THE MELBOURNE RAIL PLAN 2020-2050

PUBLIC TRANSPORT FOR A CITY OF 8 MILLION

FINAL EDITION

RAIL FUTURES INSTITUTE INC.

>>WHAT IS THE MELBOURNE RAIL PLAN?

THE MELBOURNE RAIL PLAN is a blueprint for the next 30 years of rail development in Melbourne.

The challenges of population growth require fundamental shifts in strategic transport policy and serious integration of transport and land use planning.

Public transport services have increased in recent years but population growth has been faster.

Improved rail services as part of an integrated transport policy can play a very significant role in terms of the growth and development of Melbourne, consistent with the objectives of the State Government's *Plan Melbourne* and the *Transport Integration Act*.

***The Melbourne Rail Plan* presents a strategy for rail based transport modes within the context of a fully integrated multi-modal transport system for the future.**

It shows how such development, through phased investment, can significantly reduce Melbourne's massive car dependency and benefit the city's liveability, economic performance, social fabric and environmental sustainability.

These outcomes also require other complementary policies and programs. In particular, Government needs to take a strong strategic lead in planning policy; and new mechanisms found for funding public transport.

***The Melbourne Rail Plan* seeks to strike the right balance between ambitious and conservative approaches.**

PO Box 1257
CARLTON VIC 3053
railfutures.org.au

A0059839B
RAIL FUTURES INSTITUTE INC.

This plan has been prepared by Rail Futures Incorporated in the public interest. Rail Futures Inc. is an independent non-partisan group formed to advocate cost effective rail and intermodal solutions for public transport and freight based on sound commercial, economic and social reasoning. Rail Futures members include experienced rail professionals, engineers and economists.

Foreword

Melbourne once had one of the world's best public transport systems. The forethought and planning of Victorians more than a century ago, and their capacity to value the welfare of Victorians of the future -us - as highly as their own, helped make Melbourne one of the world's economically most productive and liveable cities. For the past few generations, myopia, carelessness and excessive valuation of the present over the future have been squandering that wonderful legacy. The economic and social life of this city will be deeply impaired by barriers to movement of people around the city unless chronic underinvestment over recent generations is remedied.

The Melbourne Rail Plan 2020-2050 demonstrates the way to correct the mistakes of recent generations, and that some contemporary Victorians are up to the challenge. The Report is comprehensive, creative and authoritative. It is an excellent foundation for rebuilding Melbourne to secure its position as one of the world's most successful cities.

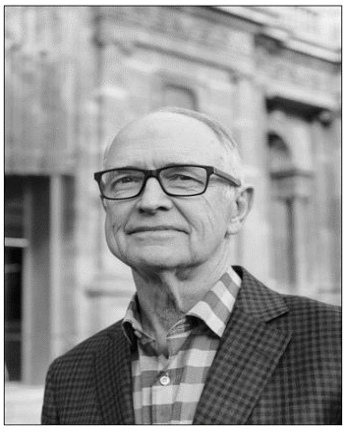
Melbourne is growing more rapidly than any other large city in the developed world.

Yet cities anywhere near Melbourne's size in Europe and east Asia now have far better metropolitan rail systems. Cities of Melbourne's size cannot function efficiently without effective rail transport.

The Report is based on integration of a range of transport technologies. Heavy and light rail is necessarily at its centre, with the strengthening of Melbourne's famed tram system an important part of the plan. While the backlog is large, catching up is supported by Melbourne's flat terrain, its railway heritage and by established grid road patterns. The Report contains carefully constructed proposals for completing rail grids in areas near the city centre and extensions to more distant suburbs where much population growth has been occurring. It discusses opportunities for lowering costs and increasing amenity by ensuring that opportunities for active transport - walking and cycling - and use of autonomous vehicles and other emerging technologies are integrated into planning for rail.

Large public investment will be required to rebuild Melbourne's public transport system. The economic case for the required investment is strong. It is stronger in the 21st century, when changes in global savings and investment patterns have greatly reduced the interest rates at which the private sector is prepared to lend to governments. Near zero real interest rates strengthen the economic case for long term investments in public infrastructure - especially on systemic changes that remedy Melbourne's rail deficit and generate benefits for the long-term life of our large city.

The Victorian Government has begun the rebuilding of Victoria's public transport infrastructure. This Report provides sound guidance for the immense task that lies ahead.



Ross Garnaut

Professor of Economics,

University of Melbourne

CONTENTS

LIST OF FIGURES

LIST OF TABLES

PREFACE

This *Melbourne Rail Plan 2020-2050* (MRP) has been prepared by a transport and planning team at the Rail Futures Institute (RFI) in collaboration with members of RMIT University School of Global Urban and Social Studies.

RFI is a self-funded, non-partisan group of rail professionals, engineers, urban planners and economists working in the public interest. We have no affiliations with governments or corporate interests. We undertake independent research and advocacy to promote rail-based solutions when we judge these will best meet the future needs of passenger and freight transport.

The MRP is the RFI blueprint for the next thirty years of rail development in Melbourne to support a projected population exceeding 8 million by 2050. It follows our 2016 report *InterCity* that aims to "shrink distance" by proposing faster rail connections between Melbourne and regional cities in Victoria.

The challenges of population growth require fundamental shifts in strategic transport policy and comprehensive integration of transport and land use planning. The RFI's work in developing the MRP has been motivated by the failure for over a decade of successive Victorian governments to produce a comprehensive Transport Plan, as mandated by the State's Transport Integration Act (TIA).

Improved rail services as part of integrated transport policy can play a very significant role in the growth and development of Melbourne, consistent with the objectives of *Plan Melbourne 2017-2050* and the TIA.

The MRP presents a strategy for rail-based transport modes within the broader context of a multi-modal transport system – integrating heavy rail, light rail, Medium Capacity Transit (MCT), tram, bus and active transport (walking and cycling) into a cohesive grid network.

Such development, through phased investment, will significantly reduce Melbourne's car dependency and thereby benefit the city's liveability, economic performance, social fabric and environmental sustainability; and make an important contribution to meeting the Government's statutory obligations and planning objectives.

Achievement of these outcomes will require complementary transport planning for Melbourne's regions as well as policies and programs beyond rail strategy. Strong leadership is required by the State Government to ensure transport infrastructure and services are planned and delivered in alignment with settlement patterns to enable more efficient access between residences, jobs and services. Key to this is reducing travel inefficiencies related to congestion and excessive commuting times arising from the dominance of the transport task by sole occupant motor vehicles.

RFI's plan for the future of public transport in metropolitan Melbourne sets out staged priorities for phased implementation of its proposals to 2050, to balance ambitious and conservative initiatives with realistic funding capacity. The MRP involves incremental investment on a realistic timeframe and acknowledges resource constraints that governments operate under. Nonetheless, the scale of investment required is unprecedented and will require new funding mechanisms, both public and private.

Planning for human settlement and movement is a dynamic process and requires continuous development to stay relevant. RFI will therefore continue to review and update our plans in line with continually evolving knowledge and experience and the wider environment in which we live. This includes adaptation to the changing climate and adoption of relevant new technologies.

We do not profess to having dealt with all issues or have provided the only solutions – that would not be possible for the complex and extensive transport systems of one of the World's most expansive cities. Rather our aim has been to inform and contribute to discussion around how Victoria can best meet the challenges of population growth, congestion and good public transport.

We welcome comments on this report and invite interested persons to contribute to our processes by joining Rail Futures. A membership application form can be completed at our web site – www.railfutures.org.au.

John Hearsch, President, Rail Futures Institute

September 2019

EXECUTIVE SUMMARY

THE MELBOURNE RAIL PLAN 2020-2050 is a blueprint for the next 30 years of rail development in Melbourne. It presents a strategy for rail-based and complementary transport modes within the context of a future fully integrated multi-modal transport system. Such development, through phased investment, will significantly reduce Melbourne's massive car dependence and benefit the city's liveability, economic performance, social fabric and environmental sustainability.

Melbourne's population reached 5 million in 2018 and the most recent forecasts are for a city in excess of 6 million by 2031, 8 million by 2047 and 9 million by 2056. Melbourne's continued urban spread and population growth has not been matched with an equivalent expansion of the public transport network. Symptoms of this transport malaise include worsening congestion, excessive journey to work times, restricted access to jobs, car dependent new suburbs, along with negative social, health and environmental impacts.

Most new outer urban growth is occurring in areas without adequate or planned provision of public transport. Strong population and employment growth in central Melbourne and inner suburbs are placing severe strain on the radial rail and road networks with overcrowded trams being among the world's slowest, operating well below their potential. Many public transport vehicles and much rail and tram infrastructure remain non-compliant with National Disability Discrimination Act (DDA) specifications.

The challenges of population growth require fundamental shifts in strategic transport policy and serious integration of transport and land use planning. Improved rail services as part of an integrated transport policy can play a very significant role in the growth and development of Melbourne, consistent with the objectives of the State Government's *Plan Melbourne 2017-2050* and the *Transport Integration Act.* Targeted investment in rail infrastructure is a powerful city shaping tool and can help transport Melbourne to 2050 by:

- providing a multiplicity of new public transport travel options as a viable alternative to car usage
- providing Melbournians much wider access to employment and other opportunities
- delivering on the *Plan Melbourne 2017-2050* polycentric city concept
- integrating the metropolitan economy by linking activity centres and boosting the role of National Employment and Innovation Clusters (NEICs)
- promoting transit-oriented development (TOD) around key rail stations
- using the tram network to help shape rapid inner area densification
- growing rail capacity to better serve Melbourne's outer growth suburbs
- delivering environmental, health and safety benefits
- providing resilience for the network and its users in time of disruption.

The Plan has eleven key elements:

- Making the existing system work better by maximising use of the existing assets
- Creating a multi-modal grid network of high frequency services
- Completing major cross-city mass transit rail routes and a dedicated CBD to Melbourne Airport rail link
- Extending electrified rail coverage of metropolitan services to outer growth areas
- Making new connections to and between National Employment Clusters and Major Activity Centres
- Maximising potential of the tram network to enhance connections for middle and inner suburbs
- New CBD tram routes and cross-suburban journeys including tram route extensions and new links to rail interchanges
- New Medium Capacity Transit (MCT) systems (including light rail and other emerging technologies) providing high frequency orbital, cross-suburban and CBD-linked routes
- Re-configuration of the bus network to effectively complement rail, trams and MCT
- Strongly facilitating active transport (cycling and walking) to and from public transport
- Improving accessibility of services for less able people and meeting DDA compliance.

Melbourne's existing train and tram networks are hugely valuable assets. Much can be done to enable these assets to work harder and deliver services more efficiently. While this Plan requires the provision of new large-

scale infrastructure, it also aims to increase the capacity, attractiveness and efficiency of the existing network through a range of investment and operational initiatives.

The Train Plan

The main components of the Train Plan are:

- 3 new mass transit heavy rail Lines
- a new express line from Southern Cross to Melbourne Airport
- 5 extensions of existing rail lines
- electrification of inner parts of 6 regional lines
- network reconfiguration to provide multiple major cross-city corridors
- duplication of 5 single-track sections
- 26 new stations on existing and extended lines
- level crossing removal priority at 16 locations which negatively impact rail and on-road public transport
- replacement of obsolete and inadequate infrastructure including track and structures, power supply and overhead upgrading, station rehabilitation, and new signalling and communications systems
- new trains of increased length and capacity
- new maintenance and train stabling facilities
- new and enhanced services operating to “turn up and go” frequencies.

The Tram Plan

Features of the Tram Plan are:

- tram priority measures
- 6 short route extensions
- 7 longer route extensions
- an extended Western and Northern CBD network
- expanded and reorganised route network
- upgraded stops and interchanges, meeting obligations for less able travellers
- improved connectivity between services at inner Melbourne locations
- a fleet of 640 low floor articulated trams by 2034, replacing over 300 older low capacity/high floor trams
- upgraded power supply and traction systems
- new tram maintenance and depot facilities
- new and enhanced services operating to “turn up and go” frequencies.

The Medium Capacity Transit (MCT) & Light Rail Plan

Medium Capacity Transit (MCT) is a key element of the Melbourne Rail Plan. A new concept for Melbourne, it provides an urban public transport solution ideally suited to new trunk routes not requiring the capacity of conventional heavy rail systems and deliverable at substantially lower cost. MCT infrastructure will be on the surface, elevated or underground, as determined by individual route conditions. MCT technologies are rapidly evolving, ranging from conventional light rail using upgraded trams, light metro railways to high capacity guided buses with electric and hybrid traction systems. In Melbourne, MCT will use one or more of these systems. It will fully complement other modes to form one network with interchanges making it convenient to transfer between modes.

The proposed 10 initial MCT routes provide high quality cross-suburban connectivity, comprising:

- one radial corridor, filling a gap in the radial rail network
- 3 major orbital corridors
- 6 major cross-suburban corridors

This part of the Plan also provides a comparative analysis of RFI’s MCT and Light Rail proposals against the Victorian Government’s proposed Suburban Rail Loop project and highlights the benefits of the more comprehensive MCT approach.

The Metropolitan Bus Network

The Plan proposes a substantial re-structure of the metropolitan bus network to effectively integrate with the proposed train, tram and MCT networks. The revised bus network will operate at 3 levels:

- High frequency SmartBus routes on trunk corridors (including routes developed to build corridor patronage in anticipation of future MCT investment)
- High frequency feeder services to train, tram or MCT interchanges
- Local services to Major and Local Activity Centres, schools, hospitals, etc.

The bus network will be pivotal in completing the grid network of high frequency public transport on routes which cannot justify investment in major fixed infrastructure. It will be designed to provide convenient interchanges at key nodes with other modes. All principal routes would operate at "turn up and go" frequencies compatible with train, tram and MCT services. Detail of the reworked metropolitan bus network is beyond the scope of this Plan; a total review should be a Department of Transport (DoT) priority.

Active Transport

For Melbourne to have strong and healthy communities and high rates of social and economic participation, the share of trips by public transport, walking and cycling must increase. A key factor in achieving this objective is promotion of walking and cycling access to trains, trams and MCT.

Provision of dedicated safe walking and cycling paths to all principal public transport corridors and mass bicycle storage facilities at train, tram and MCT interchanges are integral components of this Plan.

A Connected City

The projects promoted in this plan are focused on improving public transport access across Melbourne to ensure effective connectivity between residential areas, employment, educational, social and recreational centres without people being as dependent on cars. A high level of accessibility will allow Melbourne residents to enjoy a high quality of life in an environmentally sustainable city.

If *Plan Melbourne 2017-2050 i*s to succeed in making suburban NEICs and activity centres viable and functional places, then Melbourne will require not only much higher capacity radial rail transport, but also a quantum leap in cross-suburban public transport. The Plan proposes high-quality links to designated NEICs and some Major Activity Centres.

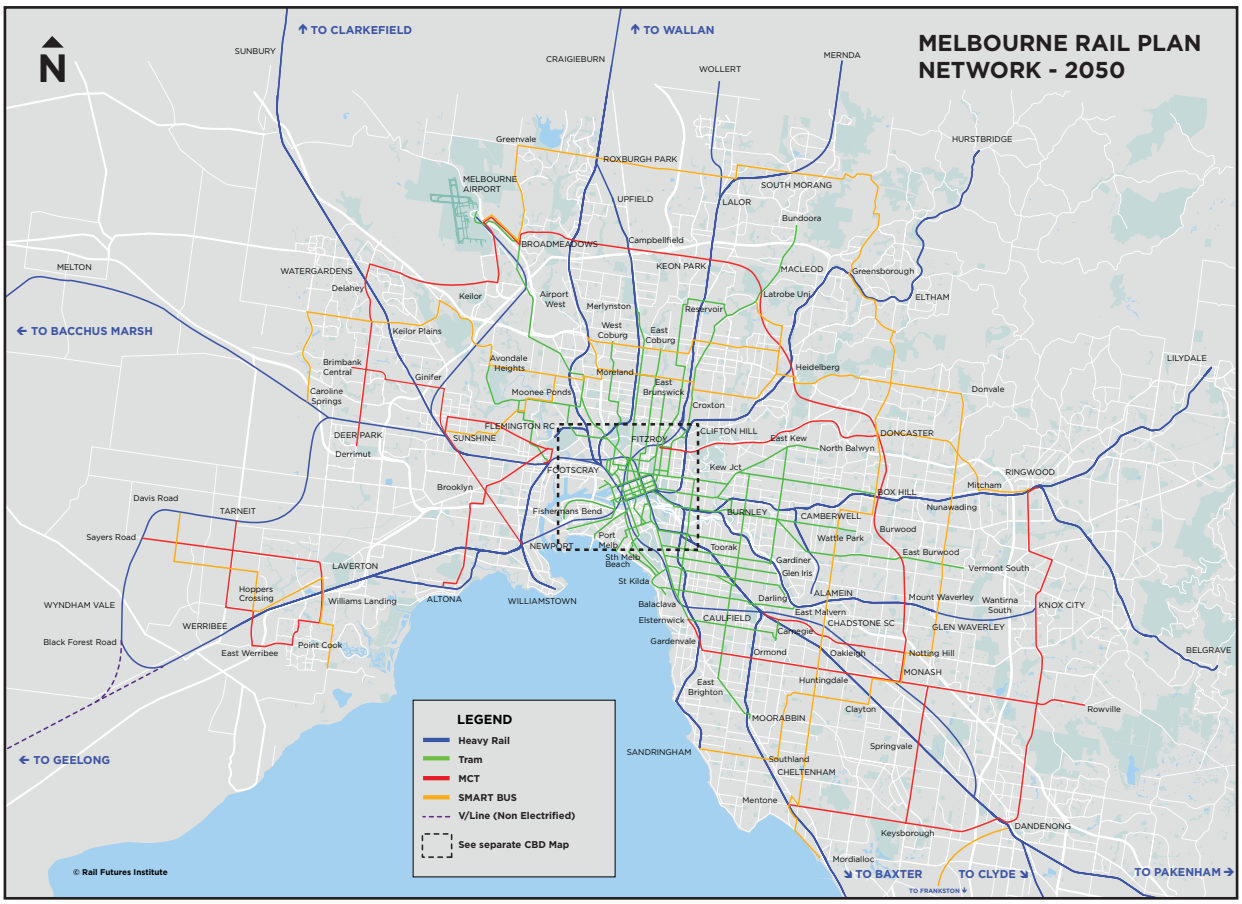
Indicative Cost Estimates

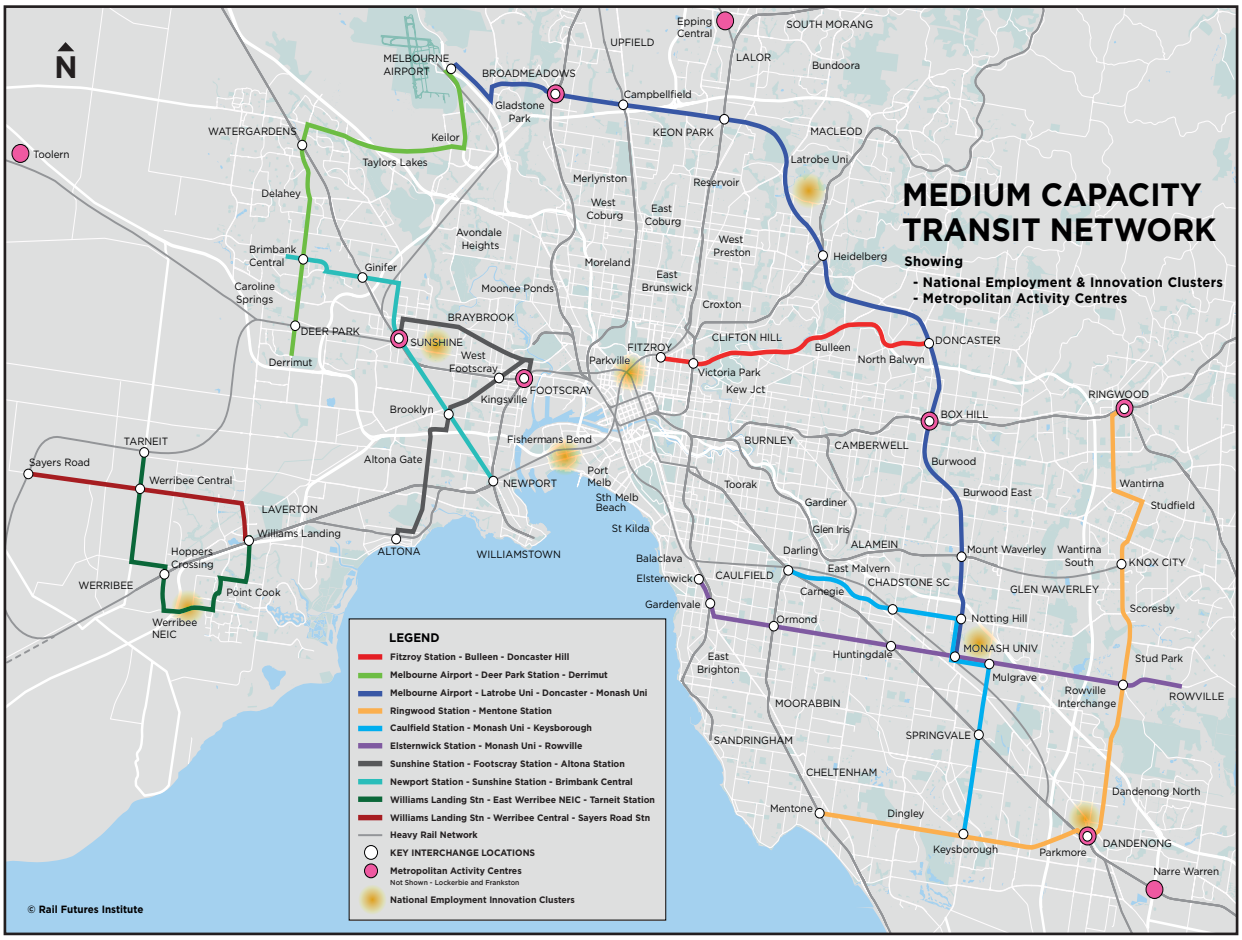
The Plan initiatives will require an investment of $120 billion over a 30-year period to 2050 comprising:

- Heavy Rail infrastructure $70 billion
- Tram infrastructure $9 billion
- Medium Capacity Transit infrastructure $30 billion
- Rolling stock (Trains, trams and MCT) $11 billion

The proposed capital investment program of $120 billion over 30 years to 2050 is the minimum required to meet Melbourne's public transport needs. Further expenditure to meet an even larger public transport task will be needed as Melbourne grows beyond 8 million people.

Overview maps of the improved network of train, tram and MCT services proposed in this Plan, together with some key SmartBus routes, are shown on the following page. An enlarged fold-out map of the proposed overall network is on the inside back cover of the document.


MELBOURNE RAIL PLAN
NETWORK - 2050
N
↑ TO CLARKEFIELD
↑ TO WALLAN
← TO BACCHUS MARSH
← TO GEELONG
↘ TO BAXTER
TO CLYDE ↘
TO PAKENHAM →
SUNBURY
CRAIGIEBURN
WOLLERT
MERNDA
HURSTBRIDGE
Greenvale
ROXBURGH PARK
MELBOURNE AIRPORT
UPFIELD
SOUTH MORANG
LALOR
Bundoora
BROADMEADOWS
Campbellfield
KEON PARK
MACLEOD
Greensborough
ELTHAM
MELTON
WATERGARDENS
Delahey
Keilor
Airport West
Merlynston
Reservoir
Latrobe Uni
West Coburg
East Coburg
Keilor Plains
Brimbank Central
Avondale Heights
Moreland
Heidelberg
LILYDALE
Ginifer
Caroline Springs
Moonee Ponds
East Brunswick
Croxton
Donvale
DEER PARK
Derrimut
SUNSHINE
FLEMINGTON RC
FITZROY
CLIFTON HILL
East Kew
DONCASTER
North Balwyn
FOOTSCRAY
Kew Jct
RINGWOOD
Brooklyn
BOX HILL
Mitcham
Davis Road
TARNEIT
Fishermans Bend
BURNLEY
CAMBERWELL
Nunawading
Sayers Road
NEWPORT
Port Melb
Wattle Park
Burwood
Toorak
East Burwood
Sth Melb Beach
Gardiner
Glen Iris
Vermont South
LAVERTON
St Kilda
ALAMEIN
Hoppers Crossing
Williams Landing
ALTONA
WILLIAMSTOWN
Balaclava
Darling
Mount Waverley
Wantirna South
KNOX CITY
WYNDHAM VALE
Elsternwick
CAULFIELD
East Malvern
CHADSTONE SC
GLEN WAVERLEY
WERRIBEE
Carnegie
Black Forest Road
Point Cook
Gardenvale
Ormond
Oakleigh
Notting Hill
BELGRAVE
East Werribee
MONASH
East Brighton
Huntingdale
Clayton
Rowville
MOORABBIN
SANDRINGHAM
Springvale
Southland
CHELTENHAM
Mentone
Keysborough
DANDENONG
Mordialloc
TO FRANKSTON
LEGEND
Heavy Rail
Tram
MCT
SMART BUS
V/Line (Non Electrified)
See separate CBD Map
© Rail Futures Institute


N
MEDIUM CAPACITY
TRANSIT NETWORK
Showing
- National Employment & Innovation Clusters
- Metropolitan Activity Centres
Epping Central
SOUTH MORANG
UPFIELD
LALOR
Bundoora
MELBOURNE AIRPORT
BROADMEADOWS
Gladstone Park
Campbellfield
KEON PARK
MACLEOD
Toolern
WATERGARDENS
Keilor
Taylors Lakes
Latrobe Uni
Merlynston
Reservoir
Delahey
West Coburg
East Coburg
Avondale Heights
West Preston
Heidelberg
Brimbank Central
Ginifer
Moreland
East Brunswick
Caroline Springs
Moonee Ponds
Croxton
BRAYBROOK
DEER PARK
SUNSHINE
CLIFTON HILL
Bulleen
DONCASTER
Derrimut
West Footscray
FITZROY
Parkville
North Balwyn
Victoria Park
Kingsville
FOOTSCRAY
Kew Jct
RINGWOOD
Brooklyn
BOX HILL
TARNEIT
Fishermans Bend
BURNLEY
CAMBERWELL
Sayers Road
Altona Gate
Burwood
Werribee Central
NEWPORT
Port Melb
Toorak
Burwood East
Wantirna
Sth Melb Beach
Gardiner
Studfield
LAVERTON
St Kilda
Glen Iris
Williams Landing
ALAMEIN
Mount Waverley
Wantirna South
KNOX CITY
Hoppers Crossing
ALTONA
WILLIAMSTOWN
Balaclava
Darling
WERRIBEE
Elsternwick
CAULFIELD
East Malvern
CHADSTONE SC
GLEN WAVERLEY
Point Cook
Carnegie
Scoresby
Gardenvale
Notting Hill
Ormond
Werribee NEIC
MONASH UNIV
Huntingdale
Stud Park
East Brighton
Mulgrave
Rowville Interchange
ROWVILLE
MOORABBIN
SANDRINGHAM
SPRINGVALE
CHELTENHAM
Dandenong North
Mentone
Dingley
Keysborough
Parkmore
DANDENONG
Narre Warren
LEGEND
Fitzroy Station - Bulleen - Doncaster Hill
Melbourne Airport - Deer Park Station - Derrimut
Melbourne Airport - Latrobe Uni - Doncaster - Monash Uni
Ringwood Station - Mentone Station
Caulfield Station - Monash Uni - Keysborough
Elsternwick Station - Monash Uni - Rowville
Sunshine Station - Footscray Station - Altona Station
Newport Station - Sunshine Station - Brimbank Central
Williams Landing Stn - East Werribee NEIC - Tarneit Station
Williams Landing Stn - Werribee Central - Sayers Road Stn
Heavy Rail Network
KEY INTERCHANGE LOCATIONS
Metropolitan Activity Centres
Not Shown - Lockerbie and Frankston
National Employment Innovation Clusters
© Rail Futures Institute

PART 01 DESCRIBES MELBOURNE'S GROWTH STORY AND SETS THE CONTEXT FOR DEVELOPING THIS PLAN.

PART 01

MELBOURNE'S GROWTH STORY

» SECTION 01
Documents Melbourne's historic and forecast population growth to 2050. It discusses the consequences and challenges of rapid and unprecedented growth.

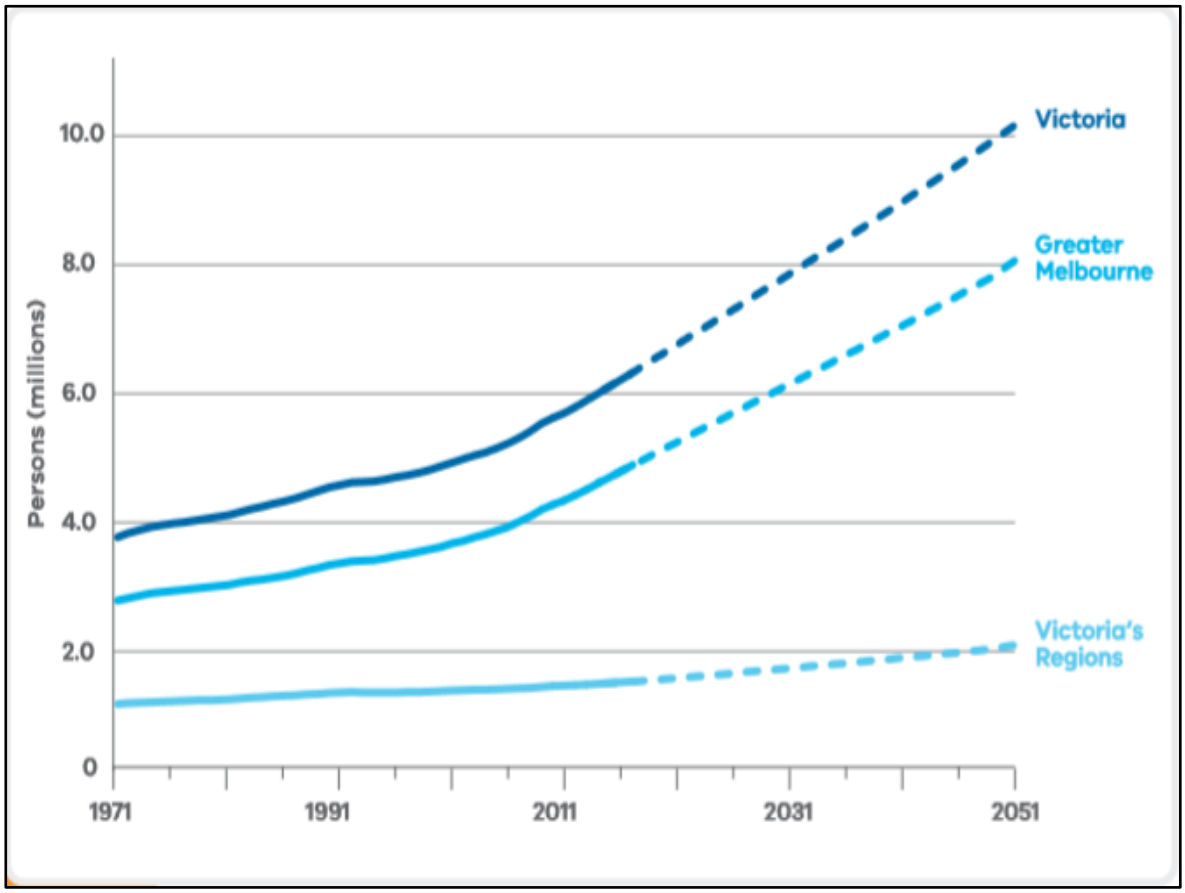
» SECTION 02
Contains a review of current planning policies.

1. Melbourne's Growth

1.1 Population Growth

Founded in 1836, Melbourne has grown to a city of more than 5 million people. Melbourne's population has increased by 50% since 1990 and is now increasing by about one million every 8 years. (Figure 1).

Figure 1: Population Growth in Victoria and Greater Melbourne



Source: *Victoria in Future 2016 (VIF 2016)*
https://www.planning.vic.gov.au/__data/assets/pdf_file/0030/97608/Victoria-in-Future-2016-FINAL-web.pdf

In 2018, the Australian Bureau of Statistics (ABS) produced forecasts of the size, structure and distribution of population in Australia under various assumptions of fertility, mortality and migration rates. These assumptions are based on long and short-term trends and scenarios dictated by research in Australia and elsewhere.

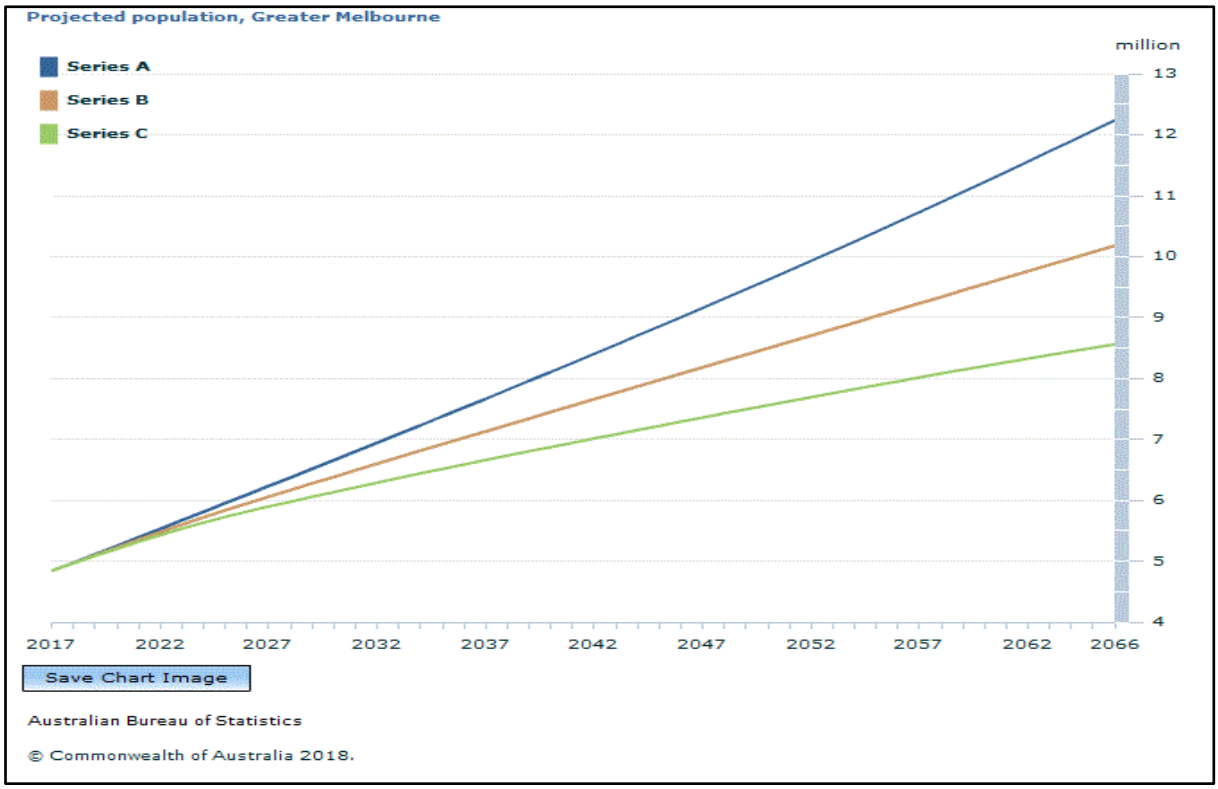
For simplicity, most analysis is limited to 3 selected series which cover 3 sets of possible population growth outcomes: higher (series A), medium (series B) and lower (series C). Projections for Greater Melbourne are shown in Figure 2.

The ABS predicted Greater Melbourne's population to increase from 4.8 million at 30 June 2017 to between 5.9 million (series C) and 6.2 million (series A) in 2027. By 2051, the ABS predicted Victoria's population to exceed 10 million with more than 8 million in Melbourne.

The latest 2019 population forecasts by *Department of Environment, Land, Water and Planning, Victoria* now predict the population of Melbourne will reach 8 million by 2047 and 9.0 million in 2056[1]. By then , Melbourne would have 80.4% of the State's total population compared with 76.4% in 2016.

[1] Victoria in Future 2019. Population Projections 2016-2019

Figure 2: Projected Population, Greater Melbourne



Source: *Australian Bureau of Statistics* (http://www.abs.gov.au/AUSSTATS/abs@.nsf/Latestproducts)

1.2 Urban Area Growth

Historical population growth has led to progressive expansion of Melbourne's urban area. The macro-urban form of this growth has been determined largely by dominant modes of transport at various periods in Melbourne's history.

Until the1950s, Melbourne's urban expansion followed train and tram routes. Since then, policies favouring car-based access to housing, employment, retailing and recreation have promoted the adoption of private cars for most travel. As a result, much of the population increase has been accommodated in spaces between train and tram catchments and increasingly in outer suburban areas, generally remote from public transport. (Figure 3).

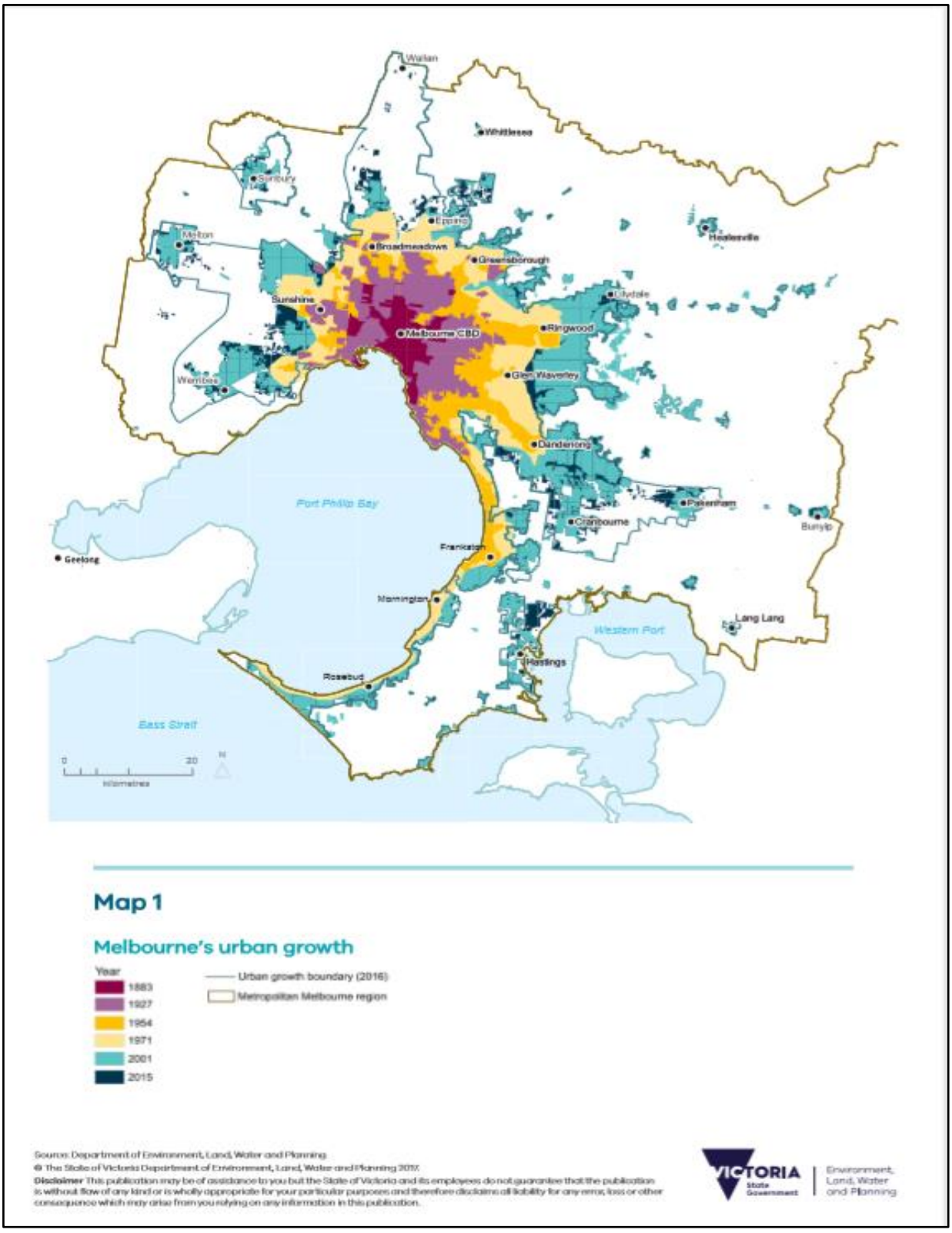
Apart from the central city, outer suburbs are still the fastest growing areas in Melbourne, especially in the west, north, and far south-east. Much of Melbourne's growth is expected to occur in communities in Melbourne's growth areas: Casey-Cardinia, Hume, Melton-Caroline Springs, Whittlesea and Wyndham. Almost one million people are expected to move into the western Local Government areas of Wyndham, Brimbank, Melton, Maribyrnong and Hobsons Bay, with Melbourne's western region alone reaching a population of 1.76 million by 2051. If trends continue, the western and northern suburbs will experience the largest population growth becoming home to 3.5 million people by 2051 *(The Age 10/03/2017).*

An increasing mismatch is evident between job availability and population growth in most municipalities. While housing is less expensive in outer Melbourne, residents there are generally impacted by inadequate access to jobs and services and thus bear significant transport costs.

Melbourne's population density spread has been driven by land development economics rather than by integrated transport and land use planning. Since the 1990s, a permissive planning system has shifted effective decision making about the direction and type of urban growth to private land markets. Decades of deficiency in aligning spatial development with transport planning has led to car dependent low density outer urban subdivisions beyond the reach of effective public transport.

Significantly, the spread of Melbourne's population over middle, inner and outer areas as shown in Table 1 below, contrasts with the more even spread of density in European cities where public transport reach has been extended in line with settlement

Figure 3: Melbourne's Urban Growth 1883 to 2015



Source: *Plan Melbourne 2017-2050*
http://www.planmelbourne.vic.gov.au/__data/assets/pdf_file/0003/376653/Map-1-Melbournes-urban-growth.pdf

.

Table 1: Melbourne's Population Spread

		Inner Area	Middle Area	Outer Area	Metropolitan Melbourne
Population 2006	No (000s) % of Metro Melbourne	335.8 9.0%	1,749.1 46.7%	1,659.4 44.3%	3,744.4 100%
Population 2011	No (000s) % of Metro Melbourne	352.2 8.9%	1,804.0 45.8%	1,784.5 44.3%	3,940.8 100%
Population 2016	No (000s) % of Metro Melbourne	427.3 9.7%	1,930.7 43.7%	2,057.3 46.6%	4,415.4 100%
Total Area	Square km	104	922	7,790	8,816
Population Density 2016	Persons per sq km	4109	2094	264	500

1.3 Melbourne's Growth Challenges

The challenge of servicing population growth is exacerbated by environmental and geographic limits to Melbourne's area. Melbourne's spread is amongst the world's most extensive. The area within its Urban Growth Boundary (UGB) is already much larger than the urbanised area of Greater London or New York City, whose current populations are comparable to the 8 million projected for Melbourne by 2050. The 2003 UGB generally continued historic planning policy confining outer urban growth to corridors based around heavy rail. However, extensions in 2004, 2010 and 2014 greatly expanded growth into green wedges between corridors. The greatest increase, in 2010, expanded the UGB by 43,000 hectares providing a 25-year outer urban land supply at some of the world's lowest densities.

Current outer suburban, low density, car-dependent growth is leading many new suburbs to dysfunction. Inadequate public transport and infrastructure have contributed to poor public health outcomes, social isolation, family violence issues, poor access to jobs, unacceptably long commuting times, traffic congestion and high infrastructure costs. If Melbourne is to successfully accommodate projected growth, a step-change from sole occupant car use to public transport is essential.

This low-density model of development located away from rail and without adequate public transport services condemns residents to car dependency for decades, or even indefinitely. Other impacts from sprawling outer urban growth include the loss of productive farmland close to the city and a range of environmental consequences.

A different issue exists in inner Melbourne. Population and jobs growth in the inner Melbourne area is putting demand pressure on the existing network with congestion impacting street based public transport.

Melbourne's future growth and economic success is now best served by giving the highest priority to public transport investment. Building more roads is counterproductive, generating more traffic and worsening congestion.

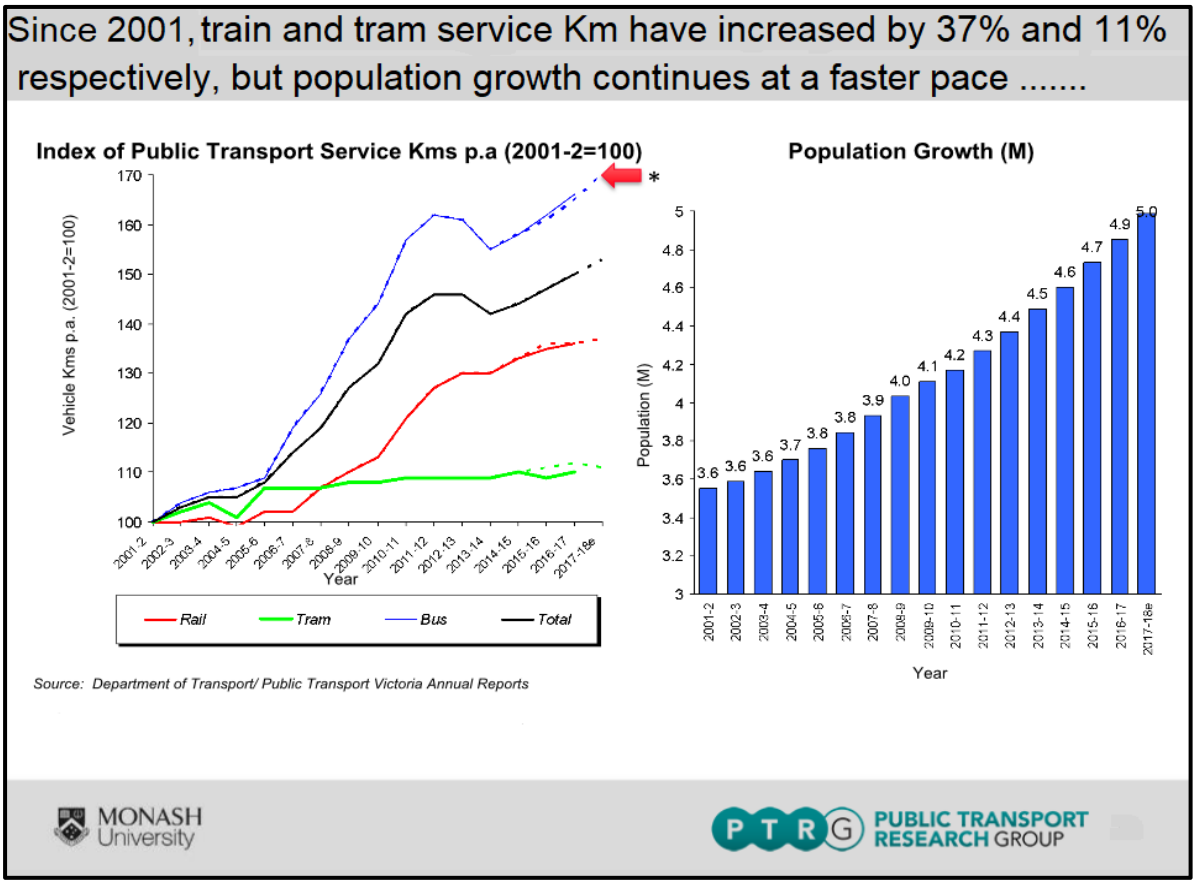
Public transport and congestion are rapidly rising in importance on the political agenda, with regular and increasing calls for action by local communities, regions, business and peak organisations to remedy city dysfunctionality.

While Greater Melbourne has a land use plan, *Plan Melbourne 2017-2050* (see Section 2.2), there is no complementary integrated long-term transport plan. This is despite such a plan being mandated under Section 63 of the Victorian Government's Transport Integration Act (2010).

Moreover, development of a comprehensive transport plan is critical to the success of *Plan Melbourne 2017-2050*, -particularly the Plan objective to achieve a polycentric city.

Credit must be given to the high level of transport investment in Melbourne by the current State Government, however, the public projects are mostly "catch-up" investments and are not keeping pace with Melbourne's growth. Public transport services have not been increased at the same rate as population growth. (Figure 4).

Figure 4: Public Transport Service Growth compared to Population Growth



A report prepared for Infrastructure Victoria (IV) by KPMG/Arup Infrastructure for the *Managing Transport Demand Research Program*[2i] provides an understanding of transport demand across Melbourne. This report summarises transport activity patterns now and in the future as perceived by Infrastructure Victoria.

The report provides key results for changes in demand and network performance between 2015 and the predicted future at 2031 stating:

> *"Over the next 15 years (between 2015 and 2031) the population of Greater Melbourne is estimated to grow from 4.5 million to almost six million. An additional 400,000 workers are expected by 2031 increasing the number of daily trips to work within Greater Melbourne by 25% to almost two million. However, the growth is not predicted to be evenly distributed across Melbourne, with the growth corridors in Melbourne's outer southeast, north and west as well as inner Melbourne, expected to contribute approximately two-thirds of the population increase. Over three-quarters of the projected increase in employment is forecast to occur in the inner and middle regions."*

The *Public Transport Barometer Report*[3] released in 2018 by the Tourism and Transport Forum Australia found:

> *"Rising congestion is estimated to be costing Australian cities $16.5 billion per year ($6b in private time costs, $8b in business time, $1.5b in extra vehicle operations and $1b in added air pollution costs).*
>
> *Melbourne bus patronage has fallen significantly due to congestion leading to slow travel times.*
>
> *Gridlock is adding an extra 34 minutes of average daily commute time in Melbourne".*

Research on *Life in the Commuter Belt* by Price Waterhouse Coopers for "The Australian" newspaper[4] found:

> *"Melbourne had reached a critical point where a range of factors was putting upward pressure on travel time.*

[2] *Managing Transport Demand Research Program,* KPMG/Arup Infrastructure for Infrastructure Victoria
[3] *Public Transport Barometer Report*
[4] "*Life in the Commuter Belt*" by Price Waterhouse Coopers for "The Australian" newspaper[4] *(Source: The Australian 12/10/2017-*

Studies in other Australian cities have found that people who do not have to travel long hours to and from work are more likely to seek medical advice, eat fresh food and vegetables, spend time with their family and spend money in the local community.

Melbourne was designed well for a city of 2 or 3 million people with a radial transport network feeding into the CBD, but the limits to that design are becoming evident with current massive growth."

The report recommended developing a series of polycentric clusters or mini CBDs around the metropolitan area to distribute jobs and medium density living but noted these would only work with effective public transport.

A *Liveability Snapshot* released in Sept 2017 by *Interface Councils*[5] found growing pockets of inequity were developing on the outskirts of Melbourne, with unemployment, obesity, family violence, education and youth unemployment issues on the rise. It noted that:

"More than 40% of interface LGA residents do not live near public transport.
20% spend more than two hours commuting every day.
Almost 75% are completely car dependent.
Unemployment in these areas at 6.9% was the highest in the State and 11% above the State average".

The Monash University Public Transport Research Group[6] identified that public transport service provision per capita had been declining rapidly in Melbourne since 2011-12 as city infrastructure failed to keep pace with population growth. It was predicted:

"Melbourne will have an extra five hours of peak traffic by 2030 unless the current congestion crisis is fixed.
Drivers would spend 20% more time sitting in traffic than they do now.
The daily distances people have to travel in the outer suburbs will grow by 25%.
Trains running through the new Metro tunnel will be at capacity by 2030, just five years after completion.

Melbourne has lost its world's most liveable city status. Transport deficiencies, unprecedented road congestion and afternoon traffic peak now lasting 3.75 hours are seen as significant elements in this loss of status.

The Melbourne tram network has speeds in the lowest 20% of the world's tram networks; and overcrowding and vehicle congestion are causing trams to spend 17% of their time stopped at traffic lights".

The *Future of the West: Investing in Melbourne's Newest Generation* released in June 2018 by *LeadWest*[7], found that:

Less than 3% of the West's workers relied on trains or trams to get to work.
Nearly 70% of the West's workers do not have frequent weekday services within walking distance of their house.
Failure to invest in high quality public transport now will simply result in unnecessary diversion of public funds into roads, entrenching disadvantage and gridlock."

It is evident that Rail Futures is not alone in highlighting the transport challenges facing Melbourne. There is growing consensus that Melbourne is at a critical stage of its development where substantial added investment in public transport infrastructure and services must be given priority for the city to function effectively.

[5] *Liveable Communities – Interface Councils Liveability Snapshot Indices, September* 2017 by *Interface Councils.* Interface Councils are the 10 municipalities that form a ring around Metropolitan Melbourne, housing 1.6 million residents.

[6] Source: Government News 06/07/2018.

[7] http://www.leadwest.com.au/files/files/666_The_Future is West LeadWest Report

2. Current Planning Policy

2.1 Overview

- The *State Planning Policy Framework* (SPPF) and *Plan Melbourne 2017-2050* provide the framework for land use planning in metropolitan Melbourne.
- While policies speak of rebalancing growth from Melbourne to regional Victoria, population projections are that by 2050 Melbourne will contain an even higher proportion of the State's population.
- Key elements of *Plan Melbourne 2017-2050* are to recognise the primacy of the central city, expand central Melbourne with major urban renewal precincts, re-shape greater Melbourne from a monocentric to a polycentric city, continue extensive outer urban corridor development and maintain urban intensification across the established metropolitan area.
- Intensification of polycentric development in national employment and innovation clusters (NEICs) and activity centres has major unaddressed transport implications; some of the largest are not served by rail and have poor accessibility.
- Apart from zoning, no mechanisms are offered to attract employment to clusters and activity centres to provide greater job accessibility.
- While planning policy encourages residential intensification near public transport, retail policy is weak resulting in proliferation of car-based centres and ever-increasing demand for car-based travel.
- Continuing large-scale outer urban growth has serious implications for the transport system. Most new outer urban growth is occurring in areas without adequate or planned provision of public transport.
- Outdated planning provisions continue to institutionalise car dependency through mechanisms such as mandated minimum car parking provisions and a focus on car access over other forms of mobility.
- Growth corridor precinct structure plans (PSPs) perpetuate the pattern of car-based, relatively low-density detached housing separated from retail and services with little local employment, mostly in areas not easily accessible to the metropolitan rail system or on lines served only by regional (V/Line) trains.
- Without change in policy direction, the growth of car-based outer urban development will further isolate the 1.5 million new residents from employment opportunities and access to services condemning them to ongoing car dependency on increasingly congested roads.

2.2 Plan Melbourne 2017-2050

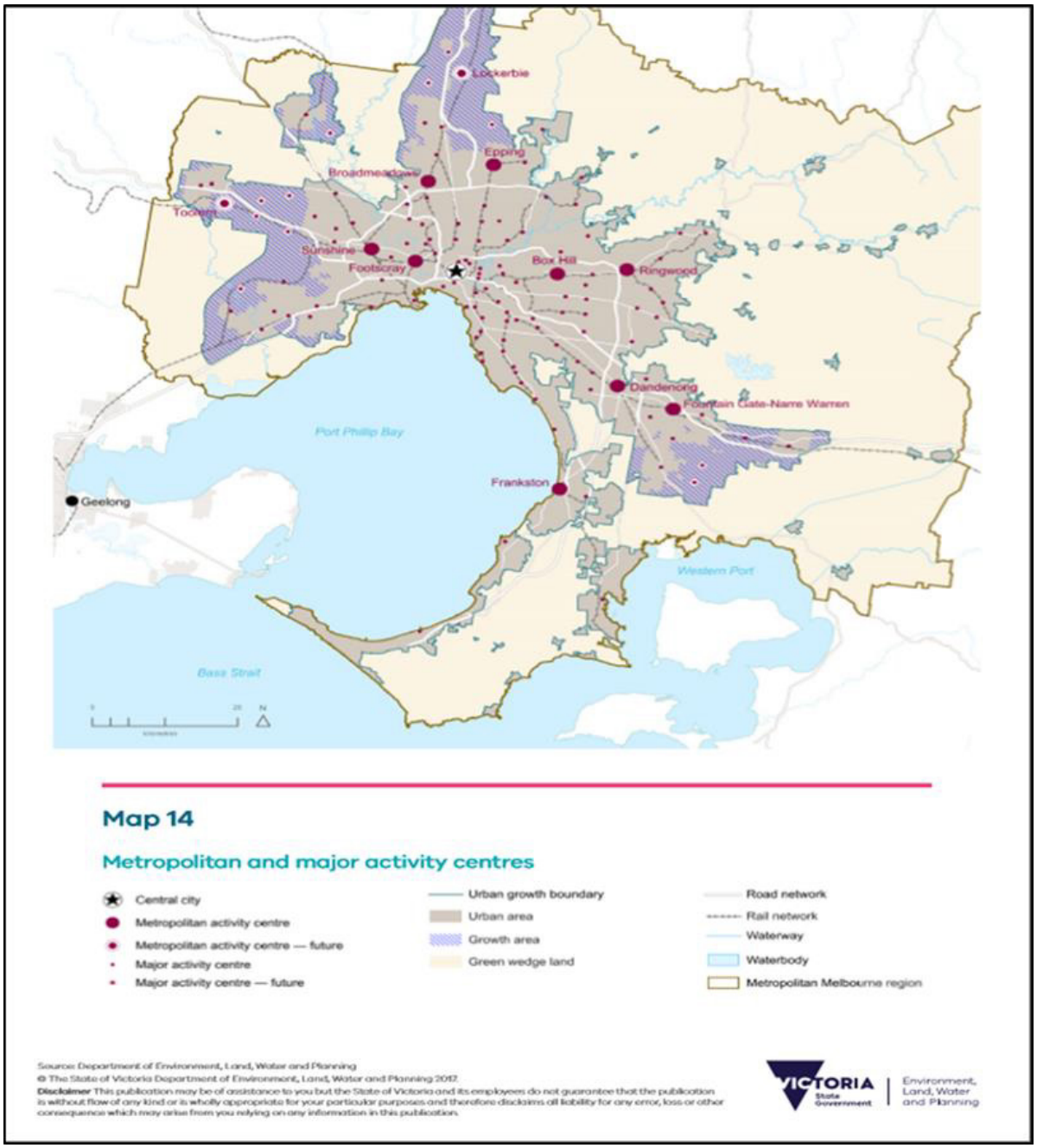
2.2.1 Key Features

Plan Melbourne 2017-2050 is a long-term metropolitan strategic plan to respond to the challenges and opportunities Melbourne faces between now and 2050. It is intended to provide continuity, clarity and certainty for communities, businesses and governments by guiding planners, councils, developers and the Victorian Civil and Administrative Tribunal (VCAT). It purports to be a long-term 35-year vision with a tangible implementation plan to ensure Melbourne remains sustainable, productive and liveable as its population approaches 8 million.

Key features in *Plan Melbourne 2017-2050* are:

- a strategy to focus investment and growth in places of State significance, including central Melbourne and metropolitan Melbourne's key centres and precincts, as well as 10 major regional cities
- support for the primacy of the central city as a commercial, retail and residential hub. This centrality will be strengthened by progressive development of major infill precincts around the central city and by market-based concentration of employment in advanced business services, new technology industries and the professions in the City of Melbourne and in the inner and middle ring suburbs
- a proposal to change Melbourne from a monocentric to a polycentric city through *"National Employment and Innovation Clusters"*, (NEICs), a network of metropolitan and major activity centres and links to regional Victoria
- adoption of a hierarchy of importance in nominating centre locations, identifying seven *NEICs*, nine *Metropolitan Activity Centres* and 112 *Major Activity Centres*. (Figure 5).

Figure 5: Map showing Growth and Major Activity Centres



Source: *Plan Melbourne 2017-2050*

2.2.2 Transport Proposals in Plan Melbourne 2017-2050

Plan Melbourne 2017-2050's discussion of public transport is limited to generalised statements of intent coupled with a listing of projects already underway and due for completion in the short term. For example, it is stated[8]:

"Melbourne needs an integrated 21st-century transport system to connect people to jobs and services. Creating an integrated transport system will require:

- *the completion of the Metro Tunnel project*
- *the removal of level crossings across Melbourne's suburbs*
- *better transport infrastructure and services in newer suburbs - including new bus services for outer suburbs and, where there is sufficient demand, expansions to the rail network*

Under the headings of "Directions and Policies" the Plan includes the following policies:

[8] *Plan Melbourne 2017-2050 Summary Outcome 3*

Transform Melbourne's transport system to support a productive city

- *Create a metro-style rail system with 'turn up and go' frequency and reliability*
- *Provide high-quality public transport access to job-rich areas*
- *Improve arterial road connections across Melbourne for all road users*
- *Provide guidance and certainty for land use and transport development through the Principal Public Transport Network and the Principal Freight Network*
- *Improve the efficiency of the motorway network*
- *Improve outer-suburban public transport*
- *Support cycling for commuting*

Improve transport in Melbourne's outer suburbs[9]

- *Improve roads in growth areas and outer suburbs*
- *Improve outer suburban public transport*

Improve local travel options to support 20-minute neighbourhoods

- *Create pedestrian friendly neighbourhoods*
- *Create a network of cycling links for local trips*
- *Improve local transport choices*
- *Locate schools and other regional facilities near existing public transport and provide safe working and cycling routes and drop off areas*

Plan Melbourne 2017-2050 does not include any comprehensive public transport plan looking forward over its projected life. The principal rail project in *Plan Melbourne 2017-2050* (see Figure 6 below) is Melbourne Metro (MM1) which is due for completion in 2025. The others listed are "catch up" infrastructure enhancements that will add capacity to parts of the train system by 2020. They are responding to demand growth from CBD and suburban development that in most cases has already occurred.

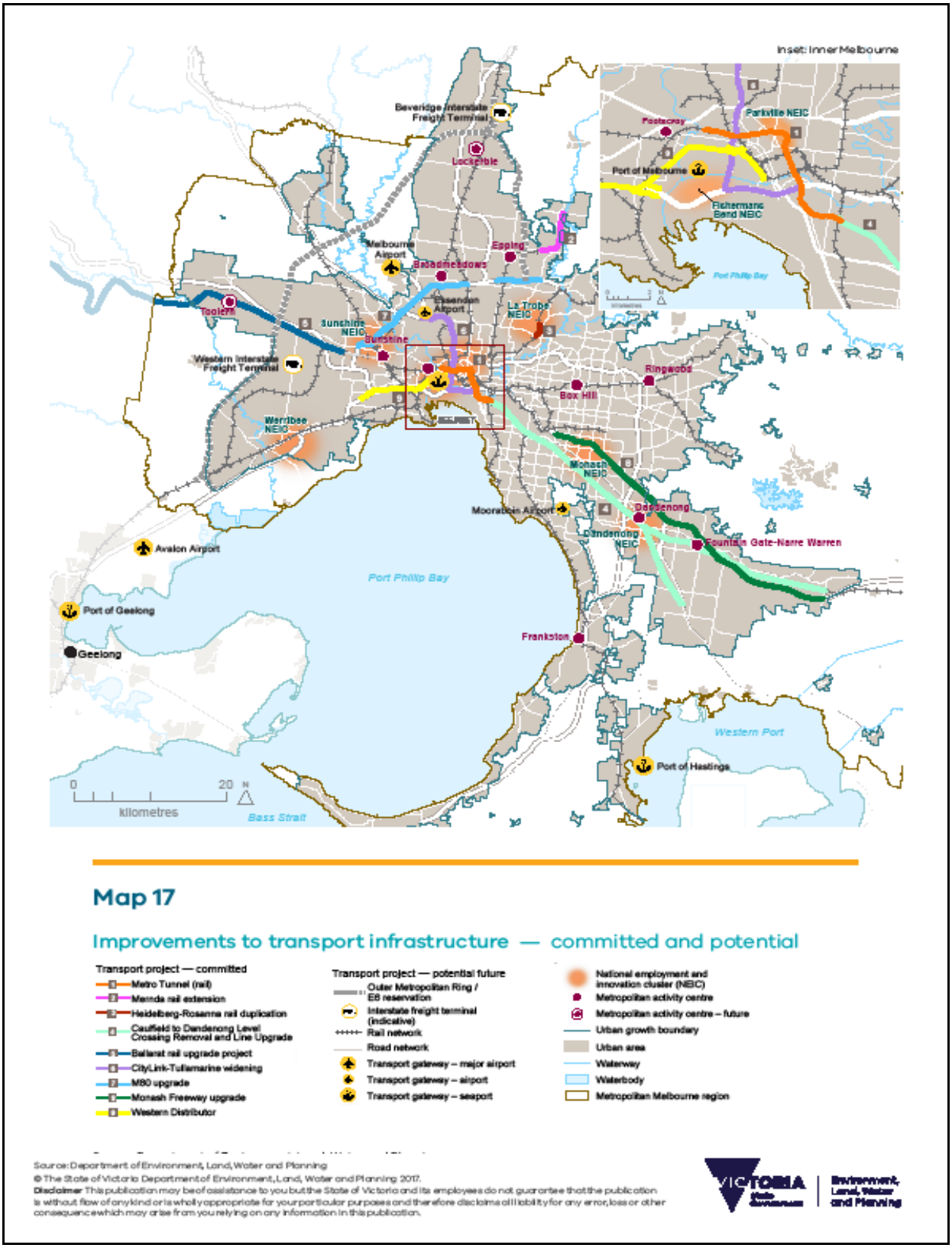
Furthermore, except for MM1, the only current and proposed large scale transport projects are for major roads such as the West Gate Tunnel, the North-East Link, widening of the Tullamarine Freeway and upgrading of the Monash Freeway and Western Ring Road (M80). These are significant city-shaping projects that will make Melbourne a less sustainable city and further entrench car dependency.

Concept image of proposed Anzac Station and tram interchange on the Melbourne Metro (MM1) project
Source*: Rail Projects Victoria*

[9] *Plan Melbourne 2017-2050 Summary Outcome 3*

Specific land use and associated transport issues associated with meeting the transport objectives in *Plan Melbourne 2017-2050* are shown in Figure 6 below.

Figure 6: Transport Projects in Plan Melbourne 2017-2050



Source: *Plan Melbourne 2017-2050 (http://www.planmelbourne.vic.gov.au/maps)*

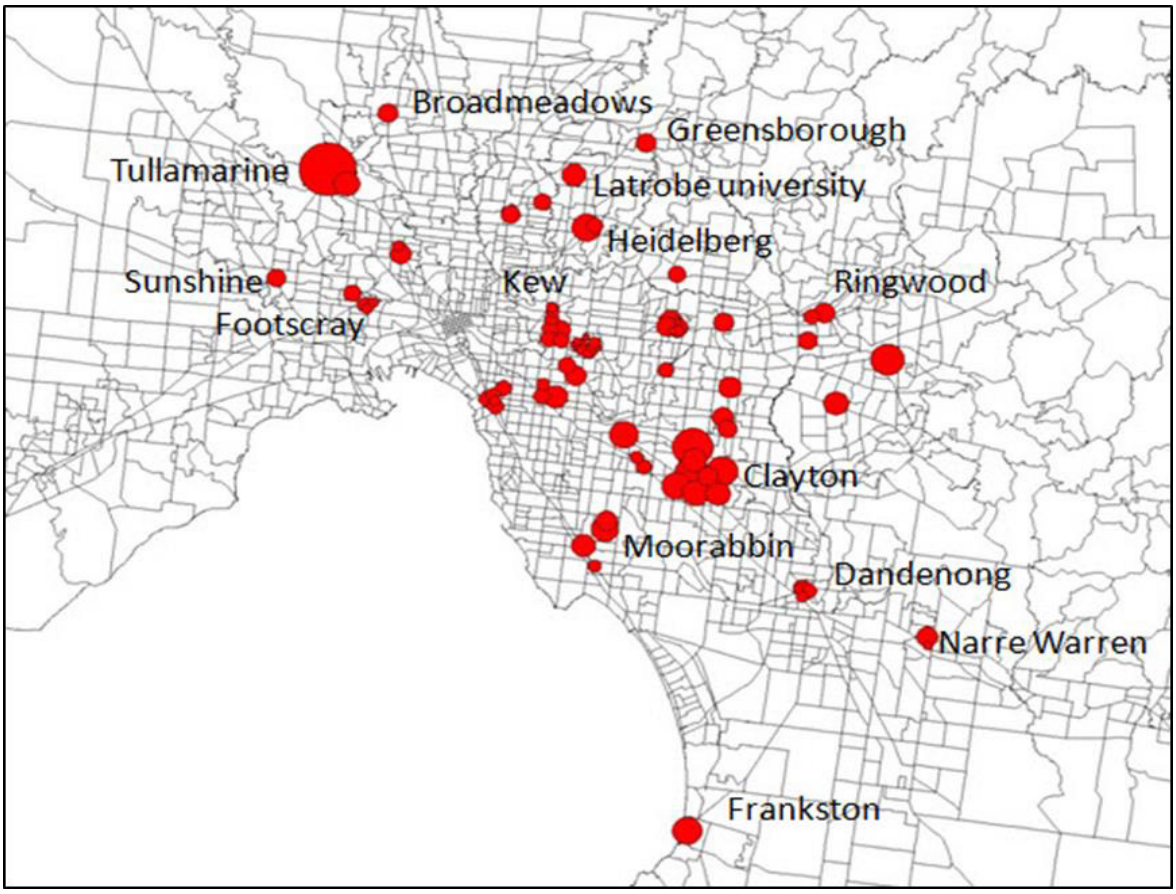
2.2.3 The Polycentric City

There is a need to serve not only the CBD but also create fast and frequent connections between bus, tram and train lines to link the most significant origins and destinations across the metropolitan area with travel times that compete with the car. The Victorian Government's announcement to commence planning for a "Suburban Rail Loop"[10] recognises the need for significant improvement in non-radial public transport in Melbourne, however this proposal, notwithstanding its massive cost, falls well short of Melbourne's overall cross suburban travel needs. These issues are addressed later in this RFI Plan (see Part 3).

Intensification of development in all Activity Centres has major implications for metropolitan transport. Some are positioned on radial rail or tram routes, but even without intensification, many are not served adequately by public transport. Three NEICs (La Trobe, Werribee East and Monash), 27 Major Activity Centres and 9 Future Major Activity Centres and Melbourne Airport - are not directly accessible from the current rail system, and most are not accessible by tram.

MM1, currently under construction, will provide the opportunity for journeys from Sunshine to Dandenong along a route connecting 4 NEICs and 3 metropolitan activity centres. However, the Monash NEIC, one of the most important, is located away from this link. While Melbourne Airport is not designated a NEIC, it has a larger workforce than any NEIC other than Monash. It is very poorly served by public transport. Public transport has a key role in serving not only NEICs but all centres with high concentrations of jobs. (Figure 7). This includes areas with potential for development of future industry technologies, such as between Brooklyn and Altona.

