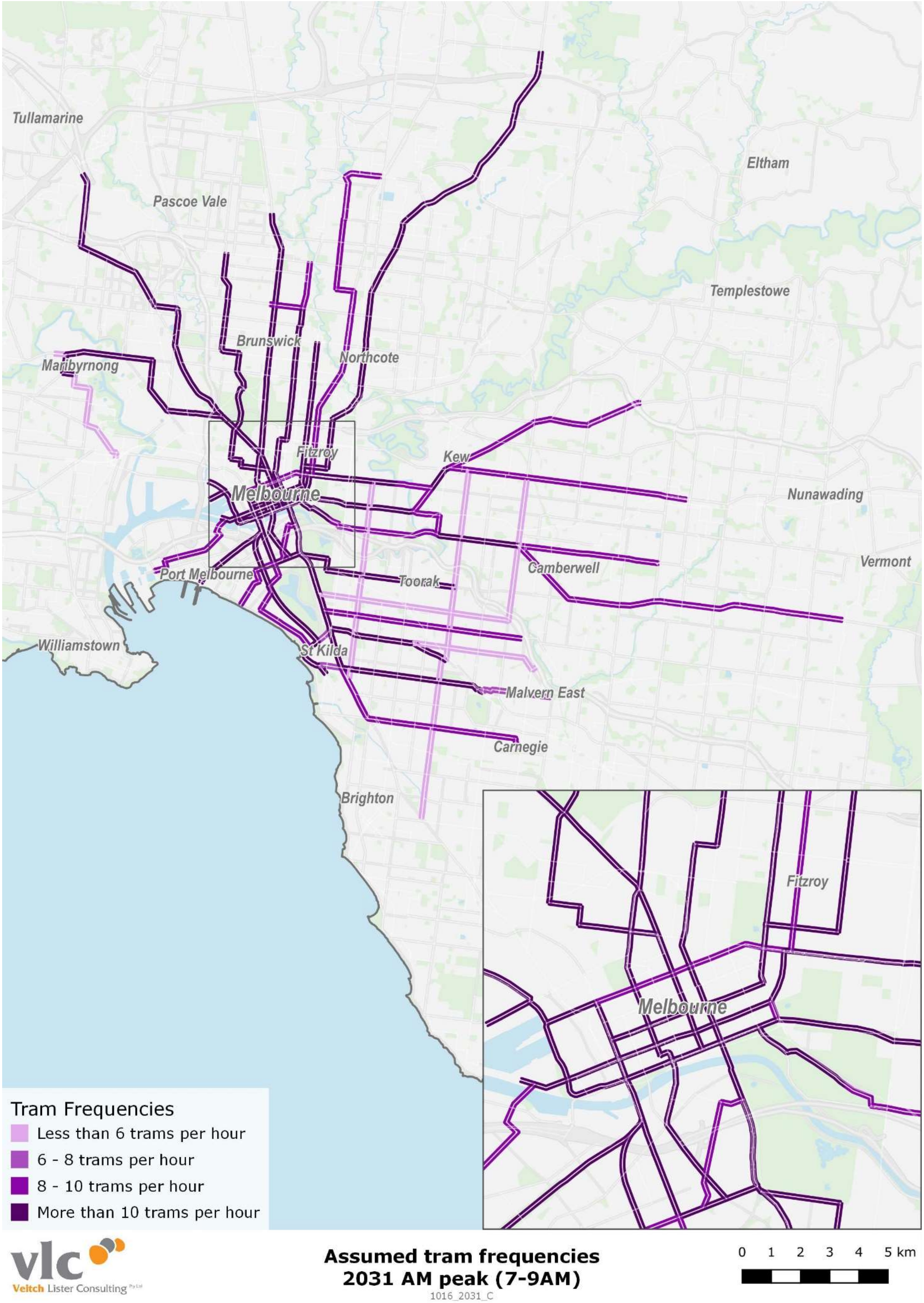
Source: Public Transport Victoria

Appendix Figure B-14 – Melbourne GCCSA assumed tram frequencies - 2016 PM peak (4-6PM)

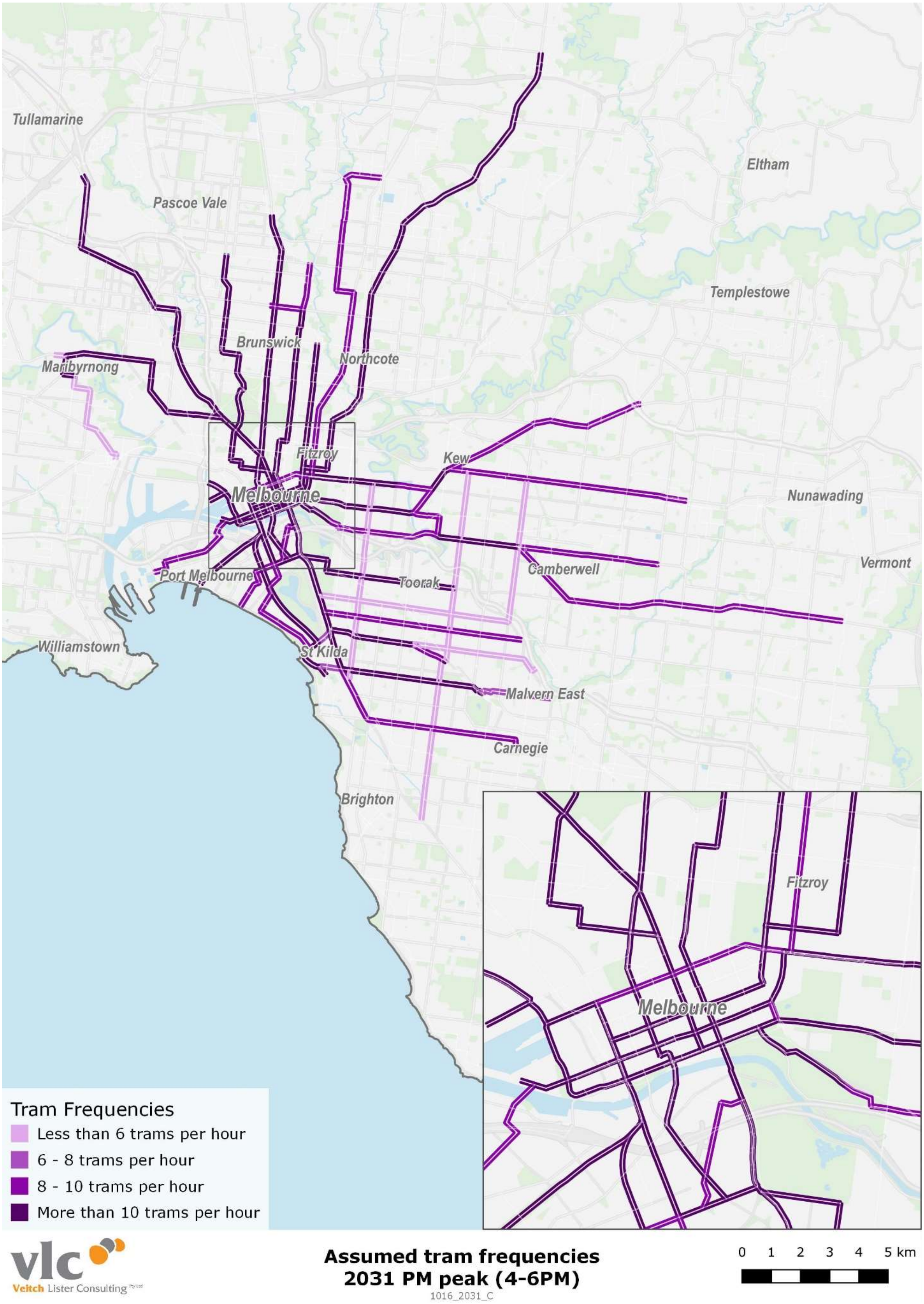


Source: Public Transport Victoria

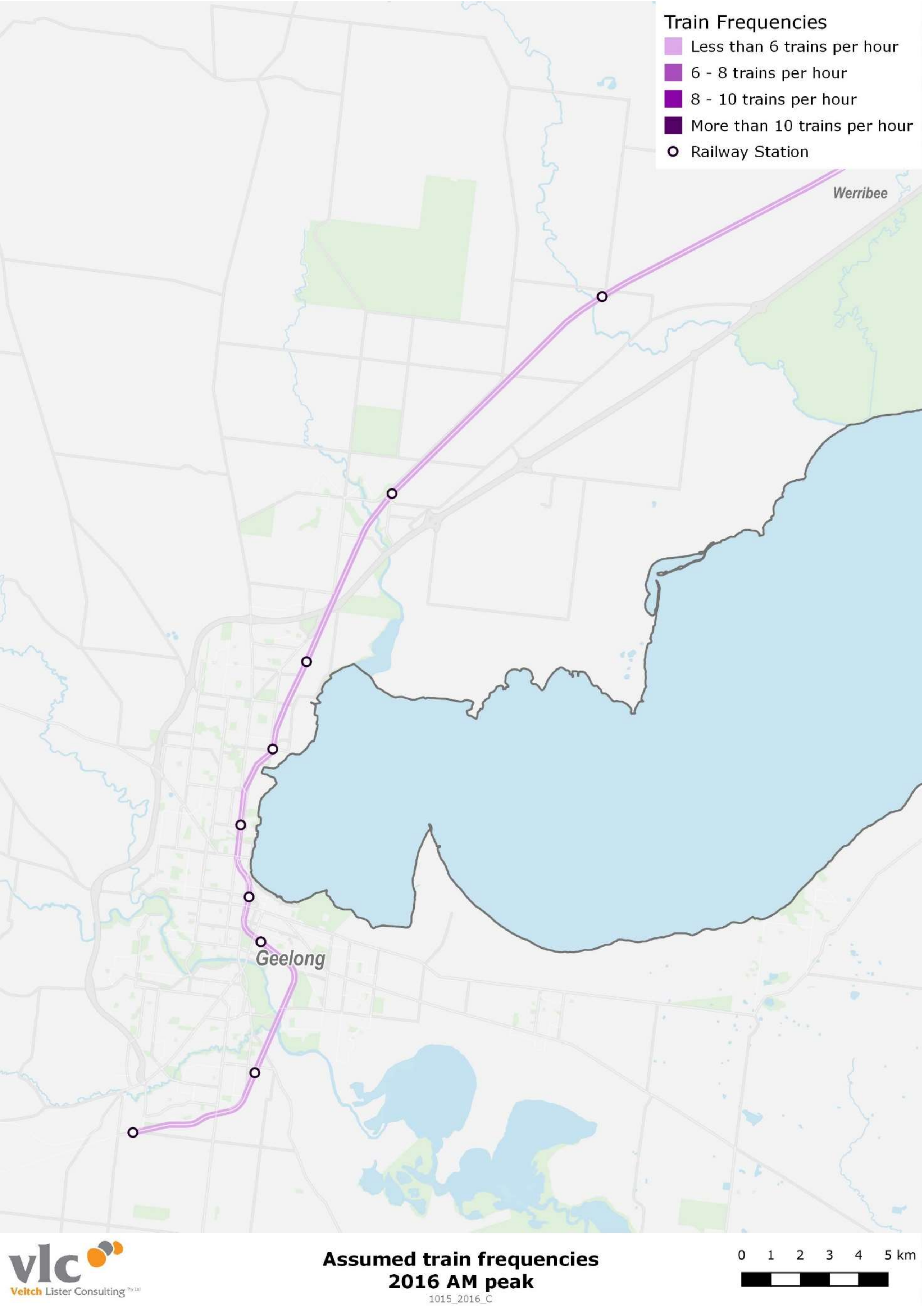
Appendix Figure B-15 – Melbourne GCCSA assumed tram frequencies - 2031 AM peak (7-9AM)



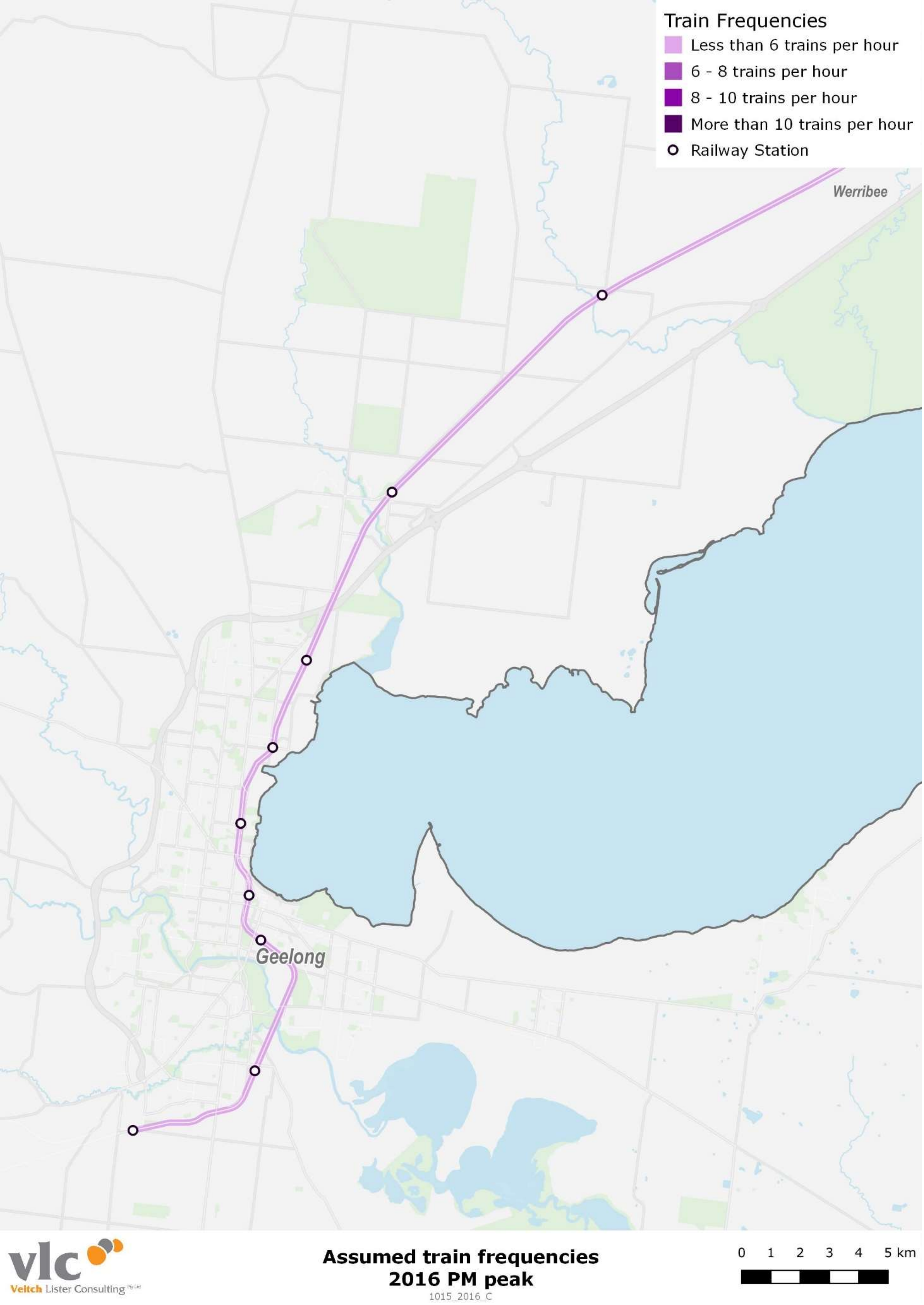
Appendix Figure B-16 – Melbourne GCCSA assumed tram frequencies - 2031 PM peak (4-6PM)



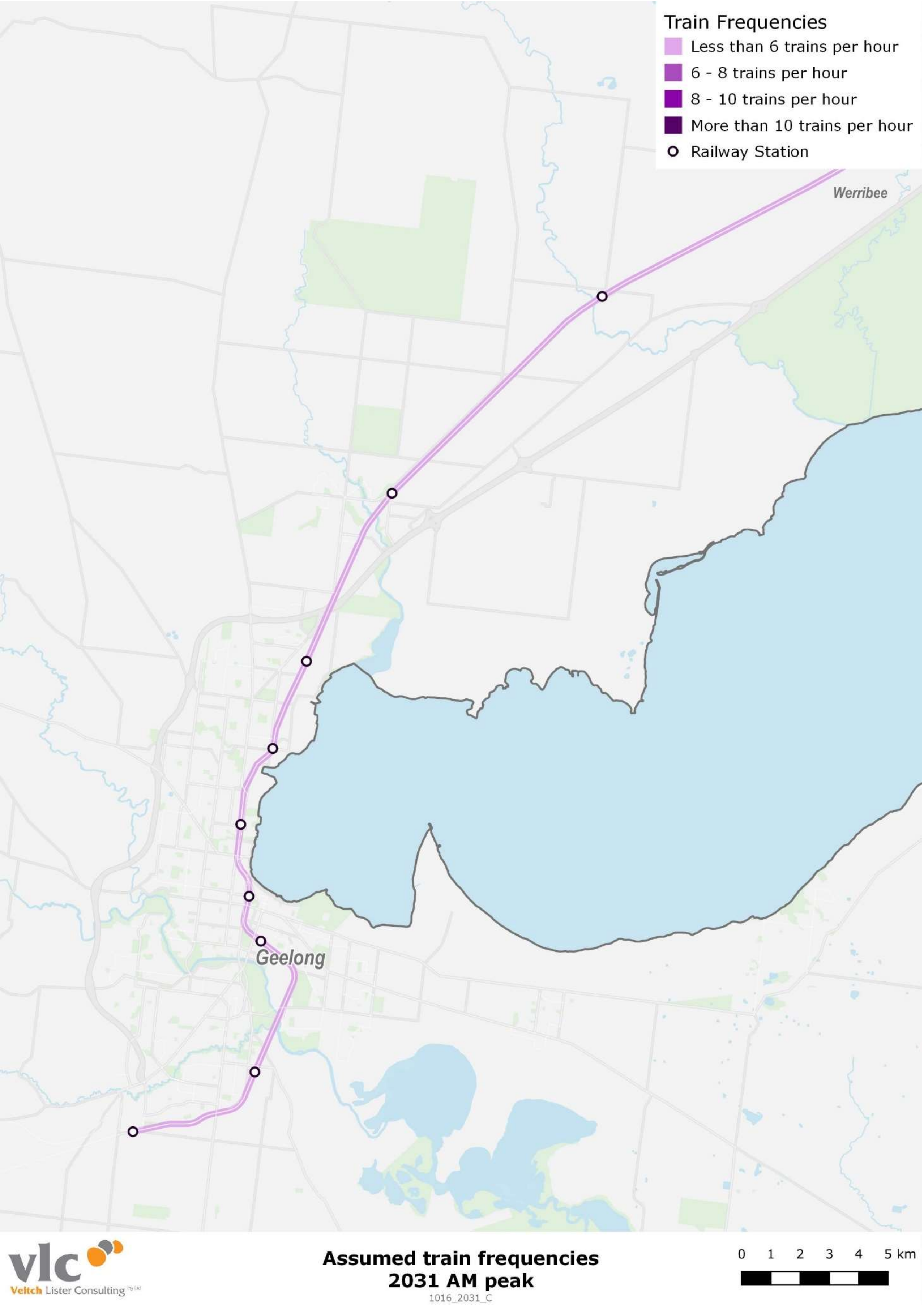
Appendix Figure B-17 – Geelong assumed regional rail frequencies - 2016 AM peak (7-9AM)



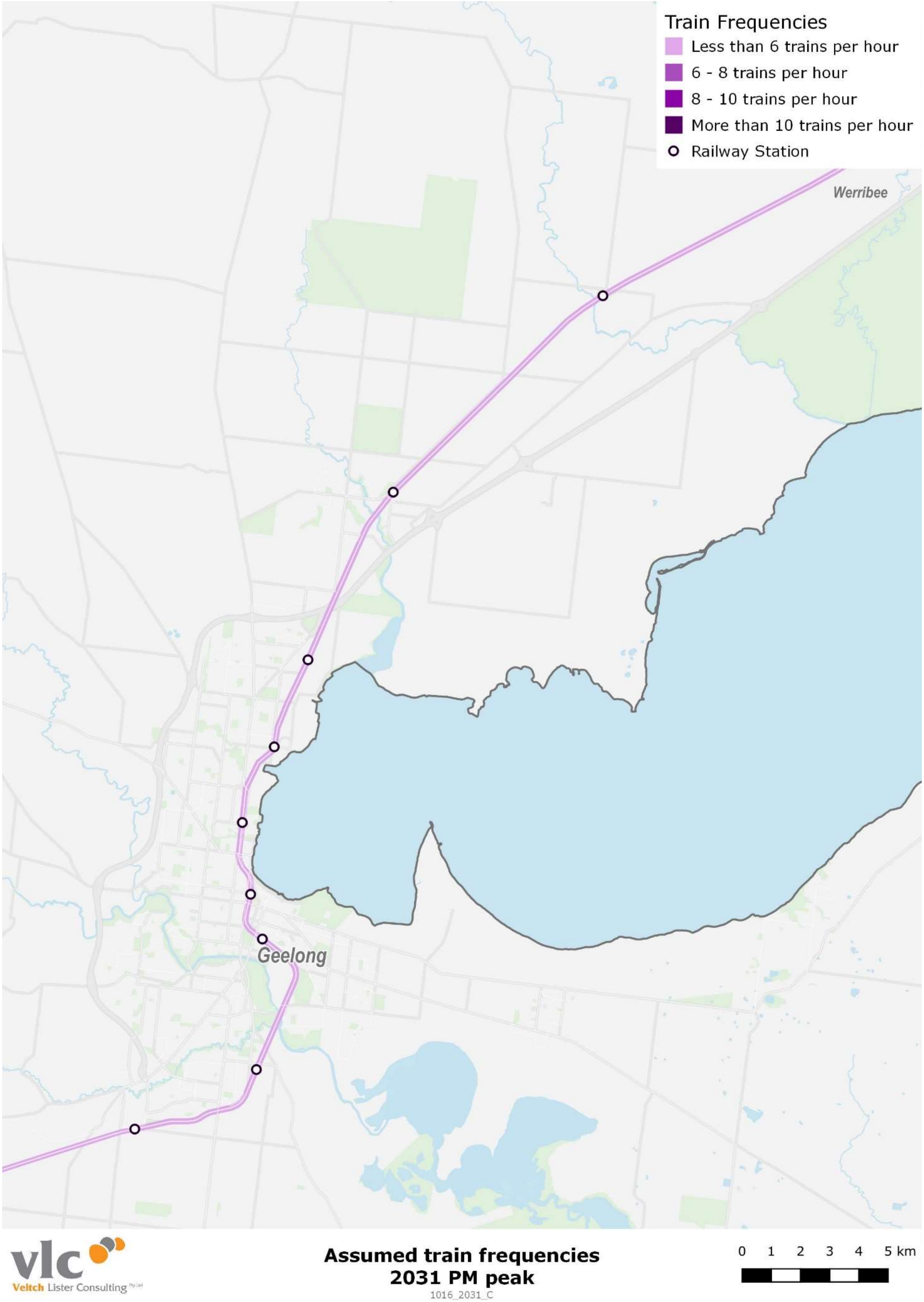
Appendix Figure B-18 – Geelong assumed regional rail frequencies – 2016 AM peak (4-6PM)



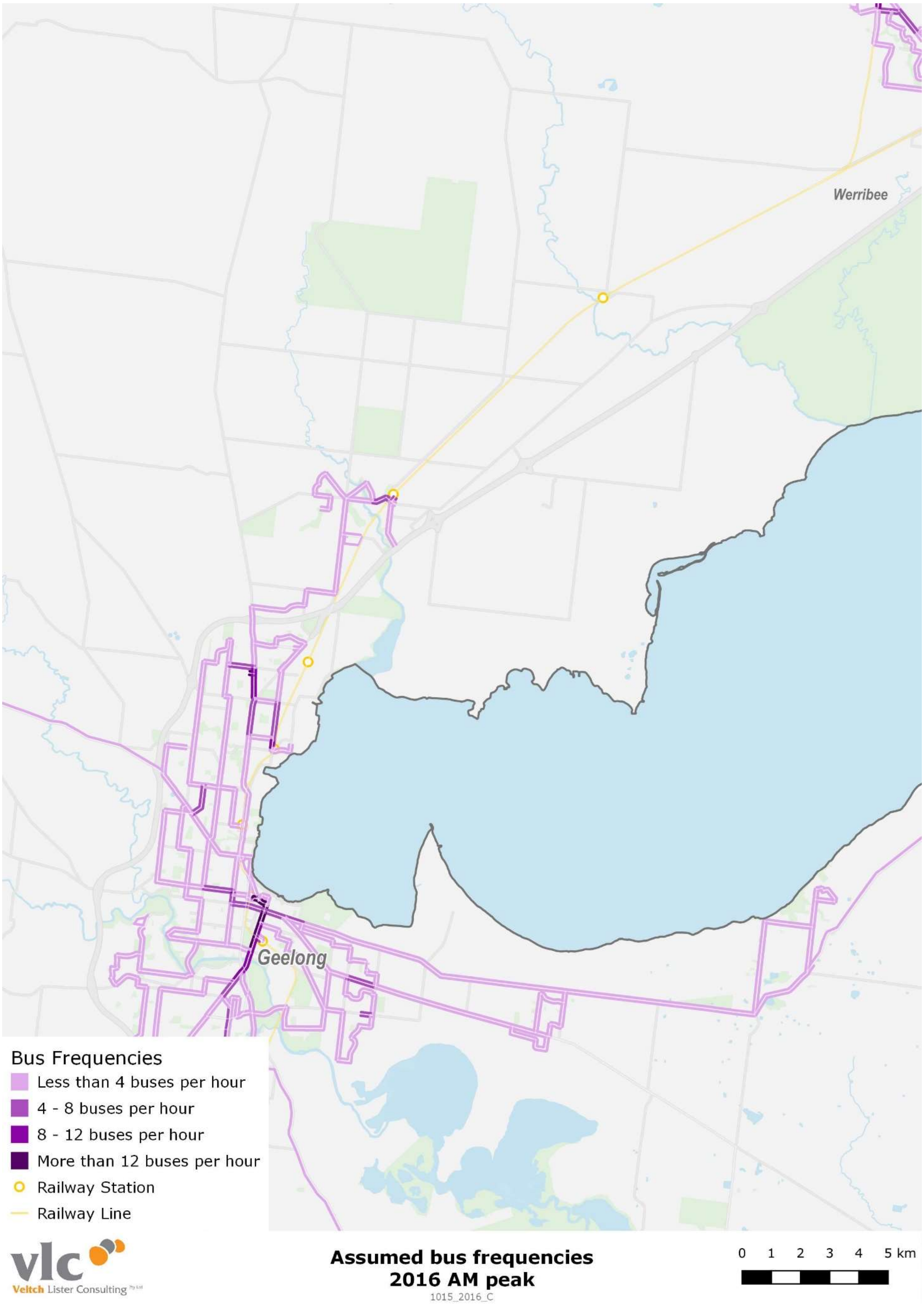
Appendix Figure B-19 – Geelong assumed regional rail frequencies - 2031 AM peak (7-9AM)



