SOUTH WEST GROUP

A Co-operative venture of the municipalities of:
Cockburn, East Fremantle, Fremantle, Kwinana, Melville & Rockingham

Date: 12 February 2014
Contact: Mick McCarthy (08) 9364 0631
Reference: SWG Submission – Inquiry into Public Transport and Productivity

The Committee Secretary
Senate Rural and Regional Affairs and Transport References Committee
PO Box 6100
Parliament House
CANBERRA ACT 2600
Australia

Dear Sir/Madam

SOUTH WEST GROUP SUBMISSION – INQUIRY INTO THE ROLE OF PUBLIC TRANSPORT IN DELIVERING PRODUCTIVITY OUTCOMES

The South West Group welcomes the opportunity to lodge this submission on the above. The South West Group, formed in November 1983, is a Voluntary Regional Organisation of Councils (VROC). It comprises the Cities of Cockburn, Fremantle, Kwinana, Melville, and Rockingham, and the Town of East Fremantle. The South West Group is managed by a Board consisting of the Mayors and CEOs of its member local governments.

The South West Group seeks to work with these six local governments and through cooperation with industry, community and the other spheres of government to capture a wide range of opportunities to enhance economic growth as well as supporting a diversity of quality lifestyles whilst servicing and sustaining cohesive, productive communities in an enviable environmental setting.

Public transport is a key focus for the South West Group given its significant social, environmental and economic benefits, and potential to reduce car dependency and congestion.

The South West Group's Transport and Land Use Policy supports the following position in regards to public transport:

- High quality public transport integrated with active modes of transport, affordable living, targeted higher residential density and increased local employment
- Greater investment in public transport infrastructure and services to improve personal mobility and accessibility within and across the region

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- Improved intermodal functionality for public transport passengers
- Bus rapid transit (BRT) and light rail in meeting the future public transport needs of the region

Congestion in the South West Metropolitan Region has a major impact on the Australian and West Australian economies due to the significant contribution of the South West Metropolitan Region economy to trade and GDP.

The $30 billion Gross Region Product (GRP) from the South West Metropolitan Region will continue to grow over time and increase further if regional productivity can be improved. At present one dollar in every six dollars of personal income in Western Australia is earned by residents living in the South West Metropolitan Region.

Strong population growth, increased residential densities and employment growth result in increased traffic volumes, which combined with a corresponding expansion of road freight, are contributing to readily evident congestion throughout the region. Further growth will exacerbate congestion over the next 20 years.

Part of the solution to congestion is a quantum change in the use of public transport within and across the region. Increasing residential density, in conjunction with the growth of activity centres and within the inner suburbs, will make high frequency and high quality public transport viable.

The annual avoidable social cost of congestion in the South West Metropolitan Region has been calculated at $300 million at present and increasing to $450 million by 2020. The projected avoidable costs of congestion on roads in the Perth metropolitan area will increase by 70% in the 10 years to 2020 (BTRE, 2007, Estimating urban traffic and congestion cost trends for Australian cities: Working paper 71, BTRE, Canberra ACT)

The South West Group has set a target of 30% of all trips on public transport by 2031 in implementing the objectives of the Western Australia's Directions 2031 and Beyond planning initiaitve. There is a convergence of technology between light rail and bus rapid transit making high quality public transport more affordable.

The South West Group has a major advocacy role to play in communicating the extent of growth and congestion in the South West Metropolitan Region, promoting local employment whilst supporting the work of its member Councils in stimulating behaviour change to walking, cycling and public transport. The South West Group is also an advocate for light rail and the development of bus rapid transit using new technology buses.

Examples of relevant studies undertaken in the region regarding light rail and transit corridors include the Southwest Metro Transit Network Study (Parsons Brinckerhoff, 2011) and the South West LRT Corridor Study: Murdoch to Fremantle 2013 (refer to Attachments 1 and 2).

The South West Group member Councils has also been active in investigations, research, planning and feasibility studies on public transport and mass transit in the region. Of particular relevance are some of the more recent economic and cost benefit studies undertaken by the City of Melville that considered to role of public transport in supporting activity centres and municipality wide strategic initiatives.

A summary of this work is provided in the case study below and copies of the reports referenced in the case study can be provided on request.

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Case Study – City of Melville and Murdoch Activity Centre

The City of Melville commissioned a number of key economic studies that highlight the need for effective public transport systems to support employment and business investment in activity centres.

Melville to 2050 Intergenerational Local Government report[1] identified increased localised congestion in the City of Melville, as a result of greater levels of employment activity, and the requirement for increased public transport to support localised travel networks and relieve productivity losses associated with traffic congestion.

The Murdoch Activity Centre (MAC) Costs and Benefits report[2] is a detailed study focussing on the transit oriented development (TOD) located in Murdoch and containing the Fiona Stanley Hospital, St John of God Hospital, Murdoch University, Challenger Institute, Murdoch Train Station and proposed mixed use and other developments.

TOD is a planning approach that promotes using both urban land and infrastructure efficiently to maximise community benefit, by clustering specific activities (including commercial, residential, retail or other uses) around public transport nodes and improving residential access to the transport facility.

The MAC Costs and Benefits report identified the need for regional improvements by the public sector in line with long□term funding for public transport services and interchange infrastructure, traffic intersections, service relocation and road infrastructure delivery

Macroplan estimated that the optimal development scenario for the MAC would deliver a $3 to $1 benefit cost ratio as a successful TOD and major employer in the region based on a range of road and transport improvements including public transport infrastructure (additional rail cars, station upgrades and signalling and bus transport) as critical components.

[1] *Melville to 2050 Intergenerational Local Government (Macroplan Australia, 2011a)*
[2] *Murdoch Activity Centre (MAC) Costs and Benefits report (Macroplan Australia, 2011b)*

The South West Group has also initiated work on the study known as *Our Public Transport Future*.

Our Public Transport Future outlines elements of the three tiers of public transport in terms of opportunities and constraints by proposing how the South West Metropolitan Region should collaborate with the State Government in planning and implementation of the public transport network, advocate on the circumstances for adopting and advancing the public transport network in the region and identify and promote opportunities for attracting users to public transport.

The elements of transition to *Our Public Transport Future* are proposed as follows:

- Identify transit priority routes
- Engage with current activity on planning the Thornlie-Canning Vale-Glen Iris-Cockburn Central Rail Line
- Promote discussion and understanding of new transport technology
- Work to progressively improve intermodal functionality and connectivity at major rail stations
- Seek a firm timetable for new rail stations such as Karnup and transport links to Keralup
- Explore opportunities for partnerships with the private sector for linking major public transport routes to industrial areas with Cat Type and shuttle services

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- Support trials of new transport technology within the South West Metropolitan Region
- Seek to have a metropolitan wide coordination mechanism for transport and land use between State Government and Local Governments

The South West Group has identified a range of activity centres and transit orientated developments (TOD) in the South West Metropolitan Region that rely upon effective public transport networks and services including:

- Karnup – Keralup
- Wellard – Kwinana
- Aubin Grove (Success/Mandogalup)
- Cockburn Central
- Cockburn Coast
- Canning Bridge
- Garden City Murdoch Activity Centre and
- Rockingham Strategic Metropolitan Centre

Other key employment centres requiring improved public transport infrastructure and services include Jandakot City and Garden City Shopping Centre, with the latter about to undergo a $450 million expansion.

A copy of the preliminary draft of the *Our Public Transport Future* paper is provided in Attachment 3, which includes more detailed descriptions of the activity centres and TOD's in the region where further investment in public transport infrastructure is required.

The South West Group member Councils have been working pro-actively with State and Federal Government to ensure that the land use planning is integrated with transport planning and the provision of public transport in these growth centres. Providing affordable housing and higher density dwellings in and around these activity centres is a key strategy for increased productivity and the optimisation of public transport investment in the region.

It is clear from the studies undertaken and the experiences gained in the development of activity centres that more investment in public transport is urgently required, particularly in regards to efficient and well connected cross regional and mass transit modes of public transport that connect people to employment centres.

The current public transport network will not be able to cope with the projected increase in public transport use and growth of the metropolitan area. A significant change in the way public transport is funded and operates is required if it is to play its crucial role in reducing congestion, improving accessibility and reducing car dependency and the consumption of fossil fuels. Over the next 17 years, much of the investment in public transport infrastructure and system improvements is needed within 15 – 30 km of the Perth Central Business District.

The funding for public transport relies upon the State and Federal Government taking lead roles. Funding delays for the MAX light rail project recently announced by the Western Australian State Government and announcements from the current Federal Government indicating reluctance to contribute funding toward public transport will have a long term and detrimental impact on delivering productivity outcomes for the region and the nation.

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Improving public transport is an issue of national significance and therefore requires ongoing financial support from the Federal Government to reduce productivity impacts caused by congestion. Research undertaken by the Grattan Institute (Productive Cities) and the Committee for Perth (FACTBase Bulletin 21) strongly support the business case for increased investment in public transport and associated economic and social benefits.

The South West Group requests that the Federal Government reconsider its position on public transport funding and work with the Western Australian State Government to establish a long term investment plan for public transport.

I trust that consideration will be given to the feedback provided in this submission.

If you have any queries regarding this correspondence, please contact the Director South West Group (Mick McCarthy) by email director@southwestgroup.com.au, phone on (08) 9364 0631 or mob 0478 325 469.

Yours sincerely,

Logan Howlett
Chair South West Group

Attachment 1: South West Metro Transit Network (Parsons Brinckerhoff, 2011)
Attachment 2: South West LRT Corridor Study: Murdoch to Fremantle (Crocker, 2012)
Attachment 3: Our Public Transport Future – draft paper prepared by the South West Group (in prep)

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Southwest Metro Rapid Transit Network Study - Recommendations Report

September 2011

Transit Study Steering Group

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Author: R. Dick.....

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Signed: .....

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Distribution: .....

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Executive Summary

LandCorp, along with Cities of Fremantle, Cockburn and Melville are investigating the requirements for a future rapid transit network, within the southwest metro area of Perth. The Southwest Metro Rapid Transit Network study aims to achieve the following objectives:

- Increase the mode share for public transport by providing higher quality and more reliable transit services
- To enhance the network effect by improving the integration of transit services from the study area to the wider Perth Metropolitan network
- To link key activity centres through high quality transit services
- To provide a catalyst for development.

This report will also be used to inform the draft Public Transport Plan for Perth in 2031 (draft 2031 plan) and present a case for BRT/LRT investment within the southwest metro area.

The study incorporated the following stages in order to reflect a structured approach to planning the rapid transit network for the southwest metro area:

- Identify key activity centres (existing and future)
- Identify all potential rapid transit corridors
- Shortlist transit corridors through a rapid appraisal
- Develop a preferred rapid transit network, from the shortlisted transit corridors
- Recommend a preferred rapid transit network and mode options for the southwest metro area, based upon a patronage forecasting, high level indicative costs and benefits assessment and other considerations.

The Directions 2031 and Beyond state planning policy was used to guide the identification of the existing and planned key activity centres within the Southwest Metro study area. Potential rapid transit corridors were then identified, with a focus on linking the key activity centres. The potential rapid transit corridors were then shortlisted based on an appraisal against the following five guiding principles:

- Linking key activity centres, meeting minimum destination employment and residential thresholds (Fatal flaw guiding principle)
- Minimising impacts to the community and the road network (Fatal flaw guiding principle)
- Opportunities for rapid transit to catalyse development
- Increasing the mode share for public transport
- Enhancing the network effect.

The shortlisted rapid transit corridors then formed the recommended Southwest Metro Rapid Transit Network, as shown in the figure below. This network and the individual corridors were then further investigated in terms of forecast patronage and a high level indicative costs and benefits assessment in order to assist in developing recommendations for the preferred mode to operate the network.

Recommended Southwest Metro Trunk Rapid Transit Network

A summary of the key recommendations and supporting data is presented in the below Table.

Recommendations Summary

Mode Recommendations						
	Rapid Transit Corridor					
	Fremantle – Canning Bridge	Fremantle - Murdoch	Cockburn Central – Cockburn Coast	Murdoch – Canning Bridge	Cockburn Coast - Murdoch	Cockburn Coast - Fremantle
Recommended Mode (2031)	BRT	BRT to LRT	BRT	BRT	BRT	BRT to LRT
Draft 2031 transit plan proposal	Future Rapid Transit (post 2031)	BRT (2031)	BRT (2031)	Half BRT (2020/2031)	No BRT/LRT	BRT (2020) LRT potential post 2031
Corridor Length	12.4	11.8	14.6	9.5	14.1	5
BRT boardings/km	1,357	977	696	1,105	787	1,914
LRT boardings/km	1,566	1,146	879	1,275	908	2,324
Employment density (jobs/km)	2,146	3,218	610	1,819	1,333	4,301
Re-development potential	East and west ends	East and west ends	East and west ends	Around rail stations	East and west end	Along entire corridor

A summary of the table above has been provided to further discuss the recommendations and key results of the Southwest Metro Rapid Transit Network Study:

Recommended mode (2031):

BRT has been recommended on all the corridors forming the Southwest Metro Rapid Transit Network, with the Fremantle to Murdoch and Cockburn Coast to Fremantle corridors also recommended for incremental staging from BRT to LRT at 2031. The recommendations for incremental staging from BRT to LRT on these corridors were formed through consideration for a number of factors, as investigated as part of the Southwest Metro Rapid Transit Network Study:

- High level costs and indicative benefits assessment
- Patronage forecasting
- Investigation into the employment potential within rapid transit corridors
- Opportunities for LRT to catalyse development
- Accessibility benefits

It is also recommended that a staged approach to the introduction of BRT on these corridors (as recommended in the draft 2031 plan) should be investigated further, in particular for sections that

experience significant congestion and where the passenger flow by public transport is higher than that the passengers moved by private vehicle.

The recommendations for each of the southwest metro rapid transit corridors were formed based upon the following:

Fremantle to Canning Bridge:

This corridor achieved a forecast patronage that warrants the introduction of BRT, combined with the direct access that this corridor provides to the Mandurah rail line at the Canning Bridge Station. LRT was not recommended on this corridor due to the level of employment opportunities within the corridor, with the exception of the Fremantle CBD, which limits the accessibility benefits that could be achieved through this mode.

Fremantle to Murdoch:

The Fremantle to Murdoch corridor was recommended as an initial BRT with incremental staging to LRT at 2031. Due to the level of employment and re-development potential available at the Murdoch Activity Centre, substantial accessibility benefits within the study area can be attained. The results of the rapid appraisal cost-benefit analysis also provides further support for this recommendation, as this corridor ranked within the top three corridors for BRT and LRT.

Cockburn Central to Cockburn Coast:

This corridor has been recommended for BRT at 2031, which aligns with the draft 2031 plan recommendation. This corridor will provide a strategic connection between Cockburn Coast and Cockburn Central, with a range of potential alignment opportunities available to access key activity centres, such as Spearwood and the Bibra Lake Industrial area. The preferred alignment on this corridor will require further investigation. LRT was not recommended on this corridor due to the lower forecast patronage and employment densities, when compared to the other corridors.

Murdoch to Canning Bridge:

The Murdoch to Canning Bridge corridor provides a strategic north-south connection to the Booragoon bus interchange and has been recommended as BRT for this reason as well as the level of patronage forecast on the corridor. LRT was not recommended on this corridor due to the low employment accessibility benefits (excepting the Murdoch Activity Centre) that could be achieved through this mode. Integration with the Booragoon bus interchange is also a consideration, which supports the recommendation of BRT.

Cockburn Coast to Murdoch:

The Cockburn Coast to Murdoch corridor was recommended as BRT and provides a second north-south connection within the recommended Southwest Metro Rapid Transit Network, linking the Spearwood activity centre with Kardinya Park Shopping Centre and further onto Murdoch Activity Centre. LRT was not recommended on this corridor due to the lower forecast patronage and employment densities, when compared to the other corridors.

Cockburn Coast to Fremantle:

The Cockburn Coast to Fremantle corridor was recommended as an initial BRT with incremental staging to LRT at 2031, due to the forecast patronage density, level of employment and re-development potential available at Cockburn Coast and other locations along this corridor. The results of the rapid appraisal

cost-benefit analysis also provides further support for this recommendation, as this corridor ranked within the top three corridors for BRT and LRT.

Draft 2031 transit plan proposal

The draft 2031 public transport plan for Perth (draft 2031 plan) provides a number of rapid transit corridor and mode recommendations for the 2020 and 2031 scenarios within the southwest metro study area. As shown in the table above, there are some key differences between the recommendations from the draft 2031 plan and the Southwest Metro Rapid Transit Network Study, including:

- BRT has been recommended on the Fremantle to Canning Bridge corridor at 2031, as part of this study
- BRT with incremental staging to LRT has been recommended on the Fremantle to Murdoch corridor
- BRT has been recommended on the entire corridor from Murdoch to Canning Bridge, via Booragoon
- BRT has been recommended on the Cockburn Coast to Murdoch, via Spearwood corridor
- BRT with incremental staging to LRT has been recommended on the Cockburn Coast to Fremantle corridor

This report represents a submission to the draft 2031 public transport plan for Perth and provides an alternative view to the provision of rapid transit within the Southwest Metro area. One of the objectives of the Southwest Metro Rapid Transit Network study was to inform the draft 2031 plan and therefore the DOT are encouraged to review and consider the recommendations outlined in this report.

Corridor length

The corridor lengths are represented in the table above and were calculated based upon the modelled alignments that were identified as part of the study to guide the patronage forecasting task. It should be noted that further investigation is required to determine the preferred alignments for each corridor.

BRT/LRT boardings/Km

The BRT/LRT boardings/km provides an indication of the forecast (2031) patronage density across each corridor. These figures provide an indication as to the likely uplift in patronage that may be achieved for LRT over BRT. The patronage forecasting results indicate that the Cockburn Coast to Fremantle provides the highest patronage density of all the corridors, which can be attributed to the high population and employment density within the corridor.

It is recommended that the DOT provide an improved level of direction in the draft 2031 plan in relation to the patronage warrants for rapid transit (BRT/LRT), with consideration for patronage density (i.e. boardings/km).

Employment density

The employment density provides an indication as to the number of employment positions per kilometre along the corridors, to provide further supporting information to the patronage forecasting data also provided (i.e. boardings/km). It should be noted that the majority of employment within these corridors is concentrated on the eastern and western edges of the southwest metro study in areas, such as Fremantle CBD, Murdoch Activity Centre and Cockburn Coast, rather than being uniformly distributed across the length of the corridor. This data indicates that the employment concentration is highest in the Cockburn Coast to Fremantle and Fremantle to Murdoch corridors, which further supports the rapid transit recommendations for these corridors.

Re-development potential

A broad assessment was undertaken to investigate the re-development potential within each of the recommended rapid transit corridors that could occur as a result of the introduction of rapid transit, in particular LRT. This assessment indicated that the majority of corridors only demonstrated re-development potential on the east and western edges of the corridors at the key activity centres, with limited opportunities distributed along the lengths of the corridors. The Cockburn Coast to Fremantle corridor was the exception, due to the development potential at the Douro Road shopping precinct and Cockburn Coast district centre. This corridor was also significantly shorter than the other corridors and covers higher density areas due to its proximity to Fremantle and South Fremantle.

General Recommendations

The recommended rapid transit network for the southwest metro area has been developed to provide a foundation to prioritise further detailed investigations to be undertaken along each individual rapid transit corridor. It is recognised that more detailed alignment investigations and economics studies are required within each of the recommended rapid transit corridors to determine the potential viability for rapid transit in the future to increase the public transport mode share and to catalyse development around proposed stations.

The draft 2031 plan outlines warrants relating to rapid transit within Perth, however it is also recommended that consideration be given to other factors in addition to patronage that can further justify investment in rapid transit, including:

- Improvements to accessibility
- The influence of rapid transit in catalysing development around stations
- Cost and benefits analysis.

1. Introduction

LandCorp, along with Cities of Fremantle, Cockburn and Melville are investigating the requirements for a future rapid transit network, to achieve the following objectives:

- Increase the mode share for public transport by providing higher quality and more reliable transit services
- To enhance the network effect by improving the integration of transit services from the study area to the wider Perth Metropolitan network
- To link key activity centres through high quality transit services
- To provide a catalyst for development.

The Southwest Metro Transit Network study will also be used to inform the draft Public Transport Plan for Perth in 2031 (draft 2031 plan) and present a case for BRT/LRT investment within the southwest metro area.

1.1 Methodology

The project was undertaken in the following stages:

- Identify key activity centres (existing and future)
- Identify all potential rapid transit corridors
- Shortlist transit corridors through a rapid appraisal
- Develop a preferred rapid transit network, from the shortlisted transit corridors
- Recommend a preferred rapid transit network and mode options for the southwest metro area, based upon a patronage forecasting, high level indicative costs and benefits assessment and other considerations.

In addition to the elements listed in the methodology this report includes:

- Guiding principles used to assess the initial list of corridor options through a high level rapid appraisal
- Key assumptions
- Review of the Public Transport for Perth in 2031 draft report
- Baseline conditions data sourced within the study area, including: demographic, public transport and traffic data

1.2 Study area

The study area for the Southwest Metro Rapid Transit Network Study, shown in Figure 1.1 incorporates the Cities of Fremantle, Melville and Cockburn and extends to the Swan River in the North, the Kwinana Freeway/Mandurah rail line in the east, the Indian Ocean in the west and the Beeliar Drive corridor between Woodman Point and Cockburn Central Station in the south.

The extents of the study area were agreed to by the TSSG, prior to commencing the study; however it should be noted that broad references will be made to rapid transit connections to other key activity centres in the vicinity of the southwest metro study area. It should also be noted that the Draft 2031 public transport plan for Perth provides recommendations for the rapid transit network across the Perth metropolitan network, including the area in the vicinity of the southwest metro study area.

Figure 1.1 Southwest Metro transit network study area

2. Key activity centres

Table 2.1 shows the centres that have been defined as key activity centres in the State Government Directions 2031 policy and have therefore been considered to be an integral part of the Southwest Metro Rapid Transit Network Study. The key activity centres within the study area are also shown in Figure 1.1.

It has been recognised that there are a number of other activity centres within and surrounding the southwest metro study area that may generate public transport demand, however for the focus of this study has been placed upon linking the key activity centres defined in the Directions 2031 policy, as outlined in Table 2.1.

Table 2.1 Key activity centres

Activity Centre	Definition (Directions 2031 Policy)	Descriptions
Fremantle	Strategic Metropolitan Centre	Multi-purpose centres that provide a mix of retail, office, community, entertainment, residential and employment activities and are well serviced by high frequency public transport
Cockburn Central	Secondary Centres	These centres form the next tier of the activity centres hierarchy. They share similar characteristics with strategic metropolitan centres but generally serve smaller catchments and offer a more limited range of activities and employment opportunities
Booragoon		
Murdoch Activity Centre	Specialised Centre	These centres provide strong specialised roles based around major institutions, located within the centre (i.e. Murdoch University and proposed Fiona Stanley Hospital)
Cockburn Coast	District Centres	These centres serve a lower order of services than the Secondary centres and are generally focused on servicing the daily and weekly needs of residents
Phoenix Road Shopping Centre		
Canning Bridge		
Kardinya Park Shopping Centre		
Melville Plaza		
Riseley Street Shopping Precinct		

Figure 2.1, Figure 2.2 and Figure 2.3 below show examples of three key existing and future activity centres within the cities of Fremantle, Melville and Cockburn.

Figure 2.1 Fremantle station

Figure 2.2 Proposed Fiona Stanley Hospital - Murdoch

Source: http://www.planning.wa.gov.au/656.asp

Figure 2.3 Future Cockburn Coast

3. Transit corridors

Table 3.1 presents the potential east-west and north-south transit corridors that have been identified within the southwest metro study area. These corridors were discussed in the project inception meeting with the Transit Study Steering Group (TSSG), held on 11 July, 2011.

Table 3.1 Potential transit corridors

East-West			
No.	**Name**	**Features**	**Length**
1	Fremantle – Canning Bridge	via Melville Plaza and Booragoon	12.4 km
2	Fremantle – Bull Creek	via Booragoon	11.5 km
3	Fremantle – Murdoch	via Kardinya Park S.C and Murdoch Ed-Med	11.8 km
4	Cockburn Coast – Roe Highway Interchange	Connecting with the Kwinana Freeway Interchange	~9.0 km
5	East-west freight corridor	Fremantle to Kwinana Freeway	~12 km
6	Cockburn Coast – Cockburn Central	via Phoenix Road S.C.	14.6 km
North-South			
No.	**Name**	**Features**	**Length**
7	Kwinana Freeway/Mandurah Rail line	Cockburn Central – Canning Bridge	14 km
8	Murdoch – Canning Bridge	via Murdoch Ed-Med, Booragoon and Riseley St	9.5 km
9	Cockburn Coast – Murdoch	via Kardinya Park S.C and Phoenix Road S.C.	14.1 km
10	Beeliar – Melville Plaza	via Stock Road	11 km
11	Beeliar - Palmyra	via Phoenix Road S.C.	11 km
12	Cockburn Coast - Fremantle	via South Fremantle	5 km

Figure 3.1 shows an example of a transit corridor, demonstrating the higher level of detail in comparison to an alignment or running way.

Figure 3.1 Example transit corridor

3.1 Key study assumptions

It is assumed that the recommended rapid transit network should:

- Operate in existing road reserves, as shown in Figure 3.2 below (i.e. in order to minimise land acquisition and projects costs).
- Not impact upon existing road and rail freight routes for safety and operational reasons.
- Not result in a significant reduction in roadway capacity; however consideration should be given to person flow through a corridor, rather than only vehicle flow.
- Allow for one local bus service change for 95% of residents living within the study area to access the higher quality transit network.

Figure 3.2 Existing transit priority on Hampton Road

4. Public Transport Plan for Perth in 2031 (Draft)

The draft Public Transport Plan for Perth in 2031 (draft 2031 plan) identifies the proposed rapid transit network that is required to support Perth's growing population and links to and between strategic centres in 2031. The preferred public transport mode and the priorities for infrastructure investment across the network are also identified within the plan. The public transport network for 2031 has been designed to be compatible with a longer-term vision for a city of 3.5 million people.

Summary of Key Points relating to the Southwest Metro Transit Network Study

The following key points were summarised from the draft 2031 plan and were identified as potentially having an impact on the southwest metro study area:

- Stage 1 rapid transit network (at 2031) - rapid transit corridors have been recommended from Fremantle to Murdoch and Fremantle to Rockingham along the Cockburn Coast, and Cockburn Coast to Cockburn Central Station.
- Stage 2 rapid transit network (beyond 2031) - a rapid transit corridor has been recommended from Fremantle to Canning Bridge.
- Most of the new growth corridors can be served by road based services (i.e. Bus Rapid Transit), but strategic decisions need to be made to ensure these services have substantial priority over general traffic.
- Major bus interchanges will be upgraded providing faster bus services to transfer passengers to rail services.
- The rapid transit network will need to be expanded by providing priority bus lanes along routes that connect major centres and through congested intersections.

Policy documents

The following key policy documents were considered as part of developing the draft 2031 plan:

- Directions 2031 and Beyond (based on project population of 2.2 Million people by 2031).
- Activities Centres State Planning Policy.
- Transit Oriented Development (TOD) Development Control Policy.

Light Rail Investment considerations

The draft 2031 plan highlights the need for light rail proposals to demonstrate how they can:

- Be consistent with and effectively expanded into a broader network.
- Ensure a consistent use of technology to maximise operational flexibility and synergies across the network.
- Be subject to detailed master planning and a business case.

Understanding these considerations is of particular importance in undertaking the Southwest Metro Transit Network study, as it provides an indication as to some of the key criteria that may be used by the DOT to assess rapid transit network proposals.

Network effect

The draft 2031 plan provides the following summary of the importance associated in developing a transit network that focuses on connecting key centres with orbital links, rather than primarily focusing on radial travel to the CBD:

- Public transport is important to Perth, given that it connects centres – not everyone wants to travel radially to the CBD, including:
  - University and school students
  - People working at strategic centres
  - People accessing goods and services outside of the Perth CBD.
- One of the weaknesses of the bus system is that the current focus on CBD travel does not support connectivity between the strategic centres identified in the Directions 2031 and Beyond.

Figure 4.1 provides an overview of the proposed combined stage 1 and stage 2 rapid transit network for Perth, which highlights the large number of orbital links connecting key centres. This network provides a visual understanding of the importance in creating a network in that it opens up a range of transit opportunities to improve accessibility.

Figure 4.1 Draft rapid transit network

Passenger expectations

The draft 2031 plan provides a summary of passenger expectations on the Perth public transport network, which highlights the key attributes that passengers value in a transit system:

- Passengers want services that are frequent, on time and affordable.
- They want to be able to travel quickly to their destination.
- They want to feel safe and secure.

- There are virtually no priority measures to improve the effectiveness of services, particularly in the congested peak periods, as a result buses are vulnerable to delays caused by road congestion.
- 93% of train passengers are satisfied or very satisfied with services.
- 81% of bus passengers are satisfied or very satisfied (88% in Belmont, 58% in Morley).

It is likely that these same passenger expectations are representative of passenger preferences in the southwest metro study area and therefore any proposed rapid transit network should have consideration for them.

Figure 4.2 shows an example of the ticket machines and information available at Cockburn Central station, highlighting the access to clear ticket and emergency information available to passengers at the station.

Figure 4.2 Ticket machines at Cockburn Central station

Environmental and social benefits

The following comments have been made in the draft 2031 plan in relation to the impact of private vehicle use and the role that public transport can play in providing environmental and social benefits:

- Transport contributes 14% of Australia's total greenhouse gas emissions, of which 90% is generated by private vehicles.
- Public transport can offer a range of environmental benefits through improved air quality and reduced noise pollution.

- Public transport can also promote more active lifestyles, through the use of active transport to connect with bus stops and train stations.
- Greater use of public transport, resulting in reduced car use can have a positive effect through a reduction in the costs of road trauma.

Current public transport statistics

The following statistics have been summarised from the draft 2031 plan to provide an understanding of current trends:

- 330,000 public transport trips are made every weekday.
- 2/3 of public transport trips are for work and education, during the peak periods.
- Public transport use in Perth has increased by 67% in the past ten years (three times the rate of population growth over the same period).
- 76% of public transport trips occurring within 15 kilometres of the Perth CBD.
- 44% of public transport trips are made using rail.
- 56% of all public transport trips are made by the bus network.
- In area, Perth is one of the largest cities in the world (in terms of area), with its elongated shape, Perth metro now extends 120km.
- Fremantle is the only centre within the southwest metro study area that has over 5,000 workers.
- The central area of Perth (including Northbridge, West Perth and East Perth) provides nearly 120,000 jobs, representing 18% of all jobs in the Metropolitan area. This statistic reflects the need provide a transit network, rather than focusing on a strong radial system reliant on the CBD.

The rate of public transport growth in Perth has been occurring at a rate of three times the rate of population growth. It is important for this patronage growth to continue to be captured through the provision of a high quality rapid transit network, particularly in areas where it can be used as a catalyst for development.

Future Public Transport Growth

By 2031 Perth residents are expected to more than double their use of public transport, by which time it is expected to account for:

- One-in-eight of all motorised trips (currently one-in-fourteen).
- One-in-five motorised trips in the morning peak period (currently one-in-eight).
- Over 30% of peak hour distance travelled (currently around 20%).
- Nearly 70% of all trips to the CBD (currently around 47%).

Travel demand

The demand for travel in Perth is evaluated using the Strategic Transport Evaluation Model (STEM), which has produced the following outputs:

- Population growth to 2031 will see a 33% increase in personal travel from 5.8 to 7.7 million trips per day (all modes).

- By 2031 it is predicted that Perth's 2.2 million people will make twice as many trips by public transport (760,000) per day than they do now or 120% increase equating to 3.85% per annum.
- The longer term vision for 2050 could see a further 59% increase in passenger travel to 12.25 million trips per day.
- By 2050 the number of trips by public transport per day could be in the order of 1.5-2.0 million trips per day.
- Base case data (2008) indicates that the Canning Highway corridor carries 3,000-10,000 public transport passengers per day between Fremantle and Riseley Street, increasing to 10,000-30,000 between Riseley Street and Canning Bridge Station.
- Future 2031 modelling indicates that the following transit corridors are expected to carry 3,000-10,000 passengers per day, highlighting the areas that will need rapid transit infrastructure to address this demand for quality public transport infrastructure:
  - Fremantle to Canning Bridge
  - Fremantle to Murdoch
  - Riseley Street/Leach Highway to Bull Creek
  - Cockburn Coast corridor
  - Beeliar Drive.

This forecast patronage demand provides an indication as to the likely 2031 public transport demand within key corridors of the southwest metro study area. Based on warrants for public transport as outlined in the draft 2031 plan, these levels of demand are likely to achieve DOT thresholds for public transport priority.

Figure 4.3 shows the 2008 base demand and forecast 2031 patronage demand for corridors with patronage greater than 3,000 passengers per day.

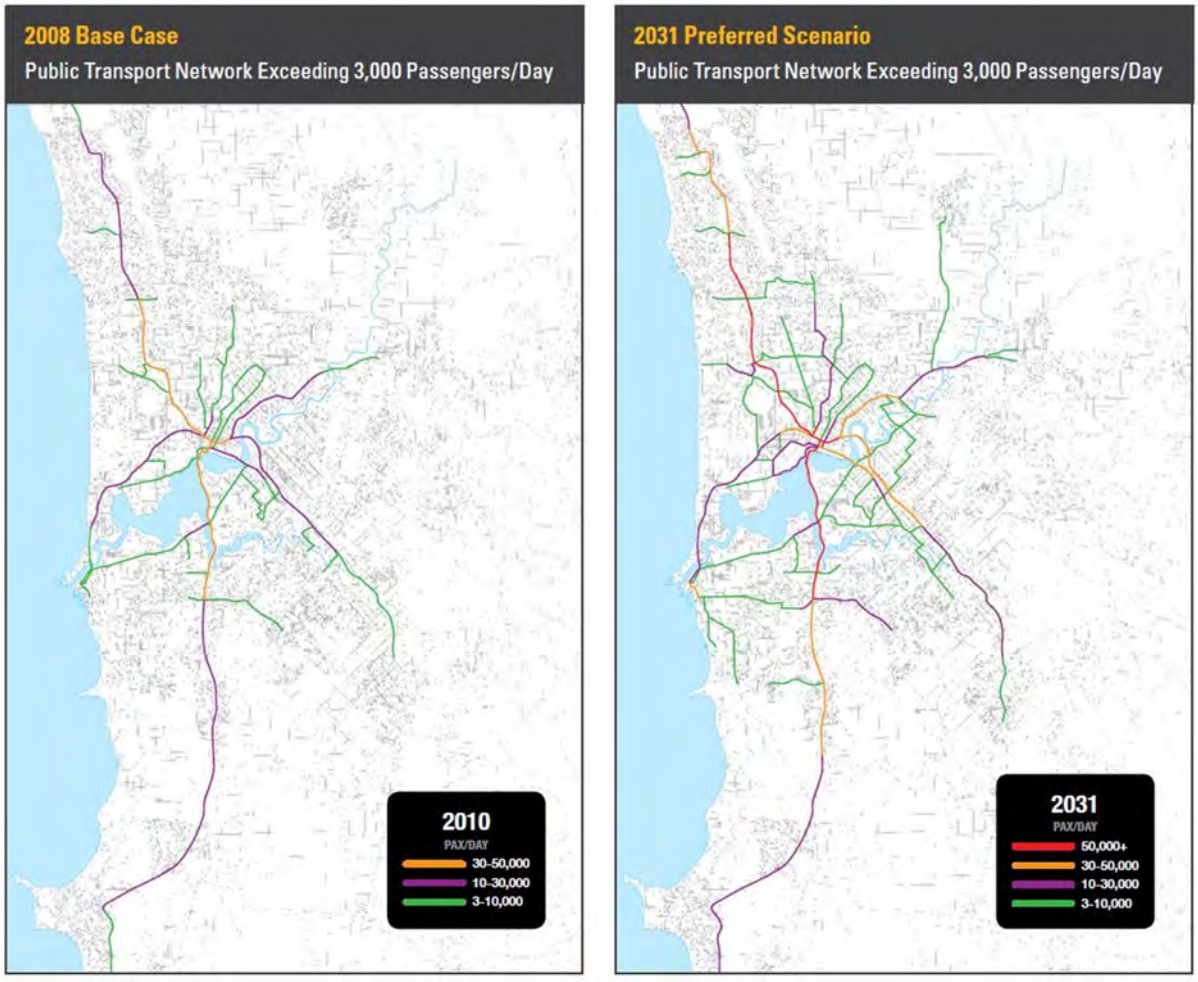


Figure 4.3 2008 and 2031 scenarios

Public transport warrants

The draft 2031 plan provides the following summary of the warrants that have been developed to guide investment into priority for transit routes within Perth:

- The warrants for public transport priority on roads will vary depending on the level of service and patronage, and impacts on land uses.
- Queue jump lanes are generally provided on approach to busy signalised intersections causing significant delays to buses (daily patronage 3,000 people).
- Bus lanes are necessary where the speed and reliability of the service is being adversely impacted on a regular basis, at intersections and midblock (services along these corridors should average 6,000 passengers per day).
- Where a traffic lane has to be converted into a bus lane, the projected patronage of the facility should exceed 1,200 passengers in the peak hour, within five years of opening.
- Corridors with initial patronage of 10,000 passengers per day (1,500-2,000 passengers in the peak hour) may justify a high capacity rapid transit system using articulated buses and/or light rail.

The warrants appear to be unclear in the way in which they should be interpreted and are also strongly focused towards achieving patronage thresholds and make no mention for the

opportunities that rapid transit infrastructure creates for acting as a catalyst for development. Figure 4.4 shows an example of Seattle's South Lake Union Streetcar, which has undergone real estate success over the last eight years, with $2.4 billion of investment occurring within three blocks of the line. This example provides a case study for how high quality public transport can act as a catalyst for development.

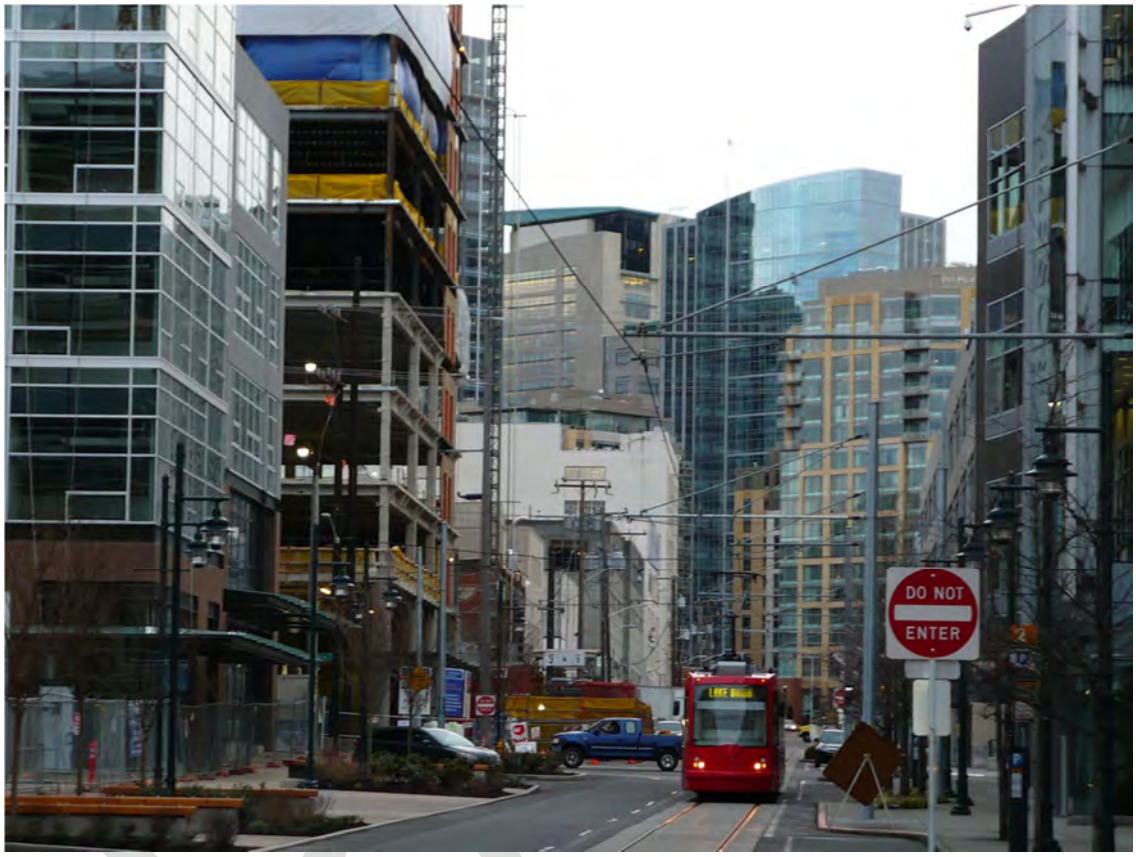


Figure 4.4 Public Transport as a catalyst for development

A review of the combined Stage 1 and Stage 2 draft rapid transit network plan presented in the draft 2031 plan provides a level of inconsistency in relation to the LRT warrants also outlined in the draft plan. The north-south corridor between Glendalough Station and Subiaco Station includes a proposed LRT corridor link in the before 2031 horizon period, however the 2031 forecast passenger volumes (sourced from STEM outputs) on this link appear to be <3,000 passengers per day. The level of patronage on this link is well below the LRT warrants of 10,000 passengers per day, as stated in the draft plan.

It is however understood that this proposed LRT link will provide relief for passenger numbers entering the Perth CBD, by effectively bypassing the need for some passengers to access the CBD. This example highlights the importance in considering other factors when assessing rapid transit proposals, in addition to patronage forecasts.

Rapid transit system growth corridors

The following key points were raised in the draft 2031 plan in relation to the key characteristics of a rapid transit system for Perth:

- The majority of new growth corridors and strategic centres can be served by road based services, but strategic decisions need to be made to ensure these services have substantial priority over general traffic.

- Major roads within the central areas will need to move substantially more people acknowledging the fact that public transport can move more passengers per traffic lane than cars.
- Road based transit could be light rail or bus rapid transit, operating within dedicated priority on streets with short sections of mixed use running.
- Passenger travel on the future network will likely be more dependent on transfers between local bus services and rapid transit services (35% of public transport journey's use more than one vehicle (bus/bus or bus/train).
- Transit Oriented Development (TOD) at Stations such as Canning Bridge will lead to increased boarding at this station.
- Routes will be developed to provide a network with priority for transit services, with journey times being faster, with fewer more widely spaced stops up to 800m apart.
- Local bus services will act as feeders to the train and transit network, connecting local centres and destinations across the metropolitan area.

These points highlight the importance associated in the provision of dedicated public transport priority for road based transit within the southwest metro study area in order to achieve desired outcomes for rapid transit services. It also highlights the need for transfers between local bus feeder services and higher quality rapid transit or rail services.

Strategic centres

Fremantle, as shown in Figure 4.5 and Murdoch in Figure 4.6 have been highlighted as key strategic centres, with the following comments made in the draft 2031 plan:

- Priority is required south of Douro Road to Rockingham Road.
- Investigations are underway to look at options between South Street and Fremantle Station. "*It is likely that services south of Fremantle would be bus rapid transit*".
- A committed project exists for bus priority west of Murdoch Station through the Main Street between Fiona Stanley Hospital and St John of God Hospital into Murdoch University. The final part of this project connects the western end of Discovery Drive in Murdoch University back to South Street.

Figure 4.5 Market Street - Fremantle

Figure 4.6 Fiona Stanley Hospital under construction

Short-term projects

One of the short-term projects highlighted in the draft 2031 plan included the Canning Bridge Station transit interchange, which is at capacity and requires an upgrade to improve bus connections and pedestrian access. This project would include introduction of priority lanes along Canning Highway between Reynolds Road and Henley Street. This project is needed in the next 5 to 10 years.

