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Environmental impact assessment

Yanchep rail extension: Part 2 - Eglinton station to Yanchep station

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Assumptions and caveats

This following assumptions and caveats are applicable to this Environmental Impact Assessment (EIA) report.

No.	Assumptions
1	The *Biodiversity Conservation Act 2016* will eventually fully replace the *Wildlife Conservation Act 1950* (WC Act) in listing threatened species and regulating the protection of native species, however these provisions cannot be brought into effect until the necessary Biodiversity Conservation Regulations have been endorsed
2	Changes to government agencies: • Office of the EPA is now part of Department of Water, Environment and Regulation (DWER) • Department of Environmental Regulation (DER) is now part of the DWER • Department of Environmental Protection (DEP) is now part of DWER • Department of Environment and Conservation (DEC) is now the Department of Biodiversity, Conservation and Attractions (DBCA)
3	Minor variation in the areas of the vegetation types and fauna habitat when compared to GHD (2018b) is attributed to a difference in GIS operators' dataset analysis and rounding
4	Native vegetation in "Degraded" or worse condition is not considered by DEE (2016) to be part of the Banksia Woodlands of the Swan Coastal Plain TEC
5	Potential breeding trees which only partially intersect the development envelope will be retained

1 Executive summary

1.1 Introduction

The Public Transport Authority (PTA) is proposing to implement the first stage of the Western Australian Government's METRONET vision to transform Perth's transport network. The first stage of METRONET's priority projects includes 7.19 km of dual narrow-gauge track extension to the existing Joondalup electrified railway line from Butler to Yanchep, also known as the Yanchep Rail Extension (YRE) project. The YRE project responds to the rapid population growth in Perth's northern suburbs and the highly congested traffic network of the North-west Sub-region, through delivering an accessible, environmentally sensitive and economically sustainable form of public travel. Planning for the implementation of this new public transport system has been undertaken over many years, as described in subsequent sections of this report.

The entire YRE project is located within the City of Wanneroo, (approximately 40 kilometres (km) north-west of Perth's Central Business District (CBD)) focused within the suburbs of Butler, Alkimos, Eglinton and Yanchep.

The YRE project's total development envelope is 143.10 hectares (ha), divided into two discrete parts; Part 1 and Part 2 (Figure A):

- **Part 1: Butler Station to Eglinton Station** includes the southern portion of the YRE project area to the north of the Butler Station and generally follows the land reserved "Railway" under the Metropolitan Region Scheme (MRS) before terminating to the north of the proposed Eglinton Station. The Part 1 development footprint includes a contingency for a turnback facility to be constructed to the north of Eglinton Station, to allow for the turning of two six car trains (if required), should Part 2 of the YRE project not proceed.
- The 70.22 ha Part 1 development envelope is comprised of a 45.42 ha development footprint and 24.80 ha of construction and access areas (Figures A, B and C).
- **Part 2: Eglinton Station to Yanchep Station** includes the northern portion of the YRE project area to the north of the Eglinton Station and generally coincides with the land reserved "Railway" under the MRS before terminating within the northern section of the Yanchep City Local Structure Plan (LSP). The development footprint includes a turnback facility to the north of the Yanchep Station to allow for the turning and stowage of trains.

  The 72.88 ha Part 2 development envelope (development envelope) is comprised of a 60.31 ha development footprint and 12.57 ha of construction and access areas (Figures A, B and C).

This EIA report specifically assesses the environmental impacts associated with Part 2: Eglinton Station to Yanchep Station of the YRE project. The environmental impacts associated with Part 1 of the YRE project are addressed by Environmental Impact Assessment: Yanchep Rail Extension: Part 1: Butler Station to Eglinton Station (RPS 2018a).

1.1.1 Purpose of the report

The YRE project is being referred to the Environmental Protection Authority (EPA) under Section 38 of the *Environmental Protection Act 1986* (EP Act) in two parts. Part 1 of the YRE project, Butler Station to Eglinton Station, was referred to the EPA on 25 January, 2018. Part 1 is currently under assessment by the EPA at the level of "Referral Information with Additional Information (4 week public review)".

This EIA report has been prepared to support the referral of Part 2 of the YRE project to the EPA under Section 38 of the EP Act.

The purpose of this EIA report is to describe and assess the significance of the environmental impacts to the EPA's environmental factors associated with the construction and operation of Part 2 of the YRE project, with reference to specific technical investigations and detailed analysis undertaken by the PTA to assess the factors.

1.2 Background and context

METRONET is the long-term plan to connect our suburbs, reduce road congestion and meet Perth's future planning needs.

The ongoing growth of Perth's northern suburbs has been historically underpinned by the provision of rail infrastructure to the Yanchep community in key strategic planning documents including:

- draft Directions 2031 and Beyond (Department of Planning Western Australian Planning Commission [WAPC] 2010)
- Transport @ 3.5 million (Department of Transport [DoT], PTA and Main Roads Western Australia [MRWA] 2017)
- draft Perth and Peel Green Growth Plan (Department of Premier and Cabinet 2015)
- Perth and Peel@3.5million (Department of Planning, Lands and Heritage [DPLH] and WAPC 2018a).

The YRE project will form the principal public transport option serving the Yanchep and Two Rocks growth areas, providing current and future residents with a direct rail connection to Joondalup, the Perth CBD, and other parts of the metropolitan region. The rail extension also provides an important opportunity for the development of transit-oriented centres in Alkimos, Eglinton Yanchep, within the walkable catchments to the planned stations.

The key benefits arising from Part 2 of the YRE project include:

- improved access to public transport for Perth's northern suburbs
- improved connection to Perth's CBD and other destinations across the metropolitan area for residents living in Perth's northern most suburbs
- reduction of congestion on the Mitchell Freeway, Wanneroo Road and Marmion Avenue
- improved sustainability in terms of an overall reduction in vehicular emission pollutants.

Specifically, Part 2 of the YRE project also addresses three key local issues:

1. Worsening urban congestion due to a lack of efficient transport alternatives.
2. Continued planned land development that promotes private vehicle use and limits opportunities to create higher density residential areas.
3. Social inequality and lower levels of opportunity for people who do not own or are unable to use a private vehicle.

The YRE project responds to the rapid population growth in Perth's northern suburbs and the highly congested traffic network with an efficient electrified public rail system.

1.2.1 Previous and future planning considerations

In addition to key strategic planning documents identified above in Section 1.2, the MRS "Railways" reservation has been acknowledged in State Planning Policy 2.8: Bushland Policy for the Perth Metropolitan Region (SPP 2.8). Map 1 of SPP 2.8 shows the railway corridor intersecting Bush Forever Site No. 289: *Ningana Bushland, Yanchep/Eglinton* (Bush Forever Site No. 289), which was in place prior to the Bush Forever reservation.

Alternative alignment options were considered by the PTA early in the detailed design of the YRE project. An alternative railway alignment was considered for the portion of the development footprint that intersects Bush Forever Site No. 289 as part of the works package undertaken to inform the preparation of Northern Suburbs Railway Alignment Definition (Alkimos to Yanchep) Alignment Definition Report (GHD 2005; Figure F).

After undertaking a detailed review of the alternative alignment, the PTA could not accept the alternative for the following reasons:

- Track curvature was severe and below the minimum acceptable standards, which if adopted would have required significant speed restrictions, and would have produced wheel squeal as trains ran through those curves. This would also result in higher operational and maintenance costs to track and rollingstock.
- The alignment traversed highly undulating terrain which would have required very deep cuttings (up to 20 m) to achieve the required grades resulting in reserve widths approaching 100 m. This would have significantly increased the visual footprint of the railway, the clearing of native vegetation and the cost of earthworks.
- The alignment was 369 m longer, resulting in a larger footprint and more expensive implementation.
- The alignment was closer to proposed residential developments, presenting greater potential for community impacts and complaints, particularly with respect to the aforementioned noise issues.
- Development had commenced within the southern Yanchep Local Structure Plans (LSP) and it was estimated that the alternative alignment would have directly impacted around 150 properties if implemented.

Opportunities to amend the development footprint are limited due to residential construction being progressed on adjacent lands, or adjacent lands being zoned for future urban development and associated uses, which restricts the development footprint to the MRS “Railways” reservation. Notwithstanding the planning constraints imposed on the YRE project by surrounding developments, the development envelope has been iteratively modified by the PTA to minimise environmental and social impacts. The following amendments have been made:

- modification of the northern extent of the development footprint to reduce the clearing of native vegetation and avoid direct impacts to Bush Forever Site No. 288: *Yanchep National Park and Adjacent Bushland*
- construction and access areas have been selected to coincide with proposed future urban development cells or roads either reserved by the MRS (Figure B), or as detailed within approved and draft LSPs, to reduce the likelihood of impacting native vegetation proposed to be retained within future Public Open Space (POS) reservations
- previous MRS amendments 1192/57 and 1248/57 have determined the point of egress into Bush Forever Site No. 289 for the “Railways” reservation, however the development envelope has been situated to
  - minimise impacts to the Quindalup 2 parabolic dunes (Figure S)
  - maximise the size and viability of the western portion of Bush Forever Site No. 289 (Figure L)
  - include approximately 29% of previously disturbed land (Section 8.6.5.1.1), which are not considered to be representative of remnant native vegetation
- access tracks within Bush Forever Site No. 289 have been planned to accommodate PTA, Department of Biodiversity Conservation and Attractions (DBCA) and Department of Fire and Emergency Services (DFES) operational requirements, thereby eliminating the potential for the duplication of access tracks by the agencies and reducing native vegetation clearing
- development footprint and volumes of sand to be excavated within Bush Forever Site No. 289 has been reduced through a decision to raise the vertical alignment of the railway through this site, which has minimised the potential impacts to flora and vegetation, fauna habitat and landform.

Previous amendments to the MRS and Town Planning Scheme (TPS) within parts of the development envelope have been referred to the EPA for assessment under Section 48a of the EP Act, and have been subject to formal environmental assessment (Table 9).

1.2.1.1 State planning policy 2.8: bushland policy for the perth metropolitan region

SPP 2.8 provides a policy and implementation framework that will ensure bushland protection and management issues in the Perth Metropolitan Region are appropriately addressed and integrated with broader land use planning and decision-making, in order to secure long-term protection of biodiversity and associated environmental values. The policy is based on the Bush Forever report by the Government of Western Australia (2000).

SPP 2.8 recognises the protection and management of significant bushland areas as a fundamental consideration in the planning process, while also seeking to integrate and balance wider environmental, social and economic considerations. In general terms, the policy does not prevent development where it is consistent with the policy measures and other planning and environmental considerations.

Section 5.1.2.3 Bush Forever Area – Government lands or public infrastructure within SPP 2.8 states:

Where land includes—

- *regionally significant bushland within the government lands or public infrastructure site implementation category on map 1 (and any subsequent amendments); or*
- *regionally significant bushland located within another site implementation category on map 1 that is likely to be adversely affected by existing or proposed public infrastructure or utility services.*

Proposals or decision-making should—

(i) Seek to protect regionally significant bushland as a priority, except where a proposal or decision—

(a) is consistent with the overall purpose and intent of an existing reserve, existing approved uses and/or existing planning or environmental commitments or approvals, in particular, existing reserves for roads (regional or local), railways, pipelines, water or drainage services and any associated emergency maintenance works, with any impacts minimised and managed, where practical, in accordance with existing environmental management plan best practice requirements;

(Government of Western Australia 2010)

As noted, the railway corridor intersecting Bush Forever Site No. 289 was in place prior to the Bush Forever reservation. The Bush Forever report includes Practice Note 18: Road and Railway Reserves, which provides guidance for sites affecting regional railway and road reserves. Practice Note 18 encourages the due consideration of bushland protection in the design and location of future roads/railways, however acknowledges the primary purpose of these reserves to accommodate the State's vital transport infrastructure (Government of Western Australia 2000).

Section 8.6.5 provides a detailed assessment of the potential impacts to the vegetation and flora within Bush Forever Site No 289 from the implementation of Part 2 of YRE project, whilst Sections 8.7 and 8.8 detail how these potential impacts will be mitigated and managed.

1.3 Overview of the proposal

Part 2: Eglinton Station to Yanchep Station includes the construction of a dual narrow-gauge track from a future connection with the Joondalup railway line, approximately 0.67 km north of the future Eglinton Station. The railway will pass through Bush Forever Site No. 289 and existing urban development in Yanchep before terminating approximately 0.93 km north of the future Yanchep Station (Figures A, C and H).

The 72.88 ha development envelope is comprised of a 60.31 ha development footprint and 12.57 ha of construction and access areas. Table 1 provides an overview of the proposal and the potential native vegetation clearing requirements.

Table 1 Proposal overview

Proposal title	Yanchep Rail Extension, Part 2: Eglinton Station to Yanchep Station
Proponent name	Public Transport Authority
Short description	The 7.19 km of dual narrow-gauge track will be located within a 60.31 ha development footprint. The development footprint is inclusive of a turnback facility to the north of the Yanchep Station and all ancillary infrastructure such as stations, stormwater drainage basins, principal shared paths for pedestrian and cyclist use and railway maintenance access roads. The railway will be cut approximately 5 m below the surrounding ground level where adjacent to existing and future urban developments.The railway corridor will be stabilised either through battering the excavation or using retaining walls. The corridor is approximately 40 m wide. The width of the railway corridor ranges from 74 m to 127 m within Bush Forever Site No. 289 (Figures G-2 and G-3). Yanchep Station will be an at grade station which will serve the Yanchep locality and surrounding future suburbs. The Yanchep Station development footprint is included within the development footprint and is approximately 6.37 ha in extent (Figures G-1). The construction and access areas will be located within a 12.57 ha extent outside of the development footprint but within the development envelope (Figures G-1 to G-4).
Development envelope	72.88 ha
Development footprint	60.31 ha
Construction and access area	12.57 ha
Native vegetation clearing requirements	Up to 62.32 ha of vegetation comprised of: • 53.19 ha of remnant native vegetation • 9.13 ha of planted vegetation comprised of a mixture of native and introduced flora species not considered to be remnant native vegetation.

1.4 Community engagement and stakeholder consultation

METRONET projects are about creating benefit for the communities they are built in. The PTA is implementing a Communications and Stakeholder Engagement Plan (PTA 2017b) to guide the community relations activities for the various phases (i.e. planning, design and procurement; and construction and commissioning) of the YRE project.

The Communications and Stakeholder Engagement Plan's community relations activities include:

- identifying and resolving issues that affect stakeholders, residents, businesses and other community members, and managing their information needs
- issuing communications to stakeholders

- establishing and maintaining relationships with local community groups, residents, businesses, City of Wanneroo (CoW) and other stakeholders where relevant
- identifying and responding to local issues, including preparation of, and contribution to, communication strategies to address issues
- responding to email, telephone and general inquiries from the public and stakeholders, including directing enquiries to relevant project staff and ensuring timely responses
- managing complaints
- liaising with relevant PTA project managers and contractor project managers on issue close-outs and residual community matters
- managing the PTA's database of stakeholders.

Further, a dedicated METRONET website[1] has been established which, in addition to providing a detailed overview of the YRE project, allows interested parties to inquire about METRONET through a dedicated email address[2] and register for project updates.

The PTA has consulted with the relevant government agencies and community-based environmental groups as part the implementation of the YRE project's Communications and Stakeholder Engagement Plan. These government agencies and groups include:

- Commonwealth Department of the Environment and Energy (DEE)
- Department of Water and Environmental Regulation (DWER)
- EPA
- DBCA
- CoW
- Urban Bushland Council
- Quinns Rocks Environmental Group.

1.5 Summary of potential impacts, proposed mitigation and outcomes

The following environmental factors are considered relevant to Part 2 of the YRE project:

- land factors
  - flora and vegetation
  - landforms
  - subterranean fauna
  - terrestrial environmental quality
  - terrestrial fauna
- water factor
  - inland waters
- people factor
  - social surroundings.

[1] http://www.metronet.wa.gov.au/
[2] mailto:info@metronet.wa.gov.au

Technical surveys, investigations and environmental impact assessments have been undertaken for each of these environmental factors to specifically assess the potential and residual environmental impacts which may result from the construction and operation of Part 2 of the YRE project.

Table 2 summarises the results of this EIA report's assessment of the potential impacts, proposed mitigation measures and predicted outcomes (after the application of the EPA's mitigation hierarchy) for each of the identified environmental factors.

1.5.1 Key conclusions

This EIA report demonstrates that the potential environmental impacts from the implementation of Part 2 of the YRE project are relatively minor when considered in local, regional and bioregional receiving environmental contexts, and are capable of being managed to meet the EPA's relevant environmental factor objectives. The environmental values identified within the development envelope are well represented within the North-west Sub-regional area.

Through the application of the EPA's mitigation hierarchy (avoid, minimise, rehabilitate) to manage the potential environmental impacts, the risk of significant residual impacts to the environmental factors from the implementation of Part 2 of the YRE project has been reduced to be as low as practicable.

This EIA report has identified the following significant residual impacts to the environmental factors of Flora and Vegetation and Terrestrial Fauna:

- permanent loss of up to 0.05 ha *Melaleuca huegelii – M. acerosa* [*M. systena*] shrublands on limestone ridges Threated Ecological Community (TEC) 26a in "Very Good" condition
- permanent loss of up to 12.10 ha of Banksia Woodlands of the Swan Coastal Plain TEC
- permanent loss of up to 18.11 ha of regionally significant bushland within Bush Forever Site No. 289, including 12.38 ha of regionally significant bushland reserved as "Parks and Recreation"
- permanent loss of up to 56.96 ha of Carnaby's Black Cockatoo foraging habitat and 37 potential breeding trees.

To counterbalance these significant residual environmental impacts an appropriate Offset Strategy will be prepared and implemented to the satisfaction of DWER and the Commonwealth DEE. The Offsets Strategy will provide details of the PTA's proposed approach to directly offset the significant residual impacts to TECs, regionally significant bushland within Bush Forever Site No. 289 and Carnaby's Black Cockatoo.

This will likely involve the acquisition and/or securing of land that has no existing conservation tenure and transfer to the conservation estate and undertaking rehabilitation works in local degraded areas. PTA may also consider the funding of research or monitoring that will inform the conservation of the TECs and/or Bush Forever Site No. 289 and/or Carnaby's Black Cockatoo, particularly if an appropriate area of land is not able to be acquired or rehabilitated.

The PTA has advanced discussions with the DBCA to inform the preparation of an Offsets Strategy for Part 2 of the YRE project. A number of offset locations have been identified, and these sites are currently being reviewed by the PTA.

Table 2 Summary of the potential impacts, proposed mitigation and outcomes

Flora and vegetation		
EPA objective		To protect flora and vegetation so that biological diversity and ecological integrity are maintained
Policy and guidance		• *Environment Protection and Biodiversity Conservation Act 1999* • *Wildlife Conservation Act 1950* / *Biodiversity Conservation Act 2016* • Environmental Factor Guideline: *Flora and Vegetation* (EPA 2016a) • Technical Guidance: *Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016b) • SPP 2.8: Bushland Policy for the Perth Metropolitan Region
Potential impacts	Direct impacts	• Permanent loss of 47.30 ha of native vegetation representative of the previously mapped vegetation associations and regional vegetation complexes in "Degraded" or better condition • Permanent loss of one *Hibbertia spicata* subsp. *leptotheca* (Priority 3) individual; two low density populations of *Beyeria cinerea* subsp. *cinerea* (Priority 3); up to 22 *Conostylis pauciflora* subsp. *euryrhipis* (Priority 4) individuals; and one *Conostylis pauciflora* subsp. *pauciflora* (Priority 4) individual • Permanent loss of 0.05 ha of *Melaleuca huegelii – M. acerosa* [*M. systena*] shrublands on limestone ridges TEC 26a in "Very Good" condition • Permanent loss of 12.65 ha of Banksia dominated woodlands of the Swan Coastal Plain IBRA Region PEC (Priority 3) in "Degraded" or better condition, which includes 12.10 ha of Banksia Woodlands of the Swan Coastal Plain TEC • Permanent loss of 15.72 ha of Northern Spearwood shrublands and woodlands PEC (Priority 3) in "Degraded" or better condition • Permanent loss of 2.14 ha of Tuart (*Eucalyptus gomphocephala*) woodlands of the Swan Coastal Plain PEC (Priority 3) in "Degraded" condition • Permanent loss of 18.11 ha of regionally significant bushland within Bush Forever Site No. 289, including 12.38 ha of regionally significant bushland reserved as "Parks and Recreation" under the MRS
	Indirect impacts	• Introduction and distribution of Declared Pests and other weed species • Introduction and distribution of *Phytophthora* dieback • Disturbance to surrounding native vegetation during construction works

Mitigation	Avoid	• Modification of the development footprint to reduce the clearing of native vegetation and avoid direct impacts to Bush Forever Site No. 288: *Yanchep National Park and Adjacent Bushland*
		• Access tracks within Bush Forever Site No. 289 have been planned to accommodate PTA, DBCA and DFES operational requirements thereby eliminating the potential for the duplication of access tracks by the agencies and reducing native vegetation clearing
		• Construction Environment Management Plan (CEMP) will be prepared to avoid the introduction and distribution of Declared Pests, other weed species and *Phytophthora* dieback as well as avoid disturbance to surrounding native vegetation during the construction of Part 2 of the YRE project. CEMP will be prepared to accord with the approved management plans for the portion of the Part 2 YRE project development envelope which intersects the EPBC 2011/ 6021 approval:
		  • Conservation Management Plan for Regional Open Space and Pubic Open Space (Strategen 2015)
		  • Clearing and Revegetation Management Plan (Strategen 2014)

	Minimise	• Construction and access areas have been selected to coincide with proposed future urban development cells or roads either reserved by the MRS, or as detailed within approved and draft LSPs, to reduce the likelihood of impacting native vegetation proposed to be retained within future POS reservations
		• CEMP will be prepared to ensure that clearing is restricted to the development envelope. CEMP will be prepared to accord with the approved management plans for the portion of the development envelope which intersects the EPBC 2011 / 6021 approval:
		  • Conservation Management Plan for Regional Open Space and Pubic Open Space (Strategen 2015)
		  • Clearing and Revegetation Management Plan (Strategen 2014)
		• CEMP will include adaptive management measures that will be implemented should the avoidance measures not be met
		• Operational railway corridor will be managed by the PTA in perpetuity in accordance with its Vegetation Management Manual. The PTA's Urban Rail Reserve Vegetation Management Plan (PTA 2016) requires herbicide application for weeds to be undertaken on a 6 monthly basis along an 8 metre track corridor and on an annual basis for fences and associated rail structures. Additionally, the PTA undertakes regular inspections for and treats Declared Pests, as required (PTA 2016)
		• Alternative railway alignment with a reduced direct impact on Bush Forever Site No. 289 was considered however was determined not to be feasible (Section 4.2.4).
		• Previous MRS amendments have determined the point of egress into Bush Forever Site No. 289 for the "Railways" reservation, however the development envelope has been situated to:
		  • minimise impacts to the Quindalup 2 parabolic dunes (Figure S)
		  • maximise the size and viability of the western portion of Bush Forever Site No. 289 (Figure L)
		  • include approximately 29% of previously disturbed land (VT12 and CL; Section 8.6.5.1.1), which is not considered to be representative of remnant native vegetation
		• Construction and access areas have intentionally not been located within Bush Forever Site No. 289, reducing the native vegetation clearing to only that required for operational purposes
		• Development footprint and volumes of sand to be excavated within Bush Forever Site No. 289 has been reduced through a decision to raise the vertical alignment of the railway through this site, which has minimised the potential impacts to flora and vegetation

	Rehabilitate	• Cleared construction and access areas will be managed by the PTA during and post construction to prevent weed establishment • Detailed engineering design will be undertaken to minimise landform impacts and identify structural controls (i.e. battering the excavation and / or retaining walls) that will be implemented to stabilise the affected landform. Should the batters be of a suitable gradient and material, they will be stabilised with planting of locally endemic species and/or bioengineering controls that will be sympathetic to the surrounding native vegetation within Bush Forever Site No.

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Outcome	Residual impact	• Permanent loss of up to 47.30 ha of native vegetation representative of the previously mapped vegetation associations and regional vegetation complexes in “Degraded” or better condition • Permanent loss of up to one *Hibbertia spicata* subsp. *leptotheca* (Priority 3) individual; two low density populations of *Beyeria cinerea* subsp. *cinerea* (Priority 3); up to 22 *Conostylis pauciflora* subsp. *euryrhipis* (Priority 4) individuals; and one *Conostylis pauciflora* subsp. *pauciflora* (Priority 4) individual • Permanent loss of up to 0.05 ha *Melaleuca huegelii – M. acerosa* [*M. systena*] shrublands on limestone ridges TEC 26a in “Very Good” condition • Permanent loss of up to 12.65 ha of Banksia dominated woodlands of the Swan Coastal Plain IBRA Region PEC (Priority 3) in “Degraded” or better condition, which includes 12.10 ha of Banksia Woodlands of the Swan Coastal Plain TEC • Permanent loss of up to 15.72 ha of Northern Spearwood shrublands and woodlands PEC (Priority 3) in “Degraded” or better condition • Permanent loss of up to 2.14 ha of Tuart (*Eucalyptus gomphocephala*) woodlands of the Swan Coastal Plain PEC (Priority 3) in “Degraded” condition • Permanent loss of 18.11 ha of regionally significant bushland within Bush Forever Site No. 289, including 12.38 ha of regionally significant bushland reserved as “Parks and Recreation” under the MRS
	Offset	The permanent loss of up to 0.05 ha of *Melaleuca huegelii – M. acerosa* [*M. systena*] shrublands on limestone ridges TEC 26a in “Very Good” condition, 12.10 ha Banksia Woodlands of the Swan Coastal Plain TEC and 18.11 ha of regionally significant bushland within Bush Forever Site No. 289 (which includes 12.38 ha of regionally significant bushland reserved as “Parks and Recreation”) will be appropriately counterbalanced through the preparation and implementation of an appropriate Offsets Strategy
	Flora and vegetation will be appropriately protected so that biological diversity and ecological integrity are maintained to meet the EPA’s Flora and Vegetation objective	
Landforms		
EPA objective	To maintain the variety and integrity of significant physical landforms so that environmental values are protected	
Policy and guidance	Environmental Factor Guide*l*ine: *Landforms* (EPA 2018a)	
Potential impacts	Direct impacts	Permanent loss of 17.54 ha of the Quindalup 1 and 2 parabolic dune systems within the development envelope
	Indirect impacts	Cleared earthworks batters could result in the creation of blow outs which may further alter the parabolic dune’s morphology as well as encroaching on the adjacent extents of conservation significant native vegetation
Mitigation	Avoid	• Alternative alignment that was considered traversed highly undulating terrain which would have required very deep cuttings (up to 20 m) to achieve the required grades resulting in reserve widths approaching 100 m. This would have significantly increased the potential interruption of geomorphological processes resulting from implementation of the proposal • CEMP will be prepared to ensure that clearing is restricted to the development envelope and that batters are stabilised post construction
	Minimise	• Development footprint and volumes of sand to be excavated within Bush Forever Site No. 289 has been reduced through a decision to raise the vertical alignment of the railway through this site, which has minimised the potential impacts to landform • CEMP will be prepared to address the potential impacts to landforms during the construction, ensure that clearing is restricted to the development envelope and that batters are stabilised post construction
	Rehabilitate	Detailed engineering design will be undertaken to minimise landform impacts and identify structural controls (i.e. battering the excavation and / or retaining walls) that will be implemented to stabilise the affected landform. Should the batters be of a suitable gradient and material, they will be stabilised with planting of locally endemic species and/or bioengineering controls that will be sympathetic to the surrounding native vegetation within Bush Forever Site No. 289
Outcome	• Through the implementation of the EPA’s mitigation hierarchy, the permanent loss of 17.54 ha of Quindalup 1 and 2 parabolic dune system in the development envelope and indirect impacts will be managed to be as low as reasonably practicable. The physical impacts associated with Part 2 of the YRE project will be mitigated within Bush Forever Site No. 289 by detailed engineering design and land stabilisation • The variety and integrity of the Quindalup 1 and 2 parabolic dune systems within Bush Forever Site No. 289 will be maintained and that the Alkimos Dune System still has adequate representation at the regional scale so that environmental values are protected to meet the EPA’s Landforms objective	
Short-range endemic (SRE) invertebrates and subterranean fauna		
EPA objective	• To protect subterranean fauna so that biological diversity and ecological integrity are maintained • To protect terrestrial fauna so that biological diversity and ecological integrity are protected	
Policy and guidance	• Technical Guidance: *Sampling of Short Range Endemic Invertebrate Fauna* (EPA 2016c) • Environmental Factor Guideline: *Subterranean Fauna* (EPA 2016d) • Technical Guidance: *Subterranean Fauna Survey* (EPA 2016e) • Technical Guidance: *Sampling Methods for Subterranean Fauna* (EPA 2016f) • Environmental Factor Guideline: *Terrestrial Fauna* (EPA 2016h)	
Potential	Direct impacts	Permanent loss of SRE invertebrate habitat and subterranean fauna habitat

impacts	Indirect impacts	• Habitat fragmentation and genetic isolation • Weed incursion • Increased sedimentation and alteration of surface hydrology • Native vegetation clearing reducing amount of organic carbon entering the subterranean environment • Alteration of existing hydrological regimes due to the construction of roads, buildings and other hard stand areas that will restrict the infiltration of water into the subterranean environment • Groundwater contamination due to spills impacting habitat for subterranean fauna
Mitigation	Avoid	• Modification of the development envelope to reduce the clearing of SRE invertebrate habitat and avoid direct impacts to Bush Forever Site No. 288: *Yanchep National Park and Adjacent Bushland* • Access tracks within Bush Forever Site No. 289 have been planned to be accommodate PTA, DBCA and DFES operational requirements thereby eliminating the potential for the duplication of access tracks by the agencies and reducing SRE habitat clearing • No large scale karstic features, such as sinkholes or caverns, have been identified within Part 2 of the YRE project's development footprint • Dewatering will not be required to facilitate construction • Prior to the commencement of construction activities, a further detailed geotechnical investigation will be undertaken to supplement and validate the initial findings of the Advisian (2017) investigation and enable detailed design of key structural elements

	Minimise	• Construction and access areas have been selected to coincide with proposed future urban development cells or roads either reserved by the MRS, or as detailed within approved and draft LSPs, to reduce the likelihood of impacting SRE invertebrate habitat proposed to be retained within future POS reservations
		• Development footprint and volumes of sand to be excavated within Bush Forever Site No. 289 has been reduced through a decision to raise the vertical alignment of the railway through this site, which has minimised the potential impacts to SRE invertebrate habitat
		• CEMP will be prepared to ensure that construction activities are limited to the development envelope and to manage the potential impacts to SRE invertebrates and subterranean fauna during the construction of Part 2 of the YRE project
		• Four fauna underpasses will be located underneath the railway line within Bush Forever Site No. 289. It is anticipated that the fauna underpasses will provide some opportunity for the limited dispersion of SRE invertebrates, such as the millipede (*Antichiropus whistleri*) and trapdoor spider (*Idiosoma sigillatum*), that will assist in maintaining local connectivity between the extents of Bush Forever Site No. 289 and assist in maintaining genetic connectivity
		• If significant caves or voids are encountered during construction activities, work will be suspended until their potential impact on subterranean fauna can be assessed by a suitably qualified person:
		  • Engineering solutions to significant caves or voids that are encountered will be discussed with a suitably qualified subterranean biologist to ensure their suitability
		  • If significant cave or voids that contain potentially important subterranean biodiversity will be destroyed, then collection of specimens and genetic material for deposition into the Western Australian Museum collections should be undertaken by a suitably qualified person
		• Groundwater abstraction for construction water will be regulated under the *Rights in Water and Irrigation Act 1914*
		• Potential indirect impacts to groundwater quality (potential groundwater contamination) from the operation of the railway will be managed through the implementation of the PTA's standard spill response framework for rail corridors

	Rehabilitate	Implementation of best practice Water Sensitive Urban Design (WSUD) principles in the design of and stormwater management approach for the YRE railway and station infrastructure will control the quality of stormwater recharged to the groundwater aquifers
Outcome		• Through the implementation of the mitigation hierarchy the potential impacts to SRE invertebrates and Subterranean Fauna associated with Part 2 of the YRE project will be managed to be as low as reasonably practicable • Given the above and PTA's past performance in implementing appropriate mitigation measures as part of the construction and operation of railway projects it is considered that SRE invertebrates and subterranean fauna will be protected so that biological diversity and ecological integrity are maintained to meet the EPA's Subterranean Fauna and Terrestrial Fauna objectives
Terrestrial environmental quality		
EPA objective		To maintain the quality of land and soils so that environmental values are protected
Policy and guidance		• *Contaminated Sites Act 2003* • Environmental Factor Guideline: *Terrestrial Environmental Quality* (EPA 2016g) • Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes (DER 2015a) • Treatment and Management of Soils and Water in Acid Sulfate Soil Landscapes (DER 2015b) • Assessment and Management of Contaminated Sites (DER 2014)
Potential impacts		• Acidification and release of heavy metals from ASS into the terrestrial environment and underlying groundwater • Injury from UXOs • Contaminated soil or groundwater is unearthed during construction
Mitigation	Avoid	• Development envelope is not mapped at being at risk of ASS occurring and it is considered unlikely that ASS would be encountered during construction • No registered contaminated sites are located within the development envelope or locally within 1 km of the proposal • CEMP will be prepared to ensure that construction activities are limited to the development envelope to decrease the low residual risk of construction workers being injured by UXOs
	Minimise	• Construction program proposed in Advisian (2017) involves filling of the lower lying areas within the development footprint. This approach further decreases the already low residual risk of ASS being unearthed during earthworks • In the unlikely event that ASS is encountered during construction, it is proposed to be managed in accordance with the DWER's Acid Sulfate Soils Guidelines

		• Prior to the commencement of earthworks, a technical investigation will be conducted of all areas identified as being of risk of containing UXOs • CEMP will be prepared to manage any unexpected finds in accordance with the *Contaminated Sites Act 2003* and also includes adaptive management measures that will be implemented should the avoidance measures not be met
	Rehabilitate	If the technical investigation indicate that UXOs are or may be present within the development envelope then the affected areas will be remediated
Outcome		• Through the implementation of the mitigation hierarchy the quality of the existing environmental values of the land and soils within the development envelope will be protected • Given the above and PTA's past performance in implementing appropriate mitigation measures as part of the construction and operation of railway projects it is considered that the EPA's Terrestrial Environmental Quality objective will be met
Terrestrial fauna		
EPA objective		To protect terrestrial fauna so that biological diversity and ecological integrity are protected
Policy and guidance		• *Environment Protection and Biodiversity Conservation Act 1999* • *Wildlife Conservation* / *Biodiversity Conservation Act 2016* • Environmental Factor Guideline: *Terrestrial Fauna* (EPA 2016h) • Technical Guidance: *Sampling Methods for Terrestrial Vertebrate Fauna* (EPA 2016i) • Technical Guidance: *Terrestrial Fauna Surveys* (EPA 2016j)
Potential impacts	Direct impacts	• Permanent loss of up to 62.32 ha of fauna habitat, considered to be of high to medium habitat value • Permanent loss of up to 56.96 ha of Carnaby's Black Cockatoo foraging habitat and 37 potential breeding trees • Injury and/or mortality during clearing activities and construction and operation of the railway • East-west ecological linkage will be permanently fragmented by the implementation of Part 2 of the YRE project • Disturbance during construction (clearing activities and noise) and operation (noise and vibration) may affect the local abundance of fauna populations due to interruption to fauna behaviour
	Indirect impacts	Habitat and food source degradation through increased pollution, waste, spread of weeds and altered hydrology edge effects
Mitigation	Avoid	• Modification of the development envelope to reduce the clearing of fauna habitat and avoid direct impacts to Bush Forever Site No. 288: *Yanchep National Park and Adjacent Bushland* • Access tracks within Bush Forever Site No. 289 have been planned to accommodate PTA, DBCA and DFES operational requirements thereby eliminating the potential for the duplication of access tracks by the agencies and reducing fauna habitat clearing • Appropriate fencing will be installed within Bush Forever Site No. 289 to restrict terrestrial fauna access to the rail corridor (avoiding injury and/or mortality)

	Minimise	• Construction and access areas have been selected to coincide with proposed future urban development cells or roads either reserved by the MRS, or as detailed within approved and draft LSPs, to reduce the likelihood of impacting fauna habitat proposed to be retained within future POS reservations
		• Development footprint and volumes of sand to be excavated within Bush Forever Site No. 289 has been reduced through a decision to raise the vertical alignment of the railway through this site, which has minimised the potential impacts to fauna habitat
		• CEMP will be prepared to address the potential impacts to terrestrial fauna during the construction of Part 2 of the YRE project. CEMP will be prepared to accord with the approved management plans for the portion of the development envelope which intersects the EPBC 2011 / 6021 approval:
		  ◦ Conservation Management Plan for Regional Open Space and Pubic Open Space (Strategen 2015)
		  ◦ Clearing and Revegetation Management Plan (Strategen 2014)
		• Four fauna underpasses will be located underneath the railway line within Bush Forever Site No. 289 to maintain the east-west ecological linkage and provide for the long-term movement of native fauna. The fauna underpass will be appropriately sized to allow for the movement of larger species of terrestrial fauna, such as Western Grey Kangaroo (*Macropus fuliginosus*) and Western Brush Wallaby (*Macropus irma*), as well as smaller non-avian / ground dwelling fauna species, such as the Southern Brown Bandicoot (*Isoodon obesulus* subsp. *fusciventer*) and reptile species
		• Appropriate fencing will be installed within Bush Forever Site No. 289 to restrict terrestrial fauna access to the rail corridor and to encourage terrestrial fauna movement towards the openings of the fauna underpasses. Fencing will be maintained by the PTA on an as required basis
		• Operational railway corridor will be managed by the PTA in perpetuity, standard measures for pollution control and waste disposal will be implemented at the stations and within the rail corridor
		• Opportunities to amend the development footprint are limited due to the gazetted MRS "Railways" reservation. PTA has previously considered an alternative alignment with Bush Forever Site No. 289 which was determined to not be feasible

	Rehabilitate	Detailed engineering design will be undertaken to minimise landform impacts and identify structural controls (i.e. battering the excavation and / or retaining walls) that will be implemented to stabilise the affected landform. Should the batters be of a suitable gradient and material, they will be stabilised with planting of locally endemic species and/or bioengineering controls that will be sympathetic to the surrounding native vegetation within Bush Forever Site No. 289. Species selection will be considerate of creating habitat for Carnaby's Cockatoo

Outcome	Residual impact	• Permanent loss of up to 62.32 ha of fauna habitat, considered to be of high to medium habitat value • Permanent loss of up to 56.96 ha of Carnaby's Black Cockatoo foraging habitat and 37 potential breeding trees • East-west ecological linkage will be permanently fragmented by the implementation of Part 2 of the YRE project however four fauna underpasses will be located underneath the railway line to maintain the east-west ecological linkage and provide for the long-term movement of native fauna. Through the provision of fauna underpasses underneath the operational railway line potential impacts from habitat fragmentation and loss of ecological connectivity will be managed to be as low as reasonably practicable
	Offset	The permanent loss of 56.96 ha of Carnaby's Black Cockatoo foraging habitat and 37 potential breeding trees will be counterbalanced through the provision of an appropriate Offset Strategy to be prepared and implemented to the satisfaction of DWER and Commonwealth DEE
	Terrestrial fauna will be appropriately protected so that biological diversity and ecological integrity are maintained so that the EPA's Terrestrial Fauna objective is met.	
Inland waters		
EPA objective	To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected	
Policy and guidance	Environmental Factor Guideline: *Inland Waters* (EPA 2018b)	
Potential impacts	Direct impacts	• Alteration of the existing landscape within the development envelope which in turn alters the surface water flow paths and recharge locations during rainfall • Contamination of groundwater during construction activities, with potential sources including uncontained spills, refuelling and plant and vehicle fluid leaks • Contaminated stormwater runoff from the operational railway and stations may impact groundwater
	Indirect impacts	• Reduction in groundwater availability for nearby native vegetation • Reduction of groundwater available for nearby abstractors
Mitigation	Avoid	• No surface water features are located with the development envelope • Development envelope has avoided the Water Corporation's existing Production Bores and the groundwater bores of other users • Dewatering will not be required to facilitate construction
	Minimise	• CEMP will be prepared to address the potential impacts to groundwater quality (potential groundwater contamination) during the construction of Part 2 of the YRE project • Best practice WSUD principles in the design of and stormwater management approach for the YRE railway and station infrastructure will be implemented to maintain the existing local hydrological flows and protect the ground water quality of the Priority 3 Perth Coastal Underground Water Pollution Control Area • Location and anticipated usage of the PTA's proposed abstraction bores has minimised drawdown impacts to Water Corporation's existing Production Bores, other ground water users and sensitive environmental receptors at the local and regional scales • Groundwater abstraction for construction water will be regulated under the *Rights in Water and Irrigation Act 1914* • Potential indirect impacts to groundwater quality (potential groundwater contamination) from the operation of the railway will be managed through the implementation of the PTA's standard spill response framework for rail corridors
	Rehabilitate	• Drainage basins and urban water management features will be appropriately landscaped (where practicable in the context of an operational railway line and associated infrastructure) • Infill or replacement planting of WSUD infrastructure to be undertaken by the PTA on an as-required basis
Outcome	• Through the implementation of the mitigation hierarchy the potential impacts to the groundwater underlying Part 2 of the YRE project will be managed to be as low as reasonably practicable • Given the above and PTA's past performance in implementing appropriate mitigation measures as part of the construction and operation of railway projects it is considered that the EPA's objective for the Inland Waters will be met	
Social surroundings		
EPA objective	To protect social surroundings from significant harm	
Policy and guidance	• *Aboriginal Heritage Act 1972* • *Heritage of Western Australia Act 1990* • *Fire and Emergency Services Act 1998* • Environmental Factor Guideline: *Social Surroundings* (EPA 2016k) • Environment Protection (Noise) Regulations 1997 • SPP 5.4: Road and Rail Transport Noise and Freight Considerations in Land Use Planning • AS 2670.2-1990 Evaluation of human exposure to the whole-body vibration; Part 2: Continuous and shock-induced vibration in buildings (1 to 80 Hz) • A Guideline for Managing the Impacts of Dust and Associated Contaminants from Land Development Sites, Contaminated Site Remediation and other Related Activities (DEC 2011) • National Environmental Protection (Ambient Air Quality) Measure • SPP 3.7: Planning in Bushfire Prone Areas • PTA's Noongar Standard Heritage Agreement	

Potential impacts	Direct impacts – Aboriginal heritage	Excavation / construction activities may unearth and/or damage artefacts or other items of Aboriginal cultural significance
	Direct impacts – noise and vibration	• Temporary exposure of site workers and existing and future residents to the construction-related noise and vibration • Ongoing exposure of existing and future residents to the railway-related noise and vibration
	Direct impacts – dust	• Existing residences located adjacent to or in close proximity of the development envelope may be exposed to elevated dust levels • Dust may accumulate on adjacent native vegetation, where it settles on leaves and restricts physiological function
	Direct and indirect impacts – fire	• Damage to infrastructure from fire • Death and/or injury of people/fauna due to fire
	Indirect impacts	• Temporary exposure of visitors to State heritage sites located within close proximity to the development envelope (i.e. Yanchep National Park) to construction-related noise • Introduction and distribution of weed species to Yanchep National Park from plant machinery and service vehicles movements • Introduction and distribution of *Phytophthora* dieback to Yanchep National Park from plant machinery and service vehicles movements • Dust may be generated by the crushing of excavated limestone
Mitigation	Avoid	No heritage places listed on the State Register of Heritage Places or the CoW's Scheme Heritage List are mapped within the development envelope
	Minimise	• Construction and access areas have been selected to coincide with proposed future urban development cells or roads either reserved by the MRS, or as detailed within approved and draft LSPs, to reduce the likelihood of impacting Registered Aboriginal Heritage sites proposed to be retained within future POS reservations • Aboriginal monitors will be onsite for clearance and initial groundwork at the Yanchep station site to assist with the identification and management of any Aboriginal objects identified or unearthed during construction • Should any Aboriginal objects be identified or unearthed then construction will be stopped and the findings will be reported to the DPLH • CEMP will be prepared to address weeds, dust, *Phytophthora* dieback and noise during the construction of Part 2 of the YRE project • To reduce noise impacts on existing and future adjacent residents, the new railway line will be constructed in a cutting that is approximately 5m below existing and/or future surrounding ground levels, except through Bush Forever Site No. 289 where it will be at grade • Noise attenuation barriers (noise walls) will be designed and constructed during the construction phase, as outlined in the NVMP (Lloyd George Acoustics 2018b) • Noise and Vibration Management Plan (NVMP; Lloyd George Acoustics 2018a) has been prepared to address the potential noise and vibration impacts during the operation of the railway line • Ballast matting will be installed below the rail where adjacent to existing and future residential developments to reduce vibration impacts (lesson learnt from the extension of the Joondalup line to Butler) • If significant limestone deposits are required to be crushed onsite, this activity may meet the definition of a 'prescribed premises' and therefore be regulated through the Environmental Protection Regulations 1987 • Project-specific limestone crushing protocol will be developed and implemented should the YRE project be required to crush limestone onsite, however not meet the definition of a 'prescribed premises' • PTA's Bushfire Management Strategy provides the bushfire management framework that will be implemented during the construction and operation of the YRE project
	Rehabilitation	No rehabilitation is anticipated to be required
Outcome	• Through the implementation of the mitigation hierarchy the potential impacts to Aboriginal heritage and culture, natural and historic heritage, noise and vibration, dust and bushfire have been / will be managed to be as low as reasonably practicable • Given the above and PTA's past performance in implementing appropriate mitigation measures as part of the construction and operation of railway projects it is considered that social surroundings will be protected from significant harm so that EPA's Social Surroundings objective is met	

2 Introduction

The PTA is proposing to implement the first stage of the Western Australian Government's METRONET vision to transform Perth's transport network. The first stage of METRONET's priority projects includes the extension of the existing Joondalup railway line from Butler to Yanchep, which is known as the YRE project.

