Government of **Western Australia**
Public Transport Authority

Forrestfield-Airport Link

Environmental Impact Assessment

November 2014

Executive Summary

Directions 2031 and Beyond and *Draft Public Transport for Perth in 2031* (Department of Transport, 2011) recognise that the current public transport infrastructure in Perth will not be sufficient to cope with the projected population growth and highlights priorities for infrastructure investment including a rail line to Perth Airport.

The Forrestfield–Airport Link forms an integral component of Perth's long term public transport network and is designed to meet existing and future public transport demand. The proposed rail line will provide improved connectivity between the eastern suburbs, aviation hubs and the Perth Central Business District, as well as providing a viable alternative to traditional car travel between these destinations.

A Feasibility Study undertaken in 2010 (AECOM, 2010) identified a variety of alignment options and methods of construction to link the existing Perth to Midland rail line to Perth Airport and the eastern suburbs. A detailed evaluation of three of these options was undertaken to determine the preferred alignment and method of construction. This included an assessment of cost, social, environmental and heritage impacts. Based on this evaluation, a subterranean option was selected due to the reduced environmental and social impacts; in particular the lack of impact to the Swan River and the limited noise emissions during operation of the rail line. The key characteristics of the subterranean option are summarised below.

Proposal Title	**Forrestfield-Airport Link**	
Proponent Name	Public Transport Authority of Western Australia	
Project Description	The Project involves a 9 km spur rail line from the Bayswater Station/Midland line through to the eastern suburb of Forrestfield and provision of three stations and associated rail infrastructure.	
Physical Elements		
Element	**Location**	**Proposed Extent / Description**
General Alignment	The proposed alignment will begin from a connection with the Midland Line, east of Bayswater Station. The alignment will generally follow along Tonkin Highway and then deviate towards Perth Airport where it will run beneath the airport surfacing to the east.	The proposed infrastructure will comprise twin bored tunnels, structures and facilities including stations, car parks, cross passages, emergency egress shafts, signalling and telecommunication equipment as well as relocation of underground services and amendments to the road network. The Approval Boundary comprises all of the elements discussed in this table as well as any areas required for construction.
Bored Tunnels	Two bored tunnels are proposed for the project, to be constructed by Tunnel Boring Machines (TBMs). The TBMs will commence tunnelling in Forrestfield Station and surface in Bayswater where the FAL connects to the existing Perth to Midland line.	Approximately 8 km of the FAL will comprise twin bored tunnels with an internal diameter of 6.16m. The twin tunnels will be spaced approximately 7 m apart and connected longitudinally by cross passages and vertically to the surface by emergency egress shafts. The tunnels will have a thickness of at least 275mm and be reinforced by a combination of reinforced cages and steel fibres. The concrete segments comprising the tunnels will also contain polypropylene fibres to control any damage caused by fire.

Airport West Station	The proposed Airport West Station is located on State land to the west of the Perth Airport, along the Brearley Avenue	Airport West Station will be an underground station with the platform below ground level and the station at the surface. Provision has been made for a bus interchange and a 500 to 1,000 bay car park.
Consolidated Airport Station	The proposed Consolidated Airport Station will be located underground, adjacent to the current International Terminal and to the south of the control tower.	The Consolidated Airport Station will be below ground, with passengers arriving from the suburban rail network and utilising a combination of lifts, stairs and escalators to connect from the platform level to the airport. No car parking is proposed at this station.
Forrestfield Station	The proposed Forrestfield Station will be located east of the Perth Airport and the Forrestfield Marshalling Yard and west of Dundas Road near the intersection with Maida Vale Road. It is situated in an area which comprises some undeveloped semi rural land, light industrial to the south and residential to the north.	The Forrestfield Station is an at grade station which will serve the suburbs of High Wycombe, Forrestfield and Kalamunda. A transport interchange is proposed which will include for a bus interchange and a 2,000 to 2,500 bay car park. The station also includes pedestrian and bicycle infrastructure.
Emergency Egress Shafts	Four Emergency Egress Shafts are proposed along the alignment. These are located adjacent to Tonkin Highway in Bayswater, at the intersection of Tonkin Highway and Brearley Avenue, within the Domestic Airport Precinct and on Abernethy Road in Forrestfield.	The Emergency Egress Shafts connect the tunnels to the ground level and provide emergency escape in the event of an incident. The depth of the emergency egress shafts is approximately 20m from the existing ground level. Once constructed there will be a small building and a small hardstand for emergency and maintenance vehicles to park.
Cross Passages	Five Cross Passages are proposed along the alignment. These are located adjacent to Tonkin Highway in Bayswater, adjacent to the Tonkin Highway road bridge and within Perth Airport.	The cross passages provide a connection between the tunnels. The cross passages provide tunnel users with a safe passage from one tunnel to another in the event of an emergency. The cross passages will be constructed from within the tunnels with some pre-treatment of the ground from ground surface required.
Road Realignment	The concept design for the Forrestfield Station will require Dundas Road to be realigned.	It is proposed that Dundas Road will be relocated to the west, adjacent to the Forrestfield Marshalling Yard boundary over a distance of approximately 1km. Access to Dundas Road from Maida Vale Road and Imperial Street will be maintained. Any properties that are isolated from the new alignment will be connected via a new access location.
Underground Service Relocation	A number of underground services and utilities exist within and adjacent to the project area.	Underground services and utilities within the project area will require either diversion or protection to ensure the proposed infrastructure can be accommodated.

This Environmental Impact Assessment addresses matters relevant to the project on State land and has been developed to support the Section 38(1) referral under the Western Australian *Environmental Protection Act 1986*. It is only the matters relevant to the project on State land that are subject to assessment by the Environmental Protection Authority under the *Environmental Protection Act 1986*. Impacts to environmental values within Commonwealth land, or to any Matters of National Environmental Significance which (on both State and Commonwealth land) will be referred to the Department of the Environment under the federal *Environment Protection and Biodiversity Conservation Act 1999*.

The Forrestfield–Airport Link has been designed to avoid environmental and heritage impacts where possible. The most significant mitigation or avoidance measures are summarised below:

- Constructing the rail line underground within bored tunnels will avoid direct impacts to the following:
  - 30 potential black cockatoo habitat trees
  - Over 3 ha of potential black cockatoo foraging habitat
  - Water Rat habitat in the vicinity of the Swan River
  - Sensitive receptors of elevated levels of noise and vibration
  - Disturbance to the bed or banks of the Swan River
  - Vegetation potentially comprising Subtropical and Temperate Coastal Saltmarsh along the Swan River
- Identification of construction methods to limit the extent of dewatering activities has demonstrated that it is possible to minimise impacts to wetland, black cockatoo habitat trees and threatened and priority ecological communities
- Designing the Forrestfield Station Precinct footprint to avoid Poison Gully Creek which is a Bush Forever and Aboriginal Heritage site that contains of 12 *Conospermum undulatum* plants, threatened ecological communities and black cockatoo habitat
- Designing the Forrestfield Station Precinct footprint to avoid 3.51 ha of a Critically Endangered Threatened Ecological Community

Environmental management measures have been developed to further reduce potential environmental impacts. Environmental impacts which are relevant to the Section 38(1) referral once relevant mitigation and management measures have been taken into consideration are summarised below:

- Disturbance of acid sulfate soils through excavation activities and groundwater dewatering
- Potential mobilisation of contaminated groundwater due to dewatering activities albeit preliminary modelling demonstrates that potential impacts can be managed effectively
- Clearing 2.47 ha of remnant vegetation in good or better condition. This remnant vegetation is classified as Threatened Ecological Communities as described below:
  - 1.72 ha of Swan Coastal Plain Floristic Community Type 20a/20b (*Banksia attenuata* woodland over species rich dense shrublands/*Banksia attenuata* and/or *Eucalyptus marginata* woodlands of the eastern side of the Swan Coastal Plain) which are listed as Endangered under the *Wildlife Conservation Act 1950*.
  - 0.75 ha of Swan Coastal Plain Floristic Community Type 20c (Shrublands and woodlands of the eastern side of the Swan Coastal Plain) which is listed as Critically Endangered under the *Wildlife Conservation Act 1950*.
- Impacts to significant flora include clearing 25 *Conospermum undulatum* plants which are listed as Vulnerable under the *Wildlife Conservation Act 1950*.

- Impacts to significant fauna habitat includes:
  - Clearing 15 potential black cockatoo habitat trees. The black cockatoo is listed as specially protected fauna under the *Wildlife Conservation Act 1950.*
  - Clearing 3.56 ha of potential black cockatoo foraging habitat
  - Clearing 5.3 ha of Quenda habitat. Quenda is listed as a Priority 5 species under the *Wildlife Conservation Act 1950.*
- Impacts to wetlands include clearing 3.28 ha of Resource Enhancement Wetland (UFI15876). This includes 1.72 ha of Swan Coastal Plain Floristic Community Type 20a/20b.
- Potential impacts to the registered Aboriginal Heritage sites Swan River and Poison Gully Creek

Using the Environmental Protection Authority's *Environmental Assessment Guideline for Application of a Significance Framework in the Environmental Impact Assessment Process* (Environmental Protection Authority, 2013), the significance of the potential impacts has been assessed. The significance of the potential impacts once relevant mitigation and management measures have been taken into consideration are not likely to have a significant effect on the environment and are therefore considered to meet the EPA's environmental objectives. There are also alternate regulatory processes to ensure the EPA's environmental objectives will be met.

A summary of the additional studies which will be undertaken and the subsequent management plans which will be produced to manage potential environmental and heritage impacts during construction and operation is provided below. All management plans will be prepared to the satisfaction of the Department of Environment Regulation with input from other relevant agencies as required.

- Detailed Contamination and Acid Sulfate Soil Investigation
- Detailed Groundwater Modelling
- Detailed Noise and Vibration Modelling
- Construction Environmental Management Plan
- Acid Sulfate Soils and Dewatering Management Plan
- Construction Noise and Vibration Management Plan
- Operational Noise and Vibration Management Plan
- Site Management Plan (if required) to manage any contamination identified as part of the Detailed Contamination and Acid Sulfate Soil Investigation which may pose a risk to human health or the environment
- Development and implementation of an Environmental Offset Strategy

A summary of the alternate regulatory processes and approvals that will ensure that the EPA's environmental objectives will be met are provided below.

- A Native Vegetation Clearing Permit under the *Environmental Protection Act 1986*
- A Licence to Take protected flora under the *Wildlife Conservation Act 1950*
- A Fauna Relocation Permit under the *Wildlife Conservation Act 1950*
- A Section 18 Approval under the *Aboriginal Heritage Act 1972*
- Dewatering licences under the *Rights in Water and Irrigation Act 1914*
- Works Approval and licences for spoil reuse under the *Environmental Protection Regulations 1987*
- A Bed and Banks Permit under the *Rights in Water and Irrigation Act 1914*
- Noise and Vibration Management under the State Planning Policy 5.4 and the *Environmental Protection (Noise) Regulations 1997*

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1 Introduction

1.1 Project Overview

Directions 2031 and Beyond and *Draft Public Transport for Perth in 2031* (Department of Transport, 2011) recognise that the current public transport infrastructure in Perth will not be sufficient to cope with the projected population growth and highlights priorities for infrastructure investment including a rail line to Perth Airport.

The Forrestfield–Airport Link (FAL) forms an integral component of Perth's long term public transport network and is designed to meet existing and future public transport demand. The proposed rail line will provide improved connectivity between the eastern suburbs, aviation hubs and the Perth Central Business District (CBD), as well as providing a viable alternative to traditional car travel between these destinations.

The location of the FAL is presented on Figure 1. Detailed information on the project is provided in Section 2.

1.2 Scope of Environmental Impact Assessment

Under section 38(1) of the *Environmental Protection Act 1986* (EP Act), the Public Transport Authority of Western Australia (PTA) is referring the proposed FAL project to the Environmental Protection Authority (EPA) for a decision on whether or not it requires assessment.

The purpose of this Environmental Impact Assessment (EIA) is to support the Section 38(1) referral and establish the following elements of the FAL project:

- Define the key characteristics of the FAL and the associated timelines to deliver the project
- Identify the key environmental factors raised by the FAL and their significance
- Identify the relevant policy and guidance documents to be considered for each key environmental factor
- Define the EPA objective, environmental values, potential impacts and proposed management for each identified key environmental factor

As shown on Figure 1, the FAL alignment traverses both State and Commonwealth land. This EIA details those matters relevant to the State environmental approvals, which includes environmental values and potential environmental impacts on State land. It is only the matters relevant to the project on State land that are subject to assessment by the EPA under the EP Act.

An *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) referral will be submitted for assessment by the Department of the Environment (DoE) to obtain Commonwealth approval for all matters within the Commonwealth land and for any Matters of National Environmental Significance (NES) within the project area. The Commonwealth land within the project area is depicted on Figure 1.

1.3 Environmental Assessment Approach

The primary approvals which are required at a State and Commonwealth level are outlined in Plate A below. The EP Act and the EPBC Act are the principal pieces of environmental legislation applicable to the project. The EP Act functions to prevent pollution and environmental harm and to protect, enhance and manage existing environmental values. The EPBC Act provides a framework for the protection and management of matters of national and international environmental and cultural significance. As discussed above, this EIA has been prepared to support the Section 38(1) referral.

The Commonwealth land within the project area is also subject to the Commonwealth *Airports Act 1996* which is administered by the federal Department of Infrastructure and Regional Development (DIRD). The key approval requirement under the *Airports Act 1996* is a Major Development Plan (MDP). The MDP process contains an environmental assessment by the DoE and a mandatory public comment period. For the FAL project it is anticipated that any environmental assessment required under the *Airports Act 1996* will reference the EPBC Act process.

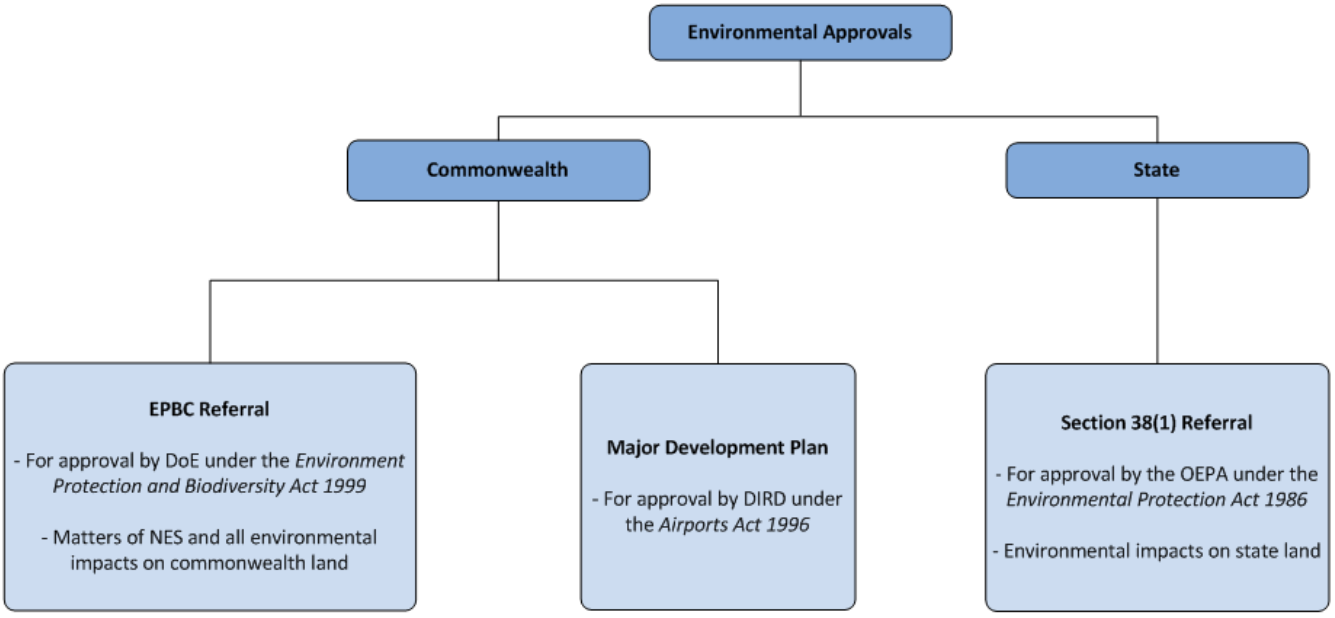


Plate A:Forrestfield-Airport Link Environmental Approvals Flowchart

1.4 Key Studies

The following key environmental and heritage studies were commissioned by the PTA to define the proposed FAL alignment and construction method and to support the State and Commonwealth environmental approvals:

- Flora, Vegetation and Fauna Assessments
  - Forrestfield-Airport Link – Environmental Investigation (GHD, 2014c)
  - A level 1 flora and vegetation survey of the Bayswater foreshore site (Brian Morgan, 2014)
  - Fauna Survey of the Proposed Forrestfield-Airport Link Swan River Crossing (Bamford Consulting Ecologists, 2014)
  - Forrestfield-Airport Link – Phytophthora Dieback Occurrence Assessment (Glevan Consulting, 2014)
  - Forrestfield-Airport Link – Swan River Benthic Habitat and Riverine Fauna Assessment (RPS, 2014a)
  - Forrestfield-Airport Link – Options to Avoid Areas of Environmental Value in Forrestfield (Public Transport Authority, 2014)
  - Spring Field Survey – Interim Findings (RPS, 2014b)
- Aboriginal Heritage Studies
  - Aboriginal Heritage Study of Part Lot 15531, Dundas Road, High Wycombe (O'Conner, 2011)
  - Desktop Aboriginal Heritage Review for the Proposed Airport Rail Link (Waru Consulting, 2013a)
  - Additional Archaeological Verification of DAA Site #4408 "Newburn: Bingham St" (Waru Consulting, 2013c)
  - Desktop Aboriginal Heritage Review "Gap Analysis" for Proposed Airport Rail Link (Waru Consulting, 2013b)

  - Consultations for Forrestfield-Airport Rail Link at Aboriginal Site "Swan River" (DAA#3536) (Waru Consulting, 2014a)
  - Consultations for Forrestfield-Airport Link Railway at Aboriginal Site "Poison Gully Creek" (DAA#25023) (Waru Consulting, 2014b)
- Contaminated Sites Investigations
  - Perth Airport Rail Link – Preliminary Site Investigation (GHD, 2013)
  - Perth Airport Rail Link – Sampling and Analysis Plan (GHD, 2014b)
- Groundwater, Dewatering and Acid Sulfate Soils Assessments
  - Perth Airport Rail Link – Acid Sulfate Soil Sampling and Analysis Plan (GHD, 2014a)
  - Forrestfield-Airport Link – Groundwater Management Advice (Mobile Dewatering, 2014)
  - Forrestfield-Airport Link – Preliminary Dewatering Assessment (Golder Associates, 2014a)
  - Addendum No.1 Preliminary Dewatering Assessment; Forrestfield-Airport Link (Golder Associates, 2014b)
  - Forrestfield Airport Link Geotechnical Desk Study (GHD, 2014d)
  - Forrestfield Airport Link - Stage 1 Geotechnical Interpretative Report (GHD, 2014e)
  - Forrestfield Airport Link - Stage 1 Factual Geotechnical Investigation Report (GHD, 2014f)
- Noise and Vibration
  - Forrestfield-Airport Link – Noise and Vibration Feasibility Assessment (AECOM, 2014a)
- Hydrology
  - Forrestfield-Airport Link – Swan River Flood Modelling (JDA, 2014)
- Sustainability
  - Forrestfield-Airport Link – Sustainability Framework (Aurecon, 2014)

Additional data has also been sourced from reports which were not commissioned by the PTA. The PTA was given access to the data from these reports on the basis that the reports are not published. The data sourced from these reports has been published in this report and used as part of the Section 38(1) referral. These are as follows:

- A Vegetation and Flora survey undertaken for an area within and adjacent to the Forrestfield Station Precinct (Brian Morgan, 2013).
- Flora, vegetation and fauna surveys undertaken within Perth Airport in 2007 (Mattiske Consulting, 2008), 2012 (Ecologia Environment, 2013) and 2013 (Bamford Consulting Ecologists, 2013).
- Land contamination, groundwater and surface water data provided by Perth Airport Pty Ltd (PAPL)

The areas assessed by various consultants during the flora and fauna surveys listed above are provided in Figure 2. When combined, this data covers the majority of the Approval Boundary, with the only data gaps occurring in cleared or degraded areas such as pasture, rail or road reserves in which ecological surveys were not considered necessary.

Studies which are currently being undertaken or proposed to support project delivery and inform future approval applications and management plans include:

- Stage 2 Geotechnical and Hydrogeological Investigation
- Detailed Groundwater Modelling
- Detailed Contamination and Acid Sulfate Soil Investigation
- Detailed Noise and Vibration Modelling
- Targeted Flora and Vegetation surveys

2 Project Description

2.1 Planning Background

2.1.1 Directions 2031 and Beyond

Directions 2031 and Beyond (Department of Planning, 2010) is the State Government's high-level spatial framework and strategic plan which establishes a vision for future growth in the metropolitan Perth and Peel regions. It provides a framework for the detailed planning and delivery of housing, infrastructure and services necessary to accommodate various growth scenarios. Perth Airport and Forrestfield have been identified within *Directions 2031 and Beyond* as a Strategic Specialised Centre and District Centre respectively.

Strategic Specialised Centres are an important part of the metropolitan centres network as they are key drivers of innovation and information exchange, and generators of employment. They also provide significant opportunities for the development of business synergies and agglomeration of like activities. Due to their specialised nature, these centres generally have a wider catchment than strategic city centres and rely on a high level of access, particularly to public transport, for their effective operation.

Directions 2031 and Beyond identifies the 'connected city' model as the preferred medium density future growth scenario for the metropolitan Perth and Peel regions. The 'connected city' model projects that the population of Perth will reach 3.5 million by around 2050. It investigates scenarios for planning for a city of 3.5 million people, providing an indication of how the planning system could spatially accommodate the housing and land supply needs of a city with that population.

Connecting Perth Airport to the public transport system is a key element in *Directions 2031 and Beyond*. An emphasis is placed on consolidating development around existing and future public transport infrastructure, and around strategic centres and areas of future urban development. These major employment centres include the Perth Airport Precinct which is identified as a strategic specialised centre.

2.1.2 In Motion (Draft): A 20 year public transport plan for Perth

In Motion identifies the public transport network which will be required by 2031 to support Perth's growing population, including the links to and between strategic centres. It outlines that Perth's current public transport infrastructure will not be able to cope with projected population growth.

In terms of infrastructure investment across the Perth network, one of the priorities identified in the draft plan is the construction of a spur on the Midland Line from Bayswater Station to the airport.

The draft plan includes a station at Forrestfield to serve the local community and wider catchment areas. Due to the significant forecasted demand for public transport to and from Perth's eastern suburbs, the requirement for the Forrestfield Station is considered greater than that for Airport West Station or the Consolidated Airport Station, and hence is a key driver in the justification for the FAL project.

2.1.3 Perth Airport Master Plan

Perth Airport facilitates the majority of travel within the State, to other Australian capital cities and to international destinations. Perth's isolation makes Perth Airport an essential element in the lives of those living in Western Australia. Furthermore, Western Australia's position as a major export income earner for Australia through the resource sector relies on Perth Airport's capacity to efficiently process the fly in fly out workers on remote project sites (Perth Airport, 2013a).

In 1997, control of Perth Airport was transferred from the Commonwealth of Australia to Westralia Airports Corporation (WAC) under a 50 year lease with a 49 year option for extension. In 2011, WAC changed its trading name to Perth Airport Pty Ltd (Perth Airport, 2013a).

While the day to day management of Australian airports has been transferred to private operators, the Commonwealth Government continues to play an important regulatory and oversight role through administration of the *Airports Act 1996* and a number of associated Regulations. This statutory regime places a number of controls over the operation of federally leased Australian airports to ensure that the public interest is always protected (Perth Airport, 2013a).

PAPL is required to prepare a master plan every 5 years in accordance with the *Airports Act 1996*, to describe expected developments within the Airport estate and provide an indicative plan for progression of that development. The *Perth Airport Master Plan 2009* (current version), provides a framework to cater for the expanded airport capacity and acknowledges the development of a railway to the airport. The draft Perth Airport Master Plan 2014 has been prepared and submitted to the Commonwealth Government for approval. The Airport Master Plan 2014 will include provision for the FAL.

2.2 Project Justification

The need for the FAL project has been outlined in a number of planning documents and strategies and is based on the predicted growth of Perth's population and traffic through the airport as discussed below.

2.2.1 Improved Access to Public Transport

By 2021, the FAL is expected to generate 20,000 boardings on the suburban rail network every day – increasing to 29,000 daily by 2031. The Forrestfield Station Precinct and surrounding area features substantial areas of undeveloped land and low density living. These low levels of development may be attributed to the poor transport links in the area, with a trip to the CBD by car currently taking approximately 25 minutes in free flowing traffic and 45 minutes during peak periods, while public transport options are typically greater than 50 minutes. It is anticipated that provision of a rail service to the area will substantially reduce these travel times.

The largest economic benefit associated with the FAL is the expected change in land development, with a significant increase in residential and commercial development likely to occur in the catchment area associated with the Forrestfield Station.

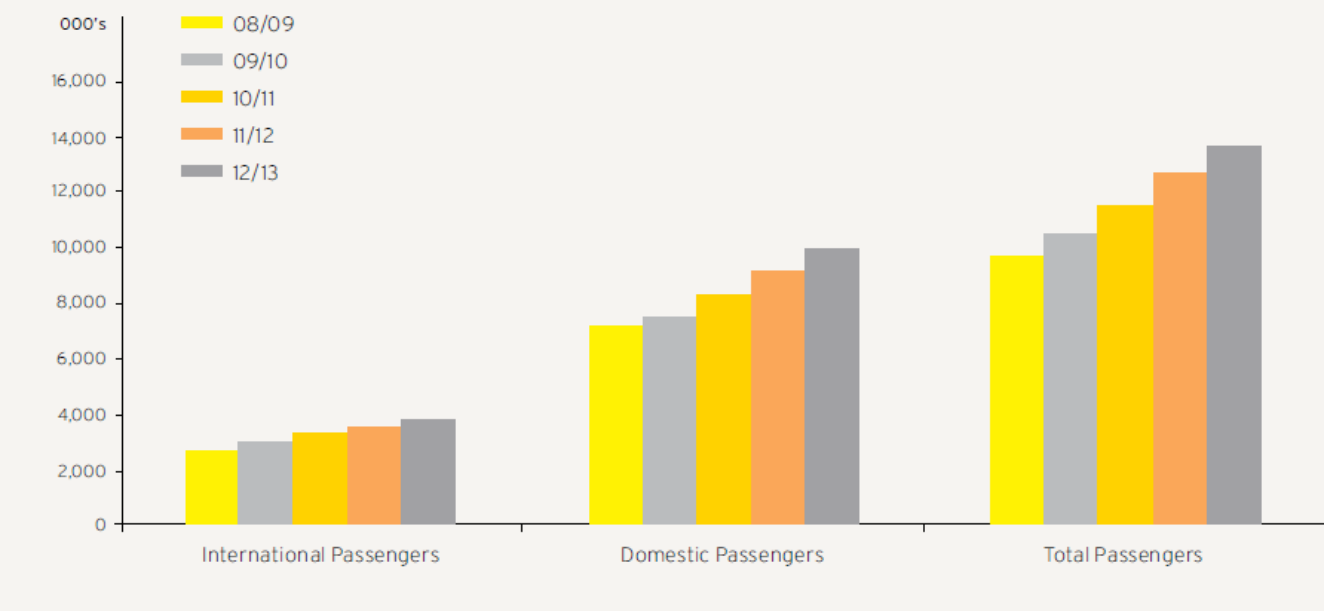
A further benefit from increased land availability in the Forrestfield area is improved access to the CBD for low income earners. The increased availability of affordable land with a quality public transport link to the CBD will result in greater CBD employment participation by low income workers as the cost of travelling to and accessing employment within the CBD falls. The value of lower employee costs and a greater level of choice for CBD employers will result in lower prices and better service in the CBD.

2.2.2 Perth Airport

At present, public transport servicing Perth Airport is limited (Perth Airport, 2013b), with projected increases in passenger numbers through the airport putting further strain on the existing infrastructure. PAPL recognises that hassle free transport services are an important feature of the overall airport and travel experience. Consequently during 2012 / 2013, PAPL undertook the following to improve transport to and from the airport (Perth Airport, 2013b):

- Expanding and improving car parking to provide more than 17,000 car parking bays at Perth Airport
- Planning and design of multi-storey car parks and redevelopment of the Terminal 1 forecourt system.
- Construction is well advanced on the Gateway WA project which is expected to transform future road access to Perth Airport

Growth in air passenger traffic through Perth Airport has increased at around 9.5 per cent annually over the last decade, while in the last four year period since 2007-08, aircraft movements at Perth Airport increased by 32.2 per cent from 107,489 to 142,079 in 2011-12. This growth is depicted in Plate B.



International Passengers		Change		Domestic Passengers		Change	
08/09	2,618,738	106,082	4.2%	08/09	7,116,335	449,837	6.7%
09/10	2,993,874	375,136	14.3%	09/10	7,470,097	353,762	5.0%
10/11	3,265,581	271,707	9.1%	10/11	8,185,872	715,775	9.6%
11/12	3,492,160	226,579	6.9%	11/12	9,140,640	954,768	11.7%
12/13	3,763,667	271,507	7.8%	12/13	9,900,727	760,087	8.3%

Plate B: Passenger Statistics for Perth Airport over a 5 year period (Perth Airport, 2013b)

More recent forecasts by the Bureau of Infrastructure, Transport and Regional Economics (BITRE) anticipate that passenger numbers will increase to 20 to 25 million per annum by 2031, which represents a doubling of passenger numbers in the next 20 years. This predicted growth is depicted in Plate C.

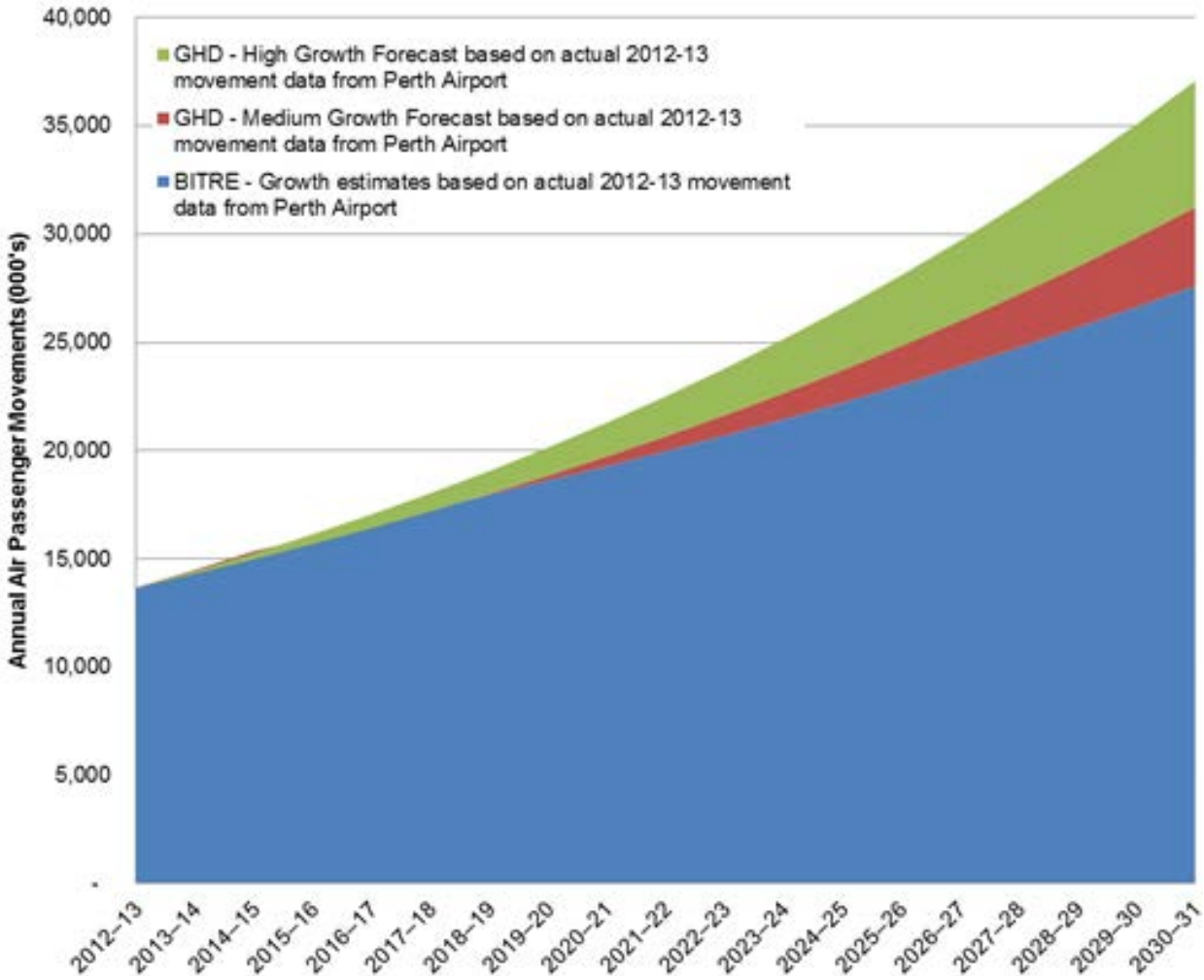


Plate C: Forecast of a Range of Possible Passenger Movements at Perth Airport

This increase in passenger numbers will also lead to an increase in the number of people utilising both public and private transport to and from the airport. Provision of a rail link will improve the public transport servicing the airport and cater for the expected increase in traffic.

