

Perth's South West Metropolitan Railway

Balancing benefits and costs

***Report for the Public Transport Authority of Western Australia
by the Planning and Transport Research Centre***

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PATREC

**Planning and
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Research Centre**

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PREFACE

This report is the result of a five month research project by the Planning and Transport Research Centre. It was made possible by a research grant from the Public Transport Authority of Western Australia (PTA). The PTA and other State agencies have provided data for the study, but in all other respects it has been conducted independently. It contains no recommendations.

The Planning and Transport Research Centre (PATREC) is an independent research body, formed by a collaboration of the four public universities in Western Australia – Curtin University of Technology, Edith Cowan University, Murdoch University and The University of Western Australia. It receives base funding from these institutions, which is matched by the State Government of Western Australia through the Department of Planning and Infrastructure and Main Roads WA.

The team which has carried out the research for this independent study, and assisted in other ways with advice and guidance with economic, modelling and urban issues included Dr Peter Lawrence (Adjunct Assoc Prof, Faculty of Business and Public Management, Edith Cowan University), Mr John Georgiades (Adjunct Assoc Lecturer, Faculty of Business and Public Management, Edith Cowan University), Ms Carlindi Holling (Research Assistant, Faculty of Built Environment, Art and Design, Curtin University), Dr Craig Townsend (Research Associate, Planning and Transport Research Centre), Ms Carey Curtis (Senior Lecturer, Faculty of Built Environment, Art and Design, Curtin University), Assoc Prof Jeffrey Kenworthy (Institute of Sustainability and Technology Policy, Murdoch

University), Prof John Taplin (Faculty of Economics and Commerce, University of Western Australia), and Professor Fred Affleck (Director of the Planning and Transport Research Centre).

The PTA asked that this research build on and update previous work to gain an improved understanding of triple bottom line, sustainability, urban development and generational equity issues, and to use improved strategic transport modelling.

It was intended to describe and (as far as possible) quantify the potential economic, environmental and other benefits and costs to the community, in current and future generations, of developing a rail-based public transport system in Perth's southern suburbs, compared with continuing to rely predominantly on extension and development of a road-based (car and bus) passenger transport system which currently exists in this area. It was intended that as far as practicable, it would also identify implementation strategies to enhance benefits flowing from rail-based public transport development, to inform and assist future transport/land use decision making by governments and the community.

Benefits and costs to be taken into account in this project appraisal should include the economic, financial, environmental and other costs and benefits to individuals, families and the community in present and future generations from changes in public and private transport operations, and resulting changes in travel choices, from:

- Construction, operation and maintenance of the project works, including rail and connecting bus services, road and other ancillary works.

- Provision, operation and maintenance of alternative 'base case' works, including bus services, road and other ancillary works.
- Changes in land use, urban development and urban amenity.

There are issues raised in this report which suggest a need for further research – mainly relating to urban form and design, and social and individual choice behaviour in and context of urban growth and technology change. This further collaborative and interdisciplinary research should assist in better understanding how the new transit system and new urban developments in the south west corridor can best be managed to contribute to the success of the South West Metropolitan Railway insustaining Perth's high level of 'liveability', and to the underlying motivators of travel behaviour and travel mode choice. PATREC can contribute further to understanding these important issues. They do not however, affect the principal findings of the research reported here.

The Centre is grateful for the opportunity to contribute to the consideration of the important issues which are the subject of this report.

Professor Fred Affleck
Director
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1 INTRODUCTION

The Government of Western Australia has begun construction of a new 73-kilometre passenger railway, the South West Metropolitan Railway (SWMR), shown here in Figure 1.1. The four existing railway lines which provide Perth's present rail rapid transit service total 90 route-kilometres.

The SWMR will provide a rapid transit spine in the south western sector of the Perth metropolitan area, and by joining directly to the Northern Suburbs railway, it will provide an unbroken north-south service with connections to the Fremantle, Midland and Armadale lines at Perth Station. The project includes purchase of new railcars and construction of new railcar maintenance facilities. In conjunction with the project, there will also be expenditure on feeder bus services, commuter parking and related road infrastructure.

At the same time new infrastructure is also being built to extend existing railway lines:

- Currambine to Clarkson (Northern Suburbs railway)
- Kenwick -Thornlie branch (Armadale line).

These other rail projects are being constructed independently of the SWMR project. Therefore their construction and operating costs and all economic and other benefits derived from them have been excluded from this study.

Chapter 6 of this report examines the interaction between the use of this railway and the development of residential and other land uses in the south west

corridor. The report does not examine the more complex interactions between this project and future development in the central Perth area, as these are being managed separately by the State Government and the Perth City Council.

The forecast capital cost of the SWMR rail project is approximately \$1.276 billion (including provision for new railcars, a new railcar depot and repair facility, and forecast cost escalation). This study also considers the impacts of other required investments in roads, buses and other ancillary infrastructure.

The project horizon for this study is 2041. With appropriate maintenance, the rail infrastructure asset being constructed by the project will continue in service well beyond this date¹; the rollingstock fleet will need replacement and augmentation to accommodate growing patronage beginning in approximately 2020 and this has been provided for in this study. It is our understanding that debt contracted to pay the majority of capital investment in the rail project will also be repaid with interest within the project planning horizon we have adopted.

Technical and design details of the project are available in the *Perth Urban Rail Development Supplementary Master Plan* (August 2002)², *Coming to a New Vision for Perth* (Final Report of the Perth City Rail Advisory Committee) (May 2002)³, and at <http://www.newmetrorail.wa.gov.au/>. In general this report does not contain information already available from these sources.

¹ This numeral and others like it the text refer to Endnotes at the rear of this report.



Figure 1.1: South West Metropolitan Railway

2 THE CONTEXT AND PURPOSE OF THIS REPORT

There is wide agreement that Perth is one of the world's most 'liveable' medium size cities. To sustain this level of amenity with continuing strong growth in population and demand for personal mobility, management of the urban area must include complementary land use and transport plans.

This report describes the benefits – i.e. *net* benefits – which can potentially flow from the SWMR project and ways in which these can be used to enhance Perth's 'liveability' in coming decades. Because the perspective is long term, the study uses a 'planning horizon' year of 2041.

In the coming three decades Perth's metropolitan population is expected to grow by 49% from 1.4 million in 2001 to 2.1 million in 2031. Among its fastest growing areas will be the south west corridor.

As well as investment in rail infrastructure, the SWMR 'package' contains complementary investment in buses and roads (for cars and buses). It will also require future expansion of bus and rail capacity for population growth beyond years in the middle of the planning period.

The alternative – not building the SWMR – would of course not be 'cost-free': it would also require substantial on-going investment in roads, buses and other infrastructure.

Both 'project' and alternative 'base case' will also involve very large operating and maintenance expenditure, which has been included in this study.

The 'triple bottom line'

Although this report assesses the balance between the economic costs and benefits of the planned SWMR project and compares these with the alternative 'base case', it was not its exclusive purpose to assess the economic merits or otherwise of the SWMR project.

This study has had a triple focus, aimed at reporting on a 'triple bottom line' of outcomes from the project:

- *Economic outcomes:* The study has quantified the economic costs and benefits from the SWMR project and *associated* expenditure, and compared them with a hypothetical no-railway 'base case' – i.e. it has been a conventional benefit-cost analysis, using accepted benefit-cost methodology. Economic costs and benefits include financial effects incurred by public and private entities, including transport system user benefits, as well as the economic value of travel time gains and losses and the added 'consumer surplus' gains from perceived improvements in accessibility and travel quality.

The economic performance of urban infrastructure is important to the community in general and to the business sector in particular:

The [business] sector points to the risk that incremental infrastructure deficits and slow overall decline in urban functioning, will undermine [Australia's] international competitiveness. 'Proactive' planning and strong urban management at the metropolitan level are

seen as necessary to reduce business transaction costs and restore and maintain liveability....

Liveability is viewed as an important variable of ... investment as high environmental amenity attracts international economic decision-makers and highly skilled employees. From this perspective, urban amenity is a precondition for economic growth.

- *Environmental outcomes:* The study has also quantified the 'external' benefits and costs from the project; where these have a quantifiable economic value, they have been included in the benefit/cost analysis. 'Externalities' are effects not incurred directly by producers and users of infrastructure services. They include the economic cost of air and water pollution, greenhouse gas emissions, noise, transport accidents and road damage. Some effects of new road and rail infrastructure (eg community 'severance') the study has not examined or attempted to quantify.
- *Social outcomes:* This category encompasses a range of effects which generally are not amenable to direct measurement and valuation, although there are some that have indirect economic impacts as well as a broader qualitative value to the community. They generally affect the 'amenity' or 'liveability' of the metropolitan area, and include improved urban design, housing choice, social equity and sense of place and community.

In this area, the concern of this study has been the interaction between transport and strategic and local land use development and planning. New transport infrastructure – be it road-based (cars and buses), rail-based, public and private – has inevitable effects on urban form and liveability.

There is strong research evidence and wide agreement that “...transport systems have a significant effect on the structure of urban development. The development of transport networks drives changes in land use.”⁵ This is the basis for the ‘integrated land use and transport plan’ adopted by the WA Planning Commission:

*Integrating land uses and transport can deliver a more sustainable city with a high quality of life for current and future residents.... The financial costs and benefits of land use and transport systems are fundamental to making a plan work....*⁶

It is recognised by many who live in Perth, that opportunities should be created to develop a greater diversity of urban forms and higher densities in selected areas (e.g. in railway station precincts). The evidence is that this is happening most rapidly in planned redevelopments and in ‘green fields’ areas.

There is a growing body of research outcomes from Australia and overseas which demonstrate the importance of ‘transit led development’ and ‘transit-oriented development’ to creating more sustainable and liveable urban environments. In part this report is aimed at drawing upon this research to confirm the importance of starting now to develop Perth’s transport systems in new directions – not waiting

until land use patterns suited only to car-oriented transport systems are firmly entrenched in the growing southern suburbs.

Cars and public transport

However, common sense (and economic research⁷) show that cars will continue to be dominant for most travel purposes in Perth, though it is certain that car technology will evolve over the long term to rely mainly on non-petroleum based energy sources.

This study has not assumed rising petroleum-based fuel prices over the study period, although it is very likely these will occur and probably result in more choices made in favour of public transport use than those found by the modelling performed for this study. This is consistent with the generally ‘conservative’ approach adopted by this study

The concept of ‘car dependence’ is controversial. The analysis and conclusions in this report are not based on a naïve physical determinism which links supply of rail-based public transport directly to massive reductions in car use, other than the ‘marginal’ effects of changing relative costs to users. This report does not argue that the only ‘remedy’ for high levels of car use is a “breakthrough, involving major changes in the way society operates”, which is seen by some commentators as the only remedy for ‘car dependence’ and its effects.⁸

Confirming a part of the argument of these ‘radical’ sceptics, the evidence presented in this report shows the value of solutions to future growth of population and mobility which promote greater *choice* for

satisfying people’s mobility aspirations, combined with incentives (including new forms of urban design) to influence these choices. These ‘solutions’ are being added to a richer policy mix which has also included improved feeder and trunkline bus services, rail electrification and extension to other new areas, improved transit security, TravelSmart Individualised Marketing (shown to yield high benefit-cost ratios) and State-wide sustainability initiatives being promoted by private and public sectors.

The SWMR is one part of this policy mix aimed at providing more effective choice, and helping incrementally to shift travel choices and habits, to reduce the undesired effects on liveability of high levels of car travel. By making new choices available – and getting in early with ‘transit-lead development’ – many transport system users will develop new travel habits.

Our research shows that the numbers of passenger trips diverted to the south west metro railway service will grow, responding to its ability to move people quickly and efficiently, and delivering growing benefits from the investment planned in this decade.

Experience in Perth and elsewhere shows this growth trend will start slowly and accelerate. Its strength and the delivery from it of desired effects on individual and community transport costs, will depend on the pace and direction of change in Perth’s land use density and distribution. Evidence in the report suggests that rail systems can act as catalysts in the process of urban change.