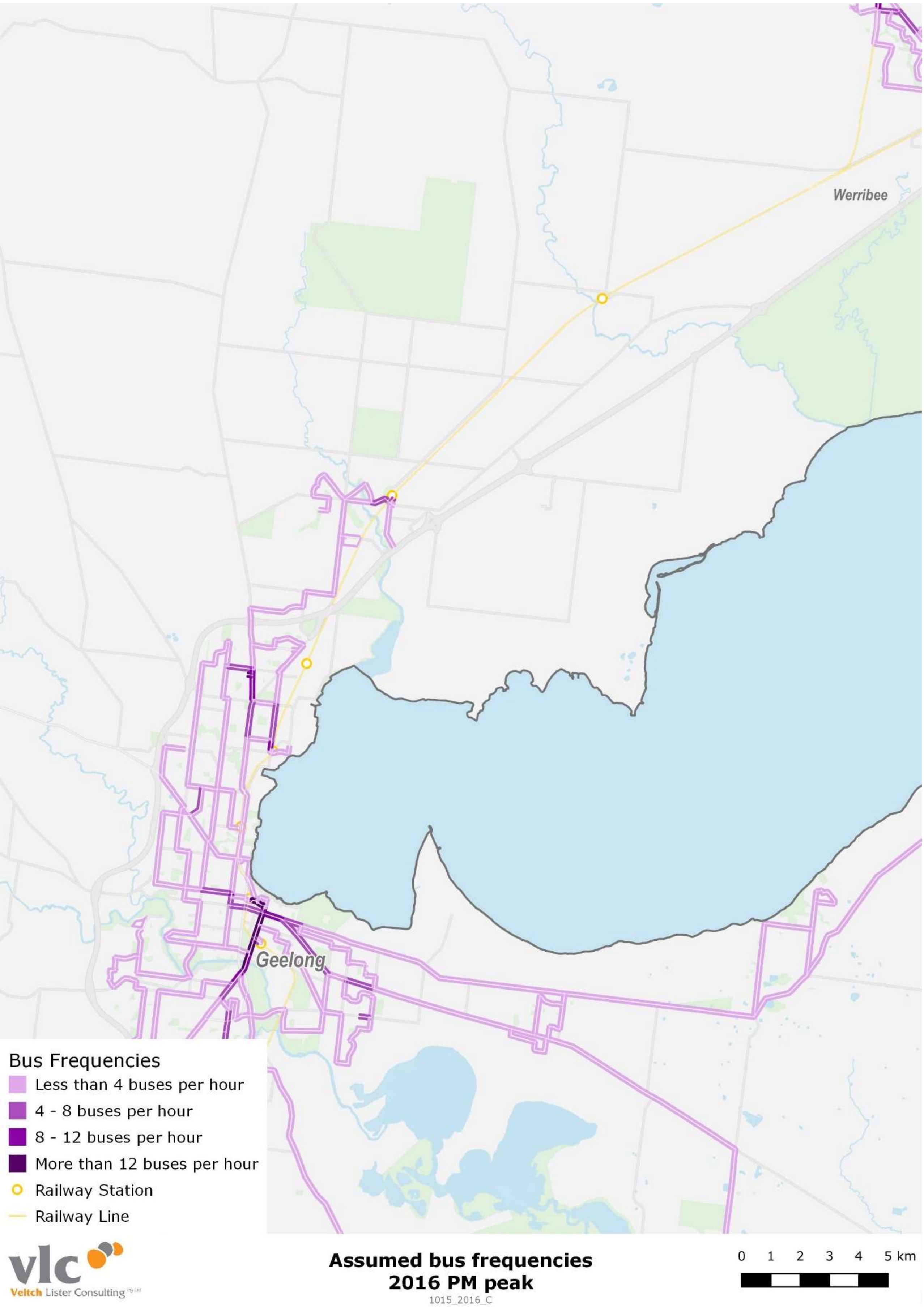
Appendix Figure B-20 – Geelong assumed regional rail frequencies - 2031 PM peak (4-6PM)



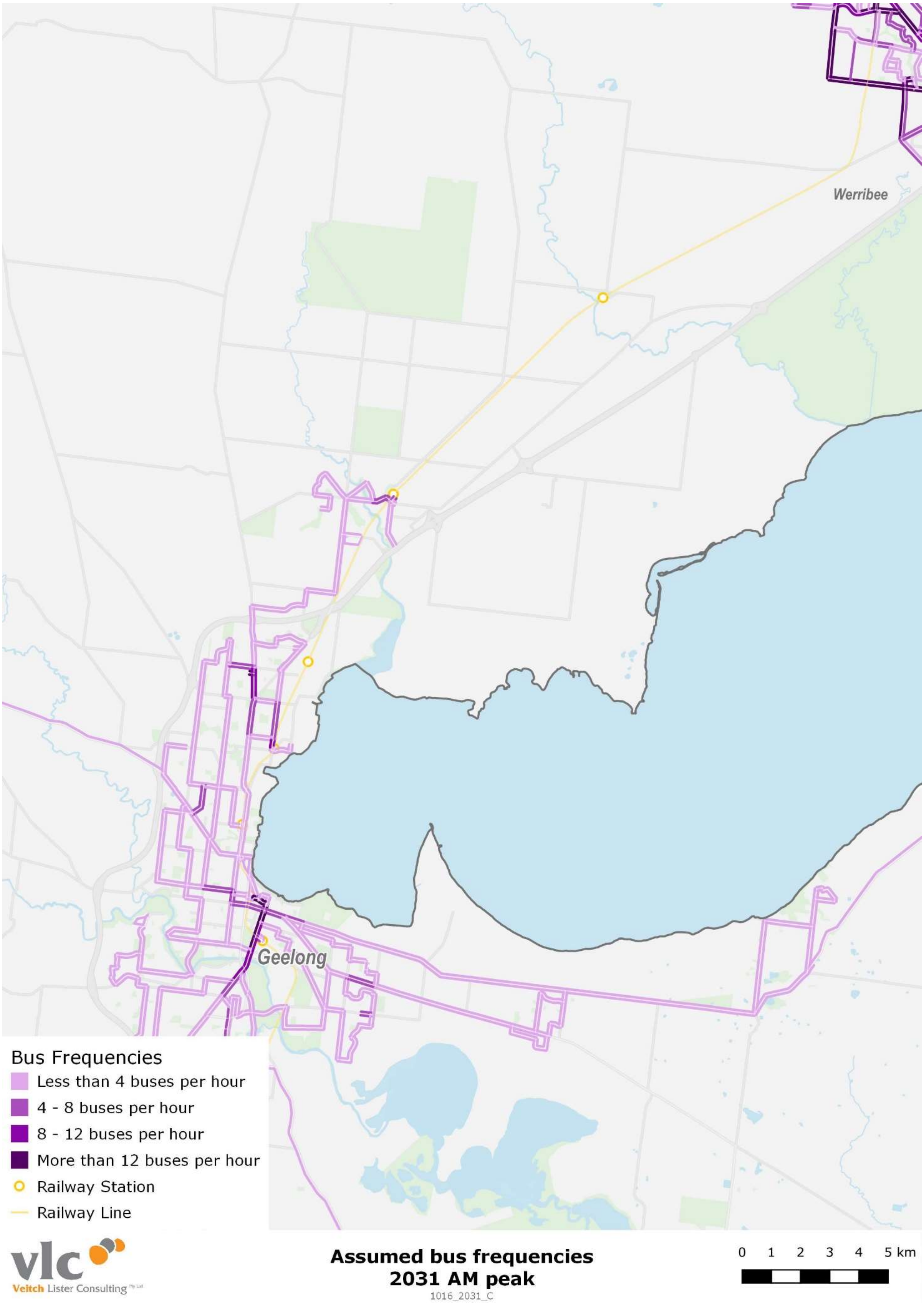
Appendix Figure B-21 – Geelong assumed bus frequencies - 2016 AM peak (7-9AM)



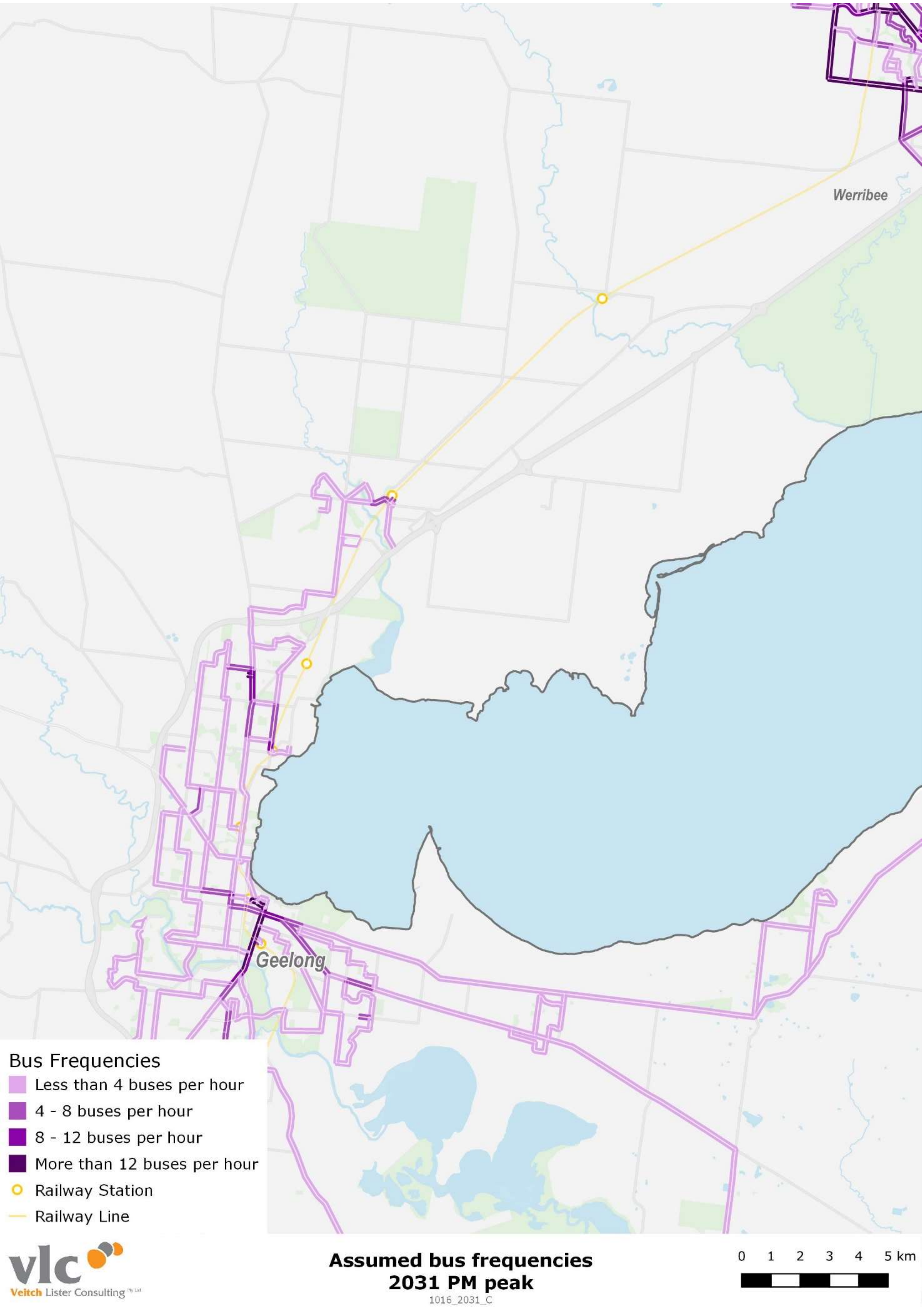
Appendix Figure B-22 – Geelong assumed bus frequencies - 2016 PM peak (4-6PM)



Appendix Figure B-23 – Geelong assumed bus frequencies - 2031 AM peak (7-9AM)



Appendix Figure B-24 – Geelong assumed bus frequencies - 2031 PM peak (4-6PM)



Appendix C: Melbourne Road Corridors

Appendix Table C-1 – Melbourne road corridors

Corridor number	Corridor name
1	Western/Metropolitan Ring Road
2	Western Freeway Corridor
3	West Gate/Princes Freeway Corridor
4	Geelong Bypass
5	Hume Freeway Corridor
6	Sydney Rd Corridor
7	Calder Freeway Corridor
8	Tullamarine Freeway (Airport) Corridor
9	Ballarat Rd Corridor
10	Geelong Rd Corridor
11	Docklands Hwy Corridor
12	Outer Metropolitan Ring Corridor
13	City Link Western Link
15	City Link-Eastern Fwy connection north of CBD
16	Eastern Fwy Corridor to Ringwood
17	Eastlink/Frankston Fwy Corridor
18	Mornington Peninsula Corridor
19	South Gippsland Highway Corridor
20	Inner Beach Suburbs Corridor
21	City Link Southern Link
22	Monash/Princes Fwy Corridor (Monash/Princes Fwy)
23	East-West Arterials - Eastern Suburbs (Heidelberg/Main Rd)
24	East-West Arterials - Northern Suburbs (Mahoneys Rd)
25 and 26	North-South Arterials - Northern Suburbs
27 to 30	East-West Arterials - Eastern Suburbs
31	North East Link (2031), Greensborough Rd/Rosanna Road (2016)

Appendix D: Model Assumptions

D.1 Purpose

This appendix sets out the overarching assumptions and methodology applied in our modelling. It also documents some of the city specific assumptions such as parking charges and public transport fares.

D.2 Modelling methodology

This section briefly describes the Zenith Travel Models developed by VLC and used to undertake all modelling for the Audit.

D.2.1 Development of the Zenith Travel Models

The Zenith models have been established through applying behavioural relationships calibrated from household travel surveys and validating these against traffic counts and public transport passenger surveys. These relationships have been updated on several occasions over the past 18 years. Zenith models operate using OmniTRANS, offering a versatile and interactive platform for multimodal transport planning. The platform also adds value in the presentation and discussion of patronage forecasts.

The models simulate all travel undertaken by households and firms, and visitors to the region during an average weekday in each forecast year. Given a scenario of land use and demographic change, the models reflect the level of participation in a range of activities across the region and the frequency of travel to them, as well as the choice of destination, mode and route.

The models are unique in their ability to reflect access to public transport, which is a key influence on accessibility in Australian cities, and in reflecting the travel choices made by their residents and visitors.

Many of the parameters of the multimodal model have their genesis in the calibration of the Zenith model of Melbourne in 1995, which made extensive use of the Victorian Activity and Travel Survey (VATS) database. When household travel surveys later became available in other regions, this provided the opportunity to revalidate the regional models against local data and to recalibrate selected sub-models and market segments where appropriate to better reflect behaviour specific to each region.

VLC is continually undertaking research and development to ensure the Zenith models remain at the forefront of transport planning practice and incorporates evolving state-of-the-art techniques when it is appropriate to do so. All of the data sets underpinning the models are reviewed frequently and maintained to be consistent with the latest information available.

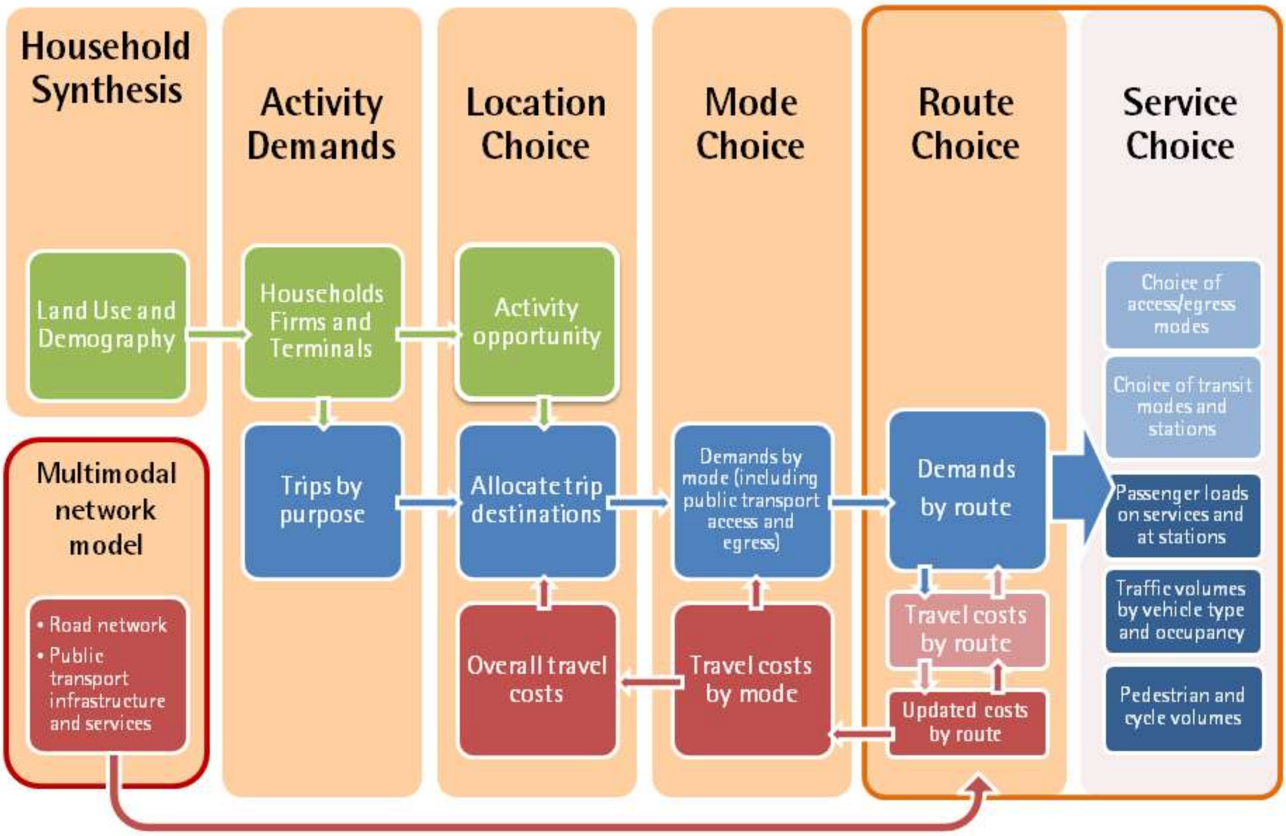
D.2.2 Model Architecture

The prime objective of Zenith is to provide a planning tool to support the evolving policy issues of relevance to planners and government. This is accomplished through replicating the demand for travel by residents and visitors in the modelled region, which is derived from the demand for participation in activities. Travel choices may differ depending on the activity for which the travel is undertaken. The nature of the activity may influence the frequency, timing and duration of participation, the location, as well as the mode of travel and in some cases, the route chosen.

The Zenith travel demand model simulates the travel behaviour of households, firms and visitors within the modelled region associated with their participation in the range of activities described above. The model makes use of information that is available to describe the potential demands for these activities in each location, such as statistics on employment in various industries, enrolments at educational facilities, and demographic variables such as population and households.

The key stages of the Zenith model process are illustrated in Appendix Figure D-1.

Appendix Figure D-1 – Key Stages of the Zenith Models



Each region is divided into several thousand travel zones, providing a high degree of resolution for forecasting movements between suburbs and across the city. A large range of demographic, socioeconomic and land use variables are used to identify the types of households and range of activities in each zone.

The model forecasts the number of trips made for work, education, shopping, personal business, recreation, social and “other” journey purposes (why travel?). It simulates the decisions made by households regarding the time period (when?), destination (where?) and mode of travel (how?) for each trip, with models developed from surveys of travel behaviour undertaken in each region.

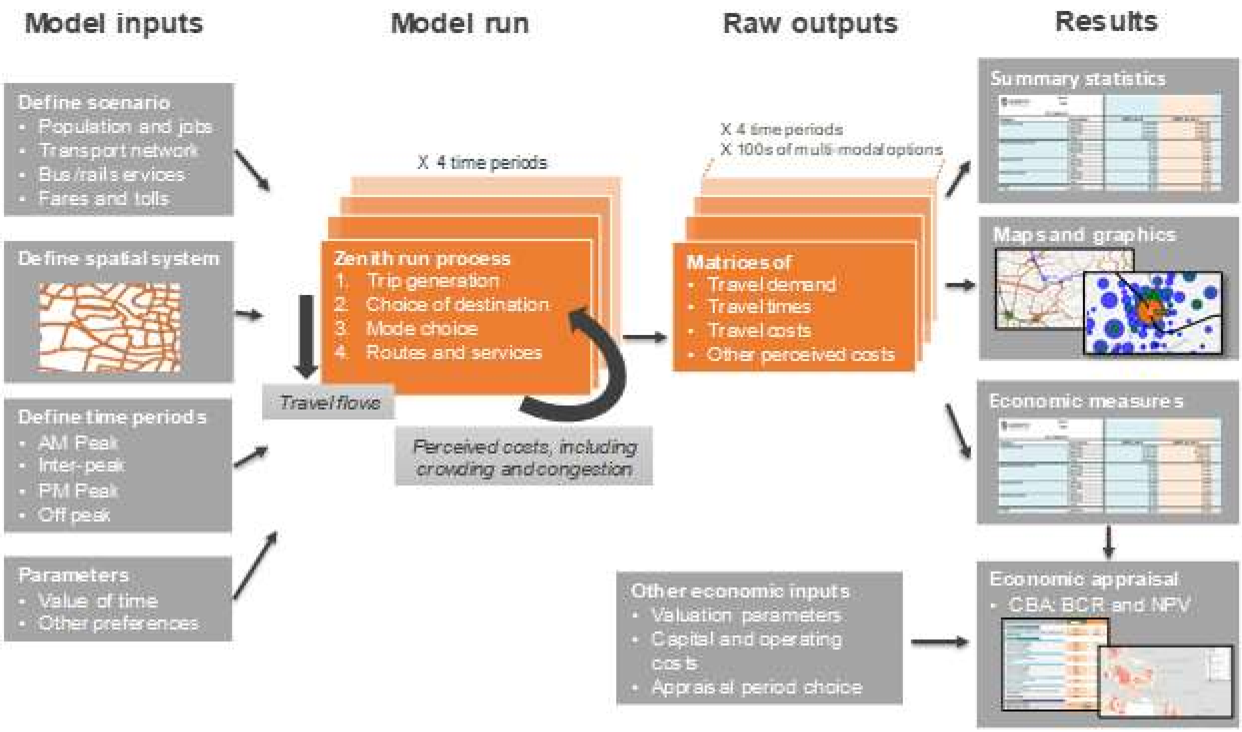
Having determined the destination and mode of travel, the model then reflects the choice of route for trips by private or commercial vehicle, public transport and active travel modes such as cycling and walking.

The more fine-grained the travel zone system, the more accurate travel forecasts have the potential to be. This is particularly the case on parts of the road network with lower traffic volumes, and on public transport services, as smaller zones capture vehicle movements on lower-order roads used to reach major arterials, and more closely reflect walking distances to the public transport stops.

D.2.3 Model process

The practicalities of establishing and running a given forecast year scenario are described in Appendix Figure D-2. For a given set of infrastructure and services assumptions, inputs are devised and entered into the Zenith user interface, the model is run, raw outputs are produced, and finally a range of detailed results are prepared.

