EAST WEST RAIL LINK

ANALYSIS ON RAIL CAPACITY

March 2008

PREAMBLE

This paper has been prepared with technical assistance from the Public Transport Division of the Department of Infrastructure to enable the East West Needs Assessment to assess the potential for constructing a major new east-west rail link across Melbourne.

It is a preliminary assessment. More detailed project development would be required to confirm benefits and identify construction issues and costs.

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1. Executive Summary

The demand for travel on Melbourne's trains has been growing strongly for many years and has grown by more than 30% over the past three years. It is very likely that patronage will more than double again within the next 20 years. Continuation of the recent growth pattern would see a doubling in patronage within the next 10 years.

Increasing use of trains is important to Melbourne in responding to increasing concerns about road congestion, climate change and rising petrol prices; supporting urban development in Melbourne's designated growth corridors; and enabling central Melbourne to continue to grow strongly.

Many trains are already overcrowded and service reliability has suffered.

A series of operational changes, new infrastructure works and pricing incentives are underway to expand peak capacity to meet demand until the arrival of new high-capacity rolling stock commencing in 2013. New rolling stock will be designed to progressively add up to 25% to the capacity of the most crowded lines.

However, the demand on the western and northern lines (the Northern Group) will reach the capacity limit by 2015 and the demand on the south-eastern lines (the Caulfield Group) will reach their capacity limit within 5 years thereafter, but more immediately if development of the Port of Hastings and/or a major 'inland freight hub' at Dandenong creates a need for significant freight train movements on the Dandenong line at an earlier stage.

At this point, the limited capacity of the central part of the rail network will prevent any further train services being introduced without major investments. A decision to build a new underground rail link between the Northern and Caulfield Groups (the East West Rail Link), coupled with a new rail link through the growing western suburbs (the Tarneit Link) would address rail capacity problems for a generation, similar to the doubling of capacity facilitated by the construction of the Underground Loop a generation ago.

Such investments would also open up opportunities to extend the suburban rail network into growth areas, develop rail freight services to Dandenong/Hastings, encourage urban redevelopment around new stations and relieve the overcrowding on tram services operating between Melbourne University and St Kilda Road.

Projects of this scale would take a decade to plan, design and construct and planning would need to commence immediately to meet anticipated capacity problems. They would need very substantial capital expenditure, which would of course need to be weighted against other potential needs on the Government budget.

Together with the Tarneit connection, the East West Rail Link would more than double the capacity of both the Northern and Caulfield groups of lines, the lines serving four of the five Growth Areas of Melbourne. Furthermore, it would provide capacity for an additional 40,000 commuters to enter and leave central Melbourne each hour, equivalent to the construction of 20 new freeway lanes to each of the west and south-east. On existing roads these trips would add some $600 million each year to traffic congestion costs and $200 million each year to car parking costs.

2. Context

2.1. Introduction

Travel on Melbourne's trains is growing strongly and is expected to continue to grow strongly in the short and long term future.

The purpose of this paper is to examine the capability of the railway to continue to grow and to identify necessary changes to ensure future needs can be met. It focuses on the need for a new underground rail link between the rail lines serving the rapidly growing western and northern suburbs and the lines serving Melbourne's south-east, bypassing the existing underground loop that is rapidly approaching its capacity limits.

The paper comprises a review of the current rail system (Sections 2 to 5); projections of expected future needs (Section 6); and necessary steps to be taken to meet those needs (Sections 7 to 12).

2.2. Melbourne's rail system

Melbourne's rail system performs four roles:

- It provides more than 1860 suburban passenger rail services each day that carried 179 million passengers in 2006/07.
- It provides access to and from central Melbourne for 119 V/Line passenger rail services each day that carried around 8.9 million passengers in 2006/2007, many commuting to and from towns and regional centres in the Geelong, Ballarat, Bendigo and Traralgon corridors.
- It provides access to and from central Melbourne for interstate passenger trains to Sydney and Adelaide.
- It provides for freight trains into and out of Melbourne, most to and from the Port of Melbourne and associated freight handling facilities.

This paper considers the need to progressively expand the capacity of the railway to allow for continuing growth in suburban and V/Line passenger services.

Interstate passenger and freight trains operate on the national standard gauge network, usually separate from the metropolitan broad gauge network. Standard gauge services are not considered further in this review, although it is recognised that broad and standard gauge tracks often parallel each other and requirements of both must be appreciated when planning infrastructure in some corridors.

Many intrastate freight services operate on broad gauge and are important to the planning of the suburban rail network.

The key advantage of railways is their operation in their own right of way with safeworking systems to control the movement of trains. This allows higher capacity and higher speeds than can be achieved by other transport modes. A two-track passenger railway can carry up to 25,000 passengers an hour in each direction, the equivalent of more than 20 lanes of freeways. Suburban trains operate at speeds up to 115 kph, while V/Line trains operate at speeds of up to 160 kph. Interstate standard gauge freight trains of up to 1.5 kilometres of length, carrying 2,500 tonnes of freight, equivalent to 125 semi-trailer trucks, currently run in and out of Melbourne.

Development of the railway is important in addressing a number of concerns about Melbourne's future:

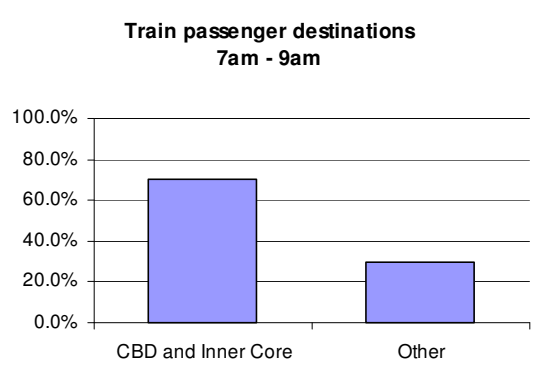
- It provides an alternative to growing traffic congestion.
- It caters for increases in demand on the transport network because of population growth in the growth areas.
- It facilitates employment growth, particularly in central Melbourne.
- It helps address concerns about climate change by:
    - offering an environmentally efficient alternative to cars with the further potential to move to zero emissions by sourcing electricity from "green energy" sources; and
    - providing an alternative means of travel as and when climate change factors increase costs of motoring.
- It helps address concerns about "peak oil" by providing an alternative means of travel as petrol prices rise.
- It provides the "transport spine" for future urban development in existing rail corridors.
- It provides the basis for future extensions to the rail network.
- It enables central Melbourne to continue to grow. Public transport already provides for more than 60% of travel into central Melbourne and there are only limited opportunities to expand the road network and parking spaces.

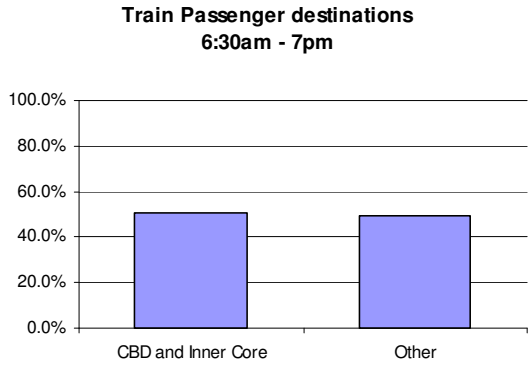
2.3. Train passengers

Melbourne has an extensive rail network: 60% of Melbourne's population lives within two kilometres of an existing railway station. The greatest concentrations of employment, tertiary institutions and retailing are in central Melbourne and other centres served by the railway.

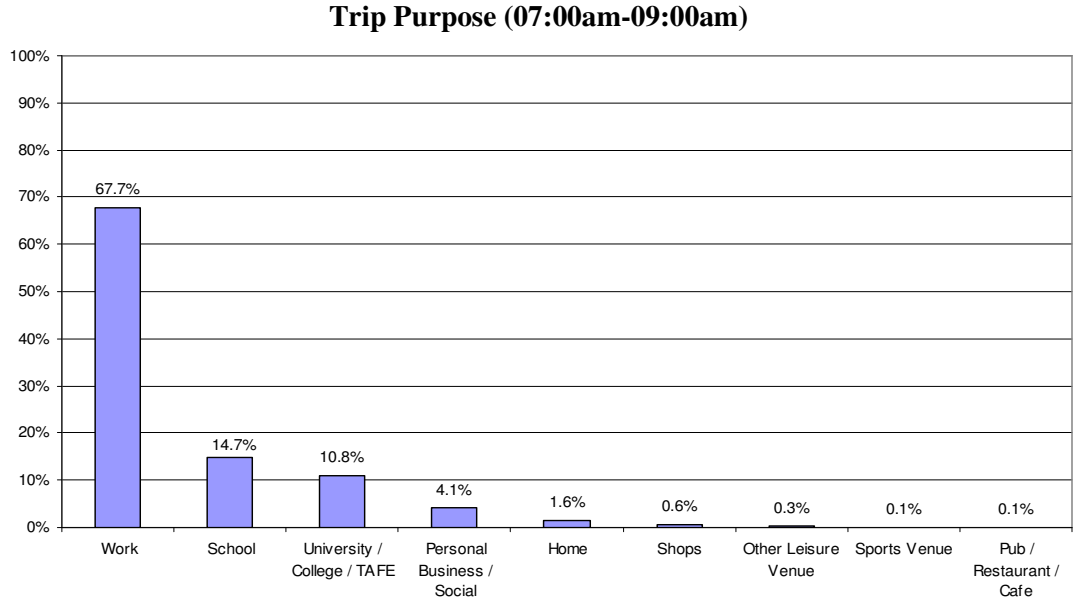
Suburban trains carried 179 million passengers in 2006/07. It is projected that these trains will carry around 200 million passengers in 2007/08. Around 600,000 passengers are carried on a typical weekday.

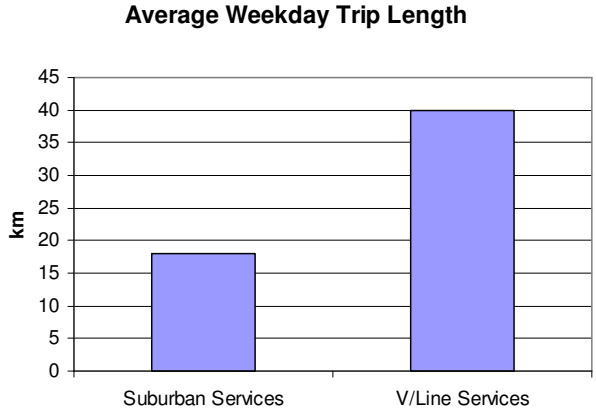
Train travel is dominated by access into and out of central Melbourne, particularly in peak hours. In the AM peak, about two-thirds of travel from suburban stations has a final destination at a City Loop or Inner Core station. Over the entire day, around half of all trips are orientated toward the City Loop or Inner Core stations.





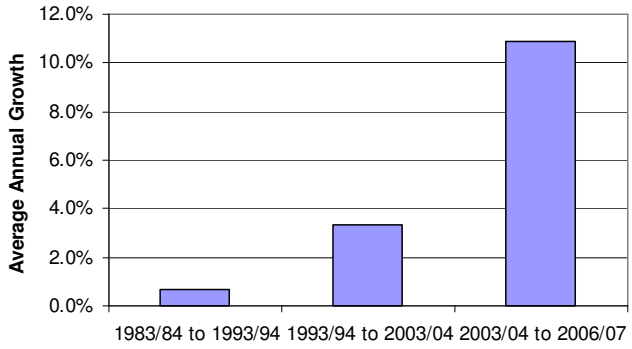
Peak hour travel is predominantly for work and education purposes. Trips are often very long. While suburban trips are, on average, 18 kms long, some trips are up to 60 kms long. Some V/Line daily commutes are more than 100 kms long.





Patronage on suburban trains has been growing for the past 25 years. Growth was initiated in the early 1980's by major investments in rail infrastructure (notably the Underground Loop) and new trains and the introduction of multi-modal tickets. Growth was initially slow but has accelerated to rates averaging 10.2% pa over the past three years. This amounts to an increase of more than 30% over the past three years.

Annual Patronage Growth



Peak period passenger counts at the city cordon stations show that loads have risen by 25% over the past three years at an annual growth rate of 7.6% pa. Patronage growth is stronger in off peak periods than in peaks.

The dramatic acceleration in patronage over the past three years is due to a range of factors including:

- stronger than expected population growth across Melbourne
- stronger than expected employment growth in central Melbourne
- increase in educational opportunities in central Melbourne
- rising petrol prices
- increasing awareness of environmental concerns
- the introduction of a levy on central city car parking
- increasing road congestion
- MOTC initiatives to upgrade train and feeder bus services

The suburban railway carried such loads during and immediately after the Second World War. However, at that time, travel was not concentrated into peak periods in the way that it now is and trips are now much longer, necessitating the operation of longer distance express trains interspersed with short services.

For the V/Line commuter and long distance businesses, growth has been dampened over recent years with the heavy engineering works of the Regional Fast Rail Project disrupting services to the country. With the project completed, passengers have returned to the network with patronage levels on some lines being 20% above that of pre-disruption levels.

2.4. Government policy framework

Various government policy objectives are reliant upon a rail network that can play an increasing role in meeting Melbourne's transport needs.

Melbourne 2030, the strategy for the future growth of Melbourne, provides for a further population growth of one million over the next 25 years. Outward growth is to be channeled into five growth corridors enforced by an Urban Growth Boundary. Four of the growth corridors are along existing rail lines and a rail extension is planned for the fifth corridor. At the same time infill development is directed at Activity Centres in established suburbs : all but a handful of Centres are based on existing rail stations. Melbourne 2030 therefore relies on a rail system that can carry increasing numbers of passengers.

Government has recently set a target to reduce Victoria's greenhouse gas emissions by 60% from 2000 levels by the year 2050. An increasing use of electric trains will be an important component of achieving this target in that it already produces significantly lower emissions per passenger carried than alternative modes and has greater scope to move toward zero emissions than modes based on liquid fuels.

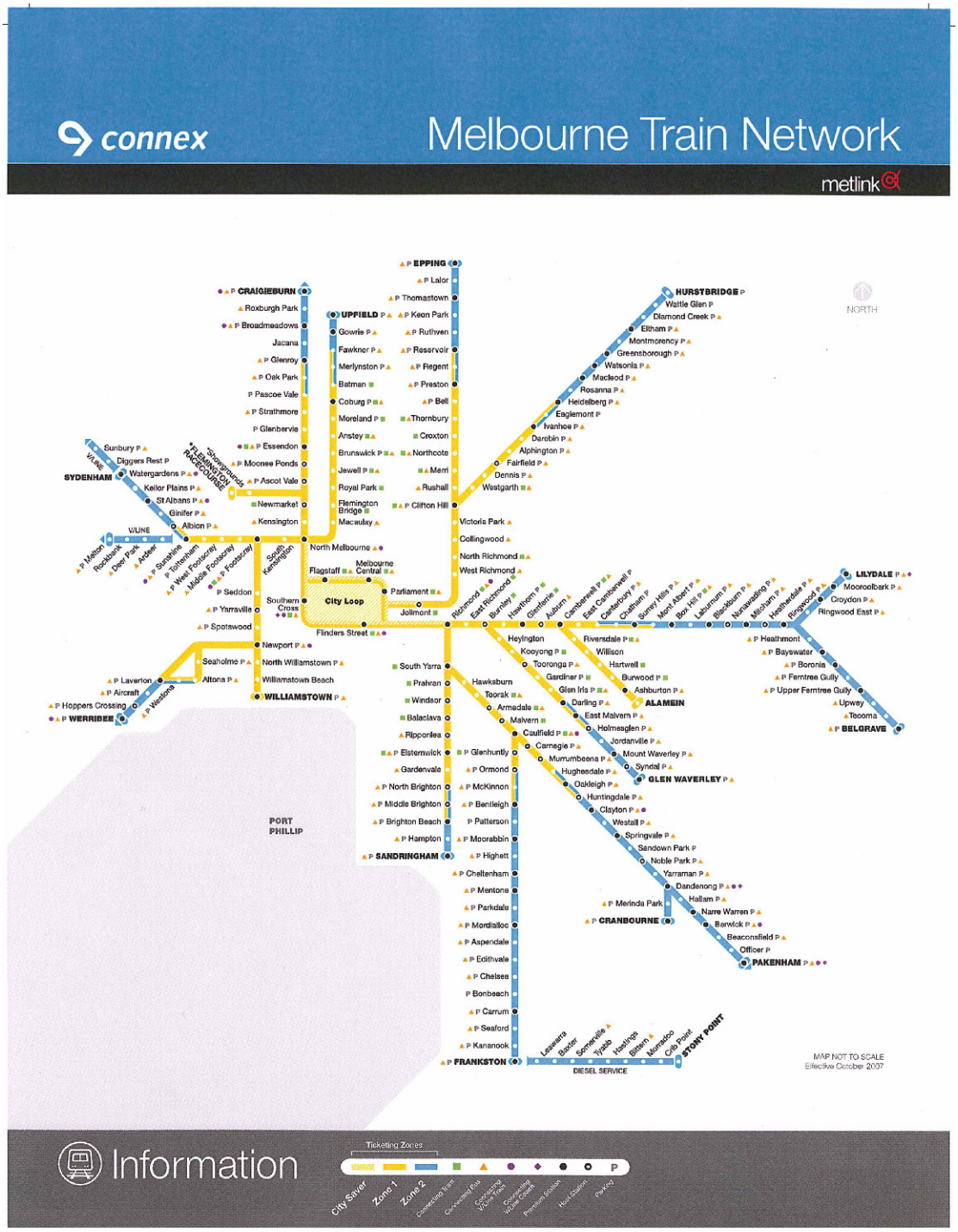
In light of these and other considerations, Government has set a target to double the proportion of travel in Melbourne being mode by public transport. Recent patronage growth rates have been consistent with movement to a 20% mode share target by 2020.