Figure 4.7 shows the constraints associated with the existing Canning Bridge station bus interchange, in relation to the available capacity for passengers waiting to access bus services.

Figure 4.7 Passengers waiting for a bus Canning Bridge station

Transit Plan - Stage 1 Projects

The following recommendations have been made as part of Stage 1 of the draft 2031 plan:

- Bus rapid transit (BRT) before 2020 between Cockburn Coast and Fremantle, utilising existing bus lanes on Hampton Road.
- BRT on Canning Highway between Reynolds Road and Canning Bridge station.
- BRT on South Street between Murdoch Drive and Murdoch.

The proposed Stage 1 rapid transit network for Perth is presented in Figure 4.8, with the Stage 1 rapid transit network for the southwest metro study area highlighted in Figure 4.9.

Figure 4.8 Proposed Stage 1 projects – Metropolitan Perth

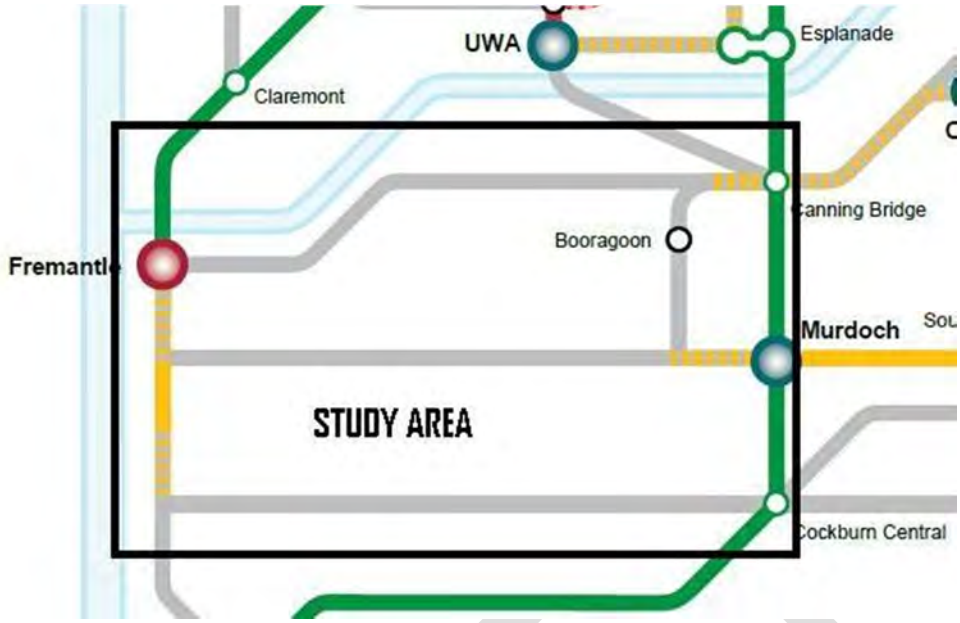


Figure 4.9 Proposed Stage 1 projects – Southwest Metropolitan study area

Transit Plan - Stage 2 Projects

The following recommendations have been made as part of Stage 2 of the draft 2031 plan:

- Bus rapid transit at 2020 between Cockburn Central and Fremantle, via Cockburn Coast ("*this is likely to be a BRT facility in the period leading up to 2031, although a case for light rail may be made in the longer term*").
- BRT before 2031 on South Street between Fremantle and Murdoch.
- BRT before 2031 on Beeliar Drive between Cockburn Coast and Cockburn Central.
- Future rapid transit on Canning Highway between Fremantle and Canning Bridge.
- There are no central north-south rapid transit corridors identified within the southwest metro transit network study area.

The proposed Stage 2 rapid transit network for Perth is presented in Figure 4.10, with the Stage 2 rapid transit network for the southwest metro study area highlighted in Figure 4.11.

Figure 4.10 Proposed Stage 2 projects – Metropolitan Perth

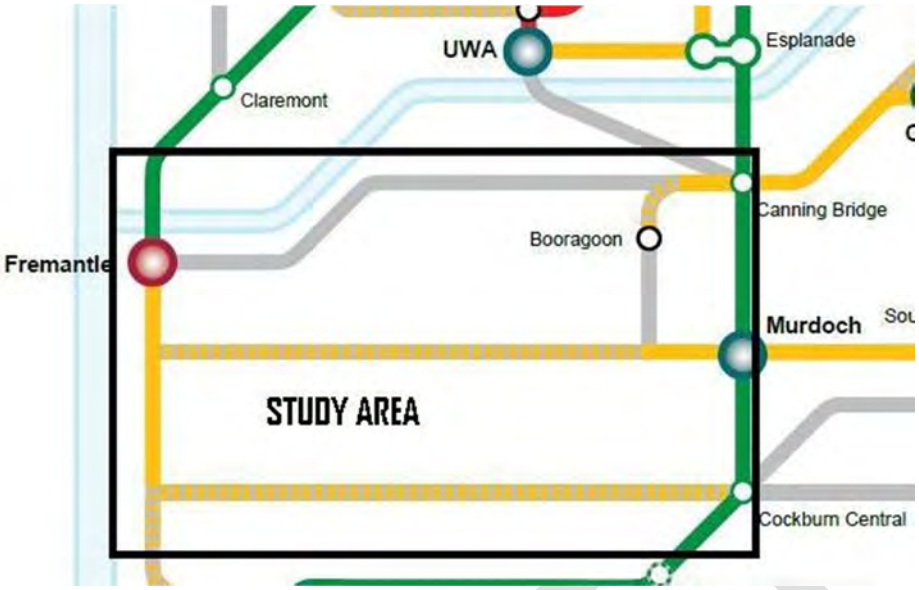


Figure 4.11 Proposed Stage 2 projects – Southwest Metropolitan study area

Valuing Public Transport Investment

The following capital and operating cost information was discussed in the draft 2031 plan:

- 2009/2010 annual operating cost of providing the public system is $499.1M, and $691.2M including capital and interest charges.
- $534.9M is provided by the State Government in the way of subsidy (representing 77% of the total costs).
- By 2031, it is expected that the annual operating costs for the Perth public transport system will have risen to $820M.
- The major components of the proposed infrastructure expenditure are:
  - Rail system expansion: $1.2Billion
  - Light rail: $1Billion
  - BRT and bus priority infrastructure: $343M
  - Rail, bus and light rail depot and maintenance facilities: $180M
  - Transit interchanges, including park and ride: $135M.

Funding options

The following options for funding were discussed in the draft 2031 plan that may be of relevance to the southwest metro rapid transit network study:

- The Independent panel for the draft 2031 plan has outlined the general principle for funding options that enables a clear link between attributable benefit and the level of funds provided by any group or source.
- The DOT needs to prepare a detailed funding plan and strategy in consultation with the Department of Treasury and Finance for consideration by the Government.

- A short (five years) and long term funding plan needs to be prepared.
- Major capital projects should be developed utilising a public partnership approach.
- Some longer term options that should be considered include:
  - Congestion charging, with a specific amount of revenue dedicated to public transport improvements
  - Developer charges in areas where improved public transport can facilitate significantly higher densities in key precincts and major centres.

In addition to the points highlighted above from the draft 2031 plan, it is important to also consider the opportunities that high quality public transport could create by catalysing development within the southwest metro study area. The opportunity for rapid transit to catalyse development have been defined as one of the guiding principles of the southwest metro transit network study and will therefore be a consideration for how transit modes will be selected as part of this study.

Activating and integrating

The following principles were outlined in the draft 2031 plan in relation to supporting the integration of public transport and land use transport planning:

1. Concentrate development in centres particularly designated strategic centres
2. Align centres within corridors
3. Connect streets
4. Improve access
5. Manage parking supply
6. Improve road management.

The public transport network identified in the draft 2031 plan was analysed using the spatial Network Analysis for Multi-nodal Urban Transport Systems (SNAMUTS), developed by Curtis and Scheurer. Some of the key findings of this analysis included:

- Doubling of the overall efficiency of the system, while only requiring a 60% increase in service frequencies.
- Speed and competitiveness of public transport over road travel improves in 2031 over 2010, mainly due to more efficient transfers between routes.
- The analysis confirms the importance of a number of strategic centre public transport hubs, including Fremantle and Murdoch, while also highlighting the importance of Canning Bridge and Bull Creek.

Transformational projects

The following points have been summarised from the draft 2031 plan in relation to the potential for transit projects to act as a catalyst for development:

- Light rail transit networks and systems have the opportunity to act as a catalyst for urban consolidation and renewal.
- The feasibility of these types of projects has been assisted by private sector contributions, recognising the increased value for property development as a result of the light rail project.

Some key success factors have also been outlined for transformational projects being conditional on the following criteria:

- A contribution of the capital cost of the projects by the private sector, based on the value transfer from increased property value.
- Alignment of support from local authorities to achieve a practical network across local boundaries.
- Minimum density outcomes being secured.

Summary

Table 4.1 has been prepared to summarise the key points outlined in the draft 2031 plan that relate to the Southwest Metro Rapid Transit Network Study.

Table 4.1 Draft Public Transport for Perth in 2031 summary

Key Points	Description
Light Rail Transit	There has been no recommendation for Light Rail Transit within the southwest metro study area in either the Stage 1, Stage 2 or the Ultimate rapid transit network maps
Bus Rapid Transit	BRT has been recommended along various east-west corridors and on a limited number of north-south corridors within the study area
On-road priority	Moving people, not cars, is a key focus of the plan (dedicated priority on streets, acknowledging that short sections may require mixed street running)
Activating and integrating	The importance was highlighted for the need to align key centres along corridors and analysis has demonstrated the benefits of creating a network to improve efficiency on the public transport network
Transformational projects	The opportunity for transit projects to act as a catalyst for urban consolidation and renewal has been recognised, along with the need for private sector contributions and alignment of support between local authorities

5. Transit corridor rapid appraisal

A high level transit corridor rapid appraisal has been undertaken to short-list the potential corridors that were discussed in Section 3. The purpose of this approach is to short-list transit corridors that address a set of guiding principles developed for the study in order to develop a preferred rapid transit network for the southwest metro area.

5.1 Guiding principles

The following guiding principles have been developed to highlight the desired outcomes of the preferred southwest metro rapid transit network that will be recommended as part of this study. These guiding principles recognise the importance associated in integrating land use and transport in order to increase public transport mode share and catalyse development, while also minimising the impacts on the community:

1. **Link key activity centres, meeting minimum destination employment and residential thresholds (Fatal flaw guiding principle) –** Will the corridor link multiple key activity centres with the combined existing or future total of 10,000 (population + employment positions). Need to consider existing population and employment data as well as forecast future data.

2. **Minimise impacts (Fatal flaw guiding principle) –** To what extent will the introduction of a transit corridor impact upon the community living within the corridor (i.e. land acquisition, noise, vibration, road safety and amenity) and general operation of the transport network. Need to consider width of the corridor reserve for transit development, assuming that road space will not be taken from the existing network, as well as consideration for impacts on the freight transport network.

3. **Catalyse Development –** To what extent will the surrounding land use provide an opportunity to catalyse development, as the result of the introduction of a transit corridor within the corridor (i.e. Brownfield development sites, vacant land, gentrification, value capture)? Need to consider land use zoning, land tenure, property value, identified sites through existing policies/strategies and plans).

4. **Increase the mode share for public transport –** To what extent will the transit spine increase the mode share for public transport within the corridor (i.e. is there likely to be a mode shift from private vehicle travel to transit as a result of the higher quality transit corridor). Need to consider how many key activity centres are linked, the increased speed and reliability of the transit corridor, in comparison to private vehicle travel and the accessibility to stations/stops through walking and cycling.

5. **Enhance the network effect –** To what extent will the transit corridor enhance the network effect, through creating improved integration between bus/bus and bus/rail? (i.e. how many additional transit trip opportunities will be created as a result of the network integration)? Need to consider the number and frequency of local bus route connections that may be possible with the corridor, in order to provide a minimum of one mode/trip change in order to access a key activity centre.

Fatal flaw guiding principles

Guiding principles 1 and 2 have been defined as fatal flaw guiding principles, in order to recognise the importance in proposing a rapid transit network that links key activity centres and minimises impacts on the community.

Each of the transit corridor options are screened against the fatal flaw guiding principles (1) and (2) to determine if the option has a fatal flaw relating to these principles. (i.e. if the transit corridor does not link two key activity centres or if it includes impacts on the community).

5.2 Methodology

A high level rapid appraisal methodology has been developed to assess each of the initial corridors defined above against the guiding principles that have been developed for the study. This approach provides a high level qualitative assessment of each of the corridors by assigning one of the following coloured dots against each of the guiding principles:

- Green – Adequately addresses the guiding principle
- Yellow – Marginally addresses the guiding principle
- Red – Does not address the guiding principle.

If the corridor option is awarded a red dot for the fatal flaw guiding principles 1 (linking key activity centres) and/or 2 (impacts on community) the option is consider to have failed the high level assessment based on it not meeting these key guiding principles.

The rapid appraisal takes into account all of the options discussed in the project inception meeting held with the TSSG on Monday 11 July 2011.

5.3 Rapid appraisal results

The rapid appraisal results for each of the identified transit corridors are summarised in the following section, which includes:

- Transit corridor map.
- Summary of key activity centres connected, key alignments, existing bus routes and public transport connection opportunities.
- Ranking against the five guiding principles and (fatal flaws), including comments.
- Recommendation as to whether the transit corridor should be shortlisted to the preferred Southwest Metro Rapid Transit Network.

Corridor 1 – Fremantle to Canning Bridge (via Melville Plaza and Riseley Street Precinct)

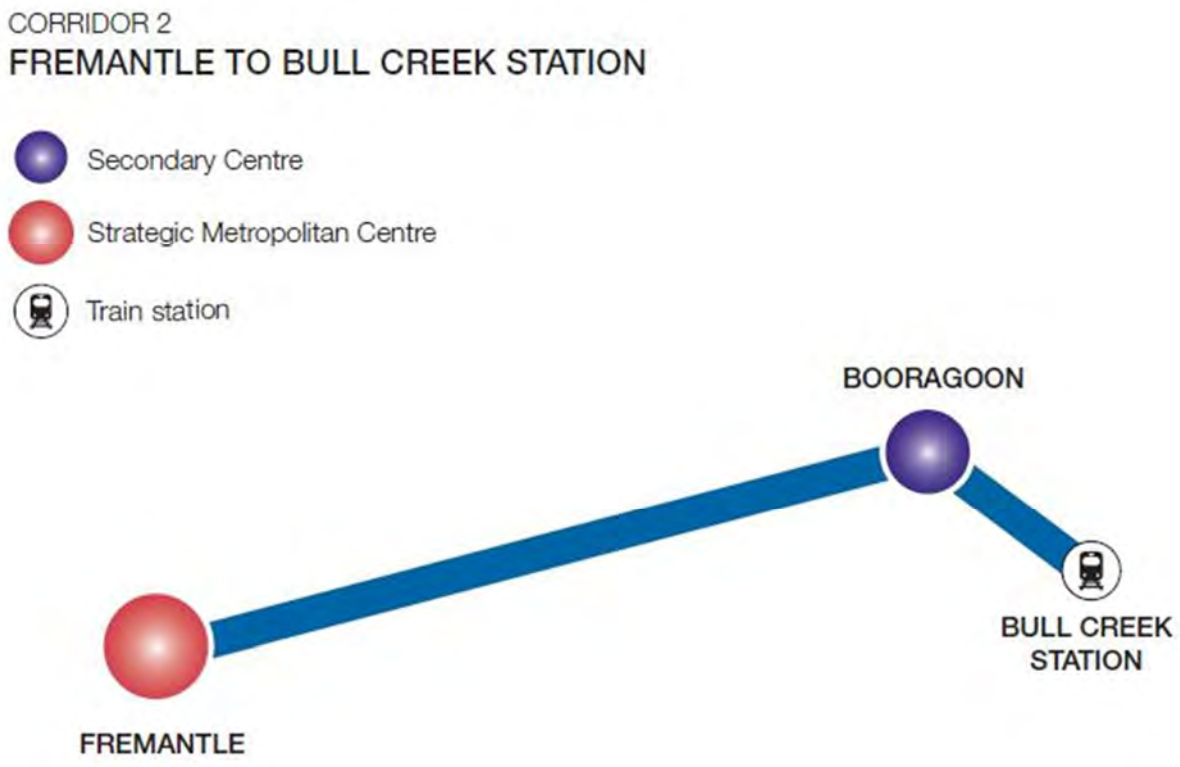
Key activity centres:	**Key alignments within corridor:**	**Bus routes operating/intersecting corridor:**	**Public transport network connections:**
Fremantle Rail Station/CBD Melville Plaza Riseley Street Shopping Precinct Canning Bridge Rail Station	Canning Highway	Routes 106, 111, 148, 158, 150, 160, 500, 501, 510, 881, 940	Bus/Bus, Bus/Rail, orbital connection between Mandurah and Fremantle rail lines

High Level Analysis

Guiding Principle	Ranking	Comments
1.Destination threshold	●	Connects multiple key activity centres meeting the minimum thresholds (Fremantle and Canning Bridge)
2.Minimising impacts	●	Road space may need to be re-allocated to avoid land acquisition, however consideration needs to be given to the person flow through the corridor (i.e. public transport versus private vehicle)
3.Increasing PT mode share	●	Links multiple key activity centres promoting an increase in mode share, also provides higher quality bus/rail connections at Fremantle and Canning Bridge Stations, encouraging ridership
4.Network effect	●	This corridor provides bus/bus & bus/rail connection opportunities at Fremantle Station and Canning Bridge Station. It also creates an orbital link between rail lines
5.Catalyse development	●	Minor opportunities to catalyse development within the corridor, through increased residential densities

Recommendation: Shortlist to preferred southwest metro rapid transit network

Corridor 2 – Fremantle to Bull Creek Station (via Booragoon)



Key activity centres: Fremantle Rail Station/CBD Booragoon/Garden City Bull Creek Rail Station	**Key alignments within corridor:** Leach Highway Marmion Street	**Bus routes operating/intersecting corridor:** Routes 501, 502, 503, 504, 505, 510, 881, 140, 160	**Public transport network connections:** Bus/Bus, Bus/Rail, orbital connection between Mandurah and Fremantle rail

High Level Analysis

Guiding Principle	Ranking	Comments
1.Destination threshold	🔴	Does not connect multiple key activity centres meeting the minimum threshold for population and employment
2.Minimising impacts	🔴	Sections of the corridor may incorporate relatively high levels of freight traffic (i.e. Leach Highway alignment)
3.Increasing PT mode share	🟡	Links a number of activity centres promoting an increase in mode share, also provides higher quality bus/rail connections at Fremantle and Bull Creek Stations, encouraging ridership
4.Network effect	🟡	This corridor provides bus/bus & bus/rail connection opportunities at Fremantle Station, Bull Creek Station and Booragoon bus station. It also creates an orbital link between rail lines
5.Catalyse development	🟡	Development potential at the Knutsford site, as well as the potential for an increase in residential densities

Recommendation: Not shortlisted to preferred southwest metro rapid transit network

Corridor 3 – Fremantle to Murdoch (via Kardinya Park Shopping Centre)

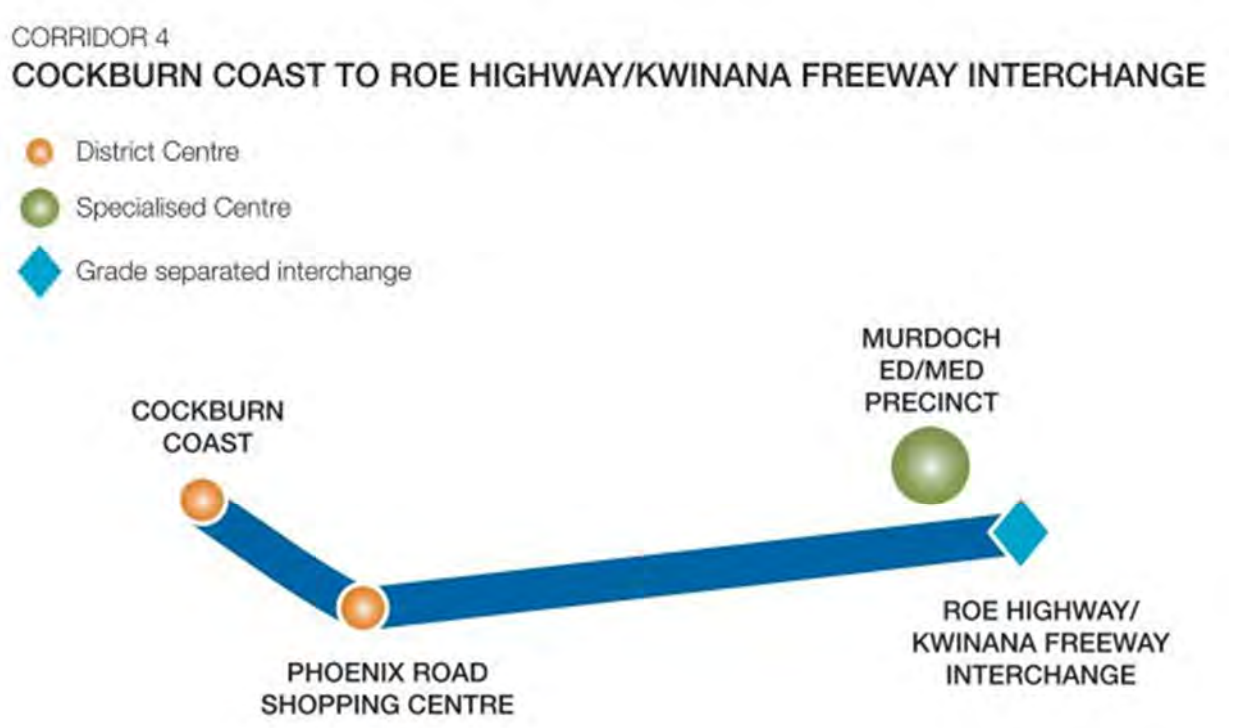
Key activity centres:	**Key alignments within corridor:**	**Bus routes operating/intersecting corridor:**	**Public transport network connections:**
Fremantle Rail Station/CBD Kardinya Park S.C. Murdoch Activity Centre	South Street/Lefroy Road Clontarf/Winterfold/Farrington Rd University Road	Routes 98, 99, 140, 160, 511, 513, 503	Bus/Bus, Bus/Rail, orbital connection between Mandurah and Fremantle rail

High Level Analysis

Guiding Principle	Ranking	Comments
1.Destination threshold	●	Connects multiple key activity centres meeting the minimum thresholds (i.e. Fremantle and Murdoch Activity Centre)
2.Minimising impacts	●	Wide road median available for majority of corridor, reducing the likelihood for land acquisition
3.Increasing PT mode share	●	Links multiple key activity centres promoting an increase in mode share, also provides higher quality bus/rail connections at Fremantle and Murdoch Stations, encouraging ridership
4.Network effect	●	This corridor provides bus/bus & bus/rail connection opportunities at Fremantle Station and Murdoch Station. It also creates an orbital link between rail lines
5.Catalyse development	●	Minor opportunities for catalyse development within the corridor, through increased residential densities

Recommendation: Shortlist to preferred southwest metro rapid transit network

Corridor 4 – Cockburn Coast to Roe Highway / Kwinana Freeway Interchange



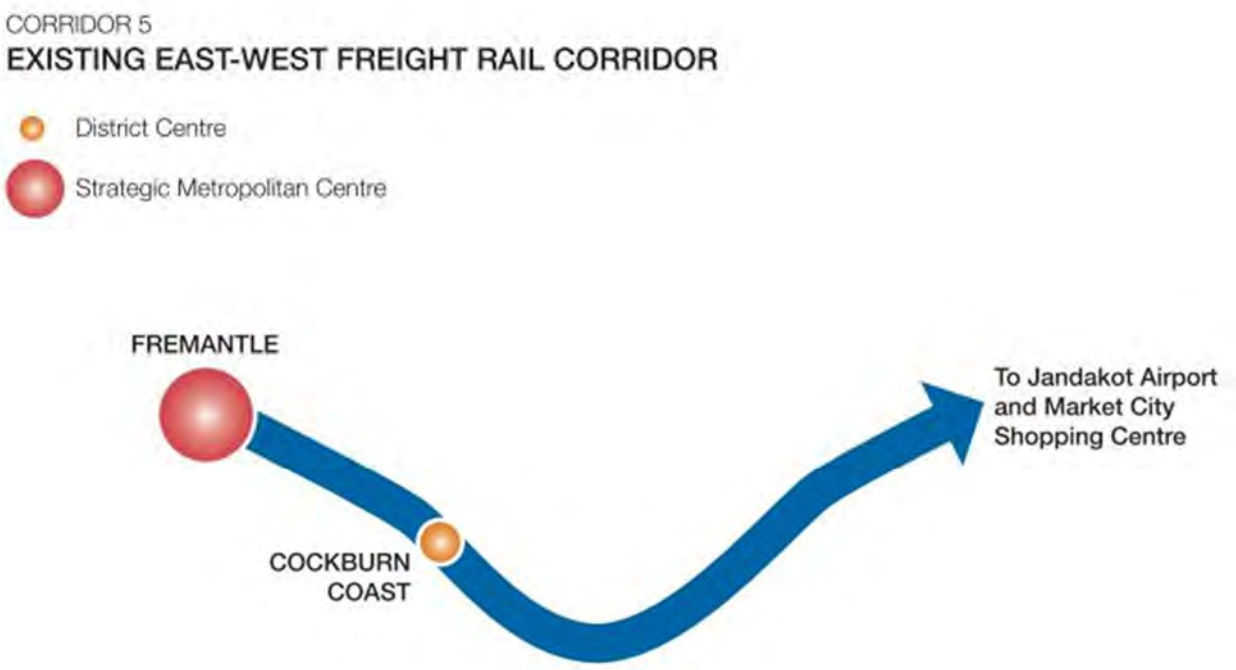
Key activity centres: Cockburn Coast Phoenix Road S.C.	**Key alignments within corridor:** Forest Road/Hope Road Roe Highway MRS reserve Rockingham Road/Phoenix Road	**Bus routes operating/intersecting corridor:** Routes 514, 520, 531, 533, 920	**Public transport network connections:** Bus/Bus

High Level Analysis

Guiding Principle	Ranking	Comments
1.Destination threshold	🔴	Does not connect multiple key activity centres meeting the minimum population and employment threshold. Murdoch University and proposed Fiona Stanley Hospital are located just north of the interchange, however the corridor does not integrate both of these activity centres with Murdoch Station and the overall Murdoch specialised activity centre
2.Minimising impacts	🟡	Road reserve may be available through the Roe Highway extension road reservation
3.Increasing PT mode share	🟡	Links multiple key activity centres promoting an increase in mode share, however the lack of connection to Murdoch rail station is likely to limit patronage on this corridor
4.Network effect	🟡	This corridor provides limited bus/bus connection opportunities, however no bus/rail connection opportunities
5.Catalyse development	🟠	Cockburn Coast precinct and Douro Road shopping precinct

Recommendation: Not shortlisted to preferred southwest metro rapid transit network

Corridor 5 – Existing East-West Freight Rail Corridor



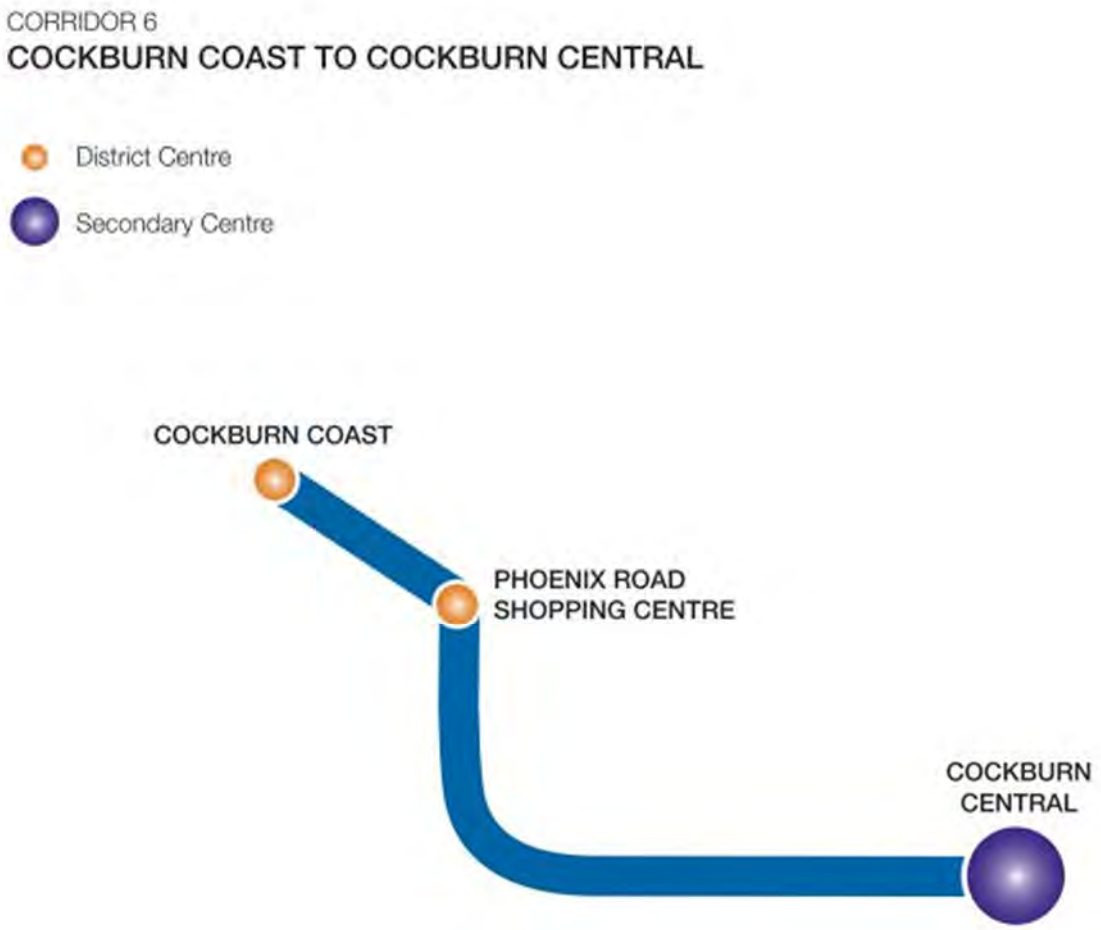
Key activity centres: Fremantle Jandakot Airport and Market City Shopping Centre (both outside study area)	**Key alignments within corridor:** Existing east-west freight rail line	**Bus routes operating/intersecting corridor:** 514, 520, 920, 530, 531, 532, 533, 881	**Public transport network connections:** Bus/Bus

High Level Analysis

Guiding Principle	Ranking	Comments
1.Destination threshold	🔴	Does not connect multiple key activity centres meeting the minimum population and employment threshold. Activity centres that are connected are also not all located within the southwest metro study area
2.Minimising impacts	🟡	Constraints associated with acquiring land if additional rail reservation is required. It is likely that the existing rail line can't be used for passenger rail for safety and operational policy reasons
3.Increasing PT mode share	🟡	Does not provide links between activity centres along the corridor, apart from short section between Cockburn Coast and Fremantle. This would limit the patronage potential for a transit corridor of this length
4.Network effect	🟡	This corridor provides connection opportunities at locations along the corridor
5.Catalyse development	🟡	Watsonia meat-packing site

Recommendation: Not shortlisted to preferred southwest metro rapid transit network

Corridor 6 – Cockburn Coast to Cockburn Central (via Phoenix Road Shopping Centre)



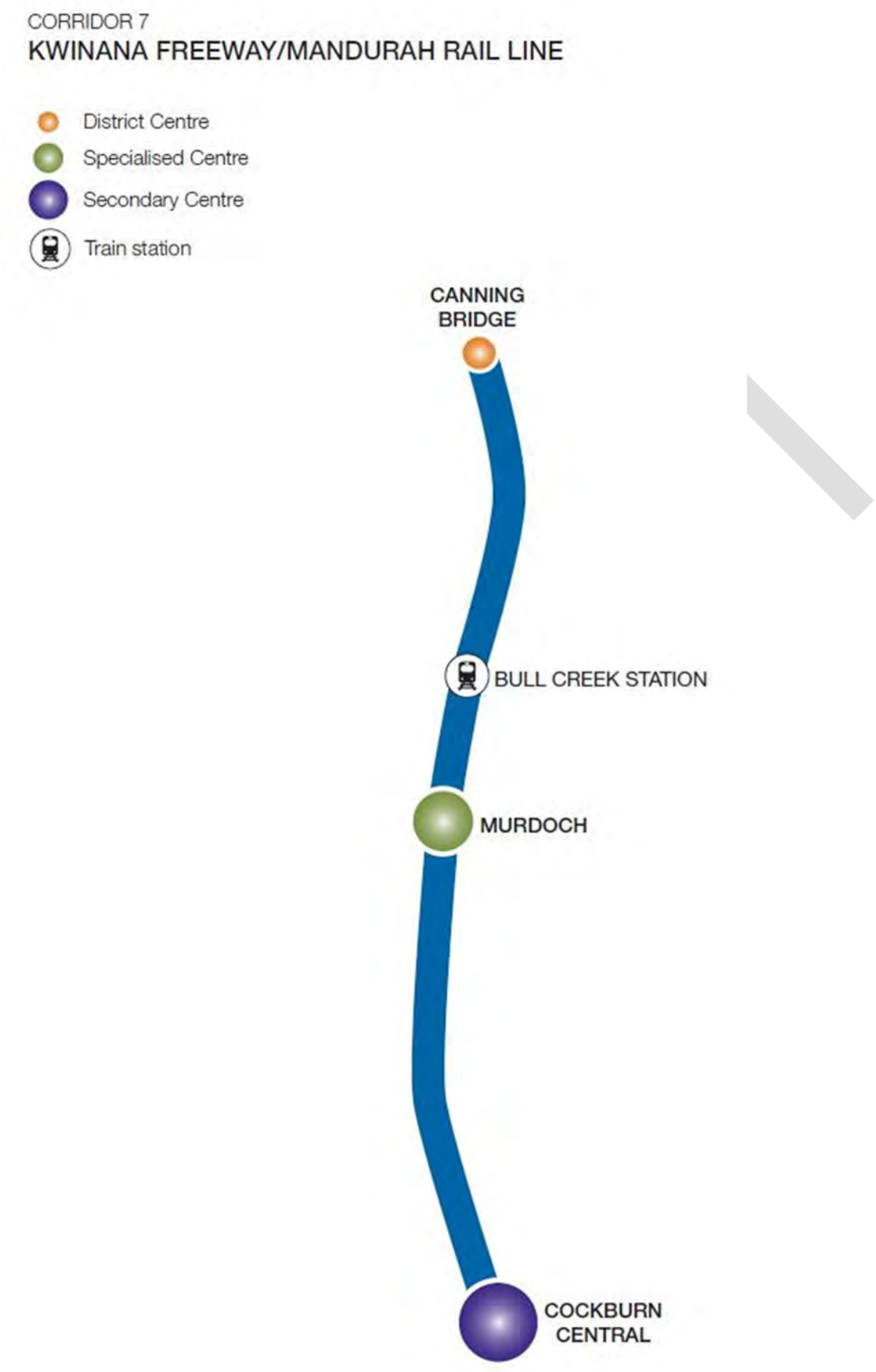
Key activity centres:	**Key alignments within corridor:**	**Bus routes operating/intersecting corridor:**	**Public transport network connections:**
Cockburn Coast Cockburn Central Station Gateways Shopping Centre Phoenix Road S.C	Beeliar Drive Rockingham Road Spearwood Avenue Cockburn Road Redundant rail corridor	Routes 522, 530, 531, 532, 533, 920, 514, 520	Bus/Bus

High Level Analysis

Guiding Principle	Ranking	Comments
1.Destination threshold	●	Connects multiple key activity centres meeting the minimum population and employment threshold (Cockburn Coast & Cockburn Central/Gateways Shopping Centre)
2.Minimising impacts	●	Wide road median available for majority of corridor, reducing the likelihood for land acquisition
3.Increasing PT mode share	●	Key east-west activity centres linked that are likely to result in PT mode shift from private vehicles. Large residential catchment also living within the majority of the corridor
4.Network effect	●	This corridor provides bus/bus connection opportunities at various locations along the corridor
5.Catalyse development	●	Proposed Cockburn Coast development

Recommendation: Shortlist to preferred southwest metro rapid transit network

Corridor 7 – Kwinana Freeway / Mandurah Rail Line



Key activity centres:
Cockburn Central, Murdoch, Bull Creek and Canning Bridge Rail Stations

Key alignments within corridor:
Kwinana Freeway, Mandurah rail line

Bus routes operating/intersecting corridor:
Routes 106, 111, 148, 150, 158, 160, 881, 940, 170, 179, 500, 501, 502, 503, 504, 505, 507, 508, 509, 707, 98, 99, 206, 207, 208, 510, 511, 513, 514, 515, 516, 517, 519, 850, 851, 520, 522, 525, 526, 527, 530, 531, 532, 533

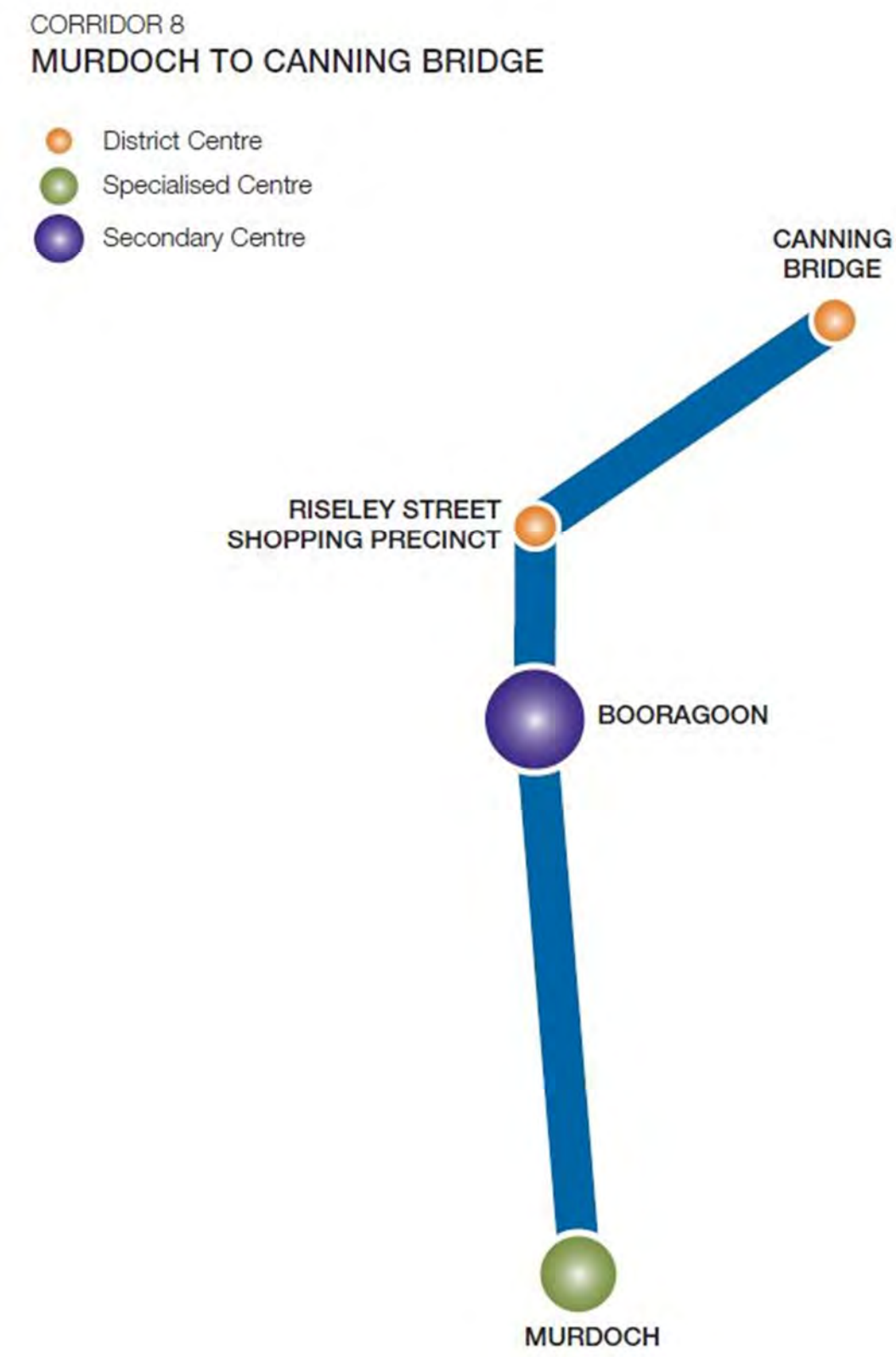
Public transport network connections:
Bus/Rail

High Level Analysis

Guiding Principle	Ranking	Comments
1.Destination threshold		Connects multiple key activity centres meeting the minimum population and employment thresholds (Cockburn Central, Murdoch and Canning Bridge)
2.Minimising impacts		There is no available reserve width for another rail line within the corridor, particularly at stations. There is also no reason for a competing rapid transit mode to be introduced in this corridor, as the existing rail line meets the level of demand
3.Increasing PT mode share		This corridor is already serviced by the Mandurah rail line and would therefore be unlikely to attract passengers from rail to BRT/LRT
4.Network effect		This corridor provides bus/rail connections at each of the four rail stations within the study area
5.Catalyse development		Limited opportunities to catalyse development within the corridor, that aren't already underway

Recommendation: Not shortlisted to preferred southwest metro rapid transit network

Corridor 8 – Murdoch to Canning Bridge (via Booragoon and Riseley Street)



Key activity centres:
Murdoch and Canning Bridge Rail Stations, Murdoch Ed-Med, Booragoon/Garden City S.C, Riseley Street

Key alignments within corridor:
Murdoch Drive/Riseley Street/ Canning Highway

Bus routes operating/intersecting corridor:
Routes 140, 150, 160, 500, 501, 510, 881, 940, 505, 510

Public transport network connections:
Bus/Bus, Bus/Rail

High Level Analysis

Guiding Principle	Ranking	Comments
1.Destination threshold		Connects multiple key activity centres meeting the minimum thresholds (Canning Bridge and Murdoch Activity Centre)
2.Minimising impacts		There is limited available road reserve within Murdoch Drive and Riseley Street
3.Increasing PT mode share		Links a number of key activity centres promoting an increase in mode share, also provides higher quality bus/rail connections at Canning Bridge and Murdoch Stations, encouraging ridership
4.Network effect		This corridor provides bus/bus & bus/rail connection opportunities at Canning Bridge Station and Murdoch Station, as well as the Booragoon Bus Station
5.Catalyse development		Minor opportunities to catalyse development within the corridor, through increased residential densities

Recommendation: Shortlist to preferred southwest metro rapid transit network

Corridor 9 – Cockburn Coast to Murdoch

Key activity centres:
Cockburn Coast, Phoenix Road Shopping Centre, Kardinya Park Shopping Centre and Murdoch

Key alignments within corridor:
Spearwood Avenue, Phoenix Road, North Lake Road, South Street and University Road

Bus routes operating/intersecting corridor:
Routes 514, 520, 825, 940, 513, 511, 140, 160