2.2.3 Other Benefits

In addition to providing strategically-located stations and improving transport access to the airport and Forrestfield, the FAL Project will also create a number of indirect benefits including:

- reduced road traffic congestion associated with the increased public transport mode will improve transport movement along key freight routes including Roe Highway, Tonkin Highway and Leach Highway
- creating additional rail capacity on the Midland Line in the inner suburbs of Perth, where demand is expected to exceed current supply in the near future
- connecting an increased number of regional bus services to Perth Airport, providing access from over 200 regional towns
- encouraging access to strategic centres to promote local tourism activity
- boosting employment, residential and economic growth by promoting new and existing centres
- minimising the impact of the airport as a physical divide in the area, improving social equity and quality of life for Perth's community

2.3 Project Objectives

On behalf of the Western Australian Government, the PTA is committed to delivering an integrated and affordable transport system for the eastern suburbs of Perth. The FAL will be designed and operated with the customer at the centre of its design philosophy. The primary objectives for the FAL are:

- To improve the liveability, connectivity and amenity for current and future residents of the eastern suburbs
- To design and construct a project that will be sensitive to and promote environmental, economic and social sustainable outcomes
- To provide an accessible, reliable and safe public transport system
- To assist in alleviating congestion and improve productivity and capacity of the existing transport network
- Value-for-money outcomes in service and infrastructure delivery

2.4 Route Selection

Key to the success of the new rail line is the route the railway will take. To determine that route, it was necessary to look to the future – at population growth patterns, projected demand, economic and infrastructure plans and stimulus potential. A detailed assessment process determined the most appropriate station locations, the catchments that will be served, the most efficient way to connect those catchments to the Perth CBD, and the capacity for future extension. Route planning and importantly the construction methodology for the FAL was also guided by the key environmental and heritage values identified by the PTA.

In the early stages of the project design, the PTA considered an alignment option which comprised a spur line heading south from the Midland line from near Ashfield Station towards the airport. A desktop assessment of this proposed alignment identified areas of significant environmental value and was consequently rejected. These environmental values included:

- Six threatened species, including *Darwinia* sp. Muchea which is Critically Endangered under the EPBC Act and *Lepidosperma rostratum* which is Endangered under the EPBC Act
- Habitat for black cockatoo species
- Ashfield Flats which provides riverine and wetland habitat for seven migratory bird species protected under the EPBC Act
- Ashfield Flats also comprises Bush Forever Site 214
- Conservation Category wetland

An option to construct the railway in the Tonkin Highway median between Bayswater and the airport, similar to the location of the Joondalup and Mandurah railways in the Mitchell and Kwinana Freeways respectively, was also explored in the early stages of the project design. This option was not considered to be feasible due to the substantial road works which would require to be constructed, including a new bridge over the Swan River, to create the necessary median width. Alternative engineering options were therefore evaluated.

During the later stages of the design process, attention focused on three route alignment options to find the best option to accommodate existing road layouts and future upgrades, to minimise impact on landowners and traffic as well as minimise environmental and heritage impacts. The eastern portion of these alignments through and beyond Perth Airport was the same. A summary of these options is provided below and presented in Plate D.

- Elevated Option (Option 1) – A combination of elevated and at grade rail running to the north of Tonkin Highway entering a subterranean section on Brearley Avenue and then into Commonwealth land. A new bridge would be required to cross the Swan River.
- Partially Subterranean Option (Option 2) – A combination of at grade and subterranean rail running to the south of Tonkin Highway, with a crossing under Tonkin Highway and then into Commonwealth land. The subterranean sections would be excavated from the surface. A new bridge would be required to cross the Swan River.
- Entirely Subterranean Option (Option 3) – An entirely subterranean rail option crossing under the Swan River and Brearley Avenue and then into Commonwealth land. The subterranean sections would be excavated below ground using a tunnel boring machine.

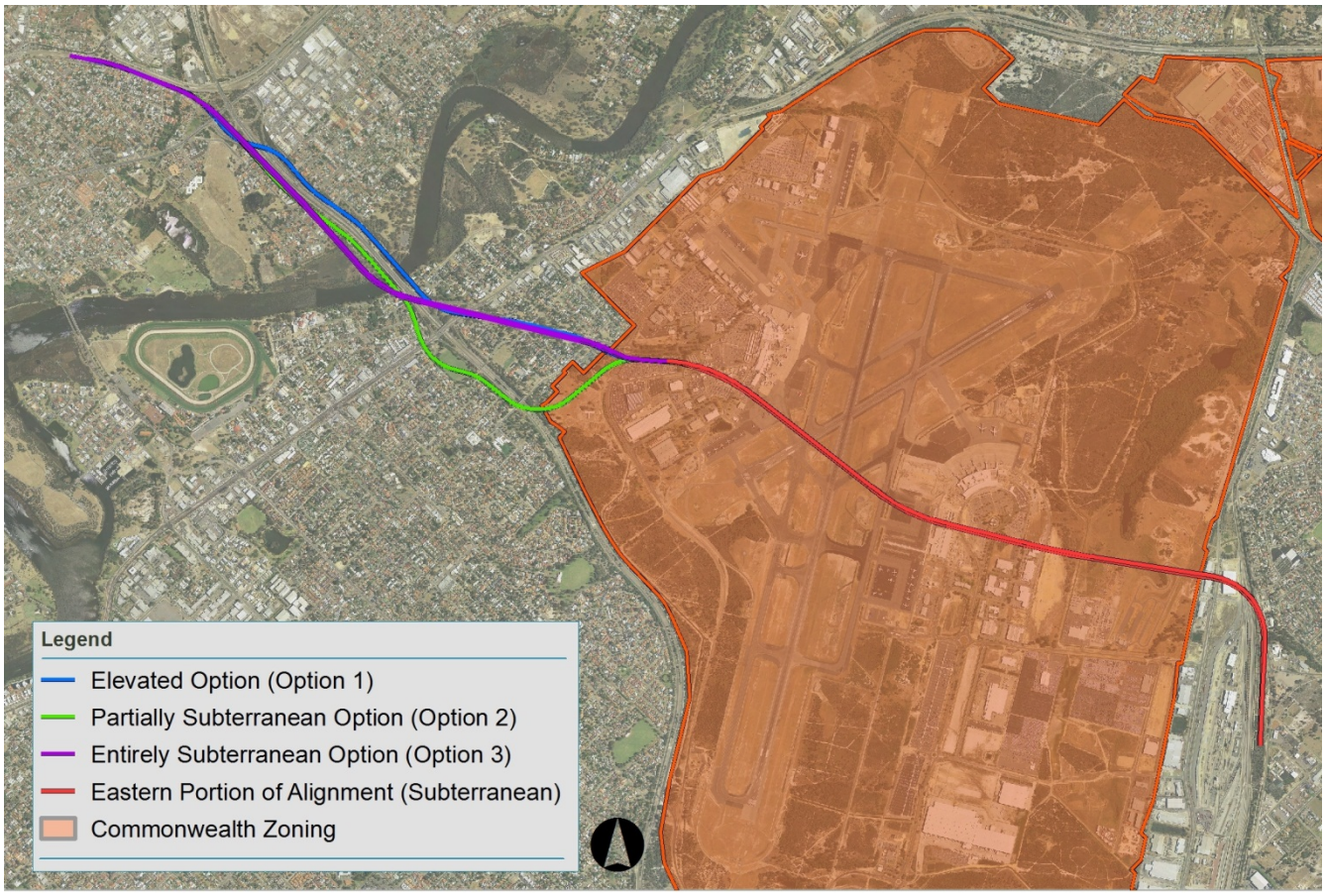


Plate D: Forrestfield-Airport Link Alignment Options

An evaluation of these options was undertaken which included an assessment of each option's social, environmental and economic impact. The assessment was based on the data collected during the investigations detailed in Section 1.4. The results of this assessment are summarised below in Table 1.

Table 1: Summary of Potential Impacts from Options Assessed

Potential Impacts		Alignment Options (including eastern portion of alignment depicted as red in Plate D)		
		Elevated option (Option 1)	**Partially Subterranean Option (Option 2)**	**Entirely Subterranean Option (Option 3)**
Vegetation and flora	SCP20c	- Clearing 0.75 ha	- Clearing 0.75 ha	- Clearing 0.75 ha
	SCP20a / 20b	- Clearing 1.72 ha	- Clearing 1.72 ha	- Clearing 1.72 ha
	Remnant vegetation	- Clearing 2.46 ha vegetation in Good or better condition	- Clearing 2.47 ha vegetation in Good or better condition	- Clearing 2.47 ha vegetation in Good or better condition
	Conospermum undulatum	- Clearing 25 plants	- Clearing 25 plants	- Clearing 25 plants
Fauna	Black cockatoo habitat	- Clearing 20 potential habitat trees - Clearing 4.58 ha potential foraging habitat	- Clearing 53 potential habitat trees - Clearing 6.59 ha potential foraging habitat	- Clearing 15 potential habitat trees - Clearing 3.56 ha potential foraging habitat
	Water rat habitat	- Impacts to 0.06 ha potential water rat habitat	- Impacts to 0.05 ha potential water rat habitat	- No impacts to potential water rat habitat
Noise and Vibration	Noise	- Impacts to 5 sensitive receptors (exceedance to noise target criteria)	- Impacts to 13 sensitive receptors (exceedance of noise target criteria) - Impacts to 3 sensitive receptors (exceedance of noise limit criteria	- Impacts to one sensitive receptor (exceedance of noise target criteria)
	Vibration	- No vibration impacts	- Potential ground borne regenerated noise exceedances at 12 houses	- No vibration impacts
Surface water	Swan River	- Construction within the Swan River and clearing of riparian vegetation	- Construction within the Swan River and clearing of riparian vegetation	- No physical impacts to the Swan River (e.g. disturbance of bed or banks)
Acid Sulfate Soils and Dewatering		- Limited excavation and dewatering required	- High level of dewatering required which may expose potential Acid Sulfate Soils - Large amounts of excavated material which may require treatment	- Some dewatering required which might expose potential Acid Sulfate Soils - Large amounts of excavated material which may require treatment
Land acquisition		- 13 properties (8 landowners)	- 27 properties (22 landowners)	- 13 properties (8 landowners)
Economic	Property values, ongoing costs, disruption to road users	- Significant disruption to road users over an extended period - The proximity of the proposed infrastructure is likely to reduce adjacent property value	- Significant disruption to road users over an extended period - The proximity of the proposed infrastructure is likely to reduce adjacent property value	- Few impacts to surrounding properties - Minimal disruption to road users due to the bored tunnel construction methodology

The final alignment and construction methodology of tunnelling throughout (Option 3) was chosen in part to minimise potential environmental, social and economic impacts. The concept design for this option was subsequently modified during the final stages of the design process to further avoid significant environmental and heritage impacts. These mitigation methods are discussed within this report and include:

- Avoidance of the Poison Gully Creek bushland in the vicinity of the Forrestfield Station Precinct. This area comprises a significant Aboriginal heritage site, Bush Forever Site, Declared Rare Flora (DRF), Threatened Ecological Communities (TEC) and black cockatoo habitat
- Redesign of the Forrestfield Station Precinct car park to avoid direct impacts to a critically endangered TEC (SCP20c)
- Avoidance of direct impacts to vegetation potentially comprising Subtropical and Temperate Coastal Saltmarsh along the Swan River

2.5 Project Details

The FAL comprises an 8.5km spur rail line from east of Bayswater Station on the existing Perth to Midland line to the eastern suburb of Forrestfield. The majority of the rail line will be constructed underground within two tunnels. The proposed alignment traverses State and Commonwealth land and generally follows Tonkin Highway and Brearley Avenue before crossing Perth Airport and surfacing to the east in Forrestfield.

The FAL Project will provide three new stations as summarised below:

- Airport West Station - located outside the western boundary of the airport within the Brearley Avenue Road reserve on State land. This station will have below ground platforms with the station access at the surface similar to the Esplanade Station in Perth.
- Consolidated Airport Station - located at the current International Terminal on Commonwealth land. This station will be underground similar to the Perth Underground Station in the CBD.
- Forrestfield Station - located adjacent to Dundas Road in High Wycombe. This station will be at the existing ground level.

Car parking, bus, pedestrian, taxi and cycle access facilities will be provided at Airport West and Forrestfield Stations. Forrestfield Station also includes a train stabling facility which is a minor maintenance depot where the trains are parked overnight and cleaned.

Infrastructure to allow for safe egress from the tunnels will also be constructed along the alignment; specifically Emergency Egress Shafts which link the tunnels to the surface and Cross Passages which provide an underground link between the two tunnels. Ancillary works will also be required to facilitate successful delivery of the project including relocation of underground services and amendments to the road network in the vicinity of the project area.

The location of the proposed infrastructure is shown on Figure 3. Figure 3 also shows the Approval Boundary to which this EIA applies and is the subject of the Section 38(1) referral to the EPA. The Approval Boundary specifies the areas in which construction activities will take place at the surface (referred to as surface disturbance on Figure 3 and throughout this report) as well as encompassing the alignment of the bored tunnels. The areas of surface disturbance are associated with the stations, the Emergency Egress Shafts, the Cross Passages and where the FAL connects to the existing Perth to Midland train line in Bayswater. Between these locations, the construction work will be fully underground associated with constructing the tunnels. Access to the construction areas will be via the existing road network or previously disturbed areas and tracks.

The project is comparable to the city section of the Perth to Mandurah railway in that it comprises twin bored tunnels of a similar diameter which will be constructed at a similar depth and within similar geological units to those in Perth as well as two underground stations. A summary of the key characteristics of the FAL project is provided in Table 2 and further details are provided in this section.

Table 2: Key Characteristics of the Forrestfield-Airport Link

Proposal Title	**Forrestfield-Airport Link**	
Proponent Name	Public Transport Authority of Western Australia	
Project Description	The Project involves a 9 km spur rail line from the Bayswater Station/Midland line through to the eastern suburb of Forrestfield and provision of three stations and associated rail infrastructure.	
Physical Elements		
Element	**Location**	**Proposed Extent / Description**
General Alignment	The proposed alignment will begin from a connection with the Midland Line, east of Bayswater Station. The alignment will generally follow along Tonkin Highway and then deviate towards Perth Airport where it will run beneath the airport surfacing to the east.	The proposed infrastructure will comprise twin bored tunnels, structures and facilities including stations, car parks, cross passages, emergency egress shafts, signalling and telecommunication equipment as well as relocation of underground services and amendments to the road network. The Approval Boundary comprises all of the elements discussed in this table as well as any areas required for construction.
Bored Tunnels	Two bored tunnels are proposed for the project, to be constructed by Tunnel Boring Machines (TBMs). The TBMs will commence tunnelling in Forrestfield Station and surface in Bayswater where the FAL connects to the existing Perth to Midland line.	Approximately 8 km of the FAL will comprise twin bored tunnels with an internal diameter of 6.16m. The twin tunnels will be spaced approximately 7 m apart and connected longitudinally by cross passages and vertically to the surface by emergency egress shafts. The tunnels will have a thickness of at least 275mm and be reinforced by a combination of reinforced cages and steel fibres. The concrete segments comprising the tunnels will also contain polypropylene fibres to control any damage caused by fire.
Airport West Station	The proposed Airport West Station is located on State land to the west of the Perth Airport, along the Brearley Avenue	Airport West Station will be an underground station with the platform below ground level and the station at the surface. Provision has been made for a bus interchange and a 500 to 1,000 bay car park.
Consolidated Airport Station	The proposed Consolidated Airport Station will be located underground, adjacent to the current International Terminal and to the south of the control tower.	The Consolidated Airport Station will be below ground, with passengers arriving from the suburban rail network and utilising a combination of lifts, stairs and escalators to connect from the platform level to the airport. No car parking is proposed at this station.
Forrestfield Station	The proposed Forrestfield Station will be located east of the Perth Airport and the Forrestfield Marshalling Yard and west of Dundas Road near the intersection with Maida Vale Road. It is situated in an area which comprises some undeveloped semi rural land, light industrial to the south and residential to the north.	The Forrestfield Station is an at grade station which will serve the suburbs of High Wycombe, Forrestfield and Kalamunda. A transport interchange is proposed which will include for a bus interchange and a 2,000 to 2,500 bay car park. The station also includes pedestrian and bicycle infrastructure.

Emergency Egress Shafts	Four Emergency Egress Shafts are proposed along the alignment. These are located adjacent to Tonkin Highway in Bayswater, at the intersection of Tonkin Highway and Brearley Avenue, within the Domestic Airport Precinct and on Abernethy Road in Forrestfield.	The Emergency Egress Shafts connect the tunnels to the ground level and provide emergency escape in the event of an incident. The depth of the emergency egress shafts is approximately 20m from the existing ground level. Once constructed there will be a small building and a small hardstand for emergency and maintenance vehicles to park.
Cross Passages	Five Cross Passages are proposed along the alignment. These are located adjacent to Tonkin Highway in Bayswater, adjacent to the Tonkin Highway road bridge and within Perth Airport.	The cross passages provide a connection between the tunnels. The cross passages provide tunnel users with a safe passage from one tunnel to another in the event of an emergency. The cross passages will be constructed from within the tunnels with some pre-treatment of the ground from ground surface required.
Road Realignment	The concept design for the Forrestfield Station will require Dundas Road to be realigned.	It is proposed that Dundas Road will be relocated to the west, adjacent to the Forrestfield Marshalling Yard boundary over a distance of approximately 1km. Access to Dundas Road from Maida Vale Road and Imperial Street will be maintained. Any properties that are isolated from the new alignment will be connected via a new access location.
Underground Service Relocation	A number of underground services and utilities exist within and adjacent to the project area.	Underground services and utilities within the project area will require either diversion or protection to ensure the proposed infrastructure can be accommodated.

2.6 Project Delivery

The majority of the construction works will be procured using a Design and Construct contract and delivered by a lead contractor. The PTA will prepare the reference design for the project prior to the main construction contract being awarded. The lead contractor will be responsible for the detailed design and construction of the infrastructure. The detailed design of the infrastructure will inform the specific construction environmental management requirements for the project.

The PTA is proposing to deliver some of the works as early works packages ahead of the main construction contract being awarded to facilitate successful delivery of the project. This is likely to be associated with the ancillary works and primarily relocation of underground services.

The estimated timeframes to deliver the project are provided below:

- Q3 2015 – Early Works Commence
- Q3 2016 – Award of Main Construction Contract
- Q4 2016 – Commence Construction Works
- Q3 2017 – Commence Tunnel Boring
- Q2 2019 – Complete Tunnel Boring
- Q4 2019 – Complete Construction Works and Commence Commissioning
- Q3 2020 – Project Complete

2.7 Construction Methodology

Construction of the infrastructure involves two methodologies; these are Tunnel Boring and Cut and Cover (or Cut and Open). The majority of the alignment will be constructed as twin bored tunnels using the Tunnel Boring methodology. Both below ground stations and the Emergency Egress shafts will be constructed using the Cut and Cover construction methodology. These methodologies are discussed further below.

The Cross Passages which are the underground connections between the two tunnels will be constructed by excavating a passage between the two tunnels after they are constructed. To safely construct the Cross Passages the ground must be stabilised prior to the excavation between the two tunnels commencing. Ground stabilisation involves localised filling of the soil pores with cement grout using specialised drilling equipment. Only the soil which surrounds the tunnels is grouted thus creating a stabilised block of soil at the depth of the tunnels.

2.7.1 Tunnel Boring

Tunnel Boring will be undertaken using two TBMs designed for the ground conditions present. TBMs are commonly used to construct road and railway tunnels where access to the surface is not possible such as in dense urban areas, below infrastructure and waterways and through hills and mountains. Importantly, dewatering or alterations to the groundwater regime are not required to facilitate construction of bored tunnels.

A TBM comprises a heavy steel cylinder with a rotating cutting head at one end. The cylinder, or shield, prevents the collapse of the soils and protects the machine operators. Behind the cutting head and within the cylinder, reinforced concrete rings segments are installed. As the machine moves forward the pre-cast concrete ring segments are moved into position mechanically from the back of the cylinder and secured, thus forming the tunnel. The tunnel is then used to convey excavated soil back to the start of the tunnel. The process is continuous except for times when the machine is halted for maintenance to take place.

For this project the machines will excavate two tunnels with a diameter of 6.7 m which in most areas will be approximately 12 metres or more below the ground surface. The lining of the tunnels will be watertight, reinforced concrete and capable of supporting the ground above plus any loading that is applied to the ground surface such as aircraft landing, taxiing or taking off and building development with certain controls in place.

The TBMs will start their journey from a below ground concrete box structure within the Forrestfield Station Precinct and end in another concrete box in Bayswater where the FAL connects to the existing Perth to Midland train line. As it traverses the alignment, the TBMs will break into and out of the Consolidated Airport Station and the Airport West Station which will be designed specifically for this purpose. Tunnelling works are anticipated to be completed by tunnel crews working day and night. All soil excavated by the TBMs will be transported within the tunnels to the Forrestfield Station precinct.

2.7.2 Cut and Cover/Open

Airport West and Consolidated Airport Stations and the Emergency Egress shafts will be constructed using the Cut and Cover construction methodology. This is likely to be undertaken by building diaphragm walls (D-walls), which are deep narrow trenches cut into the ground, retained open by injecting a bentonite slurry, which is then displaced as the trench is filled with concrete to form the side walls of the underground structure.

After the walls are constructed, they will either be braced (Cut and Open) or a roof slab will be built from precast concrete planks laid between the walls (Cut and Cover). In order to form the base of the underground structure, soil is excavated down to the invert level where the base slab is then constructed. Temporary dewatering is required to facilitate construction of the base slab.

2.8 Excavated Material

Construction of the FAL will generate spoil from excavations and the tunnelling process. The estimated total quantity of spoil material excavated throughout the length of the project is approximately 770,000 m^3 (in situ). A preliminary study undertaken by the PTA into productive use of the treated spoil material identified potential infrastructure projects which will need to source large quantities of fill material. Ongoing discussions are being held with possible users of the treated spoil material, including other government agencies and PAPL.

3 Relevant Legislation and Policy

3.1 State Legislation and Policy

The principal legislation governing environmental protection and approvals in Western Australia is the EP Act. Section 38(1) of the EP Act States that where a proposal is likely to have a significant impact on the environment, a proponent may refer the proposal to the EPA for a decision on whether it requires assessment under the EP Act.

The PTA is referring the FAL project to the EPA with the view that the potential environmental impacts from the project are not significant. The PTA has avoided impacts where possible and proposes to minimise residual impacts through management and monitoring procedures prior to, during and following construction. The PTA considers these procedures to adequately address the environmental impacts of the project, without the need for a formal assessment by the EPA. The management and monitoring procedures currently proposed and which will develop as the design of the project progresses will be subject to endorsement by the relevant regulatory bodies

Other Western Australian legislation and policy which is relevant to this proposal are detailed below:

- *Aboriginal Heritage Act 1972*
- *Contaminated Sites Act 2003*
- *Environmental Protection (Noise) Regulations 1997*
- *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*
- *Environmental Protection (Unauthorised Discharges) Regulations 2004*
- *Environmental Protection (Controlled Waste)Regulations 2004*
- *Land Administration Act 1997*
- *Occupational Safety and Health Act 1984*
- *Planning and Development Act 2005*
- *Rights in Water and Irrigation Act 1914*
- *State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning*
- *State Planning Policy 5.1; Land Use in the Vicinity of the Perth Airport*
- *Swan and Canning Rivers Management Act 2006*
- *Waterways Conservation Act 1976*
- *Wildlife Conservation Act 1950*

3.2 Commonwealth Legislation

The EPBC Act is the Australian Government's central piece of environmental legislation which provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places – defined in the Act as Matters of NES. Matters of NES protected under the EPBC Act include:

- world heritage sites;
- national heritage places;
- wetlands of international importance
- nationally threatened species and ecological communities;
- migratory species;
- Commonwealth marine areas;
- Great Barrier Reef Marine Park
- nuclear actions

In addition, the EPBC Act confers jurisdiction over actions that have a significant impact on the environment where the actions affect, or are taken on, Commonwealth land or are carried out by a Commonwealth agency even if that significant impact is not a matter of NES.

The project will be referred to the DoE via an EPBC Act referral.

4 Existing Environment

This section details the existing environment and environmental values present along the proposed FAL alignment on State land, which are relevant to the Section 38(1) referral. An exception has been made for geology, acid sulfate soils, groundwater and surface water which better understood when presented in their entirety. Potential impacts to these environmental values, mitigation and management measures are discussed in Section 5.

Environmental values and impacts on the Commonwealth land will be assessed by the DoE through an EPBC referral, including all Matters of NES along the entire alignment and any environmental values on Commonwealth land. Consequently, environmental values and potential environmental impacts on Commonwealth land are not detailed fully in this report, however, a summary has been provided in Section 7 to provide a holistic overview of the project.

4.1 Geology

The geological units present along the alignment as identified by investigations undertaken by GHD and Golder Associates are depicted in Plate E and are further described below (Golder Associates, 2014a). The units present include Bassendean Sand, Guildford Formation, Ascot Formation and Osborne Formation.

- The Bassendean Sand is a superficial unit exposed at the ground surface over the majority of the proposed alignment. It generally comprises a well sorted, fine to medium grained, loose to medium dense sand. This unit was originally deposited as a coastal dune system but also contains dense to very dense indurated iron rich horizons referred to as “coffee rock”. Along the alignment this unit varies between approximately 2 to 10 m in thickness. It is thickest beneath the main airport runway and thins west toward the Swan River and east toward the escarpment.

- The Guildford Formation comprises interbedded sand, silt and clays of varying stiffness ranging from loose to very dense and soft to very stiff. Along the alignment the predominant grain size in this unit is sand. Unlike the Bassendean Sand, this unit often contains a medium to high percentage of fines within the sand. West of the Swan River this unit also includes a silt and clay sequence. This clayey sequence is approximately 5 m thick in the vicinity of the existing Perth to Midland train line and thickens toward the Swan River. Near the eastern side of the airport the Guildford Formation may comprise a pebbly silt that may be at or very close to surface, Although this unit is generally associated with coalescing alluvial fans, the alluvial deposits associated with infill of Swan River paleochannels have been collectively included as Guildford Formation for the purpose of this report.

- Underlying the Bassendean Sand and Guildford Formation is the Ascot Formation which generally comprises weakly to well cemented calcarenite with interbedded sand and shell layers. The unit may also contain sand fill voids and cavities. The upper surface of the unit is best differentiated from overlying Guildford and Bassendean sand by the presence of carbonate and obvious shell fragments. The base of the unit may be indicated by calcareous silty and clayey sands with visible shells and black, polished phosphatic nodules. The Ascot Formation is only known to occur east of the Swan River.

- The Osborne Formation comprises the Mirrabooka Member, the Kardinya Shale Member and the Henley Sandstone Member. The Osborne Formation along the proposed alignment is comprised of extremely to very low strength sandstone, likely associated with the lower parts of the Mirrabooka Member or upper sandy sequences of the Kardinya Shale Member. The sandstone observed along the alignment to date is largely fine grained, but some coarse grained sands up to 5 m in thickness have been noted near the interface with the overlying Ascot Formation. Davidson suggests that the Osborne Formation below the alignment consists of the Kardinya Shale Member, which is overall considered to be an aquitard (Davidson, 1995).

- The Swan River Alluvium is a superficial unit exposed at ground surface in the vicinity of the Swan River, comprising silt, sand and clay. The deposition of these materials is associated with infilling of the ancient Swan River following the last glaciation and are associated with a paleochannel. Deposits near the central part of the paleochannel are generally fine grained and predominantly include sulphurous silt and clay. Sandy faces are present as interbeds in the silt and clays, as well as near the sides of the paleochannel as sand bars and bank deposits.

<table>
<tr><th>West of Swan River</th><th>At Swan River</th><th>East of Swan River</th></tr>
<tr><td>Bassendean Sand</td><td>Swan River Alluvium</td><td>Bassendean Sand</td></tr>
<tr><td colspan="2">Guildford Formation (clay unit)</td><td>Guildford Formation (sandy unit)</td></tr>
<tr><td colspan="2">Guildford Formation (sandy unit)</td><td>Ascot Formation</td></tr>
<tr><td colspan="3">Osborne Formation</td></tr>
</table>

Plate E: Geological Units along FAL Alignment

4.2 Acid Sulfate Soils

Acid Sulfate Soils (ASS) are naturally occurring soils containing iron sulfide minerals (notably pyrite) formed under saturated anoxic conditions. In an undisturbed State below the water table, these soils are benign and non-acidic. However, if the soils are exposed to the atmosphere through activities such as drainage, excavation or dewatering, the sulfides may react with oxygen to form sulfuric acid.

ASS can be present in the form of:

- Potential ASS (PASS) – Soil that contains unoxidised iron sulphides. When exposed to oxygen through drainage or disturbance these soils produce sulphuric acid
- Actual ASS (AASS) – PASS that has been exposed to oxygen and water and has generated acidity

An assessment of the Department of Environment Regulation's (DER) ASS mapping indicates that the risk of ASS occurring along the FAL alignment ranges from 'moderate to low risk of ASS occurring within 3 m of the natural soil surface' to a 'high to moderate risk of ASS beyond 3 m of the natural soil surface (Figure 4).

Preliminary ASS investigations have been undertaken by GHD (2013) along the alignment. The results indicate that PASS is likely to be present within all geological units. The results are summarised in Table 3 below. A detailed ASS investigation in accordance with the DER guidelines will be undertaken in late 2014/early 2015.

Table 3: Preliminary ASS Testing Results

Geological Unit	No. Samples Tested	Minimum CRS (%S)	Maximum CRS (%S)
Bassendean Sand	8	<0.02	0.24
Coffee-Rock	2	<0.02	0.09
Swan River Alluvium	4	0.62	1.88
Guildford Formation	15	<0.02	0.37
Ascot Formation	7	<0.02	1.41
Osborne Formation	9	0.03	2.21

CRS – Chromium Reducible Sulfur, a commonly used method for determining reducible inorganic sulfur compounds (e.g. pyrite) in ASS determination. Values >0.03%S are generally identified as ASS requiring management if disturbed.

4.3 Groundwater

4.3.1 Aquifers

All materials overlying the Osborne Formation are considered to be part of the Superficial Aquifer (Golder Associates, 2014a). However, given the presence of a clay sequence within the Guildford Formation to the west of the Swan River and the high fines content in this unit, there is a possibility that this Superficial Aquifer may be separated into an Upper and Lower Aquifer at a local scale.

The low permeability clay layer is likely to act as a confining layer restricting groundwater movement between the Upper (Bassendean) and Lower (Guildford) sandy sequences. The presence of "coffee rock" in the Bassendean sand may also result in perched groundwater conditions in local areas above the coffee rock layer (Golder Associates, 2014a).

4.3.2 Groundwater Levels

Groundwater levels measured along the alignment by GHD during the Phase 1 Geotechnical Investigation range from 0.7 m AHD to 25.2 m AHD and 0.3 meters below ground level (m bgl) at the Swan River to 4.8 m bgl in Forrestfield. Recorded groundwater levels are summarised in Table 4 below and the location of the boreholes is shown on Figure 5.

Table 4: Groundwater levels

Borehole ID	Groundwater Level (m AHD)	Groundwater Level (m bgl)	Location
BH0-01	13.3	2.3	Emergency Egress Shaft 3
BH0-02	5.8	1.0	Bayswater
BH0-03	0.7	0.4	Swan River
BH0-04	9.8	2.3	Airport West Station
BH0-05	15.3	2.3	Cross Passage 3
BH0-06	17.3	1.2	Consolidated Airport Station
BH0-07	25.2	4.8	Forrestfield Station
BH0-08	0.8	0.3	Swan River

4.3.3 Groundwater Flow Direction

To the east of the Swan River, groundwater flow is in a west and north west direction towards the river, while to the west of the Swan River, groundwater flow is in a south easterly direction towards the river. The inferred groundwater flow direction is shown on Figure 5. Detailed geotechnical and environmental site investigations are currently being undertaken to further characterise groundwater conditions in the project area.

4.4 Hydrology

The key hydrological features within the project area and its immediate surrounds are:

- Poison Gully Creek in High Wycombe
- Munday Swamp in the north east corner of the Commonwealth land
- The drainage network within Commonwealth land
- The Bayswater Main Drain
- The Swan River

The location of these water bodies are shown on Figure 6 and further details are provided below.

Originating in the Kalamunda hills, Poison Gully Creek flows in a westerly direction to the eastern boundary of the Perth Airport estate. Poison Gully retains its natural form and is well vegetated east of Dundas Road in High Wycombe; however, on the western side of Dundas Road it loses all natural form and is completely modified.

Surface water flows through the Commonwealth land in two main drains, the Airport Northern Main Drain and the Airport Southern Main Drain. These drains generally flow east to west and have been constructed as extensions and modifications to naturally-occurring watercourses. The Northern Main Drain receives surface flow from Poison Gully and Munday Swamp. Both drains discharge into the Swan River.

