Appendix C1

Suburban Rail Loop Demand Modelling Report

15 February 2021

Disclaimer and limitations

Inherent limitations and economic projections

This report has been prepared as outlined in scope section (Section 1.3). The services provided in connection with this engagement comprise an advisory engagement, which is not subject to assurance or other standards issued by the Australian Auditing and Assurance Standards Board and, consequently no opinions or conclusions intended to convey assurance have been expressed.

Model outputs are always an approximation of what can be expected in the real environment. The Victorian Integrated Transport Model (VITM), CityPlan and the Melbourne Agent and Activity Based Model (MABM) are strategic planning tools that are best at representing strategic level demands and patterns, rather than for small areas, or individual links within a transport network. Notwithstanding this, there will usually be differences between forecasts or projected and actual results because events and circumstances frequently do not occur as expected or predicted, and those differences may be material. KPMG does not make any confirmation or assessment of the commercial merits, technical feasibility or compliance with any applicable legislation or regulation of the transport policy reforms, technology interventions and/or major transport projects described in this report.

No warranty of completeness, accuracy or reliability is given in relation to the statements and representations made by, and the information and documentation provided by Suburban Rail Loop Authority (SRLA) management and personnel consulted as part of the process.

KPMG have indicated within this report the /s of the information provided. We have not sought to independently verify those sources unless otherwise noted within the report.

VITM (including its associated output reporting modules) is a Victorian Government model and KPMG does not accept any liability arising from errors that might be embedded in the model. KPMG was provided VITM by the Victorian Government and has not sought to independently verify the inputs, model logic or outputs (aside from those expressly discussed within the validation section of this report). The VITM version Stage C model was used which was provided to KPMG by the Suburban Rail Loop Authority in July 2020.

KPMG is under no obligation in any circumstance to update this report, in either oral or written form, for events occurring after the report has been issued in final form.

The findings in this report have been formed on the above basis.

COVID-19

The current COVID-19 crisis poses a range of risks to global and Victorian economic conditions, and the length and severity of these impacts remain unknown. COVID-19 has contributed to significant change in work and travel patterns. It has also raised questions about our location decisions including where and how we might choose to live, work and shop for example. It is uncertain however to what extent these immediate impacts will result in a permanent change to travel behaviour and location decisions. The current assumptions underpinning VITM, CityPlan and MABM as provided by DoT (including trip generation and attraction rates, airport patronage forecasts, population forecasts and employment forecasts for example) are based on pre-COVID-19 data. Given the uncertainty of COVID-19 and its long-term impacts, it is likely that there may be material differences between forecasts or projected and actual results.

The VITM, CityPlan and MABM outputs and associated forecasts and projections contained in this report need to be interpreted with an understanding of the above as well as the specific strengths and weaknesses of the relevant models.

Third party reliance

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Glossary

Term	Definition
ABS	Australian Bureau of Statistics
AJM	Aurecon Jacobs Mott MacDonald Joint Venture
AM Peak	The two-hour AM peak period (7:00am to 9:00am) on a typical weekday
ATAP	Australian Transport Assessment and Planning Guidelines
AV	Autonomous vehicle
Base Case	Starting point for the modelling and economic appraisal, consisting of the Reference Case transport network for a given year, but excluding some infrastructure projects such as Suburban Rail Loop (SRL), along with SRL enabled projects and critically interdependent projects
B2B	Business to business cumulative opportunities measure
BRT	Bus Rapid Transit
C2J	Commuter to jobs cumulative opportunities measure
CBD	Central business district of Greater Melbourne, bordered by Spencer Street to the west, La Trobe Street to the north, Spring Street to the east and Flinders Street to the south
CDV	Conventionally driven vehicle
CIE	Centre for International Economics
CLUS	Corridor Land Use Strategy (VPA)
CPZ	CityPlan zone
DELWP	Department of Environment, Land, Water and Planning (Victoria)
DoT	Department of Transport (Victoria)
DTF	Department of Treasury and Finance (Victoria)
Economic Appraisal Report	Suburban Rail Loop Economic Appraisal Report dated 15 February 2021 prepared by KPMG
EV	Electric vehicle
IA	Infrastructure Australia
Inner ring	Inner ring of Greater Melbourne as defined in Section 3
IP	Inter-peak period (9:00 am – 3:00 pm) on a typical weekday
LCM	Location Choice Model
LGA	Local government area
LUTI	Land use and transport interaction model
MABM	Melbourne Activity and Agent-Based Model
MACs	Metropolitan activity centres
MAR	Melbourne Airport Rail
MATSim	Multi Agent Transport Simulation
Middle ring	Middle ring of Greater Melbourne as defined in Section 3
MSD	Melbourne statistical division
MTP	Metro Tunnel Project
MTWP	Method of travel to work

Term	Definition
NEICs	National employment and innovation clusters
NELP	North East Link project
OD	Origin and destination
OMR	Outer Metropolitan Ring Road
OP	Off-peak period (6:00 pm – 7:00am) on a typical weekday
Option A	Timing for delivery of SRL – Cheltenham to Airport to be completed in 2053
Option B	Timing for delivery for SRL – Cheltenham to Airport to be completed in 2043
Outer ring	Outer ring of Greater Melbourne as defined in Section 3
PHT	Passenger Hours Travelled
PKT	Passenger Kilometres Travelled
PM peak	The three-hour PM peak period (3:00 – 6:00 pm) on a typical weekday
Program Case	The representation of the SRL – Cheltenham to Airport scenario (including rail and precinct initiatives) for the modelling and economic appraisal, to compare against the Base Case scenario
PT	Public transport
PV	Private vehicle
Radial	Radial may be used to describe radial services, radial lines or radial network, which reflects the structure of the rail network where rail lines converge in the central city
Reference Case	A set of current and future year network, land use and transport cost assumptions used for transport modelling in Victoria (developed and managed by DoT)
RPV	Rail Projects Victoria
SALUP	Small Area Land Use Projections (Victorian Government land use forecasts) based on DELWP Projections 2018 (Unpublished)
SAV	Shared autonomous vehicle
SRL	Suburban Rail Loop, an orbital rail loop connecting Melbourne's middle suburbs stretching from Cheltenham to Werribee, together with a series of integrated initiatives to create value and improve the precincts around the new stations
SRL Business and Investment Case	The Business and Investment Case for SRL – Cheltenham to Airport providing the strategic rationale for the eastern and northern sections of SRL
SRL East	Section of the Suburban Rail Loop between Cheltenham and Box Hill
SRL North	Section of the Suburban Rail Loop between Box Hill and Melbourne Airport
SRL Precincts	An area which is a 1600m radius around an SRL station. The SRL East Precincts are: • Cheltenham Precinct • Clayton Precinct • Monash Precinct • Glen Waverley Precinct • Burwood Precinct • Box Hill Precinct The SRL North Precincts are: • Doncaster Precinct • Heidelberg Precinct • Bundoora Precinct • Reservoir Precinct

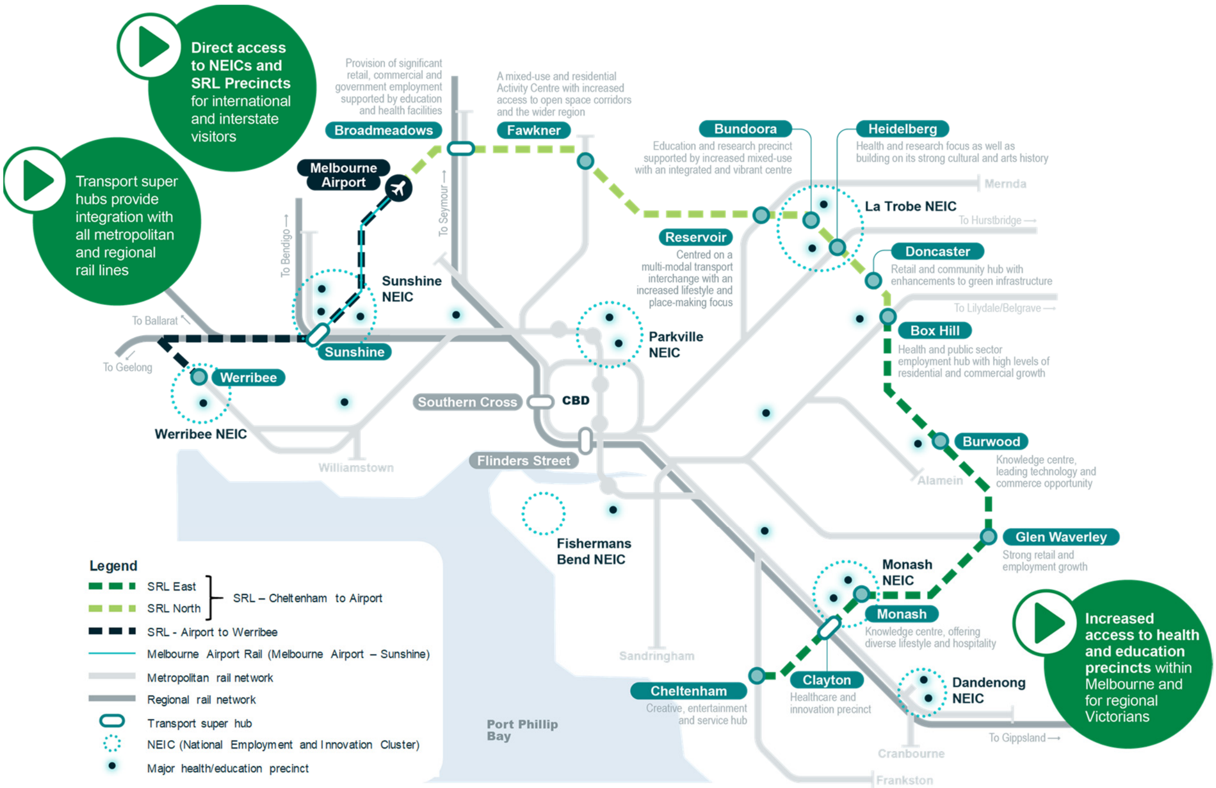
Term	Definition
	• Fawkner Precinct • Broadmeadows Precinct • Melbourne Airport (anchor precinct)
SRL – Airport to Werribee	The section of SRL from Melbourne Airport to Werribee, together with a series of integrated initiatives to create value and improve the precincts in and around the new stations
SRL – Cheltenham to Airport	The section of SRL from Cheltenham to Melbourne Airport, together with a series of integrated initiatives to create value and improve the precincts in and around the new stations
SRLA	Suburban Rail Loop Authority
TNP	Transport network pricing
VHT	Vehicle Hours Travelled
VIF	Victoria in Future
VISTA	Victorian Integrated Survey of Travel and Activity
VITM	Victorian Integrated Transport Model
VKT	Vehicle kilometres travelled
VPA	Victorian Planning Authority
WFH	Working from home

Executive Summary

The Business and Investment Case (**SRL Business and Investment Case**) articulates the strategic rationale for the section of SRL between Cheltenham and Melbourne Airport (**SRL – Cheltenham to Airport**), which will be delivered by the Suburban Rail Loop Authority (**SRLA**). SRL – Cheltenham to Airport is a multi-generational, transformative, city and State-shaping investment that will transform Victoria's public transport system and deliver urban renewal outcomes for Melbourne.

The SRL – Cheltenham to Airport alignment is shown in the following figure.

Figure ES - 1: SRL – Cheltenham to Airport alignment (2056)



Source: SRLA

An investment of this scale requires a sequenced approach. For the purposes of this assessment, it has been assumed that SRL – Cheltenham to Airport will be delivered in three sections: between Cheltenham and Box Hill, followed by Box Hill to Reservoir and then Reservoir to Melbourne Airport.[1] For ease of reference, the section between Cheltenham and Box Hill is referred to as **SRL East**, and the section between Box Hill and Melbourne Airport is referred to as **SRL North**. For the purposes of the demand modelling and economic appraisal, two Program Cases have been assessed with SRL – Cheltenham to Airport delivered by 2053 (**Option A**) and by 2043 (**Option B**). As SRL North is

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[1] SRLA advises that further detailed planning and technical design for SRL North will be undertaken over the coming years. Specific packaging and procurement decisions will be made at an appropriate time in the future.

still in early planning, the assessment of two Program Cases reflects that final delivery dates are yet to be confirmed.

The power of city-shaping infrastructure

Strategic or 'city-shaping' transport infrastructure has the power to alter relative accessibility across a city and change a city's development patterns and growth projections. It influences where a business chooses to locate and where a person chooses to live. It can make locations more attractive, generating urban renewal. More broadly, it can continue to influence behaviour and generate land use changes long after it has been built.

When new areas become more attractive because of city-shaping infrastructure, this redirects the property market and intensifies urban development, leading to a shift in urban form. This shift in urban form can include increasing density and new mixed-use opportunities in a precinct. This dynamic is evident in projects such as Melbourne's City Loop, West Gate Bridge, Western Ring Road, CityLink or EastLink, that all helped balance Melbourne's lopsided growth in the south-east to the north-west and west.

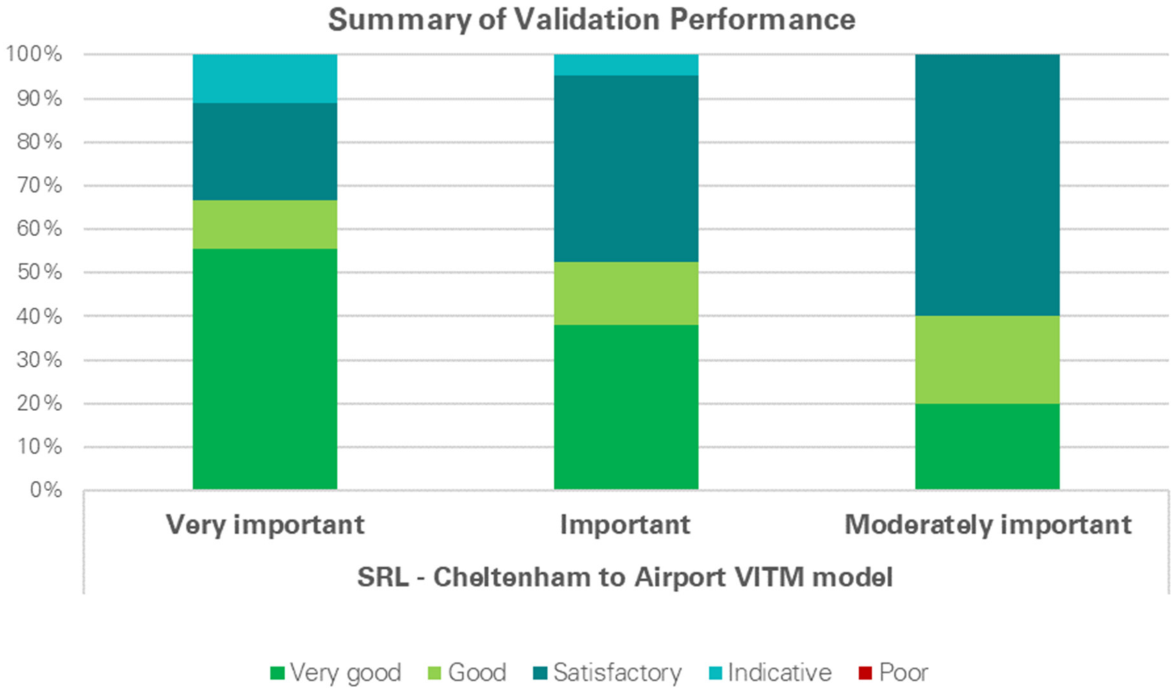
Assessing SRL – Cheltenham to Airport

A 4th generation Land Use Transport Interaction (**LUTI**) model using the UrbanSim platform was used to assess the land use, and city-shaping impacts of SRL – Cheltenham to Airport. CityPlan is a scenario analysis tool which estimates the expected city-shaping impacts of interventions such as changes in planning policy, population growth and the supply of major infrastructure. KPMG used the CityPlan and Victorian Integrated Transport Model (**VITM**) to forecast the transport and land use demands. KPMG also used the Melbourne Activity and Agent-Based Model (**MABM**) to provide a beneficiary and customer insight assessment. This report details the methodology and results of this strategic modelling.

Demand model validation

The outcomes of the VITM validation assessment used in the final SRL Business and Investment Case demonstrated that the SRL – Cheltenham to Airport VITM model showed acceptable validation performance, including the prioritised measures that were deemed critical for modelling the Program Case, as shown in the following figure.

Figure ES - 2: Summary of VITM validation performance



Source: KPMG analysis of VITM modelling

As outlined in Volume A of this report, the model compared well against aggregate demand measures as expected, and also reasonably well for the SRL – Cheltenham to Airport project area measures, including train station boardings, orbital trips and screenline traffic volumes. The assessment also showed that VITM reaches a good level of model loop and highway assignment convergence. The results from the validation analysis suggested that the model is suitable for assessing high level demand differences due to the project.

Similarly, the calibration and validation of CityPlan is deemed fit for purpose for application in an SRL context. The results of the calibration and validation of CityPlan are described in detail in a separate report, CityPlan Volume 2: Calibration and Validation Report, and a summary is provided within Volume B of this report.

Validation of MABM is outlined within Volume C of this report. Furthermore, the forecast demand drawn from MABM closely represents the forecast demand from VITM which demonstrates the consistency of the two models in demand forecasting. This indicates the appropriateness of using MABM as a complementary tool to VITM for drawing insights relating to customers and beneficiaries of SRL – Cheltenham to Airport.

Key Findings

Melbourne without SRL – Cheltenham to Airport

The strategic transport modelling indicates that many of the stresses of rapid population growth and the constraints of Melbourne’s urban form will persist, and in some cases, worsen over time without intervention.

Melbourne’s monocentric network focus, with movement mainly focused on radial trips in and out of the city centre, continues into the future. As a result, existing issues around congestion, travel time and accessibility within Melbourne will persist and worsen in the future without SRL – Cheltenham SRL – Cheltenham to Airport.

The current radial train network already experiences significant capacity constraints which will worsen over time. While significant committed and proposed rail network upgrades provide some relief in 2036, the growing transport demands of the city result in increased crowding, with capacity being met or exceeded on an increasing number of line sections in 2056.

For people travelling by private vehicle, travel times to the Central Business District (**CBD**) and to tertiary education will increase in 2036 relative to 2018, and then again in 2056. This increase in travel times between 2036 and 2056 is most pronounced in outer areas. Other key economic precincts across Melbourne that are not well connected by public transport will be significantly affected by slower private vehicle journey times.

Many Melburnians are reliant on car travel to access employment opportunities outside of the central city, exacerbating congestion, especially in areas with poor public transport connectivity. This worsens into the future, reflected in peak period average speeds, which between 2018 and 2056 fall from 36 km/h to 31 km/h in the AM peak, and from 38 km/h to 30 km/h in the PM peak.

National Employment and Innovation Clusters (**NEICs**) in the middle ring of Melbourne, such as Monash and La Trobe, are poorly serviced by public transport and hence heavily reliant on car travel for access. The proportion of Greater Melbourne accessible within 60 minutes of Monash by car declines from 61% in 2018 to 44% in 2056. The proportion of Greater Melbourne within 60 minutes of Bundoora by car declines from 61% in 2018 to 36% in 2056.

Public transport mode share in middle and outer precincts and NEICs is very low compared to the CBD. Poor public transport connectivity combined with a more congested road network will limit the potential of these key economic precincts. Whilst inner areas see accessibility to jobs and education improve over time, the middle and outer suburbs see a decline in accessibility over time, driven by increased congestion and travel times.

Melbourne with SRL – Cheltenham to Airport

Creating a city of centres

The introduction of SRL – Cheltenham to Airport has a significant impact on where people live and work, and on how people move around Greater Melbourne, with the city shifting to a more polycentric form. This will help realise *Plan Melbourne's* vision to transform Melbourne into a 'city of centres'.

The LUTI modelling using VITM and CityPlan has forecast that the introduction of SRL – Cheltenham to Airport, versus a scenario in which it is not completed will result in a 26% increase in the number of households across the 13 SRL East and SRL North Precincts in 2056, and a 43% increase in the number of jobs is also expected compared to the same future without SRL – Cheltenham to Airport.

With SRL – Cheltenham to Airport, more people will work and live in precincts with good access to jobs, services and amenities, with SRL East and SRL North Precincts expected to have around 232,000 households and 545,000 jobs by 2056. Communities, businesses and institutions located in SRL East and SRL North Precincts, and more broadly, across Melbourne's middle corridor, will benefit from increased economic activity and the creation of more vibrant communities.

By 2056, SRL – Cheltenham to Airport, versus a future without SRL – Cheltenham to Airport, will generate an additional:

- 26% increase in the number of households in the 13 SRL East and SRL North Precincts
- 43% increase in the number of jobs in the 13 SRL East and SRL North Precincts
- 46% increase in knowledge based jobs within SRL East and SRL North Precincts – improving access to knowledge based jobs and services
- 12%, on average increase, in land values in SRL East and SRL North Precincts.

Transforming how we travel

SRL – Cheltenham to Airport will transform how people and goods move around Greater Melbourne and Victoria. With new public transport connections and more people living and working in the SRL East and SRL North Precincts, accessibility to opportunities, travel times and public transport patronage, all improve with SRL – Cheltenham to Airport.

Benefits for **SRL – Cheltenham to Airport passengers**

More than 430,000 orbital journeys will occur per day, enabling direct access and connectivity across the middle ring

Passengers will enjoy a median travel time saving of 40 minutes for a one-way journey compared to a radial rail journey today

The busiest SRL – Cheltenham to Airport hubs will facilitate around 90,000 transfers per day more than twice the transfers enabled by Richmond or Parliament stations today

Turn up and go service, enabling efficient journeys and reducing wait times

Benefits for **public transport passengers**

More than **230,000 extra public transport trips per day** across Melbourne compared to a future without SRL – Cheltenham to Airport

Crowding will be reduced on Melbourne's busiest radial rail lines

Passengers in the outer ring and Regional Victoria will be able to transfer at stations along the SRL – Cheltenham to Airport corridor improving their ability to move around the city more efficiently

More than 80 per cent of Melburnians will experience a more efficient journey

Benefits for **road users**

There will be over 600,000 fewer vehicle-based journeys across Melbourne per day

Travel time savings of 110,000 hours per day

Major roads, such as the Monash Freeway and Tullamarine Freeway, will experience improved speeds and support travel time savings of up to 14 per cent between strategic precincts

Source: KPMG analysis of VITM modelling

Benefitting Melburnians and Victorians

Many different cohorts of the Victorian community will benefit from SRL – Cheltenham to Airport. By reducing reliance on private vehicles for orbital trips, SRL – Cheltenham to Airport will also help to make travel more affordable and alleviate household financial stress, increasing the amount of household income available to spend on items such as fresh food, education and health. This provides households with new opportunities and the ability to best support their health and education outcomes. More affordable transport will also mean that households should be able to save more and establish a financial buffer in the event of a sudden economic downturn or difficulties.

SRL – Cheltenham to Airport customer insights indicate that:

Workers
in the middle and northern suburbs of Melbourne particularly benefit from SRL – Cheltenham to Airport

ORBITAL TRAVEL

72% of workers using SRL – Cheltenham to Airport are those who **work** in the **middle suburbs**

76% of people who use SRL – Cheltenham to Airport **live** in the **middle suburbs** and **outer north**

LOW INCOME
SRL – Cheltenham to Airport is used by people who need it most. **65%** of workers using SRL – Cheltenham to Airport are in the low income categories

77% of people using SRL – Cheltenham to Airport are in the **working age cohort** and **17%** of them are **tertiary-aged young people**

Lower and middle income households
will benefit the most from SRL – Cheltenham to Airport

Residents in middle and outer suburbs
People who benefit from SRL – Cheltenham to Airport mainly live in the middle and outer suburbs

Age
SRL – Cheltenham to Airport will bring the most benefits to tertiary-aged travellers (18-25) and middle aged persons (40-64)

Source: KPMG analysis of MABM modelling

Sensitivity assessments

The SRL – Cheltenham to Airport demand modelling appraisal horizon spans over five decades. Within this period, it is likely that the supply of transport infrastructure and people's behaviour towards transport costs and accessibility might evolve. These uncertainties, which may impact transport demand and hence the economic viability of the project, may include potential changes in future demographics and travel patterns (e.g. due to the impact of COVID-19), changes to vehicle fleet including adoption of autonomous vehicles (**AV**), alternative fare structures, and users' inherent preference for public transport.

A range of sensitivity assessments have been undertaken, taking into consideration the impacts of land use changes as well as the resultant transport demand changes to incorporate these uncertainties. These assessments provide confidence that while the future may be uncertain, in all scenarios SRL – Cheltenham to Airport will help shape Melbourne's growth and travel patterns in a positive way, facilitating improved public transport use, and better access and outcomes for Victoria.

1. Introduction

1.1 Overview

The Suburban Rail Loop (**SRL**) is a transformative, city- and State-shaping investment that will enhance Victoria's public transport system and deliver urban renewal outcomes. It includes a new 90 kilometre rail link connecting Melbourne's middle suburbs from Cheltenham to Werribee and a series of integrated initiatives to create value and improve the precincts around the new stations.

The Business and Investment Case (**SRL Business and Investment Case**) articulates the strategic rationale for the section of SRL between Cheltenham and Melbourne Airport (**SRL – Cheltenham to Airport**), which will be delivered by the Suburban Rail Loop Authority (**SRLA**).

An investment of this scale requires a sequenced approach. For the purposes of this assessment, it has been assumed that SRL – Cheltenham to Airport will be delivered in three sections: between Cheltenham and Box Hill, followed by Box Hill to Reservoir and then Reservoir to Melbourne Airport.[2] For ease of reference, the section between Cheltenham and Box Hill is referred to as **SRL East**, and the section between Box Hill and Melbourne Airport is referred to as **SRL North**. For the purposes of the demand modelling and economic appraisal, two Program Cases have been assessed with SRL – Cheltenham to Airport delivered by 2053 (**Option A**) and by 2043 (**Option B**). As SRL North is still in early planning, the assessment of two Program Cases reflects that final delivery dates are yet to be confirmed. More detail on SRL – Cheltenham to Airport is provided in Chapter 2.

The coordinated investments in rail infrastructure and precinct initiatives will deliver a step-change in economic outcomes transforming our communities for generations. To underpin the economic appraisal of SRL – Cheltenham to Airport that supports the SRL Business and Investment Case, tailored transport and land use modelling was undertaken by KPMG to reflect the scale, intergenerational nature and city-shaping impact of SRL – Cheltenham to Airport. Along with the use of the Victorian Integrated Transport Model (**VITM**), broader demand modelling techniques have been incorporated using a fourth generation land use and transport interaction model (**CityPlan**), as well as the Melbourne Agent and Activity Based Model (**MABM**). The modelling was undertaken to provide comprehensive insights for the SRL Business and Investment Case and the accompanying economic assessment.

This report details the methodology and results of the strategic modelling undertaken for SRL – Cheltenham to Airport.

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[2] SRLA advises that further detailed planning and technical design for SRL North will be undertaken over the coming years. Specific packaging and procurement decisions will be made at an appropriate time in the future.

1.2 Purpose

The strategic modelling detailed in this report has been undertaken to understand the impact of SRL – Cheltenham to Airport, a city-shaping investment including both a rail line and an indicative package of precinct initiatives designed to enhance productivity, connectivity and liveability for citizens across Victoria. The transport demand and land use modelling results presented in this report have been used as inputs to the economic appraisal of SRL – Cheltenham to Airport, as detailed in Suburban Rail Loop Economic Modelling Report dated 15 February 2021 prepared by KPMG (and herein after referred to as the **Economic Appraisal Report**).

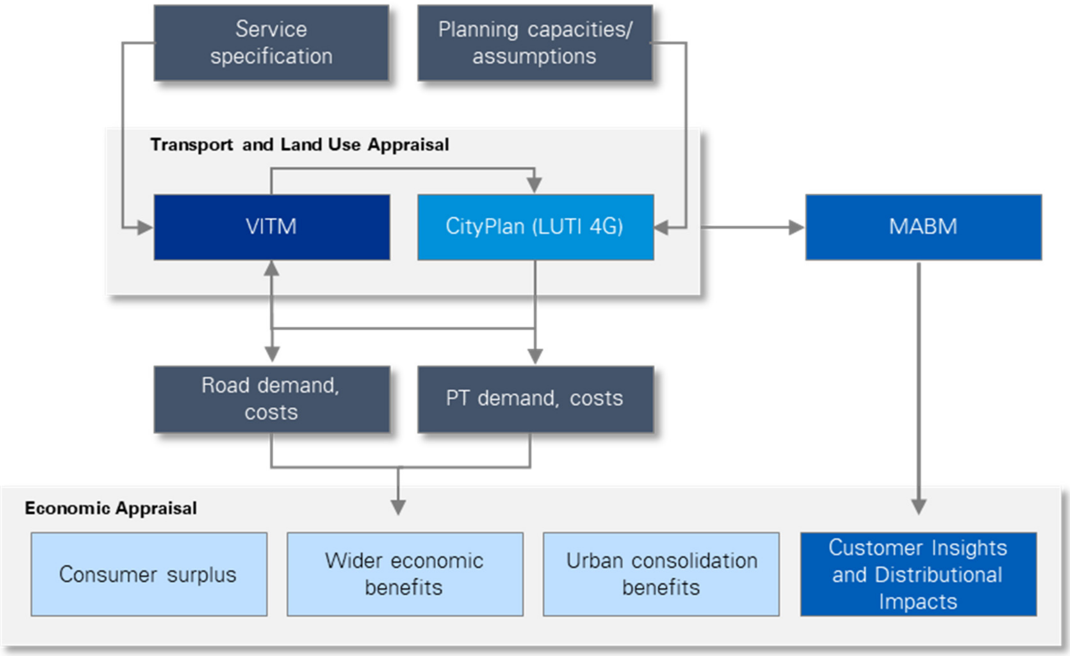
This report details the transport demand and land-use modelling approach adopted for SRL – Cheltenham to Airport and summarises the results.

1.3 Scope of demand modelling

KPMG has undertaken strategic transport and land use demand modelling using VITM, CityPlan and MABM modelling tools to inform the SRL Business and Investment Case and Economic Appraisal of SRL – Cheltenham to Airport. This scope does not include demand modelling for design purposes, which is part of a separate package of works. As it is an integrated land use and transport investment, the benefits generated by SRL – Cheltenham to Airport are intrinsically linked to both the enhanced transport connections and precinct development initiatives. As such, the demand modelling is assessed taking into consideration both elements.

The modelling approach used is considered appropriate for the scale and impact of the intergenerational and city-shaping nature of SRL. The modelling draws upon the relevant transport demand and land-use demand modelling guidelines and assumptions agreed with key stakeholders, including the Victorian Department of Transport (**DoT**) and SRLA. Figure 1-1 summarises the demand modelling framework adopted for SRL.

Figure 1-1: Strategic Modelling Interactions

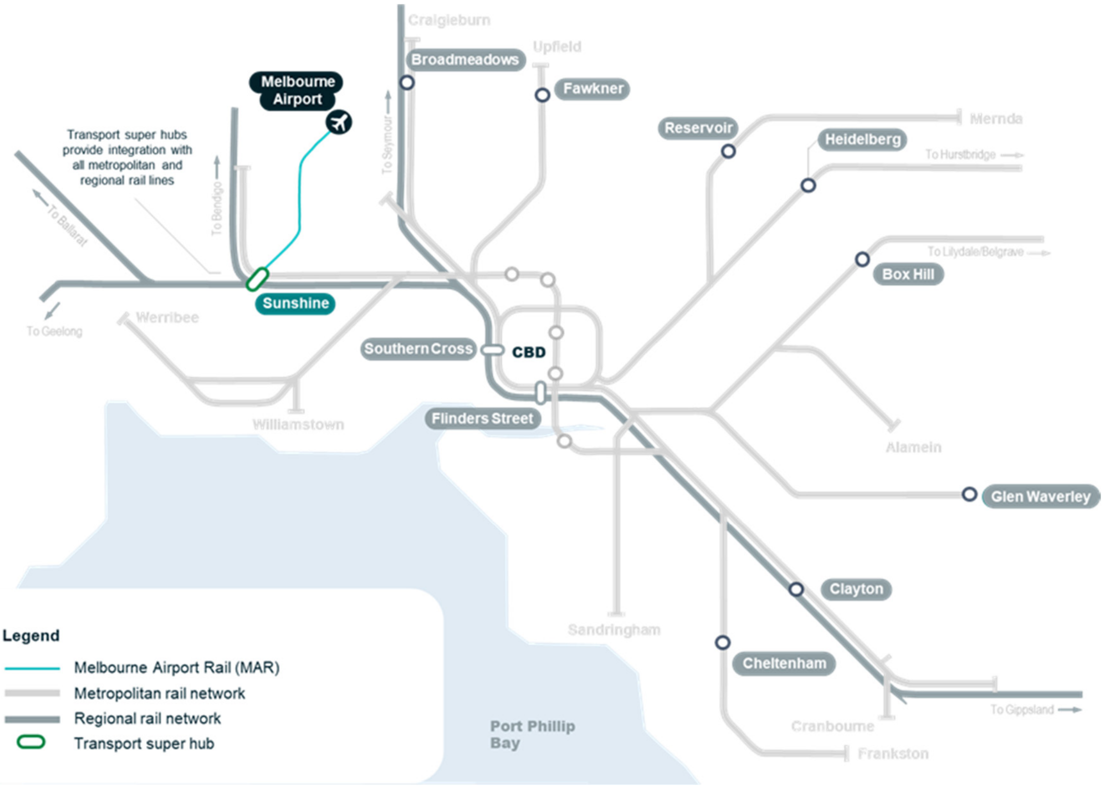


Source: KPMG modelling framework agreed with DoT and SRLA

The economic evaluation assesses and compares the incremental costs and benefits of SRL – Cheltenham to Airport (Program Cases) to a future without the investment (Base Case). Both the Program Case and Base Case were modelled using the above modelling framework and are noted below:

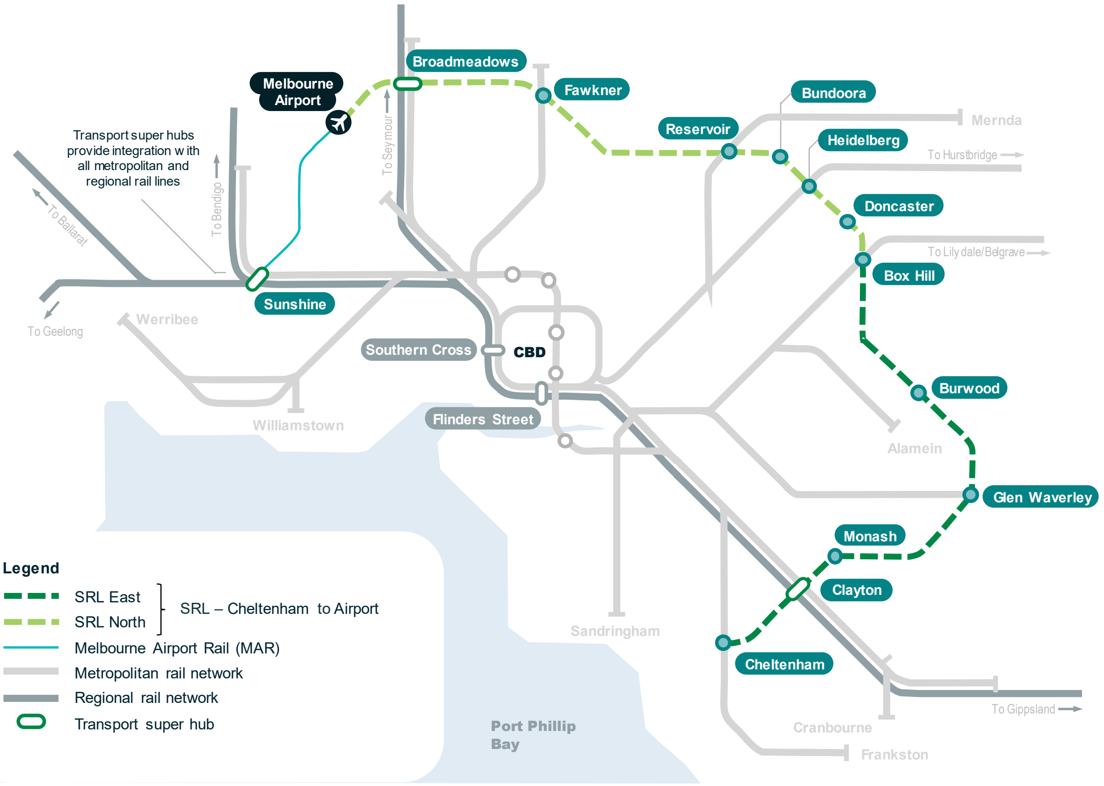
- **Base Case** – The Base Case is the reference point which considers future transport network assumptions and land use projections consistent with the DoT Reference Case, but excludes SRL (including SRL – Cheltenham to Airport) or other Enabled Investments that are dependent on the Program Case being in place. The Base Case network configuration is presented in Figure 1-2, and is described in more detail in Section 3.5.
- **Program Case** – The Program Case considers the Base Case described above, plus the changes to the transport network and land use and precinct initiatives delivered by SRL – Cheltenham to Airport. The network configuration associated with the Program Case is provided in Figure 1-3, and is described in more detail in Section 3.6.

Figure 1-2: Base Case rail network (2056)



Source: DoT

Figure 1-3: Program Case rail network with SRL – Cheltenham to Airport alignment (2056)



Source: SRLA

Two options for the opening of SRL – Cheltenham to Airport have been assessed as outlined in Table 1-1:

Table 1-1: Summary of Program Case Option A and B

Section	Program Case Option A Opening Year	Program Case Option B Opening Year
Cheltenham to Box Hill	2035	2035
Box Hill to Reservoir	2043	2038
Reservoir to Melbourne Airport	2053	2043

The assessment of Program Case Option A and Program Case Option B reflects that SRL North is still in early planning stages and consequently ultimate delivery dates are yet to be confirmed.

In addition, Program Case assessments assume that tailored bus service plans, designed to feed the SRL East and SRL North Precincts, will be implemented corresponding to the relevant phase in the SRL – Cheltenham to Airport sequence.

The Program Cases uses land use / urban renewal outcomes as assessed using CityPlan.

For the avoidance of doubt, this assessment is provided for SRL – Cheltenham to Airport as a complete package of investment; sequencing has been developed to allow a practical delivery approach.

More detail on the demand modelling methodology is provided in Chapter 3.

1.4 Report Structure

Following this introductory chapter, the remainder of this report is structured as follows:

- **Section 2** provides the context for SRL – Cheltenham to Airport
- **Section 3** provides an overview of the demand modelling methodology
- **Section 4** outlines the key findings from demand modelling outputs
- **Volume A** details the approach and results from VITM transport demand forecast modelling
- **Volume B** details the approach and results from CityPlan land use modelling
- **Volume C** details the approach and results from MABM user insights modelling.

2. Context

2.1 The power of city-shaping infrastructure

Strategic or 'city-shaping' transport infrastructure has the power to alter relative accessibility across a city and change a city's development patterns and growth projections. It influences where a business chooses to locate and where a person chooses to live. It can make locations more attractive, generating urban renewal. More broadly, it can continue to influence behaviour and generate land use changes long after it has been built.

When new areas become more attractive because of city-shaping infrastructure, this redirects the property market and intensifies urban development, leading to a shift in urban form. This shift in urban form can include increasing density and new mixed-use opportunities in a precinct. This dynamic is evident in projects such as Melbourne's City Loop, West Gate Bridge, Western Ring Road, CityLink or EastLink, that all helped balance Melbourne's lopsided growth in the south-east to the north-west and west.

2.2 Background

Plan Melbourne 2017-2050 is the Victorian Government's long-term planning strategy that sets out the vision for Melbourne as a global city of opportunity and choice.[3] A key principle of *Plan Melbourne* is that Melbourne needs to transform and be a city of centres, linked to regional Victoria. Melbourne's urban form needs to strengthen and support the city's competitiveness for jobs and investment.

To help deliver on *Plan Melbourne* objectives, the Victorian Government investigated options to influence the distribution of population and employment across Melbourne. These investigations culminated in the *Strategic Assessment: Suburban Rail Loop*[4], which recommended an orbital rail line.

Three broad potential corridors were considered: inner, middle and outer Melbourne. Following an assessment of the three options, the middle region was selected as the preferred corridor. This 90 kilometre corridor through Melbourne's middle suburbs was selected on the basis that it would support mass transit through the emerging western and northern suburbs, close to some of Melbourne's largest growth areas and into the established eastern suburbs with some of the largest employment, health and education clusters outside of central Melbourne.

Following the *Strategic Assessment*, in August 2018, the Victorian Government announced its commitment to SRL. In the 2019-20 State Budget, the Victorian Government allocated $300 million for detailed planning and investigations and the development of a Business and Investment Case, together with the establishment of SRLA.[5] As part of the 2020-21 State Budget, the Victorian Government

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[3] Victorian Government, *Plan Melbourne 2017-2050*.

[4] Development Victoria, *Strategic Assessment Suburban Rail Loop*, (2018). https://bigbuild.vic.gov.au/_data/assets/pdf_file/0006/325572/Suburban-Rail-Loop-Strategic-Assessment.pdf

[5] Media release from the Premier of Victoria, *Underground Suburban Rail Loop to Connect Victoria,* (28 August 2018). https://www.premier.vic.gov.au/underground-suburban-rail-loop-connect-victoria

committed $2.2 billion for Initial and Early works on SRL East – laying the groundwork for tunnelling, including preparation of tunnel boring machine launch sites and geotechnical investigation.[6]

SRL is more than a strategic response to our city's future travel demands; it is about shaping Melbourne for the needs of future generations.

It is intended that SRL will:

- Connect every major railway line from the Frankston line to the Werribee line
- Establish a direct rail connection between Melbourne's major employment, health, education and activity precincts outside Melbourne's central business district (**CBD**), catalysing urban renewal across Melbourne's middle suburbs
- Implement new planning settings to catalyse urban renewal, facilitate developments around the new stations, provide local transport improvements, and deliver place-making initiatives and amenity improvements in the precincts around SRL stations (**SRL Precincts**)
- Unlock the economic potential of Melbourne's middle suburbs, including the national employment and innovation clusters (**NEICs**) of Werribee, Sunshine, La Trobe and Monash
- Deliver three new transport super hubs at Clayton, Broadmeadows and Sunshine that will connect regional passengers into the SRL rail line, providing more direct and convenient journeys
- Better connect our suburbs and regions to education and health precincts, Melbourne Airport and each other
- Improve access to jobs across Melbourne's middle suburbs for Melburnians and regional Victorians.

The alignment of SRL through Melbourne's middle suburbs is shown in Figure 2-1.

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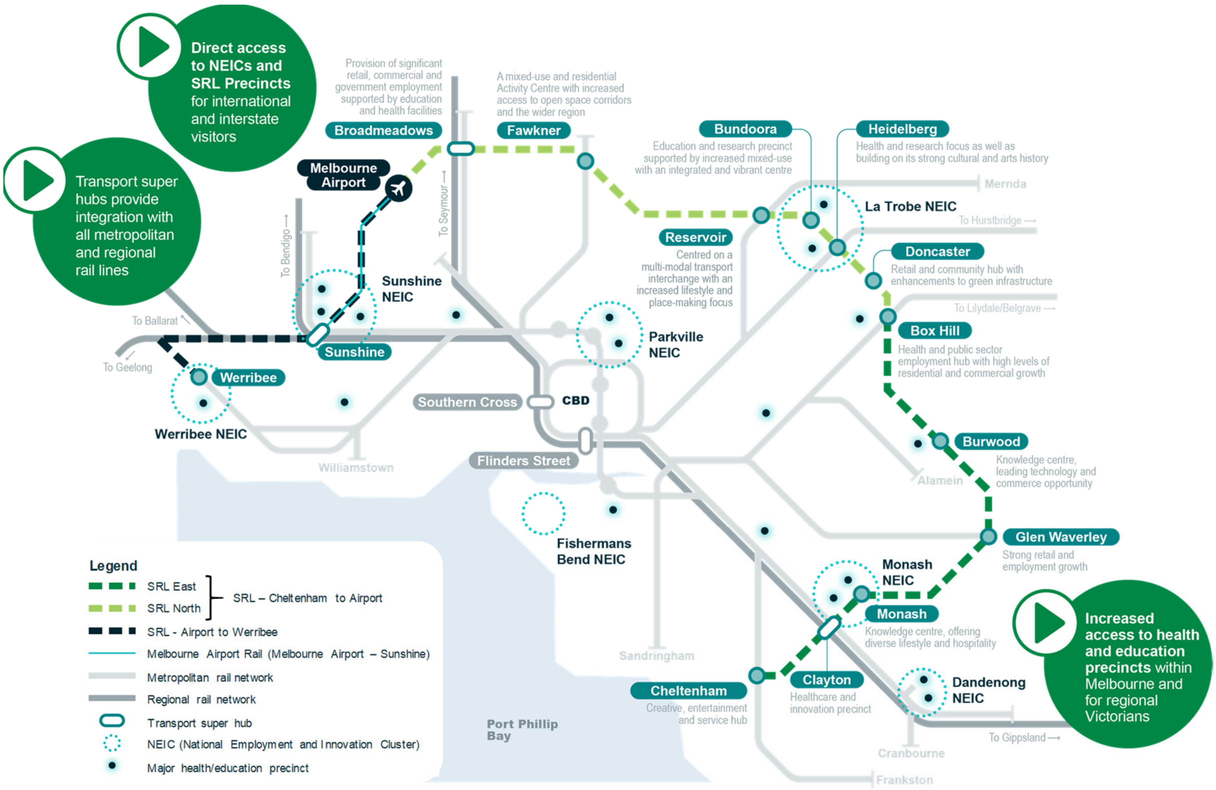
[6] Victorian Budget 2020/21, Budget Overview.

Figure 2-1: SRL – Cheltenham to Airport alignment and SRL East and SRL North Precincts



Source: SRLA

The SRL Business and Investment Case, and the modelling within this report, is focussed on the assessment of SRL – Cheltenham to Airport.

A project of this scale required a sequenced approach. Further detailed planning and technical design for the sequencing and timing will be undertaken by SRLA over the next few years, and the actual opening years will be finalised through this process. For the purpose of the SRL Business and Investment Case, assumptions for the sequencing of SRL – Cheltenham to Airport has been based around two options as outlined in Table 2-1.

Table 2-1: Summary of Program Case Option A and B[7]

Section	Program Case Option A Opening Year	Program Case Option B Opening Year
Cheltenham to Box Hill	2035	2035
Box Hill to Reservoir	2043	2038
Reservoir to Melbourne Airport	2053	2043

Along with the rail and transport interventions, SRL will include a number of precinct initiatives to fully capture benefits of SRL and to derive continued value from this significant investment, including:

- **Planning settings** – developing framework plans and structure planning to guide land use, built form, local access and public spaces necessary to support changing community needs

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[7] SRLA advises that further detailed planning and technical design for SRL North will be undertaken over the coming years. Specific packaging and procurement decisions will be made at an appropriate time in the future.

- **Station development** – provision of over-station and adjacent-to-station development to capitalise on the opportunity to leverage land for additional commercial, residential and community infrastructure
- **Catalyst projects** – focal investments in transport interchanges, civic infrastructure and commercial developments that shape thriving communities and leverage Victoria's competitive strengths
- **Broader infrastructure** – coordinating the delivery of community facilities and services to enhance the liveability, productivity and connectivity of precincts for current and future generations.

2.3 The need for SRL - Cheltenham to Airport

Melbourne's population is expected to continue to grow, reaching 9 million people by 2050.[8] Although Melbourne's central city will continue to serve Victoria well for many years, it was not designed to support 9 million people to live and work. Many of the stresses of Melbourne's rapid population growth are starting to show and, without intervention, are expected to worsen over time.

- **Melbourne's monocentric urban form is constraining economic growth** – although the central city is well serviced by public transport connections, people living in the outer suburbs experience poor public transport accessibility, which includes limited accessibility to amenities and jobs in the suburbs. Dispersed businesses in the suburbs also miss out on agglomeration benefits that come from being located in clusters. With increasing pressure and congestion on our transport networks and a lack of alternative economic centres to the central city, Melbourne is at risk of becoming less attractive and less competitive compared to other cities, leading to an erosion in prosperity.
- **The concentration of population growth in the inner and outer suburbs of Melbourne is contributing to inefficient infrastructure and service provision** – continued population growth in the outer areas of Melbourne over the next few decades will mean that services and infrastructure in established middle suburbs will continue to be under-used. Ongoing population growth in the outer suburbs also poses additional costs to ensure adequate provision of services and infrastructure.
- **Melbourne's housing options are constrained, leading to inequitable access to jobs and services and entrenching disadvantage** – Melbourne will become less affordable over time, but especially for people living in the outer suburbs and some areas in the middle suburbs. Although housing is more affordable in the outer suburbs, there is a trade-off between cheaper housing, poor access to services and amenities, and higher transport costs. This also means that people are increasingly living further away from key centres. Inequitable access to jobs, services and amenities, in turn, can lead to different outcomes for different communities across Melbourne.

Melbourne is at a critical point in its growth as a global city. Victorians are at risk of continuing to feel the increasing effects of urban expansion, congestion and reduced economic growth – all leading to a worsening in quality of life.

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[8] ABS, Australian Historical Population Statistics (2019) and DELWP Projections Unpublished (2018).

2.4 Outcomes

The anticipated outcomes of SRL – Cheltenham to Airport are provided below.

- **Increase Victoria's productivity and economic growth** – by connecting Melbourne's middle suburbs, SRL – Cheltenham to Airport will unlock the economic potential of the NEICs and Metropolitan Activity Centres (**MACs**) within the middle corridor
- **Improve connectivity across Victoria** – by improving transport connectivity, SRL – Cheltenham to Airport will enhance the overall resilience, punctuality, reliability and safety of Melbourne's transport network, better connecting people and places across Victoria
- **Improve Melbourne's liveability and create thriving communities** – SRL – Cheltenham to Airport will create more opportunities for lifelong homes in locations with quality and inclusive spaces, and good access to jobs, services and amenities in Melbourne's middle corridor.

SRL – Cheltenham to Airport also aims to realise the objectives of *Plan Melbourne*.

- **Creating a 'city of centres'** – SRL – Cheltenham to Airport will re-shape Melbourne's urban form to become a polycentric city, supporting ongoing economic growth, jobs and investment. SRL – Cheltenham to Airport adopts a multi-faceted approach, including integrated transport, land use and precinct planning to develop connected, liveable and productive polycentric centres that will accommodate around 232,000 households and 545,000 jobs by 2056.
- **Providing a transport network for the future** – SRL – Cheltenham to Airport will transform how we travel across and around our city, decreasing the demand on the existing transport network and shifting people out of their cars and off the road. By increasing the share of public transport and active transport trips across Melbourne, SRL – Cheltenham to Airport will help ensure Melbourne remains a sustainable and liveable city.
- **Encouraging 'local living'** – SRL – Cheltenham to Airport will create a healthier and more inclusive city comprised of 20-minute neighbourhoods to support people to live locally.
- **Connecting regional Victoria** – SRL – Cheltenham to Airport will improve access between regional rail lines, Melbourne's middle suburbs and the airport, increasing the accessibility of regions and the middle suburbs to health, education and jobs. SRL – Cheltenham to Airport will improve the connectivity, productivity and liveability of regional Victoria through improved connections and opportunities.

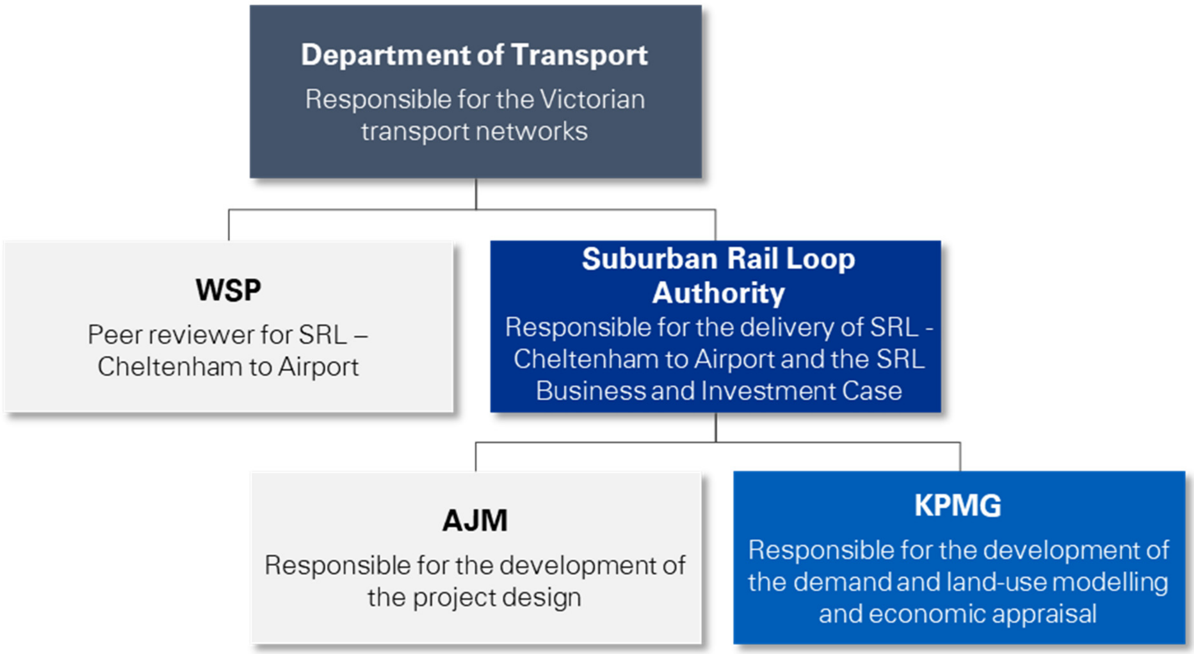
This report provides the details of the land use, transport and customer modelling that underpins the assessment of these outcomes.

3. Methodology

3.1 Governance

Governance arrangements for the SRL Business and Investment Case were established by DoT to provide inquiry and oversight of transport demand and land use modelling for SRL – Cheltenham to Airport and are outlined in Figure 3-1. These arrangements aim to ensure a high degree of rigour and consistency in transport modelling undertaken on behalf of the Victorian Government.

Figure 3-1: Governance framework for SRL Business and Investment Case



Source: KPMG modelling framework agreed with DoT and SRLA

An overview of responsibilities is provided below:

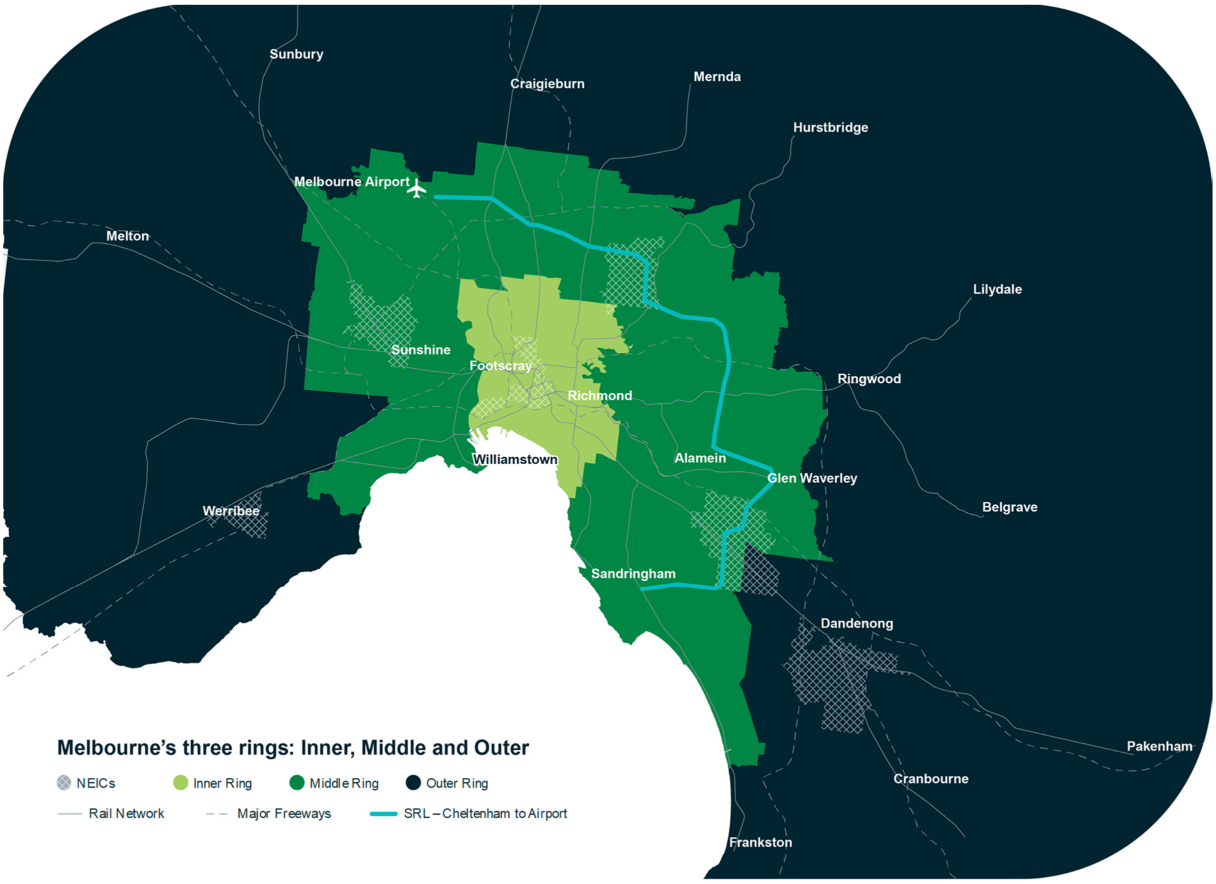
- VITM is a strategic transport model of Victoria, and key inputs are provided by SRLA, DoT or its advisors to inform the demand model runs. Demand forecasting for the economic appraisal has been undertaken by KPMG while demand forecasting for design purposes has been undertaken by Aurecon Jacobs Mott MacDonald Joint Venture (**AJM**).
- The land use modelling, demand modelling and economic appraisal have been undertaken by KPMG and independently peer reviewed by WSP US, WSP and Centre for International Economics (**CIE**) as part of a separate engagement directly appointed by DoT.
- A peer reviewer has been involved in the land use, demand and economic appraisal throughout the process including reviewing the framework, the detailed approach and the draft analysis; and the peer reviewer’s feedback has been incorporated in the final analysis as appropriate.

3.2 Approach to spatial analysis

To support the analysis in this demand modelling assessment for the SRL Business and Investment Case, Greater Melbourne has been conceptualised into three geographic 'rings': inner, middle and outer. The three geographic rings are based on statistical and government areas and enable a more comprehensive analysis of emerging problems and city-shaping outcomes discussed in this report.

Melbourne's three geographic rings and the seven NEICs (as defined in *Plan Melbourne*) are illustrated in Figure 3-2, together with select, high-level comparative demographic analysis.

Figure 3-2: Melbourne's three rings: Inner, Middle and Outer



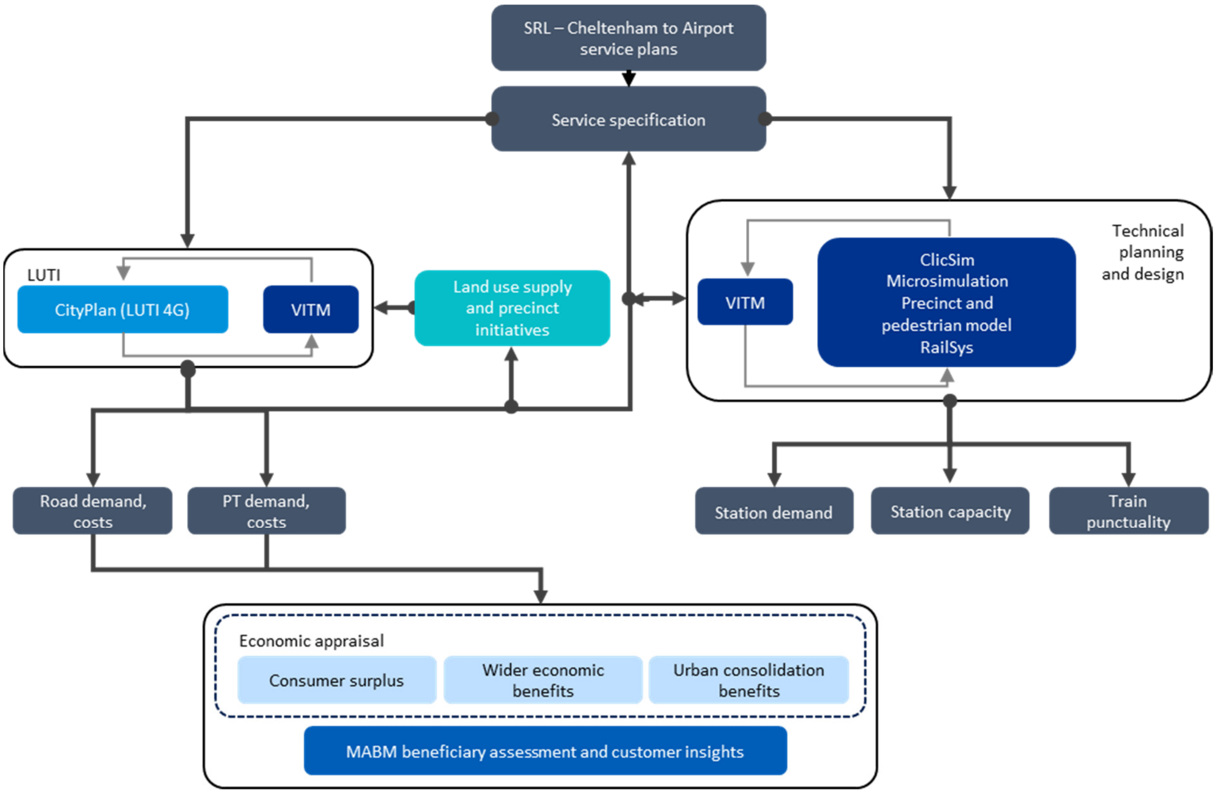
*Source: KPMG analysis, Victorian Integrated Transport Model (**VITM**) Zoning System and 2019 Small Area Land Use Projections (**SALUP**)*

3.3 Modelling roles and stages

3.3.1 Demand modelling tools and interactions

A range of modelling tools are used in the development and assessment of SRL – Cheltenham to Airport. These models interact, sometimes in an iterative process. The strategic modelling interactions used for the assessment of SRL – Cheltenham to Airport are outlined in Figure 3-3.

Figure 3-3: Strategic modelling interactions



Source: KPMG modelling framework agreed with DoT and SRLA

KPMG is responsible for the CityPlan and VITM modelling as part of the LUTI modelling – which are used as inputs to the Economic Appraisal of SRL – Cheltenham to Airport. Land use supply and precinct initiatives were supplied by SRLA as inputs to CityPlan. In turn, CityPlan land use outputs are used as inputs to VITM. KPMG has also used MABM to provide a beneficiary and customer insight assessment. KPMG is also responsible for the economic appraisal, which is provided in the separate Economic Modelling Report.

The relevant models used by KPMG in this process and their interactions have been outlined in more detail in the following sections.

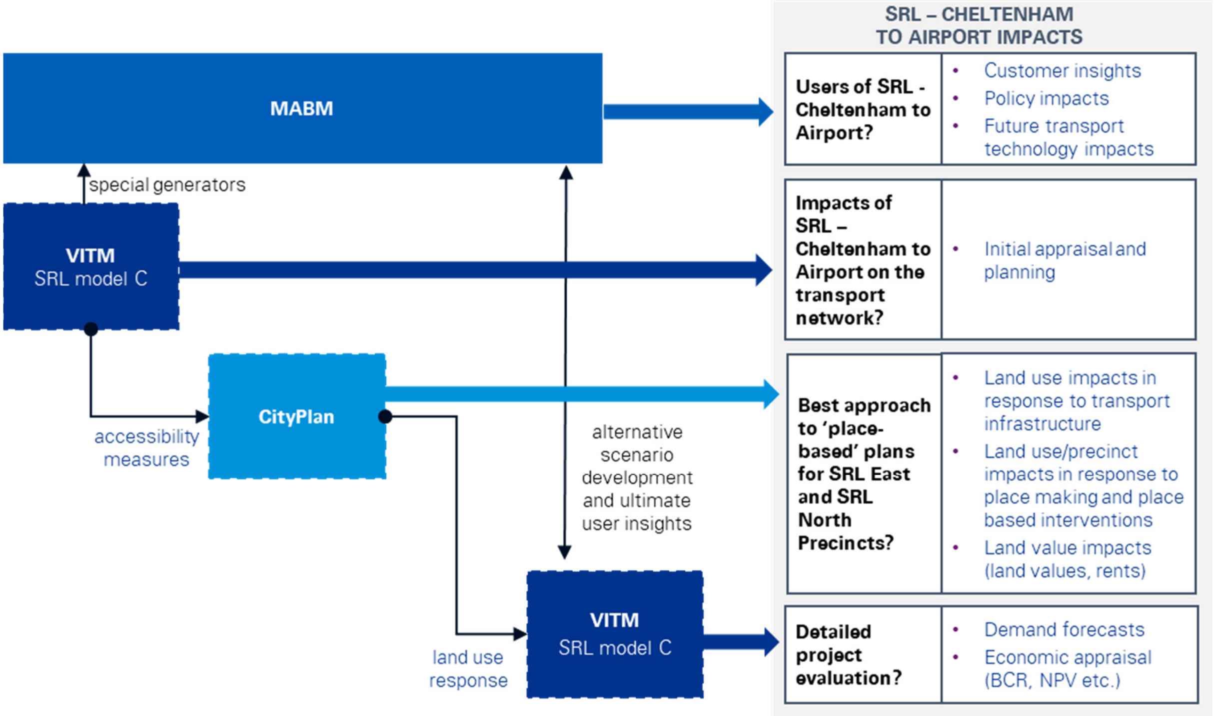
3.3.2 Modelling tools

The strategic demand modelling presented within this Report has been conducted using three tools:

- **VITM** – Strategic transport model
- **CityPlan** – Land-use model
- **MABM** – Agent and activity based model.

An overview of the roles these three tools serve for SRL – Cheltenham to Airport is shown in Figure 3-4 below.

Figure 3-4: Roles for the strategic transport modelling tools



Source: KPMG modelling framework agreed with DoT and SRLA

VITM interacts with CityPlan to provide land-use updates through an iterative process, and MABM is utilised to develop user-specific insights and add additional information on SRL beneficiaries within the demand forecasting.

These three tools are each described in more detail in the following sections. The three tools will be supplemented by analysis using some additional supporting modelling – a brief description of these is also provided below.

Strategic transport model (VITM)

Strategic transport demand models, built on a 'four-step' framework, are commonly used for the planning and assessment of major transport infrastructure projects, particularly where it is expected that travel behaviour will change due to introduction of SRL.

VITM was selected as the primary strategic transport model and is preferred by the State for assessing major transport projects. It is a multi-modal model with capability to assess the changes to travel behaviour between and within modes across the network. This is important as almost all public transport trips involve a combination of travel modes, such as driving to a train station, travelling by train and walking to a destination. It also assesses the impacts of changes to road network congestion.

VITM was used to assess the transport network impact of SRL – Cheltenham to Airport for the purpose of project development, including the SRL Business and Investment Case, technical solution and planning proposals. The scope of this Demand Modelling Appendix deals only with the strategic modelling conducted as part of the demand forecasting for the economic appraisal, and does not include the modelling undertaken for the purposes of design and planning. Due to the different roles and requirements of each work stream, technical design and planning will require significantly different VITM outputs. For example, the modelling for design is based on peak hour for a given ultimate design year, and is focused on forecasting high side patronage (to future proof the infrastructure design). However, the modelling for the economic appraisal will utilise all time periods across multiple forecast years, using more conservative assumptions to provide a clear assessment of the SRL benefits.

VITM does not consider all responses to major transport infrastructure, such as land use changes, the assessment of policy changes and future transport technology. Due to these limitations, VITM will be supplemented by a suite of modelling tools to support the economic appraisal and design for SRL – Cheltenham to Airport.

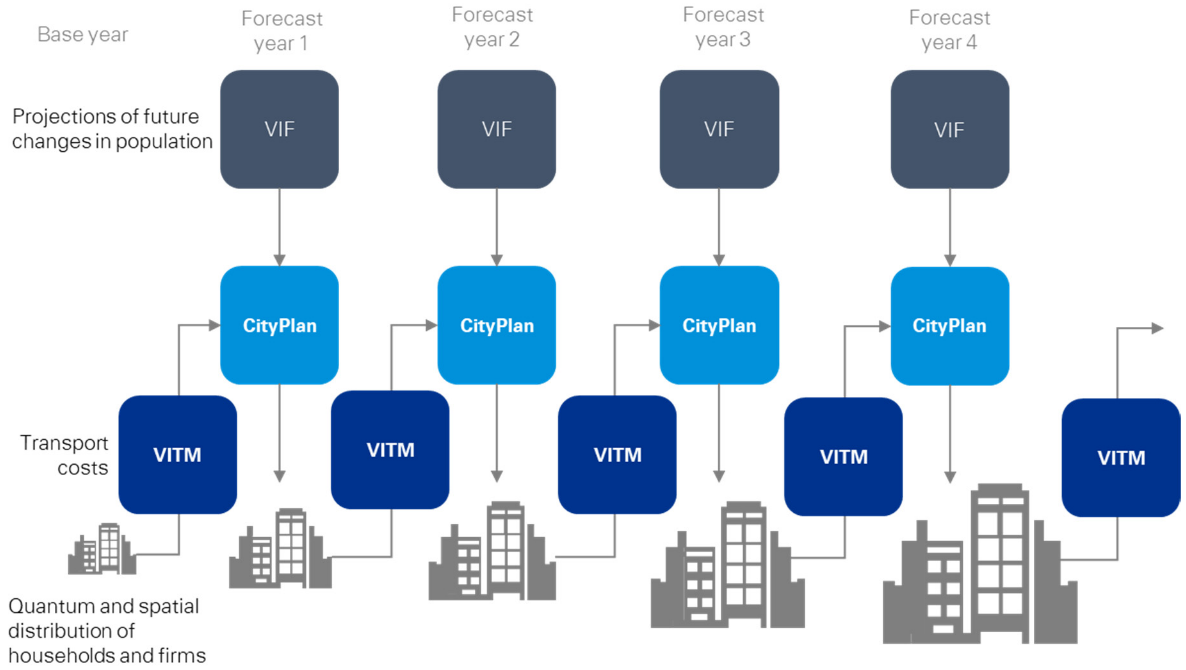
More details on the VITM model application are provided in Volume A.

Land Use model (CityPlan)

CityPlan is a dynamic urban simulator that simulates how land use is likely to evolve under different potential future scenarios. This simulation can aid in informing long-term strategic policy and planning decisions. In combination, CityPlan and VITM form an advanced land-use transport interaction model. Used in parallel, these models can inform key questions in the context of transport planning, policy and strategy, including demand forecasting and economic appraisal for major transport infrastructure, such as for SRL – Cheltenham to Airport.

The CityPlan and VITM configuration, known as LUTI mode, is represented in Figure 3-5.

Figure 3-5: CityPlan working in conjunction with land use projections and VITM (LUTI mode)



Source: KPMG CityPlan Volume 1: Model Specification Report

In this figure, VIF represents Victoria in Future Victorian Government land use projections, or can be applied to work with other population projections or forecasts.

More details on the CityPlan model application are provided in Volume B.

Agent and Activity Based model (MABM)

MABM is an agent- and activity-based strategic transport model. A fundamental premise of activity-based travel models is that travel demand derives from people's needs and desires to participate in activities. MABM is based on behavioural theories about how activity participation decisions are made in the presence of each individual's constraints, including where and when to participate in activities and how to get to these activities.

MABM can evaluate alternative investments and policies that are difficult to test using trip-based models, for instance, pricing policies and the impact of emerging technologies. Furthermore, since MABM functions at the level of individual persons ('agents') and represents how these persons travel across the entire day, it produces more detailed performance metrics. This includes how travel benefits (or disbenefits) accrue to different populations, which is used to support equity analyses. MABM provides insight on the customers and their needs and preferences, including:

- How customers with different socio-economic and demographic characteristics – such as income, household composition and age – respond to changes in transport policy or new infrastructure
- How fair and equitable a transport policy or investment is, who are the beneficiaries and to what extent they are impacted.

MABM is developed on a Multi Agent Transport Simulation (**MATSim**) platform, and is based on a co-evolutionary algorithm. This means each individual agent mutates their travel plans to maximises their utility while competing with each other for time and space on the transport network to execute their daily plans.

MABM has been adopted for SRL – Cheltenham to Airport as a complementary model to VITM enriching the results by providing insights into transport users' profiles, and the socioeconomic characteristics of future SRL – Cheltenham to Airport customers and beneficiaries.

More details on the MABM model application are provided in Volume C.

3.4 Scenario definitions

3.4.1 Reference Case

In order to use a standardised set of modelling assumptions, the VITM transport modelling is based on DoT's Transport Modelling Reference Case (the 'Reference Case'). The Reference Case is the key platform for transport modelling in Victoria and is developed and managed by DoT's Transport Analysis and Assessment Branch.[9]

The Reference Case provides a set of current and future year assumptions, including networks, land use and transport cost assumptions. It includes committed projects in addition to an agreed set of projects, including arterial road upgrades, rail service upgrades, motorway improvements, tram and bus upgrades and service levels to supply a reasonable capacity that is supportive of the future demand associated with the Reference Case land use.

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[9] Department of Transport (2019). *The standard approach to transport modelling and economic evaluation in Victoria, 2019-20.*

Inclusion of transport projects in the Reference Case does not imply any commitment from the government or DoT to undertake these projects. It merely indicates that DoT has determined that it is reasonable to represent the project, or a similar investment, in the future network for the purposes of modelling demand in the transport system.

The latest Reference Case includes key transport modelling inputs, such as:

- New government policies or strategies
- Population and employment forecasts
- Updated travel survey data
- Significant changes to transport networks.
- Responsibilities for the various inputs to the Reference Case are shown in Table 3-1.[10]

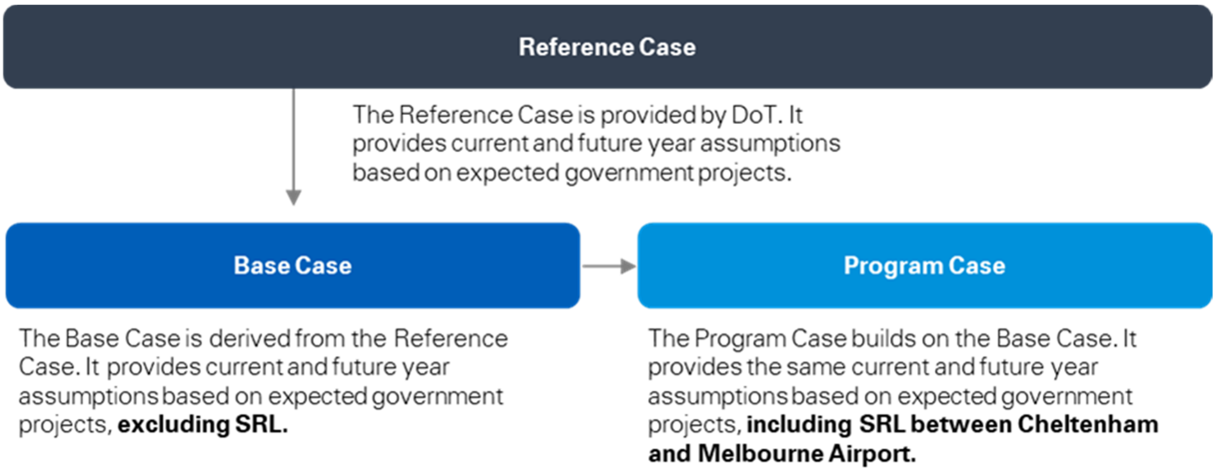
Table 3-1: Inputs to Reference Case

Reference Case Inputs	Responsibility	Version
Population and Employment Land Use Forecasts	Department of Environment, Land, Water and Planning (DELWP), DoT	SALUP19, Victorian Integrated Transport Model Reference Case – Model Inputs and Parameters 2020
Road Network	DoT	AJM Stage C
Public Transport Network and Service Plans	DoT	Reference Case March 2020
Freight Network and Forecasts	DoT	Reference Case March 2020
Air Passenger Forecasts	DoT	Jet fuel forecasts 2019

Source: As shown

The Reference Case also includes some assumptions regarding the potential SRL infrastructure and/or complementary projects. These assumptions must be removed to produce a Base Case to realistically compare and assess the impacts of the Program Case, as discussed in the following section.

Figure 3-6: Reference Case, Base Case and Program Case



The Reference Case is provided by DoT. It provides current and future year assumptions based on expected government projects.

The Base Case is derived from the Reference Case. It provides current and future year assumptions based on expected government projects, **excluding SRL.**

The Program Case builds on the Base Case. It provides the same current and future year assumptions based on expected government projects, **including SRL between Cheltenham and Melbourne Airport.**

Source: KPMG modelling framework agreed with DoT and SRLA

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[10] Department of Transport (2019). *The standard approach to transport modelling and economic evaluation in Victoria, 2019-20.*

3.4.2 Definition of Base Case and Program Case

The definitions of networks and demographics/land use for the Base Case and Program Case scenarios are critical for economic appraisal and the modelling runs which support it. Where projects are assessed in parallel, consistency between the appraisals is important.

The Base Case scenario is the starting point for the economic appraisal. It consists of the Reference Case transport network for a given year, but excludes some infrastructure projects such as SRL (including SRL – Cheltenham to Airport), along with SRL enabled projects and critically interdependent projects.

The Program Cases include the SRL – Cheltenham to Airport rail and precinct initiatives to be assessed.

Sections 3.5 and 3.6 outline the inclusions and exclusions of these scenarios.

3.4.3 Forecast years

Transport modelling demand forecasts have been developed across a number of years to 2056.

Table 3-2: Purpose of model runs

Transport Impact Appraisal / Economic / Financial Appraisal Data Points	**Modelling Year**						
	2018	**2031**	**2036**	**2041**	**2046**	**2051**	**2056**
Base Case for economic appraisal	✓ For model validation	✓	✓	✓	✓	✓	✓
Program Cases A and B for economic appraisal		✓	✓	✓	✓	✓	✓
Sensitivity tests and alternative future scenarios		✓	✓	✓		✓	✓

Source: KPMG modelling framework agreed with DoT and SRLA

Details regarding the change in transport networks, households, employment and other assumptions are provided in the following sections.

3.4.4 Time periods

For the purposes of this analysis, results are analysed across different daily time periods. Where data is presented for the AM peak, this refers to the 7:00 to 9:00 am peak period on a typical weekday. Where data is presented for the PM peak, this refers to the 3:00 to 6:00 pm peak period on a typical weekday. Inter-peak (IP) represents 9:00 am to 3:00 pm while off-peak (OP) represents 6:00 pm to 7:00 am.

3.5 Base Case

The Base Case is developed from the DoT Reference Case, and includes the Reference Case transport network and land use projections, but excludes SRL (including SRL – Cheltenham to Airport) or other Enabled Investments that are dependent on the Program Case being in place. As such, the Base Case for this appraisal:

- Reflects the scenario without costs or benefits associated with SRL – Cheltenham to Airport
- Includes land use assumptions similar to the Reference Case, but without SRL – Cheltenham to Airport investments.

Table 3-3 shows key transport projects and land use projections included in the Base Case.

Table 3-3: Base Case description

Parameter	Description
Road network	Includes road network projects in line with the Reference Case. The most significant projects contained within the Base Case are: In 2026: • Mordialloc Freeway (2021) • Monash Freeway widening Springvale Road to East link and Clyde Road to Cardinia Road (2021) • North East Link and other associated upgrades to Eastern Freeway • M80 widening (8 lanes) • Several other widening projects of major roads in the West, North and the South East In 2031: • Bulla Bypass (Sunbury Road to Wildwood Road and Tullamarine Extension) • Calder Freeway widening • Craigieburn Road Duplication • Melbourne Airport - new elevated ring road connecting to Tullamarine Freeway • Melton Highway Duplication • New East–West Connector In 2036: • Boundary Road Widening • Calder Freeway Widening • Completion of E6 • Hume Freeway widening • M80 widening (associated with E6) • Western Freeway Widening In 2041: • North–South Connector • Western Link Road • Monash Freeway Widening – Cardinia Road to Koo Wee Rup Road • EastLink Widening In 2051: • Dingley Freeway • Outer Metropolitan Ring Road (OMR)

Parameter	Description
	• Tullamarine Freeway Extension to OMR • Mornington Peninsula Freeway widening
Public transport network	Includes public transport investment projects in line with the Reference Case. The most significant projects contained within the Base Case are: In 2026: • Melbourne Metro Tunnel operational • Cranbourne Line Duplication and extension to Clyde complete • Cross-City Line Upgrade Stage 1 complete • Nine car velocity rolling stock (VL9s) introduced on Bacchus Marsh and Geelong lines In 2031: • Loop split (City Loop reconfiguration) complete • Melbourne Airport Rail (MAR) • Cross-City Line Upgrade Stage 2 complete • Geelong Fast Rail Stage 1 complete • Extension from Wyndham Vale to Black Forest Rd and connection to Werribee complete In 2036: • Hopkins Road quadruplication and electrification complete • Sunshine to Southern Cross RRL capacity uplift works In 2041: • Melbourne Metro 2, including Newport Tunnel operational with Geelong and Werribee services from the west running through to Mernda In 2051: • Baxter electrification, allowing the extension of Frankston Line services to Baxter • Addition of a fourth track between Box Hill and Burnley
Land use	The Base Case land use projections are in line with the Reference Case, namely Small Area Land Use Projections (SALUP19) based on DELWP Projections 2018 (unpublished).

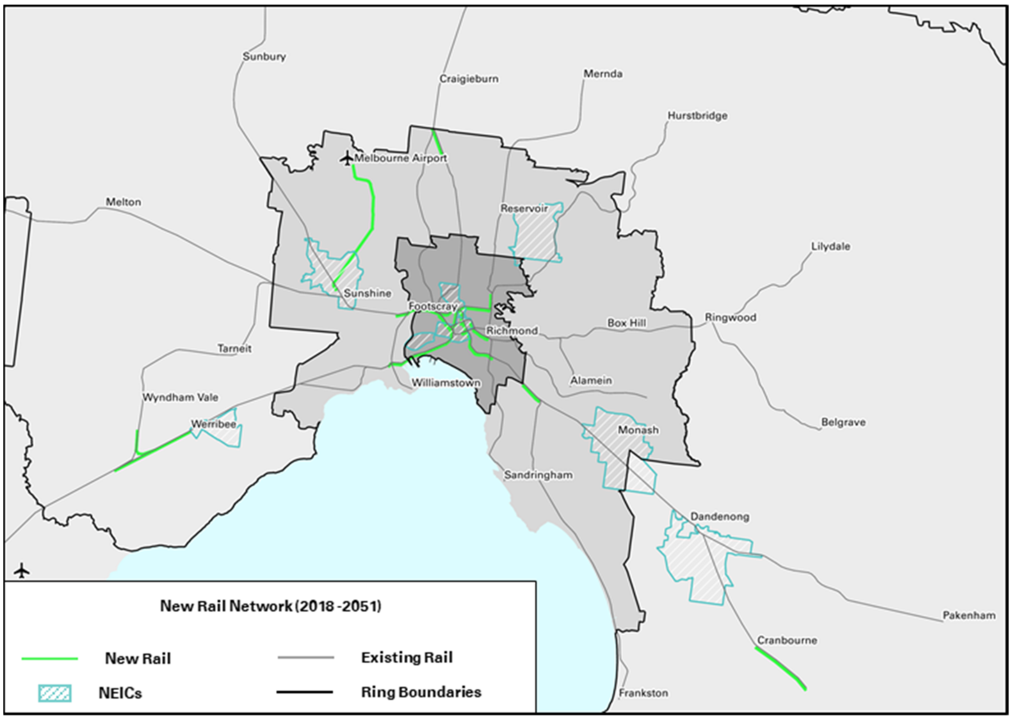
*Source: DoT: Full details of the transport network inputs are provided in the DoT Reference Case (Department of Transport, 2018) and Victorian Rail Infrastructure Plan: Strategic Demand Modelling Specification (Rail Projects Victoria (**RPV**), 2018)*

The Base Case also deviates from the Reference Case in car parking assumptions. Parking costs for private vehicle trips at the trip attraction end for zones in SRL East and SRL North Precincts have been modified in both the Base Case and Program Case VITM modelling. More detail is provided in Volume A.

3.5.1 Rail network

The Base Case rail network changes are shown in Figure 3-7, with changes over time representing the assumed upgrades to the rail networks.

Figure 3-7: Base Case rail network changes 2018-2051



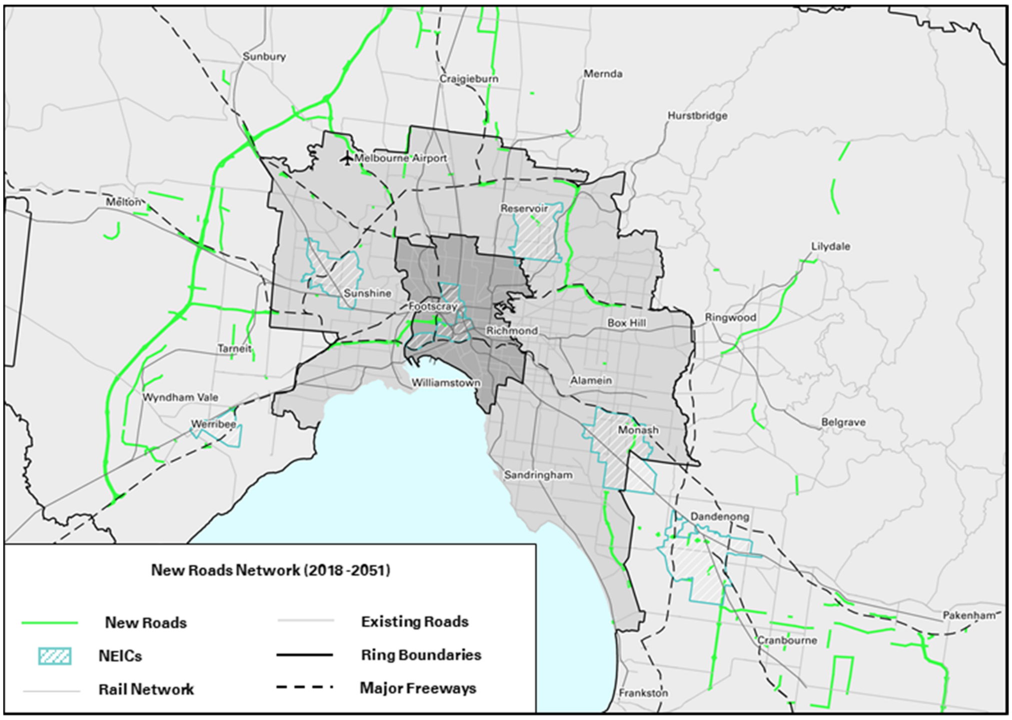
Source: DoT Reference Case

Beyond 2051 (i.e. for 2056 modelled scenarios), the Base Case rail network is assumed to be consistent with the 2051 network.

3.5.2 Road network

The Base Case road network changes are shown in the following Figure 3-8, with changes over time representing the assumed upgrades to the road networks.

Figure 3-8: Base Case road network changes 2018-2051



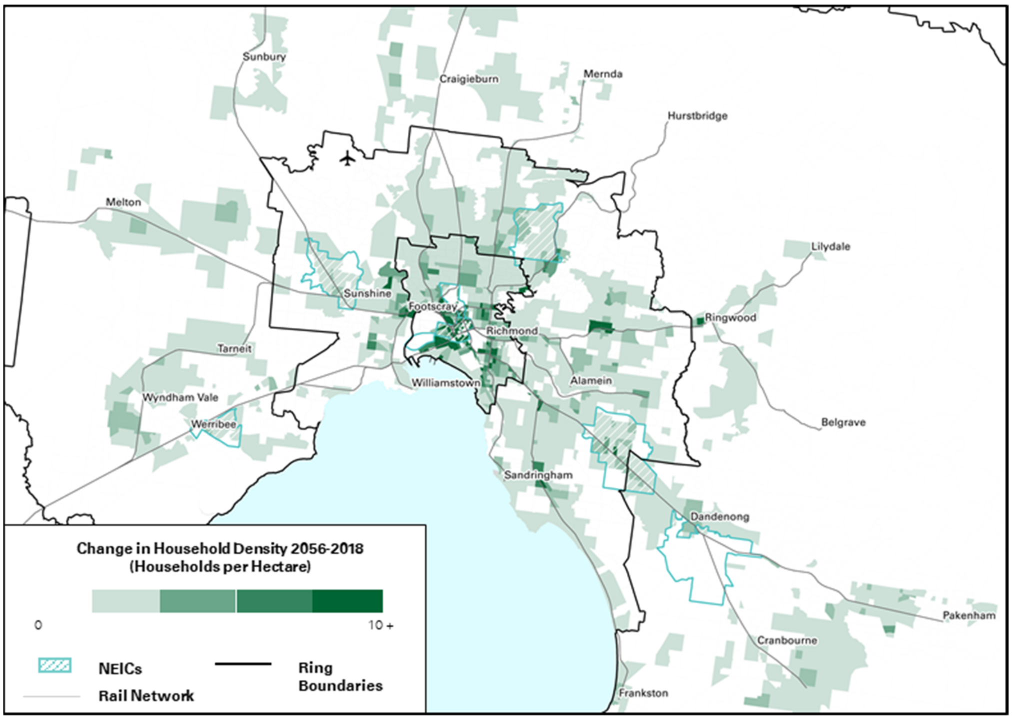
Source: DoT Reference Case

Beyond 2051 (i.e. for 2056 modelled scenarios), the Base Case road network is assumed to be consistent with the 2051 network.

3.5.3 Land use

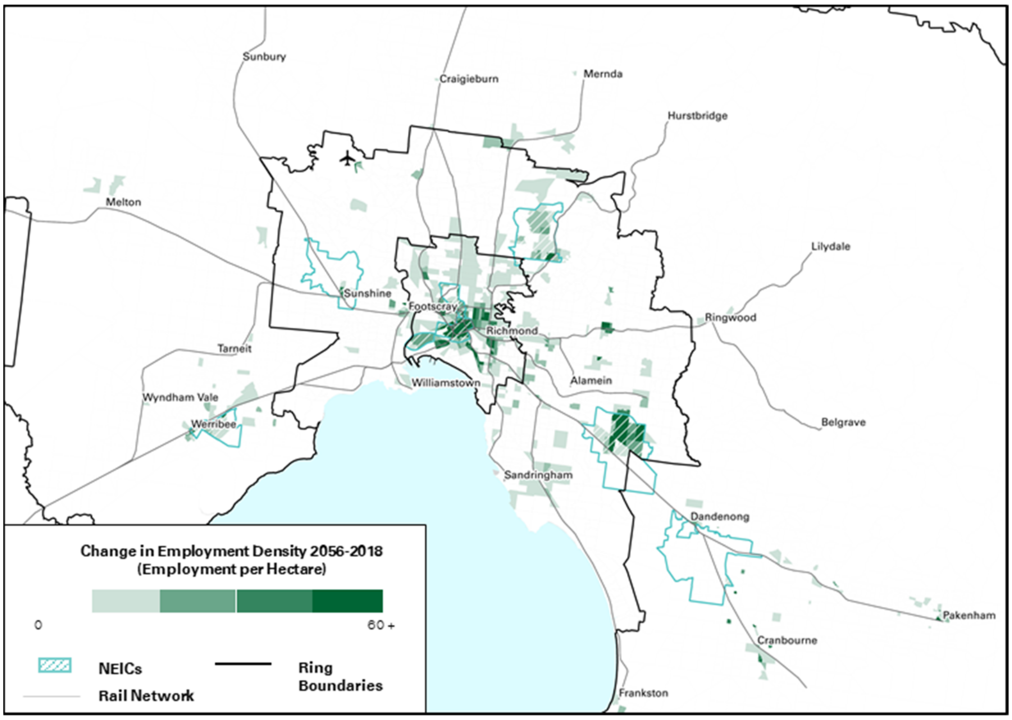
The Base Case uses Small Area Land Use Projections (SALUP19), which give a projection of population and employment distribution across Victoria for a network without SRL. The following figures show household and employment density for future years 2036 and 2056.

Figure 3-9: Base Case change in households 2018-2056



Source: SALUP19 based on DELWP Projections 2018 (unpublished)

Figure 3-10: Base Case change in employment density 2018-2056



Source: SALUP19 based on DELWP Projections 2018 (unpublished)

3.6 Program Case

3.6.1 SRL – Cheltenham to Airport key inputs and assumptions

The Program Case uses the Base Case as a starting point but also incorporates the network improvements delivered by SRL – Cheltenham to Airport. A core component of the SRL – Cheltenham to Airport improvements is the sequenced delivery of a heavy rail link between Cheltenham and Melbourne Airport in three sections.

Two Program Case scenarios have been assessed, taking into account two timing alternatives for sequencing. As SRL North is still in early planning stages and consequently delivery timelines are yet to be confirmed, two different dates for the commencement of services have been used to define the Program Cases. Under Option A, delivery of SRL – Cheltenham to Airport will be complete by 2053, while Option B will be complete by 2043.

Detailed rail parameters for SRL – Cheltenham to Airport that are assumptions or inputs for the modelling are described in the table below.

Table 3-4: Key inputs and assumptions – SRL – Cheltenham to Airport

Section	Cheltenham – Box Hill	Box Hill – Reservoir	Reservoir – Melbourne Airport
Opening Year (Option A)	2035	2043	2053
Opening Year (Option B)	2035	2038	2043
Rail Distance (Combined)	26.0 kilometres	45.0 kilometres	60.2 kilometres
Travel Time (Combined)	22 minutes	38 minutes	50 minutes
Trains per hour (peak periods)	10	12	24
Trains per hour (inter-peak)	6	6	12
Trains per hour (off-peak)	6	6	6
Seated Capacity	188 passengers per service	188 passengers per service	188 passengers per service
Load Standard	820 passengers per service	820 passengers per service	820 passengers per service
Crush capacity	1,136 passengers per service	1,136 passengers per service	1,136 passengers per service

Source: SRLA

In addition to the detailed parameters described above, the following assumptions have also been made regarding SRL – Cheltenham to Airport:

Key assumptions relating to rail

- **Interchanges**: interchanges generally support a three to five minute interchange between SRL – Cheltenham to Airport and radial services. (More detail is provided in Volume A, Table A - 38: Transfer time assumptions.)

- **MAR to SRL – Cheltenham to Airport interchange time at Melbourne Airport**: interchange time between MAR and SRL – Cheltenham to Airport at Melbourne Airport is approximately three minutes (based on a 250m walk link) – broadly a concourse to concourse transfer.
- **Fare**: subject to the below, the existing radial network fare structure will apply to SRL – Cheltenham to Airport.
- **Fare at Melbourne Airport**: as assumed by the MAR Business Case, there will be an $18 surcharge for passengers boarding and alighting SRL – Cheltenham to Airport at Melbourne Airport. (Transferring passengers between SRL – Cheltenham to Airport and MAR will not be subject to this surcharge).

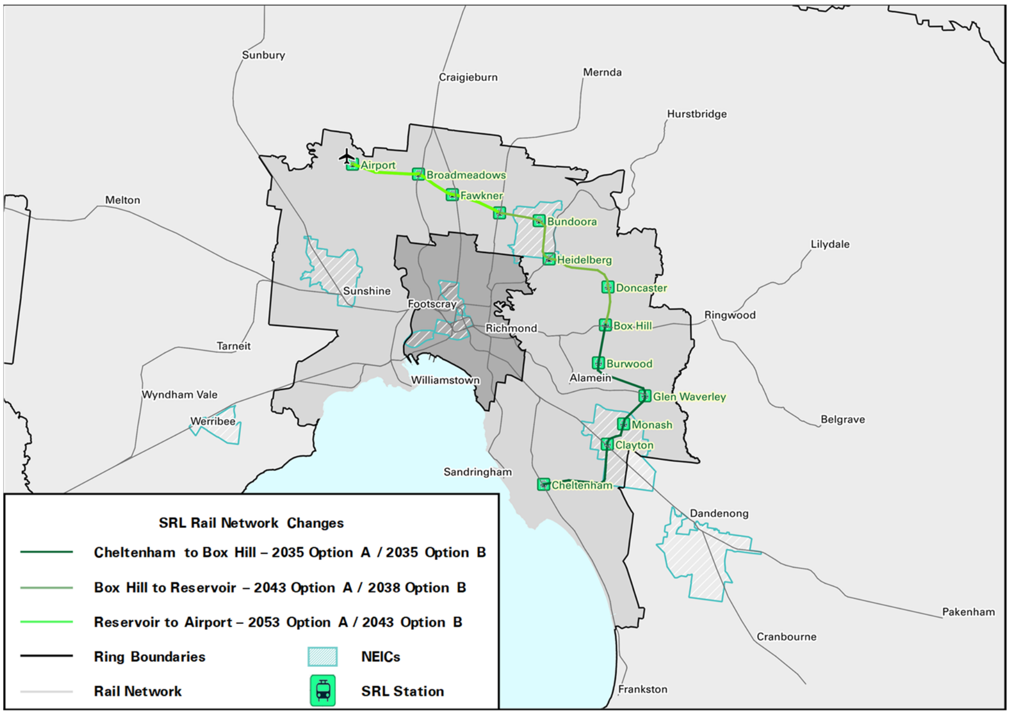
Key assumptions relating to precincts

- **Car ownership:** Across Melbourne, denser suburbs and / or those suburbs with higher public transport accessibility have lower car ownership rates. It is therefore assumed that the households that move to the precincts are also more likely to have lower car ownership. Reduced car ownership assumptions for transport zones in the precincts have been adopted using a benchmarking approach based on accessibility and density, assuming future car ownership in the precincts could be similar to other parts of inner Melbourne. Refer to Volume A for further details.
- **Car parking:** Amendments to the planning scheme parking requirements have been assumed in the SRL East and SRL North Precincts in both the Base Case and the Program Case. (More details are provided in Volume A.)
- **Land use changes**: Assumption of potential development capacities specified by the Victorian Planning Authority (**VPA**) have been adopted by SRLA. Additional productivity and liveability initiatives (e.g. business parks / employment parks, place-making initiatives) have also been included.

3.6.2 Public transport network

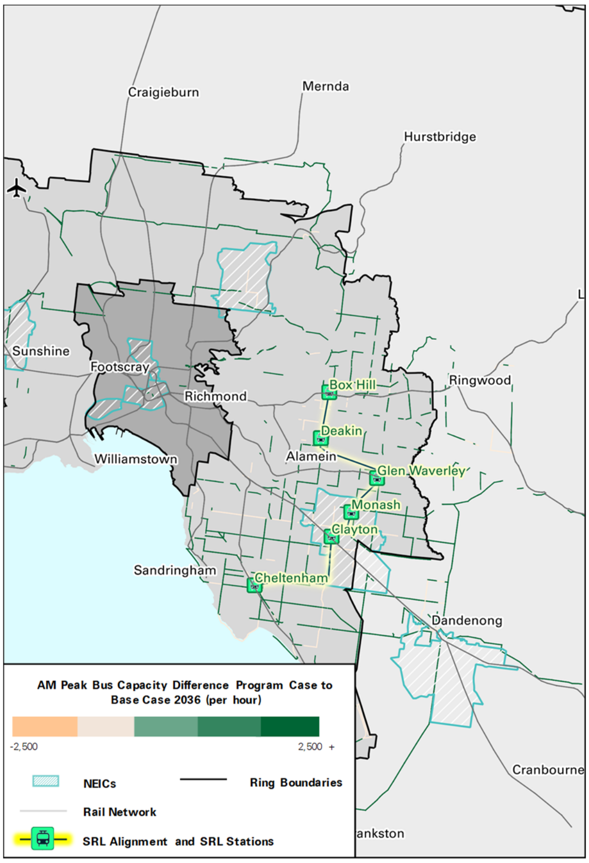
In addition to the SRL – Cheltenham to Airport rail network changes, shown in Figure 3-11, the Program Case includes tailored bus service plans. These are designed to provide buses feeding the SRL East and SRL North Precincts. Separate sets of bus service plans corresponding to the relevant phase in the SRL – Cheltenham to Airport sequence were modelled. The indicative bus network changes are illustrated in Figure 3-12 (2036) and Figure 3-13 (2056).

Figure 3-11: Program Case rail network changes



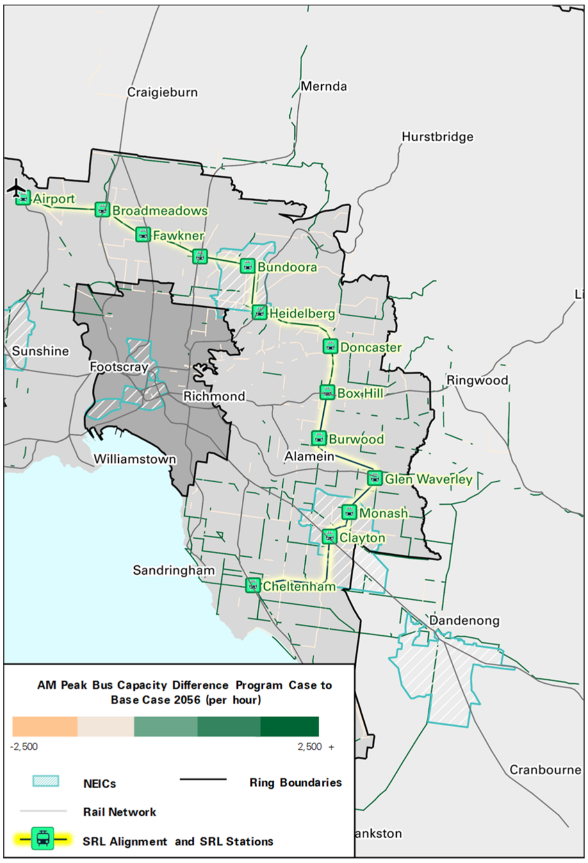
Source: SRLA

Figure 3-12: Program Case bus network changes 2036



Source: SRLA, DoT

Figure 3-13: Program Case bus network changes 2056



Source: SRLA, DoT

3.6.3 Road network

The road network for the Program Case utilises the same road network used in the Base Case – refer to Section 3.5.2.

3.6.4 Land use

Population and employment distribution across Melbourne will change in response to the transport interventions and precinct initiatives of SRL. The extent of these land use changes have been modelled using CityPlan. Through specification of distinct Base and Program Cases, the extent of change due to different interventions and initiatives can be quantified.

Assumptions regarding interventions have included changes in accessibility due to alternative specifications of the transport network, along with additional land use development capacity and development rates facilitated by the provision of additional mass transport capacity.

Assumptions have also been made regarding initiatives for select liveability and productivity changes in the SRL East and SRL North Precincts which could impact demand for specific locations. The productivity initiatives are assumed to result in the creation of jobs within the SRL East and SRL North Precincts. Liveability initiatives relate to the inclusion of different amenities within the SRL East and SRL North Precincts that may make a location more attractive for residents. These initiatives have been grouped into broad categories of civic squares, station plazas, community parks, neighbourhood parks and community facilities.

A summary of the assumptions regarding capacity changes, productivity and liveability initiatives in each SRL East and SRL North Precinct has been provided in the following table. Further input assumptions in relation to indicative precinct initiatives were also provided by SRLA. These form the basis for the assumptions used in CityPlan to help assess the impacts of the SRL – Cheltenham to Airport on land use changes. More detail on the specific assumptions and inputs, including timing of the initiatives, are provided in Volume B.

Table 3-5: Summary of Precinct land use capacity, productivity and liveability assumptions. Household and job capacity are reported as percentage increase versus the CityPlan base case capacity assumptions

Household Capacity Change		Jobs Capacity Change	Productivity Initiatives	Liveability Initiatives
Cheltenham	+97%	+96%	✓	✓
Clayton	+106%	+24%		
Monash	+93%	+111%		
Glen Waverley	+175%	+48%		
Burwood	+113%	+66%		
Box Hill	+106%	+15%		
Doncaster	+148%	+48%		
Heidelberg	+174%	+15%		
Bundoora	+113%	+211%		
Fawkner	+172%	+59%		
Reservoir	+130%	+81%		
Broadmeadows	+145%	+46%		

Source: SRLA

4. A future with and without SRL - Cheltenham to Airport

4.1 Demand Forecasts

The following sections provide an overview of the future without and with SRL – Cheltenham to Airport. Details of the modelling, including the model validation, and more extensive results are presented in Volume A: Transport Demand Forecasting and Volume B: Land Use Impacts of SRL – Cheltenham to Airport.

4.1.1 Melbourne without SRL – Cheltenham to Airport

How Melbourne will grow

Without SRL – Cheltenham to Airport, land use distribution is expected to broadly align with the SALUP19 land use projections.

Transport network performance

The strategic transport modelling indicates that many of the stresses of rapid population growth and the constraints of Melbourne's urban form will persist, and in some cases, worsen over time without intervention.

Melbourne's monocentric network focus, with movement mainly focused on radial trips in and out of the city centre, continues into the future. As a result, existing issues around congestion, travel time and accessibility within Melbourne will persist and worsen in the future without SRL – Cheltenham to Airport.

The current radial train network already experiences significant capacity constraints which will worsen over time. While significant committed and proposed rail network upgrades provide some relief in 2036, the growing transport demands of the city result in increased crowding, with capacity being met or exceeded on an increasing number of line sections in 2056.

For people travelling by private vehicle, travel times to the CBD and to tertiary education will increase in 2036 relative to 2018, and then again in 2056. This increase in travel times between 2036 and 2056 is most pronounced in outer areas. Other key economic precincts across Melbourne that are not well connected by public transport will be significantly affected by slower private vehicle journey times.

Many Melburnians are reliant on car travel to access employment opportunities outside of the central city, exacerbating congestion, especially in areas with poor public transport connectivity. This worsens into the future, reflected in peak period average speeds, which between 2018 and 2056 fall from 36 km/h to 31 km/h in the AM peak, and from 38 km/h to 30 km/h in the PM peak.

NEICs in the middle ring of Melbourne, such as Monash and La Trobe, are poorly serviced by public transport and hence heavily reliant on car travel for access. The proportion of Greater Melbourne accessible within 60 minutes of Monash by car declines from 61% in 2018 to 44% in 2056. The proportion of Greater Melbourne within 60 minutes of Bundoora by car declines from 61% in 2018 to 36% in 2056.

Public transport mode share in middle and outer precincts and NEICs is very low compared to the CBD. Poor public transport connectivity combined with a more congested road network will limit the potential of these key economic precincts. Whilst inner areas see accessibility to jobs and education improve over time, the middle and outer suburbs see a decline in accessibility over time, driven by increased congestion and travel times.

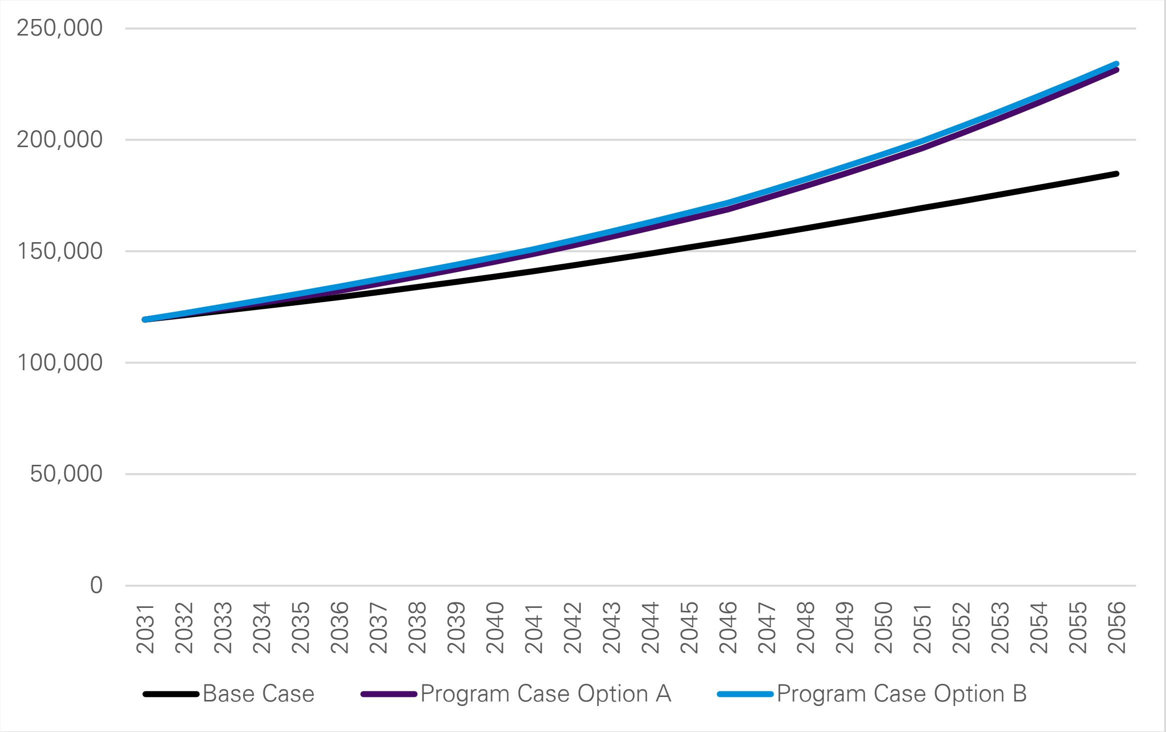
4.1.2 Melbourne with SRL – Cheltenham to Airport – creating a city of centres

The introduction of SRL – Cheltenham to Airport has a significant impact on where people live and work, and on how people move around Greater Melbourne, with the city shifting to a more polycentric form. This will help realise *Plan Melbourne's* vision to transform Melbourne into a 'city of centres'.

Growth of SRL East and SRL North Precincts

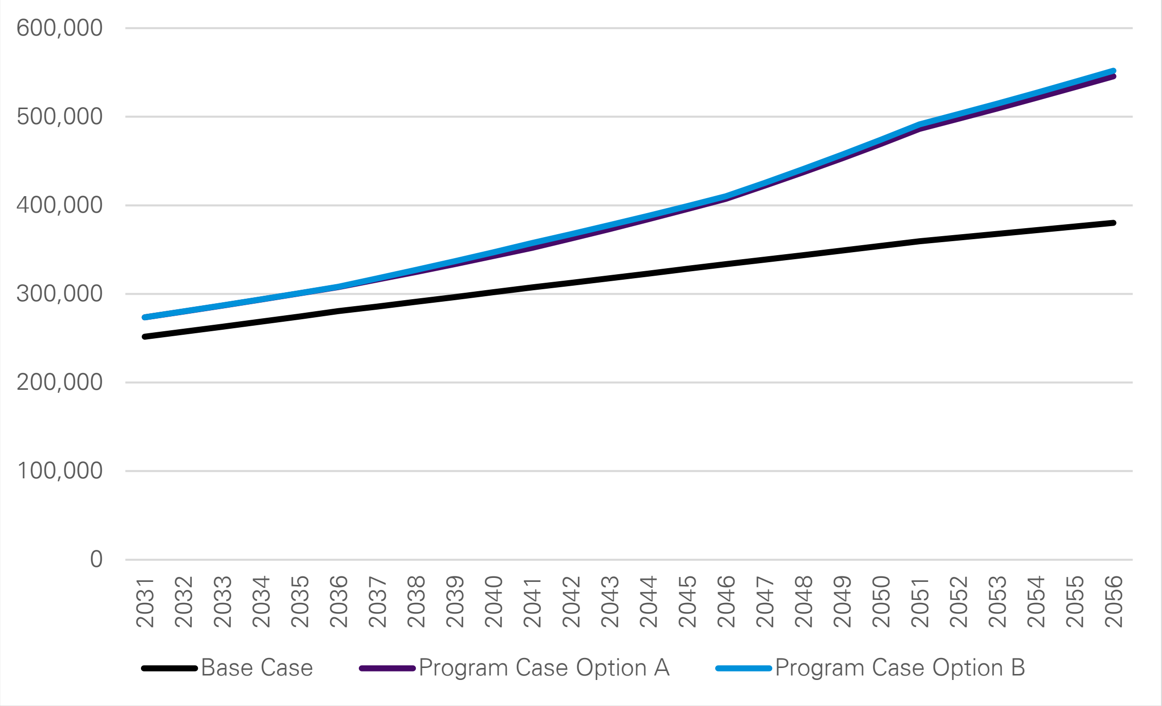
The land use impacts of SRL – Cheltenham to Airport, including the response to rail and transport interventions, along with planning settings, catalyst projects and broader infrastructure (liveability) initiatives, are expected to lead to significant additional growth in and around the SRL East and SRL North Precincts, compared with the SALUP19 forecasts. Figure 4-1 and Figure 4-2 respectively indicate a 26% increase in the number of households and a 43% increase in the number of jobs across the SRL East and SRL North Precincts (including Melbourne Airport) by 2056. In total, around 232,000 households and 545,000 jobs are expected to be located within SRL East and SRL North Precincts by 2056.

Figure 4-1: Household growth across all 13 SRL East and SRL North Precincts – Program Case Options vs Base Case



Source: KPMG analysis of CityPlan modelling

Figure 4-2: Job growth across all 13 SRL East and SRL North Precincts – Program Case Options vs Base Case



Source: KPMG analysis of CityPlan modelling

Growth in knowledge-based jobs in SRL East and SRL North Precincts

SRL – Cheltenham to Airport will also improve access to knowledge-based jobs and services within Greater Melbourne, particularly to knowledge centres such as Monash, Box Hill and La Trobe. Within this 43% job growth, a 46% increase is expected in the number of knowledge-based jobs locating within SRL East and SRL North Precincts, which can be attributed to the SRL – Cheltenham to Airport. Monash alone sees a growth of more than 144% by 2056, encouraging and unlocking the economic potential around these knowledge-based centres.

Reducing urban expansion

SRL – Cheltenham to Airport will re-shape Melbourne's urban form to become a polycentric city, supporting economic growth, jobs and investment.

Analysis of Base Case trends highlights the continual expansion of growth towards outer suburbs, with a clear urban expansion trend. The introduction of SRL – Cheltenham to Airport results in a 1.5% decline in urban expansion, with more than 16,000 households locating within the inner/middle ring suburbs rather than the outer ring.

Land value impacts

The increased growth and unlocking of potential as part of SRL – Cheltenham to Airport in households, jobs and accessibility results in an increase of land values of approximately 12% across the 13 SRL East and SRL North Precincts, with the highest modelled difference being 32% in Bundoora.

Transport network performance

With SRL – Cheltenham to Airport, more people will work and live in precincts with good access to jobs, services and amenities. Communities, businesses and institutions located in SRL East and SRL

North Precincts, and more broadly, across Melbourne's middle corridor, will benefit from increased economic activity and the creation of more vibrant communities.

