



UCL

PROJECT PROFILE

Australia

South West Corridor Railway

omega centre

Centre for Mega Projects in Transport and Development

A global Centre of Excellence in Future Urban Transport
sponsored by Volvo Research and Educational Foundations (VREF)

This report was compiled by the University of Melbourne, Melbourne, Australia.

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A INTRODUCTION

Type of project

Project name

South West Corridor Railway.

Description of mode type

Urban railway.

Technical specification

The Perth to Mandurah rail line travels 70.1km from central Perth to Mandurah in the south. The line crosses the Swan River at the Narrows Bridge and follows the central median of the Kwinana freeway south to Jandakot. At Jandakot the line passes from the median of the freeway under the western lanes and then takes a route separate to the freeway to Rockingham and then south to Mandurah.

Future rapid transit in the northern corridor which is directly connected to the Perth to Mandurah line will mean the line extends beyond Yanchep and will be a total of 120km long (Department of Transport, 2000, p1).

The technical specifications of the line allow for speeds of up to 140km/hr, and are as follows (for full details see (Martinovitch, 2002)): the railway is 1067mm gauge, with two tracks for the entire length, constructed for 16 tonne axle load with 50kg/m standard carbon steel rail fastened on concrete sleepers (except from Northbridge to Mount Henry Bridge where continuous concrete slab track is laid with 60kg/m rails). The track is laid in continuous steel ribbons to ensure a smooth ride, with a maximum speed of 140km/h.

The railway has no level crossings between Perth and Mandurah, but there are 29 grade separated crossings of roads, two river crossings (the Swan River on the Narrows Bridge and the Canning River on the Mount Henry Bridge) and two sets of tunnels. The main set of tunnels run beneath the central business district for 600m from Northbridge under the Fremantle railway tracks through to the Esplanade train station. The second set of tunnels allows egress from the Kwinana freeway median under the western lanes of the freeway at Jandakot just after Anketell Road.

The project included development of two new underground stations within the central business district, and nine other stations (Wikipedia, 2009). Learning from the northern suburbs railway, the project designers looked at the concept of needing to have 'catchment areas' for services. They found that for successful feeder buses there needs to be a large enough catchment for the bus, which is why most of the stations are placed about 4km apart (Gill, 1992).

Below ground the tunnels under the CBD were constructed using the bored tunnel method to the underground station at the Esplanade. The Esplanade station was constructed by cut-and-cover methods. A shallow cut-and-cover tunnel, containing two tracks, extends from the south end of the Esplanade station to a point 80m from the Kwinana Freeway. The tracks emerge from the tunnel, pass under the southbound carriageway of the freeway before curving south to run over the Narrows bridge in the freeway median. The northbound track runs on the new Narrows Bridge and the other track runs on its own bridge between the old and new Narrows bridges.

New electricity feeder stations were provided at Kenwick, Jandakot and Karnup, taking 132kV supply. Midpoint switching stations of 25kV were built at Esplanade, Leda, Anketell and Waikiki.

Thirty-one three-car units (comprising 93 cars) were supplied by EDI Rail-Bombardier Transportation Pty Ltd, representing almost a doubling of the size of the urban rail passenger car fleet.

A railcar depot for repairs, maintenance, cleaning and sidings for overnight stabling and minor maintenance attentions was constructed in East Rockingham just south of Wellard Rd, on the western boundary of the Kwinana-Mundijong railway reserve (Department of Transport, 2000).

Figure 1: section of principal infrastructure



Principal transport nodes

Planning and design of the nine transit station sites had four objectives: identify function; quantify function; define precise land requirement and location; identify and estimate costs. This was achieved through: patronage projections; analysis of catchment size and modes of access; briefing stakeholders; stakeholder consensus; concept development; planning and design. Each site addressed: town planning; forecast patronage on each modal component; transit station function; bus feeder services; road traffic and internal circulation; parking configuration; pedestrian and bike facilities; platform configuration; and special requirements (Martinovitch, 2002, p47).

Transit stations were designed to blend into the surrounding environment and become icons (Department of Transport, 2000). Landscaping was used to return areas around the stations and track to the original state where possible. Areas for three future transit stations have been reserved at Success, Mandogalup and Anketell (Department of Transport, 2000, p67).

Transit stations at Ennis Avenue and Dixon Rd were designed to meet acceptable individual and society risk parameters. Gas and fuel pipelines in the rail reserve required assessment of risk at transit stations. Risk management measures were required (Department of Transport, 2000, p59).

Transit stations are 'intermodal passenger transfer points'. They are placed at the "convergence of the railway and major regional feeder roads as interception points to maximise the convenience of access by potential patrons and minimise disinclination to transfer from initial mode" (Department of Transport, 2000, p75). The stations were located to get the largest walk on numbers possible (Martinovitch, 2002, p29).

The transit station at South Perth was not built because there was no room for parking, and therefore even though South Perth is a high density residential area, patronage was considered to be low (Martinovitch, 2002, p49). Provision is made in the freeway median for later installation of this station. Further details of the current transit stations are provided below.

Canning Bridge

Canning Bridge, located at the junction of Canning Highway with the Kwinana freeway, is the first transit station travelling south from Perth. It serves primarily as a connection with Curtin University. A bus station was developed as part of the station on the Canning Highway as it crosses the freeway. Bus only entrance ramps onto the freeway allow buses to connect with the bus transit lane running north along the inside lanes of the freeway. These bus transit lanes are the remnant of the bus system which the train replaced. The station has high pedestrian access mainly from the buses. Curtin University is accessible via a ten minute bus ride and provides the major trip generation point. There is no Park-and-Ride (Martinovitch, 2002).

Planning by City of South Perth and City of Melville, is aimed at improving access for pedestrians and cyclists and promoting bus/rail interchange. The 800m pedestrian shed includes most of the developing Applecross commercial and medium/high density residential area (all within 1.2km of the station) (Planning and Transport Research Centre (PATREC), 2004, p22). The station is difficult for pedestrians to access because of the clover leaf design of the 'on and off' ramps for general traffic for the freeway. However, the problem is less acute than that of later stations, because the road design is from the late 1970s to 1980, with tighter curves at the ramps.

Pedestrian access to the station is very convoluted, as when crossing the river (bottom of Figure 2) there is a footpath only on the northern side of the bridge. Pedestrians join the cycle way passing beneath the Perth direction on the ramp, before crossing the extension of the bus lane to an island (direction south) and then turning east to cross the rest of the bus lane to access the station on the northern side of Canning Highway. Access to the bus station on the southern side of Canning Highway is obtained either by descent to the station platforms, crossing under the road and then ascending the other side, or by travelling the length of the bridge over the freeway to the eastern end and crossing at pedestrian lights at the eastern end of the bus station. This presents a primary barrier to the success of any transit oriented development proposed on the western side of the river.

Figure 2: Canning Bridge



Bull Creek - Leach Highway

Bull Creek station is in the freeway median and connects vertically to a purpose built bus concourse running alongside Leach Highway. Outside the area bounded by the on and off ramps of the freeway, the station is surrounded by low density residential housing. In the top right hand corner of Figure 3 is the Royal Australian Air Force Retirement Village, which is two-, three- and four-stories at most. The housing at the bottom right of Figure 3 is new medium density housing. Both developments are surrounded by a high wall, the project for the station included a hole in the wall of the retirement village and development of a pedestrian walkway to provide access to the bus concourse. There is considerable pedestrian flow to local schools, but pedestrian access to the station is inhibited by the on and off ramps to the freeway, the clover leaf pattern of which is much bigger than seen at Canning Bridge, and which have been further developed to allow access to and egress from the parking area for the station. Bull Creek is a major transit interchange with facilities for bus-rail interchange, parking for 700 cars, car set down/pick up and walk on/bike facilities (Martinovitch, 2002, p50).

Due to the importance of the Leach Highway as a major east-west connection between Fremantle and the Albany Highway, the Freeway interchange was initially designed to provide maximum possible unconstrained movement for vehicles. Pedestrian access to the station from the west (bottom of Figure 3) and the south east (the retirement complex) is relatively straightforward. Access to the station from the northeast (top left of Figure 3) requires pedestrians to cross the off ramps of the freeway, and then turn south, crossing half Leach Highway, before proceeding the length of the bus concourse down a footpath provided in the centre of the highway. At the western end of the footpath, pedestrians must cross back to the north side of the highway, continuing west between the Highway and the freeway on ramp, before turning south to cross the entire Highway, and then east again to cross the freeway exit ramps, and the access point to the station car park.

Figure 3: Bull Creek - Leach Highway



Murdoch

Murdoch is a major transit interchange 14km south of Perth. It has two significant trip generating sites nearby; Murdoch University and the St John of God hospital (both located to the west of the station, left of Figure 4). The station is located in the freeway median attached to a purpose built bus concourse. There is provision for 925 parking bays. The bus station is on the Circle bus route and riders can access Bull Creek shopping centre on South St. There is land available for development to the southwest (lower left hand side of Figure 4) (Martinovitch, 2002). City of Melville has plans for higher density residential development in a small area of vacant land, Noalimba, 300m from the station. They are likely to zone the area medium density R40. Further land owned by Murdoch University is likely to be released for commercial development (Planning and Transport Research Centre (PATREC), 2004, p51).

St John of God hospital is the largest private hospital in Western Australia and the second largest employer in the southern suburbs, currently with 1,200 employees. The government is also establishing the new Fiona Stanley Tertiary hospital and a health precinct on an adjoining site (the yellow area at the bottom left of Figure 4). It is due to open 610 beds in 2011 and over 1,000 beds by 2015. The educational facilities will have, by 2011, 19,000 students, and the combined hospitals and educational facilities will have 7,000 employees. Between these developments and the station there is a planned retail and residential complex which will sit on top of the existing car park, including a main street development with offices and biotech industries leveraging off the health, veterinary and agriculture departments (Alannah Mactiernan MLA, 2006). The planned TOD development will possibly also include changes to the road network, especially the northbound off ramp of the freeway, and require rethinking for access to what remains of the car parks. The proposed TOD is the subject of a full master plan, but there is still uncertainty about who is responsible for developing areas that are not hospital land.

Figure 4: Murdoch



Cockburn Central

Cockburn Central is a major transit point which intersects with Cockburn Central shopping centre, a big box shopping centre on Armadale Rd, serving the southern corridor of Perth (outside the frame of Figure 5 in the lower right hand corner). Parking at the station is currently limited (Martinovitch, 2002, p56). The station is part of the emerging regional town centre of Cockburn Central. Landcorp has developed structure plans for the area which provide for mixed development of commercial, professional and government, health and welfare and cultural services with pedestrian access to the station. In the bottom of Figure 5 can be seen the first of the planned high rise developments, on old industrial land (Planning and Transport Research Centre (PATREC), 2004). Cockburn Central will ultimately serve a population of more than 200,000 people living and working in the region (Alannah Mactiernan MLA, 2006).

One of the issues with the station location was its relationship to the shopping centre. The metropolitan regional centres policy is to allow one developer 50,000m² of floor space. Thus the proposed TOD is mostly residential, due to caps placed on any other areas containing retail spaces. The station includes a bus interchange, with an underpass under the main road to allow buses to connect with the shopping centre at the front of the shopping centre. However the shopping centre has resisted this on the grounds that people buying groceries do not travel by bus, and the buses have been relegated to the back of the shopping centre. However the new owners of the centre have made adjustments to their future plans for the centre, to focus development towards the expected TOD development, which may create a walkable environment with the right sort of urban design.

Already urban design principles have been used in developing the connection from the proposed development to the station in the centre of the freeway. An enclosed tunnel allows pedestrians to travel from the development to the station at the same level before going

down only once to reach the required platform. The proposal is to continue this idea where possible to minimise difficulty for pedestrians in navigating what are reasonably large distances. Initial plans to have the car park located directly outside the station were revised, with the configuration in Figure 5 the result. The WAPC has retained ownership of the land currently used for car parks , so it will be possible to change that use in the future as it becomes logical to do so.

Figure 5: Cockburn Central



Kwinana

Kwinana station is located just south of Thomas Rd and is the first station following the departure of the train from the freeway median. The station development included development of parking bays and an access road, the extension of Sulphur Rd. The undeveloped land seen in Figure 6 is an extension of vegetation from the reserved bushland north of Tomas Rd.

Kwinana is an old residential area built in the 1950s. There are five suburbs in Kwinana but none are actually called Kwinana, which is the name of the local authority. The main areas of current residential development lie to the bottom left of Figure 6. Urban infill has brought the houses to within 600m or so of the station site. The land directly around the station is owned by developers, with a new development called Belgravia Heights being built by Satterley Property Group south of Suphur Rd on the eastern side of the freeway (bottom right below in Figure 6). Subdivision of this development has been completed, and land sales and development have commenced. The subdivision has been made with fairly small frontages and lots to provide reasonably high housing density of about 35 dwellings per net hectare. This is in line with the directives of the policy on livable neighbourhoods.

Figure 6: Kwinana



Wellard

Wellard Station is planned as the central focus of Wellard village development (Planning and Transport Research Centre (PATREC), 2004). Wellard village will be an extension of development already in place just to the north (top right hand side of Figure 7). In some literature concerning the railway, the station was called Leeda. Figure 7 indicates that development is already in progress, with the road layout and central square already in place (upper half of Figure 7). Sales of house and land packages had just commenced in November 2008 when this research was undertaken. Both bridges shown in the picture were put in place as part of the station development. As a new development the site has good options for pedestrian access, and car parking has been developed on the opposite side of the railway to provide maximum opportunity for walk-on ridership.