Munday Swamp is a freshwater wetland in the north east corner of the Commonwealth land. It is a conservation category fed by both groundwater and surface water. The area is considered to be of high environmental value and was detailed within Perth Airport's Environment Strategy 2009-2014 as a major component within one of two conservation precincts on the airport estate.

The Bayswater Main Drain, on the western side of the Swan River, is a permanently flowing watercourse. It was once a natural watercourse that has been highly modified as the surrounding area has been developed. The drain flows below the existing rail reserve, near to where the FAL will leave the existing Perth to Midland Line, before discharging into the Swan River.

The Swan River, which is the downstream receiving watercourse, flows from the Darling Scarp to the Indian Ocean. The river system passes through a large urban and agricultural catchment and is characterised by relatively low flows. The alignment crosses the Swan River in Bayswater within the vicinity of the existing Tonkin Highway road bridge.

4.5 Wetlands

A search of the Geomorphic Wetlands of the Swan Coastal Plain dataset identified eight wetlands occurring along or adjacent to the alignment within State land as summarised below (Figure 6):

- Wetlands within the Approval Boundary include:
  - Swan River - UFI13384 (Multiple Use)
  - Swan River - UFI13316 (Conservation Category)
  - Forrestfield - UFI15314 (Multiple Use)
  - Forrestfield - UFI13977 (Multiple Use)
  - Forrestfield - UFI15876 (Resource Enhancement)
- Wetlands located directly adjacent to the alignment include:
  - Bayswater - UFI8431 (Multiple Use)
  - Forrestfield - UFI15880 (Resource Enhancement)
  - Forrestfield - UFI15875 (Resource Enhancement)

Some of these areas have been significantly modified and as such, have few important ecological attributes or wetland-dependent vegetation.

There are no Ramsar wetlands or wetlands of national significance located along the proposed alignment on State land.

4.6 Vegetation

4.6.1 Bioregion

The FAL is located within the Swan Coastal Plain Interim Biogeographic Regionalisation of Australia (IBRA) Region and Swan Coastal Plain 2 Subregion. This subregion is a low lying coastal plain covered with woodlands dominated by Banksia and Tuart on sandy soils, *Casuarina obesa* on outwash plains and paperbark in swampy areas.

4.6.2 Vegetation Complexes

Vegetation complexes present along the proposed alignment as mapped by Heddle includes (Figure 7) (E. M. Heddle, 1980):

- Swan Complex
- Southern River Complex
- Bassendean Complex – central and south

The EPA recognises vegetation associations that are not well represented in reserves as being “significant”. Vegetation associations that have under 30% of their pre-European extent remaining may be considered regionally significant, while proposals that could impact on a vegetation complex with 10% or less remaining may be assessed by the EPA (Environmental Protection Authority, 2006).

Table 5 shows the percentages remaining of the vegetation complexes within State land. It should be noted that although mapped as these complexes, much of the project area has been previously cleared.

Table 5: Vegetation Extents Remaining

Vegetation Complex	Pre - European Extent (ha)	Current Extent (2013) (ha)	Remaining (%)	Current Extent with formal protection (ha)	Comments
Southern River	57,172	11,255	19.7	1,234	<30% of the pre-European extent remaining in the Peel Region Scheme (PSR) and Metropolitan Region Scheme (MRS)
Bassendean Complex – central and south	87,393	24,206	27.7	2,244	<30% of the pre-European extent remaining in the PRS and MRS
Swan Complex	16,652	2,305	13.8	93	<10% of the pre-European extent remaining in the PRS and MRS

4.6.3 Vegetation Type

Twenty three vegetation types were identified along the proposed alignment during surveys undertaken by GHD (GHD, 2014c) and Brian Morgan (Morgan 2013 and 2014). These vegetation types and areas (ha) occurring within the areas surveyed during the flora and vegetation surveys, the Approval Boundary and the areas of surface disturbance are depicted in Figure 8 and details of these vegetation types are provided in Table 6 below.

Table 6: Vegetation Types on State land

Vegetation Type	Area Surveyed (ha)	Approval Boundary (ha)	Surface Disturbance (ha)
Allocasuarina fraseriana low open woodland over *Xanthorrhoea preissii* open shrubland over *Verticordia densiflora* var. *densiflora*, *Hibbertia hypercoides* low shrubland over *Alexgeorgea nitens, Caustis dioica*, open sedgeland / herbland / grassland	0.28	0.01	0.01
Bolboschoenus caldwellii closed sedgeland with *Sarcocornia quinqueflora / blackiana* scattered shrubs to low open shrubland	0.40	0.04	0.00
*Bolboschoenus caldwellii, Suaeda australia, *Cynodon dactylon, *Atriplex prostrata* herbland/sedgeland/grassland	0.25	0.00	0.00
Casuarina obesa, Eucalyptus rudis subsp. *rudis* low woodland over *Melaleuca preissiana, Melaleuca rhaphiophylla* high open shrubland to high shrubland over **Eragrostis curvula, *Cynodon dactylon* grassland	0.42	0.00	0.00
Casuarina obesa low open woodland to low woodland over *Bolboschoenus caldwellii, Suaeda australia, Samolus repens, *Cynodon dactylon, *Atriplex prostrate* herbland / sedgeland / grassland with *Juncus kraussii* subsp. *australiensis* sedgeland along river banks	1.74	0.13	0.00
Casuarina obesa low woodland over *Tecticornia lepidosperma* low open shrubland over **Carex divisa* sedgeland with **Atriplex prostrata, Suaeda australis* very open herbland	0.12	0.04	0.00
Corymbia calophylla open woodland over Hypocalymma *angustifolium, Verticordia densiflora* var. *densiflora* low open shrubland to low open heath over *Caustis dioica* open sedgland / herbland	1.07	0.00	0.00
Corymbia calophylla open woodland over *Verticordia densiflora* var. *densiflora* low open heath over *Caustis dioica, Hypolaena exsulca* very open sedgeland / herbland	2.09	0.01	0.01
Eucalyptus rudis subsp. *rudis* open woodland to woodland over **Cynodon dactylon, *Cenchrus clandestinus* grassland	4.86	0.05	0.00

Eucalyptus rudis subsp. *rudis* scattered trees over *Casuarina obesa* low woodland over *Juncus kraussii* subsp. *australiensis* sedgeland and **Cynodon dactylon* grassland	0.44	0.02	0.00
Eucalyptus rudis subsp. *rudis* scattered trees over *Melaleuca rhaphiophylla* low open forest to low closed forest over **Cynodon dactylon, *Cenchrus clandestinus* scattered grasses to very open grassland (closed grassland in Degraded areas)	1.21	0.00	0.00
Eucalyptus rudis subsp. *rudis* scattered trees to open woodland over *casuarina obesa* scattered low trees over *Melaleuca cuticularis, Meleuca rhaphiophylla* scattered tall shrubs to high open shrubland over **Cynodon dactylon, *Bromus diandrus, Avena barbata*, **Lotus* sp. closed grassland / herbland	0.84	0.19	0.00
Low Open Woodland of remnant *Eucalyptus marginata* and *Banksia* spp. over a native mid-storey of mixed native species and an understorey of either mixed native species or weedy grasses and herbs	1.03	0.00	0.00
Remnant *Casuarina obesa* Low Woodland over an understorey of (*Juncus* sp. and) weedy grasses and herbs	0.12	0.03	0.00
Remnant *Eucalyptus marginata / E. rudis / Corymbia calophylla* Woodland over a mid-storey and understorey of mixed native species	3.15	0.23	0.23
Remnant *Eucalyptus rudis* Open Woodland over completely altered understorey in drainage lines	0.99	0.19	0.16
Sarcocornia quinqueflora/blackiana low closed heath with *Suaeda australis* low open herbland	0.42	0.00	0.00
Scattered *Corymbia calophylla* and/or *Eucalyptus rudis* over a weedy understorey	11.86	3.06	1.07
Sparse Woodland of *Corymbia calophylla* over *Xanthorrhoea preissii* and low shrubs, sedges and herbs	2.24	2.24	2.24
Tecticornia halocnemoides, *Tecticornia pergranulata* subsp. *pergranulata* low open heath	0.18	0.00	0.00
Tecticornia indica subsp. *bidens*, *Tecticornia lepidosperma, Sarcornia quinqueflora / blackiana* low closed heath with *Triglochin mucronata* very open herbland	2.57	0.21	0.00
Areas rehabilitated with native and non-native species following road-works	22.57	11.55	8.89
Plantings of non-native species over an understorey of weedy grasses and herbs	2.89	2.87	2.87
Pasture Areas, disturbed areas, cleared areas and drains	0.02	0.02	0.00
Open Water	1.79	0.44	0.00
Roads/infrastructure/completely altered	90.19	19.00	17.00
Degraded to Completely Degraded	22.72	8.18	7.70
Inaccessible/not assessed	13.23	6.36	2.23
TOTAL (ha)	**189.67**	**55.06**	**42.41**

The data indicates that 38.69 ha of the 42.41 ha (91.2%) within the areas of surface disturbance comprises completely disturbed areas or areas planted with native and non-native species. The areas which were inaccessible/not assessed occurred in cleared or degraded areas such as pasture, rail or road reserves in which ecological surveys were not considered necessary.

4.6.4 Vegetation Condition

Vegetation Condition along the proposed alignment was assessed in 2013 by GHD and 2013 and 2014 by Brian Morgan according to the Keighery vegetation condition rating scale given in Bush Forever (Department of Environmental Protection 2000).

Vegetation condition along the alignment ranges from Excellent to Completely Degraded, with over 87% of the vegetation within the areas of surface disturbance classified as Completely Degraded. Vegetation condition is provided in Figure 9 and Table 7.

Table 7: Vegetation Condition on State land

Vegetation Condition	Area recorded on State land (ha)		
	Area Surveyed	Approval Boundary	Area of Surface Disturbance
Pristine	0.00	0.00	0.00
Excellent	5.93	2.24	2.24
Very Good	5.86	0.22	0.01
Good to Very Good	1.97	0.35	0.22
Good	1.73	0.04	0.00
Good to Degraded	2.38	0.04	0.00
Degraded	6.82	0.43	0.21
Degraded to Completely Degraded	7.65	2.28	0.56
Completely Degraded	141.28	42.23	36.49
Inaccessible/not assessed	15.03	6.78	2.20
TOTAL	**188.65**	**54.61**	**41.93**

4.6.5 Threatened Ecological Communities

During their 2013 flora survey (GHD, 2014c), GHD identified vegetation types within the Approval Boundary with affinities to Floristic Community Types (FCT) which are classified under State legislation as Threatened Ecological Communities (TECs) (Appendix 1). In the absence of sufficient quadrats and associated statistical analysis, the PTA liaised with the Department of Parks and Wildlife (DPaW) to confirm which TECs (if any) the vegetation types were most closely associated with.

To provide clarification on the likely FCTs present, Val English and Jill Pryde (Species and Communities Branch, DPaW) undertook a site visit on 27 March 2014 accompanied by the PTA. Soil and landform units and observations of substrate, combinations of key species and overall species composition were utilised to clarify the FCTs present.

One area within the area of surface disturbance was identified as likely to have affinities with both FCT SCP20a and SCP20b and was considered by DPaW to be indicative of transitional zone between FCT SCP20a/SCP20b. A second area, also within the area of surface disturbance, was considered by DPaW to be FCT SCP20c. Correspondence with DPaW is included in Appendix 2.

Based on information from GHD and DPaW, the TECs are considered to occur along the FAL alignment are summarised in Table 8. The locations of these TECs are depicted in Figure 10.

Table 8: Threatened Ecological Communities occurring along FAL Alignment

TEC	Description	Status	
		State	Federal
SCP20a / SCP20b	*Banksia attenuata* woodland over species rich dense shrublands / *Banksia attenuata* and/or *Eucalyptus marginata* woodlands of the eastern side of the Swan Coastal Plain	Endangered	-
SCP20c	Shrublands and woodlands of the eastern side of the Swan Coastal Plain	Critically Endangered	Endangered
-	Subtropical and Temperate Coastal Saltmarsh	-	Vulnerable

Flora and Vegetation surveys undertaken by Brian Morgan in 2013 also identified TECs in the Forrestfield area; these TECs included FCT SCP20c and a vegetation type with affinities to FCTsSCP20c/SCP3/ SCP3b (for the purposes of this assessment the entire area is referred to as SCP20c). The site visit with DPaW also indicated the Poison Gully Creek bushland was predominantly comprised of FCT SCP20a. The locations of these TECs are also depicted in Figure 10.

4.6.6 Priority Ecological Communities

A Level 1 survey undertaken by Brian Morgan (Brian Morgan, 2014) (Appendix 3) along the Swan River foreshore identified a potential PEC within the Approval Boundary (Table 8 and Figure 10). Saltmarsh vegetation identified during the survey was identified as falling within the description for 'Subtropical and Temperate Coastal Saltmarsh'. This community is listed as a Priority 3 Priority Ecological Community under the *Wildlife Conservation Act 1950* and a Vulnerable TEC under the EPBC Act.

This community consists of an assemblage of plants, animals and micro-organisms associated with saltmarsh in coastal regions of sub-tropical and temperate Australia (south of 23^{o}S latitude) and comprise coastal areas under tidal influence. The community consists mainly of salt-tolerant vegetation (halophytes) including grasses, herbs, reeds, sedges and shrubs.

A small area on Commonwealth land was also identified by DPaW during the site visit of 27 March 2014 as having affinities with FCT SCP21c which is a Priority 3 Ecological Community.

4.6.7 Dieback

A dieback assessment of the vegetation within the area of surface disturbance in Forrestfield was undertaken by Glevan Consulting (Glevan Consulting, 2014). No Phytophthora Dieback infestations were mapped within the area surveyed. The majority (95%) of the area surveyed, including the TECs, was unmappable due to disturbance and a lack of reliable indicator species. A small area was mapped as uninfested during the survey. This area is associated with the northern portion of the SCP20a/SCP20b TEC.

Three soil and tissue samples were taken during the assessment, all of which tested negative for the presence of Phytophthora Dieback. The results are presented on Figure 11 and the report is included in Appendix 4.

4.6.8 Groundwater Dependent Ecosystems

A search undertaken of the Groundwater Dependent Ecosystems (GDE) database (Bureau of Meteorology, 2014) identified no GDEs within the Approval Boundary. There is however the potential for the TECs to comprise phreatophytic vegetation and to be partially reliant on groundwater.

4.7 Flora

4.7.1 Declared Rare and Priority Flora

A desktop assessment was undertaken to determine those flora species potentially occurring along the alignment which are protected under the EPBC Act or *Wildlife Conservation Act 1950*. The results of this assessment are provided in Appendix 5.

As the vegetation condition is mostly degraded along the alignment, there is a low likelihood of these species occurring within the FAL Approval Boundary, with flora and vegetation surveys only identifying *Conospermum undulatum, Eucalyptus caesia* and *Calothamnus rupestris* within the FAL Approval Boundary as discussed below.

4.7.1.1 *Conospermum undulatum*

The *Conospermum undulatum* (Wavy leaved smokebush) is listed as Vulnerable under the *Wildlife Conservation Act 1950* and EPBC Act. Thirty seven (37) individual plants (over eleven locations) of *Conospermum undulatum* were recorded during the spring surveys undertaken by GHD in 2013 (GHD, 2014c) and RPS in 2014 (RPS, 2014b) (Appendix 6). The location of the *Conospermum undulatum* is depicted on Figure 10.

The *Conospermum undulatum* plants were identified within the following vegetation units:

- 12 individuals were recorded within the Poison Gully Creek bushland (Bush Forever Site 45) within 'Remnant *Eucalyptus marginata/E. rudis/Corymbia calophylla* woodland over a mid-storey and understorey of mixed native species'.
- 25 individuals (over two locations) were recorded within 'Sparse woodland of *Corymbia calophylla* over *Xanthorrhoea preissii* and low shrubs, sedges and herbs'.

4.7.1.2 *Eucalyptus caesia* and *Calothamnus rupestris*

Calothamnus rupestris is listed under the *Wildlife Conservation Act 1950* as a Priority 4 species. Scattered occurrences of *Calothamnus rupestris* were recorded within the 'low open woodland of remnant *Eucalyptus marginata* and *Banksia spp.* Over a native mid storey of mixed native species and an understorey of either mixed native species or weedy grasses and herbs'.

Eucalyptus caesia is listed under the *Wildlife Conservation Act 1950* as a Priority 4 species and was identified in roadside plantings along Dundas Road, High Wycombe. Both of these species have commonly been planted in landscaping and revegetation works on the Swan Coastal Plain and have become naturalised outside their normal range (GHD, 2014c).

4.7.2 Introduced Flora

As detailed in Section 4.6.4, the majority of the alignment is degraded and highly disturbed, featuring mainly roads, buildings and other cleared areas. Although a large number of exotic species were identified along the alignment during surveys, no species listed as Weeds of National Significance (WONS) or Declared Pests under the *Biosecurity and Agriculture Management Act 2007* were identified.

4.8 Fauna

4.8.1 Significant Species

A desktop assessment (undertaken April 2014) identified 29 significant fauna species (protected under the *Wildlife Conservation Act 1950* and EPBC Act) potentially occurring within vicinity of the proposed alignment. These species and the likelihood of occurrence are tabulated in Appendix 7.

During fauna surveys undertaken by GHD (GHD, 2014c) and Bamford Consulting Ecologists (Bamford Consulting Ecologists, 2014) (Appendix 8), only four of those species from the desktop assessment were identified along the alignment:

- Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*)
- Forest Red tailed Black Cockatoo (*Calyptorhynchus banksia* subsp. *naso)*
- Quenda (*Isoodon obesulus* subsp. f*usciventer*)
- Water rat (*Hydromys chrysogaster*)

Other species with the potential to occur but which were not identified during the survey are outlined in Appendix 6. Those species considered unlikely to occur along the alignment due to lack of suitable habitat such as marine species (e.g. albatross, marine turtles) have not been included in the summary.

4.8.2 Significant Fauna Habitat

Large areas of habitat along the proposed alignment have previously been cleared or degraded. Potentially significant fauna habitat which has not been previously cleared is detailed below and is shown on Figure 12. Due to the high levels of disturbance along the alignment, much of this habitat occurs in non-contiguous or isolated patches.

4.8.2.1 Black Cockatoo

The black cockatoo is listed as specially protected fauna under the *Wildlife Conservation Act 1950*. During site surveys, the following potential black cockatoo habitat was identified:

- Potential foraging and breeding habitat was identified by GHD (2013)
- Surveys undertaken by Brian Morgan (2013 and 2014) were used to identify potential foraging habitat
- Potential breeding habitat was identified by Bamford Consulting Ecologists (2014)

Results from these surveys is summarised below:

- 21.7 ha of potential foraging or roosting habitat was identified along the alignment on State land based on the surveys undertaken.
- 85 potential habitat trees, of which 15 are located within areas of surface disturbance.
- Of the 15 potential habitat trees located within areas of surface disturbance, 10 were considered potential breeding trees and of these, none had suitable hollows.

Habitat on Commonwealth land is discussed in Section 7.6. Any impacts to habitat on both State and Commonwealth land will be assessed in its entirety under the EPBC Act.

As outlined above and in Table 9 and Table 10, the majority of habitat identified during the site survey was avoided during the route selection process. Habitat mapping and potential habitat tree locations are provided in Figure 12.

Table 9: Potential black cockatoo foraging habitat on State land

Habitat Description	Total Habitat Area (ha)			Habitat Type
	Area Surveyed	Approval Boundary	Surface Disturbance	
Low Open Woodland of remnant *Eucalyptus marginata* and *Banksia* spp. over a native mid-storey and understorey of mixed native species or weedy grasses and herbs.	1.03	0	0	- *Eucalyptus marginata* (medium priority feeding and roosting) - *Banksia* spp (medium to high priority foraging)
Remnant *Eucalyptus marginata/E. rudis /Corymbia calophylla* Woodland over a mid-storey and understorey of mixed native species.	3.15	0.23	0.23	- *Eucalyptus marginata* (medium priority feeding and roosting) - *Eucalyptus rudis* (low priority roosting) - *Corymbia calophyla* (high priority feeding, breeding and roosting)
Sparse Woodland of *Corymbia calophylla* over *Xanthorrhoea preissii* and low shrubs, sedges and herbs.	2.24	2.24	2.24	- *Corymbia calophyla* (high priority feeding, breeding and roosting) - *Xanthorrhoea preissii* (medium priority feeding)
Scattered *Corymbia calophylla* and/or *Eucalyptus rudis* over a weedy understorey.	11.86	3.06	1.07	- *Eucalyptus rudis* (low priority roosting) - *Corymbia calophyla* (high priority feeding, breeding and roosting)
Allocasuarina fraseriana low open woodland over *Xanthorrhoea preissii* open shrubland over *Verticordia densiflora* var. *densiflora*, *Hibbertia hypercoides* low shrubland over *Alexgeorgea nitens*, *Caustis dioica*, open sedgeland / herbland / grassland	**0.28**	0.01	0.01	- *Xanthorrhoea preissii* (medium priority feeding)
Corymbia calophylla open woodland over *Hypocalymma angustifolium*, *Verticordia densiflora* var. *densiflora* low open shrubland to low open heath over *Caustis dioica* open sedgland / herbland	1.07	0.00	0.00	- *Corymbia calophyla* (high priority feeding, breeding and roosting)
Corymbia calophylla open woodland over *Verticordia densiflora* var. *densiflora* low open heath over Ca*ustis dioica, Hypolaena exsulca* very open sedgeland / herbland	2.09	0.01	0.01	- *Corymbia calophyla* (high priority feeding, breeding and roosting)
Total (ha)	**21.72**	**5.55**	**3.56**	

Table 10: Potential black cockatoo habitat trees on State land

Habitat type	Habitat species	Number of trees	
		Total within Survey Area	Total within Area of Surface Disturbance
Low priority roosting trees	*E. rudis, E. camaldulensis*	18	1
Medium priority feeding and roosting trees	*E. marginata*	21 (1 with hollows)	4
High priority feeding, nesting and roosting trees	*C. calophylla, E. gomphocephala, dead trees*	46 (1 with hollows)	10
TOTAL		**85**	**15**

4.8.2.2 Quenda

The Quenda (*Isoodon obesulus fusciventer*) is listed as a Priority 5 species under the *Wildlife Conservation Act 1950*. Priority 5 species are those that are not threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years. Quendas favour habitat comprising dense shrubland and understory, with their distribution often linked to wetland and woodland areas.

GHD identified 19.5ha of potential Quenda habitat along the alignment during the fauna survey (GHD 2013), of which only 5.3 ha is located within the areas of surface disturbance. This is in the Forrestfield Station where GHD observed a Quenda foraging beneath a thicket of Victorian tea tree. Potential Quenda habitat within the Forrestfield Station Precinct includes:

- Sparse Woodland of *Corymbia calophylla* over *Xanthorrhoea preissii* and low shrubs, sedges and herbs
- Remnant *Eucalyptus marginata/E. rudis/Corymbia calophylla* Woodland over a mid-storey and understorey of mixed native species
- Plantings of non-native species over an understorey of weedy grasses and herbs

4.8.2.3 Water Rat

The Water Rat is listed as a Priority 4 species, taxa in need of monitoring, under the *Wildlife Conservation Act 1950*. They occupy habitats around permanent water, and in the south west of Western Australia they have been shown to prefer areas with riparian vegetation, better water quality and a degree of habitat complexity (Bamford Consulting Ecologists, 2014).

During the fauna survey undertaken by Bamford Consulting Ecologists (Bamford Consulting Ecologists, 2014), signs of the Water Rat were identified along the Swan River near the Tonkin Highway crossing. The thick reed and wetland habitat along the river is likely to provide a stronghold for the species amongst the developed areas of the Swan River (Bamford Consulting Ecologists, 2014). During the survey, 18.35 ha of this habitat type were identified.

4.9 Heritage

4.9.1 Aboriginal Heritage

The PTA has commissioned a number of Aboriginal heritage investigations to date including:

- Aboriginal Heritage Study of Part Lot 15531, Dundas Road, High Wycombe (O'Conner, 2011)
- Desktop Aboriginal Heritage Review for the Proposed Airport Rail Link (Waru Consulting, 2013a) (Appendix 9)
- Additional Archaeological Verification of DAA Site #4408 "Newburn: Bingham St" (Waru Consulting, 2013c) (Appendix 10)
- Desktop Aboriginal Heritage Review "Gap Analysis" for Proposed Airport Rail Link (Waru Consulting, 2013b) (Appendix 11)
- Archaeological Survey and Site Verification for Proposed Airport Rail Link – Preliminary Advice (Waru Consulting, 2013d) (Appendix 12)
- Consultations for Forrestfield-Airport Rail Link at Aboriginal Site "Swan River" (DAA#3536) (Waru Consulting, 2014a)
- Consultations for Forrestfield-Airport Link Railway at Aboriginal Site "Poison Gully Creek" (DAA#25023) (Waru Consulting, 2014b)

The reports pertaining to the Swan River and Poison Gully Creek have not been included as appendices as they contain culturally sensitive information.

The search of the DAA AHIS and the Desktop Assessment (Waru Consulting, 2013a) identified nine potential Aboriginal heritage sites within the Approval Boundary; of these eight are located on State land. Three of the eight sites are registered Aboriginal heritage sites as it has been deemed that they meet the definition of a site as per Section 5 or Section 39 of the *Aboriginal Heritage Act 1972*. The other five sites are Heritage Places which have been assessed as not meeting the definition of a site.

Mapping of sites on the AHIS is sometimes broad as it includes a buffer zone around the site or conceals the actual location of the site. Project specific heritage surveys commissioned by the PTA and liaison with the DAA have assisted to confirm the actual location of some of these sites. The PTA also commissioned Waru to undertake an archaeological inspection and site verification survey of five portions of land within the project area which had not previously been cleared or developed (Waru Consulting, 2013d). The purpose was to establish if any previously unrecorded Aboriginal heritage sites were likely to exist within the Approval Boundary. No previously unrecorded Aboriginal heritage sites or archaeological material were identified.

A summary of the Aboriginal heritage sites known to occur on State land is provided in Table 11. These sites are shown on Figure 13.

Table 11: Aboriginal Heritage Sites on State land

Site ID	Site Name	Site Type	Site Significance
Registered Sites			
3719	Munday Swamp	Ceremonial, Mythological, Artefact / scatter	The published extent of this site occurs over both Commonwealth and State land. The PTA has confirmed in consultation with the DAA that the actual heritage site only occurs on Commonwealth land. Munday Swamp was an ancient camping area which provided a valuable plant and animal food source. It was also used as a ceremonial and mythological ground and is considered to be an important archaeological site.
25023	Poison Gully Creek	Ethnographic Site	Poison Gully Creek is an ancient camping area of particular significance to Aboriginal women. The published extent of this site occurs over both Commonwealth and State land. The PTA commissioned R. and E. O'Connor Pty Ltd (O'Conner, 2011) to undertake an Aboriginal heritage assessment to establish the actual extent of the site. It was considered that the heritage values for this site extend 50 m from either bank of Poison Gully Creek.
3536	Swan River	Mythological	The Swan River is of great significance to the Noongar people due to its connection to the Waugal – a mythical water serpent believed to be responsible for shaping the landscape and creating springs, rivers and lakes.
Heritage Places (Stored Data)			
3616	Kenmure Ave, Bayswater	Camp	Kenmure Ave is listed as a camp and it also has purported mythological and water source components.
3667	Crumpet Creek, Forrestfield	Artefact / scatter	Crumpet Creek was identified as an artefact scatter containing 29 quartz artefacts located on a firebreak. This place has been incorrectly mapped on the AHIS and is actually situated approximately 2km to the south of the existing mapping.
3866	Brearley Ave	Artefact / scatter	Brearley Ave was originally recorded in 1979 and it contained 15 glass artefacts from a brown bottle. In 2007 verification work was undertaken to relocate the artefacts. The likely location for this site was searched but no artefacts were found. It was concluded that site no longer exists.
4090	Wyatt Rd, Bayswater	Artefact / scatter	Wyatt Rd was originally reported to be a single quartz artefact.
4043	Mathieson Rd, Redcliffe	Artefact / scatter	Mathieson Road was an artefact scatter. Construction of Tonkin Highway destroyed the site.

4.9.2 European Heritage

There is no listed European heritage in proximity to the proposal that would be likely to be impacted. This assessment is based on online searches undertaken in April 2014 of the Australian Heritage Places Inventory and the Heritage Council of WA Places Database.

4.10 Land Use Considerations

4.10.1 Surrounding Land Uses

Various land uses exist surrounding the alignment. These include residential, recreational and commercial/industrial areas and the airport.

4.10.2 Environmentally Sensitive Areas

Environmentally Sensitive Areas (ESAs) are declared by a notice under Section 51B of the EP Act. There is one ESA located within an area of surface disturbance on State land as shown in Figure 14. This is associated with the Swan River buffer zone.

4.10.3 Bush Forever

As shown in Figure 14, there are no areas of surface disturbance within Bush Forever Sites on State land. Bush Forever Site 45 which is associated with the Poison Gully Creek bushland is adjacent to the area of surface disturbance in Forrestfield.

4.10.4 Swan River Trust Development Control Area

The Swan River Trust Development Control Area (DCA) includes the waters of the Swan Rivers and adjoining parks and recreation reservations. As shown on Figure 6, there are no areas of surface disturbance within the DCA. The bored tunnels however pass through the DCA.

4.10.5 Potentially Contaminated Land

A Preliminary Site Investigation (PSI) in accordance with the DER guidelines has been undertaken by GHD to identify known contaminated sites and potential sources of contamination along the length of the proposed alignment (Appendix 13) (GHD, 2013). The PSI included a search of the DER's Contaminated Sites Database which identified two known contaminated sites within the vicinity of the proposed alignment on State land (Figure 15). The PSI has been reviewed and endorsed by an approved auditor under the *Contaminated Sites Act 2003*, the DER and the Department of Health (DoH). The potential sources of contamination and the known contaminated sites located on State land are outlined in Table 12 (also refer to Figure 15).

Table 12: Contamination Sites and Potential Sources of Contamination on State land

Site ID	Potential Contamination	Location
Former CSBP fertiliser manufacturing plant	Registered as 'contaminated remediation required'. Contaminated groundwater plume (acidity, metals and nutrients)	Located hydraulically up gradient of the area of surface disturbance in Bayswater.
Fly tipping and stockpiles	Potential soil contamination or contaminated stockpiles (metals, hydrocarbons, pesticides and potential asbestos containing materials (ACM))	Located within the area of surface disturbance in Bayswater.
Asbestos Containing Materials fly tipping and stockpiles	Potential ACM on the surface or in stockpiles	Located within the area of surface disturbance for Cross Passage 1.
Workshops	Metals, hydrocarbons, solvents and phenols	Located hydraulically down gradient of the area of surface disturbance associated with Emergency Egress Shaft 4.
Stockpiles	Potential soil contamination or contaminated stockpiles (metals, hydrocarbons, pesticides and ACM)	Located within the area of surface disturbance in Forrestfield.
Access Park	Potential groundwater contamination or contaminated stockpiles (metals, hydrocarbons, solvents and nutrients)	Located hydraulically down gradient of the area of surface disturbance associated with the Forrestfield Station Precinct.
Bayswater Industrial Area	Metals, hydrocarbons, solvents and phenols	Located hydraulically up gradient of the area of surface disturbance in Bayswater.

A Sampling and Analysis Plan (SAP) in accordance with the DER guidelines was prepared by GHD following completion of the PSI ((GHD, 2013)). The SAP outlines the investigation required to delineate the extent of contamination at the sites identified in the PSI and to determine the risk posed to the environment and human health during construction and operation of the FAL. The SAP has been reviewed and endorsed by an approved auditor under the *Contaminated Sites Act 2003*. The DER and the DoH declined to review the SAP given it had been endorsed by an approved auditor.

5 Potential Impacts and Management Measures

The site investigations and desktop assessments undertaken have informed the main characteristics of the FAL allowing for the project to be designed to avoid environmental and heritage impacts where feasible. This EIA has been undertaken to identify residual impacts to environmental and heritage values in the context of the EPA's objectives. Mitigation and management measures have been developed and approval requirements for implementation and operation of the project have been identified.

Temporary lowering of the groundwater table during construction dewatering operations has the potential to impact on different environmental factors. Potential dewatering impacts are therefore discussed throughout this section.

5.1 Acid Sulfate Soils

5.1.1 EPA Environmental Factors and Objectives

The relevant EPA environmental factors are:

- Terrestrial Environmental Quality
- Inland Waters Environmental Quality

The EPA's objectives relating to these factors are:

- To maintain the quality of land and soils so that the environmental values, both ecological and social, are protected.
- To maintain the quality of groundwater and surface water, sediment and biota so that the environmental values, both ecological and social, are protected.

5.1.2 Project Objective

The project's environmental management objective is to minimise the potential for ASS to be oxidised in-situ and hence avoid acidification impacts on groundwater or surface water.

5.1.3 Legislation and Guidelines

The following documents provide guidance for managing risks related to ASS:

- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (Australian and New Zealand Environment and Conservation Council, 2000)
- *Water Quality Protection Note 13: Dewatering of Soils at Construction Sites* (Department of Water, 2012)
- *Treatment and management of soils and water in acid sulfate soil landscapes* (Department of Environment and Conservation, 2011)
- *Identification and investigation of acid sulfate soils and acidic landscapes* (Department of Environment and Conservation, 2013)

5.1.4 Potential Impacts

5.1.4.1 Excavation of Acid Sulfate Soils

The project will excavate approximately 770,000 m^3 of material while constructing the tunnels, stations and other infrastructure. Preliminary laboratory analysis has indicated that it is likely that the bulk of excavated material will be classified as PASS.