Public transport network connections:
Bus/Bus, Bus/Rail

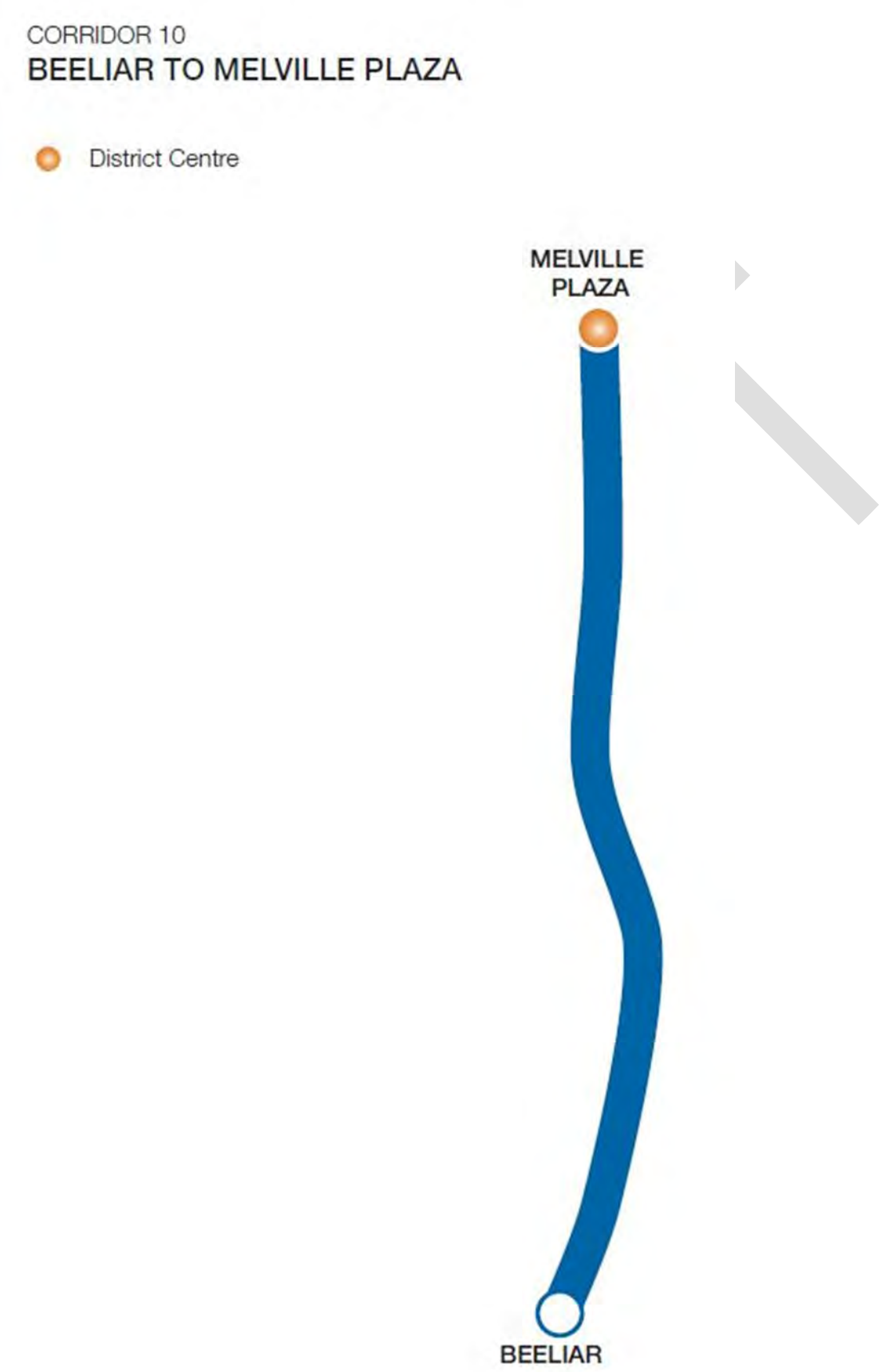
High Level Analysis

Guiding Principle	Ranking	Comments
1.Destination threshold	●	Connect multiple key activity centres meeting the minimum population and employment thresholds
2.Minimising impacts	●	Road space may need to be re-allocated to avoid land acquisition, however consideration needs to be given to the person flow through the corridor (i.e. public transport versus private vehicle)
3.Increasing PT mode share	●	Links key activity centres promoting an increase in mode share, also provides higher quality bus/rail connections at Murdoch Station, encouraging ridership

Guiding Principle	Ranking	Comments
4.Network effect		This corridor provides bus/bus & bus/rail connection opportunities at Murdoch Station, Phoenix Road S.C., Kardinya Park S.C and Cockburn Coast
5.Catalyse development		Opportunities for catalyse development within the corridor, through increased residential densities

Recommendation: Shortlisted to preferred southwest metro rapid transit network

Corridor 10 – Beeliar to Melville Plaza



Key activity centres:
Melville Plaza

Key alignments within corridor:
Stock Road

Bus routes operating/intersecting corridor:
Routes 920, 530 531, 532, 533, 520, 511, 513, 940, 98, 99, 140, 160

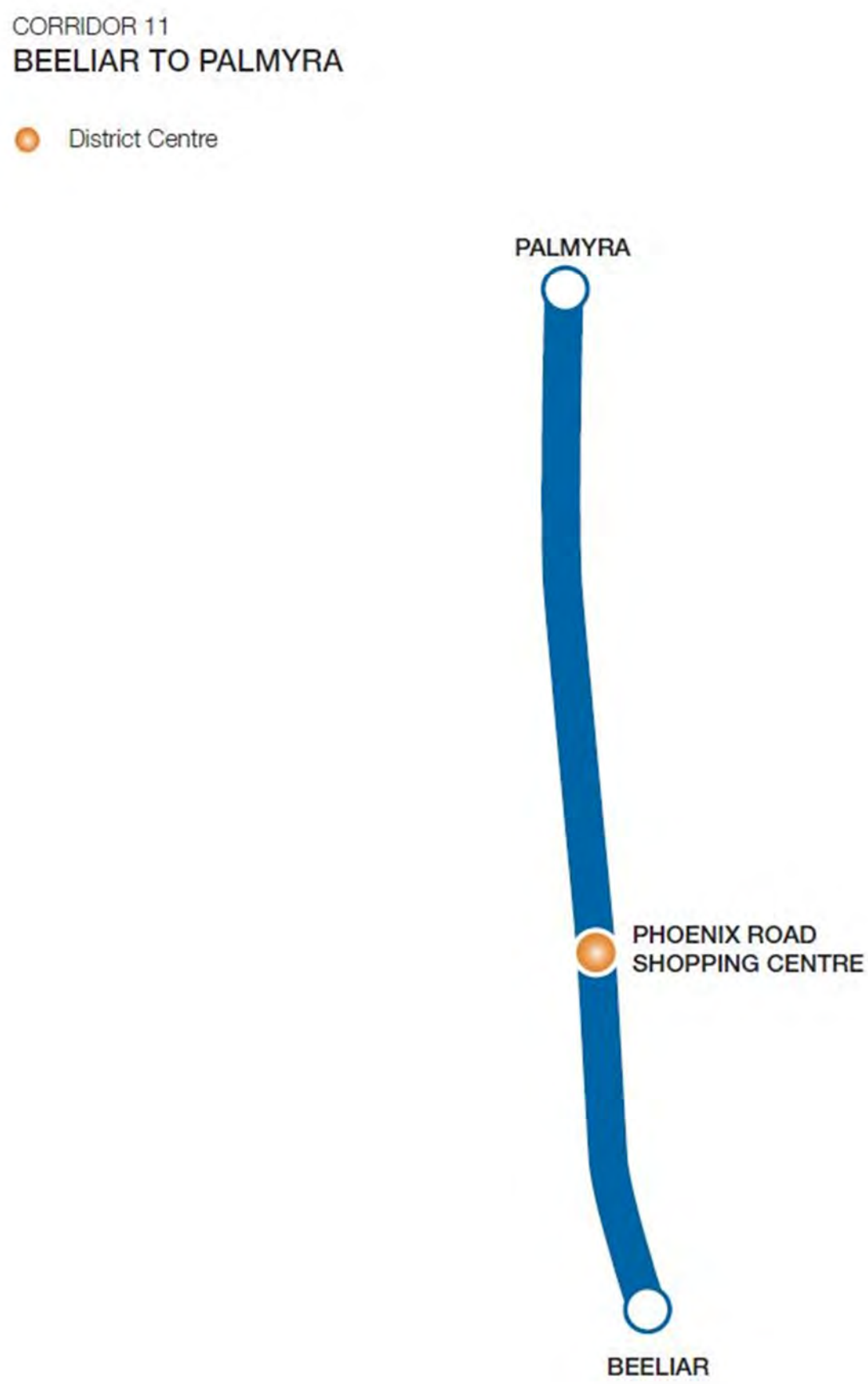
Public transport network connections:
Bus/Bus

High Level Analysis

Guiding Principle	Ranking	Comments
1.Destination threshold		Does not connect multiple key activity centres meeting minimum population and employment thresholds
2.Minimising impacts		No road reserve or median available within this corridor, without impacting upon the freight route
3.Increasing PT mode share		Limited north-south activity centre connections provided therefore limited opportunities to increase PT mode share
4.Network effect		This corridor provides bus/bus connection opportunities at intersections along the route
5.Catalyse development		Minor opportunities to catalyse development within the corridor, through increased residential densities

Recommendation: Not shortlisted to preferred southwest metro rapid transit network

Corridor 11 – Beeliar to Palmyra



Key activity centres:
Phoenix Road Shopping Centre

Key alignments within corridor:
Carrington Street

Bus routes operating/intersecting corridor:
Routes 522, 532, 502, 881, 98, 99, 501, 511, 513, 940

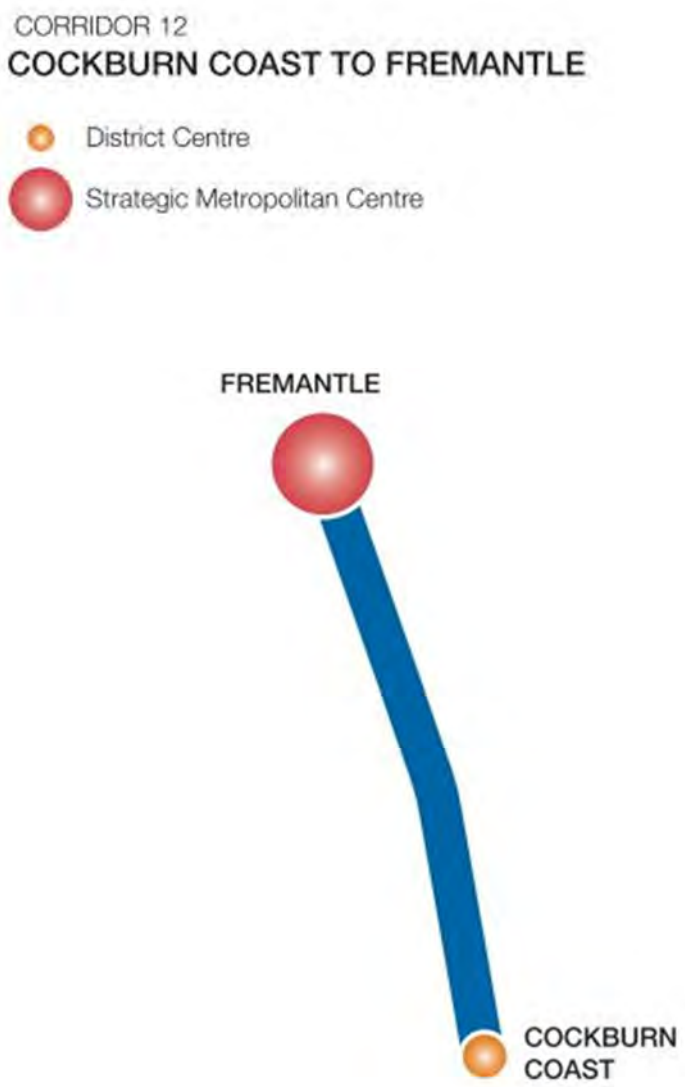
Public transport network connections:
Bus/Bus

High Level Analysis

Guiding Principle	Ranking	Comments
1.Destination threshold		Does not connect multiple key activity centres meeting minimum population and employment thresholds
2.Minimising impacts		Road space may need to be re-allocated to avoid land acquisition, however consideration needs to be given to the person flow through the corridor (i.e. public transport versus private vehicle)
3.Increasing PT mode share		Limited north-south activity centre connections provided therefore limited opportunities to increase PT mode share
4.Network effect		This corridor provides bus/bus connection opportunities at intersections along the route
5.Catalyse development		Watsonia meat packing site

Recommendation: Not shortlisted to preferred southwest metro rapid transit network

Corridor 12 – Cockburn Coast to Fremantle



Key activity centres:
Cockburn Coast, Fremantle Station/CBD

Key alignments within corridor:
Cockburn Road/Hampton Road/South Terrace/N-S Freight rail line

Bus routes operating/intersecting corridor:
Routes 825, 520, 530, 531, 532, 533, 920, 511, 513, 98, 99

Public transport network connections:
Bus/Bus & Bus/Rail

High Level Analysis

Guiding Principle	Ranking	Comments
1.Destination threshold		Connects multiple key activity centres meeting the minimum thresholds (i.e. Cockburn Coast and Fremantle)
2.Minimising impacts		Existing bus lanes available on Hampton Road, resulting in established road based priority
3.Increasing PT mode share		Links a number of key activity centres promoting an increase in mode share, also provides higher quality bus/rail connections at Fremantle Station, encouraging ridership
4.Network effect		This corridor provides bus/bus connection opportunities at intersections along the route, as well as bus/rail connections at Fremantle
5.Catalyse development		Future development opportunities in Cockburn Coast and South Fremantle

Recommendation: Shortlist to preferred southwest metro rapid transit network

High Level Rapid Appraisal – Results Summary

Table 5.1 provides a summary of the rapid appraisal for each of the transit corridors that were assessed and the recommendation for the corridor. The green dots represent the transit corridors that have been recommended for inclusion in the southwest metro rapid transit network; whereas the red dots represent the transit corridors that did not meet the fatal flaw guiding principles as part of the rapid appraisal.

Table 5.1 also provides a summary of how the recommendation made for each rapid transit corridor compares to the Public Transport for Perth in 2031 recommendations.

Table 5.1 High level rapid appraisal summary

Corridor No.	Corridor Name	Ranking	Finding	Alignment with 2031 Transit Plan
1	Fremantle – Canning Bridge	🟡	Short-listed	BRT future, post 2031
2	Fremantle – Bull Creek	🔴	Failed the fatal flaw	Not included in plan
3	Fremantle – Murdoch	🟡	Short-listed	BRT before 2031
4	Cockburn Coast – Roe Highway Interchange	🔴	Failed the fatal flaw	Not included in plan
5	East-west freight corridor	🔴	Failed the fatal flaw	Not included in plan
6	Cockburn Coast – Cockburn Central	🟡	Short-listed	BRT before 2031
7	Kwinana Fwy/Mandurah Rail line	🔴	Failed the fatal flaw	Not included in plan
8	Murdoch – Canning Bridge	🟡	Short-listed	BRT before 2031
9	Cockburn Coast – Murdoch	🟡	Short-listed	Not included in plan
10	Beeliar – Melville Plaza	🔴	Failed the fatal flaw	Not included in plan
11	Beeliar - Palmyra	🔴	Failed the fatal flaw	Not included in plan
12	Cockburn Coast - Fremantle	🟡	Short-listed	BRT before 2020

5.4 Southwest Metro Rapid Transit Network

The recommended southwest metro rapid transit network is proposed to be made up of a two tiered network structure, which have differing characteristics and serve different functions. These include:

- Trunk rapid transit network
- Local bus network.

Both categories are discussed in further detail below.

5.4.1 Trunk rapid transit network

Figure 5.1 shows the recommended trunk rapid transit network for the southwest metro area, which will provide direct links between the key activity centres proposed in the Directions 2031 planning policy. Further details have been provided in Section 5.4.2 in relation to the local bus network that is recommended to integrate with the trunk rapid transit network.

Key features of the trunk rapid transit network may include:

- A combination of segregated and mixed running ways to provide a high level of priority to transit services
- Direct connections between the key activity centres, outlined in the State Government planning policy
- Provide coverage to high density residential areas
- Service frequencies and spans that are comparable to the heavy rail network
- Specialised BRT or LRT vehicles, with higher capacity and level of comfort over regular buses and trams
- To raise the image of public transport in the southwest metro area, through a high quality service that has comparisons to heavy rail transit.

A comparison of the rapid transit networks shown in Figure 5.1 and Figure 5.2 indicates that the two networks presented compare very closely in terms of the corridors within the southwest metro area. One of the key differences is that the draft 2031 plan provides an indication as to the likely mode to be used on each corridor and an indicative timeframe for when the rapid transit infrastructure is required. The following sections of this report provide further discussion and recommendations for mode(S) to operate the southwest metro transit network.

Figure 5.1 Recommended Trunk Network from Rapid Appraisal

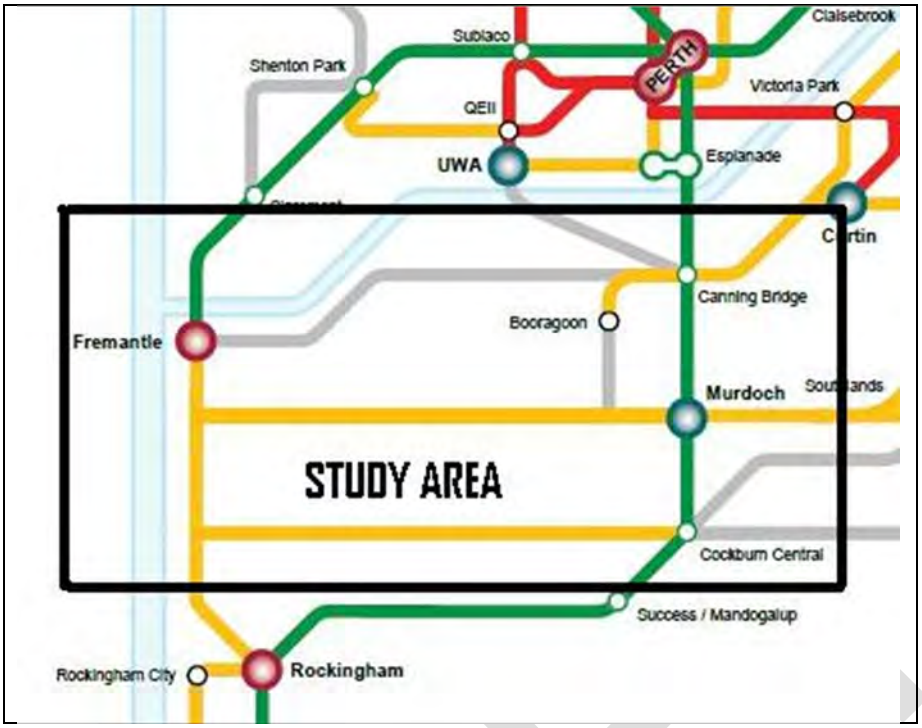


Figure 5.2 Ultimate Vision for transit network (draft 2031 plan)

5.4.2 Local bus network

The local bus network is likely to provide an integrated support/feeder role to the recommended trunk rapid transit network and is unlikely to require significant changes to the current local bus network. The local bus network will service the lower density residential areas and provide connections to the recommended trunk rapid transit network and heavy rail network, at key interchange locations.

5.4.3 Regional connections

The study area for the Southwest Metro Rapid Transit Network Study was bounded by the Mandurah rail line in the east and Beeliar Drive in the south; however consideration has been given to how the proposed rapid transit network in the southwest metro area could be expanded into the wider Perth Metropolitan region.

As indicated in the draft 2031 public transport plan for Perth, the following east-west rapid transit connections should be further investigated to integrate with the rapid transit network that has been recommended for the southwest metro area, as outlined in Figure 5.1:

- Jandakot Airport
- Southlands
- Canning Vale
- Curtin University
- Armadale.

These additional connections have not been investigated as part of the southwest metro study, however they are considered to be suitable in terms of the integration that may occur at key activity centres within the southwest metro area, including:

- Canning Bridge
- Murdoch
- Cockburn Central.

5.4.4 Fremantle – Booragoon – Bull Creek Station Corridor

Although not recommended as part of this trunk rapid transit network, the Fremantle – Booragoon – Bull Creek Station corridor has been identified as requiring further investigation for the introduction of and improvement to transit services:

Route 501 currently operates between Bull Creek Station and Fremantle, via Booragoon, providing a direct connection between Fremantle and Garden City Shopping Centre, via Marmion Street. The Fremantle – Booragoon – Bull Creek corridor was not recommended as a rapid transit corridor because it did not meet all of the guiding principles, as defined in Section 5 of this report. However, it is recognised that consideration should be given to improving the standard of this corridor to encourage patronage and to integrate with the recommended rapid transit network. The following improvements could be considered:

- Focus on providing a more reliable and direct connection between Fremantle, Booragoon and Bull Creek Station.
- Introducing bus priority via on-road or signal priority to improve travel time and reliability for bus services, particularly during peak periods
- Enhancing the service frequency and service span
- Improving bus stop infrastructure along the route.

5.4.5 Alternative Alignment Opportunity

Cockburn Central – Phoenix Road Shopping Centre (Industrial corridor)

A study was undertaken by Curtin University and the City of Cockburn in 2009, incorporating two community forums, which focused on public transport for the City of Cockburn. The primary objectives of the forums were to identify the community's aspirations for an effective public transport service in the region.

The key findings of the study included the following:

- A direct east-west transit corridor that connected Cockburn Central with Fremantle, via Lakes Shopping Centre, Spearwood Activity Centre and Cockburn Coast
- A potential alignment was identified through the disused rail corridor that extends through the centre of the Bibra Lake industrial precinct to provide a transit connection for employees within this area

- There was also desire for an additional link between the Lakes Shopping Centre, Yangebup and the Spearwood Activity Centre.
- The community overwhelmingly indicated that light rail was their preferred mode choice.

The recommended Southwest Metro rapid transit network incorporates a corridor between Cockburn Central and Cockburn Coast, via the Spearwood Activity Centre.

There are two potential alignments that require further investigation within this corridor:

- Beeliar Drive/Rockingham Road
- North Lake Road/dis-used rail corridor through Bibra Lake Industrial precinct/Spearwood Avenue, as identified in the Curtin University/City of Cockburn study.

The alignment of Beeliar Drive and Rockingham Road has emerged, following an analysis of population within the corridor, as this area serves a large residential catchment, as it is likely to generate the highest patronage between these activity centres. In order to justify the costs associated in developing rapid transit infrastructure, it is important that sufficient benefits are realised by maximising the patronage potential of the transit corridor.

Given the community and Council interest for a connection through the Bibra Lake Industrial Precinct to serve the growing employee base within this area, it is recommended that further investigation be undertaken to define the most suitable alignment between Cockburn Central Station and the Spearwood Activity Centre. This investigation should consider:

- Forecast patronage on both alignments
- Potential to increase densities in the industrial precinct and create a hub within this area to facilitate a rapid transit connection
- Demand and origins/destinations from employees in this area to use public transport to access employment.

5.4.6 Sensitivity testing

A further sensitivity test of the southwest metro rapid transit network as presented in Figure 5.1 has been undertaken by providing a visual representation of the population density within the southwest metro study area, as shown in Figure 5.3. An overlay of the recommended rapid transit network and key activity centres has been shown on the population density map to provide an indication as to the density along the rapid transit corridor. This map demonstrates how the transit network provides a strong level of coverage across the most densely populated areas of the study area. It also highlights the low density areas, such as the industrial and parkland areas, which are not covered by the rapid transit network.

The next stages of the southwest metro rapid transit network study will provide further investigation into the population density within the transit network corridors, as well as more detailed information relating to the alignments within these corridors and other information.

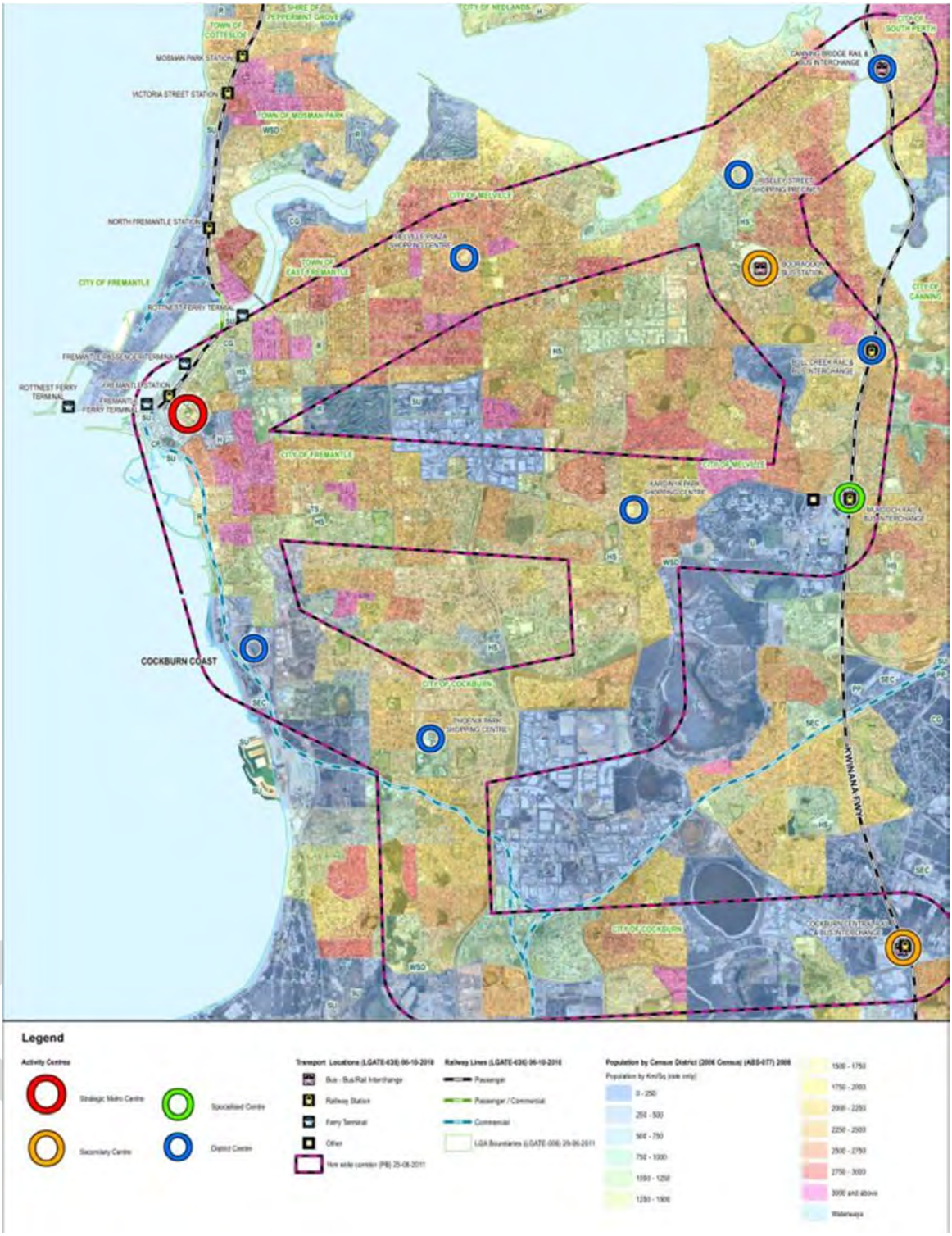


Figure 5.3 Population density and transit network

6. Mode options assessment

A mode options assessment has been undertaken for the rapid transit corridors that make up the recommended Southwest Metro Rapid Transit Network, as shown in Figure 6.1 below. The purpose of this assessment is to determine the potential viability of each corridor to accommodate Bus Rapid Transit (BRT) or Light Rail Transit (LRT). The results of this assessment have then been used to assist in determining the preferred combination of modes to operate the recommended southwest metro rapid transit network.

In order to provide a recommendation for the recommended mode of operation for the rapid transit corridors, the following assessments have been undertaken:

- **Qualitative discussion** – focusing on opportunities and constraints for the BRT/LRT mode options, based on a range of characteristics, which are discussed in the draft 2031 public transport plan for Perth
- **Patronage forecasting assessment –** A high level patronage forecasting assessment of the corridor patronage for BRT and LRT operation
- **Rapid appraisal cost-benefit analysis** – An analysis of the high level costs and indicative benefits in providing BRT and/or LRT

Figure 6.1 Recommended Southwest Metro Trunk Rapid Transit Network

6.1 Rapid transit corridors analysis

The recommended Southwest Metro Rapid Transit Network has been split into the individual corridors, as outlined in Table 6.1.

Table 6.1 Recommended Rapid Transit Corridors

Corridor No.	Corridor Length (km)	Corridor Name
1	12.4	Fremantle – Canning Bridge
2	11.8	Fremantle – Murdoch
3	14.6	Cockburn Coast – Cockburn Central
4	9.5	Murdoch – Canning Bridge

Corridor No.	Corridor Length (km)	Corridor Name
5	14.1	Cockburn Coast – Murdoch
6	5	Cockburn Coast - Fremantle

A modelled roadway alignment was selected for each corridor to enable an assessment to be undertaken at a more detailed level. The modelled alignments for each corridor were selected based on the highest residential population living within an 800m walkable catchment either side of the modelled alignment.

For the purpose of this study, the alignment with the highest residential population living within the 800m catchment either side of the alignment was used. The actual preferred alignment should be determined in a future more detailed assessment.

The recommended rapid transit network for the southwest metro area is presented in Figure 6.2 and outlines the modelled alignments that have been assessed as part of this study.

Figure 6.2 Modelled alignments

6.2 Modelled alignment characteristics

A summary of the key characteristics for each of the modelled alignments within the corridors is presented below.

Corridor 1 – Fremantle to Canning Bridge

The modelled Fremantle to Canning Bridge alignment is presented in Figure 6.3.

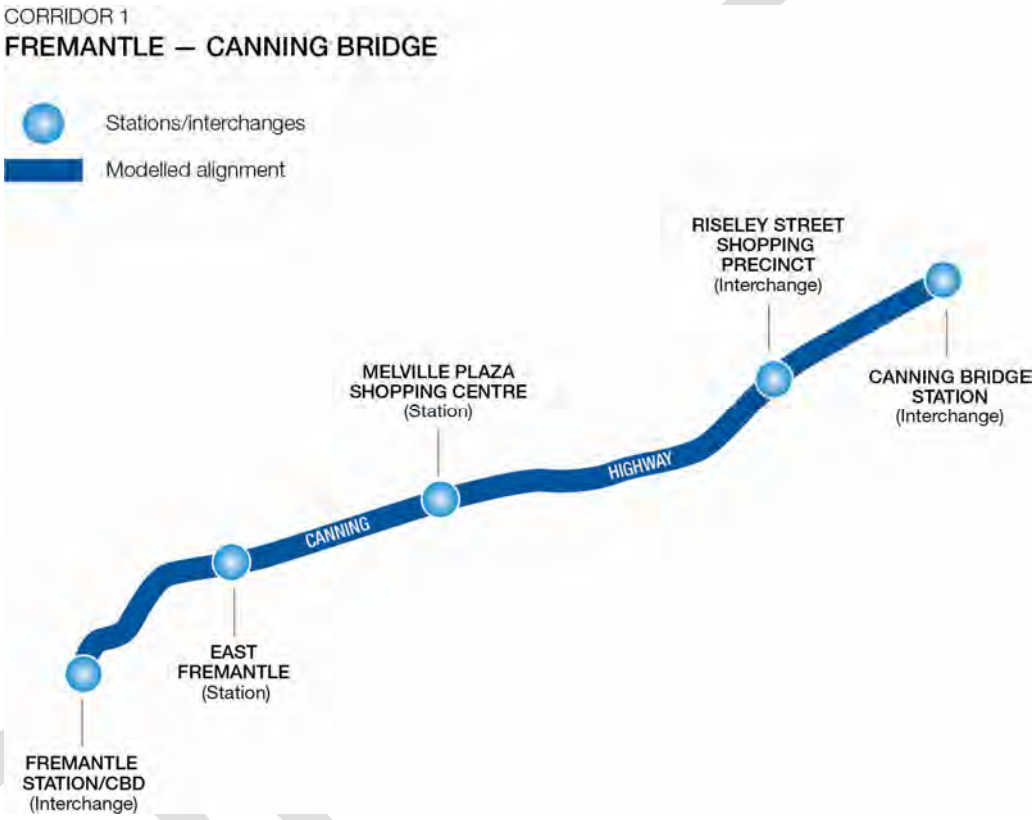


Figure 6.3 Freemantle to Canning Bridge Modelled Alignment

The key characteristics within the Fremantle – Canning Bridge corridor are presented in Table 6.2.

Table 6.2 Freemantle to Canning Bridge Corridor – Key characteristics

Corridor Name:	Fremantle to Canning Bridge
Modelled alignment:	**Origin:** Fremantle Rail Station Route: Elder Place to Phillimore Street to Queen Street to Adelaide Street to Queen Victoria Street to Canning Highway **Destination:** Canning Bridge Rail Station
Alternative alignment options:	High Street to East Street to Canning Highway High Street to Stirling Highway to Canning Highway
Alignment length:	12.4 km

Corridor Name:	Fremantle to Canning Bridge
Activity centres linked:	Fremantle Rail Station/CBD Melville Plaza Canning Bridge Rail Station Riseley Street Shopping Precinct East Fremantle
Key interchanges:	Fremantle Rail Station (rail and bus) Melville Plaza (bus) Canning Bridge Rail Station (rail and bus)
Potential stop spacing:	500m-800m
Corridor function in network context:	To provide a direct link between Fremantle and Canning Bridge stations, also linking key activity centres in between with network connection opportunities. To provide the residential catchment along the corridor with direct access to Fremantle and Canning Bridge Stations for onward connections or as a destination
Regional Connection Opportunities:	Perth CBD, Fremantle rail corridor, Mandurah rail corridor, Curtin University, UWA
Corridor Characteristics (Key Sections):	
Section A)	**Queen Victoria Street from Adelaide Street to Canning Highway**
Section Length:	1.6 km
No. lanes:	4 lanes (two-way)
AAWT[1]:	Highest: 29,890 (2006/2007) - West of Canning Highway Lowest: 15,880 (2008/2009) - West of James Street
Carriageway:	Un-divided (central islands located within median)
Road reserve availability:	Restricted to 4-lane carriageway due to existing dwellings
Car parking:	Parking available on both sides of Queen Victoria Street
Speed limit:	60 km/h
Max vertical grade:	<6%
Signalised intersections:	3
Bus stops:	On-street bus stops
Footpath	Both sides of Queen Victoria Street
Cycle lanes:	None
Section B)	**Canning Highway from Queen Victoria Street to Canning Bridge Station**
Section Length:	10.8 km
No. lanes:	4 lanes (two-way) – west of Reynolds Road 5 lanes (two-way) – 3 lanes eastbound: east of Reynolds Road
AAWT:	Highest: 68,490 (2007/2008) – at Canning Bridge Lowest: 10,720 (2006/2007) – East of Queen victoria Street

[1] *Annual average weekday traffic volumes (source:MRWA)*

Corridor Name:	Fremantle to Canning Bridge
Carriageway:	**Combination of:** Divided (5-15m wide central median) Divided (1m wide median, line marked with central islands) Undivided (line-marking separation)
Road reserve availability:	Constrained in some areas by existing dwellings, however width available in central median in some areas
Car parking:	No parking available on both sides of Canning Highway
Speed limit:	60 km/h
Max vertical grade:	7% on Canning Highway
Signalised intersections:	12
Bus stops:	Indented bus bays
Footpath	Both sides of Canning Highway
Cycle lanes:	None

Corridor 2 – Fremantle to Murdoch

The modelled Fremantle to Murdoch alignment is presented in Figure 6.4.

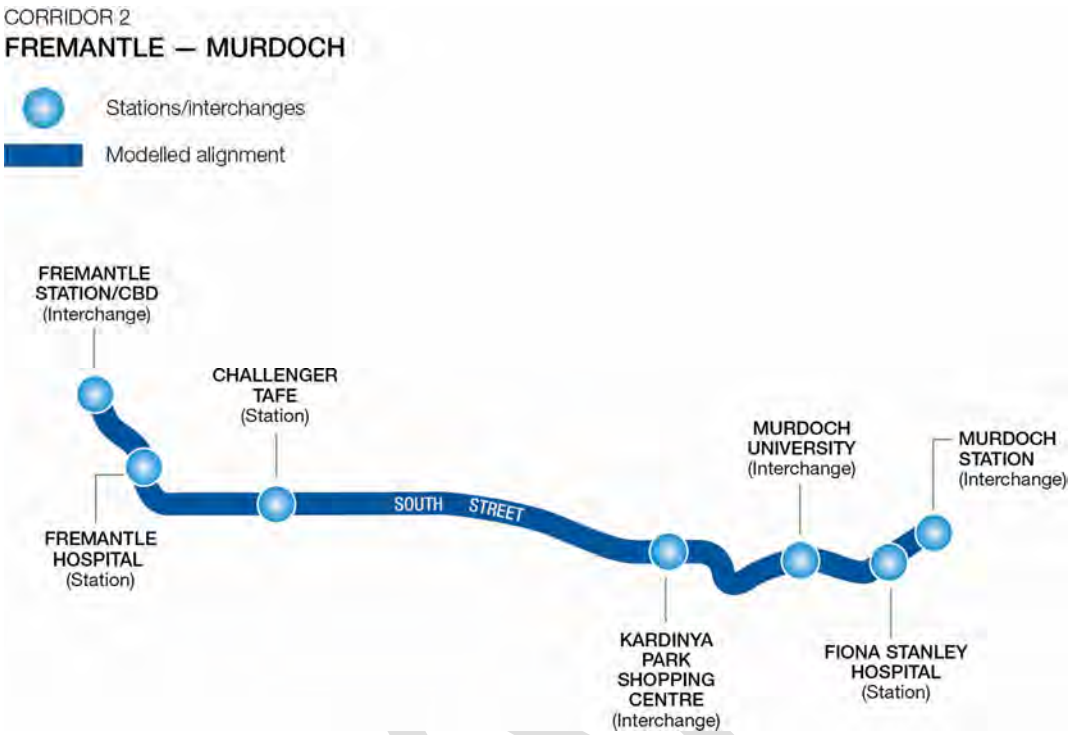


Figure 6.4 Freemantle to Murdoch Modelled Alignment

The key characteristics within the Fremantle – Murdoch corridor are presented in Table 6.3

Table 6.3 Freemantle to Murdoch Corridor – Key characteristics

Corridor Name:	Fremantle to Murdoch
Modelled alignment:	**Origin:** Fremantle Rail Station Route: Elder Place to Phillimore Street to Market Street to South Terrace to South Street to Windelya Drive to University Drive to new Main Street link through Fiona Stanley Hospital **Destination:** Murdoch Rail Station
Alternative alignment options:	Queen Street – High Street (i.e. not via South Terrace) Extend entire length of South Street (i.e. no deviation through University and Fiona Stanley Hospital)
Alignment length:	11.8 km
Activity centres linked:	Fremantle Rail Station/CBD Kardinya Park Shopping Centre Murdoch University Future Fiona Stanley Hospital Murdoch Rail Station Challenger TAFE
Key interchanges:	Fremantle Rail Station (rail and bus) Kardinya Park Shopping Centre (bus) Murdoch Rail Station (rail and bus) Murdoch University (bus)
Potential stop spacing:	500-800m

Corridor Name:	Fremantle to Murdoch
Corridor function in network context:	To provide a direct link between Fremantle and Murdoch stations, also linking key activity centres in between with network connection opportunities. To provide the residential catchment along the corridor with direct access to Fremantle and Murdoch Stations for onward connections or as a destination
Regional Connection Opportunities:	Fremantle rail corridor, Mandurah rail corridor, Perth CBD, Canning Vale and Jandakot Airport
Corridor Characteristics (Key Sections):	
Section A)	**Market Street/South Terrace from Phillimore Street to South Street**
Section Length:	1.7 km
No. lanes:	2 lanes (two-way)
AAWT:	**Market Street:** Highest: 11,060 (2006/2007) – North of South Terrace Lowest: 5,550 (2008/2009) – South of Phillimore Street **South Terrace:** Highest: 16,620 (2008/2009) – South of Norfolk Street Lowest: 10,070 (2008/2009) – North of Collie Street
Carriageway:	Combination of un-divided and divided roadway (varied median width of up to 1m)
Road reserve availability:	Restricted to 2-lane carriageway due to existing dwellings
Car parking:	On-street/on-kerb car parking available on South Terrace with areas of parking also available on Market Street
Speed limit:	50 km/h
Max vertical grade:	<6%
Signalised intersections:	4
Bus stops:	Combination of on-street bus stops and indented bus bays
Footpath	Both sides of Market Street and South Terrace
Cycle lanes:	None
Section B)	**South Street from South Terrace to Windelya Road**
Section Length:	6.9km
No. lanes:	2 lanes (two-way) – west of Carrington Street 4 lanes (two-way) – west of McCombe Avenue 6 lanes (two-way) – west of Windelya Road
AAWT	**2 lane section:** Highest: 19,720 (2006/2007) – West of Carrington Street Lowest: 11,720 (2008/2009) – East of South Terrace **4 lane section:** Highest: 29,570 (2006/2007) – East of Stock Road Lowest: 24,990 (2008/2009) – East of Carrington Street **6 lane section:** Highest: 37,840 (2008/2009) – East of North Lake Road

Corridor Name:	Fremantle to Murdoch
	Lowest: 32,620 (2008/2009) – West of North Lake Road
Carriageway:	**2 lane section:** Un-divided carriageway **4 lane section:** Combination of un-divided carriageway and divided carriageway (5m-10m wide central median) **6 lane section:** Divided carriageway (5m wide central median)
Road reserve availability:	**2 lane section:** Un-divided carriageway **4 lane section:** Combination of un-divided carriageway and divided carriageway (5m-10m wide central median) **6 lane section:** Divided carriageway (5m wide central median)
Car parking:	**2 lane section:** Parking available on both sides of street, only west of Hampton Road **4 lane section:** No parking **6 lane section:** No parking
Speed limit:	**2 lane section:** 50 km/h **4 lane section:** 70 km/h **6 lane section:** 70 km/h
Max vertical grade:	7% on South Street
Signalised intersections:	6
Bus stops:	Combination of on-street and indented bus bays
Footpath	Both sides of South Street, for the majority of its length
Cycle lanes:	Only available on South Street between Hampton Road and Carrington Street
Section C)	**Windelya Rd / University Drive / Fiona Stanley Hospital Link[2]**
Section Length:	3.2 km
No. lanes:	2 lanes (two-way)
AAWT:	Not available on University Drive and Fiona Stanley link is not yet constructed
Carriageway:	Un-divided carriageway

[2] *Further details of the proposed Fiona Stanley Hospital link road is provided in the following report: Murdoch Activity Centre Structure Plan – Part A*

Corridor Name:	Fremantle to Murdoch
Road reserve availability:	Constrained in some areas by existing dwellings, however width available through Murdoch University grounds
Car parking:	No parking
Speed limit:	50 km/h
Max vertical grade:	<6%
Signalised intersections:	None
Bus stops:	On street bus stops
Footpath	Available in some locations
Cycle lanes:	None

Corridor 3 – Cockburn Coast to Cockburn Central

The modelled Cockburn Coast to Cockburn Central alignment is presented in Figure 6.5.

Figure 6.5 Cockburn Coast to Cockburn Central Modelled Alignment

The key characteristics within the Cockburn Coast to Cockburn Central corridor are presented in Table 6.4.

