PERTH'S AIRPORT LINE – HOW THREE TRAIN STATIONS ARE SET TO BECOME URBAN CATALYSTS WHILE PROVIDING AFFORDABLE TRANSPORT SOLUTIONS

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SUMMARY

The growth in activity in the eastern suburbs of Perth, Western Australia has led to increased traffic congestion, placing pressure on road infrastructure and public transport. In 2014, the Federal and State Governments funded a new rail service to better connect suburbs while reducing road congestion. From 2015 to 2022, the Forrestfield-Airport Link was procured, designed and built, opening to the public in late 2022.

This landmark project created a faster, convenient transportation link and integration between the Perth CBD, International Airport, and the foothills, ultimately extending the rail network to areas previously only serviced by the road network.

Travelers now have more choice, greater accessibility, and convenience. This paper will explore the project with a focus on architecture and the social impact on users, tourists and the urban fabric.

1 INTRODUCTION

The Public Transport Authority delivered an 8.5 km rail extension to Perth's existing rail line, running a new line underground in twin bored tunnels beneath the Swan River, Tonkin Highway and Perth Airport. Included were three new rail stations – Airport Central, Redcliffe and High Wycombe – which later included rail-bus interchanges servicing suburbs in the adjacent areas, particularly areas in the Perth Hills. This landmark project expanded the transportation options for the foothills area, as well as improving options to and from Perth Airport in a fast and affordable way.

The Airport Line's stations include highly visible facilities, providing the best 'whole of journey' experience and contributing to the attractiveness and utilisation of public transport. The integration of public transport infrastructure into the urban environment required close attention to design quality, both for stations and precincts. This has enabled two of the three stations to become catalysts for the future development of the communities within these earmarked areas, increasing both density and urban precincts. Those precincts are going to be activated and will include a range of living, employment, entertainment, and recreation options for the current and future population.

This paper has been written in the author's previous capacity as the Lead Consultant's Architectural Team Leader for the Forrestfield-Airport Link (FAL) project.

Footnote: The Airport Line runs from Claremont Station to Terminal 1, International Airport. The Forrestfield-Airport Link project was responsible for the new rail line segment connecting the existing network at Bayswater Station to Forrestfield, where High Wycombe Station is located. High Wycombe Station was originally named Forrestfield Station. Redcliffe Station was originally named Airport West Station. Both names were changed during FAL's design stages.

NOTATION

BIM	Building Information Modelling
CBD	Central Business District
CCTV	Closed-circuit television
CoK	City of Kalamunda
CoB	City of Belmont
D&C	Design and Construct
DPLH	Department of Planning, Lands and Heritage of Western Australia
DSP	District Structure Plan
EOI	Expression of Interest
EES	Emergency Egress Shaft
EM4P	Engineering Management for Projects (PTA)
FAL	Forrestfield-Airport Link
ISCA	Infrastructure Sustainability Council of Australia
JV	Joint venture
LOD	Level of Detail/Development (BIM)
PAPL	Perth Airport Pty Ltd
PTA	Perth Transport Authority of Western Australia
SI-NRW JV	Salini Impregilo & NRW Joint Venture
SmartRider	The SmartRider system is a card-based system, where the information from travel is stored on your card along with payment

2 PROJECT BACKGROUND

This section provides the context to the project by explaining the issues that triggered the need for this rail line, along with Government initiatives which procured and managed the design and construction processes.

2.1 Metronet

In February 2013, the then Western Australian Government pledged to build a $1.895 billion airport rail link, transporting domestic and international passengers to and from Perth Airport. As well as offering public transport to travellers, the rail link would also offer more options to residents in Perth's Eastern suburbs wanting to travel into the city, as well as businesses at the proposed airport business and industrial park [1]. In August 2014, a media statement announced a tunnel design option for the Forrestfield Airport Link (FAL) [2]. This new line would be part of METRONET: a set of rail infrastructure projects within the Perth metropolitan area [3].

Subsequent to the State election in 2017, METRONET was created as a multi-agency team, with staff reassigned predominantly from Perth Transport Authority (PTA) and the Department of Planning, Lands & Heritage (DPLH). As per the Western Australian Government's website [4], "METRONET is the single largest investment in public transport that Perth has seen, with a vision of a well-connected Perth with more transport, housing, and employment choices. With approximately 72 kilometres of new passenger rail and 23 new stations, METRONET is a catalyst to turn more than 8,000 hectares of land around new stations into desirable places to live, work and play".