3 POPULATION, LAND USE AND TRANSPORT TRENDS

Population trends and forecasts

Perth's population has been growing rapidly for several decades, driven in part by the attraction of growing employment opportunities. Over the four decades to 2001 Perth's average annual rate of population growth (2.59%) was the highest of all State capitals. For the 3 decades to 2031, the State Government's forecast in 2000¹⁰ was that growth in the metropolitan area will continue, although at a lower annual rate (1.4%) than in the decade to 2001 (1.54%), reaching a total of 2.078 million by 2031.¹¹

Population density in Perth is low (less than 11 persons per hectare) but increased slightly during the 1990s¹². This minor increase was partly due to in-fill development in inner suburbs (e.g. East Perth, West Perth, South Perth, Leederville and Subiaco), which seems to have counterbalanced the continuing low density expansion of suburbs at Perth's fringes.

Transport trends

During past decades of rapid population growth, spreading suburbs and downward trending population density, people in Perth have chosen to travel longer distances and to buy and use cars to do this. In the four decades to 2001 car occupant-kilometres per capita increased by 96%.

The trend of car-based mobility slowed in the 1980s and 1990s, mainly due to increased use of public transport services. Electrification and expansion of Perth's rail system in the 1980s and 1990s affected travel trends. In the 1990s the total of bus and train

passenger-kilometres per capita grew by 13%. At the same time, rail passenger-kilometres per capita increased dramatically (193%) returning to levels last seen in the 1950s and demonstrating the ability of appropriate infrastructure investment to modify apparently inexorable trends. Rail passenger journeys in Perth climbed steeply from 8 million p.a. in 1991 (before electrification) to 31 million p.a. in 2001 (after electrification and construction of the northern suburbs railway).

However, Perth's continuing very low density of development means its growing population still rely mainly on buying and operating their own cars for access to leisure, work and services.

Very high levels of car use – some call it 'car dependence' – are driven by strong economic and social factors. The words quoted below were written from UK experience, but they apply also to Perth.

*"... [car dependence is] a dynamic process both at the individual and the social level. Individually, people increase the use made of cars, tend to rely on them more, and over time pay less and less attention to other alternatives which are open to them. Socially, changes take place in land use and the provision of services, which make a car more necessary, and the alternatives less attractive. Thus at the time of first purchase, the car may be seen as a luxury. However, once bought it encourages changes in behaviour and circumstances, which in effect turn it into a necessity. Car-dependence grows rather than simply existing."*¹³

Cars have brought high levels of mobility and accessibility and with them great benefits to most people in Perth. However, travel choices can be modified – most effectively by 'transit-lead development'.

Numerous studies including several of direct relevance to Perth, have demonstrated the adverse environmental impacts of high levels of car usage¹⁴, and also their economic and public health costs. For example, at the micro level, driving on congested roads is known to cause stress, aggressions and even fatalities.¹⁵ Some have tried to formulate a broader conceptual framework for environmental quality and quality of life studies¹⁶ to assist in analysing this issue, which is of increasing political importance in developed countries. The economic consequences of high levels of car use are becoming better understood, as in a recent Australian property consultant's study:

*It is not difficult to appreciate the implications of increasing car dependency for the wider economy when we consider that the multiplier effects associated with car-related expenses are relatively low, due to the share of the car market accounted for by imports. By comparison, a shift in expenditure towards labour intensive sectors, such as retailing, hospitality, recreation and the services sector in general, will have significantly greater impacts upon employment and economic growth.*¹⁷

Empirical research evidence also implies that high levels of car usage come at a cost to the community: Figure 3.1 shows a moderately strong association

between relatively higher levels of public transport mode share and lower proportions of GDP devoted to urban passenger travel: a third of the variability in the economic cost of urban transport is explained by variations in the rate of car travel *per capita*.

According to ABS data for 1997/98¹⁸, Perth households spend one-sixth (16.8%)¹⁹ of weekly income on transport (approximately \$117 per week). Figure 3.2 shows this is the second highest proportion for Australian capital cities.

Figure 3.3 implies that low population density is strongly associated with high car usage: a survey of 84 cities including Perth shows that 84% of variability in car travel intensity is explained by variations in urban population density.

Other recent Australian research provides supporting evidence that higher population densities, supported by 'transit oriented development' can significantly lower the cost of public infrastructure provision.²⁰

Perth's – and Australia's – high level of car usage is not unique, but it remains very high on a number of measures compared with most cities of comparable size. According to standardised data (for 1995) comparing 84 cities around the world, Perth's length of road infrastructure *per capita* was exceeded by only two cities – Houston (Texas USA) and Melbourne. Perth's level of car ownership was exceeded only by three cities – Atlanta (Georgia USA), Calgary (Alberta Canada), and Houston. Perth's level of CBD parking per job was exceeded by only five other cities – Houston, Phoenix (Arizona,

USA), San Diego (California, USA), Riyadh (Saudi Arabia) and Wellington (New Zealand).²¹

Also evident in Perth are the environmental impacts of high car usage, as indicated by the following findings from a study conducted in 2002 and 2003 for the intergovernmental Australian Motor Vehicle Environment Committee:

*Perth is on the threshold of an air quality problem.... The Western Australian Department of Environmental Protection ... has found that motor vehicle emissions are the single largest contributor to air pollution in Perth.*²²

Public opinion appears to be reacting. A 2003 survey of public opinion in Perth conducted by major independent Australian research and strategy consulting firm, Colmar Brunton, asked the question "How important is it to you that a liveable city reduce dependence on motor vehicles and thus reduce pollution/greenhouse gases?" 87% said that it was "very important" or "quite important". In response to another question, 88% said they would like to see "public transport and other modes of transport start to take much of the load off private cars". 87% also said it was "very important" or "quite important" to ensure that people can travel efficiently by car.²³

The inference from this attitudinal research is that Perth's community is seeking opportunities to increase the share of its total urban travel performed by public transport, to sustain the city's liveability and increase economic efficiency by reducing the cost of urban mobility to the community and to households.

Figure 3.1: Relationship between urban population density and *per capita* car use
Source: Kenworthy and Laube (2002)

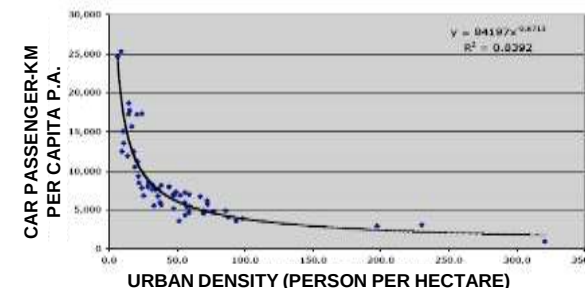


Figure 3.2: Transport as a percentage of household income in Australian Capital Cities
Source: ABS Survey of household incomes

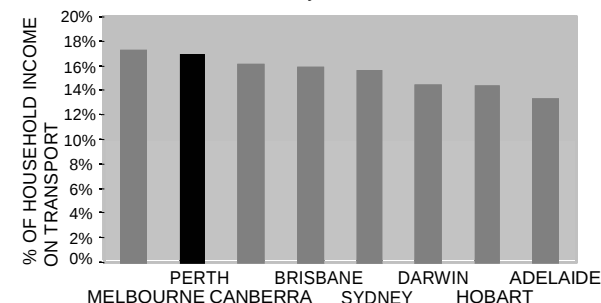
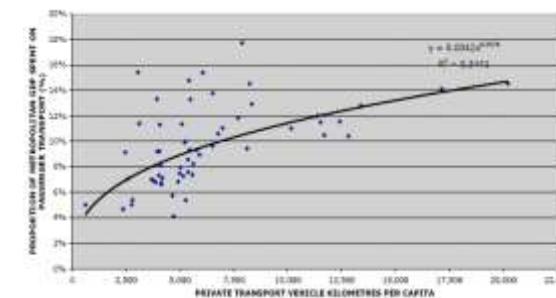


Figure 3.3: Relationship between private vehicle travel *per capita* & GDP for urban passenger travel
Source: Kenworthy and Laube (2002)



Governments continue to build roads in the metropolitan area. However, to provide a greater choice of travel resources, and to encourage their use, recent governments have adopted a twin strategy of demand management (of which the TravelSmart Individual Marketing program is the best example, though it is very limited in scope by the small budget devoted to it), and supply management, including improved provision of bus and rail services (with efforts made to improve security).

The northern suburbs railway

As previously indicated, the planned SWMR will not be Perth's first major new investment in rail-based transit. In the past two decades:

- The 19-km Perth-Fremantle line reopened in 1983.
- Electrification of the whole existing suburban system, much of it built before 1900, was completed in 1992, and
- The new 29-km Northern Suburbs railway was completed in 1993.

The effect of these changes in the railway system was substantial. Research conducted immediately following the opening of the northern suburbs railway showed that 23% of its patronage (totalling 28,000 per day within 6 months of opening) was from people who previously drove cars for their journey, and 40% of passengers used bus feeder services:

This [was] an increase of 25-30 per cent on what the previous bus-only network in the [northern suburbs railway] catchment areas would have yielded

[The] level of [total railway] patronage [28,000 per day] compares with prior estimates of around 25,000 per day.²⁴

The rail system experienced two upward kicks in patronage from electrification and extension, with both exceeding forecasts – a demonstration of the familiar 'sparks' effect noted in overseas examples of new rail, light rail, jet air travel and other transport system technology innovations which provide widely perceived sudden advances in service quality.

Population and transport trends in the south west corridor

Population in Perth's south-west region is forecast to more than double its proportion of the metropolitan area population by 2031.

The population of the south west region is currently one-eighth of Perth's total: in the 2001 Census population in the south west metropolitan area was 178,000 (13% of the total for metropolitan Perth).

According to the Australian Bureau of Statistics, the south west portion of Perth's metropolitan region, including Mandurah, were among the fastest growing urban areas in Australia between 1996 and 2001:

... major population centres experiencing significant population increases between 1996 and 2001 were the Statistical Districts of Gold Coast-Tweed on the Queensland-New South Wales border, and Mandurah in Western Australia, both of which grew by 3.8%, while Sunshine Coast in Queensland and Bunbury in Western Australia increased by an average 3.5% and 3.4% per year respectively.²⁵

Population growth in the south-west region is forecast to continue strongly, especially in the more distant southern fringe area²⁶. Total south-west corridor population is forecast to grow to 601,000 in 2031 (more than doubling proportionately to 29% of the total metropolitan area population), an increase of 66% in the 30 years from 2001. Population in the southern portion of the corridor (in Kwinana, Rockingham, Mandurah and Murray local government areas) is forecast to grow to 338,000 by 2031, an increase of 118% in 30 years.

According to the WA Planning Commission, plans for the SWMR have increased the residential development projections of the corridor by more than 50 per cent, with developers indicating "that the South-West and Peel Planning Sectors could now develop at twice the rate of Perth's North-West sector"²⁷.

Figure 3.4 on the next page shows the numbers and distribution of households in the south-west corridor and the remainder of the metropolitan area. The more distant 'fringe' areas, which tend to be less well provided with public transport services, are more heavily represented in the south west.

Patterns of car ownership and usage in the south west are similar to the remainder of the metropolitan area. Figure 3.5 shows that in outer and fringe areas of the south west metropolitan region, which comprise both newer and established suburbs between Rockingham and Mandurah, a large proportion of current households own two or more cars. The graph implies that similar numbers of households in outer and fringe areas in all parts of

the metropolitan area own two or more cars, suggesting that in the outer and fringe suburbs of all regions desired levels of mobility impose high levels of car dependency – and high costs – on all households.

This also confirms there is an opportunity through the SWMR project to offer a choice to the large future south west corridor population to reduce their purchase of new cars. The SWMR will be first opportunity to shape transport patterns in fringe locations before communities are fully established.