The entire YRE project is a 14.5 km extension of the Joondalup railway line, which includes three new stations at Alkimos, Eglinton and Yanchep. The YRE project forms an integral component of Perth's long term public transport network and will provide essential transportation services to the rapidly expanding northern coastal suburbs. The delivery of the YRE project will foster the continued growth and development of activity centres in the North-west Sub-region, stimulating new employment opportunities, vibrancy, higher density land use and better sustainability outcomes envisioned by the State Government's Perth and Peel @ 3.5 million plan (DPLH and WAPC 2018).

The YRE project is located within the City of Wanneroo, approximately 40 km north of Perth's CBD. The YRE project's 143.10 ha total development envelope, which encompasses the Part 1 and 2 development footprints (including railway extension and stations) and construction and access areas, generally lies between the suburbs of Butler and Yanchep and includes the suburbs of Alkimos and Eglinton (Figure A).

2.1 Project staging

The YRE project is being referred to the EPA under Section 38 of the EP Act in two discrete parts:

- **Part 1: Butler Station to Eglinton Station** includes the southern portion of the YRE project area to the north of the Butler Station and generally follows the land reserved "Railway" under the Metropolitan MRS before terminating to the north of the proposed Eglinton Station. The Part 1 development footprint includes a contingency for a turnback facility to be constructed to the north of Eglinton Station, to allow for the turning of two six car trains (if required), should Part 2 of the YRE project not proceed. The 70.22 ha Part 1 development envelope is comprised of a 45.42 ha development footprint and 24.80 ha of construction and access areas (Figures A, B and C).
- **Part 2: Eglinton Station to Yanchep Station** includes the northern portion of the YRE project area to the north of the Eglinton Station and generally coincides with the land reserved "Railway" under the MRS before terminating within the northern section of the Yanchep City LSP. The development footprint includes a turnback facility to the north of the Yanchep Station to allow for the turning and stowage of trains. The 72.88 development envelope is comprised of a 60.31 ha development footprint and 12.57 ha of construction and access areas (Figures A, B and C).

This EIA report specifically assesses the environmental impacts associated with Part 2 – Eglinton Station to Yanchep Station of the YRE project. The environmental impacts associated with Part 1 of the YRE project have been previously addressed by Yanchep Rail Extension: Part 1 – Butler Station to Eglinton Station (RPS 2018a).

2.1.1 Staging rationale

The PTA identified that an early earthworks package was required to be commenced in late 2018 in order to meet the State Government's scheduled 2021 delivery date for the YRE project. Noting that some landholdings adjacent to the southern portion (Part 1) of the YRE development envelope have already been subject to construction and development to facilitate urban land uses and given the historical planning framework (Table 9) and Commonwealth approvals (RPS 2018a). As a result, the PTA considered that Part 1 was less environmentally constrained than Part 2. Therefore, in order to meet the scheduled delivery date the YRE project was divided into two parts with the aim that Part 1 can be implemented (pending environmental approval), whilst Part 2 is under assessment by the State and Commonwealth governments.

2.2 Purpose and scope of this document

This EIA report has been based on the EPA's Instructions on how to prepare an Environmental Review Document (EPA 2018c).

2.2.1 Purpose of this document

The purpose of this EIA report is to describe and assess the significance of the environmental impacts to the EPA's environmental factors associated with the construction and operation of Part 2 of the YRE project, with reference to specific technical investigations and detailed analysis undertaken by the PTA to assess the environmental factors.

This EIA report has been prepared to support referral of Part 2 of the YRE project to the EPA under Section 38 of the EP Act.

2.2.2 Scope of this document

The scope of this EIA report focusses on the assessment of the environmental impacts and management requirements associated with the construction and operation of Part 2 of the YRE project.

2.2.3 Structure of this document

This EIA report has been prepared to reflect the revised framework for environmental impact assessment under the *Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2016* and the associated *Procedures Manual (Part IV Divisions 1 and 2).*

The structure of the report follows the *Template for an Environmental Review Document* attached to EPA (2018d).

2.3 Proponents details

The proponent of the YRE project is:

Name:	Public Transport Authority
Postal Address:	Public Transport Centre, West Parade
	PERTH WA 6000
ABN:	61 850 109 576

The key contact for the environmental approvals component is:

Name:	Miranda Ludlow
Position:	Environmental Manager, Infrastructure Planning and Land Services
Phone:	(08) 9326 3972
Email:	miranda.ludlow@pta.wa.gov.au

Further information on the proponent can be sourced from the PTA's website (http://www.pta.wa.gov.au/).

2.4 Environmental impact assessment process

2.4.1 *Environmental Protection Act 1986*

The EP Act is the key legislative tool for environmental protection in Western Australia. The EP Act provides for the prevention, control and abatement of pollution and environmental harm, for the conservation, preservation, protection, enhancement and management of the environment.

The EP Act is administered by the EPA and the Minister for the Environment.

2.4.1.1 Part iv of the *environmental protection act 1986*

Following recommendations made as a result of the independent EPA legal and governance review in early 2016, updated procedures for environmental impact assessment were formally gazetted under Section 122 of the EP Act on 13 December 2016 as the *Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2016* (Administrative Procedures).

The Administrative Procedures are the highest level document under the EP Act and provide the overarching framework for the EPA to undertake environmental impact assessment.

The Administrative Procedures are grouped according to the following key stages:

- Stage 1: referral of a proposal to the EPA
- Stage 2: EPA to decide whether or not to assess a referred proposal
- Stage 3: assessment of proposals
- Stage 4: EPA report on the assessment of proposal
- Stage 5: deciding if proposal may be implemented and implementation of proposals.

2.4.1.1.1 Yanchep rail extension context

As outlined in Section 2.1, the YRE project is being referred to the EPA under Section 38 of the EP Act as two referrals, Part 1 – Butler Station to Eglinton Station and Part 2 – Eglinton Station to Yanchep Station. Part 1 of the YRE project was referred to the EPA on 25 January 2018. The Chairman of the EPA has set the level of assessment at "Referral Information and Additional Information (4 week public review)".

This EIA report supports the referral of Part 2 – Eglinton Station to Yanchep Station of the YRE project. The referral of this EIA report, and accompanying Section 38 referral form to the EPA under Section 38 of the EP Act, allows for the EPA to determine if the Part 2 referral is valid under the EPA's Administrative Procedures. The PTA has undertaken specific technical investigations and detailed analysis for the YRE project with the view to supporting an assessment on referral information by the EPA for Part 2 of the YRE project.

2.4.2 Other state legislation, regulation and approval

Part 2 of the YRE project is required to comply with the requirements of other relevant pieces of State legislation, regulation and policy. Table 3 provides an overview of other potential state-based approval requirements that may also be relevant to Part 2 of the YRE project. The policy context of the relevant SPPs in relation to Part 2 of the YRE project is provided in Section 2.4.2.1.

Table 3 Other approval requirements

Potential activities	Type of approval	Legislation regulating the activity	Approval agency
Clearing of native vegetation will be undertaken prior to[3] and as part of the earthworks	Clearing Permit	EP Act	DWER
Disturbance of a site of Aboriginal heritage significance	Section 18	*Aboriginal Heritage Act 1972*	DPLH
Development of the railway, stations, car parks and public transport interchange outside of the	Development Application/s	*Planning and Development Act 2005*	CoW / WAPC

[3] A clearing permit application was submitted to DWER in November 2017 to facilitate additional geotechnical works and further unexploded ordnance investigations for the YRE project.

Potential activities	Type of approval	Legislation regulating the activity	Approval agency
rail corridor.			
Storage and handling of hazardous materials may be required during construction.	Licence	*Dangerous Goods Safety Act 2004*	Department of Mines, Industry Regulation and Safety
Groundwater abstraction may be required, for instance to supply groundwater for dust suppression purposes during construction.	Licence	*Rights in Water and Irrigation Act 1914*	DWER
Crushing of excess limestone may be required during construction	Licence	Environmental Protection Regulations 1987	DWER

2.4.2.1 Relevant state planning policies

2.4.2.1.1 State Planning Policy 2.8: Bushland Policy for the Perth Metropolitan Region

SPP 2.8 aims to provide a policy and implementation framework that will ensure bushland protection and management issues in the Perth Metropolitan Region are appropriately addressed and integrated with broader land use planning and decision-making in order to secure long-term protection of biodiversity and associated environmental values.

The policy is based on the Bush Forever report by the Government of Western Australia (2000). Specifically, the Bush Forever report includes Practice Note 18: Road and Railway Reserves, which provides guidance for sites affecting regional railway and road reserves. Practice Note 18 encourages the due consideration of bushland protection in the design and location of future roads/railways, however acknowledges the primary purpose of these reserves to accommodate the State's vital transport infrastructure (Government of Western Australia 2000).

SPP 2.8 recognises the protection and management of significant bushland areas as a fundamental consideration in the planning process, while also seeking to integrate and balance wider environmental, social and economic considerations. In general terms, the policy does not prevent development where it is consistent with the measures in this policy and other planning and environmental considerations.

Section 5.1.2.3 Bush Forever Area – Government lands or public infrastructure within SPP 2.8 states:

Where land includes—

- *regionally significant bushland within the government lands or public infrastructure site implementation category on map 1 (and any subsequent amendments); or*
- *regionally significant bushland located within another site implementation category on map 1 that is likely to be adversely affected by existing or proposed public infrastructure or utility services.*

Proposals or decision-making should—

(i) Seek to protect regionally significant bushland as a priority, except where a proposal or decision—

(a) is consistent with the overall purpose and intent of an existing reserve, existing approved uses and/or existing planning or environmental

> *commitments or approvals, in particular, existing reserves for roads (regional or local), railways, pipelines, water or drainage services and any associated emergency maintenance works, with any impacts minimised and managed, where practical, in accordance with existing environmental management plan best practice requirements;*

(Government of Western Australia 2010)

SPP 2.8 provides a process for impact assessment, and criteria to assess the impact against, which applies to any proposal or decision-making that is likely to have an unavoidable adverse impact on regionally significant bushland (Bushland) within a Bush Forever area consistent with the requirements of the policy.

SPP 2.8 defines Bushland as:

> *land on which there is vegetation which is either a remainder of the natural vegetation of the land, or, if altered, is still representative of the structure and floristics of the natural vegetation and provides the necessary habitat for native fauna.*

(Government of Western Australia 2010)

SPP 2.8 defines Bush Forever area as:

> *classification of land in the Metropolitan Region Scheme (established through Metropolitan Region Scheme Amendment 1082/33) to protect and manage regionally significant bushland in accordance with this Policy.*

(Government of Western Australia 2010)

Map 1 in SPP 2.8 includes a railway alignment through Bush Forever Site No. 289, as gazetted by the Government of Western Australia (2010).

2.4.2.1.2 State Planning Policy 3.7: Planning in Bushfire Prone Areas

The WAPC released SPP 3.7 to reduce the risk of bushfire to people, property and infrastructure. SPP 3.7 defines a bushfire-prone area as an area that has been designated by the Fire and Emergency Services Commissioner under Section 18 of the *Fire and Emergency Services Act 1998* (as amended) as an area that is subject, or likely to be subject, to bushfires.

SPP 3.7 provides the foundation for land use planning to address bushfire risk management in Western Australia. The policy is intended to implement effective, risk-based land use planning and development to preserve life and reduce the impact of bushfire on property and infrastructure.

2.4.2.1.3 State Planning Policy 5.4: Road and Rail Transport Noise and Freight Considerations in Land Use Planning

SPP 5.4 has the following objectives:

- Protect people from unreasonable levels of transport noise by establishing a standardised set of criteria to be used in the assessment of proposals.
- Protect major transport corridors and freight operations from incompatible urban encroachment.
- Encourage best-practice design and construction standards for new development proposals and new or redeveloped transport infrastructure proposals.
- Facilitate the development and operation of an efficient freight network.
- Facilitate the strategic co-location of freight handling facilities.

Under SPP 5.4, transport infrastructure providers should design mitigation measures to achieve the noise limit of LAeq(Day) of 60Decibel (dB) and LAeq(Night) of 55dB. Additionally, transport infrastructure providers

are also required to consider design measures to meet the noise target of LAeq(Day) of 55dB and LAeq(Night) of 50dB and to implement these measures where reasonable and practicable.

2.4.3 Zoning and land use

Table 4 identifies the extent of land within the development envelope subject to the reservations, zoning and notice of delegation under the MRS, whilst Figure B shows the MRS mapping relative to the development envelope. Approximately 40% of the development envelope is either zoned “Central City Area” or “Urban” under the MRS, whilst approximately 30% is reserved “Railways” and 25% is reserved “Parks and Recreation” (Table 4).

Table 4 Metropolitan region scheme mapping within the development envelope

MRS description	Area (ha)	Area (%)
Reservations		
Railways	21.95	30.12%
Parks and Recreation	18.68	25.63%
Other Regional Roads	3.30	4.53%
Zones		
Central City Area	14.69	20.16%
Urban	14.26	19.56%
Total	**72.88**	**100%**
Notice of delegation		
Bush Forever Area	28.82	39.54%

2.5 *Environment Protection and Biodiversity Conservation Act 1999*

The *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) protects Matters of National Environmental Significance (MNES) and is administered by the Commonwealth Minister of the Environment and Energy. If an action is likely to have a significant impact on any MNES a referral to the Commonwealth DEE is required.

MNES that relate to Part 2 of the YRE project are nationally threatened species, such as Carnaby’s Black Cockatoo, and ecological communities, including the Banksia Woodlands of the Swan Coastal Plain TEC.

The MNES that are considered by the Commonwealth government are only a subset of the matters that the State government considers. The State may require offsets to other environmental values which are not relevant to the EPBC Act. In situations where these values overlap, the WA Environmental Offsets Guidelines (EPA 2014) identifies that the State government agencies will work cooperatively with the Commonwealth DEE to align offsets and avoid duplication to the fullest extent practicable.

Of relevance for Part 2 of the YRE project, EPA (2014) identities that where a proposal has already been assessed under the EPBC Act and offsets have been applied, the State will consider these offsets as contributing to the State requirements.

2.5.1 Previous EPBC act assessment

A 4.44 ha portion of the development envelope was included in the Eglinton / South Yanchep Residential Development (EPBC 2011 / 6021) referral to the Commonwealth under the EPBC Act, which was assessed to be a “Controlled Action” (Figures D-1 to D-4). Additionally, Residential Development at Yanchep Beach Road, Yanchep, WA (EPBC 2016 / 7642) referral lies adjacent to but not within the development envelope (Figure D-2).

The Commonwealth has set conditions for the Eglinton / South Yanchep Residential Development (EPBC 2011 / 6021) approval, which include the provision of 197.42 ha of land containing Carnaby’s Black Cockatoo habitat to counterbalance the residual impact of this action on Carnaby’s Black Cockatoo.

Figure D-3 identifies that approximately 4.07 ha of the Black Cockatoo foraging habitat recorded within the development envelope has been previously assessed under the EPBC Act. Of the 4.07 ha, an approximate 0.14 ha has been included within the 197.42 ha offset area for the Eglinton / South Yanchep Residential Development (EPBC 2011 / 6021) approval, whilst the remaining 3.93 ha was approved to be cleared.

2.5.2 Accredited assessment context

The Assessment Bilateral Agreement between the Western Australian and Commonwealth Governments refers to the 2012 and earlier versions of Administrative Procedures. The Agreement requires amendment to reflect the 2016 Administrative Procedures. This process is not yet complete.

Until the Agreement is amended, the assessment of any new proposals that would otherwise have been assessed by the EPA under the agreement will be individually accredited by the Commonwealth Government.

This EIA report has been prepared to support referral of Part 2 of the YRE project to the EPA under the EP Act. A separate EPBC Act referral for Part 2 of the YRE project has been submitted to the Commonwealth DEE for assessment. To ‘switch on’ the accredited assessment process, Part 2 of the YRE project has been referred to both agencies requesting that an accredited assessment is undertaken.

3 PTA previous experience

In describing the potential environmental impacts from the implementation of Part 2 of the YRE project, it is relevant to consider the PTA's track record in successful environmental management.

The PTA takes its corporate environmental responsibility very seriously and has established a solid and consistent record of delivering public infrastructure projects in compliance with all environmental management requirements and within its environmental policy and Environmental Management System (EMS), which has been developed in accordance with the ISO 14001.

The PTA's recent rail projects, which are either now operational or still under construction, are provided in Table 5.

Table 5 PTA rail project summary

Project title	Location	Ministerial statement number	Status
South West Metropolitan Railway (SWMR)	Perth to Mandurah	Ministerial Statement No. 637	Operational December 2007
Butler Rail Extension	Currambine to Butler	Ministerial Statement No. 563	Operational September 2014
Perth Stadium Transport Corridor	Perth Stadium Station	Not Applicable	Operational January 2018
Forrestfield Airport Link	Bayswater Station to Forrestfield	Ministerial Statement No. 1022	Under construction

The SWMR is a recent and relevant example of a large scale PTA rail project planned and constructed in a similar urban coastal environment to Part 2 of the YRE project.

The Chairman of the EPA decided that the SWMR project should be formally assessed at the level of Public Environmental Review under the EP Act. The EPA considered the construction and operation of the SWMR project to be environmentally acceptable and advised that following environmental management plans be prepared and implemented for the entire alignment:

- Construction management plans
- Biodiversity and wetland mitigation plan
- Fauna management plan
- Wetlands, hydrology and drainage management plan
- Stakeholder consultation strategy
- Visual amenity, rehabilitation and landscape management plan
- Access management plan (bushland)
- Operations noise and vibration management plans
- Contamination assessment and management plan
- Vegetation management plan for unexploded ordnance search areas.

The SWMR project was approved by the Minister for Environment on 14 November 2003 by way of Ministerial Statement No. 637.

3.1 SWMR environmental factors

The EPA determined environmental factors for the SWMR project are similar to those identified for Part 2 of the YRE project.

Table 6 identifies the:

- environmental factors assessed by the EPA for the SWMR project
- management plans prepared to address potential impacts to the EPA's environmental factors.

The PTA undertook a review of its environmental performance for the SWMR project against Ministerial Statement No. 637 (PTA 2013). In assessing the PTA's compliance with Ministerial Statement No. 637, the (then) Office of the EPA found the PTA to be fully compliant.

Table 6 provides a summary of the findings of PTA (2013) for each of the environmental factors assessed by the EPA.

Table 6 PTA's environmental performance for the SWMR project

Environmental factors assessed	Management plans prepared/ measures implemented	PTA's environmental performance

Terrestrial Flora	• Construction Management Plans
	• Biodiversity and Wetland Mitigation Plan
	• Environmental Management Plan for the Waikiki Station site
	• Visual Amenity, Rehabilitation and Landscape Management Plan
	• Access Management Plan (bushland)
	• Vegetation Management Plan for Unexploded Ordnance Search Areas
	• Land purchased for railway comprising 7.4 hectares (ha) of land adjoining the southern tip of Stakehill Swamp transferred to conservation estate
	• Land purchased for railway comprising 6.7 ha of land adjoining the north-west tip of Anstey Swamp transferred to conservation estate
	• PTA to pursue the transfer to conservation estate of land reserved for "Railways" that is surplus to requirements and has the potential to be added to the adjoining conservation estate
		• PTA prepared and implemented all the identified environmental management plans
		• PTA spent over $5 million on the protection of *Caladenia huegelii* population in redesign, mitigation and management
		• Dieback was identified at the site in 2009 for the first time. It is unknown if it was present prior to the construction of the Perth to Mandurah Railway. It is believed there are four infestations mainly along the perimeter. Phosphite treatment has been instigated on the basis that although it will not eradicate dieback from the infected plant or guarantee the plant's survival, it will generally increase the life expectancy of susceptible plants in the conservation area
		• Weed control has been effective in reducing and maintaining the low abundance of weed species within the preservation area
		• PTA committed to managing the preservation area for five years following completion of the Perth to Mandurah Railway (until December 2012) when it handed the site over to the (then) Department of Environment Regulation (DER)
		• PTA committed to managing the Threated Ecological Community (TEC)19b preservation area for three years following completion of the Perth to Mandurah Railway, until December 2010 when it was handed over to the (then) Department of Environment and Conservation (DEC). PTA believes its design of Warnbro Station and managing the TEC preservation area was successful in maintaining the condition and ecological function of the TEC19b vegetation
		• PTA rehabilitated and transferred 14.9 ha of land in Wellard Road, Leda to conservation estate
		• PTA transferred to the conservation estate
		  • 7.4 ha of land adjoining the southern tip of Stakehill Swamp
		  • 6.7 ha of land adjoining the North West tip of Anstey Swamp
		  • land acquired for the Perth to Mandurah Railway which was no longer required
		• PTA rehabilitated a small artificial wetland adjacent to Stakehill Swamp and purchased land in the City of Mandurah for conservation purposes

Fauna	• Fauna Management Plan
	• Wetlands, Hydrology and Drainage Management Plan
		• PTA prepared and implemented all the identified environmental management plans
		• PTA's management of fauna, particularly during construction, went beyond compliance with the requirements of Ministerial Statement No. 637 and set the standard for construction projects within Western Australia including
		  • trapping and relocation of native fauna species, including Southern Brown Bandicoot (Priority 4); bats; possums; ducks; snakes; lizards; tadpoles, immediately prior to vegetation clearing
		  • construction and monitoring of fauna underpasses to allow movement of fauna between conservation areas intersected by the railway
		  • fencing rail reserves adjacent conservation areas with fauna proof fencing to prevent fauna access to rail

Environmental factors assessed	Management plans prepared/ measures implemented	PTA's environmental performance
Wetlands	• Construction Management Plans • Biodiversity and Wetland Mitigation Plan • Wetlands, Hydrology and Drainage Management Plan • Visual Amenity, Rehabilitation and Landscape Management Plan • Stakeholder Consultation Strategy	• PTA prepared and implemented all the identified environmental management plans • PTA spent $300 000 over seven years monitoring groundwater and surface water for the SWMR project. Half of the groundwater bores were between 300 metres (m) to over 1 kilometre (km) away from the railway • Groundwater levels and quality were generally consistent with seasonal and/or annual variations. Two bores (at Murdoch Train Station and Lake Cooloongup) showed decline in groundwater levels (recorded as dry) between October 2010 and February 2011 (final monitoring event) and May 2009 and February 2011 (final monitoring event), most likely attributed to changes in regional hydrological flows • PTA recommended that ministerial conditions for such monitoring programs are limited to projects with a high likelihood of significant impacts to groundwater and/or wetlands in future
Noise and Vibration – operations phase	• Operations Noise and Vibration Management Plans • Stakeholder Consultation Strategy	• PTA prepared and implemented all the identified environmental management plans • Construction noise was managed under the Environmental Protection (Noise) Regulations 1997 • SPP 5.4 was in draft at the time Ministerial Statement No. 637 was granted, however noise and vibration criteria were developed for the SWMR project in accordance with the draft SPP 5.4 and on advice from the (then) Department of Environmental Protection (DEP). These criteria were set as conditions on Ministerial Statement No. 637 • Noise and vibration monitoring concluded that noise emissions and vibrations complied with Ministerial Statement No. 637, with the exception of vibration levels at one location. This was due to a weld fault between two portions of rail, which was immediately rectified • 123 noise and vibrations complaints (106 related to noise, 61 to vibrations) were received by PTA in the first six months of rail operation • 24 noise and vibration complaints were received in the following 5 years (from May 2008 to May 2013)
Surface Water and Groundwater Quality	• Construction Management Plans • Wetlands, Hydrology and Drainage Management Plan • Contamination Assessment and Management Plan • Acid Sulfate Soil and Dewatering Management Plans	PTA prepared and implemented all the identified environmental management plans
Visual Amenity	• Visual Amenity, Rehabilitation and Landscape Management Plan • Stakeholder Consultation Strategy	• PTA prepared and implemented all the identified environmental management plans • No visual amenity complaints were received from the community or local government

(Sources: EPA 2003 and PTA 2013)

3.2 SWMR environmental Initiatives

Environmental initiatives for the SWMR project achieved sound environmental performance. These environmental initiatives, identified in Table 7, set the benchmark for environmental management of future rail projects and will be incorporated and expanded upon throughout the PTA's METRONET projects, including the YRE project (where applicable).

Table 7 SWMR environmental initiatives

Environmental initiatives	PTA's environmental performance
Regenerative braking technology	PTA purchased 93 new trains which utilise regenerative braking technology. This technology returns at least 20% of the electricity produced by braking feeding back into the electrical distribution system, reducing greenhouse gas emissions. Regenerative braking technology is now the standard in all new trains
Landscaping/rehabilitation	• Use of only native species • Seeding and planting in autumn/winter months to maximise establishment and minimise irrigation required • Salvage of 5,000 grass trees and 2,000 zamia plants from the SWMR project's development envelope. Survival rate of these plants was over 90%. The plants were donated to local conservation projects within the Rockingham area • Collection of over 150 kilograms of seed from within the SWMR project's development envelope which was then used in the rehabilitation program
Tunnel boring machine	First time a tunnel boring machine was used in Perth, which resulted in the following environmental reductions to: • development envelope area • dewatering volumes • spoil excavation, treatment and disposal • disruption to businesses, traffic and pedestrian movement within Perth's Central Business District (CBD)
Industry awards	• 2004 WA Environment Award – Finalist • 2007 WA Environment Award – Finalist • 2008 Public Relations Institute of Australia Golden Target – Winner • 2008 WA Engineering Excellence Awards – Winner (Environment Category) • 2000-2008 WA Engineering Excellence Awards – Winner and Finalist (Engineering Category)
Sustainability	Prepared and operated in accordance with a Sustainability Strategy
EMS	EMS prepared for the SWMR project in line with ISO 14001 standards
Environmental Community Consultative Committee (ECCC)	ECCC was established to provide an interface between the SWMR project and local environmental interest groups. ECCC comprised of members of 10 different community groups and met monthly to discuss environmental issues during the design, construction and operational phases of the SWMR project. ECCC initiatives included: • Provision of one single multi-purpose access track adjacent the railway in bush areas to allow access for State Government Agencies and Local Government Authorities • Adjustment of the alignment in the Leda Nature Reserve to minimise fragmentation of bushland
Department of Environmental Regulation (DER) Funding	PTA funded a full time Environmental Officer within the (then) DER for three years to assist in ensuring PTA and contractor compliance with environmental approvals

(Source: PTA 2013)

4 The proposal

4.1 Background

The planning rationale for the ongoing growth of Perth's northern suburbs has been historically underpinned by the provision of rail infrastructure to the Yanchep community in key strategic planning documents such as the draft Directions 2031 and Beyond (Department of Planning and WAPC 2010), Transport @ 3.5 million (DoT, PTA and MRWA 2017), draft Perth and Peel Green Growth Plan (Department of Premier and Cabinet 2015) and Perth and Peel@3.5million (DPLH and WAPC 2018a).

Table 8 provides an overview of the relationship of the key strategic planning documents to Part 2 of the YRE project. Table 9 details the historical planning framework which has provided the key drivers for the project and informed the location of the MRS "Railways" reservation (and subsequently the location of the development footprint). Specifically, previous MRS amendments 1192/57 and 1248/57 have determined the points of egress into Bush Forever Site No. 289 for the "Railways" reservation (Table 9; Figure E).

Opportunities to amend the development footprint are limited due to residential construction being progressed on adjacent lands, or adjacent lands being zoned for future urban development and associated uses, which restricts the development footprint to the MRS "Railways" reservation. Notwithstanding the planning constraints imposed on the YRE project by surrounding developments, the development envelope has been iteratively modified by the PTA to minimise environmental and social impacts (Section 4.2.4.1).

Table 8 Key strategic planning documents

Key document	Alignment with YRE Project
Perth and Peel@ 3.5million (Department of Planning and WAPC 2018)	Identifies sub-regional planning frameworks for Central, North-west, North-east and South Metropolitan Peel areas which clearly depict where future homes and jobs should be located and where important environmental assets should be avoided and protected. The growth of the Perth and Peel regions depends on the provision of critical infrastructure to provide road and rail transport options for both commuters and business. The four sub-regional planning frameworks facilitate and support a future regional transport network and facilitate the provision of service infrastructure. Importantly, the North-west Sub-regional Planning Framework proposes passenger rail from Butler to Yanchep with a station at the Yanchep Strategic Metropolitan Activity Centre.
Transport @ 3.5 million (DOT, PTA and MRWA 2017)	Long term plan for transport infrastructure to consider the efficient use of the transport network as the population of the Perth and Peel regions increases. Specifically, Transport @ 3.5million envisions the following objectives for the future transport network: • optimise use of the existing network and as it grows • integrate with land use and across the public transport, active transport and road networks • deliver high frequency, 'turn up and go' mass rapid transit connected with effective public transport feeder services • provide a safe, connected active transport network of primarily off-road cycle ways and walkways • maintain a free-flowing freeway and arterial road network for the efficient distribution of people and freight. Transport @ 3.5million identifies the planned extension of the Joondalup Line to the future major metropolitan strategic centre at Yanchep, as part of the rapid transit network required for to support a population of 2.7 million people in the Perth and Peel region.
Draft Perth and Peel Green Growth Plan (Department of the Premier and Cabinet 2015)	Supports projected growth in the population of the Perth and Peel regions and deliver an efficient and liveable city while protecting its significant environmental assets. The Perth and Peel Green Growth Plan was underpinned by the EPA's interim strategic advice (EPA 2015) to deliver the following critical outcomes: • cutting red tape by securing upfront Commonwealth environmental approval and streamlining State environmental approvals for the development required to support growth to 3.5 million • unprecedented protection of bushland, rivers, wildlife and wetlands through implementation of a comprehensive plan to protect the environment. Action Plan C – Infrastructure identifies the planned extension of the Joondalup line to Yanchep, with a station at Yanchep.
Perth and Peel@ 3.5million Environmental Impacts, Risks and Remedies (EPA 2015)	Under Section 16(e) of the EP Act the EPA provided interim strategic advice to the Minister for Environment on the four sub-regional planning frameworks and the broader implications for the environment from significantly increasing the population of Perth and Peel regions. The EPA noted that a number of proposed infrastructure corridors are likely to impact areas of high conservation value and that these should be the subject of whole of Government decisions that transparently demonstrate avoidance (consideration of alternatives), mitigation (minimising temporary impacts through use of innovative technologies and rehabilitation), or offsetting as appropriate. Further, the EPA considered that ad hoc impacts can be avoided if there is a long term integrated plan for transport infrastructure, with a particular emphasis on public transport.

Draft Public Transport Plan 2031 (DOT 2011)	Long term vision for a public transport network to support a population of 3.5 million which provides clear guidance for the medium term network (to 2031) Short term priorities along with current commitments include: • extension of the northern suburbs railway from Butler to Yanchep with a station at Yanchep • providing priority bus lanes along routes that connect major centres and through congested intersections.
Draft Directions 2031 and Beyond (Department of Planning and WAPC 2010)	• Balances urban growth needs with the goal to protect natural ecosystems. The framework provides for different lifestyle choices, vibrant nodes for economic and social activity and proposes to deliver on the aspiration of a more sustainable urban transport network • States that it is critical that the provision of infrastructure is fully integrated with land use planning and development • Strongly supports the development of a number of key strategic activity centres well connected by public transport • Included the extension of the Joondalup railway line to Yanchep with new station at Yanchep.

Table 9 Historical planning framework

Key document	General description	Assessment context	Final outcome
Town Planning Scheme No. 1 Amendment 787	The CoW initiated Amendment 787 to Town Planning Scheme (TPS) No.1 to amend reservations and zonings in the Yanchep-Two Rocks area from "Rural" and "Residential Development" to "Urban Development Zone".	TPS Amendment 787 was initiated to ensure that zonings of the Yanchep-Two Rocks area under TPS No. 1 reflected the zoning already given statutory effect by the gazettal in September 1996 of Amendment 975/33 to the MRS. Figure E shows the spatial extent of TPS Amendment 787.	The (then) Chairman of the EPA decided that TPS Amendment 787 should be formally assessed at the level of Environmental Review under the EP Act to manage the indirect impacts to substantial areas of regionally significant vegetation (Coastal Strip from Two Rocks to Burns Beach and Yanchep National Park) adjacent to the development. Planning approval required that Environmental Conditions were incorporated into the CoW's TPS No. 1 through inclusion of a new Schedule (Schedule 9). The Environmental Conditions required: • environmental management plans • vegetation and fauna management • stygofauna and troglobitic fauna management • assessment of karst landform • solid and liquid waste management • Aboriginal heritage management • environmental reporting.
Alkimos Eglinton District Structure Plan	Encompassed approximately 2,600 ha of land which included: • Alkimos regional centre, Eglinton district centre and three new coastal villages • Rail alignment which included railway stations in Alkimos and Eglinton centres • A wide range of residential housing density and diversity to accommodate approximately 23,000 new dwellings and 57,000 people.	The WAPC initiated Amendment 1029/33 to the MRS to rationalise zones and reservations in the Alkimos and Eglinton localities to correspond with the Alkimos-Eglinton DSP. Figure E shows the northern spatial extent of MRS Amendment 1029/33. MRS Amendment 1029/33 proposed the relocation of the northern suburbs rail line reservation to be more centrally located within the Alkimos Regional and Eglinton District Centres. However, the (then) DPI commissioned GHD to undertake a separate alignment definition study for the extension of the northern suburbs railway to ensure that the proposed railway stations were better integrated into proposed centres.	The (then) Chairman of the EPA decided that MRS Amendment 1029/33 should be formally assessed at the level of Environmental Review under the EP Act because the proposed land use changes may have potentially significant impacts on a number of environmental factors. The EPA identified that it supported the realignment of the railway reservation as part of a future amendment to the MRS to avoid the fragmentation of the geoheritage and landform values (Alkimos dune system). It was agreed by all stakeholders that changes to the railway alignment would be the subject of a separate MRS Amendment.

Key document	General description	Assessment context	Final outcome
		This review was entitled the Northern Suburbs Railway Alignment Definition – Alkimos to Yanchep –Alignment Definition Report (GHD 2005). No changes to the railway alignment were undertaken as part of MRS Amendment 1029/33.	
Northern Suburbs Railway Alignment Definition (Alkimos to Yanchep) Alignment Definition Report (GHD 2005)	Defined the railway alignment, major road crossings and stations to enable the preparation of land requirement plans for incorporation into an MRS amendment from Romeo Road to the Yanchep town centre station. The alignment definition report concluded that the proposed alignment meets current standards for urban passenger railways and is suitable for incorporation into the MRS. It was expected that the rail will be in a cutting for most of its length, especially through residential areas. The alignment definition report also included a preliminary drainage assessment and identified areas to be set aside for drainage basins. The alignment definition report also addressed geotechnical constraints and concluded that the soil and rock formations anticipated over the proposed alignment are generally expected to represent competent founding conditions, however the possible presence and influence of karst conditions must be considered and detailed geotechnical studies will be required as part of the railway master planning process. A station was proposed at the Yanchep town centre.	MRS Amendment 1192/57 realigned the northern suburbs railway reservation further west, primarily between the Mitchell Freeway and Marmion Avenue, in Alkimos and Eglinton and significantly contributed to the viability of the Alkimos and Eglinton centres. MRS Amendment 1248/57 realigned the northern suburbs railway reservation further west, primarily between the Mitchell Freeway and Marmion Avenue / Toreopango Avenue, in Yanchep and significantly contributed to the viability of the Yanchep City Centre LSP. Figure E shows the spatial extent of MRS Amendments 1192/57 and 1248/57. MRS Amendments 1192/57 and 1248/57 accorded with intent of draft Directions 2031 and Beyond (Department of Planning and WAPC 2010), as it rationalised the alignment of the northern suburbs railway which provided for public transport services to be accessible to a greater proportion of the community.	MRS Amendment 1192/57 was referred to the EPA for assessment under Section 48a of the EP Act. In May 2010 the (then) Chairman of the EPA considered that the likely environmental impacts of the proposed scheme amendment were not so significant as to warrant formal environmental assessment. The following minor modifications were made to MRS Amendment 1192/57 as a result of the submissions received during the advertising period: • modification of the width of the “Railways” reservation from a minimum of 35 m to a minimum of 40 m • minor realignment of the northern portion of the “Railways” reservation to better accommodate the existing topography • rationalising a small areas of “Parks and Recreation” reservation to the Central City Area zone • minor rationalisation of the “Railways” reservation at various locations between Alkimos and Eglinton. The EPA raised no objections to these minor modifications. MRS Amendment 1248/57 was referred to the EPA for assessment under Section 48a of the EP Act. In May 2010 the (then) Chairman of the EPA considered that the likely environmental impacts of the proposed scheme amendment were not so significant as to warrant formal environmental assessment. The final gazetted “Railways” reservation is presented in relation to MRS Amendment 1192/57 and 1248/57 and the development footprint in Figure E.

4.1.1 Local structure planning

The approved Yanchep-Two Rocks and Alkimos-Eglinton DSPs provide the strategic framework to inform the preparation of LSPs for parcels of land zoned either “Urban” or “Central City Area” under the MRS that are situated directly adjacent to the development footprint.

To date, the following LSPs have been approved by the CoW and the WAPC:

- Yanchep City
- Lots 1 and 102 Yanchep Beach ROAD
- Lots 1 and 2 Yanchep Beach Road
- North Eglinton.

The draft Yanchep City Centre Activity Centre Structure Plan has also been prepared to facilitate the development of the Yanchep City Centre as the primarily Strategic Metropolitan Centre for the north-west corridor. The spatial extent of the draft Yanchep City Centre Activity Centre Structure Plan is included within the Yanchep City LSP. This draft LSP is pending endorsement by the CoW / WAPC.

The location of the approved DSPs, LSPs and draft LSP in respect to the development envelope is presented in Figure C.

4.2 Justification

The PTA is proposing to extend the Joondalup railway line from Eglinton Station to Yanchep Station (Part 2 of the YRE project) as part of delivering the priority projects for the Western Australian Government's METRONET vision, a core election promise to the Western Australian public by the current government.

The planning rationale for the ongoing growth of Perth’s northern suburbs has been historically underpinned by the provision of rail infrastructure to the Yanchep community in key strategic planning documents (Table 8). Importantly, the detailed design and planning for LSPs adjacent to the development footprint has been specifically premised on the assumption that the YRE project will be constructed.

The Part 2 – Eglinton Station to Yanchep Station extension of the railway line will form the principal public transport serving the Yanchep and Two Rocks growth areas, providing current and future residents with a direct rail connection to Joondalup, Perth CBD and other parts of the metropolitan region. The rail corridor will provide an important opportunity for the development of transit oriented centres in Yanchep within the walkable catchments of the planned station.

The key benefits arising from Part 2 of the YRE project include:

- improved access to public transport for Perth’s northern suburbs
- improved connection to Perth’s CBD and other destinations across the metropolitan area for residents living in Perth’s northern most suburbs
- reduction of congestion on the Mitchell Freeway, Wanneroo Road and Marmion Avenue.

Specifically, Part 2 of the YRE project also addresses three key local issues:

1. Worsening urban congestion due to a lack of efficient transport alternatives.
2. Continued planned land development that promotes private vehicle use and limits opportunities to create higher density residential areas.
3. Social inequality and lower levels of opportunity for people who do not own or are unable to use a private vehicle.

4.2.1 Rapid population growth

The North-west Sub-region is one of Australia's fastest growing areas with population predicted to increase from 320,000 people in 2011 to 500,000 people by 2026 and 740,000 people by 2050 (PTA 2017a).

The estimated 27,000 people currently living between Jindalee and Two Rocks do not have access to major public transport infrastructure beyond the Butler station. Population in this area is predicted to reach in excess of 136,000 people by 2041(.idcommunity 2017).

Employment self-sufficiency in the North-west Sub-region (49.2% in 2011) is lower than all other sub-regions within Perth and Peel (Department of Premier and Cabinet 2015). The extension of the Joondalup rail line will provide a low-cost option for residents commuting to work in Perth's CBD as well as other destinations across the metropolitan area.

4.2.2 Highly congested traffic network

The North-west Sub-region is already experiencing significant traffic congestion along its entirety (CoW 2017a). The road network is at capacity in many areas and cannot be upgraded in key areas due to a number of constraints (CoW 2017a).

The extension of the Joondalup rail line addresses existing and future traffic congestion issues facing the North-west Sub-region by providing an alternative to private vehicle use which will in turn reduce local traffic volumes.

4.2.3 Sustainability outcomes

In addition to responding to rapid population growth in the City of Wanneroo and the highly congested traffic network of the North-west Sub-region, the YRE project responds to the growing need for an accessible, environmentally sensitive and economically sustainable means of public travel.

The YRE project will provide the opportunity for improved sustainability outcomes including the potential to reduce greenhouse gas emissions through reducing commuters' reliance on private vehicle use.

Passengers will be encouraged to use sustainable modes of transport to access new stations, such as walking, cycling and catching the bus. The YRE project will create and connect to local pathways and cycling infrastructure at each station (PTA 2017a). Subject to future funding approval, more than 8 million additional service kilometres and up to 56 new buses will be introduced to provide passenger access to the YRE project (PTA 2017a).

Further, increased use of Perth's public transport system will likely improve its economic performance, with value capture opportunities at new stations also being assessed as part of the planning and design.