More than a transport program of projects, METRONET also provided and continues to provide long-term legacies for the communities by implementing program strategies through new policies such as Gnarla Biddi Aboriginal Engagement, Sustainability and Public Art policies.

2.2 Forrestfield-Airport Link

The identification of two stations servicing Perth Airport was included in the Perth Airport's Masterplan in 2004 [5]. This entire area of the Perth Metropolitan area was serviced by road transport only, and connectivity to the Perth CBD was deemed insufficient for the forecasted population. Now opened, the Airport Line comprises 25.4 kilometres of rail track between Claremont Station, Perth Station (CBD), Bayswater Station and High Wycombe Station at the base of the Perth Hills. The FAL project consisted in the final 8.5 kilometres connecting Bayswater Station to High Wycombe Stations, with Redcliffe and Airport Central Stations in between (Figure 1).

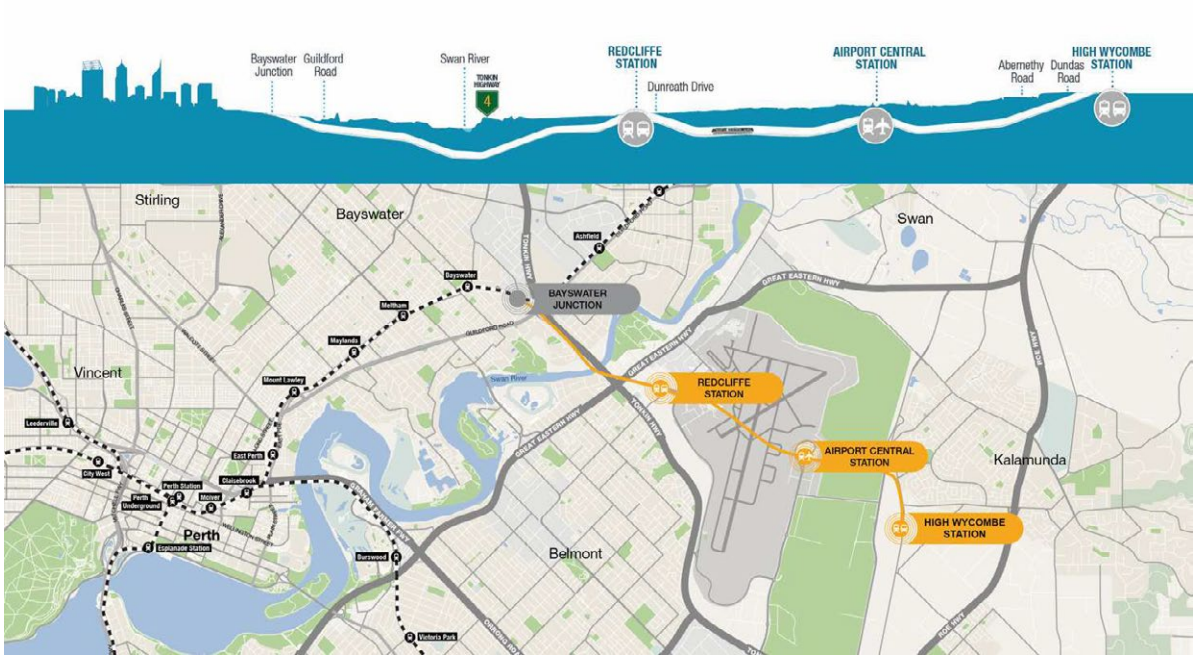


Figure 1: FAL section and map

In March 2015, five separate joint ventures lodged their EOI submissions for the design and construction of the FAL project. The Salini Impregilo & NRW Joint Venture (SI-NRW JV) were selected after a two-stage process. As part of the SI-NRW JV, the following companies were involved in FAL:

- **Design:** GHD, GHD Design with Weston Williamson and Partners, Coffey, Geodata, D'Appolonia, WSP
- **Construction:** Salini Impregilo, NRW, Coleman Rail, Downer, Ansaldo STA
- **Maintenance** (10-year contract): Downer.

After seven years, the first train travelled through the tunnels on March 28, 2022. The official line opening occurred on October 9, with events at both Redcliffe and High Wycombe Stations and free train rides across the entire line.

The following sections provide more specific information for each of the building components of the FAL project.

3 DESIGN AND DOCUMENTATION

3.1 Project Statistics

A collaborative approach was essential to the project's success. Table 1 outlines some of FAL's statistics.