Figure 3.6 suggests that the social impacts of car dependency are likely more severe in existing south

west suburbs. This graph shows that households with no car are proportionately more numerous than the average for other parts of the metro area, especially in middle and fringe areas.²⁸ These statistics suggest that without access to effective public transport, mobility for many 'middle' and 'fringe' households in the south west is restricted. The data also suggest that households in outer and fringe areas are spending a higher than average proportion of their incomes on transport.

More research would be desirable into the impact of transport costs and car dependency on household expenditure patterns in these suburbs.

Figure 3.4: Number and spatial distribution of households in the Perth metropolitan area.
Source: Census 2001

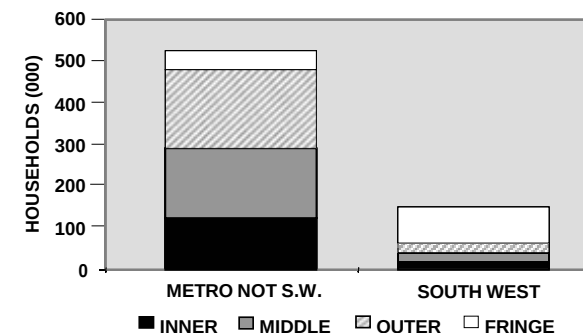


Figure 3.5: Households with 2 or more cars, Perth, 1997-98

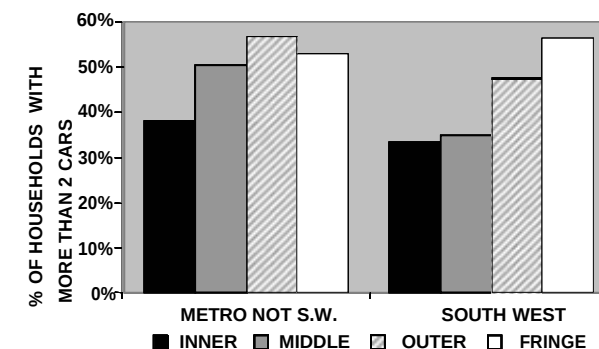
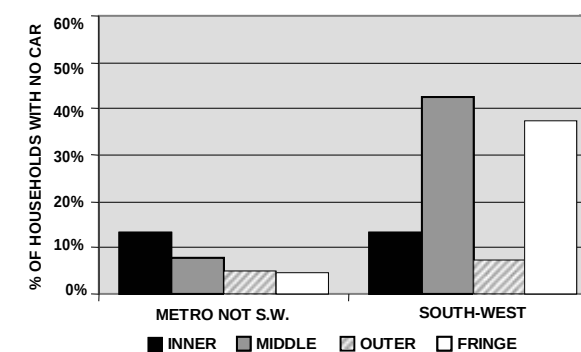


Figure 3.6: Households with no car, Perth, 1997/98



4 ECONOMIC AND ENVIRONMENTAL EVALUATION OF THE SOUTH WEST METROPOLITAN RAILWAY PROJECT

The evaluation reported here integrates appraisal of economic and environmental factors. With the data available for this research we have not been able to evaluate local impacts on 'sustainability' such those on *local* air quality, landscape, heritage, biodiversity or distributional effects.

The costs and benefits from the project works (including all other costs in the total project 'package') have been compared with those for an alternative 'base case' system which would continue to expand and improve roads and bus-based transport infrastructure in the south west corridor, sufficient to sustain current levels of service in line with population growth and expansion of urban land uses. This base case is described further below and in Appendix 1 at the rear of this report.

The study has recognised there are important effects which cannot be 'monetised', and where appropriate data exist for Perth or for comparable cities we have attempted other forms of analysis. We have not used any form of 'multi-criteria analysis', as it requires complex and controversial weighting of benefits and costs.²⁹

Economic benefits

The findings from this study show that the economic value of the SWMR project is high (Table 4.1). Results from evaluation of the project are expressed in three conventional measures: a discounted net present value, a benefit/cost ratio (the ratio of discounted benefited to discounted costs), and an

Table 4.1: Overview of economic outcomes of SWMR

Treasury discount rate	7.0	percent
Net present value (NPV)	1,427	\$ million
Benefit-cost ratio (BCR)	3.3:1	ratio
Internal rate of return (IRR)	16.5	percent
Social time preference discount rate	3.5	percent
Net present value (NPV)	3,833	\$ million
Benefit-cost ratio (BCR)	6.2:1	ratio
Internal rate of return (IRR)	16.5	percent

internal rate of return (which is independent of the discount rate); this last measure is often used by businesses to test a project's viability against a minimum acceptable 'hurdle' rate.

Evaluation of benefits and costs from commencement of construction to the chosen planning horizon of 2041 has produced:

- An 'internal rate of return' of 16.5%
- A benefit/cost ratio of 3.3:1 at a discount rate of 7% and 6.2:1 at 3.5% (these alternative rates are explained below); and
- A net present value of \$1.43 billion at a discount rate of 7% and \$3.83 billion at 3.5%.

Table 4.2 presents *undiscounted* costs for construction and operation of the SWMR, compared with the 'base case' (including rollingstock and associated works in both cases).

After completion of the SWMR, the passenger transport system in the south west region of Perth will comprise an extensive road system, including the Kwinana Freeway and extensive arterial and local

Table 4.2: Project costs for SWMR and 'base case' (\$000)

	Base Case	SWMR
<i>Capital Costs (undiscounted):</i>		
Rail infrastructure	NIL	1,061,490 (a)
Rail rollingstock	164,944 (f)	502,805 (b)
Road construction	608,900 (g)	403,600 (c)
Road construction (buslanes)	469,700 (h)	347,200 (d)
Buses	226,870 (i)	67,598 (e)
Totals		

Notes:

- (a) Includes all expenditure (actual [2002-2003] and forecast [2004-2007]) for rail infrastructure contract packages A-H (scope of these works in Supplementary Master Plan, page 139), environmental and land use planning, land acquisition, miscellaneous works and project administration.
- (b) Includes expenditure for 63 railcars allocated to the SWMR and Nowergup depot (\$214.3 m 2002-07), plus additions and refurbishments (\$232.4m 2020-29 and \$56.1m 2036-39).
- (c) Includes expenditure in SW corridor on freeways and local roads to maintain existing levels of service (average \$31.9m p.a. 2008-09; and average \$68.0m p.a. 2017-21).
- (d) Includes expenditure on road works for bus operations (busways, buslanes and local roads) required to provide trunk line and feeder bus services, plus new bus stands.
- (e) Includes expenditure on new buses (\$33.8m 2007-12), which are replaced after 20 years.
- (f) Includes expenditure on portion of rollingstock order used only on northern suburbs railway for Currambine-Clarkson extension and capacity growth.
- (g) Includes expenditure in SW corridor on freeways and local roads to maintain existing levels of service (average \$60.9m p.a. 2008-17).
- (h) Includes expenditure in 2007-2023 on roads and associated works for bus operations required to provide feeder and truck bus services (freeway lane extensions (23km 2007-21), other bus lanes (57km 2007-10), and bus stands (65 2007-12), 2,400 park 'n ride bays at major bus stations 2007-16, and a new Central Perth busport and access routes (\$97.5m in 2025).
- (i) Includes expenditure on new buses (\$113.4m 2007-12), which are replaced after 20 years.

roads, a spinal rail system, supported by local, feeder and 'trunkline' buses, and networks of cycleways and walking pathways. Some current express services will cease operation and be reoriented to feed the rail service.

All costs and benefits for the SWMR project are marginal costs. That is, the additional costs and

benefits which will occur as a result of building and operating the SWMR. Similarly, the 'base case' quantifies the marginal future costs and benefits from the alternative 'no rail' scenario. All costs for infrastructure, maintenance and operation of rail, buses and roads have been obtained from the Public Transport Authority, the New MetroRail project team and Main Roads WA.

New urban passenger railways have well documented impacts on the direct and indirect costs of travel for individuals and the community, environmental outcomes and land use. New riders are attracted to use rail services by lower costs and perceived travel times compared with competing car travel and bus services. Although the fares and prices paid for both modes (private and public) do not generally reflect full economic costs (for construction, operation and maintenance of road and rail transport modes and the economic value of journey and transfer time), net reductions in economic and environmental costs resulting from the actions of individuals and service providers are real benefit s to the community.

Our calculation of benefits from the new system take into account time savings, operating costs savings and the net benefits from changes in the 'external' effects of transport operations (noise, air and water pollution, greenhouse gas emissions, accident trauma costs, and road damage costs). Our calculations of *net* economic impact take account of all costs for construction, purchase, operation, maintenance and regular replacement of rail infrastructure and rollingstock, buses, cars, roads and related infrastructure within the study period.

Figures 4.1 and 4.2 present operating and maintenance costs for roads, rail and bus services. Figure 4.3 presents benefits which occur in the form of reduced user costs and reduced external costs. In all cases, the magnitude of benefits is driven by growth in rail patronage and operating capacity.

Evaluation framework

The form of benefit-cost analysis used in this study was entirely conventional,³⁰ in keeping with the generally conservative approach adopted.

This study has applied the same evaluation framework (economic principles and method of analysis) as were used in the earlier study of the SWMR conducted in 1998 by consultants Sinclair Knight Merz for the WA Department of Transport; the 1998 study, which reported in January 1999, examined the then proposed railway via the 'Kenwick' route.³¹

Figure 4.1: Operating and Maintenance Cost - Base Case

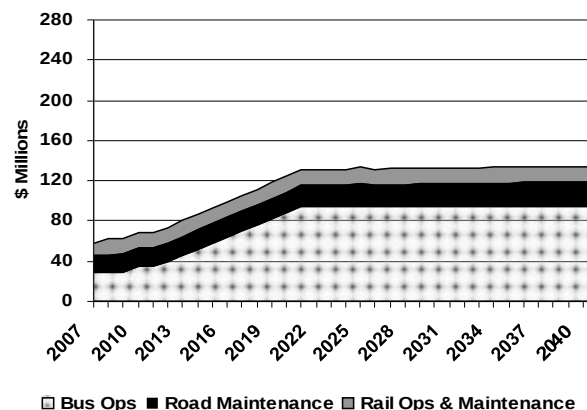


Figure 4.2: Operating and Maintenance Cost - SWMR Project

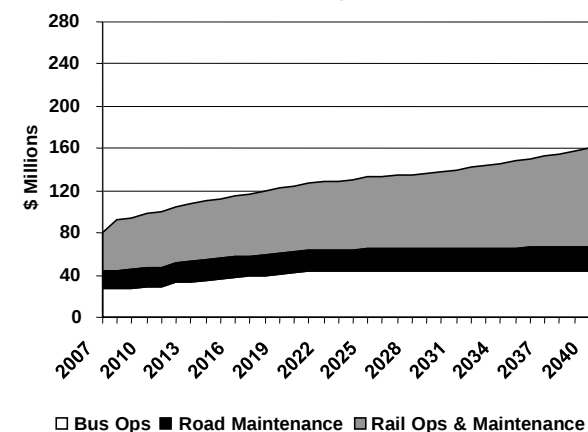
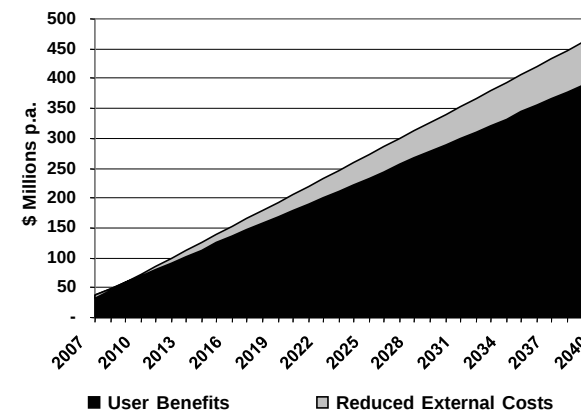


Figure 4.3: Benefits in SWMR Project - User Costs and Reduced External Costs



Patronage and traffic

Forecasts of numbers of passengers using the SWMR service, feeder buses, park and ride facilities and the south west region's road system have been developed using a conventional four-stage modelling process; inputs to the model are detailed actual and forecast travel and activity data from 484 zones in the Perth metropolitan area and the local government areas of Mandurah and Murray; population, land use and economic data such as car operating costs, transit fares and empirically determined values of travel time for a range of activity types.