Appendix Figure D-2 – Scenario testing with the Zenith model



Model inputs

- Define scenario – the distribution of population and employment in the forecast year, the nature of the transport network (including any upgrades assumed) as well as all of the service attributes (such as tolls, fares and service frequencies) must each be set.
- Define spatial system – the zone system determines how wide the model's coverage will be (generally the greater metropolitan area), how disaggregated the representation of the area will be in the model (number of zones), and which areas have more or less detailed representation (e.g. disaggregated zones in the corridor under consideration). In general, major capital cities are modelled In Zenith with between around 2000 and 4500 zones. More zones gives greater detail (for example for people choosing whether or not to walk to train stations), but requires longer model running times.
- Define time periods – some models only consider a single period of a weekday. Zenith applies a four-period breakdown of the weekday, with the actual hours distinguishing the AM and PM peaks potentially varying depending on local travel conditions.

- Input parameters – a range of behavioural parameters define the trade-offs people in the model are assumed to make, for example the trade-off between travel time and out-of-pocket spending is represented by the value of time. These parameters are estimated to best reflect existing travel behaviour.

Model run

The process of the Zenith model's operation is described in some detail in the remainder of this document. From the perspective of running a single model scenario, the most important feature is the iterative nature of the estimation of travel costs and travel demand. The model attempts to find an 'equilibrium' set of costs and demands for a wide range of travel modes, routes and services. Through making increasingly small adjustments to variables it converges towards the most consistent set of costs and demands for each period of the day.

Raw outputs

The key outputs of the model run are the equilibrium travel costs and travel demands for each origin-destination pair across each period of the day and each travel mode. Given the number of alternative travel options (e.g. walk to rail station 1, bus to rail station 2, car driver, car passenger, etc.) and the number of origin and destination zones, the resulting data is a very large number of matrices ('trip tables' and 'cost skims').

Results

The raw outputs can be adapted to any range of output formats to understand the implications of the modelled scenario, including tables, graphs, static maps and interactive maps. Common measures are total travel time, total vehicle kilometres (by road and vehicle type) and travel time spent in crowded public transport vehicles. Transport network performance measures can be estimated on a stand-alone basis or comparing scenarios across time (time series), across options (comparative), and between with and without-project (incrementally). Outputs can also be further processed to understand the incremental economic benefits of a 'with project' scenario compared to a 'without project' scenario for use in cost-benefit analysis, either within Zenith's economics module or with third-party economics spreadsheets.

D.3 Model inputs

Many of the model inputs described in Section D.2.3 above are specific to each modelled city and will be dealt with in the respective Technical Appendixes. However, there are a number of inputs that have been agreed with Infrastructure Australia and harmonised across all six major city Zenith models. These are assumptions to do with travel costs, technology and the approach to the value of travel time.

D.3.1 Travel costs

Fuel price

There is a range of influences on the unit cost of fuel consumed in urban transport, which can be affected by global and local conditions. The most significant influences on the costs of fuel include:

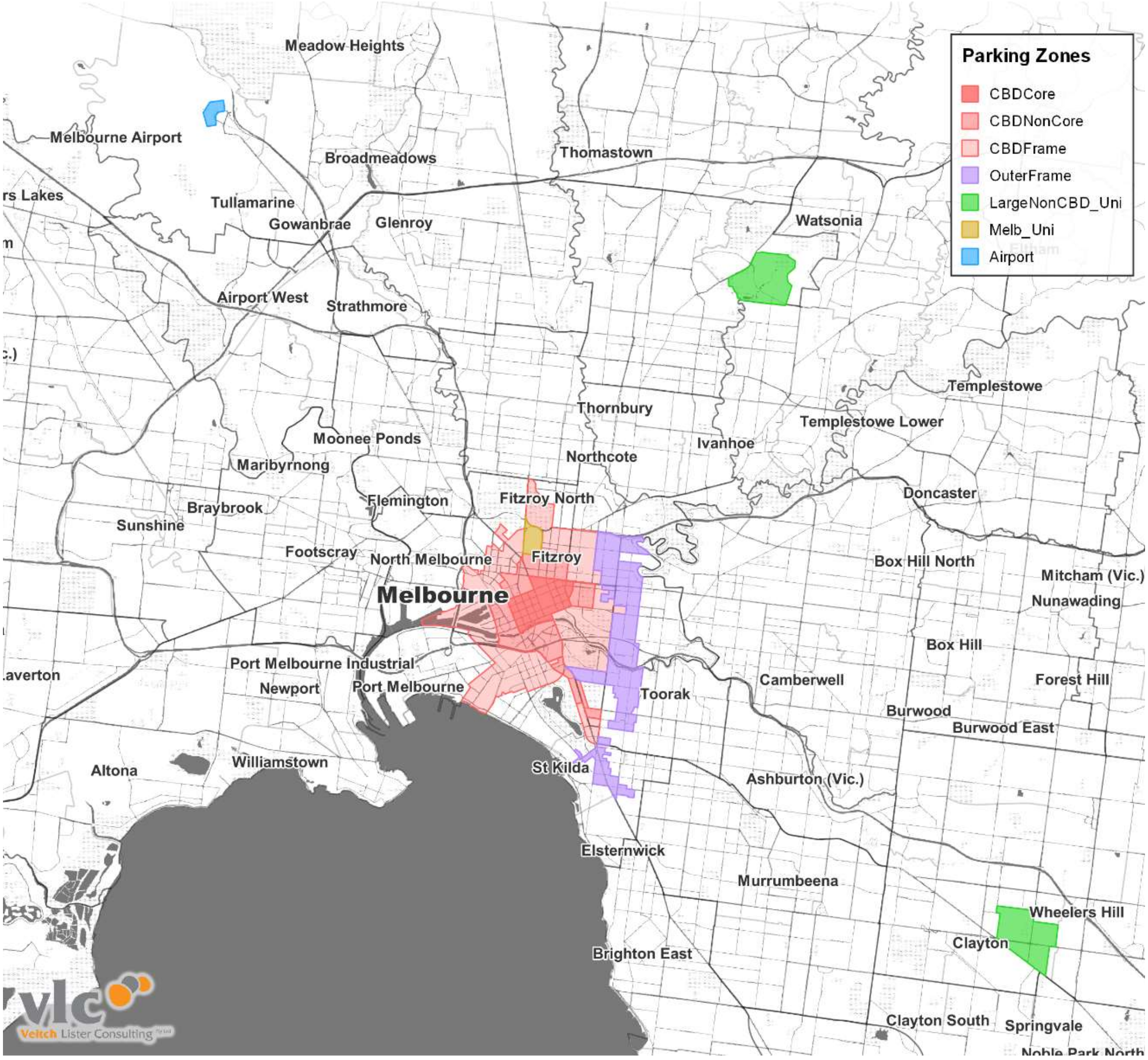
- real increases in the price of transport fuels; and
- reduction in the rate of fuel consumption due to improved vehicle efficiency and increased use of more efficient fuels within the vehicle fleet.

These two factors act to counter each other, and with insufficient evidence to indicate which will dominate in future, may well result in no real change in the average unit costs of fuel. For this work, it has therefore been assumed no real change in the unit of costs of fuel in future (i.e. fuel prices change in line with the Consumer Price Index - CPI).

Parking costs

A real annual increase of 1.5 per cent (i.e. above CPI) in parking charges is assumed. The intention is to represent the strong pressures on price arising from increasing demand and constrained supply of parking in the CBD and major activity centres, as well as the non-linear increase in price associated with moving towards more parking structures rather than surface parking. This is consistent with the assumption applied for the modelling in the first Infrastructure Audit. The parking zones used in the modelling are illustrated in Appendix Figure D-3.

Appendix Figure D-3 – Melbourne parking zones



Tolls

Tolls on existing affected roads in Melbourne have been assumed to grow in line with CPI. There are two new toll roads included in the 2031 network, with the following assumptions:

- North East Link: charges are consistent with the per kilometre toll on East Link
- Western Distributor: charges reflect what has been published in the project's business case

Public transport fares

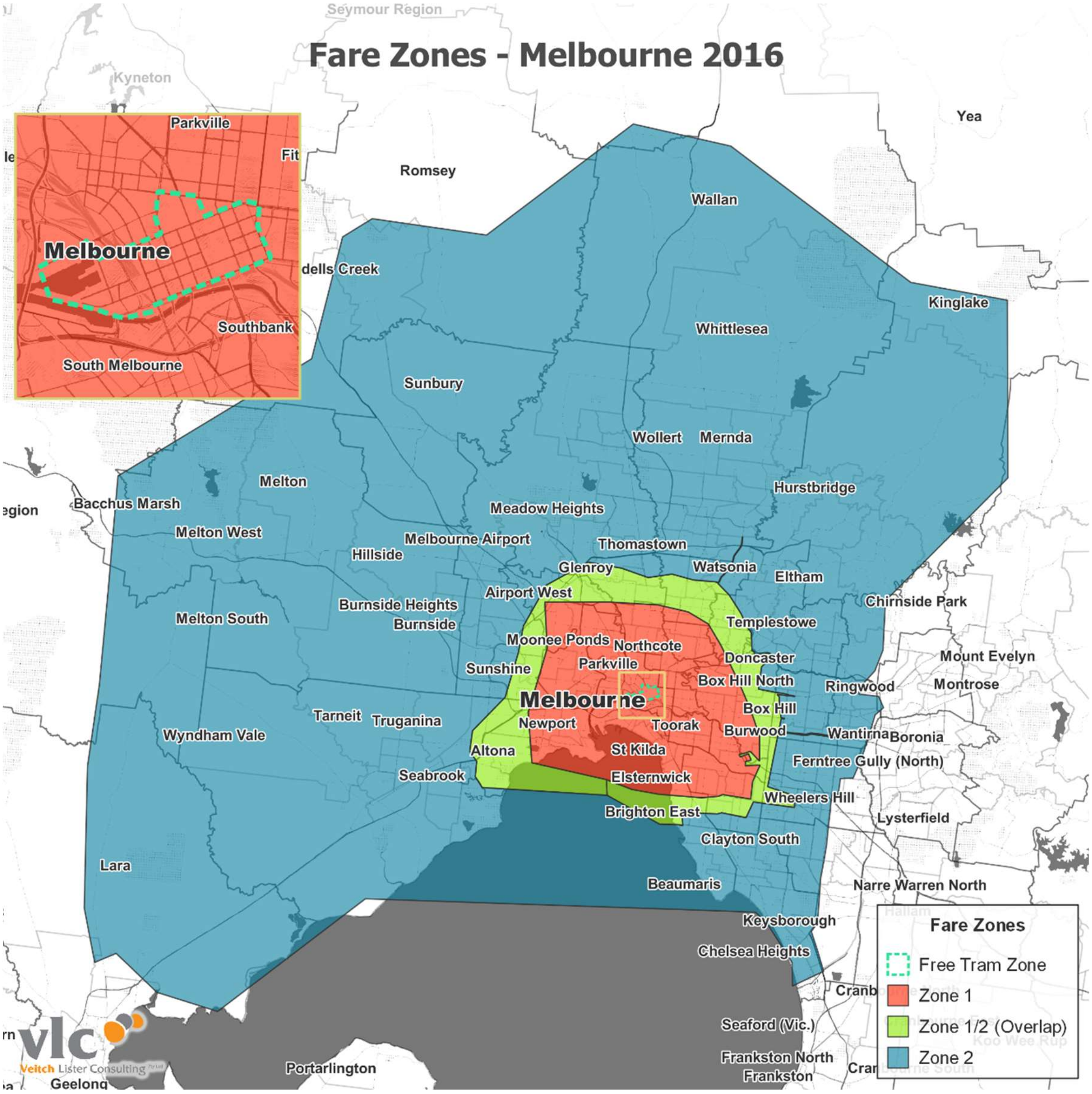
While any observed increases in the cost of public transport fares between 2016 and the time of modelling in 2018 have been factored into all future scenarios, beyond 2018 fares have been assumed to grow in line with CPI. The public transport fares and costs have been documented in Appendix Table D-1 – Public transport costs and fares.

The spatial definition of fare zones changes between 2016 and the forecast scenarios. These are illustrated in Appendix Figure D-4.

Appendix Table D-1 – Public transport costs and fares

Public Transport Cost Parameters		Zenith
Public Transport VOT, 2016 (AUD 2008)		$12 / hour
Public Transport Fares, 2016 (AUD 2008)	Zone 1 and 1 + 2	2.37
	Zone 2	1.67
	Zone 1/2 (overlap)	2.37 if travelling to zone one 1.67 if travelling within zone1/2 or to zone 2
	Free tram zone	Free only for tram trips within the free tram zone. Any other public transport mode trip is charged as zone 1 + 2

Appendix Figure D-4 – Public transport fare zones, 2016



D.3.2 Technology uptake

While transport models are useful planning tools, they are also limited in that they are estimated and calibrated based on historical survey data. There are numerous exogenous factors, particularly changes in technology, that are difficult to predict and quantify. These changes include:

- Electric vehicles;
- Shared mobility business models
- Driverless vehicles;
- Home deliveries; and
- Telecommuting.

Due to uncertainty around how these technologies might change how people travel, the current uptake of each is assumed to continue into the future modelled years.

D.3.3 Value of travel time

There are two approaches to the value of travel time: a 'behavioural' value that is relevant in trying to accurately predict how different market segments will respond to travel options, and an 'economic' value that is relevant for measuring community impacts of travel time. This section relates to the behavioural values used in modelling. Section D.4.1 discusses the relevant values for estimating economic costs of crowding – these values reflect equity values (ensuring infrastructure investment is not focused on areas with high incomes) and resource values (where travel time has real economic opportunity costs, e.g. due to people travelling during the course of their paid work).

The behavioural value of time spent travelling and its influence on travel behaviour depends on a range of factors, such as the reason for travel, and the use to which the time might otherwise be put. The modelling of travel choices reflects preferences that imply different values of travel time for each trip purpose and for each mode of travel, including walking and waiting associated with using public transport and the use of toll roads.

These behavioural values of time are indirectly estimated for each journey purpose and city travel market through the model estimation process (i.e. statistically estimating the model parameters that best describe traveller choices from household travel surveys). Consequently these parameter values are not drawn directly from guidelines.

The values of time are estimated more or less for the current day, but an assumption is needed for modelling the way that travellers will trade off time and money in the forecast years. There is a significant volume of behavioural research that suggests values of travel time increase with growing average income. For the purposes of the modelling on this project VLC has assumed that values of travel time remain at current levels in the future.

The exception to this assumption is that people are assumed to have an increased willingness to pay tolls in the future. This is reflected in the application of an elasticity of 0.8 between value of time and increases in real average weekly earnings. This assumption is consistent with that applied in the previous Infrastructure Audit modelling.

D.3.4 Public transport frequencies

While public transport frequencies are partly driven by the completion of infrastructure projects, additional services are regularly added to the network. This includes more regular services along established public transport corridors, as well as new routes to growth areas. In both cases, this is generally in response to population growth.

Determining appropriate future public transport frequencies is based on a combination of the following approaches:

- Increasing service kilometres according to planning and policy documents (as documented in the project list for each market);
- Adding new bus routes to growth areas not serviced by other infrastructure proposals; and
- Increasing service kilometres on remaining bus services to bring overall network frequencies to growth rate of 1.5% per annum. This assumption was applied uniformly across jurisdictions based on actual growth in major-city scheduled bus kilometres documented in jurisdictions' budget papers where available over the past five years.

D.3.5 Commercial vehicle definitions

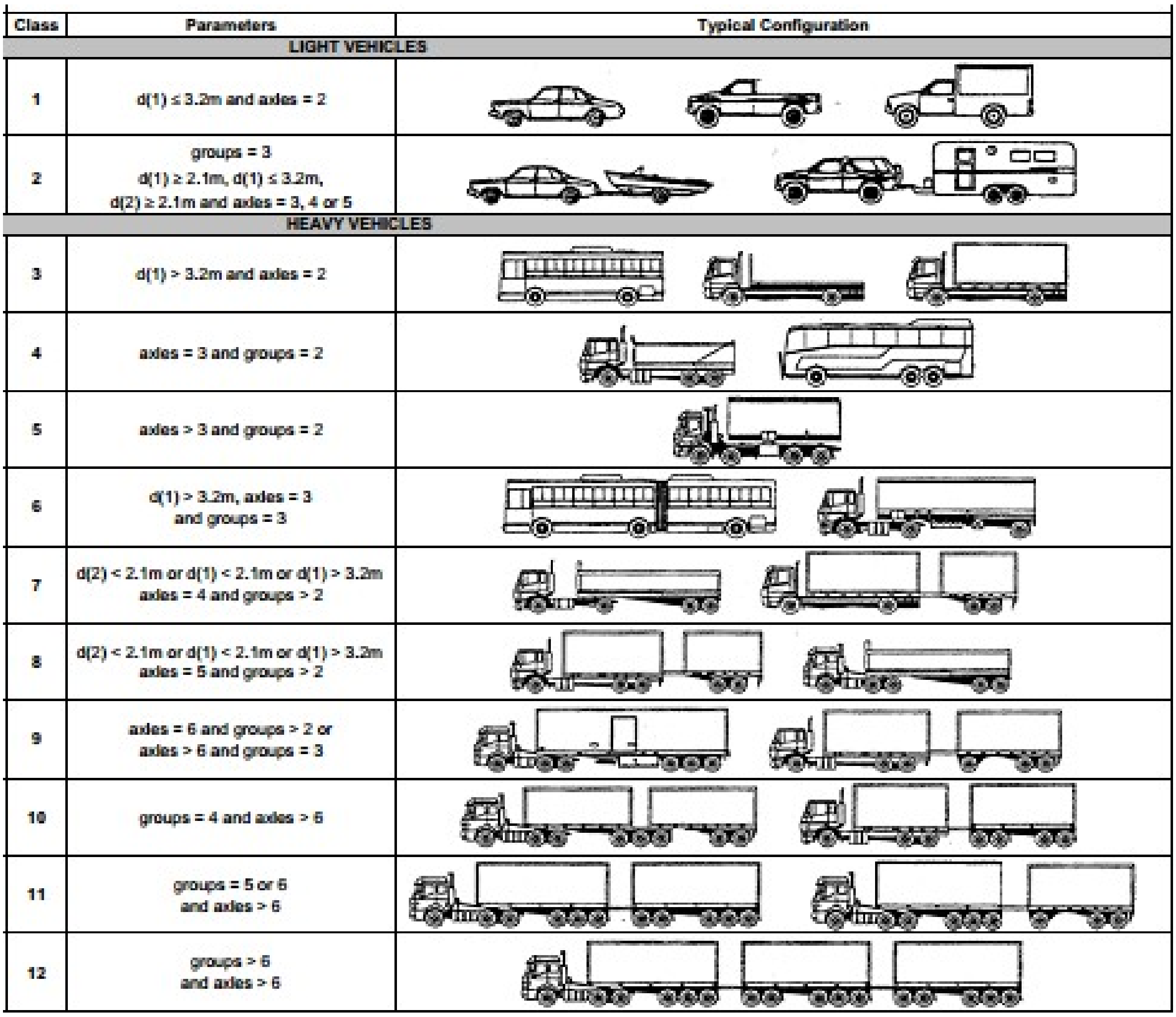
In the Zenith model private vehicle traffic is split into cars and commercial vehicles. Commercial vehicles are further split into sub-categories of light commercial vehicles and heavy commercial vehicles.

Vehicles are classified according to the Austroads Vehicle Classification System (Appendix Figure D-5). Appendix Table D-2 – details how the VLC vehicle types equate to Austroads vehicle classes.

Appendix Table D-2 – VLC vehicle types with Austroads classes

VLC vehicle type	Sub type	Austroads vehicle class
Car	NA	1 & 2
Commercial vehicles	Light commercial vehicles	3
	Heavy commercial vehicles	3 to 12

Appendix Figure D-5 – Austroads Vehicle Classification System



Class	Parameters	Typical Configuration
LIGHT VEHICLES		
1	d(1) ≤ 3.2m and axles = 2	
2	groups = 3 d(1) ≥ 2.1m, d(1) ≤ 3.2m, d(2) ≥ 2.1m and axles = 3, 4 or 5	
HEAVY VEHICLES		
3	d(1) > 3.2m and axles = 2	
4	axles = 3 and groups = 2	
5	axles > 3 and groups = 2	
6	d(1) > 3.2m, axles = 3 and groups = 3	
7	d(2) < 2.1m or d(1) < 2.1m or d(1) > 3.2m axles = 4 and groups > 2	
8	d(2) < 2.1m or d(1) < 2.1m or d(1) > 3.2m axles = 5 and groups > 2	
9	axles = 6 and groups > 2 or axles > 6 and groups = 3	
10	groups = 4 and axles > 6	
11	groups = 5 or 6 and axles > 6	
12	groups > 6 and axles > 6	

Source: Austroads

D.4 Economic cost methodology

VLC provides two measures of economic costs associated with the performance of the transport network: cost of road congestion and cost of public transport crowding. This section briefly outlines the methodology and input assumptions applied in all models.

D.4.1 Cost of road congestion

Modelling approach to estimate impacts

Congested travel times are calculated by comparing the total travel time for a road link under congested conditions, with the travel time of the same link under free-flow conditions.

The amount of time spent travelling under congested conditions is then aggregated to the desired geography in order to understand which parts of the network are most heavily affected by excess travel demand. Weekday forecasts of congested travel times are annualised by a factor of 345 in all cities, reflecting the relatively high traffic volumes on weekends (TfNSW 2016).[5]

Method to quantify

A monetary value of travel time factor is applied to the congested hours, distinguishing between business and non-business travel, as well as an additional freight value of time for commercial vehicles, which are separately identified in the model outputs. The values of time applied are estimated relative to average hourly earnings of the traveller or vehicle to reflect the differing economic costs associated with time lost for each type of trip.

The valuation parameters used are consistent with ATAP (2016) guidelines, updated to December 2017 values:

- Value of time per occupant (excluding freight vehicles):
    - Business-related travel (129.8% of hourly earnings = **$53.78/hr**). Applied using an average vehicle occupancy of 1.3 people per car.
    - Non-business travel (40% of hourly earnings = **$16.57/hr**). Applied using an average vehicle occupancy of 1.7 people per car.
- Freight value of time per vehicle (including occupants):
    - Light commercial vehicles = **$38.23/hr** (Austroads class 3 vehicle, two-axle truck)
    - Heavy commercial vehicles = **$71.36/hr** (Austroads classes 4-10, weighted average according to typical urban conditions Australia-wide, with the majority assumed to be within classes 4, 5, 9 and 10).

D.4.2 Cost of public transport crowding

Modelling approach to estimate impacts

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[5] Transport for NSW (2016), *Principles and Guidelines for Economic Appraisal of Transport Investment and Initiatives - Transport Economic Appraisal Guidelines"*, Sydney, Australia.

The modelling approach to estimating crowding includes three components. These are:

- Measures of service capacity
- Crowding cost function, and
- Linking of outward and return journeys.

Measures of service capacity

Measures of service capacity are provided as a model input, detailing the number of passengers that can be accommodated on each individual service in the modelled public transport network. Seated and standing passenger capacities are specified separately, as passenger comfort levels tend to differ considerably under crowded conditions depending on whether they are travelling in a seat or are standing in passages and doorways.

Appropriate capacities are determined for each city individually. Factors that are considered in specifying service capacities include:

- The rolling stock deployed on particular routes/lines
- The percentage of services run with higher or lower capacity rolling stock to determine 'average' seated and standing capacities (where that level of detail is available)

Appendix Table D-1 sets out the public transport vehicle seated and crush capacities used in the modelling (it is assumed that vehicle capacities remain the same in 2031 as they were in 2016).

Appendix Table D-3 – Public transport vehicle capacities

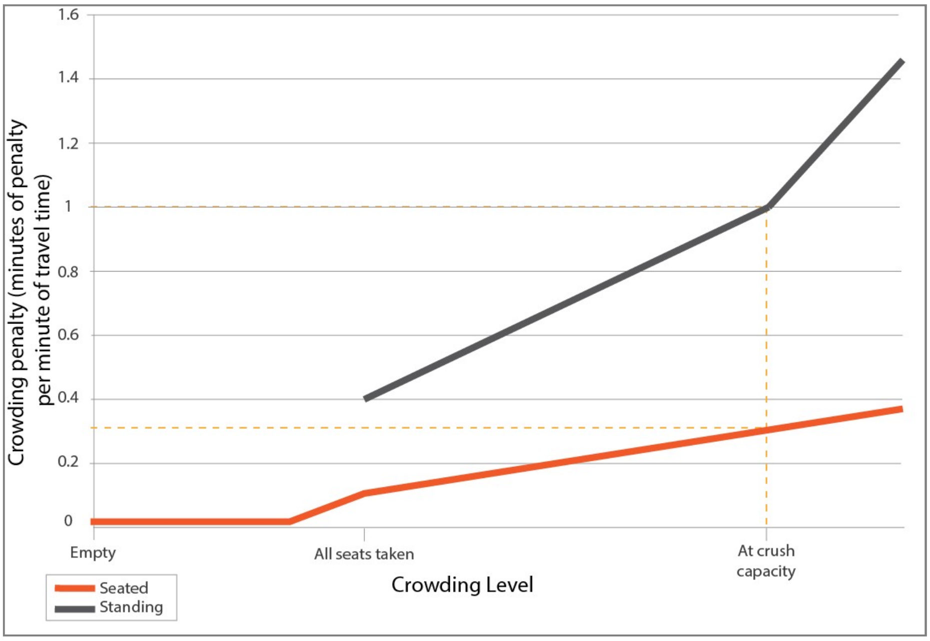
Vehicle	Seated Capacity	Crush capacity
Suburban Rail	500	1250
Tram	35 to 64	100 to 260
Bus	50	75
Regional Rail	222 to 750	335 to 1875

Crowding cost function

The crowding cost function is an estimate of the level of discomfort experienced by passengers at different levels of crowding, depending on whether passengers are seated or standing. The function is based on parameters provided in Australian Transport Council (ATC) guidelines and is shown in Appendix Figure D-6.[6] These broadly align with the latest guidance from ATAP, though the ATAP guidelines do not provide adequate detail to quantify impacts for seated and standing travellers.