Exposure of this material may result in the oxidation of PASS, which can result in the release of sulfuric acid and metals/metalloids (notably aluminium, iron and on occasion arsenic) which once mobilised may impact waterways, wetlands, vegetation and can corrode and degrade built-structures.

5.1.4.2 Dewatering

Temporary dewatering is required to construct the stations and emergency egress shafts. If the temporary drawdown results in groundwater levels falling below areas of PASS, there is the potential to cause sulfidic minerals in the soil to oxidise and acidify the groundwater. This in turn can result in metals being leached into the groundwater. Affected groundwater has the potential to impact sensitive environmental receptors such as wetland ecosystems, bore users and structures. Importantly, no dewatering is required to construct the tunnels or the cross passages.

5.1.5 Proposed Management

A site investigation in accordance with the DER guidelines is currently being undertaken to delineate the extent of PASS present within the project area. The results from this investigation will be used to develop management measures to minimise potential environmental impacts during construction. The investigation will be subject to endorsement by the DER or an accredited contaminated sites auditor acting on behalf of the DER.

The approach to ASS management approach for the FAL project is as follows:

- Undertake a Desktop Assessment. This has been completed as part of a PSI (GHD, 2013) and endorsed by the DER and an accredited contaminated sites auditor (Jason Clay of Aecom).

- Develop a Sampling and Analysis Plan (SAP). This has been completed by GHD (GHD, 2014a) (Appendix 14) and endorsed by an accredited contaminated sites auditor (Jason Clay of Aecom). The DER declined to review the SAP once it was confirmed that the auditor has endorsed it.

- ASS investigations are currently being undertaken in accordance with the approved SAP and the DER guidelines to confirm the presence or absence of ASS and the existing groundwater quality within the vicinity of the project area.

- Detailed hydrogeological modelling will be undertaken based on the findings of the site investigations to refine the predictions made in the Preliminary Dewatering Assessment (Golder Associates, 2014a) and to inform the development of management controls.

- Once the ASS investigation is completed, an Acid Sulfate Soils and Dewatering Management Plan (ASSDMP) will be prepared to outline best practice procedures to manage and treat any ASS encountered and disturbed during excavation and dewatering activities. The management plan will provide management and monitoring measures to:
  - Reduce potential for ASS oxidation
  - Minimise impacts to groundwater
  - Protect nearby environmental receptors (e.g. wetlands, surface water courses)
  - Protect nearby infrastructure including domestic and commercial production bores

The ASSDMP will be drafted to the satisfaction of DER prior to any dewatering or excavation activities being undertaken that may expose PASS. Where proposed construction works have the potential to disturb ASS (either through ground disturbance or dewatering), works will be implemented in accordance with the ASSDMP to ensure potential impacts are managed and mitigated accordingly. Management and mitigation measures are summarised in Table 13.

Measures proposed to mitigate and reduce magnitude and extent of groundwater level drawdown and thereby reduce the quantity of PASS which is disturbed are discussed in Section 5.2.5.

5.1.6 Spoil Reuse

Construction of the FAL will generate spoil from excavations and the tunnelling process. The estimated total quantity of spoil material excavated throughout the length of the project is approximately 770,000 m^3. The majority of spoil material, once treated, is likely to be suitable for reuse as general purpose bulk fill for engineering purposes. As part of the current geotechnical investigations, the suitability of excavated material for different uses is being assessed to assist in identifying reuse opportunities.

A preliminary study undertaken by the PTA into productive use of the treated spoil material identified potential infrastructure projects which will need to source large quantities of fill material. Ongoing discussions are being held with possible users of the treated spoil material, including other government agencies such as Main Roads WA and the Department of Housing, as well as PAPL.

5.1.7 Waste Management

It is recognised that some of the excavated material will not be suitable for reuse and may have to be disposed of to landfill. Management of this material will be implemented according to the following management plans, guidelines and legislation as they apply:

- ASSDMP
- Site Management Plan for contaminated material
- *Environmental Protection Regulations 1987*
- *Environmental Protection (Controlled Waste) Regulations 2004*
- Landfill Waste Classification and Waste Definitions 1996
- Treatment and Management of Soils and Water in Acid Sulfate Soil Landscapes (Department of Environment and Conservation, 2011)

5.1.8 Approval Requirements

Approvals that will be required to manage potential impacts from ASS are summarised below:

- An approved ASSDMP is required prior to any dewatering or excavation activities being undertaken that may expose PASS.
- Dewatering licenses will be required from the Department of Water (DoW) including for groundwater recharge. These are summarised in Section 5.2.7.
- Dewatering effluent disposal licences for disposal to sewer (Water Corporation)
- Reuse of the excavated material may also be subject to approval and licensing requirements under Part 5 of the EP Act.

5.1.9 Acid Sulfate Soil Summary

A summary of the potential ASS impacts and management measures is provided in Table 13.

Table 13: Acid Sulfate Soils Management and Mitigation Summary

	Management Action
EPA Objectives	- To maintain the quality of land and soils so that the environmental values, both ecological and social, are protected. - To maintain the quality of groundwater and surface water, sediment and biota so that the environmental values, both ecological and social, are protected.
Impact Summary	- Dewatering and excavation activities have the potential to disturb ASS.
Approval Requirements	- An approved ASSDMP - Dewatering licenses under the *Rights in Water and Irrigation Act 1914* - Any dewatering effluent disposal licences as they apply (Water Corporation)
Mitigation Measures	- Fully characterise the material which is to be excavated prior to the commencement of construction. - Implement strategic excavation and dewatering practices in accordance with the approved ASSDMP. - Exposure of any PASS material through excavations will be minimised where possible to reduce the potential for oxidation and acid generation. All PASS soils will be treated in accordance with the approved ASSDMP. - Minimise groundwater drawdown as far as reasonably practicable through methods such as re-injection of abstracted groundwater, use-of diaphragm wall or sheet piling for deeper excavations, use of wet working techniques (as applicable), and with effective groundwater level monitoring via a network of bores - Groundwater dewatering controls will be agreed with the DER and DoW and established within the ASSDMP
Management and Monitoring	- ASS investigations will be undertaken in accordance with the approved SAP to identify the potential for ASS to occur along the alignment - Monitoring of groundwater and surface water along the alignment prior to, during and post construction activities will be undertaken to ensure management measures are effectively implemented and that there are no substantive impacts to the environment - Treatment and monitoring of excavated materials will be undertaken as specified in the ASSDMP - Validation testing will be performed on treated PASS material - Records will be kept of all monitoring undertaken, results and lime dosing rates - Material excavation, treatment and disposal documentation will be maintained throughout the duration of construction operations

Management plans	Management measures for excavation and dewatering will be outlined in an ASSDMP approved by the DER. This plan will provide management, monitoring, reporting, mitigation and contingency measures to: - Reduce potential for ASS oxidation - Minimise impacts to groundwater and surface water and maximise groundwater recharge - Minimise impacts to other sensitive receptors e.g. wetlands and groundwater dependent vegetation - Protect nearby infrastructure

5.2 Groundwater

5.2.1 EPA Environmental Factors and Objectives

The relevant EPA environmental factors are:

- Hydrological Processes
- Inland Waters Environmental Quality

The EPA's objectives relating to these factors are:

- To maintain the hydrological regimes of groundwater and surface water so that existing and potential uses, including ecosystem maintenance are protected
- To maintain the quality of groundwater and surface water, sediment and biota so that the environmental values, both ecological and social, are protected

5.2.2 Project Objective

The project's environmental management objective during and post construction activities is to maintain and protect the quality of surface water and groundwater resources.

5.2.3 Legislation and Guidelines

The following documents provide guidance for managing risk to groundwater:

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment and Conservation Council, 2000)
- *Identification and investigation of acid sulfate soils and acidic landscapes* (Department of Environment and Conservation, 2013)
- *Treatment and management of soils and water in acid sulfate soil landscapes* (Department of Environment and Conservation, 2011)

5.2.4 Potential Impacts

5.2.4.1 Groundwater Quality

Potential impacts to groundwater quality include deterioration of groundwater quality from the disturbance of PASS or mobilisation of existing contamination. Temporary dewatering is required for construction of underground structures including the stations and emergency egress shafts. Longer term drawdown of the groundwater table beyond normal seasonal fluctuations has the potential to lead to PASS oxidation and acidification risk. This can occur even under shorter term dewatering programs where soils are highly reactive and poorly buffered. PASS oxidation can lead to an increase in acidity, drop in pH and liberation of metals from soils into water. The recharging of oxygen enriched dewatering effluent back into an aquifer can also create conditions for PASS oxidation.

Existing contaminant sources in groundwater that may exist in the vicinity of the alignment may be moved by dewatering activities. Displacement of existing sources of contaminated groundwater has the potential to generate contaminated dewatering effluent or move contaminated plumes into previously uncontaminated areas of the aquifer. There is the potential for contaminated groundwater to be mobilised through dewatering at the connection to the existing Perth to Midland line in Bayswater, at Airport West Station and in Forrestfield where the tunnelling will commence. Any impacts and proposed management measures regarding the potential mobilisation of existing contamination during dewatering activities is discussed in Section 5.8.

A reduction in groundwater quality has the potential to impact ecological communities, wetlands and water courses where there is shallow groundwater-surface water interaction, and also impact groundwater users (domestic and commercial production bores) and potentially surrounding infrastructure.

5.2.4.2 Groundwater Flow

Potential impacts to groundwater flow include alteration of the groundwater flow regime from temporary dewatering activities and construction of subsurface structures. Temporary groundwater level drawdown during dewatering may impact sensitive environmental receptors including ecological communities, wetlands and water courses that rely on the shallow groundwater for year-round replenishment. This occurs where drawdown extends beyond normal seasonal fluctuations and for extended periods, without supplementary water being applied. DER also identifies a risk of interrupted supply to groundwater bore users (noting it would only occur under significant drawdown operations), and to surrounding buildings and infrastructure through subsidence.

Ongoing studies will assess the potential for the tunnels to alter the groundwater flow regime by causing an obstruction to groundwater flow. Preliminary assessment identifies that the tunnels will occupy approximately 7 m thickness of the aquifer, this being relatively insignificant compared to the available aquifer thickness, and hence permitting groundwater to flow around the tunnels. The tunnels are generally aligned parallel with the groundwater flow direction, being towards the Swan River, and this would reduce the impact of any obstruction effect when compared to construction perpendicular to the groundwater flow direction.

The stations while extending to depth, occupy a relatively smaller area of the aquifer, and hence impacts would be expected to be localised around these structures. Monitored data from groundwater levels measured during construction of the Perth to Mandurah railway demonstrated no substantive change in groundwater levels attributable to the construction of underground structures, and this has been confirmed via post-construction monitoring. The effect of the FAL tunnels and station infrastructure as a possible obstruction to groundwater flow, and the magnitude of this effect, will be further considered once the results of current hydrogeological studies are available.

5.2.5 Mitigation Measures

5.2.5.1 Construction Methods

To minimise potential impacts to groundwater during construction, the project will work to reduce the magnitude and lateral extent of groundwater level drawdown (also known as the cone of depression) during temporary dewatering activities. The mechanisms to achieve this are well understood within the civil contracting industry, and generally align with the need for contractors to minimise dewatering requirements to facilitate construction.

The lead contractor appointed by the PTA onto the FAL project will be required to demonstrate via their Construction Environment Management Plan and ASSDMP how they will strategically program and deliver construction elements to minimise dewatering demand and groundwater drawdown. It is anticipated that this will be achieved via the following mechanisms:

- Use of barrier techniques such as diaphragm walls (D-walls) and sheet piling to reduce groundwater ingress into excavations, and to reduce the size of open excavations
- Use of wet-working techniques (where practicable)
- Practice groundwater re-injection in proximity to areas of drawdown operations to reduce the extent of dewatering drawdown particularly near sensitive receptors
- Strategic programming of dewatering works to avoid multiple areas of dewatering drawdown occurring at one time

D-walls will most likely be used to build the underground structures including the stations and emergency egress shafts. D-Walls (and sheet piling where used in other applications) provide a barrier to groundwater ingress, performing best where the structures finish in soil units of low hydraulic conductivity. Plate F shows a schematic representation of a D-wall structure (in cross-section) installed into the FAL geology, such that the D-wall finishes in the lower permeability Osborne Formation. These cut-off walls form part of the final structure, and are installed from the ground-surface without the requirement for dewatering. Recent examples of their use in Perth include works on the Perth City Link Project and the inlet walls for Elizabeth Quay.

Groundwater re-injection is fundamental to managing dewatering effluent that is otherwise problematic to dispose of. The groundwater can be re-injected strategically to manage the lateral extent of dewatering drawdown, with priority being given to re-inject groundwater between dewatering operations and any groundwater sensitive receptors. It is likely that groundwater re-injection will be utilised by the lead contractor to ensure areas of wetland and groundwater dependant vegetation have minimal impact or to avoid drawing areas of contaminated groundwater into a working excavation.

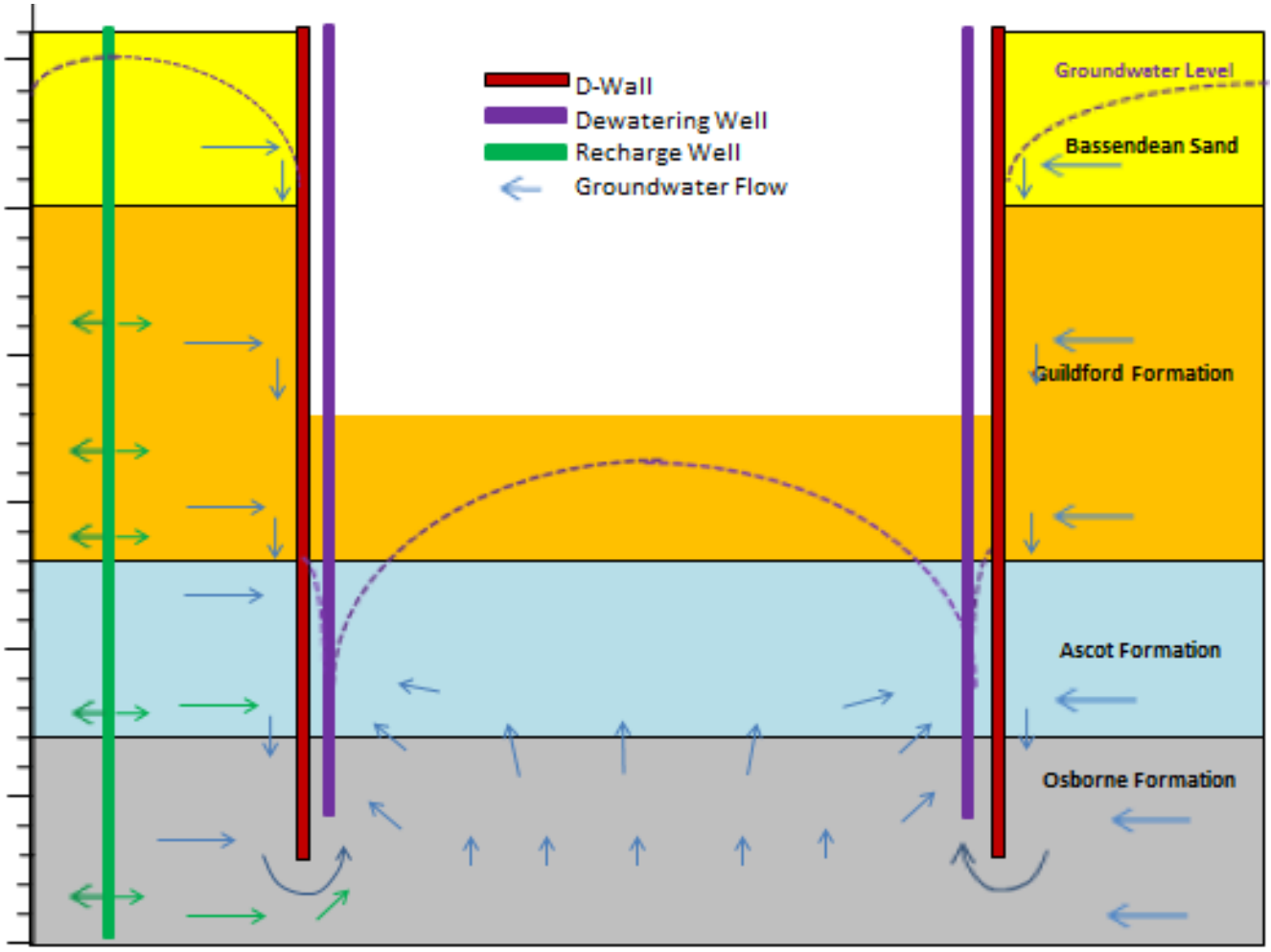


Plate F: Groundwater flow during dewatering activities

5.2.5.2 Preliminary Modelling

A preliminary Dewatering Assessment was undertaken by Golder Associates (Golder Associates, 2014a) (Appendix 15) to assess the likely magnitude and lateral extent of groundwater level drawdown for the key structures which require dewatering. The modelling is preliminary recognising that important geotechnical and hydrogeological studies had not been completed at the time of the model development, and that the authors have had to make assumptions in terms of the construction approaches taken, ahead of the lead contractor being appointed.

During the assessment, the drawdown from a number of different scenarios involving combinations of re-injection of dewatering discharge and the design of the underground structures were modelled to assess what effect different approaches had on dewatering drawdown. The modelling scenarios included a combination of groundwater re-injection and D-walls in the design. These preliminary modelling results demonstrated that it is possible to avoid or significantly reduce impacts on the below:

- Avoidance and reduction of significant drawdown impacts to all Resource Enhancement or Conservation Category Wetlands
- Reduction of potentially significant drawdown impacts to Black Cockatoo habitat trees
- Avoidance of significant drawdown impacts to mapped TECs and PECs
- Reduction of the risk of mobilisation of existing contamination

5.2.6 Proposed Management

Groundwater will be managed in accordance with the ASSDMP developed for the project. The ASSDMP will be prepared to ensure dewatering activities do not have a detrimental impact on groundwater quality, the groundwater flow regime and areas of environmental value that might be impacted. Dewatering activities will be undertaken in accordance with the following documents:

- *Water Quality Protection Note 13: Dewatering of Soils at Construction Sites* (Department of Water, 2012)
- *Identification and investigation of acid sulfate soils and acidic landscapes* (Department of Environment and Conservation, 2013)
- *Treatment and management of soils and water in acid sulfate soil landscapes* (Department of Environment and Conservation, 2011)

The ASSDMP will reflect and be in general accordance with the above documents and will specify the following:

- Dewatering effluent discharge should first be recharged on-site, or re-used (i.e. for dust suppression), before other disposal options are considered
- Minimum water quality requirements (as outlined in the DER ASS guidelines) will be established for any abstracted groundwater that is recharged into the aquifer, and or for other uses, noting that they may differ.
- Groundwater level "drawdown trigger levels" will be established as required, in areas of dewatering operations. The lateral extent of groundwater level drawdown will be controlled to levels identified within the ASSDMP in order to minimise environmental impacts. These levels will be developed based on detailed hydrogeological modelling (following completion of the current phase of site investigations), known or likely construction activities and will take account of proximate sensitive receptors. These trigger levels may be revised ahead of construction, based upon the final construction practices specified by the lead contractor, and in consultation with the DER.
- Controls and contingency responses that will ensure adverse impacts to groundwater quality and areas of environmental value are minimised and adequately monitored and managed during construction
- Monitoring including but not limited to:
  - Baseline groundwater quality and level monitoring prior to construction or dewatering activities
  - Water quality monitoring of dewatering discharge
  - Groundwater discharge/dewatering rates
  - Monitoring groundwater levels and quality during construction
  - Monitoring groundwater levels and quality post construction

Baseline monitoring of the receiving groundwater aquifers will be undertaken to understand the existing conditions. The ASSDMP will provide details on the expected range of concentrations for analytes including pH, total titratable acidity, alkalinity, acidity, metals and nutrients, determined from the baseline studies. Over the period of construction, any trends in groundwater quality would be assessed to confirm that groundwater quality is not deteriorating as a result of the works, and that any impacts are addressed via prescribed contingency measures. Abstracted groundwater re-used onsite (for dust suppression) or disposed to surface waterways would also be required to meet water quality criteria as prescribed in the ASSDMP.

A network of groundwater monitoring bores will be established ahead of site works as detailed in the ASSDMP, and monitored over the duration of dewatering activities in those areas, and for a time post-construction to confirm any ASS oxidation impacts have been avoided/controlled. These monitoring bores will also be used confirm that dewatering activities have not impacted areas of environmental value such as wetlands, TECs and surface water bodies or mobilised existing contamination.

A Construction Environmental Management Plan (CEMP) will also be prepared prior to the commencement of construction to specify the management measures required to protect environmental values throughout the construction phase. Groundwater management and monitoring recommendations in the CEMP will be in accordance with the ASSDMP.

5.2.7 Approval Requirements

Licenses that will be required prior to dewatering and re-injection of abstracted groundwater are summarised below:

- Re-injection of abstracted groundwater through recharge bores is managed under the DoW Managed Aquifer Recharge Policy. A licence to construct or alter a well (section 26D) is required to construct injection, recovery and monitoring bores
- A licence to take water (section 5C). Documentation to be provided to the department in support of the section 5C licence application includes:
  - Application of other relevant national guidelines (e.g. Australian guidelines for water recycling – Augmentation of drinking water; Stormwater harvesting and reuse; Managed aquifer recharge modules).
  - A hydrogeological assessment that examines the potential impacts of the infiltration or injection, and the potential for banking of recharge water, if required.
  - An operating strategy will be required and must be approved before the granting of the licence to take water.
- Acid Sulfate Soils Summary Form A – Investigation and Management Plans

5.2.8 Groundwater Management Summary

A summary of the groundwater impacts from the project and proposed mitigation and management measures throughout the construction phase and post construction phase are summarised below in Table 14.

Table 14: Proposed Management and Mitigation to Ensure Minimal Impacts to Groundwater

	Management Action
EPA Objectives	- To maintain the hydrological regimes of groundwater and surface water so that existing and potential uses, including ecosystem maintenance are protected - To maintain the quality of groundwater and surface water, sediment and biota so that the environmental values, both ecological and social, are protected
Impact Summary	The main potential impact to groundwater is through dewatering activities. Potential impacts from dewatering activities are summarised below: - Groundwater drawdown, which may impact surrounding vegetation, wetlands, buildings or infrastructure (subsidence) and groundwater users - Acidification created by the oxidation of PASS soils - Mobilisation of pollutants.
Approval Requirements	- An approved ASSDMP - Dewatering licenses under the *Rights in Water and Irrigation Act 1914*.
Mitigation Measures	Mitigation measures proposed to reduce impacts from dewatering include: - Minimise groundwater drawdown as far as reasonably practicable through methods such as re-injection of abstracted groundwater, use-of diaphragm wall or sheet piling for deeper excavations, use of wet working techniques (as applicable), and with effective groundwater level monitoring via a network of bores - Groundwater dewatering controls will be agreed with the DER and DoW and established within the ASSDMP
Monitoring and Management	Monitoring will be undertaken as per the ASSDMP and will include: - Monitoring water quality of dewatering discharge - Monitoring rate of dewatering discharge - Groundwater quality and level monitoring (pre, during and post activities)
Management Plans	Preparation of an ASSDMP to the satisfaction of the DER prior to undertaking any dewatering or excavation activities. This plan should include but not be limited to: - Details of the ASS investigations undertaken - Description of dewatering and construction activities (including dewatering volumes, D-wall construction, groundwater re-injection etc.) - Groundwater modelling information - Establishing treatment for any ASS or acidic groundwater - Establishing treatment requirements prior to disposal of abstracted groundwater - Monitoring and contingency measures - Reporting requirements

5.3 Wetlands and Surface Water

5.3.1 EPA Environmental Factors and Objectives

The relevant EPA environmental factors are:

- Flora and Vegetation
- Hydrological Processes
- Inland Waters Environmental Quality

The EPA's objectives relating to these factors are:

- To maintain representation, diversity, viability and ecological function at the species, population and community level
- To maintain the hydrological regimes of groundwater and surface water so that existing and potential uses, including ecosystem maintenance are protected
- To maintain the quality of groundwater and surface water, sediment and biota so that the environmental values, both ecological and social, are protected

5.3.2 Project Objective

The project's environmental management objective during and post construction activities is to minimise and manage the impacts to wetlands, including ecological function, vegetation condition and structure and water quality.

5.3.3 Legislation and Guidelines

All wetlands and associated ecosystems will be managed and protected in accordance with the following legislation:

- *Wildlife Conservation Act 1950*
- *Environmental Protection Act 1986*
- *Environment Protection and Biodiversity Conservation Act 1999*

The following documents also provide guidance for managing risk to wetlands and surface water from the FAL alignment:

- EPA Position Statement No. 4: Environmental Protection of Wetlands (Environmental Protection Authority, 2004b)
- EPA Position Statement No. 3: Terrestrial Biological Surveys as an element of Biodiversity Protection (Environmental Protection Authority, 2000b)
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment and Conservation Council, 2000)
- A Guide to Managing and Restoring Wetlands in Western Australia (Department of Environment and Conservation, 2012)
- Swan River Trust Policy SRT/D4 – Stormwater Management

5.3.4 Potential Impacts to Wetlands

5.3.4.1 Clearing

Direct impacts to wetlands on State land from the project include clearing 3.28 ha of Resource Enhancement wetland (UFI15876) during construction of the Forrestfield Structure (Plate G below and Figure 6). Approximately half of the vegetation in this area has been assessed as TEC (FCT SCP20a/20b) in excellent condition (1.75 ha). The remaining vegetation was mapped as degraded to completely degraded consisting of plantings of non-native species over an understory of weedy grasses and herbs.

There are no other wetlands located within areas of surface disturbance that will be directly impacted by the proposal.

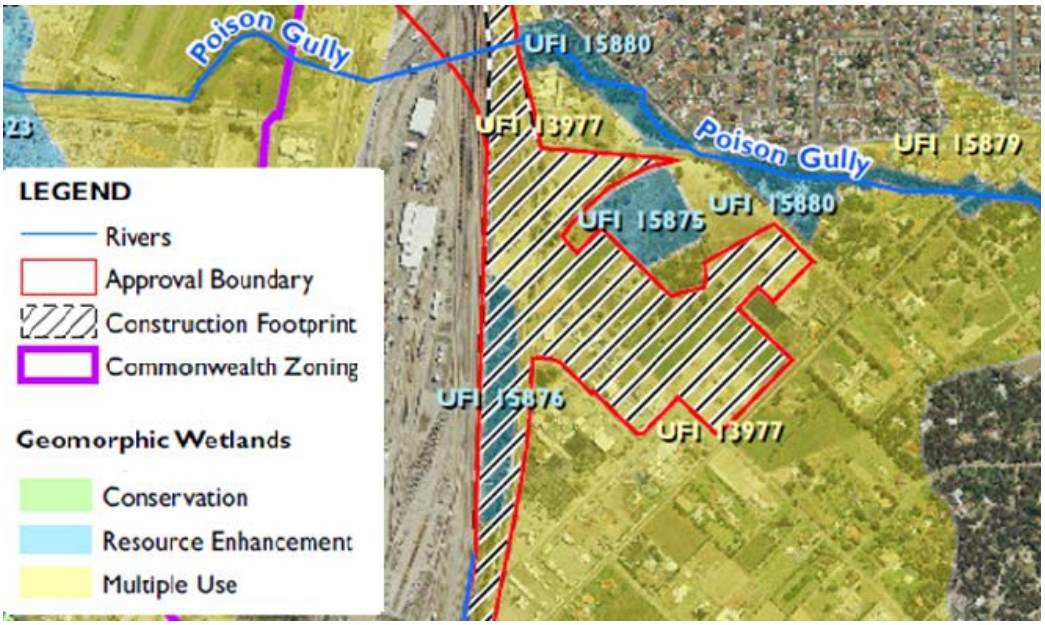


Plate G: Location of wetlands within the Forrestfield area

5.3.4.2 Dewatering

The preliminary groundwater modelling undertaken by Golder Associates (Golder Associates, 2014a) assessed the likely extent of groundwater table drawdown in areas of wetlands, and assumed groundwater reinjection was practised (equivalent to 85% of abstracted water) to reduce the lateral extent of drawdown. This report has referenced the outcomes of modelled scenarios which are based on the current concept design and assuming that 85% of abstracted groundwater is re-injected. The modelled scenarios are 1B, 4B, 6, 7, 9 and 14A (Refer Appendix 15).

The assessment identified one wetland on State land which may be indirectly impacted due to its proximity to the dewatering activities in the Forrestfield Station precinct; UFI15875 (Plate G and Figure 6). The results of the preliminary modelling indicate that dewatering activities may lower the groundwater level by approximately 0.1 m over a 16 week period in the area of this wetland.

An assessment of the significance of these predicted water table lowering impacts was undertaken and the outcomes identify that the risk to the wetland is low given:

- The predicted 0.1 metre water table drop is within the expected natural groundwater fluctuations, and occurs over a relatively short duration
- That this magnitude of fall is identified as a low risk to wetland vegetation

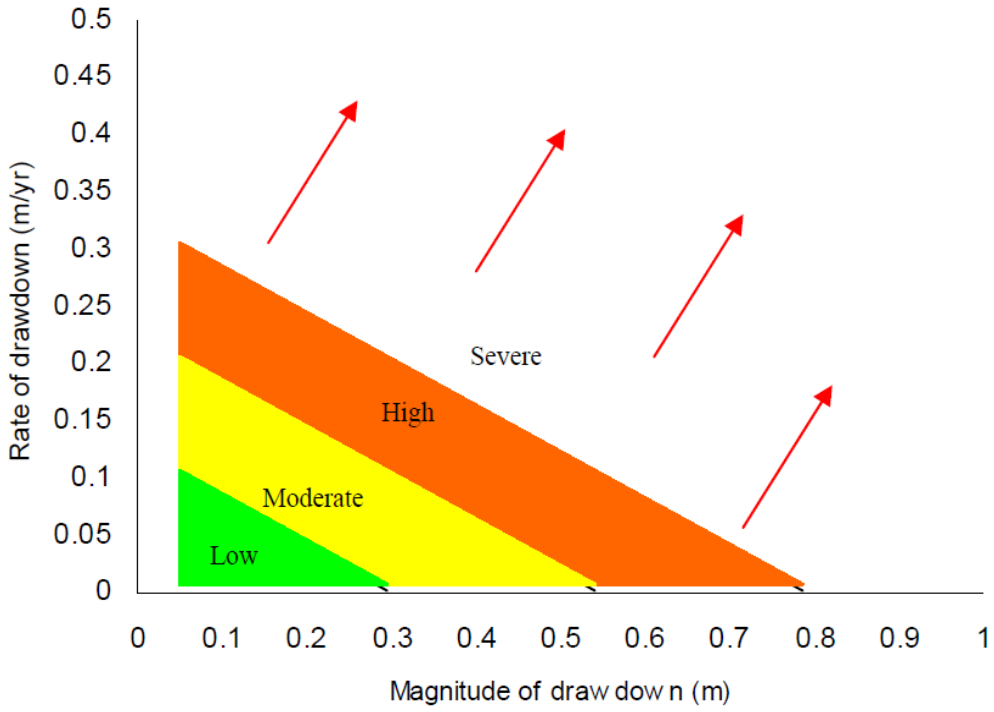
Advice on this conclusion was sought from Ray Froend (Professor, Edith Cowan University) in May 2014. Professor Froend confirmed that a drawdown of 0.1 m over a 12 month period would be unlikely to have a significant impact on the wetland and associated vegetation.

These results are further described below.

A desktop assessment of groundwater levels in the High Wycombe and Forrestfield areas shows annual groundwater levels fluctuating by between 0.3 m bgl to 1.0 m bgl (ENV, 2012). Consequently, the change of 0.1 m over a 16 week period experienced at wetland UFI15875 is within the natural groundwater level fluctuations. The duration of the groundwater level change also occurs over a short period of time.

The DoW has established Ecological Water Requirements (EWRs) for the Swan Coastal Plain and Blackwood region (R. Froend, R. Loomes, 2006). These generic EWRs relate to maximum drawdown limits and rate of change limits for wetlands and phreatophytic vegetation. The document includes "risk of impact" categories for wetlands that were developed by Froend and Loomes (Dr. R. Froend, 2004).

As stated in (R. Froend, R. Loomes, 2006), these categories were developed based on the results of research into the response of vegetation to groundwater decline. The cumulative rate and magnitude of the predicted groundwater drawdown is defined and the possible ecological responses to the varying degrees of drawdown are described broadly as either low, moderate, high or severe in terms of probability of noticeable impact to groundwater change. The risk categories for wetlands are shown on Graph 1.