The SPECTRE model (Version 2.0), used for this study, is a metropolitan-wide model to ensure that forecasts take into account interactions between the south west and the remainder of the metropolitan area. This model was developed for Perth and has been refined to improve its treatment of a number of issues including park and ride patronage, travel, waiting and transfer times, traffic congestion and the current and future bus network. The model's forecasts of mode split between rail and other forms of transport take into account the effect of traffic congestion on travel times by incorporating an iterative 'feedback loop'. The model has been independently peer reviewed.^{32, 33}

The SPECTRE model produces very detailed travel forecasts for two years, 2006 (commencement of SWMR operations) and 2031, with intermediate and 'beyond' years derived by inter/extrapolation.

Population and land use data are sourced from planning documents prepared by the WA Planning Commission and other State and Commonwealth agencies, and are consistent with forecasts presented in the SWMR Supplementary Master Plan and summarised earlier in this report.

Rail service frequencies and typical travel times are detailed in the *Supplementary Master Plan* (2002).

Figure 4.4 presents a picture of the *changes* in passenger-kilometres travelled by car, bus and rail during the study period. Figure 4.5 presents a picture of the *total* passenger-kilometres travelled by each mode with the SWMR project in place during the study period.

The travel modelled by this study includes *travel for all purposes*.

It is realistic to forecast that within the planning horizon of this research (to 2041), most trips for work and leisure will continue to be made by car drivers and their passengers, as availability of new energy sources in future are likely to ensure these continue to play a dominant role in urban mobility. However, modal transfers on the scale experienced in the northern suburbs in the past decade can generate major economic benefits.

Tourism trips

Rockingham and Mandurah are favoured day-trip and longer-stay tourist destinations – for visitors from the Perth metropolitan area, interstate and overseas. The new rail service will increase accessibility to the area. The Peel region (which includes Mandurah)

attracted over 500,000 overnight visitors in 2002, and many more day-trippers. Rail users in this segment of the travel market have *not* been included in the demand forecasts used in this study.

Figure 4.4: Changes in Passenger-Km Travelled

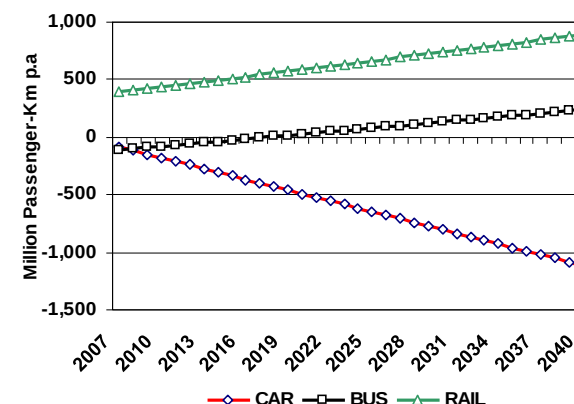
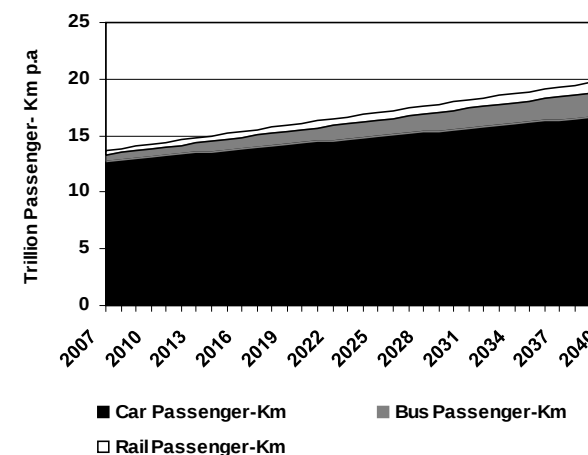


Figure 4.5: Total Passenger-Kilometres travelled with SWMR operations



Patronage on the Brisbane-Gold Coast railway, opened in 1996, grew by an average of 10.4% in its first five years of operation. This Gold coast line serves a larger market, but its experience is a pointer to potential growth in this sector for the Peel region. As noted earlier, the 'sea change' urban areas of Gold Coast and WA's Peel Region share top place in the high population growth league table of Australia.

The 'base case'

Understanding the 'base case' is critical to understanding outcomes from this study. There are many transport development strategies and scenarios which could be alternatives to the SWMR. To undertake the evaluation of costs and benefits of the SWMR, this study has used an alternative scenario which would provide extensive express and feeder buses in the south west corridor and adequate capacity for car-based transport where indicated by demand modelling (details are contained in Appendix 1).

The 'base case' is not a '*do nothing*' option. It has a large direct cost for expenditure on infrastructure (roads, parking facilities, bus lanes, buses and city bus terminals), and for private expenditure on cars and their operation. It also has a large cost for operation and maintenance of public infrastructure and services and for environmental effects.

The value of time saved

In economic assessments of transport infrastructure projects it is conventional to include as an economic benefit a monetised value for the time saved as a

result of faster travel times. The value of time saved by travellers is an important part of the total economic benefits produced by the project, comprising time saved by the faster transit times provided by rail services and by the reduced road congestion due to reduced traffic flow. Average values of travel time used in this study were:

- Rail passengers: \$6.70 per hour
- Bus passengers: \$6.48 per hour
- Car occupants: \$8.52 per hour.^{34, 35}

Values of travel time saved vary with trip purpose, mode of travel, and between time in-vehicle and out-of-vehicle (access, waiting and egress from vehicles). It is usual to attribute to out-of-vehicle time a greater value, based on travellers' higher uncertainty about the time taken for intermodal transfers; out-of-vehicle time for bus and rail passengers has been valued at twice that of in-vehicle time; this tends to disadvantage public transport modes, and is another example of the generally conservative approach used in this study.

Residual values

Undiscounted residual capital values for infrastructure and moveable assets have been included in the final year of this evaluation where applicable. These are shown in Table 4.3.

Discounting of benefits and costs is discussed in the next paragraphs below. The effect of discounting residual values at 7% in the economic evaluation is to reduce the values shown to approximately one-fifteenth of the values shown.

Table 4.3: Residual Values (\$million - undiscounted)

	Base Case	SWMR
Buses	74,757	13,196 (a)
Rail Infrastructure	NIL	332,852 (b)
Railcars	NIL	169,485 (c)
TOTAL	74,757	515,533

Notes:

(a) Buses are assumed to have an accounting life of 16 years.

(b) Rail track and related infrastructure is assumed to have an accounting life of 50 years.

(c) Rail rollingstock and related depot and other assets are assumed to have an accounting life of 30 years.

Valuing future benefits and costs

It is usual in evaluating economic outcomes from infrastructure projects to apply a compounding rate of discount to costs and benefits occurring in future years to convert them to 'present values'. This is a separate concept from inflation, and all dollar values are expressed in 'real terms' (i.e. adjusted for inflation) before discounting.

There are two complementary approaches to valuing future costs and benefits, both of which have been used in this study. These involve use of two alternative discount rates: 7% (referred to here as the 'Treasury rate') and 3.5% (referred to here as the 'social time preference rate').

Australian government Treasury departments in the Commonwealth, States and Territories generally use a discount rate around 7% to reflect the risk-adjusted cost of capital for government financed projects (with alternative rates of 4% and 10% to test the sensitivity of outcomes to the timing of benefits and costs).

The Western Australian Treasury does not recommend a specific rate, but suggests that the rate used should reflect an appropriate 'weighted average cost of capital'. For the Public Transport Authority, this has recently been determined to be 6.9% by the WA Rail Access Regulator (now in the WA Economic Regulation Authority).³⁶

For the SWMR project, the strongest flow of benefits will go to future generations in the period say from 2020 to 2040 and beyond, i.e. the children and grandchildren of current working West Australians.

The effect of discounting is to strongly weight up-front costs (and benefits) and heavily discount long-term benefits (and costs); the higher the discount rate, the greater the difference between the weights given to short-term and long-term values. Using a 7% discount rate, the value of costs and benefits occurring in the tenth year out is only half of their 'nominal value', and after 20 years barely a quarter; the effect is to 'punish' projects combining high up-front capital costs with long-term benefits. Over the evaluation period used in this project, initial infrastructure costs are affected very little by discounting, but the continuous and gradually increasing stream of benefits occurring from commencement of operation in 2006/07 until 2041 is valued at only a third of their nominal value.

In reaction to this 'intergenerational bias' there is a commonly held (but far from unanimous) view that 7% is too high. The bias – in favour of projects whose economic (and usually also financial) impact is short term implies that future generations will be less well off than current generations and therefore

unwilling to repay debt incurred to provide benefits they receive from past investments. This appears to be an unreasonable assumption. It would also deprive future generations of benefits they could receive from decisions made now. The question which this evaluation tries to answer is whether the planned investment in the SWMR will in fact deliver long-term economic and other benefits at least commensurate with its cost. The answer (shown in Table 4.1) appears to be 'yes it will'.

To address this issue of 'intergenerational bias', this study has also used a second optional discount rate of 3.5%, conventionally known as the 'social time preference rate' (STPR). Since 2003, use of the STPR has been mandated for evaluation of all long-lived infrastructure and other projects in Great Britain. The Australian Bureau of Transport and Regional Economics has commented:

*The STPR embodies moral judgments about the welfare of different generations. Generational considerations are particularly important for projects with long lives. A common expectation, which broadly agrees with historical trends, is that future generations will be better off than people today.*³⁷

Environmental effects

Changes in environmental side-effects from transport may also be counted as net benefits or costs. These include changes in the economic cost of accidents involving all transport modes, air quality, noise, greenhouse gas emissions, and other less tangible effects where they can be valued.

Table 4.4: Unit values for external costs

	Cars	Buses	Rail
	(Cents per Vehicle-Kilometre)		
Incremental road damage	0.17	2.16	0.00 (a)
Accident trauma	5.10	5.10	0.01 (b)
Air and water pollution	4.94	11.59 (d)	1.49 (c)

Notes:

(a) These values adopted from 1998 SKM study of Kenwick route, adjusted for inflation; see Sinclair Knight Merz (1999).

(b) Values for cars and buses adopted from Australian Road Research Board Transport Research (2003); for rail adopted from Sinclair Knight Merz (1999), adjusted for inflation.

(c) Includes air pollution, water pollution and Greenhouse gas emissions. Values for cars adopted from ARRB Transport Research (2003); the values used here are one-third greater than in Sinclair Knight Merz (1999). Values for buses and rail have been adopted from Sinclair Knight Merz (1999), adjusted for inflation.

(d) this figure for buses has been reduced by 80% from 2016 to take into account the probability of ultra-low pollution performance in the next generation of buses.

Differences in the value of tangible environmental effects are generally driven by differences in the kilometres operated by transport vehicles. Table 4.4 presents the unit values used in this study³⁸, which are comparatively conservative.³⁹

Non-renewable energy consumption

Net changes in non-renewable energy consumption have *not* been counted as an external cost in the economic evaluation. Current and forecast future fuel costs are included in vehicle operating costs.

However, a large amount of non-renewable energy – provided by petroleum-based fuels for cars and buses and by electrical power for trains – will be saved by the operation of the SWMR project.⁴⁰ This is due to the lower energy consumption required for

train operations compared with cars and buses. Consumption rates for Perth are as follows:^{41 42}

- 2.43 MJ/passenger kilometre for car travel
- 1.77 MJ/passenger-kilometre for bus travel
- 0.56 MJ/passenger-kilometre for rail travel.

Total energy saved during the planning period for the project 2004-2041 will be approximately 27.3 million Gigajoules. This is equivalent to nearly 6 months total electricity consumption in WA.