Figure 7: Concentration of Jobs across Suburban Melbourne (excluding CBD)



Source: *The Melbourne Urbanist / Crikey.com*

This polycentric pattern in Melbourne differs from many North American cities, which tend to locate mixed-use activity centres on freeway and arterial road networks with much lower provision of rail-based public transport. Melbourne's pattern also differs significantly from European polycentric cities, where activity nodes are generally served with high-capacity rail-based public transport. Even many relatively modest-sized European and British cities, with smaller populations than many of Melbourne's middle and outer suburban Local Government Areas, are well served by trams or light rail.

[10] *"Underground Suburban Rail Loop to connect Victoria"* – media release by Hon. Daniel Andrews, Premier of Victoria, 28 August 2018.

Residential and employment intensification in many of Melbourne's suburban employment and activity centres will reinforce access difficulties with continued reliance on car-based travel. Malls and "big-box" retail centres have now captured almost 50% of Melbourne retailing. These centres are diversifying their activities to include entertainment, large-scale office, hotel and residential uses. Since almost all such centres depend entirely on the road network, this intensification will substantially increase road traffic movements and increasingly deny access to non-car uses unless alternative, transit-oriented modes of access are provided.

Plan Melbourne 2017-2050 needs to provide much greater clarity on how the concept of a polycentric city will be delivered. Activity Centres and NEICs need to be linked by a network of high-capacity public transport corridors allowing both radial and orbital movement between centres. This network will attract higher development intensity and offer new residents and businesses far greater locational choices and the connectivity needed for productivity, innovation and liveability.

Plan Melbourne 2017-2050 does not discuss whether the inner urban and central city concentrations of high value employment should be altered and to what extent and how this concentration could be varied.

Plan Melbourne 2017-2050 largely ignores the potential of integrating metropolitan growth with regional centre growth and employment connected to Melbourne through fast rail. It assumes that over 83% of State growth will occur in an expanded metropolitan area. Population projections do not assume any policies to divert growth from Melbourne to regional Victoria. In *Plan Melbourne 2017-2050*, little differentiation is made at metropolitan level between inner, middle and outer areas and their relative settlement pattern advantages despite their significance.

2.2.4 Outer Urban Growth Areas

Plan Melbourne 2017-2050 assumes that the designation of outer urban employment precincts will lead to high value employment locating there. However, it does not identify employment types to be sought more generally in outer suburban areas but assumes that zoning for business and industry will lead to job creation.

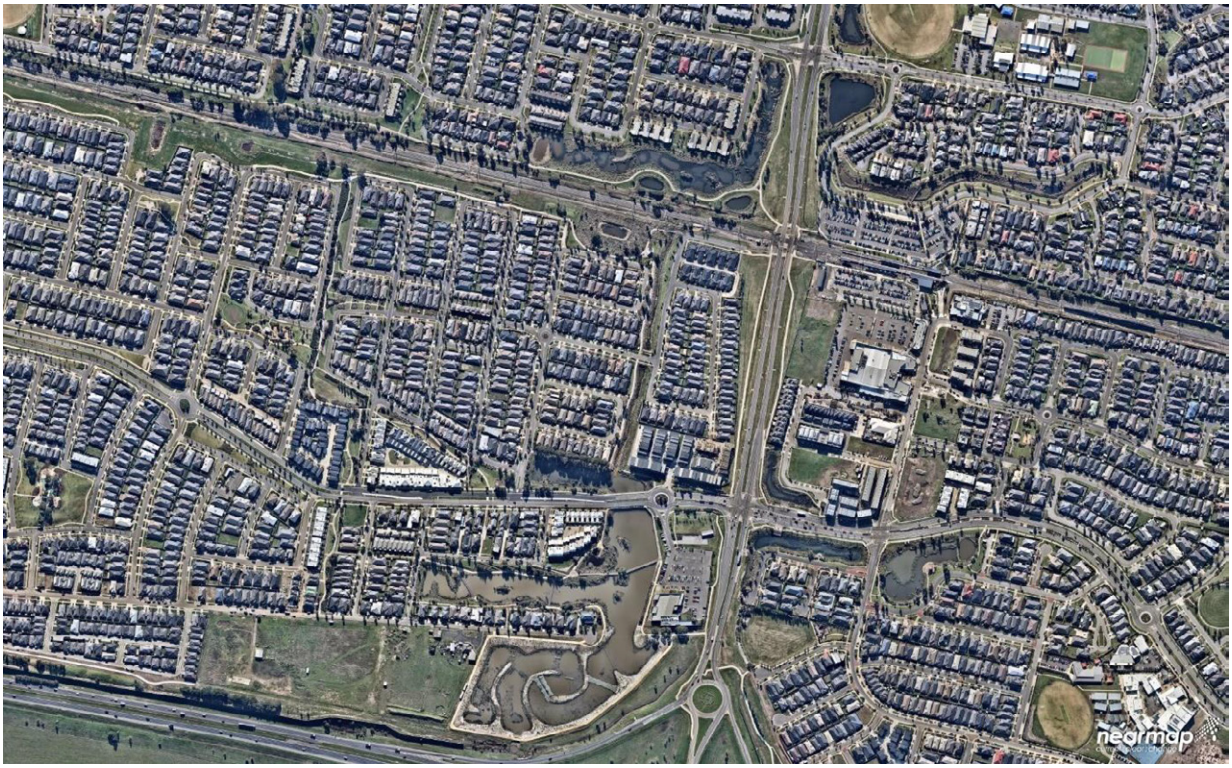
Continuing large-scale outer urban growth has serious implications for the transport system. Most new outer urban growth is occurring in areas without adequate public transport provided or planned. *Precinct Structure Plans (PSPs)* are frequently not integrated with transport planning in ways that would have land use designed for efficient public transport supply and ensure early provision of public transport consistent with the pace of development. PSPs are being approved for outer suburbs to provide a large outer urban land supply. These plans cover large areas of land usually located far from the metropolitan rail system and, where a rail service exists, this is often a V/Line service not designed to provide mass transportation for suburban passengers.

Regional V/Line trains are being overwhelmed by passengers from suburban stations on non-electrified corridors
Photo: *Bob Wilson*

PSPs generally continue an established pattern of low-density detached housing separated from retail and services and with little local employment. The retailing and services indicated on previous PSPs are often arranged in ways that are difficult to access from rail. Nor were they planned around the provision of buses at the outset, making it difficult to retrofit effective transport services once suburbs are constructed. As an example, Caroline Springs town centre is well-designed with good urban amenity but the nearest rail service is over 3 km away at a station of that name located in the adjoining suburb of Ravenhall.

Many new suburbs being developed are car-based, reliant on roads for both internal and external travel. Although densities in more recent developments are higher than in the past, increases are modest and still relatively low. Net residential densities are about 16 dwellings per hectare dominated by large detached residences but with minimal outside space. The more recent aim has been 18 dwellings per hectare, but only 10 dwellings per hectare gross residential density. This is one of the world's lowest.

An increased average density of a modest 20 dwellings per hectare in new growth corridors – still low by international standards – would accommodate 61% more dwellings on only 45% of the land required for a continuation of business-as-usual practice and make provision of public transport more economical. RFI recommends modification to the prevailing type of outer urban development, with specifications for subdivisions containing a wide range of denser, walkable, energy efficient housing types and sizes, integrated with high quality transport and other urban services.



Typical development in an outer urban growth area – Cardinia in Melbourne's south east
Photo: *Nearmap*

This urban form model of intensified high-density inner areas coupled with dispersed service poor, low density outer suburbs has serious implications for Melbourne's successful future functioning and social integration. Disadvantage is spatially located. That is, the services, access and opportunity in some locations are vastly superior to those in other areas. Higher-income, tertiary-educated, professionally employed households are now concentrated in inner and middle ring suburbs, and selected outer urban areas, while lower income households without tertiary qualifications are concentrated primarily in outer urban areas. Radically different types of urban form coupled with unequal transport provision between areas are associated with increasing social differences between inner and outer urban areas. For example, transport costs are now the second highest costs for many low income outer urban households.

As Infrastructure Australia has observed,

> *"Inadequate access to public transport and poor service levels are important drivers of disadvantage for people in outer urban areas. These conditions can have a tangible impact on the quality of life and*

prosperity of these communities by limiting access to employment, education and other social infrastructure within reasonable travel time. As a result, people residing in these areas have become more reliant on private vehicles. Subsequently, they pay more for operating their vehicles and have less money to spend on other household expenses[11]".

The outer areas of Melbourne comprise 88% of Melbourne's area and 47% of the population and rail-based PT cover is a very meagre 4% of this area. Without a change of policy direction there is every reason to suppose that the concentration on such massive car-based outer urban development will further isolate the planned 1.5 million new residents to be located there from employment opportunities and condemn them to ongoing car dependency on increasingly congested roads.

2.2.5 Urban Infill

The facilitation of urban intensification anywhere across the metropolitan area is also leading to extensive lot-by-lot redevelopment of land often distant from public transport, even in established suburbs. This policy is particularly problematic, as increasing densities in established suburbs not well served by public transport will lead to significant further road congestion. The mechanism in *Plan Melbourne 2017-2050* for identifying appropriate infill in established suburbs is to identify areas of minimal, incremental and high change residential development. However, this policy does not adequately integrate higher levels of residential development with access to adequate public transport, or with a plan to provide public transport to such areas.

As an example, development around the existing tram network is proof of the feasibility of transit-oriented development within a Melbourne context, however these developments are limited to inner Melbourne. Their popularity is also now resulting in stress being placed on the tram network in some places (particularly the busiest routes in the northern suburbs) and indicates the need to upgrade services to cater for rising demand. *Plan Melbourne 2017-2050's* proposal for extensive urban infill would seem to be compatible with the principles of a compact city and increased public transport use. However, the plan's failure to examine issues and propose detailed solutions leaves much unresolved. Urban land consolidation should be correlated with new and existing corridors.

In recent years, approximately 18,000 new dwellings have been constructed in each of three areas: Central Business District/inner urban area, middle ring and some other established suburbs, and new growth corridors. However, the model of urban form varies considerably between the high-rise apartments of the CBD and surrounds, lower rise apartments and townhouses of middle ring suburbs, and low-density housing in growth corridors. Significant infill is occurring in middle ring and some established suburbs. Townhouses and apartments 1-3 stories in these suburbs increased from 4,000 in 2005 to 11,000 in 2017, while new high-rise apartments in middle ring suburbs rose from 600 in 2005 to 9,000 in 2015 and 7,500 in 2017.

Much of the redevelopment of the inner and middle ring suburbs is occurring in the commercial and mixed-use zone, rising from 30% of new dwellings in 2005-2010 to 50% in 2011-2016. The amount of redevelopment in the Commercial 1 zone in the inner and middle ring suburbs is equivalent to the total amount of high-rise development in the Capital City and Docklands zones. The scale of this inner and middle ring suburban redevelopment has been largely ignored but has important implications for public transport use.

The lack of density and height controls in non-residential zones and the allowance of medium density development in residential zones will facilitate significant unplanned and incremental dwelling concentrations. Much new development is serviced by the tram network but is often linear, extending along arterial and tram routes, leading potentially to significant cross-town car use and increased pressure on radial routes, and now particularly evident on the tram network.

Apartment location is determined by accessibility to advanced business services, professional, research and educational employment and education centres. However, apartments are relatively expensive and reinforce Melbourne's social division. *Plan Melbourne 2017-2050* ignores the implications of the type, location and scale of urban infill, and does not specify preferred urban form for different areas of the city, or how to achieve desired building types matched to locations. It omits any reference to high-rise development, car-based shopping malls and "big box" retail centres. Instead it transfers such a strategic vision for infill to a deregulated planning system which is intended to facilitate industry selection of development sites and building type. The plan proposes further urban concentration in activity centres requiring greater flexibility in planning controls.

[11] "*Outer Urban Public Transport – Improving accessibility in lower density areas*", Infrastructure Australia Reform Series, October 2018.

Such concentration at nominated densities in a limited number of public transport hubs may lead to increased public transport use. However, without substantial additions to cross-suburban public transport for travel between these intensifying suburban centres, cross suburban car use will also increase. Undifferentiated increased densities in 120 activity clusters and centres often poorly connected to each other and sometimes only via road-based transport is certain to lead to substantial further road use and congestion.

2.2.6 Retail Centres

Plan Melbourne 2017-2050 transfers retail policy to a deregulated statutory system which facilitates dispersed malls and stand-alone retailing. The emphasis on creating a city of 20-minute neighbourhoods close to services, jobs and public transport is laudable but lacks explanation as to how it can be achieved. Much of Melbourne is not located within 20 minutes travel by walking or public transport to centres with a broad range of retail activities.

The lack of firm policy to direct retail development into locations well-serviced by public transport, coupled with the proliferation of "out of centre" retailing, undermines the policy of encouraging higher residential densities near public transport. The aim of intensifying population in traditional centres will concentrate people in mixed-use centres usually far from retail outlets, necessitating longer distance travel to car-based dispersed retail centres, and increasing reliance on car-based travel for shopping. This is a planning policy failure.

2.2.7 Jobs

Plan Melbourne 2017-2050 recognises the CBD including adjacent city areas as appropriate for high job concentrations. Separately, NEICs are also recognised. Beyond this recognition, sound strategy supported by jobs growth trends and modelling should demonstrate where, when and in what sectors jobs would grow, with transport infrastructure. Whilst urbanisation and land planning can facilitate jobs and population growth, fully integrated land use and transport planning with less car dependence will drive a more productive city.

2.3 Transport Integration Act 2010 (TIA)

The lack of long-term integrated transport planning and the disconnect between policy and implementation are at odds with the fundamental aims of the *Transport Integration Act 2010 (TIA)* to reduce reliance on private cars and alleviate the need for extended commuting travel. The TIA is Victoria's principal transport statute. It aims to provide a common set of objectives and decision-making principles by which all transport and land use agencies work together towards an integrated and sustainable transport system. In practice however, the TIA provisions have been largely disregarded by successive governments.

PART 02 DESCRIBES MELBOURNE'S PUBLIC TRANSPORT AND SETS THE CONTEXT FOR DEVELOPING THE MELBOURNE RAIL PLAN.

PART 02

MELBOURNE'S TRANSPORT STORY

» SECTION 03
Describes Melbourne's current public transport services.

» SECTION 04
Describes the challenges and opportunities.

3. Melbourne's Public Transport

3.1 Overview

Historically, Melbourne has been blessed with extensive rail systems envied by many world cities.

Electrified heavy rail fans out from the city core connecting its urbanised area. Melbourne has one of the world's largest tram networks serving its inner and middle suburbs. The rail-based modes are complemented by a mixture of bus services, and flexible taxi and "Uber" style services. Car travel and active transport (walking and cycling) complete the total transport mix.

While rail modes are the primary focus of this plan, RFI acknowledges the essential role of both scheduled and "on-demand" bus services in a comprehensive and fully integrated system. Also recognised is the importance of active personal transport – walking and cycling in their own right, but also playing a far greater role in providing access to the public transport network. RFI also acknowledges that the use of motor vehicles will always be a feature of Melbourne's transport mix but if growth in traffic is left unchecked, it will threaten Melbourne's future as a sustainable and liveable city.

3.1.1 Mode Share

Victorian Integrated Survey of Travel and Activity (VISTA), 2013 found that the weekday shares of travel for all purposes in 2012-13 were as shown in Table 2

Table 2: Weekday Mode Shares

Mode	All Trips	Motorised Trips
Private Vehicle	72%	88%
Public Transport	9%	11%
Active Transport	18%	N/A
Other	1%	1%

Source: *Victorian Department of Economic Development, Jobs, Transport and Resources, Victorian integrated survey of travel and activity (VISTA), 2013*

3.1.2 Journey to Work

For journeys to work, the public transport (PT) mode share is higher. ABS census data of 2006, 2011 and 2016 reveals a more than 70% increase in the number of people using public transport for their commute to work over the last decade alone.

In Greater Melbourne, public transport share for journeys to work increased from 14% to 16% between 2011 and 2016. This is equivalent to an additional 67,000 people using some form of public transport to access work. (Table 3). In European countries, typical mode PT share varies from 18% to 59% with typical percentages being in the order of 35% with proportionately lower private car usage.

Table 3: Journey to Work by Public Transport (Daily)

Census Year	Journey to work trips by public transport	% of work trips by public transport
2006	184,137	12.3
2011	250,449	14.5
2016	317,784	16.2

Source: *ABS Census Data 2006, 2011 and 2016*

Residents in Inner Melbourne have a higher public transport mode share, between 25 and 34% (2016). Areas located along the heavy rail network also have a higher proportion of public transport commuting, particularly along the Pakenham and Lilydale / Belgrave train lines.

Key public transport mode share increases between 2011 and 2016 were:

- Docklands and Melbourne experiencing a 10% increase

- West Footscray and Seddon experiencing a 5 to 6% increase
- growth areas to the west and north of Melbourne including Truganina, Wyndham Vale and South Morang experiencing a 5% to 6% increase.

In Melbourne more broadly, there is a correlation between access to train services and increased use of public transport. In areas without immediate access to a train line, public transport use has also increased; suggesting, for example, commuters are switching transport modes, taking a bus or driving to a rail station.

3.1.3 Patronage Growth

Over the last decade, annual patronage of trains and trams in Melbourne has risen by 118 million, (an increase of 40% since 2008). This has been driven largely by strong jobs growth in central Melbourne and population growth in inner suburbs as well as growth corridors to the north, west and south–east.

Over the last 5 years the total patronage on trains, trams and buses has increased by 7.8%. (Figure 8) with train patronage increasing 6.8%, tram patronage 12.9% and bus patronage 1.8%. However, between 2013/14 and 2017/18 bus patronage has decreased by 7.7%. Figure 9 shows the patronage for each mode between 2012/13 and 2017/18.

Figure 8: Total Public Transport Patronage 2012/13 to 2017/18

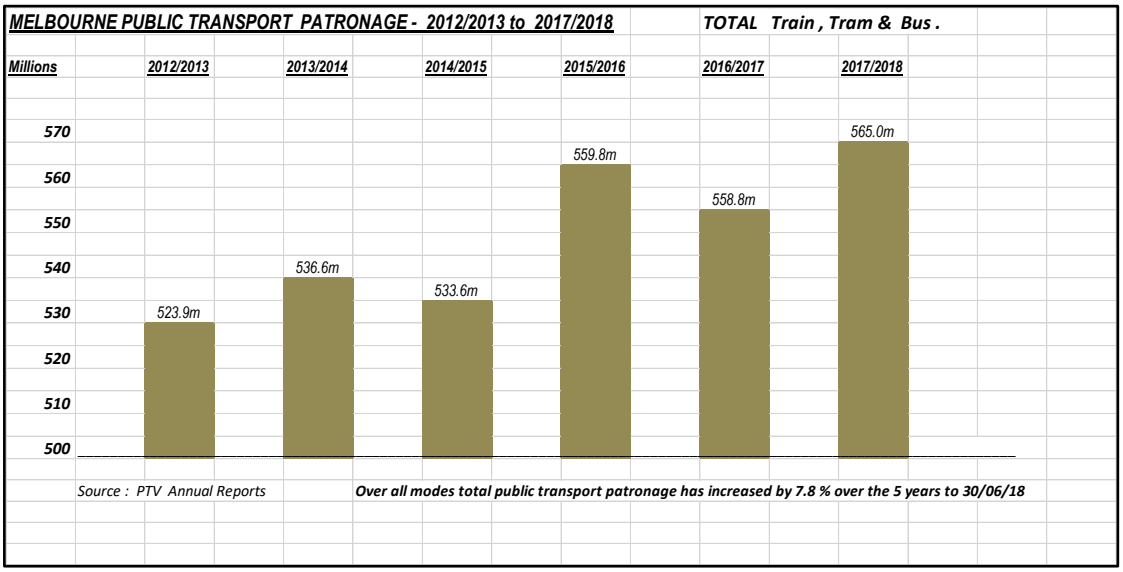
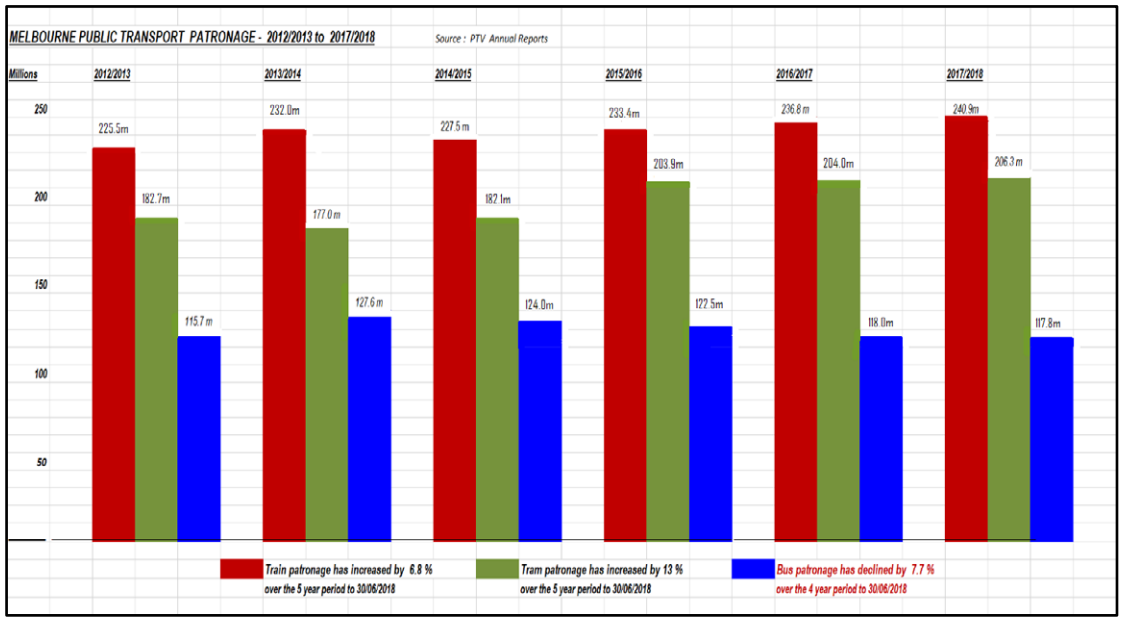


Figure 9: Public Transport Patronage by Mode in Melbourne 2012/13 to 2017/18



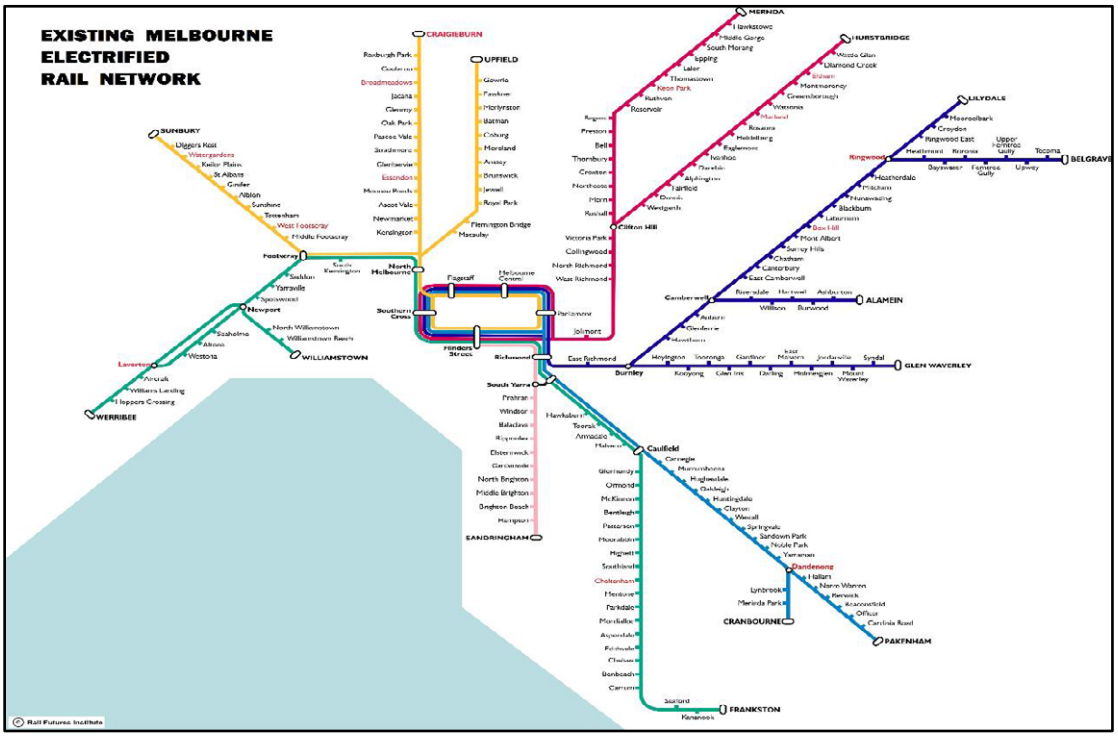
3.2 The Heavy Rail Network

Todays' train system is largely a legacy of the 19th century when Melbourne's population was less than one million and places such as Ringwood, Dandenong and Werribee were not urban centres but country towns. Most lines were electrified by the 1920s to serve a "suburbanised" population of around 1.5 million. The network has since remained relatively unaltered apart from construction of the Glen Waverley line (1931), post-war suburban train extensions to Werribee, Laverton (via Altona), Upfield, Alamein, Belgrave and Pakenham, and relatively recent electric train extensions to Cranbourne, Mernda, Sunbury and Craigieburn. The last major development on the electrified metropolitan rail system was construction of the Melbourne Underground Rail Loop (MURL) which opened progressively between 1981 to 1985.

Melbourne's train network plays a key role in the city's total transport system particularly as a radial network to the Central Business District (CBD). Key characteristics:

- The electrified train network now extends some 372 route km on 16 separate routes, with 218 stations and a fleet of around 224 trains. The longest route is to Pakenham (58 km) and the shortest are to Alamein (15 km) and Williamstown (16 km) (Figure 10).
- The network serves a walking catchment of about 600 square km based on a 400m walk up catchment either side of the corridor. Surprisingly the walking catchment is only about 7% of Melbourne's area.
- The average length of train journeys is approximately 18 km.
- The average distance between stops is 1.8 km.
- Current trains operate in 6-carriage consists and each has nominal capacity of 900 passengers, of which around 45% have seats, the remainder being standees.
- Much of the network is operating at capacity or near capacity during weekday peak periods, in relation to its ability to accommodate additional train services. The inner core of the network, extending from Richmond and Jolimont to North Melbourne via the City Loop and Flinders Street is effectively full at peak periods with 18 to 22 trains per hour per direction on the main trunk corridors.
- Average operational speed over the network is 31-40 km/hr. Higher speeds are achieved in outer sections where the line speed is between 80 and 115 km/h. Closer to the CBD, trains typically run at an average speed of less than 30 km/h.
- The system has a large focus on journeys to work in the CBD with pronounced peak orientation.

Figure 10: Existing Melbourne Electrified Rail Network



Beyond the electrified area, some of Melbourne's outer growth suburbs are presently served by V/Line diesel regional trains, the principal examples being Tarneit/Wyndham Vale, Caroline Springs/Melton, Donnybrook/Wallan and Hastings/Stony Point. Electrification will be progressively extended to serve most of these lines, bringing the electrified route network to around 440 km.

Electric Trains operating on Melbourne's Suburban Network

X'Trapolis train – over 100 train sets of this type have been delivered since 2003, with more on order
Photo: courtesy *Alstom Australia*

Comeng train – 95 trains delivered between 1981 and 1990 will be progressively retired over the next 15 years
Photo: *Bob Wilson*

Siemens Nexas train – 36 trains of this type entered service between 2002 and 2005
Photo: *Bob Wilson*

3.3 The Tram Network

Melbourne's tram system is an iconic part of the city's identity and plays a key role in the city's total transport system, particularly in inner and middle suburbs. Much of the network was laid out between the 1880s and the 1920s and unlike many other cities, Melbourne retained most of its tram routes. However, it has remained relatively unaltered since the mid-1950s apart from recent extensions to Box Hill, Bundoora, Vermont South and into the Docklands area and conversion of the St Kilda and Port Melbourne heavy rail lines. Biased towards the inner suburbs, it does not serve well the western and north-western suburbs, several newer activity centres or other growth areas. Also, many major activity centres have since emerged in suburbs which are not served by tram or train such as Chadstone, Doncaster, Monash University and Melbourne Airport.

Although Melbourne is renowned for its trams, only 2.8% of the Melbourne Metropolitan area and about 22% of the population is served by the tram network within a 400m walk up catchment.

Having developed independently, the tram network has relatively poor connectivity with the train network.

If it were possible to build the existing tram network in today's environment, its construction cost would exceed $55 billion.

Trams play a vital role in the city's transport system and provide access to 34% of all jobs in Metropolitan Melbourne. In 2017/18 tram patronage (by boardings) equalled 86% of the total patronage carried by Melbourne's heavy rail network.

Tram travel primarily has a focus on CBD and inner suburbs movement and plays an important role distributing people around the inner city and its surrounds – as trips in their own right or transfers from CBD train stations.

Currently, individual tram routes typically perform three key tasks: suburban travel, CBD access and intra-CBD travel. For example, while the eastern portion of Route 109 to Box Hill operates parallel to a heavy rail line it meets local needs along Whitehorse Road through Kew Junction and along Victoria Street in Richmond and Abbotsford, it has a mass transit role in the designated 'light rail' section from Port Melbourne to the CBD, and distributes people within the CBD.

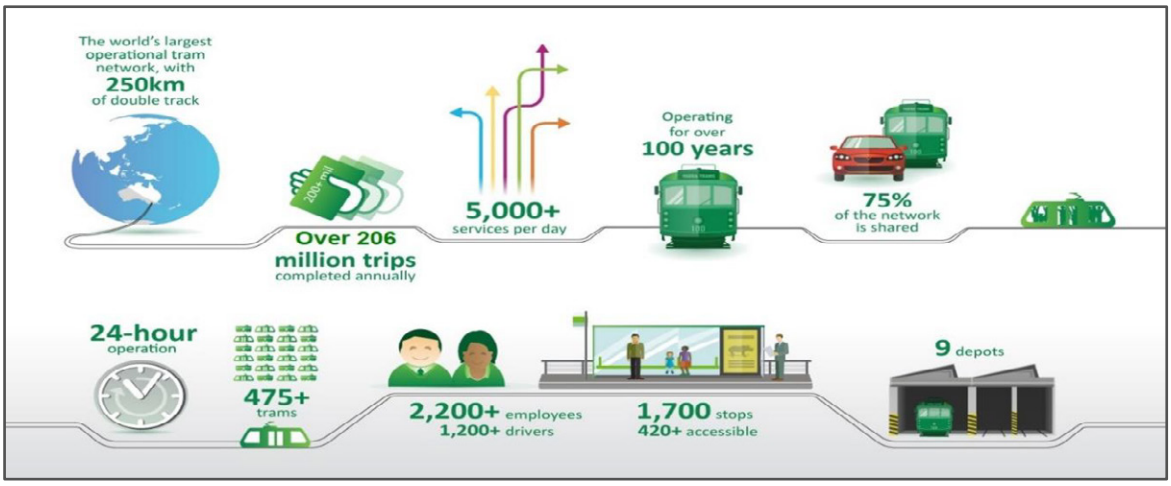
Key characteristics of trams:

- A network that extends some 250 route km on 24 separate routes (including the City Circle tourist service), (Figure 11).
- The network has 1760 designated stops at typically four per km.
- Tram route lengths are generally less than 22 km with routes typically between 12km and 16km.
- About 80% of the total network operates as a 'street transit' system. Only 18% of the network operates in segregated right-of-way (ROW). Over three-quarters of the tram network operates in road space shared with other vehicles (Figure 12).
- A fleet of 506 trams comprising a mixture of vehicle types with passenger carrying capacities varying from 65 to 210 (Figure 13). Of these, 180 (36%) are DDA compliant with low floors and 310 (61%) are air-conditioned. The latest trams carry up to 210 people; more than double the capacity of most trams in the current fleet.
- An average speed of 16 km/h. Higher speeds are achieved in the outer sections of the routes while closer to the city the average speed drops to 11 km/h. Only a few sections meet modern world operating parameters with 30 km/h average speeds.
- Current passenger capacity on most routes is limited to between 750 and 1,300 passengers in each direction per hour, increasing to around 2,100 where the largest trams run. This is at the lower end of international best practice. Route capacity is limited by low capacity vehicles, closely spaced stops, road traffic delays, poor traffic signal priority and lack of separation from road traffic. Many routes have a potential to accommodate 16-20 trams per hour in a uni-directional flow. This equates to a potential passenger capacity of up to 7,200 per hour per single track per direction, or more than 3 times the typical capacity of a single lane of freely moving freeway with average car occupancy of 1.2 persons.
- Average journeys are between 3 and 4 km (longer during peak times) and passenger turnover as much as 5 to 6 times on each trip.

Figure 11: Melbourne's Tram Network

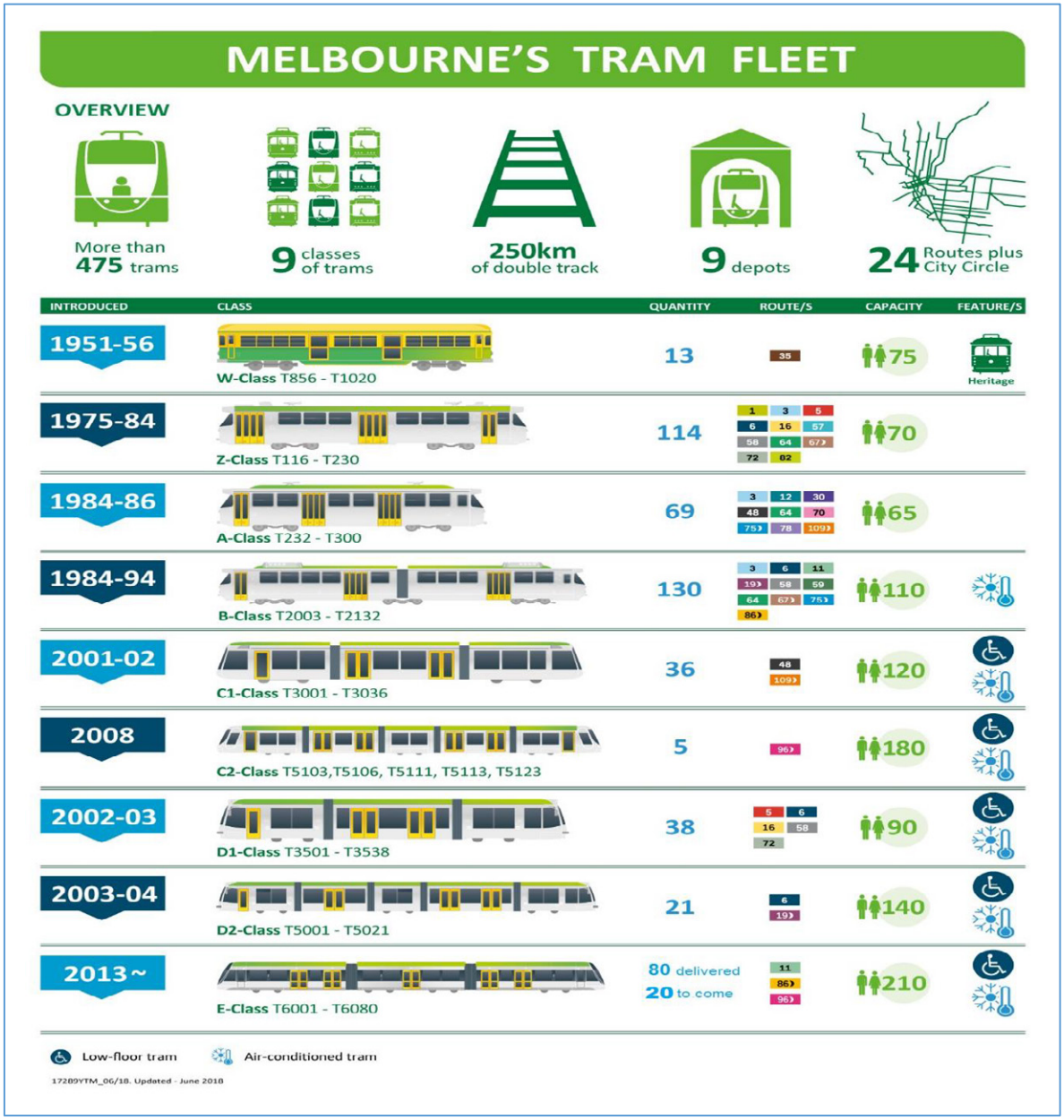
Source*: Public Transport Victoria*

Figure 12: Melbourne Tram Network – Key Facts



Source: Yarra Trams

Figure 13: Types of Trams in Melbourne – 2019



Source*: Yarra Trams*

3.4 Train and Tram Network Coverage

The heavy rail network of about 372 km (830 track km) covers about 600 square km (within 800m of a route). The train network is effectively used by more than 1,000 people per square km each day.

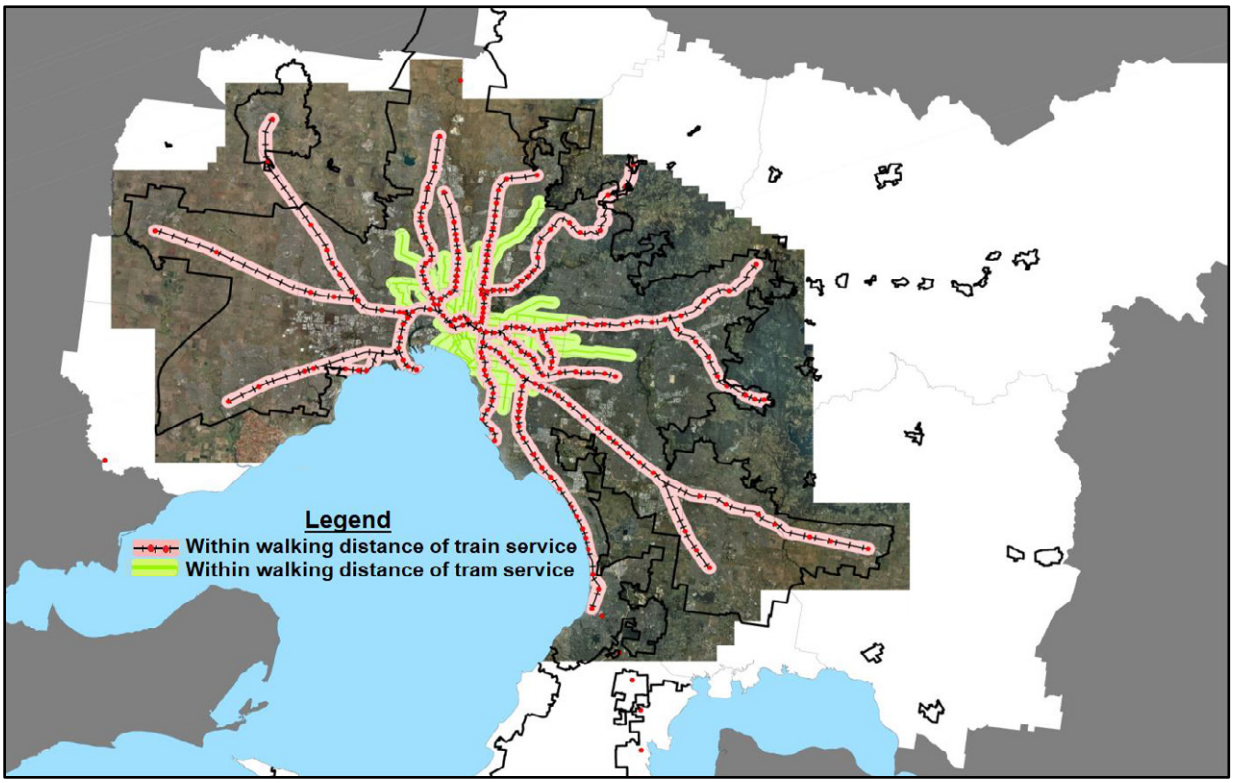
The tram network covers about 250 square km and carried 206 million people in 2017/18 serving over 2,250 people per square km each day.

The extent of both heavy rail and tram coverage is shown in Figure 14 below. The figure shows that while inner suburbs of Melbourne receive a comprehensive service, many outer suburbs are remote from any rail-based services.

Melbourne's inner area is almost completely served by rail services, 50% of middle suburbs are served while in outer areas less than a quarter of the population live within a rail catchment. Outer areas must rely on bus services or cars for most travel.

The radial nature of heavy rail leaves large unconnected gaps between radial lines. In outer ring suburbs, stations cater for more than their local catchments with extensive car parks but demand usually exceeds parking capacity. Some stations have bus interchanges but the current priority for extending station catchment areas is through provision of car parking spaces. In the middle suburbs, there are many stations along the radial lines, numerous bus interchange points and some car parking provision.

Figure 14: Train and Tram coverage of Melbourne Metropolitan Area



Source: O,Connell, J and Roberts, *M "Filling the Capacity Gap for Global Cities: Medium CapacityRail Systems."*

3.5 The Bus Network

Melbourne has an extensive bus network comprising 340 individual routes, currently delivered by 13 operators using a fleet of more than 1,700 buses with some 18,000 designated stops.

Unlike other public transport modes, bus patronage has been declining in recent years. Many services are characterised by near empty buses operating at infrequent intervals, often with few or no services at night or weekends, traversing indirect and meandering routes.

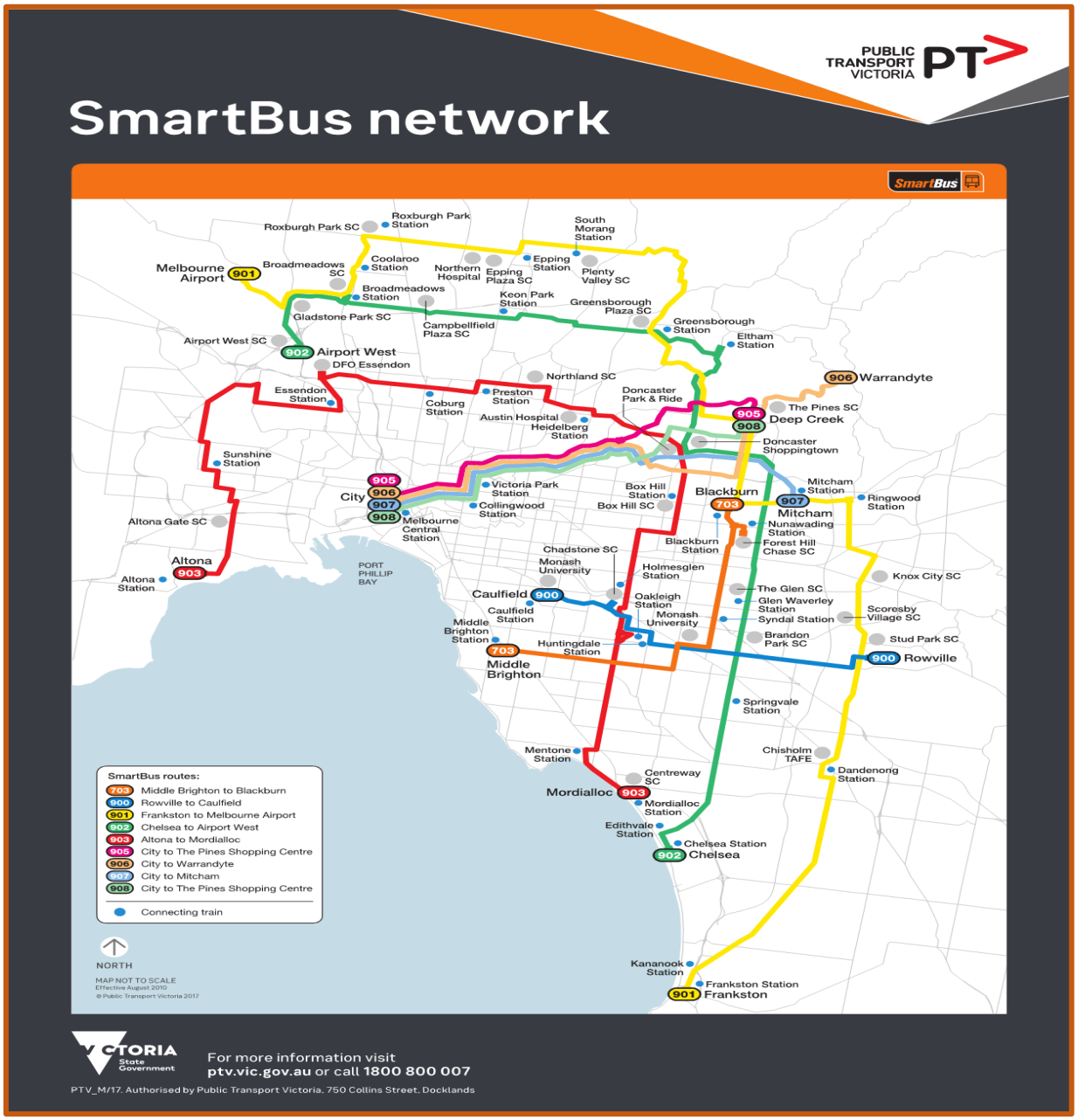
By contrast, 9 SmartBus routes (Figure 15) have provided high quality services since 2010, operating at 15-minute intervals over extended hours, 7 days per week. They have experienced increased patronage, although, the roll-out of this successful program appears to have been discontinued.

Typical route buses and SmartBuses in Melbourne

Photo: Wikipedia - *Marcus Wong*

Photo: *Liam Davies*

Figure 15: SmartBus Routes in Melbourne



Source: *Public Transport Victoria*

4. The Challenges and Opportunities for Public Transport

4.1 Overview

The principal challenges facing Melbourne's transport system are increased demand on the existing radial rail and road networks, due primarily to rapid population growth particularly in outer growth suburbs, and the lack of quality public transport services on cross-suburban and orbital corridors leading to high levels of car dependency.

Significant parts of the road network in inner, middle and some parts of outer suburbs are already at or approaching capacity. Apart from a few very expensive freeway projects, there are few situations where road infrastructure capacity can be significantly expanded. Any such construction exacerbates congestion as car use inevitably expands to fill the new capacity and motorists still need to exit freeways onto already constrained arterial and local roads to the detriment of the urban environment.

Realistic options for meeting Melbourne's growing travel demands will involve a progressive shift to public transport from private car use. In part, this can be achieved by city-shaping actions, for example by generating employment opportunities closer to where people live, or by encouraging residential densification in areas closer to areas with high employment potential. Public transport provision is a powerful incentive for such densification. Unfortunately, Melbourne's low-density residential sprawl often leaves transport planners with little alternative but for best endeavours to retrofit public transport into already established built environments.

Maintaining and enhancing Melbourne's liveability will require greater reliance on mass transit systems operating on dedicated or segregated corridors, feeder buses to key transit nodes, local buses and active transport (walking and cycling). This will require a combination of more effective use of existing infrastructure with investment in new public transport infrastructure and services. The aim is a connected grid network of easily accessible high-quality services.

The bus network will play an increasingly important role in supporting the mass transit elements of the public transport network, including a significant role in completing the grid network. As with trams, the effectiveness of bus services is also dependent on being accorded appropriate road space.

4.2 Meeting Travel Demand

Modelling for Infrastructure Victoria (IV)[12] predicts a 75.9% increase in public transport trips across Greater Melbourne between 2015 and 2031; corresponding to an additional 879,000 public transport trips each day. Annual patronage is forecast to expand to more than a billion passengers by 2031.

Given projected travel demand growth and proposed changes in network supply in the next decade, travel patterns associated with public transport are also forecast to change. Inner areas of Melbourne are forecast to experience the greatest absolute growth in daily public transport trips, but outer regions are also expected to have higher growth rates with a 16.6% increase. The IV Report predicts that public transport mode share will increase from 10.0% to 13.6% with the most significant increase in peak periods due to a combination of population growth, improved public transport services and road congestion. For trips departing during morning peak hours (7am to 9am) the share of public transport as a proportion of motorised travel is projected to increase from 12.3% to 17.6%.

The IV Report states that public transport in 2031 will be more accessible, more interconnected and have higher service frequencies across many areas of Melbourne compared to the 2015 network. In addition, due to increased demand and resulting delays, the 2031 road network will be relatively less competitive compared to the public transport system in terms of delivering fast journey times. Despite these factors, the report concludes:

> *"Melbourne will still remain a car–dependent city, with the large majority of travellers (more than 70%) continuing to use private vehicles in 2031. This is unsurprising, given the geometry of Melbourne's public transport. The backbone of the system is the train lines, which exhibit the highest capacities, highest speeds and greatest level of service across all public transport modes. These lines radiate from the CBD, leaving little opportunity for convenient cross radial travel using this mode. While this supports public*

[12] *Victoria's 30 Year Infrastructure Strategy* – December 2015 Infrastructure Victoria

transport use as a significant mode of travel for trips originating in inner regions growing from 39% in 2015 to 48% in 2031, for other parts of the Metropolitan areas, this is not the case. Journeys that do not involve central Melbourne areas form the majority of all travel across the city. Particularly for outer suburbs, this often leaves bus services as the only viable public transport alternative – which can struggle to compete with private vehicles in terms of journey times".

Even the relatively modest shift in mode choice predicted in the IV report will place unprecedented demand on existing public transport services and require massive increases in network capacity.

Currently, Melbourne's public transport is concentrated on providing radial transport in peak periods by train and tram. Orbital inter-suburban and cross-town travel by public transport is made difficult by a lack of major train or tram lines that serve this purpose, regardless of Melbourne having over 7,000 km of bus routes. Most bus routes provide low frequency service and are inefficiently routed. The few orbital and shuttle SmartBus routes that exist generally provide good quality services and unsurprisingly have patronage that far outstrips other bus services. On a relative basis, their overall use is still low compared with the radial rail system.

The shortcomings of these arrangements are that, for all but those who travel into and out of the Melbourne CBD and some inner suburbs, public transport is usually not the chosen option. Travel between suburban centres located on different rail corridors often requires a journey into the city centre and out again. For most travellers these options do not provide a viable choice.

Projected population growth and the intensification of suburban NEICs and activity centres will likely double the number of people travelling overall. While upgrades to the heavy rail system as set out in this plan will address much of the need for radial and cross city travel via the CBD, it will not cater for the majority of inter-suburban travel demand[13]. Demand for non-radial travel is addressed in Section 7 under Medium Capacity Transit and in Section 8 dealing with the metropolitan bus network.

4.3 Increasing Network Capacities

4.3.1 Optimizing the Use of each Transport Mode

To optimise the use of Melbourne's public transport assets and to expand the network's capacity and reach, each mode must be developed in ways that take advantage of its inherent advantages:

- **Heavy Rail** – for high demand corridors focussed on the CBD, cross-city and contra-flow journeys. Rail Futures envisages that heavy rail will continue to play the primary role in serving the high-volume radial corridors linking suburban areas and major activity centres with the central city area. To meet the needs of the growing metropolitan area, capacity enhancement is needed on some existing electrified corridors, together with electrification extensions along several regional corridors. Several new cross-city routes are proposed to form the basis of an integrated grid network by physically connecting pairs of radial corridors that currently terminate in the CBD. Projects to meet these requirements are detailed in Section 5.
- **Tram** – for frequent, quality service in the CBD, higher density inner and middle suburbs, also for local suburban access. Our proposed tram network restructure aims to create a simple and legible network with a strong customer focus. Part of this involves changing tram operations through the CBD and inner suburbs to support:
    - access to and across the expanded central city and surrounding areas
    - many more journey options facilitated by user-friendly interchange hubs
    - linking of trunk routes to provide seamless cross-network access.

  Melbourne's tram network can become more efficient through measures such as selective tram stop rationalisation and construction of level access stops. However, the greater challenge is to separate trams from general road traffic to increase their speed and reliability and maximize use of available road space. These and related issues are fully detailed in Section 6.
- **Medium Capacity Transit (MCT)**– in medium demand corridors, particularly non-radial routes linking NEICs and key activity centres. Currently only sections of the "Light Rail" routes to St Kilda and Port Melbourne

[13] On 28 August 2018, the Victorian Government announced its intention to construct an underground Suburban Rail Loop encircling Melbourne's suburb from Cheltenham to Werribee with 13 intermediate stations at an estimated cost of $50 billion and for progressive completion over a 30-year period to 2051. RFIs alternative proposals for cross suburban travel are detailed in Section 7 of this Plan

could be classified as MCT in Melbourne. The potential for MCT in Melbourne is very significant (see Section 4.7.1). Options for new MCT corridors and the prospective application of a range of emerging technologies is described in Section 7.

- **SmartBus** – to complete the principal public transport network comprising radial, cross-suburban and orbital routes where rail modes are unsuitable or unviable.
- **Feeder Bus Services** – to train, MCT and tram interchanges.
- **Local Bus** – providing local services to local activity centres, schools, hospitals, etc.
- **On-Demand Service –** to provide irregular or "as required" services using small buses, taxis or "ride sharing" vehicles.
- **Active Transport** – Safe cycling (typically up to 5 km) and walking (typically up to 500m) for personal connectivity, including between home, neighbourhoods, public transport nodes or other linkages.

4.3.2 Trams versus Buses

In the Melbourne context, there has not been serious debate regarding the respective roles of trams and buses in recent years, perhaps because Melbourne's trams are so much an accepted part of the city's psyche and electric traction is now generally viewed as cleaner, quieter and more environmentally friendly. Melbourne owes a massive debt to those who successfully argued in the 1950's and 1960's against the prevailing trend in other Australian cities and around the world to abandon tramway systems in favour of buses.

The tram network also provides other benefits to Melbourne, particularly for CBD-oriented or inner suburban travel. As population pressures intensify, a positive influence on land values is derived from the perceived permanence and predictability of fixed rail transport, a trend also evident in many other cities. Added to this is the quiet efficiency with which modern trams and/or light rail vehicles (LRV's) can provide capacity to move several hundred people at a time. Serving an equivalent task with buses would require many more vehicles and more road and footpath space. Trams have been a major factor in Melbourne's identification as a liveable city.

Nevertheless, the bus network will become an increasingly critical element of Melbourne's public transport complementing the tram, MCT and heavy rail transport networks. Rail-based modes must be supplemented by SmartBus and enhanced local bus services, primarily to provide services which cannot generate sufficient patronage to justify more expensive rail-based modes. Providing SmartBus high frequency cross-town connectivity is essential to a fully integrated multi-modal network. Local feeder services to rail stations are a vital component of the network, especially in the growth areas where service frequency improvement and route development are increasingly urgent. There are also many locations where bus routes could effectively co-ordinate with the tram network. An example of good co-ordination is at the Route 75 Vermont South tram terminus where buses provide a frequent scheduled connection to the Knox City Shopping Centre.

While this Plan focuses primarily on rail transport for providing the busiest trunk routes connecting areas of Melbourne, it is recognised that Melbourne also needs a complete overhaul and mass investment in the bus system. Although taxi and ride-share options can help with this vacuum, a great deal of bus route and service level investment is urgently needed.

Further commentary regarding Melbourne's bus network in the context of our Melbourne Rail Plan blueprint is in Section 8.

4.3.3 Increasing Heavy Rail Capacity

Melbourne's radial heavy rail services are currently constrained in the following ways:

- Peak period trains fill before reaching the inner suburbs and become overcrowded by the middle to inner suburban interface.
- Peak flow is concentrated on city-oriented weekday peak services although peak periods are expanding into mid-morning and mid-afternoon services.
- Rail routes with older signalling systems result in longer headways between trains and proportionally reduced overall corridor capacity[14].

[14] Each trunk rail route equipped with modern signalling systems can theoretically support trains carrying up to 1000 people operating at 2.5-minute intervals (headways) i.e. 24 trains per hour on each track carrying a total of 24,000 passengers per track/hour. On lines where high

- Flat junctions and converging/diverging routes create conflicts between train movements which reduce corridor capacity by comparison with corridors not constrained in this way.
- Routes with sections of single track have far lower capacity for accommodating train movements than corridors with twin tracks. Similarly, routes with three tracks (with two used in the peak direction) tend to have overall capacity constrained by the single track used for counter-peak movements.
- Rail routes with trains having different performance characteristics and/or operating with inconsistent stopping conditions also suffer reduced capacity compared with those having more uniform rolling stock and operating patterns. This particularly applies where metropolitan and regional trains share the same infrastructure.

To cope with the increasing demand, Melbourne's train network must be converted to a more intensive operation to maximise passenger carrying capacity, initially within the limits of existing infrastructure. Multiple options are available to increase the passenger carrying capacity of the network including:

- increasing train frequency by reducing train headways within the limitations of the signalling system
- altering train stopping patterns to provide greater consistency between successive services
- ensuring train types operating on any single corridor have very similar performance characteristics
- increasing train size (by length or height) within the limits of platform lengths and other infrastructure
- accelerating procurement of higher capacity trains to make better use of the infrastructure in a transport corridor
- changing the internal train seating/standing ratio by reordering interior train layouts
- reducing station dwell times by more effective management of passenger flows on platforms, through ticket barriers and/or on vertical transport within station environs

capacity trains operate, each carrying up to 1500 people, the theoretical capacity increases up to 36,000 passengers per track/hour. Trunk lines with two branches can run half of this capacity on each branch; with three branches about a third (or other proportions) not accounting for other constraints and reliability.

- electrification of existing rail lines to major growth suburbs
- duplication of remaining single line sections
- re-configuration of the Melbourne Underground Rail Loop
- further segregation of regional from metropolitan train services through network re-configuration and selective track amplification
- adding turnback locations for trains to better handle shorter distance peak journeys
- providing additional tracks and/or platforms on existing corridors
- developing new corridors to directly or indirectly accommodate demand growth.

Other measures include new and more sophisticated signalling systems to allow trains to operate at closer headways, most likely involving new technologies, and introducing automated or semi-automated train operation to optimise train network performance. These options are inevitably highly complex and costly, tend to have long lead times and can introduce technology and human interface risks.

Proposed measures to increase passenger carrying capacity on Melbourne's heavy rail network are detailed further in Section 5 of this Plan.

4.3.4 Increasing Tram Capacity

Trams serve mainly central areas and run from the City's centre to the middle suburbs. Some cross-city travel is available by tram. Passenger turnover varies but can be as much as 5–6 times over the length of any one end-to-end service. Overcrowding is now common in peak hours on many routes with capacity being limited by factors including:

- most trams carrying around 100 to 120 people with new E-Class rolling stock rated to carry 210 people. However, about 40% of the fleet consists of lower capacity vehicles carrying only between 65 and 90 people
- passenger capacity on most routes between 750 and 1300 in each direction per hour – at the lower end of international practice – constrained by low capacity vehicles, closely spaced stops, road traffic delays, lack of traffic signal priority and few dedicated tram "rights of way"
- trams being particularly hampered by road traffic congestion, excessively low speeds and traffic management policies that still prioritise cars over people. These diminish user benefits, inflate operating costs and impede vehicle utilisation. Traffic congestion accounts for some 40% of tram running time. Other key delay factors include turning road vehicles blocking tram lines, passenger loading and unloading and car-biased traffic signal programming. Creating effective tram priority for on-road tram operations is a significant challenge that cannot be achieved in all cases due to cross-grid priorities, such as, a north-south set of flows conflicting with an east-west set of flows
- most tram stops being not easily accessible by all travellers impinging on passenger safety and slowing boarding and alighting times.

Most of these challenges are amenable to a range of solutions, as discussed in Section 6 of the Plan.

4.3.5 Providing adequate stabling, depot and power facilities for future operations

Heavy Rail Requirements

As new and more technologically advanced trains come into service and the fleet increases, the rail network will require new and extended train maintenance, servicing and stabling facilities. As the operations on each group of lines are progressively restructured to be largely independent of operations on other lines, each line group should be self-sufficient in terms of train fleet and supporting functions. This will require new servicing and stabling facilities at various locations as detailed in Section 5.13.

An increased train fleet and larger trains will require additional traction power supplies with additional substations across an expanded electrified rail network.

Tram Requirements

The introduction of longer trams operating more frequently will require increased power supplies across the network. Larger trams also require longer platform stops and additional maintenance and stabling facilities. An emerging issue is the availability of sites for additional tram electrical supply sub-stations especially in the CBD

and inner areas. This requirement needs to be considered when issuing planning approvals as often the only potential site is located within an existing re-development site. Development approval for such sites should consider sub-station requirements before approvals are issued. The space required for a modern new tram electric sub-station is not large and usually can be readily absorbed into a major new development or redevelopment at a site along a tram route.

Existing suburban tram depots are already facing difficulty in housing and maintaining the growing fleet. In addition, most depots were not designed to house or maintain the longer articulated type trams increasing in numbers on the Melbourne network. The proposed network extensions, progressive increase in overall fleet size and increasing proportion of modern, longer vehicles emphasises the need for suitably equipped new depots on reasonably large sites in the middle and outer suburbs. These developments must be dovetailed with the procurement program for new trams. Potential inner area locations for new depots are at Fishermans Bend, in the Footscray Road, West Melbourne area and at Melbourne Airport.

These issues are further discussed in Sections 6.6 and 6.7.

4.4 Extending Network Coverage

4.4.1 Heavy rail

The need to extend Melbourne's conventional heavy rail network is primarily driven by a combination of very large increases in CBD and near-CBD employment and Melbourne's continuing sprawl into outer metropolitan areas that are not currently provided with frequent electrified Metro services. Almost all the extensions proposed in this Plan are designed to extend full metropolitan network coverage to the residential growth areas in Melbourne's west, north and south-east.

Such extended coverage can be provided by electrification and/or duplication of existing lines, some of which are presently inadequately served by V/Line regional trains. Other cases involve re-opening and re-building closed lines which, fortunately, have corridors that were retained in public ownership – excellent examples of future proofing not always so evident in some more recent cases.

A total of 8 extensions of electrification on existing lines are proposed. Full details are in Section 5.4 of this Plan.

4.4.2 Trams

The tram network still serves Melbourne well, but is heavily biased towards travel to the CBD and Docklands.

If Melbourne is to take full advantage and leverage the benefits of the tram network, it requires enhancements to maximize its potential to serve Melbourne more efficiently. These enhancements include:

- maximizing the capacity and route connectivity of the existing network, with a range of additional track connections at intersections, coupled with a restructure of existing routes and introduction of additional new routes to offer many new tram travel options
- extensions to several tram routes from suburban termini at poorly defined destinations to new termination points at railway stations and commercial centres
- creation of new non-CBD cross-suburban routes (mostly using existing infrastructure) to provide improved connectivity with other radial tram and rail routes, complementing the SmartBus network and forming important inner suburban elements of the new public transport grid network. Improved cross-town links are critical for Melbourne and a major feature of this Plan
- introduction of longer trams up to 40m in length, and accelerated delivery of new larger capacity trams to replace outdated low capacity, labour intensive small tram operation, allowing fleet expansion and introduction of new and extended routes.

These proposals are detailed in Section 6 of the Plan.

In addition, the Plan identifies new cross-suburban routes that are likely to require both higher capacity vehicles and faster operation than is practicable with conventional trams. These may operate on similar infrastructure to the tram network but substantially segregated from other traffic. In some cases, such vehicles may also operate over parts of the existing tram network. In other cases, they will employ a range of technologies which differ from conventional tramway steel wheel-on-steel rail operation. These possibilities are canvassed in Section 7 dealing with MCT.

4.5 Commuter travel times

The failure of public transport to attract a significant proportion of the total travel market is not only due to limited accessibility of many residents to services. It is also because public transport does not provide attractive door to door travel times for many common journeys, particularly if a transfer is involved. Door-to-door travel time rather than travel distance is a critical factor for most regular commuters and for many journeys, is also a primary determinant of mode choice. This includes the so-called "first and last mile" at journey origin and destination, which may involve walking or a short tram, bus or car trip.

The Marchetti Constant travel time budget of just over an hour per day on average has been found to universally apply across all cities[15]

> *"Some people can go beyond an hour and some much less, but the average everywhere is an hour. This has been found over and over to apply in every city ……. if people find it hard to live with so much time "wasted", they move to somewhere more within their travel time budget"*[16]

Recent research by the Federal Government on long distance commuting reiterates the Marchetti effect and finds that the direct effects of long-distance commuting are negative[17]. In general, commuters adapt by reassessing their location and commuting options. The option of using public transport is often not considered if the journey time exceeds an hour when the same journey by car is under the hour.

This underscores the obvious importance of the primary mode journey time, inclusive of waiting time at origin locations and the need for very frequent services if the notion of "turn up and go" is to be realised in practice. Where lesser service frequency is prescribed in timetables, reliability (perceived and actual) in terms of timetable adherence becomes another key consideration for regular users.

Most public transport trips in Melbourne involve at least one transfer between origin and destination and many involve two or more transfers between the same or different modes. Service frequency and reliability of the connecting modes, as well as the convenience of interchange itself are further key factors that strongly influence overall journey time and hence mode choice, often with the result that public transport is currently not a viable alternative to private car use.

Data from "Moovit Melbourne[18]" suggest the following:

- Average trip lengths of 9.8 km, but 26% of trips are over 12 km.
- 60% of public transport trips involve one transfer and 19% of trips involve two or more transfers.
- 14 minutes is average waiting time, with over 20% of passengers waiting over 20 minutes.
- Average walk to public transport is 780m, but over 26% trips involve walking over 1 km.
- Average one-way commuting time is 40 minutes, but 28% of public transport trips are over 60 minutes.

4.6 Providing a Grid Network in Melbourne

4.6.1 The Importance of a Grid Network

The keystone of RFI's Melbourne Rail Plan is to become significantly less car dependent by progressively transforming the current mostly radial network into an integrated connected cross-city grid network.

Melbourne's primary public transport systems of heavy rail and tram largely evolved as radial networks focussed originally on the Hoddle Grid as the central part of Melbourne's CBD. Creation of a comprehensive grid network of public transport readily accessible to all across the breadth of Melbourne's massive suburban footprint is unlikely to ever be fully deliverable in terms of affordability or physical practicality. Some elements of such a grid already exist, for example in Melbourne's CBD. The grid can be further developed in ways that will provide an extensive range of public transport options that can replace many trips currently made by car. For such trips to be an attractive alternative to a car trip, services must be part of a well-structured grid network with

[15] See: http:/www.cesaremarchetti.org/archive/scan/MARCHETTI_052.pdf
[16] "Defying the one-hour rule" for city travel, traffic modelling drives policy madness, Peter Newman, The Conversation, 15January 2016
[17] BITR (2016), "Lengthy commutes in Australia", Bureau of Infrastructure, Transport and Regional Economics (BITRE) Report 144
[18] https://moovitapp.com/insights/en-gb/Moovit_Insights_Public_Transport_Index-2803 - Melbourne public transport statistics.

convenient interchanges to maximise the range of places one can reach with just one transfer and by having frequent services to ensure short waiting times at interchange points.

The effectiveness of a grid network is highlighted by the current situation, in which:

- 88% of the area and 92% of the population of Melbourne's inner area (where there is a partial grid network) is covered within a 400m walking distance by high capacity (rail and tram) public transport
- 41% of the area and 54% of the population of Melbourne's middle area (which has a limited grid network) is covered by high capacity (rail and tram) public transport
- just 4% of the area and 24% of the population of Melbourne's outer area (which has no grid network) is covered by any type of high capacity public transport.

Short to medium term, some principal non-radial corridors used for journeys to work need to be identified and provided with high frequency SmartBus type services. However, as traffic congestion increases on these routes, such services will prove ineffective if buses are caught in traffic and cannot operate to reliable schedules. Dedicated bus lanes will be essential where they can be provided. Assuming proven and sufficient potential demand, these corridors are likely to become candidates for MCT solutions, as discussed in Section 7.

4.6.2 Converting a Radial Network to a Grid Network

The ideal distance between parallel routes in the grid is about 1 km. This avoids the need to walk more than 500m to catch a service and, if necessary, make only one change at a suitable connecting point to arrive at any other intersection on the grid. Effective grid design maximizes the range of destinations gained with just one connection.

Because Melbourne covers such a huge area, it is not feasible to create a grid pattern across its breadth and depth or one which intersects every existing radial route. However, Melbourne's relatively flat terrain has meant that much of its suburban development has occurred on a grid form of streets and roads with few barriers to pedestrian access. This should aid the evolution of a grid-like pattern of public transport services, even though the ultimate grid network will take many years to fully develop.

Much can be achieved through better traffic management and re-allocation of road space to provide public transport priority to improve existing routes. Genuine policy change and the will to reduce car dependency will maximise the movement of people rather than vehicles. Other pre-requisites for creation of a successful grid network are passenger-friendly interchanges and, above all, frequent services along the main elements of the grid. When the policy objective is to reduce car dependency, a high frequency service level is particularly important.

In many smaller cities, extensive grid networks have developed from original radial networks that served their city centres. Portland, Oregon in the US is an example of an excellent public transport (transit) network. As shown in Figure 16, many lines extending north and east from the Portland city centre form elements of a grid, but still converge in the city. Many other major routes do not proceed to the city centre, but instead complete the grid pattern. The balance between grid and radial patterns was re-constructed in 1982, replacing an old network in which almost all routes were radially oriented.

Figure 16: Portland, Oregon, USA – Public Transport Grid Network

Source: *www.imagesofus.co/portland-oregon-public-transportation-map*

Melbourne's existing rail and tram networks provide the basic infrastructure for a future grid network. Additional elements to progressively enable the evolution of a grid network are summarised below and detailed in Sections 5, 6 and 7 of this Plan. They include:

- heavy rail electrification extensions
- restructuring the heavy rail radial network into multiple cross-city mass transit corridors
- adding short "missing" sections to connect existing tram lines
- tram route re-structuring and selective route extensions
- adding other supplementary tram infrastructure
- introducing MCT routes (including Light Rail)
- providing new and upgraded SmartBus routes and feeder services to stations and MCT routes
- providing new stations on existing rail lines
- removing level crossings to facilitate intersecting public transport corridors
- constructing and upgrading modal interchanges

Above all, operations on the above infrastructure need to provide genuine "turn up and go" service standards.

4.6.3 Tram Route Re-structuring and Extensions

The existing tram network suffers from inbuilt factors deriving from its history as a largely radial, but incomplete network. As such, re-structuring is needed to offer a partial grid network that maximizes interchange opportunities, both with other tram routes and the rail network. Extensions to logical termini at activity centres or rail stations are also proposed. Their purpose is to provide new travel opportunities and, where relevant, to encourage increased patronage at outer ends of the tram routes concerned, including for counter-peak direction travel. Bus routes will complete the ultimate grid.

It is proposed to progressively restructure the existing and extended tram network over 15 years to 2034 to achieve key elements of a new grid network that:

- offers a greater number of cross-CBD, inner circular and cross-suburban travel options
- offers much improved connectivity between tram routes and between trams and the rail network
- offers a wide choice of tram travel options to/from and between all 15 City area rail stations
- introduces supplementary peak hour services from the CBD to selected inner suburban locations
- offers extended tram routes to major activity centres, rail stations and other significant destinations.

Details are in Section 6 of this Plan.

4.7 Introducing Medium Capacity Transit (MCT)

4.7.1 MCT in Melbourne

While Melbourne has extensive rail and tram networks, a significant deficiency in the network is the lack of high-quality public transport to meet the need for:

- cross-suburban travel along relatively high usage corridors and where the installation of permanent transit infrastructure will engender market confidence resulting in land value uplift along the route and at key nodes
- connectivity with large employment clusters/activity centres
- cross-city connectivity with the heavy rail radial system, other MCT routes and trams
- capacity requirements along a route higher than could be provided by a bus service .