4.2.4 Alignment options

Alternative alignment options were considered by the PTA early in the detailed design of the YRE project. An alternative railway alignment was considered for the portion of the development footprint that intersects Bush Forever Site No. 289 as part of the works package undertaken to inform the preparation of Northern Suburbs Railway Alignment Definition (Alkimos to Yanchep) Alignment Definition Report (GHD 2005; Figure F).

After undertaking a detailed review of the alternative alignment, the PTA determined the alignment was not feasible for the following reasons:

- Track curvature was severe and below minimum acceptable standards, which if adopted would have required significant speed restrictions, and would have produced wheel squeal as trains ran through those curves. This would also result in higher operational and maintenance costs to track and rollingstock.
- Alignment traversed highly undulating terrain which would have required very deep cuttings (up to 20 m) to achieve the required grades resulting in reserve widths approaching 100 m. This would have significantly increased the visual footprint of the railway, the clearing of native vegetation and the cost of earthworks.

- Alignment was 369 m longer.
- Alignment was close to proposed residential developments, presenting greater potential for community impacts and complaints, particularly with respect to the aforementioned noise issues.
- Development had commenced within the southern Yanchep LSPs and it was estimated that the alternative alignment would have directly impacted on around 150 properties (if implemented).

The option of tunnelling to avoid impacts to Bush Forever Site No. 289 was not deemed to be an economically feasible option.

4.2.4.1 Minimising environmental impacts

Opportunities to amend the development footprint are limited due to residential development adjacent to the MRS "Railways" reservation. Notwithstanding the planning constraints imposed on the YRE project by surrounding developments, the development envelope has been iteratively modified by the PTA to minimise environmental and social impacts. The following amendments have been made:

- modification of the northern extent of the development footprint to reduce the clearing of native vegetation and avoid direct impacts to Bush Forever Site No. 288: *Yanchep National Park and Adjacent Bushland*
- construction and access areas have been selected to coincide with proposed future urban development cells or roads either reserved by the MRS (Figure B), or as detailed within approved and draft LSPs, to reduce the likelihood of impacting native vegetation proposed to be retained within future POS reservations
- previous MRS amendments 1192/57 and 1248/57 have determined the point of egress into Bush Forever Site No. 289 for the "Railways" reservation, however the development envelope has been situated to
  - minimise impacts to the Quindalup 2 parabolic dunes (Figure S)
  - maximise the size and viability of the western portion of Bush Forever Site No. 289 (Figure L)
  - include approximately 29% of previously disturbed land (VT12 and CL; Section 8.6.5.1.1), which is not considered to be representative of remnant native vegetation
- access tracks within Bush Forever Site No. 289 have been planned to accommodate PTA, DBCA and DFES operational requirements thereby eliminating the potential for the duplication of access tracks by the agencies and reducing native vegetation clearing
- development footprint and volumes of sand to be excavated within Bush Forever Site No. 289 has been reduced through a decision to raise the vertical alignment of the railway through this site, which has minimised the potential impacts to flora and vegetation, fauna habitat and landform.

4.3 Proposal description

The high-level objectives of Part 2 of the YRE project include:

- delivery of a world class public transport system
- connection of the northern suburbs to the city
- reduction of vehicle congestion
- support for the objectives of Transport @ 3.5 million (DoT, PTA and MRWA 2016).

An overview of the Part 2 – Eglinton Station to Yanchep Station proposal is provided in Table 10, in accordance with the EPA's *Instructions on how to define the key characteristics of a proposal* (EPA 2016l).

Table 10 Proposal summary

Proposal title	Yanchep Rail Extension: Part 2 – Eglinton Station to Yanchep Station
Proponent name	Public Transport Authority
Short description	The proposal is to extend the Joondalup railway line from Eglinton Station to Yanchep Station, including a turnback facility to the north of the Yanchep Station to allow for the turning and stowage of trains.
	The proposal also includes the construction of a new station at Yanchep with intermodal rail, bus, 'park and ride', 'kiss and ride' and active mode (cycling and walking) facilities at the Yanchep Station.

Table 11 provides a comprehensive description of the Part 2 – Eglinton Station to Yanchep Station proposal, in accordance with the EPA's *Instructions on how to define the key characteristics of a proposal* (EPA 2016l). The 72.88 ha development envelope, which includes a 60.31 ha development footprint and 12.57 ha construction and access area, is identified in Figures G-1 to G-4. The development footprint is inclusive of all ancillary infrastructure such as Yanchep Station, stormwater drainage basins and principal shared paths for pedestrian and cyclist use.

Table 11 Infrastructure layout and extent of physical and operational elements

Element	Location	Proposed extent / description
Physical elements		
Railway Extension	The dual narrow-gauge track will begin from a future connection with the Joondalup railway line, approximately 0.67 km north of the future Eglinton Station. The railway will pass through Bush Forever Site No. 289 and existing urban development in Yanchep before terminating approximately 0.93 km north of the future Yanchep Station (Figures A, C and H).	The 7.19 km of dual narrow-gauge track will be located within a 60.31 ha development footprint. The development footprint is inclusive of a turnback facility to the north of the Yanchep Station and all ancillary infrastructure such as stations, stormwater drainage basins, principal shared paths for pedestrian and cyclist use and railway maintenance access roads. The railway will be cut approximately 5 m below the surrounding ground level where adjacent to existing and future urban developments.The railway corridor will be constrained, either through battering the excavation or using retaining walls, restricting the corridor to an approximate 40 m width. Within Bush Forever Site No. 289, railway will not be located within a cutting. The width of the railway corridor ranges from 74 m to 127 m (Figures G-2 and G-3), inclusive of battering, to meet the surrounding ground levels.
Yanchep Station	The proposed Yanchep station is located within the north of the Yanchep City LSP area, approximately 1.6 km to the north of Yanchep Beach Road.	Yanchep Station will be an at grade station which will serve the Yanchep locality and surrounding future suburbs. Yanchep Station is included within the development footprint and is approximately 6.37 ha in extent (Figures G-1). Provision has been made for an intermodal rail, bus, 'park and ride', 'kiss and ride' and active mode facilities.
Construction and Access Areas	Construction and access areas have been selected to coincide with proposed future urban development or roads either reserved by the MRS (Figure B) or as detailed within approved and draft LSPs.	The construction and access areas will be located within a 12.57 ha extent outside of the development footprint but within the development envelope (Figures G-1 to G-4).

Element	Location	Proposed extent / description
Operational elements		
Railway Line	The dual narrow-gauge track will begin from a future connection with the Joondalup railway line, approximately 0.67 km north of the future Eglinton Station. The railway will pass through Bush Forever Site No. 289 and existing urban development in Yanchep before terminating approximately 0.93 km north of the future Yanchep Station (Figures A, C and H).	The constructed railway line will operate train services between the Eglinton and Yanchep stations, with the turnback facility allowing for the turning and stowage of trains.
Yanchep Station	The proposed Yanchep station is located within the north of the Yanchep City LSP area, approximately 1.6 km to the north of Yanchep Beach Road.	Bus and train services will operate from the Yanchep station.

4.4 Local and regional context

4.4.1 Development envelope existing land uses

The majority of the development envelope is undeveloped and characterised by coastal dune formations and associated native vegetation. Approximately 53.19 ha (or 72.98%) of the development envelope's 72.88 ha extent contains remnant native vegetation (i.e. vegetation that is representative of the previously mapped vegetation associations and regional vegetation complexes). Approximately 10.56 ha has been previously cleared.

Disturbance events have historically occurred; planting of shrubs and trees of both native and introduced species has been undertaken. These areas of disturbance account for 9.13 ha (or 12.53%) of the development envelope and are identified by vegetation type Planted (VT12) in Figures J-2 and J-3. Vegetation type Planted (VT12) is not considered representative of remnant native vegetation. Approximately 8.08 ha (or 88.50%) of vegetation type Planted (VT12) is located within Bush Forever Site No. 289.

Access tracks and firebreaks also intersect the development envelope. More recently a portion of the development envelope, within the Yanchep City Local Structure Plan area, has been cleared as part of the approved construction and development of the adjacent housing estates (Figures J-1 and J-2).

4.4.1.1 Conservation areas

Approximately 28.82 ha (or 4.38%) of the 657.51 ha Bush Forever Site No. 289 has been included within the development envelope. Within Bush Forever Site No. 289, a 10.14 ha portion of the development envelope is reserved as "Railways" under the MRS. The remaining 18.68 ha is reserved for "Parks and Recreation" under the MRS (Figure L).

Outside of the development envelope, approximately 1.46 ha of land reserved for "Railways" will remain within Bush Forever Site No. 289. To assist in addressing the long-term protection of Bush Forever Site No. 289 it is intended that the 1.46 ha of "Railways" reservation outside the development envelope is amended to be reserved for "Parks and Recreation".

4.4.2 Surrounding land uses

The development envelope is located approximately 1.80 km east of the coastline and approximately 13.64 km north from the Joondalup Strategic Metropolitan Centre (Figure A). The development envelope intersects the future Yanchep Strategic Metropolitan Centre, which is zoned Central City Area in the MRS (Figure B).

4.4.2.1 Urban development

Approximately 55.93% of the land directly adjacent to the development envelope has either been developed for urban uses, including residential housing, or is reserved for future urban uses under the MRS. Existing land development estates in close proximity to the development envelope include but are not limited to the Allara, Jindowie and Yanchep Golf Estate developments (Figure H).

The approved LSP areas adjacent to the development envelope will be developed over time to meet market demand for residential housing and associated urban land uses. The development of the LSP areas will result in assessed and approved changes to the existing landscape character of the lands directly adjacent and those surrounding the development footprint.

4.4.2.1.1 Future urban development

GHD (2018b) identifies that the development envelope intersects future urban development areas subject to the Urban Land Development Outlook 2016/17.

The Urban Land Development Outlook 2016/17 data indicates that of the land within 1 km of the development envelope approximately 366 ha will support likely future residential/commercial development within the next 5 years, with approximately 160 ha (43.65%) having current conditional approval (GHD 2018b; Table 12). Further, the Urban Land Development Outlook 2016/17 data indicates that of the land within the North-west Sub-region approximately 1,350 ha will support future residential/commercial development over the next 5 years, with approximately 848 ha (62.8%) having current conditional approval (GHD 2018b; Table 12).

Table 12 Future residential, commercial and industrial development

Development type	Staging	Extent of land within 1 km of development envelope (ha)	Extent of land within north-west sub-region (ha)
Residential/ Commercial	Short term (0-5 years) with current conditional approval	159.98	847.47
	Short term (0-5 years)	206.50	501.99
	Medium term (6-10 years)	78.11	789.73
	Long term (10+ years)	551.12	4,370.36
Industrial	Short term (0-5 years)	-	39.94
	Medium term (6-10 years)	-	27.23
	Long term (10+ years)	-	680.77
Total		**995.71**	**7,257.49**

(Source: GHD 2018b)

4.4.2.2 Transport infrastructure

Marmion Avenue, which lies approximately 1 to 2 km to the west of the development envelope, is the key current transport infrastructure asset providing north-south connections for the constructed stages of adjacent housing estates (Figure H). Marmion Avenue is reserved as “Other Regional Roads” under the MRS (Figure B).

Wanneroo Road, which becomes Indian Ocean Drive north of Yanchep Beach Road, is situated to the east of the development envelope and currently provides a north-south connection for the adjacent rural landholdings (Figure H). South of Bush Forever Site No. 288: *Yanchep National Park and Adjacent Bushland,* Wanneroo Road is reserved as “Primary Regional Roads” under the MRS (Figure B).

4.4.2.2.1 Future transport infrastructure

The 72.88 ha development envelope is located directly to the north of the 70.22 ha Part 1 development envelope (Figure A).

Land reserved for the extension of the Mitchell Freeway, "Primary Regional Roads" under the MRS, is situated less than 1 km to the east of the development envelope, will provide for future car related travel north to Lancelin and south to Perth's CBD (Figure H).

4.4.2.3 Conservation areas

4.4.2.3.1 Local conservation areas

The regional environmental values located within 1 km of the development envelope have been reserved as "Parks and Recreation" reserves in the MRS with the management of these reservations dictated by their delegation as Bush Forever areas (Figure P). Approximately 593 ha of land within 1 km of the development envelope is delegated as Bush Forever area under the MRS.

The key environmental attributes of the two Bush Forever sites located locally relative to the development envelope are:

- Bush Forever Site No. 289: *Ningana Bushland, Yanchep/Eglinton* is intersected by the development envelope and directly connected to Bush Forever Site No. 397 and separated from Bush Forever Site No. 288 by land reserved for the Mitchell Freeway (Figure H). This site is 657.51 ha in extent and contains 551.5 ha of bushland comprised of woodland, heath, shrubland and grassland communities. More than 60% of the bushland is considered to be in "Very Good" or better condition. Upland woodland and heath communities include potential foraging and breeding habitat for Carnaby's Black Cockatoo, whilst upland heaths are dominated by *Lomandra maritima*. Contains the Alkimos Dune Complex, a system of parabolic dunes of Holocene age containing a chronological sequence (Government of Western Australia 2000; Figure H).

  From a limited survey, 30 bird species, one native mammal species, and eight reptile species have been recorded within the site (Government of Western Australia 2000).

- Bush Forever Site No. 288: *Yanchep National Park and Adjacent Bushland* is separated from Bush Forever Site No. 289 by land reserved for the Mitchell Freeway (Figure H). This site is 2,902ha in extent and contains 2,706 ha of bushland comprised of floristic supergroups of seasonal wetlands, uplands centred on Bassendean Dunes and Dandaragan Plateau and uplands centred on Spearwood and Quindalup Dunes. More than 90% of the bushland considered to be in "Very Good" or better condition. *Melaleuca huegelii – M. acerosa* [*M. systena*] shrublands on limestone ridges TEC 26a forms a part of the uplands centred on Spearwood and Quindalup Dunes supergroup, whilst the two upland supergroups include potential foraging and breeding habitat for Carnaby's Black Cockatoo. The Southern Brown Bandicoot and Western Brush Wallaby are identified as residents, whilst over 400 caves provide an important historical record of the local geology and significant habitat resource for subterranean fauna species (Government of Western Australia 2000, Parks and Wildlife Service 2018; Figure H). A portion of this Bush Forever site contains the DBCA managed Yanchep National Park (Figure H).

  From multiple surveys, 134 bird species (including one species listed under the WC Act), 15 native mammal species (including Southern Brown Bandicoot, Western Brush Wallaby, Ash Grey Mouse and Echidna) and 47 reptile species have been recorded within the site (Government of Western Australia 2000).

4.4.2.3.2 Regional conservation areas

The key environmental attributes of the three Bush Forever sites located regionally, but in relatively close proximity to the development envelope are:

- Bush Forever Site No. 397: *Coastal Strip from Wilbinga to Mindarie* is located less than 2 km to the west of the development envelope and is directly connected to Bush Forever Site No. 289. This site is 574.13 ha in extent and contains 404 ha of bushland comprised of floristic supergroups of seasonal wetlands and uplands centred on Spearwood and Quindalup Dunes. Native vegetation condition ranges from near "Pristine" to "Degraded" (Government of Western Australia 2000; Figure H).

  From a limited survey, 30 bird species (including one species listed under the WC Act), one native mammal species, and eight reptile species have been recorded within the site (Government of Western Australia 2000).

- Bush Forever Site No. 129: *Bernard Road Bushland, Carabooda* is located approximately 3.1 km to the south-east of the development envelope (Figure H). This site is 102.79 ha in extent and contains 102.2 ha of bushland comprised of woodlands dominated by *Eucalyptus gomphocephala*, *Banksia attenuata, Banksia menziesii* and *Allocasuarina fraseriana*; and shrublands to closed heaths dominated by *Melaleuca huegelii*, *Melaleuca systena* and *Banksia sessilis* var. *cygnorum*.

- Bush Forever Site No. 130: *Link between Yanchep and Neerabup National Parks* is located approximately 3.4 km to the south-east of the development envelope (Figure H). This site is 91.98 ha in extent and contains 94.3 ha of bushland comprised woodlands dominated by *Eucalyptus gomphocephala*, *E. marginata* and *Banksia attenuata*; and heaths to low shrublands dominated by *Banksia sessilis* var. *cygnorum*, *Xanthorrhoea preissii*, *Scaevola thesiodes* and *Trymalium ledifolium* var. *ledifolium*. More than 75% of the bushland considered to be in "Very Good" or better condition. These vegetation structural units include potential foraging and breeding habitat for Carnaby's Black Cockatoo (Government of Western Australia 2000; Figure H).

  From a limited survey, 41 bird species (including two species listed under the WC Act), four native mammals (including Southern Brown Bandicoot) and 17 reptile species (including a dragon, clawless gecko and black monitor) have been recorded within the site (Government of Western Australia 2000).

4.4.3 North-west sub-regional planning framework area

Approximately 43,000 ha or 55% of the North-west sub-region is comprised of lands reserved under the MRS for "Parks and Recreation" or "State Forest", with many of the natural areas incorporating Bush Forever sites (DPLH and WAPC 2018b).

Figure 1 depicts reserved land containing key environmental and landscape features, which informed the planning framework for the North-west Sub-region. Figure 1 indicates the lands reserved for "Railways" in the context of the lands reserved for "Parks and Recreation" under the MRS.

The key protected environmental features within the North-west Sub-region include:

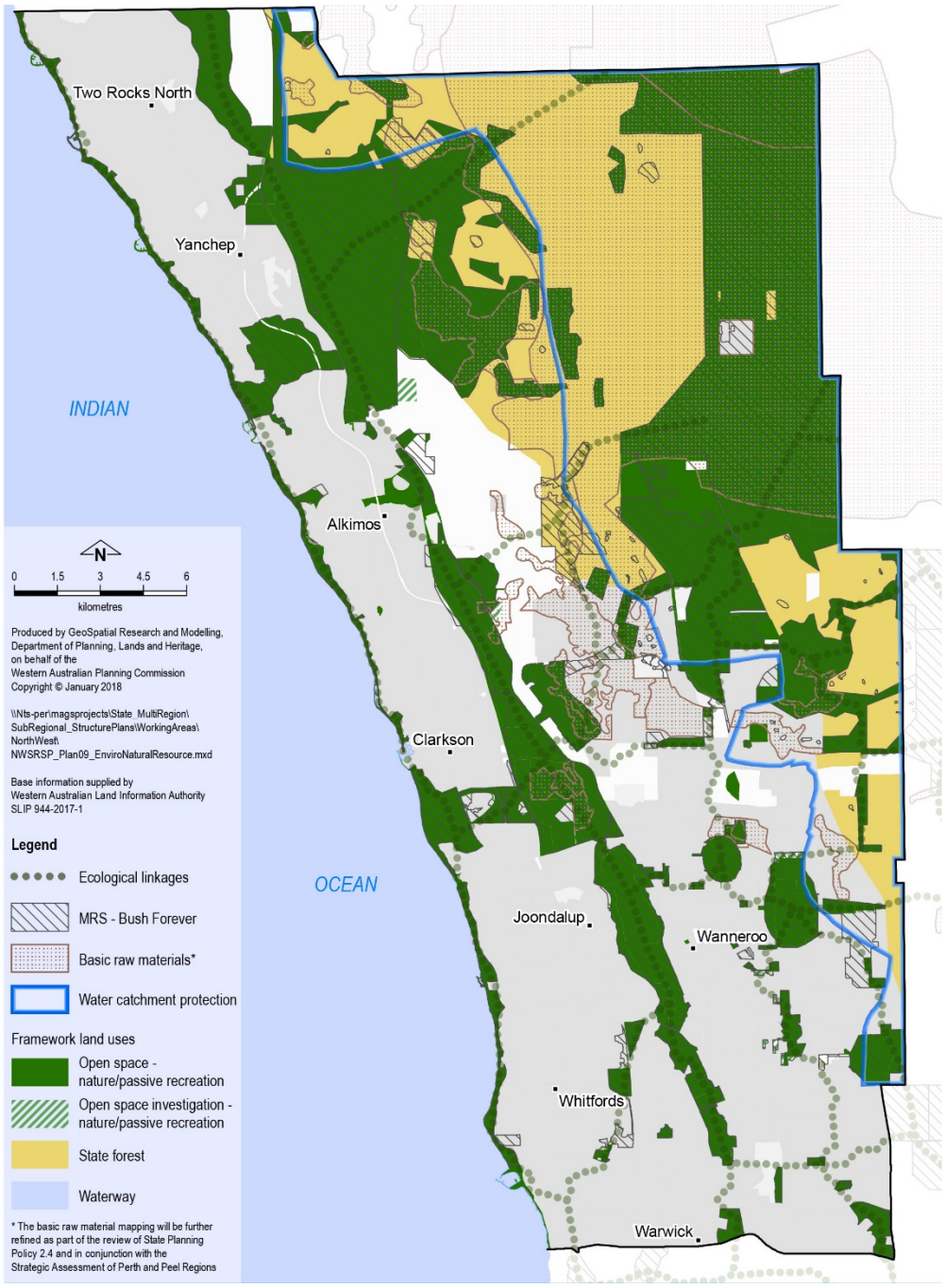
- approximately 48 km of coastline
- National and regional parks that encompass wetlands and Banksia woodlands
- other wetlands (DPLH and WAPC 2018b).

Figure 1 identifies the full extent of Bush Forever delegations and parks and recreation reserves in the North-west Sub-region. Approximately 27,459 ha of the land within the North-west Sub-region is delegated as Bush Forever area under the MRS.

4.4.3.1.1 Regional ecological linkages

Figure 1 identifies the regional ecological linkages which informed the planning framework for the North-west Sub-region. The North-west Sub-region regional ecological linkages run from north to south adjacent to the west and east of the "Railways" reservation.

The CoW's Local Biodiversity Strategy 2011-2016 also documents a regional ecological linkage that runs east-west across Bush Forever Site No. 289 (Figure 2).



(Source: DPLH and WAPC 2018b)

Figure 1 North-west sub-region key environmental and landscape features

4.4.4 Swan coastal plain subregion

The development envelope and the North-west Sub-region (WAPC 2018a) lie within the broader Interim Biogeographic Regionalisation for Australia (IBRA) region of the Swan Coastal Plain. The Swan Coastal Plain is comprised of the Dandaragan Plateau (SWA1) and Swan Coastal Plain (SWA2) subregions. It stretches from around Jurien Bay in the north to Quindalup in the south, and variably from the Indian Ocean coast up to approximately 40 km inland.

The development envelope and the North-west Sub-region are situated within the 1,333,901 ha SWA2 subregion, which is described as:

A low lying coastal plain, mainly covered with woodlands. It is dominated by Banksia or Tuart on sandy soils, Casuarina obesa on outwash plains, and paperbark in swampy areas. In the east, the plain rises to duricrusted Mesozoic sediments dominated by Jarrah woodland. The climate is Warm Mediterranean. Three phases of marine sand dune development provide relief. The outwash plains, once dominated by C. obesa-marri woodlands and Melaleuca shrublands, are extensive only in the south.

The Perth subregion is composed of colluvial and Aeolian sands, alluvial river flats, coastal limestone. Heath and/or Tuart woodlands on limestone, Banksia and Jarrah-Banksia woodlands on Quaternary marine dunes of various ages, Marri on colluvial and alluvials. Includes a complex series of seasonal wetlands and also includes Rottnest, Carnac and Garden Islands.

Mitchell, Williams and Desmond 2002

Mitchell, Williams and Desmond (2002) estimate that approximately 124,199 ha (or 10.74%) of SWA2 subregion has been reserved for conservation purposes. The key protected environmental features within the SWA2 subregion include:

- the coastline
- areas along the Swan, Canning, Serpentine and Murray Rivers
- lakes and wetlands
- National and regional parks, Bush Forever sites and State forests
- areas around the Peel-Harvey Estuary (DPLH and WAPC 2018b).

4.5 Proposal delivery

The procurement options for the delivery of Part 2 of the YRE project are currently being reviewed by the PTA, but the proposal is likely to be delivered under an alliance contract with the PTA. Construction of Part 2 is anticipated to commence in 2019.

5 Stakeholder consultation

5.1 Key stakeholders

To inform preliminary planning for the YRE project and confirm its development footprint, PTA has consulted extensively with key stakeholders. Table 13 identifies the key government and community stakeholders consulted for the YRE project.

Table 13 Key stakeholders

Key stakeholder	Project role / interest
Commonwealth Government	
Department of the Environment and Energy	Environmental approval(s) under the EPBC Act (as required)
State government	
Department of Water and Environmental Regulation	• Environmental assessment under the EP Act (as required) • Assistance with implementation of Water Sensitive Urban Design principles • Assistance with noise and vibration assessment and mitigation options
Environmental Protection Authority	Environmental advice under the EP Act (as required)
Department of Biodiversity Conservation and Attractions	• Environmental offset advice • Firebreaks, access and fauna underpasses relevant to Bush Forever Site No. 289
Department of Planning, Lands and Heritage	• Land acquisition and MRS Amendment • Liaison with other landowners • Aboriginal heritage • Interface for wider infrastructure requirements • Advice on management of Bush Forever Site No. 289
Western Australian Planning Commission	Rezoning and development application approval(s)
Public Transport Authority	• Project definition and delivery • Construction delivery • Asset owner and operator
Main Roads WA	Fauna underpass designs
Department of Fire and Emergency Services	Firebreaks and service vehicle access requirements relevant to Bush Forever Site No. 289
Water Corporation	Assistance with location of production bores and wellhead protection zones
Local government	
City of Wanneroo	• Advocacy and community relations • Rezoning and development application approval(s)
Local community	
South West Aboriginal Land and Sea Council (on behalf of the Whadjuk people)	Compliance with the state government's Noongar Standard Heritage Agreement (NSHA) Coordination of Aboriginal heritage surveys

Key stakeholder	Project role / interest
Whadjuk working group	• Compliance with the NSHA • Coordination of Aboriginal heritage surveys
University of Western Australia	Fauna underpass design, location, usage and efficiency
Multiple property developers	Project definition and delivery
Urban Bushland Council	Community organisation
Quinns Rocks Environmental Group	Community group

5.2 Stakeholder engagement process

A Communications and Stakeholder Engagement Plan (PTA 2017b) has been developed by the PTA to guide the community relations activities for the various phases (i.e. planning, design and procurement; and construction and commissioning) of the YRE project.

The Communications and Stakeholder Engagement Plan's community relations activities include:

- identifying and resolving issues that affect stakeholders, residents, businesses and other community members, and managing their information needs
- issuing communication to stakeholders
- establishing and maintaining relationships with local community groups, residents, businesses, CoW and other stakeholders where relevant
- identifying and responding to local issues, including preparation of, and contribution to, communication strategies to address issues
- responding to email, telephone and general inquiries from the public and stakeholders, including directing enquiries to relevant project staff and ensuring timely responses
- managing complaints and claims
- liaising with relevant PTA project managers and contractor project managers on issue close-outs and residual community matters
- managing the PTA's database of stakeholders.

Further, a dedicated METRONET website[4] has been established. In addition to providing a detailed overview of the YRE project, this allows interested parties to inquire about METRONET through a dedicated email address[5] and register for project updates.

5.3 Stakeholder consultation

5.3.1 Department of Biodiversity Conservation and Attractions

A number of meetings have been held with DBCA to review potential options for environmental offsets.

The key outcomes from these meetings are:

- Various sites have been earmarked for acquisition by the DBCA in Gingin and Chittering localities, which could be purchased by the PTA to offset the residual impacts of clearing Banksia Woodlands of the Swan Coastal Plain TEC and black cockatoo habitat.
- Options were identified for counterbalancing the residual impacts of clearing a small area of *Melaleuca huegelii – M. acerosa* [*M. systena*] shrublands on limestone ridges (TEC 26a).

[4] http://www.metronet.wa.gov.au/
[5] mailto:info@metronet.wa.gov.au

DBCA's Swan Coastal District Office has also been consulted to review firebreak and access requirements and discuss the provision of fauna underpasses within Bush Forever Site No. 289. Additionally, DFES was consulted with regard to firebreak requirements.

The outcome of this consultation resulted in shared access tracks being planned to be located outside of the fenced rail reserve and eliminated the potential for the duplication of access requirements by the PTA and DBCA (Section 4.2.4).

5.3.2 Chairman of the Environmental Protection Authority and Department of Water and Environmental Regulation

A YRE project briefing was conducted for the Chairman of the EPA, Dr Tom Hatton, and officers from DWER with the PTA and its consultants on 4 September 2017.

The key outcomes of the briefing were that:

- Potential environmental impacts to the following land-themed environmental factors were considered to be the critical elements of the YRE project:
  - flora and vegetation
  - terrestrial fauna.
- DWER agreed with simultaneously referring the YRE project to the EPA and Commonwealth DEE with a request to trigger an accredited assessment.

Further meetings were held with DWER officers on 2 November 2017 and 1 December 2017 to progress the drafting of the referral. The meeting held with DWER in November reviewed the status of previous State environmental assessments which had included the YRE project within their assessment boundary, whilst the December meeting informed the PTA's decision to refer the YRE project as two separate parts. The PTA meets with DWER officers on a regular basis to discuss the YRE project and assessment process.

5.3.3 Department of the Environment and Energy

On 8 December 2017 a meeting was held with the Commonwealth DEE's Western Australia Assessments Branch to review the existing environmental approvals provided for land development projects under the EPBC Act and the associated implications for the YRE project.

The key outcome from the meeting was that the DEE confirmed that existing environmental approvals for the various land development projects were valid for impacts to MNES for the YRE project, where the EPBC Act assessment boundaries of the approved referrals intersected the YRE project's development footprint. The DEE identified that in each case, as the proponent or person taking the approved action is not the PTA, the approval holder takes responsibility for the implementation of the approval conditions associated with the YRE construction works conducted under its approval. The PTA will ensure that Part 2 of the YRE project is implemented in accordance with the agreed EPBC Act decision for Residential Development at Yanchep Beach Road, Yanchep, WA (EPBC 2016 / 7642).

5.3.4 Community

The PTA has commenced a series of pop in events where community members can share their thoughts, ask questions and learn more about the YRE project, as part the implementation of the YRE project's Communications and Stakeholder Engagement Plan. These pop in events have been well attended, to date, with the local community being generally supportive of the proposal.

The PTA has also consulted with community-based environmental groups. A brief summary of these discussions is provided below.

5.3.4.1 Quinns Rocks Environmental Group

On 17 November 2017, a meeting was held with representatives from the Quinns Rocks Environmental Group to review the environmental context of the YRE project. The Quinns Rocks Environmental Group's concerns related to the fragmentation of Bush Forever Site No. 289 and Lot 200 Alkimos Drive "Parks and Recreation" reservation (which relates to Part 1).

The PTA is committed to undertaking additional consultation with the Quinns Rocks Environmental Group to inform detailed design for the YRE project.

5.3.4.2 Urban Bushland Council

On 7 December 2017, a meeting was held with representatives from the Urban Bushland Council to review the environmental context of the YRE project. Additionally a METRONET briefing, which included the YRE project context, was also delivered at the Urban Bushland Council's general meeting on 14 February 2018.

The Urban Bushland Council's key consideration for the YRE project relates to clearing of native vegetation within Bush Forever Site No. 289. The PTA is committed to undertaking additional consultation with the Urban Bushland Council to inform detailed design for the YRE project.

6 Environmental investigations

A summary of key technical environmental investigations that have been undertaken specifically for the YRE project is provided in Table 14.

Table 14 Key technical environmental investigations

Environmental factor	Investigation	Year	Key assessment standards	Description	Reference section
Flora and Vegetation	Northern Suburbs Railway, Alkimos to Yanchep, *Phytophthora cinnamomi* occurrence assessment (Glevan Consulting 2011)	2011	• *Phytophthora cinnamomi* and disease caused by it, Volume I – Management Guidelines (Department of Environment and Conservation [DEC] 2003). • *Phytophthora cinnamomi* and disease caused by it, Volume II – Interpreter Guidelines for Detection, Diagnosis and Mapping (DEC 2001).	Assesses the presence of *Phytophthora cinnamomi* within the proposed Northern Suburbs Railway – Alkimos to Yanchep extension project.	Section 8
	Northern Suburbs Railway Alignment Butler to Yanchep Environmental Investigation (GHD 2012)	2012	• *Environment Protection and Biodiversity Conservation Act 1999* • *Wildlife Conservation Act 1950* • Guidance Statement No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA 2004a)	Describes vegetation and flora values of the proposed Northern Suburbs Railway Alignment Butler to Yanchep and provides an ecological impact assessment.	Section 8
	Yanchep Rail Extension, *Phytophthora* dieback Occurrence Assessment (Glevan Consulting 2017)	2017	• FEM047 *Phytophthora* Dieback Interpreter's Manual for Lands Managed by the Department (Department of Parks and Wildlife 2015)	Assesses the presence of *Phytophthora cinnamomi* for the YRE project.	Section 8
	Yanchep Rail Extension Biological Assessment (GHD 2018a)	2018	• *Environment Protection and Biodiversity Conservation Act 1999* • *Wildlife Conservation Act 1950 / Biodiversity Conservation Act 2016* • Technical Guidance: *Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016b).	Describes flora and vegetation values of the YRE project's development footprint and provides an ecological impact assessment.	Section 8
	Yanchep Rail Extension Part 2, Biological Factors (GHD 2018b)	2018	• *Environment Protection and Biodiversity Conservation Act 1999* • *Wildlife Conservation Act 1950 / Biodiversity Conservation Act 2016* • Technical Guidance: *Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016b).	• Provides additional contextual flora and vegetation information for the development envelope, as well as at local and regional scales. • Describes and quantifies the potential impacts (direct and cumulative) associated with the Part 2 of the YRE project on flora and vegetation at local and regional scales.	Section 8
Landform	Yanchep Rail Extension, Geotechnical Investigation Report (Advisian 2017)	2017	N/A	Describes the geological profile and provides an interpretation of the geotechnical engineering implications for construction.	Section 9
	Yanchep Rail Extension Part 2, Biological Factors (GHD 2018b	2018	Environmental Factor Guide*l*ine: *Landforms* (EPA 2018a)	• Provides additional contextual landforms information for the development envelope, as well as at local and regional scales. • Describes and quantifies the potential impacts (direct and cumulative) associated with the Part 2 of the YRE project on landforms at local and regional scales.	Section 9
Short-range Endemic Invertebrates	Desktop Review and Risk Assessment of Short Range Endemic Invertebrates for the Yanchep Rail Extension (Invertebrate Solutions 2018a)	2018	Technical Guidance. *Sampling of Short Range Endemic Invertebrate Fauna* (EPA 2016c)	Provides an assessment for the likelihood of SRE Invertebrates within the development footprint.	Section 10
Subterranean Fauna	Northern Suburbs Railway Alignment Butler to Yanchep Environmental Investigation (GHD 2012)	2012	Guidance Statement No. 54: Consideration of Subterranean Fauna in Groundwater and in Caves during Environmental Impact Assessment in Western Australia (EPA 2003)	Provides an assessment of the likelihood of stygofauna, stygofauna habitat or karst formations within the development footprint.	Section 10
	Desktop Review and Risk Assessment of Subterranean Fauna for the Yanchep Rail Extension (Invertebrate Solutions 2018b)	2018	• Environmental Factor Guideline: *Subterranean Fauna* (EPA 2016d) • Technical Guidance: *Subterranean Fauna Survey* (EPA 2016e) • Technical Guidance: *Sampling Methods for Subterranean Fauna* (EPA 2016f)	Provides a desktop habitat and preliminary risk assessment for the likelihood of subterranean fauna (stygofauna and troglofauna) within the development footprint.	Section 10
Terrestrial Environmental Quality	Yanchep Rail Extension, Preliminary Site Investigation (Golder Associates 2017)	2017	• Assessment and Management of Contaminated Sites (Department of Environment Regulation [DER] 2014) • National Environmental Protection (Assessment of Site Contamination) Measure 1999	Provides an assessment of whether current or former site land uses are likely to have caused or contributed to contamination.	Section 11
	METRONET – YRE Hydrology Assessment (RPS 2018b)	2018	N/A	Provides an assessment of the potential risk of groundwater acidification.	Section 11
Terrestrial Fauna	Report for Northern Suburbs Railway Alignment from Romeo Road (Alkimos) to Yanchep, Graceful Sun-moth Survey (GHD 2011)	2011	• *Environment Protection and Biodiversity Conservation Act 1999* • *Wildlife Conservation Act 1950* • Survey Guidelines for the Graceful Sun-moth (*Synemon gratiosa*) and site habitat requirements (DEC 2010)	Provides the findings of a Graceful Sun-moth survey of the proposed Northern Suburbs Railway Alignment from Romeo Road (Alkimos) to Yanchep.	Section 12

Environmental factor	Investigation	Year	Key assessment standards	Description	Reference section
	Northern Suburbs Railway Alignment Butler to Yanchep Environmental Investigation (GHD 2012)	2012	• *Environment Protection and Biodiversity Conservation Act 1999* • *Wildlife Conservation Act 1950* • Guidance Statement No. 54: Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia (EPA 2003) • Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA 2004b)	Describes fauna values of the proposed Northern Suburbs Railway Alignment Butler to Yanchep and provides an ecological impact assessment.	Section 12
	Yanchep Rail Extension Biological Assessment (GHD 2018a)	2018	• *Environment Protection and Biodiversity Conservation Act 1999* • *Wildlife Conservation Act 1950 / Biodiversity Conservation Act 2016* • Technical Guidance: *Terrestrial Fauna Surveys* (EPA 2016j)	Describes fauna values of the YRE project's development footprint and provides an ecological impact assessment.	Section 12
	Yanchep Rail Extension Part 2, Biological Factors (GHD 2018b)	2018	• *Environment Protection and Biodiversity Conservation Act 1999* • *Wildlife Conservation Act 1950 / Biodiversity Conservation Act 2016* • Technical Guidance: *Terrestrial Fauna Surveys* (EPA 2016j)	• Provides additional contextual terrestrial fauna information for the development envelope, as well as at local and regional scales. • Describes and quantifies the potential impacts (direct and cumulative) associated with the Part 2 of the YRE project on terrestrial fauna at local and regional scales.	Section 12
Inland Waters	METRONET – YRE Hydrology Assessment (RPS 2018b)	2018	N/A	Assesses: • potential expected drawdown from YRE project's proposed construction groundwater abstraction bores • direct, indirect and cumulative impacts of temporarily taking groundwater within the YRE project's development envelope • potential temporary impact to nearby waterbodies • offset distances for the YRE project's temporary abstraction bores from Water Corporation's existing production bores, its Wellhead Protection Zones and other local groundwater users.	Section 13
Social Surroundings	Desk-top Aboriginal Heritage Study of Proposed Northern Suburbs Railway Route (R. & E. O'Connor Pty Ltd 2012)	2012	*Aboriginal Heritage Act 1972*	Investigates and makes recommendations for managing identified Aboriginal heritage issues that may be affected by the proposed Northern Suburbs Railway.	Section 14
	Report on an Archaeological Survey of the Butler to Yanchep Railway Alignment (John Cecchi Heritage Management Consulting (JCHMC) 2013)	2013	*Aboriginal Heritage Act 1972*	Assesses the presence of archaeological sites within Butler to Yanchep Railway Alignment.	Section 14
	Northern Suburbs Railway Extension Alignment (R. & E. O'Connor Pty Ltd 2017a)	2017	*Aboriginal Heritage Act 1972*	Describes methodology, execution and results of consultative process and Aboriginal heritage survey.	Section 14
	Addendum to report on the Aboriginal Heritage Survey of the Northern Suburbs Railway Extension (R. & E. O'Connor Pty Ltd 2017b)	2017	*Aboriginal Heritage Act 1972*	Describes methodology, execution and results of additional consultative process and Aboriginal heritage survey for the proposed station sites and associated facilities.	Section 14
	Northern Suburbs Railway Extension Butler to Yanchep, Noise Assessment (Herring Storer Acoustics 2012a)	2012	SPP 5.4: Road and Rail Transport Noise and Freight Considerations in Land Use Planning	Determines noise emissions from trains travelling on extension of the Joondalup railway, provides an assessment of the predicted noise levels for compliance with the appropriate criteria and advises on appropriate controls.	Section 14
	Northern Rail Extension Romeo Road to Yanchep, Ground Vibration Assessment (Herring Storer Acoustics 2012b)	2012	AS 2670.2-1990 Evaluation of human exposure to whole-body vibration; Part 2: Continuous and shock-induced vibration building (1 to 80 Hz)	Measures ground vibration from passing passenger trains on the Perth-Mandurah line, provides an assessment of the predicted vibration levels for compliance with the appropriate criteria and advises on appropriate controls.	Section 14
	METRONET – Yanchep Rail Extension, Transport Noise and Vibration Assessment (Lloyd George Acoustics 2018b)	2018	• SPP 5.4: Road and Rail Transport Noise and Freight Considerations in Land Use Planning • AS 2670.2-1990 Evaluation of human exposure to whole-body vibration; Part 2: Continuous and shock-induced vibration building (1 to 80 Hz)	Assesses the noise and vibration emissions from the YRE project and provides recommendations on mitigation measures to ensure compliance with the noise and vibration criteria and minimise impacts to all existing and planned sensitive premises.	Section 14
	METRONET – Yanchep Rail Extension, Noise and Vibration Management Plan (Lloyd George Acoustics 2018a)	2018	• SPP 5.4: Road and Rail Transport Noise and Freight Considerations in Land Use Planning • AS 2670.2-1990 Evaluation of human exposure to whole-body vibration; Part 2: Continuous and shock-induced vibration building (1 to 80 Hz)	Provides the environmental management actions to manage the potential impacts of the proposal on amenity (noise and vibration).	Section 14

7 Environmental factors

7.1 Environmental principles

Section 4A of the EP Act establishes that the objective of the Act is to protect Western Australia's environment, having regard for the following principles:

1. The precautionary principle.
2. The principle of intergenerational equity.
3. Principles relating to improved valuation, pricing and incentive mechanisms.
4. The principle of the conservation of biological diversity and ecological integrity.
5. The principle of waste minimisation.

Table 15 identifies how these five EP Act principles have been considered by the YRE project.

Table 15 EP Act principles

Principle	Consideration
The precautionary principle	
Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In application of this precautionary principle, decisions should be guided by: a. Careful evaluation to avoid, where practicable, serious or irreversible damage to the environment. b. An assessment of the risk-weighted consequences of various options.	Part 2 of the YRE project has been underpinned by key strategic planning documents (Table 8) and TPS Amendment 787 to support district structure planning in the Yanchep-Two Rocks localities (Table 9) and the alignment of the current "Railways" reservation (Table 9). The strategic planning framework and complementary environmental assessments have been augmented by additional environmental investigations undertaken to inform the detailed design of LSPs (Section 4.1.1) and support environmental assessment under the EPBC Act (Section 2.5). The detailed design for the development footprint has been informed by more than 6 years of detailed environmental investigation (Table 14). Modifications to the development envelope have been made to avoid and minimise environmental impacts, where practicable to do so (Section 4.2.4). The PTA has also maintained close correspondence with relevant government agencies (Table 13) to minimise any uncertainty surrounding the environmental impact of the YRE project. Detailed design plans, when coupled with the development and implementation of the CEMP and PTA standard operating procedures, will avoid and minimise impacts to the identified environmental factors within the development envelope.
The principle of intergenerational equity	
The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for benefit of future generations.	Part 2 of the YRE project has been designed to address the EPA's objectives for the identified environmental factors, with mitigation measures provided to reduce any residual environmental impacts. The YRE project responds to the growing need for an accessible, environmentally sensitive and economically sustainable means of public travel in the North-west Sub-region (Section 4.2.3). This EIA report demonstrates that Part 2 of the YRE project can be implemented to avoid significant impacts on the health, diversity or productivity of the environment for the benefit of future generations.
Principles relating to improved valuation, pricing and incentive mechanisms	
1. Environmental factors should be included in the valuation of assets and services.	Environmental factors were considered when evaluating an alternative railway alignment considered for the portion of the development footprint that intersects Bush Forever Site No. 289 (Section 4.2.4). Alternative construction methodologies, such as tunnelling, were also considered by the PTA as part of the evaluation of design options for Part 2 of YRE project to reduce potential impacts to Bush Forever Site No. 289 (Section 4.2.4). The PTA has assessed the relevant environmental factors and has iteratively modified the development envelope of its preferred development option during planning to minimise its environmental impacts (Section 4.2.4). Avoidance of significant environmental attributes and ongoing management costs have also been considered by the PTA in the detailed design for the YRE project (Section 4.2.4).
2. The polluter pays principles-those who generate pollution and waste should bear the cost of containment, avoidance and abatement.	
3. The users of goods and services should pay prices based on the full lifecycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste.	