Figure 7: Wellard



Rockingham

Rockingham is fairly old town, about 30km south of Perth, which used to serve Perth as a seaside resort. Rockingham station is approximately 2.5km from the newly developed town centre. The City of Rockingham is developing a plan for a town centre, to which transit will be required (Planning and Transport Research Centre (PATREC), 2004). At present the new town centre and foreshore are serviced by a dedicated busway and shuttle bus, which acts like the Perth CAT services, running at high frequency and costing no more than the train ticket already in hand.

Although land development around the station is considered limited, the area south of the station (lower portion of Figure 8) and between the station and the town centre provides lots of potential for development. The government has promised the City of Rockingham that it will upgrade the bus system with a light rail system once population density has built. In line with this promise the project included provision of groves within the laid concrete for the tracks of the lightrail system when it is built. Rockingham also has a university campus and is a major destination in its own right (Alannah Mactiernan MLA, 2006).

The railway enters the picture in Figure 8 (top) following the Garden Island Highway reserve, which continues straight through the picture. The station is located where provision has been made for the intersection of the future highway with Ennis Avenue. The land on which the car park sits, extending past the bottom of Figure 8, was available as a future diamond interchange with these major roads. The open space currently around the station is the remaining road reservation and, although a carriageway could be built along the railway line, in the current road reserve, this is now considered unlikely. The space is therefore available for either an extension of the parking bays or TOD. The transit way that has been built includes an underpass under Ennis Avenue, with rapid access into the centre of Rockingham.

While development plans have not yet been concluded for the area, the PTA would like to see TOD development there.

The City of Rockingham however has a focus on development of what it calls its main street near the council buildings, although development has been slow to achieve. A great deal of land is available along the planned street, but most development in Rockingham tends to focus on the foreshore. The Council has moved a number of playing fields around the council building to promote the development of a main street and TOD development along it.

The positioning of the station in Rockingham was a major controversy for the project, the problem being that the City of Rockingham wanted to bring the railway into the centre of the city, but without creating a barrier to movement. As noted above the city centre is located several kilometres from the main line, and therefore bringing the line into the centre would necessitate creating a considerable kink in the line, subsequently slowing the trains as they negotiated the corners. It was initially proposed in the SWAT study that this could be overcome with a tunnel, at the cost of an extra AUD 100m. An alternative spur line was suggested using the cut and cover method at a cost of AUD 35-50m (South West Corridor Transport Study Steering Committee, 1990). The SWAT study concluded that the costs of either option were unrealistic for the project but, after protests by the City of Rockingham and further negotiations, the Master Plan of April 2000 was put forward with three options for Rockingham proposed: the direct line – supplemented by a busway to the city centre; through the city centre, with the central core of the route below ground; and a longer tunnel version. The base cost of the project was estimated at AUD 868.7m without the Rockingham loop or AUD 988.7m with it (Department of Transport, 2000). As noted above the direct route was finally chosen with a bus transit provided.

Figure 8: Rockingham



Warnbro

After departing Rockingham, the train line follows Ennis Avenue (the major route south to Mandurah). Warnbro is a major transit interchange with 700 parking spaces for Park-and-Ride (Martinovitch, 2002). Warnbro serves the already developed area of Rockingham including the suburbs of Safety Bay, and Waikiki. As is the case elsewhere the train line traces the outside of this development rather than attempting to traverse the centre. The undeveloped land on the east of the train line (top half of Figure 9) is reserved to protect the underground water mounds and forms part of the Lake Kalinga National Park.

Figure 9: Warnbro



Mandurah

Mandurah is the final station on the line. There is some potential for development to the east and west of the line, (top and bottom of Figure 10) but it is limited. There is also some provision for train stowage (Martinovitch, 2002, p65). Mandurah has space for development of limited commercial/mixed use (Planning and Transport Research Centre (PATREC), 2004, p23). The station is located approximately 2km from the centre of town and main tourist attractions. The council has made a free bus service available connecting the centre of town and city hall with the station. All other Transperth bus lines serving the Mandurah area also connect with the station, which includes a bus station and bus stabling area. The land between the station car park and the housing in the bottom of the picture is all owned by WAPC and thus is potential TOD. The station, while not in the centre of Mandurah as it is currently configured, is very central to a number of trip attracting sites, sitting almost equidistant from Mandurah city centre, the beach and Peel Health Campus. The potential for successful TOD development is thus considered very high.

Figure 10: Mandurah



Major associated developments

Circle bus route

The Circle bus route connects a number of centres around Perth's CBD. It was introduced in 1999, and has increased services to every 15 minutes on weekdays and every 30 minutes on weekends and weeknights. The route connects with the Perth to Mandurah train line at Murdoch, and with the northern end of the line at Stirling. The route connects all of the major university campuses in Perth. Around 100,000 passengers use the bus each week (Transperth, 2010).

LUTI projects around stations

In addition to the planned developments around the existing stations, the railway has pre-empted village building around future stations. "According to the WA planning commission, plans for the SWMR have increased the residential development projections of the corridor by more than 50% with developers indicating that 'the South-West and Peel planning sectors could now develop at twice the rate of Perth's North-West sector'" (Planning and Transport Research Centre (PATREC), 2004, p8).

The cost benefit analysis of the project estimated that there could be a benefit ratio of 3.3:1 at a 7% discount rate, and IIR 16%, for the project in part due to the opportunities for TOD (Planning and Transport Research Centre (PATREC), 2004). A TOD development has been created at Harvest Lakes by Landcorp. It is an environmentally friendly estate, one of the first developed. The village centre is planned around one of the original south west master plan transit stations which has subsequently not been built. It has medium density and a neighbourhood centre near the future station site. There is room for a car park on the other side of the freeway, under the high voltage powerlines. However it is not currently planned

to develop the station, as a longer term vision for the next set of stations has not been undertaken by the PTA.

Development of the city centre

The project included development of two new stations in the city centre. The objective of the city project was to improve access to the southern part of the city through providing better public transport options, particularly at the Esplanade. "It will help liberate central Perth from cars, making it a pleasure to walk the streets and savour the bright lights of the big city" (Leighton Kumagai Joint Venture). Another objective was to encourage development opportunities at the north end of William St, which had become relatively run down. The South West Railway Master Plan estimated that over the 25 years to 2031 the SWMR will encourage an additional AUD 210m worth of development in the central business district of Perth (Martinovitch, 2002, p38). The entire city block above Perth Underground station was purchased by WAPC to allow for the station development. The land above the station was then made available for development as a single site using LandCorp as the vehicle to manage the exchange. Seven buildings were demolished to make way for a new five-star green energy office building, the first of its kind in Perth.

Figure 11: Perth Underground Station Development



Source: LandCorp, 2008

The site is indicated in Figure 12. Beside it on the other side of William St is another large development known as Rain Square.

Figure 12: Perth underground development site and Rain Square development site



Source: Google Earth, 2010

Amalgamation of department

On gaining government in 2001, the incoming Labour government sought to amalgamate the Departments responsible for land use planning, and transport planning into one super agency. This was seen as key to the ability to integrate land use and transport (Curtis, 2007, p4). One of the first actions of the new Department was to undertake development of a new strategic plan for the city, called Network City.

Rockingham Fremantle Bus Transit way

A key controversy in the development of the idea of the railway was consideration given to the need for a better connection between Fremantle and Rockingham. The SWAT process noted that more trips were undertaken by people of the southwest to Fremantle than to Perth. A early route suggested for the railway was along the current freight line from Jandakot to Fremantle, and then connecting to the line from Fremantle to Perth. To reconcile the final decision not to connect the railway with Fremantle, the Rockingham Fremantle Transit was developed and has been declared a dedicated rapid transit route initially using buses. It was to be built at a cost of AUD 39m (Low, 1996).

Roe Highway developments

As discussions for the railway continued, another development, the upgrade of the Roe Highway, was proceeding. The Roe Highway intersects with Albany Highway and the Armadale rail line at what is known as the Kenwick Junction. The point of intersection includes an intersection with a freight line which traverses the city east-west from Fremantle, through Jandakot. One proposal for the South West Railway at the time was to divert the

railway from the Kwinana freeway median at Jandakot east to the Kenwick junction, so that it could join the Armadale line to travel into Perth. The development of the Roe Highway necessitated a major redevelopment of the intersections. Aware of this, Westrail put forward a proposition to the government, to provide for a number of tunnels for the future railway, in conjunction with the Roe Highway developments. In 1996 the government announced that South West Railway Stage 1 (Perth - Jandakot) had been funded at AUD 160m for construction of the section from Kenwick Junction to Jandakot by 2005, with direction given that in 1997/98 a master plan would be developed for the remainder of the line from Jandakot to Rockingham and Mandurah (Low, 1996). Out of this approval, three tunnels were built: one to connect the Armadale line at Kenwick; one to allow access to the Kwinana Freeway median at Glen Iris (north of Jandakot); and the last to take the railway out of the Kwinana freeway median about 28km from Perth. Only this last tunnel was used in the final South West Railway, although the New Metro Rail Project included development of a spur line to Thornlie, which was completed (Martinovich, 2008). The government announced at the same time that improved access to Perth from the southwest would be provided by extension of the Kwinana freeway bus lane to Murdoch Park-and-Ride (Low, 1996).

Nowergup rail maintenance depot

The New Metro Rail Project also included development of a new railcar maintenance facility in Nowergup. Nowergup was chosen as the main depot because the depot would be needed to maintain new trains for the northern line, before the southern line was to be finished. The Claisebrook maintenance facility was considered too small to manage three car rail sets, and at a disadvantage because it was not located on the line (Martinovich, 2002). The Claisebrook facility also had minimal capacity for expansion to accommodate the new trains ordered with the new line. The contract signed with EDI Rail-Bombardier includes the design and construction of the new railcar depot and servicing facility at Nowergup (Martinovich, 2002, p119).

City Connection Project

A related project is the sinking of the Fremantle Line, to provide the possibility of connection between the city and Northbridge. This project was initially proposed by the City of Perth in negotiations relating to the final route of the South West Rail line into the city. The proposal was that it would be funded through sale of the recovered land. The government did not agree to put the project forward as part of the South West Rail project, however the Barnett Government announced that the project would go ahead on 29 November 2009. The project includes a new town square of 11,000m², surrounded by shops, restaurants and cafés, that would link the Perth Cultural Centre with the City Centre. The total project area includes 13.5ha bounded by the Mitchell Freeway, Roe and Wellington Streets and the Horseshoe bridge, and will include more than 1,650 dwellings, and 244,000m² of commercial space. A central three- to four-storey building will house a mix of community related services. The project cost is estimated at AUD 500m ("Government releases final Northbridge Link plan", 2009). The project is to be run as a collaboration between the East Perth Redevelopment Authority, City of Perth and the Public Transit Authority. Further details can be found at <http://www.epra.wa.gov.au/Projects/The-Link/About-the-Project/> (EPRA, 2010).

Esplanade Development

The vision for the Esplanade Station was that it would enhance the link between the Perth CBD and Swan River foreshore. The station will play an important role for future special events on the foreshore and Esplanade (Leighton Holdings, 2008c). The development of this station brought with it visions to further develop the Perth foreshore and connect it to the city. At present the foreshore is separated from the city buildings by an expanse of park and Riverside Drive, a four-lane road designed to allow cars travelling along the river to bypass

the city. This road currently acts as a major impediment to pedestrian access to the foreshore, even though significant developments have been put in place along the river itself, including a bike path, and parks and seating.

The new waterfront proposal includes a huge area, development of a marina (which will bring the river inland a little), major Aboriginal heritage buildings, development of new plazas and major buildings, and the extension of city streets to meet the river. Concept plans can be found at <http://www.planning.wa.gov.au/Plans+and+policies/Metropolitan+planning/Perth+Waterfront/default.aspx>

Parent projects

The South West Rail line project is part of a long term project to resurrect the passenger rail system in Perth. During the 1970s the passenger rail system, running with diesel engines, had been allowed to decline, with minimal investment. The system consisted of only three lines, the Armadale, Fremantle and Midland lines.

Proposed closure of Fremantle to Perth Line

In 1979 the government decided to close the Perth-Fremantle railway line and replace it with an integrated transport route. At the time the rail service was very rundown, with freight traffic sharing the Fremantle Perth line. The policy of closure was to provide best service for least cost, ensure alternatives to the private car, retain options in corridors, make use of rail where justified by patronage, make use of bus where characteristics of area reflect it, upgrade to air conditioning, develop other energy sources as demanded (Minister for Transport, 1979, p1). A freight diversion railway was to be built from Canning Vale to Cockburn. Factors influencing the decision included declining patronage and no potential for growth; capital cost savings; operating cost savings; efficiency in energy usage; road planning benefits; advantage of removing freight rail traffic from the passenger rail system. The determination regarding no potential for growth was predicated on the fact that no more land was available for development, and supposedly higher density had not seemed to have affected patronage. Capital cost savings were estimated at \$9.4m, operating cost savings were estimated at about AUD 2-3.6m per year. The government's subsidy on the line would be reduced from 53c to 23c because buses were more energy efficient and cheaper to run. The change to the reserve would also make room for another road connection (Minister for Transport, 1979, p4). The Fremantle line was closed in September 1979, public protest concerning the closure of the rail line commenced virtually immediately.