In May 2006, Government released its transport strategy for Melbourne : *Meeting Our Transport Challenges* (MOTC). It provides funding over the next 10 years for rail to:

- expand capacity through a range of infrastructure projects
- introduce new rollingstock
- modernize train control and communication systems
- build new stations, upgrade existing stations and expand Park and Ride facilities
- upgrade feeder bus services

3. The Broad Gauge Rail Network

Melbourne's broad gauge rail network covers over 350 kilometres, a large network by international standards. It services 209 stations on 16 lines which converge on central Melbourne.

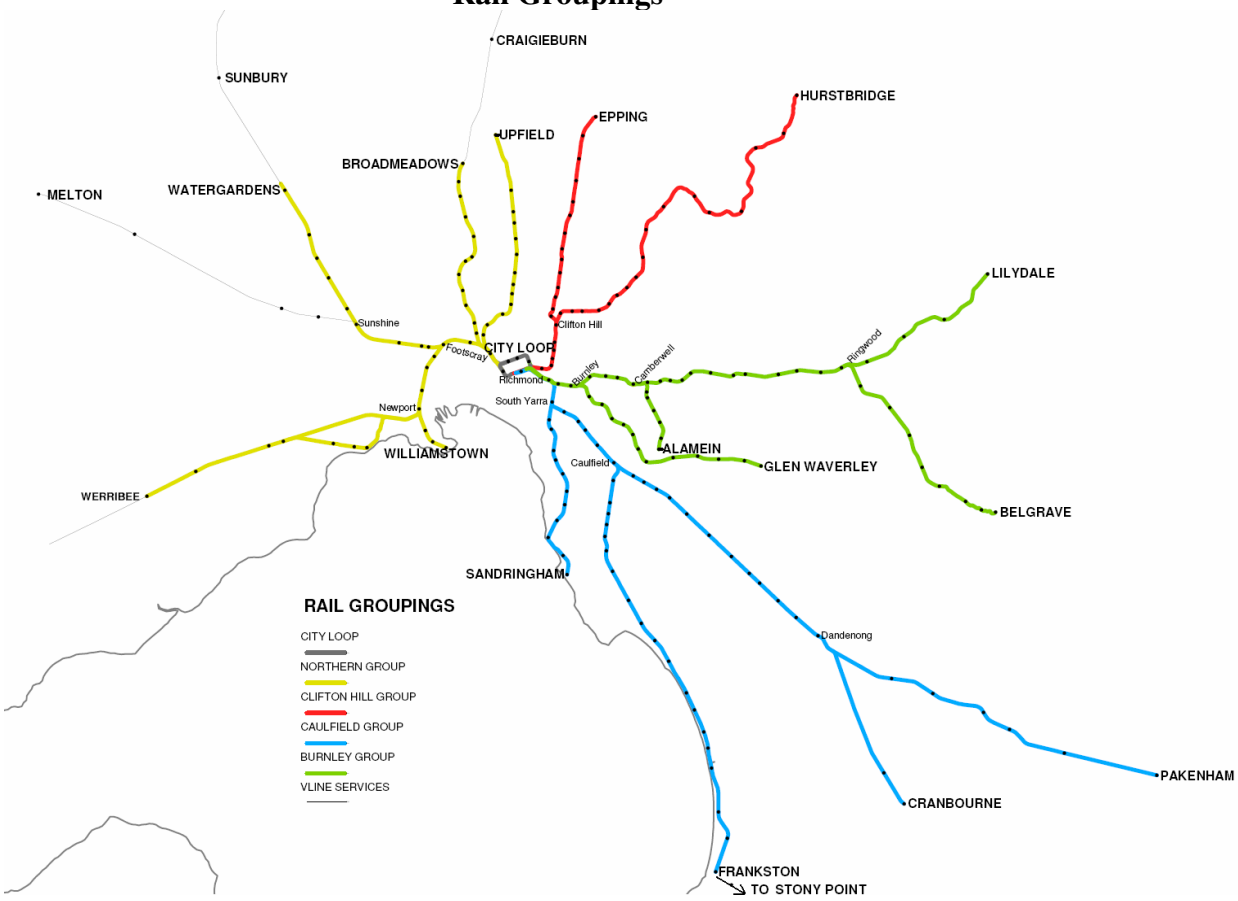


Some of the lines merge before reaching the city and form train "groups". The network is currently operated as four line groups:

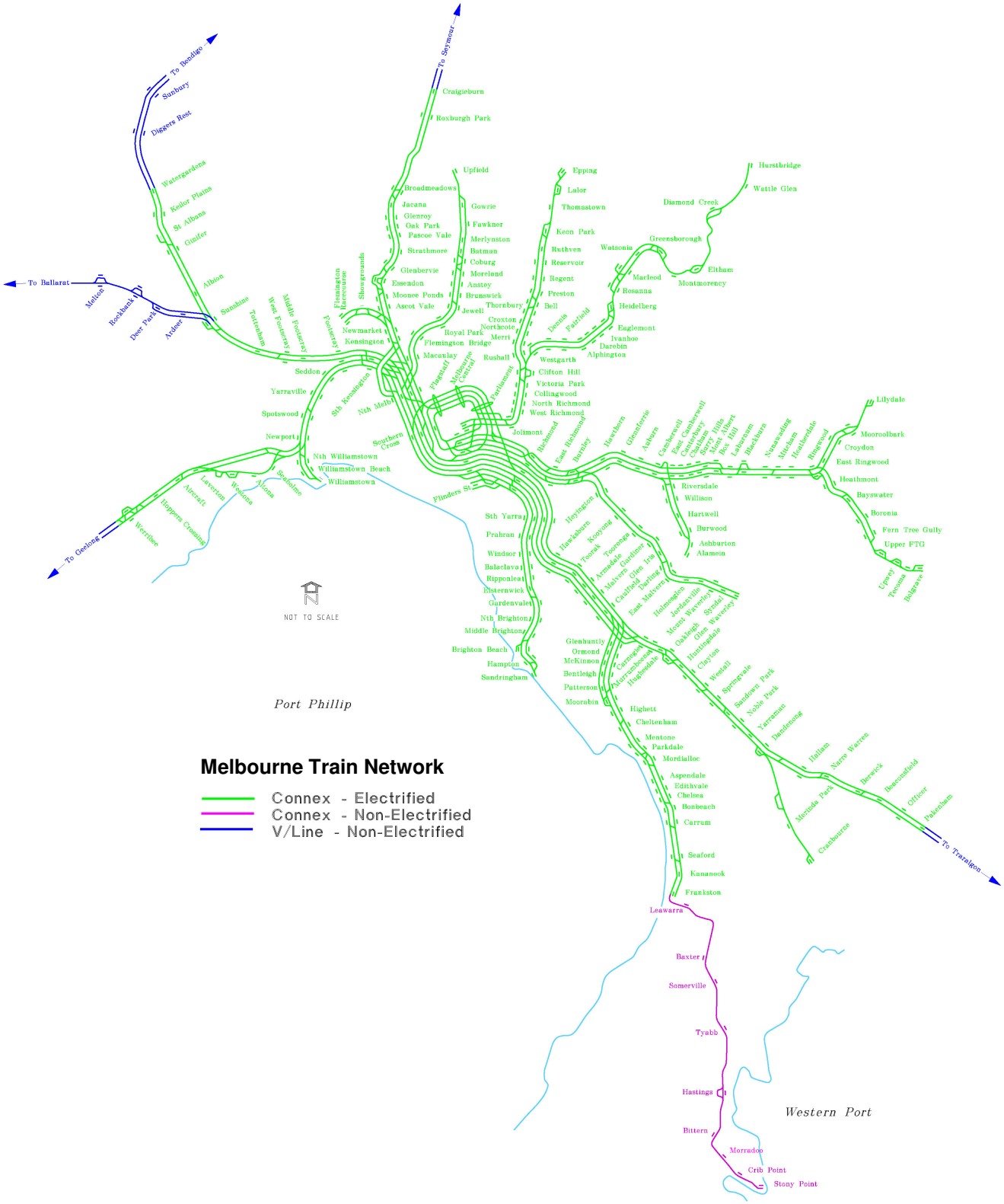
- The ***Northern Rail Group*** comprising of the Williamstown, Werribee, Sydenham, Craigieburn and Upfield lines.
- The ***Clifton Hill Group*** comprising of the Epping and Hurstbridge lines
- The ***Burnley Group*** comprising of the Glen Waverley, Alamein, Lilydale and Belgrave lines.
- The ***Caulfield Group*** comprising of the Pakenham, Cranbourne, Frankston and Sandringham lines.

The four groups converge on the ***Inner Core Network*** comprising of the Melbourne City Loop, including Flinders Street Station (FSS), Southern Cross Station and the links to North Melbourne, Jolimont and Richmond Stations.

Rail Groupings



The majority of the system consists of double track although there is approximately 65km of single track and 30km of triple or greater track.



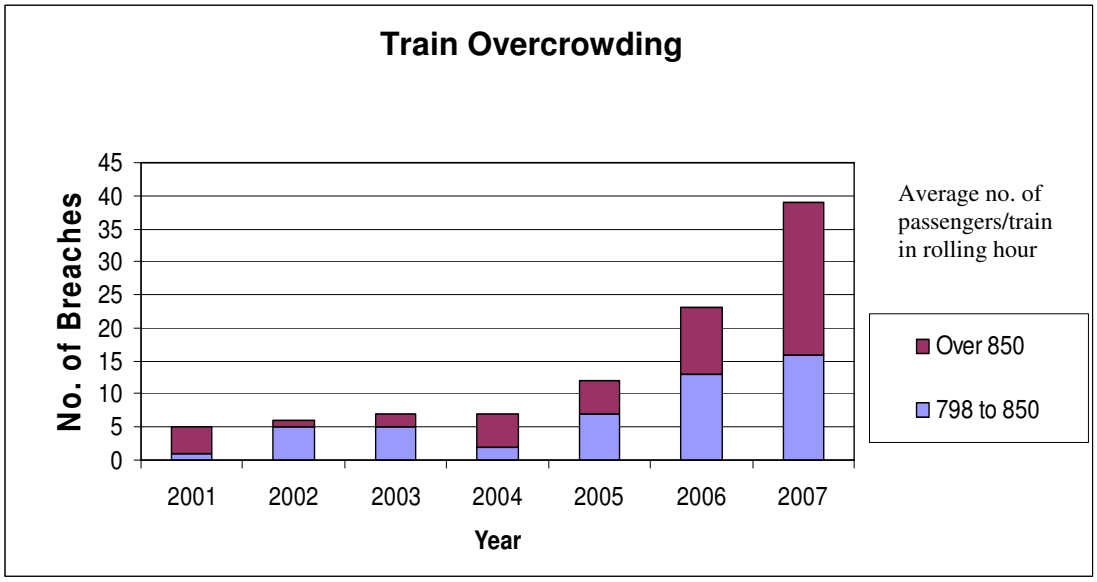
4. Train Services

Various services operate on the network in the morning peak period. In summary:

- 106 suburban and V/Line trains arrive in central Melbourne in the busiest morning peak hour
- all V/Line services terminate at Southern Cross Station; most suburban services (80%) operate via the Underground Loop with the remainder operating direct to and from Flinders Street Station
- the Northern group is the busiest and has the greatest mix of suburban and V/Line train operations
- express services are provided on all V/Line runs and for suburban runs typically longer than 25 kms,
- average train speeds of 36 km/h for suburban services
- load standards are being breached on most lines ie. trains are overcrowded

Suburban trains are deemed to be overcrowded if the average load over a one hour period as counted at the city cordon exceeds 798 passengers. This load standard has been set to avoid excessive loading (greater than 1100) on individual trains at the peak loading point on the route. Beyond this load, passengers regularly complain about overcrowding and it becomes very difficult to maintain the reliability of the service as loading and unloading times become excessive.

The graph below shows the number of periods when load standards were breached for each of the years 2001 to 2007. It can be seen that the incidences of overcrowding are rising rapidly. In most cases the breaches are in excess of not only 798 passengers per train but also 850.



Average train loads in excess of 1,000 passengers on services in the Northern and Caulfield Groups often lead to situations where passengers cannot physically board a service. This is a regular occurrence at city loop stations.

Peak hour train services

Line	Services in AM peak hr (May 2007)	Express Running	Average Speed (km/h)	City Loop Access	Exceeds Load Standard
Northern Group					
Connex Services					
Werribee	4	Yes	44	Yes	Yes
Williamstown	3	No	33	No	Yes
Sydenham	6	No	41	Yes	Yes
Craigieburn	7	No	38	Yes	Yes
Upfield	3	No	34	Yes	No
V/Line Services					
Sunbury	3	Yes	69	No	No
Geelong	4	Yes	76	No	Yes
Seymour	2	Yes	66	No	No
Ballarat / Melton	4	Yes	97	No	Yes
Bendigo	2	Yes	83	No	Yes
Total Services	38				
Clifton Hill Group					
Epping	5	Yes	27	Yes	Yes
Greensborough	2	Yes	29	Yes	Yes
Hurstbridge	5	Yes	36	Yes	Yes
Total Services	12				
Burnley Group					
Lilydale	7	Yes	40	Yes	Yes
Ringwood	5	Yes	32	No	No
Belgrave	7	Yes	38	Yes	Yes
Glen Waverley	6	Yes	28	Yes	Yes
Alamein	3	No	30	No	No
Total Services	28				
Caulfield Group					
Connex Services					
Pakenham	6	Yes	46	Yes	Yes
Dandenong	3	Yes	33	Yes	Yes
Cranbourne	3	Yes	41	Yes	Yes
Frankston	8	Yes	44	Yes	Yes
Sandringham	6	No	37	No	Yes
V/Line Services					
Traralgon	2	Yes	71	No	No
Total Services	28				
Grand Total Services	**106**				

As the train service runs closer and closer to its capacity limits there is less room to recover from service delays and the overall reliability of the railway deteriorates. This has been evident over the past three years as more services have been added to the existing network and many trains are heavily overcrowded.

There are options for a new type of train to be introduced when the existing Comeng trains are retired commencing in 2013. The load standard will be reset when the new design has been resolved. Options are discussed in Section 8.2.

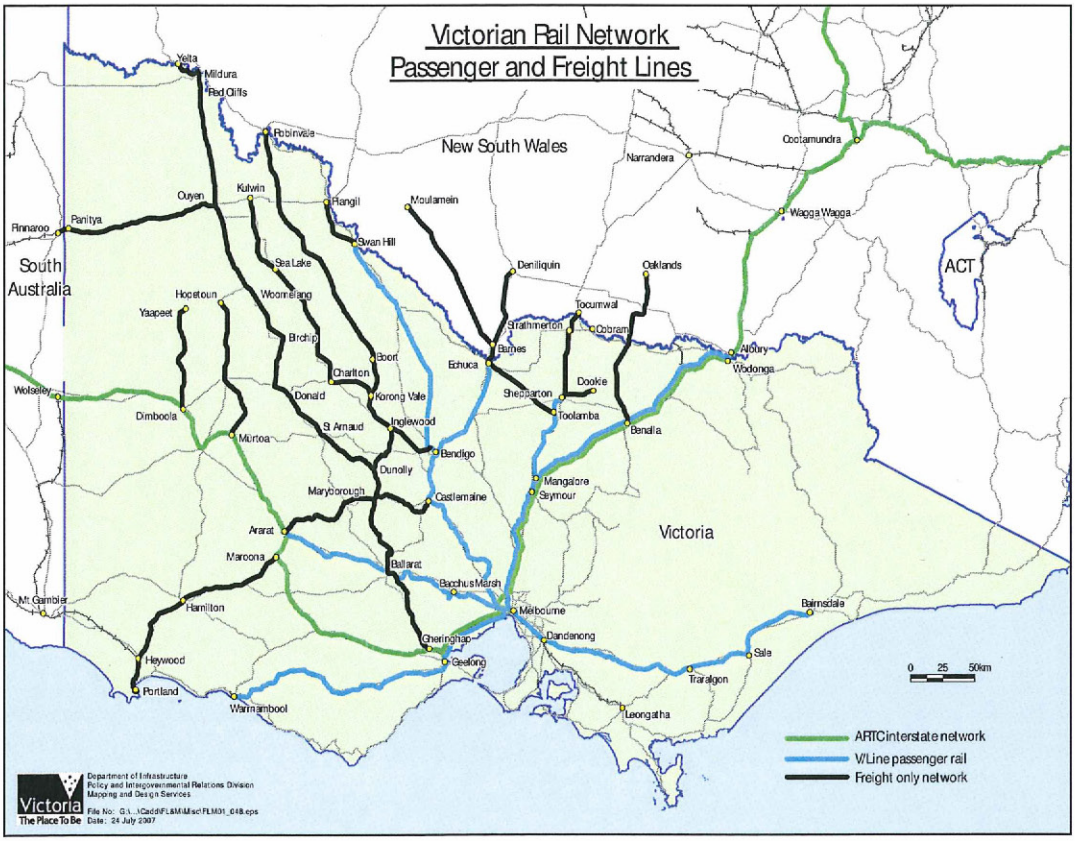
Generally, express trains carry heavier loads than stopping trains. Commonly, express trains are overcrowded even though stopping services provided either side may have seats available. The desirability of express services is such that passengers will eschew the relative comfort of stopping services in favour of a shorter travel time.

V/Line trains are deemed to be overcrowded if there are regularly standees. Many existing services are overcrowded.