Graph 1: Risk of Impact for Wetland Vegetation based on Magnitude of Groundwater Level Change (Dr. R. Froend, 2004)

The predicted changes to groundwater levels and the duration of the dewatering activities in this area are preliminary values estimated by the PTA and Golder Associates based on the project's concept deign. Further detail on these estimates, and revisions based on the lead contractor's employed methods, and more detailed geotechnical and hydrogeological studies will be forthcoming in later planning and management documents, including the ASSDMP. The lateral extent of groundwater level drawdown will be controlled to levels specified within the ASSDMP in order to minimise impacts to the wetlands. These levels will be developed in consultation with the DER and other relevant regulatory agencies using the results of future studies.

5.3.4.3 General Construction

An area set aside for a construction site and then a car park will be located adjacent to UFI15875. Potential construction related impacts incurred during or post-construction are summarised below:

- During construction activities, potential impacts to UFI15875 include:
  - Accidental clearing during construction activities
  - Surface water run-off into the wetland which may contain sediment and other contaminants
  - Potential spread of weeds and disease into the wetland

- Once the FAL is operational, the car park adjacent to the wetlands northern and western edge, may have the following potential impacts onUFI15875:
  - Unauthorised access which may lead to vegetation degradation and spread of weeds and disease
  - Potentially contaminated surface water run-off from the car park entering the wetland

Management measures to avoid these impacts are discussed in Section 5.3.7.

5.3.5 Potential Impacts to Surface Water

5.3.5.1 Swan River

The proposed rail alignment will comprise twin bored tunnels under the Swan River at a depth of approximately 20 m below the bed of the river. Given the depth of the tunnels and the wholly subterranean construction process, construction of the tunnels will not disturb the bed, banks, associated riparian habitat or groundwater flow into the river.

Cross passage 2 is located within close proximity to the Swan River. The cross passages will be constructed from within the tunnels and some pre-treatment of the ground is required. The ground treatment process involves localised filling of the soil pores with cement grout using specialised drilling equipment. Only the soil which surrounds the tunnels is grouted thus creating a stabilised block of soil at the depth of the tunnels. This requires a small area to be cleared for a temporary construction site to be established. Part of the area which requires clearing is mapped within the Swan River Environmentally Sensitive Area buffer zone. However, the area of surface disturbance has been positioned by the PTA on the embankment for the Tonkin Highway road bridge in an area of Completely Degraded vegetation.

The preliminary modelling undertaken by Golder Associates (Golder Associates, 2014a) indicates that the cone of depression from dewatering activities associated with Emergency Egress Shafts 1 and 2 is unlikely to impact to the Swan River or any associated wetland vegetation.

There remains the potential for construction and dewatering activities to impact the water quality within the Airport Southern Main Drain (Swan River Trust Site Code – SCCIS11) which is located within the area of surface disturbance associated with Airport West station and Emergency Egress Shaft 2. The Airport Southern Main Drain is an open ditch which is in hydraulic continuity with the groundwater and receives surface water flow from the Darling Scarp and the airport estate. The drain discharges directly into the Swan River. At this stage in the project design process, two options are being considered for management of the drain during construction, these include:

- Avoiding the drain during construction and fencing it off from the construction site to avoid any impacts.
- Replacing those portions of the drain impacted by the construction footprint to a piped drain.

Regardless of the option selected, flow within the drain will not be compromised during construction or operation of the FAL.

5.3.5.2 Poison Gully Creek

The area of surface disturbance in Forrestfield has been designed to avoid direct impacts to Poison Gully Creek where it flows in its natural form (i.e. to the east of Dundas Road). West of Dundas Road construction activities will be occurring proximate to the creek and hence there is the potential for construction and dewatering activities to impact the water quality within the creek. The creek in this area however is completely modified, and does not retain any of its natural form, and has limited environmental value. The creek is fed by surface water flows off the Darling Scarp and is dry in summer.

As with the Swan River, two options are being considered for treatment of the creek where it flows through the project area, these include:

- Avoiding the creek during construction and fencing it off from the construction site to avoid any impacts.
- Replacing those portions of the creek impacted by the construction footprint to a piped drain.

Regardless of the option selected, flow within the creek will not be compromised during construction or operation of the FAL. It is also likely that a gas pipeline which is buried beneath the modified section of the creek within the area of surface disturbance will relocated. This will require temporary disturbance to the bed of the creek in this localised area.

5.3.5.3 Other Water Courses

Potential impacts to the Airport Northern Main Drain as the receiving water course of Poison Gully Creek and the Bayswater Main Drain include deterioration in water quality resulting from construction and dewatering activities. No physical disturbance to the bed or banks of these water courses is proposed.

5.3.6 Mitigation Measures

Mitigation measures undertaken to reduce or avoid impacts to wetlands and surface water courses include:

- During the project design phase, the construction footprint was amended to avoid direct impacts via vegetation clearing to UFI15875
- Construction methods have been identified which can be used to reduce the cone of depression during dewatering activities (e.g. D-wall design and dewatering discharge reinjection) and therefore avoid any significant impacts to wetlands or surface water courses
- The area of surface disturbance for Cross Passage 2 has been located on the embankment for the Tonkin Highway road bridge in an area of Completely Degraded vegetation
- The area of surface disturbance in Forrestfield has been designed to avoid direct impacts to Poison Gully Creek where it flows in its natural form

To mitigate the residual impacts to wetlands, the PTA will develop and implement an Environmental Offset Strategy.

5.3.7 Proposed Management

5.3.7.1 Wetlands

Management measures to reduce impacts to wetlands will be outlined in a CEMP which will include the measures summarised below. With these management measures in place, any indirect impacts to wetlands are considered unlikely to be significant:

- Management measures proposed during construction activities to prevent potential indirect impacts to UFI15875 include:
  - Fencing the wetland area to prevent accidental clearing
  - Location of any chemical, refuelling or machinery storage areas 50m or more from the wetland
  - Diversion of surface water run-off from the construction site so that no potentially contaminated surface water enters the wetland
  - Compliance with appropriate hygiene measures to ensure no spread of weeds or disease into the wetland
  - Groundwater level monitoring to ensure drawdown levels remain within the ranges specified within the ASSDMP.
  - Groundwater quality monitoring to ensure groundwater quality is maintained at concentrations specified within the ASSDMP, and any deteriorating trends are identified.
  - Adopting contingency measures (if required) such as supplementary watering, to ensure there are no detrimental impacts to the ecological health of the wetland.

- Management measures proposed post construction activities to prevent potential indirect impacts to UFI15875 include:
  - Fencing and signage between the proposed wetland and car park area to prevent unauthorised access by users of Forrestfield Station
  - Stormwater management to prevent potentially contaminated surface water entering the wetland

5.3.7.2 Swan River

The Airport Southern Main Drain is located within the area of surface disturbance for Airport West Station and Emergency Egress Shaft 2. There is the potential for the project to impact the water quality of the drain and in turn the Swan River which the drain discharges into.

It is proposed that management measures are put in place to ensure water quality within the drain does not deteriorate during construction. Baseline water quality will be established by the PTA over the next 12 months by collecting water samples on a quarterly basis. The results of this sampling will be used in conjunction with data held by PAPL and the Swan River Trust to develop risk based water quality targets. These targets will be agreed with the Swan River Trust and specified in the project's Construction Environmental Management Plan (CEMP).

The CEMP will specify measures to ensure water quality within the drain is not impacted including erosion and storm water management measures. The CEMP will also specify surface water quality monitoring and reporting requirements. The CEMP will be endorsed by the DER and other relevant regulatory agencies as required.

5.3.7.3 Other Surface Water Courses

As with the Airport Southern Main Drain, it is proposed that management measures and monitoring requirements are specified in the project's CEMP to ensure that water quality within other surface water courses is not impacted by the proposed construction works. The CEMP will also detail the management measures that will be adopted during construction works which disturb the bed or banks of water courses to ensure that surface water flows and water quality is not impacted.

5.3.8 Approval Requirements

Approvals that will be required to manage potential impacts to wetland and surface water are summarised below:

- A Bed and Banks Permit will be required from the DoW under the *Rights in Water and Irrigation Act 1914* prior to any disturbance to the bed or the banks of surface water courses
- An approved ASSDMP is required prior to any dewatering or excavation activities being undertaken that may expose PASS.
- An approved CEMP is required prior to any construction works commencing.
- A Clearing Permit under the EP Act from the DER will be required for the direct impacts to wetlands.
- Dewatering licenses will be required from the Department of Water (DoW).

5.3.9 Wetlands and Surface Water Summary

Impacts to wetlands and surface water and proposed mitigation and management measures are summarised in Table 15.

Table 15: Wetlands and Surface Water Management and Mitigation Summary

Issue	Management Action
EPA Objectives	- To maintain representation, diversity, viability and ecological function at the species, population and community level - To maintain the hydrological regimes of groundwater and surface water so that existing and potential uses, including ecosystem maintenance are protected - To maintain the quality of groundwater and surface water, sediment and biota so that the environmental values, both ecological and social, are protected

Impacts Summary	- Clearing of 3.28 ha of Resource Enhancement wetland (UFI15876)
	- Potential indirect impacts to UFI15875, including:
	  - Accidental clearing
	  - Run off from adjacent construction sites entering the wetland
	  - Run off from the proposed Forrestfield Station car park entering the wetland
	  - Unauthorised access
	  - Ecological health from groundwater drawdown.

Approval Requirements	- Bed and Banks Permit under the *Rights in Water and Irrigation Act 1914* - An approved ASSDMP - An approved CEMP - A Clearing Permit under the EP Act - Dewatering licenses under the *Rights in Water and Irrigation Act 1914*
Mitigation Measures	Mitigation and avoidance of impacts to wetlands achieved during the project design process is summarised below:

	- Avoidance of UFI15875 in establishing the project footprint - Minimise groundwater drawdown as far as reasonably practicable through methods such as re-injection of abstracted groundwater, use-of diaphragm wall or sheet piling for deeper excavations, use of wet working techniques (as applicable), and with effective groundwater level monitoring via a network of bores to limit impacts to surface water and significant wetlands (Resource Enhancement or Conservation Category Wetlands) - Groundwater dewatering controls will be agreed with the DER and DoW and established within the ASSDMP - The area of surface disturbance for Cross Passage 2 has been located on the embankment for the Tonkin Highway road bridge in an area of Completely Degraded vegetation - The area of surface disturbance in Forrestfield has been designed to avoid direct impacts to Poison Gully Creek where it flows in its natural form To mitigate the residual impacts to wetlands, the PTA will develop and implement an Environmental Offset Strategy.
Management and monitoring	Management measures to minimise potential impacts to UFI15875 and the surface water courses in the vicinity of the project area during construction activities will be outlined in the CEMP which will be prepared and endorsed by the DER and other regulatory agencies as required prior to any construction activities being undertaken. The CEMP will include but not be limited to: - Management of surface water to ensure contaminated run off from the construction site does not enter the wetland - Erection of fencing around the wetland prior to construction activities to prevent accidental clearing during construction - Provision of signage along the fencing to prevent unauthorised access - Hygiene measures to prevent the spread of any weeds or disease - Dust suppression - Surface water quality and level monitoring - Auditing and reporting The ASSDMP will specify management and monitoring measures required in order to minimise impacts to wetlands and surface water courses. This includes: - Controls to ensure that the lateral extent of groundwater level drawdown achieves levels specified within the ASSDMP. These levels will be developed in consultation with the DER and other relevant regulatory agencies using the results of detailed hydrogeological modelling. - Groundwater level monitoring to ensure that drawdown levels remain within the specified ranges. - Groundwater quality monitoring to ensure that groundwater quality is within expected ranges, and any trends towards deteriorating conditions can be identified and contingency measures implemented in a timely manner.
Management plans	Management measures to minimise potential impacts to wetlands and the surface water courses in the vicinity of the project area during construction activities will be outlined in the CEMP and ASSDMP.

5.4 Vegetation

5.4.1 EPA Environmental Factors and Objectives

The relevant EPA environmental factor is:

- Flora and Vegetation

The EPA's objectives relating to this factor is:

- To maintain representation, diversity, viability and ecological function at the species, population and community level

5.4.2 Project Objectives

The project's environmental management objectives during and post construction activities are to manage and protect ecological values through:

- Minimising and managing impacts on vegetation proposed for retention
- Minimise the area of ground disturbance where possible

5.4.3 Legislation and Guidelines

All vegetation will be managed and protected in accordance with the following legislation:

- *Wildlife Conservation Act 1950*
- *Environmental Protection Act 1986*
- *Environment Protection and Biodiversity Conservation Act 1999*

The following EPA guidance statements provide guidance for managing risk to vegetation that is applicable to construction works on the FAL project:

- EPA Position Statement No. 2: Environmental Protection of Native Vegetation in Western Australia (Environmental Protection Authority, 2000a)
- EPA Position Statement No. 3: Terrestrial Biological Surveys as an element of Biodiversity Protection (Environmental Protection Authority, 2000b)

5.4.4 Potential Impacts

The flora and vegetation surveys as detailed in Section 1.4 identified the following vegetation values along or within the vicinity of the Approval Boundary on State land:

- Approximately 15.5 ha of remnant vegetation in Good or better condition.
- One occurrence of TEC SCP 20a/20b (1.72ha)
- One occurrence of TEC SCP20a (2.96ha)
- Two occurrences of TEC SCP20c:
  - SCP20c Community 1 (0.75ha)
  - SCP20c Community 2 (3.51ha)
- One occurrence of PEC Subtropical and Temperate Coastal Saltmarsh (3.16 ha)

The locations of the TECs and PEC are shown on Figure 10.

5.4.4.1 Potential Impacts to Remnant Vegetation

Vegetation along or adjacent to the FAL alignment is constrained by existing development and infrastructure and is therefore likely to already be impacted by weed invasion, spread of disease, edge effects, rubbish

dumping, illegal clearing and fire. Consequently, further impacts to remnant vegetation along the proposed alignment are considered low. The potential residual impacts are summarised below.

Approximately 200 ha of remnant vegetation was surveyed along the alignment, of this 15.5 ha was assessed as Good or better condition. During the design process, Good quality vegetation was avoided where possible, however 2.47 ha of Good quality or better vegetation is located within the areas of surface disturbance and will require clearing to construct the project. This vegetation is associated with FCTs that are listed as TECs. Potential impacts to TECs are discussed in the following sections.

The remainder of the vegetation located within areas of surface disturbance is Degraded to Completely Degraded and any actions undertaken within this vegetation are not considered significant. No further direct impacts to remnant vegetation along the alignment are considered likely.

It is estimated that construction of the FAL will involve the following potential impacts to the vegetation complexes:

- Clearing 0.44 ha (0.02% of current extent remaining) of Swan Complex.
- Clearing 12.54 ha (0.11% of current extent remaining) of Southern River Complex
- Clearing 0.67 ha (0.003% of current extent remaining) of Bassendean Complex – central and south

Potential indirect impacts to vegetation adjacent to the areas of surface disturbance that is not already degraded (e.g. for example the Poison Gully Creek bushland) are discussed below:

- Potential impacts during construction of stations, emergency egress shafts and cross passages include:
  - accidental clearing
  - unauthorised access and rubbish dumping
  - potential spread of weeds and disease
  - fire

- possible impacts to vegetation surrounding the proposed stations due to the increase in the number of people visiting the area post construction include:
  - increased risk of fire
  - unauthorised access and rubbish dumping
  - potential spread of weeds and disease (only likely if unauthorised access is not managed)

5.4.4.2 Potential Impacts to FCT SCP20c

Potential impacts to SCP20c include:

- Removal of 0.75 ha (Community 1) of the TEC (17% of the SCP20c identified during site surveys). As outlined in Section 5.4.5, redesigning the rail alignment to avoid this portion of vegetation was not considered feasible (Refer Appendix 16).
- Potential indirect impacts to the 3.51 ha of TEC (Community 2) which has been identified for retention during and post construction.

5.4.4.2.1 Direct Impacts

Direct impacts to SCP20c include clearing 0.75 ha (Community 1). An assessment of the significance of this impact is discussed below.

Regional Assessment

A search of DPaW's TEC database identified four occurrences of SCP20c within 10 km of the SCP20c communities identified in the vicinity of the Approval Boundary, totalling an overall area of approximately 123 ha. The potential clearing of 0.75 ha of Community 1 will have an overall impact on the regional occurrences of this community of 0.6%. Regional TEC mapping is provided in Figure 16.

Existing Threats and Impacts

The existing impacts and threats to Community 1 are discussed below:

- The majority of this community is mapped as Very Good condition, but is surrounded by degraded or cleared land and is therefore likely to be susceptible to weed encroachment.
- The required fire regimes are unknown for this community; consequently it is difficult to determine the current or future impacts due to changes to fire regimes. However, grassy weeds present in the understorey are likely to increase fire events.

Based on the existing impacts and threats to Community 1, the significance of clearing 0.75 ha is likely to be less than if the community was under no existing impacts or threats.

Consequently, based on the small percentage of the ecological community being cleared in comparison to that present in the surrounding area and the existing impacts and threats, the significance of clearing 0.75 ha of SCP20c is considered low.

5.4.4.2.2 Indirect Impacts

Potential indirect impacts to Community 2 (3.51 ha) which has been identified for retention are summarised below:

- Potential impacts during construction activities include:
  - Spread of weeds and disease
  - Unauthorised access and rubbish dumping
  - Increased risk of fires
  - Accidental clearing
  - Groundwater drawdown from temporary dewatering activities
  - Potential run off of surface water containing sediments and possible contaminants

- Potential impacts from post construction activities include:
  - Unauthorised access (potentially resulting in vegetation degradation)
  - Potential run off of surface water from the car park
  - Spread of weeds and disease is not considered likely post construction due to the proposed final use as a car park

Indirect Impacts from Dewatering Activities

Preliminary groundwater modelling undertaken by Golder Associates (Golder Associates, 2014a) identified that the cone of depression from dewatering activities may extend to SCP20c Community 2. The results of the preliminary modelling indicate that groundwater drawdown at this TEC during dewatering activities may lower the groundwater level by approximately 0.1 m over an estimated 16 week period. An assessment of the significance of impacts from the predicted change to groundwater levels during dewatering was undertaken and is discussed below.

Possible water sources for terrestrial vegetation are limited to soil water (unsaturated zone) and groundwater (zone of saturation). Vegetation which relies on groundwater to some extent is called Phreatophytic vegetation and is separated into the following categories based on the maximum depth to groundwater (R. Froend, 2005):

- Category 1; 0-3 m to groundwater
- Category 2; 3-6 m to groundwater
- Category 3; 6-10 m to groundwater

Discussions with Ray Froend (2014) confirmed that SCP20c contains some Phreatophytic species, this combined with the fact that it is also a wetland indicates that the TEC may have some groundwater dependence. Froend (2004) identified the magnitude of permissible groundwater change for the Phreatophytic categories listed above, as outlined in Table 16.

Table 16: Risk of impact level and magnitude or rate of permissible change for phreatophytic vegetation (Froend 2004)

Phreatophytic category	Low	Moderate	High
Magnitude of permissible change (m)			
Category 1: 0-3m (wetland)	0-0.25	0.25-0.5	0.5-0.75
Category 1: 0-3m (terrestrial)	0-0.75	0.75-1.25	1.25-1.75
Category 2: 3-6m	0-1.0	1.0-1.5	1.5-2.25
Rate of permissible change (m/year)			
Category 1: 0-3m (wetland)	0-0.1	0.1-0.2	0.2-0.3
Category 1: 0-3m (terrestrial)	0-0.1	0.1-0.25	0.25-0.5
Category 2: 3-6m	0-0.1	0.1-0.25	0.25-0.5

For the purposes of assessing the significance of drawdown impacts to SCP20c, the vegetation has been classified as '0-3 m (wetland)' due to its classification as a wetland under the geomorphic wetlands database. It should be noted however the groundwater level measured by the PTA in borehole BH0-07 which is located approximately 500 m northwest of SCP20c Community 2 indicates that the groundwater table is approximately 4.8 m below ground level. This suggests that the vegetation present within SCP20c Community 2 may not be groundwater dependant.

Based on the assumption that the vegetation is classified within Phreatophytic category '0-3 m (wetland)', the modelled groundwater drawdown of 0.1 m over a 16 week period, the drawdown falls within the low risk of impact as outlined in Table 16.

5.4.4.3 Potential Impacts to SCP20a/SCP20b

Potential impacts to SCP20a/SCP20b through construction of the Forrestfield Structures include clearing 1.72 ha of the TEC. As outlined in Section 5.4.5, redesigning the alignment to avoid this portion of vegetation was not a feasible alternative.

This portion of vegetation has been assessed as Excellent condition by GHD. However, due to the surrounding land uses and vegetation condition it is likely that vegetation condition will reduce over time through processes such as weed encroachment, rubbish dumping and firebreak maintenance.

5.4.4.4 Potential Impacts to SCP20a

Direct impacts to 2.94 ha of SCP20a were avoided through the project design process. However, potential indirect impacts to this community include:

- impacts during construction of the Forrestfield Station precinct include:
  - accidental clearing
  - unauthorised access causing vegetation degradation
  - potential spread of weeds and disease

- possible impacts to vegetation surrounding the Forrestfield Station precinct post construction due to the increase in the number of people visiting the area include:
  - increased risk of fire
  - unauthorised access
  - potential spread of weeds and disease

5.4.4.5 Potential Impacts to PEC Subtropical and Temperate Coastal Saltmarsh

This vegetation community does not occur within areas of surface disturbance and therefore there will be no direct impacts. There is however the potential for dewatering activities at Emergency Egress Shaft 1 to impact the community.

Preliminary groundwater modelling undertaken by Golder Associates identified that the cone of depression from dewatering activities at Emergency Egress Shaft 1 is unlikely to extend to the area of coastal saltmarsh. Using the same assessment undertaken in Section 5.4.4.2.2 and Table 16, it is considered that dewatering activities are unlikely to have a significant impact to the vegetation community.

Due to the distance of Emergency Egress Shaft 1 from the saltmarsh community (over 150m) indirect impacts during general construction activities are considered unlikely.

5.4.5 Mitigation Measures

The Poison Gully Creek bushland was identified for retention during the initial assessment of environmental values as part of the design process due to the presence of wetland values, TECs, rare flora, fauna habitat and Aboriginal heritage significance, allowing for retention and protection of 2.94 ha of SCP20a (Figure 10).

SCP20c (Community 2) was initially located within the area for surface disturbance in Forrestfield for the proposed use as a car park. Once the PTA was made aware of the presence of SCP20c in this area, the car park was redesigned to avoid direct impacts to SCP20c (Community 2). This ensures that 3.51 ha is retained.

SCP20c (Community 1) was also initially located within the area for surface disturbance in Forrestfield. This area however was within the proposed rail corridor. The PTA undertook a design options appraisal to identify alternate design options which could avoid direct impacts to this TEC. The associated report is provided in Appendix 16.

A number of design options were developed and assessed. Due to the constrained area of the Forrestfield Station precinct, with existing rail, roads and services, none of the options considered were able to entirely avoid direct impacts to Community 1. Given the area of vegetation comprising the TEC is already minimal (0.75 ha) and isolated, it is considered that any reduction in area is likely to reduce the future viability of the community. In particular, any clearing will result in a narrower area of vegetation which will be increasingly subject to edge effects such as weed invasion.

The key constraints such as station access, safety and railway design criteria associated with the alternative design options were considered to outweigh the minimal environmental benefits expected from retaining a small isolated pocket of the TEC. Consequently, the alternative design options were not considered viable.

Potential impacts to the PEC Subtropical and Temperate Coastal Saltmarsh have been avoided through the proposed construction methodology (bored tunnels) and placement of area of surface disturbance over 100m from the vegetation community.

To mitigate the residual impacts to vegetation, the PTA will develop and implement an Environmental Offset Strategy.

A summary of the impacts and areas where impacts were avoided are provided in Table 17 and Table 18.

Table 17: Summary of Direct Impacts to Vegetation

Vegetation Value	Area Impacted (ha)	Area Avoided (ha)
SCP20a (TEC)	-	2.96
SCP20a/20b (TEC)	1.72	-
SCP20c (TEC)	0.75	3.51
Subtropical and Temperate Coastal Saltmarsh (PEC)	-	3.16
Other remnant vegetation (in Good or better condition)	2.47	13.03

Table 18: Summary of Indirect Impacts to TECs

Vegetation Value	Vegetation Area (ha)	Indirect Impacts
SCP20a / remnant vegetation	2.96	▪ impacts during construction of the Forrestfield Station precinct include: - accidental clearing - unauthorised access and rubbish dumping - potential spread of weeds and disease ▪ possible impacts to vegetation surrounding the Forrestfield Station precinct post construction due to the increase in the number of people visiting the area include: - increased risk of fire - unauthorised access and rubbish dumping - potential spread of weeds and disease (only likely if unauthorised access is not managed)
SCP20c	3.51	

5.4.6 Proposed Management

Management measures proposed to ensure there are no significant impacts to any vegetation proposed for retention will be outlined in the CEMP which will incorporate:

- During the construction phase, vegetation identified for retention will be protected through:
  - Interface treatments including fencing and set backs
  - Management of access
  - Design of construction sites to ensure no machinery is parked near significant vegetation
  - Significant vegetation will be clearly marked on all construction plans as 'no go zones'
  - Surface water and drainage controls to ensure no contaminated run off (sediment, oil etc.) enters SCP20c Community 2
  - Suitable hygiene measures
  - Groundwater level monitoring to ensure drawdown levels remain within the ranges specified within the ASSDMP.
  - Groundwater quality monitoring to ensure groundwater quality is maintained at concentrations specified within the ASSDMP and within expected ranges.
  - Adopting contingency measures such as supplementary watering to ensure there are no detrimental impacts to the ecological health of the vegetation.

- Post construction, vegetation identified for retention will be protected through:
  - Interface treatments including permanent fencing and set backs
  - Management of access
  - Management of surface water from the car park at Forrestfield Station

5.4.7 Approval Requirements

Approvals that will be required to manage potential impacts to vegetation are summarised below:

- A Clearing Permit under the EP Act from the DER will be required for the direct impacts to wetlands.
- An approved ASSDMP is required prior to any dewatering or excavation activities being undertaken that may expose PASS.
- An approved CEMP is required prior to any construction works commencing.

5.4.8 Vegetation Summary

Impacts to vegetation and proposed mitigation and management measures are summarised in Table 19.

Table 19: Vegetation Management and Mitigation Summary

Issue	Management Action
EPA Objective	- To maintain representation, diversity, viability and ecological function at the species, population and community level

Impact Summary	In accordance with the EPAs Environmental Assessment Guidelines (EAG9), the PTA considers that the impacts to remnant vegetation and TECs have been avoided or reduced where possible and mitigated to a point where residual impacts can be managed in order to successfully meet the EPAs objective.
	- Clearing 0.75 ha of SCP20c
	- Clearing 1.72 ha of SCP20a / SCP20b
	- Clearing 2.5ha of remnant vegetation in Good or better condition
	- Potential indirect impacts to retained vegetation includes
	  - accidental clearing
	  - unauthorised access
	  - increased risk of fire
	  - potential spread of weeds and disease (only likely if unauthorised access is not managed)
	  - groundwater drawdown

Approval Requirements	- An approved ASSDMP - An approved CEMP - A Clearing Permit under the EP Act

Mitigation	- Minimise groundwater drawdown as far as reasonably practicable through methods such as re-injection of abstracted groundwater, use-of diaphragm wall or sheet piling for deeper excavations, use of wet working techniques (as applicable), and with effective groundwater level monitoring via a network of bores to limit impacts to significant vegetation
	- Groundwater dewatering controls will be agreed with the DER and DoW and established within the ASSDMP
	- Avoiding direct impacts to the vegetation below through project design:
	  - 3.51 ha of SCP20c (TEC)
	  - 2.96 ha of SCP20a (TEC)
	  - 3.16 ha of Subtropical and Temperate Coastal Saltmarsh (PEC)
	  - 13.03 ha of remnant vegetation in good or better condition
	To mitigate the residual impacts to vegetation, the PTA will develop and implement an Environmental Offset Strategy.

Management and Monitoring	The CEMP will outline but not be limited to the following management measures during construction activities: - Maintenance of interface treatments including fencing and set backs - Management of access during construction activities through fencing, signage and inclusion of any vegetation identified for protection on all construction plans - Design of construction sites to ensure no machinery is parked near vegetation to reduce fire risk - Surface water and drainage controls to control contaminated run off

	- Suitable hygiene measures to control the spread of weeds - Adopting contingency measures such as supplementary watering to ensure there are no detrimental impacts to the ecological health of the vegetation The CEMP will outline but not be limited to the following management measures post construction activities: - Interface treatments and access management such as fencing - Management of surface water from the car park The ASSDMP will specify management and monitoring measures required in order to minimise impacts to vegetation. This includes: - Controls to ensure that the lateral extent of groundwater level drawdown achieves levels specified within the ASSDMP. These levels will be developed in consultation with the DER and other relevant regulatory agencies using the results of detailed hydrogeological modelling. - Groundwater level monitoring to ensure drawdown levels remain within the ranges specified within the ASSDMP - Groundwater quality monitoring to ensure groundwater quality is maintained at concentrations specified within the ASSDMP and within expected ranges
Management plans	Management measures to protect retained vegetation during and post development will be detailed in a CEMP which is to be endorsed by the DER and other regulatory agencies as required. Groundwater monitoring to ensure no impacts to vegetation surrounding the project during or after construction activities will be outlined in the ASSDMP.

5.5 Significant Flora

5.5.1 EPA Environmental Factors and Objectives

The relevant EPA environmental factor is:

- Flora and Vegetation

The EPA's objectives relating to this factor is:

- To maintain representation, diversity, viability and ecological function at the species, population and community level

5.5.2 Project Objectives

The project's environmental management objectives during and post construction activities are to manage and protect ecological values through:

- Minimising and managing impacts on vegetation proposed for retention
- Minimising the area of ground disturbance where possible

5.5.3 Legislation and Guidelines

All flora will be managed and protected in accordance with the following legislation:

- *Wildlife Conservation Act 1950*
- *Environmental Protection Act 1986*
- *Environment Protection and Biodiversity Conservation Act 1999*

The following EPA guidance Statements provide guidance for managing risk to vegetation from the FAL:

- EPA Position Statement No. 2: Environmental Protection of Native Vegetation in Western Australia (EPA 2000)
- EPA Position Statement No. 3: Terrestrial Biological Surveys as an element of Biodiversity Protection (EPA 2000)

5.5.4 Potential Impacts

Significant flora identified during the site assessments included 37 Conospermum undulatum individuals, of which 25 occur within the proposed areas of surface disturbance (Figure 10). The potential impacts to this species and management or mitigation measures identified are discussed below.

A summary of existing threats to the population of Conospermum undulatum within the project area, especially in regards to the major threats identified in the Recovery Plan (Department of Environment and Conservation, 2009) are summarised below:

- The vegetation unit in which the population occurs is bound directly to the west by existing rail, to the east by existing road and industrial land and to the north and south by a thin strip of degraded land. It is likely that the population is currently impacted by edge effects such as weed encroachment.

- The largest occurrence of *Conospermum undulatum* within the alignment occurs on the edge of a firebreak. Therefore, there is the potential for this population to be impacted by firebreak maintenance activities.

- *Conospermum undulatum* is dependent on fire for reproduction and lack of fires is classified as one of the main threats in the Recovery Plan. The survey undertaken by GHD identified that it had been at least 5 years since a fire had been through the area.

Due to these existing threats and impacts, the long term viability of this population is potentially reduced. Residual impacts to *Conospermum undulatum* are summarised below.

- Clearing 25 *Conospermum undulatum* plants
- Potential impacts to the remaining 12 *Conospermum undulatum* during construction activities is unlikely due to the distance maintained between areas of surface disturbance and the location of the plants

Impacting 25 individuals of *Conospermum undulatum* occurring within highly fragmented areas of remnant vegetation which are already subject to a number of existing threats and impacts is unlikely to be significant. Further, the project has been designed to avoid clearing 12 individuals, which are subject to fewer existing threats and impacts and therefore, likely to have greater long term viability.

Furthermore, an assessment of other populations of *Conospermum undulatum* occurring within the area has been undertaken to determine whether removal of 25 individuals is likely to impact the *Conospermum undulatum* population as a species. This assessment is provided in Table 20 and demonstrates that the proposed impact comprises 1.1% of the existing plants in the conservation estate within a 10 km radius (0.002% of the total number of plants (both in reserves and on private land) within a 10km radius).

Table 20: Regional Vegetation Protected in Reserves and National Parks

	Number of plants	Number of occurrences
Within Conservation Estate	2,258	8
Within Private Tenure	8,439	284
Total	**10,697**	**292**

Calothamnus rupestris and *Eucalyptus caesia* are listed under the *Wildlife Conservation Act 1950* as a Priority 4 species. Both of these species have commonly been planted in landscaping and revegetation works on the Swan Coastal Plain and have become naturalised outside their normal range. Consequently, it is considered likely that the presence of these two species within the areas of surface disturbance is not natural and any impacts will not be significant.

5.5.5 Mitigation Measures

Due to the width and area of land required for construction of the Forrestfield Station Precinct and the location of the existing rail and roads in the Forrestfield area, it was not possible to design the project to avoid all locations of *Conospermum undulatum* (Refer Appendix 16). However, during the initial project design process, PTA identified the importance of retaining the population of *Conospermum undulatum* within the Poison Gully Creek bushland as this population was less constrained by existing impacts as discussed below:

- The population occurs in a larger area (approximately 3 ha) and is therefore less likely to be impacted by edge effects
- The entire area of vegetation within the Poison Gully Creek bushland in which the population occurs has been classified as Excellent condition
- Due to the greater area and better condition of vegetation, the *Conospermum undulatum* within the Poison Gully Creek bushland is likely to have less competition from weed species.