[6] Australian Transport Council. 2006. *Volume 4: Urban Transport*. Canberra: ATC.

Appendix Figure D-6 – Crowding cost function



The crowding cost function works by applying a penalty to journeys that are made under crowded conditions. Based on the function, a 10-minute journey at crush capacity would incur a three-minute penalty for seated passengers and a 10 minute penalty for standing passengers.

Beyond crush capacity, the penalty increases at a rapid rate in order to further deter passengers from boarding extremely crowded services. While loads in excess of crush capacity may seem to contradict the definition of crush capacity, passenger load surveys have observed services operating with passenger volumes significantly higher than their theoretical service capacity.

Linking of outward and return journeys

Zenith links outward and return journeys, ensuring that additional travel costs associated with crowded travel conditions impact on the mode of travel for both inbound and outbound trips. This ensures that the model produces balanced travel demands depending on the time period or direction of travel. This is an important feature, because passenger crowding experiences may be inconsistent depending on the time of day.

For example, in the morning peak passengers living at the end of a train line will generally be able to get a seat. Even if the train gets very crowded as it approaches the inner city, they will have a lower perceived cost of crowding than if they were forced to stand. Returning home in the afternoon, the same passengers may be required to stand for significant lengths of their journey, which is associated with a higher perceived cost of crowding. Using linked outward and return journeys, the likelihood of standing on the return journey will be factored into mode and destination choice decisions made for the outward journey as well. This not only ensures that the model has suitably consistent inbound / outbound passenger demands, but also that it is appropriately responsive to infrastructure and policies aimed at reducing crowding.

Method to quantify

Quantifying the cost of public transport crowding involves estimating traveller outcomes in a capacity constrained model run for current (2016) and future (2031) crowding levels.

The number of daily 'disbenefit' or 'penalty' hours experienced by public transport users due to crowding is first calculated. The number of seating and standing hours at different levels of crowded conditions are combined with the disutilities at each crowding level (Appendix Figure D-6).

For example, in the example in the previous subsection, passengers standing at crowded capacity (e.g. a loading factor (LF) of 200% of seated capacity, where LF is passengers / provided seats on services on a link) for a 10-minute journey would experience a crowding disutility of:

Journey time x crowding penalty (at the relevant load factor) = 10 x 1 = 10 minutes

Seated passengers would experience a crowding disutility of 3 minutes during the same journey in addition to their ordinary (uncrowded) travel time disutility of 10 minutes.

Generalising this calculation for a given link (potentially serving multiple lines) yields:

Link average crowding	Crowding disutility for seated passengers	Crowding disutility for standing passengers
Uncrowded LF < 0.7	0	0
Nearing seated capacity 0.7 < LF < 1.0	JT * Pax * (LF - 0.7) * 1 / 3	0 (or if people stand it is by choice with disutility as per seating passengers)
Crowded 1.0 < LF < Crush	JT * Seats * [0.1 + (Pax – Seats) * 0.2 / (Crush – Seats)]	JT * (Pax – Seats) * [0.4 + (Pax – Seats) * 0.6 / (Crush – Seats)]
Crushed LF > Crush	JT * Seats * [0.1 + (Pax – Seats) * 0.2 / (Crush – Seats)]	JT * (Pax – Seats) * [1 + (Pax – Crush) * 1.2 / (Crush – Seats)]

Notes: 1) Total crowding costs sum the two columns for any given load factor (LF)
2) LF is defined at a link level capturing all services operating on that link and all passengers travelling on the link (Pax) during a time period, such as the 2-hour AM peak
3) JT is the journey time across the link, including travel time and dwell time at stops
4) 'Seats' is the total seated capacity for vehicles operating services on the link during the time period
5) 'Crush' is the total crush capacity for vehicles operating services on the link during the time period.

For national consistency we follow ATAP (2018) guidelines by applying an annualisation factor of 286 to scale up the weekday average estimates, reflecting the perspective that crowding is primarily a weekday phenomenon.[7] Annualised disbenefit hours are multiplied by the value of time for non-business travellers ($16.57/hour from section D.4.1 above) to determine the annual cost.

[7] Australian Transport Assessment and Planning Guidelines (2018), *"M1 – Public Transport"*, ATAP, Canberra, Australia.

Appendix E: Differences between 2015 and current modelling

Modelling undertaken for Melbourne in the 2018-19 Audit differs slightly from work undertaken in 2014-15. Changes have been made to the model inputs and assumptions. This section compares the 2018-19 Audit to the 2014-15 Audit, using the 2014-15 inputs / outputs as a base.

E.1 Changes to the models

Significant changes have been made to the Zenith models across all markets since 2014-15.

Appendix Table E-1 – Changes to the Zenith models since the 2014-15 Audit

Change	Detail	Affected markets
Demand model re-estimation	This is the process of using a household travel survey to estimate parameters used to model the behaviour of trips for different purposes, particularly for mode and destination choice steps. This affects the balance between trip lengths and trip numbers. While trip number decrease, network volumes remain broadly unchanged.	• SEQ and Sydney models have both undergone full re-estimation. • Adelaide and Perth models use parameters adapted from the SEQ re-estimation. • Melbourne and ACT models have not been re-estimated
Incorporation of crowding	Additional components were added into the four-step models to capture the perceived cost of travelling under heavily crowded conditions on public transport services. All models were run in 2018 on the basis of crowding levels influencing travel choices; none used this feature in 2014.	• SEQ, Sydney, Perth and Adelaide have undergone software upgrades to include public transport crowding • Melbourne and ACT models were previously public transport crowding-capable, but for consistency reasons this option was not used in 2014-15.
Changing to a 2016 base year	Population and employment inputs were updated to reflect the 2016 Census. Travel costs and transport networks were also updated. Of particular significance was the reduction in fuel price between 2011 and 2016. This was based on a structural decrease observed in fuel retail prices collected by the Australian Competition and Consumer Commission.	• All markets have updated base years • All markets have undergone re-calibration and validation to ensure that changes made to the models are both robust and appropriate.
Model calibration	After model parameters have been estimated (see above) model calibration is the process of adjusting these parameters. The aim is to improve the level of correlation between the model's outputs and observed measures of travel demand (traffic counts, public transport patronage, origin-destination surveys etc.)	

E.2 Changes to model inputs and assumptions

E.2.1 Population and land use

In the 2014-15 Audit, 2031 population projections for all six markets were derived from ABS Series B projections. In the latest work, projections have been provided by each state government. For Melbourne, the impact is as follows:

Appendix Table E-2 – Comparison of Melbourne and Geelong SA4 2031 forecast population

	2014-15 Audit	2018-19 Audit	Difference
Melbourne and Geelong SA4	6.2 million	6.4 million	+4%

The 2031 population forecast used in this audit expects slightly more people to live in Melbourne and Geelong than the forecast used in the 2014-15 Audit. Population is also distributed slightly differently. A map showing this change spatially by SA3 is shown in Appendix Figure E-1. Forecast population is higher in most areas with Geelong now predicted to have a greater number of residents than previously expected (an extra 12,000). Compared to the last audit, the number of people living in inner areas is assumed to be higher (Port Phillip, Melbourne City, Maribyrnong, Yarra and Port Phillip).

Outer areas, such as Casey are also expected to have higher populations. Tullamarine/ Broadmeadows and Melton Bacchus Marsh, are also expected to have higher populations, although this is partially offset by a substantial decrease in Sunbury. A limited number of areas are forecast to have slightly smaller populations than in the 2014-15 Audit. These differences will have a small effect on the models results.

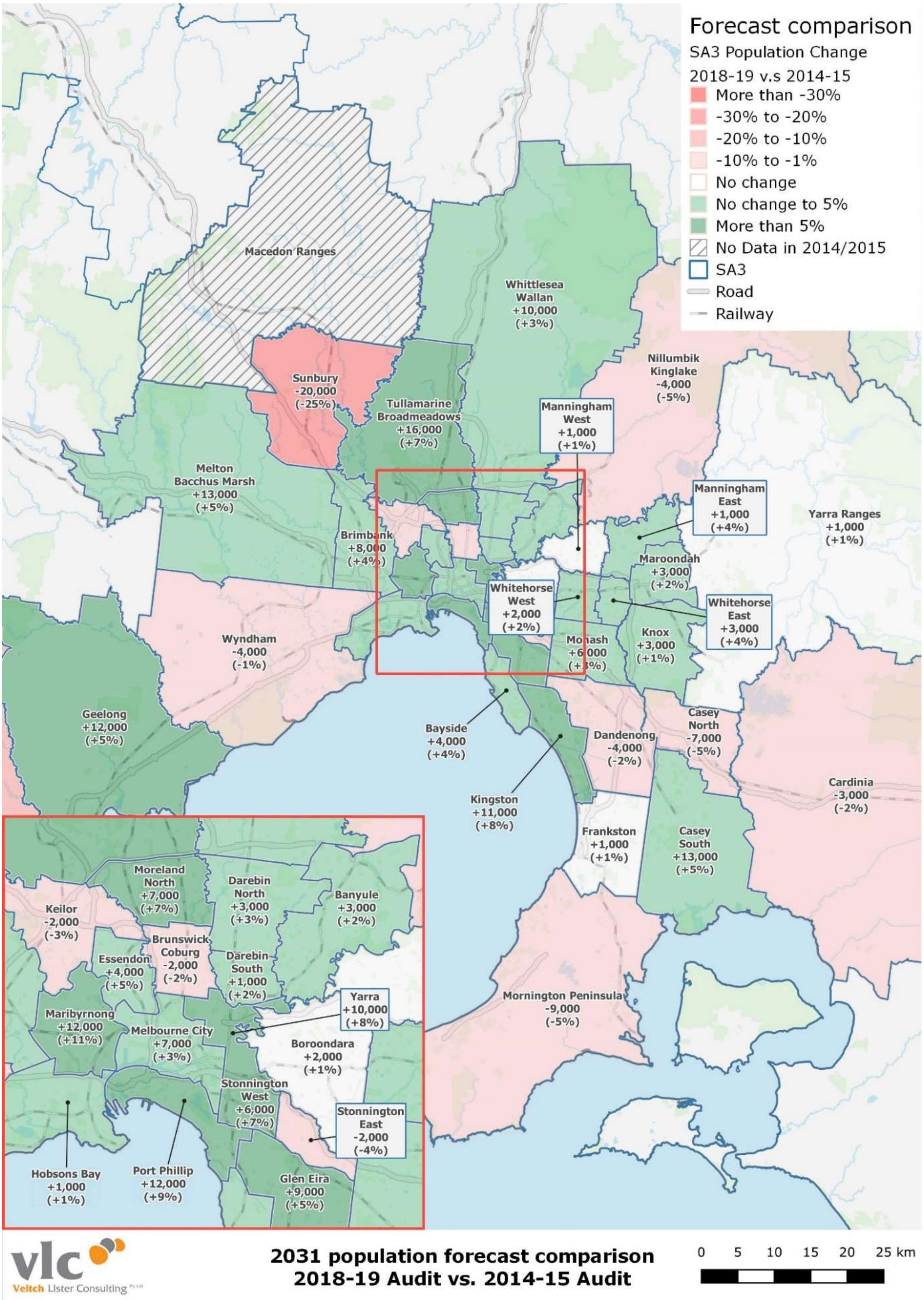
In the 2014-15 Audit, VLC prepared forecasts for employment, consistent with the population projections constrained to the ABS B series forecast. The employment forecasts are based on projected levels of employment self-containment within each LGA, which recognise the structure planning of local authorities and the longer-term infrastructure and development planning by each state government. In the latest work, projections have been provided by each state government. For Melbourne, the impact is as follows:

Appendix Table E-3 – Comparison of Melbourne and Geelong SA4 2031 forecast employment and centralisation

	2014-15 Audit	2018-19 Audit	Difference
Employment in Melbourne and Geelong SA4	3.3 million	3.4 million	+4%
Proportion of employment in Melbourne City SA3	21%	19%	-2%

The way in which jobs are distributed across a city is a key determinant of trip destination, and as such mode choice (more jobs in the CBD encourages more PT travel). In strategic modelling, a gravity model is used to distribute trip destinations, with features such as jobs attracting trips. As such the attractiveness of an area is determined by its **share** of total employment rather than the actual **number** of jobs it contains. Given that the distribution of employment remains relatively similar in the 2018-19 Audit, there is little impact on the balance between car and PT travel (employment centralisation has been used as a proxy for the overall distribution of trip destinations) (Appendix Table E-3).

Appendix Figure E-1 – 2031 Population forecast - 2018-19 Audit compared to 2014-15 Audit base



E.2.2 Network assumptions

Both Audits use a similar approach to developing network assumptions – i.e. a 'minimal intervention' approach, that assumes only projects with funding or significant levels of political commitment will be completed by 2031. For Melbourne, key differences in network assumptions are as follows:

Appendix Table E-4 – Major projects in each Audit

Major projects in 2014-15 NOT in 2018-19	Major projects in 2018-19 NOT in 2014-15
	• North East Link • Melbourne Metro • Melbourne Airport Rail Link • West Gate Tunnel / Monash Freeway Upgrade • Mernda Rail extension (in operation) • CityLink widening • Fishermans bend Tram Extension

E.2.3 Cost assumptions

Cost assumptions in Melbourne (public transport fares and parking charges) and are consistent between 2014-15 Audit and 2018-19 Audit. In this audit, tolls are grown by CPI (as was done in the 2014-15 Audit). New toll roads are added to the network (West Gate Tunnel and North East Link), however this is unlikely to discourage car travel.

E.3 Impacts on model metrics and outputs

Model metrics and outputs are impacted by the changes made to the model inputs and model calibration.

Appendix Table E-5 compares the following high-level outputs:

- Total trips
- Car trips
- Car vehicle kilometres travelled
- Public transport trips.

The number of car and public transport trips forecast in this study are similar those forecast in the 2014-15 Audit (Appendix Table E-5). This is despite substantial additional investment in road and public transport infrastructure (Appendix Table E-4). The reason for this is that these projects make both car and public transport travel more attractive, as such there is not a significant shift in the balance between car and public transport trips.

Relative to the previous audit car vehicle kilometres travelled increase. This is mostly a function of the reduction in fuel cost.

Traffic volumes on Melbourne's major roads are broadly consistent in both Audits, however slightly higher volumes forecast in this study (Appendix Table E-6). The largest increases traffic (The Monash/Princes Freeway and Eastern Fwy Corridor to Ringwood) are driven by upgrades and new infrastructure. The widening of the Monash Freeway increases traffic volumes on this corridor while widening and North East Link increase traffic on the Eastern Freeway.

Higher vehicle delays are forecast on the key corridors in this study relative to those in the 2014-15 Audit. In percentage terms the increase in delay hours is larger than the corresponding change in traffic volumes (Appendix Table E-6). This is a function of the underlying dynamics of traffic flow (when additional traffic is added to an already congested road, the resultant delay is disproportionately higher than in less congested conditions). Results for the PM peak showed a similar outcome.

Appendix Table E-5 – Changes in model inputs and key outputs between the 2014-15 and 2018-19 Audit modelling

		Demographic assumptions		Network assumptions		Travel cost assumptions				Model Parameters
		Population	*Jobs*	*Road investment*	*Public transport investment*	*Fuel*	*PT Fares*	*Parking*	*Tolls*	
Change in inputs		⇧ **Population forecasts have increased slightly (+4%)**	⇧ **Employment forecasts have increased slightly (+4%), however the proportion of jobs in Melbourne City SA3 remains stable**	⇧ **More investment in the road network (+9% network lane km)**	⇧ **More investment in the PT network*** ***While service kilometres are 14% lower compared to the 2014-15 Audit, this is purely due to more conservative bus service assumptions. Rail service kms increase by +15% and Tram by +17%**	⇩ **Reduction in fuel price (140 c/L to 104 c/L AUD 2011)**	- **No change in other transport costs**		- **Tolls grown at CPI. New toll roads with similar costs**	• **The 2016 base models have lower fuel prices (per observed reduction in fuel prices between 2011 and 2016)** • **The 2016 base models include capacity-constrained public transport networks**
Impact on output (AM peak)	Total trips (no change)	- Slight increase in total population does not substantially change total modelled trips	- Total trips are generated by population assumptions and model parameters only.							• The Melbourne model has not been recalibrated (only updated to a 2016 base year). As a result, it is not affected by re-calibrated parameters.
	Car trips (+4%)	- Slight increase in total population does not substantially change the number of card trips	- The distribution of employment is similar between the audits, as such a decline in overall employment does not substantially alter the balance between car and PT travel	⇧ Better roads encourage car travel	⇩ Better PT can encourage more PT travel and fewer car trips	⇧ Lower fuel prices encourage car travel	- No change = no impact		- Negligible impact	• The Melbourne model has not been recalibrated (only updated to a 2016 base year). As a result, it is not affected by re-calibrated parameters.
	Car vehicle kms travelled (+20%)	- Slight increase in total population does not substantially affect car vehicle kms	- The distribution of employment is similar between the audits, as such a decline in overall employment does not substantially alter the balance between car and PT travel	⇧ Better roads encourage car travel	⇩ Better PT can encourage more PT travel and fewer car kms	⇧ Lower fuel prices encourage car travel	- No change = no impact		- Negligible impact	• The Melbourne model has not been recalibrated (only updated to a 2016 base year). As a result, it is not affected by re-calibrated parameters.
	Public transport trips (+1%)	- Slight increase in total population does not substantially change number of PT trips	- The distribution of employment is similar between the audits, as such a decline in overall employment does not substantially alter the balance between car and PT travel	⇩ Better roads encourage car travel and fewer PT trips	⇧ Better PT can encourage more PT travel	⇩ Lower fuel prices encourage car travel and reduce PT travel	- No change = no impact		- Negligible impact	• Capacity constraining public transport networks would reduce demand for services where crowding occurs • The Melbourne model has not been recalibrated (only updated to a 2016 base year). As a result, it is not affected by re-calibrated parameters.

Appendix Table E-6 – Melbourne GCCSA 2031 top fifteen most delayed road corridors AM peak (ranked by total delay)

Rank IA Audit 2018-19	Direction	Corridor Name	Corridor	Average Peak Hour Traffic 2031 forecasts			Total Delay Hours 2031 forecasts			Rank IA Audit 2014-15
				IA Audit 2014-15	IA Audit 2018-19	% Diff	IA Audit 2014-15	IA Audit 2018-19	% Diff	
1	EB	West Gate/Princes Freeway Corridor	3	5,600	6,100	8%	11,500	16,800	47%	1
2	WB	Monash/Princes Fwy Corridor (Monash/Princes Fwy)	22	5,400	7,500	39%	9,500	15,900	67%	2
3	SB	Western/Metropolitan Ring Road	1	6,600	6,800	3%	5,700	8,500	49%	6
4	EB	Calder Freeway Corridor	7	4,000	4,700	18%	6,400	8,200	28%	4
5	WB	Monash/Princes Freeway Corridor (Princes Hwy)	22	2,500	2,800	13%	5,100	7,500	46%	7
6	NB	Western/Metropolitan Ring Road	1	6,500	6,400	-2%	4,400	7,000	58%	8
7	EB	Western Freeway Corridor	2	3,500	3,200	-10%	6,600	5,700	-13%	3
8	SB	Hume Freeway Corridor	5	4,400	4,800	9%	6,000	5,700	-5%	5
9	SB	Outer Metropolitan Ring Corridor*	12	-	900	-	-	4,300	-	-
10	SB	Sydney Rd Corridor	6	2,500	2,400	-7%	4,300	4,500	4%	9
11	WB	Eastern Fwy Corridor to Ringwood	16	4,500	6,700	49%	2,600	4,400	73%	12
12	WB	East-West Arterials - Eastern Suburbs (Maroondah Hwy)	27	2,100	2,100	2%	2,300	3,800	62%	13
13	NB	Inner Beach Suburbs Corridor (Nepean Highway)	20	2,900	3,200	12%	1,900	3,500	88%	18
14	EB	Ballarat Rd Corridor	9	2,600	2,800	8%	2,200	3,400	56%	14
15	WB	East-West Arterials - Eastern Suburbs (Canterbury Rd)	27	1,900	2,100	10%	2,000	3,300	70%	15

*This corridor was not defined in the previous audit.

Appendix F: Additional outputs

Although the body of this report has focussed on the Melbourne GCCSA, the Zenith model extent also includes the Geelong SA4. This appendix contains a summary snapshot of key performance indicators of the Geelong SA4 and Melbourne GCCSA.

Appendix Table F-1 – Melbourne GCCSA and Geelong SA4 public transport in vehicle service kilometres

Metric	Time period	2016	2031	Change	% change
Melbourne GCCSA					
Regional rail	AM peak (7-9AM)	5,000	8,000	+3,000	+47%
	Inter-peak (9AM-4PM)	12,000	19,000	+7,000	+54%
	PM peak (4-6PM)	5,000	8,000	+3,000	+71%
	Off-peak (6PM-7AM)	10,000	29,000	+18,000	+175%
	Daily total	**33,000**	**64,000**	**+31,000**	**+94%**
Suburban rail	AM peak (7-9AM)	12,000	17,000	+5,000	+42%
	Inter-peak (9AM-4PM)	25,000	36,000	+11,000	+47%
	PM peak (4-6PM)	10,000	17,000	+6,000	+60%
	Off-peak (6PM-7AM)	24,000	58,000	+34,000	+144%
	Daily total	**70,000**	**127,000**	**+57,000**	**+81%**
Tram	AM peak (7-9AM)	9,000	14,000	+4,000	+47%
	Inter-peak (9AM-4PM)	30,000	31,000	+1,000	+2%
	PM peak (4-6PM)	10,000	14,000	+4,000	+36%
	Off-peak (6PM-7AM)	22,000	57,000	+35,000	+161%
	Daily total	**71,000**	**115,000**	**+44,000**	**+61%**
Bus	AM peak (7-9AM)	48,000	62,000	+14,000	+30%
	Inter-peak (9AM-4PM)	143,000	177,000	+34,000	+24%
	PM peak (4-6PM)	49,000	63,000	+15,000	+30%
	Off-peak (6PM-7AM)	95,000	141,000	+46,000	+49%
	Daily total	**334,000**	**443,000**	**+109,000**	**+33%**
Total	AM peak (7-9AM)	75,000	101,000	+26,000	+35%
	Inter-peak (9AM-4PM)	210,000	263,000	+53,000	+25%
	PM peak (4-6PM)	74,000	101,000	+28,000	+38%
	Off-peak (6PM-7AM)	150,000	284,000	+133,000	+89%
	Daily total	**509,000**	**749,000**	**+241,000**	**+47%**
Geelong SA4					
Regional rail	AM peak (7-9AM)	1,400	1,700	+300	+23%
	Inter-peak (9AM-4PM)	3,700	4,500	+800	+22%
	PM peak (4-6PM)	1,200	1,700	+500	+40%
	Off-peak (6PM-7AM)	2,800	5,400	+2,600	+96%
	Daily total	**9,100**	**13,300**	**+4,300**	**+47%**
Suburban rail	AM peak (7-9AM)	-	-	-	-
	Inter-peak (9AM-4PM)	-	-	-	-
	PM peak (4-6PM)	-	-	-	-
	Off-peak (6PM-7AM)	-	-	-	-
	Daily total	**-**	**-**	**-**	**-**
Tram	AM peak (7-9AM)	-	-	-	-
	Inter-peak (9AM-4PM)	-	-	-	-
	PM peak (4-6PM)	-	-	-	-
	Off-peak (6PM-7AM)	-	-	-	-
	Daily total	**-**	**-**	**-**	**-**
Bus	AM peak (7-9AM)	3,300	3,300	0	+0%
	Inter-peak (9AM-4PM)	10,500	10,500	0	+0%
	PM peak (4-6PM)	3,300	3,300	0	+0%
	Off-peak (6PM-7AM)	4,800	4,800	0	+0%
	Daily total	**21,900**	**21,900**	**0**	**+0%**
Total	AM peak (7-9AM)	4,600	5,000	+300	+7%
	Inter-peak (9AM-4PM)	14,300	15,100	+800	+6%
	PM peak (4-6PM)	4,500	5,000	+500	+11%
	Off-peak (6PM-7AM)	7,500	10,200	+2,600	+35%
	Daily total	**30,900**	**35,200**	**+4,300**	**+14%**
Total Region*					
Regional rail	AM peak (7-9AM)	5,000	8,000	+3,000	+47%
	Inter-peak (9AM-4PM)	12,000	19,000	+7,000	+54%
	PM peak (4-6PM)	5,000	8,000	+3,000	+71%
	Off-peak (6PM-7AM)	10,000	29,000	+18,000	+175%
	Daily total	**33,000**	**64,000**	**+31,000**	**+94%**
Suburban rail	AM peak (7-9AM)	12,000	17,000	+5,000	+42%
	Inter-peak (9AM-4PM)	25,000	36,000	+12,000	+47%
	PM peak (4-6PM)	10,000	17,000	+6,000	+60%
	Off-peak (6PM-7AM)	24,000	58,000	+34,000	+144%
	Daily total	**70,000**	**127,000**	**+57,000**	**+81%**
Tram	AM peak (7-9AM)	10,000	14,000	+5,000	+47%
	Inter-peak (9AM-4PM)	30,000	31,000	+1,000	+2%
	PM peak (4-6PM)	10,000	14,000	+4,000	+36%
	Off-peak (6PM-7AM)	22,000	57,000	+35,000	+161%
	Daily total	**71,000**	**115,000**	**+44,000**	**+61%**
Bus	AM peak (7-9AM)	51,000	65,000	+14,000	+28%
	Inter-peak (9AM-4PM)	153,000	188,000	+34,000	+22%
	PM peak (4-6PM)	52,000	66,000	+15,000	+28%
	Off-peak (6PM-7AM)	99,000	145,000	+46,000	+46%
	Daily total	**356,000**	**465,000**	**+109,000**	**+31%**
Total	AM peak (7-9AM)	78,000	104,000	+26,000	+34%
	Inter-peak (9AM-4PM)	220,000	274,000	+53,000	+24%
	PM peak (4-6PM)	77,000	105,000	+28,000	+36%
	Off-peak (6PM-7AM)	155,000	289,000	+133,000	+86%
	Daily total	**530,000**	**771,000**	**+241,000**	**+45%**

* Totals do not equate with the sum of the two sub-regions as cross-regional trips are counted once in each sub-region they pass through, whereas the Total counts unique trips once.