The introduction of SRL – Cheltenham to Airport has a significant impact on how people move around Greater Melbourne. It is also expected to change Melbourne's land use and urban form to that of a polycentric city, helping to ease growing pressure on radial travel demands. Accessibility, travel times and public transport patronage all improve with SRL – Cheltenham to Airport. Key findings identified from the modelling are presented below:

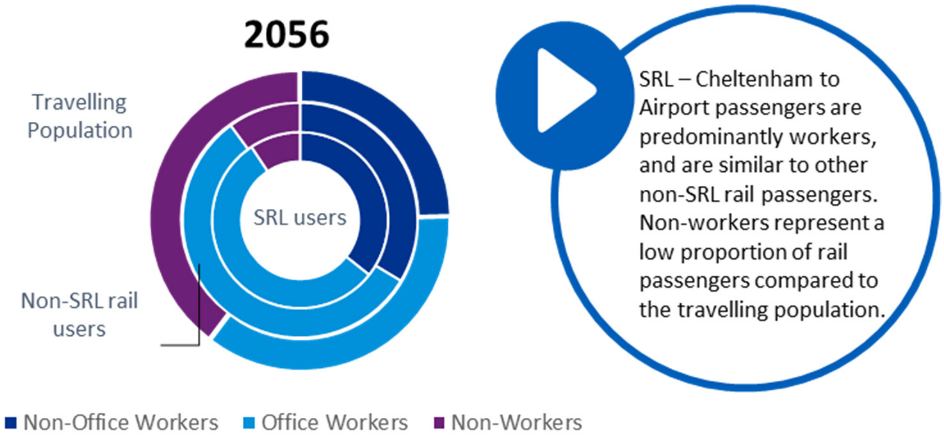
- There is strong demand for SRL – Cheltenham to Airport, with daily boardings of over 430,000 expected by 2056 under Option A or Option B. This drives an increase in daily public transport trips by over 230,000 across Greater Melbourne, and reduces private vehicle trips by over 600,000. Public Transport (PT) mode share will increase across Greater Melbourne, and increases significantly in the SRL East and SRL North Precincts.
- SRL – Cheltenham to Airport shortens public transport travel times for Melbourne's north, east and south-east. The Monash and La Trobe NEICs are accessible in less than an hour by public transport for substantially larger areas of Melbourne with SRL – Cheltenham to Airport. The road congestion relief provided by SRL – Cheltenham to Airport also improves private vehicle travel times to the CBD from northern and eastern LGAs.
- SRL – Cheltenham to Airport facilitates improved accessibility across the east and north of Melbourne. Areas in the SRL – Cheltenham to Airport corridor, as well as areas with radial rail connections to SRL – Cheltenham to Airport, see vastly improved public transport accessibility, with some LGAs seeing an increase of 500,000 jobs accessible in less than an hour by PT in 2056. Private vehicle accessibility also improves in 2056, as road congestion is alleviated by SRL – Cheltenham to Airport.
- SRL – Cheltenham to Airport eases radial highway congestion across Greater Melbourne, by shifting travel towards public transport and encouraging more orbital trips. In 2056 with SRL – Cheltenham to Airport, daily vehicle kilometres travelled drop by 2,200,000, and daily vehicle hours drop by 90,000. A significant effect is also seen on the Monash Freeway, where AM peak travel times from Springvale Road to the Domain Tunnel fall from 45 minutes to 38 minutes in 2056 – comparable to travel times seen in 2036.
- The introduction of SRL – Cheltenham to Airport also has a considerable effect on existing radial rail services, with crowding being alleviated in 2056 along lines which intersect SRL – Cheltenham to Airport. The crowding relief is most significant on the inner sections of the radial lines.
- With SRL – Cheltenham to Airport, regional Victorians located along Victoria's key regional rail lines will have access to significantly more employment, health and education opportunities across Greater Melbourne, specifically in the middle corridor, via both private vehicle and public transport. In 2056, places in the Latrobe Valley such as Traralgon and Morwell have access to an additional 420,000 to 520,000 jobs within 180 minutes by public transport with SRL – Cheltenham to Airport.

4.2 Key beneficiaries

The following provides an overview of the key beneficiaries of SRL – Cheltenham to Airport, for Program Case Option A. Details of the modelling, and more extensive results are presented in Volume C: SRL – Cheltenham to Airport Customer Insights.

Who is using SRL – Cheltenham to Airport?

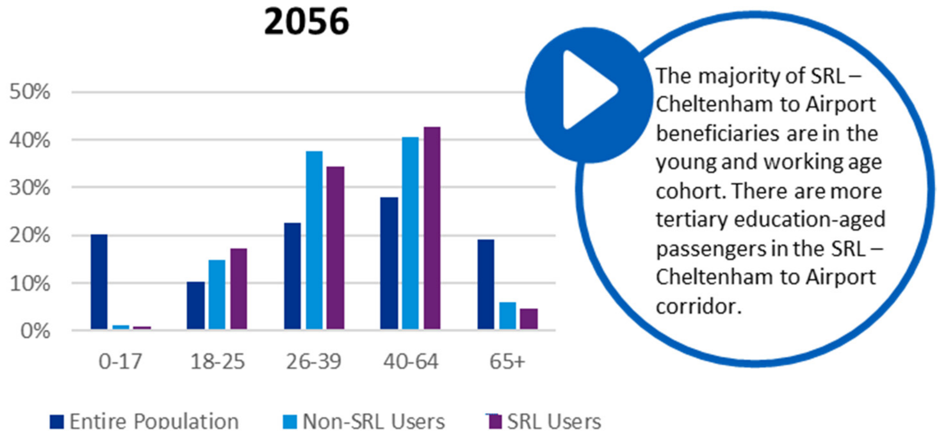
Figure 4-3: Comparison of SRL – Cheltenham to Airport users, non-SRL rail users and the travelling population by work status[11]



SRL – Cheltenham to Airport passengers are predominantly workers, and are similar to other non-SRL rail passengers. Non-workers represent a low proportion of rail passengers compared to the travelling population.

Source: KPMG analysis of MABM modelling

Figure 4-4: Comparison of SRL – Cheltenham to Airport users, non-SRL rail users and the entire population by age



The majority of SRL – Cheltenham to Airport beneficiaries are in the young and working age cohort. There are more tertiary education-aged passengers in the SRL – Cheltenham to Airport corridor.

Source: KPMG analysis of MABM modelling

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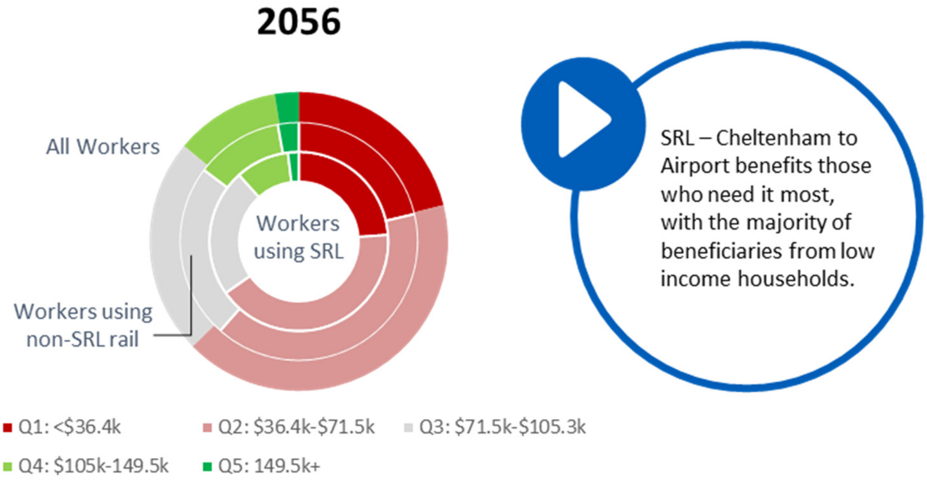
[11] "Non-SRL rail users" refers to all rail passengers who do not use SRL – Cheltenham to Airport at all during their daily travel.

Figure 4-5: Comparison of SRL – Cheltenham to Airport users, non-SRL rail users and the travelling population of workers by equivalised household income



SRL – Cheltenham to Airport benefits those who need it most, with the majority of beneficiaries from low income households.

Source: KPMG analysis of MABM modelling

SRL – Cheltenham to Airport customers insights indicate that:

- SRL – Cheltenham to Airport customers are mainly workers. 72% of workers using SRL – Cheltenham to Airport are those who work in the middle suburbs. Workers in the middle and northern suburbs of Melbourne particularly benefit from SRL – Cheltenham to Airport.
- SRL – Cheltenham to Airport is used by people who need it most. 65% of workers using SRL – Cheltenham to Airport are in the low income categories.
- The majority of beneficiaries of SRL – Cheltenham to Airport are from low and middle income households, located mainly in the middle and outer suburbs. 76% of people who use SRL – Cheltenham to Airport live in the middle suburbs and the outer north.
- The share of tertiary-aged users are noticeably higher than for non-SRL rail users, with 17% of SRL – Cheltenham to Airport passengers in the tertiary-aged young people cohort.

In 2056, SRL – Cheltenham to Airport is expected to:

- Increase the number of rail customers in lower-income brackets by around 17%
- Increase the number of rail customers in the 18-25 year old age group by around 16%.

Many different cohorts of the Victorian community will benefit from SRL – Cheltenham to Airport, including those that need it most. By reducing reliance on private vehicles for orbital trips, SRL – Cheltenham to Airport will help to make travel more affordable and alleviate household financial stress for some of the more vulnerable cohorts within the community.

5. Sensitivities and uncertainties

The SRL – Cheltenham to Airport demand modelling appraisal horizon spans over five decades. Within this period, it is likely that the supply of transport infrastructure and people's behaviour towards transport costs and accessibility might evolve. These uncertainties, which may impact transport demand and hence the economic viability of SRL, may include potential changes in future demographics and travel patterns (e.g. due to the impact of COVID-19), changes to vehicle fleets including adoption of autonomous vehicles (**AV**) and electric vehicles (**EV**), alternative fare structures, and users' inherent preference of public transport.

Given the inherent uncertainties associated with the long-term projections underpinning projects such as the SRL – Cheltenham to Airport demand and economic appraisal, it is appropriate to consider the outcomes of a range of future scenarios via alternative Base Case and/or Program Case combinations.

To incorporate the inherent uncertainties, a range of sensitivity analyses were undertaken. A summary of these sensitivity assessments, both on land-use and the demand impacts, are provided in the following sections.

Land Use sensitivities

Several sensitivity scenarios were undertaken as part of the land use modelling for SRL – Cheltenham to Airport to understand the impact of various alternative scenarios. Each of these and their permutations are outlined below, and the linewide impacts shown in Table 5-1. For further details on each of these sensitivities, see Volume B Land Use Impacts of SRL – Cheltenham to Airport, Section B.6.3.

- *S1 – Covid sensitivities:* are completed for both Program Case Options A and B. While the land use interventions remain constant, various refinements are made to better reflect the understood impacts of COVID-19 on population and employment growth along with travel behaviour. These include a reduction in future land use assumptions and reduction in the number of home to work and airport trips as described in DELWP and DTF guidance[12], and an expectation that individuals will be willing to travel further for work.
    - *S1a – Covid Program Case Option A:* Shifting back growth and implementing higher rates of working from home (**WFH**) result in lower levels of growth across SRL East and SRL North Precincts, particularly in earlier years. Sequencing of transport and interventions is consistent with Program Case Option A. By 2056, the delta between Program Case Option A and COVID Program Case Option A reduces, which is due to general decentralisation as it is assumed that people will be willing to accept longer commutes if they are commuting less frequently (like that of S6), making SRL East and SRL North Precincts more attractive.
    - *S1b – Covid Program Case Option B:* Covid Program Case Option B is largely consistent with S1a but with sequencing of transport and interventions aligned with Program Case Option B. Land use follows a similar trend to that reported in Program Case Option A, but with slightly more growth in the SRL East and SRL North Precincts associated with the earlier rollout of transport and land use uplift.

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[12] Department of Transport (2020). *COVID-19 impacts on demand forecasts – sensitivity and scenario testing project analysis.* Note that air passenger assumptions are based on IATA and Qantas announcements and have been agreed with RPV / DoT.

- *S2 - Central city uplift:* uplifting capacities, including initiatives in and around Melbourne CBD, leads to lower levels of household and growth within SRL East and SRL North Precincts, due to the CBD and inner-core providing the most attractive development locations with the highest development land values in metropolitan Melbourne.
- *S3 – Comparable precinct uplift:* Uplifting capacities and including initiatives in competing precincts such as Footscray, Sunshine, Werribee and Dandenong, leads to lower levels of growth within the SRL East and SRL North Precincts, similar to that of S2 but to a lesser extent.
- *S4 - Central city capacity increase and comparable precinct equivalent initiatives:* The combination of S2 and S3 leads to a compounding of reduced growth in household and jobs across SRL East and SRL North Precincts, particularly for jobs.
- *S5 – Lower development rates in SRL East and SRL North Precincts:* Reducing the development rates leads to lower levels of growth in the SRL East and SRL North Precincts, particularly for households.
- *S6 – Increased urban expansion:* Increasing low-density capacity in growth regions and implementing a more shallow deterrence and higher saturation leads to higher levels of household and job growth across SRL East and SRL North Precincts, reflecting people's willingness to accept higher levels of travel impedance (i.e. willingness to accept longer travel times for various trip purposes). This growth is reflective of general decentralisation, as other precincts become more attractive.
- *S8 – VPA Corridor Land Use Strategy (CLUS) scenario:* Uplifting capacities and including initiatives beyond the 1600m precinct buffer and into the wider SRL – Cheltenham to Airport corridor leads to lower levels of growth in SRL East and SRL North Precincts. This trend follows that of S2 – S4, with a reduction in household growth being more prominent, which is likely the result of inner-city areas having higher levels of accessibility and land values than SRL East and SRL North Precincts.

Outputs are presented relative to the Program Case Option A, with the following exceptions:

- S1a and S1b (COVID scenarios) are presented relative to the COVID base case. The COVID base case is an update to the Reference Case incorporating DELWP lower population and employment growth projections post COVID-19.[13] Further details of the COVID base case and its assumptions are reported in Volume B Table B-27.

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[13] Department of Transport (2020). *COVID-19 impacts on demand forecasts – sensitivity and scenario testing project analysis.* Note that air passenger assumptions are based on IATA and Qantas announcements and have been agreed with RPV / DoT.

Table 5-1: Difference in households and jobs for sensitivities in 2056

Precinct (1600m)	**Households**			**Jobs**		
	SRL East Precincts	**SRL North Precincts**	**SRL – Cheltenham to Airport – All Precincts**	**SRL East Precincts**	**SRL North Precincts**	**SRL – Cheltenham to Airport – All Precincts**
Base	**101,000**	**83,500**	**184,500**	**226,000**	**154,500**	**380,500**
Program Case Option A	**126,500**	**105,500**	**232,000**	**354,000**	**191,500**	**546,000**
S2 – Inner city uplift	-2,500	-3,000	-5,000	-21,000	-8,000	-29,000
S3 – Comparable precinct uplift	-1,000	-2,500	-3,500	-3,500	-4,000	-7,500
S4 – Inner city and comparable precinct uplift	-3,500	-3,500	-7,000	-21,000	-12,500	-33,500
S5 – Lower development rates	-13,500	-11,500	-25,000	-16,500	-500	-17,000
S6 – Increased urban expansion	6,500	+12,000	+18,500	+8,500	+13,000	+21,500
S8 – VPA CLUS	-3,500	-6,500	-10,000	+2,500	-4,000	-1,500
Covid Base	**94,500**	**77,500**	**172,000**	**216,500**	**147,500**	**364,000**
S1a – COVID Program Case Option A	+26,500	+26,500	+53,000	131,000	+41,500	+172,500
S1b – COVID Program Case Option B	+26,500	+32,500	+59,000	130,500	+45,000	+175,500

Source: KPMG analysis of CityPlan modelling

Transport demand sensitivities

The following sensitivity assessments have been considered as part of the transport demand scenario testing, with full details available in Volume A: Transport Demand Forecasting, Section A.7:

- *COVID-19 sensitivity*[14] includes adjustments to population growth projections, the impact of increased WFH and reduced domestic and international air travel. Along with the associated reduced land-use growth in the SRL East and SRL North Precincts determined through the land-use sensitivity test discussed above (S1a), this scenario resulted in a 5 to 10% reduction in daily SRL – Cheltenham to Airport boardings by 2056.

- *Airport user preference* – This scenario uses different alternative-specific constants (**ASC**) in the VITM airport module to test different user response assumptions to public transport for airport travel.[15] This test provides a 10 minute preference to rail as a mode choice for air passengers. Melbourne Airport boardings and alightings increased by around 5,000 per day, however the impacts on SRL – Cheltenham to Airport total boardings were negligible.

- *Airport user rail fares* – Applying an alternative fare structure of $14.42 + Myki for those travelling to the Melbourne Airport upon the completion of SRL – Cheltenham to Airport (reduced from $18.00 + Myki). This fare structure is applied to both MAR and SRL – Cheltenham to Airport, and results in an increase in rail patronage at Melbourne Airport. However, the impacts on SRL – Cheltenham to Airport rail boardings are negligible.

- *High AV and EV use* – This tests potential consequences of higher prevalence of autonomous vehicles (**AVs**) and Electric Vehicles (**EVs**) and higher ride sharing use associated with AVs and EVs. These scenarios also include 20% to 48% increases in road capacity assumed to reflect higher efficiency of autonomous vehicles. SRL – Cheltenham to Airport boardings were reduced by between 5 and 10% in 2056 under these tested scenarios.

- *Transport network pricing (**TNP**)* – This scenario tests potential impacts of an alternative pricing system for public and private transport, including a flagfall and distance-based public transport fare system, road distance pricing, and an inner Melbourne road cordon charge. The impacts on SRL – Cheltenham to Airport rail boardings are negligible.

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[14] Department of Transport (2020). *COVID-19 impacts on demand forecasts – sensitivity and scenario testing project analysis.* Note that air passenger assumptions are based on IATA and Qantas announcements and have been agreed with RPV / DoT.

[15] The ASCs in the Airport Module account for the unobserved attributes not captured by the time and cost incurred by a user which impact air passenger mode choice. The use of alternative ASCs aims to test the variability of the unobserved user attributes on modelled results (e.g. sensitivity of mode share).

Volume A: Transport Demand Forecasting

Victorian Integrated Transport Model (VITM)

Volume B: Land Use Impacts of SRL – Cheltenham to Airport

CityPlan Modelling

Volume C: SRL – Cheltenham to Airport User Insights

Melbourne Agent and Activity Based Model (MABM)

Attachment 1: The Economic Value of Access to Amenities Technical Paper

Contact us

Praveen Thakur
Partner
Transport & Infrastructure, Management Consulting
+ 61 3 9288 5808
thakurp@kpmg.com.au

kpmg.com.au

Volume A: Transport Demand Forecasting

Victorian Integrated Transport Model (VITM)

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A.1 Transport Demand Forecasting

A.1.1 Overview

VITM is the primary demand forecasting tool utilised in the strategic modelling for the SRL Business and Investment Case and economic appraisal. This volume provides an overview of demand forecasts for the selected modelling years and covers the following sections:

- Modelling approach for SRL – Cheltenham to Airport (Section A.2): provides an overview of VITM and the application and enhancements used for assessment of SRL – Cheltenham to Airport
- Model validation (Section A.3): outlines the data, criteria, convergence and validation performance to assess the suitability of the model for forecasting for SRL – Cheltenham to Airport
- Key assumptions (Section A.4): outlines the underlying public transport network, road network and land use assumptions for the modelled scenarios
- Melbourne in 2036 and 2056 without SRL – Cheltenham to Airport (Section A.5): outlines the forecast future year transport network performance
- A future with SRL – Cheltenham to Airport (Section A.6): outlines the forecast future year transport network performance and patronage with SRL – Cheltenham to Airport
- Sensitivity tests (Section A.7): outlines the impacts of various sensitivity assessments for a range of potential changes to input assumptions.

For the purposes of this assessment, it has been assumed that SRL – Cheltenham to Airport will be delivered in three sections: between Cheltenham and Box Hill, followed by Box Hill to Reservoir and then Reservoir to Melbourne Airport.[1] For ease of reference, the section between Cheltenham and Box Hill is referred to as SRL East, and the section between Box Hill and Melbourne Airport is referred to as SRL North. For the purposes of the demand modelling and economic appraisal, two Program Cases have been assessed with SRL – Cheltenham to Airport delivered by 2053 (Option A) and by 2043 (Option B). As SRL North is still in early planning, the assessment of two Program Cases reflects that final delivery dates are yet to be confirmed.

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[1] SRLA advises that further detailed planning and technical design for SRL North will be undertaken over the coming years. Specific packaging and procurement decisions will be made at an appropriate time in the future.

A.2 Modelling approach for SRL – Cheltenham to Airport

A.2.1 Overview

Victorian Integrated Transport Model

VITM is a strategic four-step transport model which can forecast travel demand based on changes to model assumptions such as land use, road networks, and public transport networks. Broadly speaking, four-step models involve:

- **Trip generation** to identify the number of trips from a particular location
- **Trip distribution** to identify where these trips are destined
- **Mode choice** to identify what proportion of trips use car and public transport
- **Trip assignment** to identify what routes and services are used to complete car and public transport trips.

VITM is commonly used to assess and compare the demand and potential network impacts of transport policies, strategies and major road and public transport infrastructure projects. VITM outputs also feed into other models used in the SRL – Cheltenham to Airport modelling program, including CityPlan and economic modelling, as outlined in Section 3.3.

VITM was selected as the primary forecast model due to its model performance and validation.

As a strategic transport model, VITM represents a simplification of transport characteristics, behaviours, networks and service patterns, with an inherent level of approximation. Given its strategic nature, some disaggregate outputs of VITM should be treated with caution, and interpreted in the context of the model's relative strengths and weaknesses. An assessment of these relative strengths and weaknesses is provided in Section A.3 of this report.

To assess the degree to which changing certain key assumptions affects VITM outputs, a range of sensitivity tests were undertaken. For SRL – Cheltenham to Airport VITM modelling, sensitivity tests assessed various factors including COVID-19 and increased rates of remote working, airport user preferences, airport user rail fares, autonomous vehicles, and transport network pricing.

A.2.2 Model application

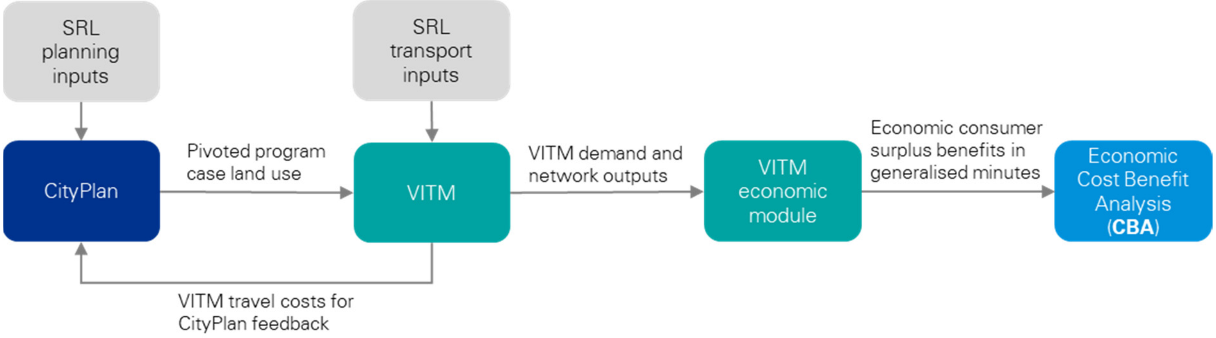
Key interactions between the transport models are described below:

- Transport network impacts (including road network impacts) are informed by VITM, which provides public transport loads on each mode
- CityPlan provides land use impacts of SRL and changes to accessibility
- If there are material land use impacts from CityPlan, these changes are then modelled using VITM to quantify the network impacts of the changes
- The economic assessment is undertaken using the VITM economic module which draws on outputs from VITM

- Local area and construction impacts, including traffic, meso and micro-simulation models and station precinct impact assessments, and detailed station modelling, are not part of this assessment and are being undertaken on behalf of SRLA by AJM or others.

This interaction is represented in the following Figure A- 1.

Figure A- 1: Model application and interaction



Source: KPMG modelling framework agreed with DoT and SRLA

A.2.3 Model enhancements

VITM was enhanced and improved in 2019, as part of the VITM Refresh[2] project, bringing it up to date with the latest available data to develop a 2018 model base year.

Preliminary SRL – Cheltenham to Airport transport modelling was undertaken using the VITM Refresh model by AJM, the SRLA technical advisors, to provide preliminary patronage forecasts and demand insights. This model, referred to as the Stage A model, was subsequently refined to Stage B and then Stage C versions of the model throughout 2020 by AJM. The Stage B and C models included various network refinements including rail interchange and network coding updates informed by preliminary modelling. The Stage C model was subsequently provided to KPMG to use as a starting point for demand modelling for economics.

Since the model handover, a number of enhancements have been made to the Stage C model to further enhance model stability necessary for economic appraisal.

The key enhancements include:

- The Reference Case has been updated, including up to date population, employment and education enrolment forecasts through Small Area Land Use Projections (**SALUP**) based on DELWP Projections 2018 (Unpublished).
- Minor updates have also been made for the SRL Business and Investment Case demand modelling to further improve model stability and accuracy. These measures included increasing the number of iterations in the highway assignment, and reading in costs from a reference model for each model year to be used as starting costs to improve model convergence.
- Updated trip generation rates in light of more recent highway screenline validation data which has improved model validation, particularly for modelled traffic across Greater Melbourne and in the study area.

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[2] KPMG, Victorian Integrated Transport Model (VITM) Refresh, (2019).

- Updated public transport parameters such as boarding penalties, time period factors and public transport alternative-specific constants (**ASCs**) to improve the validation performance of the model.
- Improved local area network representation in the study corridor, including refinements to the local road network and centroid connectors.
- Set future active trip generation rates to base 2018 rates.

Broadly speaking, the enhancements focused on improving model performance and refining the model within the SRL – Cheltenham to Airport corridor.

The VITM modelling undertaken for this assessment has used the latest upgrades and refinements available, generated through the above modelling tests.

A.2.4 Model uncertainty

VITM is a strategic multi-modal model used to estimate levels of transport demand for future transport corridors or for major transport infrastructure projects. The model estimates the demand response to changes in land use and transport supply. In doing so, the model uses mathematical equations and assumptions, which in part are determined by data availability and computing constraints. To achieve a practical and workable model, VITM simplifies some real-life behaviour, so it is important to understand the limitations of the model when making an assessment based on outputs from the model.

The demand forecasts for SRL – Cheltenham to Airport necessarily involve risk and uncertainty because they are dependent on events and circumstances that will occur in the future. The rate of population growth and the nature of infrastructure developments are examples. Furthermore, there is the uncertainty resulting from using a model to simplify real world interactions.

Base year model validation

The base year validation can provide an indication of how well the model replicates base year conditions. This provides an indication of how well the model performs when forecasting, however, it may identify some areas where the model is deficient or provide an indication of the model's level of precision.

This report summarises the VITM base year validation with respect to the transport measures that are important for modelling SRL – Cheltenham to Airport (refer to Section A.3).

Input assumptions used for forecasting

Input assumptions have been provided by DoT and are documented within Section A.4 of this report. These can broadly be classified into three categories:

- Future year public transport and highway networks
- Future year demographic and land use information
- Future year transport behaviour and cost parameters.

Steps taken to minimise model uncertainty

There are a number of factors that could cause actual SRL – Cheltenham to Airport demand to differ materially from the forecasts presented in this report. In recognition of the inherent uncertainty and to reduce the risk of the actual demand differing materially from the reported forecasts, a number of mitigating steps were undertaken. These steps focused on reducing the risk related to model inputs and understanding the behaviour of the transport model:

- Validating the model with a focus on the key corridors of influence on SRL – Cheltenham to Airport (and providing a level of importance to each validation measure)

- Enhancing the model processes within VITM to improve the stability of the model and help make the forecasts intuitive and explainable. This included increasing the number of iterations within the model and improving the starting point of each model run
- Model assumptions being circulated amongst experienced public transport professionals including the peer reviewer
- Demographic forecasts being provided by experienced specialists
- Following generally accepted practice with respect to strategic modelling processes
- Conducting a number of sensitivity tests where the model inputs were varied across possible future values (refer to Section A.7).

A.3 Model validation

A.3.1 Objective of the VITM validation

Generally, the purpose of model validation is to give confidence in the ability of the model to replicate a set of observations given a set of base data and, consequently, have the confidence in the fitness of the model to forecast travel demands.[3] These results form the inputs into the economic analysis and SRL Business and Investment Case to aid decision-making. The following considerations are central to the VITM validation:

- **The similarity of outputs with observed data**. If VITM modelling outputs are similar to observed data (to the extent that observed data is reliable) then modelling outputs for future projection years are more likely to be congruent with empirical data.
- **The robustness of the modelling approach of outputs**. Robust modelling provides confidence that the conclusions reached for project scenarios are more likely to be logical.
- **The level of convergence of results across modelling runs**. If model runs converge well then the differences between scenario results are more likely to be attributable directly to the relevant tested changes, than due to model instability.
- **The prioritisation of validation of key outputs, compared with other outputs**. While the validation of all outputs of VITM are important, some outputs are used more directly in the economic analysis and SRL Business and Investment Case. Therefore, validation of these outputs is prioritised to ensure that the focus of the economic analysis and SRL Business and Investment Case is supported by robust modelling outputs.

As stated in the Australian Transport Assessment and Planning (**ATAP**) Guidelines[4]:

> *'Model Validation criteria give a benchmark to facilitate both discussion and critical analysis of a model's performance. In particular, the criteria can assist a transport modeller to identify the strengths and weaknesses of a* model *and they can contribute to evidence that the model is accurate enough for the desired purpose of the forecasts.'*

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[3] Australian Transport Assessment and Planning (**ATAP**), *Australian Transport Assessment and Planning Guidelines*, (2016) p. 69. https://www.atap.gov.au/

[4] ATAP, Australian Transport Assessment and Planning Guidelines, (2016) p. 69.

That is, the model validation criteria should not be seen as 'pass or fail' measures, but rather an indicator of how the model results should be interpreted.

Section A.3.4 to A.3.8 provides details on the validation performance of the model.

A.3.2 Data sources

Data sources used for validation and their relevant accuracy or potential limitations are summarised in the following table. The below data sources were used to validate against the VITM 2018 base model year.

Table A - 1: Data Sources and Accuracy

Data	Source/Collection Method	Comment on Accuracy
Mode Split		
VISTA data (Victorian Integrated Survey of Travel and Activity)	Household travel and activity survey time series data (survey is undertaken over multiple years) Approximately 46,000 respondents from 18,000 households across Victoria in 2012-2018 dataset	Limited sample size Data is normalised to reflect sample rates Collected across 2012-2018, weighted to 2018 population for validation.
Highway validation		
Screenline traffic volumes	DoT annual traffic volumes, utilises permanent traffic monitoring stations, loop data and other sources, and includes estimates in some locations	DoT does not guarantee the accuracy of this data. Data used for validation is representative of 2018 data.
Travel time routes	Travel time survey data from North East Link Project (NELP)	Actual travel time survey data collected in 2017.
Public transport validation		
DoT patronage estimates by mode	Based on estimates derived from Myki public transport ticket data and patronage survey data	Estimated data for 2018.
Metropolitan Train		
CBD cordon loads	Annual CBD cordon passenger load survey conducted in May	The manual collection methodology is not as accurate when train loads exceed 1000 passengers per train. Peak period numbers may therefore be under-represented. Collected for 2018.
Station entries	Station patronage is calculated from Myki data adjusted using stratified touch on rates	Reasonable accuracy due to sufficient observations in each stratum (does not capture variation between individual stations within each stratum). Data representative of 2018.
Line loads	TrainSUMdata (modelled data outputs)	This data is an output from modelling, therefore typical modelling accuracy limitations are applicable.

Source: Assorted data sources as shown

A.3.3 Validation criteria

The SRL – Cheltenham to Airport VITM strategic model has been developed to model the relevant demographic, public transport and road network data. Validating key outputs provides confidence in the model's ability to aid decision-making regarding future projects.

In recognition of this, the validation process is focused on achieving higher levels of validation for outputs that are important to the decision-making process in relation to major rail projects.

Two key measures were used in the validation process to assess the appropriateness of the model. These included the **importance** and the **rating**. The importance relates to the relative impact that some model outputs will have on rail planning goals for Victoria over others. The importance segments model outputs based on their ability to affect rail demand. The importance is determined by professional judgement. This helps to determine what measures are likely to be more critical to the decision-making of key projects.

The rating system uses a five-level rating system (Very Good, Good, Satisfactory, Indicative, Poor) based on the number of outputs that can meet the selected criteria. For example, if the modelled volumes for eight or nine out of the nine train lines meet the validation criteria for line loading, a "Very Good" rating is achieved. If, however, six or seven lines meet the criteria, a "Good" rating is achieved. The rating level achieved depends on how many elements of the model achieve the validation criteria. The boundaries that makeup the rating scoring were determined through the professional judgement of KPMG. These ratings are shown in Table A - 2.

General VITM validation criteria and project specific criteria, importance ratings along with the relevant rationale for these ratings are provided in Table A - 3 and Table A - 4.

Table A - 2: Validation rating

Level	Rating/Terminology	% of criteria met	Application in forecasting
1	Very Good	>80%	Forecasts from the model scenarios can be used as is, without adjustments.
2	Good	60% to 80%	
3	Satisfactory	40% to 60%	Out-of-model adjustments (i.e. post processing) may be needed if an aspect of the model is not satisfactory and is the focus of the forecast scenario. For example, a low fuel price elasticity may require a modification for a fuel price scenario.
4	Indicative	20% to 40%	Base year observed data is grown by the growth forecasted by the model, or a different model is used.
5	Poor	<20%	

Source: KPMG analysis of VITM modelling

Table A - 3: General Validation Criteria

Element	Segmentation	No. of elements	Desired Criteria	Criteria Source	Importance	Rationale for Importance score
Global validation Compare modelled mode split with VISTA data	Total PT trips (statewide)	1	±5%	As agreed with SRLA and DoT	Important	Segmentation for the Global validation is collectively scored as important. The desired criteria are comparatively uncompromising. The number of trips taken at a daily level can have a significant altering effect on the benefit of rail-based projects, particularly if there are areas that are over or underestimated (in terms of person trips). The Melbourne Statistical Division (**MSD**) is prioritised because of the scale of key projects in these areas.
	Total PT trips (Melbourne) by period	5	±5%	As agreed with SRLA and DoT	Important	
	Total PT Trips by Origin LGA	31	±10%	As agreed with SRLA and DoT	Important	
	Total PT Trips by Destination LGA	31	±10%	As agreed with SRLA and DoT	Important	
	PT trips by home-based purpose	8	±10%	As agreed with SRLA and DoT	Important	
Trip distribution	PV average trip lengths by purpose	10	±10%	As agreed with SRLA and DoT	Important	
	PT average trip lengths by purpose	10	±10%	As agreed with SRLA and DoT	Important	
Highway convergence	RAAD	4	<1%	DoT	Moderately Important	Highway convergence is listed as moderately important because of its ability to affect the screenline volume. Individual link flows and the consistency in volumes can be affected by poor model convergence.
	RGAP	4	<1%	DoT	Moderately Important	
Global PT modes	Boardings by PT mode by time period	16	±10%	As agreed with SRLA and DoT	Important	PT boardings by mode and time period are important for appropriate mode choice assignment.
Train boardings	By group (AM & PM Peak)	8	±10%	PTV	Very important	One of the key drivers of SRL – Cheltenham to Airport is to encourage more rail trips, consequently the validation of rail travel is deemed very important.
	By line (AM & PM Peak)	22	±15%	PTV	Very important	
	By line segment (daily)	6	$R^2 \geq 0.85$	As agreed with SRLA and DoT	Very important	

Element	Segmentation	No. of elements	Desired Criteria	Criteria Source	Importance	Rationale for Importance score
Train loads	Metropolitan volumes by group	8	±15%	PTV	Very important	Similar to train boardings, train loads were classed generally as very important, as future projects have a strong focus on rail. Closely linked train loads at different points along the network provide an indication of the crowding and where relief is required.
	Metropolitan volumes by line	22	±20%	As agreed with SRLA and DoT	Very important	
Tram boardings and loads	Total boardings by route	1	$R^2 \geq 0.85$	PTV	Moderately important	Tram validation is moderately important because tram demand is interrelated with demand for other modes of transport. However, it is not central to the decision-making processes for rail investments.
	Cordon loads	22	±20%	PTV	Moderately important	
Screenline traffic volume	By time period and by direction and by vehicle class	20	$R^2 \geq 0.85$, slope>0.9 and <1.1	DoT	Important	Although the primary objective of SRL – Cheltenham to Airport is to attract more rail patronage, the validation performance of screenline traffic volumes is important to ensure that the model is representing traffic demand in the model accurately, as it will impact public transport mode shares.
Traffic volume at individual count sites	By time period and by direction and by vehicle class	20	$R^2 \geq 0.85$, slope>0.9 and <1.1	DoT	Important	Traffic validation at individual count sites has been classified as important, as it can provide an indication of how well the model represents traffic and associated congestion at specific locations.
Metropolitan cordon traffic volume	Metropolitan cordon totals by time period	10	±10%	DoT	Moderately important	The model validation at the metropolitan cordon is listed as moderately important. It can provide an indication of how well the inter-city trip demand model is performing.

Source: KPMG analysis of VITM modelling

Table A - 4: Project Validation Criteria

Element	Segmentation	No. of elements	Desired Criteria	Criteria Source	Importance	Rationale for Importance score
Orbital public transport trips	Daily trips	4	±20%	As agreed with SRLA and DoT	Important	Orbital public transport trips have been listed as important, as the project will provide an attractive orbital rail service which will likely provide the most benefits to these types of trips.
Train boardings	By SRL East and SRL North radial station	8	±20%	PTV	Important	Train boardings by station that provide connections to SRL – Cheltenham to Airport in the Program Cases have been listed as important, as the project is expected to improve existing rail connections, and facilitate a large number of rail transfers. The model performance at these stations can provide an indication of how the model would forecast patronage at SRL East and SRL North stations.
Orbital bus boardings (time period)	Daily boardings	1	±20%	PTV	Important	Orbital bus patronage has been listed as important, as it provides a key alternative to rail travel. The model performance of orbital bus travel could provide confidence in the orbital public transport demand produced by the model, which is likely to be a key driver of benefits for SRL – Cheltenham to Airport.
Orbital screenline traffic volume	By screenline and by time period (AM, PM and daily)	21	±10%	As agreed with SRLA and DoT	Very important	Orbital screenline traffic volume validation has been classified as very important. The validation performance of orbital screenline traffic volumes are very important in producing robust forecasts, as the attractiveness of SRL – Cheltenham to Airport is strongly dependent on the levels of congestion on the road network in the corridor.
Individual traffic counts on orbital screenlines	By time period (AM, PM and daily) and by direction	6	$R^2 \geq 0.85$, slope>0.9 and <1.1	DoT	Very important	Individual traffic count volume validation at orbital screenline locations has been classified as very important, as the performance of the model at individual locations may differ to the performance across a screenline. Robust performance at the individual count location level would suggest the model is not over or underestimating traffic in certain areas and provide confidence in the use of the outputs for calculation of benefits.

Element	Segmentation	No. of elements	Desired Criteria	Criteria Source	Importance	Rationale for Importance score
AM and PM peak travel times in study area	By time period and by direction	4	$R^2 \geq 0.85$, slope>0.9 and <1.1	As agreed with SRLA and DoT	Important	Modelled travel times in the study area can provide an indication of how well the model replicates observed congestion levels. Congestion levels are important because one of the key benefits of the project is to relieve road congestion. Congestion levels in the model also impact public transport mode share. A model that replicates observed travel times well provides confidence that forecasted public transport patronage and associated benefits can be relied upon.

Source: KPMG analysis of VITM modelling

A.3.4 Summary of model validation performance

The validation results presented in this report provide a summary of the model performance for key global and SRL – Cheltenham to Airport corridor specific metrics. A detailed validation assessment was undertaken against the validation criteria to provide an objective view of the performance of the model and its fit for purpose.

Table A - 5 summarises the results of the validation assessment against the validation criteria. This shows the results for both global measures and measures more specific to SRL – Cheltenham to Airport. The performance rating of the model against each of the items in the criteria have been grouped by validation dimension and level of importance respectively. Figure A- 2 presents the validation performance by level of importance for both the model that was provided to KPMG from SRLA that was used for preliminary design modelling by AJM (Stage C model), and the model with enhancements made for the purpose of demand forecasting for economics for the SRL Business and Investment Case.

The validation assessment shows that the prioritised measures that are critical for modelling the Program Case demonstrated improved performance compared to the Stage C model. In particular, the traffic screenline validation performance of the model has improved significantly both globally and in the study area, whereas the Stage C model was systematically underestimating daily screenline traffic volumes by approximately between 5 and 10%.

The model performed well for aggregate demand measures as expected of a strategic model, and reasonably well for more disaggregated measures such as boardings by line and by individual stations. The variances between modelled and observed data for the disaggregated measures can be partly explained by the level detail of the VITM networks and zone structure. Overall, the results provide confidence in the model's ability to reasonably replicate strategic public transport and traffic demand in the study area for the purpose of assessing SRL – Cheltenham to Airport. However, there was also limited data available for the study area, particularly for orbital travel and road travel times and traffic counts. Additional data such as more recent travel time surveys in the SRL – Cheltenham to Airport corridor could potentially further improve the level of confidence for assessing SRL – Cheltenham to Airport, particularly with regard to travel time benefits. As part of economic appraisal, this has been addressed through a sensitivity test to help understand the implication of over/under estimation of travel times for SRL – Cheltenham to Airport.

The analysis also shows that VITM reaches a good level of assignment convergence with the increased number of assignment iterations, even in the 2056 model. The results for the model loop convergence also suggest that VITM is converging reasonably well at six model loops.

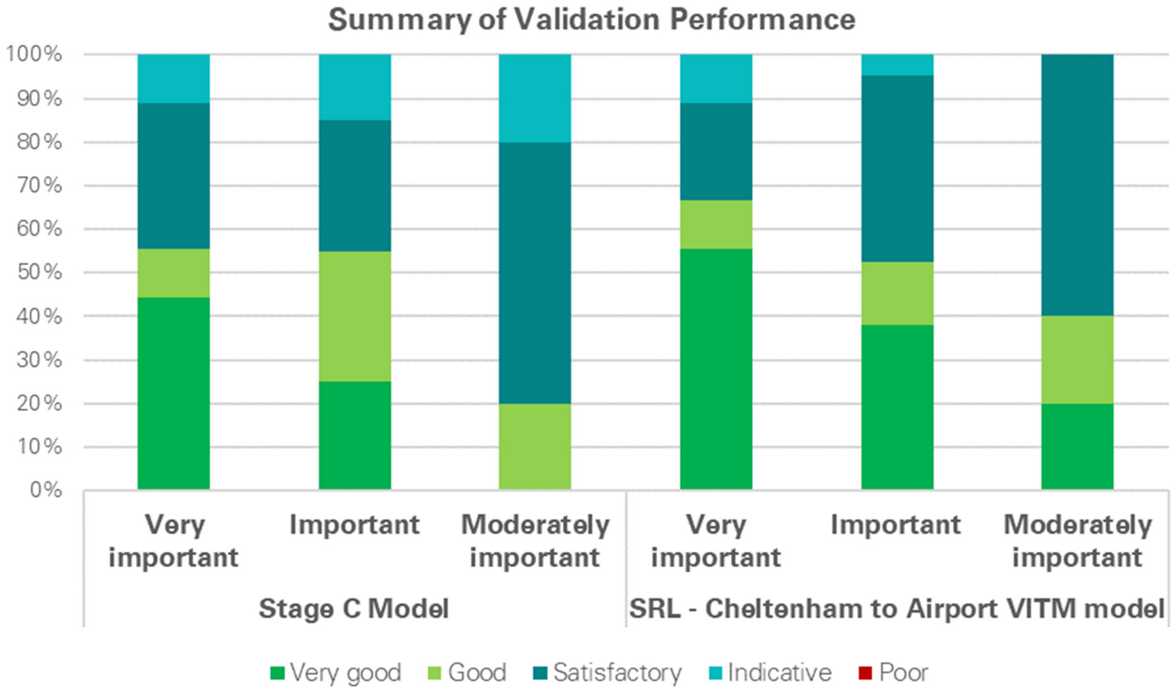
Table A - 5: Summary of validation results

Validation measure	Level of Importance	Stage C model	SRL – Cheltenham to Airport model
Total PT trips (state-wide)	Important	Satisfactory	Satisfactory
Total PT trips (MSD) by period	Important	Indicative	Indicative
Total PT trips by destination LGA	Important	Satisfactory	Satisfactory
PT trips to City of Melbourne (Daily)	Important	Not satisfied	Satisfactory
PT trips by home based purpose	Important	Indicative	Satisfactory
PT mode share by origin LGA (AM)	Important	Indicative	Satisfactory
PV average trip lengths by purpose	Important	Satisfactory	Satisfactory
PT average trip lengths by purpose	Important	Satisfactory	Satisfactory
RAAD	Important	Satisfactory	Satisfactory
RGAP	Important	Satisfactory	Satisfactory

Validation measure	Level of Importance	Stage C model	SRL – Cheltenham to Airport model
Boardings by PT mode by time period	Important	Very good	Very good
By Group (AM & PM Peak)	Very Important	Satisfactory	Satisfactory
By Line (AM & PM Peak)	Very Important	Indicative	Indicative
By Line section (Daily)	Very Important	Satisfactory	Satisfactory
By Line section (AM, PM, Daily)	Very Important	Satisfactory	Good
Metro train cordon volumes by group	Very Important	Very good	Very good
Metro train cordon volumes by line	Very Important	Very good	Very good
Total boardings by route (Daily)	Moderately Important	Indicative	Satisfactory
Total boardings by route (Daily)	Moderately Important	Not satisfied	Not satisfied
Cordon loads (AM & PM Peak)	Moderately Important	Satisfactory	Satisfactory
Screenline totals car - inbound	Important	Good	Very good
Screenline totals car - outbound	Important	Good	Very good
Screenline totals HCV - outbound	Important	Very good	Very good
Individual counts car - inbound	Important	Very good	Very good
Individual counts car - inbound	Important	Very good	Very good
Individual counts car - outbound	Important	Good	Very good
Individual counts HCV - outbound	Important	Good	Good
Individual counts HCV - outbound	Important	Very good	Very good
Metropolitan Outer Cordon	Moderately Important	Satisfactory	Good
SRL – Cheltenham to Airport project area			
Screenline totals all vehicle - both directions (AM, PM, Daily)	Very Important	Good	Very good
Individual counts all vehicle - inbound	Very Important	Very good	Very good
Individual counts all vehicle - outbound	Very Important	Very good	Very good
Orbital public transport trips (Daily)	Important	Good	Good
Train entries/exits by SRL East and SRL North radial station (Daily)	Important	Good	Good
Orbital bus boardings (Daily)	Moderately Important	Good	Very Good
NELP Corridor travel times	Moderately Important	Satisfactory	Satisfactory

Source: KPMG analysis of VITM modelling

Figure A- 2: Summary of validation performance



Source: KPMG analysis of VITM modelling

A.3.5 Model convergence

Model convergence is an important element of validation and refers to an iterative process reaching an equilibrium state where the differences in model results between successive iterations become insignificant. Convergence therefore provides a level of confidence that result differences are due to scenario differences, not due to model instability.

Convergence of the VITM four-step model is critical to the useability of VITM outputs. Differences in the costs between model iterations may lead to changes in demand for highway and public transport. Table A - 6 summarises the convergence statistics of the highway volumes for a 2056 Base Case model between model loops. The results generally show the differences in highway volumes between successive loops becoming smaller, which suggests the model has reasonably converged.

Table A - 6: Model convergence statistics for 2056 model

Cycle	Mean AAD	Max AAD	Mean RAAD	Max RAAD	RMSE	%RMSE	Mean GEH	Max GEH	% GEH
1	855.5	23,814	0.0	0	1843.8	0.0	32.7	218.2	5.0
2	75.5	4,461	251.3	4.00E+06	206.5	24.1	2.1	42.8	69.8
3	62.2	3,958	0.5	10558	171.3	18.6	1.7	46.4	74.8
4	32.5	1,208	1.6	46155	79.3	9.1	1.1	29.5	83.6
5	19.3	1,089	1.9	13028	55.4	6.5	0.6	17.1	93.2
6	15.2	940	0.3	970.68	42.6	5.1	0.5	19.1	95.2

Source: KPMG analysis of VITM modelling

A.3.6 Highway assignment convergence

Convergence of the highway assignment is critical to the useability of VITM outputs. Differences in results between iterations may lead to changes in the demand for highway use. Ideally, the difference in highway assignment results should be minimal.

Table A - 7 shows the highway assignment convergence statistics for the four time periods modelled in VITM for the 2018 model. Two different measures are used to determine the level of convergence during the highway assignment:

- The relative average absolute difference in link volumes between successive iterations (RAAD)
- The percentage difference between the total network cost as determined by the current flow pattern, and the costs of the minimum cost routes as calculated for the next all or nothing assignment (Relative Gap).

Overall, the model achieved the 'Very Good' rating for highway convergence with eight out of eight observations meeting the criteria.

As demand increases in future model years, the convergence performance in future years may also change. The maximum number of iterations was increased to 200 for all time periods for all runs feeding into economic appraisal, to minimise the differences between iterations. The results are shown in Table A - 8 for a 2056 Base Case model and show that the model satisfies the convergence criteria with eight out of eight observations.

Figure A- 3 shows the highway convergence performance by iteration for each individual time period assignment for a 2056 Base Case model. The results show that the assignment for each time period has converged, with the AM and PM peak periods converging at roughly 130 iterations. The inter-peak and off-peak periods reached convergence in fewer iterations.

Figure A- 4 shows the highway convergence performance in the AM peak for a 2056 Base Case and a 2056 Program Case. This indicates that the difference in vehicle hours between the Base and Program Cases is significantly larger than the differences in cost between successive highway assignment iterations. This suggests that the performance of the highway assignment is suitable for assessing SRL.

Table A - 7: Highway convergence statistics for base model 2018

Period	Measure (criteria)	Modelled
AM	Max iterations	60
	RAAD (<1%)	0.0%
	RGAP (<1%)	0.6%
IP	Max iterations	40
	RAAD (<1%)	0.0%
	RGAP (<1%)	0.09%
PM	Max iterations	60
	RAAD (<1%)	0.0%
	RGAP (<1%)	0.6%
OP	Max iterations	30
	RAAD (<1%)	0.0%
	RGAP (<1%)	0.1%
	Criteria met (±5%)	8/8
	Rating achieved	Very Good
	Level of importance	Important

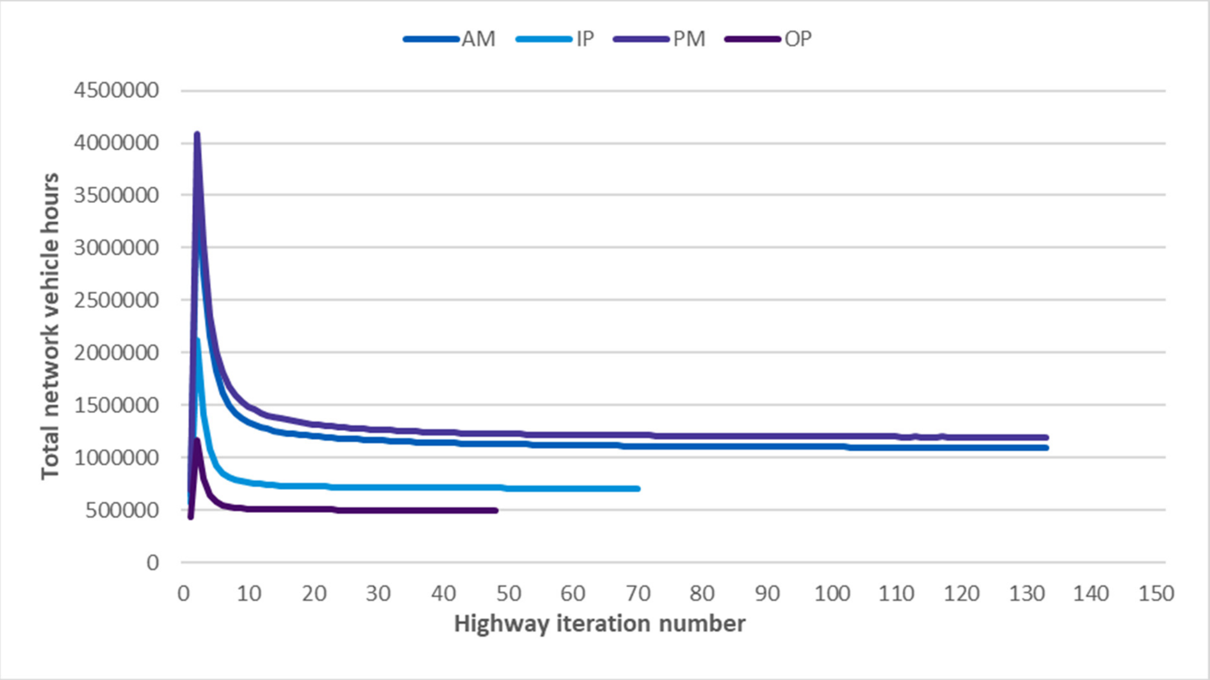
Source: KPMG analysis of VITM modelling

Table A - 8: Highway convergence statistics for a 2056 Base Case model

Period	Measure (criteria)	Modelled
AM	Max iterations	200
	RAAD (<1%)	0.0%
	RGAP (<1%)	0.2%
IP	Max iterations	200
	RAAD (<1%)	0.0%
	RGAP (<1%)	0.4%
PM	Max iterations	200
	RAAD (<1%)	0.2%
	RGAP (<1%)	0.3%
OP	Max iterations	200
	RAAD (<1%)	0.0%
	RGAP (<1%)	0.3%
	Criteria met (±5%)	8/8
	Rating achieved	Very Good
	Level of importance	Important

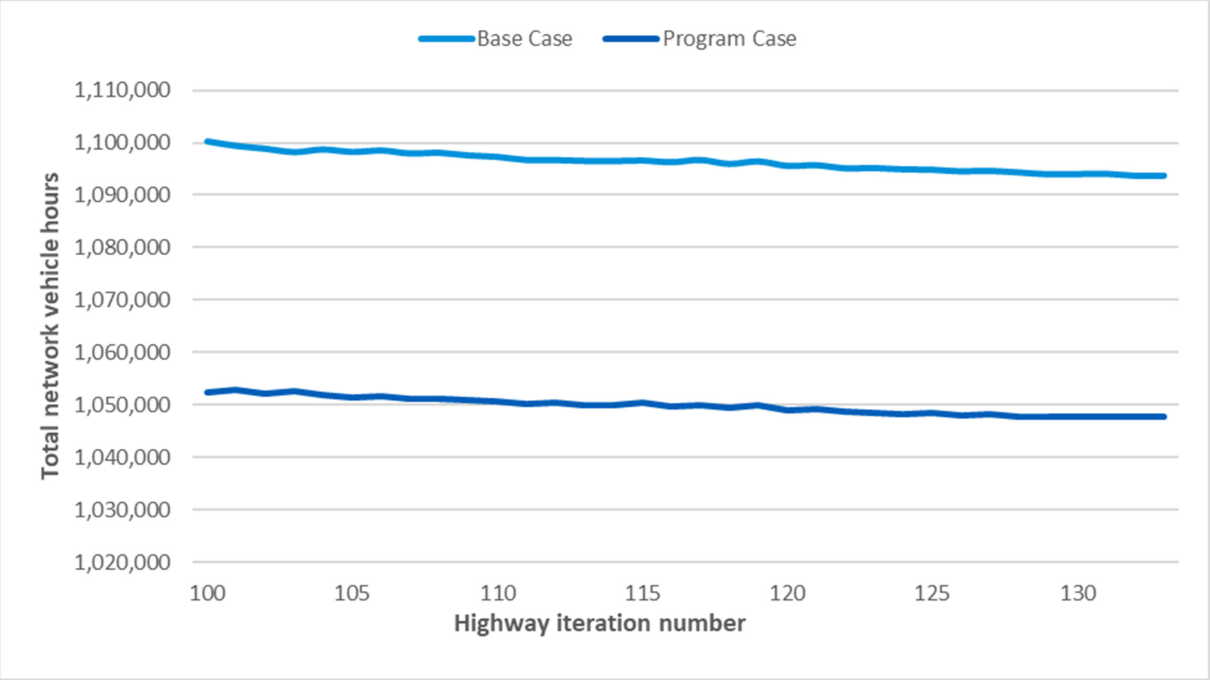
Source: KPMG analysis of VITM modelling

Figure A- 3: Highway assignment convergence for a 2056 Base Case model



Source: KPMG analysis of VITM modelling

Figure A- 4: AM peak highway assignment convergence for a 2056 Base Case and Program Case model



Source: KPMG analysis of VITM modelling

A.3.7 Global validation performance

This section highlights the performance of VITM used for SRL – Cheltenham to Airport modelling against observed data for key network wide criteria, including total weekday trips, public transport boardings, daily screenline totals and train cordon volumes. The purpose of this section is to show how the model is generally performing across Greater Melbourne in forecasting private vehicle and public transport demand.

Total Greater Melbourne PT mode share

Table A - 9 shows the validation results for total public transport (**PT**) and private vehicle (**PV**) trips within the MSD. The model demonstrates a strong performance at modelling total Melbourne PT trips with a modelled figure within 5% of that observed in VISTA. However, there is a slight overestimation of total Melbourne PV trips. This indicates that the validation of mode share is at 'Satisfactory' level.

Table A - 9: Weekday public transport and private vehicle trips within the MSD in 2018

Mode	Modelled	Observed	% difference
Public Transport	1,382,586	1,407,281	-2%
Private Vehicle	14,559,392	13,059,814	11%
		Criteria met (±5%)	1/2
		Rating achieved	Satisfactory
		Level of importance	Important

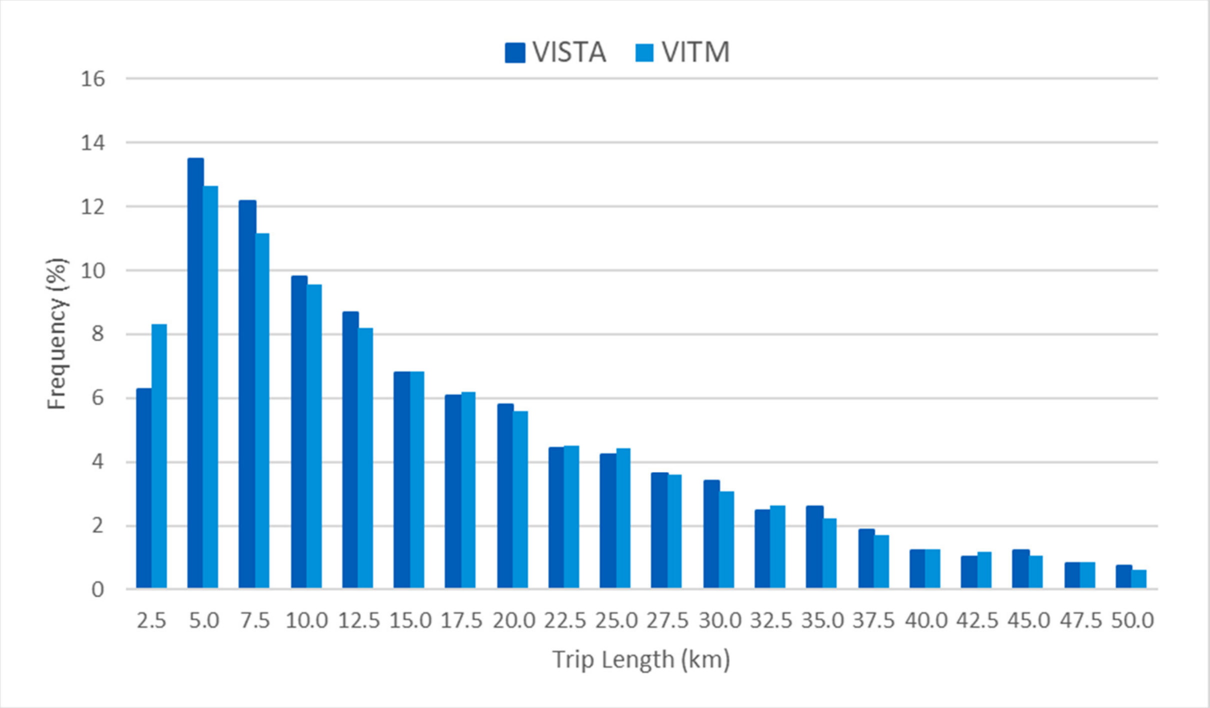
Source: KPMG analysis of VITM modelling

Trip length distribution

Figure A- 5 shows the trip length distribution for all PT trips for observed VISTA data and from SRL VITM. This indicates that SRL VITM overestimates very short trips slightly, however, generally matches the trip length distribution of VISTA quite well.

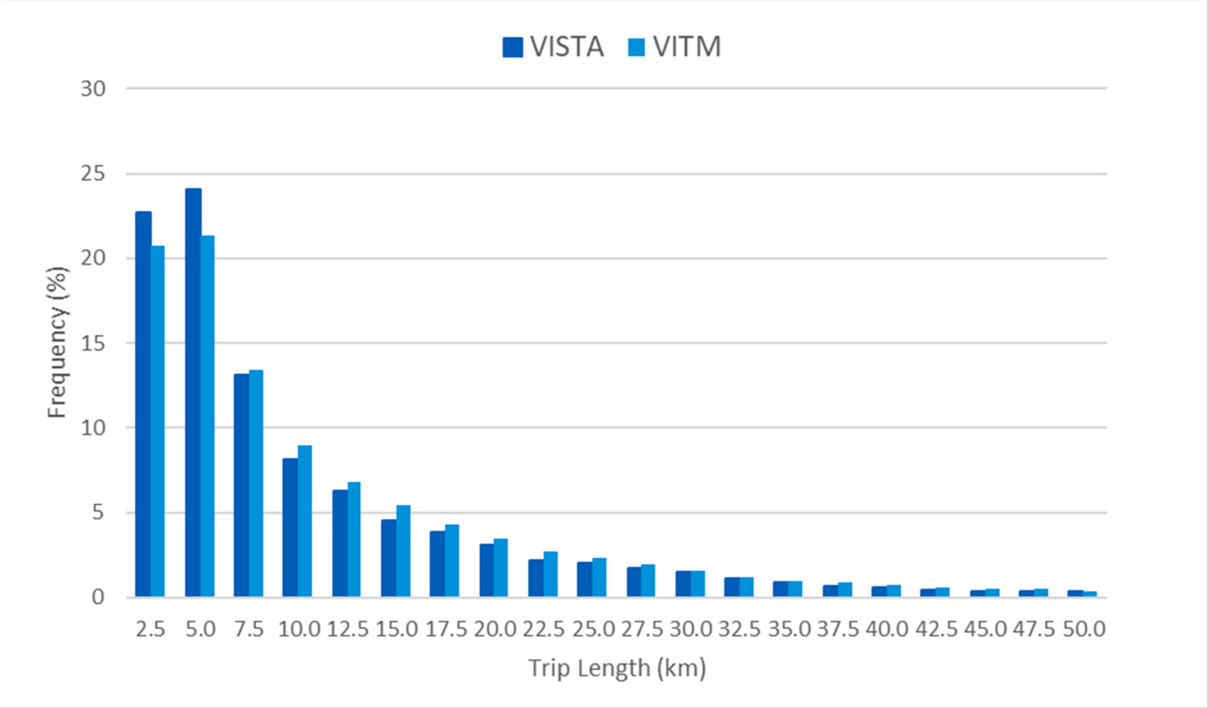
Figure A- 6 shows the trip length distribution for all private vehicle trips. This indicates that SRL VITM tends to slightly underestimate short trips and overestimate longer trips.

Figure A- 5: Public transport trip length distribution



Source: KPMG analysis of VITM modelling

Figure A- 6: Private vehicle trip length distribution



Source: KPMG analysis of VITM modelling

Public transport boardings by mode and time period

The validation results for total PT boardings by mode are shown in Table A - 10. The model performs reasonably well with respect to all PT modes across all time periods, except for inter-peak train and tram boardings and off-peak bus boardings. Of note, there is a slight overestimation of train boardings, whereas tram boardings in the inter-peak are marginally below the lower bound of the criteria. The number of boardings by bus is also underestimated in the off-peak period. Overall, the model achieved 12 out of 15 observations meeting the given criteria, which indicates a 'Very Good' performance rating.

Table A - 10: Public transport boardings by mode and by time period

Mode	Period	Modelled	Observed	% difference
Metropolitan Train Boardings	AM peak	205,148	208,277	-1.5%
	Inter-peak	69,204	58,925	17.4%
	PM peak	172,475	162,889	5.9%
	Off-peak	57,962	58,667	-1.2%
	Daily	845,399	805,386	5.0%
Tram Boardings	AM peak	123,302	117,528	4.9%
	Inter-peak	60,835	74,228	-18.0%
	PM peak	113,089	119,817	-5.6%
	Off-peak	46,896	49,195	-4.7%
	Daily	616,129	667,523	-7.7%
Bus Boardings	AM peak	93,282	98,689	-5.5%
	Inter-peak	44,769	42,889	4.4%
	PM peak	86,372	85,157	1.4%
	Off-peak	24,713	32,139	-23.1%
	Daily	431,285	451,509	-4.5%
			Criteria met (±15%)	12/15
			Rating achieved	Very Good
			Level of importance	Important

Source: KPMG analysis of VITM modelling

Metropolitan train cordon volumes

Cordon validation of metropolitan train volumes at the train line level is shown in Table A - 11 and Table A - 12 for the AM and PM peaks respectively. The model demonstrates strong performance in the AM peak for all lines except for Sandringham which is underestimated. For the PM peak, the model performance satisfies the criteria for all lines except for the Frankston Line. The model achieves a 'Very Good' rating for cordon load validation performance by line for both AM and PM peak periods.

Table A - 11: AM peak two-hour metropolitan train cordon volumes by line

Metropolitan train line	Observed	Modelled	Difference	% difference
Newport Corridor	16,789	16,274	-515	-3%
Sunbury Line	12,721	12,725	4	0%
Craigieburn Line	13,128	13,465	337	3%
Upfield Line	4,107	4,301	194	5%
Epping Line	10,938	9,489	-1,449	-13%
Hurstbridge Line	10,724	10,489	-236	-2%
Camberwell Corridor	26,132	25,284	-848	-3%
Glen Waverley Line	8,323	7,668	-655	-8%
Dandenong Corridor	19,132	17,960	-1,171	-6%
Frankston Line	14,947	15,640	693	5%
Sandringham Line	10,093	7,854	-2,238	-22%
			Criteria met (±20%)	10/11
			Rating achieved	Very Good
			Level of importance	Very Important

Source: KPMG analysis of VITM modelling

Table A - 12: PM peak two-hour metropolitan train cordon volumes by line

Metropolitan train line	Observed	Modelled	Difference	% difference
Newport Corridor	11,468	12,651	1,183	10%
Sunbury Line	10,164	9,506	-658	-6%
Craigieburn Line	9,310	10,731	1,421	15%
Upfield Line	3,088	3,114	26	1%
Epping Line	7,579	7,587	8	0%
Hurstbridge Line	7,142	6,802	-340	-5%
Camberwell Corridor	17,355	17,321	-34	0%
Glen Waverley Line	5,814	5,105	-709	-12%
Dandenong Corridor	14,149	12,511	-1,637	-12%
Frankston Line	8,751	11,648	2,897	33%
Sandringham Line	6,238	5,250	-988	-16%
			Criteria met (±20%)	10/11
			Rating achieved	Very Good
			Level of importance	Very Important

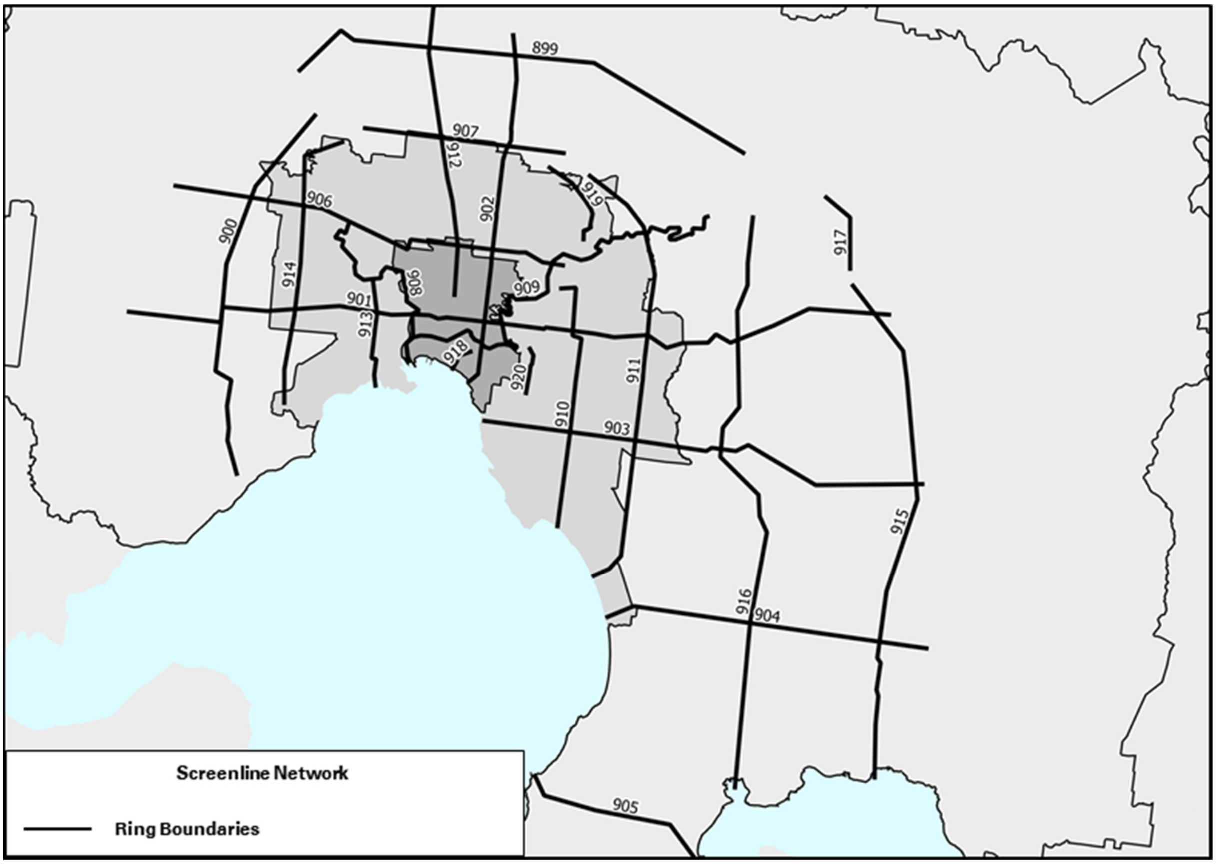
Source: KPMG analysis of VITM modelling

Global screenlines

Screenline analysis is commonly used in strategic modelling to determine a model's ability to replicate observed levels of traffic entering and/or exiting specific areas. A screenline is an imaginary line which intersects numerous roads and, when the traffic volumes are assessed across the screenline as a whole, can provide an indication of the aggregate performance of the model at estimating traffic in a particular area.

The validation of model results against observed weekday screenline traffic data for all vehicles across Greater Melbourne is summarised in Table A - 13. A map of the screenlines used in the validation is shown in Figure A- 7. The model performance across all screenlines in Melbourne is excellent, aside from a slight underestimation of AM and IP outbound volumes. The model achieves a 'Very Good' rating for this measure.

Figure A- 7: Screenline locations



Source: DoT

Table A - 13: Summary of global screenline totals – all vehicles by time period and direction

Direction	Time period	Observed	Modelled	Coefficient	R-squared
Inbound	AM Period	1,074,419	1,080,461	1.0040	0.9877
	IP Period	721,901	719,340	0.9946	0.9911
	PM Period	839,496	792,695	0.9637	0.9756
	OP Period	614,032	601,306	0.9855	0.9879
	24 Hour	6,405,574	6,293,058	0.9884	0.9938
Outbound	AM Period	757,009	688,419	0.9295	0.9648
	IP Period	698,057	661,680	0.9513	0.9885
	PM Period	1,075,387	1,074,040	1.0080	0.9861
	OP Period	619,686	622,677	1.0124	0.9928
	24 Hour	6,383,290	6,215,675	0.9831	0.9927
Two Way	AM Period	1,831,429	1,768,880	0.9729	0.9882
	IP Period	1,419,958	1,381,020	0.9733	0.9912
	PM Period	1,914,882	1,866,735	0.9890	0.9854
	OP Period	1,233,718	1,223,983	0.9994	0.9915
	24 Hour	12,788,864	12,508,733	0.9858	0.9939
Criteria met (Coefficient 0.9-1.1 and R-squared >0.9)					15/15
Rating achieved					Very Good
Level of importance					Important

Source: KPMG analysis of VITM modelling

A.3.8 Study area validation performance

This section provides a comparison of the modelled demand against observed data in the SRL – Cheltenham to Airport corridor. The purpose of this section is to provide an indication of how the model performs at estimating overall and orbital demand in the SRL – Cheltenham to Airport corridor using a number of measures.

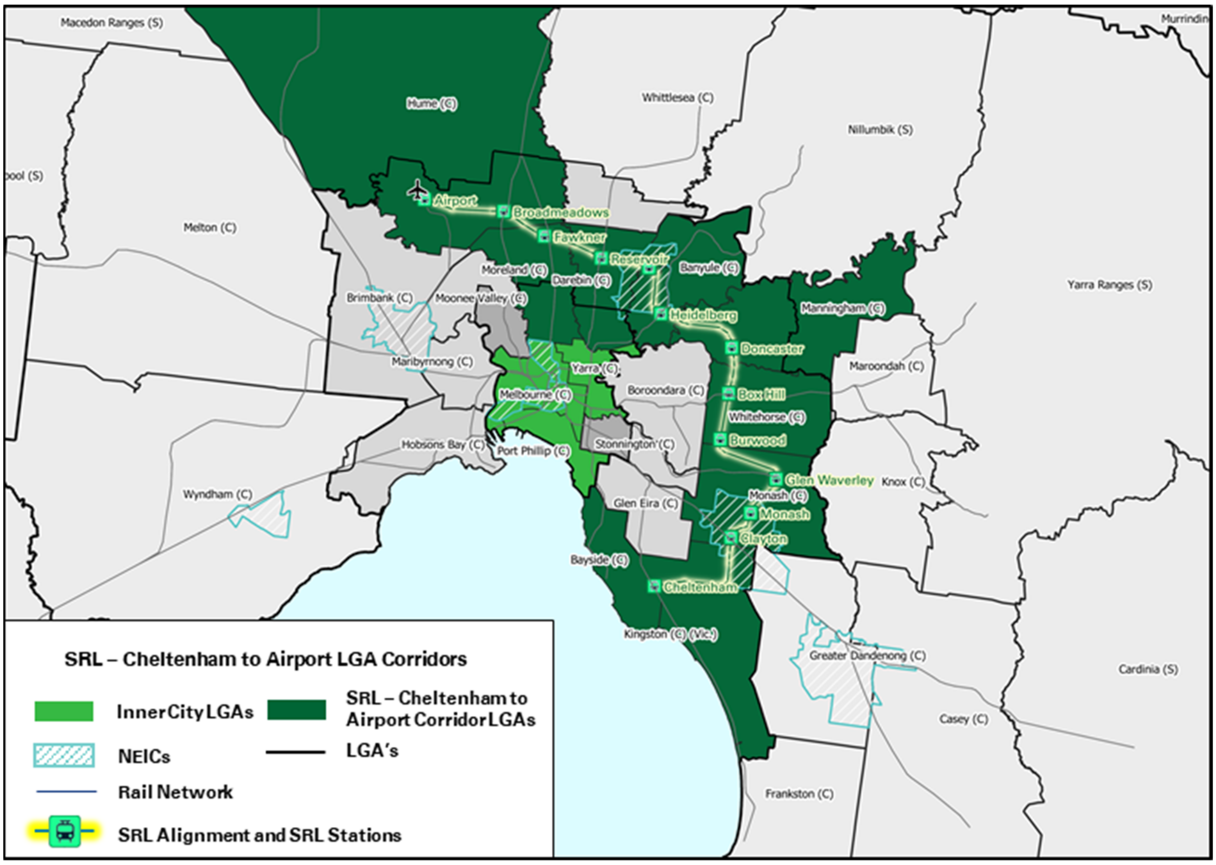
Orbital public transport trips

VITM is typically validated against observed data for radial trips in Melbourne, due to the existing dominant nature of radial travel in Melbourne. For this assessment, it is necessary to also validate whether orbital trips generated by VITM, within middle and outer suburbs, are generally in line with observed data. In the absence of surveyed orbital trip data, the VITM orbital trips were compared to those observed in the VISTA data set to provide confidence in the model's forecasting ability for SRL – Cheltenham to Airport. It is noted that the nature of the VISTA survey data generates some uncertainties as to the level of reliability of representation of orbital trips, but nonetheless VISTA was the only data source available.

The validation undertaken compared modelled and observed daily trips in Greater Melbourne, for all trip purposes, with trips beginning and ending in the same LGA excluded.[5] Trips are then categorised by their origin and destination Local Government Areas (**LGA**s). LGAs have been categorised as inner city, SRL – Cheltenham to Airport corridor, or neither. A map of these LGA definitions is shown in Figure A- 8.

Figure A- 9 shows a comparison of modelled daily public transport trips across Greater Melbourne in VITM for the 2018 model against VISTA. The results show that VITM represents orbital trips between SRL – Cheltenham to Airport LGAs against VISTA relatively well, with the model total falling within 2% of the observed total. VITM also compares reasonably well against VISTA for radial trips between SRL – Cheltenham to Airport and inner city LGAs, however slightly overestimates inner city to inner city trips. Figure A- 10 shows that the proportion of daily trips using public transport between the SRL – Cheltenham to Airport LGAs in VITM is around 3.2%, validating closely against the 2.8% observed in VISTA.

Figure A- 8: SRL – Cheltenham to Airport corridor and inner city LGAs



Source: KPMG analysis of VITM modelling

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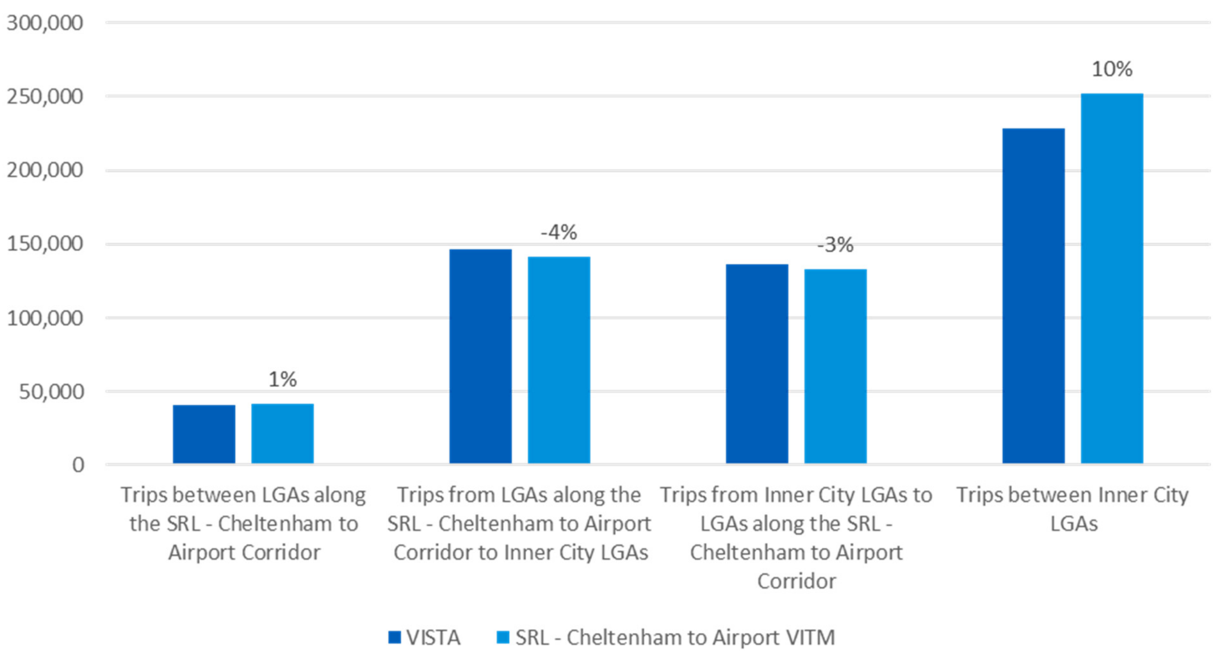
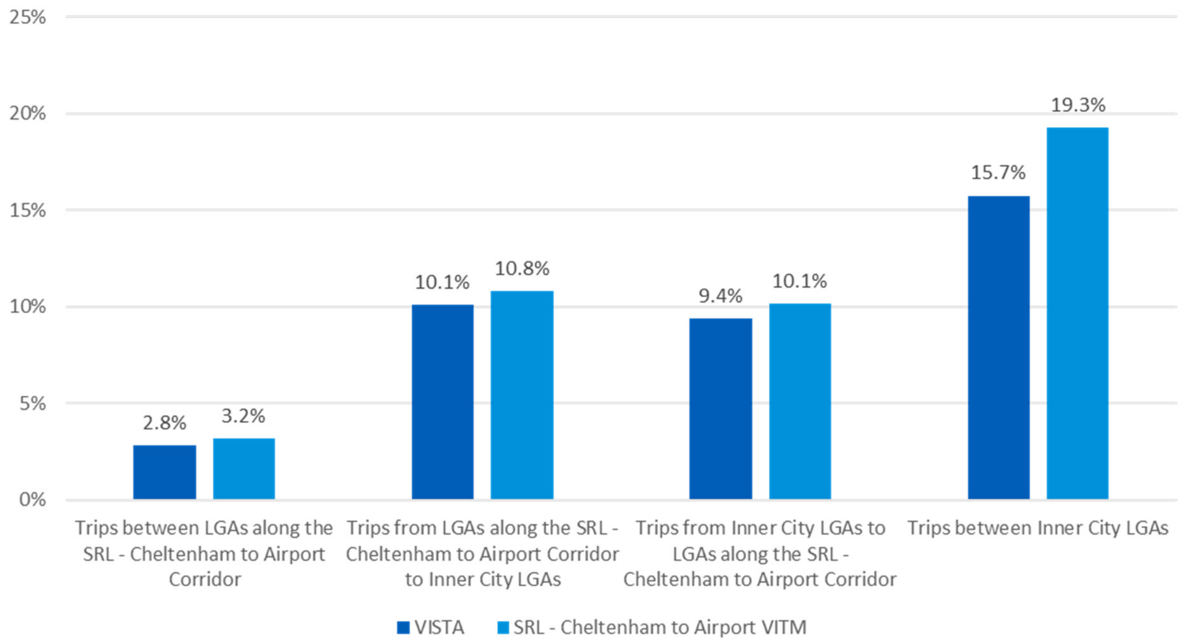
[5] The rationale for excluding intra-LGA trips from orbital PT validation is that intra-LGA trips in the SRL – Cheltenham to Airport corridor are shorter distance, and are less likely to be the types of trips shifting to SRL – Cheltenham to Airport.

Figure A- 9: Comparison of modelled daily public transport trips from 2018 VITM against VISTA



Source: KPMG analysis of VITM modelling

Figure A- 10: Comparison of modelled daily public transport trips as a proportion of Greater Melbourne trips from 2018 VITM against VISTA



Source: KPMG analysis of VITM modelling

LGA-specific validation for the SRL – Cheltenham to Airport corridor

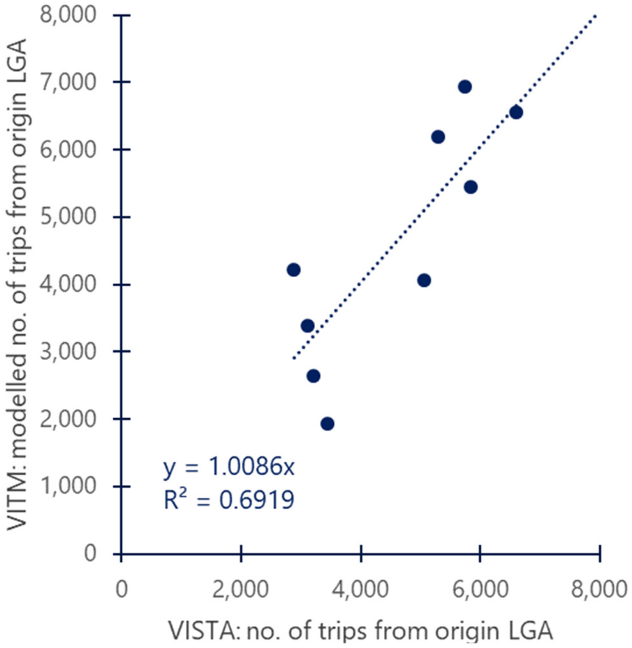
Total trips from LGAs along the SRL – Cheltenham to Airport corridor have been assessed against observed VISTA data, to assess the SRL VITM's ability to generate public transport and private vehicle trips in the SRL – Cheltenham to Airport corridor, both across the day and in the AM peak.

Public transport

Figure A- 11 compares modelled PT trips and observed PT trips, considering trips originating from the nine SRL – Cheltenham to Airport LGAs, across the day. Modelled PT trips from LGAs along the SRL – Cheltenham to Airport corridor validate well against observed data, with seven out of nine LGAs within +/-20% of VISTA.

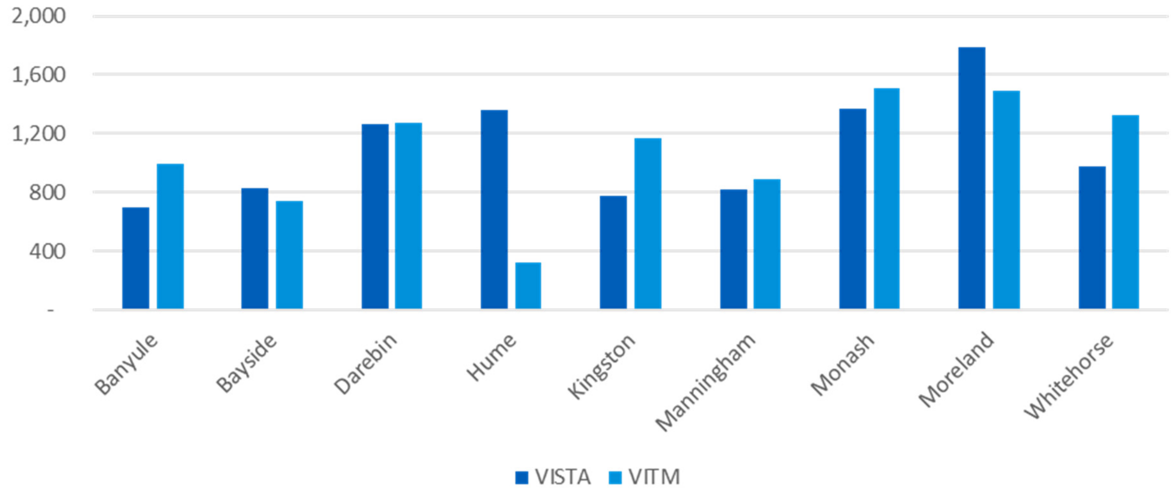
Figure A- 12 compares modelled PT trips and observed PT trips, considering trips originating from the nine SRL – Cheltenham to Airport LGAs, in the AM peak. Modelled PT trips from LGAs along the SRL – Cheltenham to Airport corridor validate well against observed data, with five out of nine LGAs within +/-20% of VISTA.

Figure A- 11: Comparison of modelled daily public transport trips in VITM vs. trips in VISTA data, by origin LGA in SRL – Cheltenham to Airport corridor (all intra-LGA trips removed)



Source: KPMG analysis of VITM modelling

Figure A- 12: Comparison of modelled public transport trips in VITM vs. trips in VISTA data, by origin LGA in SRL – Cheltenham to Airport corridor (all intra-LGA trips removed), during the AM Peak



Source: KPMG analysis of VITM modelling

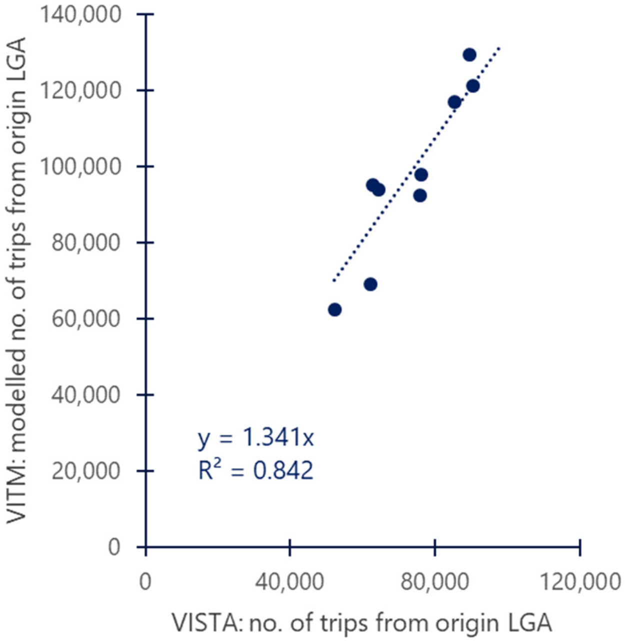
Private vehicle

Figure A- 13 compares modelled car trips and observed car trips, considering trips originating from the nine SRL – Cheltenham to Airport LGAs, across the day. The observed VISTA data suggests that modelled car trips from LGAs along the SRL – Cheltenham to Airport corridor are overestimated in total.

Figure A- 14 compares modelled car trips and observed car trips, considering trips originating from the nine SRL – Cheltenham to Airport LGAs, in the AM peak. Modelled car trips from LGAs along SRL – Cheltenham to Airport validate well against observed car trips in the AM peak, when the majority of home-based work trips take place.

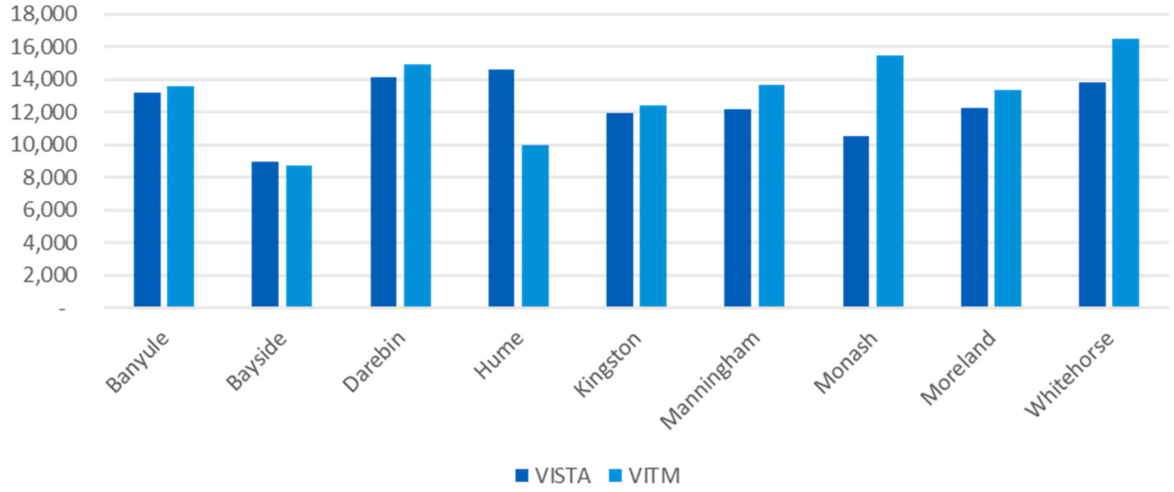
The fact that AM peak car trips validate well, while daily car trips are overestimated compared to VISTA, suggests that the PM peak, inter-peak and off-peak time periods may not validate as strongly as the AM peak. This could potentially be due to underreporting of certain types of trips in the non-peak periods in VISTA. This may be worthy of future investigation and analysis.

Figure A- 13: Comparison of modelled daily private vehicle trips in VITM vs. trips in VISTA data, by origin LGA in SRL – Cheltenham to Airport corridor (all intra-LGA trips removed)



Source: KPMG analysis of VITM modelling

Figure A- 14: Comparison of modelled private vehicle trips in VITM vs. trips in VISTA data, by origin LGA in SRL – Cheltenham to Airport corridor (all intra-LGA trips removed), during the AM Peak



Source: KPMG analysis of VITM modelling

Train boardings at SRL East and SRL North radial stations

Table A - 14 shows a comparison between daily modelled train station entries and exits against observed data for existing metropolitan train stations that are planned to interchange with SRL – Cheltenham to Airport in the Program Case. The model generally performs well at replicating observed train station entries and exits across all the stations, despite some variances observed at the individual station level which is expected in a strategic model. The model does slightly overestimate boardings on the whole, however the validation criteria is still satisfied. The model achieves a 'Good' rating for this measure.

Table A - 14: Comparison of modelled and observed daily station entries and exits at SRL East and SRL North radial stations

Station	Observed entries	Modelled entries	Difference (%)	Observed exits	Modelled exits	Difference (%)
Broadmeadows	3,124	3,918	25%	3,736	3,412	-9%
Gowrie	1,009	1,714	70%	999	1,616	62%
Reservoir	3,848	4,151	8%	4,145	4,323	4%
Heidelberg	2,815	3,593	28%	3,316	3,509	6%
Box Hill	12,664	11,691	-8%	13,275	11,480	-14%
Glen Waverley	5,752	5,621	-2%	5,958	6,024	1%
Clayton	5,084	6,183	22%	5,183	5,367	4%
Cheltenham	2,981	3,714	25%	3,306	3,299	0%
Total SRL East and SRL North radial stations	**37,276**	**40,585**	**9%**	**39,918**	**39,030**	**-2%**
Criteria met (±25%)			5/8			7/8
						12/16
Rating achieved					Good	
Level of importance					Important	

Source: KPMG analysis of VITM modelling

Orbital bus boardings

SRL – Cheltenham to Airport is likely to facilitate largely orbital trip movements, therefore the validation included an assessment of the model's performance at forecasting orbital public transport patronage. Table A - 15 shows the comparison of modelled daily bus boardings against observed data for orbital bus routes 902 and 903. The results indicate that the model closely matches the observed data for both bus routes (within 10%). The model achieves a 'Very Good' rating for this important measure.

Table A - 15: Comparison of modelled and observed daily bus boardings for orbital bus routes

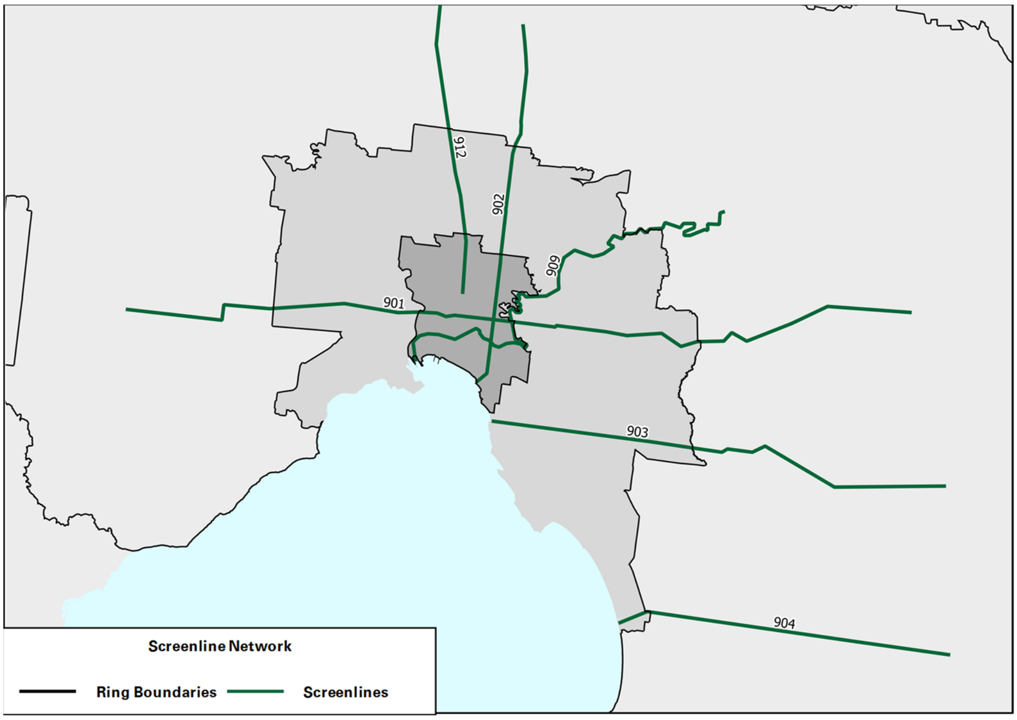
Route	Observed	Modelled	Difference (%)
902 – Chelsea to Airport West	14,400	15,055	5%
903 – Altona to Mordialloc	18,400	20,047	9%
		Criteria met (±20%)	2/2
		Rating achieved	Very Good
		Level of importance	Important

Source: KPMG analysis of VITM modelling

Study area screenlines

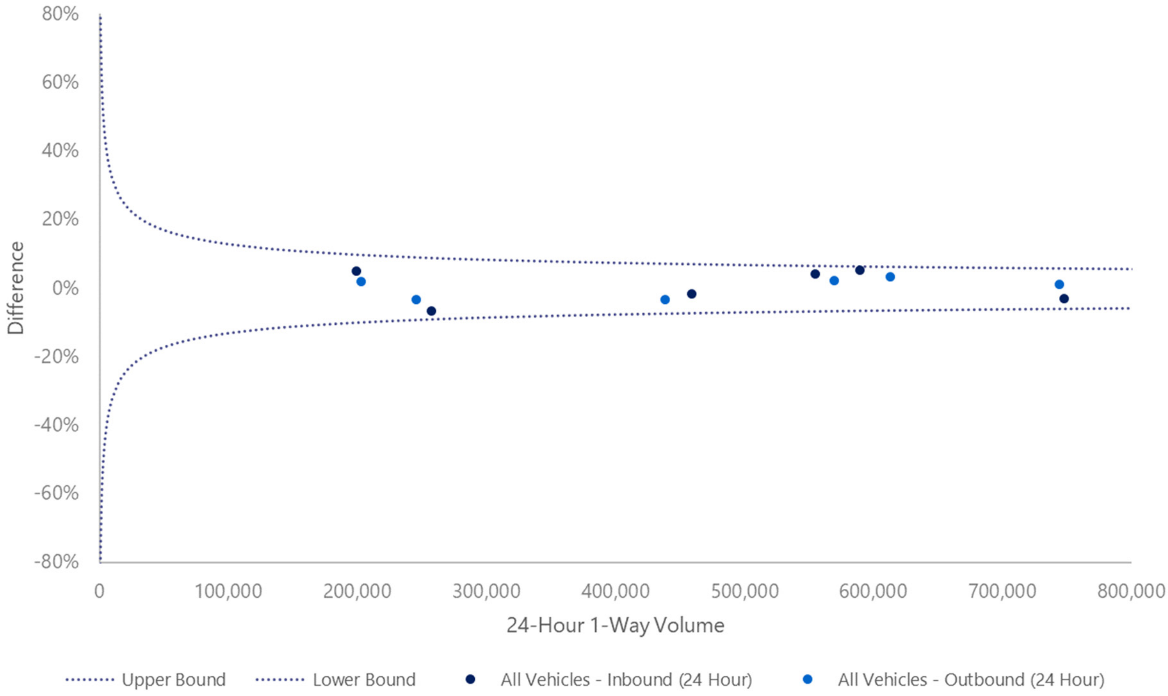
The DoT screenlines that intersect the SRL – Cheltenham to Airport corridor, as seen in Figure A-15, have been used to assess the performance of the model against the observed daily traffic volumes got all vehicles by direction. Figure A- 16 illustrates that the model performed well at modelling all-vehicle flows for each screenline in the corridor, satisfying the criteria.

Figure A- 15: Screenlines used for SRL – Cheltenham to Airport study area screenline comparison



Source: KPMG and DoT

Figure A- 16: Comparison of modelled and observed screenline daily all vehicle volumes



Source: KPMG analysis of VITM modelling

Table A - 16 to Table A - 18 show comparisons of modelled and observed vehicle volumes for relevant screenlines in the SRL – Cheltenham to Airport corridor, for daily, AM and PM time periods. The results show that the model demonstrates strong performance across all screenlines in all time periods, indicating there is no systematic overestimation or underestimation of volumes in the corridor. The model performs well at the individual screenline level, and is generally within 5% of the observed volumes.

Table A - 16: Summary of screenline totals in SRL – Cheltenham to Airport study area – 24 hour all vehicles by screenline both directions

Screenline	Observed	Modelled	Difference	Difference (%)
901 - Barkly St - Victoria St - Barkers Rd - Canterbury Rd	1,484,018	1,470,371	-13,647	-1%
902 - Fitzroy St / Punt Rd / Hoddle St / High St	1,111,483	1,148,705	37,222	3%
903 - North Rd / Wellington Rd	912,801	890,712	-22,089	-2%
904 - McLeod Rd / Thompson Rd	398,271	412,262	13,991	4%
909 - Yarra River	1,182,501	1,233,048	50,547	4%
912 - Sydney Rd	511,368	486,480	-24,888	-5%
Total	**5,600,442**	**5,641,578**	**41,136**	**1%**
Criteria met (±10%)	7/7			
Rating achieved	Very Good			
Level of importance	Very Important			

Source: KPMG analysis of VITM modelling

Table A - 17: Summary of screenline totals in SRL – Cheltenham to Airport study area – AM peak two-hour all vehicles by screenline both directions

Screenline	Observed	Modelled	Difference	Difference (%)
901 - Barkly St - Victoria St - Barkers Rd - Canterbury Rd	209,593	211,484	1,891	1%
902 - Fitzroy St / Punt Rd / Hoddle St / High St	157,471	162,256	4,785	3%
903 - North Rd / Wellington Rd	138,223	126,589	-11,634	-8%
904 - McLeod Rd / Thompson Rd	61,145	59,385	-1,760	-3%
909 - Yarra River	166,833	171,291	4,458	3%
912 - Sydney Rd	70,122	69,590	-532	-1%
Total	**803,386**	**800,595**	**-2,791**	**0%**
Criteria met (±10%)	7/7			
Rating achieved	Very Good			
Level of importance	Very Important			

Source: KPMG analysis of VITM modelling

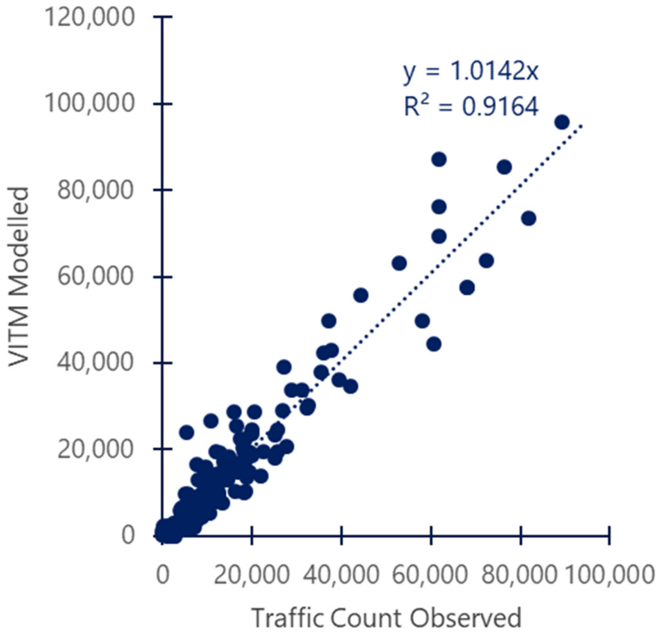
Table A - 18: Summary of screenline totals in SRL – Cheltenham to Airport study area – PM peak two-hour all vehicles by screenline both directions

Screenline	Observed	Modelled	Difference	Difference (%)
901- Barkly St - Victoria St - Barkers Rd - Canterbury Rd	330,019	338,968	8,949	3%
902 - Fitzroy St / Punt Rd / Hoddle St / High St	236,173	256,758	20,585	9%
903 - North Rd / Wellington Rd	209,897	197,804	-12,093	-6%
904 - McLeod Rd / Thompson Rd	97,837	95,401	-2,436	-2%
909 - Yarra River	250,559	267,322	16,763	7%
912 - Sydney Rd	111,717	110,361	-1,356	-1%
Total	**330,019**	**338,968**	**8,949**	**3%**
Criteria met (±10%)	7/7			
Rating achieved	Very Good			
Level of importance	Very Important			

Source: KPMG analysis of VITM modelling

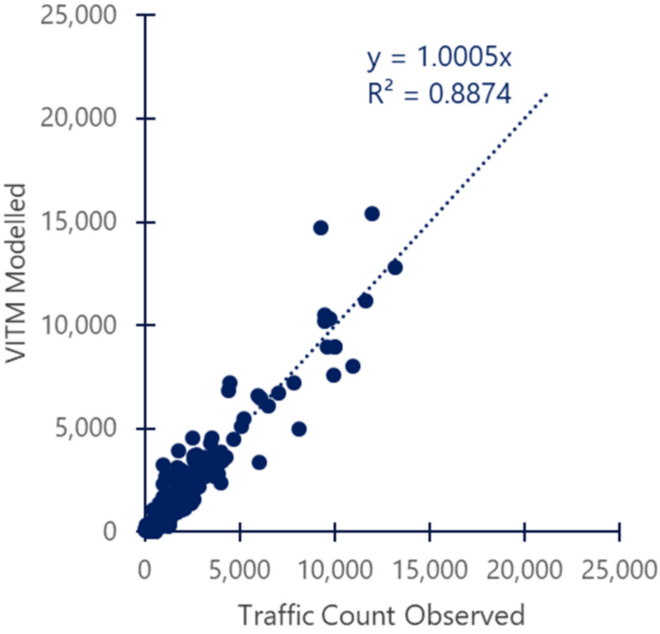
Figure A- 17 to Figure A- 22 show the scatterplots of modelled versus observed traffic counts for individual screenline count sites in the SRL – Cheltenham to Airport corridor for daily, AM and PM time periods, for the inbound and outbound directions. The results show strong model performance at the individual count site level for the daily period, AM and PM peaks for inbound and outbound directions satisfying the criteria for both the slope coefficient and the R-squared. These results suggest that the model is performing well at estimating traffic across the study area at the daily level and in the AM and PM peaks at the individual count site level. The model achieves a 'Very Good' rating for this measure as shown in Table A - 19.

Figure A- 17: Scatterplot of modelled and observed daily inbound all vehicles for individual count sites at screenlines in study area



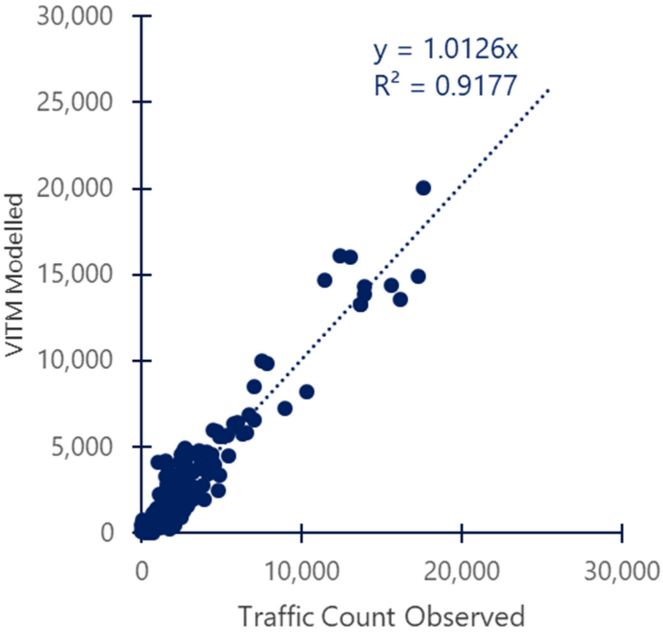
Source: KPMG analysis of VITM modelling

Figure A- 18: Scatterplot of modelled and observed AM peak inbound all vehicles for individual count sites at screenlines in study area



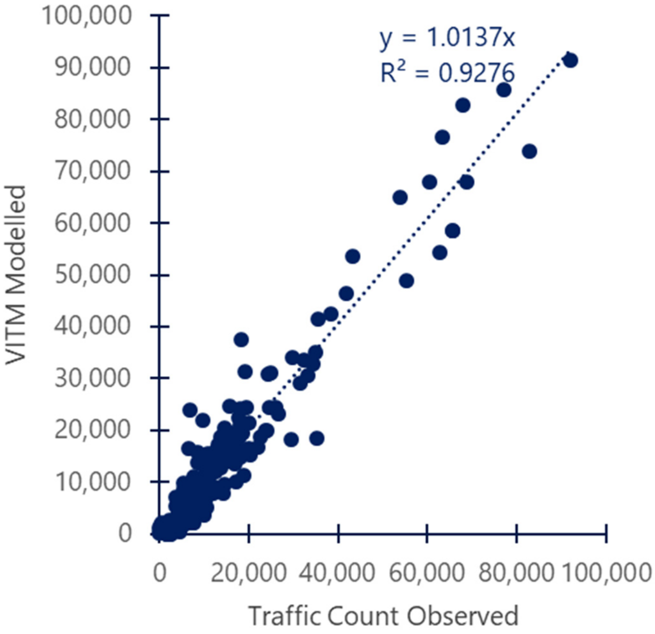
Source: KPMG analysis of VITM modelling

Figure A- 19: Scatterplot of modelled and observed PM peak inbound cars for individual count sites at screenlines in study area



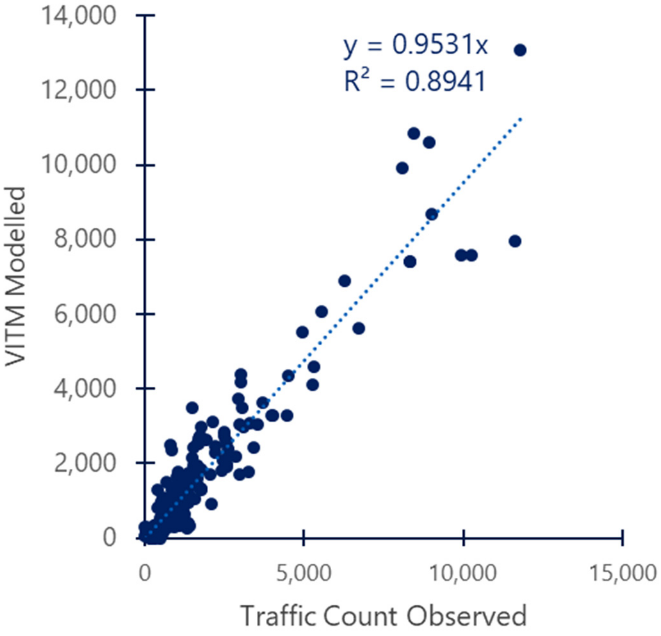
Source: KPMG analysis of VITM modelling

Figure A- 20: Scatterplot of modelled and observed daily outbound all vehicles for individual count sites at screenlines in study area



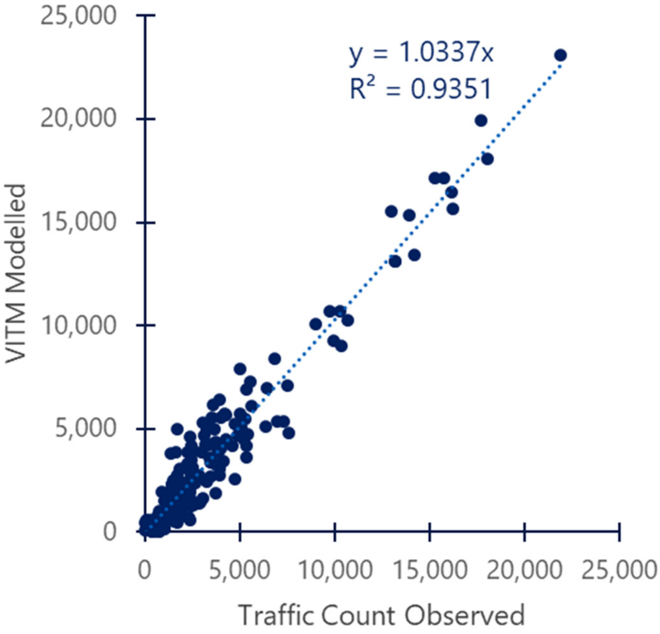
Source: KPMG analysis of VITM modelling

Figure A- 21: Scatterplot of modelled and observed AM peak outbound all vehicles for individual count sites at screenlines in study area



Source: KPMG analysis of VITM modelling

Figure A- 22: Scatterplot of modelled and observed PM peak outbound cars for individual count sites at screenlines in study area



Source: KPMG analysis of VITM modelling

Table A – 19: Individual count site validation – Summary

Period	**Slope**	**R^2**
Daily – inbound	1.0142	0.9164
AM peak – inbound	1.0005	0.88742
PM peak – inbound	1.0126	0.9177
Daily – outbound	1.0137	0.9276
AM peak – outbound	0.9531	0.8941
PM peak – outbound	1.0337	0.9351
Criteria met (R^2≥0.85, slope>0.9 and <1.1)	6/6	
Rating achieved	Very Good	
Level of importance	Very Important	

Source: KPMG analysis of VITM modelling

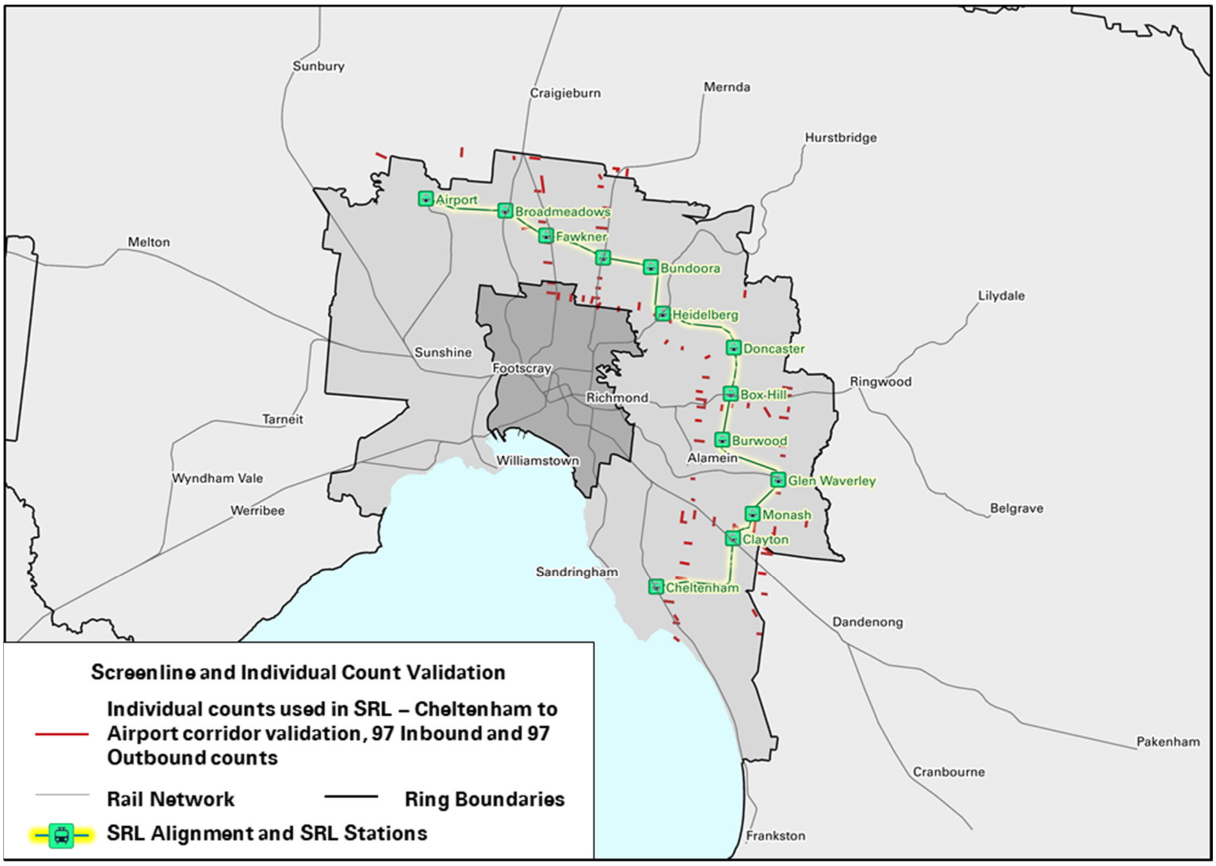
SRL – Cheltenham to Airport corridor traffic validation

Traffic count and orbital screenline model validation performance for car vehicles only are shown in this section for count locations within the immediate SRL – Cheltenham to Airport corridor, to provide further confidence that the model is suitable for assessing demand changes due to SRL. The validation of car vehicles is important, as SRL is expected to shift car users to public transport. Figure A- 23 shows the individual count locations used for the SRL – Cheltenham to Airport corridor traffic validation.

Table A – 20 and Table A – 21 show the performance of the model against daily observed data for orbital screenlines that were formed using the traffic counts intersecting SRL – Cheltenham to Airport for inbound and outbound directions respectively. The results show that the model performed well at estimating daily car vehicle traffic in both directions at the screenline level, achieving 'Good' and 'Very Good' ratings for this measure. This suggests that the model performs well at modelling car vehicle traffic within the SRL – Cheltenham to Airport corridor. Figure A- 24 and Figure A- 25 show the scatterplots of the modelled daily car vehicles against observed data for inbound and outbound directions. The model satisfies the validation criteria for both slope and R-squared, indicating that the model is performing well at estimating car vehicle traffic at individual count locations within the SRL – Cheltenham to Airport corridor.