Table 1 – Project's statistics summary, GHD 2023

One Swan River crossing (tunnel)	Over 20 km of rail track	9,900 drawings and docs
Tunnel excavation dia. 7,020 mm	54,000 concrete lining segments	99 BIM Models
Twin tunnels 7.1 km long, with dia. 6,170 mm	875,000 m3 of excavation	15,000 Asset tags
2 Tunnel boring machines	160,000 m3 of concrete	350,000 man-hours
3 emergency egress shafts	1,700 new car parking bays	98 FTE - Peak Manhours
3 new stations	7 Years duration from tender to opening day	6,000+ shop drawings
2 portal buildings and dive structures	10 years of operational maintenance (ongoing)	Design to BIM WD 300
12 cross passages	Fully compliant with QHSE standards	Project data 6TB – 1.57M docs on the project folder, 320,000+ emails

3.2 Technical Challenges

Deep excavations in soft ground near Perth Airport's control tower needed careful risk analysis. The Airport Central Station (ACS) is located adjacent to the 80m high control tower. All likely impact on the control tower's foundation stability was minimised by limiting the station box width. This was achieved by critically analysing the building operational criteria and then optimising plant and circulation areas to fit a minimal footprint. The station box volume was further reduced with post-tensioned floor slabs produced during top-down construction methods.

The track alignment and station box requirements for ACS were key factors determining the space available for ACS and Redcliffe Station. ACS included substantial back-of-house services due to mechanical, signal and electrical services to and from the trains. Furthermore, both stations included provision for structural redundancy due to design for threat requirements.

Bayswater Junction was the project's most complex brownfield site. It required a new grade separated rail junction to connect the new Forrestfield lines and existing Midland lines. Using a staged approach, the existing Midland alignment was temporarily moved to the North. The re-aligned Midland lines and new FAL lines were then phased in during weekend shutdowns. This approach reduced impacts on the Midland railway as the supporting infrastructure came online.

An LOD300 design model, under a well-established BIM delivery framework, enabled the determination of spatial requirements for service routes in and out of major equipment rooms. The constructability and creation of maintainable routes were assessed prior to site works.

Excavated materials from various sites were classified and process strategies were developed throughout the project. This balanced spoil treatment and handling costs with quality risk of the material product. Through this process the team identified potential spoil re-use of up to 95%. As a result of the sustainability initiatives, the project was given an "Excellent" rating by ISCA.

4 BUILT FORM

4.1 Redcliffe Station

Built underground in the residential heart of Redcliffe, the station (Figure 2) will be the catalyst for the area to become an urban village that will serve the growing community, airport business park and the DFO. Due to this key objective, the design team worked with METRONET staff to closely engage with the City of Belmont on its plans which will eventually see the area designed with public spaces, shops, housing, cafes, and other services nearby. The station design has considered the principles determined by the City of Belmont's Redcliffe Station Precinct DA6 framework which provided a specific vision for the area. The station also includes a 500-bay car park and two bike shelters with 88 bicycle bays.



Figure 2: External view of Redcliffe Station

Redcliffe Station required specific consideration of the surrounding urban context, with a series of interactions with local councils necessary to demonstrate that the development reflects the future high-density nature of the suburb. The station setting, landscape and overall planning, coupled with the roof, all play a fundamental role in defining the space in and out of the station, leading the passengers' journey. Due to its central precinct location, the station offers dual entry options to passengers.

The station has a light structure which allows for airflow and light to penetrate the concourse at ground level, and the platform level below. In addition, the artwork is intrinsically embedded in the station's design and narrative, connecting stories from the adjacent area or represented by a myriad of leaves applied to walls and hanging from the ceiling. As the station is connected to the twin bored tunnels at platform level, the level of services, particularly mechanical, is significant. Double height ventilation stacks are located at the end of each platform, allowing the mechanical systems to perform accordingly.

4.2 Airport Central Station

Airport Central Station's highly recognisable building form (Figure 3) brings to life the Public Transport Authority's objective to provide Perth Airport with the most appealing transport mode and convey the message and overall motto: 'the network is here to serve you.' Due to the project brief, objectives and forecasted patronage, this station's differentiated design differs from the other two on this line.



Figure 3: ACS main façade

The design response elevates the passenger experience beyond a commute to an inviting, intuitive, convenient, and safe journey that delivers a seamless connection between the airport terminal and the train, connecting the Perth Hills and the CBD. Aligning the building's shell with the airport's main road and leveraging the strong visual link created by this iconic building to the control tower created a natural path to the terminals and a sense of place.