5. Freight services

The suburban rail network is also utilised for intrastate freight trains (interstate freight uses the separate standard gauge network). Freight trains are generally scheduled to operate outside peak periods when they can be scheduled between the suburban services and therefore do not add to the capacity issues during peak periods. The following provides a brief outline of freight services:

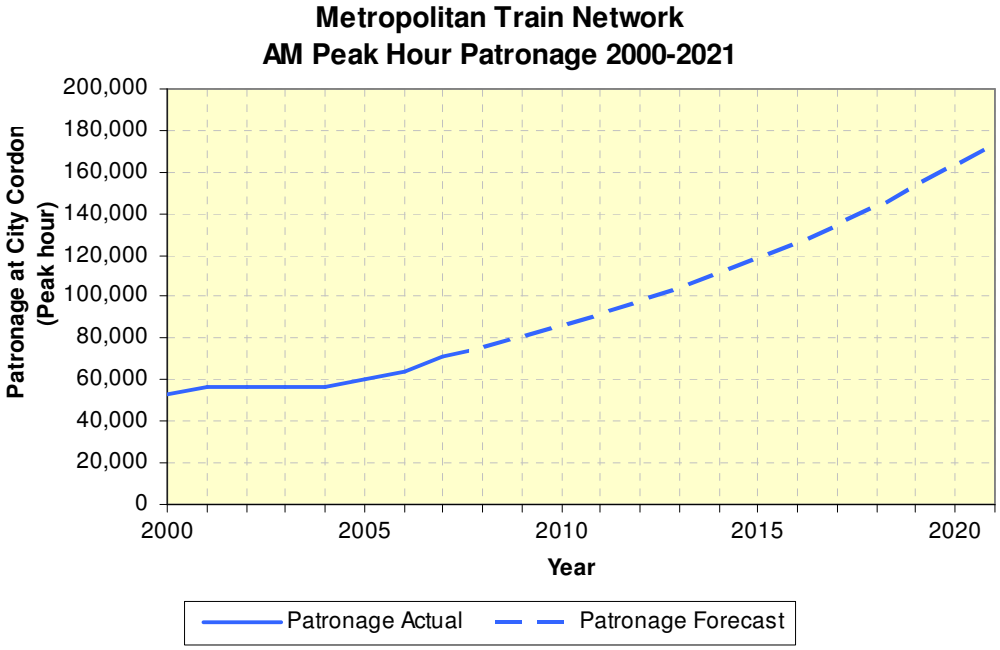
- Frankston Line – Long Island steel trains (approx. two services per day).
- Dandenong Line – Gippsland line trains hauling paper products, logs and general freight (two to three services per day)
- Sydenham Line – Trains to Bendigo (general freight), Deniliquin (rice), Albury/Wodonga (intermodal), Kilmore East (quarry) as well as seasonal grain train movements to the ports of Melbourne and Geelong. Some of these trains do not travel the full length of the corridor as they diverge at Albion to connect to the Seymour corridor. Standard gauge trains to Sydney/Brisbane use a separate line via Albion.
- Werribee Line – Warrnambool (intermodal), Mildura (intermodal) and grain trains use the corridor. Standard gauge trains to Adelaide use a separate corridor via Brooklyn to Newport, then parallels the Werribee suburban line.



6. Expected growth

Section 2.3 discussed the very significant changes affecting demand for train services in recent years resulting in peak period patronage growth averaging 7.6% pa since 2004.

The major drivers of this growth are likely to continue in the years ahead and continuing strong peak patronage growth of 6.6% pa is expected to 2021 when growth rates are anticipated to decline. Patronage will double in the next 10 to 12 years. Patronage will grow to levels well in excess of any previous experience in Melbourne and in excess of current loads on the Sydney rail network.

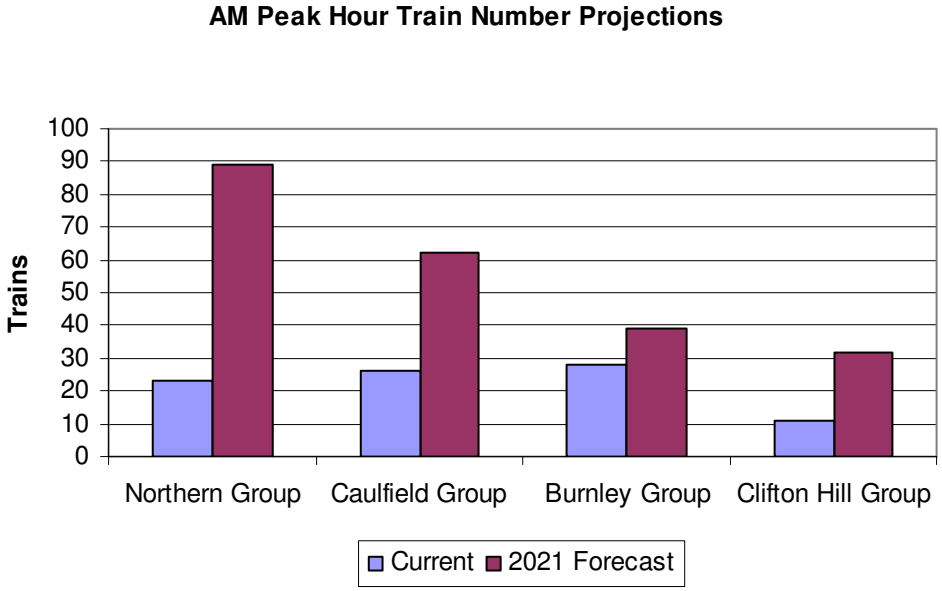


Growth will not be even across the network, being stronger on lines serving growth corridors. Predicted growth in each of the line groups is summarised below:

Group	AM Peak Hour Annual Growth Rate Forecast
Northern	9.5%
Caulfield	5.5%
Burnley	3.4%
Clifton Hill	7.0%
All Services	**6.6%**

It can be seen that all rail groups will experience significant growth in demand over the next two decades. Pressure on the Northern Group will be the greatest with a doubling in patronage within the next 8 to 10 years.

The trains that are required to service passenger demand on the network can be calculated on the basis that each train trip has a fixed passenger carrying capacity to facilitate efficient and safe operations. In this case, an average capacity of 798 passengers per train trip is used to predict required numbers of train trips to service the AM peak hour in the future.



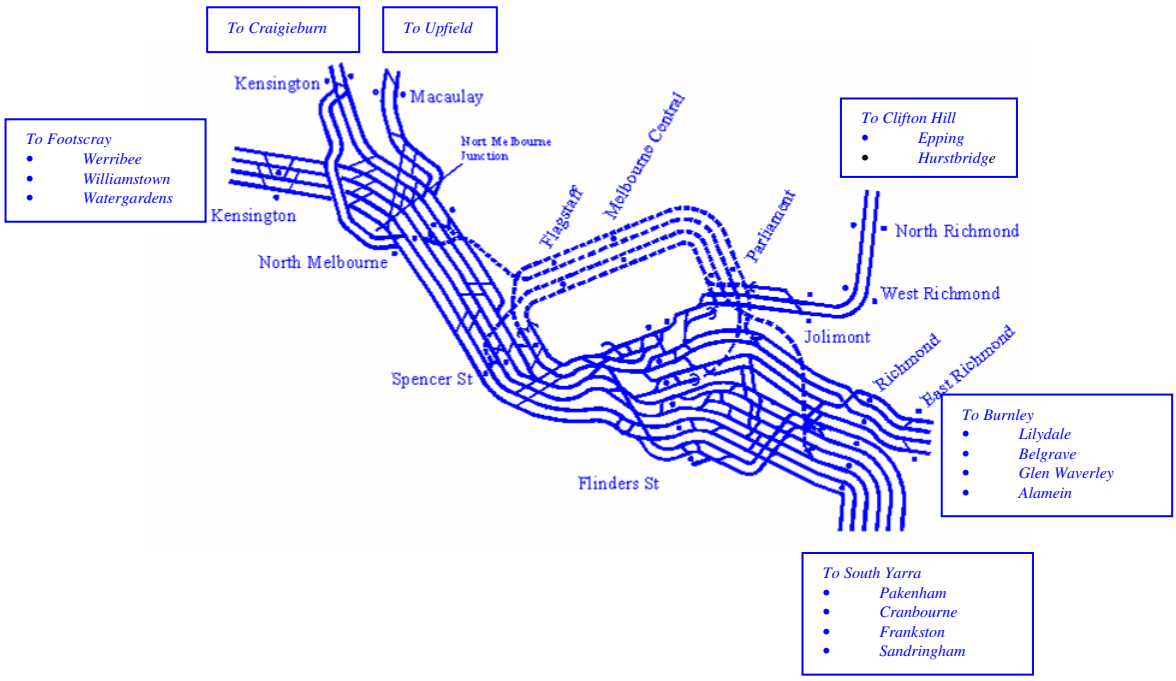
7. System capacity constraints

In general terms, issues constraining the capacity of the network, and therefore the network's ability to increase its supply, comprise of the following:

Train Pathways
The railway timetable is constructed on the basis that a train can run without being held unduly at stations, from origin to destination. The train run is termed a pathway. Each railway line has a finite number of pathways, these being determined by the characteristics of the infrastructure and the frequency and characteristics of trains operated. A mixture of stopping patterns for trains sharing a track reduces the number of train paths that can be provided.

Junctions and Termini
Trains need to be separated at points of conflicting movements to ensure safe operations. The form of railway junctions and the terminal stations trackwork directly influence the capacity and hence number of pathways the network can provide. The Inner Core Network has complex trackwork as lines converge and train movements into and out of the Underground Loop are provided for.

Schematic of the Inner Core rail network



Signalling Systems
The Melbourne railway signalling system has various capacities depending on location and the age of the assets. More frequent signal control points allows higher capacity but reduces safe operating speeds. The capacity in the inner areas is typically 20 trains per hour but there are inconsistencies in this number on various line sections and at junctions. Outer sections of the network generally have less capacity.

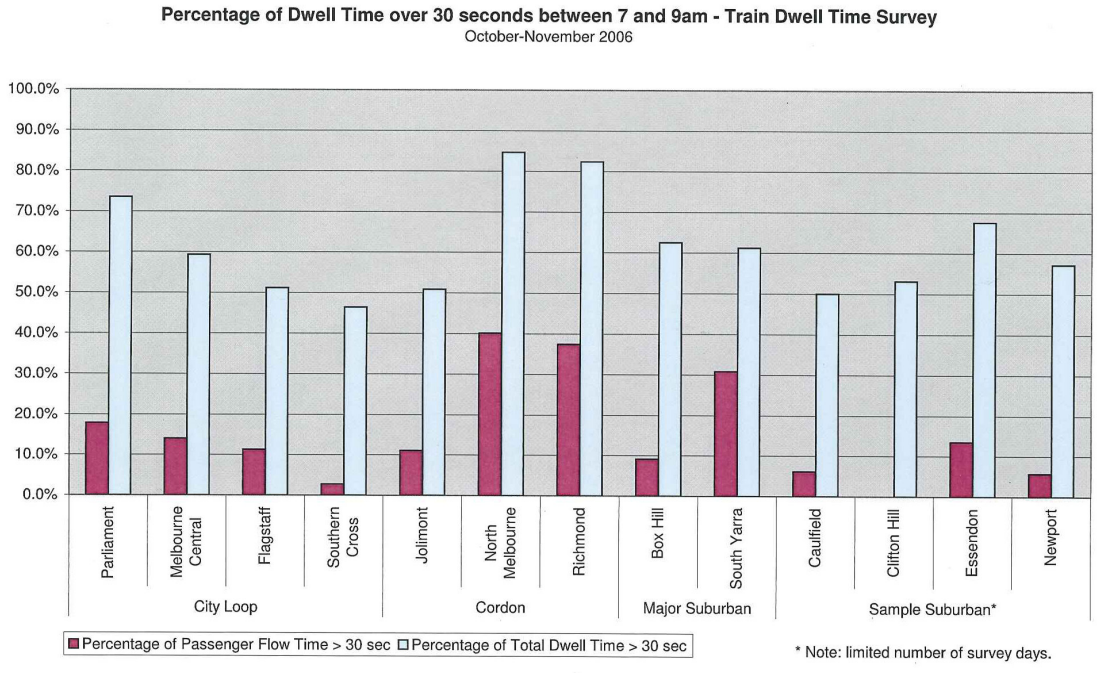
Traction Supply Capability
Electric power to supply the trains is provided by substations located at six to eight kilometre intervals along the network. Unfortunately, these substations are not of uniform capacity such that some track sections between substations will supply only two trains simultaneously, whilst others will provide for over five trains.

Signalling Power Supply
The power supply to the signalling system still uses the design principles introduced in the 1920s. Whilst generally reliable, failures do occur and are difficult to analyse and correct in a timely manner. With increased services, disruptions from any cause quickly lead to excess crowding.

Passenger Access and Egress
The management of passengers into stations, onto trains and from trains to platforms and to the wider environment is an essential operation of the railway. Escalators facilitate passenger movements and the flow of people away from the escalators is critical.

Station dwell times are a major determinant of minimum train headways, and hence line capacities.

As passenger numbers increase so does train dwell times at stations. Train layouts and the placement of doors, and accessible ramp installation will also affect the amount of time a train is stationary at a station. During peak periods when passenger loading is at its greatest, train dwell times increase as passengers make their way onto the train and find a space to stand. A typical 30 second dwell time in off peak periods can swell up to 90 seconds per station for all inner core stations.



8. Developing system capacity

System capacity will need to be expanded progressively to meet the growing demand. Development will take place in three stages.

8.1. Stage 1 Immediate Initiatives

A program of operational changes, new infrastructure works and pricing incentives are underway or being planned to expand peak capacity until the arrival of new generation rollingstock commencing in 2013 and to allow maximum utilisation of new generation rollingstock when delivered:

Demand management initiatives :

Free "earlybird" travel is being trialled to encourage passengers to travel before the morning peak period, thereby releasing capacity for other travellers. Further pricing incentives will be considered depending on the outcome of the trials.

The "Flex in the City" initiative is being launched to further encourage commuters to travel outside peak hours.

Interim rollingstock :

Steps are being taken to increase the availability of the existing train fleet in advance of the procurement of new generation trains. Connex has introduced more efficient train maintenance practices that have already released an extra 9 trains for daily services and expect to release a further 4 by the end of 2008. In addition, the government has approved funding for the purchase of a further 18 current style trains to be delivered from late 2009 and for the construction of associated train stabling and maintenance facilities.

Simplified operating patterns :

On some lines there are currently as many as 6 or 7 different train stopping patterns on the one track. This leads to confusion for passengers and reduces the effective capacity of the line.

Stopping patterns will be simplified with the general aim of not more than two stopping patterns – one meeting short distance trip needs and the other for long distance trips. Simplified timetables should be supported by depot and maintenance facilities (such as at Westall) located to allow direct running into and out of service without complicated positional runs.

The potential to run more trains direct to and from Flinders Street rather than through the City Loop will be explored where this would simplify timetabling. Upgrading of North Melbourne Station and planning for possible reversal of the direction of some Loop operations is underway.

Upgrading of Laverton Station could simplify operation of the Werribee line, allowing more services to run and with greater reliability.

Met and V/Line segregation

Suburban and V/Line trains have different operating requirements and different city terminals. Sharing of track, and the crossing of paths of suburban and V/Line trains, particularly in the environs of Southern Cross Station, significantly degrades the performance of both services.

Triplication of sections of the Dandenong line will allow greater separation of the running of suburban and V/Line trains in the south-east.

Electrification of the railway between Watergardens and Sunbury could allow Sunbury trains to be fully integrated with suburban trains, increasing network capacity through Sunshine.

In addition, additional platforms at Southern Cross Station could reduce conflicts between suburban and V/Line trains on the northern approach to the Station.

Additional tracks

A program of works to add tracks to existing lines, improve platforming at terminal stations, add new stabling and maintenance facilities and upgrade signalling is described in MOTC.

8.2. Stage 2 New Generation Trains

The specification of new trains for the replacement of existing units and the provision of new services provides an opportunity to provide more capacity commencing in 2013. Nearly half of the existing train fleet will be replaced over a period of 8-10 years.

Two main options are available for the design of the new fleet:

- Double-deck trains
- Single deck trains re-configured for increased capacity

Double deck trains offer more capacity on each train but the longer loading and unloading times reduces the numbers of trains that can be run. Either option will allow for about a 25% increase in effective line capacity.

The design of existing central area stations precludes the operation of significantly longer trains. However, a new underground rail link that bypassed existing city stations would remove such constraints.

8.3. Capacity Limits

At the completion of the above potential future capacity improvements, it is projected that there would be sufficient capacity to operate reliable rail services for the next decade for both the Clifton Hill and Burnley Groups. Additional 'higher capacity' trains could be added to these groups when they become available to satisfy demand. However the rate of growth on the Northern Group and Caulfield Group is expected to outstrip the available capacity much sooner.

The balance between patronage growth on the Northern Group and Caulfield Group, and the capacity that can be provided through the Stage 1 and Stage 2 initiatives is shown in Figures 8.1 and 8.2. It can be seen that:

- the significant spare capacity that was available in 2000 has been totally absorbed by subsequent patronage growth;
- new initiatives may well not keep pace with growing demand on the Northern Group; and
- substantial overcrowding will be evident in 2012 and beyond on the Northern Group and from 2016 on the Caulfield Group.

Network extensions into growth areas such as Tarneit, Melton and Mernda will not be possible if the additional capacity is not provided on the existing network. Extensions into growth areas would require additional services to be scheduled so that passengers are able to get onto trains.

Growth in mode share of the rail network will be significantly inhibited should capacity improvements be limited to those proposed in Stages 1 and 2 which would enable the network to carry around 99,000 passengers in the morning peak hour. For the Northern and Caulfield groups, their capacity will be able to carry 62,000 passengers, including 55,000 suburban passengers, while demand will continue to grow well beyond that level.