There is a significant disparity in capacity between Melbourne's trams and trains as both serve different markets. Also, there is a general lack of coverage by each vehicle type. This Plan recognises a need to introduce new types of vehicles to serve different markets and different geographic areas.

MCT systems can provide an intermediate step between 'street' and 'rapid' transit such as heavy rail systems. MCT can meet this capacity/service gap by offering a medium capacity urban public transport solution ideally suited to new trunk routes not requiring the capacity offered by traditional heavy rail. MCT can provide a range of benefits to Melbourne and significantly contribute to the consolidation of the grid public transport network.

MCT can take the form of rail-based technology such as Light Rail Transit (LRT), road-based systems such as Bus Rapid Transit (BRT), light metro operations on the surface or underground such as the Paris Metro and London Docklands Light Rail, or more recent developments such as very large guided buses as in China, otherwise known as "trackless trams". MCT vehicles of varying types have their own distinct advantages for specific markets.

Examples of Medium Capacity Transit Vehicles

Docklands Light Railway, London

Photo: *By Hippoattack at English Wikipedia*

Paris Metro - rubber-tyred Line 1 train at Bastille station
Photo: *Max Michell*

Experimental optically guided MCT vehicle, otherwise known as a "trackless tram" in Zhuzhou, Hunan Province, China
Photo: *CRRC Zhuzhou Institute*

Examples of Medium Capacity Transit Vehicles

Sheffield UK - Vossloh Citylink Tram/Train
Photo: *By Buttons0603 - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=69754031*

These tram/train vehicles can operate at up to 100km/h. They can use 750v DC or 25kv AC traction systems.

A Utah Transit Authority Trax light rail vehicle in downtown Salt Lake City, USA
Photo: *Garrett - Flickr: Green line Trax at Gallivan Plaza*

A TriMet light rail vehicle in Portland, Oregon, USA
Photo: *John Hearsch*

4.7.2 Comparative Features of Heavy Rail, MCT and Trams

The characteristics of MCT transport technology compared to Heavy Rail are:

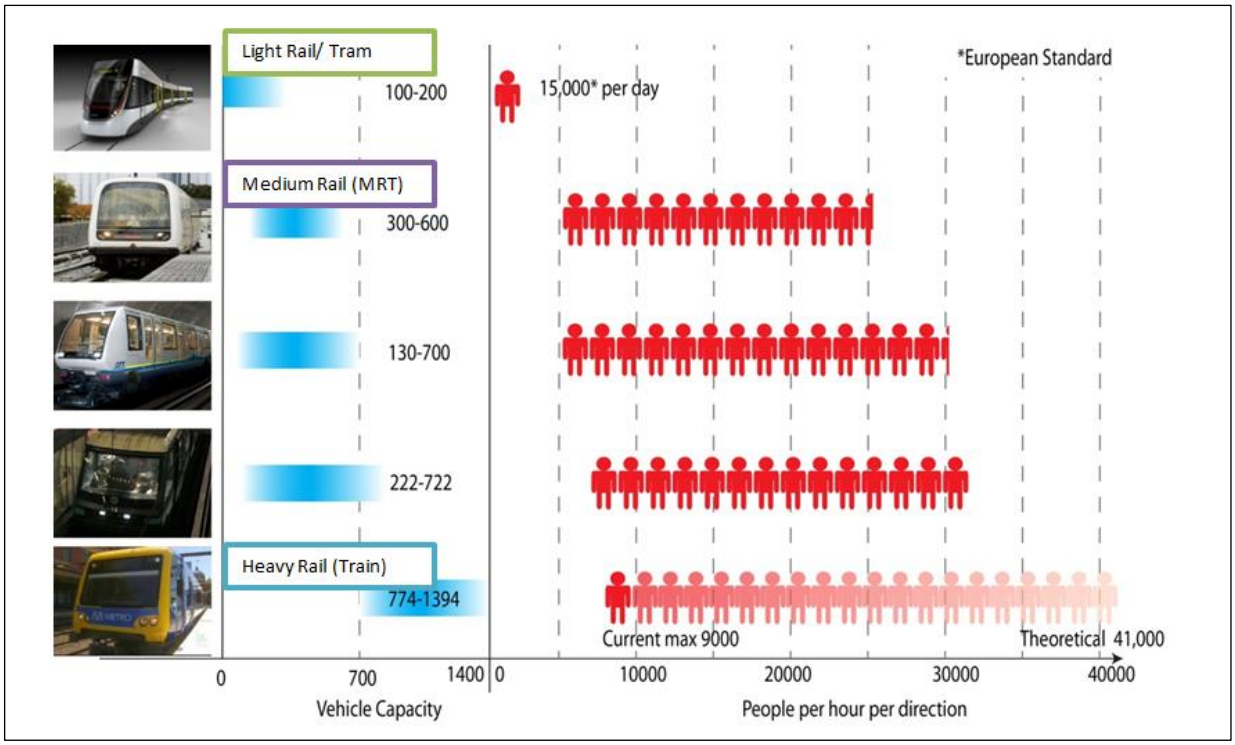
- MCT solutions can potentially deliver greater benefits than heavy rail for far less cost and with speedier timelines. *Speed of construction and delivery is a key factor, because Melbourne's transport tasks need to be met sooner rather than later.*
- MCT, including Light Rail can handle from around 3,000 to 13,000 passengers per hour in each direction, which is typical of the capacity task for orbital and cross-suburban routes.
- MCT has much higher operating speeds than buses on conventional roads. (Melbourne bus patronage is declining mainly due to poor service levels.)
- MCT can climb steeper gradients and negotiate tighter curves than heavy rail, enabling more flexible routing and requiring less land take than heavy rail.
- Compared to heavy rail, MCT including Light Rail can be more readily "inserted" into the urban fabric, can penetrate the centre of activity precincts and has an activating and revitalization impact on the urban environment.
- Because MCT stops are much closer together than on heavy rail lines, the proposed MCT corridors offer many more opportunities for leveraging urban development.
- Typically, MCT is easier to board and disembark compared to heavy rail, as it is more immediately located at street level, requiring less walking in and out compared to both underground and surface stations. This is beneficial for disabled passengers, as it is usually combined with abundant large doors and full low floor access.
- MCT stops/stations are relatively inexpensive to build compared to underground heavy rail stations and can be located at more frequent intervals, delivering access to more places.
- MCT vehicles have shorter train lengths than heavy rail trains but can be operated at high frequencies - more frequently than heavy rail services would be expected to operate on most corridors.

Table 4 (below) and Figure 17 show a comparison of the key characteristics of tram, heavy rail and MCT modes.

Table 4: Characteristics of Rail Modes and MCT

Characteristic	Tram	Heavy Rail (Train)	MCT (incl. Light Rail)
Vehicle capacity - current (future)	100-200 (250)	800-1400 (1200-1650)	400-600 (800)
Journey length (km) Typical/Maximum (Future)	12-16/22 (Same as now)	25-35/60 (70)	10-40/40 (30-40)
Typical stop spacing (km) – current (future)	0.25 (0.4 to 0.5)	1.6 (3.0) No change in outer area	0.9-2.5 (2.5)
Average speed (km/h) – current (future)	16 (16)	40 (50+)	40 (50+)
Average trip length (passenger km) - current (future)	3-4 (same)	11-15 (20)	7-10
Turnover of passengers per trip	4-5	2	4-6
Route coverage	Inner, well covered, 250 sq. km	Whole metro area, sparse coverage, 600 sq. km	Inner, middle, selected outer
Land	Mostly on road	Own ROW	Own ROW
Resourcing	Drivers	Drivers	Option for supervised or driverless

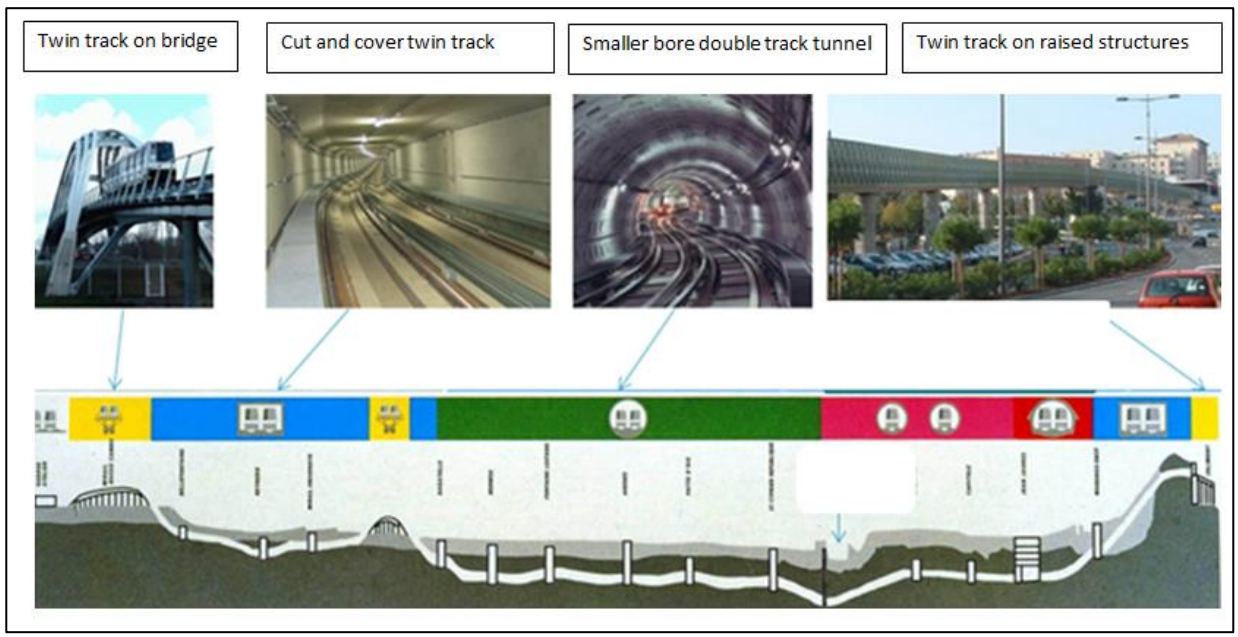
Figure 17: Relative vehicle capacities: Light, Heavy and Medium Capacity Vehicles



MCT routes are ideally installed in freeway or wide boulevard medians but can also use elevated structures in suitable thoroughfares. Many potential MCT corridors in inner and middle suburbs of Melbourne can utilise wide arterial road easements and boulevards, a legacy of previous generations of sensible road planning. Where this is not practicable, new infrastructure on high patronage corridors may need to be built to provide completely segregated ROWs for increased capacity and speeds, including on elevated structures or lowered ROWs in cut and cover trenches. Tunnelling may be unavoidable in high value areas that are fully developed and where retrofitting a new corridor into the existing built environment is not feasible.

Figure 18 (below) shows typical options for MCT infrastructure where construction at grade is not feasible.

Figure 18: Options for MCT Infrastructure Construction



MCT does not require the significant infrastructure or take as much space as heavy rail but can deliver higher operating speeds, greater reliability and capacity than conventional buses at expenditure levels closer to regular tram infrastructure and much less than the very high cost of conventional heavy rail technologies. MCT capital costs are typically 25% to 35% of heavy rail and much lower if heavy rail requires tunnelling.

4.7.3 MCT and Land Use Planning

MCT systems are widely recognised as providing a catalyst for significant investment around stops and along routes and for improving liveability and amenity by attracting investment. This is a consequence of the long-term nature of fixed MCT infrastructure providing certainty for developers. MCT also offers the ability to closely integrate into the community and very efficiently bring people into the centre of high activity areas. To be effective, MCT combines fully or largely segregated ROWs, relevant system technologies and attractive service quality (frequency, span of hours, stopping patterns) into a package of public transport technology that is highly marketable.

As part of any plan to develop MCT corridors, a coordinated mix of land use and transport strategies must be developed. This applies where it is proposed to upgrade key routes on the existing network to MCT standards and/or construct new MCT routes and corridors. Many other land use considerations potentially affect the redevelopment of rail-based corridors, such as the existence of large numbers of historic buildings, and loss of amenity. Planning should also consider the extensive research demonstrating the benefits of concentrating increased population in mixed use activity nodes connected by high quality public transport.

With appropriate land use planning controls in place, MCT provides opportunities to change land use patterns and enhance land values along key corridors, around stations and in activity centres, as evidenced by experience in many other cities. MCT is often considered the ideal foundation for maximising development along new trunk public transport corridors. Those corridors which link activity centres become vibrant and sought-after areas in which to live. These issues are further explored in Section 10.

Planning for such corridors will have long lead times and involve many institutional and physical interfaces. In some cases, short term, high frequency SmartBus or similar services may be a logical transition to MCT in helping to change travel behaviour and prove up potential demand. They will also allow time to progress corridor protection measures and, above all, undertake an integrated process of transport and land use planning at a localised level.

Much international experience is now available to show how MCT (and particularly Light Rail) projects can be successfully integrated into the urban environment. According to the International Association of Public Transport (UITP), in 2018, 46 new Light Rail infrastructure projects were completed in 20 countries and 40 cities over a total of 309.4 km, with 66% of new lines and 22% of line extensions. The remaining 12% consisted of conversion of under-used secondary railway lines to Light Rail. Seven cities opened their first modern Light Rail line in 2018, bringing to 411 the number of cities worldwide with such networks.[19]

Details of the proposed MCT routes in Melbourne are included in Section 7.

4.8 Integration of Services

4.8.1 Co-ordination of routes and service

A feature of Melbourne's public transport network is that it has been multi-modal for more than 30 years, with integrated fares and ticketing. However, aside from fares co-ordination, there is no overarching network monitoring and control system to ensure that actual performance (particularly at modal interfaces) matches scheduled service.

Much of the tram network was developed in an era when rail and tram services operated as competing rather than complementary modes. This reflected a culture partly derived from a history of operation by municipal authorities followed by creation of the Melbourne and Metropolitan Tramways Board in 1923 as an independent statutory authority.

This legacy of poor co-ordination between different modes remains evident in many parts of Melbourne. Outside the CBD, the benefits of the 'network effect' are yet to be fully realised.

While parts of the bus network provide notional connectivity with rail, this is largely undermined by poor service frequency, unreliability of actual connections and/or restricted hours of operation. These factors contribute to poor bus patronage and have a causal link with ever-increasing demand for all-day parking at stations, even when well-designed feeder bus routes to stations would otherwise provide a suitable service in many cases.

[19] UITP Statistics Brief – *New Urban Infrastructure 2018*.

Instances of rail and tram connectivity is more by historical accident than design. Further lack of connectivity occurs in most cases where trams interface with the bus network. Relatively low-cost additions to the tram network would enable it to take advantage of potential traffic generators, enhance overall network connectivity and better serve the changed demography of Melbourne.

Integration of modes requires the following measures:

- High service frequency and comparable spread of operating hours of the connecting modes to provide genuine "turn up and go" service levels.
- Where high service frequencies are not practical or economically viable, timetable co-ordination must be planned, publicised, implemented and managed in real time.
- Modal co-ordination underpinned by service agreements and operational protocols that provide guidance to operators for dealing with late running and unscheduled disruptions to services.
- Establishment of an overarching Public Transport Coordination Control Centre alongside existing train, tram and bus operational control centres. This Centre would monitor scheduled intermodal connection arrangements providing a central facility for managing issues and ensuring accurate and fully updated information is communicated to travellers, especially at times of service disruption.

4.8.2 Modal Interchanges

Inevitably, public transport, no matter how comprehensive, cannot serve all combinations of passenger origin and destination. Hence, the effectiveness of the public transport network will depend on the willingness of travellers to transfer between routes. Car preference is unlikely to be reduced if transfers between routes involve long waiting times and/or are perceived as unattractive, unreliable or complicated.

Interchanges should offer physical facilities and information systems that support such passenger transfers.

Transfer between routes needs to be facilitated through public education and readily available information on journey options. In the field, transfer facilitation also requires excellent wayfinding signage, service information and suitable waiting areas. To minimise transfer time, high service frequencies are essential on key routes that form the principal public transport grid. Real time experience needs to be supported by dynamic timetable information and infrastructure for safe boarding and alighting. This requires all stops to meet DDA standards.

Dedicated interchanges should be constructed at key transfer locations. These should be designed to ensure transfer between modes with minimal difficulty. Facilities for rapid interchange between cars and rail-based transport ("kiss and ride") should be provided at most rail stations. However, the development of large park and ride facilities should be largely limited to outer metropolitan sites where it is impracticable to provide broad local coverage with bus feeder services. The focus should be on substantial time savings for commuters and overall reduction in travel costs to the community.

Detailed design of interchanges is not considered in the Plan as the requirements of individual interchanges will depend on local conditions at each site. However, the following are key principles for major interchanges:

- Vehicle loading, unloading and transfer areas should be configured such that there are no ground level pedestrian crossings and thus no conflict between people and vehicles.
- Passengers should be able to clearly identify boarding points and exits.
- Effective lighting, clear and extensive signage, local directions and maps, static and dynamic service and security information are fundamental and must be available to all including less able travellers.
- Interchanges should be overseen by control centres with full knowledge of the operation of all services and able to make necessary day-to–day changes, especially where timetable connections are involved.
- Major interchanges should incorporate retail sections, the income from which can contribute to running costs as well as providing community and passenger service and amenity. Retail sections can also increase opportunities for more productive use of waiting times.
- Irrespective of mode used to access the interchange, the design should minimise walking distance, congested areas and queuing situations particularly at barriers and ticket validators.
- Transfer paths between modes should offer all-weather protection.

Tram / Train Interchange at Den Haag Central Station, Netherlands
Source: *Courtesy Jannes Linders, Benthem Crouwel Architects, Amsterdam NL.*

4.9 Car Parking at Stations

Melbourne's rail network already has some large car parks, up to 1000 spaces at some stations. There are more than 40,000 spaces across the metropolitan network and thousands more on the non-electrified V/Line network. Continued expansion of commuter car parking is not a sustainable method of attracting commuters to rail. This is because:

- car parks are expensive at $10,000 to $15,000 per space at ground level and as much as $45,000 per multi storey space, plus ongoing maintenance, lighting and security costs
- users typically drive just 1-2 km to a rail station, leaving their vehicle there all day dictating that users own a car to access rail, and encouraging households to own 2 or more cars
- many car parks are full by 7.00-8.00am, catering for early peak commuters, thus providing poor access for the rest of the day, including off-peak times when there is ample capacity on the rail network
- car parks occupy large areas of valuable land that could be used for more appropriate urban development
- they increase traffic congestion around stations and detract from efficient access by walking and cycling[20].

"Park and Ride" may be appropriate for urban fringe areas where land is cheaper and not suited to other uses such as residential or commercial development, walking and cycling distances are too long for most people, and density does not support good bus services. However, with large volumes of passengers carried by trains, MCT and trams, it is invariably not feasible for cost and logistic reasons, to provide more than limited car and taxi parking, with drop off points for people with luggage, disabled passengers, and kiss and ride.

4.10 Integrating Active Transport with Public Transport

While active transport as a separate important transport mode is covered in further detail in Section 9 below, emphasised here is the role of walking and cycling to access public transport. Such integration helps reduce car dependency with positive health, environmental and cost impacts. Ideally, access for most mass transit passengers needs to be by walking, cycling and bus.

[20] http://economicdevelopment.vic.gov.au/transport/cycling-and-walking/active-transport-victoria; PTUA's Myth: Park-and-Ride facilities will encourage public transport use: https://www.ptua.org.au/myths/parkride/

It is critical therefore that rail station access is supported by a well-located bus interchange, and by safe walking and cycling routes, segregated from vehicle access to maximise safety and encourage active transport modes. Secure bike storage facilities with showers and repair facilities, together with bike hire through bike share provision including "e-bikes" with charging points, will also maximise scope for efficient access to rail journeys.

There is scope for substantial improvement of access to rail and MCT stations by bicycle. The case study below demonstrates excellent integration of cycling journeys with rail at Houten in the Netherlands. With a population of only 50,000, this city caters for thousands of passengers seamlessly accessing Houten rail station by bike to travel further by train. The model can also apply to key MCT stations and bus interchanges.

CASE STUDY » BIKE/RAIL MODE

Access to rail stations is a major issue where homes and jobs are beyond station walking distance. With insufficient land for car parking to meet access demand, alternatives are essential.

Apart from bus interchanges, many cities encourage access to stations by bicycle. This necessitates safe bicycle routes and well located bike parking with direct connections to platforms or the station hall.

These facilities make access to rail stations easy and attractive. Significantly, the cycle catchment to rail stations is 15 times the size of the walking catchment.

In the Netherlands, near 50% of all train passengers cycle to their rail station. Key success factors for the bike/rail combination:

- safe bike access to reach the station
- safe, convenient, sheltered bike parking
- easy public bike rental at stations
- integrated payment of bike/rail services
- marketing that bike/rail mode is easy, fast, affordable, convenient and cool

IMAGE: Houten Station: population 50,000
SOURCE: Martin Bond / Alamy Stock Photo.

Combining the rail and bike modes is highly effective being the most energy efficient and sustainable means of mobility in cities, providing seamless door-to-door transport.

4.11 Serving the Central Business District and immediate surrounds

4.11.1 Heavy rail

Extensions and enhancements of the conventional heavy rail network are expensive but nonetheless provide the most viable mass transit solution for corridors that carry large passenger volumes. In the Melbourne context, such corridors are limited to those serving the CBD and adjacent inner suburbs which provide major concentrations of high value jobs and innovation. This job-rich area now covers a much greater area than the historic Hoddle Grid originally well served by Flinders and Spencer Street stations and, over more recent decades, by the Melbourne Underground Rail Loop.

Melbourne's job-rich centre also provides an imperative to restructure much of the existing inner network into a series of high capacity cross-city corridors that provide similar functionality to the massive *Crossrail* project in London, thereby providing efficient rapid access across the network. The Melbourne Metro (MM1) project will provide a critically needed cross-city corridor linking lines stretching almost 100 km from Melbourne's north-west to its outer south-east. An early priority is to also provide a segregated fast line to directly link Melbourne's CBD at Southern Cross station to Melbourne Airport via Sunshine and to also provide excellent connectivity with the wider rail regional network. (Section 5).

Section 5.5 of this RFI Plan explains proposed re-configuration of the City Loop to provide an essential north-south cross-city corridor. Also covered in that section is the vital Melbourne Metro 2 (MM2) project that

similarly provides essential cross-city connectivity from Melbourne's outer north-east to its massively growing south-west. These cross-city connections will be complemented by two others – one that links the middle southern and western beach suburbs and another that links Melbourne's outer north with its middle and outer east. Each of these cross-city connections intersect at existing CBD stations or, in the case of MM1 and MM2, in the heart of Melbourne's university and medical precinct at nearby Carlton/Parkville, a designated NEIC under *Plan Melbourne 2017-2050*. The goal is to provide fast convenient access to Melbourne's inner core and, with a maximum of one transfer, to all its immediate surrounds.

The above major network changes will release capacity on the two remaining corridors that traverse the City Loop. This will enable services to be augmented to the CBD from other parts of middle, inner eastern and north-eastern Melbourne that are growing through residential densification, albeit at a more modest rate than the outer growth areas and in some of Melbourne's inner and middle ring suburbs.

Finally, Section 5.5.8 of the Plan also describes an ambitious medium-term project to substantially improve rail services from Melbourne's inner, middle and outer south-east and from the Gippsland region and, in turn, provide a direct connection from these regions to the Melbourne Airport line.

4.11.2 Trams

The existing network is already under extreme pressure handling current traffic volumes particularly within the CBD. If the potential of trams to serve the CBD is to be realised enhancements are required to:

- maximise the capacity and route connectivity of the existing network, with additional track connections at intersections, coupled with a restructure of existing routes and introduction of additional new routes to offer many new tram travel options
- extend several tram routes to connect with existing and new stations, including the routes of MM1 and MM2, and residential, commercial and employment areas of Fishermans Bend
- introduce longer trams up to 40m in length and accelerate delivery of new larger capacity trams to replace outdated low capacity, labour intensive small tram operation, allowing fleet expansion and introduction of new and extended routes
- improve tram stops
- initiate greater tram priority measures along key routes.

These proposals are detailed in Section 6 of the Plan.

D1 Class Tram in Congested Traffic – Burke Road, Camberwell

The 30 cars in front of and behind this tram carry an average 36 persons in total, whilst the latest articulated trams can carry 210 persons. This illustrates the current poor utilisation of road space in many parts of Melbourne.

4.12 Linking National Employment and Innovation Clusters and High Employment Areas

The tram network still serves Melbourne well, but is heavily biased towards inner northern, eastern and south-eastern suburbs in ways that largely reflect Melbourne's development between World Wars 1 and 2. Some major activity centres such as Footscray, Box Hill, Ringwood, Dandenong and Frankston are well served by the radial rail network to the extent that their access can be achieved from other locations on the same rail lines. Connecting these lines presents some of the best opportunities for public transport to provide cross-suburban access to these centres and our MCT proposals (see Sections 7 and 10) provide many of these links.

Some areas just beyond the Central Business District, such as Cremorne in Richmond are developing into significant commercial centres (see Case Study below).

CASE STUDY >> PUBLIC TRANSPORT LINKS UNLEASH DEVELOPMENT IN CREMORNE

City fringe locations like Cremorne are attracting significant interest from businesses who previously would have sought CBD office space. The Cremorne/Richmond area is supported by good public transport access with 3 rail stations, 2 tram lines and proximity to major activity centres of Swan/Church/Chapel Streets and the CBD. Lured by these factors, Cremorne is thriving with new businesses including creative, retail and technology companies. It is now one of Melbourne's most attractive commercial markets.

The area's amenity includes some of Melbourne's best cafés and retail strips, good public transport, Yarra River access and parks. Many businesses are avoiding a CBD location to harness the benefits of well serviced inner suburban locations like Cremorne, joining start-ups in key co-working arrangements.

Excellent public transport together with its vibrant character, are key reasons why the Rea Group moved from Victoria Gardens to Cremorne. So too for Red Energy, Seek, and David Jones,

Similar development could be expected along other well located inner areas such as Alexandra Parade if the gap in east-west rail and tram transport was remedied to link with north-south rail and tram lines; and in suburban major activity centres like Doncaster Hill, the Monash precinct, Footscray, Sunshine and others across Melbourne.

ARTICLE SOURCE: *Good public transport is key to more intense development as has occurred in Cremorne.*
https://urban.melbourne/development/2018/04/24/icon-and-wood-marsh-combine-600-church-street

Other important activity centres have emerged in the middle suburbs and beyond, not served by tram or train. The most obvious are Melbourne Airport, Doncaster, Knox City, Chadstone and the Monash precinct (see Case Study below). In most cases, these warrant a mix of high capacity radial links with the CBD, supported by cross-suburban links to provide access for centre employees, customers and visitors.

Similarly, there has been almost no extension of the tram network into middle western, north-western and south-eastern suburbs established during the decades following World War 2 when the motor car was widely perceived as the solution to mobility needs. Good quality public transport from middle suburbs has been only available via the radial rail network to the Melbourne CBD. Parts of these lines are now struggling for capacity driven by the combined effects of burgeoning growth toward their outer reaches and residential densification now occurring in many middle suburbs.

Access to middle suburb stations on these lines has largely relied on car parking availability (for which unconstrained demand greatly outstrips supply) or on feeder bus services of variable quality. Cross-suburban trips from middle suburbs to other areas of employment concentration are almost exclusively undertaken by car in the absence of usable public transport alternatives.

New growth areas in Melbourne's north, west and south-east already have some rail access to the job-rich Melbourne CBD. This should further improve in coming years through proposed rail electrification extensions or

various rail capacity enhancement projects. Some of these suburbs are also gaining feeder bus services to rail stations. However, in growth areas, except for some parts of the south-east, a significant gap remains between where people live and must travel to access employment outside the Melbourne CBD. Presently very little useable public transport is available to bridge that gap.

Major employment nodes are designated National Employment and Innovation Clusters (NEICs) under *Plan Melbourne 2017-2050* are developing in Werribee, Sunshine, La Trobe, Parkville, Fishermans Bend, Monash and Dandenong. Parkville is becoming an integral part of the wider Melbourne CBD while NEICs in the East Werribee area, at Sunshine and at Fishermans Bend are in their early stages of development. The latter has planned tram extensions and prospective MM2 heavy rail line.

The Monash precinct is strong in its own right; but when combined with the Chadstone precinct and Oakleigh, the combined area is becoming a super cluster. This rapidly developing area urgently requires a combination of new heavy rail and both east-west and north-south MCT corridors to strengthen its role in education, medical research and scientific innovation. Heavy rail and MCT proposals are detailed in Sections 5 and 7 of the Plan and proposed overall public transport access to the Monash precinct is detailed in Section 10.

CASE STUDY >> POOR PUBLIC TRANSPORT STIFLING MONASH UNIVERSITY RESEARCH PRECINCT

Monash University is identified in Plan Melbourne 2017-2020 as a major employment and innovation cluster - 53,000 students and workers seek access to the precinct daily.

However, poor public transport links are stifling its growth. The bus between the University and Huntingdale Station is now Melbourne's busiest bus route; but it has limited capacity and does not provide a long term solution to accommodate the precint's growth. With increasing congestion, the Monash precinct will be unable to accommodate as many students and workers in 2025 as it does today - unless its public transport access is very substantially enhanced.

Rail Futures proposes to support the Monash precint with high capacity train and light rail services.

The La Trobe and Austin Hospital precincts combine to form a strong relationship, but also require stronger transport linkages for employment access from the Heidelberg, Preston, Reservoir, Thornbury and Northcote residential areas. This too could become a super cluster of its own accord, supported by tram extensions, new SmartBus routes and potential MCT, details of which are set out in Section 10 of the Plan.

Dandenong is well served by existing heavy rail corridors extending from Pakenham and Cranbourne but lacks effective cross-suburban north-south or east-west connections. MCT proposals in this Plan are designed to provide these important new cross-town linkages.

Large employment nodes exist at Melbourne Airport and its surrounds, forming a super cluster of activity spread much wider than the immediate airport environs. It is possible that the Sunshine NEIC will combine with the Airport and Broadmeadows environs to create a mega cluster. There is available human capital as well as cheaper land to drive a different cluster unit here in addition to potential relationships which currently link each area with the Airport. The proposed Melbourne Airport Rail Link (MARL) from Southern Cross via Sunshine combined with proposals in this Plan for a tram extension and MCT east-west corridors, will provide much of the required connectivity with the Airport.

4.13 Meeting Disability Discrimination Act (DDA) Requirements

4.13.1 DDA Obligations and Standards

> *"Inaccessible public transport can have a profound effect on people's lives. It can frustrate and isolate people, and erode their ability to live confidently and independently"*[21]

Public transport in Victoria is gradually being made more accessible for people with disabilities and to comply with provisions of the Commonwealth Disability Discrimination Act 1992 (DDA). The DDA seeks to eliminate discrimination, 'as far as possible', against people with disabilities. Under the DDA, standards have been specified for access to public services including transport (Disability Standards for Accessible Public Transport 2002 - DSAPT). In prescribing how public transport is to be made accessible, the Standards acknowledge certain rights of passengers, operators and providers, as well as imposing some responsibilities to meet the Standards.

These Standards apply to all operators providing public transport services, and to the conveyances they use, supporting premises and infrastructure. There are specifications for manoeuvring areas, passing areas, bridges, resting places, ramps, waiting areas, boarding, handrails, lifts, etc. A target date of 31 December 2032 is stipulated for all public transport services to fully comply with the relevant Standards.

In December 2013, Public Transport Victoria (PTV) released *The Accessible Public Transport Action Plan 2013-17* for delivering accessible bus, train, tram and taxi services throughout Victoria. No update has been published to date.

"Absolutely Everyone", *Victorian State Disability Plan 2017-2020* (SDP) was released by the Victorian Government in December 2016. It observes that:

> *"Accessible public transport is critical for people with a disability. People with a disability need accessible public transport so they can easily travel to school, work and social events. Universal access to public transport services and facilities provides opportunities for people with a disability to make their contribution and lead a satisfying life. This means making public transport easy to use across all parts of the system including buses, trains, trams, taxis and other commercial passenger vehicles."*[22]

Key Priority 3 of the SDP covers public transport, but mostly in generalised statements such as to, *"prepare and maintain an accessibility implementation plan detailing how they* (public transport operators) *will make Victoria's public transport easier to use".* Specific matters addressed in Key Priority 3 mainly relate to accessibility issues in regional Victoria. There is no reference to metropolitan train and tram services.

As detailed in the following Sections, given progress to date, it will be extremely challenging to achieve the legislated target date of 31 December 2032 for both tram and train infrastructure and the tram fleet to meet the DSAPT requirements.

4.13.2 Trains and Access

All metropolitan trains are wheelchair-accessible but require train driver assistance to deploy a portable ramp at most stations. A small number of stations have a raised section of platform alongside the front carriage that permits unassisted level boarding of wheelchairs. However, train drivers are still required to ascertain the destination of such passengers to enable them to assist if required at relevant stations. Overall, this system, whilst somewhat unique to Melbourne, works satisfactorily. It has the added benefit of bringing train drivers into direct contact with the travelling public.

Metropolitan train stations (except Heyington on the Glen Waverley line) are theoretically accessible for people using mobility aids. However, while some metropolitan stations have ramps to enter the station and platforms, many are steep and do not comply with DDA standards. Such stations require people with a mobility aid to be assisted for access, and station staff (where provided) do not usually perform this function. Lifts are available at CBD and some suburban stations[23].

---

[21] *Public Transport Ombudsman Accessibility Report*, Victorian Public Transport Ombudsman, April 2019.

[22] *Victorian State Disability Plan 2017-2020*, p.11, released in December 2016.

[23] Lifts are currently available at Bayswater, Bentleigh, Blackburn, Box Hill, Boronia, Carnegie, Clayton, Coolaroo, Dandenong, Elsternwick, Epping, Flinders Street, Footscray, Gardiner, Ginifer, Hawksburn, Heatherdale, Hughesdale, Laverton, McKinnon, Mernda, Middle Gorge, Mitcham, Murrumbeena, Noble Park, North Melbourne, Nunawading, Ormond, Ringwood, South Morang, Southern Cross, Springvale, Thomastown, Watergardens, West Footscray, Westall, Williams Landing and City Loop stations.

Many stations (other than those constructed or rebuilt within the past decade or so) also do not comply with the DSAPT in relation to platform curvature, height, width and gradient. Curved platforms pose design challenges in providing an acceptable gap, both horizontal and vertical, between trains and the platform edge.

Curved platforms pose challenges in providing an acceptable gap between trains and the platform edge. Melbourne has many of these – this example is at Hawksburn (between South Yarra and Caulfield).
Photo: *John Hearsch*

4.13.3 Trams and Access

Large parts of Melbourne's tram network remain inaccessible to wheelchairs and other mobility devices. This is either because of the non-provision or limited provision of low floor trams on many routes and/or because less than one quarter of Melbourne's tram stops are DDA compliant.

Low floor trams have colour-contrasting grab handles, step edging for people and improved customer service information via automated announcements and electronic displays. All have a minimum of two allocated spaces for passengers using wheelchairs or mobility aids. This area is inside the double-door marked with a wheelchair symbol.

On low floor trams, a specially marked call button overrides the automatic door closing mechanism to allow passengers using wheelchairs or mobility aids extra time to enter or exit the tram. These trams also have an external door release (a blue button) to help passengers using wheelchairs.

High floor trams have steps, so are inaccessible for mobility aids including wheelchairs, scooters and motorised vehicles. They also present difficulty of access for those who are elderly or infirm and for those with children in pushers or prams. Over 300 high floor trams currently remain in operation.

On completion of current orders for new E class trams in 2021, there will be 200 low floor trams in use on Melbourne's tram network, representing approximately 37% of the total tram fleet. Yarra Trams aims to run all services on routes 19, 96 and 109 with low floor trams, to which routes 11 and 86 will be added when current new E class procurement has been completed. Meanwhile, routes 5, 6, 11, 16, 48, 58, 72 and 86 are partly serviced by low floor trams.

To meet DDA compliance by 2032 and to meet the projected peak traffic task by 2034 and beyond, a vastly accelerated tram fleet acquisition and replacement program is required, as detailed in Section 6. This would see the fleet grow from the current 500 trams to around 640 by 2034.

High floor tram at a DDA compliant stop

Photo: *Max Michell*

High floor tram at a non-compliant stop in Fitzroy Street, St Kilda

Photo: *Max Michell*

4.13.4 Accessible tram stops

Accessible stops have ramps for passengers, including people in wheelchairs, parents with prams and elderly people. Accessible stops feature improved lighting, granite and stainless-steel finishes, raised platforms with ramp access, real-time tram arrival information and glass shelters. Many of the newest accessible stops feature pedestrian crossings with flashing amber lights and tactile paving to assist customers to safely cross adjacent roads. Selected stops in the CBD have audio buttons providing real-time arrival information.

As at early 2019, 420 of the 1740 stops (24%) were DDA compliant (*source: PTV*) to complement low floor trams. However, some of these stops are on routes where low floor trams do not currently operate. Over 1300 stops still are not DDA compliant and the current platform stop construction and rationalisation program needs to be greatly accelerated. Additionally, new accessible tram stops on a route by route basis will need to be constructed to accommodate trams 33m in length. On specified routes, CBD and inner suburban platform stops will need to be extended to handle trams up to 40m in length.

Low floor trams at non-DDA compliant stops

Both photos: *Max Michell*

4.14 Encouraging Transit Oriented Developments (TODs)

Transit Oriented Developments (TODs) around major rail stations will be key to creating connected and lively urban areas. TODs also create job opportunities in service industries that generate counter-peak travel that the public transport network can accommodate at zero marginal cost.

Currently, most Australian rail stations have very basic and uninviting flow-through areas, but in other parts of the world they are lively recreational and retail hubs. Historically, decisions about station and over-station development have been made in isolation from urban planning decisions. However, in countries like Japan, Hong Kong and the UK, the development of recreational and retail precincts is fully integrated into station design. Railway stations in such countries also operate as the focus of wider land uses fully integrated with the public transport service, connecting employment, retail, and dense residential uses to a broader metropolis.

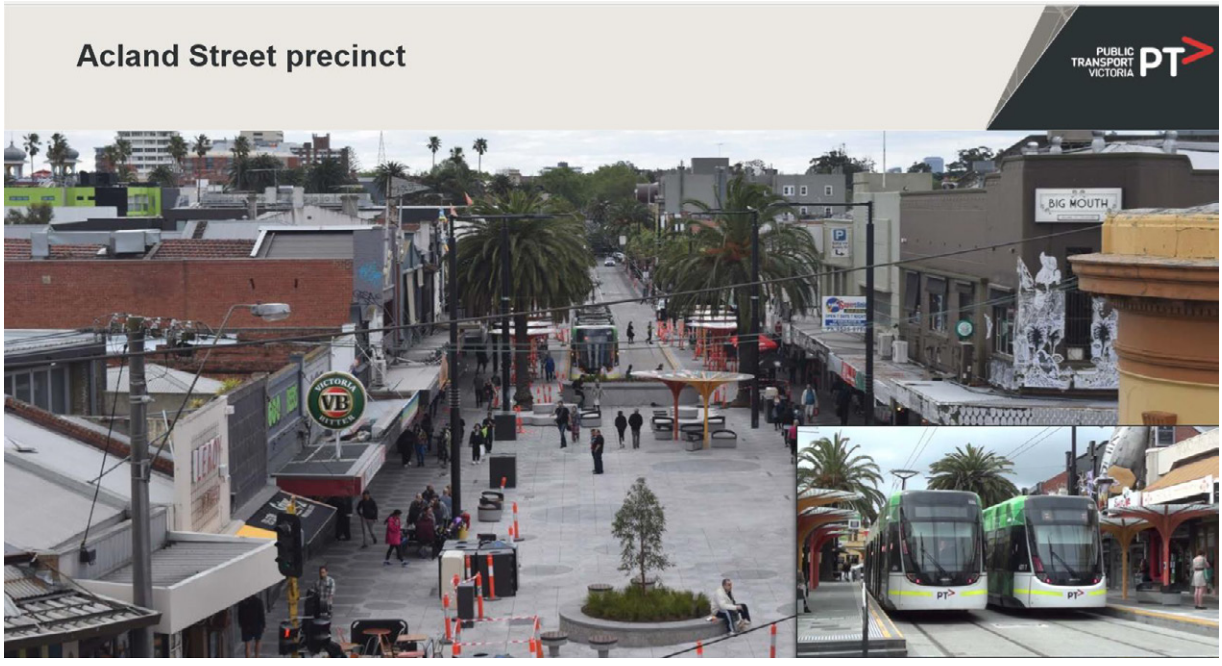
Managing station precinct developments is a key part of managing land assets towards better transport and community outcomes. With a focus on sustainable development, a range of benefits to precincts from upgrades and improvements to existing transport and community infrastructure, can be delivered, including,

- apartments
- shops and cafes
- landscaping and parkland
- improved station amenities
- access improvements
- bike storage and seating.

Completed in 2016, an example of a TOD is at Glen Waverley where a combined residential, commercial and retail development has been successfully integrated into the station facilities, as shown in the picture below.

Transit oriented development at Glen Waverley station
Photo: *Courtesy VicTrack*

The picture below shows a recent precinct upgrade in Acland Street, St Kilda at the terminus of Route 96. The tram route has been slightly shortened, two side platform stops created and cars banned from the terminus area which has been turned into an attractive pedestrian only zone. Initially strongly opposed by local shopkeepers, it has now been accepted as an improvement which benefits everyone.

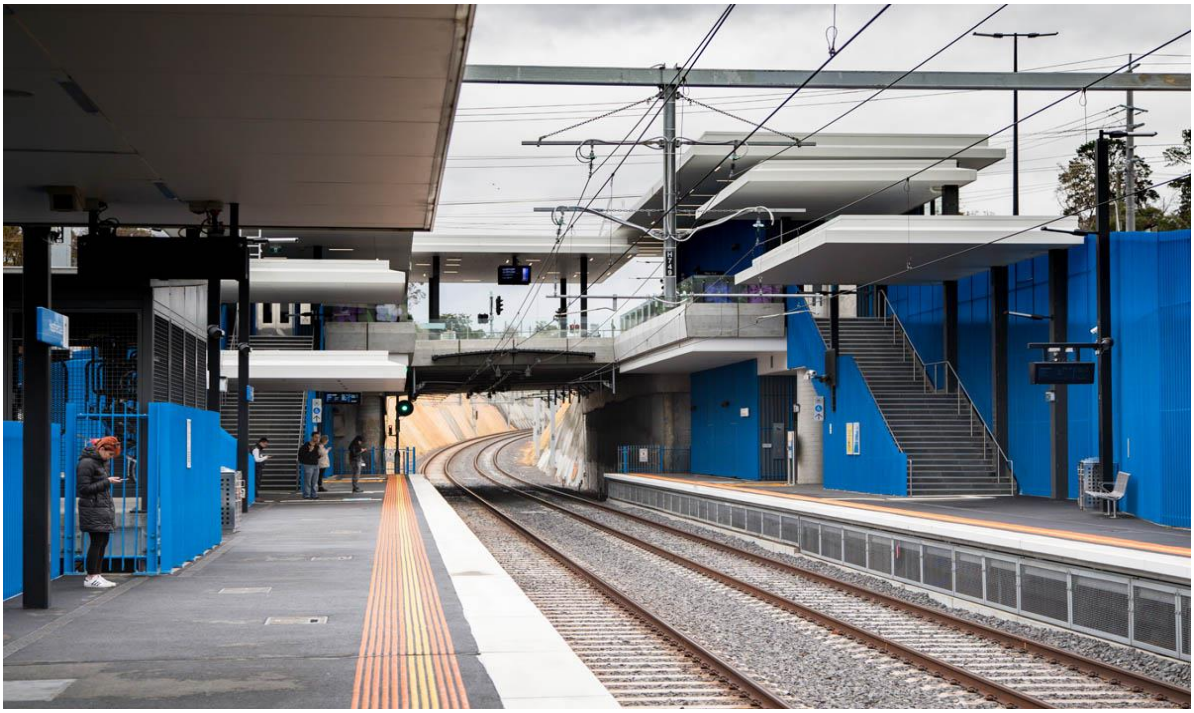


New twin track tram terminus in Acland Street, St Kilda
Courtesy: *Public Transport Victoria*

4.15 Removing Level Crossings

Operations on selected corridors will require grade separation of road and rail to improve safety and reliability, and to reduce road delays as rail services become more frequent and are intersected by other public transport routes. This particularly applies to Melbourne's remaining three rail/tram level crossings, (Kooyong, Riversdale and Glenhuntly), and those on key bus routes and other proposed tram and MCT routes.

Well-designed grade separation will facilitate improved intermodal transfer opportunities and enhance urban planning and design outcomes. Level crossing removals considered to be of high priority for removal are detailed in Section 5.9.



Heatherdale Station after removal of Heatherdale Road level crossing
Courtesy: *Level Crossing Removal Authority*

4.16 Determining Service Standards

Service standards for trains and trams are detailed in Sections 5.6 and 6.5 respectively

4.16.1 Service Frequency

Service frequency is the most critical element in the delivery of a grid public transport network that is sufficiently attractive to induce significant reductions in car dependency. This requires genuine "turn up and go" schedules that, for many journeys, eliminate the need to consult or understand timetables; this means intervals between services not exceeding 10-minutes. Weekday peak period services on most trunk rail and tram routes and a few bus routes already achieve this or better. This is of even greater importance where journeys involve interchange between two or more routes, irrespective of travel mode.

4.16.2 Hours of Operation

Services on all full-time routes by all modes would normally operate during a minimum spread of hours from 6am to 10pm on weekdays and 7am to 9pm at weekends. All heavy rail, tram and future MCT routes would generally provide services from 4.30am to 1.30am on weekdays and 5.30am to 12.30am on weekends. Trunk rail, tram, future MCT and SmartBus routes would also provide minimum hourly all-night services during the early hours of Saturday and Sunday mornings.

4.16.3 Reliability Standards

Existing service delivery and timetable adherence standards are generous by international standards and need to be tightened to reflect current community expectations and service reliability requirements that provide a viable alternative to private vehicle use. Proposed revised standards would require 99% monthly delivery of all scheduled services and on-time performance measured on departure, designed intermediate points and destination at 95% within 2 minutes during designated weekday peak periods and 3 minutes at other times for heavy rail services and 90% within 4 minutes for all other services. Mitigation would only be allowed in exceptional circumstances.

On the tram network, consideration should be given to monitoring service delivery relative to timetabled frequency of service, rather than adherence to timetable at specific locations en-route. To tram passengers,

reliability and adherence to the advertised frequency is far more important than timetables. Already in many cases, the timetables at stops indicate the frequency of service at specific times of the day. That is what tram travellers expect.

4.16.4 Capacity and Crowding

Maximum passenger load carrying standards should continue to apply to all vehicle types. All rolling stock and buses should be equipped with load monitoring devices linked to the MYKI ticketing system which would generate continuous passenger capacity utilisation data for each route journey.

4.17 Separating Metropolitan, Regional and Freight Services

Regional passenger services need to be segregated from burgeoning metropolitan services to increase overall capacity for the rail system, enhance reliability and to segregate express from slower stopping services. Each has quite different requirements in relation to stopping conditions, speed and technology and each serves a market with different user expectations.

Where both types of service are forced to use common infrastructure, the outcome has increasingly become sub-optimal as regional trains operate on train paths squeezed between more frequent Metro trains and their differing performance characteristics consume disproportionate levels of scarce track capacity. Regional passengers are increasingly frustrated by very slow journeys through the metropolitan area following Metro trains that mostly stop at all stations.

The Regional Rail Link project, completed in mid-2015, provided separate tracks for Geelong, Ballarat and Bendigo line regional passenger services between Southern Cross and Sunshine where they had previously intermingled with Metro services. This substantially increased capacity and reliability for both regional and Metro services, while allowing regional trains to operate at much faster speeds on segregated regional tracks.

However, Metro and regional trains still compete for track capacity on the following line sections:

- Bendigo trains – between Sunshine and Sunbury
- Seymour/Shepparton trains – between Southern Cross and Craigieburn
- Gippsland trains – between Southern Cross and Pakenham

In the absence of major additional infrastructure, the situation will considerably worsen when Metro electric train operations are extended, e.g. to Wyndham Vale/Black Forest Road, Melton/Bacchus Marsh, Clarkefield and Wallan as proposed in the following Train Plan (see Section 5.4). Hence the need to provide separate express tracks for regional trains and/or divert them on to a separate route. The proposed solutions are described in Section 5.7.

Rail freight movements that once serviced numerous sidings and terminals within the metropolitan area no longer operate wholly within the metropolitan area. Current rail freight movements are mostly for containerised and some bulk commodity exports from regional Victoria and interstate to the Port of Melbourne or for interstate domestic freight moving between Melbourne and other capital cities, particularly Brisbane and Perth. Virtually all other freight that moves within metropolitan Melbourne is handled by road transport.

The principal opportunity for changing this situation lies with the development of rail/port shuttle trains. Containerised freight comprises the largest volume of cargo handled at the Port of Melbourne, currently at almost 3 million x 20-foot equivalent units (TEU)[24] per annum. Some 60% of this volume comprises import cargo. Of this, nearly 90% has destinations within the greater Melbourne area. This volume generates thousands of truck movements per day to and from the Port precinct. Up to one-third of these movements could be handled by dedicated rail/port shuttle trains operating between the Port and metropolitan hub terminals strategically located in Melbourne's west, north and south-east. These could operate on existing rail infrastructure using available track capacity outside of weekday peak periods, including on one or more metropolitan passenger routes.

Three hub terminals have already been established for this purpose, although two are yet to be physically connected to the rail network. One or more complementary terminals would have to be established within the Port of Melbourne precinct to make the concept operate successfully. Other potential rail freight flows that

[24] TEU - Twenty Foot Equivalent Unit . Conventional Measure of the number of containers transported or handled at any facility.

could be developed to operate within or through the metropolitan rail network include building materials (sand, stone and gravel and cement) and containerised household garbage destined for recycling or reprocessing.

In 2017, the Victorian Government sought Expressions of Interest for the provision of rail/port shuttle train services between the Melbourne Port precinct and the abovementioned hub terminals. In October 2018, the Government announced partial funding to connect two metropolitan hub terminals to the proposed Port/Rail Shuttle Network[25]. The announcement also indicated a potential 'full on-dock' solution for port/rail shuttles at the Port of Melbourne.

4.18 Adapting to new transport innovations

4.18.1 New Technologies for Conventional Transport Modes

In recent years there have been rapid developments in transport technology throughout the world. The developments have been applied to existing train and tram services and to initiate proposals for radically new modes.

The conventional transport modes are continually adopting innovative technology to improve operational efficiency, reduce energy costs, improve operating performance, achieve better environmental outcomes and improve customer experience. Undoubtedly Melbourne will benefit from the development and incorporation of new technology into its transport systems, particularly in areas of:

- power supply
- overhead traction system
- infrastructure upgrading including stations
- signalling system replacement
- rolling stock design
- communications and security systems upgrading
- enhancing the customer experience
- automation of signalling and train control, to increase train throughput as all trains would operate without the variability associated with human control
- improving tram throughput with vehicle activated traffic signals
- reduced vehicle crowding problems with electronic monitoring of passenger movements to enable services to be varied to distribute loads more evenly
- using power inputs from environmentally acceptable sources

Detailed review of many of the opportunities for applying new technologies are beyond the scope of this Plan but RFI recommends immediate attention be given to the following areas:

- Melbourne's power supply system was designed for a fleet of traditional trains and trams. It must transition to a future network operating much larger vehicles, operating at greater frequencies. This will require detailed study of future options in terms of vehicle technology, energy efficient traction systems and an updated power supply network that provides resilience through redundancy and leverages the latest and most suitable technologies.
- Some substantial extensions to Melbourne's electrified heavy rail network are proposed in this Plan. Where these have the potential to largely stand alone and and/or where connections to the existing network are limited, consideration should be given to adopting a more modern and efficient overhead traction power system based on 25kv AC rating rather than the traditional 1.5kv DC system. This has several advantages including many fewer sub-stations, lighter less intrusive structures and cabling and better train performance potential relative to the system's capital cost.
- Much signalling equipment and some elements of the electric traction system are both life expired and obsolescent. Replacement provides the opportunity to progressively introduce technology which enhances both network capacity and reliability. Replacement of obsolete and inadequate infrastructure is required on a significant scale on the Melbourne metropolitan networks over at least a 15-year period.

[25] See https://www.premier.vic.gov.au/port-rail-projects-to-take-trucks-off-local-roads/ dated 26 October 2018.

- An ongoing program is also needed specifically directed at using the latest technologies to progressively improve passenger experience and amenity at stations and interchanges. The station improvement program needs to encompass a wide range of matters including weather protection, lighting, security systems, DDA compliance and information systems (static, dynamic, visual and audio). Public transport will be able to significantly improve customer information, security, and the entire customer experience with adoption of the latest technology. Personalised real time information can be made available about services, routes, timetables, travel conditions and parking availability. Travellers can be informed, entertained and educated while travelling.

Clear, informative displays at stations and interchanges are a basic requirement
Photo: *John Hearsch*

4.18.2 Autonomous Vehicles

The introduction of autonomous driving raises many issues for transport planners and operators. Autonomous on-road driving technology has the potential to vastly alter the nature of passenger and freight travel. How and when this happens will have considerable implications for mode share and travel patterns. Some predict that by 2040 these vehicles will account for up to half of all road travel. Not only will autonomous vehicles affect travel behaviour, but they could change the development patterns of the city.

While the implications of autonomous vehicles are extremely difficult to anticipate, there are undoubted opportunities to integrate pubic transport services with driverless cars in ways to optimise the overall effectiveness of each mode. For example, the use of driverless cars to provide local access to railway stations could provide a high quality and efficient end-to-end passenger journey.

4.19 Framework and Principles for Evaluating Projects

4.19.1 Criteria for Selecting Projects

The RFI Plan has been developed applying the following criteria for selecting projects to increase mode share for public transport by:

- improving the efficiency of the networks
- improving the accessibility and coverage provided by public transport
- providing greater connectivity across the metropolitan area (developing a grid network)

- facilitating the development of employment clusters, transit corridors and transit-oriented centres
- increasing capacity to match demand
- improving service quality.

Proposed projects will require detailed planning beyond the scope of this Plan. In the proposals detailed in Part 3 of this Plan the following important considerations have been recognised:

- The estimated cost of the option, both in its cost to build and operate
- The likely economic, social and environmental impacts of the option
- The level of transport integration achieved
- Appropriate timing, including when utility of existing infrastructure will be maximised before the next stage of a planned progression will be implemented
- Extent to which public transport access to principal and major activity centres is improved
- Relationships between options including how they might enable, complement or inhibit one another
- Extent to which the project provides relevant future proofing
- The potential level of community support (or otherwise) for the option
- Resilience of the options under alternative future scenarios
- Any relevant interactions with current state planning strategies
- In the case of a heavy rail project, whether it will reduce the operational complexity of the network
- Operational feasibility and constructability
- The contribution of each segment as part of a wholistic implementation of a total transport plan.

The required economic analysis of proposals must also take account of wider economic benefits, some of which are not readily quantifiable.

4.19.2 Benefits from Investing in Public Transport

Increasing transport supply will invariably induce changes in transport demand, particularly with provision of fixed rail infrastructure. Availability and time involved in travel are very strong factors in housing and work location decisions. Sustained investment in transport infrastructure (and rail specifically) will materially assist in managing the challenges posed by population and economic growth and is likely to result in additional benefits. These include:

- **Population change** - Improved rail services will expand the reach of the Melbourne commuting area and result in population growth being concentrated in areas served by upgraded rail services and in accordance with planning policies. There will be a net benefit to the State because growth can be achieved more efficiently and at lower cost.
- **Business development** – Population growth in planned locations will generate multiplier effects, in turn creating further investment in a wide range of business activities, leading to new enterprises and employment. Greater connectivity reduces transport costs for businesses located in these centres and increases labour mobility. More people will be able to live in suburban areas and still access economic and social opportunities in major activity centres. The substantial increase in attractiveness and capacity of the public transport network will allow Melbourne to grow by allowing concentrated employment centres to prosper while minimising road congestion that would otherwise develop.
- **Strategic Integration** – Improved rail will facilitate closer integration of the economies of urban centres and central Melbourne. Reduction in travel times will encourage more business and educational travel as people find it more convenient to attend meetings, seminars and courses in Melbourne and these centres.
- **Labour market efficiencies** – Improved rail travel between central Melbourne and between urban centres will open access to a much wider labour pool for business, with skill shortages becoming less of an impediment to business and economic development throughout the entire metropolitan area.
- **Safety benefits** - Any shift from road to rail travel will reduce the potential for death and trauma from road accidents, since rail travel is vastly safer than travel by car.

- **Environmental benefits** – Rail is more efficient per passenger km than car travel, therefore a shift from road to rail travel will reduce the overall energy requirements for travel and reduce motor vehicle-related pollution effects including carbon emissions.
- **Health benefits** - Major health benefits are associated with active travel, including walking and cycling to reach public transport. This will help reduce the adverse health impacts of sedentary travel patterns.
- **Personal productivity benefits –** Public transport travel provides an opportunity for productive use of the time involved in ways that are not legally available to car drivers.

4.20 Other issues

This Plan does not profess to having dealt with all issues or have provided the only solutions for rail, let alone other transport modes for Melbourne. That would not be possible for the city's complex and extensive transport systems - one of the World's most expansive cities. Rather, our aim is to help in creating a vision for Melbourne's public transport and contribute to discussion around how Victoria can best meet the challenges of population growth, congestion and good public transport when properly integrated with land use planning.

As such, proposals in the following sections of this Plan need to be considered in parallel with other important issues which are necessarily beyond the scope of this report. Most of these issues need to be part of strategic policy and a long-term program which becomes embedded and enduring. For example, the scale of investment required (quantified in Section 13) transcends decision-making within election cycles. Hence, Victoria's growth strategy needs to be understood and owned by the community and across the political spectrum.

Other important issues (not listed in any particular order) requiring consideration in this context include:

- adequacy and suitability of consultation processes for major and minor transport projects
- availability of up to date transport statistics (e.g. detailed patronage data) in the public domain
- the extent to which project business cases should be in the public domain
- desirability of major project post-audits being undertaken in the public domain to identify lessons learned, add to corporate memory and be a basis for continuous improvement
- the extent to which projects should incorporate sensible future proofing
- the respective roles of Commonwealth, State and Local Government in transport planning
- role of the private sector in transport planning (e.g. in submitting unsolicited proposals)
- maintaining continuity of project programs and delivery, e.g. for rolling stock manufacture
- maintaining and upgrading human skills in transport project planning and construction
- the need for identification and protection of future transport corridors, stations, depots, maintenance and stabling facilities
- consideration of longer-term transport infrastructure requirements, e.g. to service a future Bay West port complex and a potential third major airport to the south-east of the metropolitan area
- critical environmental factors, including vehicle emissions and noise standards
- the impact of emerging technologies for all transport modes
- the impact of electric vehicles and diminished revenue from fuel excise payments
- project funding and financing, including the potential role of value capture
- road user pricing, including congestion and parking levies
- road design including provision for transit lanes and safe cycling
- public transport cost recovery and subsidies
- public transport fares policy, including differential peak and off-peak pricing to better spread loadings

The Plan that follows is a blueprint for the implementation of a substantial program of projects. The phased program has been carefully designed to allow projects to be progressively brought on stream over a 30-year period. It is ambitious but achievable.

PART 03 DESCRIBES A PLAN FOR MELBOURNE'S RAIL-BASED PUBLIC TRANSPORT.

PART 03

A RAIL PLAN FOR MELBOURNE 2050

5. The Train Plan

5.1 Train Plan Overview

The broad objectives of the Rail Futures' Train Plan are to:

- increase capacity of the existing metropolitan rail network to meet projected patronage growth
- simplify and streamline the rail operation to improve its overall efficiency, reliability and resilience
- provide enablers to allow metropolitan rail services to achieve consistently high levels of service quality
- extend the reach of the metropolitan rail network into high growth areas it does not presently serve
- provide direct rail access to nominated key metropolitan Employment Clusters and Major Activity Centres
- transform much of the existing radial rail network into high capacity cross-city and cross-metropolitan corridors
- segregate metropolitan and regional train operations so that each can provide high quality services
- encourage Transit Oriented Development around suitably located stations
- be an integral part of a fully integrated multi-modal Melbourne Public Transport Grid Network
- enhance the travel experience of users as part of a wider process for reducing car dependency.

The Train Plan aims to provide the essential linkage between the above objectives and their achievement by means of investment in infrastructure, rolling stock, associated facilities and systems, and through non-investment operational measures. In this Section there are recommendations for:

- projects to increase network capacity
- projects to improve operational efficiency
- extensions of electrification to outer metropolitan growth areas
- creation of major cross-city mass transit corridors
- steps in the segregation of metropolitan and regional train services
- proposals for new stations
- rail infrastructure upgrading and renewal
- additional level crossings that should be removed
- passenger amenity improvements at stations and interchanges
- new rolling stock requirements
- stabling and maintenance facility requirements
- operational (non-investment) measures.

5.2 Projects to Increase Network Capacity

By far the most significant increment to network capacity since completion of the Melbourne Underground Rail Loop in the early 1980's will be the opening of the Melbourne Metro (MM1) project in 2024.

The MM1 project will considerably increase capacity on all corridors (other than those served by the Burnley and Clifton Hill City Loops) and enable longer trains on the MM1 corridor and more efficient operations overall. As a standalone project[26], it will achieve this by:

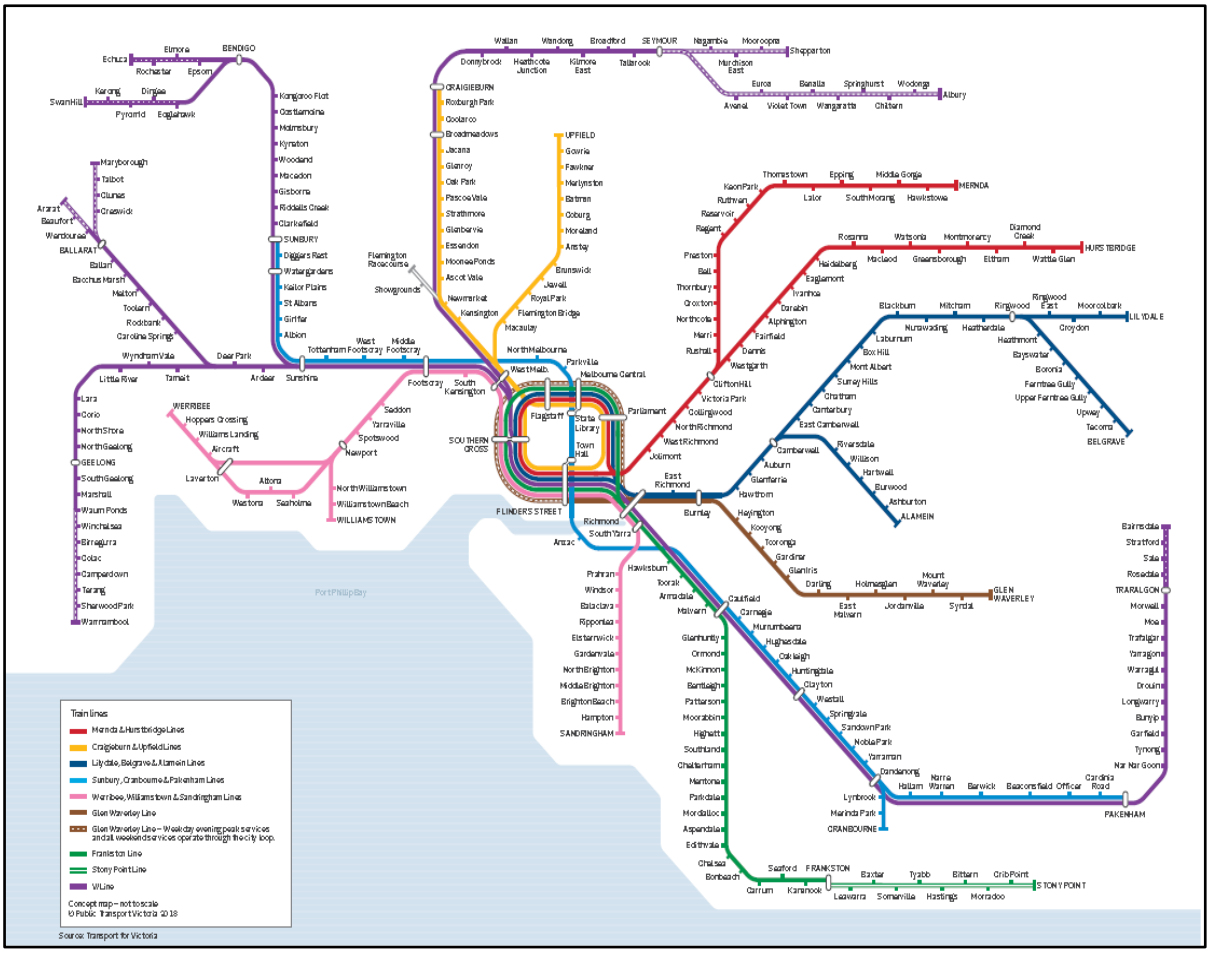
- creating a high capacity corridor between South Kensington and Hawksburn for exclusive use by trains on the Sunbury and Cranbourne/Pakenham lines, including subsequent extensions to Melton/Bacchus Marsh and to Clyde, and operated independently of all other Metro services
- releasing capacity in the Northern City Loop presently used by Sunbury trains allowing increased services on the Craigieburn and Upfield lines

[26] Some of these outcomes will change in the event that reconfiguration of the City Underground Loop is implemented immediately after MM1 is completed (see Sections 5.5.3 and 5.5.5).

- releasing capacity in the Caulfield City Loop presently used by Dandenong/Cranbourne/Pakenham trains allowing increased services on the Frankston line
- releasing capacity on the through suburban lines between Flinders Street and North Melbourne presently used by some peak period Sunbury trains to allow increased services on the Williamstown, Altona/Laverton and Werribee lines, including linking of the Werribee and Sandringham lines into a single cross CBD corridor, thereby also allowing increased services on the Sandringham line
- providing updated signalling to allow trains to run at closer headways between Sunbury and Pakenham.

A diagrammatic representation of the overall metropolitan and regional network upon completion of MM1 is shown in Figure 19 and detailed in Section 5.5.

Figure 19: Victorian train network configuration following completion of MM1 Project



Source: Public Transport Victoria

The following associated works are required to ensure that the MM1 project can achieve its full functionality from commencement of operations. These works will allow more effective use of corridor capacity and contribute to a more intensive use of train sets:

- New turnbacks at West Footscray, Essendon and Cheltenham
- Signalling upgrades - Newport to Werribee, Broadmeadows to Craigieburn, South Kensington to Sunbury
- Traction power upgrades to support increased service frequencies and new trains
- Platform lengthening to accommodate longer electric trains
- Sandringham second platform

These projects are shown in Figure 20.

Further measures to increase metropolitan rail network capacity include other targeted infrastructure investments, use of higher capacity rolling stock and a range of operational measures.

Proposed targeted infrastructure investments in this Plan, also detailed below, include the following:

- Electrification extensions enabling metropolitan services to outer growth suburbs
- Duplication of single line sections that are constraints to provision of additional services
- Reconfiguration of the Melbourne Underground Rail Loop
- Developing new corridors to directly or indirectly accommodate demand growth
- Modifying station track and junction layouts to eliminate conflicting train movements
- Providing additional tracks on selected corridors to facilitate operational segregation between metropolitan and regional trains
- Extending platforms and stabling sidings to accommodate longer trains
- Introducing new and more sophisticated signalling systems to allow trains to operate at closer headways, most likely involving new technologies
- Introducing automated or semi-automated train operation to optimise train network performance.

Rolling stock measures include the following:

- Purchase of new higher capacity trains to make better use of the infrastructure, including the option of acquiring longer trains with more carriages
- Changing the internal train seating/standing ratio by reconfiguring interior train layouts.

Operational (non-investment) measures include the following:

- Increasing train frequency by reducing train headways within the limitations of the signalling system
- Altering train stopping patterns to provide greater consistency between successive services
- Ensuring train types operating on any single corridor have very similar performance characteristics
- Reducing station dwell times by more effective management of passenger flows on platforms, through ticket barriers and/or on vertical transport within station environs.

5.3 Projects to Improve Operational Efficiency and Resilience

Projects to improve efficiency are primarily directed at reducing the operational complexity of the network and promoting its progressive disassembly into standalone operational units. Each of these units becomes self-contained in relation to train timetabling, fleet allocation, train stabling and maintenance and, to a significant extent, train crew. In this way, overall network management is simplified, and resilience increased because incidents that impact a particular line do not spread into other parts of the network.

By 2024, the Melbourne Metro (MM1) project will create a standalone corridor from Sunbury and Melton to Pakenham and Cranbourne/Clyde supported by a major depot at Pakenham East and a supplementary facility at Calder Park.

In subsequent years, further corridor segregation will occur to create six additional standalone operational units in the form of major Mass Transit Cross-City corridors (see Section 5.5). Short term, this will be facilitated by the proposed reconfiguration of the Melbourne Underground Rail Loop (MURL). Each standalone corridor will be supported by major maintenance and stabling facilities at specified locations (see Section 5.13).