In 1982 the government released a new transport policy, 'Transport 2000: A Perth Study', the study recognised that the layout of Perth required the use of private cars, and that the role of the public transport system should be limited to enabling commuter traffic into the city centre, and for those who could not afford a private car. The road system it was believed would be able to withstand the projected growth in traffic, with the exception of the Narrows Bridge. Bus transit was recommended to alleviate congestion on the north/south freeway, especially on the Narrows Bridge, with development of Park-and-Ride services from Murdoch north to the city. The report found that electrification of the remaining railways was not economically viable (Knox, 1982). This report indicated to protestors over the Fremantle line closure, that the government was seemingly firmly committed to the eventual closure of the railways, and development of a public transport system based entirely on buses. Protestors thus sought to broaden their actions, and make the future of the public transport system in Perth a key issue for the 1983 election. The Labour party won that election, taking power for the first time since 1974 (Sharman, 2010). The service was reintroduced on 29 July 1983 following an official opening on that day by the Premier B T Burke (Westrail, 1984).

Electrification of Perth's Railways

Following the re-opening of the Fremantle line, the condition of the passenger rail system needed to be addressed. The Westrail annual report for 1984 estimated that during 1983/84 the suburban rail passenger service carried an estimated eight million passengers, compared to 6.6 million in the preceding year when the Perth-Fremantle line was not in operation. Results for 1983/84 compared to the previous year indicate a slight increase between the two years on the Perth-Midland and Perth-Armadale routes. They forecast a need for another 40 new railcars to refurbish the fleet (Westrail, 1984). The government created an inquiry into the electrification of the suburban rail system. This inquiry reported to government in June 1985, recommending that the system be electrified without delay on the basis that the cost of maintenance would be lower and that 75% of the existing rolling stock needed to be replaced. Thus capital expenditure on the system would be required in any case, and overall this would reduce costs: "the economic analysis favours electrification" even though such an analysis did not take into account any social or environmental objectives such as increased amenity, patronage, reduced noise (Co-ordinator General of Transport, 1985). The report also considered the introduction of light rather than heavy rail, but concluded that the introduction of such 'radically new' technology would be risky, could impose high costs and would require changes in work practices and skills of railway workers.

The report was produced by a committee and was not unanimously agreed. Two members, the representative of tertiary institutions and the representative of the Institution of Engineers, put forward a minority report suggesting the government should scrap rail altogether and build busways. However they did agree that if the railways were to be kept then they should be electrified (Co-ordinator General of Transport, 1985).

Once this major upgrade to the public transport system was announced, the new suburbs of northwestern Perth along the Mitchell freeway began to demand a system to assist commuter traffic and reduce peak hour congestion on the Mitchell freeway. As part of its election promises in 1986 the Labour government announced a study into the most appropriate form of rapid transit for the growing northern corridor ('Northern Suburbs Transit System', 2009).

Northern Suburbs Rail line

The main precursor to the South West Rail line was the Northern Suburbs Rail line, which opened on 21 March 1993. The Northern line arose out of a series of studies into the best form of rapid transit for the northern suburbs. An initial study concluded in September 1988 recommended a rapid bus transit system, using dedicated lanes on the median of the Mitchell Freeway, despite a small majority of people preferring a railway. The Minister of the time, when announcing the findings of the report, noted that further detailed evaluation of a rail based option was being carried out ('Northern Suburbs Transit System', 2009). Enabling legislation for the railway option was passed by parliament on 15 January 1989.

Objectives for the project included:

- reducing operating costs for the public transport operator;
- converting car drivers to public transport, thereby increasing public transport patronage and reducing road traffic levels;
- providing improved levels of service and satisfaction to public transport users;
- encouraging higher density nodal development around railway stations in the northern suburbs, thereby reducing urban sprawl (McDougall & Piotrowski, 1994).

The Northern Suburbs Transit System is an integrated system of public transport comprising a railway along the Mitchell Freeway with associated feeder bus services and park-and-ride facilities. The twin track system was laid 29km long (Perth to Currabine just north of Joondalup). Eight stations were built, five of which are major bus/train interchanges, whilst six have car parks. Peak hour services average eight minutes headway north of Whitford (about 18km north of Perth, and four minutes headway south of there. The capital cost for the system was AUD 277m in 1993 prices for all of the infrastructure and the railcar fleet of 22 two-car rail sets. This is 50% higher than the AUD 145m (AUD 185m in 1993 prices) estimated in 1988. The capital cost increased because the railway extended three kilometres beyond Joondalup. Also station designs were embellished to provide close interchange with buses. The railcar specification was upgraded to a 110km/hr operating speed instead of the original 100km/hr and prices escalated between study estimates and construction (a period of three to five years) (McDougall & Piotrowski, 1994). The Westrail annual report for 1994 notes that passenger numbers on the Perth to Joondalup line were significantly higher than planning predictions (Westrail, 1994).

Even as the government confirmed its announcement to build a railway to the northern suburbs, it also announced a new study into the transport needs of the South West corridor, the only remaining corridor of Perth without a rail line.

Country/location

South West Corridor, Perth, Western Australia.

Western Australia is a large and isolated place. The 1996 Transport Policy noted: "Everything in Australia is big and nothing in this sunburnt country is bigger than the State of Western Australia". Western Australia is 3.5 times the size of Texas. "Its coastline and border placed in a straight line would stretch from Perth two-thirds of the way to London or across the continent and the Pacific Ocean almost to Los Angeles". "Perth is the most isolated capital city in the world". In 1996 the total road network was 170,000km, total rail track was 7,000km, the coastline was 12,500km long, the population 1.7m of whom 70% live in the capital city (Transport, 1996, p4). The South West Corridor forms part of the coastal strip of Perth, which extends 135km from Dawesville in the north to the City of Mandurah, and is approximately 15km wide. This strip is formed because there are water catchment areas for underground water mounds which provide 56% of Perth's water supply (Heath, 2007). The Master Plan for the South West railway anticipated that 75% of Perth's predicted growth would settle on this strip of land.

Current status

The project has been completed at a cost of AUD 1.6bn (Leighton Kumagai Joint Venture, p7).

Project location map

An undistorted map of Perth is not readily available.

B PROJECT BACKGROUND

In conjunction with the 1989 election and passage of legislation on the Northern Rail line the government announced in February 1989 that it was committed to examining the possibilities for extending the railway to the South West, by setting up the South West Rapid Transit Study, with a steering committee from the Departments of Transport, Main Roads and Planning and Urban Development, Transperth and Westrail (Bettison, 1992a). This group presented a report for consultation in 1990 recommending a rapid transit system to Rockingham and Mandurah. The report considered two options for the line, either through Kenwick or through Fremantle. The route through Fremantle was considered to have a greater population, while the route through Kenwick would pick up more new areas. Both options already had most of the line available (on freight lines) although the route through Fremantle was single track only along the foreshore and thus presented some problems. The report did not fully consider alternative modes to rail, but did note that buses were more flexible and easier to implement, and that the advantages of light rail could mostly be achieved by the (light) heavy electrified rail system being put in place in the Northern line. The report ultimately found that there was justification for rapid transit in the corridor at least as far as Rockingham, and in the future to Mandurah (Steering Committee of the South West Corridor Transport Study, 1990).

In February 1992 the Premier announced an in principle decision to extend the commuter rail from Fremantle to Rockingham and Mandurah, and that Transperth would establish a South West Area Transit project steering committee with government members from the south west and the CEOs of the main departments. The task of the South West Area Transit (SWAT) project was thus "to establish the type of rail transit most suited to the future development of this area and the route that it should take. Thus it must have the direct involvement of local communities" (Bettison, 1992a, p3).

SWAT's tasks were to provide the Minister for Cabinet with:

- a supported recommendation of the rail transit type most suitable to meet the government's urban planning and development objectives for the South West area;
- a recommended route for this rail transit type;
- a cost estimate for this rail transit type;
- a profile of the South West Area community's preferences regarding the type of rail transit and route.

Major activities were to include a consolidation of planning and development proposals, identification of the interplay between development, expected transit patronage and route options, identification of funding and private sector involvement, identification of needs, alternative rail type costings, development of an information kit, public meetings and displays (Bettison, 1992a). The Premier of the time noted in a public announcement that options being considered included a proposal submitted by a consortium to privately fund rail infrastructure between Rockingham and Mandurah (Lawrence, 1992).

The SWAT project was initially developed (April 1992) around a vision for retaining the self sufficiency of the South West area through "a high level of access to work, shopping, education and leisure activities within the Area - accessibility, not simply mobility" (Bettison, 1992a). In this vision, future transit is thought of as a rail transit system working with land use planning to provide fast transit between SW area centres and "close convenient access within centres". Such a system would still facilitate longer distance movement through the area, including to the centre of Perth, but it may not have this as its primary focus (Bettison, 1992a). By July 1992 the vision had expanded to include "unites the Perth region by

providing mobility to and from the Area" (Bettison, 1992c, p6), although it was still focused on maintaining and increasing employment self-sufficiency to protect the initial vision. By November 1992 the vision had been further adjusted to include an objective "to facilitate travel conveniently between the area and other parts of the metropolitan region" (Bettison, 1992b).

In October 1992 legislation entered parliament to enable a railway from Fremantle to Rockingham and then Mandurah. The objective of the railway was to "provide a real alternative to car use" ('Fremantle - Mandurah Railway Bill', 1992). In the second reading speech Mrs Beggs noted that the main drivers for the selection of the route to be reserved in the bill, from Fremantle to Rockingham and Mandurah, was travel within the south west area, with travel time as a major consideration, and convenient access to an appropriate number of stations and stops. The legislation was designed to enable the route to be adjusted should that be desired, and to allow for either light or heavy rail systems (metro or access rail) (Beggs, 1992).

The report released by the Department of Transport in February 1992 (prior to SWAT commencing), had recommended a light rail system to traverse the South West Corridor to Fremantle. It can be assumed that the design of the SWAT project was to research and support this finding. The report was not released, however a report given to the City of Cockburn in August 1992 indicated that Westrail did not support the broad findings of the investigations and strongly supported a heavy rail alternative through Kenwick, supplying access to Perth quicker than the Fremantle option (City of Cockburn, 1992). This was the first public indication that Westrail wanted to pursue an alternative route to Perth, using heavy rail.

The Westrail process proceeded, and included in December 1994 an adjustment to the Metropolitan Regional Scheme to provide the route for the southern part of the railway from Rockingham to Mandurah. In July 1995 Cabinet announced the extension of the existing rail system from Kenwick to Mandurah, in association with the decisions taken on the Roe Highway (see above). In April 1997 they approved the preparation of a master plan, which commenced later that year (Department of Transport, 2000).

The initial Master Plan was released in April 2000 detailing the exact details of the railway as it would pass out of the city along the Armadale line, and then turn at the Kenwick interchange west until it joined with the Kwinana Freeway at Jandakot. The route then proceeded down the freeway median until it departed the railway, turning down the Garden Valley Highway reserve towards Rockingham. The Master Plan provided for three options concerning Rockingham (detailed above), and then described the route from Rockingham south to Mandurah down the reserve already made for it (Department of Transport, 2000).

A second Master Plan was developed after the election of 10 February 2001, when the incoming government chose to amend the plan and route the freeway straight into Perth down the median of the Freeway. This necessitated reversing the development of a dedicated bus transit way which had only just been completed. This was a change to government policy concerning buses on the Kwinana freeway, and also led to a decision to allow the railway to bypass Rockingham, thereby saving significant funds to enable the more expensive construction of the railway over the Mount Henry and Narrows bridges (Martinovitch, 2002). This announcement came as something of a surprise to the outgoing government as they had been told (due to the presence of the busway) that the train line could not be accommodated in the freeway meridian north of Jandakot. It was the willingness to abandon the already sunk costs of approximately AUD 38m in the busway that allowed for the change to occur.

It can be noted that, following the abandonment of the SWAT project, the objectives for the South West Railway were all about transport. They encourage public transport for trunk routes, with high service levels, integrated with local and feeder bus services. The ideas of land use and transport integration inherent in the SWAT analysis disappear (Ker, 2003).

Principal project objectives

Prior to and including the project for electrification of the railways, the objective of public transport in Perth was provision of transport for those who could not drive, and only secondly to provide an alternative to the car and avoid congestion (Director General of Transport Western Australia, 1976). Until the late 1980s and the development of the Northern line, the issue of congestion was considered unlikely to pose a significant problem because of the well designed highway system available. The one place where traffic congestion was an issue was the Narrows Bridge crossing of the Mitchell/Kwinana Freeway.

The objective then for the South West Metropolitan Railway, in the original master plan, was to provide a fast, regular, comfortable, safe and attractive electric passenger train service. The line was to provide a standard of travel comparable in transit time, convenience and cost with the private car (Department of Transport, 2000). Other objectives in the original Master Plan include:

- bringing to the south west metropolitan area a system similar to that in the rest of Perth;
- contributing to the containment of investment in road infrastructure and optimisation of its use;
- a contribution to air quality;
- travel time of 44 minutes to Perth from Rockingham and 60 minutes from Mandurah;
- maximising the use of heavy rail on a dedicated right of way, leading to minimisation of journey times, high frequency, good connection with feeder services and high standards of comfort;
- well-designed transit stations to minimise time lost and inconvenience transferring from bus or car to the train, with good feeder bus connections;
- to provide an inter-regional integrated service;
- ensuring passenger security and safety;
- to provide a new maintenance facility at Nowergup.