Table 6.4 Cockburn Coast to Cockburn Central Corridor – Key characteristics

Corridor Name:	Cockburn Coast to Cockburn Central
Modelled alignment:	**Origin:** Cockburn Coast Route: Cockburn Road to Spearwood Avenue to Phoenix Road Shopping Centre to Rockingham Road to Beeliar Drive to Cockburn Gateway Shopping Centre **Destination:** Cockburn Central Rail Station
Alternative alignment options:	North Lake Road – dis-used rail corridor through Bibra Lake industrial area – Spearwood Avenue Rockingham Road to Beeliar Drive (i.e. not via Spearwood Ave)
Alignment length:	14.6 km
Activity centres linked:	Cockburn Coast district centre Phoenix Road shopping Centre

Corridor Name:	Cockburn Coast to Cockburn Central
	Stargate Shopping Centre Gateway Shopping Centre Cockburn Central Rail Station
Key interchanges:	Cockburn Coast (bus) Phoenix Road Shopping Centre (bus) Gateway Shopping Centre (bus) Cockburn Central Rail Station (rail and bus)
Potential stop spacing:	500-800m
Corridor function in network context:	To provide a direct link between Cockburn Coast and Cockburn Central Station, also linking key activity centres in between with network connection opportunities. To provide the residential catchment along the corridor with direct access to Cockburn Coast and Cockburn Central for onward connections or as a destination
Regional Connection Opportunities:	Mandurah rail corridor, Perth CBD, Rockingham, Canning Vale and Armadale
Corridor Characteristics (Key Sections):	
Section A)	**Cockburn Road / Spearwood Avenue / Rockingham Road**
Section Length:	7.0 km
No. lanes:	**Cockburn Road:** 2 lanes (two-way) **Spearwood Avenue:** 4 lanes (two-way) **Rockingham Road:** 4 lanes (two-way) – North of Reserve Road 2 lanes (two-way) – South of Reserve Road
AAWT:	**Cockburn Road:** 15,540 (2006/2007) – South of Rockingham Road **Spearwood Avenue:** 4,350 (2006/2007) – West of Rockingham Road **Rockingham Road:** 21,130 (2007/2008) – South of Spearwood Avenue
Carriageway:	**Cockburn Road:** Un-divided carriageway **Spearwood Avenue:** Divided carriageway (5-10m central median) **Rockingham Road:** Un-divided carriageway
Road reserve availability:	Restricted to 4-lane carriageway due to existing dwellings
Car parking:	No car parking available on Cockburn Road, Spearwood Avenue or Rockingham Road
Speed limit:	**Cockburn Road:** 60 km/h **Spearwood Avenue:** 60 km/h **Rockingham Road:** 60 km/h
Max vertical grade:	<6%

Corridor Name:	Cockburn Coast to Cockburn Central
Signalised intersections:	2
Bus stops:	On-street bus stops
Footpath	Only available on Rockingham Road
Cycle lanes:	None
Section B)	**Beeliar Drive**
Section Length:	7.6 km
No. lanes:	2 lanes (two-way) – west of Spearwood Avenue 4 lanes (two-way) – between Spearwood Avenue and Dunraven Drive 2 lanes (two-way – between Dunraven Drive and Hammond Road 4 lanes (two-way) – east of Hammond Road
AAWT	**Highest:** 35,540 (2006/2007) – West of Kwinana Freeway **Lowest:** 9,730 (2006/2007) – West of Stock Road
Carriageway:	**Combination of:** Divided (1-10m wide central median) Undivided (line-marking separation)
Road reserve availability:	Constrained in some areas by existing dwellings, however width available in central median in some areas
Car parking:	No parking available on both sides of Cockburn Road, Spearwood Avenue and Rockingham Road
Speed limit:	80 km/h – East of Spearwood Avenue 70 km/h – West of Spearwood Avenue
Max vertical grade:	7% on Beeliar Drive
Signalised intersections:	2
Bus stops:	On street bus stops
Footpath	Both sides of Beeliar Drive (built up areas only)
Cycle lanes:	None

Corridor 4 – Murdoch to Canning Bridge

The modelled Murdoch to Canning Bridge alignment is presented in Figure 6.6.

Figure 6.6 Murdoch to Canning Bridge Modelled Alignment

The key characteristics within the Murdoch – Canning Bridge corridor are presented in Table 6.5

Table 6.5 Murdoch to Canning Bridge Corridor – Key characteristics

Corridor Name:	Murdoch to Canning Bridge
Modelled alignment:	**Origin:** Murdoch Rail Station Route: Future Fiona Stanley road link to Murdoch Drive to Leach Highway to Riseley Street to Booragoon to Canning Highway **Destination:** Canning Bridge Rail Station
Alternative alignment options:	South Street (instead of future Fiona Stanley road link)
Alignment length:	9.5 km
Activity centres linked:	Murdoch Rail Station Future Fiona Stanley Hospital Murdoch University Garden City Shopping Centre Riseley Street Shopping Precinct Canning Bridge Rail Station
Key interchanges:	Murdoch Rail Station (bus and rail) Murdoch University (bus) Booragoon bus interchange (bus) Riseley Street Shopping Precinct (bus) Canning Bridge Rail Station (bus and rail)
Potential stop spacing:	500-800m
Corridor function in network context:	To provide a direct link between Booragoon/Garden City and Canning Bridge/Murdoch stations, also linking key activity centres in between with network connection opportunities. To provide the residential catchment along the corridor with direct access to Canning Bridge and Murdoch Stations for onward connections or as a destination
Regional Connection Opportunities:	Perth CBD, Mandurah rail corridor, Curtin University, UWA, Canning Vale and Jandakot Airport
Corridor Characteristics (Key Sections):	
Section A)	**Murdoch Drive / Leach Highway**
Section Length:	4.1 km (includes new Fiona Stanley Hospital link road)
No. lanes:	4 lanes (two-way) – Murdoch Drive 6 lanes (two-way) – Leach Highway
AAWT:	**Murdoch Drive:** 19,950 (2007/2008) – South of Leach Highway **Leach Highway:** 66,580 (2008/2009) – East of Riseley Street
Carriageway:	**Murdoch Drive:** Divided carriageway (1-5m wide central median) **Leach Highway:** Divided carriageway (5m wide central median)
Road reserve availability:	Murdoch Drive is constrained on the eastern side due to existing dwellings and also on the western side between Hawke Pass and South Street
Car parking:	No car parking available on Murdoch Drive or Leach Highway
Speed limit:	70 km/h on Murdoch Drive
Max vertical grade:	<6%
Signalised intersections:	3
Bus stops:	On-street bus stops

Corridor Name:	Murdoch to Canning Bridge
Footpath	Available on both sides of Murdoch Drive and Leach Highway
Cycle lanes:	None
Section B)	**Riseley Street**
Section Length:	3.0 km
No. lanes:	4 lanes (two-way)
AAWT:	Highest: 25,590 (2008/2009) – South of Marmion Street Lowest: 18,240 (2007/2008) – South of Canning Highway
Carriageway:	Divided carriageway (1-2m wide central median)
Road reserve availability:	Constrained on both sides of Riseley Street by existing dwellings
Car parking:	No parking on either side of Riseley Street
Speed limit:	60 km/h
Max vertical grade:	7% on Riseley Street
Signalised intersections:	4
Bus stops:	On street bus stops
Footpath	Both sides of Riseley Street
Cycle lanes:	None
Section C)	**Canning Highway**
Section Length:	2.4 km
No. lanes:	4 lanes (two-way) – west of Reynolds Road 5 lanes (two-way) – 3 lanes eastbound: east of Reynolds Road
AAWT:	Highest: 68,490 (2007/2008) – at Canning Bridge Lowest: 44,160 (2008/2009) – east of Riseley Street
Carriageway:	Divided (1-10m wide central median)
Road reserve availability:	Constrained in some areas by existing dwellings, however width available in central median in some areas
Car parking:	Eastbound: no parking Westbound: no parking
Speed limit:	60 km/h
Max vertical grade:	<6%
Signalised intersections:	5
Bus stops:	Indented bus bays
Footpath	Both sides of Canning Highway
Cycle lanes:	None

Corridor 5 – Cockburn Coast to Murdoch

The modelled Cockburn Coast to Murdoch alignment is presented in Figure 6.7.

Figure 6.7 Cockburn Coast to Murdoch Modelled Alignment

The key characteristics within the Cockburn Coast to Murdoch corridor are presented in Table 6.6.

Table 6.6 Cockburn Coast to Murdoch Corridor – Key characteristics

Corridor Name:	Cockburn Coast to Murdoch
Modelled alignment:	**Origin:** Cockburn Coast Route: Cockburn Road to Spearwood Avenue to Rockingham Road to Phoenix Road to North Lake Road to South Street to University Drive to Fiona Stanley link Road **Destination:** Murdoch Rail Station
Alternative alignment options:	Rockingham Road (instead of Spearwood Avenue) Farrington Road and Murdoch Drive (instead of linking to Kardinya Park Shopping Centre)
Alignment length:	14.1 km
Activity centres linked:	Cockburn Coast District Centre Phoenix Road Shopping Centre Kardinya Park Shopping Centre Murdoch University Future Fiona Stanley Hospital Murdoch Rail Station

Corridor Name:	Cockburn Coast to Murdoch
Key interchanges:	Cockburn Coast District Centre (bus) Phoenix Road Shopping Centre (bus) Kardinya Park Shopping Centre (bus) Murdoch University (bus) Murdoch Rail Station (bus and rail)
Potential stop spacing:	500-800m
Corridor function in network context:	To provide a direct link between Cockburn Coast and Murdoch station, also linking key activity centres in between with network connection opportunities. To provide the residential/employment catchment along the corridor with direct access to Cockburn Coast and Murdoch Station for onward connections or as a destination
Regional Connection Opportunities:	Perth CBD, Mandurah rail corridor, Canning Vale and Jandakot Airport
Corridor Characteristics (Key Sections):	
Section A)	**Cockburn Road / Spearwood Avenue / Rockingham Road**
Section Length:	4.4 km
No. lanes:	**Cockburn Road:** 2 lanes (two-way) **Spearwood Avenue:** 4 lanes (two-way) **Rockingham Road:** 4 lanes (two-way)
AAWT:	**Cockburn Road:** 15,540 (2006/2007) – South of Rockingham Road **Spearwood Avenue:** 4,350 (2006/2007) – West of Rockingham Road **Rockingham Road:** 20,330 (2006/2007) – South of Phoenix Road
Carriageway:	**Cockburn Road:** Un-divided carriageway **Spearwood Avenue:** Divided carriageway (5-10m wide central median) **Rockingham Road:** Un-divided carriageway
Road reserve availability:	Rockingham Road is restricted to 4-lane carriageway due to existing dwellings
Car parking:	No car parking available on Cockburn Road, Spearwood Avenue or Rockingham Road
Speed limit:	**Cockburn Road:** 60 km/h **Spearwood Avenue:** 60 km/h **Rockingham Road:** 60 km/h
Max vertical grade:	<6%
Signalised intersections:	3
Bus stops:	On-street bus stops

Corridor Name:	Cockburn Coast to Murdoch
Footpath	Only available on Rockingham Road
Cycle lanes:	None
Section B)	**Phoenix Road**
Section Length:	3.1 km
No. lanes:	4 lanes (two-way)
AAWT:	Highest: 19,850 (2007/2008) – West of North Lake Road Lowest: 15,110 (2008/2009) – East of Rockingham Road
Carriageway:	Divided carriageway (5-10m wide central median)
Road reserve availability:	Constrained on both sides of Phoenix Road by existing dwellings
Car parking:	No parking on either side of Phoenix Road
Speed limit:	60 km/h
Max vertical grade:	<6%
Signalised intersections:	4
Bus stops:	On street bus stops
Footpath	Entire length on northern side of Phoenix Road, only west of Stock Road on southern side of Phoenix Road
Cycle lanes:	None
Section C)	**North Lake Road**
Section Length:	2.8 km
No. lanes:	5 lanes (two-way) – south of Winterfold Road, with 3 lanes southbound, 2 lanes northbound 6 lanes (two-way) – north of Winterfold Road
AAWT:	Highest: 31,310 (2008/2009) – South of Farrington Road Lowest: 27,160 (2008/2009) – South of Winterfold Road
Carriageway:	Divided carriageway (5-10m wide central median)
Road reserve availability:	Constrained in some areas by existing dwellings
Car parking:	No parking on either side of North Lake Road
Speed limit:	70 km/h
Max vertical grade:	<6%
Signalised intersections:	3
Bus stops:	Combination of indented and on-street bus bays

Corridor Name:	Cockburn Coast to Murdoch
Footpath	Limited footpath available on both sides of North Lake Road
Cycle lanes:	None
Section D)	**South Street / Windelya Road / University Drive / Fiona Stanley Link Road**
Section Length:	3.8 km
Details provided in Corridor 2 (Fremantle to Murdoch)	

Corridor 6 – Cockburn Coast to Fremantle

The modelled Cockburn Coast to Fremantle alignment is presented in Figure 6.8.

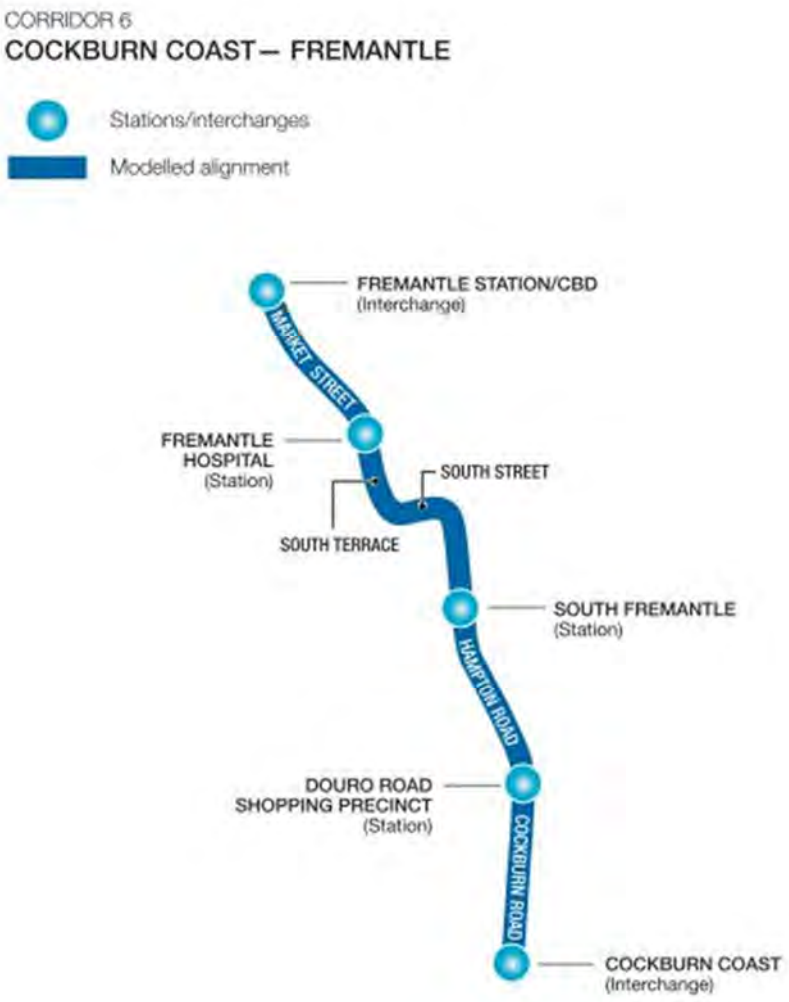


Figure 6.8 Cockburn Coast to Freemantle

The key characteristics within the Cockburn Coast to Fremantle corridor are presented in Table 6.7.

Table 6.7 Cockburn Coast to Freemantle Corridor – Key characteristics

Corridor Name:	Cockburn Coast to Fremantle
Modelled alignment:	**Origin:** Cockburn Coast Route: Cockburn Road to Hampton Road to South Street to South Terrace to Market Street to Phillimore Street **Destination:** Fremantle Rail Station (NOTE: BRT corridor study currently underway, therefore this alignment may be subject to change)

Corridor Name:	Cockburn Coast to Fremantle
Alternative alignment options:	South Terrace Marine Terrace
Alignment length:	5 km
Activity centres linked:	Cockburn Coast district centre Fremantle Rail Station Fremantle CBD South Fremantle
Key interchanges:	Cockburn Coast (bus) Fremantle Rail Station (rail and bus) Fremantle CBD (bus)
Potential stop spacing:	500-800m
Corridor function in network context:	To provide a direct link between Cockburn Coast and Fremantle station/CBD, also linking key activity centres in between. To provide the residential/employment catchment along the corridor with direct access to Fremantle or Cockburn Coast for onward connections or as a destination. To provide a catalyst for development within the corridor
Regional Connection Opportunities:	Fremantle rail corridor, Rockingham
Corridor Characteristics (Key Sections):	
Section A)	**Cockburn Road / Hampton Road**
Section Length:	3.1 km
No. lanes:	**Cockburn Road:** 2 lanes (two-way) **Hampton Road:** 4 lanes (two-way) – includes kerbside bus lanes (1 km long) between Douro Road and south Street
AAWT:	**Cockburn Road:** 15,540 (2006/2007) – South of Rockingham Road **Hampton Road:** 31,480 (2008/2009) – South of Douro road 19,870 (2008/2009) – South of South Street (bus lanes section)
Carriageway:	**Cockburn Road:** Un-divided carriageway **Hampton Road:** Un-divided carriageway
Road reserve availability:	**Cockburn Road:** Available road reserve in some sections currently, however Cockburn Coast ITP will define future reserve widths **Hampton Road:** Constrained road reserve due to existing dwellings, particularly between Rockingham Road and Douro Road
Car parking:	No car parking available on Cockburn Road or Hampton Road
Speed limit:	**Cockburn Road:** 60 km/h **Hampton Road:** 60 km/h
Max vertical grade:	<6%

Corridor Name:	Cockburn Coast to Fremantle
Signalised intersections:	6
Bus stops:	On-street bus stops
Footpath	Only available on both sides of Hampton Road
Cycle lanes:	None
Section B)	**South Street / South Terrace**
Section Length:	1.5 km
No. lanes:	2 lanes (two-way) – South Terrace 2 lanes (two-way) – South Street
AAWT:	**South Terrace:** Highest: 16,620 (2008/2009) – South of Norfolk Street Lowest: 10,070 (2008/2009) – North of Collie Street **South Street:** 11,720 (2008/2009) – East of South Terrace
Carriageway:	Combination of un-divided and divided roadway (varied median width of up to 1m)
Road reserve availability:	Restricted to 2-lane carriageway due to existing dwellings
Car parking:	**South Terrace:** On-street/on-kerb car parking available on at sections along both sides of South Terrace **South Street:** On-street car parking available on both sides of South Street
Speed limit:	**South Terrace:** 50 km/h **South Terrace:** 50 km/h
Max vertical grade:	<6%
Signalised intersections:	2
Bus stops:	Combination of on-street bus stops and indented bus bays
Footpath	Both sides of South Street and South Terrace
Cycle lanes:	None
Section C)	**Market Street**
Section Length:	0.4 km
No. lanes:	2 lanes (two-way)
AAWT:	Highest: 11,060 (2006/2007) – North of South Terrace Lowest: 5,550 (2008/2009) – South of Phillimore Street
Carriageway:	Combination of un-divided and divided roadway (varied median width of up to 1m)
Road reserve availability:	Restricted to 2-lane carriageway due to existing dwellings
Car parking:	On-kerb car parking available on Market Street

Corridor Name:	Cockburn Coast to Fremantle
Speed limit:	50 km/h
Max vertical grade:	<6%
Signalised intersections:	1
Bus stops:	On-street bus stops
Footpath	Both sides of Market Street
Cycle lanes:	None

6.3 Qualitative discussion

The draft 2031 Public Transport plan for Perth highlights a number of considerations for the provision of a rapid transit network in Perth. The proposed Southwest Metro Rapid Transit Network outlined in this report has been discussed in relation to some of the draft 2031 plan considerations, to provide further support for recommendations that have been developed and to assist in selecting the preferred modes.

A range of criteria have been considered as part of this assessment to discuss the varying opportunities and constraints that need to be understood for this type of high level study. Some of the criteria, as presented in Table 6.8 provide an opportunity to distinguish between the differences associated in operating BRT and LRT modes on the individual transit corridors.

Table 6.8 Mode selection criteria

Criteria Name	Criteria Description
Travel time savings	Estimated travel time savings of BRT and LRT compared with existing travel times in peak periods
Topographical constraints	Estimated maximum roadway grades and the subsequent constraints for operating BRT and LRT
Alignment to policies/strategies	Consistency with and opportunities to inform the draft 2031 public transport plan for Perth
Development catalyst and value uplift	Opportunities associated with BRT/LRT infrastructure to catalyse development
Network integration	Opportunities to enhance the network effect
Linking to a broader network	Consideration for DOT requirements to have a network that is linked, providing consistent technology
Active transport integration	Opportunities and constraints associated with active transport integration with rapid transit network
Corridor reservation availability	Rapid transit design criteria and opportunities and constraints associated in accommodating rapid transit within corridors

6.3.1 Transport user perspective

The draft 2031 plan provides a summary of passenger expectations on the Perth public transport network, which highlights the key attributes that passengers value in a transit system:

- Passengers want services that are frequent, on time and affordable
- They want to be able to travel quickly to their destination
- They want to feel safe and secure
- There are virtually no priority measures to improve the effectiveness of services, particularly in the congested peak periods, as a result buses are vulnerable to delays caused by road congestion

It is likely that these same passenger expectations are representative of passenger preferences in the southwest metro study area and therefore a rapid transit network that can accommodate these elements will have a greater likelihood of success.

The criteria provide a discussion for the opportunities and constraints for all rapid transit corridors and modelled alignments that make up the recommended Southwest Metro rapid transit network. The criteria provide a further understanding of what the opportunities and constraints are likely to be for the operation of BRT/LRT on the recommended transit corridors and modelled alignments.

6.3.2 Travel time savings

A high level travel time assessment has been undertaken to determine the estimated total travel time for Corridor 1 for BRT and LRT operation. Assumptions have been made in relation to average BRT and LRT operating speeds. The estimated travel times for BRT and LRT have then been compared to the existing travel times for the same corridor during a typical AM peak period.

The following assumptions have been made in relation to the average operating speeds for BRT/LRT, compared within local bus network speeds, operating in mixed traffic:

- **BRT/LRT average operating speeds:** 20 km/h (includes acceleration/deceleration and dwell times)
- **Local bus average operating speeds:** 15 km/h (assumes operation in general traffic)

Source: Stirling City Centre Light Rail Feasibility Study – Phase 2 - 30 June 2010

Travel times have been assumed to be the same for BRT and LRT, assuming similar maximum operating speeds and dwell times at stops.

Table 6.9 Travel time savings

Travel Time Comparison						
	Rapid Transit Corridor					
	Fremantle – Canning Bridge	Fremantle - Murdoch	Cockburn Central – Cockburn Coast	Murdoch – Canning Bridge	Cockburn Coast - Murdoch	Cockburn Coast - Fremantle
Total corridor length (km):	12.4	11.8	14.6	9.5	14.1	5
Operating speed (km/h) – BRT/LRT:	20	20	20	20	20	20
Operating speed (km/h) – local bus:	15	15	15	15	15	15
BRT/LRT Total travel time (minutes):	37	35	44	29	42	15
Local bus travel times (minutes):	50	47	58	38	56	20
Percentage reduction for BRT/LRT	26%	26%	24%	24%	25%	25%

Based upon the high level travel time saving estimates presented in Table 6.9, the following conclusions can be made:

- BRT/LRT are likely to result in similar travel times for each of the rapid transit corridors, as a result of the same average operating speed of 20km/h being assumed

- Travel time savings in the order of 24-26% are likely to be achieved on each of the rapid transit corridors, when compared to the travel time of local bus travel operating with general traffic, however this is conditional upon the following:
  - The length of segregated running way that is provided compared to mixed traffic running along the corridor
  - The improvements made to wait times and boarding times as a result of improved frequencies, collection of fares and number of doors available for boarding
  - The level of priority allocated to BRT/LRT at traffic signals in comparison to local bus services

Travel time comparisons between BRT/LRT and local bus require further detailed investigation for each of the rapid transit corridors, once each of the factors mentioned above are understood in greater detail.

6.3.3 Topographical constraints

The topography of the potential alignment within all corridors has been investigated to determine the likely impacts associated with running transit vehicles within each of the corridors. The key focus of this assessment relates to the operation of LRT vehicles on the alignment. As outlined in the Design Standards Working Paper for the Central Northern Corridor LRT system, the maximum grade specified for LRT vehicles is 6% (in exceptional cases up to 8% for a maximum length of 250m along a straight alignment).

Table 6.10 Topographical constraints

Topographical constraints						
	Rapid Transit Corridor					
	Fremantle – Canning Bridge	Fremantle -Murdoch	Cockburn Central – Cockburn Coast	Murdoch – Canning Bridge	Cockburn Coast - Murdoch	Cockburn Coast - Fremantle
Total corridor length (km):	12.4	11.8	14.6	9.5	14.1	5
Maximum grade (%):	7%	7%	7%	7%	<6%	<6%
Location of maximum grade:	Canning Hwy[3]	South St[4]	Beeliar Drv[5]	Riseley St[6]	-	-

The following key points have been made in relation to the topographical constraints on the rapid transit corridors:

- The desirable grade for LRT running (i.e. 6%) has been exceeded on four of the six rapid transit corridors, which may create constraints that need to be further assessed in relation to the operation of LRT in the future, however it is worth noting the following:
  - The design standards allow for LRT to operate on 8% grades for short, straight sections, however this would be dependent on further detailed studies

[3] *Between Preston Point Road and Williams Road*

[4] *Between Stock Road and Collick Street*

[5] *east of Birchley Road*

[6] *Between Portree Way and Grimsay Road*

- There may be potential to reduce the severity of the grade through earthworks to meet the desirable grade requirements, however this is likely to increase the cost of providing LRT on these corridors
- Further detailed alignment studies are required to determine the construction and cost constraints associated in providing LRT on these corridors.

- The Cockburn Coast to Fremantle and Cockburn Coast to Murdoch corridors have grades within 6% and would therefore not be limited to operating LRT based on topographical constraints.
- The east and west bound lanes on Canning Highway are split vertically at certain locations, which would cause design challenges and cost escalation if rapid transit was recommended in the central median along this alignment

It should be noted that the corridors where road grades exceed 6% are not necessarily unable to accommodate LRT; however the constraints and construction cost risks are likely to be greater in order to meet operational requirements. Further investigation is therefore required to assess these potential constraints.

6.3.4 Alignment to policies/strategies

A review of the key differences between the recommended Southwest Metro Rapid Transit network from this study compared with the Stage 1 (2020) and Stage (2031) southwest metro area rapid transit network has been undertaken. The key differences between the two have been highlighted, with the opportunities discussed.

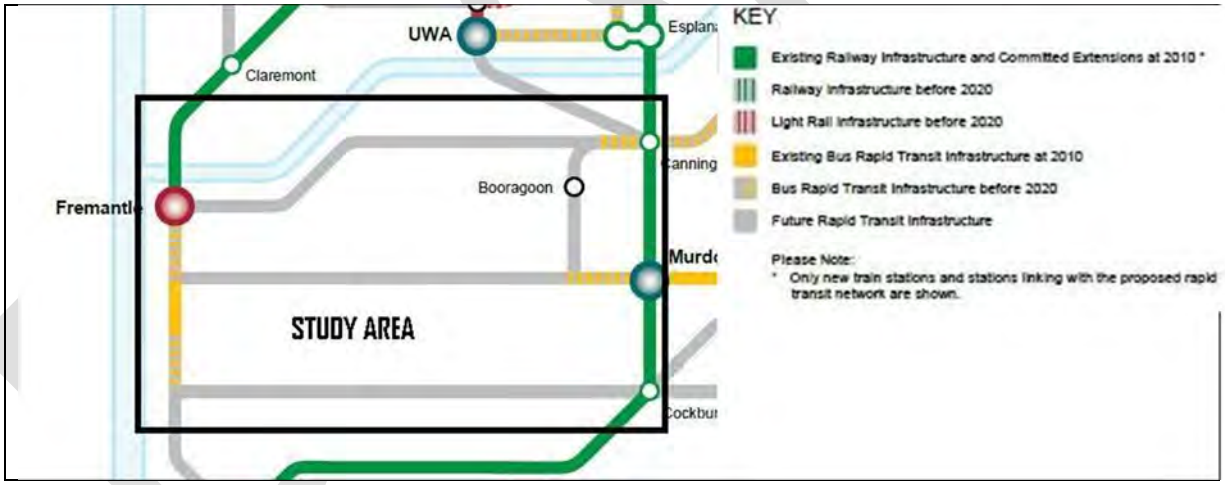


Figure 6.9 Draft 2031 Public Transport Plan for Perth – Proposed Stage 1 (2020)

The following key additions in the recommended Southwest Metro Rapid Transit Network study compared to the Stage 1 draft 2031 plan, include:

- Rapid transit on entire Fremantle to Canning Bridge Station corridor
- Rapid transit on entire Fremantle to Murdoch corridor
- Rapid transit on entire Murdoch to Canning Bridge corridor
- Rapid transit on Cockburn Coast to Cockburn Central corridor
- North-south rapid transit link between Spearwood and Kardinya Park Shopping Centre

Short sections of BRT are recommended on key sections of the Southwest Metro study rapid transit corridors before 2020 in the Stage 1 draft 2031 plan

BRT is recommended on the Cockburn Coast to Fremantle corridor before 2020 in the Stage 1 draft 2031 plan

Figure 6.10 Recommended Southwest Metro Rapid Transit Network

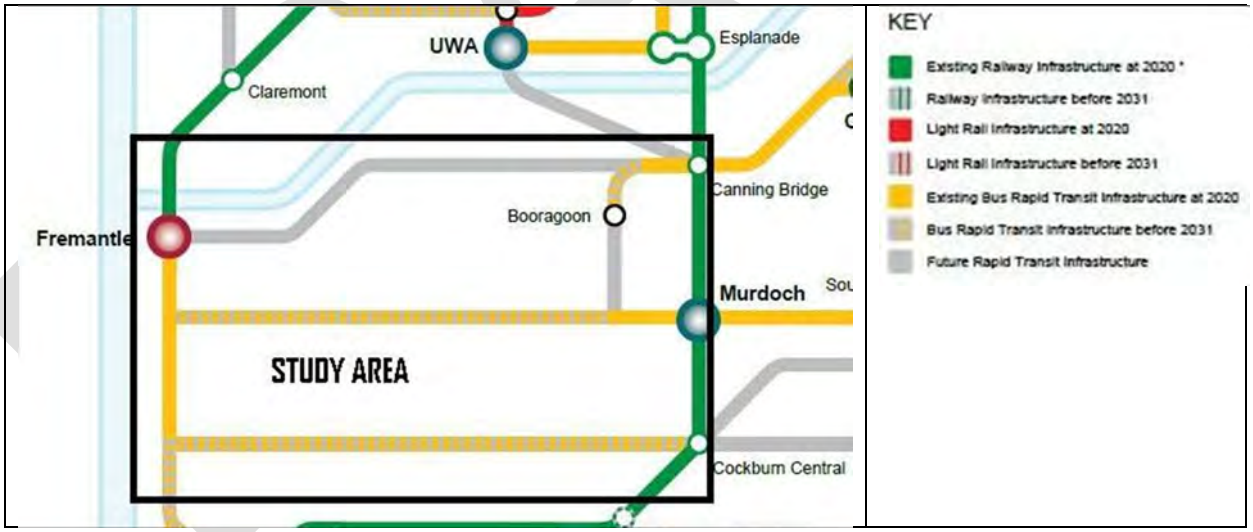


Figure 6.11 Draft 2031 Public Transport Plan for Perth – Proposed Stage 2 (2031)

The following key additions in the recommended Southwest Metro Rapid Transit Network study compared to the Stage 2 draft 2031 plan, include:

- Rapid transit on entire Fremantle to Canning Bridge Station corridor
- Rapid transit on entire Murdoch to Canning Bridge corridor
- North-south rapid transit link between Spearwood and Kardinya Park Shopping Centre

Short sections of BRT are recommended on key sections of the Southwest Metro study rapid transit corridors before 2020 in the Stage 2 draft 2031 plan

BRT is recommended on the Cockburn Coast to Fremantle corridor at 2020 in the Stage 2 draft 2031 plan

There has been no recommendation for LRT within the Stage 2 draft 2031 plan, apart from references to consideration for LRT after 2031 on the Fremantle to Cockburn Central corridor, via Cockburn Coast.

Figure 6.12 Recommended Southwest Metro Rapid Transit Network

Directions 2031 and Beyond - Planning Policy

Alignment with the Directions 2031 and Beyond framework and strategic plan has been achieved as a result of recommending a rapid transit network that links existing and future strategic metropolitan centres, secondary centres, specialised centres and district centres with each other.

6.3.5 Development catalyst and value uplift

Numerous studies have examined the positive relationship between rail transit and property development. These studies have shown that transit can attract development and increase values for nearby property. It is also noteworthy that the concept of using rail to catalyse development of land was the underlying premise for the numerous privately developed tram lines in the first half of the twentieth century.

The findings of studies on value uplift show the effect of rail on land value is considerable. For example, a study in 2002 showed the value of commercial property in Santa Clara County, California (US) was 23 per cent higher near light rail and 120 per cent higher near commuter rail. (Cervero, R. et al. "Transit's Value Added: Effects of Light Commercial Rail Services on Commercial Land Values," Presented at TRB Annual Meeting, 2002).

Two major factors that influence the impact of rail transit on nearby property are network's regional connectivity and the frequency of service. The principal benefit of being located near transit is the access it offers to other places. The more extensive the network, the more benefits there will be to surrounding property. Better accessibility is also a function of more frequent transit service, thus this factor has a positive impact on property development and value.

Other key factors include healthy real estate market conditions, supportive land use policy and traffic congestion (Cervero, et al, Report 102, Transit Cooperative Research Program, 2004). Realistically, infill development is challenging and generally incurs higher costs for the developer. In some cases, the use that is the most profitable for a developer to build (the "highest and best use") is not one that will support transit by stimulating ridership. Thus, it is essential that the potential for transit dependent land uses being supported by local land use policy is relatively high. The effects of congestion (e.g., lost time, fuel consumption costs and environmental impacts) can make transit a more appealing option.

While an address near a rail station is a good one, there must also be potential for redevelopment within walking distance of the station in order for new development to be attracted. Thus it requires vacant or underutilised property to be located near the transit station. This can be indicated by the capital value of a property as a ratio to the land value of a property. It can also be indicated by the age of the structure (conversely, heritage areas are unlikely candidates) as well as the potential for amalgamation of multiple properties.

From a developer's perspective there are several ways that transit can have a positive impact on development opportunities of which the transit premium is only one. Other advantages include the following:

- Marketability – transit is a desirable amenity that enhances the appeal of a nearby property to potential buyers or tenants.
- New sites – sites that previously were undevelopable due to potential traffic impacts become viable due to availability of transit as an alternative to automobile trips. In addition, land that would otherwise be developed for regional roadways may become available for development.
- Density – proximity to transit makes it possible to provide less parking per unit thus supporting higher densities
- Financial feasibility of higher density – since higher prices and rents can be obtained; the higher costs to build higher density development can be justified.

While there is emerging evidence that proximity to BRT stations can increase property values, there is limited evidence of BRT inducing new development compared to LRT. The challenge with BRT is there are too few examples compared with rail to give developers certainty of potential benefits. Excepting some projects in Brisbane, BRT is too new of a mode to have a 'track record' so developers tend to consider it into the same category as conventional bus. In North American BRT projects, real estate development also tends to be more secondary than it has been with LRT.

Regardless of mode of rapid transit, key measures in attracting development will be the local travel market and the development plans and policies that underpin the station areas. Potentially, if the state and local policy makers embrace BRT, put in locations with supportive plans and incentives at stops, the potential for development with BRT will improve. In particular, this would require stations being located in areas that are 'ripe for redevelopment' as opposed to lower density areas that are likely to remain unchanged. In addition, the experience of the government in leveraging projects from transit investments would also be critical.

A high level review of the six recommended rapid transit corridors indicates the following key areas that are undergoing or can be considered for redevelopment.

1. **Fremantle to Canning Bridge**

   - Fremantle CBD Westgate precinct
   - Fremantle East End precinct
   - Canning Bridge precinct.

2. **Fremantle to Murdoch**

   - Murdoch precinct
   - Fremantle CBD Westgate precinct

3. **Cockburn Coast to Cockburn Central**

   - Cockburn Coast district
   - Watsonia Meat Factory precinct.

4. **Murdoch to Canning Bridge**

   - Canning Bridge precinct
   - Murdoch precinct.

5. **Cockburn Coast to Murdoch**

   - Cockburn Coast district
   - Murdoch precinct.

6. **Cockburn Coast to Fremantle**

   - Cockburn Coast district
   - Douro Road/Hampton Road precinct
   - Fremantle CBD Westgate precinct.

It is clear from the summary above that the major redevelopment opportunities are concentrated at the east and western edges of the network. Major redevelopment

opportunities within the central portion of the network are not apparent based on current council strategies.

6.3.6 Network integration

Network integration in the context of this study relates to the enhanced network effect that a rapid transit network will provide for the Southwest Metro area, through the following ways:

- Linking high quality BRT/LRT transit with heavy rail and local bus services.
- Providing service frequencies and service spans that are comparable to heavy rail to improve the coordination between modes, reducing the impact of transfer penalties.
- Improving accessibility within, to/from outside of the southwest metro area, by increasing the number and attractiveness of integration opportunities.

The opportunities and constraints associated with the network integration for the recommended Southwest Metro Rapid Transit Network has been outlined below.

Opportunities:

- Direct rapid transit to bus/rail transfer at Canning Bridge, Murdoch, Cockburn Central and Fremantle Stations.
- Rapid transit to rapid transit transfers at key activity centres within the Southwest metro area to provide high quality transfers and direct connections.
- Rapid transit to local bus transfers at key activity centres and local bus stops located on the rapid transit network to provide greater penetration into the residential areas in the Southwest metro area that are not serviced within 400m of rapid transit.
- To reduce the impact of transfer penalties, rapid transit frequencies need to be similar to connecting rail service frequencies and spans of service.
- Increased attractiveness for passengers to use rapid transit to connect with rail, rather than using park and ride facilities at rail stations and parking within the CBD, due to the improved travel time reliability associated with rapid transit.
- Improvements to rail service frequencies and service spans is also likely to improve network integration for the recommended rapid transit network, to improve the attractiveness for transfers to be made from rapid transit to rail. This is of particular consideration for the Fremantle line, where the frequency is longer when compared to the Mandurah rail line.

Constraints:

- Transfer penalties will be a factor for passengers changing modes to access CBD or other destinations on the network, however the impact of this can be minimised through comparable service frequencies and service spans for the rapid transit when compared to rail.
- Capacity and ease of integration is a factor at each of the proposed rapid transit interchanges, with Canning Bridge station likely to have capacity constraints as an increased number of services are using this interchange. It should be noted that a study is currently underway to investigate the feasibility for this station to be upgraded to increase the capacity for bus interchanges.

6.3.7 Linking to a broader network

The draft 2031 public transport plan for Perth provides a discussion about the need for light rail project proposals to address the following requirements in addition to other patronage related warrants discussed below:

- The need should be demonstrated for how LRT project proposals are consistent with, and can be effectively expanded into, a broader network.
- To ensure consistent use of technology to maximise operational flexibility and synergies across the network.
- Detailed master planning and a business case would also be required

A discussion is provided below for the opportunities and constraints that exist for the proposed Southwest Metro rapid transit corridors in terms of the ability for each corridor to link into a broader network, with a particular focus on LRT.

Opportunities:

- Opportunity to realise cost savings on maintenance / spares, etc. if all elements are consistent.
- Opportunity to see technology proven (or not) on other lines before new infrastructure is proposed in the Southwest Metro area for example.
- Public view of a bigger network has perception advantages within the community.
- Supporting development that encourages increased densities by integrating high quality rapid transit.
- Distributing benefits across communities, rather than only focusing on central areas such as a 15km radius of the Perth CBD.

Issues:

- As with any technology, over time and with potentially separate entities undertaking procurement, there is the potential that the characteristics differ in the same region (i.e. LRT with two different sized vehicles as a simple example, or different internal technologies which are not compatible such as signalling or power).
- Unlinked LRT lines will need to ensure that there are appropriate provisions in place for maintenance and stabling. This is of particular concern where a vehicle might not be able to travel along the lines to reach the depot.
- Different branding to the system may occur with two separate networks which can create confusion for passengers and additional costs to authorities operating the network.
- Consistency is required in the approach to the provision of stops, equipment, branding, to ensure that public transport is the focus and consistent for the passenger.
- Separate (unconnected) lines potentially creates the requirement to change modes.

In general, the main opportunities that exist for providing a network are around the economies of scale, especially for maintenance in the longer term, as well as the opportunities with later stages of having “proven” technologies and outcomes.

It is worth noting that the mode recommendations for each of the Southwest Metro rapid transit corridors will influence this discussion further, depending upon whether one, some or all of the rapid transit corridors are recommended to operate as LRT. For example if only one of the six corridors is recommended for LRT, then it is likely that this link would be in isolation to the remainder of the proposed LRT network in Perth and therefore not link with each other. Alternatively if multiple corridors in the Southwest metro area are recommended for LRT, then the opportunity for a separate network of LRT lines is created in this area that could operate as a network on its own outside of the CBD.

6.3.8 Active transport integration

The opportunities and constraints associated with the integration of active transport modes, such as walking and cycling within each of the recommended rapid transit corridors have been discussed in the table below. The Perth Bike Map Series maps were sourced from the Department of Transport website, for the southwest metro study area to provide an understanding of the following cycling and shared path routes:

- Perth Bicycle Network (PBN)
- Principal shared path
- Bicycle lanes or sealed shoulders
- Shared path.

Opportunities:

- There are bicycle lanes available on sections of roadway leading to key stations along the Fremantle to Canning Bridge corridor, (i.e. Stock Road, north of Canning Highway, North Lake Road, Reynolds Road and Riseley Street).
- There are bicycle lanes/sealed shoulders suitable for cyclists on sections of roadway leading to the South Street corridor, (i.e. McCombe Avenue, Murdoch Drive, Gilbertson Road and Windelya Road).
- There is an existing shared pedestrian and cyclist path located on the eastern side of Murdoch Drive. There are also shared user paths on the approaches to Riseley Street and Murdoch Drive providing active transport accessibility to potential rapid transit stops/stations at these locations.
- There is an existing shared pedestrian and cyclist path located on the southern side of Beeliar Drive. There are also shared user paths on the approaches to Beeliar Drive at Osprey Drive and Spearwood Avenue providing active transport accessibility to potential rapid transit stops/stations at these locations.
- It is important to consider the need for stations and stops to be located with consideration for cycle and pedestrian access via signalised pedestrian crossings.
- Further consideration should be given to cycle and pedestrian access to the rapid transit network in the detailed alignment studies that are required to further assess the rapid transit alignments and running ways.

Constraints:

- If rapid transit is recommended as central median running ways it may result in increased safety risks for pedestrians and cyclists accessing rapid transit services, in order to access stations/stops.

- Many of the corridors that have been recommended for rapid transit do not currently have cycle lanes available, which is likely to reduce the appeal for residents to cycle to rapid transit connections.

6.3.9 Corridor reservation availability:

A broad assessment of the suitability of the alignments reservation to accommodate BRT/LRT rapid transit has been undertaken by discussing the opportunities and constraints within the key sections identified along the corridors, based upon the potential running way.

The following requirements in relation to typical LRT cross sections are outlined in the Design Standards Working Paper for the Central Northern Corridor LRT system, prepared by Aurecon in January 2011:

Light Rail Typical Cross Sections:

Central Median Operation:

- Segregated running way: 7.2m minimum & 7.3m desirable typical cross section (two-way)
- Mixed traffic running way: 6.4m minimum & 6.7m desirable typical cross section (two-way).

Kerbside Operation:

- Segregated running way: 3.4m minimum & 3.45m desirable typical cross section (one-way)
- Mixed traffic running way: 2.95m minimum & desirable typical cross section (one-way).