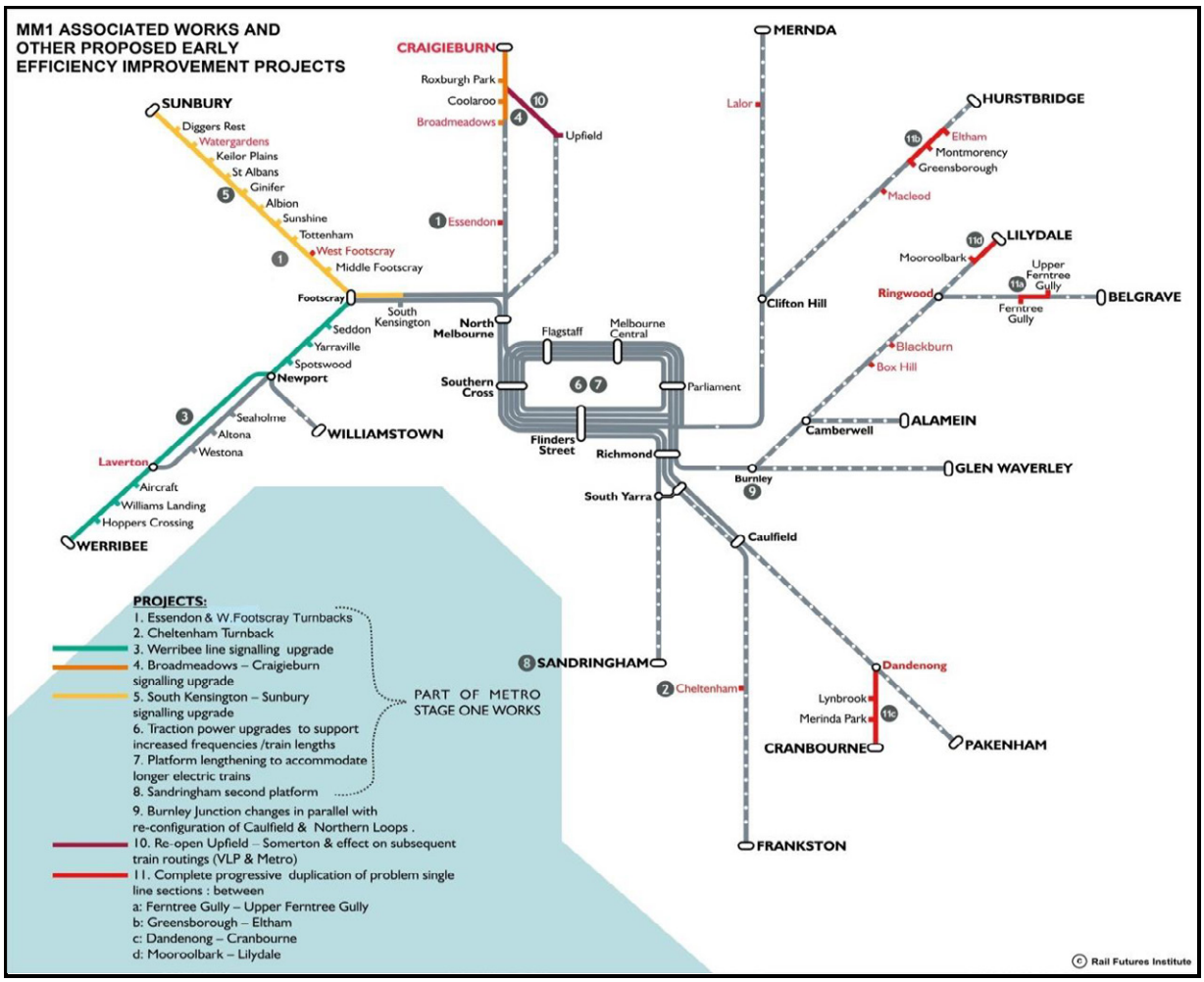
Other projects are very important for providing both additional corridor capacity and enhancing operational efficiency and reliability through the elimination of delays from conflicting train on single line sections and specified junctions. Those which are required, including in advance of, or concurrent with MM1 completion and/or proposed City Loop reconfiguration (i.e. by 2024), are:

- Progressive duplication of problematic single line sections in the following priority sequence:
  - **By 2023** - Dandenong – Cranbourne
  - **By 2024** - Gowrie – Upfield (part of Upfield – Roxburgh Park project - see below)
  - **By 2025** - Greensborough – Eltham
  - **By 2025** - Mooroolbark – Lilydale
  - **By 2027** - Ferntree Gully – Upper Ferntree Gully

- **By 2024** - Burnley Junction reconfiguration to enable counter peak services to Ringwood and Glen Waverley lines to be fully segregated This is a critical prerequisite for City Loop reconfiguration. The project would also be designed in anticipation of future track quadruplication between Burnley and Camberwell (see Section 5.5.5 below).
- **By 2024** - Re-opening, duplication and electrification Upfield – Roxburgh Park. This project will enable some Craigieburn trains to travel via Upfield, thus releasing capacity on the corridor via Essendon for additional regional trains to operate between Southern Cross and Wallan, pending electrification being extended from Craigieburn to Wallan by 2028 (see Section 5.4.4, below).

These projects are shown in Figure 20. More detail on these projects is set out in Appendices HR 3 to HR 26.

Figure 20: Efficiency Improvement Projects



5.4 Extensions of Metro Services to Outer Metropolitan Growth Areas

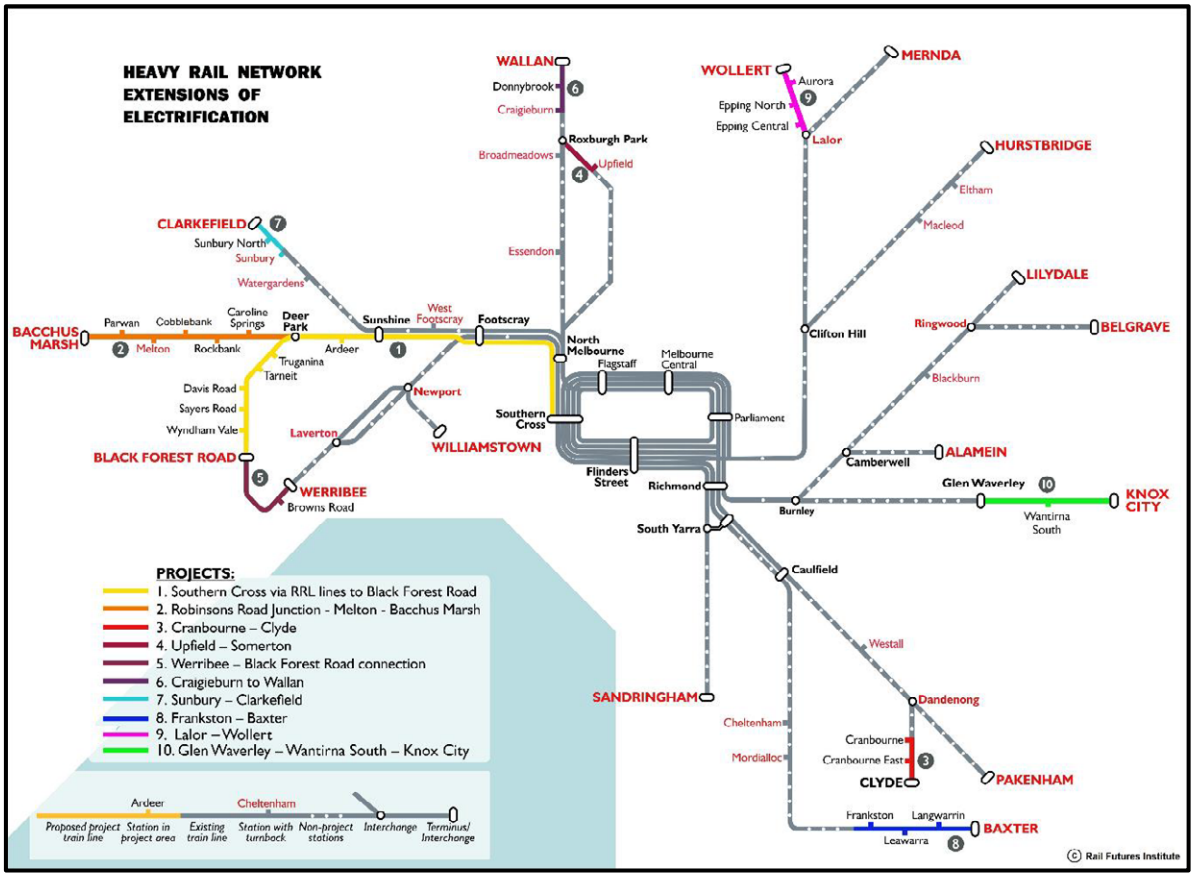
5.4.1 Rationale and priorities

Extensions of existing metropolitan lines and/or electrification of inner parts of regional lines to service designated metropolitan growth areas are an urgent requirement. Rail extensions into outer metropolitan growth areas are directed to overcoming identified deficiencies in access to effective public transport by provision of frequent services using high capacity electric trains. Ideally, these projects should be used to guide development of new growth areas and to encourage a culture of reduced car dependency in new sub-divisions from the outset. However, in most cases the developments will largely be in place by the time these projects can be implemented.

To address these deficiencies, the following electrification extensions are proposed, shown in indicative priority sequence (see Figure 21):

- **By 2023**: Southern Cross (platforms 15/16) via RRL lines to Sunshine, Wyndham Vale and extended to a new station at Black Forest Road
- **By 2024**: Deer Park (Robinsons Road Junction) to Melton
- **By 2024**: Upfield to Roxburgh Park
- **By 2025**: Cranbourne to Clyde
- **By 2026**: Extension Melton to Bacchus Marsh
- **By 2026**: Frankston to Baxter
- **By 2027**: Werribee to Black Forest Road
- **By 2028**: Craigieburn to Wallan
- **By 2032**: Sunbury to Clarkefield
- **By 2034**: Lalor to Wollert
- **By 2040**: Glen Waverley to Knox City

Figure 21: Proposed Electrification Extensions



The functionality and scope of each project is described below.

5.4.2 By 2023: Southern Cross to Black Forest Road via Sunshine and Wyndham Vale

The Regional Rail Link (RRL) lines from Southern Cross to Sunshine and from Deer Park (Robinsons Road Junction) to Manor Junction on the original Geelong line opened in mid-2015. The RRL project provided an interim solution to a capacity crisis by transferring all V/Line diesel trains from the Metro lines to a new non-electrified track pair between Southern Cross and Sunshine, but within two years these were operating at near capacity (in terms of available train paths) during weekday peak periods.

Currently, the RRL lines exclusively carry all V/Line trains to Geelong and Wyndham Vale over its full length, Ballarat, Bacchus Marsh and Melton trains as far as Robinsons Road Junction and Bendigo and Kyneton services as far as Sunshine.

With few additional train paths available between the CBD and Sunshine, the current position is unsustainable in that V/Line Geelong trains are being overwhelmed by increasing patronage from the Geelong Region,

compounded by burgeoning growth throughout the outer metropolitan municipality of Wyndham, reflected in travel from Tarneit and Wyndham Vale. Three additional stations are planned between Deer Park and Wyndham Vale and a fourth, at Black Forest Road, on this corridor 2.8 km beyond Wyndham Vale.

The proposed solution is to electrify the entirety of the present RRL corridor between Southern Cross (platforms 15 and 16) and Black Forest Road to allow for early introduction of high capacity Metro trains up to 9-cars in length. These trains would be stabled and maintained at a new depot (stage 1) south of Black Forest Road.

A precursor for these works will be grade separation of three level crossings at Fitzgerald Road, Ardeer, and Station Road and Robinsons Road, Deer Park, approved by the State Government in late 2018. (see Section 5.9).

Project scope for extension of electrification from Southern Cross to Black Forest Road would include:

- installation of electric traction infrastructure extending 43 km from Southern Cross (platforms 15/16) to Black Forest Road via Footscray, Sunshine, Robinsons Road Junction and Wyndham Vale
- track rearrangement between Sunshine and Robinsons Road Junction to allow for a future Melton electrified suburban track pair on the northern side of the corridor
- rebuilding of Ardeer and Deer Park stations and their relocation to the northern side of the rail corridor to suit future incorporation into the Melton electrified suburban track pair
- re-arrangement of Robinsons Road Junction with improved alignment and provision for future additional track pairs to separate Black Forest Road and Melton suburban and regional express tracks
- new stations at Truganina, Davis Road (West Tarneit) and Sayers Road
- new terminal station at Black Forest Road including turnback facilities and two additional platforms for interchange with Geelong line trains on the regional express track pair (See below)
- new stabling sidings and train maintenance facility (stage 1) south of Black Forest Road station.

Subsequently, it will be necessary to install an additional regional express track pair between Sunshine, Robinsons Road Junction and Black Forest Road to enable full separation of Metro and V/Line regional trains. This aspect of the required infrastructure changes is detailed in Section 5.7.

5.4.3 By 2024: Deer Park (Robinsons Road Junction) to Melton

Rapid population growth is also occurring on the Ballarat line corridor between Deer Park and Melton with new stations recently opened at Caroline Springs and Cobblebank. An additional station is planned at Mount Atkinson (located west of Hopkins Road) whilst Rockbank has recently been rebuilt to cater for increasing patronage. Full duplication of the line between Caroline Springs and the western end of Melton was recently commissioned with provision for extension of electrification to Melton.

Stations between Sunshine, Deer Park and Melton are currently served by V/Line trains operating between Sunshine, Bacchus Marsh and Ballarat, however ongoing patronage growth is expected to substantially exceed the capacity of these services within less than 5 years.

Completion of the Melbourne Metro (MM1) project (see Section 5.5.2) has been regarded as a pre-requisite for commencement of electrified services to Melton. MM1 has been designed to accommodate Metro services to both Sunbury and Melton. These will work through to Dandenong, Cranbourne/Clyde and Pakenham.

It is therefore proposed by 2024 to electrify the existing duplicated track between Robinsons Road Junction and Melton – covering an overall distance of 24 route km. A stabling facility for Melton trains will be constructed on the northern side of the rail corridor between Cobblebank and Melton.

Project scope for extension of electrification from Robinsons Road Junction to Melton will include an additional electrified Metro track pair between Sunshine and Robinsons Road Junction located on the north side of the existing corridor, including a grade separated rail/rail junction at the western end of Sunshine station, incorporating the rebuilt stations at Ardeer and Deer Park on the Melton electrified track pair.

Other works scope for this project would include:

- installation of electric traction infrastructure extending 24 km from Robinsons Road Junction to Melton
- new station at Mount Atkinson (between Caroline Springs and Rockbank, near Hopkins Road)
- new train stabling sidings between Cobblebank and Melton
- third platform at Melton for terminating trains

An additional non-electrified track pair will also be required between Robinsons Road Junction and Melton to enable full separation of Metro and V/Line regional trains. This aspect of the required infrastructure changes is detailed in Section 5.7.

5.4.4 By 2024: Upfield to Roxburgh Park (Upfield Diversion project)

The Upfield line closely parallels the Craigieburn line for much of its length, however both lines serve fast growing populations, generated by inner and middle suburbs residential densification as well as outer northern suburbs growth. Due to capacity of the Northern City Loop being at its limit, there is no remaining capacity to operate additional services during peak periods on either line pending completion of MM1 and removal of Sunbury line trains from the City Loop. Currently, the Craigieburn line has 11 tph scheduled during peak periods while the Upfield line has only 3 tph at all times.

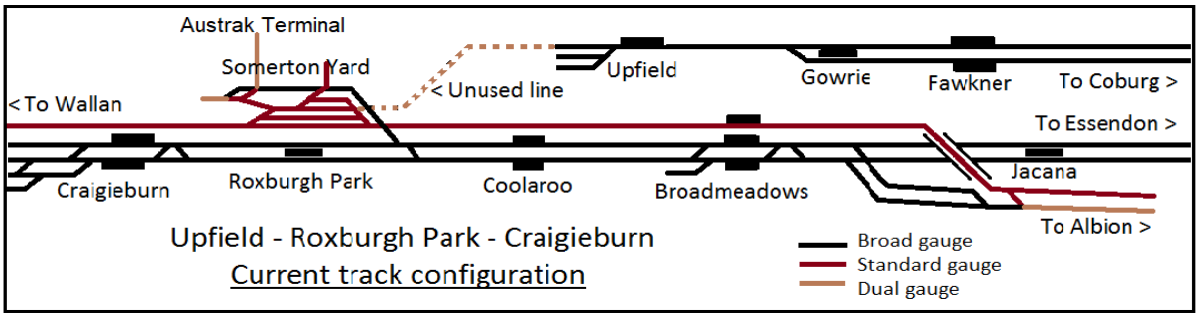
When the constraints imposed by the City Loop are removed, pent up demand on both lines coupled with increased frequency of regional trains on the Seymour/Shepparton line will necessitate substantial increases in service frequency in both corridors.

In this case, it is proposed to physically connect the two lines at Roxburgh Park by reopening, duplication and electrification of the former freight line between Upfield and Roxburgh Park (otherwise known as Somerton). This will enable Metro trains to operate between the CBD and Craigieburn via either Coburg/Upfield or Essendon/Broadmeadows, potentially increasing the train path capacity of the combined corridors from 14 to 24 tph.

Proposed City Loop reconfiguration (see Section 5.5.5) will further increase the combined corridor capacity. This will provide ample future proofing to accommodate the proposed extension of electrification from Craigieburn to Wallan (see Section 5.4.9, below).

The current track and route configuration of the northern part of both lines is shown in Figure 22 below.

Figure 22: Current configuration of Upfield and Craigieburn lines (northern section)

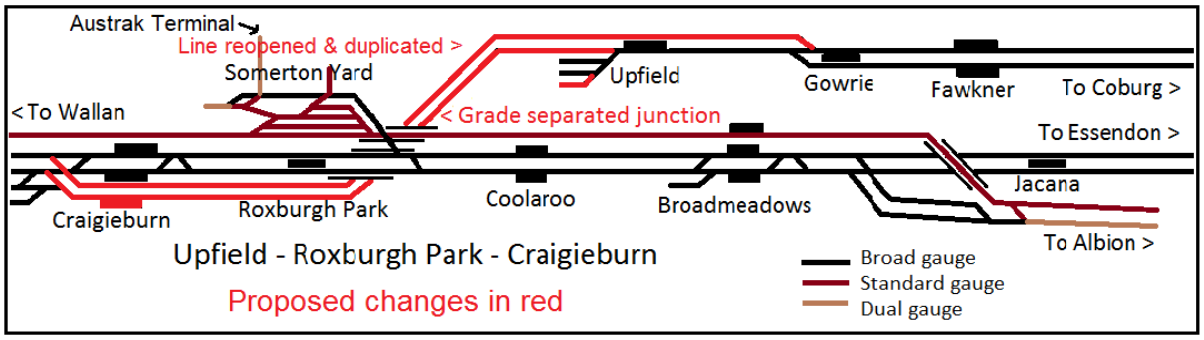


The overall scope of the proposed Upfield Diversion project also includes duplication of the existing 4 km single line section between Gowrie and Upfield (see Section 5.3) and a new station at Campbellfield (see Section 5.8), together with the following works:

- Provision of a second platform at Upfield
- Potential grade separation of the Barry Road level crossing at Upfield
- Re-arrangement of existing Upfield stabling sidings
- Rebuilding, duplication and installation of electric traction infrastructure on the former 2 km freight line between Upfield and Somerton
- Rail/rail grade separated junction at Roxburgh Park, with the reopened line passing beneath the standard gauge interstate line and the existing Craigieburn line in the vicinity of the Somerton Road overpass
- An additional electrified track pair between Roxburgh Park and Craigieburn (4 km).
- Two additional platforms at Craigieburn.

The anticipated track and route configuration following completion of the above works is shown in Figure 23.

Figure 23: Proposed configuration of Upfield and Craigieburn lines post-Upfield Diversion works



5.4.5 By 2025: Cranbourne to Clyde

Melbourne's outer south-eastern suburbs, in common with its outer western and northern suburbs, are experiencing rapid population growth. Much of this growth has occurred in the City of Casey including the area served by the former South Gippsland railway between Dandenong and Tooradin. V/Line trains ceased serving Cranbourne in 1993, with Metro electrification extended from Dandenong to Cranbourne in 1995. Freight trains continued to use the line beyond Cranbourne until it was closed in 1998.

For several years, there has been agitation for the line to be reopened to Clyde and in the longer term to Koo-Wee-Rup or Lang Lang. Current population densities clearly support provision of Metro services to Clyde but there is little medium-term justification for rail passenger services beyond that point[27].

Duplication of the line between Dandenong and Cranbourne is a high priority (see Section 5.3) and a necessary precursor to the restoration of train services beyond Cranbourne. It is therefore proposed that works to reactivate the line between Cranbourne and Clyde be undertaken as soon as possible after the Cranbourne line duplication is completed. The project scope will include:

- restoring, rebuilding, duplicating and electrifying the 5.8 km of line between Cranbourne and Clyde
- grade separation of the South Gippsland Highway level crossing at Cranbourne
- Rebuilding Cranbourne station as a consequence of both the aforementioned grade separation and extended through rail operation to Clyde
- grade separation of four additional level crossings (at Narre Warren Road, Broad Oak Drive, Berwick-Cranbourne Road and Clyde-Five Ways Road)
- relocation of the existing Cranbourne train stabling facility and its re-establishment at Clyde
- a new intermediate station at Cranbourne East and new terminal station at Clyde

5.4.6 By 2026: Extension Melton to Bacchus Marsh

Although outside of Melbourne's designated Urban Growth Boundary, the Bacchus Marsh area, including the adjacent suburbs of Darley and Maddingley, has exhibited substantial growth over recent years and this is expected to continue. Further new residential development is anticipated at Parwan potentially requiring provision of a new station.

Located within the Shire of Moorabool, there are mixed views within the community and Council as to whether extension of electrification from Melton to Bacchus Marsh is supported or not.

A decision in this regard involves trade-offs for investment and service levels:

- The Melton/Bacchus Marsh/Ballarat corridor will support a two-level service comprising stopping all stations Metro trains terminating at either Melton or Bacchus Marsh (but not both), and express and semi-express trains serving the Ballarat area and beyond
- Electrification will provide Bacchus Marsh with a more frequent service and much greater capacity for growth than would be the case were electric services to permanently terminate at Melton , with Bacchus Marsh being served by V/Line Ballarat trains

[27] It is noted that *Plan Melbourne's* future third Melbourne airport is located close to the railway reserve between Koo-Wee-Rup and Lang Lang. However, the area is not ideally located to service future growth in Melbourne or Gippsland. The Victorian Government is expected to assess the need for a third Melbourne airport in coming years.

- If electrification does not progress beyond Melton trains to and from Ballarat must provide capacity for Bacchus Marsh travellers, involving sub-optimal utilisation of costly rolling stock
- Patronage at a future new station at Parwan will be challenging to accommodate on Ballarat trains
- An additional train stabling facility will be provided between Cobblebank and Melton should Metro electric services permanently terminate at Melton
- The recently commissioned train stabling facility at Maddingley (near Bacchus Marsh) is likely to become redundant should Metro electric services not be extended to Bacchus Marsh
- Melton - Bacchus Marsh electrification will be expensive (see proposed scope below)
- An ongoing requirement to service Bacchus Marsh passengers with Ballarat trains (i.e. permanent termination of electric services at Melton) will inhibit development of a Ballarat fast train service which would include construction of a rail bypass around Bacchus Marsh.

Project scope for extension of electrification from Melton to Bacchus Marsh would include:

- installation of electric traction infrastructure extending 16 km from Melton to Bacchus Marsh and Maddingley stabling sidings
- duplication of the single line section between Telephone Road (west of Melton Reservoir viaduct) and Bacchus Marsh including incorporation of the existing crossing loop at Parwan
- future proofing for later construction of an additional Melton Reservoir viaduct track
- provision for a future station at Parwan
- potential grade separation of the Fisken Street level crossing at the eastern end of Bacchus Marsh
- provision of a third platform at Bacchus Marsh for terminating Metro electric trains.

5.4.7 By 2026: Frankston to Baxter

Development of the Mornington Peninsula south of Frankston has been proceeding at a modest pace over many years and has reached the point where extension of metropolitan electrification beyond Frankston is warranted. Options are to extend Metro operations to Baxter (8 km), Hastings (21 km) or Stony Point (31 km), each with progressively diminishing net benefits. This could change subject to future development at the Port of Hastings.

Baxter appears to be a logical location for a train/bus interchange location, supplemented with a major 'park and ride' facility at nearby Langwarrin, because of its relatively easy road access from:

- Peninsula Link from Mount Martha and Dromana
- Moorooduc Highway from Mornington and Mount Martha
- Frankston-Flinders Road from Hastings and other towns on the Stony Point line
- Baxter-Tooradin Road from Pearcedale and Tooradin
- parts of Frankston South and Mount Eliza.

Baxter electrification will inevitably raise the question of whether retention of a diesel shuttle service between Baxter and Stony Point will still be justified, noting that modest growth is still occurring in this corridor and Stony Point provides ferry access to French and Phillip Islands. Its retention has been assumed for the purpose of this Plan. Another issue is the planned restoration of the Baxter-Moorooduc section of the former Mornington line for heritage train operations. These trains operate between Moorooduc and Mornington on nominated days.

Project scope for extension of electrification from Frankston to Baxter would include:

- duplication and installation of electric traction infrastructure extending 8 km from Frankston to Baxter
- provision of third platform at Frankston for through trains
- grade separation of the existing level crossing at Moorooduc Highway, Frankston
- rebuilding and relocation of Leawarra station to service Monash University Peninsula Campus
- potential grade separation of level crossings at Robinsons Road and Golf Links Road, Langwarrin South
- new station at Langwarrin including major 'park and ride' facility with access from McClelland Drive
- Metro train stabling sidings at Baxter
- new twin platform terminal station at Baxter with major bus interchange
- potential third or dock platform at Baxter for Stony Point shuttle trains and/or heritage trains.

5.4.8 By 2027: Werribee to Black Forest Road connection

This project is effectively a further stage beyond the proposed electrification of the RRL lines from Southern Cross (platforms 15/16) to Black Forest Road (see 5.4.2, above). It will provide a connecting link between Werribee and the proposed new station and interchange at Black Forest Road. The new 1.6 km connecting link is on greenfield land between the original Werribee – Geelong and the new RRL rail corridors. Land for the connecting link is shown as an approved Public Acquisition Overlay in the City of Wyndham Planning Scheme.

The connecting link would allow Werribee line trains, which later become part of the MM2 corridor from Mernda via Parkville and Fishermans Bend (see Section 5.5.7), to continue past Werribee to the Black Forest Road interchange station, as shown in Figure 21. This would allow:

- Geelong line passengers to interchange at Black Forest Road with MM2, directly serving Fishermans Bend, Southern Cross, Flagstaff, Parkville, Fitzroy and the Mernda line
- passengers from Laverton, Werribee and intermediate stations to access the Geelong line with one change at Black Forest Road.

Conversely, trains from Southern Cross via Sunshine that would otherwise terminate at Black Forest Road would continue to Werribee, as shown in Figure 21. This would allow:

- passengers from stations between Sunshine and Wyndham Vale direct access to Werribee
- passengers from stations between Sunshine and Wyndham Vale to interchange at Black Forest Road with MM2, directly serving Laverton, Fishermans Bend, Southern Cross, Flagstaff, Parkville, Fitzroy and the Mernda line
- passengers from Werribee to access Melbourne Airport with one change at Sunshine, plus additional connections at Sunshine direct to Albury, Ballarat and beyond, Bendigo, Swan Hill and Echuca.

Project scope for the Werribee to Black Forest Road connection would include:

- construction of a 3.2 km double track connection from west of Werribee to Black Forest Road
- installation of electric traction infrastructure extending 7.8 km from Werribee to Black Forest Road
- rearrangement of Werribee station to provide two terminating platforms for trains from Southern Cross via Sunshine, Wyndham Vale and Black Forest Road, plus two through platforms for MM2 trains to/from Black Forest Road
- grade separation of the level crossing at Werribee Street, Werribee (if not already completed as part of current level crossing program)
- new station in the vicinity of Browns Road on the original Geelong line
- grade separated rail junction at West Werribee to pass over ARTC interstate line
- grade separated rail junction at Black Forest Road
- provision of four additional platforms at Black Forest Road – two for V/Line Geelong line trains and two for terminating MM2 corridor trains extended from Werribee
- Stage 2 of major Metro train stabling and maintenance facility in the rail enclosed triangle south of Black Forest Road.

5.4.9 By 2028: Craigieburn to Wallan

Several new suburbs are being developed in Melbourne's northern growth region which spans much of the main north-eastern railway between Craigieburn and Wallan. Between Donnybrook and Wallan, a population of approximately 23,000 in 2018 is expected to increase to 170,000 by 2036. Well before then, the existing V/Line operated Seymour/Shepparton line trains which service this area will be overwhelmed by rapid growth in patronage.

It is therefore proposed that Metro electric services be extended from Craigieburn to Wallan by the late 2020s to form part of the Craigieburn (via Upfield) – Glen Waverley/Alamein Cross-City line (see Section 5.5.5). In addition to Donnybrook and Wallan, new stations will be added at Cloverton and Beveridge either prior to, or as an integral part of the electrification project.

At that time, Wallan will become the interchange station between metro and regional train services, with regional trains potentially diverted in the longer term via the Outer Metropolitan Ring (OMR) corridor and

Melbourne Airport (see Section 5.7). New stabling sidings will be provided at Wallan to support the extended Metro services, with trains for this corridor continuing to be maintained at Craigieburn.

Project scope for extension of electrification from Craigieburn to Wallan would include:

- installation of electric traction infrastructure extending 21 km from Craigieburn to Wallan
- new stations at Cloverton and Beveridge (if not provided beforehand)
- two additional platforms at Wallan for terminating trains
- additional station infrastructure at Wallan to facilitate passenger interchange with V/line regional train services
- Metro train stabling sidings at Wallan
- potential grade separation of level crossings at Donnybrook Road, Donnybrook; Beveridge Road, Beveridge and Wallan-Whittlesea Road, Wallan

5.4.10 By 2032: Sunbury to Clarkefield

Urban growth is continuing to the north and east of Sunbury, supported by planning for at least one, and possibly two, new stations within the Urban Growth Boundary between Sunbury and Clarkefield. By the early 2030s, the extent of this growth is expected to generate patronage well beyond the capacity of Bendigo line V/Line regional services to absorb. Ongoing growth of peri-urban townships at Romsey and Lancefield is already leading to increased patronage at Clarkefield. Subject to the extent of this urban and peri-urban development occurring as predicted, it is proposed to extend Metro electric services from Sunbury to Clarkefield at this time. These services will be integrated with the MM1 Cross-City corridor as described In Section 5.5.2.

Ideally, also by the early 2030s, Bendigo line services would be diverted to operate via Melbourne Airport using a new corridor to be constructed between the Airport and Clarkefield. If this option eventuates, Clarkefield would become an interchange station between Metro and V/Line Bendigo line regional trains.

Project scope for extension of electrification from Sunbury to Clarkefield would include:

- installation of electric traction infrastructure extending 12.5 km from Sunbury to Clarkefield
- new station at Sunbury North (and possibly also at Wildwood)
- one or two additional platforms at Clarkefield for terminating Metro electric trains
- additional station infrastructure to facilitate passenger interchange between Metro and V/Line regional trains
- Metro train stabling sidings at Clarkefield

5.4.11 By 2034: Extension Lalor to Wollert

Large scale housing development is occurring in the suburbs of Epping North and Wollert in areas that are poorly served by public transport. A suitable reservation for a heavy rail corridor extending approximately 7 km from Lalor to Wollert has previously been identified and incorporated into the relevant Planning Schemes. The reservation runs between the major Epping Plaza shopping centre and the rapidly developing Northern Hospital, immediately south of Cooper Street, Epping.

A fundamental pre-requisite for this project is the capacity generated by MM2 (see Section 5.5.7, below) which will create a new cross-city mass transit corridor linking the Black Forest Road/Werribee line with the Mernda line. This will provide for up to 24 tph to ultimately operate between the CBD and proposed junction at Lalor.

Project scope for the extension from Lalor to Wollert will include:

- grade separated rail/rail junction at Lalor
- construction of new formation, track and overhead wiring for 7km from Lalor to Wollert, the majority on elevated structure
- new elevated stations at Epping Central (adjacent to Epping Plaza and Northern Hospital), Epping North, Aurora and Wollert
- Metro train stabling sidings north of Wollert station

5.4.12 By 2040: Extension Glen Waverley to Knox City

The Glen Waverley line has currently significant unused capacity. By 2040, it is proposed that the Wallan/Upfield – Glen Waverley corridor will be extended a further 6 km in Melbourne's east from Glen Waverley to Knox City, resulting in a 75 km overall corridor from Wallan to Knox City serving at least 36 stations.

The Knox City extension will provide two sections of underground twin tunnel totalling 5 km to extend the line from Glen Waverley to Knox City. It will provide new underground platforms at Glen Waverley, a new intermediate station, major "park and ride" facility, bus interchange and train stabling sidings on the surface at Wantirna South, and a new underground terminal station at Knox City Major Activity Centre.

The new stations at Wantirna South and Knox City will serve an extensive area of Melbourne's east including the suburbs of Wheelers Hill, Scoresby, Wantirna South, Wantirna, Knoxfield and Studfield together with parts of Ferntree Gully, Mountain Gate, Rowville and Lysterfield, all of which have relatively poor access to high quality public transport. Wantirna South station would be located close to the intersection of High Street Road and Eastlink providing an ideal location for a major bus interchange and active transport links feeding from a wide arc extending over a radius of some 5 km from Wantirna South.

5.5 Developing Major Cross-City Mass Transit Corridors

5.5.1 Transforming a radial network into multiple cross-city mass transit corridors

Several major projects will transform Melbourne's metropolitan rail network from its traditional radial configuration and underground City Loop circuit into a series of major intersecting cross-city mass transit corridors. All these routes will intersect at key stations within Melbourne's extended CBD (see Table 5 below), facilitating efficient interchange between the lines involved.

The combination of these major new and reconfigured corridors will provide high capacity, high frequency connectivity across Melbourne for a wide range of users, in addition to those travelling to the CBD. Journeys from one side of Melbourne to another for employment, education or health purposes will become more straightforward, faster and facilitate counter peak travel. They will also help reduce the operational complexity of the network through its progressive disassembly into standalone rail operational units.

Viewed in combination with proposed enhancements to the tram network and proposed MCT orbital corridors detailed in Sections 6 and 7 respectively, these major cross-city corridors will form the basis of a high-quality public transport grid network.

As shown in Table 5, the new and reconfigured heavy rail routes described below provide six high capacity cross-city and cross-suburban corridors. These, in combination with the Melbourne Airport Rail Link and existing Clifton Hill and Burnley City Loop services and efficient interchange facilities, will progressively convert the traditional heavy rail radial network into a series of high capacity cross-metropolitan rail corridors that intersect at six locations within the extended Melbourne CBD, including Parkville.

New heavy rail corridors are very costly and are only justified if they can generate significant concentrated demand. Within this Plan's timeframe, the required concentration of demand is only likely in corridors that connect with and/or pass through the extended CBD area. The major cross-city connections proposed in this Section meet the concentrated demand criteria. Moreover, they provide a wide range of new and efficient travel options through a combination of high frequency services and efficient rail/rail interchanges.

In addition to the new North-West/South-East, North-East/South-West and North/South connections via the CBD and substantially increased corridor capacity provided by MM1, MM2 and the reconfigured City Loop, these projects enable two additional cross-city routes to be formed via West Melbourne, Southern Cross, Flinders Street and Richmond. This occurs through re-allocation of released track capacity and adjusted and enhanced services on existing corridors:

- Wallan/Craigieburn/Upfield to Glen Waverley/Knox City (later also Alamein)
- Williamstown/Laverton via Altona to Sandringham

The Clifton Hill and Burnley groups of lines will continue to circulate through the underground City Loop, each operating continuously, but in clockwise and anti-clockwise directions respectively. This will overcome drawbacks of the present middle of the day loop reversal process. Both line groups will have added capacity to

provide increased services, by virtue of the Mernda line transferring to MM2 and the Glen Waverley line, and later the Alamein line, becoming part of the Wallan-Knox City corridor.

Table 5: New Cross-City Connections and Interchange Stations

Corridor	Cross-city Connection Directions	Corridor End Points	Interchange Stations	
			Extended CBD	Others
MM1	North-West <> South East	Sunbury, Melton, Cranbourne/Clyde, Pakenham	Parkville, State Library Town Hall	Sunshine Footscray Caulfield
MM2	North-East <>South-West	Mernda/Wollert Werribee/Black Forest Road	Parkville Flagstaff, Southern Cross	Laverton, Newport Croxton
Reconfigured City Loop	North <> South	Craigieburn Frankston/Baxter	Parliament, Flagstaff Melbourne Central	West Melbourne, Richmond South Yarra Caulfield
Bayside Cross-City	Inner West <>Inner South	Williamstown/Laverton Sandringham	Southern Cross Flinders Street	Laverton, Newport Footscray West Melbourne Richmond South Yarra
Wallan - Knox City & Alamein	North <> East	Craigieburn/Wallan Glen Waverley/Knox City Alamein	Southern Cross Flinders Street	West Melbourne Richmond, Burnley, Camberwell
South-East FastLine	Outer West <> South-East	Werribee/Black Forest Road/Sunshine/CBD/ Dandenong/Pakenham	Southern Cross	Caulfield Footscray Sunshine

The proposed cross-city rail route structure is shown in Figure 24 below.

Figure 24: Proposed New Cross-City Mass Transit Corridors

The combination of six cross-city rail routes, and the existing Clifton Hill and Burnley City Loop services will interface with a restructured CBD and inner suburbs tram network to allow efficient train/tram interchange at a total of 16 CBD and peripheral CBD stations (Southern Cross, Flinders Street, Parliament, Melbourne Central, Flagstaff, Footscray, West Melbourne, North Melbourne, State Library, Town Hall, Anzac, South Yarra, Parkville, Fitzroy, Clifton Hill and Richmond).

This will provide a wider range of new travel options and a local access service to areas surrounding those key stations, effectively creating a grid network, especially in the extended CBD area.

It is proposed that the major new corridor projects be sequentially implemented because of the extensive planning, approval and construction resource requirements, and cost. Proposed sequencing is generally at 4 to 5-year intervals after MM1, City Loop reconfiguration and the Melbourne Airport Rail Link are completed in 2024, 2025 and 2027 respectively. The functionality and scope of each project is described below.

5.5.2 By 2024: Melbourne Metro 1 (MM 1)

MM1 creates a unified cross-city mass transit corridor extending almost 100 km from Sunbury (potentially Clarkefield) and Melton (potentially Bacchus Marsh) in Melbourne's outer north-west to Pakenham and Clyde in its outer south-east, initially serving some 52 stations, including five new stations in the inner core area between (new) North Melbourne and Anzac.

It provides new underground twin tunnels from South Kensington to Hawksburn via new underground stations at North Melbourne, Parkville, State Library, Town Hall and Anzac. Now under construction, this new cross-city corridor will physically connect the Melton/Sunbury lines to the Pakenham/Clyde lines, providing a new high capacity north-west to south-east mass transit corridor joining job rich areas across Melbourne, and interchanging with other lines at Sunshine, Footscray, State Library, Town Hall and Caulfield. Later, MM1 will also interchange with MM2 at Parkville.

A grade separated junction between South Yarra and Hawksburn will enable V/Line regional trains and freight trains to merge/split with the MM1 corridor and link with existing surface tracks between South Yarra, Flinders Street and Southern Cross.

Trains using the MM1 corridor will be based at stabling facilities at Calder Park and Pakenham East with Pakenham East being the corridor's primary maintenance facility. Some minor maintenance and servicing will also be undertaken at Calder Park. When electric trains commence running to Melton, a new stabling facility will also be provided near Melton on a site to be determined.

When commissioned, MM1 will release capacity in the Northern and Caulfield underground loops and on the existing cross-city corridor via Flinders Street, enabling additional services to operate on the Craigieburn, Upfield, Williamstown/Werribee, Frankston and Sandringham lines. It will also enable introduction of the Bayside Cross-City line between Williamstown/Altona/Laverton/Werribee and Sandringham (see below).

However, before these additional services can be introduced, reconfiguration of the existing Northern and Caulfield City Loops must be completed to create the Craigieburn-Baxter Cross-City line, as described below.

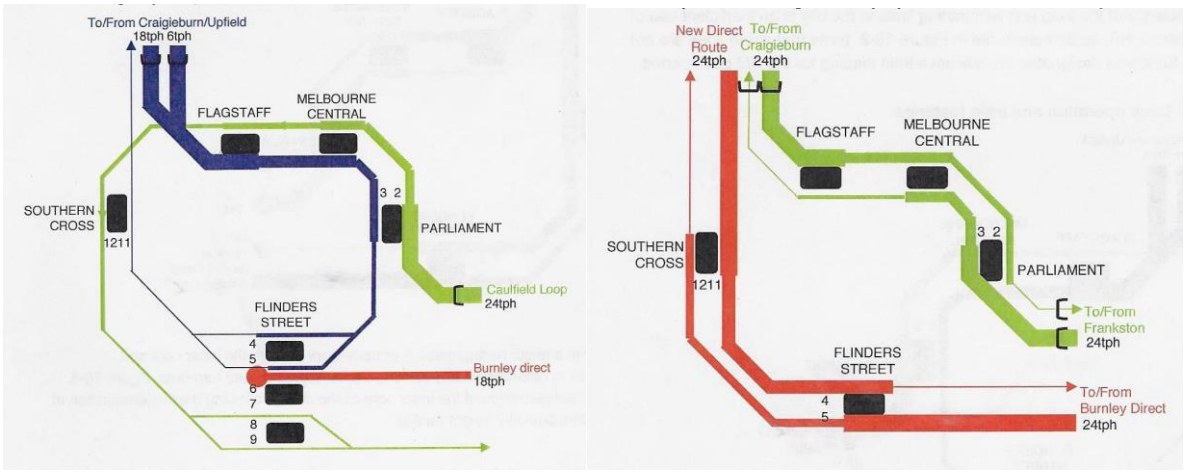
5.5.3 By 2025: Craigieburn (via Essendon)-Baxter Cross-City line

This project will create a unified north-south cross-city mass transit corridor extending some 80 km from Craigieburn in Melbourne's north to Frankston and (by 2026) Baxter in the south, serving 50 stations, including five inner core stations at West Melbourne, Flagstaff, Melbourne Central, Parliament and Richmond.

To create this corridor, reconfiguration will be required of the existing Caulfield and Northern Loop elements of the existing City Underground Loop. This involves construction of new tunnelled connections linking the Caulfield Loop to the Craigieburn line at West Melbourne and linking the Northern Loop to the Frankston line at Richmond, thus forming two opposing direction tunnels passing through Flagstaff, Melbourne Central and Parliament stations. Other works are required at West Melbourne and between South Yarra and Richmond to facilitate convenient cross-platform interchange with the Bayside Cross-City line at West Melbourne and Richmond, as the Craigieburn-Baxter Cross-City line will bypass Southern Cross and Flinders Street.

The achievable benefits from City Loop reconfiguration are very significant. From Figure 25 below, it can be seen that the combined capacity of the existing Caulfield and Northern Loops plus the Burnley direct line that terminates at Flinders Street is a theoretical 66 trains per hour. Loop reconfiguration increases this to a theoretical 96 trains per hour – a 45% capacity increase.

Figure 25: Simplified before and after diagram of City Loop Reconfiguration Concept



Source: Public Transport Victoria – *Network Development Plan, Metropolitan Rail, December2012*

The construction and operational logistics of this project are such that its only practical timing is for it to effectively become an addition to the MM1 project with construction underway before MM1 is completed. This will enable the necessary works to modify the existing Caulfield and Northern City Loops to be undertaken with minimal disruption prior to the full introduction of post-MM1 services. Therefore, this project needs to be closely coordinated with works to complete MM1.

The Craigieburn (via Essendon)-Baxter Cross-City line will allow Craigieburn trains to be through routed via the reconfigured City Loop to Frankston and Baxter and vice versa. In this way, it will provide a major north to south mass transit corridor across Melbourne, strongly complementing and enabling interchange with MM1 at the linked Melbourne Central/State Library station and later with MM2 at Flagstaff.

Trains using this corridor will be based at stabling facilities at Craigieburn, Kananook and Baxter with Craigieburn being the corridor's primary maintenance facility. Minor maintenance and servicing will also be undertaken at Kananook.

5.5.4 By 2025: Bayside Cross-City line

MM1 and City Loop reconfiguration enable implementation of a further cross-city connection extending 42 km from Williamstown and Altona/Laverton in Melbourne's inner west to Sandringham in its inner south, serving 29 stations including 4 stations in the inner core area at West Melbourne, Southern Cross, Flinders Street and Richmond. Once MM1 and the Craigieburn-Baxter Cross-City lines are fully operational, the Bayside Cross-City line can also become operational without the need for additional track infrastructure.

It will enable interchange with MM1 at the linked Flinders Street/Town Hall station, also at Footscray. Interchange with the Craigieburn-Baxter Cross-City line will be available at West Melbourne, Richmond and South Yarra. Later, it will also interchange with MM2 at Southern Cross.

Initially, the Bayside Cross-City lines will also service stations between Laverton, Werribee and Black Forest Road, pending construction of MM2 by 2032 (see 5.5.7 below). At that time, the Newport to Werribee and Black Forest Road line will become part of the MM2 corridor. Trains using this corridor will be stabled and maintained at Newport with supplementary stabling at Sandringham.

5.5.5 By 2025: Craigieburn (via Upfield)-Glen Waverley/Alamein Cross-City line

Underground City Loop reconfiguration to create the Craigieburn-Baxter Cross-City line also enables implementation of a new cross-city connection using released capacity from the former Caulfield and Northern City Loop viaduct tracks between Southern Cross and Flinders Street. Initially extending 42 km from Craigieburn via Upfield in Melbourne's mid-north to Glen Waverley in its mid-east, this unified corridor will initially serve 29 stations including four inner core stations between West Melbourne and Richmond. It will also allow Upfield trains to operate directly via Southern Cross and Flinders Street to Glen Waverley and thereby release capacity on the Burnley City Loop for additional services to run on the Ringwood, Lilydale and Belgrave lines. It will enable interchange with the MM1 corridor at the linked Flinders Street/Town Hall station and later with MM2 at Southern Cross.

This assumes prior completion (by 2024) of the reconfiguration of Burnley Junction, duplication between Gowrie and Upfield, reopening, duplication and electrification of the former freight line between Upfield and Somerton (now Roxburgh Park), a grade-separated junction with the existing Craigieburn and ARTC interstate lines at Roxburgh Park, quadruplication from Roxburgh Park to Craigieburn and two additional platforms at Craigieburn, as described in Section 5.3.

Trains using this corridor will be based at stabling facilities at Craigieburn, Upfield, Burnley and Glen Waverley with Craigieburn also being this corridor's primary maintenance facility. Minor maintenance and servicing will also be undertaken at Macaulay.

By 2028, this corridor will be extended from Craigieburn to Wallan in Melbourne's outer north, increasing the corridor to 69 km in length and initially adding a further 4 stations at Donnybrook, Cloverton, Beveridge and Wallan, with additional stabling sidings provided at Wallan.

By 2036, patronage growth from suburban residential densification will be putting further pressure on the lines served by the Burnley City Loop. To relieve this, the Camberwell to Alamein line will also become part of Craigieburn-Upfield-Glen Waverley Cross-City line. For this to occur, a fourth track will be added to the section of line between Burnley and Camberwell, with additional platforms provided at Hawthorn, Glenferrie, Auburn and Camberwell. This will create two inner express tracks for the Ringwood, Lilydale and Belgrave lines and two outer tracks for trains stopping all stations used by Alamein trains and some Box Hill trains.

By 2040, at the Glen Waverley end, this corridor will be extended to Knox City via Wantirna South (see Section 5.4.12).

5.5.6 By 2027: Melbourne Airport Rail Link (MARL)

This is a standalone project to provide direct fast and frequent dedicated train services extending 27 km between Southern Cross and Melbourne Airport with an intermediate stop at Sunshine for interchange with the MM1 corridor, Wyndham Vale/Black Forest Road/Werribee, Geelong, Ballarat, Bendigo and Albury lines. MARL involves a new corridor, partly underground and partly on the surface, from Southern Cross via new platforms at Sunshine to an underground station at Melbourne Airport.

MARL will use specially designed dedicated electric trains based at new stabling sidings and depot at Tottenham.

By 2036, in conjunction with construction of the *South-East FastLine* (see 5.5.8 below), an underground connection would be provided between it and MARL in the vicinity of West Melbourne, enabling direct journeys to the airport for the first time from Melbourne's south-east and Gippsland.

As a separate stage, with timing to be determined by the regional *InterCity* program[28], it is proposed to provide northern extensions beyond Melbourne Airport to link with the Bendigo line at Clarkefield and the Seymour line at Wallan, enabling through regional services to Bendigo and beyond and Seymour and beyond to operate to and from Southern Cross via the Airport. Interchange with metropolitan services would occur resulting from electrification extensions from Sunbury to Clarkefield and from Craigieburn to Wallan.

5.5.7 By 2032: Melbourne Metro 2 (MM 2)

MM2 creates a unified cross-city mass transit corridor extending approximately 72 km from Black Forest Road via Werribee in Melbourne's outer south-west to Epping and Mernda in its outer north-east, initially serving some 29 stations, including two existing CBD stations (Southern Cross and Flagstaff), three new stations in the inner core area between Fishermans Bend and Fitzroy, and a major interchange with MM1 at Parkville.

MM2 will provide new underground twin tunnels from west of Newport to Northcote/Croxton via two new underground stations at Fishermans Bend (most likely at Sandridge and Employment Precinct) and Fitzroy, together with new underground platforms and passenger interchanges at Newport, Southern Cross, Flagstaff and Parkville.

This new cross-city mass transit corridor will link the Black Forest Road/Werribee line with the Mernda line, providing a major north-east to south-west corridor across Melbourne, and interchanging with other lines at Black Forest Road, Laverton, Newport, Southern Cross, Flagstaff, Parkville and Croxton.

[28] *InterCity*: How Regional Rail can Re-balance Population Growth and create a "State of Cities" in Victoria – Rail Futures Institute, August 2016 (revised and updated version to be released in 2020).

MM2 is a critical element in providing efficient access to the 480 hectares Fishermans Bend development precinct which, based on Victorian Government projections, is expected to be home to approximately 80,000 residents and provide employment for up to 80,000 people by 2050. MM2 will also provide speedy access from Melbourne's growth suburbs to job rich areas in the CBD and inner Melbourne, including Carlton/Parkville NEIC and major activity centres in Fitzroy/Collingwood and facilitate regeneration of Alexandra Parade as a major residential and commercial boulevard.

Trains using the MM2 corridor will be based at stabling facilities at Mernda, Epping, Newport and Wyndham Vale with Wyndham Vale being the corridor's primary maintenance facility. Some minor maintenance and servicing will also be undertaken at Mernda. Later, additional train stabling will be provided at Wollert when a new line is constructed from Lalor to Wollert.

Once commissioned, MM2 will release capacity in the Clifton Hill underground loop and on the Bayside Cross-City corridor between Flinders Street and Newport via Southern Cross and Footscray, enabling additional services to operate on the Hurstbridge, Williamstown, Altona/Laverton and Sandringham lines. Post-MM2, the Clifton Hill loop will continue to host some trains proceeding as far as Croxton on the Mernda line, ensuring continued connectivity between the Hurstbridge and Mernda lines and retaining services at Rushall and Merri stations, as shown in Figure 24.

MM2 would overlap the *South-East FastLine* between Werribee and Black Forest Road allowing:

- Geelong line passengers to interchange at Black Forest Road with MM2, directly serving Fishermans Bend, Southern Cross, Flagstaff, Parkville and Fitzroy
- passengers from Laverton, Werribee and intermediate stations to access the Geelong line with one change at Black Forest Road
- passengers from Werribee to access Melbourne Airport with one change at Sunshine, plus additional connections at Sunshine direct to Albury, Ballarat and beyond, Bendigo, Swan Hill and Echuca.

5.5.8 By 2036: South-East FastLine

South-East FastLine (SEFL) provides a limited stop cross-city rail corridor extending approximately 100 km, linking the Werribee/Black Forest Road/Wyndham Vale line in Melbourne's outer south-west to Pakenham in its outer south-east via Sunshine, Footscray, Southern Cross, Caulfield and Dandenong. New stations would be provided at Chadstone and Monash University. Subject to detailed assessment of their viability, new underground stations could also be provided in the vicinity of St Kilda Junction and/or South Melbourne.

This new express line would carry Metro express services from beyond Dandenong and all V/Line Gippsland services, including services to/from Bendigo via Melbourne Airport, thus enabling direct journeys to the airport for the first time from Melbourne's south-east and Gippsland.

Trains stopping at all stations between Caulfield and Dandenong would continue to use the existing Dandenong Rail Corridor (DRC) and MM1 to Sunbury and Melton/Bacchus Marsh. Freight trains would continue to use the DRC between Hawksburn and Dandenong and the existing surface tracks between Southern Cross, Flinders Street and South Yarra/Hawksburn.

SEFL will provide new underground twin tunnels from north of Southern Cross to Caulfield with new underground platforms at Southern Cross and Caulfield and additional platforms at Dandenong and Pakenham. It will connect into the RRL lines north of Southern Cross with most trains operating to Wyndham Vale and Black Forest Road via Footscray and Sunshine. An underground connection would also extend from Southern Cross to the MARL corridor near West Melbourne for use by V/Line trains operating between Gippsland and the Bendigo line via Melbourne Airport.

Between Caulfield and Dandenong, SEFL will be closely associated with the Princes Highway corridor and a short section of Eastlink, and therefore be mostly on a separate alignment to the existing Dandenong Rail Corridor. The expectation is that it will be largely in tunnel between Caulfield and Chadstone, then on elevated structure to near Yarraman, before re-joining the existing rail corridor between Yarraman and Dandenong through a short tunnel connection.

A 7 km section of third track, suitable for bi-directional operation would be provided between Beaconsfield and Cardinia Road, enabling express trains to overtake stopping all stations trains between Dandenong and Pakenham.

Metro trains using the SEFL corridor will be based at stabling facilities at Pakenham East and Wyndham Vale with Wyndham Vale being the corridor's primary maintenance facility.

SEFL overcomes a serious deficiency of the Dandenong Rail Corridor by enabling much faster travel to the CBD from Melbourne's outer south-eastern suburbs and Gippsland. It also provides long needed direct links to the Monash Precinct (with a major interchange at Monash University) and a station at Chadstone, Australia's largest non-CBD shopping centre.

SEFL would overlap MM2 between Black Forest Road and Werribee allowing:

- passengers from stations between Sunshine and Wyndham Vale direct access to Geelong line fast trains with one change at Black Forest Road
- passengers from stations between Sunshine and Wyndham Vale direct access to Werribee
- passengers from stations between Sunshine and Wyndham Vale to interchange at Black Forest Road or Werribee with MM2, directly serving Fishermans Bend, Southern Cross, Flagstaff, Parkville and Fitzroy.

5.6 Train Service Levels

5.6.1 Service Frequency

As explained in Section 4.14.1, service frequency is the most critical element in the delivery of a grid public transport network that is sufficiently attractive to induce significant reductions in car dependency. "Turn up and go" schedules eliminate the need to consult or understand timetables. Genuine "turn up and go" schedules mean intervals between services not exceeding 10-minutes which should be the default standard on trunk rail corridors. Weekday peak period services on most trunk rail routes already achieve this or better.

At non-peak times, major improvements are needed on most routes. On the heavy rail network, currently only trunk routes to Newport, Clifton Hill, Blackburn, Dandenong and the Frankston line offer "all day" 10-minute service frequencies until about 8pm. The same applies at weekends until about 7pm to Ringwood, Dandenong and Frankston. On other trunk routes, "all day" weekday frequencies vary between 15 and 20 minutes, weekends mostly 20 minutes and evenings between 20 and 30 minutes. On some outer sections, "all day" frequencies extend to 40 minutes.

RFI proposes a minimum 10-minute service frequency from 6am to 10pm weekdays and from 7am to 9pm weekends on all trunk rail routes. Additional services would operate during peak periods and at other times as needed to meet demand, or to help induce demand. Outside these hours, a minimum service frequency of 20 minutes would apply. Non-trunk sections of heavy rail routes would always have a minimum frequency of 20 minutes to 10pm weekdays, 9pm at weekends and 40 minutes outside these times.

5.6.2 Hours of Operation

All heavy rail routes would generally provide services from 4.30am to 1.30am on weekdays and 5.30am to 12.30am on weekends. Trunk rail routes would also provide minimum hourly all-night services during the early hours of Saturday and Sunday mornings.

5.6.3 Reliability Standards

Proposed revised standards would require 99% monthly delivery of all scheduled services and on-time performance measured on departure, designed intermediate points and destination at 95% within 2 minutes during designated weekday peak periods and 3 minutes at other times for heavy rail services. Mitigation would only be allowed in exceptional circumstances.

5.6.4 Capacity and Crowding

Maximum passenger load carrying standards would continue to apply to all vehicle types. All trains would be equipped with load monitoring devices linked to the MYKI ticketing system which would generate continuous passenger capacity utilisation data for each route journey.

5.7 Segregating Metropolitan and Regional Train Services

In addition to capacity issues on the metropolitan rail network, expansion of regional rail passenger services has also been hampered by a legacy of under-investment in Melbourne's metropolitan rail infrastructure. Demand growth is necessitating a far more intensive Metro operation. Regional rail services still share Metro tracks on three of the five routes into Melbourne. Accordingly, ongoing increases in Metro services are slowing or crowding out regional services. This often results in delays to both regional and Metro services.

The major new projects and electrification extensions detailed in Section 5.4, coupled with other proposed works on the regional network, as described in RFIs *InterCity* report[29] and additional works on the expanded metropolitan network will provide long term solutions to these deficiencies. The generalised scope of the required additional works is described below:

- Electrification and introduction of Metro services to Black Forest Road by 2023 and Melton by 2024 will release capacity on Geelong and Ballarat line trains, enabling more comfortable travelling conditions for regional passengers. From 2024 onwards, separate pairs of express tracks will be needed for regional trains between Sunshine and Black Forest Road and from Robinsons Road Junction to Melton. This will allow fast regional trains on the Geelong and Ballarat corridors to operate without being impeded by Metro trains stopping at all stations. However, most (but not all) regional trains will stop at Black Forest Road and Melton to facilitate passenger interchange between Metro and V/Line regional services.

- When MARL opens in 2027, the option exists for fast trains between Southern Cross and Geelong, and possibly Ballarat, to also utilise the separate MARL corridor between Southern Cross and Sunshine, thus releasing constrained capacity on the RRL lines for additional Metro services to Black Forest Road /Werribee and/or for the Ballarat and Bendigo lines. To the extent that the MARL corridor is utilised for this purpose, long tunnels on that route and the consequent need to avoid exhaust emissions will preclude the use of existing diesel trains. Instead, new regional trains, either of bi-modal type using electric power in tunnels and seamlessly switching to diesel power elsewhere, or straight electric trains will be required. This implies the potential for full electrification of the Geelong line to Waurn Ponds and possibly, the Ballarat line, using modern high voltage (25kv AC) traction equipment.

- Seymour/Shepparton line services must currently dovetail into the busy Craigieburn Metro line via Broadmeadows. This is possible because capacity constraints imposed by the Northern City Loop currently prevent the operation of additional Metro trains between Broadmeadows and North Melbourne. Following completion of MM1, removal of Sunbury trains from the City Loop will largely remove these constraints. Following the subsequent reconfiguration of the City Loop and creation of a Craigieburn-Frankston Cross-City corridor (see Section 5.5.3), Craigieburn line peak period services will initially increase from 11 to 16 trains per hour (tph) and later to 18 tph. Upfield line services will at least double from 3 to 6 tph, and possibly 8 tph once the Upfield-Glen Waverley Cross-City corridor becomes operational (see Section 5.5.5). This will, of necessity, require the Upfield corridor diversion (see Section 5.4.4) to be operational by 2024 so that some additional Metro services can be diverted via Upfield and sufficient train paths retained via Broadmeadows for V/Line regional services. However, this will not overcome the problem of regional trains continuing to experience very slow journeys between Craigieburn and North Melbourne (to become West Melbourne) while following Metro trains stopping at all stations.

- By 2028 when Metro electric services are extended from Craigieburn to Wallan, Seymour/Shepparton services will be severely impeded, irrespective of whether operated via Broadmeadows or Upfield. Ideally, the proposed link between Melbourne Airport and Wallan via the Outer Metropolitan Ring (OMR) corridor will be completed by the early 2030s, enabling these services to divert from the existing corridor at Wallan, with provision for interchange with metropolitan services at Wallan. This will free the existing corridor south of Wallan to increasingly provide the level of Metro services required to adequately service this burgeoning growth corridor.

- By 2035 or sooner, the Metro lines through Sunshine will be fully utilised by suburban services from Melton/Bacchus Marsh and Watergardens/Sunbury, with additional impact on Bendigo services between Sunshine and Sunbury. The ideal solution is for Bendigo services to be diverted via Melbourne Airport

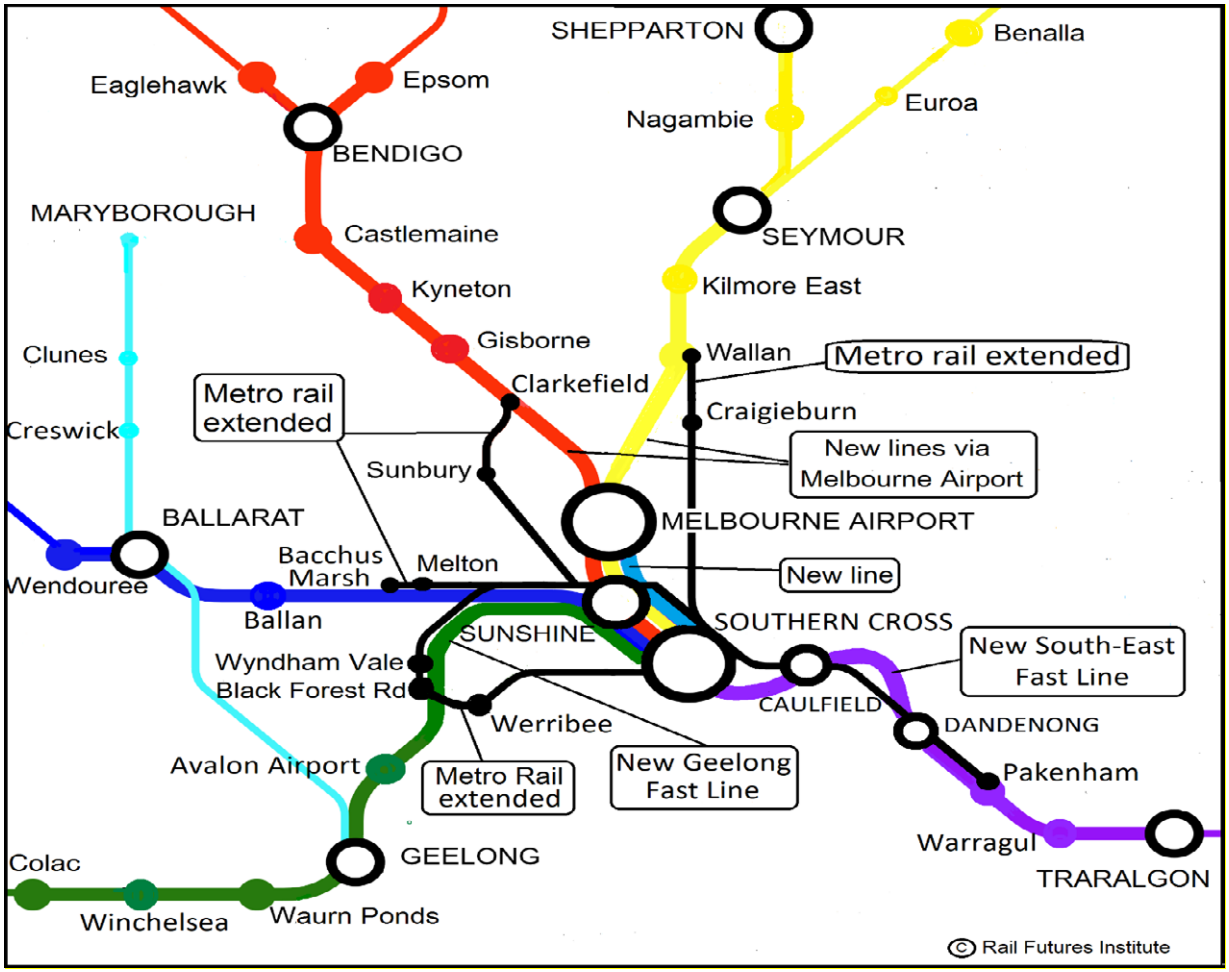
[29] *InterCity*: *How Regional Rail can Re-balance Population Growth and create a "State of Cities" in Victoria* – Rail Futures Institute, August 2016 (revised and updated version to be released in 2020).

and a new direct link to Clarkefield, with interchange with Metro services then occurring at Clarkefield, following the proposed extension of metropolitan electric services to Clarkefield in 2032.

- The recently upgraded Caulfield-Dandenong corridor still only comprises two tracks between South Yarra, Caulfield, Dandenong and Pakenham to accommodate all Regional, Metro and freight services. As set out in in Section 5.5.8, this Plan proposes completion of the *South-East FastLine* from Southern Cross to Dandenong by 2036, with intermediate stations only at Caulfield, Chadstone and Monash, enabling both Gippsland trains and Metro express trains to bypass the busy MM1 corridor between the CBD and Dandenong. It will also allow Gippsland trains to overtake stopping Metro trains on a section of bi-directional third track between Dandenong and Pakenham.

A conceptual view as to how the regional and metropolitan networks would ultimately interface in the manner described above is shown in Figure 26 below.

Figure 26: Conceptual Interfaces between Metropolitan and Regional Rail Networks



Both the success and growth of regional rail and the effective operation of the metropolitan rail network are dependent on major investment in new infrastructure to enable progressive full segregation of regional express services from frequent metropolitan services which stop at all or most stations. This is necessary to increase overall capacity of the rail system, enhance reliability, meet customer expectations for faster regional journeys and ensure that each operation can maximise its effectiveness.

More detail and the estimated cost of these projects are found in Appendices HR 3 to HR 26

5.8 New stations

New stations are proposed at several locations on existing rail lines to service existing and/or proposed development areas. Many proposed station sites are included in existing Planning Schemes or are proposed in draft or finalised Precinct Structure Plans. Existing stations need to be a minimum of 4 km apart before new stations at intermediate locations should be considered. In some cases, there will be opportunities for multi-

purpose developments within or close to station precincts with significant value capture potential to offset establishment costs.

Several new and additional stations will be needed on both existing metropolitan lines and on sections where electrification is to be extended to support rapid residential development in designated growth areas. In some cases, specific developments are being promoted and funded by property developers. The following new station sites have been identified based on criteria including general site suitability, distance from adjoining stations (minimum 2 km, ideally 3 km or greater), extent of potential residential development or workplaces within 1 km radius, ease of road access, suitability for bus interchange, and land availability for commuter parking. Indicative timelines based on anticipated need are also shown.

Stations on existing electrified lines to be completed by:

- 2022: Toomuc Creek *(Pakenham Line)*
- 2024: Campbellfield *(Upfield Line*)
- 2025: Cave Hill *(Lilydale Line*),
- 2028: Jacksons Hill (*Sunbury Line*)
- 2028: Blue Gum Park (*Pakenham Line)*
- 2030: Delahey (*Sunbury Line*)

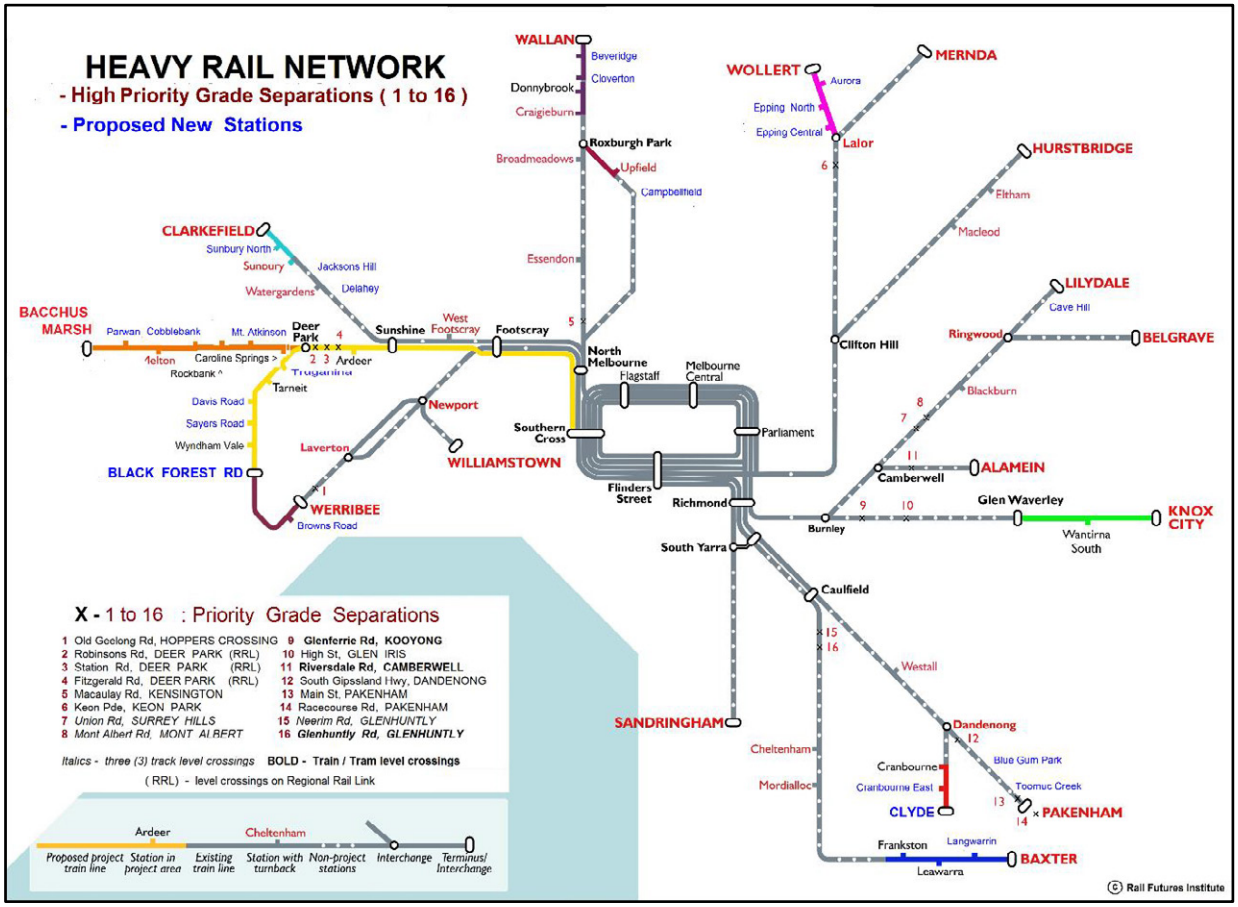
Stations on proposed extended/electrified Metro lines to be completed by:

- 2020: Cobblebank *(Melton Line*)
- 2023: Davis Road and Black Forest Road (*Black Forest Road Line)*
- 2024: Mount Atkinson (*Melton Line)*
- 2024: Sayers Road and Truganina (*Black Forest Road Line)*
- 2025: Cranbourne East and Clyde *(Clyde Line)*
- 2026: Langwarrin Parkway *(Baxter Line*)
- 2027: South Werribee (*Werribee/Black Forest Road Link)*
- 2028: Cloverton and Beveridge *(Wallan Line)*
- 2030: Parwan *(Bacchus Marsh Line)*
- 2032: North Sunbury (*Clarkefield Line*)
- 2034: Epping Central, Epping North, Aurora and Wollert (*Wollert Line*)
- 2040: Wantirna South and Knox City (*Knox City Line*)

Cobblebank station under construction in June 2019
Source: *Rail Projects Victoria*

The location of each of the above new stations is illustrated in Figure 27 below.

Figure 27: Proposed New Stations and High Priority Level Crossing Removals



5.9 Level Crossings

While the State Government has initiated a major level crossing removal program since 2014, more intensive services and increasing line speeds will require an expansion of the program. Operations on selected corridors need grade separation of road and rail to improve safety and reliability, and to reduce road delays (including delays to road-based public transport) as rail services become more frequent. This is a high priority component in the program and will also deliver major benefits to road users, including road-based public transport services.