Appendix Table F-2 – Melbourne GCCSA and Geelong SA4 person trips by mode

Metric	Time period	2016	2031	Change	% change
Melbourne GCCSA					
Person car trips	AM peak (7-9AM)	1,794,000	2,236,000	+442,000	+25%
	Inter-peak (9AM-4PM)	5,035,000	6,225,000	+1,191,000	+24%
	PM peak (4-6PM)	1,721,000	2,124,000	+404,000	+23%
	Off-peak (6PM-7AM)	2,529,000	3,136,000	+607,000	+24%
	Daily total	**11,079,000**	**13,722,000**	**+2,644,000**	**+24%**
Public transport trips	AM peak (7-9AM)	373,000	574,000	+201,000	+54%
	Inter-peak (9AM-4PM)	616,000	879,000	+262,000	+43%
	PM peak (4-6PM)	262,000	409,000	+147,000	+56%
	Off-peak (6PM-7AM)	247,000	422,000	+175,000	+71%
	Daily total	**1,499,000**	**2,284,000**	**+785,000**	**+52%**
Walk/cycling trips	AM peak (7-9AM)	225,000	264,000	+39,000	+17%
	Inter-peak (9AM-4PM)	813,000	872,000	+59,000	+7%
	PM peak (4-6PM)	233,000	267,000	+34,000	+15%
	Off-peak (6PM-7AM)	388,000	437,000	+49,000	+13%
	Daily total	**1,659,000**	**1,840,000**	**+181,000**	**+11%**
Total trips	AM peak (7-9AM)	2,393,000	3,075,000	+682,000	+29%
	Inter-peak (9AM-4PM)	6,464,000	7,977,000	+1,512,000	+23%
	PM peak (4-6PM)	2,216,000	2,800,000	+584,000	+26%
	Off-peak (6PM-7AM)	3,163,000	3,995,000	+832,000	+26%
	Daily total	**14,236,000**	**17,847,000**	**+3,610,000**	**+25%**
Geelong SA4					
Person car trips	AM peak (7-9AM)	122,000	159,000	*+36,000*	*+30%*
	Inter-peak (9AM-4PM)	353,000	470,000	*+117,000*	*+33%*
	PM peak (4-6PM)	122,000	158,000	*+37,000*	*+30%*
	Off-peak (6PM-7AM)	173,000	231,000	*+58,000*	*+34%*
	Daily total	**770,000**	**1,019,000**	***+248,000***	***+32%***
Public transport trips	AM peak (7-9AM)	8,000	14,000	*+6,000*	*+72%*
	Inter-peak (9AM-4PM)	13,000	22,000	*+9,000*	*+65%*
	PM peak (4-6PM)	5,000	9,000	*+4,000*	*+80%*
	Off-peak (6PM-7AM)	4,000	8,000	*+5,000*	*+117%*
	Daily total	**30,000**	**53,000**	***+23,000***	***+76%***
Walk/cycling trips	AM peak (7-9AM)	13,000	15,000	*+1,000*	*+10%*
	Inter-peak (9AM-4PM)	53,000	62,000	*+9,000*	*+16%*
	PM peak (4-6PM)	16,000	18,000	*+2,000*	*+14%*
	Off-peak (6PM-7AM)	27,000	30,000	*+3,000*	*+12%*
	Daily total	**110,000**	**125,000**	***+15,000***	***+14%***
Total trips	AM peak (7-9AM)	144,000	187,000	*+43,000*	*+30%*
	Inter-peak (9AM-4PM)	420,000	555,000	*+135,000*	*+32%*
	PM peak (4-6PM)	142,000	185,000	*+43,000*	*+30%*
	Off-peak (6PM-7AM)	204,000	270,000	*+66,000*	*+32%*
	Daily total	**910,000**	**1,197,000**	***+287,000***	***+32%***
Total Region*					
Person car trips	AM peak (7-9AM)	1,905,000	2,377,000	*+472,000*	25%
	Inter-peak (9AM-4PM)	5,362,000	6,646,000	*+1,284,000*	24%
	PM peak (4-6PM)	1,831,000	2,265,000	*+434,000*	24%
	Off-peak (6PM-7AM)	2,685,000	3,338,000	*+652,000*	24%
	Daily total	**11,784,000**	**14,626,000**	***+2,842,000***	**24%**
Public transport trips	AM peak (7-9AM)	378,000	580,000	*+201,000*	53%
	Inter-peak (9AM-4PM)	627,000	891,000	*+264,000*	42%
	PM peak (4-6PM)	265,000	412,000	*+147,000*	56%
	Off-peak (6PM-7AM)	250,000	425,000	*+176,000*	70%
	Daily total	**1,520,000**	**2,308,000**	***+788,000***	**52%**
Walk/cycling trips	AM peak (7-9AM)	239,000	279,000	*+41,000*	17%
	Inter-peak (9AM-4PM)	866,000	935,000	*+68,000*	8%
	PM peak (4-6PM)	248,000	284,000	*+36,000*	15%
	Off-peak (6PM-7AM)	415,000	467,000	*+52,000*	13%
	Daily total	**1,768,000**	**1,965,000**	***+197,000***	**11%**
Total trips	AM peak (7-9AM)	2,522,000	3,236,000	*+714,000*	28%
	Inter-peak (9AM-4PM)	6,856,000	8,472,000	*+1,616,000*	24%
	PM peak (4-6PM)	2,345,000	2,962,000	*+617,000*	26%
	Off-peak (6PM-7AM)	3,350,000	4,230,000	*+880,000*	26%
	Daily total	**15,073,000**	**18,900,000**	***+3,827,000***	**25%**

* Totals do not equate with the sum of the two sub-regions as cross-regional trips are counted once in each sub-region they pass through, whereas the Total counts unique trips once.

Appendix Table F-3– Melbourne GCCSA and Geelong SA4 car traffic statistics

Metric	Time period	2016	2031	Change	% change
Melbourne GCCSA					
Car trips	AM peak (7-9AM)	1,345,000	1,676,000	+331,000	+25%
	Inter-peak (9AM-4PM)	3,726,000	4,622,000	+896,000	+24%
	PM peak (4-6PM)	1,345,000	1,663,000	+318,000	+24%
	Off-peak (6PM-7AM)	1,880,000	2,331,000	+451,000	+24%
	Daily total	**8,295,000**	**10,291,000**	**+1,996,000**	**+24%**
Car kilometres	AM peak (7-9AM)	18,455,000	24,664,000	+6,208,000	+34%
	Inter-peak (9AM-4PM)	45,801,000	61,655,000	+15,854,000	+35%
	PM peak (4-6PM)	18,192,000	24,313,000	+6,121,000	+34%
	Off-peak (6PM-7AM)	26,908,000	36,367,000	+9,459,000	+35%
	Daily total	**109,357,000**	**146,999,000**	**+37,642,000**	**+34%**
Car hours	AM peak (7-9AM)	537,000	826,000	+289,000	+54%
	Inter-peak (9AM-4PM)	934,000	1,281,000	+347,000	+37%
	PM peak (4-6PM)	470,000	705,000	+235,000	+50%
	Off-peak (6PM-7AM)	488,000	642,000	+153,000	+31%
	Daily total	**2,429,000**	**3,454,000**	**+1,025,000**	**+42%**
Car Average assigned speed (kph)	AM peak (7-9AM)	34	30	-5	-13%
	Inter-peak (9AM-4PM)	49	48	-1	-2%
	PM peak (4-6PM)	39	35	-4	-11%
	Off-peak (6PM-7AM)	55	57	+2	+3%
	Daily total	**45**	**43**	**-2**	**-5%**
Geelong SA4					
Car trips	AM peak (7-9AM)	91,000	118,000	*+27,000*	*+29%*
	Inter-peak (9AM-4PM)	261,000	345,000	*+85,000*	*+32%*
	PM peak (4-6PM)	96,000	124,000	*+29,000*	*+30%*
	Off-peak (6PM-7AM)	130,000	173,000	*+43,000*	*+33%*
	Daily total	**577,000**	**761,000**	***+184,000***	***+32%***
Car kilometres	AM peak (7-9AM)	1,290,000	1,788,000	*+499,000*	*+39%*
	Inter-peak (9AM-4PM)	3,414,000	4,849,000	*+1,435,000*	*+42%*
	PM peak (4-6PM)	1,307,000	1,809,000	*+502,000*	*+38%*
	Off-peak (6PM-7AM)	2,104,000	2,967,000	*+863,000*	*+41%*
	Daily total	**8,115,000**	**11,413,000**	***+3,299,000***	***+41%***
Car hours	AM peak (7-9AM)	23,000	35,000	*+13,000*	*+58%*
	Inter-peak (9AM-4PM)	52,000	75,000	*+23,000*	*+43%*
	PM peak (4-6PM)	22,000	34,000	*+12,000*	*+54%*
	Off-peak (6PM-7AM)	30,000	42,000	*+12,000*	*+39%*
	Daily total	**127,000**	**186,000**	***+59,000***	***+47%***
Car Average assigned speed (kph)	AM peak (7-9AM)	57	50	*-7*	*-12%*
	Inter-peak (9AM-4PM)	65	65	*-1*	*-1%*
	PM peak (4-6PM)	60	54	*-6*	*-10%*
	Off-peak (6PM-7AM)	70	71	*+1*	*+1%*
	Daily total	**64**	**61**	***-3***	***-4%***
Total Region*					
Car trips	AM peak (7-9AM)	1,427,000	1,779,000	*+353,000*	25%
	Inter-peak (9AM-4PM)	3,966,000	4,931,000	*+965,000*	24%
	PM peak (4-6PM)	1,431,000	1,773,000	*+342,000*	24%
	Off-peak (6PM-7AM)	1,997,000	2,482,000	*+485,000*	24%
	Daily total	**8,820,000**	**10,965,000**	***+2,145,000***	**24%**
Car kilometres	AM peak (7-9AM)	19,725,000	26,421,000	*+6,696,000*	34%
	Inter-peak (9AM-4PM)	49,163,000	66,414,000	*+17,250,000*	35%
	PM peak (4-6PM)	19,478,000	26,091,000	*+6,612,000*	34%
	Off-peak (6PM-7AM)	28,975,000	39,275,000	*+10,299,000*	36%
	Daily total	**117,342,000**	**158,200,000**	***+40,858,000***	**35%**
Car hours	AM peak (7-9AM)	559,000	861,000	*+302,000*	54%
	Inter-peak (9AM-4PM)	986,000	1,355,000	*+369,000*	37%
	PM peak (4-6PM)	491,000	738,000	*+247,000*	50%
	Off-peak (6PM-7AM)	518,000	683,000	*+165,000*	32%
	Daily total	**2,554,000**	**3,638,000**	***+1,083,000***	**42%**
Car Average assigned speed (kph)	AM peak (7-9AM)	35	31	-5	-13%
	Inter-peak (9AM-4PM)	50	49	*-1*	-2%
	PM peak (4-6PM)	40	35	*-4*	-11%
	Off-peak (6PM-7AM)	56	57	*+2*	3%
	Daily total	**46**	**43**	***-2***	**-5%**

* Totals do not equate with the sum of the two sub-regions as cross-regional trips are counted once in each sub-region they pass through, whereas the Total counts unique trips once.

Appendix Table F-4 – Melbourne GCCSA and Geelong SA4 commercial vehicle traffic statistics

Metric	Time period	2016	2031	Change	% change
Melbourne GCCSA					
Commercial Vehicle trips	AM peak (7-9AM)	77,000	94,000	+16,000	+21%
	Inter-peak (9AM-4PM)	254,000	309,000	+55,000	+22%
	PM peak (4-6PM)	90,000	109,000	+19,000	+22%
	Off-peak (6PM-7AM)	126,000	148,000	+23,000	+18%
	Daily total	**547,000**	**660,000**	**+113,000**	**+21%**
Commercial Vehicle kilometres	AM peak (7-9AM)	1,215,000	1,539,000	+324,000	+27%
	Inter-peak (9AM-4PM)	3,912,000	5,043,000	+1,132,000	+29%
	PM peak (4-6PM)	1,390,000	1,800,000	+411,000	+30%
	Off-peak (6PM-7AM)	2,332,000	2,911,000	+579,000	+25%
	Daily total	**8,848,000**	**11,293,000**	**+2,445,000**	**+28%**
Commercial Vehicle hours	AM peak (7-9AM)	31,000	45,000	+14,000	+45%
	Inter-peak (9AM-4PM)	73,000	98,000	+25,000	+34%
	PM peak (4-6PM)	33,000	47,000	+15,000	+45%
	Off-peak (6PM-7AM)	38,000	47,000	+9,000	+23%
	Daily total	**176,000**	**238,000**	**+62,000**	**+36%**
Geelong SA4					
Commercial Vehicle trips	AM peak (7-9AM)	5,000	8,000	*+3,000*	*+53%*
	Inter-peak (9AM-4PM)	17,000	25,000	*+9,000*	*+52%*
	PM peak (4-6PM)	6,000	9,000	*+3,000*	*+59%*
	Off-peak (6PM-7AM)	8,000	13,000	*+5,000*	*+57%*
	Daily total	**36,000**	**55,000**	***+19,000***	***+54%***
Commercial Vehicle kilometres	AM peak (7-9AM)	105,000	145,000	*+40,000*	*+38%*
	Inter-peak (9AM-4PM)	331,000	482,000	*+151,000*	*+46%*
	PM peak (4-6PM)	109,000	166,000	*+57,000*	*+52%*
	Off-peak (6PM-7AM)	224,000	318,000	*+95,000*	*+42%*
	Daily total	**768,000**	**1,112,000**	***+344,000***	***+45%***
Commercial Vehicle hours	AM peak (7-9AM)	2,000	2,000	*+1,000*	*+56%*
	Inter-peak (9AM-4PM)	5,000	7,000	*+2,000*	*+51%*
	PM peak (4-6PM)	2,000	3,000	*+1,000*	*+67%*
	Off-peak (6PM-7AM)	3,000	4,000	*+1,000*	*+44%*
	Daily total	**11,000**	**16,000**	***+6,000***	***+52%***
Total Region*					
Commercial Vehicle trips	AM peak (7-9AM)	82,000	100,000	*+19,000*	23%
	Inter-peak (9AM-4PM)	268,000	330,000	*+62,000*	23%
	PM peak (4-6PM)	94,000	116,000	*+22,000*	23%
	Off-peak (6PM-7AM)	132,000	158,000	*+26,000*	20%
	Daily total	**576,000**	**705,000**	***+129,000***	**22%**
Commercial Vehicle kilometres	AM peak (7-9AM)	1,318,000	1,681,000	*+363,000*	28%
	Inter-peak (9AM-4PM)	4,235,000	5,514,000	*+1,280,000*	30%
	PM peak (4-6PM)	1,496,000	1,963,000	*+466,000*	31%
	Off-peak (6PM-7AM)	2,550,000	3,221,000	*+671,000*	26%
	Daily total	**9,598,000**	**12,379,000**	***+2,781,000***	**29%**
Commercial Vehicle hours	AM peak (7-9AM)	33,000	48,000	*+15,000*	46%
	Inter-peak (9AM-4PM)	78,000	105,000	*+27,000*	35%
	PM peak (4-6PM)	34,000	50,000	*+16,000*	46%
	Off-peak (6PM-7AM)	41,000	51,000	*+10,000*	25%
	Daily total	**186,000**	**254,000**	***+68,000***	**36%**

* Totals do not equate with the sum of the two sub-regions as cross-regional trips are counted once in each sub-region they pass through, whereas the Total counts unique trips once.

Appendix Table F-5 – Melbourne GCCSA and Geelong SA4 total public transport, key metrics

Metric	Time period	2016	2031	Change	% change
Melbourne GCCSA					
Total PT boardings	AM peak (7-9AM)	547,000	893,000	*+346,000*	+63%
	Inter-peak (9AM-4PM)	885,000	1,333,000	*+448,000*	+51%
	PM peak (4-6PM)	396,000	671,000	*+275,000*	+69%
	Off-peak (6PM-7AM)	332,000	631,000	*+299,000*	+90%
	Daily total	**2,160,000**	**3,528,000**	***+1,368,000***	**+63%**
Total in vehicle passenger kilometres	AM peak (7-9AM)	6,267,000	11,833,000	*+5,566,000*	+89%
	Inter-peak (9AM-4PM)	8,003,000	15,226,000	*+7,223,000*	+90%
	PM peak (4-6PM)	4,584,000	8,658,000	*+4,074,000*	+89%
	Off-peak (6PM-7AM)	3,558,000	8,095,000	*+4,537,000*	+127%
	Daily total	**22,412,000**	**43,812,000**	***+21,400,000***	**+95%**
Total in vehicle passenger hours	AM peak (7-9AM)	173,000	308,000	*+135,000*	+78%
	Inter-peak (9AM-4PM)	236,000	393,000	*+156,000*	+66%
	PM peak (4-6PM)	125,000	222,000	*+97,000*	+78%
	Off-peak (6PM-7AM)	101,000	204,000	*+103,000*	+102%
	Daily total	**635,000**	**1,127,000**	***+491,000***	**+77%**
Geelong SA4					
Total PT boardings	AM peak (7-9AM)	11,000	19,000	*+7,000*	65%
	Inter-peak (9AM-4PM)	20,000	34,000	*+15,000*	75%
	PM peak (4-6PM)	8,000	15,000	*+7,000*	86%
	Off-peak (6PM-7AM)	6,000	14,000	*+8,000*	142%
	Daily total	**45,000**	**82,000**	***+37,000***	**83%**
Total in vehicle passenger kilometres	AM peak (7-9AM)	342,000	754,000	*+412,000*	120%
	Inter-peak (9AM-4PM)	385,000	1,074,000	*+689,000*	179%
	PM peak (4-6PM)	269,000	632,000	*+363,000*	135%
	Off-peak (6PM-7AM)	161,000	575,000	*+414,000*	258%
	Daily total	**1,158,000**	**3,035,000**	***+1,878,000***	**162%**
Total in vehicle passenger hours	AM peak (7-9AM)	6,000	11,000	*+5,000*	98%
	Inter-peak (9AM-4PM)	7,000	16,000	*+9,000*	120%
	PM peak (4-6PM)	4,000	9,000	*+5,000*	111%
	Off-peak (6PM-7AM)	2,000	7,000	*+5,000*	200%
	Daily total	**19,000**	**43,000**	***+24,000***	**122%**
Total Region*					
Total PT boardings	AM peak (7-9AM)	553,000	901,000	*+348,000*	63%
	Inter-peak (9AM-4PM)	898,000	1,350,000	*+452,000*	50%
	PM peak (4-6PM)	399,000	676,000	*+276,000*	69%
	Off-peak (6PM-7AM)	335,000	635,000	*+300,000*	89%
	Daily total	**2,186,000**	**3,562,000**	***+1,377,000***	**63%**
Total in vehicle passenger kilometres	AM peak (7-9AM)	6,320,000	11,910,000	*+5,589,000*	88%
	Inter-peak (9AM-4PM)	8,112,000	15,386,000	*+7,274,000*	90%
	PM peak (4-6PM)	4,611,000	8,703,000	*+4,092,000*	89%
	Off-peak (6PM-7AM)	3,578,000	8,130,000	*+4,552,000*	127%
	Daily total	**22,622,000**	**44,129,000**	***+21,507,000***	**95%**
Total in vehicle passenger hours	AM peak (7-9AM)	175,000	311,000	*+136,000*	78%
	Inter-peak (9AM-4PM)	240,000	398,000	*+158,000*	66%
	PM peak (4-6PM)	126,000	224,000	*+98,000*	78%
	Off-peak (6PM-7AM)	102,000	205,000	*+103,000*	102%
	Daily total	**642,000**	**1,137,000**	***+495,000***	**77%**

* Totals do not equate with the sum of the two sub-regions as cross-regional trips are counted once in each sub-region they pass through, whereas the Total counts unique trips once.

Appendix Table F-6 – Melbourne GCCSA and Geelong SA4 in-vehicle passenger kilometres

Metric	Time period	2016	2031	Change	% change
Melbourne GCCSA					
Suburban rail passenger kilometres	AM peak (7-9AM)	3,991,000	7,184,000	+3,193,000	+80%
	Inter-peak (9AM-4PM)	4,632,000	8,523,000	+3,891,000	+84%
	PM peak (4-6PM)	2,920,000	5,240,000	+2,319,000	+79%
	Off-peak (6PM-7AM)	2,130,000	4,820,000	+2,690,000	+126%
	Daily total	**13,673,000**	**25,767,000**	**+12,094,000**	**+88%**
Tram passenger kilometres	AM peak (7-9AM)	517,000	692,000	+175,000	+34%
	Inter-peak (9AM-4PM)	1,013,000	1,158,000	+145,000	+14%
	PM peak (4-6PM)	412,000	558,000	+145,000	+35%
	Off-peak (6PM-7AM)	495,000	725,000	+230,000	+47%
	Daily total	**2,437,000**	**3,133,000**	**+696,000**	**+29%**
Bus passenger kilometres	AM peak (7-9AM)	773,000	1,281,000	+508,000	+66%
	Inter-peak (9AM-4PM)	1,510,000	2,096,000	+586,000	+39%
	PM peak (4-6PM)	487,000	775,000	+288,000	+59%
	Off-peak (6PM-7AM)	464,000	616,000	+152,000	+33%
	Daily total	**3,234,000**	**4,768,000**	**+1,534,000**	**+47%**
Regional rail passenger kilometres	AM peak (7-9AM)	986,000	2,676,000	+1,690,000	+171%
	Inter-peak (9AM-4PM)	847,000	3,448,000	+2,601,000	+307%
	PM peak (4-6PM)	764,000	2,085,000	+1,322,000	+173%
	Off-peak (6PM-7AM)	471,000	1,935,000	+1,464,000	+311%
	Daily total	**3,067,000**	**10,144,000**	**+7,076,000**	**+231%**
Geelong SA4					
Suburban rail passenger kilometres	AM peak (7-9AM)	-	-	-	-
	Inter-peak (9AM-4PM)	-	-	-	-
	PM peak (4-6PM)	-	-	-	-
	Off-peak (6PM-7AM)	-	-	-	-
	Daily total	-	-	-	-
Tram passenger kilometres	AM peak (7-9AM)	-	-	-	-
	Inter-peak (9AM-4PM)	-	-	-	-
	PM peak (4-6PM)	-	-	-	-
	Off-peak (6PM-7AM)	-	-	-	-
	Daily total	-	-	-	-
Bus passenger kilometres	AM peak (7-9AM)	54,000	77,000	+23,000	+44%
	Inter-peak (9AM-4PM)	110,000	160,000	+50,000	+46%
	PM peak (4-6PM)	28,000	45,000	+17,000	+63%
	Off-peak (6PM-7AM)	20,000	35,000	+15,000	+77%
	Daily total	**211,000**	**317,000**	**+107,000**	**+51%**
Regional rail passenger kilometres	AM peak (7-9AM)	289,000	677,000	+388,000	+134%
	Inter-peak (9AM-4PM)	276,000	914,000	+639,000	+232%
	PM peak (4-6PM)	241,000	587,000	+345,000	+143%
	Off-peak (6PM-7AM)	141,000	539,000	+399,000	+284%
	Daily total	**947,000**	**2,718,000**	**+1,771,000**	**+187%**
Total Region*					
Suburban rail passenger kilometres	AM peak (7-9AM)	3,991,000	7,184,000	+3,193,000	+80%
	Inter-peak (9AM-4PM)	4,632,000	8,523,000	+3,891,000	+84%
	PM peak (4-6PM)	2,920,000	5,240,000	+2,319,000	+79%
	Off-peak (6PM-7AM)	2,130,000	4,820,000	+2,690,000	+126%
	Daily total	**13,673,000**	**25,767,000**	**+12,094,000**	**+88%**
Tram passenger kilometres	AM peak (7-9AM)	517,000	692,000	+175,000	+34%
	Inter-peak (9AM-4PM)	1,013,000	1,158,000	+145,000	+14%
	PM peak (4-6PM)	412,000	558,000	+145,000	+35%
	Off-peak (6PM-7AM)	495,000	725,000	+230,000	+47%
	Daily total	**2,437,000**	**3,133,000**	**+696,000**	**+29%**
Bus passenger kilometres	AM peak (7-9AM)	826,000	1,358,000	+531,000	+64%
	Inter-peak (9AM-4PM)	1,620,000	2,256,000	+636,000	+39%
	PM peak (4-6PM)	515,000	821,000	+306,000	+59%
	Off-peak (6PM-7AM)	483,000	651,000	+167,000	+35%
	Daily total	**3,445,000**	**5,085,000**	**+1,640,000**	**+48%**
Regional rail passenger kilometres	AM peak (7-9AM)	986,000	2,676,000	+1,690,000	+171%
	Inter-peak (9AM-4PM)	847,000	3,448,000	+2,601,000	+307%
	PM peak (4-6PM)	764,000	2,085,000	+1,322,000	+173%
	Off-peak (6PM-7AM)	471,000	1,935,000	+1,464,000	+311%
	Daily total	**3,067,000**	**10,144,000**	**+7,076,000**	**+231%**

* Totals do not equate with the sum of the two sub-regions as cross-regional trips are counted once in each sub-region they pass through, whereas the Total counts unique trips once.