(Department of Transport, 2000).

The second Master Plan, developed after the decision was taken to change the route of the railway to a direct passage to Perth across the Narrows Bridge and through the centre of the city, had the following additional objectives:

- to increase journey speed from Mandurah to Perth to under 48 minutes;
- to reduce the number of trains required to achieve the desired frequency;
- to increase patronage by having a quicker, more direct journey;
- to carry the equivalent in peak hour in 2006 of between two and three freeway lanes of traffic between Mount Henry and the Narrows;
- to encourage people travelling by car on trunk routes or to major activity centres to use public transport;
- to provide high service levels for those who are dependent upon public transport;
- to create a spur line to Thornlie off the Armadale line.

(Martinovitch, 2002).

In 2006, the Minister for Planning noted that the objectives for the railway aligned with those of the New Metropolitan Plan Network City, in that it would replace over ten million motor vehicle journeys each year with significant benefit to air quality and save 15 million litres a year in petrol. It would reshape the CBD with a rail link running through the city, linking the foreshore with the commercial, retail, and entertainment precincts of the city (Alannah Mactiernan MLA, 2006). This notion of reshaping the city was also noted in the publication by Leighton Kumagai Joint Venture on the City Project (Leighton Kumagai Joint Venture).

Key enabling mechanisms

Description of key enabling mechanisms

South West Metropolitan Railway Master Plan April 2000 – which provides an initial description of the railway, details technical specifications, locations of stations, detailed routing, elements for consideration, and the conclusions of community consultation processes. This is the document on which approval for the project was given.

Perth Urban Rail Development – Supplementary Master Plan 2002 – which details the additional changes to allow the railway to proceed into Perth CBD along the Kwinana Freeway and across the Narrows bridge.

Key Contracts A–H – the key design and build contracts let by the Public Transport Authority to private parties to construct the railway.

South West Corridor Transport Study 1990 – by Narin, R. J, which considered the economic feasibility of a railway in the southwest.

Fremantle – Mandurah Railway Bill 1992

Metropolitan Regional Scheme Amendment 1988

Key enabling mechanisms timeline

The timeline for the key enabling mechanisms can be derived from the Project Timeline.

Main organisations involved

The South West Metropolitan Rail line was built by the Public Transport Authority, through eight design and build contracts with the private sector. These contracts, known as ‘packages’ were tendered in separate processes to maximise competition and enable some smaller players to participate in the project. Each of the packages is described below:

Package A

| | |
|---------------------------------|--|
| NMR Principal Design Consultant | Maunsell SKM Joint Venture |
| Main Construction Contract | Contract 03/005 |
| Contractor | RailLink Joint Venture (RJV) (Joint Venture of John Holland Pty Ltd, MacMahon Contractors and Multiplex Constructions Pty Ltd) |
| Contract Value (at award) | AUD 310m |
| Contract Awarded | 23 May 2004 |
| Contract Management | New MetroRail |

Key works included design, construction, supply and installation of equipment and commissioning of the railway and road infrastructure from Perth to Mandurah including:

- construction of civil works, drainage and track structure from Mandurah to the Narrows Bridge. Other civil works between the Narrows Bridge and Canning Bridge and track slab at Eleanora Drive were design and construct;
- overhead traction wiring system – Mandurah to North of Narrows Bridge;
- bulk earthworks to stations;
- roadworks from Mandurah to Glen Iris;
- signals and communications – Mandurah to Perth Yard;
- traction power system plus two railway feeder stations and track sectioning cabins;
- extensions from Perth Yard to the Narrows of signaling communications and power systems. Including the interfaces and connections to the existing railway;
- Mandurah railcar depot and cleaning facilities;
- structures – rail, road and foot bridges and rail underpasses from Mandurah to Glen Iris (three rail bridges, eight road bridges and rail underpasses, pedestrian footbridge at Rockingham).

Package B

| | |
|---------------------------------|--|
| NMR Principal Design Consultant | Woodhead International Architects in Association with MPS Architects |
| Main Construction Contract | 04/006 |
| Contractor | Doric Brierty Joint Venture (DBJV) |
| Contract Value (at award) | AUD 32m |
| Contract Awarded | March 2005 |
| Contract Management | New MetroRail |

The scope of works included construction of three bus and rail stations:

- Cockburn Central Station – including the station, pedestrian bridges over the freeway, bus facilities, parking bays, a shared path, pedestrian and cycle facilities and full universal access standards;
- Kwinana Station - including the station, bus facilities, parking bays, a shared path, pedestrian and cycle facilities and full universal access standards;
- Wellard Station – including the station, bus facilities, parking bays, a shared path, pedestrian and cycle facilities and full universal access standards.

Package C

| | |
|---------------------------------|---|
| NMR Principal Design Consultant | Jones Coulter Young Architects (Rockingham) in association with Taylor Robinson Architects (Warnbro and Mandurah) |
|---------------------------------|---|

| | |
|----------------------------|--|
| Main Construction Contract | 04/007 [a] and [b] |
| Contractor | DBJV (Rockingham and Warnbro) JM and ED Moore (Mandurah) |
| Contract Value (at award) | AUD 32m (Rockingham and Warnbro) AUD 6m (Mandurah) |
| Contract Awarded | June 2005 |
| Contract Management | New MetroRail |

The scope of works included construction of three bus and rail stations:

- Rockingham Station – including the station, parking bays, drop off and short term parking, pedestrian and cycle facilities and full universal access standards. Bus facilities for operation of the Rockingham City Centre Transit System will link in, the dedicated transit way is provided under Package A;
- Warnbro Station - including the station, parking bays, drop off and short term parking, pedestrian and cycle facilities and full universal access standards;
- Mandurah Station - including the station, parking bays, drop off and short term parking, pedestrian and cycle facilities and full universal access standards. Bus facilities at Mandurah had been completed prior to the Station in 2003.

Package D

| | |
|---------------------------------|---|
| NMR Principal Design Consultant | Woodhead International Architects (Canning Bridge and Bull Creek) MPS Architects (Murdoch) |
| Main Construction Contract | 04/005 |
| Contractor | John Holland Pty Ltd |
| Contract Value (at award) | AUD 32m |
| Contract Awarded | October 2004 |
| Contract Management | New MetroRail |

The scope of works included construction of three bus and rail stations:

- Canning Bridge Station – including conversion of existing freeway level bus stops to marginal train platforms; new platform screens and modifications to existing screens at freeway level; modifications and additions to bus shelters on Canning Bridge level;
- Bull Creek Station – including the station platform; a bus bridge with pedestrian access pathways at the sides; a footbridge on the eastern side of the freeway; bus/drop off canopies; car parking; a principal shared path connecting with the existing path; a retaining wall, a light screen and crash barriers;
- Murdoch – alteration of the existing bus transfer station; a new station building; western entry building; a bus bridge with pedestrian access; bus/drop off canopies; car parking; a principal shared path; a retaining wall, a light screen and crash barriers; removal and relocation of existing services and infrastructure.

Package E

| | |
|--|--|
| Contractor's Principal Design Consultant | GHD Pty Ltd Coffey Wyche Consulting |
| Main Construction Contract | 367/02 Construction contract |
| Contractor | Leighton Contractors Pty Ltd |
| Contract Value (at award) | AUD 105m |
| Contract Awarded | 14 January 2004 |
| Contract Management | Main Roads WA on behalf of New MetroRail |

These works consisted of the design and construction of the Southern Suburbs Railway rail corridor in the central median of the Kwinana Freeway between the Narrows Bridge and Glen Iris (15km). The scope included:

- construction of a new southbound railway bridge across the Narrows between the existing two bridges;
- strengthening the northbound Narrows Bridge to accommodate the northbound railway on the eastern side of the bridge, realignment of traffic lanes and provision of a dedicated bus lane on part of the bridge;
- construction of a new 660m long bridge at Mount Henry to accommodate northbound road traffic. Strengthening and re-configuring the traffic lanes on the existing bridge. The railway to be constructed on the western portion of the older bridge and separated from road traffic by concrete safety barriers;
- relocation of Canning Highway to the northbound Kwinana Freeway dedicated bus bridge (they slid the 125m long bridge along 9.5m so it didn't end in the railway reserve but on the freeway);
- modifications to existing pedestrian and traffic bridges on the Kwinana Freeway between Judd St and Glen Iris, including pier and parapet protection;
- minor realignment of Kwinana Freeway carriageways and ramps to accommodate the median rail corridor and construction of dedicated bus lanes through areas of congestion between the Narrows and Canning Highway;
- realignment of freeway on and off ramps at intersections to accommodate Bull Creek Station (Leach Highway) and Murdock Station (South St);
- construction of a railway formation layer in the railway corridor between Mount Henry Bridge and the Glen Iris railway tunnel;
- installation of freeway and railway drainage requirements;
- construction of concrete barriers and retaining walls to accommodate the railway corridor;
- construction of noise walls at specific locations.

Package F

| | |
|--|--|
| Contractor's Principal Design Consultant | Maunsell GHD-SMEC Hassell Spowers Architects |
| Main Construction Contract | 27/03 |
| Contractor | Leighton Contractors Pty Ltd (Leighton Kumagai Joint Venture) |
| Contract Value (at award) | AUD 324.5m |
| Contract Awarded | February 2004 |
| Contract Management | New MetroRail |

The contract was a modified form of design and construct contract. The scope, described in

the Perth Urban Rail Development Supplementary Master Plan, is the connection between the Northern Suburbs Railway and the Narrows interchange. The contract included:

- removal of existing stowage tracks in the west end of Perth Yard;
- changes to track sectioning for overheads west of Perth Station;
- relocation of Fremantle tracks west of Perth Station;
- construction of a tunnel approach ramp to portal west of Lake St; construction of cut-and-cover tunnel from Lake St to Roe St;
- construction of a twin bored tunnel from Roe St to Perth Underground platforms;
- Perth Station works on the eastern approach;
- remedial and alteration works to Horseshoe Bridge undercroft, construction of a pedestrian plaza adjacent to Horseshoe bridge;
- staged construction of the underpass and station under Wellington St, relocation of piped services in the rail yard and Wellington St;
- demolition of existing buildings above Perth underground platforms, retaining facades as necessary (William St);
- construction of Perth Underground Platforms by cut-and-cover and station fit-out. Development of space above Perth Underground platforms including pedestrian connections;
- construction of twin bored tunnels from Perth Underground platforms to new Esplanade Station;
- relocation of services at the Mounts Bay Road/William St intersection. Construction of a sewer pump station and associated work;
- construction of Esplanade station by cut-and-cover and station fit out. Construction of pedestrian connections from Esplanade Station to the bus port and foreshore;
- construction of a cut-and-cover tunnel from Esplanade Station to portal east of Mitchell Freeway southbound carriageway;
- ground treatment and stone column piling to a cut-and-cover tunnel across the foreshore;
- landscaping of the freeway interchange;
- relocation of a major Wate Corporation drain on foreshore;
- construction of a new pedestrian connection between the foreshore and the exit to the convention centre car park. Reinstatement of Convention Centre access;
- construction of retaining walls in the space previously occupied by the busway north of Narrows Bridge. Construction of a new bus ramp from the freeway northbound under bridge N2;
- (with extra funding) demolishing the William St overpass;
- the track and overhead wiring system were part of this contract, but connected with Package A.

Package G

| | |
|--|---|
| Contractor's Principal Design Consultant | Union Switch and Signal |
| Main Construction Contract | 135/02 |
| Contractor | Ansaldo STS Australia (Union Switch and Signal) |
| Contract Value (at award) | AUD 10.6m |
| Contract Awarded | July 2003 |
| Contract Management | Public Transport Authority |

This contract was for the design, construction and commissioning of a single train control system for the Southern Suburbs Railway and the existing passenger network. The scope

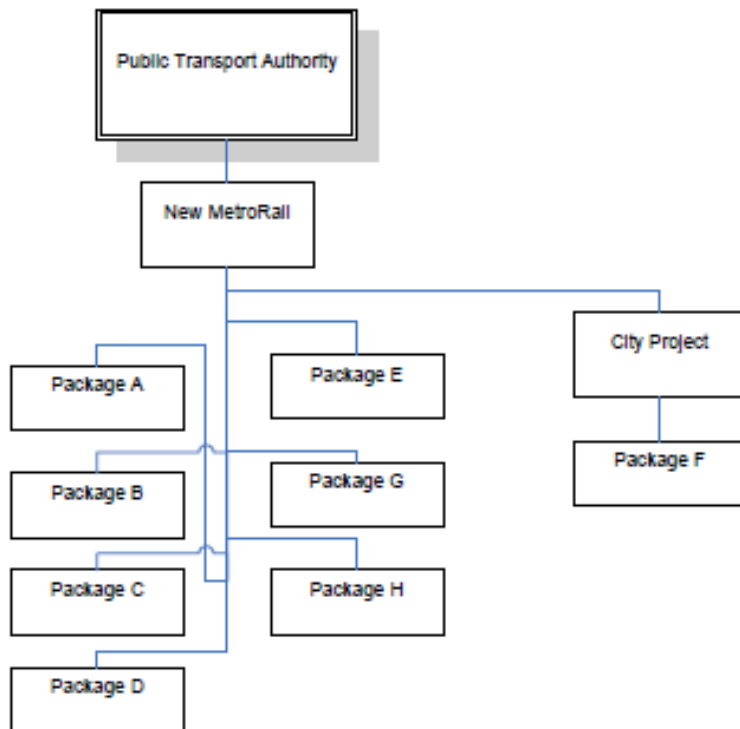
included:

- replacement of the train control system for the existing Perth urban rail network including extensions to Clarkson in 2004, the Thornlie line extension in 2005 and new Southern Suburbs Railway to Mandurah at the end of 2007;
- a customer information system including display panels at interchange and terminal stations;
- advanced train control features including train describer and automatic train routing.