Principle	Consideration
4. Environmental goals, have been established, should be pursued in the most cost-effective way, by establishing incentive structure, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solution and response to environmental problems.	
The principle of the conservation of biological diversity and ecological integrity	
Conservation of biological diversity and ecological integrity should be a fundamental consideration.	Part 2 of the YRE project is comprised of land reserved under the MRS for the purpose of “Railways”, whilst the construction and access areas have been selected to coincide with proposed future urban development cells or roads either reserved by the MRS (Figure B), or as detailed within approved and draft LSPs, to reduce the likelihood of impacting native vegetation proposed to be retained within future POS reservations. Detailed Flora and Vegetation and Terrestrial Fauna field surveys (Table 14) have been undertaken to identify and confirm the relative environmental values of the ecological attributes identified within the development envelope. Minimising potential impacts to the identified ecological attributes within the development envelope has been a fundamental design consideration. Development envelope has been iteratively modified by the PTA to minimise environmental impacts (Section 4.2.4).
The principle of waste minimisation	
All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.	Waste will be minimised during construction by adopting the hierarchy of waste controls; avoid, minimise, reuse, recycle and safe disposal. It is expected that significant amount of sand and limestone will be required to be removed from the development footprint to facilitate the final finished floor levels. The PTA is investigating numerous beneficial re-use opportunities for the excess sand and limestone in close proximity to the development footprint.

7.2 Environmental factors

This EIA report addresses the EPA's environmental factors, as outlined in the *Statement of Environmental Principles, Factors and Objectives* (EPA 2018d), of specific relevance to Part 2 of the YRE project:

- land factors
  - flora and vegetation
  - landforms
  - subterranean fauna
  - terrestrial environmental quality
  - terrestrial fauna
- water factor
  - inland waters
- people factor
  - social surroundings.

Sections 8 to 14 specifically discuss the environment impacts to the relevant land, water and people factors associated with Part 2 of the YRE project. Each section identifies the EPA's objective for the environmental factor, details the receiving environment, identifies potential impacts that may occur, provides an assessment of the potential impacts, proposes mitigation strategies that will be used to minimise the identified impacts and, finally, provides a description of the predicted outcome.

7.2.1 EPA guidance and technical reports

The YRE project is subject to compliance with applicable guidelines and technical reports which have been developed to assist proponents, and the general public, in understanding the minimum requirements for the protection of the environment that the EPA expects to be met during the assessment process.

Table 16 details the EPA's environmental factors and technical guidelines relevant to the YRE project.

Table 16 Applicable EPA guidance and technical reports

EPA environmental factor guidelines
Environmental Factor Guideline: *Flora and Vegetation* (EPA 2016a)
Environmental Factor Guideline: *Landforms* (EPA 2018a)
Environmental Factor Guideline: *Subterranean Fauna* (EPA 2016d)
Environmental Factor Guideline: *Terrestrial Environmental Quality* (EPA 2016g)
Environmental Factor Guideline: *Terrestrial Fauna* (EPA 2016h)
Environmental Factor Guideline: *Inland Waters* (EPA 2018b)
Environmental Factor Guideline: *Social Surroundings* (EPA 2016k)
EPA technical guidance
Technical Guidance: *Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016b)
Technical Guidance. *Sampling of Short Range Endemic Invertebrate Fauna* (EPA 2016c)
Technical Guidance: *Subterranean Fauna Survey* (EPA 2016e)

Technical Guidance: *Sampling Methods for Subterranean Fauna* (EPA 2016f)
Technical Guidance: *Sampling Methods for Terrestrial Vertebrate Fauna* (EPA 2016i)
Technical Guidance: *Terrestrial Fauna Surveys* (EPA 2016j)

7.2.2 Contextual information scale

To address the EPA's requirement for contextual information of the environmental values present within and surrounding the development envelope, the following spatial scales have been applied:

- **development envelope**
- **local assessment area** – land within 1 km of the development envelope
- **regional assessment area** – land within the Perth and Peel@3.5 million's North-west Sub-region planning framework (DPLH and WAPC 2018b)
- **bioregional assessment area** – land with the IBRA Swan Coastal Plain (SWA2) subregion (Mitchell, Williams and Desmond 2002).

The bioregional scale has been applied to the environmental factors of Flora and Vegetation, Subterranean Fauna and Terrestrial Fauna to assist in addressing the EPA's requirement for a further explanation of the potential direct and indirect impacts of the construction and operation of Part 2 of the YRE project.

The boundaries of these areas in the context of the development envelope are shown in Figure I.

8 Flora and vegetation

8.1 EPA objective

To protect flora and vegetation so that biological diversity and ecological integrity are maintained.

8.2 Policy and guidance

- *Environment Protection and Biodiversity Conservation Act 1999*.
- *Wildlife Conservation Act 1950* / *Biodiversity Conservation Act 2016*.
- Environmental Factor Guideline: *Flora and Vegetation* (EPA 2016a).
- Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016b).
- SPP 2.8: Bushland Policy for the Perth Metropolitan Region.

8.3 Environmental investigations

The following environmental investigations have been undertaken which assess the flora and vegetation values within the development envelope:

- Yanchep Rail Extension Biological Assessment (GHD 2018a; Appendix A)
- Yanchep Rail Extension Part 2, Biological Factors (GHD 2018b; Appendix B)
- Yanchep Rail Extension, *Phytophthora* dieback Occurrence Assessment (Glevan Consulting 2017, Appendix C)
- Northern Suburbs Railway Alignment Butler to Yanchep Environmental Investigation (GHD 2012).

Table 14 provides a brief description of each these investigations and identifies the assessment standards used to inform the scope and content of the individual investigations.

8.3.1 Level 2 flora and vegetation survey

GHD undertook a detailed (Level 2) Flora and Vegetation survey (GHD 2018a) in accordance with the EPA's Technical Guidance: *Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016b), which included:

- a desktop survey
- field surveys on 1 to 3 November 2016, 3 to 5 May 2017, 11 to 12 July 2017 and 5 to 7 December 2017.

The results of the Level 2 flora and vegetation survey are summarised in Section 8.4.

8.4 Receiving environment

8.4.1 Regional vegetation

According to Heddle et al. (1980), the vegetation within the development envelope belongs to the following regional vegetation complexes:

- Quindalup Complex
- Cottesloe Complex-North.

A description of these vegetation complexes and their percentage remaining on the Swan Coastal Plain IBRA region and within the development envelope is provided in Table 17, whilst the complexes' relationship to the development envelope is identified in Figures J-1 to J-4.

Both the Quindalup Complex and Cottesloe Complex-North have greater than 58% of their pre-European extents remaining within the Swan Coastal Plain IBRA region.

Table 17 Regional vegetation extents mapped within the development envelope

Vegetation complex	Description	Swan coastal plain IBRA region			Development envelope		
		Pre-European extent (ha)	Current extent (ha)	% remaining	Pre-European extent (ha)	Current (ha)	% remaining
Quindalup Complex	Coastal dune complex consisting mainly of two alliances- the strand and fore dune alliance and the mobile and stable dune alliance. Local variations include the low closed forest of *Melaleuca lanceolata – Callitris preissii* and the closed scrub of *Acacia rostellifera.*	54,574	33,079	61	71.70	61.29	85
Cottesloe Complex - North	Predominantly low open forest and low woodland of *Banksia attenuata* – B. *menziesii – Eucalyptus toditana*; Closed heath on the limestone outcrops.	43,474	25,169	58	1.19	1.03	87

(Source: Government of Western Australian 2000; GHD 2018a)

8.4.2 Vegetation types

Twelve vegetation types were identified by GHD during the flora and vegetation survey within the development envelope. Approximately 53.19 ha (or 72.98%) of the development envelope's 72.88 ha extent contains remnant native vegetation (i.e. vegetation that is representative of the previously mapped vegetation associations and regional vegetation complexes). Approximately 10.56 ha has been previously cleared (Table 18; Figures J-1 to J-4).

Disturbance events have historically occurred; planting of shrubs and trees of both native and introduced species has been undertaken. These areas of disturbance account for 9.13 ha (or 12.53%) of the development envelope and are identified by vegetation type Planted (VT12) in Figures J-2 and J-3. Vegetation type Planted (VT12) is not considered representative of remnant native vegetation. Approximately 8.08 ha (or 88.50%) of vegetation type Planted (VT12) is located within Bush Forever Site No. 289.

Table 18 Vegetation types

Vegetation type	Conservation significance		Area (ha)	% composition
	WC Act / DBCA listing	EPBC Act 1999		
Acacia saligna and *Xanthorrhoea preissii* tall shrubland (VT1)	-	-	10.72	14.71
Banksia sessilis and *Melaleuca systena* mid-shrubland (VT2)	Northern Spearwood shrublands and woodlands PEC (Priority 3)	-	4.83	6.63

Vegetation type	Conservation significance		Area (ha)	% composition
	WC Act / DBCA listing	EPBC Act 1999		
Banksia sessilis and *Spyridium globulosum* tall shrubland (VT3)		-	11.03	15.13
Banksia attenuata, B. menziesii low woodland (VT4)	Banksia dominated woodlands of the Swan Coastal Plain IBRA Region PEC (Priority 3)	Banksia Woodlands of the Swan Coastal Plain TEC	5.81	7.97
Lomandra sp. herbland (VT5)	-	-	5.32	7.30
Eucalyptus gomphocephala tall woodland (VT6)	Tuart (*Eucalyptus gomphocephala*) woodlands of the Swan Coastal Plain PEC (Priority 3)	-	2.14	2.94
Eucalyptus sp., *Agonis flexuosa* woodland (VT7)	-	-	0.32	0.44
Melaleuca huegelii and *M. systena* shrubland (VT8)	*Melaleuca huegelii – M. acerosa* [*M. systena*] shrublands on limestone ridges TEC 26a	-	0.05	0.07
Banksia attenuata woodland (VT9)	Banksia dominated woodlands of the Swan Coastal Plain IBRA Region PEC (Priority 3)	Banksia Woodlands of the Swan Coastal Plain TEC	7.09	9.73
Xanthorrhoea preissii shrubland (VT10)	-	-	1.57	2.15
Planted (VT12)	-	-	9.13	12.53
Scattered Natives (VT13)	-	-	4.31	5.91
Cleared (CL)	-	-	10.56	14.49
Total			**72.88**	**100**

(Source: GHD 2018a)

8.4.3 Vegetation condition

The condition of the remnant native vegetation within the development envelope ranged from “Excellent” to “Completely Degraded” (Table 19; Figures K-1 to K-4). Of the 53.19 ha of remnant native vegetation , 47.30 ha (88.94%) are considered to be in “Degraded” or better condition and 5.88 ha (11.06%) are considered to be in “Completely Degraded” condition.

Table 19 Vegetation condition

Vegetation condition	Area (ha)	% composition
Pristine	0	0
Excellent	4.48	8.42
Very Good	18.33	34.47
Good	15.52	29.18
Degraded	8.97	16.87
Completely Degraded	5.88	11.06
Total	**53.19**	**100**

(Source: GHD 2018a)

8.4.4 Flora species

GHD (2018a) identified a total of 244 flora taxa, including subspecies and varieties, from 56 families and 149 genera within the broader survey area. Of the identified flora taxa, 180 were native taxa and 64 were introduced. Dominant families recorded included Poaceae (27 taxa), Fabaceae (26 taxa) and Proteaceae (24 taxa).

No EPBC Act or WC Act listed flora were recorded within the development envelope by GHD (2018a) or GHD (2012).

One priority flora species was recorded by GHD (2018a); *Hibbertia spicata* subsp. *leptotheca* (Priority 3). Only one individual was recorded within the *Melaleuca huegelii* and *M. systena* shrubland (VT8) vegetation type in the north of Bush Forever Site No. 289 (Figure J-2).

Additionally, three priority flora species were previously recorded by GHD (2012):

- *Beyeria cinerea* subsp. *cinerea* (Priority 3). Recorded in low densities (3% and 1%) at two sampling quadrats in the north of Bush Forever Site No. 289. The vegetation types associated with the sampling quadrats in GHD (2018a) are *Banksia sessilis* and *Spyridium globulosum* tall shrubland (VT3) and *Lomandra* sp. herbland (VT5).
- *Conostylis pauciflora* subsp. *euryrhipis* (Priority 4). Two populations were recorded between the Lots 1 and 102 Yanchep Beach Road and Lots 1 and 2 Yanchep Beach Road LSPs. The two populations are comprised of approximately 12 – 22 plants in total. The vegetation types associated with the sampling quadrats in GHD (2018a) are *Banksia sessilis* and *Spyridium globulosum* tall shrubland (VT3) and *Eucalyptus* sp. and *Agonis flexuosa* woodland (VT7).
- *Conostylis pauciflora* subsp. *pauciflora* (Priority 4). Only one individual was recorded between the Lots 1 and 102 Yanchep Beach Road and Lots 1 and 2 Yanchep Beach Road LSPs. The vegetation types associated with the sampling quadrats in GHD (2018a) are *Banksia sessilis* and *Spyridium globulosum* tall shrubland (VT3) and *Eucalyptus* sp. and *Agonis flexuosa* woodland (VT7).

8.4.4.1 Introduced flora

Four Declared Pests listed under the *Biosecurity and Management Act 2007* were recorded by GHD (2018a) within the development envelope:

- *Gomphocarpus fruticosus* (narrowleaf cottonbush)
- *Solanum linnaeanum* (apple of Sodom)
- *Lantana camara* (common lantana)
- *Asparagus asparagoides* (bridal creeper).

Additionally, *Moraea flaccida* (One-leaf Cape Tulip) was recorded by GHD in low numbers in 2012.

8.4.5 Threatened and priority ecological communities

The development envelope intersects the following TECs and PECs:

- *Melaleuca huegelii – M. acerosa* [*M. systena*] shrublands on limestone ridges TEC 26a. This TEC is listed as “Endangered” under the WC Act.
  - Description: Species rich thickets, heaths or scrubs dominated by *Melaleuca huegelii*, *M. systena* (previously *M. acerosa*), *Banksia sessilis* over *Grevillea preissii*, *Acacia lasiocarpa* and *Spyridium globulosum*, occurring on skeletal soil on ridge slopes and ridge tops. Broadly occurs on Spearwood Sands (Tamala Limestone) on large limestone ridges (GHD 2018a).
  - Extent: Approximately 0.05 ha of the *Melaleuca huegelii – M. acerosa* [*M. systena*] shrublands on limestone ridges TEC 26a was recorded within the development envelope (Table 18; Figure J-2)

- Banksia dominated woodlands of the Swan Coastal Plain IBRA Region PEC (Priority 3) / Banksia Woodlands of the Swan Coastal Plain TEC. This ecological community is listed as Priority 3 by the DBCA and "Endangered" under the EPBC Act.
  - Description: Woodland associated with the SCP of southwest WA. A key diagnostic feature is a prominent tree layer of Banksia, with scattered Eucalyptus and other tree species often present among or emerging above the Banksia canopy. The understorey is a species rich mix of sclerophyllous shrubs, graminoids and forbs. The ecological community is characterised by a high endemism and considerable localised variation in species composition across its range (GHD 2018a).
  - Extent: Approximately 12.90 ha of the Banksia dominated woodlands of the Swan Coastal Plain IBRA Region PEC (Priority 3) was recorded within the development envelope, of which approximately 12.10 ha was associated with the Banksia Woodlands of the Swan Coastal Plain TEC (Table 18; Figures J-1, J-2 and J-3).
- Northern Spearwood shrublands and woodlands PEC (Priority 3). This ecological community is listed as Priority 3 by the DBCA.
  - Description: Heaths with scattered *Eucalyptus gomphocephala* occurring on deeper soils north from Woodman Point. Most sites occur on the Cottesloe unit of the Spearwood system. The heathlands in this group typically include *Banksia sessilis*, *Calothamnus quadrifidus*, and *Schoenus grandifloras* (GHD 2018a).
  - Extent: Approximately 15.85 ha of the Northern Spearwood shrublands and woodlands PEC (Priority 3) was recorded within the development envelope (Table 18; Figures J-1 to J-4).
- Tuart (*Eucalyptus gomphocephala*) woodlands of the Swan Coastal Plain PEC (Priority 3). This ecological community is listed as Priority 3 by the DBCA.
  - Description: Woodlands of *Eucalyptus gomphocephala* - *Agonis flexuosa* south of Woodman Point. Recorded from the Karrakatta, Cottesloe and Vasse units. Dominants other than tuart were occasionally recorded, including *Corymbia calophylla* at Paganoni block and *Eucalyptus decipiens* at Kemerton, however tuarts are emergent nearby. Banksias found in this community include *Banksia attenuata*, *B. grandis* and *B. littoralis*. However, Tuart formed the overstorey nearby (GHD 2018a).
  - Extent: Approximately 2.14 ha of the Tuart (*Eucalyptus gomphocephala*) woodlands of the Swan Coastal Plain PEC (Priority 3) was recorded within the development envelope (Table 18; Figures J-2 and J-3).

8.4.6 Environmentally sensitive areas

Environmentally Sensitive Areas (ESAs) are declared by the Minister for Environment under Section 51B of the EP Act.

GHD (2018a) outlines the aspects of the areas declared as an ESA under the Environmental Protection (Environmentally Sensitive Areas) Notice 2005. GHD (2018a) identifies that the majority of the development envelope is mapped as an ESA, which generally aligns with the presence of TECs and their mapped buffers.

8.4.7 Phytophthora Dieback

A *Phytophthora* dieback Occurrence Assessment was undertaken by Glevan Consulting in August 2017 for the YRE project (Appendix C). No *Phytophthora* dieback infestations were recorded within the development footprint by Glevan in 2017 or the earlier assessment in 2011 (Glevan 2011).

The majority of the development footprint was considered to be uninterpretable by Glevan (2017) primarily due to a lack of sufficient indicator species.

8.5 Potential impacts

Table 20 provides the potential impacts to flora and vegetation from construction of the development envelope and operation of the railway.

Table 20 Potential construction and operational impacts to flora and vegetation

Phase	Impact class	Works/operations	Potential impacts
Construction	Direct	Clearing of native vegetation	• Permanent loss of native vegetation • Permanent loss of TECs • Permanent loss of PECs • Permanent loss of Priority species • Permanent loss of Bushland within Bush Forever Site No. 289
	Indirect	• Clearing of native vegetation • Cut and fill works • Excavation and construction of roads, buildings and other hard stand areas • Operation of plant machinery and service vehicles	• Introduction and distribution of Declared Pests and other weed species • Introduction and distribution of *Phytophthora* dieback • Disturbance to surrounding native vegetation during construction works
Operation	Indirect	Operation and maintenance of the electrified railway line	• Introduction and distribution of Declared Pests and other weed species • Introduction and distribution of *Phytophthora* dieback

8.6 Assessment of impacts

8.6.1 Permanent loss of native vegetation

8.6.1.1 Development envelope

The implementation of Part 2 of the YRE project will result in the permanent loss of up to approximately 62.32 ha of vegetation comprised of:

- 53.19 ha of remnant native vegetation (GHD 2018b; Table 21)
- 9.13 ha of vegetation type Planted (VT12) comprised planted shrubs and trees of both native and introduced species (GHD 2018b; Table 21).

Of the approximate 53.19 ha of remnant native vegetation within the development envelope:

- 47.30 ha (or approximately 88.93%) is considered to be in “Degraded” or better condition and 5.88 ha (or 10.91%) is considered to be in “Completely Degraded” condition
- 46.25 ha (or approximately 86.95%) is located within the development footprint with the remaining 6.94 ha (or approximately 13.05%) located within the construction and access areas.

The construction and access areas have been selected to coincide with proposed future urban development cells or roads either reserved by the MRS (Figure B), or as detailed within approved and draft LSPs (Figure C), to reduce the likelihood of impacting native vegetation proposed to be retained within future Public Open Space (POS) reservations (Section 4.2.4).

Table 21 Direct impacts to native vegetation within the development envelope

Vegetation type	Development footprint		Construction and access areas		Development envelope	
	Area (ha)	% Composition	Area (ha)	% Composition	Area (ha)	% Composition
Acacia saligna and *Xanthorrhoea preissii* tall shrubland (VT1)	9.54	15.82	1.19	9.46	10.72	14.71
Banksia sessilis and *Melaleuca systena* mid-shrubland (VT2)	3.90	6.47	0.92	7.31	4.83	6.63
Banksia sessilis and *Spyridium globulosum* tall shrubland (VT3)	10.53	17.46	0.49	3.90	11.03	15.13
Banksia attenuata, B. menziesii low woodland (VT4)	3.86	6.40	1.95	15.50	5.81	7.97
Lomandra sp. herbland (VT5)	5.06	8.39	0.26	2.07	5.32	7.30
Eucalyptus gomphocephala tall woodland (VT6)	2.14	3.55	-	-	2.14	2.94
Eucalyptus sp., *Agonis flexuosa* woodland (VT7)	0.32	0.53	-	-	0.32	0.44
Melaleuca huegelii and *M. systena* shrubland (VT8)	0.05	0.08	-	-	0.05	0.07
Banksia attenuata woodland (VT9)	7.09	11.76	-	-	7.09	9.73
Xanthorrhoea preissii shrubland (VT10)	1.57	2.60	-	-	1.57	2.15
Planted (VT12)	8.31	13.78	0.82	6.52	9.13	12.53
Scattered Natives (VT13)	2.18	3.61	2.14	17.01	4.31	5.91
Cleared (CL)	5.76	9.55	4.81	38.24	10.56	14.49
Total	**60.31**	**100**	**12.57**	**100**	**72.88**	**100**

(Source: GHD 2018b)

8.6.1.2 Local and regional scales

8.6.1.2.1 Vegetation associations

Table 22 identifies the potential impact of the proposal on the extent of the regional aligned vegetation associations (949, 998 and 1007) found within the Part 2 development envelope. GHD (2018b) aligned vegetation types present within the Part 2 development envelope with regional vegetation associations (Beard 1979) to enable the local, regional and cumulative assessment to occur. Alignment was based on vegetation structure and species present.

GHD (2018b) identifies the largest percentage impact is linked to vegetation association 998 at the local scale, accounting for a 100% reduction at a local level. The notional impact to vegetation association 998 is likely:

- associated with utilising broad-scale mapping (Beard 1979) at a local scale, where the resolution does not include all local occurrences (GHD 2018b)
- compounded by the limited inferred extent of vegetation association 998 within a 1 km buffer of the proposed action (GHD 2018b). Broad-scale mapping (Beard 1979) indicates there is vegetation association 998 present within Yanchep National Park located to the east of the proposed action (GHD 2018b).

At a regional and bioregional scale this impact is significantly less at 0.8% and 0.01% (Table 22), with greater than 40% of vegetation association 998 remaining after the implementation of Part 2 of the YRE project. The current extents of the aligned vegetation associations within conservation areas range from 42.52% to 100% at the local scale, from 21.59% to 87.41% at the regional scale and from 24.19% to 64.50% at the bioregional scale (GHD 2018b).

The implementation of Part 2 of the YRE project will not reduce the vegetation associations mapped with the development envelope below 30% of their pre-European extent thresholds (GHD 2018b).

GHD (2018b) details the current extents of the aligned vegetation associations, as identified within the development envelope, and future urban development at the local and regional scales for assessment of cumulative impacts. The largest percentage is linked to vegetation association 1007, with future urban development estimated to include 51.33% at the local scale and 67.76% at the regional scale of the extent of this vegetation association (GHD 2018b). By comparison, the implementation of Part 2 of the YRE project will result in a relatively smaller reduction at the local (1.56%) and regional (0.33%) scales of vegetation association 1007's mapped extent (GHD 2018b).

Most of the vegetation associations mapped within the YRE project are well reserved within conservation areas at the regional and bioregional scale and noting that the implementation of the YRE project (Parts 1 and 2) will not result in any vegetation associations being reduced to below 30% of their pre-European extent. The potential direct and cumulative impacts to the persistence of the regional vegetation associations from the implementation of the YRE project are minor, with the potential impacts capable of being managed via the mitigation measures identified in Table 28.

Table 22 Vegetation associations mapped within the development envelope and at local, regional and bioregional scales

Vegetation association	Corresponding GHD vegetation types	Scale	Pre-European extent (ha)	Current extent (ha)	Remaining (%)	Extent in development envelope (ha)	% of current extent within development envelope	Current extent after proposal developed (ha)
949	VT2, VT3, VT4, VT9	Perth subregion	184,475.82	103,972.25	56.36%	28.36	0.03%	103,943.89 (56.35%)
		NW subregion	38,330.32	17,173.49	44.80%		0.17%	17,145.13 (44.73%)
		1 km buffer	243.65	97.973721	40.21%		28.94%	69.62 (28.57%)
998	VT6, VT7	Perth subregion	50,867.50	18,286.07	35.95%	2.46	0.01%	18,283.61 (35.94%)
		NW subregion	7,473.03	3,016.23	40.36%		0.08%	3,013.77 (40.33%)
		1 km buffer	1.61	1.61	100%		100%	-
1007	VT1, VT5, VT8, VT10, VT13	Perth subregion	30,109.89	20,681.70	68.69%	16.48	0.08%	20,665.22 (68.63%)
		NW subregion	10,801.16	5,048.24	46.74%		0.33%	5,031.76 (46.59%)
		1 km buffer	1,817.51	1,055.75	58.09%		1.56 %	1,039.27 (57.18%)

(Source: GHD 2018b)

8.6.1.2.2 Regional vegetation complexes

Table 23 identifies the potential impact of the proposal on the extent of the regional vegetation complexes (Cottesloe Complex – North, Cottesloe Complex – Central and South and the Quindalup Complex) found within the development envelope. GHD (2018b) aligned vegetation types present within the Part 2 development envelope with regional vegetation complexes (Heddle *et al.* 1980) to enable the local, regional and cumulative assessment to occur. Alignment was based on vegetation structure and species present.

The largest percentage impact is linked to the Cottesloe Complex – Central and South at the local scale (within 1 km) accounting for a 100% reduction (Table 23). The notional impact to Cottesloe Complex – Central and South is likely:

- associated with utilising broad-scale mapping (Heddle *et. al*. 1980) at a local scale, where the resolution does not include all local occurrences (GHD 2018b)
- compounded by the limited inferred extent of Cottesloe Complex – Central and South within a 1 km buffer of the proposed action (GHD 2018b).

At a regional and bioregional scale impact is 0.13% and 0.05%, respectively (Table 23). The remaining extents of regional vegetation complexes within conservation areas range from 42.52% to 100% at the local scale and from 21.59% to 87.41% at the regional scale (GHD 2018b).

The implementation of Part 2 of the YRE project is not anticipated to reduce any of the regional vegetation complexes mapped with the development envelope below 30% of their pre-European extent thresholds (GHD 2018b).

GHD (2018b) provides an overview of current extents of the regional vegetation complexes, as identified within the development envelope, which will support future urban development at the local and regional scales for assessment of cumulative impacts. The largest percentage is linked to the Quindalup Complex, with future urban development estimated to include 52.43% at the local scale and 64.00% at the regional scale of the extent of this regional vegetation complex (GHD 2018b). By comparison, the implementation of Part 2 of the YRE project will result in a relatively smaller reduction at the local (0.95%) and regional (0.17%) scales of the Quindalup Complex's mapped extent (GHD 2018b).

The majority of the regional vegetation complexes mapped within the YRE project are well reserved within conservation areas at the regional and bioregional scale. The implementation of the YRE project (Parts 1 and 2) will not result in any regional vegetation complexes being reduced to below 30% of their pre-European extent threshold (GHD 2018b). The potential direct and cumulative impacts to the persistence of the regional vegetation complexes from the implementation of the YRE project are minor, with the potential impacts capable of being managed via the mitigation measures identified in Table 28.

Table 23 Regional vegetation complexes mapped within the development envelope and at local, regional and bioregional scales

Vegetation complex	Corresponding GHD vegetation types	Scale	Pre-European extent (ha)	Current extent (ha)	Remaining (%)	Extent in development envelope (ha)	% of current extent within development envelope	Current extent after proposal developed (ha)
Cottesloe complex – north	VT2, VT3, VT4, VT9, VT10	Perth subregion	43,474.30	25,162.35	57.88%	29.83	0.12%	25,132.52 (57.81%)
		NW subregion	8,715.75	5,950.36	68.27%		0.50%	5,920.53 (67.93%)
		1 km buffer	326.55	125.33	38.38%		23.80%	95.50 (29.24%)
Cottesloe complex – central and south	VT5, VT6, VT7, VT8	Perth subregion	45,030.93	14,571.13	32.36%	7.69	0.05%	14,563.44 (32.34%)
		NW subregion	17,272.13	5,841.12	33.82%		0.13%	5,833.43 (33.77%)
		1 km buffer	1.45	1.45	100%		100%	-
Quindalup complex	VT1, VT13	Perth subregion	53,007.07	32,954.86	62.17%	9.77	0.03%	32,945.09 (62.15%)
		NW subregion	11,184.24	5,634.59	50.38%		0.17%	5,624.82 (50.29%)
		1 km buffer	1,734.76	1,028.55	59.29%		0.95%	1,018.79 (58.73%)

(Source: GHD 2018b)

8.6.2 Permanent loss of Priority flora

8.6.2.1 *Hibbertia spicata* subsp. Leptotheca (priority 3)

One individual plant was recorded within the *Melaleuca huegelii* and *M. systena* shrubland (VT8) vegetation type in the north of Bush Forever Site No. 289 (GHD 2018a; Figure J-2).

Hibbertia spicata subsp. *leptotheca* (Priority 3) is known from near-coastal limestone ridges, outcrops and cliffs and has been recorded within the Swan Coastal Plain IBRA region (Florabase 2018a). Potential habitat for this species includes the known extent of *Melaleuca huegelii – M. acerosa* [*M. systena*] shrublands on limestone ridges TEC 26a. As the *Melaleuca huegelii – M. acerosa* [*M. systena*] shrublands on limestone ridges TEC 26a is well reserved at the regional (80.00%) and bioregional (80.05%) scales, it is considered that the potential direct impact to the persistence of *Hibbertia spicata* subsp. *leptotheca* (Priority 3) from the implementation of the YRE project is relatively minor (Section 8.6.3.2.1).

8.6.2.2 *Beyeria cinerea* subsp. Cinerea (priority 3)

Beyeria cinerea subsp. *cinerea* (Priority 3) was recorded in low densities (3% and 1%) at two sampling quadrats in the north of Bush Forever Site No. 289 (GHD 2012). The vegetation types associated with the sampling quadrats in GHD (2018a) are *Banksia sessilis* and *Spyridium globulosum* tall shrubland (VT3) and *Lomandra* sp. herbland (VT5).

Beyeria cinerea subsp. *cinerea* (Priority 3) has been recorded within the Swan Coastal Plain and Geraldton Sand Plains IBRA regions (Florabase 2018b). Potential habitat for this species includes the known extent of the Northern Spearwood shrublands and woodlands PEC (Priority 3). Assuming there will remain a high level of protection afforded to the Northern Spearwood shrublands and woodlands PEC (Priority 3), it is considered that the potential direct impact to this species from the implementation of the YRE project is relatively minor at the bioregional scale (Section 8.6.4.2.2).

8.6.2.3 Conostylis pauciflora

8.6.2.3.1 *Conostylis pauciflora* subsp. Euryrhipis (Priority 4)

Two populations of *Conostylis pauciflora* subsp. *euryrhipis* (Priority 4) were recorded between the Lots 1 and 102 Yanchep Beach Road and Lots 1 and 2 Yanchep Beach Road LSPs (GHD 2012). The two populations are comprised of approximately 12 – 22 plants in total. The vegetation types associated with the sampling quadrats in GHD (2018a) are *Banksia sessilis* and *Spyridium globulosum* tall shrubland (VT3) and *Eucalyptus* sp. and *Agonis flexuosa* woodland (VT7).

Conostylis pauciflora subsp. *euryrhipis* (Priority 4) is known from white, grey or yellow sand consolidated dunes (Florabase 2018c). This species has been recorded within the Swan Coastal Plain IBRA region (Florabase 2018c). Potential habitat for this species includes the known extent of the Northern Spearwood shrublands and woodlands PEC (Priority 3). Assuming there will remain a high level of protection afforded to the Northern Spearwood shrublands and woodlands PEC (Priority 3), it is considered that the potential direct impact to this species from the implementation of the YRE project is relatively minor at the bioregional scale (Section 8.6.4.2.2).

8.6.2.3.2 *Conostylis pauciflora* subsp. Pauciflora (Priority 4)

One *Conostylis pauciflora* subsp. *pauciflora* (Priority 4) individual was recorded between the Lots 1 and 102 Yanchep Beach Road and Lots 1 and 2 Yanchep Beach Road LSPs (GHD 2012). The vegetation types associated with the sampling quadrats in GHD (2018a) are *Banksia sessilis* and *Spyridium globulosum* tall shrubland (VT3) and *Eucalyptus* sp. and *Agonis flexuosa* woodland (VT7).

Conostylis pauciflora subsp. *pauciflora* (Priority 4) is known from grey sand / limestone hillslopes and consolidated dunes (Florabase 2018d). This species has been recorded within the Swan Coastal Plain IBRA region (Florabase 2018d). Potential habitat for this species includes the known extent of the Northern Spearwood shrublands and woodlands PEC (Priority 3). Assuming there will remain a high level of protection afforded to the Northern Spearwood shrublands and woodlands PEC (Priority 3), it is considered that the potential direct impact to this species from the implementation of the YRE project is relatively minor at the bioregional scale (Section 8.6.4.2.2).

8.6.3 Permanent loss of TECs

8.6.3.1 Development envelope

TECs recorded within the development envelope were:

- *Melaleuca huegelii – M. acerosa* [*M. systena*] shrublands on limestone ridges TEC 26a
- Banksia Woodlands of the Swan Coastal Plain TEC.

TECs are ecological communities which fit into one of the following categories; “presumed totally destroyed”, “critically endangered”, “endangered” or “vulnerable”. These TECs are listed under the WC Act and EPBC Act, respectively.

Table 24 identifies the direct impact to TECs within the development envelope and at the local, regional and bioregional scales

Table 24 Direct impacts to TECs within the development envelope and at the local, regional and bioregional scales

Vegetation type	Condition	Conservation significance		Development envelope (ha)	Local scale (ha)	Regional scale (ha)	Bioregional scale (ha)
		WC Act / DBCA listing	EPBC Act				
Melaleuca huegelii and *M. systena* shrubland (VT8)	“Very Good”	*Melaleuca huegelii – M. acerosa [M. systena]* shrublands on limestone ridges TEC 26a	-	0.05	Unable to be determined	80.38	164.08
Subtotal				0.05			
Banksia attenuata, B. menziesii low woodland (VT4, VT9)	“Excellent”	Banksia dominated woodlands of the Swan Coastal Plain IBRA Region PEC (Priority 3)	Banksia Woodlands of the Swan Coastal Plain TEC	2.05	The Banksia Woodlands of the Swan Coastal Plain TEC is a subset of the Banksia dominated woodlands of the Swan Coastal Plain IBRA Region PEC (Priority 3) in “Good” or better condition. See Table 25 for TEC / PEC context		
	“Very Good”			7.57			
	“Good”			2.48			
Subtotal				12.10			

(Source: GHD 2018b)

8.6.3.2 Local, regional and bioregional scales

8.6.3.2.1 *Melaleuca huegelii – M. Acerosa* [*M. Systena*] shrublands on limestone ridges TEC 26a

Approximately 164.08 ha of the *Melaleuca huegelii – M. acerosa* [*M. systena*] shrublands on limestone ridges TEC 26a was identified in the Interim Recovery Plan for the *Melaleuca huegelii – M. acerosa* [*M. systena*] shrublands on limestone ridges TEC 26a (Department of Conservation and Land Management

[CALM] 2005) at a bioregional scale, which includes 80.38 ha at the regional scale (GHD 2018b) (Table 24). The extent of *Melaleuca huegelii – M. acerosa* [*M. systena*] shrublands on limestone ridges TEC 26a located within 1 km of the development envelope was not able to be determined using the available information in CALM (2005) (Table 24).

Approximately 64.3 ha (80%) of the estimated extent of *Melaleuca huegelii – M. acerosa* [*M. systena*] shrublands on limestone ridges TEC 26a occurs within National Parks and State Forest at the regional scale and 132.2 ha (80.5%) occurs within the National Parks and State Forest at the bioregional regional scale (GHD 2018b).

Based on the current extent (extracted from CALM 2005 and GHD 2018a), the implementation of Part 2 of the YRE project is predicted to reduce the extent of this TEC by up to 0.06% at the regional scale and 0.03% at the bioregional scale.

Regional spatial data was not available to inform a cumulative assessment for the *Melaleuca huegelii – M. acerosa* [*M. systena*] shrublands on limestone ridges TEC 26a at a local or regional scale.

When the potential impacts to the *Melaleuca huegelii – M. acerosa* [*M. systena*] shrublands on limestone ridges TEC 26a for Part 2 are considered cumulatively with those of Part 1, the implementation of the YRE project will reduce the extent the *Melaleuca huegelii – M. acerosa* [*M. systena*] shrublands on limestone ridges TEC 26a in “Degraded” or better condition by 1.17 ha. This loss represents a 1.46% and 0.71% reduction of the TEC at the regional and bioregional scales.

As the *Melaleuca huegelii – M. acerosa* [*M. systena*] shrublands on limestone ridges TEC 26a is well reserved at the regional (80.00%) and bioregional (80.05%) scales, it is considered the 0.05 ha direct impact to the long term persistence of this TEC from the implementation of the YRE project is relatively minor.

8.6.3.2.2 Banksia woodlands of the Swan coastal plain TEC

The Banksia Woodlands of the Swan Coastal Plain TEC is a subset of the Banksia dominated woodlands of the Swan Coastal Plain IBRA Region PEC (Priority 3) in “Good” or better condition. Section 8.6.4.2.1 provides an indicative summary of the potential impacts to this TEC across the local and regional scales.

8.6.4 Permanent loss of PECs

8.6.4.1 Development envelope

PECs recorded within the development envelope were:

- Banksia dominated woodlands of the Swan Coastal Plain IBRA Region PEC (Priority 3)
- northern spearwood shrublands and woodlands PEC (Priority 3)
- tuart (*Eucalyptus gomphocephala*) woodlands of the Swan Coastal Plain PEC (Priority 3).

PECs are ecological communities with insufficient information available to be considered a TEC or which are rare but not currently threatened (DBCA 2018). PECs are listed by the DBCA.

Table 25 identifies the direct impact to PECs within the development envelope and at the local, regional and bioregional scales.

Table 25 Direct impacts to PECs within the development envelope and at the local, regional and bioregional scales

Vegetation type	Condition	Conservation significance		Development envelope (ha)	Local scale (ha)	Regional scale (ha)
		DBCA listing	EPBC Act			
Banksia sessilis and *Melaleuca systena* mid-shrubland (VT2)	"Degraded" or better	Northern Spearwood shrublands and woodlands PEC (Priority 3)		4.82	Sufficient data is not readily available to inform a local or regional assessment of the Northern Spearwood shrublands and woodlands PEC (Priority 3)	
	"Completely Degraded"		-			
Banksia sessilis and *Spyridium globulosum* tall shrubland (VT3)	"Degraded" or better		-	10.90		
	"Completely Degraded"		-	0.13		
Subtotal				15.85		
Banksia attenuata, B. menziesii low woodland (VT4, VT9)	"Degraded" or better	Banksia dominated woodlands of the Swan Coastal Plain IBRA Region PEC (Priority 3)	Banksia Woodlands of the Swan Coastal Plain TEC	12.65	97.97	17,355.02
	"Completely Degraded"		-	0.25		
Subtotal				12.90		
Eucalyptus gomphocephala tall woodland (VT6)	"Degraded"	Tuart (*Eucalyptus gomphocephala*) woodlands of the Swan Coastal Plain PEC (Priority 3)	2.14	2.14	1.61	3,650.50
	"Completely Degraded"		-	-		
Subtotal				2.14		

(Source: GHD 2018b)

8.6.4.2 Local, regional and bioregional scales

8.6.4.2.1 Banksia dominated woodlands of the Swan coastal plain IBRA Region PEC

GHD (2018b) identifies that approximately 17,355.02 ha of the Banksia dominated woodlands of the Swan Coastal Plain IBRA Region PEC (Priority 3) (which includes the Banksia Woodlands of the Swan Coastal Plain TEC as a subset of this community) has been recorded at a regional scale and 97.97 ha at the local scale. Sufficient data is not readily available to inform a bioregional assessment of the Banksia dominated woodlands of the Swan Coastal Plain IBRA Region PEC (Priority 3). Approximately 87.33% of the Banksia dominated woodlands of the Swan Coastal Plain IBRA Region PEC (Priority 3) occurs within conservation areas at the regional scale, whilst 18.89% is reserved in conservation areas locally (GHD 2018b).

The implementation of Part 2 of the YRE project is expected to reduce the extent of Banksia dominated woodlands of the Swan Coastal Plain IBRA Region PEC (Priority 3) by 13.16% and 0.07% across the local and regional scales respectively.

Regional spatial data was not available to inform a cumulative assessment for the Banksia dominated woodlands of the Swan Coastal Plain IBRA Region PEC (Priority 3).

When the potential impacts to the Banksia dominated woodlands of the Swan Coastal Plain IBRA Region PEC (Priority 3) for Part 2 are considered cumulatively with those of Part 1, the implementation of the YRE project will reduce the extent the Banksia dominated woodlands of the Swan Coastal Plain IBRA Region PEC (Priority 3) in "Degraded" or better condition by 29.34 ha (GHD 2018b). This loss represents a 5.67% and 0.17% reduction of the PEC at the local and regional scales.

As the Banksia dominated woodlands of the Swan Coastal Plain IBRA Region PEC (Priority 3) (and hence Banksia Woodlands of the Swan Coastal Plain TEC) is well reserved at the regional (more than 87%) scale, it is considered that the direct impact of 12.65 ha in "Degraded" or better condition to the persistence of this PEC (and 12.10 ha in "Good" or better to the persistence of this TEC) from the implementation of the YRE project is relatively minor.

8.6.4.2.2 Northern spearwood shrublands and woodlands PEC

GHD (2018b) identifies that the proposal will result in the permanent loss of the Northern Spearwood shrublands and woodlands PEC (Priority 3), will result in a 1.57% reduction of the PEC at the bioregional scale. Sufficient data is not readily available to inform a local or regional assessment of the Northern Spearwood shrublands and woodlands PEC (Priority 3).

When the potential impacts to the Northern Spearwood shrublands and woodlands PEC (Priority 3) for Part 2 are considered cumulatively with those of Part 1, the implementation of the YRE project will reduce the extent of the Northern Spearwood shrublands and woodlands PEC (Priority 3*)* in "Degraded" or better condition by 33.02 ha, representing a 3.27% reduction of the PEC at the bioregional scale (GHD 2018b).