The SRL – Cheltenham to Airport corridor screenline and traffic count validation was also undertaken for the AM and PM peak periods, as these periods would likely experience significant public transport modal shift due to road congestion. Table A – 26 and Table A – 27 summarise the performance of the Daily, AM and PM periods. The results indicate that the model performed well at both measures, with slopes within 0.9 and 1.1, and an R-squared of greater than 0.90, satisfying the validation criteria for the Daily, AM and PM time periods.

Figure A- 23: Screenline and individual count validation



Source: KPMG analysis of VITM modelling

Table A – 20: Summary of screenline totals in SRL – Cheltenham to Airport study area – Daily, car vehicles by screenline, inbound direction

Screenline	Observed	Modelled	+/-	%
901 – Barkly St – Victoria St – Barkers Rd – Canterbury Rd	91,859	80,531	-11,328	-12%
902 – Fitzroy St / Punt Rd / Hoddle St / High St	163,073	177,199	14,126	9%
903 – North Rd / Wellington Rd	119,106	111,087	-8,019	-7%
909 – Yarra River	52,371	59,179	6,808	13%
911 – Edithvale Rd/Springvale Rd/Plenty Rd	259,482	268,491	9,009	3%
912 – Sydney Rd	155,134	157,228	2,094	1%
Total	**840,024**	**853,715**	**13,691**	**2%**
Criteria met (±10%)	4/6			
Rating achieved	Good			
Level of importance	Very Important			

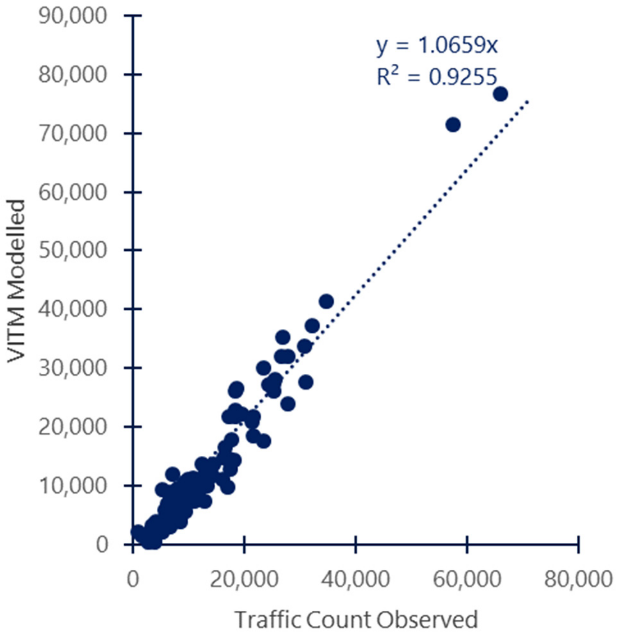
Source: KPMG VITM analysis

Table A – 21: Summary of screenline totals in SRL – Cheltenham to Airport study area – Daily, car vehicles by screenline, outbound direction

Screenline	Observed	Modelled	+/-	%
901 – Barkly St – Victoria St – Barkers Rd – Canterbury Rd	87,812	79,763	-8,049	-9%
902 – Fitzroy St / Punt Rd / Hoddle St / High St	164,017	174,147	10,130	6%
903 – North Rd / Wellington Rd	114,651	108,698	-5,953	-5%
909 – Yarra River	54,865	57,015	2,150	4%
911 – Edithvale Rd/Springvale Rd/Plenty Rd	256,530	261,266	4,736	2%
912 – Sydney Rd	157,078	160,354	3,276	2%
Total	**834,953**	**841,243**	**6,290**	**1%**
Criteria met (±10%)	6/6			
Rating achieved	Very Good			
Level of importance	Very Important			

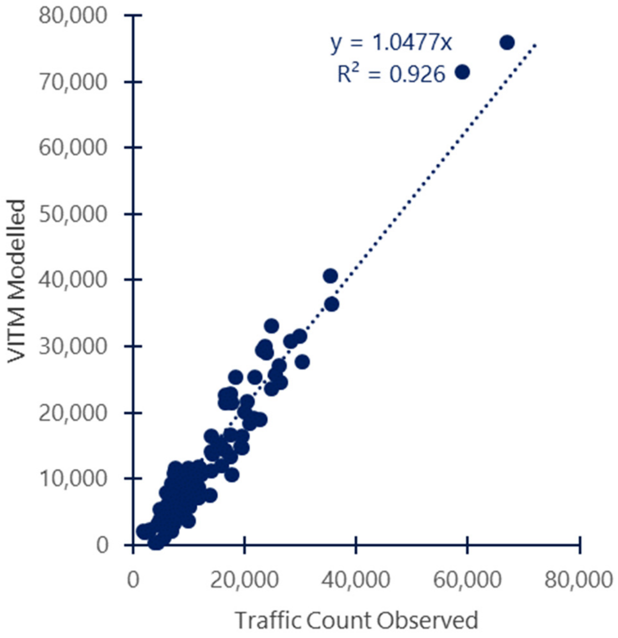
Source: KPMG VITM analysis

Figure A- 24: Scatterplot of modelled and observed daily car vehicles for individual count sites in study area, inbound



Source: KPMG VITM analysis

Figure A- 25: Scatterplot of modelled and observed daily car vehicles for individual count sites in study area, outbound



Source: KPMG VITM analysis

Table A – 22: Summary of screenline totals in SRL – Cheltenham to Airport study area – AM Peak, car vehicles by screenline, inbound direction

Screenline	Observed	Modelled	+/-	%
901 – Barkly St – Victoria St – Barkers Rd – Canterbury Rd	13,539	12,834	-705	-5%
902 – Fitzroy St / Punt Rd / Hoddle St / High St	24,095	27,144	3,049	13%
903 – North Rd / Wellington Rd	18,937	19,767	830	4%
909 – Yarra River	7,560	8,197	637	8%
911 – Edithvale Rd/Springvale Rd/Plenty Rd	52,006	52,975	969	2%
912 – Sydney Rd	20,286	20,914	628	3%
Total	**136,423**	**141,831**	**5,408**	**4%**
Criteria met (±10%)	5/6			
Rating achieved	Very Good			
Level of importance	Very Important			

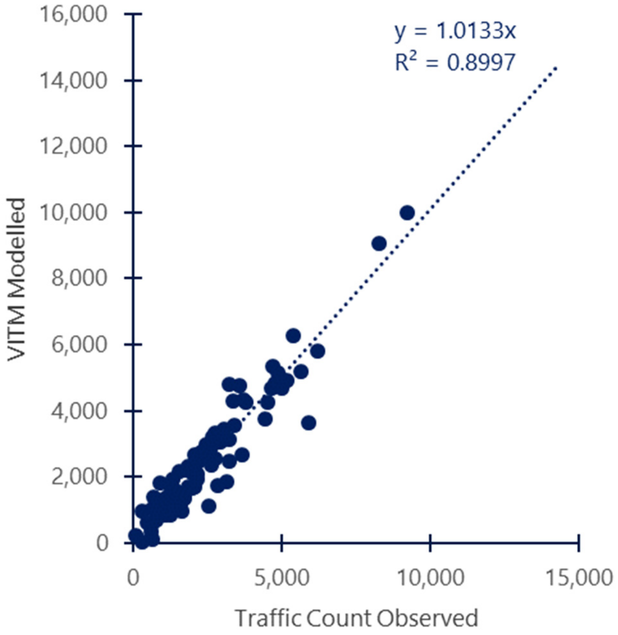
Source: KPMG VITM analysis

Table A – 23: Summary of screenline totals in SRL – Cheltenham to Airport study area – AM Peak, car vehicles by screenline, inbound direction

Screenline	Observed	Modelled	+/-	%
901 – Barkly St – Victoria St – Barkers Rd – Canterbury Rd	11,987	10,793	-1,194	-10%
902 – Fitzroy St / Punt Rd / Hoddle St / High St	20,134	23,217	3,083	15%
903 – North Rd / Wellington Rd	15,443	13,955	-1,488	-10%
909 – Yarra River	8,321	8,211	-110	-1%
911 – Edithvale Rd/Springvale Rd/Plenty Rd	27,492	26,244	-1,248	-5%
912 – Sydney Rd	22,195	24,094	1,899	9%
Total	**105,572**	**106,514**	**942**	**1%**
Criteria met (±10%)	4/6			
Rating achieved	Good			
Level of importance	Very Important			

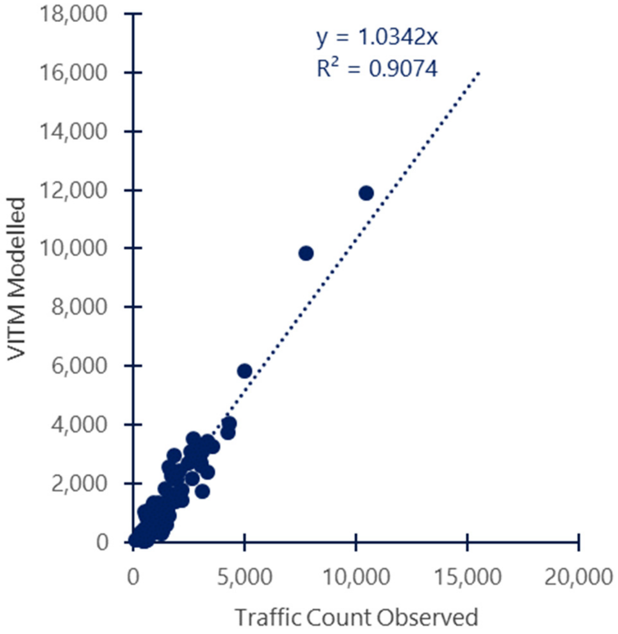
Source: KPMG VITM analysis

Figure A- 26: Scatterplot of modelled and observed AM Peak car vehicles for individual count sites in study area, inbound



Source: KPMG VITM analysis

Figure A- 27: Scatterplot of modelled and observed AM Peak car vehicles for individual count sites in study area, outbound



Source: KPMG VITM analysis

Table A – 24: Summary of screenline totals in SRL – Cheltenham to Airport study area – PM Peak, car vehicles by screenline, inbound direction

Screenline	Observed	Modelled	+/-	%
901 – Barkly St – Victoria St – Barkers Rd – Canterbury Rd	20,444	18,118	-2,326	-11%
902 – Fitzroy St / Punt Rd / Hoddle St / High St	33,680	38,612	4,932	15%
903 – North Rd / Wellington Rd	26,195	23,730	-2,465	-9%
909 – Yarra River	10,589	13,599	3,010	28%
911 – Edithvale Rd/Springvale Rd/Plenty Rd	48,635	46,241	-2,394	-5%
912 – Sydney Rd	35,293	37,325	2,032	6%
Total	**174,836**	**177,625**	**2,789**	**2%**
Criteria met (±10%)	3/6			
Rating achieved	Satisfactory			
Level of importance	Very Important			

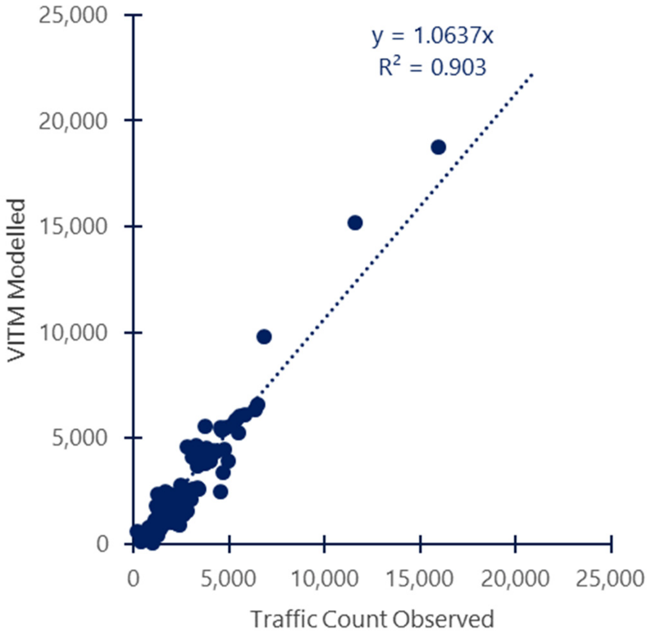
Source: KPMG VITM analysis

Table A – 25: Summary of screenline totals in SRL – Cheltenham to Airport study area – PM Peak, car vehicles by screenline, outbound direction

Screenline	Observed	Modelled	+/-	%
901 – Barkly St – Victoria St – Barkers Rd – Canterbury Rd	19,572	20,076	504	3%
902 – Fitzroy St / Punt Rd / Hoddle St / High St	40,331	42,696	2,365	6%
903 – North Rd / Wellington Rd	25,355	28,838	3,483	14%
909 – Yarra River	12,379	12,455	76	1%
911 – Edithvale Rd/Springvale Rd/Plenty Rd	74,286	78,296	4,010	5%
912 – Sydney Rd	34,085	35,738	1,653	5%
Total	**206,008**	**218,099**	**12,091**	**6%**
Criteria met (±10%)	5/6			
Rating achieved	Very Good			
Level of importance	Very Important			

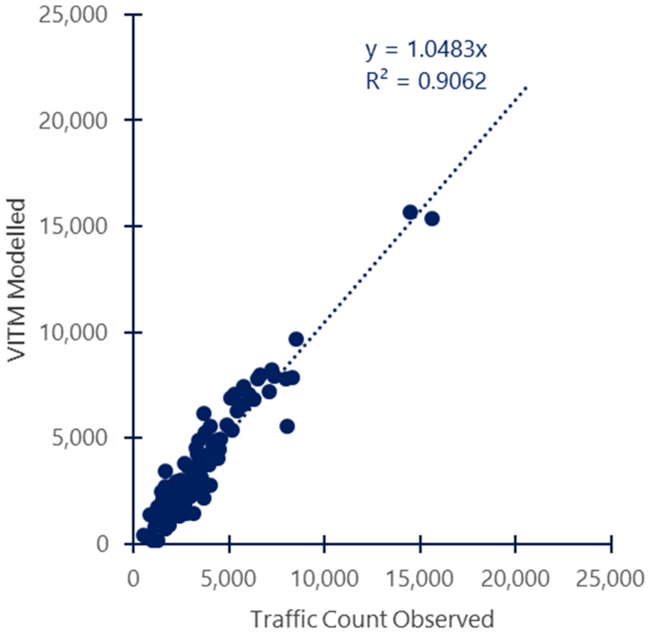
Source: KPMG VITM analysis

Figure A- 28: Scatterplot of modelled and observed PM Peak car vehicles for individual count sites in study area, inbound



Source: KPMG VITM analysis

Figure A- 29: Scatterplot of modelled and observed PM Peak car vehicles for individual count sites in study area, outbound



Source: KPMG VITM analysis

Table A – 26: Performance of screenline total variance between modelled and observed

Direction and time period	Criteria met (±10%)	Rating Achieved
Daily Inbound	4/6	Good
Daily Outbound	6/6	Very Good
AM Peak Inbound	5/6	Very Good
AM Peak Outbound	4/6	Good
PM Peak Inbound	3/6	Satisfactory
PM Peak Outbound	5/6	Very Good

Source: KPMG VITM analysis

Table A – 27: Scatter plot performance

Direction and time period	Y-slope > 0.9 and < 1.1	R^2 >0.85	Rating Achieved
Daily Inbound	1.07 – Y	0.93 – Y	Good
Daily Outbound	1.05 – Y	0.93 – Y	Good
AM Peak Inbound	1.01 – Y	0.90 – Y	Good
AM Peak Outbound	1.03 – Y	0.91 – Y	Good
PM Peak Inbound	1.06 – Y	0.90 – Y	Good
PM Peak Outbound	1.05 – Y	0.91 – Y	Good

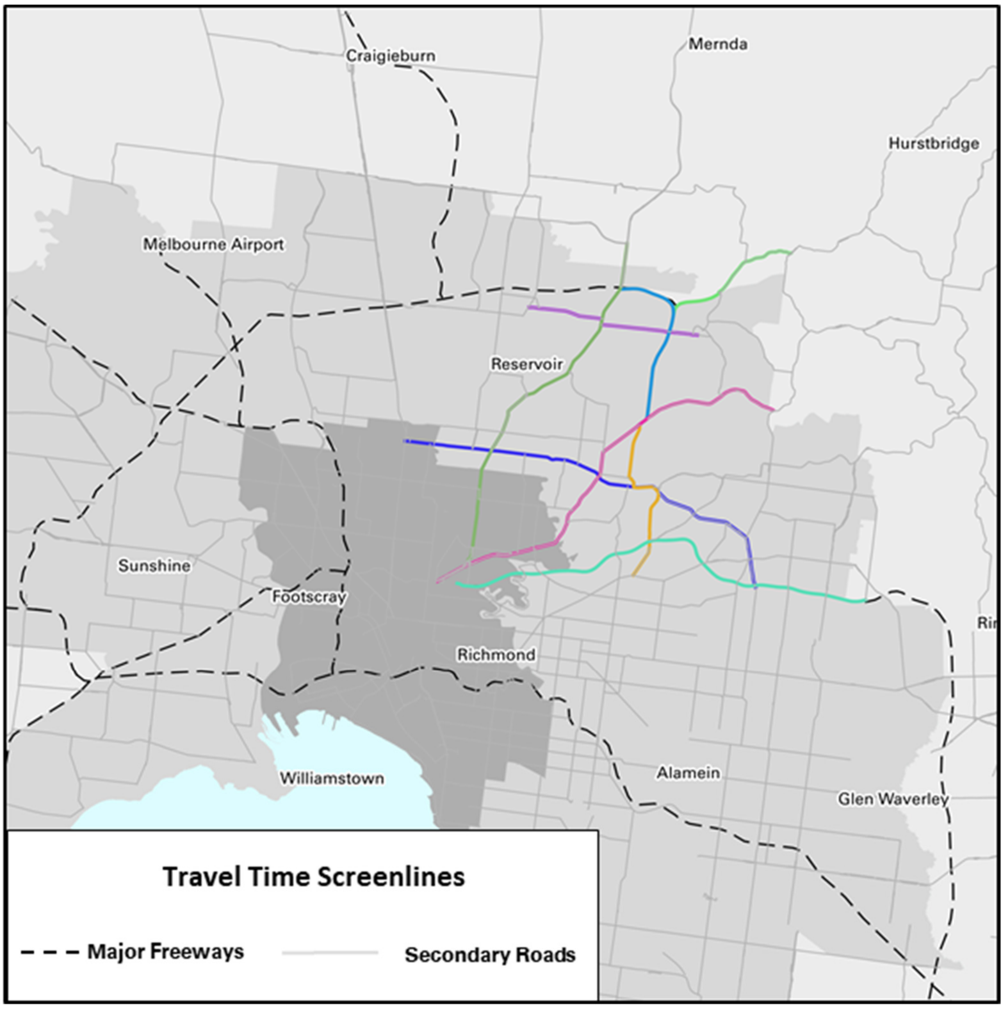
Source: KPMG VITM analysis

AM and PM peak travel times in the study area

There was no reliable travel time data available for the SRL – Cheltenham to Airport corridor between Cheltenham and Box Hill for 2018, and due to non-typical road conditions occurring throughout 2020 due to COVID-19, there were no opportunities to undertake additional surveys. However, there was 2017-2018 data available that was collected by North East Link Project (NELP) for the North East Link business case provided by DoT, which corresponds to a small part of the SRL – Cheltenham to Airport corridor between Box Hill and Reservoir, and provides an indication of the model's travel time validation performance in the corridor. The travel time routes for this analysis include Bell Street, Lower Plenty Road, Eastern Freeway, Bulleen Road, Plenty Road, Greensborough Road, and Grimshaw Street, as shown in Figure A- 30.

There were a number of surveys run on these roads in the AM and PM peaks to collect observed data. The validation was assessed against the average of the surveyed runs.

Figure A- 30: Map of travel time routes



Source: NELP

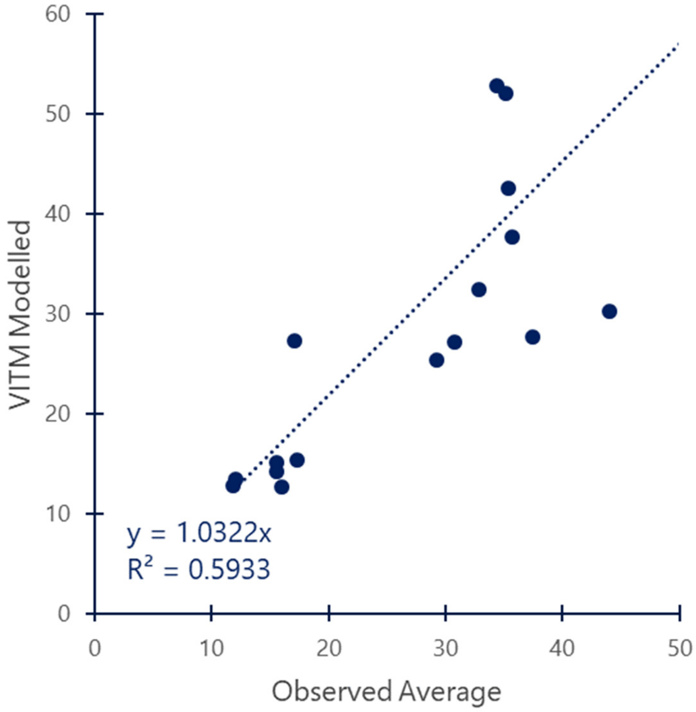
Figure A- 31 and Figure A- 32 show the scatterplot comparisons of modelled and observed AM and PM peak travel times for each of the individual routes in Figure A- 30. The performance of the model against observed data is shown in Table A - 28. The level of fit between the model and observed data is satisfactory, suggesting that overall AM and PM peak travel times in the area shown above for the routes assessed match the observed data reasonably well. The model performed better at modelling travel time along the corridors of Bell Street, Eastern Freeway and Greensborough Road. The outliers were Plenty Road and Lower Plenty Road. Overall, VITM achieved a 'Satisfactory' rating for travel times in these corridors.

Table A - 28: Summary of travel time route validation

Time Period	Model Fit against Observed
AM Peak	▪ y=1.03x ▪ R^2=0.59
PM Peak	▪ y=1.04x ▪ R^2=0.74

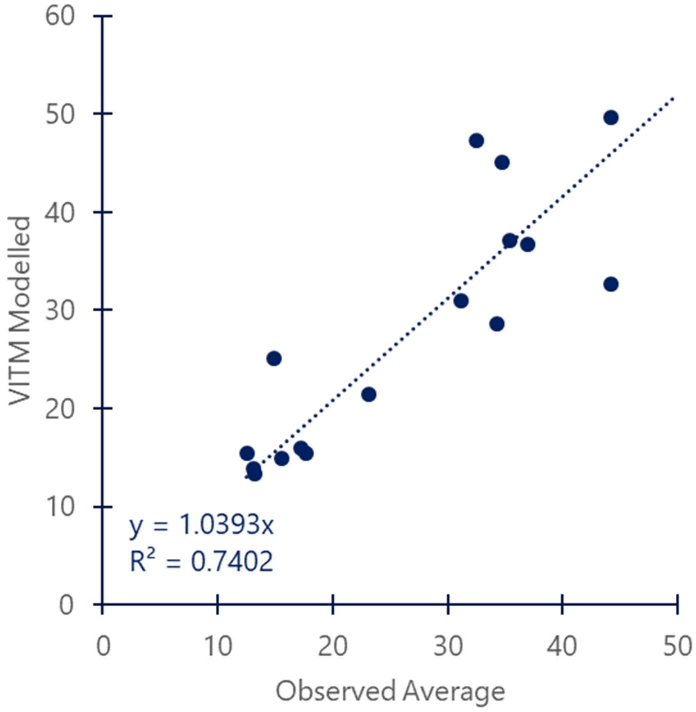
Source: KPMG VITM analysis

Figure A- 31: Scatterplot of modelled and observed AM peak inbound and outbound travel times



Source: KPMG VITM analysis

Figure A- 32: Scatterplot of modelled and observed PM peak inbound and outbound travel times



Source: KPMG VITM analysis

A.4 Key assumptions

The VITM transport modelling assumptions are based on the standard set of network, land use and transport cost assumptions in the latest version of DoT's Transport Modelling Reference Case (the 'Reference Case'), as described in Section A.3.1.

Overarching assumptions regarding the development of the Base Case and Program Case are outlined in Sections A.4 and A.5 respectively. More details relevant for VITM modelling are outlined below.

A.4.1 Base Case

VITM was used to model Base Case scenarios for 2031, 2036, 2041, 2046, 2051, and 2056. The Base Case uses road networks and public transport services predominantly based on the Reference Case, with SRL – Cheltenham to Airport removed, as outlined in Section A.4.

Minor changes have been made to the local road networks in SRL East and SRL North Precincts to improve the representation of local roads; these have been incorporated into both Base and Program Case VITM modelling.

For economic appraisal, the Base Case uses Small Area Land Use Projections (**SALUP**) based on DELWP Projections 2018 (Unpublished), which give a projection of population and employment distribution across Victoria for a network without SRL – Cheltenham to Airport. Key modelling parameters, including car ownership rates, vehicle operating costs, and public transport fares, mirrored those used in DoT's Reference Case.

Visual representations of the changes in network and demographic data across the model years are shown in the following sections.

In addition, parking costs for private vehicle trips at the trip attraction end for zones in SRL East and SRL North Precincts have been modified in both the Base Case and Program Case VITM modelling. More detail is provided in the following section.

Parking costs

Density in SRL East and SRL North Precincts is projected to increase markedly over time. Parking costs have been introduced to SRL East and SRL North Precincts in the VITM demand modelling, applied as per the method devised by SRLA, to reflect the projected increases in density. These parking costs have been applied in both Base and Program Case VITM modelling to enable the assessment of the proposed transport and behavioural changes due to SRL – Cheltenham to Airport. Separate parking costs were applied to:

- 'Inner' zones (travel zones in the immediate vicinity of the SRL East and SRL North stations), which have higher parking costs applied
- 'Outer' zones (travel zones within 1600m of the station but not in the immediate vicinity of the SRL East and SRL North stations), which have lower parking costs applied.

Additionally, different parking costs in the precincts were applied over time to reflect increasing levels of densification.

The following three parking categories from the VITM Reference Case have been applied to zones along the SRL – Cheltenham to Airport corridor:

- Category 1 (Inner Levy 1): Costs applied in the CBD in the Reference Case
- Category 2 (Inner Levy 2): Costs applied in Carlton, Collingwood, Fitzroy, North Melbourne, Parkville, South Melbourne, and St Kilda in the Reference Case

- Category 3 (Inner No Levy): Costs applied in Prahran, Richmond, and South Yarra in the Reference Case
- Category 4 (Suburban): Costs applied at selected suburban activity centres, such as shopping centres and hospitals, in the Reference Case.

Table A - 29 outlines the cost categorisation by SRL East and SRL North Precinct, for the Reference Case VITM, as well as the VITM used for SRL – Cheltenham to Airport modelling in 2036 and 2056. Table A - 30 outlines the average parking cost per trip that these categories correspond to.

Table A - 29: Parking cost categories in SRL East and SRL North Precincts in VITM, 2036 and 2056

Precinct	'Inner' Zones			'Outer' Zones		
	Reference Case VITM	SRL VITM (2036)	SRL VITM (2056)	Reference Case VITM	SRL VITM (2036)	SRL VITM (2056)
Cheltenham	-	2	2	-	3	3
Clayton	4	2	1	-	3	2
Monash	-	2	1	-	3	2
Glen Waverley	-	2	2	-	3	3
Burwood	-	2	1	-	3	2
Box Hill	4	1	1	-	2	2
Doncaster	-	-	2	-	-	3
Heidelberg	4	4	2	-	-	3
La Trobe	-	-	2	-	-	3
Reservoir	-	-	2	-	-	3
Fawkner	-	-	2	-	-	3
Broadmeadows	-	-	2	-	-	3

Source: SRLA

Table A - 30: Average parking costs by category, 2036 and 2056

Parking cost category	2036 average parking cost (2016$)		2056 average parking cost (2016$)	
	Work trips	Other trips	Work trips	Other trips
1 (Inner Levy 1)	9.22	5.07	9.22	6.78
2 (Inner Levy 2)	3.66	1.57	3.66	2.10
3 (Inner No Levy)	2.06	0.94	2.06	1.25
4 (Suburban)	2.08	1.46	2.08	1.96
No parking cost	-	-	-	-

Source: KPMG VITM analysis

Rail Network

Figure A- 33 to Figure A- 36 highlight the key public transport investments included in the DoT Reference Case and therefore within the modelled Base Case across the model years used in SRL – Cheltenham to Airport demand modelling.

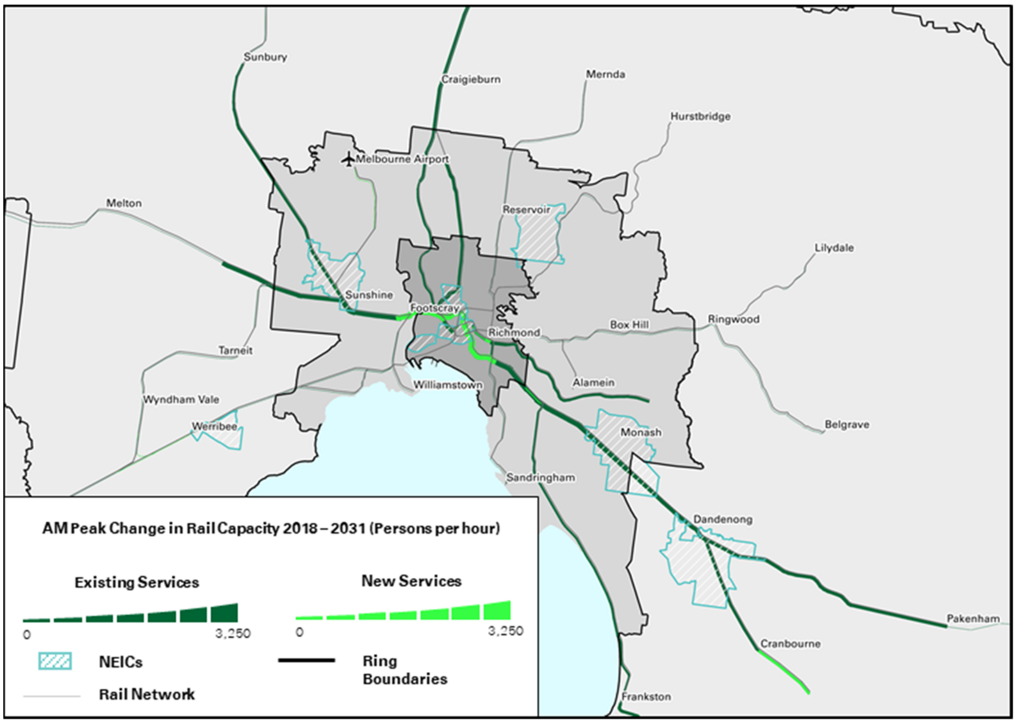
As illustrated in Figure A- 33, the 2031 Reference Case and Base Case incorporate the Metro Tunnel Project (**MTP**) and the extension of Cranbourne services to Clyde. Additionally, the City Loop Reconfiguration has been incorporated into the 2031 Reference Case and Base Case, connecting the Glen Waverley and Upfield Lines, and the Frankston and Craigieburn Lines, as through-running services.

As illustrated in Figure A- 34, the 2036 Reference Case and Base Case incorporate the Somerton Link, which connects the Upfield Line with the Craigieburn Line near Roxburgh Park Station, as well as capacity uplifts on the MTP corridor.

As illustrated in Figure A- 35, the 2041 Reference Case and Base Case incorporate Melbourne Metro 2 (**MM2**), including the Newport Tunnel. This is an underground rail link, connecting Newport and Clifton Hill via Fishermans Bend, the CBD and Parkville. Services to Wyndham Vale and Melton are electrified in the 2041 Reference Case and Base Case, resulting in capacity uplifts on the respective corridors.

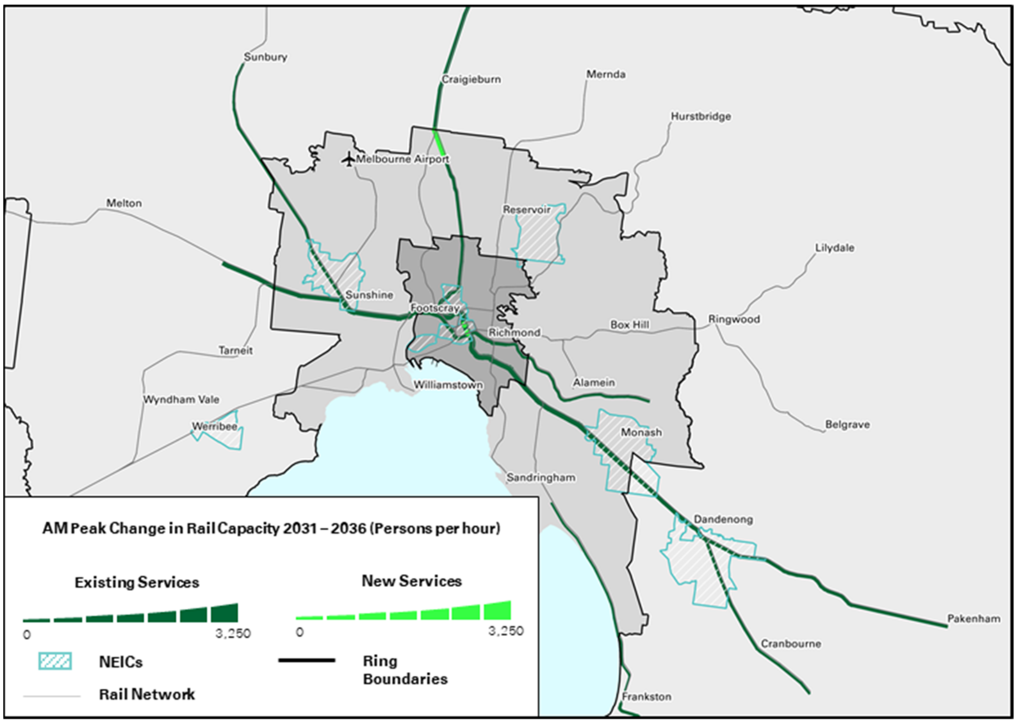
As illustrated in Figure A- 36, no new metropolitan rail services are incorporated into the 2051 Reference Case or Base Case. There are uplifts to existing services on the Werribee, Mernda, and Upfield Lines. Additionally, the incorporation of a fourth track between Box Hill and Burnley results in an increase in capacity on the Ringwood corridor. The electrification of the Frankston Line to Baxter has also been incorporated into the 2051 Reference Case and Base Case.

Figure A- 33: Rail network projects included in the 2031 Base Case



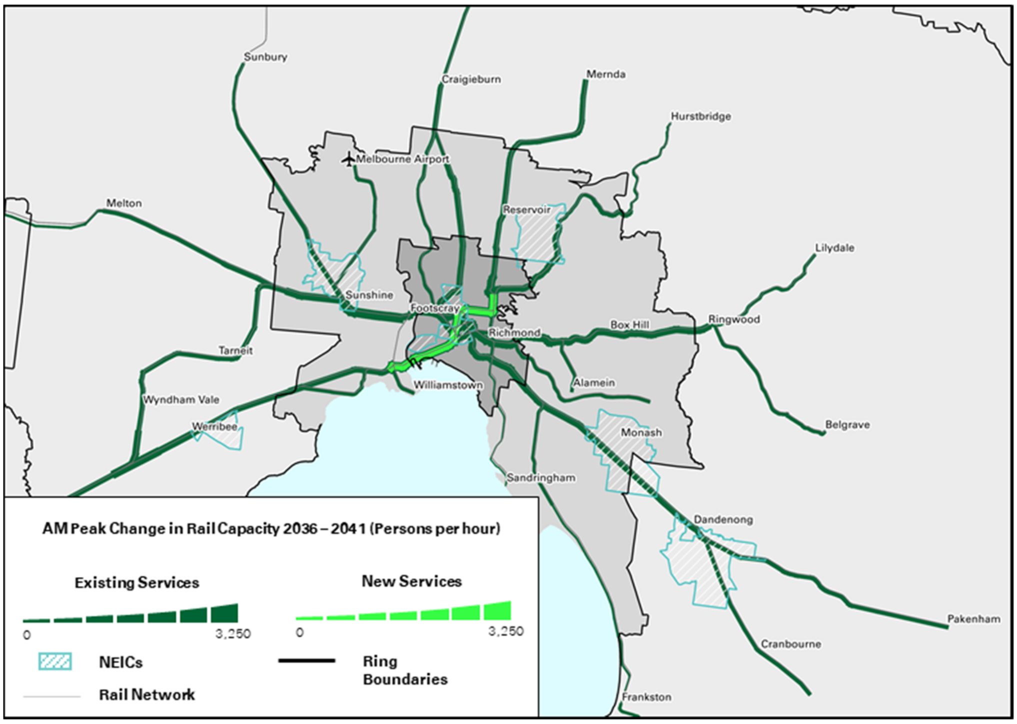
Source: DoT VITM Reference Case

Figure A- 34: Rail network projects included in the 2036 Base Case



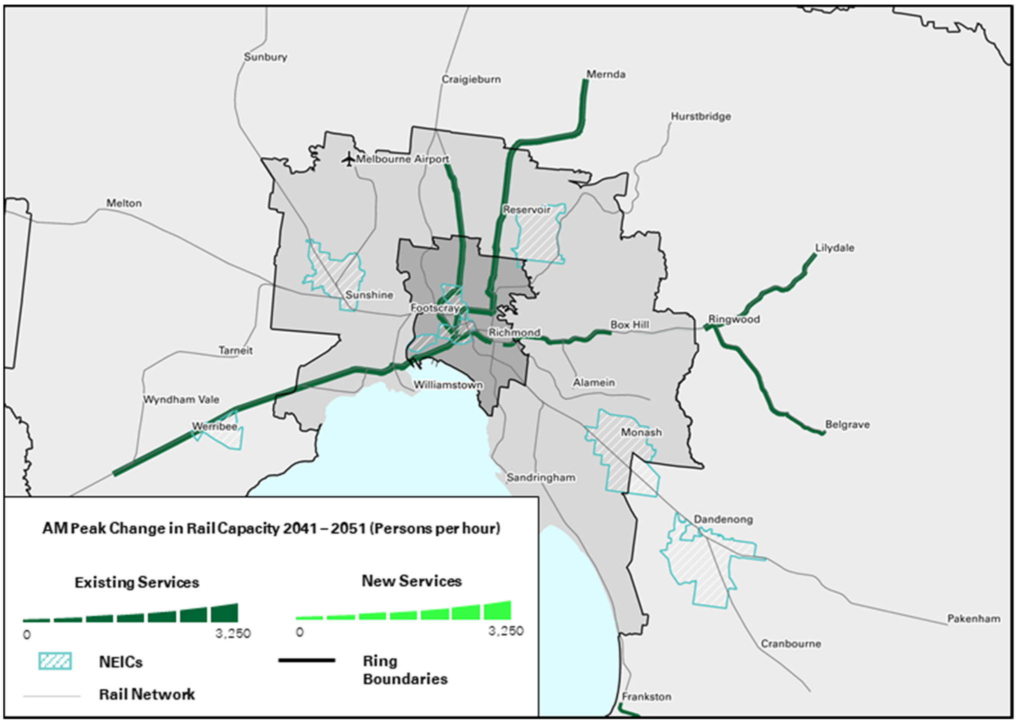
Source: DoT VITM Reference Case

Figure A- 35: Rail network projects included in the 2041 Base Case



Source: DoT VITM Reference Case

Figure A- 36: Rail network projects included in the 2051 Base Case



Source: DoT VITM Reference Case

Road Network

Figure A- 37 to Figure A- 40 highlight the key road network investments included in the DoT Reference Case and hence the modelled Base Case across the model years used in SRL – Cheltenham to Airport demand modelling.

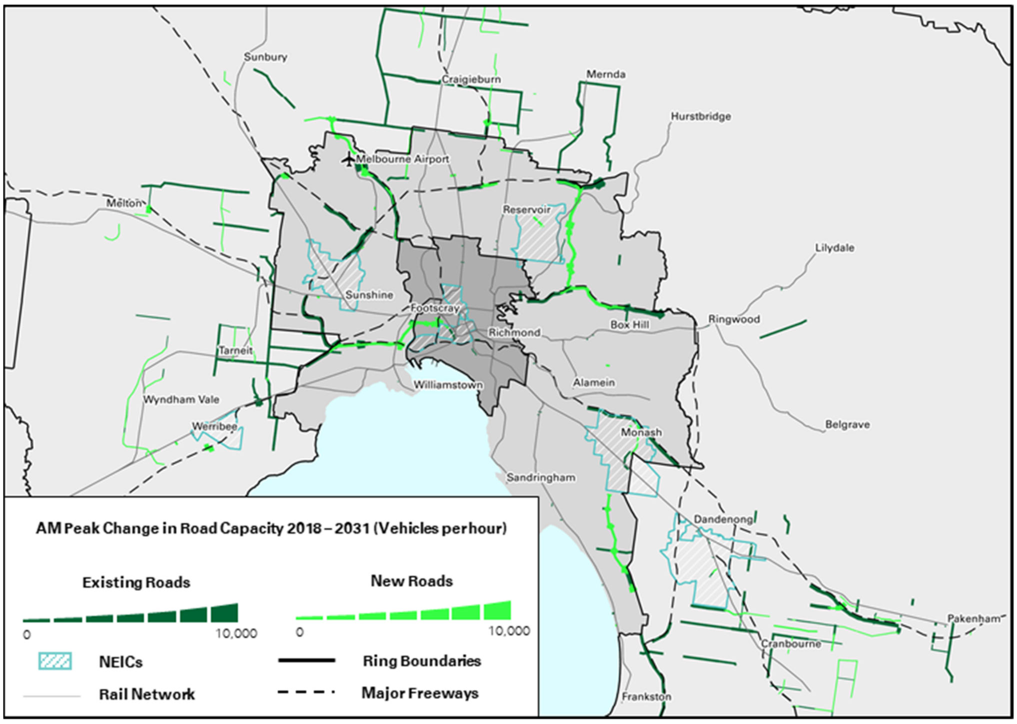
As illustrated in Figure A- 37, the 2031 Reference Case and Base Case incorporate North East Link, a freeway in the north-eastern suburbs connecting the Eastern Freeway with the Western Ring Road. Other key projects added in 2031 include the West Gate Tunnel and Mordialloc Freeway.

As illustrated in Figure A- 38, the 2036 Reference Case and Base Case incorporate E6. This is a multi-lane freeway, starting at the Western Ring Road in Mill Park and ending at the Hume Freeway in Beveridge. The E6 is a precursor to the full Outer Metropolitan Ring Road (**OMR**), which is incorporated into the Reference Case and Base Case from 2051.

As illustrated in Figure A- 39, the 2041 Reference Case and Base Case incorporate extra road capacity in the growth areas, including the south-east around Cranbourne, the west around Tarneit, and the north around Craigieburn.

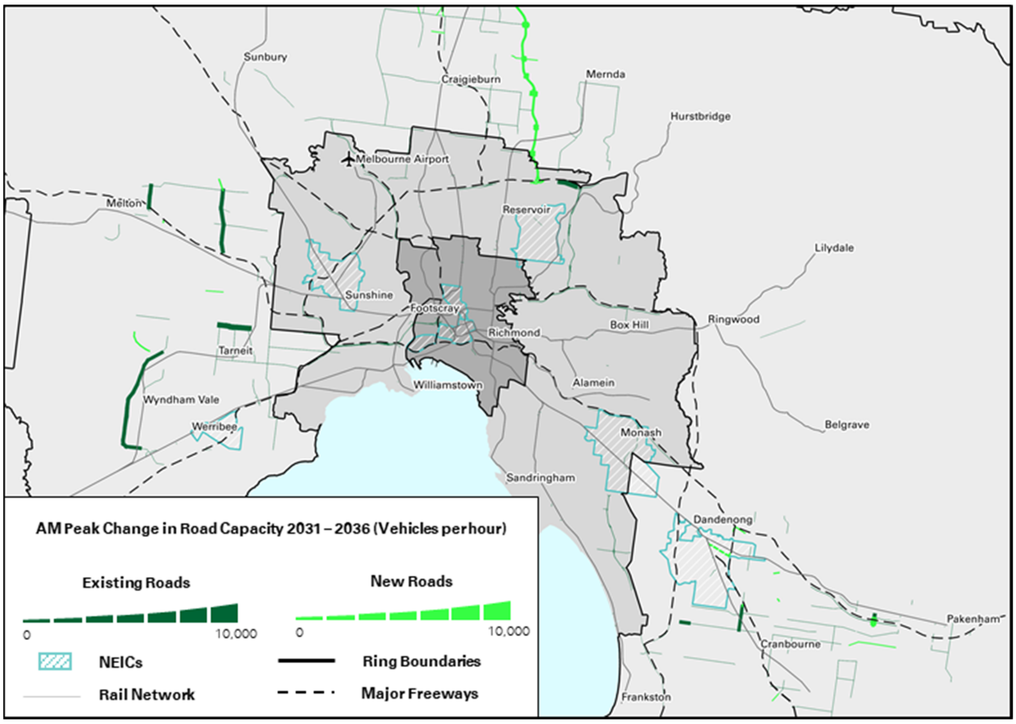
As illustrated in Figure A- 40, the 2051 Reference Case and Base Case incorporate OMR, a multi-lane freeway connecting with the E6 at Hume Freeway, extending through the outer western suburbs and Princes Freeway.

Figure A- 37: Road network projects included in the 2031 Base Case



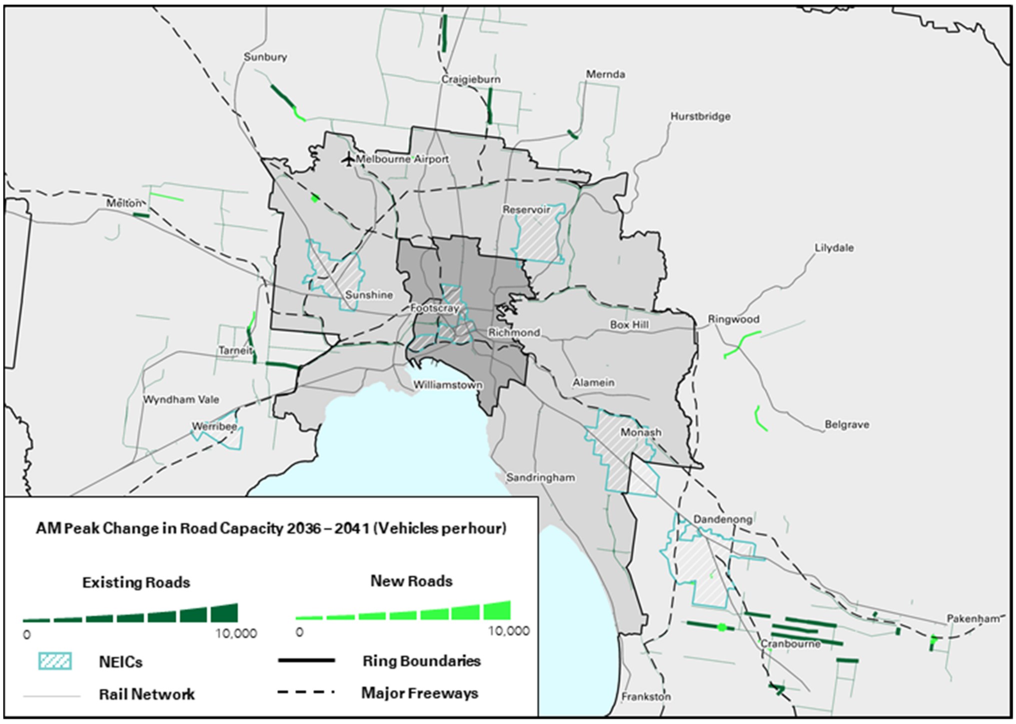
Source: DoT VITM Reference Case

Figure A- 38: Road network projects included in the 2036 Base Case



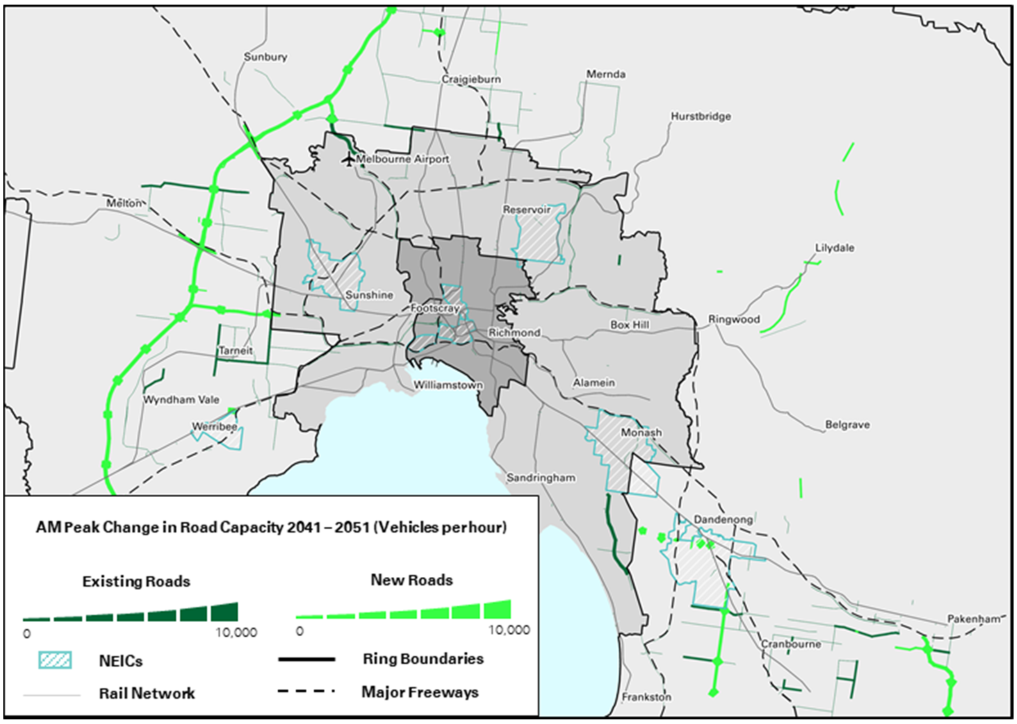
Source: DoT VITM Reference Case

Figure A- 39: Road network projects included in the 2041 Base Case



Source: DoT VITM Reference Case

Figure A- 40: Road network projects included in the 2051 Base Case

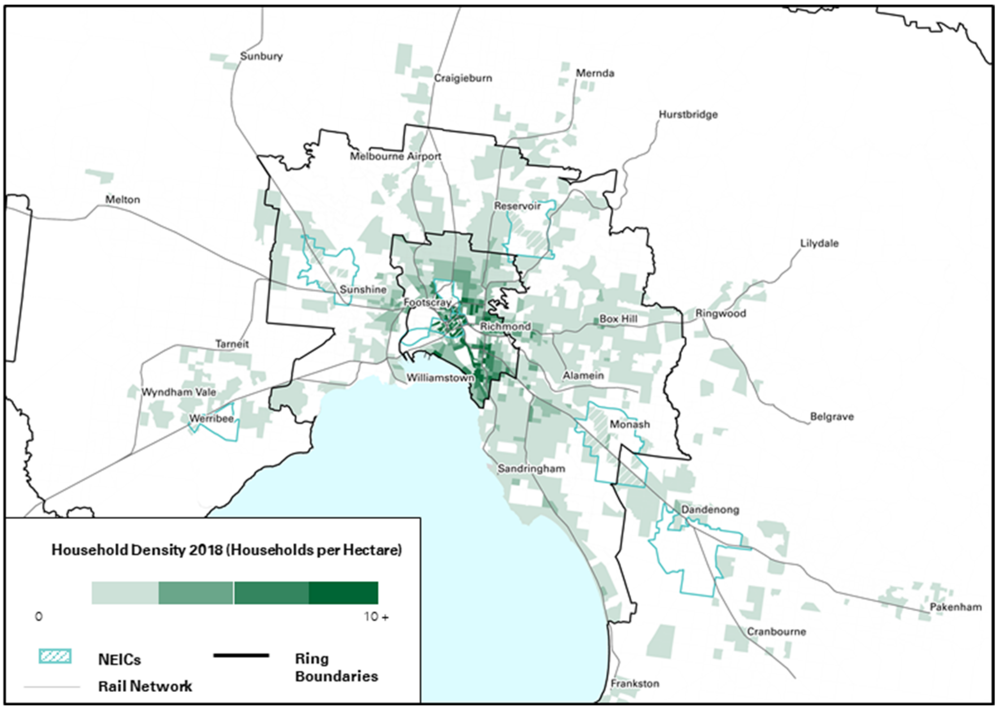


Source: DoT VITM Reference Case

Households

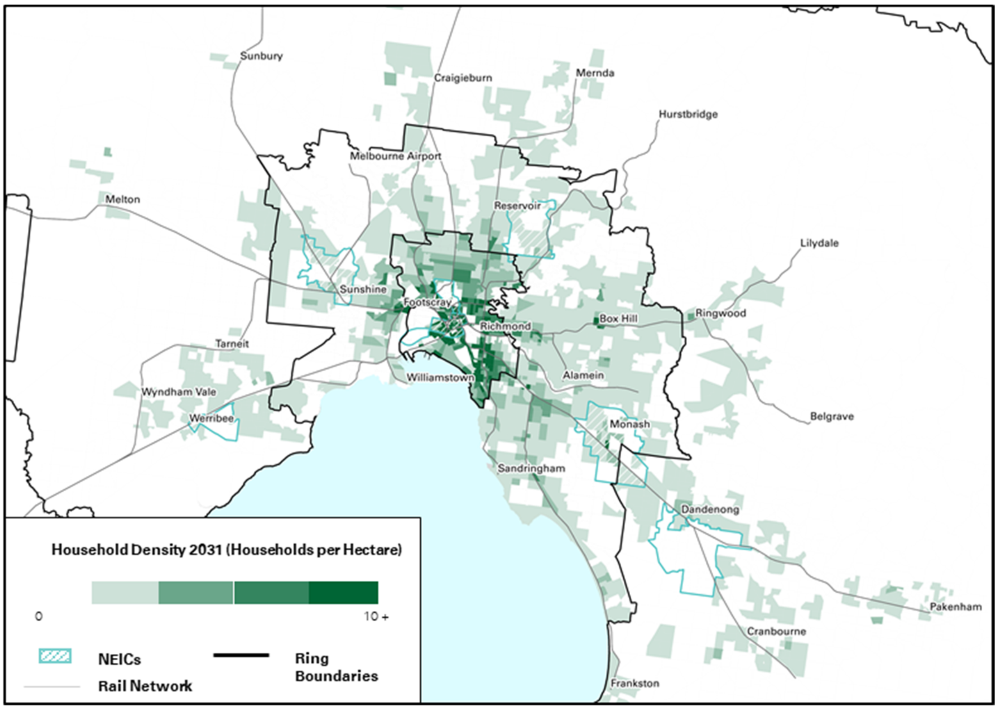
Figure A- 41 to Figure A- 46 highlight household density included in the SALUP data across the model years used in SRL – Cheltenham to Airport Base Case demand modelling. Density increases in the inner and middle ring suburbs and then expands outwards into the outer suburbs and surrounding areas as time passes with a clear urban sprawl trend.

Figure A- 41: Household density 2018



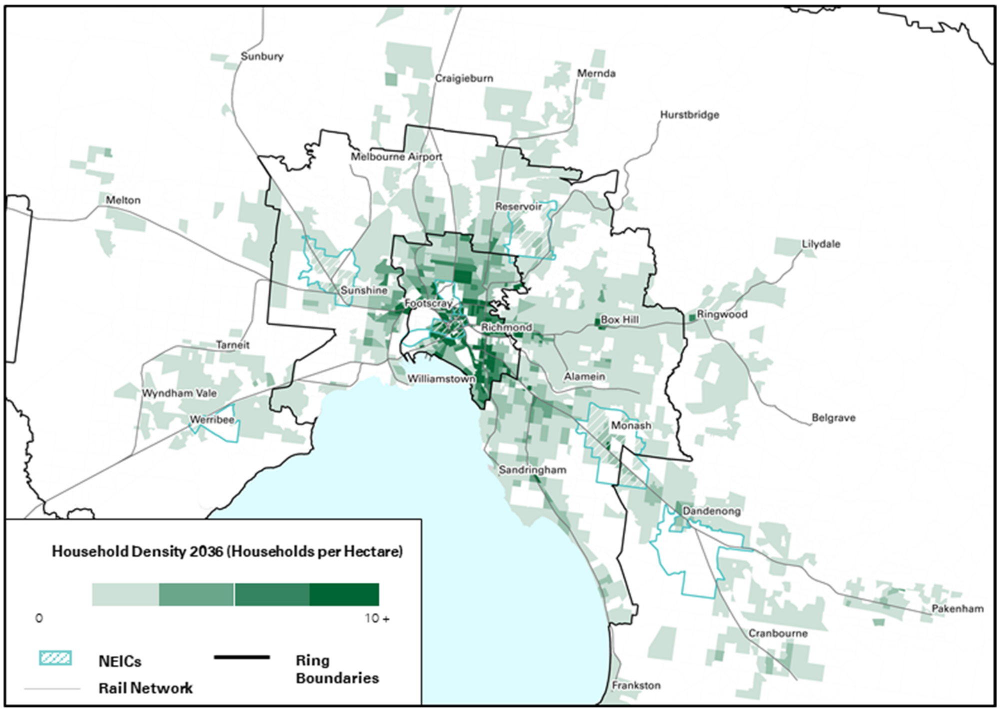
Source: SALUP based on DELWP Projections 2018 (Unpublished)

Figure A- 42: Household density 2031



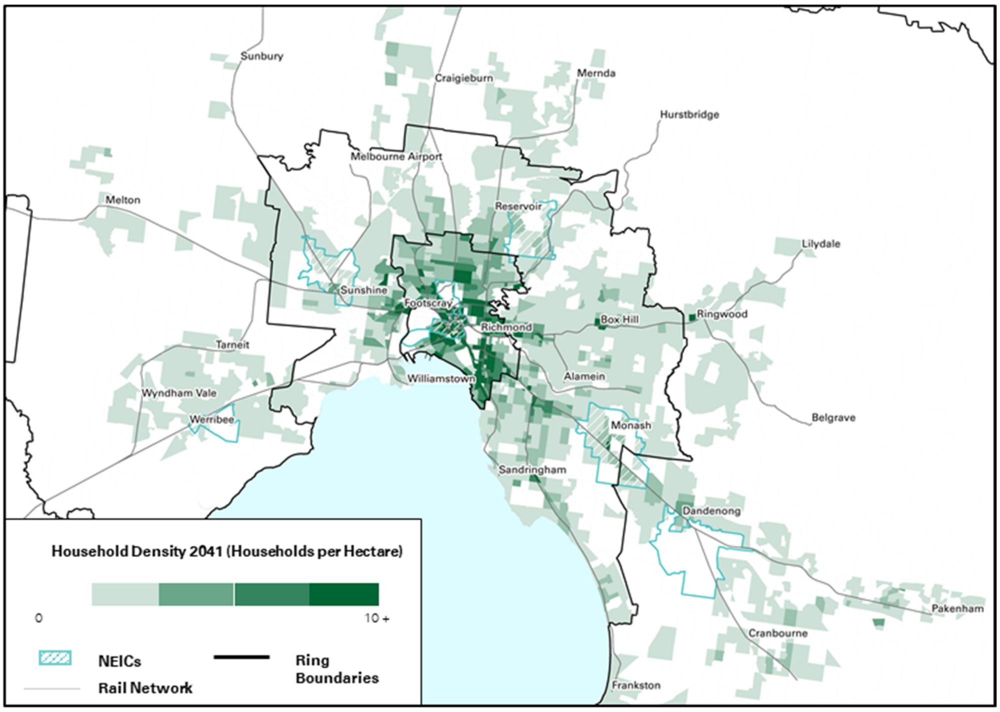
Source: SALUP based on DELWP Projections 2018 (Unpublished)

Figure A- 43: Household density 2036



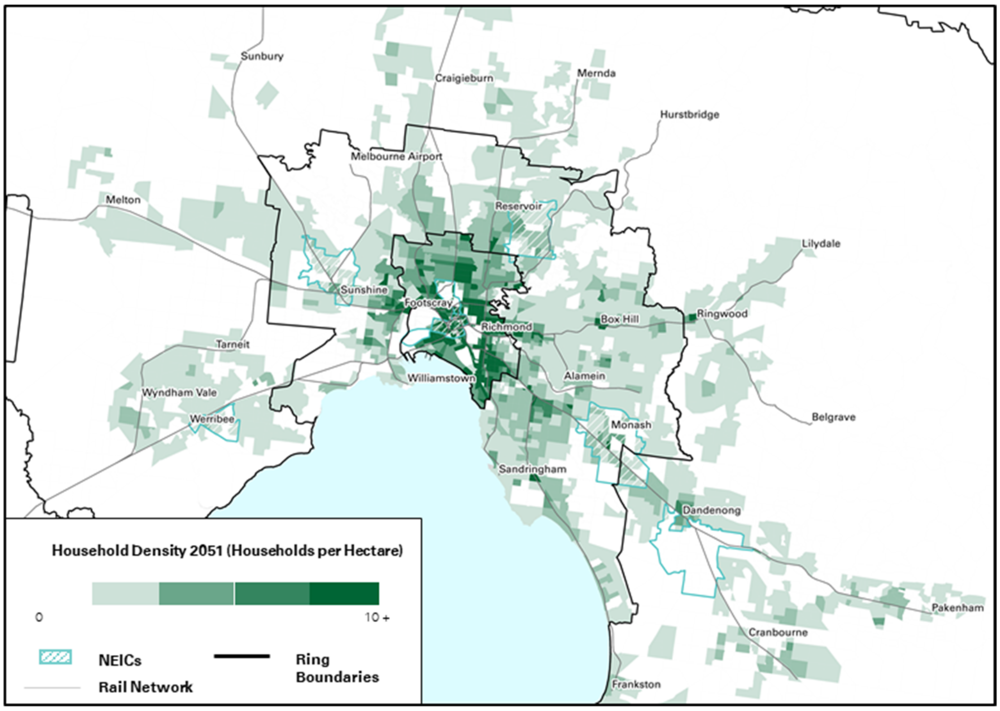
Source: SALUP based on DELWP Projections 2018 (Unpublished)

Figure A- 44: Household density 2041



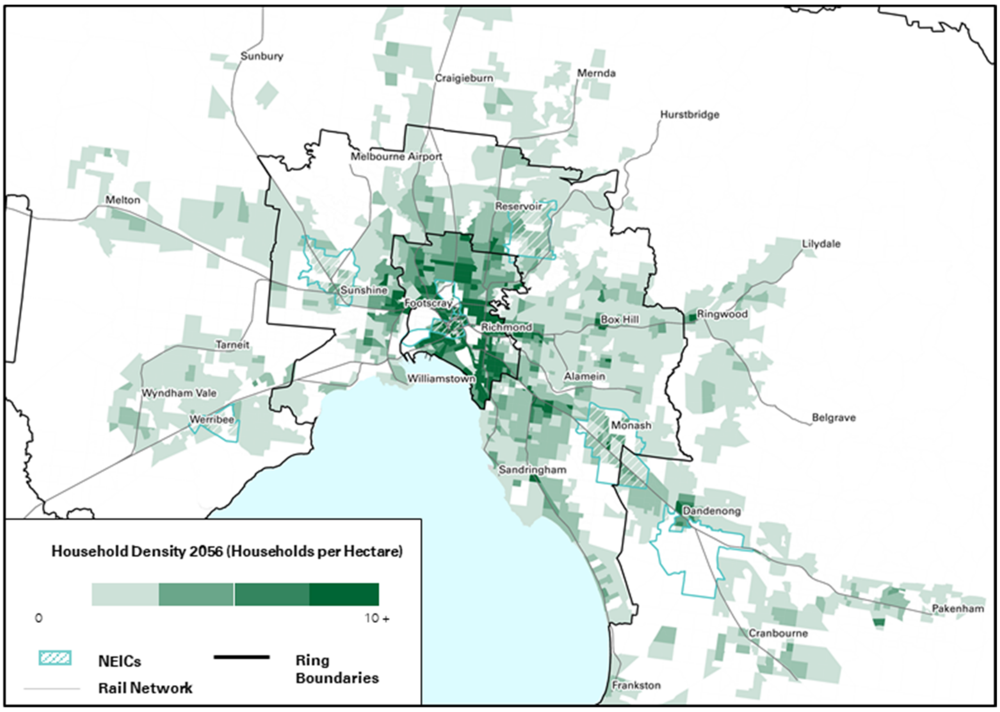
Source: SALUP based on DELWP Projections 2018 (Unpublished)

Figure A- 45: Household density 2051



Source: SALUP based on DELWP Projections 2018 (Unpublished)

Figure A- 46: Household density 2056



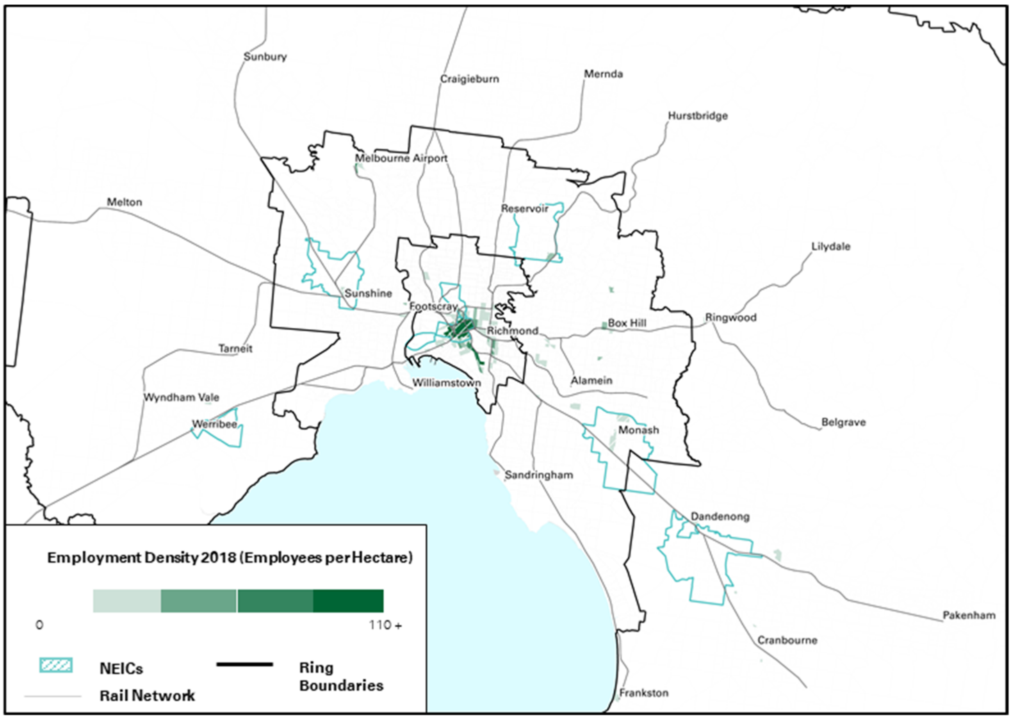
Source: SALUP based on DELWP Projections 2018 (Unpublished)

Employment

Figure A- 47 to Figure A- 52 highlight employment density included in the SALUP data across the model years used in SRL – Cheltenham to Airport demand modelling.

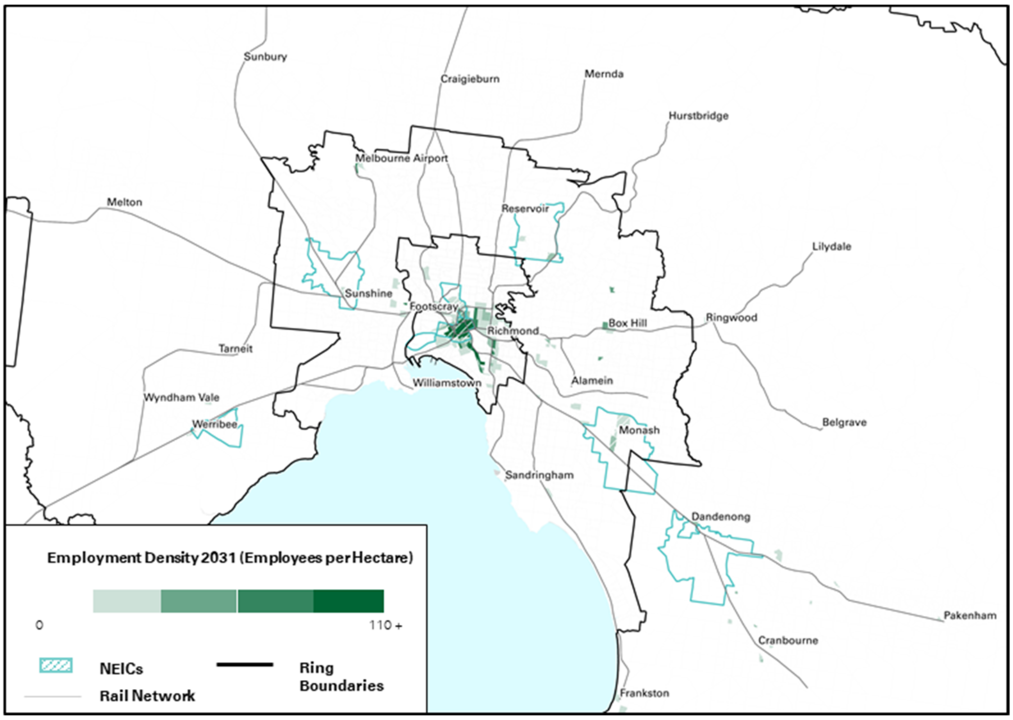
There is an increase in densification in the CBD and surrounding suburbs throughout the model years as employment density increases in key NEICs and MACs in later model years.

Figure A- 47: Employment density 2018



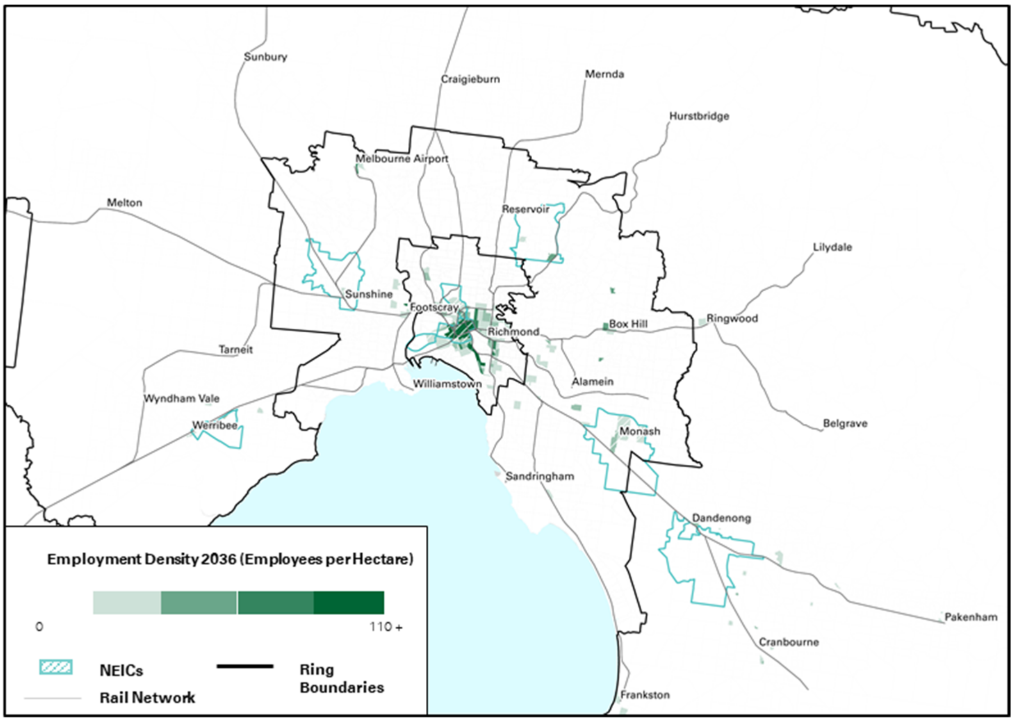
Source: SALUP based on DELWP Projections 2018 (Unpublished)

Figure A- 48: Employment density 2031



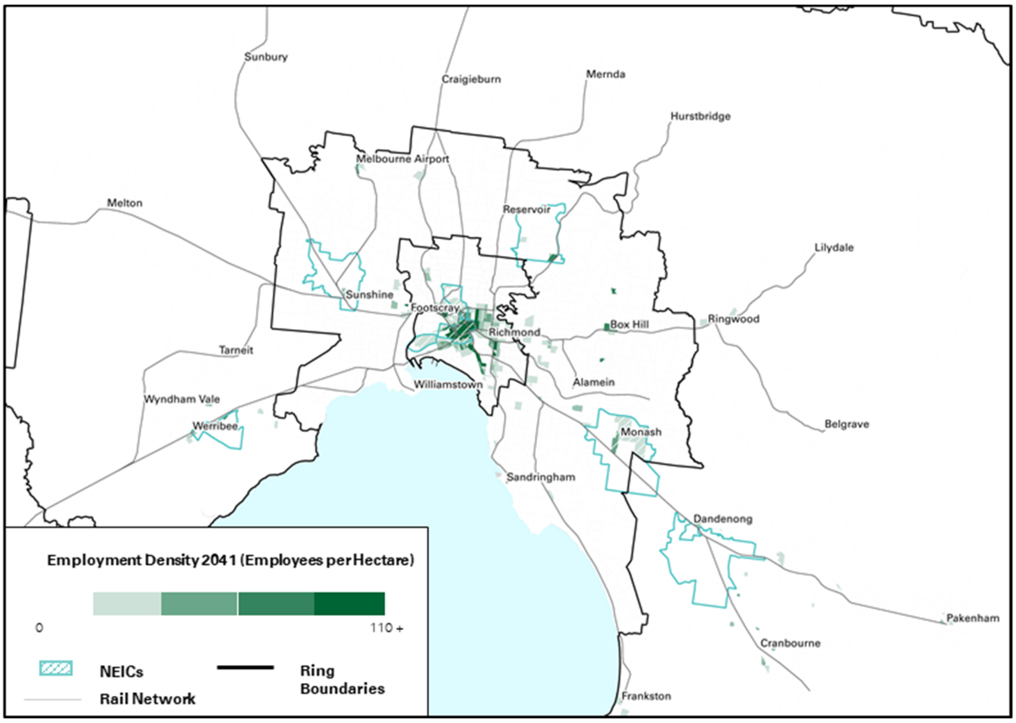
Source: SALUP based on DELWP Projections 2018 (Unpublished)

Figure A- 49: Employment density 2036



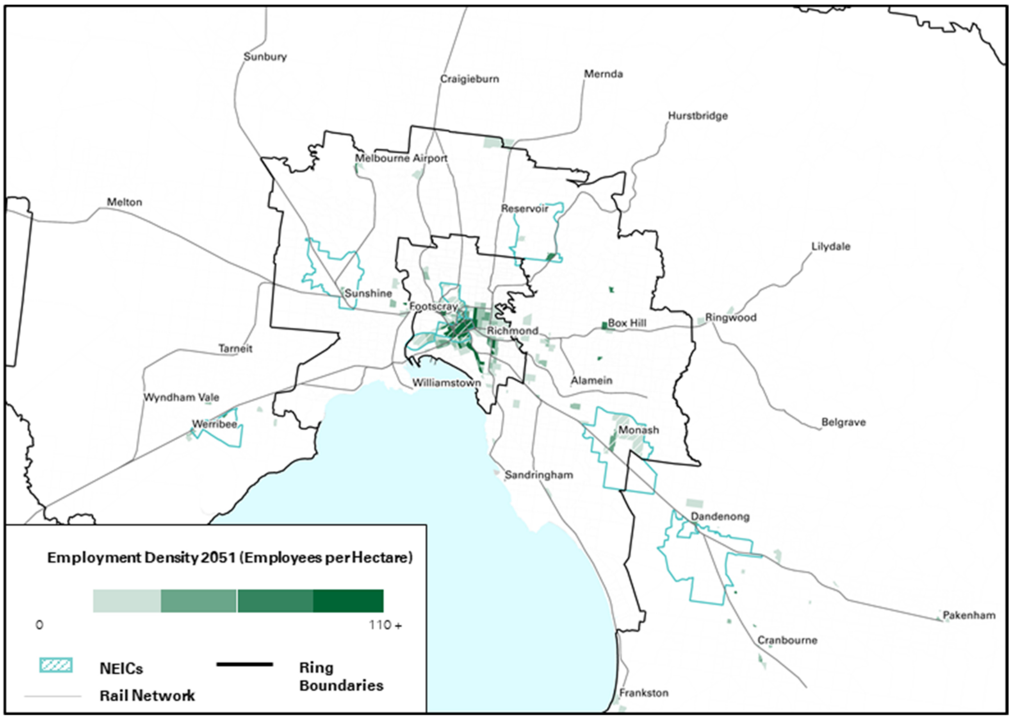
Source: SALUP based on DELWP Projections 2018 (Unpublished)

Figure A- 50: Employment density 2041



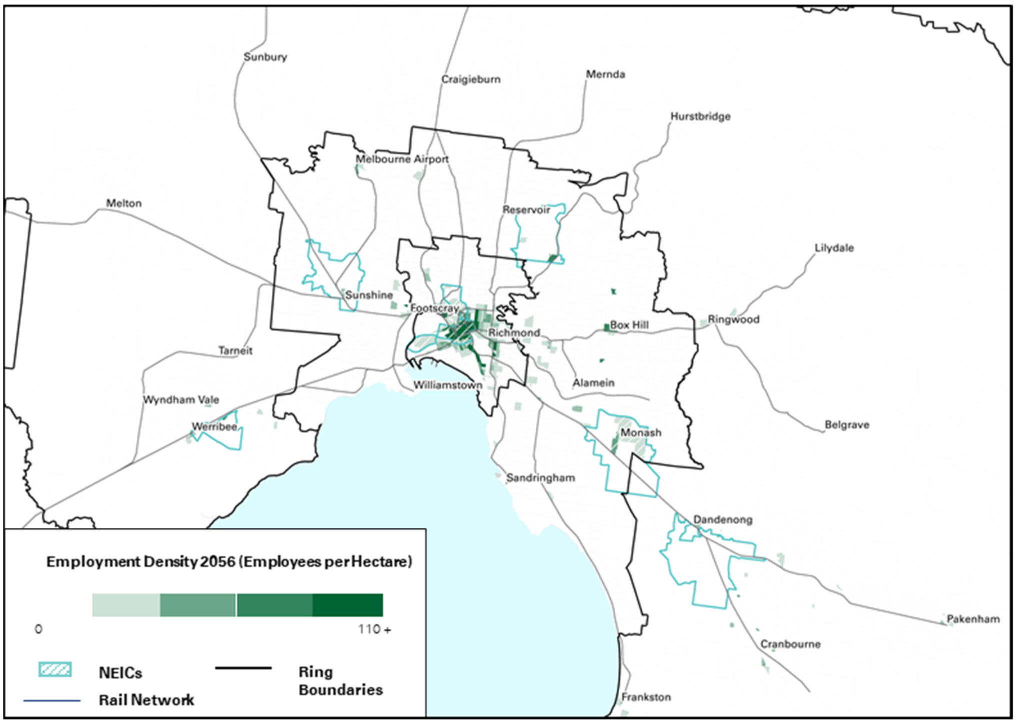
Source: SALUP based on DELWP Projections 2018 (Unpublished)

Figure A- 51: Employment density 2051



Source: SALUP based on DELWP Projections 2018 (Unpublished)

Figure A- 52: Employment density 2056



Source: SALUP based on DELWP Projections 2018 (Unpublished)

A.4.2 Program Cases

VITM was used to model Program Case scenarios for 2031, 2036, 2041, 2046, 2051, and 2056. The Program Cases use the Base Case described in Section A.4.1 as a starting point and then incorporate the network and land use improvements delivered by SRL – Cheltenham to Airport.

The assumptions for the Program Cases are outlined previously in Section 3.6.

Aspects of relevance for the VITM modelling are presented below. Two Program Cases were assessed, representing different timing for sequencing and construction completion, namely Option A completion in 2053 and Option B completion in 2043.

The modelling results for the Program Cases presented in this report are based on model runs using CityPlan land use planning and SRL – Cheltenham to Airport transport assumptions. Details regarding land use are provided in Volume B of this Demand Modelling Report.

Scope of Program Case network improvements

A core component of the SRL – Cheltenham to Airport improvements is the sequenced delivery of a heavy rail link between Cheltenham and Melbourne Airport in three sections.

Two options for the opening of SRL - Cheltenham to Airport have been assessed as outlined in Table A - 31.

Table A - 31: Summary of Program Case Option A and B[6]

Section	Program Case Option A Opening Year	Program Case Option B Opening Year
Cheltenham to Box Hill	2035	2035
Box Hill to Reservoir	2043	2038
Reservoir to Melbourne Airport	2053	2043

The Program Cases also incorporate tailored bus service plans, designed for buses feeding SRL East and SRL North Precincts. Separate sets of bus service plans corresponding to the relevant phase in the SRL – Cheltenham to Airport sequence have been modelled.

Car ownership

Across Melbourne, denser suburbs, as well as suburbs with higher public transport accessibility have lower car ownership rates. It is therefore assumed that the households that move to SRL East and SRL North Precincts are also more likely to have lower car ownership. Accordingly, reduced car ownership assumptions are used in Program Case modelling as advised by SRLA. These reduced assumptions for transport zones in the precincts have been adopted using a benchmarking approach based on public transport accessibility and density, assuming future car ownership in the precincts will be similar in the future to current day areas of inner Melbourne. As per SRLA advice, separate benchmarks were applied to:

- ‘Inner’ zones (travel zones in the immediate vicinity of the SRL East and SRL North stations), which benchmark to areas with lower car ownership

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[6] SRLA advises that further detailed planning and technical design for SRL North will be undertaken over the coming years. Specific packaging and procurement decisions will be made at an appropriate time in the future.

- 'Outer' zones (travel zones not in the immediate vicinity of the SRL East and SRL North stations, but within 800 to 1600 metres), which benchmark to areas with higher car ownership than the inner zones benchmark to.

Table A - 32 outlines the car ownership benchmarking by SRL East and SRL North Precinct in 2036 Program Case modelling.

Table A - 32: Car ownership benchmarking assumptions in SRL East and SRL North Precincts in Program Case modelling, 2036

Precinct	2036 Program Case Benchmarking Assumption	
	'Inner' Zones	'Outer' Zones
Cheltenham	Coburg	*Not benchmarked*
Clayton	Glenferrie	*Not benchmarked*
Monash	Balaclava	*Not benchmarked*
Glen Waverley	Elsternwick	*Not benchmarked*
Burwood	Footscray	*Not benchmarked*
Box Hill	South Yarra	*Not benchmarked*
Doncaster - Reservoir	*Not benchmarked*	*Not benchmarked*
Broadmeadows – Melbourne Airport	*Not benchmarked*	*Not benchmarked*

Source: SRLA

Table A - 33 outlines the car ownership benchmarking by SRL East and SRL North Precinct in 2056 Program Case modelling.

Table A - 33: Car ownership benchmarking assumptions in SRL East and SRL North Precincts in Program Case modelling, 2056

Precinct	2056 Program Case Benchmarking Assumption	
	'Inner' Zones	'Outer' Zones
Cheltenham	South Yarra	Coburg
Clayton	South Yarra	Glenferrie
Monash	South Yarra	Balaclava
Glen Waverley	South Yarra	Elsternwick
Burwood	South Yarra	Footscray
Box Hill	CBD	South Yarra
Doncaster - Reservoir	South Yarra	Elsternwick
Broadmeadows – Melbourne Airport	Elsternwick	*Not benchmarked*

Source: SRLA

Alternative-specific constants

SRL – Cheltenham to Airport is expected to fundamentally alter the character of precincts and surrounding areas in the corridor. As outlined in Section 4.1.2 (as well as provided in detail in Volume B, see Table B-15 and Table B-16), 2056 land use used in VITM modelling features 26% and 43% increases in households and employment respectively along the SRL – Cheltenham to Airport corridor, compared to Reference Case land use, resulting in significant densification. This shift in character for areas along SRL – Cheltenham to Airport is expected to change preferences and habits with respect to trip behaviour and mode choice. For example, the increased retail and entertainment venues in SRL East and SRL North Precincts that accompany the densification may lead to more public transport trips, as commuters may wish to access these opportunities after their work trip.

VITM uses alternative-specific constants (**ASC**s) to capture shifts in public transport preference that are not already captured by other model variables, such as the example above. The Base Case ASCs in VITM have been calibrated based on past travel survey data, and do not change over time to take into account any fundamental changes to the characteristics of an area. This approach is suitable for projects which only involve adding public transport capacity to existing services (e.g. not altering the land use or character of the area), however could potentially be understated for investments such as SRL – Cheltenham to Airport, which is aimed at changing the land use and fundamental character of the precincts. Therefore, different production and attraction ASCs categories have been used in Program Case modelling (similar to existing areas with good rail access) compared with Base Case modelling to capture the impact to travel behaviour that the Program Case would have on the precincts. The resultant increases in origin and destination PT mode share act to capture the shifts in preferences and habits that SRL – Cheltenham to Airport creates. The ASCs primarily affect home-based work trips.

An assessment of the projected increase in density and accessibility in the Program Case was used to inform the degree to which the Program Case ASCs have been altered. For each SRL East and SRL North station, the Program Case ASCs are applied to the SA2s immediately adjacent to the station.

Production ASCs

For trip production, areas are categorised as either Category 8, 9 or 10, representing the degree of uncaptured preference for public transport for trips beginning in an area, where:

- 8 represents a lower degree of uncaptured preference for P
- 9 represents a moderate degree of uncaptured preference for PT
- 10 represents a higher degree of uncaptured preference for PT.

The specific effect of each production ASC category on PT mode choice utility is outlined in Table A - 34 below.

Table A - 34: Effect of production ASCs on PT mode choice utility, home-based work trips

Production ASC category	Effect on PT mode choice utility
8	-4.3
9	-2.3
10	-1.3

Source: KPMG VITM analysis

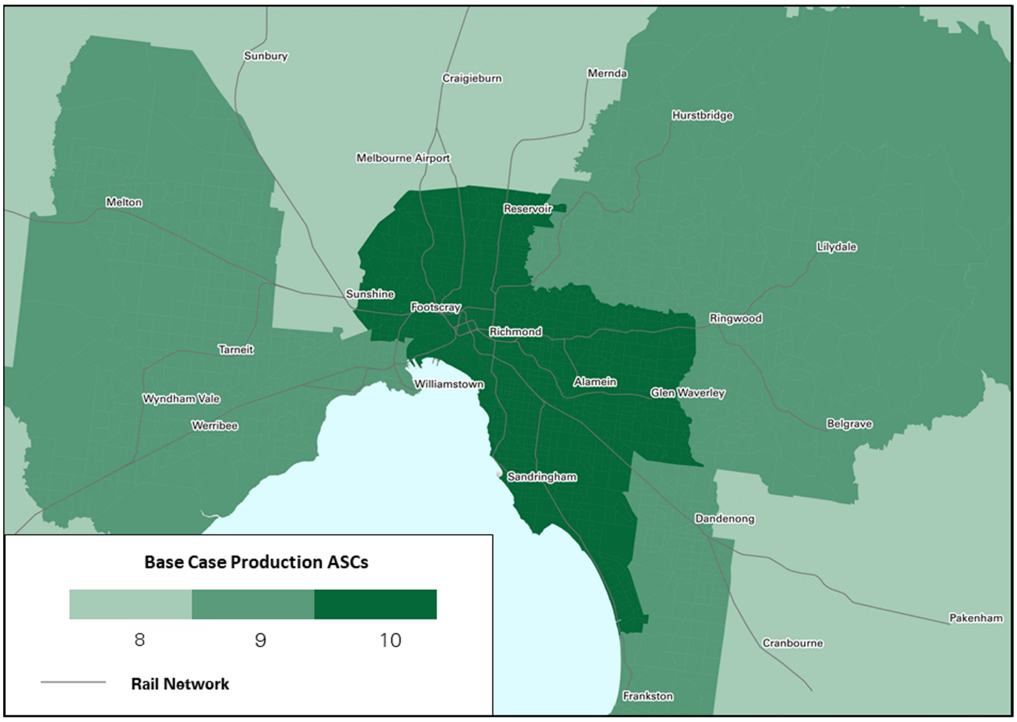
In the Base Case, the ASC for production is Category 10 in the inner city, as well as eastern and south-eastern suburbs, reflecting a strong uncaptured PT preference in these areas, as shown in Figure A- 53. With SRL – Cheltenham to Airport incorporated into the Program Case, areas such as Doncaster, Heidelberg and Broadmeadows are also modelled as Category 10, as shown in Table A - 35 and Figure A - 55.

Table A - 35: Production ASCs in the Base Case, home-based work trips

Precinct	Base Case	SRL East	SRL – Cheltenham to Airport
Cheltenham	10	10	10
Clayton	10	10	10
Monash	10	10	10
Glen Waverley	10	10	10
Burwood	10	10	10
Box Hill	10	10	10
Doncaster	9	9	**10**
Heidelberg	9	9	**10**
La Trobe	10	10	10
Reservoir	10	10	10
Fawkner	10	10	10
Broadmeadows	8	8	**10**

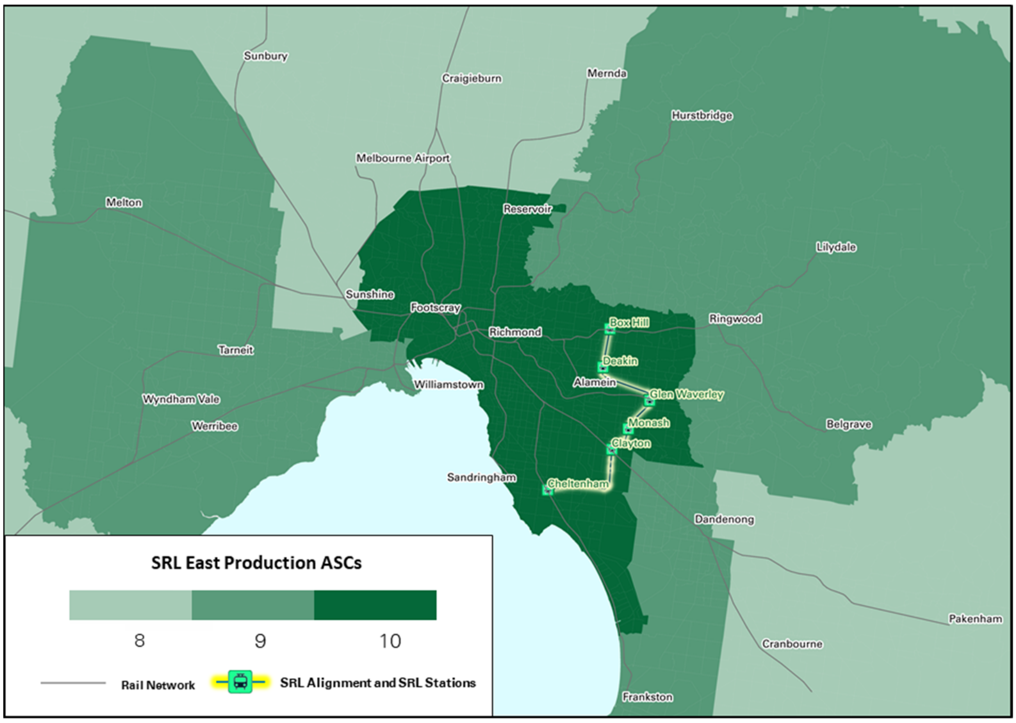
Source: KPMG VITM analysis

Figure A- 53: Production ASCs in the Base Case, home-based work trips



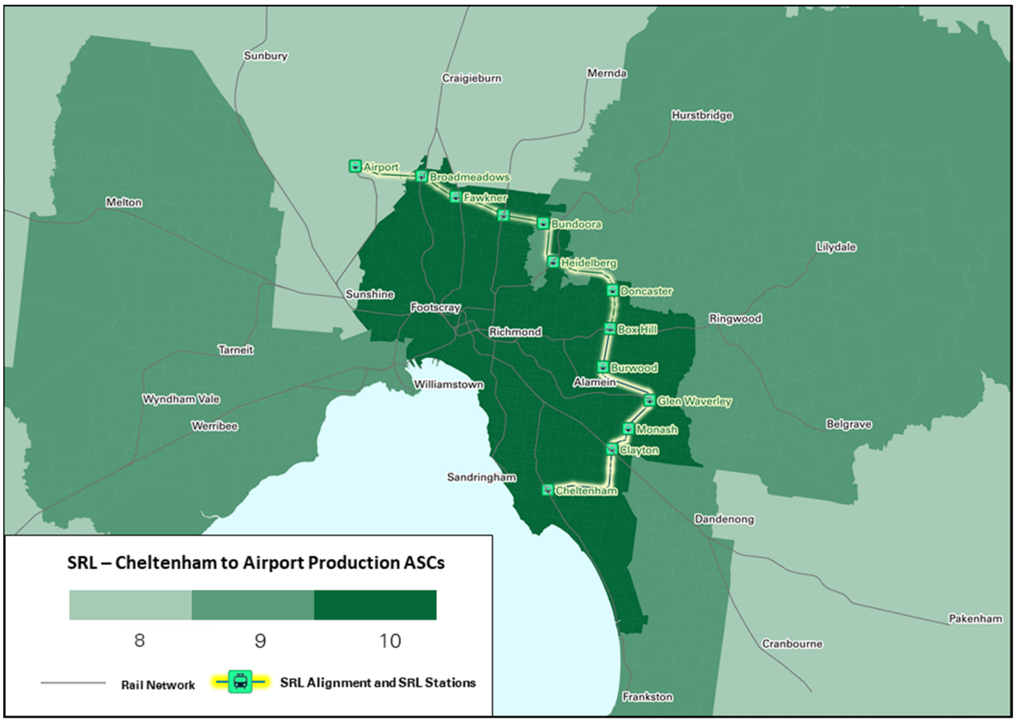
Source: KPMG VITM analysis

Figure A- 54: Production ASCs in the Program Case (at SRL East completion), home-based work trips



Source: KPMG VITM analysis

Figure A- 55: Production ASCs in the Program Case (at SRL – Cheltenham to Airport completion), home-based work trips



Source: KPMG VITM analysis

Attraction ASCs

For trip attraction, areas are categorised as either Category 6 or 7, or uncategorised, representing the degree of uncaptured preference for public transport for trips ending in an area, where:

- 6 represents a stronger degree of uncaptured preference for PT
- 7 represents a moderate degree of uncaptured preference for PT
- Uncategorised represents no assumed uncaptured preference for PT.

The specific effect of each attraction ASC category on PT mode choice utility is outlined in Table A - 36 below.

Table A - 36: Effect of attraction ASCs on PT mode choice utility, home-based work trips

Attraction ASC category	Effect on PT mode choice utility
6	+0.87
7	+0.59
Uncategorised	+0

Source: KPMG VITM analysis

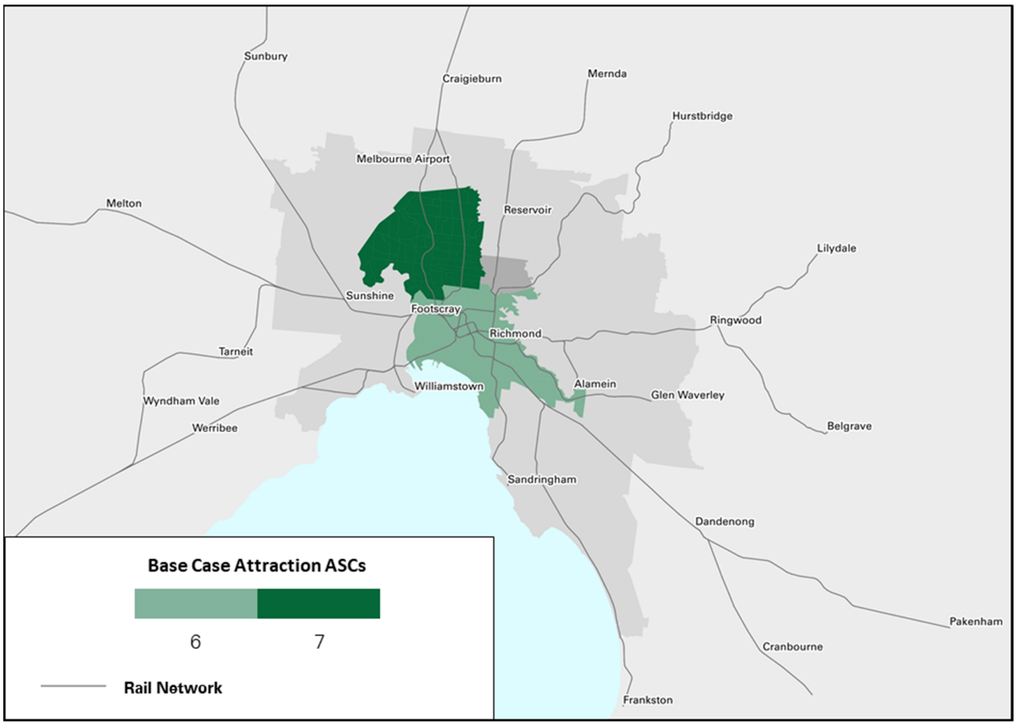
In the Base Case, the ASC for attraction is Category 6 in the inner city, reflecting a strong uncaptured PT preference for trips to these areas, as shown in Figure A- 56. Category 7, representing a moderate uncaptured preference for PT trips, is used for areas in the inner and middle northern suburbs. With SRL – Cheltenham to Airport incorporated into the Program Case, SA2s along the SRL – Cheltenham to Airport corridor are also modelled as Category 7, as shown in Table A - 37. This brings the attraction ASC for areas along the SRL – Cheltenham to Airport corridor in line with what is used for areas in the inner and middle north, such as Brunswick and Coburg.

Table A - 37: Attraction ASCs in the Base Case, home-based work trips

Precinct	Base Case	SRL East	SRL – Cheltenham to Airport
Cheltenham	-	**7**	**7**
Clayton	-	**7**	**7**
Monash	-	**7**	**7**
Glen Waverley	-	**7**	**7**
Burwood	-	**7**	**7**
Box Hill	-	**7**	**7**
Doncaster	-	-	**7**
Heidelberg	-	-	**7**
La Trobe	-	-	**7**
Reservoir	-	-	**7**
Fawkner	7	7	7
Broadmeadows	-	-	**7**

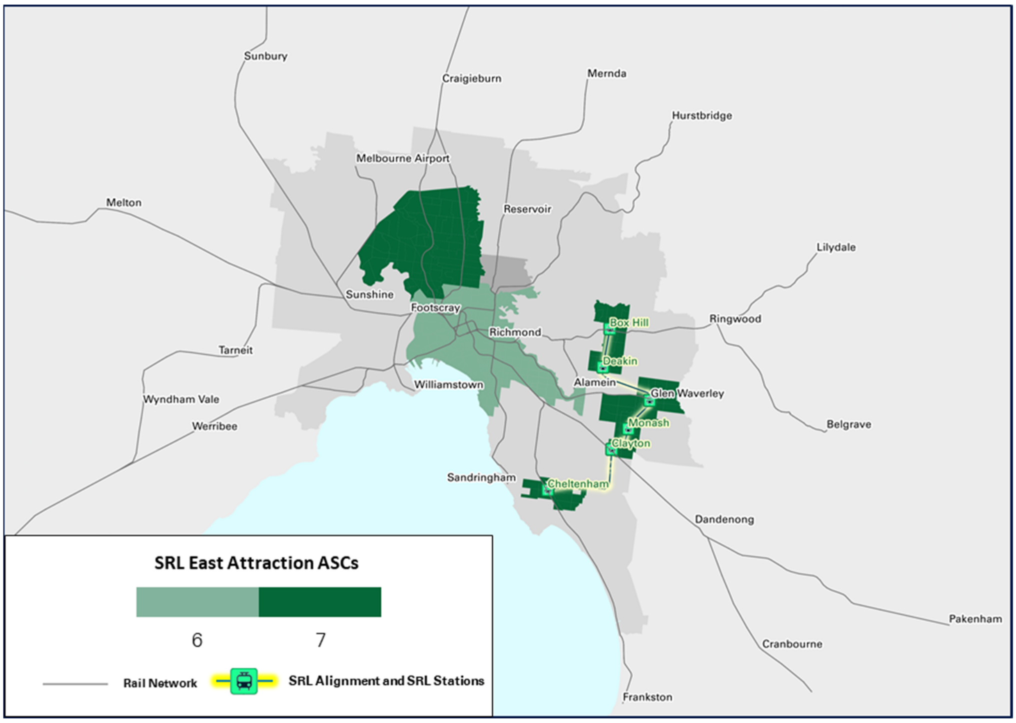
Source: KPMG VITM analysis

Figure A- 56: Attraction ASCs in the Base Case, home-based work trips



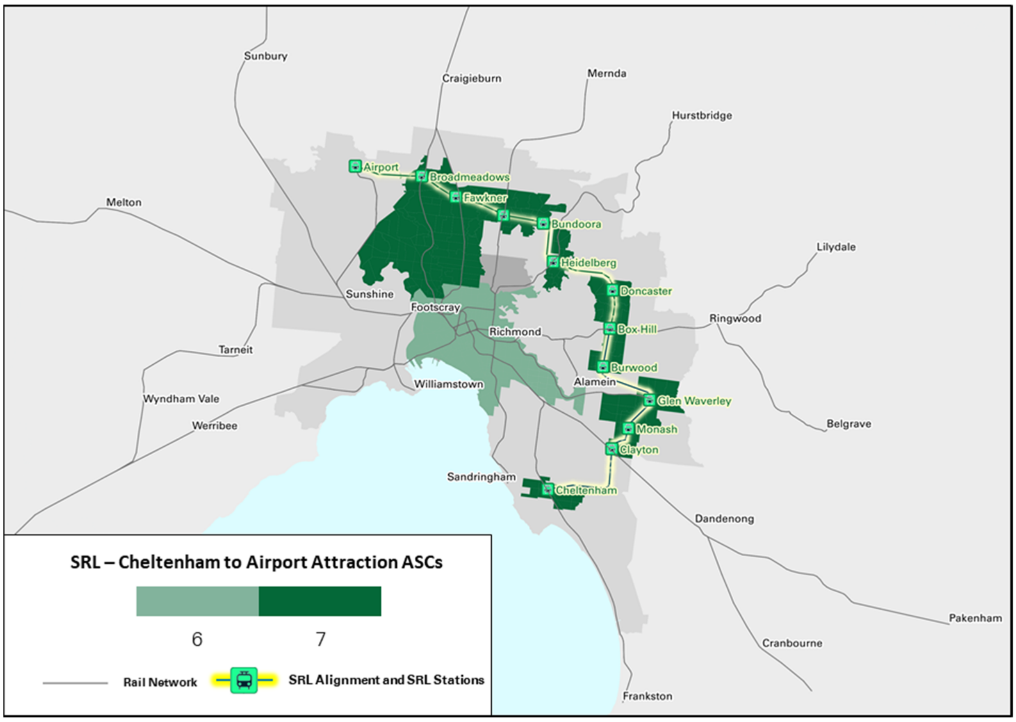
Source: KPMG VITM analysis

Figure A- 57: Attraction ASCs in the Program Case (at SRL East completion), home-based work trips



Source: KPMG VITM analysis

Figure A- 58: Attraction ASCs in the Program Case (at SRL – Cheltenham to Airport completion), home-based work trips



Source: KPMG VITM analysis

Fares

The SRL – Cheltenham to Airport fare modelled for VITM modelling purposes mirrors the Myki-based fare structure modelled for other metropolitan rail lines, with an $18 charge for trips to or from the airport, in line with MAR Business Case assumptions. (Transferring passengers between SRL – Cheltenham to Airport and MAR will not be subject to this surcharge).

Rolling stock

The modelled rolling stock in VITM for the SRL – Cheltenham to Airport service is a tailored rolling stock not modelled on any other rail services, incorporating a higher proportion of standing capacity and lower proportion of seated capacity than rolling stock modelled for other services.

Land use

For economic appraisal, the VITM Program Cases use land use derived from CityPlan. This land use features amplified households and jobs along the SRL – Cheltenham to Airport corridor in each of the station precincts based on the accessibility changes from VITM.

The growth in households between 2018, 2036 and 2056, as well as between Base and Program Case at individual precinct levels, is shown in Volume B, Table B -15. SRL – Cheltenham to Airport is anticipated to support a 151% increase in households for Program Case Option A, and a 153% increase for Program Case Option B between 2018 and 2056.

Volume B, Table B -16 shows the growth in jobs at the individual precinct level. SRL – Cheltenham to Airport is forecast to support a 184% increase in jobs for Program Case Option A, and 187% increase for Program Case Option B, with much of this growth being within the employment centres of Monash and Bundoora.

SRL – Cheltenham to Airport rail

An overview of the Program Case assumptions is shown in Table A - 38.

Table A - 38: Program Case VITM modelling key assumptions

Section	**Cheltenham – Box Hill**	**Box Hill - Reservoir**	**Reservoir – Melbourne Airport**
Opening Year (Option A)	2035	2043	2053
Opening Year (Option B)	2035	2038	2043
Rail Distance	26.0 kilometres	45.0 kilometres	60.2 kilometres
Travel Time	22 minutes	38 minutes	50 minutes
Trains per hour (peak periods)	10	12	24
Trains per hour (inter-peak)	6	6	12
Trains per hour (off-peak)	6	6	6
Seated Capacity	188 passengers per service	188 passengers per service	188 passengers per service
Load Standard	820 passengers per service	820 passengers per service	820 passengers per service
Crush Capacity	1,136 passengers per service	1,136 passengers per service	1,136 passengers per service
Transfer Times	See Table A - 39 Transfer time assumptions below		

Source: SRLA

Table A - 39: Transfer time assumptions

Transfer Times (mins:secs)	**Program Case Rail Day 1**		
	SRL-radial rail	SRL-bus/tram	Radial rail-bus/tram
Cheltenham	05:45	02:54	5:05-7:05
Clayton	04:35	05:05	*no change*
Monash	*n/a*	03:00	*n/a*
Glen Waverley	4:05	3:21	*no change*
Burwood	*n/a*	03:00	*n/a*
Box Hill	*04:10*	*4:05*	*no change*
Doncaster	*n/a*	*03:00*	*n/a*
Heidelberg	*03:00*	*03:00*	*03:00*
Bundoora	*n/a*	*03:00*	*n/a*
Reservoir	*03:00*	*03:00*	*03:00*
Fawkner	*03:00*	*03:00*	*no change*
Broadmeadows	*03:00*	*03:00*	*03:00*
Airport	*03:00*	*n/a*	*n/a*

Source: SRLA

A.5 Melbourne in 2036 and 2056 without SRL – Cheltenham to Airport

This section presents VITM modelling results for 2018, 2036 and 2056 scenarios without SRL – Cheltenham to Airport, to illustrate how travel patterns, accessibility and network performance, both for car and public transport travel, evolve over time. The modelling undertaken for these 'no SRL – Cheltenham to Airport' or Base Case scenarios incorporates SALUP land use assumptions, details of which are outlined in Section A.4.1.

A.5.1 Reinforcement of Melbourne as a monocentric city

Melbourne currently functions as a monocentric city, with the CBD attracting a significant proportion of all trips undertaken each day. Figure A- 59 displays AM peak trips (public transport and private vehicle combined) to various destinations[7] across Melbourne. Trips to the CBD far exceed trips to any precinct along the SRL – Cheltenham to Airport corridor in 2018, and also far exceed trips to key precincts

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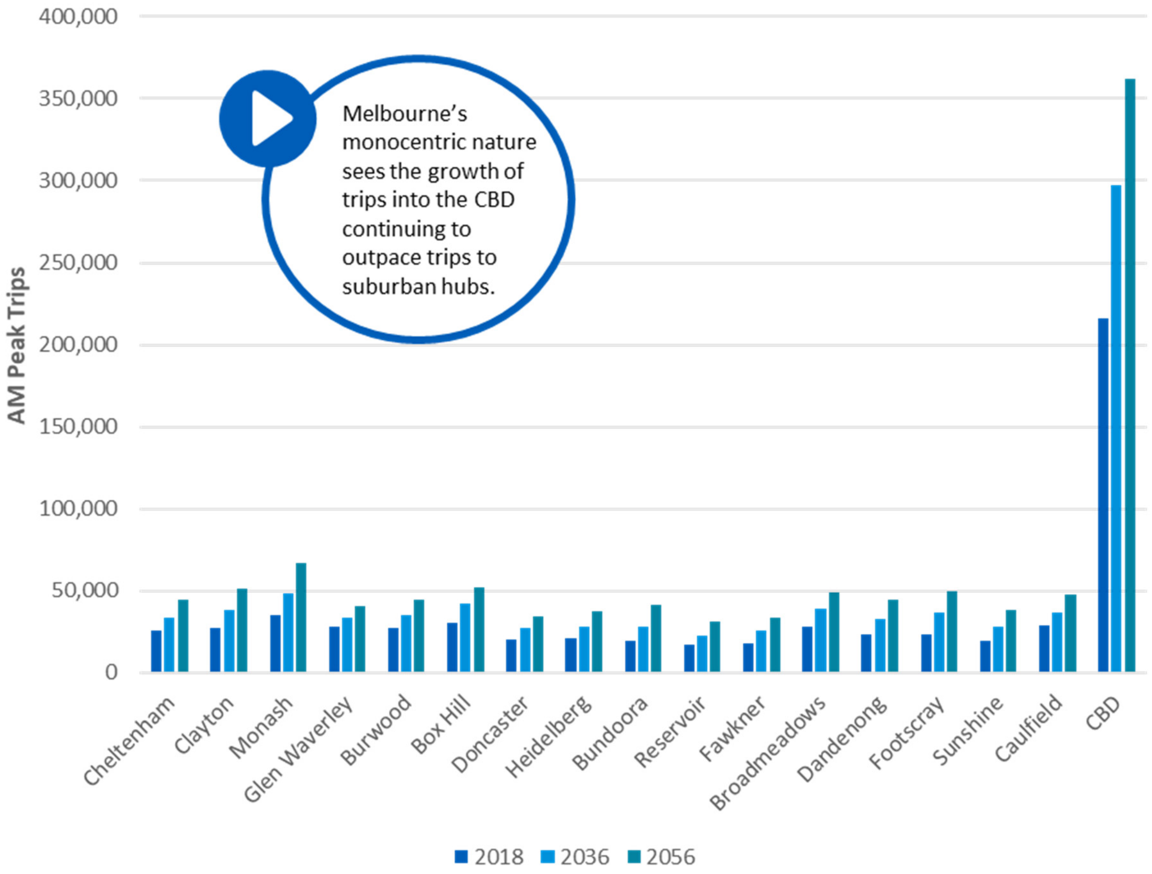
[7] All destinations are defined by taking a 1600m radius around the proposed location of the SRL East and SRL North station, existing location of radial rail station (for Dandenong, Footscray, Sunshine and Caulfield), or Melbourne GPO (for the CBD), and considering all travel zones which lie within (fully or partially) this radius.

outside of SRL – Cheltenham to Airport including Dandenong and Footscray. This trend continues through to 2036, and subsequently 2056. Whilst trips to precincts outside the CBD experience growth between 2018 and 2056, this is small compared to the increase in trips to the CBD, reinforcing Melbourne's monocentric nature.

Figure A- 59: AM peak trips to SRL East and SRL North Precincts, NEICs and CBD

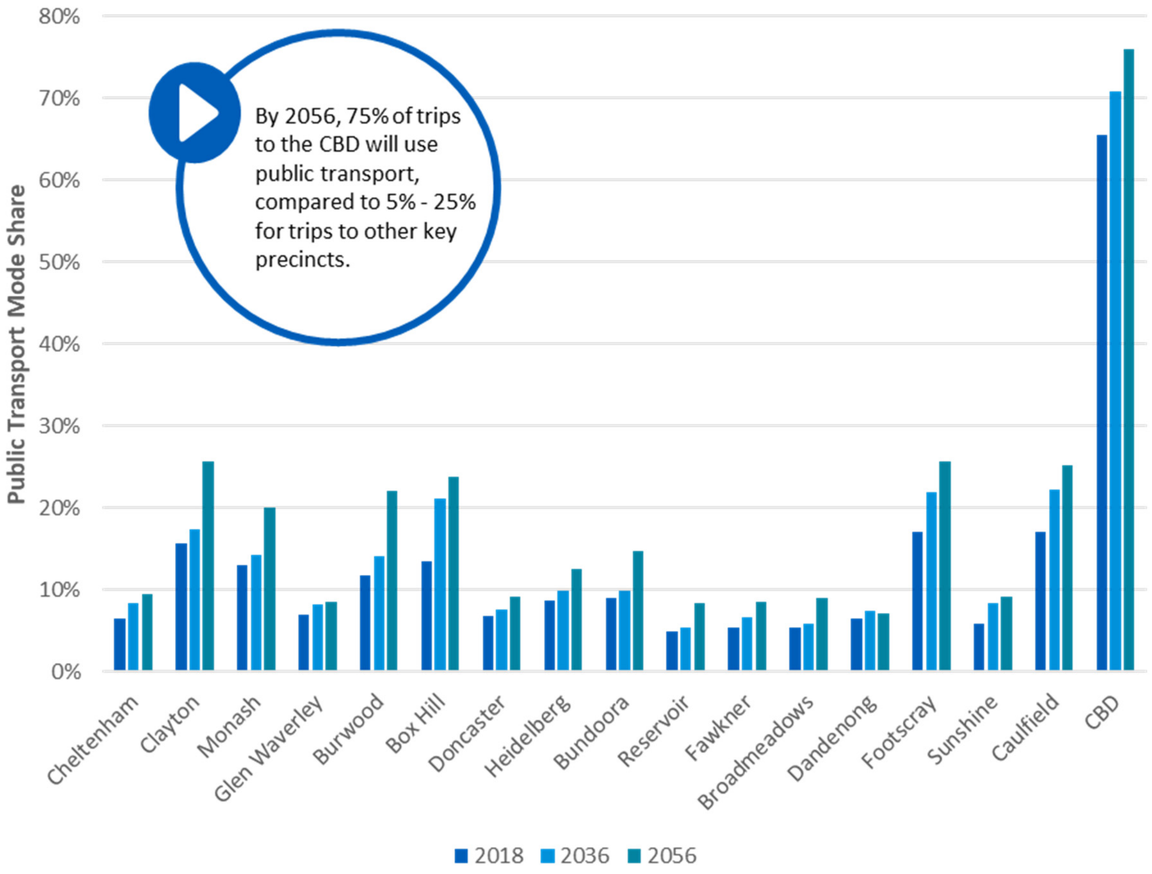


Melbourne's monocentric nature sees the growth of trips into the CBD continuing to outpace trips to suburban hubs.

Source: KPMG VITM modelling (no SRL – Cheltenham to Airport)

Figure A- 60 further highlights the discrepancy between the CBD and suburban precincts in public transport versus private vehicle reliance, displaying the public transport mode share to the same destinations shown in Figure A- 59. While commuters are largely reliant on public transport for trips into the CBD, all SRL – Cheltenham to Airport destinations and a number of NEICs are highly dependent on private vehicles for the vast majority of trips. By 2056, over 75% of trips to the CBD use public transport, while for some SRL East and SRL North Precincts and NEICs public transport mode share to the precinct is less than 10%.