Package H

Package H consisted of a number of relatively minor but critical works associated with traction power, signalling and communications systems on the existing network that had to be altered. They were directly managed by New MetroRail and Public Transport Authority engineers. All of the information in this section comes from the book '48 months, 48 minutes' (Longhurst, 2008)

Figure 13: Structure of Organisations



Planning and environmental regime

Perth's present planning regime commenced with the Stephenson-Hepburn report, Plan for the Metropolitan Region - Perth and Fremantle, produced in 1955. This plan led to the establishment in 1960 of the Metropolitan Region Planning Authority as the statutory land use planning agency for the region and the formulation in 1963 of the Metropolitan Region Scheme, the statutory land use plan. In 1970 the MRPA adopted the Corridor Plan for Perth (Director General of Transport Western Australia, 1978, p3). The Corridor Plan addressed widespread ownership of motor cars, smaller families and the need to establish sub-regional centres. It tried to deal with urban sprawl by aligning new urban areas on major transport corridors (Metroplan A Planning Strategy for the Perth Metropolitan Region, 1990).

The Corridor Plan was superseded in 1990 by Metroplan, A Planning Strategy for the Perth Metropolitan Region. The planning context for Metroplan was that Perth's population is growing and due to double and so have to have a plan so that the changes which come with that don't undermine the reasons people want to be here (Metroplan A Planning Strategy for the Perth Metropolitan Region, 1990, p3). For this reason Metroplan seeks to allow for rapid growth through a period of social and economic change that safeguards natural assets and maintains quality of life. The aim of Metroplan is for a region that is:

- urban – exciting and cosmopolitan;
- green – protects the environment and natural features;
- sustainable – energy and water conserving;
- healthy – maintaining the purity of air and water, restricting noise;
- prosperous – offering a range of employment;
- economically efficient – can bear the cost of high quality developments;
- socially just – providing high quality living and housing and a balanced distribution of employment and community services;
- culturally strong – recognising heritage and lifestyle aspirations.

(Metroplan A Planning Strategy for the Perth Metropolitan Region, 1990, p12).

Metroplan was superseded by a new strategic plan for Perth Network City. Network City was developed through extensive community consultation held between September 2004 and February 2005 (Western Australian Planning Commission, 2005, p5). Network City was confirmed as the metropolitan planning strategy for Perth and Peel under the Town Planning and Development Act 1928, in 2006. The vision of Network City is that by 2030 Perth people will have created a world class sustainable city, vibrant, more compact and accessible with a unique sense of place. The values are sustainability, inclusiveness, innovation and creativity, sense of place and equity. The centre of the plan includes the development of activity centres, activity corridors and transport corridors which will be protected for through traffic, trucks and express buses ('Statement of Planning Policy: Network City (Draft)', 2006).

During the development and construction of the South West Railway, several administrative changes were made to the structure of departments relating to land use and transport policy. For a period between 2001 and 2009 the departments of land use planning and transport were merged into a single department. During this time, the Network City policy was developed, with a strong focus on land use and transport planning integration. Much of the focus of the South West Railway project on LUTI or TOD projects can be seen as a reflection of the focus of this department. Whatever their configuration, the departments of planning and transport are concerned with support for the minister(s) of planning and transport, whose roles are variously:

- administration and review of planning legislation;
- approval of local government town planning schemes and amendments;
- approval of amendments to the Metro region scheme and to region planning schemes;
- recommending statements of planning policy for approval by the Governor;
- nomination of members for appointment to the WA PC; and
- approval of under-width roads pursuant to the local government act 1960.

The department(s) are supported by a number of line agencies:

- Main Roads;
- the Public Transport Authority;

- Port Authorities;
- the WA Land Authority (Landcorp);
- redevelopment Authorities;
- the Western Australian Planning Commission (WAPC).

(Department of Infrastructure, 2001)

The WAPC is particularly important in coordinating planning processes, and operates as a partnership between community, business and all levels and sectors of government. It was established under the Western Australian Planning Commission Act 1995. WAPC has twelve commissioners, comprising an independent chair, representatives of local government, two community and professional representatives, and regional development representatives. The CEOs of agencies with responsibility for planning, water resources, roads, transport and environment are also members. Its mission is to “to formulate and co-ordinate land use strategies for WA to facilitate its growth while continuously enhancing its unique quality of life and environment” (Department of Infrastructure, 2001).

WAPC’s responsibilities include:

- implementation and maintenance of the State Planning Strategy, a vision for the future;
- Future Perth Strategic Plan – development over the next 30 years;
- coordinating planning for the State’s ten planning regions;
- monitoring and forecasting land supply throughout the state and developing strategies to ensure the timely supply of affordable residential land;
- reviewing the Metro region scheme and initiating amendments to cater for anticipated population growth;
- initiating research projects and gathering information to enable it to keep abreast of contemporary trends in planning;
- participating in a range of major urban development projects;
- statutory responsibility in accordance with various planning acts.

Enabling legislation:

- WA planning commission act 1985;
- Town planning and Development Act 1928;
- Metro region town planning scheme act 1959;
- Metro region improvement tax act 1959;
- Strata titles Act 1985.

The WAPC receives technical expertise and other assistance from government departments to enable it to fulfil its role. The main documents concerned with planning in Western Australia are the State Planning Strategy and the Regional Schemes. The Perth Metropolitan Regional Scheme has been in operation since 1963 and provides the legal basis for planning (Department of Infrastructure, 2001).

Perth has also had a number of transport policies. In 1982 an important plan for the next 20 years was produced, ‘Transport 2000: A Perth Study’. This report looked at future transport predictions for Perth with respect to public transport and the question of cost. It acknowledged that the low density of the city meant that the city was transport intensive, and that public transport was difficult to achieve at a reasonable cost. The report saw the task of transport planning as being to serve the city in whatever shape it is, rather than to seek to shape consumer choices. The policy for public transport recognised that, due to costs, the system should focus mainly on radial commuting to the city and trunk routes, with only

minimum standards maintained on other routes to reduce costs. The policy followed a program of increasing services through development of the bus system, rather than through rail. It is this policy which developed the bus transit routes for the South West Corridor, considering that "if an urban rail system could not be justified in the Joondalup corridor it most certainly could not be justified in the Rockingham corridor" (Knox, 1982, p106).

The strategic direction for transport was updated in 1989 with a new strategy, 'Better Public Transport: Ten Year Plan for Transperth 1998 – 2007'. This policy represented a considerable departure from the previous one, indicating a concern with issues of sustainable transport and congestion. "Public transport can and must perform a greater role in achieving a more sustainable transport system. It is not a question of car travel versus public transport, but one of finding the right balance" (Department of Transport, 1998, p4). In this policy the undesirable effects of excessive car usage are seen to be road congestion, fuel use, vehicle emissions, road accidents and parking. The need for public transport to provide accessibility for those without cars is also acknowledged but is now seen as secondary to the need to provide an alternative to the car (Department of Transport, 1998).

In 1993 a new metropolitan transport strategy was developed. This policy included considerable administrative changes to the role of Transperth, with Transperth to operate as a service coordinator to a number of corporatised (and private) service providers, including MTT buses and ferries and Fasttrack. "This means the service coordinator develops and implements the policies to achieve economic, social and environmental goals while the operators focus on transport efficiency and effectiveness of their route services in the franchise area." (Transperth & Department of Transport, 1993, p14).

The Transport Strategy of 1995 represented a change to the process of transport planning in Perth. Five year plans were to be adopted, and updated annually. This strategy was also one of the first to discuss the need for more balanced transport, albeit acknowledging that the city would be car based for the foreseeable future. "Trends towards increasing car use, lower car occupancy and longer trip distances need to be reversed". "Public transport, cycling and walking need to be seen as viable alternative transport modes" (Perth Metropolitan Transport Strategy 1995-2029, 1995). This strategy was strongly based in the provision of accessibility over mobility. The objective of the metro transport strategy was to ensure Perth's transport system provides acceptable levels of accessibility on an affordable and sustainable basis for all of the region's residents and businesses. "Overall, the strategy focuses on providing access and transport for people, goods, services and experiences, rather than providing for vehicle movement in its own right. The Strategy does not seek to change the anticipated level of transport activity in the region, but does aim to alter the share of transport activity between transport options" (Perth Metropolitan Transport Strategy 1995-2029, 1995, p15).

Outline of planning legislation

- WA Planning Commission Act 1985;
- Town Planning and Development Act 1928;
- Metropolitan Region Town Planning Scheme Act 1959;
- Metropolitan Region Improvement Tax Act 1959;
- Strata Titles Act 1985.

Metropolitan Region Town Planning Scheme Act 1959 is the act which underpins the Metropolitan Region Scheme. The Scheme has two parts, a map which highlights a number of zones and reserves which shape the broad urban form of the city, and a text which explains what is allowed in each zone (Commission, 2003). The Metropolitan Region Improvement Tax Act 1959 allows for the imposition of a land tax to fund the development of

a Metropolitan Region Improvement Fund. This fund is administered directly by WAPC and provides funds for the purchase of land for reservation for various purposes (Commission, 2003). Since 1963 14,350ha of land has been publicly acquired for Region Open Space purposes funded by the Metropolitan Region Improvement Tax, a land tax levied to help provide the regional infrastructure for metropolitan growth (Metroplan A Planning Strategy for the Perth Metropolitan Region, 1990).

Statements of planning policy support the Metropolitan Regional Scheme, providing context for how the scheme should be interpreted. Policy No 1 includes the residential planning codes, which deal with the fundamental aspects of design of residential development and provide general provisions (car parking, amenity etc). Policy No 2 is the environment and natural resources policy, which falls under planning policy no 8 of the State Planning Framework policy. It defines the principles and considerations that represent good and responsible planning in terms of environment and natural resources issues. Policy no 2.6 is the state coastal planning policy which provides a whole-of-government framework for setting strategies and plans for the coast. Policy no 2.7 relates to public drinking water source policy and is about protecting drinking water sources. Policy no 3 is about protection of Gnangara Mound Crown Land. Policy No 4, the state industrial buffer policy, is about ensuring proper buffers are developed around industrial uses, and on site buffer areas for light and service industry. Some buffers are very large, from 50–100m for service stations to 3km for feedlots and gas fired power stations. Policy no 5 relates to poultry farms, how close residential building can be to them and how far away if a new farm. Policy no 6 is about protection of the Jandakot groundwater mound. Policy no 8 is the state planning framework policy 2000. It provides a framework for drawing together state and regional policies. The WAPC and local government are to have 'due regard' to provisions, plans and policies referred to in the Policy. Part A deals with general principles and part B with state and regional provisions. The SPPs are about planning for fair, orderly, etc development of land. Principles to be considered include environment and community. Policy no 9 concerns metropolitan centres and is about achieving a balanced distribution of employment throughout Perth to facilitate reduction in travel times and application of best urban design practice. Eight strategic regional centres are provided for and 14 regional centres. Policy no 10 is about basic raw materials, how to locate them and manage extraction, and how to manage development near resources so that extraction can occur at a later date. Policy no 11 relates to agricultural and rural land use planning policy, establishes a priority that agricultural land should be protected, settlement should be provided if sustainable, land use conflict should be minimised, and natural resources should be carefully managed. Policy No 13 relates to Aboriginal communities. It applies to large permanent Aboriginal communities (more than 50 people) with at least five dwellings with utilities and secure land tenure. Draft policy 5.1, on land use planning in the vicinity of Perth Airport, is to protect that operation from development with the potential to damage it, to prevent noise sensitive development nearby and to reduce the impact of the airport on future communities.

Environmental statements

Western Australia is a unique environment. It has very high levels of biodiversity, large numbers of unique species, and fragile water and land resources in many places. This sets the context for environmental issues, with sensitivity to such matters high, not least because a large percentage of water resources for the city of Perth come from water mounds virtually under the city. Many reserves in Perth are related to water catchments for underground storages such as the Gnangara water mound (Metroplan A Planning Strategy for the Perth Metropolitan Region, 1990).

The project dealt with a number of environmental issues, including heritage issues. The central business district part of the project confronted a number of sensitive environmental issues. A large amount of money was spent on retention of the outer walls of buildings on William St. The buildings over the Perth Underground also presented the problem of

asbestos in the old Myer building. Other challenges were created by the project's proximity to Swan River; proximity to heritage vegetation and buildings; large volume construction with potential for noise, dust, vibration and other impacts; dewatering and recharge of the bore field to maintain the land structure; the potential settlement and conversion of potential acid sulphate soils; and the disposal of thousands of cubic metres of contaminated and acid sulphate soils. The Esplanade station was constructed to be able to operate on zero emissions, efforts were made to minimise energy use through ventilation via the tunnel and light wells.

The project was built with a design life of 100 years, so sustainability was an important issue. The Esplanade in particular was intended to be a zero emissions development, and energy use was minimised through ventilation via the tunnel and light (Leighton Kumagai Joint Venture).