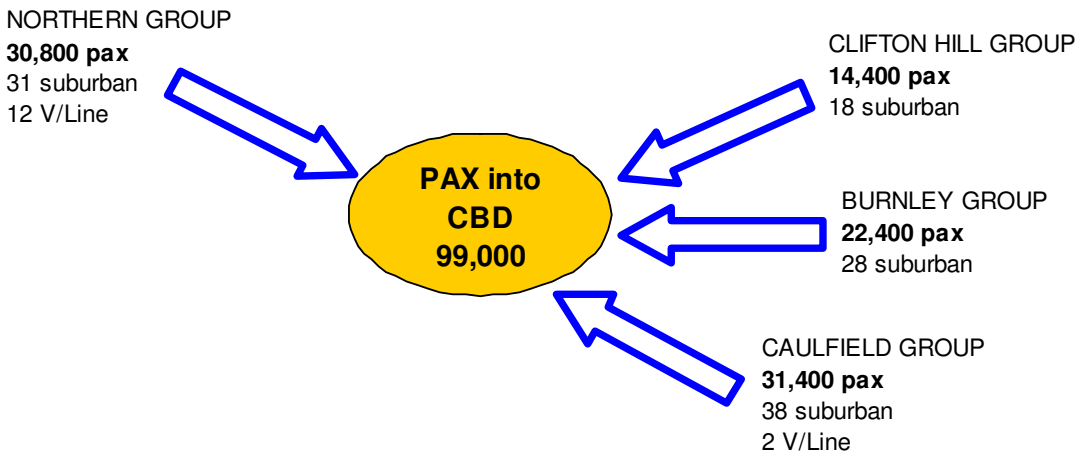


Figure 8.1: Northern Group Demand vs Capacity
Suburban Services Only

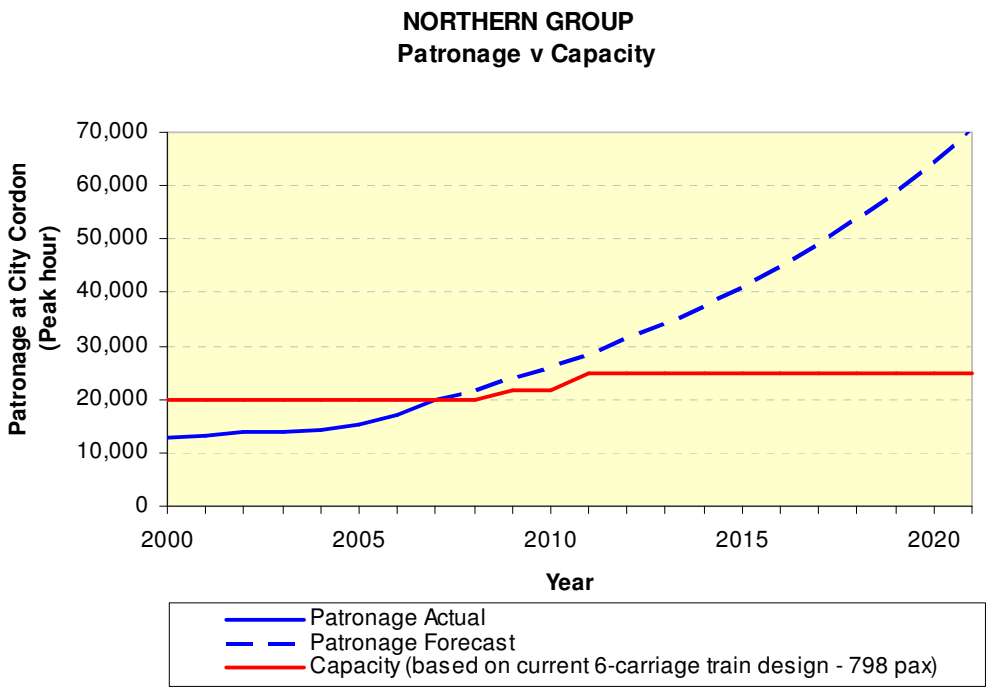
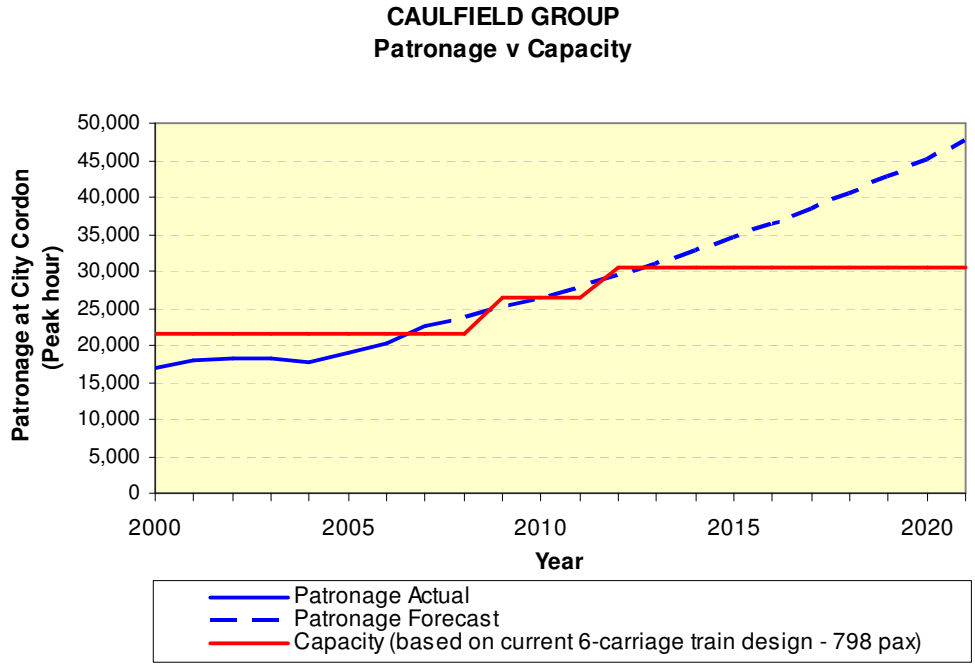


Figure 8.2: Caulfield Group Demand vs Capacity
Suburban Services Only



8.4. Stage 3 Options

Alternative options to increase network capacity beyond those proposed above for the Northern and Caulfield Groups include:

a) new infrastructure; and

b) signalling system upgrade.

a) New infrastructure options

Implementation of MOTC works coupled with operational changes will not provide sufficient capacity to cater for projected service volumes through the next decade on the Northern and Caulfield groups. The most significant constraint on the system comprises of infrastructure in the Inner Core area. It will be necessary to develop new infrastructure solutions which enable improved frequencies to operate on the feeding corridors and through the Inner Core area. Furthermore, with service levels rising, additional recovery time needs to be added to the services to protect against likely reductions in reliability.

Construction of infrastructure options that would add significant capacity to the network via additional surface tracks would cause considerable service disruption for a prolonged period and affect commuters across the network, especially works in the Inner Core area. The alternative is to add tracks below the surface in a tunnel.

Section 4 discussed the mix of V/Line and metropolitan services on shared track infrastructure. Peak hour Northern Group metropolitan services currently share track infrastructure with 15 peak hour V/Line services. Segregation of V/Line and metropolitan services would significantly improve the levels of service in this area.

Therefore, capacity improvement proposals through the Inner Core would also require complementary capacity enablers for the Northern Group through the western suburbs to segregate V/Line services from metropolitan services. These enablers will allow the full capacity benefits to be achieved from the inner core proposals.

In summary the possible options that have been considered are as follows:

Inner Core Option	**Western Suburb Capacity Enabler**
i) Expansion of city loop (i.e. new 5th and 6th loop tracks) plus new track pair between Footscray and Southern Cross OR ii) New viaduct – Flinders Street to Southern Cross plus new track pair between Footscray and Southern Cross OR iii) Northern – Burnley loops connected plus new track pair between Footscray and Southern Cross OR iv) East West Rail Tunnel	i) New third track - Footscray to Sunshine and Newport, Laverton to Werribee OR ii) Tarneit link

Inner Core Options

i) Expansion of city loop

This option involves the construction of two new tracks situated directly beneath the existing underground loop. This would entail a third level under the existing two levels, with 5th and 6th platforms at Flagstaff, Melbourne Central and Parliament and associated track connections. One of the new loops would provide a second access for the Caulfield group, while the other would accommodate a second access for the Northern group.

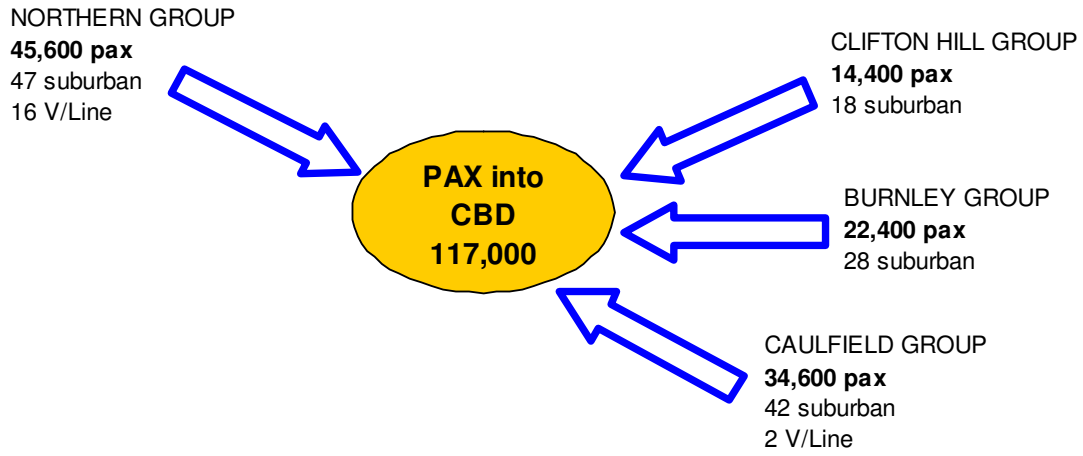
The Caulfield loop could be linked with an existing portal on the up side of Richmond station, although an additional portal would be required at Southern Cross. This would be similar for the Northern loop i.e. the second loop would connect to an existing portal on the up side of North Melbourne station but require a new portal east of Flinders Street station.

The new Northern loop would cater for Sydenham line trains, while Craigieburn and Upfield line trains would be routed through the existing Northern loop. Werribee and Williamstown services would need to operate direct to Southern Cross and terminate there unless a new viaduct was build in addition to the new loops. The new Caulfield loop could be used by all Frankston line trains, with the existing loop reserved for

Dandenong line trains. Sandringham trains would operate the same as current, as would Burnley and Clifton Hill groups.

Passenger impacts would need to be carefully managed due to the need to terminate Werribee/Williamstown trains at Southern Cross. Furthermore, this option does not offer new travel opportunities or CBD connectivity, and introduces some risk of overcrowding associated with adding new platforms at city loop stations which would need special attention during the design of this option.

This option would allow the metropolitan rail network to transport around 117,000 passengers into the CBD in the morning peak hour.



To fully utilise this option, construction of a third track between Newport and Footscray or diversion of Geelong trains via a new line from Werribee to Deer Park via Tarneit would be required.

Capacity gains from this option would achieve the following additional services and have the ability to bring an extra 18,000 passengers into the city in the morning peak hour:

- 16 more Metro train paths from the Northern group
- 4 more V/Line train paths from the Northern group
- 4 more Metro train paths from the Caulfield group
- *A total extra 24tph into the CBD*

ii) New viaduct - track pair between Southern Cross and Flinders Street

Current operations from the Northern group are constrained by the limited capacity in the North Melbourne – Southern Cross – Flinders Street corridor. Furthermore, operational reliability is affected on the Northern and Caulfield groups by the need to run trains from multiple lines into each loop, with the potential for delays by late-running trains on one line to affect other trains in the same group.

This option involves the construction of a new viaduct comprising 2 new tracks between Flinders Street and Southern Cross stations. Platforms 15 and 16 at Southern Cross and Platform 11 at Flinders Street would also need to be constructed. This option would increase capacity to four tracks between Richmond and North

Melbourne via Flinders Street and Southern Cross, allowing more cross-forming of Northern and Caulfield group services. The existing four loops would remain unchanged.

In this option all Sydenham trains would operate direct into Flinders Street and on to the Frankston line. Werribee/Williamstown trains would also run direct but would now run into platform 1 at Flinders Street and link up with the Sandringham line. This would leave only the Craigieburn/Upfield line trains running into the city via the underground loop.

The construction of a new viaduct and associated platforms provides a new route through to the CBD from the Northern group. This increases the theoretical maximum capacity of the Northern group from 40 to 60 trains per hour. The new route effectively forms an extension of the Sandringham line route and therefore provides no extra capacity that can be used by Caulfield group trains. No new capacity would be provided for the Burnley and Clifton Hill groups.

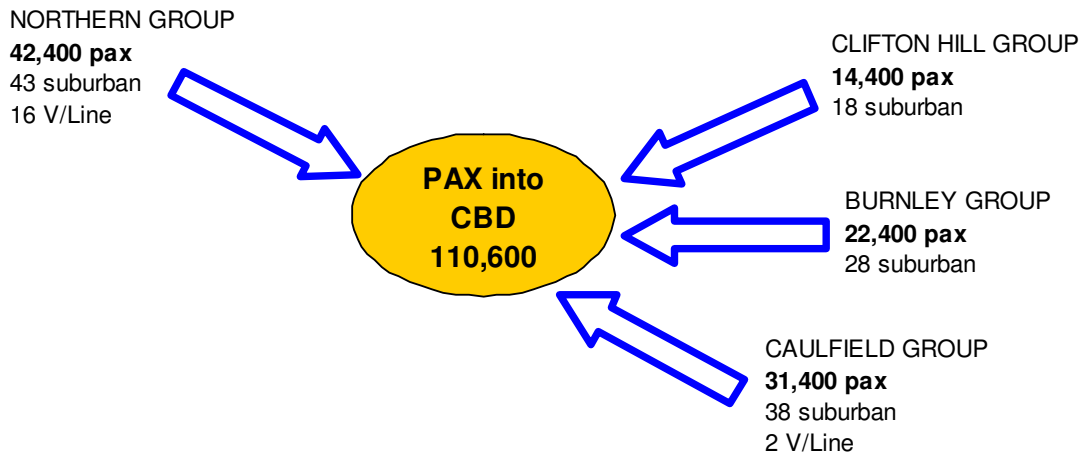
The full exploitation of the increase in capacity to 60 trains per hour would only be achievable with additional infrastructure works in suburban areas including:

- Construction of new tracks between Footscray and Southern Cross for V/line trains;
- Construction of third track between Newport and Footscray OR diversion of Geelong trains via new line from Werribee to Deer Park via Tarneit;
- Construction of a new flyover at Caulfield to allow Frankston Express and Dandenong stopping services to cross over without conflicting with one another – thus increasing capacity of the four track section into the CBD.

Environmental and land use issues associated with construction of the new viaduct between Southern Cross and Flinders Street would need to be carefully managed.

Network capacity achieved by this option would be limited by platform capacity of the Inner Core area.

This option would allow the metropolitan rail network to transport around 110,000 passengers into the CBD in the morning peak hour.



Capacity gains from this option would achieve the following additional services and have the ability to bring an extra 11,000 passengers into the city in the morning peak hour:

- 12 more Metro train paths from the Northern group
- 4 more V/line train paths from the Northern group
- *A total extra 16tph into the CBD*

iii) Northern – Burnley loops connected

The existing four city loop tunnels operate independently from each other. Rather than operating each group independently, this option would see trains running between North Melbourne and Richmond, either via Flinders Street (FSS) and Southern Cross (SXS), or via the Underground Rail Loop (URL). For this option, the following operations could be achieved:

- Sydenham to Glen Waverley / Alamein / Blackburn via FSS, SXS
- Craigieburn / Upfield to Belgrave / Lilydale via URL

Operations would assume that layovers and crew changes would take place at suburban termini rather than at Flinders Street or Southern Cross.

By allowing Burnley and Northern trains travelling in the Underground Rail Loop (URL) to continue on to North Melbourne or Richmond respectively rather than looping around to Flinders Street, track and platform capacity at Southern Cross, Flinders Street and across the viaduct would be released. In association with discontinuing the practice of reversing trains at Flinders Street station, this would allow for direct services from each group to be linked.

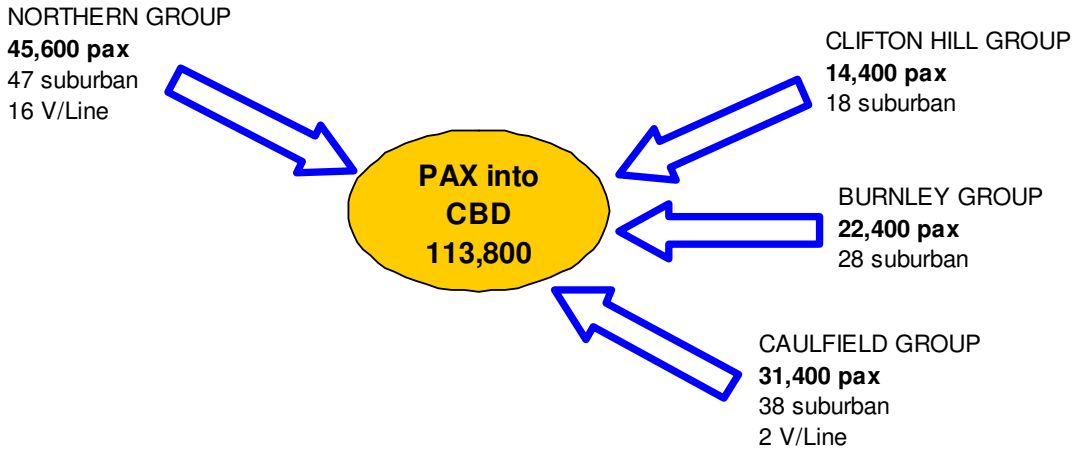
The spare capacity at Flinders Street station could be used for services from Caulfield and Clifton Hill groups, and allow for network expansion.