Bus Rapid Transit Typical Cross Sections:

Central and Kerbside Running:

- Segregated running way: 3.5m minimum desirable typical cross section (one-way).

Opportunities and Constraints

The opportunities and constraints in terms of corridor reservation availability for each of the recommended rapid transit corridors are presented in Table 6.11. It is worth noting that the opportunities and constraints for corridor reservation ultimately depend on the following factors, which will need to be further investigated in separate studies:

- The chosen alignment within the corridor (Note: for the purpose of this study a modelled alignment was selected, which was based upon the highest population within 800m either side of the alignment).
- The preferred running way along the alignment (i.e. segregated or mixed traffic running).
- The location of the running way (i.e. kerbside running or central median running).
- The priority allocated to rapid transit at signalised intersections (i.e. how right turning traffic is separated from the rapid transit lane in central median running and left turning traffic from kerbside traffic running).

- The allocation of existing road space (i.e. understanding of the likely person flow through one lane by comparing person flow for rapid transit versus person flow for private vehicles in the same lane and direction).
- Consideration for congestion levels within the roadway to determine the justification for segregation due to the level of importance in providing segregation for rapid transit.
- Width and type of stations/stops proposed for the rapid transit.
- Consideration for physical and topographical constraints and heritage structures within the road reserve.

Table 6.11 Corridor reservation availability

Corridor	Opportunities	Constraints
Fremantle – Canning Bridge	• The section of Canning Highway between Canning Bridge Station and Riseley Street is likely to warrant road space allocated to rapid transit, due to the number of bus services and subsequent person flow through this section, due to its proximity to the Booragoon bus interchange	• Further investigation will be required to determine the road reserve availability for rapid transit to be provided on Canning Highway and Queen Victoria Street as existing roadway capacity may be required to be allocated to rapid transit in these sections
Fremantle – Murdoch	• The opportunity to utilise the new road link through the Fiona Stanley Hospital will provide direct access to the rail station, via the Hospital and Murdoch University precinct • This corridor will overlap with a short section of the Cockburn Coast – Fremantle corridor from South Street to Fremantle, assisting in justifying the case for rapid transit priority in this section	• Short sections of South Street may require mixed running, where constraints exist in terms of the corridor reservation and no central median being available, however further investigation is required to determine the road reserve availability on South Street
Cockburn Coast – Cockburn Central	• Adequate road reserve is available within the road reserve on the majority of Beeliar Drive to accommodate segregated BRT or LRT rapid transit. Consideration will need to be given for central running versus kerbside running on this section	• Short sections of Beeliar Drive may require mixed running, where constraints exist in terms of the corridor reservation and no central median being available • Rockingham Road will require further investigation in terms of road reserve availability or potential to allocate existing road space to rapid transit
Murdoch – Canning Bridge	• This corridor will overlap with a short section of the Fremantle – Canning Bridge corridor from Riseley Street to Canning Bridge Station, assisting in justifying the case for rapid transit priority in this section	• Murdoch Drive and Riseley Street will require further investigation in terms of road reserve availability or potential to allocate existing road space to rapid transit • The Leach Highway section of this corridor may require mixed running, however it should be noted that this is only a short section

Cockburn Coast – Murdoch	• This corridor will overlap with a short section of the Fremantle – Murdoch corridor from Kardinya Park Shopping Centre to Murdoch Station, assisting in justifying the case for rapid transit priority in this section	• Further investigation will be required to determine the road reserve availability for rapid transit to be provided on Rockingham Road, Phoenix Road and North Lake Road, as existing roadway capacity may be required to be allocated to rapid transit in these sections
Cockburn Coast - Fremantle	• Existing bus lanes available on a 1km section of Hampton Road • Market Street constrained by road reserve width, however opportunity may exist to investigate an alternative route to/from the Fremantle Station through the CBD	• South Terrace is constrained due to on-kerb car parking • Congestion is an issue on Hampton Road between Rockingham Road and Douro Road and would therefore require road widening and potentially land acquisition or loss of roadway capacity

7. Patronage forecasting assessment

A high level patronage forecasting assessment has been undertaken to provide an understanding for the patronage potential for the recommended Southwest Metro Rapid Transit network for BRT and LRT.

It was initially proposed that the STEM model would be used to forecast patronage for each of the corridors, however this did not occur for the following reasons:

- The STEM model is the intellectual property of the Department of Planning (DoP) and is not distributed to consultants to undertake forecasting work.
- Due to the time constraints associated with the completion of this study (to meet the DOT submission deadline of 15 October); there was insufficient time available for DoP to undertake the forecasting task of the recommended rapid transit network options.

It should be noted however that a number of key inputs were sourced from the STEM, including:

- Land use forecasts for 2031
- Household trip rates
- Public transport mode share data.

Methodology

The key steps of the assessment methodology are presented in Figure 7.1 and then discussed in further detail below.

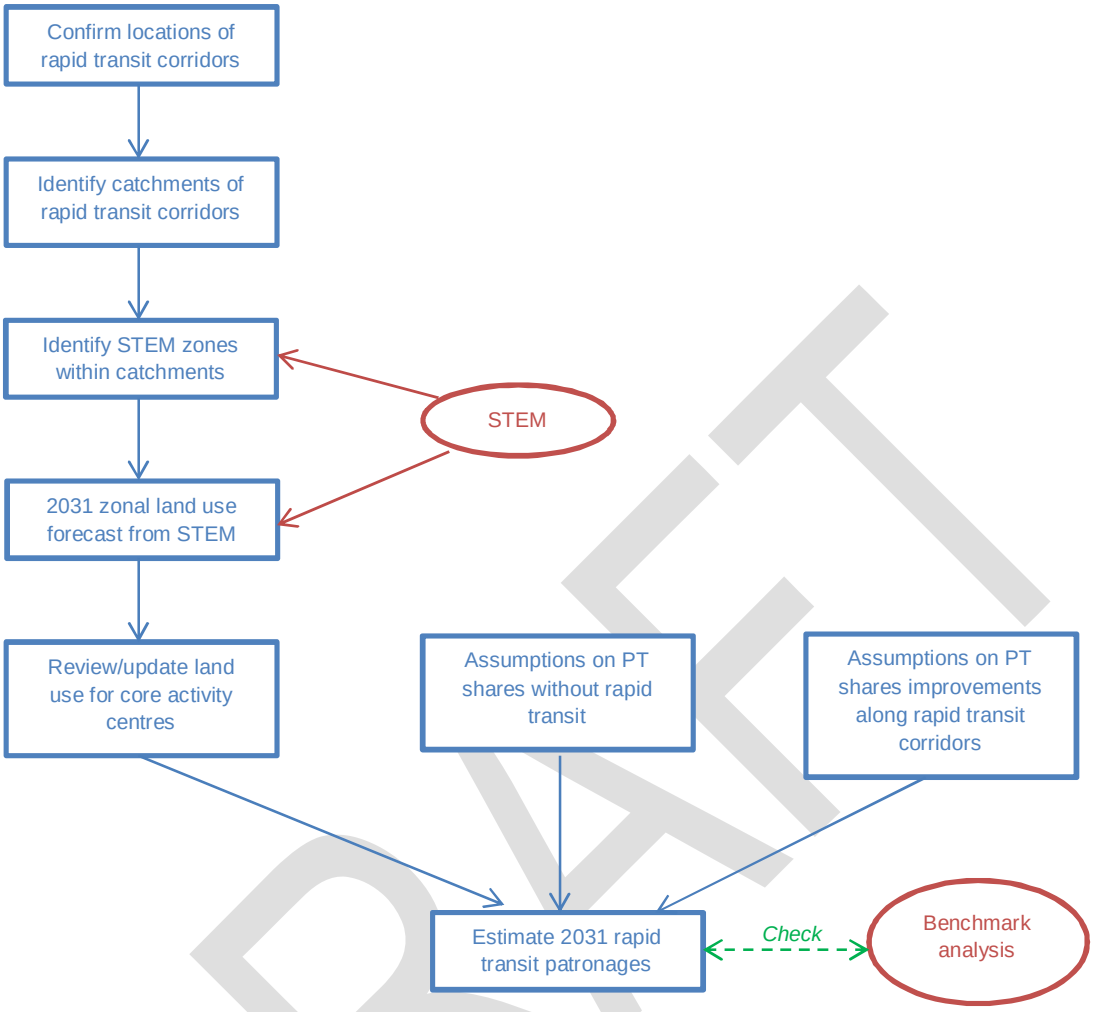


Figure 7.1 Patronage forecasting methodology

The more detailed description of the methodology used to complete the patronage forecasting task has been outlined below:

- Once the locations of the proposed rapid transit corridors were confirmed, an 800m buffer on either side of each modelled alignment was defined as the catchment where the residents are most likely to use public transport service provided along each corridor.
- A STEM zone boundary map was obtained from the Department of Planning (DoP). By overlaying the corridor catchments on the STEM zone boundary map using GIS tool, the STEM zones within the defined corridor catchments were identified as shown in Figure 7.2.
- The 2031 land use forecast used by the STEM zones was used as the initial basis. It was further reviewed and updated for some of the STEM zones that represent core activity centres in the study area, where more detailed land use forecast information was known (i.e. Cockburn Coast district).

- The likely number of trips generated by the relevant STEM zones is based on the number of households in the catchments and the daily trip rate of 6.24 per household adopted by the STEM.
- The STEM estimates an average Public Transport (PT) mode share of 5-6% across the entire Perth region. It is reasonable to expect that the PT mode share for the zones within the catchments of the defined corridors would be slightly higher. Therefore, we assumed a base PT mode share of 7% for the corridor catchments. This assumption has been based upon the fact that the PT mode share used in the STEM also represents areas with little or no public transport in Perth, whereas the Southwest Metro area has a strong established public transport network existing.
- In order to factor up the base PT mode share to account for the improved rapid transit network, research was used from the Melbourne SmartBus network, which showed 50-60% more passengers per veh/km than the conventional bus system[7]. On that basis it was assumed that a BRT system would increase the PT mode share from 7% to 10%. As a LRT system is considered to be superior to a BRT system and more similar to heavy-rail, we assumed a further increase in PT mode share to 12% for LRT.
- All six of the recommended rapid transit corridors serve the major rail stations within the study area and the majority of the rail users at these stations arrive by transfer according to the STEM. Therefore an assumed nominal uplift of 2-3% in PT mode share along these corridors was used to further refine the forecasting to take into account the network effect that is likely to occur as a result of high quality rapid transit connections to the heavy rail lines.
- The assumed PT mode shares were then applied to the populations within each of the corridor catchments to determine an estimated daily passenger boardings total on each corridor.
- Additional patronage was added onto the Cockburn coast to Fremantle corridor to account for potential transfers from BRT and local bus onto the BRT/LRT at Cockburn Coast. This assumption was based upon the fact that the network may be consolidated by providing an interchange at Cockburn Coast, to avoid operating all services from the south into Fremantle. Journey to work data was used to determine the proportion of passengers travelling from the City of Cockburn to the City of Fremantle each day.
- The boardings per day figures were then divided by the corridor length to determine the patronage density (boardings/km). This measure was calculated to provide a better indication for the efficiency of the rapid transit corridor, in terms of boardings generated per kilometre.
- A benchmarking analysis was then undertaken to provide a comparison of the rapid transit patronage figures against interstate and international existing BRT and LRT lines. A comparison was also provided with the 2031 STEM patronage figures by corridor, as shown in the draft 2031 transit plan.

Note: The patronage forecasting approach has been undertaken at a high level, in the absence of the STEM model and is primarily based on population within the corridor catchments. To compliment this high level assessment the number of employment positions held within each corridor catchment (i.e. 800m either side of the modelled alignment), has been calculated for 2031 for each of the corridors to use for discussion purposes.

[7] *Understanding ridership drivers for bus rapid transit systems in Australia, World Transit Research, Currie & Delbosc, 1-1-2010*

Figure 7.2 Rapid transit corridor catchments

Results

The results of the patronage forecasting assessment are presented in Table 7.1 and provide an indication for the likely BRT/LRT boardings on each of the six recommended rapid transit corridors and the patronage density along these corridors, by taking into account the length of each corridor. The patronage density (boardings/km) provides a more comparable representation of the patronage efficiency of each of the six corridors.

Table 7.1 Patronage forecasting results

Patronage forecasting results (BRT/LRT)						
	Rapid Transit Corridor					
	Fremantle – Canning Bridge	Fremantle -Murdoch	Cockburn Central – Cockburn Coast	Murdoch – Canning Bridge	Cockburn Coast - Murdoch	Cockburn Coast - Fremantle
Ranking (boardings/km)	2	4	6	3	5	1
Corridor Length	12.4	11.8	14.6	9.5	14.1	5
BRT boardings	16,826	11,532	10,168	10,494	11,100	9,571
BRT boardings/km	1,357	977	696	1,105	787	1,914
LRT boardings	19,414	13,522	12,834	12,108	12,807	11,618
LRT boardings/km	1,566	1,146	879	1,275	908	2,324

The number of employment positions located within 800m either side of the modelled alignments for each corridor is presented in Table 7.2.

Table 7.2 Employment within the corridor catchments

Patronage forecasting results (BRT/LRT)						
	Rapid Transit Corridor					
	Fremantle – Canning Bridge	Fremantle -Murdoch	Cockburn Central – Cockburn Coast	Murdoch – Canning Bridge	Cockburn Coast - Murdoch	Cockburn Coast - Fremantle
Ranking (Jobs/km)	3	2	6	4	5	1
Employment positions per corridor	26,612	37,976*	8,912	17,282*	18,798*	21,507
Employment density (Jobs/km)	2,146	3,218*	610	1,819*	1,333*	4,301

***The number of employment positions was sourced from the 2031 STEM land use forecast data and appears to be conservative in relation to the number of positions forecast for the Murdoch precinct. The Western Australian Planning website states that there is a potential for in the order of 35,000 employment positions within the Murdoch precinct[8].

[8] http://www.planning.wa.gov.au/656.asp

The following conclusions can be drawn from the forecasting results presented in Table 7.1:

- The Cockburn Coast to Fremantle and Fremantle to Canning Bridge corridors recorded the highest patronage per kilometre figures respectively and also ranked highly in terms of employment positions per kilometre (1st and 3rd respectively)
- Murdoch to Canning Bridge and Fremantle to Murdoch also ranked well in terms of boardings per kilometre, however these boardings figures are likely to be conservative, given the high number of employment positions within the corridors due to the Murdoch precinct
- Cockburn Coast to Murdoch and Cockburn Central to Cockburn Coast ranked towards the lower end of the scale for boardings per kilometre and also for the number of employment positions per kilometre.

Recommendations have been developed below, using the patronage forecasting results and employment positions per corridor as one of the elements in determining the recommended mode for each corridor on the recommended Southwest Metro Rapid Transit Network.

Accessibility

In assessing each of the corridors in the Southwest Metro Network as well as the modal options, it is important to understand the potential improvements in accessibility. Since accessibility is an outcome of our transportation decisions, it can be a useful measure of the quality of a transportation network. Accessibility is the ease of reaching valued destinations. As such, measuring accessibility to key destinations including jobs, shops, schools, education and entertainment shows the benefits of a transportation system.

As importantly, accessibility creates value and can be used to assess the potential degree of property value uplift that may occur from alternative investments. Capturing a portion of this value can help to finance the construction, maintenance and operation of the transport network which provides this access.

Accessibility attracts development and infrastructure creates accessibility. In those areas where a person can reach the most activities in the shortest amount of time, both building density and market rates, including rents and sales, are higher. Accordingly, land is at a premium within CBDs.

Transportation investments are typically based on another metric referred to as mobility or, how fast we can move along a network between places. The most common measure of mobility is congestion which has become embedded as the fundamental problem facing our transportation network. Another common mobility metric is used for transit systems, which typically look at inputs such as patronage.

While mobility, congestion and patronage are significant issues, a more appropriate measure for economic impact is to consider the output of transportation networks - accessibility. Accessibility measures the primary purpose of metropolitan areas – enabling people to reach each other and other places.

To better allocated scarce resources, decision makers should consider accessibility. There are many accessibility metrics available. However, as it is imperative that a metric be comparable across locations and be easily understood, the number of jobs that can be reached from a location, such as a residence, within 30 minutes during the morning peak, is most frequently used as a proxy for accessibility.

By integrating the findings in Table 7.1 – Travel Time Comparison and Table 6.9 – Employment within Corridor Catchment, improvements in accessibility can be understood. Of note, is the significant reduction in total travel time (from 47 minutes by bus to 35 minutes by BRT/LRT) along the Fremantle Murdoch corridor as well as the approximately 35,000 potential jobs in the Murdoch precinct. This indicates a significant improvement in the transportation network by introducing BRT/LRT on that corridor.

Also of note is the relatively high employment density of employment in the Cockburn Coast Fremantle corridor. As indicated in Table 7.2, the corridor exhibits the highest employment density per kilometre of BRT/LRT, highlighting the improvement to accessibility by investing in this corridor.

Benchmarking

A benchmarking analysis was undertaken to compare the forecast patronage figures for each of the six recommended rapid transit corridors with existing Interstate and International BRT/LRT lines. This comparison is presented in Table 7.3.

Table 7.3 Boardings comparison with existing BRT/LRT

Comparison to Interstate and International BRT/LRT patronage					
	Corridor Length (km)	**Daily Boardings (BRT)**	**Boardings Density (BRT)**	**Daily Boardings (LRT)**	**Boardings Density (LRT)**
Southwest Metro Corridors (lowest-highest)	5 - 14.6	9,571 – 16,826	696 – 1,914	11,618 – 19,414	879 – 2,324
Portland Streetcar	6.5	-	-	11,000	1,700
Seattle Streetcar	N/A	-	-	-	1,000
Adelaide Tram	15.0	-	-	14,000	933
Blue Line MAXX	28.8	-	-	66,300	2,302
Red Line MAXX	8.8	-	-	25,700	2,920
Yellow Line MAXX	9.3	-	-	13,600	1,462
Salt Lake City, USA	17.0	-	-	9,500	560
Dubai, UAE	75	-	-	59,347	791
Manchester, UK	37	-	-	55,00	1,486
Montpellier, France	35	-	-	190,000	5,428

The patronage figure presented in the draft 2031 plan for the 2031 preferred public transport network scenario, as shown in Figure 7.3 are presented in Table 7.4 below and aligned to the corresponding forecast patronage results for the recommended rapid transit corridors. It should be noted that the patronage volumes presented in Figure 7.3 are the number of passengers per day travelling on a particular link within the network and therefore don't represent the number of boardings attributable to that link, which is how the patronage

forecasting has been completed for the Southwest Metro Rapid transit network study. In considering these differences a comparison has however still been made between the two data sets, for discussion purposes only. These results are presented in Table 7.4.

Table 7.4 Comparison with Draft 2031 Plan Patronage

Comparison with Draft 2031 Plan Patronage		
	Draft 2031 Plan Forecast	**Southwest Metro Study Forecast (BRT/LRT)**
Canning Highway (east of Riseley St)	10,000-30,000 passengers/day	16,826 (BRT) / 19,414 (LRT) boardings/day
Canning Highway (west of Riseley St)	3,000-10,000 passengers/day	
South Street (east of Murdoch Drive)	10,000-30,000 passengers/day	11,532 / 13,522 boardings/day
South Street (west of Murdoch Drive)	3,000-10,000 passengers/day	
Riseley Street (north of Booragoon)	3,000-10,000 passengers/day	10,494 / 12,108 boarding's/day
Cockburn Coast corridor (north of South Street)	30,000-50,000 passengers/day	9,571 / 11,618 boardings/day
Cockburn Coast corridor (south of South Street)	3,000-10,000 passengers/day	
Beeliar Drive	3,000-10,000 passengers/day	10,168 / 12,834 boardings/day
Rockingham Road	3,000-10,000 passengers/day	

The following conclusions can be drawn following a review of the data presented in Table 7.4:

- Although the two sets of patronage data can't be used for direct comparison purposes, the Southwest Metro Study forecast results are in the same order of magnitude as the draft 2031 plan forecasts.
- It is recommended that STEM be used by the DOT to also extract boardings per day patronage figures for the future rapid transit scenarios in order to provide a closer comparison to the forecasting completed for the Southwest Metro study.

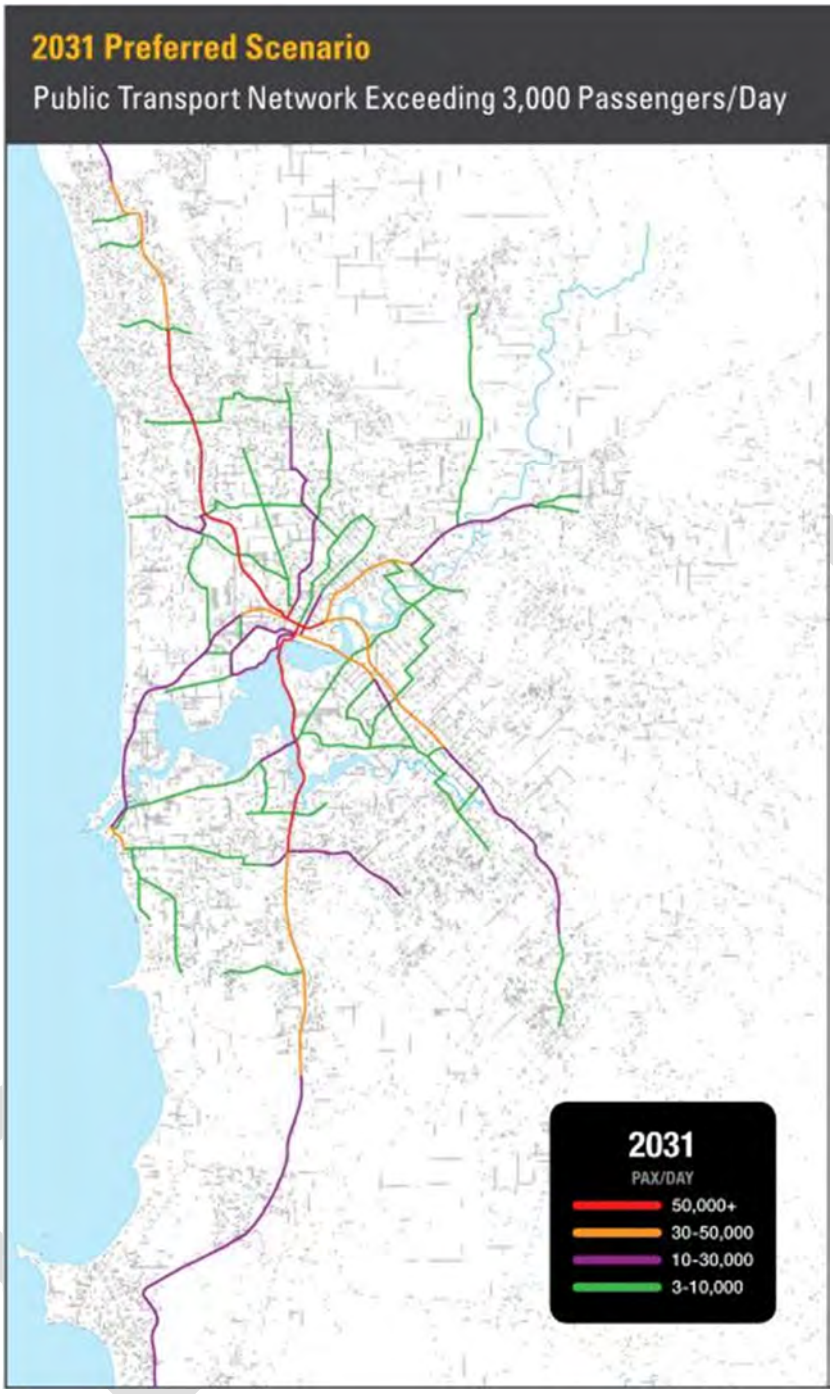


Figure 7.3 Draft 2031 Public Transport Plan for Perth – 2031 Patronage Forecast

Department of Transport Warrants

The warrants for provision of public transport priority have been summarised from the draft 2031 public transport plan for Perth in order to compare against the forecast patronage on the recommended Southwest Metro Rapid Transit Network.

As stated in the draft 2031 plan, the following warrants for public transport priority on roads can be summarised as follows:

- **Queue jump lanes** on approach to signalised intersections that is causing significant delays to buses: daily patronage should be more than 3,000 people.
- **Bus lanes** are necessary where the speed and reliability of the service is being adversely impacted on a regular basis, not only through intersections but along the length of road. Services operating along these corridors should typically average 6,000 passengers or more per day (i.e. not boardings, cumulative total of passengers travelling on the route, similar to what is shown in the 2030 transit plan patronage graphics) NOTE: in certain locations, such as through some town centres, bus lanes may be converted to kerbside parking during off-peak times to support local businesses. However, consideration will be given to regional and local accessibility and the ability to provide off-street parking as an alternative. Where a traffic lane has to be converted to a bus lane, the projected patronage of the planned facility should exceed 1,200 passengers in the peak hour within 5 years of opening, which compares to the average maximum carrying capacity of a single lane of traffic.
- **Corridors** with significantly higher forecast patronage, or with large growth potential, may justify a high capacity rapid transit system using a combination of conventional and articulated buses and/or light rail. These should be provided in a restricted access corridor with full transit priority to support the investment and to allow relatively unimpeded transit movement without the constraints of congested traffic or safety issues with turning vehicles. Initial patronage of 10,000 passengers per day, or generally 1,500-2,000 passengers in the peak hour, would be needed.

The following points have been noted in relation to the warrants outlined in the transit plan, with reference to the patronage forecasting completed as part of the Southwest Metro Rapid Transit Network Study:

- There have been no warrants defined in the draft 2031 plan for patronage density along corridors (i.e. boardings/km), which is the measurement that has been used to determine the relative patronage density along the six recommended rapid transit corridors.
- The base case and 2031 public transport patronage figures presented on page 18 of the draft 2031 plan appear to provide a cumulative daily patronage figure on links within the southwest metro area, rather than the number of daily boardings generated on these links.
- It is not clear from the draft 2031 plan as to whether the warrants for high capacity rapid transit are 10,000 passengers per day at opening of a line or at a single point on the line.

In considering the warrants outlined in the draft 2031 plan, the following recommendations have been made in relation to the six rapid transit corridors recommended as part of the Southwest Metro Rapid Transit Study:

- The forecast BRT/LRT daily boardings appear to meet the DOT requirements for queue jump lanes, bus lanes and high capacity rapid transit on all corridors apart from BRT on the Cockburn Coast to Fremantle corridor, as the forecast passengers per day is greater than 10,000 on all these corridors (refer to Table 7.1 above), however this conclusion fails to consider the density of the boardings by considering the length of route that it takes to generate that number of boardings.

- When considering boardings per kilometre the Cockburn Coast to Fremantle route generates the highest value of all six recommended rapid transit corridors for BRT and LRT, however can't be compared to the draft 2031 plan warrants as there aren't any available for this measure.
- The lowest boardings per kilometre patronage densities are recorded on the Cockburn Central to Cockburn Coast corridor, which may reflect the lower population densities within this corridor and larger un-developed areas of land.
- The highest three patronage densities were recorded on the following rapid transit corridors:
  - Cockburn Coast to Fremantle – recommended for BRT at 2020 in the draft 2031 plan
  - Fremantle to Canning Bridge – recommended as future rapid transit (i.e. post 2031) in the draft 2031 plan
  - Murdoch to Canning Bridge, via Booragoon – recommended as BRT in sections at 2020 and 2031 in the draft 2031 plan.

8. High level costs and indicative benefits

In order to compare BRT and LRT systems along the identified rapid transit corridors from an economic perspective, PB undertook a cost-benefit assessment (CBA) at the rapid appraisal level based on high-level costs and benefits. Following is a brief outline of our approach with undertaking the high level CBA.

The CBA is based on the requirements for a rapid appraisal outlined in the Australian Transport Council's *National Guidelines for Transport System Management in Australia*. The high level comparative economic CBA followed generally accepted discounted cash flow practices for calculating the benefit-cost ratio (BCR) based on 2031 patronage projections, a 30 year evaluation period, and a 7% discount rate.

Benefits of the BRT and LRT systems over and above a commuter bus service operating in mixed traffic conditions considered in vehicle travel time savings, wait time savings, benefits to induced patronage, accident cost savings, environmental impacts, and wider economic benefits to account for the expected productivity gains stemming from agglomeration in the major employment centres. The wider economic benefits are likely to be more attributable to LRT in comparison to BRT, due to the opportunities that are likely to be created through the LRT catalysing development around new stations.

Implementation cost included right of way, rolling stock, and stations and stops. Allowance was made for operating and maintenance cost of infrastructure, rolling stock, as well as service overhead cost. These costs were based on unit prices derived from recently completed projects in Australia and abroad. It should be appreciated that these costs could vary widely and were not corridor specific.

Although the CBA was undertaken at a high level, and could therefore not provide conclusive evidence on economic viability or the preferred mode choice, it shows that the results compared relatively closely for the BRT and LRT modes. It also showed that that corridors linking Fremantle with Canning Bridge, Cockburn Coast and Murdoch has the highest priority from an economic perspective, in comparison to other corridors.

The CBA assessment has therefore been used to inform the recommendations of the study, by providing an understanding for which corridors should be prioritised for further detailed investigation.

9. Recommendations

In addition to the recommended Southwest Metro Rapid Transit Network presented in Figure 9.1, recommendations have also been made in relation to the mode of operation on each of the rapid transit corridors for the 2031 horizon year. Table 9.1 provides a summary of the key information used to develop the mode recommendations for each of the recommended rapid transit corridors.

The two different types of modes that have been recommended include:

- **Bus Rapid Transit (BRT) –** This includes higher quality rapid transit service operating along the recommended trunk rapid transit corridors, including segregated running on the roadway, priority at intersections, improved service frequencies and spans and higher quality stations and stops.
- **Light Rail Transit (LRT)** – Similar high quality rapid transit service as described for BRT with light rail infrastructure and technology within the right of way. Enhanced opportunity for the rapid transit to catalyse development around the stations.

Figure 9.1 Recommended Southwest Metro Rapid Transit Network

Table 9.1 Recommendations summary

Mode Recommendations						
	Rapid Transit Corridor					
	Fremantle – Canning Bridge	Fremantle - Murdoch	Cockburn Central – Cockburn Coast	Murdoch – Canning Bridge	Cockburn Coast - Murdoch	Cockburn Coast - Fremantle
Recommended Mode (2031)	BRT	BRT to LRT*	BRT	BRT	BRT	BRT to LRT*
Draft 2031 transit plan alignment	Future Rapid Transit (post 2031)	BRT (2031)	BRT (2031)	Half BRT (2020/2031)	No BRT/LRT	BRT (2020) LRT potential post 2031
Corridor Length	12.4	11.8	14.6	9.5	14.1	5
BRT boardings/km	1,357	977	696	1,105	787	1,914
LRT boardings/km	1,566	1,146	879	1,275	908	2,324
Employment density (jobs/km)	2,146	3,218	610	1,819	1,333	4,301
Re-development potential	East and west ends	East and west ends	East and west ends	Around rail stations	East and west end	Along entire corridor

*These recommendations have been based upon incremental staging from BRT to LRT on the Fremantle to Murdoch and Cockburn Coast to Fremantle corridors. The recommendations for incremental staging to LRT on these corridors were formed through consideration for a number of factors, as investigated as part of the Southwest Metro Rapid Transit Network Study:

- High level costs and indicative benefits assessment
- Patronage forecasting
- Investigation into the employment potential within rapid transit corridors
- Opportunities for LRT to catalyse development
- Accessibility benefits

The following discussion has been provided to support the recommendations presented in Table 9.1:

Corridor 1 – Fremantle to Canning Bridge

This corridor has been recommended for BRT in 2031, based upon the level of patronage forecast along this corridor, which can be primarily attributed to the population density and catchment living within 800m either side of the modelled alignment of Canning Highway. There is a level of re-development potential identified within the Canning Bridge, Fremantle CBD Westgate and Fremantle East-end precincts, however minimal other opportunities along the corridor, apart from increases to residential densities.

The high level costs and indicative benefits assessment indicated that this corridor ranked within the top tier (i.e. top three ranking corridors) in terms of the costs versus benefits for BRT and LRT.

This recommendation conflicts with the draft 2031 plan, which identified BRT on the section of Canning Highway between Canning Bridge and Reynolds Road at 2020. It is therefore recommended that further investigation be undertaken to determine the viability for a BRT along the entire length of this corridor.

Broader network opportunities also exist through the development of this corridor as BRT, through onward connections to Curtain University as identified in the draft 2031 plan.

Other considerations that need to be taken into account along this corridor is the proposed development of Canning Bridge rail station to improve access for buses and pedestrians, which would facilitate the potential for a BRT interchange to rail that provides a direct high quality transfer for onward travel to the CBD.

This corridor also needs to be considered in relation to its importance in providing a direct access for the Southwest Metro area to the Mandurah rail line and also further onwards to the Perth CBD. The absence of park and ride spaces at Canning Bridge Stations further warrants the justification for a rapid transit corridor from Fremantle to Canning Bridge to encourage ridership and improve transfers to therefore reduce the attractiveness in using a private vehicle to travel to a park and ride station or onwards to the Perth CBD.

LRT was not recommended on this corridor due to the level of employment opportunities within the corridor, with the exception of the Fremantle CBD, which limits the accessibility benefits that could be achieved through this mode.

Corridor 2 – Fremantle to Murdoch

The Fremantle to Murdoch corridor was recommended as an initial BRT with incremental staging to LRT at 2031. Due to the level of employment and re-development potential available at the Murdoch Activity Centre, substantial accessibility benefits within the study area can be attained.

It is recognised that the patronage density is not as high as some of the other rapid transit corridors, however the high concentration of proposed employment at the Murdoch Activity Centre (in the order of 35,000 jobs[9]) contributes to justifiying the recommendation for LRT in 2031. A review of the number of employment positions within this corridor in comparison to

[9] *http://www.planning.wa.gov.au/656.asp*

the other corridors supports this recommendation. It is recommended that the 2031 land use and employment forecasts be reviewed by DoP and incorporated in the STEM modelling with a particular focus on the assumed number of employment positions within the Murdoch precinct.

The high level costs and indicative benefits assessment indicated that this corridor ranked within the top tier (i.e. top three ranking corridors) in terms of the costs versus benefits for BRT and LRT.

This recommendation aligns with the Stage 2 draft 2031 plan, for BRT along the corridor, however the Stage 1 plan only recommended BRT between Murdoch Drive and Murdoch. It is therefore recommended that further investigation be undertaken to the opportunity to provide rapid transit along the entire length of this corridor. The incremental change to LRT is not recommended in the draft 2031 plan and therefore does not align with the recommendation outlined in this report.

Broader network opportunities also exist through the development of this corridor as BRT and LRT, through onward connections to Southlands and Canning Vale as identified in the draft 2031 plan.

Another consideration that needs to be taken into account along this corridor is the new link road which is currently under construction through the new Fiona Stanley Hospital. It is recommended that further investigation be undertaken to use this link road as the alignment for the BRT to provide greater penetration into the new Hospital and the University. It is however recommended that further investigation be undertaken into the preferred alignment for this corridor.

Corridor 3 – Cockburn Central to Cockburn Coast

This corridor has been recommended as BRT in the 2031 scenario. The patronage forecast along this corridor is the lowest of all six corridors, which is most likely due to the lower density residential along this corridor and also large areas of undevelopable land. The opportunities for redevelopment potential along this corridor are also limited to Cockburn Coast district and to a lesser extent Cockburn Central station and Gateways Shopping Centre. This recommendation aligns with the Stage 2 draft 2031 plan, for BRT along the corridor.

The high level costs and indicative benefits assessment indicated that this corridor ranked within the bottom tier (i.e. bottom three ranking corridors) in terms of the costs versus benefits for BRT and LRT.

Broader network opportunities also exist through the development of this corridor as BRT, through onward connections to Fremantle through Cockburn Coast and to the east connecting to Armadale Station from Cockburn Central as identified in the draft 2031 plan.

Other considerations that need to be taken into account along this corridor include the need to further investigate the potential for the alignment to extend from Cockburn Central via North Lake Road and the dis-used rail corridor, through the Bibra Lake Industrial Estate to the Spearwood Activity Centre. This is an alternative alignment to the modelled alignment used for the patronage forecasting assessment along Beeliar Drive and Rockingham Road. It is recommended that further investigation be undertaken into selecting the preferred alignment for this corridor, by considering master planning for the industrial precincts to sustain a rapid transit corridor. This needs to be balanced against the larger population catchment living along the Beeliar Drive/Rockingham Road alignment.

LRT was not recommended on this corridor due to the lower forecast patronage and employment densities, when compared to the other corridors. There are also sections of Beeliar Drive where the road grade exceeds 6%, which is not desirable for LRT running and therefore may result in higher construction costs and operational constraints.

Corridor 4 – Murdoch to Canning Bridge

This corridor has been recommended as BRT in the 2031 scenario. This recommendation has been based upon importance recognised in linking the Booragoon bus interchange with the Murdoch and Canning Bridge rail stations.

It should be noted that the following short sections of this corridor have been recommended for BRT at 2020, which is supported as it provides an incremental approach to future BRT, along the entire length of the corridor:

- Canning Highway – between Canning Bridge Station and Reynolds Road
- The approach to Murdoch Station, from the western side of the Mandurah rail line.

The high level costs and indicative benefits assessment indicated that this corridor ranked within the bottom tier (i.e. bottom three ranking corridors) in terms of the costs versus benefits for BRT and LRT.

This recommendation aligns with the Stage 2 draft 2031 plan, for BRT along the corridor, with the exception of the section south of Booragoon to just west of Murdoch. It is therefore recommended that further investigation be undertaken into the opportunity to provide BRT along the entire length of this corridor by 2031. The importance of Booragoon as a major bus interchange in the Southwest Metro has been recognised by the recommendation for BRT on this corridor.

Broader network opportunities also exist through the development of this corridor as BRT, through onward connections to Curtin University from Canning Bridge and Southlands and Canning Vale from Murdoch as identified in the draft 2031 plan.

Other considerations that need to be taken into account along this corridor are the Canning Bridge Station re-development as discussed in Corridor 1 and the new link road which is currently under construction through the new Fiona Stanley Hospital, as discussed in Corridor 2.

LRT was not recommended on this corridor due to the low employment accessibility benefits (excepting the Murdoch Activity Centre) that could be achieved through this mode. Integration with the Booragoon bus interchange is also a consideration, which supports the recommendation of BRT. There are also sections of Riseley Street where the road grade exceeds 6%, which is not desirable for LRT running and therefore may results in higher construction costs and operational constraints.

Corridor 5 – Cockburn Coast to Murdoch

This corridor has been recommended as BRT in the 2031 scenario. This recommendation has been based upon the need for a north-south corridor that links the Spearwood activity centre to Kardinya Park Shopping centre, with wider connections to Cockburn Coast and Murdoch activity centre.

The high level costs and indicative benefits assessment indicated that this corridor ranked within the bottom tier (i.e. bottom three ranking corridors) in terms of the costs versus benefits for BRT and LRT.

This recommendation does not align with the draft 2031 plan, as there was no north-south rapid transit link recommended within the central Southwest Metro area. It was identified that this north-south link would complete the Southwest Metro rapid transit network by improving accessibility for the residents/employees in the south western areas of the study area, by directly linking Cockburn Coast with Murdoch, via Spearwood and Kardinya Park Shopping Centre.

Broader network opportunities also exist through the development of this corridor as BRT, through onward connections to Southlands and Canning Vale from Murdoch as identified in the draft 2031 plan.

Another consideration that needs to be taken into account along this corridor is the need for further investigation into the preferred alignment from Cockburn Central to Cockburn Coast, via Spearwood. The conclusion of this alignment study may have an impact upon the preferred alignment between Spearwood and Kardinya Park Shopping Centre, as there may be an opportunity for consolidation of alignments through the central industrial area at Bibra Lake.

LRT was not recommended on this corridor due to the lower forecast patronage and employment densities, when compared to the other corridors.

Corridor 6 – Cockburn Coast to Fremantle

This corridor has been recommended for BRT with incremental change to LRT in 2031, based upon the patronage forecast along this corridor and the level of existing and forecast employment, particularly within the Cockburn Coast district centre. This recommendation is based upon the higher level of patronage density forecast along this corridor, which can be primarily attributed to the population density of the proposed Cockburn Coast district, combined with the relatively short length of corridor. In addition to the Cockburn Coast district there are other re-development opportunities, such as the Douro Road shopping precinct and the Fremantle CBD Westgate precinct. The recommendation for LRT on this corridor provides the opportunity to catalyse development within the corridor and result in value uplift around proposed stations.

This recommendation is further supported by the level of employment available along a continuous length of the corridor, providing accessibility advantages to passengers. An employment density (jobs/km) figure of 4,301 was calculated for this corridor, which was the highest of all six corridors recommended.

The high level costs and indicative benefits assessment indicated that this corridor ranked within the top tier (i.e. top three ranking corridors) in terms of the costs versus benefits for BRT and LRT.

This recommendation aligns with the draft 2031 plan recommendation for BRT on this corridor by 2020, however conflicts with the recommendation for LRT by 2031, which was recommended as BRT in the draft 2031 plan for the stage 2 scenario. It should be noted however that the draft 2031 plan does mention that a case for light rail may be made in the longer term on this corridor.

A BRT alignment study is currently being undertaken to investigate the preferred alignment for a BRT between Cockburn Coast and Fremantle, which will also investigate the potential to be incrementally staged to LRT in the future.

Broader network opportunities also exist through the development of this corridor as BRT and LRT, through onward connections via the Fremantle rail line and to the south to Rockingham and Cockburn Central.

General Recommendations

This report represents a submission to the draft 2031 public transport plan for Perth and provides an alternative view to the provision of rapid transit within the Southwest Metro area. One of the objectives of the Southwest Metro Rapid Transit Network study was to inform the draft 2031 plan and therefore the DOT are encouraged to review and consider the recommendations outlined in this report.

The recommended rapid transit network for the southwest metro area has been developed to provide a network of rapid transit corridors to guide further detailed investigations to be undertaken along each corridor. It is recognised that more detailed alignment investigations and economics studies are required within each of the recommended rapid transit corridors to determine the potential viability for rapid transit in the future to increase the public transport mode share and to catalyse development around proposed stations.

One of these detailed investigations is currently underway for the Fremantle to Cockburn Coast corridor, which will identify alignment options along this corridor and recommended and design the preferred alignment. This study will also include a more detailed patronage forecasting analysis, using the STEM as well as CAPEX and OPEX cost estimates.

It is recommended that additional alignment studies be undertaken for the other recommended rapid transit corridors within the Southwest Metro area, in order to further investigate the preferred alignments, running ways and modes to operate these corridors as rapid transit.

In undertaking these more detailed investigations, it is also recommended that the DOT provide an improved level of direction in relation to the warrants outlined in the draft 2031 plan for the implementation of rapid transit (BRT/LRT). As part of these warrants it is also recommended that considerations also be given to other factors in addition to patronage that can further justify investment in rapid transit, including:

- Improvements to accessibility
- The influence of rapid transit in catalysing development around stations
- Cost and benefits analysis.

Appendix A

Data

Demographic data

Table A.1 presents a summary of municipality demographic data for the cities of Fremantle, Melville and Cockburn to provide an understanding and comparison of key population and household data that may influence public transport use within the study area.