Assuming there will remain a high level of protection afforded to this Northern Spearwood shrublands and woodlands PEC (Priority 3*)*, it is considered that the potential direct impact to this PEC from the implementation of the YRE project is relatively minor at the bioregional scale.

8.6.4.2.3 Tuart (*Eucalyptus gomphocephala*) woodlands of the Swan coastal plain PEC

GHD (2018b) identifies that the permanent loss of the Tuart (*Eucalyptus gomphocephala*) woodlands of the Swan Coastal Plain PEC (Priority 3) as part of the implementation of Part 2 of the YRE project will contribute a 100% and 0.06% reduction of the PEC at the local and regional scales. Sufficient data is not readily available to inform a bioregional assessment of the Tuart (*Eucalyptus gomphocephala*) woodlands of the Swan Coastal Plain PEC (Priority 3). GHD (2018b) identifies the perceived impact to the Tuart (*Eucalyptus gomphocephala*) woodlands PEC at the local scale is likely a reflection of:

- utilising broad scale mapping (Beard 1979) to infer extent
- limited extent of this PEC within a 1 km buffer of the development envelope.

The vegetation within Bush Forever Site No. 289 includes an upland *Eucalyptus gomphocephala* community as part of the mapped vegetation structural units (Government of Western Australia 2000). The inclusion of this community as a structural unit may suggest its occurrence occurs more broadly throughout the Bush Forever site than regional mapping indicates (GHD 2018b). The upland *Eucalyptus gomphocephala* community is also recorded within Bush Forever Site No. 288: *Yanchep National Park and Adjacent Bushland* (Government of Western Australia 2000).

Of the estimated current extent of the Tuart (*Eucalyptus gomphocephala*) woodlands PEC remaining, 79.48% is within conservation areas at a local scale, whilst 100% is within conservation areas at a regional scale (GHD 2018b).

Regional spatial data was not available to inform a cumulative assessment for the Tuart (*Eucalyptus gomphocephala*) woodlands of the Swan Coastal Plain PEC (Priority 3).

As the Tuart (*Eucalyptus gomphocephala*) woodlands of the Swan Coastal Plain PEC (Priority 3) is well reserved at the regional (more than 79%) scale and may occur more broadly throughout the Bush Forever site, it is considered that the potential direct impact to the persistence of this PEC from the implementation of the YRE project is relatively minor.

8.6.5 Permanent loss of bushland within Bush Forever Site No. 289

This section specifically assesses the potential impacts to Bush Forever Site No. 289 in accordance with the impact assessment process for Bush Forever areas outlined in Appendix 1 of SPP 2.8. This section represents the statement of environmental effects, which has been compiled by the PTA, in order for the proposal to be reviewed against the impact assessment criteria in Appendix 2 of SPP 2.8 by a decision making authority.

This section also addresses the impact assessment criteria outlined in Appendix 2 of SPP 2.8, specifically:

- conservation and design considerations (Section 8.6.5.1)
- long-term protection and management considerations (Table 29)
- offset considerations (Section 8.8.3).

It is noted that impacts related to fragmentation of fauna habitat within Bush Forever Site No. 289 are discussed in Section 12.6.4. The EPA's mitigation hierarchy has been applied to Bush Forever Site No. 289 in Table 29, to seek to protect the site's core (highest) conservation values.

8.6.5.1 Development envelope

Approximately 28.82 ha (or 4.38%) of the 657.51 ha Bush Forever Site No. 289 is included within the development envelope. Of the 28.82 ha, approximately 10.14 ha is comprised of land reserved for "Railways" and 18.68 ha of "Parks and Recreation" under the MRS (Table 26; Figure L).

The development footprint and volumes of sand to be excavated within Bush Forever Site No. 289 has been reduced through a decision to raise the vertical alignment of the railway through this site, which has minimised the potential impacts to flora and vegetation, fauna habitat and landform. However, the implementation of this approach results in an increased width of the development envelope when compared to the other portions of the alignment.

8.6.5.1.1 Vegetation types

Ten vegetation types were identified by GHD within the portion of the development envelope which intersects Bush Forever Site No. 289 (Table 26; Figure M). Within the development envelope, there is approximately 20.46 ha of remnant native vegetation (Table 26).

The vegetation types where previous disturbance has occurred are:

- Planted (VT12) – comprised of 8.08 ha of land (Figure M) where previous clearing has resulted in the existing native vegetation community being replaced by planted shrubs and introduced species. This vegetation type is not considered representative of remnant native vegetation.

  This vegetation type comprises approximately 28.04% of the vegetated area within the portion of the development envelope which intersects Bush Forever Site No. 289.

- Cleared (CL) – comprised of 0.28 ha of cleared land (Figure M).2046

  This vegetation type comprises approximately 0.97% of the vegetated area within the portion of the development envelope which intersects Bush Forever Site No. 289.

8.6.5.1.2 Vegetation condition

The condition of the remnant native vegetation within the portion of the development envelope which intersects Bush Forever Site No. 289 ranged from "Excellent" to "Completely Degraded" (Table 26; Figure N). Of the 20.46 ha of vegetation types considered to be representative of the previously mapped vegetation associations and regional vegetation complexes, 18.11 ha are considered to be in "Degraded" or better condition and 2.35 ha are considered to be in "Completely Degraded" condition.

Table 26 Direct impacts to Bush Forever Site No. 289

Vegetation type	Condition	Conservation significance		"Railways" reservation		"Parks and Recreation" reservation		Development envelope (ha)	
		WC Act / DBCA listing	EPBC Act 1999	Vegetated area (ha)	SPP 2.8 bushland (ha)	Vegetated area (ha	SPP 2.8 bushland (ha)	Vegetated area (ha	SPP 2.8 bushland (ha)
Acacia saligna and *Xanthorrhoea preissii* tall shrubland (VT1)	"Degraded" or better	-	-	0.19	0.19	0.33	0.33	0.52	0.52
Banksia sessilis and *Spyridium globulosum* tall shrubland (VT3)	"Degraded" or better	Northern Spearwood shrublands and woodlands PEC (Priority 3)	-	1.56	1.56	2.88	2.88	4.44	4.44
	"Completely Degraded"		-	0.10	-	0.02	-	0.12	
Banksia woodland (VT4,VT9)	"Degraded" or better	Banksia dominated woodlands of the Swan Coastal Plain IBRA Region PEC (Priority 3)	Banksia Woodlands of the Swan Coastal Plain TEC	3.50	3.5	4.37	4.37	7.87	7.87
	"Completely Degraded"		-	0.11	-	0.14	-	0.25	
Lomandra sp. herbland (VT5)	"Degraded" or better	-	-	0.40	0.40	1.72	1.72	2.12	2.12
	"Completely Degraded"	-	-	0.13	-	0.01	-	0.14	
Eucalyptus gomphocephala tall woodland (VT6)	"Degraded" or better	Tuart (*Eucalyptus gomphocephala*) woodlands of the Swan Coastal Plain PEC (Priority 3)		0.05	0.05	1.44	1.44	1.49	1.49
Melaleuca huegelii and *M. systena shrubland* (VT8)	"Degraded" or better	*Melaleuca huegelii – M. acerosa* [*M. systena*] shrublands on limestone ridges TEC 26a		0.03	0.03	0.02	0.02	0.05	0.05

Vegetation type	Condition	Conservation significance		"Railways" reservation		"Parks and Recreation" reservation		Development envelope (ha)	
		WC Act / DBCA listing	EPBC Act 1999	Vegetated area (ha)	SPP 2.8 bushland (ha)	Vegetated area (ha	SPP 2.8 bushland (ha)	Vegetated area (ha	SPP 2.8 bushland (ha)
Xanthorrhoea preissii shrubland (VT10)	"Degraded" or better	-	-	-	-	1.48	1.48	1.48	1.48
	"Completely Degraded"	-	-	-		0.09	-	0.09	
Planted (VT12)	"Completely Degraded"	-	-	3.62	-	4.46	-	8.08	-
Scattered Natives (VT13)	"Degraded" or better	-	-	-	-	0.14	0.14	0.14	0.14
	"Completely Degraded"	-	-	0.40	-	1.35	-	1.75	-
Cleared (CL)	Cleared			0.05		0.23	-	0.28	-
Total				**10.14**	**5.73**	**18.68**	**12.38**	**28.82**	**18.11**

(Source: GHD 2018a)

8.6.5.1.3 SPP 2.8: Bushland Policy for the Perth Metropolitan Region

Bushland context

The native vegetation within the development envelope was assessed by GHD (2018a) in accordance with the vegetation condition rating scale (adapted from Keighery [1994] and Trudgen [1988]) identified in the EPA's Technical Guidance: *Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016b). The scale recognises the intactness of vegetation and consists of six rating levels as outlined in Table 27.

Table 27 Vegetation condition descriptions

Vegetation condition rating	South west and interzone botanical provinces description	Defined as "Bushland" under SPP 2.8
"Pristine"	Pristine or nearly so, no obvious signs of damage caused by human activities since European settlement.	Yes
"Excellent"	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. Damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle tracks.	Yes
"Very Good"	Vegetation structure altered, obvious signs of disturbance. Disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.	Yes
"Good"	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.	Yes
"Degraded"	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds at high density, partial clearing, dieback and grazing.	Yes
"Completely Degraded"	The structure of vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.	No

(Source: EPA 2016b)

The 18.11 ha of vegetation types representative of the previously mapped vegetation associations and regional vegetation complexes in "Degraded" or better condition is considered to be Bushland, as defined by SPP 2.8 (Section 2.4.2.1.1).

Metropolitan region scheme context

Of the 18.11 ha of Bushland, approximately 5.73 ha is situated within the "Railways" reservation whilst 12.38 ha of Bushland is situated within the "Parks and Recreation" reservation (Table 26). SPP 2.8 identifies that proposals should seek to protect Bushland as a priority, except where a proposal (or decision) is consistent with the overall purpose and intent of an existing reserve and in particular existing reserves for roads (regional or local), railways, pipelines, water or drainage services (Section 2.4.2.1.1).

It is considered that where the alignment of the development envelope intersects the "Railways" reservation within Bush Forever Site No. 289 that the overall purpose and intent of the "Railways" reserve is being met (Figure L). However, where the alignment of the development envelope intersects the "Parks and Recreation" reservation within Bush Forever Site No. 289, it is considered that the overall purpose and intent

of the “Parks and Recreation” reserve is not being met. To assist in addressing the long-term protection of Bush Forever Site No. 289 it is intended that the 1.46 ha of “Railways” reservation outside the development envelope is amended to be reserved for “Parks and Recreation”.

The potential impact from the implementation of Part 2 of the YRE project upon Bushland within Bush Forever Site No. 289 is considered to be the permanent loss of 18.11 ha (GHD 2018b). Should the provisions of Section 5.1.2.3 in SPP 2.8 be applied, then the impact would be the permanent loss of 12.38 ha of Bushland reserved as “Parks and Recreation” under the MRS. EPA’s mitigation hierarchy has been applied to Bush Forever Site No. 289 in Table 29, to seek to protect the site’s core (highest) conservation values.

Previous consideration

The fragmentation of Bush Forever Site No. 289 by a future railway line has been identified within key strategic planning documents including the draft Directions 2031 and Beyond (Department of Planning and WAPC 2010), draft Perth and Peel Green Growth Plan (Department of the Premier and Cabinet 2015) and Perth and Peel@3.5million (DPLH and WAPC 2018b). Map 1 in SPP 2.8 includes a railway alignment through Bush Forever Site No. 289, as gazetted by the Government of Western Australia in 2010.

8.6.5.1.4 Commonwealth matters of national environmental significance

MNES identified within the portion of the development envelope which intersects Bush Forever Site No. 289 by GHD (2018b) are Banksia Woodlands of the Swan Coastal Plain TEC and Carnaby’s Black Cockatoo.

Approximately 7.55 ha of Banksia Woodlands of the Swan Coastal Plain TEC, 26.24 ha of Carnaby’s Black Cockatoo foraging habitat and 18 potential breeding trees were recorded within Bush Forever Site No. 289 (Figure O). Approximately 14.18 ha (or 54.04%) of the Carnaby’s Black Cockatoo foraging habitat was determined to be high value foraging habitat, 10.17 ha (or 38.76 %) was determined to be medium value foraging habitat and 1.89 ha (or 7.20%) was determined to be low value foraging habitat (Figure O).

Potential impacts to the Banksia Woodlands of the Swan Coastal Plain TEC and Carnaby’s Black Cockatoo are addressed in Sections 8 and 12 as part of the assessment of these MNES within the entire development envelope.

8.6.5.1.5 Local and regional scales

Approximately 593 ha of land within 1 km of the development envelope is delegated as Bush Forever area under the MRS, whilst approximately 512.17 ha are reserved as “Parks and Recreation” (Figure P). The permanent loss of 18.11 ha of Bushland within Bush Forever Site No. 289 represents approximately 3.05% of the extent of land delegated as Bush Forever areas at the local scale, whilst the permanent loss of 12.38 ha of Bushland within “Parks and Recreation” reservations represents approximately 2.42% of the extent of land reserved for “Parks and Recreation” at the local scale.

Approximately 27,459 ha of the land within the North-west Sub-region is delegated as Bush Forever area under the MRS, whilst approximately 26,551 ha are reserved as “Parks and Recreation” (Figure P). The permanent loss of 18.11 ha of Bushland within Bush Forever Site No. 289 represents approximately 0.07% of the extent of land delegated as Bush Forever areas at the regional scale, whilst the permanent loss of 12.38 ha of Bushland within “Parks and Recreation” reservations represents approximately 0.05% of the extent of land reserved for “Parks and Recreation” at the regional scale (Figure P).

As Bushland is likely to be well reserved within Bush Forever area delegations and “Parks and Recreation” reservations at the regional scale, it is considered that the potential direct impact to the persistence of Bushland within the North-west Sub-region from the implementation of Part 2 of the YRE project is relatively minor.

8.6.6 Significance of direct impacts

The key conclusions with respect to Flora and Vegetation are:

- implementation of Part 2 (and Part 1) of the YRE project is not anticipated to reduce any of the vegetation associations and complexes mapped with the Part 2 (and Part 1) development envelope below 30% of their pre-European extents
- low numbers of Priority flora species will be impacted by the implementation of Part 2 of the YRE project, however the level of impact to these species at the regional and bioregional scales is likely to be relatively minor
- TECs and PECs will be impacted by the implementation of Part 2 of the YRE project, however the level of impact to these communities at the regional and bioregional scales is relatively minor (i.e. generally around 1%)
- contribution of Part 2 (and Part 1) of the YRE project to the cumulative loss of native vegetation at the local and regional scales is likely to be relatively minor when compared other complimentary land uses
- Bushland within Bush Forever Site No. 289 will be impacted by the implementation of Part 2 of the YRE project, however the level of impact to bushland at the regional scales is relatively minor (i.e. between 0.05% and 0.07%).

The direct impacts to flora and vegetation from the implementation of the YRE project are considered to be relatively minor across the spatial scales. Table 28 and Table 29 identify the avoidance measures that have been undertaken by the PTA, as part of the detailed design of Part 2 of the YRE project, to reduce the direct residual impacts to flora and vegetation during project construction.

8.6.7 Impacts to adjacent native vegetation

The implementation of Part 2 of the YRE project has the potential to indirectly impact native vegetation extents within adjacent land holdings. These indirect impacts could include:

- introduction and distribution of Declared Pests and other weed species
- introduction and distribution of *Phytophthora* dieback
- disturbance to surrounding native vegetation during construction works.

It is considered that these potential impacts are capable of being appropriately addressed through standard construction management practices (Table 28). The PTA's past performance in implementing appropriate mitigation measures as part of the construction and operation of railway projects is demonstrated in Section 3.

8.7 Mitigation measures

Table 28 demonstrates how the EPA's mitigation hierarchy (avoid, minimise and rehabilitate) has been applied to the environmental factor of Flora and Vegetation to address the key potential impacts. EPA's mitigation hierarchy has also been applied to Bush Forever Site No. 289 in Table 29 to protect the site's core (highest) conservation values.

Table 28 Application of mitigation hierarchy for flora and vegetation

Potential impacts	Impact class	Mitigation hierarchy	Proposed mitigation measures	Residual impacts
Construction				
• Permanent loss of native vegetation • Permanent loss of TECs • Permanent loss of PECs • Permanent loss of Priority species	Direct	Avoid	Modification of the development footprint to reduce the clearing of native vegetation and avoid direct impacts to Bush Forever Site No. 288: *Yanchep National Park and Adjacent Bushland*	• Permanent loss of up to 47.30 ha of native vegetation representative of the previously mapped vegetation associations and regional vegetation complexes in "Degraded" or better condition • Permanent loss of one *Hibbertia spicata* subsp. *leptotheca* (Priority 3) individual; two low density populations of *Beyeria cinerea* subsp. *cinerea* (Priority 3); up to 22 *Conostylis pauciflora* subsp. *euryrhipis* (Priority 4) individuals; and one *Conostylis pauciflora* subsp. *pauciflora* (Priority 4) individual • Permanent loss of up to 0.05 ha *Melaleuca huegelii – M. acerosa* [*M. systena*] shrublands on limestone ridges TEC 26a in "Very Good" condition • Permanent loss of up to 12.65 ha of Banksia dominated woodlands of the Swan Coastal Plain IBRA Region PEC (Priority 3) in "Degraded" or better condition, which includes 12.10 ha of Banksia Woodlands of the Swan Coastal Plain TEC • Permanent loss of up to 15.72 ha of Northern Spearwood shrublands and woodlands PEC (Priority 3) • Permanent loss of up to 2.14 ha of Tuart (*Eucalyptus gomphocephala*) woodlands of the Swan Coastal Plain PEC (Priority 3) in "Degraded" condition
		Minimise	• Construction and access areas have been selected to coincide with proposed future urban development cells or roads either reserved by the MRS, or as detailed within approved and draft LSPs, to reduce the likelihood of impacting native vegetation proposed to be retained within future POS reservations • Construction Environment Management Plan (CEMP) will be prepared to ensure that clearing is restricted to the development envelope • CEMP will be prepared to accord with the approved Conservation Management Plan for Regional Open Space and Pubic Open Space (Strategen 2015) and the approved Clearing and Revegetation Management Plan (Strategen 2014) for the portion of the development envelope which intersects the EPBC 2011 / 6021 approval	
		Rehabilitate	Cleared construction and access areas will be managed by the PTA during and post construction to prevent weed establishment	

Potential impacts	Impact class	Mitigation hierarchy	Proposed mitigation measures	Residual impacts
• Introduction and distribution of Declared Pests and other weed species • Introduction and distribution of *Phytophthora* dieback • Disturbance to surrounding native vegetation during construction works	Indirect	Avoid	• CEMP will be prepared to avoid the introduction and distribution of Declared Pests, other weed species and *Phytophthora* dieback as well as avoid disturbance to surrounding native vegetation during the construction of Part 2 of the YRE project • CEMP will be prepared to accord with the approved Conservation Management Plan for Regional Open Space and Pubic Open Space (Strategen 2015) and the approved Clearing and Revegetation Management Plan (Strategen 2014) for the portion of the development envelope which intersects the EPBC 2011 / 6021 approval	With appropriate management, potential impacts are as low as reasonably practicable
		Minimise	CEMP will include adaptive management measures that will be implemented should the avoidance measures not be met	
		Rehabilitate	Cleared construction and access areas will be managed by the PTA during and post construction to prevent weed establishment	
Operation				
• Introduction and distribution of Declared Pests and other weed species • Introduction and distribution of *Phytophthora* dieback	Indirect	Avoid	Avoidance of trains and service machinery using the operational railway corridor is not a feasible option	With appropriate management, potential impacts are as low as reasonably practicable
		Minimise	Operational railway corridor will be managed by the PTA in perpetuity in accordance with its Vegetation Management Manual. The PTA's Urban Rail Reserve Vegetation Management Plan (PTA 2016) requires herbicide application for weeds to be undertaken on a 6 monthly basis along an 8 metre track corridor and on an annual basis for fences and associated rail structures. Additionally, the PTA undertakes regular inspections for and treats Declared Pests, as required (PTA 2016)	
		Rehabilitate	No rehabilitation is anticipated to be required	

Table 29 Application of mitigation hierarchy to Bush Forever Site No. 289

Potential impacts	Impact class	Mitigation hierarchy	Proposed mitigation measures	Residual impacts
Construction				
Permanent loss of Bushland within Bush Forever Site No. 289	Direct	Avoid	Access tracks within Bush Forever Site No. 289 have been planned to accommodate PTA, DBCA and DFES operational requirements thereby eliminating the potential for the duplication of access tracks by the agencies and reducing native vegetation clearing	Permanent loss of 18.11 ha of Bushland within Bush Forever Site No. 289, including 12.38 ha of Bushland reserved as "Parks and Recreation" under the MRS

		Minimise	• Alternative railway alignment with a reduced direct impact on Bush Forever Site No. 289 was considered however was determined not to be feasible (Section 4.2.4)
			• Previous MRS amendments have determined the point of egress into Bush Forever Site No. 289 for the "Railways" reservation, however the development envelope has been situated to
			  • minimise impacts to the Quindalup 2 parabolic dunes (Figure S)
			  • maximise the size and viability of the western portion of Bush Forever Site No. 289 (Figure L)
			  • include approximately 29% of previously disturbed land (VT12 and CL; Section 8.6.5.1.1), which is not considered to be representative of remnant native vegetation
			• Construction and access areas have intentionally not been located within Bush Forever Site No. 289, reducing the native vegetation clearing to only that required for operational purposes
			• Development footprint and volumes of sand to be excavated within Bush Forever Site No. 289 has been reduced through a decision to raise the vertical alignment of the railway through this site, which has minimised the potential impacts to flora and vegetation, fauna habitat and landform
			• CEMP will be prepared to ensure that clearing is restricted to the development envelope	

		Rehabilitate	• Detailed engineering design will be undertaken to minimise landform impacts and identify structural controls (i.e. battering the excavation and / or retaining walls) that will be implemented to stabilise the affected landform. Should the batters be of a suitable gradient and material, they will be stabilised with planting of locally endemic species and/or bioengineering controls that will be sympathetic to the surrounding native vegetation within Bush Forever Site No. 289 • Cleared construction and access areas will be managed by the PTA during and post construction to prevent weed establishment	

Potential impacts	Impact class	Mitigation hierarchy	Proposed mitigation measures	Residual impacts
• Introduction and distribution of Declared Pests and other weed species • Introduction and distribution of *Phytophthora* dieback • Disturbance to surrounding native vegetation during construction works	Indirect	Avoid	CEMP will be prepared to avoid the introduction and distribution of Declared Pests, other weed species and *Phytophthora* dieback as well as avoid disturbance to surrounding native vegetation during the construction of Part 2 of the YRE project	With appropriate management, potential impacts are as low as reasonably practicable
		Minimise	CEMP will include adaptive management measures that will be implemented should the avoidance measures not be met	
		Rehabilitate	• Where batters are of a suitable gradient and material, their rehabilitation will be sympathetic to the surrounding native vegetation within Bush Forever Site No. 289 • Cleared construction and access areas will be managed by the PTA during and post construction to prevent weed establishment	
Operation				
• Introduction and distribution of Declared Pests and other weed species • Introduction and distribution of *Phytophthora* dieback	Indirect	Avoid	Avoidance of trains and service machinery using the operational railway corridor is not a feasible option	With appropriate management, potential impacts are as low as reasonably practicable
		Minimise	Operational railway corridor will be managed by the PTA in perpetuity in accordance with its Vegetation Management Manual. The PTA's Urban Rail Reserve Vegetation Management Plan (PTA 2016) requires herbicide application for weeds to be undertaken on a 6 monthly basis along an 8 metre track corridor and on an annual basis for fences and associated rail structures. Additionally, the PTA undertakes regular inspections for and treats Declared Pests, as required (PTA 2016)	
		Rehabilitate	No rehabilitation is anticipated to be required	

8.8 Residual impact management

8.8.1 Threatened ecological communities

8.8.1.1 *Melaleuca huegelii – m. Acerosa* [*m. Systena*] shrublands on limestone ridges tec 26a

The implementation of the proposal will result in the permanent loss of 0.05 ha of *Melaleuca huegelii – M. acerosa* [*M. systena*] shrublands on limestone ridges TEC 26a in "Very Good" condition, which will be counterbalanced through the provision of an appropriate Offset Strategy (Sections 8.8.4 and 15).

8.8.1.2 Banksia woodland of the swan coastal plain tec

The implementation of the proposal will result in the permanent loss of 12.10 ha of Banksia Woodlands of the Swan Coastal Plain TEC. This residual impact is at variance with the DEE's Draft Banksia Woodlands of the Swan Coastal Plain Ecological Community – Guidance for Referrals under the EPBC Act (DEE 2017a). It is considered likely that this action would meet the DEE's definition of a 'significant impact' (Department of the Environment 2013) to a Matter of National Environmental Significance (Banksia Woodlands of the Swan Coastal Plain TEC) and require referral to the DEE under the EPBC Act for assessment.

The permanent loss of 12.10 ha of the Banksia Woodlands of the Swan Coastal Plain TEC will be counterbalanced through the provision of an appropriate Offset Strategy (Sections 8.8.4 and 15).

8.8.2 Priority species and priority ecological communities

The implementation of the proposal will result in the permanent loss of:

- one *Hibbertia spicata* subsp. *leptotheca* (Priority 3) individual; two low density populations of *Beyeria cinerea* subsp. *cinerea* (Priority 3); up to 22 *Conostylis pauciflora* subsp. *euryrhipis* (Priority 4) individuals; and one *Conostylis pauciflora* subsp. *pauciflora* (Priority 4) individual
- 12.65 ha of Banksia dominated woodlands of the Swan Coastal Plain IBRA Region PEC (Priority 3) in "Degraded" or better condition
- 15.72 ha of northern spearwood shrublands and woodlands PEC (Priority 3) in "Degraded" or better condition
- 2.14 ha of tuart (*Eucalyptus gomphocephala*) woodlands of the Swan Coastal Plain PEC (Priority 3) in "Degraded" condition.

The potential impacts to these Priority Species and PECs is considered to be minor in context of the extent of their area remaining regionally and not likely to result in their conservation status being elevated or increasing the cumulative impact to a critical level.

8.8.3 Bush Forever Site No. 289

The implementation of the proposal will result in the permanent loss of up to 18.11 ha of Bushland within Bush Forever Site No. 289, which includes 12.38 ha of Bushland reserved as "Parks and Recreation". This permanent loss of Bushland will be counterbalanced through the provision of an appropriate Offset Strategy (Sections 8.8.4 and 15).

8.8.4 Offset strategy

To counterbalance the significant residual impacts to *Melaleuca huegelii – M. acerosa* [*M. systena*] shrublands on limestone ridges TEC 26a; Banksia Woodlands of the Swan Coastal Plain TEC; and bushland within Bush Forever Site No. 289 from the implementation of Part 2 of the YRE project, an appropriate Offset Strategy will be prepared and implemented to the satisfaction of DWER and the Commonwealth DEE (see Section 15).

8.8.4.1 Pta's proposed approach

The Offsets Strategy will provide details of the PTA's proposed approach to directly offset the significant residual impacts to TECs and Bushland within Bush Forever Site No. 289. This will likely involve either the acquisition and/or securing of land that has no existing conservation tenure and transfer to the conservation estate and/or undertaking of rehabilitation works in local degraded areas.

PTA may also consider the funding of research or monitoring that will go towards informing the conservation of the TECs and/or Bush Forever Site No. 289 particularly if a sufficient area is not able to be acquired or rehabilitated.

The PTA has advanced discussions with the DBCA to inform the preparation of an Offsets Strategy for Part 2 of the YRE project. A number of suitable offset locations have been identified, and these sites are currently being reviewed by the PTA.

8.8.4.2 Additional inclusions

Overlapping offset requirements, for instance direct impacts to native vegetation identified as Banksia Woodlands of the Swan Coastal Plain TEC and Carnaby's Black Cockatoo foraging habitat, and previous offsets provided by others, for instance the provision of offsets for significant impacts to Carnaby's Black Cockatoo as part of the Eglinton / South Yanchep Residential Development (EPBC 2011 / 6021) approval (Section 2.5), will also be addressed by the Offset Strategy.

8.9 Predicted outcome

The permanent loss of up to 0.05 ha of *Melaleuca huegelii – M. acerosa* [*M. systena*] shrublands on limestone ridges TEC 26a in "Very Good" condition, 12.10 ha of Banksia Woodlands of the Swan Coastal Plain TEC and 18.11 ha of Bushland within Bush Forever Site No. 289 (which includes 12.38 ha of Bushland reserved as "Parks and Recreation") will be appropriately counterbalanced through the preparation and implementation of an appropriate Offsets Strategy.

The proposed mitigation measures identified in Table 28 and Table 29 will ensure that the potential indirect impacts to flora and vegetation are managed to be as low as reasonably practicable during construction and operation of the railway.

Given the above and PTA's past performance in implementing appropriate mitigation measures as part of the construction and operation of railway projects (as demonstrated in Section 3), it is considered that flora and vegetation will be appropriately protected so that biological diversity and ecological integrity are maintained to meet the EPA's Flora and Vegetation objective.

9 Landforms

9.1 EPA objective

To maintain the variety and integrity of significant physical landforms so that environmental values are protected.

9.2 Policy and guidance

Environmental Factor Guideline: *Landforms* (EPA 2018a)

9.3 Environmental investigation

The following environmental investigations have been undertaken which assess the landform values within the development envelope:

- Yanchep Rail Extension, Geotechnical Investigation Report (Advisian, 2017; Appendix D) presents the results of the initial geotechnical investigation undertaken to assess the geotechnical conditions expected to be encountered during construction of the YRE project
- Yanchep Rail Extension Part 2, Biological Factors (GHD 2018b; Appendix B).

Table 14 provides a brief description of these investigations and identifies the assessment standards used to inform the scope and content of the individual investigations.

9.4 Receiving environment

9.4.1 Topography

The regional physiography and geology of the YRE project is provided on the Geological Survey of Western Australia (GSWA) 1:50,000 Environmental Geology Series map “Yanchep” (Gozzard 1982).

The Yanchep map indicates that the natural geomorphology throughout the YRE project is associated with superimposed coastal dune (aeolian) systems of varying age. The relatively old and non-active Spearwood Dune system is present as a “Degraded surface of aeolian origin” and is interspersed with “Deflation plains and basins”.

These landforms typically have natural slopes varying between 0° and 10° throughout the project area with elevations mostly varying from around 20 metres (m) to 40 m above sea-level, reflecting a general reduction in slope and relief due to erosion and deflation (‘natural settlement’). These landforms are partly overlain by a “Parabolic and nested parabolic dune complex” of the Quindalup Dunes.

The younger and more recently active Quindalup Dunes are expected to have steeper natural slopes, mostly between 10° and 20° throughout YRE project’s development envelope, with elevations varying from around 20 m to 60 m above sea-level.

The natural topography associated with the development envelope is presented in Figures Q-1 to Q-4.

9.4.1.1 Alkimos dune system

The Alkimos dune system is considered to have national and world significance as an excellent example of parabolic dunes belonging to the Quindalup dune system (EPA 2018a). The dunes, which are approximately 2 km wide and extend 4 km inland, provide both amenity and geo-heritage values in addition to supporting coastal vegetation, which provides stability for the dunes (EPA 2018a). Other important dunes also occur along the coast of Western Australia (EPA 2018a).

Four phases of the Quindalup dune system have been defined, on the basis of profile maturity, soil development and vegetation cover:

- Quindalup South Oldest Dune Phase (Q1): Occurs as a wall of sand with low relief, a smooth outline and a symmetrical cross section, it can occur up to 6 km inland. The soil profile is calcareous throughout has organic matter to at least 30 centimetres (cm), white sand below which shows cementation at about a metre below the surface.
- Quindalup South Second Dune Phase (Q2): Similar to Q1 with slightly higher relief and slightly less organic matter.
- Quindalup South Third Dune Phase (Q3): Has steeper slopes and greater relief than Q1 and Q2 and an irregular outline. Organic matter to 10 cm, cementation is minimal.
- Quindalup South Youngest Dune Phase (Q4): Generally, dunes are asymmetric with gentle inner slopes and steep outer faces. The outline is very jagged with many deep scallops and irregularities. The soils show very little pedological development other than slight organic accumulation at the surface.

9.4.2 Geology

The broad soil associations mapped within the development footprint identify that the underlying geology is comprised of sand and limestone associations (Figures R-1 to R-4).

9.4.2.1 Geotechnical investigation

The general geological conditions within the development envelope were found to be typical of what is expected in 'limestone' terrains common to the greater Swan Coastal Plain (Advisian 2017), and comprised of:

- Safety Bay Sand (S2)
- Cemented Safety Bay Sand (LS4)
- Tamala Sand (S7)
- Tamala Limestone (LS1).

9.5 Potential impacts

Table 30 provides the potential impacts to landforms from construction of the development envelope.

Table 30 Potential construction and operational impacts to landforms

Phase	Impact class	Works/operations	Potential impacts
Construction	Direct	• Clearing of native vegetation • Cut and fill works • Operation of plant machinery and service vehicles	Alteration of the localised shape of the parabolic dune formation within the development envelope
	Indirect	• Clearing of native vegetation • Cut and fill works • Operation of plant machinery and service vehicles	Cleared earthworks batters could result in the creation of blow outs which may further alter the parabolic dune's morphology, as well as encroaching on the adjacent extents of conservation significant native vegetation

9.6 Assessment of impacts

9.6.1 Alteration of the parabolic dune formation

9.6.1.1 Development envelope

The development envelope intersects the Q1 and Q2 parabolic dunes (Figure S). Figure S shows the dunes aligned generally in an east-west orientation and that the development envelope avoids the majority of the mapped extent of the Q2 dunes and intersects the Q1 and Q2 parabolic dunes through the narrow alignment.

The implementation of Part 2 of the YRE project will result in the permanent removal of 17.54 ha of the parabolic dune system. Approximately 14.76 ha of the 17.54 ha extent is comprised of Q1 parabolic dunes, whilst 2.80 ha is comprised of the Q2 parabolic dunes (GHD 2018b). Given the narrow intersection of the dune systems, it is not expected that the implementation of the proposal will result in disruption of geomorphological processes associated with the parabolic dunes.

9.6.1.2 Local and regional scales

Figure T shows the mapped extent of the four phases of the Quindalup dune system for surrounding lands within 1 km of the development envelope and at the regional scale.

GHD (2018b) identifies that the permanent loss of the Quindalup parabolic dunes within the development envelope represents approximately 4.55% at the local scale and 0.49% at the regional scale. The remaining extent of the Quindalup parabolic dunes at a local and regional scale is greater than 65.26% of the mapped pre-European extent (GHD 2018b). Approximately 39.29% of the Quindalup dune system is reserved in conservation areas at the local scale, whilst 29.82% is reserved in conservation areas at the regional scale (GHD 2018b).

The cumulative loss of the Quindalup dune system when considering Parts 1 and 2 of the YRE development envelope will reduce the extent of the dune system by 4.78% at the local scale, whilst at the regional scale this percentage is 0.73% (GHD 2018b).

GHD (2018b) provides an overview of the Quindalup dune system which will support future urban development at the local and regional scales to provide an assessment of cumulative impacts. Future urban development is estimated to include 48.97% at the local scale and 63.03% at the regional scale of the Quindalup dune system (GHD 2018b). By comparison the implementation of the YRE project includes 4.78% at the local scale and a 0.73% at the regional scale of the Quindalup dune system (GHD 2018b).

9.6.1.2.1 Previous Consideration and Future Impacts

Strategic planning documents

Although the potential impacts to the parabolic dunes within Bush Forever Site No. 289 from a railway has not been specifically considered, key strategic planning documents including the draft Directions 2031 and Beyond (Department of Planning and WAPC 2010), draft Perth and Peel Green Growth Plan (Department of the Premier and Cabinet 2015) and Perth and Peel@3.5million (DPLH and WAPC 2018b) have identified that a future railway is planned to intersect the Bush Forever site.

Future impacts

From an existing and future land use perspective, the Q1 and Q2 parabolic dune systems (which intersect the development envelope) are already fragmented by Marmion Avenue and will be subject to future impacts and loss, at both the local and regional scales, as a direct result of the development of the approved LSP areas adjacent to the development envelope and construction of the future Mitchell Freeway.

9.6.2 Significance of direct impacts

The key conclusions with respect to Landforms are that:

- given the narrow intersection of the development envelope with the parabolic dunes, it is not expected that the implementation of the proposal would result in disruption of geomorphological processes associated with the parabolic dunes
- the permanent loss of the Q1 and Q2 parabolic dunes is considered to be relatively minor (less than 0.49% of the total parabolic dune system) at the regional scale and is not anticipated to adversely affect the function at this scale.

Table 31 identifies the avoidance measures that have been undertaken by the PTA, as part of the detailed design of Part 2 of the YRE project to reduce the direct residual impacts to the parabolic dunes during project construction. Informed by the minimisation and rehabilitation measures proposed in Table 31 it is considered that the potential direct and indirect impacts will be managed to be as low as reasonably practicable and in accordance with the EPA's environmental factor for landforms.

9.6.3 Stability of adjacent parabolic dune formation

The Q1 and Q2 parabolic dunes within Bush Forever Site No. 289 directly adjacent to the development envelope are vegetated (Figure T) and hence currently stabilised from windblown erosion causing blowouts.

Post construction of Marmion Avenue, the created batters were rehabilitated with locally endemic species. Visual observation of this linear infrastructure corridor and adjacent lands, which include Bush Forever Site No. 289 indicate that the construction of Marmion Avenue has not had a detrimental impact on the stability of the adjacent Quindalup dune formation (inclusive of the Q1 and Q2 formations). The construction of Marmion Avenue provides a highly relevant example illustrating the relative stability and robust nature of the Quindalup dune formation.

Informed by the proposed mitigation measures (Table 31) and the Marmion Avenue case, the coverage of native vegetation and the stability of the upon Q1 and Q2 parabolic dunes adjacent to the development envelope is not anticipated to be altered as a result of the implementation of the proposal.

9.7 Mitigation

Table 31 demonstrates how the EPA's mitigation hierarchy (avoid, minimise and rehabilitate) has been applied to the environmental factor of Landforms to address the key potential impacts.

Table 31 Application of mitigation hierarchy for landforms

Potential impacts	Impact class	Mitigation hierarchy	Proposed mitigation measures	Residual impacts
Alteration of the localised shape of the parabolic dune formation within the development envelope	Direct	Avoid	Alternative alignment that was considered (Figure F) traversed highly undulating terrain which would have required very deep cuttings (up to 20 m) to achieve the required grades resulting in reserve widths approaching 100 m. This would have significantly increased the potential interruption of geomorphological processes resulting from implementation of the proposal.	Permanent loss of 17.54 ha of Q1 and Q2 parabolic dune systems.
		Minimise	• Development footprint and volumes of sand to be excavated within Bush Forever Site No. 289 has been reduced through a decision to raise the vertical alignment of the railway through this site, which has minimised the potential impacts to landform • CEMP will be prepared to address the potential impacts to landforms during the construction of Part 2 of the YRE project	
		Rehabilitate	Detailed engineering design will be undertaken to minimise landform impacts and identify structural controls (i.e. battering the excavation and / or retaining walls) that will be implemented to stabilise the affected landform. Should the batters be of a suitable gradient and material, they will be stabilised with planting of locally endemic species and/or bioengineering controls that will be sympathetic to the surrounding native vegetation within Bush Forever Site No. 289	
Cleared earthworks batters could result in the creation of blow outs which may further alter the parabolic dune's morphology as well as encroaching on the adjacent extents of conservation significant native vegetation	Indirect	Avoid	CEMP will be prepared to ensure that clearing is restricted to the development envelope and that batters are stabilised post construction	With appropriate management, potential impacts are as low as reasonably practicable
		Minimise	• Development footprint and volumes of sand to be excavated within Bush Forever Site No. 289 has been reduced through a decision to raise the vertical alignment of the railway through this site, which has minimised the potential impacts to landform • CEMP will include adaptive management measures that will be implemented should the avoidance measures not be met	
		Rehabilitate	Where batters are of a suitable gradient and material, their rehabilitation will be sympathetic to the surrounding landforms and native vegetation within Bush Forever Site No. 289	

9.8 Predicted outcome

Through the implementation of the EPA's mitigation hierarchy (Table 31) the permanent loss of 17.54 ha of the Q1 and Q2 parabolic dune systems in the development envelope, together with indirect impacts, will be managed to be as low as reasonably practicable. The physical impacts associated with Part 2 of the YRE project will be mitigated within Bush Forever Site No. 289 by detailed engineering design and land stabilisation.

Given the above and PTA's past performance in implementing appropriate mitigation measures as part of the construction and operation of railway projects (as demonstrated in Section 3), it is considered that the variety and integrity of the Q1 and Q2 parabolic dune systems within Bush Forever Site No. 289 will be maintained and that the Alkimos Dune System will retain adequate representation at the regional scale so that environmental values are protected to meet the EPA's Landforms objective.

10 Short-range endemic invertebrates and subterranean fauna

10.1 EPA objectives

- To protect subterranean fauna so that biological diversity and ecological integrity are maintained.
- To protect terrestrial fauna so that biological diversity and ecological integrity are protected.

10.2 Policy and guidance

- Technical Guidance: Sampling of Short Range Endemic Invertebrate Fauna (EPA 2016c)
- Environmental Factor Guideline: *Subterranean Fauna* (EPA 2016d)
- Technical Guidance: *Subterranean Fauna Survey* (EPA 2016e)
- Technical Guidance: Sampling Methods for Subterranean Fauna (EPA 2016f)
- Environmental Factor Guideline: *Terrestrial Fauna* (EPA 2016h).

10.3 Environmental investigations

The following environmental investigations have been undertaken which assess the values associated with short-range endemic invertebrates and subterranean fauna within the development envelope:

- Desktop Review and Risk Assessment of Short Range Endemic Invertebrates for the Yanchep Rail Extension, Western Australia (Invertebrate Solutions 2018a; Appendix E)
- Desktop Review and Risk Assessment of Subterranean Fauna for the Yanchep Rail Extension, Western Australia (Invertebrate Solutions 2018b; Appendix F)
- Yanchep Rail Extension, Geotechnical Investigation Report (Advisian 2017; Appendix D) provides an assessment of the presence of karstic features
- Northern Suburbs Railway Alignment Butler to Yanchep Environmental Investigation (GHD 2012) details a desktop and field investigation undertaken to assess portions of the YRE project area between Romeo Road and Yanchep for the presence of outcropping karstic features that could indicate the presence of subterranean voids suitable for supporting subterranean fauna communities.
- Fauna Underpass Cross Section (Appendix G).

Table 14 provides a brief description of these investigations and identifies the assessment standards used to inform the scope and content of the individual investigations.

10.4 Receiving environment

10.4.1 Short-range endemic invertebrates

Invertebrate Solutions (2018a) completed a desktop assessment of the likelihood that SRE invertebrates are present in the habitats located within the assessed study area and considers the potential impacts to SRE invertebrates that may occur as a result of implementation of the YRE project (i.e. Part 1 and 2 development envelopes). The spatial extent of Invertebrate Solutions (2018a) study area is similar in size to the spatial extent of the North-west Sub-region, therefore this assessment represents a regional scale assessment in the framework used by this EIA report (Section 7.2.2).