Appropriately designed grade separations offer opportunities to facilitate intermodal transfers and enhance urban design and planning outcomes. Melbourne's extensive program of level crossing removals should be used to maximise revitalisation of the surrounding urban area.

The following 16 level crossings impact adversely on rail operations (and in some cases tram operations) as well as road users and are recommended as high priority additions to the existing 2019-2022 level crossing removal program[30]:

- **Werribee Line**: Old Geelong Road*, Hoppers Crossing
- **Melton Line**: Fitzgerald Road*, Station Road* and Robinsons Road*, Deer Park
- **Craigieburn Line:** Macaulay Rd, Kensington
- **Mernda Line**: Keon Parade, Keon Park
- **Ringwood/Lilydale Line**: Union Road, Surrey Hills* and Mont Albert Road, Mont Albert*
- **Glen Waverley Line:** Glenferrie Road, Kooyong (rail/tram crossing) and High Street, Glen Iris
- **Alamein Line:** Riversdale Road, Camberwell (rail/tram crossing)
- **Pakenham Line:** Webster Street*, Dandenong, Main Street* and Racecourse Road*, Pakenham
- **Frankston Line**: Neerim Road* and Glenhuntly Road*, Glenhuntly (latter is rail/tram crossing).

[30] Level crossings marked with an asterisk have since been added to the Government's level crossing program for removal by 2025.

The location of each of the above level crossings is illustrated in Figure 27 above.

Note that the two Ringwood Line and two Frankston Line crossings proposed for removal are particularly hazardous as they are located on three track line sections, with the centre track being signalled for bi-directional use by peak period express services.

Train / Tram level crossing on the Frankston line at Glenhuntly Road, Glenhuntly
Photo: *Max Michell*

5.10 Rail Infrastructure Upgrading and Renewal

Ongoing upgrading and renewal programs will be essential to bring the general standard of the metropolitan rail network infrastructure to a level where it is considerably more robust and resilient than is presently the case in many areas. Many service failures and delays are attributable to known infrastructure deficiencies, most of which have been developing over a long period.

Progressive segregation of the network into standalone operational groups (see Section 5.3) will improve network reliability and resilience but it is equally important for the condition of both new and legacy infrastructure assets to be at a suitable standard to overcome the likely impacts of climate change and to ensure maximum benefit is obtained from the new projects detailed in this Plan.

Track condition needs lifting to a standard where it becomes sustainable with relatively low ongoing maintenance input and allows for the removal of all longstanding speed restrictions. Most of these derive from poor underlying formation, fouled ballast and inadequate drainage, leading to unsatisfactory track geometry and ride quality. These conditions, while generally not unsafe, impact timekeeping and service reliability. They can also become problematic during weather events.

Much signalling equipment and some elements of the electric traction system are both life expired and obsolescent. Replacement provides the opportunity to progressively introduce technology which enhances network capacity, reliability and resilience. Replacement of obsolete and inadequate infrastructure is required on a significant scale on the Melbourne metropolitan network over at least a 15-year period. This will involve progressive asset renewal and upgrading. The required work includes:

- rehabilitation of formation, drainage and ballast
- replacement of timber sleepers with concrete sleepers
- rail replacement and rail grinding
- turnout renewal
- power supply upgrading and redundancy

- overhead traction system upgrading
- station platform rehabilitation and (where required) lengthening
- signalling system replacement
- communications and security systems upgrading
- corridor fencing renewal and upgrading.

These programs will necessarily go beyond that which is regarded as routine maintenance. Properly planned and executed and designed for resilience and redundancy using high quality, durable and robust materials and equipment, these programs will also produce a long-term decline in ongoing network maintenance costs.

5.11 Passenger Amenities at Stations and Interchanges

An ongoing program is needed specifically directed at progressively improving passenger experience and amenity at stations and interchanges. An audit of present conditions would identify many opportunities for improvement. The station improvement program needs to encompass a wide range of matters including weather protection, lighting, security systems, DDA compliance, placement of entrances and exits, information systems (static, dynamic, visual and audio), toilet upgrading and wayfinding.

Particularly serious deficiencies exist at the metropolitan network's two busiest stations – Flinders Street and Southern Cross, both exacerbated by very large increases in passenger throughput in recent years and not reflective of the way the CBD itself has spatially and demographically changed. Flinders Street station requires a new western elevated concourse, linked by escalators to all platforms and connected to Southbank via the Sandridge Bridge and to a proposed Elizabeth Street pedestrian mall by a bridge passing over Flinders Street.

Southern Cross station, extensively rebuilt between 2003 and 2006, is now struggling to accommodate current passenger throughput, driven by a combination of very large patronage increases on both the Metro and V/Line regional networks and the massive redevelopment of Docklands and western parts of the CBD Hoddle Grid. The station requires a new central elevated concourse with escalators to all platforms, continuing to a covered pedestrian bridge over Spencer Street and linked to Little Collins Street. Additional escalators are also required to provide better connections between the southern end upper and lower concourses and between the northern end (Bourke Street) pedestrian bridge and regional platforms.

Other key interchange stations in need of significant upgrading include Richmond (noting its important role in facilitating major events), South Yarra and Caulfield.

Southern Cross Station is now struggling to handle current passenger throughput
Photo: *Peter Don*

5.12 New Trains

As at September 2018, the metropolitan train fleet comprises 219 train sets of the following types:

- 93 Comeng 6-car trains built between 1980 and 1988
- 36 Siemens 6-car trains built between 2003 and 2006
- 90 Alstom X'Trapolis 6-car trains built between 2002 and 2018, plus a further 21 trains on order for delivery to 2020.

Each of these current train types were illustrated in Section 3.2.

In addition, 65 High Capacity Metropolitan 7-car trains (HCMTs) are on order from Downer Rail and Changchun Railway Vehicles, China, for delivery between 2018 and 2023. This order provides sufficient rolling stock for operation of the MM1 corridor between Sunbury and Cranbourne/Clyde/Pakenham when it opens in 2024-25.

Further orders of HCMTs and possibly other train types such as X'Trapolis 2.0 (both types illustrated below) are likely to follow, initially to support electrification to Melton and including a substantial requirement for progressive replacement of the ageing Comeng fleet.

New HCMT train type for Metro Trains network
Courtesy: *PTV Victoria*

In PTV's 2012 Network Development Plan – Metropolitan Rail (NDPMR), it was estimated that the required train fleet would increase to 249 trains upon opening of MM1, then expected to occur by 2021. RFI estimates this should now be a requirement for 276 trains in 2024 as the Mernda extension and electrification to Melton, Wyndham Vale and Clyde were not included at that time.

The NDPMR estimated a further fleet size increase to 290 trains by 2026 with the part opening of MM2, electrification to Melton and various other projects, some of which are no longer proposed for heavy rail solutions, such as to Doncaster and Rowville, but offset by several other projects being brought forward in this Plan. The NDPMR estimated fleet requirement further increased to 326 trains by 2031, including provision for the Geelong line which will continue to be a regional fleet issue.

After making approximate adjustments for these differences, we estimate that the required fleet to support this Plan, including when MM2 opens in 2032 will be 310 trains, increasing to 332 trains by 2037, including requirements for the *South-East FastLine* project. This excludes the dedicated MARL fleet which is likely to be separately owned and managed.

This also assumes that retirement of Comeng trains commences in 2020, with the last of the type being removed from service by around 2035.

By 2037, the oldest of the Siemens trains will have been in operation for 35 years and a succession plan for these and the oldest of the X'Trapolis trains will need to be under active consideration. However, because of expected technological and other changes, no estimates of overall heavy rail fleet requirements have been attempted beyond 2037.

On this basis, this Plan's estimated fleet requirement over the next 20 years is likely to be as shown in Table 6.

Table 6: Estimated Overall Metropolitan Train Fleet Requirements 2018 to 2037

Train type	2018	2024	2028	2032	2037
Comeng	93	64	43	18	
Siemens	36	36	36	36	36
X'Trapolis	90	111	111	111	111
HCMT (7-cars)		65	75	70	110
HCMT (10-cars)			30	75	75
Fleet totals	**219**	**276**	**295**	**310**	**332**

Artist's impression of proposed X'Trapolis 2.0 train for Melbourne

Courtesy: Alstom Australia

5.13 Stabling and Maintenance Facilities

The progressive re-structuring of the metropolitan heavy rail network into a series of self-contained operating groups requires train stabling facilities at suitable locations that are aligned with train crew depots and of sufficient scale to accommodate dedicated train fleets for each group. This also requires train maintenance facilities [31] to support routine servicing and maintenance for each dedicated train fleet to a level that enables achievement of required availability and reliability performance.

With the coming of non-divisible HCMTs, much larger facilities are needed that have the capacity for jacking entire train sets up to 230m in length and for efficient component exchange.

Such a facility has been recently completed at Pakenham East. This compares with older facilities such as those at Epping that was designed around 6-car trains consisting of two 3-car units, each being only approximately

[31] Train maintenance facilities for routine servicing and maintenance are separate to major workshop or back shop facilities used for rolling stock construction, major overhauls, collision repairs or major modifications. Such facilities are provided at Newport and at original manufacturer's premises at Dandenong (Bombardier) and Ballarat North (Alstom).

72m long. As such, the new facilities require buildings around three times the size of those at Epping and considerably larger than the new facility at Craigieburn. Nonetheless, 3-car units of the Siemens and X'Trapolis fleets will doubtless remain in service for many years to come, enabling some of the existing maintenance facilities to remain functional for the foreseeable future.

The following Table 7 shows the expected requirement for maintenance facilities to support the anticipated network and fleet deployment in 2037:

Table 7: Maintenance Facilities Required by 2037

Main Depot Location	Secondary Depot Location	Corridors served	Train types	Fleet size
Craigieburn	Kananook	Wallan-Glen Waverley Craigieburn-Baxter	Siemens X'Trapolis	10 56
Lilydale	Bayswater	Clifton Hill/Burnley Groups	X'Trapolis	55
Newport	Macaulay	Williamstown/Laverton-Sandringham	Siemens	26
Pakenham East	Calder Park	Sunbury/Melton-Pakenham/Clyde (MM1)	HCMT	90
Tottenham	n/a	Southern Cross-Melbourne Airport (MARL)	Dedicated EMUs	10
Wyndham Vale	Mernda	Black Forest Rd-Mernda/Wollert (MM2) Werribee/Black Forest Rd-Pakenham (SEFL)	HCMT	95

Additional train stabling capacity will also be required at several locations to accommodate more than 100 additional trains (including longer trains) on the network. The largest stabling facilities will be at Pakenham East and Wyndham Vale, however, new and/or expanded facilities will also be required at Melton and/or Bacchus Marsh, Calder Park or Clarkefield, Wallan, Upfield, Baxter, Clyde, Mernda and Lilydale. The small dedicated MARL fleet is likely to be stabled at Tottenham.

5.14 Operational (non-investment) Measures

RFI has identified a menu of potential operational measures that can be adopted, standing alone and/or in association with investment proposals, to increase corridor capacity and resilience, improve service reliability and enhance customer service.

Examples include:

- increasing train frequency by reducing train headways within the limitations of the signalling system
- altering train stopping patterns to provide greater consistency between successive services
- adjusting timetables to minimise conflicting train movements at junctions or other pinch points
- adjusting train driver rosters to minimise turnaround times at termini
- locating train driver changeover points at train termini
- co-locating train driver depots with train stabling locations
- ensuring train types operating on any single corridor have very similar performance characteristics
- reducing station dwell times by more effective management of passenger flows on platforms, through ticket barriers and/or on vertical transport within station environs
- enhanced staff training regimes directed at improving customer communication and incident management.

While it is not the intent of this Plan to propose detailed operational arrangements, it is emphasised that most, if not all, of these measures will need to be implemented to ensure that the recommended investments achieve their stated purpose.

6. The Tram Plan

6.1 Tram Plan Overview

The broad objectives of the Rail Futures' Tram Plan are to:

- increase capacity of the existing tram network to meet current and projected patronage growth
- reduce journey times on routes presently suffering delays due to shared use of road space
- enhance overall tram network efficiency and asset utilisation
- provide "turn up and go" service frequency wherever feasible
- better serve the northern and western parts of the enlarged Melbourne CBD, and Fishermans Bend
- offer new cross-CBD tram routes
- provide better tram connectivity to CBD and inner area rail stations
- provide new tram links to NEICs and Major Activity Centres by extending routes presently ending at "nowhere in particular"
- provide new cross-suburban routes to link existing radial train and tram lines
- facilitate passenger interchange where tram routes intersect or meet bus routes and train lines
- accelerate progress toward tram fleet DDA compliance and level boarding at tram stops by 2032
- integrate the tram network as a key element of a Melbourne multi-modal Public Transport Grid Network
- enhance the travel experience of users as part of a wider process for reducing car dependency.

The Tram Plan aims to link the above objectives and their achievement by means of investment in infrastructure, rolling stock, associated facilities and systems, and through non-investment operational measures, including the following:

- Tram priority measures
- Proposed tram route extensions
- Proposed re-routings and additional new tram routes
- Tram route service levels
- Proposed changes to tram stops
- Proposed development of new tram/tram and tram/train interchanges
- Tram fleet requirements
- Depot, stabling and maintenance facility requirements
- Tram infrastructure enhancement, renewal and upgrading needs
- DDA compliance measures
- Other operational (non-investment) measures.

A critical requirement is to improve interchange with other modes - the best performing tram systems are tightly connected with bus and heavy rail to form an integrated grid network, multiplying the range of possible destinations and providing a credible travel alternative to the car.

The opportunity exists to progressively transform Melbourne's tramway network towards best practice, thus expanding the system's capacity to match Melbourne's growth and development; and greatly increase both efficiency and passenger attractiveness.

6.2 Tram Priority Measures

For the tram system, the prime way of improving efficiency is through traffic priority measures. The average operating speed of trams is affected by traffic congestion, delays at traffic signals, road accidents, trams braking and accelerating, dwell time at stops and distance between stops. Effective use of the tramway infrastructure and vehicles necessitates that overall transit times be reduced through more effective traffic management systems which prioritise trams and cars based on numbers of people travelling rather than the number of vehicles.

About 80% of Melbourne's tram network operates 'on street' with ROWs located on arterial and local roads. This means average operating speeds on the network are relatively low, around 16 km/h compared to other Australian and overseas systems which feature greater separation from road traffic. On some built-up tram corridors through shopping strips, particularly Sydney Road and Chapel Street, average speeds can go as low as 6 km/h. Unfortunately, such corridors are presently constrained from achieving better operational performance (increased average speeds, higher frequencies, greater reliability) and higher passenger capacity because of a combination of closely spaced tram stops, delays caused by mixed traffic operation, lack of adequate traffic light priority and lack of dedicated tram ROWs.

Critical actions are to improve tram ROWs and tram priority to increase speed, reliability and improve tram utilisation, including measures such as re-allocation of existing road space with a focus on key locations where the impact is greatest. The current situation results in everyone losing - motorists are delayed, tram passengers are delayed, and capacity of the tram infrastructure is seriously compromised - perpetuating a very inefficient system of competing modes sharing the limited available road space.

Ongoing delays to trams and current low average tram speeds make for poor utilisation of available street space, extends passenger travel times and imposes ongoing cost imposts on operation of the system. As the travel time along any route extends, more trams are required to maintain the same service frequency at extra capital cost. Additional trams also require additional drivers, consume additional energy and incur added labour and maintenance costs.

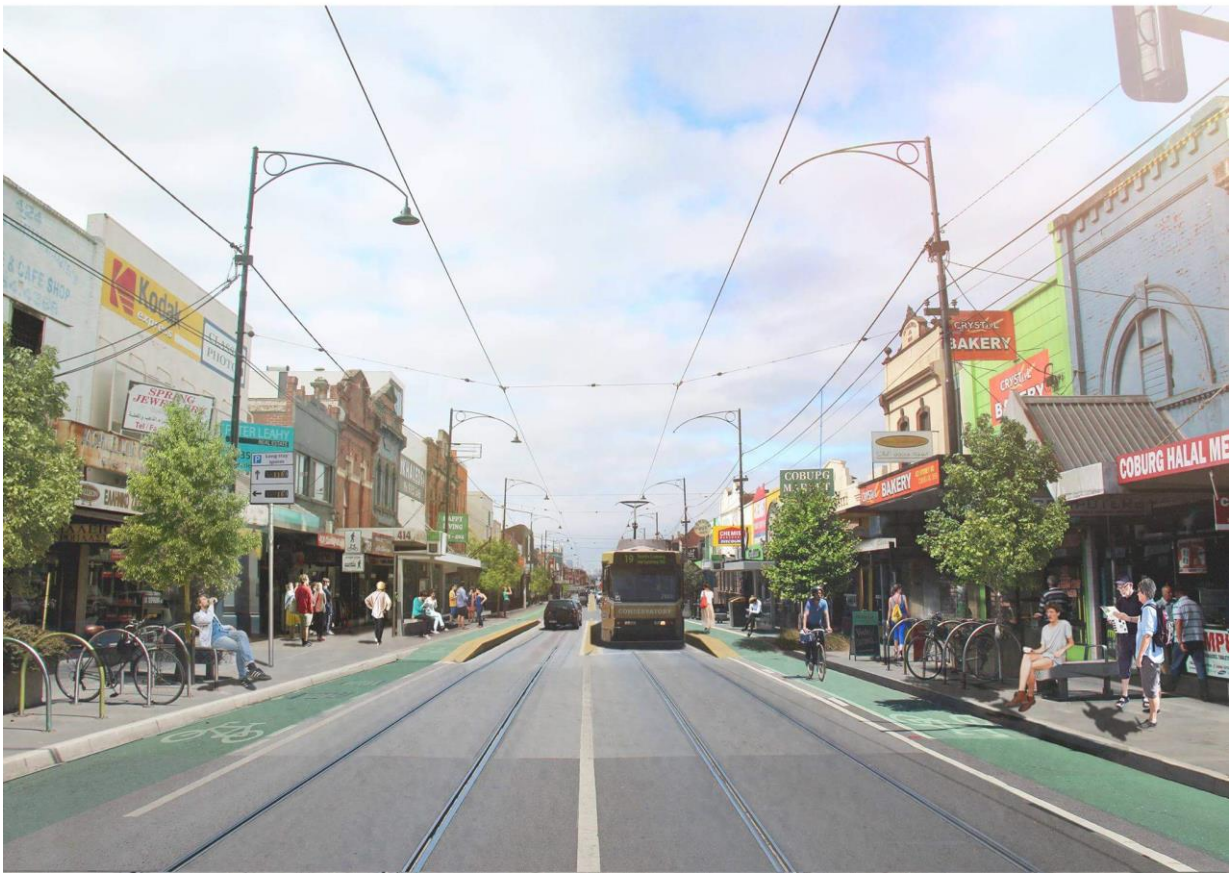
A concerted and renewed ongoing joint effort is required by Government, Councils, VicRoads and Yarra Trams to tackle tram prioritisation so that the existing and extended network can reach its optimum and full passenger carrying potential in coming years. The issue is one of moving people, NOT cars, and the most efficient use of the limited available road space.

The following package of improvements is proposed:

- Introduction of hook turns wherever feasible at all signalised intersections where cars and trams share the same road space, potentially offering an early low-cost prioritising of tram throughput on all on-street tram routes
- Improved tram priority at traffic lights, including giving trams in the CBD in Collins and Bourke Streets priority over traffic in King, Russell and Exhibition Streets which have little or no public transport
- Extended use of on-tram technology which allows approaching trams to trigger traffic light priority (including early application in William, Elizabeth and Swanston Streets at Flinders Lane and all "Little" cross streets and at Flinders Lane/ Market Street within the Hoddle Grid
- More aggressive use of Intelligent Transport Systems (ITS) including software to enhance the sophistication of traffic signal phasing
- More hard edge tram clearways as opposed to painted road line markings
- Minimising kerbside parking in narrow thoroughfares
- Selective rationalisation of closely spaced stops to accelerate services
- Accelerated provision of DDA compliant stops to facilitate access and reduce dwell times.
- Selective relocation of stops away from intersections to expedite tram flow, while maintaining interchange connections
- Ongoing enforcement by Police of tram clearways and road vehicles obstructing tram flow at intersections

Priority for tram throughput in congested inner suburban streets including Sydney Road, Victoria Street, Bridge Road, Swan Street, Toorak Road and Chapel Street requires early resolution. It is evident that various solutions could be applied on a case by case basis, however differing local conditions make a single "one size fits all" solution inappropriate.

The image below shows one concept for the allocation of road space designed to provide tram priority whilst improving local amenity and making safe provision for cyclists and pedestrians.



Conceptual Option for Road Space Allocation in restricted width Inner Suburban streets

Courtesy: OCULUS Landscape Architecture and Urban Design

6.3 Tram Route Extensions

The following tram route extensions are proposed for completion by 2034 (see Section 12 for implementation program):

Short distance extensions to facilitate network integration

- Route 3: extended from East Malvern (Darling Road) terminus 0.8 km to EAST MALVERN STATION
- Route 5: extended from Malvern (Burke Road) terminus 1.4 km to DARLING STATION.
- Route 19: extended from North Coburg (Bakers Road) terminus 0.7 km to MERLYNSTON STATION
- Route 67: extended from Carnegie (Koornang Road) terminus 0.9 km to CARNEGIE STATION
- Route 72: extended from Camberwell northwards 1.9 km to EAST KEW (Kilby Rd) meeting Route 48 to North Balwyn
- Route 86 (existing Route 109): Station Pier, Port Melbourne - 200m of new track crossing Waterfront Place to a new twin track interchange/terminus at the Station Pier gate.

Longer distance extensions to increase network coverage

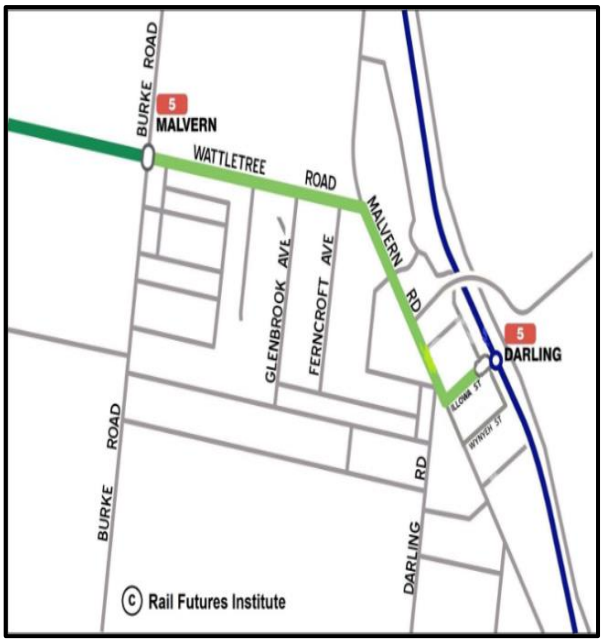
- Route 11: extended from West Preston 5.2 km to LA TROBE UNIVERSITY via Reservoir Station
- Route 57: extended from West Maribyrnong 3.4 km to AVONDALE HEIGHTS (Buckley Street)
- Route 59: extended from Airport West 6.5 km to MELBOURNE AIRPORT
- Route 64: extended from East Brighton 3.4 km to MOORABBIN STATION
- New Route 44 from Collins Street West 4.2 km to SANDRIDGE and WIRRAWAY (See Sections 6.4 and 10.3)
- New Route 46 from Collins Street West 4.9 km to WESTGATE PARK (See Sections 6.4 and 10.3)

Further detail of the above proposals, including the rationale and the estimated cost for each extension are shown in Appendices T 27 to T 42.

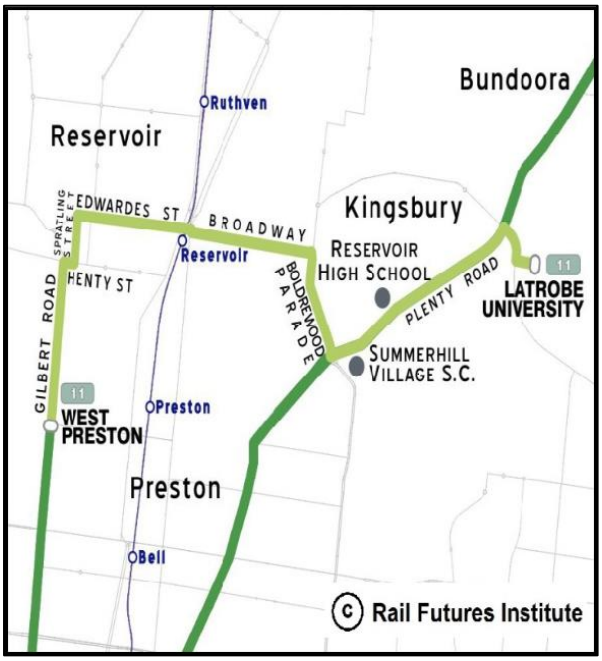
Examples of the above route extension concepts are illustrated in Figure 28, below.

Figure 28: Proposed Tram Route Extensions

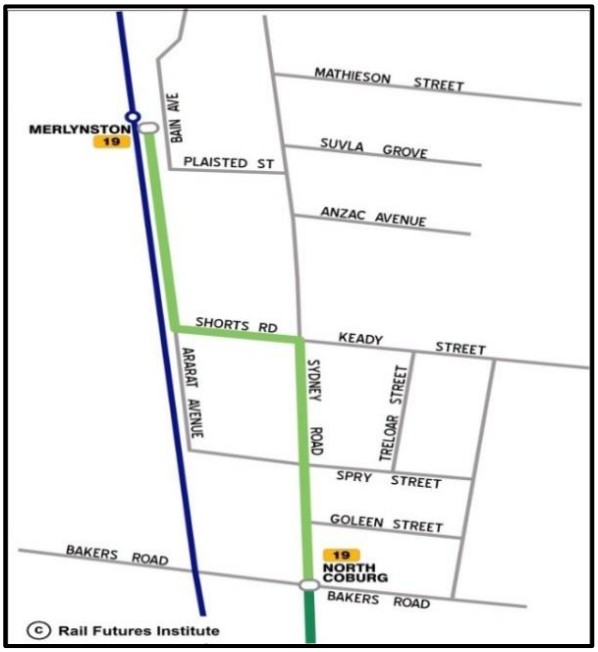
Route 3 extension to East Malvern Station



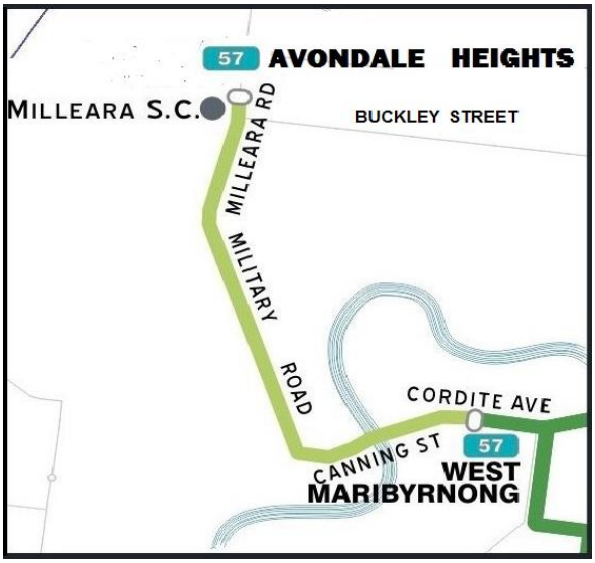
Route 5 extension to Darling Station



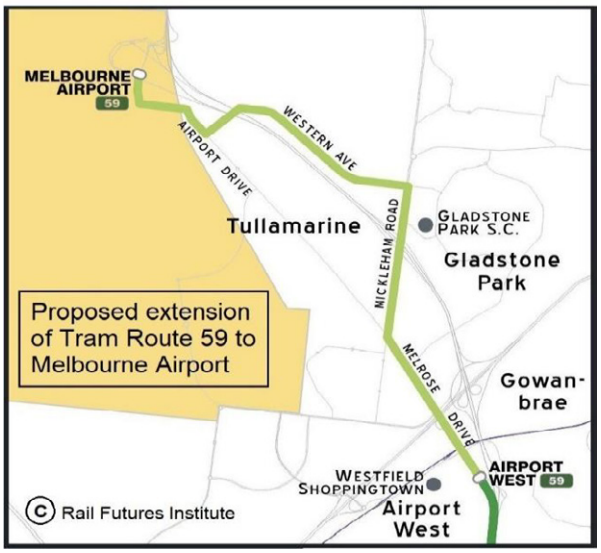
Route 11 extension to La Trobe University



Route 19 extension to Merlynston Station

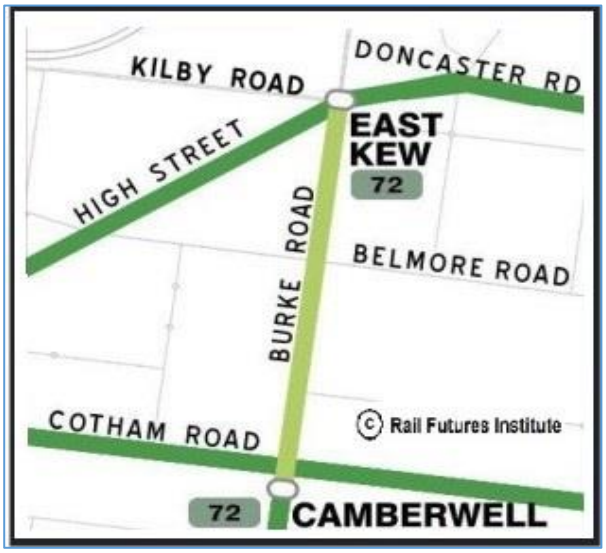


Route 57 extension to Avondale Heights

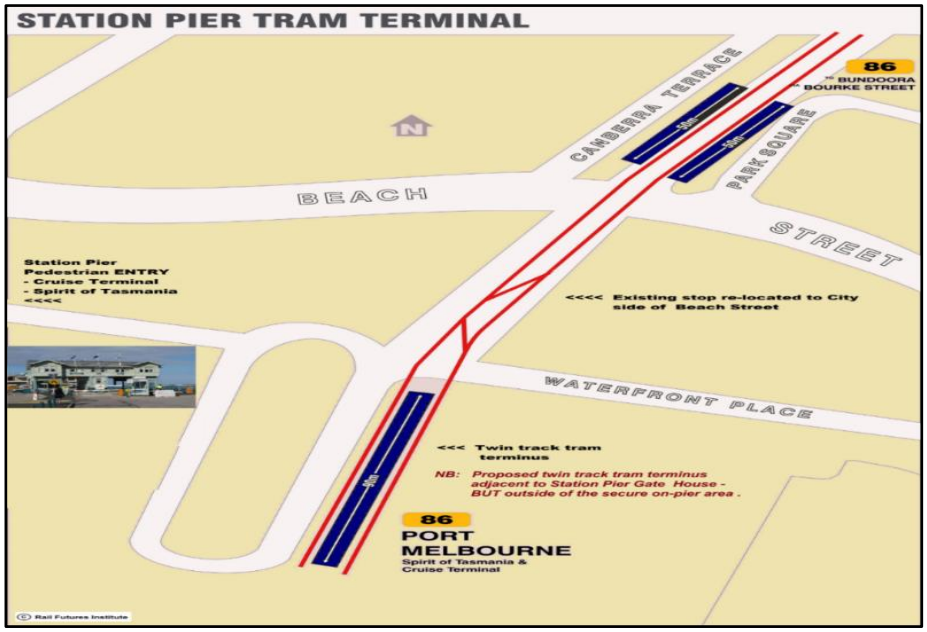


Route 59 extension to Melbourne Airport

Route 68 (existing Route 64) to Moorabbin Station



Route 72 extension to East Kew



Route 86 (existing Route 109) extension to Station Pier gate, Port Melbourne

Potential future network extensions - for consideration (2035 – 2049)

- Route 48: North Balwyn to GREYTHORN SHOPPING CENTRE and DONCASTER HILL (See also 7.2.1)
- Route 57: further extension north beyond AVONDALE HEIGHTS to EAST KEILOR
- Route 72: extension from GARDINER Station via Burke Road to CAULFIELD STATION, thus creating a new North/South tram route from EAST KEW via Burke Rd and Gardiner Station to CAULFIELD STATION providing connection between eight East/West tram routes and three radial rail lines
- Route 75: Vermont South extension to KNOX CITY
- Route 86: Bundoora RMIT extension to SOUTH MORANG STATION

6.4 Tram Re-routings and Additional New Tram Routes

The existing largely radial tram network, whilst limited by historical factors, provides an excellent base to build a grid network which maximises interchange opportunities with other public transport routes and meets increasing demand for local access.

It is proposed to progressively restructure the existing and extended network in 3 stages over 15 years to 2034 to progress towards a grid network that:

- provides a greater number of cross-CBD tram routes, helping avoid current tram changes to complete existing trips within the CBD
- offers improved connections between tram routes and with the rail network
- offers new cross-suburban routes including linking of Clifton Hill station to West/North Melbourne stations and to the Parkville Precinct
- offers an additional CBD access route for St Kilda Road trams via Spencer Street to Southern Cross station and the western end of the CBD
- introduces a new CBD / Inner East circular tram route and a new CBD/Inner North circular route
- provides new and extended tram services to Sandridge/Wirraway, Westgate Park, La Trobe University via Reservoir, Melbourne Airport and Moorabbin station
- offers a wider choice of tram travel options to/from and between 16 city/inner area rail stations including the new MM1 stations at North Melbourne, Parkville, State Library, Town Hall and Anzac and future MM2 stations at Sandridge and Employment Precinct (Fishermans Bend) and Fitzroy
- extends the existing tram network to closely connect with the rail network at a further 6 existing stations – Carnegie, Clifton Hill, Darling, East Malvern, Moorabbin and Reservoir
- provides a new terminal facility at Port Melbourne with an easy link to trams for Spirit of Tasmania and cruise ship passengers
- introduces new supplementary peak hour services on key routes from the CBD to inner suburban locations, relieving pressure on longer distance routes from the CBD

To achieve this, new twin track sections, connecting links and turnbacks would be constructed within the CBD and near inner suburbs linking with existing tracks to leverage best use of the existing track infrastructure and allow introduction of the new CBD and cross-CBD routes. As shown in Figures 29 and 30, this would occur in:

- Park Street, South Melbourne - 300m of new track between Kingsway and Heather Street
- Victoria Street, Melbourne – 750m of new track between La Trobe and Swanston Streets
- Elizabeth and Victoria Streets (Queen Victoria Market intersection) - new cross connection enabling continuous tram transit along Victoria Street
- Smith Street, Abbotsford – 250m of new track between Gertrude Street and Victoria Parade
- Spencer Street, Hawke Street and Adderley Streets, West Melbourne – 1.3 km of new track from Remand Centre terminus to West Melbourne Station
- Hawke Street, West Melbourne – 350m of new track between Victoria Street and Spencer Street
- Laurens, Arden and Dryburgh Streets, North Melbourne – 1.8 km uni-directional (single track) tram loop linking West Melbourne and new North Melbourne stations
- Harbour Esplanade, Docklands – new turnback facility at Docklands Park

- Reserved tram corridor in Royal Park – new turnback facility off Flemington Road at Royal Children's Hospital
- Clifton Hill – new 250m tram connection from Queens Parade to Hoddle Street interchange and turnback facility linked via pedestrian bridge over Hoddle Street to Clifton Hill station (Figure 37)
- Queensberry Street - from Errol Street to Chetwynd Street, then via Chetwynd Street, Wreckyn Street to Grattan Street. Then via Grattan Street (converted to a priority transit corridor) to Rathdowne Street. Then via Barkly Street to Nicholson Street at Johnston Street.

New curve pairs would also be installed at selected intersections to maximize utilisation of existing track assets.

Fishermans Bend will be Australia's largest urban renewal project covering approximately 480 hectares. It is expected that by 2050, it will be home to approximately 80,000 residents and provide employment for up to 80,000 people[32]. It is proposed to construct two new tram routes into Fishermans Bend, connected via a new tram crossing of the Yarra River to the existing Collins Street West tram routes near Victoria Harbour. The two routes will service the northern and southern parts of the precinct respectively, described below and shown in Figure 30:

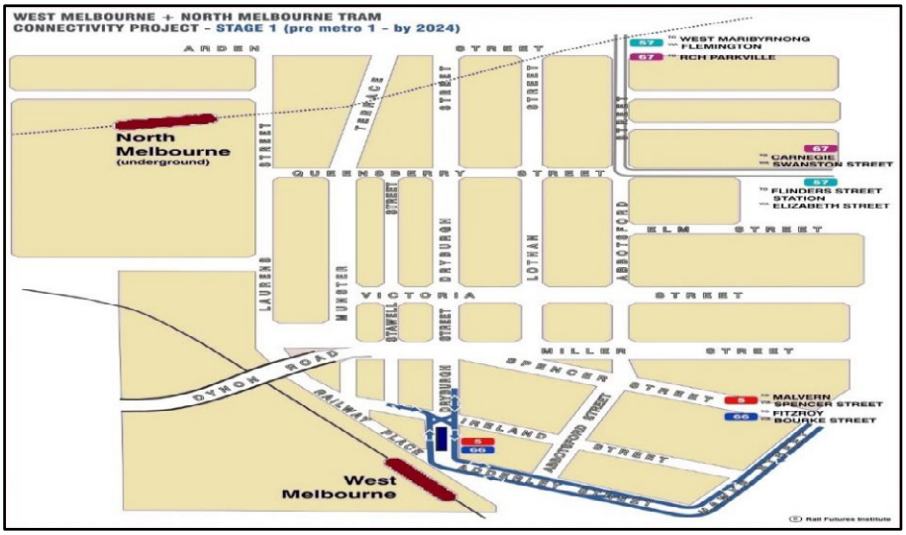
- Proposed Route 44 will extend approximately 4.2 km to service SANDRIDGE and WIRRAWAY, generally running east-west along the Plummer Street alignment before turning south into Prohasky Street and terminating at Williamstown Road. An interchange is proposed with the Sandridge underground station on the MM2 corridor. Route 44 will run to Kew Depot via Collins Street, Victoria Parade and Victoria Street, supplementing Route 42 to Box Hill (formerly Route 109) on this corridor.
- Proposed Route 46 will extend approximately 4.9 km (of which 0.6 km is common with Route 44) to WESTGATE PARK, generally running east-west along the Turner Street alignment to serve the new suburb of Lorimer and the Fishermans Bend Employment Precinct. An interchange is proposed with the Employment Precinct underground station on the MM2 corridor. Route 46 will run to Camberwell Junction via Collins Street and Bridge Road, supplementing Routes 48 to North Balwyn, 70 to Wattle Park and 75 to Vermont South on parts of these corridors.

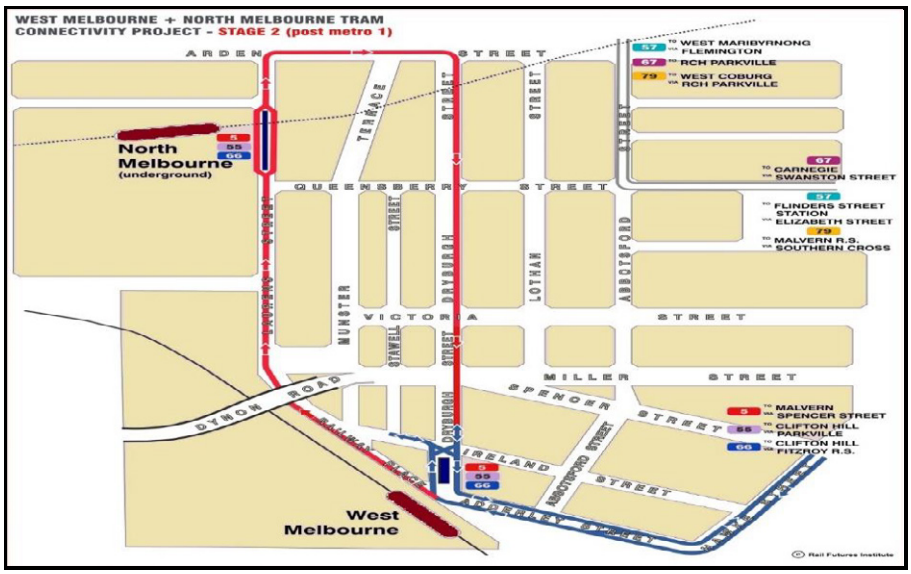
In addition, it is proposed to provide new tram tracks totalling 7 km along Alexandra Parade, Barkly, Grattan, Wreckyn, Chetwynd, Queensberry and Hawke Streets. This would provide a northern CBD bypass forming a continuous east-west route between Clifton Hill and West and North Melbourne stations (see Figures 29 and 30), operated as new Route 55. This is a relatively major project to be undertaken in two stages – Stage 1 from Clifton Hill to Parkville and Stage 2 from Parkville to North Melbourne. It aims to:

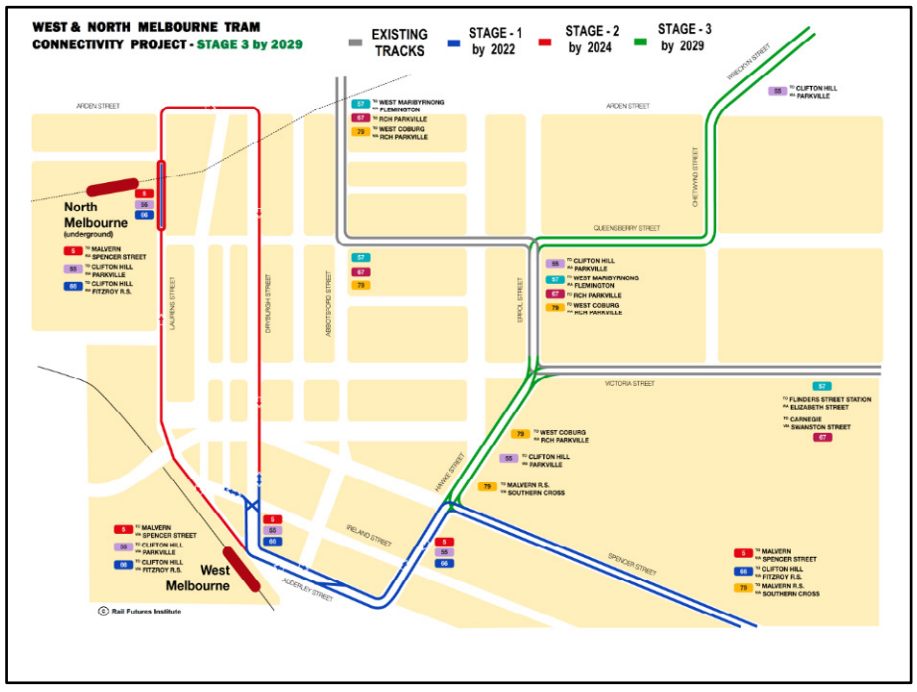
- attract concentrated redevelopment along Alexandra Parade, Fitzroy, with a vision of that thoroughfare becoming an attractive commercial and residential boulevard, similarly to Victoria Parade or St Kilda Road, served by trams in the central median between Smith and Nicholson Streets
- provide connectivity via a new tram/train interchange at Clifton Hill Station between the Hurstbridge rail line and Fitzroy, Parkville NEIC, West and North Melbourne
- provide an interchange with Fitzroy underground station, likely to be located beneath Queens Parade between Brunswick and Smith Streets on the MM2 corridor from Mernda
- provide an interchange facility with Route 96 trams in Nicholson Street at Johnston Street, Fitzroy
- install tram tracks in Barkly Street, Carlton between Nicholson and Rathdowne Streets together with dedicated bicycle paths
- convert Grattan Street into a dedicated transit corridor for trams and buses (with limited local access for cars) between Rathdowne Street and Royal Parade, inclusive of a high capacity interchange with MM1 and MM2 underground stations to service the important university and medical precincts at Parkville
- replace the Route 401 bus between North Melbourne and Parkville in an appropriate timescale as Stage 2 of the project
- provide an interchange facility between Routes 57, 67 and 79 trams in Errol Street, North Melbourne
- merge with the proposed West Melbourne extension in Hawke Street at Spencer Street and new tram loop linking tram/train interchanges at West Melbourne and the new North Melbourne station on the MM1 corridor

[32] *Fishermans Bend Framework*, Government of Victoria, October 2018.

Figure 29: Proposed Tram Loop serving West Melbourne and new North Melbourne Stations

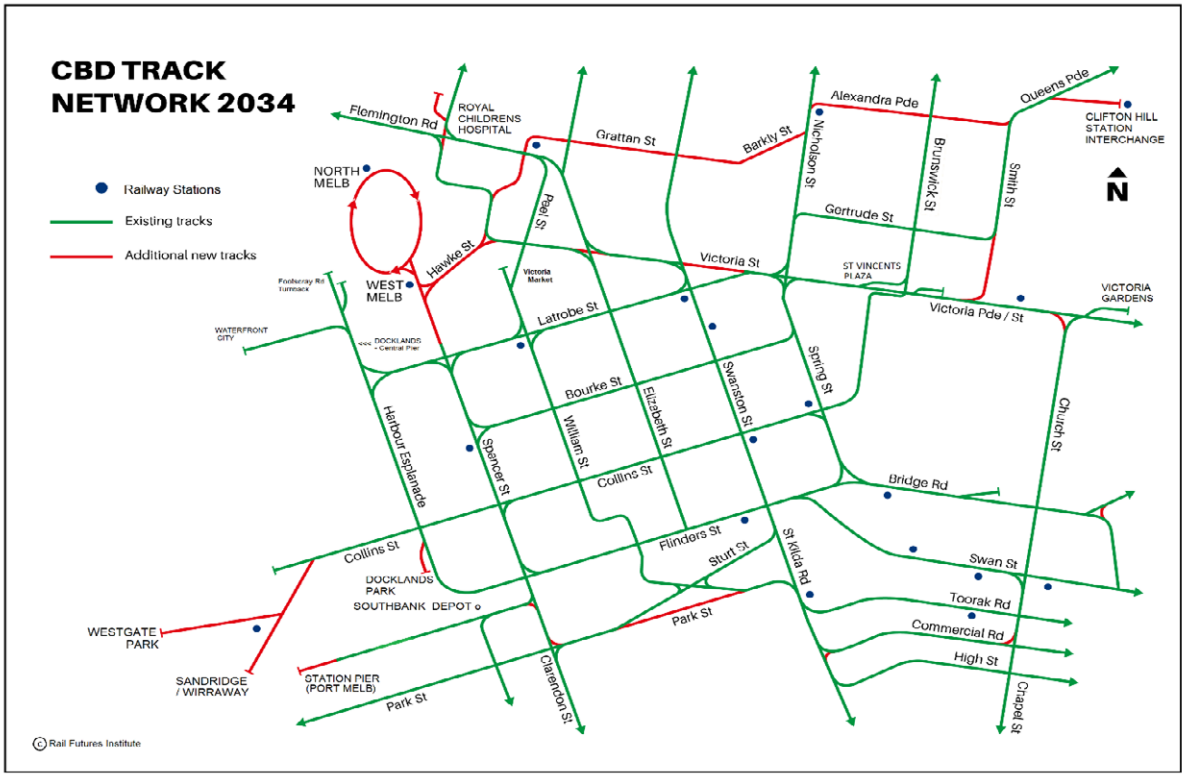






Detail of the proposed new twin track sections, connecting links and turnbacks to be constructed within the CBD and near inner suburbs is shown in Figure 30. The proposed implementation program for these works is in Section 12.

Figure 30: New track connections proposed within the CBD and inner suburbs by 2034



When completed in 2034, the proposed reconfigured CBD tram network is expected to provide service frequencies and route structures in the various Melbourne CBD streets as shown in Table 8, below.

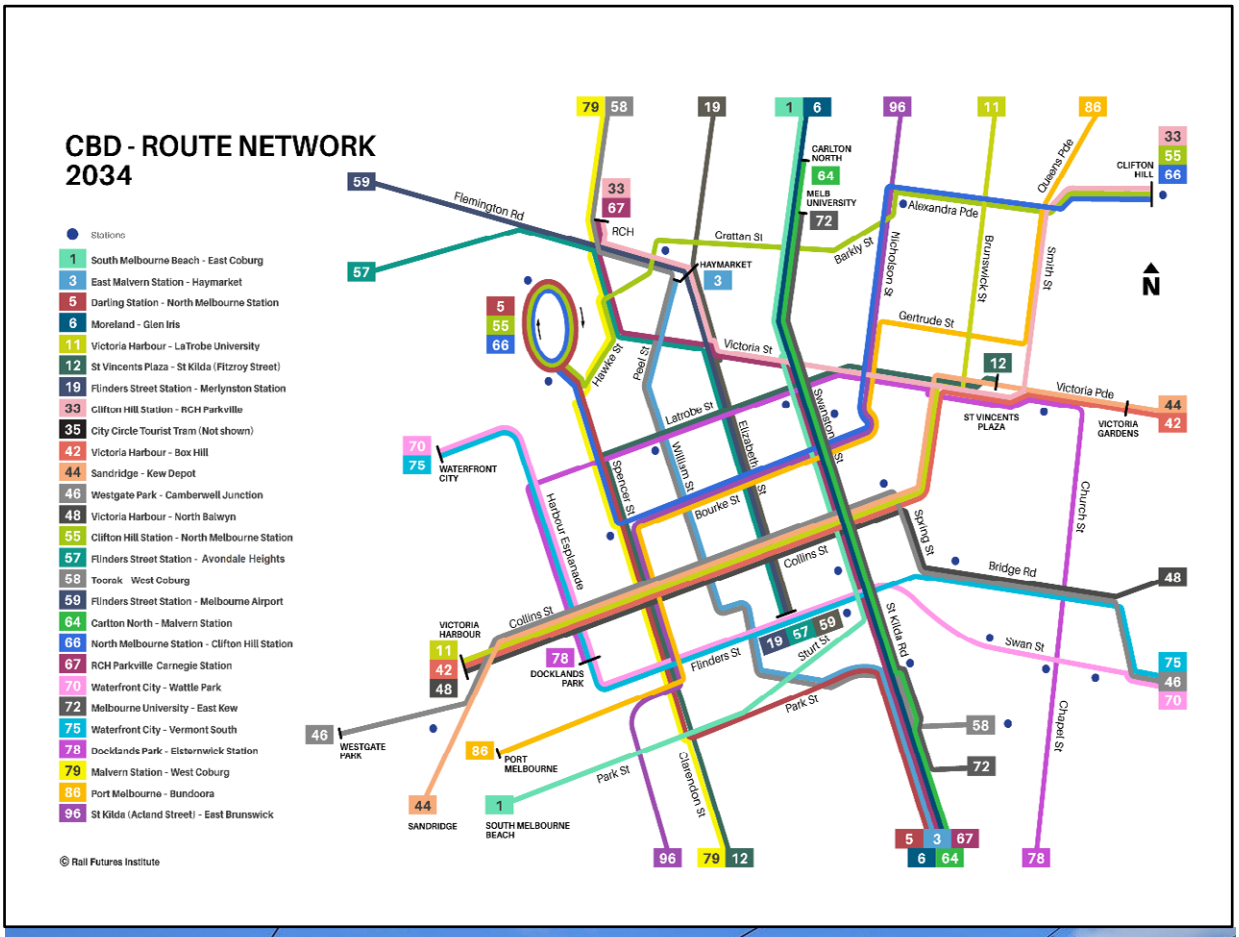
A greater diversity of route destinations will become available in all CBD streets, other than Swanston Street, reflecting the very significant shifts in commercial activity and job location within the extended Melbourne CBD and Docklands over the past 20 years or thereabouts. The reduced number of routes using Swanston Street will be offset by greater service frequency provided on Routes 1, 6, 64, 67 and 72 and introduction of MM1.

Table 8: Comparison by CBD streets of peak period frequency and routes serviced (2018 and 2034)

CBD Streets	TRAMS per hour EACH WAY		Number of Routes per CBD street		Route operation by street	
	2018 Existing	**2034 Proposed**	2018 Existing	**2034 Proposed**	2018 Existing	**2034 Proposed**
EAST / WEST ROUTES						
Harbour Esplanade	16	**34**	3	**5**	35 70 75	**35 70 71# 75 78**
Spencer Street	34	**40**	4	**5**	12 86 96 109	**5 12 79 86 96**
William Street	11	**28**	1	**4**	58	**3 56# 58 73#**
Elizabeth Street	31	**36**	3	**5**	19 57 59	**19 33 57 59 59a#**
Swanston Street	49	**34**	8	**5**	1 3 5 6 16 64 67 72	**1 6 64 67 72**
NORTH / SOUTH ROUTES						
Flinders Street	16	**23**	3	**4**	35 70 75	**35 70 71# 75**
Collins Street	35	**43**	4	**5**	11 12 48 109	**11 42 44 46 48**
Bourke Street	19	**34**	2	**4**	86 96	**66 85# 86 96**
La Trobe Street	12	**30**	2	**4**	30 35	**10# 12 35 78**
Victoria Street	8	**14**	1	**3**	57	**33 57 67**
Flemington Road	22	**37**	2	**5**	58 59	**33 56# 58 59 59a#**
See Table 9 below for key to route numbering.			***# - Weekday Peak Supplementary routes 0700-0930 and 1600-1830***			

Figure 31 below shows the complete configuration of CBD and near-CBD tram routes when the proposed changes are fully implemented in 2034.

Figure 31: Proposed CBD Tram network in 2034



E class tram on Route 96 in The Esplanade, St Kilda
Photo: *Hugh Llewelyn*

The resultant overall tram route network will be substantially different to that on offer today, as summarised in Table 9 and illustrated in Figure 32, below.

Table 9: Comparison of Tram Routes existing in 2018 and proposed in 2034

EXISTING 2018 *(24 routes)*		PROPOSED 2034 *(36 routes)*	
Route	***From / To***	***Route***	***From / To***
1	South Melbourne Beach – East Coburg	1	South Melbourne Beach – East Coburg
3	Melbourne University – East Malvern	**3**	**Haymarket – East Malvern Station**
5	Melbourne University - Malvern	**5**	**North Melbourne Station – Darling Station**
6	Moreland – Glen Iris	6	Moreland – Glen Iris
	NEW PEAK ROUTE >>>>>	**10 #**	**Docklands (Central Pier) – Preston Depot**
11	Victoria Harbour – West Preston	**11**	**Victoria Harbour – La Trobe University**
12	Victoria Gardens - St Kilda (Fitzroy St)	**12**	**St Vincents Plaza – St Kilda (Fitzroy St)**
16	Melbourne University – Kew (Cotham Rd)	Incorporated into Routes 68 and 79	
19	Flinders Street Station – North Coburg	**19**	**Flinders St Station – Merlynston Station**
30	Marvel Stadium – St Vincents Plaza	Incorporated into Route 78	
	NEW ROUTE >>>>>>>>	***33***	**Clifton Hill Station – RCH Parkville**
35	City Circle – Tourist Tram	35	City Circle – Tourist Tram
	Replaces Route 109 >>>	**42**	**Victoria Harbour – Box Hill**
	NEW ROUTE >>>>>>>>	**44**	**Sandridge – Kew Depot**
	NEW ROUTE >>>>>>>>	**46**	**Westgate Park – Camberwell Junction**
48	Victoria Harbour – North Balwyn	48	Victoria Harbour - North Balwyn
	NEW ROUTE >>>>>>>>	**55**	**Clifton Hill Station – North Melbourne Stn**
	NEW PEAK ROUTE >>>>>	**56 #**	**Southbank – Ascot Vale**
57	Flinders Street Station – West Maribyrnong	**57**	**Flinders St Station – Avondale Heights**
58	Toorak – West Coburg	58	Toorak – West Coburg
59	Flinders Street Station - Airport West	**59**	**Flinders St Station - Melbourne Airport**
	NEW PEAK ROUTE >>>>>	**59a #**	**Flinders St Station – Moonee Ponds Jctn**
64	Melbourne University – East Brighton	**64**	**Carlton North - Malvern Station**
	NEW ROUTE >>>>>>>>	***66***	**North Melbourne Station – Clifton Hill Stn**
67	Melbourne University - Carnegie	**67**	**RCH Parkville - Carnegie Station**
	Replaces Routes 16 and 64 >>>	**68**	**Kew Junction – Moorabbin Station**
70	Waterfront City – Wattle Park	70	Waterfront City – Wattle Park
	NEW PEAK ROUTE >>>>>	**71 #**	**Docklands (Central Pier) – Burnley**
72	Melbourne University – Camberwell	**72**	**Melbourne University – East Kew**
	NEW PEAK ROUTE >>>>>	**73 #**	**Victoria Market – Gardiner Station**
	NEW PEAK ROUTE >>>>>	**74 #**	**Gardiner Station – East Kew**
75	Marvel Stadium – Vermont South	**75**	**Waterfront City – Vermont South**
78	North Richmond - Balaclava	**78**	**Docklands Park – Elsternwick Station**
	Incorporates Route 16 >>>>	**79**	**Malvern Station – West Coburg**
82	Footscray – Moonee Ponds	82	Footscray – Moonee Ponds
	NEW PEAK ROUTE >>>>>	**85 #**	**Docklands (Central Pier) – East Preston**
86	Waterfront City - Bundoora RMIT	**86**	**Port Melbourne – Bundoora RMIT**
96	St Kilda (Acland Street) - East Brunswick	96	St Kilda (Acland Street) - East Brunswick
109	Port Melbourne – Box Hill		Replaced by Route 42

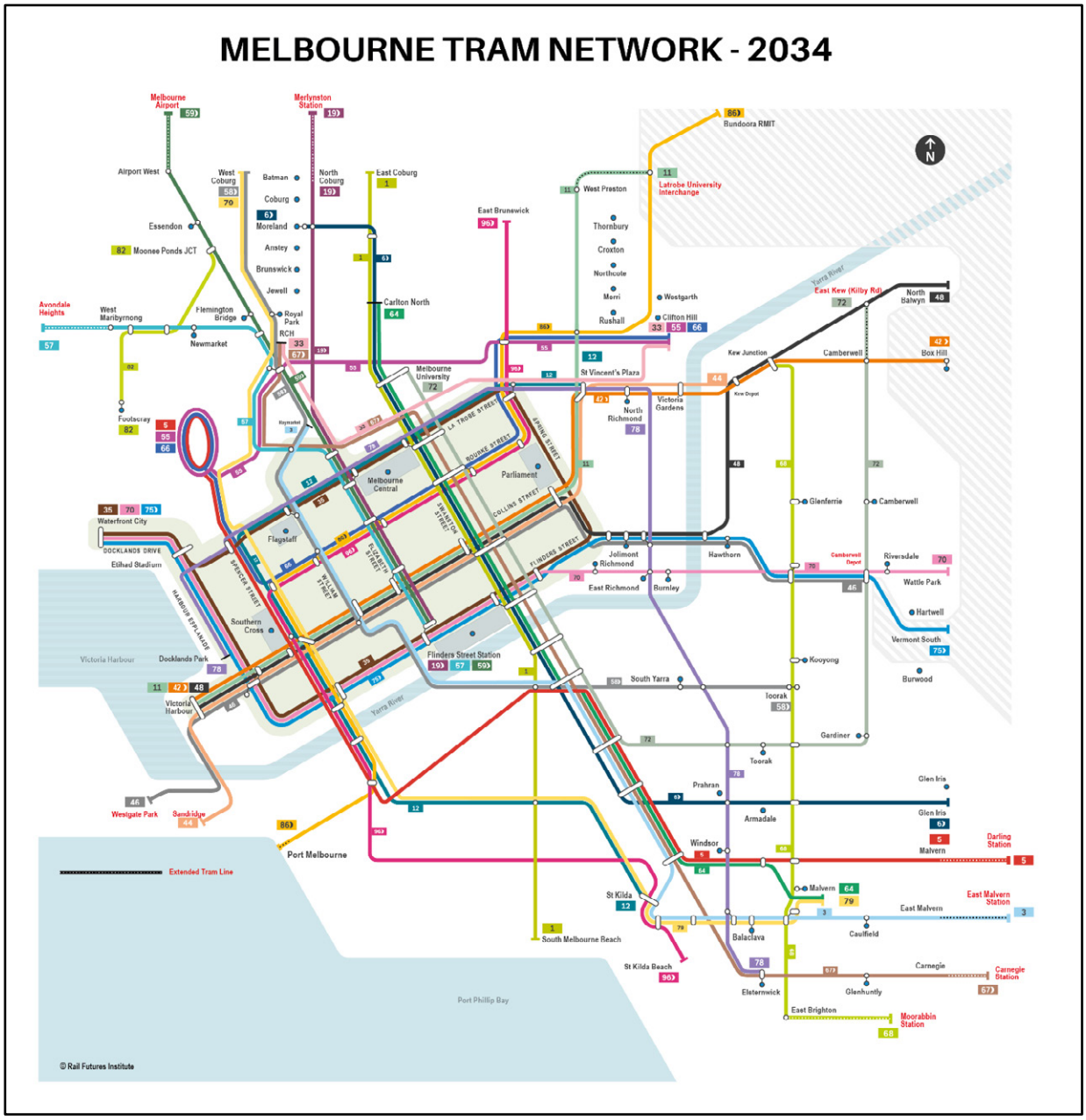
BOLD - Indicates NEW Route, or change of route number, or origin/destination

- Denotes Supplementary Inner Suburban Weekday PEAK Routes - 0700 to 0930 and 1600 to 1830

For the existing track network to maximize its peak carrying capacity a small number of existing routes, whilst still using the same CBD streets, would be altered to originate/terminate at different points beyond the CBD. This will minimize tram turning movements within the CBD and achieve significant improvements in operational reliability, whilst at the same time allowing for extra peak capacity to operate across the CBD. For example, to eliminate trams turning at the corner of Collins and Spencer Streets, Route 86 from Bundoora would operate to Port Melbourne (instead of Waterfront City) and Route 42 (formerly Route 109) from Box Hill would operate to Victoria Harbour instead of Port Melbourne. Route 12 to St Kilda (Fitzroy Street) would now operate via Latrobe and Spencer Streets instead of Collins Street.

The transition from the existing route network of 24 routes at 2018, to that of 36 routes in 2034, takes place over 3 stages as set out in Appendix T 3.

Figure 32: Proposed Melbourne Tram Network – 2034



In addition to the basic route structure described above, it is also proposed to progressively introduce supplementary peak period services on inner parts of several tram routes to provide additional capacity in these areas and relieve pressure on full distance routes. These would be introduced progressively from 2029 to 2039, as listed in Tables 10 and 11 below and shown in Figure 33, below.

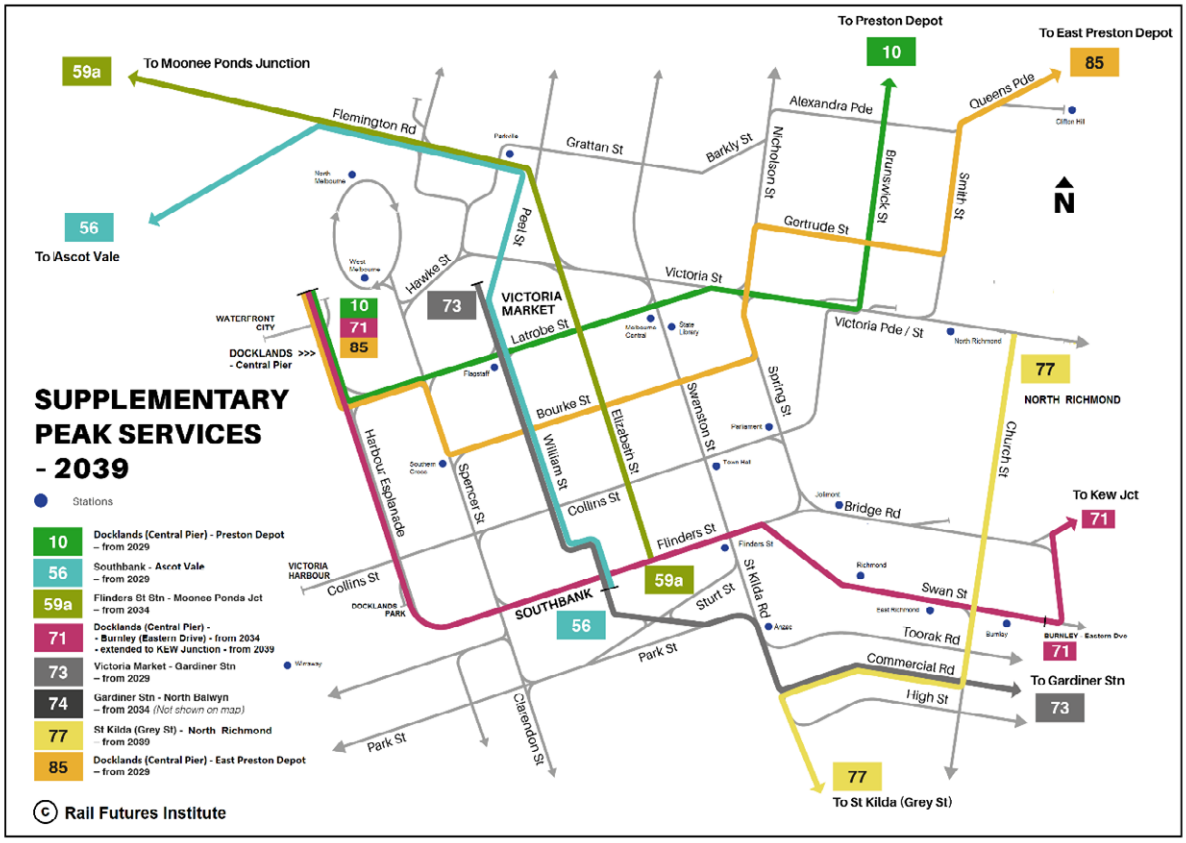
Table 10: New and altered Cross-City route choices

NEW AND ALTERED CROSS-CBD TRAM ROUTE CHOICES AT 2034		
Route	**Origin - Destination**	**Via**
3	**Haymarket– East Malvern Station**	Victoria, Market, & William Streets, Southbank & Domain
5	**North Melbourne Station – Darling Station**	West Melb Stn, Southern Cross Stn, South Melbourne & Domain
12	**St Vincents Plaza - St Kilda (Fitzroy Street)**	Victoria, La Trobe, Spencer & Clarendon Streets
33	**Clifton Hill Station – RCH Parkville**	St Vincents Plaza, Victoria Market & RMH Parkville
42*	**Victoria Harbour – Box Hill**	Docklands, Collins Street, St Vincents Plaza & Victoria Gardens
44	**Sandridge / Wirraway – KEW Depot**	Docklands, Collins Street, St Vincents Plaza & Victoria Gardens
46	**Westgate Park – Camberwell Junction**	Docklands, Collins Street, Jolimont, MCG & Bridge Road
55	**Clifton Hill Station – North Melbourne Stn**	Alexandra Pde, Fitzroy Station, Grattan Street & Parkville Station
64	**Carlton North - Malvern Station**	Lygon, Elgin &Swanston Streets, Domain & St Kilda
66	**North Melb Station – Clifton Hill Station**	West Melb Stn, Southern Cross Stn, Bourke St & Alexandra Pde
67	**RCH Parkville - Carnegie Station**	Victoria Market, Swanston Street, Domain & St Kilda
75	**Waterfront City – Vermont South**	Waterfront City, Harbour Esplanade, Flinders St, Camberwell Jct
78	**Docklands Park – Elsternwick Station**	Latrobe St, St Vincents Plaza, Nth Richmond, Prahran & Balaclava
79	**Malvern Station – West Coburg**	St Kilda, South Melb, Southern Cross, West & North Melb stations
86	**Port Melbourne – Bundoora RMIT**	Exhibition Centre, Southern Cross, Bourke & Nicholson Streets
**-Formerly Route 109 from Port Melbourne to Box Hill*		

Table 11: New Supplementary Routes

NEW SUPPLEMENTARY WEEKDAY PEAK ROUTES AT 2039			
Route	**Origin / Destination**	**Inner suburban back-up to Route**	**Supplementary Service Route**
10	**Docklands – Preston**	**11**	From Docklands via Latrobe Street, St Vincents Plaza then as for Route 11 to PRESTON DEPOT.
56	**Southbank – Ascot Vale**	**57**	From Southbank, via William Street, Peel Street, Flemington Road, then as Route 57 to Maribyrnong Road
59a	**Flinders Street Station – Moonee Ponds Junction**	**59**	From Flinders Street Station as Route 59 to terminate at Moonee Ponds Junction (Connect to Route 82)
71	**Docklands – Burnley – Kew Junction**	**42, 48, 70, 75**	From Docklands via Harbour Esplanade then as Route 70 to Hawthorn Bridge, then to Kew Junction
73	**Victoria Market – Gardiner Station**	**72**	From Victoria Market via William Street, Southbank, Domain then as Route 72 to Gardiner Station.
74	**Gardiner Station – East Kew**	**NEW Mid Suburban**	From GARDINER Station (Connect from Route 73) via Burke Road to Kilby Road EAST KEW (Connect Route 48)
77	**St Kilda – North Richmond**	**NEW Cross Suburban**	From Grey St via Fitzroy Street, St Kilda Road, Commercial Road, Alfred Hospital, Chapel Street and Church Street to Victoria Street at NORTH RICHMOND.
85	**Docklands – East Preston**	**86**	From Docklands via Latrobe Street, Spencer Street then as for Route 86 to terminate at EAST PRESTON.
The above routes operate in the AM Peak (0700 to 0930) and in the PM Peak (1600 to 1830)			

Figure 33: Proposed Supplementary Peak CBD – Inner Suburban tram routes



Full details of these routes are provided in Appendix T 2.

The reconfigured tram network effectively creates two circular corridors in inner Melbourne to form a critical component of an inner area grid network. They are a CBD and inner eastern circular route formed by the combination of Routes 78 and 79 and a CBD and inner northern circular route formed by the combination of Routes 55 and 66.

These are illustrated in Figures 34 and 35, respectively, below.