Conceptually, the station serves as the central point of the airport's main precinct, viewable in the roundabout by vehicles circling its arc. Splaying the façade resolved the challenge of maintaining a compact footprint and created space for the main escalators. The compact footprint was dictated by the track alignment and the requirement to minimise land take at ground level, allocated to customer parking.

The roof's complex geometry, curved in three different directions uses aerodynamic references to expand on the idea of travel while performing critical functions. These included preventing glare from impeding control tower operations, accommodating the skylight and access to it, and opening 260-degree views from the mezzanine.

Horizontal vistas provide travellers with views of the airport precinct, CBD skyline and Darling Scarp, presenting the broader idea of Perth, the city, and the state as a destination. The amplification of transparency and natural light are instrumental design devices in this departure from typical underground, artificially lit stations. A central void visually connects the station's three levels and pulls natural light from the skylight through the building to penetrate the underground platform. Travellers arriving on the platform have full visibility of the triple-height space when they look up.

Natural light, colours and materials combine to create a calming decompression zone, offering respite from aircraft confines. Acoustic treated laminate timber panels lining the ceiling add warmth and tell the story of Western Australia's timber history. The artwork includes the narrative of the Noongar People, the Traditional Owners of the southwest, and their journeys, traditionally taken during the six Indigenous seasons, feature on a glass panel in the concourse.

4.3 High Wycombe Station

The catchment area for High Wycombe Station (Figure 4) includes the suburbs of High Wycombe, Forrestfield, Maida Vale, Gooseberry Hill and Kalamunda. To connect these suburbs more easily, the station precinct was designed as an intermodal transport hub. This means there will be facilities for passengers arriving at the station by bus, car, bicycle or on foot.



Figure 4: High Wycombe Station aerial view

To meet demand for parking, a multi-deck car park accommodating 1200 cars has been built on land bordered by Maida Vale Road and Ibis Place. While the original plan was for an at-grade car park, the new design improved access to the station's entrance. This new design frees up approximately eight hectares of land for future development. The solution not only meets passenger needs, but also supports METRONET's vision to create connected communities within walking distance of the station and the City of Kalamunda's Forrestfield North District Structure Plan.

The character of the local areas was reflected in the stations designs, through the choice of construction materials. For example, the canopy soffit panels were given earthy brown tones to create a soft, warm feel, and blend into the tree-lined green surroundings.

The rural character of the area has inspired the design approach and materials selection. The station proudly showcases a locally supplied Kimberley stone cladding used on the main façade. The variations in the colour of this stone and its unique texture will define the station precinct for years to come. Not dissimilar to Redcliffe and Airport Central Stations, the roof plays a fundamental role in defining the space in and out of the station, leading the passengers' journey. Both Redcliffe Station and High Wycombe Station include rail-bus interchanges servicing suburbs in the adjacent areas.

Full disability access was integrated into each of the stations, including platforms, concourse, terminals, car parks, and safe drop off zones. Intermodal transportation hubs were created at High Wycombe and Redcliffe incorporating new bus/rail interchanges and car parking. Also provided were drop off bays, a series of public pathways in and around the station for safe pedestrian and cycle movement, and weather-proof bicycle shelters. The landscape design included the use of Australian native trees and shrubs where provided.

4.4 Ancillary Buildings

The twin bored tunnels are interconnected via cross passages and at both ends by two portal buildings and respective track dives. As part of the project, and in compliance with PTA and overall rail safety regulations, 12 cross passages were designed, connecting the twin bored tunnels and allowing for escape in case necessary. There are also three emergency egress shafts, allowing passengers to ascend to the surface.

Although these buildings may be used by the public in case of an emergency, they are predominantly technical buildings and include services such as mechanical, comms, and electrical. Their design and functionality are intrinsically rail operations related. The EES (Figure 5) and cross passages were ultimately very complex design exercises by the multi-disciplinary team. Digital design played a key part of the process considering space constraints and requirements dictated by both budget and technical perspectives.



Figure 5: Egress Emergency Shaft, PTA 2022.

5 PUBLIC BENEFITS

Public transport must operate with efficiency, ensures safety of passengers and provides inclusivity. Public transport also enables the connection of places and people. Across all three stations, efforts to rationalise back-of-house and seamlessly integrate technical services cocoons passengers from the complexity of transport environments and keeps the focus on enhancing the customer experience and journey.