Invertebrate Solutions (2018a) identifies there are two confirmed SRE invertebrates, a millipede (*Antichiropus whistleri*) and a trapdoor spider (*Idiosoma sigillatum*), that have a high likelihood of occurring within YRE project's overall development envelope. Invertebrate Solutions (2018a) identifies that there are seven likely SRE invertebrates that have a moderate likelihood of occurring within the YRE project's development envelope:

- three mygalomorph spiders (*Synothele lowei*, *Synothele michaelseni* and *Synothele taurus*)
- two slaters (*Buddelundia cinerascens* and *Buddelundia opaca*)
- tree cricket (*Austrosaga spinifer*)
- woolybush bee (*Hylaeus globuliferus* [Priority 3]).

Invertebrate Solutions (2018a) considers the Woolybush Bee to be widespread. There are also two possible SRE invertebrates; a harvestman arachnid (*Bindoona glauerti*) and a pseudoscorpion (*Protochelifer cavernarum*) that are considered to have a moderate and high likelihood of occurring within the YRE project's development envelope (Invertebrate Solutions 2018a).

In addition to the findings of Invertebrate Solutions (2018a), the Graceful Sun Moth (*Synemon gratiosa*) (Priority 4) was recorded by GHD (2011) within and adjacent to the development envelope in the north of Bush Forever Site No. 289. Ground cricket (*Pachysaga munggai* [Priority 3] / *Pachysaga strobila* [Priority 1]) was recorded in GHD (2012) within the Part 1 development envelope.

The vegetation types identified by GHD (2018a) were considered by Invertebrate Solutions (2018a) to have moderate suitability for SRE invertebrates.

10.4.2 Subterranean fauna

Invertebrate Solutions (2018b) conducted a desktop assessment of the likelihood that subterranean species are present in the habitats located within the assessed study area, and considers the potential impacts to subterranean species that may occur as a result of the implementation of YRE project (i.e. Part 1 and 2 development envelopes). The spatial extent of Invertebrate Solutions (2018b) study area is similar in size to the spatial extent of the North-west Sub-region, therefore this assessment represents a regional scale assessment in the framework adopted by this EIA report (Section 7.2.2).

Invertebrate Solutions (2018b) desktop assessment identified that the regional study area contains significant subterranean fauna habitat within the Yanchep National Park and immediately adjacent areas, however the YRE project's development envelope intersects lower value habitat to the west of the high-risk karst area. The Invertebrate Solutions (2018b) study area contains the Threatened Aquatic Root Mat community within the Yanchep National Park, along with associated stygofauna and troglofauna species. None of these species or any aquatic root mat communities are known to occur in the YRE project's development envelope.

No large scale karstic features such as sinkholes or caverns, which would provide a significant habitat resource for subterranean fauna, were identified within the vicinity of the YRE project by Advisian (2017). However potential habitat for both stygofauna and troglofauna does occur within the YRE project's development envelope due to the presence of the karstic Tamala limestone underlying the Safety Bay sands (Section 9.4.2).

Tamala limestone underlies Part 2 of YRE project's development envelope, therefore the above analysis is considered to be representative of the subterranean fauna context for Part 2 the YRE project.

10.5 Potential impacts

Table 32 provides the potential impacts to SRE invertebrates and subterranean fauna from construction of the development envelope and operation of the railway.

Table 32 Potential construction and operational impacts to SRE invertebrates and subterranean fauna

Phase	Impact class	Works/operations	Potential impacts
SRE invertebrates			
Construction	Direct	Clearing of native vegetation	Permanent loss of SRE invertebrate habitat
	Indirect	• Clearing of native vegetation • Cut and fill works • Excavation and construction of roads, buildings and other hard stand areas • Operation of plant machinery and service vehicles	• Habitat fragmentation and genetic isolation • Weed incursion • Increased sedimentation and alteration of surface hydrology
Subterranean fauna			
Construction	Direct	• Cut and fill works • Excavation and construction of roads, buildings and other hard stand areas • Clearing of native vegetation • Operation of plant machinery and service vehicles	Permanent loss of subterranean fauna habitat
	Indirect	• Clearing of native vegetation • Cut and fill works • Excavation and construction of roads, buildings and other hard stand areas • Storage and use of hydrocarbons/chemicals	• Native vegetation clearing reducing amount of organic carbon entering the subterranean environment • Alteration of existing hydrological regimes due to the construction of roads, buildings and other hard stand areas that will restrict the infiltration of water into the subterranean environment • Groundwater contamination due to spills impacting habitat for subterranean fauna
Operation	Indirect	Operation and maintenance of the electrified railway line	Groundwater contamination due to spills impacting habitat for subterranean fauna

(Sources: Invertebrate Solutions 2018a; Invertebrate Solutions 2018b)

10.6 Assessment of impacts

10.6.1 Short-range endemic invertebrates

10.6.1.1 Permanent habitat loss

10.6.1.1.1 Development envelope

Invertebrate Solutions (2018a) identifies that the only potential direct impact to SRE invertebrates is the permanent loss of SRE invertebrate habitat. Approximately 53.19 ha of native vegetation, representative of the previously mapped vegetation associations and regional vegetation complexes, will be cleared by the implementation of Part 2 of the YRE project. This direct impact is relevant for the two confirmed SRE invertebrates, a millipede (*Antichiropus whistleri*) and a trapdoor spider (*Idiosoma sigillatum*), that have a high likelihood of occurring within YRE project's overall development envelope and the surrounding native vegetation (Invertebrate Solutions 2018a).

No high SRE invertebrate suitability habitat is contained within the development envelope (Invertebrate Solutions 2018a). The implementation of Part 2 of the YRE project will remove approximately 52 ha (or approximately 0.91%) of medium SRE invertebrate suitability habitat and 21 ha (or approximately 1.36%) of low SRE invertebrate suitability habitat within the development envelope (See Table 5 of Invertebrate Solutions 2018a; Appendix E).

Due to the narrow linear nature of Part 2 of the YRE project, and that similar SRE habitat values are likely to be present within the surrounding vegetation and conservation areas, Invertebrate Solutions (2018a) considers it unlikely that the implementation of the proposal would result in local extinction of SRE invertebrates.

10.6.1.1.2 Local and regional scales

Invertebrate Solutions (2018a) identifies that no high SRE invertebrate suitability habitat is available at the local scale. Part 2 of the YRE project represents:

- 0.92% of the available medium SRE invertebrate suitability habitat at the local scale
- 1.33% of the available low SRE invertebrate suitability habitat at the local scale.

Approximately 2,965 ha (or 52.05%) of the available medium SRE invertebrate suitability habitat and 52 ha of the available low SRE invertebrate suitability habitat (or approximately 3.37%) are contained within conservation areas at the local scale (Invertebrate Solutions 2018a).

At a regional scale, Invertebrate Solutions (2018a) identifies that of the 11,897 ha of high SRE invertebrate suitability habitat and approximately 4,799 (or 40.34%) is contained within conservations areas. Part 2 of the YRE project represents 0.04 % of the available medium SRE invertebrate suitability habitat and 0.02% of the low SRE invertebrate suitability habitat at the regional scale (Invertebrate Solutions 2018a). Approximately 4,448 ha (or 3.71%) of the available medium SRE invertebrate suitability habitat and 52 ha of the available low SRE invertebrate suitability habitat (or approximately 0.04%) are contained within conservation areas at the regional scale (Invertebrate Solutions 2018a).

Invertebrate Solutions (2018a) considers that potential risk to SRE invertebrates from the permanent loss of SRE habitat to be low across both the local and regional scales.

10.6.1.2 Habitat fragmentation and genetic isolation

10.6.1.2.1 Development envelope

Invertebrate Solutions (2018a) identifies that the key potential indirect impact to SRE invertebrates is habitat fragmentation and genetic isolation. This impact is largely unavoidable and has a greater potential to impact upon SRE invertebrates due to their inherent lack of dispersal capability that allows other more mobile species to move between remnant vegetation patches in an urban mosaic (Invertebrate Solutions 2018a).

10.6.1.2.2 Local and Regional Scales

Invertebrate Solutions (2018a) considers the potential risk of impact to SRE invertebrates from habitat fragmentation and genetic isolation to be moderate/high at the local scale, and moderate at the regional scale.

Invertebrate Solutions (2018a) generally considers the risk to SRE invertebrates from the remaining potential indirect impacts to be low/moderate at the local scale and low at the regional scale (See Table 10 in Invertebrate Solutions 2018a; Appendix E).

10.6.1.3 Significance of impacts

The key conclusions in relation to SRE invertebrates are:

- implementation of Part 2 of YRE project is considered unlikely to result in local extinction of SRE invertebrates
- unavoidable potential impact of habitat fragmentation and genetic isolation is considered to be the most significant impact
- remaining potential impacts are generally low or able to be managed through standard construction and operational management and mitigation measures (Table 33)
- when considered at the bioregional scale, the potential direct and indirect impacts are considered to be relatively minor due to the narrow linear nature of the development envelope and the similar habitat values that exist in surrounding native vegetation and conservation estates.

Four fauna underpasses will be located underneath the railway line within Bush Forever Site No. 289 to maintain the east-west ecological linkage and provide for the long-term movement of native fauna. The fauna underpass will be appropriately sized to allow for the movement of larger species of terrestrial fauna, such as Western Grey Kangaroo (*Macropus fuliginosus*) and Western Brush Wallaby (*Macropus irma*), as well as smaller non-avian / ground dwelling fauna species, such as the Southern Brown Bandicoot (*Isoodon obesulus* subsp. *fusciventer*) and reptile species (Section 12.6.4). A railway cross-section showing the indicative location of a fauna underpass underneath the railway corridor has been provided in Appendix G.

It is anticipated that the fauna underpasses will provide some opportunity for the limited dispersion of SRE invertebrates, such as the millipede (*Antichiropus whistleri*) and trapdoor spider (*Idiosoma sigillatum*), that will assist in maintaining local connectivity between the extents of Bush Forever Site No. 289 and assist in maintaining genetic connectivity. The implementation of this mitigation measure responds to the key risk to SRE invertebrate species from habitat fragmentation and genetic isolation.

Table 33 identifies the avoidance measures that have been undertaken by the PTA, as part of the detailed design of Part 2 of the YRE project to reduce the direct impacts to SRE invertebrates during project construction. Informed by the remaining minimisation and rehabilitation measures proposed in Table 33 it is considered that the potential direct and indirect impacts have been / will be managed to be as low as reasonably practicable.

10.6.2 Subterranean fauna

10.6.2.1 Permanent loss of subterranean fauna habitat

Invertebrate Solutions (2018b) identifies that the key potential direct impact to subterranean fauna species is from the permanent loss of subterranean habitat.

Invertebrate Solutions (2018b) considers the potential risk to subterranean fauna from excavation to be low for stygofauna and moderate for troglofauna (if present) due to the generally shallow depths of excavation. The railway will be cut approximately 5 m below the surrounding ground level (Table 11).

The potential risk to subterranean fauna from the permanent loss of subterranean habitat linked to the clearing of native vegetation is considered to be high for stygofauna and moderate for troglofauna (if present) (Invertebrate Solutions 2018b). However the likelihood of this impact occurring is considered to be extremely unlikely, as no areas of high likelihood for karst and caves are intercepted by the development envelope (Invertebrate Solutions 2018b).

Invertebrate Solutions (2018b) generally considers the risk to subterranean fauna from the remaining potential direct impacts to be low (See Table 8 in Invertebrate Solutions 2018b; Appendix F).

10.6.2.2 Organic carbon reduction

Invertebrate Solutions (2018b) identifies that the key potential indirect impact to subterranean fauna species is a reduction in the amount of organic carbon (that acts as a primary energy source for the subterranean environment) entering the subterranean environment. Invertebrate Solutions (2018b) considers the risk to subterranean fauna from this potential indirect impact to be low (See Table 9 in Invertebrate Solutions 2018b; Appendix F).

10.6.2.3 Alteration of subsurface hydrology

Invertebrate Solutions (2018b) identifies that the alteration of surface and subsurface hydrology from excavation and construction of roads, buildings and other hard stand areas has the potential to have moderate impact upon troglofauna by filling micro and meso caverns habitats (see Table 9 in Invertebrate Solutions 2018b; Appendix F).

10.6.2.4 Contamination of groundwater

Invertebrate Solutions (2018b) identifies that contamination of groundwater during construction and operations may also impact significantly upon subterranean fauna habitat, but risks of contamination can be minimised by employing management and mitigation measures. The potential for contamination during construction is limited to isolated areas of chemical storage and small quantities of hydrocarbons where machinery or generators are working (Invertebrate Solutions 2018b).

10.6.2.5 Significance of impacts

The key conclusions in relation to subterranean fauna are:

- low likelihood of overall impact to subterranean fauna from the implementation of Part 2 of the YRE project
- cumulative impacts at the bioregional scale are expected to be minimal as the known subterranean diversity is low compared with other regions of Western Australia
- due to the narrow linear nature of the development envelope and the similar or better subterranean habitat values in surrounding conservation estates, it is considered unlikely that the implementation of Part 2 of the YRE project would result in local extinction of subterranean fauna species.

Table 33 identifies the avoidance measures that have been undertaken by the PTA, as part of the detailed design of Part 2 of the YRE project to reduce the direct impacts subterranean fauna during project construction. Informed by the minimisation and rehabilitation measures proposed in Table 33, it is considered that the potential direct and indirect impacts will be managed to be as low as reasonably practicable and in accordance with the EPA's environmental factor for subterranean fauna.

10.7 Mitigation

Table 33 demonstrates how the EPA's mitigation hierarchy (avoid, minimise and rehabilitate) has been applied to SRE invertebrates and subterranean fauna to address the key potential impacts.

Table 33 Application of mitigation hierarchy for short-range endemic invertebrates and subterranean fauna

Potential impacts	Impact class	Mitigation hierarchy	Proposed mitigation measures	Residual impacts
Short-range endemic invertebrates				
Permanent loss of SRE invertebrate habitat	Direct	Avoid	• Modification of the development envelope to reduce the clearing of SRE invertebrate habitat and avoid direct impacts to Bush Forever Site No. 288: *Yanchep National Park and Adjacent Bushland* • Access tracks within Bush Forever Site No. 289 have been planned to accommodate PTA, DBCA and DFES operational requirements thereby eliminating the potential for the duplication of access tracks by the agencies and reducing SRE habitat clearing	With appropriate management, potential impacts are as low as reasonably practicable
		Minimise	• Construction and access areas have been selected to coincide with proposed future urban development cells or roads either reserved by the MRS, or as detailed within approved and draft LSPs, to reduce the likelihood of impacting SRE invertebrate habitat proposed to be retained within future POS reservations • Development footprint and volumes of sand to be excavated within Bush Forever Site No. 289 has been reduced through a decision to raise the vertical alignment of the railway through this site, which has minimised the potential impacts to SRE invertebrate habitat • CEMP will be prepared to ensure that construction activities are limited to the development envelope	
		Rehabilitate	No rehabilitation is anticipated to be required	
• Habitat fragmentation and genetic isolation • Weed incursion • Increased sedimentation and alteration of surface hydrology	Indirect	Avoid	• Modification of the development envelope to reduce the clearing of SRE invertebrate habitat and avoid direct impacts to Bush Forever Site No. 288: *Yanchep National Park and Adjacent Bushland* • Access tracks within Bush Forever Site No. 289 have been planned to accommodate PTA, DBCA and DFES operational requirements thereby eliminating the potential for the duplication of access tracks by the agencies and reducing SRE habitat clearing	
		Minimise	• Construction and access areas have been selected to coincide with proposed future urban development cells or roads either reserved by the MRS, or as detailed within approved and draft LSPs, to reduce the likelihood of impacting SRE invertebrate habitat proposed to be retained within future POS reservations • CEMP will be prepared to ensure that disturbance to adjacent land holdings, weed incursion, alteration to surface hydrology and noise and vibration during construction is minimised	

Potential impacts	Impact class	Mitigation hierarchy	Proposed mitigation measures	Residual impacts
			• Four fauna underpasses will be located underneath the railway line within Bush Forever Site No. 289. It is anticipated that the fauna underpasses will provide some opportunity for the limited dispersion of SRE invertebrates, such as the millipede (*Antichiropus whistleri*) and trapdoor spider (*Idiosoma sigillatum*), that will assist in maintaining local connectivity between the extents of Bush Forever Site No. 289 and assist in maintaining genetic connectivity	
		Rehabilitate	No rehabilitation is anticipated to be required	
Subterranean fauna				
Construction				
Permanent loss of subterranean fauna habitat	Direct	Avoid	• No large scale karstic features, such as sinkholes or caverns, have been identified within Part 2 of the YRE project's development footprint • Dewatering will not be required to facilitate construction • Prior to the commencement of construction activities, a further detailed geotechnical investigation will be undertaken to supplement and validate the initial findings of the Advisian (2017) investigation and enable detailed design of key structural elements	With appropriate management, potential impacts are as low as reasonably practicable

		Minimise	• If significant caves or voids are encountered during construction activities, work will be suspended until their potential impact on subterranean fauna can be assessed by a suitably qualified person:
			  • Engineering solutions to significant caves or voids that are encountered will be discussed with a suitably qualified subterranean biologist to ensure their suitability
			  • If significant cave or voids that contain potentially important subterranean biodiversity will be destroyed, then collection of specimens and genetic material for deposition into the Western Australian Museum collections should be undertaken by a suitably qualified person
			• CEMP will be prepared to manage the potential impacts to subterranean fauna during the construction of Part 2 of the YRE project	

		Rehabilitate	No rehabilitation is anticipated to be required	

Potential impacts	Impact class	Mitigation hierarchy	Proposed mitigation measures	Residual impacts
• Native vegetation clearing reducing amount of organic carbon entering the subterranean environment • Alteration of existing hydrological regimes due to the construction of roads, buildings and other hard stand areas that will restrict the infiltration of water into the subterranean environment • Groundwater contamination due to spills impacting habitat for subterranean fauna • Alteration of groundwater levels	Indirect	Avoid	No large scale karstic features, such as sinkholes or caverns, have been identified within Part 2 of the YRE project's development footprint (Advisian 2017)	
		Minimise	• CEMP will be prepared to manage the potential impacts to subterranean fauna during the construction of Part 2 of the YRE project • Groundwater abstraction for construction water will be regulated under the *Rights in Water and Irrigation Act 1914*	
		Rehabilitate	Implementation of best practice Water Sensitive Urban Design (WSUD) principles in the design of and stormwater management approach for the YRE railway and station infrastructure will control the quality of stormwater recharged to the groundwater aquifers (Section 13.6.4)	
Operation				
• Reduction in groundwater levels and quality can adversely affect stygofauna, and to a lesser extent troglofauna, as they rely upon a saturated environment • Contamination of groundwater during construction may impact the quality of suitable micro-habitats for subterranean fauna	Indirect	Avoid	Avoidance of trains and service machinery using the operational railway corridor is not a feasible option	With appropriate management, potential impacts are as low as reasonably practicable
		Minimise	Potential indirect impacts to groundwater quality (potential groundwater contamination) from the operation of the railway will be managed through the implementation of the PTA's standard spill response framework for rail corridors	
		Rehabilitate	No rehabilitation is anticipated to be required	

10.8 Predicted outcome

Through the implementation of the EPA's mitigation hierarchy (Table 33) the potential impacts to SRE invertebrates and Subterranean Fauna associated with Part 2 of the YRE project will be managed to be as low as reasonably practicable.

Given the above and PTA's past performance in implementing appropriate mitigation measures as part of the construction and operation of railway projects (as demonstrated in Section 3) it is considered that SRE invertebrates and subterranean fauna will be protected so that biological diversity and ecological integrity are maintained to meet the EPA's Subterranean Fauna and Terrestrial Fauna objectives.

11 Terrestrial environmental quality

11.1 EPA objective

To maintain the quality of land and soils so that environmental values are protected.

11.2 Policy and guidance

- *Contaminated Sites Act 2003*
- Environmental Factor Guideline: *Terrestrial Environmental Quality* (EPA 2016g).
- Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes (DER 2015a).
- Treatment and Management of Soils and Water in Acid Sulfate Soil Landscapes (DER 2015b).
- Assessment and Management of Contaminated Sites (DER 2014).

11.3 Environment investigation

The following environmental investigations have been undertaken which assess the values associated with terrestrial environmental quality within the development envelope:

- Yanchep Rail Extension, Preliminary Site Investigation (PSI; Golder Associates 2017)
- METRONET – YRE Hydrology Assessment (RPS 2018b; Appendix G).

Table 14 provides a brief description of this investigation and identifies the assessment standards used to inform the scope and content of the investigations.

11.4 Receiving environment

11.4.1 Acid sulfate soils

The DWER's Acid Sulfate Soils (ASS) risk mapping identifies that the development envelope is not at risk of ASS occurring (Figure U). Figure V shows DWER's ASS risk mapping for surrounding lands within 1 km of the development envelope and at the regional scale.

11.4.2 Potential contamination

A search of DWER's *Contaminated Sites Database* identified no known contaminated sites within the development envelope. However, the development envelope traverses Yanchep-Two Rocks Artillery and Practice Bombing Range. This range was formerly used as a live firing range with army units regularly conducting manoeuvres in the area from Toreopango Avenue, Yanchep and the Mitchell Freeway road reserve during World War II. There is a risk for Unexploded Ordnance (UXO) to occur within these areas (Figure W).

Figure X shows DWER's *Contaminated Sites Database* mapping for the surrounding lands within 1 km of the development envelope and at the regional scale.

11.5 Potential impacts

Table 34 provides the potential direct impacts from ASS and Potential Contamination from construction of the proposal.

Table 34 Potential construction and operational impacts to terrestrial environmental quality

Phase	Impact class	Works/operations	Potential impacts
Acid Sulfate Soils			
Construction	Direct	Cut and fill works	Acidification and release of heavy metals from ASS into the terrestrial environment and underlying groundwater
Potential Contamination			
Construction	Direct	• Clearing of native vegetation • Cut and fill works • Excavation and construction of roads, buildings and other hard stand areas	• Injury from UXOs • Contaminated soil or groundwater is unearthed during construction

11.6 Assessment of impacts

11.6.1 Acid sulfate soils

The development envelope is not mapped at being at risk of ASS occurring (Figure U), whilst the closest mapped area of High to Moderate ASS risk is situated more than 1 km to the south-east of the development envelope (Figure V). Approximately 2 km to the east of the development envelope, the north–south chain of geomorphic wetlands is also mapped as having a High to Moderate ASS risk (Figure V).

It is considered unlikely that ASS would be encountered during the construction of the development envelope.

11.6.1.1 Potential groundwater acidification

Whilst dewatering will not be required to facilitate construction, groundwater is proposed to be abstracted for use during the YRE project's construction phase.

The groundwater is anticipated to contain a significant concentration of dissolved calcium carbonate. As such it is anticipated that the groundwater will have a high degree of buffering capacity against acidification; due to the above and the significant clearance to groundwater from the topographical surface, groundwater acidification is not anticipated (RPS 2018b).

RPS (2018b) estimates the potential maximum drawdown from groundwater abstraction from sensitive environmental receptors in proximity to the development envelope to vary between 21 cm locally adjacent to Bush Forever Site No. 289 and 8.8 cm regionally within Bush Forever Site No. 129: *Bernard Road Bushland, Carabooda* (Figure H). This is considered negligible in terms of natural seasonal variation and would not result in any further groundwater acidification that would not already be experienced at the site during typical seasonal variations (i.e. winter and summer).

11.6.2 Potential contamination

11.6.2.1 UXO search

A UXO field validation survey will be undertaken within portions of the development envelope which intersect the Yanchep-Two Rocks Artillery and Practice Bombing Range. The UXO field validation survey will locate and identify any evidence of explosive ordnance waste to characterise any remnant UXO(s). If UXOs are demonstrated or inferred to be present, delineation and remediation of the affected areas will be undertaken. These activities will reduce the likelihood of potential impacts (Table 34) occurring during implementation of the proposal.

11.6.2.2 Potential contamination

No registered contaminated sites are located within the development envelope or locally within 1 km of the proposal. The closest registered contaminated site is situated approximately 16 km to the south-east of the development envelope (Figure X).

The Preliminary Site Investigation (Golder Associates 2017) considered risks related to contamination associated with previous land uses to be low, and recommended that an unexpected finds protocol be established to provide a methodology for identification, assessment of risk and required management procedures on a case by case basis.

Employing an unexpected finds protocol provides a standardised approach to ensure that Part 2 of the YRE project is implemented in accordance with the *Contaminated Sites Act 2003,* thereby meeting the EPA's objective for Terrestrial Environmental Quality.

11.7 Mitigation

Table 35 demonstrates how the EPA's mitigation hierarchy (avoid, minimise and rehabilitate) has been applied to the environmental factor of Terrestrial Environmental Quality to address the key potential impacts.

Table 35 Application of mitigation hierarchy to terrestrial environmental quality

Potential impacts	Impact class	Mitigation hierarchy	Proposed mitigation measures	Residual impacts
Acid Sulfate Soils				
Acidification and release of heavy metals from ASS into the terrestrial environment and underlying groundwater	Direct	Avoid	The development envelope is not mapped at being at risk of ASS occurring and it is considered unlikely that ASS would be encountered during construction	With appropriate management, potential impacts are as low as reasonably practicable
		Minimise	• Construction program proposed in Advisian (2017) involves filling of the lower lying areas within the development footprint. This approach further decreases the already low residual risk of ASS being unearthed during earthworks • In the unlikely event that ASS is encountered during construction, it is proposed to be managed in accordance with the DWER's Acid Sulfate Soils Guidelines.	
		Rehabilitate	No rehabilitation is anticipated to be required	
Potential Contamination				
• Injury from UXOs • Contaminated soil or groundwater is unearthed during construction	Direct	Avoid	• CEMP will be prepared to ensure that construction activities are limited to the development envelope to decrease the low residual risk of construction workers being injured by UXOs • No registered contaminated sites are located within the development envelope or locally within 1 km of the proposal	With appropriate management, potential impacts are as low as reasonably practicable
		Minimise	• Prior to the commencement of earthworks, a technical investigation will be conducted of all areas identified as being of risk of containing UXOs • CEMP will be prepared to manage any unexpected finds in accordance with the *Contaminated Sites Act 2003* and also includes adaptive management measures that will be implemented should the avoidance measures not be met	
		Rehabilitate	If the technical investigation indicates that UXOs are or may be present within the development envelope, then the affected areas will be remediated	

11.8 Predicted outcome

Through the implementation of the EPA's mitigation hierarchy (Table 35) the quality of the existing environmental values of the land and soils within the development envelope will be protected.

Given the above and PTA's past performance in implementing appropriate mitigation measures as part of the construction and operation of railway projects (as demonstrated in Section 3) it is considered that the EPA's Terrestrial Environmental Quality objective will be met.

12 Terrestrial fauna

12.1 EPA objective

To protect terrestrial fauna so that biological diversity and ecological integrity are protected.

12.2 Policy and guidance

- *Environment Protection and Biodiversity Conservation Act 1999*.
- *Wildlife Conservation Act 1950* / *Biodiversity Conservation Act 2016*.
- Environmental Factor Guideline: *Terrestrial Fauna* (EPA 2016h).
- Technical Guidance: Sampling Methods for Terrestrial Vertebrate Fauna (EPA 2016i).
- Technical Guidance: *Terrestrial Fauna Surveys* (EPA 2016j).

12.3 Environmental investigations

The following environmental investigations have been undertaken which assess the terrestrial fauna values within the development envelope:

- Report for Northern Suburbs Railway Alignment from Romeo Road (Alkimos) to Yanchep, Graceful Sun-moth Survey (GHD 2011)
- Northern Suburbs Railway Alignment Butler to Yanchep Environmental Investigation (GHD 2012)
- Yanchep Rail Extension Biological Assessment (GHD 2018a; Appendix A)
- Yanchep Rail Extension Part 2, Biological Factors (GHD 2018b; Appendix B)
- Fauna Underpass Cross Section (Appendix G)

Table 14 provides a brief description of each of these investigations and identifies the assessment standards used to inform the scope and content of the individual investigations.

12.3.1 Level 1 fauna survey

GHD undertook a Level 1 fauna survey (GHD 2018a; Appendix A) in accordance with Technical Guidance: *Terrestrial Fauna Surveys* (EPA 2016j), which included:

- a desktop survey
- field surveys on 1 to 2 November 2016, 3 to 5 May 2017 and 11 July 2017
- targeted black cockatoo survey.

The results of the Level 1 fauna survey are summarised in Section 12.4.

12.4 Receiving environment

12.4.1 Habitat types

Seven fauna habitats, as well as highly disturbed areas, were recorded in the development envelope:

- *Eucalyptus* woodland (High habitat value)
- *Banksia sessilis* over low mixed shrubland (High habitat value)
- mixed *Banksia* woodland (High habitat value)

- mixed tall shrubland (High habitat value)
- *Lomandra* herb lands on secondary dunes (Medium habitat value)
- LIMESTONE ridge lines (Medium habitat value)
- Planted *Eucalypt* woodland (Medium habitat value)
- highly disturbed (Low habitat value).

All of the seven identified fauna habitat types were recorded in the development footprint. Table 36 details the area of each fauna habitat type within the development footprint and construction and access areas and their habitat value. The spatial location of the fauna habitat types is presented in Figures Y-1 to Y-4.

Table 36 Fauna habitat types within the development envelope

Fauna habitat type	Habitat value	Development footprint		Construction and access		Development envelope		Carnaby's Black-Cockatoo foraging habitat			
		Area (ha)	% composition	Area (ha)	% composition	Area (ha)	% composition	Habitat	Habitat vale	Development envelope area (ha)	Development envelope area (%)
Eucalyptus woodland (VT6)	High	2.14	3.55	-	-	2.14	2.93	Yes	High	2.14	2.93
Banksia sessilis over low mixed shrubland (VT2,VT3)		14.43	23.93	1.41	11.22	15.85	21.74		High	15.85	21.74
Mixed Banksia woodland (VT4,VT9)		10.95	18.16	1.95	15.51	12.90	17.70		High	12.90	17.70
Mixed tall shrubland (VT1,VT7,VT10,VT13)		13.61	22.57	3.33	26.49	16.94	23.23		High–Low	16.93	23.23
Subtotal		41.13	68.20	6.69	53.22	47.82	65.61			47.82	65.61
Lomandra herb lands on secondary dunes (VT5)	Medium	5.06	8.39	0.26	2.07	5.32	7.30	-	-		
Limestone ridge lines (VT8)		0.05	0.08	-	-	0.05	0.07				
Planted Eucalypt woodland (VT12)		8.31	13.78	0.82	6.52	9.13	12.53	Yes	Medium	9.13	12.53
Subtotal		13.42	22.25	1.08	8.6	14.50	19.90				
Highly disturbed (CL)	Low	5.76	9.5	4.81	38.24	10.56	14.49	-	-		
Subtotal		5.76	9.55	4.81	38.24	10.56	14.49				
Total		**60.31**	**100**	**12.57**	**100**	**72.88**	**100**			**56.96**	

(Source GHD 2018b)

12.4.2 Fauna species

Sixty-eight vertebrate fauna species, including fifty-one birds, eight reptiles and nine mammals were recorded within the YRE development envelope. Carnaby's Black Cockatoo *(Calyptorhynchus latirostris*) (EPBC Act and WC Act) was the only species of conservation significance recorded during the field survey in the development envelope (GHD 2018a).

A further six conservation significant species were considered likely to occur within the development envelope by GHD (2018a):

- jewelled south-west ctenotus (*Ctenotus gemmula*) (Priority 3)
- black striped snake (*Neelaps calonotos*) (Priority 3).
- peregrine falcon (*Falco peregrinus*) (WC Act; Other specially protected fauna)
- southern brown bandicoot (*Isoodon obesulus* subsp. *fusciventer*) (Priority 4)
- western brush wallaby (*Macropus irma*) (Priority 4)
- western quoll (*Dasyurus geoffroii*) (EPBC Act; Vulnerable and WC Act; Vulnerable)

The Rainbow Bee-eater (*Merops ornatus*) was also recorded by GHD (2018a) within the Part 1 development envelope. At the time of the survey the Rainbow Bee-eater was listed as Migratory under the WC Act, however this species was deleted from the Wildlife Conservation (Specially Protected Fauna) Notice 2017 as of 16 January 2018. The Rainbow Bee-eater is listed marine under the EPBC Act.

12.4.2.1 Carnaby's Black-Cockatoo

12.4.2.1.1 Foraging habitat

The development envelope is located within the modelled feeding and breeding distribution range for Carnaby's Black Cockatoo (DEE 2017b). Approximately 56.96 ha of potential foraging habitat for Carnaby's Black Cockatoo was recorded within the development envelope (Table 36; Figures Y-1 to Y-4).

Approximately 31.20 ha (or 54.80%) was determined to be high value foraging habitat, 21.42 ha (or 37.62%) was determined to be medium value foraging habitat and 4.31 ha (or 7.57%) was determined to be of low value foraging habitat for Carnaby's Black Cockatoo. The extent and type of foraging habitat was confirmed by GHD (2018a) through the presence of foraging evidence and a comparison of the flora species recorded with a list of known foraging species. Figures Y-1 to Y-4 identify the location of the foraging evidence records.

The 56.96 ha extent of foraging habitat for Carnaby's Black Cockatoo represents approximately 78.16% of the development envelope. The remaining extent of the development envelope is comprised of approximately 15.92 ha (or 21.84%) of fauna habitat types which are not considered to provide foraging habitat for Carnaby's Black Cockatoo.

12.4.2.1.2 Breeding habitat

GHD (2018a) recorded 37 potential breeding trees within the development envelope (Figures Y-1 to Y-4).

12.4.2.1.3 Roosting habitat

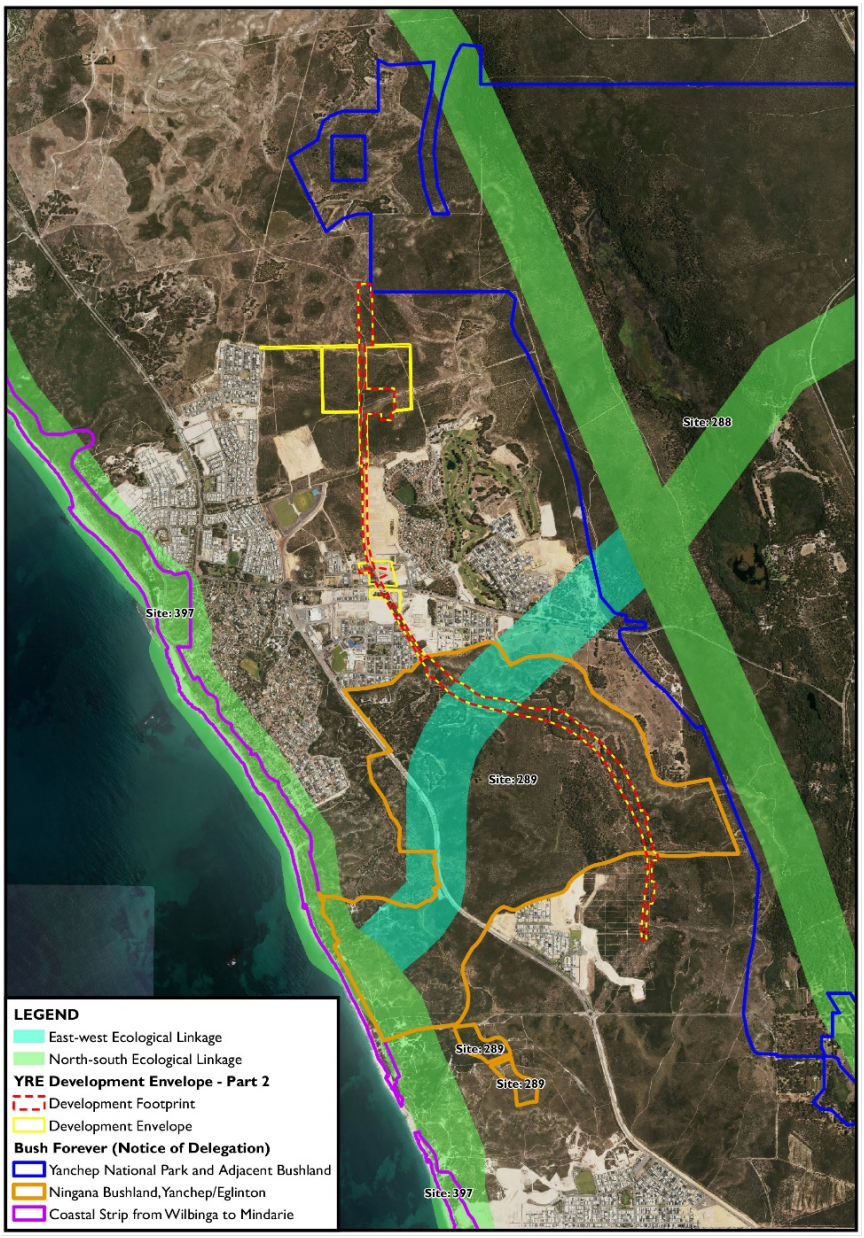
GHD (2018a) did not identify any Carnaby's Black Cockatoo roosting sites within the YRE development envelope, however approximately 13.36 ha of potential roosting habitat was identified. Within the development envelope, there are approximately 11.27 ha of suitable roosting habitat comprised of 2.14 ha of *Eucalyptus* woodland (VT6) and 9.13 ha of Planted *Eucalypt* woodland (VT12). The potential roosting habitat is a subset of foraging and breeding habitats.

12.4.3 Ecological connectivity

The North-west Sub-regional Planning Framework identifies the ecological linkages which have underpinned the State Government's planning framework for Perth and Peel@3.5million (DPLH and WAPC 2018b). A north-south regional ecological linkage (identified in Section 4.4.3.1.1; Figure 1), which connects Bush Forever Sites 288, 129 and 130, runs perpendicular to the development envelope on its eastern side. The mapped extent of the north-south regional ecological linkage is not intersected by the development envelope (See Figure 2 of GHD 2018b).

The CoW's Local Biodiversity Strategy 2011-2016 also documents a regional ecological linkage that runs east-west between Bush Forever Site 288, 289 and 397. This east-west linkage is also referenced in Bush Forever, Volume 2, Directory of Bush Forever Sites (Government of Western Australia 2000).

The regional ecological linkages identified in CoW's Local Biodiversity Strategy 2011-2016 have been indicatively displayed in Figure 2 in relation to the development envelope. The development envelope intersects the east-west linkage.



(Source: CoW 2018)

Figure 2 Regional ecological linkages

From the fauna surveys undertaken to inform the preparation of the Bush Forever report (Government of Western Australia 2000), the following broad assemblages of non-avian / ground dwelling native fauna species were recorded:

- Bush Forever Site No. 397: *Coastal Strip from Wilbinga to Mindarie*
  - one native mammal species and eight reptile species. These species are not of conservation significance (Government of Western Australia 2000).
- Bush Forever Site No. 289: *Ningana Bushland, Yanchep/Eglinton*
  - one native mammal species and eight reptile species. These species are not of conservation significance (Government of Western Australia 2000).
- Bush Forever Site No. 288: *Yanchep National Park and Adjacent Bushland*
  - 15 native mammal species (including Southern Brown Bandicoot, Western Brush Wallaby, Ash Grey Mouse and Echidna) and 47 reptile species (Government of Western Australia 2000).
  - The fauna assemblages are not anticipated to have changed significantly over time. Informed by the above it is anticipated that mammals recorded within the Bush Forever sites (such as the Southern Brown Bandicoot [*Isoodon obesulus* subsp. *fusciventer*] and Western Brush Wallaby [Macropus irma]) and reptiles (such as Jewelled South-west Ctenotus [*Ctenotus gemmula*] and Black Striped Snake [*Neelaps calonotos*]), as well as flightless bird species (such as Emu [*Dromaius novaehollandiae*]), would be the likely users of the east-west linkage.

12.5 Potential impacts

Table 37 provides the potential impacts to terrestrial fauna from construction of the development envelope and operation of the railway.

Table 37 Potential construction and operational impacts to terrestrial fauna

Phase	Impact class	Works/operations	Potential impacts
Construction	Direct	• Clearing of native vegetation • Cut and fill works • Excavation and construction of roads, buildings and other hard stand areas • Operation of plant machinery and service vehicles	• Permanent loss of fauna habitat • Permanent loss of Carnaby's Black-Cockatoo habitat • Injury and/or mortality • Habitat fragmentation and loss of ecological connectivity • Disturbance during construction (clearing activities and noise) may affect the local abundance of fauna populations due to interruption to fauna behaviour
	Indirect	• Clearing of native vegetation • Cut and fill works • Excavation and construction of roads, buildings and other hard stand areas • Operation of plant machinery and service vehicles	Habitat and food source degradation through increased pollution, waste, spread of weeds and altered hydrology edge effects
Operation	Direct	Operation and maintenance of the electrified railway line	• Injury and/or mortality from fauna train interactions • Habitat fragmentation and loss of ecological connectivity • Disturbance during operation (noise and vibration) may affect the local abundance of fauna populations due to interruption to fauna behaviour
	Indirect		Habitat and food source degradation through increased pollution, waste, spread of weeds and altered hydrology edge effects

12.6 Assessment of impacts

12.6.1 Permanent loss of fauna habitat

12.6.1.1 Development envelope context

The implementation of Part 2 of the YRE project will result in the permanent loss of up to 72.88 ha of fauna habitat. Of the 72.88 ha, 10.56 ha is considered highly disturbed and of low habitat value, whilst 62.32 ha is considered to be of either high (47.82 ha) or medium (14.50 ha) habitat value fauna (Table 36).

12.6.1.2 Local, regional and bioregional context

The implementation of Part 2 of the YRE project will result in an estimated 5.39% reduction in available fauna habitat at the local scale; and as little as 0.20% and 0.01% at the regional and bioregional scales (GHD 2018b). Of the current extent of the available fauna habitat remaining, an estimated 42.98% is located within conservation areas at the local scale and 74.60% and 44.81% at the regional and bioregional scales (GHD 2018b).

The clearing of fauna habitat with Parts 1 and 2 of the YRE development envelope will reduce the extent of the available fauna habitat by 6.41% at the local scale, whilst at the regional scale this percentage is reduced to 0.40% (GHD 2018b). GHD (2018b) provides an overview of current extents of fauna habitat, as identified within the YRE development envelope, which will support future urban development at the local and regional scales to provide an assessment of cumulative impacts. Future urban development is estimated to include 46.87% of the available fauna habitat at the local scale and 14.64% of the available fauna habitat at the regional scale (GHD 2018b). By comparison the implementation of the YRE project includes 6.41% of the available fauna habitat at the local scale and 0.40% of the available fauna habitat at the regional scale (GHD 2018b).

The vegetation associations / regional vegetation complexes (and hence fauna habitats) mapped within the YRE project are reserved within conservation areas at the regional and bioregional scale. The implementation of the YRE project (Parts 1 and 2) will not result in any vegetation associations / regional vegetation complexes (and hence fauna habitats) being reduced to below 30% of their pre-European extents. Given the above, it is considered that the potential direct and cumulative impacts to the persistence of the fauna habitat from the implementation of the YRE project are relatively minor at the regional and bioregional scales.

12.6.2 Conservation significant fauna species

The potential impacts to conservation significant fauna species from the loss of habitat within the development envelope are detailed in Table 38.