The infrastructure works required to enable Northern-Burnley operations as shown include:

- new tunnel connection from the Burnley loop tunnel west of Flagstaff to the existing western loop portal south of North Melbourne;
- new tunnel connection from the Northern loop tunnel south of Parliament to a new portal situated in the Jolimont rail yards and connected to existing Burnley down track;
- new platform 7 at North Melbourne, forming an island platform with existing platform 6;
- track slewing on either side of North Melbourne to enable sectorisation of lines.

Passenger impacts would need to be carefully managed due to need to terminate Werribee/Williamstown trains at Southern Cross. Furthermore, this option does not offer new travel opportunities or CBD connectivity, and introduces some risk of overcrowding issues associated with adding new platforms at city loop stations which would need special attention during the design of this option.

This option would allow the metropolitan rail network to transport around 114,000 passengers into the CBD in the morning peak hour.



To fully utilise this option, construction of a third track between Newport and Footscray or diversion of Geelong trains via a new line from Werribee to Deer Park via Tarneit would also be required.

Capacity gains from this option would achieve the following additional services and have the ability to bring an extra 15,000 passengers into the city in the morning peak hour:

- 16 more Metro train paths from the Northern group
- 4 more V/line train paths from the Northern group
- *A total extra 20tph into the CBD*

iv) East West Rail Tunnel

Adding capacity to the rail network via underground tunnels minimises the adverse effects on an operating railway, therefore maintaining passenger confidence in the system. Furthermore, an underground link would leave some surface capacity free for use by regional and freight rail services. This would be particularly important in the event that rail freight services would need to be accommodated in the Dandenong corridor for the Port of Hastings. Alternative infrastructure options considered above do not facilitate growth in the rail freight task.

An underground rail tunnel to facilitate capacity increases for both the Northern and Caulfield Groups would add a generational improvement to the network. The key objective of a rail tunnel would be to service the CBD for both groups. For operational efficiency reasons, both groups could be connected via the tunnel so that services could be 'through routed' via the CBD. Alternatively, if the groups were not connected, turnaround facilities would have to be provided in the CBD. Turnaround facilities would introduce inefficiencies in the operation of the railway as they usually require time to be scheduled for services to recover from an unreliable trip.

This option involves the construction of a new pair of underground tunnels running from west of West Footscray station on the Sydenham corridor to Caulfield via new station platforms at:

- Footscray
- Potentially a new station at West Melbourne
- New station at Melbourne University / Parkville Precinct
- Melbourne Central and/or Flinders Street, or new mid-block location
- New station at Domain
- New interchange station with the Sandringham line at Windsor or Balaclava
- Plus, potentially, further additional new stations between Domain and Caulfield depending on the chosen alignment.

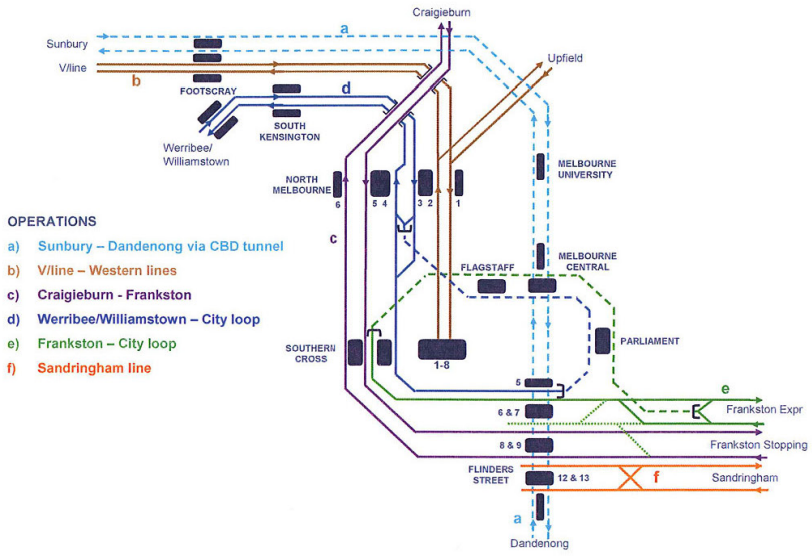
The new underground tunnel would operate services from Sunbury to Pakenham and Cranbourne. The removal of Sunbury services at West Footscray would then allow V/Line trains to continue, conflict-free along the existing tracks into platforms 1 and 2 at North Melbourne where they would merge with Upfield trains before continuing to Southern Cross terminals.

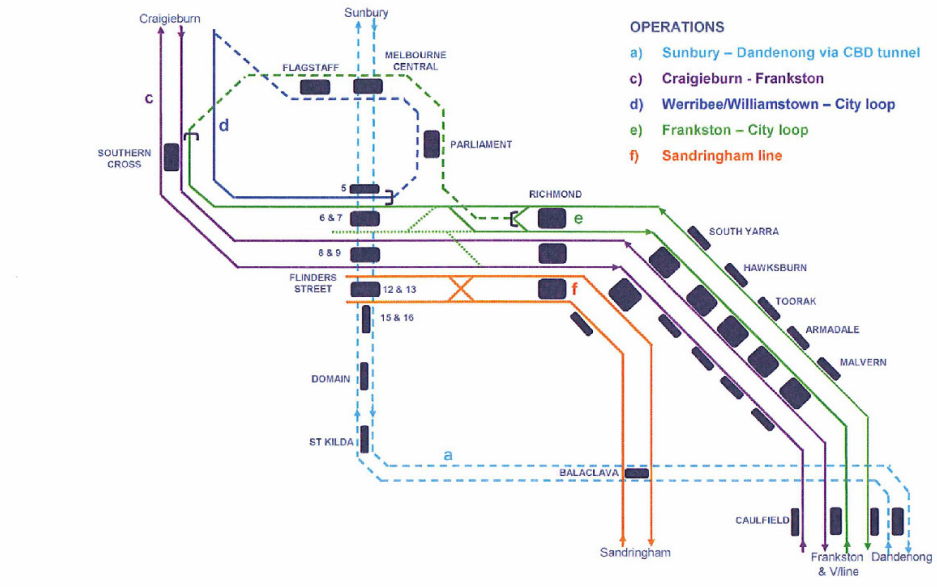
Dandenong corridor trains would run into the new CBD tunnel at Caulfield. This would leave all Frankston trains plus V/Line services from Dandenong to run via the existing four track section to Richmond.

Either Werribee/Williamstown (as shown below) or Craigieburn trains would operate through the existing Northern Loop.

The benefits of constructing a new CBD tunnel and connecting to the Sunbury line in this way are:

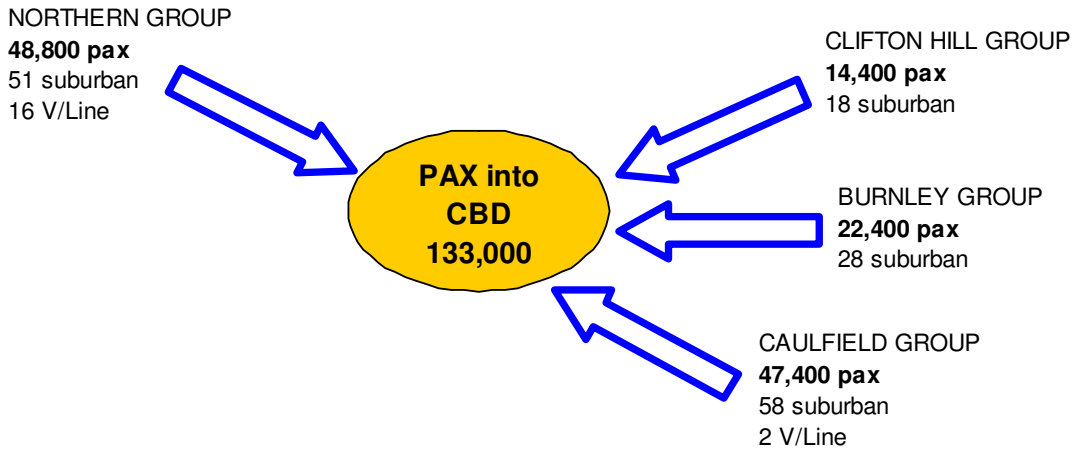
- Provides significantly improved capacity for Northern and Caulfield groups;
- Releases a dedicated track pair for V/Line services on the Ballarat and Bendigo corridors from West Footscray into Southern Cross terminals without need for new infrastructure;
- Improves reliability through complete sectorisation of all Northern lines;
- Provides rail service to new catchments and high demand area such as Melbourne University and Domain.





Note: Burnley and Clifton Hill groups not shown for clarity

This option would allow the metropolitan rail network to transport around 133,000 passengers into the CBD in the morning peak hour.



To fully utilise this option, construction of a third track between Newport and Footscray or diversion of Geelong trains via a new line from Werribee to Deer Park via Tarneit would also be required.

Capacity gains from this option would achieve the following additional services and have the ability to bring an extra 34,000 passengers into the city in the morning peak hour:

- 20 more Metro train paths from the Northern group
- 4 more V/Line train paths from the Northern group
- 20 more Metro train paths from the Caulfield group
- *A total extra 44tph into the CBD*

Coupled with the introduction of higher capacity trains, up to an extra 40,000 passengers per hour will be able to be carried.

b) Signalling upgrade

Signalling upgrade and dwell time management to enable enhanced throughput on existing tracks could be possible. Signalling upgrades in the form of Automatic Train Protection or Automatic Train Operation Systems consist of trackside and on-board equipment. This technology is standardised and all of the major railway signalling suppliers now manufacture the equipment. It is currently in use on a number of intercountry routes in Europe, however, the technology has not been retrospectively applied to a suburban network similar to Melbourne or a metro rail system.

An estimate of cost to upgrade the Melbourne network would be in excess of $1.5 billion. Implementation of such a system would have massive disruption and reliability effects in an environment where capacity of the network is almost saturated. It is considered that it would be almost impossible to continue to operate the railway on a reliable basis whilst the signalling system is being upgraded.

An upgrade to signalling could increase network capacity by allowing trains to be scheduled more closely together, however, significant constraints would remain on the network. Most of the constraints discussed in Section 7 would remain, with the most significant being at-grade junctions controlling the number of trains that can pass without conflict.

Continued shared use of rail corridors by mixed services with different stopping patterns (eg. suburban/V/Line express and all stopping) will constrain any gain achieved from releasing additional pathways by an upgrade to the signalling system.

Passenger access and egress in the peak periods plays an important role in providing a reliable rail operation. Current levels of peak hour passenger access increase dwell times that trains are at stations, and this is projected to keep growing. A signalling system upgrade will facilitate an increase in the number of trains that could be scheduled per hour, however, this increase will only be marginal and crowds on platforms will eventually grow to present the same problems that currently exist. By providing new platforms (eg. at the new stations), passengers could be distributed more evenly and dwell times can be minimised.

The most important difference, and advantage, that the infrastructure options discussed in Section 8.4 (a) have over a signalling upgrade, is that each option sectorises rail services, which allows a significant increase in the number of trains that can be scheduled per hour. A signalling system upgrade does not do this, and existing infrastructure constraints will remain. Accordingly, the signalling upgrade option is not considered further.

8.5. Infrastructure Options Assessment

In order to rapidly assess the relative value of each capacity improvement option, a multi-criteria analysis has been completed. A 2-phase assessment process has been undertaken. The first phase evaluates the Inner Core options, followed by the second phase evaluating packages of the better Inner Core option with Western Suburb options. A qualitative summary of each option and a rapid appraisal based on the qualitative assessment follows.

It should be noted that the proposed new loops have not been assessed in detail because the anticipated costs and high disbenefits created by terminating Werribee and Williamstown trains at Southern Cross make the option unviable even before considering other impacts.

Phase 1 Evaluation - Inner Core Options

Multi-Criteria Assessment

	New Viaduct	Northern-Burnley connection	East West Rail Tunnel
Capacity (peak hour)	Additional 16 trains	Additional 20 trains	Additional 44 trains
Travel Time	Similar to current	Similar to current	Better than current
Service Frequency	Average 50% increase from current	Average 50% increase from current	Average 60% increase from current
Mode Share effect	Medium improvement in mode share through further frequency enhancement	High improvement in mode share through further frequency enhancement and improved cross town journey opportunities	Very high improvement in mode share as new CBD tunnel will represent significant shift in PT provision and inspire confidence in PT
Reliability	Similar to current	Better than current	Significantly better than current
Accessibility	More interchange than present. Removes Werribee and Frankston and Sunbury lines from city loop	More interchange than present Removes Werribee and Frankston and Sunbury lines from city loop Potential to serve new corridors	Offers new access to rail in new areas around Domain, StKilda Rd, West Melbourne and Melb Uni. Potential to further increase rail coverage with extensions provided in city loops and potential to serve new corridors
St Kilda Road Capacity	No effect	No effect	Construction of new rail line connecting CBD with St Kilda and Domain will provide more than 50% more capacity compared to an upgraded tram service and reduce capital and operating costs for tram network
Stabling	New stabling required in suburbs	New stabling provided in central area	New stabling required in suburbs
Safety/ Security	Less overcrowding	Less overcrowding	Less overcrowding
Environment	Reduces road congestion Negative urban aesthetics with construction of new flyover into Flinders Street	Reduces road congestion compared to current	Significantly reduces road congestion compared to current as it will attract a higher PT mode share
Urban Redevelopment	None	None	Catalyst for re-development and higher land values in inner suburbs not currently served by rail, particularly north of CBD and St Kilda
Impact on growth areas development	Additional service frequency to growth areas will stimulate some development	Additional service frequency to growth areas will stimulate some development	Connection of growth areas to CBD rail link and consequent reduction in travel times will significantly stimulate development in growth areas
Construction and buildability	Housing acquisition and some disruption to services – one group Significant works required alongside Yarra river and Aquarium	Some disruption to services - two groups	Little disruption to services but long lead-times associated. Some housing acquisition required.
Lead time	Long planning and approval phase, significant design and development work and lengthy construction time required. Around 4-5 years	Significant design and development work, tunnelling relatively quick but associated track and signal works longer. Around 2-3 years	Major design and development work and very long construction period. Around 9-10 years.
Staging of works	No phasing possible	No phasing possible	Possible to phase works by completing and operating western section first and then constructing eastern section.
Impact on Freight	Significantly reduced opportunity for freight trains to operate	Significantly reduced opportunity for freight trains to operate	Improved opportunity to operate freight trains between Dandenong and Southern Cross
Benefits	Capacity benefits: High Service simplification benefits: High Travel time benefits: Neutral Reliability benefits: Neutral	Capacity benefits: High Service simplification benefits: High Travel time benefits: Neutral Reliability benefits: Neutral Cross-town connection benefits: High	Capacity benefits: Very High Service simplification benefits: High Travel time benefits: Significant Reliability benefits: Some Cross-town benefits: High

Rapid Appraisal (relative scoring)

	New Viaduct	Northern-Burnley connection	East West Rail Tunnel
Capacity (peak hour)	✓	✓✓	✓✓✓
Travel Time	0	0	✓
Service Frequency	✓✓	✓✓	✓✓✓
Mode Share effect	✓	✓✓	✓✓✓
Reliability	0	✓	✓✓
Accessibility	0	0	✓✓
St Kilda Road Capacity	0	0	✓
Stabling	0	✓	0
Safety/ Security	✓	✓	✓
Environment	××	✓	✓
Urban Redevelopment	0	0	✓✓
Impact on growth areas development	✓	✓	✓✓
Construction and buildability	××	×	×××
Lead time	××	×	×××
Staging of works	×	×	✓
Impact on Freight	×	×	✓
Costs	××	××	×××
Total	✓ 6 × 10	✓ 11 × 6	✓ 23 × 9

Phase 1 of the evaluation demonstrates that an East West Rail Tunnel is a superior capacity improvement option for the Inner Core area. The next phase of the assessment packages the East West Rail Tunnel with Western Suburb options to determine an optimum suite of projects that will enable the rail network to be managed effectively over the next generation.

8.6. Western Suburb capacity enablers

i) New third track – Footscray to Sunshine and Newport, Laverton to Werribee

As identified earlier the critical capacity constraints to resolve are on the trunk sections from Footscray to Sunshine and Newport. In both these sections V/Line trains are scheduled to run express whilst most metro services are required to stop at intermediate stations. The conflicting service speeds significantly reduces capacity on each section.

The introduction of third tracks on both sections allows express trains to overtake slower services in the peak direction thus protecting the travel time for V/Line passengers and providing more capacity for metro services. It is anticipated that an additional stretch of third track would also be required in the longer term between Laverton and Werribee to allow V/Line trains to overtake Werribee metro trains stopping at Hoppers Crossing, Point Cook and Aircraft.

In this scheme, the Sunshine corridor would operate as follows in the peak period:

- All metro services to run on 'local' track between Sunshine and Footscray and stop at all intermediate stations;
- All V/Line trains from Bendigo and Ballarat to run on new express track between Sunshine and Footscray;
- All trains in the counter-peak direction will use one track and therefore be forced to run at the speed of the stopping services.