The WA State Government capped all train, bus and ferry fares to anywhere in Perth, drastically reducing fares for anyone living in the city's outer suburbs, including Mandurah [7]. Under the plan, the maximum cash fare for any trip is limited to two zones (AUD4.90). This has enabled trips from anywhere in Perth's metropolitan area to the Airport for the lowest fare in Australia.

Airport Central Station is an intrinsic part of the PAPL's masterplan. The subsequent development of the airport precinct is intertwined with PAPL's business plan and financial performance. The public benefits of a station in close proximity to an airport are evident to passengers both inbound or outbound conversely not triggering any social or community impacts, different to Redcliffe Station and High Wycombe, which are stations located in residential precincts.

As a strategy, the City of Kalamunda (CoK), the local authority where High Wycombe Station is located, has put in place planning initiatives to increase population density, activation and to implement a TOD for the relevant areas [8]. In late 2014, the City commenced the preparation of a District Structure Plan (DSP) to identify new land use opportunities, guide the urban structure, vision and objectives of future urban development [8]. The new focus resulted in planning for the delivery of high-density residential housing, a new activity centre and a commercially focused precinct based around the new train station. In line with the North-East Sub-regional Framework, the aim is to connect people with their place of work and recreation.

The City of Belmont also implemented a specific development plan for the area in which Redcliffe Station is located [9]. They indicated that the transition of the area from a traditional suburban area to a more urbanised transit-oriented development will be one of the key challenging aspects of redevelopment of the Redcliffe Station Precinct. In order to become sustainable and functional, hospitality and commercial opportunities need to be created to enable the activation of the area. A redesign of open space to create opportunities for investment in community and commercial assets would encourage more frequent use of public spaces. Consequently, the improvement in the walkability of the area would be beneficial in encouraging residents and users to use and therefore activate public areas.

According to the PTA's media release from December 2022 [6], Western Australian commuters are going back to trains, buses, and ferries, helping to lift public transport patronage numbers closer to pre-COVID-19 levels. From the introduction of a two-zone fare cap to the opening of the Airport Line, public transport has become an appealing option for more commuters. This has been reflected in the numbers, as patronage rebounds to about 90 per cent of pre-pandemic levels.

Since October 9, 2022, Forrestfield-Airport Link has been connected to the Perth rail network and the Airport Line operational. The Opening Day (Figure 6) was advertised by State Government and family events were held at both Redcliffe and High Wycombe Stations. The community attendance was noticeable by the media and attendees, across all three stations and on trains. Patronage and attendance were not recorded as it was a free ride day and SmartRiders were not in use.



Figure 6: Opening day train boarding at Perth Station

Between public works and local government initiatives, the many variables needed for the development of these residential areas are in place or in development.

The patronage levels increase [6] as tourists start to return to Western Australia after COVID19. Although flight numbers are not yet at pre Covid levels, the trend is positive [6]. Throughout the design and construction stages of the FAL project, changes across all developed areas became evident and noticeable. In reviewing the basic principles of TODs [11], it is interesting to notice that the Airport Line ticks most of the boxes and is a catalyst for outstanding items to be completed.

A review of this paper in 5, 10 and 15 years would be valuable to understand how these communities have developed through time.

6 CONCLUSION

From small villages to major cities, transport systems and networks have defined the way we live and work. From the waterways to the horse-and-carts days, from steam trains to remote driven trucks, the ability to connect has always dictated progress. The Airport Line, now fully constructed and operational, is one of the first pieces of a puzzle. It opens numerous opportunities for multiple communities serviced by its three train stations. It also democratises and safely connects Perth to its international airport, working as a literal gateway to Western Australia.

In order to analyse its complexity, it is important to unpack social, planning, economic and technical aspects of its design and construction, included in this paper. The final piece of this puzzle is time. The station's structures were ultimately designed for a 100-year life. It will require time for the urban fabric to develop once the new facilities and infrastructure are fully adopted by existing and future users making sure that there is enough room for adaptations and changes if required.

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8.1 Figures

1. Forrestfield-Airport Link map', https://www.forrestfieldairportlink.wa.gov.au/tunnels-track/rail-route , (accessed March, 2023)
2. External view of Redcliffe Station, provided by PTA in February 2023
3. Airport Central Station façade, provided by PTA in February 2023
4. High Wycombe Station aerial view, , provided by PTA in February 2023
5. Egress Emergency Shaft, provided by PTA in February 2023
6. Opening day at Perth Station, provided y the author in October 2023

8.2 Tables

1. Project's statistics summary, GHD, compiled March 2023