Figure A- 60: Public transport mode share in the AM Peak to SRL East and SRL North Precincts, NEICs and CBD



Source: KPMG VITM modelling (no SRL – Cheltenham to Airport)

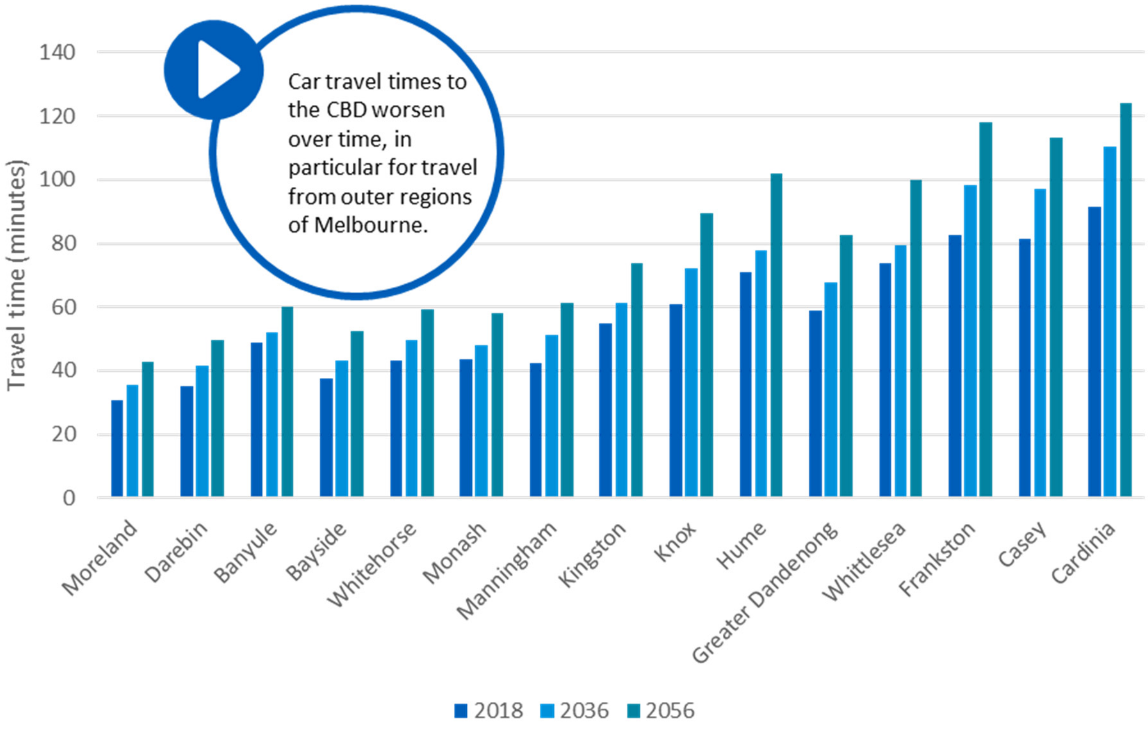
A.5.2 Increasing travel times for work and education

An implication of Melbourne's monocentric nature and high reliance on cars is an increase in travel times to the CBD over time, as a progressively larger population is funnelled towards the CBD for work and education. This is particularly detrimental for commuters from the middle and outer rings of Melbourne, with congestion increasing on freeways, highways, and major arterials that link the suburbs with the CBD.

Travel times to the CBD for work

Figure A- 61 illustrates average private vehicle travel times in the AM peak to the CBD for work purposes, from middle and outer ring LGAs from the south-east to the north of Melbourne. Travel times to work from all selected LGAs increase in 2036 relative to 2018, and increase further in 2056. The increase in travel times between 2036 and 2056 is most pronounced in outer areas. From 2036 to 2056, average AM peak travel times to the CBD for work from Hume increase by 31%, to over 100 minutes. Whilst only 6 of the 15 selected LGAs have average travel times of an hour or more in 2018, this rises to 10 out of 15 in 2056.

Figure A- 61: Average private vehicle travel times (minutes) to CBD jobs (AM peak)



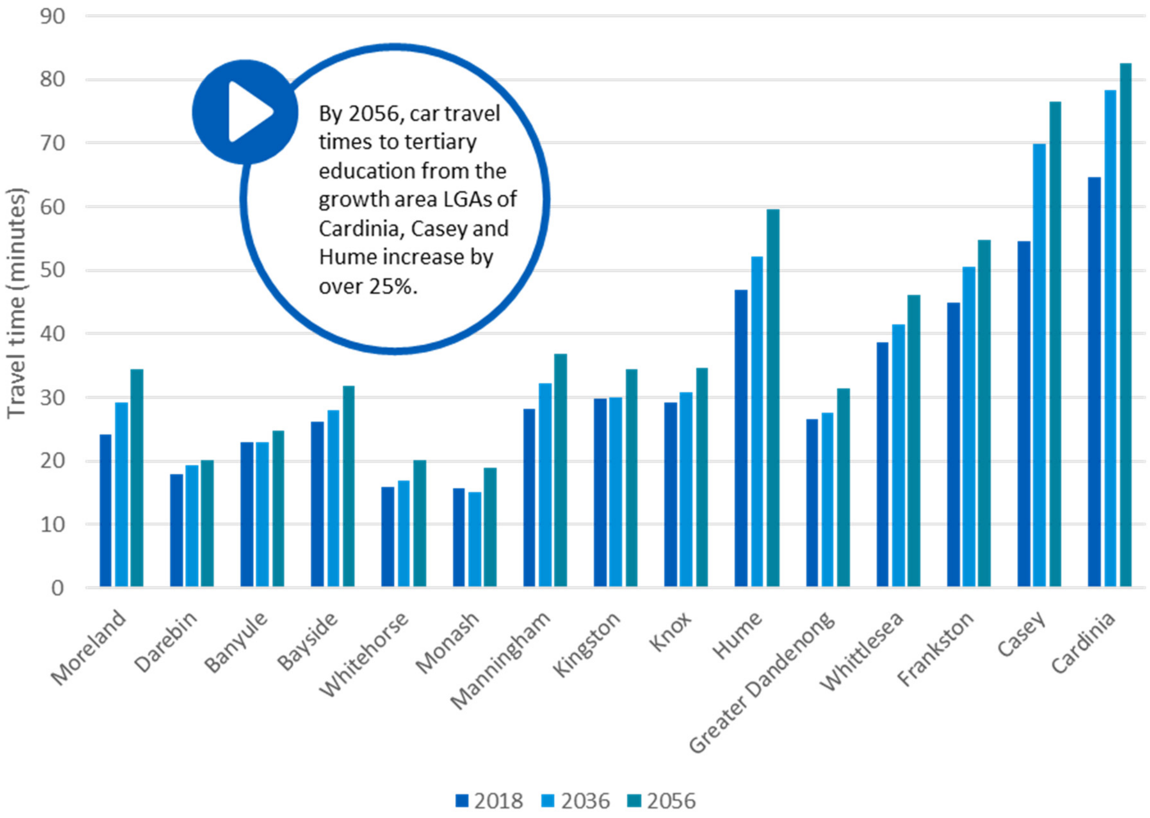
Car travel times to the CBD worsen over time, in particular for travel from outer regions of Melbourne.

Source: KPMG VITM modelling (no SRL – Cheltenham to Airport)

Travel times for tertiary education

Figure A- 62 illustrates average private vehicle travel times in the AM peak for tertiary education trips from middle and outer ring LGAs. Similar to what is seen in Figure A- 61 for work trips to the CBD, travel times for tertiary education trips are expected to increase into the future. Again, there is likely to be a significant increase for trips originating in Hume, with travel times for tertiary education trips expected to increase from an average of 47 minutes in 2018 to 60 minutes in 2056, a 28% increase.

Figure A- 62: Average private vehicle travel times (minutes) to all tertiary education (AM peak)



By 2056, car travel times to tertiary education from the growth area LGAs of Cardinia, Casey and Hume increase by over 25%.

Source: KPMG VITM modelling (no SRL – Cheltenham to Airport)

A.5.3 Increasing travel times to NEICs

Without SRL – Cheltenham to Airport, the area around the Monash SRL Precinct, forming part of the Monash NEIC, is forecast to support 143,000 jobs and 85,000 tertiary enrolments in 2056[8], and the Bundoora SRL Precinct, forming part of La Trobe NEIC, is forecast to support 38,000 jobs and 58,000 tertiary enrolments.[9] However, connectivity to many of these centres, which is critical to support the anticipated job growth within the NEICs, is poor and projected to decline into the future. This section considers how private vehicle travel times[10] to Monash and Bundoora change into the future.

Travel times to Monash

Figure A- 63 illustrates AM peak car travel times to Monash in 2018 and 2056. The proportion of Greater Melbourne within 60 minutes of Monash is expected to decline from 61% in 2018 to 44% in 2056. Additionally, the proportion of Greater Melbourne within 30 minutes of Monash is expected to decline

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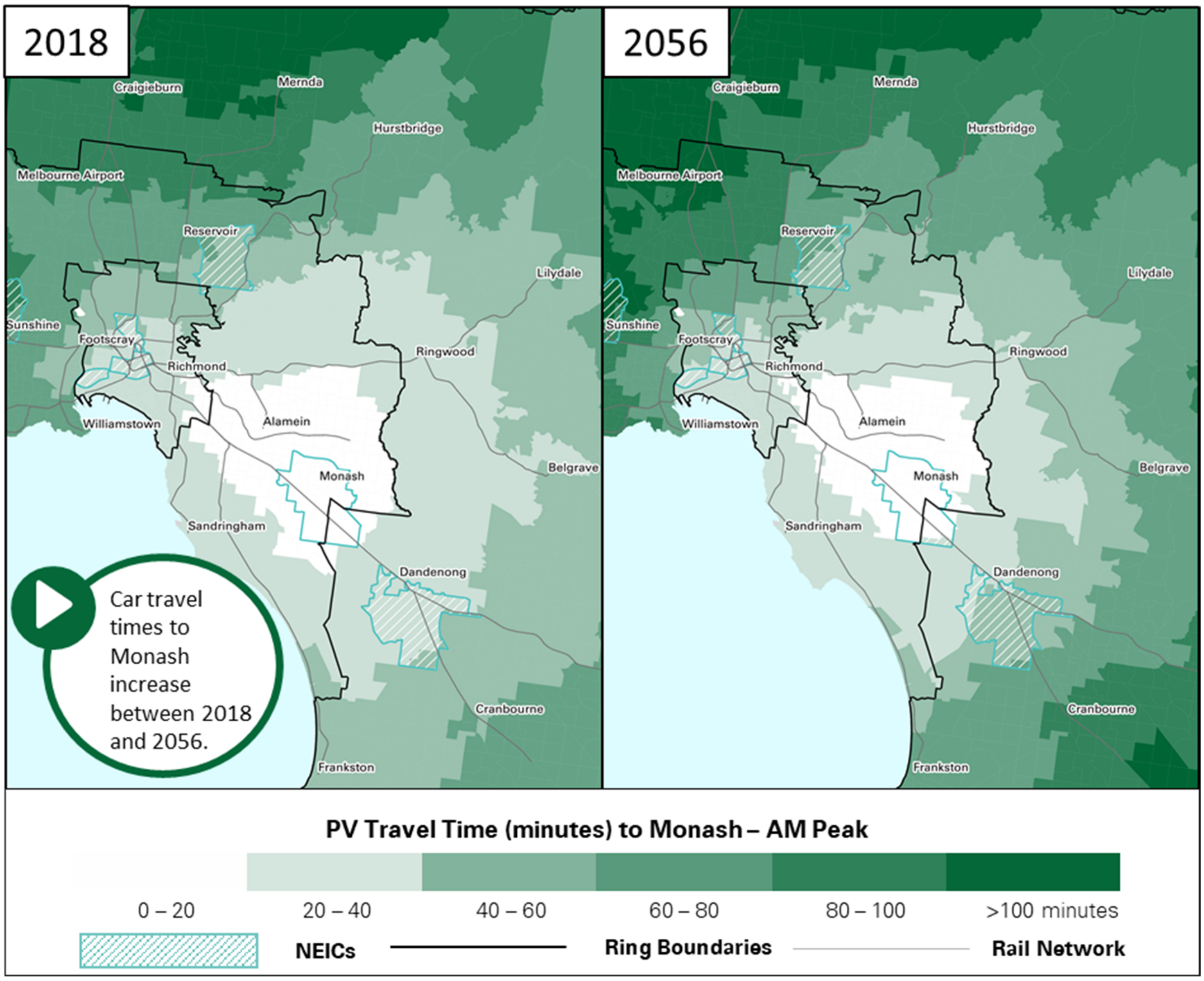
[8] SALUP forecast of Monash SRL Precinct 1600m radius catchment.

[9] SALUP forecast of Bundoora SRL Precinct 1600m radius catchment.

[10] Travel times presented in Section A.5.3 are unweighted by demand, i.e. they are travel time catchments for commuters from origin zones to the precinct, calculated independently of the demand from that origin zone to the precinct.

from 31% in 2018, to 20% in 2056. A private vehicle commuter travelling from Broadmeadows to Monash in the AM peak is expected to see their travel time increase from around 78 minutes in 2018 to around 100 minutes in 2056.

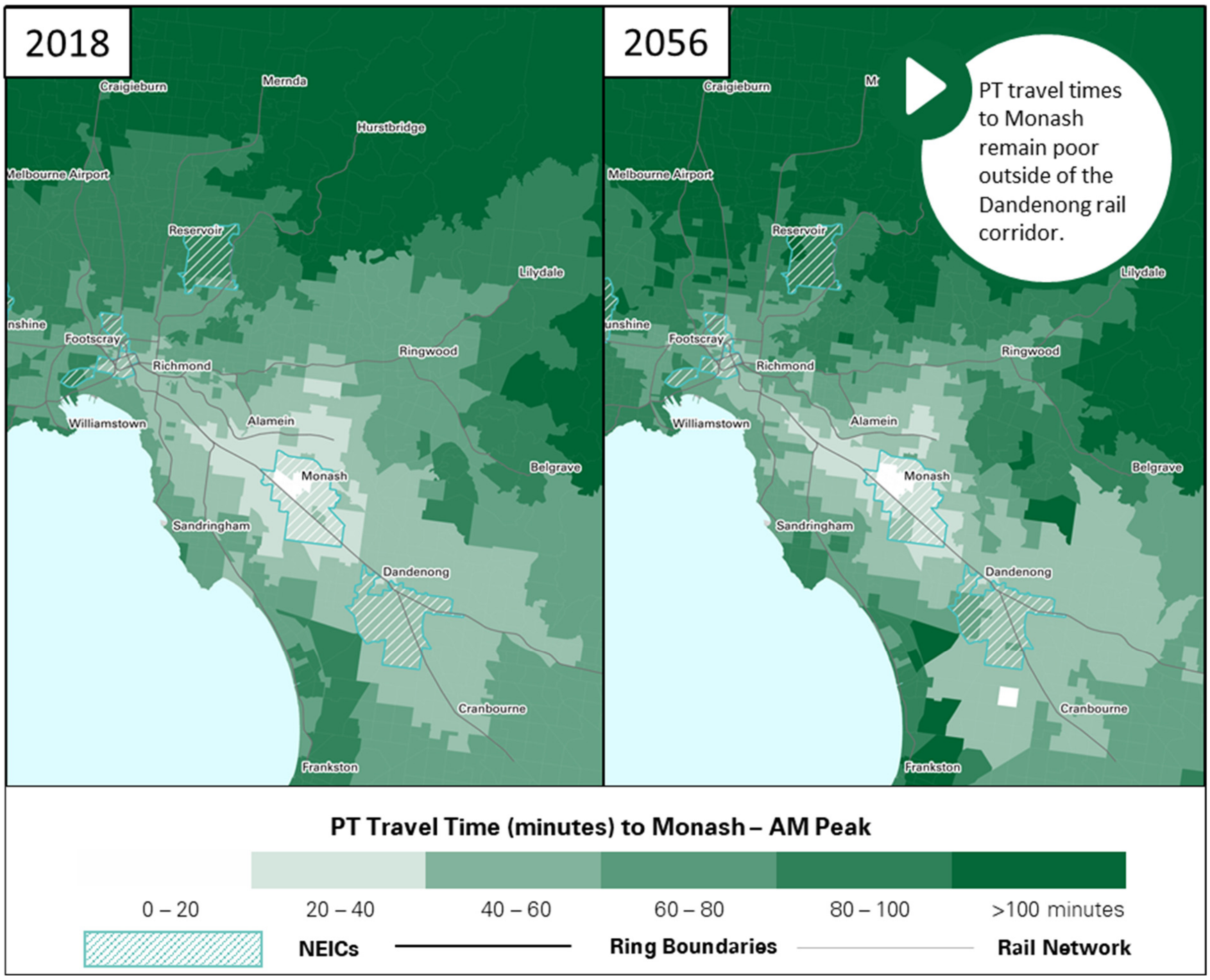
Figure A- 63: Average private vehicle travel times (minutes) to Monash (AM peak), 2018 and 2056



Source: KPMG VITM modelling (no SRL – Cheltenham to Airport)

Figure A- 64 illustrates AM peak public transport travel times to Monash in 2018 and 2056. Whilst public travel times do not increase into the future to the same extent as seen for car, the travel times are significantly longer for public transport than car. Travel times to Monash from the northern suburbs, which are more reliant on bus for part or all of the journey, are particularly poor and expected to decline into the future. A public transport commuter travelling from Broadmeadows to Monash in the AM peak is expected to experience a travel time increase from around 90 minutes in 2018, to around 103 minutes in 2056.

Figure A- 64: Average public transport travel times (minutes) to Monash (AM peak), 2018 and 2056



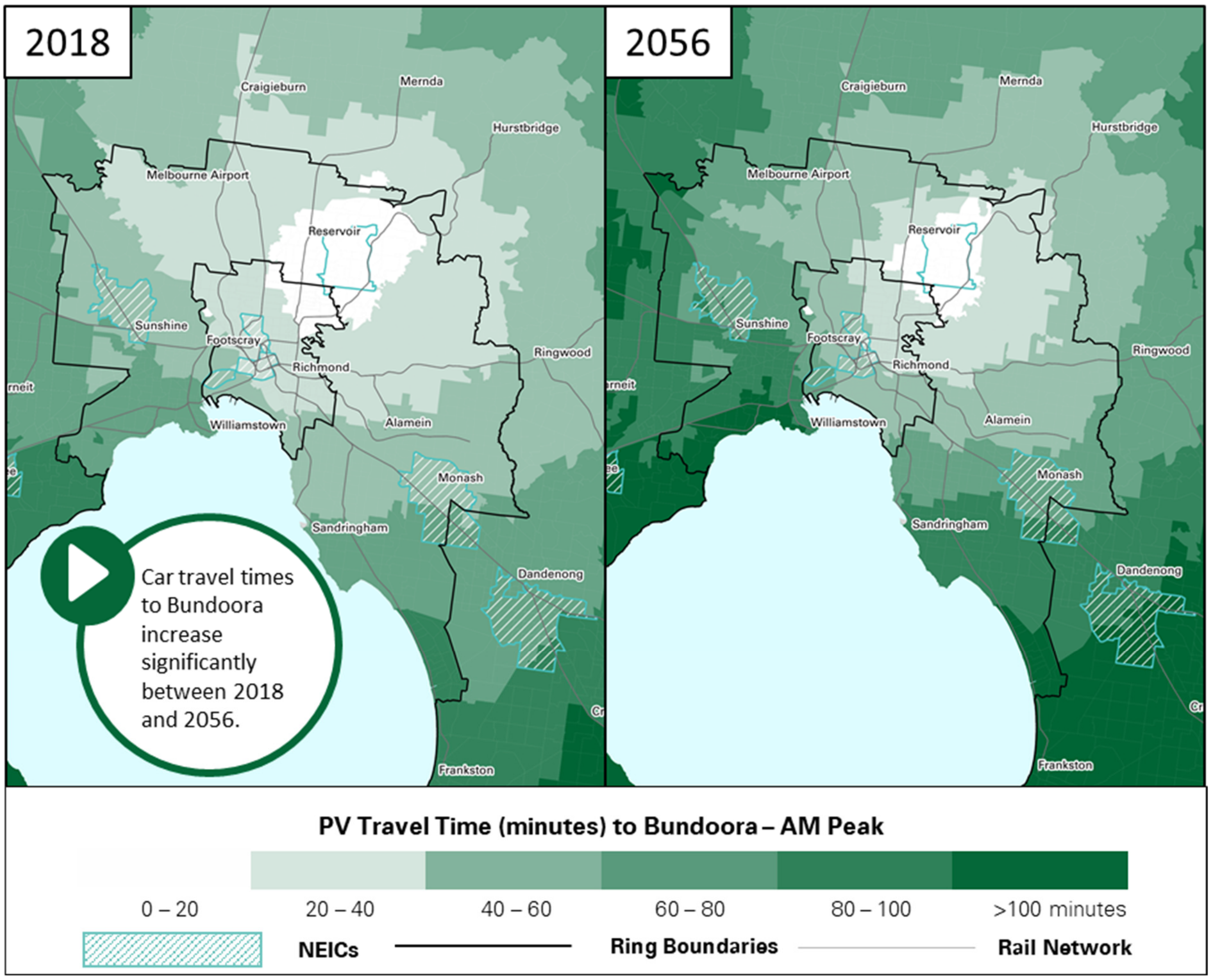
PT travel times to Monash remain poor outside of the Dandenong rail corridor.

Source: KPMG VITM modelling (no SRL – Cheltenham to Airport)

Travel times to Bundoora

A stark deterioration in travel times is expected for private vehicle trips to Bundoora, caused by poor public transport connectivity and a heavy reliance on private vehicle access, exacerbating road congestion. Figure A- 65 illustrates AM peak car travel times to Bundoora in 2018 and 2056. As with Monash, car travel times to Bundoora are expected to increase in the future, with the increase being sharper than that seen for Monash. The proportion of Greater Melbourne within 60 minutes by car from Bundoora is expected to decline from 61% in 2018 to 36% in 2056. Additionally, the proportion of Greater Melbourne within 30 minutes by car from Bundoora is expected to decline from 18% in 2018, to 6% in 2056. A private vehicle commuter travelling from Dandenong to Bundoora in the AM peak is expected experience a travel time increase from around 69 minutes in 2018 to around 93 minutes in 2056.

Figure A- 65: Average private vehicle travel times (minutes) to Bundoora (AM peak), 2018 and 2056

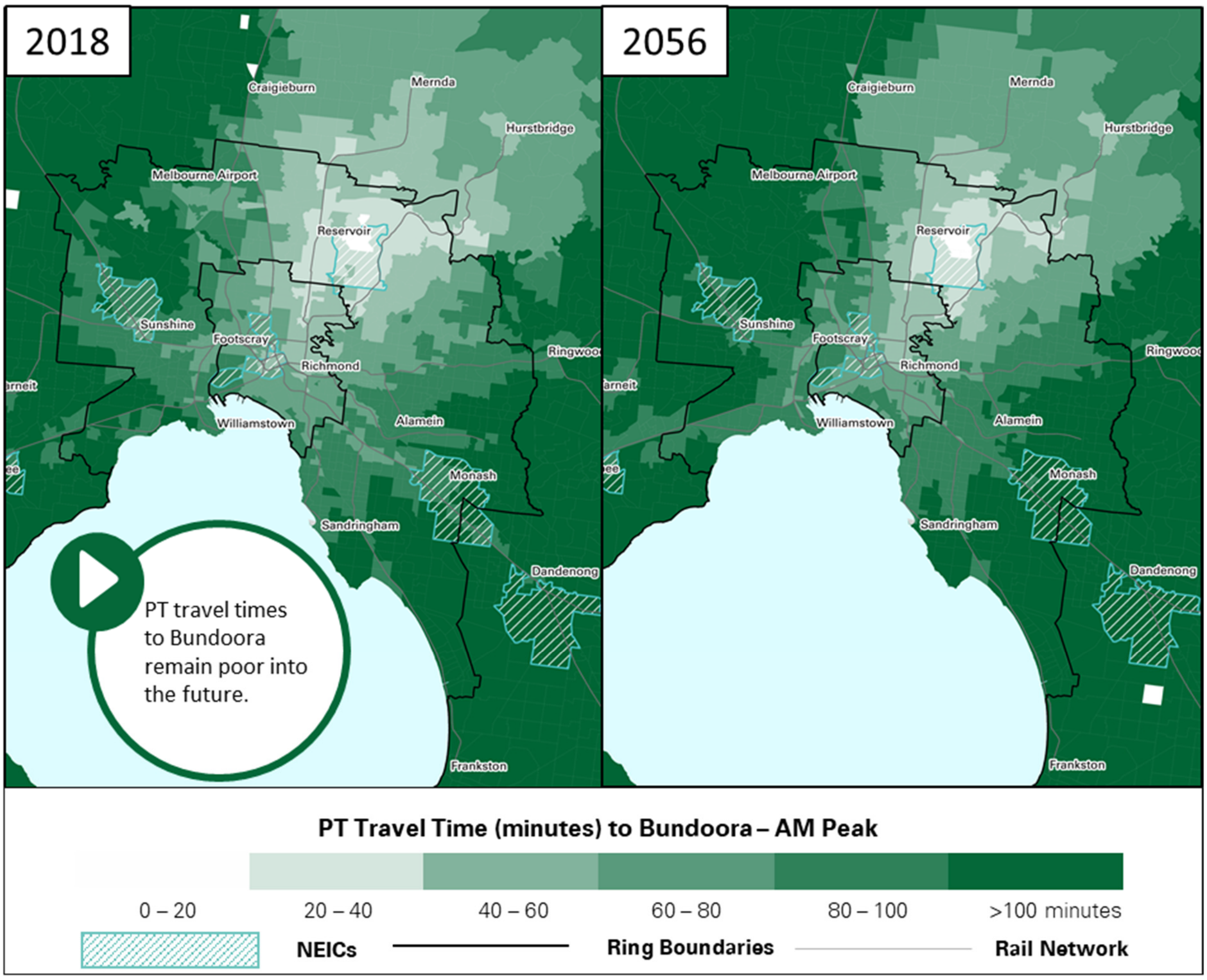


Car travel times to Bundoora increase significantly between 2018 and 2056.

Source: KPMG VITM modelling (no SRL – Cheltenham to Airport)

Figure A- 66 illustrates AM peak public transport travel times to Bundoora in 2018 and 2056. As with Monash, public transport travel times to Bundoora are markedly worse than those seen for private vehicle travel. However public transport accessibility to Bundoora is even more constrained than to Monash, as there is poorer connectivity to rail services, and greater reliance on road-based public transport services. A public transport commuter travelling from Dandenong to Bundoora in the AM peak is expected to experience a travel time increase from around 98 minutes in 2018 to around 110 minutes in 2056.

Figure A- 66: Average public transport travel times (minutes) to Bundoora (AM peak), 2018 and 2056



Source: KPMG VITM modelling (no SRL – Cheltenham to Airport)

A.5.4 Declining accessibility to jobs and education

In the future, the high reliance on central Melbourne is expected to lead to a decrease in accessibility to employment and tertiary education opportunities, notably in the middle and outer ring suburbs.

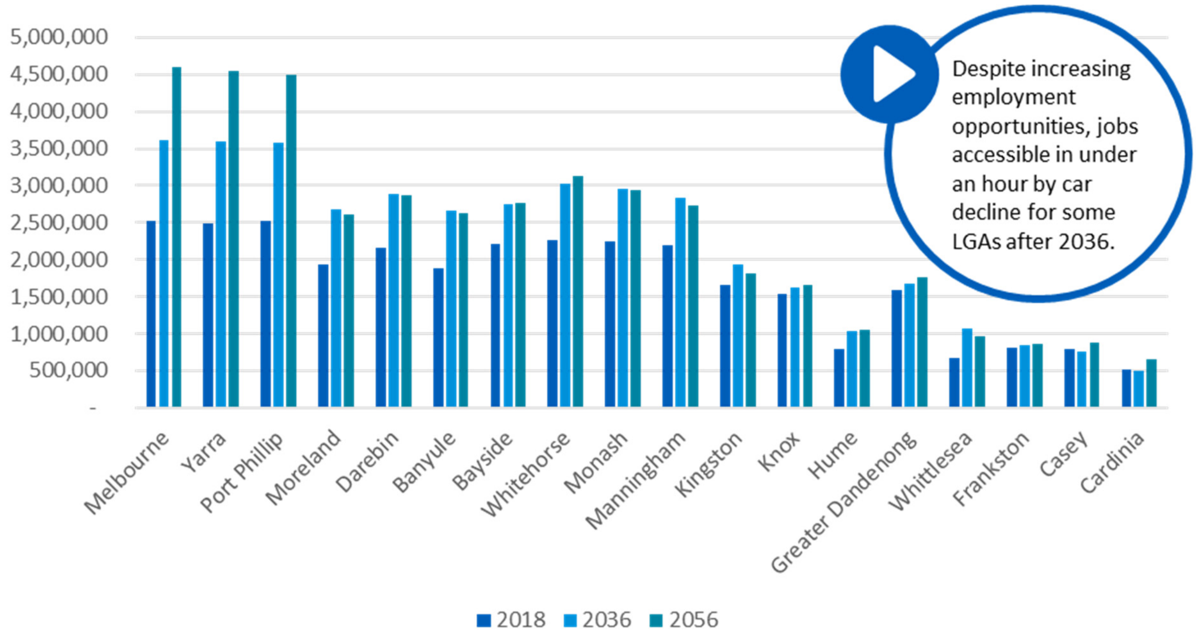
The expected decline in accessibility is driven by higher levels of congestion and public transport crowding. This deterioration is most significant for outer ring suburbs and, as a consequence, further disadvantages those living in lower socio-economic areas.

In contrast, inner city LGAs, which already have very good accessibility to employment and tertiary education opportunities, are expected to continue to enjoy improved accessibility over time as the number of accessible jobs and tertiary enrolment opportunities grow in these areas. Trends in accessibility change over time; they are very different between inner areas of Melbourne and the middle and outer suburbs, furthering the existing inequality.

Accessibility to employment via private vehicle

Figure A- 67 shows the absolute number of employment opportunities accessible by car within 60 minutes[11], from selected LGAs. Accessible opportunities are expected to increase significantly over time from inner LGAs such as Melbourne and Yarra, however accessible opportunities from middle and outer regions are not expected to grow as significantly. Several middle and outer LGAs are also expected to experience a decline in accessible employment opportunities between 2036 and 2056 due to increased congestion and travel times.

Figure A- 67: Number of employment opportunities accessible by private vehicle within 60 minutes, by origin LGA



Despite increasing employment opportunities, jobs accessible in under an hour by car decline for some LGAs after 2036.

Source: KPMG VITM modelling (no SRL – Cheltenham to Airport)

Figure A- 68 shows the proportion of Greater Melbourne employment opportunities accessible by private vehicle within 60 minutes. Despite the absolute number of accessible jobs increasing, as shown in Figure A- 67, the proportion of accessible jobs is expected to decline in the middle and outer suburbs. Between 2018 and 2056, for LGAs such as Bayside, Manningham, Kingston and Monash, the proportion of jobs accessible by car may decrease by a fifth.

The LGAs that experience a decrease in accessibility lie in the middle and outer suburbs of Melbourne, and in areas of a lower socio-economic level such as Greater Dandenong, Hume, Frankston and Whittlesea. In contrast, inner city LGAs are not expected to see such a decrease.

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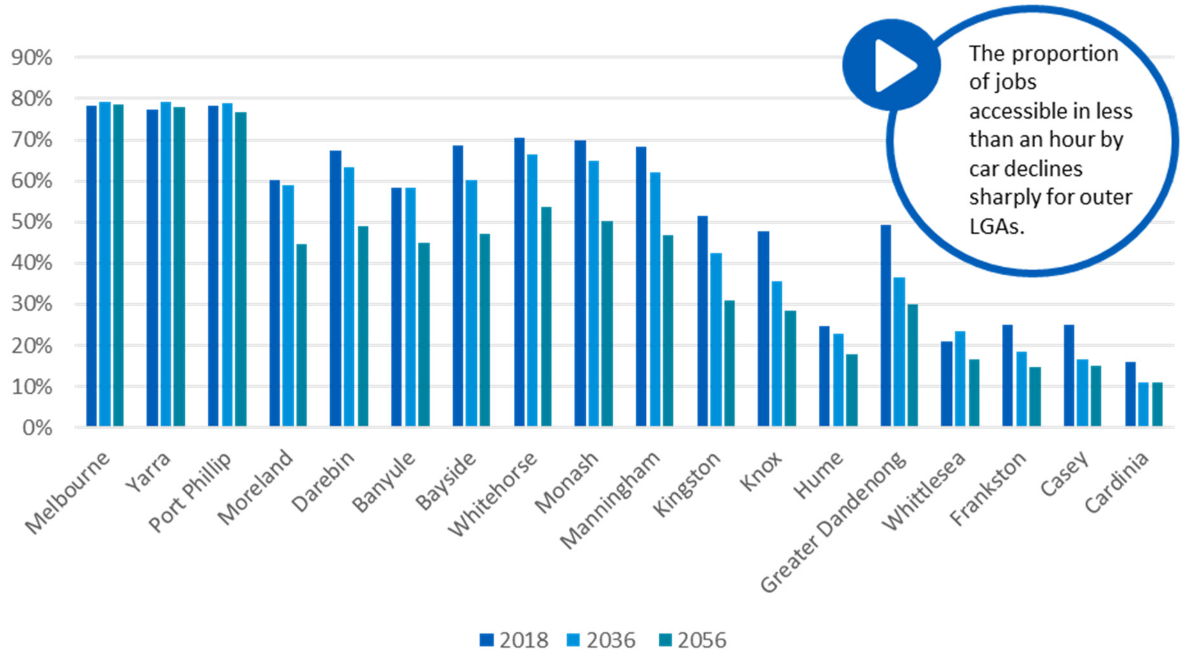
[11] All accessibility metrics in Section A.5.4 are based on modelled AM peak travel times.

Figure A- 68: Proportion of Greater Melbourne employment opportunities accessible by private vehicle within 60 minutes, by origin LGA



The proportion of jobs accessible in less than an hour by car declines sharply for outer LGAs.

Source: KPMG VITM modelling (no SRL – Cheltenham to Airport)

Similar trends can be observed in the case of access to tertiary education opportunities.

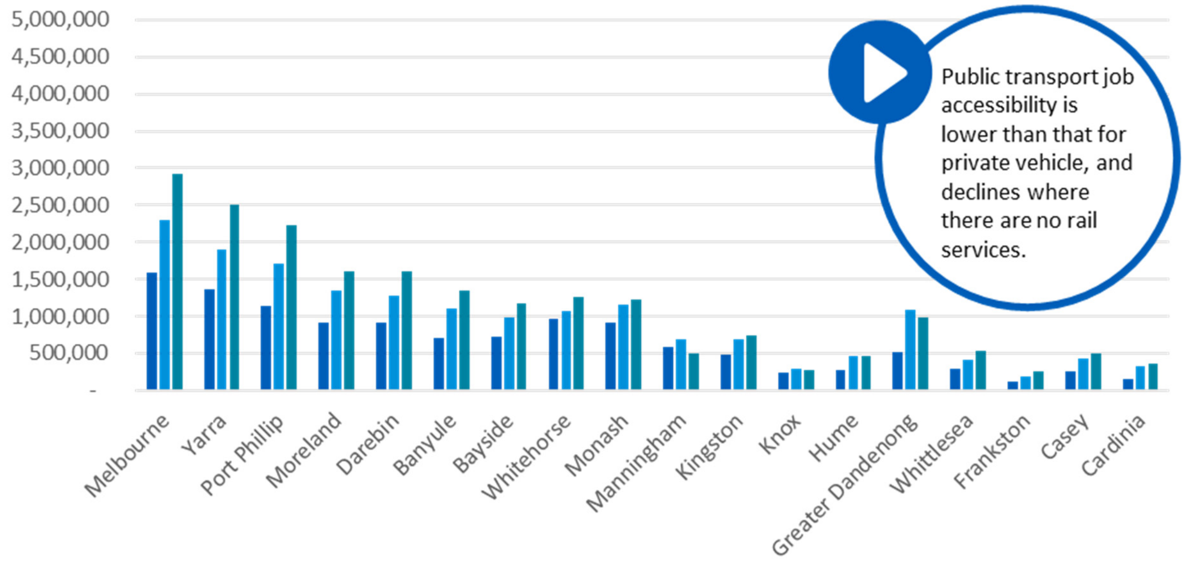
Accessibility to employment via public transport

Across all LGAs, there are fewer jobs accessible by public transport than by private vehicle. In 2018, there are around 30% fewer jobs accessible by public transport than car for many LGAs but, in some extreme cases, such as in Manningham, up to 50% fewer jobs are accessible.

In terms of access to employment by public transport, LGAs that are along existing radial train lines benefit from access to a higher number of employment opportunities. Figure A- 69 shows the absolute number of employment opportunities accessible by public transport within 60 minutes, from selected LGAs. Generally, the number of opportunities increases over time. LGAs closer to the CBD and with train services, such as Maribyrnong, Moreland and Darebin may see an increase over time in the number of jobs accessible by public transport.

However, over time, there are select LGAs that are expected to see a decline in employment opportunities accessible in less than an hour by public transport. Greater Dandenong and Knox are expected to see a decline between 2036 and 2056, while Manningham – heavily reliant on buses for public transport – may see 2056 opportunities fall below 2018 levels.

Figure A- 69: Number of employment opportunities accessible by public transport within 60 minutes, by origin LGA



Public transport job accessibility is lower than that for private vehicle, and declines where there are no rail services.

Source: KPMG VITM modelling (no SRL – Cheltenham to Airport)

Declining accessibility by public transport is expected to have a greater effect on women (ABS, 2008) and young people (ABS, 2012) who are more likely to take public transport [12], [13] A decrease in accessibility to jobs by public transport may impinge on their level of participation in society and rate of productivity.

Similar trends in accessibility can be observed in the case of access to tertiary education opportunities.

Geographical change in accessibility over time

Private vehicle

Figure A- 70 and Figure A- 71 show the change over time in the proportion of total Greater Melbourne jobs accessible by private vehicle in less than 60 minutes. Between 2018 and 2036, a stark decline in jobs accessible by private vehicle is seen in the middle and outer suburbs in the east and south-east. The outer northern and western suburbs are comparatively better off between 2018 and 2036, due to new infrastructure including OMR. However, between 2036 and 2056, a decline in accessible jobs by private vehicle is seen across Greater Melbourne. The decline is most pronounced in the middle

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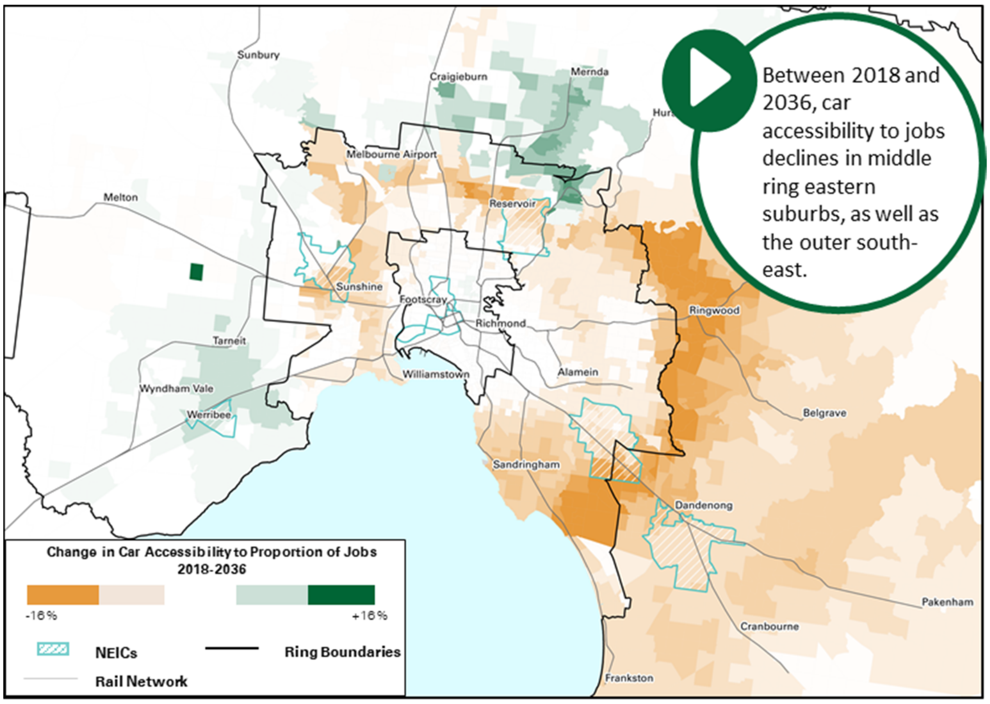
[12] ABS (Australian Bureau of Statistics) – *Australian Social Trends 4102.0 2008,* (2008) p.210 (Chapter: Public transport use for work and study, sub-chapter: Who uses public transport) (Published 2008. Accessed 14 October 2020) https://www.ausstats.abs.gov.au/ausstats/subscriber.nsf/0/DE5DE30C9CF6E5E3CA25748E00126A25/$File/41020_2008.pdf

[13] ABS (Australian Bureau of Statistics) – *Household Water and Energy Use 4602.2, Victoria, October 2011,* (2012) (Chapter 4: Public Transport, sub-chapter: Persons who used public transport in the last month) (Published 2012. Accessed 14 October 2020) https://www.abs.gov.au/ausstats/abs@.nsf/Lookup/4602.2Chapter500October%202011

suburbs. Inner suburbs have a steady proportion of accessible jobs through time, compared to middle and outer suburbs. Similar trends can be observed for access to tertiary education opportunities.

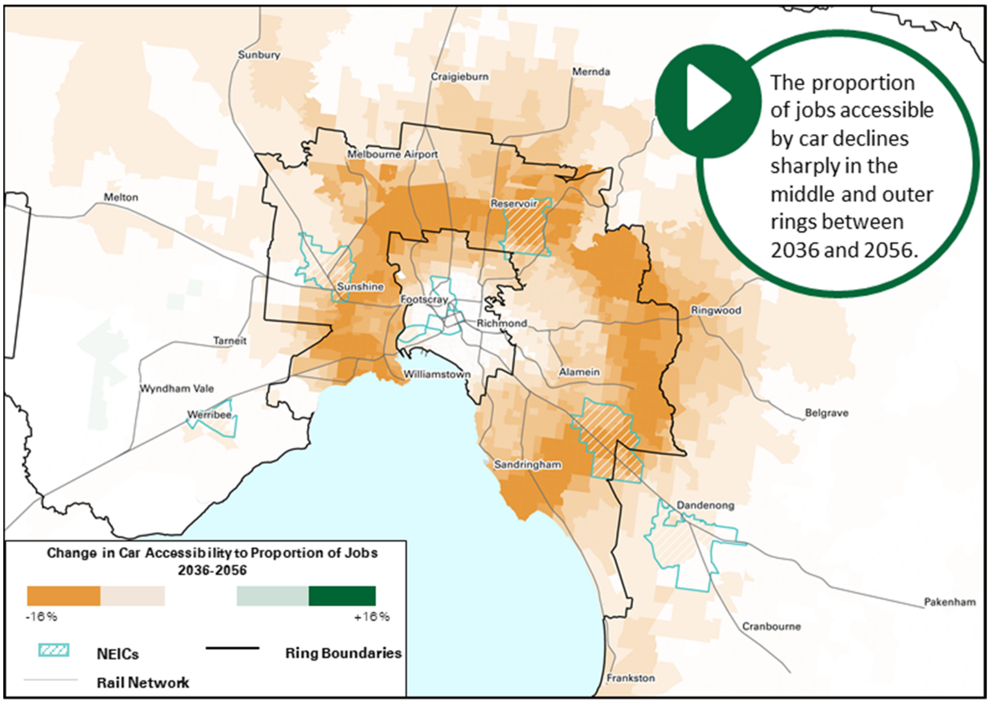
Figure A- 70: Change in proportion of employment accessible within 60 minutes by private vehicle between 2018 and 2036



Between 2018 and 2036, car accessibility to jobs declines in middle ring eastern suburbs, as well as the outer south-east.

Source: KPMG VITM modelling (no SRL – Cheltenham to Airport)

Figure A- 71: Change in proportion of employment accessible within 60 minutes by private vehicle between 2036 and 2056



The proportion of jobs accessible by car declines sharply in the middle and outer rings between 2036 and 2056.

Source: KPMG VITM modelling (no SRL – Cheltenham to Airport)

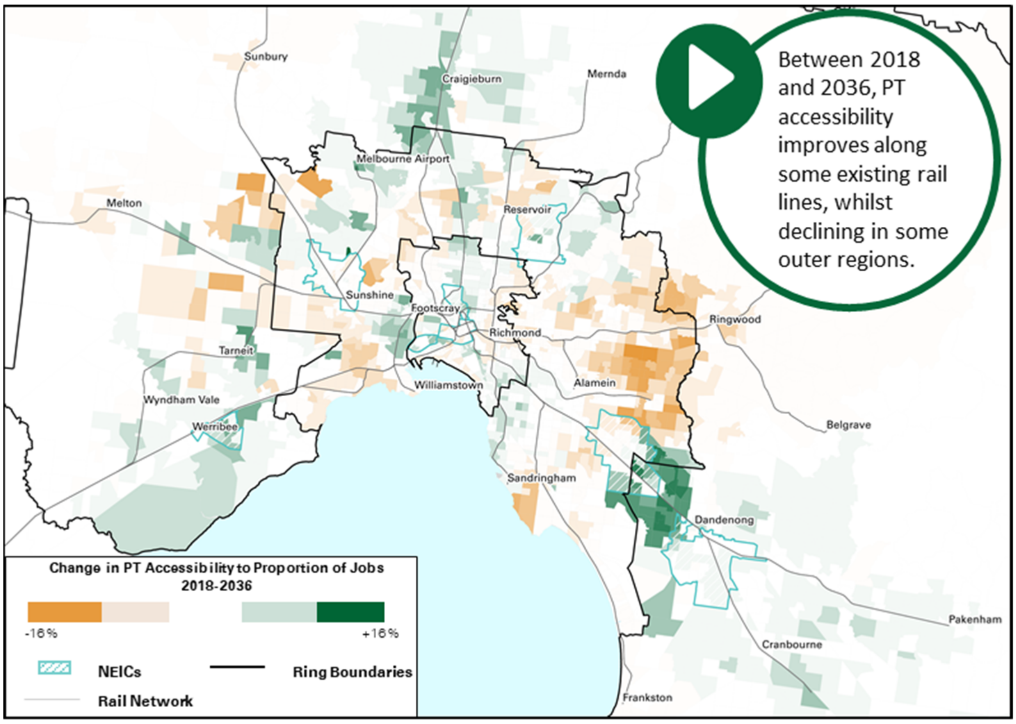
Public transport

Figure A- 72 and Figure A- 73 show the change over time in the proportion of jobs accessible by public transport in less than 60 minutes. Between 2018 and 2036, some areas, including Greater Dandenong and the northern growth areas, are expected to see an improvement in accessibility to jobs by public transport, driven by new rail infrastructure including the Metro Tunnel Project. However, the middle ring suburbs in the east of Melbourne, which are more heavily dependent on buses, are expected to see a decline.

Between 2036 and 2056, there is expected to be a significant decrease in accessibility in the Greater Dandenong, Wyndham, Moreland and Manningham LGAs. Generally, inner suburbs are not expected to experience as significant a decrease in accessibility, as opposed to the middle and outer suburbs.

Similar trends can be observed for access to tertiary education opportunities.

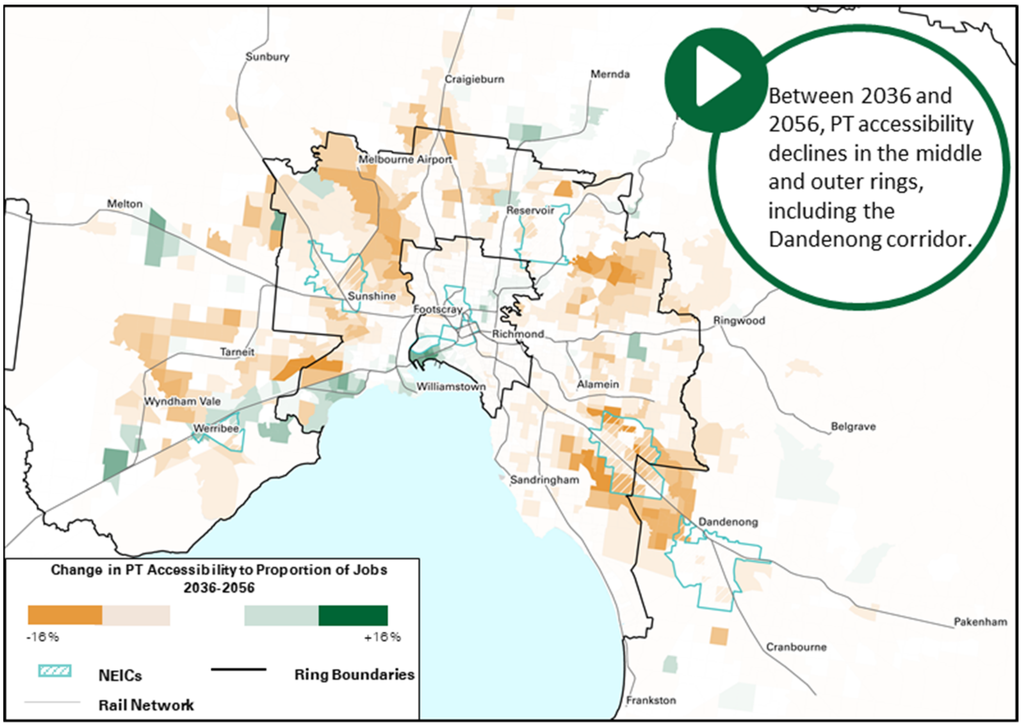
Figure A- 72: Change in proportion of employment accessible within 60 minutes by public transport between 2018 and 2036



Between 2018 and 2036, PT accessibility improves along some existing rail lines, whilst declining in some outer regions.

Source: KPMG VITM modelling (no SRL – Cheltenham to Airport)

Figure A- 73: Change in proportion of employment accessible within 60 minutes by public transport between 2036 and 2056



Between 2036 and 2056, PT accessibility declines in the middle and outer rings, including the Dandenong corridor.

Source: KPMG VITM modelling (no SRL – Cheltenham to Airport)

A.5.5 Deteriorating performance of the road network

Melbourne's public transport network is focussed around the CBD, with the radial rail network catering primarily for people moving between the suburbs and the central city. However, only 16% of jobs across Melbourne are located in the central city.[14] With a lack of alternatives, many Melburnians are reliant on car travel to access jobs outside of the central city, and with significant population growth forecast, congestion issues are expected to get worse throughout Greater Melbourne.

Volume/capacity ratios

Figure A- 74 shows volume/capacity ratios on Melbourne's road network in 2018 and 2056. In 2018, a number of major roads are already at or exceeding capacity, with congestion across the city, including localised congestion in the inner and middle sections of the eastern and northern suburbs. In these areas, buses are often the only public transport option available, and as bus travel speeds remain low given the impact of road congestion, there is increasing reliance on car trips further exacerbating congestion.

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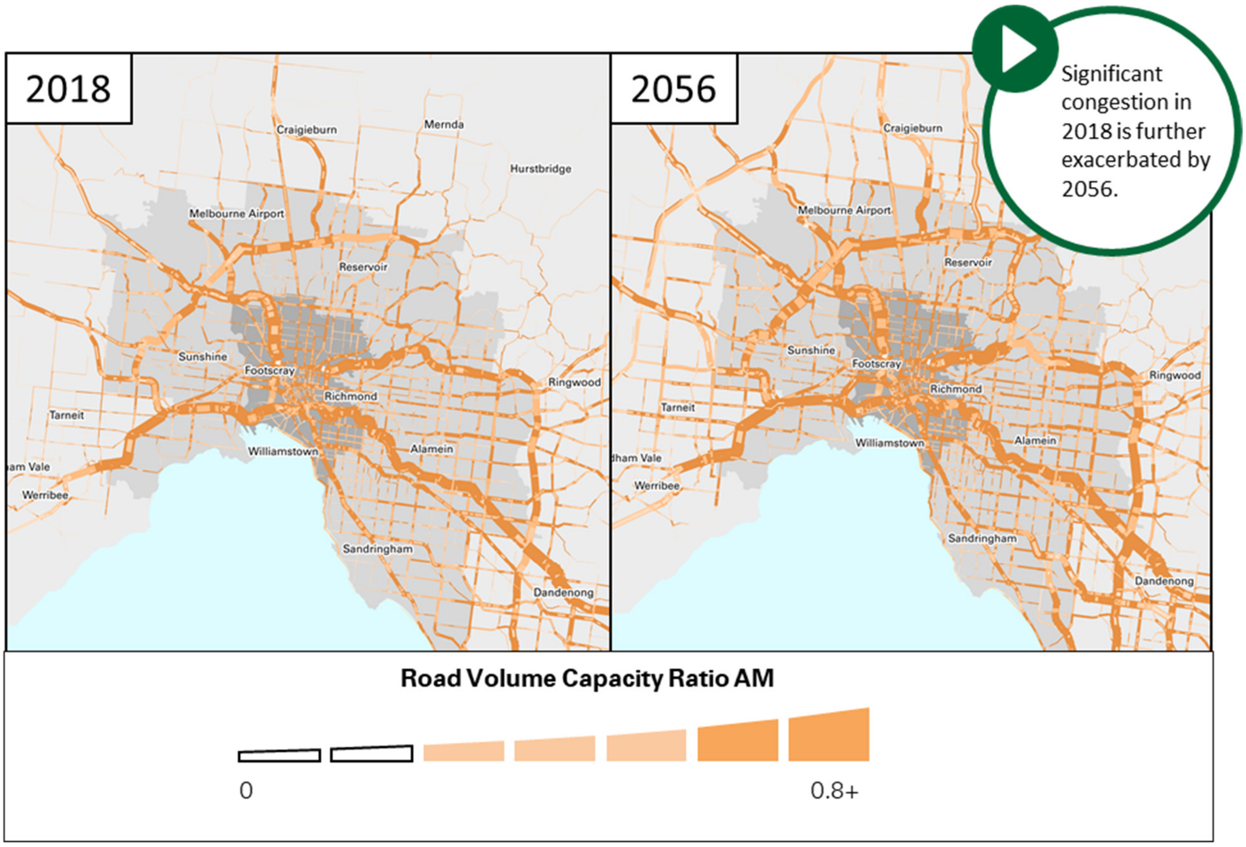
[14] Australian Bureau of Statistics, Census of Population and Housing, Employed Persons, Place of Work, (2016).

Figure A- 74: Volume/capacity ratios on major roads (AM peak), 2018 and 2056



Significant congestion in 2018 is further exacerbated by 2056.

Source: KPMG VITM modelling (no SRL – Cheltenham to Airport)

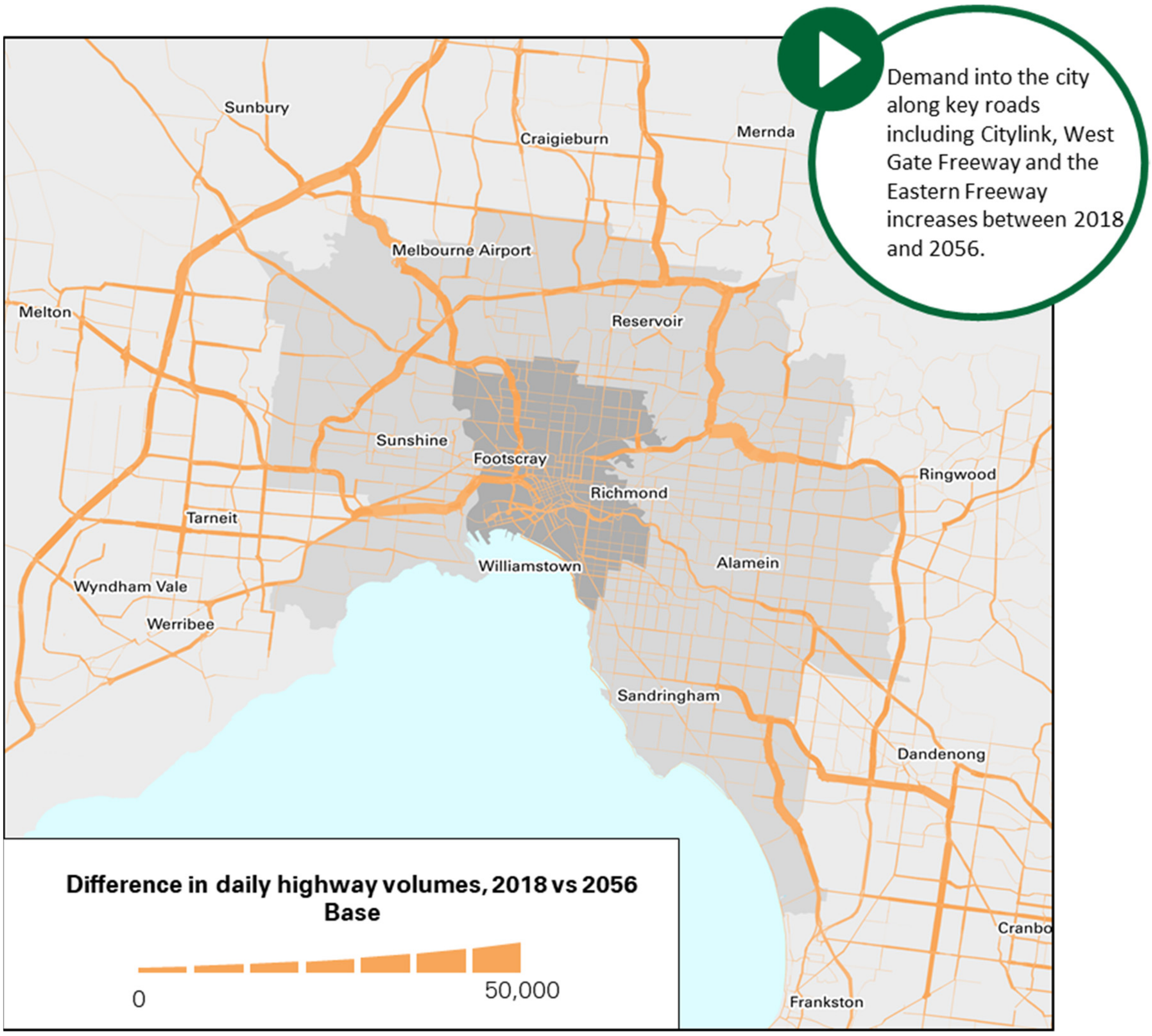
Despite the introduction of major road projects, including OMR and NELP, road congestion is expected to continue to worsen through to 2056. Many roads may reach or exceed capacity as population growth and reliance on private vehicle transport continues. Major freeways such as the Monash are expected to already be near or at capacity at 2018, with volumes projected to exceed capacity on inner south-east sections of the Monash. This amplified congestion is expected to increase road network travel times, and reduce road network reliability, leading to decreased accessibility across the network.

Highway volumes

Figure A- 75 illustrates the increase in daily vehicle volumes on major roads between 2018 and 2056, and indicates that highway congestion is increasing significantly. In particular, Melbourne's freeway network is anticipated to experience large increases in traffic in both directions due to high reliance on private vehicle travel.

In particular, orbital routes such EastLink, the Western Ring Road and OMR are expected to experience higher volumes, suggesting demand for orbital travel around Melbourne will increase in the future.

Figure A- 75: Difference in highway volumes (daily), 2018 and 2056



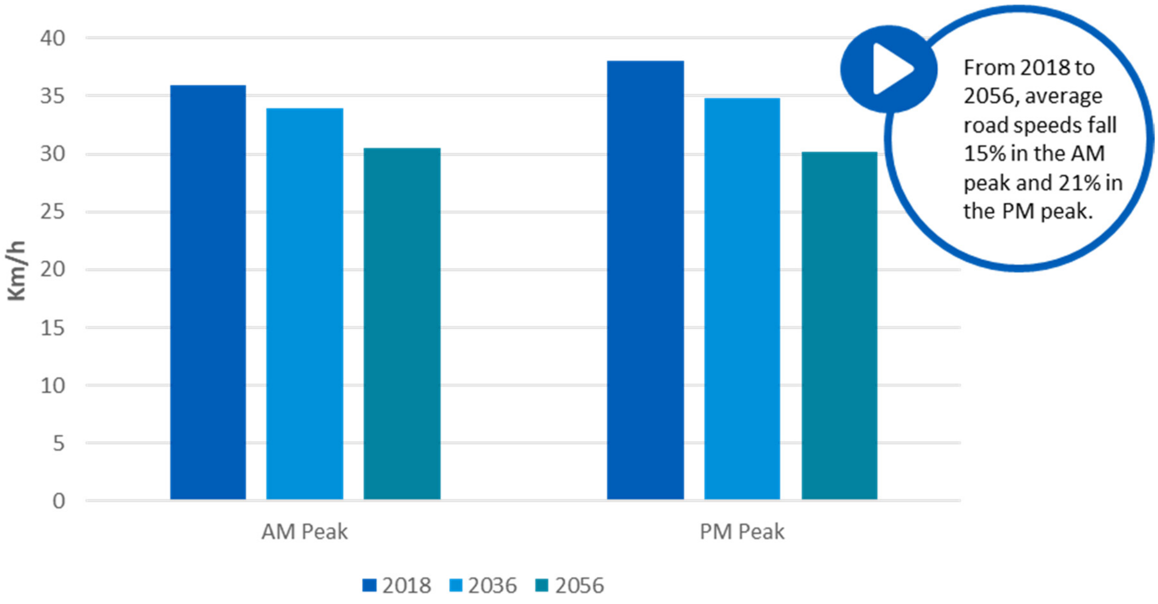
Demand into the city along key roads including Citylink, West Gate Freeway and the Eastern Freeway increases between 2018 and 2056.

Source: KPMG VITM modelling (no SRL – Cheltenham to Airport)

Average road network speeds

The increase in road volumes throughout time results in a decline in average road network speeds across Greater Melbourne. This is most evident in the peak periods, where volumes and congestion are at their worst. AM peak average speeds fall from 36 km/h in 2018 to 31 km/h in 2056, whilst PM peak average speeds fall from 38 km/h to 30 km/h. Decreasing road speeds across the network reflect longer travel times, as congestion increases.

Figure A- 76: Average Greater Melbourne road network speeds



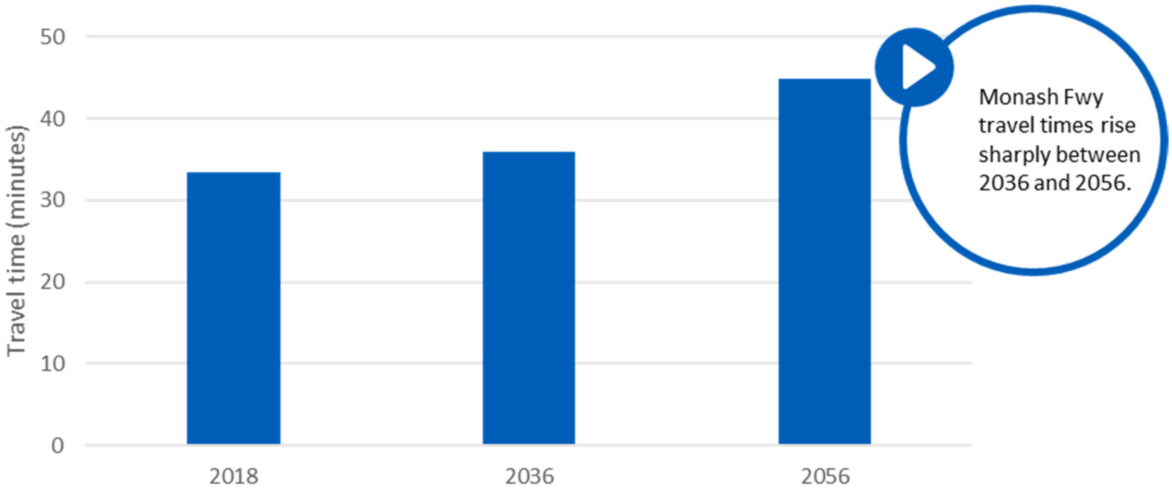
From 2018 to 2056, average road speeds fall 15% in the AM peak and 21% in the PM peak.

Source: KPMG VITM modelling (no SRL – Cheltenham to Airport)

Travel times on the Monash Freeway

The Monash Freeway is one of Melbourne's most critical freeways, providing the key link between the south-eastern suburbs to employment and education centres, and the CBD, which is vital to the economic productivity of Melbourne. At its busiest point, the Monash carries over 110,000 vehicles in a single direction each day in 2018, with this rising to over 130,000 in 2056. The increase in volumes is driven by population growth, including in the south-eastern growth areas of Melbourne. Figure A- 77 illustrates travel times on the Monash Freeway between Springvale Road and the Domain Tunnel, in the AM peak. The widening of some sections of the Monash offsets the projected volume increases between 2018 and 2036 to a degree, with travel times increasing from 33 minutes in 2018 to 36 minutes in 2036. However, in 2056 the travel time is expected to increase to 45 minutes.

Figure A- 77: Travel times on the Monash Freeway between Springvale Road and the Domain Tunnel, AM peak



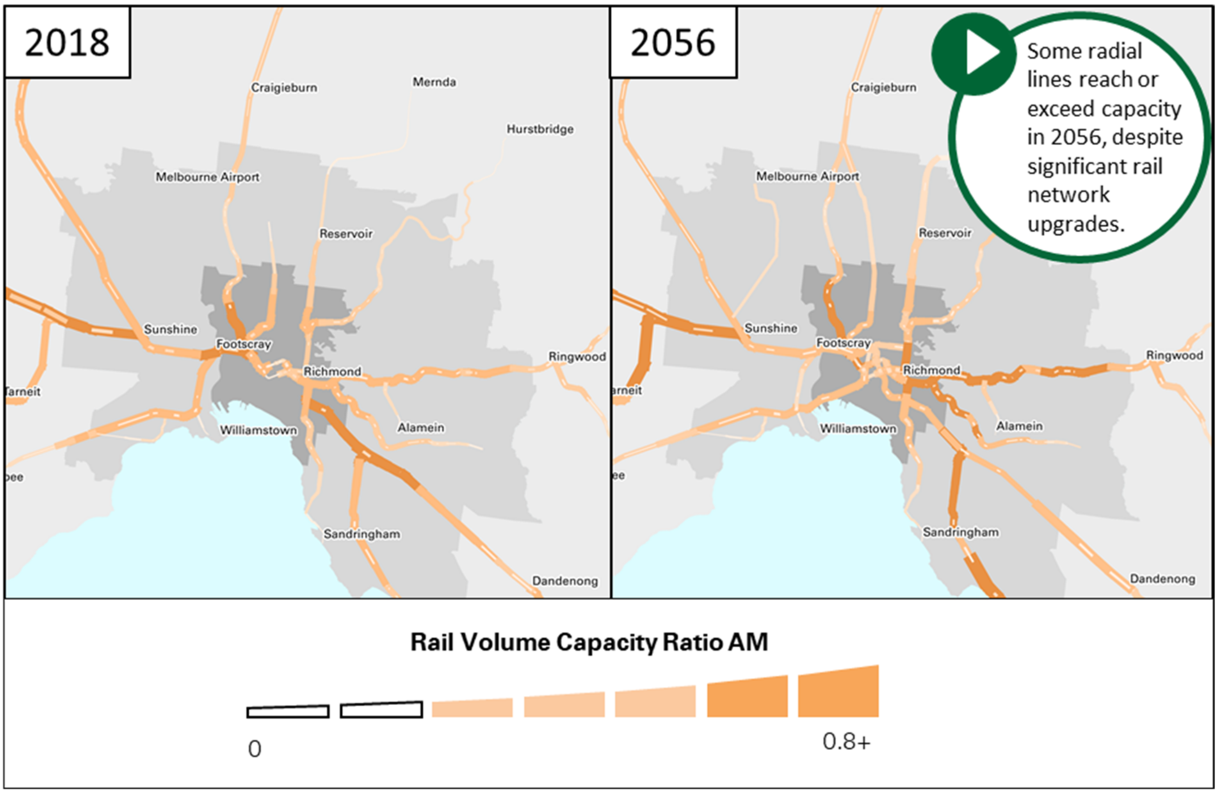
Monash Fwy travel times rise sharply between 2036 and 2056.

Source: KPMG VITM modelling (no SRL – Cheltenham to Airport)

A.5.6 More crowding on existing rail lines

Melbourne's current radial train network already experiences significant capacity constraints, which may worsen over time. Figure A- 78 depicts rail volume/capacity[15] ratios in the AM peak in 2018 and 2056. Many lines, including Melton, Sunbury, Frankston and Cranbourne have volume/capacity ratios over 0.8 in 2018, indicating that commuters on these lines are travelling in crowded conditions.

Figure A- 78: Volume/capacity ratios on radial train lines (AM peak), 2018 and 2056



Some radial lines reach or exceed capacity in 2056, despite significant rail network upgrades.

Source: KPMG VITM modelling (no SRL – Cheltenham to Airport)

Between 2018 and 2056, significant rail network upgrades are included in the modelling, including MTP, MAR, and MM2. However, this additional rail network capacity does not keep pace with the growing transport demands of the city, and rail network congestion is expected to increase. Volume/capacity ratios on many lines such as Frankston, Belgrave, Lilydale and Glen Waverley are expected to increase between 2018 and 2056, with volumes approaching or exceeding capacity on some sections of the lines.

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[15] Capacities are defined by the load standard, which is a desired operating assumption for passenger loading. The load standard is calculated as four passengers per square metre, plus seated capacity.

A.6 A future with SRL - Cheltenham to Airport

This section presents VITM modelling results for Program Case Option A to illustrate the effect of SRL – Cheltenham to Airport on travel patterns, accessibility and network performance. The specifications, including sequencing of Option A, are outlined in Section 3.6 as well as Section A.4.2 of this report. The modelling conducted for Option A incorporates land use assumptions derived from CityPlan modelling, as presented in Volume B of this report. Results presented correspond to either 2036 (completion of SRL East) or 2056 (completion of SRL – Cheltenham to Airport).

VITM modelling was also conducted for Program Case Option B, following specifications outlined in Section A.4.2, representing earlier timing for the construction of SRL – Cheltenham to Airport. Within the represented years of 2036 and 2056, both Option A and Option B are at the same point of completion, namely SRL East is complete in 2036 and SRL – Cheltenham to Airport is complete in 2056 – therefore for these years, results from Option B modelling closely mirror Option A results. Therefore, for the majority of the following sections, Option A results are presented in detail, with some select comparisons to Option B results shown in Table A - 40 and Figure A- 79.

A.6.1 Increased public transport use

Network-wide public transport trips

SRL – Cheltenham to Airport will have a significant impact on how people move around Greater Melbourne, generating a change in where people live and work (discussed in Volume B of this report) as well as improving public transport access in suburban Melbourne. As shown in Table A - 40, the completion of SRL – Cheltenham to Airport in 2056 under Option A is expected to increase public transport trips by over 230,000 per day, as well as reduce private vehicle use by over 600,000 trips per day. Similar reductions are expected for Option B.

Between 2036 and 2056, the compound annual growth rate (**CAGR**) of PT trips is 1.9% under Base Case conditions, and 2.1% under Program Case conditions. The similarity between CAGRs highlights that PT trip growth between 2036 and 2056 is driven predominantly by underlying demand for PT, with the slightly higher CAGR in the Program Case driven by the difference in land use and SRL – Cheltenham to Airport alignments between 2036 and 2056.

Table A - 40: Public transport and private vehicle trips for Greater Melbourne, Base Case vs. Program Case

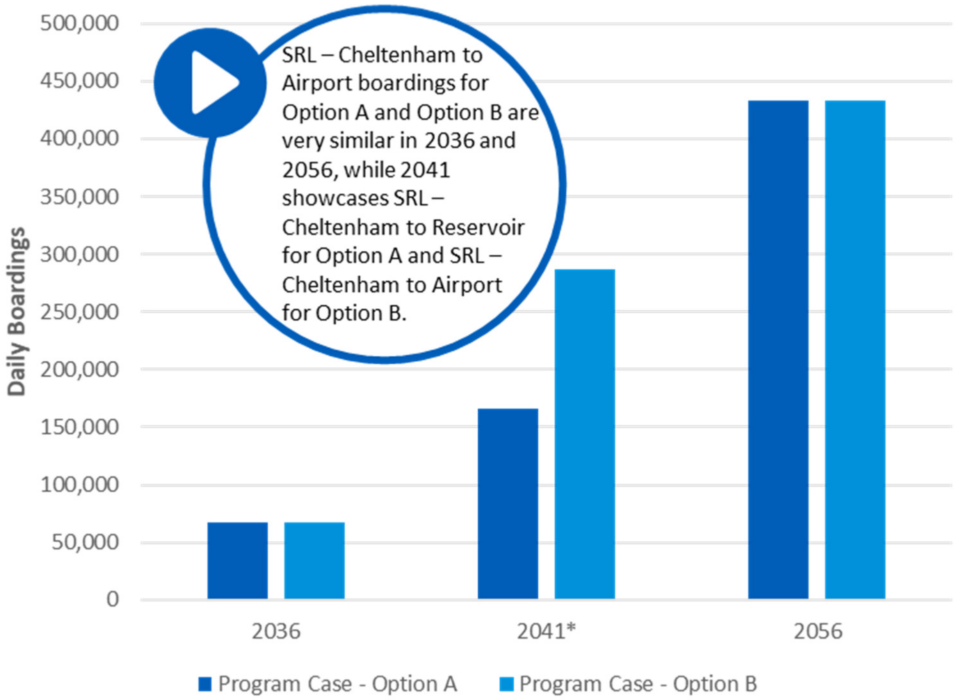
	2036			2056		
	Base Case	**Program Case Option A**	**Program Case Option B**	**Base Case**	**Program Case Option A**	**Program Case Option B**
Private vehicle	20,473,000	20,402,000	20,399,000	26,803,000	26,197,000	26,209,000
Public transport	2,281,000	2,335,000	2,335,000	3,294,000	3,530,000	3,537,000
PT mode share	10.0%	10.3%	10.3%	10.9%	11.9%	11.9%

Source: KPMG VITM modelling (with SRL – Cheltenham to Airport)

SRL – Cheltenham to Airport patronage

VITM modelling shows strong demand for SRL – Cheltenham to Airport, with demand steadily increasing from SRL East opening in 2036 to the completion of SRL – Cheltenham to Airport in 2056. With Melbourne's monocentric focus, this high demand showcases the ability to shift towards more orbital travel as well as strong demand for public transport. As shown in Figure A- 79, SRL East, under both Option A and Option B, attracts around 70,000 boardings a day in 2036, and the completion of SRL – Cheltenham to Airport to the airport in 2056 increases boardings to over 430,000 under Option A and Option B. This is more than double the present day Ringwood Line, which was the busiest train line in 2018 with 170,000 daily boardings. This emphasises the importance of constructing the full loop from Cheltenham to Melbourne Airport in order to achieve the desired outcomes of SRL – Cheltenham to Airport.

Figure A- 79: Daily SRL – Cheltenham to Airport boardings, Option A[16] and Option B[17]



SRL – Cheltenham to Airport boardings for Option A and Option B are very similar in 2036 and 2056, while 2041 showcases SRL – Cheltenham to Reservoir for Option A and SRL – Cheltenham to Airport for Option B.

***2041 is representative of the relative patronage forecasted for 2043. Under Option A in 2043, the section between Box Hill to Reservoir opens and therefore SRL - Cheltenham to Reservoir patronage for 2041 Option A has been presented. Under Option B in 2043, the section between Reservoir to Airport opens and therefore SRL – Cheltenham to Airport patronage for 2041 Option B has been presented.**

Source: KPMG VITM modelling (with SRL – Cheltenham to Airport)

Figure A- 80 and Figure A- 81 show how boardings on SRL – Cheltenham to Airport are distributed across the line, as well as the splits in access mode to the stations. Box Hill and Clayton attract the

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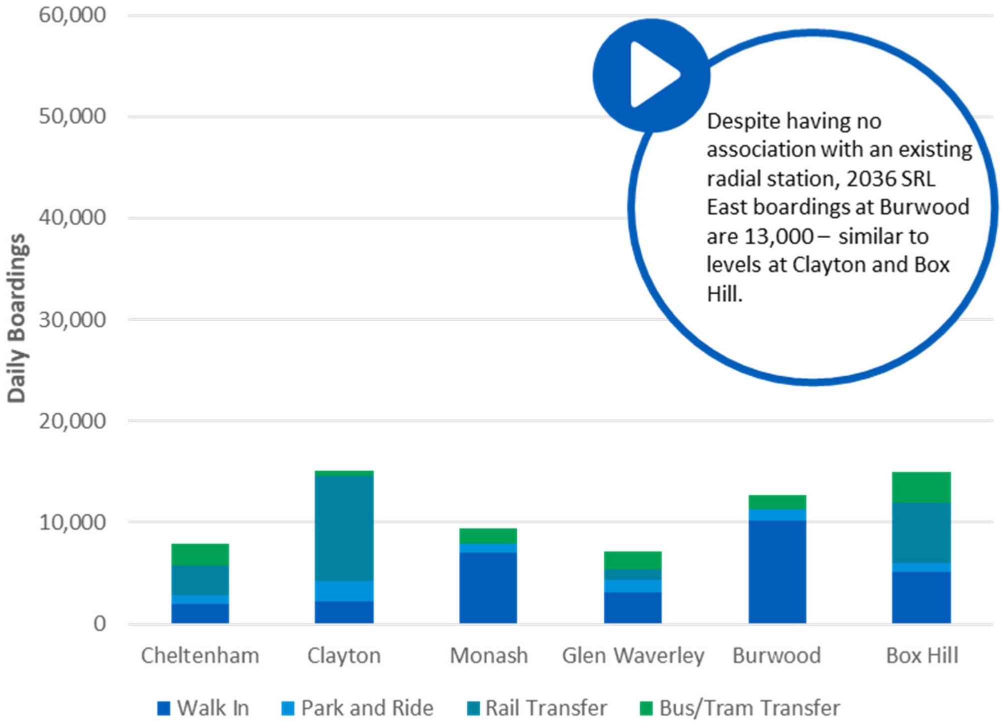
[16] Option A modelling incorporates the Cheltenham to Box Hill section in 2031 and 2036, the Box Hill to Reservoir section in 2041, and the Reservoir to Melbourne Airport section in 2051 and 2056.
[17] Option B modelling incorporates the Cheltenham to Box Hill section in 2031 and 2036, and the SRL – Cheltenham to Airport alignment in 2041, 2051 and 2056.

highest number of boardings, with Box Hill's 58,000 boardings in 2056 comparable to the number of boardings seen at Melbourne Central in 2018.

As well as increasing public transport usage, SRL – Cheltenham to Airport also shifts station access mode towards transfers and walk-ins, and away from park and ride. In 2056, 50% of boardings occur via walk-ins while 30% are rail transfers, and only 5% via park and ride.

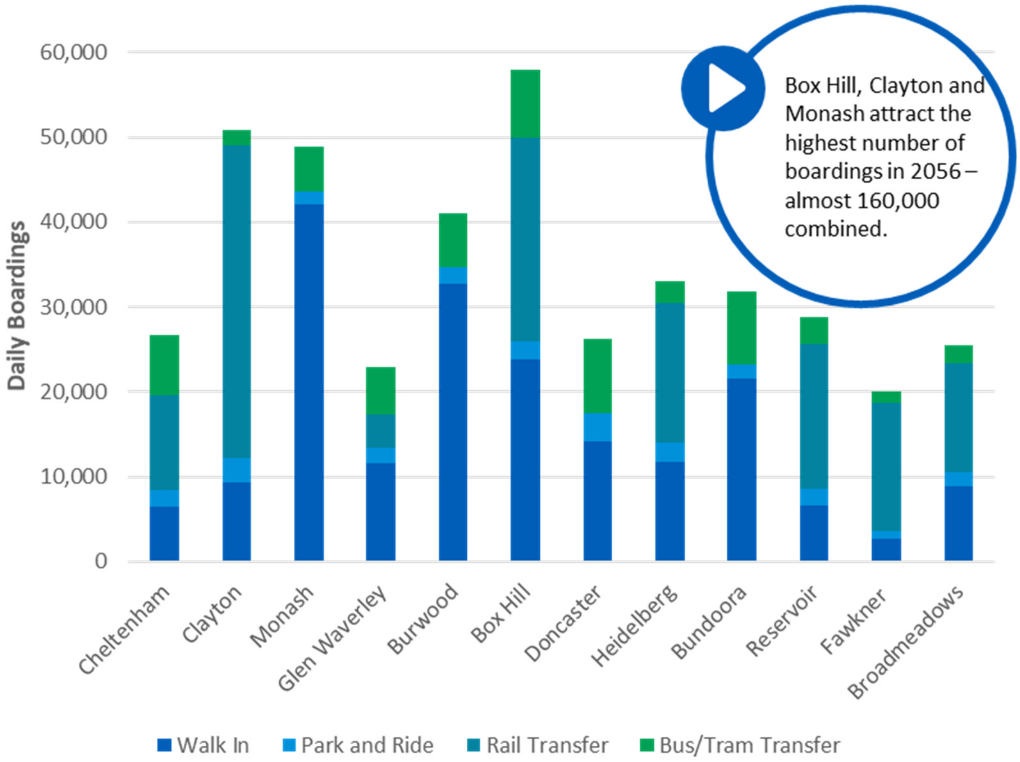
Figure A- 80: Daily SRL East boardings, 2036



Despite having no association with an existing radial station, 2036 SRL East boardings at Burwood are 13,000 – similar to levels at Clayton and Box Hill.

Source: KPMG VITM modelling (with SRL – Cheltenham to Airport)

Figure A- 81: Daily SRL – Cheltenham to Airport boardings, 2056



Box Hill, Clayton and Monash attract the highest number of boardings in 2056 – almost 160,000 combined.

Source: KPMG VITM modelling (with SRL – Cheltenham to Airport)

Figure A- 82 and Figure A- 83 illustrate line load profiles for SRL – Cheltenham to Airport[18], for the anti-clockwise and clockwise services respectively. In 2056, the highest daily loads for anti-clockwise services are seen between Burwood and Box Hill, where total passengers exceed 95,000. For clockwise services, the highest daily loads are seen between Box Hill and Burwood, where total passengers again exceed 95,000.

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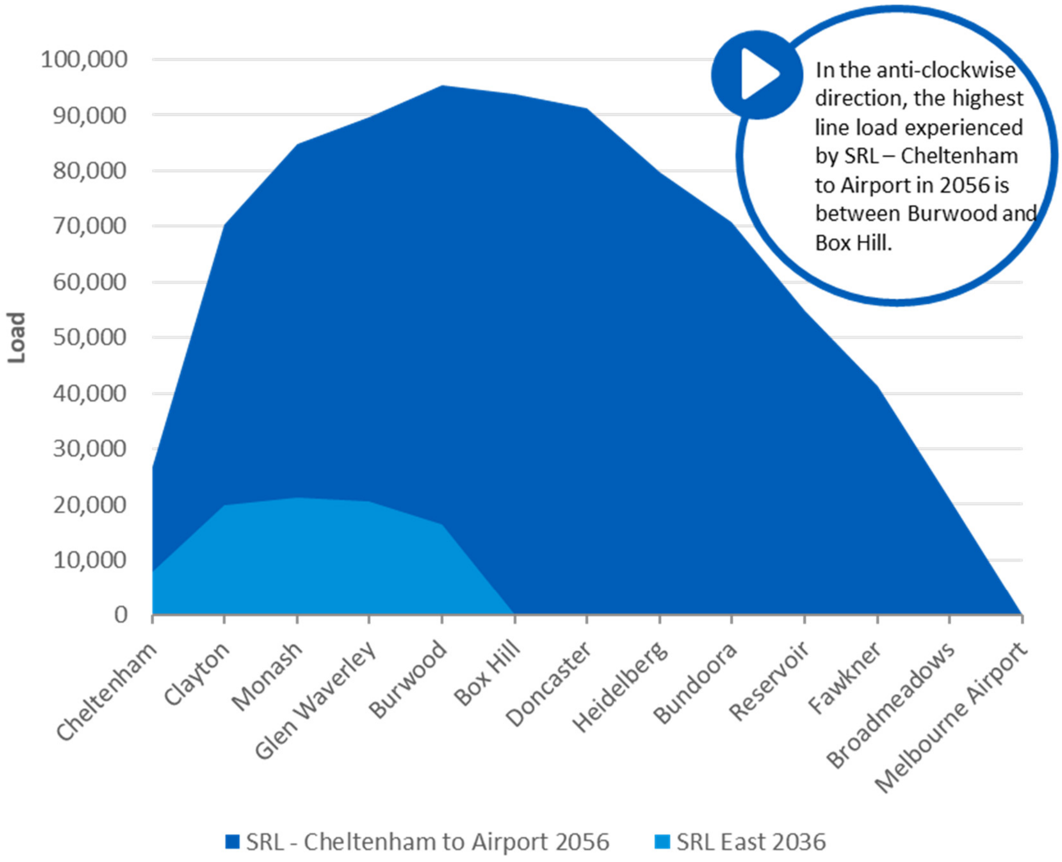
[18] Daily loads represent the total number of passengers on SRL – Cheltenham to Airport services departing the corresponding station.

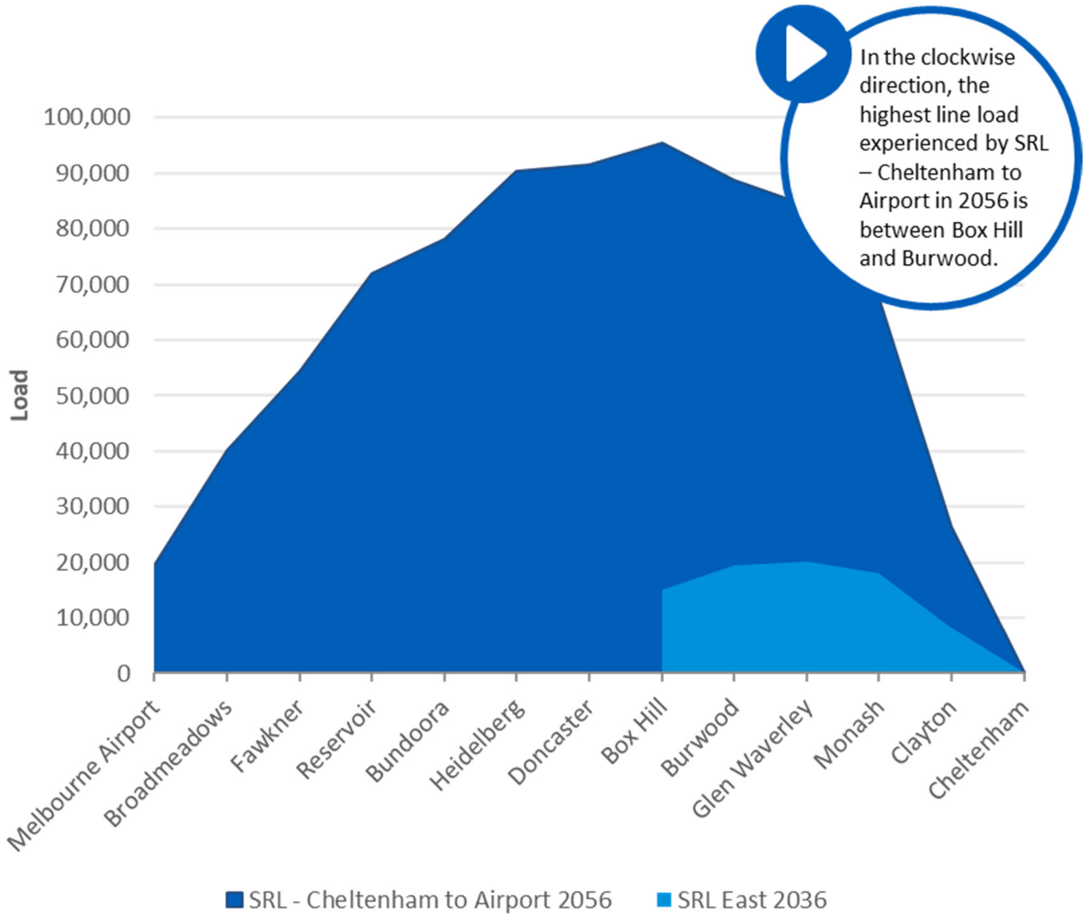
Figure A- 82: Daily SRL – Cheltenham to Airport line loads (anti-clockwise)



In the anti-clockwise direction, the highest line load experienced by SRL – Cheltenham to Airport in 2056 is between Burwood and Box Hill.

Source: KPMG VITM modelling (with SRL – Cheltenham to Airport)

Figure A- 83: Daily SRL – Cheltenham to Airport line loads (clockwise)



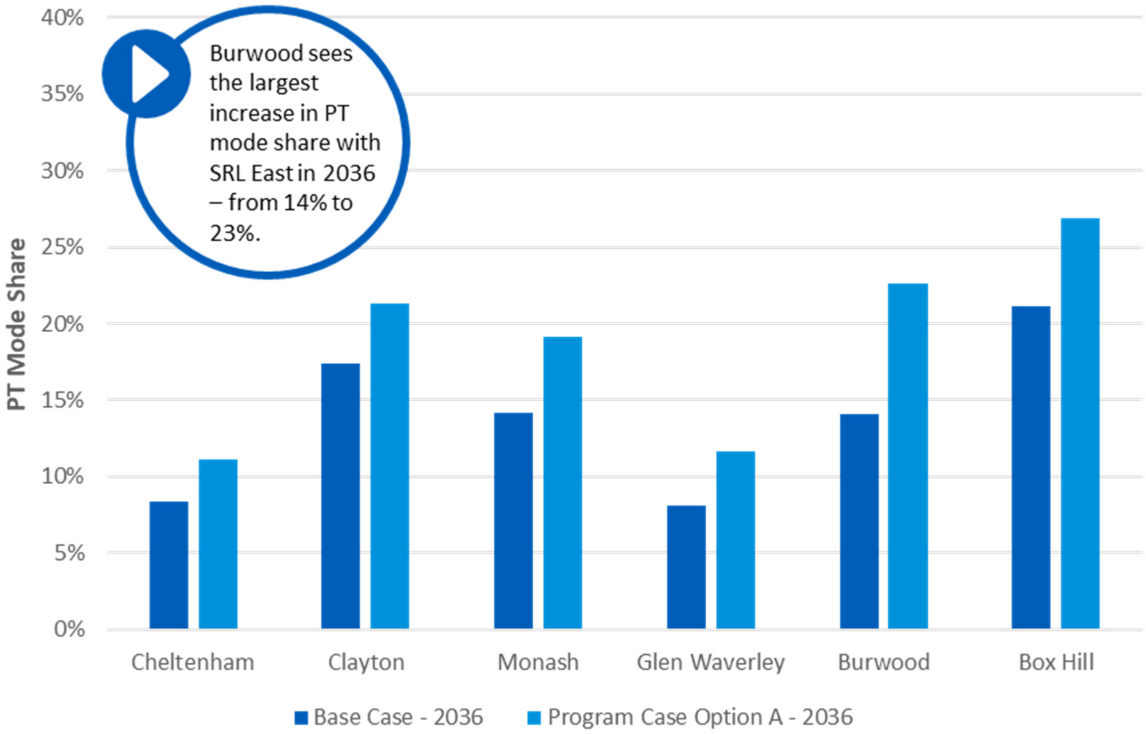
In the clockwise direction, the highest line load experienced by SRL – Cheltenham to Airport in 2056 is between Box Hill and Burwood.

Source: KPMG VITM modelling (with SRL – Cheltenham to Airport)

Public transport mode share in SRL East and SRL North Precincts

The shift towards public transport that accompanies the introduction of SRL – Cheltenham to Airport is shown in Figure A- 84 (2036) and Figure A- 85 (2056), which outline public transport mode share for trips ending in the precincts. With the introduction of SRL – Cheltenham to Airport in 2056, all precincts along the line see an increase in PT mode share. For some precincts, including Clayton, Monash, Burwood and Bundoora, there is a significant increase in absolute public transport mode share of over 10% generated by SRL – Cheltenham to Airport.

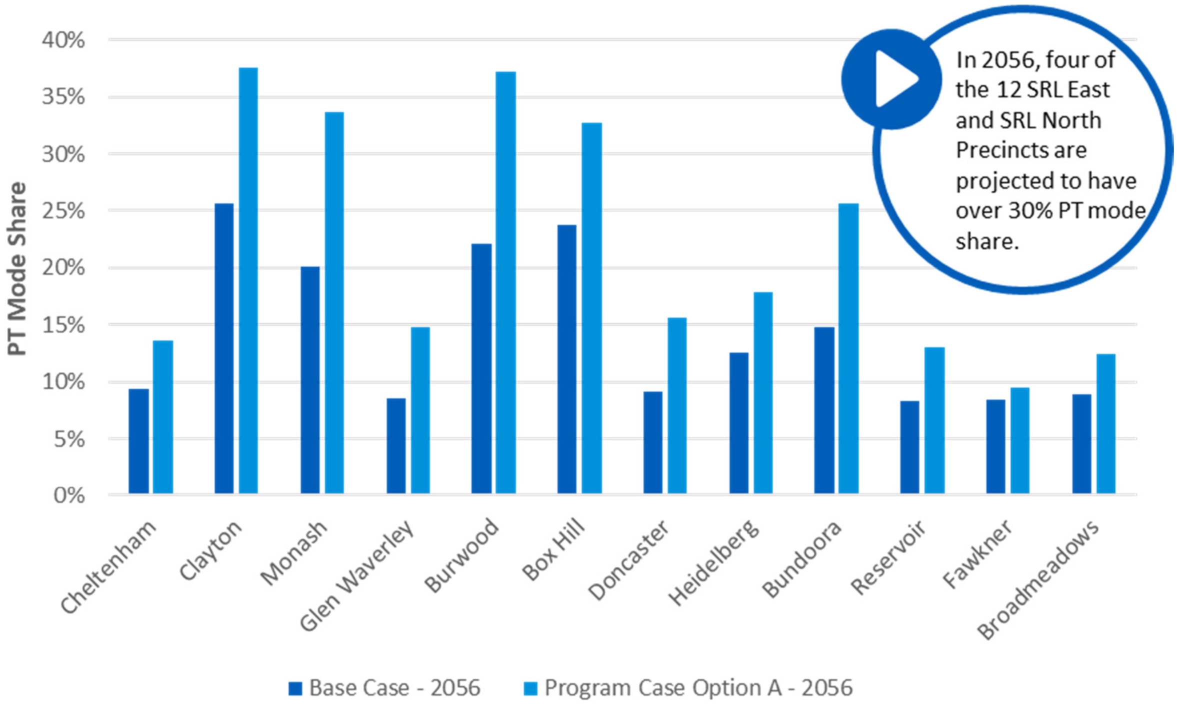
Figure A- 84: AM Peak public transport mode share, 2036



Burwood sees the largest increase in PT mode share with SRL East in 2036 – from 14% to 23%.

Source: KPMG VITM modelling (with SRL – Cheltenham to Airport)

Figure A- 85: AM Peak public transport mode share, 2056



In 2056, four of the 12 SRL East and SRL North Precincts are projected to have over 30% PT mode share.

Source: KPMG VITM modelling (with SRL – Cheltenham to Airport)

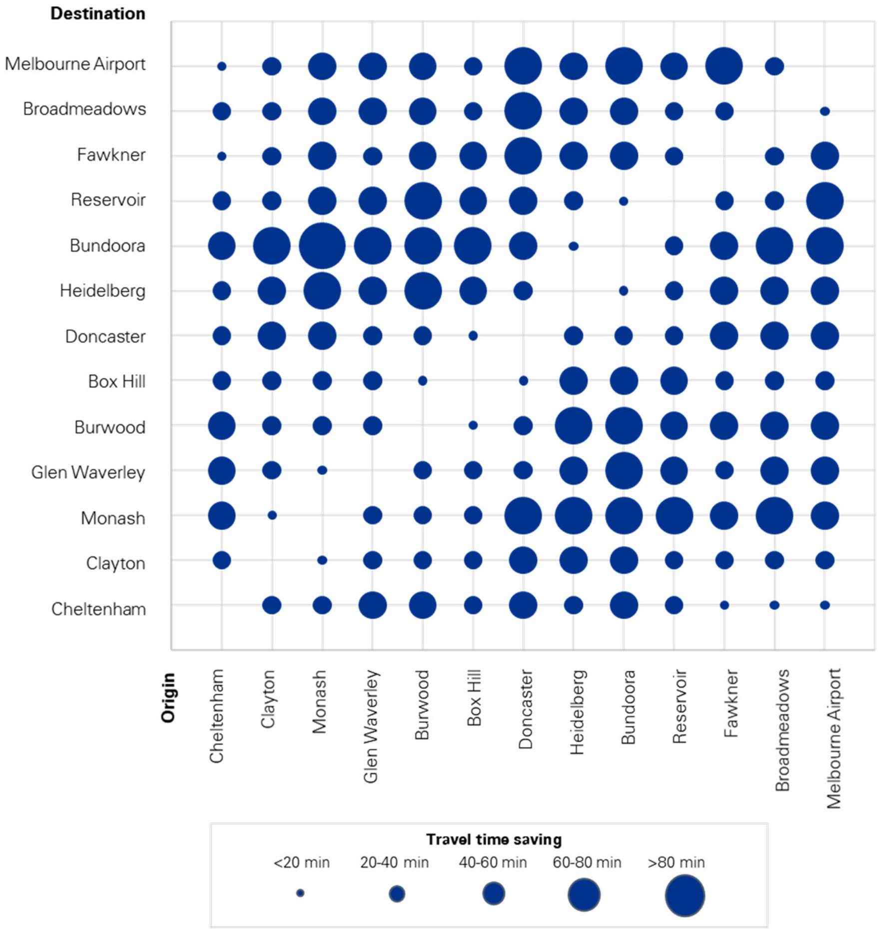
A.6.2 Shorter travel times for Melbourne's middle and outer suburbs

By providing a high frequency, heavy rail link through the middle suburbs of Melbourne, travel times to and from Melbourne's middle and outer suburbs shorten with SRL – Cheltenham to Airport. In particular, with SRL – Cheltenham to Airport providing an alternative to buses, orbital public transport travel times markedly reduce.

Public transport travel times between SRL East and SRL North Precincts

Figure A- 86 illustrates the public transport travel time savings[19] that SRL – Cheltenham to Airport is anticipated to create between SRL East and SRL North Precincts. Travel between all SRL East and SRL North Precincts shortens, with the greatest reduction to and from areas without pre-existing rail connections, such as Bundoora and Monash.

Figure A- 86: Public transport travel time savings (minutes) between SRL East and SRL North Precincts (AM peak), Base Case vs. Program Case, 2056



Source: KPMG VITM modelling (with SRL – Cheltenham to Airport)

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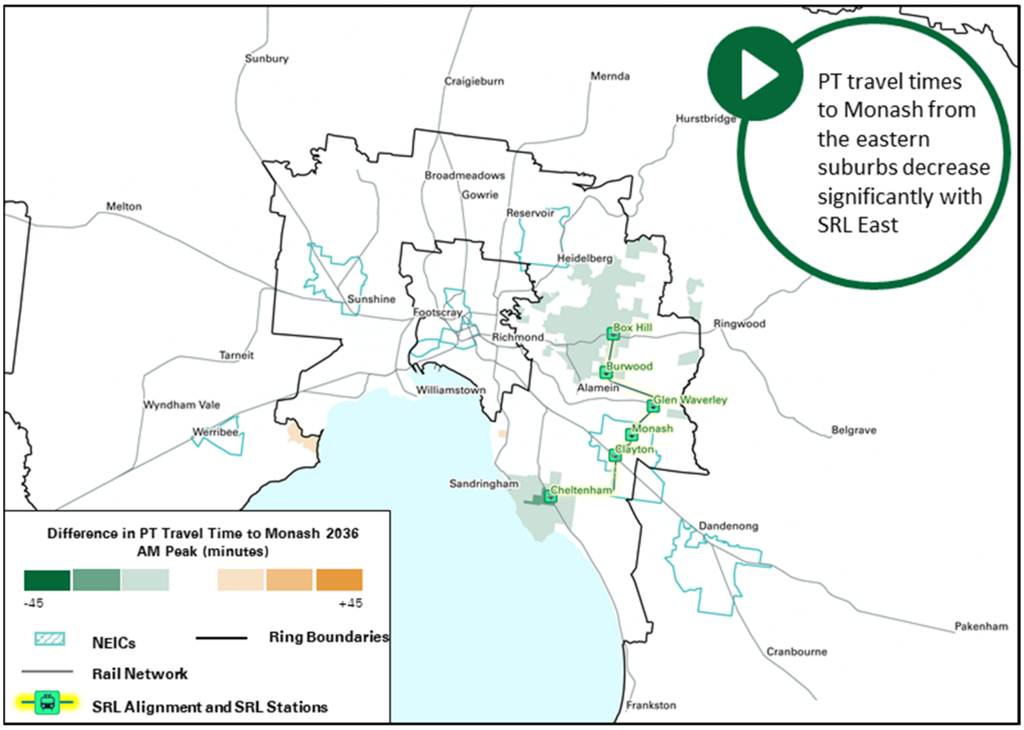
[19] Travel times for Figure A- 75 are based on travel times between individual VITM travel zones which best represent the proposed SRL East and SRL North station location within each precinct.

Public transport travel times to Monash with SRL – Cheltenham to Airport

2036 (SRL East)

Figure A- 87 illustrates the difference in AM peak public transport travel times to Monash in 2036, between the Base Case and Option A (completion of SRL East only). SRL East reduces public transport travel times to Monash for the eastern suburbs. Areas such as Box Hill and Doncaster, which were previously limited to buses for direct public transport to Monash, now have a rail link for all or part of the journey. The proportion of Greater Melbourne within 60 minutes of Monash via public transport increases from 27% to 30%. A public transport commuter travelling from Box Hill to Monash in the AM peak is expected to see their travel time decrease from around 57 minutes with no SRL East, to around 33 minutes with SRL East.

Figure A- 87: Difference in public transport travel times (minutes) to Monash (AM peak), Base Case vs. Program Case, 2036

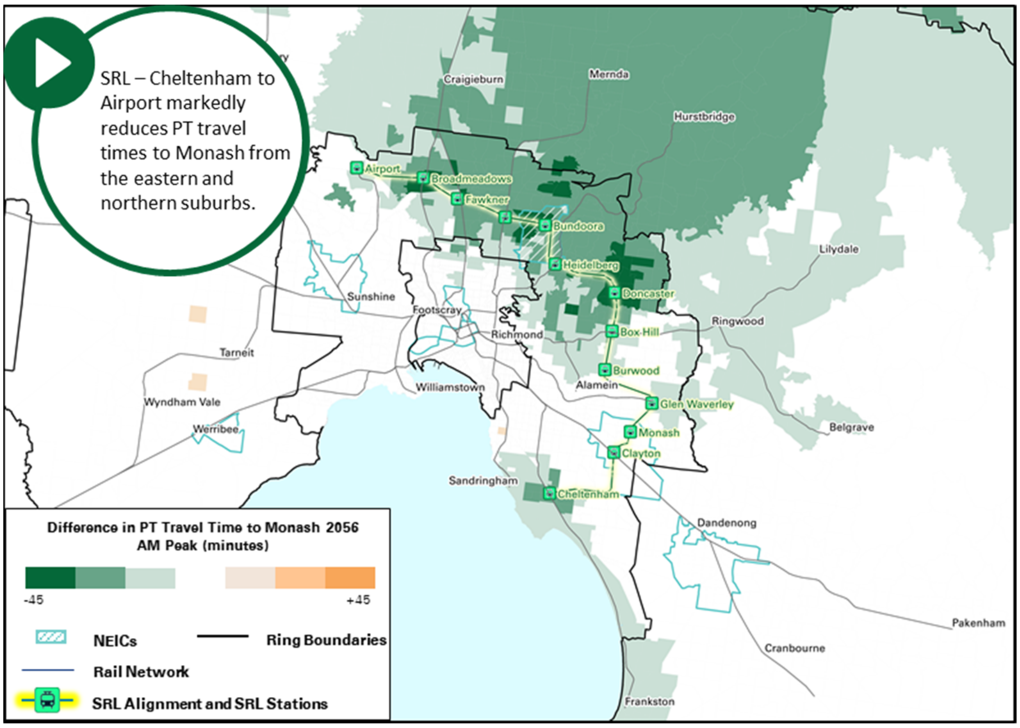


Source: KPMG VITM modelling (with SRL East)

2056 (SRL – Cheltenham to Airport)

Figure A- 88 illustrates the difference in AM peak public transport travel times to Monash in 2056, between the Base Case and Option A (completion of SRL – Cheltenham to Airport). The connectivity provided by SRL – Cheltenham to Airport results in travel times to Monash reducing significantly across vast swathes of the middle and outer northern suburbs of Melbourne. The proportion of Greater Melbourne within 90 minutes of Monash via public transport increases from 55% to 75%. Additionally, the proportion of Greater Melbourne within 60 minutes of Monash increases from 22% to 31%. A public transport commuter travelling from Broadmeadows to Monash in the AM peak is expected to see their travel time decrease from around 103 minutes with no SRL – Cheltenham to Airport, to around 56 minutes with SRL – Cheltenham to Airport.

Figure A- 88: Difference in public transport travel times (minutes) to Monash (AM peak), Base Case vs. Program Case, 2056



SRL – Cheltenham to Airport markedly reduces PT travel times to Monash from the eastern and northern suburbs.

Source: KPMG VITM modelling (with SRL – Cheltenham to Airport)

Figure A- 89 illustrates the difference in AM peak public transport travel times from selected LGAs to Monash in 2056, between the Base Case and Option A. Significant falls are seen for northern and eastern LGAs, with travel times from northern growth area LGAs Hume and Whittlesea falling by around one-third – from over 100 minutes to around 70 minutes. A 46% drop in travel times is forecast for Manningham, an LGA lacking rail service without SRL – Cheltenham to Airport.

Figure A- 89: Difference in public transport travel times (minutes) from selected LGAs to Monash (AM peak), Base Case vs. Program Case, 2056

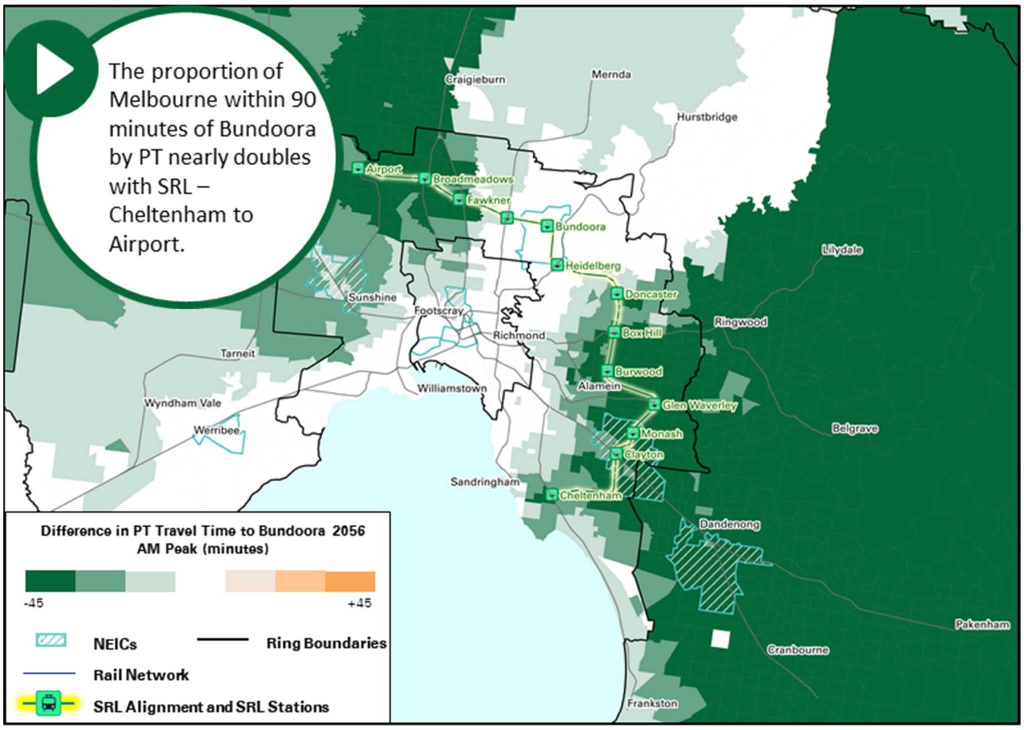
Source: KPMG VITM modelling (with SRL – Cheltenham to Airport)

Public transport travel times to Bundoora with SRL – Cheltenham to Airport

2056 (SRL – Cheltenham to Airport)

Figure A- 90 illustrates the difference in AM peak public transport travel times to Bundoora in 2056, between the Base Case and Option A. SRL – Cheltenham to Airport brings about a significant reduction in public transport travel times to Bundoora, by providing an interconnected rail link to an area only served by buses and trams in the Base Case. Travel times to Monash reduce from the vast majority of Greater Melbourne, most significantly in the eastern and north-western suburbs. The proportion of Greater Melbourne within 90 minutes of Bundoora increases from 33% to 78%. Additionally, the proportion of Greater Melbourne within 60 minutes of Bundoora increases from 10% to 30%. A public transport commuter travelling from Dandenong to Bundoora in the AM peak is expected to see their travel time decrease from around 110 minutes to around 65 minutes with SRL – Cheltenham to Airport.

Figure A- 90: Difference in public transport travel times (minutes) to Bundoora (AM peak), Base Case vs. Program Case, 2056



The proportion of Melbourne within 90 minutes of Bundoora by PT nearly doubles with SRL – Cheltenham to Airport.

Source: KPMG VITM modelling (with SRL – Cheltenham to Airport)

Figure A- 91 illustrates the difference in AM peak public transport travel times from selected LGAs to Bundoora in 2056, between the Base Case and Option A. Significant falls are forecast for travel to Bundoora from the east and north-west of Melbourne, with travel times from Hume falling from 112 minutes to 54 minutes – a 52% decrease. Prominent decreases are also expected for trips from Monash, Whitehorse and Greater Dandenong in the east and south-east.

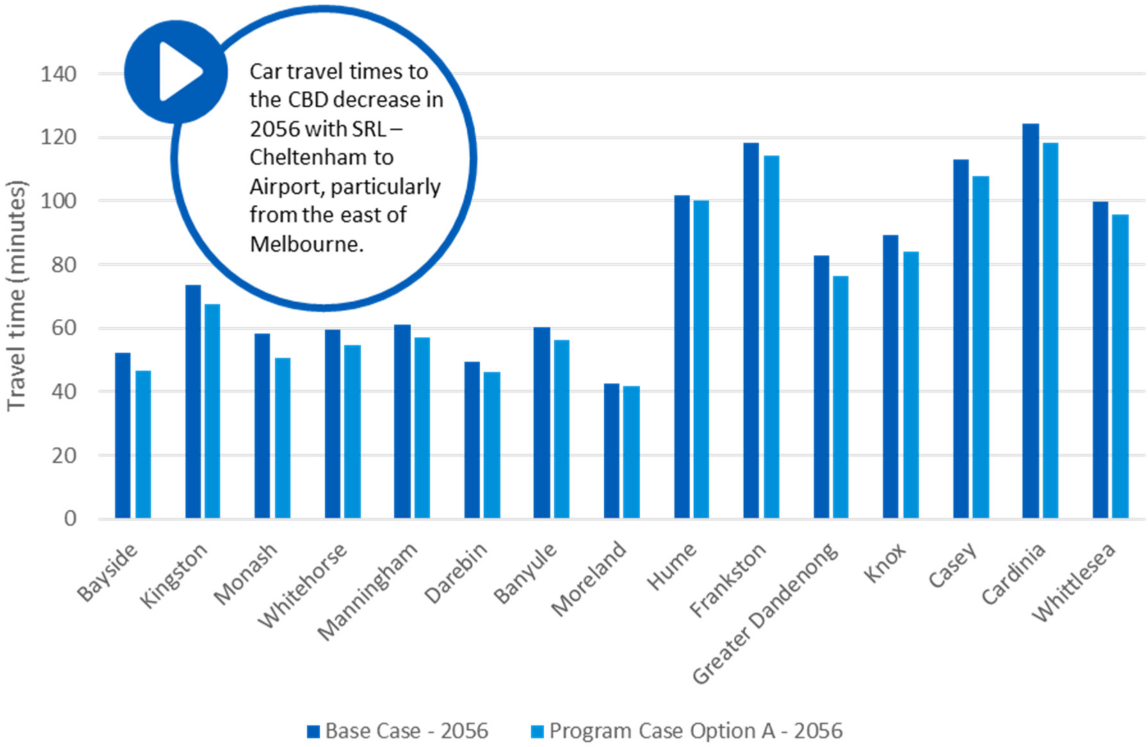
Figure A- 91: Difference in public transport travel times (minutes) from selected LGAs to Bundoora (AM peak), Base Case vs. Program Case, 2056

Source: KPMG VITM modelling (with SRL – Cheltenham to Airport)

Private vehicle travel times to the CBD for work

As well as improving public transport travel times for orbital travel, SRL – Cheltenham to Airport has the effect of reducing road travel times, particularly for radial travel on key highways and freeways. This is brought about through shifts towards public transport and orbital travel, reducing congestion on radial highways and freeways, and accordingly reducing travel times. Figure A- 92 shows average car travel times to the CBD for work, from middle and outer suburban LGAs in the north and east of Melbourne, in 2056. All selected LGAs are forecast to improve with SRL – Cheltenham to Airport, particularly those in the east of Melbourne.

Figure A- 92: Average private vehicle travel times (minutes) to CBD jobs (AM peak), Base Case vs. Program Case, 2056



Source: KPMG VITM modelling (with SRL – Cheltenham to Airport)

A.6.3 Improved accessibility to jobs and education

SRL – Cheltenham to Airport provides Melburnians access to jobs previously not easily accessible by public transport, by opening the middle and outer suburbs to easier orbital travel. The impact of SRL – Cheltenham to Airport is felt across Melbourne, especially in the middle and outer rings, as existing radial rail lines are linked to the orbital SRL – Cheltenham to Airport.

Public transport access to employment

Figure A- 93 shows jobs accessible from LGAs along or directly adjacent (on the outside) to the SRL East corridor in less than an hour by public transport[20], with and without SRL East, for 2036. SRL East increases the number of jobs accessible by public transport from these LGAs, most prominently for LGAs along SRL East. Bayside, Manningham, Monash, Greater Dandenong, Kingston and Whitehorse all see jobs accessible in less than an hour by PT increase by over 100,000 with SRL East in 2036. The connection of the existing Dandenong radial rail corridor to SRL East at Clayton also drives an increase in jobs accessible by public transport from the Greater Dandenong LGA.

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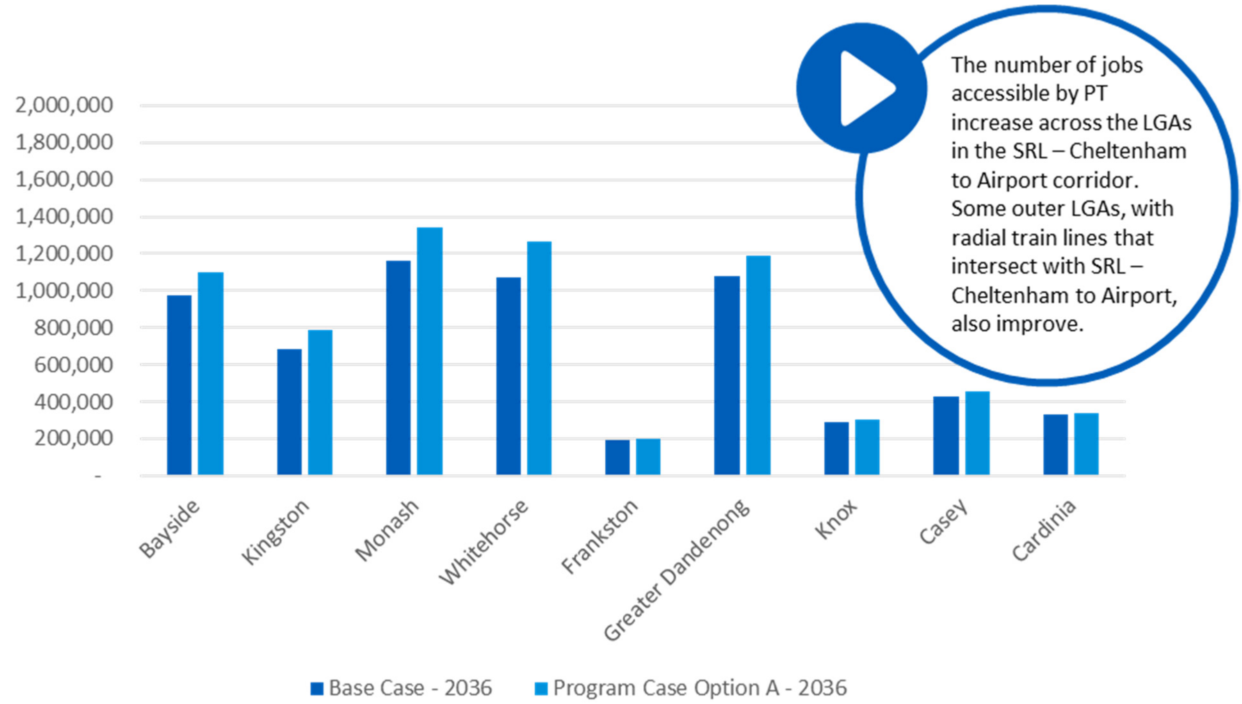
[20] All accessibility metrics in Section A.6.3 are based on modelled AM peak travel times.