Appendix Table F-7 – Melbourne GCCSA and Geelong SA4 in-vehicle passenger hours

Metric	Time period	2016	2031	Change	% change
Melbourne GCCSA					
Suburban rail passenger hours	AM peak (7-9AM)	94,000	168,000	*+75,000*	*+79%*
	Inter-peak (9AM-4PM)	112,000	204,000	*+92,000*	*+82%*
	PM peak (4-6PM)	69,000	124,000	*+55,000*	*+79%*
	Off-peak (6PM-7AM)	51,000	117,000	*+65,000*	*+127%*
	Daily total	**326,000**	**613,000**	***+287,000***	***+88%***
Tram passenger hours	AM peak (7-9AM)	33,000	47,000	*+14,000*	*+44%*
	Inter-peak (9AM-4PM)	58,000	71,000	*+12,000*	*+21%*
	PM peak (4-6PM)	26,000	37,000	*+12,000*	*+45%*
	Off-peak (6PM-7AM)	28,000	43,000	*+15,000*	*+54%*
	Daily total	**145,000**	**198,000**	***+54,000***	***+37%***
Bus passenger hours	AM peak (7-9AM)	34,000	59,000	*+26,000*	*+77%*
	Inter-peak (9AM-4PM)	55,000	76,000	*+21,000*	*+38%*
	PM peak (4-6PM)	20,000	34,000	*+14,000*	*+71%*
	Off-peak (6PM-7AM)	15,000	20,000	*+5,000*	*+31%*
	Daily total	**124,000**	**190,000**	***+66,000***	***+53%***
Regional rail passenger hours	AM peak (7-9AM)	13,000	33,000	*+20,000*	*+160%*
	Inter-peak (9AM-4PM)	11,000	42,000	*+31,000*	*+282%*
	PM peak (4-6PM)	10,000	26,000	*+16,000*	*+163%*
	Off-peak (6PM-7AM)	6,000	24,000	*+18,000*	*+295%*
	Daily total	**40,000**	**125,000**	***+85,000***	***+215%***
Geelong SA4					
Suburban rail passenger hours	AM peak (7-9AM)	-	-	-	-
	Inter-peak (9AM-4PM)	-	-	-	-
	PM peak (4-6PM)	-	-	-	-
	Off-peak (6PM-7AM)	-	-	-	-
	Daily total	-	-	-	-
Tram passenger hours	AM peak (7-9AM)	-	-	-	-
	Inter-peak (9AM-4PM)	-	-	-	-
	PM peak (4-6PM)	-	-	-	-
	Off-peak (6PM-7AM)	-	-	-	-
	Daily total	-	-	-	-
Bus passenger hours	AM peak (7-9AM)	1,900	3,000	*+1,100*	+56%
	Inter-peak (9AM-4PM)	3,500	5,100	*+1,600*	+45%
	PM peak (4-6PM)	1,000	1,700	*+700*	+73%
	Off-peak (6PM-7AM)	600	1,100	*+500*	+71%
	Daily total	**7,000**	**10,900**	***+3,900***	**+54%**
Regional rail passenger hours	AM peak (7-9AM)	4,000	8,000	*+4,000*	119%
	Inter-peak (9AM-4PM)	4,000	11,000	*+7,000*	194%
	PM peak (4-6PM)	3,000	7,000	*+4,000*	123%
	Off-peak (6PM-7AM)	2,000	6,000	*+5,000*	245%
	Daily total	**12,000**	**32,000**	***+20,000***	**161%**
Total Region*					
Suburban rail passenger hours	AM peak (7-9AM)	94,000	168,000	*+75,000*	*+79%*
	Inter-peak (9AM-4PM)	112,000	204,000	*+92,000*	*+82%*
	PM peak (4-6PM)	69,000	124,000	*+55,000*	*+79%*
	Off-peak (6PM-7AM)	51,000	117,000	*+65,000*	*+127%*
	Daily total	**326,000**	**613,000**	***+287,000***	***+88%***
Tram passenger hours	AM peak (7-9AM)	33,000	47,000	*+14,000*	*+44%*
	Inter-peak (9AM-4PM)	58,000	71,000	*+12,000*	*+21%*
	PM peak (4-6PM)	26,000	37,000	*+12,000*	*+45%*
	Off-peak (6PM-7AM)	28,000	43,000	*+15,000*	*+54%*
	Daily total	**145,000**	**198,000**	***+54,000***	***+37%***
Bus passenger hours	AM peak (7-9AM)	36,000	62,000	*+27,000*	*+76%*
	Inter-peak (9AM-4PM)	59,000	82,000	*+23,000*	*+39%*
	PM peak (4-6PM)	21,000	36,000	*+15,000*	*+71%*
	Off-peak (6PM-7AM)	16,000	21,000	*+5,000*	*+32%*
	Daily total	**131,000**	**201,000**	***+70,000***	***+53%***
Regional rail passenger hours	AM peak (7-9AM)	13,000	33,000	*+20,000*	*+160%*
	Inter-peak (9AM-4PM)	11,000	42,000	*+31,000*	*+282%*
	PM peak (4-6PM)	10,000	26,000	*+16,000*	*+163%*
	Off-peak (6PM-7AM)	6,000	24,000	*+18,000*	*+295%*
	Daily total	**40,000**	**125,000**	***+85,000***	***+215%***

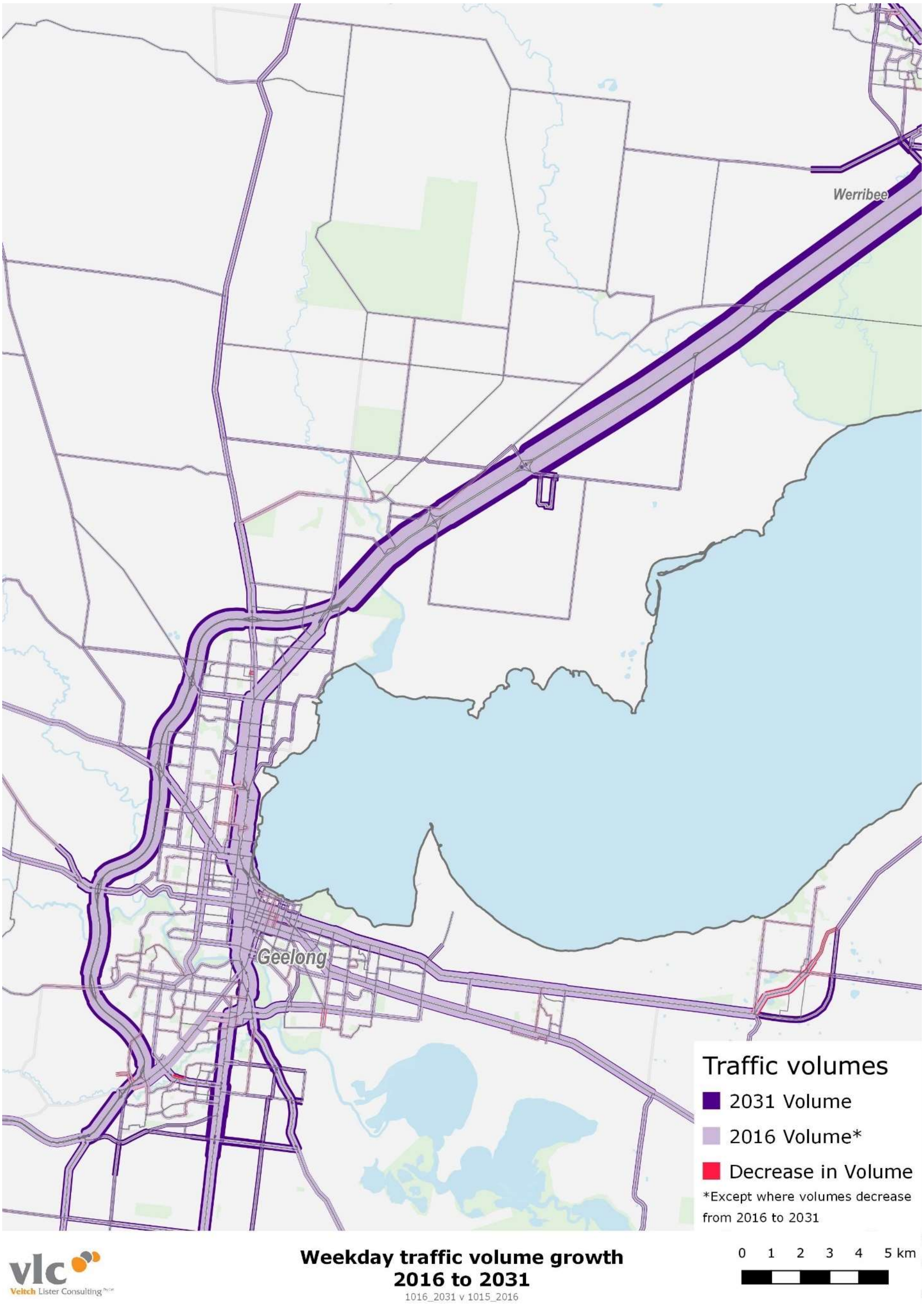
* Totals do not equate with the sum of the two sub-regions as cross-regional trips are counted once in each sub-region they pass through, whereas the Total counts unique trips once.

Appendix Table F-8 – Melbourne GCCSA and Geelong SA4 public transport boardings

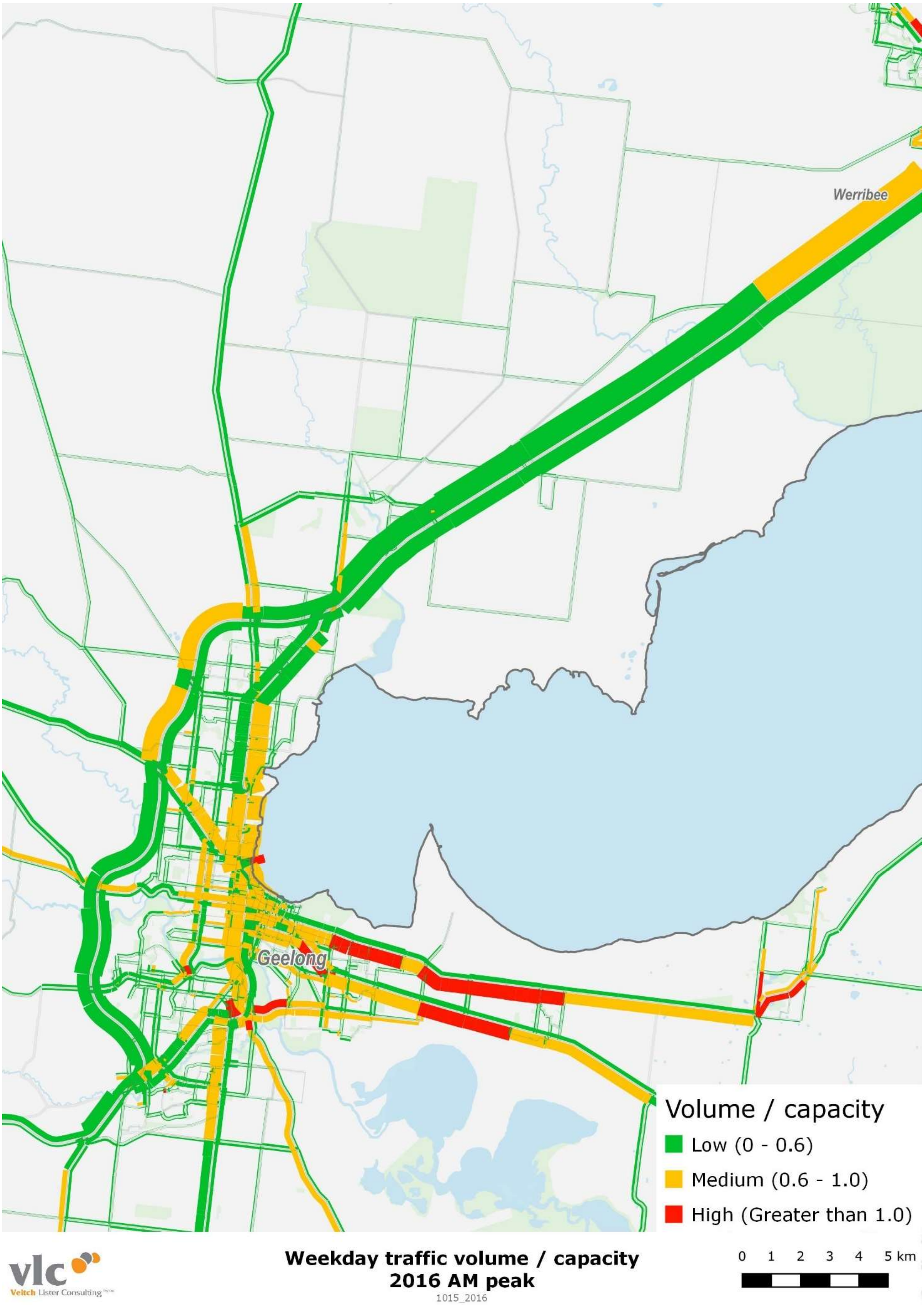
Metric	Time period	2016	2031	Change	% change
Melbourne GCCSA					
Suburban rail passenger boardings	AM peak (7-9AM)	288,000	488,000	*+201,000*	*+70%*
	Inter-peak (9AM-4PM)	384,000	650,000	*+267,000*	*+69%*
	PM peak (4-6PM)	199,000	356,000	*+156,000*	*+79%*
	Off-peak (6PM-7AM)	159,000	334,000	*+175,000*	*+110%*
	Daily total	**1,030,000**	**1,828,000**	***+799,000***	***+78%***
Tram passenger boardings	AM peak (7-9AM)	124,000	176,000	*+52,000*	*+42%*
	Inter-peak (9AM-4PM)	279,000	348,000	*+69,000*	*+25%*
	PM peak (4-6PM)	115,000	174,000	*+58,000*	*+51%*
	Off-peak (6PM-7AM)	115,000	197,000	*+82,000*	*+71%*
	Daily total	**633,000**	**895,000**	***+262,000***	***+41%***
Bus passenger boardings	AM peak (7-9AM)	117,000	182,000	*+64,000*	*+55%*
	Inter-peak (9AM-4PM)	206,000	282,000	*+76,000*	*+37%*
	PM peak (4-6PM)	68,000	105,000	*+37,000*	*+55%*
	Off-peak (6PM-7AM)	50,000	70,000	*+20,000*	*+40%*
	Daily total	**441,000**	**639,000**	***+197,000***	***+45%***
Regional rail passenger boardings	AM peak (7-9AM)	18,000	47,000	*+29,000*	*+165%*
	Inter-peak (9AM-4PM)	17,000	53,000	*+36,000*	*+217%*
	PM peak (4-6PM)	14,000	37,000	*+23,000*	*+168%*
	Off-peak (6PM-7AM)	8,000	30,000	*+22,000*	*+277%*
	Daily total	**56,000**	**166,000**	***+110,000***	***+197%***
Geelong SA4					
Suburban rail passenger boardings	AM peak (7-9AM)	-	-	-	-
	Inter-peak (9AM-4PM)	-	-	-	-
	PM peak (4-6PM)	-	-	-	-
	Off-peak (6PM-7AM)	-	-	-	-
	Daily total	-	-	-	-
Tram passenger boardings	AM peak (7-9AM)	-	-	-	-
	Inter-peak (9AM-4PM)	-	-	-	-
	PM peak (4-6PM)	-	-	-	-
	Off-peak (6PM-7AM)	-	-	-	-
	Daily total	-	-	-	-
Bus passenger boardings	AM peak (7-9AM)	6,000	8,000	*+2,000*	+33%
	Inter-peak (9AM-4PM)	13,000	17,000	*+4,000*	+33%
	PM peak (4-6PM)	3,000	5,000	*+1,000*	+39%
	Off-peak (6PM-7AM)	3,000	4,000	*+1,000*	+41%
	Daily total	**25,000**	**34,000**	***+9,000***	**+35%**
Regional rail passenger boardings	AM peak (7-9AM)	5,000	11,000	*+5,000*	+102%
	Inter-peak (9AM-4PM)	7,000	17,000	*+10,000*	+156%
	PM peak (4-6PM)	5,000	10,000	*+6,000*	+122%
	Off-peak (6PM-7AM)	3,000	10,000	*+7,000*	+232%
	Daily total	**20,000**	**48,000**	***+28,000***	**+145%**
Total Region*					
Suburban rail passenger boardings	AM peak (7-9AM)	288,000	488,000	*+201,000*	*+70%*
	Inter-peak (9AM-4PM)	384,000	650,000	*+267,000*	*+69%*
	PM peak (4-6PM)	199,000	356,000	*+156,000*	*+79%*
	Off-peak (6PM-7AM)	159,000	334,000	*+175,000*	*+110%*
	Daily total	**1,030,000**	**1,828,000**	***+799,000***	***+78%***
Tram passenger boardings	AM peak (7-9AM)	124,000	176,000	*+52,000*	*+42%*
	Inter-peak (9AM-4PM)	279,000	348,000	*+69,000*	*+25%*
	PM peak (4-6PM)	115,000	174,000	*+58,000*	*+51%*
	Off-peak (6PM-7AM)	115,000	197,000	*+82,000*	*+71%*
	Daily total	**633,000**	**895,000**	***+262,000***	***+41%***
Bus passenger boardings	AM peak (7-9AM)	124,000	190,000	*+66,000*	*+54%*
	Inter-peak (9AM-4PM)	219,000	299,000	*+80,000*	*+37%*
	PM peak (4-6PM)	71,000	109,000	*+38,000*	*+54%*
	Off-peak (6PM-7AM)	53,000	74,000	*+21,000*	*+40%*
	Daily total	**467,000**	**673,000**	***+206,000***	***+44%***
Regional rail passenger boardings	AM peak (7-9AM)	18,000	47,000	*+29,000*	*+165%*
	Inter-peak (9AM-4PM)	17,000	53,000	*+36,000*	*+217%*
	PM peak (4-6PM)	14,000	37,000	*+23,000*	*+168%*
	Off-peak (6PM-7AM)	8,000	30,000	*+22,000*	*+277%*
	Daily total	**56,000**	**166,000**	***+110,000***	***+197%***

* Totals do not equate with the sum of the two sub-regions as cross-regional trips are counted once in each sub-region they pass through, whereas the Total counts unique trips once.

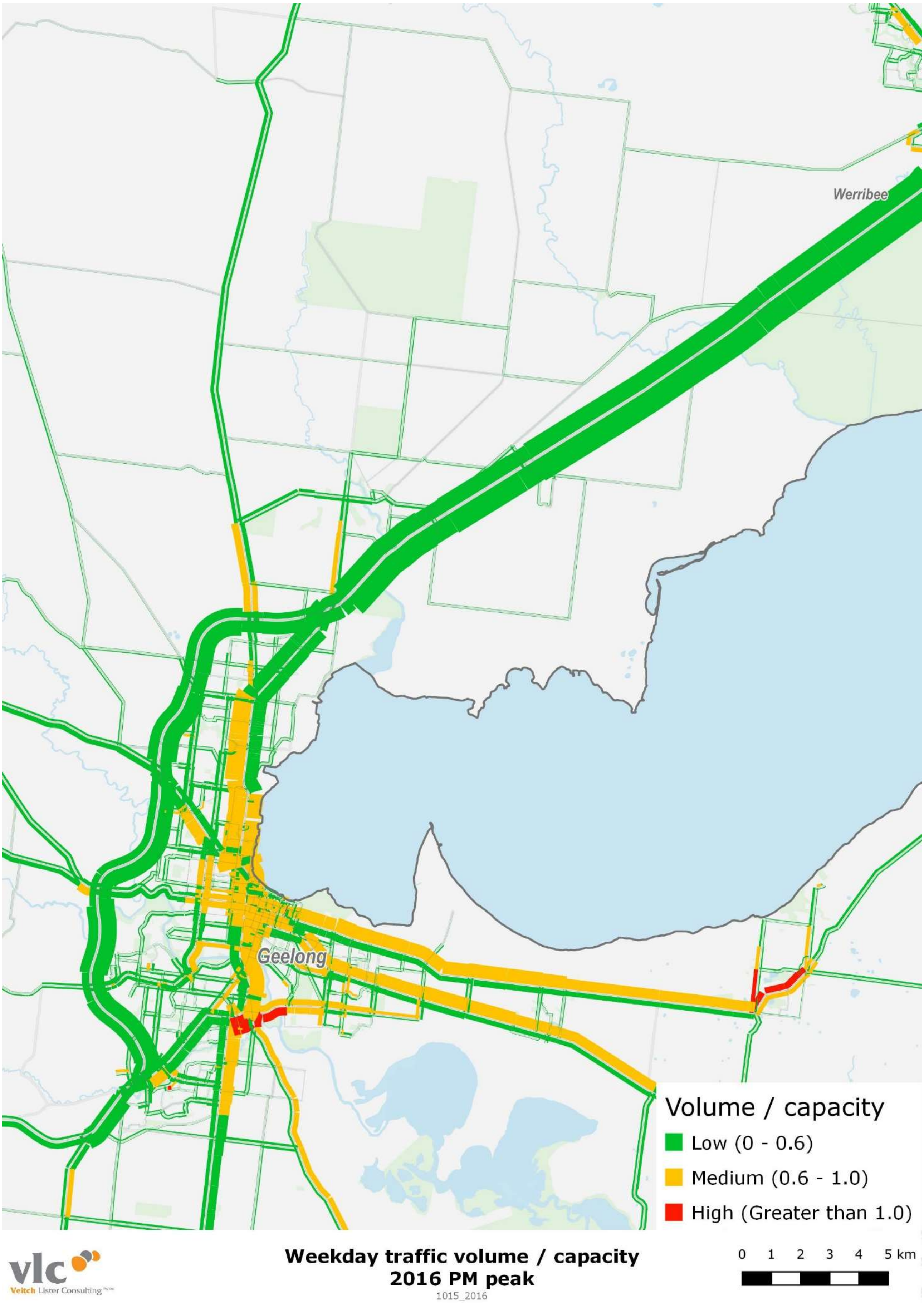
Appendix Figure F-1 – Geelong weekday traffic volume growth - 2016 to 2031