To mitigate the residual impacts to significant flora, the PTA will develop and implement an Environmental Offset Strategy.

5.5.6 Proposed Management

In order to reduce any potential impacts to *Conospermum undulatum* individuals identified for retention, the area of surface disturbance associated with the Forrestfield Station Precinct has been situated over 100 m away from the closest *Conospermum undulatum* plant. The entire vegetation community in which these plants occur has also been retained. It is considered unlikely that the proposal will have any impact on these plants.

To further ensure protection of these plants during construction activities, it is proposed that the management measures provide in Table 21 are implemented.

5.5.7 Approval Requirements

Approvals that will be required to manage potential impacts to vegetation are summarised below:

- A Clearing Permit under the EP Act from the DER will be required for the direct impacts to significant flora.
- A Licence to Take protected flora under the *Wildlife Conservation Act 1950.*
- An approved CEMP is required prior to any construction works commencing.

5.5.8 Flora Summary

A summary of the potential impacts to significant flora due to the FAL project and proposed mitigation and management measures to ensure the EPA's objectives are met are summarised in Table 21 below.

Table 21: Significant Flora Management and Mitigation Summary

Issue	Management Action
EPA Objective	- To maintain representation, diversity, viability and ecological function at the species, population and community level.
Impact summary	- Clearing 25 *Conospermum undulatum* plants
Approval Requirements	- A Clearing Permit under the EP Act - Licence to Take under the *Wildlife Conservation Act 1950* - An approved CEMP
Mitigation	- Avoiding direct impacts to 12 *Conospermum undulatum* plants within bushland that has greater long term viability - To mitigate the residual impacts to significant flora, the PTA will develop and implement an Environmental Offset Strategy
Management and Monitoring	The following management measures during construction activities will be undertaken to ensure no impacts to retained *Conospermum undulatum*: - Maintenance of suitable interface treatments between construction and retained vegetation containing *Conospermum undulatum* - Clearly mark the location of vegetation and *Conospermum undulatum* to be retained through clear construction plans, flagging plants, fencing and signage - Design of construction sites to ensure no machinery is parked near vegetation to reduce fire risk - Construction activities will be undertaken in accordance with the hygiene measures outlined in the CEMP
Management plans	Management measures to protect retained rare flora during and post development will be detailed in a CEMP which is to be endorsed by the DER and other regulatory agencies as required.

5.6 Significant Fauna

5.6.1 EPA Environmental Factors and Objectives

The relevant EPA environmental factor is:

- Terrestrial Fauna

The EPA's objectives relating to this factor is:

- To maintain representation, diversity, viability and ecological function at the species, population and assemblage level

5.6.2 Project Objectives

The project's environmental management objectives during and post construction activities are to manage and protect ecological values through:

- Minimising and managing impacts to significant fauna present within the areas of surface disturbance
- Minimising and managing impacts on significant fauna habitat proposed for retention
- Minimise the disturbance or clearing of significant fauna habitat where possible

5.6.3 Legislation and Guidelines

Fauna and fauna habitat will be managed and protected in accordance with the following legislation:

- *Wildlife Conservation Act 1950*
- *Environmental Protection Act 1986*
- *Environment Protection and Biodiversity Conservation Act 1999*

The following documents provide guidance for managing risk to fauna and fauna habitat:

- EPA Position Statement No. 2: Environmental Protection of Native Vegetation in Western Australia (EPA 2000)
- EPA Position Statement No. 3: Terrestrial Biological Surveys as an element of Biodiversity Protection (EPA 2000)
- EPA Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (Environmental Protection Authority, 2004a)
- Significant Impact Guidelines 1.1 (Department of the Environment, Water, Heritage and the Arts, 2009)
- Referral Guidelines for the three threatened black cockatoo species (Department of Sustainability, Environment, Water, Population and Communities, 2012)

5.6.4 Potential Impacts

During fauna surveys undertaken by GHD (GHD, 2014c) and Bamford Consulting Ecologists (Bamford Consulting Ecologists, 2014), the significant fauna identified to be present within the project area were black cockatoos, Water Rat and Quenda (Figure 12). Impacts to these species and their potential habitat are discussed below.

5.6.4.1 Quenda Impact Summary

Potential impacts to Quenda and potential habitat within or adjacent to the areas of surface disturbance are listed below:

- GHD identified 19.5 ha of potential Quenda habitat during the fauna survey; of this 5.3 ha (27%) is located within areas of surface disturbance.
- Accidental clearing of habitat adjacent to the areas of surface disturbance during construction
- Injury to Quenda potentially located within the areas of surface disturbance

5.6.4.2 Water Rat Impact Summary

During the fauna survey undertaken by Bamford Consulting Ecologists (Bamford Consulting Ecologists, 2014), signs of the Water Rat were identified along the Swan River near the Tonkin Highway crossing. It was estimated that approximately 18.3 ha of habitat was located within the survey area.

During the project design process, alignment options that involved clearing or impacts to vegetation along the Swan River were discounted, resulting in no Water Rat habitat being be impacted by the proposal.

5.6.4.3 Black Cockatoo Impact Summary

During the flora and fauna surveys undertaken by GHD (GHD, 2014c), Brian Morgan (Brian Morgan, 2013) & (Brian Morgan, 2014) and Mike Bamford (Bamford Consulting Ecologists, 2014) to assist the PTA to determine the alignment and construction methodology with the least environmental impacts, the following black cockatoo habitat was identified within the survey area on State land:

- Poison Gully Creek bushland which contains suitable foraging, roosting and breeding habitat (with suitable nesting hollows). During the survey, black cockatoos were also identified foraging in this area.
- 21.27 ha of potential foraging habitat
- 85 potential habitat trees

Where possible, the project was designed to avoid impacts to the habitat listed above. However as summarised below and outlined in Table 22, some impacts to black cockatoo habitat on State land could not be avoided:

- Clearing 3.56 ha of potential foraging habitat (16.4% of habitat identified during surveys)
- Clearing 15 potential habitat trees

Table 22: Potential impacts to black cockatoo habitat identified during site assessments on State land

Black Cockatoo Habitat Type	Habitat area / number of trees and potential impacts		% of habitat identified that will be impacted
	Overall Survey Area	Are of Surface Disturbance	
Potential foraging habitat	21.27 ha	3.56 ha	16.4%
High priority feeding, nesting and roosting trees	46 trees	10 trees	21.7%
Medium priority feeding and roosting trees	21 trees	4 trees	19.0%
Low priority roosting trees	18 trees	1 tree	6.3%

As discussed previously, impacts to black cockatoo habitat on both State and Commonwealth land will be referred to the DoE for assessment.

Indirect Impacts from Dewatering Activities

Preliminary groundwater modelling undertaken by Golder Associates (Golder Associates, 2014a) indicates that eight black cockatoo habitat trees are located within the dewatering cone of depression. The extent of the cone of depression is based on the project's concept design and assumes that the majority of the groundwater abstracted (85%) is re-injected into the aquifer.

The eight trees located within the dewatering cone of depression form part of the fifteen trees which will be directly impacted by clearing. Despite this, an assessment of the groundwater depth tolerances of the potential habitat tree species present has been undertaken and is discussed below.

Based on the groundwater depth tolerances specified within (R. Froend, R. Loomes, 2006) for black cockatoo habitat tree species, phreatophytic vegetation categories (as discussed in Section 5.4.4.2.2 and presented in Table 16) have been assigned to each of the species present within the dewatering cone of depression. Some of the species could fall within all three phreatophytic vegetation categories. Therefore, for the purposes of this assessment a conservative approach has been adopted, with the assumption that the black cockatoo habitat trees fall within the 0-3 m (terrestrial) category. This is summarised below in Table 23.

Table 23: Groundwater depth ranges experienced by black cockatoo (phreatophytic) habitat species (R. Froend, R. Loomes, 2006)

Black Cockatoo Habitat species	Water Depth Tolerance Range (Absolute)		Potential phreatophytic category
	Maximum (m)	Minimum (m)	
Eucalyptus rudis	1.03	-6.44	1 and 2
Eucalyptus marginata	-0.33	-10.3	1, 2 and 3
Corymbia calophylla	-0.45	-8.83	1 and 2

Note '-' indicates depth below ground level

Based on the risk assessment provided in Table 16, a change in groundwater levels for phreatophytic vegetation within the 0-3 m (terrestrial) category of less than 0.75 m is considered to pose a low risk of significant impact to the vegetation. The predicted changes to groundwater levels within the cone of depression at the habitat trees are summarised in Table 24 below including the significance of the modelled changes to groundwater levels.

Table 24: Potential impacts to black cockatoo habitat trees identified during site assessments

Predicted Drawdown Depth (m)	Dewatering Period (weeks)	Habitat Trees	Significance of impact based on magnitude of permissible change
1 m	16	1 tree (*Eucalyptus marginata*)	Moderate (however already within the construction footprint for the Forrestfield Station)
0.5 m	16	5 trees (*Corymbia calophylla, Eucalyptus marginata*)	Low (however already within the construction footprint for the Forrestfield Station)
0.1 m	16	1 tree (*Corymbia calophylla)*	Low (however already within the construction footprint for the Forrestfield Station)
	20	1 tree (*Corymbia calophylla)*	Low (however already within the construction footprint for Emergency Egress Shaft 1)

The assessment indicates that one tree that may have potentially been impacted (moderate impact level) by dewatering activities. As discussed above, this tree is located within an area of surface disturbance and is therefore included in the direct clearing impacts to potential habitat trees.

Regional Impact Assessment

Similar vegetation to that present within the FAL alignment has been mapped within a 10 km radius of the project to estimate the amount of potentially similar black cockatoo habitat present in the region. These areas are summarised in Table 25 and show that at least 112.6 ha of similar potential black cockatoo habitat is protected within 10 km of the project area.

Table 25: Regional Vegetation Protected in Reserves and National Parks within 10km of the project

Reserve	Reserve Area (ha)	Heddle Complex Areas with Reserves (ha)		
		Guildford	Southern River	Bassendean – Central and South
Nature Reserve	164.3	58.2	23.65	-
Conservation Park	75.6	0.1	5.37	-
Other Reserve	73.0	-	13.34	12.01
Total	**313.0**	**58.3**	**42.3**	**12.01**

A further assessment of regional black cockatoo habitat was undertaken based on sites identified as important to the Carnaby's black cockatoo on the Swan Coastal Plain (R. E. Johnstone, Undated). There were a number of sites present within 10 km of the proposal, including those detailed below:

- Greenmount National Park
- Remnant Banksia woodland, Hartfield Park, Forrestfield
- Vegetation in Kewdale

The proposed FAL alignment will not impact any of these sites.

Consequently, considering the large areas of habitat available to black cockatoos within the area, it is considered unlikely that clearing impacts to 15 potential habitat trees and 3.56 ha of potential foraging habitat is regionally significant. The potential impacts are also unlikely to be significant on a local scale due to the amount of habitat that was avoided during the design process as reflected in percentages provided in Table 26 and Table 27.

Significant Impact Assessment

The criteria used to assess significant impacts to vulnerable (Baudin's Black Cockatoo and the Forest red tailed Black Cockatoo) and endangered (Carnaby's Black Cockatoo) species are listed in the Significant impact guidelines 1.1 (Department of the Environment, Water, Heritage and the Arts, 2009). An assessment of the FAL against these criteria is detailed in Table 26.

Table 26: Significant Impact Criteria for Significant Species (Department of the Environment, Water, Heritage and the Arts, 2009)

Significant Impact Criterion	Discussion – Black Cockatoo Species	Meets Criterion
Lead to a long-term decrease in the size of an important population of a species	Potential foraging and breeding habitat will be impacted over four small locations on State land and will comprise: - 15 potential habitat trees (only 17.7% of those identified during site surveys) - 3.56 ha of potential foraging habitat (only 16.4% of that identified during site surveys) The impacts discussed above only comprise 3.16% of potentially similar habitat protected in reserves within 10 km of the project area. Due to the large areas of similar habitat protected within reserves in the region, clearing both potential breeding and foraging habitat is not considered a significant impact.	No

Reduce the area of occupancy of an important population	**The proposed action will involve clearing 3.56 ha over 4 small locations along a linear alignment. Considering the amount of similar habitat available to the black cockatoos within the area (including that avoided by the proposal and that contained in reserves), this is not considered likely to reduce the area of occupancy of this species especially considering their high mobility through the landscape.**	**No**
Fragment an existing important population into two or more populations	The proposed action involves clearing small patches of vegetation along a linear alignment. Consequently, no significant areas of habitat will be fragmented, and due to the mobility of this species, the proposed action will not fragment or limit the movements of any population.	No
Adversely affect habitat critical to the survival of a species	3.56 ha of the 21.7 ha identified during site surveys and 15 potential habitat trees out of the 85 identified during site surveys are proposed to be cleared. This comprises 16.4% of the habitat and 17.7% of the trees identified along the alignment. Furthermore, there are 112.6 ha of potentially similar habitat existing in reserves within 10km of the proposed action. It is not considered likely that removing 3.56 ha of foraging habitat and 15 potential habitat trees from the area will involve such a habitat decrease as to cause the species to decline. Therefore, due to the potential habitat remaining in the area, the impacts discussed above are not significant.	No
Disrupt the breeding cycle of an important population	No confirmed breeding trees will be cleared as part of the proposed action and the project is unlikely to disrupt the breeding cycle of black cockatoos.	No
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	3.56 ha of the 21.7 ha identified during site surveys and 15 potential habitat trees out of the 85 identified during site surveys are proposed to be cleared. This comprises 16.4% of the habitat and 17.7% of the trees identified along the alignment. Although the proposed action involves clearing potential feeding, roosting and breeding habitat for the black cockatoo, due to the large areas of similar habitat in the area, these impacts are not considered significant.	No
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	The proposed action is for the construction of a rail line and associated infrastructure and facilities and will not involve any activities that will result in the introduction of invasive species.	No
Introduce disease that may cause species decline	Dieback assessments have been undertaken. These assessments identified that the site is mainly uninterpretable. Hygiene measures will be in place and specified in the CEMP to ensure there is no spread of disease or weeds to retained vegetation. Therefore, the action is unlikely to cause the spread of disease	No
Interfere substantially with the recovery of the species	The proposed alignment will not impact on the recovery of this species as the habitat proposed to be impacted is not significant in comparison to that available in the area.	No

The criteria in these guidelines refer to “populations” and “important populations”. These terms have not been defined for black cockatoos due to their mobile and widely-distributed nature, and the variation in flock compositions (for example, between breeding and non-breeding seasons). The DoE released referral guidelines for the three threatened black cockatoo species (Department of Sustainability, Environment, Water, Population and Communities, 2012) which provides guidance for when one or more “habitat impacts” may trigger the need to refer an “action”. An assessment of the project clearing impact against the 2012 criteria is included in Table 27.

Table 27: Assessment of black cockatoo habitat impacts against DSEWPC Criteria (Department of Sustainability, Environment, Water, Population and Communities, 2012)

Risk Type	Referral Trigger
High Risk of Significant Impacts: Referral to DoE Recommended	
Clearing of Any Known Nesting Tree	Referral is not triggered. No breeding trees were identified within the survey area. Four trees with hollows potentially suitable for black cockatoos were identified on State land during the surveys. However none of these trees are located within the areas of surface disturbance and will not be impacted.
Clearing or Degradation of Any Part of a Vegetation Community Known to Contain Breeding Habitat	Referral may be triggered No known breeding habitat was identified within the survey area. However the proposal involves clearing 15 potential habitat trees on State land. None of these trees have hollows considered suitable for black cockatoos. During the design process, the proposal was redesigned to avoid 82.3% of the trees originally identified on State land during site surveys. Consequently, impacts to potential habitat were reduced as much as was possible. Considering 68 trees were avoided (2 of which have suitable hollows), this impact is not considered likely to have a significant impact on the species.
Clearing of More Than One Ha of Quality Foraging Habitat	Referral is triggered The project was designed to avoid the only area identified as significant habitat (Poison Gully Creek Bushland). However, the proposal will still involve clearing 3.56 ha of potential foraging habitat on State land. This comprises 16.4% of the potential habitat identified within the survey area. This foraging habitat comprises four small isolated sections along the proposed alignment. As the foraging habitat along the alignment is not one contiguous stand of vegetation in good condition, the significance of the impacts to this vegetation are considered less. A desktop assessment of similar habitat in the region identified 112.6 ha protected within reserves within 10 km of the proposed action. Consequently, clearing 3.56 ha of foraging habitat will only comprise 3.16% of that available in the region.
Clearing or Degradation (Including Pruning the Top Canopy) of a Known Night Roosting Site	Referral is not triggered No known roosting sites will be impacted.
Creating a Gap of Greater than 4 km Between Patches of Black Cockatoo Habitat (Breeding, Foraging or Roosting)	Referral is not triggered Potential foraging habitat and breeding trees are scattered along the alignment and do not comprise a contiguous stand of vegetation. The areas proposed to be cleared along the alignment are not more than 4km apart and will not cause a gap greater than this between potential habitats.

Actions That Have an Uncertain Risk of Significant Impacts	
Degradation (Such as Through Altered Hydrology or Fire Regimes) of More than 1 Ha of Foraging Habitat. Significance will Depend on the Level and Extent of Degradation and the Quality of the Habitat	Referral is not triggered Preliminary modelling has indicated that it is possible to reduce dewatering impacts at sites with significant environmental value. Therefore, there are unlikely to be any significant impacts to potential foraging habitat due to dewatering activities.
Clearing or Disturbance in Areas Surrounding Black Cockatoo Habitat that has the Potential to Degrade Habitat through Introduction of Invasive Species, Edge Effects, Hydrological Changes, Increased Human Visitation or Fire	Referral is not triggered No invasive species will be introduced to the area as part of the proposal. The alignment traverses mostly cleared areas comprising infrastructure, industrial and residential land. The proposed action will not increase the human visitation or fire regimes to the habitat proposed for retention as these areas are likely to already be subject to these existing threats and impacts. Edge effects already exist along the alignment due to the large amount of existing residential land and infrastructure, therefore the proposal is not likely to increase the edge effects on remnant vegetation. Significant impacts due to dewatering activities are unlikely.
Actions that Do Not Directly Affect the Listed Species but that have the Potential for Indirect Impacts such as Increasing Competitors for Nest Hollows	Referral is not triggered Significant impacts due to dewatering activities are unlikely. No other indirect impacts are considered likely from the proposal.
Actions with the Potential to Introduce Known Plant Diseases such as Phytophthora Spp. to an Area where the Pathogen was Not Previously Known	Referral is not triggered Dieback assessments have been undertaken. These assessments identified that the site is mainly uninterpretable. Hygiene measures will be in place and specified in the CEMP to ensure there is no spread of disease or weeds to retained vegetation. Therefore, the action is unlikely to cause the spread of disease.
Actions that have a Low Risk of Significant Impacts	
Actions that Do Not Affect Black Cockatoo Habitat or Individuals	NA
Actions Whose Impacts Occur Outside the Modelled Distribution of the Three Black Cockatoos	NA

Based on the above assessment, clearing a total of 3.56 ha of potential foraging habitat (over 4 small locations) and 15 potential habitat trees on State land is not considered likely to have a significant impact on the species.

5.6.5 Mitigation Measures

During the project design process, the following potential Quenda habitat was identified for protection, which included the Poison Gully Creek bushland and one of the TEC areas (SCP20c Community 2):

- 2.96 ha of remnant *Eucalyptus marginata, Eucalyptus rudis* and *Corymbia calophylla* Woodland over a mid-storey and understorey of mixed native species
- 2.13 ha of *Corymbia calophylla* open woodland over *Hypocalymma angustifolium, Verticordia densiflora* var. *densiflora* low open shrubland to low open heath over *Caustis dioica* open sedgeland / herbland
- 1.11 ha of *Corymbia calophylla* open woodland over *Verticordia densiflora* var. *densiflora* low open heath over *Castis dioica, Hypolaena exsulca* very open sedgeland / herbland

During the initial design process, avoidance of impacts to all habitat suitable for the Water Rat was avoided.

As outlined in Table 26 and Table 27, the following potential black cockatoo habitat identified during surveys was avoided during the project design process:

- 17.7 ha (83.2% of that originally identified during surveys) of potential breeding habitat
- 70 potential habitat trees (82.3% of that originally identified during surveys)
- Preliminary modelling has demonstrated that reduction of dewatering impacts to potential habitat is possible through re-injection of groundwater and design of the D-walls.

5.6.6 Proposed Management

Potential habitat for the Quenda has been retained through the avoidance of construction impacts to the Poison Gully Creek bushland and an area of TEC. Further measures to ensure minimal impacts to this species include:

- Trapping and relocating any Quenda from areas of surface disturbance
- Fencing and flagging the Poison Gully Creek bushland and the retained TEC SCP20c (Community 2) to prevent access to these areas during construction activities
- Undertaking all actions in accordance with the CEMP to ensure potential habitat is retained and protected through management of the spread of weeds or disease and clearing activities
- Clearing works will be undertaken in the manner specified in the CEMP to maximise the survival of fauna individuals on the site
- Inductions for construction personnel will include environmental awareness
- Presence of a qualified fauna handler on site during vegetation clearing activities

No management measures are necessary for the protection of the Water Rat as all impacts to potential habitat for this species have been avoided.

Management measures proposed to protect black cockatoo habitat retained along the alignment are discussed below:

- Flag habitat trees that have been identified for retention which are located near areas of surface disturbance to prevent damage or clearing during construction
- Fence any significant areas of black cockatoo habitat such as the Poison Gully Creek bushland to prevent accidental clearing during construction activities
- Groundwater level monitoring to ensure drawdown levels remain within the ranges specified within the ASSDMP.

- Groundwater quality monitoring to ensure groundwater quality is maintained at concentrations specified within the ASSDMP and within expected ranges
- Adopting contingency measures such as watering to ensure there are no detrimental impacts to the ecological health of the vegetation

5.6.7 Approval Requirements

Approvals that will be required to manage potential impacts to significant fauna and fauna habitat are summarised below:

- A Clearing Permit under the EP Act from the DER will be required for the direct impacts vegetation that forms black cockatoo habitat.
- An approved ASSDMP is required prior to any dewatering or excavation activities being undertaken that may expose PASS.
- An approved CEMP is required prior to any construction works commencing.
- A fauna relocation permit under the *Wildlife Conservation Act 1950* to relocate Quenda from the Project area

5.6.8 Fauna Summary

The potential impacts to significant fauna or fauna habitat due to the FAL project and proposed mitigation and management measures to reduce these impacts is summarised in Table 28 below.

Table 28: Significant Fauna Management and Mitigation Summary

Issue	Management Action
EPA Objective	- To maintain representation, diversity, viability and ecological function at the species, population and assemblage level.
Impact Summary	- Clearing 15 potential black cockatoo habitat trees - Clearing 3.56 ha of potential black cockatoo foraging habitat - Clearing 5.3 ha of potential Quenda habitat
Approval Requirements	- A Clearing Permit under the EP Act - An approved ASSDMP - An approved CEMP - A fauna relocation permit under the *Wildlife Conservation Act 1950*
Mitigation	- Avoidance of 70 potential habitat trees and 17.7 ha of potential black cockatoo foraging habitat on State land - Minimise groundwater drawdown as far as reasonably practicable through methods such as re-injection of abstracted groundwater, use-of diaphragm wall or sheet piling for deeper excavations, use of wet working techniques (as applicable), and with effective groundwater level monitoring via a network of bores to limit impacts to significant fauna habitat - Groundwater dewatering controls will be agreed with the DER and DoW and established within the ASSDMP - Avoiding impacts to Water Rat habitat - Retention of 6.2ha of potential Quenda habitat
Management and Monitoring	Management measures to protect fauna and fauna habitat during construction works will be outlined in the CEMP and will include: - Site inductions will include management of native fauna

	- A qualified wildlife handler will be on site during clearing of vegetation in the Forrestfield area - Flagging potential habitat trees identified for retention - Fencing any significant habitat adjacent to construction areas to ensure no accidental clearing - Groundwater level monitoring to ensure drawdown levels remain within the ranges specified within the ASSDMP. - Groundwater quality monitoring to ensure groundwater quality is maintained at concentrations specified within the ASSDMP. - Adopting contingency measures such as watering to ensure there are no detrimental impacts to the ecological health of the vegetation - Details on clearing methods to reduce fauna injury and mortality - Undertake a trapping programme to relocate Quenda to suitable habitat
Management plans	Management measures to protect significant fauna and fauna habitat during and post development will be detailed in a CEMP which is to be endorsed by the DER and other regulatory agencies as required.

5.7 Aboriginal Heritage

5.7.1 EPA Environmental Factors and Objectives

The relevant EPA environmental factor is:

- Heritage

The EPA's objectives relating to this factor is:

- To ensure that historical and cultural associations are not adversely affected

5.7.2 Project Objective

The project's Aboriginal heritage management objectives during and post construction activities are to:

- Protect identified Aboriginal heritage sites
- Protect previously unidentified Aboriginal heritage sites

5.7.3 Legislation and Guidelines

All Aboriginal heritage will be managed and protected in accordance with the following legislation:

- *Aboriginal Heritage Act 1972*
- *Environmental Protection Act 1986*

The following documents provide guidance for managing risk to Aboriginal heritage:

- Aboriginal Heritage Due Diligence Guidelines (Department of Aboriginal Affairs, 2013)

5.7.4 Potential Impacts

Aboriginal heritage desktop and site investigations identified nine potential Aboriginal heritage sites within the Approval Boundary that may be impacted by the project; eight of which occur on State land. Three of the eight sites are registered Aboriginal heritage sites as it has been deemed that they meet the definition of a site as per Section 5 or Section 39 of the *Aboriginal Heritage Act 1972*. The other five sites are Heritage Places which have been assessed as not meeting the criteria of a site. The locations of these sites are shown on Figure 13.

Potential impacts to these sites based on the results of the desktop and site investigations and consultation with the DAA and Aboriginal spokespersons are presented in Table 29 below.

Table 29: Potential Impacts to Aboriginal Heritage Sites

Site ID	Site Name	Site Type	Potential Impacts
Registered Sites			
3719	Munday Swamp	Ceremonial, Mythological, Artefact / scatter	The published extent of this site occurs over both Commonwealth and State land. The PTA has confirmed in consultation with the DAA that the actual heritage site only occurs on Commonwealth land. Advice from the DAA has also confirmed that the Approval Boundary does not intersect the boundary of the registered heritage site. Heritage impacts to the site are therefore considered unlikely.
25023	Poison Gully Creek	Ethnographic Site	The published extent of this site occurs over both Commonwealth and State land. The PTA commissioned R. and E. O'Connor Pty Ltd to undertake an Aboriginal heritage assessment to establish the actual extent of the site. It was considered that the heritage values for this site extend 50 m from either bank of Poison Gully Creek. The project was designed to minimise impacts to the Poison Gully Creek bushland which was thought to be the location of the Aboriginal heritage site. However, consultation with Aboriginal spokespersons that have cultural heritage knowledge of the site in 2014 indicates that the heritage values of the site may be impacted by the project due to its spiritual and mythological significance.
3536	Swan River	Mythological	The project was designed to minimise physical impacts to the bed, banks and surface water flows within the Swan River. However, consultation with Aboriginal spokespersons that have cultural heritage knowledge of the site in 2014 indicates that the heritage values of the site may be impacted by the project due to its spiritual and mythological significance.
Heritage Places (Stored Data)			
3616	Kenmure Ave, Bayswater	Camp	Site verification has confirmed that this site no longer exists and will therefore not be impacted by the FAL.
3667	Crumpet Creek, Forrestfield	Artefact / scatter	Site verification identified that the mapping of this site is incorrect and the site actually occurs 2km to the south of the mapped location. Therefore, this site will not be impacted by the FAL.
3866	Brearley Ave	Artefact / scatter	Archeological verification work was undertaken for this site in 2007. No artefacts were found during the site search and it was concluded that this site no longer exists. Therefore, this site will not be impacted by the FAL.
4090	Wyatt Rd, Bayswater	Artefact / scatter	Site verification could not locate this site. The mapped location is also not within an area of surface disturbance and therefore it is not considered that this site will be impacted by the FAL.
4043	Mathieson Rd, Redcliffe	Artefact / scatter	The mapped location of this site is not within an area of surface disturbance and therefore it is not considered that this site will be impacted by the FAL.

Potential impacts to Aboriginal heritage also includes disturbance to previously unidentified sites. The PTA also commissioned Waru to undertake an archaeological inspection and site verification survey of five portions of land within the project area which had not previously been cleared or developed (Waru Consulting, 2013d). The purpose was to establish if any previously unrecorded Aboriginal heritage sites were likely to exist within the Approval Boundary. No previously unrecorded Aboriginal heritage sites or archaeological material were identified.

Whilst physical disturbance to the bed and banks of the Swan River and Poison Gully Creek where it flows in it natural form have been avoided, consultation with Aboriginal spokespersons indicate that these sites may be impacted by the project due to their spiritual and mythological significance.

Management and mitigation measures proposed to avoid or reduce impacts to Aboriginal heritage are discussed below.

5.7.5 Mitigation Measures

Avoidance of impacts to registered Aboriginal sites was attempted through project design as discussed below:

- The bored tunnel construction methodology avoids physical impacts to the Swan River (Site ID 3536). Consultation with stakeholders is ongoing regarding potential impacts to this site.
- The significance of Poison Gully Creek (Site ID 25023) has been recognised and any construction impacts to the bushland associated with the creek have been avoided. Consultation with stakeholders is ongoing regarding potential impacts to this site.

5.7.6 Proposed Management

Consultation with the DAA and Aboriginal spokespersons regarding impacts to the Swan River and Poison Gully Creek heritage sites is ongoing. If impacts to the heritage values of these sites are likely, a Section 18 notice seeking consent to use the land containing registered Aboriginal heritage sites under the *Aboriginal Heritage Act 1972* will be sought.

Ongoing consultation with key stakeholders will be undertaken during the remaining planning phase of the project and during its delivery. Construction heritage management measures including procedures should Aboriginal artefacts are encountered will be specified in the project's CEMP.

5.7.7 Approval Requirements

Approvals that will be required to manage potential impacts to Aboriginal heritage are summarised below:

- A Section 18 notice under the *Aboriginal Heritage Act 1972*
- An approved CEMP is required prior to any construction works commencing

5.7.8 Aboriginal Heritage Summary

Potential impacts to Aboriginal heritage and mitigation and management measures proposed are summarised in Table 30 below.

Table 30: Aboriginal Heritage Management and Mitigation Summary

Issue	Management Action
EPA Objective	- To ensure that historical and cultural associations are not adversely affected.
Impact Summary	- Potential impacts to the heritage values of the Swan River and Poison Gully Creek sites - There is the potential to disturb unknown Aboriginal heritage sites or skeletal remains during construction activities.
Approval Requirements	- A Section 18 notice under the *Aboriginal Heritage Act 1972* - An approved CEMP
Mitigation	- The bored tunnel construction methodology avoids physical impacts to the Swan River - Impacts to the bushland associated with Poison Gully Creek have been avoided.
Management and Monitoring	- Section 18 application prior to any disturbance of a Registered Aboriginal Site - Ongoing consultation with relevant stakeholders - Cease construction works should any skeletal material or Aboriginal artefacts are encountered. - If Aboriginal artefacts are uncovered, the DAA and relevant stakeholders will be contacted and all construction works will cease until an archaeologist has examined the material. - If skeletal material is uncovered, the police and DAA will be contacted and all works ceased until clearance is given. If the remains are determined to be of Aboriginal origin, the DAA and relevant stakeholders will be consulted on management of the remains. - Monitors will be engaged to monitor excavations for the presence of cultural heritage material as required
Management plans	Management measures to protect Aboriginal heritage during construction will be detailed in a CEMP which is to be endorsed by the DER and other regulatory agencies as required, in this case the DAA

5.8 Contamination

5.8.1 EPA Environmental Factors and Objectives

The relevant EPA environmental factors are:

- Terrestrial Environmental Quality
- Inland Waters Environmental Quality
- Human Health

The EPA's objectives relating to this factor is:

- To maintain the quality of land and soils so that the environmental values, both ecological and social, are protected
- To maintain the quality of groundwater and surface water, sediment and biota so that the environmental values, both ecological and social, are protected
- To ensure that human health is not adversely affected

5.8.2 Project Objective

The project's environmental management objective relating to contaminated sites during and post construction activities is to maintain and protect the quality of water and soils and the health of construction workers and operational staff and passengers.

5.8.3 Legislation and Guidelines

All contaminated sites will be managed in accordance with the following legislation:

- *Contaminated Sites Act 2003*
- *Environmental Protection Act 1986*

The following documents provide guidance for managing risks associated with land contamination:

- DER Contaminated Sites Management Series
- National Environment Protection Measure 1999, Assessment of Site Contamination (as amended 2013) (ASC NEPM, 2013)
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment and Conservation Council, 2000)
- Australian Standard AS 4482 – 2005 Guide to the Sampling and Investigation of Potentially Contaminated Soil (Standards Australia, 2005)

5.8.4 Potential Impacts

5.8.4.1 Investigation Overview

The contaminated sites investigations performed to date are preliminary only, and based on desktop assessments and this report only discusses generalised risks/impacts from contaminant sources. A comprehensive series of contamination investigations, reports and management plans will be developed over the period 2014-2015 in accordance with the DER Contaminated Sites Management Series and NEPM (ASC NEPM, 2013).