Figure A- 93: Employment opportunities accessible by public transport within 60 minutes, by origin LGA, Base Case vs. Program Case, 2036



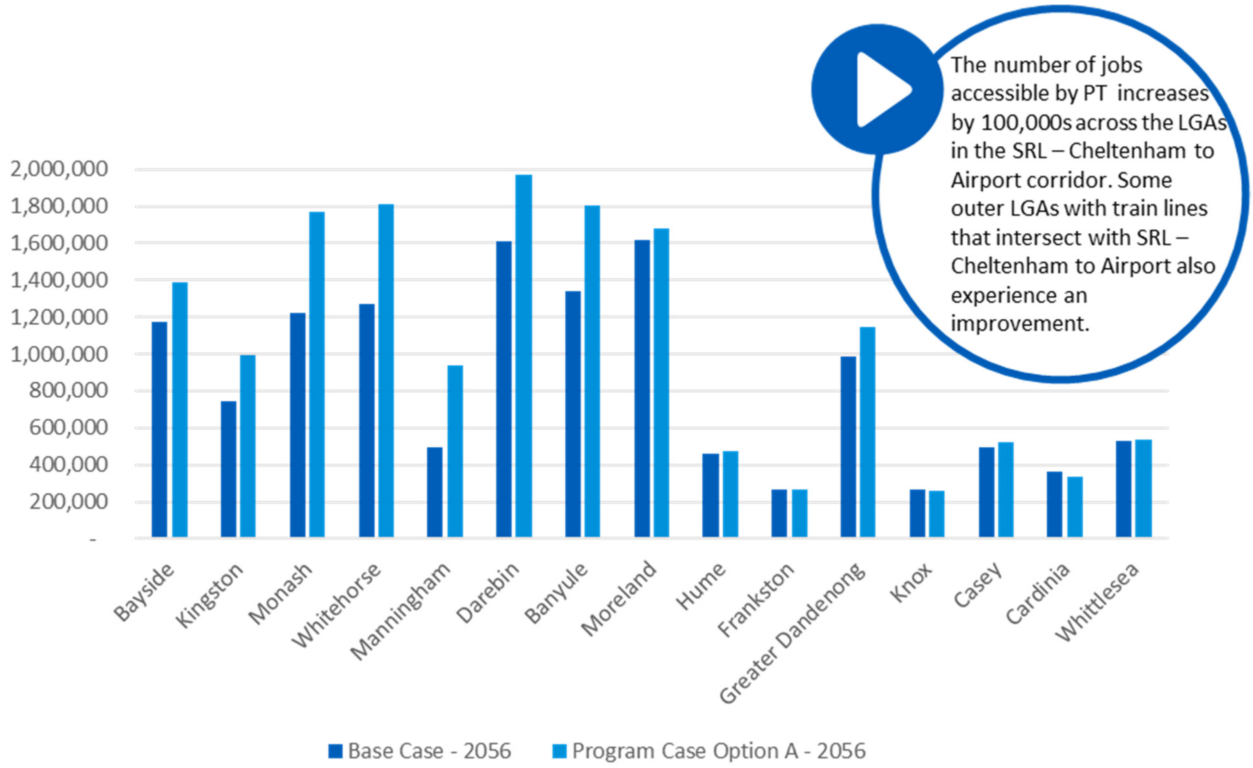
The number of jobs accessible by PT increase across the LGAs in the SRL – Cheltenham to Airport corridor. Some outer LGAs, with radial train lines that intersect with SRL – Cheltenham to Airport, also improve.

Source: KPMG VITM modelling (with SRL East)

Figure A- 94 shows jobs accessible from LGAs along or directly adjacent (on the outside) to the SRL – Cheltenham to Airport corridor in less than an hour by public transport, with and without SRL – Cheltenham to Airport, for 2056. Public transport accessibility increases markedly, with the Monash and Whitehorse LGAs each seeing an extra 540,000 jobs accessible within 60 minutes by PT. Areas which have radial rail connections to SRL – Cheltenham to Airport, such as Dandenong, also see a marked increase in the number of accessible jobs, as SRL – Cheltenham to Airport opens up the possibility of public transport access to other middle and outer ring suburbs.

The number of accessible jobs in less than 60 minutes for LGAs such as Frankston and Knox by public transport does not change substantially. This is driven by public transport travel times to the inner city, where the majority of employment opportunities remain, staying over 60 minutes from these locations even after the addition of SRL – Cheltenham to Airport.

Figure A- 94: Employment opportunities accessible by public transport within 60 minutes, by origin LGA, Base Case vs. Program Case, 2056



The number of jobs accessible by PT increases by 100,000s across the LGAs in the SRL – Cheltenham to Airport corridor. Some outer LGAs with train lines that intersect with SRL – Cheltenham to Airport also experience an improvement.

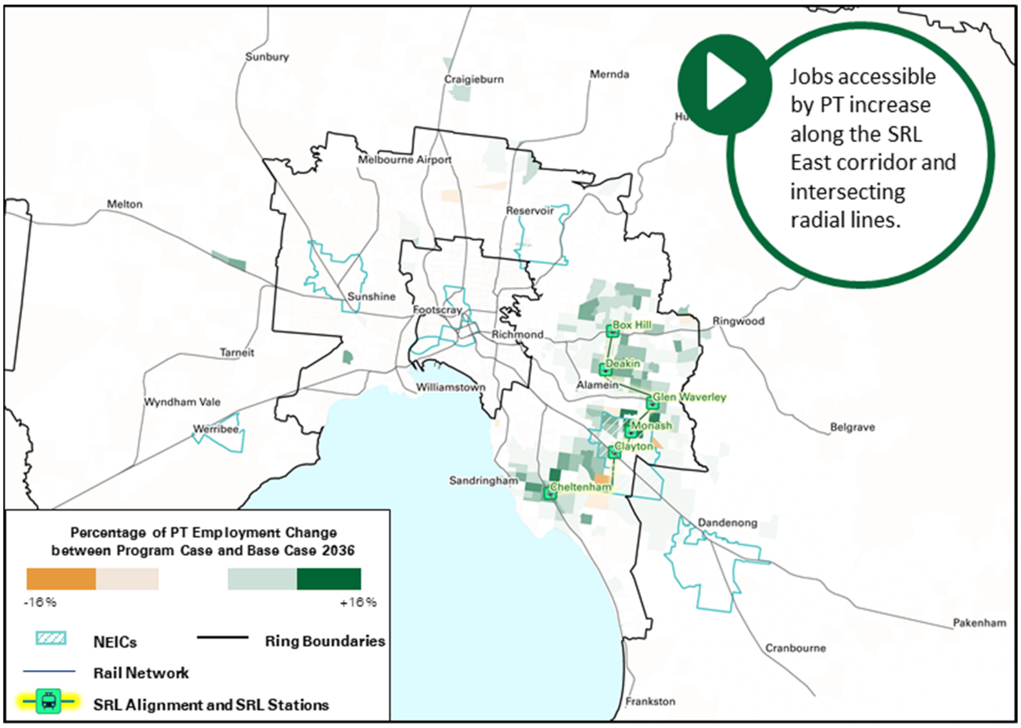
Source: KPMG VITM modelling (with SRL – Cheltenham to Airport)

Similar trends can be observed in the case of access to tertiary education opportunities.

Geographical change in public transport accessibility with SRL – Cheltenham to Airport

Figure A- 95 shows the change in proportion of employment accessible in less than 60 minutes by public transport that is generated by SRL East in 2036. Around Cheltenham and Box Hill, commuters can access jobs both radially and orbitally by rail. Monash and Burwood-based commuters can now easily access more jobs by rail with SRL East. This opens the possibility of accessing more jobs within a 60-minute public transport commute.

Figure A- 95: Change in proportion of employment accessible in less than 60 minutes by public transport, Base Case vs. Program Case, 2036



Jobs accessible by PT increase along the SRL East corridor and intersecting radial lines.

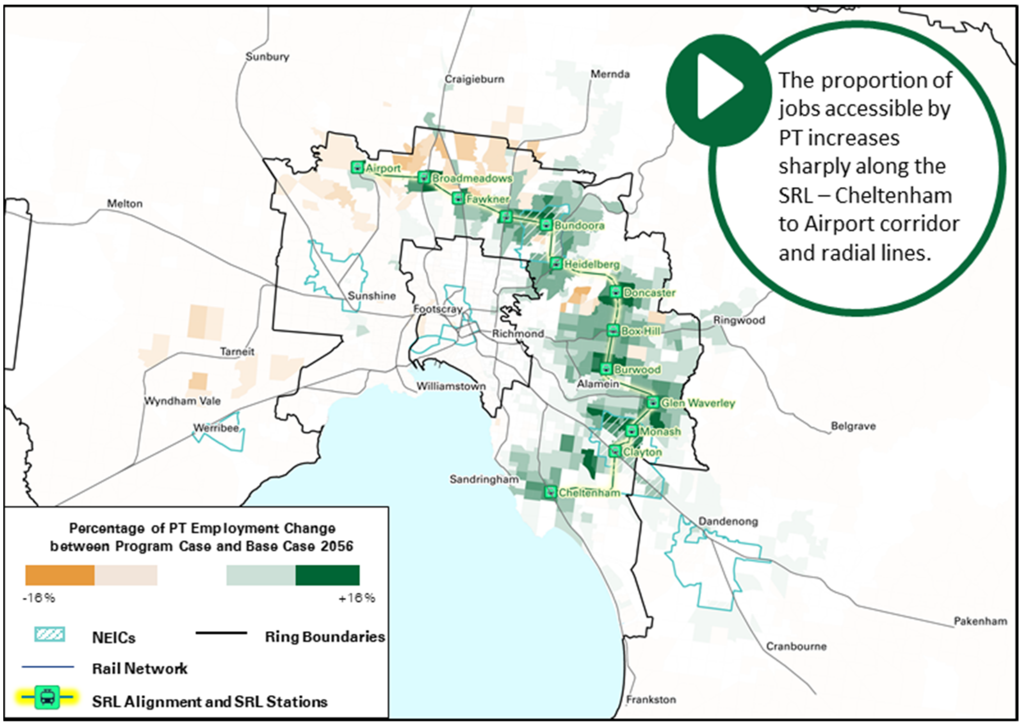
Source: KPMG VITM modelling (SRL East)

Figure A- 96 shows the change in proportion of employment accessible in less than 60 minutes by public transport that is generated by SRL – Cheltenham to Airport in 2056. Accessibility increases along the SRL – Cheltenham to Airport corridor. Bundoora and Doncaster benefit from gaining access to the train network, both orbitally, and by extension, radially.

Intersections of orbital and radial stations at Broadmeadows, Heidelberg, Box Hill, Glen Waverley, Clayton and Cheltenham, and the surrounding areas, see a pronounced increase in the proportion of jobs accessible in less than an hour by public transport with SRL – Cheltenham to Airport.

The same trends occur in the case of access to tertiary education.

Figure A- 96: Change in proportion of employment accessible in less than 60 minutes by public transport, Base Case vs. Program Case, 2056



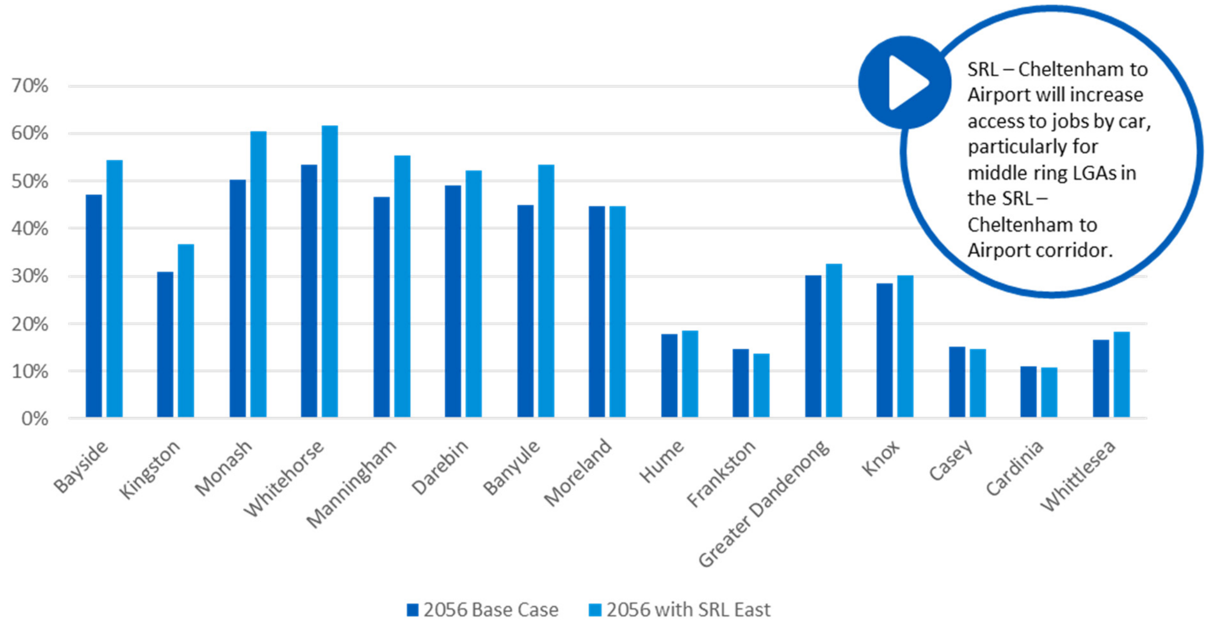
The proportion of jobs accessible by PT increases sharply along the SRL – Cheltenham to Airport corridor and radial lines.

Source: KPMG VITM modelling (SRL – Cheltenham to Airport)

Private vehicle access to employment

Figure A- 97 shows jobs accessible in less than an hour by private vehicle, with and without SRL – Cheltenham to Airport, for 2056. SRL – Cheltenham to Airport shifts commuters away from private vehicle and towards public transport, alleviating road network congestion, thus increasing the number of jobs within 60 minutes by car. Around 595,000 more jobs become accessible in less than 60 minutes by car from Monash, and around 495,000 from LGAs such as Whitehorse, Manningham and Banyule. Outer LGAs such as Greater Dandenong and Knox also see an increase in accessibility of up to 155,000 and 98,000 jobs respectively.

Figure A- 97: Employment opportunities accessible by private vehicle within 60 minutes, by origin LGA, Base Case vs. Program Case, 2056



SRL – Cheltenham to Airport will increase access to jobs by car, particularly for middle ring LGAs in the SRL – Cheltenham to Airport corridor.

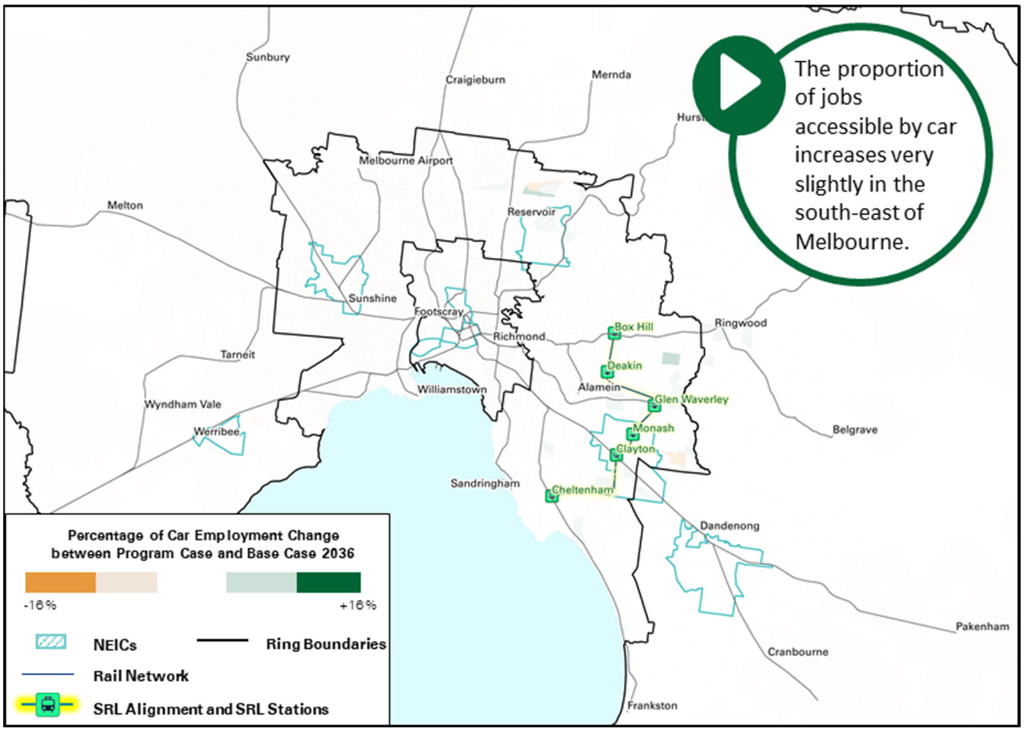
Source: KPMG VITM modelling (with SRL – Cheltenham to Airport)

Similar trends can be observed in the case of access to tertiary education opportunities.

Geographical change in private vehicle accessibility with SRL – Cheltenham to Airport

Figure A- 98 shows the change in proportion of employment accessible in less than 60 minutes by private vehicle, with and without SRL East, in 2036. The change in private vehicle accessibility is relatively minor, occurring in the middle and outer eastern rings of Melbourne.

Figure A- 98: Change in proportion of employment accessible in less than 60 minutes by private vehicle, Base Case vs. Program Case, 2036

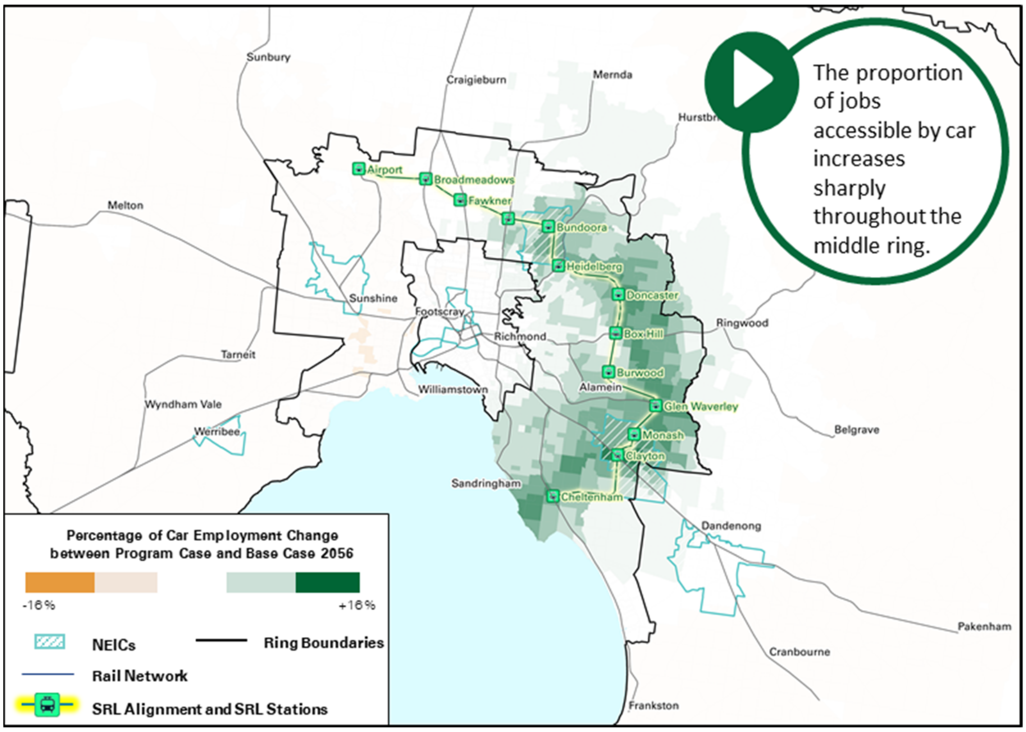


The proportion of jobs accessible by car increases very slightly in the south-east of Melbourne.

Source: KPMG VITM modelling (SRL East)

Figure A- 99 shows the change in proportion of employment accessible in less than 60 minutes by private vehicle, with and without SRL – Cheltenham to Airport, in 2056. The Program Case generates a stark increase in private vehicle accessibility to employment along the SRL – Cheltenham to Airport corridor. This flows from decongestion of the road network as more users transfer to SRL – Cheltenham to Airport to move around Melbourne, as well as the movement of jobs to the corridor.

Figure A- 99: Change in proportion of employment accessible in less than 60 minutes by private vehicle, Base Case vs. Program Case, 2056



The proportion of jobs accessible by car increases sharply throughout the middle ring.

Source: KPMG VITM modelling (SRL – Cheltenham to Airport)

A.6.4 Improved performance of the road network

SRL – Cheltenham to Airport eases radial highway congestion across Greater Melbourne, by shifting travel towards public transport, and encouraging more orbital trips.

The introduction of SRL – Cheltenham to Airport in 2056 is forecast to remove around 2.2 million vehicle kilometres travelled from the road network in Greater Melbourne each day under Option A and around 2.5 million under Option B. SRL – Cheltenham to Airport is also expected to save close to 90,000 daily vehicle hours travelled under Option A, and 105,000 under Option B. This will save around 110,000 passenger hours per day under Option A.

Table A - 41: Daily vehicle and passenger distance and hours travelled for Greater Melbourne, Base Case vs. Program Case

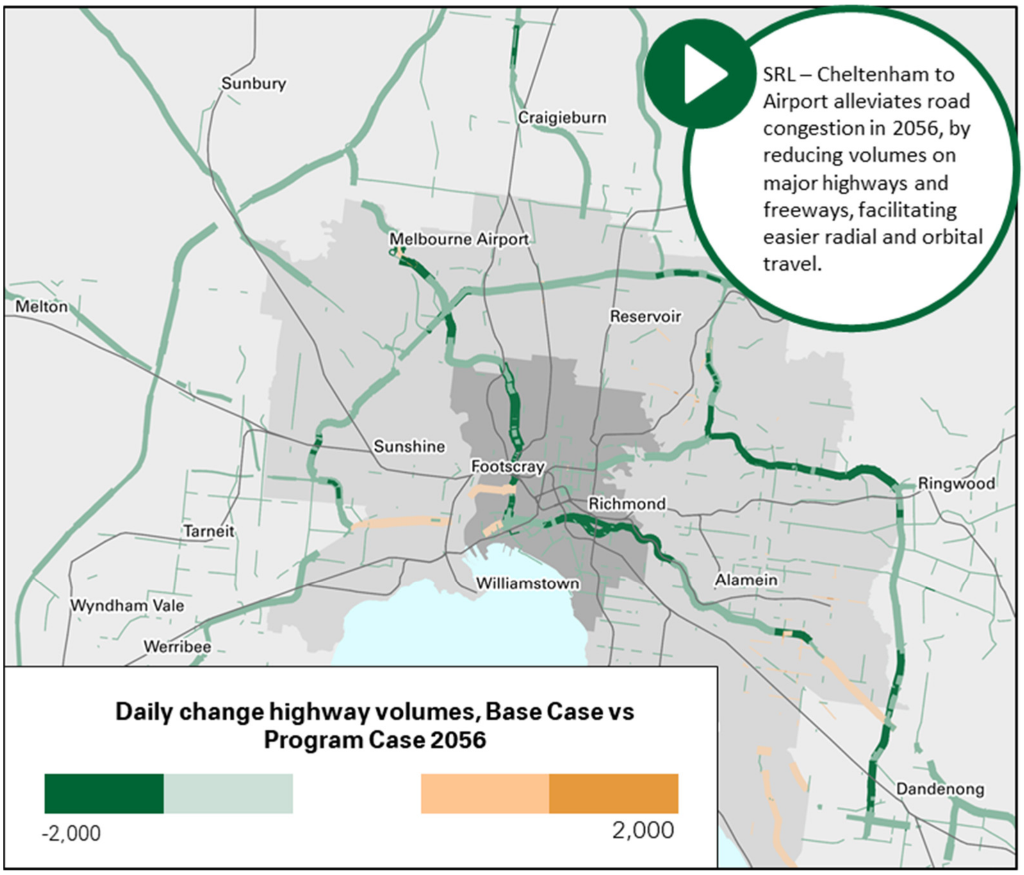
	2036			2056		
	Base Case	**Program Case Option A**	**Program Case Option B**	**Base Case**	**Program Case Option A**	**Program Case Option B**
Vehicle Kilometres Travelled	153,842,000	153,586,000	153,391,000	190,046,000	187,853,000	187,526,000
Vehicle Hours Travelled	3,600,000	3,589,000	3,579,000	4,861,000	4,775,000	4,756,000
Passenger Kilometres Travelled	205,177,000	204,850,000	204,611,000	252,003,000	249,070,000	248,721,000
Passenger Hours Travelled	4,933,000	4,916,000	4,901,000	6,598,000	6,488,000	6,468,000

Source: KPMG VITM modelling (with SRL – Cheltenham to Airport)

Reduction in highway volumes

While the introduction of SRL East in 2036 reduces road congestion marginally, the effect of SRL – Cheltenham to Airport in 2056 is more significant, alleviating road congestion and improving car travel times. As shown in Figure A- 100, there is a significant reduction in the number of vehicles travelling along major radial highways such as the CityLink, Eastern Freeway and Monash Freeway. The addition of SRL – Cheltenham to Airport does increase some AM peak outbound road volumes on key freeways including the Monash Freeway. These freeways however experience no counterpeak congestion, and therefore the increased volumes do not deteriorate the performance of these freeways in the counterpeak direction.

Figure A- 100: Difference in highway volume (daily), Base Case vs. Program Case, 2056



SRL – Cheltenham to Airport alleviates road congestion in 2056, by reducing volumes on major highways and freeways, facilitating easier radial and orbital travel.

Source: KPMG VITM modelling (with SRL – Cheltenham to Airport)

Average road network speeds

The alleviation of congestion across the road network that accompanies SRL – Cheltenham to Airport results in improved road network performance. This improved performance results in increased road network speeds, as illustrated in Table A - 42. In 2056, AM peak average road network speeds increase from 30.5 km/h in the Base Case, to 31.0 km/h with SRL – Cheltenham to Airport.

Table A - 42: Average Greater Melbourne road network speeds, Base Case vs. Program Case

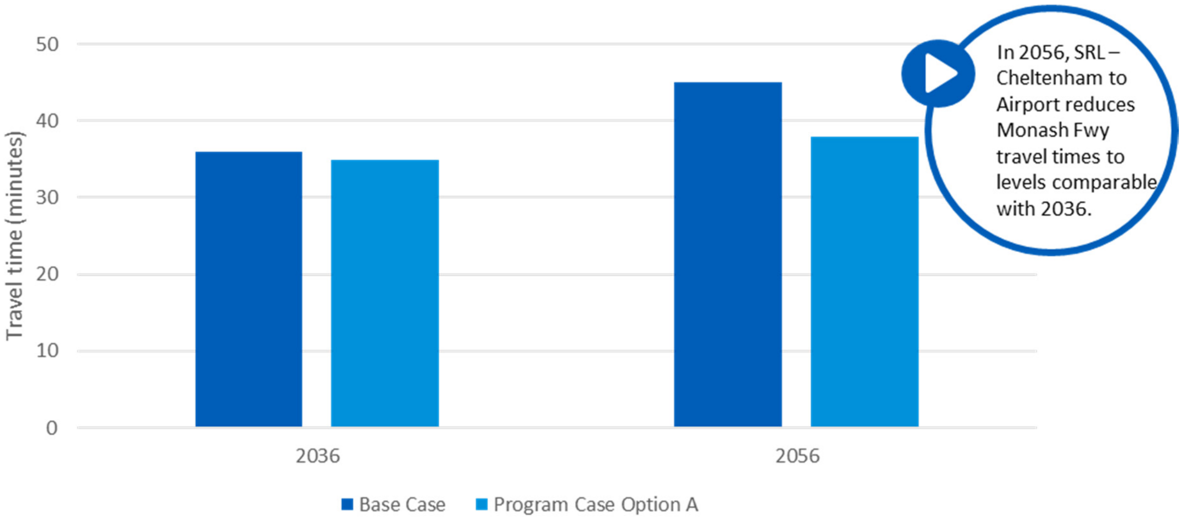
	2036		2056	
	Base Case	Program Case Option A	Base Case	Program Case Option A
AM Peak	34.0	34.1	30.5	31.0
PM Peak	34.8	34.8	30.1	30.3

Source: KPMG VITM modelling (with SRL – Cheltenham to Airport)

Reduction in Monash Freeway travel times

Section A.5.5 illustrates that travel times on the Monash Freeway increase markedly between 2036 and 2056, without SRL – Cheltenham to Airport. The incorporation of SRL – Cheltenham to Airport has the effect of taking vehicles off the Monash (inbound) in the AM peak, driven by the shift of travel patterns – both towards public transport and away from radial travel to the CBD. This reduction in traffic volume improves travel times along the Monash Freeway. Figure A- 101 shows AM peak travel times on the Monash between Springvale Road and the Domain Tunnel, with and without SRL – Cheltenham to Airport. In 2036, SRL East has a marginal effect on travel times. The effect of SRL – Cheltenham to Airport in 2056 is more significant, bringing the travel time down from 45 minutes to 38 minutes – comparable to forecasted travel times for 2036.

Figure A- 101: Travel times on the Monash Freeway between Springvale Road and the Domain Tunnel (AM peak), Base Case vs. Program Case



In 2056, SRL – Cheltenham to Airport reduces Monash Fwy travel times to levels comparable with 2036.

Source: KPMG VITM modelling (with SRL – Cheltenham to Airport)

A.6.5 Reduced crowding on radial rail lines

Many of Melbourne's radial railway lines are experiencing considerable crowding. As outlined in Section A.5.6, this crowding generally worsens over time without SRL – Cheltenham to Airport. The introduction of SRL – Cheltenham to Airport alleviates crowding on some of the most crowded sections of the radial rail lines which intersect it, by providing an alternative public transport service, as well as encouraging more orbital travel. Figure A- 102 illustrates the effect of SRL – Cheltenham to Airport in 2056 on crowding, by showing volume/capacity[21] ratios for AM peak inbound services, for radial lines which intersect SRL – Cheltenham to Airport. Decreases in volume/capacity ratios, reflecting less crowded services and better travelling conditions for commuters, are forecast for all the intersecting radial lines. The most significant drops are seen for the Frankston, Dandenong, and Glen Waverley Lines, with maximum volumes on the Frankston Line moving from above capacity without SRL – Cheltenham to Airport to below with SRL – Cheltenham to Airport.

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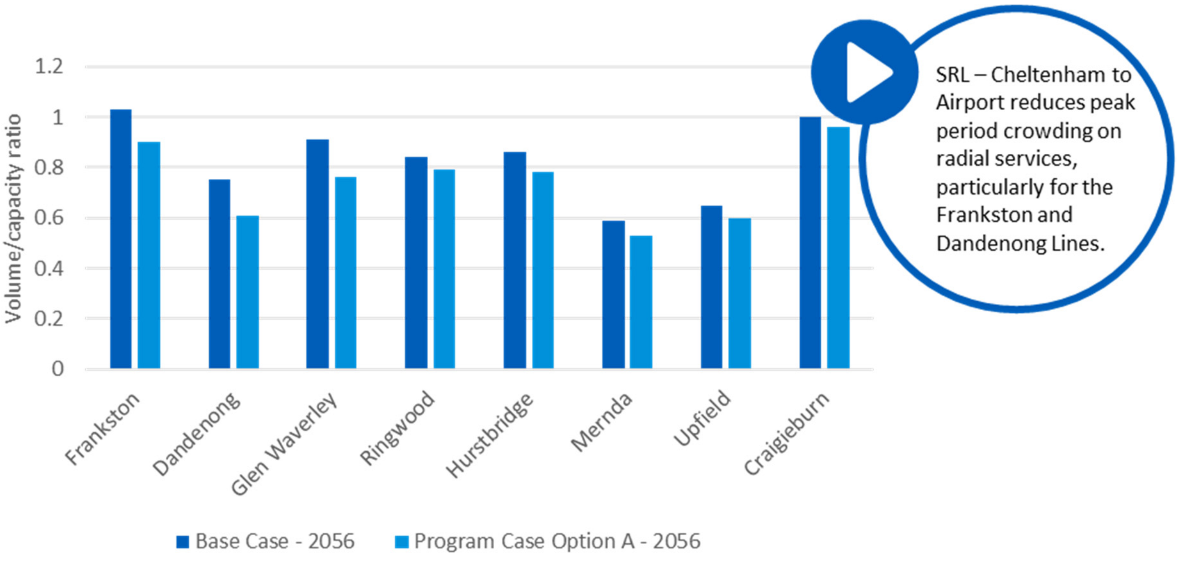
[21] Capacities are defined by the load standard, which is a desired operating assumption for passenger loading. The load standard is calculated as 4 passengers per square metre, plus seated capacity.

Figure A- 102: Citybound volume/capacity ratios (at maximum load) on radial train lines (AM peak), 2056

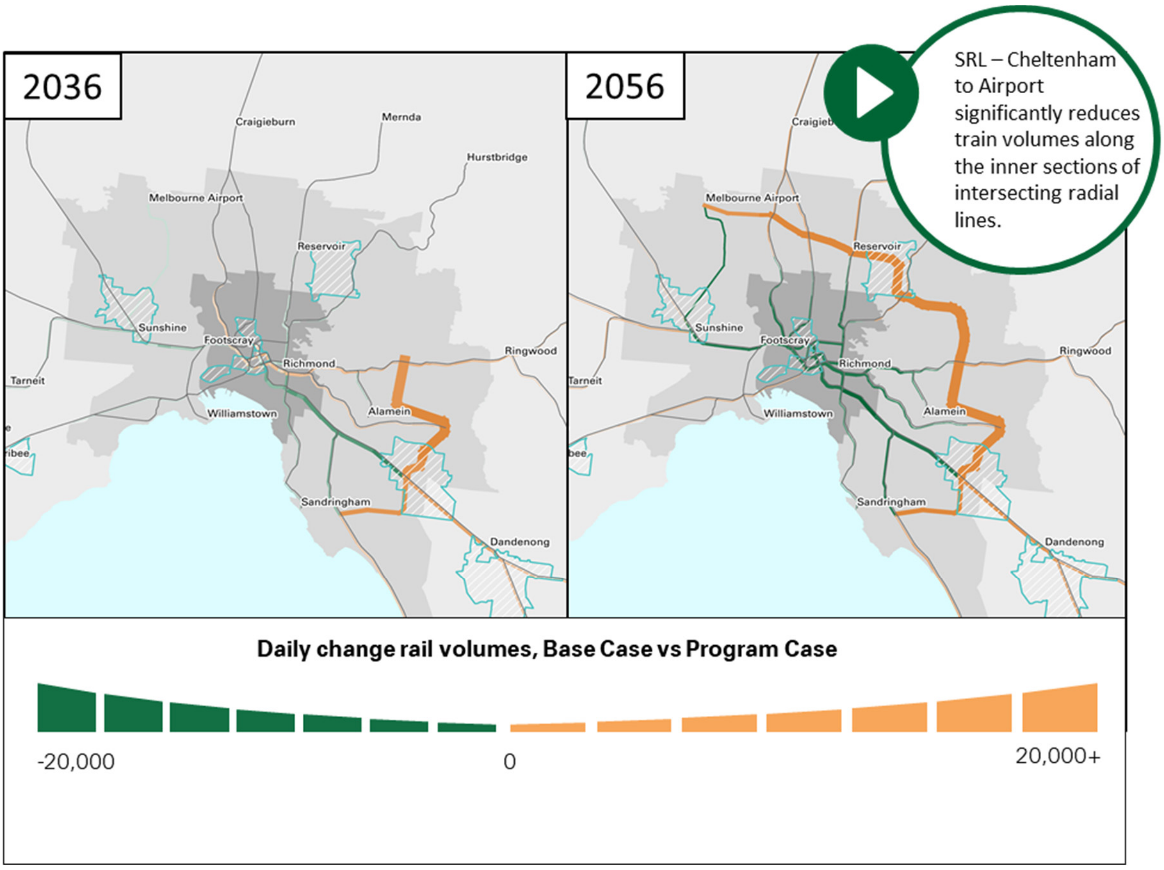


SRL – Cheltenham to Airport reduces peak period crowding on radial services, particularly for the Frankston and Dandenong Lines.

Source: KPMG VITM modelling (with SRL – Cheltenham to Airport)

Figure A- 103 highlights the difference in daily metropolitan train volumes between the Base Case and Program Case. In 2056, the addition of SRL – Cheltenham to Airport is expected to reduce volumes on the inner sections of the radial lines which intersect SRL – Cheltenham to Airport. These inner sections are where the greatest crowding is experienced – the anticipated reductions in train volumes due to SRL – Cheltenham to Airport will reduce crowding on these sections of the network, as shown in Figure A- 102.

Figure A- 103: Change in public transport volumes (daily), Base Case vs. Program Case, 2036 and 2056



SRL – Cheltenham to Airport significantly reduces train volumes along the inner sections of intersecting radial lines.

Source: KPMG VITM modelling (with SRL – Cheltenham to Airport)

A.6.6 Improvements for regional areas

Increasing regional rail demands

SRL – Cheltenham to Airport connects with regional rail services via interchanges at two transport super hubs: Clayton and Broadmeadows. A third transport super hub will be connected by SRL – Airport to Werribee at Sunshine. This will improve the connectivity from regional areas to Melbourne's middle ring and drive increased public transport demand.

At Broadmeadows, regional passenger boardings and alightings are expected to increase to around 8,500 per day with SRL – Cheltenham to Airport in 2056, with over half of all passengers on regional services approaching Melbourne from the Hume corridor alighting at Broadmeadows. At Clayton, regional passenger movements triple to around 7,000 per day with SRL – Cheltenham to Airport in 2056. Over 40% of regional passengers approaching Melbourne from the Gippsland corridor alight at Clayton with SRL – Cheltenham to Airport.

With SRL – Cheltenham to Airport in 2056, regional passenger loads across the day approaching Melbourne are anticipated to increase by around 20% for Hume corridor services, and by around 10% for Gippsland corridor services. The number of passengers using V/Line services across Victoria also increases, with V/Line boardings increasing by 5% per day.

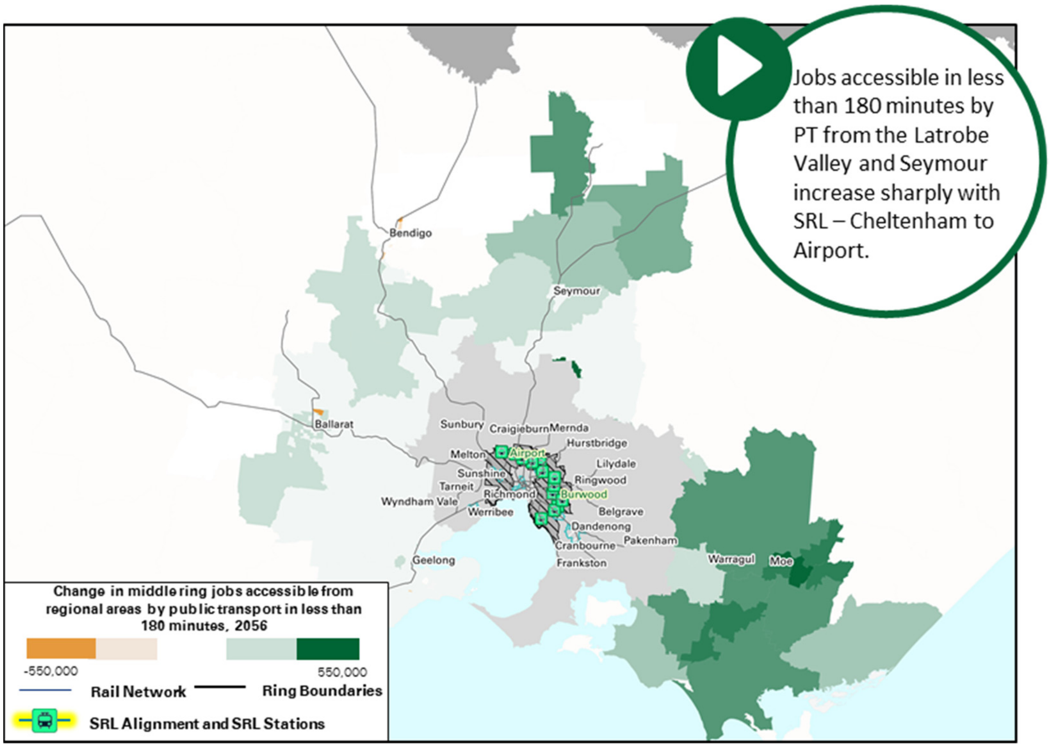
Collectively, the number of passenger boardings and alightings within inner Melbourne to and from regional services is expected to decrease by around 5,000 per day – including a 4,000 drop at Southern Cross Station – as passengers instead use Clayton and Broadmeadows as preferred connections between regional and metropolitan public transport services.

Improving regional access to jobs, health and education

By 2056, over 11%[22] of Melbourne's jobs are expected to be located within SRL East and SRL North Precincts (from Melbourne Airport to Cheltenham), with 13%[23] located in the central city (including CBD, Southbank and Docklands). With SRL – Cheltenham to Airport, regional Victorians located along Victoria's key regional rail lines will have better access to employment, health and education opportunities across Greater Melbourne – particularly in the middle and outer corridor.

SRL – Cheltenham to Airport will increase accessibility from regional areas to jobs and education, in places such as Box Hill and Monash. Figure A- 104 shows the change in number of middle ring jobs accessible by public transport in less than 180 minutes with SRL – Cheltenham to Airport in 2056, from regional areas. A 180-minute journey by public transport from places such as Morwell, Traralgon and Moe in the Latrobe Valley has access to an additional 420,000 to 520,000 middle ring jobs in 2056 with SRL – Cheltenham to Airport. The number of jobs in Melbourne's middle ring accessible in less than 180 minutes by public transport from Nagambie and Euroa on the Seymour corridor increases by 210,000 and 295,000 respectively with SRL – Cheltenham to Airport.

Figure A- 104: Change in employment accessible from regional areas in less than 180 minutes by public transport, Base Case vs. Program Case, 2056



Jobs accessible in less than 180 minutes by PT from the Latrobe Valley and Seymour increase sharply with SRL – Cheltenham to Airport.

Source: KPMG VITM modelling (with SRL – Cheltenham to Airport)

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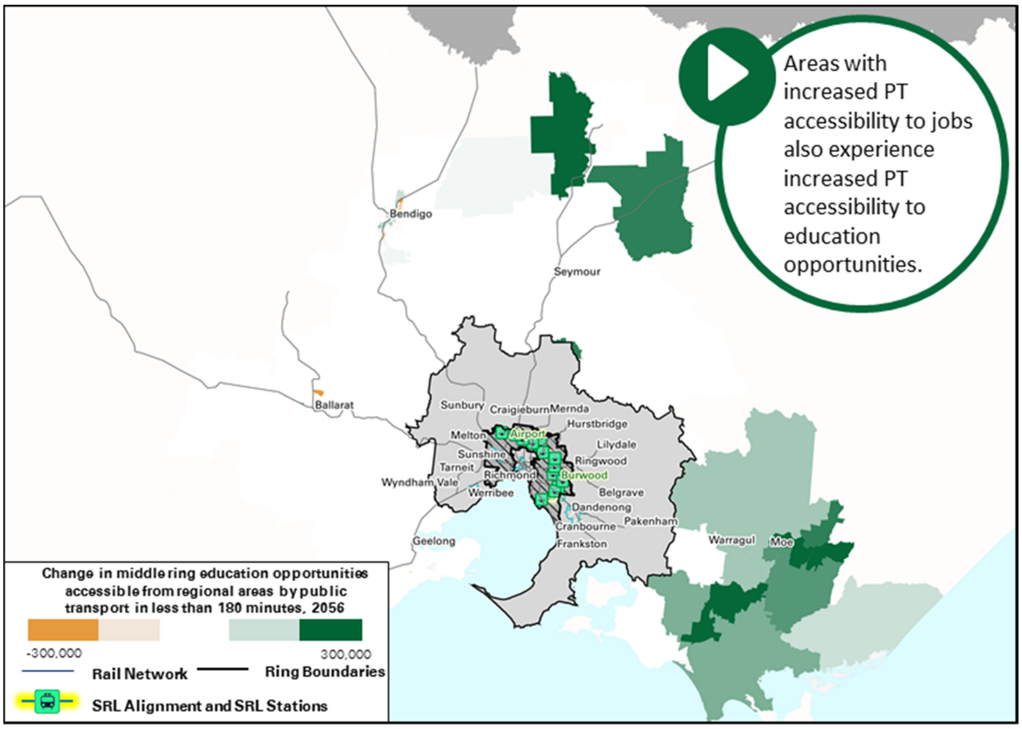
[22] Derived from CityPlan modelling under Program Case Option A assumptions.
[23] Derived from CityPlan modelling under Program Case Option A assumptions.

Figure A- 105 shows the change in number of middle ring tertiary education opportunities accessible by public transport in less than 180 minutes with SRL – Cheltenham to Airport in 2056, from regional areas. Around 250,000 extra middle ring tertiary education opportunities are accessible within 180 minutes from the Latrobe Valley. An additional 265,000 tertiary education places are also expected to be accessible in less than 180 minutes from Euroa.

Figure A- 105: Change in tertiary education opportunities accessible from regional areas in less than 180 minutes by public transport, Base Case vs. Program Case, 2056



Source: KPMG VITM modelling (with SRL – Cheltenham to Airport)

Improved regional travel times

SRL – Cheltenham to Airport will enable regional populations to connect to the radial network, bypassing the existing transit through Melbourne's CBD at Southern Cross Station, and as such, decreasing commute times. Commuters may transfer at Broadmeadows, Clayton, and – in the case of SRL – Airport to Werribee – at Sunshine, to move around the inner and outer rings of Melbourne where many job and educational opportunities lie. Examples of the travel time savings and benefits this will create for regional rail passengers include:

- Wallan: Access to Deakin University from Wallan by public transport is expected to be around 45 minutes faster with SRL – Cheltenham to Airport in 2056 – making it around a 73 minute travel time, and significantly faster than access via private vehicle during peak periods.
- Traralgon: Public transport travel times between Traralgon and Box Hill hospital are anticipated to be around 26 minutes faster with SRL – Cheltenham to Airport in 2056 – taking around two and a half hours, and making train travel times comparable to private vehicle travel times.
- East Gippsland: A resident of East Gippsland travelling to Glen Waverley by rail can save around 25 minutes in 2056 with SRL – Cheltenham to Airport, from faster travel times between Clayton and Glen Waverley, improving access from East Gippsland.

Airport connectivity for regional areas

When travelling to Melbourne Airport from northern areas of regional Victoria, SRL – Cheltenham to Airport will remove the need for regional passengers to rely on taxis or local bus trips between Broadmeadows and the airport. Current transport options offer poor connectivity between services, challenges for luggage transfer and cumbersome access to passenger terminals. Public transport travel times between Broadmeadows and the airport are expected to be reduced by around 45% in 2056 – and comfort, ease of transfer and reliability of access will increase.

A.7 Sensitivity tests

Sensitivity tests play an important role in assessing the robustness of the demand modelling findings and conclusions from primary analyses. These tests enable an assessment of the impact, effect, and influence of key modelling assumptions on results. For SRL – Cheltenham to Airport VITM modelling, the sensitivity tests undertaken assess various factors including COVID-19 and remote working, airport user preferences, airport user rail fares, autonomous and electric vehicles, and transport network pricing. This section outlines the methodology behind the implementation of these sensitivity tests, and their impact on SRL – Cheltenham to Airport patronage.

Sensitivities have been conducted using static land use modelling runs, as opposed to dynamic runs used for the Program Case assessment, in order to reduce the burden of modelling run times; accordingly, sensitivity results are compared against Core Static Option A scenarios to understand the relative impact. As a consequence of this, core static results used for comparison purposes in this section will not exactly match the dynamic results discussed in Section A.6. (See Volume B: Land Use Impacts of SRL – Cheltenham to Airport, Section B.6.2 for a more detailed description of the modest static and dynamic land use differences). The land use sensitivity assessments which underpin some of these demand modelling runs are described in more detail in Volume B, Section B.6.3.

A.7.1 COVID-19 and remote working

The core demand modelling runs undertaken used land use assumptions founded on projections made before the onset of COVID-19. COVID-19 may be expected to influence population growth, as well as population distribution. Additionally, travel habits and preferences may change as a result of COVID-19, with the uptake of remote working possibly increasing.

To understand possible impacts of these consequences of COVID-19 on SRL – Cheltenham to Airport patronage, a sensitivity test was undertaken. This test combined three key variations on the core modelling scenarios, as advised by DoT[24]:

1. A reduction in future year land use assumptions compared to the SALUP assumptions that underpin core modelling, reflecting lower migration rates and other trends resulting from COVID-19. Specifically, land use growth was delayed by two years in earlier model years, increasing to a four year delay by 2056.

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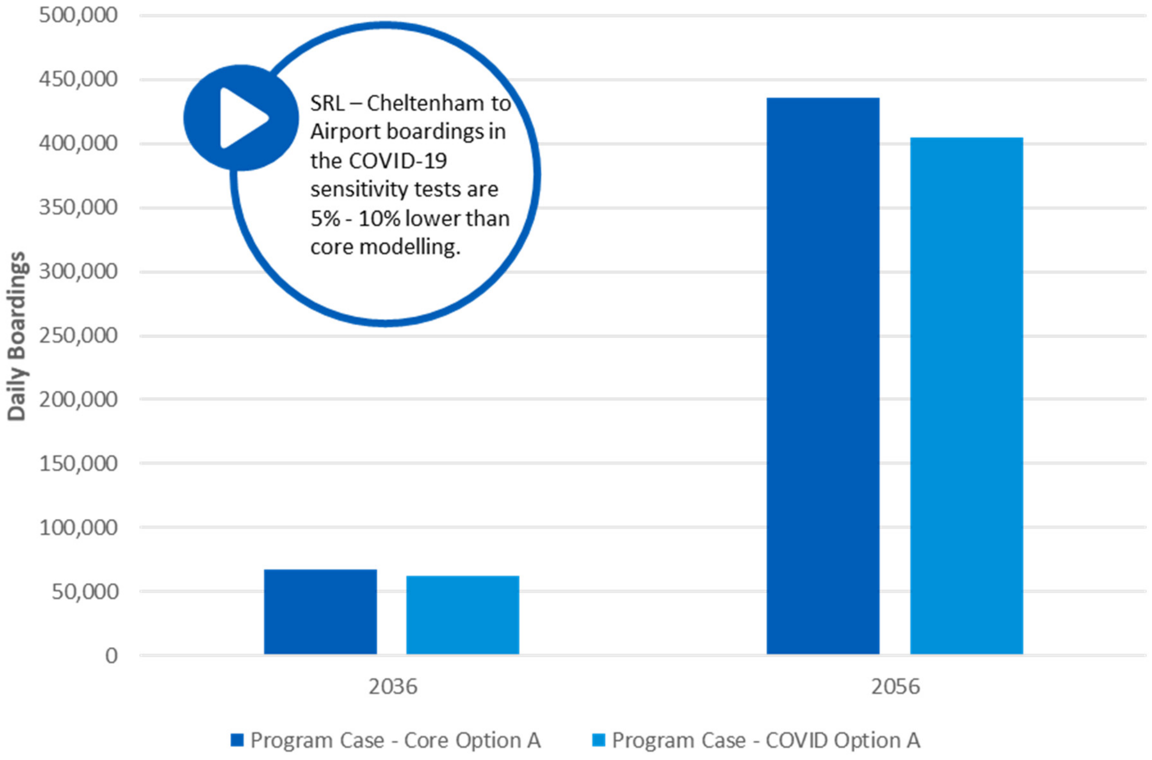
[24] Department of Transport (2020). *COVID-19 impacts on demand forecasts – sensitivity and scenario testing project analysis.* Note that air passenger assumptions are based on International Air Transport Association (**IATA**) and Qantas announcements and have been agreed with RPV / DoT.

2. A reduction in home-based work trips[25], reflecting an increase in the uptake of remote working as a result of COVID-19, compared to remote working rates implicit in the parameters in the core model. Specifically, the DoT guidance stated that 29% of jobs in Victoria can be worked remotely, and those working in these jobs will work from home for 2-3 days a week.
3. A reduction in trips to and from Melbourne Airport, reflecting lower levels of domestic and international air travel. Specifically, trip rates assumed in the model are based on air travel returning to 2019 levels by 2023 for domestic and short haul travel, and 2024 for all travel[26], with air travel returning to pre COVID-19 forecast levels by 2031.

Figure A- 106 shows the reduction in trips forecast for SRL – Cheltenham to Airport daily boardings modelled in the COVID-19 sensitivity. Compared to Core Static Option A runs, COVID Option A modelling shows 6,000 fewer SRL – Cheltenham to Airport daily boardings in 2036, and 30,000 fewer in 2056. Across Greater Melbourne, there is also a reduction in total public transport and private vehicle trips by over 1,500,000 in 2036, and almost 2,000,000 in 2056 as shown in Table A - 43 and Table A - 44, driven by the variations in land use and trip behaviour.

Figure A- 106: Daily SRL – Cheltenham to Airport boardings, Core and COVID-19 sensitivity scenarios



SRL – Cheltenham to Airport boardings in the COVID-19 sensitivity tests are 5% - 10% lower than core modelling.

Source: KPMG VITM modelling

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[25] As an additional consequence of more remote working, in the COVID-19 sensitivity test a proportion of Employer's Business trips are redistributed to start or end at the worker's home location, rather than their work location.
[26] As per IATA outlook.

Table A - 43: Public transport and private vehicle trips for Greater Melbourne, Core and COVID-19 sensitivity scenarios, 2036

	Base Case - Core	Base Case – Covid Sensitivity	Program Case Option A - Core	Program Case Option A - Covid Sensitivity
Private vehicle	20,473,000	19,097,000	20,401,000	19,017,000
Public transport	2,281,000	2,096,000	2,335,000	2,159,000
PT mode share	10.0%	9.9%	10.3%	10.2%

Source: KPMG VITM modelling

Table A - 44: Public transport and private vehicle trips for Greater Melbourne, Core and COVID-19 sensitivity scenarios, 2056

	Base Case - Core	Base Case – Covid Sensitivity	Program Case Option A - Core	Program Case Option A - Covid Sensitivity
Private vehicle	26,803,000	24,983,000	26,205,000	24,503,000
Public transport	3,294,000	3,117,000	3,529,000	3,310,000
PT mode share	10.9%	11.1%	11.9%	11.9%

Source: KPMG VITM modelling

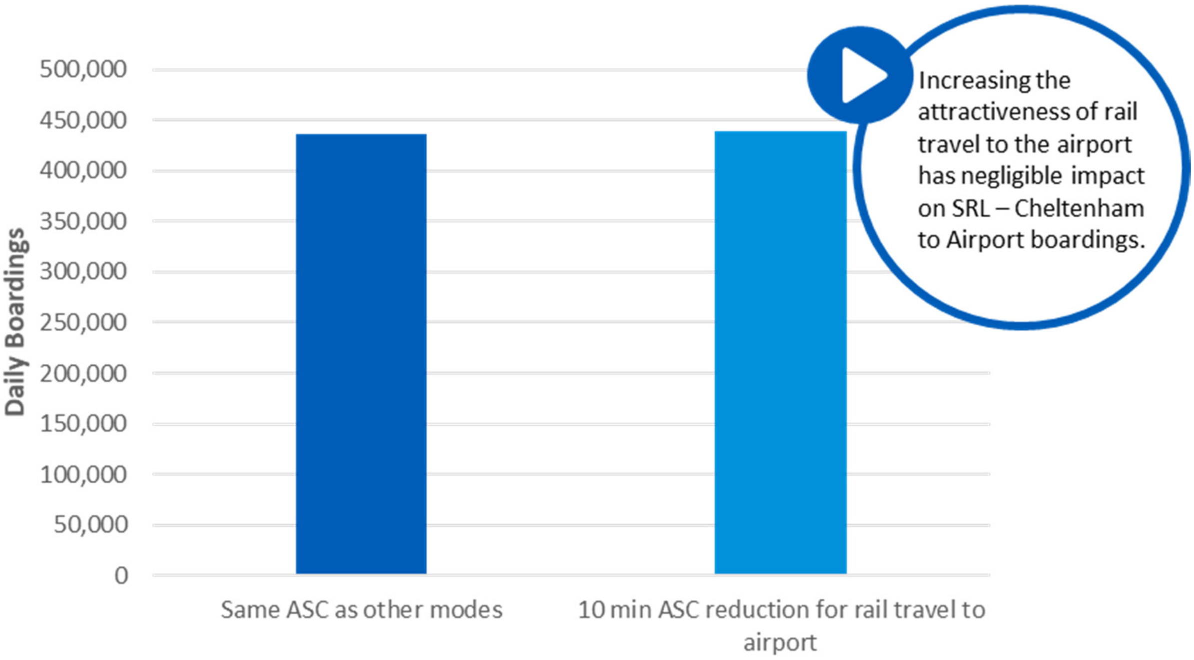
A.7.2 Airport user preferences

The core scenarios modelled factor in observable trade-offs, such as journey time, public transport fares, and public transport transfers. However, the core modelling does not consider an inherent preference for rail over and above the observable attributes of the generalised cost equation.

To understand the impact of an inherent user preference for rail travel compared to bus travel for airport users (driven by factors such as travel time reliability), a scenario using modified alternative-specific constants in VITM's airport module has been undertaken. The ASCs in the airport module account for unobserved attributes which impact air passenger mode choice, not captured by the time and cost incurred by a user. The use of modified ASCs aims to test the variability of the unobserved user attributes on rail demand to the airport. The sensitivity test models journeys on both MAR and SRL – Cheltenham to Airport to and from the airport with a 10-minute time reduction compared to other modes, to understand the impact of a potential user preference for rail.

Figure A- 107 shows the impact of the modified ASC for rail transport to Melbourne Airport on SRL – Cheltenham to Airport daily boardings in 2056. Despite the reduction in the journey time of using SRL – Cheltenham to Airport to access the airport in the sensitivity test, the impact on SRL – Cheltenham to Airport patronage is negligible, with line wide boardings increasing by 2,000. As illustrated in Figure A- 108, the 10-minute time reduction compared to other modes does impact the number of boardings and alightings at Melbourne Airport via MAR and SRL – Cheltenham to Airport, with Program Case boardings and alightings increasing by 5,000 in 2056.

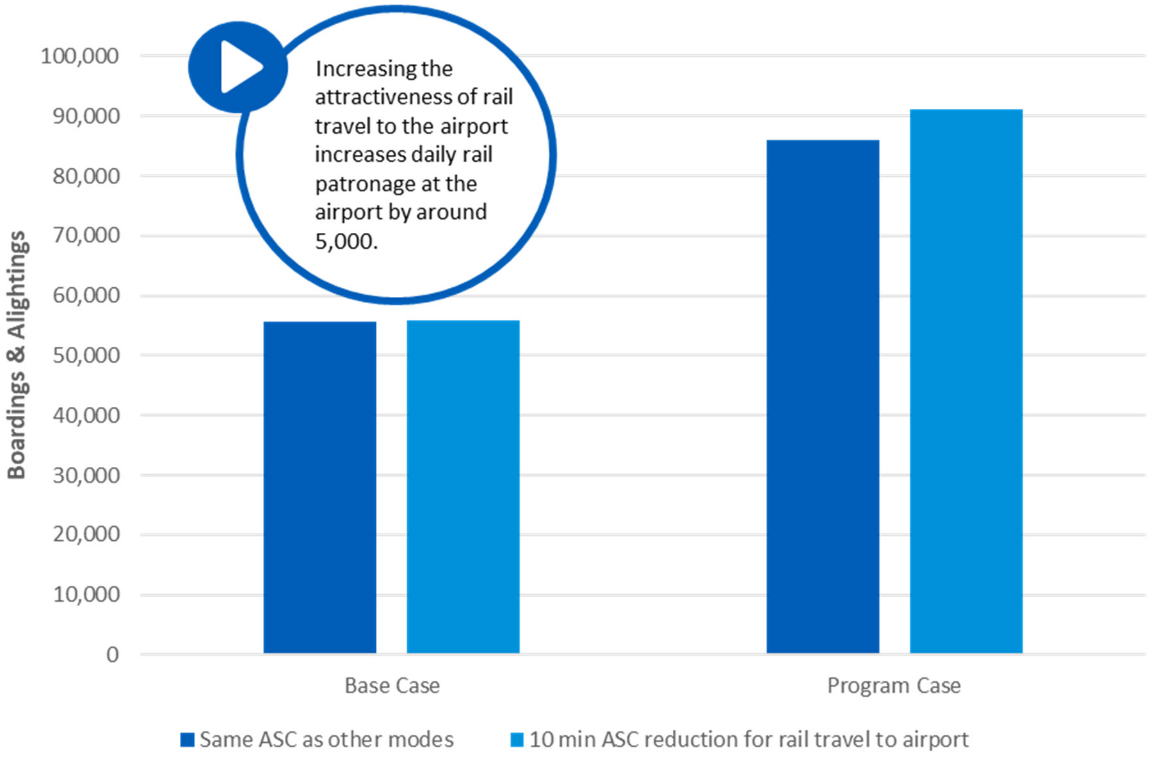
Figure A- 107: Daily SRL – Cheltenham to Airport boardings, Core and Airport User Preference sensitivity scenarios, 2056



Increasing the attractiveness of rail travel to the airport has negligible impact on SRL – Cheltenham to Airport boardings.

Source: KPMG VITM modelling

Figure A- 108: Daily boardings and alightings at Melbourne Airport via MAR and SRL – Cheltenham to Airport, Core and Airport User Preference sensitivity scenarios, 2056



Increasing the attractiveness of rail travel to the airport increases daily rail patronage at the airport by around 5,000.

Source: KPMG VITM modelling

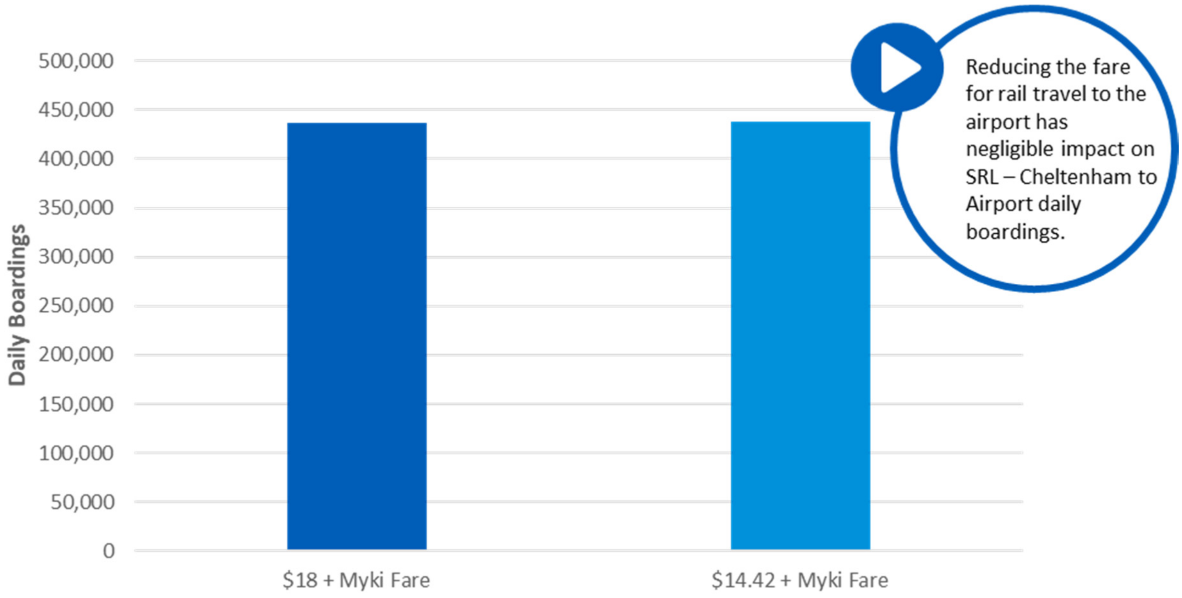
A.7.3 Airport user rail fares

Public transport fares are a component of the perceived cost of travel in VITM, and therefore have an effect on mode choice and overall patronage on public transport. For instance, an increase in public transport fare may encourage a certain proportion of commuters to use a different mode of travel, such as private vehicle. Price sensitivity of public transport fares identifies the degree to which commuter behaviour is affected by the price of a service.

A sensitivity test was conducted which incorporated a reduced fare premium for rail transport to Melbourne Airport. This reduced fare premium affects the cost of travel to Melbourne Airport via both MAR and SRL – Cheltenham to Airport. The fare premium of $18.00 (plus Myki fare) that is modelled in core scenarios (both Base and Program Case) was reduced to $14.42 (plus Myki fare) for this test.

Figure A- 109 shows the impact of the reduction in public transport fares for rail transport to Melbourne Airport on SRL – Cheltenham to Airport daily boardings in 2056. Despite the cost of using SRL – Cheltenham to Airport to access the airport reducing in the sensitivity test, the impact on SRL – Cheltenham to Airport patronage is negligible, with line wide boardings increasing by 2,000. Figure A- 110 outlines the impact of this fare reduction on boardings and alightings via MAR and SRL – Cheltenham to Airport at the airport. The fare reduction results in both MAR and SRL – Cheltenham to Airport airport travel becoming more attractive, with a 6,000 increase in boardings and alightings in the Base Case and 5,000 in the Program Case.

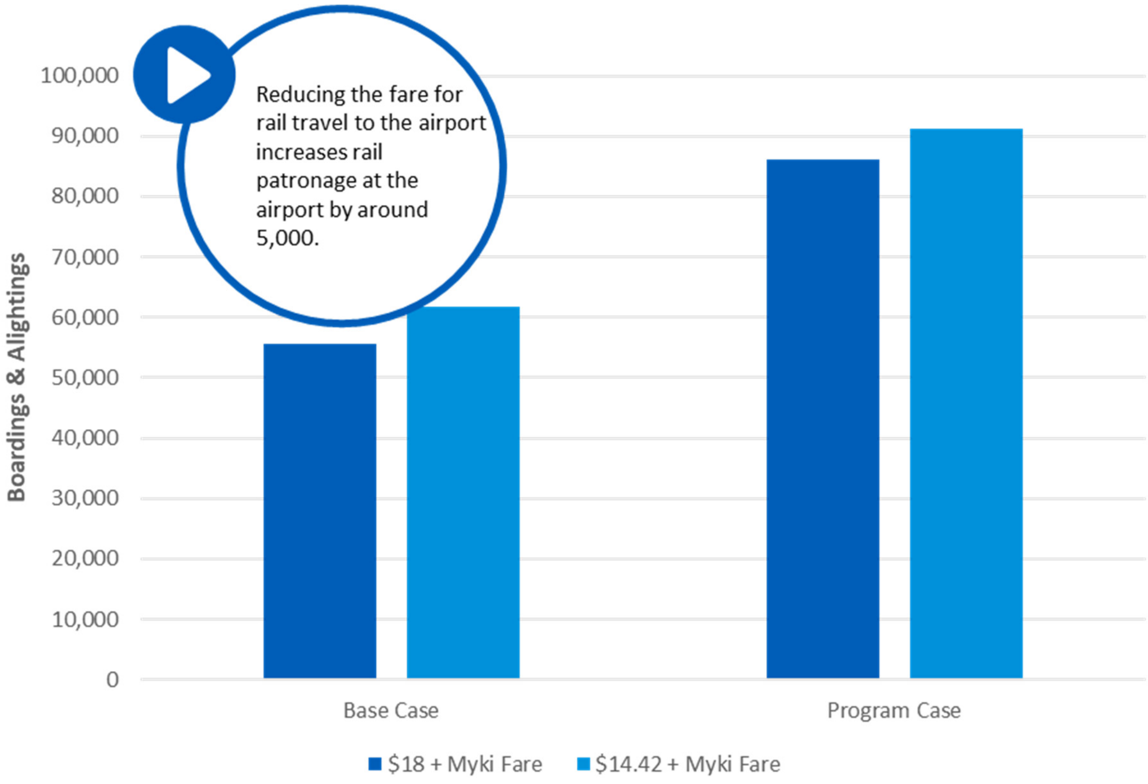
Figure A- 109: Daily SRL – Cheltenham to Airport boardings, Core and Airport Fare sensitivity scenarios, 2056



Reducing the fare for rail travel to the airport has negligible impact on SRL – Cheltenham to Airport daily boardings.

Source: KPMG VITM modelling

Figure A- 110: Daily boardings and alightings at Melbourne Airport via MAR and SRL – Cheltenham to Airport, Core and Airport Fare sensitivity scenarios, 2056



Source: KPMG VITM modelling

A.7.4 Autonomous and electric vehicles

Evolving technologies such as autonomous vehicles (**AVs**) and electric vehicles (**EVs**) may influence travel patterns and behaviour in the future. For instance, the increasing attractiveness and accessibility of AVs would be expected to influence the future mode split of private vehicle and public transport trips.

The following two scenarios were modelled as sensitivities, testing potential consequences of higher prevalence of AVs and EVs:

- A high technology and automation, high private use (**PAV**) scenario, which assumes 35% conventionally driven vehicles (**CDVs**) which are EVs and 65% privately owned AVs/EVs.
- A high technology and automation, high rideshare (**SAV**) scenario, which assumes 21% CDVs/EVs, 39% privately owned AVs/EVs and 40% shared, on-demand AVs/EVs.

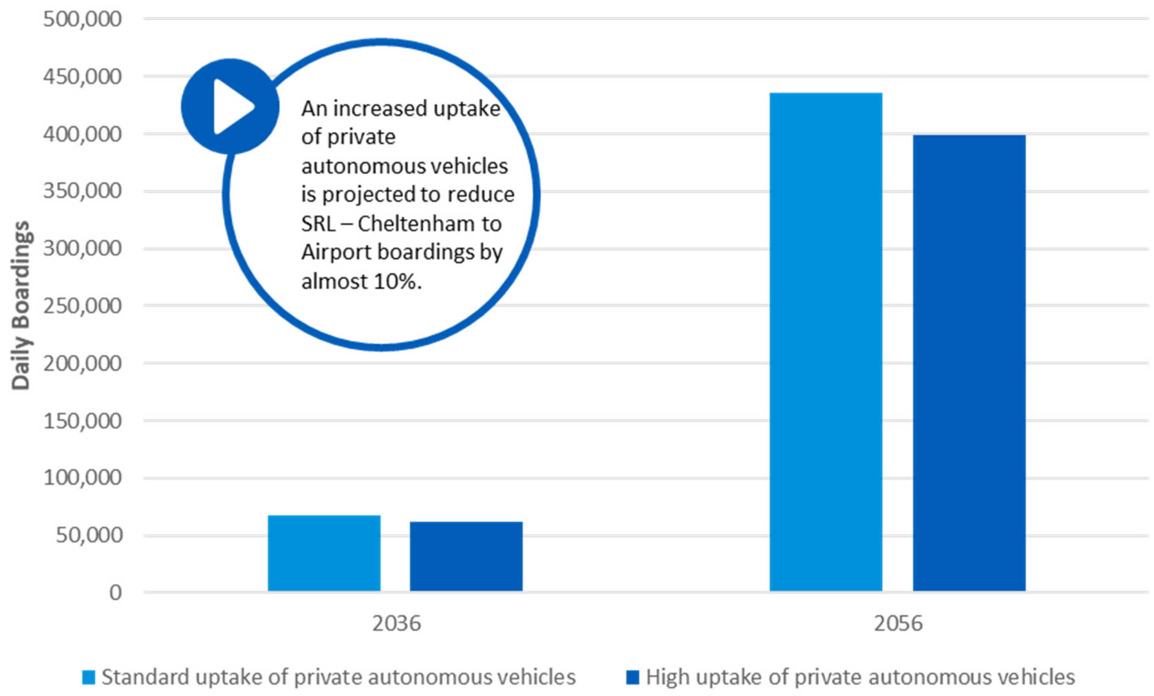
The demand results from the MABM scenarios undertaken as per the specifications above were used to derive scale factors, reflecting how public transport and private vehicle trips changed under the AV/EV specifications compared with standard conditions assumed in core modelling. These scale factors were used to undertake the sensitivity tests within VITM, by scaling trip totals from the core VITM scenarios.

Private autonomous vehicle scenario

This scenario tests the impact of a high uptake of private autonomous vehicles. Using the MABM scale factors discussed above, private vehicle trips from the core modelling scenarios were scaled upwards for this scenario, to reflect a shift towards private vehicles stemming from the uptake of private autonomous vehicles. Public transport trips were scaled downwards to reflect the shift towards private vehicles. Additionally, road capacity was increased by 20% for this test, to reflect the assumed higher efficiency of AVs compared to other road vehicles, increasing effective road capacity.

Figure A- 111 shows the impact that this shift has on SRL – Cheltenham to Airport boardings, with modelling conducted under the high uptake of private AVs reducing daily boardings by 6,000 in 2036 and 37,000 in 2056.

Figure A- 111: Daily SRL – Cheltenham to Airport boardings, Core and Private Autonomous Vehicle sensitivity scenario, 2056



An increased uptake of private autonomous vehicles is projected to reduce SRL – Cheltenham to Airport boardings by almost 10%.

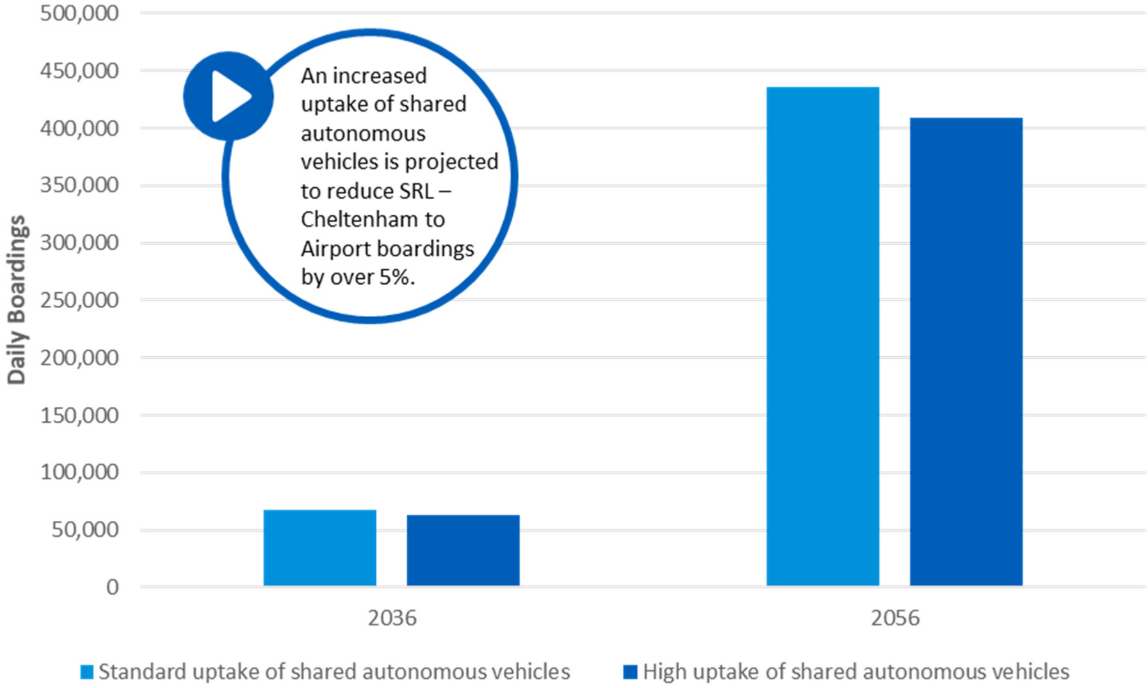
Source: KPMG VITM modelling

Shared autonomous vehicle scenario

This scenario tests the impact of a high uptake of shared autonomous vehicles. Using the MABM scale factors discussed above, private vehicle trips from the core modelling scenarios were scaled downwards for this scenario, to reflect a shift towards shared autonomous vehicles, increasing private vehicle occupancy rates and lowering trips. Public transport trips were scaled upwards. Additionally, road capacity was increased by 48% for this test, to reflect the assumed higher efficiency of autonomous vehicles compared to other road vehicles, increasing effective road capacity.

Figure A- 112 shows the impact that this shift has on SRL – Cheltenham to Airport boardings, with modelling conducted under the high uptake of shared AVs reducing daily boardings by 4,000 in 2036 and 27,000 in 2056.

Figure A- 112: Daily SRL – Cheltenham to Airport boardings, Core and Shared Autonomous Vehicle sensitivity scenario



An increased uptake of shared autonomous vehicles is projected to reduce SRL – Cheltenham to Airport boardings by over 5%.

Source: KPMG VITM modelling

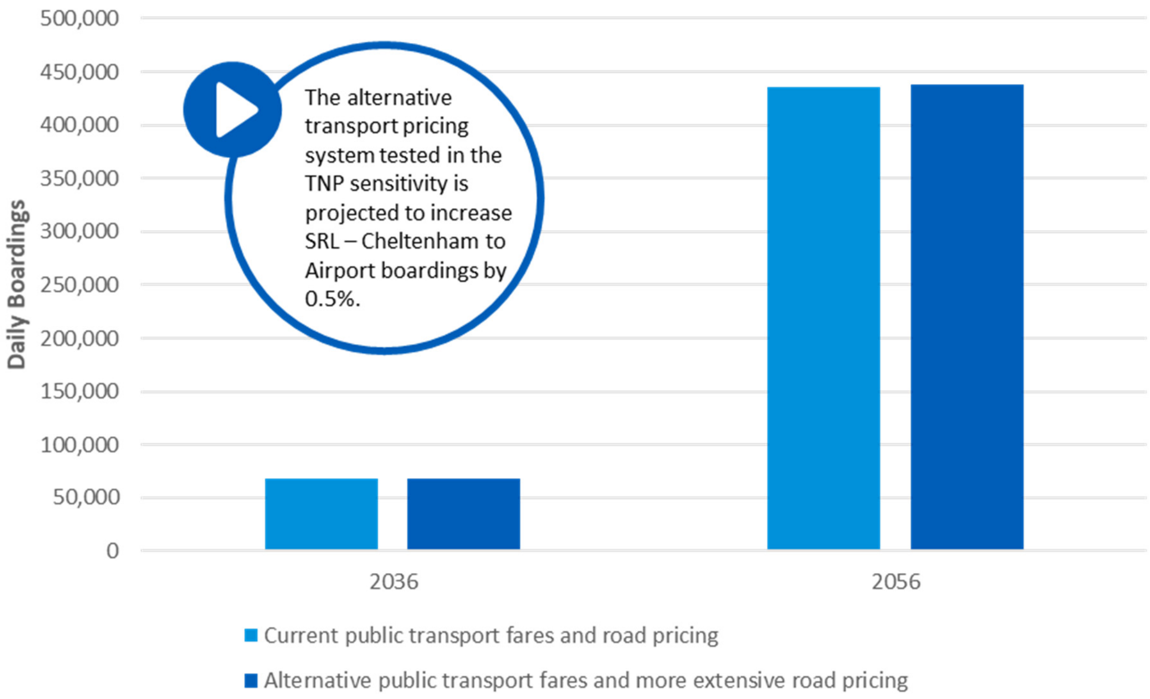
A.7.5 Transport network pricing

For future year modelling, VITM assumes public transport fares and road pricing will stay structurally similar to what exists in the present day, with the Myki fare system applied for most public transport, and tolls applied only to a limited number of roads plus a select few other proposed roads such as OMR. To test the impact of using alternative public transport fare systems and more extensive road pricing, a transport network pricing (**TNP**) sensitivity scenario was undertaken. This involved using outputs from MABM scenarios, which incorporated various fare and pricing interventions, to scale the number of private vehicle and public transport trips assigned in VITM. The MABM TNP scenario incorporated the following fare and pricing interventions:

- A road distance pricing of $0.155/km, as opposed to the $0.048/km applied in MABM Base Case conditions.
- A cordon charge of $1/km applied within inner Melbourne, to further discourage private vehicle usage in and around the CBD.
- Public transport fares based upon distance travelled ($0.09/km in the peaks, $0.07/km outside the peaks) and a flagfall ($1.70 in the peaks, $1.50 outside the peaks), as opposed to the Myki-based system.

Figure A- 113 shows the impact that this alternative network pricing has on SRL – Cheltenham to Airport boardings. Daily boardings are projected to increase slightly by approximately 300 in 2036, and 2,000 in 2056.

Figure A- 113: Daily SRL – Cheltenham to Airport boardings, Core and TNP sensitivity scenario



The alternative transport pricing system tested in the TNP sensitivity is projected to increase SRL – Cheltenham to Airport boardings by 0.5%.

Source: KPMG VITM modelling

Volume B: Land Use Impacts of SRL - Cheltenham to Airport

CityPlan Modelling

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B.1 Land Use Modelling

B.1.1 Overview

Land use modelling plays an important role in understanding the city-shaping impacts of major infrastructure projects. This volume provides a comprehensive summary of the land use and land use transport interaction modelling undertaken using CityPlan completed as part of the SRL Business and Investment Case. The volume is structured as follows:

- Background to the CityPlan model (Section B.2): outlines the assumptions, performance and limitations of the CityPlan model
- Modelling approach for SRL – Cheltenham to Airport (Section B.3): outlines the requirement for land use modelling and the suitability of CityPlan
- CityPlan Calibration and Validation (Section B.4): outlines the calibration process used for CityPlan and reports on the model's validation
- Key Assumptions (Section B.5): outlines the underlying base case assumptions and the specific assumptions associated with the Core scenarios and associated sensitivities
- A future with SRL – Cheltenham to Airport (Section B.6): outlines modelled future land use based on Core Program Case assumptions along with a range of sensitivities

For the purposes of this assessment, it has been assumed that SRL – Cheltenham to Airport will be delivered in three sections: between Cheltenham and Box Hill, followed by Box Hill to Reservoir and then Reservoir to Melbourne Airport.[1] For ease of reference, the section between Cheltenham and Box Hill is referred to as SRL East, and the section between Box Hill and Melbourne Airport is referred to as SRL North. For the purposes of the demand modelling and economic appraisal, two Program Cases have been assessed with SRL – Cheltenham to Airport delivered by 2053 (Option A) and by 2043 (Option B). As SRL North is still in early planning, the assessment of two Program Cases reflects that final delivery dates are yet to be confirmed.

B.1.2 Context of this report

The primary purpose of this volume of the Demand Modelling Report is to outline the land use impacts associated with each of the Core Program Case scenarios for SRL – Cheltenham to Airport and their associated sensitivities (Sections B.5 and B.6).

Sections B.2 through B.4 describe the background of CityPlan, including the general mechanics of the model and the assumptions and limitations associated with the approach. References to the CityPlan Model Specification[2] and Model Calibration[3] reports (recorded in Table B – 1 below) is made throughout this volume. Where further detail is available in either of the reports, explicit reference is provided. This appendix does not include detail of the CityPlan models and sub-models such as specific model parameters or model fit statistics; these can be found in the Model Specification report. Likewise, additional details of the model responsiveness and forecasting ability are reported in the Model Calibration Report.

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[1] SRLA advises that further detailed planning and technical design for SRL North will be undertaken over the coming years. Specific packaging and procurement decisions will be made at an appropriate time in the future.

[2] KPMG, CityPlan *Volume 1: Model Specification* (2020).

[3] KPMG, CityPlan *Volume 2: Model Calibration* (2020).

Table B – 1: CityPlan model development reports

Volume	Name	Description
1	**Model Specification**	The model specification report provides detail of the modelling framework, its key assumptions and limitations and high-level structure and logic of CityPlan and its sub-models. In addition, details of the model platform selection process KPMG, CityPlan Volume 1: Model Specification (2020)
2	**Model Calibration**	The model calibration report describes in detail the data inputs, assumptions and limitations, model estimation, model validation, response testing and projections KPMG, CityPlan Volume 2: Model Calibration (2020)
3	**User Guide**	The user guide, not referenced in this document, describes and demonstrates how users can set up, run and output results from CityPlan KPMG, CityPlan Volume 3: User Guide (2020)

Section B.5 and B.6 are concerned with the specific application of CityPlan to modelling land use associated with SRL – Cheltenham to Airport. Section B.5 provides a detailed overview of the modelling and reporting assumptions inherent in the core project scenarios and associated sensitivities. Where inputs have been provided externally, details of the source and justification are provided as appropriate. In the case of SRL specific inputs, summaries of the inputs are provided in tabular or map form as appropriate. Details of the individual initiatives which compose Program Case inputs are not provided – rather they are modelled as large scale, strategic initiatives.

B.2 Background

In recent years, awareness of the role of major transport projects on the evolution of land use has increased significantly. Despite this, the impacts are often omitted from the appraisal process for major transport infrastructure or considered only at a high-level. This has driven demand for more sophisticated and granular modelling tools.

In 2018, a scoping study was undertaken by DoT to assess the requirement and options for a Land Use and Transport Interaction (LUTI) model suitable for the appraisal of major transport infrastructure projects in Victoria. The study led to a recommendation for a bespoke implementation of UrbanSim; an open-source, agent-based land use modelling framework. Subsequently, CityPlan, a Victorian implementation of UrbanSim was developed with input from various stakeholders within the Victorian Government.

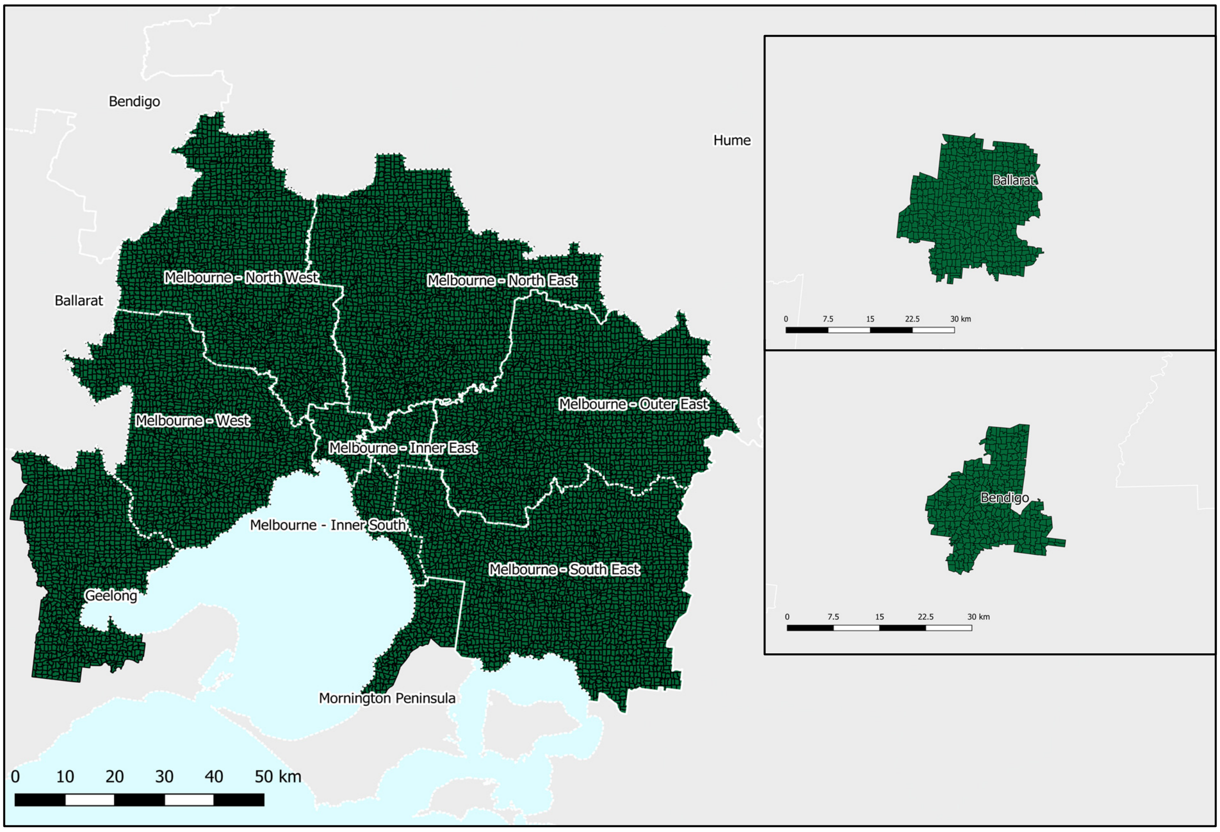
Modelling approach

CityPlan provides a tool to estimate the expected city-shaping impacts of interventions and initiatives, such as shifts in planning policy, population growth or supply of major infrastructure among others.

CityPlan is a dynamic disequilibrium land use model. This means CityPlan forecasts the evolution of cities under different assumptions about future conditions. Dynamic disequilibrium land use models do not use equilibration of supply, demand or prices of real estate to generate outcomes. Rather, they simulate the decisions of economic actors, assuming that the city is constantly evolving in response to changing conditions.

CityPlan divides Metropolitan Melbourne, Geelong, Ballarat and Bendigo into 10,998 roughly equal sized zones (of approximately 100 ha), with each having their own unique characteristics. The geographic extent of the model is shown in Figure B - 1. Although some UrbanSim implementations are *parcel-based* (representing jobs and households at the land parcel level), a zone-based implementation was selected due to data and time constraints. CityPlan is designed to be able to be migrated to a *parcel-based* implementation in a future version.

Figure B - 1: CityPlan 10,998 zone system covering the primary metropolitan areas of Victoria



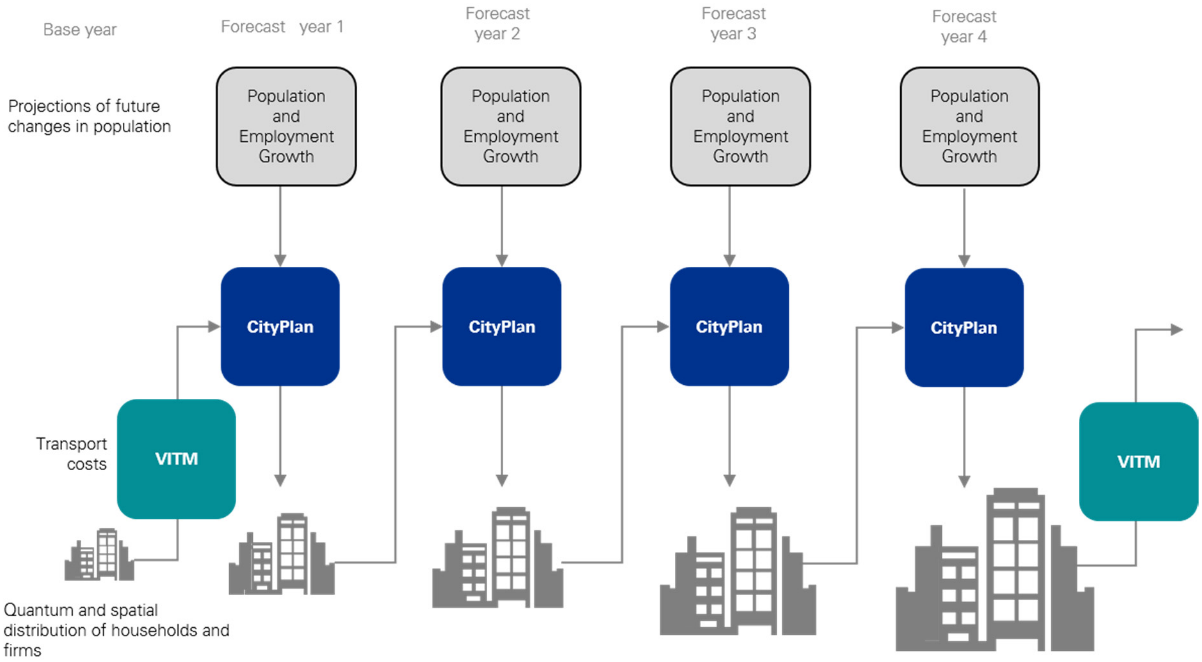
Source: CityPlan

CityPlan works in conjunction with several other Victorian strategic planning tools: DELWP population Projections 2018 (Unpublished), Victorian Government employment projections and the Victorian Integrated Travel Model (VITM). When used in conjunction with VITM, CityPlan is an advanced (fourth generation or 4G) LUTI model.

VITM estimates multi-modal flows, capacities and travel costs across the Victorian transport system. Figure B - 2 illustrates the interaction between CityPlan, DELWP Projections and VITM. CityPlan derived land use is used as an input to VITM which produces updated travel costs that can be fed back into CityPlan.

In order to keep the overall model run times manageable, and for consistency with VITM, CityPlan is configured to perform feedback with VITM at multi-year intervals rather than every year. These intervals are designed to coincide with VITM model years (5-year intervals between 2016 and 2056). In turn, the revised travel costs, generated by VITM, inform the spatial allocation of households and firms. This approach to modelling, in which feedback is made between CityPlan and VITM is referred to as 'dynamic' mode. Where travel costs are based on reference case land use, this is referred to as 'static' mode. Due to the model run time, dynamic runs are used for core scenarios while, static runs are used for sensitivity analysis. This allows for a large number of alternative sensitivity scenarios to be modelled expeditiously.

Figure B - 2: CityPlan working in conjunction with DELWP Projections 2018 (Unpublished) and VITM (LUTI model)



Source: KPMG, CityPlan Volume 1: Model Specification Report

B.2.2 Model structure

CityPlan comprises four sub-model types and is designed to interact directly with VITM. Table B - 2 shows an overview of the sub-models and their order of execution. This order is repeated in each year in which the model iterates.

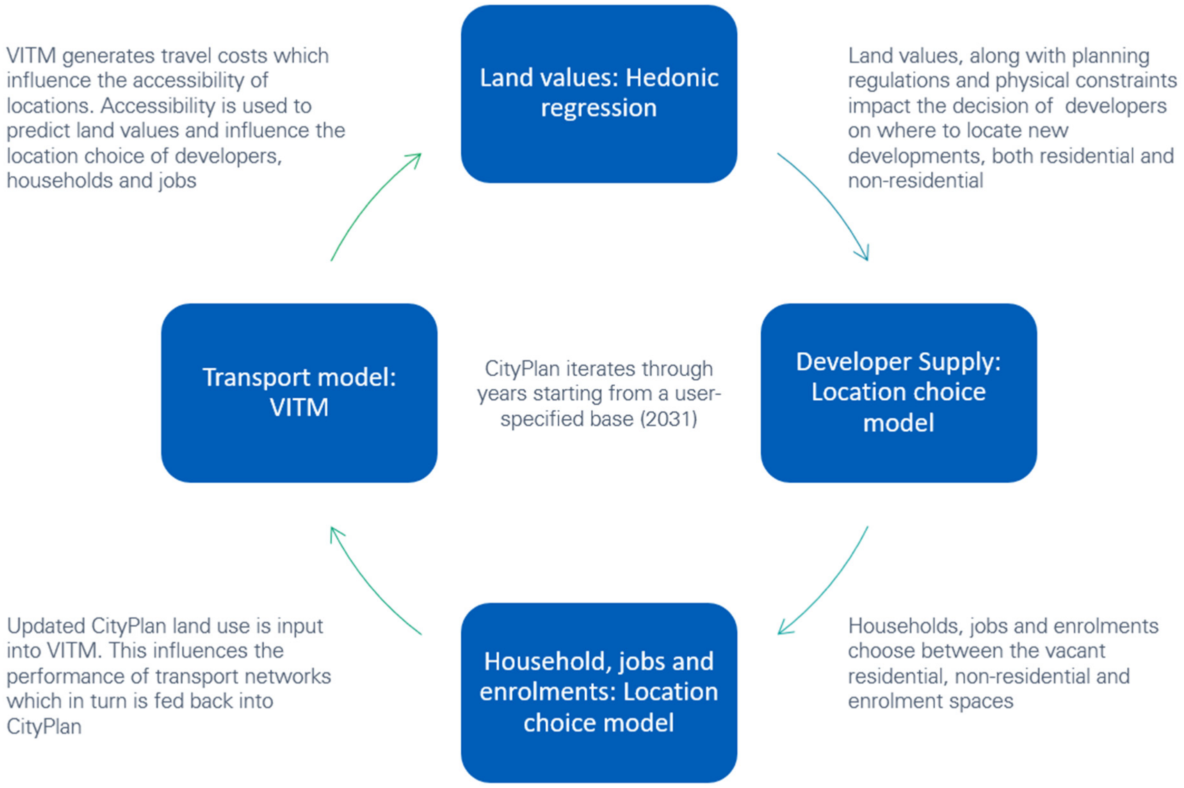
Table B - 2: CityPlan sub-models

Transport model (VITM)
Purpose: To estimate the travel costs of trips between zones within the study area **Configuration:** Trip-based four-step model (VITM) **Spatial Resolution:** 2,968 Travel Zone (TZN) **Temporal Resolution:** 5 years **Primary inputs:** Transport networks, Land use **Primary outputs:** Travel costs
Land values: Hedonic Regression
Purpose: To estimate land values per square metre **Configuration:** Ordinary least squares regression **Spatial Resolution:** 10,998 CityPlan Zone (CPZ) **Temporal Resolution:** 1 year **Primary inputs:** Travel costs **Primary outputs:** Median land value per square metre
Developer supply location choice model
Purpose: To simulate the decisions of developers about where to provide new residential units, office, retail and industrial space **Configuration:** Multinomial logistic regression **Spatial Resolution:** 10,998 CPZ **Temporal Resolution:** 1 year **Primary inputs:** Land value, development capacity and development rate **Primary outputs:** Locations of newly provided stock
Households, businesses and enrolment location choice models
Purpose: To simulate the decisions of households, businesses and enrolments (segmented by category) about where to locate **Configuration:** Multinomial logistic regression **Spatial Resolution:** 10,998 CPZ **Temporal Resolution:** 1 year **Primary inputs:** Locations of vacant stock (high and low density residential, retail, office, industrial and educational spaces) **Primary outputs:** Locations of new or relocating households, jobs and enrolments

Source: KPMG, CityPlan Volume 1: Model Specification Report

The relationship between the four sub-models is illustrated in Figure B - 3.

Figure B - 3: CityPlan operation overview



VITM generates travel costs which influence the accessibility of locations. Accessibility is used to predict land values and influence the location choice of developers, households and jobs

Land values, along with planning regulations and physical constraints impact the decision of developers on where to locate new developments, both residential and non-residential

CityPlan iterates through years starting from a user-specified base (2031)

Updated CityPlan land use is input into VITM. This influences the performance of transport networks which in turn is fed back into CityPlan

Households, jobs and enrolments choose between the vacant residential, non-residential and enrolment spaces

Source: KPMG, CityPlan Volume 1: Model Specification Report

B.2.3 Key concepts

Reference Case land use (SALUP)

Reference Case land use refers to the official Small Area Land Use Projections (SALUP) based on DELWP Projections 2018 (Unpublished). These data sets are provided by DoT as a primary input to demand modelling. The SALUP data are provided at two scales, the 21k zone system (20,690 zones) and the 7k system (6,973 zones). Table B - 3 records the Reference Case land use spatial resolution and version.

Table B - 3: Reference Case land use and version

System	Version
21k	Based on DELWP Projections 2018 (Unpublished)
7k	

Source: KPMG, CityPlan Volume 1: Model Specification Report

Base Case and Program Case scenario

CityPlan is run using matched ‘*Base*’ and ‘*Program*’ Case scenario pairs. For each, the scenarios initiate from a common base year (2031 for SRL – Cheltenham to Airport) and forecast land-use evolution from that point forward. The difference between the Base and Program Case land use in a given zone is the estimated ‘land use impact’ of SRL.

Travel costs (impedance)

Travel costs are an output of VITM. The travel costs, split by trip purpose and transport mode, are calculated as a generalised travel cost (disutility or travel impedance). The travel disutilities are the same as those used for mode choice in VITM. Where alternative transport scenarios, such as the opening of SRL – Cheltenham to Airport or changes in land use, alter travel demand, these changes are reflected in the cost of travel. In understanding the travel costs, it is important to understand generalised travel time used in VITM, travel disutilities and the logsum method used to generate an overall travel disutility across all modes.

In VITM, generalised travel time represents a single mode at a given time. Generalised travel time considers the 'time value' of other factors, such as the monetary cost of travel (e.g. fares, tolls) and inconveniences (e.g. transfers, crowding, unreliability). These considerations are added to the actual travel time to generate an overall measure of impedance as it is perceived by the user. The functional form for generalised travel time is shown in Equation 1.

Economic disutility is directly related to generalised travel time. It is a measure of a single mode for a given purpose at a given time. The functional form for economic disutility is shown in Equation 2. Economic disutility is the variable used in estimating discrete choice models within trip-based transport models such as the VITM (e.g. for mode choice).

Logsum is a technique to combine the utility of alternative available modes (e.g. car and public transport) to produce a travel impedance that is 'mode blind' and considers all available options. CityPlan uses Logsum to combine Public Transport (**PT**) and car disutilities into a single measure. The functional form for logsum disutility is shown in Equation 3.

$$GTT = f(TT, C, O)$$ Equation 1

Where:

GTT is generalised travel time in minutes

TT is travel time in minutes

C is travel cost converted from dollars to equivalent minutes

O is a set of other relevant factors converted to equivalent minutes.

$$U_m = \lambda \cdot GTT + MSC$$ Equation 2

Where:

U_m is the economic disutility of travel of a given mode

GTT is generalised travel time in minutes

MSC is a mode specific constant

λ is a model parameter.

$$U = \ln \sum_m e^{U_m}$$ Equation 3

Where:

U is the logsum disutility.

CityPlan Volume 1: Model Specification Report[4] provides further explanation of the travel cost calculation process.

Accessibility

Accessibility represents the ease and convenience of access to opportunities. Accessibility is generally higher in locations with high numbers of opportunities (e.g. jobs) and good transport supply (e.g. Melbourne CBD). In CityPlan, accessibility plays several important roles. These include the estimation of land values, and in location choices of households and jobs. CityPlan uses a cumulative opportunities measure with the addition of a saturation function as specified in Espada & Luk (2011)[5] for the calculation of accessibility. The measures yield accessibility indices are a continuous variable between 0.0 (being the worst possible accessibility) and 1.0 (being the best possible accessibility). Accessibility measures in CityPlan can be defined as either origin measures or destination measures.

Origin measure represents accessibility to opportunities in all destinations in the study area from a given origin zone. The functional form for origin measures is shown in Equation 4. For example, an origin measure might be used to represent how well a commuter can access job opportunities from a given location (e.g. a house they are considering purchasing).

$$A_i = s\left(\sum_j d(C_{ij})X_j\right) \qquad \text{Equation 4}$$

Where:

X_j is the number of opportunities available at zone j (destination)

C_{ij} is the travel impedance between zones i (origin) and j (destination)

d is the deterrence function

s is the saturation function.

Destination measures represent the accessibility to opportunities in all origins in the study area from a given destination. The functional form for origin measures is shown in Equation 5. Destination measures are often used to represent catchments. For example, a destination measure might be used to represent how many workers can access a given location (e.g. a job-focused precinct).

$$A_i = s\left(\sum_i d(C_{ij})X_i\right) \qquad \text{Equation 5}$$

Where:

X_i is the number of opportunities available at zone i (origin)

C_{ij} is the travel impedance between zones i (origin) and j (destination)

d is the deterrence function

s is the saturation function.

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[4] KPMG, *Volume 1: Model Specification* (2020), p. 39.

[5] Espada, I., & Luk, J. (2011). Development of an accessibility metric and its application to Melbourne. *Road & Transport Research*, 20(3), pp. 66-77.

The two primary measures of accessibility in CityPlan, C2J and B2B (both origin measures) are described below, although various others are also used:

- *Commuter to Jobs (C2J)* is an origin-based, cumulative opportunities measure based on the number of jobs accessible from a given origin. It represents the ease with which the workforce can access employment for trip-lengths typical of commuting.
- *Business to Business (B2B)* like C2J is an origin-based, cumulative opportunities measure based on the number of jobs accessible from a given origin. It represents the ease with which businesses can access other businesses for trip-lengths typical of (short) business trips.

For further explanation of the CityPlan accessibility measures, see CityPlan Volume 1: Model Specification Report.[6]

Land values: Hedonic regression

The purpose of the hedonic regression model is to estimate the typical value of land as the site value per square metre for low density residential land in each of the 10,998 CPZs used in CityPlan. In CityPlan, land values are a key driver of both the developer supply models (higher land values mean higher density development) and the household and job location demand models (higher land values serve as a 'brake' on demand, with negative coefficients).

$$y = \beta_a X_a + \beta_n X_n + e \qquad \text{Equation 6}$$

Where:

y is the dependent variable (site value per square metre)

X_a is a set of accessibility variables

β_a is a set of fitted coefficients relating to the accessibility variables

X_n is a set of neighbourhood and amenity variables

β_n is a set of fitted coefficients relating to the neighbourhood and amenity variables

e is the error term.

Specific initiatives which will influence land values can be represented as 'hedonic multipliers'. These multipliers enable exogenously specified initiatives to be represented within the model. Such initiatives may include anticipated land value uplift associated with improvement amenity such as green space or civic plazas. Within the SRL – Cheltenham to Airport context, these initiatives are referred to as Liveability initiatives.

CityPlan Volume 1: Model Specification Report[7], and CityPlan Volume 2: Model Calibration and Validation Report[8] provide further explanation of the Hedonic modelling process and Hedonic Regression specification and performance.

Land use settings (land use capacity and development rates)

Land use capacity and development rates are key drivers of development in CityPlan:

- *Capacity* represents the total stock that could exist per zone per building type under current (or alternative) planning scenarios.
- *Development rates* define the allowable rate of development per zone per year for each building type. The development rates represent a realistic constraint on the rate of possible development.

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[6] KPMG, *Volume 1: Model Specification* (2020), p. 37.

[7] KPMG, *Volume 1: Model Specification* (2020), p. 48.

[8] KPMG, *Volume 2: Model Calibration* (2020), p. 22.

Base year land use capacities and development rates are modelling assumptions. The specification of these is informed by anticipated growth in population and employment, planning policy and long-term government forecasts and projections.

Base Case capacities

Base Case capacities are derived using the SALUP data. For each building type within each CPZ, the highest observed figure up to and including the year 2056 is calculated. Outside the CBD, this capacity is increased by 20% to account for longer-term growth and to ensure long-term responsiveness of the model and avoid the outcomes being 'steered' by capacities. In the CBD, capacity is set explicitly to match long term Reference Case (SALUP) projections. This CBD capacity is informed by work completed by Urbis for DoT examining the capacity for residential and non-residential development within the CBD. For a discussion on the CBD capacity, including both physical and planning constraints, as well as assumed outcomes, see "Unlocking Melbourne's CBD" a report by Urbis published in 2018.[9]

For residential units, the capacity derived from the forecast number of households is split between low- and high-density dwellings. Low-density capacity is assigned either as the minimum number of households or the feasible low-density (determined to be up to 15 dwellings per hectare of low-density supporting land), with the remaining capacity assigned to high-density[10] The proportion of each CPZ able to support low-density residential is informed by the 2018 Victorian Planning scheme.

Base development rates

Each CPZ is attributed with a class which represents the maximum possible rate of development per building type in any single year. This parameter represents both the 'permissiveness' of planning regulations in a given zone and realistic constraints relating to developer behaviour and the real estate market. For example, even if planning permission is provided, developers will usually not deliver the full capacity of a development in a single year for the following reasons:

- Limits to the availability of labour force and materials
- Management of supply such that it responds to demand in an appropriate manner.

Each CPZ is attributed with a class which represents the maximum possible rate of development per building type in any single year. This parameter represents both the 'permissiveness' of planning regulations in a given zone and realistic constraints relating to developer behaviour and the real estate market. For example, even if planning permission is provided, developers will usually not deliver the full capacity of a development in a single year due to limits to the availability of labour force and materials and management of supply such that it responds to demand in an appropriate (and profitable) manner.

The development classes and associated magnitude of development rates are set during the calibration process. This ensures that CityPlan is delivering growth at rates that are in line with observed historical developments. Development rates are implemented as a two-step process. First, for each developer (low density residential, high density residential, office, industrial and retail) the CPZ is classified for each of multiple development 'classes' based on the rate of development the zone could support. This classification is guided by the Victorian Planning Scheme, with adjustments based on an interpretation of the planning scheme and accepted norms. The development classes are then adjusted during a calibration process against historical growth in the 2006-16 period. The development rates corresponding to each class are also calibrated to observed historical growth. CityPlan Volume 1: Model Specification Report[11] provides further details on base development rates.

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[9] Urbis, *Unlocking Melbourne's CBD* (2018).

[10] Household density per hectare https://www.vpa.vic.gov.au/wp-content/Assets/Files/PSP%20Guidelines%20-%20PART%20TWO.pdf

[11] KPMG, CityPlan *Volume 1: Model Specification* (2020), p. 80.

Transition: Demographic, economic and enrolment

CityPlan demographic, economic and enrolment transition models are responsible for matching annual control totals. In each case, the objective is to match the forecast growth or decline across these groups each time the model advances a year.

- Demographics: Annual control totals, derived from DELWP Projections 2018 (Unpublished), indicate growth by age and household type. The transition model matches both the household and individual level control totals to accurately model the new population.
- Employment: Annual control totals, derived from Victorian Government projections, indicate change in employment split by ANZSIC industry and collar (there are 19 industries and two collars for a total of 38 categories). The transition model adds or removes jobs from each of these groups to ensure the control totals are met.
- Enrolments: Annual control totals, derived from DELWP Projections 2018 (Unpublished), indicate change in the number of enrolments split by enrolment level (primary, secondary and tertiary). The transition model adds or removes jobs from each of these levels to ensure the control totals are met.

In the case of each transition model, where additional agents are added, these agents are initially unplaced. The location of these agents is determined as part of the developer supply model.

CityPlan Volume 1: Model Specification Report[12] provides further details of the transition models.

Transition: Real estate

The CityPlan real estate transition model creates the new dwellings and job spaces required to support projected growth. The target of new real estate, split by building type, is designed to cover all households and jobs in addition to a target nominal vacancy rate of 1%. Note the vacancy rate is a model mechanism and is not intended to be a true representation of the actual vacancy rate.

The low-high density ratio reflects the proportions of new dwellings being built that are either high density or low density. This is a global assumption, and it impacts the locations in which development will occur. The CityPlan definition of low-density and high-density is considered a 'functional' rather than strict definition. The first 15 dwellings per hectare of residential zoned land is classified as 'low-density', and any additional dwellings beyond that density threshold is classified as 'high-density'. This approach, described in the CityPlan Volume 1: Model Specification, is necessary due to the subjective nature of the terms and varying definitions between data sources (for example, Census definitions vary from Valuer General definitions).

Typically, high density development tend to occur in established areas while low density development tend to occur in greenfield growth areas on the urban fringe. The change in the low-high density ratio between Base and Program Case is intended to represent the change in opportunity for developers to build (and consumers to choose) higher density development due to 'unlocking' of capacity by a project (in this case, unlocking of high density residential capacity by SRL – Cheltenham to Airport).

The Base Case proportions are calibrated to provide a similar outcome to the Reference Case SALUP projections balancing growth in established areas against growth on the urban fringe. The Program Case higher density proportions are pivoted off the Base Case proportional to the change in the ratio of total high-density capacity to low-density capacity in the study area. This calculation is shown in Table B - 4 and Table B - 5 for any given single year, as well as the impact shown in Figure B – 4. Figure B - 4 also illustrates the impact this changing ratio has over time.

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[12] KPMG, CityPlan *Volume 1: Model Specification* (2020), p. 31.

Table B - 4: Low-high density ratio calculation (a)

Year	Low-density capacity	High density capacity	Proportion of high density
Base Case	2,804,648	1,843,549	39.7%
Program Case Option A	2,804,648	2,166,711	43.6%

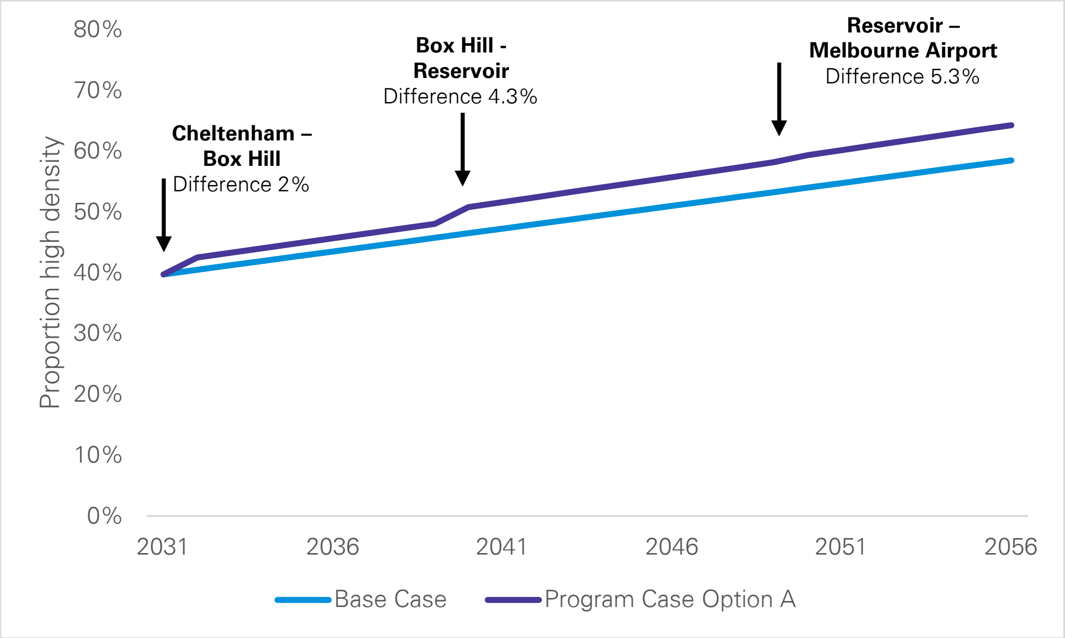
$$\text{Uplift Ratio} = \frac{43.6}{39.7} = 1.098$$

Equation 7

Table B - 5: Low-high density ratio calculation (b)

Proportion of new dwellings that are higher density in Base Case in a given year. This number is calibrated.	Uplift ratio	Proportion of new dwellings that are higher density in Program Case Option A
54%	1.098	59.34%

Figure B - 4: Implementation of changing the ratio of high and low density residential dwellings



Source: KPMG, CityPlan Volume 1: Model Specification Report. Program Case Option A

Further details on the low-high density ratio methodology can be found in CityPlan Volume 1: Model Specification Report.[13]

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[13] KPMG, CityPlan *Volume 1: Model Specification* (2020), p. 66.

Location choice

As an agent-based model, CityPlan represents real estate (residential, non-residential and enrolment spaces) and also individual households, businesses and enrolments as individual agents. Each agent is independent and has a unique set of characteristics which influence and constrain their location choice.

Agents' location choices are represented using Location Choice Models (**LCMs**). The LCMs are modelled using discrete choice models; a quantitative method of representing the real-world decision-making process. LCMs estimate the probability of selecting between alternative locations. At a high level, these location choice models can be split into two sets:

- Developer supply
- Households, businesses and enrolments.

Developer supply

The developer supply models are responsible for distribution of unplaced real estate. This real estate, introduced in the 'real estate transition' step, includes low and high density residential dwellings, industrial, office and retail spaces. A distinct location choice model exists for each building type. A key feature of the developer supply model is that it is constrained by both ultimate capacities and development rates. Where no capacity remains within a zone, development within that category is no longer possible.

For further explanation of the developer location choice modelling process, see CityPlan Volume 1: Model Specification Report.[14]

Developer location choice models are discussed in greater detail in CityPlan Volume 1: Model Specification.[15]

Households, businesses and enrolments

The household, business and enrolment models are responsible for distribution of unplaced households, businesses and enrolments introduced as part of the transition model. There are nine household models, nine business models and a single model for tertiary enrolments.

For further explanation of the location choice modelling process, see CityPlan Volume 1: Model Specification Report.[16]

Primary and secondary school enrolments

The distribution of primary and secondary school enrolment spaces and enrolments is deterministic. The approach is explicitly tied to the distribution of dependents aged 5 to 11 for primary enrolments and 12 to 17 for secondary enrolments. The deterministic approach to the distribution of primary and secondary enrolments is:

1) Zones with corresponding enrolment spaces are classified as school zones
2) Zones without enrolment spaces are assigned to the catchment of the nearest school zone
3) Enrolments within the school zone are equal to the number of the corresponding age of young people aged 5 to 11 for primary and 12 to 17 for secondary enrolments within the school zone catchment.

The general rule is that children within households will typically travel to the nearest school and that the number of enrolments within a catchment will be equal to the number of appropriately aged children within the catchment.

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[14] KPMG, CityPlan *Volume 1: Model Specification* (2020), p. 58.
[15] KPMG, CityPlan *Volume 1: Model Specification* (2020), p. 61.
[16] KPMG, CityPlan *Volume 1: Model Specification* (2020), p. 61.