Comparison with 1999 study

As detailed earlier in this section of this report, the previously proposed SWMR project on the 'Kenwick route' was subject to a detailed economic assessment by consultants Sinclair Knight Merz in 1999 (reported to the WA Department of Transport in 1999).⁴³ This 1999 study and the current one reported here use many of the same analytic tools and data sources. The transport model used for estimating travel demand and mode split and the economic evaluation model are the same, with a number of technical enhancements which have been incorporated in the intervening five years; these enhancements have been described elsewhere in this report.

The 1999 study compared with 'Kenwick' option with two alternatives:

- A 'base case' which entailed "*extension of current transport facilities, with no new rail line but with additional bus services under existing infrastructure conditions*", and

- A 'bus option' which "*provides the maximum modal share to bus compatible to the willingness of passengers to divert from private motor vehicles. Supply [was] designed to provide a comparable level of bus service to the proposed rail service. Additional specific infrastructure such as bus lanes [was] incorporated to cater for the corresponding increase in bus volume*".⁴⁴

Both economic evaluations included the economic value of external costs and benefits (environmental, road trauma and road damage).

Table 4.5 on the next page presents the key outcomes from the two studies to allow comparison.

Land use benefits

This area of interest is explored more fully in the next section of this report.

Appropriate integration of land use planning with the pace and direction of railway infrastructure development can enhance net benefits. The measure of this enhancement is in increased land use densities and land values, reflecting the value of increased accessibility to activities. This enhancement can occur through effective 'transit-oriented development' to improve user access to stations and promote higher density development in station 'precincts'.

Experience in the northern suburbs shows that vacant land is most likely to be the first locus of response to opportunities for greater density and for development of new transit-oriented forms of development. Experience of land use development

on the longer established suburban rail lines, and on similar and younger lines elsewhere in Australia and overseas, confirms that in the longer term (at least 20 years and beyond) existing developed areas might also be responsive to these opportunities, provided planning strategies facilitate strong guidance to new development and redevelopment.

The Subi Centro project is a good example of this process occurring in Perth. It has contributed to an increase in average weekly passenger movements through Subiaco station from 9,017 in 1996 to 15,426 in 2002 (a 47% increase in six years).⁴⁵

Table 4.5: Sinclair Knight Merz (1999) and PATREC (2004) Compared

	1999 Study (a)			PATREC Study (a)		Notes:
	Base Case	Bus Option	Rail Option	Base Case	Rail Option	
Planning Horizon:	2031			2041		
Rail passengers p.a. (Thousands)						(b)
1996	21,556	21,556	21,555	27,816	27,816	
2006	30,426	30,295	37,395	33,481	47,402	(c)
2021	31,689	31,506	41,410	41,379	62,552	(d)
2031				51,437	72,652	(d)
Bus passengers p.a. (Thousands)						(b)
1996	35,899	35,899	35,899	32,502	32,502	
2006	42,799	43,769	38,477	41,037	29,676	
2021	48,907	50,135	43,371	63,975	53,559	(d)
2031				79,267	69,481	(d)
Car passengers p.a. (Millions)						(e)
1996	1,526	1,044	1,044	1,126	1,126	
2006	1,242	1,241	1,240	1,359	1,354	
2021	1,526	1,525	1,521	1,726	1,701	
2031				1,970	1,932	
Capital cost (\$ Million)						
Rail (incl railcars)			910	144	1,563	(f)
Roads	125	141	24	469	347	(g)
Buses	373	592	204	227	68	
Operating & Maintenance Costs (\$ Million average p.a. undiscounted)						
Rail			30	16	67	(h)
Bus	69	84	37	77	40	
Road	16	17	16	21	21	
User benefits (\$ Million average p.a. undiscounted)						
Existing traffic		20	35		67	
Diverted traffic		5	15		56	
Car op'g costs		7	11		89	
Total Benefits		32	61		212	
External costs (\$ million - total undiscounted)						(i)
Costs incurred	16,145	16,175	16,029	44,646	43,054	
Discount rate 7%						
Net present value (\$m)		60	-65		1,427	
Benefit cost ratio		1.7	-0.9		3.29	
Internal rate of return		0.2	0.1		16.5%	

(a) All financials use 7% discount rate for both studies. The 1999 Study modelled two forecast years (2006 and 2021). The PATREC study modelled three forecast years (2006, 2021 and 2031).

(b) In both the 1999 Study and the PATREC Study all numbers for rail and bus patronage and car users are Perth metropolitan system-wide. For the 2003 study only, rail passenger statistics also include all bus feeder passengers; each combined journey is counted as one.

(c) PATREC Study Base Case 2006 rail patronage includes passengers originating and terminating on the Thornlie branchline; not included in Base Case or Bus Option in 1999 Study.

(d) Different rail and bus patronage in PATREC Study Rail Option results in part from modification of transport model to include the effects of congestion (see PATREC report, section 4, heading 'Patronage and traffic'). This affects the travel speed and journey times for bus and cars. the effect on bus travel speeds and travel times is more marked; in the 1999 Study the average speeds for buses in the Base Case and Bus Option were assumed to be free-flow traffic speeds.

(e) The 1999 Study assumed constant car ownership per capita. The PATREC study assumes rising car ownership with saturation reached in 2031.

(f) The 1999 Study capital costs are for 2004-2030; the PATREC Study capital costs are for 2003-2041; in the last decade the PATREC Study assumes \$56 million expenditure on railcars and \$12.5 million on buses. PATREC Base case rail costs are for Thornlie line. The 1999 Study capital costs are in 1997 dollars and were 'concept' or preliminary estimates; the PATREC Study capital cost are in 2004 dollars and are contract prices or firm estimates including cost escalation.

(g) In the 1999 Study capital costs for roadworks include only those required to accommodate bus operations; it was assumed the same road network would be built to accommodate car traffic in all scenarios, and therefore road capex for this purpose was set at zero in all scenarios. In the PATREC study, road capital expenditure includes requirements for buses (freeway bus lanes and arterial roads) and for car traffic; the latter were varied in timing to reflect time displacement of congestion (the difference was largely in timing, but this affected the discounted present values of road expenditure).

(h) Source for costs used in PATREC Study was the PTA rail division finance division; they are considered to be more realistic than those used in the 1999 Study. Small rail operations and maintenance expenditure in Base Case is attributable to the Thornlie branchline.

(i) This is the total of all road damage, pollution and accident trauma costs. In the 1999 Study, the costs are shown from 2007 to the end of the study period in 2030 (24 years); in the PATREC Study the figure shown is the total for 2007-2040 (35 years).

5 TRANSIT ORIENTED DEVELOPMENT IN THE SOUTH WEST CORRIDOR

As suggested in previous sections of this report, the long-term success of the SWMR should be greatly enhanced by land use strategies and urban design policies supporting 'transit oriented development' (TOD). The result of successfully applying TOD principles will be to enhance opportunities for developing rail system patronage, and by this means to reduce the cost of mobility to the WA economy and individual Perth households.

Some major commuter rail improvements in Europe and North America have led to significant land-use intensification.⁴⁶ Studies of 'transit-focussed development' in the United States have found that:

"Transit accessibility confers value on development near rail stations.... Commercial real estate values are more affected by accessibility to transit than are residential values.... [Case studies] have shown that investment decisions have been accelerated in response to new transit service."⁴⁷

The findings from a major synthesis of North American experience⁴⁸ provide some guidance in formulating principles:

Researchers observe that transit-focused development is characterized by the following patterns of transit-supportive land use:

- *At the regional scale, concentrations of residential uses with convenient transit connections to concentrations of employment uses.*
- *Around transit stations, concentrations of development that put many residents and*

employees within walking distance of stations (generally less than [800 metres])

- *Within these concentrations - mixes of uses that can satisfy daily needs by walking between uses, making use of transit more convenient; building designs and pedestrian pathway systems that provide convenient and attractive access to and from stations....*

However, the same study cautions that integration of public transport infrastructure and operations with land use management is vitally important:

Land use characteristics such as density, distribution of population and employment centers, mix of uses, and development design can increase transit ridership by making transit accessible to more residents, workers, and shoppers and by providing attractive and convenient ways for people to use transit....

Policies in some Australian States reflect similar experience:⁴⁹

Neighbourhood design should seek to increase pedestrian catchment areas to [suburban] centres and public transport services. New developments must be located near services and designed to encourage safe pedestrian links to public transport.

The WA Planning Commission's Development Policy 1.6 *Planning to Enhance Public Transport Use* also contains principles for supportive urban design. The Commission's *Liveable Neighbourhoods* guidelines are also aimed to produce walkable commuting and are especially relevant to railway station precincts.

Planning for TOD in the SW corridor

Research and experience in Australia and overseas suggest *three principles for successful 'transit oriented development'* in the south west corridor.

- Regional structure plans should locate residential development where there are convenient rail and integrated bus connections
- Concentrations of mixed residential, employment, commercial, retail, personal and public service uses should be clustered in 'pedsheds' of 800-1,200 metres from stations, to promote easy walking between uses.⁵⁰
- Pedestrian pathways within these areas of activity concentration should be designed for safe, secure and convenient access to rail stations.

We have undertaken a review of structure planning for the south west corridor over the last two decades to better understand the evolution of planning for a public transport system in the corridor, and the extent to which planning has integrated transport with land use development.

The south west corridor comprises areas of three broad types:

- *Previously developed areas.* In these areas there are few opportunities for strategic planning and urban design based on TOD principles. However, there are some infill and redevelopment opportunities at specific sites, and the impetus for redevelopment could increase in future as the

effect of the new railway is felt. These sites include the areas surrounding planned transit stations at Canning Bridge, Leach Highway and South Street. The circumstances at these sites are similar to those at several stations in the north west transit corridor where the influence of the railway on urban form and land values has so far been slight, eg Leederville and Warwick.

- *Newly emerging areas* where there are current and medium term future opportunities to influence development and urban design in line with TOD principles. These areas, which will develop rapidly in the next decade, include Thomsons Lake and Mandurah. Structure plans exist in these areas and opportunities exist for good TOD urban designs.
- *Greenfields areas* where structure planning can still make a difference in combination with TOD designs. These areas include the station precincts at Thomas Road, Leda, Rockingham and Waikiki. These circumstances also exist at possible future station sites between Thomsons Lake and Rockingham (Success, Mandogalup and Anketell Road) and south of Waikiki (Stakehill and Karnup).

Early identification and reservation of land for road infrastructure has contributed to efficient development of an extensive road network in Perth. Until recently, this process has not been undertaken for public transport infrastructure. The results of this are apparent where planning for the SWMR route involved negotiating through developed areas.

Structure plans should seek to provide some certainty for future transit provision and identify land to be reserved through appropriate zoning in the Metropolitan Region Scheme. Road reserve locations should maximise the developable land around stations; they have been a limited factor in some instances on the northern suburbs line.

Seven planning documents completed between 1980 and 2002 were examined. The shortcoming in most structure plans up to 1997 was their failure to address how transport integration should be achieved. There was little recognition of the need to protect land from incremental development around future stations; land parcels in single ownership can facilitate the comprehensive planning and development of urban structures to support transit and minimise the need for car travel. This has clearly affected past developments in the South Street and Leach Highway areas.

The 1997 *Inner Peel Regional Structure Plan* noted the need to integrate land use and transport and describes the current objectives for station precinct design, to accommodate increasing densities, mixed land use, pedestrians and cyclists with a permeable street network. It also recognised the need for matching the transport profile of land use activities with locational accessibility; this means positioning activities generating large traffic volumes on arterial roads, and high pedestrian generating activities in catchment areas of transit stations. These directions were restated by the 2002 *Mandurah Inner Area Strategic Plan*.⁵¹

The 2002 SWMR *Supplementary Master Plan* (SMP) complements strategic land use planning undertaken in the south-west corridor and Peel Region to implement the relevant principles embodied in the overarching strategy for the development of Western Australia, the *State Planning Strategy* (1995).