At several stations down the line, bushland was either preserved through changes to design or relocation of valuable species. At Warnbro station, maintenance of the surrounding A class reserve was an imperative and some land swaps were done to protect the most important parts of the site. At Murdoch, a reserve was created for a series of rare spider orchids found at the site.

The PATRC cost benefit analysis estimated that the total energy saved as a result of the project will be approximately 27.3 million gigajoules over the period 2004 to 2041 (Planning and Transport Research Centre (PATREC), 2004, p16). This report also noted that "with the data available we have not been able to evaluate local impacts on 'sustainability' such those on local air quality, landscape, heritage, biodiversity or distributional effects" (Planning and Transport Research Centre (PATREC), 2004, p11). The Minister for Planning noted that the project would 'directly save 550,000 tonnes of carbon dioxide emissions over 20 years' and replace over ten million motor vehicle journeys each year, with benefits to air quality and fuel saved (Alannah Mactiernan MLA, 2006).

The original Master Plan stated that the railway would produce no more noise than the freeway already created, create less air pollution, and provide a benefit because it would use energy from Western Australia rather than foreign sources in the form of petrol. The report noted that an environmental management plan had been prepared but not released for public review. It contained commitments which will be implemented by the Proponent including: a baseline assessment of flora and fauna along the surveyed rail alignment, an environmental management plan for construction to minimise vegetation clearance, outline landscaping, a review of drainage and hydrology during design, detailed consideration of wetlands during construction and operation, studies to minimise disturbance or destruction of heritage sites, and a requirement to engage in detailed community consultation before, during and after construction and operation (Department of Transport, 2000). The Master Plan also considered issues such as:

- vibration that would be given off by the train. Modelling indicated this would generally be at an acceptable level, but more assessment would be required once the rail was actually in service;
- the need to meet acceptable individual and society risk parameters at stations where gas and fuel pipelines were in the rail reserve;
- hydrology requirements including the assessment of drainage requirements and water management;
- Aboriginal heritage.

The Supplementary Master Plan noted that environmental management needed to consider vegetation; fauna; wetlands and water courses; noise and vibration (operational and

construction); other construction impacts; soil and groundwater contamination; visual amenity; public risk and safety; Aboriginal culture and heritage; pedestrian and traffic management during and after construction; a discussion on environmentally sustainable development; other potential environmental factors.

An Environmental Management Plan was prepared for the section south of Mandogalup in accordance with Ministerial Conditions set out in Statement 368 on the original assessment of the Metropolitan Railway Scheme amendments to the South West Transport corridor in 1994. The final draft for this document has been completed and is now under review by the various stakeholders. Several Aboriginal sites have been located in central Perth, including Swan River. Application for approval by indigenous affairs was made for the Narrows crossing changes. Canning river crossing is also an Aboriginal site, and widening requires approval (Martinovitch, 2002). A further additional concern for heritage was identified as Shenton's Mill near the Narrows. Visual intrusion was also identified as a major issue for South Perth Foreshore. Consideration was given to using a third rail rather than overhead wires. The project opted instead for minimal overhead wires because safety concerns would mean construction of a large fence if third rail technology was adopted. To mitigate visual intrusion three of the overhead wires were placed along the track. This probably made the translation to tunnel more difficult (Martinovitch, 2002). The report noted that, because power for the railway line would be generated at Collie power station, pollutants would be removed from the Perth Metro Area (Martinovitch, 2002).

Overview of public consultation

Public consultation was conducted at several stages in the development of the proposal. The result of technical investigations undertaken between March and July 1992, as part of the initial plans for the Railway Enabling Act, were made available to the public, and public meetings held. A reportedly statistically valid survey was conducted, indicating support for a railway from Fremantle to Rockingham ('Fremantle - Mandurah Railway Bill', 1992). The SWAT study conducted a number of consultations examining the relationship of the South West Corridor to the metropolitan region in terms of travel needs and availability, and likely trip generation effects. The original Master Plan was "underpinned by major studies which were undertaken to examine the land use and travel needs of the expanding south west metropolitan area" (Department of Transport, 2000). The plan development was overseen by a Steering Committee comprising the Director General of Transport, the Chief of the Ministry for Planning, the Under Treasurer, the Commissioners of Westrail and Main Roads WA, the Chief Executive of the Environmental Protection Authority and a representative of the Local Government Municipal Association. An important group which was consulted on the plan was the Local Government Planning and Liaison Group. This group consisted of the Mayor and CEO of Victoria Park, the cities of Canning, Gosnells, Cockburn, Kwinana, Rockingham and Mandurah. Approval was largely reached on local issues, but not on the route through Rockingham (Department of Transport, 2000). A separate set of consultations on the preferred route through Rockingham was conducted by the city of Rockingham, and indicated considerable support for the development of a station in the city centre. The supplementary Master Plan also included community consultation including:

- ten briefings for local councils, 21 stakeholder meetings, and 16 public meetings;
- a website to gather community feedback, which went live on 14 December 2001;
- distribution of hard copy feedback forms at meetings;
- development of an eight-page newsletter in August 2001, which was distributed to local councils along the route. Displays used at public meetings;
- production of an animated model of the railway between Mount Henry bridge and Perth;

- letterbox drops advertising public meetings, in some areas restricted to those most likely to be affected by the railway;
- development of a mailing list of community members who attended public meetings and personally invited to subsequent meetings;
- letter senders replied to personally;
- telephone calls registered;
- community and mainstream media assisted, with briefings with selected journalists who promoted meetings and publicised outcomes.

Issues were addressed using the following approach: Understanding community perceptions; educating, informing, improving and facilitating collective problem solving; leading local communities to define desirable outcomes, in the best interests of the wider community; aligning the Government's program with the community's expectations.

The strategy involved: identifying key stakeholders and those directly affected; identifying and addressing key issues; ensuring high awareness of the project; reinforcing that it is part of an integrated solution to transport problems; focussing on the fact that it is a project for the benefit of the wider community.

Key issues were resolved through negotiation. Where serious disadvantage occurred, modified designs were possible. Special attention was paid to noise and vibration concerns. Consultation was carried out in a frank and empathic manner without hidden agendas (Martinovitch, 2002).

As the head of the Master Plan development process later noted; community consultation was about "the need to inform what was proposed; seek feedback; develop a consensus in finalising concepts; and engendering stakeholder ownership". "When properly and sincerely executed community consultation forces the proponent to distil and articulate what is envisaged and to seriously consider the feedback for the benefit of all concerned" (Martinovich, 2008).

City route

The route of the railway through the central business district and to Perth Station elicited fierce community reactions and consultation. The initial announcement of the change to the route (from Kenwick to direct) was made without consultation with the City of Perth (Hipkins, 2001). The council was in favour of a route which continued up the freeway, and entered Perth CBD from the west, past Parliament House. A large community meeting was held concerning the selection of the route up William St. In the face of this public pressure, New MetroRail set up a special committee, the Perth City Railway Advisory Committee (PCRAC), to examine options and report.

"Although the PURD office had recommended to the PCRAC a William St route constructed by a cut and cover method, there was a possibility to materially limit disruption during construction by adopting a bored tunnel method of construction for which there had been insufficient time available prior to the PCRAC March report to support this as a sound option." (Martinovitch, 2002).

Ecological mitigation

Five thousand grass trees and 2,000 zamia were removed and relocated to City of Rockingham heritage areas, and some were replaced in the rail reserve once the building works were completed (Longhurst, 2008). At Murdoch an area of about 1ha was reserved after the third largest colony of Giant Spider Orchids were found growing near the site of the

railway station. This necessitated a realignment of the freeway on-ramp, the loss of approximately 260 car parks, and an additional six months of planning (Longhurst, 2008).

Landscape mitigation information is not available.

Regeneration

Estimated jobs created: The project book lists 68,833 names of persons who worked on the project (Longhurst, 2008).

Office Space Created: Nil.

New Homes: Nil.

Clarifications: The project included development of control systems for Transperth, but the system was housed in the existing control centre.

Appraisal methods

Before construction

Economic analysis was undertaken on the project in 1992 (the Narin Report) and in 2004 (the PATREC report). Studies to determine the environmental impact of the project were undertaken as part of the Master Planning process (see above). The Public Environmental Review was undertaken in 2001, consulting with engineers, hydrologists, botanists, zoologists, Aboriginal heritage consultants, community representatives and noise and vibration specialists.

During construction

Environmental management plans were approved under the Environmental Protection Act, conditional on numerous environmental management requirements. New MetroRail employed an environmental manager to ensure all parties to the contract met these requirements.

After construction

Review of the project was underway by Treasury and by the Special Projects group at the time this document was prepared.

Baseline studies

The Narin economic report of 1990 estimated the costs for a line from Mandurah to Kenwick, at AUD 113.5m. It estimated a net present value (NPV) for the project of AUD 29,565,000 at an 8% discount rate, AUD 13,031,000 at a 10% discount rate, and AUD 3,538,000 at a 12% discount rate with a benefit cost ratio of 1.94 at an 8% discount rate with an IIR of 13.1%. This report also found that the benefits calculated were sensitive to a halving of the value of time, but not to a delay in the project or a 20% increase in cost (Narin, 1990).

Studies undertaken in 1992 as part of the SWAT process showed that 78% of residents work in the region and only 10% of commuter trips are to Perth (City of Cockburn, 1992).

A comparative analysis in the original master plan found the following for various options for the railway. The rail direct option presented here is a reference to the different possibilities concerning Rockingham, the route to the city considered is via Kenwick. The results show

that the benefits at a 6% discount rate are zero, and that they increase as the discount rate increases (Department of Transport, 2000).

Table 1: Results of cost-benefit analysis

| At 7% discount rate incremental to base case | Bus | Rail Direct | Rail with Rockingham Loop |
|--|-----------|-------------|---------------------------|
| NPV | AUD 60.2m | (AUD 64.5m) | (AUD 225.8m) |
| NPV/Capital Cost | 0.67 | -0.09 | -0.27 |
| Benefit-cost ratio | 1.67 | 0.91 | 0.73 |
| IIR | 20.4% | 6.0% | 4.6% |

The PATREC report on balancing the benefits and costs of the South West Railway line presents a baseline economic analysis of the project as it was designed and constructed, that is the route directly to the city rather than through Kenwick. It concluded that a benefit cost ratio of 3.3:1 at a 7% discount rate and IIR 16% were possible. It estimated that substantial environmental and other non-economic benefits would flow from the project: in particular there was significant opportunity for sustaining Perth's 'liveability'. The report found that through helping TOD, there could be substantial transfer to rail from cars (Planning and Transport Research Centre (PATREC), 2004). They estimated that the total number of dwellings under current zoning around the stations would be 3,294 but that this could be brought as high as 11,388 if higher zonings were put in place (Planning and Transport Research Centre (PATREC), 2004).

Monitoring environmental variables

The Public Environmental Review represents a significant baseline study, documenting the presence and location of numerous significant species in the railway reserve and affected by it.

Risk analyses

Specific local risk analysis was allocated to contractors to be undertaken as part of the contract. This information is not readily available. The government did not undertake its own risk analysis.

Complaints procedures

The procedures were managed under the contract. Details are not available.

Land acquisition

The number and type of compulsory acquisitions is unknown. Land is mostly on railway reserves, major road reserves and government land, with some private property. Mostly the land is undeveloped. Estimated land values are:

Table 2: Land requirements and costs

| Cost area section | Land area (ha) | Land cost (\$,000) | Ancillary cost (\$,000) |
|----------------------------------|----------------|--------------------|-------------------------|
| Bekenham to Thomsons Lake | 22.2 | 5347 | |
| Thomsons Lake to Old Mandurah Rd | 65.5 | 3546 | |
| Rockingham – direct route* | 29.0 | 2284 | 1191 |
| Rockingham through route* | 28.2 | 6747 | 600 |
| Rockingham Rail Car Depot | 14.9 | 3060 | |
| Rockingham to Metro boundary | 60.0 | 2793 | 513 |
| Metro boundary to Mandurah | 47.3 | 3850 | |
| Totals for direct route* | 238.7 | 20,880 | 1704 |
| Totals for through route* | 237.9 | 25343 | 1113 |

(Source: Department of Transport, 2000, p61)

Note * The Direct and through route options have overlapping land requirements.

C PRINCIPAL PROJECT CHARACTERISTICS

Detailed description of route

Travelling north to south, the railway commences where it attaches to the Northern Suburbs line as it passes through the Perth Underground Station located on William St. It passes through a tunnel which runs aligned with William St, to the Esplanade Station, then follows an S bend to travel under the southbound lanes of the Kwinana freeway and crosses the Narrows bridge in the median of the Kwinana freeway. The railway then follows the freeway to a point at Glen Iris where it crosses under the northbound lanes of the freeway to continue south down the Garden City Highway reserve to the intersection of Rae Rd and Ennis Avenue, approximately 1.6km from the centre of Rockingham. The freeway then kinks to the east before continuing south, following the edges of the nature reserves to Mandurah. There are eight intermediate stations (described above under 'Principal Transit Nodes').

Detailed description of main and intermediate travel nodes

Introduction

A description of the principal transit nodes has been provided under the 'Principal Transit Nodes' section of this report.

The project included the revision and complete replacement of about 80 existing bus routes and alteration of another 15.