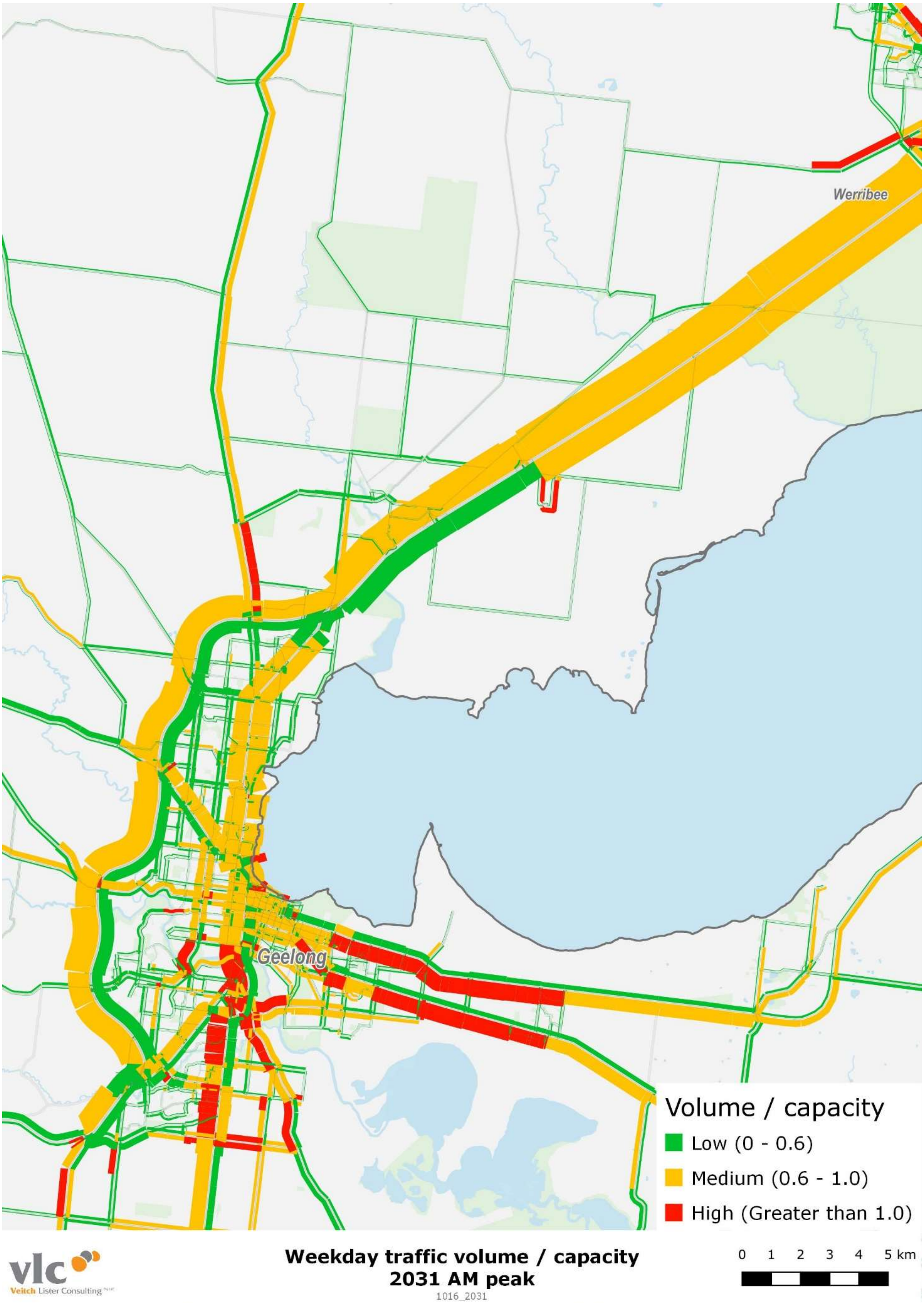
Appendix Figure F-2 – Geelong weekday traffic volume / road capacity - 2016 1-hour AM peak (7-9AM)



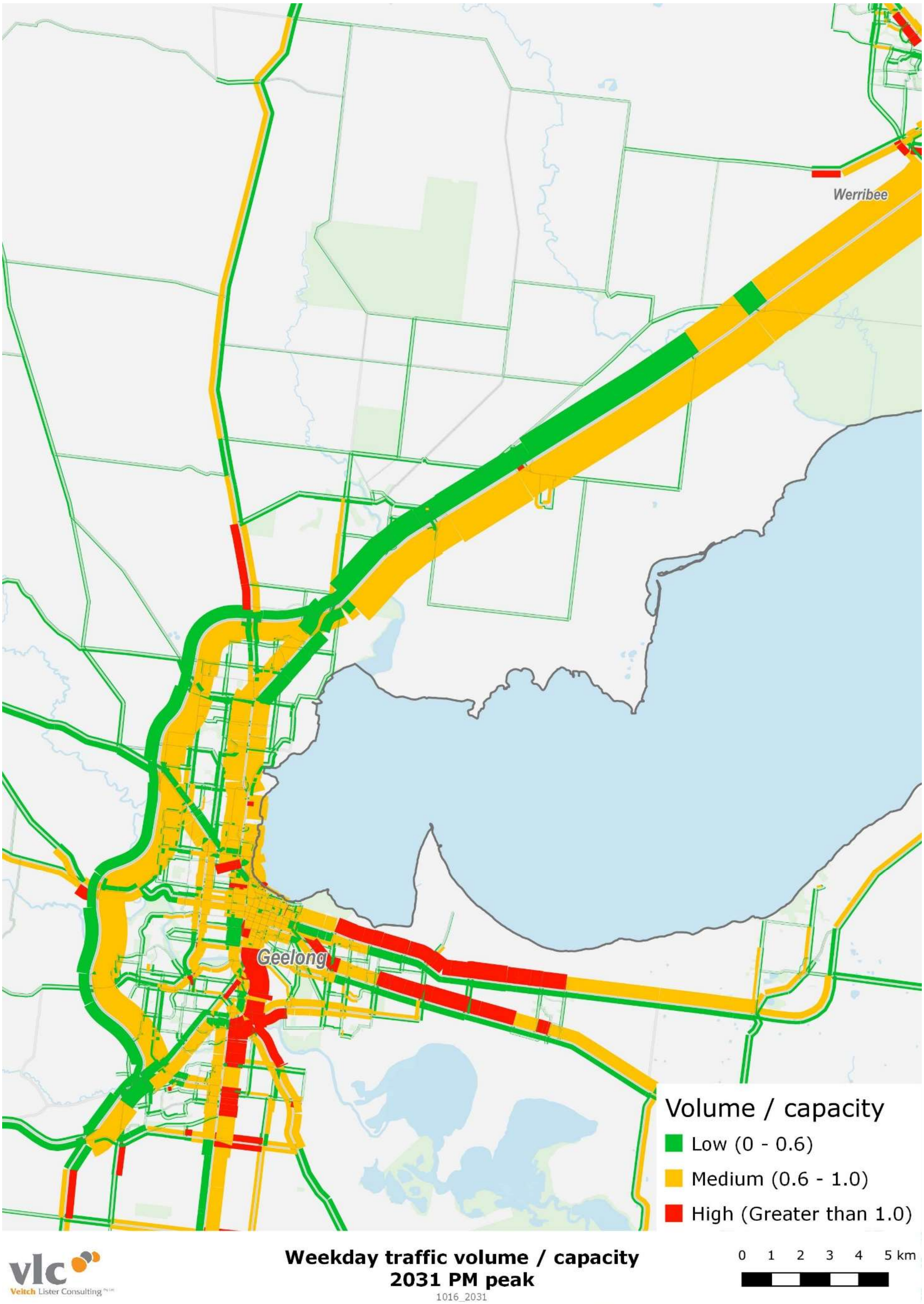
Appendix Figure F-3 – Geelong weekday traffic volume / road capacity - 2016 1-hour PM peak (4-6PM)



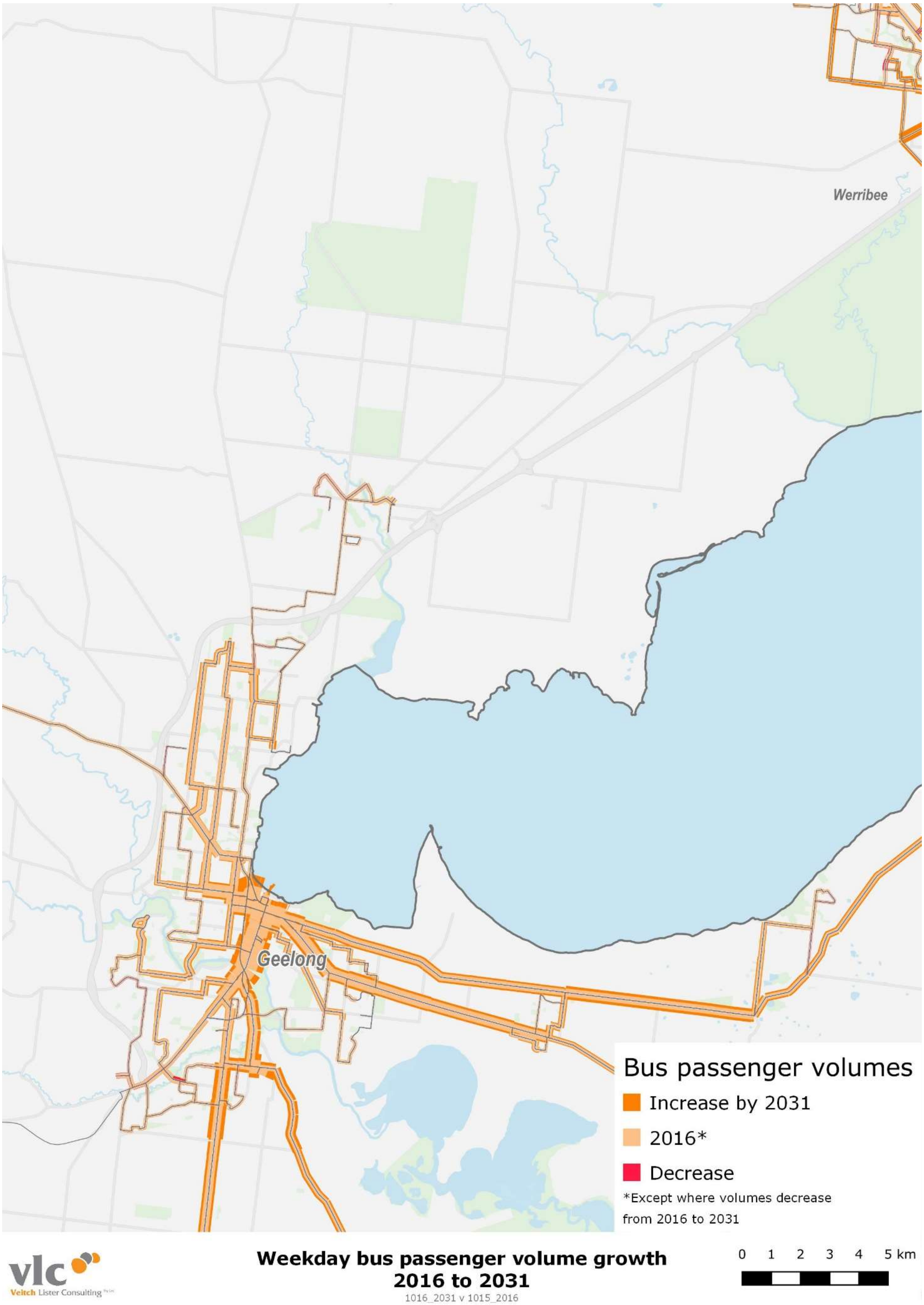
Appendix Figure F-4 – Geelong weekday traffic volume / road capacity - 2031 1-hour AM peak (7-9AM)



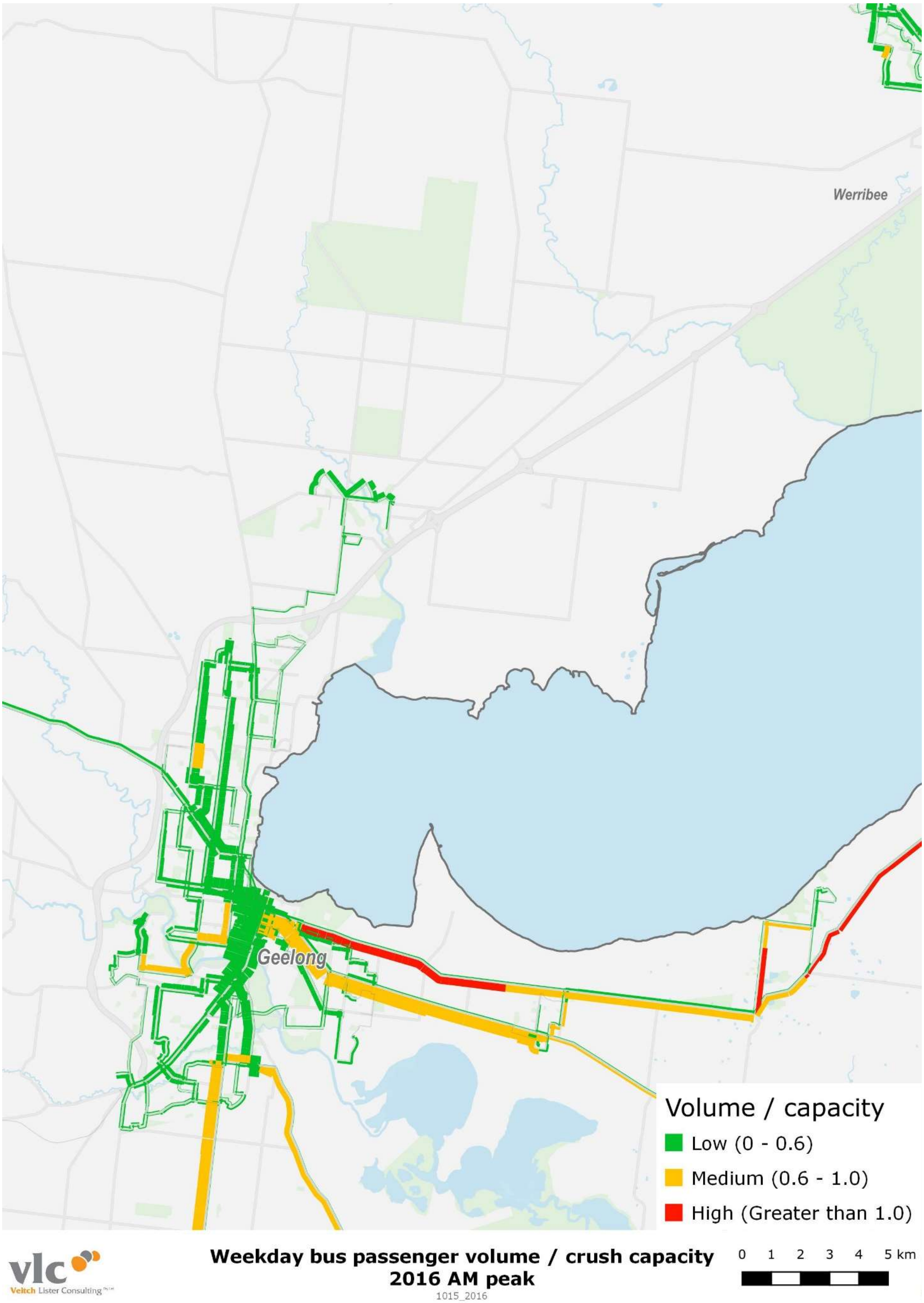
Appendix Figure F-5 – Geelong weekday traffic volume / road capacity - 2031 1-hour PM peak (4-6PM)



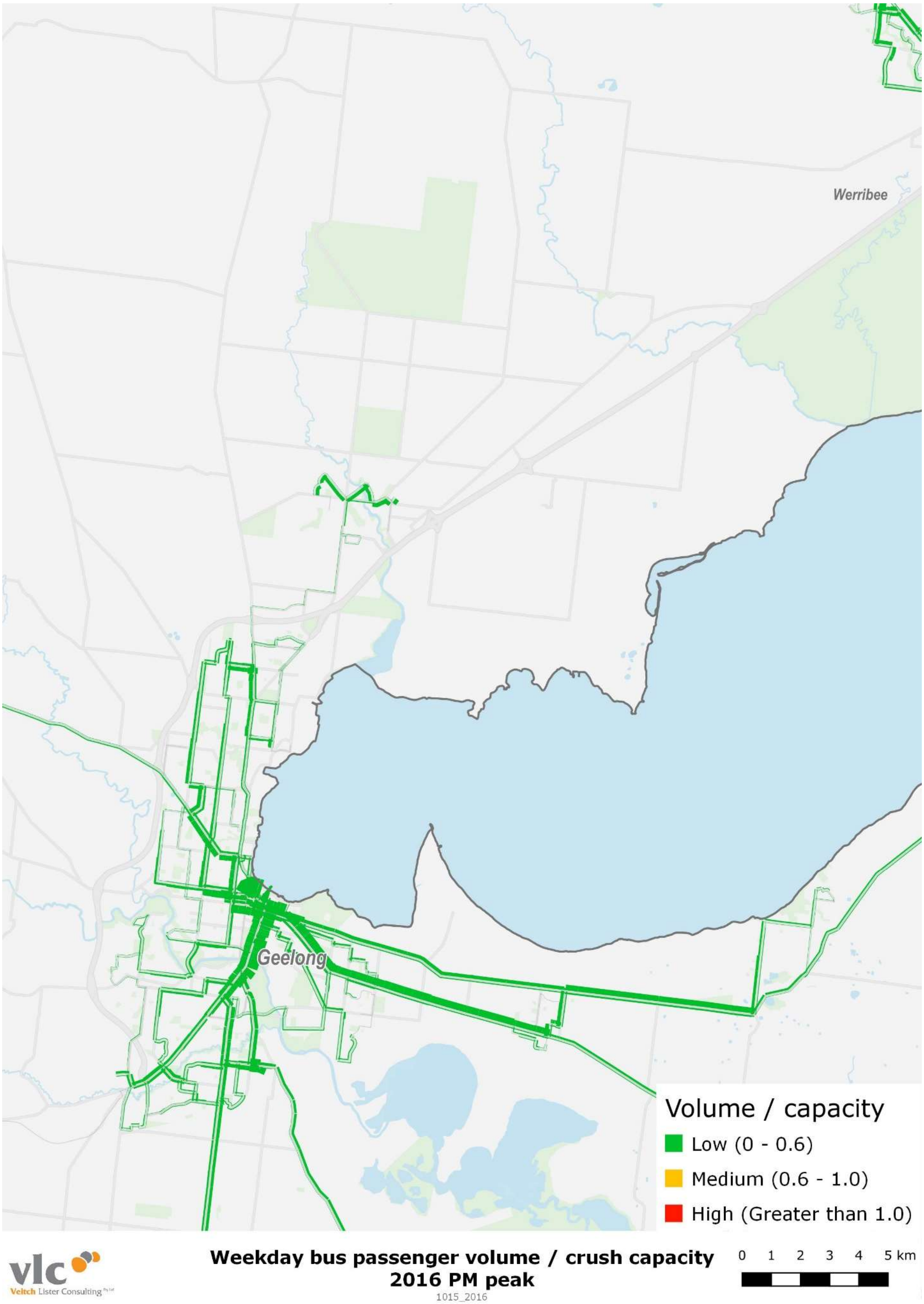
Appendix Figure F-6 – Geelong weekday bus passenger volume growth – 2016 to 2031



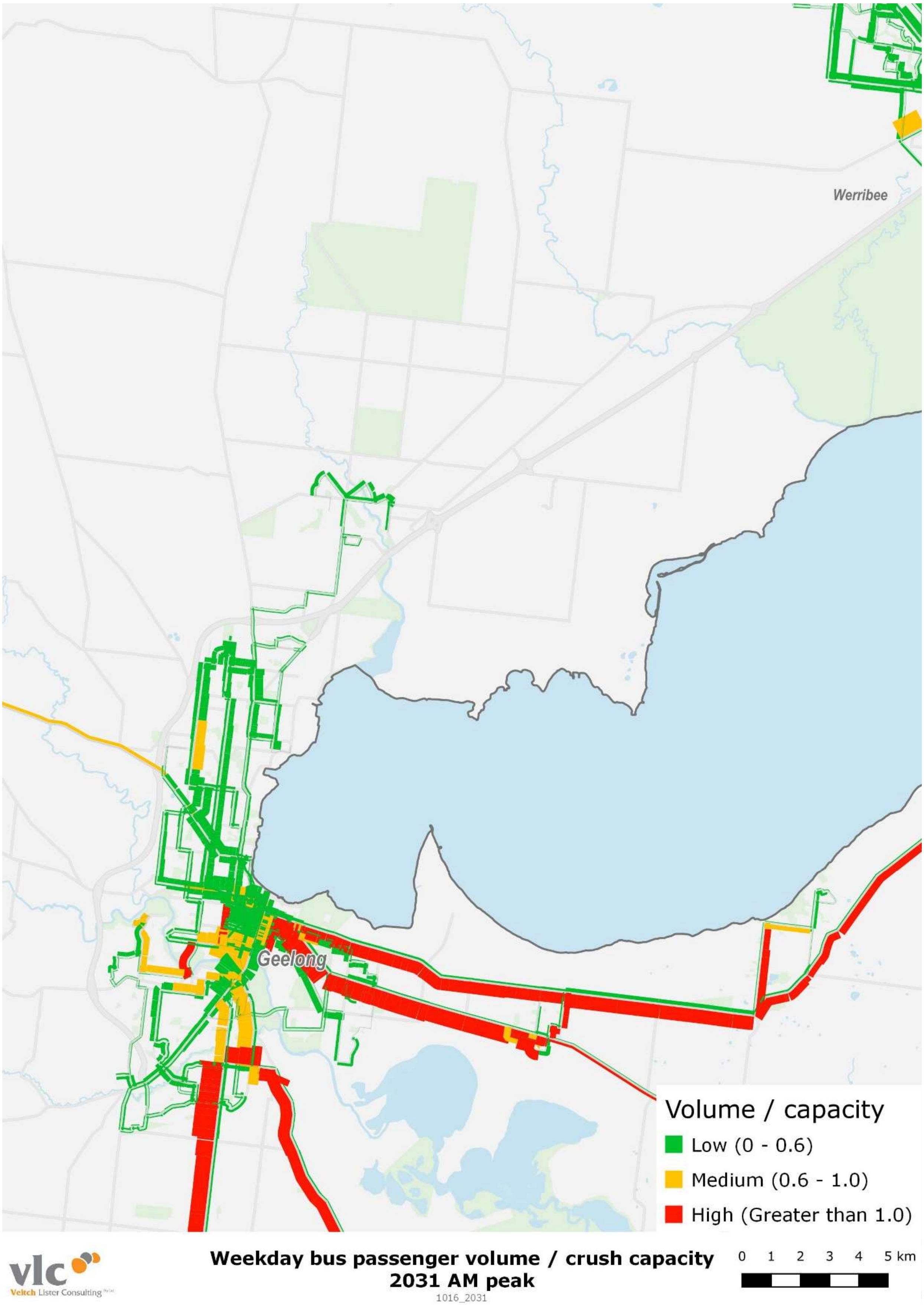
Appendix Figure F-7 – Geelong weekday bus passenger volume / crush capacity - 2016 1-hour AM peak (7-9AM)



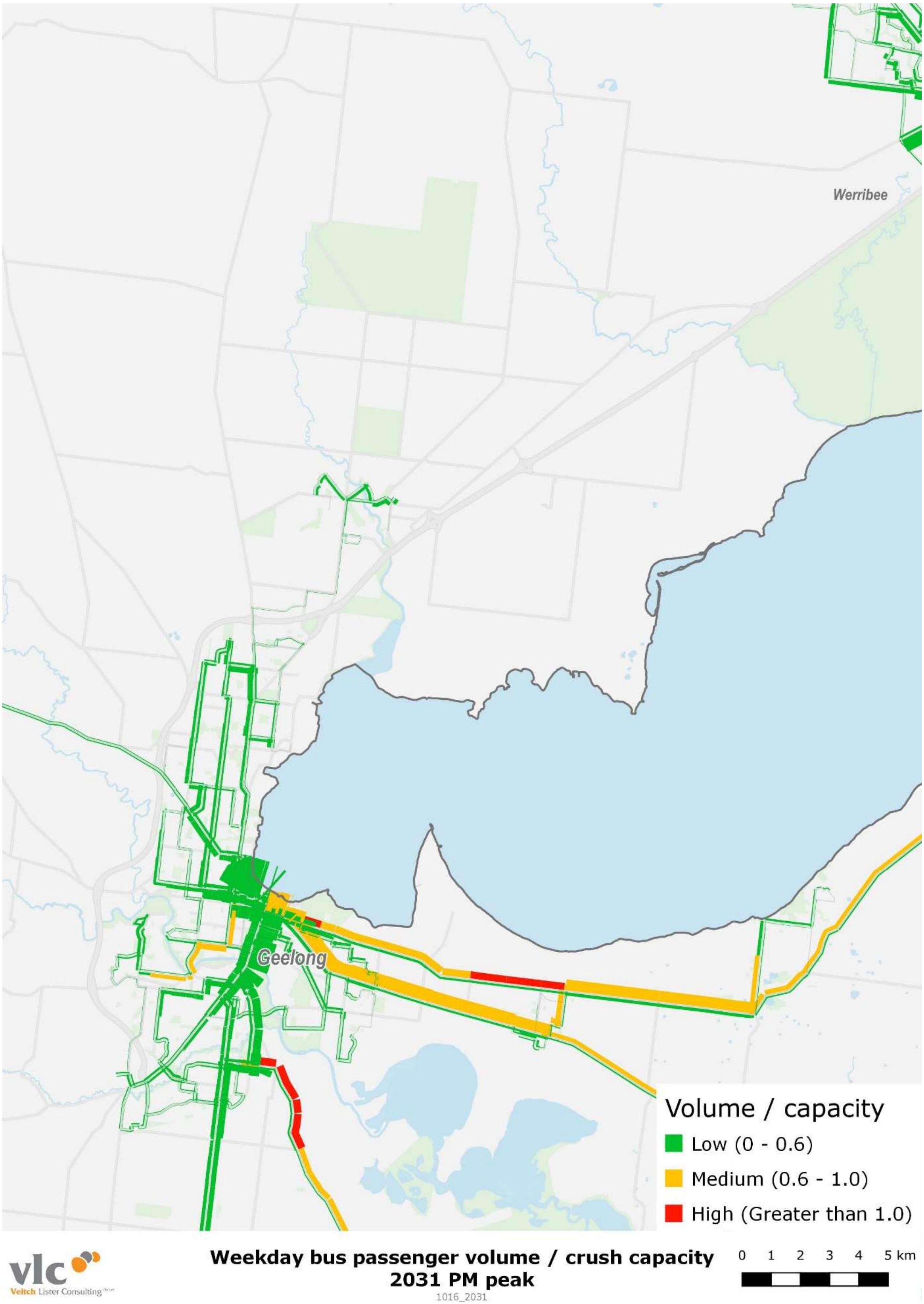
Appendix Figure F-8 – Geelong weekday bus passenger volume / crush capacity - 2016 1-hour PM peak (4-6PM)