Figure 34: Proposed combined Routes 78 / 79 – CBD and Inner Eastern Circular Route

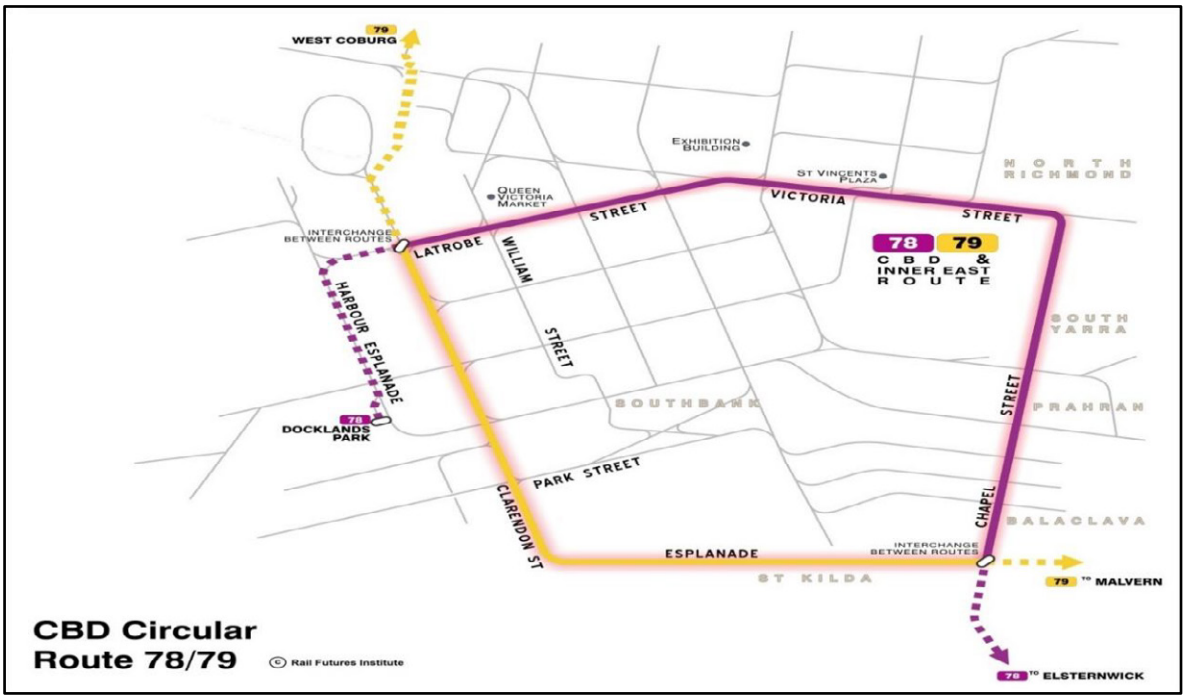
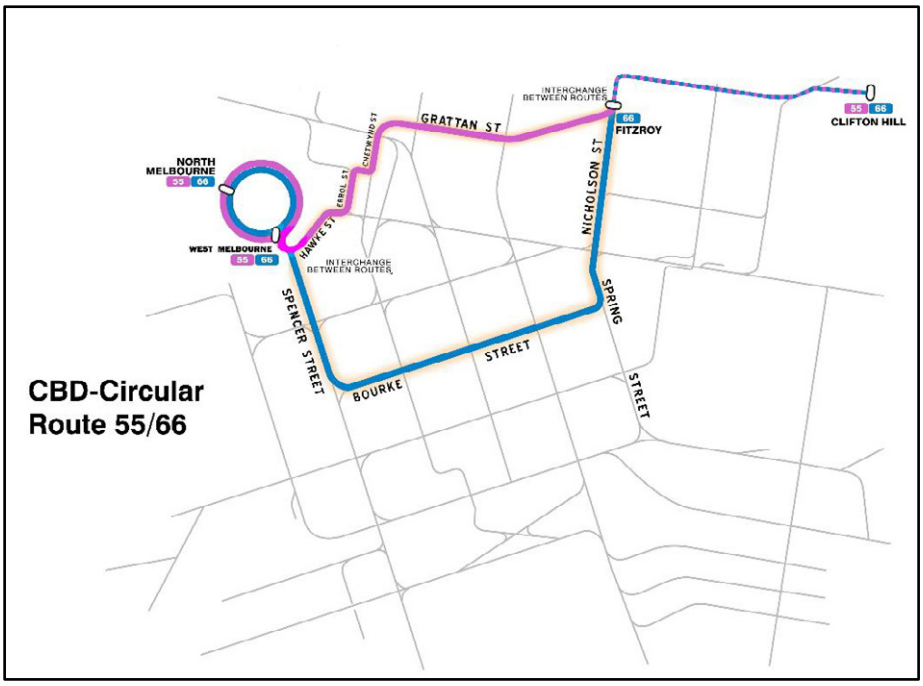


Figure 35: Proposed combined Routes 55 / 66 – CBD and Inner Northern Circular Route



6.5 Tram Service Levels

The overall principles for public transport services were outlined in Section 4.14. The RFI recommended standards for tram services are as follows:

6.5.1 Service Frequency

- "Turn up and go" schedules eliminate the need to consult or understand timetables.
- A minimum 10-minute service frequency from 6am to 10pm weekdays and from 7am to 9pm weekends on all trunk tram routes.
- Additional services during peak periods and at other times to meet demand, or to induce demand.
- Outside these hours, a minimum service frequency of 20 minutes would apply.

6.5.2 Hours of Operation

All tram routes would generally provide services from 4.30am to 1.30am on weekdays and 5.30am to 12.30am on weekends. Trunk tram routes would also provide minimum hourly all-night services during the early hours of Saturday and Sunday mornings.

6.5.3 Reliability Standards

On the tram network service reliability should in future be measured in comparison to the timetabled headway within a set criterion in minutes, rather than to actual timetable adherence at various points along the route, as is current practice. To the passenger, adherence to headway (frequency) is important, not adherence to timetable. Already on many routes the timetables at stops do not indicate departure times, but rather frequency of service between defined times of the day. Therefore, a monitoring regime that measures performance in terms of services delivered compared to plan; and adherence to the planned headway, is more appropriate in future.

Proposed revised standards would require 99% monthly delivery of all scheduled services. Headway between services would be measured at designated locations on each route. This requires 90% of all services to operate within ±4 minutes of scheduled headways. Mitigation would only be allowed in exceptional circumstances.

6.5.4 Capacity and Crowding

Maximum passenger load carrying standards would continue to apply to all vehicle types. All trams would be equipped with load monitoring devices linked to GPS location monitoring and the MKYI ticketing system which would generate continuous passenger capacity utilisation data for each route journey.

6.6 Tram Fleet Requirements

Current orders for new trams are limited to the acquisition of 100 E-class trams with a capacity of 210 passengers, of which the first 79 were in service in August 2019. When the current order for E class trams is fulfilled, there will be 200 low floor trams on Melbourne's network, comprising 40% of the fleet. The immediate aim is to run all services on routes 19, 96 and 109 with low floor trams. Routes 5, 6, 11, 16, 48, 58, 72 and 86 are partly serviced by low floor trams.

The Victorian Government recently announced a plan to refurbish a significant part of the existing tram fleet to improve passenger safety and undertake life extension works on the older parts of the fleet. The work includes major structural repairs, particularly on the B2 class fleet. Enhancements include new seating, replacement of glass and decals and provision of state-of-the-art passenger information systems (PIDS).

To meet DDA compliance by 2032 and to meet the projected peak traffic task over the next 15 years, a vastly accelerated tram acquisition program is required that will see the fleet grow from the current 500 trams to around 640 by 2034 and retirement of all smaller non-DDA compliant trams of the Z and A classes.

Whilst the tram fleet will increase by 28%, the peak carrying capacity will more than double through the transition to a new fleet of three articulated tram types of 24m, 33m (the present E class) and 40m in length, with carrying capacities between 150 and 275 passengers. Over the 15-year period, acquisition of an additional 175 E class, 45 x 40m F class and 250 x 24m G class is recommended. Over the same period 311 older non-DDA-compliant trams would be withdrawn. The fleet projections also allow for an annual write-off of a small number of vehicles damaged in traffic accidents and thus deemed to be beyond economic repair.

Short term, to 2025, this will require an increase in new tram procurement from its current rate of around 10 trams per annum to 25 new trams per annum. Between 2025 and 2034, the procurement rate will need to further step up to 35 new trams per annum.

The projected capital cost of the recommended 15-year fleet acquisition program is $2.8 billion.

The proposed acquisition (and retirement schedule for aged, low capacity high floor trams that do not meet DDA requirements) is shown in Appendix T 25.

Whilst over the 15-year period, the fleet would only grow by 149 trams (28%), peak capacity would increase by 116% due to the fleet transitioning to a totally articulated fleet of larger capacity longer trams.

The projected tram fleet requirements are shown in Table 12, below.

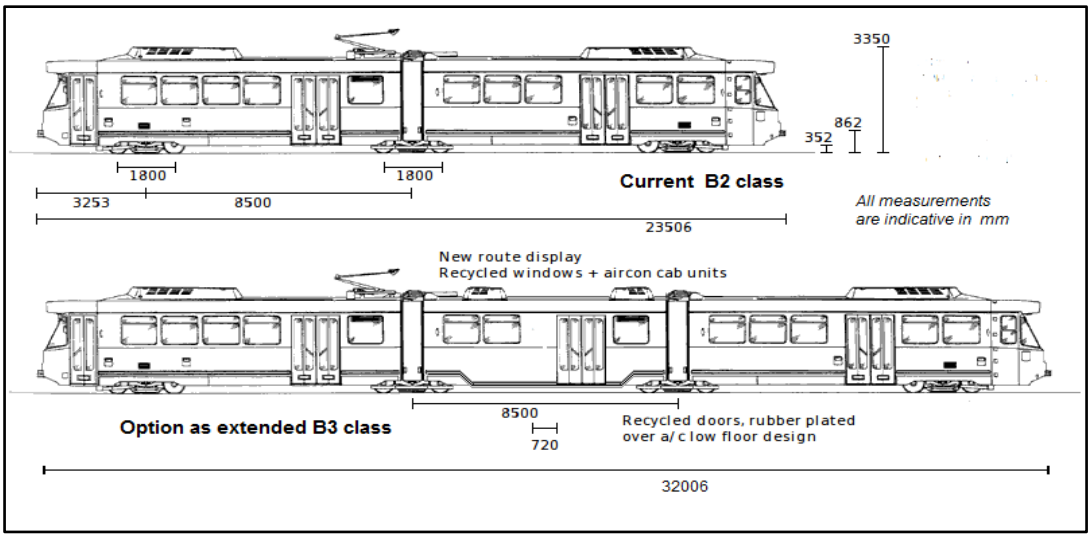
Table 12: Tram Fleet Requirements 2018 to 2044

Tram Type				*Year*					
Tram Class	***Length***	***Capacity***	***DDA Compliant***	***2018***	***2024***	***2029***	***2034***	***2039***	***2044***
A	15m	65	No	69	65	0	0	0	0
B2	24m	110	No	130	128	125	0	0	0
C1	23m	120	Yes	36	35	34	33	29	25
C2	33m	180	Yes	5	5	4	3	2	0
D1	20m	90	Yes	38	37	35	33	31	30
D2	30m	140	Yes	21	20	19	18	18	18
E	34m	210	Yes	72	181	216	254	252	251
F	40m	275	Yes	0	0	32	43	93	141
G	24m	120	Yes	0	0	120	250	276	302
W	15m	75	No	13	13	13	13	13	13
Z	17m	70	No	114	0	0	0	0	0
Fleet Totals				**498**	**484**	**598**	**647**	**714**	**780**

The above fleet proposals include the retirement by 2034 of 130 high-floor articulated B2 class trams which are also non-DDA-compliant. Given the cost of new trams, a cost-effective alternative may be to insert a centre DDA compliant low-floor module to increase their capacity over a 3 to 4-year program at an estimated cost of $250 million. Cost savings may be possible by recycling some key components from withdrawn Z and A class trams.

In the short term, this would increase the proportion of DDA compliant trams in the present overall fleet from 35% to 61%. With associated life extension works (being undertaken in any event), this would enable these 25-year old vehicles to continue in operation until the late 2030s. It would also defer the requirement for approximately 120 new G class trams by around 10 years with a net cost saving of approximately $400 million during the period to 2034. The proposed B2 to B3 class conversion concept is illustrated in Figure 36 below.

Figure 36: Potential Conversion of B2 class to B3 class DDA- compliant tram



Potential Melbourne Future Tram Fleet Types

G Class 24m - 120 passengers
Photo: *Siemens*

E Class 33m - 210 passengers
Photo: *Bob Wilson*

F Class 40m - 275 passengers
Photo: *John Hearsch*

6.7 Depots, Stabling and Maintenance Facilities

The progressive increase in fleet size coupled with the transition to a total fleet of longer articulated vehicles will require the provision of expanded depot/stabling space and additional maintenance facilities. Analysis has indicated that the progressive transition to a larger fleet of exclusively articulated trams of longer length will require a near doubling of stabling capacity.

The provision of additional stabling and maintenance facilities must be programmed to dovetail with the procurement program for new trams. The existing legacy depots (especially the smaller sites) are already having difficulty in stabling the increasing number of longer articulated trams.

Initially, a suitable site exists in Footscray Road, West Melbourne and other potential sites exist or are likely to exist at Fishermans Bend and near Melbourne Airport for which suitable land should be acquired. Additionally, some of the larger legacy depots (including Moreland and Essendon) may lend themselves to expansion and/or re-configuration to hold more and longer trams. The installation of a traverser at constrained sites (instead of conventional track configuration) should be considered in this context.

The need for any specific additional non-revenue track connections should be assessed to enable deployment of vehicles between depots for stabling, and to maximize fleet utilisation as the traffic task grows and changes. This allows for more efficient transfer of trams between existing depots.

6.8 DDA Compliance

The Commonwealth Disability Discrimination Act (DDA) specifies a target date of 31 December 2032 for all public transport services to fully comply with relevant standards. A vastly accelerated program of tram stop upgrades and new tram acquisitions is required if tram services are to comply with the Act. It will require a concerted commitment of Federal, State and Local Governments to create a tram system that is accessible to all Melburnians.

High floor trams have steps, so they are unsuitable for mobility aids including wheelchairs, scooters and motorised vehicles, irrespective of whether these trams are at an accessible or non-accessible stop.

Melbourne still has over 300 older high floor trams with steps. Replacing these older trams and meeting passenger growth predictions will require a tripling of the current tram procurement rate.

Currently only about one quarter of tram stops are DDA- compliant and at the current upgrading rate it will be many decades before the remaining 1300 are fully accessible. A new platform stop would need to be opened every 5 days to meet the 2032 target.

Photo: *Max Michell*

Incompatible: Low floor tram and street level stop

Photo : Bob Wilson

Compatible: Low floor trams at raised island platform stop

6.9 Tram Stops and Interchanges

The combination of accessible tram stops, and low floor trams enables people of all abilities to reach jobs, educational, health and leisure facilities. Currently, only a quarter of 1700 stops currently have level boarding access. The current program for providing stops with level boarding access needs to be substantially accelerated.

In general, tram stops need significant improvement to ease overcrowding and improve access, particularly in inner city areas. This includes designs that comply with the Disability Discrimination Act (DDA). Better tram stop design and traffic treatment, particularly for some of the most important stops in the city which are interchanges between tram, train or bus, can help to create a more permeable walking environment to ease some of the current overcrowding, safety and amenity issues.

Within the CBD and inner area, the progressive provision of platform stops offers the opportunity to rationalise closely spaced stops and relocate stops away from major intersections. This improves passenger access and safety and expedites the throughput of trams and road traffic in shared and limited road space. New platform stops need to be future proofed to allow for the projected tram types planned for operation on each route/corridor by 2034. New and existing platform stops at specific high passenger volume stops offer the option of off-tram MYKI touch on, potentially speeding up the boarding process and reducing stop dwell times and expediting tram throughput per hour.

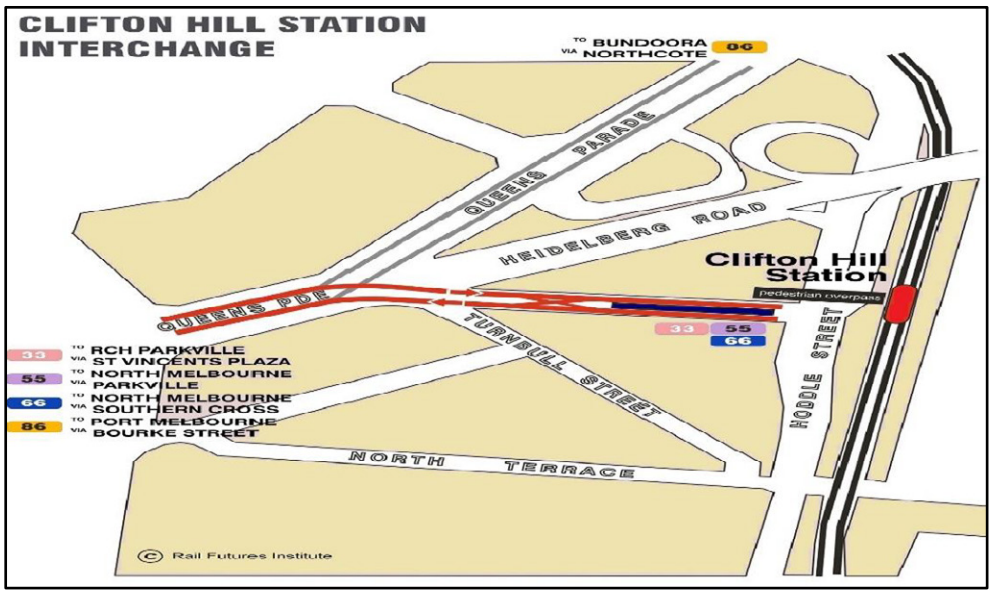
Upgraded real-time information displays should be provided at all major stops on the network and at key tram/train, tram/tram and tram/bus interchange points. These displays should list the next tram information strictly in order of departure by time, similarly to those in use across the rail network.

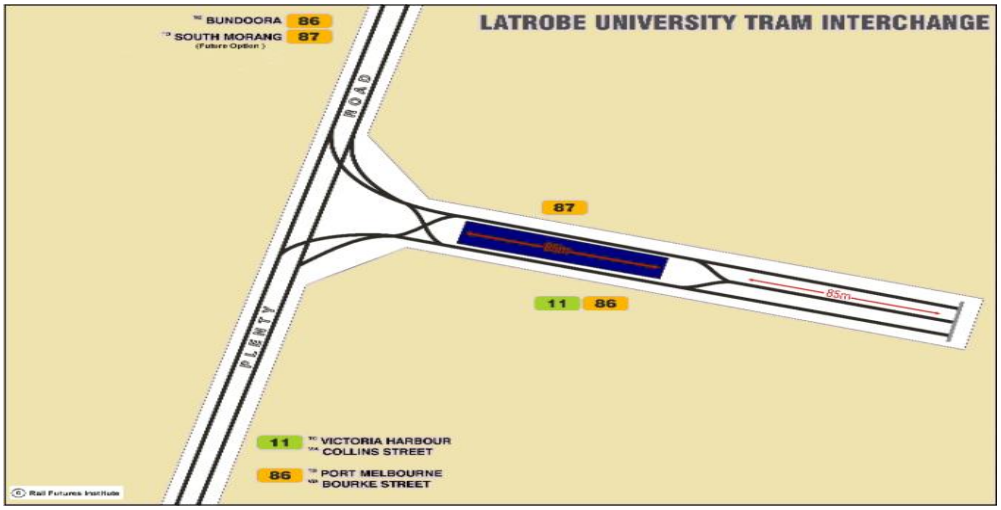
Several sites have been identified as opportunities to provide high quality intermodal passenger interchanges between trains, trams and buses as part of the development of a grid pattern of routes in Melbourne.

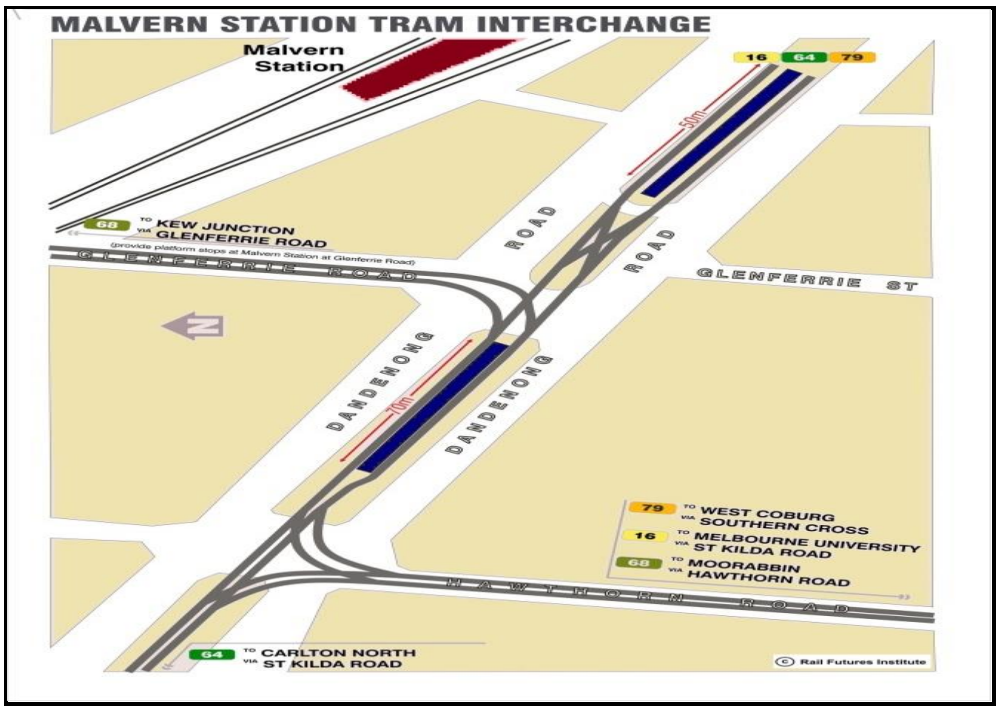
Examples are shown below (Figure 37) of proposed new interchanges at Clifton Hill, La Trobe University and Malvern station. Another new interchange will be at Anzac station.

Longer trams will also progressively require selective extension of existing platform stops on a limited number of trunk routes to accept trams up to 40m in length.

Figure 37: Proposed Tram Interchanges







6.10 Tram / Train Interchange at key CBD Stations

The volume of passengers transferring between trams and trains at key CBD stations especially Southern Cross and Flinders Street at street level has and will become an increasing problem as the city and public transport patronage grows. The City of Melbourne has identified these locations recently as critical pedestrian / road traffic interfaces to be addressed.

Innovative safe solutions providing improved passenger access within the stations and platforms coupled with better direct interface with the on-street tram network will need to be developed jointly by Yarra Trams, station management, State Government and the City of Melbourne.

Such solutions may include, but not be limited to:

- additional overhead station concourses at both Southern Cross and Flinders Street
- pedestrian bridges over Spencer Street at Southern Cross station
- car-free street level tram interchanges at the foot of both Elizabeth and Bourke Streets.

6.11 Upgrading Tram Infrastructure

Melbourne's basic tramway infrastructure (primarily track and overhead wiring) has been maintained to a generally satisfactory standard over the years. During a 30-year period from the 1950s, much of the network was rehabilitated by relaying track in mass concrete, usually using short lengths of rail joined by fishplates. Half a century later, these tracks were worn out with concrete breaking up and rail joints failing. Substantial parts of the network have now been rebuilt using more appropriate track design and construction materials, but much remains to be completed before the entire network can be described as being in good overall condition. The advent of longer and heavier articulated trams places greater demands on the track structure hence tram infrastructure upgrading will be an ongoing requirement.

The transition to a totally articulated fleet will also require improved traction power supplies to support both longer trams and services operating at higher frequencies. This includes the need to acquire suitable sites for new sub-stations, often a challenge in an existing built environment. Options include inclusion of sub-stations in the basement of new apartment or commercial development sites. The requirement for additional sub-stations needs to be considered by planning authorities before approval of major new developments, especially in the CBD and inner areas.

In recent years there have been rapid developments in both Asia and Europe in innovative new tram traction technologies and traction power systems designed to improve operational efficiency, reduce energy costs, improve tram performance and achieve better environmental outcomes.

Melbourne's transition from a network and power supply system designed for a fleet of traditional small trams, to a future network operating much larger trams operating at greater frequencies will require detailed study of future options in terms of vehicle technology, energy efficient traction systems and an updated power supply network that leverages the latest and most suitable technologies.

7. The Medium Capacity Transit (MCT) and Light Rail Plan

7.1 Overview

Medium Capacity Transit (MCT) is a key element of the RFI Plan and a new concept for Melbourne. This public transport solution is ideally suited to new trunk routes not requiring the capacity of traditional heavy rail systems that service Melbourne's radial corridors. MCT systems are being constructed or expanded in many cities worldwide and are increasingly favoured as a highly efficient, attractive, affordable and environmentally friendly means to facilitate sustainable urban development and reduce motor car dependency.

The broad characteristics of MCT were described in Section 4.7. As noted, MCT infrastructure can be on the surface, elevated or underground, as determined by individual route conditions. MCT technologies are rapidly evolving, ranging from conventional light rail using upgraded trams to light metro railways and high capacity guided buses with electric and hybrid traction systems. In Melbourne, MCT will use one or more of these systems to provide high frequency services on segregated corridors. MCT complements other modes and, with convenient interchanges, will form a critical part of a multimodal public transport grid.

In accordance with *Plan Melbourne 2017-2050*, the aim is to develop medium density transport corridors that support the concept of a polycentric city. The MCT proposals in this Plan connect some 120 nodes/stations, job precincts, activity centres and provide easy access to high quality public transport from adjacent suburbs. New MCT routes and corridors provide important spines that anchor urban renewal and consolidation, especially in brownfield sites in the inner and middle suburbs and provide important cross-town and infill connectivity on key routes that complement the radial heavy rail network.

There are opportunities to create new MCT routes, nodes and corridors, particularly in areas of Melbourne with strong 'knowledge job' centres such as key tertiary education and biomedical research precincts. MCT has considerable potential on several key Melbourne corridors, typically where demand is likely to exceed 5000 passengers per hour in one direction for at least 6 hours on weekdays and where conventional bus services would not provide an attractive alternative to private car use.

RFI's proposed MCT routes provide 230 km of high-quality cross-suburban connectivity to 120 nodes/stations at an estimated cost of approximately $32 billion, including rolling stock. Progressive implementation would occur between 2030 and 2050, but with detailed planning processes underway from 2025 onwards. They comprise:

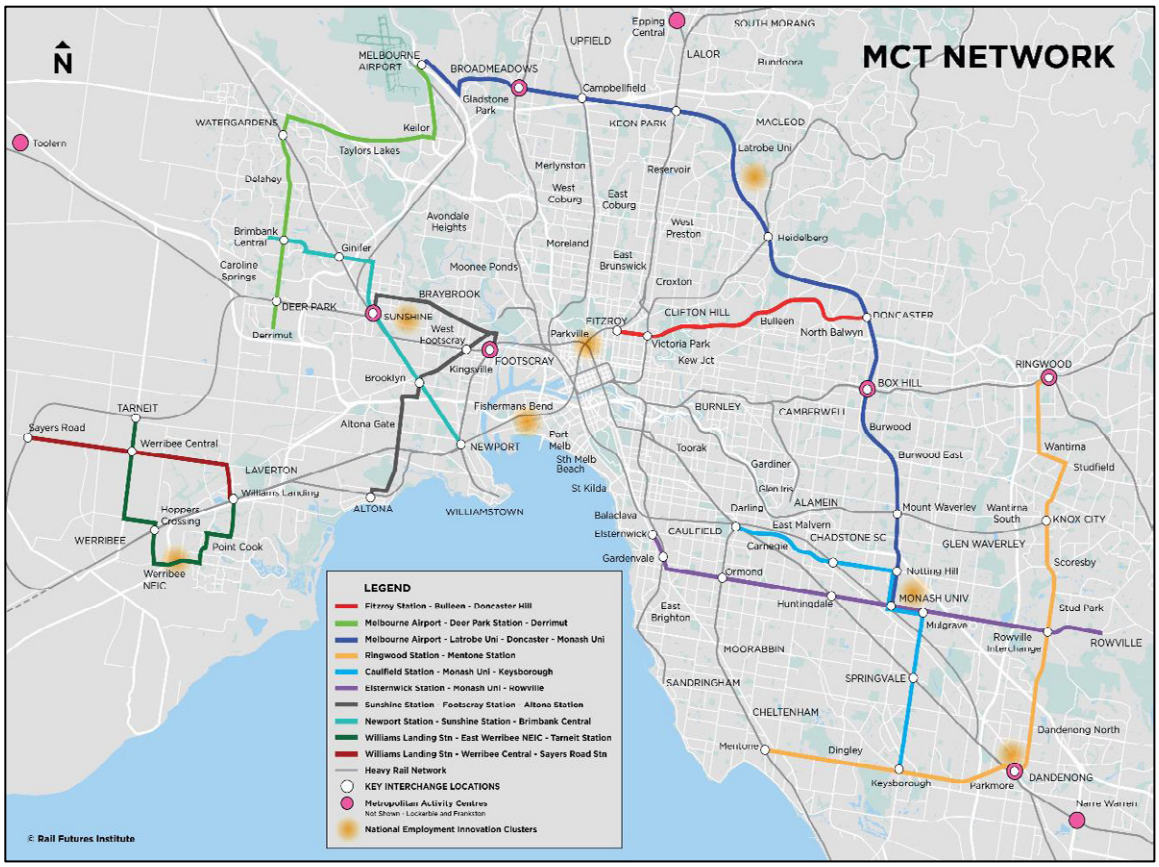
- One radial corridor
  - Fitzroy to Doncaster via Victoria Park and Bulleen
- 3 major orbital corridors:
  - Melbourne Airport to Derrimut via Keilor, Taylors Lakes, Delahey and Deer Park
  - Melbourne Airport to Monash University via Broadmeadows, Campbellfield, Keon Park, La Trobe University, Heidelberg, Doncaster, Box Hill, Burwood and Mount Waverley
  - Ringwood to Mentone via Knox City, Rowville, Dandenong and Keysborough
- 6 major cross-suburban corridors:
  - Caulfield to Keysborough via Chadstone, Monash University and Springvale
  - Elsternwick to Rowville via Ormond, Huntingdale and Monash University
  - Sunshine to Altona via Braybrook, Maidstone, Footscray and Kingsville
  - Newport to Brimbank Central via Brooklyn, Sunshine, Ginifer and Cairnlea
  - Williams Landing to Tarneit via Point Cook, East Werribee NEIC and Hoppers Crossing
  - Williams Landing to Sayers Road (future station) via Truganina

The following section sets out proposals for the MCT corridors and route structures. These are preliminary proposals that illustrate how MCT concepts can be applied in various metropolitan environments. The identified routes, while considered appropriate in relation to overall network design and connectivity, will each require extensive investigation and assessment to determine an optimum solution, having regard to community input, environmental factors, urban form, proposed technology, cost and constructability.

RFI's MCT proposals provide an interesting contrast with the Victorian Government's major Suburban Rail Loop proposal announced in August 2018. A comparative analysis is in Section 7.3, below.

The proposed MCT Route Network is shown in Figure 38 with details of each route following.

Figure 38: Proposed MCT Route Network



7.2 Identified Corridors for MCT

7.2.1 Doncaster Radial Corridor

Rail transport for the Doncaster Corridor has been the subject of numerous proposals since 1890. Detailed planning for a railway commenced soon after the release of The Transportation Plan[33] in 1969 and a route was determined in 1972. A section of the route used part of the median of the Eastern Freeway. Property acquisition along the route was completed in 1975. However, by 1982 plans to build the line were shelved by the State Government, and by 1984, land for the line was sold. Freeway expansions and the sale of properties have diminished Government enthusiasm for rail in favour of upgraded bus services.

The former Victorian Government's 2013 feasibility study for a heavy rail line to Doncaster was never completed[34]. The "Terms of Reference" for the study were very narrow, limiting consideration to an alignment to the Doncaster "Park and Ride", distant from the Major Activity Centre at Doncaster Hill. It used conservative population and travel projections, a brief that assumed building of the East West Link road tunnel and focussed exclusively on heavy rail to the exclusion of alternatives such as Light Rail.

The current Government's decision in 2017 to build a North East Link (NEL) connecting the Metropolitan Ring Road and Eastern Freeway now proposes exclusive bus lanes described as Bus Rapid Transit (BRT) along an expanded Eastern Freeway. There is no indication that the proposed bus lanes meet BRT standards or have the capacity to be converted to any other form of transit such as light or heavy rail to meet growing public transport demand.

[33] *The Transportation Plan*, prepared by The Metropolitan Transportation Committee, released December 1969.

[34] *Doncaster Rail Study: Phase One Recommendations Report* (URS, June 2013)

RFI recognises the continuing need for an effective high-quality transit system between Doncaster and the CBD but also agrees with the findings of multiple studies that a heavy rail option in the Eastern Freeway corridor is unlikely to be economically viable. Other options offer better prospects of also meeting a greater diversity of user needs from the wider Doncaster area and beyond.

Several MCT solutions require consideration for the Doncaster-CBD corridor, all of which potentially provide greater capacity and enhanced service quality by comparison with the currently proposed bus-only solution. These options are not mutually exclusive, and a combination of options should be considered. All options assume some level of continued Eastern Freeway bus operations.

The various MCT options for serving Doncaster are described below.

(1) City-Doncaster MCT

Assuming the State Government maintains its position that the East-West Link road project will not proceed, the case for a direct City to Doncaster MCT solution is strong in the absence of a better alternative. (See Option 3). This should be the subject of an early planning and business case process in conjunction with present proposals for the NEL and an enhanced Eastern Freeway busway.

An MCT corridor to Doncaster along the Eastern Freeway is an attractive option to meet capacity and future service levels for predicted patronage. Upgraded Light Rail would be suitable for this corridor using tram/train type vehicles, as parts would overlap the existing tram network at the CBD end.

A staged development package to bring MCT to Doncaster Hill could be achieved by:

- interim improvement of Eastern Freeway bus services to grow patronage and capacity through:
  - greater bus priority on Hoddle Street/Victoria Parade, currently being implemented
  - a bus/rail interchange at Victoria Park
  - a dedicated busway along the Eastern Freeway capable of conversion to MCT/Light Rail
- extending the existing Route 48 (City–North Balwyn) tram along Doncaster Road for approximately 3.6 km from Balwyn Road to Westfield Shoppingtown at the Doncaster Hill Major Activity Centre, joining the Doncaster MCT corridor near the Doncaster Road freeway interchange
- constructing a 15 km high-capacity MCT corridor from the Doncaster Hill Major Activity Centre to Fitzroy via Doncaster Road, the Eastern Freeway and Alexandra Parade
- integrating the Doncaster MCT corridor into the tramway network at Fitzroy (see below), with interchanges to heavy rail at Victoria Park Station and the proposed MM2 Fitzroy Station, serving the expanding Major Activity Centres of Smith and Brunswick Streets Fitzroy/Collingwood.

Alexandra Parade is a wide boulevard with a central median extending to Nicholson Street that could readily accommodate Light Rail or other MCT infrastructure. Tramway intersections at Smith and Brunswick Streets would require suitable signalised control to ensure MCT priority. Importantly, Alexandra Parade presently lacks any form of east-west public transport. Yet it presents an opportunity for transformation into a grand commercial and residential boulevard like St Kilda Road or Royal Parade in line with the original vision for Melbourne. MCT, in conjunction with the proposed MM2 Fitzroy Station, would stimulate regeneration along Alexandra Parade on a significant scale given its proximity to the CBD.

The most appropriate corridors for entry into the CBD under a Light Rail scenario require detailed assessment. However, a merger with tram Route 96 for about 600m between Princes and Johnston Streets and thence via Barkly, Rathdowne and Latrobe Streets to Melbourne Central Station and Docklands, is one of several potential options. Another option is for the route to split at the corner of Barkly and Rathdowne Streets, Carlton with alternate services operating along Grattan Street interchanging with the Carlton/Parkville MM1 station, then following the same route as the proposed Route 55 tram through to West Melbourne and North Melbourne stations.

To be competitive with private car travel (by way of perception and reality) and to emulate as far as possible the performance of a heavy rail solution, very few stops would be provided on the Eastern Freeway section. Rolling stock selected for use on the corridor would be high capacity, high performance units similar to tram/train vehicles now operating in Europe, capable of operating at 100 km/h freeway speed. Significant peak mode shift is expected with such MCT far exceeding peak freeway average car speed of 20-30 km/h.

(2) Connecting Doncaster Hill to the CBD via Box Hill Heavy Rail

The Government in September 2018 announced it would construct a Suburban Rail Loop orbiting Melbourne including a section between Box Hill and Doncaster[35]. The same locations would be linked by the proposed MCT orbital corridor from Melbourne Airport to Monash University. (See Section 7.2.3 below).

While the primary aim of an orbital corridor is to enable cross-town public transport, should the proposed rail loop eventuate in the form suggested by the Government or as an MCT corridor as proposed in this plan, it could provide an attractive travel option between the CBD and Doncaster in both trip time and frequency in conjunction with the existing CBD - Box Hill railway, albeit requiring interchange at Box Hill. In this context, both service frequency and interchange convenience will be critical factors in user acceptance.

An implication of this option could be the additional passenger capacity demand imposed on already crowded trains between the CBD and Box Hill. This may well be a catalyst for a proposed 4th track between Camberwell and Box Hill and operation of more "short starter" services from and to Box Hill, noting that the train path capacity constraint on this corridor is that of counter-peak capacity on the single-track operating in the non-peak direction.

(3) Doncaster Bus Rapid Transit (BRT) to Fitzroy MM2 Interchange station

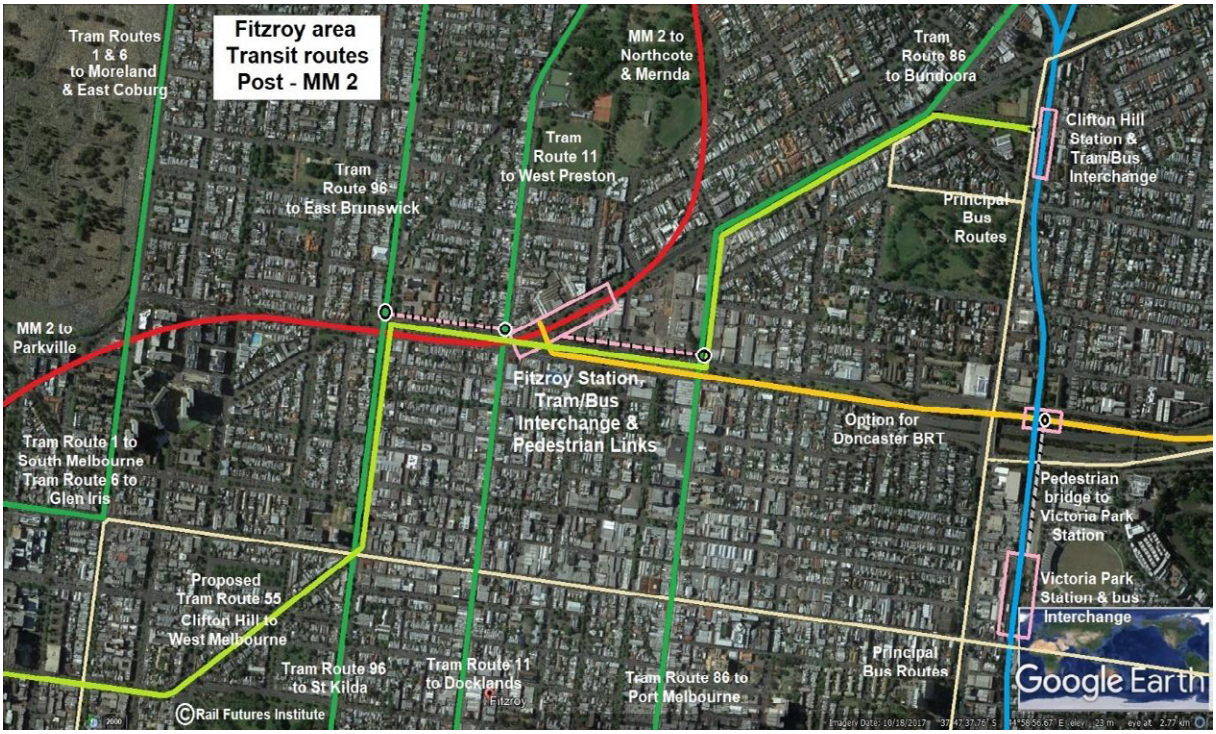
This RFI proposal is based on using the proposed bus transit lanes on the Eastern Freeway between Doncaster Road and Hoddle Street, but built to appropriate BRT standards[36]. The BRT lanes would continue along Alexandra Parade to interchange with the proposed MM2 Fitzroy rail station; providing fast access to Carlton/Parkville (MM1), then Flagstaff, Southern Cross, Fishermans Bend and suburbs west of the Yarra.

In effect, large capacity express buses would exit exclusive BRT lanes directly into an underground interchange and bus terminal at the new Fitzroy station. With high frequency buses and Metro trains co-ordinating at Fitzroy, travel times from Doncaster to Parkville, CBD stations and stations west of the city served by MM2 would be significantly reduced.

It is envisaged that some buses would continue to operate on the existing route via Hoddle Street and Victoria Parade to a suitable CBD terminus.

This concept is illustrated in Figure 39, below.

Figure 39: Fitzroy and surrounding area Transit Routes



[35] *Suburban Rail Loop Strategic Assessment*, Development Victoria, released by Victorian Premier, 28 August 2018

[36] International Transport and Development Policy 2016, BRT Standard v7.75 – refer https://www.itdp.org/the-brt-standard/

Under this BRT-based option, intermediate stations are proposed at:

- Victoria Park station interchange (with elevated walkway to station entrance)
- Chandler Highway
- Burke Road
- Bulleen Road
- Doncaster Road Park and Ride
- Heritage Boulevard

At the Doncaster end, the present part-time and non-continuous bus lanes would become full time and re-worked to become continuous on both sides of Doncaster Road between the Park and Ride facility and Shoppingtown.

In addition to providing a high-quality service to Doncaster, the potential combination of these east-west transit options would facilitate interchange with the north-south rail and tram networks and enhance public transport connectivity to major activity centres in Melbourne's inner north.

The MM2 station under Alexandra Parade and Queens Parade at Fitzroy would become a major hub for buses, trams and trains serving the north-eastern suburbs as a major East-West public transport connector, thereby substantially reducing pressure on the East-West road corridor.

This Plan proposes adoption of combined Options (2) and (3), as detailed as above. This will provide excellent connectivity to the Doncaster Major Activity Centre and the Doncaster area more generally- see further detail in Section 10.11.

7.2.2 Melbourne Airport to Derrimut Orbital Corridor

This is one of three proposed MCT and tram links to Melbourne Airport. In addition to the proposed fast heavy rail service from Southern Cross to the Airport, two MCT corridors will provide vastly better public transport connections to the Airport. (The other links are the extension of Tram Route 59 from Airport West – see section 6.3, and the Monash University orbital corridor described below).

The Airport-Derrimut orbital corridor, 25 km in length, is designed to provide high quality connectivity between the Airport and Melbourne's rapidly growing north-western and western suburbs and, longer term, extended to connect through to the Wyndham/Werribee area. It will provide both east-west (Airport to Watergardens via Keilor) and north-south (Watergardens to Derrimut) links on high demand corridors which are currently devoid of quality public transport alternatives to private car use.

The corridor will interchange with the heavy rail network at Watergardens and Deer Park and the Newport to Brimbank Central MCT corridor at Cairnlea.

***Conceptual Route*:**
From the Airport Terminal precinct, the proposed corridor would run south along Airport Drive to Sharps Road, turn west into Sharps Road to Keilor Park Drive and thence on a new corridor-oriented south-west to cross the Maribyrnong River valley and Arundel Road on a major bridge spanning some 950m. It then continues on an elevated structure crossing the Calder Freeway and Overnewton Road to join the Old Calder Highway and Melton Highway to Watergardens Shopping Centre. From Watergardens, the corridor turns south and runs the length of Kings Road and Station Road to Deer Park Station.

Following elimination of the Station Road level crossing at Deer Park, the corridor continues south along Mount Derrimut Road to an interim terminus at Windsor Boulevard, Derrimut. Longer term, the corridor would be extended to continue south along Mount Derrimut Road, turn west into Boundary Road and south into Palmers Road and continue to Williams Landing Station.

The entire corridor is expected to be developed at grade, apart from the major bridge and elevated structure over the Maribyrnong River valley. It would be on segregated right-of-way, principally in the median of the multi-lane roads described above, with automated traffic light priority at intersections. Appropriate vehicles would operate at a maximum speed of 80 km/h. Intermediate stations are proposed at:

- Tullamarine (corner Airport drive and Sharps Road)
- Keilor (Old Calder Highway, near Overnewton Road)
- Taylors Lakes (Taylors Lakes Shopping Centre)

- Watergardens Shopping Centre
- Delahey Village
- Brimbank Central Shopping Centre/Cairnlea MCT Interchange
- Ballarat Road, Deer Park
- Deer Park Station Interchange
- Derrimut Village

7.2.3 Melbourne Airport to Monash University Orbital Corridor

The Airport to Monash University orbital corridor, 49 km in length, is designed to provide extensive east-west and north-south connectivity between the Airport and many of Melbourne's middle suburbs which are experiencing significant residential densification. It is also designed to connect the Airport with the NEICs at La Trobe and Monash Universities, Deakin University's Burwood Campus, the Austin Hospital at Heidelberg and Major Activity Centres at Broadmeadows, Doncaster and Box Hill.

The corridor will interchange with the heavy rail network at Broadmeadows, Campbellfield (future station on the Upfield line), Keon Park, Heidelberg, Box Hill and Mount Waverley, other MCT corridors at Doncaster, Notting Hill and Monash University and the tram network at La Trobe University, Box Hill and East Burwood.

As parts of this corridor pass through environmentally sensitive areas and suburbs with a long-established built environment with only a few suitable road reservations for surface treatment, the overall corridor would be a mix of infrastructure at grade, on elevated structures and underground.

Potential vehicle type is a tram/train concept as operated in Europe, essentially high capacity, upgraded tram type vehicles, capable of operating at modest speeds on existing tram corridors and at up to 100km/h on dedicated right-of-way fully segregated from other vehicular traffic. Alternatively, if warranted by patronage projections, light metro rolling stock, similar to that used on the London Docklands Light Railway and Paris Metro (see Section 4.7.1) could be used.

Conceptual Route:

From the Airport terminal precinct, the proposed corridor would run south along Airport Drive, turn west alongside Mercer Drive, pass over the Tullamarine Freeway, then via Western Avenue, Mickleham Road and Johnstone Street including an elevated high-level structure over Moonee Ponds Creek to Broadmeadows Station. Then via Camp Road, Mahoneys Road, Keon Parade, Holt Parade, then part elevated/underground beneath Bundoora Park and Plenty Road to La Trobe University proposed interchange. The corridor then continues, principally underground, via Heidelberg, Bulleen, Doncaster, Box Hill, Burwood, Mount Waverley and Notting Hill to Monash University. Intermediate stations are proposed at:

- Gladstone Park (Mickleham Road)
- Broadmeadows Station
- Campbellfield (Future Station)
- Keon Park Station
- La Trobe University Interchange
- Heidelberg Station/Austin Hospital
- Bulleen Plaza, Manningham Road
- Doncaster Hill (Shoppingtown)
- Box Hill Station/Box Hill Central Shopping Centre
- Deakin University (Burwood Campus)
- Burwood East (Route 75 Tram Interchange)
- Mount Waverley Station
- Notting Hill (Monash Business Park)

7.2.4 Ringwood to Mentone Orbital Corridor

This 35 km corridor provides major north-south and east-west connectivity along high usage arterial corridors linking Ringwood with the Dandenong NEIC and Mentone via Knox City and established and growth suburbs of Wantirna, Scoresby, Rowville, Dandenong North, Keysborough and Parkdale. It will interchange with the heavy rail network at Ringwood, Knox City (future extension from Glen Waverley – see Section 5.5.9) and Mentone, and other MCT corridors at Rowville and Keysborough.

Most of this route would be on the surface using the median of major multi-lane arterial roads apart from a short-tunnelled section between Ringwood and Canterbury Road in Heathmont. This enables more opportunities for local access at modest cost than could be justified on an underground corridor. Potential vehicle types could be conventional Light Rail or guided tram/bus operating on a segregated corridor with traffic light priority at intersections and a maximum speed of 80km/h.

***Conceptual Route*:**
From Ringwood Station via Wantirna Road (partly underground), Boronia Road and Stud Road to Dandenong, then Foster Street, Cheltenham Road, Lower Dandenong Road and Balcombe Road to Mentone Station. Intermediate Stations are proposed at:

- Canterbury Road (Heathmont)
- Wantirna Hospital complex (Boronia Road)
- Studfield
- Knox City
- Swinburne University (Wantirna Campus)
- High Street Road
- Balmoral Gardens
- Scoresby (Ferntree Gully Road)
- Caribbean Gardens
- Stud Park Shopping Centre
- Rowville MCT Interchange (Wellington Road)
- Rowville South (Police Road)
- Dandenong North/M1 Interchange (Park and Ride)
- Heatherton Road
- Dandenong Hospital/Chisholm Dandenong TAFE
- Dandenong Plaza
- Dandenong Station
- Keysborough (Chandler Road)
- Parkmore Shopping Centre
- Corrigan Road
- Keysborough MCT Interchange (Springvale Road)
- Dingley Village (Boundary Road)
- Parkdale (Warren Road)
- Nepean Highway

7.2.5 Caulfield to Keysborough Cross-Suburban Corridor

This corridor, 20 km in length, provides direct connections between Caulfield, Chadstone Shopping Centre, the Monash NEIC, Springvale and interchanges at Keysborough with the Ringwood-Dandenong-Mentone MCT corridor and with the tram network at Caulfield and Carnegie. Principally at grade, but in a segregated corridor with traffic light priority at intersections, it would partly run parallel to the underground and elevated *South-East FastLine* between Caulfield and Monash University with additional stopping places for local access.

It then provides north-south connectivity between the Monash precinct, Springvale South and Keysborough, at grade wherever practicable and otherwise on elevated structures, particularly over heavily trafficked road junctions. Conventional Light Rail or guided tram/bus vehicles operating at a maximum speed of 80km/h are likely to prove suitable for this corridor.

***Conceptual Route*:**
From Caulfield Station via John Monash Drive, Princes Highway, Ferntree Gully Road, then on a segregated route through the Monash Business Park and Monash University campus. Then via Wellington Road and Springvale Road to Keysborough Interchange at Cheltenham Road. Intermediate stations are proposed at:

- Carnegie (Koornang Road)
- Murrumbeena Road
- Chadstone Shopping Centre
- Warrigal Road
- Oakleigh East (Huntingdale Road)
- Clayton Road
- Notting Hill (Monash Business Park)
- Monash University Interchange
- Australian Synchrotron (Blackburn Road)
- Mulgrave (Springvale and Wellington Roads)
- Centre Road/Police Road
- Springvale Station
- Heatherton Road
- Springvale South

7.2.6 Elsternwick to Rowville Cross-Suburban Corridor

This 25 km corridor provides direct east-west connectivity linking the Sandringham, Frankston and Dandenong rail lines, Monash University, Clayton/Mulgrave research precinct and the Rowville area. It would also interchange with other MCT corridors at Monash University, Mulgrave and Rowville and with the tram network at Elsternwick and East Brighton.

It would be mostly at grade in segregated corridor on high usage multi-lane arterial roads and with traffic light priority at intersections. It would transition to elevated structures where road reserves are insufficiently wide and to pass over complex, very busy road junctions. Conventional Light Rail vehicles operating at a maximum speed of 80km/h are also likely to prove suitable for this corridor.

***Conceptual Route*:**
From Elsternwick Station via Horne Street, McMillan Street, Nepean Highway, North Road, Wellington Road to terminate at Napoleon Road. Intermediate Stations are proposed at:

- Gardenvale Station
- Hawthorn Road (interchange with Route 68 Tram)
- Ormond Station
- Bentleigh East (Boundary Road)
- Oakleigh South (Warrigal Road)
- Huntingdale Station
- Monash University Interchange
- Australian Synchrotron (Blackburn Road)
- Mulgrave (Springvale Road)
- Wheelers Hill (Jells Road)
- Jacksons Road

- Eastlink Interchange (Park and Ride)
- Rowville MCT Interchange (Stud Road)
- Wellington Village

7.2.7 Sunshine to Altona Cross-Suburban Corridor

This 20.5 km corridor provides a semi-orbital route linking the Sunshine NEIC to Altona via Footscray through suburbs in transition from old industrial to commercial and residential renewal and lacking good public transport on other than direct rail corridors to the Melbourne CBD. It will interchange with the heavy rail network at Sunshine, Footscray and Altona, with the Newport to Brimbank Central MCT corridor at Sunshine and Brooklyn and with the Route 82 tram to Moonee Ponds at Footscray.

The corridor would be mostly at grade in segregated corridor in multi-lane arterial roads with traffic light priority at intersections and/or on elevated structures over high traffic volume road junctions. Again, conventional Light Rail vehicles operating at a maximum speed of 80 km/h are also likely to prove suitable for this corridor and if necessary, suitable for tandem operation with Tram Route 82 for around 300m in Ballarat Road, Footscray.

Conceptual Route:
From Sunshine Station via Hampshire Road, Ballarat Road, then diverting into and out of Footscray Station interchange via Moore Street and Irving Street. Thence via Ballarat Road, Geelong Road, Cemetery Road, rail overpass then a new corridor paralleling Cawley Road and West Gate Freeway, then via Millers Road, Civic Parade and Pier Street to Altona Station. Intermediate Stations are proposed at:

- Sunshine Marketplace Shopping Centre
- Victoria University (Sunshine Campus)
- Braybrook College
- Braybrook Shopping Centre (Ashley Street)
- Summerhill Road
- Victoria University (Footscray Campus)
- Footscray Station Interchange (reverse direction in Irving Street)
- West Footscray Station
- Kingsville
- Brooklyn MCT Interchange
- Altona Gate Shopping Centre
- Bayside College
- Altona North (Ross Road)
- Seaholme

7.2.8 Newport to Brimbank Central Cross-Suburban corridor

This corridor, 16.5 km in length, runs generally in a north-western orientation from Newport to Sunshine. This would connect the former industrial and gentrifying suburb of Newport with the Sunshine NEIC, Sunshine Hospital and the transport-poor suburbs of Cairnlea and Albanvale, while also linking the Wyndham Vale, Melton and Sunbury lines via the proposed Sunshine Station “superhub”. It will also support urban redevelopment in parts of Yarraville and Brooklyn. It would interchange with the MM2 corridor at Newport, other heavy rail lines at Newport and Ginifer and MCT corridors at Brooklyn, Sunshine and Brimbank Central in Cairnlea. Longer term, it could integrate with the heavy rail line between Newport and Williamstown.

This corridor would be mainly at grade using available width in existing rail corridors. Some widening of existing arterial roads in Sunshine North would accommodate a segregated corridor at grade or, where necessary, on elevated structures. Conventional Light Rail vehicles operating at a maximum speed of 80km/h are also likely to prove suitable for this corridor.

Conceptual Route:

From Newport Station via the Newport-Brooklyn-Sunshine rail corridor to Sunshine Station (south side), then via Anderson Road, McIntyre Road, Furlong Road, Cairnlea Drive and Neale Road to Brimbank Central Shopping Centre. Intermediate Stations are proposed at:

- South Kingsville
- Yarraville Gardens
- Brooklyn MCT Interchange
- Somerville Road
- Sunshine Road/Wright Street
- Sunshine Station Interchange
- City West Plaza
- Sunshine North
- Ginifer Station/Sunshine Hospital
- VUSC Cairnlea Campus/Cairnlea Town Centre
- Cairnlea MCT Interchange (Station Road)

7.2.9 Wyndham area Cross-Suburban corridors

These two corridors, 15.5 and 13 km in length respectively, are designed to link the Werribee and Wyndham Vale rail corridors to the proposed Werribee NEIC and with a large part of the burgeoning residential areas of the City of Wyndham which are already suffering from serious road congestion and extreme car dependency.

The corridors would interchange with heavy rail at Williams Landing, Hoppers Crossing and Tarneit stations and the future Sayers Road station adjacent to the proposed Wyndham A-League Stadium. They would form the first stage of a more comprehensive MCT network in the Wyndham municipality and ultimately connect with the Melbourne Airport to Derrimut MCT corridor through Truganina.

Retrofitting MCT corridors into the existing road network in Wyndham will be challenging due to inadequate future proofing of most key arterial road reservation widths, reflecting poor past planning practices. However, wherever possible, the corridors would be at grade using available or widened medians with traffic light priority in existing arterial roads, or where unavoidable, on elevated structures.

Conceptual Route 1: Williams Landing Station to Tarneit Station

From Williams Landing Station via Palmers Road (South), Dunning's Road, Boardwalk Boulevard, Sneydes Road, then on a new corridor through the Werribee Employment Precinct to the Princes Highway at Hoppers Crossing Station. Then via Old Geelong Road (post completion of level crossing removal at Hoppers Crossing), Morris Road, Heaths Road and Derrimut Road to Tarneit Station. Intermediate Stations are proposed at:

- Emmanuel College
- Point Cook Town Centre
- Point Cook Senior Secondary College
- Featherbrook Shopping Centre
- Victoria University (Werribee Campus)
- Werribee Mercy Hospital
- Hoppers Crossing Station
- Mossfiel Drive
- Werribee Pacific Shopping Centre
- Hogans Corner Shopping Centre
- Sayers Road/Derrimut Road MCT Interchange
- Baden Powell Drive
- Tarneit Central Shopping Centre

Conceptual Route 2: Williams Landing Station to Sayers Road Station

From Williams Landing Station via Palmers Road (North) and Sayers Road, extended in stages to future Sayers Road Station. Intermediate Stations are proposed at:

- Williams Landing Town Centre
- Palmers/Sayers Road corner
- Westbourne Grammar School/Werribee Islamic College
- Wyndham Village Shopping Centre
- Sayers Road/Derrimut Road MCT Interchange
- Tarneit Road
- Davis Road
- Sewells Road
- Wyndham A-League Stadium

The overall proposed initial MCT route network for Melbourne is shown in Figure 38.

7.3 Comparing Suburban Rail Loop and Melbourne Rail Plan's MCT Network

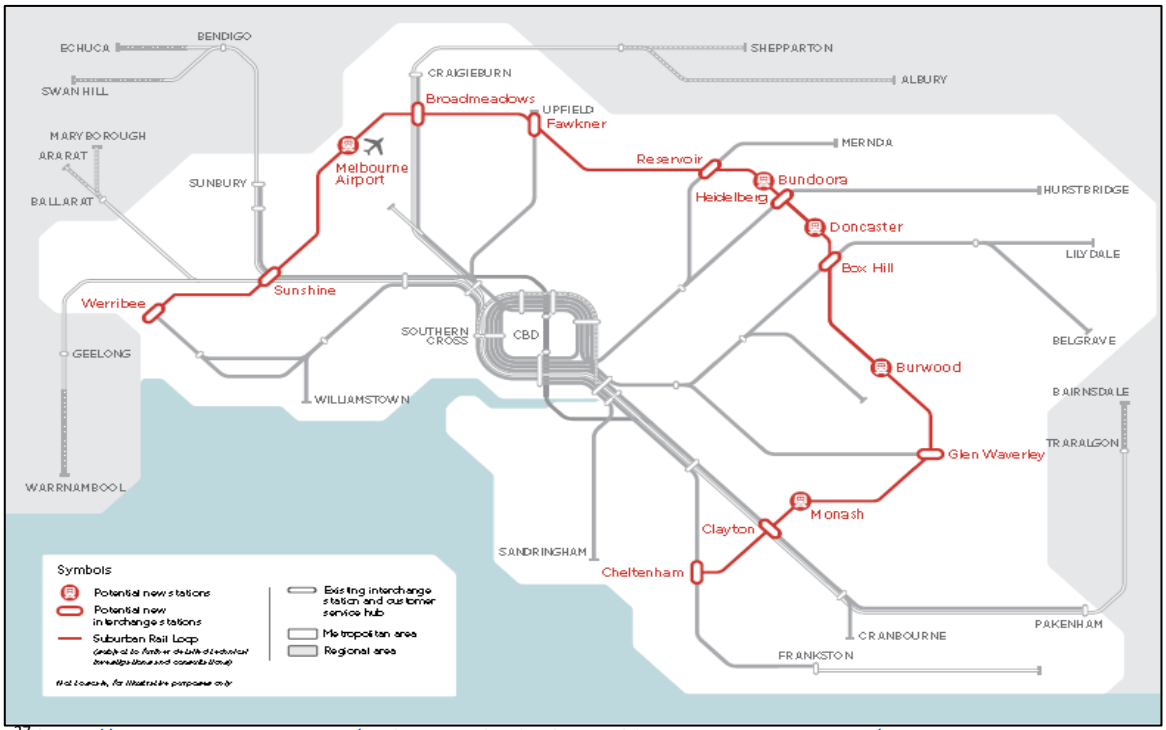
7.3.1 The Suburban Rail Loop (SRL) Proposal

In August 2018, the Victorian Government announced the Suburban Rail Loop (SRL) project[37].

SRL is a proposed circumferential underground railway from Cheltenham to Werribee, stated as costing $50+ billion and taking 30 years to build. Conceptually, it will have stations at Cheltenham, Clayton, Monash, Glen Waverley, Box Hill, Doncaster, Heidelberg, Bundoora, Reservoir, Fawkner, Broadmeadows, Melbourne Airport, Sunshine and Werribee (see Figure 40).

The proposal is bold, visionary and a welcome alternative to freeway proposals that induce more car travel. It seeks to connect key activity centres, re-frame the predominant radial pattern of rail lines, reduce congestion, provide an alternative to car travel, cater for population growth; and provide a long-term pipeline of economic activity and employment. RFI fully supports these objectives.

Figure 40: The Victorian Government's proposed Suburban Rail Loop



[37] https://www.premier.vic.gov.au/underground-suburban-rail-loop-to-connect-victoria/

Source: *Rail Projects Victoria*

The Government has made clear its intent to proceed with the project and is commencing more detailed feasibility studies. Therefore, the SRL proposal must be examined objectively against other feasible options.

7.3.2 The underlying rationale for non-radial transit corridors is sound… but is SRL the right solution?

Leaving aside the question of which type of technology is best suited to this application, there is little doubt the rationale for circumferential or cross-suburban high-quality public transport is sound:

- Cross-town trips between suburbs and major activity centres not on the same rail line are poorly catered for by public transport. Buses have carried that burden for years, but their patronage has declined, and fare avoidance, heavy subsidies and empty trips are too common. The *SmartBus* initiative introduced a decade ago was a serious attempt to provide cross-town links but provides far less than what is now needed. Melbourne's strongest performing public transport networks – trains and trams, are both radial in design.
- Successive metropolitan strategies such as *Plan Melbourne 2017-2050* have proposed that Melbourne's massive population growth be underpinned by a series of polycentric metropolitan activity centres and *National Employment and Innovation Clusters* (NEICs), including Box Hill, Epping, Monash, Ringwood, Dandenong, Footscray, Sunshine and others. Rail links connecting such nodes would strongly reinforce their development; indeed, they will be essential for achieving the polycentric vision. (Noting that currently 3 NEICs, 27 major activity centres, 9 proposed activity centres and Melbourne Airport are not linked by rail.)

RFI supports the key principles on which the SRL is premised, and which align with *Melbourne Rail Plan* objectives:

- Complementing Melbourne's rail network with a medium capacity cross-city transit network.
- Enabling a wider range of journeys to be made by public transport instead of by car.
- Supporting the *Plan Melbourne 2017-2050* polycentric city model.
- Linking key economic clusters, activity centres and education precincts.
- Making more jobs and job choices accessible to more people.
- Facilitating regional rail connections to Melbourne Airport.

The key question is which approach - the SRL or the proposed MCT network – will best deliver these intended outcomes? Comparing the SRL and MCT proposals, some of the key questions that need exploring are:

- Is heavy rail the most appropriate solution compared to other technologies such as light rail?
- What are the comparative costs and benefits?
- Which approach delivers the greatest range of travel options?
- Which approach fits best as a component of an overall integrated transport plan for Melbourne?
- Which approach is likely to have the largest city shaping impact, and in what way?
- Is the role of the SRL to take pressure off the suburban road network?
- Is the SRL intended to take pressure of the radial train network?
- Is the role of the SRL to avoid the need to catch a train into the city and back out to reach a destination elsewhere on the rail network?
- Does the comparative speed difference between heavy and light rail matter?
- Is the SRL intended for longer orbital journeys, or primarily for short intermediate trips?

These issues are discussed in the following sections of this Plan.

7.3.3 Suburban Rail Loop vs Melbourne Rail Plan MCT Technology

A key difference between the SRL model and RFI's MCT model is that the SRL is proposed as a fully underground rail corridor, inferred but not clearly stated as heavy rail and unclear as to whether compatibility with the existing rail network is assumed. Conversely, the MRP proposals could utilise a variety of "Medium Capacity Transit" systems such as automated light rail, conventional light rail or possibly emerging technologies such as

optically guided busways. A comparison of the characteristics of heavy rail and MCT is in Section 4.7.2. The final choice should be based on rigorous assessment.

7.3.4 Success Factors for Orbital /Cross-Suburban Systems

Public transport and urban planning expert Dr Garry Glazebrook[38] identified the following key characteristics for successful orbital or cross-suburban rail systems, based on extensive experience of systems in overseas cities:

- S*ervice frequency* must be very high - perhaps every two minutes during peak day periods and 5 minutes at night. This is because most trips on the orbital corridor will not be the only leg of the journey (transfers will be required to and from other lines or modes) and short waiting times are imperative.
- *Interchanges* must be well integrated with the radial train and tram routes, as well as major bus routes, and be designed for fast transfers - typically 2 minutes to interchange - otherwise the overall journey will be inconvenient and not sufficiently attractive compared with driving.
- *The required capacity* of orbital / cross-suburban corridors is significantly less than radial corridors because they serve fewer jobs. While there will be significant numbers of jobs generated in the NEICs and key metropolitan activity centres, in total these will still be only a fraction of the jobs in central Melbourne, even with the stimulus provided by orbital rail. [39] Typically, orbital / cross suburban corridors will need around 30% to 50% (3,000 to 10,000 passengers per direction per hour in the peak) of the capacity of the radial heavy rail corridors.
- Because orbital / cross-suburban corridors must be *retro-fitted into the existing urban fabric*, the chosen technology needs to be flexible enough to adapt to the physical conditions. Typically, this means the ability to cope with sharper curves and steeper gradients and have shorter trains and stations, and thus be able to more readily penetrate the core of existing activity centres and nodes.

These factors suggest that MCT is likely to be a better fit for an orbital or cross-suburban corridor than traditional heavy rail.

7.3.5 Coverage and Travel Options:

The proposed MCT corridors (excluding the Doncaster corridor which is radial rather than cross-suburban) total 218 km in route length, compared to 90 km for the SRL.

There are 15 points (stations) at which one can board the SRL, including the two end points (Cheltenham and Werribee) with an average spacing of 6 km, but up to 13 km apart between Sunshine and Melbourne Airport. This compares with the existing Melbourne rail system, which has 219 stations over 372 route km - an average distance between stations of 1.7 km.

The proposed MCT corridors (excluding the Doncaster corridor) will offer over 120 stops based on current plans, enabling a much greater range of trip choices and over eight times the number of points at which one can board or leave the network. This will be critically important for access between residences and jobs at NEICs and major activity centres.

The proposed MCT corridors link with an additional three radial heavy rail lines compared to the SRL, at Elsternwick (Sandringham line), Newport (Williamstown line) and Altona.

The proposed MCT corridors link with all the existing heavy rail stations served by the proposed SRL except:

- Fawkner (MCT instead links with proposed Campbellfield station)
- Reservoir (MCT instead links with Keon Park station)
- Cheltenham (MCT instead links with Mentone station)
- Glen Waverley (MCT instead links with Mount Waverley station).

The proposed MCT network is more comprehensive, enabling a more detailed grid pattern and journey combinations. For example, in south-east Melbourne there are two east-west corridors and two north-south

[38] Dr Garry Glazebrook, well known and highly respected Australian transport and urban planner, and former Manager, Transport Policy, City of Sydney. https://blogs.crikey.com.au/theurbanist/2017/03/13/proposal-melbourne-ring-metro/

[39] Marion Terrell, Transport and Cities Director at the Grattan Institute, reported in The Age, 12 March 2019, as stating that currently, the 15 suburbs proposed to have stations on the SRL have only 9% of Melbourne's jobs between them.

corridors. Similarly, in the west it offers multiple travel options.

The proposed MCT routes collectively serve:

- over 25 significant shopping centres
- more than 9 university and TAFE campuses
- many large activity centres
- 5 of the 7 NEICs
- 23 railway stations
- Melbourne Airport
- several health precincts

It is important to note that, given Melbourne's massive geographical spread, a single orbital corridor cannot alone provide an adequate public transport solution capable of making a significant dent in overall car dependency. This is a key reason why this Plan proposes multiple corridors using alternative and much less costly technologies compared to heavy rail. This way, more routes can be built for less cost than the SRL.

7.3.6 Speed Comparison

Heavy Rail as proposed for the SRL is capable of faster maximum speeds than MCT / Light Rail technologies, however MCT tends to have superior acceleration and braking capability which is advantageous when stations are more closely spaced. Whether this is a critical factor will depend on station spacing and the type of journeys most users will take on the SRL.

For example, a journey from Clayton to Melbourne Airport using SRL would be comparatively fast and efficient, but only marginally less convenient than using the MM1 corridor from Clayton to Sunshine and a quick change there to the MARL. For a shorter journey, say from Box Hill to Monash University, the travel time difference between SRL and our proposed MCT corridor would be a few minutes at most. However, there has been no analysis of the likely journey preferences. It seems likely that many SRL riders will traverse only relatively short legs of the corridor, in which case the comparative speed advantage of heavy rail over light rail is less important.

Commentary by transport and community stakeholders suggests that the SRL should have more stations than currently planned, given that the currently planned stations are several km apart, as mentioned above. Additional stations may well be needed to achieve viable patronage levels, but each additional station reduces the speed advantage of heavy rail over MCT and underground heavy rail stations are extremely high cost items. -

7.3.7 Cost Comparisons

The majority of MCT applications worldwide, including within Australia, to date have tended to use conventional light rail technology, hence the costs of constructing such systems are reasonably well understood. Typically, in the Australian context, light rail systems on the surface cost between $60m and $100 million per route km, excluding rolling stock, depending on the extent of necessary services relocation and associated road works. If placed on elevated structures, the cost can increase to between $100 and $150 million per route km.

MCT underground sections could cost between $200 million and $250 million per route km, depending on ground conditions and station siting.

Taking the most conservative upper figures, the proposed 165 km of MCT surface corridor plus around another 27 km on elevated structures (excluding Doncaster radial) could be delivered for around $21 billion.

The proposed 26 km of mainly underground route (generally from La Trobe University to Monash University via Heidelberg, Doncaster, Box Hill and Burwood), including stations, could cost up to $8 billion.

For the 230 km of all MCT routes, the cost of rolling stock and depots would be around $3 billion.

This brings the overall cost for the 230 km MCT network to around $32 billion (equivalent to $139 million per route km).

This compares with the $50+ billion estimate for the 90 km SRL (= $555 million per route km).

The MCT network costs an estimated 25% of the SRL per route km.

A saving of around $18 billion (not allowing for any escalation in the SRL construction cost) is significant in the context of overall State Government expenditure and which could be directed to other urgent transport

infrastructure needs or other essential government services.

Dr Garry Glazebrook in his article of March 2017[40] also noted that:

> *"The lower operating costs and relatively high speeds (compared with street-running light rail) of an automated light metro should mean that farebox revenue should be capable of covering 100% of operating costs, with the potential to fund a component of the capital costs. In addition, application of land value capture mechanisms at key centres on the route would provide further opportunities for recovering part of the capital costs."*

7.3.8 Will SRL take pressure off the radial rail network and the need for MM2?

It has been suggested that the SRL will reduce passenger congestion on the radial heavy rail network and obviate the need for further major investment in that network.