Table: A.1 Municipality demographic data summary 2006 ABS)

Data	Fremantle	Melville	Cockburn
Population			
2006 Population	25,467	92,398	73,887
Est. current population	28,626 (30/6/2010)	99,611 (2011)	91,451 (2011)
Forecast 2031 population	35,000	109,194	127,888
% Growth	37%	18%	73%
Fastest growth area	-	Murdoch 4.38% avg annual %change	Aubin Grove 6.71% avg annual %change
Average household size	2.29	2.55	2.65
Age structure (2006)			
<18 y.o.	17.6%	22.7%	26.1%
>60 y.o.	21.4%	20.4%	14.0%
Household Income (2006)			
Low income (<$500 p/w)	23.7%	15.7%	16.8%
High income (>$1700 p/w)	22.9%	30.6%	23.6%
Employment (2006)			
Employed Full time	57%	57.9%	61.3%
Employed Part time	35.8%	36.8%	32.4%
% unemployed (2006)	4.6%	3.1%	3.4%
Travel to work (2006)			
Train	6.7%	0.8%*	0.9%*
Bus	3.9%	7.7%	5.4%
Car as driver	54.8%	64.3%	66.9%
Car as passenger	4.8%	5.1%	6.3%
Household car ownership (2006)			
No vehicles	12.9%	5.9%	5.9%
1 car	38.6%	33%	29.2%
2 cars	29%	37.9%	39.4%
3 cars or more	9.2%	17.2%	18.1%
Housing (2006)			
Separate house	57%	75%	81.7%
Medium density (1-2 storey)	23.3%	16.8%	8.8%
High density (3 storey or greater	7.4%	0.9%	1.6%

***Mandurah line not opened until late 2007

Data source:

City of Cockburn: http://profile.id.com.au/Default.aspx?id=350&pg=11&gid=250&type=enum
(Community Profile)

City of Melville: http://profile.id.com.au/templates/profile/Clients/253Melv/PDF/10.pdf
(Community Profile)

City of Fremantle: http://profile.id.com.au/templates/profile/Clients/372Frem/PDF/10.pdf
(Community Profile)

Summary of 2006 Demographic data

The following key points have been summarised from the 2006 demographic data and grouped into each of the three municipalities:

- Cockburn has the highest forecast growth (73%), compared to Melville (18%) being the lowest.
- Cockburn has the highest percentage of young people (26.1% <18 y.o.), young people can be regular public transport users for school and also being unable to drive. Fremantle has the lowest (17.6% < 18 y.o.).
- Conversely Fremantle has the highest proportion of elderly (21.4% >60 y.o.), with Cockburn recording the lowest with 14%. There is also a relationship between elderly and public transport use, as a result of being unable to drive or no car ownership.
- Fremantle has the highest proportion of low income households (23.7% <$500 p/w), with Melville the lowest (15.7%). There is also a relationship between low income and public transport use.
- Melville has the highest proportion of high income households (30.6% > $3000 p/w).
- Fremantle has the highest unemployment rate (4.6%).
- The travel to work data is not representative of current trends, given that the Mandurah rail line was not opened when the 2006 ABS data was collected. This explains the low travel to work by train for Melville and Cockburn.
- The travel to work by bus is also high for Melville, with some of these passengers most likely switching to train once the rail line was opened.
- Cockburn had the highest travel to work via car and as passenger (66.9% and 6.3% respectively), which may be attributed to the lack of other alternatives prior to the rail line opening. Melville travel to work by car was also relatively high in comparison to Fremantle.
- Fremantle had the highest proportion of no vehicle households (12.9%), which may equate to a greater public transport mode share. Cockburn and Melville no vehicle households were less than half of Fremantle's.
- Cockburn and Melville had very high proportions of 2 and 3 car households in comparison to Fremantle.
- Cockburn had the highest proportion of separate housing (81.7%), compared to 57% for Fremantle, which was the lowest.
- Fremantle had the highest proportion of medium and high density housing (23.3% and 7.4% respectively).

- Melville and Cockburn had very low proportions of high density (0.9% and 1.6%) respectively. There is an established relationship between the density of housing and public transport use.

Journey to work data has also been sourced for the southwest metro study, in order to investigate travel to work patterns within the southwest metro study area. Figure A.1 provides a summary of the travel to work patterns between and outside of each of the three municipalities that are within the study area.

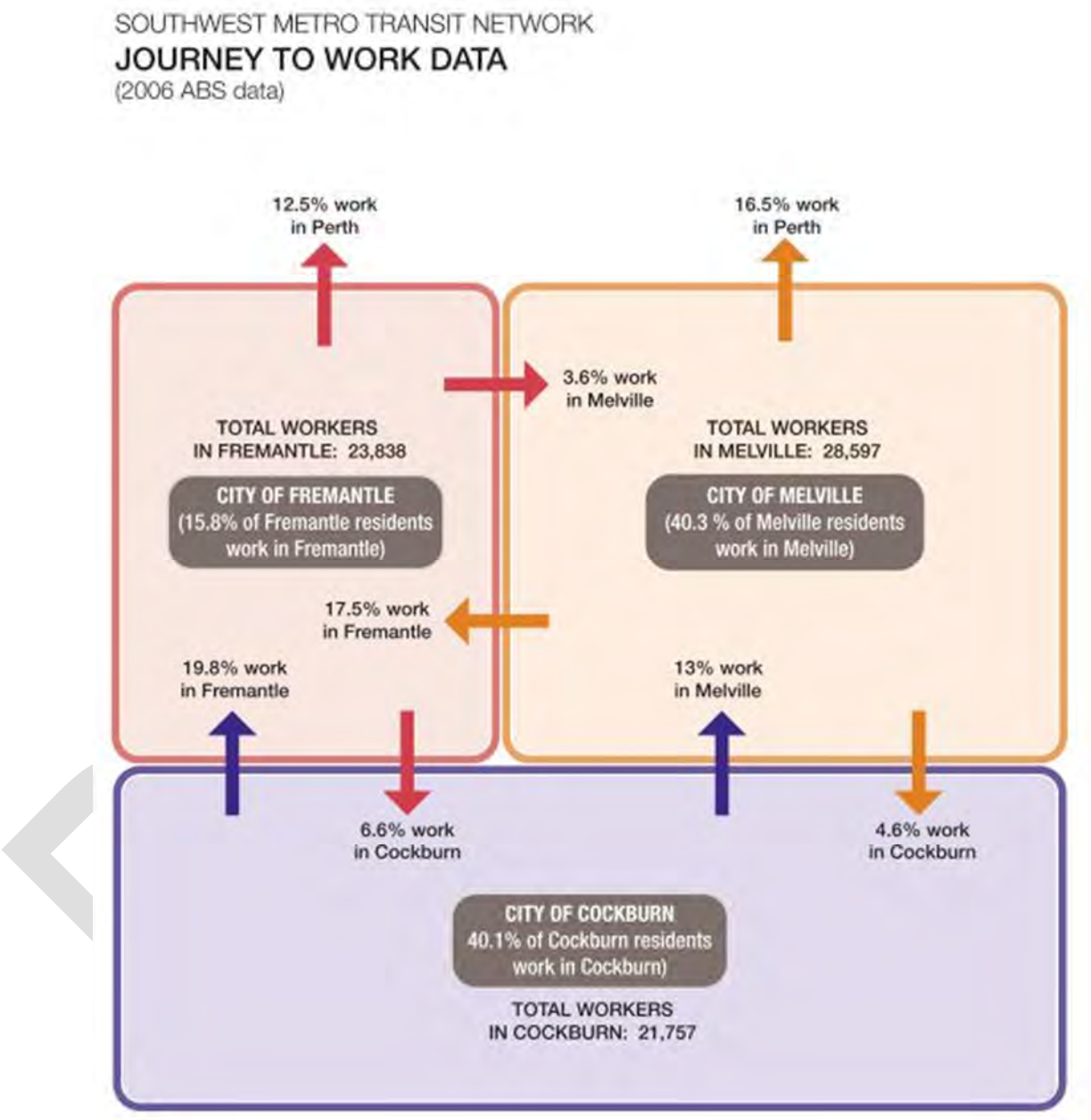


Figure A.1: Journey to work data

Data Source:

City of Fremantle: http://profile.id.com.au/Default.aspx?id=372&pg=250&gid=10&type=enum

City of Melville: http://profile.id.com.au/Default.aspx?id=253&pg=310&gid=10&type=enum

City of Cockburn: http://profile.id.com.au/Default.aspx?id=350&pg=250&gid=250&type=enum

Journey to work data was sourced from the profile.id website for the cities of Fremantle, Cockburn and Melville in order to understand the travel patterns of workers within each of the three municipalities. The data is based on 2006 ABS data. The following key points have been summarised from the journey to work data:

- 15.8% of Fremantle workers live and work in Fremantle; this is significantly lower than the percentages in Melville and Cockburn.
- The highest proportion of Fremantle workers are travelling from Cockburn (19.8%) and Melville (17.5%).
- 40.3% of Melville workers live and work in Melville. 3.6% of the workers in Melville travel from Fremantle and 13% from Cockburn.
- 40.1% of Cockburn workers live and work in Cockburn. 6.6% of the workers in Cockburn travel from Fremantle and 4.6% from Melville.
- Fremantle had a total of 23,838 workers.
- Melville had a total of 28,597 workers (Note: the growth in workers in Melville is expected to increase significantly once the new Fiona Stanley Hospital is opened).
- Cockburn had a total of 21,757 workers.
- Only 12.5% of residents in Fremantle were travelling to Perth for work, with 16.5% of Melville residents were travelling to work in Perth.

This data shows that there is a significant amount of work travel occurring within and between the three Cities of Fremantle, Melville and Cockburn and also highlights the importance of this travel in addition to travel to Perth.

Public transport and traffic data

A range of public transport patronage and station data was sourced from the Department of Transport, with a particular focus on the study area. The data has been presented in the following sections:

- Rail line and station boardings
- Rail station park and ride origin/destination data
- Rail station park and ride occupancy data
- Bus and rail patronage
- Traffic volumes.

Rail line and station boardings

The Department of Transport (DOT) has provided rail station boardings data for the five rail stations within the southwest metro study area. This data is presented in Table A.2 and provides an indication of the average weekday boardings, separated into Smart rider tag-ons and total boardings for the period between 19-23 October 2009. Total boardings were also sourced from March 2011, with the percentage change from 2009 to 2011 also calculated. It should be noted that the figures include boardings only and not alightings.

Table A.2: Rail station boardings within study area

Station	Smart Rider tag-ons (Oct 2009)	Total boardings (Oct 2009)	Total boardings (Mar 2011)	% Change (Oct 2009 to Mar 2011)
Fremantle	2,711	4,323	5,287	22%
Canning Bridge	2,221	2,638	4,054	54%
Bull Creek	3,554	4,373	5,023	15%
Murdoch	5,438	6,723	8,383	25%
Cockburn Central	2,591	3,488	4,870	40%

Source: Department of Transport

The DOT has also provided boardings data for all five metropolitan rail lines within Perth, which were collected at the same time as the rail stations boardings data (i.e. 19-23 October 2009). The rail line boardings data is presented in Table A.3.

Table A.3: Perth Rail line boardings

Line	Total boardings (Oct 2009)
Fremantle	26,030
Mandurah	50,323
Joondalup	61,081
Midland	21,367
Armadale	30,967

Source: Department of Transport

Rail Station Park and Ride Catchment Data

The Department of Transport has provided origin/destination data for vehicles travelling to the Cockburn Central, Murdoch and Bull Creek rail stations. This data has been mapped visually to provide an indication as to the main areas where train passengers are travelling from in order to access the Mandurah rail line.

Figure A.2 shows the catchment study results for Cockburn Central station for the period of May 2007. The majority of travel demand to Cockburn Central was generated from the suburbs of: Success, Yangeup and Attwell, with some demand also generated from South Lake, Coogee and Hammond Park.

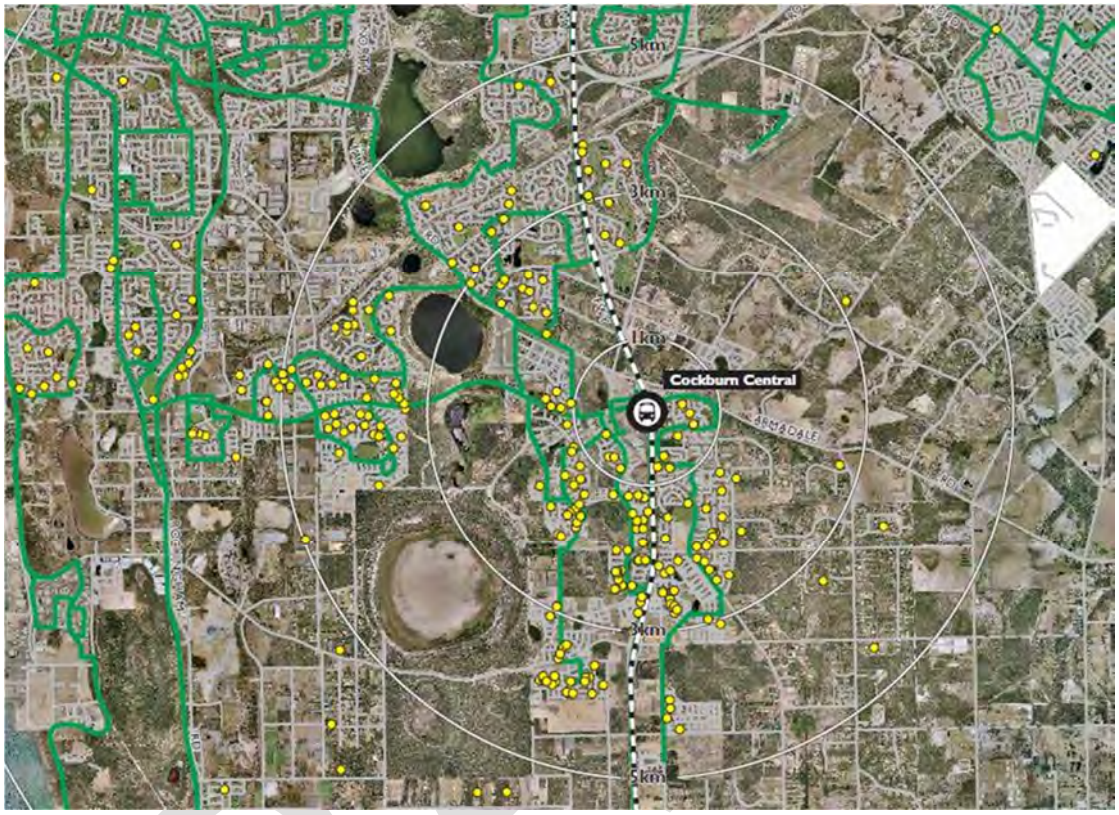


Figure A.2: Cockburn Central catchment study – May 2007

Figure A.3 shows the catchment study results for Murdoch station for the period of October 2008. The travel demand to Murdoch was more dispersed than Cockburn central, with the majority generated from the suburbs of: Samson, O'Connor, South Lake/Bibra Lake and Leeming, with some demand also generated from Coogee and Winthrop.

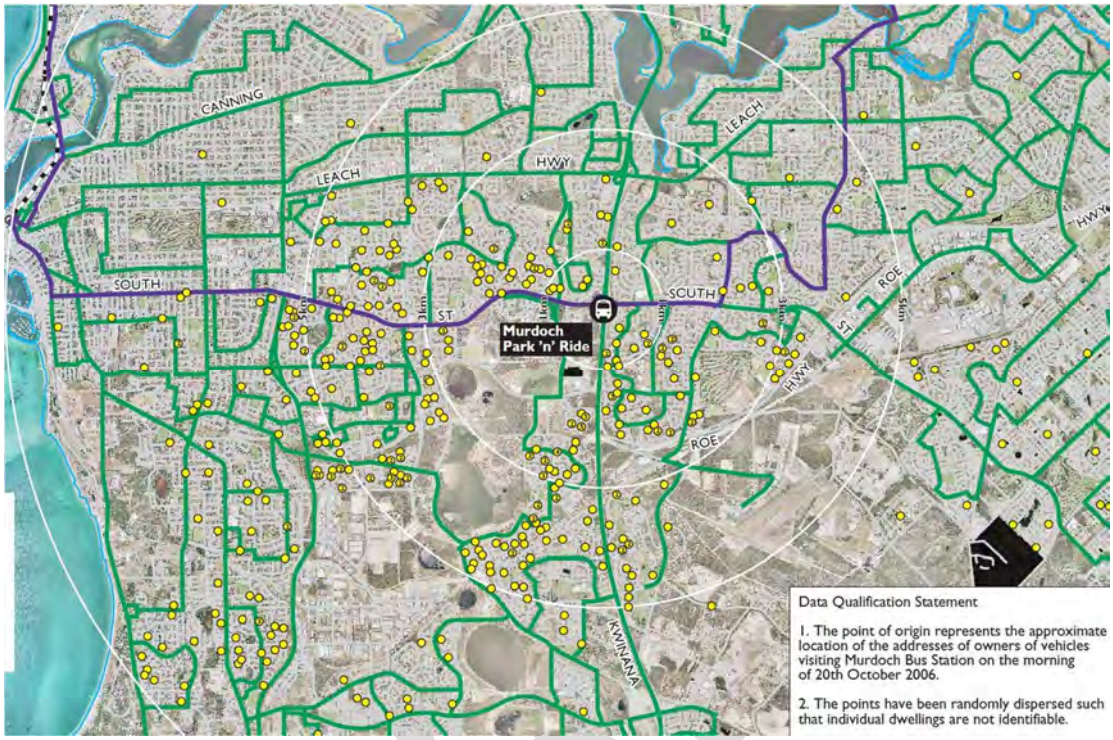


Figure A.3: Murdoch catchment study – October 2008

Figure A.4 shows the catchment study results for Bull Creek station for the period of April 2008. The majority of travel demand to Bull Creek station was generated from the eastern side of the Mandurah rail in the suburbs of: Bull Creek, Willetton, Rossmoyne, Shelley and Leeming. There was also demand from the western side of the Mandurah rail line in the vicinity of the Leach Highway.

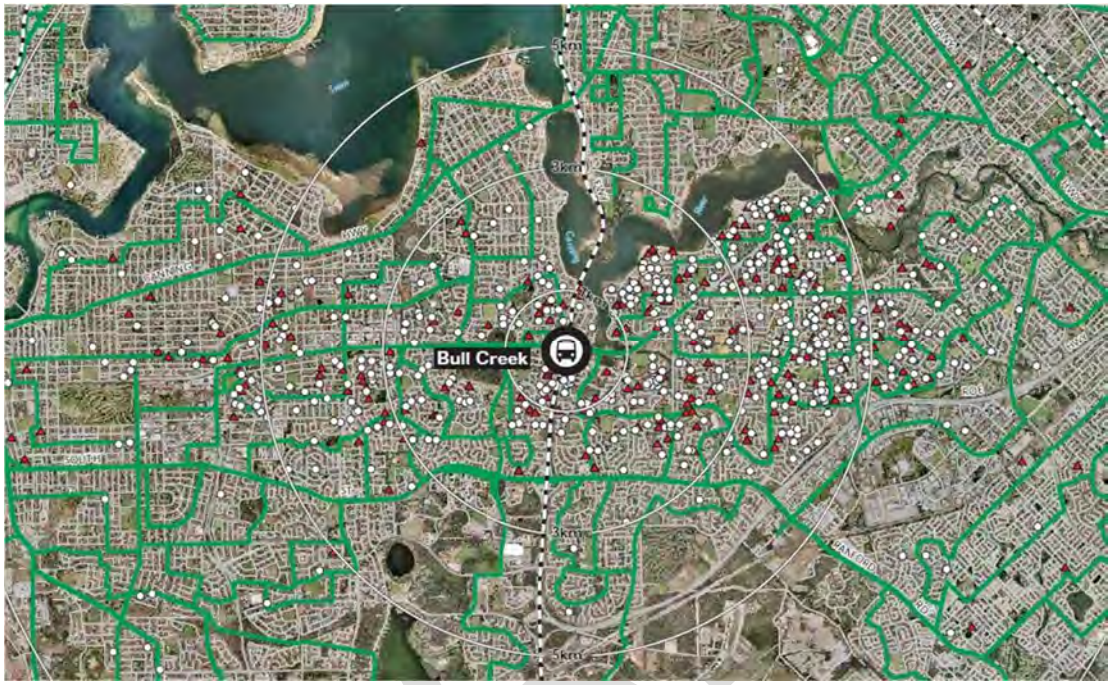


Figure A.4: Bull Creek catchment study – April 2008

Public Transport Accessibility

Scheurer and Curtis completed a study in 2008, which focused on the assessment of the change in public transport accessibility within Metropolitan Perth, after the opening of the Mandurah rail line. Figure A.5 and Figure A.6 show the change in public transport accessibility before and after the opening of the rail line.

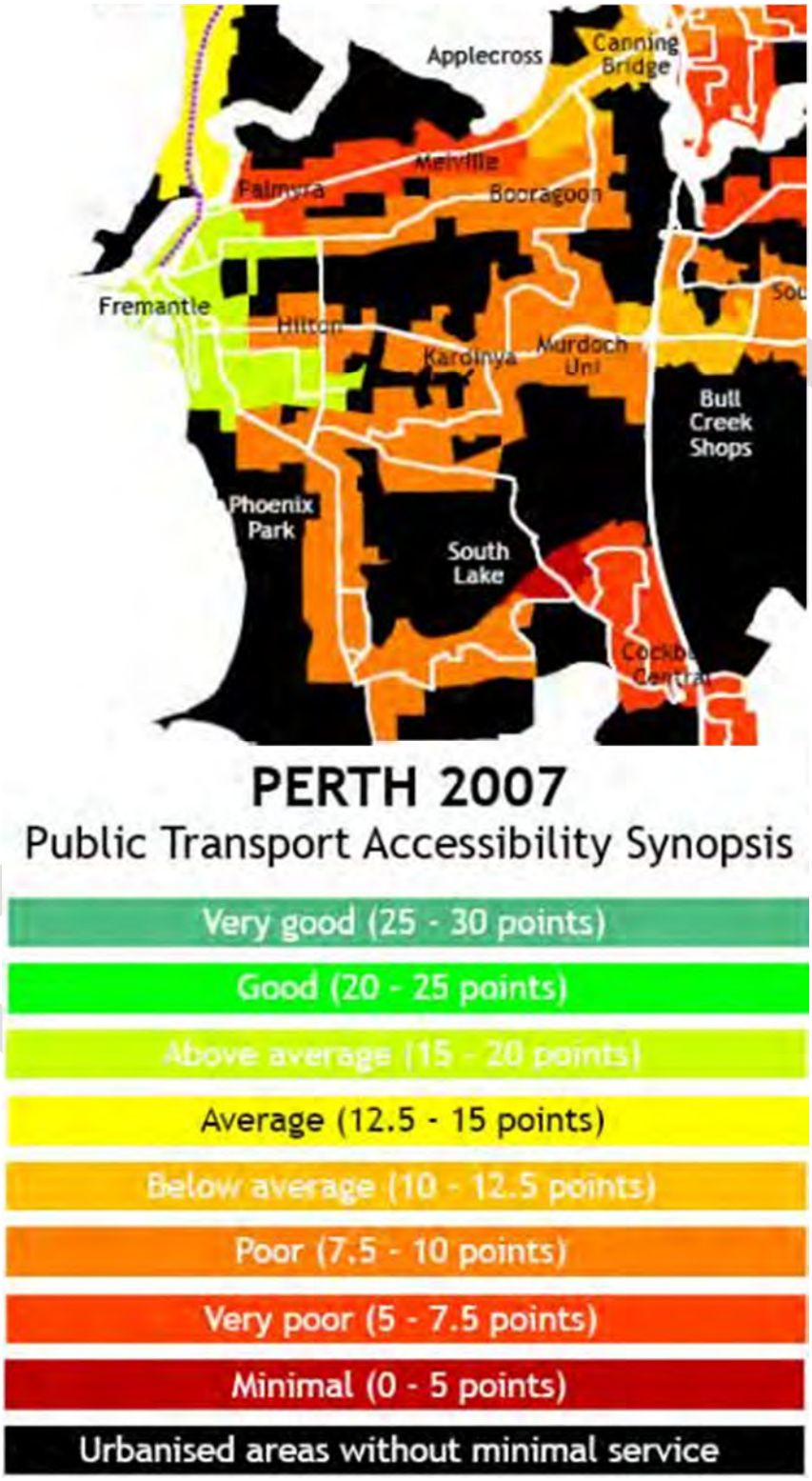


Figure A.5: 2007 Public Transport Accessibility

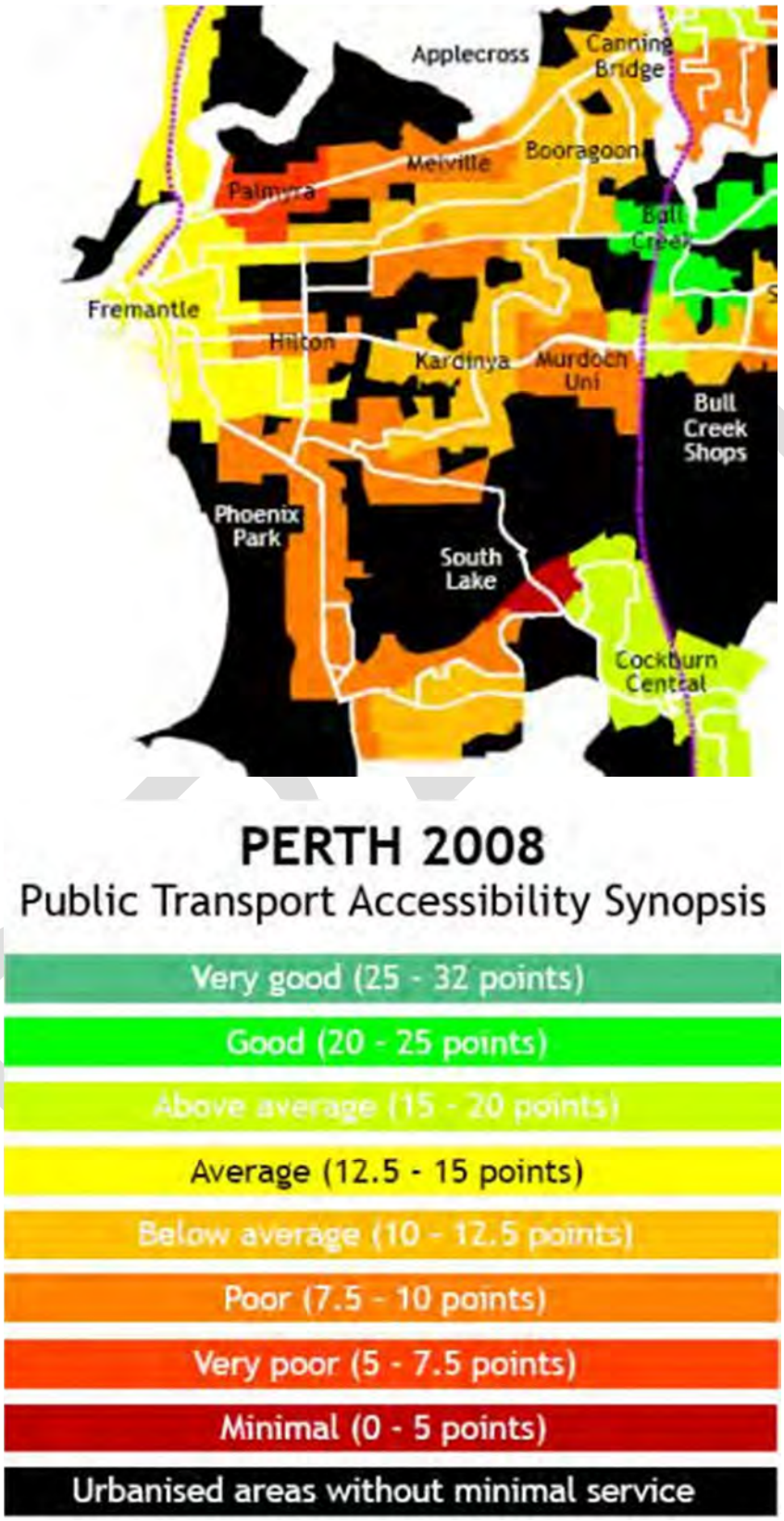


Figure A.6: 2008 Public Transport Accessibility

Source:

(RM) Scheurer J, Curtis C (2008) Spatial Network Analysis of Multimodal Transport Systems: Developing a Strategic Planning Tool to Assess the Congruence of Movement and Urban Structure. Research Monograph, Curtin University Sustainability Policy Institute (CUSP) and Australian Centre for Governance and Management of Urban Transport (GAMUT), Perth (WA)/Melbourne (VIC), June 2008, available online at www.abp.unimelb.edu.au/gamut/pdf/perth-snamuts-report.pdf

Park and Ride occupancy

Table A.4 provides a summary of the number of the estimated occupancy at each of the park and ride facilities at the rail stations located within the southwest metro study area.

Table A.4: Park and Ride occupancy

Station	Average occupancy
Bull Creek	At capacity
Murdoch	At capacity
Cockburn Central	At capacity
Fremantle	At capacity
Canning Bridge	No park and ride facility

Source: Site visit undertaken on 12 July 2011

Bus patronage

Bus patronage was provided by DOT for all of the bus routes operating within the southwest metro network study area. This data provides an indication as to the existing level of patronage along key corridors within the study area. The data has been compared to the daily number of services operated on each of the routes in order to understand the efficiency of each routes in terms of passengers per trip.

Table A.5 provides a summary of the bus patronage data for all routes within the study area.

Table A.5: Bus Patronage Summary

Route No	From	To	via	Patronage	No. trips (p/d)	Avg patronage per trip
825*	Rockingham	Fremantle	Cockburn Coast	827	62	13.3
920*	Rockingham	Fremantle	Kwinana	3439	122	28.2
522	Cockburn Central	Fremantle	Spearwood, Munster	65	15	4.3
532	Cockburn Central	Fremantle	Beeliar Drive	767	62	12.4
530	Cockburn Central	Fremantle	Osprey Drive	1489	65	22.9
531	Cockburn Central	Fremantle	Doolette St	687	46	14.9
533	Cockburn Central	Fremantle	Carmel Way	111	4	27.8
520	Cockburn Central	Fremantle	North Lake Rd	1346	83	16.2
514	Cockburn	Murdoch	Murdoch drive	665	53	12.5

Route No	From	To	via	Patronage	No. trips (p/d)	Avg patronage per trip
	Central	Station				
511	Murdoch Station	Fremantle	Sommerville Bvd	927	64	14.5
513	Murdoch Station	Fremantle	Ralston St	1065	62	17.2
940*	Hamilton Hill Hall	Wellington St Bus Station	Booragoon/Canning Bridge	2695	116	23.2
503	Murdoch Station	Bull Creek Station	Gilbertson Rd	267	38	7.0
504	Murdoch Station	Bull Creek Station	Jackson Ave	273	42	6.5
505	Murdoch Station	Bull Creek Station	Dean Rd/Murdoch Drv	194	37	5.2
500	Booragoon	Bull Creek	Canning Avenue	184	38	4.8
510	Murdoch	Booragoon	Murdoch Drv/Riseley St	367	66	5.6
501	Fremantle	Bull Creek Station	Marmion St	2399	113	21.2
502	Fremantle	Bull Creek Station	Leach Hwy	1418	81	6.2
98*	Circle Route	clockwise	Murdoch & Fremantle	-	93	-
99*	Circle Route	Anti-clockwise	Fremantle & Murdoch	-	88	-
140	Fremantle	Booragoon	South St	50	6	8.3
160*	Fremantle	Perth	Booragoon	1417	53	26.7
148*	Fremantle	Como	Canning Bridge	66	7	9.4
158*	Fremantle	Perth	Canning Bridge	724	36	20.1
106*	Fremantle	Perth	Canning Bridge, South Perth	4433	126	35.2
111*	Fremantle	Perth	Canning Bridge, Kwinana Fwy	987	31	31.8
881*	Munster	Perth	Booragoon, Canning Bridge	1837	72	25.5

Source: Department of Transport

*Denotes that the route does not both originate and terminate within the study area (i.e. patronage data does reflect actual demand within the southwest metro study area, as some of the patronage is likely to be attributed to areas such as Rockingham, Kwinana, South Perth and Como).

Patronage data was not provided for routes 98 and 99, due to the length of the route that they cover and the difficulty associated in determining what proportion of the patronage can be attributed to the southwest metro network study area. A more detailed analysis of the patronage that these routes generate within the study area will be undertaken in the next stages of the assessment.

Figure A.7 provides a summary of the rail station boardings at each of the five stations within the southwest metro study area, rail line boardings on the Fremantle and Mandurah rail lines and indicative bus boardings on key corridors.

Figure A.7: Public Transport Patronage by corridor

The existing patronage figures presented in Figure A.7 contain the following limitations:

- The 4,300 boardings on the Cockburn Coast corridor includes patronage from Rockingham and Kwinana

- The 6,200 boardings on the Fremantle to Canning Bridge corridor includes patronage from South Perth and Como, as the data could not be separated into boardings within the study area

- The 3,450 boardings on the Fremantle to Murdoch corridor are under-represented as they do not include patronage generated from bus routes 98 and 99 (circle routes)

Table A.6 provides an indication as to the five most efficient bus routes operating within the study area in terms of passengers per trip.

Table A.6: Five most efficient bus routes

Route No.	Route name	Avg passengers per trip
106	Fremantle – Perth (via Canning Bridge & South Perth)	35.2
111	Fremantle – Perth (via Canning Bridge & Kwinana Freeway)	31.8
920	Rockingham – Fremantle (via Kwinana)	28.2
533	Cockburn Central – Fremantle (via Beeliar Drive and Rockingham Rd)	27.8
160	Fremantle – Perth (via Booragoon and Canning Bridge and Kwinana Fwy)	26.7

Table A.7 provides an indication as to the five least efficient bus routes operating within the study area in terms of passengers per trip.

Table A.7: Five least efficient bus routes

Route No.	Route name	Avg passengers per trip
522	Cockburn Central – Fremantle (via Spearwood and Munster)	4.3
500	Booragoon – Bull Creek (via Canning Ave)	4.8
510	Murdoch – Booragoon (Murdoch Drv and Riseley St)	5.6
502	Fremantle – Bull Creek (Leach Highway)	6.2
504	Murdoch Station – Bull Creek Station (via Jackson Ave)	6.5

Traffic volume data

Figure A.8 provides a visual representation for the level of traffic volumes on key road corridors within the southwest metro study area. This data was sourced from Main Roads Western Australia (MRWA) for the period between 2004 and 2010.

Figure A.8: Traffic volumes within study area

South West Group
Australian Greens

Southwest LRT Corridor Study: Murdoch to Fremantle

Author:
Michael Crocker

Foreword

Scott Ludlam – Australian Greens Senator for Western Australia

Scott Ludlam is the Greens' spokesperson for Transport, Infrastructure and Sustainable Cities.

He developed a comprehensive plan for light rail for Perth in 2007 and has been working with a broad coalition campaigning for light rail to become part of Perth's transport mix (see www.scottludlam.org.au/perthlightrail).

This report, instigated as a research project for the Office of Senator Scott Ludlam, is intended to help inform and assist further planning for light rail in Perth's south-western suburbs in particular.

Senator Ludlam would like to thank Michael Crocker for his hard work and dedication to this project and Chris Fitzhardinge from the South-West Group for his assistance.

South West Group

The South West Group is a Voluntary Regional Organisation of Councils formed in 1983, representing the cities of Cockburn, Fremantle, Melville and Rockingham, as well as the towns of East Fremantle and Kwinana. Representing the councils in the study area, The South West Group has a keen interest in promoting sustainable and effective transit options for it's citizens, incorporating LRT into a holistic and comprehensive approach to the future of the region. for more information, please see: http://www.southwestgroup.com.au/

The South West Group provided background information and technical advice during the preparation of the study, as well as a peer review role, and as such are identified as a study partner to reflect this contribution.

Formation of this report

This report was created as a result of both the passion of all parties involved, and the need for investigation into LRT in the area. The author approached the office of Scott Ludlam regarding LRT projects, and the South West Group (represented by Chris Fitzhardinge) was asked to collaborate and assist where required with technical expertise and networking resources, as well as general advice on the structure of the project.

Executive Summary

The following report presents the findings of a Light Rail Transit (LRT) corridor study between the Murdoch and Fremantle Train stations. Potential corridors were identified and evaluated against criteria identified by preceding studies. This study does not make a comparison between LRT and other forms of transit, and as such alternatives should always be considered prior to further investigation. However, it is the author's opinion that LRT would be an appropriate method of transit within the area, as the areas surrounding both terminals prepare to grow in density and therefore require faster, higher capacity transport.

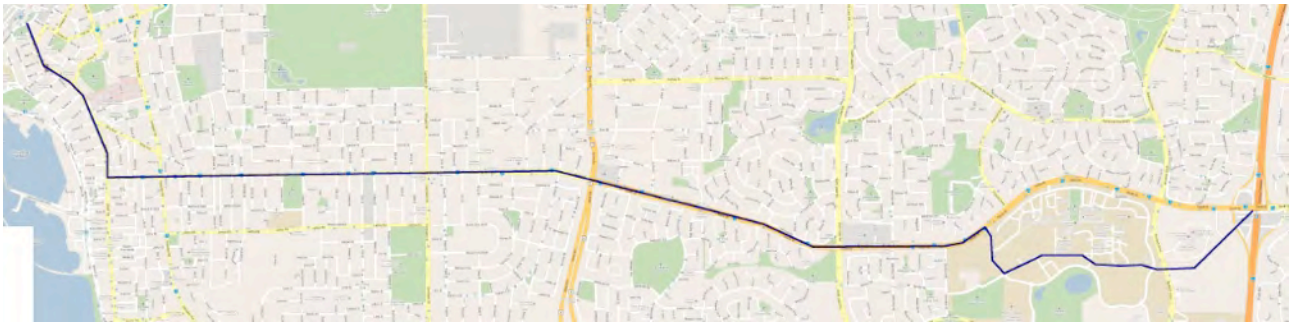
The reasons for implementing LRT can vary, and hence this report does not recommend a particular report. Instead, the evidence is presented in such a way as to make selection based on a particular set of criteria a simple process.

Table i. Route Recommendations

Rationale	1st Recommended Route	2nd Recommended Route
Cost	3	5
Environmental Impact	2	3
Feasibility	1	5/6
Legibility	3	5
Placemaking	2	6/7
Ridership	7	2
Speed	3	1
Trip Generators	5/6	2
Urban Renewal	3	7

If a particular route had to be recommended, then a combination of routes 2 and 3 would be most appropriate. This route would run from Fiona Stanley Hospital (down Barry Marshall avenue) to South street via Discovery drive. It would then follow South st, before connecting with the proposed Cockburn Coast LRT line, heading into Fremantle. Passing most trip generators, and several already high density areas, this route would capture a significant ridership.

Figure i. Recommended Route



Opportunities for Transit Oriented Development (TOD) exist surrounding Carrington street, as well as the Murdoch Activity Centre and Eastern Precinct near the Murdoch terminus, and such options can help raise capital to fund the line itself. By utilising an existing thoroughfare (South street), environmental damage is minimised and a rapid service is ensured.

It must also be noted that this is a very preliminary study, and further investigation may be needed to substantiate the data within and advance LRT Projects within the area. Wherever data is presented within, every attempt is made to give the source and rationale behind the interpretation.

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Background & Scope

Background

Recently, the Western Australian Department of Transport released the first medium-term plan for Perth's public transport sector, titled Public Transport for Perth in 2031: Mapping out the Future for Perth's Public Transport Network. According to this report, Perth's "public transport system is regarded as one of the best, newest and most efficient in the nation", but noted that "much more needs to be done to ensure the capacity and quality of service to meet the transport needs of a rapidly growing city" (Department of Transport 2011, p.3).

This acknowledgement of the growing importance of public transport reflects a worldwide shift shunning the private automobile and the associated planning principles of the post WWII period, such as the 1955 Stephenson-Hepburn plan for Perth (Committee for Perth 2011). Although considered appropriate in their time, these plans allowed for the rapid urban sprawl seen in cities such as Perth on the back of large highways. It must be noted that the Stephenson-Hepburn plan also called for a corresponding expansion of the heavy passenger rail system, but this did not receive the same level of political enthusiasm or investment (Committee for Perth 2011). The impact of this transport planning can be seen in the differences between older suburbs such as Mt Lawley and North Perth, and post-war suburbs such as Bedford and Morley. The higher density and 'Main st' style retail of the more established suburbs contrast with the sprawl and 'big box' retail style of the newer suburbs (Thomas 2002).

Although most cities in the world followed this oil dependent planning process, some cities experienced a transit renaissance of sorts. Following WWII, European planners were faced with the monumental task of rebuilding the continent's transport infrastructure. Cities such as Karlsrühe in Germany and Strasbourg in France kept or expanded their existing tram system, eventually switching to LRT (Thomas 2002). Several groups in Portland, Oregon noticed the relative successes in Europe and began to campaign for a similar shift in mentality. During the 1970's, increased awareness of the inherent troubles of urban sprawl led to a defined urban growth boundary (Thomson 2007). Combined with the Federal Aid Highway Act of 1973 which allowed regions to refuse federally funded road projects, and redistribute the funds to other transit projects with demonstrated viability, meant that the counties comprising the Portland Metropolitan Area were able to redistribute the funds allocated towards the future Mt Hood Freeway and I-5 towards 286 other transit projects. This is interesting to note as Perth and other Australian cities are similarly becoming aware of the dangers of urban growth and the importance of infill development (Curtis & Sheurer 2009, Adams 2009, WAPC 2010).

Perth's population is growing, standing to reach at least 2.2 million by 2031 (WAPC 2010). This represents a growth of almost 500,000 people, who must be housed and given options for transport. The Western Australian Planning Commission has called for 47% of new dwellings to be within the current Perth Metropolitan Area, resulting in an average increase in density from 10 to 15 dwellings per hectare in urban areas (WAPC 2010). Perth's public is also becoming increasingly aware that simply widening existing roads is not an effective solution (Estill 2006). These represent fundamental changes in the traditional thinking and point to a change in transit planning in the near future.

Light Rail Transit, or LRT, is often defined as "electric or diesel powered light rail vehicles running on a track, which can be an exclusive right of way (e.g. in a road median) or shared with general traffic" (SKM 2010). In terms of weight and passenger capacity, LRT occupies the space between the urban tram and a heavy rail passenger car. Commonly carrying 150-200 passengers per car (Maunsell & AECOM 2007), a Light Rail line can carry up to 20,000 people per hour per direction, and needs at least 10,000 passengers per day to be considered viable by the Department of Transport (2011). LRT is most effective as a mid tier transit solution, where the cost of a heavy passenger rail line cannot be justified but the predicted patronage exceeds reasonable bus capacity.

According to the US Department of Energy, Light Rail uses just 0.51 kWh per passenger km, compared to 0.64 kWh for a car or .77 kWh for a transit bus (assuming average passenger loads) (DART 2010). These figures do not take into account the added energy saved (and health benefits gained) by LRT passengers walking to their nearest station, or energy consumed by cars idling at traffic lights, or in traffic jams. This difference, combined with the 'sparks' effect, demonstrates the potential for LT to reduce the total energy consumed by a city. LRT can also be powered by renewable power more easily than cars, as energy storage is not an issue for most LRT carriages (there are alternatives to overhead wire powered cars that do require batteries, and these are described in detail later).

The social benefits of public transit has been well known and can be partially summarised as the cost to the community that is avoided when a commuter choses public transit over a car. The costs to society of car ownership and use can be seen in the expansive use of desirable areas wasted in the forms of carparks and freeways. To properly understand the impact of public transit, it may help to imagine the following scenario: If every commuter in Perth used an automobile to travel, what would Perth resemble? There would be a critical shortage of space required for carparks, productive time lost due to traffic jams would increase, as would the environmental impact (and price of fuel). The Department of Transport (2011) estimates that for an average peak time commuter using his or her car, the social cost to Perth is $30. By utilising public transport, the commuter 'saves' the community $20 (the remaining cost is predominately time lost in transit). These savings will only increase as the impact of traffic congestion sure increase, and the land value of dedicated automobile space increase.