In this scheme, the Werribee corridor would operate as follows in the peak period:

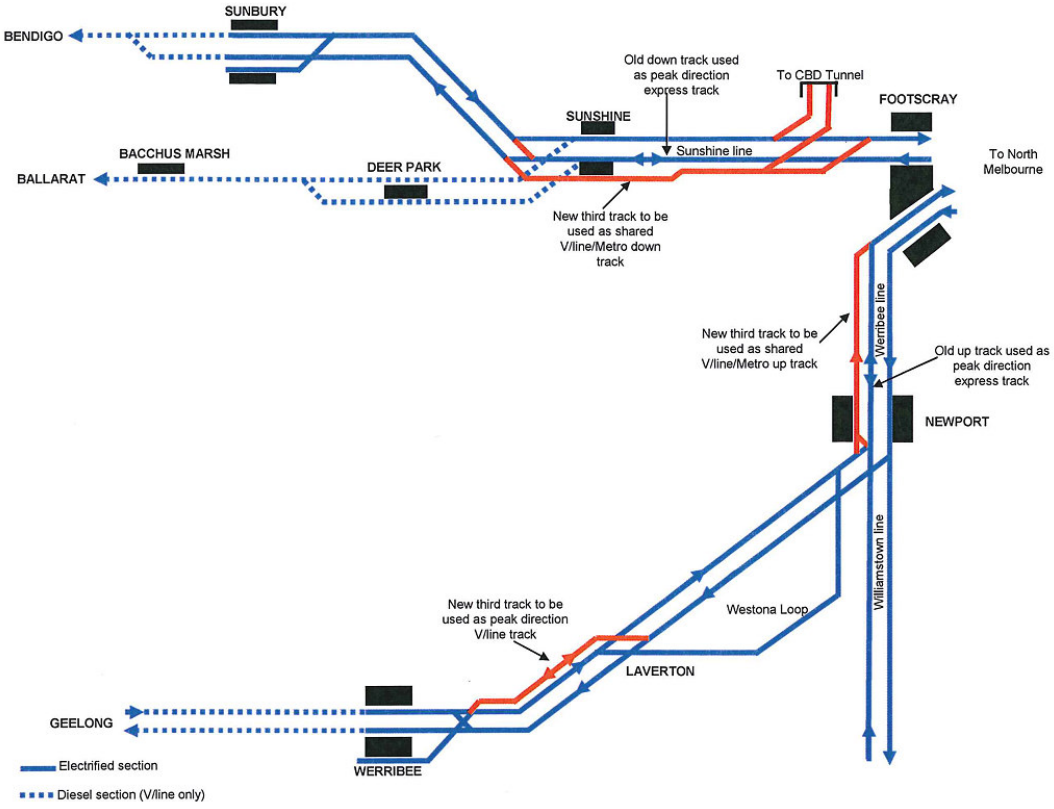
- All metro services from Williamstown and Laverton to run on 'local' track between Newport and Footscray and stop at all intermediate stations;
- All V/Line trains from Geelong and express trains from Werribee to run on express track between Newport and Footscray;
- All V/Line trains from Geelong to run on express track between Laverton and Werribee;
- All trains in the counter-peak direction will use one track and therefore many V/Line trains will be forced to run at the speed of the stopping services.

This option would require significant land and housing acquisition in some areas as the existing corridor would not be able to accommodate additional trackwork. Work would also be required to reconfigure Footscray and Newport stations to enable an additional track from the Sunshine corridor. On both corridors it is anticipated that the new track would be built on the outside of the existing tracks and one of the current tracks converted into the express, bi-directional track.

In the event that an East West CBD tunnel is constructed and connected to the Sydenham line then there would not be any requirement to remodel Footscray station at surface level (new platforms underground), with the existing Sunbury platforms dedicated to V/Line services from Bendigo and Ballarat only. Additional connections would be required from each of the three tracks to the new tunnel portal near West Footscray station.

In this scenario the key works required would be as follows:

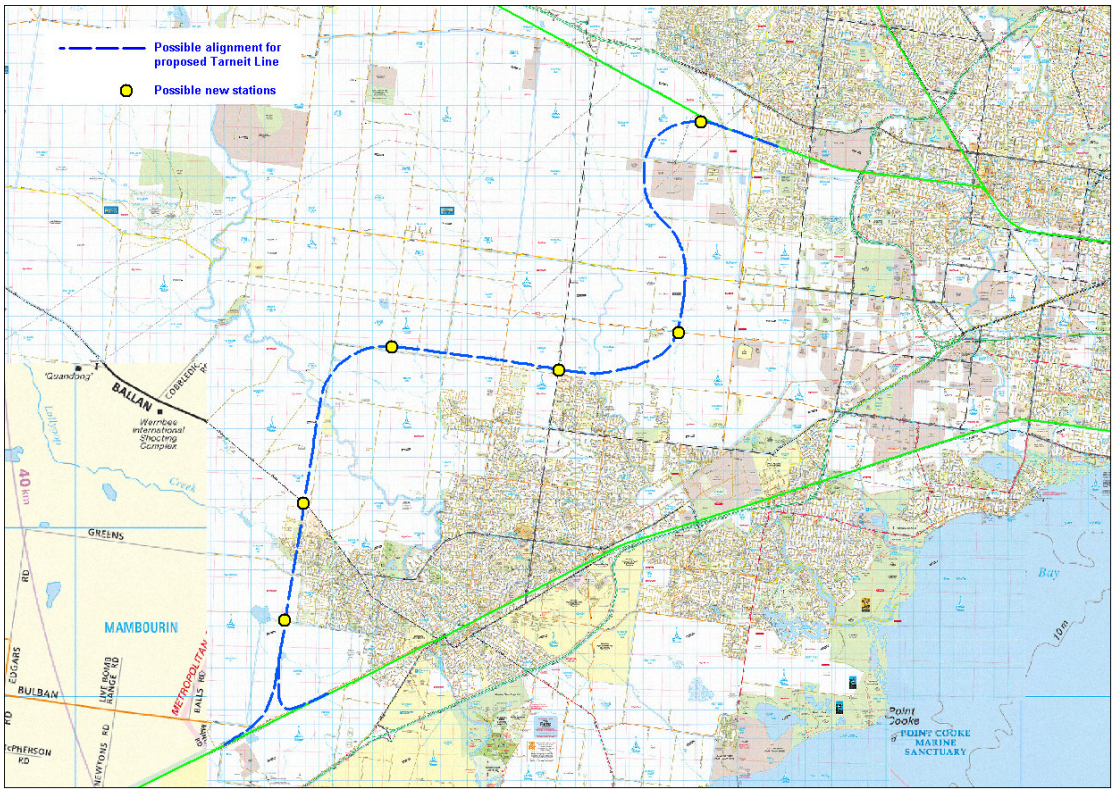
- Widening of existing cutting between Footscray and Newport to provide additional track alongside existing track pair;
- Widening of existing cutting between Footscray and West Footscray to provide additional track alongside existing track pair;
- Provision of additional track between West Footscray and Sunshine – adequate room exists in corridor (this element already included in MOTC);
- Reconfiguration of Footscray station to provide three platforms for Sunshine corridor (not required if new CBD tunnel connected to Sunbury line);
- Relocation of platform at Newport;
- Introduction of bi-directional signalling on express track.



ii) Tarneit link

As part of *MOTC*, a new rail reservation is being established between Werribee and Deer Park through Tarneit to allow Geelong trains to join with Ballarat and Bendigo trains and be efficiently pathed through Sunshine and Footscray. The alignment would service an entire new regional area and offer stations at some or all of the following locations in new growth corridors:

- Derrimut;
- Truganina;
- Tarneit; and
- Wyndham Vale.

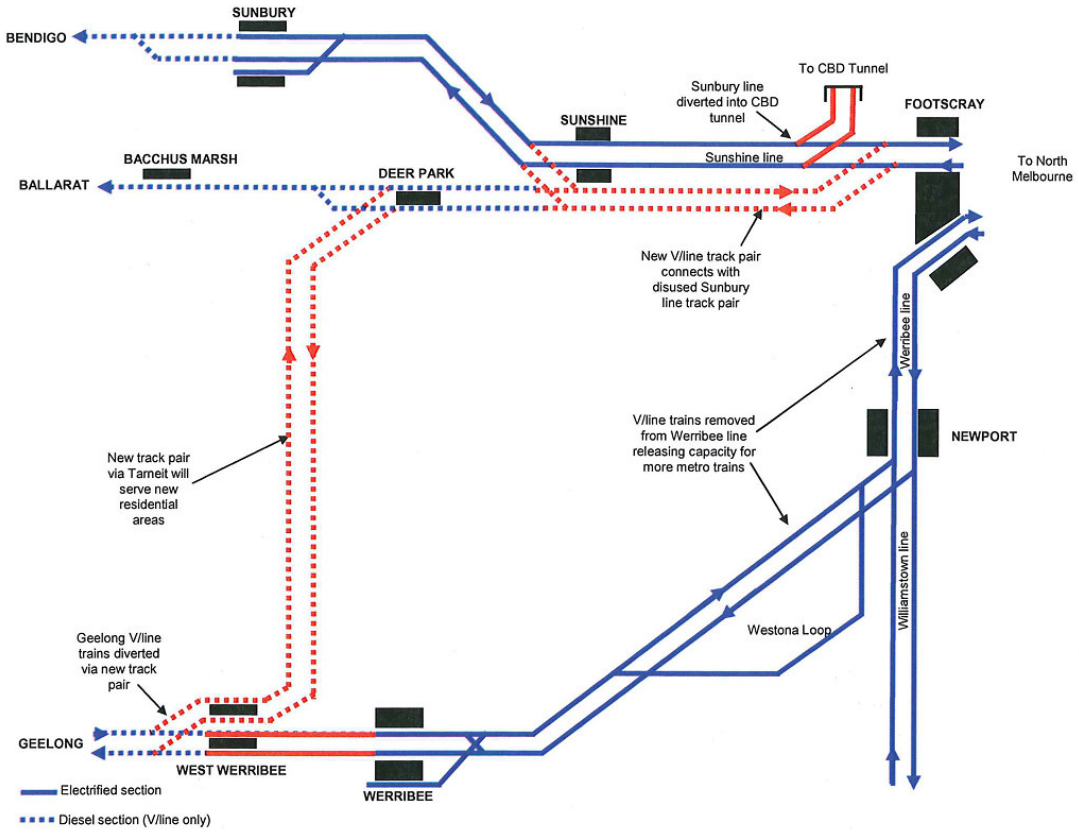


V/Line trains from Geelong would branch off from the Werribee line at Browns Road, West Werribee and follow the new line through to Deer Park, joining with other V/Line trains from Ballarat, Bendigo and Melton. Only metro trains would operate on the Werribee line (apart from freight trains using the standard gauge track).

In addition, some additional V/Line diesel services could commence journeys from West Werribee or Lara and provide suburban services similar to existing Sunbury and Melton services. The separation of express V/Line services from stopping all stations metro services would improve reliability and reduce journey times for all train types as well as significantly improving capacity on the Sunbury and Werribee lines.

The line could be electrified at a later time if warranted.

In the event that an East West CBD tunnel is constructed and connected to the Sydenham line then all Sydenham services would be diverted into the tunnel and this would release the existing surface tracks of the Sydenham line from West Footscray for exclusive use by all V/Line trains in the Northern Group.



Package 1

East West Rail Tunnel combined with new third track - Footscray to Sunshine and Newport, Laverton to Werribee

In this option the provision of the new CBD tunnel removes all Sydenham, Pakenham and Cranbourne line trains from the existing CBD network. V/Line trains from the west take over exclusive use of the disused Sydenham line tracks from Footscray into Southern Cross via platforms 1 and 2 at North Melbourne where they are joined by Upfield line trains running direct to Southern Cross.

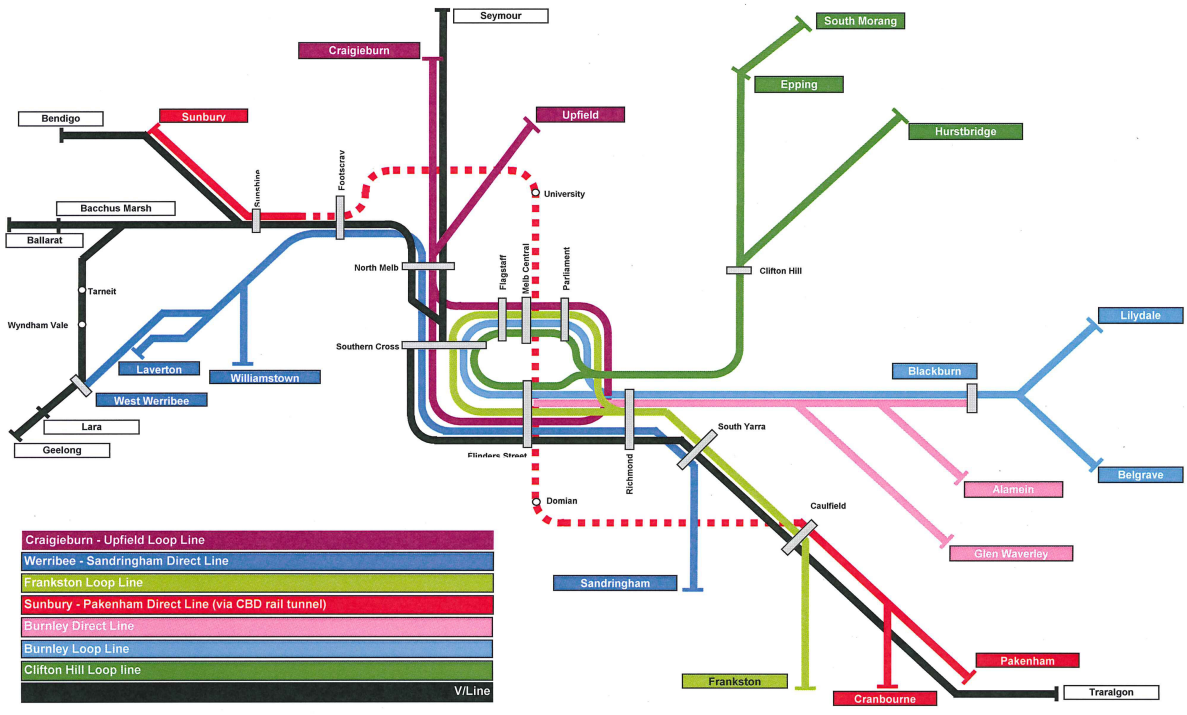
In turn this forces all Craigieburn trains to run into platforms 5 and 6 at North Melbourne and therefore run direct to Flinders Street and on to Sandringham. Werribee/Williamstown trains would then need to be routed into the existing Northern loop.

The removal of the Dandenong trains at Caulfield allows all Frankston trains to run into the Caulfield loop (possibly joined by some Westall trains if capacity in the CBD tunnel is limited to 20tph). The direct line into Flinders Street will only be used by 2tph V/Line services, leaving spare capacity for future growth or freight movements.

Package 2

East West Rail Tunnel combined with Tarneit Link

The services offered in Package 2 are shown schematically in the following figure. Metro services would be similar to Package 1 but V/Line services from the west are routed via the new Tarneit line.



Phase 2 Evaluation – Inner Core combined with Western Suburb options

Multi-Criteria Assessment

	Package 1 **East West Tunnel with new third track**	**Package 2** **East West Tunnel with Tarneit link**
Capacity **(peak hour suburban and V/Line)**	Approximately 30% less passenger capacity than Package 2.	Full utilisation of capacity gained from existing infrastructure and the East West Rail Tunnel. Approximate doubling in passenger capacity for Northern and Caulfield Groups.
Travel Time	Overall improvement but small increase for V/Line and contra peak passengers.	Improved travel time for all.
Reliability	Better than current	Significantly better than current
Mode Share effect	High improvement as new tunnel will link new CBD areas, frequency enhancement and cross-town links	Very high improvement through frequency enhancement, improved crosstown links, provision of new corridor and links to new CBD areas
Stabling	New stabling required in suburbs	Same as Package 1
Accessibility	Provides access to rail in new CBD areas and allows sufficient capacity to increase rail coverage to new areas.	Provides access to rail in new CBD areas and improves access in west through provision of new corridor
St Kilda Road Capacity	Construction of CBD tunnel will provide rail link from CBD to St Kilda and Domain. This will offer 50% more capacity compared to an upgraded tram service and reduce capital and operating costs for the tram network	Same as Package 1
Safety/ Security	Less overcrowding compared to Phase 2	Same as Package 1
Environment	Significantly reduces road congestion compared to Phase 2 as it will attract a higher PT mode share.	Generally same as Package 1. Slightly better mode share effects make this more environmentally positive.
Impact on growth areas development	Connection of growth areas to CBD via new tunnel and reduction in travel times will significantly stimulate development in growth areas.	Provision of new corridor via Tarneit will significantly stimulate development of growth areas in Brimbank, Melton and Wyndham. CBD tunnel and reduction in travel times will further stimulate development of growth areas.
Urban Redevelopment	CBD tunnel will be catalyst for re-development and higher land values in inner suburbs not currently served by rail, particularly, Parkville and St Kilda.	Same as Package 1
Construction and buildability	Significant impact on housing acquisition, road network reconfiguration and disruption to services.	Corridor for Tarneit link largely allowed for in planning of the area. Land acquisition and some disruption to services
Staging of works	CBD tunnel can be built in two phases in line with demand requirements with Northern group operating to Domain only in first phase.	CBD tunnel can be built in two phases in line with demand requirements with Northern group operating to Domain only in first phase. Early delivery of Tarneit line in this option would provide little benefit without CBD tunnel.
Lead time	Major design and development work, very long construction period. Around 10 years.	Same as Package 1
Impact on Freight	Potential opportunity to operate freight trains between Caulfield and Southern Cross via existing alignment due to significantly lower number of passenger services.	Potential opportunity to operate freight trains between Caulfield and Southern Cross via existing alignment due to significantly lower number of passenger services. Tarneit line offers new route for freight in western suburbs.
Costs	East West Rail Tunnel – Western section $4.5b East West Rail Tunnel – Eastern section $2.5b Western Suburb third track works - $1.0b **Total Capital Cost - $8.0b**	East West Rail Tunnel – Western section $4.5b East West Rail Tunnel – Eastern section $2.5b Western Suburb Tarneit link - $1.5b **Total Capital Cost - $8.5b**

Rapid Appraisal (relative scoring)

	Package 1 East West Tunnel with new third track	Package 2 East West Tunnel with Tarneit link
Capacity	✓	✓✓
Travel Time	✓	✓✓
Reliability	✓	✓✓
Mode Share effect	✓✓	✓✓✓
Stabling	×	×
Accessibility	✓	✓✓✓
St Kilda Road Capacity	✓	✓
Safety/ Security	0	0
Environment	✓	✓
Impact on growth areas development	✓	✓✓
Urban Redevelopment	✓	✓
Construction and buildability	××	×
Staging of works	✓	✓
Lead time	×	×
Impact on Freight	✓	✓✓
Costs	××	×××
Total	✓ 12 × 6	✓ 20 × 6

8.7. Stage 3 Capacity

The East West Rail Link combined with the Tarneit Link would double the capacity of both the Northern and Caulfield Groups. For the Sydenham and Dandenong services using the proposed East West Rail Link, capacity could be further increased by the addition of modern signalling technology and subsequent operation with 9-carriage trains, or potentially 12-carriage trains, thereby meeting growth needs for a generation. Figures 8.3 and 8.4 illustrate capacity gains achieved by the preferred package.