However, the earlier 2000 report of the South West Metropolitan Transit Planning Steering Committee (SWMTPSC) says that the SWMR and associated bus transit ways “can be integrated with existing and projected land use”. The SWMTPSC promoted access to transit stations predominantly via car and bus, commenting that “because of the low density land use development within the South West Metropolitan Area, the percentage of potential patronage within walking distance of the transit station is generally low”. Station form, park and ride, kiss and ride, bus passenger transfer, and road and rail alignment were addressed, but consideration of adjacent development focused on separation, buffering and the supply of sufficient parking bays to meet projected demand. This approach tends to bolster continuation of the current low density urban form and ignores the potential for ‘emerging’ and ‘green fields’ station sites on the SWMR to adopt TOD principles.

The SMP proposes station precinct master plans which recognise urban designs compatible with the three design principles referred to above, but does not fully address TOD design issues or extend TOD design principles to the outer limit of pedestrian catchment areas.

Land use trends in new rail corridors

To gauge the strength of TOD development in the south west corridor, this study examined the proportion of commercial and residential development occurring in the southern rail corridor's 800-metre station precincts and compared this with trends in the north west rail corridor.

Experience in the south west corridor, especially in the 'emerging' and 'green fields' categories, is consistent with that in North America, reported in the synopsis of its experience cited above:

Developers can take advantage of the heightened accessibility afforded by transit to gain an edge in the marketplace. Business interests often view transit stations as natural focal points for commercial and employment development....

Our comparison of north west and south west corridors revealed that the south west sector has proportionally more residential development within future 800-metre station precincts than has occurred in the north west sector over the same period. This is shown in Figure 5.1. A similar trend is evident for industrial development (Figure 5.2). Commercial development in the north west sector indicates a stronger tendency to locate within the 800m precinct of stations; although this is a result of the uptake in vacant commercially zoned land, it provides evidence that commercial development will capitalise on available sites within station precincts.

As development and population growth proceeds within the station precincts on the SWMR, it is likely that with appropriate zoning, a substantial proportion

of commercial development will also locate in these 800-metre station precincts. This has positive implications for the opportunities to develop strong mixed use nodes at station sites on the SWMR.

Evidence of the direction and strength of trends in land use densification in areas of high accessibility to rail services can foreshadow the potential for this to occur in the south west corridor, and indicate how development strategies might be used to enhance the success of the SWMR in the long term.

Research undertaken for this report using data from the north west corridor for 1993 to 2003 (relevant data are not available before this time), shows some evidence of the railway influencing land development and density, but trends are not yet well established.

The recovery in per capita usage of rail services in Perth since the mid-1980s following electrification and commencement of rail services in the northern suburbs has barely begun to affect land use and population density in this corridor. This is consistent with experience North America which indicates that in previously developed areas, around two decades are required to see strong responses to changes in accessibility brought by new transit services, as previously well-established land uses and building stock are modified or replaced by new development.

Figure 5.3 shows new development of non-residential (business/office/retail) floor space in station precincts on the northern suburbs railway. A variety of land uses have been developed, notably where vacant land has been readily available. Where little or no vacant land has been available,

Figure 5.1: Commercial development in 800m station precincts

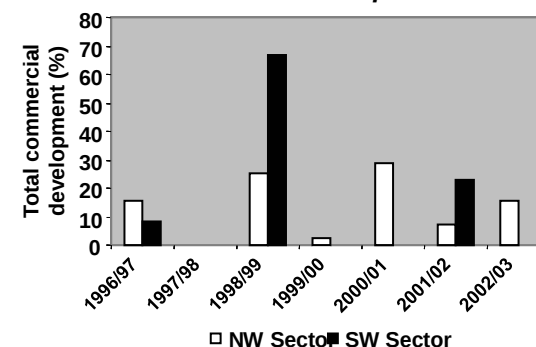


Figure 5.2: Industrial development in 800m station precincts

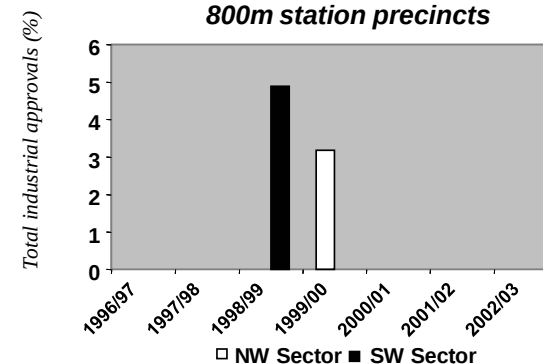
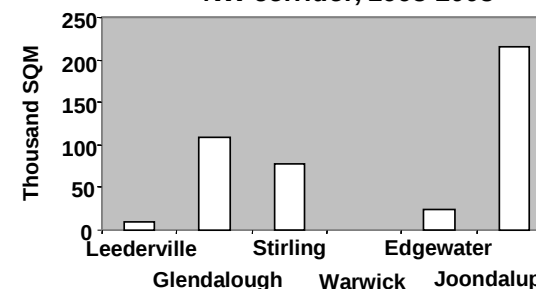


Figure 5.3: Non-residential floor space increase in station precincts NW corridor, 1993-2003



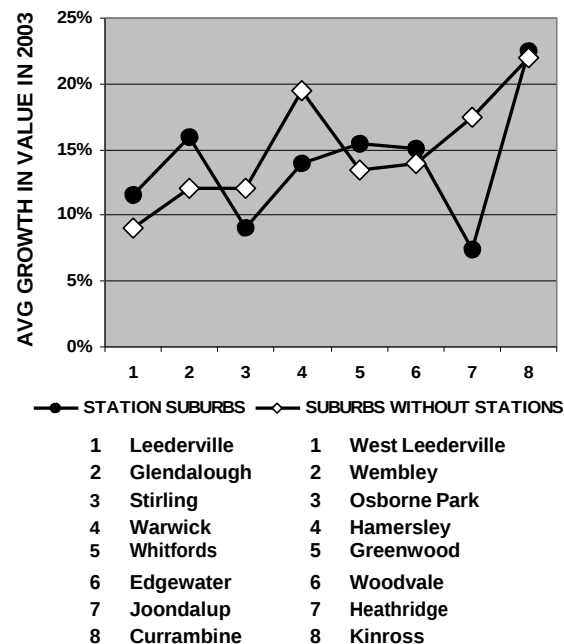
growth in floor space has been slight. This evidence suggests that development intensification is not yet occurring. In older suburbs where redevelopment of residential land uses has occurred within station precincts (eg in the Leederville station precinct), densities remain moderate to low. This is in spite of much higher *maximum* density zonings sanctioned by WAPC Development Policy 1.6 *Planning to Enhance Public Transport Use*.

Higher land values should push up densities, but the same reasons for lagged response as were mentioned above appear to apply. Our research shows a discernable but weak impact by the northern suburbs railway on property values in suburbs served by the line; however, analysis of this data is complicated by the high growth in land values in the decade to 2003.

Figure 5.4 presents a comparison between the growth rates in land values (for established homes only) in eight 'rail' suburbs and eight adjacent 'non-rail' suburbs on the northern suburbs railway, and shows a weak influence if any. This is consistent with experience in other cities with newly installed rail transit systems, where their influence has been most evident only after 20 years of rail service.

Figure 5.5 shows a similar analysis for properties on the Midland suburban railway (a 100 yr-old line in Perth's eastern suburbs), clearly showing the impact of rail services on land values. In the older rail corridors (to Midland, Fremantle and Armadale), where the influence of rail on land values has had longer to work its influence, its effects are more evident, in spite of the weakening influence of the

Figure 5.4: Northern Suburbs Railway - Land value growth rates in suburbs with railway stations and without.
Source: REIWA

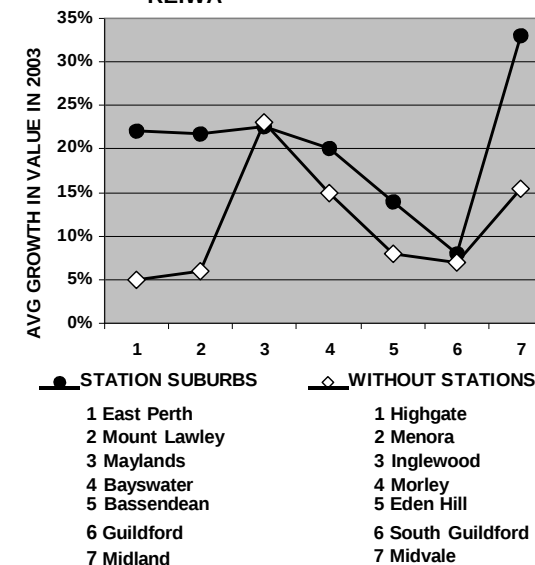


long-term decline in rail usage in the three decades from the mid-1950s.

Development in the north west corridor suggests two conclusions for the south west corridor:

- *There is a need to provide for a range of land uses within station precincts.* The north west corridor experience to date suggests that station precincts developed with a predominance of private residential land use do not undergo land use change with any degree of rapidity. Thus station precincts such as Whitford continue to

Figure 5.5: Midland suburban railway - Land value growth rates in suburbs with railway stations and without. Source: REIWA



under perform, functioning as a dormitory suburb rather than a node of mixed land uses. Joondalup has in contrast, gradually seen the development of vacant land to provide a range of land uses and employment opportunities.

- *Minimum density zonings for residential land use within station precincts warrant strong consideration.* "The application of minimum density requirements for outward urban expansion" was recommended following the findings of recent research examining the implications of development patterns in Perth and in other Australian cities⁵² Leederville, although coded for appropriate residential densities that accord with WAPC Development Control Policy

1.6 *Planning to Enhance Public Transport Use*, remains predominately low density. Because maximum density zonings are rarely achieved, alternative mechanisms appear to be required within railway station precincts.

TOD opportunities in the SW corridor

Clearly there is a major opportunity to develop detailed structure plans and urban designs (as has been done successfully for areas such as Subi Centro and Joondalup town centre). More detailed planning is being done by local governments in the south west corridor, in conjunction with the government bodies including the Department of Planning and Infrastructure, LandCorp, Landstart, the Public Transport Authority and its SWMR planning team.

A recent study of the potential for TOD in the southwest rail corridor has estimated the capacity of 800-metre station precinct areas for additional dwelling units where higher densities can be achieved. These are shown in Table 5.6,⁵³ which suggests there is large potential, especially where zonings are lifted in station precincts.

In the area of *Canning Bridge station*, planning by the Cities of South Perth and Melville is aimed at improving access to the station for pedestrians and cycling and promoting the rail/bus interchange as a significant transfer station; the 800-metre 'pedshed' includes most of the adjacent developing Applecross commercial and medium/high density residential area (all of this area is within 1.2 km of the station). Table 5.6 indicates potential for further residential

development, which will be enlarged by completion of new high density accommodation in the area.

South Street (Murdoch) station is another of those which will be in a previously developed area and has an established 925-bay park and ride carpark. The City of Melville has developed concept plans for higher density residential development in a small area of vacant land (Noalimba) which is 300 metres from the station, and is likely to amend zoning to medium density R40. Further land in this area owned by Murdoch University is likely to be released for commercial development.

Thomsons Lake station is part of the planned and emerging regional town centre of Cockburn Central. After announcement of the SWMR, structure planning has shifted attention to the government-owned land adjacent to the station. The Cockburn Central Draft Regional Centre Structure Plan 2001 provides for mixed development of commercial, professional and government, health and welfare and cultural services, with convenient pedestrian access to the station. The table indicates there is an opportunity for substantially enhanced residential capacity in the station area. This is a good example of TOD and will enhance the area's potential for increasing transit usage in a key part of the corridor.

Leda station is a greenfield site and is planned as the central focus of the Wellard Village development.