As part of the project, Transperth redesigned the bus route network to feed services previously bound for Perth CBD into South West Metro Rail stations. There are no CBD-bound services from south of Mount Henry Bridge. Buses continue to operate between the Perth CBD and Melville districts, via Canning Highway and South Perth via Labourchere Rd, with an appropriate level of bus priority (Martinovitch, 2002, p125). The bus route frequency to rail stations was forecast to be 10-15 minutes in peaks and 20-30 minutes in off-peak periods. The frequency was to be finalised as the train timetable was confirmed. This included a significant change to the bus network in five of the ten contract service areas (Martinovitch, 2002).

The priority access for buses on the Kwinana freeway at Canning Bridge reduces their running time by 30% (Martinovitch, 2002).

"With the July 2001 decision to locate Rockingham Transit Station at the intersection of Rae Road and Ennis Avenue, it was identified that Rockingham would benefit from a high frequency fast public transport service between the Transit Station and major Rockingham activity centres". This system is known as the RCCT. "The integration of this bus transit service with the train service is directed at enhancing the city of Rockingham as a destination rather than an origin for trips elsewhere. In this way, the combined integrated system of feeder buses, train service, RCCTS and Rockingham to Fremantle Transit bus service will provide and complete the highest level of public transport service to the Rockingham area." (Martinovitch, 2002, p128).

Planning context

The planning for the project is complex. The critical elements relating to the project that was built were:

- the need to reduce congestion on the freeway without building more road space;
- completing the railway system of Perth.

The Stevenson-Hepburn Corridor Plan (1955) contained the railway project and made provision for a land reservation for it. Network City was developed quite independently from the planning for the project and its aims in some ways contradicted those of the project.

Proposed development

Map of location

As noted above, an accurate location map relating the project to the Perth region has been very difficult to find.

Key features

See above.

Project costs

Leighton Holdings's website states that the design and construct contract for package A was started in May 2004 and completed in December 2007 for WA Public Transport Authority. It was a joint venture contract with a total value of AUD 390m. John Holland's share was AUD 254m (at 31 December 2007) (Leighton Holdings, 2008a). The total value of Package F is stated as AUD 429m, with Leighton Contractors' share valued on 30 June 2007 at AUD 236m (Leighton Holdings, 2008c). The contract for Package E had a total cost of AUD 325m (Leighton Holdings, 2008b).

Table 3: Estimated costs

| | 1998 & 1999 AUD m base | 2002 AUD m current | 2006/07 AUD m future |
|---|---------------------------|--------------------|----------------------|
| General items, project management and engineering | 141.5 | 158.0 | 158.0 |
| Rolling stock and depots | 300.0 | 300.0 | 300.0 |
| Northern suburbs extension | 48.3 | 48.9 | 48.9 |
| Perth to Thornlie | 115.7 | 87.8 | 87.8 |
| Perth to Mandurah | 611.5 | 696.8 | 696.8 |
| Escalation to 2006/07 | - | - | 127.5 |
| Total estimated project cost | 1,217.0 | 1,291.5 | 1,419.0 |

(Source: Martinovitch, 2002, p133).

The estimates include:

- general items, project management and engineering;
- rolling stock allocation for 93 rail cars and depot facilities at Nowergup and Mandurah;
- the main SWMR works Perth to Mandurah;

- NSTS extension to Clarkson;
- Infrastructure improvements Perth to Kenwick and a new line to Thornlie;
- Escalation based on the Perth Consumer Price Index from 1998/99 to 2002 and 2002 to 2006/07.

Costs are in April 2002 dollar values and have a PCI of 107.00 compared to July 1998 (PCI = 98.00) and July 1999 (PCI = 100.00).

Table 4: Perth to Mandurah in more detail estimated costs are

| Section | 2002 \$m Current |
|---|---------------------|
| Perth Yard to Narrows Bridge (excl) | 195.5 |
| Narrows Bridge (inc) to Glen Iris Tunnel (inc) | 194.7 |
| Glen Iris Tunnel (exc) to Thomsons Lake (inc) | 20.8 |
| Thomsons Lake (exc) to Mandurah Rd (exc) | 98.9 |
| Mandurah Rd (inc) to Waikiki (inc) | 72.5 |
| Waikiki (exc) to Mandurah | 114.4 |
| Total (including contingency but excluding general items, project management and engineering) | \$696.8 |

Funds were to come from:

- AUD 300m from proceeds of ALinta Gas sale, via the capital appropriation;
- AUD 1.1035bn from public borrowings;
- further AUD 15.5 to cover works through Perth;
- total AUD 1.419m.

The original appropriation in the Master Plan of April 2000, approved in October 2000, was for AUD 1.147bn, with AUD 398m funded by way of an operating lease with the private sector for the supply of railcars and infrastructure. The cost included AUD 749m for infrastructure and AUD 398m for railcars. In July 2001, a new approval was granted including a borrowing transfer of AUD 70m from the Kwinana freeway bus way program. In October 2001 the cabinet agreed not to lease railcars. In April 2002, the cabinet as part of the state budget agreed a variation in the project delivery dates. Waikiki was now to commence in December 2006, and Mandurah in December 2007. Escalation and the associated costs of this decision were AUD 186.5m, (Martinovitch, 2002, p138). The revised cost approved in the 2002/03 budget was AUD 1.4035bn, consisting of:

- AUD 1.217bn approved budget July 2001;
- AUD 168m escalation;
- AUD 18.5m extended construction time and works Mandurah.

Final breakup of costs:

- AUD 1.1035bn infrastructure;
- AUD 300m railcars including maintenance depots.

In May 2002, AUD 15.5m was added after a report on the central route (Martinovitch, 2002).

Construction costs

These costs have been detailed in the description of 'Project Packages' above. No further information is available under the heading above: Main Organizations Involved.

Project delivery

The initial Master Plan (Department of Transport, 2000) envisaged a staged development of the project as funds became available. The final project however foresaw the project commencing on a much shorter timeframe, with services to Rockingham and Waikiki commencing at the end of 2006 and to Mandurah by the end of 2007. The work was delivered through a series of packages of contract, staged so that the project through the city could be delivered quickly (Martinovitch, 2002). The start of construction in the city suffered considerable delay. Package F (the city tunnels) commenced work in February 2004 after some delay, and was completed in June 2007 (Leighton Holdings, 2008c).

Table 5: Project delivery

| | Construction Start | | Construction Complete | | Commence Use | |
|-----------|--------------------|--------|-----------------------|----------|--------------|--------|
| | Forecast | Actual | Forecast | Actual | Forecast | Actual |
| Package A | | May 04 | | Dec 07 | | Dec 07 |
| Package B | | | | | | |
| Package C | | | | | | |
| Package D | | | | | | |
| Package E | | Dec 03 | | April 06 | | |
| Package F | Early 03 | Feb 04 | June 04 | Sept 07 | | |
| Package G | | | | | | |
| Package H | | | | | | |

Rolling stock was to arrive by 2004 so Nowergup had to be ready by then (Martinovitch, 2002). Packages were contracted according to the following key attributes:

- appropriate allocation of risk;
- tailored and robust documentation;
- opportunity for innovation and cost saving;
- excellence in personnel/management teams;
- integrity and cultural maturity of organisations involved;
- excellence in documentation/administration/quality safety and environmental management;
- a partnering and team building approach, with opportunities for continuous improvement;
- local availability of management teams personnel and resources; excellence in leadership.

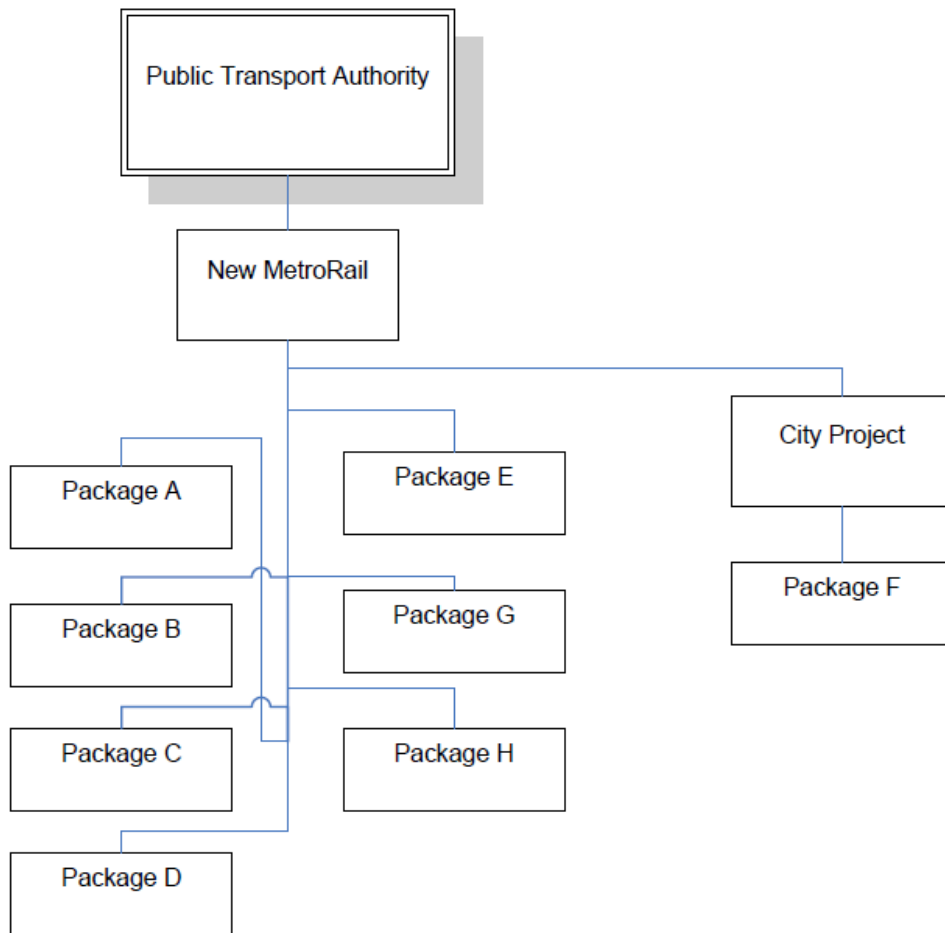
Main engineering features

Most of the main engineering features are described in the description of the packages given under the 'Main organisations involved' section. The track was laid using the self-contained track-laying equipment and method used in the Alice Springs to Darwin railway, also built by

Leighton Holdings (Leighton Holdings, 2008a). The tunnel boring under Perth City was highly difficult. The bored tunnels in Perth were constructed through a mixture of sand, clay and fine gravel, well below the water table. Tunnelling in 'soft ground' such as this is a particularly specialised field and is very different to 'hard rock' tunnelling. The Tunnel Boring Machine (TBM) for the City Project was an 'Earth Pressure Balance' machine designed especially for soft ground work. It operates by applying pressure to the excavation face ahead of the machine while soil is removed at a carefully controlled rate. This 'balance' between pressure at the face and the rate at which soil is removed allows ground settlement - and hence impact on buildings above - to be minimised. The selection of the TBM for the City Project drew on extensive geological investigation to ensure the machine was properly equipped to deal with the ground conditions that would be encountered. As the TBM advanced through the ground, a special conditioning agent, similar to biodegradable detergent, was mixed into the soil to make excavation easier. The excavated spoil or 'muck' was deposited into a small locomotive operating behind the TBM inside the completed tunnel, removed and carted away by trucks to appropriate landfill sites (Leighton Holdings, 2008c). The boring of the tunnels carried considerable risk to the city buildings, in part because ground conditions were extremely difficult (so difficult in fact that tunnel boring had never been attempted in Perth before). The risk of significant settlement was large, carrying a risk to tall buildings on either side of William St, and the exact location of building anchors was not known. The project involved the installation of 5,000 seismic sensors on surrounding buildings, and preparation of stabilisation injection points across the tunnel, to ensure that should settlement occur, filling could be injected into sites to prevent building collapse. Some works from the old Kenwick route were also continued, some not. The remaining projects included the dual use cycle/ pedestrian bridge near Victoria Park, reconstruction of Victoria Park station at a new site, closure of the Bishopsgate Street level crossing, closure of Lathlain station, a new road crossing over lowered railway near Bishopsgate, upgrade of Carlisle station, construction of a road bridge at Cannington. These elements were retained to achieve maximum connectivity and feeder bus services (Martinovitch, 2002).

Details of engineering and construction

Figure 14: Map of main contracts



Details of main contracts

See details under 'Main organisations involved' section.

Main engineering key facts and figures

See details under 'Main organisations involved' section and technical specifications.