The investigations undertaken to date have identified potential areas of soil and groundwater contamination within or adjacent to the Approval Boundary. The presence of contaminated soil in the areas of surface disturbance has the potential to affect the health of construction workers and the community during excavation and other ground disturbance activities. For pollutant sources outside of the footprint alignment, the main contaminant risk is in mobilising contaminated groundwater generally via dewatering and pulling groundwater into the area of construction activities.

No known contaminated sites were identified within the Approval Boundary. Potential sources of contamination within areas of surface disturbance are associated with stockpiles of soil from unknown origins, referred to as fly-tipping. In some areas, potential Asbestos Containing Materials were observed in these stockpiles. This type of potential contamination is not uncommon in an urbanised environment and is unlikely to result in groundwater contamination.

Contaminated groundwater within or surrounding the project area may be mobilised during dewatering activities which could have a detrimental impact on the environment. Two known contaminated sites and areas which contain potentially contaminative land uses were identified adjacent to areas of surface disturbance. These were generally associated with current or former commercial or industrial land uses.

The areas of potential soil contamination within the Approval Boundary and areas of potential groundwater contamination adjacent to the Approval Boundary are presented on Figure 15 and are discussed in further detail below.

Poor site management practises during construction may also result in soil and groundwater contamination.

5.8.4.2 Fly Tipping and Stockpiles

Fly tipping and stockpiles of soil from unknown origins are located within the area of surface disturbance in Bayswater where the FAL connects to the existing rail line, in the Forrestfield Station Precinct and in the location where Cross Passage 1 will be constructed. These are depicted as Potential Areas of Environmental Concern 10, 11 and 15 on Figure 15.

The presence of contaminated soil in these areas has the potential to affect the health of construction workers and the community during excavation and other ground disturbance activities. In order to minimise potential impacts these areas will be investigated to assess the levels and extent of contamination. The stockpiles and fly-tipped material will then be removed prior to construction activities commencing and disposed of at an appropriately licenced facility. Following remediation of these areas, the residual risk to human health is considered to be minimal.

5.8.4.3 Bayswater Industrial Area

The Bayswater Industrial Area is located hydraulically up gradient of the area of surface disturbance in Bayswater and within the drawdown capture zone identified by Golder Associates in the Preliminary Dewatering Assessment (Golder Associates, 2014a). Therefore, if contaminated groundwater is present there is the potential for dewatering activities to mobilise it towards the dewatering activities which could result in impacts to groundwater quality.

A Detailed Site investigation is currently being undertaken to confirm the presence or absence of groundwater contamination in this area. If required, mitigation and management measures will be developed to reduce the mobilisation of contaminated groundwater during construction. These are outlined in Sections 5.8.5 and 5.8.6.

5.8.4.4 Former CSBP Fertiliser Manufacturing Plant

The Former CSBP Fertiliser Manufacturing Plant is located hydraulically up gradient of the area of surface disturbance in Bayswater and within the drawdown capture zone identified by Golder Associates in the Preliminary Dewatering Assessment (Golder Associates, 2014a). Therefore, there is the potential for dewatering activities to cause contaminated groundwater to be mobilised in a southerly direction towards the dewatering activities which could result in impacts to groundwater quality.

A Detailed Site investigation is currently being undertaken to confirm the presence or absence of groundwater contamination in this area. If required, mitigation and management measures will be developed to reduce the mobilisation of contaminated groundwater during construction. These are outlined in Sections 5.8.5 and 5.8.6.

5.8.4.5 Workshops

As with any commercial or industrial land use there is the potential soil and/or groundwater contamination to occur. Based on this, the workshops located hydraulically down gradient of the area of surface disturbance associated with Emergency Egress Shaft 4 have been identified as an area which warrants further investigation.

A review of historical aerial photographs indicates that these workshops were constructed in the last 10 years and therefore it is considered unlikely that soil or groundwater contamination is present. In addition, the Preliminary Dewatering Assessment undertaken by Golder Associates (Golder Associates, 2014a) indicates that the likely extent of groundwater level change in this area from the construction of Emergency Egress Shaft 4 is in the order of 0.1 m. Therefore, the potential to mobilise existing contamination (if present) is considered low.

A Detailed Site investigation is currently being undertaken to confirm the presence or absence of groundwater contamination in this area. If required, mitigation and management measures will be developed to reduce the mobilisation of contaminated groundwater during construction. These are outlined in Sections 5.8.5 and 5.8.6.

5.8.4.6 Access Park

Similarly to the workshops discussed above in Section 5.8.4.5, Access Park in Forrestfield also has the potential for soil and/or groundwater contamination to be present. The Preliminary Dewatering Assessment undertaken by Golder Associates (Golder Associates, 2014a) indicates that the likely extent of groundwater level change in this area from construction activities in the Forrestfield Station Precinct is in the order of 0.1 m. Therefore, the potential to mobilise existing contamination (if present) is considered low.

A Detailed Site Investigation is currently being undertaken to confirm the presence or absence of groundwater contamination in this area. If required, mitigation and management measures will be developed to reduce the mobilisation of contaminated groundwater during construction. These are outlined in Sections 5.8.5 and 5.8.6.

5.8.5 Mitigation Measures

A method that can be employed to mitigate the potential mobilisation of existing groundwater contamination from dewatering activities is the strategic placement of re-injection bores between a contaminant source and the point of dewatering extraction.

5.8.6 Proposed Management

A Detailed Site investigation is currently being undertaken to confirm the presence or absence of soil and groundwater contamination within and adjacent to the Approval Boundary. The investigation will be undertaken in accordance with the approved Sampling and Analysis Plan (GHD, 2014b) (Appendix 17) and the DER guidelines. The investigation will also be subject to endorsement by an approved auditor under the *Contaminated Sites Act 2003* as agreed with the DER.

The investigation will delineate the extent of contamination at the potential areas of soil and groundwater contamination to allow for an assessment of the risk posed to the environment and human health during construction and operation of the FAL. The investigation will also assist with waste classification of the excavated material and establish baseline soil and groundwater condition prior to the commencement of construction.

If the site investigation identifies contamination requiring remediation or management during construction, a Site Management Plan (SMP) will be prepared to the satisfaction of the DER, Department of Health or an approved auditor acting on behalf of the DER and DoH. The SMP will detail but not be limited to:

- Findings of DSI investigations, including detailing the Conceptual Site Model
- Identification of potential exposure pathways and sensitive receptors
- Risk Assessments (environmental / human health, as required)
- Site Management & Remediation criteria and details, including:
  - Site inductions (e.g. access and personal protective equipment)

- Groundwater monitoring during dewatering activities to identify any potential contaminated groundwater mobilisation
- Stormwater and groundwater control (if required)
- Dust control and air monitoring (if required)
- Appropriate disposal of contaminated materials (e.g. removal of stockpiles potentially containing contaminants which are located within proposed construction areas)
- Emergency and incident response
- Contingency plans

It can be expected that within the SMP the following approaches will be advocated:

- Undertake a Forward Works program to remove surficial contamination within the area of the alignment footprint where disturbance will occur, ahead of the main works program
- Excavated soil or spoil from areas known or suspected to contain contamination during construction works will be subject to further testing, treatment and disposal in accordance with the SMP
- Scope the dewatering works program and construction operations to reduce the potential for contaminants in groundwater to be mobilised (i.e. further dispersed)
- Any groundwater contamination drawn into the working areas via dewatering operations will be subject to ongoing monitoring of water quality, and with treatment undertaken as specified within the SMP.

Groundwater and the potential for mobilisation of existing groundwater contamination will be managed in accordance with an ASSDMP developed for the project. The ASSDMP will be prepared to ensure dewatering activities do not have a detrimental impact on groundwater quality, the groundwater flow regime and other areas of environmental value. The ASSDMP will be prepared to the satisfaction of DER prior to any dewatering or excavation activities being undertaken.

A CEMP will be prepared prior to the commencement of construction to specify the management measures required to ensure the project area is not contaminated throughout the construction phase due to poor site management practices. The CEMP will also outline procedures should unexpected contamination be encountered during construction. The CEMP will be endorsed by the DER and other relevant regulatory agencies as required.

5.8.7 Approval Requirements

All contamination reporting will be required to be endorsed by the DER and other relevant regulatory agencies as required or an approved auditor acting on their behalf. In instances where asbestos material is present, contamination reporting must be prepared to the satisfaction of the Department of Health.

Approvals that will be required to manage potential impacts related to land contamination are summarised below:

- A SMP will be prepared(if required) to manage or remediate existing contamination
- An approved ASSDMP is required prior to any dewatering or excavation activities being undertaken that may mobilise existing groundwater contamination.
- An approved CEMP is required prior to any construction works commencing.
- Dewatering licenses will be required from the Department of Water (DoW).

5.8.8 Contaminated Sites Summary

Potential impacts regarding land contamination and proposed management and mitigation measures are summarised in Table 31.

Table 31: Contaminated Sites Management and Mitigation Summary

Issue	Management Action
EPA Objectives	- To maintain the quality of land and soils so that the environmental values, both ecological and social, are protected - To maintain the quality of groundwater and surface water, sediment and biota so that the environmental values, both ecological and social, are protected - To ensure that human health is not adversely affected
Impact Summary	- Potential mobilisation of existing groundwater contamination - Potential disturbance of existing soil contamination - Poor site management practises during construction may result in soil and groundwater contamination.
Approval Requirements	- An approved ASSDMP - An approved CEMP - An approved SMP - Dewatering licenses
Mitigation	Mitigation measures will be detailed in a Site Management Plan (or plans), following further intrusive investigations. Strategies developed in the SMP will then inform the CEMP and lead contractor's working methods. Mitigation measures proposed to reduce impacts the potential for mobilisation of existing groundwater contamination include: - Minimise groundwater drawdown as far as reasonably practicable through methods such as re-injection of abstracted groundwater, use-of diaphragm wall or sheet piling for deeper excavations, use of wet working techniques (as applicable), and with effective groundwater level monitoring via a network of bores - Groundwater dewatering controls will be agreed with the DER and DoW and established within the ASSDMP
Management and Monitoring	A Detailed Site Investigation will be undertaken to confirm the presence or absence of soil and groundwater contamination within and adjacent to the Approval Boundary. Management and remediation of contaminated sites will be outlined in SMPs (as required) which will include but not be limited to: - Details on remediation (if required) - Groundwater monitoring requirements - Disposal of any contaminated materials Management of dewatering activities will include but not be limited to: - Monitoring water quality of dewatering discharge - Monitoring rate of dewatering discharge - Groundwater quality and level monitoring (pre, during and post activities)

	Site management activities will include but not be limited to: - Development and implementation of spill response procedures - Bunding for hazardous chemicals
Management plans	- SMP (if required) - ASSDMP - CEMP These plans will be prepared to the satisfaction of DER and other relevant regulatory agencies as required or an approved auditor acting on their behalf

5.9 Noise and Vibration

5.9.1 EPA Environmental Factors and Objectives

The relevant EPA environmental factors are:

- Amenity
- Human Health

The EPA's objectives relating to these factors are:

- To ensure that impacts to amenity are reduced as low as reasonably practicable
- To ensure that human health is not adversely affected

5.9.2 Project Objectives

The project's environmental management objectives regarding noise and vibration during construction activities and once the FAL is operational are summarised below:

- Ensure that noise and vibration emissions do not significantly impact sensitive receptors
- Ensure that noise and vibration emissions comply with relevant legislation and guidelines

5.9.3 Legislation and Guidelines

Noise and vibration emissions will be managed in accordance with the following legislation:

- *Environmental Protection Act 1986*
- *Environmental Protection (Noise) Regulations 1997*
- EPA Guidance Statement No. 8: Guidance for the Assessment of Environmental Factors; Environmental Noise (Environmental Protection Authority, 2007)
- *State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning (SPP5.4)*

5.9.4 Potential Impacts

Construction and operation of the FAL has the potential to affect the health and amenity of the community through increased levels of noise and vibration within proximity of the rail infrastructure.

5.9.4.1 Operational Noise and Vibration

The PTA engaged AECOM to undertake a Noise and Vibration Feasibility Assessment (AECOM, 2014a) and (AECOM, 2014b) of the operational noise and vibration emissions associated with the three alignment options presented in Section 2.4. This included the alignment and construction methodology of twin bored tunnels which is the subject of this EIA.

The purpose of the assessment was to inform the route/construction methodology selection process and involved detailed modelling to demonstrate that the predicted noise and vibration emissions are compliant with relevant policies, standards and guidelines. The assessment was based on the project's concept design and the current understanding of the operational requirements of the FAL with regards to train speeds, train type and service frequency. The AECOM reports are included in Appendix 18.

Noise

The noise criterion adopted for the feasibility assessment are summarised below and are primarily based on the requirements of SPP5.4.

- During the day (6am to 10pm):
  - Noise target – 55dB(A) $L_{eq, 16h}$
  - Noise limit – 60dB(A) $L_{eq, 16h}$
- During the night (10pm to 6pm):
  - Noise target – 50dB(A) $L_{eq, 8h}$
  - Noise limit – 55dB(A) $L_{eq, 8h}$
- Whilst not a requirement of SPP5.4, at the request of the DER the results were also assessed against a maximum noise level criterion to account for the elevated and intermittent nature of rail noise sources. The adopted criterion is 80dB L_{Amax}

The noise criteria were agreed with the DER for the purposes of the feasibility assessment. The criterion may be subject to revision in consultation with the DER.

The results of the feasibility assessment indicated that the subterranean (bored tunnel) alignment and construction methodology had the least noise impacts to surrounding sensitive receptors. The predicted noise levels did however indicate that noise levels exceed the adopted assessment criteria and therefore noise mitigation options are likely to be required.

Introduction of services on the FAL will also result in an increase in rail traffic between Bayswater and Daglish Stations. Whilst an increase in rail traffic in the absence of physical construction works does not trigger SPP5.4, the PTA recognise that there may be adverse impacts to amenity and will therefore work with the DER to assess the potential impacts.

Vibration

The vibration criterion adopted for the feasibility assessment are summarised below.

- Tactile vibration criteria (AS 2670) of 100dB at residential receivers translated from velocity rms (m/s) to decibel (dB) as per AS 2670.2 Evaluation of human exposure to whole-body vibration (AS 2670)
- Regenerated ground borne noise criteria of $L_{Amax\ slow}$ 35 dB(A) at residential receivers

The vibration criteria were agreed with the DER for the purposes of the feasibility assessment. The criterion may be subject to revision in consultation with the DER.

The results of the feasibility assessment indicated that the subterranean (bored tunnel) alignment and construction methodology had the least noise impacts to surrounding sensitive receptors. The predicted vibration levels did however indicate that vibration levels exceed the adopted assessment criteria and therefore vibration mitigation options are likely to be required.

5.9.4.2 Construction Noise and Vibration

Construction noise and vibration was not assessed as part of the AECOM Noise and Vibration Feasibility Assessment. The noise and vibration impacts associated with construction of the tunnels are related to the rate of TBM advance. Given that the TBMs advance at a rate of 10 to 20 m per day, potential impacts will be temporary in nature.

The PTA has commissioned a Detailed Noise and Vibration Assessment to predict likely construction noise and vibration emissions. The scope of works includes but is not limited to:

- A review and collation of noise and vibration data obtained during previous projects delivered by the PTA (Perth to Mandurah Rail and Perth City Link) and comparable infrastructure projects in Australia and internationally
- Identification of sources of construction noise and vibration.
- Identification of sensitive noise and vibration receptors within proximity of the FAL.
- Predict noise and vibration levels likely to be received at the identified sensitive receptors during construction.

The outputs from the assessment will be used to develop controls and management measures which are to be implemented during construction in order to minimise impacts to sensitive receptors. Construction noise and vibration impacts will be identified by the lead contractor as specific construction activities and timings are known.

5.9.5 Mitigation Measures

5.9.5.1 Operational Noise

AECOM undertook noise modelling to identify mitigation measures to reduce noise impacts to surrounding residential properties and achieve compliance with the adopted assessment criteria. The results indicate that by adopting a noise barrier where the FAL connects to the existing Perth to Midland line, operational noise emissions are able to achieve compliance with the SPP5.4 noise limits and the maximum noise level criterion adopted for the feasibility assessment. Noise emissions from the FAL following the use of noise barriers are therefore not deemed to be significant.

5.9.5.2 Operational Vibration

AECOM undertook vibration modelling to identify mitigation measures to reduce vibration impacts to surrounding residential properties and achieve compliance with the adopted assessment criteria. The results indicate that by adopting resilient rail fasteners in certain sections of the alignment in order to reduce the energy transmitted from the trains into the ground, operational vibration emissions are able to achieve compliance with the criterion adopted for the feasibility assessment. Vibration emissions from the FAL following the use of resilient rail fasteners in certain sections of the alignment are therefore not deemed to be significant.

5.9.5.3 Construction Noise and Vibration

Measures to mitigate construction noise and vibration impacts will be developed by the lead contractor as the detailed design for the project progresses and specific construction activities and timings are known.

5.9.6 Proposed Management

5.9.6.1 Operational Noise and Vibration

Operational noise and vibration emissions will be agreed with the DER. A Detailed Noise and Vibration Assessment will then be undertaken to refine the operational noise and vibration emissions predicted during the feasibility assessment and to demonstrate that the emissions are compliant with the agreed levels.

The outputs from the detailed assessment will be used to develop mitigation and management measures which are to be implemented during operation of the FAL in order to minimise impacts to sensitive receptors. An Operational Noise and Vibration Management Plan (ONVMP) will be prepared by the PTA prior to the commencement of operations. The ONVMP will detail monitoring and maintenance requirements post construction. The ONVMP will be endorsed by the DER and other relevant regulatory agencies as required.

5.9.6.2 Construction Noise and Vibration

A Construction Noise and Vibration Management Plan (CNVMP) will be prepared by the lead contractor prior to the commencement of construction. Consultation with key stakeholders is a key element of managing noise and vibration impacts during construction. The CNVMP will detail consultation requirements, control measures to be implemented during construction and monitoring and reporting requirements. The CNVMP will be endorsed by the DER and other relevant regulatory agencies as required.

Construction noise and vibration will be assessed to ensure compliance with the *Environmental Protection (Noise) Regulations 1997* in order to minimise impacts to the amenity of the community. This includes preparation of Noise Management Plans for construction work which is undertaken out of hours. Noise Management Plans will be prepared on a case by case basis as specific construction activities and timings are known. The plans will be subject to approval by the DER or the Local Government Authority acting on behalf of the DER.

5.9.7 Approval Requirements

Approvals that will be required to manage potential noise and vibration impacts are summarised below:

- An approved ONVMP
- An approved CNVMP
- Noise Management Plans for specific construction activities

5.9.8 Noise Summary

Potential noise and vibration impacts to sensitive receptors and the proposed mitigation and management measures are summarised in Table 32.

Table 32: Noise and Vibration Management and Mitigation Summary

Issue	Management Action
EPA Objectives	- To ensure that impacts to amenity are reduced as low as reasonably practicable - To ensure that human health is not adversely affected
Impact Summary	- Potential impacts to the health and amenity of the community through increased levels of noise and vibration within proximity of the rail infrastructure.
Approval Requirements	- An approved ONVMP - An approved CNVMP - Noise Management Plans

Mitigation	Noise and vibration modelling for three alignment options identified that the bored tunnel construction methodology would have the least noise and vibration impacts. Mitigation options to further reduce potential noise and vibration impacts include: - Use of resilient rail fasteners - Construction of a noise barrier
Management and Monitoring	- Stakeholder consultation during construction. - Monitoring of noise and vibration emissions during construction. - Agreement of operational noise and vibration emissions with the DER. - Monitoring of noise and vibration emissions once the FAL is operational. - Periodic maintenance once the FAL is operational.
Management plans	A CNVMP and ONVMP will be prepared to the satisfaction of DER to manage noise and vibration emissions during construction and operational phases of the project. Noise Management Plans will be prepared to the satisfaction of DER or the Local Government Authority acting on behalf of the DER for construction work which is undertaken out of hours.

5.10 Light Pollution

5.10.1 EPA Environmental Factors and Objectives

The relevant EPA environmental factor is:

- Amenity

The EPA's objective relating to this factor is:

- To ensure that impacts to amenity are reduced as low as reasonably practicable

5.10.2 Project Objective

The project's environmental management objective regarding light pollution during construction activities and once the FAL is operational are to ensure that light emissions do not significantly impact sensitive receptors.

5.10.3 Potential Impacts

Due to the primarily subterranean construction methodology, there is little potential for light pollution from the majority of the project area to impact surrounding sensitive receptors. There will however be an active construction site in the Forrestfield Station Precinct where the majority of the tunnelling activities will take place. It is anticipated that night works will be required during construction of the tunnels which if not managed appropriately could affect the amenity of nearby sensitive receptors.

As with the construction phase of the project, there is little potential for light pollution from the majority of the FAL to impact surrounding sensitive receptors due to the subterranean construction methodology. Light emissions from Airport West and Forrestfield Stations and car parks may however affect the amenity of nearby sensitive receptors.

5.10.4 Management and Mitigation Measures

The project's CEMP will specify the measures to mitigate and manage light emissions during construction such as directional lighting. The CEMP will be subject to approval by the DER and other regulatory agencies as required prior to any construction activities being undertaken.

During the detailed design process, Airport West and Forrestfield Stations and car parks will be designed where possible to direct lighting so that it shines away from residential properties. Where considered necessary in proximity to sensitive receptors, light spill modelling will be undertaken to predict potential light spill and allow for the design to be optimised in order to minimise potential impacts associated with light spill.

6 Significance of Residual Impacts

Using the Environmental Protection Authority's *Environmental Assessment Guideline for Application of a Significance Framework in the Environmental Impact Assessment Process* (Environmental Protection Authority, 2013), the significance of the potential impacts has been assessed. The significance of the potential impacts once relevant mitigation and management measures have been taken into consideration are not likely to have a significant effect on the environment and are therefore considered to meet the EPA's environmental objectives. This assessment is summarised in Table 33 below.

Table 33: Assessment of Significance of Residual Impacts

EPA Factor	Potential Impacts Without Avoidance or Mitigation	Mitigation and Avoidance	Residual Impacts	Proposed Management Measures	Significance of Residual Impacts
Flora and Vegetation (Flora)	Clearing 37 *Conospermum undulatum* plants	Early identification of the environmental values of Poison Gully Creek allowed for its removal from the project's construction footprint and consequent protection 12 *Conospermum undulatum* plants Different design scenarios were considered for the Forrestfield Station Precinct, however due to the constrained nature of this area it was not possible to protect the remaining 25 plants. Development and implementation of an Environmental Offset Strategy	Clearing 25 *Conospermum undulatum* plants	Preparation of a CEMP to the satisfaction of the DER and other regulatory agencies as required ensuring protection of vegetation retained adjacent to the proposed alignment. The CEMP will include: - Interface treatments such as fencing - Access management - Hygiene measures	Impacts have been avoided where possible, however after careful design considerations, it was concluded that clearing 25 *Conospermum undulatum* plants could not be avoided. The significance of this impact is considered low as the small area of vegetation these plants are located in makes current or future pressures from weed and disease spread and unauthorised access likely. A regional assessment was undertaken to assist in determining the significance of this impact. Clearing 25 *Conospermum* comprises 1.1% of those plants present within conservation estates within a 10km radius of the site.
Flora and Vegetation (Vegetation)	Clearing 4.26 ha of SCP20c (over 2 locations)	Removal of 3.51 ha of SCP20c from the project's construction footprint Development and implementation of an Environmental Offset Strategy	Clearing 0.75 ha of SCP20c Potential indirect impacts to the retained 3.51 ha of SCP20c including: - Accidental clearing - Unauthorised access - Potential spread of weeds and disease - Potential impacts from dewatering activities	A CEMP will be prepared to manage potential impacts to the retained SCP20c during and post construction. The CEMP will include (but not be limited to) the following management measures: - Interface treatments such as fencing - Access management - Hygiene measures An ASSDMP will detail dewatering controls and monitoring requirements	Impacts to SCP20c have been avoided where possible, however due to design constraints, avoidance of 0.75 ha was not feasible The 3.51 ha TEC was considered more valuable than the 0.75 ha TEC as its larger size makes it less susceptible to edge effects and therefore is likely to have a better long term viability The significance of this residual impact is low due to small area proposed to be impacted and the existing and future impacts this community is likely to be impacted by A regional assessment of SCP20c was undertaken to assist in determining the significance of impacts. It was determined that clearing 0.75 ha comprises 0.6% of the TEC present within a 10km radius of the site.
	Clearing 1.72 ha of SCP20a / 20b	No avoidance possible Development and implementation of an Environmental Offset Strategy	Clearing 1.72 ha of SCP20a / 20b	No management proposed	Due to surrounding land uses (rail and road reserve) it is likely that the vegetation of this community will degrade over time and considering the small area that will be cleared, the impact is not considered significant.
	Clearing 15.5 ha of vegetation in good or better condition	During the design process, significant vegetation was avoided where possible through selection of a bored tunnel method and design of construction areas.	Clearing 2.47 ha of vegetation in good or better condition	Preparation of a CEMP to the satisfaction of the DER and other regulatory agencies as required ensuring protection of vegetation retained adjacent to the proposed alignment. The CEMP will include: - Interface treatments such as fencing - Access management	Impacts to vegetation have been avoided where possible along the project extent through constructing a bored tunnel and through modifying construction areas. Residual impacts to 2.47 ha are not considered significant.

EPA Factor	Potential Impacts Without Avoidance or Mitigation	Mitigation and Avoidance	Residual Impacts	Proposed Management Measures	Significance of Residual Impacts
				- Hygiene measures	
	Clearing 2.96 ha of SCP20a	Removal of the area of SCP20a from the project's construction footprint due to its environmental values Development and implementation of an Environmental Offset Strategy	No direct impacts to SCP20a Potential indirect impacts to the retained 2.96 ha of SCP20a are considered unlikely due to the set back of approximately 25 m from the project's construction footprint and over 100m from the proposed car park. Potential indirect impacts include: - Accidental clearing - Unauthorised access - Potential spread of weeds and disease - Potential impacts from dewatering activities	A CEMP will be prepared to manage potential impacts to the retained SCP20a during and post construction. The CEMP will include (but not be limited to) the following management measures: - Interface treatments such as fencing - Access management - Hygiene measures An ASSDMP will detail dewatering controls and monitoring requirements	There are no direct impacts to SCP20a and due to the setback between this community and the construction area it is unlikely that there will be any significant indirect impacts.
	Clearing 3.16 ha of PEC Subtropical and Temperate Coastal Saltmarsh	During the design process, this vegetation was avoided through selection of a bored tunnel method and design of construction areas.	No direct impacts to PEC Subtropical and Temperate Coastal Saltmarsh Potential indirect impacts to the retained 3.16 ha of PEC Subtropical and Temperate Coastal Saltmarsh include: - Accidental clearing - Unauthorised access - Potential spread of weeds and disease - Potential impacts from dewatering activities	A CEMP will be prepared to manage potential impacts to the retained of PEC Subtropical and Temperate Coastal Saltmarsh during and post construction. The CEMP will include (but not be limited to) the following management measures: - Interface treatments such as fencing - Access management - Hygiene measures An ASSDMP will detail dewatering controls and monitoring requirements	There are no direct impacts to PEC Subtropical and Temperate Coastal Saltmarsh and due to the setback between this community and the construction area it is unlikely that there will be any significant indirect impacts.
Terrestrial Fauna	Clearing over 50 potential habitat trees.	During the design process, 35 potential habitat trees were avoided through selection of a bored tunnel method and design of construction areas.	Clearing 15 potential black cockatoo habitat trees	All actions during construction will be undertaken in accordance with a CEMP which will outline measures to ensure protection of fauna habitat during construction activities. This plan will be prepared to the satisfaction of DER and other regulatory agencies as required. Management measures to protect fauna habitat will include: - Fencing or flagging significant areas such as Poison Gully Creek and SCP20c and flagging any habitat trees to be retained during construction - Undertake groundwater monitoring to ensure dewatering does not impact significant habitat	A significant impact assessment undertaken in accordance with DoE guidelines concluded that impacts to black cockatoo habitat were unlikely to be significant. To further confirm the significance of clearing 3.56 ha of foraging habitat, a regional assessment of similar vegetation in the region was undertaken. It was estimated that 112.6 ha of similar vegetation or foraging habitat is present within reserves within a 10km radius of the site. Consequently, clearing 3.56 ha will impact 3.1% of potential habitat present in the region.
	Clearing 6.59 ha of potential black cockatoo foraging habitat	The initial project design involved 3 alignment options. The selection of a bored tunnel method had the least impacts to black cockatoo habitat	Clearing 3.56 ha of potential black cockatoo foraging habitat		
	Clearing 19 ha of potential Quenda habitat	The project was designed to minimise significant habitat where possible through selection of a bored tunnel method and	Clearing 5.3 ha of potential Quenda habitat	All actions during construction will be undertaken in accordance with the CEMP which will outline measures to ensure	Considering the small area of potential habitat proposed to be cleared in comparison to that being retained in the area (e.g. Poison Gully Creek), clearing 5.3 ha of potential habitat is not likely to be

EPA Factor	Potential Impacts Without Avoidance or Mitigation	Mitigation and Avoidance	Residual Impacts	Proposed Management Measures	Significance of Residual Impacts
		design of construction areas		protection of fauna habitat during construction activities. This plan will be prepared to the satisfaction of DER and other regulatory agencies as required. Management measures to protect fauna habitat will include: - Trapping and relocating any Quenda from the construction sites prior to clearing - Fencing or flagging significant areas such as Poison Gully Creek	significant. Impacts to individual animals will be further reduced through the relocation program prior to clearing activities.
	Clearing 18.35 ha of Water Rat habitat	Avoidance of significant impacts to riparian vegetation along the Swan River and the bored tunnel construction method lead to impacts to this habitat being avoided.	No impacts	No management proposed	No impacts
Hydrological processes Inland Waters Environmental Quality (Groundwater and Surface Water Courses)	Dewatering activities will cause groundwater drawdown, which in turn has the potential to expose PASS and mobilise potentially contaminated groundwater.	Identification of construction methods such as re-injection of abstracted groundwater, use-of diaphragm wall or sheet piling for deeper excavations and use of wet working techniques to avoid significant environmental impacts during dewatering activities	By adopting dewatering controls during construction the extent of groundwater drawdown can be reduced thus minimising the potential to disturb PASS and mobilise contaminated groundwater.	Dewatering activities and potential impacts will be managed and monitored through the ASSDMP which will be prepared to the satisfaction of DER and other regulatory agencies as required. Groundwater monitoring will be undertaken to ensure impacts are not significant.	It has been demonstrated that by adopting dewatering controls during construction, dewatering activities are unlikely to have significant impacts on groundwater or surface water courses.
Hydrological Processes Flora and Vegetation (Wetlands)	Clearing Resource Enhancement Wetland (UFI15875)	Removal of UFI15875 from the project's construction footprint	No direct impacts. Indirect impacts to the retained Resource Enhancement Wetland (UFI15875) include: - Accidental clearing during construction - Surface water run-off from the construction site - Surface water run-off into wetland from the car park post construction - Potential spread of weed and disease during construction activities - Unauthorised access - Potential impacts from dewatering activities	Management measures to reduce indirect impacts to UFI15875 will be outlined in the CEMP which will be prepared to the satisfaction of DER and other regulatory agencies as required. The CEMP will include management measures such as: - Fencing and signage of the wetland area during and post construction - Management of surface water during and post construction - Hygiene measures during construction An ASSDMP will detail dewatering controls and monitoring requirements	Direct impacts to UFI15875 have been avoided through redesign of the project's construction footprint. Management measures will be implemented during and post construction to reduce potential indirect impacts. The preliminary dewatering modelling and significance assessment undertaken concluded that dewatering activities can be managed to avoid any significant impacts to this wetland. Consequently, significant impacts to this wetland are considered unlikely.
	Clearing Resource Enhancement Wetland (UFI15876)	No mitigation or avoidance possible Development and implementation of an Environmental Offset Strategy	Clearing Resource Enhancement Wetland (UFI15876) for construction of the Forrestfield Station Precinct	No management proposed.	Clearing 3.28 ha of this of Resource Enhancement Wetland (UFI15876) is the project's only direct impact to wetlands Considering the avoidance and management measures proposed to reduce impacts to other wetlands, impacts to this wetland are not considered significant.
Heritage	Potential impacts to Aboriginal sites along the entire alignment prior to any avoidance or mitigation measures included:	Selection of the bored tunnel construction method allowed for the avoidance of any physical impacts to the Swan River. During the initial design phase, Poison Gully Creek where it flows in its natural	Potential impacts to the Swan River (ID 3536) and Poison Gully Creek (ID 25023) heritage sites due to their mythological and spiritual significance	Any impacts to Registered Aboriginal heritage sites will be managed via a Section 18 notice under *the Aboriginal Heritage Act 1972.* Measures to protect of Aboriginal heritage (known or unknown sites) during construction	The significance of impacts to the Swan River (ID 3536) and Poison Gully Creek heritage sites will be assessed by the DAA via a Section 18 notice under *the Aboriginal Heritage Act 1972.*

EPA Factor	Potential Impacts Without Avoidance or Mitigation	Mitigation and Avoidance	Residual Impacts	Proposed Management Measures	Significance of Residual Impacts
	- Potential impacts to the Swan River (ID 3536) - Potential impacts to the Poison Gully Creek (ID 25023) - Disturbance to yet unidentified Aboriginal heritage sites - Disturbance of non-registered (Stored) Aboriginal heritage sites	state was identified for avoidance due to its Aboriginal heritage significance. Advice from the DAA and a site inspection confirmed that it is unlikely that unidentified Aboriginal heritage sites exist within the project area or that non-registered Aboriginal heritage sites will be impacted.		activities will be outlined in the CEMP.	
Terrestrial Environmental Quality Inland Waters Environmental Quality (Acid Sulfate Soils)	Excavation of PASS	No mitigation measures are proposed	Excavation of PASS	Preparation of an ASSDMP to the satisfaction of the DER and other regulatory agencies as required to manage excavation and treatment of PASS	Environmental impacts due to exposure of PASS are unlikely to be significant as long as they are managed in accordance with the ASSDMP which will specify treatment requirements. It has been demonstrated that by adopting dewatering controls during construction, PASS disturbance from dewatering activities is unlikely to have significant environmental impacts.
	Disturbance of PASS due to dewatering activities	Identification of construction methods such as re-injection of abstracted groundwater, use-of diaphragm wall or sheet piling for deeper excavations and use of wet working techniques to avoid significant environmental impacts during dewatering activities	By adopting dewatering controls during construction the extent of groundwater drawdown can be reduced thus minimising the potential to disturb PASS during dewatering activities.	Preparation of an ASSDMP to the satisfaction of the DER and other regulatory agencies as required to manage dewatering activities.	
Terrestrial Environmental Quality Inland Waters Environmental Quality Human Health (Contamination)	Potential disturbance of existing soil contamination or mobilisation of existing contaminated groundwater	Characterisation of potential sources of soil and groundwater contamination within and adjacent to the alignment. Identification of construction methods such as re-injection of abstracted groundwater, use-of diaphragm wall or sheet piling for deeper excavations and use of wet working techniques to avoid significant environmental impacts during dewatering activities	Potential of existing contaminated groundwater	Management and remediation (if required) will be outlined in a Site Management Plan. Undertake a Forward Works program to remove surficial contamination within the area of the alignment footprint where disturbance will occur, ahead of the main works program Excavated soil or spoil from areas known or suspected to contain contamination during construction works will be subject to further testing, treatment and disposal.	Impacts regarding potential contaminated sites will not be significant if adequate characterisation of potential sources of soil and groundwater contamination is undertaken and the Site Management Plan is implemented. It has been demonstrated that by adopting dewatering controls during construction, PASS disturbance from dewatering activities is unlikely to mobilisation of existing contaminated groundwater.
Amenity Human Health (Vibration and Noise)	Elevated levels of noise and vibration being received at sensitive receptors during operation of the FAL	Selection of the bored tunnel construction method allowed for potential noise and vibration impacts to sensitive receptors to be minimised. Adoption of design measures such as noise barriers and resilient rail fasteners in certain sections of the alignment.	It has been demonstrated that operational noise and vibration emissions are able to achieve compliance with the SPP5.4 noise limits, the maximum noise level criterion and the vibration criterion adopted for the feasibility assessment.	Operational noise and vibration management will be detailed in an Operational Noise and Vibration Management Plan which will be prepared to the satisfaction of DER.	Operational noise and vibration emissions from the FAL following the use of noise barriers and resilient rail fasteners are able to achieve the compliance criteria and are therefore not deemed to be significant The noise and vibration impacts associated with construction will be temporary in nature and therefore are not deemed to be significant. Community consultation will also be undertaken during the construction phase of the project to ensure the surrounding residents and businesses are informed of planned activities.
	Elevated levels of noise and vibration being received at sensitive receptors during construction of the FAL	Selection of the bored tunnel construction method allowed for potential noise and vibration impacts to sensitive receptors to be minimised.	The noise and vibration impacts associated with construction will be temporary in nature.	Noise and vibration management during construction activities will be detailed in a Construction Noise and Vibration Management Plan which will be prepared to the satisfaction of DER.	Further noise and vibration assessment will be undertaken in consultation with the DER to ensure impacts to sensitive receptors are managed appropriately.