Scheduled developments and adjustments

Scheduled developments allow the user to 'force' supply in any given year. For example, if it is known that a major employment development is scheduled for completion in a known year, the job spaces which this will create can be explicitly specified. These scheduled developments are specified based on the year in which they will be realised and within the CPZ which will be affected. Instituting this involves the user specifying a year, a quantum and a type of development (e.g. houses, units, office, retail and industrial). This development is then allocated prior to the development supply LCMs being executed. A similar process can be applied for residential developments in which additional dwelling stock can be specified.

Adjustments allow the user to 'force' demand in specific years. The user specifies a year, a quantum and a category (e.g. health jobs). The additional demand is then allocated to the zones specified. It is a modelling assumption whether these adjustments respect or exceed the corresponding capacity. Unlike scheduled developments, the adjustment model performs a redistribution of supply and demand rather than creating new supply only. These aim to replicate forced demand, such as those associated with planning infrastructure development. Adjustments are an assumption input provided by SRLA, with these referred to as productivity initiatives.

For further details, see CityPlan Volume 1: Model Specification Report.[17]

Pivoting

In transport demand forecasting, it is common practice to utilise a *pivot method* to reconcile differences between synthetic (modelled) outcomes with either known or expected outcomes.[18] The method is commonly used in strategic modelling. Pivoting provides a consistent method to standardise outputs between models and reference systems.

The pivot method has been applied widely within applications, including:

- Transport for NSW (**TfNSW**) uses the approach for their Strategic Transport Evaluation Model (**STEM**)
- UK Web-based Transport Analysis Guidance (**WebTAG**) suggests using the pivot approach where appropriate
- Victorian DoT is considering adopting the pivot approach for the next VITM Recalibration
- Cross City Link demand forecasting adopted the pivot approach
- Victorian Level Crossing Removal Project uses it for assessing station to station matrix.

CityPlan uses the pivot method to reconcile modelled land use outcomes against the Reference Case. This allows the Reference Case land use to be used as the Base Case as per DoT guidance. This means that, in this context, CityPlan is used to estimate the land use impacts of the intervention, but not to estimate the Base Case land use itself.

The difference between matched CityPlan Base Case and Program Case scenarios is added to (or subtracted from) the SALUP Reference Case. For economic purposes, this allows for the outputs of CityPlan to be compared directly against demand runs using the SALUP Reference Case data.

Figure B - 5 illustrates the process. The application of the pivot method for the SRL – (Cheltenham to Airport) Business and Investment Case has been endorsed by SRLA.

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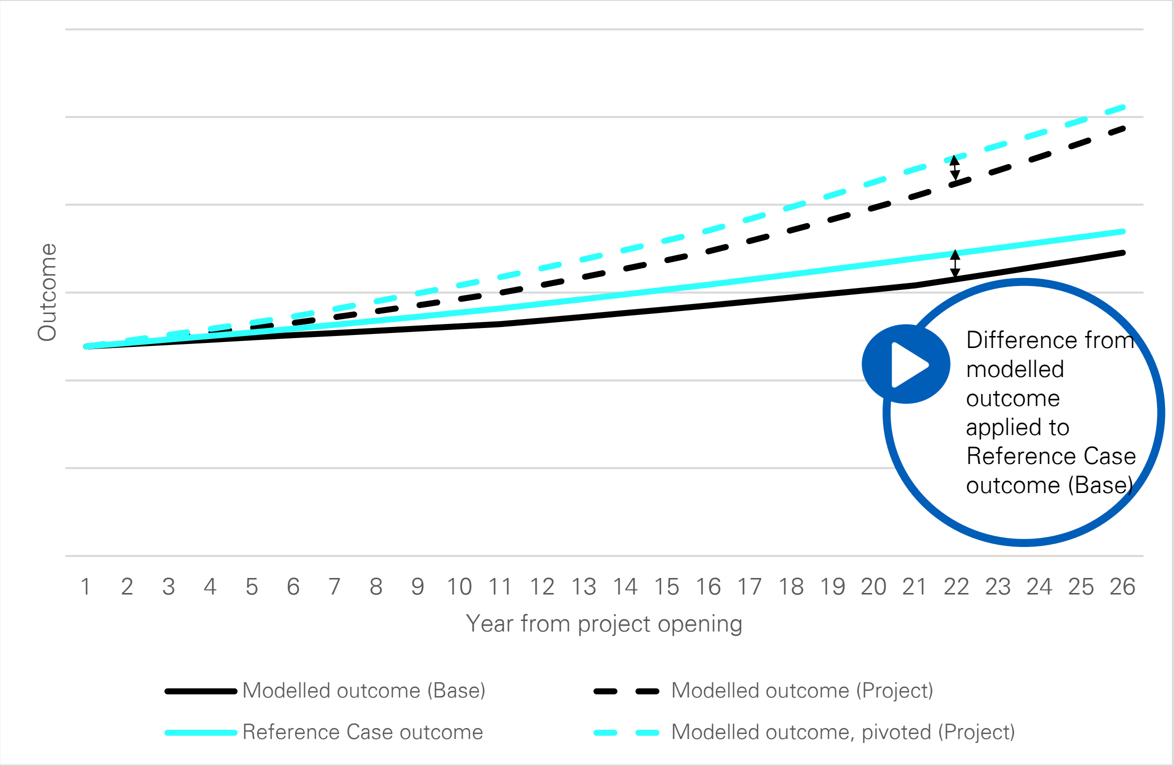
[17] KPMG, CityPlan *Volume 1: Model Specification* (2020), p. 66.
[18] RAND Pivot Method - https://www.rand.org/pubs/technical_reports/TR1181.html

Figure B - 5: Illustration of pivoting method



Source: KPMG, CityPlan Volume 1: Model Specification Report

B.2.4 Assumptions and limitations

Table B - 6 provides a list of the overarching assumptions and limitations relevant to CityPlan. More detail on these assumptions and limitations can be found in CityPlan Volume 1: Model Specification Report.[19] In addition, details of the developments taken to refine CityPlan and address limitations in the V1.0 version of the model are detailed in Section B.4.

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[19] KPMG, CityPlan *Volume 1: Model Specification* (2020), p. 73.

Table B - 6: General CityPlan Assumptions Overview

Category	Overview	Assumptions / Limitations
General	Several assumptions are generic to the UrbanSim platform (a zone-based implementation)	• Land use regulations are assumed to be binding constraints on the actions of developers • Large scale and microscopic events cannot be accurately predicted • Model users should not expect to accurately predict large scale, idiosyncratic events (i.e. development of a high-rise office building on a specific parcel of land) • Behavioural patterns are assumed to be relatively stable over time, with observed (past) behaviours acting as a guide to future behaviour
Transition	Transition represents how the number and make-up of Victoria's households and firms is expected to change over time	• Transition volumes adhere to control totals specified by DELWP Projections 2018 (Unpublished)
Relocation	Relocation represents the movement of existing households and firms between different zones within the study area	• Relocation module not used
Synthetic population	The synthetic population is a disaggregate population dataset which accurately represents the statistical properties of the observed or projected population. See CityPlan Volume 1: Model Specification Report[20] for more details	• Synthetic population base is 2031 using SALUP 2031 based on DELWP Projections 2018 (Unpublished)
Land values	CityPlan represents the land value per square meter for each zone within the study area, including how different factors influence those values	• Potential variable correlation in hedonic model • Hedonic model is strategic; it does not account for localised factors • Hedonic model has potential for omitted variable bias • Hedonic model is impacted by spatial auto-correlation to a degree
Stocks, capacities and development rates	CityPlan represents the 'stock' of buildings in each zone, and the 'capacity' of each zone to support new buildings in the future	• Capacities are user defined. It is incumbent on the user to ensure that Base Case and Program Case capacities are defined in a reasonable way • Capacity is not 'removed' in CityPlan in an automated way. If one land use type is replacing another – the user needs to manually adjust the capacities (e.g. removing industrial capacity to allow for residential capacity to be added). Similarly, there is no overall accounting for development capacity across all land use types – the user must ensure this is defined reasonably

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[20] KPMG, CityPlan *Volume 1: Model Specification* (2020), p. 19.

Category	Overview	Assumptions / Limitations
		• Stocks are derived from SALUP for the base year, with the process for determining Base Case capacities outlined in Section B.5.1. Base development rates are a calibrated measure, with the Program Case development rates process outlined in Section B.5.1 • Employment stock is split into pre-determined employment sectors (office, retail, industrial and other) • Residential stock is split into two groups – low- and high-density residential units • Development rates / classes are high-level and imply 100% adherence by developers. They are manually set and can be overridden by scheduled developments / adjustments inputs if the latter exceed the former • A nominal vacancy rate of 1% is used
Developer supply	CityPlan represents how developers respond in producing real estate supply in response to market conditions (including constraints on developers, i.e. due to planning regulations)	• Developer supply models are driven by the hedonic model and the capacity and development class assumptions • There is a defined set of developer categories; low-density residential, high-density residential, office, retail and industrial • Competition between land uses (e.g. between office and residential) is not represented
Location demand	CityPlan uses location choice modules to estimate the choices of households, firms and enrolments	• Household LCM does not account for residential stock type • Employment LCM is not directly impacted by land value (although non-residential developer supply is affected by land value)
Zones	CityPlan covers the most populous urban areas of Victoria, including Greater Melbourne, Geelong, Ballarat and Bendigo. This region is divided into 10,988 zones of approximately 100 hectares each.	• A zone-based implementation was chosen over parcel-based implementation due to time and data constraints • CityPlan is a strategic model and should be interpreted at a regional and corridor level. Individual zone-level outputs should not be considered reliable • The modifiable area unit problem (MAUP) is present, associated with spatial aggregation and disaggregation • A small number of zones are non-contiguous

Source: KPMG, CityPlan Volume 1: Model Specification Report

B.3 Modelling approach for SRL - Cheltenham to Airport

The transformative, city- and State-shaping nature of SRL – Cheltenham to Airport means that it cannot be assessed or evaluated as a typical transport infrastructure project. Given the scale of SRL – Cheltenham to Airport and its potential to drive land use change, and deliver economy-wide productivity and social benefits, a conventional approach to economic appraisal would not reflect its full merit and could potentially understate its value. Conventional economic appraisal typically assumes static land use (i.e. no change in land use between the Base and Program Case). That is to say that city-shaping effects of major infrastructure investments, shifts in planning policy or other initiatives, have no impact on the geography of households or employment. Failure to account for land use change due to an investment on the scale of SRL – Cheltenham to Airport may have several adverse consequences, including:

- Underestimating demand
- Underestimating or overestimating congestion
- Underestimating benefits
- Underestimating the benefits of agglomeration.

Further to the above, the use of conventional transport demand modelling in isolation lacks the scope to fully capture the broad range of investments, interventions and initiatives proposed as part of SRL – Cheltenham to Airport . In particular, increases in land use capacity are driven by SRL, along with targeted initiatives to improve productivity and liveability. Given the above, a bespoke modelling approach has been used, appropriate for the scale and impact of SRL – Cheltenham to Airport. This approach combines VITM, a conventional four-step transport demand model, with CityPlan, an advanced land use model developed for application on infrastructure projects in Victoria. Used in combination, VITM and CityPlan are an advanced fourth generation LUTI model. They enable the broad scope of SRL – Cheltenham to Airport to be modelled. Table B - 7 outlines the two models and their key capabilities.

Table B - 7: Summary of key model capabilities of VITM and CityPlan

Model	Capability
VITM	• Impact of land use on performance of the transport network • Assess impact of alternative transport infrastructure investments, sequencing and service plans • Impacts of policy such as parking charges
CityPlan	• Impact of accessibility on the evolution of land use • Impact of changes in planning policy (both in regard to development capacity and permissibility) • Impact of changes due to initiatives to improve liveability such as additional parks or plazas • Impact of initiatives to improve productivity such as the introduction of anchor tenants

Source: KPMG, CityPlan Volume 1: Model Specification Report

For further details of the CityPlan model testing, see the CityPlan Volume 2: Model Calibration.[21]

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[21] KPMG, CityPlan *Volume 1: Model Calibration* (2020), p. 100.

B.4 CityPlan calibration and validation

This section provides an overview of the model calibration and validation process completed in March 2020 following the development of CityPlan (version 1.0). Key model fit and performance statistics are reported from the CityPlan Volume 2: Model Calibration, unless explicitly stated. These metrics span the four components of the model calibration and validation. Each component and its goals are outlined below:

- *Model estimation*: The sub-models are statistically robust and are consistent with the relevant statistical assumptions
- *Model validation:* The model can adequately reproduce growth patterns that have occurred historically
- *Model response:* The model's projections respond reasonably to changes in transport network and planning inputs
- *Model projections:* The model produces reasonable projections for the spatial distribution of future growth.

Comprehensive model calibration and validation results can be found in CityPlan Volume 2: Model Calibration.

In addition, this section details several incremental improvements which have been made to the model following version 1.0 to improve the model's performance and its fitness for purpose for appraisal of SRL – Cheltenham to Airport. The model represented for this assessment is version 1.1 of CityPlan. Changes since version 1.0 include the following:

- Replaced primary and secondary enrolment logic with deterministic process rather than LCM
- A module which allows the low-high density ratio for residential transition to be varied between Base and Program Case
- Incorporated iterative proportional updating for household-person transition
- A pre-processing module which allows adjustments to be incorporated prior to the baseline year.

The deterministic distribution of primary and secondary enrolments is specified to ensure that education enrolments are directly tied to the geographic distribution of children of the corresponding age. Given the intrinsic relationship between children and education enrolments, this approach is seen as a marginal, yet important, development. Details of the improved approach to the distribution of primary and secondary enrolments is provided in Section B.2.3 subheading 'Primary and secondary school enrolments.

The progressive ratio of high versus low density ensures that residential development transitions steadily towards high-density through time. In combination with land capacities, this ensures residential development can continue to be accommodated, whilst also enabling the model to successfully clear. Details of the progressive ratio of high vs low density residential development is provided in Section B.2.3 'Transition: Real estate'.

The Household and Person Transition Model is specified to ensure that Annual Demographic Control Totals, informed by DELWP Projections 2018 (Unpublished), are met for both households and persons. This development represents an incremental improvement from version 1.0 of CityPlan in which only households' control totals were met. The refined approach uses a process largely consistent with that used in the construction of the CityPlan synthetic population, details of which are reported in the CityPlan Volume 1: Model Specification Report.[22] The key difference is that the Household and Person

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[22] KPMG, CityPlan *Volume 1: Model Specification* (2020), p. 31.

Transition Model synthesises a single set of households and persons which are initially unplaced. These new households are subsequently distributed based on the household characteristics.

The pre-adjustment model is mechanically identical to the standard adjustment model. The pre-adjustment model commences at the start of the first simulation year, such that productivity initiatives completed prior to the model base year can be accurately reflected in the base year and model outputs.

Calibration and validation outcomes

The calibration and validation of CityPlan is deemed fit for purpose for application in an SRL – Cheltenham to Airport context. The results of the calibration and validation of CityPlan are described in detail in CityPlan Volume 2: Model Calibration. An updated summary of the Model estimation and Model validation sections of the report are provided below. Where refinements have been made post completion of the model calibration and validation, these figures are asterisked.

B.4.1 Model estimation results

A high-level summary of the broad outcomes of model estimation are shown in Table B - 8, with all outcomes meeting the criteria.

Table B - 8: Summary of model estimation outcomes

Element	Outcome	Comments
Accessibility deterrence curves	**Meets**	All six deterrence curves meet the criteria of having an R^2 greater than 0.7 when compared to observed travel data.
Hedonic regression	**Meets**	The hedonic regression sub-model meets the criteria of having an R^2 greater than 0.5 when compared to observed valuation data.
Developer supply – residential	**Meets**	Both residential developer supply sub-models meet the criteria of having a ρ^2 greater than 0.10 when compared to observed valuation data.
Developer supply – non-residential	**Meets**	All three non-residential developer supply sub-models meet the criteria of having a ρ^2 greater than 0.10 when compared to observed valuation data. Two have a ρ^2 greater than 0.30.
Location choice – households	**Meets**	Eight of the nine household location choice sub-models have a ρ^2 greater than 0.10 when compared to observed valuation data, meeting the criteria that 80% of the models have a ρ^2 greater than 0.10. Six of nine have a ρ^2 greater than 0.15.
Location choice – employment	**Meets**	All nine employment location choice sub-models meet the criteria of having a ρ^2 greater than 0.10 when compared to observed valuation data. Seven of nine have a ρ^2 greater than 0.20.
Location choice – tertiary enrolments	**Meets**	The tertiary enrolment location choice sub-model meets the criteria of having a ρ^2 greater than 0.10 when compared to observed valuation data. Note, primary and secondary enrolments are forecast using a deterministic function.

Source: KPMG CityPlan Volume 2: Calibration and Validation Report, KPMG CityPlan V1.1

B.4.2 Model validation results

High priority criteria

The model is validated using historical observed data from 2006 to 2016. The outcomes for high priority criteria are shown in Table B - 9, with all elements meeting the criteria.

Table B - 9: Summary of model validation results

Element	Geog.	Outcome	Target	Actual
Change in households	SA2	**Meets**	70.0%	75.0%
Change in employment	SA2	**Meets**	70.0%	70.9%
Change in population	SA2	**Meets**	70.0%	78.6%

Source: KPMG CityPlan Volume 2: Calibration and Validation Report, KPMG CityPlan V1.1

Medium priority criteria

The outcomes for the medium priority criteria are shown in Table B - 10, Table B - 11 and Table B - 12. All six population by age groups meet the criteria, and the primary enrolment model meets the criteria. One out of four employment categories meet the criteria, however the one that meets the criteria is by far the largest group, accounting for over 56% of job growth, and it performs very strongly, with 95% predictive accuracy. Further, as noted above, across all employment, CityPlan had a predictive accuracy of just over 70%.

Table B - 11, enrolments by type, includes updated outcomes and actual fit statistics to reflect the refined model for the deterministic distribution of primary and secondary enrolments.

Table B - 10: Summary of model validation results, population by age

Element	Geog.	Outcome	Target	Actual
Change in population age 0-4	SA3	**Meets**	70.0%	94.1%
Change in population age 5-11	SA3	**Meets**	70.0%	90.4%
Change in population age 12-17	SA3	**Meets**	70.0%	82.8%
Change in population age 18-24	SA3	**Meets**	70.0%	86.3%
Change in population age 15-64	SA3	**Meets**	70.0%	94.0%
Change in population age 65 plus	SA3	**Meets**	70.0%	80.0%

Source: KPMG CityPlan Volume 2: Calibration and Validation Report, KPMG CityPlan V1.1

Table B - 11: Summary of model validation results, enrolments by type

Element	Geog.	Outcome	Target	Actual
Change in primary enrolments	SA3	**Meets**	70.0%	85.0%
Change in secondary enrolments	SA3	**Misses**	70.0%	47.7%
Change in tertiary enrolments	SA3	**Almost**	70.0%	63.90%

Source: KPMG CityPlan Volume 2: Calibration and Validation Report, KPMG CityPlan V1.1

Table B - 12: Summary of model validation results, employment by group

Element	Geog.	Outcome	Target	Actual
Change in general office jobs (represents 57% of jobs)	SA3	**Meets**	70.0%	95.6%
Change in retail jobs (represents 9% of jobs)	SA3	**Misses**	70.0%	37.4%
Change in industrial jobs (represents 21% of jobs)	SA3	**Misses**	70.0%	48.7%
Change in other jobs (represents 13% of jobs)	SA3	**Almost**	70.0%	68.6%

Source: KPMG CityPlan Volume 2: Calibration and Validation Report, KPMG CityPlan V1.1

B.5 Key Assumptions

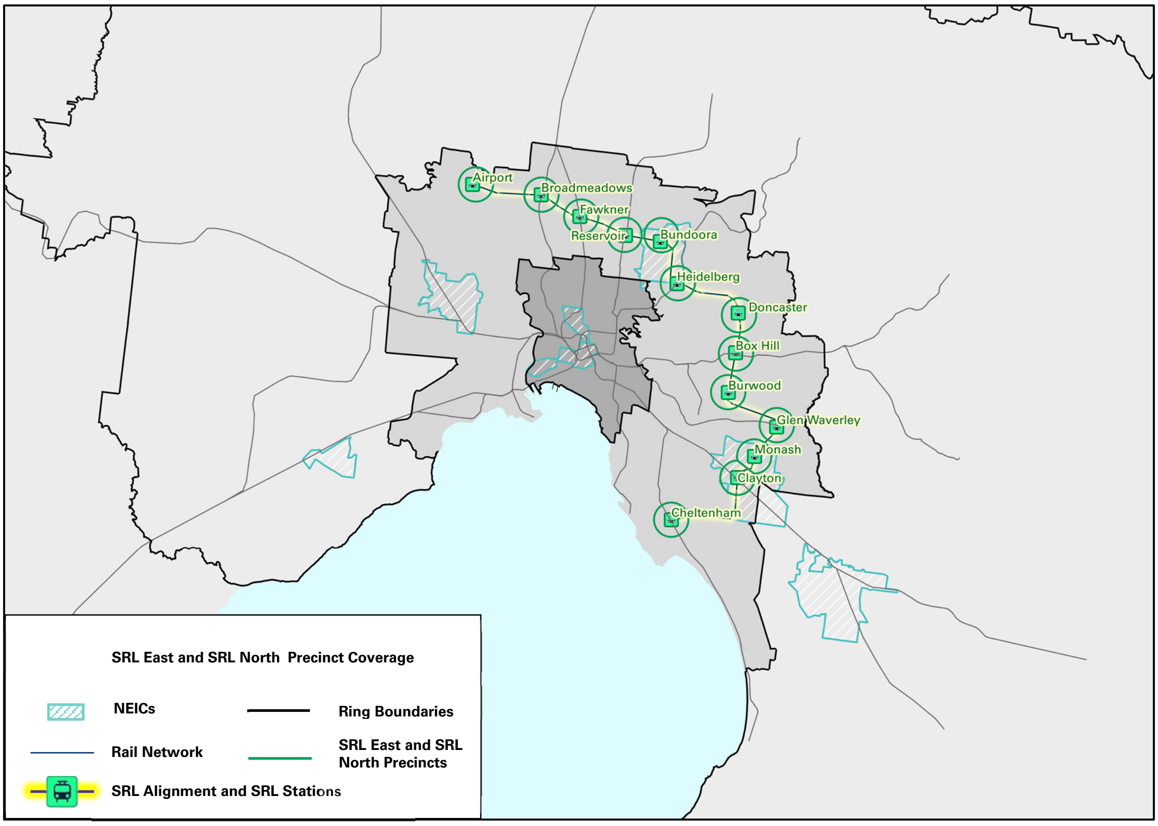
B.5.1 Assumptions

This section explains the additional assumptions and decisions made for SRL – Cheltenham to Airport specific scenarios relevant for CityPlan. This includes all the transport and land use types and their permutations used for select scenarios run in CityPlan.

SRL East and SRL North Precincts

Figure B - 6 illustrates SRL East and SRL North Precinct definitions. These precinct definitions are used for the purpose of reporting. Each SRL East and SRL North Precinct is represented as a 1,600 metre buffer from the assumed station location. Where these buffers overlap for Monash and Clayton, the proportional weight of each precinct within the buffer is utilised (to avoid overlapping catchments). CityPlan results are presented using these weighted 1,600 metre buffers.

Figure B - 6: SRL East and SRL North Precinct definition based on 1,600 metre catchments



Source: SRLA

B.5.2 Model inputs

As a city-shaping investment, SRL – Cheltenham to Airport leverages a range of CityPlan's capabilities. This section details the SRL-specific inputs used to apply CityPlan to SRL – Cheltenham to Airport.

Transport

Changes in travel costs derived from VITM are the primary means of representing shifts in the supply of transport infrastructure associated with the introduction of SRL – Cheltenham to Airport. These costs are sourced from VITM modelling, as part of the LUTI process.

Land use capacities

Specific land use capacities for SRL – Cheltenham to Airport have been provided for various scenarios by SRLA, with a summary of these shown in Table B - 13. Please note household capacity is the sum of low-and-high density capacity and job capacity is the sum of industrial, office and retail capacity. The capacities shown are those within a 1,600 metre radius of the train station.

SRL – Cheltenham to Airport includes a range of major initiatives designed to ensure that the benefits of the investment can be fully captured. A key component of these include developing framework plans and Structure planning to guide land use and built form. These initiatives are represented in both land use capacities and development rates. Specific land use capacities provided by SRLA form the Program Case Options for the 1,600 metre precinct boundaries (shown in Table B - 13).

Table B - 13: Summary of land use capacities

Precinct	Ultimate capacity (2056)					
	Household Capacity Base Case	Household Capacity Program Case	% change Household Capacity	Job Capacity Base Case	Job Capacity Program Case	% change Jobs Capacity
Cheltenham	21,791	42,831	97%	29,937	58,764	96%
Clayton	21,761	44,917	106%	55,512	68,666	24%
Monash	11,452	22,101	93%	77,810	164,026	111%
Glen Waverley	16,071	44,267	175%	22,295	33,024	48%
Burwood	18,008	38,346	113%	20,260	33,580	66%
Box Hill	31,295	64,529	106%	49,610	57,196	15%
Doncaster	20,480	50,697	148%	22,023	32,634	48%
Heidelberg	17,062	46,814	174%	46,024	52,760	15%
Bundoora	15,446	32,913	113%	28,206	87,837	211%
Fawkner	11,345	30,904	172%	13,553	21,506	59%
Reservoir	22,230	51,151	130%	9,623	17,463	81%
Broadmeadows	14,043	34,425	145%	23,361	34,209	46%
Melbourne Airport	10	10	0%	35,595	36,118	1%
SRL East Precincts	**120,378**	**256,991**	**113%**	**255,424**	**415,256**	**63%**
SRL North Precincts	**100,616**	**246,914**	**145%**	**178,385**	**282,527**	**58%**
SRL – Cheltenham to Airport – All Precincts	**220,994**	**503,905**	**128%**	**433,809**	**697,783**	**61%**

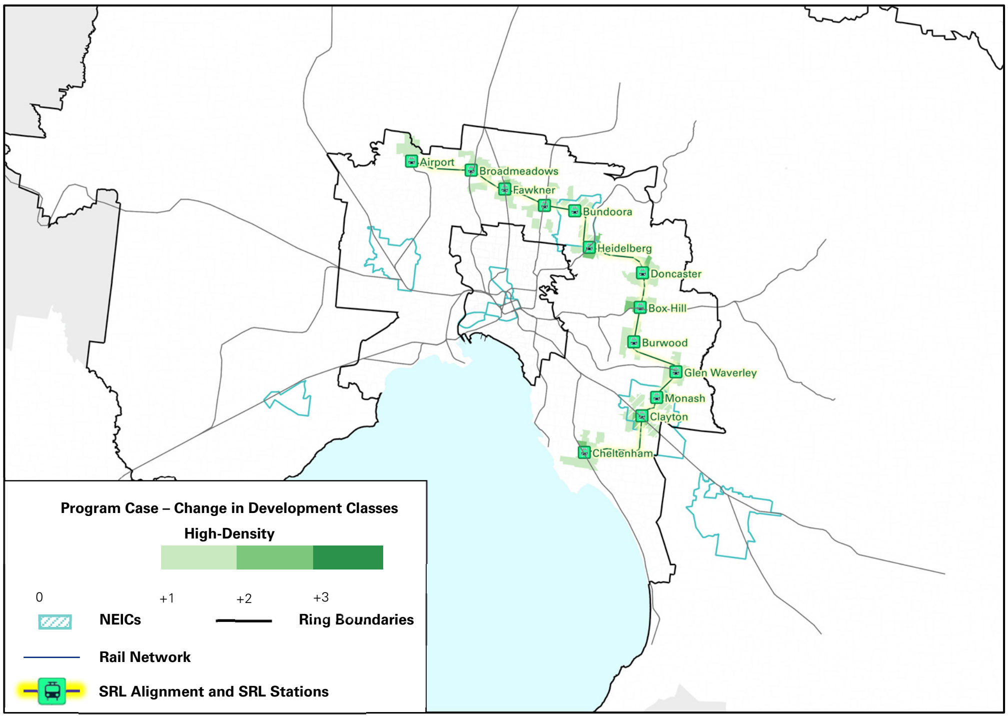
Source: SRLA

Development classes

Development classes in the precincts are updated in the Program Case to reflect the increase in development feasibility and government support enabled by SRL – Cheltenham to Airport. This reflects that upzoning tends to increase the permissiveness of planning regulations and therefore enable more rapid development. This is because proximity to new or enhanced high capacity rail services facilitates the approval of higher density developments. The increase in development rates also reflects that upzoning tends to attract developer interest by increasing the potential profitability of development, and ensures that the specified development rates do not artificially constrain the capacities. Development classes are set so that the prescribed land use capacities by building type can be achieved within a 25-year time horizon. The uplift in development rates is timed to coincide with the capacity adjustment.

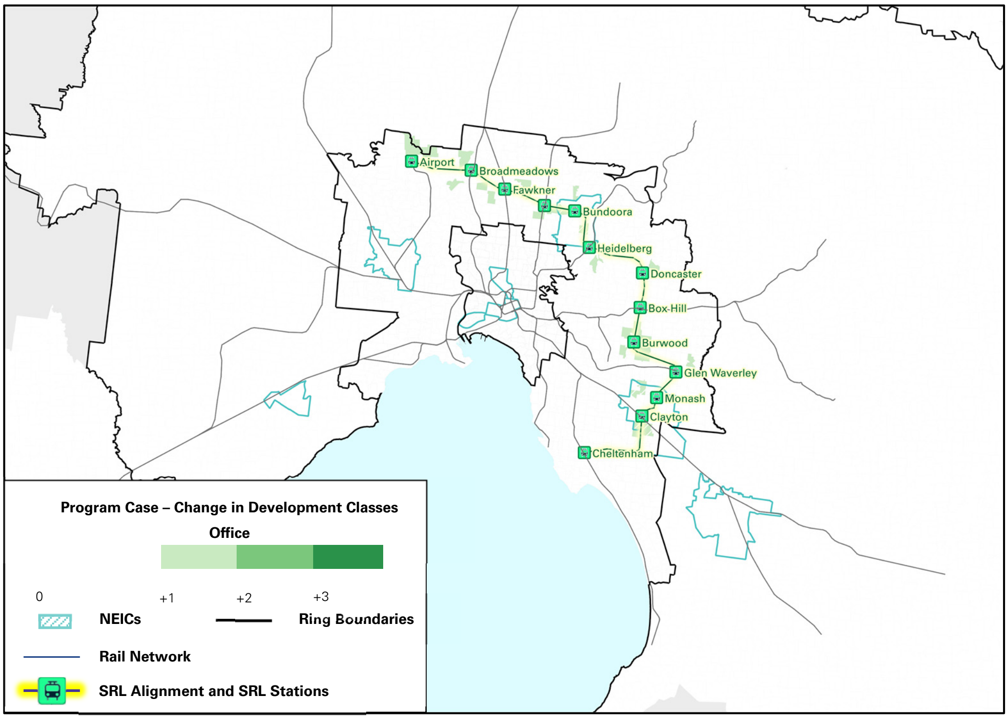
Figure B - 7 illustrates the increase in development classes between the Base Case and Program Case Option A by 2056 for high-density households. Figure B - 7 highlights that there are limited increases in development rates across the entire SRL - Cheltenham to Aiport corridor. Figure B - 8 and Figure B - 9 illustrate the increase in office and retail development rates, with these figures showing that for these building types there is limited change in classes as a result of SRL – Cheltenham to Airport.

Figure B - 7: Program Case Change in Development classes – High density residential



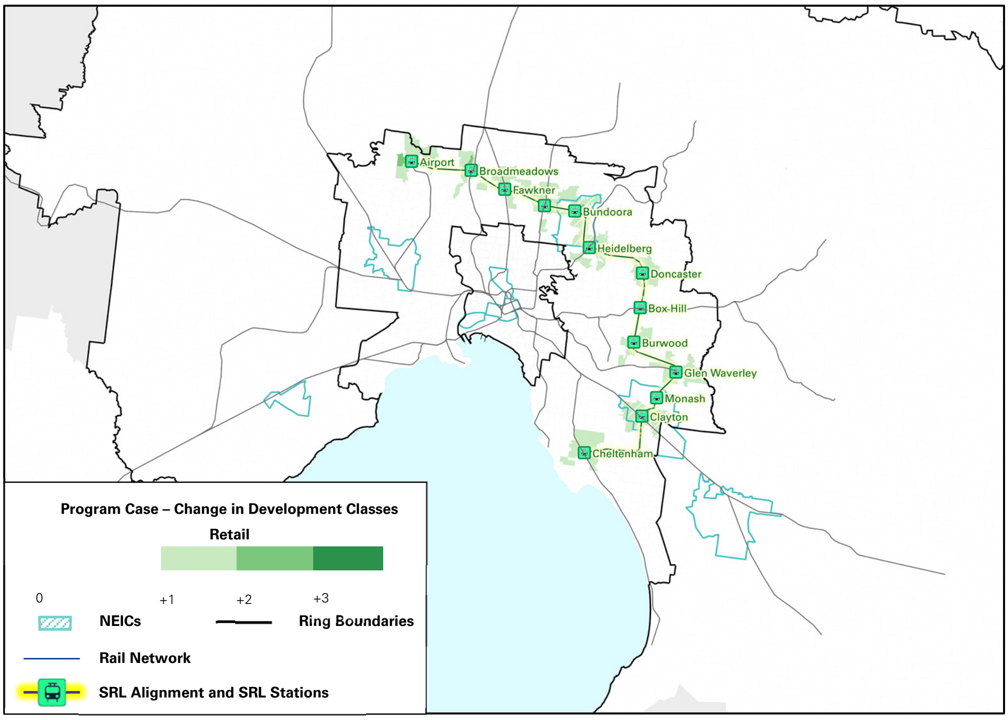
Source: CityPlan

Figure B - 8: Program Case Change in Development classes – Office



Source: CityPlan

Figure B - 9: Program Case Change in Development classes – Retail



Source: CityPlan

Productivity

Productivity initiatives, represented in CityPlan as Adjustments, have been provided for various scenarios by SRLA. These initiatives represent a range of station developments and catalyst projects. The productivity initiatives, representative of full-time equivalent job numbers, have been split by employment sector and precinct. These initiatives incorporated as part of the Program Case Options A and B are shown in Table B - 14. It should be noted that these initiatives are deemed to be directly attributable to SRL and their relocation to the precincts would not occur otherwise. Further, productivity initiatives are assumed to consume land use capacities in CityPlan. This means that productivity interventions tend to 'bring forward' land use impacts so they occur earlier, rather than significantly increasing the magnitude in the long run.

Table B - 14: Summary of productivity initiatives (Core, enabling and critically interdependent)

Precinct	Industrial	Education	General Office	Health
Cheltenham	✓	-	✓	-
Clayton	✓	-	✓	✓
Monash	✓	-	✓	-
Glen Waverley	-	-	✓	-
Burwood	✓	-	✓	-
Box Hill	✓	-	✓	✓
Heidelberg	✓	-	✓	✓
Bundoora	✓	✓	✓	-
Broadmeadows	✓	-	✓	✓

Source: SRLA

Liveability

Liveability initiatives, represented in CityPlan as 'hedonic multipliers', have been provided for various scenarios by SRLA. These initiatives represent various additional green spaces and other local amenity improvements which can be directly attributable to SRL – Cheltenham to Airport. The economic value of different amenities is an important input into an evidence-based cost-benefit analysis of these proposed amenity initiatives, with further information on the method to ascertain these values outlined in the attached document: The e*conomic value of access to amenities – a hedonic pricing method (DJPR).*[23] This paper is attached as **Attachment 1**. The liveability initiatives, split by type, are reported in Table B - 15. Initiatives assumptions have been assumed to come in the same year as land-use interventions.

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[23] Tian, J., Nguyen, D & Yang, C (2020) The economic value of access to amenities – a hedonic pricing approach. *DJPR.*

Table B - 15: Summary of Liveability initiatives

	Liveability initiatives				
Section	**H1 Civic Squares (core and enabling)**	**H2 Station Plazas (core)**	**H3 Community Parks (core and enabling)**	**H4 Neighborhood Parks (core, enabling and critically interdependent)**	**H5 Community Facilities (enabling)**
Cheltenham – Box Hill	✓	✓	✓	✓	✓
Box Hill - Reservoir	✓	✓	X	X	✓
Reservoir – Melbourne Airport	✓	✓	X	X	X

Source: SRLA

Program Case Option A and B assumptions

Program Case Option A and B input assumptions are displayed in Table B - 16.

Table B - 16: CityPlan Program Case Option A and B assumptions

Scenario	Transport interventions	Land use interventions	Productivity initiatives	Liveability initiatives
Reference Case	N/A	N/A	X	X
Program Case Option A	Cheltenham to Box Hill: 2035 Box Hill to Reservoir: 2043 Reservoir to Melbourne Airport: 2053	Cheltenham to Box Hill: 2032 Box Hill to Reservoir: 2040 Reservoir to Melbourne Airport: 2050	✓	✓
Program Case Option B	Cheltenham to Box Hill: 2035 Box Hill to Reservoir: 2038 Reservoir to Melbourne Airport: 2043	Cheltenham to Box Hill: 2032 Box Hill to Reservoir: 2035 Reservoir to Melbourne Airport: 2040	✓	✓

Source: SRLA

B.6 A future with SRL - Cheltenham to Airport

This section provides an overview of the key economic runs and the estimated land use impacts of SRL – Cheltenham to Airport. Two core scenarios were tested, as outlined in Table B - 17.

Table B - 17: Summary of Program Case Option A and B[24]

Section	Program Case Option A Opening Year	Program Case Option B Opening Year
Cheltenham to Box Hill	2035	2035
Box Hill to Reservoir	2043	2038
Reservoir to Melbourne Airport	2053	2043

Both Option A and Option B have the pivoting method applied, allowing comparisons with the SALUP Reference Case data. For reporting purposes, the Reference Case (i.e. SALUP) is hereinafter referred to as the 'Base Case'. The Program Case assumptions (in terms of transport and land-use) are outlined in Table B - 16. Program case outputs are derived by running CityPlan in the dynamic mode described in Section B.2, with different VITM years run in sequence.

B.6.1 Results – Program Case Options

CityPlan is configured to perform feedback with VITM for a specified set of forecast years, which for the current study is 2036, 2041 and 2051. In turn, the revised costs inform the spatial allocation of households and firms. This process forms the basis of the dynamic Program Case Options.

Accessibility plays an important role in the location choices of households and firms. CityPlan uses a range of bespoke accessibility metrics to explain the decisions of agents, with two key measures of accessibility in CityPlan being C2J and B2B (with each of these measures outlined in Section B.2.3).

Accessibility

Figure B - 10 shows the difference in C2J and Figure B - 11 shows B2B accessibility, in 2036 and 2056 between the Base Case and Program Case Option A. There are increases in C2J Accessibility, which are attributed to the introduction of SRL North. The full SRL – Cheltenham to Airport alignment sees increases in the south-east and north, whereas the western regions see a minor decline. B2B accessibility improvements are systematic, with increased accessibility observed along the SRL Cheltenham – Airport corridor, particularly around the employment hubs such as Monash and Clayton.

Figure B - 12 shows the difference in C2J and Figure B - 13 shows B2B accessibility, in 2036 and 2056 between the Base Case and Program Case Option B. Changes in C2J accessibility are slightly higher than Program Case Option A, with this being the result of transport and precinct land-use interventions being introduced at earlier years in the model, resulting in improved accessibility within the precincts and the wider corridor. This trend is also visible for B2B accessibility.

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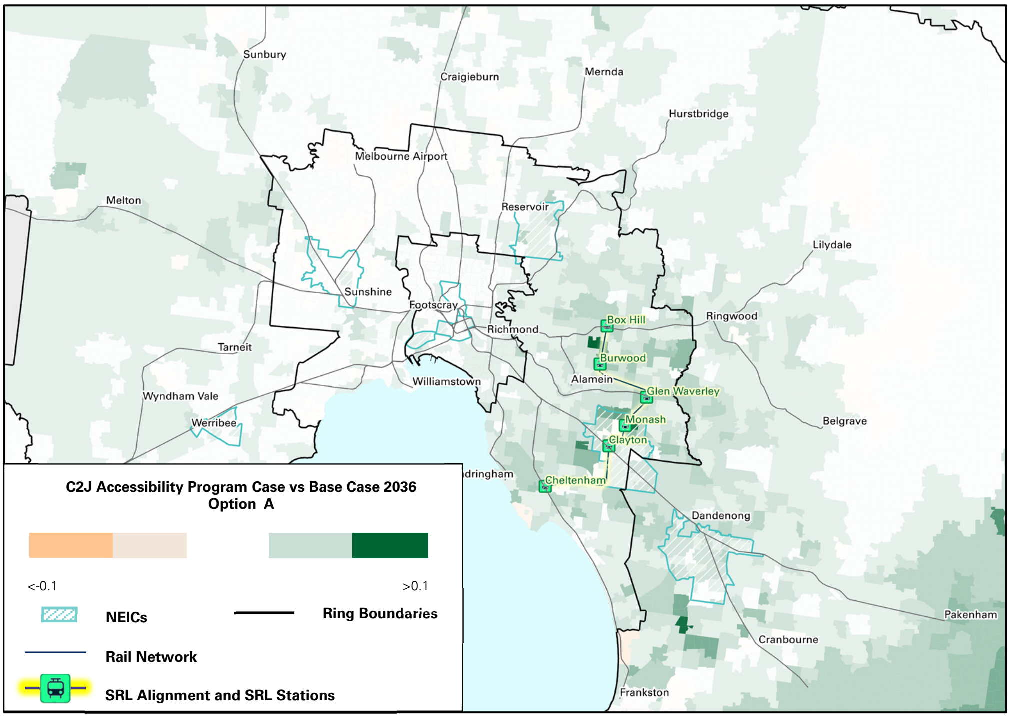
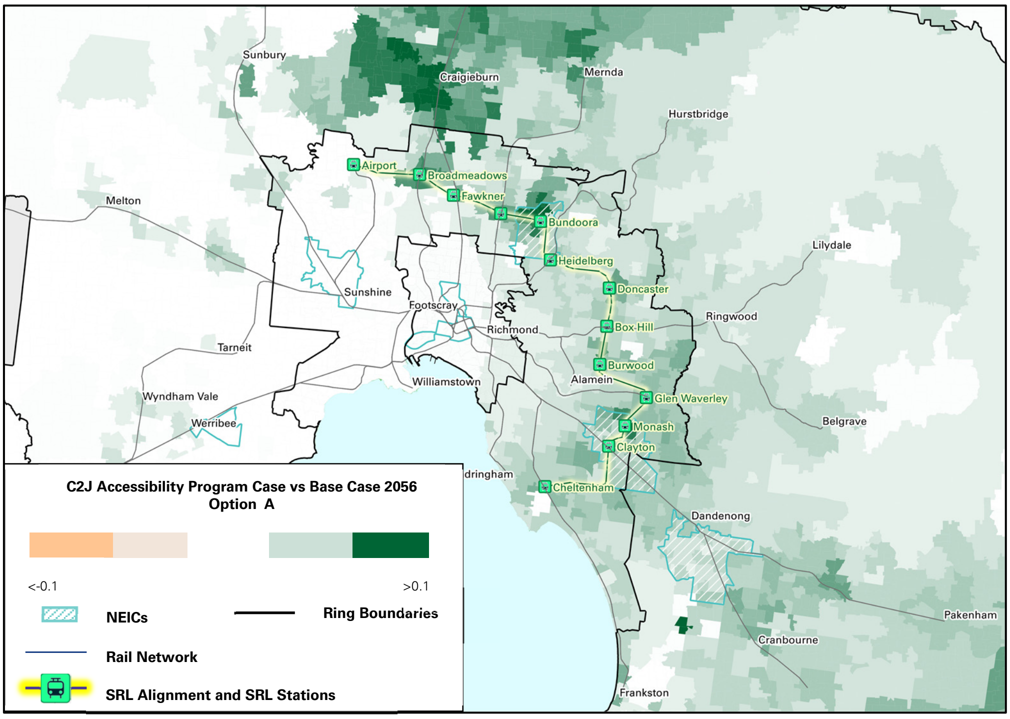
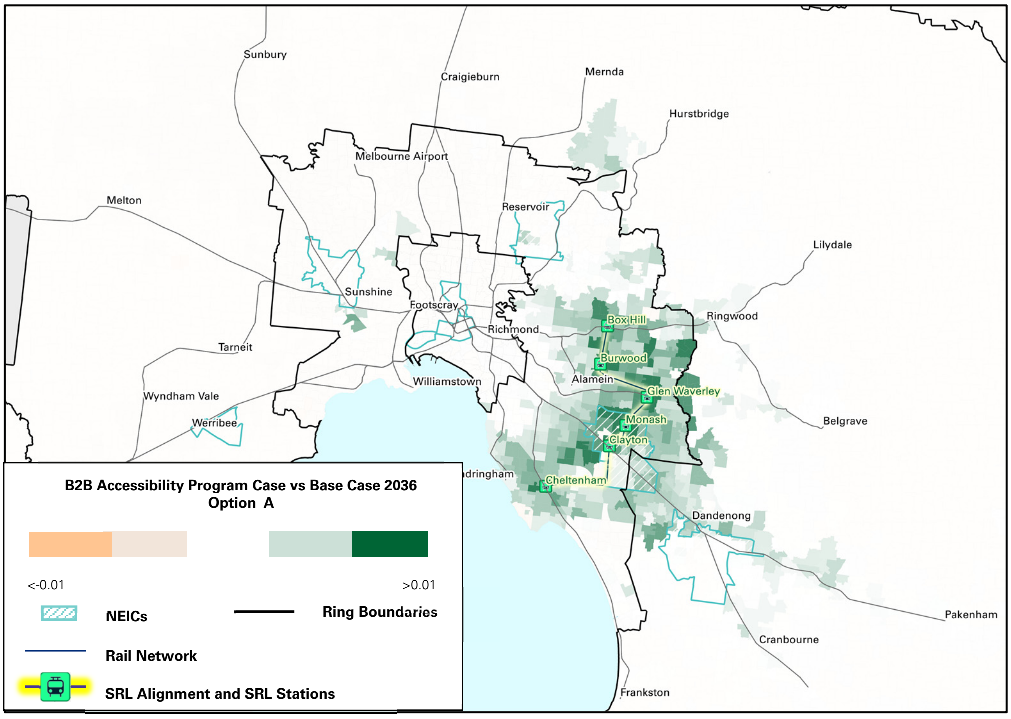
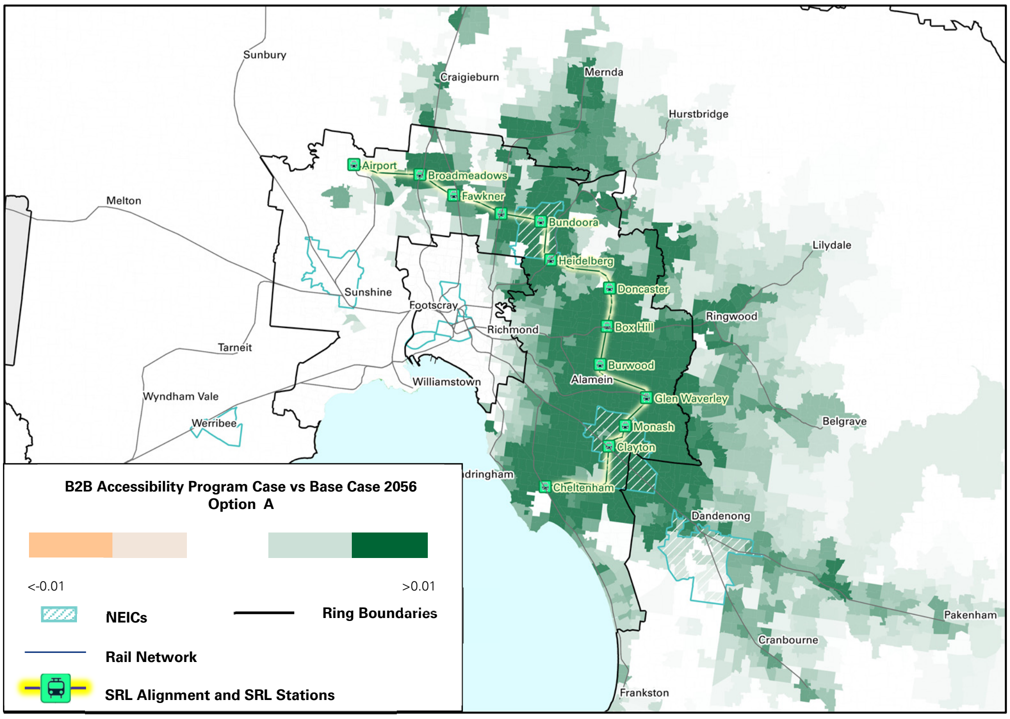
[24] SRLA advises that further detailed planning and technical design for SRL North will be undertaken over the coming years. Specific packaging and procurement decisions will be made at an appropriate time in the future.

Figure B - 10: Difference in C2J between the Base Case and Program Case Option A

Year	C2J
2036	
2056	

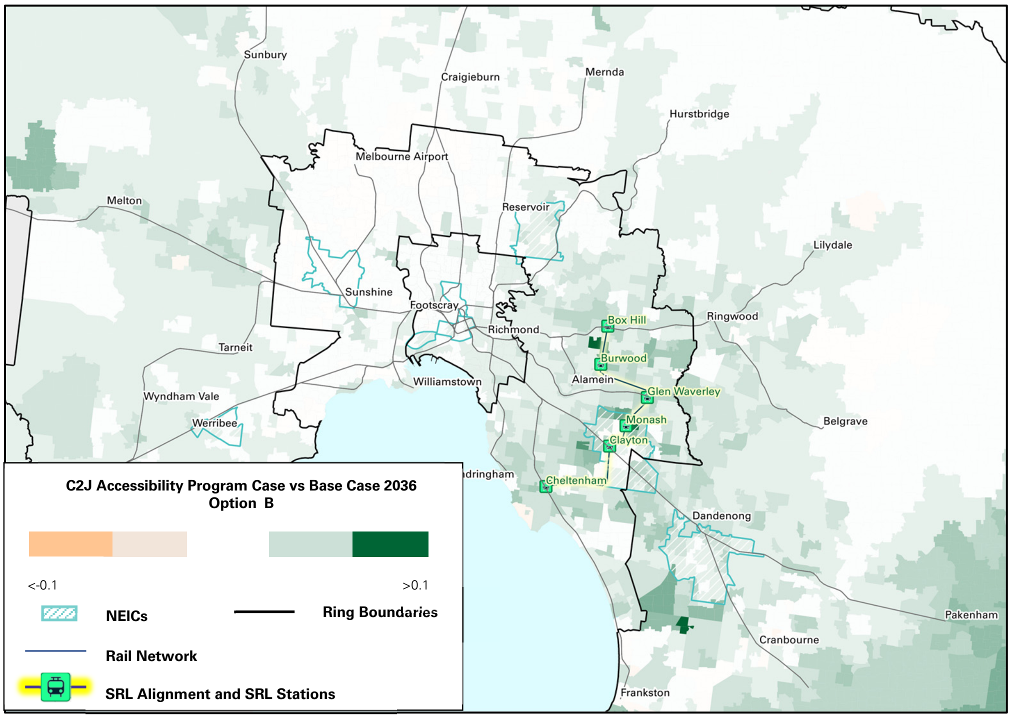
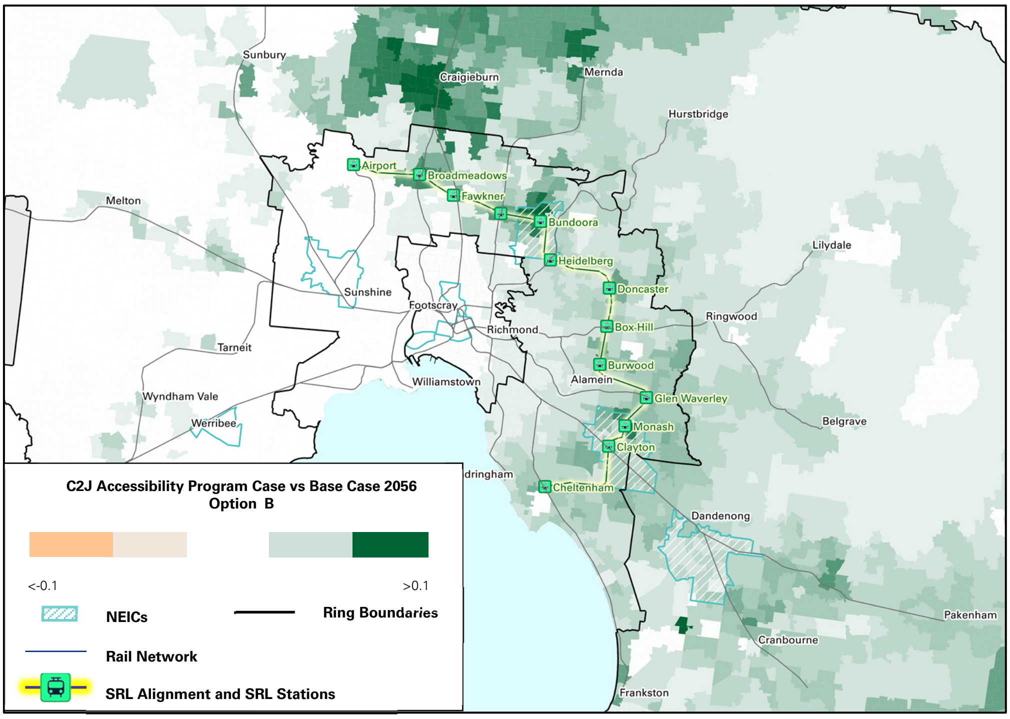
Source: KPMG analysis of CityPlan modelling

Figure B - 11: Difference in B2B between the Base Case and Program Case Option A

Year	B2B
2036	
2056	

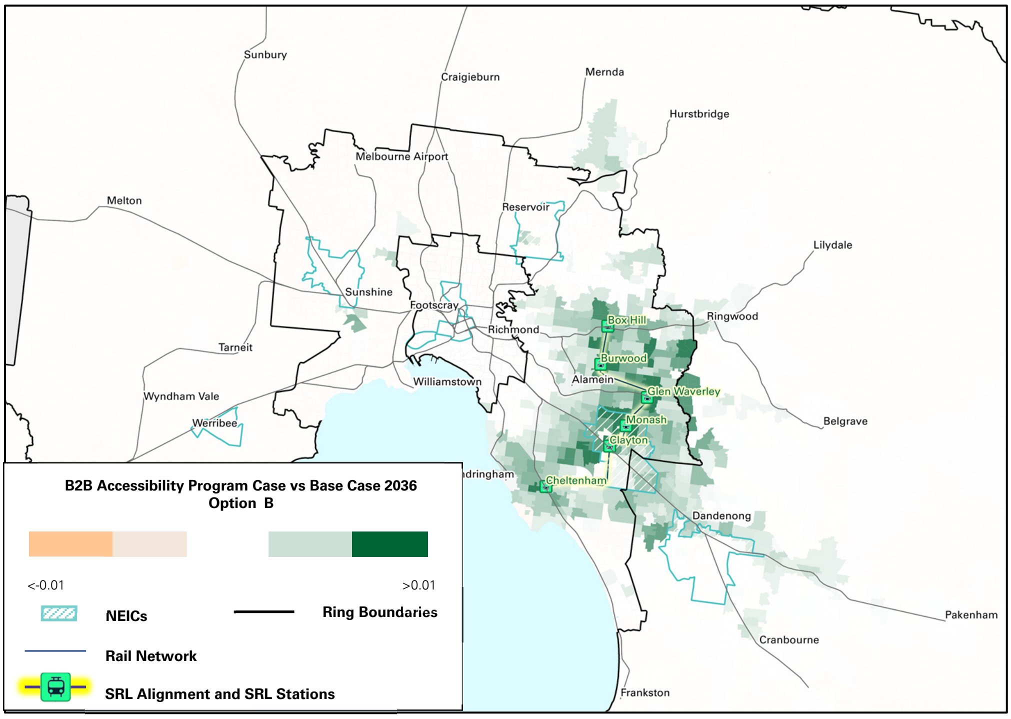
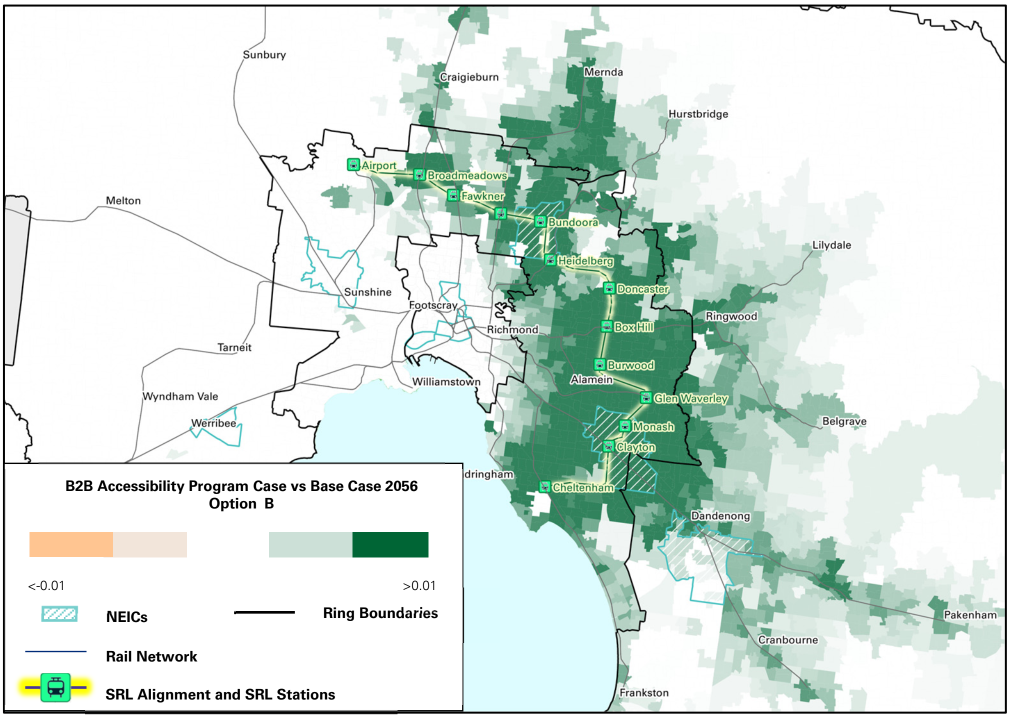
Source: KPMG analysis of CityPlan modelling

Figure B - 12: Difference in C2J between the Base Case and Program Case Option B

Year	C2J
2036	
2056	

Source: KPMG analysis of CityPlan modelling

Figure B - 13: Difference in B2B between the Base Case and Program Case Option B

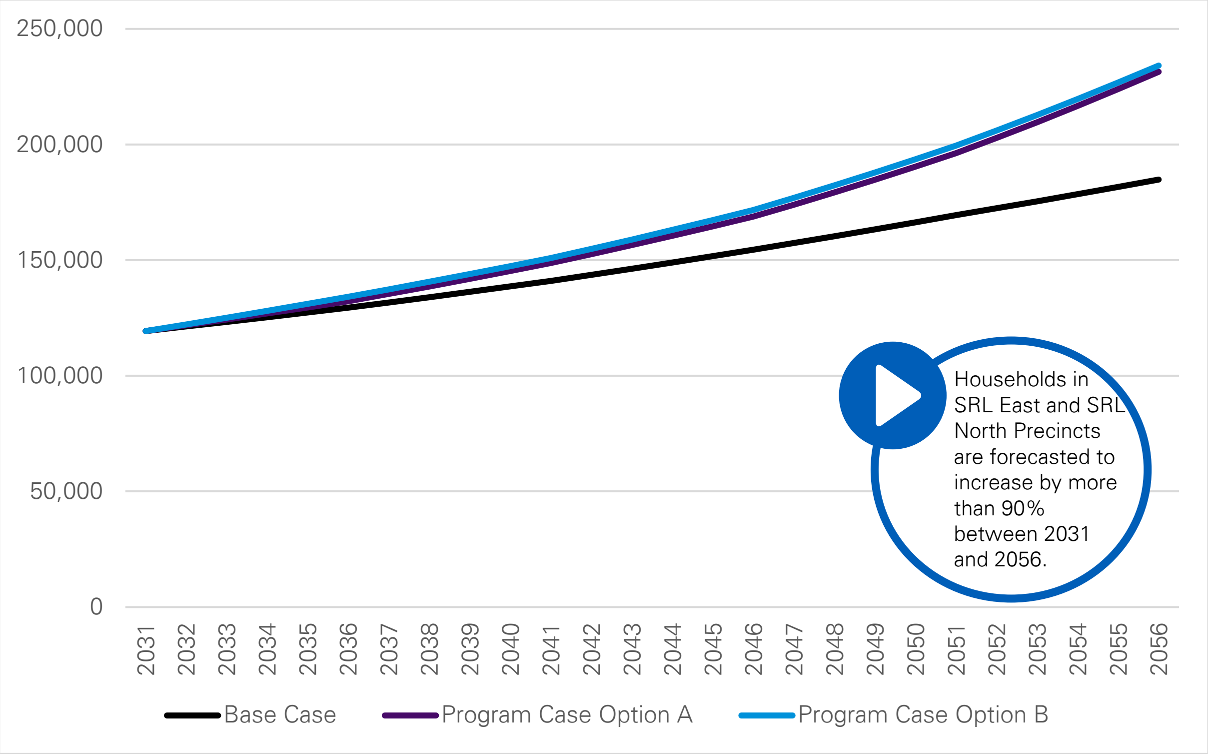
Year	B2B
2036	
2056	

Source: KPMG analysis of CityPlan modelling

Household growth across SRL East and SRL North Precincts

SRL – Cheltenham to Airport will increase growth in households along the SRL – Cheltenham to Airport corridor, and particularly within the SRL East and SRL North Precincts. The Program Case Option B scenario sees a slightly higher increase in the number of households locating within the SRL East and SRL North Precincts, when compared to the Program Case Option A scenario. This increase is due to earlier completion of SRL – Cheltenham to Airport rail and accompanying land-use interventions, resulting in SRL East and SRL North Precincts becoming more attractive sooner. This is shown in Figure B - 14.

Figure B - 14: Household growth across all SRL East and SRL North Precincts – Program Case Options versus Base Case



Households in SRL East and SRL North Precincts are forecasted to increase by more than 90% between 2031 and 2056.

Source: KPMG analysis of CityPlan modelling

This growth at individual precinct levels is shown in Table B - 18, which shows that across all SRL East and SRL North Precincts, Program Case Option B experienced higher levels of growth. Table B - 18 shows that SRL – Cheltenham to Airport will support a 151% increase in households for Program Case Option A, and a 153% increase in Program Case Option B by 2056. Much of this growth is experienced in SRL North Precincts (particularly Heidelberg).

Table B - 18: Total number of households by precinct, 2018, 2036 and 2056[25]

Precinct (1600m)	2018	2036			2056			Percentage increase from 2018 to 2056	
	Base Case	Base Case	Program Case Option A	Program Case Option B	Base Case	Program Case Option A	Program Case Option B	Program Case Option A	Program Case Option B
Cheltenham	8,500	12,500	13,000	13,000	18,500	22,500	22,500	165%	165%
Clayton	8,500	13,000	13,000	13,000	18,000	23,000	23,000	171%	171%
Monash	4,000	6,000	6,000	6,000	9,500	11,500	11,500	188%	188%
Glen Waverley	8,000	10,000	11,000	11,000	13,500	18,000	17,500	125%	119%
Burwood	8,000	10,500	11,000	11,000	15,000	17,000	17,000	113%	113%
Box Hill	11,500	18,500	19,000	19,000	26,500	34,500	34,500	200%	200%
Doncaster	9,000	12,500	12,500	13,500	16,500	19,500	19,500	117%	117%
Heidelberg	8,000	11,000	11,000	11,500	14,500	25,500	27,000	219%	238%
Bundoora	4,500	7,500	7,500	7,500	13,000	14,500	14,500	222%	222%
Fawkner	6,000	7,500	7,500	7,500	10,000	12,500	13,000	108%	117%
Reservoir	11,000	13,500	13,500	13,500	18,500	22,000	22,500	100%	105%
Broadmeadows	5,500	7,500	7,500	7,500	11,000	11,500	11,500	109%	109%
Melbourne Airport	0	0	0	0	0	0	0	0	0
SRL East Precincts	**48,500**	**70,500**	**73,000**	**73,000**	**101,000**	**126,500**	**126,000**	**161%**	**160%**
SRL North Precincts	**44,000**	**59,500**	**59,500**	**61,000**	**83,500**	**105,500**	**108,000**	**140%**	**145%**
SRL – Cheltenham to Airport – All Precincts	**92,500**	**130,000**	**132,500**	**134,000**	**184,500**	**232,000**	**234,000**	**151%**	**153%**

Source: KPMG analysis of CityPlan modelling

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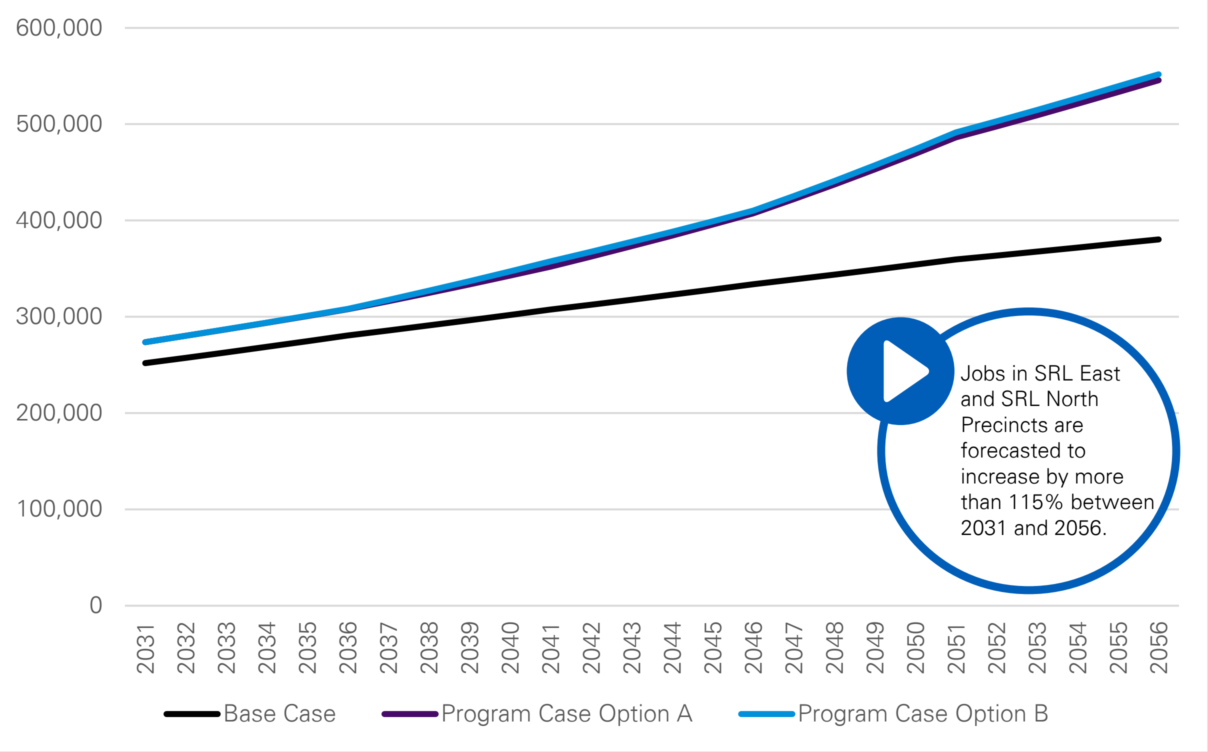
[25] Numbers are rounded to the nearest 500.

Job growth across SRL East and SRL North Precincts

Job growth in SRL East and SRL North Precincts is expected to grow at a faster rate under the Program Case than under the Base Case scenario, with an additional 165,000 or more jobs located in the precincts by 2056. The earlier introduction of interventions in Program Case Option B leads to a slightly higher level of job growth across the SRL East and SRL North Precincts, compared to Option A, as shown in Figure B - 15. The assessment for jobs growth assumes an earlier uplift (prior to 2031) resulting in a difference between the Base and Program Case Options at 2031, which is due to productivity initiatives being included as an input assumption by SRLA (see Section B.5 for more detail).

Figure B - 15: Job growth across all SRL East and SRL North Precincts – Program Case Options versus Base Case



Jobs in SRL East and SRL North Precincts are forecasted to increase by more than 115% between 2031 and 2056.

Source: KPMG analysis of CityPlan modelling

This growth at individual precinct levels is shown in Table B - 19, which shows that across all SRL East and SRL North Precincts, Program Case Option B experienced higher levels of growth in terms of jobs.

Table B - 19 shows that SRL – Cheltenham to Airport will support a 184% increase in jobs for Program Case Option A, and 187% for Program Case Option B when compared to 2018, with much of this growth experienced within the employment centres of Monash, Bundoora and Clayton.

Table B - 19: Total number of jobs by precinct, 2018, 2036 and 2056[26]

Precinct (1600m)	2018	2036			2056			Percentage increase from 2018 to 2056	
	Base Case	Base Case	Program Case Option A	Program Case Option B	Base Case	Program Case Option A	Program Case Option B	Program Case Option A	Program Case Option B
Cheltenham	16,500	20,500	22,500	22,000	25,000	36,500	36,500	121%	121%
Clayton	21,000	32,000	41,000	40,500	46,500	57,500	57,000	174%	171%
Monash	36,500	53,000	60,000	60,000	75,000	162,000	162,500	344%	345%
Glen Waverley	11,500	14,500	15,000	15,000	18,500	25,000	25,500	117%	122%
Burwood	11,500	15,500	16,500	16,500	19,000	24,000	24,500	109%	113%
Box Hill	23,500	32,500	37,500	37,500	41,500	48,500	48,500	106%	106%
Doncaster	12,000	16,500	16,500	17,000	20,500	24,500	24,500	104%	104%
Heidelberg	18,500	28,500	30,000	30,000	42,000	50,000	50,500	170%	173%
Bundoora	8,500	15,500	18,000	18,500	25,000	41,500	43,500	388%	412%
Fawkner	4,500	7,500	7,500	7,500	10,500	11,500	11,500	156%	156%
Reservoir	4,500	6,000	5,500	5,500	7,500	9,000	9,500	100%	111%
Broadmeadows	9,000	15,000	15,000	15,000	19,500	26,000	28,000	189%	211%
Melbourne Airport	14,500	23,000	22,500	22,500	29,500	29,000	29,500	100%	103%
SRL East Precincts	**120,500**	**168,000**	**192,500**	**191,500**	**225,500**	**353,500**	**354,500**	**193%**	**194%**
SRL North Precincts	**71,500**	**112,000**	**115,000**	**116,000**	**154,500**	**191,500**	**197,000**	**168%**	**176%**
SRL – Cheltenham to Airport – All Precincts	**192,000**	**280,000**	**307,500**	**307,500**	**380,000**	**545,000**	**551,500**	**184%**	**187%**

Source: KPMG analysis of CityPlan modelling

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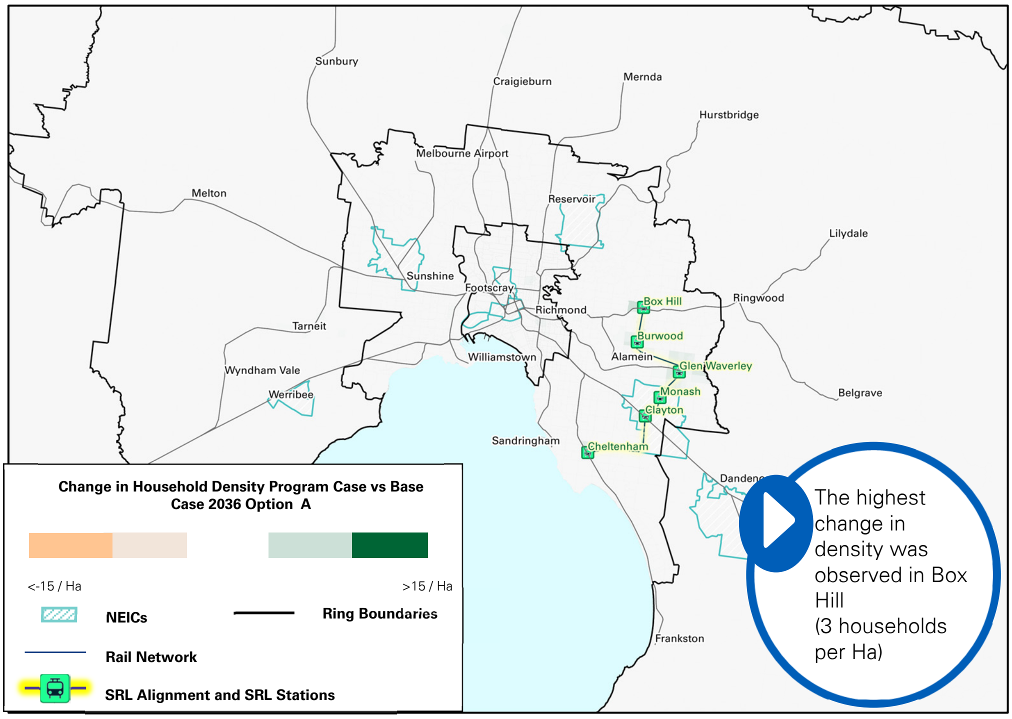
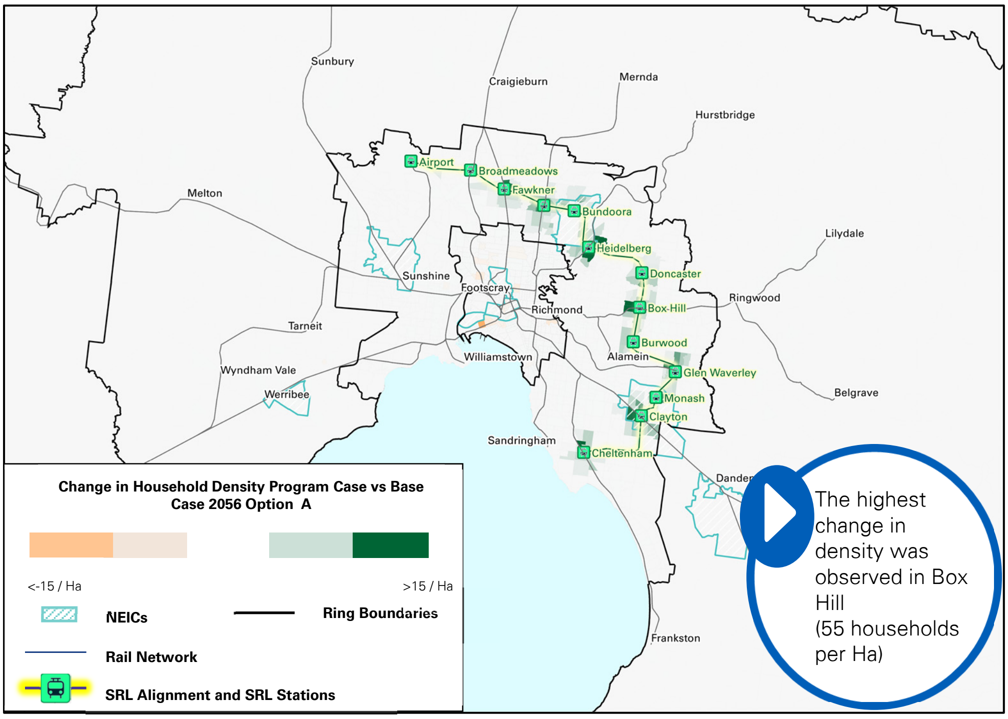
[26] Numbers are rounded to the nearest 500.

Households and jobs

Figure B - 16 shows the differences in the density of households, with Figure B - 17 showing the change in job density in 2036 and 2056 between the Base Case and Program Case Option A. It is evident that the introduction of SRL North leads to a quantum shift in the number of households choosing to locate within the SRL East and SRL North Precincts. Much of this household growth stems from the movement of households from the inner CBD and inner-rings, as SRL East and SRL North Precincts become more attractive over time, particularly for SRL East precincts.

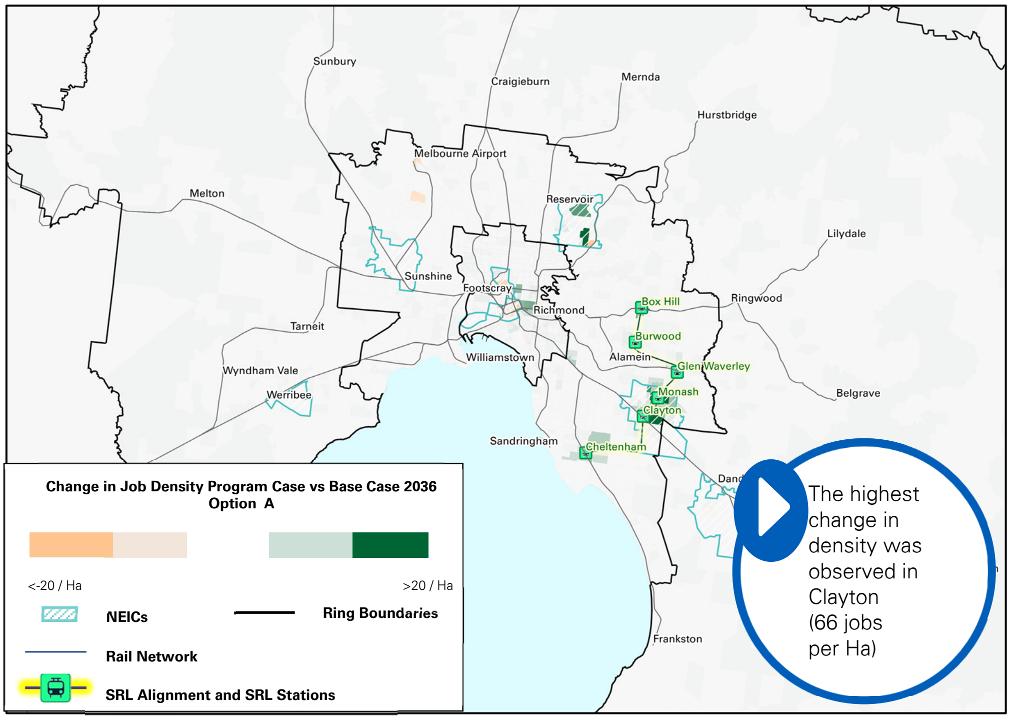
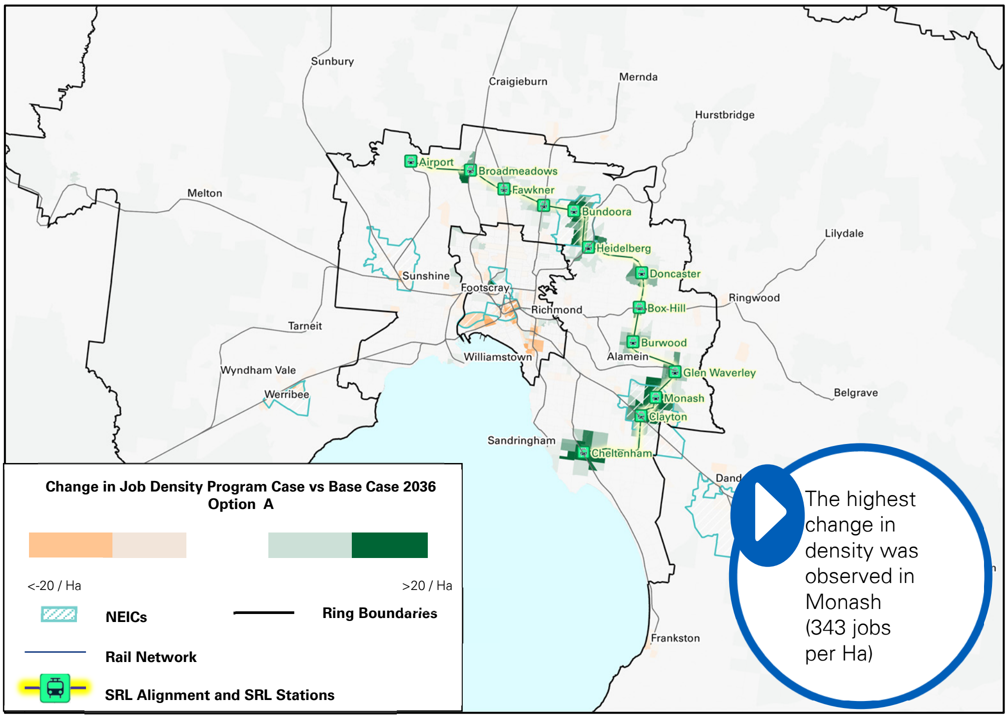
In terms of job growth, the introduction of SRL East sees a greater shift in job growth (particularly around Monash and Clayton), attributable to improved accessibility and land-use interventions within this NEIC. This growth increases over time, where by 2056, it is observed that much of this growth comes from not only the inner-CBD (similar to households), but also the western region and along the SRL – Cheltenham to Airport corridor.

Figure B - 16: Difference in household density between the Base Case and Program Case Option A

Year	Households
2036	 The highest change in density was observed in Box Hill (3 households per Ha)
2056	 The highest change in density was observed in Box Hill (55 households per Ha)

Source: KPMG analysis of CityPlan modelling

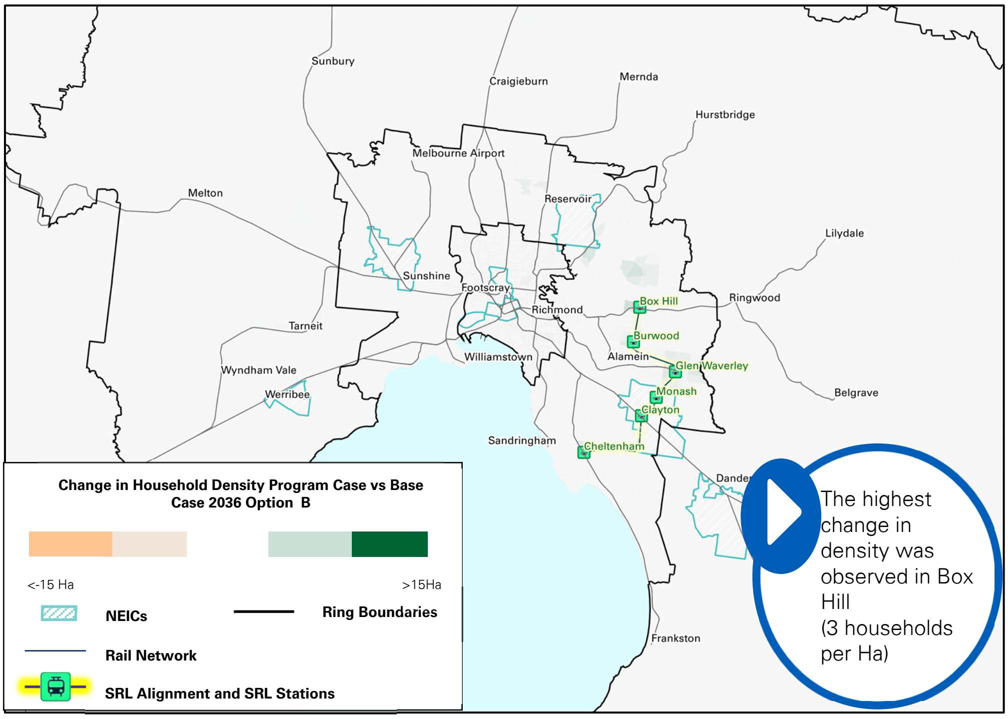
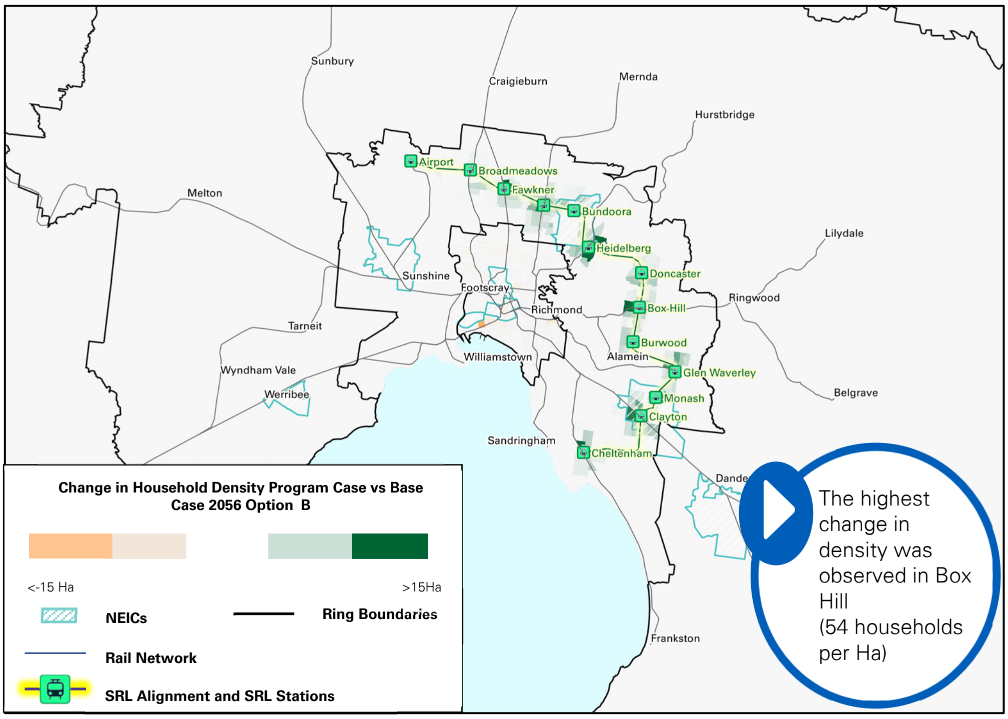
Figure B - 17: Difference in job density between the Base Case and Program Case Option A

Year	Jobs
2036	 The highest change in density was observed in Clayton (66 jobs per Ha)
2056	 The highest change in density was observed in Monash (343 jobs per Ha)

Source: KPMG analysis of CityPlan modelling

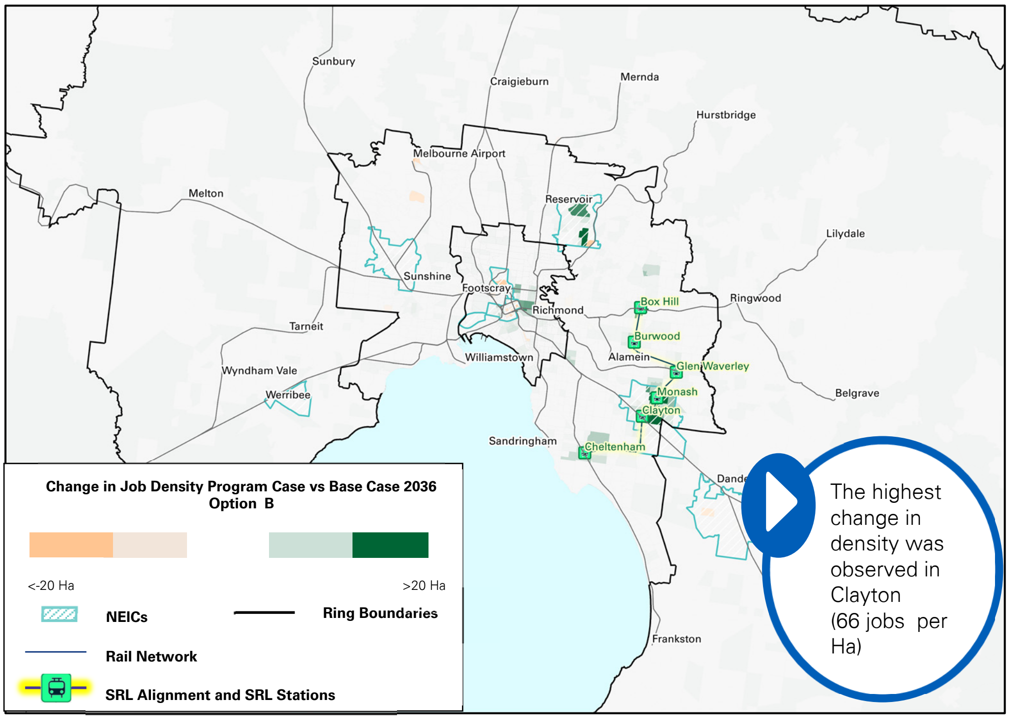
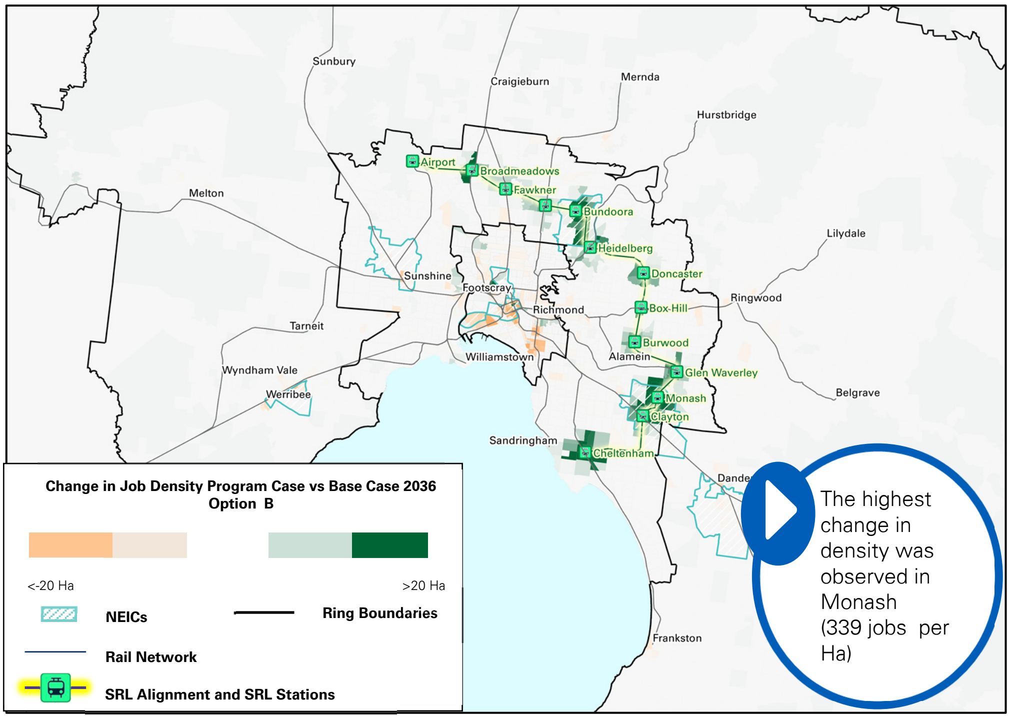
Figure B - 18 shows the differences in the density of households, with Figure B - 19 showing the difference in job density in 2036 and 2056 between the Base Case and Program Case Option B. These figures show that Program Case Option B leads to slightly higher levels of household and job growth across the SRL East and SRL North Precincts than Program Case Option A. This is due to transport and precinct land-use interventions being introduced earlier. Like Program Case Option A, most of this household growth stems from the inner ring and CBD region, with job growth also coming from the inner ring and CBD, as well as the western region and the SRL – Cheltenham to Airport corridor.

Figure B - 18: Difference in household density between the Base Case and Program Case Option B

Year	Households
2036	 The highest change in density was observed in Box Hill (3 households per Ha)
2056	 The highest change in density was observed in Box Hill (54 households per Ha)

Source: KPMG analysis of CityPlan modelling

Figure B - 19: Difference in job density between the Base Case and Program Case Option B

Year	Jobs
2036	 The highest change in density was observed in Clayton (66 jobs per Ha)
2056	 The highest change in density was observed in Monash (339 jobs per Ha)

Source: *KPMG analysis of CityPlan modelling*

Knowledge-based jobs

A key intent of SRL – Cheltenham to Airport is to improve commuters' ability to access knowledge-based jobs and services within Melbourne, particularly to knowledge centres such as Monash, Box Hill and Bundoora. Knowledge-based jobs have been defined as the following Australian and New Zealand Standard Industrial Classifications (ANZSIC) industry classifications:

- Information media and telecommunications
- Financial and insurance services
- Rental, hiring and real-estate services
- Professional, scientific and technical services
- Administrative and support services
- Public administration and safety
- Education and training
- Health care and social assistance.

The growth in jobs across each of the SRL East and SRL North Precincts (shown in Table B - 20) is also represented in terms of growth in knowledge-based jobs, particularly within knowledge centres including Monash. This analysis is shown in Table B - 20. It shows knowledge-based jobs increase in SRL East and SRL North Precincts over time, both in number (more than three times the knowledge-based jobs currently) and as a proportion of total jobs within SRL East and SRL North Precincts, from 65% in the Base Case to 66% in Program Case Option A.

Table B - 20: Total number of Knowledge-Based Jobs by precinct by 2056[27]

Precinct (1600m)	2018	2036			2056		
	Base Case	Base Case	Program Case Option A	Program Case Option B	Base Case	Program Case Option A	Program Case Option B
Cheltenham	5,500	8,000	8,000	8,000	10,500	17,000	17,000
Clayton	12,000	22,000	27,500	27,500	35,000	40,000	39,500
Monash	18,000	30,500	34,000	33,500	49,000	119,500	119,500
Glen Waverley	6,000	8,500	8,500	8,500	11,500	14,500	15,000
Burwood	6,500	9,500	10,000	10,000	12,500	15,000	15,000
Box Hill	17,500	25,500	28,000	28,000	33,000	35,500	36,500
Doncaster	4,500	7,000	7,000	7,000	9,500	12,500	12,500
Heidelberg	14,500	23,000	24,000	24,000	35,000	40,000	40,000
Bundoora	5,500	11,000	13,000	13,000	19,500	30,500	32,000
Fawkner	2,000	4,000	4,000	4,000	6,500	6,500	7,000
Reservoir	2,000	3,500	3,500	3,500	5,000	6,000	6,000
Broadmeadows	5,500	10,500	10,500	10,500	14,500	18,500	19,500
Melbourne Airport	2,500	5,000	5,000	5,000	6,500	6,500	6,500
SRL East Precincts	**65,500**	**104,000**	**116,000**	**115,500**	**151,500**	**241,500**	**242,500**
SRL North Precincts	**36,500**	**64,000**	**67,000**	**67,000**	**96,500**	**120,500**	**123,500**
SRL – Cheltenham to Airport – All Precincts	**102,000**	**168,000**	**183,000**	**182,500**	**248,000**	**362,000**	**366,000**
Knowledge-based jobs as a proportion of total jobs across SRL – Cheltenham to Airport – All Precincts	**53%**	**60%**	**60%**	**59%**	**65%**	**66%**	**66%**

Source: KPMG analysis of CityPlan modelling

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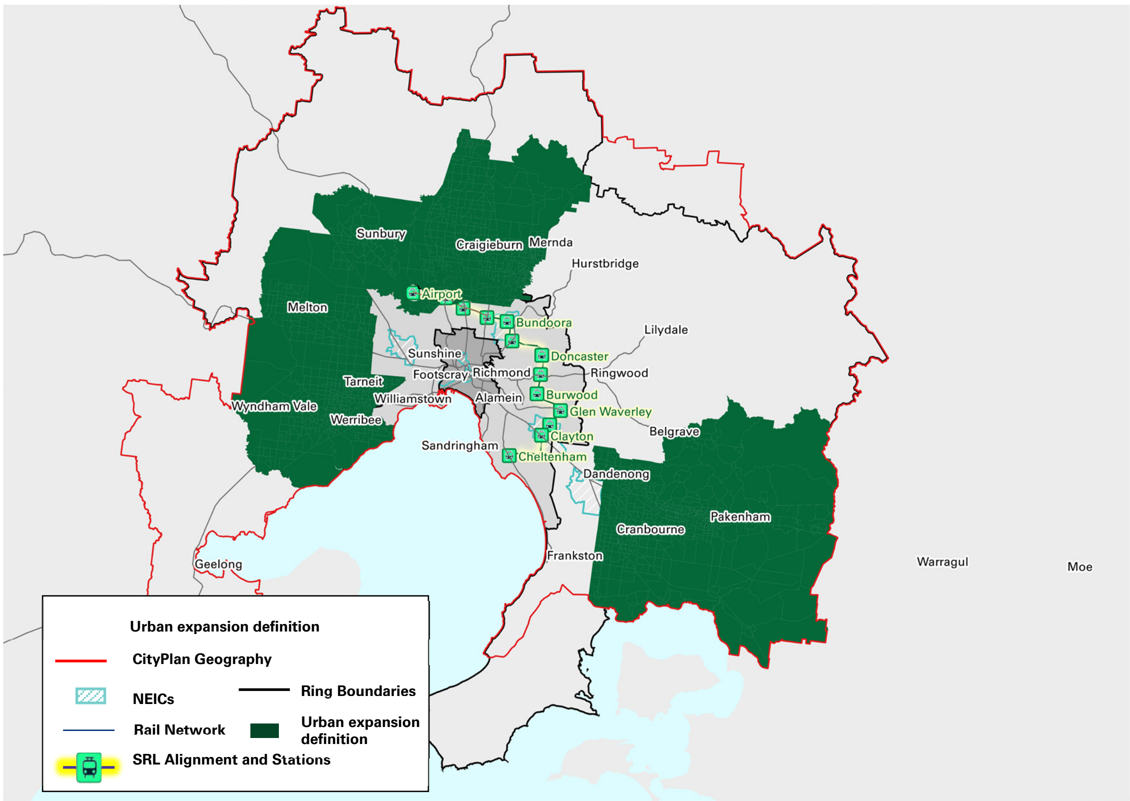
[27] Numbers are rounded to the nearest 500.

Urban expansion

The delivery of SRL – Cheltenham to Airport results in substantial uplift in households and jobs in and around the proposed SRL East and SRL North Precincts. SRL – Cheltenham to Airport will facilitate more high and medium density development in Melbourne's middle ring, enabling people to live closer to where they work, and closer to high quality public transport services. In turn, the increased growth facilitated in SRL East and SRL North Precincts will divert, or slow, some of the continuous urban expansion occurring in Melbourne's outer suburbs. Analysis was undertaken to assess the impact of SRL – Cheltenham to Airport on reducing urban expansion in regions deemed to be growth areas in Greater Melbourne. For the purpose of the assessment, the areas in which growth in households contributes to urban expansion is shown in Figure B - 20.

Figure B - 20: Areas of growth defined as urban expansion



Source: Plan Melbourne

Analysis of SRL – Cheltenham to Airport's impact on urban expansion is shown in Table B - 21 as measured through lower growth in households in the urban growth areas.

Table B - 21 shows that both Program Case Options result in a reduction in urban expansion by more than 16,000 households by 2056, with the Program Case Option B resulting in a greater reduction. SRL – Cheltenham to Airport will reduce urban expansion of housing most within the City of Wyndham, City of Melton and the City of Casey. Table B - 21 shows that the introduction of SRL East has an immediate impact on the reduction of urban expansion, with Program Case Option B seeing 8,000 less households across the municipalities locating in these growth regions, with this decline continuing over time.

Table B - 21: Impact of urban expansion in terms of households by 2056[28]

Municipalities	2018	2036			2056		
	Base Case	Base Case	Program Case Option A	Program Case Option B	Base Case	Program Case Option A	Program Case Option B
City of Cardinia	38,500	66,000	0	0	87,500	-1,000	-1,000
City of Casey	110,500	178,000	-500	-1,500	228,500	-3,000	-3,000
City of Hume	67,500	112,000	-500	-500	149,500	-2,000	-2,000
City of Melton	51,500	111,500	-1,500	-2,500	179,500	-3,000	-3,500
Shire of Mitchell	4,500	18,500	0	0	45,000	-1,000	-1,000
City of Whittlesea	76,000	126,000	-1,000	-1,500	167,000	-2,000	-2,500
City of Wyndham	83,500	155,500	-1,500	-2,000	228,500	-4,000	-4,000
Total	432,000	767,500	-5,000	-8,000	1,085,500	-16,000	-17,000

Source: KPMG analysis of CityPlan modelling

Comparable Precincts

An assessment of what future SRL East and SRL North Precincts look like in terms of today's activity density has been undertaken, with activity density being defined based on Equation 8 below. This has been calculated for each precinct, with a 2018 Base Case comparison being provided. These comparable precincts have been calculated based on a weighted 1600m overlapping radius for all Greater Melbourne stations, as well as select activity centres and NEICs.

$$Activity\ density = \frac{Total\ population + Total\ jobs}{Precinct\ area} \qquad \text{Equation 8}$$

Table B - 22 shows the activity density for Program Case Option A. All precincts (except Reservoir) see a 100% increase or greater in activity density between 2018 and 2056, with the employment centres of Monash and Bundoora seeing the largest increase.

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[28] Numbers are rounded to the nearest 500.

Table B - 22: Comparable precincts for Program Case Option A[29]

Precinct	Population in 2056	Jobs in 2056	Total activity in 2056 (Pop+Jobs)	Activity density in 2056 (Pop+Jobs per Ha)	Activity density in 2018 (Pop+Jobs per Ha)	Change in activity density between 2018 – 2056	Comparable precincts (using 2018 density)
Cheltenham	52,500	36,500	89,000	111	45	147%	Cremorne Hawksburn
Clayton	55,000	57,500	112,500	148	58	155%	Collingwood
Monash	30,500	162,000	192,500	254	66	285%	South Melbourne East Melbourne
Glen Waverley	46,500	25,000	71,500	89	42	112%	Balaclava
Burwood	44,500	24,000	68,500	85	42	102%	Carlton North
Box Hill	77,500	48,500	126,000	157	65	142%	South Yarra
Doncaster	49,000	24,500	73,500	91	43	112%	Balaclava
Heidelberg	59,000	50,000	109,000	136	49	178%	Windsor
Bundoora	37,000	41,500	78,500	98	26	277%	Albert Park
Fawkner	35,500	11,500	47,000	58	27	115%	Northcote
Reservoir	52,000	9,000	61,000	76	39	95%	Ripponlea
Broadmeadows	33,000	26,000	59,000	73	31	135%	Brunswick
Melbourne Airport	0	29,000	29,000	36	18	100%	N/A
Total	**572,000**	**545,000**	**1,117,000**				

Source: KPMG analysis of CityPlan modelling

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[29] Numbers are rounded to the nearest 500.

Table B - 23 shows the activity density for Program Case Option B, with projections being similar to that of Program Case Option A, with increased levels of activity density in Monash and Heidelberg.

Table B - 23: Comparable precincts for Program Case Option B[30]

Precinct	Population in 2056	Jobs in 2056	Total activity in 2056 (Pop + Jobs)	Activity density in 2056 (Pop + Jobs per Ha)	Activity density in 2018 (Pop + Jobs per Ha)	Change in activity density between 2018 – 2056	Comparable precincts (using 2018 density)
Cheltenham	51,000	36,500	87,500	109	45	142%	Cremorne Hawksburn
Clayton	55,000	57,000	112,000	148	58	155%	Collingwood
Monash	30,500	162,500	193,000	254	66	285%	South Melbourne East Melbourne
Glen Waverley	46,000	25,500	71,500	89	42	112%	Balaclava
Burwood	45,000	24,500	69,500	86	42	105%	Carlton North
Box Hill	78,000	48,500	126,500	157	65	142%	South Yarra
Doncaster	48,000	24,500	72,500	90	43	109%	Balaclava
Heidelberg	61,000	50,500	111,500	139	49	184%	Windsor
Bundoora	36,000	43,500	79,500	99	26	281%	Albert Park
Fawkner	35,000	11,500	46,500	58	27	115%	Northcote
Reservoir	52,500	9,500	62,000	77	39	97%	Ripponlea
Broadmeadows	33,500	28,000	61,500	77	31	148%	Brunswick
Melbourne Airport	0	29,500	29,500	37	18	106%	N/A
Total	**571,500**	**551,500**	**1,123,000**				

Source: KPMG analysis of CityPlan modelling

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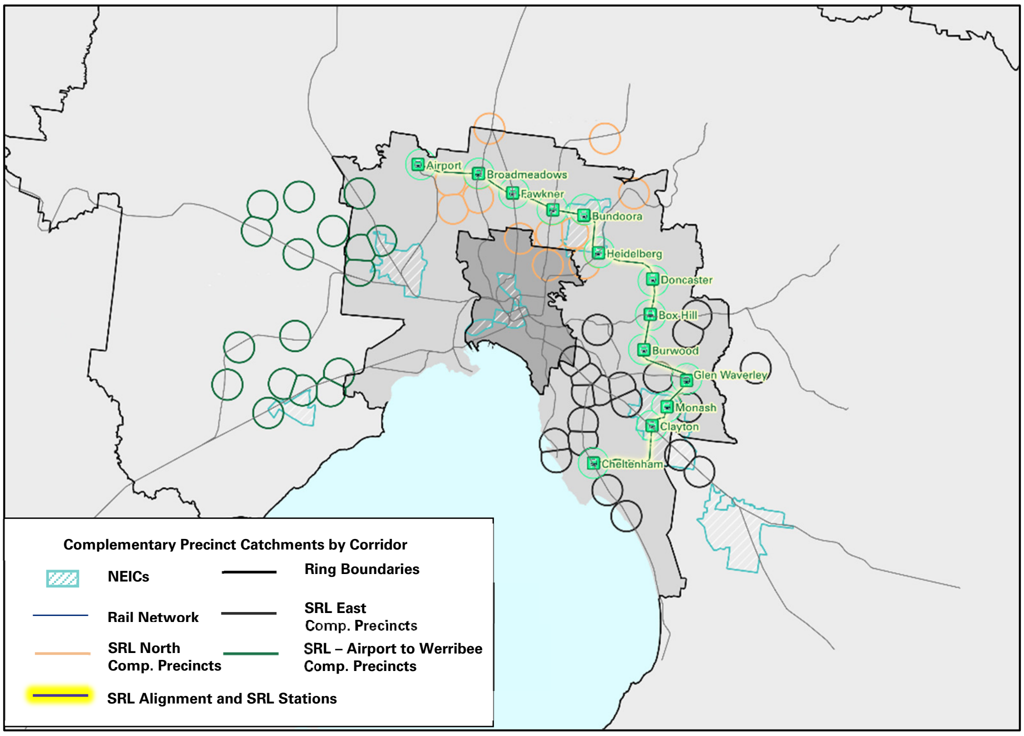
[30] Numbers are rounded to the nearest 500.

Local impacts of SRL – Cheltenham to Airport

SRL – Cheltenham to Airport has the potential to alter the economic geography of Greater Melbourne, leading to shifts in the distribution of both households and jobs. While the previous discussion is centred on the effects across the SRL East and SRL North Precincts, the area of influence extends notably further. Here, we examine the effect of Program Case Option A and B on the growth in households and jobs in complementary precincts. For the purpose of this analysis, these complementary precincts are considered as the 1600m non-overlapping buffers of the Major Activity Centres which intersect with the SRL – Cheltenham to Airport, and potential SRL – Airport to Werribee wider corridors. These 'complementary' catchments explicitly exclude the 1600m extents of the SRL East and SRL North Precincts. The catchments, including a definition by section, are illustrated in Figure B - 21.

Figure B - 21: Definition of Major Activity Centre Catchments split by Corridor Section



Source: KPMG

Table B - 24 reports the growth in households across the SRL East and SRL North Precincts and equivalent growth in the Complementary Precincts. The data indicates that precincts across all groups, both core and complementary, see long-term consistent and significant growth in households. The rate of growth is generally consistent across both Program Case Options A and Option B. Within the complementary precincts, the highest growth rate observed 2.1% in those precincts between Melbourne Airport and Werribee. Across all the complementary precincts, the rate of growth in households is not materially impacted by SRL – Cheltenham to Airport. Observed alongside the 0.6% CAGR increase in the SRL East and SRL North Precincts, this suggests that SRL – Cheltenham to Airport is supporting a sustained net increase in household growth both within the SRL East and SRL North Precincts, and across the wider corridor.

Table B - 24: Growth in Households for non-SRL Major Activity Centres[31]

	2018	2056			CAGR 2018 - 2056		
	Base Case	Base Case	Program Case Option A	Program Case Option B	Base Case	Program Case Option A	Program Case Option B
SRL – Cheltenham to Airport corridor (1600m non-overlapping buffers of the SRL East and SRL North Precincts)							
SRL East	48,500	101,000	126,500	126,000	+1.9%	+2.6%	+2.5%
SRL North	44,000	83,500	105,500	108,000	+1.7%	+2.3%	+2.4%
Total	**92,500**	**184,500**	**232,000**	**234,000**	**+1.8%**	**+2.4%**	**+2.5%**
Complementary precincts (1600m non-overlapping buffers of MAC's in the SRL – Cheltenham to Airport corridor and SRL – Airport to Werribee corridor. Excluding 1600m SRL East and SRL North station buffers)							
SRL East MACs	158,500	265,000	263,000	262,500	+1.4%	+1.3%	+1.3%
SRL North MAC's	86,000	154,000	154,000	155,000	+1.5%	+1.5%	+1.6%
SRL – Airport to Werribee MACs	69,000	154,000	152,000	152,000	+2.1%	+2.1%	+2.1%
Total	**313,500**	**573,000**	**569,000**	**569,500**	**+1.6%**	**+1.6%**	**+1.6%**

Source: KPMG analysis of CityPlan modelling

Table B - 25 reports the growth in jobs across both the SRL East and SRL North Precincts and equivalent growth in the complementary precincts. The data indicates that precincts across all groups, both core and complementary see long-term consistent growth in employment. The rate of growth is generally consistent across both Program Case Options A and Option B. Within the complementary precincts, the highest growth rate is observed between Melbourne Airport and Werribee; 2.5% and 2.4% for Options A and B respectively. Across the Complementary Precincts, the rate of growth in jobs is only minimally impacted by SRL – Cheltenham to Airport with a reduction in CAGR of 0.1%. This, in parallel to the CAGR increase within the SRL East and SRL North Precincts (1.0%), suggests an overall increase in agglomeration of jobs and in turn, the benefits that this can bring.

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[31] Numbers are rounded to the nearest 500.

Table B - 25: Growth in Jobs for non-SRL Complementary Precincts[32]

	2018	2056			CAGR 2018 - 2056		
	Base Case	Base Case	Program Case Option A	Program Case Option B	Base Case	Program Case Option A	Program Case Option B
SRL – Cheltenham to Airport corridor **(1600m non-overlapping buffers of the SRL East and SRL North Precincts)**							
SRL East	120,500	225,500	353,500	354,500	+1.7%	+2.9%	+2.9%
SRL North	71,500	154,500	191,500	197,000	+2.0%	+2.6%	+2.7%
Total	**192,000**	**380,000**	**545,000**	**551,500**	**+1.8%**	**+2.8%**	**+2.8%**
Complementary precincts **(1600m non-overlapping buffers of MAC's in the SRL – Cheltenham to Airport corridor and SRL – Airport to Werribee corridor. Excluding 1600m SRL East and SRL North station buffers)**							
SRL East MACs	166,500	294,000	285,000	284,000	+1.5%	+1.4%	+1.4%
SRL North MAC's	93,500	198,500	191,000	192,500	+2.0%	+1.9%	+1.9%
SRL – Airport to Werribee MACs	50,500	135,500	127,000	126,500	+2.6%	+2.5%	+2.4%
Total	**310,500**	**628,000**	**603,000**	**603,000**	**+1.9%**	**+1.8%**	**+1.8%**

Source: KPMG analysis of CityPlan modelling

Capacity utilisation

Capacity utilisation provides useful insights into the growth of households and jobs within precincts, including on the timing of growth versus land use capacity uplift. Figure B - 22 and Figure B - 23 below illustrate this relationship for households and jobs respectively. Within the Inner – Melbourne SA4, it is observed that growth in households increases overtime, with this rate of growth flattening from around 2050. A similar flattening is observed for jobs from 2045. Within the SRL East and SRL North Precincts, household growth is typically linear with an increase observable in the rate of growth through time. Employment growth is generally more responsive to capacity and development rate increases and can be seen to include the effect of Adjustments.

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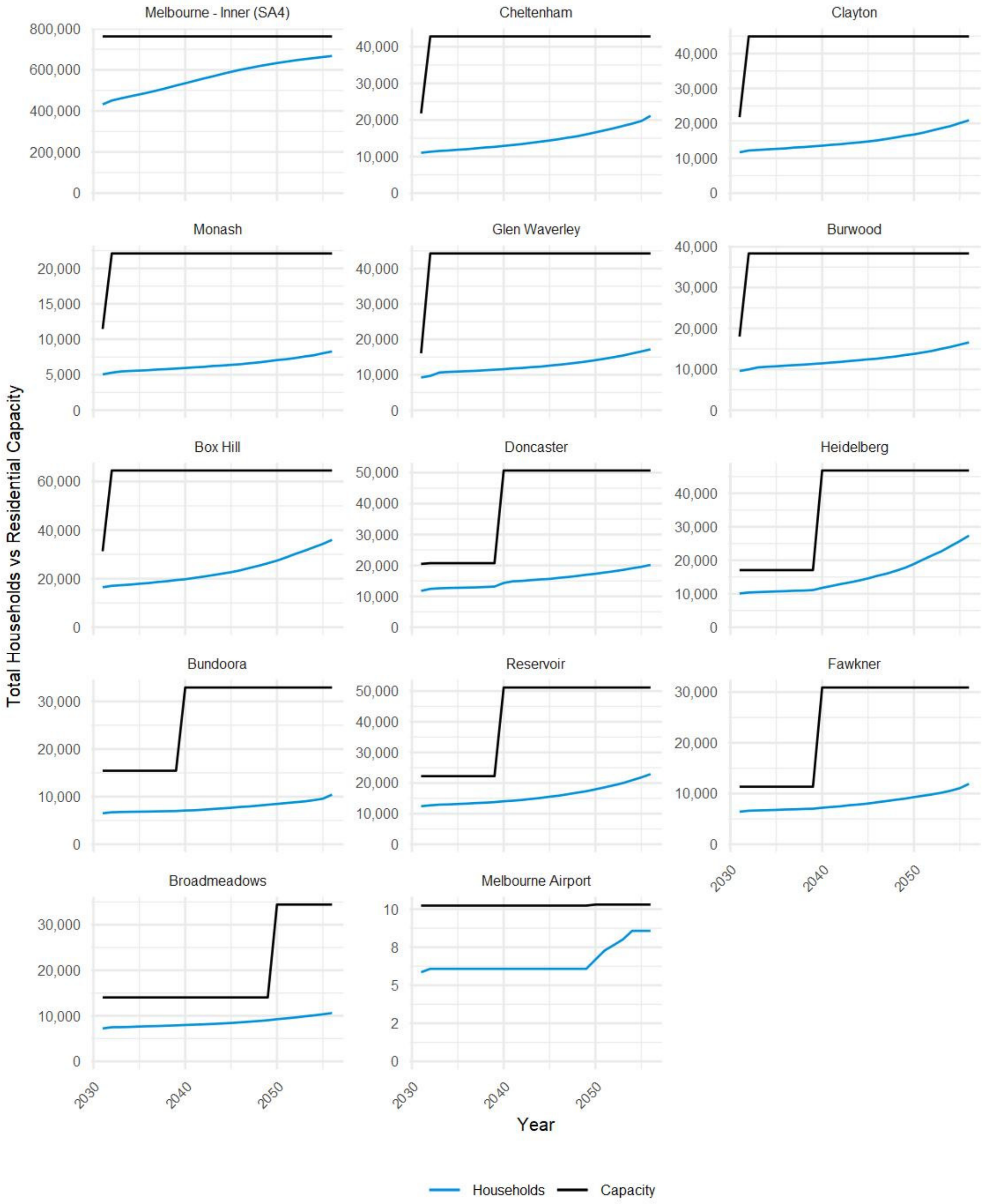
[32] Numbers are rounded to the nearest 500.