Table 5.6: Residential development potential in SW corridor station precincts

Station	Vacant land area (ha) (a)	Development Potential					
		Current zoning		With Revised Rcodes			
		Dwlg	Rcode	Dwlg	Rcode	Dwlg	Rcode
Stations with high availability of vacant land:							
Thomsons Lake	42.1 (b)	242	R20	606	R50	727	R60
Thomas Road	56.9	715	R20	2,900	R30/40	3,729	R40/50
Leda	163.2	1,958	R20	3,110	R30/40	3,999	R40/50
Waikiki	27.1 (b)	244	R12.5/15	1,987	R30/40	2,554	R40/50
<i>Subtotal</i>		3,159		8,603		11,009	
Stations with low availability of vacant land:							
Canning Highway	0.37	19	R50	22	R60	30	R80
Leach Highway	0.41	8	R20	12	R30	21	R50
South Street	0.45	9	R20	14	R30	23	R50
Rockingham	0.39	6	R12.5/20	12	R30	20	R50
Mandurah	5.7	93	R12.5/20	171	R30	285	R50
<i>Subtotal</i>		135		231		379	
TOTALS		3,294		8,834		11,388	

(a) 'Vacant land area' takes account of requirements for roads, open space and potential for future non-residential uses.

(b) Vacant land for all uses.

Comprehensive planning of the site is facilitated by its single ownership. It is being developed by government-owned Landstart and a private developer in accordance with the WA Planning Commission's 'Liveable Neighbourhoods' guidelines. Consistent with TOD, higher densities are proposed within the Village Centre.

Rockingham station is 2.5 km from the town centre. City of Rockingham officers, with the Departments of Planning and Infrastructure and Premier and Cabinet, are developing a Master Plan for the proposed Rockingham City Centre Transit Centre. Planning and design of the station precinct is at an early stage (the area referred to in Table 5.6 is not that now designated for the station precinct).

Mandurah station will be the terminus of the SWMR and an important rail/bus interchange. The area of the station is bounded by low density residential development, but there is a small area within the station precinct available for limited commercial/mixed use. There is potential for increasing residential development in the station precinct.

Issues raised by TOD opportunities

The issues raised by proposals for 'Transit Oriented Development' are important for the future of the south west corridor. Recent research confirms this view is widespread among local government officers and professional planners in the public and private sectors.⁵⁴ This research also suggests there is little optimism that policies and planning processes and instruments will achieve the outcomes advocated in this report.

There is a need for planning processes mandated by the WA Planning Commission setting out clear urban design principles for station precincts, rather than the current 'guidelines'. This could involve enforcing *minimum* R codes in selected areas.

These are not issues on which this study has sought to comment in detail, as there is clearly a need for more research to identify needs for improved processes and planning principles which could be developed by the WA Planning Commission and public and private sector planning and land development organisations. There is also a need for on-going research relating to how travel choices by Perth residents are influenced by specific types of urban design, including TOD. Our experience in this

areas is still limited to a few examples like Subi Centro.

The greatest opportunities to encourage change are in the undeveloped areas through which the new railway will operate, and where it will provide the greatest enhancement accessibility for residents, commercial businesses and public and private services.

6 CONCLUSIONS

The conclusions from this study are simple and can be summarised very briefly:

- On conventional measures of economic viability, the planned SWMR project is a good project, with a benefit-cost ratio of 3.3:1 at a discount rate of 7%, and an internal rate of return of more than 16%.
- Substantial environmental and other non-economic benefits would also flow from the project. The project offers a significant opportunity to sustain Perth's current levels of 'liveability', in spite of rapidly growing population and mobility.
- It is important that the railway be built when it is still possible for it to influence the future shape of development in the SW corridor – i.e., 'transit-led development'.
- Opportunities for increasing the range of housing and mobility choices and the effective operation of the new rail-based public transport system can be achieved by 'Transit Oriented Development' of station precincts in the southern corridor. There is evidence of commercial development already being attracted to these precincts.
- The evidence is strong from previous development of new and improved suburban railway infrastructure and services in Perth in the last two decades that users respond and there can be substantial transfer of travellers to rail.
- There is a need for further research in a number of areas relating to the integration of transport infrastructure and land use. In particular, research into how the travel choices and habits of newly arriving residents of the SW corridor respond to the greater availability of a strong rail-based public transport service.

APPENDIX 1: BASE CASE

Summary of 2006 forecast Base Case	
Land Use (Note: the land use for the rail direct scenario is identical)	MLUFS 2006
Road Network	MRWA 2006
PTA Network	Modified PTA 2006/07
PTA Infrastructure	Busway to Thomson's Lake No Rockingham – Fremantle Transitway
Mandurah & Rockingham linehaul bus routes	High frequency services (similar to 900 series)
Service frequencies	PTA specifications
Service routing	Mini links remain as feeders Feeders modified to through routes at Thomson's Lake and north

Forecast Year 2006

Land Use: There is little opportunity to impact on the land use in the short time frame to 2006, so the study has adopted the MLUFS (Metropolitan Land Use Future Strategy) 2006 projections.

Road Network: MRWA model network for 2006.

Public transport (PT) Network: Transperth SWMR-associated bus network for 2006/07 modified to reflect the absence of rail (see table).

PT Infrastructure: Freeway busway extended to Thomson's Lake; no Rockingham to Fremantle transitway. **Bus Services:** The key features are:

- Dedicated high frequency express bus routes from Mandurah to Perth and Rockingham to Perth introduced with access to Kwinana

Freeway at Safety Bay Road and Thomas Road respectively.

- Frequencies of series 900, major linehaul, feeder and mini link routes as per PTA specification.
- Mini link routes remain as feeder services to freeway linehaul routes.
- From Thomson's Lake and north all feeder routes extended as linehaul services on freeway to Perth CBD.
- South of Thomson's Lake all feeder routes remain as feeder services to linehaul routes on freeway.

Forecast Year 2021

Land use: The Base Case scenario land use re-locates between 5% and 10% of the MLUFS projected population from the south west corridor to the inner Roe Highway ring south of the river (part "dense city") and to the Joondalup area north of the river (part "regional centres city").

Alternative projections developed for Future Perth Strategic Transport Evaluation (at 2031) included a "compact city" (development constrained to the existing urban extent and the current 5 year MDP) and a "regional centres city" (development concentrated on Joondalup and Rockingham). As a separate policy evaluation by the Portfolio Policy and Strategy Branch of DPI a "dense city" scenario (development concentrated within the Reid/Roe Highway ring) has already been modelled for 2021. In 1996 some 52% of households were located within the ring. In the "business as usual" projected land use this falls to 40% by 2021. The "dense city" restores this to 52%.

Summary of 2021 forecast Base Case	
Land Use (Note: land use for the rail direct scenario is:	MLUFS 2021 revised downwards to reflect slower population growth in south west corridor MLUFS 2021 revised upwards to reflect a higher population growth in the south west corridor)
Road Network	MRWA 2031 network in south west corridor
PT Network	Interpolation of PTA 2006 network and Future Perth 2031 base network
PT Infrastructure	Busway to Safety Bay Road Rockingham – Fremantle Transitway
Mandurah & Rockingham linehaul routes	High frequency services (similar to 900 series)
Service frequencies	Upgraded from PTA specifications
Service routing	Additional routes: 2 Thomson's Lake 3 Rockingham 5 Mandurah

Road network: The 2031 MRWA network has been previously modelled. To reflect the “car based” emphasis of the “no rail” scenario the

MRWA program of road construction projects in the south corridor between 2021 and 2031 be advanced ten years to between 2011 and 2021.

Public transport (PT) network: Three public transport networks for 2031 have been previously modelled for the Future Perth Project, a base case (car-based) and two public transport-based networks. The 2021 PT network will be an enhanced 2006 network with additional routes (mostly in the Mandurah area) and upgraded frequencies representing a development towards the 2031 base case network.

PT Infrastructure: The major linehaul routes connecting Rockingham and Mandurah to Perth and Fremantle have been expanded to provide for exclusive right of way on some routes (or parts of routes). The maximum extent of this right of way is a busway along the Kwinana Freeway to Baldivis (Safety Bay Road) and a Transitway between Rockingham and Fremantle

ENDNOTES

- 1 The standard accounting life of the rail track asset is 50 years, but significant elements of this asset, e.g. the right-of-way and track formation, are 'permanent'. Physically, the railway track and associated assets will last indefinitely if fully maintained, although elements of it (e.g. electrical wiring and signaling) may be replaced for reasons of obsolescence within the 50-year life.
- 2 http://www.newmetrorail.wa.gov.au/files/rdb/NewMetroRail_Supplementary_Master_Plan_Aug2002%28web%29.pdf
- 3 http://www.newmetrorail.wa.gov.au/city/documents/pcrac_final_report.pdf
- 4 "The Difference that Metropolitan Strategies Make: the Australian Experience", a research paper prepared for Planning NSW by the Urban Policy Program, Griffith University, June 2003 (unpublished).
- 5 Western Australian Planning Commission (2003b), page 3
- 6 Western Australian Planning Commission (2003b), *Greater Perth: Integrating Land Use and Transport*. Discussion Paper Five, pages 1-2.
- 7 John Taplin (2003), "A Simple Demand Model to Project Consumption Impacts of Rising Petrol Prices", 25th Conference of Australian Institutus of Transport Research, Adelaide 2003.
- 8 Ray Brindle (2003a), "Kicking the habit (Part 1): some musings on the meaning of 'Car Dependence'", *Road & Transport Research*, September 2003; and Brindle (2003b), "Kicking the habit (Part 2): What are the real options for reducing 'Car Dependence'?", *Road & Transport Research*, December 2003.
- 9 Ian Ker (2002), *Preliminary Evaluation of the Financial Impacts and Outcomes of the TravelSmart Individualised Marketing Program – Update*, for the WA Department for Planning and Infrastructure.
- 10 Department for Planning and Infrastructure (2000), *Population Report No 4, Western Australia Tomorrow, October 2000*; medium scenario projections.
- 11 Western Australian Planning Commission (2003a), *Greater Perth: Population and Housing*. Discussion Paper Two. Page 29.
- 12 This was the average density in 1995. Source: J. Kenworthy and F. Laube (2001), *The Millennium Cities Database for Sustainable Transport*, prepared for the International Association of Public Transport and the Institute for Sustainability and Technology Policy. Data from CD-Rom database.
- 13 RAC Foundation for Motoring and the Environment (1995), *Car Dependence*. Quoted in Western Australian Planning Commission (2003b), page 53.
- 14 There is a vast literature on this topic. A recent and very comprehensive review of this literature, with estimates relevant to Perth conditions, is contained in a 2-volume report to the WA Department of Planning and Infrastructure by GHD Pty Ltd and the Australian Road Research Board Transport Research (2003), *External Costs of Transport, Technical Report; and Guide for Project Evaluators*. See also David A. Hensher and Kenneth J. Button (2003), *Handbook of Transport and the Environment, Handbooks in Transport*, Volume 4.
- 15 Laura E. Jackson (2003), "The relationship of urban design to human health and condition", *Landscape and Urban Planning*, No 64, p 196.
- 16 See for example Irene van Kamp, et al (2003), "Urban environmental quality and human well-being. Towards a conceptual framework and demarcation of concepts; a literature study", *Landscape and Urban Planning*, No 65, pp 5-18.
- 17 Charter, Keck Cramer, Strategic Property Consulting (2001), "Cars – Where are They Taking Us?" *Research Insight*, March 2002, prepared by Blair Warman, Senior Urban Economist.
- 18 Australian Bureau of Statistics, Cat No. 6535.0 1998-99 *Household Expenditure Survey, Australia: Detailed Expenditure Items - companion data*, Table 2. Household Expenditure on Goods and Services, by Capital city-1998-99.
- 19 'Transport expenditure' defined for this comparison includes all motor vehicle purchase and operation expenses and public transport fares. It excludes air fares, taxi fares and removal and other freight transport charges.
- 20 Kinhill Engineers and Queensland Department of Housing Local Government and Planning (1995), *Smart Planning Not Sprawl: the Costs and Benefits of Alternative Fringe Development*. Discussion Paper No 5 (Australian Urban and Regional Development Review), cited in *Costs of Urban Form. Discussion Paper*, by SGS Economics and Planning Pty Ltd for the WA Planning Commission, May 2003.
- 21 Kenworthy and Laube (2001). See also J. Kenworthy and F. Laube (1999), "The significance of Rail in Building Competitive and Effective Urban Public Transport Systems: An International Perspective", *Global Mass Transit*, 69-74, November.
- 22 Motor Vehicle Environment Committee (2003), *Vehicle Emissions and Fuel Standards Review, Discussion Paper*, prepared by the Department of Transport and Regional Services and Environment Australia on behalf of MVEC Vehicle Emissions and Fuel Standards Review Working Group, 16 May 2003, pp 15 & 19.
- 23 WA Planning Commission (2003), "Dialogue with the City, Survey Results", conducted by Colmar Brunton for the Department of Planning and Infrastructure, page 1.
- 24 Ian R. Ker (1994), "Riding the (Suburban) rails: Views from the Cab or the Caboose?" Presented to the Australian Institute of Traffic Planning and Management, 8th National Conference, Sydney ; reference paper 94/5.
- 25 Australian Bureau of Statistics, *Australian Demographic Statistics* (3101.0). This is part of the radical 'sea change' population movement described by Bernard Salt in *The Big Shift* (2003).
- 26 Western Australian Planning Commission (2003b), page 37.
- 27 Western Australian Planning Commission (2003b), page 4.