For example, recent government press releases claim that *"…the SRL will take thousands of passengers off existing rail lines and 200,000 cars off major roads".*[41]

This prediction appears to be based on the notion that large numbers of people make journeys that involve a trip into the city on one radial line and a trip out of the city on another radial line in order to reach a destination that would otherwise need only one orbital journey leg. Or to use an analogy, *"people travel two sides of a triangle because the third side of the triangle does not exist."*

RFI considers this to be a flawed assumption not supported by evidence. The number of work journeys of this type on the rail network are insignificant compared to the vast number of trips to the CBD. The reality is that, except for journeys by train where transit through the CBD is both convenient and logical, cross-suburban journeys are overwhelmingly undertaken by car, and a very small percentage by bus.

There have also been suggestions that the SRL's claimed reduction in pressure on the radial rail network will obviate the need to build Melbourne Metro 2 (MM2). RFI does not agree with this contention. MM2 will provide critically important south-west to north cross metropolitan connectivity, joining rapid growth areas in the western and northern suburbs with job-rich areas in Fishermans Bend, the CBD, Parkville and Fitzroy. These are a different set of transport needs to those that the SRL can provide.

RFI considers that the SRL will take little, if any, pressure off the radial rail system. Rather, ridership on the radial network will continue to grow in line with Melbourne's overall population growth including significant population increase in the growth corridors. Moreover, it would experience additional passenger numbers joining radial lines from the SRL, and more so from our proposed MCT routes.

However, RFI does agree that the SRL will take some traffic off the existing road system by providing a public transport alternative to some of the non-radial trips currently concentrated on the road system. By virtue of their much greater accessibility and coverage, the proposed MCT routes will produce a significantly larger mode shift and reduced car dependency.

7.3.9 Land use implications of an orbital rail link

RFI's proposed MCT network and the Government's SRL options both introduce the concept of orbital and cross-suburban rail corridors to the current radial network, which will be a fundamental change to the nature of greater Melbourne rail transport.

The proposed MCT network is a more comprehensive plan than the SRL, serving many more activity centres, shopping centres and other locations, with many more stations over a much greater area. This will enable a more detailed grid pattern and many more journey combinations. The impact on journeys for varying purposes will remain unclear pending very detailed research and modelling, well beyond the resources of RFI and yet to be undertaken in any detail for the SRL.

Similarly, the impacts on land use and development have not been modelled and are unknown in detail. However, the construction of a circumferential rail loop or a series of orbital and cross-suburban corridors in Melbourne will have profound implications for land use and development, significantly affecting Melbourne's urban form and functioning.

---

[40] https://blogs.crikey.com.au/theurbanist/2017/03/13/proposal-melbourne-ring-metro/

[41] https://www.premier.vic.gov.au/suburban-rail-loop-goes-to-market-for-registrations-of-interest/ dated 13 June 2019.

The MCT and SRL proposals will both lead to extensive redevelopment of middle ring and established suburbs. The Government has not yet planned for this change and it is essential that clear land use planning directions be formulated and legislated at an early stage and well before any construction commences. Under the current flexible planning system, the development industry will have undue influence on the types, uses, locations and performance of buildings, including building height, building quality, open space and service provision.

The MCT and SRL proposals will also both help achieve the long-standing strategic aim of developing a polycentric city across greater Melbourne. However, the impacts on central Melbourne's agglomeration economy are unknown. While both will trigger employment growth in the suburban polycentric centres, it is likely that this will be relatively small compared to the vast job numbers that will continue to be concentrated in and around the central city and therefore continue to be reflected in high demand on the radial rail and tram networks. This further supports arguments in favour of MM2, as discussed in previous Section 7.3.8.

The MCT network will reinforce the role of a greater number of nodal centres than the SRL by facilitating access to them and linking radial rail routes through them. The role of national employment clusters and other activity centres where radial and circular routes intersect (see details in Section 10) will be most affected, but the MCT and SRL corridors will both also influence development of other centres located along their routes.

Both options will reinforce the mixed-use nature of the most affected activity centres where development of complementary employment, residential and retail land uses is likely. Current planning rules will reinforce high and medium rise residential construction as the dominant urban form already evident in centres such as Box Hill, South Yarra, Footscray and elsewhere. The intensification of residential development in centres will encourage further mixed uses.

Significant linear residential development also will occur along a circumferential rail route, but more so when the stations are relatively closely spaced as is the case on the MCT corridors. Either project will open extensive areas of land to further low and medium rise development and become a significant factor in increasing the population of middle ring suburbs. The argument that the low-rise nature of established suburbs does not justify further heavy or light rail construction underestimates the potential for new rail services to increase development and population.

A rail loop (whether it be heavy or light rail) will drive change to Melbourne's urban form and become a significant factor in redeveloping large middle ring suburban areas. The distance between stations will influence walkability and other amenity issues. Should the SRL prevail, further station provision and connecting bus services at each station should be considered in project planning.

The extensive development triggered by orbital and/or cross-suburban rail corridor/s will require the government to make some critical and courageous choices about how this development will be planned and the degree to which the planning system provides clear directions compared to a purely market-led approach.

Market led redevelopment is the most unsatisfactory option, leading to a range of detrimental economic, social and environmental outcomes along with the certainty of significant conflict over impacts. At an early stage, a process for nominating redevelopment areas, land uses, the scale and types of construction, and financing arrangements should be part of decisions on the route/s. Social outcomes should form part of a new set of mandated rules for the provision of affordable and social housing.

The potential for integrating future land use with financing arrangements for new rail infrastructure is particularly significant. Unlike many other countries, the Victorian Government has not used the potential of the land use system as a means of financing public infrastructure. The increased land value from rail construction and the granting of development rights offer the potential for value capture to contribute to the capital cost of public transport provision.

The Government should examine case studies of other country responses to such opportunities. For example, the London Crossrail and U.S. west coast redevelopment provide contrasting models. The London model is leading to extensive high-rise construction linked to value capture. The U.S. west coast redevelopment has been based on extensive low to medium rise urban intensification linked to mandated affordable housing, amenity protection and build-to-rent apartment construction.

Should it proceed, the SRL project will be the largest Victorian public transport investment since the beginning of the twentieth century. The Victorian Government should be the principal agency determining in the public interest the changes to land use which accompany this investment.

7.3.10 Overall assessment of SRL versus MCT

MCT embodies a range of applicable technologies and construction solutions, all at significantly less cost and more readable adaptable into the existing built environment than would be possible with a fully underground solution, and more so if SRL adopts a heavy rail option.

Overall, the proposed MCT network delivers a superior outcome in terms of transforming Melbourne's rail network from a radial system to a grid system, opening many more opportunities for non-car-based trips and maximising the range of places one can conveniently reach by public transport than would be possible from a single orbital corridor. With only 15 stations, SRL will provide limited access to the key nodes where it is hoped to be a catalyst for significant new development.

Irrespective of whether the SRL or the proposed MCT corridors become a reality, it is essential that:

- an appropriate suite of funding mechanisms such as value capture, congestion pricing special levies etc. be adopted, and
- complementary detailed land use planning takes place to ensure integrated land use and transport outcomes are implemented along the corridors.

8. The Metropolitan Bus Network

8.1 Overview

This Plan proposes a substantial re-structure and mass investment in the metropolitan bus network so that it more effectively complements the train, tram and MCT networks. Buses then become an increasingly critical element of Melbourne's public transport providing high frequency public transport on routes which cannot justify investment in major fixed infrastructure. The bus network will be designed to provide convenient interchange at key nodes with other modes and with all principal routes operated at "turn up and go" frequencies compatible with train, tram and MCT services. Detail of the reworked metropolitan bus network is beyond the scope of this Plan, but it is envisaged that the revised bus network will operate at four levels:

- High frequency SmartBus routes on trunk corridors, including routes developed to build corridor patronage in anticipation of future MCT investment or altered following introduction of MCT routes
- Feeder services to train, tram or MCT interchanges
- Local services to Major and Local Activity Centres, schools, hospitals, etc.
- On-Demand services to provide irregular or "as required" services

8.2 SmartBus services for high use, high frequency routes

High frequency bus services, using the already well recognised *SmartBus* branding, should be further developed and/or implemented to provide services that match the frequency and span of hours of the rail, tram or MCT services with which they interconnect. Ideally, they would operate on dedicated lanes and at 10-minute or better "turn up and go" frequency, other than early morning and late at night. Such services should be provided to:

- complete the principal network where rail modes are unsuitable or unviable
- enhance cross-town connectivity necessary to properly integrate the overall grid network
- service some routes likely to become candidates for MCT solutions

The last point is particularly important as high frequency SmartBus or similar services may be a logical transition to MCT in helping to change travel behaviour and prove up potential demand. They will also allow time to build community support, progress corridor protection measures and, above all, to progress an integrated process of transport and land use planning at a localised level. Several of the existing SmartBus routes are effectively precursors, at least in part, to some of the MCT corridors proposed earlier in this Plan.

However, as traffic congestion increases on these routes, such services will prove ineffective if buses are caught in traffic and cannot operate to reliable schedules. Dedicated transit lanes will be essential where these can be provided.

The existing SmartBus network (see Figure 15) will require extensive modification as the proposed MCT routes are implemented. These will progressively replace all or parts of:

- Route 900 Caulfield to Rowville
- Route 901 Melbourne Airport to Dandenong and Frankston
- Route 902 Airport West to Chelsea
- Route 903 Altona to Mordialloc

Several new SmartBus routes, complementary to the proposed MCT network are proposed. These are shown in Figure 60. They are:

- Melbourne Airport to Ringwood via Roxburgh Park, South Morang, Greensborough and Doncaster
- Caroline Springs to Mordialloc via Keilor Plains, Essendon, Moreland, Heidelberg, Doncaster, Box Hill, Holmesglen, Oakleigh and Mentone
- Sunshine to Latrobe University via Highpoint, Essendon, Coburg, Preston and Northland
- Latrobe University to Sandringham via Heidelberg, Nunawading, Glen Waverley, Monash and Southland
- Point Cook to Davis Road (future station) via Williams Landing and Hoppers Crossing

Doncaster SmartBus
Photo: *Liam Davies*

8.3 Feeder Bus Services to Train, Tram or MCT Interchanges

Feeder routes to train, tram or MCT stations and interchanges form a critical part of the grid public transport network. This applies especially in growth areas where service frequency improvement and route development are increasingly urgent. Wherever possible, these services should match the frequency and span of hours of the rail, tram or MCT services with which they interconnect, again ideally operating at 10-minute or better frequency, other than early morning and late at night.

Users of these services are generally "time poor" hence route directness is important. As with the SmartBus routes, such services will prove ineffective if buses are caught in traffic and cannot operate to reliable schedules. Dedicated transit lanes, most likely applicable for peak direction traffic flows, will be needed in congested areas.

For bus routes serving areas of lower population density, it is unlikely that service frequencies can be justified that match those provided by trains or MCT routes at connecting stations. In these cases, reliable connections are essential. These need to be monitored centrally and with dynamic information displays for both bus operators and passengers. Such connections would be managed in accordance with prescribed protocols stipulating the processes to be adopted when services run late or are impacted by unplanned events[42].

There are also many locations where bus routes could effectively co-ordinate with the tram network. An example is the Route 75 Vermont South tram terminus where buses provide a frequent scheduled connection to the Knox Shopping Centre. Put simply, buses have a significant role in complementing the tram, MCT and heavy rail transport tasks.

8.4 Local Bus Services

Local bus services are also needed to link residential neighbourhoods to major and local activity centres. Users of these routes are usually less time-sensitive than regular commuters so that area coverage is probably more important than travel time or route directness for these services. Many of these routes will not support "turn up and go" service frequency but regularity and spread of hours are still important factors for achieving adequate patronage support.

[42] This requires the establishment of a Public Transport Coordination Control Centre as detailed in Section 4.8.1

Urban Route Bus
Photo: Marcus Wong – Wikipedia

8.5 On-Demand Service

Where demand is insufficient to support regularly scheduled local bus services, provision of irregular or "as required" services using small buses, taxis or "ride sharing" vehicles will have many applications, especially in areas of low residential density or where street layouts are not suitable for accommodating conventional buses. On-demand services may also be appropriate for serving community needs which cannot be satisfactorily met by normal bus routes. Such a service has successfully operated in Woodend since 2016 and would be appropriate in some outer metropolitan areas.

On-demand FlexiRide bus serving Woodend township
Photo: *Craig Halsall*

9. Active Transport

9.1 Role in the Transport Mix

The importance of encouraging active transport via walking and cycling is well recognised in a range of Victorian Government State policies. Both forms of active transport play a vital role in the transport mix as independent modes as well as supporting public transport services.

The State's Transport Integration Act 2010 articulates important integrated transport and land use objectives relevant to active transport. These include:

- promoting forms of transport that have the least impact on the natural environment and have the greatest benefit for, and least negative impact on health and well-being
- reducing the need for private motor vehicle transport and the extent of travel in terms of number of trips and distances travelled
- increasing the mode share of public transport, walking and cycling trips as a proportion of all transport trips.[43]

Active Transport Victoria (ATV), within the Department of Transport, is focused on increasing walking and cycling. It updated *Victoria's Cycling Strategy 2018-2028* to encourage cycle transport to work, school, and around neighbourhoods and to support local Councils in their crucial role in providing and managing much of the cycle network. ATV is also working with VicRoads and the TAC to target investment in enhancing cyclist and pedestrian safety.

Cycling is also supported in *Plan Melbourne 2017-2050*, the *Victoria Public Health and Wellbeing Plan 2015-2019* and in Infrastructure Victoria's *30-year Infrastructure Strategy*.

At the national level, Infrastructure Australia in its reform series,[44] highlights:

> *"Walking and cycling are environmentally friendly and healthy ways to access the public transport network, and also amongst the cheapest to accommodate and should therefore be embraced."*

9.2 Active Transport to access Rail Stations

As discussed earlier in Section 4.9, building big car parks around stations is not an efficient means to get more people onto public transport and, in many cases, not the best use of valuable land around stations.

Despite lobbying to build more car parks to expand park and ride at rail stations, there is demand for more sustainable access. Figure 41 below shows that a majority of train travellers use active transport to reach rail stations, in the main by walking. An increasing proportion arrive by bus or tram. People walking to trains increased by 63% between 2001-2011, those using feeder buses or trams increased by 89%, while driving or being driven to stations increased by just 8%.[45] Cycling to rail stations is also on the increase.

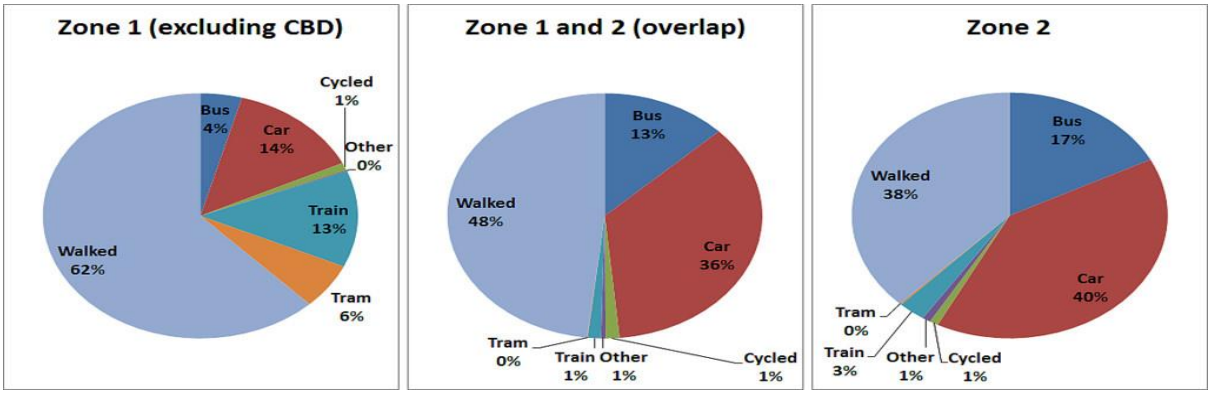
A combination of walking, cycling and train travel is an effective and sustainable alternative in metropolitan areas to journeys by car or a combination of car and train and should be supported over building more park and ride facilities.

[43] Transport Integration Act Sections 11(2)(c),12(2), 13(2)(c), 86(2)(b);

[44] Infrastructure Australia's Reform Series*: Outer Urban Public Transport: Improving accessibility in lower-density areas, Recommendations 3,4; see also National Cycling Strategy 2011-2016*

[45] Myth: Park-and-Ride facilities will encourage public transport use: https://www.ptua.org.au/myths/parkride/

Figure 41: Access modes to railway stations



Source: *Daniel Bowen …….*

9.3 Integrating cycling and public transport

Cycling to stations is handicapped because cycle networks are not continuous and do not adequately protect cyclists. Required are continuous, low-stress routes that connect directly and conveniently to stations and major interchanges. Cycling can also be encouraged through facilities such as lockers, bicycle parking and an expanded Parkiteer cage network. On-demand bike services such as bike share including e-bikes available at rail stations enable passengers to extend how far they can travel once they end their public transport trip.

PTV's policy is for bicycles to be carried for free on Melbourne metropolitan trains. Carriage of bicycles is allowed on V/Line trains subject to space availability, and space is often limited. At peak time on commuter services (both Metro and V/Line), emphasis should be on maximising train space for passengers, so bikes are not permitted, other than folding bicycles, or for counter-peak travel [46]. Alternatives to carriage of bicycles on peak period trains are:

- riding from home to the station, then leaving the bike in secure storage at the "home" rail station
- readily available bike hire options at major Melbourne CBD stations. These should be expanded to busy suburban rail stations
- promotion of improved CBD tram network connectivity options, frequency and routes at all 15 key CBD and inner area stations
- availability of Parkiteer cages at destination stations such as Flinders Street, Southern Cross, West Melbourne, Richmond and Clifton Hill, to enable passengers to leave their prime bike at home stations, commute by train and complete their journey using a second bicycle housed in other Parkiteer cages at key CBD and inner area stations

Parkiteer cages provide free, secure bike parking at Victorian train stations and transport hubs like Doncaster Park and Ride.

Bicycle Storage at South Morang railway station

Source: https://www.bicyclenetwork.com.au/newsroom/2019/02/12/how-do-you-ride-to-the-station/

[46] Myth: Park-and-Ride facilities will encourage public transport use: https://www.ptua.org.au/myths/parkride/

There are currently hundreds of Parkiteer bicycle spaces cages on the metropolitan and regional rail network, and over 100 metropolitan stations with one or more cages. Some stations currently enjoy substantial levels of bicycle access, often outstripping capacity of bike cages. Given one cage storing 26 bikes takes the space of about 2 cars and is something like an eighth of the cost, clearly provision of additional secure cycle space is far more cost-effective than continued provision of car spaces.

Bicycle hoops in weather-protected locations at shops and stations are an inexpensive alternative to Parkiteer cages. Bike hoops can be found at almost every station across Victoria, with the number of hoops increasing regularly. End-of-trip facilities include showers, changing rooms, lockers and bicycle maintenance at major rail stations.

Many people who ride bikes to stations leave them at railings and lamp posts where bikes are vulnerable to damage and theft. Increased facilities are needed to meet demand and it is time to commence installing more substantial secure parking stations.

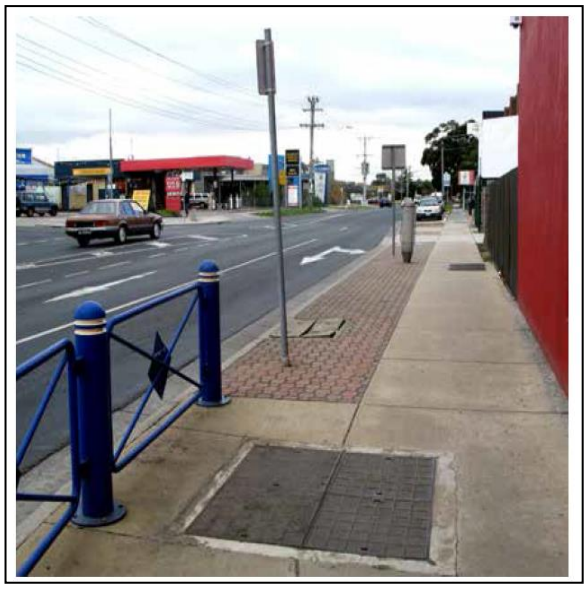
9.4 Improving the Walking Catchment for Public transport

As well as health benefits, walking is easy and convenient for local trips, or to connect other forms of transport. As evidenced above, more people walk to most stations than drive, despite often adverse walking conditions.

A market intelligence review by Public Transport Victoria (PTV) for April to June 2012, found that 44% of people using train services walked to the station from their homes and 77% walked from their destination train station to their final destination. Over half of the respondents walked 1.2 km to a station and many walked much further.

Development of high-quality walking routes to stations covering a catchment area of walkable distances from a station is needed. The identification and delineation of Principal Pedestrian Networks (PPNs)[47] enables effective planning for pedestrians in the broader context of transport and land use planning.

PPNs aim to identify routes within the built environment that can carry more pedestrians walking to key destinations including transport nodes. A PPN is an important planning and policy tool for the development and promotion of walking as a mode of transport, recognising that walking has a valuable role to play in creating a more effective and resilient transport system. PPNs can reinforce the strengths of existing land use and transport patterns by encouraging pedestrian movement in desired areas.



An uninviting existing pedestrian route

An attractive Principal Pedestrian Network Route

[47] http://www.victoriawalks.org.au/Assets/Files/5.%20Kristie%20Howes%20Principal%20Pedestrian%20Networks%20.pdf

Encouraging walking as a transport mode requires attention to several elements that contribute to attractive walking environments. These elements include smooth surfaces, creating high quality public spaces and streetscapes, street lighting and seating, pedestrian crossings and signage and of course, appropriate repair and maintenance of all of these. Improved walking environments, as shown above, can be achieved through a variety of measures including:

- adjustments to signalised intersections
- installation of increased priority crossing opportunities such as zebra or wombat crossings
- increases to pavement width or quality
- installation of trees, vegetation or other landscaping
- the provision of seating, other street furniture, street art, shade and drinking fountains

9.5 Increasing Active Transport Mode Share

As set out above, an objective set out in the Transport Integration Act is "to increase the mode share of public transport, walking and cycling trips as a proportion of all transport trips"[48]

The United Nations recommends that to increase mode share, governments dedicate 20% of transport funding to active transport. However, the Federal and Victorian Governments spend less than 1% of their transport funding on active transport infrastructure.[49]

The bulk of funding for walking and cycling initiatives falls to local governments. Cycling has increased substantially with investments in bicycle paths and bicycle parking, particularly in parts of inner Melbourne where the cycle mode reaches 15-20% of journey to work trips. For the most part, cycling's share across Melbourne remains under 2%.

Yet much of Melbourne is ideal for cycling and walking for most of the year. Increasing the mode shares of public transport, walking and cycling trips requires far enhanced investment by all tiers of government, Councils, State and Federal governments.

[48] Section 86(2)(b)(i)
[49] https://theconversation.com/cycling-and-walking-are-short-changed-when-it-comes-to-transport-funding-in-australia-92574

10. Connections to National Employment Clusters and Major Activity Centres

10.1 Overview

This Section provides additional detail of proposed heavy rail, MCT, tram (where applicable) and SmartBus connections to the seven NEICs and specified MACs as set out in this Plan. The proposed heavy rail and MCT connections and key interchange locations are illustrated in Figure 42, below.

The principal grid public transport network, including new SmartBus routes, proposed for implementation by 2050 is shown in Figure 60, contained as a fold-out at the back of this document. Feeder and local bus services need to be separately added to complete the network.

Figure 42: Proposed overall rail and MCT network including locations of NEICs and MACs

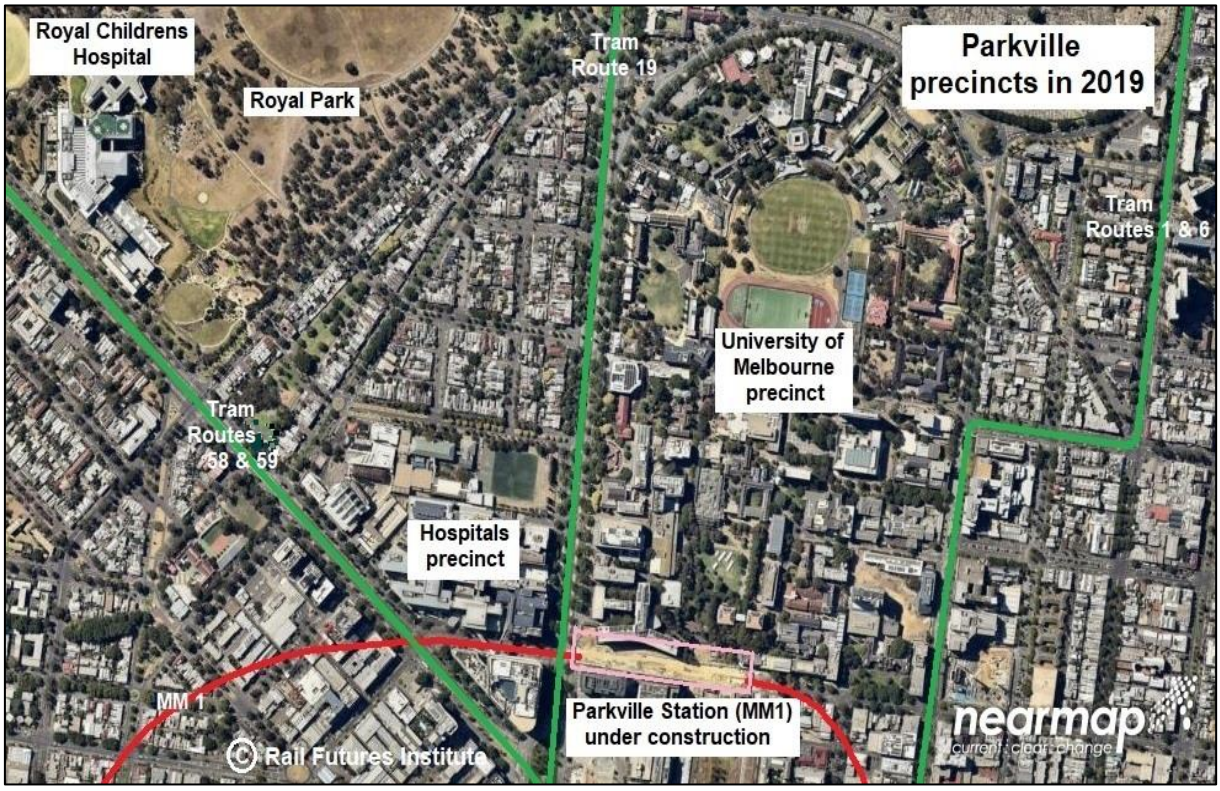
The listing below provides a snapshot of the rail lines and multiplicity of origins and destinations that will provide direct high-quality links to the designated National Employment and Innovation Clusters (NEIC) and some of the Major Activity Centres when this Plan is fully implemented.

10.2 Parkville NEIC

The Parkville NEIC covers most of the compact suburb of Parkville (postcode 3052) on the northern outskirts of the Melbourne CBD. It includes most of the campus of the University of Melbourne, Royal Melbourne Hospital, Royal Women's Hospital, Royal Children's Hospital and the Peter McCallum Cancer Centre. World leading medical research facilities are embedded within these centres. Extensive sporting facilities and Melbourne Zoo are in Royal Park which comprises Parkville's western precinct, bisected by the Route 58 tram to West Coburg and the Upfield railway including Royal Park station.

The general location of these facilities and the existing radial tram routes in Parkville are shown in Figure 43. Also shown is the approximate underground route of MM1 and construction works at Parkville station.

Figure 43: Parkville NEIC overview in 2019

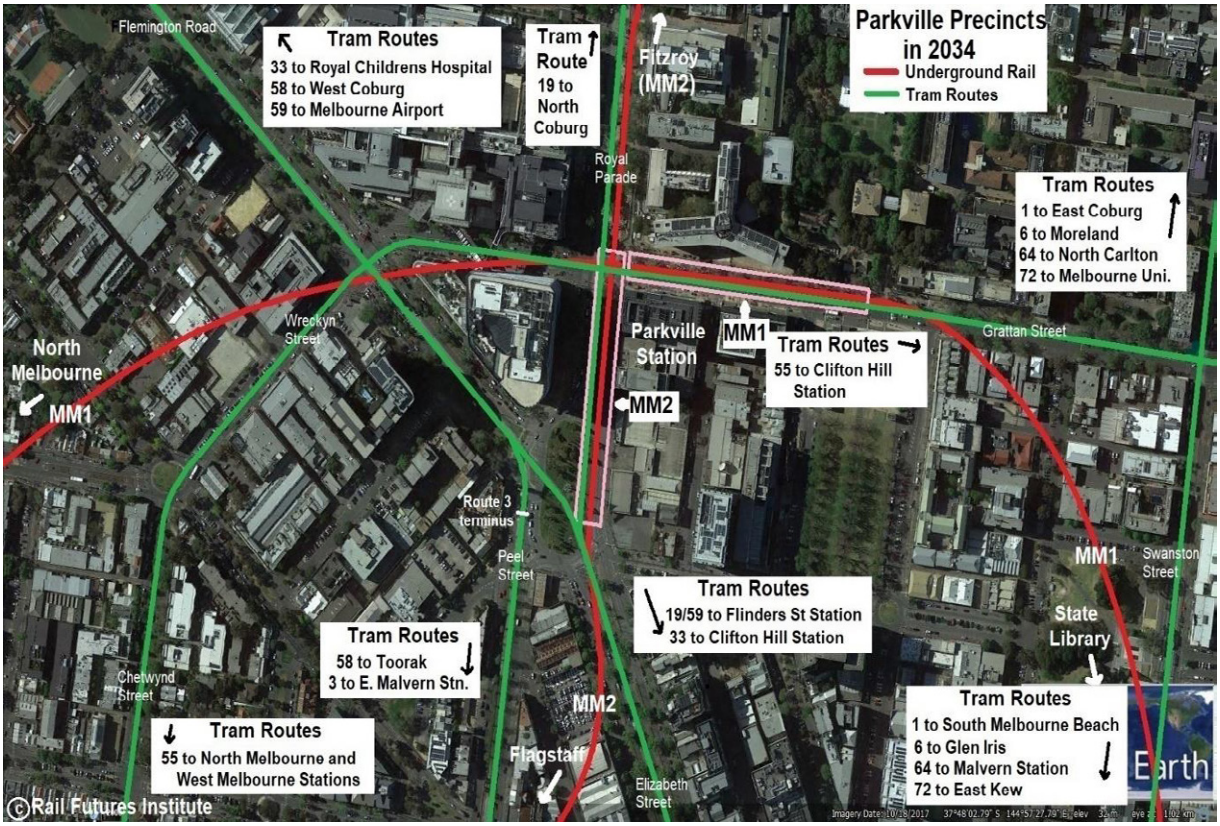


From the principal university and medical precincts, the following network would develop:

- MM1 providing direct services to the Sunbury, Melton, Pakenham and Clyde lines via new City stations, Anzac, Caulfield, Dandenong, North Melbourne, Footscray and Sunshine, served by a new Parkville underground station beneath Grattan Street
- MM2 providing direct services to the Mernda/Wollert and Werribee/Black Forest Road lines via Flagstaff, Southern Cross, Fishermans Bend, Newport, Fitzroy, Preston, Reservoir and Epping, served by additional underground platforms beneath Royal Parade
- Tram Route 1 in Swanston Street to East Coburg and South Melbourne Beach
- Tram Route 3 in Peel Street to East Malvern and Caulfield
- Tram Route 6 in Swanston Street to Moreland and Glen Iris
- Tram Route 19 in Royal Parade to North Coburg
- New Tram Route 33 in Flemington Road to St Vincent's Plaza, Fitzroy and Clifton Hill station
- New Tram Route 55 in Grattan Street to North Melbourne and West Melbourne Stations, Fitzroy and Clifton Hill station
- Tram Route 58 in Flemington Road to Toorak and South Yarra
- Tram Routes 58 and 79 in Flemington Road to West Coburg
- Tram Route 59 in Flemington Road to Airport West and Melbourne Airport
- Tram Route 64 in Swanston Street to North Carlton and Malvern Station
- Tram Route 72 in Swanston Street to Camberwell and East Kew

The proposed configuration of underground rail corridors for MM1 and MM2 and tram routes inherent in this Plan are shown in Figure 44, below.

Figure 44: Parkville NEIC showing proposed Rail and Tram access



10.3 Fishermans Bend NEIC

The 480 hectares Fishermans Bend development precinct is expected to be home to approximately 80,000 residents and provide employment for up to 80,000 people by 2050. The overall development area has been sub-divided into five precincts: Lorimer, Sandridge and Montague with a mix of residential and commercial development and the Employment Precinct and Wirraway which are earmarked for light industrial, research and commercial development.

The area includes the former General Motors Holden car production plant and significant aviation industry manufacturing and research establishments, including Boeing. The precinct directly abuts the Yarra River on its northern boundary, including the South Wharf facilities of the Port of Melbourne, whilst immediately to its west is Webb Dock, also part of the Port of Melbourne. The former rail freight line to Webb Dock (opened 1986, closed 1996) will be replaced by a new rail reservation, mainly on elevated structures, and most likely along the Turner Street alignment as shown in Figure 45.

Current public transport in the precinct is provided by tram route 96 (one stop only at City Road), route 109 which serves the Montague area and several bus routes. Upon full implementation of this Plan, the Fishermans Bend NEIC would be served by:

- MM2 providing direct services from new underground stations at Sandridge and Wirraway to Mernda/Wollert and Werribee/Black Forest Road lines via Parkville, Flagstaff, Southern Cross, Newport, Fitzroy, Preston, Reservoir and Epping. (Note: Final route of MM2 through Fishermans Bend to be determined – alternative route could be via Employment Precinct)
- new Tram Route 44 from Sandridge and Wirraway via Collins Street to Kew Depot
- new Tram Route 46 from Employment Precinct and Montague via Collins Street to Camberwell Junction
- Tram Route 86 from Montague to Port Melbourne and Bundoora
- Tram Route 96 from Montague (City Road) to St Kilda and East Brunswick

Potential options for heavy rail, rail freight and tram routes within the Fishermans Bend Development Precinct are shown in Figure 45. Alternative alignments for some or all these routes may be adopted as the development process proceeds.

Figure 45: Fishermans Bend Development Precinct showing proposed MM2, Tram and Rail Freight access

10.4 Monash NEIC

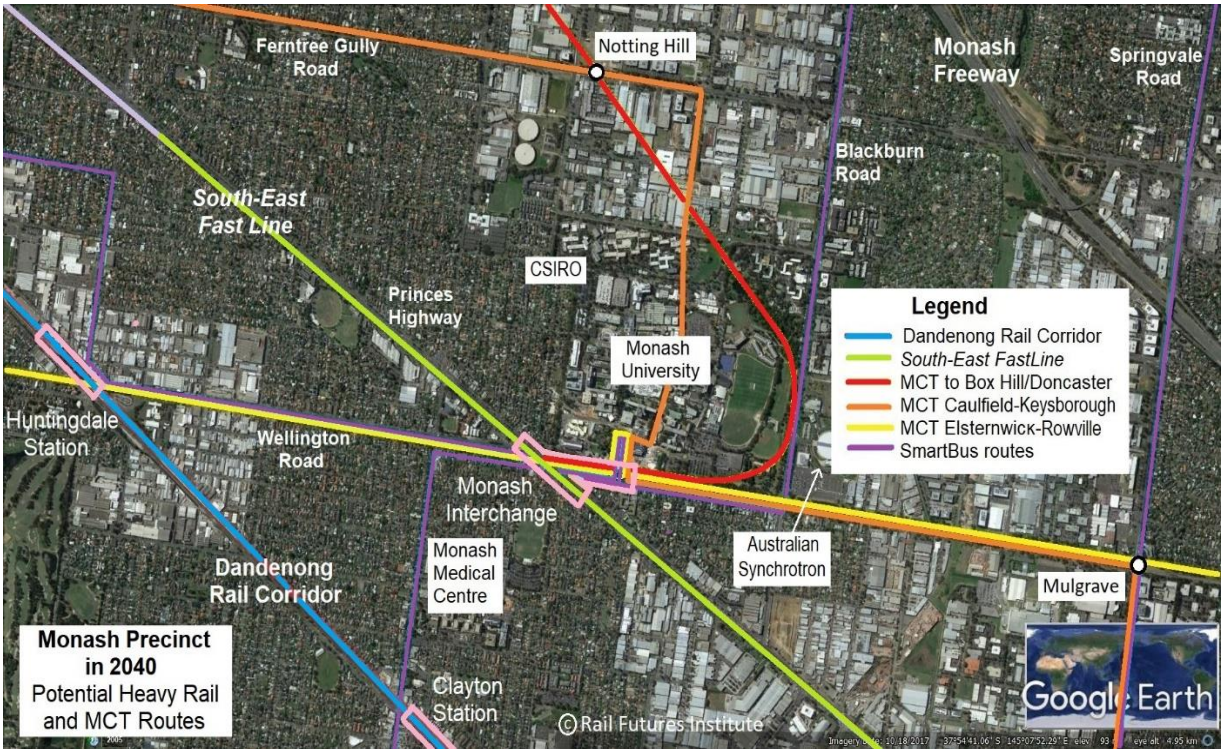
Monash NEIC located in Clayton, some 20 km south-east of central Melbourne, has the highest concentration of jobs outside of the Melbourne CBD. It currently supports approximately 85,000 jobs across a diverse range of industries with the potential for employment numbers to double by 2050. It contains nationally significant facilities centred upon Monash University, Australian Synchrotron, CSIRO, Monash Business and Technology Precincts, Monash Children's Hospital and Monash Medical Centre.

The principal elements of the NEIC are in an area bounded to the north by the Monash Freeway, by the Dandenong rail corridor to the south, Clayton Road to the west and Springvale Road to the east. Current public transport is provided by Clayton, Westall and Springvale stations on the Dandenong line and a significant number of bus routes including three SmartBus routes. Upon full implementation of this Plan, the Monash NEIC will be served by:

- *South-East FastLine* from a new station at Monash University providing rapid direct services to the Melbourne CBD at Southern Cross station, Sunshine and Dandenong NEICs, Caulfield, Chadstone, and all stations on heavy rail lines to Wyndham Vale and Pakenham, together with regional services to Gippsland
- Dandenong line at Clayton, Westall and Springvale stations providing direct services via MM1 to the Melbourne CBD, Parkville and Sunshine NEICs, also Dandenong NEIC and all stations on heavy rail lines to Sunbury, Melton, Pakenham and Cranbourne/Clyde
- proposed MCT route from Caulfield to Keysborough via Chadstone, Notting Hill, Monash University, Mulgrave and Springvale
- proposed MCT route from Elsternwick to Rowville via Monash University, Ormond and Mulgrave
- proposed MCT route from Melbourne Airport to Monash University via Broadmeadows, Keon Park, La Trobe University, Doncaster, Box Hill, Deakin University (Burwood) and Mount Waverley
- SmartBus route to LaTrobe University via Glen Waverley, Nunawading and Heidelberg
- SmartBus route to Sandringham via Clayton and Southland
- SmartBus route (existing 703) from Middle Brighton to Blackburn via Bentleigh and Burwood East
- local bus services on multiple routes

The conceptual arrangement of the routes described above is shown in Figure 46.

Figure 46: Monash NEIC showing proposed Rail, MCT and SmartBus access



10.5 Dandenong NEIC

Dandenong NEIC incorporates the Southern State Significant Industrial Precinct (SSIP) in Dandenong South and the Dandenong Metropolitan Activity Centre (MAC) as illustrated in Figure 47 below. The cluster area is bounded by the Monash Freeway and Heatherton Road to the north, EastLink to the west, Hallam Road to the east and Glasscocks Road to the south.

The cluster currently supports approximately 66,000 jobs and is one of Australia's largest manufacturing areas. Increasingly, it is also supporting knowledge-based manufacturing activity, typified by development of the Logis Eco-Industrial Park, which is expected to generate around 5,000 jobs, one of several industrial precincts which reflect the transition away from traditional manufacturing. Other key sectors include health, education, retail, wholesale trade and transport and warehousing activities.

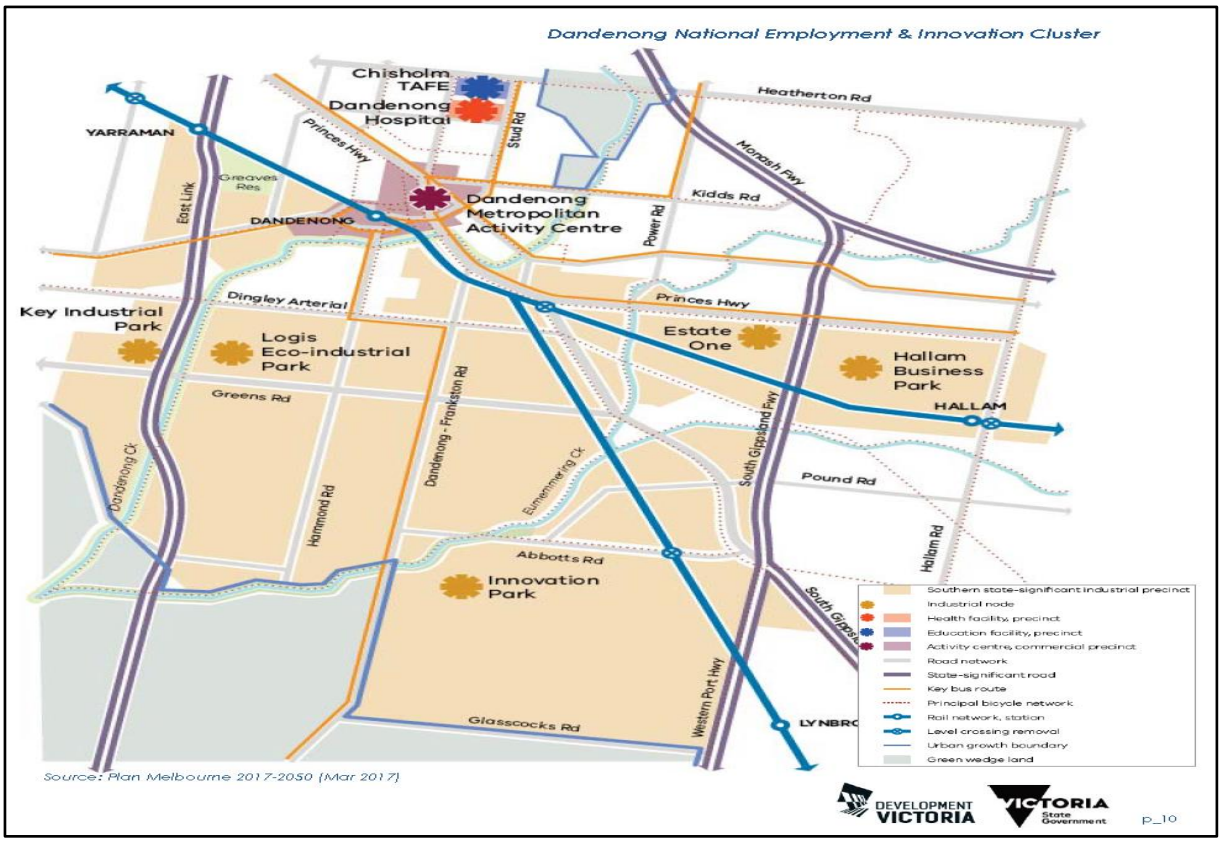
The Dandenong MAC includes Dandenong Hospital and Chisholm TAFE. Dandenong's central area is the focus of the Government's Revitalising Central Dandenong initiative. It also includes the Dandenong Plaza and Dandenong Market, the second largest retail market in Melbourne.

Current public transport is provided by the Dandenong rail corridor at Dandenong and Hallam stations and a multiplicity of bus routes including the Route 901 SmartBus which is a lengthy orbital route extending from Melbourne Airport to Frankston. Upon full implementation of this Plan, the Dandenong NEIC will be served by:

- Dandenong line at Dandenong and Hallam stations providing direct services via MM1 to the Melbourne CBD, Parkville and Sunshine NEICs, and all stations on heavy rail lines to Sunbury, Melton, Pakenham and Cranbourne/Clyde
- *South-East FastLine* providing rapid direct services to the Melbourne CBD at Southern Cross station, Monash and Sunshine NEICs, Caulfield and Chadstone, and all stations on heavy rail lines to Wyndham Vale and Pakenham, together with regional services to Gippsland
- proposed MCT route to Ringwood via Wantirna, Knox, Scoresby and Rowville
- proposed MCT route to Mentone via Keysborough
- SmartBus route to Frankston via Carrum Downs (part of existing SmartBus Route 901)
- local bus services on multiple routes

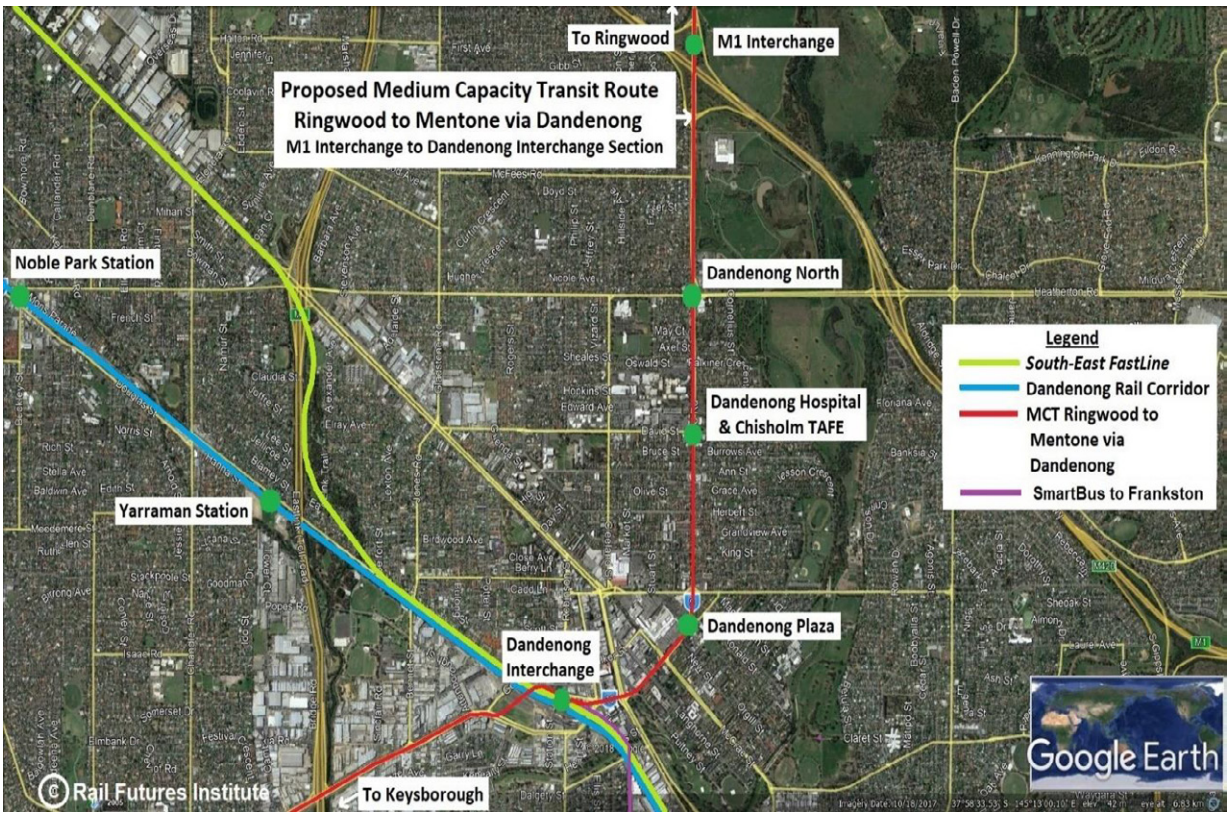
The proposed rail, MCT and SmartBus access within the Dandenong NEIC area is shown in Figure 48.

Figure 47: Dandenong NEIC area



Source: *Development Victoria*

Figure 48: Dandenong NEIC showing proposed Rail, MCT and SmartBus access



10.6 La Trobe NEIC

The La Trobe National Employment and Innovation Cluster (La Trobe Cluster) sits within the northern sub-region of Melbourne in the suburb of Bundoora, 14 km north-east of the Melbourne CBD.

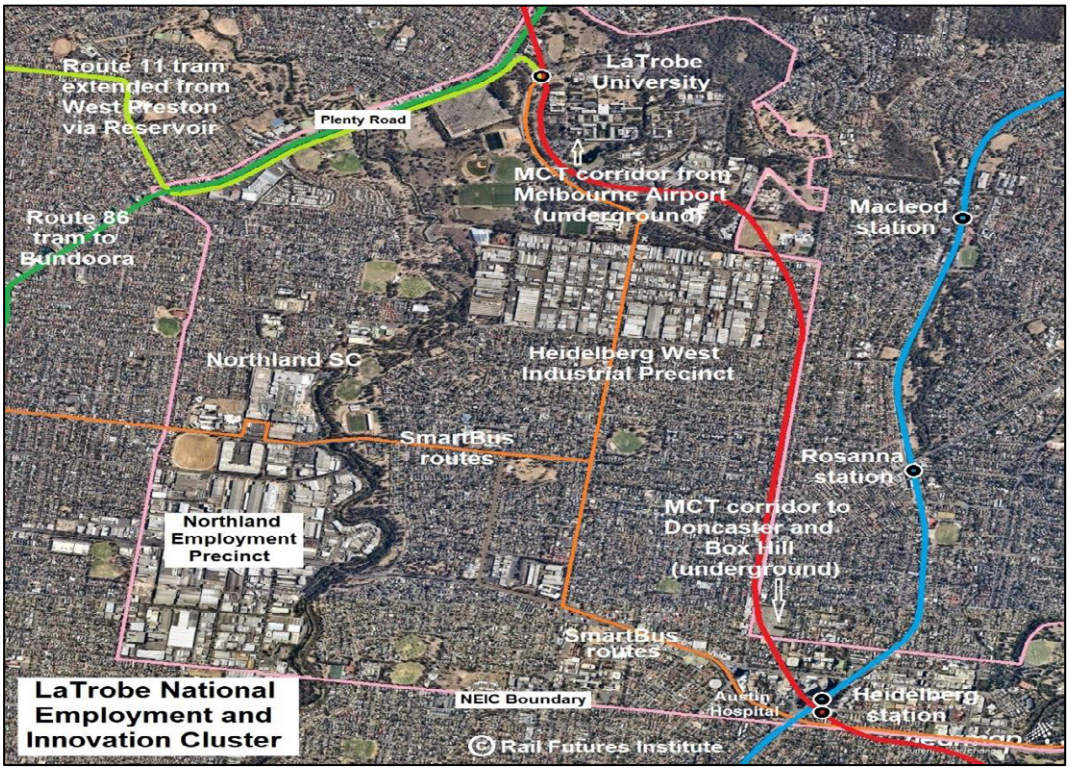
With the highest concentration of jobs in Melbourne's north-east, the La Trobe NEIC is seen as the key location for the growth of business and employment in Melbourne's north, leveraging the established specialised facilities at La Trobe University and Austin Hospital. There are currently almost 28,000 jobs within the cluster with a critical mass of leading education, health and research facilities including Rio Tinto and the agricultural and bio-science research centre at La Trobe University.

The cluster also includes other significant employment locations including the Heidelberg Major Activity Centre and medical precinct, Northland Major Activity centre and industrial area and Heidelberg West industrial estate.

Current public transport is provided by the Hurstbridge rail line at Heidelberg station (also at Rosanna and Macleod stations which are outside of the NEIC boundary), Route 86 Bundoora tram on Plenty Road and several bus routes including SmartBus Route 903 from Mordialloc to Altona via Heidelberg and Northland Shopping Centre. When this Plan is fully implemented, as shown in Figure 49, La Trobe NEIC will be served by:

- Hurstbridge line from Heidelberg station and all stations to Greensborough, Eltham and Hurstbridge, also all stations to Melbourne CBD (City Loop) via Clifton Hill
- proposed MCT route from La Trobe University to Melbourne Airport via Keon Park, Campbellfield and Broadmeadows
- proposed MCT route from La Trobe University to Monash University via Heidelberg, Doncaster, Box Hill, Deakin University (Burwood) and Mount Waverley
- extended Tram Route 11 from La Trobe University to Victoria Harbour (Docklands) via Reservoir, West Preston, Fitzroy and Melbourne CBD via Collins Street
- Tram Route 86 from La Trobe University to Melbourne CBD (via Bourke Street) and Port Melbourne, also to RMIT University at Bundoora
- SmartBus route to Sunshine via Northland, Preston, Coburg, Essendon and Highpoint
- SmartBus route to Sandringham via Heidelberg, Nunawading, Glen Waverley, Monash University, Clayton and Southland
- local bus services on multiple routes

Figure 49: La Trobe NEIC showing proposed Rail, Tram, MCT and SmartBus access



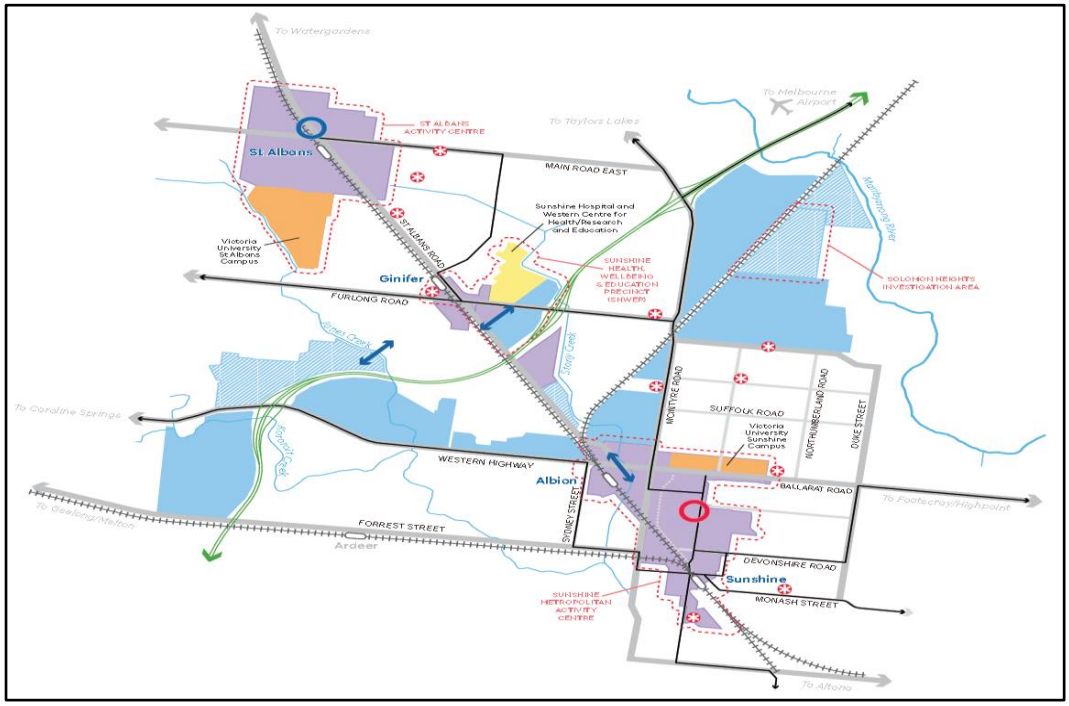
10.7 Sunshine NEIC

The Sunshine Cluster is located within Brimbank City Council, 12-14 km west of Melbourne's CBD. The cluster is developing as an economic hub that provides a central service function for Melbourne's west. The cluster supports approximately 14,600 jobs across a diverse range of industries stretching between the established Activity Centres of Sunshine and St Albans. The cluster also includes the suburbs of Albion, Ardeer, Sunshine North, Cairnlea and part of Deer Park, as shown in Figure 50, below.

In recent decades, Sunshine's fortunes have declined with the loss of manufacturing enterprises. The area is ripe for renewal, the next phase of investment and re-emergence as a major job centre and focal point for health and education services. Current major facilities include Sunshine Hospital and Victoria University Campuses at Sunshine and St Albans.

Current public transport is provided by the Sunbury rail line stations at Sunshine, Albion, Ginifer and St Albans and Ardeer station on the Melton line. There are no tram services in the Brimbank municipality. The cluster has a multiplicity of local and cross-suburban bus services including SmartBus Route 903 from Mordialloc to Altona which stops at Sunshine station and the main Sunshine shopping precinct.

Figure 50: Sunshine NEIC area

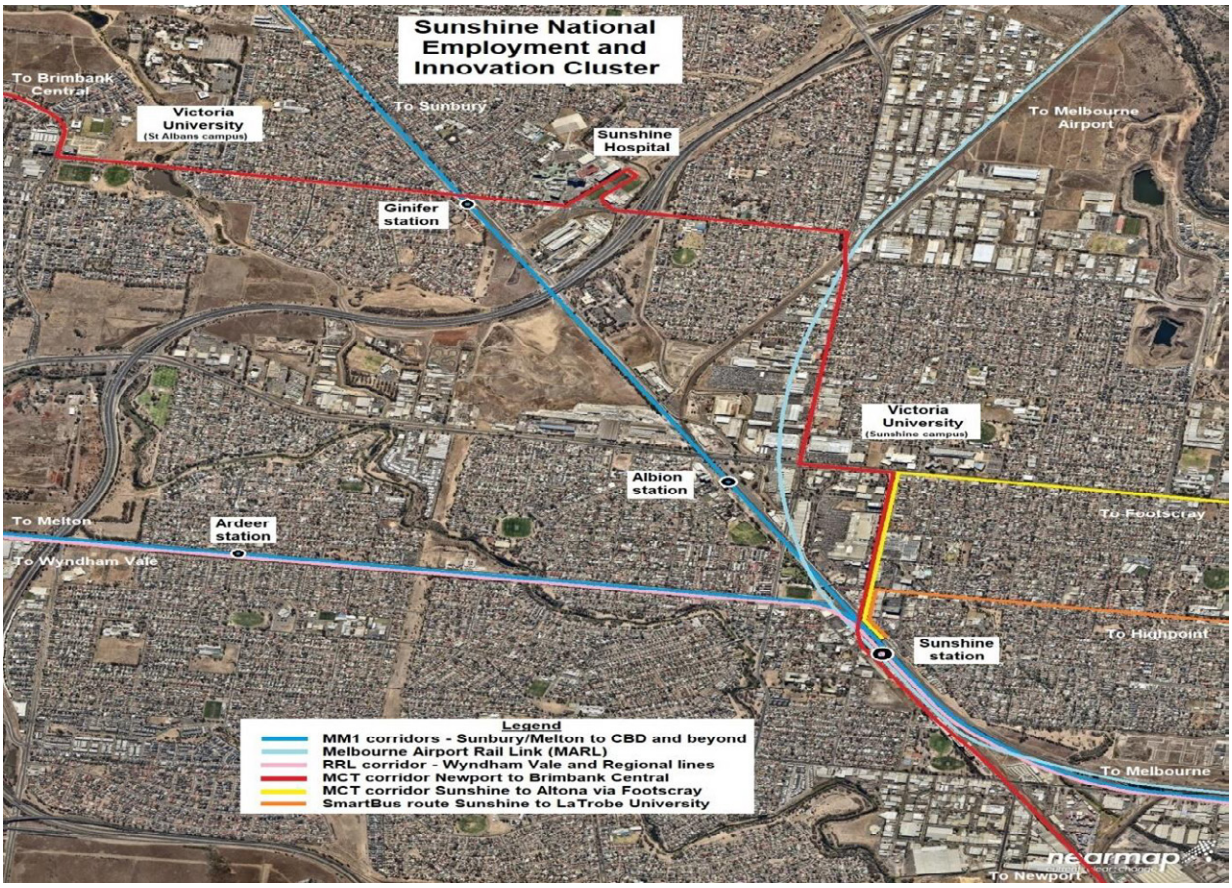


Source: *Victorian Planning Authority*

When this Plan is fully implemented, as shown in Figure 51, Sunshine NEIC will be served by:

- MM1 providing direct services from Sunshine, Albion, Ginifer, St Albans and Ardeer stations to all stations on the Sunbury, Melton, Pakenham and Clyde lines via new City stations, Anzac, Caulfield, Dandenong, Footscray, North Melbourne and Parkville
- MARL providing fast direct services to Melbourne Airport and Southern Cross
- Black Forest Road line from Sunshine station to Wyndham Vale and Tarneit
- direct regional services from Sunshine station to the Geelong, Ballarat, Bendigo and North-Eastern lines
- proposed MCT route from Sunshine station to Altona via Braybrook, Footscray, Kingsville and Brooklyn
- proposed MCT route from Sunshine station to Brimbank Central via Sunshine Hospital, Ginifer and Cairnlea
- proposed MCT route from Sunshine station to Newport via Brooklyn
- SmartBus route to Latrobe University via Highpoint, Essendon, Coburg, Preston and Northland
- local bus services on multiple routes

Figure 51: Sunshine NEIC showing proposed Rail, MCT and SmartBus access



10.8 Werribee NEIC

The Werribee cluster is situated within the City of Wyndham approximately 32 km from the Melbourne CBD, one of the fastest growing municipalities in Australia. It currently supports around 8,400 jobs and could ultimately support more than 50,000 predominantly white-collar jobs in health, education and high-tech research. Its major potential lies in 775 hectares of predominantly greenfield land south of the Princes Highway which comprises the East Werribee Employment Precinct and Werribee Agriculture and Food Technology Precinct.

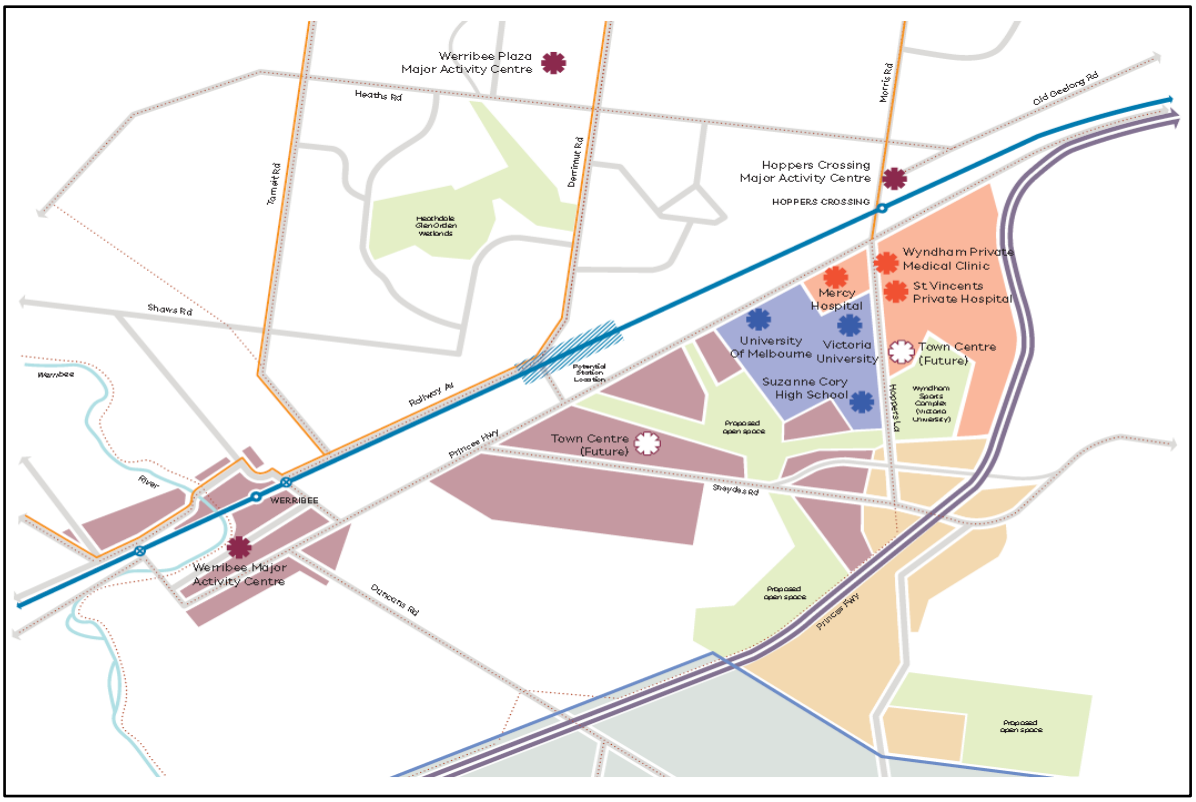
The cluster includes the University of Melbourne Veterinary Hospital, University of Notre Dame, Victoria University, Werribee Mercy Hospital, Wyndham Private Medical Centre, CSIRO, Suzanne Cory High School and a range of research companies in the food and agricultural industries, as shown in Figure 52. Many of these white-collar job providers have significant expansion plans for the next 20 years. A site for a new hospital has also been purchased within the cluster by St Vincent's Private Hospital.

Public transport is currently provided by the Werribee rail corridor with stations at Hoppers Crossing and Werribee and multiple bus routes which connect to these stations. No SmartBus routes currently operate in the City of Wyndham.

When this Plan is fully implemented, as shown in Figure 53, Werribee NEIC will be served by:

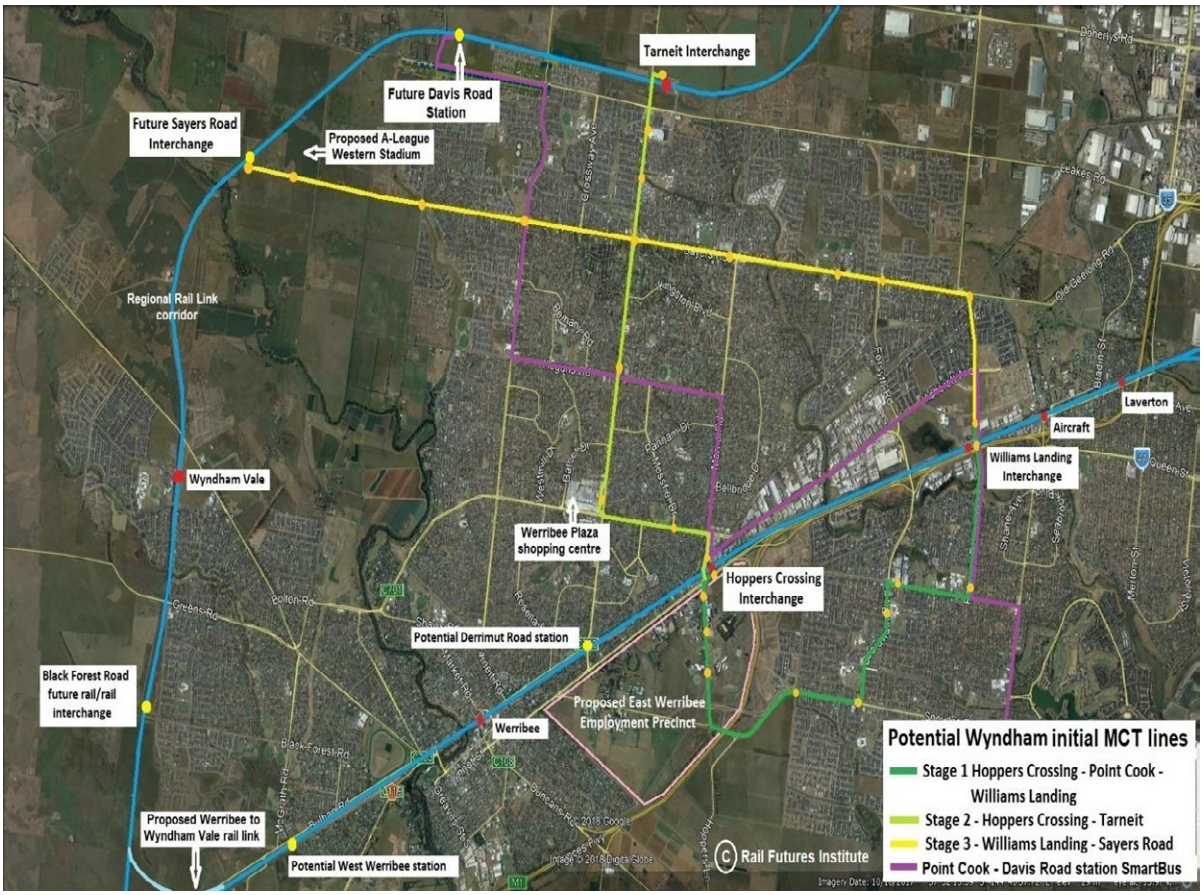
- MM2 providing direct services from Hoppers Crossing and Werribee to the Mernda/Wollert line via Newport, Fishermans Bend, Southern Cross, Flagstaff, Parkville, Fitzroy, Preston, Reservoir and Epping, also to Black Forest Road
- proposed MCT route from Hoppers Crossing and Derrimut Road to Williams Landing via East Werribee and Point Cook (also see Section 7.2.9)
- proposed MCT route from Hoppers Crossing to Tarneit station via Werribee Plaza MAC
- proposed MCT route from Williams Landing to Sayers Road (future station) via Truganina
- SmartBus route from Point Cook to Davis Road station via Williams Landing and Hoppers Crossing
- local bus services on multiple routes

Figure 52: Werribee NEIC area



Source: *Plan Melbourne 2017-2050 (Map 11)*

Figure 53: Werribee NEIC showing proposed Rail, MCT and SmartBus access



10.9 Melbourne Airport

Melbourne Airport covers an area of 2,600 hectares, adjoining the suburbs of West Meadows and Tullamarine, some 22 km north-west of the Melbourne CBD. Being in proximity to major industrial areas and Melbourne's residential growth corridors, apart from its primary role as Australia's second busiest domestic and international airport for passengers, it serves as a hub for the freight and logistics industry. Although it is does not have NEIC designation, Melbourne Airport handled a record 37.3 passenger movements in 2018/19[50] and is a major employment generator with around 20,000 jobs currently located within the wider airport precinct. This is expected to increase to around 35,000 jobs by 2050.

Apart from premium fare Skybus services to the Melbourne CBD, Docklands and some suburbs including St Kilda, Frankston and Werribee, Melbourne Airport is poorly served by public transport by way of destinations, service frequency, accessibility from some terminals and visibility for arriving passengers. A partial exception is the Route 901 SmartBus which runs at 15 minutes frequency to Frankston via an outer orbital route through Broadmeadows, Epping, Greensborough, Ringwood and Dandenong. This will be replaced by the proposed MCT route to Monash University and a new SmartBus service to Ringwood (see below).