The health benefits of LRT, and public transport usage in general, should also be considered when judging whether LRT is a sound economic investment. Studies have shown that the increased level of physical activity such as cycling or walking inherent in using public transport can have a small but noticeable effect on the health of users (Stokes et al. 2008).

Scope

The area to be studied stretches from the Kwinana Fwy in the east to the Indian ocean in the west, extending from the Beeliar wetlands in the south to the Swan river in the north (see Appendix). The area comprises 3 local governments - the cities of Fremantle, Melville and Cockburn, who are member Councils the South West Group.

A 'mid tier' transit system is sadly lacking in Perth, with heavy rail and local bus services comprising the bulk of public transport options. It is assumed that the current density and proximity to heavy rail lines means that a new heavy rail line is not justified, and the substantial cost of heavy rail invalidate it as an option. Local bus services are not an effective alternative for transit across such a large area, but can be utilised as a feeder option for an effective 'mid tier' option..

Currently, transport planners can use either Bus Rapid Transit or Light Rail Transit. This study investigates the feasibility and suitability of Light Rail Transit, with the Murdoch and Fremantle train stations as fixed terminals. Thus, the study doesn't investigate Bus Rapid Transport (BRT) or other forms of transport. However, it is expected that the information contained within may be used as a basis for advocating LRT within the area.

The study follows a simple process, similar to those observed in similar works around the world. Firstly, all probable routes were identified, regardless of identifiable boundaries or drawbacks. These options were then evaluated according to a range of criteria such as ridership, cost and environmental impact. While most of these criteria are scalable, some (such as feasibility and environmental impact) have cut-off points, beyond which a route is considered unsuitable, regardless of potential benefits in other areas.

LRT can serve several purposes such as accelerated transit or as an impetus for redevelopment , and has been employed both successfully and unsuccessfully around the world to serve these objectives. In deference to this, the study will not propose to recommend a particular route option over another. Rather, the collected information will be presented so that others may decide upon the intended purpose of LRT in the area, and select the appropriate route.

It must be made clear that this study is very preliminary, and much work remains before decisions can be made with confidence. As a result, it is expected that the study will serve mainly as a stimulant for discussion and as an indicator of potential impediments inherent with specific route sections. A chapter in this report examines the future work in greater detail.

This study was undertaken as part of the Perth Light Rail project, and it is envisaged the it will form part of this wider scope.

Route Descriptions

Introduction

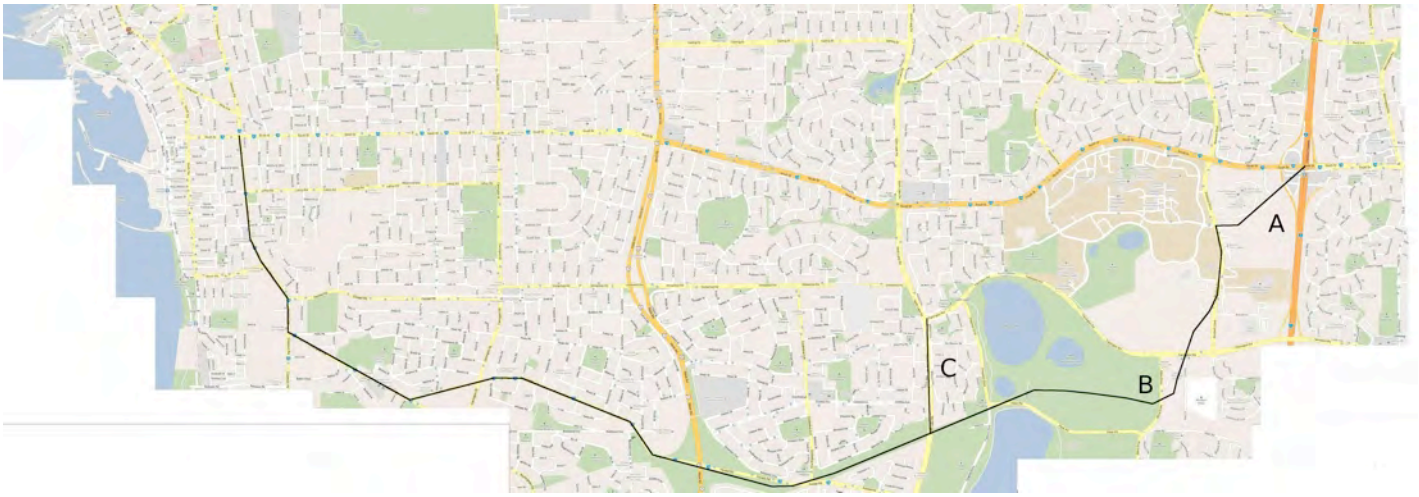
Several primary routes were identified, and divided into sections where appropriate to allow for a more comprehensive and flexible approach. The primary corridors identified were:

- Roe Hwy Reserve / Forrest Rd
- Winterfold Rd / Lefroy
- South St
- Garling St
- Leach Hwy
- Marmion St
- Canning Hwy

Route 1 - Roe Hwy / Forrest Rd - Black Line Description

This route begins with section 1A at the Murdoch train station, heading down Barry Marshall Avenue toward Murdoch Drive and the Murdoch Activity Centre. Section 1B then turns towards the Beeliar wetlands, passing through via the Roe Hwy reserve towards Stock Road before connecting and running along Forrest Rd, turning right on Cockburn Rd, connecting with Route 3 at the intersection with South St. Section 1C deviates from this course, connecting Route 1 and 2 along North Lake Rd. This route would be relatively simple and cheap to build (per km), due to an existing reservation. The environmental impact inherent in traversing the Beeliar wetlands pose a serious hurdle however.

Figure 1. Route 1



Route 2 - Winterfold Rd / Lefroy Rd - Yellow Line Description

This Route begins at the Murdoch Activity Centre (it is assumed section 1A would be included). Section 2A crosses Murdoch University along Discovery Wy, while section 2B heads north along Murdoch Dr towards South St. Section 2C also connects routes 2 and 3 via St Ives. Section 2D continues from St Ives to Farrington Rd, connecting to Winterfold Rd. After crossing Stock Rd, Section 2E turns right at Carrington st, before heading west along Lefroy Rd, towards South Tce, where Several routes converge on the approach to Fremantle. This line would anchor a community and provide transport links to several schools, but lacks visibility on main arterial roads and will be slower than other routes.

Figure 2. Routes 2 &3

Route 3 - South St - Red Line Description

Arguably the most direct route at approximately 11 km between terminals, this route begins with section 3A, departing from the current bus station on the South st freeway overpass to the Murdoch Dr intersection. Section 3B runs along the northern edge of Murdoch University, connecting with section 2C. Section 3C continues along South St to the North Lake Rd intersection, where the Kardinya Park shopping centre is located. Continuing until Stock Rd, section 3D is followed by section 3E, which extends until Hampden Rd. Section 3F marks the final approach to Fremantle along South Tce, shared by several routes. This route is both direct and very visible, as it traverses a main arterial road. However, the length of the route dictates that there is less potential riders within the catchment area.

Route 4 - Garling St Purple Line - Description

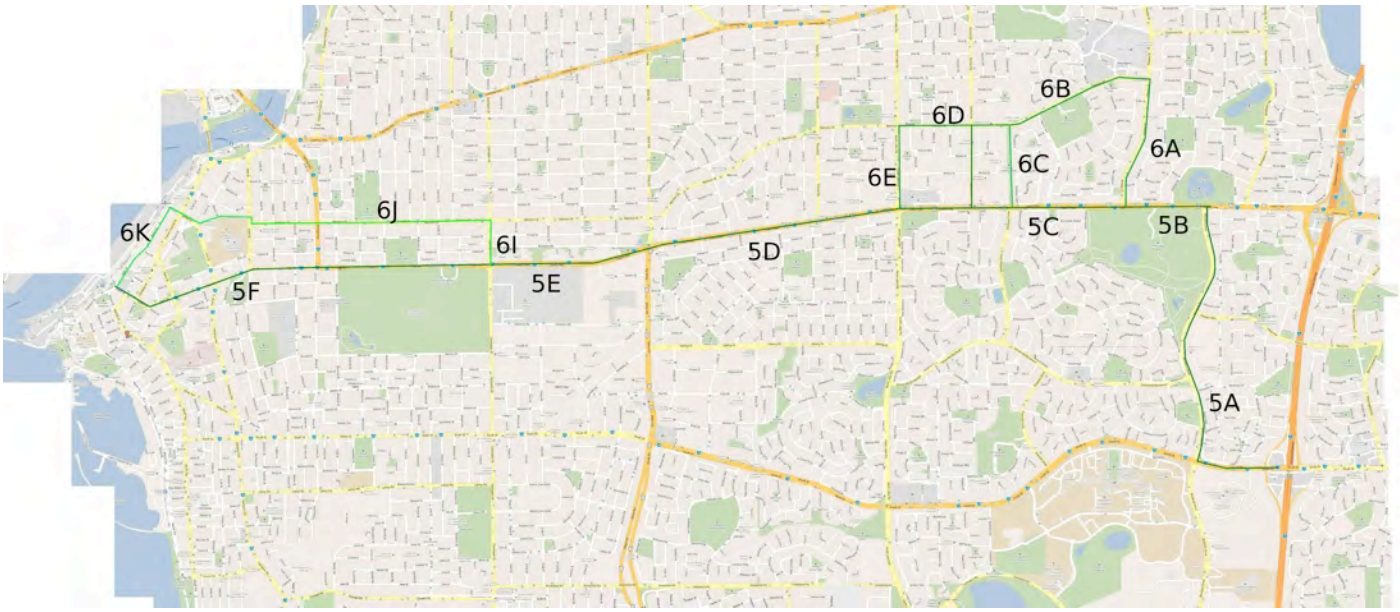
The main objective of this route is to supplement options provided by routes 3 and 5. Beginning at the South St/North Lake Rd intersection, Section 4A terminates at the intersection with Garling st. Section 4B continues along North Lake Rd to Leach Hwy and route 5. Section 4C leaves North Lake Rd along Garling St, turning north on Stock Rd past the Southern Coast Transit Bus depot to Leach Hwy and Route 5. This route provides a novel form of transport to an area relatively neglected by public transit, but significantly lengthens any route, and hence increases cost. The impact on locals also needs to be considered further.

Figure 3. Routes 4 & 6

Route 5 - Leach Hwy Dark Green Line - Description

This route also begins with section 5A at the Murdoch Dr/South St, heading north past corpus Christi College and Piney Lakes reserve to Leach Hwy. Section 5B traverses the northern boundary of Piney Lakes reserve to the intersection with Riseley St. Section 5C then continues west along Leach Hwy to the intersection with North Lake Rd and route 4. Section 5D connects North Lake Rd and Stock Rd via Leach Hwy, while section 5E terminates at Carrington St. Section 5F marks the final approach into Fremantle along High St. This route shares characteristics with route 3 but with a longer length, and correspondingly, a higher ridership and cost.

Figure 4. Routes 5 & 6



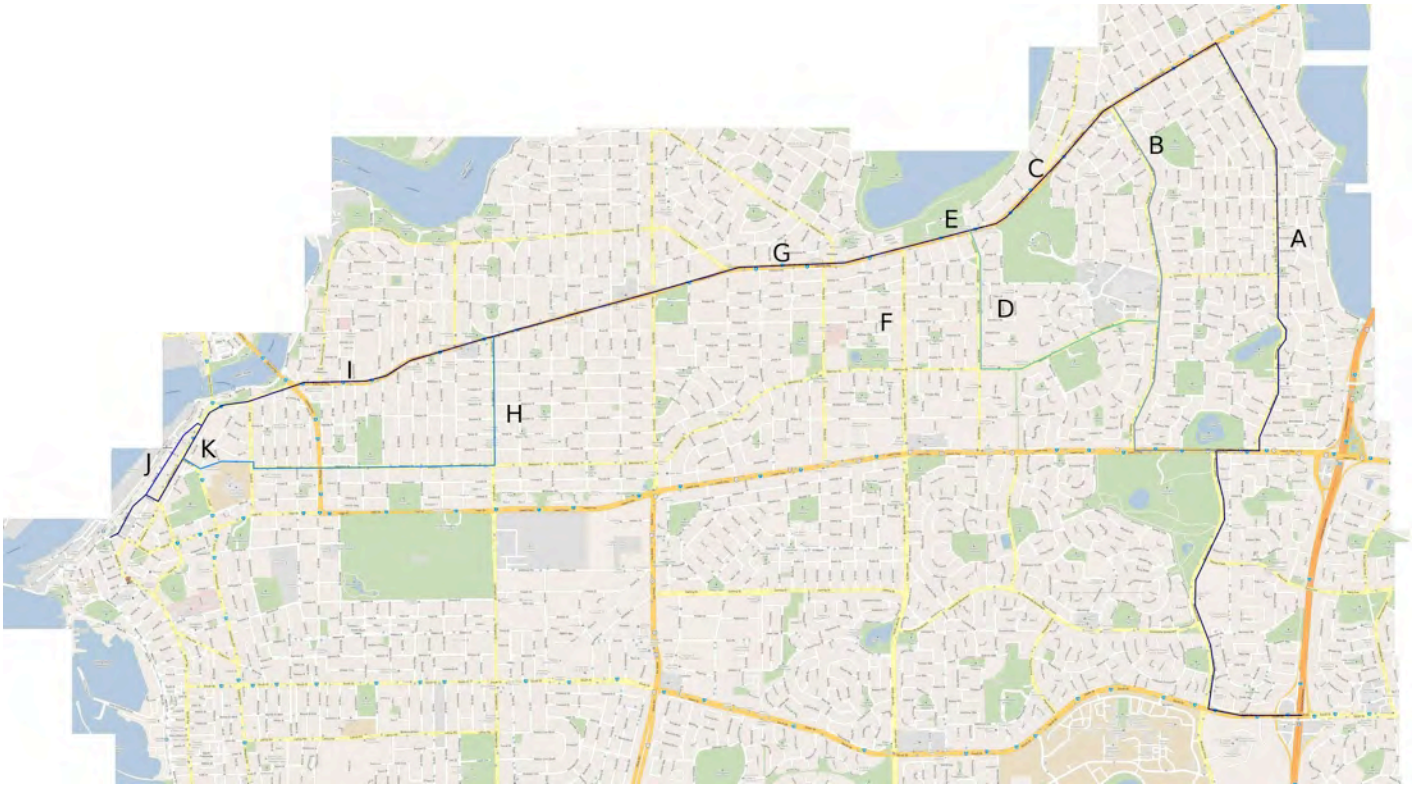
Route 6 - Marmion St - Light Green/Magenta Line - Description

This Route features several links between Marmion St and Leach Hwy, namely Riseley St, Robert Crawford Park, North Lake Rd, Stock Rd and Carrington St (designated sections 6A,C,E,G & I respectively). Section 6B runs from Riseley St along Marmion St to Robert Crawford park and the adjoining industrial area. Section 6D continues past through the industrial zone to North Lake Rd, where section 6F continues to Stock Rd. Section 6H then travels along Marmion st to Carrington st before section 6J heads towards Fremantle, past John Curtin college. Finally, section 6K runs parallel to the heavy rail line along Beach St towards Fremantle train station. This route links several major trip generators and would seem to be relatively simple to build, but will reduce the visibility of any route when compared to the nearby alternatives of Leach or Canning Hwy.

Route 7 - Canning Hwy - Dark Blue Line - Description

By far the longest route at almost 18 km (nearly 7 km longer than the South St option), this route features many options to connect to other routes. Starting at the Murdoch Dr/Leach Hwy intersection, section 7A runs the length of Reynolds Rd, turning Southwest along Canning Hwy until Riseley St. Section 7B connects canning Hwy to Marmion St along Riseley St. Section 7C continues along Canning Hwy from Riseley St to Norma Rd, where section 7D connects to route 6. Section 7E passes Tompkins park to North Lake Rd. Section 7F connects this intersection with route 6 (and by using section 6E, to route 5). Section 7G continues westward along Canning Hwy to Carrington St, where section 7H connects to routes 6 & 5. section 7I crosses Stirling Hwy, leaving 2 choices for the final corridor into Fremantle - either 7J, along Beach Rd to section 5K, or section 7K, which also joins 6K, but covers Queen Victoria St. This route would significantly add to the potential ridership and visibility of any route, but at a large cost. The reduced catchment on the northern side for parts of the route is also a concern.

Figure 5. Route 7



Feasibility

Introduction

As a rail-based form of mass transit (with correspondingly hefty loads), LRT favours relatively straight and flat corridors. Each of the potential routes were evaluated for Engineering Feasibility on a pass or fail basis. Design criteria were taken from the City of Fremantle (SKM) and Perth Light Rail Study (Maunsell/AECOM).

Table 1. Feasibility Criteria (SKM 2010)

Criteria	Preferred	Limit
Horizontal Turning Radius	150 metres	20 metres
Vertical Grade (< 250 metres)	6% or lower	8%
Vertical Grade (> 250 metres)	4% or lower	6%

Horizontal Turning Radius

The horizontal grades, or minimum turning circle represents the tightest corner the chosen LRT train could take. It must be noted that the train would need to slow down considerably to take this turn. Accordingly, routes with a minimal number of sharp turns should be favoured over meandering (and hence slower) routes.

Several intersections were shown to require land to be purchased, either publicly or privately owned, for LRT to travel (see Figure 1). While this can present challenges to any project, no heritage places were found to be affected, and so no route failed on this basis. Below is a list of intersections where parcels of land may need to be acquired.

Figure 6. Demonstration of tight corner. NE property would need to be resumed

Table 2. Intersections that will require further investigation or resumption of land

Corner of	And
Beach Rd	James St
Queen St	High St
Caning Hwy	Carrington St
Caning Hwy	Norma Rd
North Lake Rd	Marmion St
Robert Crawford	Marmion St
South Tce	South St
Stock Rd	Marmion St
Stock Rd	Garling St
Hampton Rd	South St
Lefroy Rd	Hampton Rd
Reynolds Rd	Canning Hwy

Vertical Grade

Light Rail capacity is heavily dependent on the corridor's vertical grade (and the length of that slope). Steeper slopes require smaller & more powerful trains, drastically reducing the capacity and financial potential of the line, as well as increasing the travel time. As a result, the maximum vertical grades in were assessed on a pass/fail basis. Sections 4C & 5F have been found to have a considerable grades, and will not be considered further

The eastern half of the study area is relatively flat, without any serious concerns. However, the approach towards Fremantle involves several large hills, particularly surrounding Stock Rd. The main arterial roads have already been graded for heavy haulage trucks and articulated buses, so should pose no great problems for Light Rail. Smaller roads have also been surveyed for any unsuitably steep gradients.

Table 3. Vertical Grade

Grade	Route Sections
Flat	1A, 1B, 2A, 2B, 2C, 3F, 5B, 6B, 6C, 6D, 6E, 6K, 7A, 7C, 7E, 7I, 7J, 7K
Minimal	1C, 2D, 3A, 3B, 4A, 4B, 5A, 5C, 6A, 6G, 6I, 7B, 7D, 7F
Moderate	2E, 3C, 3D, 3E, 5D, 6F, 6H, 6J, 7G, 7H
Considerable	4C, 5F

Table 4 is a list of road sections that have a vertical grade of at least 5%, and will need further assessment if they are to be considered.

Table 4. Road Sections for Further Investigation

Road	Between	And
Canning Hwy	Stock Rd	North Lake Rd
Canning Hwy	Stock Rd	Carrington St
Garling St	Stock Rd	North Lake Rd
High St	Parry St	East St
Leach Hwy	Stock Rd	Carrington St
Leach Hwy	Stock Rd	North Lake Rd
Lefroy St	Hampton Rd	Carrington St
Marmion St	Rome Rd	Carrington St
Reynolds Rd	Canning Ave	Queens Rd
South St	Stock Rd	North Lake Rd
South St	Caesar St	Carrington St
Winterfold Rd	Stock Rd	Carrington St
Winterfold Rd	Coolbellup Ave	North Lake Rd

Depot Locations

Light Rail Transit requires an area for maintenance and storage. Drawing from the Perth Light Rail Study (Maunsell & AECOM 2007), a line between Murdoch & Fremantle would need at least one depot, possibly a second, depending on future extensions of the line. An area of at approximately 110 metres by 120 metres is required, in the vicinity of one of the terminals. This represents a potential hurdle, as both terminals have scarce land suitable for such a terminal. As a well established area, Fremantle has minimal areas that could be considered suitable for a depot. However, the ability for a depot to act as a temporary 'cover' for environmentally hazardous areas unsuitable for other developments provides for several potential candidates. These areas contain residues (such as petroleum products) that make residential developments unsuitable. It must be noted that any potential route must pass a potential depot site. Some routes (3,5,7) lie on major thoroughfares, with little land available, and so may require a turnoff, with minor (<250m) rail extensions. A list of identified potential sites is listed in table 5.

Table 5. Potential Depot Sites & Relevant Routes

Depot Location	Relevant Route Sections
Garden City - Marmion / Riseley	6A,6B,7B
Garling / Bowen	4C
Stock / Sainsbury	4C
Stockdale / Peel	3E, 4C
Rockingham / Cockburn	1B
Norma / McCoy	6C,6D,7D
Farrington / Murdoch Drive	1B
Lefroy Rd (next to South Fremantle High School)	2E
Winterfold / Stock	2E

Redevelopment

Potential For Redevelopment

LRT has been shown to provide the impetus needed to spark urban redevelopment through improvements in accessibility and liveability (ACT Light Rail 2009), and is often used as the transit basis for TOD projects (Joshi et al 2006). In fact, the ability of LRT to spark this urban redevelopment is often employed as a method of funding transit projects - capturing the expected increase in taxes as a result of increased density can partially cover the initial capital costs. Private consortiums have more confidence developing near rail lines, due to the inherent permanence of the capital infrastructure (a rail line is much harder to move than a bus stop).

The characteristics of areas ripe for development - large parcels of land owned by limited parties, with ageing infrastructure but in a desirable area, applies to several precincts within the study area. These have been highlighted as targets for LRT service. It is expected that redevelopment will occur throughout the length of the corridor selected, but that these areas provide an initial boost to the fiscal responsibility and potential ridership of any LRT line. The Murdoch Activity Centre and surrounding developments have been excluded from consideration, as well as developments within the Fremantle CBD, as all lines will pass within 400m of these areas.

Transit Oriented Development

Transit Oriented Development (TOD) is the urban planning concept whereby districts are built around, and built to serve, mass public transport, generally by increasing density around transit and pedestrian thoroughfares (Adams 2009). This sort of development leads to an increase in mass transit use, and is a major focus in urban planning for Perth's future (WAPC 2010). The focus is on developing hubs, so as to reduce the need for traveling by car, by promoting pedestrian and transit modes of transport. Developments such as East Perth and Subiaco are the best examples of TOD in Perth so far (Renne 2007), but it is expected that these kind of sustainable developments will only increase in number and effectiveness in reducing the number of private automobile trips taken.

Consultation with Local Government

To ensure a truly comprehensive and collaborative approach, each of the three main local councils involved were consulted to identify potential areas for development, as well as ensure that TOD is a priority for all municipalities concerned

City of Melville

The City of Melville have released the Melville 2050 plan, providing a strong planning framework and direction for the area. In it, and after meeting with strategic urban planner Gavin Ponton several priorities and opportunities were identified.

The city (and it's residents share the view that simply widening lanes is not an effective transport option, and TOD has in principle support along main thoroughfares, such as Leach Highway and South Street. This is consistent with a planning study conducted in 2006 by Estill on behalf of the council, where residents themselves suggested a LRT route along Riseley st past Garden City Shopping Centre.

The intersection of Canning Highway and Riseley Street has recently been redeveloped, and could become a TOD anchor point. The Murdoch Activity Centre and Garden City were also identified as having significant potential to become TOD style areas.

Myaree has been identified as an expensive area for development, and not recommended as a potential depot site. Within the City of Melville, two areas have been determined as good potential candidates for depots: an area south of the MAC, on the intersection of Murdoch Drive and Farrington Road (subject to the Roe Stage 8 development) and south of Garden City, near the intersection of Riseley Street and Marmion Street

City of Fremantle

As an established area, Fremantle is relatively difficult to develop, and sites suitable for potential depots are a rarity. However, the local council is showing considerable foresight in recognising the need for infill development.

Recently, bureaucratic controls and regulations concerning the building of 'granny flat' style housing has been relaxed, allowing residents to construct multiple dwellings on single plots without the burden of council oversight. It is hoped that this will allow for an increase in density without the voter backlash typical of large scale developments.

Some sites outside the CBD have been distinguished as undeveloped. Recently the immediate area surrounding the intersection of Carrington Street and South Street have had the density limits increased, meaning the area is currently ripe for development. However, the overwhelming potential for TOD lies on the Cockburn Coast, and this should be considered when selecting an approach into the CBD, as track sharing may reap significant financial savings.

As mentioned previously, there are areas of the city that are considered environmentally hazardous, and hence economically unfeasible to develop for residential and commercial areas. It is these areas (such as adjacent to South Fremantle High School) that should be considered for temporary depots.

City of Cockburn

Although only a small portion of the study area, the City of Cockburn has the potential to lead the state in TOD planning and LRT implementation. Currently, the main LRT priority in Cockburn is the Cockburn Coast project, and opportunities for TOD reflect this. However, some areas along Clontarf Road are ripe for development.

As previously mentioned, the proposed Cockburn Coast LRT route should be considered in the routing of the final approach into the Fremantle CBD.

Table 6. Potential for development

Areas With Immediate Potential For Development	Nearby Route Sections
Carrington / South St	3D,3E,2E
Clontarf / Cockburn	1B
Wood / Knutsford	5F
Canning / Riseley	7A,7B,7C

Accessibility

Transport for the masses

Light rail provides transport options to members of society for whom conventional forms of transport such as automobiles remain out of reach. Groups such as students and the differently-abled rely on public transit for access to services (such as shopping and entertainment) across the city. By linking education institutions (such as Murdoch University and local high schools) and other trip generators with low floor vehicles, LRT can improve public access to services for all members of society.

LRT needs to be judged not only on the impact on society in general, but specifically the impact on disadvantaged sectors of Perth's population. In this way, LRT can be judged as a social good, and possibly open up new avenues for funding.

In Portland, Oregon, TriMet have actively worked to encourage bicycle use on their LRT network through the use of bicycle hooks and end of trip facilities. By encouraging the use of multiple modes of transit, authorities can greatly increase the catchment areas of any one mode. Coordinating services to encourage use of multiple modes of transit including bicycles should be considered a top priority.

The design and location of stations is critical to the success of Light Rail. Stations must be accessible for those with disabilities. Low floor vehicles enable stations to be built at a level close to kerb height, with small ramps to allow for wheelchair access. The need to integrate a station with its surrounds needs to be balanced with ensuring that stations are conspicuous enough to serve as a visual reminder of LRT. Pedestrian access to stations located within the median of arterial roads must be balanced with avoiding a traffic bottleneck on these important roads. While parking should not be considered as high a priority as heavy rail, pick up and drop off areas and a small number of parking bays should be considered. Stations should be located near trip generators, according to the principles of transit oriented development.

Speed vs. Placemaking

Speed

In order to attract rides, the speed of any LRT system needs to be comparable to other forms of transit. Current evidence suggests that many residents living south of Fremantle travel east to Murdoch train station rather than Fremantle, due to the difference in speeds of the two heavy rail lines. LRT offers an opportunity for commuters to use public transport for this eastward journey, rather than park their cars at the already straining Murdoch Park and Ride. To reduce both energy use and travel time, LRT will be given priority at intersections. Paul Zebell from TriMet in Portland, OR, explained in an interview how their system works: essentially a communication system is established between intersections and LRVs, allowing intersections to anticipate incoming LRVs and alter signals appropriately. This ensures that intersections are clear, and LRVs can pass through unobstructed, without needing to slow down (and hence wasting energy). If LRVs are given an exclusive right of way, speeds of up to 130 km/hr are achievable, only stopping for stations. Table 7 lists the expected time taken to travel the entire length of each respective route. For more information, please refer to Appendix.

Table 7. Speed of Sections

Route	Travel Time	Rating
1	28.59	2nd
2	39.08	4th
3	26.01	1st
4	5.21	-
5	33.48	3rd
6	22.71	-
7	42.29	5th

Placemaking

It has been well documented that LRT has the ability to 'anchor' a community, and become a catalyst for renewal. In order to optimise this effect, potential corridors should emphasise legibility and overall visibility within a community.

However, this need for 'placemaking' must be reasoned with a need to provide a fast, efficient service. Light rail (and public transport in general) must be comparable in time cost compared to private automobile use (REFERENCE). The future speed of lines can be estimated using the length of track, predicted placement of stations and mode of travel (with traffic or exclusive right of way). It is expected that future LRT lines will utilise predictive technology to avoid time delays at traffic intersections, similar to that currently in use in cities such as Portland, Oregon. Indeed, transport planners in Zurich, Switzerland found that giving priority to LRT increased the ridership, as a passing LRV served as a visual reminder of the potential of transit (Thomas 2002).

Table 8. Areas of high potential for placemaking

Area	Applicable Route
Canning Hwy / Riseley St	7A,7B
Discovery Dr	2A
Winterfold Rd / Carrington St	2E
Barry Marshall Ave	All
Marmion St / Carrington St	6H,6I,7H
Beach St / James St	6K,7J

Legibility

The legibility, or visibility of a route is also an important factor to be accounted for in routing decisions. Essentially this boils down to the ratio of main arterial versus residential road traversed. Therefore, there will be a high correlation with the speed of the routes, and the relative evaluation is considered identical.

Table 9. Legibility

Legibility	Route Sections
Main Road	1B,1C,3A,3B,3C,3D,3E,4A,4B,5B,5C, 5D,5E,7B,7C,7E,7G,7I
Busy Residential/Commercial	1A,2B,2D,3F,4C,5A,5F,6A,6B,6D,6E,6F, 6G,6H,6I,6K,7D,7F,7H,7J,7K
Quiet Residential/Commercial	2A,2C,2E,6C,6J,7A

Trip Generators

Definition

Trip generators are destinations that draw large populations to their centres and hence represent an opportunity for significant ridership on any potential LRT corridor. Therefore, any transit corridor must attempt to capture as many trip generators as possible from a variety of sources to ensure a consistently high patronage.

Description

The Murdoch train station on the Southern Suburbs rail line is currently the 2nd busiest station in Perth, with 9,500 boardings per day. Combined with the expanding St John of God Murdoch / Fiona Stanley Hospital complex, the Murdoch Activity Centre and Murdoch University, the imperative to adequately service this area with a mid tier public transport option is obvious. The Directions 2031 report has appropriately named Murdoch as a major Activity Centre, meaning surrounding areas will be encouraged to increase both commercial and residential densities, according to the principles of TOD.

The City of Fremantle contains a multitude of trip generators, ranging from Notre Dame University and John Curtin College to the cappuccino strip and shopping malls. The current parking problems (that will no doubt worsen with time) mean that a public transport alternative will be required to improve accessibility for the growing number of visitors looking to explore the historic port city.

Shopping centres have a distinct advantage as trip generators, as shoppers typically travel outside of peak periods. While Australians are not as enthusiastic as Europeans about using public transport for shopping trips, these attitudes are beginning to change. Accordingly, a LRT line should pass a shopping centre, preferably closer to the Murdoch terminus as the Fremantle CBD has ample shopping opportunities.

Located in Booragoon on Riseley St, Garden City shopping centre is a 'big box' style retail destination, offering shoppers a multitude of stores to choose from. Comprising of several supermarkets, a cinema complex and an array of speciality shops, Garden City is the largest and most popular single shopping destination in the Southwest area. The Hamilton Hill IGA is the largest store in a small group of shops located at the intersection of Carrington St and Winterfold Rd. Although not a significant destination compared to Garden City or others, by it's own estimates, it attracts several thousand shoppers a day on weekends. Several shopping centres are located along North Lake Road, on both South Street and Leach Highway, and these should also be considered. Essentially, the only route not to pass any shopping centres is Route 1. All sizeable shopping centres outside the Fremantle CBD were asked to participate in the study and submit estimated patronage, although many did not (or could not) respond.

Schools can also be considered limited trip generators. For the purposes of this study, all schools in the study area were assessed, although only large high schools were considered on the basis of the relative independence of the students.

The concentration of reasonably sized high schools around Murdoch University needs to be considered, and routing LRT along Discovery Way should sufficiently 'capture' these students. Other important schools to consider include Applecross adjacent to Garden City Shopping Centre, and Melville, along Leach Highway.

Table 10. Trip Generators and Applicable Routes

Trip Generator	Size (if known)	Applicable Routes
Murdoch Train Station / Fiona Stanley Hospital Complex	9500	All
Murdoch Activity Centre		All
Eastern Precinct		All
Murdoch University	19000 (total)	All
Fremantle Train Station		All
City of Fremantle		All
Notre Dame University	5500	All
Applecross Senior High School	1300	7B
Garden City		6A,6B,7B
CBC	800	5F,6J,7K
John Curtin College of the Arts	1050	5F,6J,7K
Melville Senior High School	1000	5D,6F
Corpus Christi	1360	5A
North Lake Shopping Centre		4B,5C
Fremantle Hospital	~1000	3F
Kardinya Park		3C,4A
Hamilton Hill IGA	1000-2000	2E
Challenger TAFE (Lefroy Rd Campus)		2E
St Ives / Murdoch Village	1100	2A,2B
Winthrop Baptist College	680	2A

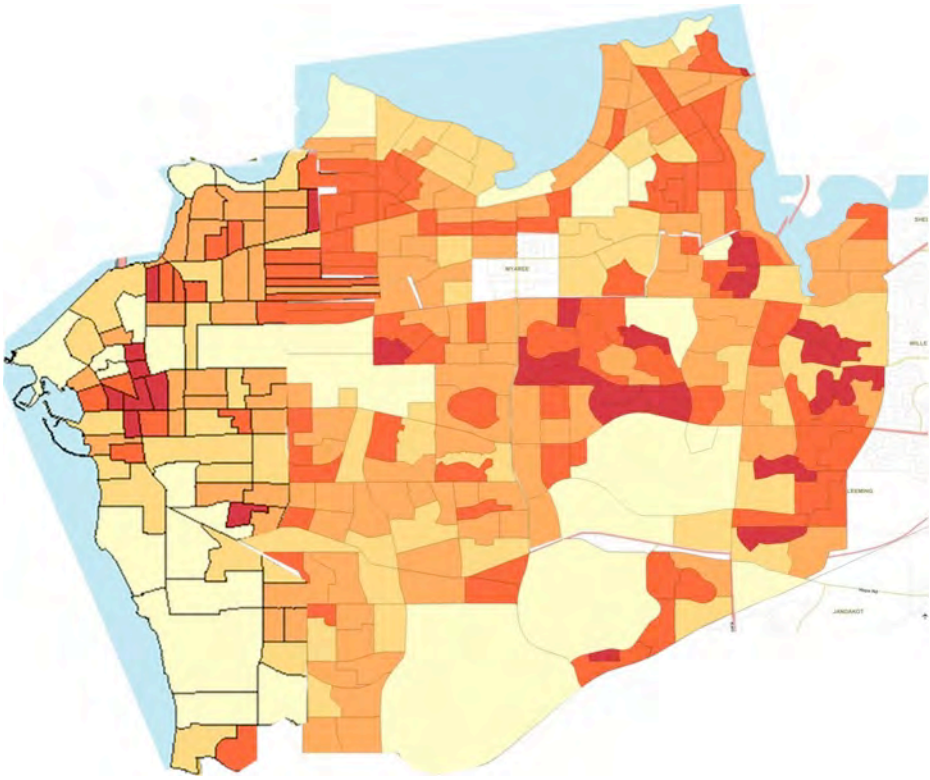
Ridership

Introduction

The most critical component in determining the viability of any LRT line is the ridership, or the predicted popularity and usage (Joshi et al 2006). A LRT line is considered justified when expected ridership exceeds 10,000 passengers per day, within the accepted 8-21,000 that would be needed to significantly contribute to the operating costs of the line (Ginn 1998). While this level of patronage will not mean the line is financially self-sufficient, it will be cost competitive with road transport, insofar as Western Australia has no toll roads, and therefore no financially self-supported roads.

Prediction Rationale & Method

Expected ridership was calculated using population data from the 2006 census conducted by the Australian Bureau of Statistics. From population densities taken at a collection district level, and accounting for local population increases (also provided by ABS) an approximate number of residents within 400m of each line could be calculated. Adding expected riders traveling to trip generators, and using the expected % share of transit in Perth (Department of Transport 2011), the number of potential riders along a line can be calculated. The 'sparks' effect (the unexplained higher level of patronage for rail based transit over other forms) is also accounted for.



NB: trip generators where the size could not be determined have been excluded. Therefore, these results represent the ***minimum*** expected ridership. In reality, it is expected that the connection to the Fremantle CBD will ensure that most lines 'capture' sufficient riders. Employment numbers, where available, were included. However, these details are not often recorded or published, and so often have not been accounted for. It is stressed that more investigation is required in this area.

For more detail, a spreadsheet is available online from the South West Group website with embedded formulae. Routes 4 and 6 do not include Murdoch trip generators as they are intended as 'option extenders' for other routes.

Table 11. Predicted Ridership

Route	Predicted Ridership
1	6374
2	7076
3	6883
4	240
5	7081
6	2612
7	9461

Cost

The total cost (capital and operating) were estimated using data and research from several studies, both in Perth and around the world (Department of Transport 2011; Maunsell & AECOM 2007; Parsons Brinckerhoff 2009; Gunduz 2011 amongst others). It must be stressed that the data used in the study is expressed to be used as a rough indicator only, and hence is not used to pass/fail any potential routes.

The critical component in determining the cost of LRT is the level of the guideway - either below ground (subway), at grade (either shared running with traffic or exclusive ROW), or elevated (as seen in Vancouver). Running LRT at grade produces significant cost savings (Parsons Brinckerhoff 2009), and is feasible across most routes. Hence, running LRT above or below grade will not be considered further.

Therefore, the most significant cost factor in this study is simply the length of the respective routes (Gunduz 2011). The costs of trackway (per km) are assumed to be similar for all sections. According to the US Federal Transit Administration (2005), prices have not experienced any great fluctuations in price over the last few decades, and so comparisons can be made from lines constructed some time ago with some confidence (assuming CPI changes have been accounted for). In order to guarantee service frequency, longer routes would require more vehicles, incurring a greater rolling stock and operating cost. The assumptions are: an average speed of 50 km/hr for street running and 100 km/hr in exclusive right-of-ways with 2 minute delays at stations, and 5 minute turnaround at terminals. This is a conservative estimate based on data from similar systems around the world, but will be used to calculate the maximum necessary number of vehicles required to ensure a peak service frequency of 10 minutes.

A study by Professor Alan Hoback (2007) (available at: http://eng-sci.udmercy.edu/programs/eng/civil-environmental/research/transit-research/index.htm) resulted in an accurate methodology and spreadsheet calculator that has been proven to estimate costs on average within +/-6%. This research is continuing and utilising more data is expected to further improve this accuracy. As around 85% of costs involved are local costs, and the study uses cost of living comparisons between US cities, an appropriate scaling factor was applied for Perth, taking the base year as 2011. The results: $ 49.9 million/km for in-road construction, $24.95 million/km for median/exclusive ROW construction, and $4 million per LRV.

This is in stark contrast to predicted figures of up to $20 million/km released by Bombardier (Maunsell & AECOM 2007) based on experience in Melbourne and Adelaide. It is believed that the difference in these results may be attributed to the high cost of living index for Perth, and that in-street construction in the Hoback study usually was located within the CBD of the selected city. The Bombardier estimates would also need to take into account depot costs, etc.

Table 12. Estimated Costs

Route	Length (km)	# Vehicles	Estimated Cost (Hoback)	Estimated Cost (Bombardier)
1	13.56	7	$578,641,227.00	$299,200,000.00
2	11.95	9	$618,776,102.00	$275,000,000.00
3	11.11	7	$387,953,506.00	$250,200,000.00
4	1.01	3	$68,453,433.00	$32,200,000.00
5	12.44	8	$462,018,197.00	$280,800,000.00
6	7.25	6	$406,983,362.00	$169,000,000.00
7	17.74	10	$676,230,173.00	$394,800,000.00

This cost cannot be assessed on it's own, but as a comparative cost. The expected restructuring of bus services could produce significant savings, and savings generated by averting additional road construction costs should also be considered.

The expected costs of route sections are available online from the South West Group. For a more detailed investigation in the trend of LRT capital and operating costs, see the Federal Transit Administration (2005) report.

Environmental Impact & Heritage

Environmental Impact

Although LRT may be a more environmentally beneficial form of transport than the automobile, the construction of the transit corridor can have a considerable effect on the environment. Accordingly, a windshield study was completed, and each route option was assessed according to the potential for impact on the environment.

Most routes involve simply altering existing road reserved, with a minimal or almost non existent effect on the environment. The distinction between the two categories lies in the removal of some mature trees on the edges of the road reserve, or on the island on dual carriageway sections. Aboriginal burial remains have been discovered in the bushland located in the Southwest corner of the Murdoch drive/South street intersection. While resumption of this land is not expected, it must remain foremost in consideration of any potential LRT corridor, particularly section 2B.

Moderate effects on the environment include an expected resumption of small parcels of bushland, or large numbers of trees on road reserves.

2 route sections are considered to have potentially considerable environmental consequences. Section 1B not only passes bushland in the Southeast corner of Murdoch University, but also passes through the Beeliar wetlands. The Beeliar wetlands are a rich and diverse chain of natural preserves, and contain several protected species such as the Quenda (Isodon obesulus fusciventer) and Carnaby's Black Cockatoo (Calyptorhynchus latirostris) (DPI 2007).

While the Roe hwy extension is expected to continue, the expansion of the road reserve required to accommodate LRT has probably not been considered. This option is strongly recommended against without a thorough Environmental Impact Assessment.

Section 6C passes through Robert Crawford park, and would involve the resumption of the park, and potentially some private land. The noise and environmental impact is outweighed by the potential benefits of the route option. As a result, section 6C will not be considered further in the study.

Table 13. Environmental Impact of Routes

Impact Level	Routes
Negligible Impact	1A, 2A, 2C, 3A, 3B, 3F, 4A, 4B, 5F, 6A, 6B, 6D, 6E, 6G, GI, GK, 7D, 7F, 7H, 7J, 7K
Minimal Impact	2B, 2D, 2E, 3C, 4C, 5A, 5B, 5E, 6F, 6H, 6J, 7A, 7B, 7I
Moderate Impact	1C, 3D, 3E, 5C, 5D, 7C, 7E, 7G
Considerable Impact	1B, 6C

Heritage

The south west metro area is home to a significant proportion of culturally and historically significant buildings, landmarks and places. While LRT is important for the future of Perth, it doesn't have to be at the expense of the past (In fact, LRT can be a visual reminder of Perth's enviable tram history).

A comparison between potential routes and heritage lists of place, buildings and landmarks in the study area shows no significant heritage impact. This was to be expected, as LRT is not expected to require an expansion of road reserves in sensitive areas. The majority of track to be laid will be within the road reserve on major roads with little heritage value. It must be noted that this comparison did not include the southern approach to Fremantle station, as the heritage issues associated with this area have already been partially addressed in the SKM corridor study, and further assessment will be completed during the course of the Cockburn Coast LRT study.

No heritage places were found to be on tight corners where land may have to be resumed (such as South tce / Lefroy).

Within the Fremantle CBD, significant heritage value combined with tight clearances would require further investigation. LRT carriages could be propelled using induction/third rail power or batteries, as this would avoid the need for overhead catenary poles and similar infrastructure.

Future Work

This report only begins to scratch the surface of the work required, and the following gives an indicator of the required direction of future work:

• Most of the work in this study has been at a high, or conceptual level. Therefore, most sections require further and more focused work to confirm and clarify the rationales and decisions made. The Downtown Dallas or Perth Light Rail Study both provide good examples of more advanced studies.