28 The areas referred to in the SW region are shown in the table below:

SW Suburbs (excluding those with no residents)			
Inner	Middle	Outer	Fringe
Como Manning Northbridge Perth Salter Point South Perth West Perth	Applecross Bateman Bibra Lake Brentwood Bull Creek Mount Pleasant Murdoch North Lake Rossmoyne	Atwell Banjup Bertram Calista Cooloongup East Rockingham Hillman Leda Orelia Parmelia Rockingham Safety Bay Success Wandi Warnbro	Golden Bay Greenfields Madora Meadow Springs Parklands Port Kennedy Secret Harbour Singleton Waikiki

29 The Australian Bureau of Transport and Regional Economics has noted the “Lack of an established theoretical framework for multi-criteria analysis [MCA]...” and that “...most Australian MCA studies appear to use the goals achievement matrix approach... The GAM approach is based on ‘scoring’ goals (or ‘impacts’) that are considered relevant to the evaluation of a project. The results are adjusted by applying weights determined by analysts or planners.” The Bureau goes on to comment:

Despite the very considerable mathematical and statistical sophistication that has been applied to weighting and scoring systems, the underlying analytical framework remains highly arbitrary and subjective. Nor can weighting systems obviate any errors introduced by double counting where overlapping goals are included in the analysis. A major failing of the GAM approach is its limited policy relevance, because it cannot be used to compare projects in different sectors. A road project subjected to GAM analysis cannot be compared directly to the results tabulated for a hospital project, for example, in the absence of a common metric. Even if a GAM analysis is used to compare different transport alternatives, a BCA is still essential if decision-makers are to be informed of the overall social cost.

For a fuller critique of MCA see

<http://www.bte.gov.au/docs/htm/chap13.htm>.

30 Y. Hayashi and H. Morisugi (2000), “International comparison of background concepts and methodology of transportation project appraisal”, *Transport Policy*, 7, pages 73-88.

31 Sinclair Knight Merz (1999), *Economic Assessment of the Proposed South West Metropolitan Railway, Final Report*, for the WA Department of Transport. The evaluation framework used by Sinclair Knight Merz study and by this PATREC study were described as follows in the Sinclair Knight Merz (1999) report (second page of Executive Summary):

The results ... were derived from a conventional quantified cost-benefit analysis, which measured the changes in consumer and producer surpluses plus external third party impacts, and compared these with the incremental capital and operating costs. Each option is evaluated on an incremental basis from the Base Case. The economic benefit measures used are the following:

- *User benefits are measures of gains in consumer surplus. These benefits have been estimated using a variety of measures including:*
 - *Willingness to pay [see note 35 below], a measure of amenity benefits to passengers diverting to the new rail link*
 - *The reduction in vehicle operating and travel time costs for car users who stay on the road network, and the savings in travel time costs for bus users who remain on the bus as a result of a less congested network.*
- *Operator benefits are measures of gains in producer surplus estimated as changes in operator costs (bus and rail) and fare revenues (for car switchers) associated with different passenger levels. The evaluation assumes that there is no change in overall producer revenues as a result of passengers switching from line haul bus to rail because of Perth’s zonal fare structure.*
- *External benefits are estimated as:*
 - *Avoided costs of accidents and pollution*
 - *Avoided costs of road construction*
 - *Avoided costs of road damage.*

32 Asymptote Consulting (2003), *Strategic Transport Evaluation Travel Demand Model: A Technical Report on*

the Model – Description, Calibration and Validation of Spectre 2.0, prepared for the Department of Planning and Infrastructure, February 2003. This publication was prepared to document the use of the SPECTRE model for the 1999 evaluation of the SWMR ‘Kenwick’ route, and details the operation of the model, its calibration, forecasts, economic and other values used, and outcomes obtained in that study. For the current study reported here, the same model has been used (with minor technical improvements), and data have been updated where appropriate to reflect recent values (household incomes, parking costs, car operating costs, public transport fares, and values of time).

33 The journal *Transport Policy* has published a series of summaries of transport project evaluation practice in North America, Europe and Asia. The article summarising US practice provides a useful overview of the principles underlying economic evaluations of the kind presented in this report: D.B. Lee Jr. (2000), “Methods for evaluation of transport projects in the USA”, *Transport Policy* 7 (2000), pp 41-50.

34 These values are the same as were used in 1998 evaluation of the ‘Kenwick route’ by consultants SKM, WA Department of Transport (1999), brought up to 2003 values using the Australian Bureau of Statistics CPI.

35 The benefit to travellers changing to rail from bus and car is measured by their ‘consumer surplus’, i.e. the amount they would be willing to pay if required to do so. This is conventional practice (see Y. Hayashi and H. Morisugi (2000), and was also used by the 1998 SKM consultant’s study of the ‘Kenwick route’. The report from that study, in Sinclair Knight Merz (1999), page 14, described the approach used in that study (which was also used in this study by PATREC) as follows:

A willingness to pay measure (WTP) has been used as a proxy for the benefits derived by passengers diverting to rail from car and bus.... Average travel times are modelled to increase on the network, as a result of passengers joining the existing network and travelling greater distances [this occurs less with the current SWMR proposed route]. Clearly, diverting

passengers derive some benefit from changing to rail ... other they would not do so.

The following measures have been adopted for changes in consumer surplus:

- For passengers diverting from bus to rail, the WTP for rail minus the fare
- For passengers diverting from car to rail, the WTP for rail minus the fare minus the consumer surplus for car....

Because of the dominance of car travel, it is likely that car travellers would be enjoying some consumer surplus, i.e. they would be willing to pay more to stay in their cars. Hence, the benefits to diverted traffic away from the car must subtract so me estimate of this consumer surplus.

A figure of \$7 [\$8.20] per trip has been adopted for the WTP in the rail [option] ... and \$1 [\$1.17] per trip for the consumer surplus associated with car travel. An average fare of \$5 [\$5.86] has been used.

The figures in square brackets in the final paragraph above are the figures used in the study, which are the SKM figures adjusted for inflation (multiplied by 1.17 for the CPI change since the 1998 study.

36 Office Of The Rail Regulator (2003), *Weighted Average Cost of Capital to apply to WestNet Rail and the Western Australian Government Railways Commission*. Determination of the Western Australian Independent Rail Access Regulator in accordance with the requirements of Clause 3, Schedule 4 of the Railways (Access) Code 2000, 1 July 2003, Page 23.

37 Bureau of Transport and Regional Economics (1999), *Facts and Furphies in Benefits Cost Analysis*. <http://www.bte.gov.au/docs/html/chap6.htm>.

38 Data in Table 5.3 are sourced from GHD Pty Ltd and the Australian Road Research Board Transport Research (2003), *External Costs of Transport - Guide for Project Evaluators*, prepared for the WA Department of Planning and Infrastructure; and Sinclair Knight Merz (1999). See table notes for further information.

39 See for example the much larger range of environmental impacts and higher unit values proposed by

the Canada-based Victoria Transport Policy Institute, in Todd Litman (2002), *Transportation Cost and Benefit Analysis: Techniques, Estimates and Implications* (Litman includes the costs of road trauma, parking, congestion, land value, traffic services, transport diversity, air pollution, noise, barrier effects, resource externalities, land use impacts, water pollution and waste (total AUD 1.77 per car-km). On the other hand, Pratt (2002) proposes lower values, in Caroline Pratt (2002), "Estimation and valuation of environmental and social externalities for the transport sector", in *Proceedings of 25th Australian Transport Research Forum* (Pratt includes the costs of road trauma, air pollution, greenhouse gases, water pollution, noise pollution (total AUD 0.024 per car-km); Pratt suggests a number of factors considered by Litman for further development, including vibration, barrier effects, loss of amenity value and loss of land). These alternative estimates compare with the total value of externalities of AUD 0.1/car-km used in this study.

40 There is substantial empirical research demonstrating the substantially smaller energy consumption of urban commuter rail services compared with use of motor vehicles. A recent authoritative European contribution is in an OECD report, Working Party on National Environment Policy, Working Group on Transport (2002), "Environmentally Sustainable Transport : Is Rail on Track?" *Report on the International Conference on Environmentally Sustainable Transport*, Sweden 2002, document ENV/EPOC/WPNEP/T(2001)9/FINAL, page 21.

41 J. Kenworthy and F Laube (2001), *The Millennium Cities Database for Sustainable Transport*, prepared for the International Association of Public Transport and the Institute for Sustainability and Technology Policy. Data from CD-Rom database.

42 The figures used here are consistent with those shown in Stephen Potter (2003), "Transport Energy and Emissions: Urban Public Transport", in David A. Hensher and Kenneth J. Button (eds.), *Handbook of Transport and the Environment*, Handbooks in Transport Vol 4, 2003, page 254.

43 Sinclair Knight Merz (1999), *Economic Assessment of the Proposed South West Metropolitan Railway, Final Report*, for the WA Department of Transport, January 1999.

44 Sinclair Knight Merz (1999), Executive summary, [page 1].

45 Source: Public Transport Authority.

46 A very useful synthesis is: Douglas R. Porter (1997), *Transit-Focused Development: A Synthesis of Transit Practice*, TCRP Synthesis 20, Transportation Research Board; and Department of the Environment and Department of Transport (UK (1993), *Reducing Transport Emissions through Planning*. Page 52.

47 Porter (1997), pages 7-8.

48 Porter (1997), pages 6-8.

49 Department of Transport [NSW] 91995), *Shaping Up: Integrating transport and urban structure in New South Wales*, page 3.

50 Some empirical research in Perth has suggested that transit users are willing to walk greater distances than 800 metres to railway stations, and that standard 'pedsheds' (pedestrian catchments) should be expanded to 1.2 kilometres. Ian Ker and Simon Ginn (2003), "Myths and realities in walkable catchments: The case of walking and transit", *Road and Transport Research*, Vol. 12 No. 2 (June 2003)

51 WA Planning Commission (2002), *Strategic Land Use and Transport Integration Study, Final Report*, June 2002.

52 SGS Economics and Planning Pty Ltd (2003), *Costs of Urban Form. Discussion Paper*, for the WA Planning Commission, May 2003.

53 Rhiannon Russell (2003), *Getting on Track. The Perth to Mandurah Rail Line: Opportunities for Transit-Oriented Development*, Thesis for the degree of BA (Hons) (Sustainable Development), Murdoch University, 2003.

54 Russell (2003), page 157ff.