Figure B - 22: Program Case Option A Residential capacity utilisation by SRL East and SRL North Precinct versus the Melbourne – Inner SA4[33]



Source: KPMG analysis of CityPlan modelling

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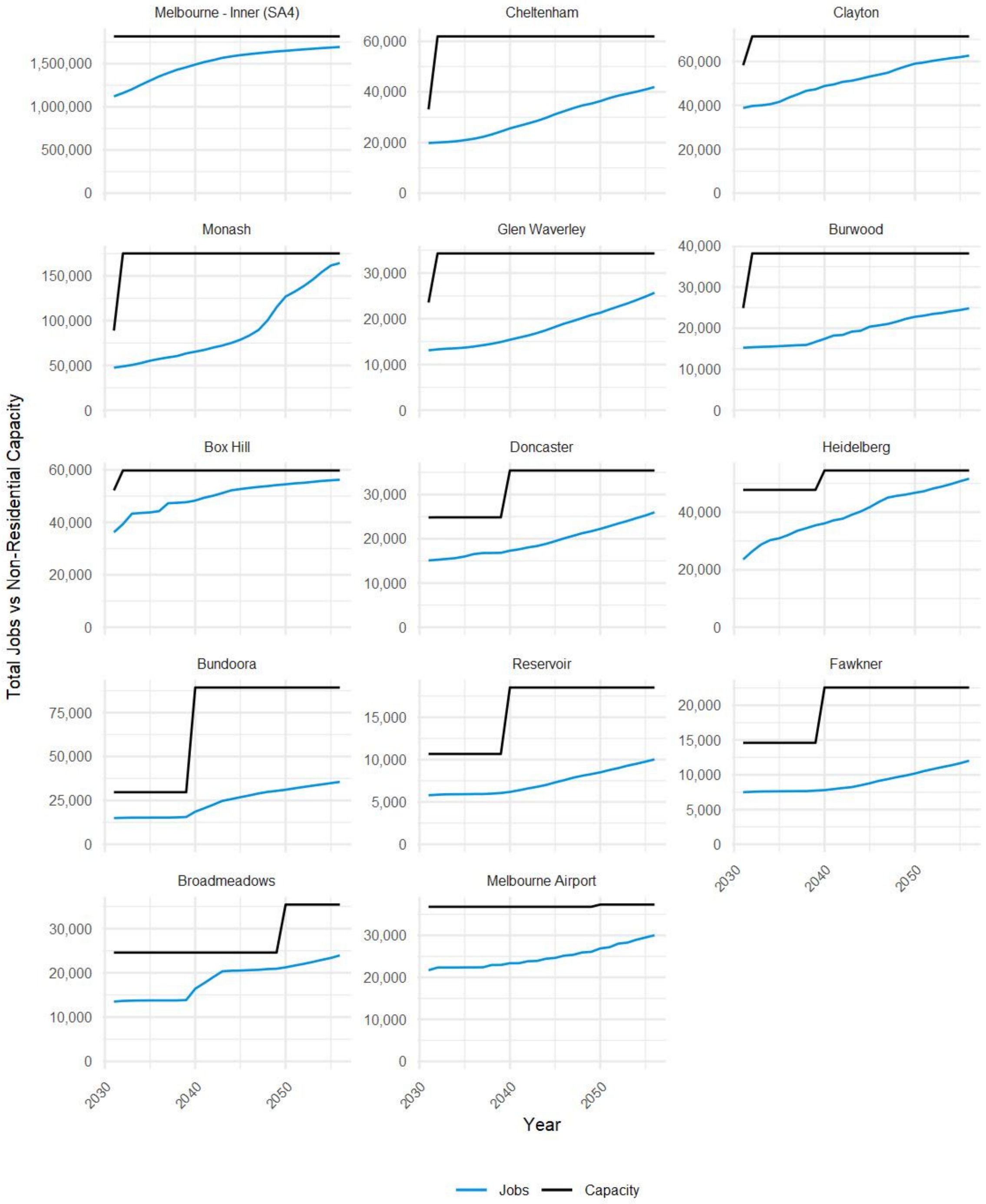
[33] Capacity utilisation figures are based on unpivoted raw CityPlan outputs and may differ from the Precinct figures reported within this volume.

Figure B - 23: Program Case Option A non-residential capacity utilisation by SRL East and SRL North Precinct versus the Melbourne – Inner SA4[34]



Source: KPMG analysis of CityPlan modelling

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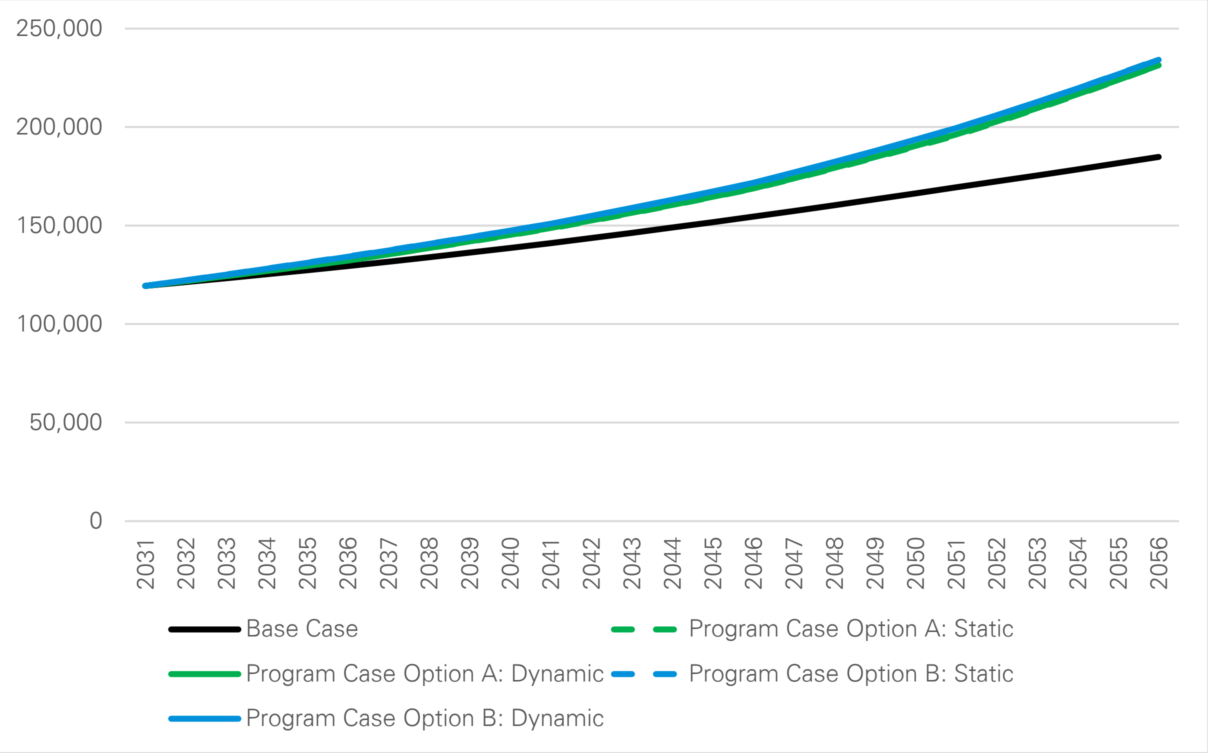
[34] Capacity utilisation figures are based on unpivoted raw CityPlan outputs and may differ from the Precinct figures reported within this volume.

B.6.2 Results – Dynamic versus static

The Program Case Options use CityPlan's dynamic mode. However, application of this process to all sensitivities is not feasible due to the long and computational run times for dynamic feedback. Therefore, static core runs were undertaken in addition to the dynamic versions of those runs to provide a point of comparison against the modelled sensitivities. Static outputs are derived by undertaking all VITM runs (Base and Program Case) with Reference Case land use. This allows VITM runs for different horizon years to be run in parallel and fed into CityPlan once. Static runs produce similar results to Dynamic runs, with a substantially reduced run time. Dynamic runs are used for core Program Case Options and static runs are used for sensitivity or comparison scenarios. A comparison between the dynamic and static runs are outlined in this section to demonstrate the similarity of results and hence the suitability of using static runs for sensitivity analysis.

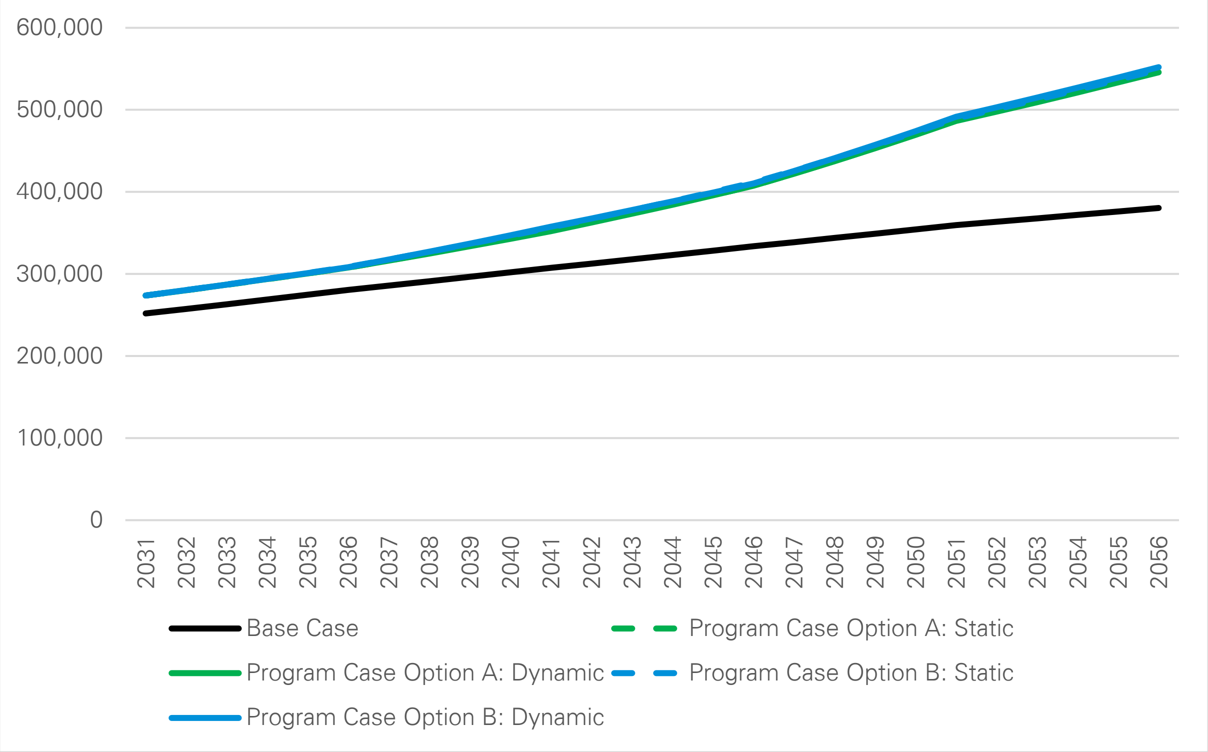
Figure B - 24 and Figure B - 25 illustrate the difference between static and dynamic Option A and B respectively. Compared to the dynamic runs, both Static Program Case Options see relatively similar levels of growth across the SRL East and SRL North Precincts. In terms of households, there is no overall change in the number across SRL – Cheltenham to Airport, with the Static Program Case Option A seeing a slightly higher number of jobs across SRL – Cheltenham to Airport. Static Program Case Option B sees a slightly lower number of jobs than the dynamic version across SRL – Cheltenham to Airport. Details of the precinct level differences in households and jobs is provided in Table B - 26 and Table B - 27.

Figure B - 24: Difference in household growth across all SRL East and SRL North Precincts – Program Case Options static vs dynamic



Source: KPMG analysis of CityPlan modelling

Figure B - 25: Difference in job growth across all SRL East and SRL North Precincts – Program Case Options static vs dynamic



Source: KPMG analysis of CityPlan modelling

Table B - 26: Total number of Households by precinct between static and dynamic, 2056[35]

Precinct (1600m)	2056					Difference	
	Base Case	Program Case Option A Dynamic	Program Case Option A Static	Program Case Option B Dynamic	Program Case Option B Static	Program Case Option A	Program Case Option B
Cheltenham	18,500	22,500	23,000	22,500	22,000	+500	-500
Clayton	18,000	23,000	23,000	23,000	23,000	0	0
Monash	9,500	11,500	11,500	11,500	11,500	0	0
Glen Waverley	13,500	18,000	17,500	17,500	18,000	-500	+500
Burwood	15,000	17,000	17,000	17,000	17,000	0	0
Box Hill	26,500	34,500	35,000	34,500	34,500	+500	0
Doncaster	16,500	19,500	19,500	19,500	19,500	0	0
Heidelberg	14,500	25,500	25,000	27,000	27,000	-500	0
Bundoora	13,000	14,500	14,500	14,500	14,500	0	0
Fawkner	10,000	12,500	12,500	13,000	13,000	0	0
Reservoir	18,500	22,000	22,000	22,500	22,500	0	0
Broadmeadows	11,000	11,500	11,500	11,500	11,500	0	0
Melbourne Airport	0	0	0	0	0	0	0
SRL East Precincts	**101,000**	**126,500**	**127,000**	**126,000**	**126,000**	**+500**	**0**
SRL North Precincts	**83,500**	**105,500**	**105,000**	**108,000**	**108,000**	**-500**	**0**
SRL – Cheltenham to Airport – All Precincts	**184,500**	**232,000**	**232,000**	**234,000**	**234,000**	**0**	**0**

Source: KPMG analysis of CityPlan modelling

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[35] Numbers are rounded to the nearest 500.

Table B - 27: Total number of Jobs by precinct between static and dynamic, 2056[36]

Precinct (1600m)	2056					Difference	
	Base Case	Program Case Option A Dynamic	Program Case Option A Static	Program Case Option B Dynamic	Program Case Option B Static	Program Case Option A	Program Case Option B
Cheltenham	25,000	36,500	36,500	36,500	37,000	0	+500
Clayton	46,500	57,500	57,500	57,000	57,500	0	+500
Monash	75,000	162,000	161,500	162,500	158,000	-500	-4,500
Glen Waverley	18,500	25,000	25,000	25,500	25,500	0	0
Burwood	19,000	24,000	24,000	24,500	24,500	0	0
Box Hill	41,500	48,500	48,500	48,500	48,500	0	0
Doncaster	20,500	24,500	25,000	24,500	25,000	+500	+500
Heidelberg	42,000	50,000	50,000	50,500	50,000	0	-500
Bundoora	25,000	41,500	42,000	43,500	44,500	+500	+1,000
Fawkner	10,500	11,500	11,500	11,500	11,500	0	0
Reservoir	7,500	9,000	9,500	9,500	10,000	+500	+500
Broadmeadows	19,500	26,000	26,000	28,000	28,000	0	0
Melbourne Airport	29,500	29,000	29,000	29,500	29,500	0	0
SRL East Precincts	**225,500**	**353,500**	**353,000**	**354,500**	**351,000**	**-500**	**-3,500**
SRL North Precincts	**154,500**	**191,500**	**193,000**	**197,000**	**198,500**	**+1,500**	**+1,500**
SRL – Cheltenham to Airport – All Precincts	**380,000**	**545,000**	**546,000**	**551,500**	**549,500**	**+1,000**	**-2,000**

Source: KPMG analysis of CityPlan modelling

B.6.3 Results - Sensitivities

Several sensitivity scenarios have been undertaken to understand the impact of various alternative scenarios, with each of these scenarios and their permutations run through CityPlan outlined in Table B - 28 below.

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[36] Numbers are rounded to the nearest 500.

Table B - 28: Sensitivity scenarios

<table>
<tr><th>ID</th><th>Description</th><th>Assumptions</th></tr>
<tr><td>S1a</td><td><i>COVID lower population and higher working from home scenario</i>, which are outlined in DoT's COVID-19 sensitivity scenario.[37] The approach is based on the new Central Scenario developed by DELWP in conjunction with DTF for use within government for planning and modelling purposes. Key assumptions include:

SALUP based on DELWP Land use and population projections 2018 (unpublished) are shifted back by up to 4 years by 2056, effectively assuming that economic growth and transition are delayed by an equivalent period
Higher rates of working from home (WFH) reflected in less congestion and therefore generally higher accessibility. The central WFH scenario estimates 29% of the workforce working from home on an average of 2 – 3 days per week
As agreed with SRLA, demand-side adjustments including a shallower deterrence curve for C2J accessibility. This reflects that commuters are assumed to be prepared to accept a longer commute, given that they undertake these trips less frequently.

The total number of households and jobs across Victoria for both the Reference Case and COVID Base is shown in the two tables below, which highlights that the COVID Base control totals are lower than the Reference Case.
<table>
<tr><th>Total Households</th><th>2031</th><th>2036</th><th>2041</th><th>2046</th><th>2051</th><th>2056</th></tr>
<tr><td>Reference</td><td>3,218,125</td><td>3,485,670</td><td>3,756,460</td><td>4,031,417</td><td>4,311,878</td><td>4,595,871</td></tr>
<tr><td>COVID Base</td><td>3,112,940</td><td>3,325,143</td><td>3,593,986</td><td>3,866,443</td><td>4,143,601</td><td>4,368,676</td></tr>
</table>
<table>
<tr><th>Total Jobs</th><th>2031</th><th>2036</th><th>2041</th><th>2046</th><th>2051</th><th>2056</th></tr>
<tr><td>Reference</td><td>4,159,902</td><td>4,553,387</td><td>4,908,455</td><td>5,235,942</td><td>5,548,672</td><td>5,844,588</td></tr>
<tr><td>COVID Base</td><td>3,998,959</td><td>4,317,296</td><td>4,695,414</td><td>5,039,450</td><td>5,361,034</td><td>5,607,856</td></tr>
</table>
</td><td>Program Case Option A intervention years and land-use</td></tr>
<tr><td>S1b</td><td><i>COVID lower population and higher working from home scenario</i>, with Program Case Option B intervention years. Same assumptions outlined in S1a.</td><td>Program Case Option B intervention years and land-use</td></tr>
<tr><td>S2</td><td><i>Central city capacity increase</i>, including:

CBD – Hoddle Grid: household and job capacity target of SALUP + 20% (SALUP in the base)
Fishermans Bend: capacity target of 160,000 jobs (from 120,000 in the base) and household capacity of 101,500 (from 46,500 in the base), plus productivity initiatives
Docklands: capacity target of 180,000 jobs (from 110,000 in the base), plus productivity initiatives.

These above-mentioned interventions are atop of Program Case Option A land-use interventions.</td><td>Program Case Option A transport interventions</td></tr>
</table>

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[37] Department of Transport (2020). *COVID-19 impacts on demand forecasts – sensitivity and scenario testing project analysis.* Note that air passenger assumptions are based on IATA and Qantas announcements and have been agreed with RPV / DoT.

ID	Description	Assumptions
S3	*Non-SRL comparable precinct interventions*, including: • Sunshine: Job capacity of 104,000 (from 82,000 in the base) and household capacity of 70,000 (from 58,500 in the base), plus productivity initiatives • East Werribee Employment Precinct: Household capacity of SALUP + 40% and 60,000 job capacity (from 29,000 in the base), plus productivity initiatives • Werribee NEIC (remainder): Household and jobs capacity of SALUP + 40%, plus productivity initiatives • Footscray MAC: Household and jobs capacity of SALUP + 40%, plus productivity initiatives • Dandenong NEIC: Household and jobs capacity of SALUP + 40%, plus productivity initiatives. These above-mentioned interventions are atop of Program Case Option A land-use interventions.	Program Case Option A transport interventions
S4	*Central city capacity increase and non-SRL comparable precinct initiatives* (combination of S2 and S3).	Program Case Option A transport interventions
S5	*Lower development rates in SRL East and SRL North Precincts* Project scenario development rates updated to ensure that the reflective development rate can achieve the prescribed land use capacity within a 50-year time horizon, rather than 25 years incorporated as part of the core Program Case Options.	Program Case Option A transport interventions and land-use capacity interventions.
S6	*Increased urban expansion and working from home*, including: • Residential capacities have been uplifted in those CPZ's falling within Plan Melbourne's defined urban growth areas (having more than 75% overlap). In these areas, low-density capacity is uplifted to meet a minimum target of 15 dwellings per hectare. • Low-high density ratio updated to represent the change in opportunity for developers to build (and consumers to choose) lower-density dwellings within these growth areas. • Demand-side adjustments such as a shallower deterrence curve and higher saturation for C2J accessibility. This reflects that commuters are assumed to be prepared to accept a longer commute, given that they undertake it less frequently.	S1a transport interventions and Program Case Option A non-residential land use interventions.
S8	*VPA CLUS scenario,* with land use interventions extending beyond the SRL – Cheltenham to Airport corridor. The VPA Corridor Land Use Strategy (CLUS) scenario includes: • Capacity variations within SRL East and SRL North Precincts, as well as uplifts that extend beyond precinct boundaries into the wider SRL – Cheltenham to Airport corridor. • Development rates updated in these zones to achieve the prescribed land use capacity within a 25-year time horizon. These above-mentioned interventions are atop of Program Case Option A land-use interventions.	Program Case Option A transport interventions

Outputs are presented relative to the Program Case Option A, with the following exception:

- S1a and S1b (COVID scenarios) are presented relative to the COVID base case.

SRL – Cheltenham to Airport corridor wide results

Table B - 29 and Table B - 30 present household and job differences by precinct for each of the modelled sensitivities. A summary of each sensitivity in relation to its associated base is detailed below:

- *S2 - Central city uplift:* uplifting capacities and including initiatives in and around the central city has a minor impact on growth within the SRL East and SRL North Precincts. The reduction in households and jobs by 2056 is in the order of 2.4% and 5.3% respectively. This reduction can be attributed to the increased competition for growth created within the central city.
- *S3 – Comparable precinct uplift:* uplifting capacities and including initiatives in competing precincts such as Footscray, Sunshine, Werribee and Dandenong leads to a relatively small decline in growth within the SRL East and SRL North Precincts. Similar to the S2 scenario, competition from available capacity in other high-value precincts reduces precinct growth but to a lesser extent than S2. The reduction in households and jobs by 2056 is in the order of 1.5% and 1.4% respectively.
- *S4 - Central city capacity increase and comparable precinct equivalent initiatives:* uplifting capacities and including initiatives in both the central city and competing precincts leads to a compounding of both S2 and S3. The reduction in households and jobs by 2056 is in the order of 3.0% and 6.1% respectively. Much of this reduction in job growth comes from Monash.
- *S5 – Lower development rates in SRL East and SRL North Precincts:* Reducing the Program Case development rate assumptions leads to lower levels of growth within the SRL East and SRL North Precincts. The reduction in households and jobs by 2056 is in the order of 10.8% and 3.1% respectively.
- *S6 – Increased urban expansion:* Increasing low-density capacity in growth regions and implementing a shallower deterrence curve and higher saturation leads to higher growth within the SRL East and SRL North Precincts. This growth in the precincts is reflective of people being willing to accept higher levels of travel impedance for a given trip purpose (i.e. people are generally more willing to accept longer travel times for various trip purposes such as work). Growth in the precincts is reflective of general decentralisation, as other precincts become more attractive. This trend is visible for both households and jobs. The increase in households and jobs by 2056 is in the order of 8.0% and 3.9% respectively.
- *S8 – VPA CLUS scenario:* uplifting capacities and including initiatives beyond the 1600m precinct buffer and into the wider SRL – Cheltenham to Airport corridor leads to a small decline in growth in SRL East and SRL North Precincts. Uplifted areas (such as those bordering the eastern edges of the inner-city) which have higher land values than SRL East and SRL North Precincts, leads to increased growth in these areas. This is more prominent for households, which see a greater reduction than jobs in the SRL East and SRL North Precincts. This difference in households and jobs is largely due to the additional capacity within the SRL – Cheltenham to Airport corridor being residential rather than non-residential. By 2056, while the difference in jobs is negligible (less than 0.3%), the reduction in households in 2056 is 4.3%.
- *S1a – Covid Program Case Option A:* Shifting back DELWP's projections by up to 4 years by 2056 and higher rates of WFH result in slightly lower levels of growth (particularly for households) across SRL East and SRL North Precincts by 2056, with earlier years having the greatest difference. By 2056 this difference is reduced due to decentralisation associated with household's higher willingness to accept longer commutes if they are commuting less frequently, making SRL East and SRL North Precincts more competitive (implemented with a shallower deterrence curve and higher saturation). The reduction in households and jobs by 2056 versus Program Case Option A is in the order of 3.0% and 0.4% respectively.
- *S2a – Covid Program Case Option B:* Covid Program Case Option B follows a similar trend to that experienced by Program Case Option A, but to a slightly lesser extent. The reduction in households and jobs by 2056 versus Program Case Option A is in the order of 1.6% and 1.0% respectively.

Table B - 29: Difference in households for sensitivities, 2036 and 2056[38]

Precinct (1600m)	2036			2056		
	SRL East Precincts	SRL North Precincts	SRL – Cheltenham to Airport – All Precincts	SRL East Precincts	SRL North Precincts	SRL – Cheltenham to Airport – All Precincts
Base	**70,500**	**59,500**	**130,000**	**101,000**	**83,500**	**184,500**
Program Case Option A	**73,000**	**59,500**	**132,500**	**126,500**	**105,500**	**232,000**
S2 – Inner city uplift	0	0	0	-2,500	-3,000	-5,500
S3 – Comparable precinct uplift	0	0	0	-1,000	-2,500	-3,500
S4 – Inner city and comparable precinct uplift	0	0	0	-3,500	-3,500	-7,000
S5 – Lower development rates	-2,000	0	-2,000	-13,500	-11,500	-25,000
S6 – Increased urban expansion	+1,000	0	+1,000	+6,500	+12,000	+18,500
S8 – VPA CLUS	0	0	0	-3,500	-6,500	-10,000
Covid Base	**66,500**	**56,500**	**123,000**	**94,500**	**77,500**	**172,000**
S1a – COVID Option A	+2,000	0	+2,000	+26,500	+26,500	+53,000
S1b – COVID Option B	+2,000	+1,500	+3,500	+26,500	+32,500	+59,000

Source: KPMG analysis of CityPlan modelling

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[38] Numbers are rounded to the nearest 500.

Table B - 30: Difference in jobs for sensitivities, 2036 and 2056[39]

Precinct (1600m)	2036			2056		
	SRL East Precincts	SRL North Precincts	SRL – Cheltenham to Airport – All Precincts	SRL East Precincts	SRL North Precincts	SRL – Cheltenham to Airport – All Precincts
Base	**168,500**	**112,000**	**280,500**	**225,500**	**154,500**	**380,500**
Program Case Option A	**192,500**	**115,000**	**307,500**	**353,500**	**191,500**	**545,000**
S2 – Inner city uplift	+500	0	+500	-21,000	-8,000	-29,000
S3 – Comparable precinct uplift	-1,500	0	-1,500	-3,000	-4,500	-7,500
S4 – Inner city and comparable precinct uplift	-1,500	0	-1,500	-21,000	-12,500	-33,500
S5 – Lower development rates	-500	-500	-1,000	-16,500	-500	-17,000
S6 – Increased urban expansion	+500	+500	+1,000	+8,500	+13,000	+21,500
S8 – VPA CLUS	+1,500	-1,500	0	+2,500	-4,000	-1,500
Covid Base	**159,000**	**104,500**	**263,500**	**216,500**	**147,500**	**364,000**
S1a – COVID Program Case Option A	+21,500	+2,000	+23,500	+131,000	+41,500	+172,500
S1b – COVID Program Case Option B	+22,000	+2,500	+24,500	+130,500	+45,000	+175,500

Source: KPMG analysis of CityPlan modelling

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[39] Numbers are rounded to the nearest 500.

Land Use Sensitivities

Household growth

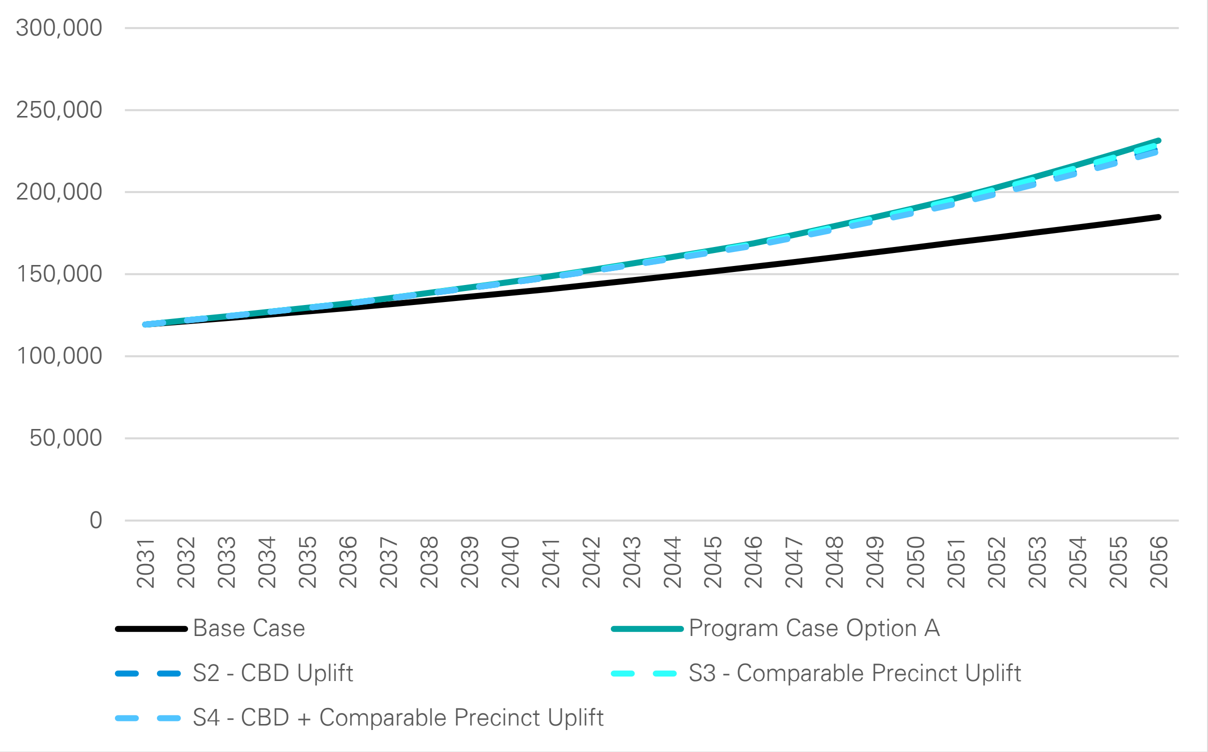
The outcome of the Land use sensitivities are illustrated in Figure B - 26 and Figure B - 27 which show difference in household growth across scenarios. In each case, the effects are minor and move in the anticipated direction.

Uplifting capacities and including initiatives in and around Melbourne's CBD (S2) and comparable precincts (S3 and S8) results in only a minor reduction in household growth within the SRL East and SRL North Precincts when compared to Program Case Option A. This reduction typically occurs from the mid 2040's onwards and may be attributed to the increased attractive choices available to agents.

Reducing development rates to realise land-use capacity (S5) to within a 50-year rather than a 25-year horizon, results in lower household growth across the SRL East and SRL North Precincts, with the difference between Program Case Option A and S5 being 25,000 by 2056.

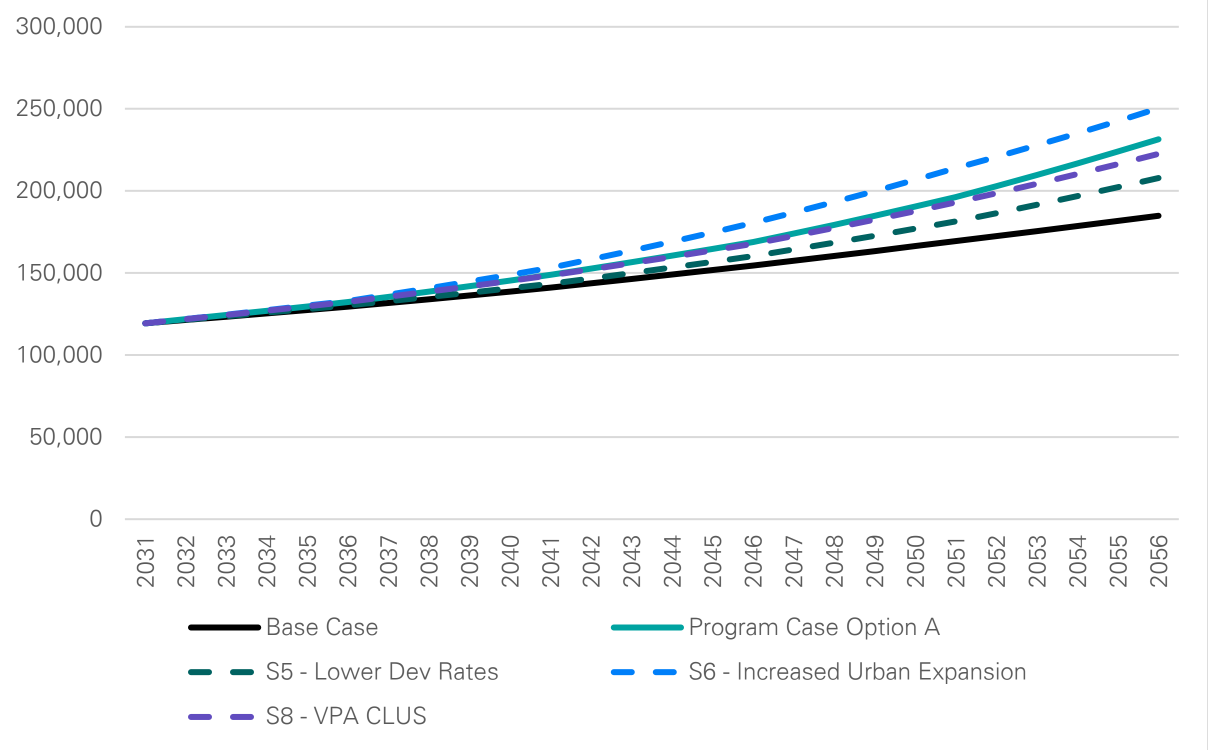
Increasing people's willingness to accept higher levels of travel impedance (S6) results in increased household growth across the SRL East and SRL North Precincts. This increase can be attributed to decentralisation with growth in the precincts increasing at an increased rate from 2040 onwards.

Figure B - 26: Household growth across all SRL East and SRL North Precincts – Comparable Precincts S2 – S4



Source: KPMG analysis of CityPlan modelling

Figure B - 27: Household growth sensitivity across all SRL East and SRL North Precincts – Comparable Precincts S5, S6 and S8



Source: KPMG analysis of CityPlan modelling

Table B - 31 reports households change at the precinct level for the capacity change scenarios. This increase in capacity results in reduced growth in those SRL East and SRL North Precincts which saw the highest level of growth in Program Case Option A.

Lowering development rates further reduces household growth in those SRL East and SRL North Precincts which are projected to cater for much of the household growth along the SRL – Cheltenham to Airport corridor including Heidelberg, Box Hill and Clayton. Conversely, the S6 scenario, reflecting greater decentralisation, sees higher household growth in SRL East and SRL North Precincts as they become more attractive seeing an additional 18,500 household by 2056 (in the order of 8% higher).

Table B - 31: Difference in households against Program Case Option A sensitivity by precinct, 2056[40]

Precinct (1600m)	2056							
	Base Case	Program Case Option A	S2 (Inner city uplift)	S3 (Comp. precincts uplift)	S4 (Inner city & comp. precincts uplift)	S5 (Low dev.)	S6 (Urban expansion)	S8 (VPA CLUS)
Cheltenham	18,500	22,500	0	0	-500	-3,000	+5,000	-500
Clayton	18,000	23,000	-500	0	-500	-3,500	+1,000	-1,000
Monash	9,500	11,500	-500	-500	-500	-500	-500	0
Glen Waverley	13,500	18,000	-500	-500	-500	-3,000	+1,500	-500
Burwood	15,000	17,000	-500	0	-500	+500	0	-500
Box Hill	26,500	34,500	-500	0	-1,000	-4,000	-500	-1,000
Doncaster	16,500	19,500	-500	-500	-500	-1,500	+2,500	-500
Heidelberg	14,500	25,500	-1,500	-1,000	-1,500	-9,000	+7,000	-2,500
Bundoora	13,000	14,500	0	-500	-500	+500	+500	-1,000
Fawkner	10,000	12,500	0	0	0	-1,000	+1,000	-500
Reservoir	18,500	22,000	-500	-500	-500	-500	+1,000	-1,500
Broadmeadows	11,000	11,500	-500	0	-500	0	0	-500
Melbourne Airport	0	0	0	0	0	0	0	0
SRL East Precincts	**101,000**	**126,500**	**-2,500**	**-1,000**	**-3,500**	**-13,500**	**+6,500**	**-3,500**
SRL North Precincts	**83,500**	**105,500**	**-3,000**	**-2,500**	**-3,500**	**-11,500**	**+12,000**	**-6,500**
SRL – Cheltenham to Airport – All Precincts	**184,500**	**232,000**	**-5,500**	**-3,500**	**-7,000**	**-25,000**	**+18,500**	**-10,000**

Source: KPMG analysis of CityPlan modelling

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[40] Numbers are rounded to the nearest 500.

Job growth

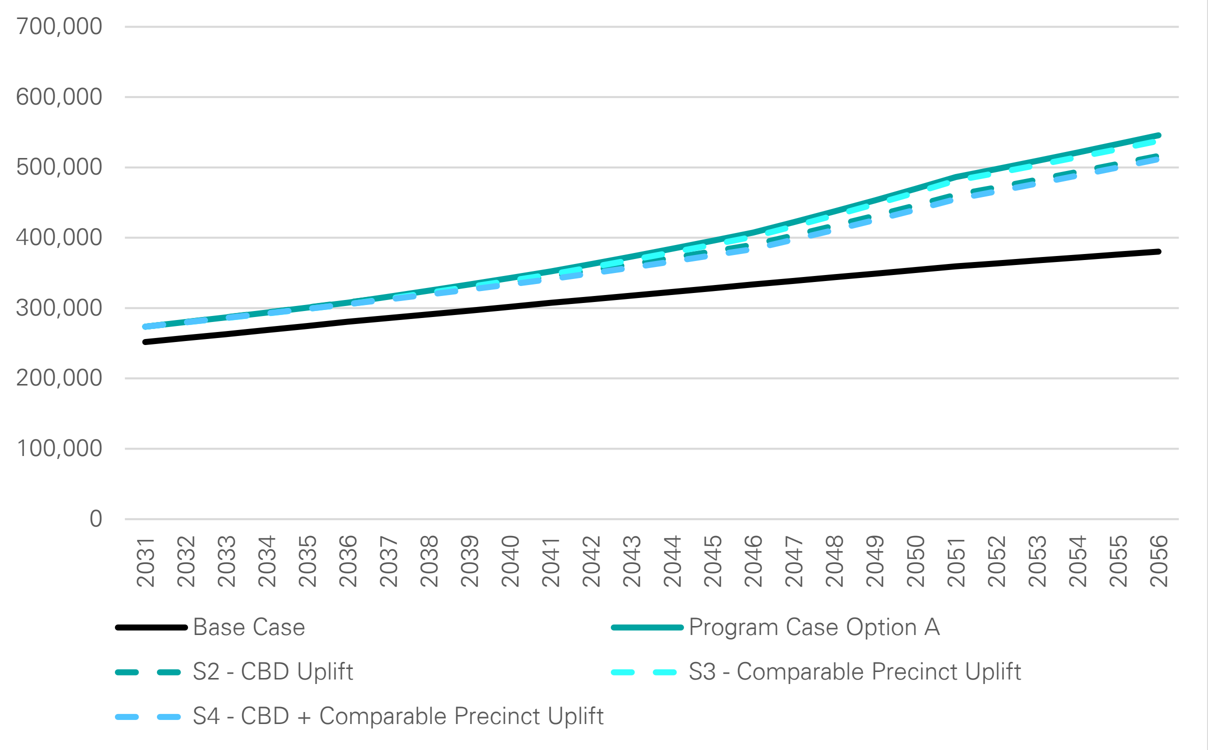
In terms of job growth across the SRL East and SRL North Precincts, some reductions in jobs is observed across the SRL East and SRL North Precincts for the four comparable precinct uplift scenarios (S2, S3, S4 and S8), with S4 resulting in a reduction of about 33,500 jobs from Program Case Option A (a decline of 6%).

Reduced development rates (S5) has a lesser impact in terms of job growth across the SRL East and SRL North Precincts when compared to the decline in households, with 17,000 fewer households (a decline of 3%) locating within SRL East and SRL North Precincts.

The S6 sensitivity (increased urban expansion) sees higher levels of job growth across the SRL East and SRL North Precincts than Program Case Option A from the early-mid 2040s, with this rate of growth slowing from the early 2050s.

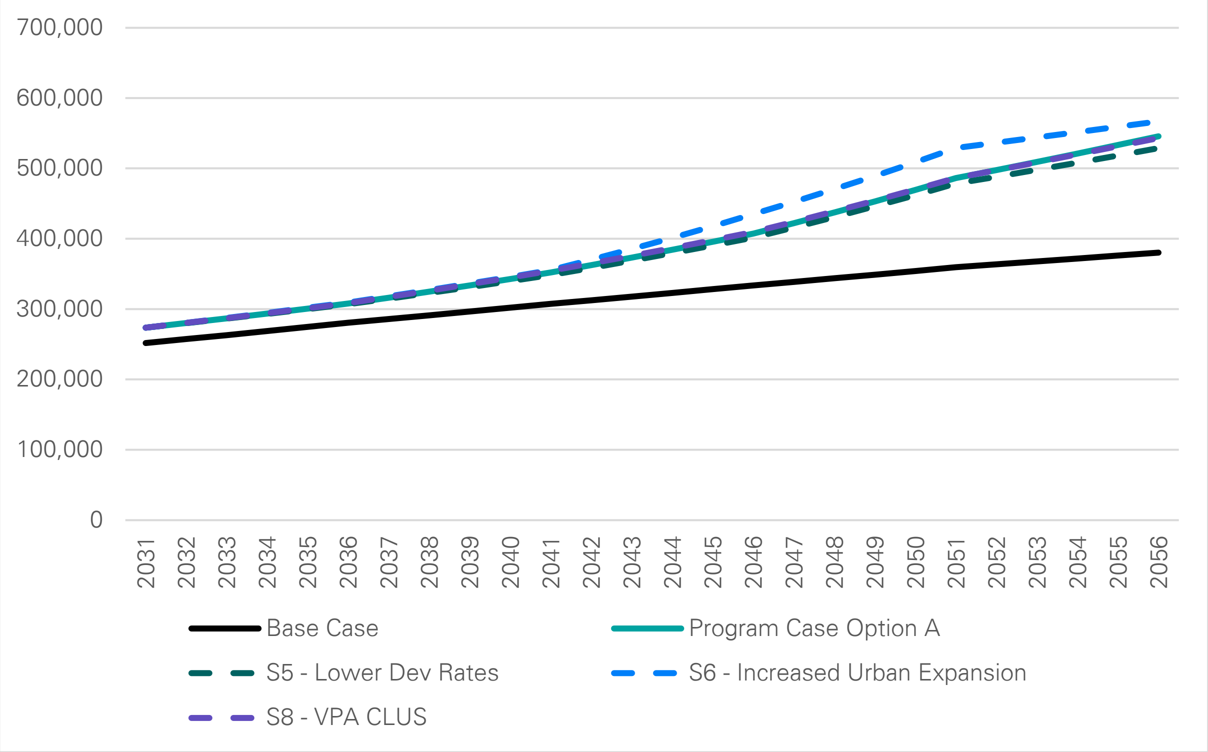
Job growth for these sensitivities are shown in Figure B - 28 and Figure B - 29 below.

Figure B - 28: Job growth sensitivity across all SRL East and SRL North Precincts – Comparable Precincts S2 – S4



Source: KPMG analysis of CityPlan modelling

Figure B - 29: Job growth sensitivity across all SRL East and SRL North Precincts – Comparable Precincts S5, S6 and S8



Source: KPMG analysis of CityPlan modelling

Job change across the SRL East and SRL North Precincts is shown in Table B - 32 highlighting those scenarios which see job capacity uplifts in inner Melbourne and comparable precincts. This results in reduced growth in those SRL East and SRL North Precincts that see the highest level of growth in Program Case Option A (such as Monash in the S2 scenario, which sees a reduction of 15,000 (9%) jobs by 2056). Cumulatively, S4 sees the greatest decline in jobs of around 33,500 across the SRL East and SRL North Precincts by 2056 (in the order of 6%).

Lowering development rates (S5) has a lesser effect on job growth in those SRL East and SRL North Precincts which are projected to cater for much of the household growth along the SRL – Cheltenham to Airport corridor (with Monash forecasted to see a decline of 14,000, 9% by 2056). Conversely, the S6 scenario reflects a decentralisation of the CBD, as those high growth SRL East and SRL North Precincts become more attractive, leading to an increase in job growth across SRL East and SRL North Precincts of 21,500 by 2056 (in the order of 4%).

Table B - 32: Difference in Jobs against Program Case Option A sensitivity by precinct, 2056[41]

Precinct (1600m)	2056							
	Base Case	Program Case Option A	S2 (Inner city uplift)	S3 (Comp. precincts uplift)	S4 (Inner city & comp. precincts uplift)	S5 (Low dev.)	S6 (urban expansion)	S8 (VPA CLUS)
Cheltenham	25,000	36,500	-2,000	-500	-2,500	-500	+4,500	+9,500
Clayton	46,500	57,500	-1,500	-500	-2,500	-500	+500	-1,000
Monash	75,000	162,000	-15,000	-1,500	-11,500	-14,000	+1,000	-7,000
Glen Waverley	18,500	25,000	-500	-500	-2,000	-1,000	+2,500	+4,000
Burwood	19,000	24,000	-1,000	0	-1,500	-500	0	-2,500
Box Hill	41,500	48,500	-1,000	0	-1,000	0	0	-500
Doncaster	20,500	24,500	-1,500	-500	-2,500	0	+3,500	+2,000
Heidelberg	42,000	50,000	-2,500	-1,500	-3,500	-500	+500	-4,000
Bundoora	25,000	41,500	-1,000	0	-1,500	+500	+4,500	+3,000
Fawkner	10,500	11,500	-1,000	-500	-1,500	-500	+1,000	-1,500
Reservoir	7,500	9,000	-500	-500	-1,000	+500	+1,000	-1,000
Broadmeadows	19,500	26,000	-1,000	-500	-1,000	-500	+2,500	-500
Melbourne Airport	29,500	29,000	-500	-1,000	-1,500	0	0	-2,000
SRL East Precincts	**225,500**	**353,500**	**-21,000**	**-3,000**	**-21,000**	**-16,500**	**+8,500**	**+2,500**
SRL North Precincts	**154,500**	**191,500**	**-8,000**	**-4,500**	**-12,500**	**-500**	**+13,000**	**-4,000**
SRL – Cheltenham to Airport – All Precincts	**380,000**	**545,000**	**-29,000**	**-7,500**	**-33,500**	**-17,000**	**+21,500**	**-1,500**

Source: KPMG analysis of CityPlan modelling

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[41] Numbers are rounded to the nearest 500.

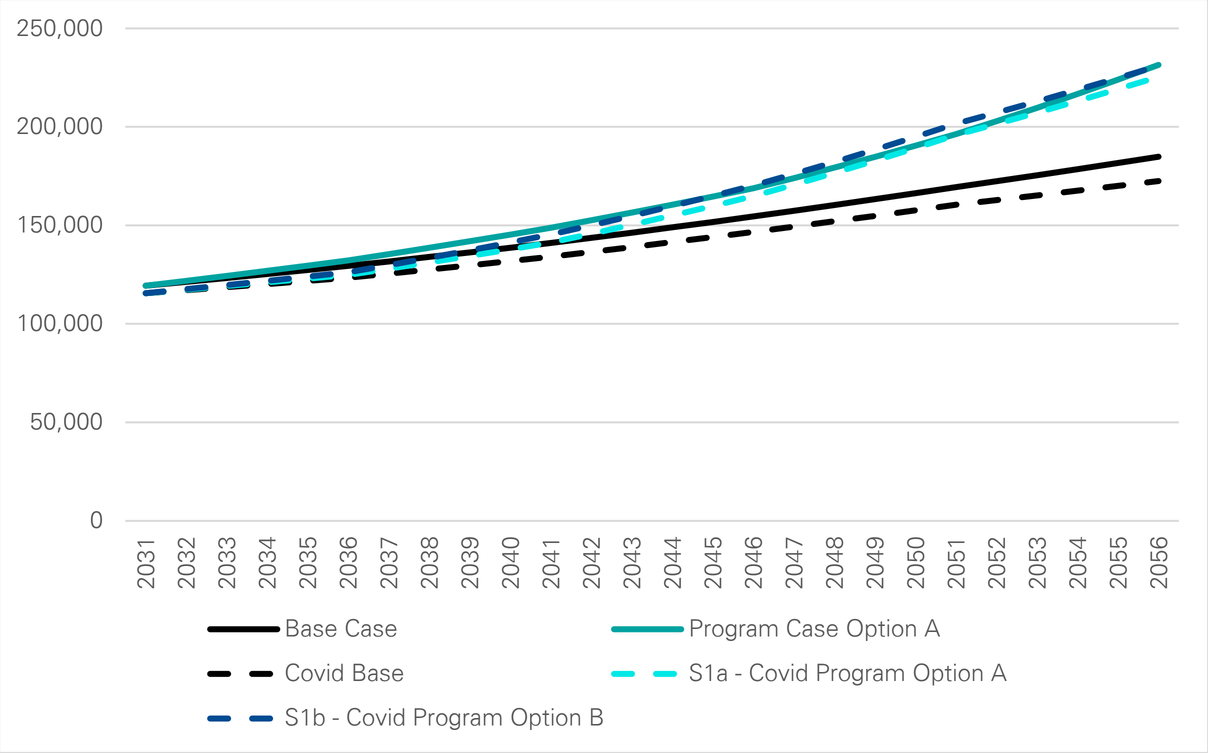
COVID Sensitivities

Household growth

Lower population growth based on DoT guidance and higher rates of WFH result in slightly lower total growth across the SRL East and SRL North Precincts by 2056. In the earlier years the impact is slightly higher, but the difference reduces by 2056. This can be attributed to general decentralisation associated with the assumption that people will be willing to accept longer commutes if they are commuting less frequently (via the implementation of a shallower deterrence curve, as used in scenario S6), making SRL East and SRL North Precincts more attractive.

When removing the delta between the Base Case and COVID Base, the COVID Program Case Option A has 6,000 more households across SRL East and SRL North Precincts than Program Case Option A. This is illustrated in Figure B - 30 below.

Figure B - 30: Household growth sensitivity across all SRL East and SRL North Precincts – COVID scenarios



Source: KPMG analysis of CityPlan modelling

Table B - 33 reports change across the SRL East and SRL North Precincts. Both Cheltenham and Heidelberg see increased growth in the COVID Option A and B when compared to Program Case Option A. When compared to its relevant base, Cheltenham in COVID Option A sees an increase of more than 4,000 compared to Program Case Option A. Growth in precincts such as the above two are at the detriment of those precincts with higher household capacity in Program Case Option A, such as Box Hill and Reservoir, which have the two highest household capacities across the 13 SRL East and SRL North Precincts.

Table B - 33: Total number of households by precinct relative to COVID base sensitivity, 2056[42]

Precinct (1600m)	2056				
	Base Case	Program Case Option A	COVID Base Case	S1a (COVID Option A)	S1b (COVID Option B)
Cheltenham	18,500	22,500	17,000	+8,000	+8,000
Clayton	18,000	23,000	17,000	+4,500	+4,500
Monash	9,500	11,500	9,000	+1,000	+1,000
Glen Waverley	13,500	18,000	13,000	+4,500	+4,500
Burwood	15,000	17,000	14,000	+1,500	+1,500
Box Hill	26,500	34,500	24,500	+7,000	+7,000
Doncaster	16,500	19,500	15,500	+4,500	+5,000
Heidelberg	14,500	25,500	13,500	+14,500	+18,000
Bundoora	13,000	14,500	11,500	+1,500	+2,000
Fawkner	10,000	12,500	9,500	+2,500	+3,000
Reservoir	18,500	22,000	17,000	+3,500	+4,000
Broadmeadows	11,000	11,500	10,500	0	500
Melbourne Airport	0	0	0	0	0
SRL East Precincts	**101,000**	**126,500**	**94,500**	**+26,500**	**+26,500**
SRL North Precincts	**83,500**	**105,500**	**77,500**	**+26,500**	**+32,500**
SRL – Cheltenham to Airport – All Precincts	**184,500**	**232,000**	**172,000**	**+53,000**	**+59,000**

Source: KPMG analysis of CityPlan modelling

Job growth

A similar trend to households can be observed for jobs, where both COVID Program Cases experience job growth across the SRL East and SRL North Precincts, but at a lesser scale than that of households. When removing the delta between the Base Case and COVID Base, the COVID Program Case Option A has 8,000 more jobs across SRL East and SRL North Precincts than Program Case Option A. This is shown in Figure B - 31 below.

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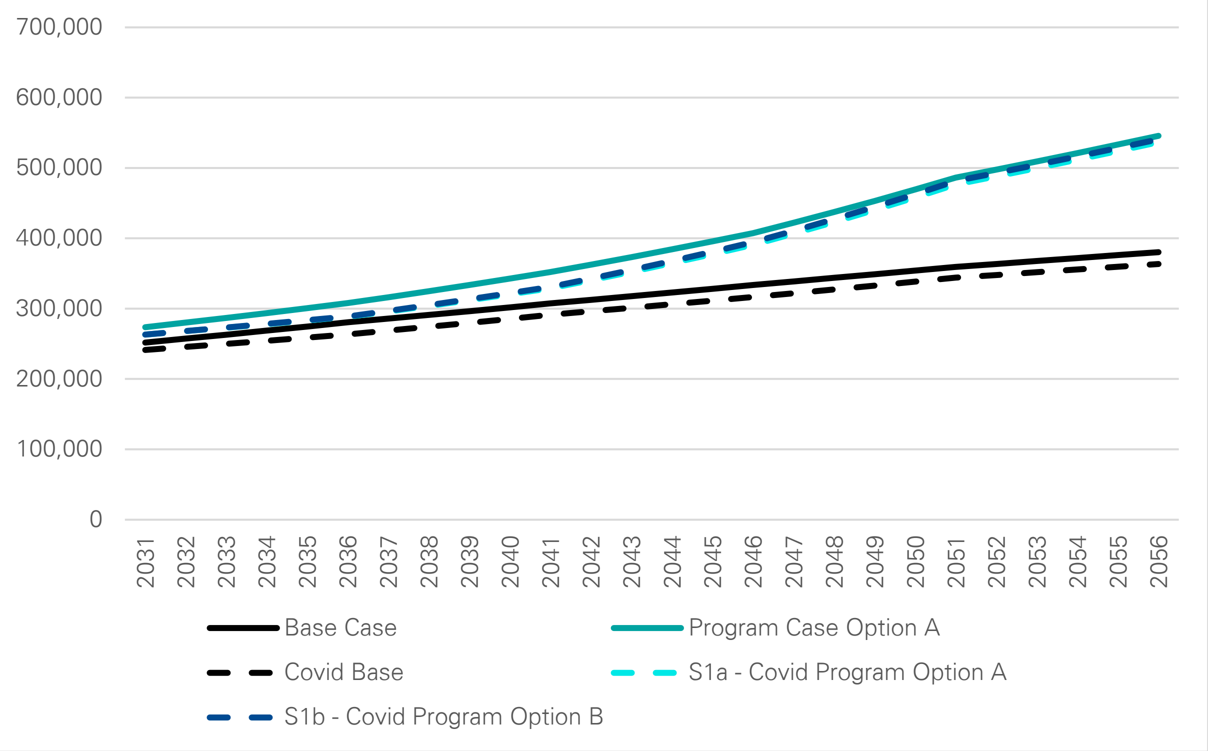
[42] Numbers are rounded to the nearest 500.

Figure B - 31: Job growth sensitivity across all SRL East and SRL North Precincts – COVID scenarios



Source: KPMG analysis of CityPlan modelling

This change across the SRL East and SRL North Precincts is shown in Table B - 34 which demonstrates that, like Program Case Option A, Monash experiences the highest increase in job growth, with Bundoora and Cheltenham following.

Table B - 34: Total number of jobs by precinct relative to COVID base sensitivity by 2056[43]

Precinct (1600m)	2056				
	Base Case	Program Case Option A	COVID Base Case	S1a (COVID Option A)	S1b (COVID Option B)
Cheltenham	25,000	36,500	24,500	+13,500	+13,500
Clayton	46,500	57,500	44,000	+10,500	+10,000
Monash	75,000	162,000	72,000	+89,000	+88,000
Glen Waverley	18,500	25,000	17,500	+7,500	+8,500
Burwood	19,000	24,000	18,500	+4,000	+4,000
Box Hill	41,500	48,500	40,000	+6,500	+6,500
Doncaster	20,500	24,500	19,500	+6,000	+5,000
Heidelberg	42,000	50,000	40,000	+8,500	+8,000
Bundoora	25,000	41,500	23,500	+18,000	+19,500
Fawkner	10,500	11,500	10,000	+1,000	+1,000
Reservoir	7,500	9,000	7,000	+2,000	+2,000
Broadmeadows	19,500	26,000	19,000	+6,000	+9,500
Melbourne Airport	29,500	29,000	28,500	0	0
SRL East Precincts	**225,500**	**353,500**	**216,500**	**+131,000**	**+130,500**
SRL North Precincts	**154,500**	**191,500**	**147,500**	**+41,500**	**+45,000**
SRL – Cheltenham to Airport – All Precincts	**380,000**	**545,000**	**364,000**	**+172,500**	**+175,500**

Source: KPMG analysis of CityPlan modelling

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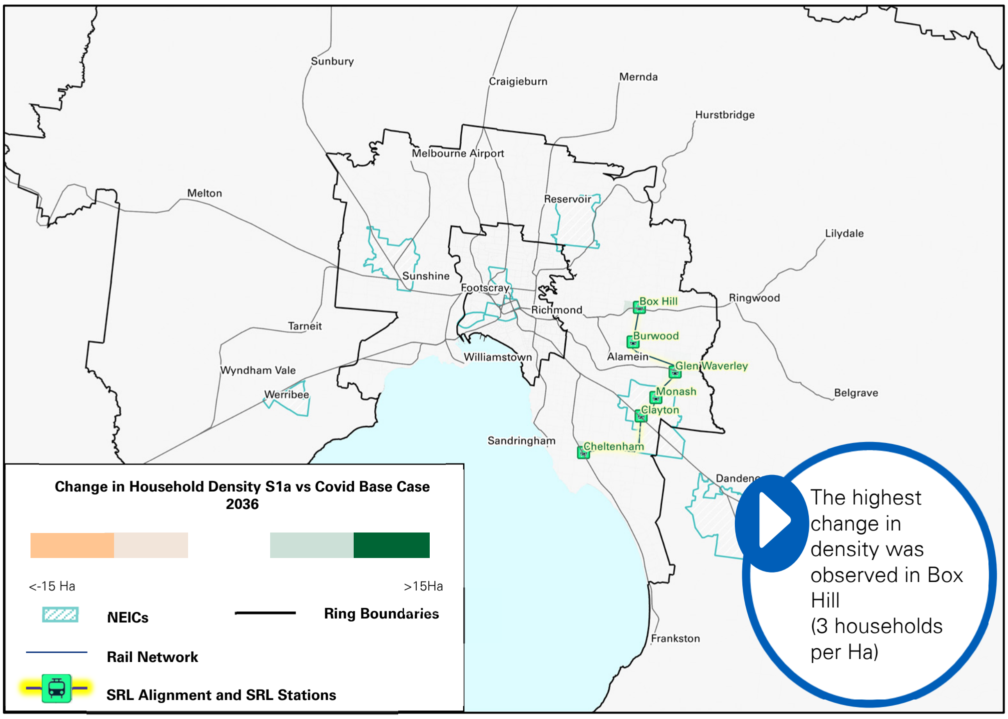
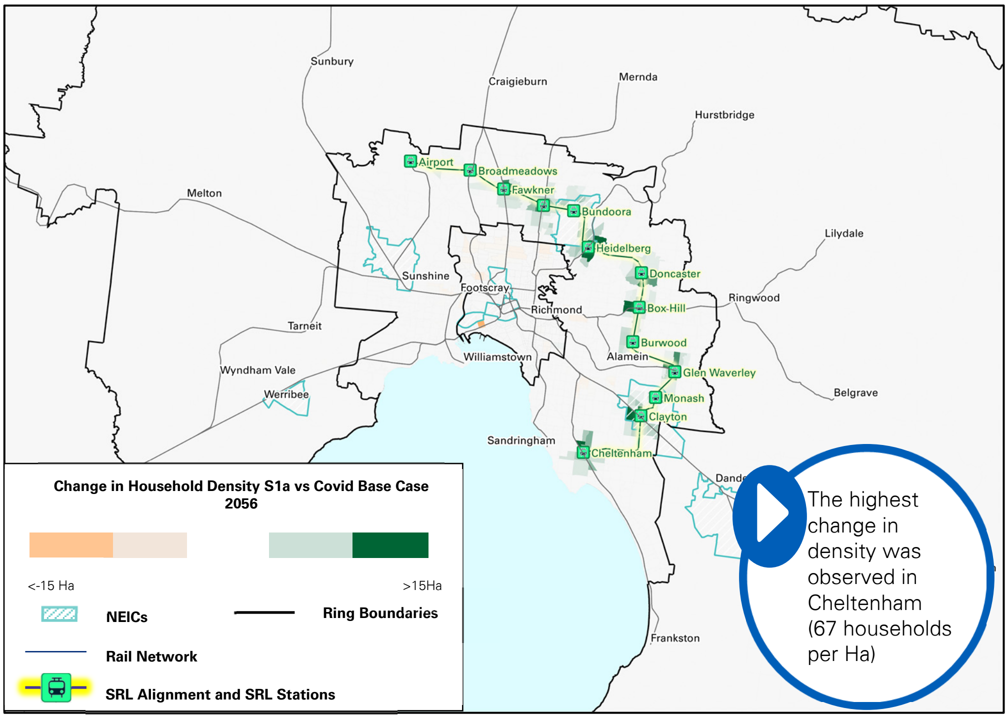
[43] Numbers are rounded to the nearest 500.

Households and jobs

Figure B - 32 shows the difference in the density of households, with Figure B - 33 showing the change in job density in 2036 and 2056 between the COVID Base and COVID Program Case Option A (S1a). Although the scale of growth when compared to Program Case Option A is slightly lower, it is still evident that the introduction of SRL North leads to a shift in the number of households choosing to locate within the SRL East and SRL North Precincts. Much of this household growth stems from the movement of households from the inner core of the city, as the SRL East and SRL North Precincts become more attractive over time, particularly for SRL East precincts.

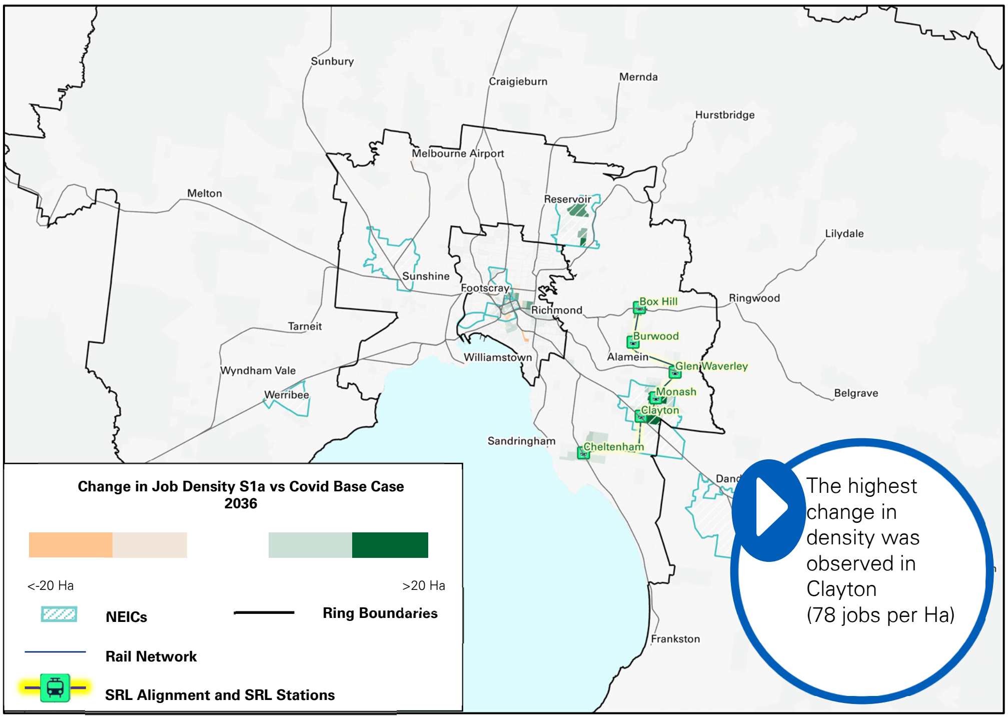
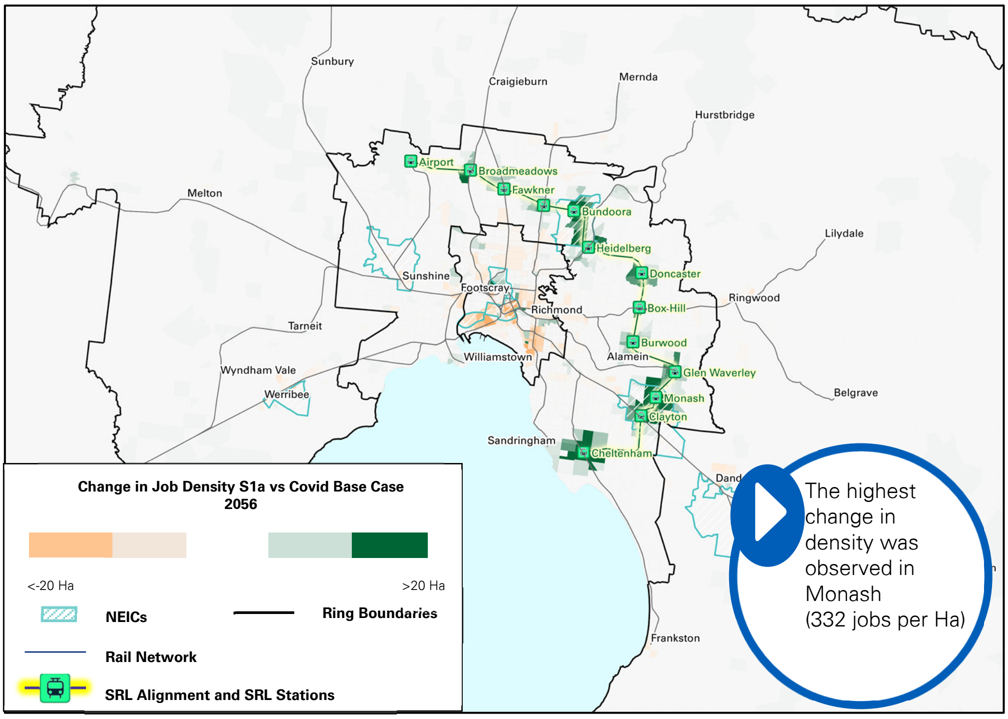
In terms of job growth, the introduction of SRL East sees a greater shift in job growth (particularly around Monash and Clayton), which is attributed to improved accessibility and land-use interventions within this NEIC. This growth increases over time, where by 2056, much of this growth comes from not only the inner-CBD (such as households), but also the western region and along the SRL – Cheltenham to Airport corridor.

Figure B - 32: Difference in household density between the Covid Base Case and S1a sensitivity

Year	Households
2036	 The highest change in density was observed in Box Hill (3 households per Ha)
2056	 The highest change in density was observed in Cheltenham (67 households per Ha)

Source: KPMG analysis of CityPlan modelling

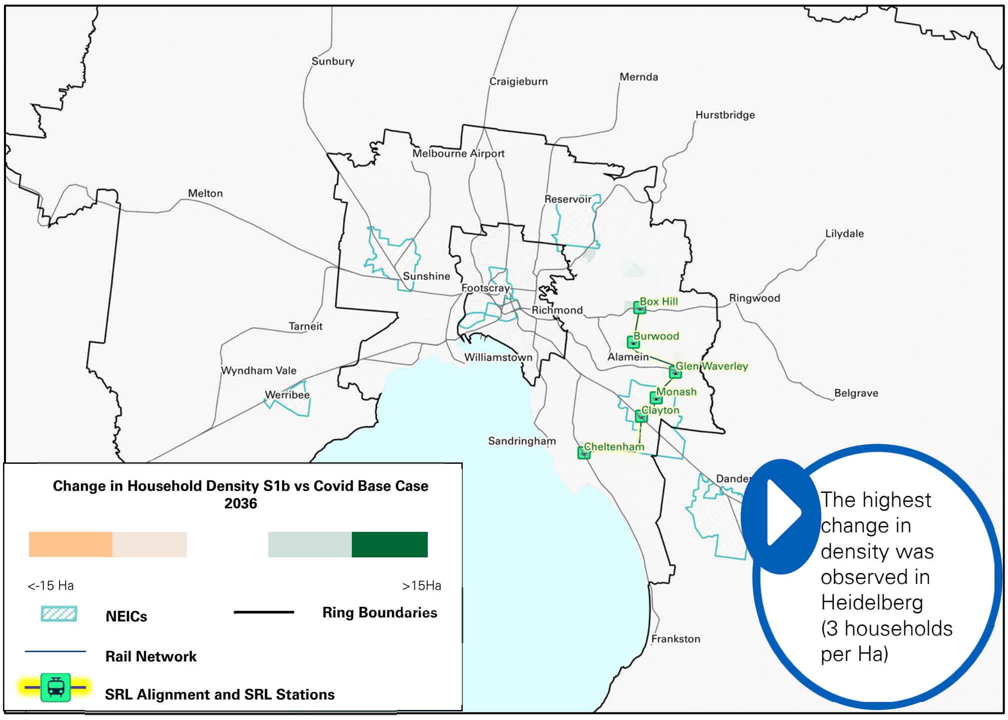
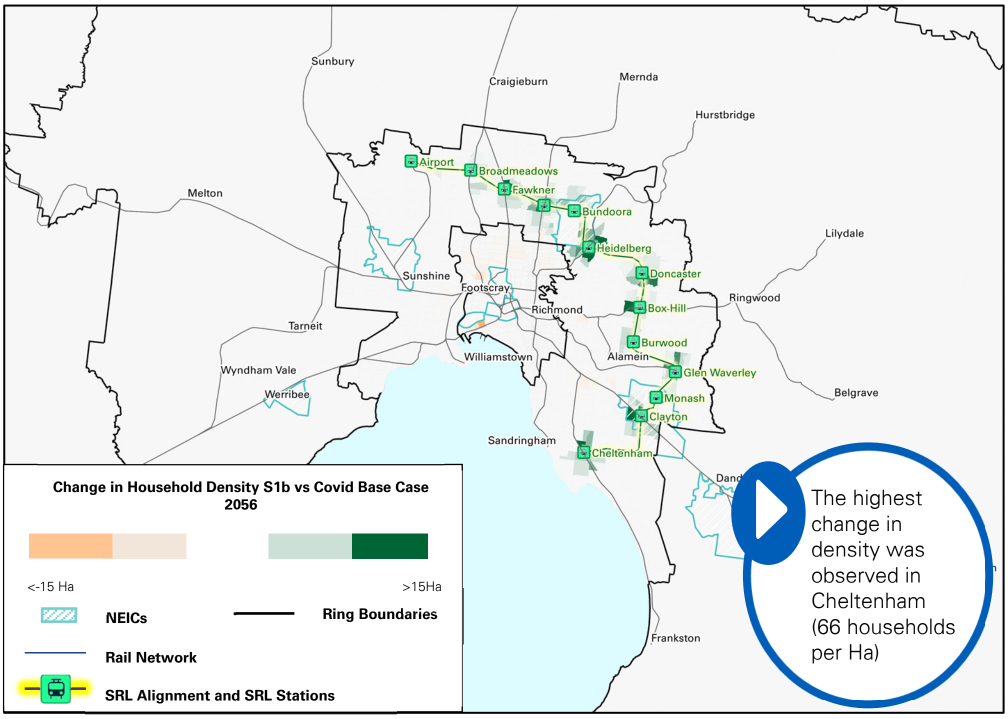
Figure B - 33: Difference in job density between the Covid Base Case and S1a sensitivity

Year	Jobs
2036	 The highest change in density was observed in Clayton (78 jobs per Ha)
2056	 The highest change in density was observed in Monash (332 jobs per Ha)

Source: KPMG analysis of CityPlan modelling

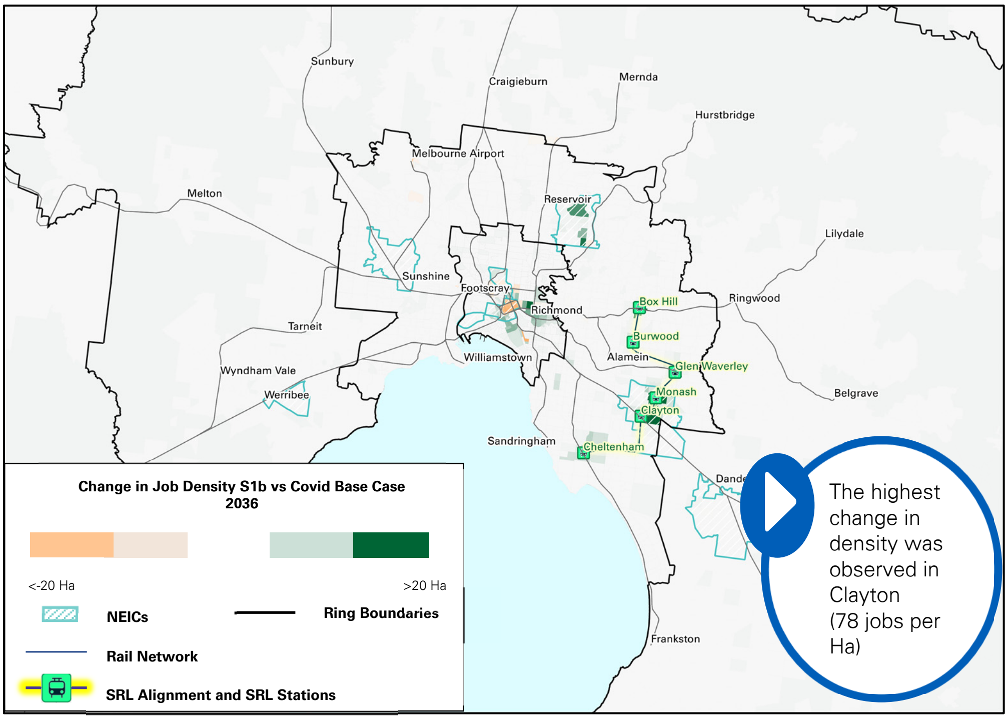
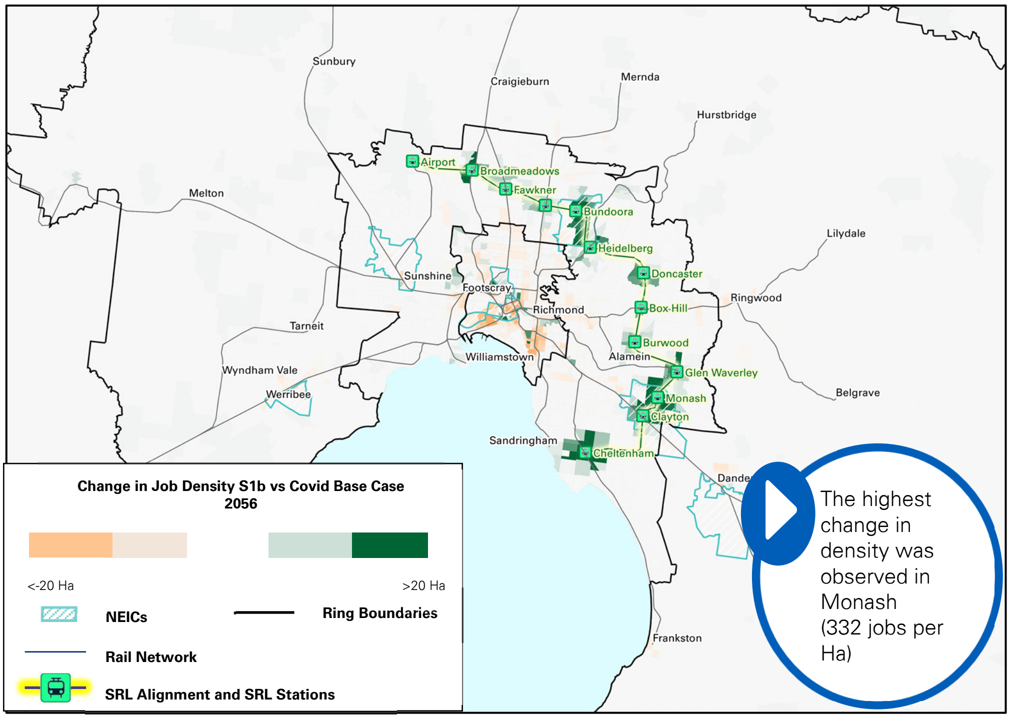
Figure B - 34 shows the difference in density of households, with Figure B - 35 showing the difference in job density in 2036 and 2056 between the COVID Base and COVID Program Case Option B (S1b). Figure B - 35 shows that S1b leads to slightly higher levels of household and job growth across the SRL East and SRL North Precincts than S1a. This difference can be attributed to the earlier introduction of transport and precinct land-use interventions. When compared to Program Case Option B, slightly lower levels of growth are observed around the Clayton / Monash precincts, but like Program Case Option B, most of the household and job growth stems from the inner ring and CBD region, but to a lesser extent.

Figure B - 34: Difference in household density between the Covid Base Case and S1b sensitivity

Year	Households
2036	 The highest change in density was observed in Heidelberg (3 households per Ha)
2056	 The highest change in density was observed in Cheltenham (66 households per Ha)

Source: KPMG analysis of CityPlan modelling

Figure B - 35: Difference in job density between the Covid Base Case and S1b sensitivity

Year	Jobs
2036	
2056	

The highest change in density was observed in Clayton (78 jobs per Ha)

The highest change in density was observed in Monash (332 jobs per Ha)

Source: KPMG analysis of CityPlan modelling

Urban expansion

Analysis of SRL – Cheltenham to Airport's impact on urban expansion for the COVID scenario is shown in Table B - 35, as measured through lower growth in households in urban growth municipalities. Table B - 35 shows that both COVID Program Case Option A and Option B result in a reduction in urban expansion by around 14,500 households by 2056, with the COVID Program Case Option B resulting in a marginally greater reduction. With SRL – Cheltenham to Airport, urban expansion of housing will be most prominent in the City of Casey, City of Wyndham and the City of Melton.

When compared to Program Case Option A and Program Case Option B, the COVID scenarios see higher levels of urban expansion (in the order of 1,500 households by 2056) which is the result of reduced population growth in the COVID scenarios.

Table B - 35: Impact of urban expansion in terms of households relative to the COVID base sensitivity, 2056[44]

Municipalities	2056			
	Base Case	COVID Base Case	S1a (COVID Option A)	S1b (COVID Option A)
City of Cardinia	87,500	83,000	-1,000	-1,000
City of Casey	228,500	221,500	-3,500	-4,000
City of Hume	149,500	143,000	-2,000	-1,500
City of Melton	179,500	167,000	-2,000	-2,500
Shire of Mitchell	45,000	39,000	-1,000	-500
City of Whittlesea	167,000	160,000	-2,000	-2,500
City of Wyndham	228,500	217,000	-3,000	-3,000
Total	**1,085,500**	**1,030,500**	**-14,500**	**-15,000**

Source: KPMG analysis of CityPlan modelling

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[44] Numbers are rounded to the nearest 500.

Volume C: SRL - Cheltenham to Airport Customer Insights

Melbourne Agent and Activity-Based Model (MABM)

Contents

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C.1 Overview

MABM is an agent- and activity-based strategic transport model. In this context, it is applied to provide insights relating to potential SRL – Cheltenham to Airport customers and beneficiaries. This volume provides an overview of MABM modelling undertaken for the SRL Business and Investment Case and is structured as follows:

- Background to MABM (Section C.2)
- Modelling approach for SRL – Cheltenham to Airport (Section C.3) outlines the scope of work for MABM to assess the Program Case
- Model updates and calibration (Section C.4) presents the updates to this version of the model and calibration procedures
- Model validation (Section C.5) reports on validation criteria and performance
- Key assumptions (Section C.6)
- A future without SRL – Cheltenham to Airport (Section C.7) reports on the forecast results for the future (without SRL – Cheltenham to Airport) with a comparison to the base year
- A future with SRL – Cheltenham to Airport (Section C.8) reports on the forecast results for the future with SRL – Cheltenham to Airport including land use uplift and compares this future to the forecast years without SRL – Cheltenham to Airport
- SRL – Cheltenham to Airport customer insights (Section C.9) outlines the story of the SRL – Cheltenham to Airport customers and beneficiaries and how they benefit from SRL – Cheltenham to Airport.

For the purposes of this assessment, it has been assumed that SRL – Cheltenham to Airport will be delivered in three sections: between Cheltenham and Box Hill, followed by Box Hill to Reservoir and then Reservoir to Melbourne Airport.[1] For ease of reference, the section between Cheltenham and Box Hill is referred to as SRL East, and the section between Box Hill and Melbourne Airport is referred to as SRL North. For the purposes of the demand modelling and economic appraisal, two Program Cases have been assessed with SRL – Cheltenham to Airport delivered by 2053 (Option A) and by 2043 (Option B). As SRL North is still in early planning, the assessment of two Program Cases reflects that final delivery dates are yet to be confirmed.

C.2 Background to MABM

MABM can be used to estimate the magnitude of travel demand and the effects of travel on the performance of the road network and public transport networks, as well as to provide insights on the socio-economic and demographic characteristics of travellers. MABM is based on the MATSim theoretical framework and software platform.

This section provides a brief overview of the MABM framework, and why MABM is well suited to provide customer-centric insights. It also outlines the overall model structure and the geographical extent of the model.[2]

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[1] SRLA advises that further detailed planning and technical design for SRL North will be undertaken over the coming years. Specific packaging and procurement decisions will be made at an appropriate time in the future.

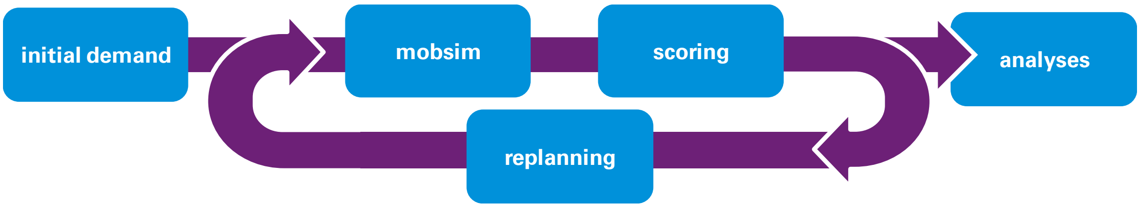
[2] For more detailed information relating to MABM, refer to KPMG & Arup, *Model Calibration and Validation Report*, (2017). For more detailed information relating to MATSim, refer to Horni, A, Nagel, K & Axhausen, K.W., *The Multi-Agent Transport Simulation MATSim*, (2016).

C.2.1 Overview of the MABM framework

MATSim is underpinned by a co-evolutionary algorithm. Each agent (representing a 'person' in the model) optimises their daily activity schedule with each iteration of the model, where they have a multi-dimensional choice of time, mode, and route. This sees agents select an existing plan or choose to generate a new plan with the ability to change their route choice, mode choice or activity departure times.

When selecting between existing plans, each agent possesses a memory containing previous plans, and its associated daily activity chain and respective 'score'. Plan selection uses a multinomial logit model, under which scores form the basis for plan selection. When a plan is selected, a portion of agents in each model iteration have the ability to 'mutate' the plan in a 'replanning' phase. If an agent has reached the limit for the maximum allowable number of plans in their memory, the plan with the lowest score will be discarded. Figure C - 1 outlines this cycle, which is the overall framework of MATSim.

Figure C - 1: MATSim cycle



Source: MATSim book

The iterative process of plan selection based on higher scoring plans and the resulting discarding of lower scoring plans pushes agent behaviour towards a user equilibrium. In this sense, agents 'learn' how to optimise their plan with respect to their travel behaviour. As the optimisation process continues, agents will see diminishing improvements on their plan scores. This gradual stabilisation in average scores continues along a logarithmic path and, as such, convergence can be informed by the rate of average score improvement.

To achieve this equilibrium, a standard MABM run goes through two chronological stages:

1. Initial iterations where plan innovation is enabled, allowing agents to generate and follow new activity plans (pre-innovation).
2. Final iterations where plan innovation is halted and agents must choose from an existing stored plan (post-innovation).

C.2.2 Customer-centric transport modelling

MABM is an agent and activity-based strategic transport model. MABM models the activities undertaken by individuals, and the travel required to move between these activities throughout the day. This means, unlike traditional trip-based models, each agent's trips across the day are linked together representing their constraints in terms of time and mode (e.g. an agent cannot catch the train to work and then drive home, as they would not have a car available).

Other key differences between activity-based models and traditional modelling practice are the linkages between activities and travel, the allowance for variable departure time, and the incorporation of individual household and person-level attributes in utility functions.[3] Another core feature of the MATSim framework is the usage of a co-evolutionary algorithm, which allows individual agents to maximise their 'utility' by mutating their travel plans according to interactions with other agents, and the resulting time and space constraints on the transport network.

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[3] Transport Research Board, *Strategic Highway Research Program*, (2015).

Some topics that MABM is better suited to providing insights on than traditional models include:

- Understanding transport 'customers' and their needs and preferences
- Understanding how customers with different socio-economic and demographic characteristics – such as income, household composition and age – respond to changes in transport policy or new infrastructure
- Understanding how fair and equitable a transport policy or investment is, which groups are the beneficiaries and to what extent they are impacted.

MABM is also more suited to modelling behavioural responses to complex changes to the transport landscape that are likely to occur in coming years and decades. Some examples include:

- Increasing popularity of car sharing services
- Increasing popularity of taxis and ride-hailing services
- The emergence of connected and autonomous vehicles
- Demand responsive transport and Mobility as a Service
- New infrastructure and facilities for active modes such as cycling and walking.

Some key advantages of using MABM to provide customer-centric insights are summarised below.

Person-based rather than trip-based

The unit of analysis for MABM is a person or 'agent'. MABM represents each person in Melbourne and their daily travel plans, including when, where and how they will access their various activities. It also includes their demographic characteristics such as age, income and household composition.

This means that MABM is more suited to understanding the customer profiles, and therefore equity impacts, of transport interventions in greater detail. This is particularly useful for significant projects such as SRL – Cheltenham to Airport, as improving transport accessibility on a network-wide level is likely to catalyse considerable socio-economic impacts.

Focussed on plans and activities rather than journeys

MABM considers all journeys and activities taken by a person in a day. This means that MABM is able to more realistically represent traveller behaviour in some circumstances. For example, if you need to pick your child up from school after work, you might bring your car even if public transport would have been quicker. MABM is able to account for these types of choices, and assist in understanding the unique impacts these decisions have on travel demand.

Able to consider peak spreading impacts

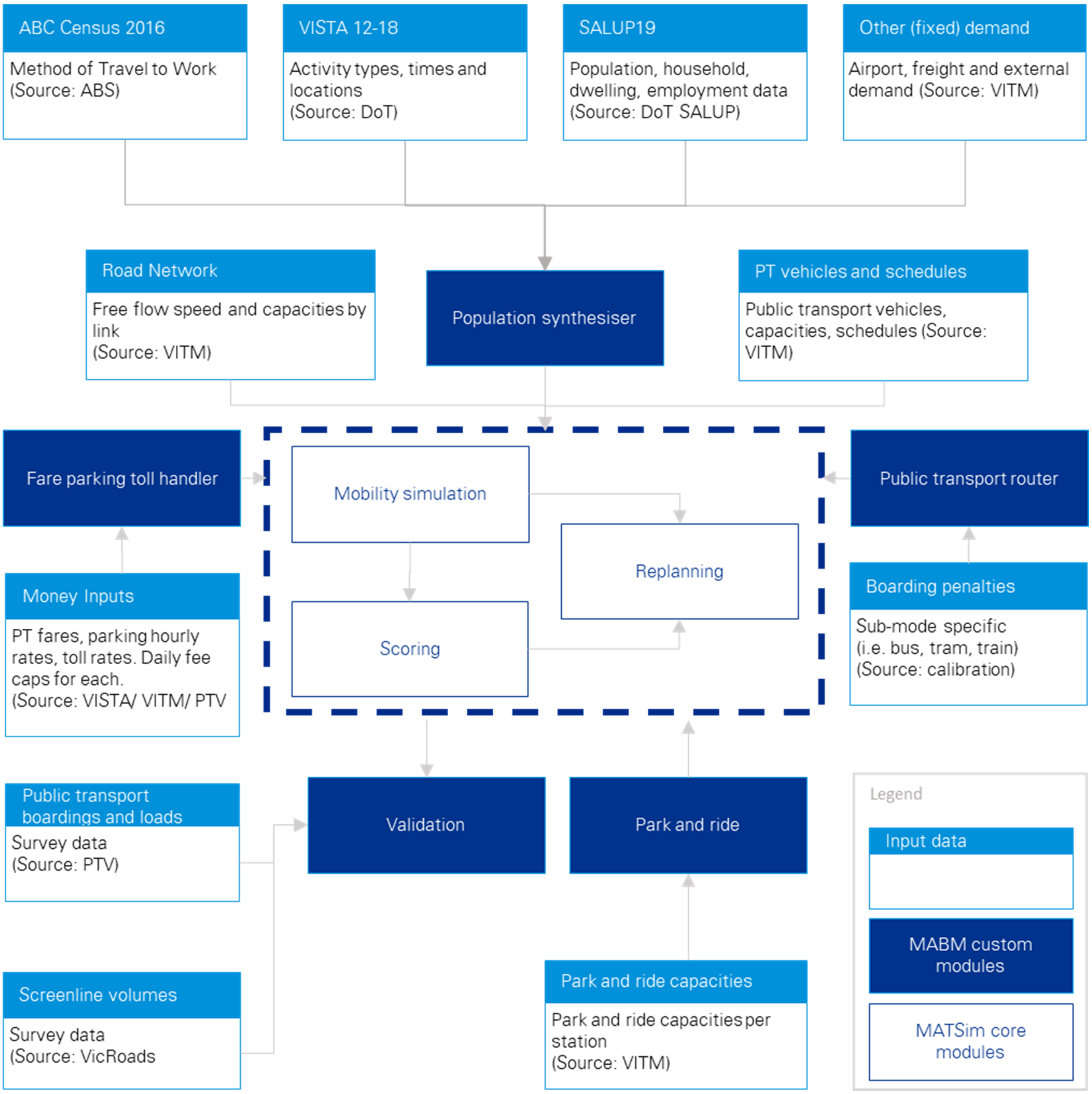
MABM uses a continuous timescale in the simulation, with each second of the day modelled. This means that MABM is well suited for understanding 'peak spreading' impacts.

Peak spreading refers to people making small changes in their departure times to work around congestion. For example, Melbourne's morning peak duration has increased from 2 hours in 2002 to 2.5 hours currently, now starting from 6:30 and stretching to 9:00 in the morning. Understanding peak spreading and its behavioural implications is particularly important to cities that are growing larger and more congested over time, such as Melbourne.

C.2.3 Model structure and geographical extent

The model structure and process flow for MABM is illustrated in Figure C - 2, highlighting the input data sources, the supporting custom modules used in MABM and the core MATSim modules which are centred around a co-evolutionary algorithm approach.

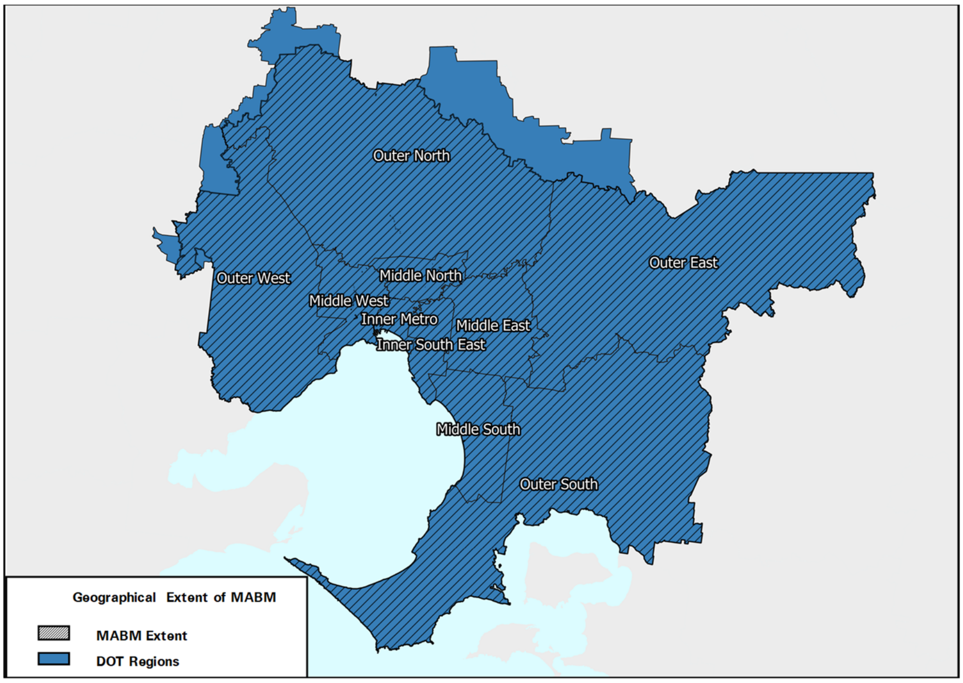
Figure C - 2: MABM model structure



Source: MABM

Figure C - 3 shows the MABM study area, and how it relates to planning regions used by DoT. Greater Melbourne is sub-divided into 10 regions which are used for reporting purposes. All results in this report reference MABM's coverage across all of these regions (labelled 'MABM Extent' on the map).

Figure C - 3: Regions of metropolitan Melbourne, and MABM Extent



Source: MABM

C.3 Modelling approach for SRL - Cheltenham to Airport

The first version of MABM was developed in 2017 for the initial purpose of investigating a series of transport network pricing scenarios, and the validation results were published.[4] Since then, numerous updates have been made to MABM. In particular, updates made for the *30-year Strategy Update* for IV in 2018 provided a major improvement in the population synthesis for public transport modelling and validation.

The scope of work using MABM for SRL – Cheltenham to Airport appraisal includes several steps:

- Data updates, model calibration and validation – MABM was updated using the latest data available, ensuring it was consistent with the latest version of VITM. This step included updates to several model inputs and calibrating and validating the 2018 base year model accordingly.
- Forecast future years without SRL – Cheltenham to Airport (Base Case) – Model the forecast years' Base Case (for 2036, 2041 and 2051) to understand the people's behaviour and changes in the network in a future without SRL – Cheltenham to Airport, and report on changes compared to the base year.
- Forecast future years with SRL – Cheltenham to Airport (Program Case) – The final step is to forecast the travel behaviours in the future with SRL – Cheltenham to Airport and the associated land use uplift. This step also includes providing insight on SRL – Cheltenham to Airport customers and beneficiaries and how SRL – Cheltenham to Airport impacts the equity in the city. This utilises

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[4] KPMG & Arup, *Model Calibration and Validation Report*, (2017).

the changes to the transport networks (sourced from VITM) along with the changes to land use (sourced from CityPlan).

In the remainder of this section, the model input and data sources used for calibration and validation and their limitations are outlined.

C.3.1 Model inputs

Transport network and special demand generator inputs to the enhanced MABM are based on data from VITM. Table C - 1 shows the scenario names of the base VITM model used for each year.

Table C - 1: Transport network model year sources (VITM)

MABM run code	MABM model year	VITM model
SRL18.50	Base year of 2018	Y2018_VR19_Ref_C_02
SRL36.16	Forecast year of 2036	Y36_SRLSilver_BaseCase_v2
SRL41.07	Forecast year of 2041	Y41_SRLSilver_BaseCase_v2
SRL51.23	Forecast year of 2051	Y51_SRLSilver_BaseCase_v2

Source: KPMG VITM modelling

The year 2056 is not explicitly modelled in MABM, and the reported results for 2056 are derived from 2051 using two approaches:

- First, we use the trends between 2051 and 2056 of VITM results to extrapolate 2051 results, where there is an absolute number reported
- Second, we use the result of 2051 directly when a relative comparison is reported.

Road network

The road network used for MABM is derived from the VITM transport network. It reflects road capacities (inclusive of intersection capacities) and how capacities may change throughout the day (e.g. due to clearways). This version of MABM includes a 10% increase in the effective flow factor of the network to account for the differences between static assignment in VITM and dynamic assignment in MABM.

While the road, bus and tram networks cover the entire study area, the rail network covers the study area and extends beyond that into the regions. The network was cut from the state-wide VITM network and is converted from the .NET format associated with Cube Voyager to the XML format used in MABM.

Public transport capacities and schedules

Public transport schedules and capacities are derived from the VITM lines file to ensure cross-model consistency and ease of integration within an agent-based model.

Public transport capacities and schedules

MABM uses hourly parking rates which are consistent with the recently released VISTA data and the most recent version of VITM.[5] There are four distinct levels of hourly parking rates which are distributed accordingly across all of Greater Melbourne, as shown in Figure C - 4. A global parking cap of $26 per day is also applied to agents.

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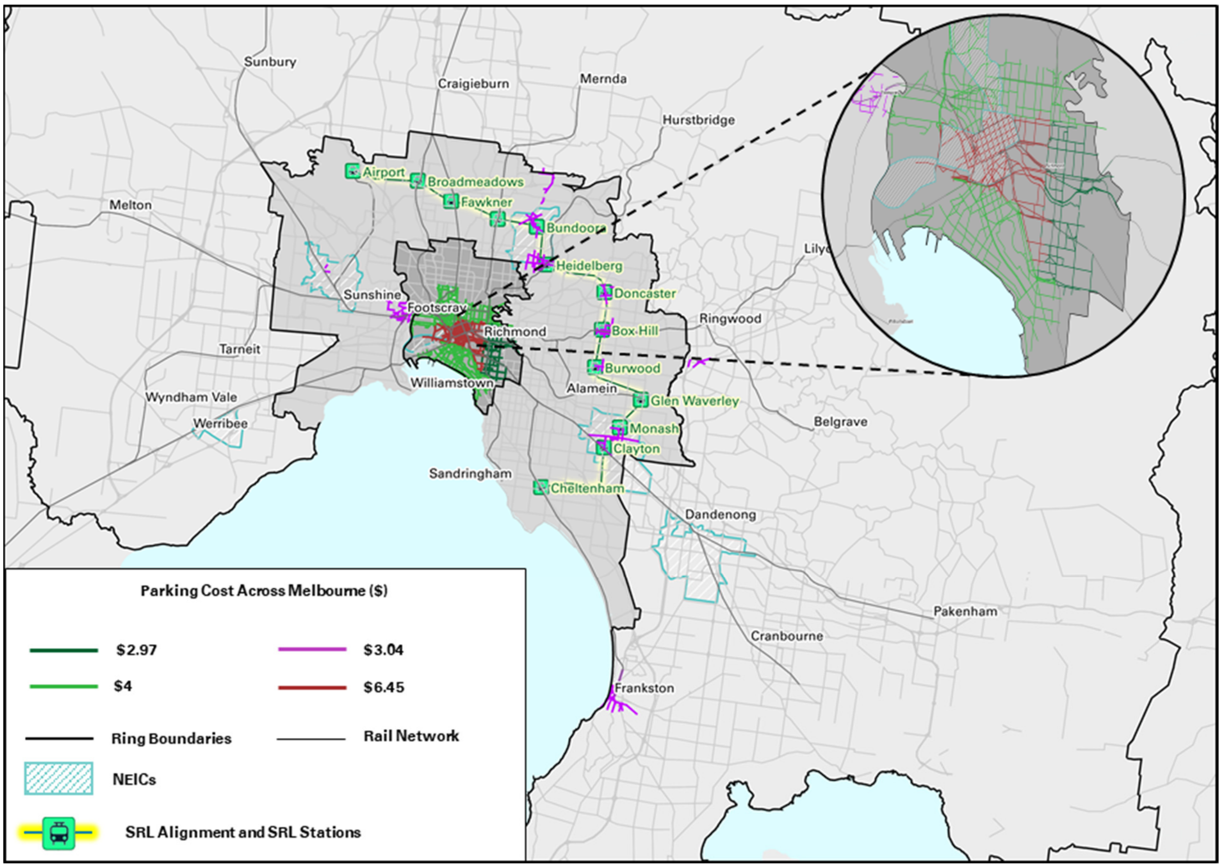
[5] KPMG, *Victorian Integrated Transport Model Refresh*, (2019).

Figure C - 4: Hourly parking rates



Source: KPMG MABM modelling

Fares

The distribution and pricing of public transport fares in MABM is consistent with the current fare regime as charged using the Myki system. As such, the fare a passenger pays is dependent on the origin and destination travel zone of an agent's trip.

The model accounts for concession fares which provide a 50% discount on public transport trips, and hence motivates public transport travel for concession card holders. For full fare agents, the maximum daily spend is $8.60, while for concession card holders, the maximum daily spend is 50% of the full fare ($4.30). Travel within the free tram zone in Melbourne's CBD is also accounted for in MABM.

C.3.2 Data sources

Data sources used in the development (calibration) and validation of MABM are listed in Table C - 2.

Table C - 2: Data sources used in validation process

Data	Source/collection method/usage
SALUP19	Population projections in SALUP19 based on Department of Environment, Land, Water and Planning (DELWP) Projections 2018 (Unpublished) are used as control totals in each age bracket, and in turn for the total population.
VISTA	Household travel and activity survey time series data. The survey is undertaken between the years 2012-2018 with approximately 36,000 survey respondents from 25,000 households across Victoria. All respondents completed travel diaries that covered their weekday travel plan. The survey also includes additional information about the traveller's demographics, household income and location. Using this dataset as the travel pattern input for MABM allows for the agents to have realistic travel plans which represent realistic travel behaviour of Melburnians.
MTWP	Work activities using an upscaled version of the ABS Census 2016 Method of Travel to Work (**MTWP**) data. Upscaling is undertaken using the RAND pivot method.[6] to estimate 2018 work origin-destination patterns. MTWP Census data is used for generating the home and work locations of workers, and their initial mode. The Census data is used as it is a more reliable dataset (compared to VISTA) due to the significantly larger sample size.
Screen line traffic volumes	Traffic volumes across all of Melbourne. Data is sourced from DoT by using permanent traffic monitoring stations, loop data and additional sources.
2018 Public transport station Patronage Data (DoT)	A set of observed patronage data from Myki touch-ons for the major modes of public transport in Melbourne, including train, tram and bus.

Source: KPMG MABM modelling

Use of these data sources must take into account the limitations associated with the data and therefore the suitability of the data. An outline of these limitations is listed below.

VISTA

A total of 46,000 records have been used in the process of developing travel and activity plans in MABM. To ensure the correct application of a specific agent's attributes, the VISTA records have been filtered by demographic information such as age, employment status and household location. This act of filtering significantly reduces the sample size from which any one agent can choose. This means that there is an unknown non-response bias in VISTA which also applies to the agents in the MABM.

2016 Census data

Census data is generally a reliable data source, given its large sample size and wide range of demographic questions asked. However in this case, the clear limitation is that simulations of travel behaviour in 2018 are based on Census data collected in 2016, which can introduce a level of uncertainty. Any biases in the Census data (particularly the MTWP data) would also be applicable to MABM.

The Census data is used to develop the projected proportion of population by age, and employment at the VITM zone level. These proportions are then scaled up from 2016 to 2018 (only two additional years). This up-scaling task puts an effective lock on the demographic profiles of each area in the Greater Melbourne region. Moreover, any inherent biases in the data are slightly magnified with upscaling.

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[6] Fox, J, Daly, A & Patruni, B, *Enhancement of the pivot point process used in the Sydney Strategic Model*, (2012).

2018 Public transport station patronage data

This dataset provides reasonably accurate insights into the actual usage of all public transport modes. However, certain service disruptions caused by events such as projects, maintenance works or accidents can lead to a patronage reduction on affected lines (e.g. disruption to Dandenong and Hurstbridge services due to the Level Crossing Removal Project). The patronage impact of these disruptions are not discarded by this set of data and therefore may lead to an under-estimation of typical patronage. Moreover, touch-on data do not account for transfers within stations. A potential source of inaccuracy in the data can be the manual input from drivers in route allocation of buses and trams.

Demographic estimates and projections

SALUP19 relies on estimates and projections from Department of Environment, Land, Water and Planning 2018 (unpublished) and official Victorian Government employment estimates and projections. For future year projections, the 2016 Census data is used. With future year projections comes a level of uncertainty associated with the household and population projections. All limitations relating to SALUP and Victorian Government employment estimates and projections are also applicable to MABM.

C.4 Model updates and calibration

C.4.1 Model updates

The updates implemented within this report's scope of work to enhance MABM are two-fold. Firstly, inputs and assumptions have been aligned with those from the 2019 VITM Refresh (where possible). This includes changes to:

- Networks, including link capacities and posted speeds
- Transit schedule and capacities
- Parking locations and pricing
- Park and ride stations and capacities.

Secondly, the new update incorporates the most recently available data sources on which to base current travel patterns and improve the accuracy of the synthetic population. These include:

- VISTA 2012 – 2018[7]
- SALUP19.

Figure C - 5 shows the four main inputs of MABM and highlights the updated elements to generate them.

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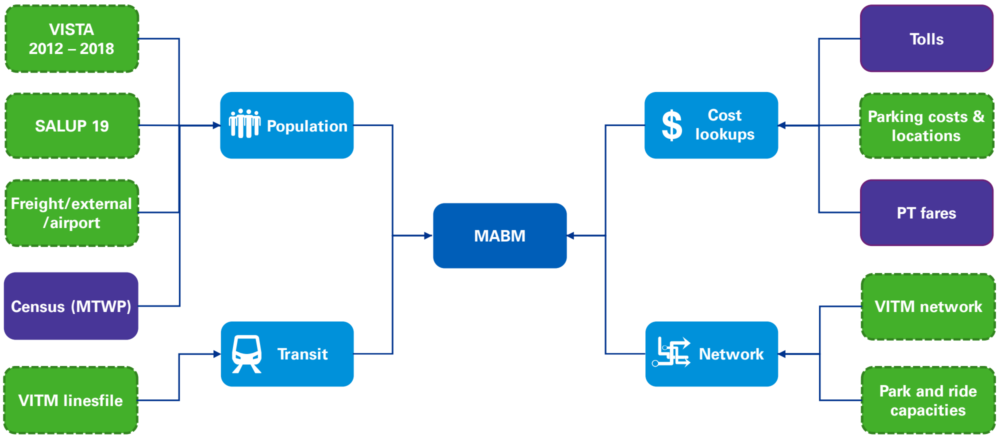
[7] Department of Economic Development, Jobs, Transport and Resources, *Victorian Integrated Survey of Travel and Activity (VISTA),* (2018). https://transport.vic.gov.au/About/Data-and-research/Vista

Figure C - 5: Updated components of MABM (highlighted in green)



Source: KPMG MABM modelling

C.4.2 Calibration

Although scoring function parameters are a key component of the MABM calibration process, they have not been revised in this version of MABM, and therefore are not discussed in this technical volume of this report. The only exception is the minor adjustments that have been made to the earliest allowable work start time to improve the representation of the shape of the morning peak.

There are three main components of the calibration:

1 *Population synthesis*: generating a synthetic population of agents which match the demographic characteristics of the target population at an acceptable resolution

2 *Activity-based pattern generation:* assigning travel plans to the agents based on revealed travel behaviour from the VISTA survey

3 *Scoring function parameters:* generating coefficient values for the scoring function that reflect travel and activity behaviour and allow the model to validate to an acceptable level.

The first two components have been recalibrated using recently available data sets, while the third has not changed from the original MABM validation report.[8]

The calibration method of these three components is described in the following sections.

Population synthesis

The MABM population synthesis module has three main inputs, as described below:

- SALUP provides small area estimates of the locations of persons by age for the study area (Greater Melbourne). This is used by MABM to create the initial set of agents which are each assigned a home location and an age group. This ensures MABM has the right number of agents per age group (for a 25% sample of the target population) and that the spatial distribution of these agents matches the target population.
- A MTWP data matrix of home-work pairs (SA2 by SA2) from the 2016 ABS Census is used to assign the work locations and journey to work mode (e.g. car or public transport) of agents created as part

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[8] KPMG & Arup, *Model Calibration and Validation Report*, (2017).

of step 1[9], if relevant. The RAND pivot method[10] is used to account for growth between the Census year of 2016 and the baseline year of 2018 before applying the work locations to the existing agents.

- Each agent randomly 'samples' the remainder of their demographic attributes (e.g. single year age, gender, occupation and many others) from a weekday survey participant in the VISTA dataset. The random sampling is stratified by a 'demographic signature' (which includes home SA4, age group and whether or not the person is working on the day of their survey). The sampling also applies statistical weights to adjust for survey response bias.

Activity-based pattern generation

Once the synthetic population is created, each individual agent is assigned an activity plan that represents their travel movements and activities for the entire day.

The VISTA record for the relevant survey participant is used to determine the sequence, timing and duration of activities along with an initial mode for each trip. The location of non-home and non-work activities is allocated using a stochastic process which considers the likelihood of different trip lengths occurring along with the likelihood of certain types of activities occurring in certain areas (according to VISTA). Each activity in MABM is designated one of the following classifications:

1 Home

2 Work

3 Business

4 Education (primary/secondary)

5 Education (tertiary)

6 Education (drop-off/pick up)

7 Other.

Scoring function parameters

The scoring function balances the positive utility associated with activities against the disutility for travel by different modes. These scoring functions are pre-existing within the MATSim framework, with the coefficients used for these scoring functions being modified to reflect the travel behaviour that is representative of the Greater Melbourne region.

The first step is to calibrate these scoring coefficients to reflect real-life travel behaviour in Greater Melbourne. This was achieved by using a multinomial logistic regression on travel survey data for Melbourne. This travel data was sourced from 2012-2014 VISTA records and is documented in the original MABM validation report.[11]

By implementing this regression analysis, the marginal utility of money (β_m) can be estimated. This represents the sensitivity of individuals within the model to the change in travel cost, such as fares and tolls, relative to their income.[12] This gives MABM a unique ability to incorporate income-dependent travel behaviour at an individual agent level.

The scoring function parameters adopted in MABM have not been updated for this work, and therefore remain the same as those presented in the original MABM validation report[13] as shown in Table C - 3 for ease of reference.

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[9] ABS, *Method of Travel to Work*, (2017). https://www.abs.gov.au/ausstats/abs@.nsf/Lookup/2901.0Chapter41002011

[10] Fox, J, Daly, A & Patruni, B, *Enhancement of the pivot point process used in the Sydney Strategic Model*, (2012).

[11] KPMG & Arup, *Model Calibration and Validation Report*, (2017).

[12] Horni, A, Nagel, K & Axhausen, K.W., *The Multi-Agent Transport Simulation MATSim*, (2016) pp. 23-34.

[13] KPMG & Arup, *Model Calibration and Validation Report*, (2017).

Table C - 3: Scoring function parameters

Parameter	Calibration Value
β_m	28.30 utils/$
β_{dur}	2.14 utils/h
$\beta_{tt,car}$	0 utils/h
$\beta_{tt,PT}$	-0.98 utils/h
$\beta_{tt,walk}$	-2.43 utils/h
$\beta_{tt,cycle}$	-6.64 utils/h
$\beta_{late.ar}$	-6.42 utils/h
$\gamma_{d,car}$	17.6c/Km

Source: KPMG & Arup 2017

The following should be noted in relation to the calibration parameters:

- β_m is to be divided by the individual daily household income per person with an income floor of $65/day
- β_{dur} is the pre-factor of car travel time (the parameter sign changes to a positive value)
- $\beta_{tt,car}$ is set to zero, due to travelling by car being punished by the opportunity cost of time
- $\beta_{tt,PT}/\beta_{tt,walk}/\beta_{tt,cycle}$ are parameters derived from the regression analysis
- $\beta_{late.ar}$ following from MATSim’s default configuration, this value is set to three times the value of β_{dur}.
- To determine the monetary distance rate for car travel, $\gamma_{d,car}$ is an estimated value derived from the fuel price estimate using the ATAP guidelines of 17.6 cents in 2016 prices.[14]

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[14] ATAP, Australian Transport Assessment and Planning Guidelines – Parameter Values, PV2 Road transport, (2017). https://www.atap.gov.au/parameter-values/road-transport/index

C.5 Validation

C.5.1 Approach and criteria

The application of agent- and activity-based modelling is relatively new in Australia and, unlike the traditional four-step approach, there are no standard guidelines for the validation of such models.

The validation approach in this report is derived from, and consistent with, the approach described in the original MABM validation report.[15] However, there is an increased focus on improving rail validation with more detailed and stringent criteria applied with respect to public transport demand.

Many of the inputs from the latest version of VITM are used to update and enhance MABM. The validation criteria have been developed to:

- Be consistent with validation frameworks implemented for major policies or projects
- Recognise that some aspects are critical in developing a model that is fit-for-purpose and tailored to meet the requirements of the analysis and agreed scope of works
- Be suitable for assessing the impact of potential transport network demand management, including network pricing options while other components are of lower importance.

For each validation criteria, performance of MABM is rated according to the rank and expected performance range shown in Table C - 4 and Table C - 5. The desired criteria adopted for validation of all components of MABM is detailed in Table C - 6.

Table C - 4: Rating of model performance against validation measures

Rank	Expected performance range	Validation measures
Very Important	1-2	• Activity generation and distribution • Mode share by region • Peak period train loads at CBD cordon • Road screenline volumes • Daily train boardings
Medium Importance	2-3	• Daily orbital bus boardings
Low Importance	3-4	• Bus and tram boardings

Source: MABM

Table C - 5: Criteria adopted

Level	Desired criteria
1	At least good quality data and base year validation meet desired criteria for 80% of elements
2	At least good quality data and base year validation meet desired criteria for 60% of elements
3	At least good quality data and base year validation within range for majority of highest priority items
4	Complies with most global validation criteria and uses at least representative data
5	Model has not been validated against global criteria

Source: MABM

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[15] KPMG & Arup, *Model Calibration and Validation Report*, (2017).

Table C - 6: MABM validation steps and elements

Element	Segmentation	Ranking	Desired criteria	Comparison data
Activity generation and distribution				
Number of persons and households	By local government area (LGA)	Very Important	±5%	SALUP19
Total modelled trips	By activity type By region	Very Important	± 20% on at least 60% of elements	VISTA household survey data
Key activity start time distribution	By activity type	Very Important	Demonstrate that the model replicates household survey data via visual comparison	VISTA household survey data
Key activity duration distribution	By activity type	Very Important	Demonstrate that the model replicates household survey data via visual comparison	VISTA household survey data
Activity frequency	By activity type	Very Important	± 20% on at least 60% of elements	VISTA household survey data, ABS Census data
Travel distance to activity location	By key pairs	Very Important	Demonstrates that the model replicates household survey data; report on comparison with survey data	VISTA household survey data
Overall travel demand patterns	LGA to LGA	Very Important	± 20% on at least 60% of elements	VISTA household survey data
Multiple modes				
All trips mode share	By origin sub-region	Very Important	±10%	VISTA household survey data
Work trips mode share	By destination sub-region	Very Important	±10%	ABS journey to work data (work activities only)
Highway volumes				
Screenline volumes	By peak time of day and direction	Very Important	Percentage difference for all screenlines within the bounds of the DoT target curve as defined by DoT (5Diff±50xV-0.3953), comparing 2 hour, one way volumes	DoT annual traffic volumes
Public transport				
Train station entries	by line group	Very Important	±20% for at least 60% of elements	DoT Myki data
CBD cordon loads	By peak time and direction	Very Important	±20% for at least 60% of elements	DoT Myki data
Orbital bus boardings	Daily	Medium importance	± 30% for at least 60% of elements	DoT Myki data
Bus boardings	Daily	Low importance	±30%	DoT Myki data

Element	Segmentation	Ranking	Desired criteria	Comparison data
Tram boardings	Daily	Low importance	±30%	DoT Myki data

Source: MABM

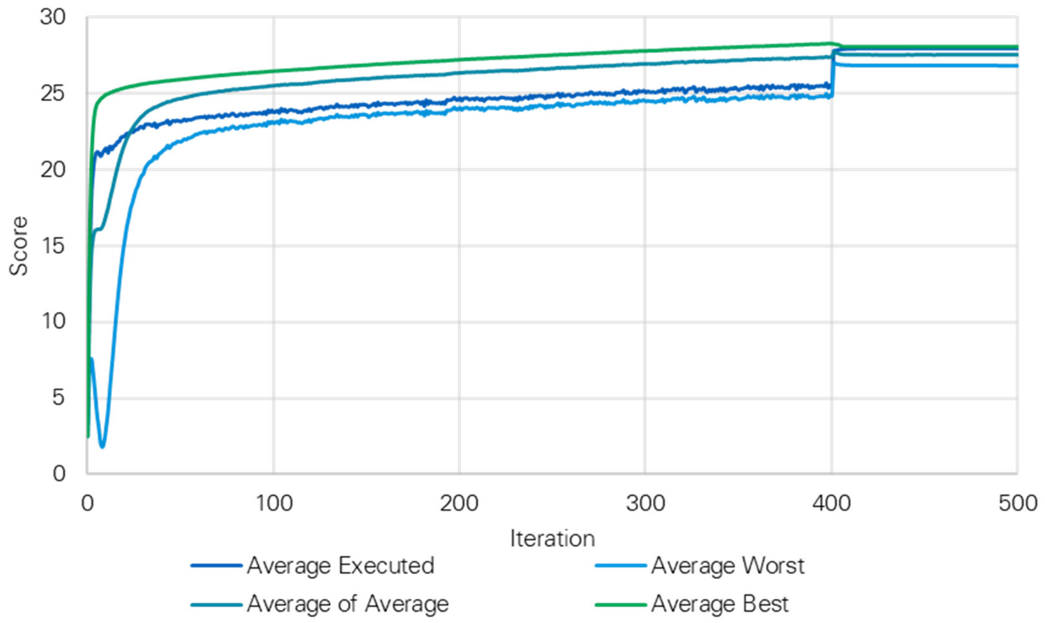
Convergence

While convergence is not a criteria or measure of validation of the model, it is important for the modeller to observe and ensure the model has adequately converged.