Figure 8.3 : NORTHERN GROUP (Suburban Services Only)
Package 2 East West Tunnel with Tarneit Link
Patronage v Capacity

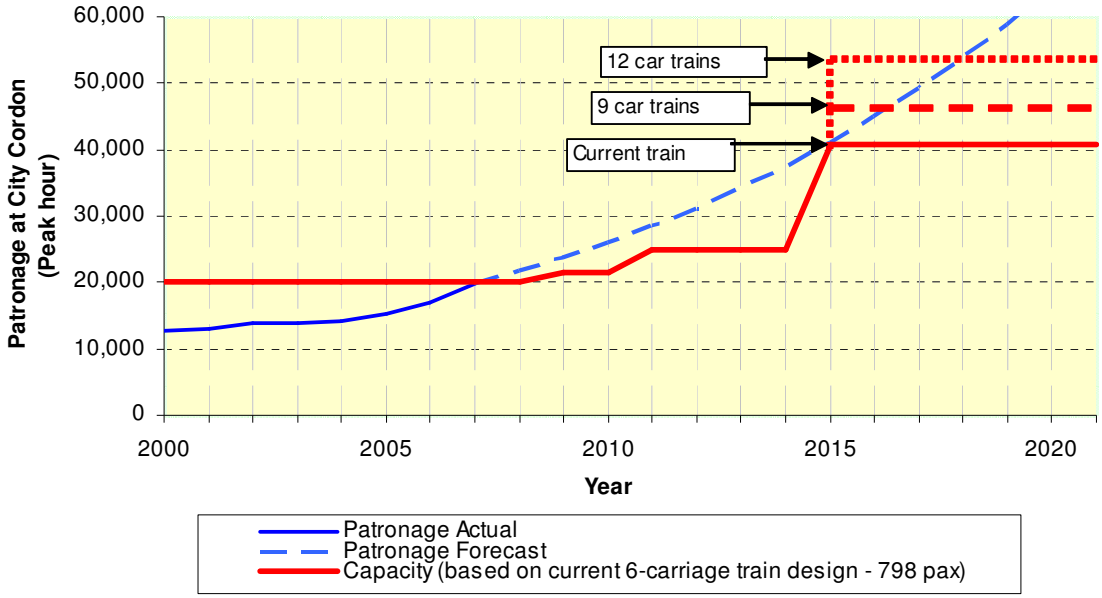
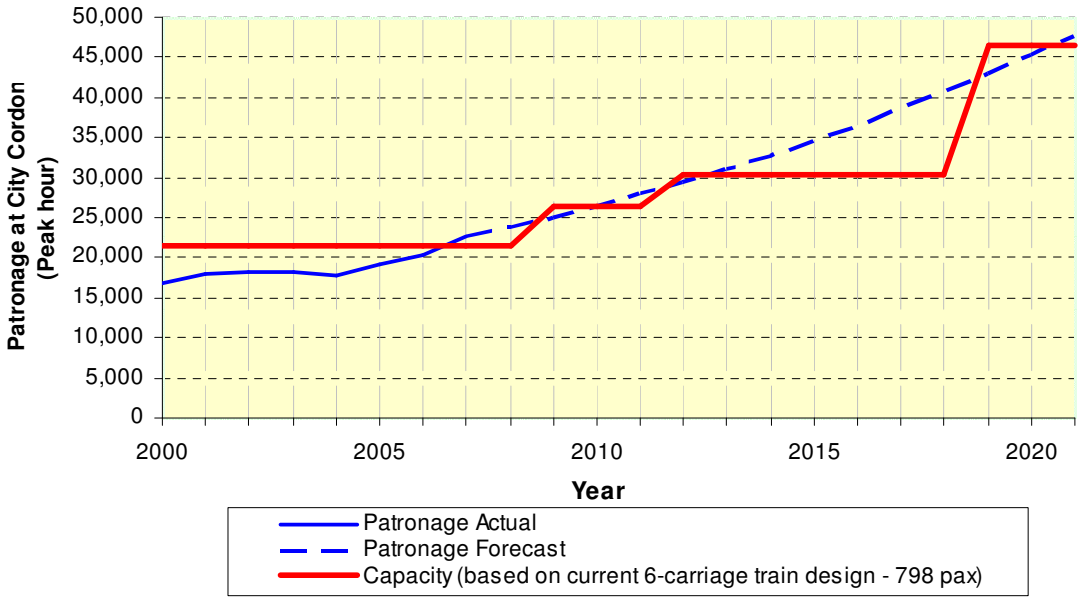


Figure 8.4: CAULFIELD GROUP (Suburban Services Only)
Package 2 East West Tunnel
Patronage v Capacity

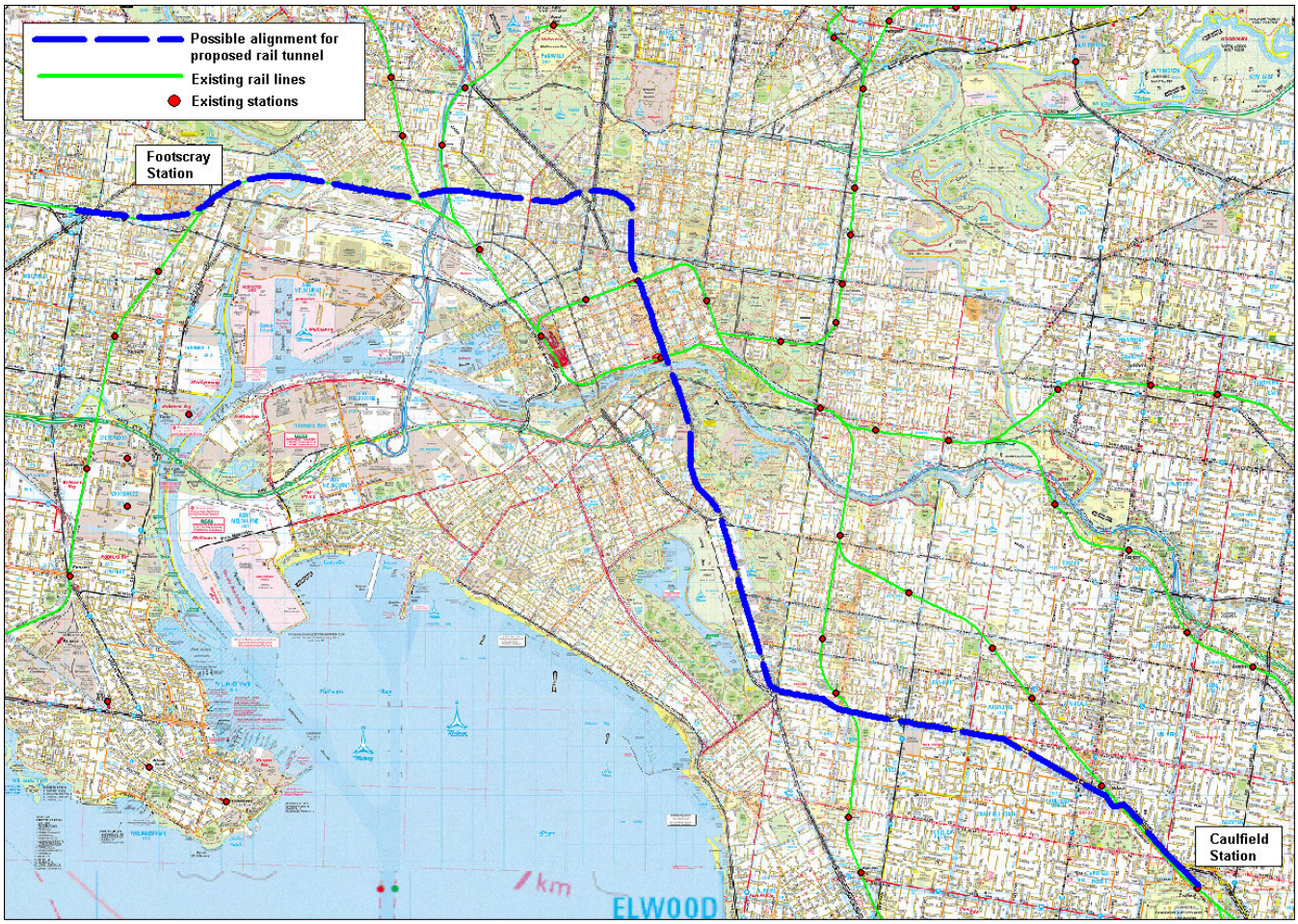


9. The East West Rail Tunnel

9.1. Alignment

Key areas that will influence a preferred alignment include operational strategies, portal locations, station opportunities, urban redevelopment opportunities, impact on rail operations and staging opportunities. The following figure proposes a preferred alignment that has been considered in providing capacity improvement to the inner core.

Whilst a number of options through the city have been considered at (William, Elizabeth, Swanston and Russell Streets), there is very little difference between them in terms of cost and functionality. The William Street option could be eliminated due to its additional cost and reduced accessibility. The remaining three are almost identical, with the main difference being that the Swanston Street alignment has the ability to alleviate tram capacity problems along Swanston Street and StKilda Road.



9.2. Tunnel Portals

One of the controlling issues as to the availability and diversity of options that could be considered are the issues associated with identifying suitable portal sites.

A portal in the vicinity of West Footscray can be achieved within the existing rail easement. A portal for the Caulfield Group could be considered in the vicinity of either the South Yarra or Caulfield.

i) South Yarra Area

Solutions involving a portal at South Yarra to serve the Dandenong and/or Frankston lines requires the provision of two additional tracks within the existing surface corridor between South Yarra and Caulfield in order ensure to make these options directly comparable to the Caulfield portal options.

The provision of the two additional tracks is challenging both from the engineering perspective (particularly relating to constructability and service disruption) and the social perspective (due to impacts on adjoining land uses). The cost of construction, including land acquisition, is expected to be not much lower than the cost of tunnelling. Given the extent of community impacts, and drawing on the Dandenong Rail Corridor Project experience, there is a risk that the approval processes could become very lengthy and could even jeopardise the project delivery.

It is important to note that a decision will be required as to the most efficient/effective allocation of scarce space within the corridor. Is it the best use of the space (and cost) to allocate it to suburban rail operation expansion in order to avoid the costs associated with a new tunnel route, or is it better to allocate it to potential future freight train operations to the corridor which are not well suited to tunnel style operations.

The demand for freight train operations already exists with freight services operating to Gippsland on the Dandenong line and to Long Island on the Frankston line but these services are generally able to be scheduled during the off peak periods thus avoiding adding to the peak capacity issue. The potential future development of the Port of Hastings is most likely to influence the future demand levels in the freight corridors and also the nature of the rail infrastructure required.

It is necessary to consider the cost of constructing two additional surface tracks in this corridor giving special consideration to land acquisition requirements, and historic station buildings. It is estimated that the addition of 2 new surface tracks would cost in the order of $1.5 billion.

Two options exist for placing a portal at South Yarra:

- Option 1 connects to the Sandringham line and as such does not resolve the anticipated future capacity problems between South Yarra and Caulfield.
- Option 2 requires substantial alterations to the corridor between Sth Yarra and Caulfield in order to feed capacity to the new tunnel. This will be costly to achieve, but probably comparable to the cost of a tunnel. However there are significant undesirable implications to this approach meaning that this option should not be considered further. These impacts will include:
  - Significant property acquisitions and modifications (eg Chapel Street shops, Jam Factory, private houses etc)
  - Major constructability issues in terms of the ability to gain access to the operating corridor to undertake the widening works
  - Disruptions to road traffic as all the bridges on the route are reconstructed
  - Removal of the outside platforms at each station along the route and modifications to the pedestrian footbridges that supply access to the remaining island platforms.
  - Heritage issues associated with the stations
  - Social impacts due to the construction works and potential damage to nearby properties
  - Social impacts on surround residential areas resulting from noise/vibration from increased train operations brought about by the additional throughput capacity enabled by the additional tracks
  - The trade off between providing capacity for suburban trains in the corridor as opposed for freight trains, especially with the potential development of a new port at Hastings. If standard gauge and double stack container criteria are to be achieved then this will not be compatible with the design of a suburban track and infrastructure. Therefore if the corridor capacity is absorbed for suburban operations then the option for freight access will be closed out.

Consequently no South Yarra portal options are taken through for further evaluation.

ii) Caulfield area

Access to the rail corridor in the vicinity of Caulfield is controlled by a number of local features.

The introduction of the tunnel back to the surface between Malvern and Caulfield Stations would lead to three primary infrastructure considerations:

- Sufficient space between the existing rail corridor to incorporate the tunnel ramps and the associated junction with the surface tracks
- Sufficient space at Caulfield to incorporate additional platforms
- The ability to upgrade Caulfield Station to perform the role of a significant interchange station

Area where the tunnel would connect to the rail network

The portal could be located between Malvern Station and Caulfield Station. The fact that the railway tracks are located on a significant embankment would lengthen the ramps of the tunnel and the options available would be limited by:

- The depth of the Dandenong Road underpass
- The midsection road underpass between Dandenong Road and Normanby Road.
- The midsection pedestrian underpass opposite the Bourke Road/Dandenong Road intersection

- The minimum height requirements for traffic using the Railway Avenue road underpass given that additional spans will need to be inserted. The bridge already has a road height limit of 3.9m. The Route 3 tram also uses this underpass.
- The presence of significant stances of mature trees in the reservation on both sides of the rail reserve.

Engineering assessment has identified that the reservation space towards the Caulfield end is less than that at the other end. At the Caulfield end, only two additional tracks can be fitted without significant property acquisition and road re-arrangement, whilst four additional tracks will fit at the Malvern end.

In order to support these portal options it would be necessary to expand the Caulfield Station platform capacity at grade, which will necessitate the acquisition of additional land. Options to the north are severely constrained by the close proximity of Sir John Monash Drive (which services Monash campus, contains the bus interchange, and has a tram stop at the intersection with Derby Road), Monash university Campus, and proposed Activity Centre development.

An at-grade station expansion is one of many options that would need to be investigated in detail to determine whether impacts on the surrounding area can be adequately managed. Alternative station layouts such as underground platforms would also need to be considered.

9.3. Station Options

The proposed alignment opens options to develop new stations at many locations. Options include:

- West Melbourne (a relatively underdeveloped area only 2kms from the CBD)
- Melbourne University
- Melbourne Central (connecting to the existing station)
- Flinders Street (connecting to the existing station)
- The Domain
- StKilda Road / StKilda Junction
- Windsor (connecting with the Sandringham line)
- Malvern area (1 or 2 stations)

The indicative costing in Section 10 allows for 8 new stations in addition to connections at Footscray and Caulfield.

9.4. Geotechnical issues

There are no serious impediments to tunnelling within the study area.

The vertical and horizontal tunnel alignment that is likely to present the most favourable tunnelling conditions through the CBD is a deep tunnel aligned beneath St. Kilda Road, Swanston St and passing up to University Square, and vertically aligned such that the tunnel is formed completely within the rock of the Melbourne Formation.

Tunnelling within the rock of the Melbourne Formation is likely to present less difficult challenges in tunnel construction than tunnelling at a shallower depth through the mixed ground of the Basalt and Yarra Delta sediments.

Tunnelling within existing road envelopes avoids the conflict with the foundations and basements associated with existing structures. The number of tunnels, tunnel configuration and diameter will all impact on the tunnel footprint and therefore the potential to interact with the sub-surface structures that exist outside of the road envelope. This will need close consideration once the preferred tunnel alignments are identified.

The factors that will influence the minimum tunnel depth along this alignment will be the depth of the Yarra Delta sediments, the existing Melbourne Rail Loop Tunnels, the CityLink Tunnels and the existing foundations and sub-surface structures. It is expected that to pass beneath the Yarra River, and stay within the Melbourne Formation, the tunnel will have to be in the order of -42mAHD deep.

At the intersection of Grant Street and St Kilda Road a tunnel depth of approximately -20mAHD is likely required to pass beneath the CityLink Tunnels and at Lonsdale Street a depth of approximately -15mAHD is likely required to pass beneath the existing rail loop tunnels. These tunnel levels will achieve a minimum clearance of one tunnel diameter below the stated existing sub-surface structures. Depths will need to be confirmed once an alignment has been confirmed.

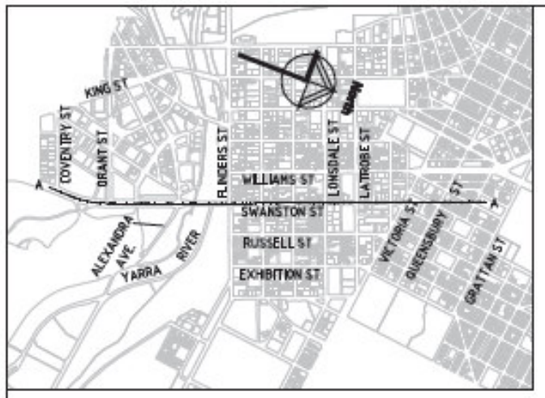
The main disadvantage of a deep tunnel will be the increased costs associated with the construction of stations at a greater depth, the higher running costs associated with trains operating on tracks at the limiting vertical geometry and stations at the low points, and longer passenger access travel distances.