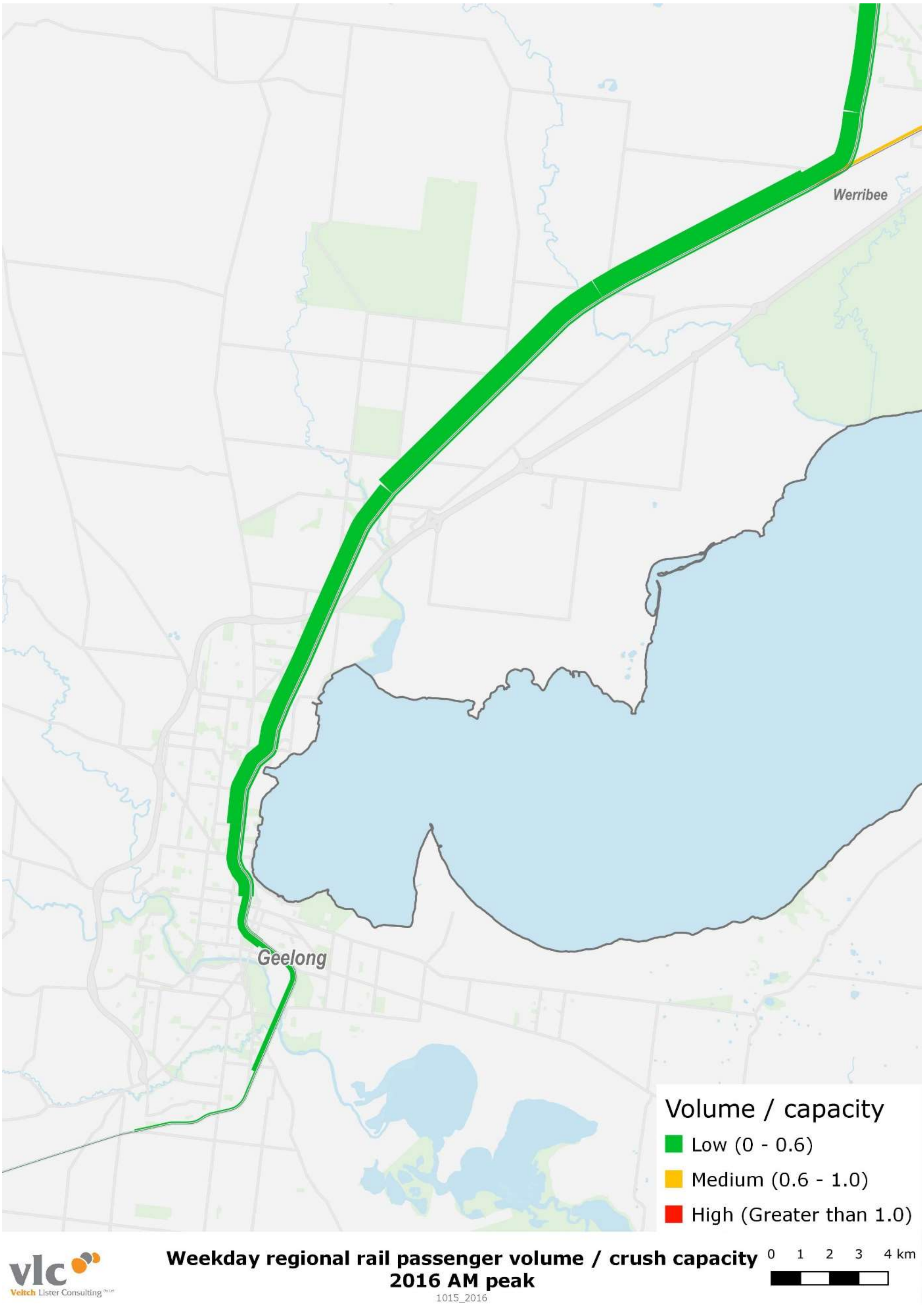
Appendix Figure F-9 – Geelong weekday bus passenger volume / crush capacity - 2031 1-hour AM peak (7-9AM)



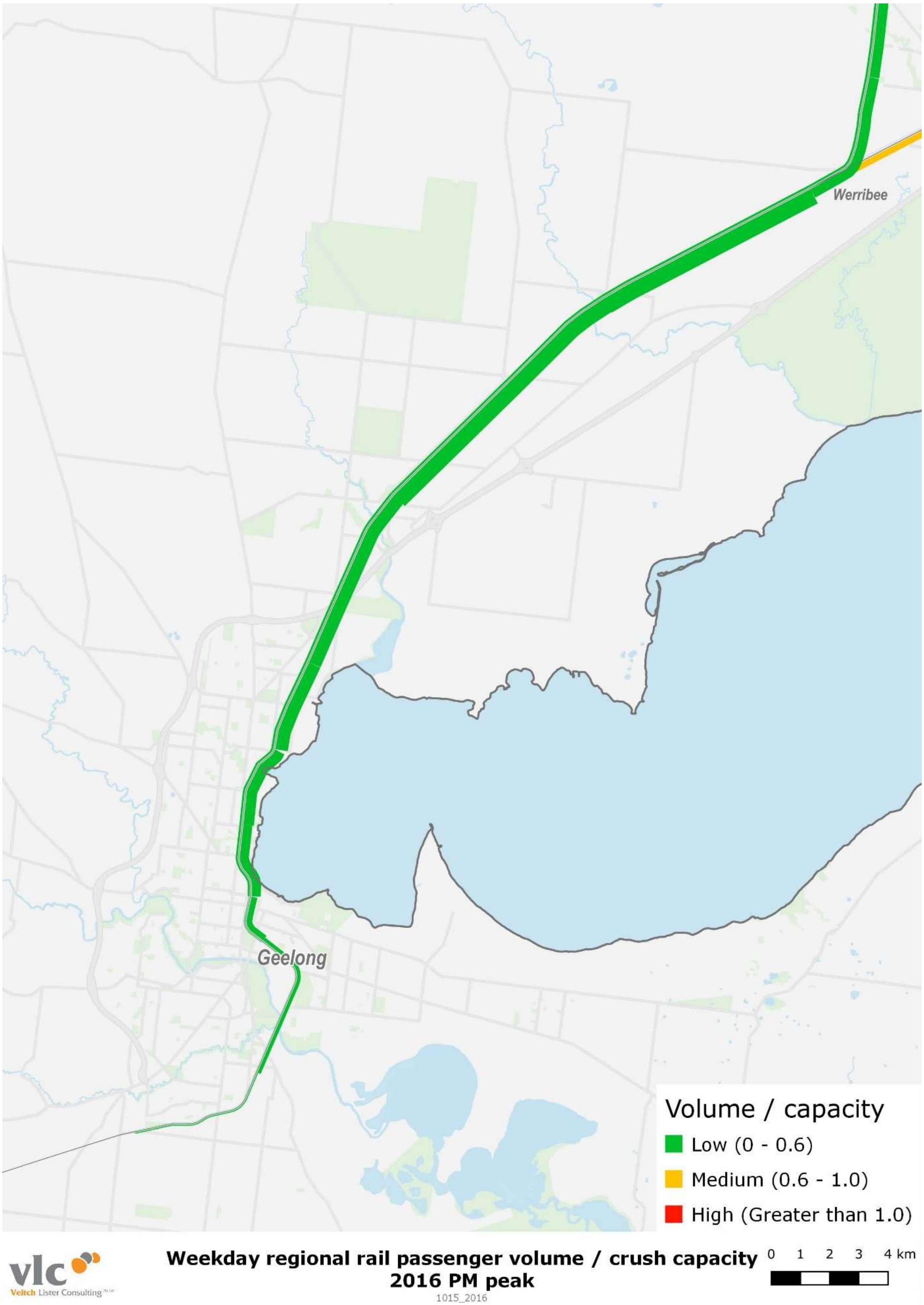
Appendix Figure F-10 – Geelong weekday bus passenger volume / crush capacity - 2031 1-hour PM peak (4-6PM)



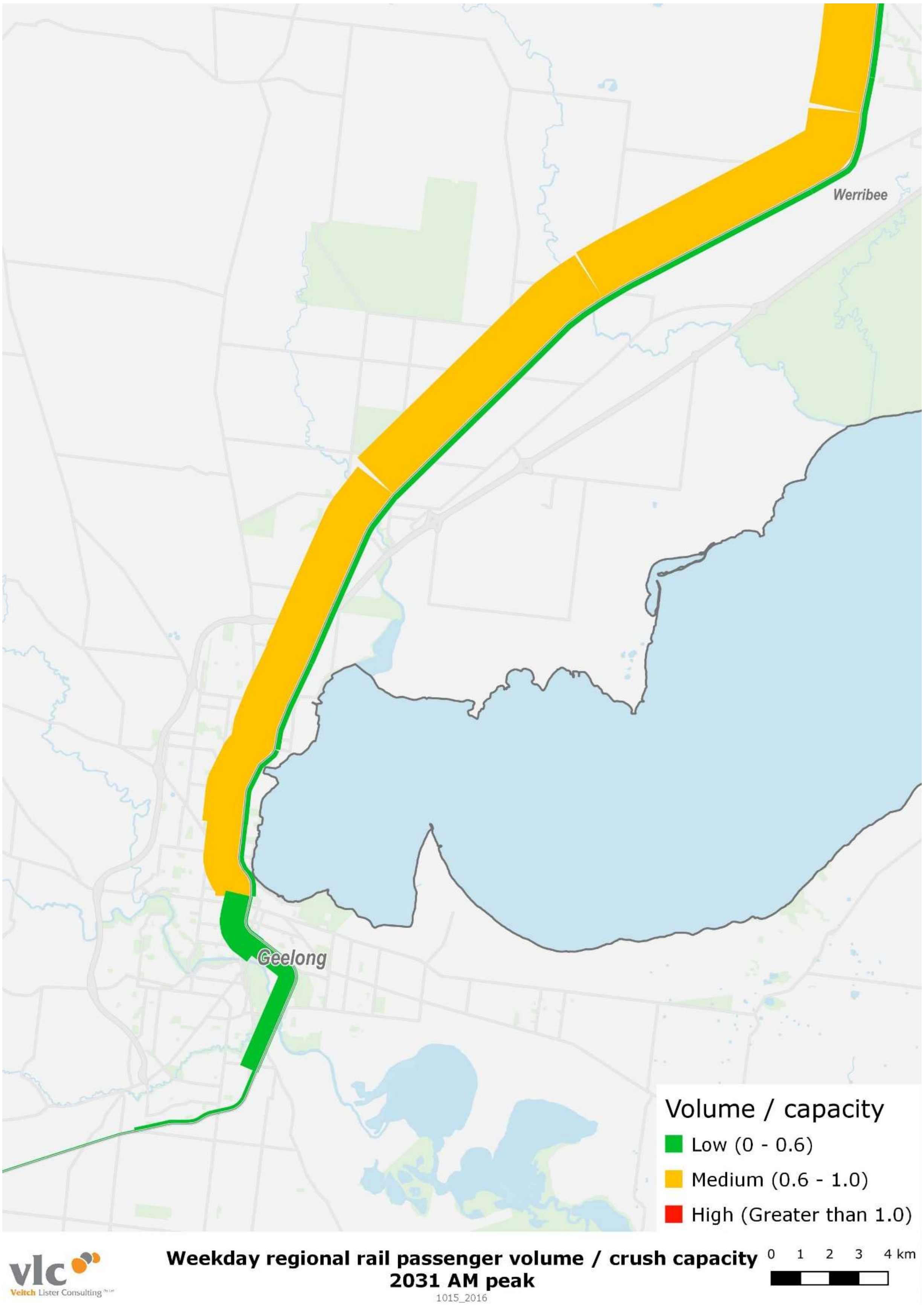
Appendix Figure F-11 – Geelong weekday regional rail passenger volume / crush capacity - 2016 1-hour AM peak (7-9AM)



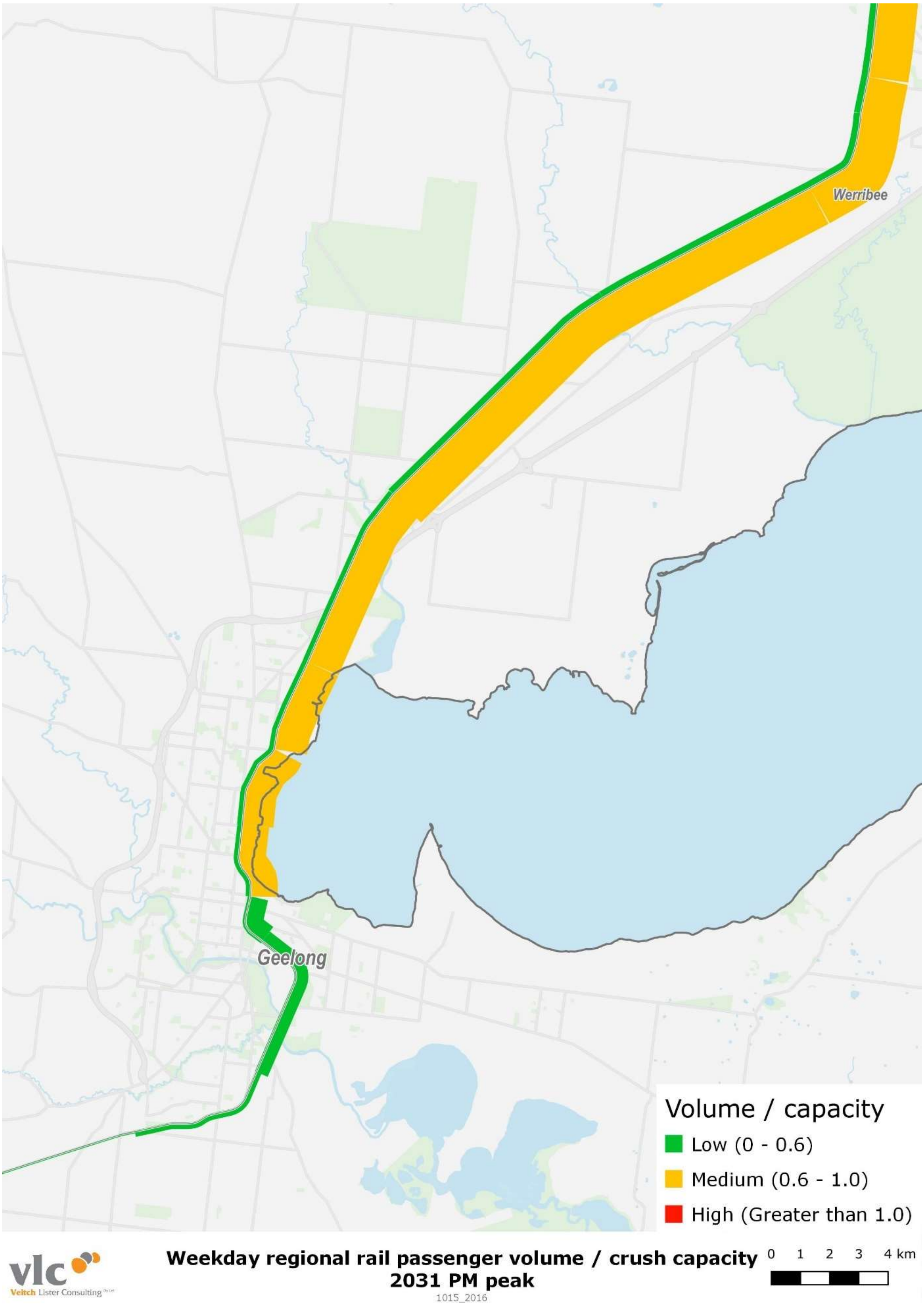
Appendix Figure F-12 – Geelong weekday regional rail passenger volume / crush capacity - 2016 PM peak (4-6PM)



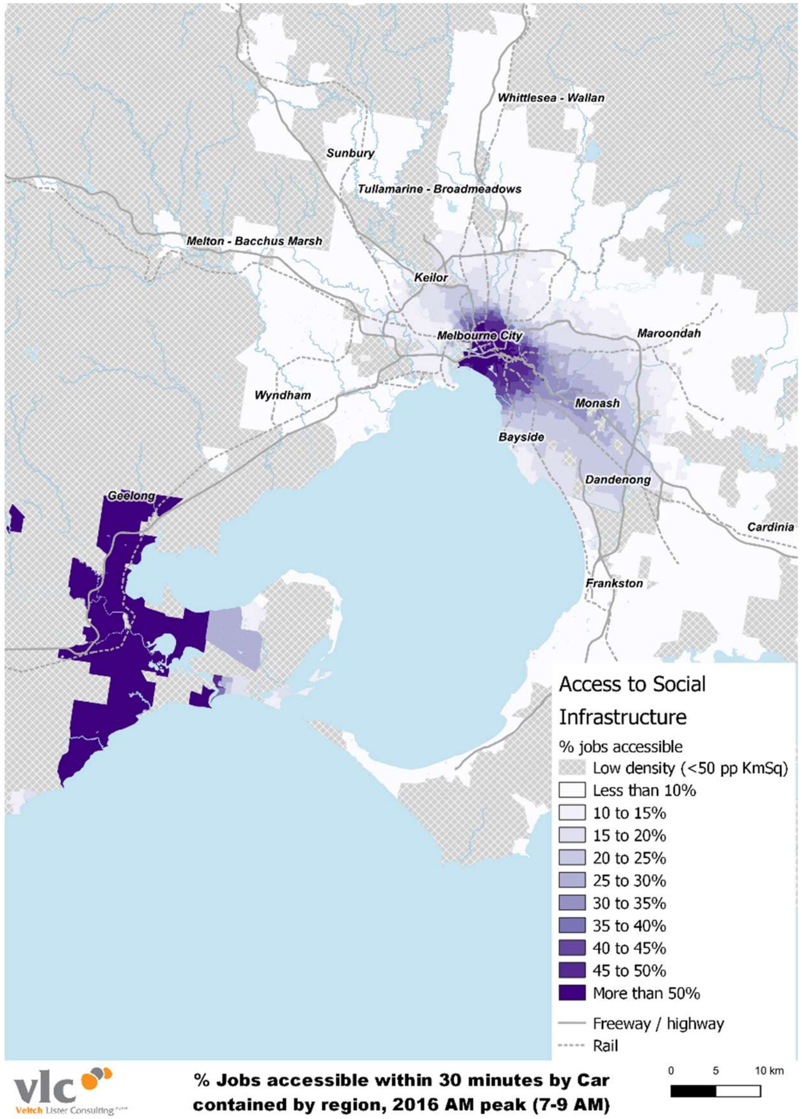
Appendix Figure F-13 – Geelong weekday regional rail passenger volume / crush capacity - 2031 AM peak (7-9AM)



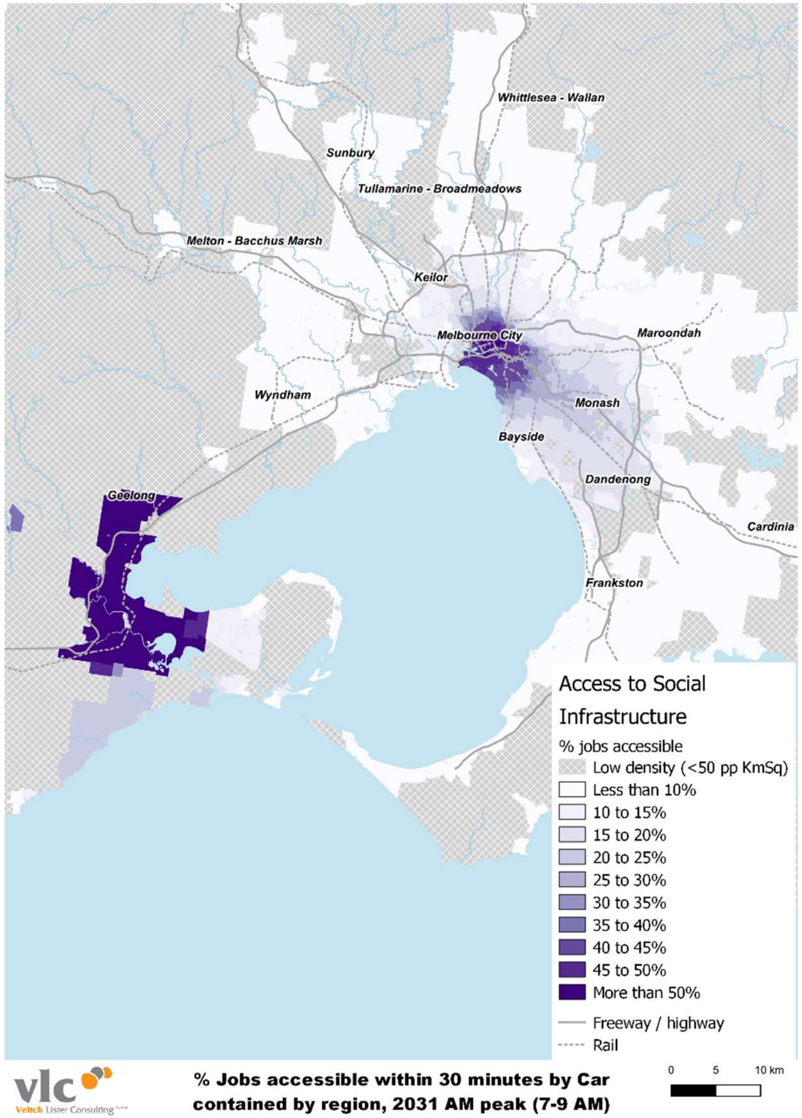
Appendix Figure F-14 – Geelong weekday regional rail passenger volume / crush capacity - 2031 1-hour PM peak (4-6PM)



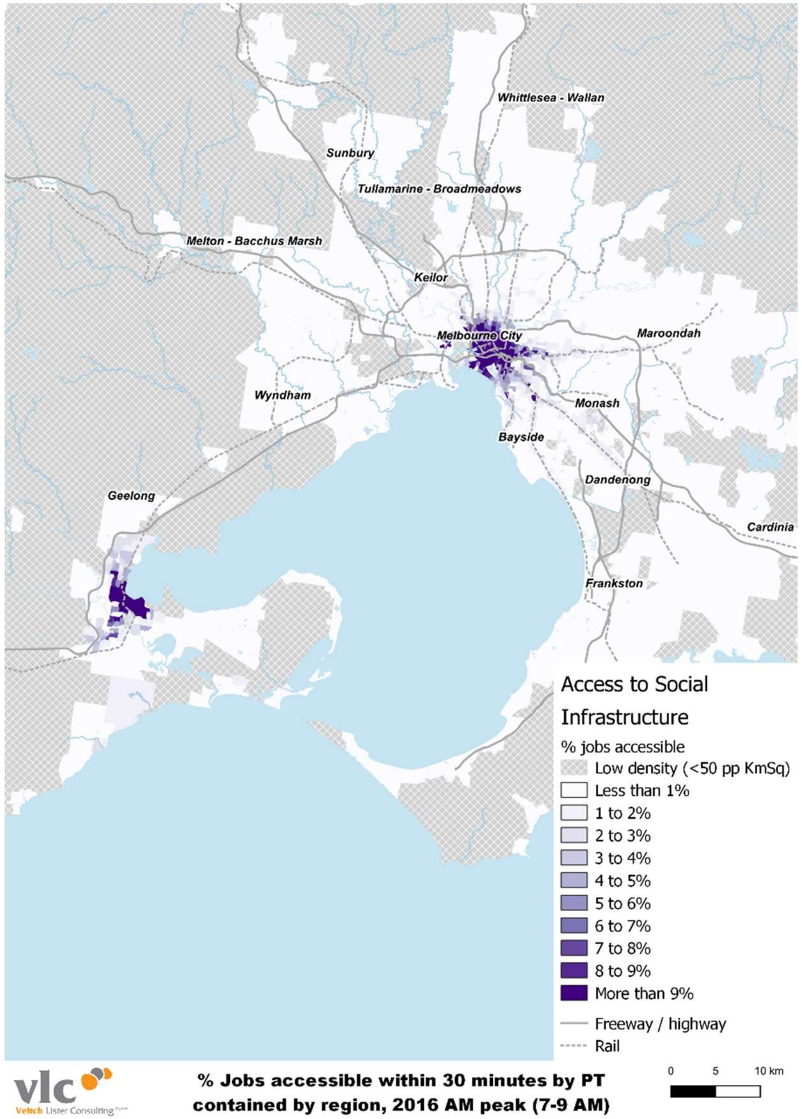
Appendix Figure F-15 – Melbourne GCCSA and Geelong access to jobs by Car, contained by region - 2016 AM peak (7-9AM)



Appendix Figure F-16 – Melbourne GCCSA and Geelong access to jobs by Car, contained by region - 2031 AM peak (7-9AM)



Appendix Figure F-17 – Melbourne GCCSA and Geelong access to jobs by PT, contained by region - 2016 AM peak (7-9AM)



Appendix Figure F-18 – Melbourne GCCSA and Geelong access to jobs by PT, contained by region - 2031 AM peak (7-9AM)