• The study area represents only a part of metropolitan Perth, and as such, the findings within this report need to be integrated into a city-wide vision for transit such as 'Light Rail for Perth' or the Department of Transport's 2031 plan

• Further investigation is needed to establish

• Strategic relationships are critical to the success of multidimensional projects like these. Accordingly, effort needs to be made to include all stakeholders in future discussions and planning processes

• LRT operates most efficiently within a legislative and community framework that restricts car use while promoting transit use. Effort needs to be made in the political arena to alter transport priorities, and encourage density increases with the existing metropolitan area.

• Considerable further investigation is needed in costing a LRT line in Perth. It is expected that more advanced proposed lines will yield hard data that will improve the reliability of such estimates.

• Additional effort needs to be made to raise the public awareness of the potential of LRT and shift public perceptions towards transit.

Conclusions

Cities across the globe are embracing Light Rail Transit, or LRT, as a solution for rapid transit over small distances. By occupying a space between local bus and heavy rail services, LRT can significantly contribute to the future transportation mix in Perth. Taking into consideration the future direction of planning in Western Australia as outlined in the Directions 2031 report, an increase in density in the study area is expected. With proper planning and investment, this increase can be accommodated in attractive and functional Transit Oriented Developments, encouraging higher public transport use. By anchoring these communities with LRT, Perth can slow the rapid widening and expansion of roads built to carry more users further each day.

This report has identified and investigated several potential LRT corridors between the Murdoch and Fremantle train stations. Each route have been evaluated according to different criteria (listed in Table 14), and ranked accordingly. In deference to LRT's ability to serve different interests according to the desires of planners, corridors are rated according to each criteria, not overall.

Table 14. Recommended Routes

Rationale	1st Recommended Route	2nd Recommended Route
Cost	3	5
Environmental Impact	2	3
Feasibility	1	5/6
Legibility	3	5
Placemaking	2	6/7
Ridership	7	2
Speed	3	1
Trip Generators	5/6	2
Urban Renewal	3	7

While it is not the intention of this report to recommend a particular route, it would appear that a combination of both routes 2 and 3 would be an optimal solution. This route would run from Fiona Stanley Hospital (down Barry Marshall avenue) to South street via Discovery drive. It would then follow South st, before connecting with the proposed Cockburn Coast LRT line, heading into Fremantle. Passing most trip generators, and several already high density areas, this route would capture a significant ridership. Opportunities for Transit Oriented Development (TOD) exist surrounding Carrington street, as well as the Murdoch Activity Centre and Eastern Precinct near the Murdoch terminus, and such options can help raise capital to fund the line itself. By utilising an existing thoroughfare (South street), environmental damage is minimised and a rapid service is ensured.

Bibliography

ACT Light Rail 2009, 'Solution assessment', Proposal submitted to Infrastructure Australia. pp 46-68.

Adams, R 2009, Transforming Australian Cities for a More Financially Viable and Sustainable Future, City of Melbourne & Department of Transport, Melbourne.

Australian Conservation Foundation 2009, Investing in Sustainable Transport: Our clean, Green Transport Future.

Cohen-Blankshtain, G & Feitelson, E 2011, 'Light rail routing: do goals matter?' Transportation, vol. 38, pp 343-361. Available from: Springer Science+Business [7 April 2011].

Committee for Perth 2011, What we thought would kill us: The Evolution of Perth's Passenger Rail, Available from: [13 June 2011].

Curtis, C & Sheurer, J 2009, Network City Activity Centres: Developing an analysis, conception and communication tool for integrated land use and transport planning in the Perth metropolitan area, Curtin University Sustainability Policy Institute, Fremantle.

DART 2010, Downtown Dallas Transit Study Dallas CBD AA/DEIS, Federal Transit Administration, Dallas.

De Bruijn, H & Veenman, W 2009, 'Decision making for light rail' Transport Research Part A, vol. 43, pp 349-359. Available from: Elsevier [7 April 2011].

Department of Transport 2011, Public Transport for Perth in 2031: Mapping out the Future for Perth's Public Transport Network, Available from www.transport.wa.gov.au .

DPI 2007, Murdoch Activity Centre Structure Plan: Part A- Fiona Stanley Hospital and Health Precinct, Department for Planning and Infrastructure & the Department of Health, Perth.

Dueker, KJ & Bianco, MJ 1999, 'Light Rail Transit Impacts in Portland: The First Ten Years', Presented at the seventy-eighth annual meeting of the Transportation Research Board, Washington D.C.

Estill 2006, Dialogue with the City of Melville (Melville Visions): Community Consultation Report, Available from the City of Melville, Perth.

Federal Transit Administration 2005, *Analysis of Cost Elements and Their Effect on Operating Elements.* Available from: www.utrc2.org/research/assets/107/utrc-2005-fta1.pdf [22 September 2011].

Ginn, S 1998, An overview of light rail technology and its potential within an australian environment, Western Australian Planning Commission, Perth.

Gunduz, M, Ugur, LO & Ozturk, E 2011, 'Parametric cost estimation system for light rail transit and metro trackworks' Expert Systems with Applications, vol 38, pp 2873-2877.

Hoback, A 2007, *Sensitivity Analysis of Light Rail Transit Unit Capital Costs.* Available from: eng-sci.udmercy.edu/programs/eng/civil.../research/.../08-0024.pdf [22 September 2011].

Joshi, H, Guhathakurta, Konjevod, G, Crittenden, J & Li, K 2006, 'Simulating the effect of light rail on urban growth in Phoenix: An application of the UrbanSim modeling environment', Journal of Urban Technology, vol. 13, no. 2 pp 91-111.

Manning, I 1984, Beyond Walking Distance - The gains from speed in Australian urban travel, Australian National University, Canberra.

Maunsell & AECOM 2007, Perth Light Rail Study: Feasibility Study for a Light Rail Alignment between Subiaco and East Perth, Available from the Western Australian Department for Planning and Infrastructure, [5 May 2011].

Parsons Brinckerhoff 2006, Ipswich to Springfield Transport Corridor Study, Queensland Transport & Ipswich City Council.

Parsons Brinckerhoff 2009, Alternatives Development and Alignment Screening Report, Dallas Area Rapid Transit

Parsons Brinckerhoff 2010, Stirling tram feasibility study - Preliminary patronage estimates, City of Stirling, Available from: [29 March 2011].

Parsons Brinckerhoff, KPMG, APD & Steer Davies Gleave 2004, Gold Coast Light Rail: Feasibility Study [DRAFT], Gold Coast City Council, Australian and Queensland Governments.

Renne, JL 2007, Measuring the Performance of Transit-Oriented Developments in Western Australia, Planning and Transport Research Centre & Institute for Sustainability and Technology Policy (Murdoch University), Available from the Western Australian Department for Planning and Infrastructure.

SKM 2010, Transit Corridor Alignment Study, City of Fremantle, [29 March 2011].

Stokes, RJ, MacDonald, J & Ridgeway, G 2008, 'Estimating the effects of light rail on health care costs' *Health & Place,* vol. 14, pp. 45-58.

Thomas, L 2002, Light Rail for Perth. Honours Thesis, Murdoch University.

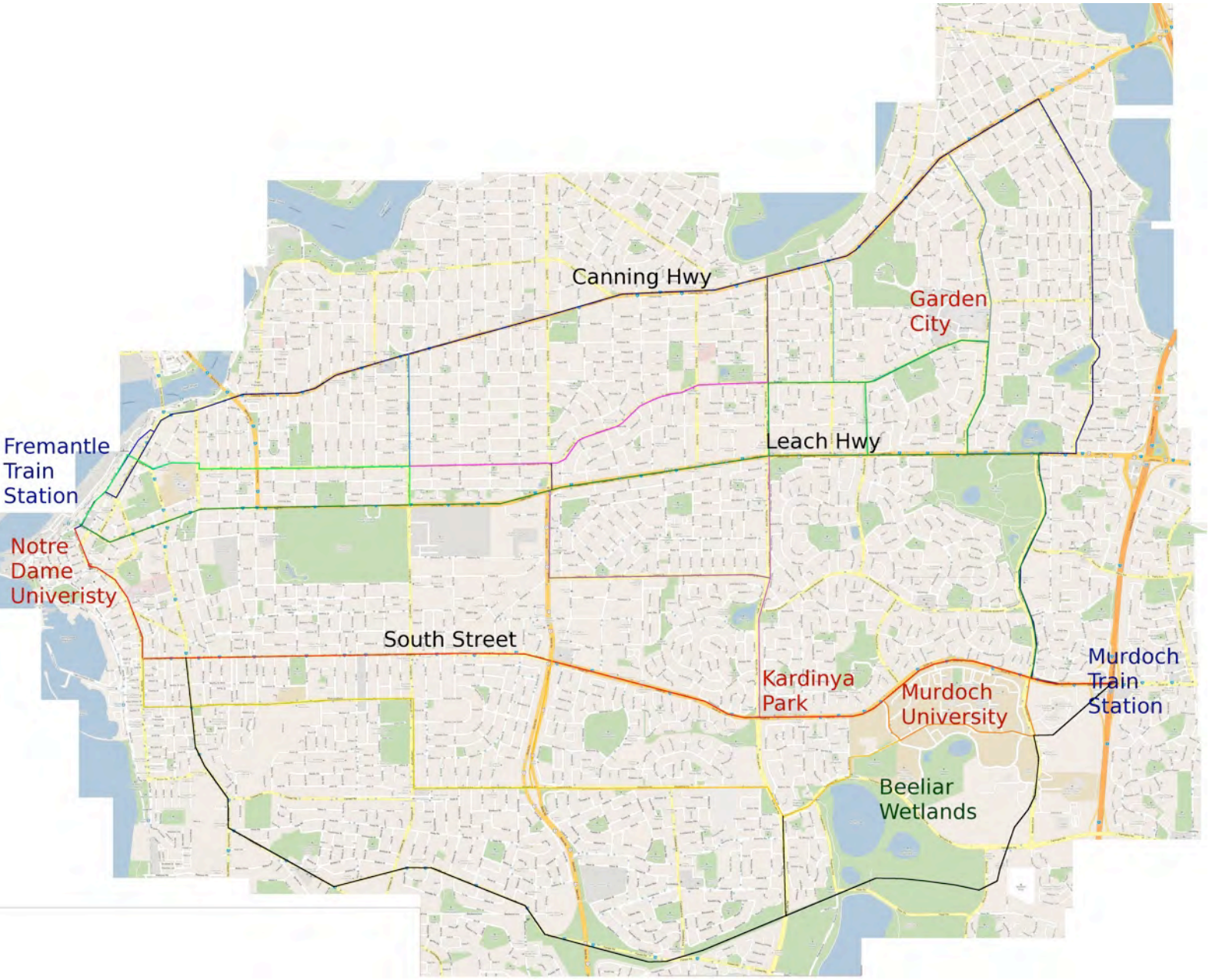
Thompson, GL 2007, 'Taming the Neighborhood Revolution: Planners, Power Brokers and the Birth of Neotraditionalism in Portland, Oregon', Journal of Planning History, vol. 6, no. 3, pp214-247. Available from: http://jph.sagepub.com/content/6/3/214 [1 July 2011].

Trubka R, Newman P & Blisborough, D 2008, Assessing the Costs of Alternative Development Paths in Australian Cities, Curtin University Sustainability Policy Institute and Parsons Brinckerhoff, Fremantle.

WAPC 2006, Development Control Policy 1.6: Planning to Support Transit Use and Transit Oriented Development, Available from the Western Australian Planning Commission, Perth.

WAPC 2010, Directions 2031 and beyond: metropolitan planning beyond the horizon. Available from Department of Planning & Infrastructure [31st March 2011]

Appendix A: Map



SOUTH WEST METROPOLITAN REGION

OUR PUBLIC TRANSPORT FUTURE

Draft Paper for Discussion Purposes

25 June 2013

June 2013

EXECUTIVE SUMMARY

Our Public Transport Future seeks to create a vision for the transport network in 2031 for the South West Metropolitan Region.

The vision is aspirational and seeks to communicate what is possible within the region.

The State Government's draft Public Transport Network Plan for Perth 2031 (Department of Transport, 2011) anticipates Perth's population growth generating a 33% increase in personal travel from 5.8 to 7.7 million trips per day by 2031. Public transport patronage will increase by 120% to 760,000 trips per day in the next 20 years.

The Plan proposes a three tier network of services:

- Tier 1 - Trains as the primary mass transit service
- Tier 2 - Road based "rapid transit services"
- Tier 3 - Regular bus services – local coverage and feeder services to main transport spines.

Our Public Transport Future outlines elements of the three tiers in terms of opportunities and constraints by proposing how the South West Metropolitan Region should collaborate with the State Government in planning and implementation of the public transport network, advocate on the circumstances for adopting and advancing the network in the region and identify and promote opportunities for attracting users to public transport.

The elements of transition to *Our Public Transport Future* are proposed as follows:

- Identify transit priority routes
- Engage with current activity on planning the Thornlie-Canning Vale-Glen Iris-Cockburn Central Rail Line
- Promote discussion and understanding of new transport technology
- Work to progressively improve intermodal functionality at major rail stations
- Seek a firm timetable for new rail stations such as Karnup
- Explore opportunities for partnerships with the private sector for linking major public transport routes to industrial areas with Cat Type Services
- Support trials of new transport technology within the South West Metropolitan Region

POLICY AND CONTEXT

Our Public Transport Future seeks to create a vision for the transport network in 2031 for the South West Metropolitan Region ***taking into account emerging trends, technologies and opportunities***.

The vision is an aspirational one and seeks to communicate what is possible within the region if we place priority on developing high quality, high frequency transport systems that have universal access and are integrated with walking and cycling.

The policy objective is to improve regional amenity, productivity, affordability and sustainability by developing a high quality public transport network that functions to improve accessibility within and across the region. This will inevitably get a greater proportion of passenger transport trips onto public transport and support initiatives for affordable living and local employment. This will increase the efficiency of use of existing road space for passenger and freight transport, accommodate population and freight growth as much as possible on existing road infrastructure and reduce social and environmental costs to society.

The South West Group has set a target of 30% of all trips on public transport by 2031 in implementing the objectives of Directions 2031.

The projected avoidable costs of congestion on roads in the Perth metropolitan area will increase by 70% in the 10 years to 2020.[1]

A separate paper will discuss the need for greater investment in public transport in the South West Metropolitan Region.

CURRENT PUBLIC TRANSPORT NETWORK AND SERVICES

The State Government's draft Public Transport Network Plan[2] anticipates Perth's population growth generating a 33% increase in personal travel from 5.8 to 7.7 million trips per day by 2031.

By 2031 public transport will account for one-in-eight of all motorised trips (currently one-in-fourteen); one-in-five motorised trips in the morning peak (currently one-in-eight); over 30% of peak hour distance travelled (currently around 20%); and nearly 70% of all trips to the CBD (currently around 47%).

Public transport patronage will increase by 120% to 760,000 trips per day in the next 20 years. The vision is for access to the CBD and Strategic Centres to be predominantly by mass transit.

Currently (2011/12) there are 144.1 million passenger trips on public transport each year in Perth with 80.6 million trips on buses and 60.3 million on trains. The public transport demand has increased from 100.9 million passenger trips in 2006/07 representing a 42.8% increase

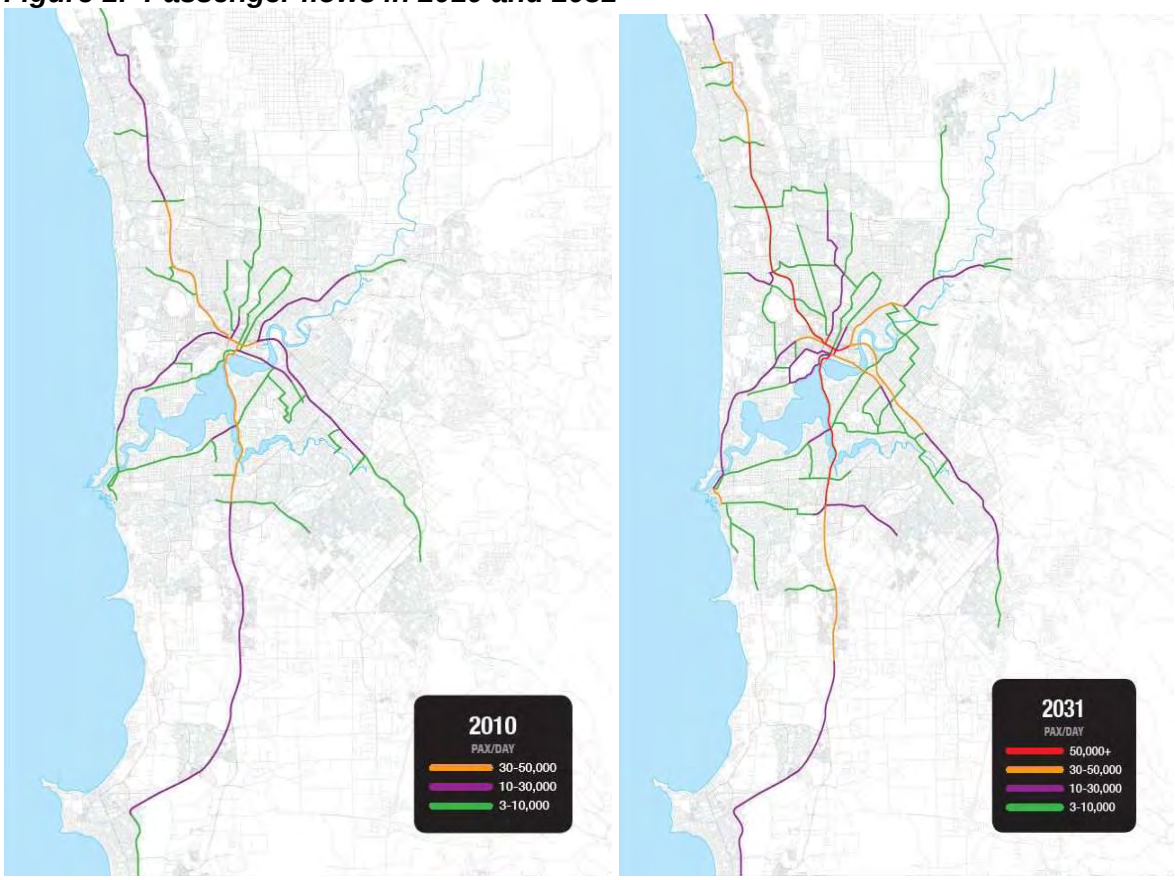
[1] BTRE, 2007, Estimating urban traffic and congestion cost trends for Australian cities: Working paper 71, BTRE, Canberra ACT.

[2] Department of Transport, 2011, Public Transport for Perth in 2031, Draft for Consultation. http://www.transport.wa.gov.au/mediaFiles/ABOUT_P_PT_Plan2031.pdf

in 5 years. This rapid increase has placed pressure on the public transport network, particularly during the morning peak.

The figure below show the current passenger flows on key transit routes in 2010 and as projected for 2031.

Figure 1: Passenger flows in 2010 and 2031



This provides the context for considering *Our Public Transport Future* in the South West Metropolitan Region.

The South West Group Board has set a target of 30% of Journeys on Public Transport by 2030 as part of an integrated land use and transport plan linked to the implementation of activity centres, greater housing diversity and greater housing density under Directions 2031.

FUTURE SCENARIOS

The draft Public Transport Network Plan proposes a three tier network of services:

1. Trains – Primary mass transit service
2. Road based "rapid transit services"
    - Frequent services operating all day
    - Full priority over general traffic
    - Functional stations up to up to 1 km apart
    - Legible network – easy to understand
    - Larger capacity vehicles

- Convenient interchanges for transfers

3. Regular bus services – local coverage and feeder services to main transport spines

It is likely that the most effective and efficient future public transport system operating in the South West Metropolitan Region will require a combination of a network of services.

The network of services should be flexible and able to adapt to behaviour changes on then use of public transport, changes in land use and major developments, growth in population and establishment of employment centres as well as providing linkages between activity centres and employment zones.

Tier 1 - Heavy Rail

The electrification of the rail and the extension of the system with the Perth – Mandurah line demonstrated the attraction of clean, reliable and efficient passenger rail services for commuters and off-peak users. They provide high volume passenger transport capacity on the route and rely heavily on direct access or feeder services.

Heavy rail becomes a challenge when the residential population is dispersed over low density urban development or the line is remote from employment centres.

Concentrating higher density residential and employment centres on or close to rail lines should be an aspiration in deriving greater benefit from heavy rail investment and services.

The Western Australian Government has committed to building new rail stations at Aubin Grove (by 2016) and Karnup. By 2031 it is expected that there will be another two stations on the Southern Suburbs line.

The rolling stock are likely to be 9 car sets operating on a three minute headway from Cockburn Central to Perth and with 9 car sets operating on a nine to twelve minute headway from Mandurah to Cockburn Central.

A heavy rail link will have been made from Cockburn Central to the Perth Airport via Glen Iris, Canning Vale, Thornlie and Cannington.

The Canning Bridge rail station will have been relocated with the construction of a new bridge allowing kiss and go access and a more efficient transport interchange.

It is likely that there will be several changes of political party in government between now and 2031 so it is pragmatic to consider the transport planning of both the current government and the opposition.

The WA Labor 2013 Policy Statement, “Metronet Connecting Perth’s Suburbs” presents a vision for North Circle and South Circle routes to connect most of the future suburban centres together, allowing east-west connections across the suburbs of Perth, meaning people will no longer have to travel into the CBD to get to their final destination.

A single connection between Fremantle and South Lake, as proposed for the South West Metropolitan Region under Metronet, would be catalyst for development and enable easier access across the southern metropolitan area for employment of other activities.

Figure 2: Metronet Heavy Rail Concept

Tier 2 - Light Rail or Bus Rapid Transit StreetCars

The draft Public Transport Network Plan focuses on a more intense system of rapid transit infrastructure and services, including both light rail and bus rapid transit. The proposal is for two stages, the first before 2020 and the second by 2031.

Figure 3: Perth Public Transport Plan Draft Concept

The combined stages 1 and 2 shown above feature bus rapid transit based on current assumptions of a geographically dispersed population and employment base, but with strategic connections between major activity centres.

The Plan introduces light rail connecting inner suburban routes to the Perth CBD. This will provide experience with the technology and its ability to attract patronage and meet demand.

There is strong support for light rail within the South West Metropolitan Region, with the South West Metro Transit Network Study identifying a light rail network linking Fremantle, Murdoch Activity Centre and Cockburn Central.

The estimated $1 billion cost for the light rail network also includes a light rail link between the Rockingham Rail Station to the Rockingham Strategic Metropolitan Centre

Figure 4 includes the light rail network proposal for the northern part of the South West Metropolitan Region, noting that the southern section has yet to be subject to detailed investigation, but also requires significant investment in the establishment of light rail infrastructure.

Figure 4. Network for early consideration of light rail

The State Government has committed to a light rail system to be called Metro Area Express or MAX, to link Mirrabooka and the CBD via Alexander Drive and Fitzgerald Street, with construction aimed to start in 2016.

The first phase of the system, which also extends east-west through the CBD to the QEII Medical Centre and the Causeway, is scheduled to be operational by 2018 although there is significant conjecture about this date due to the complexity of the project and funding.

Figure 5: Metro Area Express Concept

The State Government has committed $11.8 million to the planning phase of the project, which will include extensive community consultation and feasibility, engineering and design studies. The project has a Federal Government contribution of $4 million to date, and future funding options may require Federal and State Government funding and private investment.

A number of other studies have proposed more extensive light rail system across Perth and the suburbs. This has not been embraced by the State Government at this time.

The Greens 2010 Perth Light Rail Network 'get on board' Report[3] "sketches a vision for the future of Perth as we move into an era where climate change, petrol prices and traffic congestion demand that we rethink the way our city works".

The convergence of bus and light rail technology evident in the current BRT UK StreetCar design will allow for light rail type services to link Fremantle to Murdoch, Fremantle to Cockburn Central and Fremantle to Rockingham. Another BRT or Light Rail link will be constructed from Murdoch via Booragoon and Canning Bridge to Curtin University.

[3] http://greensmps.org.au/sites/default/files/perth_light_rail_report_june_2010_low_res_0.pdf

Figure 5: BRT UK StreetCar

Tier 3 - CAT Type Bus services

CAT Type Bus and shuttle services have proven successful for short trips on defined high frequency closed loop routes in and around urban activity centres such as the Perth CBD, Fremantle, Rockingham and Joondalup.

The major expansion of Garden City, Booragoon provides an early opportunity to develop a CAT Type Bus Service in partnership with the PTA.

The aging population and the increasing residential density combined with higher charges for activity centre parking create the conditions for CAT Type Bus services. These services will allow regular bus services to focus on major routes.

Current CAT services in the Greater Perth have funding in full or in part by bodies other than the PTA. The three services are:

- Perth CAT funded from the proceeds of the Perth Parking Management Fund
- Fremantle CAT funded 60% by the City of Fremantle; and
- Joondalup CAT funded 33% each by the City of Joondalup and Edith Cowan University.

Tier 3 - Bus services

While attracting new public transport users has resulted from new technology (rail electrification, CAT buses, etc.), a more fundamental feature is the convenience and level of service by public transport for users. Once on public transport, a fast direct service to the desired destination is important.

To meet this need, it is desirable that bus services no longer wind their way through circuitous routes providing intermittent services. The focus will be on major routes with bus priority at intersections, fewer stops and greater frequency. Services such as those along Canning Highway will operate at 10 minute frequencies and have full technology access.

However the first step is getting people on to public transport. In the SWMR the ability to collect passengers needs attention. Location and facilities at collection points (minor and major) is something which warrants more thought and discussion. The notion of a feeder system and what would make it more effective is worth discussion.

At a regional level, the adequacy of public transport for South West Metropolitan Region residents and/or employees should be a focus as compared with public transport users travelling through the region. Journey to work is the highest priority while access to activity centres in the non-peak is important for citizens and business

Taxis and Minibuses

There remains the attraction of on demand minibuses will operate doorstep to doorstep on broadly defined routes. While this is not a service favoured by mainstream public transport authorities, it is a potential business opportunity for the taxi/small charter vehicle/ community transport operators, subject to costs and funding support.

Ferries

Conceptual studies of an extended Perth river system ferry service have not found support by government. A trial conducted some years ago faltered on low patronage and high costs. The catchment areas along the river suggest thin demand and travel times are not competitive with conventional car or public transport.

In time, a ferry service from Canning Bridge to Nedlands and a Rivercat service from Fremantle to Perth could prove viable.

Intermodal Functionality

Rail Stations in more densely populated areas close to the city centre will have less parking as land values increase. Perth will move to a Munich style park and ride due to the shortage of parking within the city centre. There will be a preference to leave the car in a park & ride car park in the outer rail stations and use public transportation within the inner areas of city centre.

Bus Rapid Transit routes will link to rail stations which have park and ride facilities.

Southern Suburbs Rail Stations will have full facilities for cyclists and pedestrians with simple intelligible access.

Technology

Identifying how to incentivise (with a combination of positive and negative influencers) the use of public transport is an important consideration. There are a wide range of opportunities to influence public transport appeal and behaviour change. In a strategic sense, this needs to be an integral part of introducing new technology, new vehicles and new services.

Nominated bus and rail services will have wireless and XG data services. All transport vehicles will be GPS enabled. Passengers will have updated estimates of time of arrival at their destination and connecting services.

Emerging Technology

There are a range of emerging technologies that will influence public transport types and modes in the future, some of which are outlined below.

- Straddle Bus – Chinese concept that straddles one or two lanes of traffic and can pass over parked cars
- Mini Monorail – lightweight concept that has wheels that can operate on an elevated trackway or on a normal road with small pods carrying around a dozen people each in sets of 4 to 6.
- Automated Bus Technology – provides for full autonomous operation of buses with limited driver intervention to optimise operational efficiency through precision braking, docking, lane keeping, bus coupling and acceleration.
- Guided Light Transit and Translohr - rubber tyred trams guided by a single central rail
- Optically Guided Buses and Magnetically Guided Buses

The applicability, cost, feasibility of applying these emerging technologies to public transport needs of the South West Metropolitan Region requires consideration and investigation.

TRANSITIONING TO OUR PUBLIC TRANSPORT FUTURE

While attracting new public transport users has resulted from new technology (rail electrification, CAT buses, etc.), a fundamental requirement is convenience and level of service by public transport for users.

In the South West Metropolitan Region, the ability to collect passengers needs attention.

Once on public transport, a fast direct service to the desired destination is important, but the first step is getting people on to public transport. The location and facilities at collection points (minor and major), the nature of the feeder system and making more effective use of the public transport system is worth discussion.

At a regional level, the adequacy of public transport for South West Metropolitan Region residents and/or employees should be a focus as compared with public transport users travelling through the region. Journey to work is the highest priority during peak times, while access to activity centres in the non-peak is important for citizens and business.

Identifying how to incentivise (with a combination of positive and negative influencers) the use of public transport is an important consideration.

The elements of transition to *Our Public Transport Future* are to:

- Identify transit priority routes
- Engage with current activity on planning the Thornlie-Canning Vale-Glen Iris-Cockburn Central Rail Line
- Promote discussion and understanding of new transport technology
- Work to progressively improve intermodal functionality at major rail stations
- Seek a firm timetable for new rail stations such as Karnup and transport links to Keralup
- Explore opportunities for partnerships with the private sector for linking major public transport routes to industrial areas with Cat Type and shuttle services
- Support trials of new transport technology within the South West Metropolitan Region
- Seek to have a metropolitan coordination mechanism for transport and land use between State Government and Local Governments

Any way of making greater use of existing equipment and services will be attractive to the Public Transport Authority (PTA) and government in the face of demands on public funds.

Appendix 1

Examples of Land Use and Transport Planning within the South West Metropolitan Region

Each to include a graphic or plan and a few paragraphs of text

- Karnup- Keralup
- Wellard-Kwinana Transit Oriented Development
- Cockburn CAT Bus investigation
- Cockburn Central Transit Orientated Development
- Fremantle- Melville- Cockburn Light Rail (PB Investigation)
- Cockburn Coast Transit Orientated Development
- Canning Bridge Transport Interchange
- Murdoch Activity Centre

Our Public Transport Future Appendix 1

Examples of Land Use and Transport Planning

within the South West Metropolitan Region

All of the Case Studies are part of the Perth 3.5 million ultimate rapid transit infrastructure network

July 2013

Karnup - Keralup

Keralup Stage 1

Keralup is a 4,000 hectare urban development, located State Government owned land on the southern boundary of the City of Rockingham, which will ultimately house 100,000 people. Development will take place over a fifty year time frame. Land has been rezoned for the first stage which will accommodate 2,500 people. The Karnup-Keralup area will be served by a new rail station on the Southern Suburbs line near Paganoni Road.

Opportunities
Careful integrated land use and transport planning linked with employment opportunities at neighbouring Nambeelup and promotion of active transport through sympathetic land development. Long term stage development.

Challenges
Uncertainty about timing of transport infrastructure and that initial development will not have the community facilities. Initial development will also be a dormitory suburb with limited local employment opportunities.

Local Government Role
The City of Rockingham has been very proactive in developing a “Vision for Keralup” with strong community involvement. They are also working with the State Government on the design of Karnup Rail Station.

Current Status
Development of Keralup District Structure Plan
Planning for Karnup Rail Station

Links to Government Policy
Keralup transport links and Karnup Rail Station identified in Public Transport Plan for Perth 2031. Department of Housing priority for land release

Wellard-Kwinana Transit Oriented Development

The development of Wellard Village on a 320 hectare site as a Transit Oriented Development design has been an award winning success. The development is centred on the Wellard Rail Station on the Southern Suburbs Line and will ultimately provide 2,900 dwellings. The development is a partnership between Peet Co and the Department of Housing.

Opportunities
Development of walkable neighbourhoods and a village feel with streetscapes that take advantage of green areas surrounding the development. Proximity to schools, services and employment. Walkability of Rail Station catchment.

Challenges
Difficulty of linkages to Kwinana City Centre for active transport that may be partially offset by the development of a large greenfield site on Wellard Road that sits between Kwinana and Wellard.

Local Government Role
Close involvement in planning as well as development of recreation facilities

Current Status
Development of further stages

Links to Government Policy
Density and diversity of housing choice in Directions 2031 and links to Kwinana as an activity centre under Directions 2031. Legible and walkable rail station catchments under Public Transport Plan for Perth 2031.

July 2013

Aubin Grove (Success/Mandogalup) Rail Station

Aubin Grove will be the first new rail station on the Southern Suburbs Line since it was opened in December 2007. The $80 million project will involve a bus interchange and parking for 2,000 cars and is expected to be completed by 2016.

Opportunities
Use of low value space under high voltage power lines for car parking to take pressure away from Cockburn Central. Provision of an integrated bus exchange.

Challenges
1,000 metres from shopping centre and other services

Local Government Role
Close involvement in planning

Current Status
Tender awarded in March 2013 for Concept design and Cost Estimate
Advertised as being completed in 2016

Links to Government Policy
Aubin Grove Rail Station in an election commitment and is identified in Public Transport Plan for Perth 2031 as Success/Mandogalup

Cockburn CAT Bus investigation

Cockburn Central 10 kilometre indicative route

The success of development of Cockburn Central has seen 103,326 average monthly boardings to the Southern Suburbs Line. This has put pressure on parking and has encouraged investigation of improved public transport to Cockburn Central Rail Station. The development of a CAT type bus service is one of the options.

Opportunities
Development of a bus underpass to remove the need for at grade crossing of Beeliar Drive. Potential to dramatically increase proportion of passengers arriving by public transport at Cockburn Central Rail Station. Linkages to the industrial area and future urban development. Linkages to the Cockburn Central Gateway Shopping Centre “Mainstreet”.

Challenges
Challenge of funding for the service and patronage outside of peak periods.

Local Government Role
City of Cockburn has proactive in encouraging the PTA to investigate future bus routes to cater for strong urban growth.

Current Status
PTA have completed a report for the City of Cockburn

Links to Government Policy
Cockburn Central is an activity centre under Directions 2031 and a key transport interchange under the Public Transport Plan for Perth 2031.

Cockburn Central Transit Orientated Development

Cockburn Central is one of the first Transit Oriented Development sites delivered under Directions 2031 and has been successful in providing a diversity of housing choice within the City of Cockburn. The development has been undertaken through LandCorp**.**

Opportunities
TOD already has 500 residents. Opportunities for local employment through development such as FESA headquarters retail and health facilities. Opportunity for further development at Muriel Court and Cockburn Central West.

Challenges
Competition for parking and busy road separating TOD from shopping centre. Limited natural amenity.

Local Government Role
City of Cockburn has invested in a developing a GP Super Clinic and sporting facilities.

Current Status
Land released for Stage 2 with building expected to be completed by 2016.

Links to Government Policy
Cockburn Central is an activity centre under Directions 2031 and a key transport interchange under the Public Transport Plan for Perth 2031

Fremantle- Melville- Cockburn Light Rail (PB Investigation)

The Cities of Cockburn, Fremantle and Melville worked with LandCorp to commission PB to develop a light rail network for the region. The northern section is shown above and provides linkages between the activity centres in those three local government areas

Opportunities
High quality public transport is an essential element for managing road congestion in the South West Region. Light rail provides an opportunity to dramatically improve cross region linkages and to link with ultimate Perth transport network.

Challenges
Funding for light rail outside of the Max Project will be a challenge in the short and medium term.

Local Government Role
South West Group local governments have been proactive in promoting improved public transport between activity centres and contributed towards the cost of the PB Investigation.

Current Status
Awaiting release of Moving People and Final Public Transport Plan for Perth 2031

Links to Government Policy
Improved public transport links between activity centres is a key element of Directions 2031. The light rail routes perform the same function as the Tier 2 routes identified under the Public Transport Plan for Perth 2031.

Cockburn Coast Transit Orientated Development

Cockburn Coast is urban and commercial redevelopment of the area previously occupied by industry including the South Fremantle Power Station and the Robb's Jetty Abattoir. The development will ultimately house 10,000 people.

Opportunities

Cockburn Coast is a rare opportunity to develop a large coastal area close to employment and services applying Transit Orientated Development principles. The area should be ideal for development of high quality public transport links to Fremantle and Cockburn Central.

Challenges

Protecting the current and future functionality of the freight rail corridor and managing traffic impacts on Hampton and Rockingham Road.

Local Government Role

The City of Cockburn has played a pivotal role in the planning of Cockburn Coast. Together with the Cities of Fremantle and Melville they have sought to develop high quality public transport for the TOD.

Current Status

Local Structure Planning is underway

Links to Government Policy

Cockburn Coast is the type of development that will contribute to Directions 2031 density targets and is on a Tier 2 route identified in the Public Transport Plan for Perth 2031.

Canning Bridge Transport Interchange

The existing Canning Bridge Rail Station and Bus Interchange both have poor access for dropping passengers and stationary buses block the already congested Canning Highway. The Canning Bridge Precinct Vision provides for a dramatic improvement of the functionality of the transport interchange through relocating it to west of the Freeway and providing road access through a new bridge over the Freeway.

Opportunities

Greater densities and diversity of housing at Canning Bridge will depend on improved public transport. Increasing the mode share for public transport will be facilitated by the elements contained in the Canning Bridge Precinct Vision.

Challenges

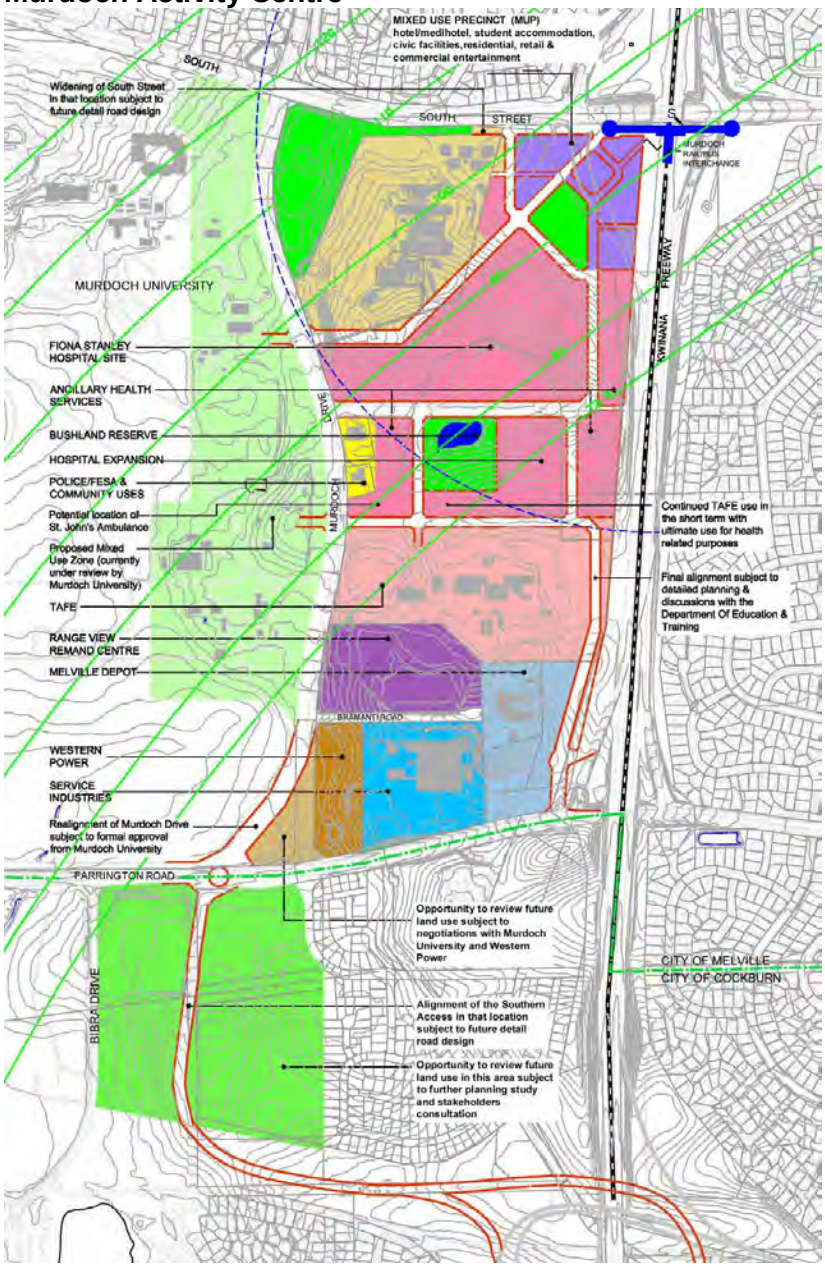
Community acceptance of greater density and infrastructure funding.

Local Government Role
The Cities of Melville and South Perth have worked with the WA Planning Commission to develop the concept as a part of the Canning Bridge Precinct Vision.

Current Status
Structure planning is underway based on the Canning Bridge Precinct Vision

Links to Government Policy
Canning Bridge Precinct is an important District Centre for achieving the targets for inner city development and density under Directions 2031 and is a key transport interchange under the Public Transport Plan for Perth 2031.

Murdoch Activity Centre



July 2013

Murdoch Activity Centre is identified as a specialised activity centre under Directions 2031 based on the significant projected employment of 30,000 persons in health, education and commercial activity expected to be developed over the next 20 years. The opening of Fiona Stanley Hospital in 2014 combined with significant development at St John of God hospital, Murdoch and the development of the Murdoch University Campus will place significant pressure on vehicle movements.

Opportunities
Murdoch Rail Station is already the busiest station outside of the Perth CBD and has a high proportion of patrons arriving by public transport. The development of a "main street" linked to a new access through Murdoch University will facilitate improved public transport connectivity. Later development of commercial space at Murdoch Rail Station and within the Murdoch University site provides an opportunity to develop significant employment coupled with increased residential development.

Challenges
Avoiding crippling congestion and gaining community support for greater density in all of the Murdoch Activity Centre quadrants.

Local Government Role
The Cities of Melville has worked closely with the WA Planning Commission, Murdoch University and other precinct stakeholders to develop the Murdoch Activity Centre planning. The City of Cockburn has been involved with transport planning for the precinct.

Current Status
Development of the St John of God Hospital, Murdoch is well advanced with Fiona Stanley Hospital scheduled to open in 2014. Murdoch University is progressing structure planning on its site. Road works are underway at the intersection of Murdoch Drive and South Street and a southern connection to Kwinana Freeway is being planned.

Links to Government Policy
Murdoch is an activity centre under Directions 2031 and a key transport interchange under the Public Transport Plan for Perth 2031

Rockingham Strategic Metropolitan Centre Planning

The Rockingham Strategic Metropolitan Centre covers 600 hectares stretching from the Rockingham Rail Station to the coast. The area is being planned using Transit Oriented Development principles. A transit corridor was developed in 2007 to link the newly constructed rail station to the city centre, Murdoch University and beaches. The Rockingham Shuttle comprising four gas powered buses operate at 15 minute intervals through the transit corridor.

Opportunities
A transit corridor was designed to cater for light rail and as elements of the Strategic Metropolitan Centre are developed light rail will become more viable. Rockingham is one of Perth's fastest growing cities and development of the area will encourage higher use of both public and active transport.

Rockingham Strategic Metropolitan Centre boundary

Challenges
The limited rail stations and low frequency public transport in the other areas of Rockingham mean that journeys to the centre will continue to be car dominated.

Local Government Role
The City of Rockingham has been a strong advocate for high quality public transport systems and is planning the Strategic Metropolitan Centre to be consistent with TOD principles.

Current Status
SKM have recently completed a Transport Plan for the City of Rockingham.

Links to Government Policy
Rockingham is a secondary metropolitan centre under Directions 2031 and a key transport interchange under the Public Transport Plan for Perth 2031