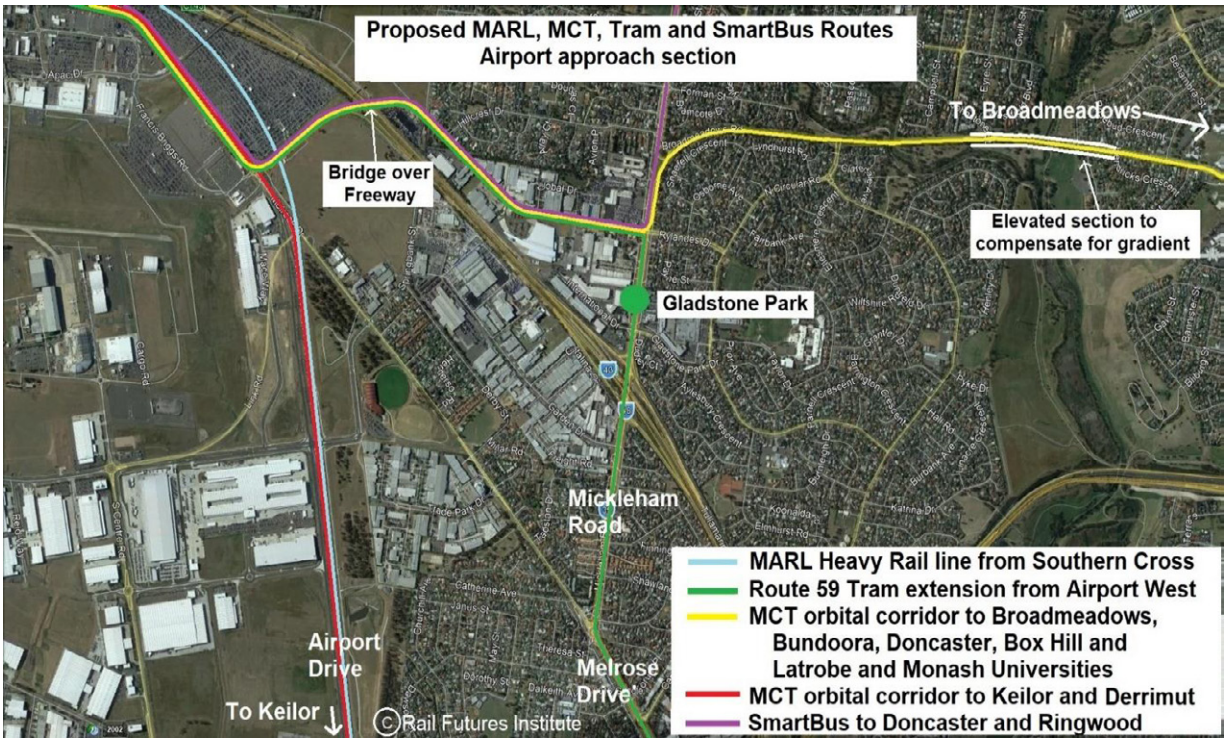
When this Plan is fully implemented, Melbourne Airport will be served by:

- MARL fast direct services to Sunshine and Southern Cross, connecting with MM1 at Sunshine
- Tram Route 59 to Melbourne CBD via Gladstone Park, Airport West, Essendon and Moonee Ponds
- proposed MCT route to Monash University via Broadmeadows, Campbellfield, Keon Park, La Trobe University, Heidelberg, Doncaster, Box Hill, Burwood (Deakin University) and Mount Waverley
- proposed MCT route to Derrimut via Keilor, Taylors Lakes, Watergardens, Delahey and Deer Park
- SmartBus to Ringwood via Roxburgh Park, South Morang, Greensborough, Doncaster and Mitcham
- local bus services on multiple routes

Longer term, potential exists for direct regional services from Melbourne Airport to the Bendigo and North-Eastern lines.

The approximate location of proposed MCT, Tram and SmartBus routes as they approach Melbourne Airport is shown in Figure 54, below.

Figure 54: Proposed Rail, MCT, Tram and SmartBus routes approaching Melbourne Airport



50

10.10 Chadstone Major Activity Centre

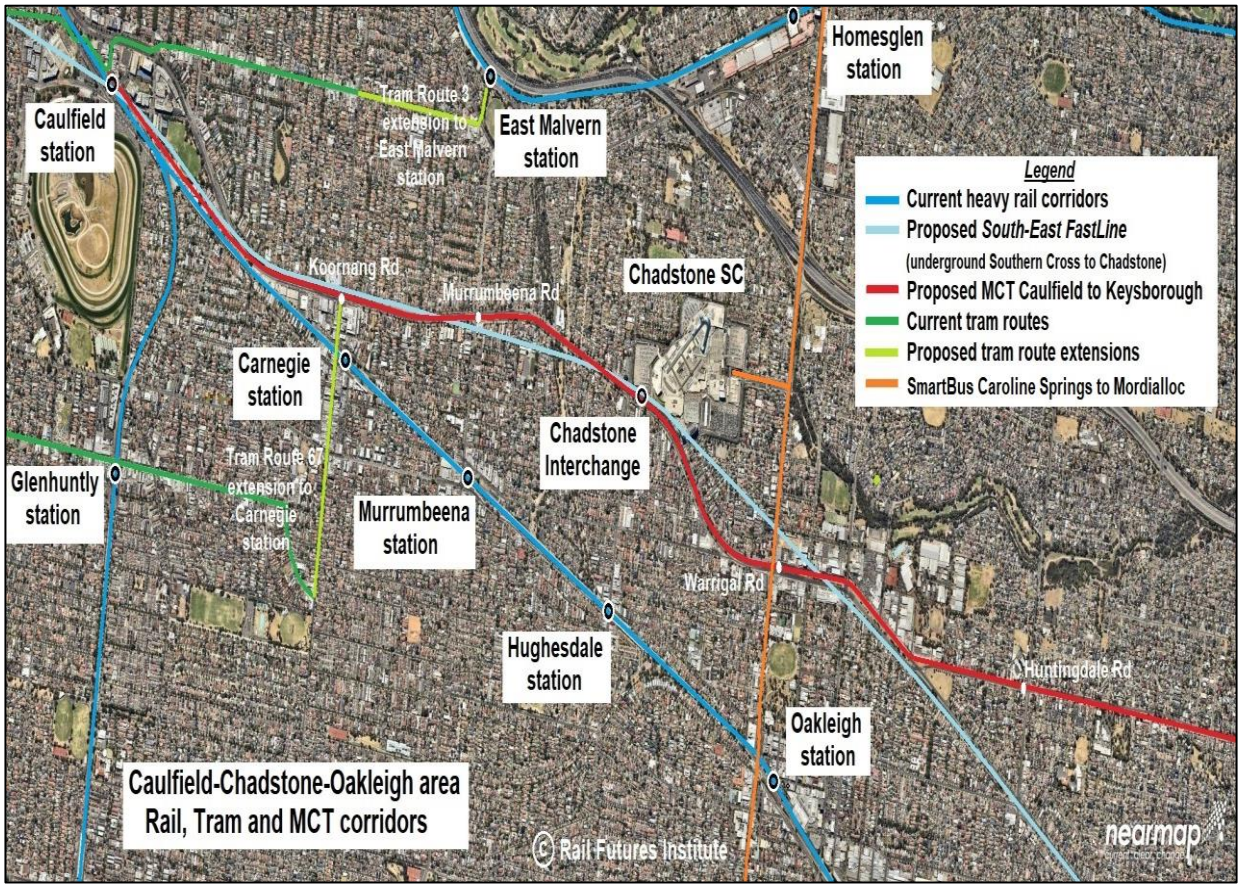
Chadstone MAC, located approximately 15 km south-east of Melbourne's CBD, is Australia's largest shopping mall with some 550 shops and some 23 million visits annually. The site is being developed into a major retail, entertainment and commercial precinct with a 250-room hotel currently under construction. The Centre currently provides approximately 10,000 free car parking spaces.

Reflective of there being no rail-based transport in the immediate vicinity, Chadstone Shopping Centre operates its own regularly scheduled shuttle bus to and from the Melbourne CBD. Local public transport access is provided by several bus routes, including two SmartBus routes (700 Caulfield to Rowville and 703 Altona to Mordialloc). Chadstone's continuing development therefore inevitably reinforces very high levels of car dependency.

Under this Plan, as shown in Figure 55, below, Chadstone MAC will become a major train/MCT/bus interchange served by:

- *South-East FastLine* providing direct services to Black Forest Road via Caulfield, Southern Cross and Sunshine and to the Pakenham and Gippsland lines via Monash University and Dandenong
- proposed MCT route from Caulfield to Keysborough via Notting Hill, Monash University, Mulgrave and Springvale
- SmartBus route to Caroline Springs via Holmesglen, Box Hill, Doncaster, Heidelberg, Moreland, Essendon, and Keilor Plains
- SmartBus route to Mordialloc via Oakleigh and Mentone
- local bus services on multiple routes

Figure 55: Chadstone MAC and surrounding suburbs showing proposed Rail, MCT and SmartBus access



10.11 Doncaster Major Activity Centre

Doncaster MAC is located approximately 15 km east of the Melbourne CBD. It is dominated by the Westfield Doncaster Shopping Centre located on an elevated site on Doncaster Hill. The Centre has 400 shops and approximately 5,000 car park spaces.

As described in Section 7.2.1, several prior studies have examined options for a heavy rail corridor to Doncaster, but each have been rejected by successive governments. The Centre is therefore only serviced by bus, although it also promotes travel by train to Box Hill and the use of connecting bus routes to Doncaster as a viable public transport option. Current bus routes servicing Doncaster MAC include SmartBus routes 902 (Airport West to Chelsea), 903 (Altona to Mordialloc) and 907 (City to Mitcham) although the latter stops outside the main centre in Doncaster Road.

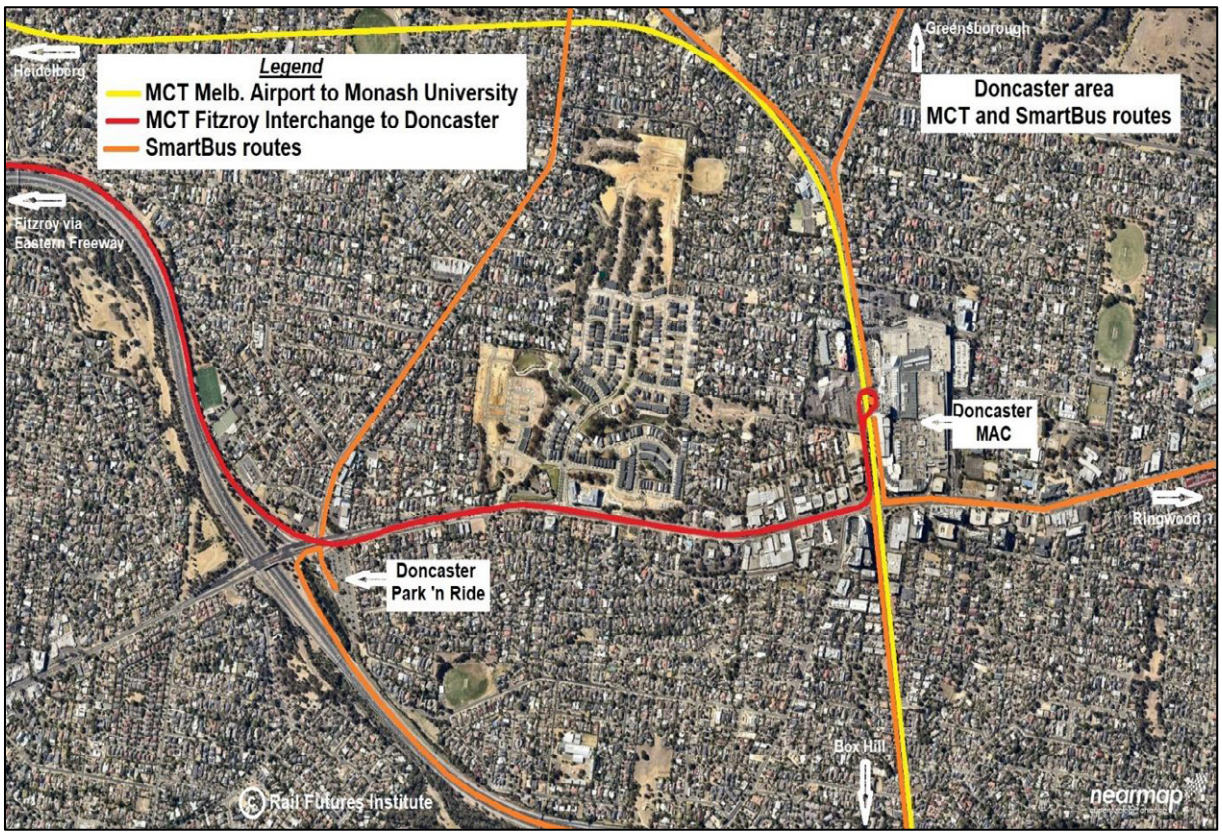
Other bus routes operate through the Doncaster Park and Ride facility, about 2 km west of the MAC on the corner of Doncaster Road and the Eastern Freeway. This provides approximately 350 commuter car park spaces representing a very small proportion of bus users from that location.

When this Plan is fully implemented, as shown in Figure 56, Doncaster MAC will be served by:

- proposed MCT (most likely Bus Rapid Transit) to Fitzroy interchange via Eastern Freeway
- other bus routes including to Collingwood and CBD via Eastern Freeway
- proposed MCT to Melbourne Airport via Heidelberg, La Trobe University, Keon Park and Broadmeadows
- proposed MCT to Monash University and Clayton via Box Hill, Burwood and Mount Waverley
- SmartBus route to Melbourne Airport via Greensborough, South Morang and Roxburgh Park
- SmartBus route to Ringwood via Mitcham
- SmartBus route to Caroline Springs via Heidelberg, Moreland, Essendon and Keilor Plains
- SmartBus route to Mordialloc via Box Hill, Holmesglen, Chadstone, Oakleigh and Mentone
- local bus services on multiple routes

For more details of Doncaster MCT options refer to Section 7.2.1.

Figure 56: Doncaster MAC and surrounding area showing proposed MCT and SmartBus access



11. Access and Connectivity Benefits

The projects proposed in this Plan are focused on improving public transport across Melbourne so that they can ensure a high degree of connectivity between residential areas, employment, educational, social and recreational centres without people being completely dependent on cars. A high level of accessibility will allow the city to continue to provide opportunities for an increasing population to enjoy a high quality of life in an environmentally sustainable city.

The effects of the Melbourne Rail Plan on network performance and accessibility (land use and transport integration) have been assessed using the Spatial Network Analysis for Multimodal Urban Transport Systems (SNAMUTS) tool. SNAMUTS is an interactive decision tool designed to assist in examining the performance of a city region's current public transport network framed around the accessibility of the transport network and accessibility of place. The SNAMUTS tool enables the quantification of the effect of transport infrastructure improvements and modifications, and of land use intensification, on the accessibility of activity centres and corridors by different modes of transport to all centres across the metropolitan area.

Figures 57 and 58 provide an overview of the levels of public transport accessibility achieved across Metropolitan Melbourne in the base case (2016) and after completion of the measures proposed in this Plan. Traffic light colours identify spatial accessibility levels from green (excellent to good), yellow and orange (average) to red and maroon (poor or minimal). Grey shading indicates urbanised areas where current (bus-based) public transport services do not meet the minimum standard of 20-minute daytime frequencies on weekdays and 30-minute frequencies on weekends. However, it is likely and highly desirable (though beyond the scope of this Plan to assess in detail) that bus services across the metropolitan region will also be improved to support the enhanced rail mode network measures.

The maps show the synergy effects on accessibility that emerge from the provision of a high and medium-capacity rapid transit network extending into Melbourne's middle suburbs and beyond. The boost to the rail system proposed in this report ensures that adequate locational choices exist for both residents and businesses.

The MCT route from Melbourne Airport to Monash University provides an orbital corridor through Broadmeadows, Bundoora, Heidelberg, Doncaster and Box Hill which connects a string of 'super-hubs' that become as easy, if not easier, to get to and from by public transport than by car. The MCT semi-orbital corridor from Ringwood to Mentone via Knox City, Rowville, Dandenong and Keysborough connects major activity centres with the Dandenong NEIC to provide similar benefits.

The percentage of Melbourne residents and jobs that enjoy 'good to excellent public transport access' (the green colour brackets on the map) increases from 7% in 2016 to 31% if all proposals in this Plan are implemented.

About SNAMUTS

Spatial Network Analysis for Multi-modal Urban Transport Systems or SNAMUTS is a collaborative international research project headed by Professor Carey Curtis and Doctor Jan Scherer.

The primary objective of the research project was to develop an interactive decision tool (SNAMUTS) to assist in examining scenarios for the future growth of metropolitan areas.

Rail Futures gratefully acknowledges the SNAMUTS assessment of The Melbourne Rail Plan done by RMIT University School of Global Urban and Social Studies

(For more detail on the methodology see www.snamuts.com)

Figure 57: Map showing Public Transport Accessibility Index for Melbourne 2016

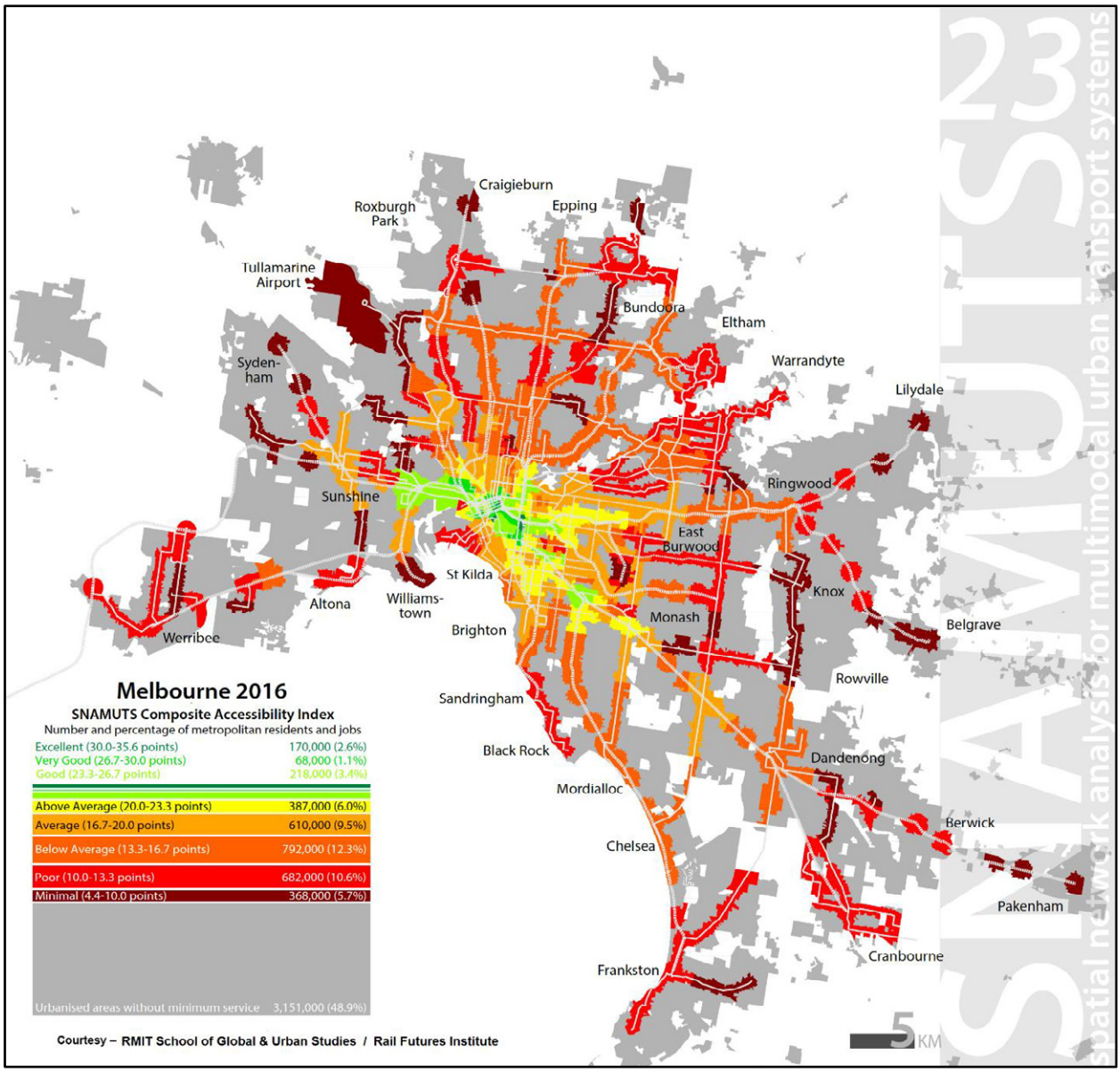
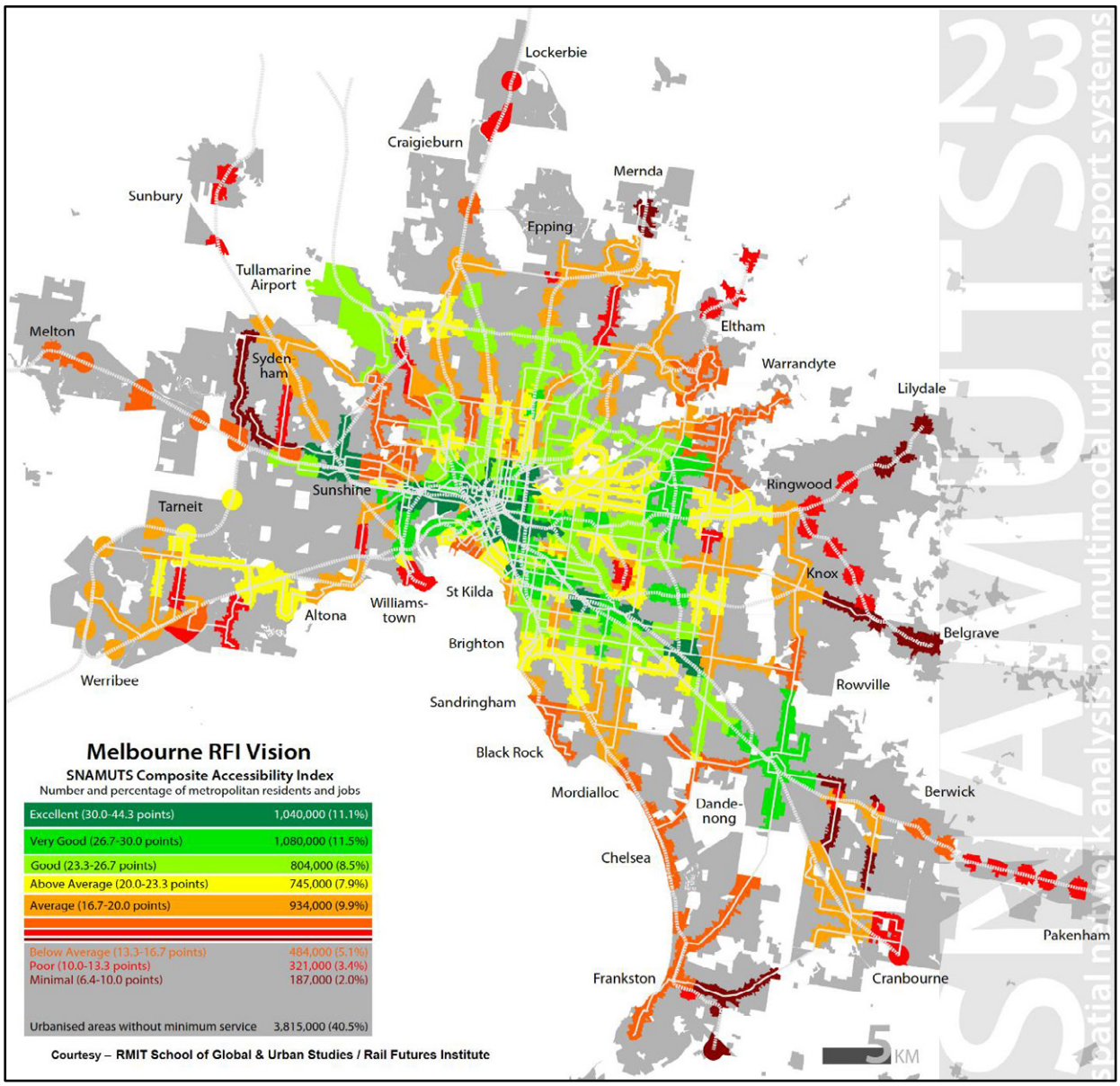


Figure 58: Map showing Public Transport Accessibility Index with inclusion of RFI Projects



12. Staging and Timing

Development and delivery of the public transport projects proposed in this Plan will be a significant challenge for the Victorian Government in terms of expertise needed to integrate the program and then obtain the resources and skills to successfully plan, design, procure and deliver the projects. This section of the Plan addresses the issue of physical program integration and reflects our expectations of the capacity of the State to undertake these processes in parallel for multiple projects.

Each project must pass through at least three major phases from conception to completion:

- Phase 1 – initial conception, high level scoping, detailed project planning, business case preparation, funding approval
- Phase 2 – detailed or reference design[51], statutory planning approvals, project procurement
- Phase 3 – construction, testing and commissioning

While some projects may be developed, managed and completed through all three phases with the same project team, this is unusual as each phase generally requires different skills and resources. Sometimes it is not a continuous process from one phase to the next. For example, completion of detailed project planning and a satisfactory business case does not necessarily imply that the project will immediately flow to the next phase.

Some projects, particularly large and costly ones, can be developed and constructed in discrete stages, if each stage can be brought into operation and achieve benefits independently of any subsequent stages. In such cases, the phasing of each stage can be separately considered. For example, the proposed *South-East FastLine* can be considered as three separate but related projects:

- Stage 1 – Caulfield to Dandenong – combination of underground and elevated construction
- Stage 2 – Southern Cross to Caulfield – entirely underground construction
- Stage 3 – Dandenong to Pakenham – almost all at ground level

The following tables showing the recommended staging and implementation programs for programs in the Plan have been developed on the understanding of the above considerations. The proposed programs reflect relative priorities based on our assessment of need and the timing of pre-requisite precursor projects (where applicable). In each phase, the projects are also prioritised having regard to lead times from inception to delivery. In turn, this reflects the relative difficulty, complexity and scale of each project.

For each project, the expected degree of difficulty and complexity and its relative scale is graded at 1 (least demanding and smallest scale) to 10 (most demanding and largest scale). These values are subjective and do not have a linear relationship. In making these assessments, Rail Futures acknowledges that all proposals in the Plan should be the subject of formal analysis, at least to the level of Phase 1, as described above.

Heavy rail, tram and Medium Capacity Transit (MCT) projects are separately colour coded in the following tables to assist identification.

[51] Detailed design is usually undertaken at this stage if subsequent procurement is for construction only. More commonly, a reference design is undertaken which is sufficiently detailed to fully specify the project deliverables and provide reasonably robust cost estimates. Put simply, a reference design tends to specify "what" the client requires but is not definitive about "how" the project is to be undertaken. Under these conditions, the procurement phase usually provides for the successful contractor to undertake both detailed design and construction.

Table 13: Phase 1 – Proposed Project Planning, Business Case, Funding Approval Processes

Proposed Phase 1 – Project Planning, Business Case and Funding Approval Processes				
Year	**Projects**	**DOD ***	**Project Scale**	**Notes**
2018/19	Cheltenham Turnback	3	2	Part of LXRA level crossing project
	West Footscray Turnback	3	2	MM1 support project
	Werribee line signalling upgrade	3	2	MM1 support project
	Platform lengthening for HCMT trains	2	3	MM1 support project
	Traction power upgrading	5	5	MM1 support project
	Essendon turnback	2	2	MM1 support project
	Sandringham second platform	2	2	MM1 support project
	Park Street, South Melbourne tram connection	1	1	MM1 support project
	East Dandenong-Cranbourne duplication	4	4	
	Melbourne Airport Rail Link	9	9	Includes new Airport station
2019/20	Cranbourne-Clyde re-opening	5	5	Duplication, electrification & two new stations
	Southern Cross-Wyndham Vale electrification	6	6	Includes track amplification beyond Sunshine
	Deer Park-Melton electrification	7	7	Includes track amplification
	Craigieburn line signalling upgrade	2	2	MM1 support project
	Station Pier, Port Melbourne tram extension	2	1	
2020/21	Caulfield/Northern Loops reconfiguration	8	8	
	Gowrie-Upfield duplication	3	3	Includes new Campbellfield station
	Upfield-Roxburgh Park re-opening	6	5	Duplication, electrification & quad to Craigieburn
	Greensborough-Eltham duplication	4	4	
	Spencer St to West Melbourne tram extension	3	2	
2021/22	Frankston-Baxter electrification	5	4	Includes duplication & two new stations
	Mooroolbark-Lilydale duplication	4	3	Includes new Cave Hill station
	Burnley Junction upgrade	3	3	
	Melton-Bacchus Marsh electrification	5	4	Includes part duplication
	West Melbourne-Nth Melbourne stations tram loop	3	2	
2022/23	Werribee-Black Forest Road link	4	4	Includes electrification & one new station
	Fishermans Bend tram extensions	5	5	Includes Yarra River bridge
	Clifton Hill-Fitzroy-Parkville tram extension	4	3	
2023/24	MM2 tunnel Newport-Croxton	10	10	3-year process starting 2021
	Stony Point line crossing loop	2	1	
	Craigieburn-Wallan electrification	4	4	Includes two new stations
	West Preston-La Trobe Uni tram extension	5	4	
	North Coburg-Merlynston tram extension	2	2	
2024/25	Burnley-Camberwell 4th track	5	4	
	Ferntree Gully-Upper Ferntree Gully duplication	3	2	
	East Brighton-Moorabbin tram extension	4	3	
2025/26	SEFL Stage 1 - Caulfield-Dandenong	9	8	2-year process starting 2024
	Carnegie-Carnegie Station tram extension	2	2	
	Darling Rd-East Malvern Station tram extension	2	2	
	Airport West-Melbourne Airport tram extension	4	5	
	Parkville-West Melb-N Melb tram extension	4	3	
2026/27	SEFL Stage 2 – Southern Cross-Caulfield	10	9	3-year process starting 2024
	Caulfield-Monash-Keysborough MCT	7	6	2-year process starting 2025
2027/28	SEFL Stage 3 – Dandenong-Pakenham	5	4	
	W Maribyrnong-Avondale Heights tram extension	4	3	
	Elsternwick-Monash-Rowville MCT	7	6	2-year process starting 2026
2028/29	Sunbury-Clarkefield electrification	4	4	
	Lalor-Wollert extension	5	4	
	Malvern-Darling Station tram extension	2	2	
	Camberwell-East Kew tram extension	3	3	
	Ringwood-Dandenong-Mentone MCT	7	7	3-year process starting 2026
2029/30	Glen Waverley-Knox City extension	8	7	3-year process. Includes two new stations
2030/31	Camberwell-Box	5	4	
	Melbourne Airport-La Trobe-Box Hill-Monash MCT	9	8	3-year process starting 2028
2031/32 onwards	Melbourne Airport-Keilor-Deer Park-Derrimut MCT	7	7	2-year process starting 2033
	CBD-Vic Park-Bulleen-Doncaster Hill MCT	7	6	3-year process starting 2033
	Williams Landing-Point Cook-Tarneit MCT	6	6	2-year process starting 2036
	Williams Landing-Truganina-Sayers Rd MCT	6	6	2-year process starting 2037
	Sunshine-Footscray-Kingsville-Altona MCT	6	6	2-year process starting 2038
	Newport-Sunshine-Ginifer-Brimbank C MCT	6	6	2-year process starting 2039
DOD * - Relative Degree of Project Difficulty and/or Complexity				
Second year of each timeline infers State Budget funding approval in that year, e.g. 2019/20 infers funding in May 2020 State Budget				

Table 14: Phase 2 – Proposed Detailed/Reference Design, Planning Approvals, Procurement Program

Proposed Phase 2 - Design, Approvals and Procurement Program													
Projects	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
Cheltenham Turnback													
West Footscray Turnback													
Werribee line signalling upgrade													
Platform lengthening for HCMT trains													
Traction power upgrading													
Park Street, South Melbourne. tram connection													
Melbourne Airport Rail Link													
Dandenong-Cranbourne duplication													
Cranbourne-Clyde re-opening													
S. Cross-Wyndham Vale electrification													
Deer Park-Melton electrification													
Station Pier, Port Melbourne. tram extension													
Caulfield/Northern Loops reconfiguration													
Gowrie-Upfield duplication													
Upfield-Roxburgh Park re-opening													
Essendon turnback													
Craigieburn line signalling upgrade													
Sandringham second platform													
Greensborough-Eltham duplication													
Spencer St to West Melbourne tram extension													
Frankston-Baxter electrification													
Mooroolbark-Lilydale duplication													
Burnley Junction upgrade													
Melton-Bacchus Marsh electrification													
West Melbourne-North Melb stations tram loop													
rribee-Black Forest Road link													
Fishermans Bend tram extensions													
Clifton Hill-Fitzroy-Parkville tram extension													
MM2 tunnel Newport-Croxton													
Stony Point line crossing loop													
Craigieburn-Wallan electrification													
West Preston-La Trobe Uni tram extension													
North Coburg-Merlynston tram extension													
Burnley-Camberwell 4th track													
Ferntree Gully-Upper Ferntree Gully duplication													
East Brighton-Moorabbin tram extension													
SEFL Stage 1 - Caulfield-Dandenong													
Carnegie-Carnegie Station tram extension													
Darling Rd-East Malvern Station tram extension													
Airport West-Melbourne Airport tram extension													
Parkville-West Melb-North Melb tram extension													
SEFL Stage 2 – Southern Cross-Caulfield													
SEFL Stage 3 – Dandenong-Pakenham													
W Maribyrnong-Avondale Heights tram extension													
Sunbury-Clarkefield electrification													
Lalor-Wollert extension													
Caulfield-Monash-Keysborough MCT													
Elsternwick-Monash-Rowville MCT													
Malvern-Darling Station tram extension													
Camberwell-East Kew tram extension													
Ringwood-Dandenong-Mentone MCT													

Proposed Phase 2 - Design, Approvals and Procurement Program (continued)													
Projects	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**
Ringwood-Dandenong-Mentone MCT													
Melbourne Airport-La Trobe-Box Hill-Monash MCT													
Melbourne Airport-Keilor-Deer Park-Derrimut MCT													
CBD-Vic Park-Bulleen-Doncaster Hill MCT													
Glen Waverley-Knox City extension													
Camberwell-Box													
Williams Landing-Point Cook-Tarneit MCT													
Williams Landing-Truganina-Sayers Rd MCT													
Sunshine-Footscray-Kingsville-Altona MCT													
Newport-Sunshine-Ginifer-Brimbank C MCT													

Table 15: Phase 3 -Proposed Construction, Testing and Commissioning Program

Proposed Phase 3 - Construction, Testing and Commissioning Program													
Projects	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
MM1 tunnel South Kensington-Town Hall-Hawksburn													
Cheltenham Turnback													
West Footscray Turnback													
Werribee line signalling upgrade													
Platform lengthening for HCMT trains													
Traction power upgrading													
Park Street, South Melbourne. tram connection													
Melbourne Airport Rail Link													
Dandenong-Cranbourne duplication													
Cranbourne-Clyde re-opening													
S. Cross-Wyndham Vale electrification													
Deer Park-Melton electrification													
Station Pier, Port Melbourne. tram extension													
Caulfield/Northern Loops reconfiguration													
Gowrie-Upfield duplication													
Upfield-Roxburgh Park re-opening													
Essendon turnback													
Craigieburn line signalling upgrade													
Sandringham second platform													
Greensborough-Eltham duplication													
Spencer St to West Melbourne tram extension													
Frankston-Baxter electrification													
Mooroolbark-Lilydale duplication													
Burnley Junction upgrade													
Melton-Bacchus Marsh electrification													
West Melbourne-North Melb stations tram loop													
Werribee-Black Forest Road link													
Fishermans Bend tram extensions													
Clifton Hill-Fitzroy-Parkville tram extension													
MM2 tunnel Newport-Fishermans Bend-Croxton													
Stony Point line crossing loop													
Craigieburn-Wallan electrification													
West Preston-La Trobe Uni tram extension													
North Coburg-Merlynston tram extension													
Burnley-Camberwell 4th track													
Ferntree Gully-Upper Ferntree Gully duplication													
East Brighton-Moorabbin tram extension													
SEFL Stage 1 - Caulfield-Dandenong													
Carnegie-Carnegie Station tram extension													
Darling Rd-East Malvern Station tram extension													
Airport West-Melbourne Airport tram extension													
Parkville-West Melb-North Melb tram extension													
Caulfield-Monash-Keysborough MCT													
W Maribyrnong-Avondale Heights tram extension													
Sunbury-Clarkefield electrification													
Malvern-Darling Station tram extension													

Proposed Phase 3 - Construction, Testing and Commissioning Program (continued)													
Projects	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**
Caulfield-Monash-Keysborough MCT													
Elsternwick-Monash-Rowville MCT													
Ringwood-Dandenong-Mentone MCT													
Melbourne Airport-La Trobe-Box Hill-Monash MCT													
Melbourne Airport-Keilor-Deer Park-Derrimut MCT													
MM2 tunnel Newport-Croxton													
SEFL Stage 2 – Southern Cross-Caulfield													
SEFL Stage 3 – Dandenong-Pakenham													
Lalor -Wollert extension													
W Maribyrnong-Avondale Heights tram extension													
Sunbury-Clarkefield electrification													
Malvern-Darling Station tram extension													
Camberwell-East Kew tram extension													
CBD-Vic Park-Bulleen-Doncaster Hill MCT													
Glen Waverley-Knox City extension													
Camberwell-Box													
Williams Landing-Point Cook-Tarneit MCT													
Williams Landing-Truganina-Sayers Road MCT													

Proposed Phase 3 - Construction, Testing and Commissioning Program (continued)													
Projects	**2045**	**2046**	**2047**	**2048**	**2049**	**2050**							
Williams Landing-Truganina-Sayers Road MCT													
Sunshine-Footscray-Kingsville-Altona MCT													
Newport-Sunshine-Ginifer-Brimbank Central MCT													

Further details of each project are in Appendices HR 3 to HR 26, T 17 to T 42 and M 4 to M 15 including project description, purpose, infrastructure requirements, operational and fleet implications and a high-level cost estimate.

13. Investment Profile

In this Plan, a detailed cash flow profile has not been developed for the proposed investments as this would require robust cost estimates based on full project scoping, risk assessment, good knowledge of constructability issues and assumptions regarding procurement strategies. These are matters that would normally be addressed in the Business Case for each project. Instead, based on high level capital cost estimates for each project, aggregate cash flows by mode have been prepared in 5-year blocks, commencing from the 2019/20 financial year, as shown in the following table.

Table 16: Estimated Cash Flows over 30 years for Proposed Projects

Melbourne Rail Plan Estimated Project Cash Flows 2019/20 to 2048/49								
Project Group	**2019/20 to 2023/24 $m**	**2024/25 to 2028/29 $m**	**2029/30 to 2033/34 $m**	**2034/35 to 2038/39 $m**	**2039/40 to 2043/44 $m**	**2044/45 to 2048/49 $m**	**30-year Program $m**	**Notes**
Heavy rail infrastructure	20,465	19,085	20,550	9,200	1,000		70,300	(1)(4)(5)
Heavy rail rolling stock	1,500	1,500	1,155	900	200		5,255	(3)(5)
Tram infrastructure	3,260	4,170	1,180	40			8,650	(1)(5)
Tram rolling stock	715	1,100	1,015	540			3,370	(3)(5)
MCT infrastructure		250	6,200	9,585	8,885	5,445	30,365	(1)
MCT rolling stock		150	600	515	515	450	2,230	(2)(3)
Totals	**25,940**	**26,255**	**30,700**	**20,780**	**10,600**	**5,895**	**120,170**	
Average Annual Outlay	**5,188**	**5,251**	**6,140**	**4,156**	**2,120**	**1,179**	**4,006**	

Notes to the above table:

(1) Includes associated systems for operational control, passenger information, power supply management, etc.
(2) Excludes cost of depots and rolling stock maintenance facilities – these items are included in MCT infrastructure
(3) Rolling stock capital costs assume compliance with Government policy of minimum 60% local content
(4) First 5 years to 2023/24 includes the estimated cost of MM1, less expenditure incurred prior to 2019/20
(5) Additional heavy rail and tram projects are likely to be added to the program from 2034/35 onwards. These will be identified in subsequent updated versions of this Plan.

Individual estimated capital costs of each project included in the aggregate figures above are shown in Appendices. HR 2-H 26 (Heavy Rail), T 16-T 43 (Tram) and M 3-15 (MCT)

Initial investments to 2024 should largely be within the funding capacity of the State Government, supported by Federal Government contributions, within normal budgetary and electoral cycles. This part of the program is dominated by the Melbourne Metro (MM1) project, associated works and western suburbs electrification extensions.

The following 10 years to 2034 is more ambitious with a program that will also entail Federal Government contributions, new and innovative funding sources, including significant private sector involvement and greater use of value capture. The 10 years to 2034 will be dominated by the delivery of several very large projects including reconfiguration of the City Loop, Melbourne Airport Rail Link (MARL), MM2 and the first stage of the *South-Eastern FastLine.* It will also include the first two of several cross-suburban Medium Capacity Transit (MCT) projects, significant re-investment in the tram network and tram fleet and numerous smaller but important projects.

With the majority of proposed heavy rail projects completed or nearing completion, the primary focus for the 10 years to 2044 will be development of the MCT second tier network, providing intermediate level capacity, mainly over key orbital and cross-suburban corridors, as a critical alternative to private car dependency and creating much of the base public transport network grid that will require further infill in subsequent years.

The potential for value capture as a source of project funding is the subject of on-going debate. Value capture refers to the potential uplift in economic values, such as property, to contribute a proportion of infrastructure investment costs. Experience from other jurisdictions indicates that there is potential for this in Victoria, and while its capacity to be a source of upfront funding should not be overstated, it should still be pursued and utilised more aggressively in future by Victorian Governments.

APPENDICES

Category	*Appendix*	*Title*
Heavy Rail	HR 1	Metro Train Service Specification
		Heavy Rail Capex Project Details
Heavy Rail	HR 2	Heavy Rail Capex Summary
	HR 3	Metro 1 Tunnel – Ancillary Works Package
	HR 4	Duplication Single Line Sections
	HR 5	RRL Electrification Southern Cross – Black Forest Road
	HR 6	Melton Electrification – Stage 1 Robinsons Rd Junction – Melton
	HR 7	Melton Electrification – Stage 2 Quadruplication – B Marsh
	HR 8	Extension electrification and Reopening - Cranbourne – Clyde
	HR 9	Extension electrification and Reopening – Upfield – Somerton
	HR 10	Link – Black Forest Rd – Werribee and Electrification
	HR 11	Extension electrification – Craigieburn to Wallan
	HR 12	Extension electrification – Sunbury to Clarkefield
	HR 13	Extension electrification – Frankston to Baxter
	HR 14	Metro 1 Rail Tunnel
	HR 15	City Loop Re-configuration and Burnley Junction Changes
	HR 16	Airtrain – Southern Cross – Sunshine – Melbourne Airport
	HR 17	Metro 2 - Newport – CBD – Parkville – Fitzroy - Croxton
	HR 18	South East FastLine – Stage 1 Caulfield - Dandenong
	HR 19	South East FastLine – Stage 2 Southern Cross - Caulfield
	HR 20	Extension electrification and line – Glen Waverley – Knox City
	HR 21	Metro Train Fleet Acquisitions
	HR 22	Metro Train Power supplies, Signalling
	HR 23	Train stabling and Maintenance
	HR 24	New stations on existing electrified lines
	HR 25	Quadruplication – Burnley Junction to Camberwell
	HR 26	Quadruplication - Camberwell to Box Hill
	HR 27	Lalor -Wollert extension
		Tram Capex Project Details
Category	***Appendix***	***Title***
Tram	T 1	Tram Service Specification
	T 2	Proposed Tram Route Alterations and Extensions
	T 3	Comparison and Evolution Existing to Route Network – 2034
	T 4	Comparison of Existing and Proposed Peak Route Frequencies
	T 5	Comparison of Existing and Proposed Peak Route Capacities
	T 6	Existing and Proposed CBD Route Capacity by CBD Street
	T 7	Existing and proposed CBD Points of Route Termination
	T 8	Summary of CBD Key Tram Interchanges - Connectivity
	T 9	Projected Tram Fleet Profile and Fleet Acquisitions
	T 10	Stage 1 2024 Proposed Peak Fleet Disposition by Route
	T 11	Stage 2 2029 Proposed Peak Fleet Disposition by Route
	T 12	Stage 3 2034 Proposed Peak Fleet Disposition by Route
	T 13	Stage 5 2044 Proposed Peak Fleet Disposition by Route
	T 14	Proposed Routes – Progressive Introduction of 40m Trams
	T 15	Tram Infrastructure Program - Staged Improvements

Tram Capex Project Details (continued)		
Category	***Appendix***	***Title***
Tram	T 16	Tram Capex Summary
	T 17	Additional Curve Pairs
	T 18	CBD – Additional Twin Trackage
	T 19	CBD – Additional Track Connections
	T 20	NEW Twin Track Network Turnbacks
	T 21	Port Melbourne – Extension to Station Pier and Turnback
	T 22	Conversion Single to Twin Track Termini
	T 23	Depots and Maintenance Facilities
	T 24	Accessible Platform Stops, Power Supplies, Tram Priority
	T 25	Tram Fleet Acquisitions
	T 26	Tram Supervisory, Monitoring and PIDS Systems
	T 27	Additional twin trackage Park Street – South Melbourne
	T 28	Extension Remand Centre to West Melbourne Station
	T 29	One Way Loop West Melbourne – North Melbourne Stations
	T 30	NEW Cross-Northern Connection – North Melb to Clifton Hill
	T 31	Extension Route – 3 to East Malvern Station
	T 32	Extension Route – 5 to Darling Station
	T 33	Extension Route - 11 to La Trobe University
	T 34	Extension Route – 19 to Merlynston Station
	T 35	Extension Route – 48 Victoria Harbour to Westgate Park
	T 36	Extension Route – 57 to Avondale Heights (Buckley Street)
	T 37	Extension Route – 59 to Melbourne Airport
	T 38	Extension Route – 67 (Stage 1) to Carnegie Station
	T 39	Extension Route – 67 (Stage 2) to Dandenong Road
	T 40	Extension Route – 68 to Moorabbin Station
	T 41	Extension Route – 72 to East Kew (Kilby Road)
	T 42	Extension Route – 109 Victoria Harbour to Sandridge/Wirraway
MCT Capex Project Details		
Category	***Appendix***	***Title***
MCT	M 1	MCT Service Specification
	M 2	MCT Characteristics
	M 3	MCT Capex Summary
	M 4	Doncaster BRT - Fitzroy and Doncaster End Components
	M 5	Derrimut – Deer Park Station - Melbourne Airport
	M 6	Melbourne Airport – La Trobe University – Monash NEIC
	M 7	Ringwood Station to Mentone Station
	M 8	Caulfield Station to Keysborough
	M 9	Elsternwick Station to Rowville
	M 10	Sunshine Station – Footscray Station – Altona Station
	M 11	Newport Station – Sunshine Station – Brimbank Central
	M 12	Williams Landing Station to Tarneit Station
	M 13	Williams Landing Station to Sayers Road Station
	M 14	MCT Fleet Acquisitions
	M 15	MCT Depots and Maintenance Facilities

REFERENCES

Australian Bureau of Statistics, 2017: *Australian Demographic Statistics, June 2017 – Estimated Resident Population, States and Territories*

Australian Bureau of Statistics, 2017: *Population Projections, Australia, 2012 (base) to 2101.*

Australian Bureau of Statistics: *Census Data 2006,2011 and 2016*

Australian Government, 2017: *The National Rail Program: Investing in rail networks for our cities and regions*

Australian Government: *Disability Discrimination Act 1992*

Australian Government: *Disability Standards for Accessible Public Transport 2002*

Bureau of Infrastructure, Transport and Regional Economics (BITRE) Research Report 131, 2012: *Understanding Australia's Urban Railways*

Bureau of Infrastructure, Transport and Regional Economics (BITRE) Report 142, 2013: *Population growth, jobs growth and commuting flows – a comparison of Australia's four largest cities*

Bureau of Infrastructure, Transport and Regional Economics (BITRE) Report 144, 2016: *Lengthy Commutes in Australia*

Carey Curtis, John L Renne, Luca Bertolini, Ashgate, 2009: *Transit Oriented Development, Making it Happen*

Carey Curtis, Nicholas Low, Ashgate, 2012: *Institutional Barriers to Sustainable Transport*

City of Melbourne, May 2019: *Draft Transport Strategy 2030*

City of Melbourne, 2018: *Transport Strategy Discussion Paper – Public transport Network*

Department of Economic Development, Jobs, Transport and Resources, Victoria: *Victorian Integrated Survey of Travel and Activity (VISTA) 2013*

Department of Environment, Land, Water and Planning, Victoria 2016: *Victoria in Future 2016, Population and Household Projections to 2051*

Department of Environment, Land, Water and Planning, Victoria 2019: *Victoria in Future 2019, Population Projections 2016-2056*

Department of Environment, Land, Water and Planning, Victoria, 2017: *Plan Melbourne 2017-2050*

Department of Transport, 2017: *Strategic approach to network development. Summary Guide – February 2017*

Development Victoria, August 2018: *Suburban Rail Loop Strategic Assessment*

Geoffrey B Churchman, IPL Books, 1995: *Railway Electrification in Australia and New Zealand*

Ian Manning, George Allen and Unwin, 1978: *The Journey to Work*

Infrastructure Australia website. *http://infrastructureaustralia.gov.au/policy-publications/publications/future-cities-melbourne-maps.aspx*

Infrastructure Australia, 2018: *Future Cities: Planning for our growing population*

Infrastructure Australia, February 2019: *Infrastructure Priority List*

Infrastructure Australia, October 2018: *Outer Urban Public Transport – Improving Accessibility in Lower Density Areas*

Infrastructure Victoria, April 2018: *Five-Year Focus - Immediate actions to tackle congestion*

Infrastructure Victoria, April 2019: *Growing Victoria's Potential – The opportunities and challenges of Victoria's population growth*

Infrastructure Victoria, December 2016: *Victoria's 30-Year Infrastructure Strategy*

Interface Councils, September 2017: *Liveable Communities – Interface Councils Liveability Snapshot Indices*

International Association of Public Transport (UITP), 2018: U*ITP Statistics Brief – New Urban Infrastructure 2018*

International Transport of Development Policy, 2016: *Bus Rapid Transit (BRT) Standard v8.75*

Jane-Frances Kelly and Paul Donegan, Melbourne University Press, 2015: *City Limits – Why Australia's cities are broken and how we can fix them*

Keolis Downer, 2016: *An Economic, Environmental and Social Analysis of Melbourne's Tram Network*

KPMG ARUP, 2017: *Travel Demand and Movements Patterns Report*

Leadwest and Western Transport Alliance, AECOM, October 2012: *Western Melbourne Transport Strategy 2012-2030*

Leadwest, 2012: *Western Agenda 2012-16 – A Strategic Action Plan for Melbourne's West*

Leadwest, June 2018: *The Future of the West: Investing in Melbourne's Newest Generation*

Matthew J Diemer, Graham Currie, Chris De Gruyter, Ian Hopkins, Journal of Transport Geography, 2018: *Filling the space between trams and place: Adapting the "Movement & Place" framework to Melbourne's tram network,*

Metropolitan Transport Forum, 2000: *Creating Choices – the transport web*

Metropolitan Transportation Committee, December 1969: *The Transportation Plan*

Michael Buxton, Joe Hurley, Kath Phelan, Centre for Urban Research, RMIT University, 2015: *Melbourne at 8 Million, Matching Land Supply to Dwelling Demand*

Michael Buxton, Robin Goodman and Susie Moloney, CSIRO Publishing, 2016: *Planning Melbourne – Lessons for a Sustainable City*

Nicholas Low, Routledge, 2013: *Transforming Urban Transport – The Ethics, Politics and Practices of Sustainable Mobility*

O'Connell, J and Roberts M, *Filling the Capacity Gap for Global Cities: Medium Capacity Rail* Systems in AusRAIL PLUS 2012, Rail's Role in Society, 27-28 November 2012, Canberra, ACT, Australia

Paul Mees, Melbourne University Press, 2000: *A Very Public Solution – Transport in the Dispersed City*

Peter Seamer, Nero, 2019: *Breaking Point – The Future of Australian Cities*

Philip Laird, Peter Newman, Mark Bachels, Jeffrey Kenworthy, UNSW Press, 2001: *Back on Track – Rethinking Transport Policy in Australia and New Zealand*

Price Waterhouse Coopers for *The Australian* newspaper 12 October 2017: *Life in the Commuter Belt*

Professor E W Russell, Report to the Victorian Minister of Transport, July 1991: *On the Right Track – Freeways or Better Public Transport for Melbourne's East*

Public Transport Victoria, 2013: *The Accessible Public Transport Action Plan 2013-17*

Public Transport Victoria, 2016: *Metropolitan Train Load Standard Survey Report*

Public Transport Victoria, December 2012: *Network Development Plan, Metropolitan Rail*

Public Transport Victoria: *Various Annual Reports*

Rail Futures Institute, August 2016: *InterCity: How Regional rail can re-balance population growth and create a "State of Cities" in Victoria*

Rail Futures Institute, December 2013: *The Case for Melbourne Metro*

Rail Futures Institute, July 2014: *Melbourne Metro and Melbourne Rail Link – an objective comparison*

Rail Futures Institute, July 2015: *Trams and Light Rail in Melbourne's Transport Future*

Rail Futures Institute, June 2015: *Future Proofing Melbourne: Advocating a Plan for Melbourne that integrates metropolitan land use and transport strategy and ensures a sustainable, resilient, less car dependent city*

Rail Futures Institute, June 2016: *Submission to department of Environment, Land, Water and Planning – Fishermans Bend Recast Vision*

Rail Futures Institute, June 2018: *AirTrain – the Airport Train Melbourne Needs!*

Rail Futures Institute, September 2018: *The Melbourne Rail Plan 2019-2050 – Moving People in a City of 8 million -Summary Edition*

Randall Wilson, Dale Budd, Transit Australia Publishing, 2014, *Destination Waterfront City – A Guide to Melbourne's Trams*

Terence Bendixson, Temple Smith, London, 1974: *Instead of Cars*

The Conversation, 15 January 2016, Peter Newman: *Defying the one-hour rule for city travel, traffic modelling drives policy madness*

Tourism and Transport Forum Australia, 2018: *Public Transport Barometer Report*

Transport for Victoria, 2016: *Victorian Integrated Survey of Travel and Activity (VISTA)*

Transport for Victoria, 2017: *Victorian Cycling Strategy 2018-28: Increasing Cycling for Transport*

Transport for Victoria, October 2018: *Western Rail Plan – Fast, high-capacity rail for our regional cities and growing suburbs*

URS, June 2013: *Doncaster Rail Study: Phase One Recommendations Report*

Victorian Auditor-General, August 2014: *Coordinating Public Transport*

Victorian Government, 2008: *The Victorian Transport Plan*

Victorian Government, August 2012: *Victoria's 2012 Priority Infrastructure Submission to Infrastructure Australia*

Victorian Government, December 2016: *Absolutely Everyone, Victorian State Disability Plan 2017-2020*

Victorian Government, July 2009: *Towards an integrated and sustainable transport future: A new legislative framework for transport in Victoria – Policy Statement*

Victorian Government, May 2006: *Meeting our Transport Challenges – Connecting Victorian Communities – The Plan*

Victorian Government, October 2017: *Victorian Infrastructure Plan*

Victorian Government, October 2018: *Fishermans Bend Framework*

Victorian Government: *Transport Integration Act 2010*

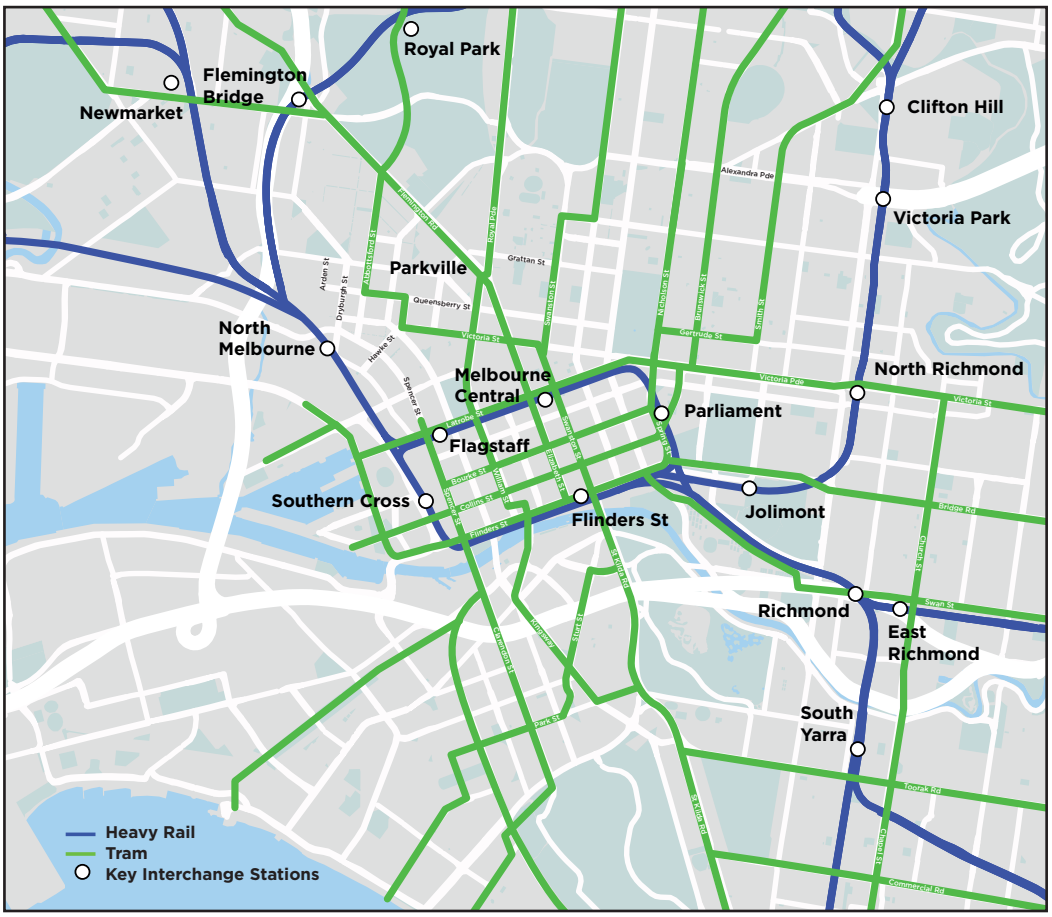
Victorian Public Transport Ombudsman, April 2018: *Public Transport Ombudsman Accessibility Report*

GLOSSARY

ABS – Australian Bureau of Statistics
ARTC – Australian Rail Track Corporation – Australian Government operator of interstate rail corridors
Active Transport – personal movement requiring physical effort - usually referring to walking and cycling
Articulated trams – trams comprising two or more flexibly connected sections linked by a common bogie
Bayside Cross-City line – proposed line connecting Sandringham with Williamstown and Altona/Laverton
BRT – Bus Rapid Transit – buses operating on a corridor segregated from other vehicular traffic
Burnley City Loop – part of MURL which currently serves the Ringwood, Alamein and Glen Waverley lines
Caulfield City Loop – part of MURL which currently serves the Dandenong and Frankston lines
CBD – Central Business District of Melbourne
City Circle – circular tram route (Route 35) which runs in opposing directions around the CBD and Docklands
City Loop – alternative name for MURL
Clifton Hill City Loop – part of MURL which currently serves the Mernda and Hurstbridge lines
DDA – Commonwealth Disability Discrimination Act 1992 –mandates access requirements to buildings and PT
DoT – Department of Transport, Victoria
DSAPT – Disability Standards for Public Transport 2002 – sets standards for access to buildings and PT
Electrification – provision of electric traction infrastructure for use by trains, trams and MCT
Grid Network – a network of intersecting PT routes accessible (ideally) within 500m of any location
HCMTs – High Capacity Metropolitan Trains –
Headway – time interval between successive services on a rail or tram line
Heavy Rail – rail infrastructure and services using conventional/traditional rail passenger and freight trains
IA – Infrastructure Australia –an independent Australian Government statutory advisory body
IV – Infrastructure Victoria – an independent Victorian Government statutory advisory body
Km - Kilometres
Light Rail – rail infrastructure and services using smaller/lighter vehicles than conventional passenger trains
LRVs – Light Rail Vehicles designed to operate on Light Rail infrastructure
M80 – Western Ring Road and Metropolitan Ring Road
MACs – Major Activity Centres
MARL – Melbourne Airport Rail Link – proposed from Southern Cross to Melbourne Airport via Sunshine
MCT- Medium Capacity Transit – technologies providing intermediate capacity between Heavy Rail and trams
Melbourne Metro 1 – see MM1
Melbourne Metro 2 – see MM2
Metro – generic term covering designated rail infrastructure and services within metropolitan Melbourne
MM1 - rail tunnel through South Kensington, CBD, Domain linking Sunbury and Dandenong lines
MM2 - rail tunnel through Fishermans Bend, CBD, Parkville, Fitzroy linking Werribee and Mernda lines
MRP – Melbourne Rail Plan 2019-2050 – this document
MTM – Metro Trains Melbourne – franchised operator of Melbourne's electrified metropolitan rail network
MURL – Melbourne Underground Rail Loop (also known as City Loop)
MYKI – Melbourne and Regional Victoria's integrated ticketing and fares system
NEICs – National Employment and Innovation Clusters
NEL – North-East Link – proposed major road connection between the M80 and Eastern Freeway
Non-radial routes – PT routes which do not directly connect to the Melbourne CBD
Northern City Loop - part of MURL which currently serves the Upfield, Craigieburn and Sunbury lines
OMR – Outer Metropolitan Ring – a major road and rail reservation linking Little River with Beveridge
Overhead traction system – infrastructure supplying electrical energy to trains via overhead wires
Parkiteer cages – lockable cages at rail stations for the secure storage of bicycles
PIDS – Passenger Information Display System
Plan - Melbourne Rail Plan 2020-2050 – this document
Plan Melbourne 2017-2050 – Victoria's principal planning document for metropolitan Melbourne
PPNs – Principal Pedestrian Networks
PSPs – Precinct Structure Plans prepared by the Victorian Planning Authority
PT – Public Transport
PTV – Public Transport Victoria – statutory authority responsible for rail/tram franchises and bus contracts
Radial routes – PT routes which direct connect to the Melbourne CBD
Regional network – non-metropolitan rail passenger and freight network leased to V/Line or ARTC

Regional services – rail passenger and freight services that extend beyond metropolitan Melbourne
RFI – Rail Futures Institute
RPV – Rail Projects Victoria – an administrative body responsible for delivering major rail projects
ROW – a segregated "right of way" such as dedicated road lanes for trams or buses
SDP – Victorian State Disability Plan 2017-2020
SEFL - *South-East FastLine* – proposed new line Southern Cross to Dandenong via Chadstone and Monash
SmartBus – high frequency buses on designated metropolitan bus routes
SNAMUTS – Spatial Network Analysis for Multimodal Urban Transport Systems – an RMIT analytical tool
SPPF – Victoria's State Planning Policy Framework
SRL – Suburban Rail Loop – proposed orbital railway from Cheltenham to Sunshine via Box Hill and Bundoora
Sub-station – part of Overhead traction system which converts input power supply to overhead wiring voltage
TIA - Transport Integration Act 2010
TOD – Transit oriented development
TPH (or tph) – trains per hour
Trackless trams – developing technology enabling large buses to be autonomously guided using road markings
Tram/Train – tram-like vehicle (or LRV) adapted to safely operate on conventional Heavy Rail lines
Traverser – a moving platform for transferring rail vehicles laterally between parallel tracks
Turn Up and Go Service – generally regarded as services operating at no greater than 10 minutes headway
Turnouts – track system for diverting rail vehicles from one track to another track or tracks
UGB – Melbourne's legislated Urban Growth Boundary
UITP – International Association of Public Transport
V/Line –manager of Victorian regional rail infrastructure and regional passenger train and coach operator
VCAT – Victorian Civil and Administrative Tribunal
VicRoads -Victorian authority for vehicle registration, road safety and planning/managing arterial
VicTrack –owner of Victoria's transport land, infrastructure and assets
VPA – Victorian Planning Authority
Wayfinding – system of signage and other methods of providing spatial guidance to PT users
Yarra Trams – franchised operator of Melbourne's tram network

Figure 59: CBD Existing Network



THE MELBOURNE RAIL PLAN NETWORK 2050

Figure 61: Melbourne Rail Plan Network 2050, CBD Inset

CENTRAL CITY INSET

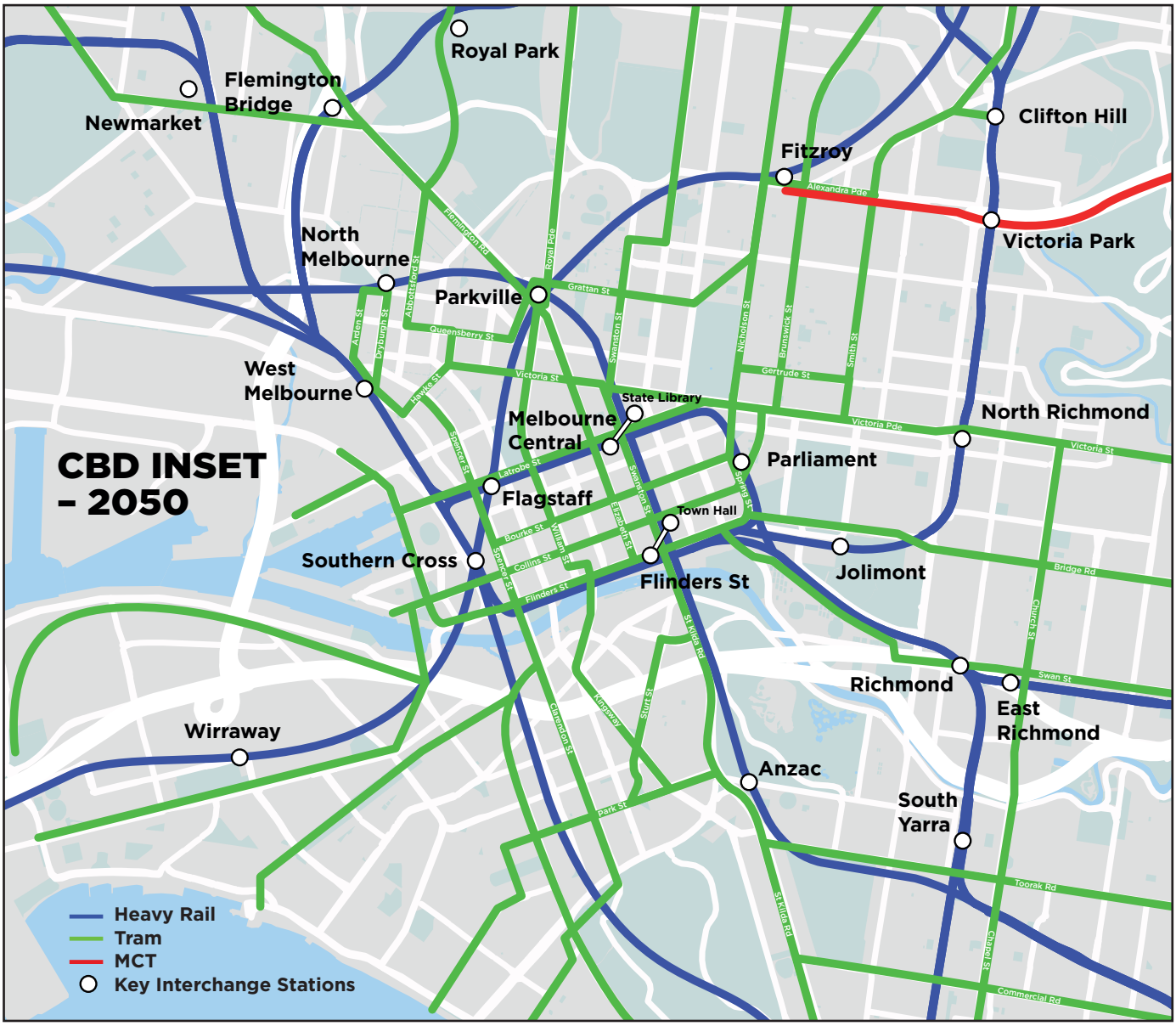


Figure 60: MELBOURNE RAIL PLAN NETWORK - 2050

N

↑ TO CLARKEFIELD

↑ TO WALLAN

← TO BACCHUS MARSH

← TO GEELONG

SUNBURY
CRAIGIEBURN
WOLLERT
MERNDA
HURSTBRIDGE
Greenvale
ROXBURGH PARK
MELBOURNE AIRPORT
UPFIELD
LALOR
SOUTH MORANG
Bundoora
BROADMEADOWS
Campbellfield
KEON PARK
MACLEOD
Greensborough
ELTHAM
MELTON
WATERGARDENS
Delahey
Keilor
Airport West
Merlynston
Reservoir
Latrobe Uni
West Coburg
East Coburg
Keilor Plains
Avondale Heights
Moreland
Heidelberg
LILYDALE
Brimbank Central
Ginifer
East Brunswick
Donvale
Caroline Springs
Moonee Ponds
Croxton
FLEMINGTON RC
CLIFTON HILL
DONCASTER
DEER PARK
SUNSHINE
FITZROY
East Kew
North Balwyn
Derrimut
FOOTSCRAY
Kew Jct
RINGWOOD
Brooklyn
BOX HILL
Mitcham
Davis Road
Fishermans Bend
BURNLEY
CAMBERWELL
Nunawading
TARNEIT
Burwood
Sayers Road
Wattle Park
Port Melb
NEWPORT
Toorak
East Burwood
Sth Melb Beach
Gardiner
Glen Iris
Vermont South
LAVERTON
St Kilda
Hoppers Crossing
Williams Landing
ALTONA
WILLIAMSTOWN
Darling
ALAMEIN
Mount Waverley
Wantirna South
KNOX CITY
WYNDHAM VALE
Balaclava
East Malvern
Elsternwick
CAULFIELD
CHADSTONE SC
GLEN WAVERLEY
WERRIBEE
Carnegie
Black Forest Road
Gardenvale
Point Cook
Ormond
Oakleigh
Notting Hill
BELGRAVE
East Werribee
MONASH
East Brighton
Huntingdale
Rowville
Clayton
MOORABBIN
SANDRINGHAM
Springvale
Southland
CHELTENHAM
Mentone
Keysborough
DANDENONG
Mordialloc

↘ TO BAXTER

TO CLYDE ↘

TO FRANKSTON ↓

TO PAKENHAM →

LEGEND

- **Heavy Rail**
- **Tram**
- **MCT**
- **SMART BUS**
- **V/Line (Non Electrified)**
- **See separate CBD Map**

WANT MORE DETAIL?

Visit www.railfutures.org.au

PO Box 1257
CARLTON VIC 3053
railfutures.org.au

A0059839B
RAIL FUTURES INSTITUTE INC.

This plan has been prepared by Rail Futures Institute Incorporated in the public interest. Rail Futures Inc. is an independent non-partisan group formed to advocate cost effective rail and intermodal solutions for public transport and freight based on sound commercial, economic and social reasoning. Rail Futures members include experienced rail professionals, engineers and economists.