Table 38 Assessment of impacts to conservation significant fauna species with the development envelope

Species	Conservation status (state)	Conservation status (EPBC)	Habitat requirements	Occurrence within the development envelope	Direct impacts	Significance of direct impacts
Reptiles						
Jewelled south-west ctenotus *(Ctenotus gemmula)*	Priority 3	-	Jewelled South-west Ctenotus occurs on pale sandplains supporting heaths is association with Banksia or mallee woodlands (Wilson and Swan 2013; Kay and Keogh 2012).	Likely, the habitat within the development envelope is suitable for this species (GHD 2018a). This species was not detected by GHD's field surveys.	• Clearing of up to 12.90 ha of Mixed *Banksia* woodland of high habitat value • Clearing of up to 16.93 ha of Mixed tall shrubland of high habitat value • Clearing of up to 5.32 ha of *Lomandra* herbland on secondary dunes of medium habitat value • GHD (2018a) identifies that the Jewelled South-west Ctenotus may utilise / reside in these above habitats (if present) • Fragmentation of Bush Forever Site No. 289 will isolate local populations (if present)	GHD (2018a) considers it likely that the Jewelled South-west Ctenotus would occur within the development envelope. The movement of this species within Bush Forever Site No. 289 and across Bush Forever areas will be restricted by the operational railway line. Given the proximity of development envelope to larger areas of similar or better quality habitat locally available within Bush Forever sites (Section 4.4) it is considered unlikely that the Jewelled South-west Ctenotus would be significantly impacted by habitat loss associated with Part 2 of the YRE project. The proposed terrestrial fauna mitigation measures (Table 39), including the provision of four fauna underpasses and installation of appropriate fencing within Bush Forever Site No. 289, provide the opportunity for the limited dispersion of Jewelled South-west Ctenotus within the site and ensures this species is unlikely to be injured or killed by the operational railway line. The provision of fauna underpasses also provides the opportunity for the ecological connectivity for the Jewelled South-west Ctenotus to be maintained at the local and regional scales. It is considered unlikely that the Jewelled South-west Ctenotus would be significantly impacted by habitat fragmentation associated with Part 2 of the YRE project.
Black striped snake (*Neelaps calonotos*)	Priority 3	-	Black striped snakes are generally found on coastal dunes and sandplains vegetated with heaths and eucalypt / *Banksia* woodlands on the Swan Coastal Plain (Pearson 2013).	Likely, the habitat within the development envelope is suitable for this species (GHD 2018a). This species was not detected by GHD's field surveys.	• Clearing of up to 12.90 ha of Mixed *Banksia* woodland of high habitat value • Clearing of up to 16.93 ha of Mixed tall shrubland of high habitat value • Clearing of up to 5.32 ha of *Lomandra* herbland on secondary dunes of medium habitat value • GHD (2018a) identifies that the Black striped snake may utilise / reside in these above habitats (if present) • Fragmentation of Bush Forever Site No. 289 will isolate local populations (if present)	GHD (2018a) considers it likely that the Black striped snake would occur within the development envelope. The movement of this species within Bush Forever Site No. 289 and across Bush Forever areas will be restricted by the operational railway line. Given the proximity of development envelope to larger areas of similar or better quality habitat locally available within Bush Forever sites (Section 4.4) it is considered unlikely that the Black striped snake would be significantly impacted by habitat loss associated with Part 2 of the YRE project. The proposed terrestrial fauna mitigation measures (Table 39), including the provision of four fauna underpasses and installation of appropriate fencing within Bush Forever Site No. 289, provide the opportunity for the limited dispersion of Black striped snake within the site and ensures this species is unlikely to be injured or killed by the operational railway line. The provision of fauna underpasses also provides the opportunity for the ecological connectivity for the Black striped snake to be maintained at the local and regional scales. It is considered unlikely that the Black striped snake would be significantly impacted by habitat fragmentation associated with Part 2 of the YRE project.
Birds						
Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*)	Schedule 2	Endangered	Carnaby's Black Cockatoo is endemic to south-west Western Australia occurring from the Murchison River to Esperance, and inland to Coorow, Kellerberrin and Lake Cronin. Carnaby's Black Cockatoo foraging habitat includes native shrubland, kwongan heathland and woodland dominated by proteaceous plant species including *Banksia* spp., *Hakea* spp. and *Grevillea* spp. Carnaby's Black Cockatoo is known to forage in pine plantations, eucalypt woodland, forest that contains foraging species and individual trees and small stands of these species (DEE 2017c).	Carnaby's Black Cockatoo was observed within the development envelope and evidence of feeding was also recorded.	Clearing of up to 56.96 ha of foraging habitat and 37 potential breeding trees	Clearing of up to 56.96 ha of foraging habitat and 37 potential breeding trees is at variance with the EPBC Act Referral Guidelines for the three species of black cockatoos (Department of Sustainability, Environment, Water, Populations and Communities [DSEWPaC] 2012). It is considered likely that this action would meet the DEE's definition of a 'significant impact' (Department of the Environment 2013) to Carnaby's Black Cockatoo. This significant impact will be counterbalanced through the provision of an appropriate Offset Strategy (Section 12.8.1). The proposal has been referred to the DEE under EPBC Act

Species	Conservation status (state)	Conservation status (EPBC)	Habitat requirements	Occurrence within the development envelope	Direct impacts	Significance of direct impacts
Peregrine falcon (*Falco peregrinus*)	Schedule 7	N/A	Peregrine falcons are widely distributed throughout Australian habitats inclusive of woodlands, wetlands and open country, although they are generally absent from treeless and waterless deserts and dense forests. Peregrine falcons prefer cliff faces as nest sites (Birds Australia 2012).	Likely, the nearest record is within 10 km of the development envelope (GHD 2018a). This species was not detected by GHD's field surveys.	• Clearing of up to 72.88 ha of potential habitat • GHD (2018a) identifies that the peregrine falcon may opportunistically use all habitat types within the development envelope for foraging (if present)	It is considered likely that peregrine falcons may be observed overflying the development envelope infrequently. However, given the substantial extent of potential habitat locally available within Bush Forever sites (Section 4.4) and the proposed terrestrial fauna mitigation measures (Table 39), the peregrine falcon is considered unlikely to be significantly impacted by the Part 2 of the YRE project.
Mammals						
Southern brown bandicoot (*Isoodon obesulus* subsp. *fusciventer*)	Priority 4	N/A	Southern brown bandicoots are broadly distributed near the south-west coast from Guilderton, north of Perth, to east of Esperance with a more patchy distribution through the jarrah and karri forests, swan coastal plain and inland regions. Southern brown bandicoots are generally found in scrubby, often swampy, vegetation with dense cover up to 1 m high and on the Swan Coastal Plain are often associated with wetlands (DEC 2012a).	Likely, the habitat within the development envelope is suitable for this species (GHD 2018a). This species was not detected by GHD's field surveys.	• Clearing of up to 2.14 ha of *Eucalyptus* woodland of high habitat value • Clearing of up to 15.85 ha of *Banksia sessilis* over mixed shrubland of high habitat value • Clearing of up to 12.90 ha of Mixed *Banksia* woodland of high habitat value • Clearing of up to 16.93 ha of Mixed tall shrubland of high habitat value • GHD (2018a) identifies that the Southern Brown Bandicoot is a likely resident of these above habitat types, whilst an additional 14.41 ha of opportunistic potential foraging habitat will also be cleared • Fragmentation of Bush Forever Site No. 289 will isolate local populations	GHD (2018a) considers it likely that Southern brown bandicoots would occur within the development envelope. The movement of this species within Bush Forever Site No. 289 and across Bush Forever areas will be restricted by the operational railway line. Given the proximity of development envelope to larger areas of similar or better quality habitat locally available within Bush Forever sites (Section 4.4) it is considered unlikely that the Southern brown bandicoot would be significantly impacted by habitat loss associated with Part 2 of the YRE project. The proposed terrestrial fauna mitigation measures (Table 39), including the provision of four fauna underpasses and installation of appropriate fencing within Bush Forever Site No. 289, provide the opportunity for the dispersion of Southern brown bandicoot within the site and ensures this species is unlikely to be injured or killed by the operational railway line. The provision of fauna underpasses also provides the opportunity for the ecological connectivity for the Southern brown bandicoot to be maintained at the local and regional scales. It is considered unlikely that the Southern brown bandicoot would be significantly impacted by habitat fragmentation associated with Part 2 of the YRE project.
Western brush wallaby *(Macropus irma)*	Priority 4-	N/A	The western brush wallaby's optimum habitat is open forest or woodland, particularly favouring open, seasonally to wet flats with low grasses and open scrubby thickets. Western brush wallabies are also found in some areas of mallee and heath-land, however is uncommon in karri forests (DEC 2012b).	One Western Brush Wallaby was recorded by GHD's field surveys in the Mixed tall shrubland within Part 1 of the YRE project.	• Clearing of up to 7.89 ha of potential habitat • GHD (2018a) identifies that the Western Brush Wallaby is able to use all habitat types within the development envelope either as a resident or for foraging, however the Mixed tall shrublands, *Banksia* woodlands and *Eucalyptus* woodlands are of higher value for seeking shelter and foraging • Fragmentation of Bush Forever Site No. 289 will isolate local populations	Given that one Western Brush Wallaby was recorded by GHD's field surveys and the proximity of development envelope to larger areas of similar or better quality habitat locally available within Bush Forever sites (Section 4.4) it is considered unlikely that the Western Brush Wallaby would be significantly impacted by habitat loss associated with Part 2 of the YRE project. The movement of this species within Bush Forever Site No. 289 and across Bush Forever areas will be restricted by the operational railway line. The proposed terrestrial fauna mitigation measures (Table 39), including the provision of four fauna underpasses and installation of appropriate fencing within Bush Forever Site No. 289, provide the opportunity for the dispersion of Western Brush Wallaby within the site and ensures this species is unlikely to be injured or killed by the operational railway line. The provision of fauna underpasses also provides the opportunity for the ecological connectivity for the Western Brush Wallaby to be maintained at the local and regional scales. It is considered unlikely that the Western Brush Wallaby would be significantly impacted by habitat fragmentation associated with Part 2 of the YRE project.
Western quoll (*Dasyurus geoffroii*)	Schedule 3	Vulnerable	Western quolls are restricted to the south-west of Western Australia and are generally found in most kinds of wooded habitat including eucalypt forest (especially jarrah), dry woodland and mallee shrublands. Western quolls den in hollow logs and burrows and have also been recorded in tree hollows and cavities (DEC 2012c).	Likely, there are records present within 10 km of the development envelope and there is suitable habitat available for this species (GHD 2018a). This species was not detected by GHD's field surveys.	• Clearing of up to 15.85 ha of *Banksia sessilis* over mixed shrubland of high habitat value • Clearing of up to 12.90 ha of Mixed *Banksia* woodland of high habitat value • Clearing of up to 16.93 ha of Mixed tall shrubland of high habitat value • GHD (2018a) identifies that the Western Quoll is a likely resident of these above habitat types, whilst an additional 16.64 ha of opportunistic potential foraging habitat will also be cleared • Fragmentation of Bush Forever Site No. 289 will isolate local populations (if present)	GHD (2018a) considers it likely that Western Quolls would occur within the development envelope. The movement of this species within Bush Forever Site No. 289 and across Bush Forever areas will be restricted by the operational railway line. Given the proximity of development envelope to larger areas of similar or better quality habitat locally available within Bush Forever sites (Section 4.4) it is considered unlikely that the Western Quoll would be significantly impacted by habitat loss associated with Part 2 of the YRE project. The proposed terrestrial fauna mitigation measures (Table 39), including the provision of four fauna underpasses and installation of appropriate fencing within Bush Forever Site No. 289, provide the opportunity for the dispersion of Western Quoll within the site and ensures this species is unlikely to be injured or killed by the operational railway line. The provision of fauna underpasses also provides the opportunity for the ecological connectivity for the Western Quoll to be maintained at the local and regional scales. It is considered unlikely that the Western Quoll would be significantly impacted by habitat fragmentation associated with Part 2 of the YRE project.

12.6.2.1 Potential loss of Carnaby's Black Cockatoo habitat

12.6.2.1.1 Development envelope context

The implementation of Part 2 of the YRE project will result in the permanent loss of up to 56.96 ha of Carnaby's Black Cockatoo foraging habitat and 37 potential breeding trees. Approximately 31.20 ha (or 54.80%) was determined to be of high value foraging habitat, 21.42 ha (or 37.62%) was determined to be of medium value foraging habitat and 4.31 ha (or 7.57%) was to be of low value foraging habitat for Carnaby's Black Cockatoo (Figures Y-1 to Y-4).

Carnaby's Black Cockatoo is listed as "Endangered" under the WC Act and "Endangered" under the EPBC Act.

12.6.2.1.2 Local and regional context

The implementation of Part 2 of the YRE project will result in an estimated 57.16% and 100% reduction in Carnaby's Black Cockatoo foraging and potential breeding habitat respectively at the local scale, and 0.23% and 0.03% reduction in potential Carnaby's Black Cockatoo foraging and breeding habitats at the regional scale (GHD 2018b).

The notional impact to breeding habitat is likely:

- associated with utilising broad-scale mapping (Beard 1979) at a local scale, where the resolution does not include all local occurrences (GHD 2018b)
- compounded by the limited inferred breeding extent within a 1 km buffer of the proposed action (GHD 2018b).Broad-scale mapping (Beard 1979) indicates there is breeding habitat present within Yanchep National Park located to the east of the proposed action (GHD 2018b). Figure H shows the location of the Yanchep National Park relative to the development envelope.

Of the current extent of potential Carnaby's Black Cockatoo foraging and breeding habitats remaining, an estimated 47.84% and 100% of potential foraging and breeding habitat respectively are situated in conservation areas at the local scale (GHD 2018b). At the regional scale, approximately 84.66% and 78.15% of potential Carnaby's Black Cockatoo foraging and breeding habitats are situated with conservation areas (GHD 2018b).

The clearing of Carnaby's Black Cockatoo foraging and potential breeding habitats with Parts 1 and 2 of the YRE development envelope will reduce the extents of these habitats by 67.92% and 100% at the local scale, whilst at the regional scale these percentages are 0.44% and 0.07% (GHD 2018b). GHD (2018b) provides an overview of current extents of Carnaby's Black Cockatoo foraging and potential breeding habitats, as identified within the YRE development envelope, which will support future urban development at the local and regional scales to provide an assessment of cumulative impacts.

Future urban development is estimated to include no potential foraging or breeding Carnaby's Black Cockatoo habitat at the local scale (GHD 2018b). This outcome is attributed to the use of broad-scale mapping (Beard 1979) for the local scale, where the resolution is not sufficiently detailed to include all local occurrences. Approximately 4.44% of the available Carnaby's Black Cockatoo foraging habitat and 4.95% of the available potential Carnaby's Black Cockatoo breeding habitat is included in future urban development at the regional scale[6].

As the potential Carnaby's Black Cockatoo foraging and breeding habitats are well reserved at the regional (84.66% and 78.15%) scale, it is considered that the potential direct impact to the persistence of Carnaby's Black Cockatoo from the implementation of the YRE project is relatively minor.

[6] No additional potential Carnaby's Black Cockatoo foraging or breeding habitat was identified by GHD (2018b) within 1 km of the Part 2 development envelope.

12.6.3 Significance of impacts

The permanent loss of up to 56.96 ha of Carnaby's Black Cockatoo foraging habitat and 37 potential Carnaby's Black Cockatoo breeding trees within the development envelope is at variance with the EPBC Act Referral Guidelines for the three species of black cockatoos (Department of Sustainability, Environment, Water, Populations and Communities [DSEWPaC] 2012). It is considered likely that this action would meet the DEE's definition of a 'significant impact' (Department of the Environment 2013) to Carnaby's Black Cockatoo. This significant impact will be counterbalanced through the provision of an appropriate Offset Strategy (Section 12.8.1).The proposal has been referred to the DEE under EPBC Act.

The direct impacts to fauna habitat, including Carnaby's Black Cockatoo foraging and breeding habitats, and the contribution of Part 2 (and Part 1) of YRE project to the cumulative loss of fauna habitat is considered to be relatively minor when the regional scale is applied. Table 39 identifies the avoidance measures that have been undertaken by the PTA, as part of the detailed design of Part 2 of the YRE project, to reduce the direct residual impacts to terrestrial fauna during project construction.

12.6.4 Habitat fragmentation and loss of ecological connectivity

12.6.4.1 Development envelope

12.6.4.1.1 Habitat fragmentation

Approximately 28.82 ha of the east-west ecological linkage within Bush Forever Site No. 289 will be directly impacted by the implementation of Part 2 of the YRE project (GHD 2018b).Of the 28.82 ha, approximately 18.11 ha comprises native vegetation in "Degraded" or better condition (or Bushland) with the remaining 10.71 ha comprising native vegetation in "Completely Degraded" condition, planted species and cleared areas (GHD 2018b).

The implementation of Part 2 of the YRE project will bisect the 657.51 ha Bush Forever Site No. 289. The area west of the rail corridor will be approximately 498.59 ha (or 74.07%) in extent, which includes an approximately 11.58 ha (or 1.76%) extent of the "Other Regional Roads" reservation for Marmion Avenue. The area to the east will be approximately 130.08 ha (or 19.78%) in extent. These western and eastern areas will be separated by the operational railway corridor, which will be fenced to restrict human and terrestrial fauna access to the rail corridor.

The fragmentation of fauna habitat could potentially lead to:

- Restricted dispersal: Potential loss of territory and inability to find a mate, due to a restriction in home range.
- Loss of genetic diversity: Potential for limiting gene flow between populations, which can lead to an increased risk of inbreeding and a higher susceptibility to impacts such as disease, droughts and fires.
- Loss of ecological diversity: Local extinctions of specific species could reduce the faunal assemblage of the remnant vegetation in the area, which can lead to a reduction in functionality within an ecosystem.
- Higher susceptibility to impact: Impacts such as fire, disease and feral predation can lead to localised extinction.

12.6.4.1.2 Loss of ecological connectivity

The YRE project is a linear infrastructure development which runs 7.19 km from the existing Butler Station to approximately 0.93 km north of the future Yanchep Station. The YRE project predominantly extends north-south, potentially limiting the ecological connectivity in an east-west direction. For the majority of the development envelope, ecological connectivity is not significant as the proposal directly borders existing and future areas of urban development. Approximately 2.90 km of the development envelope passes through Bush Forever Site No. 289.

The implementation of the proposal will restrict the movement of fauna species within Bush Forever No. 289. This is of particular relevance for non-avian / ground dwelling fauna species due to their restricted dispersal abilities. Table 38 identifies the potential impacts to conservation significant non-avian / ground dwelling fauna identified as being likely to occur within the development envelope from the fragmentation of Bush Forever Site No. 289. Non-conservation significant mammal, reptile and flightless bird species (such as Emu [*Dromaius novaehollandiae*]) will also be impacted.

To maintain the east-west ecological linkage for the non-avian / ground dwelling native fauna species, four fauna underpasses will be located beneath the railway line within Bush Forever Site No. 289. The provision of fauna underpasses also provides the opportunity for the ecological connectivity to be maintained. The implementation of this mitigation measure, along with the other mitigation measures identified in Table 40, will assist to address the key risks to terrestrial fauna from loss of ecological connectivity. A railway cross-section showing the indicative location of a fauna underpass underneath the railway corridor has been provided in Appendix G, however the final location of the underpasses will be determined during the detailed design phase of the project.

Local and regional scales

Bush Forever Site No. 289 forms a central part of the east-west ecological linkage between Bush Forever Site No. 397: *Coastal Strip from Wilbinga to Mindarie* on the coast to Bush Forever Site No. 288: *Yanchep National Park and Adjacent Bushland* (Figure 2). Implementation of Part 2 of the YRE project will fragment the east-west ecological linkage by removing approximately 4.38% of Bush Forever Site No. 289. The remaining extent of Bush Forever Site No. 289 will be approximately 628.69 ha and comprised of a 498.59 ha western area (which includes an approximately 11.58 ha extent of the “Other Regional Roads” reservation for Marmion Avenue) and 130.08 ha eastern area. A fenced operational railway line will separate the two portions.

The implementation of the proposal will restrict the movement of fauna species within Bush Forever Site No. 289 as well as impede the regional movement of larger species of non-avian / ground dwelling fauna, such as Western Brush Wallaby (*Macropus irma*), Western Grey Kangaroo (*Macropus fuliginosus)* and Emu (*Dromaius novaehollandiae*) between Bush Forever Site No. 397: *Coastal Strip from Wilbinga to Mindarie* on the coast to Bush Forever Site No. 288: *Yanchep National Park and Adjacent Bushland* (Figure 2).

However the western portion of Bush Forever Site No. 289 will maintain connectivity to Bush Forever Site No. 397: *Coastal Strip from Wilbinga to Mindarie*, whilst the eastern portion will maintain connectivity to Bush Forever Site 288: *Yanchep National Park and Adjacent Bushland*. This local and regional connectivity is of importance for larger fauna species, such as Western Grey Kangaroo (*Macropus fuliginosus)* and Emu (*Dromaius novaehollandiae*), which have larger home ranges, as they will retain connectivity to bushland extents outside of Bush Forever Site No. 289.

The four fauna underpasses located beneath the railway line within Bush Forever Site No. 289 will provide the opportunity for the local and regional ecological connectivity to be maintained for the non-avian / ground dwelling native fauna species between Bush Forever Site No. 397: *Coastal Strip from Wilbinga to Mindarie* and Bush Forever Site No. 288: *Yanchep National Park and Adjacent Bushland.*

Previous consideration and future impacts

The east-west ecological linkage is currently fragmented by Marmion Avenue and Wanneroo Road / Indian Ocean Drive. Approximately 11.58 ha of the Marmion Avenue “Other Regional Roads” reservation is included in Bush Forever Site No. 289 (Figure H). It is anticipated that the future construction of the Mitchell Freeway will result in the additional fragmentation of the east-west linkage (Figure H).

The EPA previously supported the realignment of the “Railways” reservation to the south of Bush Forever Site No. 289 as part of its formal assessment of MRS Amendment 1029/33, whilst MRS Amendment 1192/57 realigned the “Railways” reservation further west to its current location (Figure E). These previous MRS amendments determined the point of egress into Bush Forever Site No. 289 for the “Railways” reservation.

The fragmentation of the east-west ecological linkage within Bush Forever Site No. 289 by a future railway line has been identified within key strategic planning documents including the draft Directions 2031 and Beyond (Department of Planning and WAPC 2010), draft Perth and Peel Green Growth Plan (Department of the Premier and Cabinet 2015) and Perth and Peel@3.5million (DPLH and WAPC 2018b).

Map 1 of SPP 2.8 also includes a railway alignment through Bush Forever Site No. 289, as gazetted by the Government of Western Australia (2010).

12.6.4.2 Significance of impacts

The east-west ecological linkage is already intersected by the existing Marmion Avenue and Wanneroo Road. The implementation of Part 2 of the YRE project will create an additional barrier (operational railway corridor) for the east-west ecological linkage that traverses Bush Forever Site No. 289. The operational rail corridor will also be fenced to restrict terrestrial fauna access to the rail corridor. This is of particular relevance for non-avian / ground dwelling fauna species more likely to be impacted by habitat fragmentation and loss of ecological connectivity due to their restricted dispersal abilities.

Four fauna underpasses will be located underneath the railway line within Bush Forever Site No. 289 to provide the opportunity for local and regional ecological connectivity to be maintained and provide for the long-term movement of native fauna between Bush Forever sites.

The University of Western Australia considers that fauna underpasses can help solve the problem of habitat fragmentation in urban areas in Armadale, and recorded underpass use by Southern Brown Bandicoot (*Isoodon obesulus* subsp. *fusciventer*), Western Grey Kangaroo (*Macropus fuliginosus)* and various reptile species (Bamford 2014).

The fauna underpass movement survey undertaken for the Main Road's NorthLink project found that Western Grey Kangaroos (*Macropus fuliginosus)* and reptiles accounted for 83% and 17% respectively in the Whiteman Park / Cullacabardee Bushland, and 70% and 29% respectively within Maralla Road Bushland (MRWA 2015). Emus accounted for the extra 1% of fauna movements in the Maralla Road Bushland (MRWA 2015).

A fauna movement study conducted in Neerabup, in relatively close proximity to the YRE project, found that Western Grey Kangaroo (*Macropus fuliginosus)* accounted for 45% of all fauna movements, with reptiles (18%) and fox (9%) also being recorded (GHD 2014). Informed by these recent studies; the previous surveys of Bush Forever sites 397, 288 and 289; and GHD's Level 1 Fauna findings, it is likely that larger macropods, Western Grey Kangaroo (*Macropus fuliginosus)* and Western Brush Wallaby (*Macropus irma*), smaller mammals, Southern Brown Bandicoot (*Isoodon obesulus* subsp. *fusciventer*), and reptile species are the most likely future users of the fauna underpasses within Bush Forever Site No. 289.

The PTA will continue to consult with DBCA, MRWA and the University of Western Australia to inform the consideration of the design, location, usage and efficiency of fauna underpasses underneath the railway for the YRE project. Indicatively, the location of the fauna underpasses within Bush Forever Site No. 289 will take into consideration the following:

- East –west linkage. The southern portion of Bush Forever Site No 289 directly adjoins Bush Forever Site 397: *Coastal Strip from Wilbinga to Mindarie* and is only separated from Bush Forever Site No. 288: *Yanchep National Park and Adjacent Bushland* by land reserved for the Mitchell Freeway. The fauna underpasses will be located within Bush Forever Site No. 289 to provide the opportunity for the regional movement of larger species of non-avian / ground dwelling fauna, such as Western Brush Wallaby (*Macropus irma*) and Western Grey Kangaroo (*Macropus fuliginosus),* between these sites.
- Width of the development envelope. Shorter sections of the development envelope will be selected, where possible, to reduce the length of the underpass through which the fauna species have to traverse. Chambers and Bencini (2014) found that underpass length negatively correlated with the frequency of use by bandicoots and recommended the length of underpasses be kept to a minimum.
- Locations where the railway will be raised in order to facilitate installation of the underpass structure. To minimise engineering and native vegetation clearing requirements, the fauna underpasses will be located in the areas where the railway will be raised on fill, thus providing the ability to construct an underpass below the railway with entry and exit points approximating the existing terrain elevations.

The fauna underpass will be appropriately sized to allow for the movement of larger species of terrestrial fauna, such as Western Grey Kangaroo (*Macropus fuliginosus*) and Western Brush Wallaby (*Macropus irma*), as well as smaller non-avian / ground dwelling fauna species, such as the Southern Brown Bandicoot (*Isoodon obesulus* subsp. *fusciventer*) and reptile species.

The provision of fauna underpasses underneath the operational railway line provides the opportunity for ecological connectivity for non-avian / ground dwelling fauna species to be maintained at the local and regional scales. The implementation of this mitigation measure, along with the other mitigation measures identified in Table 40, will assist to address the key risks to terrestrial fauna from habitat fragmentation and loss of ecological connectivity.

12.7 Mitigation

Table 39 demonstrates how the EPA's mitigation hierarchy (avoid, minimise and rehabilitate) has been applied to Terrestrial Fauna to address the key potential impacts, whilst Table 40 applies the EPA's mitigation hierarchy to habitat fragmentation and loss of ecological connectivity.

Table 39 Application of mitigation hierarchy for terrestrial fauna

Potential impacts	Impact class	Mitigation hierarchy	Proposed mitigation measures	Residual impacts
Construction				
• Permanent loss of fauna habitat • Permanent loss of Carnaby's Black Cockatoo habitat • Injury and/or mortality • Disturbance during construction (clearing activities and noise) may affect the local abundance of fauna populations due to interruption to fauna behaviour	Direct	Avoid	• Modification of the development envelope to reduce the clearing of fauna habitat and avoid direct impacts to Bush Forever Site No. 288: *Yanchep National Park and Adjacent Bushland* • Access tracks within Bush Forever Site No. 289 have been planned to accommodate PTA, DBCA and DFES operational requirements thereby eliminating the potential for the duplication of access tracks by the agencies and reducing fauna habitat clearing	• Permanent loss of up to 62.32 ha of fauna habitat, considered to be of high to medium habitat value • Permanent loss of up to 56.96 ha of Carnaby's Black Cockatoo foraging habitat and 37 potential breeding trees
		Minimise	• Construction and access areas have been selected to coincide with proposed future urban development cells or roads either reserved by the MRS, or as detailed within approved and draft LSPs, to reduce the likelihood of impacting fauna habitat proposed to be retained within future POS reservations • Development footprint and volumes of sand to be excavated within Bush Forever Site No. 289 has been reduced through a decision to raise the vertical alignment of the railway through this site, which has minimised the potential impacts to fauna habitat • CEMP will be prepared to address the potential impacts to terrestrial fauna during the construction of Part 2 of the YRE project • CEMP will be prepared to accord with the approved Conservation Management Plan for Regional Open Space and Pubic Open Space (Strategen 2015) and the approved Clearing and Revegetation Management Plan (Strategen 2014) for the portion of the development envelope which intersects the EPBC 2011 / 6021 approval • Four fauna underpasses will be located underneath the railway line within Bush Forever Site No. 289 to maintain the east-west ecological linkage and provide for the long-term movement of native fauna. The fauna underpass will be appropriately sized to allow for the movement of larger species of terrestrial fauna, such as Western Grey Kangaroo (*Macropus fuliginosus*) and Western Brush Wallaby (*Macropus irma*), as well as smaller non-avian / ground dwelling fauna species, such as the Southern Brown Bandicoot (*Isoodon obesulus* subsp. *fusciventer*) and reptile species. • Appropriate fencing will be installed within Bush Forever Site No. 289 to restrict terrestrial fauna access to the rail corridor and to encourage terrestrial fauna movement towards the openings of the fauna underpasses. Fencing will be maintained by the PTA on an as required basis	
		Rehabilitate	Detailed engineering design will be undertaken to minimise landform impacts and identify structural controls (i.e. battering the excavation and / or retaining walls) that will be implemented to stabilise the affected landform. Should the batters be of a suitable gradient and material, they will be stabilised with planting of locally endemic species and/or bioengineering controls that will be sympathetic to the surrounding native vegetation within Bush Forever Site No. 289. Species selection will be considerate of creating habitat for Carnaby's Cockatoo	
Habitat and food source degradation through increased pollution, waste, spread of weeds and altered hydrology edge effects	Indirect	Avoid	• Modification of the development envelope to reduce the clearing of fauna habitat and avoid direct impacts to Bush Forever Site No. 288: *Yanchep National Park and Adjacent Bushland* • Access tracks within Bush Forever Site No. 289 have been planned to accommodate PTA, DBCA and DFES operational requirements thereby eliminating the potential for the duplication of access tracks by the agencies and reducing fauna habitat clearing	
		Minimise	• Construction and access areas have been selected to coincide with proposed future urban development cells or roads either reserved by the MRS, or as detailed within approved and draft LSPs, to reduce the likelihood of impacting fauna habitat proposed to be retained within future POS reservations • CEMP will be prepared to address the potential impacts to terrestrial fauna during the construction of Part 2 of the YRE project • CEMP will be prepared to accord with the approved Conservation Management Plan for Regional Open Space and Pubic Open Space (Strategen 2015) and the approved Clearing and Revegetation Management Plan (Strategen 2014) for the portion of the development envelope which intersects the EPBC 2011 / 6021 approval • Four fauna underpasses will be located beneath the railway line within Bush Forever Site No. 289 to maintain the east-west ecological linkage and provide for the long-term movement of native fauna. The fauna underpass will be appropriately sized to allow for the movement of larger species of terrestrial fauna, such as Western Grey Kangaroo (*Macropus fuliginosus*) and Western Brush Wallaby (*Macropus irma*), as well as smaller non-avian / ground dwelling fauna species, such as the Southern Brown Bandicoot (*Isoodon obesulus* subsp. *fusciventer*) and reptile species • Appropriate fencing will be installed within Bush Forever Site No. 289 to restrict terrestrial fauna access to the rail corridor and to encourage terrestrial fauna movement towards the openings of the fauna underpasses. Fencing will be maintained by the PTA on an as required basis	
		Rehabilitate	Detailed engineering design will be undertaken to minimise landform impacts and identify structural controls (i.e. battering the excavation and / or retaining walls) that will be implemented to stabilise the affected landform. Should the batters be of a suitable gradient and material, they will be stabilised with planting of locally endemic species and/or bioengineering controls that will be sympathetic to the surrounding native vegetation within Bush Forever Site No. 289. Species selection will be considerate of creating habitat for Carnaby's Cockatoo	
Operation				
• Injury and/or mortality from fauna train interactions • Disturbance during operation (noise and vibration) may affect the local abundance of fauna populations due to interruption to fauna behaviour	Direct	Avoid	Appropriate fencing will be installed within Bush Forever Site No. 289 to restrict terrestrial fauna access to the rail corridor (avoiding injury and/or mortality)	With appropriate management, potential impacts are as low as reasonably practicable
		Minimise	• Four fauna underpasses will be located beneath the railway line within Bush Forever Site No. 289 to maintain the east-west ecological linkage and provide for the long-term movement of native fauna. The fauna underpass will be appropriately sized to allow for the movement of larger species of terrestrial fauna, such as Western Grey Kangaroo (*Macropus fuliginosus*) and Western Brush Wallaby (*Macropus irma*), as well as smaller non-avian / ground dwelling fauna species, such as the Southern Brown Bandicoot (*Isoodon obesulus* subsp. *fusciventer*) and reptile species • Appropriate fencing will be installed within Bush Forever Site No. 289 to restrict terrestrial fauna access to the rail corridor and to encourage terrestrial fauna movement towards the openings of the fauna underpasses. Fencing will be maintained by the PTA on an as required basis	
		Rehabilitate	No rehabilitation is anticipated to be required	
Habitat and food source degradation through increased pollution, waste, spread of weeds and altered hydrology edge effects	Indirect	Avoid	Avoidance of trains and service machinery using the operational railway corridor is not a feasible option	With appropriate management, potential impacts are as low as reasonably practicable
		Minimise	Operational railway corridor will be managed by the PTA in perpetuity, standard measures for pollution control and waste disposal will be implemented at the stations and within the rail corridor	
		Rehabilitate	Appropriate fencing will be installed within Bush Forever Site No. 289 to restrict terrestrial fauna access to the rail corridor and to encourage terrestrial fauna movement towards the openings of the fauna underpasses. Fencing will be maintained by the PTA on an as required basis	

Table 40 Application of mitigation hierarchy for habitat fragmentation and ecological connectivity

Potential impacts	Impact class	Mitigation hierarchy	Proposed mitigation measures	Residual impact
Construction				
Habitat fragmentation and loss of ecological connectivity	Direct	Avoid	Access tracks within Bush Forever Site No. 289 have been planned to accommodate PTA, DBCA and DFES operational requirements thereby eliminating the potential for the duplication of access tracks by the agencies and reducing fauna habitat clearing	East-west ecological linkage will be permanently fragmented by the implementation of Part 2 of the YRE project
		Minimise	• Opportunities to amend the development footprint are limited due to the gazetted MRS "Railways" reservation. PTA has previously considered an alternative alignment with Bush Forever Site No. 289 which was determined to not be feasible • Four fauna underpasses will be located beneath the railway line within Bush Forever Site No. 289 to maintain the east-west ecological linkage and provide for the long-term movement of native fauna. The fauna underpass will be appropriately sized to allow for the movement of larger species of terrestrial fauna, such as western grey kangaroo (*Macropus fuliginosus*) and western brush wallaby (*Macropus irma*), as well as smaller non-avian / ground dwelling fauna species, such as the southern brown bandicoot (*Isoodon obesulus* subsp. *fusciventer*) and reptile species • Appropriate fencing will be installed within Bush Forever Site No. 289 to restrict terrestrial fauna access to the rail corridor and to encourage terrestrial fauna movement towards the openings of the fauna underpasses. Fencing will be maintained by the PTA on an as required basis	
		Rehabilitate	No rehabilitation is anticipated to be required	
	Indirect	Avoid	Access tracks within Bush Forever Site No. 289 have been planned to accommodate PTA, DBCA and DFES operational requirements thereby eliminating the potential for the duplication of access tracks by the agencies and reducing fauna habitat clearing	
		Minimise	• Opportunities to amend the development footprint are limited due to the gazetted MRS "Railways" reservation. PTA has previously considered an alternative alignment with Bush Forever Site No. 289 which was determined to not be feasible • Four fauna underpasses will be located beneath the railway line within Bush Forever Site No. 289 to maintain the east-west ecological linkage and provide for the long-term movement of native fauna. The fauna underpass will be appropriately sized to allow for the movement of larger species of terrestrial fauna, such as western grey kangaroo (*Macropus fuliginosus*) and western brush wallaby (*Macropus irma*), as well as smaller non-avian / ground dwelling fauna species, such as the southern brown bandicoot (*Isoodon obesulus* subsp. *fusciventer*) and reptile species • Appropriate fencing will be installed within Bush Forever Site No. 289 to restrict terrestrial fauna access to the rail corridor and to encourage terrestrial fauna movement towards the openings of the fauna underpasses. Fencing will be maintained by the PTA on an as required basis	
		Rehabilitate	No rehabilitation is anticipated to be required	

12.8 Residual impact management

The permanent loss of up to 56.96 ha of Carnaby's Black Cockatoo foraging habitat and 37 potential breeding trees is at variance with the DEE's EPBC Act referral guidelines for three threatened black cockatoo species (DSEWPaC 2012). It is considered likely that this action would meet the DEE's definition of a 'significant impact' (Department of the Environment 2013) to a Matter of National Environmental Significance (Carnaby's Black Cockatoo). The proposal has been referred to the DEE under EPBC Act.

The east-west ecological linkage within Bush Forever Site No. 289 will be permanently fragmented by the implementation of Part 2 of the YRE project, however four fauna underpasses will be located beneath the railway line to maintain the east-west ecological linkage and provide for the long-term movement of native fauna. Through the provision of fauna underpasses underneath the operational railway line potential impacts from habitat fragmentation and loss of ecological connectivity will be managed to be as low as reasonably practicable.

12.8.1 Offset strategy

To counterbalance the significant residual impacts to Carnaby's Black Cockatoo from the implementation of Part 2 of the YRE project, an appropriate Offset Strategy will be prepared and implemented to the satisfaction of DWER and the Commonwealth DEE (Section 15).

12.8.1.1 PTA's proposed approach

The Offsets Strategy will provide details of the PTA's proposed approach to directly offset the significant residual impacts to Carnaby's Black Cockatoo. This will likely involve the acquisition and/or securing of land that has no existing conservation tenure and transfer to the conservation estate.

PTA may also consider undertaking rehabilitation works in local degraded areas of Carnaby's Black Cockatoo habitat and/or the funding of research or monitoring that will go towards informing the conservation of Carnaby's Black Cockatoo.

The PTA has advanced discussions with the DBCA to inform the preparation of an Offsets Strategy for Part 2 of the YRE project. A number of suitable offset locations have been identified, and these sites are currently being reviewed by the PTA.

12.8.1.2 Additional inclusions

Overlapping offset requirements, for instance direct impacts to native vegetation identified as Banksia Woodlands of the Swan Coastal Plain TEC and Carnaby's Black Cockatoo forging habitat, and previous offsets provided by others, for instance the provision of offsets for significant impacts to Carnaby's Black Cockatoo as part of the Eglinton / South Yanchep Residential Development (EPBC 2011 / 6021) approval (Section 2.5), will also be addressed by the Offset Strategy.

12.9 Predicted outcome

The permanent loss of up to 56.96 ha of Carnaby's Black Cockatoo foraging habitat and 37 potential breeding trees will be appropriately counterbalanced through the preparation and implementation of an appropriate Offsets Strategy.

The proposed mitigation measures identified in Table 39 will ensure that the potential indirect impacts to terrestrial fauna are managed to be as low as reasonably practicable during construction and operation of the railway. Implementation of the proposal will result in the permanent loss of 18.11 ha of native vegetation in "Degraded" or better condition (or Bushland) which will result in the fragmentation of Bush Forever Site No. 289 and create an additional barrier (operational rail corridor) within the east west ecological linkage. The operational rail corridor will also be fenced to restrict terrestrial fauna access to the rail corridor. Through the provision of fauna underpasses beneath the operational railway line potential impacts from habitat fragmentation and loss of ecological connectivity will be managed to be as low as reasonably practicable.

Given the above and PTA's past performance in implementing appropriate mitigation measures as part of the construction and operation of railway projects (as demonstrated in Section 3), it is considered that terrestrial fauna will be appropriately protected so that biological diversity and ecological integrity are maintained to meet the EPA's Terrestrial Fauna objective.

13 Inland waters

13.1 EPA objective

To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.

13.2 Policy and guidance

Environmental Factor Guideline - *Inland Waters* (EPA 2018b)

13.3 Environmental investigation

A targeted hydrological assessment has been undertaken to assess the impacts of the proposed abstraction of groundwater during construction for the YRE project (RPS 2018b; Appendix H), estimated conservatively to be 500 days.

RPS (2018b) assesses:

- potential expected drawdown from YRE project's proposed construction groundwater abstraction bores
- direct, indirect and cumulative impacts of temporarily taking groundwater within the YRE project's development envelope
- potential temporary impact to nearby water bodies
- offset distances for the YRE project's temporary abstraction bores from Water Corporation's existing production bores, its Wellhead Protection Zones and other local groundwater users.

Table 14 provides a brief description of this investigation and identifies the assessment standards used to inform the scope and content of the investigations.

13.4 Receiving environment

13.4.1 Groundwater

The development envelope is located in the Perth Basin, which comprises a regional sedimentary basin up to 12 km thick with several significant aquifers (Advisian 2017). The Water Register (DWER 2018a) identifies that the unconfined Superficial, semi-confined / confined Leederville and confined Yarragadee North aquifers underlie the development envelope.

The key aquifer of interest in relation to the construction activities (i.e. cutting and filling works identified in Advisian 2017) is the unconfined Superficial aquifer which comprised of Safety Bay Sand and Tamala Limestone formations (Advisian 2017). These soil associations are highly transmissive and have a saturated thickness of approximately 20 m to 30 m (Advisian 2017).

The Perth Groundwater Map (DWER 2018b) identifies the depth from ground level to the water table fluctuates with the undulating local topography across the development footprint from approximately 11 m in the south of the development footprint, to around 32 m to the east of Lots 1 and 102 Yanchep Beach Road LSP and approximately 26.0 m in the north of Toreopango Avenue.

The groundwater flows from the Gnangara Mound in a westerly direction towards the coast, where groundwater discharges over a saline wedge (Water Corporation 2007; Advisian 2017).

13.4.1.1 Groundwater quality

The Water Register (DWER 2018a) identifies the following physiochemical information for the groundwater below the development footprint:

- salinity is estimated to vary from approximately 250 - 500 mg/L which is considered to be suitable for garden bores / irrigation
- low risk of iron staining
- no known ASS risk (see discussion in Section 11.6.1).

The Water Register (DWER 2018a) also identifies that the development envelope is entirely contained within the Priority 3 Perth Coastal Underground Water Pollution Control Area. The Priority 3 Perth Coastal Underground Water Pollution Control Area generally extends from Warwick at its southern end to Two Rocks at its northern limit (Figure Z).

13.4.1.1.1 Public drinking water source protection areas

DWER's *Land Use Compatibility Tables for Public Drinking Water Source Areas* (Department of Water [DoW] 2016) identifies that the land uses of "Railway" and "Railway Station" are considered to be "Acceptable" and "Compatible with Conditions" within Priority 3 areas respectively.

13.4.1.1.2 Production bores and wellhead protection zones

There are 39 production bores in the Perth Coastal Underground Water Pollution Control Area, all drawing public drinking water from the Gnangara groundwater system (DoW 2012). The Neerabup borefield (including Quinns Rock and Whitfords bores) draws from the Superficial (25), Leederville (7) and Yarragadee (1) aquifers (DoW 2012). Wellhead protection zones are declared around production bores in public drinking water source areas to protect the groundwater from immediate contamination threats in the nearby area (DoW 2012).

Figure Z shows the location of the existing and proposed Water Corporation production bores in relation to the development envelope, whilst Figure AA shows the local and regional context for the existing and proposed Water Corporation production bores.