Alternatively a shallow tunnel alignment may be feasible, however, there are several additional significant risks to be considered, these are:

- A higher potential to lower the ground water table which may induce increased regional settlement of the Coode Island Silt and cause damage to existing infrastructure.
- High potential to intersect significant groundwater aquifers beneath the Yarra River which will result in challenging tunnelling conditions and potential groundwater drawdown and surface settlement.
- Mixed ground conditions may impede tunnel progression and increase tunnelling equipment costs.
- Higher risk of undermining / intersecting / interacting with existing foundations, services and subsurface structures.

The main advantage of the shallower tunnelling option is the easier access that would be provided for passengers and reduced cost associated with the construction of the stations at shallower depth. However, this saving may be offset by the increased tunnelling costs associated with the above risks. The assessment of the feasibility of either vertical tunnel alignment is subject to obtaining further information on ground conditions and existing structures.

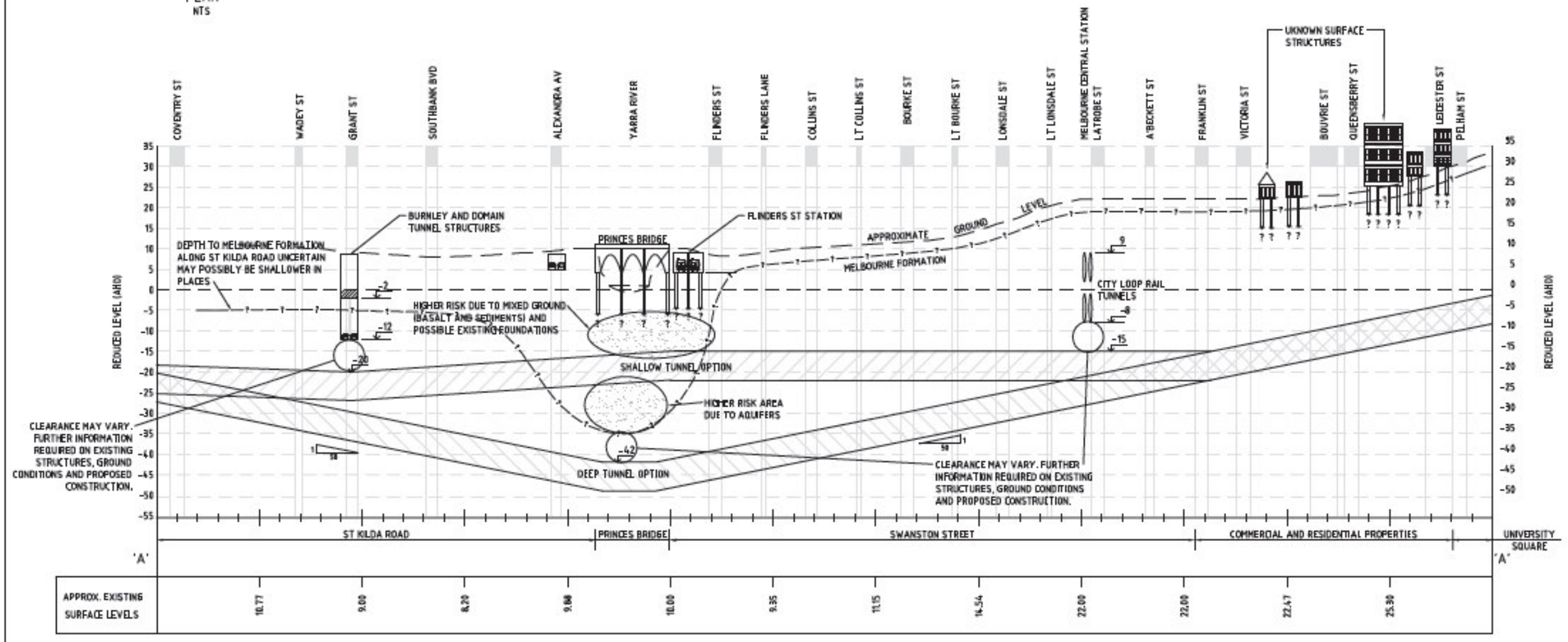
The following drawing provides a representation of the likely positioning of the tunnel under the CBD identifying the depth compared to the best information available at this time relating to the depth of features, structures and footings.



PLAN
NTS

NOTE:

1. TUNNEL DEPTH AND ALIGNMENT IS CONCEPTUAL ONLY. FURTHER ANALYSIS AND ADDITIONAL INFORMATION ON GROUND CONDITIONS AND EXISTING STRUCTURES IS REQUIRED TO ASSESS FEASIBILTY.
2. GROUND LEVEL APPROXIMATE.
3. LEVEL OF MELBOURNE FORMATION SHOWN IS ESTIMATE ONLY. FURTHER INVESTIGATION REQUIRED TO CONFIRM ACTUAL GROUND CONDITIONS.



SECTION A-A – SCHEMATIC LONG SECTION, ST KILDA ROAD TO UNIVERSITY SQUARE
NTS

REVISIONS

No.	BY	DATE	DESCRIPTION	APP'D
			REVISION IN PROGRESS	

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SECTION A-A
SCHEMATIC LONG SECTION
ST KILDA ROAD TO UNIVERSITY SQUARE

Status: SKETCH
Drg No.: 60027396/sk161007-1
Rev.

9.5. Construction concepts

There are many factors that will influence the approach to tunnelling. The basic choices for methods of tunnelling include:

- *Open cut / Cut and cover:* Cut-and-cover is a method of tunnel construction that is typically used for shallow depth tunnels. Generally speaking the construction involves the excavation of a cavity / trench from the surface (cut) which is roofed over (cover) to form the tunnel. Cut and cover tunnels may be constructed using 'top-down' or 'bottom-up' construction.

  'Top-down' construction involves the construction of the tunnel side walls and roof support structure from ground surface level. Once these structures are complete, excavation equipment removes the materials within the area bounded by the roof and walls (ie. area below the roof and between the walls) and the tunnel cavity is formed.

  In 'bottom-up' construction the tunnel cavity is excavated as a trench from the ground surface before construction of the permanent wall and the roof structure commences.
- *Road Header Machine:* Road Header Machines (RHMs) are typically used in rock and comprise of a track mounted machine with a cutting head mounted on a boom (a movable 'arm'). The cutting head type can vary dependant on the rock / soil type but generally comprises of a rotating head. The machine operator moves the boom and cutting head over the materials requiring removal, the rotating head displaces / rips the materials which are then loaded onto a conveyor for removal from the tunnel.
- *Tunnel Boring Machine:* Tunnel Boring Machines (TBMs) are purpose built 'all in one' tunnelling machines which can operate in a wide range of ground conditions, including rock and soil. The machine excavates materials using a full face (ie. full tunnel diameter) rotating cutter head. The cutting head components vary dependent on the ground conditions and groundwater conditions. A shield surrounds the machine to provide temporary protection to the operators from falling rock. In some cases, the shield also provides tunnel wall support. As the TBM progresses forward, temporary or permanent tunnel lining is placed through or behind the shield. The TBM progresses forward by either jack / pushing off the edge of the placed tunnel lining or by 'gripping' onto the natural materials of the tunnel walls and pushing forward. Materials are removed from the machine by means of a conveyor.
- *Drilling and Blasting:* Drill and blast excavation involves the detonation of explosive charges that have been installed in drill holes in the face of the advancing tunnel. This technique is typically used in rock conditions where strength is too great for mechanical excavation methods (such as excavation with a Road Header). Drilling and blasting breaks up and loosens the rock mass. Once broken and loosened, the materials are removed by underground truck loaders and placed in dump trucks that transport the rock out of the tunnel.

10. Indicative Cost Estimate

A high level cost estimate for the preferred package of treatments, comprising of the East West Rail Link and the Tarneit Link is in the order of $8.5 billion. An indicative breakdown of the estimate is as follows:

- East West Rail Tunnel –Western Section (Footscray to Domain) $4.5 billion
- East West Rail Tunnel – Eastern Section (Domain to Caulfield) $2.5 billion
- Western Suburbs Tarneit Link (Werribee to Deer Park) $1.5 billion

11. Staging

A major tunnelling project from Caulfield to West Footscray, some 17km or more, and a new rail corridor through Tarneit, some 34km, would take a number of years to deliver. Therefore, if this approach is to be successful it will be necessary to divide the project into manageable stages such that the benefits of the total scheme can be progressively delivered and benefits realised. The following is a suggested conceptual approach. Significant additional work would be required in order to prove the staging concepts before accepting this as a solution.

- Stage 1 – East West Rail Tunnel Western Section, Footscray through to Domain plus Tarneit Link

- Stage 2 – East West Rail Tunnel Eastern Section, tunnel continues from Domain through to Caulfield

Timing of the proposal will be dependant on the appropriate planning approvals process and availability of appropriate construction resourcing.

12. Other considerations

Freight Context

The movement of freight is a derived demand and a function of production and consumption in the context of the demographic and geographic characteristics of the location of that movement. It is a private sector activity undertaken on public (largely) infrastructure, which is generally shared with other users. It occurs in the context of global supply chains and is influenced by local and global financial effects, and Government policy.

The efficient and safe movement of freight is recognised as being important to the Victorian economy. This relates to the movement of domestic freight, and also interstate and export trade. In addition to being efficient and safe, freight transport impacts on the environment and amenity need to be minimised to ensure the liveability of Melbourne (in particular) continues to be highly rated. However, the prevailing dynamics of the freight transport system may alter substantially over the next two to three decades as population increases (potentially substantially increasing traffic congestion in Melbourne), community standards for safety and amenity increase, and environmental considerations increase in prominence (especially GHG minimisation and an increased price for energy).

For supply chains that operate in or through Victoria to remain globally competitive it is necessary for the most efficient transport mode(s) to be used as part of those supply chains. While the market is generally effective in this regard, there may be some areas of market failure, including the market's inability to address deficiencies in public infrastructure and regulation. The market is also relatively unable to account for unpriced externalities.

In this context, the Victorian Government has a policy of seeking to increase the rail mode share for freight, especially from Ports. This is articulated in strategies, such as the draft Port@L Strategy, including the potential development of metropolitan container shuttle trains and a network of outer metropolitan inter-modal (road/rail) terminals / inland ports.

South Eastern Rail Freight

The concentration of industry and population in the south-eastern suburbs suggests the potential development of a major inter-modal facility in the Dandenong region, potentially at Lyndhurst.

In addition, while the focus of port development will be at the Port of Melbourne for the foreseeable future, the Port of Hastings offers potential for development in the longer term. A range of options to improve rail connections to Hastings are currently being explored.

Separately or collectively these two developments would require an expanded capacity for rail freight movement between the south-east and the existing interstate rail freight network focussed on the rail yards adjacent to the Port of Melbourne. There are no easy options for providing this capacity.

The most viable option is to expand the use of the existing Dandenong rail corridor. The existing rail reservation offers potential for additional rail tracks between Dandenong and Oakleigh. Between Oakleigh and the Port of Melbourne the available reservation is severely constrained and land acquisition would be problematic. Further, projected passenger railway growth alongside a freight railway will lead to the need to grade separate the road and rail movements. The only potential answer is to find an alternate route with a new underground link being the best option.

The characteristics of passenger and freight railways are significantly different with the passenger railway able to tolerate much greater gradients and curves than the freight railway. Also, an underground passenger railway is able to be constructed with stations at strategic locations which enhances transport opportunities and regional development. For these reasons, the underground railway needs to be a passenger system as described elsewhere in this report.

The alignment of the surface railway between Oakleigh and Richmond is suited for freight train operations. With the long term projected freight track and the efficiencies able to be gained from modern freight train operations, it is most likely that the surface railway operating with freight only services would not require grade separations. A new underground rail freight link between Richmond and Dynon, and possibly further west, would be unavoidable in the long term if the rail freight task is to grow substantially and freight train movements through the CBD are considered unacceptable.

Northern and Western Rail Freight

There is potential to further develop a major inter-modal facility to the north of Melbourne, at Somerton and possibly at Donnybrook, to allow transfer of interstate freight movement to and from the north to transfer between road and rail. A dedicated freight rail link already exists between Donnybrook and the Port of Melbourne that could be developed to meet an expanded demand.

There is also potential to develop a major inter-modal facility to the west of Melbourne. No site has been identified for such a facility. The development of the Tarneit rail line for passenger services would open up a range of options for a new facility connected with the existing freight rail network at Sunshine.

Any development of a Melbourne-Brisbane inland railway would increase the interstate rail freight task and may bring forward the need for the above facilities.

Urban Redevelopment

Construction of the East West Rail Link would create options for redevelopment around new stations.

In particular, a new station in West Melbourne would encourage higher value use of land currently used for industrial and light industrial purposes within 2 kilometres of the CBD, similar to the current redevelopments to the south (Southbank) and the west (Docklands) of the CBD.

Other key areas which may provide urban renewal opportunities include West Footscray, Footscray, particularly supporting its function as a transit city, Carlton and the hospital precinct, and the Domain. Further opportunities may exist on the eastern section depending on where new stations are included in the tunnel.

Impacts on the Tram System

The corridor between Melbourne University and StKilda Road is one of the busiest corridors in Melbourne. The corridor is served by numerous tram routes operating to and from suburbs to the north and south. Tram stops are amongst the busiest loading points in the network, busier than most railway stations.

The concentration of nine tram routes in Swanston Street is close to the limit of capacity of operations.

The East West Cross City Rail Link would allow many commuters from the Northern and Caulfield Groups to directly access Melbourne University and StKilda Road without needing to transfer to trams. Similarly, rail commuters from the Clifton Hill and Burnley Groups could transfer to the new train link to complete their journey.

Impacts on the Environment

The East West Rail Link would allow for the metropolitan rail system to carry significantly more people, relieving road congestion and reducing the environmental impacts of the transport system. By allowing approximately 34,000 additional people to access the city by rail during the peak hour, at least 60,000 tonnes of greenhouse gases would be saved per annum. Diverting travel from cars to rail would also reduce air pollution health impacts, noise, and improve amenity.

13. Conclusions & recommendations

Continuing strong growth in patronage on Melbourne's trains has led to overcrowding and declining service reliability. Progressive expansion of the capacity of the rail system will be needed if it is to meet the future transport needs of Melbourne.

Various initiatives are underway or planned to expand capacity to meet needs for the next decade. At that point, however, further growth will be constrained by the limitations of the central area, particularly as it affects the Northern and Caulfield rail groups, and western access to the central area.

Demand projections clearly indicate that the Northern and Caulfield Groups will have problems in satisfying the future movement of passengers into Melbourne's CBD.

In order to continue to satisfy passenger demand, a 'bypass' of the inner core area will be required or additional capacity added to the existing infrastructure. Without these measures it is expected that the network's reliability will diminish and its ability to provide a competitive public transport option to the growth areas of Melbourne will be significantly constrained. Furthermore, it is considered that this constraint will also have a negative affect on the growth of central Melbourne.

The network's ability to continue to operate reliable services whilst capacity of the infrastructure is increased will be a key challenge in coming years. Most infrastructure options will have significant disruptive elements which will affect passenger confidence in the system.

A new underground rail link between the Northern and Caulfield groups (the East West Rail Link) would provide capacity for growth for a generation, similar to the doubling in train patronage enabled by the construction of the existing Underground Loop a generation ago. At the same time it would open opportunities to develop rail freight services in the Caulfield corridor.

An East West Rail Link is technically feasible and would involve a 17 kilometre two-track tunnel between West Footscray and Caulfield, 7 new stations, and connections to Melbourne Central and Flinders Street Stations. Construction could be staged to match growth in demand.

The East West Rail Link would only address Inner Core capacity constraints and significant capacity upgrades will be required in the western suburbs for the Northern Group of rail services to be able to cater for projected growth. A Tarneit link would provide the required capacity improvement in the west by completely segregating metropolitan operations from V/Line operations, and would enable full utilisation of the East West Rail Link.

The project would cost an estimated $8.5 billion and take a decade to plan, design and construct.

A strategy that that packaged the East West Rail Tunnel with the Tarneit Link would enable the rail network to be managed effectively over the next generation, and could be operationally staged as follows:

Stage 1 – East West Rail Tunnel Western Section plus Tarneit Link
Stage 2 – East West Rail Tunnel Eastern Section

The package would:

- more than double the capacity of both the Northern and Caulfield groups of lines, the lines serving four of the five Growth Areas of Melbourne;
- provide capacity for an additional 40,000 commuters to enter and leave the CBD each hour, equivalent to the construction of 20 new freeway lanes to each of the west and south-east. On existing roads these trips would add some $600 million each year to traffic congestion costs and $200 million each year to car parking costs;
- reduce greenhouse gas emissions by 60,000 tonnes each year compared with the alternative of not providing additional rail capacity;
- reduce travel times for individual commuters by as much as 20 minutes;
- provide capacity for the rail network to be extended into growing outer suburbs in the future;
- provide opportunities to introduce new technologies into Melbourne's railways, such as new signalling technologies for the East West Rail Tunnel or much longer trains, thereby further expanding the capacity for growth;
- provide opportunities for expansion of rail freight capacity when needed for the development of inland ports and the development of the Port of Hastings;
- provide opportunities for urban redevelopment around new stations; and
- provide capacity for travel in the busy Melbourne University-StKilda Road corridor, relieving pressure on tram services in Swanston Street.