EPA Factor	Potential Impacts Without Avoidance or Mitigation	Mitigation and Avoidance	Residual Impacts	Proposed Management Measures	Significance of Residual Impacts
Amenity (Light)	Light emissions being received at sensitive receptors	The majority of light emissions were avoided through selection of a bored tunnel method	The light emissions associated with construction will be temporary in nature	The project's CEMP will specify the measures to mitigate and manage light emissions during construction such as directional lighting.	Impacts from light emissions are not considered to be significant following implementation of mitigation and management measures during construction and operation.

7 Potential Environmental Impacts on Commonwealth Land

This report has been prepared to support the Section 38(1) referral. Impacts on Commonwealth land will not form part of this referral as they will be assessed by the DoE through the EPBC referral process. However, a brief summary of environmental values and potential impacts on Commonwealth land has been included below to provide the EPA with an overall view and understanding of the proposal.

7.1 Acid Sulfate Soils

An assessment of the DER ASS mapping indicates that the risk of ASS occurring along the FAL alignment within Commonwealth land ranges from 'moderate to low risk of ASS occurring within 3m of the natural soil surface, to a high to moderate risk of ASS beyond 3m of the natural soil surface'.

The results of the preliminary investigations undertaken by GHD (2013) indicate that PASS is likely to be present within all geological units present on Commonwealth land. A detailed ASS investigation in accordance with the DER guidelines will be undertaken in late 2014/early 2015 to confirm the presence and extent of ASS.

Potential environmental impacts associated with disturbance of ASS during excavation or dewatering activities on State land as discussed in Section 5.1.4 are applicable on Commonwealth land. It is proposed that excavation and dewatering activities will be managed in accordance with an ASSDMP.

7.2 Groundwater

Groundwater levels measured along the alignment within Commonwealth land range from 9.8 m AHD to 17.3 m AHD and 1.2 m bgl to 2.3 m bgl. Temporary dewatering on Commonwealth land will be required to construct Consolidated Airport Station and Emergency Egress Shaft 3. Also, dewatering undertaken on State land to construct Airport West Station and Emergency Egress Shaft 4 may alter groundwater levels on Commonwealth land.

Potential environmental impacts associated with dewatering activities on State land as discussed in Section 5.2.4 are generally applicable on Commonwealth land. Dewatering may directly impact groundwater quality and flows and indirectly impact vegetation, fauna habitat and surface water bodies. Preliminary modelling however indicates that the extent of temporary drawdown can be managed by design of the underground structures and re-injection of abstracted groundwater and therefore environmental impacts are not considered likely to be significant. It is proposed that dewatering activities will be managed in accordance with an ASSDMP.

7.3 Wetlands and Surface Water

A search of the Geomorphic Wetlands of the Swan Coastal Plain dataset identified three wetlands within the Approval Boundary on Commonwealth land as summarised below:

- UFI15314 (Multiple Use Palusplain)
- UFI8823 (Resource Enhancement Sumpland)
- UFI15264 (Multiple Use Dampland)

The majority of these wetlands either do not occur within areas of surface disturbance or the vegetation within the wetlands has been previously cleared and therefore impacts are considered minimal.

Munday Swamp is a Conservation Category Wetland which comprises approximately 20 ha; of which approximately one hectare is open water. It is a freshwater wetland fed by both groundwater and surface-water flows. The area is considered to be of high environmental value and was detailed within Perth Airport's Environment Strategy 2009-2014 as a major component within one of two conservation precincts on the airport estate. There will be no direct impacts to this wetland resulting from construction of the FAL. Preliminary dewatering modelling has demonstrated that dewatering activities can be managed by design of the underground structures and re-injection of abstracted groundwater and therefore indirect impacts to Munday Swamp are considered not likely to be significant.

7.4 Vegetation

7.4.1 Vegetation Type and Condition

Much of the Commonwealth land was inaccessible during the flora survey undertaken by GHD (GHD, 2014c). Consequently, data from surveys undertaken in 2007 (Mattiske Consulting, 2008) and 2012 (Ecologia Environment, 2013) has been used to assess vegetation types within the Commonwealth land. Vegetation types present within the Approval Boundary on Commonwealth land are summarised below:

- Cleared areas, disturbed areas, pasture areas, drains and infrastructure
- Low Forest to Low Woodland of *Eucalyptus marginata, Banksia attenuata* and *Banksia menziesii* with occasional *Allocasuarina fraseriana* over *Acacia pulchella, Patersonia occidentalis* and *Dasypogon bromeliifolius*
- Woodland of *Corymbia calophylla* over *Kingia australis* and *Xanthorrhoea preissii* over low shrubs and herbs.
- Woodland of *Corymbia calophylla, Melaleuca preissiana* and *Banksia* spp. over *Xanthorrhoea preissii*, *Hypocalymma angustifolium* and *Jacksonia sternbergiana* over low herbs and shrubs.
- Woodland of *Melaleuca rhaphiophylla*, *Eucalyptus rudis, Melaleuca preissiana* with occasional *Banksia ilicifolia* over *Lyginia barbata, Xanthorrhoea preissii, Hypocalymma angustifolium, Dasypogon bromeliifolius, Pericalymma ellipticum* var. *elliptic*
- Woodland of *Corymbia calophylla, Melaleuca preissiana, Banksia* spp. and occasional *Adenanthos cygnorum* over *Xanthorrhoea preissii, Hypocalymma angustifolium* and *Jacksonia sternbergiana* over low herbs and shrubs

The majority of vegetation within the Approval Boundary on Commonwealth land has is completely degraded and comprises cleared areas, degraded pasture, buildings or infrastructure. Over 80% of the vegetation within the areas of surface disturbance has been previously cleared and consequently significant impacts to vegetation on Commonwealth land are unlikely.

7.4.2 Ecological Communities

Due to the degraded and cleared nature of vegetation along the proposed alignment within Commonwealth land, no TECs have been previously mapped or are considered likely to occur within the Approval Boundary. Data obtained from a flora and vegetation survey undertaken by Ecologia Environment (Ecologia Environment, 2013) on behalf of PAPL confirmed that there were no TECs on Commonwealth land which will be impacted by the FAL.

Vegetation mapping undertaken by GHD (GHD, 2014c) and liaison with DPaW identified the potential for a PEC to occur adjacent to the Approval Boundary (Figure 10). Based on the data from the survey undertaken by GHD (GHD, 2014c) and a site visit undertaken by Val English and Jill Pryde of DPaW, it was concluded that this community is most likely to have the closest affinities to FCT SCP04 (*Melaleuca preissiana* damplands) or FCT SCP21c (Low lying *Banksia attenuata* woodlands or shrublands) which is listed under the *Wildlife Conservation Act 1950* as a Priority 3 PEC (Appendix 2). No direct impacts to this potential PEC are proposed.

7.4.3 Dieback

A dieback assessment of the vegetation associated with the potential area of FCT SCP21c was undertaken by Glevan Consulting. Results from this assessment identified that this area was unmappable (Figure 11). If required, hygiene measures will be outlined in the project's CEMP.

7.5 Significant Flora

A desktop assessment was undertaken to identify significant flora species (protected under the EPBC Act or *Wildlife Conservation Act 1950*) potentially occurring in the vicinity of the alignment. These species are listed in Appendix 5.

None of these species were identified within the Approval Boundary on Commonwealth land. As the vegetation condition is mostly completely degraded there is a low likelihood of these species occurring within the Approval Boundary on Commonwealth land.

7.6 Significant Fauna

Based on the vegetation units and condition present within the Approval Boundary, the likelihood of the significant fauna species identified during desktop (Appendix 7) and site surveys (GHD, 2014c) occurring within the Approval Boundary on Commonwealth land is very low.

The only potentially significant habitat within the Approval Boundary on Commonwealth land comprises black cockatoo habitat (breeding trees and foraging habitat). Impacts to black cockatoo habitat on both State and Commonwealth land will be referred to the DoE via an EPBC referral. Impacts to black cockatoo habitat are not considered to be significant.

7.7 Aboriginal Heritage

The search of the DAA AHIS and the Desktop Assessment (Waru Consulting, 2013a) identified nine potential Aboriginal heritage sites within the Approval Boundary; of these four are mapped as being located on Commonwealth land. Three of the eight sites are registered Aboriginal heritage sites. The other site is a Heritage Place which has been assessed as not meeting the definition of a site.

Mapping of sites on the AHIS is sometimes broad or inaccurate. Liaison with the DAA has assisted to confirm the actual location of some of these sites. A summary of the Aboriginal heritage sites known to occur on Commonwealth land and the potential impacts to these sites is provided in Table 34. These sites are shown on Figure 13.

Table 34: Potential Impacts to Aboriginal Heritage sites on Commonwealth Land

Site ID	Site Name	Site Type	Potential Impacts
Registered Sites			
3719	Munday Swamp	Ceremonial, Mythological, Artefact / scatter	The published extent of this site occurs over both Commonwealth and State land. The PTA has confirmed in consultation with the DAA that the actual heritage site only occurs on Commonwealth land. Advice from the DAA has also confirmed that the Approval Boundary does not intersect the boundary of the registered heritage site. Heritage impacts to the site are therefore considered unlikely.
4408	Newburn – Bingham St	Artefact / Scatter	An archeological survey undertaken by Waru (Waru Consulting, 2013c) confirmed the location and boundary of this site. This site is within the Approval Boundary but is not impacted by any surface disturbance. Advice from the DAA has confirmed that construction of bored tunnels below this site is unlikely to impact its heritage values.
25023	Poison Gully Creek	Ethnographic Site	The published extent of this site occurs over both Commonwealth and State land. The PTA has confirmed in consultation with the DAA and based on the findings of an Aboriginal heritage assessment undertaken by R. and E. O'Connor Pty Ltd (O'Conner, 2011) that the actual heritage site only occurs on State land. Potential impacts to this site are therefore discussed in Section 5.7.4.
Heritage Places (Stored Data)			
3866	**Brearley Ave**	**Artefact / scatter**	Archeological verification work was undertaken for this site in 2007. No artefacts were found during the site search and it was concluded that this site no longer exists. Therefore, this site will not be impacted by the FAL.

7.8 Environmentally Sensitive Areas

Within Commonwealth land, the areas of surface disturbance associated with the Consolidated Airport Station and Cross Passages 4 and 5 occur within an ESA. These ESAs appear to be associated with the wetland system located on Commonwealth land. Impacts to wetlands on Commonwealth land are discussed above in Section 7.3.

7.9 Bush Forever

Bush Forever Site 386 (Perth Airport and Adjacent Bushland) is located within the Approval Boundary and the area of surface disturbance associated with Cross Passage 4. Much of the vegetation in this area has previously been cleared.

7.10 Contaminated Sites

The Preliminary Site Investigation undertaken by GHD (GHD, 2013) identified known contaminated sites and potential sources of contamination within or adjacent to the alignment on Commonwealth land. Potential environmental impacts associated with disturbance of existing contamination on State land as discussed in Section 5.8.4 are applicable on Commonwealth land. It is proposed that the known contamination sources will be investigated prior to the commencement of construction to assess potential risks to human health and the environment. Site contamination on Commonwealth land will be addressed as per the proposed mitigation and management measures detailed in Section 5.8.

8 Stakeholder Consultation

PTA has undertaken consultation with relevant stakeholders from the early stages of the FAL design process. Comments and advice received from government agencies and other relevant stakeholders were incorporated into the concept design of the FAL. A summary of stakeholder consultation undertaken to date is summarised in Appendix 19. Key meetings and liaison which is relevant to the Section 38(1) referral is provided in more detail below.

8.1 State and Commonwealth Environmental Approval

The PTA first met with the Office of the EPA (OEPA) in November 2013. The purpose of the meeting was to introduce the project to the OEPA and the present the route options being considered by the PTA and the associated environmental and heritage considerations. It was confirmed in the meeting that the EPA would not consider potential environmental impacts on Commonwealth land.

The PTA provided an update on the FAL project and the likely alignment option to officers from the OEPA in May 2014. The following key points were discussed:

- Project timelines
- Potential environmental impacts and proposed mitigation and management measures
- Approvals strategy for the project and potential interaction with the DoE
- Seek feedback from the OEPA on the environmental investigations undertaken to date
- Seek feedback from the OEPA regarding what level of detail to provide on potential environmental impacts on Commonwealth land

The OEPA were satisfied with the environmental investigations undertaken to date. The OEPA requested that a brief summary of environmental values and potential impacts on Commonwealth land is provided in the Section 38(1) referral whilst noting that these impacts will not be considered by the EPA.

The PTA briefed the EPA Chairman and officers from the OEPA on the project in June 2014 ahead of referral of the project to the EPA later in 2014. The PTA provided an overview of the project and discussed the potential environmental impacts and proposed mitigation and management measures.

The PTA has also undertaken regular liaison with the DoE throughout the planning phase of the project. The project was introduced to the DoE in November 2013 and periodic updates and pre-referral discussions have taken place since.

8.2 Acid Sulfate Soils and Contamination

The PTA introduced the project to the DER Contaminated Sites Branch and the Department of Health (DoH) in October 2013. The PTA presented the route options being considered and the planned investigations to identify and characterise potential sources of contamination within or adjacent to the project and to confirm the presence of ASS.

The PTA advised that the first stage of the investigation will be a desk based assessment which would be undertaken in accordance with the relevant DER guidelines and subject to a voluntary audit by a DER accredited auditor. The DER and DoH endorsed the proposed approach and welcomed the early engagement. The desk based assessment report (GHD, 2013) was provided to the DER and DoH upon completion and was subsequently endorsed.

A meeting was recently held in October 2014 with the DER to provide an update on the project and to discuss the next phase of investigation. The PTA advised that the fully subterranean (bored tunnel) option had been selected and that this would avoid some areas of potential contamination. The PTA also outlined the general approach to the field investigation and confirmed that this phase of work will also be undertaken in accordance with the relevant DER guidelines and subject to a voluntary audit by a DER accredited auditor. The DER endorsed the proposed approach.

8.3 Groundwater and Surface Water

A meeting was held with the Swan River Trust (SRT) in September 2013 to introduce the project to the SRT and the present the options being considered for the crossing of the Swan River; these being a new bridge or tunnels below the river. The SRT advised that the fully subterranean (bored tunnel) option was preferable with regards to minimising impacts to the Swan River.

The PTA also sought advice on approval requirements from the SRT. Given the subterranean nature of the proposed development, the requirement for approval from the SRT was considered unlikely. Since the meeting, the PTA has continued to provide project updates and seek advice on approval requirements and potential environmental impacts to the Swan River. Liaison with the SRT is ongoing.

The Department of Water (DoW) were also consulted in September 2013. A meeting was held in which the PTA provided an introduction to the project and informed the DoW of the route options being considered. The PTA advised the DoW of the likely dewatering required to construct the project and the hydrogeological investigations proposed to understand the potential impacts to groundwater and surface water. The PTA also sought advice on approvals required to undertake such dewatering activities.

The DoW advised that dewatering licences and accompanying management plans are required prior to the commencement of dewatering activities and that such approvals were generally sought during the detailed design stage of a project. The DoW also indicated that they do not regulate activities undertaken on Commonwealth land and advised of the requirement for a permit if any works are to disturb the bed or bank of a water course.

8.4 Flora and Vegetation

The PTA briefed the Department of Parks and Wildlife (DPaW) on the project in March 2014 upon completion of the Environmental Investigation (GHD, 2014c). A meeting was held in which the PTA provided a general project overview to DPaW staff. Discussions pertained to previously identified alignment options, the likely alignment option and its potential environmental impacts.

This meeting was an information sharing exercise and acknowledged PTA's intent of developing the project with due consideration of potential environmental impacts. DPaW noted the potential environmental impacts associated with dewatering and clearing of significant flora and vegetation communities. The Environmental Investigation (GHD, 2014c) was provided to and reviewed by DPaW following the meeting. DPaW advised that the 2013 flora and vegetation survey was undertaken at a suitable time as to target any significant flora that may occur.

A site visit was undertaken two days after the meeting with officers from the Species and Communities Branch of DPaW to confirm the presence of Threatened Ecological Communities and Declared Rare Flora within and adjacent to the project area. The site visit clarified that the TECs within and adjacent to the project area included FCT SCP20a, SCP20b and SCP20c and potentially FCT SCP21b which is a PEC. The presence of *Conospermum undulatum* within and adjacent to the project area was also confirmed by DPaW.

Acknowledging the likely requirement for environmental offsets to mitigate impacts to flora and vegetation, discussions were held with the Land Tenure branch of DPaW in May 2014. The PTA presented the work undertaken to date which included identifying potential offset sites using DPaW's TEC and DRF database and evaluating options for propagation of *Conospermum undulatum*. The advice from DPaW regarding potential offsets for the project was to not take any further steps in identifying potential offset sites until the requirement for offsets has been determined. DPaW also advised that if offsets are required, they will work with PTA to identify and obtain appropriate sites.

The PTA also met with the DER Native Vegetation Conservation Branch in May 2014 to provide an introduction to the FAL project and discuss the potential environmental impacts. The DER confirmed they were satisfied with the investigations undertaken to date and that appropriate management measures will be required to protect the native vegetation which has been retained adjacent to the project.

8.5 Noise and Vibration

The PTA briefed the DER Environmental Noise Branch on the project in August 2013 prior to the commencement of the Noise and Vibration Feasibility Study (AECOM, 2014a). The purpose of the meeting was to introduce the project to the DER and the present the route options being considered and the associated noise and vibration considerations. The DER advised that they considered the fully underground (bored tunnel) option to be preferable with regards to minimising noise and vibration impacts. Guidance from the DER was also sought regarding appropriate assessment criteria and methodology for the feasibility assessment.

The noise and vibration feasibility assessment criteria and methodology were subsequently agreed with the DER at a second meeting held in September 2013. In May 2014 and upon completion of the Noise and Vibration Feasibility Study (AECOM, 2014a), the PTA presented the findings of the study to the DER. The PTA also advised the DER of the likely subterranean alignment option. The DER was satisfied that the feasibility study had demonstrated that the operational noise and vibration emissions from the subterranean alignment option could be mitigated and managed to acceptable levels. The feasibility study report was provided to the DER but no response was received.

8.6 Aboriginal Heritage

The PTA has undertaken regular liaison with the Department of Aboriginal Affairs, the South West Aboriginal Land and Sea Council (SWALSC) and the Whadjuk Working Party throughout the planning phase of the project. The project was first introduced to the DAA, SWALSC and the Whadjuk Working Party in July 2013. A model for Aboriginal engagement on matters related to cultural heritage and the role of SWALSC was subsequently agreed with the DAA and the Department of Premier and Cabinet in August 2013.

Over the past 15 months the PTA has continued to provide project updates and seek advice on potential heritage impacts and approval requirements from the DAA, SWALSC and the Whadjuk Working Party. In 2014, the PTA has attended the May and October Whadjuk Working Party meetings. On site consultation to discuss potential heritage impacts to the Swan River and Poison Gully Creek have also been conducted with spokespersons nominated by SWALSC as having relevant cultural heritage knowledge of the sites in question.

The PTA also periodically provides updates to PAPL's Aboriginal Partnership Group regarding the proposed works on Commonwealth land. The PTA is currently working with SWALSC, the Whadjuk Working Party and the Cultural Connection Code to develop an engagement strategy for broader Aboriginal engagement. Liaison with the DAA is also ongoing.

8.7 Community Engagement

The PTA is committed to working with the community and stakeholders throughout the life of the project. A number of Community Information Sessions were held in September 2014 to provide a forum for members of the community to gain information about the project. The information session was advertised through a variety of media including the project website, letter drops and posters in local shopping centres. A representative from the project's environmental team was present at each of the sessions. The key environmental factors raised in the community information sessions related to amenity (noise and vibration) and terrestrial fauna (Quenda habitat). Community consultation will be undertaken as the project progresses to help inform elements of the stations design and amenities.

The PTA has built proactive relationships with the surrounding local government agencies and continues to engage with these stakeholders. The PTA is currently working with the local government agencies to develop stakeholder reference groups.

The PTA has also developed a project website which contains general information on the project as well as details of the environmental and heritage considerations. The website has a feedback section which members of the community can use to seek information about the project. All queries are responded to in a timely manner.

9 Conclusion

9.1 Summary of Mitigation and Avoidance Measures

Based on the studies undertaken to date and the advice received from stakeholders, the FAL has been designed to avoid environmental and heritage impacts where possible. The most significant mitigation or avoidance measures are summarised below:

- Identifying the environmental and heritage values present along each of the three main route alignment options considered (refer Section 2.4) and selecting the option with the least environmental impacts. This assisted in avoiding the following:
  - 30 potential black cockatoo habitat trees
  - Over 3 ha of potential black cockatoo foraging habitat
  - Impacts to Water Rat habitat
  - Noise and vibration impacts to sensitive receptors
  - Disturbance to the bed or banks of the Swan River
  - Impacts to PEC Subtropical and Temperate Coastal Saltmarsh
- Identifying construction methods such as re-injection of abstracted groundwater, use-of diaphragm wall or sheet piling for deeper excavations and use of wet working techniques to avoid significant environmental impacts during dewatering activities. Avoidance of the following impacts has been demonstrated to be possible by adopting these measures:
  - Impacts to wetlands from groundwater drawdown
  - Impacts to black cockatoo habitat trees from groundwater drawdown
  - Impacts to TECs and PECs from groundwater drawdown
- Undertaking flora and fauna surveys which allowed for the Forrestfield Station Precinct footprint to avoid the following environmental values:
  - Poison Gully Creek which has the following environmental and heritage values; Bush Forever Site, Aboriginal Heritage, presence of 12 *Conospermum undulatum* plants, presence of the TEC SCP20a and black cockatoo habitat
  - Avoidance of direct impacts to 3.51 ha of SCP20c which is a critically endangered TEC

9.2 Summary of Residual Environmental Impacts

Environmental impacts on State land once relevant mitigation and management measures have been taken into consideration are summarised below:

- Disturbance of PASS through excavation activities and groundwater dewatering
- Potential mobilisation of contaminated groundwater due to dewatering activities albeit preliminary modelling demonstrates that potential impacts can be managed effectively
- Clearing 2.47 ha of remnant vegetation in good or better condition. This remnant vegetation is classified as Threatened Ecological Communities as described below:
  - 1.72 ha of Swan Coastal Plain Floristic Community Type 20a/20b (*Banksia attenuata* woodland over species rich dense shrublands/*Banksia attenuata* and/or *Eucalyptus marginata* woodlands of the eastern side of the Swan Coastal Plain) which are listed as Endangered under the *Wildlife Conservation Act 1950*.
  - 0.75 ha of Swan Coastal Plain Floristic Community Type 20c (Shrublands and woodlands of the eastern side of the Swan Coastal Plain) which is listed as Critically Endangered under the *Wildlife Conservation Act 1950*.

- Impacts to significant flora include:
  - Clearing 25 *Conospermum undulatum* plants
- Impacts to significant fauna habitat includes:
  - Clearing 15 potential black cockatoo habitat trees
  - Clearing 3.56 ha of potential black cockatoo foraging habitat
  - Clearing 5.3 ha of Quenda habitat
- Impacts to wetlands include:
  - Clearing 3.28 ha of Resource Enhancement Wetland (UFI15876)
- Potential impacts to the registered Aboriginal Heritage sites Swan River and Poison Gully Creek

Using the Environmental Protection Authority's *Environmental Assessment Guideline for Application of a Significance Framework in the Environmental Impact Assessment Process* (Environmental Protection Authority, 2013), the significance of the residual impacts has been assessed. The significance of the potential impacts once relevant mitigation and management measures have been taken into consideration are not likely to have a significant effect on the environment and are therefore considered to meet the EPA's environmental objectives.

9.3 Environmental Management

The environmental management strategy for the FAL comprises preparation of a number of management plans which will specify management and mitigation measures and monitoring procedures for the potential environmental impacts described in this EIA. The management plans will be prepared by the PTA or the lead contractor to the satisfaction of the DER and relevant regulatory authorities as required. The management plans will be implemented by the PTA or lead contractor and will be monitored for compliance as required. Details of the management plans are provided below.

9.3.1 Construction Environmental Management Plan

To further reduce environmental impacts from the proposed alignment, all construction activities will be undertaken in accordance with a CEMP. The CEMP will present management measures that PTA and contractors will be responsible for implementing to ensure that the project is environmentally acceptable.

The CEMP will detail parties responsible for each management measure required to minimise environmental impacts. The management measures outlined in the CEMP will provide a basis for which performance and compliance can be measured throughout delivery of the project. The CEMP will include but not be limited to the following:

- Roles and responsibilities of the PTA and the contractor
- Timing of construction activities
- Detailed maps of proposed construction zones, including:
  - Permanent infrastructure and temporary works
  - Exclusion zones (e.g. high conservation areas, Aboriginal heritage sites)
- Vegetation clearing strategy, including:
  - Measures to minimise the extent of any vegetation clearing
  - Appropriate interface treatments, including fencing between the approved clearing area and any environmental receptors
  - Measures to ensure vehicle parking, laydown areas and stockpiles do not indirectly impact environmental values adjacent to the project area which are proposed for retention and protection
  - Access management

- Hygiene management program to minimise the spread of weeds and dieback, including:
  - Cleaning procedures for vehicles and equipment prior to entering / leaving the project area
  - Certification for the absence of weeds and dieback on any imported materials (including plants proposed for rehabilitation works)
- Stockpile management
- Air quality and dust suppression
- Waste management measures
- Measures to protect any registered or yet unidentified Aboriginal heritage
- Stormwater management measures
- Fauna management

During the construction phase, regular compliance monitoring of the CEMP's implementation will be undertaken and any non-conformances addressed. Records of non-conformances and the status of improvement actions will be detailed in appropriate construction documentation.

9.3.2 Other Management Plans

Additional management plans which will be prepared to ensure there are no adverse environmental impacts from the proposed project are summarised below:

- A Site Management Plan will be prepared to manage potential contamination
- An ASSDMP will be prepared to manage ASS and dewatering. The ASSDMP will be prepared to outline best practice procedures to manage and neutralise any ASS encountered and disturbed during excavation and dewatering activities
- A Construction Noise and Vibration Management Plan and task specific Noise Management Plans will be prepared to manage noise and vibration during construction activities
- An Operational Noise and Vibration Management Plan will be prepared to manage noise and vibration during operation of the FAL

9.3.3 Environmental Offsets

To mitigate the residual impacts to flora and vegetation, the PTA will develop and implement an Environmental Offset Strategy. The PTA will consult with the relevant government agencies to develop and implement an Environmental Offset Strategy.

The PTA has held preliminary discussions with the Land Tenure branch of DPaW in which the PTA presented the work undertaken to date with regards to identifying potential offset sites using DPaW's TEC and DRF database and evaluating options for translocation and propagation of *Conospermum undulatum*. The advice from DPaW was to not take any further steps in identifying potential offset sites until the requirement for offsets has been determined. DPaW also advised that if offsets are required, they will work with PTA to identify and obtain appropriate sites.

9.4 Approval Requirements

There are a number of regulatory processes and approvals which will be secured by the PTA or the lead contractor to ensure the environmental management and mitigation measures and monitoring procedures are commensurate to the potential impacts. The approval requirements required for the project are summarised in Table 35. The management plans which will be prepared are also included in Table 35.

Table 35: Summary of Management Strategy

Project Element	Relevant Legislation	Relevant Authority	Action	Responsibility
Construction Environmental Management	Various	Department of Environment Regulation	Construction Environmental Management Plan	Contractor
Flora and Vegetation	*Environmental Protection Act 1986* *Wildlife Conservation Act 1950*	Department of Environment Regulation Department of Parks and Wildlife	Native Vegetation Clearing Permit	PTA
			Licence to Take Flora	PTA
			Translocation Proposal	PTA
			Construction Environmental Management Plan	Contractor
			Environmental Offset Strategy	PTA
Fauna	*Wildlife Conservation Act 1950*	Department of Parks and Wildlife	Fauna Relocation Permit	Contractor
Contaminated Sites	*Contaminated Sites Act 2003*	Department of Environment Regulation	Site Management Plan (if required)	PTA
Acid Sulfate Soils	*Contaminated Sites Act 2003*	Department of Environment Regulation	Acid Sulfate Soils and Dewatering Management Plan	Contractor
Aboriginal Heritage	*Aboriginal Heritage Act 1972*	Department of Aboriginal Affairs	Section 18 Approval	PTA
Dewatering	*Rights in Water and Irrigation Act 1914*	Department of Water	5C licence to take water	Contractor
			26D licence to construct a bore	Contractor
Discharge of dewatering effluent	Various	Various	Gain consent to discharge dewatering effluent	Contractor
Spoil Reuse	*Environmental Protection Regulations 1987*	Department of Environment Regulation	Works Approval/Licence	Contractor
Surface Water Courses	*Rights in Water and Irrigation Act 1914*	Department of Water	Bed and Banks Permit	Contractor
Noise	*Environmental Protection (Noise) Regulations 1997*	Department of Environment Regulation	Construction Noise and Vibration Management Plan	Contractor
	Environmental Protection (Noise) Regulations 1997	Department of Environment Regulation	Noise Management Plan	Contractor
	SPP5.4	Department of Environment Regulation	Operational Noise and Vibration Management Plan	PTA

10 References

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