D PROJECT TIMELINE

| Month | Year | Type of Decision | Key Decision Event |
|-------|------|--------------------|--|
| | 1976 | | Corridor plan recommends rapid transitway up Mitchell Freeway to Northern Suburbs |
| May | 1984 | | Inquiry into electrification of Perth's suburban railways commenced |
| | 1988 | | Travers Morgan report recommends construction of bus rapid transit for northern corridor |
| | 1988 | | Second study confirms rail as preferred option for rapid transit for northern corridor |
| | 1989 | | Master planning for Northern Suburbs railway commences |
| | 1989 | Election | |
| Feb | 1989 | | South West Rapid Transit Study formed |
| | 1990 | | South West Rapid Transit Study recommends South West Metropolitan Railway as economically viable rapid transit. Recommends further review of alternative forms of light rail and bus |
| | 1990 | | Westrail begins to examine whether freight route south of Fremantle could provide route to Rockingham |
| | 1991 | | Construction of Northern Suburbs Railway commences |
| | 1991 | | Rail planning responsibility transferred from Westrail to Department of Transport. Felt that intra-regional system required to Fremantle. |
| Feb | 1992 | Economic statement | Premier announced 'in principle' decision to extend commuter rail from Fremantle to Rockingham and Mandurah |
| Feb | 1992 | | Transperth establishes South West Area Transit project (SWAT) to review alternatives for area |
| | 1992 | | DPUD undertakes review of Metropolitan Regional Schemes and releases policy concluding rail focused on CBD would best serve South West Corridor |
| Oct | 1992 | | Railway Enabling Act passed Parliament |
| | 1993 | | Northern Suburbs Railway Completed |
| | 1993 | | CEO of DPUD approaches CEO of Westrail for assistance to plan and reserve the most direct route for a railway from Perth to Mandurah, accessing key regional centres along the way – to be reserved in a new version of the Metropolitan Regional Scheme or South West Corridor Plan |
| | 1994 | | SWAT produces Rapid Transit Review which recommended buses for the line haul from Perth to Rockingham and Mandurah, and rail for the coastal corridor to Fremantle |
| Dec | 1994 | | Route for railway reserved through gazetted change to metro regional scheme. |
| July | 1995 | | Cabinet announced the extension of the existing rail system from Kenwick to Mandurah and confirmed its intention in principle to extend the urban rail system to Jandakot within ten years, announced funding for the required tunnels under the new Roe Highway development, and that Kwinana freeway would commence straight away. |
| | 1996 | | A confidential report recommends that the most direct route could be accomplished by replacing the busway on the Kwinana Freeway with a railway (the report was not brought to the attention of the master planning team until 2001) |

| Month | Year | Type of Decision | Key Decision Event |
|----------|------|------------------|--|
| April | 1997 | | Work on Master Plan for Railway Perth to Rockingham/Mandurah via Kenwick approved by Cabinet |
| August | 1997 | | Cabinet endorsed alignment for the railway through Rockingham City Centre |
| Late | 1997 | | Work on Master Plan for Railway Perth to Rockingham/Mandurah via Kenwick commences |
| March | 1999 | | Master Plan for Railway Perth to Rockingham/Mandurah via Kenwick endorsed by Cabinet |
| April | 2000 | | Master Plan for Railway Perth to Mandurah via Kenwick published |
| June | 2000 | | Northern suburbs extension Master Plan prepared. April 2000 Master Plan augmented with appendices. Both Master Plans approved and funded and referred to umbrella project the Perth Urban Rail Development Project (PURD). |
| | 2001 | | Busway down Kwinana Freeway constructed |
| December | 2001 | | State Election – Alannah MacTiernan becomes Minister for Planning and Infrastructure |
| | 2001 | | Minister reverses decision to route railway through Kenwick |
| May | 2002 | | Rail car contract awarded |
| | 2002 | | Two lane busway between Esplanade Busport and Canning Bridge completed on Kwinana Freeway, to provide express services for buses from Mandurah. |
| Aug | 2002 | | Supplementary Master Plan for Railway Perth to Mandurah, direct down Kwinana Freeway published |
| Jan | 2004 | | Package E tender let and commenced work |
| Feb | 2004 | | Package F tender let and commenced works |
| May | 2004 | | Package A tender let and commenced work |
| April | 2006 | | Package E tender completed |
| June | 2007 | | Package F tender complete |
| Dec | 2007 | | Package A tender completed |

Project timeline key issues

Leighton Kumagai are currently in dispute with the government over the timing of the city project, and whether they met targets. They provide the following in a pamphlet they published on the project. "Despite being the most complex of the seven construction packages for the Southern suburbs railway, the New MetroRail City Project (NMC) was the first to be powered up, run test trains and become operational. Despite industrial action, geotechnical complexity, heritage issues and other challenges that caused compression of the already ambitious timeline, NMC was completed within the original SSR target date.

The NMC team contend the project was completed on time and are currently seeking an extension of time from the Public Transport Authority to legitimise this position. More than 70 working days were lost to industrial action making construction extremely challenging and impacting on the costs. Major ensuing delays were mitigated through innovative engineering solutions and program acceleration and night work where appropriate. The shortage of labor and materials also adversely impacted costs, (particularly in the small market of Perth) make cost control more problematic" (Leighton Kumagai Joint Venture, p46).

E PROJECT FUNDING

Introduction

The project was fully funded by the government. Initial discussions were held about private sector involvement, but a review by Deutsche Bank, Booz Allen and Hamilton, Blake Dawson Waldron and Skea Nelson Hager concluded that the most cost effective method of funding was by government (Department of Transport, 2000). In the end the government found that it had sufficient surplus available to completely pay for the project. The project is thus debt free.

Background to funding

Revenue

The project is a fully publicly funded public transport project and revenue is the responsibility of TransPerth, the planning agency. Farebox revenue was always intended to be subsidised. The rate of subsidy enunciated in the Master Plan is inaccurate because it was based on estimated costs of borrowing, and the project was eventually transferred to TransPerth debt free.

Prediction of financing costs

Predicted: unknown. Actual: Nil

Funding key stage

Not applicable.

Traffic forecasts

One of the main reasons given for the change in route to the direct one, was that it would decrease travel times and therefore increase the attraction of the railway over the car. The option was found to save money because of time savings and reduced accidents, plus greater speed means fewer rail cars (Newman, Power, & Kenworthy, 2000). The traffic forecast was also responsible for determining that a railway was preferable to a bus system. "Assuming each train is a basic two car set accommodating 312 passengers, the overall capacity provided at that frequency is 6,240 passengers per hour. The size of the trains can be extended to three (two car) sets, giving capacity of just over 18,700 passengers per hour. By comparison, assuming the same three minute frequency, the capacity provided by a rigid bus would be 1,200 passengers per hour. An articulated bus would provide a capacity of just over 1,800 passengers per hour." (Martinovitch, 2002, p. 71)

The railway was designed to be competitive with the private car. "In 2006, the journey time from Mandurah to Perth will be 20 minutes faster by train than by car at peak times and ten minutes faster in the off peak" (Martinovitch, 2002). Traffic estimates focused on the morning peak, because that is where the greatest 50% of trips were made by transit. This reflects a higher number of commuters in the morning than the afternoon (Martinovitch, 2002). There was some controversy with the traffic forecasts because initial numbers generated by SWAT for a metropolitan rail to Perth considered only the traditional 800m passenger shed. The Master Planning team recalculated passenger numbers based on

predicted use of the park-and-ride facilities. This increased the estimates dramatically for some stations. In fact the numbers predicted for the line meet and exceed those predicted for the initial years of the line's operation. A major complaint from the passengers is insufficient park-and-ride facilities.

Funding sources

The original Master Plan considered five funding options, from government fully funds and operates through to private sector fully BOOT with the rest of the railway thrown in. The report showed that as private involvement increased, there was an increase in overall project risk but that the government part of that risk declined. The lowest cost was provided by the full public model due to the low cost of finance. A franchise model was only a little more costly, however, at +AUD 1.8m. None of the models investigated showed a cost of more than +AUD 13.9m, which shows that the cost of transfer of operations over the life of the project increases CSO per passenger except in the franchise case (Department of Transport, 2000). The choice to fully fund the project was made due to the availability of funds, the relative cost of the funds and a sense that this would reduce risk on the project overall.

Table 6: Funding scenarios

| Scenario Description | Capital cost to government AUD m | Annual net recurrent cost to government over 30 years for operating and capital AUD m |
|---|-------------------------------------|---|
| 1 Government funds entire project | 941 | 80.6 |
| 2 Government funds all infrastructure only | 589 | 84.2 |
| 3 Government only funds a minimum share of the infrastructure | 253 | 86.7 |

(Source: Department of Transport, 2000, p. 121)

Commentary on financing and funding

At the time of funding the project, the Western Australian economy was in a significant boom caused by booming resources, demand and prices. This meant that funds were available to pay for the project without borrowing. It should be noted however that the Northern Suburbs Railway had similarly been funded by government (although not without borrowings), on the basis that at that time a recession was in place and it was the government's role to provide investment in the economy and jobs at such times.

The Public Transport Authority note that the operating costs of the railway are significantly reduced because of the lack of service payments to debt. This has freed up more of the funds provided by government annually for the direct provision of transport services, rather than for the servicing of debt, something which has made budgeting difficult for the organisation for many years. The view is that this puts the cost of public transport more on a par with calculation of the costs of transport via private vehicle, because private vehicles do not pay the debt service cost for the infrastructure they use.

F OPERATIONS

Performance of Mandurah rail line:

- from Perth to Mt Henry trains operate at 100km/hr;
- south of Mt Henry they operate at 130km/hr;
- five minute train intervals from Cockburn Central (20.4km out) to Perth at peak times, serving four of nine stations on the route and supplying about 60% of the patronage;
- this service extends to Whitford (19.8km north);
- a ten minute peak service frequency operates over distance of 104km to Mandurah;
- combined, these services result in five minute peak frequencies at peak times. Fifteen minute frequencies operate the rest of the time (Martinovich, 2008).

The original plan was for two trains per hour from Mandurah and eight trains from Waikiki, there are now six trains per hour from Mandurah and a further six from Thompsons Lake. Journey times have been reduced by 20% from Mandurah and 26% from Rockingham.

Reported traffic volume

Six months after commissioning, the South West Railway carries 96% of the 50,000 daily trips predicted for the first year (Martinovich, 2008). The upgrades to the rail system since the reopening of the Fremantle line in 1987 have resulted in massive increases in use. In 1987 there were less than ten million annual trips on rail. Today there are close to 50 million rail trips per annum (Martinovich, 2008). Projected patronage was 25,000 each way for the line, in early June 2008 actual patronage was about 48,000 weekday trips. 40 - 50% of all day arrivals occur in the two hour morning peak. Just over 25% arrive at the largest stations within the morning peak hour. The line has ample capacity during the day. Capacity is adequate during shoulders, 'passengers can be and are left behind for a short period during the middle of the peak'. There is no longer any spare car parking on the Mandurah line despite the provision of 6,000 car bays (Martinovich, 2008).

How traffic forecasts were formulated

The first set of traffic forecasts was produced by the Narin report in 1990, on which the original South West Rapid Transit committee based its recommendations. This forecast was estimated to 1986, 2006 and 2021. The assessment was based on land-use projection and demographic trends and using existing data sources. The interaction between land use and transport was assessed, in particular how residential and employment development would be stimulated in the corridor and region by construction of the link. The assessment sought to take account of how other modes might be linked in and also estimated likely patronage as levels of demand on the roads were modified, especially critical inner city road links giving access to the CBD. The assessment also assumed that urban travel is ubiquitous and that trips can be expected between any part of the Perth metropolitan area, then the whole metro area has been included in the study, not just the immediate corridor. The study was done in the context of full competition with road-based travel by car or bus, assuming full co-operative planning of the bus feeder services, and of ferry and park-and-ride. Bus congestion was also fully simulated. The study used land use/transport interaction and passenger demand modelling, and relied on use of TRANSTEP computer simulation and forecasting. TRANSTEP derives travel demand directly from land use and network parameters. The model was thought to balance demand with supply automatically within limits for future services and including feeder services. "This means that the operational

aspects of future public transport services - rail, bus and bus feeder services - can be properly optimised so that network operational costs are accurately represented in the analysis. Also allows for congestion effect on buses, and effect of buses on congestion. Have modelled the actual road network for 1986 and expected forms for 2006 and 2021. Unfortunately the actual numbers from the model were not presented in the report. The report did not however that demand for public transport is growing. That the highest source of new rail passengers will be in transfer from bus. That travel distances are increasing, and that by 2021 it is expected that transit will be faster than car (Narin, 1990). The original master plan showed that all day weekday boardings would be 19,1000 in the year 2006 for the Kenwick route. The Supplementary Master plan (Martinovitch, 2002) estimated that numbers for the Kenwick route would be 17,980 in 2006. Direct route modeling shows all day weekday boardings for the direct route at 24,950 in 2006. (This included the boardings from the Thornlie spur which expects 3,500 boardings in 2006). The differences in these figures can be found in a change in the model to Spectre 2.00. The model was used to indicate the difference that a faster journey time would make. It predicted a 110% increase in patronage at Thomsons Lake with 42% decrease in journey time and 50% increase in frequency. "The patronage demand analysis carried out as part of the SWMR Master Plan, public surveys and even a careful analysis of the SWAT patronage analysis, all showed that the overwhelming major demand for travel was to the Perth Central area. For example, in the SWAT work, the majority of people travelling by rail to Fremantle did not end the journey there, but continued towards Perth. This was also borne out by an informed assessment of even the current high rail patronage to and from Fremantle." (Martinovitch, 2002, p2). The model used in the forecasting, Spectre 2.0, is based on a conventional four stage modelling process that attempts to answer four questions: how many journeys are made; between which centres of population and activities are journeys made; by what mode; by what routes (Martinovitch, 2002). Newman et al (2000) estimated in their paper that the direct route would provide extra patronage, at Murdoch of 40,000 passengers, at Leach Highway of 30,000 passengers, at Canning Bridge of 60,000 passengers, and at South Perth (walking) of 15,000 passengers. They also noted that the Convention Centre could be a major destination in own right.

Martinovitch (2008) provides a description of how catchments for stations were widened by park-and-ride, with 91% of the catchment then being beyond walking range: "surveys show that up to 91% of commuters come from beyond the walking radius by car or bus". He notes that bus feed on the southern line is better than the northern line with about 40% of passengers arriving by bus, 49% by car.

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