13.4.2 Surface water

Recharge is primarily from rainfall infiltration and some run-off from the Gingin Scarp (Advisian 2017). There are no surface water features, such as rivers, creeks, streams or brooks, or wetlands mapped within the development envelope (Figure AA). Figure BB identifies the mapped geomorphic wetlands (Resource Enhancement wetlands and Conservation Category wetlands) in relation to the development envelope at the local and regional scales.

13.5 Potential impacts

Table 41 provides the potential impacts to the Inland Waters factor from construction of the development envelope and operation of the railway.

Table 41 Potential construction and operational impacts to inland waters

Phase	Impact class	Works/operations	Potential impacts
Construction	Direct	• Abstraction of groundwater • Clearing of native vegetation • Cut and fill works • Excavation and construction of roads, buildings and other hard stand areas • Operation of plant machinery and service vehicles • Storage and use of hydrocarbons/ chemicals	• Alteration of the existing landscape within the development envelope which in turn alters the surface water flow paths and recharge locations during rainfall • Contamination of groundwater during construction activities, with potential sources including uncontained spills, refuelling and plant and vehicle fluid leaks
	Indirect	• Groundwater abstraction • Clearing of native vegetation • Cut and fill works • Excavation and construction of roads, buildings and other hard stand areas	• Reduction in groundwater availability for nearby native vegetation • Reduction of groundwater available for nearby abstractors
Operation	Direct	Operation and maintenance of the electrified railway line	Contaminated stormwater runoff from the operational railway and stations may impact groundwater

13.6 Assessment of impacts

13.6.1 Alteration of flow paths

Given the absence of surface water features within the development envelope, the alteration of existing surface water flow paths and recharge locations is considered unlikely to result in significant impacts to the existing local hydrological regimes. Similarly, given the development envelope's distant proximity to surrounding local and regional surface water features (Figure AA), it is considered that the surface water flows to these features would not be altered by the implementation of the proposal.

13.6.2 Groundwater abstraction for construction

The average depth to ground water from the natural ground surface (approximately 23 m) is significantly greater than the average cutting works required for Part 2 of the YRE project (5 m) (Table 11). Therefore modification to the local groundwater aquifers from dewatering has been avoided through the implementation of the proposed construction methodology (i.e. cutting and filling works identified in Advisian [2017]).

Given that dewatering has been avoided, this section assesses the potential impacts from groundwater abstraction for construction purposes only.

13.6.2.1 Hydrological assessment

RPS (2018b) is underpinned by information from the Draft Yanchep YB80 H3 Hydrogeological Assessment (Water Corporation 2015) and is therefore considered to be representative of a regional assessment in the context of this EIA report.

The PTA has outlined five provisional abstraction locations across the YRE project's development envelope, with four bores proposed to be used for temporary construction groundwater abstraction in total. One proposed bore is located within the development envelope, whilst the other three bores are located with the Part 1 development envelope (See Figure 3 in RPS 2018b; Appendix H).

RPS (2018b) provides an assessment of a worst-case temporary groundwater abstraction scenario for the YRE project, with 100% the project's water requirements being abstracted from a single bore and without any rainfall recharge during the abstraction period. Abstraction from multiple bores will result in a reduction in drawdown impacts to the Superficial aquifer; which is the likely scenario during construction of Part 2 of the YRE project.

13.6.2.1.1 Potential impacts to groundwater users

With regard to the development envelope, the potential maximum drawdown at a Water Corporation bore caused by groundwater abstraction from a proposed PTA Bore is anticipated to be approximately 11 cm (drawdown caused by PTA Bore 3b) (RPS 2018b). The maximum drawdown at the closest groundwater draw point is 15 cm for LandCorp (drawdown caused from PTA Bore 1 abstraction) and Peet Alkimos Pty Ltd (drawdown from PTA Bore 2 abstraction) (RPS 2018b).

RPS (2018b) considers the potential impact to surrounding groundwater users from the PTA's proposed abstraction to be low due to the low magnitude of drawdown calculated in the Superficial aquifer, and the highly transmissive nature of the aquifer. At the local and regional scale, RPS (2018b) considers the potential impact to surrounding groundwater users to be low.

RPS (2018b) considers the potential cumulative impacts from the PTA's planned temporary groundwater abstraction to the groundwater availability of other users to be low to very low across local and regional scales.

13.6.2.1.2 Potential impacts to environmental receptors

With regard to the development envelope, the potential maximum drawdown from temporary groundwater abstraction from sensitive environmental receptors in proximity to the development envelope varies between 21 cm locally and 8.8 cm regionally (RPS 2018b). The rate and magnitude of drawdown is small and considered a low risk of impacting on the ecological water requirements of the vegetation within these Bush Forever sites (RPS 2018b).

The risk of impact occurring to all other sites identified by RPS (2018b) at both the local and regional scales is considered low as the maximum magnitude of drawdown and rate of drawdown is <21 cm/year. This is inclusive of drawdown impacts to the nearest wetlands, Lake Wilgarup and Loch McNess, which ranges from 1–2 cm after the 500 day construction period.

RPS (2018b) considers the potential cumulative impacts from the PTA's planned groundwater abstraction to the groundwater availability for sensitive environmental receptors to be low to very low across all the local and regional scales, with regional flows not being impacted.

13.6.3 Potential groundwater contamination

There is a low risk that groundwater could be contaminated during construction and operation activities with potential sources including (but not limited to) uncontained spills, refuelling and plant and vehicle fluid leaks.

The low risk of groundwater contamination will be mitigated through the implementation of the CEMP during construction and through the implementation of the PTA's standard spill response framework for rail corridors during operation (Table 42).

13.6.4 Water sensitive urban design approach

The PTA is committed to implementing best practice WSUD principles in the design of the stormwater management approach for the operational railway and station infrastructure, particularly given the project is located within the Priority 3 Perth Coastal Underground Water Pollution Control Area.

The PTA recognises the following benefits of adopting a WSUD approach to stormwater management:

- Maintain hydrological regimes by maximising infiltration at-source.
- Reduce stormwater runoff volumes and peak flow rates.
- Prevent water quality impacts on groundwater and receiving water bodies.
- Enhance public amenity through implementation of waterwise landscape designs.

The following WSUD strategies will be implemented where feasible on the YRE project:

- Manage the first 15 mm of rainfall at-source as much as practical.
- Minimise the volume of water directed to large drainage basins through maximising infiltration at source within the railway corridor open drains.
- Choose water efficient fixtures and appliances to reduce the use of mains water and water consumption.
- Adopt waterwise landscape design and install water efficient irrigation systems within the station sites.
- Provide for flood protection of critical infrastructure, as the railway must remain operable during major flood events.

During the planning phase of the YRE project, the PTA has consulted with the DWER Urban Water branch and the Water Corporation with regards to the adoption of WSUD and management of impacts to the Priority 3 Perth Coastal Underground Water Pollution Control Area and its associated existing and future wellhead protection zones. This consultation will be ongoing through the construction phase of the YRE project and into operations.

The pathways for adopting WSUD and protecting the Priority 3 Perth Coastal Underground Water Pollution Control Area for the YRE project are:

- Develop detailed drainage designs in consultation with the DWER Urban Water branch and in accordance with the following guidelines:
  - Decision Process for Stormwater Management in Western Australia (DWER 2017)
  - Stormwater Management Manual for Western Australia (Department of Water [DoW] 2004-2007)
  - WSUD brochures published by DWER (available www.dwer.wa.gov.au).
- Incorporate the adoption of WSUD into procurement and contractual documentation.
- Implement the following Water Quality Protection Notes that are of relevance to 'Railway' and 'Railway Station' land uses, as identified in DWER's *Land Use Compatibility Tables for Public Drinking Water Source Areas* (DoW 2016):
  - Contaminant Spills – Emergency Response (DoW 2006a)
  - Roads near Sensitive Water Resources (DoW 2006b)
  - Tanks for Mobile Fuel Storage in Public Drinking Water Source Areas (DoW 2013).

METRONET will also provide design guidance for development of the station precincts. This includes supporting environmentally sustainable urban development and better urban water management practices, together with guidance regarding opportunities to integrate WSUD from the early stages of station precinct design.

13.7 Mitigation

Table 42 demonstrates how the EPA's mitigation hierarchy (avoid, minimise and rehabilitate) has been applied to Inland Waters to address the key potential impacts.

Table 42 Application of mitigation hierarchy to inland waters

Potential impacts	Impact class	Mitigation hierarchy	Proposed mitigation measures	Residual impacts
Construction				
• Alteration of the existing landscape within the development envelope which in turn alters the surface water flow paths and recharge locations during rainfall • Contamination of groundwater during construction activities, with potential sources including uncontained spills, refuelling and plant and vehicle fluid leaks	Direct	Avoid	No surface water features are located with the development envelope	With appropriate management, potential impacts are as low as reasonably practicable
		Minimise	• CEMP will be prepared to address the potential impacts to groundwater quality (potential groundwater contamination) during the construction of Part 2 of the YRE project • Best practice WSUD principles in the design of and stormwater management approach for the YRE railway and station infrastructure will be implemented to maintain the existing local hydrological flows and protect the ground water quality of the Priority 3 Perth Coastal Underground Water Pollution Control Area	
		Rehabilitate	Drainage basins and urban water management features will be appropriately landscaped (where practicable in the context of an operational railway line and associated infrastructure)	
• Reduction in groundwater availability for nearby native vegetation • Reduction of groundwater available for nearby abstractors	Indirect	Avoid	• Development envelope has avoided the Water Corporation's existing Production Bores and the groundwater bores of other users • Dewatering will not be required to facilitate construction	
		Minimise	• Location and anticipated usage of the PTA's proposed abstraction bores has minimised drawdown impacts to Water Corporation's existing Production Bores, other ground water users and sensitive environmental receptors at the local and regional scales • Groundwater abstraction for construction water will be regulated under the *Rights in Water and Irrigation Act 1914*	
		Rehabilitate	No rehabilitation is anticipated to be required	
Operation				
Contaminated stormwater runoff from the operational railway and stations may impact groundwater	Direct	Avoid	Avoidance of trains and service machinery using the operational railway corridor is not a feasible option	With appropriate management, potential impacts are as low as reasonably practicable

13.8 Predicted outcome

Through the implementation of the EPA's mitigation hierarchy (Table 42) the potential impacts to the groundwater underlying Part 2 of the YRE project will be managed to be as low as reasonably practicable.

Given the above and PTA's past performance in implementing appropriate mitigation measures as part of the construction and operation of railway projects (as demonstrated in Section 3) it is considered that the EPA's objective for the Inland Waters will be met.

14 Social surroundings

14.1 EPA objective

To protect social surroundings from significant harm.

14.2 Policy and guidance

14.2.1 Aboriginal heritage and culture

- *Aboriginal Heritage Act 1972*.
- Environmental Factor Guideline: *Social Surroundings* (EPA 2016k).
- PTA's Noongar Standard Heritage Agreement.

14.2.2 Natural and historic heritage

- *Heritage of Western Australia Act 1990*.
- Environmental Factor Guideline: *Social Surroundings* (EPA 2016k).

14.2.3 Noise and vibration

- Environment Protection (Noise) Regulations 1997.
- Environmental Factor Guideline: *Social Surroundings* (EPA 2016k).
- SPP 5.4: Road and Rail Transport Noise and Freight Considerations in Land Use Planning.
- AS 2670.2:1990 Evaluation of human exposure to the whole-body vibration; Part 2: Continuous and shock-induced vibration in buildings (1 to 80 Hz).

14.2.4 Dust

- Environmental Factor Guideline: *Social Surroundings* (EPA 2016k).
- National Environmental Protection (Ambient Air Quality) Measure.
- A Guideline for Managing the Impacts of Dust and Associated Contaminants from Land Development Sites, Contaminated Site Remediation and other Related Activities (DEC 2011).

14.2.5 Bushfire

- *Fire and Emergency Services Act 1998*.
- Environmental Factor Guideline: *Social Surroundings* (EPA 2016k).
- SPP 3.7: Planning in Bushfire Prone Areas.

14.3 Environmental investigations

14.3.1 Aboriginal heritage and culture

The following studies have been undertaken which assess the values associated with aboriginal heritage and culture within the development envelope:

- R. & E. O'Connor Pty Ltd undertook further heritage surveys and Aboriginal consultation for the YRE project in 2017 (R. & E. O'Connor Pty Ltd 2017a and b; Appendix I

- An archaeological survey of the, then, Butler to Yanchep railway alignment was completed by JCHMC in 2013. JCHMC (2013) reported that no sites or isolated artefacts were recorded within the project area of the Butler to Yanchep railway alignment. JCHMC (2013) recommended that no further archaeological research was warranted.
- A desk-top Aboriginal heritage study of the, then, proposed northern suburbs railway route was undertaken by R. & E. O'Connor Pty Ltd in 2012. R. & E. O'Connor Pty Ltd (2012) identified that no aboriginal sites had been recorded within the project area of the northern suburbs railway route alignment.

Table 14 provides a brief description of each of these investigations and identifies the assessment standards used to inform the scope and content of the individual investigations.

14.3.2 Noise and vibration

The following investigations have been undertaken which assess the noise and vibration considerations associated with the YRE project:

- METRONET – Yanchep Rail Extension, Transport Noise and Vibration Assessment (Lloyd George Acoustics 2018b; Appendix J)
- NVMP (Lloyd George Acoustics 2018a; Appendix K)
- Northern Suburbs Railway Extension Butler to Yanchep, Noise Assessment (Herring Storer Acoustics 2012a)
- Northern Rail Extension Romeo Road to Yanchep, Ground Vibration Assessment (Herring Storer Acoustics 2012b).

Table 14 provides a brief description of each of these investigations and identifies the assessment standards used to inform the scope and content of the individual investigations.

14.4 Receiving environment

14.4.1 Aboriginal heritage and culture

The DPLH's *Aboriginal Heritage Inquiry System* identified that no Registered Heritage Sites or additional Other Heritage Places are located within the development envelope (Figure CC). Figure DD shows the DPLH *Aboriginal Heritage Inquiry System* database mapping for surrounding lands within 1 km of the development envelope and at the regional scale.

Western Australian Government land users, such as the PTA, are required to enter into and follow the Noongar Standard Heritage Agreement in the South West Native Title Settlement Area. As part of implementing the agreement, further aboriginal heritage surveys and consultation was undertaken by R. & E. O'Connor Pty Ltd in 2017 for the YRE project.

14.4.1.1 Aboriginal heritage surveys

R. & E. O'Connor Pty Ltd (2017a) confirmed that the development footprint did not impact any areas of Aboriginal significance.

An additional Aboriginal Heritage Survey was undertaken of the station sites and ancillary facilities (R. & E. O'Connor Pty Ltd 2017b). R. & E. O'Connor Pty Ltd (2017b) confirmed that the station sites and ancillary facilities did not impact any areas constituting an Aboriginal site. The Whadjuk representatives approved the additional areas assessed by R. & E. O'Connor Pty Ltd (2017b) subject to monitors to be onsite for clearance and initial groundworks.

14.4.2 Natural and historic heritage

The State Heritage Office's *inHerit* database identified that no heritage places listed on the State Register of Heritage Places are located within the development envelope (Figure EE). Further, no landholdings contained on the CoW's Scheme Heritage List are located within the development envelope.

Figure FF shows the State Heritage Office's *inHerit* database mapping for surrounding lands within 1 km of the development envelope (local scale) and also at the regional scale.

14.4.3 Noise and vibration

A noise and vibration assessment was undertaken by Lloyd George Acoustics for the YRE project to assess the potential noise and vibration emissions received from trains travelling on the railway line (Lloyd George Acoustics 2017b).

14.4.3.1 Noise

Under SPP 5.4, transport infrastructure providers should design mitigation measures to achieve the noise limit of $L_{Aeq(Day)}$ of 60 Decibel (dB) at ground floor level. The Lloyd George Acoustics (2018a) reports the results of the $L_{Aeq(Day)}$ noise predictions to the ground floor of representative receiver locations, together with a comparison against the Policy target criterion. The following are the key results of the modelling at 60 locations:

- Target criterion (55 dB) for Predicted Noise Level $L_{Aeq(Day)}$ dB are exceeded at 18 locations.
- Limit criterion (60 dB) for Predicted Noise Level $L_{Aeq(Day)}$ dB are exceeded at 11 locations.
- Target criterion (55 dB) for Predicted Max Level dB are exceeded at eight locations.
- Limit criterion (60 dB) for Predicted Noise Level $L_{Aeq(Day)}$ dB are exceeded at six locations.

The receiver locations have been chosen to represent the changing conditions along the railway alignment. Modelling results are shown in Figures 4-1 to 4-5 in Lloyd George Acoustics (2018a).

14.4.3.2 Vibration criteria

For the existing railway south of Butler Station, the ground-borne vibration criteria resulting from the train pass-bys was given in the Ministerial Statement 623. The Ministerial Conditions required that the proponent meet specific vibration criteria with reference to the *Australian Standard AS 2670.2-1990: Evaluation of human exposure to whole body vibration - Part 2: Continuous and shock induced vibration in buildings (1 to 80 Hz)*. This Standard characterises sources (of vibration) which operate intermittently, but which would produce continuous vibration if operated continuously, such as railway trains. The preferred method of assessing the influence of continuous vibrations is to determine the root mean square (RMS) value of the weighted particle acceleration. In terms of vibrational energy, both particle acceleration and velocity are identical.

The criteria in the Ministerial Statement 623 were as follows:

- Criterion 1: vibration isolation measures will be provided where the predicted or actual vibration is Curve 2 (106 dB) or greater, as defined in AS 2670.2.
- Criterion 2: the proposal will be designed to meet Curve 1.4 (103 dB), as defined in AS 2670.2.
- Criterion 3: Vibration will be managed to be as low as reasonably practicable.

The vibration assessment was based on measured vibration levels adjacent to the Northern Suburbs Railway undertaken by Herring Storer Acoustics. The assessment considered the profile of the track (straight, bend) and distance from the track to the sensitive receptor (Lloyd George Acoustics 2018b).

The attenuation of vibration levels occurs with distance from the source and the damping properties of the ground material (Lloyd George Acoustics 2018b). Based on the measured vibration levels, the distances required to achieve the criterion of Curve 1.4 in Australian Standard 2670.2-1990 “Evaluation of human exposure to whole-body vibration; Part 2: Continuous and shock-induced vibration in buildings (1 to 80 Hz)” are:

- near station - 50 m
- inside bend - 55 m
- outside bend - 40 m
- straight track - 40 m.

The results of the vibration predictions to representative receiver locations, together with a comparison against the target criterion of Curve 1.4 (103 dB_V (re 1E-6 mm/s)) of AS2670.2-1990, apply to both continuous and intermittent vibration. Only existing buildings or those where the development is completed or under construction have been included. The results of the modelling presented in Lloyd George Acoustics (2018a) report show target criterion for Predicted Vibration Level dB_V (re 1E-6 mm/s) are exceeded at 10 locations.

14.4.4 Dust

Dust can arise from a range of natural and man-made sources causing various acute and chronic health effects, as well as nuisance and visibility impacts (DEC 2011).

In the case of the YRE project, wind-borne dust may arise from:

- exposed surfaces such as cleared land
- sand stockpiles
- construction activities
- crushing activities
- vehicle movements.

The composition of dust particles will depend on the nature of the source material (DEC 2011). Dust generated from the construction of Part 2 of the YRE project will reflect the composition of the sands and limestone which underlie the development footprint.

14.4.5 Bushfire

The WAPC released SPP 3.7 to reduce the risk of bushfire to people, property and infrastructure. SPP 3.7 defines a bushfire-prone area as an area that has been designated by the Fire and Emergency Services Commissioner under Section 18 of the *Fire and Emergency Services Act 1998* (as amended) as an area that is subject, or likely to be subject, to bushfires.

A search of the DFES *Map of Bushfire Prone Areas* identified that Part 2 of the YRE project is entirely mapped as a Bushfire Prone Area (Figure GG). Figure HH shows the Department of Fire and Emergency Services *Map of Bushfire Prone Areas* mapping for surrounding lands within 1 km of the development envelope and at the regional scale.

14.5 Potential impacts

Table 43 provides the potential direct and indirect impacts relevant to the Social Surroundings considerations from construction of the development envelope and operation of the railway line.

Table 43 Potential construction and operational impacts to social surroundings

Phase	Impact class	Works/operations	Potential impacts
Aboriginal heritage and culture			
Construction	Direct	• Clearing of native vegetation • Cut and fill works • Excavation and construction of roads, buildings and other hard stand areas • Operation of plant machinery and service vehicles	Excavation/construction activities may unearth and/or damage artefacts or other items of Aboriginal cultural significance
Natural and historic heritage			
Construction	Indirect	• Excavation and construction of roads, buildings and other hard stand areas • Operation of plant machinery and service vehicles	• Temporary exposure of visitors to State heritage sites located within close proximity to the development envelope (i.e. Yanchep National Park) to construction-related noise • Introduction and distribution of weed species to Yanchep National Park from plant machinery and service vehicles movements • Introduction and distribution of *Phytophthora* dieback to Yanchep National Park from plant machinery and service vehicles movements
Noise and vibration			
Construction	Direct	• Clearing of native vegetation • Cut and fill works • Excavation and construction of roads, buildings and other hard stand areas • Operation of plant machinery and service vehicles	Temporary exposure of site workers and existing and future residents to the construction-related noise and vibration
Operation	Direct	Operation and maintenance of the electrified railway line	Ongoing exposure of existing and future residents to the railway-related noise and vibration

Phase	Impact class	Works/operations	Potential impacts
Dust			
Construction	Direct	• Clearing of native vegetation • Cut and fill works • Excavation and construction of roads, buildings and other hard stand areas • Crushing of limestone and stockpiling	• Existing residences located adjacent to or in close proximity of the development envelope may be exposed to elevated dust levels • Dust may accumulate on adjacent native vegetation, where it settles on leaves and restricts physiological function
	Indirect	• Operation of plant machinery and service vehicles	Dust may be generated by the crushing of excavated limestone
Bushfire			
Construction	Direct	• Clearing of native vegetation • Cut and fill works • Excavation and construction of roads, buildings and other hard stand areas • Operation of plant machinery and service vehicles	• Damage to infrastructure from fire • Death and/or injury of people/fauna due to fire
Operation	Direct	Operation and maintenance of the electrified railway line	

14.6 Assessment of impacts

14.6.1 Aboriginal heritage and culture

No areas of Aboriginal heritage or cultural significance were identified within the development envelope. There is a low risk that Aboriginal artefacts or other items of Aboriginal cultural significance could be unearthed during construction activities. During clearance and initial groundworks at the Yanchep station site, Monitors will be onsite for to assist with the identification and management of any Aboriginal objects identified or unearthed during construction (Table 44). Should any Aboriginal objects be identified or unearthed then construction will be stopped and the findings will be reported to the DPLH (Table 44).

Table 44 identifies the avoidance measures that have been undertaken by the PTA, as part of the detailed design of Part 2 of the YRE project to reduce the direct impacts to Aboriginal heritage and culture during project construction. Informed by the above mentioned minimisation and rehabilitation measures as well as those proposed in Table 44, it is considered that the potential direct impacts will be managed to be as low as reasonably practicable and in accordance with the EPA's environmental factor for social surroundings.

14.6.2 Natural and historic heritage

No heritage places listed on the State Register of Heritage Places or the CoW's Scheme Heritage List are mapped within the development envelope (Figure EE). Figure FF shows that a State Heritage Place (Yanchep National Park) is located in close proximity the development envelope. There is a low risk that plant machinery and service vehicles movements may result in the introduction or distribution of weed species and/or *Phytophthora* dieback to Yanchep National Park.

Table 44 identifies the avoidance measures that have been undertaken by the PTA, as part of the detailed design of Part 2 of the YRE project to reduce the indirect impacts to during project construction to natural and historic heritage. Through the implementation of the CEMP it is anticipated that the risk of indirect impacts to the Yanchep Nation Park will be reduced to be as low as reasonably practicable (Table 44) and in accordance with the EPA's environmental factor for social surroundings.

14.6.3 Noise and vibration

14.6.3.1 Construction noise and vibration

Noise and vibration will be generated during construction of Part 2 of the YRE project which may act as a nuisance to residents occupying dwellings located adjacent to or in close proximity of the development envelope (Lloyd George Acoustics 2018b).

Through the implementation of the CEMP it is anticipated that the risk of construction noise and vibration impacts to sensitive receptors located adjacent to or in close proximity of the development envelope will be reduced to be as low as reasonably practicable (Table 44) and in accordance with the EPA's environmental factor for social surroundings.

14.6.3.2 Operational noise and vibration

14.6.3.2.1 Noise

The results of the noise assessment showed that the SPP 5.4 noise target was exceeded at a number of receiver locations, and consequently noise walls are required to be incorporated into the design of the railway to achieve this criterion, where practicable (Lloyd George Acoustics 2018a).

The recommended noise walls are presented in Figures 2-5 to 2-7 of Lloyd George Acoustics (2018a). While these noise walls have been designed to achieve the SPP 5.4 noise target (wherever practicable), they do not take into consideration other mitigation measures, such as house facade protection, which are permitted under SPP 5.4 (Lloyd George Acoustics 2018a). For example, where urban development includes the

requirement for facade protection on certain lots, higher external noise levels are permitted and therefore a reduction in the height of the noise wall, or the elimination of the wall, would be considered acceptable (Lloyd George Acoustics 2018a).

Table 44 identifies the mitigation measures that have been undertaken by the PTA as part of the detailed design of Part 2 of the YRE project to reduce the direct impacts during railway operation to surrounding residences from nuisance noise. Through the implementation of the NVMP (Lloyd George Acoustics 2018a) it is anticipated that the risk of direct impacts to the sensitive environmental receptors from operational railway noise will be reduced to be as low as reasonably practicable (Table 44) and in accordance with the EPA's environmental factor for social surroundings.

14.6.3.2.2 Vibration

The results of the vibration assessment show the criterion of 103 dBV is predicted to be marginally exceeded at a number of locations along the railway alignment (Lloyd George Acoustics 2018a). While vibration criteria for above ground railways are generally set to address annoyance (i.e. Curve 1.4 AS2670.2-1990), the ground conditions south of Butler Station resulted in a number of properties experiencing structure-borne regenerated noise issues (rumbling) as trains passed by (Lloyd George Acoustics 2018a). As a result of this, the PTA has committed to installing ballast matting adjacent to all existing and approved future residential developments (Lloyd George Acoustics 2018a). A reduction of between 10 to 15 dBV can be expected which will significantly reduce vibration levels to well below the vibration criterion (Lloyd George Acoustics 2018a).

Table 44 identifies the mitigation measures that have been undertaken by the PTA, as part of the detailed design of Part 2 of the YRE project to reduce the direct impacts to during railway operation to surrounding residences from vibration. Through the implementation of the NVMP (Lloyd George Acoustics 2018a) it is anticipated that the risk of direct impacts to the sensitive environmental receptors from operational railway vibration will be reduced to be as low as reasonably practicable (Table 44) and in accordance with the EPA's environmental factor for social surroundings.

14.6.4 Dust

Dust will be generated during construction of Part 2 of the YRE project, which may act as a nuisance to residents occupying dwellings located adjacent to or in close proximity of the development envelope. Acknowledging the majority of the land directly adjacent to the development envelope is comprised of native vegetation, with only a small portion of the adjacent land being developed, the potential for dust to act as a nuisance to residents is considered to be low. Through the implementation of the CEMP it is anticipated that the risk of nuisance dust impacting nearby residents will be reduced to be as low as reasonably practicable (Table 44).

Dust could potentially impact the physiology (i.e. reducing photosynthesis and transpiration rates) of adjacent native vegetation should significant accumulation on the leaves of individual plants be experienced. The potential for dust to significantly impact adjacent native vegetation is considered to be low. Through the implementation of the CEMP it is anticipated that the risk of significant accumulation of dust on adjacent vegetation will be reduced to be as low as reasonably practicable (Table 44) and in accordance with the EPA's environmental factor for social surroundings.

14.6.4.1 Potential prescribed premises

The PTA is investigating numerous beneficial re-use opportunities for the excess limestone in close proximity to the development footprint to minimise the dust, and greenhouse gas emissions, generated by the transportation of the excess materials.

If significant limestone deposits are required to be crushed onsite, this activity may meet the definition of a 'prescribed premises' and be regulated through the Environmental Protection Regulations 1987. Schedule 1 of the Environmental Protection Regulations 1987 identifies that premises on which more than 5, 000 tonnes per year of material is extracted from the ground is screened, washed, crushed, ground, milled, sized or separated are a prescribed premises (Category No. 70).

If it is anticipated that the YRE project will meet the definition of a prescribed premises for the crushing of limestone a licence will be obtained from DWER. Should the YRE project not meet the definition of a prescribed premises for the crushing of limestone, however still be required to crush limestone, a project-specific limestone crushing protocol will be developed and implemented to ensure that the risk to surrounding residences and vegetation is reduced to be as low as reasonably practicable (Table 44) and in accordance with the EPA's environmental factor for social surroundings.

14.6.5 Bushfire

The PTA's Bushfire Management Strategy (PTA 2017c; Appendix L) outlines its approach to bushfire risk reduction across PTA owned, managed or leased land. The Bushfire Management Strategy applies to all activities and operations undertaken by the PTA and its contractors and subcontractors on PTA land (including construction, maintenance and operational activities). These activities and operations comprise those with the potential to cause bushfire and those implemented for the purpose of mitigating bushfire risk (PTA 2017c).

Implementation of the Bushfire Management Strategy will ensure that the PTA's following strategic actions are addressed:

1. Provide input as required into bushfire risk assessments undertaken by local governments and fire authorities.
2. Implement strategies for fuel reduction on PTA land, taking into account conservation, infrastructure, cultural and other surrounding land values.
3. Contribute to long-term bushfire mitigation strategies in conjunction with local governments and other land managers in areas where bushfire risk has been identified as an issue of concern.
4. Implement bushfire preparedness actions to address the threat of bushfire, including:
    a. Ensuring controlled access to PTA land, including maintenance of access tracks and assistance with access for responding agencies.
    b. Having in place safe operating procedures for high risk activities.
    c. Designing asset protection zones on a specific risk and site basis.
    d. Adhering to the fire emergency response procedures within the PTA's Emergency Management Manual.
    e. Land management practices including maintenance of signage and fencing and removing dumped rubbish.
5. Contribute to bushfire hazard reduction on PTA land through in-kind donations, the funding of fuel reduction activities (such as weed control, but excluding prescribed burning) and provide any necessary assistance with regard to rail safety to allow access to PTA land.
6. Liaise with key stakeholders to ensure that up to date data are used to identify Aboriginal heritage and vegetation conservation values within PTA land and ensure bushfire hazard reduction activities take into consideration areas of high conservation value and Aboriginal sites.

The PTA's experience in managing bush fire risk to prevent damage to infrastructure from fire and death and/or injury of people/fauna due to fire in respect to operational railway corridors is demonstrated through the successful operation of the SWMR, Butler Extension and Perth Stadium Transport Corridor projects. Through the implementation of the PTA's Bushfire Management Strategy the risk to infrastructure and people / fauna associated with Part 2 operational railway corridor is considered to be as low as reasonably practicable (Table 44) and in accordance with the EPA's environmental factor for social surroundings.

14.7 Mitigation

Table 44 demonstrates how the EPA's mitigation hierarchy (avoid, minimise and rehabilitate) has been applied to the environmental factor of Social Surroundings to address the key potential impacts.

Table 44 Application of mitigation hierarchy to social surroundings

Potential impacts	Impact class	Mitigation hierarchy	Proposed mitigation measures	Residual impacts
Aboriginal Heritage and Culture				
Excavation/construction activities may unearth and/or damage artefacts or other items of Aboriginal cultural significance	Direct	Avoid	No areas of Aboriginal heritage or cultural significance were identified within the development envelope	With appropriate management, potential impacts are as low as reasonably practicable
		Minimise	• Construction and access areas have been selected to coincide with proposed future urban development cells or roads either reserved by the MRS, or as detailed within approved and draft LSPs, to reduce the likelihood of impacting Registered Aboriginal Heritage sites proposed to be retained within future POS reservations • Aboriginal monitors will be onsite for clearance and initial groundworks at the Yanchep station site to assist with the identification and management of any Aboriginal objects identified or unearthed during construction • Should any Aboriginal objects be identified or unearthed then construction will be stopped and the findings will be reported to the DPLH	
		Rehabilitate	No rehabilitation is anticipated to be required	
Natural and Historic Heritage				
• Temporary exposure of visitors to State heritage sites located within close proximity to the development envelope (i.e. Yanchep National Park) to construction-related noise • Introduction and distribution of weed species to Yanchep National Park from plant machinery and service vehicles movements • Introduction and distribution of *Phytophthora* dieback to Yanchep National Park from plant machinery and service vehicles movements	Indirect	Avoid	No heritage places listed on the State Register of Heritage Places or the CoW's Scheme Heritage List are mapped within the development envelope	With appropriate management, potential impacts are as low as reasonably practicable
		Minimise	CEMP will be prepared to address weeds and *Phytophthora* dieback and noise during the construction of Part 2 of the YRE project	
		Rehabilitate	No rehabilitation is anticipated to be required	

Potential impacts	Impact class	Mitigation hierarchy	Proposed mitigation measures	Residual impacts
Noise and Vibration				
Construction				
• Temporary exposure of site workers to the construction-related noise and vibration • Temporary exposure of existing and future residents to the construction-related noise and vibration	Direct	Avoid	Avoidance of construction activities is not a feasible option	With appropriate management, potential impacts are as low as reasonably practicable
		Minimise	CEMP will be prepared to address noise during the construction of Part 2 of the YRE project	
		Rehabilitate	No rehabilitation is anticipated to be required	
Operation				
Ongoing exposure of existing and future residents to the railway-related noise and vibration	Direct	Avoid	Avoidance of trains and service machinery using the operational railway corridor is not a feasible option	With appropriate management, potential impacts are as low as reasonably practicable
		Minimise	• To reduce noise impacts on existing and future adjacent residents, the new railway line will be constructed in a cutting that is approximately 5m below existing and/or future surrounding ground levels, except through Bush Forever Site No. 289 • Noise attenuation barriers (noise walls) will be designed and constructed during the construction phase, as outlined in the NVMP (Lloyd George Acoustics 2018b) • NVMP (Lloyd George Acoustics 2018a) has been prepared to address the potential noise and vibration impacts during the operation of the railway line • Ballast matting will be installed below the rail where adjacent to existing and future residential developments to reduce vibration impacts (lesson learnt from the extension of the Joondalup line to Butler)	
		Rehabilitate	No rehabilitation is anticipated to be required	
Dust				
• Existing residences located adjacent to or in close proximity of the development envelope	Direct	Avoid	Avoidance of construction activities is not a feasible option	With appropriate management,
		Minimise	CEMP will be prepared to address the potential dust impacts during the construction of	

Potential impacts	Impact class	Mitigation hierarchy	Proposed mitigation measures	Residual impacts
may be exposed to elevated dust levels • Dust may accumulate on adjacent native vegetation, where it settles on leaves and restricts physiological function			Part 2 of the YRE project	potential impacts are as low as reasonably practicable
		Rehabilitate	No rehabilitation is anticipated to be required	
Dust may be generated by the crushing of excavated limestone	Indirect	Avoid	Avoidance of crushing activities (if required) is not a desirable option	
		Minimise	• If significant limestone deposits are required to be crushed onsite, this activity may meet the definition of a 'prescribed premises' and be regulated through the Environmental Protection Regulations 1987 • Project-specific limestone crushing protocol will be developed and implemented should the YRE project be required to crush limestone onsite, however not meet the definition of a 'prescribed premises'	
		Rehabilitate	No rehabilitation is anticipated to be required	
Bushfire				
• Damage to infrastructure from fire • Death and/or injury of people/fauna due to fire	Direct and Indirect	Avoid	Avoidance of trains and service machinery using the operational railway corridor is not a feasible option	With appropriate management, potential impacts are as low as reasonably practicable
		Minimise	The PTA's Bushfire Management Strategy provides the bushfire management framework that will be implemented during the construction and operation of the YRE project	
		Rehabilitate	No rehabilitation is anticipated to be required	

14.8 Predicted outcome

Through the implementation of the EPA's mitigation hierarchy (Table 44) the potential impacts to Aboriginal heritage and culture, natural and historic heritage, noise and vibration, dust and bushfire have been / will be managed to be as low as reasonably practicable.

Given the above and PTA's past performance in implementing appropriate mitigation measures as part of the construction and operation of railway projects (as demonstrated in Section 3) it is considered that social surroundings will be protected from significant harm so that EPA's Social Surroundings objective is met.

15 Offsets

The WA Environmental Offsets Guidelines (EPA 2014) identify that where a proposal has already been assessed under the EPBC Act and offsets have been applied, the State will consider these offsets as contributing to the State requirements. However, MNES that are considered by the Commonwealth government are only a subset of the matters that the State government considers. The State may require offsets to other environmental values which are not relevant to the EPBC Act.

This EIA report has identified the following significant residual impacts to the environmental factors of Flora and Vegetation and Terrestrial Fauna from the implementation of Part 2 of the YRE project:

- permanent loss of up to 0.05 ha *Melaleuca huegelii – M. acerosa* [*M. systena*] shrublands on limestone ridges TEC 26a in "Very Good" condition
- permanent loss of up to 12.10 ha of Banksia Woodlands of the Swan Coastal Plain TEC
- permanent loss of up to 18.11 ha of Bushland within Bush Forever Site No. 289. This includes 12.38 ha of Bushland reserved as "Parks and Recreation"
- permanent loss of up to 56.96 ha of Carnaby's Black Cockatoo foraging habitat and 37 potential breeding trees. This includes 3.98 ha of Carnaby's Black Cockatoo foraging habitat which was previously approved to be cleared under the EPBC Act as part of the Eglinton / South Yanchep Residential Development (EPBC 2011 / 6021) approval; and 0.14 ha which was included within an offset area.

To counterbalance these residual environmental impacts an appropriate Offset Strategy will be prepared and implemented to the satisfaction of DWER and the Commonwealth DEE.

15.1 PTA's proposed approach

The Offsets Strategy will provide details of the PTA's proposed approach to directly offset the significant residual impacts to TECs, Bushland within Bush Forever Site No. 289 and Carnaby's Black Cockatoo. This will likely involve either the acquisition and/or securing of land that has no existing conservation tenure and transfer to the conservation estate and undertaking of rehabilitation works in local degraded areas.

PTA may also consider the funding of research or monitoring that will go towards informing the conservation of the TECs and/or Bush Forever Site No. 289 and/or Carnaby's Black Cockatoo particularly if a sufficient area is not able to be acquired or rehabilitated.

The PTA has advanced discussions with the DBCA to inform the preparation of an Offsets Strategy for Part 2 of the YRE project. A number of suitable offset locations have been identified, and these sites are currently being reviewed by the PTA.

15.1.1 Additional inclusions

Overlapping offset requirements, for instance direct impacts to native vegetation identified as Banksia Woodlands of the Swan Coastal Plain TEC and Carnaby's Black Cockatoo foraging habitat, and previous offsets provided by others, for instance the provision of offsets for significant impacts to Carnaby's Black Cockatoo as part of the Eglinton / South Yanchep Residential Development (EPBC 2011 / 6021) approval, will also be addressed by the Offset Strategy.

16 Matters of national environmental significance

MNES identified within the development envelope are:

- Banksia Woodlands of the Swan Coastal Plain TEC
- Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*).

These MNES are both listed as Endangered under the EPBC Act.

16.1 Banksia woodlands of the Swan coastal plain TEC

The implementation of the proposal will result in the permanent loss of up to 12.10 ha of the Banksia Woodlands of the Swan Coastal Plain TEC.

This residual impact is at variance with the DEE's Draft Banksia Woodlands of the Swan Coastal Plain Ecological Community – Guidance for Referrals under the EPBC Act (DEE 2017a). It is considered likely that this action would meet the DEE's definition of a 'significant impact' (Department of the Environment 2013) to a Matter of National Environmental Significance (Banksia Woodlands of the Swan Coastal Plain TEC).

The proposal has been referred to the DEE under the EPBC Act. The PTA has requested that an accredited assessment under both the EP and EPBC Acts is undertaken (Section 2.5.2).

16.2 Carnaby's Black-Cockatoo

The implementation of the proposal will result in the permanent loss of up to 56.96 ha of Carnaby's Black Cockatoo foraging habitat and 37 potential breeding trees. Approximately 31.2 ha (or 54.80%) of the Carnaby's Black Cockatoo foraging habitat was determined to be high value foraging habitat, 21.42 ha (or 37.62 %) was determined to be medium value foraging habitat and 4.31 ha (or 7.57%) was determined to be low value foraging habitat.

The extent of Carnaby's Black Cockatoo impacted by the development envelope includes 4.07 ha of Carnaby's Black Cockatoo foraging habitat that has been previously assessed under the EPBC Act as part of the Eglinton / South Yanchep Residential Development (EPBC 2011 / 6021) approval. Of the 4.07 ha, an approximate 0.14 ha has been included within an offset area for the Eglinton / South Yanchep Residential Development (EPBC 2011 / 6021) approval, whilst 3.93 ha was approved to be cleared (Section 15; Figure D).

The permanent loss of up to 56.96 ha of Carnaby's Black Cockatoo foraging habitat and 37 potential breeding trees is at variance with the DEE's EPBC Act referral guidelines for three threatened black cockatoo species (DSEWPaC 2012). It is considered likely that this action would meet the DEE's definition of a 'significant impact' (Department of the Environment 2013) to a Matter of National Environmental Significance (Carnaby's Black Cockatoo).

The proposal has been referred to the DEE under EPBC Act. The PTA has requested that an accredited assessment under both the EP and EPBC Acts is undertaken (Section 2.5.2).

16.3 Assessment approach

The loss of up to 12.10 ha of the Banksia Woodlands of the Swan Coastal Plain TEC, 56.96 ha of Carnaby's Black Cockatoo foraging habitat and 37 potential breeding trees has been proposed to be counterbalanced by the PTA as part of the preparation and implementation of an appropriate Offset Strategy (Section 15).

The implementation of the PTA's proposed mitigation actions for the environmental factors of Flora and Vegetation (Table 28 and Table 29) and Terrestrial Fauna (Table 39 and Table 40) will provide complimentary actions to address potential impacts to the Banksia Woodlands of the Swan Coastal Plain TEC and Carnaby's Black Cockatoo during the construction and operation of the railway line.

17 Holistic impact assessment

Table 2 provides a high level summary of the potential impacts, assessment of the potential impacts, proposed mitigation measures and predicted outcomes after the application of the EPA's mitigation hierarchy(avoid, minimise, rehabilitate) for the environmental factors of specific relevance to Part 2 of the YRE project:

- land factors
  - flora and vegetation
  - landforms
  - subterranean fauna
  - terrestrial environmental quality
  - terrestrial fauna
- water factors
  - inland waters
- people factor
  - social surroundings.

This EIA report demonstrates that the potential environmental impacts from the implementation of Part 2 of the YRE project are relatively minor when considered in local, regional and bioregional receiving environmental contexts and can be managed to meet the EPA's relevant environmental factor objectives.

Through the application of the EPA's mitigation hierarchy (avoid, minimise, rehabilitate) to manage the potential environmental impacts, the risk of significant residual impacts to the environmental factors from the implementation of Part 2 of the YRE project has been reduced to be as low as reasonably practicable.

The risk of significant residual impacts to the identified key environmental factors of Flora and Vegetation and Terrestrial Fauna will be counterbalanced through the provision of an appropriate Offset Strategy (Section 15).

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