The score development curve is representative of an evolutionary optimisation progression typical of MATSim models.[16] This arises from the co-evolutionary algorithm model which allows agents to quickly increase their average score by allowing them to learn what travel plan works best for them.

After the rapid rise in activity score plans, a dampening effect occurs as agents deliberately choose suboptimal plans in order to test alternative options. A large step function is then seen at iteration 400, where agents are now forced to transition from the first stage in MABM (innovating trips) to the second stage where trips are locked in and agents must select from existing plans for the remaining iterations. At this stage, it is considered that agents have already found their best performing plans which they will select from their memory. The following final iterations allow the network to reach an equilibrium state. Figure C - 6 represents the convergence.

Figure C - 6: Score convergence iteration



Source: KPMG analysis of MABM modelling

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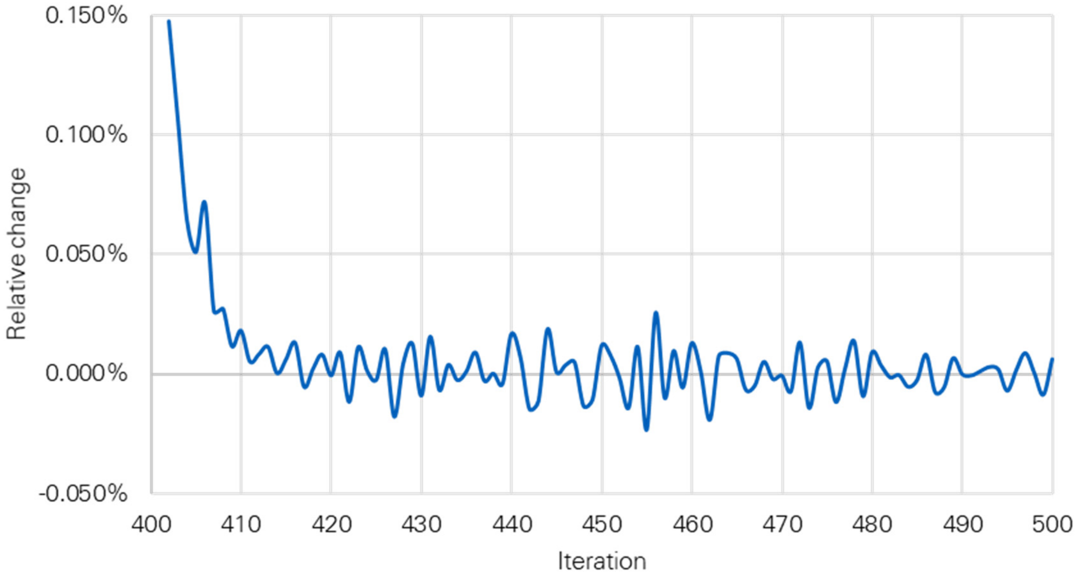
[16] Eiben, A & Smith, J, *Introduction of Evolutionary Computing*, (2003).

The relative change in the average agent plan score in the final 100 iterations (402-500) is illustrated in Figure C - 7. This shows a dampened harmonic oscillation where the change is tending to zero with the increase in iterations. This shows the model has converged and is sufficiently stable once it reaches 500 iterations.

Figure C - 7: Relative change in average agent plan scores, iteration 401 to 500



Source: KPMG analysis of MABM modelling

C.5.2 Validation performance

This section covers the validation reports and measurement on the overall performance of the 2018 MABM final baseline validation run. The specific time periods referred to for the purpose of reporting are defined in Table C - 7.

Table C - 7: Time category definitions

Time categorisation	Time period (24 hour)
AM peak (AM)	07:00 – 09:00
Interpeak (IP)	09:00 – 15:00
PM peak (PM)	15:00 – 18:00
Off peak (OP)	18:00 – 07:00

Source: KPMG MABM modelling

In some cases, the reported values are indicative of an average hourly volume for the above time periods. 24 hour results are also reported on (i.e. with activity related volumes) where relevant.

C.5.3 Summary of validation performance

The validation results are summarised in Table C - 8 below.

Table C - 8: Summary of validation performance

Ranking	Segmentation	Desired Criteria	Meets Criteria	Rationale for Accepting
Activity generation and distribution				
Very important	Modelled persons – by LGA	±5% of SALUP population by LGA	✔	100% of LGAs meet this criteria
Very Important	Modelled trips – by activity type	± 20% on at least 60% of elements	✔	100% of activities meet this criteria
Very Important	Modelled trips – by region	± 20% on at least 60% of elements	✔	100% of regions meet this criteria
Very Important	Activity start time – by activity type	Model replicates household data via visual comparison	✔	Replicates the observed distribution of starting times
Very Important	Activity duration – by activity type	Model replicates household data via visual comparison	✔	Replicates the observed distribution of starting times
Very Important	Activity frequency – by activity type	± 20%on at least 60% of elements	✔	100% of activity types meet this criteria
Very Important	Travel distance – for key activity types pairs	Model replicates household data via visual comparison	✔	Replicates observed distribution of starting times
Very Important	Overall travel demand pattern – LGA to LGA	±20% on at least 60% of elements	✗	42% of pairs meet this criteria
Multiple modes				
Very Important	All trips mode share – by origin sub-region	±10% for at least 60% of elements	✔	100% of sub-regions meet this criteria
Very Important	Work trips mode share – by destination sub-region	±10% for at least 60% of elements	✔	100% of sub-regions meet this criteria
Highway volumes				
Very important	Highway volumes – by time of day and direction	±10% for at least 60% of elements	✔	Two out of four meet this criteria with the rest missing by less than 5%
Public transport				
Very Important	Train station entries – by line group	±20% for at least 60% of elements	✔	80% of line groups meet this criteria
Very Important	Peak time and CBD cordon loads	±20% for at least 60% of elements	✔	75% of regions meet this criteria
Medium importance	Daily orbital bus boardings	± 30% for at least 60% of elements	✗	Almost there with 50% of routes meeting this criteria

Ranking	Segmentation	Desired Criteria	Meets Criteria	Rationale for Accepting
Low importance	Bus boardings – daily	±20% of the observed DoT data	✗	Does not meet criteria
Low importance	Tram boardings – daily	±20% of the observed DoT data	✗	Does not meet criteria

Source: KPMG analysis of MABM modelling

The above validation performance summary demonstrates that the model is well validated with 12 of the 13 very important validation criteria met. The model is performing well and better than any previous MABM version in the most important criteria, i.e., activity generation and train patronage criteria. The screenlines also show that the network volumes are representative of the level of road congestion. The remainder of this chapter provides an overview of a select number of most important criteria.

More details on the validation is provided in the MABM Validation Report, dated January 2021, prepared by KPMG.

C.5.4 Highway volumes

Table C - 9: Highway volumes - Validation overview

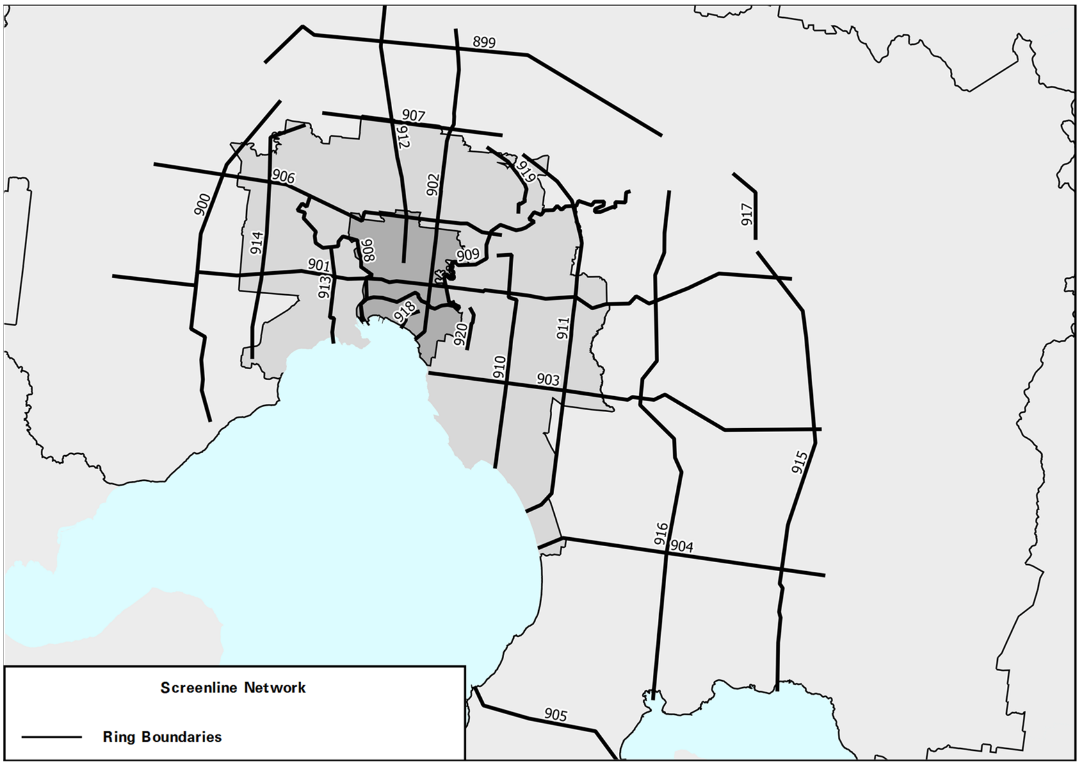
Ranking	Segmentation	Desired Criteria	Meets Criteria	Rationale for Accepting
Very important	Highway volumes – by time of day and direction	±10% for at least 60% of elements	✓	Two out of four meet this criteria with the rest missing by less than 5%

Source: KPMG analysis of MABM modelling

The validation of highway volumes involves comparing the MABM outputs against 2018 synthetic traffic volume data sourced from DoT. These comparisons employ the standard screenlines as used for reporting VITM performance (see Figure C - 8).

The desired criteria is defined as the percentage difference between modelled and observed screenline volumes within the bounds of the target curve specified by DoT's *Transport Modelling Guidelines*.

Figure C - 8: Screenline locations



Source: DoT

Table C - 10 shows the percentage of screenlines which meet the validation criteria in both inbound and outbound directions for the AM and PM periods. This is a significant improvement relative to previous versions of MABM.

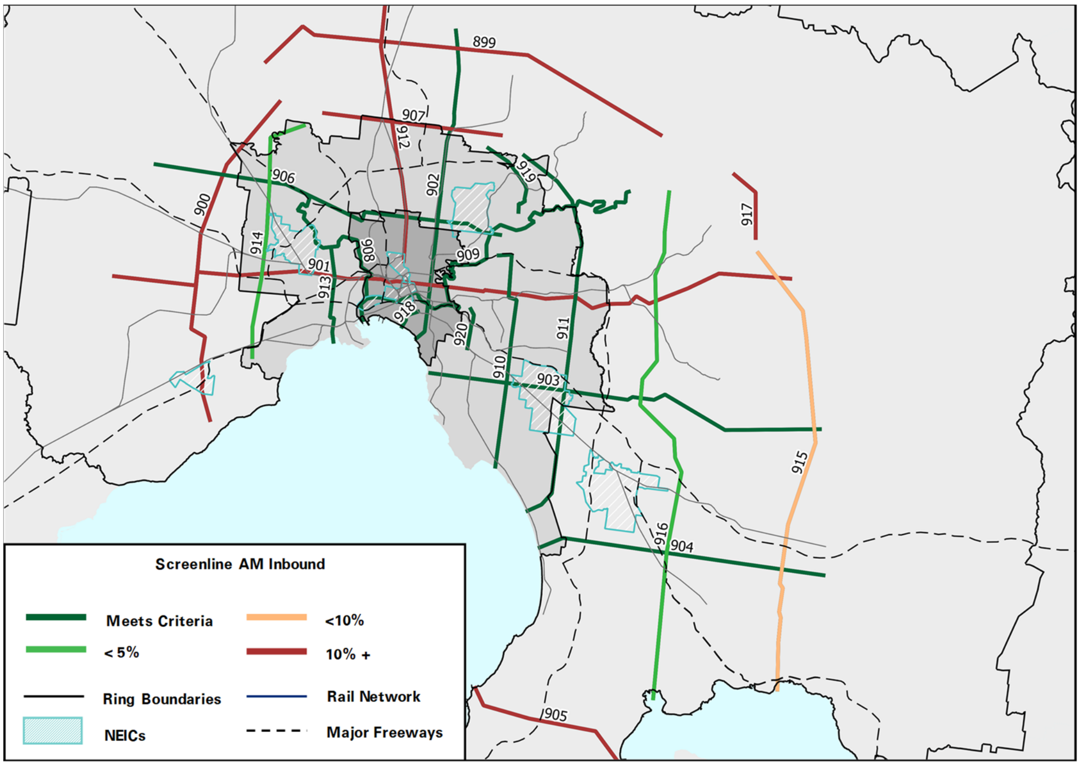
Table C - 10: Modelled screenline volumes meeting DoT's target curve

Period	Direction	Percentage of screenlines meeting criteria
AM	Inbound	55%
	Outbound	64%
PM	Inbound	59%
	Outbound	82%

Source: KPMG analysis of MABM modelling

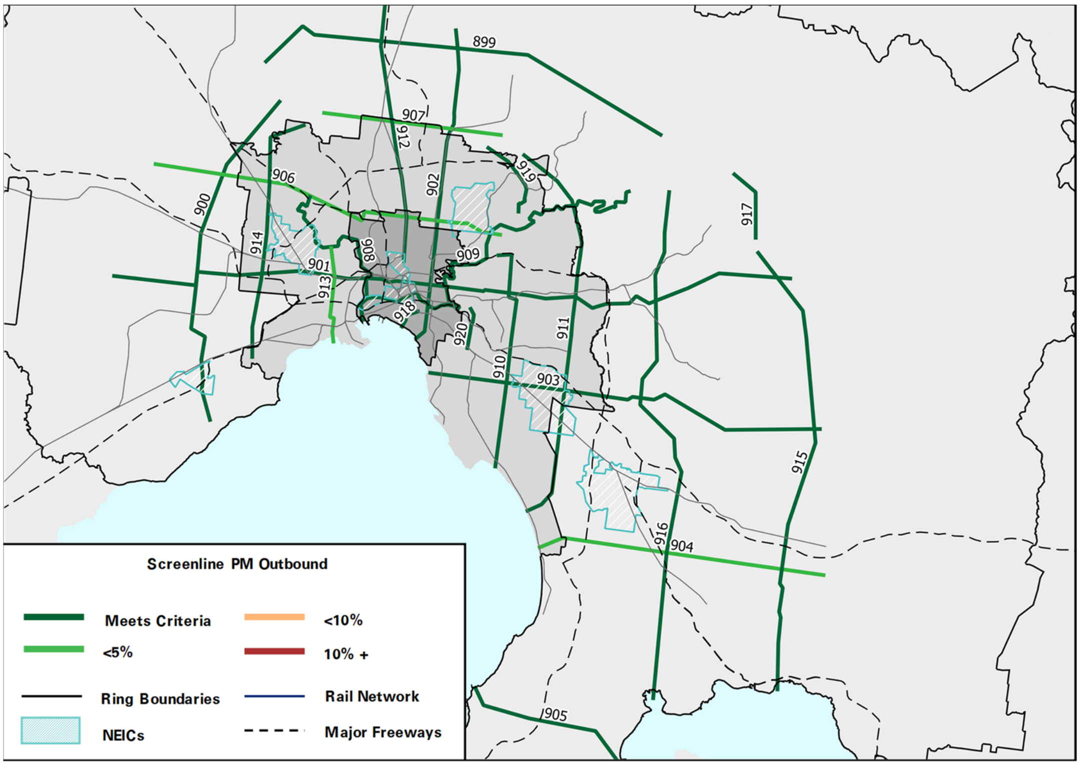
Figure C - 9 and Figure C - 10 show the validation of highway volumes at the screenline level for critical travel directions. The majority of screenlines meet the validation criteria, and fall within 10% of the observed volumes. There are no PM outbound volumes which differ from observed values by more than 10%, however in the AM peak inbound direction, some screenlines in Melbourne's outer north-west deviate from observed values by slightly more than 10%. Nonetheless, this validation demonstrates that the model is performing well in predicting highway volumes, particularly for the AM peak inbound direction.

Figure C - 9: Screenline validation results for AM peak, inbound



Source: KPMG analysis of MABM modelling

Figure C - 10: Screenline validation results for PM peak, outbound



Source: KPMG analysis of MABM modelling

C.5.5 Public transport

Train station entries and CBD cordon loads

Table C - 11: Train station entries and cordon loads – Validation overview

Ranking	Segmentation	Desired Criteria	Meets Criteria	Rationale for Accepting
Very Important	Train station entries – by line group	±20% for at least 60% of elements	✓	80% of line groups meet this criteria
Very Important	Peak time and CBD cordon loads	±20% for at least 60% of elements	✓	75% of regions meet this criteria

Source: KPMG analysis of MABM modelling

Due to limitations of the observed data, rail station entries instead of the rail boardings have been assessed. The measured criteria is for 60% of the modelled results to be within 20% of the observed data. Comparison of the modelled daily station entries against entries against the observed data is summarised in Table C - 12. This demonstrates that the station entries as estimated using MABM are broadly within the validation criteria for most line groups. However, the Clifton Hill line group has a higher difference of 48% and does not meet the desired criteria.

This is driven by two primary factors:

1 A large number of passengers transfer from tram to train at North Richmond because there is a very short, straight line distance between the tram stop and the train station. This does not work well with the idealised walk time in MABM which is based on straight line distance.

2 There is an over-estimation of boardings in the Greensborough–Westgarth section of the Hurstbridge line. This is due to over-estimated levels of road congestion within MABM in that region.

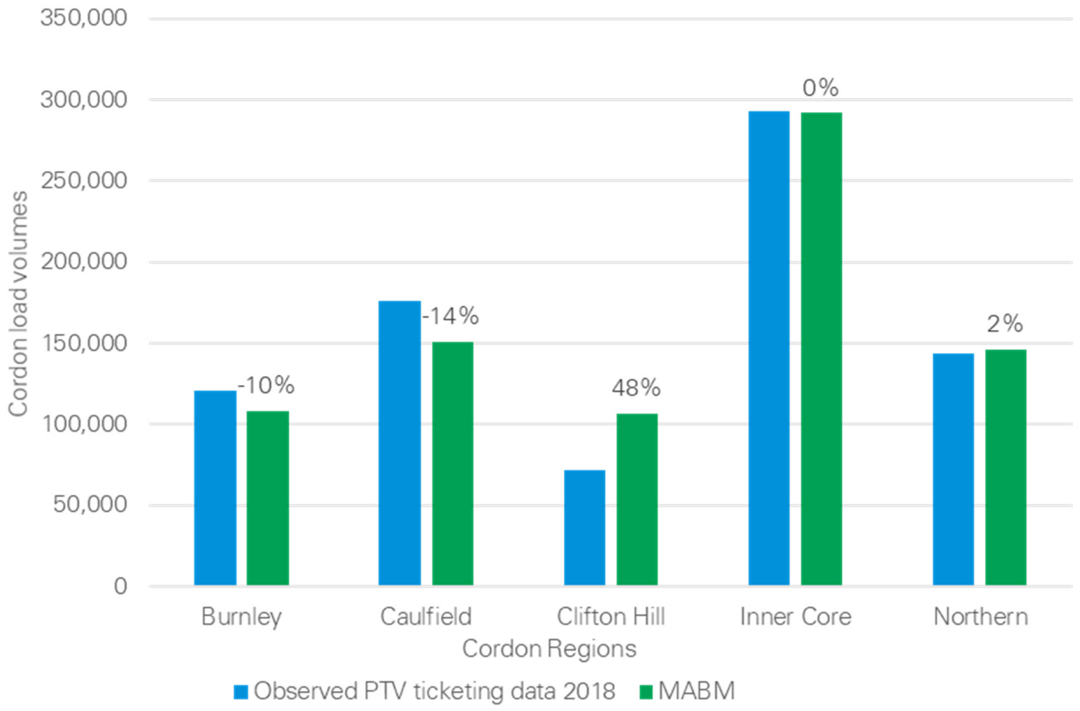
Table C - 12: Train station entries by line group, 24 hour total modelled versus observed, 2018

Line group	Observed PTV ticketing data 2018	Modelled	% Difference
Burnley	120,602	108,148	-10%
Caulfield	175,967	167,872	-5%
Clifton Hill	71,912	106,684	48%
Inner Core	293,159	279,992	-4%
Northern	143,745	141,272	-2%

Source: KPMG analysis of MABM modelling

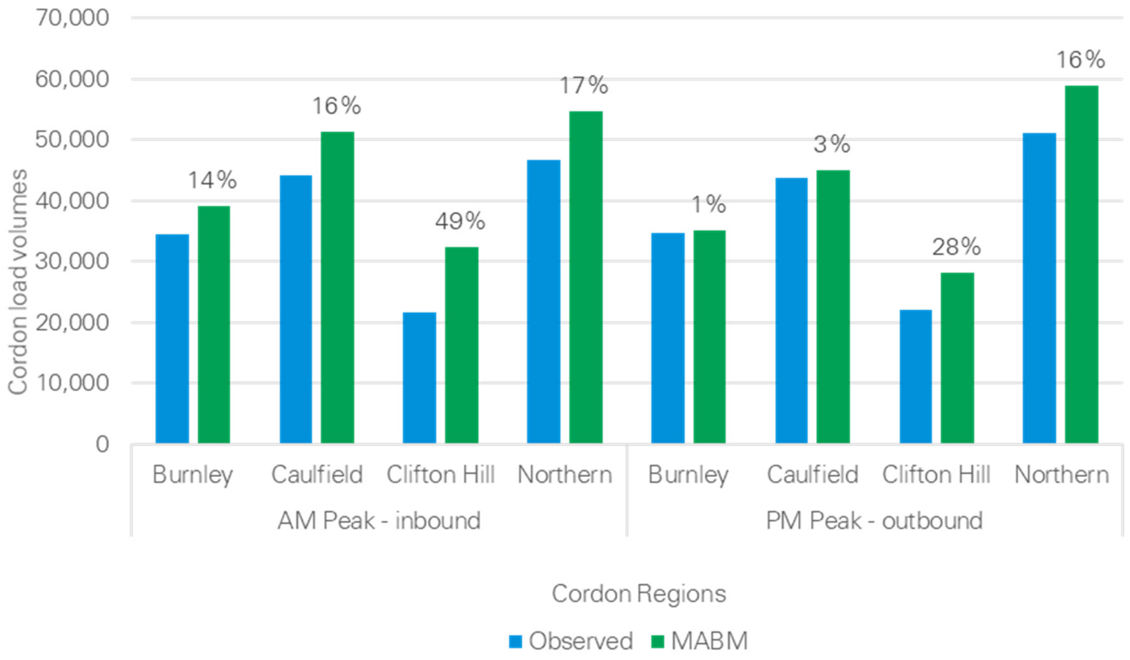
Figure C - 11 and Figure C - 12 highlight the modelled station entries against PTV entries derived from ticketing data, respectively by line group and CBD cordons. CBD cordon loads are of particular interest as they represent the point of highest load on the rail network during peak periods (AM and PM). The only line group which does not meet the desired criteria is Clifton Hill.

Figure C - 11: Train station entries by line group, 24 hour total modelled versus observed, 2018



Source: KPMG analysis of MABM modelling

Figure C - 12: Train loads at CBD cordon, modelled versus observed, 2018



Source: KPMG analysis of MABM modelling

C.6 Key assumptions

This section first outlines the demand assumptions of MABM. It then moves to describe transport and SRL – Cheltenham to Airport assumptions, which are generally consistent with VITM assumptions.

C.6.1 Base Case Demand Assumptions

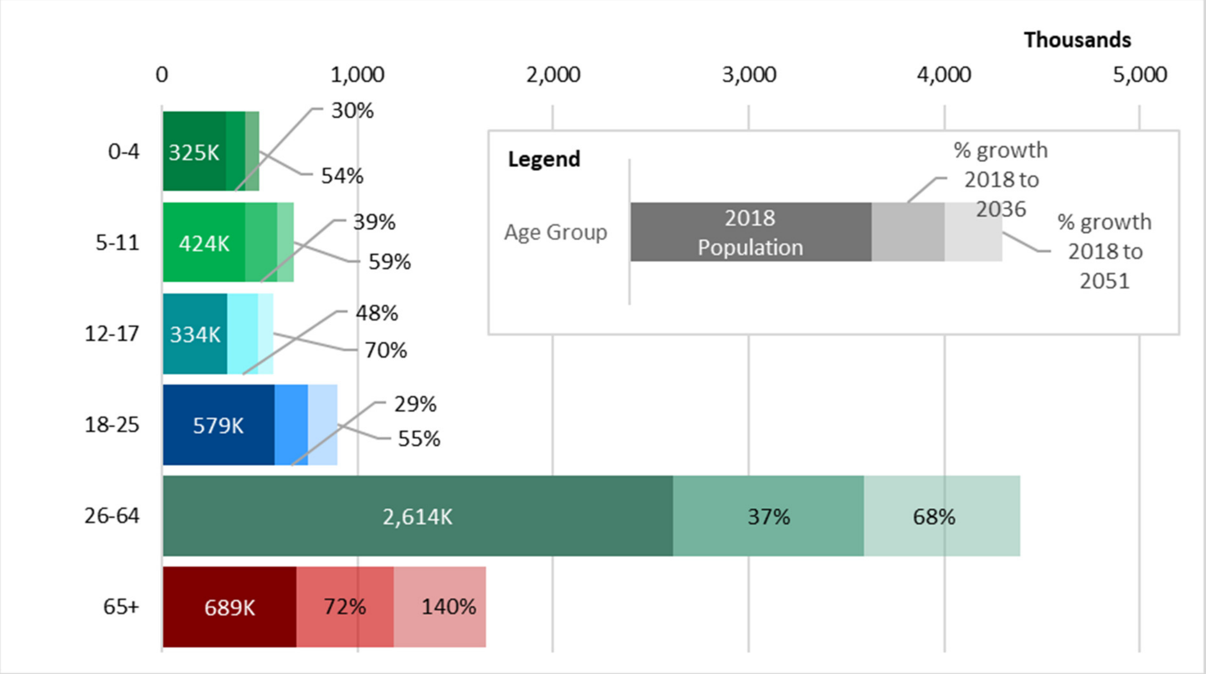
The population synthesis for the forecast years of 2036, 2041 and 2051 are generated using the same logic as for the 2018 baseline, and are also derived using the relevant SALUP19 projections. The remaining inputs are generated based on the assumptions of the relevant VITM scenarios (see Volume A, Section A.4.1).

All parameter values are the same across the four years (2018, 2036, 2041 and 2051). This means that all monetary values (e.g. fuel, fares, parking cost, and tolls) are assumed to stay constant in real terms.

An aging population

Older people are expected to make up an increasing proportion of Melbourne's population, with the 65 and over cohort projected to grow the fastest and more than double in size by 2051. Figure C - 13 shows Melbourne's projected population growth by age group.

Figure C - 13: Change in Melbourne population by age group, 2018 to 2036, 2041 and 2051

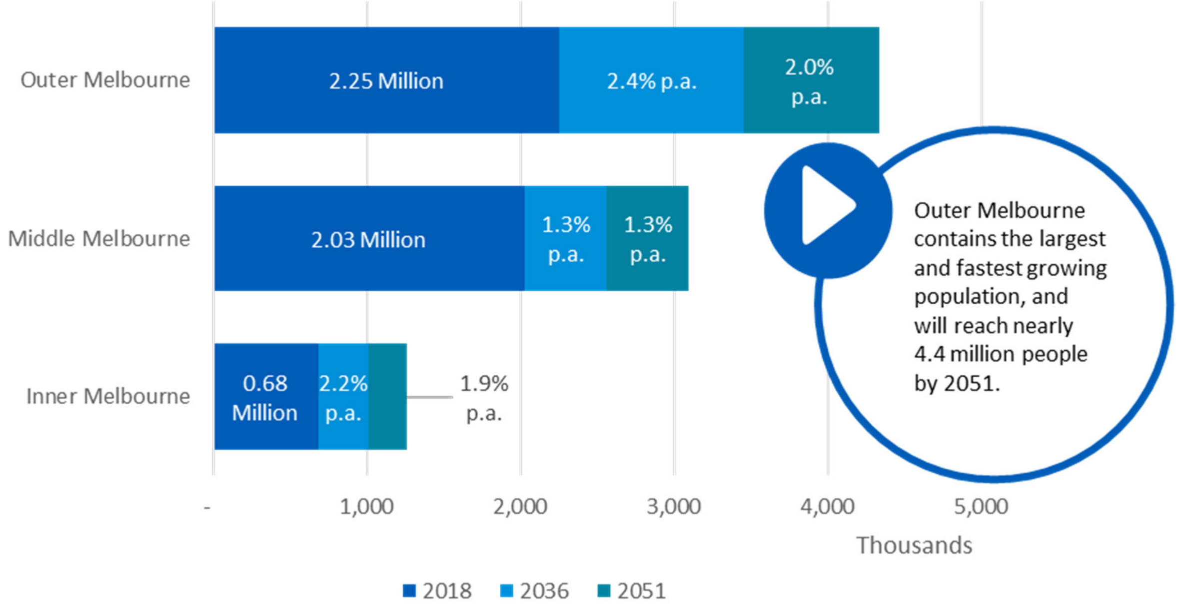


Source: SALUP19 based on DELWP Projections 2018 (Unpublished)

Melbourne's growing middle and outer suburbs

Melbourne's population is projected to almost double over the next three decades, growing from 4.9 million in 2018 to 8.7 million in 2051. A major portion of this growth is projected to occur in the middle and outer suburbs of Melbourne. Figure C - 14 shows the population growth in each region from 2018 to 2051, and the compound annual growth rate for each forecast year. (The region's definition is consistent with the ring's definition in Section C.3.2 of this report.)

Figure C - 14: Population growth by region



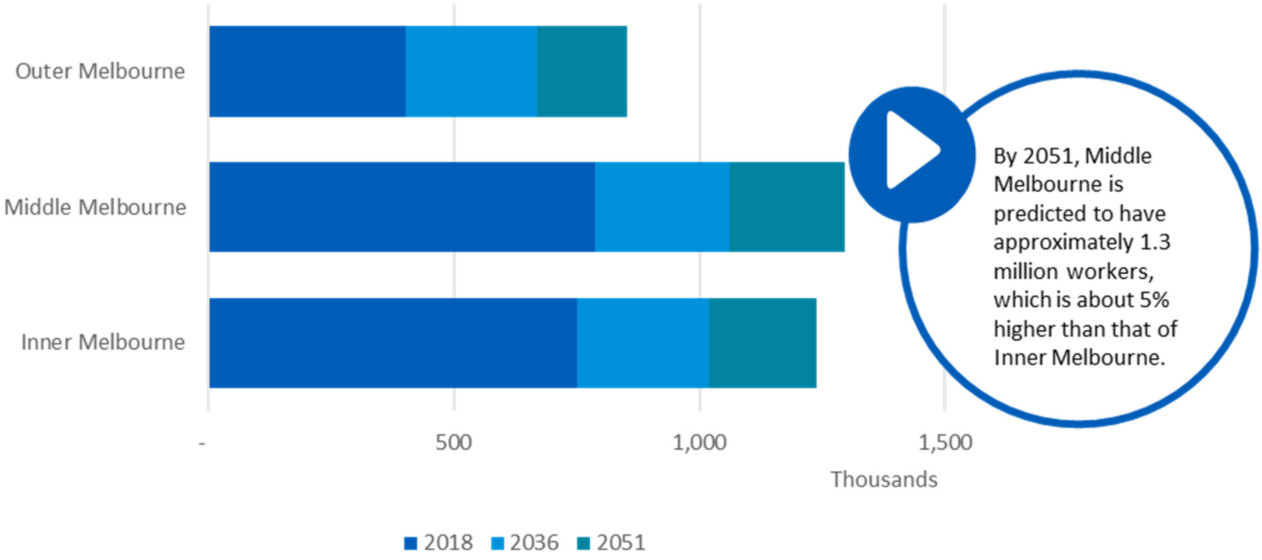
Outer Melbourne contains the largest and fastest growing population, and will reach nearly 4.4 million people by 2051.

Source: SALUP19 based on DELWP Projections 2018 (Unpublished)

Most employment growth is projected to be equally spread in Melbourne

The number of employment opportunities in Melbourne is projected to grow by 75% over the next three decades, from 1.9 million in 2018 to 3.4 million in 2051. This growth is projected to be similarly distributed across Melbourne, with slightly more growth in the Middle and Outer suburbs. Figure C - 15 shows the number of employment opportunities in 2018 and the number of jobs added by 2036 and 2051.

Figure C - 15: Employment growth by region



By 2051, Middle Melbourne is predicted to have approximately 1.3 million workers, which is about 5% higher than that of Inner Melbourne.

Source: SALUP19 based on DELWP Projections 2018 (Unpublished)

Activities grow in line with population

The number of activities, their frequency, and their annual growth by type and location are presented in Table C - 13 and Table C - 14. In line with projected population growth in the outer suburbs, the highest growth in activity frequency is observed in the Outer North, Outer South and Outer West regions. The growth in activity frequency in the Outer East is lower as the area is already more developed than the other outer suburbs.

Table C - 13: Growth in modelled activities by type

Type	2018	2036	2051	CAGR 2036	CAGR 2051
Home	5,501,504	7,720,020	9,519,708	1.90%	1.68%
Work	2,224,340	3,150,148	3,907,848	1.95%	1.72%
Business	395,292	529,352	642,496	1.64%	1.48%
University/TAFE	113,056	141,768	168,596	1.27%	1.22%
School	548,864	775,012	891,444	1.94%	1.48%
School pick-up/drop-off	606,416	831,308	1,010,152	1.77%	1.56%
Other	4,412,980	6,199,680	7,698,636	1.91%	1.70%

Source: KPMG MABM synthesised population

Table C - 14: Growth in modelled activities (excluding home activities) by location

Region	2018	2036	2051	CAGR 2036	CAGR 2051
Inner Metro	1,328,640	1,867,648	2,282,136	1.9%	1.7%
Inner South East	916,440	1,205,360	1,442,968	1.5%	1.4%
Middle East	1,303,220	1,641,056	1,954,676	1.3%	1.2%
Middle North	598,388	833,108	1,050,096	1.9%	1.7%
Middle South	873,380	1,081,848	1,280,208	1.2%	1.2%
Middle West	757,140	1,049,000	1,282,488	1.8%	1.6%
Outer East	305,316	374,884	428,396	1.1%	1.0%
Outer North	810,624	1,049,000	1,578,952	2.5%	2.0%
Outer South	832,720	1,247,096	1,511,064	2.3%	1.8%
Outer West	572,992	1,050,976	1,346,424	3.4%	2.6%

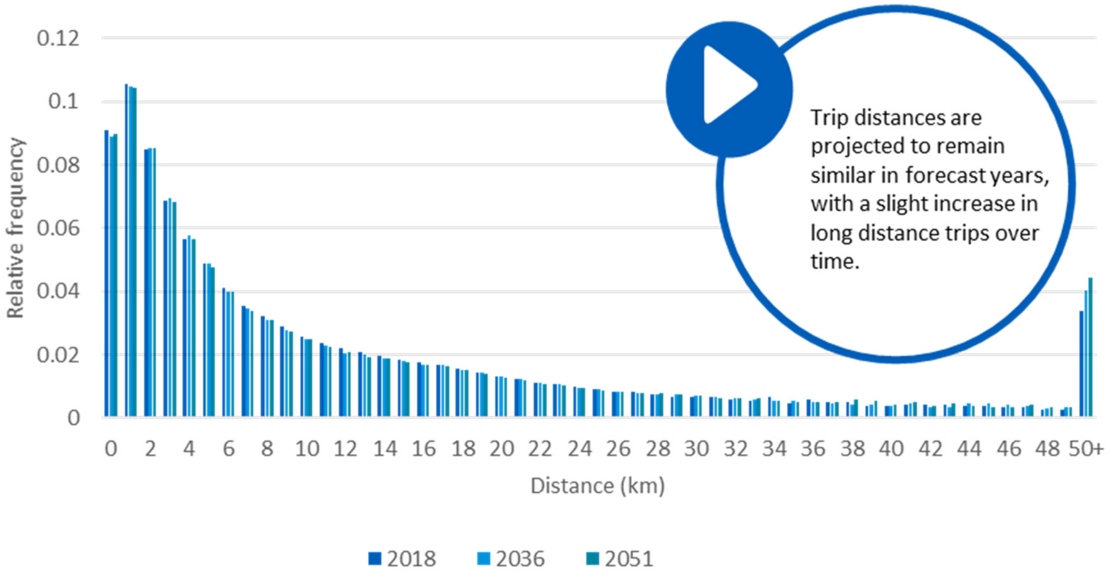
Source: KPMG MABM synthesised population

Distance distribution remains similar in future years

The trip distance distribution for future years remains similar to the 2018 baseline. This is driven by the population synthesis logic, where activity locations (except for work) are assigned to agents based on the distance data reported in VISTA. Since the same VISTA data is used for the base year and forecast year, the distance distribution for non-work trips is broadly analogous across the projection.

The agents' projected home and work locations are derived from Method of Travel to Work data within the 2016 Census, with future years adjusted to emulate SALUP19 using the RAND pivot method. Using this method results in longer home-work trips, which reflects the impact of increasing urban sprawl on the average distance between home and work locations. Figure C - 16 and Figure C - 17 show the distance distributions for all trips and home-work trips.

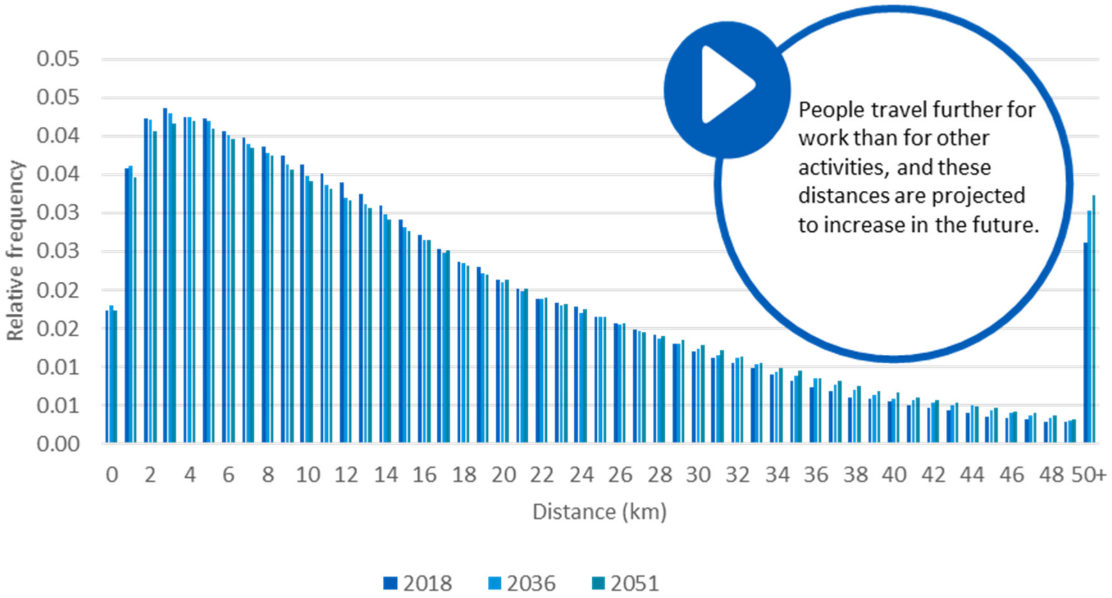
Figure C - 16: Distance distribution – all activity types



Trip distances are projected to remain similar in forecast years, with a slight increase in long distance trips over time.

Source: KPMG analysis of MABM modelling

Figure C - 17: Distance distribution – home to work



People travel further for work than for other activities, and these distances are projected to increase in the future.

Source: KPMG analysis of MABM modelling

C.6.2 Transport assumptions

The underlying road and public transport network in this version of MABM is consistent with the VITM Reference Case described in Section 3.4 and the Base Case described in Section 3.5.

C.6.3 SRL - Cheltenham to Airport assumptions

The Program Case uses the Base Case assumptions, as described previously as the starting point and incorporates the rail network improvements delivered by SRL – Cheltenham to Airport, which has been sequenced in three sections for modelling purposes, with the associated land use uplifts expected as a result of SRL.

Land use assumptions

The land use assumptions are based upon CityPlan projections for population and employment distribution across Greater Melbourne. These projections are broadly described in Volume B of this report, however due to the timing of iterations of the CityPlan and MABM modelling program, the Program Case MABM land use uses a slightly earlier iteration of these projections.

The differences between the version used in MABM) and the final land use that was used for VITM and the economic appraisal is summarised in the following table.

Table C - 15: Difference between land use forecasts used in MABM and those used in economic appraisal

Location	Base Case	Used in MABM	Used in Economics	Difference
Households				
SRL East Precincts	101,000	131,500	126,500	+5,000
SRL North Precincts	83,500	104,000	105,500	-1,500
Total Households in SRL – Cheltenham to Airport – All Precincts	184,500	235,500	232,000	+3,500
Jobs				
SRL East Precincts	225,500	348,000	353,500	-5,500
SRL North Precincts	154,500	184,000	191,500	-7,500
Total Jobs in SRL – Cheltenham to Airport – All Precincts	380,000	532,000	545,000	-13,000

Source: KPMG analysis of CityPlan modelling

The comparison highlights that employment in the SRL East and SRL North Precincts is marginally lower in the version used for MABM compared to ones used in VITM and economic appraisal, by around 2.4%. Population in the SRL East and SRL North Precincts is higher in the version used for MABM by around 1.5% when compared to the version used in VITM and economic appraisal. This marginal difference in land use is unlikely to have any material impacts on the types or proportions of beneficiaries impacted by SRL – Cheltenham to Airport. It is therefore considered appropriate to use the analysis from MABM for to undertake assessment of users and beneficiaries.

Program Case sequencing assumptions

Two Program Case scenarios have been modelled for the demand and economic analysis. However, MABM modelling only includes Option A with an assumed delivery time at 2053. Furthermore, as the future year MABM was created for 2051, based upon the VITM network and SALUP forecasts available at the time of creation, the results created here were based upon a future year 2051 with and without SRL – Cheltenham to Airport, in lieu of the specific Option A full opening year of 2053.

The 2051 future year is considered to be representative of the future opening year of 2053 for the purposes of the distributional analysis presented using MABM.

Furthermore, for consistency with the VITM future model year of 2056, the customer insights results in this Volume have been presented for 2056, where proportional distributions are assumed consistent with the 2051 full-opening considered in the SRL – Cheltenham to Airport MABM modelling.

Where real, not distributional impacts are shown, the results are presented for 2051, and where appropriate 2056 results have been extrapolated by applying the 2036 to 2051 compound annual growth rate to the 2051 to 2056 period.

The key input and assumptions are described in the table below.

Table C - 16: SRL – Cheltenham to Airport modelling assumptions

Parameter	Cheltenham – Box Hill	Box Hill – Reservoir	Reservoir – Melbourne Airport
Option A Opening Years	2035	2043	2053
Rail Distance (Combined)	26.0 kilometres	45.0 kilometres	60.2 kilometres
Trains per hour (peak periods)	10	12	24
Trains per hour (inter-peak)	6	6	12
Trains per hour (off-peak)	6	6	6
Seated Capacity	188 passengers per service	188 passengers per service	188 passengers per service
Standing Capacity	948 passengers per service	948 passengers per service	948 passengers per service

Source: SRLA

C.7 A future without SRL - Cheltenham to Airport

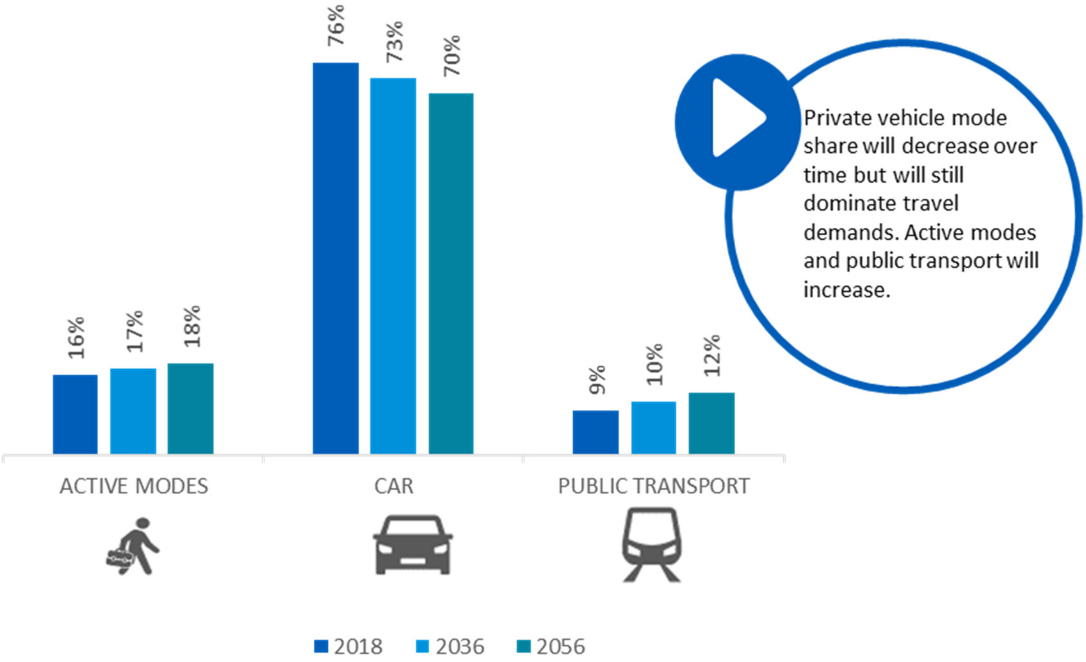
This section outlines the performance of the Base Case, i.e. the future without SRL – Cheltenham to Airport or its associated land use uplifts.

C.7.1 Mode share

People tend to use public transport more in the future

Public transport mode share is forecast to increase over time, from 8.6% in 2018 to 12.2% in 2051. The increase in the share of public transport and active mode trips is reflective of a growing number of trips, and increasing levels of network congestion. Figure C - 18 shows the forecast change in mode share for private car, public transport and active modes.

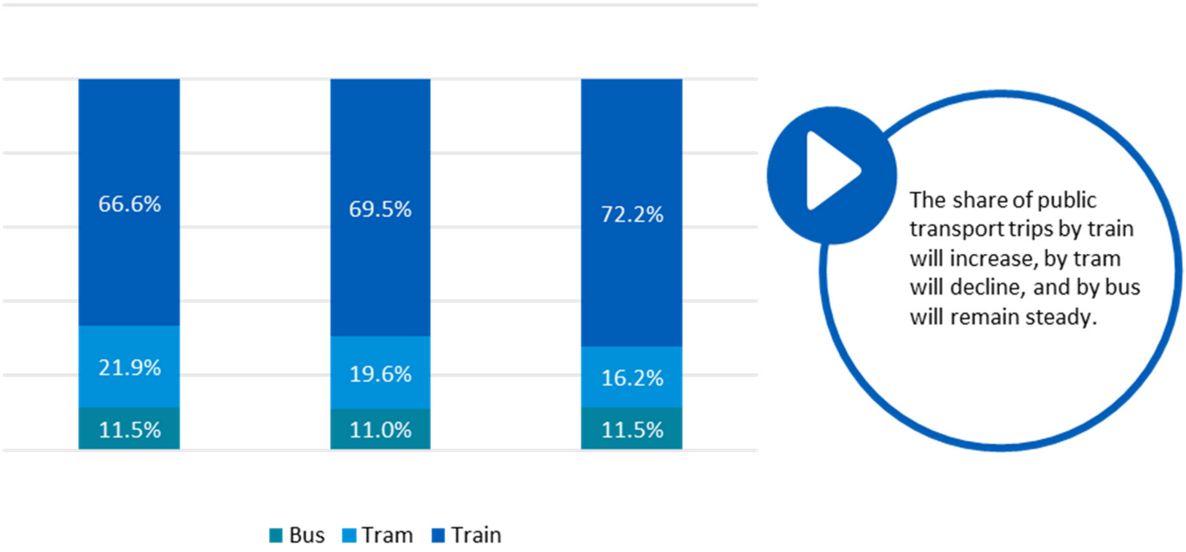
Figure C - 18: Mode share



Source: KPMG analysis of MABM modelling

The share of train trips as a proportion of all public transport trips will increase slightly from 67% to 72% between 2018 and 2051. The share of tram trips is predicted to decrease by a similar amount across that period. This shift can be partly attributed to increasing road congestion, which will affect tram travel times, along with only a small increase in the tram network or tram services compared to growth of rail and bus services. Figure C - 19 shows the public transport sub-mode share for each year. It should be noted that trips that use multiple sub-modes are assigned to the sub-mode on which the largest distance was travelled. For example, if a person rides a bus for two stops to an outer suburban train station, then takes the train to the city, the trip would be reported here as a train trip.

Figure C - 19: Public transport sub-mode share



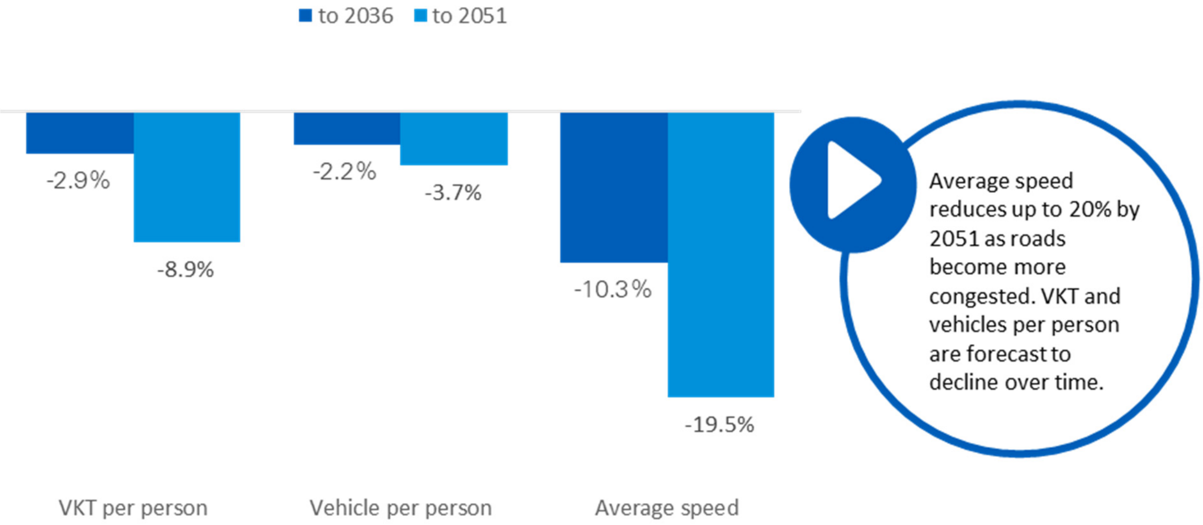
Source: KPMG analysis of MABM modelling

C.7.2 Road Network Performance

Car travel is projected to become less attractive in the future as Melbourne becomes larger and denser, and therefore more congested. Average network speed is projected to steadily reduce in the future by up to 20% to 2051.

This will lead to a reduction in the distance travelled per person (shown below as Vehicle Kilometres Travelled (**VKT**) per person), as a smaller share of people use private car for travel and, in turn, reduce the number of vehicles per person (i.e. potentially reduced vehicle ownership). Figure C - 20 summarises the changes in key network metrics from 2018 to 2036 and 2051.

Figure C - 20: Key network metrics



Average speed reduces up to 20% by 2051 as roads become more congested. VKT and vehicles per person are forecast to decline over time.

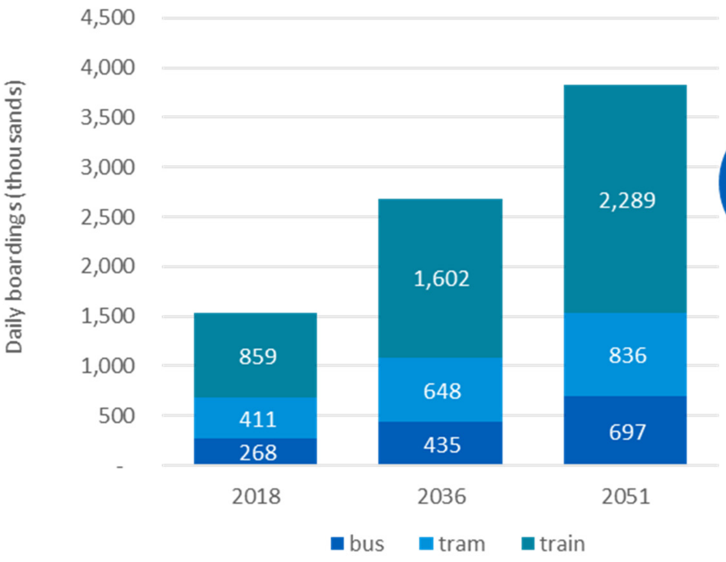
Source: KPMG analysis of MABM modelling

C.7.3 Public transport performance

Following a significant volume of assumed upgrades to the rail network as described in the Reference Case and Base Case assumptions in Sections 3.4 to 3.6, train boardings are projected to increase almost three-fold from 859,000 in 2018 to 2,290,000 in 2051. This reflects a continued reliance on rail for the daily commute of people in the growing middle and outer suburbs. This leads to a notable increase in crowded train kilometres across the three decades. This ongoing reliance on rail is also implicitly confirmed by the lower growth in bus boardings, despite a significant increase in bus service kilometres in the forecast years. Overall, public transport is expected to primarily serve a commuter function, particularly for suburban residents. Passengers' time on-board increases more than their distance, showing the reduction in tram and bus speed as congestion increases in forecast years, making these modes less attractive.

Figure C - 21 shows the boardings by mode, while Figure C - 22 shows changes in the Passenger Kilometres Travelled (**PKT**) and Passenger Hours Travelled (**PHT**).

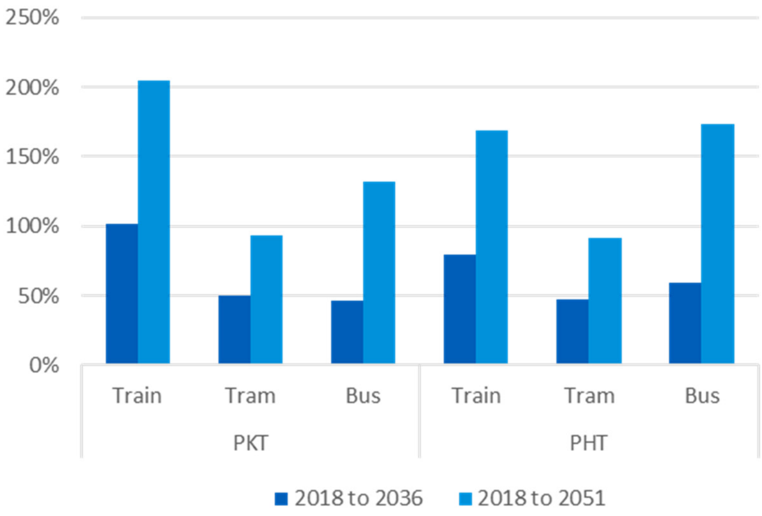
Figure C - 21: Daily public transport boardings



Public transport boardings will increase by around 75% by 2036 and 150% by 2051 compared to 2018. Boardings by train are higher than those by tram and bus combined.

Source: KPMG analysis of MABM modelling

Figure C - 22: Daily PKT and PHT changes – growth from 2018



The number of hours and kilometres travelled by passengers on public transport will increase – more than doubling between 2036 and 2051.

Source: KPMG analysis of MABM modelling

C.8 A future with SRL - Cheltenham to Airport and land use uplift

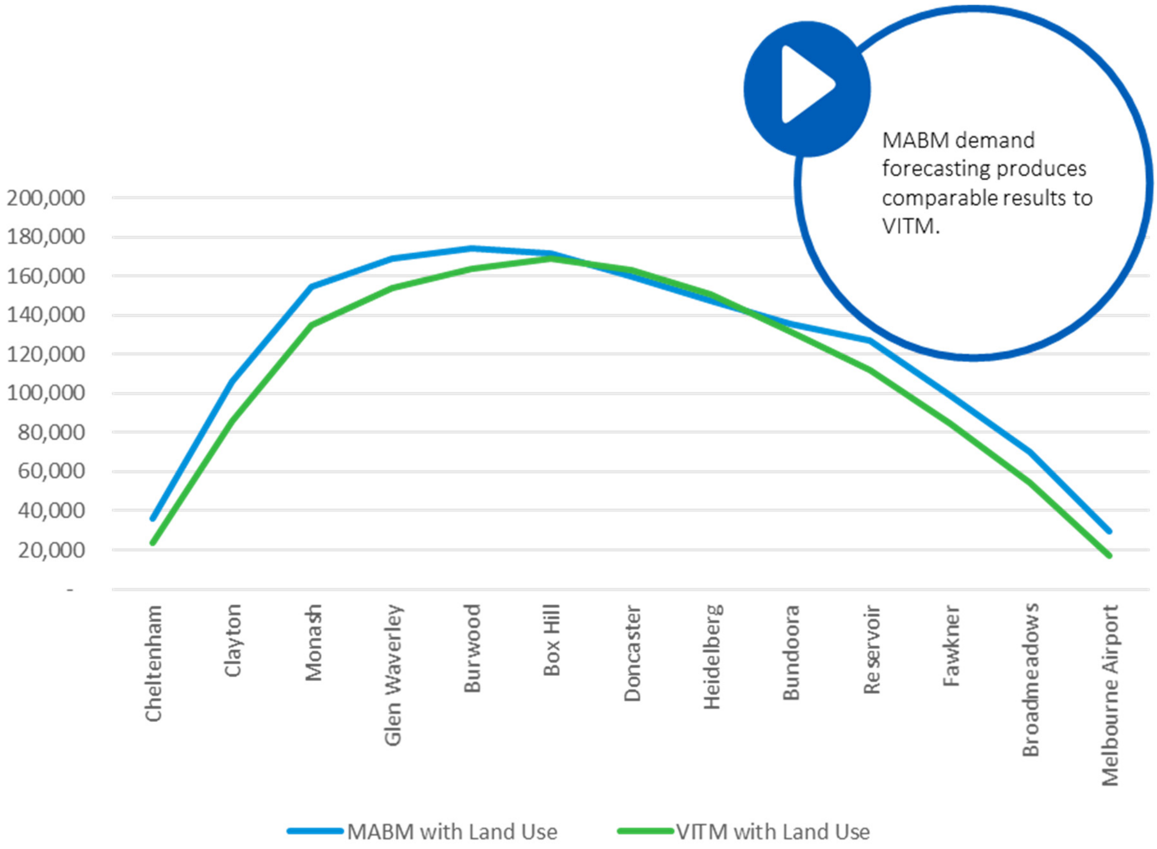
This section outlines the performance of Program Case Option A (hereinafter called the Program Case), representing the future with SRL – Cheltenham to Airport and the associated land use uplift. This section presents a high level comparison with VITM, followed by a report on the changes that SRL – Cheltenham to Airport and land use uplift introduce to travel behaviour and network performance.

C.8.1 Demand comparison

The forecast demand drawn from MABM closely represents the forecast demand from VITM as shown in Figure C - 23 for SRL – Cheltenham to Airport in 2051. This figure compares the daily bi-directional load profile of SRL – Cheltenham to Airport between the two different models.

The purpose of this chart is to demonstrate the consistency of the two models in demand forecasting, and therefore the appropriateness of using MABM as a complementary tool to VITM for drawing insights relating to customers and beneficiaries of SRL – Cheltenham to Airport. It is noted that despite the use of slightly different land-use assumptions in the MABM modelling and VITM modelling (as described previously in Section C.6.3), the magnitude of difference between the models is modest.

Figure C - 23: SRL – Cheltenham to Airport bi-directional daily load, 2051



MABM demand forecasting produces comparable results to VITM.

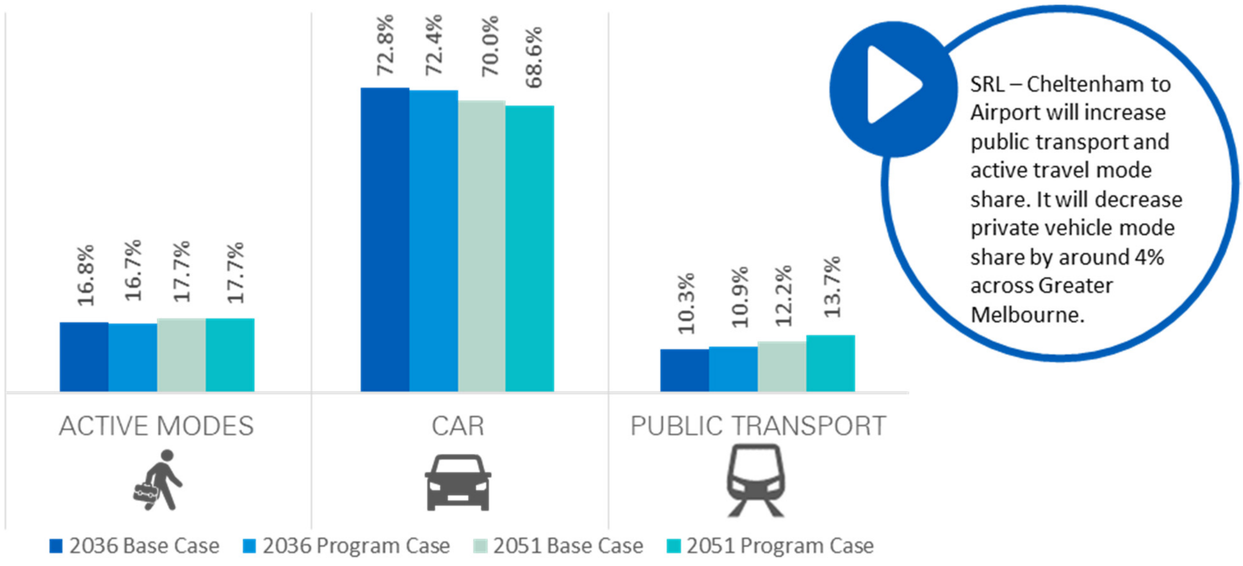
Source: KPMG analysis of MABM versus VITM modelling

C.8.2 Mode share

As previously shown in Section C.7.1 with increasing population and congestion in Melbourne in the next three decades, public transport mode share is expected to increase. SRL – Cheltenham to Airport provides more opportunity for people to avoid road congestion, and experience fast, efficient and convenient public transport travel. As a result, public transport mode share for the Program Case is projected to be higher than for the Base Case, as presented in Figure C - 24.

This shift towards public transport modes is entirely attributable to an increase in train use, when assessed at the sub-mode level. Part of this increase can be associated with the shift from Smart Bus orbital network to SRL – Cheltenham to Airport, as trains offer a shorter travel time. This shift is most notable in 2051 with the full SRL – Cheltenham to Airport in operation. Figure C - 25 shows the public transport sub-mode share in Base Case and Program Case for each modelled year.

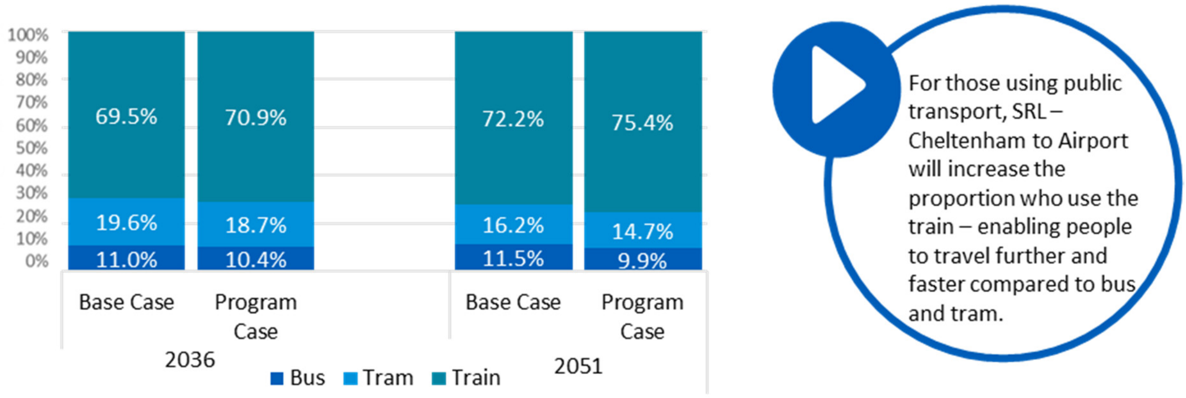
Figure C - 24: Mode share – Base Case versus Program Case



SRL – Cheltenham to Airport will increase public transport and active travel mode share. It will decrease private vehicle mode share by around 4% across Greater Melbourne.

Source: KPMG analysis of MABM modelling

Figure C - 25: Public transport sub-mode share – Base Case versus Program Case



For those using public transport, SRL – Cheltenham to Airport will increase the proportion who use the train – enabling people to travel further and faster compared to bus and tram.

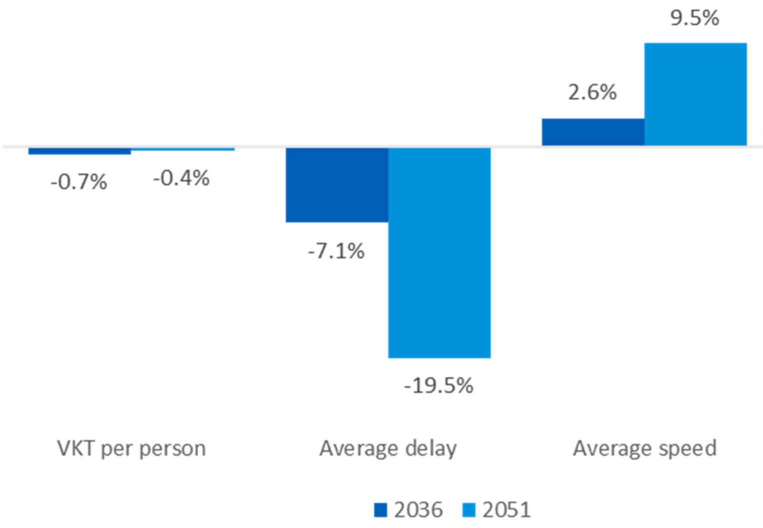
Source: KPMG analysis of MABM modelling

In total, Melburnians are expected to take about 2.4 million additional trips by walking or cycling per day in 2056 compared to today, leading to increased levels of ancillary physical activity.

C.8.3 Road Network Performance

The road network assumptions are the same for the Base Case and Program Case in each year, which helps isolate the impact of SRL – Cheltenham to Airport on the network. By providing an alternative travel option, SRL – Cheltenham to Airport helps road users by easing the congestion across the network and improving travel speed. Small reductions in VKT per person result in larger reductions in delays in both years, which shows the critical role of SRL – Cheltenham to Airport in improving network performance. Figure C - 26 summarises the changes in road network statistics between Base Case and Program Case in each modelled year.

Figure C - 26: Changes in road network statistics between Base Case and Program Case



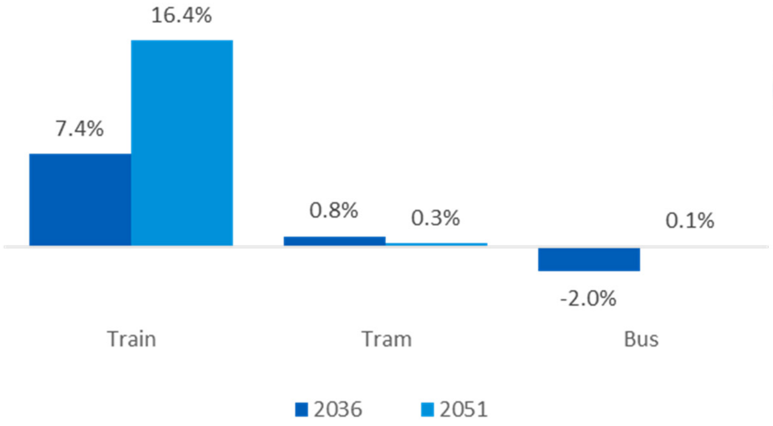
SRL – Cheltenham to Airport will decrease road network delays by around 20%, and will increase average network speeds by around 10%.

Source: KPMG analysis of MABM modelling

C.8.4 Public transport performance

The only variation between the public transport supply in the Base Case and Program Case is SRL East in 2036 and SRL – Cheltenham to Airport in 2051. The specifications of the modelling sequence are outlined in Section C.6.3.

Figure C - 27: Changes in daily public transport boardings between Base Case and Program Case

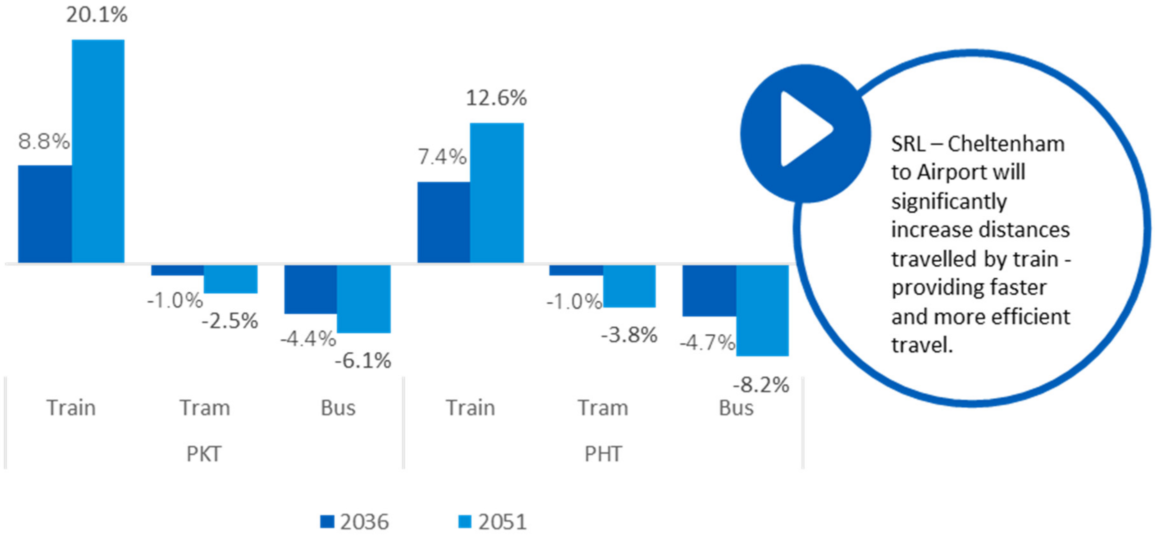


SRL – Cheltenham to Airport will increase the number of train boardings across Greater Melbourne by over 15%.

Source: KPMG analysis of MABM modelling

SRL – Cheltenham to Airport results in a notable increase in the daily train boardings as people shift to rail from private car or other public transport sub-modes to train. This increase is more notable in 2051 compared to 2036 as the full SRL – Cheltenham to Airport in 2051 offers a significantly more accessible public transport network to Melbourne's population, unlocking routes to more destinations via public transport. This, on the other side, results in the increase in train PHT and train PKT. Figure C - 28 shows changes in the PKT and PHT.

Figure C - 28: Daily PKT and PHT changes between Base Case and Program Case



SRL – Cheltenham to Airport will significantly increase distances travelled by train - providing faster and more efficient travel.

Source: KPMG analysis of MABM modelling

C.9 SRL - Cheltenham to Airport customer insights

This section presents insights on SRL – Cheltenham to Airport customers and beneficiaries based upon the assessment of the Program Case Option A, representing the future with SRL – Cheltenham to Airport and land use uplift. The 2056 results presented in this section are based upon the 2051 modelling, with proportional distributions assumed to be the same.

C.9.1 Where they live and work

The non-SRL customers' home locations are spread relatively uniformly across Melbourne. However, SRL – Cheltenham to Airport customers live predominantly in the east and south in 2036 (87%) and middle suburbs and outer north in 2056 (76%). Figure C - 29 shows the share of SRL – Cheltenham to Airport customers living in each region in comparison to non-SRL rail customers[17] in both forecast years.

Almost all workers using non-SRL rail services work in the city. This means that without an orbital line, only those working in the city, predominantly higher income workers, benefit from rail transport for their daily commute. However, orbital rail services provided by SRL – Cheltenham to Airport provide an opportunity for those working in the middle and outer suburbs to commute by rail, who are more likely to be from lower earning households. In 2056, 72% of workers using SRL – Cheltenham to Airport are those who work in middle suburbs. Figure C - 30 demonstrates this by showing the work location

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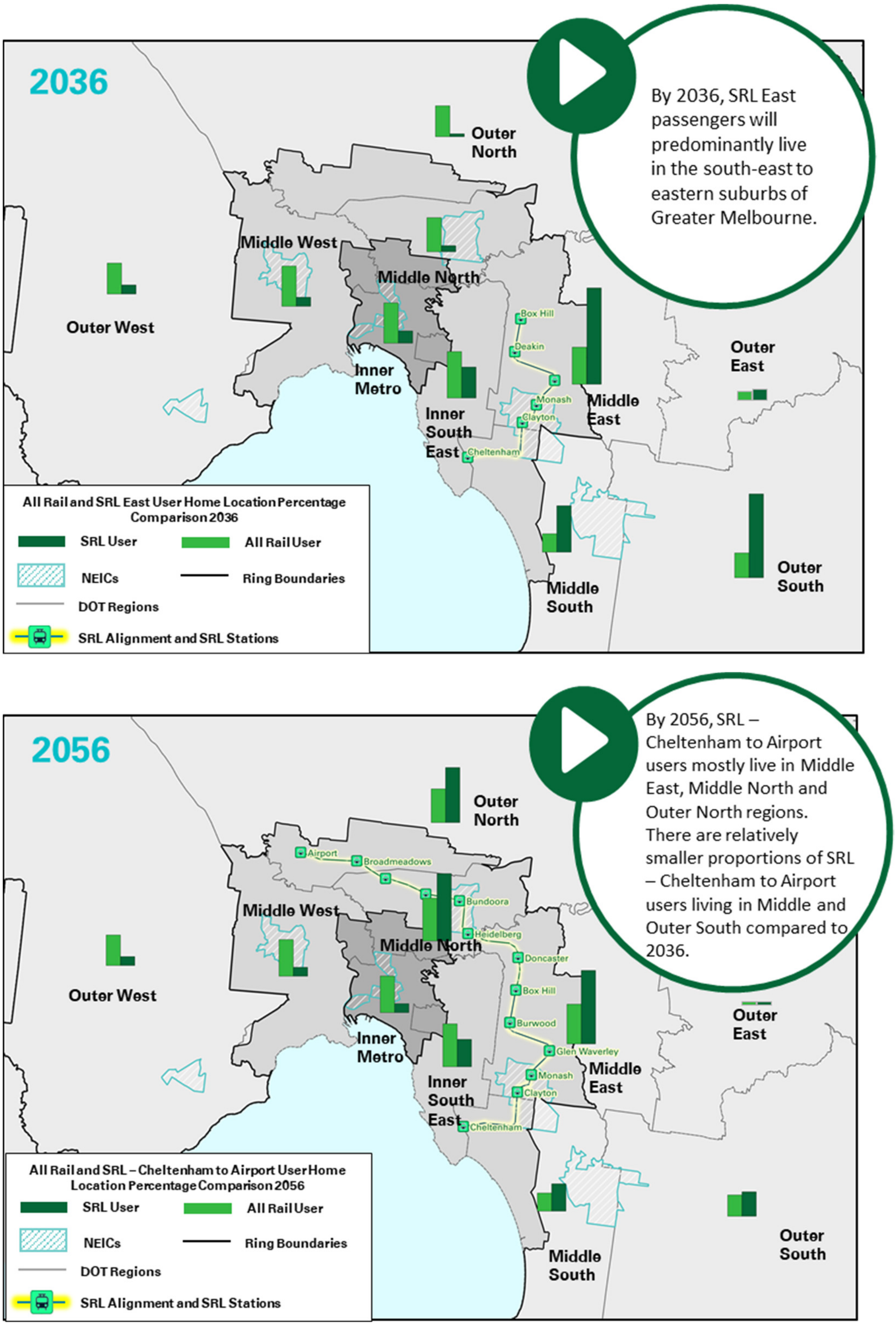
[17] "Non-SRL rail customers" refers to all rail customers who do not use SRL – Cheltenham to Airport at all during their daily travel.

distribution of SRL – Cheltenham to Airport customers and non-SRL rail customers in both forecast years.

Figure C - 29: Home locations, 2036 and 2056

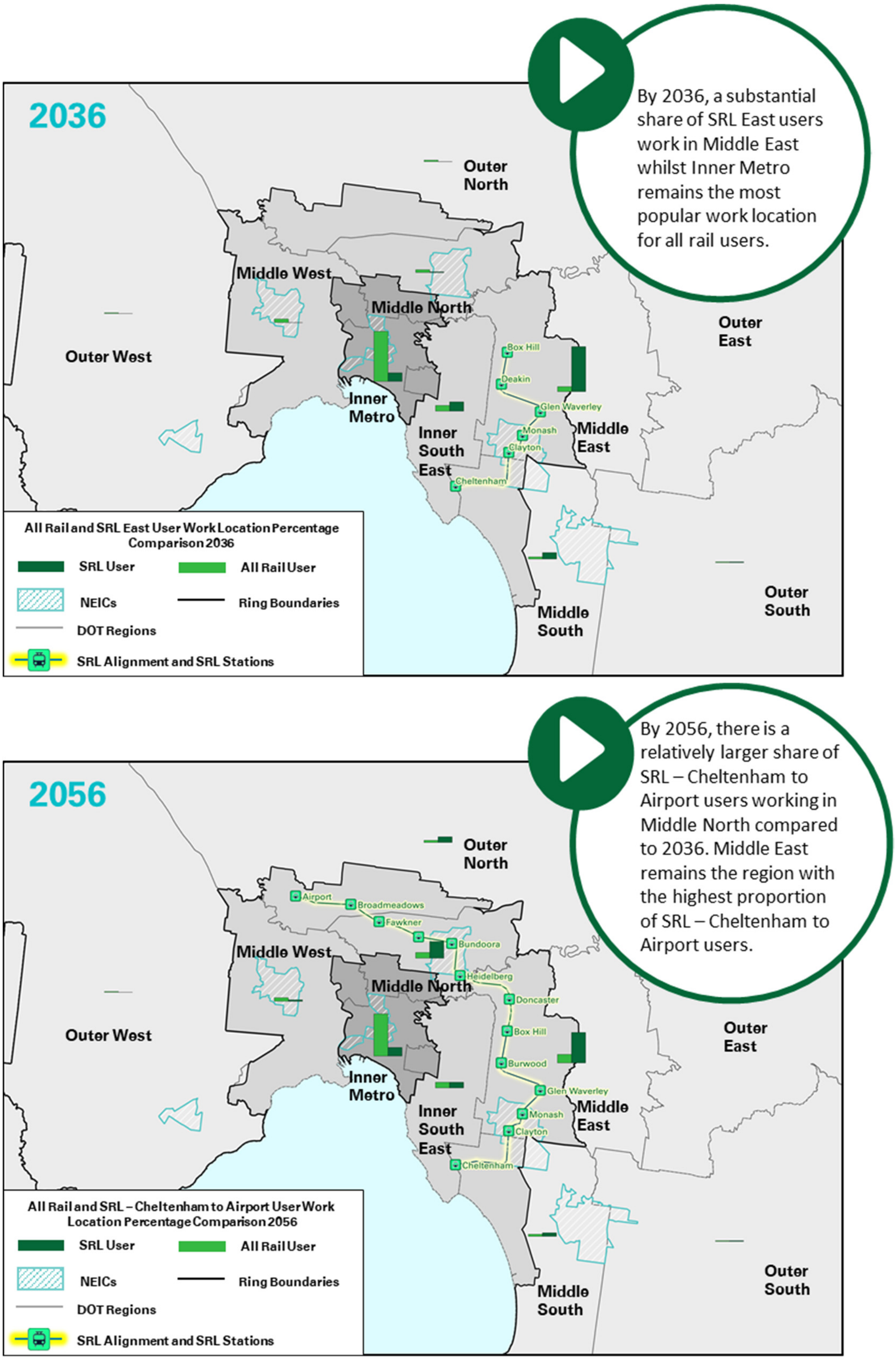


By 2036, SRL East passengers will predominantly live in the south-east to eastern suburbs of Greater Melbourne.

By 2056, SRL – Cheltenham to Airport users mostly live in Middle East, Middle North and Outer North regions. There are relatively smaller proportions of SRL – Cheltenham to Airport users living in Middle and Outer South compared to 2036.

Source: KPMG analysis of MABM modelling

Figure C - 30: Work locations, 2036 and 2056



By 2036, a substantial share of SRL East users work in Middle East whilst Inner Metro remains the most popular work location for all rail users.

By 2056, there is a relatively larger share of SRL – Cheltenham to Airport users working in Middle North compared to 2036. Middle East remains the region with the highest proportion of SRL – Cheltenham to Airport users.

Source: KPMG analysis of MABM modelling

C.9.2 Who they are

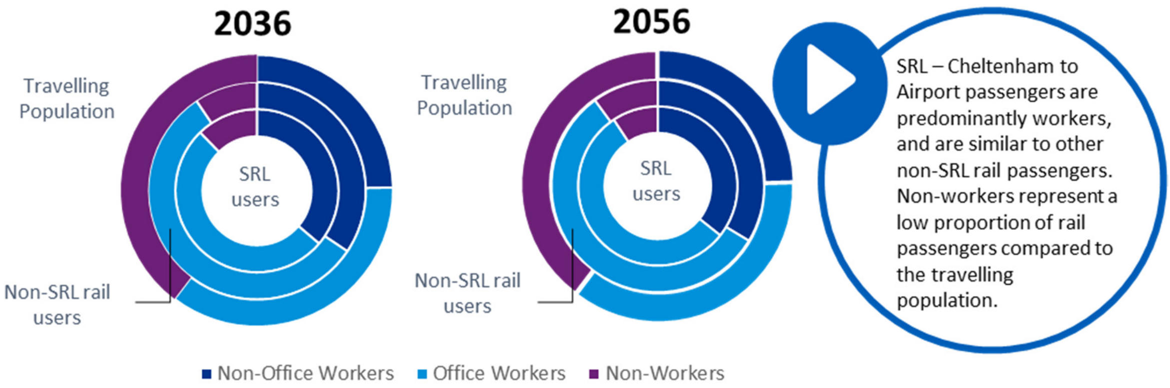
Low and medium income workers and students comprise the major beneficiaries of SRL – Cheltenham to Airport. Figure C - 31 to Figure C - 33 show a comparison of SRL – Cheltenham to Airport customers, non-SRL rail customers and all travelling population. The comparison is done in terms of three key demographics criteria:

- Work status
- Age
- Equivalised household income[18] for workers.

In 2056, SRL – Cheltenham to Airport is expected to:

- Increase the number of rail customers in the lower-income brackets by around 17%
- Increase the number of rail customers in the 18-25 year old age group by around 16%
- Have 65% of working SRL – Cheltenham to Airport customers in the low income categories
- Have 77% of SRL – Cheltenham to Airport customers in the working age cohort and 17% of them are tertiary-aged young people.

Figure C - 31: Comparison of SRL – Cheltenham to Airport users, non-SRL rail users and travelling population - based on their work status



SRL – Cheltenham to Airport passengers are predominantly workers, and are similar to other non-SRL rail passengers. Non-workers represent a low proportion of rail passengers compared to the travelling population.

Source: KPMG analysis of MABM modelling

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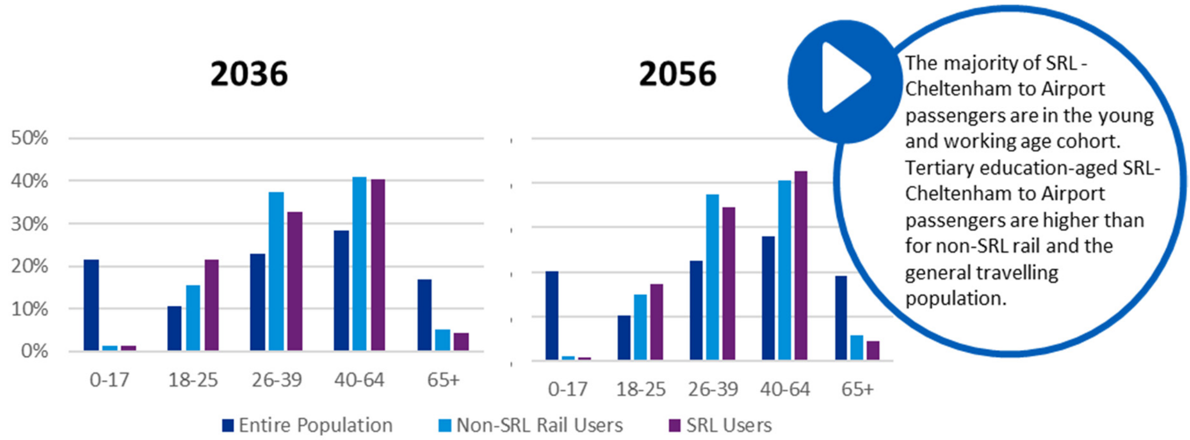
[18] Equivalised household income is total household income adjusted by the application of an equivalence scale to facilitate comparison of income levels between households of differing size and composition.

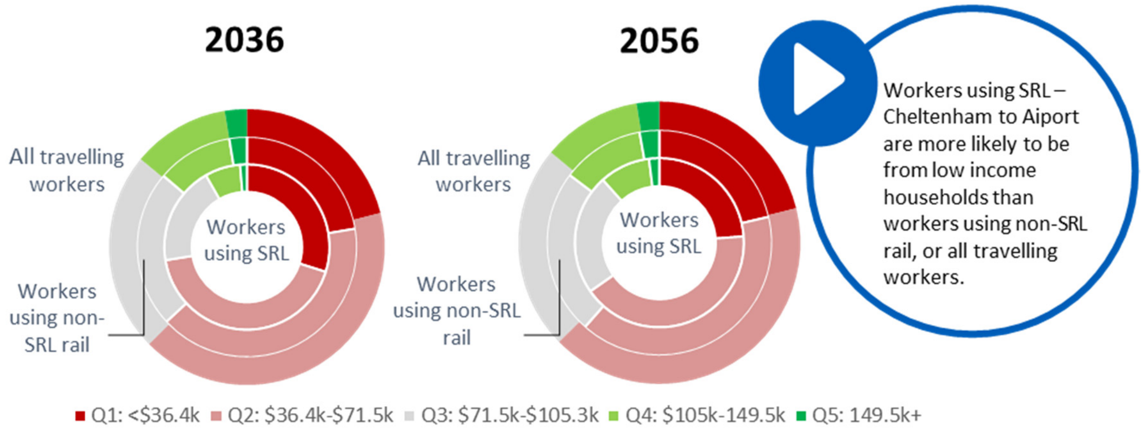
Figure C - 32: Comparison of SRL – Cheltenham to Airport users, non-SRL rail users and travelling population - based on their age



The majority of SRL - Cheltenham to Airport passengers are in the young and working age cohort. Tertiary education-aged SRL-Cheltenham to Airport passengers are higher than for non-SRL rail and the general travelling population.

Source: KPMG analysis of MABM modelling

Figure C - 33: Comparison of SRL – Cheltenham to Airport users, non-SRL rail users and travelling population - based on their equivalised household income



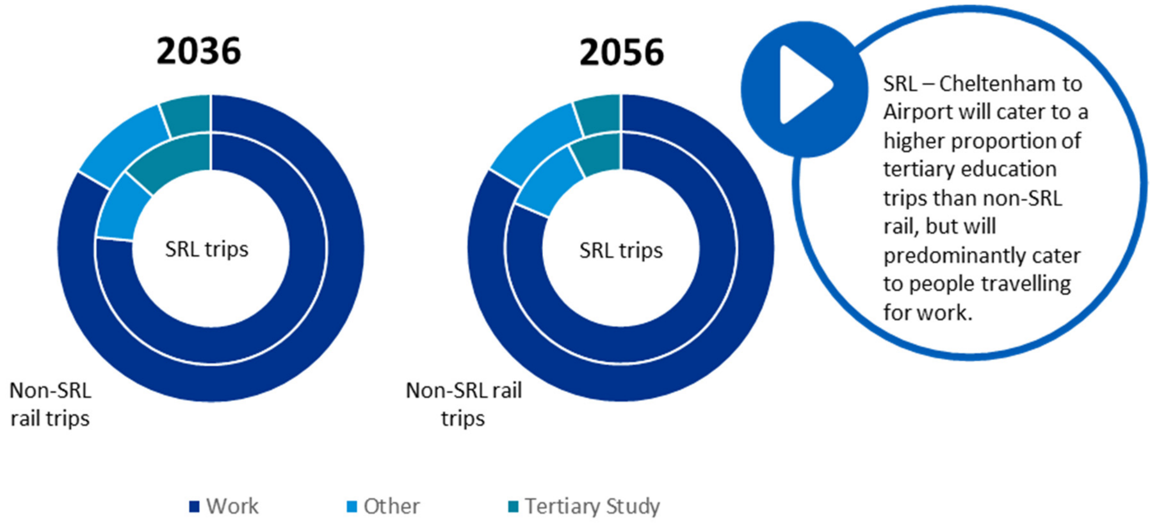
Workers using SRL – Cheltenham to Aiport are more likely to be from low income households than workers using non-SRL rail, or all travelling workers.

Source: KPMG analysis of MABM modelling

C.9.3 How they use SRL – Cheltenham to Airport

The majority of rail trips are undertaken for work purposes. However, SRL – Cheltenham to Airport trips are more likely to have a non-work destination than non-SRL rail trips. Also, SRL – Cheltenham to Airport customers are more likely to be tertiary students and workers working in the middle suburbs, who are less likely to be office workers. Both groups have either more flexible start times for their activities or start times that do not necessarily require travelling in peak times. However, since the majority of SRL – Cheltenham to Airport customers are workers, trips on SRL – Cheltenham to Airport have similar time profiles to radial rail. Figure C - 34 shows the destination of SRL – Cheltenham to Airport trips versus non-SRL rail trips. Figure C - 35 and Figure C - 36 and shows daily boardings distribution of SRL – Cheltenham to Airport and non-SRL rail in both forecast years.

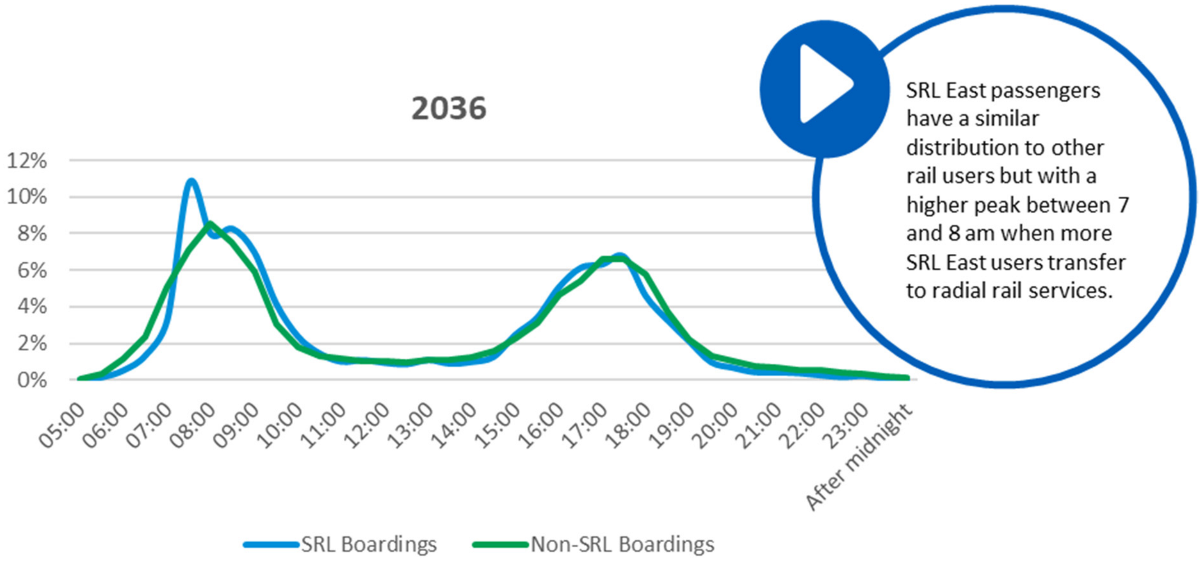
Figure C - 34: Comparison of SRL – Cheltenham to Airport and non-SRL rail trip destinations



SRL – Cheltenham to Airport will cater to a higher proportion of tertiary education trips than non-SRL rail, but will predominantly cater to people travelling for work.

Source: KPMG analysis of MABM modelling

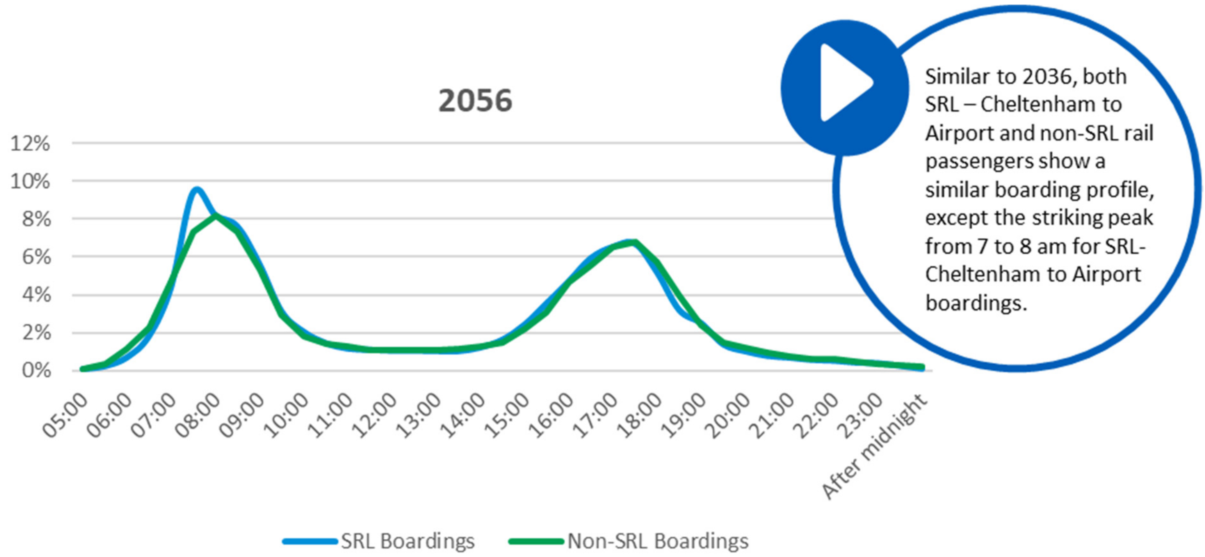
Figure C - 35: Daily rail boardings distribution, 2036



SRL East passengers have a similar distribution to other rail users but with a higher peak between 7 and 8 am when more SRL East users transfer to radial rail services.

Source: KPMG analysis of MABM modelling

Figure C - 36: Daily rail boardings distribution, 2056



Similar to 2036, both SRL – Cheltenham to Airport and non-SRL rail passengers show a similar boarding profile, except the striking peak from 7 to 8 am for SRL-Cheltenham to Airport boardings.

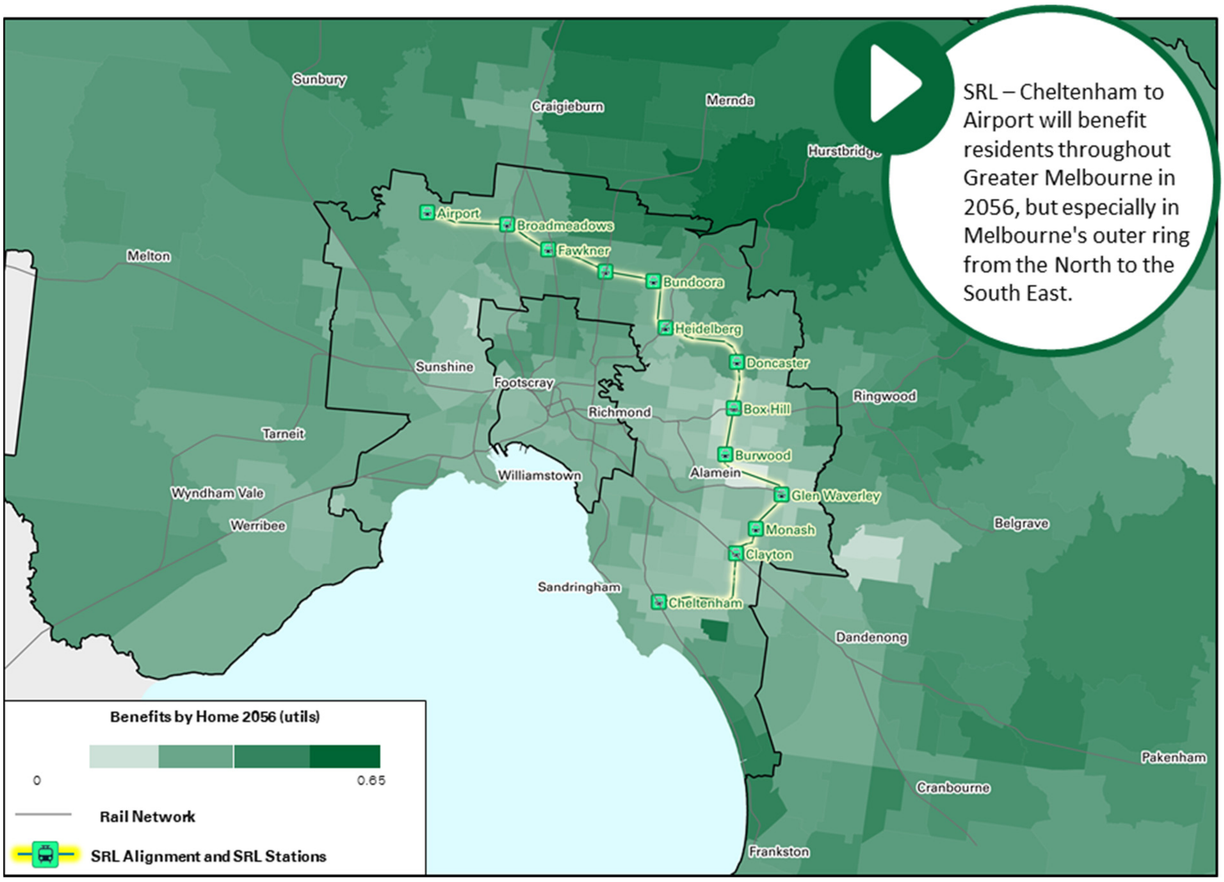
Source: KPMG analysis of MABM modelling

C.9.4 SRL – Cheltenham to Airport beneficiaries primarily live in the middle and outer suburbs

An individual's accessibility is measured based on estimates of a person's 'satisfaction' of their day – including how much time they are able to spend at their preferred activities rather than in traffic or on crowded public transport services, and how much money they spend on transport services. The metric to show this accessibility is called *score* and is measured in *utils* in MABM. An hour of someone's time is worth approximately 2.14 utils or for a Melburnian on an average hourly wage, with one util being worth about $7. If an individual has a better score in the Program Case than in the Base Case, that individual is considered and called a *beneficiary*.

SRL – Cheltenham to Airport beneficiaries are primarily residents of middle and outer suburbs. Residents in these areas benefit from alternative transport options and improved accessibility. Figure C - 37 shows the Statistical Areas Level 2 (SA2s) with residents who are better-off on average with SRL – Cheltenham to Airport in 2056. The metric to identify a SA2's status is the average of all residents' score differences between the Base Case and Program Case.

Figure C - 37: Beneficiaries home location by SA2s with SRL – Cheltenham to Airport in 2056



SRL – Cheltenham to Airport will benefit residents throughout Greater Melbourne in 2056, but especially in Melbourne's outer ring from the North to the South East.

Source: KPMG analysis of MABM modelling

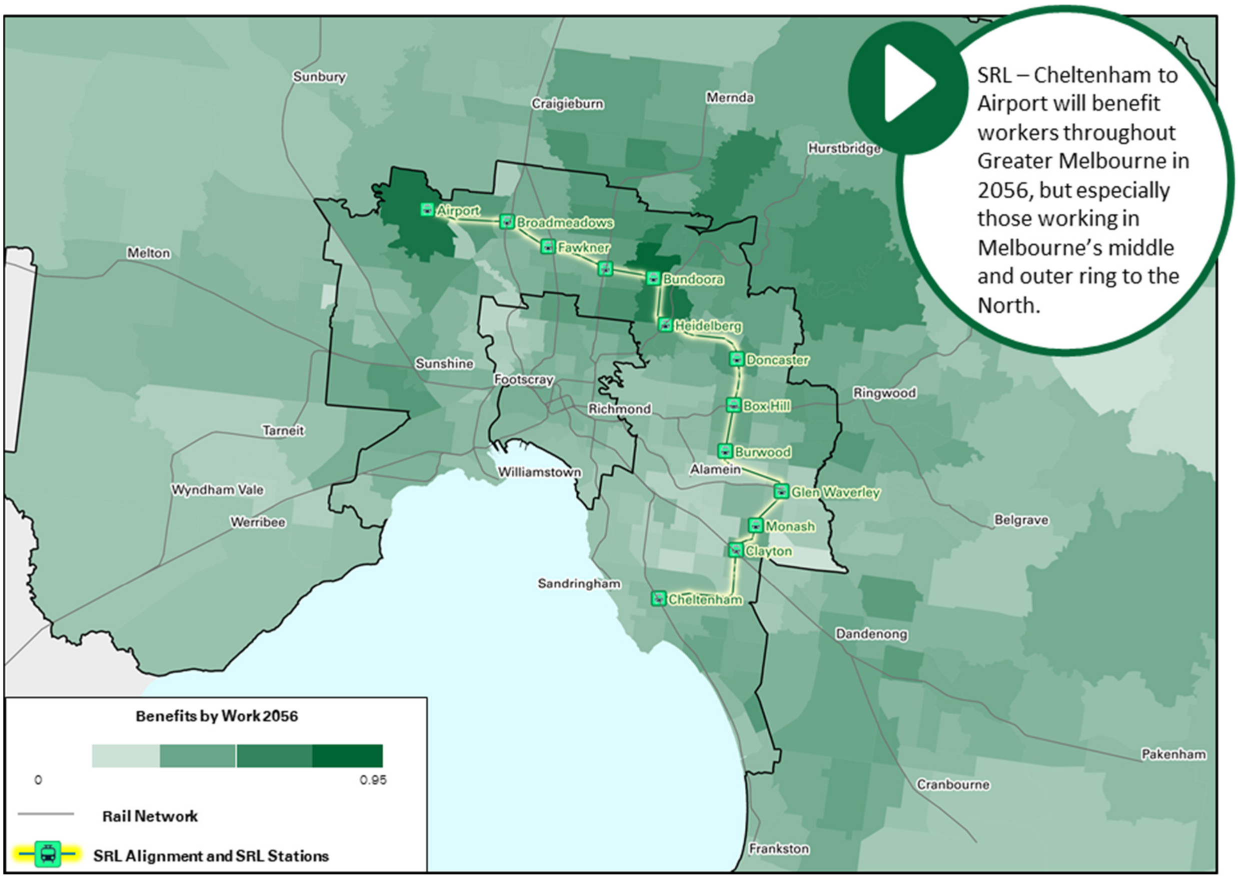
C.9.5 Beneficiaries primarily work in the middle and outer suburbs

People working in the middle and outer suburbs towards the North of Melbourne are the primary beneficiaries of SRL – Cheltenham to Airport in 2056. There are two primary reasons for this:

1. An increase in public transport access for workers in those areas
2. A shift towards public transport due to SRL – Cheltenham to Airport eases congestion for road users.

Figure C - 38 show SA2s with workers who are better off on average with SRL – Cheltenham to Airport in 2056.

Figure C - 38: Beneficiaries by work location by SA2s with SRL – Cheltenham to Airport in 2056



SRL – Cheltenham to Airport will benefit workers throughout Greater Melbourne in 2056, but especially those working in Melbourne's middle and outer ring to the North.

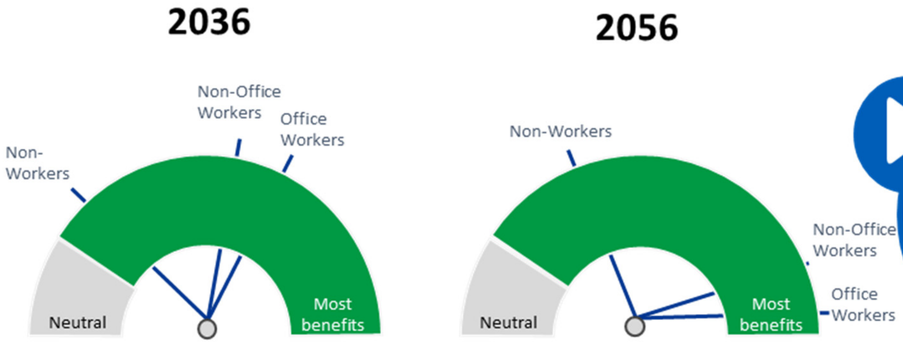
Source: KPMG analysis of MABM modelling

C.9.6 Beneficiaries are mostly workers from lower and middle income families and tertiary students

Figure C - 39 to Figure C - 41 summarise beneficiaries' insights drawn from the modelling and report in the three key demographics mentioned in the previous section "Who they are".

The categories presented in the below figures are accessibility measures based on economic utility. The purpose of the categories is to represent the differential impacts by demographic cohort, rather than to provide an absolute measure of benefit.

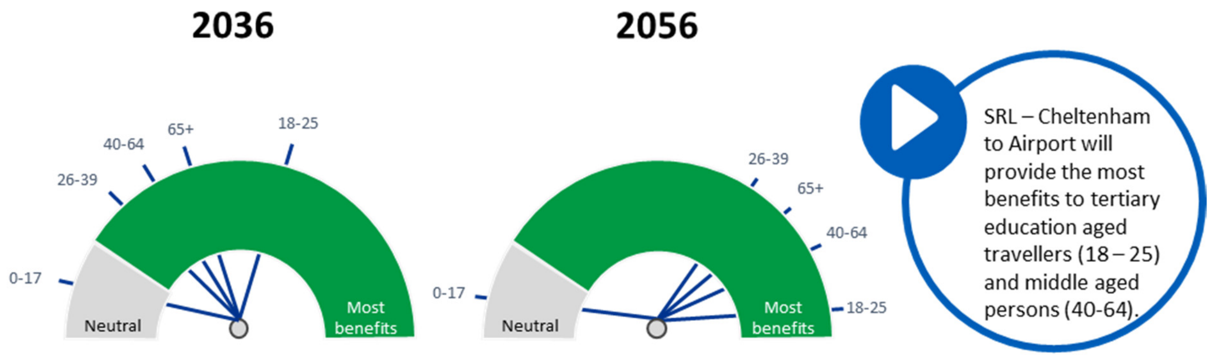
Figure C - 39: Beneficiaries of SRL – Cheltenham to Airport based on their work status



SRL – Cheltenham to Airport will provide the most benefits to workers, including office and non-office workers.

Source: KPMG analysis of MABM modelling

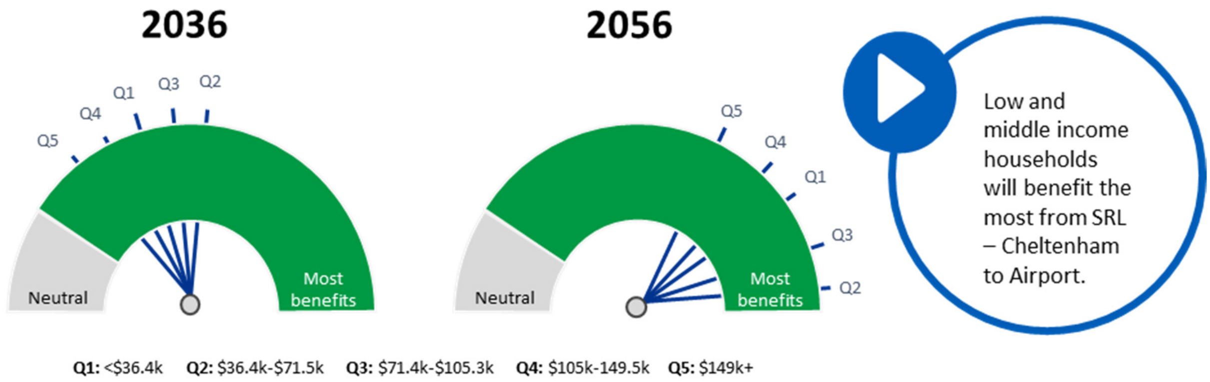
Figure C - 40: Beneficiaries of SRL – Cheltenham to Airport based on their age



SRL – Cheltenham to Airport will provide the most benefits to tertiary education aged travellers (18 – 25) and middle aged persons (40-64).

Source: KPMG analysis of MABM modelling

Figure C - 41: Beneficiaries of SRL – Cheltenham to Airport based on their equivalised household income



Low and middle income households will benefit the most from SRL – Cheltenham to Airport.

Source: KPMG analysis of MABM modelling

C.10 Alternative future scenarios

As an agent and activity-based model, MABM is the preferred tool to test the impacts of changes to transport policy and infrastructure and fleet changes, and how these changes influence the behaviour of transport system users. MABM can provide insights to customers' needs and preferences, and consideration of the socio-economic and demographic characteristics of its agents, which go beyond the ability of the traditional four-step model framework used in VITM.

This section outlines the assumptions of three alternative technology and pricing scenarios for which MABM's agent and activity based approach was able to be utilised to consider the impacts on network demand. For consistency of outputs, MABM was used to provide demand adjustments that were then applied in VITM modelling for different time period and mode.[19]

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[19] Application in VITM is essential to ensure consistent application and determination of the economic impacts of these scenarios to be considered and compared against core scenarios and other sensitivities already assessed in VITM.

These scenarios were defined by DoT to be used for economic sensitivity scenarios. The tested scenarios include:

- High AV/EV use – which tests the potential consequences or includes potential scenarios of higher prevalence of autonomous vehicles (AVs) and Electric Vehicles (EVs):
  - AV scenario – with high technology and automation, high private use scenario – assume 35% conventionally driven vehicles (CDVs) which are EVs and 65% privately owned AVs/EVs.
  - Shared autonomous vehicle (**SAV**) scenario – with a high technology and automation, high rideshare scenario – assumes 21% CDVs/EVs, 39% private AVs/EVs and 40% shared, on-demand AVs/EVs.
- A transport network pricing (**TNP**) scenario using a combination of cordon pricing, flagfall and distance-based pricing for road and public transport.

The specification details of the scenarios are summarised in the following table.

Table C - 17: Scenario specification details

	Base Case	AV scenario	SAV scenario	TNP scenario
Conventionally driven Car (CDV) Share	100%	35%	21%	100%
CDV MUTT (factor)	1	1	1	1
CDV VOC ($/km)	0.176	0.100	0.100	0.128
Private AV (PAV) Share	N/A	65%	39%	N/A
PAV MUTT (factor)	N/A	0.8	0.8	N/A
PAV VOC ($/km)	N/A	0.100	0.100	N/A
Electric Vehicle (EV) Share	N/A	100%	100%	N/A
Shared AV (SAV) Share	N/A	N/A	40%	N/A
SAV MUTT (factor)	N/A	N/A	0.8	N/A
SAV flag fall ($)	N/A	N/A	2	N/A
SAV fare/km ($/km)	N/A	N/A	0.17	N/A
SAV fare/min ($/min)	N/A	N/A	0.07	N/A
Road capacity (AV flow factor)	N/A	1.3	1.3	N/A
Road Distance Pricing ($/km)	N/A	N/A	N/A	0.155
Road Cordon Pricing	N/A	N/A	N/A	$1/km in inner cordon
Public Transport pricing	Myki	Myki	Myki	Flagfall & distance based
Dead running	N/A	To/from home if parking > return trip cost & duration > 1hr	To/from home if parking > return trip cost & duration > 1hr	N/A
Induced Demand	N/A	25% of 5-11 year olds, 50% of 12-17 year olds and 75% of over 18s without car availability switched on and ride changed to driver (~10%)	25% of 5-11 year olds, 50% of 12-17 year olds and 75% of over 18s without car availability switched on and ride changed to driver (~10%)	N/A

Source: DoT

A summary of the outcomes of the sensitivity analyses are provided below:

- The AV scenario saw a shift towards private vehicle transport due to the reduced perceived cost of using AVs relative to conventionally driven vehicles. More people are choosing to use private vehicles, with less reliance on public transport. The AV scenario saw a slight increase in average road network speed and a slight worsening of average delay. This is caused by the competing dynamics of an effective increase in road capacity due to the 'platooning' ability of AVs (i.e. shorter distances between vehicles in moving traffic) and increased road congestion in inner areas due to 'empty running' of private AVs avoiding high parking costs in the inner city.
- The SAV scenario saw a shift towards public transport due to the reduction in private vehicle ownership. More people are using a combination of shared AVs and public transport, with less reliance on private vehicle transport. Despite the reduction in private vehicle demand, there is an increase in VKT due to 'empty running' of AVs. The SAV scenario also saw a substantial increase in average road network speed and reduction in average delay due to both the shift away from private vehicle transport and an effective increase in road capacity due to the 'platooning' ability of AVs (i.e. shorter distances between vehicles in moving traffic).
- The TNP scenario saw a slight shift towards public transport use due to the general reduction in the relative cost of using public transport compared to private vehicle transport. The TNP scenario also saw a reduction in average delay due to decongestion of the road network – most notably in the congested inner areas.

MABM demand forecasting produces VKT, PKT and number of trips by mode statistics for each scenario run. The changes of VKT and PKT by each time period between Base and Program Case from MABM discussed above were used to estimate adjustment ratios for Highway and Public Transport assignment in VITM modelling respectively. The number of person trips by mode in VITM were scaled based on the changes in number of trips by mode generated in MABM forecasting. This ensures that broad changes in demand as estimated in MABM are reflected in VITM, suitable for use in economic sensitivity analysis. The adjustment ratios applied for each time period and mode in VITM modelling are outlined in the following table.

Table C - 18: Adjustment ratios applied in VITM modelling

	Base Case with 65% AV	**Program Case with 65% AV**	**Base Case with 40% SAV and 39%**	**Program Case with 40% SAV and 39% AV**	**Base Case with TNP**	**Program Case with TNP**
Highway						
AM	1.132	1.127	1.093	1.098	0.986	0.984
IP	1.064	1.063	1.026	1.030	0.982	0.983
PM	1.106	1.110	1.068	1.075	0.972	0.979
OP	1.055	1.054	1.029	1.031	0.988	0.990
Public Transport						
AM	0.979	0.980	1.097	1.075	1.087	1.039
IP	0.943	0.982	1.022	1.038	1.019	1.049
PM	0.947	0.972	1.046	1.049	1.038	1.040
OP	0.953	0.961	1.005	1.008	1.049	1.064
Person Trips						
PT	0.984	0.954	1.312	1.083	1.094	1.053
Car	1.031	1.014	0.846	0.833	0.984	0.989
Active modes	0.998	0.982	1.204	0.994	0.999	1.004

Source: KPMG analysis of MABM modelling